Center of Excellence for
Commercial Space Transportation

Federal Aviation Administration
Center of Excellence for
Commercial Space Transportation

Year 6 Annual Report

Volume 1

December 31, 2016

www.coe-cst.org

COE CST YEAR 6 ANNUAL REPORT – VOLUME 1

This report is produced by the FAA Office of Commercial Space Transportation (AST) in fulfillment of FAA Centers of Excellence program requirements. Volume 1 Year Six begins Phase 2 of the FAA Center of Excellence for Commercial Space Transportation. Volume 1 makes available the total funding provided from all sources and the cost share, both cash and in-kind. The report covers 12 months.

The full report is broken into an Executive Summary and three volumes:

- The Executive Summary provides an overview of the FAA AST, the FAA COE program and the COE CST. A brief description of the member universities precedes a series of "quad charts," one for each Task conducted by the COE CST during the sixth year of operation. The document ends with a listing of the year six students, supporting organizations, and technical publications.
- Volume 1 gives a description of the FAA COE CST, its research, structure, member universities, funding and research tasks.
- Volume 2 is a comprehensive set of research presentation charts presented at the Sixth Annual Technical Meeting in October 2016.
- Volume 3 is a comprehensive set of notes from all FAA COE CST teleconferences and face-to-face meetings.

Any questions or comments about the content of this report should be directed to Mr. Ken Davidian, FAA Program Manager for the Center of Excellence for Commercial Space Transportation, or Dr. Patricia Watts, FAA COE Program Director.

Table of Contents

1.0 FAA COE Program Overview

The FAA Center of Excellence (COE) program was established by the Omnibus Budget Reconciliation Act of 1990, Public Law 101-508, Title IX, Aviation Safety and Capacity Expansion Act.

COEs are intended to be a 10-year partnership of academia, industry, and government to create a world-class consortium that will address current and future challenges for commercial space transportation. The three main goals of every COE include research, training, and outreach.

A unique attribute of the COE program is the one-to-one matching requirement for every federal dollar granted to a COE university. The matching requirement can be satisfied through direct or in-kind contributions from any non-federal funding source, including industries, universities, or state and local government organizations.

Eight other COEs have been established by the FAA that pre-date the COE CST, including:

- The Joint Center for Computational Modeling of Aircraft Structures, 1992 to 1996.
- The Center of Excellence for Airport Technology (CEAT), established 1995.
- The National COE for Aviation Operations Research (NEXTOR), operated from 1996 to 2007.
- The Airworthy Assurance COE (AACE) operated from 1997 to 2007.
- The COE for General Aviation Research (CGAR), in operation from 2001 to 2013.
- The Partnership for Aircraft Noise & Aviation Emissions Mitigation Research (PARTNER), in operation from 2003 to 2013.
- The Joint Center for Advanced Materials (JAMS), in operation from 2003 to 2015.
- The Airliner Cabin Environment Research (ACER) Center, also called the COE for Research in the Intermodal Transport Environment (RITE), in operation from 2004 to 2014.

Since the creation of the COE CST in August 2010 and as of December 2015, four new COEs have been created. They are:

- The Center of Excellence for General Aviation Safety Research (named PEGASAS, Partnership to Enhance General Aviation Safety, Accessibility and Sustainability), established in 2012.
- The Center of Excellence for Alternative Jet Fuels and Environment (ASCENT) established in 2013.
- The Center of Excellence for Unmanned Aircraft Systems (UAS) established in 2015.
- The Center of Excellence for Technical Training and Human Performance (TTHP) established in 2016.

2.0 COE CST Overview

2.1 History

On August 18, 2009, FAA Administrator Randy Babbitt signed a document creating the COE CST with the goal of helping the Office of Commercial Space Transportation (AST) execute its dual mission through a dedicated university research program. The COE CST is a partnership of academia, industry, and government established to create a world-class consortium addressing current and future challenges impacting commercial space transportation. This announcement represented a ten-year minimum annual funding commitment of one million dollars.

The FAA released a draft solicitation for the COE CST on December 15, 2009 and held two public meetings in February 2010 before issuing the final solicitation in March.

As stated in Public Law 101-508, institutions being considered for selection as a COE are required to demonstrate in their proposal the ability to meet the following criteria:

- The extent to which the needs of the State in which the applicant is located are representative of the needs of the region for improved air transportation services and facilities.
- The demonstrated research and extension resources are available to the applicant to carry out this section.
- The ability of the applicant to provide leadership in making national and regional contributions to the solution of both long-range and immediate air transportation problems.
- The extent to which the applicant has an established air transportation program.
- The demonstrated ability of the applicant to disseminate results of air transportation research and educational programs through a statewide or regionwide continuing education program.
- The projects the applicant proposes to carry out under the grant.

The FAA released the final COE CST solicitation on March 15, 2010. Final proposals were due on April 30.

The proposals were reviewed and evaluated on a competitive basis by a panel of subject matter experts and management officials in accordance with the solicitation. Each proposal was evaluated to determine the extent to which institutions, team members, and affiliates were able to provide a quality environment for commercial space transportation research and to determine the extent to which each proposal met the selection criteria established by Congress.

Following the evaluations, a final report was provided to the FAA Administrator on August 5, 2010. On Wednesday, August 18, the FAA announced the establishment of the COE CST and cooperative agreements were executed with the nine-member universities in September 2010. Subsequently, the FAA distributed two million dollars to conduct the initial set of research tasks within the newly created center.

The next two sections of this report give brief descriptions of the COE CST member universities and describe the four research areas they are pursuing.

2.2 Year 6 Highlights

The following are the major milestones for the FAA COE CST during its sixth year:

- Sixth Annual Administrative Meeting held on the campus of the University of Texas Medical Branch in Galveston, Texas on March 29-30, 2016.
- Sixth Annual Technical Meeting held at Las Cruses, NM on October 11, 2016 in conjunction with the ISPCS held on October 12 – 13, 2016.
- The New Space Journal completed its fourth year of quarterly publications, featuring topics such as Privatizing Space Missions: The Critical Route to Boost Indian Space Economy, Outer Frontiers of Banking: Financing Space Explorers and Safeguarding Terrestrial Finance, Do “Commercial” Space Companies Exist?, The Next Wave of Internet: Global Connectivity, FAA Safety Approvals in Commercial Space Transportation, Capability and Cost-Effectiveness of Launch Vehicles, Comparing the Relative Risk of Spaceflight to Terrestrial Modes of Transportation and Adventure Sport Activities, The Elephant in the New Space Room: Risk Identification, Management, and Mitigation, A Quantitative Framework for Defining “How Safe is Safe Enough?” in Crewed Spacecraft, Space Travel: Risk, Ethics, and Governance in Commercial Human Spaceflight, Is It Time for Commercial Weather Satellites?, Is It Time for Commercial Weather Satellites? Analyzing the Case of Global Navigation Satellite System Radio Occultation, Laser Propulsion Market-Creating Innovation, What Do We Do with the Moon?, A Summary of the Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture That Leverages Commercial Space Capabilities and Public–Private Partnerships, U.S. Government Funding of Major Space Goals: A Historical Perspective, Site Selection for Lunar Industrialization, Economic Development, and Settlement, and numerous other urgent and important topics.
- Numerous awards, promotions, national and international videos, publications, and presentations were made. These are highlighted in subject areas below.

In the sixth year of COE CST operation, there were 22 ongoing from the previous year, 5 tasks on hold, 1 task completed, and 6 affiliate member tasks. The complete list of all tasks is provided.

COE CST Year-by-Year Metrics	Year 1 (FY10)	Year 2 (FY11-12)	Year 3 (FY13)	Year 4 (FY14)	Year 5 (FY15)	Year 6 (FY16)
Active Tasks	34	24	28	28	36	22
Unfunded Tasks	34	22	22	11	6	5
Principal Investigators	27	28	29	25	31	22
Students	31	37	55	47	61	28
Publications	0	38	28	22	29	19
Research Partners	-	17	20	27	27	11
Industry Partners	-	29	44	55	57	11
Affiliate Members	0	1	6	6	6	6
Associate Members	-	-	-	3	6	3
Funding Profile	$2M	$2.4M	$1.1M	$1.1M	$1M	$1M
Administrative Overhead	13.6%	20.0%	9.9%	27.0%	19.7%	16.4%

COE CST STUDENTS, PARTNERS, AND PUBLICATIONS

In the sixth year of operation, the COE CST benefited from the services of 28 students, 11research partners, and 11 industry partners. The combined effort resulted in 19 technical or programmatic papers published in journals or presented at conferences. A complete list of students, partners (both industry and research organization) and publications are given after the research task summary charts in this report.

A new row has been added to the metrics this year to show the percentage of total FAA funding that has been dedicated to the administrative costs of operating the COE CST. Accounting for funding provided over all seven fiscal years, the average annual administrative cost is just less than 15%. On the basis of six operating years, the average is under 18%. The variation seen from one fiscal year to the next results from paying for administrative costs of more than one operating year from the allocation of a single fiscal year (e.g., paying for three bi-annual meetings from a single fiscal year's budget, instead of two).

2.3 Member and Affiliate Universities

The prime nine COE CST member universities are: Florida Institute of Technology (FIT, or Florida Tech), Florida State University (FSU), New Mexico Institute of Mining and Technology, (NMT, or New Mexico Tech), New Mexico State University (NMSU), Stanford University (SU), University of Central Florida (UCF), University of Colorado at Boulder (CU), University of Florida (UF) and University of Texas Medical Branch at Galveston (UTMB)

The COE CST member universities provide a comprehensive distribution of geographical coverage representing the entire Commercial Space Transportation industry, including the top four civil space states (California, Colorado, Texas and Florida) and New Mexico, the state leading the suborbital industry as well as having a significant level of military space activity. The nine universities bring over 50 other government, industry and academic organizations as research partners.

As a single entity, the nine COE CST member universities unite complementary strengths for the benefit of the overall COE and the FAA. Each team member provides highly respected and consummate experiences that directly address the research and education needs of the commercial space industry.

In 2012, McGill University of Montréal, Canada, joined the COE CST as the first Affiliate University. The remainder of this section provides detail on each of the nine member universities and other affiliate and associate organizations.

Florida Institute of Technology (Florida Tech or FIT)

Florida Tech (FIT) offers broad expertise in aerospace and space-related engineering, science, space traffic management and launch operations, vehicle and payload analysis and design, thermal systems and propulsion.

Florida State University (FSU)

FSU brings a range expertise and unique infrastructure and unparalleled testing facilities in many areas relevant to the COE CST. These include but are not limited to cryogenics, thermal management, vehicle aerodynamics and controls, sensors, actuators, system health monitoring and high-performance simulations including multi-physics mechanics and flow surface interactions. We have substantial expertise in simulating, experimentally and numerically, the Vehicle Launch Environment and the associated challenges in aeroacoustics aero-structures.

New Mexico Institute of Mining and Technology (NMT)

NMT is a science, math and engineering university with a focus on applied research. Major research facilities include a rocket engine test fixture at the Energetic Materials Research and Testing Center and a 2.4M fast tracking telescope at the Magdalena Ridge Observatory dedicated to the study of near-earth objects.

New Mexico State University (NMSU)

NMSU and its Physical Sciences Laboratory have led space and aerospace research in areas of suborbital investigations from the time of Robert Goddard and Werner Von Braun to the current era of commercial sub-orbital space transportation with Spaceport America and its operators, Virgin Galactic, SpaceX and UP Aerospace. New Mexico Space Grant Consortium, the 21st Century Aerospace Space Group and related aerospace research focuses on annual access to space for student and faculty experiments, unmanned aerial vehicles, and cube-satellite development.

Stanford University (SU)

SU brings a 50-year history of aerospace research excellence and a broad scope of expertise to the COE CST, including the optimization and autonomous operation of complex systems, strategic research planning, organizational integration and distributed administration experience.

University of Central Florida (UCF)

UCF, as partners of Florida Center for Advanced Aero-Propulsion (FCAAP) and the Center for Advanced Turbines & Energy Research (CATER), offers its experience and expertise in thermal protection system, propulsion system components, cryogenic systems and materials, composites, sensors and actuators, and guidance and control.

University of Colorado at Boulder (CU)

CU offers the COE CST their experience in spacecraft life support systems and habitat design, spaceflight risk assessment, human factors engineering analysis, payload experiment integration, and expertise in space environment and orbital mechanics.

University of Florida (UF)

UF has been performing aeronautical and aerospace research since 1941, with current emphasis in the Department of Mechanical and Aerospace Engineering on research in space systems, MEMS, computational sciences, structural dynamics, controls, gas dynamics, and propulsion.

University of Texas Medical Branch at Galveston (UTMB)

UTMB has a long history of medical support and human spaceflight physiological research with NASA. This is complemented by more recent involvement in the commercial orbital and suborbital spaceflight industry supporting space flight participant visits to the ISS and preparation of passengers and crew for suborbital space flights.

COE CST AFFILIATE MEMBERS

Embry-Riddle Aeronautical University (ERAU)

Embry-Riddle Aeronautical University (ERAU) team focuses on the demonstration, verification, and validation of the AST funded, and ERAU developed ADS-B prototype (UAT Beacon Radio – ERAU model) for the reusable sub-orbital space vehicles for the first year.

Map of COE CST Member and Affiliate University Geographic Distribution

McGill University (MU)

McGill University's Institute of Air and Space Law (IASL) offers the most comprehensive and advanced graduate level space law program in the world covering General Principles of Space Law, Law of Space Applications and Government Regulation of Space Activities.

Satellite Communications Systems (SatWest)

Satellite Communications Systems focuses on test of Satellite Communications Systems on-board Suborbital Platforms to provide low-cost data communications for Research Payloads, Payload Operators, and Space Vehicle Operators, and government agencies such as the FAA and NASA. The satellite systems to be tested include, but are not limited to, Iridium, Globalstar, and Inmost.

COE CST ASSOCIATE MEMBERS AND PRIMARY PARTNERS

Baylor College of Medicine Center for Space Medicine (CSM)

Baylor College of Medicine Center for Space Medicine (CSM) is a collaborative enterprise involving Baylor College of Medicine, the National Space Biomedical Research Institute, NASA, Rice University, Texas Medical Center institutions, and other academic, industry and government organizations nationally and internationally. The affiliation with UTMB and the COE CST offers UTMB researchers the ability to work side-by-side CSM faculty and students in collaboration with NSBRI, NASA, and other colleagues. Most recently, this included UTMB residents working with CSM faculty Dr. Jon Clark, providing medical support and research for the RedBull Stratos project, resulting in many publications and presentations.

National Aerospace Training and Research (NASTAR) Center

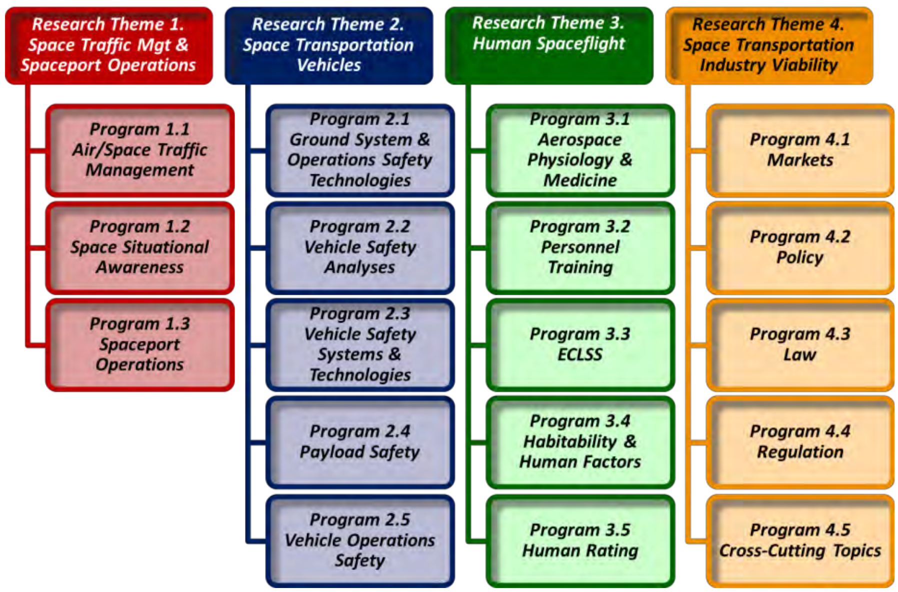
The National AeroSpace Training and Research (NASTAR) Center is partnering with UTMB and the FAA COE CST to participate as an industrial affiliate in an advisory board capacity and also as a research partner providing cost sharing support. It offers a strong foundation in flight training and research to improve the health and safety of passengers in the extreme aviation and space environments. Most recently, NASTAR donated time and use of its centrifuge for a COE CST sponsored novel study on G-tolerance of subjects with chronic diseases.

2.4 Research Structure

The research conducted within FAA AST focues on four major research themes:

- Space Traffic Management & Spaceport Operations
- Space Transportation Vehicles
- Human Spaceflight
- Space Transportation Industry Viability

Each of these major research themes is divided into programs, and these are further divided into projects and tasks.



Space Traffic Management and Spaceport Operations

The goal of this research area is "Improved Space Traffic Management", to effectively answer topics related to the development and optimization of technical and regulatory provisions and the processes used to oversee, coordinate, regulate, and promote safe and responsible space activities between space and Earth (including access to, operations in and return from space to Earth) to avoid physical and/or electromagnetic interference.

It also includes the operational and safety-related design criteria of spaceports, launch and reentry vehicles, and resident space objects, air and space traffic integration, space situational awareness (currently not within AST authority, but listed for the sake of completeness), ground support operations, and other issues which may impact the safe operation of launch, reentry, or on-orbit operations.

Space Transportation Vehicles

The goal of this research area is "Improved Vehicle Safety and Risk Management" including knowledge of all safety-critical components and systems of the space vehicles and their operations, to better identify potential hazards and to better identify, apply and verify hazard controls.

This research area encompasses all the engineering, operations, management and safety areas of study related to expendable and reusable launch vehicles, their systems and payloads.

Specific discipline areas of research include but are not limited to ground systems and operations safety technologies, vehicle safety analyses, vehicle safety systems and technologies, payload safety, and vehicle operations safety.

Human Spaceflight

The goal of this research area is "Ensured Human Safety" of those onboard during space vehicle or spaceport operations.

This research area provides opportunities for research in the areas of aerospace physiology & medicine, personnel training, environmental control and life support systems (ECLSS), habitability and human factors, and human rating of commercial spacecraft.

Research in these areas provides critical information needed to allow the ordinary citizen, i.e., that person without the benefit of the physical, physiological and psychological training and exposure to the space environment that the traditional astronaut has, to travel to space safely, to withstand the extremes of the space environment and to readjust normally after returning to Earth.

Space Transportation Industry Viability

The goal of this research area is "Increased Industry Viability" including economic, legal, legislative, regulatory, and market analysis and modeling.

This research area encompasses all the subcategories of space transportation, including market, policy, international, legal, regulatory and all cross-cutting topics.

Research in these areas includes but is not limited to a focus on developing innovative and practical commercial uses of space, innovative business and marketing strategies for companies involved in commercial launch operations and related components and services, support of the US commercial space transportation industry's international perspective and competitiveness, and developing innovative financing for commercial launch activities.

Specific COE CST research tasks are defined, evaluated and supported on an ongoing basis throughout the life of the COE CST. Descriptions for current research tasks can be found on the COE CST website (**www.coe-cst.org**).

Program Management

While not a research area, Program Management has been added as a focus area. Financial Management of COE CST includes

- Ensuring COE CST fiscal compliance with Federal Research Grant management regulations
- Working with FAA Budget Office, COE PMO, AST TMs, and COE CST PIs to provide funds to universities, and maintain and upgrade funding status and relevant provisions of existing amendments
- Advise AST CE and COE PM on relevant pending actions

2.5 Research Personnel and Partners

This section provides lists of the COE CST principal investigators, students, research partners and industry partners that were active during year six operation. Student demographics are also given. A list of conference papers and journal articles presented or published during COE CST Year 6 is provided.

Year 6 Principal Investigators

The COE CST principal investigators (PIs) and the Tasks for which they are responsible are given in the table below.

PI	Organization	Task
Alson, Juan	Stanford University	185, 193, 258, 259, 286, 332
Alvi, Farrukh	Florida State University	241, 244, 283, 297
An, Linan	University of Central Florida	253
Axelrad, Penina	University of Colorado at Boulder	244
Benjamin, Scott	Florida Institute of Technology	305
Born, George	University of Colorado at Boulder	193, 257
Boy, Guy	Florida Institute of Technology	333
Castleberry, Tarah	University of Texas, Medical Branch	255, 294, 308, 309, 310
Close, Sigrid	Stanford University	186, 244
Collins, Emmanuel	Florida State University	244
Durrance, Sam	Florida Institute of Technology	247, 282
Fiedler, Tristan	Florida Institute of Technology	296, 300, 301, 302, 304
Fitz-Coy, Norm	University of Florida	244, 288
Forbes, Jeff	Stanford University	186
Fuller-Rowell, Tim	University of Colorado at Boulder	186
Gou, Jihua	University of Central Florida	253
Hanrahan, Pat	Stanford University	259
Hubbard, Scott	Stanford University	193, 244, 258, 259, 286
Hynes, Pat	New Mexico State University	220, 284, 298, 306, 307
Jennings, Richard	University of Texas, Medical Branch	183
Kapat, Jay	University of Central Florida	253, 287
Kirk, Dan	Florida Institute of Technology	247, 282
Klaus, David	University of Colorado at Boulder	184, 187, 193, 257, 281, 320
Kochenderfer, Mykel	Stanford University	331
Kumar, Rajan	Florida State University	325
Lim, Seokbin (Bin)	New Mexico Tech	299
Miller, Keith	New Mexico Tech	293
Oates, William	Florida State University	241
Ostergren, Warren	New Mexico Tech	228, 293, 299, 303
Ryan, Eileen	New Mexico Tech	329
Rock, Steve	Stanford University	244

Ryu, Dongheon	**New Mexico Tech**	**293**
Scheeres, Daniel	**University of Colorado at Boulder**	**187, 193**
Sheplak, Mark	**University of Florida**	**241**
Vanderploeg, James	**University of Texas, Medical Branch**	**181, 182, 183, 255, 256, 289, 294, 295, 308, 309, 310, 330**
Vasu, Subith	**University of Central Florida**	**311**
Villaire, Nathaniel	**Florida Institute of Technology**	**247**
Zagrai, Andrei	**New Mexico Tech**	**228, 293, 299, 303, 323, 329**

Year 6 Students

COE university members should track all students assigned to COE projects, their major areas of study, thesis or dissertation topics, and report the intended graduation dates. ***To the extent reasonably possible: university members will report initial job placement*** as this information becomes available; each member university shall ***endeavor to maintain contact information on graduates funded to work on COE projects with the purpose of building an alumni network list***. This information, when available, must be provided to the FAA COE PMO with the COE annual report and in the final project reports.

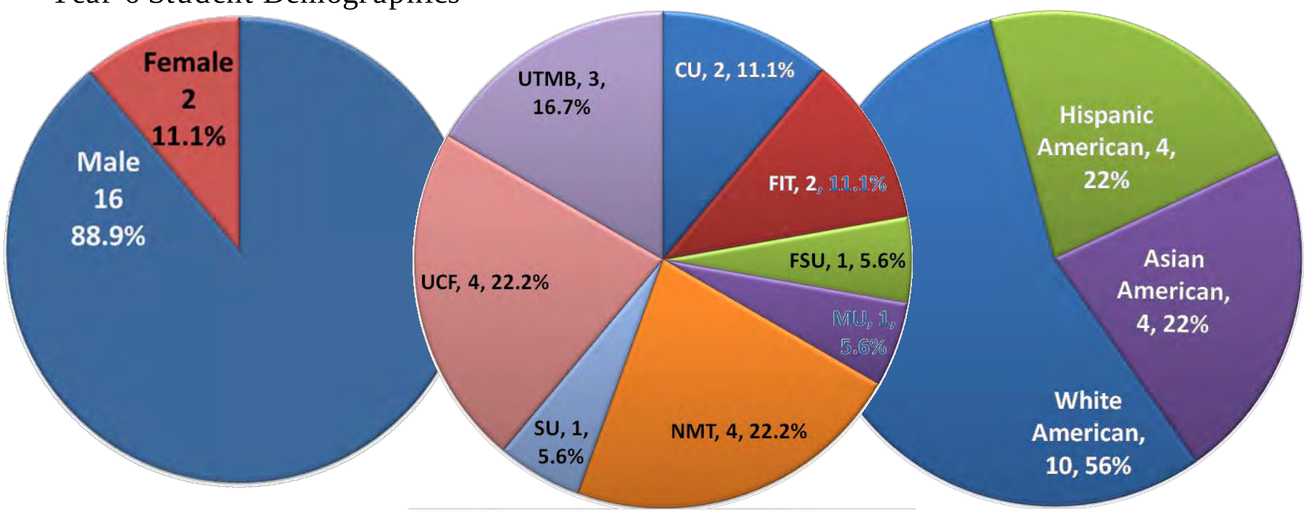
The following is a list and demographic information of the 18 COE CST students working on research tasks during the sixth year of operation.

- Anderson, Mary (323-NMT)
- Carroll, Josh (299-NMT)
- Colvin, Thomas (331-SU)
- Finnegan, Mackenzie (322-SIM)
- Flores, Meliton (299-NMT)
- Garcia, Antonio (299-NMT)
- Harris, Chris (253-UCF)
- Hernandez-Juarez-Madera, Diana (186-SU)
- Joslyn, Nick (322-SIM)
- Kerkonian, Aram (304-MU)
- Kiss, De Vere (333-FIT)
- Mehta, Yash (333-FIT)
- Negrea, Catalin (186-CU)
- Ocampo, Robert, (320-CU)
- Parupalli, Akshita (311-UCF)
- Pavela, James (308, 310-UTMB)
- Rodriguez-Jimenez, Wilfredo (308, 310-UTMB)
- Shirer, Jacob (329-NMT)
- Smith, Kristina (322-SIM)
- Suresh, Rahul (308, 309-UTMB)

- Sweeney, Steven (299-NMT)
- Thurmond, Kyle (311-UCF)
- Trujillo, Blaine (323-NMT)
- Urso, Justin (311-UCF)
- Vemula, Rohit (325-FSU)
- Villar, Michael (311-UCF)
- Woerner, Peter (241-FSU)
- Yang Hongjiang (253-UCF)

Abbreviations: CU-University of Colorado Boulder, ERAU-Embry Riddle Aeronautical University, FIT-Florida Tech, FSU-Florida State University, MU-McGill University, NMSU-New Mexico State University, NMT-New Mexico Tech, SU-Stanford University, UCF-University of Central Florida, UF-University of Florida, UTMB-University of Texas Medical Branch at Galveston

Year 6 Student Demographics



COE CST Year 6 Research and Industry Partners

The following is a list of the 11 COE CST research and industry organization partners that have contributed to the year 6 COE CST research tasks.

- Aerospace Engineering Sciences, UC Boulder
- Center for Advanced Turbomachinery and Energy
- Research (CATER), UCF
- Environmental Modeling Center, Camp Springs, MD
- FAA Technical Center
- Florida Center for Advanced Aero-Propulsion
- Oak Ridge National Laboratory
- Montclair State University
- NASA Marshall Space Flight Center
- NOAA Space Weather Prediction Center
- St. Peter's University

- University of Western Ontario

The following is a list of the 11 COE CST industry partners that have contributed to the year 6 COE CST
research tasks.

- Advanced Space
- Blue Origin
- Lockheed-Martin
- National AeroSpace Training and Research
- Center (NASTAR)
- Secure World Foundation
- Sierra Nevada Corporation Space Systems
- Solstar Communications
- Space Florida
- SpaceX
- United Launch Alliance
- Virgin Galactic

2.6 Year 6 COE CST Publications

The following is a list of the 19 publications and presentations completed during COE CST Year 6.

186-SU *Space Environment Modeling and Prediction,* Li,A., & Close, S. (2016).
Neutral density estimation derived from meteoroid measurements using highpower, large-aperture radar. Journal of Geophysical Research: Atmospheres, 121(13), 8023–8037.
241-FSU *High Temperature, Optical Sapphire Pressure Sensors,* Singh, H. B., Oates, W. S., Kumar, R., Mills, D. A., & Sheplak, M. (2016).
Experimental investigation of laser machining of sapphire for high temperature pressure transducers. Woerner, P., Blood, D., Mills, D. A., Sheplak, M., & Oates, W. S. (2016).
Modeling development and Bayesian uncertainty analysis of laser ablation in sapphire. Woerner, P. (2016).
Ultrafast laser machining of dielectrics: A sharp interface model. Woerner, P., Oates, W. S., Sheplak, M., Blood, D., & Mills, D. A. (2016).
Laser ablation of dielectrics for development of high temperature sapphire Based pressure transducers.
253-UCF *Ultra High Temperature Composites,* Cai, Y. Z., Chen, L. Q., Yang, H. Y., Gou, J., Cheng, L. F., Yin, X. W., & Yin, H. F. (2016).
Mechanical and electrical properties of carbon nanotube buckypaper reinforced silicon carbide nanocomposites. Ceramics International, 42, 4984–4992.
Liu, Z., Gao, Y. B., Liang, F., Wu, B. X., Gou, J., Detrois, M., … Wang, X. W. (2016).
Fabrication of carbon nanotube - chromium carbide composite through laser sintering. Lasers in Manufacturing and Materials Processing, 3.
Skovron, J., Zhuge, J., Gou, J., & Gordon, A. (2016).
Effect of nanopaper coating on flexural properties of a fire-treated glass fiber-reinforced polyester composite. Journal of Composite Materials. http://doi.org/10.1177/002199831663
308-UTMB *Suborbital Space Flight ParticipantAnxiety Assessment,* Mulcahy, R. A., Blue, R. S., Vardiman, J. L., Castleberry, T. L., & Vanderploeg, J. M. (2016).
Screening and mitigation of layperson anxiety in aerospace environments. Aerospace Medical Human Performance, 87(10), 1–8.
310-UTMB *Increasing Cabin Survivability in Commercial Spacecraft* Garbino, A., Nusbaum, D. M., Buckland, D. M., Menon, A. S., Clark, J. B., & Antonsen, E. L. (2016).
Emergency medical considerations in a space-suited patient. Aerospace Medical Human Performance.
Menon, A. S., Jourdan, D., Nusbaum, D. M., Garbino, A., Buckland, D. M., Norton, S., … Antonsen, E. L.

(2016). Crew recovery and contingency planning for a manned stratospheric balloon flight – the StratEx program, 1–8.
311-UCF *Robust and Low-Cost LED Absorption Sensor* Thurmond, K., Loparo, Z., Partridge, W. P. J., & Vasu, S. S. (2016).
A light-emitting-diode (LED) based absorption sensor for simultaneous detection of carbon monoxide and carbon dioxide. Applied Spectroscopy, 70(6), 962–971.
320-CU *Commercial Spaceflight Risk Assessment and Communication* Ocampo, R. P. (2016).
Defining, characterizing, and establishing "safe enough" risk thresholds for human space flight. PhD Dissertation, University of Colorado, Boulder. Ocampo, R. P., & Klaus, D. M. (2016).
A quantitative framework for defining "how safe is safe enough?" in crewed spacecraft. New Space, 4(2), 75–82. http://doi.org/10.1089/space.2015.0040 Ocampo, R. P., & Klaus, D. M. (2016).
Comparing the Relative Risk of Spaceflight to Terrestrial Modes of Transportation and Adventure Sport Activities. New Space, 4(3), 190–197. JOUR. http://doi.org/10.1089/space.2016.0012
323-NMT *Structural Health Monitoring Framework* Anderson, M., Daniel J. D, Zagrai, A. N., & Westphal, J. D. (2016). Electro-mechanical impedance measurements in an imitated low Earth orbit radiation environment. In Proceedings of the ASME 2016 International Mechanical Engineering Congress and Exposition. Phoenix, AZ.
325-FSU *Optical Measurements of Rocket Nozzle Thrust and Noise* Kumar, R. (2016). Measurement of rocket nozzle thrust and noise using optical methods.
MITRE *Safety of Launch and Reentry Ops in the NAS,* Tao, Z., Wang, G., Williams, A. G., Semanek, J. L., & Schwartz, J. L. (2016).
Assessing factors that affect the safety of space launch and re-entry operations in the national airspace system. Tao, Z., Wilde, P. D., Schwartz, J. L., Semanek, J. L., Wang, G., & Williams, A. G. (2016).
Exploring necessary altitude awareness and response times for air traffic control during space launch and reentry operations. Wang, G., Tao, Z., Masek, T., & Schwartz, J. L. (2016). A Monte Carlo simulation tool for evaluating space launch and re-entry operations.

COE CST Year 6 Presentations

The following is a list of the 14 presentations completed during COE CST Year 6.
186-SU *Space Environment Modeling and Prediction,* A. Li and S. Close, "Mean density estimation derived from satellite constellations", American Geophysical Union conference, December 2015.
253-UCF *Ultra High Temperature Composites,* M. Mohagheghi, H. Zawati, T. Pinol. J. Gou, C. Yu, J. Kapat, "Use of 1-D Finite Enthalpy Method for a High-Temperature Recuperator Made of Polymer Derived Ceramic Composite for a Supercritical Carbon Dioxide Power System,"
Proceedings of 5th International. C. Harris, J. Kapat, J. Gou, "Ultra-High Temperature Thermal Protection Systems," 5th Annual Technical Meeting of FAA COE CST, Arlington, VA, October 26-28, 2015.
304-MU *Legal Issues of Cross-Border Sub-Orbital Flights* Manfred Lachs Moot Court Competition (North American Regional Round, World Finals).
307-SSC *Commercial Satellite Communications for Spacecraft* "Texts to Space" documentary Published on Aug 31, 2016 on YouTube, https://www.youtube.com/watch?v=RwQsYKPfYo8.
308-UTMB *Suborbital Space Flight Participant Anxiety Assessment* Mulcahy RA, Blue RS, Vardiman J, Castleberry T, Vanderploeg J. Screening and Mitigation of Anxiety in Unique Environments. Presented at the Aerospace Medical Association Annual Scientific Meeting, Atlantic City, NJ, May 2016.
311-UCF *Robust and Low-Cost LED Absorption Sensor,* K. Thurmond, J. Urso, M. Villar, W.P. Partridge Jr., S.S. Vasu, "A Light-Emitting-Diode (LED) Non-Dispersive Absorption Sensor for Early Fire and Hazardous Gases Detection", presented at the ESS/CI Spring Technical Meeting, Princeton, NJ, 3/2016, paper #1.
M. Villar, J. Urso, W.P. Partridge Jr., J. Kapat, S. S. Vasu, "Progress in Development and Testing of a LED-Based Fire and Hazard Detection Sensor for Space Vehicles", National Space & Missile Materials Symposium (NSMMS) Commercial and Government Responsive Access to Space Technology Exchange (CRASTE).
J. Urso, M. Villar, K. Thurmond, Z. Loparo, W.P. Partridge Jr., J. Kapat, S. S. Vasu, "Robust Sensors for Spacecraft Fire Detection", Center of Excellence for Commercial Space Transportation Annual Technical Meeting (ATM 5), Washington, D.C., 10/2015.
320-CU *Commercial Spaceflight Risk Assessment and Communication,* NSBRI Workshop on Piloting Spacecraft: Guidance and Control of Human Vehicles, 'Functional Integration of humans in piloted spacecraft', Houston, TX, Sept 2016.
Rocky Mountain Chapter of the American Vacuum Society (RMCAVS) Annual Symposium - Space: The Final Vacuum Frontier (invited) 'Protecting Human Life in the Vacuum of Space: Challenges and Solutions', Westminster, CO, Sept. 2016.

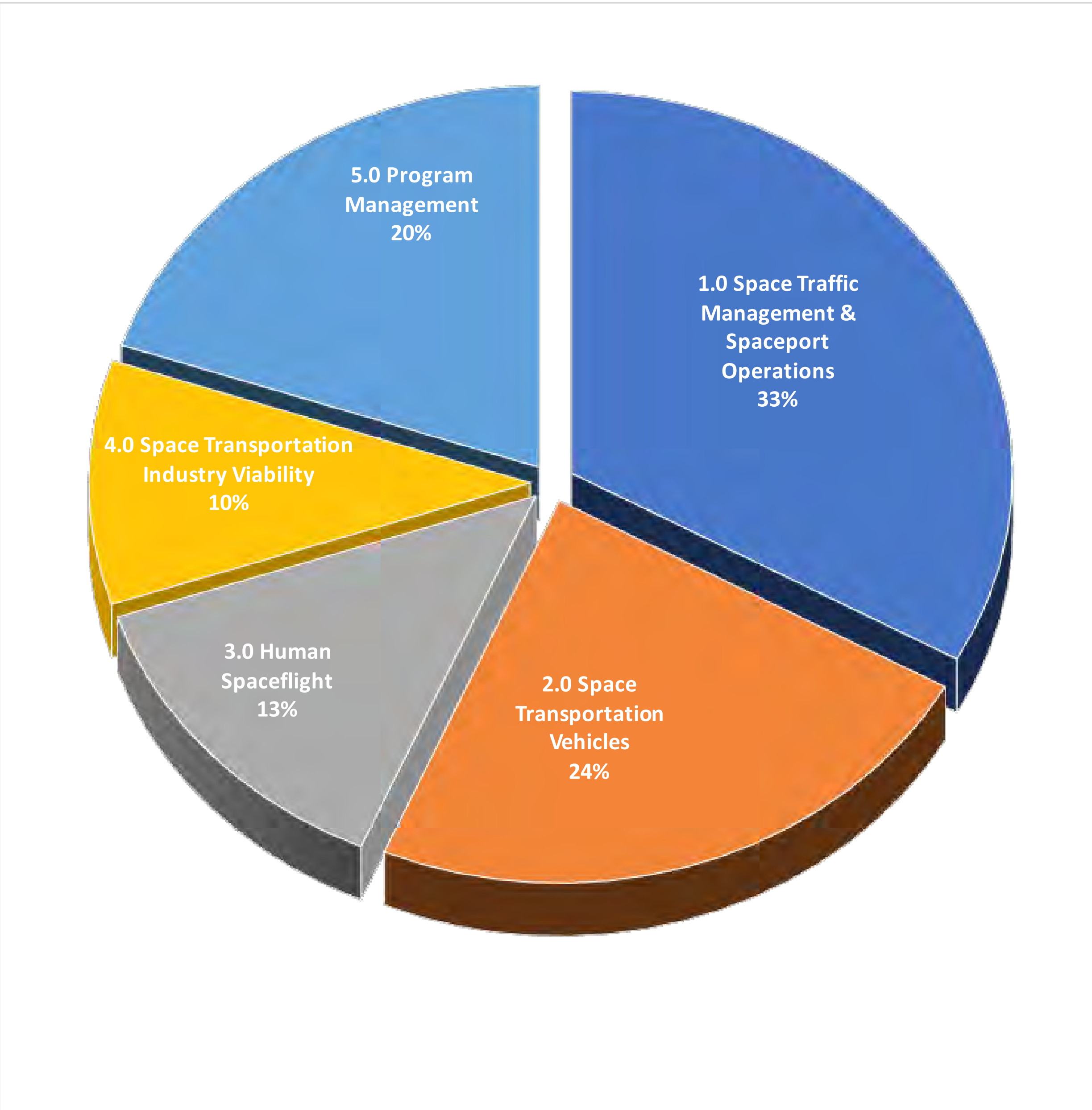
323-NMT *Structural Health Monitoring Framework* Zagrai, A., Anderson, M., Daniel, J.D., Henneke, D., and Westpfahl, D.J. (2016)
"Investigation of radiation effects on smart structures forcommercial space vehicles," invited presentation at Institute of Nuclear Materials Management(INMM) student meeting, University of New Mexico, October 21, 2016.
Zagrai, A., and Demidovich, N. (2016)
"Structural health monitoring potential of commercial space vehicles," invited talk at Commercial and Government Responsive Access to Space Technology Exchange (CRASTE), June 20-23, 2016, Westminster, Colorado. Zagrai, A., Trujillo, B. and Demidovich, N. (2016)
"Acoustic emission during thermal fatigue of aluminum alloy," presentation at Commercial and Government Responsive Access to Space Technology Exchange (CRASTE), June 20-23, 2016, Westminster, Colorado.
Anderson, M., Zagrai, A., Daniel, J.D. (2016)
"Potential use of piezoelectric sensors for structural health monitoring in radioactive environments", presentation for the workshop organized by Institute of Nuclear Materials Management Technical Exchange, Taos, New Mexico, May 19, 2016.
MITRE *Safety of Launch and Reentry Operations in the National Air Space* Air Traffic Controllers Association Annual Conference and Exposition, Nov 2015.
Commercial and Government Responsive Access to Space Technology Exchange, Jun 2016

3.0 COE CST Funding Overview

3.1 Funding By Program

The total funding to date (FY10-15) is $7,857,879.48. The division of funds among the research programs and administrative costs is shown in the figure below.

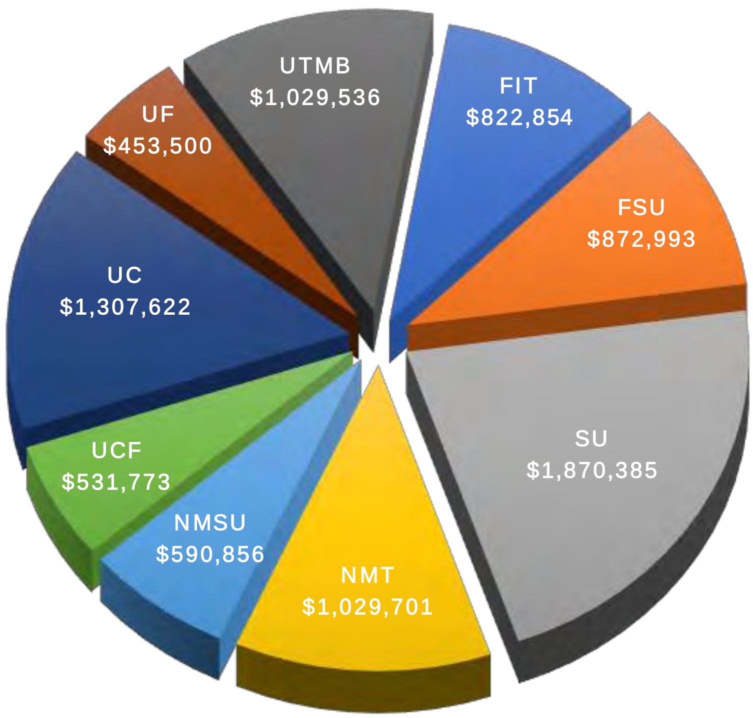
FAA COE CST Cumulative (FY10-16) Distribution of Funds among Research Programs



3.2 Funding By University

The FAA funding by University over the first five years of operation is shown below: *Freddie, we reporting for 12 months, but your thoughts on showing YTD?*

FAA COE CST Cumulative (FY10-16) Distribution of Funds among Member Universities



3.3 Funding by Task

The total funding for each COE CST over the six-year life of the center is shown below. The table below shows total funding for all tasks that were active at the end of calendar year 2016.

Total COE CST Funding (FY10-16) for All Active Tasks

ID / Org	Title	Funded
186-SU	Mitigate Threats through Space Environment Modeling/Prediction-SU	$247,003.52
186-UC	Mitigate Threats through Space Environment Modeling/Prediction-CU	$161,500.00
187-UC	Space Situational Awareness Improvements	$345,975.00
193-UC	Role of the COE-CST in Encourage, Facilitate and Promote-CU	$163,536.00
220-NMSU	Establishment of Framework for Commercial Space Launch Standards	$246,519.91
228-NMT	Magneto-Elastic Sensing for Structural Health Monitoring	$179,480.00

241-UF	High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles-UF	$272,000.00
241-FSU	High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles-FSU	$333,926.00
244-UF	Autonomous Rendezvous and Docking for Space Debris Mitigation-UF	$175,500.54
253-UCF	Ultra High Temperature Composites For Thermal Protection Systems	$317,090.00
297-FSU	Technical Oversight and OMIS Integration	$104,821.96
299-NMT	Nitrous Oxide Composite Tank Testing	$452,721.00
300-FIT	COE CST Collaboration Coordination	$446,788.00
303-NMT	OMIS Integration and COE Program Support	$307,000.00
305-FIT	Suborbital Commercial Transportation Industry Analyses	$65,425.00
308-UTMB	Suborbital SFP Anxiety Assessment	$202,197.00
309-UTMB	Suborbital Pilot Assessment	$146,675.00
310-UTMB	Reducing Cabin Lethality in Commercial Spacecraft	$70,196.00
311-UCF	LED-Based Low Cost Gas Sensor for Crew and Vehicle Safety	$193,773.00
319-UF	DebriSat Panel Preparation and Fragment Characterization	$75,000.00
320-UC	Commercial Spaceflight Risk Assessment and Communication	$118,702.00
323-NMT	Structural Health Monitoring Framework	$90,000.00
324-SU	Space Commercialization Strategies from the Internet Experience	$22,071.00
325-FSU	Optical Measurements of Rocket Nozzle Thrust and Noise	$98,435.00
329-NMT	Tracking and Monitoring Suborbital Commercial Space Vehicles	$25,000.00
330-UTMB	UTMB Administrative Support	$303,117.00
331-SU	Advanced 4D Special Use Airspace Research	$171,343.00
333-FIT	Onboard Context-Sensitive Informational System	$75,000.00
Total		$5,410,795.93

The following table shows total funding for tasks that are completed.

Total COE CST Funding (FY10-16) for All Completed Tasks

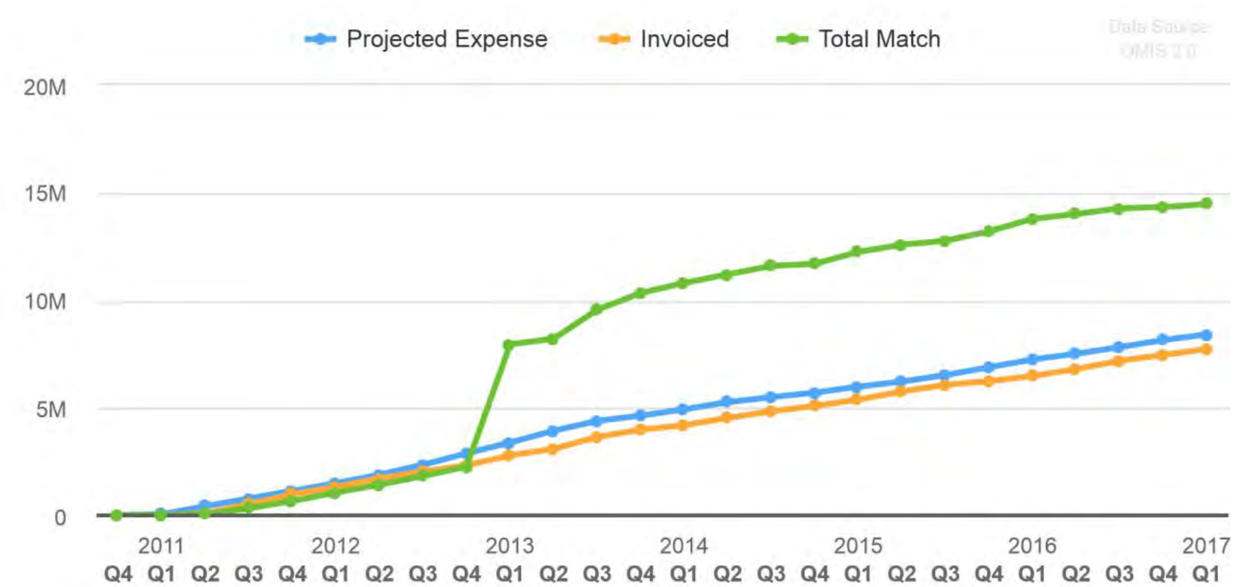
ID / Org	Title	Funded
181-UTMB	Medical and Physiological Database System	$40,657.58
182-UTMB	Human System Risk Management Approach to CST	$25,190.00
183-UTMB	Spaceflight Crew Medical Standards And Participant Acceptance Criteria	$49,006.03
184-UC	Human Rating of Commercially Operated Spacecraft	$235,282.00
185-SU	Unified 4D Trajectory Approach for Integrated Management	$400,996.00
193-SU	Role of the COE-CST in Encourage, Facilitate and Promote-SU	$628,445.00
244-FSU	Autonomous Rendezvous and Docking for Space Debris Mitigation-FSU	$301,950.00
244-SU	Autonomous Rendezvous and Docking for Space Debris Mitigation-SU	$131,128.00
244-UC	Autonomous Rendezvous and Docking for Space Debris Mitigation-CU	$119,233.00
247-FIT	Air and Space Traffic Control Considerations for Commercial Space	$196,578.00
255-UTMB	Wearable Biomedical Monitoring Equipment for Spaceflight Participants	$112,437.18
256-UTMB	Centrifuge Testing/Testing and Training of Personnel and Hardware in High-G Profiles using the NASTAR Center Centrifuge	$166,812.86
257-UC	Masters Level Commercial Space Operations Instruction	$128,510.00
258-SU	Multi-Disciplinary Analysis of Launch Vehicle Safety Metrics	$164,288.00
259-SU	Flight Software Validation and Verification for Safety	$5,110.00
281-UC	Technical Oversight - CU	$34,884.00
282-FIT	Technical Oversight - FIT	$19,988.00
283-FSU	Technical Oversight - FSU	$33,860.00
284-NMSU	COE CST Admin Lead Activities	$271,330.00

286-SU	Technical Oversight - SU	$100,000.00
287-UCF	Technical Oversight - UCF	$20,910.00
288-UF	Technical Oversight - UF	$5,999.46
289-UTMB	Technical Oversight - UTMB	$37,848.00
293-NMT	Reduced-Order Non-Linear Dynamic System Models	$75,500.00
294-UTMB	Development of Minor Injury Severity Scale for Orbital Human Space Flight	$23,233.12
295-UTMB	Effects of EMI and Ionizing Radiation on Implantable Devices	$17,025.23
296-FIT	Outreach - Commercial Space Transportation	$28,650.00
298-NMSU	Integration & Evaluation of ADS-B Payloads	$73,006.09
301-FIT	Spaceport Regulation in a Post Modern World	$0.00
302-FIT	International Commercial Space Regulations	$0.00
304-FIT	Insurers as Regulators of Space Safety and Sustainability	$0.00
306-NMSU	Advanced ADS-B Prototype for Commercial Space: Status Update and Future Opportunities	$0.00
307-NMSU	Test of COTS Satellite Communications Systems	$0.00
332-SU	Defining Class X Air Space	$0.00
Total		$3,447,857.55

3.4 Funding by Quarter

The Orion Management Information System (OMIS 2.0) was specificly designed to provide a financial and programatic engineering research tool to manage multiple FAA Air Transportation Centers of Excellence. OMIS 2.0 monitors and tracks multiple research projects within an individual center and the COE data.

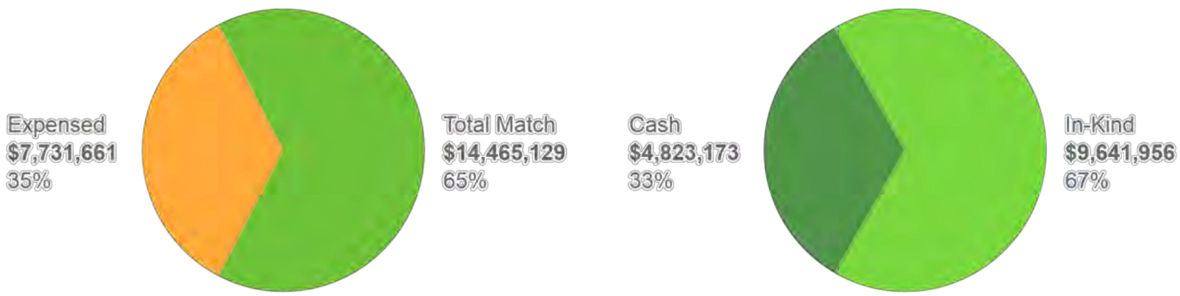
The following chart displays the expenditures by fiscal year quarter. The blue line displays the projected FAA expense. OMIS 2.0 calculates the projected expense by taking the amounts funded and divides the sum over the four quarters. The orange line displays the actual expense and the green line displays the actual match. In the first year, some anomalies occur as projects are beginning, the line chart begins to even out as the projects begin to progress.



3.5 Matching Funds

The Match Profile pie chart below displays the fraction of cash match **(33%)** and the fraction of in-kind match **(67%).**

The COE Match vs. FAA Expenditures pie chart displays the percentage of combined matching funds (cash and in-kind) over the FAA expense. Tasks funded under the FAA Grant require a 100% match and the COE CST has achieved a **2.12:1** matching ratio. The match requirement is distributed over the first five years of the COE. Each university partner can combine the total FAA funding with their matching funds to comply with the FAA matching requirements.



FAA Cash and Match by Quarter

Date / Quarter	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2010 Q4 (Jul-Sep)	$0	$0	$12,078	$12,078	$0	$0
FY2011 Q1 (Oct-Dec)	$1,745	$1,745	$0	$12,078	$0	$0
FY2011 Q2 (Jan-Mar)	$98,544	$100,289	$51,318	$63,396	$0	$0
FY2011 Q3 (Apr-Jun)	$424,638	$524,926	$215,802	$279,198	$53,416	$53,416
FY2011 Q4 (Jul-Sep)	$458,685	$983,611	$298,780	$577,978	$39,656	$93,072
FY2012 Q1 (Oct-Dec)	$348,044	$1,331,656	$279,684	$857,662	$113,483	$206,555
FY2012 Q2 (Jan-Mar)	$387,787	$1,719,443	$296,988	$1,154,650	$67,857	$274,413
FY2012 Q3 (Apr-Jun)	$322,132	$2,041,575	$347,331	$1,501,982	$51,745	$326,158
FY2012 Q4 (Jul-Sep)	$287,910	$2,329,485	$293,467	$1,795,448	$148,947	$475,105
FY2013 Q1 (Oct-Dec)	$462,689	$2,792,174	$362,115	$2,157,564	$5,318,588	$5,793,692
FY2013 Q2 (Jan-Mar)	$305,933	$3,098,107	$179,244	$2,336,807	$83,899	$5,877,591
FY2013 Q3 (Apr-Jun)	$545,467	$3,643,575	$325,930	$2,662,738	$1,018,138	$6,895,729

FY2013 Q4 (Jul-Sep)	$339,929	$3,983,504	$198,833	$2,861,571	$580,208	$7,475,937
FY2014 Q1 (Oct-Dec)	$206,647	$4,190,151	$131,597	$2,993,168	$335,979	$7,811,916
FY2014 Q2 (Jan-Mar)	$347,754	$4,537,904	$192,196	$3,185,364	$209,230	$8,021,146
FY2014 Q3 (Apr-Jun)	$301,537	$4,839,442	$256,507	$3,441,871	$131,670	$8,152,817
FY2014 Q4 (Jul-Sep)	$252,173	$5,091,614	$84,159	$3,526,030	$12,167	$8,164,984
FY2015 Q1 (Oct-Dec)	$291,867	$5,383,482	$183,131	$3,709,161	$374,664	$8,539,648
FY2015 Q2 (Jan-Mar)	$374,219	$5,757,701	$157,693	$3,866,854	$176,841	$8,716,489
FY2015 Q3 (Apr-Jun)	$311,610	$6,069,311	$117,314	$3,984,168	$63,221	$8,779,710
FY2015 Q4 (Jul-Sep)	$172,831	$6,242,142	$419,454	$4,403,621	$19,203	$8,798,913
FY2016 Q1 (Oct-Dec)	$232,843	$6,474,985	$109,784	$4,513,406	$471,480	$9,270,393
FY2016 Q2 (Jan-Mar)	$328,052	$6,803,037	$106,853	$4,620,259	$118,935	$9,389,327
FY2016 Q3 (Apr-Jun)	$383,799	$7,186,836	$43,888	$4,664,147	$219,300	$9,608,627
FY2016 Q4 (Jul-Sep)	$270,478	$7,457,314	$61,114	$4,725,261	$2,440	$9,611,067
FY2017 Q1 (Oct-Dec)	$274,348	$7,731,661	$97,912	$4,823,173	$30,889	$9,641,956
Total	$7,731,661		$4,823,173		$9,641,956	

COE CST Matching by Quarter

Expenditure and match data for each Task is provided with the individual project data in Chapter 5 in this report.

4.0 COE CST Management Plan

This document was modified in 2014 and 2016. It reflects the changes in the COE CST committee and subcommittee structure discussed and agreed on at the Annual Administrative Meeting.

4.1 Introduction

4.1.1 Background

In August 2009, the FAA Administrator created a Center of Excellence (COE) for Commercial Space Transportation (CST). The CST would be supported at a minimum level of one million dollars per year for ten years.

Following two public meetings conducted in February 2010, a competitive process was conducted over the following four months to solicit and evaluate proposals for the COE CST.

In September 2010, Cooperative Agreements (CAs) were executed between the FAA Office of Commercial Space Transportation (AST) and nine universities to create the COE CST. The member universities are (in alphabetical order):

- Florida Institute of Technology (FIT, or Florida Tech)
- Florida State University (FSU)
- New Mexico Institute of Mining and Technology, (NMT, or New Mexico Tech)
- New Mexico State University (NMSU)
- Stanford University (SU)
- University of Central Florida (UCF)
- University of Colorado at Boulder (CU)
- University of Florida (UF)
- University of Texas Medical Branch at Galveston (UTMB)

Subsequently, the FAA distributed two million dollars to the nine universities to conduct the first set of research tasks. Through the Management Plan, the FAA encourages the COE CST member universities to cooperate and collaborate with the purpose of conducting world-class research in support of the Commercial Space Transportation industry.

The nine member universities bring complementary strengths together for the benefit of the overall COE CST. The FAA finds that each team member provides highly respected and accomplished experiences that directly address the research and study needs of the commercial space industry.

- Florida Tech (FIT) offers broad expertise in aerospace and space-related engineering, science, space traffic management and launch operations, vehicle and payload analysis and design, thermal systems and propulsion.
- FSU brings a range expertise and unique infrastructure in many areas relevant to the COE CST, including but not limited to cryogenics, thermal management, vehicle aerodynamics and controls, sensors, actuators and system health monitoring and high-performance simulations.

- NMT is a science, math and engineering university with a focus on applied research. Major research facilities include a rocket engine test fixture at the Energetic Materials Research and Testing Center and a 2.4M fast tracking telescope at the Magdalena Ridge Observatory dedicated to the study of near-earth objects.
- NMSU and its Physical Sciences Laboratory have led space and aerospace research in areas of suborbital investigations from the time of Werner Von Braun to the current era of commercial sub-orbital space transportation with Virgin Galactic. The 21st Century Space and Aerospace research focus encompasses annual access to space for student and faculty experiments, unmanned aerial vehicles, scientific ballooning and nano-satellite development.
- SU brings a 50-year history of aerospace research excellence and a broad scope of expertise to the COE CST, including the optimization and autonomous operation of complex systems, strategic research planning, organizational integration and distributed administration experience.
- UCF, as partners of Florida Center for Advanced Aero-Propulsion (FCAAP) and the Center for Advanced Turbines & Energy Research (CATER), offers its experience and expertise in thermal protection system, propulsion system components, cryogenic systems and materials, composites, sensors and actuators, and guidance and control.
- CU offers the COE CST their experience in spacecraft life support systems and habitat design, human factors engineering analysis, payload experiment integration, and expertise in space environment and orbital mechanics.
- UF has been performing aeronautical and aerospace research since 1941, with current emphasis in the Department of Mechanical and Aerospace Engineering on research in space systems, MEMS, computational sciences, structural dynamics, controls, gas dynamics, and propulsion.
- UTMB has a long history of medical support and human spaceflight physiological research with NASA. This is complemented by more recent involvement in the commercial orbital and suborbital spaceflight industry supporting space flight participant visits to the ISS and preparation of passengers and crew for suborbital space flights.

Additionally, the team members provided a comprehensive distribution of geographical coverage representing the entire Commercial Space Transportation industry. The nine universities bring over 50 other government, industry and academic organizations as research partners.

4.1.2 Overview

Key FAA Personnel

In this document, the following position titles are used. The individuals named hold these positions:

- Dr. Patricia Watts, FAA Center of Excellence (COE) National Program Director
- Mr. Ken Davidian, Director of Research and COE CST Program Manager, FAA AST

Purpose

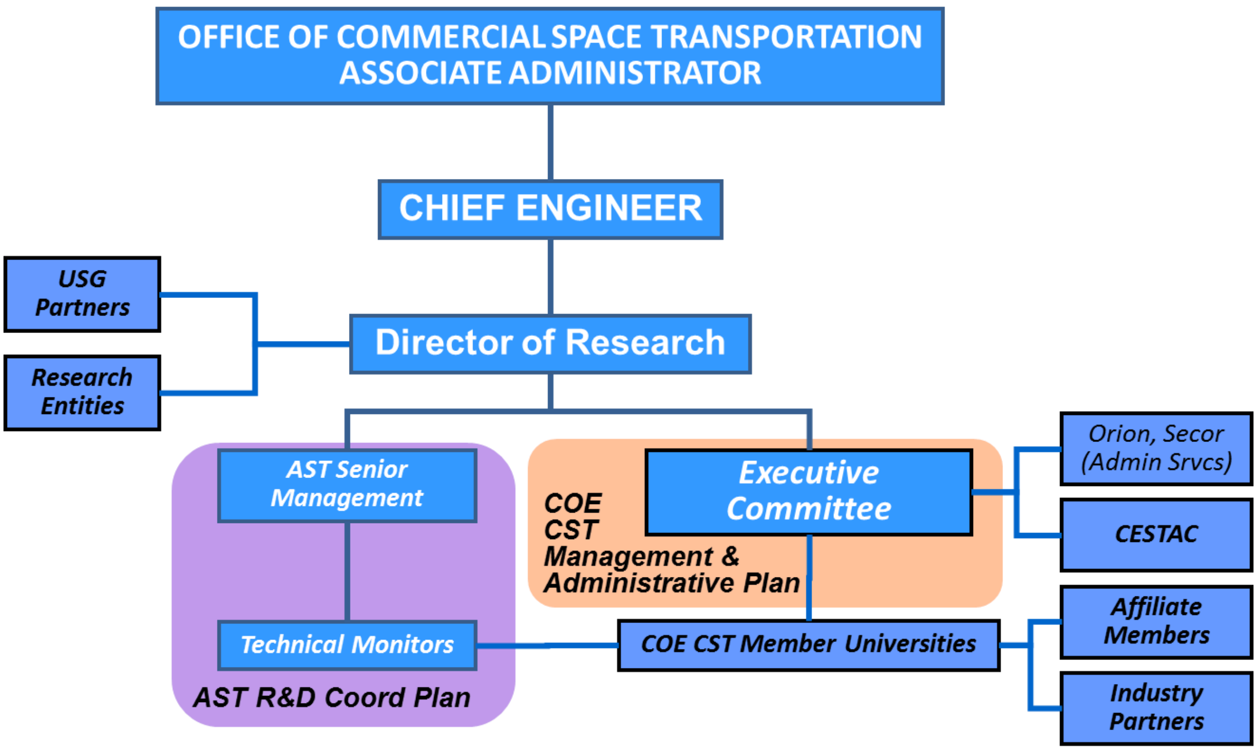
The purpose of the AST COE Management Plan is to define the relationships, roles, goals and membership of the COE CST organizational entities and AST.

Organizational Context

As shown in the figure below, the R&D Coordination and COE are programs within the following organizational hierarchy:

- Dr. George Nield, Associate Administrator, FAA AST
- Mr. Paul Wilde, Chief Engineer, FAA AST

Also shown in the figure below, COE CST member universities interface with both AST's R&D Coordination processes and the COE CST. Specifically, the research task proposal and selection process, including all competition sensitive information submitted by member universities, is coordinated by the FAA AST through the R&D Coordination activity (in coordination with AST entities such as the AST Senior Steering Committee and the Technical Monitors as shown in the figure below). All other activities of the COE CST member universities fall within the COE CST program.



4.1.3 Scope

The Center of Excellence (COE) is comprised of the AST COE Management Council (ACMC) and the Executive Committee (EC). The relationship of these entities with respect to the rest of the FAA AST R&D organization is shown below.

Administrative activities of the COE CST member universities are defined in COE CST Cooperative Agreements. For activities not specified in the COE CST Cooperative Agreements, member universities are at liberty to conduct business as agreed upon among them and by the Executive Committee through a consensus-driven decision-making process.

COE CST appraisal review and audits will be performed by the FAA COE Program Office in accordance with terms of the COE Policy Guide.

4.1.4 Abbreviations and Acronyms

Below are the abbreviations and acronyms used in this document.

AOB	Any Other Business
AST	Office of Commercial Space Transportation
CA	Cooperative Agreement
CESTAC	COE CST Industry Advisory Council
COE	Center of Excellence
CST	Commercial Space Transportation
CU	University of Colorado at Boulder
EC	Executive Committee
FAA	Federal Aviation Administration
FIT	Florida Institute of Technology
FSU	Florida State University
NMSU	New Mexico State University
NMT	New Mexico Tech
OMIS	Orion Management Information System
PI	Principal Investigator
PM	Program Manager
R&D	Research and Development
SU	Stanford University
UCF	University of Central Florida
UF	University of Florida
UTMB	University of Texas Medical Branch at Galveston

4.2 Executive Committee

4.2.1 Functions and Goals

The Executive Committee (EC) is responsible for the following COE CST functions:

- DEVELOP A SET OF SELF-GOVERNANCE DOCUMENTS. Beginning with an EC Terms of Reference document, working through the second step of an EC Management Plan of its own, and culminating with an EC Constitution that will be iteratively refined over multiple years. These will evolve toward the foundational document for the COE CST entering its self-sustaining phase after ten years of guaranteed FAA funding.
- FOSTER COOPERATIVE EFFORTS AMONG THE COE CST MEMBER UNIVERSITIES. Cooperative efforts will require some modified posturing to respond not only to FAA funding solicitations but also to external funding solicitations. The intent is to demonstrate through signaling and subsequent action that being a member of the COE CST and partnering with other member universities enhances the chances of winning funding for related research tasks.
- CONDUCTING STRATEGIC PLANNING ANALYSES. Strategic planning analyses will be very valuable to the COE CST and can provide the basis for sustained, meaningful activities among the participating members. The long-term goal is self-sustenance after ten years. The results of many structured analyses will be essential to painting a complete picture of how it can best be achieved.

4.2.2 Membership

Members of the EC include:

- EXECUTIVE COMMITTEE CHAIR. James Vanderploeg, MD, is the EC Chair. He was elected unanimously in 2014 and 2016.
- COE CST MEMBER UNIVERSITY REPRESENTATIVES. Each university can be represented by COE CST Principal Investigators (PIs) and other university personnel (including staff and student observers) on an “as interested” basis. However, each

university will designate a primary and secondary PI to attend the EC as a voting member.

4.2.3 Meetings and Schedule

Attendance at the EC meetings will be generally inclusive (allowing multiple PIs, student observers and staff as needed to attend from any given university).

EC meetings will normally be conducted by teleconference on a monthly basis with face-to-face meetings twice a year (at the annual administrative and technical meetings).

The teleconferences would normally be very short unless there were special briefings (for example, updates from the "Terms of Reference" team) or other topics to discuss.

The EC is intended to be a consensus-driven decision-making body, but if decisions were not able to be made by consensus in an open session, a closed-session vote might be necessary. Each member university would have a single vote given to their primary PI, regardless of the number of PIs representing any given university on the EC.

In the event the primary PI from a given university is not able to participate in a close-session vote, the designated secondary PI from that same university will be able to act as a substitute.

The agenda of these meetings will be determined by the EC Chair in consensus with the EC membership and distributed in advance of each meeting by the EC Chair or designee.

4.3. Administrative Processes

4.3.1 How to Submit a COE CST Research Grant Proposal

Enter www.grants.gov/
Click on Apply for Grants
FAA assigns each proposal a number and acknowledges receipt of each proposal

- Proposal number must be referred to in all future correspondence concerning the proposal.
- Provide Required Fields
- Enter CFDA 20.109
- Download Package
- Select CST New Funding Package and Download
- Complete Download Instructions and Application
- Submit

4.3.2 How to Request a No Cost Extension

- Go to www.grants.gov
- Click on Apply for Grants
- Provide Required Fields
- Enter CFDA 20.109
- Download Package
- Select CST No Cost Extension Package
- Complete Download Instructions and Application
- Submit

Mandatory Requirement: Form SF 424

4.3.3 How to Document Cost Share Contributions

Refer to OMB 2CCRF 200 Uniform Guidance Cost Sharing or Matching
Complete FAA COE Matching Contribution Form

- Submit prior to award when value of in-kind activities are calculated (vs. cost of contribution)

Based on activities not solely used for supporting a funded COE project
In the instance where the in-kind cost sharing activity is not solely for the benefit of the proposed project, the activities conducted and provided by a third-party source will be clearly defined in the proposal submission to justify the value of the anticipated contribution to the specific project(s).

A. Each investigator proposing credit for such contributions will review the anticipated cost-sharing plan with his/her Fiscal Officer.
B. Prior to submission of the proposal to the FAA, the university COE member's Fiscal Officer will discuss the plan with the COE lead institution's Fiscal Officer for consideration in accordance with the lead institution's policies and procedures on cost-sharing. The university Fiscal Officer will notify the FAA COE Program Director/Grants Officer that such a proposal is under consideration and in the process of being submitted.
C. In applying the value of a contribution versus the direct cost of contribution, the interpretation of the Fiscal Officer representing the COE Lead institution regarding the amount found to be "prudent and reasonable" will hold for all those participating in the project. The COE Lead institution is expected to conduct discussions and make a determination within five business days.
D. The COE Lead institution will forward a concurrence notice to the COE Program Office with a justification for the value of the cost-share proposed.
E. The FAA COE Program Director will consider each request on a case-by-case basis. The expectation is that all COE members and Leads will be prudent in developing value statements and formulas.
F. In keeping with the Legislative intent and the spirit of COE enabling legislation, Public Law 101-508, the FAA will not allow the nonspecific in-kind contributions that might be a result of one project to satisfy the matching obligations for an entire agreement Phase or for a significant number of other funded projects.

Although the COE Fiscal Officers and ultimately the FAA may accept the value of the documented contribution as reasonable, allowable and allocable, each university is subject to final acceptance by its own auditor(s). Any penalty imposed by a cognizant auditing agency is the sole responsibility of the recipient providing the contribution and the associated documentation (Prime or Sub-recipient).

4.3.4 Quarterly Reporting

Quarterly reports cover three-month calendar increments

- Q1: October 1 – December 31, due January 31.
- Q2: January 1 – March 31, due April 30.
- Q3: April 1 – June 30, due July 31.
- Q4: July 1 – September 30, due October 31.

Deadline for entering quarterly information is 30 days after the quarter ends

- Research accomplishments (measured against the proposed goals and objectives)
- Citation for written publications
- Journal articles published or in press
- Journal articles submitted
- Conference papers submitted and accepted
- Patents
- Follow-on research proposals submitted
- Transition of research results
- Plans for next quarter
- Update Student Information
- Update User Profile
- Fiscal Data
- Cost Matching Funds
- SF 425
- Indication of current problems, favorable or unusual developments

- COE university members should track all students assigned to COE projects, their major areas of study, thesis or dissertation topics, and report the intended graduation dates. ***To the extent reasonably possible: university members will report initial job placement*** as this information becomes available; each member university shall ***endeavor to maintain contact information on graduates funded to work on COE projects with the purpose of building an alumni network list***. This information, when available, must be provided to the FAA COE PMO with the COE annual report and in the final project reports.

4.3.5 How to Close-Out a Research Task

Project Closeout Requirements

The PI is responsible for completing all required documentation.

Due Date: 90 days after expiration of award

- Final Project Report
  - Within 90 days following the grant expiration date, a final project report must be submitted to the Technical Monitor and the Grants Office. The following technical items and a final invoice must be submitted to the Grants Office and Technical Monitor following completion of the project:
  - Completed FAA Form 9550-5 "Final Project Report" (on the web at www.faa.gov.documentLibrary/media/form/faa9550-5.pdf) with attachments below:
    - Abstracts of Theses
    - Publication Citations (published and planned) (Provide 2 copies if electronic versions are not available) (including Title, Journal or other reference, Date, Author)

- Scientific Collaborators (including Co-Investigators, Research Assistants, Associate Professors, Graduate Students, Associate Members and short statement of their participation, and others as appropriate)
- Inventions or Propriety Data (Patents and status)
- Technical Summary and results of the project
- Additional Material required under the award instrument
- OMIS Report showing no outstanding reports due
- Budget report reflecting $0 balance
- Nationality report (Updated Project Participants Form)
- Information on inventions
- Other materials required in the award instrument, including a list of purchased equipment funded by the grant award
- If students are graduating, intended position and start date
- Final Disbursement Report (Form SF 425) -- used to report the status of funds for grant projects at close-out
- Final Project Report (Form 9550-5) -- contains a summary of the completed project that will be used to answer questions by nonscientists as to the nature and significance of research
- SF 428 Tangible personal property report
- Summary of all matching contributions with sources

- Send to: FAA Technical Monitor designated on FAA award letter,
- The closeout requires the FAA Form 9550-5 be sent to Technical Director (Ken Davidian)
- TD forwards to Tech Monitors for concurrence
- TMs return approved form to TD
- TD signs off and forwards to COE Program Director (Pat Watts)
- COE Program Director approves and sends to Orion America
- Completed project information resides in two places: COE Program Director and the OMIS where it awaits audit, etc.

The closeout procedure is contained within OMIS and forwards the closeout package to the FAA PMO.

Final Unobligated Balance

FAA has a reversionary interest in the unobligated balance of a grant upon expiration or completion of the grant. Based on final disbursements reported on the SF 425, the final unobligated balance is to be computed by FAA and reported to the grantee. If the grantee's funding has been fully advanced and the unobligated balance deduction results in a negative balance, the grantee must refund by check, payable to FAA, the amount of the negative balance.

Compliance with Reporting Requirements

The FAA Technical Center accounting section monitors report submissions to ensure that the requirements for final disbursement information are fulfilled. The technical monitor is responsible for assuring that the final project reports on prior, expired awards have been submitted by principal investigators before new awards are made to those individuals.

Grant Closeout

Grant closeout is the process by which FAA determines that all applicable administrative actions and all required work of the grant are complete. Grants are closed upon receipt of final disbursement information in the final project report, and after determination that any other administrative requirements in the grant instrument have been met. In the event a final audit has not been performed prior to the closeout of the grant, FAA reserves the right to recover appropriate amounts after fully considering the recommendations on disallowed costs resulting from the final audit.

4.3.6 How to Initiate an Affiliate Membership

When a new task is proposed with an Affiliate Member, the Host University shall

Submit their proposal through the standard FAA proposal process using grants.gov
Submit the appropriate budget (even if the budget is $0)
Submit Cash/In-Kind Match form (FAA COE In-Kind Cost Sharing) with supporting documentation from the Affiliate Member
Upon acceptance, the task will be tracked in OMIS and the Affiliate Member will be set up as a "Primary Partner" permitting the OMIS to track the matching contributions
Establish a method of receiving financial reports from the Affiliate Member that will satisfy the Host University auditor(s) and their State regulations
Be responsible for entering the matching contributions in OMIS

For more information

- FAA COE In-Kind Cost Sharing Guidance
- OMB 2CCRF 200 Uniform Guidance Cost Sharing or Matching
- FAA Centers of Excellence Matching Contribution Form

5.0 Funding Details for Active Tasks

The technical effort requires monitoring and tracking progress both technically and financially.

The quarterly project reports consist of a technical report and an expenditure report. The progress report covers schedule, cost, and technical status: progress since the last report. If problems exist in schedule, cost, or technical areas, they are reported. Any problem noted requires an explanation of the solution being pursued to solve that problem. A summary display of tasks provides a color-coded indication of status: green, yellow, or red – for schedule, cost, and technical – to reflect whether there are problems (yellow) and whether they are serious (red) in one or more of these three categories. There are no pre-established criteria for establishing these color codes. They are set based upon the subjective evaluation of project status by the assigned FAA Technical Managers in conjunction with the FAA's CST Program Manager.

The reporting function is supported by the OMIS 2.0. Access to the system through the Internet is password protected and the data is transferred via SSL. The PIs and Fiscal Officers enter data through the OMIS 2.0. The FAA and the PMO management team can monitor the data through Internet access as well.

Each project has a line chart showing the FAA projected expense (based on amendments), expenditure amounts and matching for the quarter. Separate pie charts display the cash and in-kind match and expensed vs total match. Projected expenditures versus actual expenditures are plotted. The estimated expenditure rates and cumulative projections are based on straight-line projections. The quarterly expenditure estimate is calculated by dividing the total project budget by the period of performance.

There are two pie charts for every project. One indicates the relative proportion (percentage) of cash matching versus in-kind matching. The second compares the total FAA expenditure with the total match (cash + in-kind).

Following are the task fiscal summaries. The first section displays the "Active" projects and the sectiond section displays the "Completed" projects. Both are listed in cronilogical order by the task ID number for easy reference.

ACTIVE PROJECTS

TASK 186-SU: Mitigate Threats through Space Environment Modeling/Prediction-SU

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Sigrid Close	Principal Investigator	●
Karen Shelton-Mur	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

An integrated air and space traffic management system requires seamless and real-time access to density predictions for on-orbit collision avoidance and atmospheric reentry; future knowledge of deleterious particles including energetics, meteoroids, and debris; and near-surface weather prediction.

Project Outcomes

We will develop (i) a weather prediction model extending from Earth's surface to the edge of space and (ii) a micrometeoroid detection and risk assessment system that, together, predict the environmental conditions needed for safe orbital, entry, descent and landing operations.

Summary of Output

● Define the process to develop a weather prediction model extending from Earth's surface to the edge of space (~600 km altitude).
● Define the Process to develop a micrometeoroid detection and risk assessment system that, together, predict the environmental conditions needed for safe orbital, entry, descent and landing operations.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ □ ■	□

Partners

Partner	Division	Primary
Leland Stanford Junior University		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
4/4/2011	3/31/2012	2010	10-C-CST-SU-003	$49,272.00
4/1/2012	12/31/2012	2011	10-C-CST-SU-013	$50,000.00
1/1/2013	5/31/2013	2012	10-C-CST-SU-022	$50,000.00
1/1/2013	5/31/2013	2012	10-C-CST-SU-023	$18,042.00
6/1/2013	9/30/2013	2012	10-C-CST-SU-026	$0.00
9/30/2013	6/30/2014	2013	10-C-CST-SU-031	$10,000.00
9/30/2013	6/30/2014	2013	10-C-CST-SU-033	$8,000.00
6/30/2014	9/30/2015	2014	10-C-CST-SU-043	$0.00
6/30/2014	9/30/2015	2014	10-C-CST-SU-044	$19,159.52
10/1/2015	5/31/2016	2015	15-C-CST-SU-02	$42,530.00
10/1/2015	9/30/2016	2016	15-C-CST-SU-06	$0.00
Total				$247,003.52

Students

Name	Department	Discipline	Funded	Degree	Graduation
Alan Li	Aeronautics and Astronautics		●	Ph.D.	6/1/2015
Diana Madera	Aeronautics and Astronautics		●	Ph.D.	

Deliverables

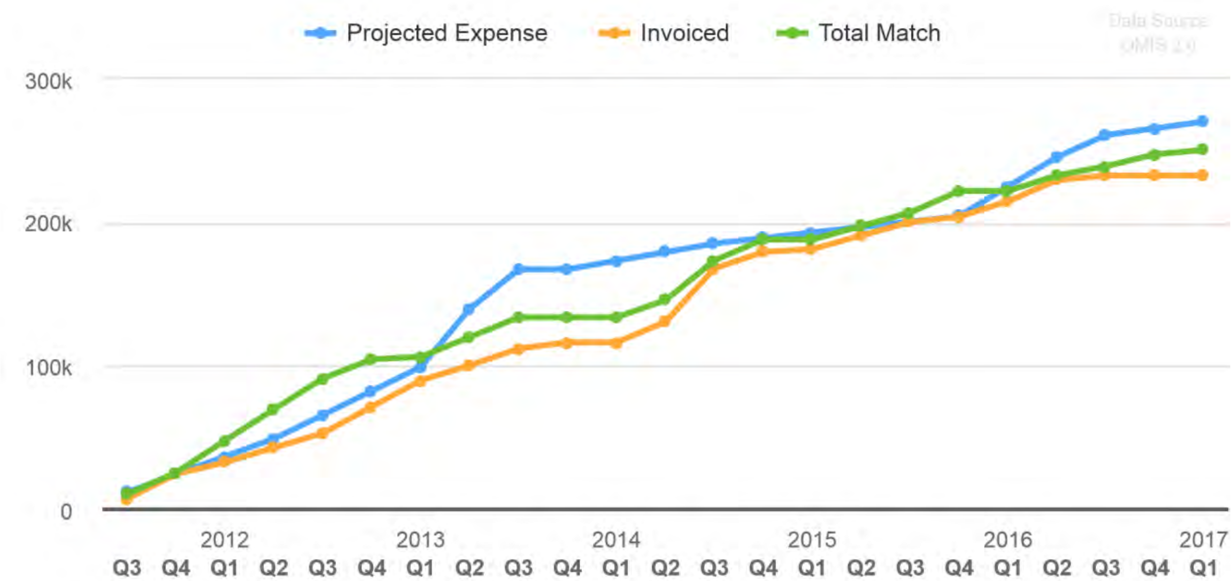
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of	4/4/2011	8/31/2018	

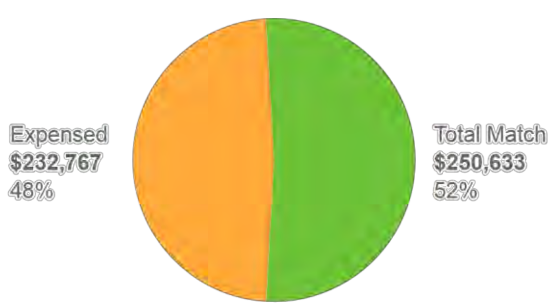
	project, with additional narrative where appropriate and with final invoice.			

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q3 (Apr-Jun)	$7,369.56	$7,369.56	$8,528.78	$8,528.78	$2,098.04	$2,098.04

FY2011 Q4 (Jul-Sep)	$17,269.68	$24,639.24	$11,762.69	$20,291.47	$3,245.83	$5,343.87
FY2012 Q1 (Oct-Dec)	$8,163.31	$32,802.55	$16,554.61	$36,846.08	$5,839.77	$11,183.64
FY2012 Q2 (Jan-Mar)	$10,235.29	$43,037.84	$16,079.76	$52,925.84	$5,571.00	$16,754.64
FY2012 Q3 (Apr-Jun)	$10,090.98	$53,128.82	$16,091.26	$69,017.10	$5,577.51	$22,332.15
FY2012 Q4 (Jul-Sep)	$18,439.41	$71,568.23	$10,767.50	$79,784.60	$2,564.26	$24,896.41
FY2013 Q1 (Oct-Dec)	$18,392.22	$89,960.45	$1,666.00	$81,450.60	$0.00	$24,896.41
FY2013 Q2 (Jan-Mar)	$10,453.90	$100,414.35	$11,125.80	$92,576.40	$2,660.09	$27,556.50
FY2013 Q3 (Apr-Jun)	$11,728.37	$112,142.72	$11,125.80	$103,702.20	$2,660.09	$30,216.59
FY2013 Q4 (Jul-Sep)	$4,305.33	$116,448.05	$0.00	$103,702.20	$0.00	$30,216.59
FY2014 Q1 (Oct-Dec)	$0.00	$116,448.05	$0.00	$103,702.20	$0.00	$30,216.59
FY2014 Q2 (Jan-Mar)	$14,348.44	$130,796.49	$10,148.00	$113,850.20	$1,841.20	$32,057.79
FY2014 Q3 (Apr-Jun)	$37,202.82	$167,999.31	$21,235.50	$135,085.70	$6,444.19	$38,501.98
FY2014 Q4 (Jul-Sep)	$11,421.40	$179,420.71	$11,780.68	$146,866.38	$2,765.29	$41,267.27
FY2015 Q1 (Oct-Dec)	$2,088.89	$181,509.60	$0.00	$146,866.38	$0.00	$41,267.27
FY2015 Q2 (Jan-Mar)	$9,412.32	$190,921.92	$6,529.26	$153,395.64	$2,883.07	$44,150.34
FY2015 Q3 (Apr-Jun)	$9,412.32	$200,334.24	$6,529.26	$159,924.90	$2,883.07	$47,033.41
FY2015 Q4 (Jul-Sep)	$3,764.94	$204,099.18	$10,446.84	$170,371.74	$4,612.92	$51,646.33
FY2016 Q1 (Oct-Dec)	$10,799.03	$214,898.21	$0.00	$170,371.74	$0.00	$51,646.33
FY2016 Q2 (Jan-Mar)	$14,725.70	$229,623.91	$6,951.60	$177,323.34	$3,934.61	$55,580.94
FY2016 Q3 (Apr-Jun)	$3,142.61	$232,766.52	$5,383.40	$182,706.74	$955.07	$56,536.01
FY2016 Q4 (Jul-Sep)	$0.00	$232,766.52	$5,894.40	$188,601.14	$2,439.69	$58,975.70
FY2017 Q1 (Oct-Dec)	$0.00	$232,766.52	$1,951.47	$190,552.61	$1,104.53	$60,080.23
Total	$232,766.52		$190,552.61		$60,080.23	

TASK 186-UC: Mitigate Threats through Space Environment Modeling/Prediction-CU

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
Tim Fuller-Rowell	Principal Investigator	●
Karen Shelton-Mur	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

An integrated air and space traffic management system requires seamless and real-time access to density predictions for on-orbit collision avoidance and atmospheric reentry; future knowledge of deleterious particles including energetics, meteoroids, and debris; and near-surface weather prediction.

Project Outcomes

We will develop (i) a weather prediction model extending from Earth's surface to the edge of space and (ii) a micrometeoroid detection and risk assessment system that, together, predict the environmental conditions needed for safe orbital, entry, descent and landing operations.

Summary of Output

- Define the process to develop a weather prediction model extending from Earth's surface to the edge of space (~600 km altitude).
- Define the Process to develop a micrometeoroid detection and risk assessment system that, together, predict the environmental conditions needed for safe orbital, entry, descent and landing operations.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UC-006	$40,000.00
1/1/2012	5/31/2012	2012	10-C-CST-UC-013	$18,000.00
6/1/2012	5/31/2013	2012	10-C-CST-UC-019	$40,000.00
5/31/2013	5/31/2014	2014	10-C-CST-UC-032	$0.00
5/31/2014	9/30/2015	2015	10-C-CST-UC-040	$0.00
10/1/2015	9/30/2017	2016	15-C-CST-CU-07	$63,500.00
Total				$161,500.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Catalin Negrea	Department of Electrical, Computer and Energy Engineering	Ionospheric and Atmospheric Physics	●	Ph.D.	7/1/2016

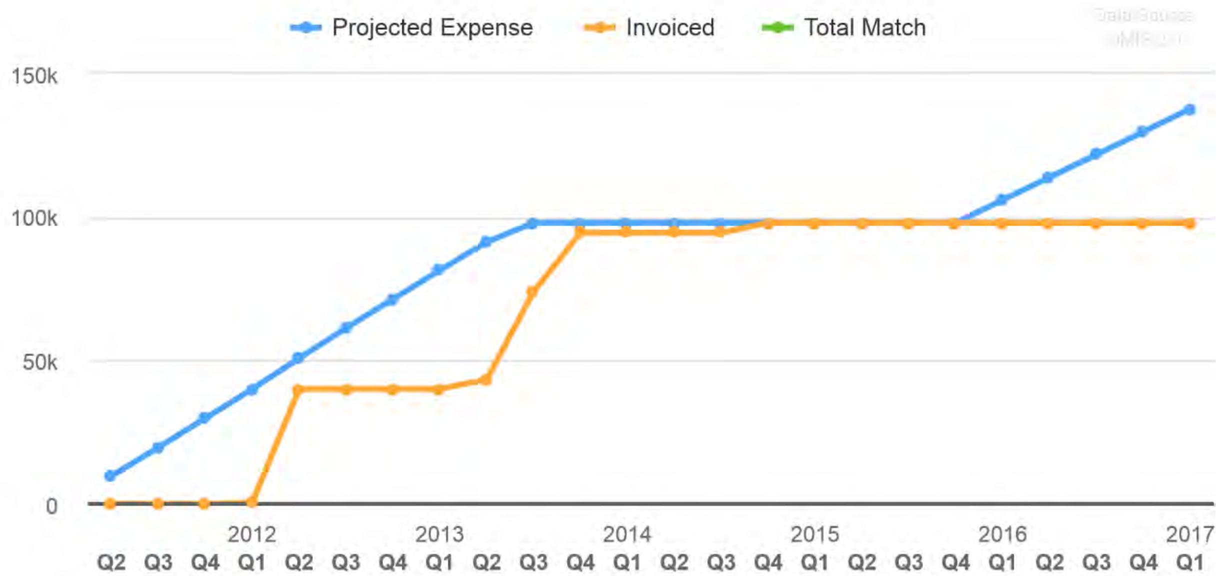
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	Complete Whole Atmosphere Model implementation coupling ionosphere and magnetospheric forcing and assimilate high-resolution data. MS Type: NARP MS Year 2020A	1/3/2011	9/30/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$506.52	$506.52	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$39,493.48	$40,000.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$65.77	$40,065.77	$0.00	$0.00	$0.00	$0.00

FY2012 Q4 (Jul-Sep)	$0.00	$40,065.77	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$40,065.77	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$3,373.00	$43,438.77	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$30,609.82	$74,048.59	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$20,490.67	$94,539.26	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$94,539.26	$0.00	$0.00	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$94,539.26	$0.00	$0.00	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$0.00	$94,539.26	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$3,455.95	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$97,995.21	$0.00	$0.00	$0.00	$0.00
Total	$97,995.21		$0.00		$0.00	

TASK 187-UC: Space Situational Awareness Improvements

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
Dan Scheeres	Principal Investigator	●
David Klaus	Principal Investigator	
Stephen Earle	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Effective space situational awareness faces the challenges of bringing together observations from disparate sensors and sources, developing computationally efficient dynamic propagation schemes, and formulating accurate estimation methods for the purpose of quantifying and qualifying space-based activities.

The goal of this effort is to improve our knowledge of current and future behavior of space objects by reducing the associated uncertainties. This project will improve, develop, and test software, hardware, and information fusion plans to produce accurate, autonomous, and near real-time understanding of objects in the operational space environment to promote orbital safety and evaluate debris threat mitigation schemes. This will require coordination with various organizations in civil, commercial, and military space sectors.

STATEMENT OF WORK
Examine the uncertainty associated with resident space objects and the time propagation of these uncertainties through coordinated extensive research of:
- Next Generation Space Catalog
- Resident Space Object Characterization
- Collision Avoidance/Conjunction Analysis
- Orbital Safety and Debris Removal.

Project Outcomes

(i) maximize the information extracted from all sources of collected data (minimize ambiguity),
(ii) gather data in a way that maximizes its information content (maximize efficiency),
(iii) recover and predict the space domain with more realistic and accurate knowledge, and
(iv) infer the space-based environment in a timely fashion so as to increase safety and enable effective decision making.

Summary of Output

The goal of this effort is to improve our knowledge of current and future behavior of space objects by reducing the associated uncertainties. This project will improve, develop, and test software, hardware, and information fusion plans to produce accurate, autonomous, and near real-time understanding of objects in the operational space environment to promote orbital safety and evaluate debris threat mitigation schemes. This will require coordination with various organizations in civil, commercial, and military space sectors.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
University of Colorado at Boulder		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UC-004	$76,906.00
1/1/2012	12/31/2012	2011	10-C-CST-UC-010	$80,000.00
1/1/2013	12/31/2013	2012	10-C-CST-UC-016	$67,069.00
12/31/2013	5/31/2014	2013	10-C-CST-UC-031	$28,000.00
12/31/2013	5/31/2014	2013	10-C-CST-UC-034	$8,000.00
5/31/2014	12/31/2014	2015	10-C-CST-UC-039	$36,000.00
1/1/2015	8/31/2015	2015	10-C-CST-UC-041C	$0.00

6/1/2016	5/31/2017	2016	15-C-CST-CU-04	$50,000.00
Total				$345,975.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Kohei Fujimoto	Aerospace Engineering Sciences	Astrodynamics	●	Ph.D.	5/13/2012

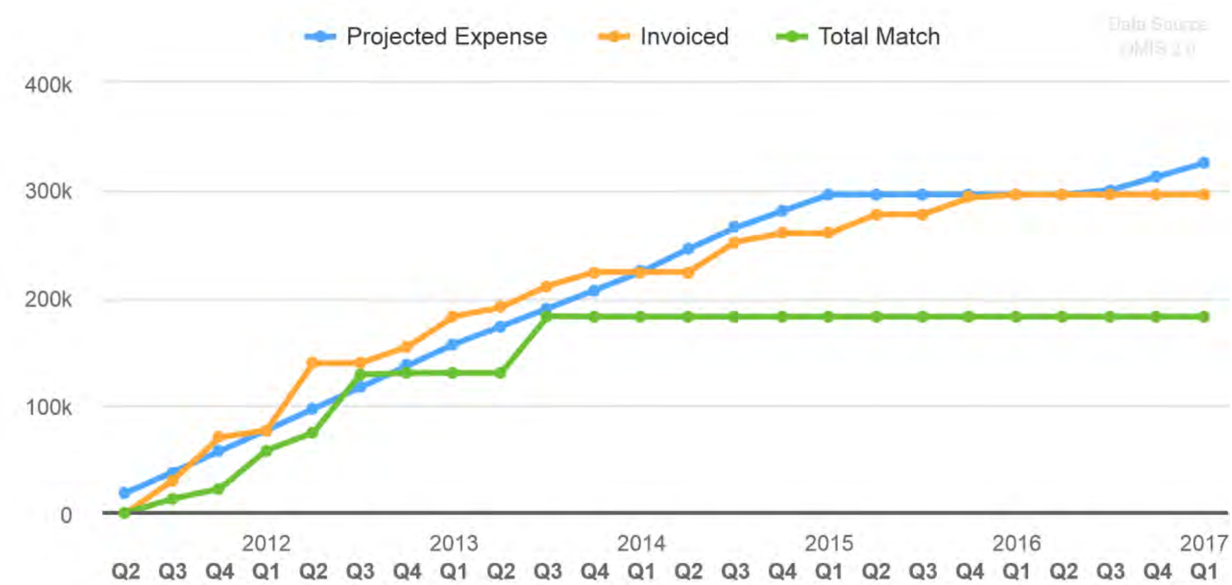
Deliverables

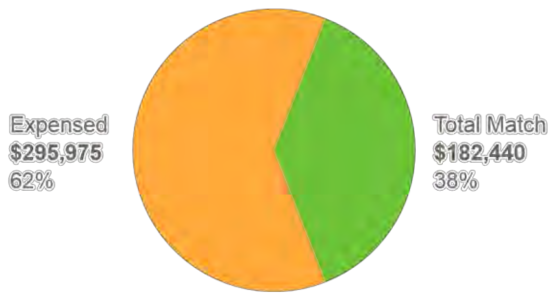
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

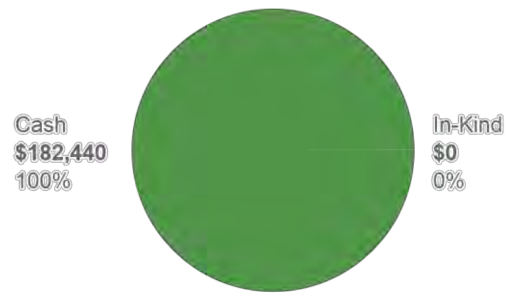
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$30,147.28	$30,147.28	$13,261.23	$13,261.23	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$40,064.15	$70,211.43	$9,223.50	$22,484.73	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$6,694.57	$76,906.00	$35,734.01	$58,218.74	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$62,359.94	$139,265.94	$16,507.50	$74,726.24	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$139,265.94	$53,981.86	$128,708.10	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$15,030.95	$154,296.89	$1,407.57	$130,115.67	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$28,367.37	$182,664.26	$0.00	$130,115.67	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$8,444.00	$191,108.26	$0.00	$130,115.67	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$20,040.16	$211,148.42	$52,743.28	$182,858.95	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$12,826.14	$223,974.56	-$419.20	$182,439.75	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$223,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$223,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$28,000.00	$251,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$8,000.00	$259,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$259,974.56	$0.00	$182,439.75	$0.00	$0.00

FY2015 Q2 (Jan-Mar)	$17,509.11	$277,483.67	$0.00	$182,439.75	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$277,483.67	$0.00	$182,439.75	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$15,554.75	$293,038.42	$0.00	$182,439.75	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$2,936.14	$295,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$295,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$295,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$295,974.56	$0.00	$182,439.75	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$295,974.56	$0.00	$182,439.75	$0.00	$0.00
Total	$295,974.56		$182,439.75		$0.00	

TASK 193-UC: Role of the COE-CST in Encourage, Facilitate and Promote-CU

Lead University

University of Colorado at Boulder

Team

Name	Role	Primary
Dan Scheeres	Principal Investigator	●
David Klaus	Principal Investigator	
Ken Davidian	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●
Brad Cheetham	Research Assistant	●

Research Area

4.0 Space Transportation Industry Viability

Project Description

This task is focused on supporting industry development through outreach, training, and research. Primarily this work falls into three categories (a) supporting industry development efforts (such as FAA COMSTAC), (b) leading workshops that educate and engage emerging leaders through industry viability studies and exposure, and (c) supporting conferences related to the emerging commercial space industry through presentations, logistics, and other means.

Project Outcomes

This task directly supports the training, outreach, and research functions of the FAA COE, particularly in areas of space transportation industry viability. Activities supported by this task impact the degree to which stakeholders of the commercial space industry are informed and involved within the context of the FAA-AST mandate to encourage, facilitate and promote the safe development of commercial space transportation industries. Inclusion of young professionals and students in this process is critical for sustained efforts and grass-roots support.

Summary of Output

Near-Term: Develop a COE CST commercial space transportation research road-map by conducting workshops.
● Far-Term: Implement the strategy for commercial space transportation EFP using analysis tools and techniques at the intersection of engineering and business.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UC-002	$11,552.00
1/3/2011	8/31/2011	2010	10-C-CST-UC-008	$15,092.00
9/1/2011	5/31/2012	2012	10-C-CST-UC-012	$13,000.00
6/1/2012	12/31/2012	2012	10-C-CST-UC-018	$0.00
6/1/2012	5/31/2013	2012	10-C-CST-UC-020	$36,000.00
5/31/2013	12/31/2013	2013	10-C-CST-UC-026	$24,716.00
12/31/2013	12/31/2014	2014	10-C-CST-UC-035	$0.00
1/1/2015	8/31/2015	2014	10-C-CST-UC-042	$0.00
9/1/2015	5/31/2016	2015	15-C-CST-UC-02	$50,176.00
10/1/2016	5/31/2017	2016	15-C-CST-UC-06	$13,000.00
Total				$163,536.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Bradley Cheetham	Aerospace Engineering Sciences	Aerospace Engineering	•	Ph.D.	
Juliana Feldhacker	Aerospace Engineering Sciences		•	Ph.D.	

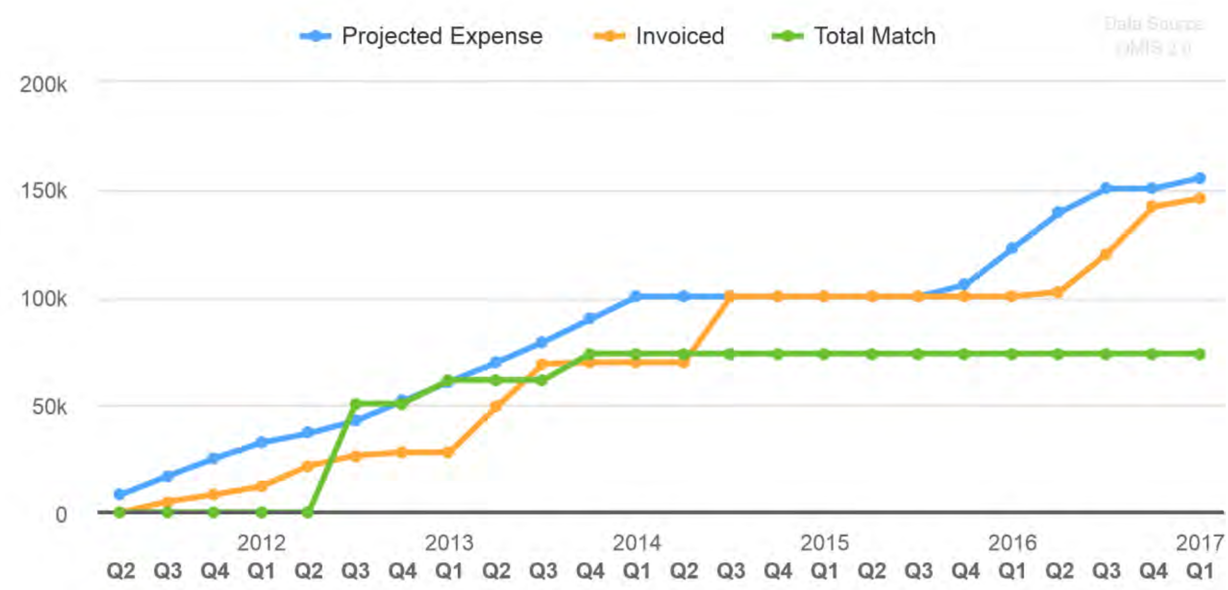
Deliverables

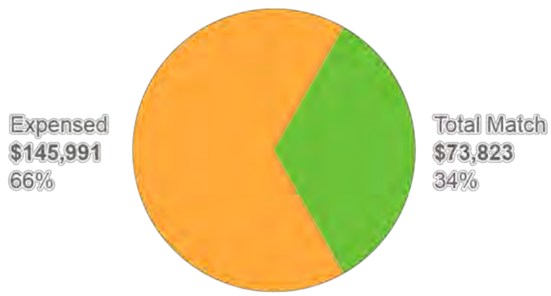
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	5/31/2017	

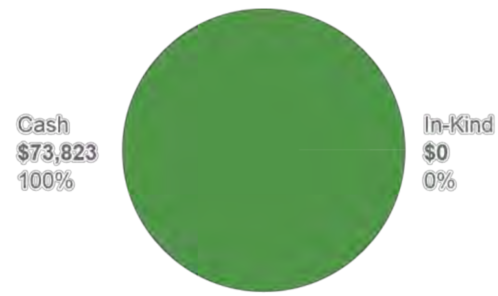
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$5,049.69	$5,049.69	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$3,290.73	$8,340.42	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$3,836.60	$12,177.02	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$9,451.10	$21,628.12	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$4,853.01	$26,481.13	$50,598.47	$50,598.47	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$1,441.84	$27,922.97	$0.00	$50,598.47	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$27,922.97	$10,965.84	$61,564.31	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$21,129.94	$49,052.91	$0.00	$61,564.31	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$19,998.54	$69,051.45	$0.00	$61,564.31	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$670.83	$69,722.28	$12,258.29	$73,822.60	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$69,722.28	$0.00	$73,822.60	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$69,722.28	$0.00	$73,822.60	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$30,637.72	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00

FY2015 Q2 (Jan-Mar)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$100,360.00	$0.00	$73,822.60	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$2,199.53	$102,559.53	$0.00	$73,822.60	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$17,569.12	$120,128.65	$0.00	$73,822.60	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$21,946.83	$142,075.48	$0.00	$73,822.60	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$3,915.50	$145,990.98	$0.00	$73,822.60	$0.00	$0.00
Total	$145,990.98		$73,822.60		$0.00	

TASK 220-NMSU: Establishment of Framework for Commercial Space Launch Standards

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Establishing a framework to capture a body of knowledge for commercial spaceport best practices will help current and future spaceport operation personnel by providing commercial and government documents that encompass commercial spaceport operations.

Project Outcomes

Develop an accepted framework and approval process for international industry consensus standards for consideration and use by the FAA in regulating commercial spaceport launch operations.

1. Enumerate the activities that must be performed at a "typical" spaceport,
2. Analyze and evaluate the structure of sub-activities that are or will be performed at a spaceport,
3. Identify the variables within this structure and the policies that impact them, and
4. Determine the ways in which changes in the relationship between these variables and spaceport policies will impact spaceport operation.

Summary of Output

It is a goal of this task to research and make available a broad range of spaceport operational information organized through a spaceport framework. Further it is our goal to the data management system capability easily accessible to the end user. The long term benefit to the spaceport operations community and to the FAA AST will be to: provide a "one stop shop" to those professionals already in the field of spaceport operations who want a current central location not only for FAA regulations, rules, standards, circulars, and guidelines, but also for relevant research conducted by industry, trade organizations and academia.

As spaceports become operational, those coming into the workforce will have easy access to the documents related to functional categories and sub-categories that pertain to their immediate professional development.

Utilize the framework and searchable DMS as a tool to educate students, new hires, and people working with launch site operators.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
AIAA		●
ATK		●
Bachner Consultants, Inc.		●
Ball Aerospace	Civil and Operational Space	●
Cimmaron Software Services Inc.		●
Digital Solutions		●
Marketing Consultant		●
NMSU Space Development Foundation		●
National Space Grant Foundation		●
New Mexico Spaceport Authority		●
New Mexico State University		●
SATWEST		●
Space News		●
Spaceport Sweden	Swedish Institute of Space Physics	●

The Boeing Company		•
CSSI Inc.		
Dynetics, Inc.	Test & Operations	
Jacobs Technology Inc.	NASA / White Sands Test facility	
Lockheed Martin Space Systems Company		
Pennsylvania State University	Aerospace Engineering	
Qinetiq		
Space Works Enterprises		
Spaceport America Consultants		
Spaceworks	Washington DC Operations	
The Tauri Group		
Webster University	Space Programs	
XCOR Aerospace, Inc.		

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2012	2010	10-C-CST-NMSU-002	$50,126.00
1/1/2012	5/31/2012	2010	10-C-CST-NMSU-004	$24,000.00
6/1/2012	5/31/2013	2010	10-C-CST-NMSU-006	$26,310.00
6/1/2012	5/31/2013	2012	10-C-CST-NMSU-007	$28,234.00
6/1/2012	5/31/2013	2012	10-C-CST-NMSU-008	$35,497.00
6/1/2012	5/31/2013	2012	10-C-CST-NMSU-010	$5,000.00
6/1/2013	5/31/2014	2012	10-C-CST-NMSU-011	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-NMSU-015	$18,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMSU-017	$3,000.00

6/1/2014	5/31/2015	2014	10-C-CST-NMSU-019	$0.00
6/1/2015	11/30/2015	2015	10-C-CST-NMSU-020	$50,168.00
12/1/2015	5/31/2016	2015	10-C-CST-NMSU-021	$0.00
6/1/2014	2/1/2017	2013	15-C-CST-NMSU-01	$6,184.91
Total				$246,519.91

Students

Name	Department	Discipline	Funded	Degree	Graduation
Marianne Bowers	Government	Government	●	Masters	12/9/2014
Jacob Deaven	Government	Government	●	Masters	12/15/2013
Emily Edwards	Engineering	Aerospace	●	Bachelors	
Hank Strevel	Government		●	Masters	12/1/2012

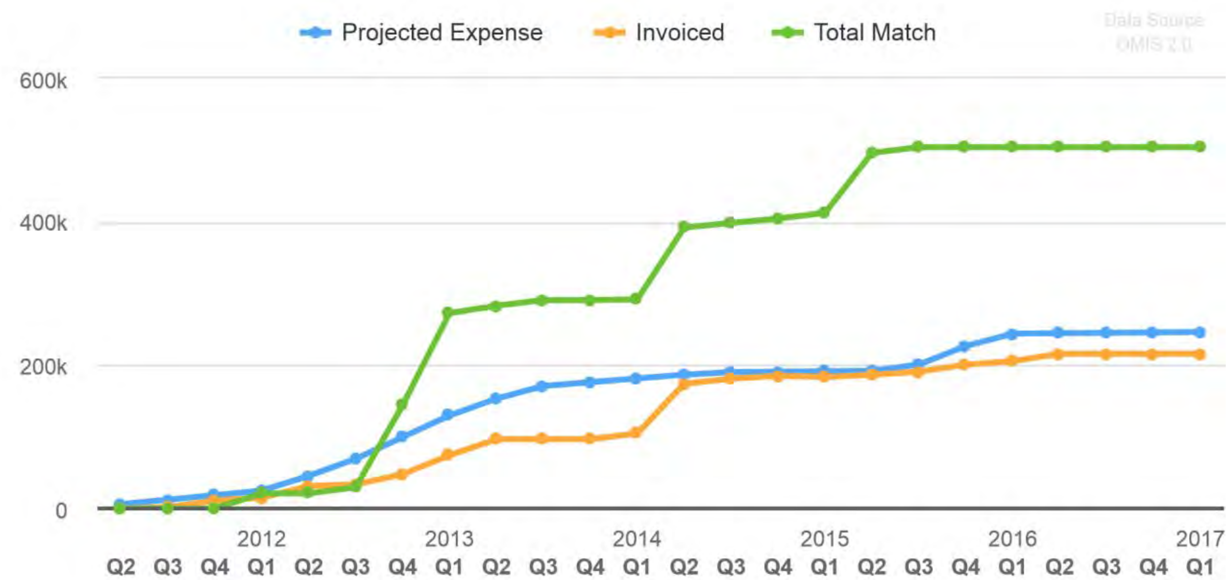
Deliverables

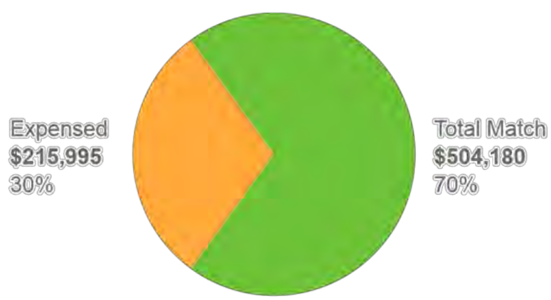
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	2/1/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$1,743.00	$1,743.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$9,265.00	$11,008.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$4,113.00	$15,121.00	$0.00	$0.00	$21,081.09	$21,081.09
FY2012 Q2 (Jan-Mar)	$16,207.31	$31,328.31	$0.00	$0.00	$0.00	$21,081.09
FY2012 Q3 (Apr-Jun)	$2,266.00	$33,594.31	$0.00	$0.00	$8,610.00	$29,691.09

FY2012 Q4 (Jul-Sep)	$14,237.00	$47,831.31	$0.00	$0.00	$114,380.00	$144,071.09
FY2013 Q1 (Oct-Dec)	$26,352.01	$74,183.32	$9,440.26	$9,440.26	$119,148.13	$263,219.22
FY2013 Q2 (Jan-Mar)	$22,539.41	$96,722.73	$10.00	$9,450.26	$10,308.60	$273,527.82
FY2013 Q3 (Apr-Jun)	$0.00	$96,722.73	$0.00	$9,450.26	$7,820.00	$281,347.82
FY2013 Q4 (Jul-Sep)	$0.00	$96,722.73	$0.00	$9,450.26	$0.00	$281,347.82
FY2014 Q1 (Oct-Dec)	$8,000.00	$104,722.73	$0.00	$9,450.26	$1,020.00	$282,367.82
FY2014 Q2 (Jan-Mar)	$69,336.00	$174,058.73	$2,999.00	$12,449.26	$97,283.00	$379,650.82
FY2014 Q3 (Apr-Jun)	$7,154.00	$181,212.73	$0.00	$12,449.26	$6,300.00	$385,950.82
FY2014 Q4 (Jul-Sep)	$4,000.02	$185,212.75	$0.00	$12,449.26	$6,180.00	$392,130.82
FY2015 Q1 (Oct-Dec)	-$1,639.08	$183,573.67	$0.00	$12,449.26	$8,000.00	$400,130.82
FY2015 Q2 (Jan-Mar)	$2,981.00	$186,554.67	$0.00	$12,449.26	$83,600.00	$483,730.82
FY2015 Q3 (Apr-Jun)	$4,267.00	$190,821.67	$0.00	$12,449.26	$8,000.00	$491,730.82
FY2015 Q4 (Jul-Sep)	$9,879.00	$200,700.67	$0.00	$12,449.26	$0.00	$491,730.82
FY2016 Q1 (Oct-Dec)	$4,966.00	$205,666.67	$0.00	$12,449.26	$0.00	$491,730.82
FY2016 Q2 (Jan-Mar)	$10,328.30	$215,994.97	$0.00	$12,449.26	$0.00	$491,730.82
FY2016 Q3 (Apr-Jun)	$0.00	$215,994.97	$0.00	$12,449.26	$0.00	$491,730.82
FY2016 Q4 (Jul-Sep)	$0.00	$215,994.97	$0.00	$12,449.26	$0.00	$491,730.82
FY2017 Q1 (Oct-Dec)	$0.00	$215,994.97	$0.00	$12,449.26	$0.00	$491,730.82
Total	$215,994.97		$12,449.26		$491,730.82	

TASK 228-NMT: Magneto-Elastic Sensing for Structural Health Monitoring

Lead University
New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Andrei Zagrai	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

Structural health monitoring (SHM) is seen as a key technology to reduce cost land improve safety of operation of modern space vehicles. Future spacecraft require sensing technologies that are reliable, multi-purpose, durable, and long-lived. These sensors need to detect and characterize impact damage from space debris, assess structural integrity of the spacecraft, provide information on structural interfaces, explore spacecraft electrical signature, enable reusable component requalification for flight, and possibly conduct non-contact inspection in space.

Project Outcomes

1. Develop adequate analytical and numerical models which describe magneto-elastic damage detection.
2. Investigate potential of the magneto-elastic SHM for characterization of interfaces in space structures and assessment of incipient fatigue damage before crack development.
3. Explore damage manifestation in the magneto-mechanical sensor signature and suggest respective feature extraction algorithms.
4. Consider methodologies for features classification / damage characterization that enable integration of the above mentioned components into a comprehensive SHM system."

Summary of Output

● Near-Term: explore if embedding sensors that can be pulsed with magnetic fields can yield reduction of space vehicle qualification time (and cost) via real time monitoring of structural interfaces during and after assembly, on-orbit diagnosis and system characterization – would enable rapid turnaround/flight

rates of RLVs
● Far-Term: deploy to industry if successful

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2012	2010	10-C-CST-NMT-002	$75,000.00
6/1/2012	5/31/2013	2010	10-C-CST-NMT-005	$37,500.00
5/31/2013	7/31/2014	2010	10-C-CST-NMT-009	$0.00
5/31/2013	7/31/2014	2013	10-C-CST-NMT-011	$19,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMT-014	$6,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMT-017	$7,000.00
5/31/2013	7/31/2014	2014	10-C-CST-NMT-020	$0.00
7/31/2014	6/1/2015	2014	10-C-CST-NMT-026	$0.00
6/1/2015	12/31/2015	2015	10-C-CST-NMT-028	$34,980.00
Total				$179,480.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Mary Anderson	Mechanical Engineering	Mechatronics Systems Engineering	●	Ph.D.	
David Conrad	Mechanical	Mechatronics Systems	●	Masters	5/15/2012

	Engineering	Engineering			
Benjamin Cooper	Mechanical Engineering	Mechatronics and Systems Engineering	●	Masters	5/15/2014
Jaclene Gutierrez	Mechanical Engineering		●	Bachelors	5/15/2011
Walter Kruse	Mechanical Engineering	Mechatronics Systems Engineering	●	Masters	5/1/2011
William Masker	Electrical Engineering	Electrical Engineering	●	Bachelors	5/15/2014
Daniel Meisner	Mechanical Engineering	Mechatronics Systems Engineering	●	Masters	5/15/2013
Joel Runnels	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/15/2014
Tracy Sjaardema	Electrical Engineering	Electrical Engineering	●	Bachelors	
Blaine Trujillo	Mechanical Engineering	Mechatronics Systems Engineering	●	Masters	5/12/2017

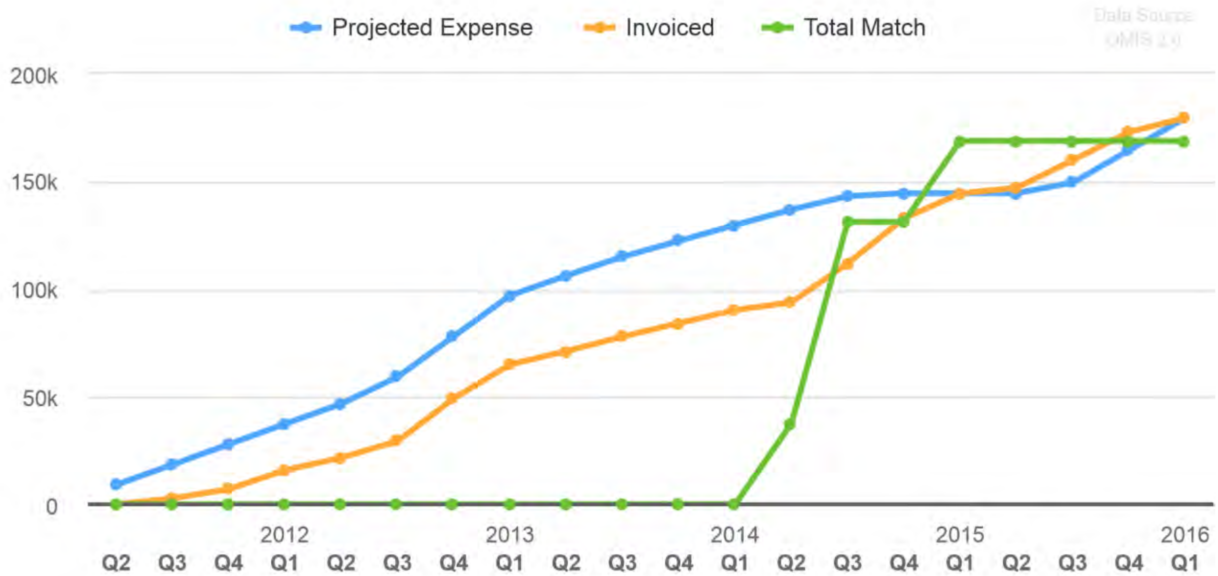
Deliverables

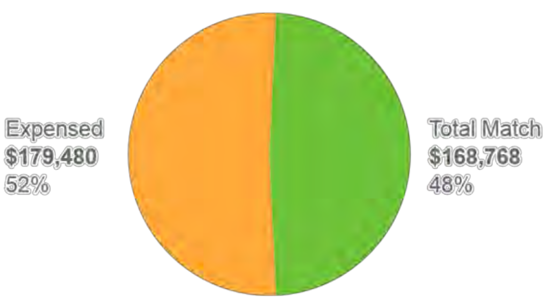
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	12/31/2015	

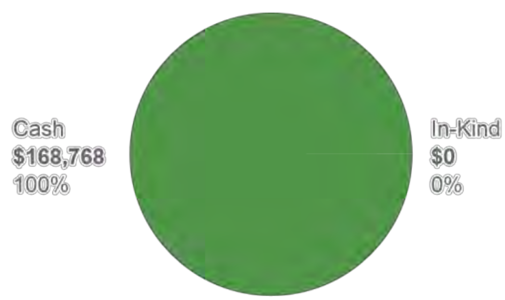
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$2,758.05	$2,758.05	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$4,290.76	$7,048.81	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$8,820.19	$15,869.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$5,798.97	$21,667.97	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$7,650.52	$29,318.49	$0.00	$0.00	$0.00	$0.00

FY2012 Q4 (Jul-Sep)	$19,845.14	$49,163.63	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$15,828.78	$64,992.41	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$6,150.00	$71,142.41	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$6,750.99	$77,893.40	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$6,260.64	$84,154.04	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$6,112.29	$90,266.33	$0.00	$0.00	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$3,540.53	$93,806.86	$37,596.32	$37,596.32	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$18,134.00	$111,940.86	$93,576.00	$131,172.32	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$20,820.70	$132,761.56	$0.00	$131,172.32	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$11,654.40	$144,415.96	$37,596.00	$168,768.32	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$2,585.69	$147,001.65	$0.00	$168,768.32	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$12,786.02	$159,787.67	$0.00	$168,768.32	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$13,101.83	$172,889.50	$0.00	$168,768.32	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$6,590.50	$179,480.00	$0.00	$168,768.32	$0.00	$0.00
Total	$179,480.00		$168,768.32		$0.00	

TASK 241-UF: High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles-UF

Lead University
University of Florida

Team

Name	Role	Primary
Mark Sheplak	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Tonya Lewis	Fiscal Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

Orbital commercial space vehicles require high-temperature sensors (~1000°C/1600°F) or various phases of flight (e.g, hypersonic flight, high speed reentry) or to monitor system and subsystem performance (e.g., for gas turbines or scramjets). Current commercial sensors are only capable of up to ~300°C/600°F.

Project Outcomes

- Design a sapphire optical lever microphone via multiphysics analytical modeling
- Develop thermocompression fabrication methods for the formation of devices with moving parts out of sapphire and platinum
- Development of techniques for ultrafast laser micromachining of sapphire for sensor and packaging fabrication
- Fabrication and packaging of pressure sensors optimized for low-noise and high-sensitivity while possessing minimal drift associated with changes in relative humidity, temperature, etc.
- Characterization of sensors in a simulated, high temperature, pressurized laboratory environment
- Implementation in a hypersonic flow facility (such as Arnold Engineering Development Center, etc.) and/or a gas turbine (such as the Capstone C60 microturbine at the University of Florida, etc.)"

Summary of Output

Design a fiber optic lever pressure sensor with a remote photo-diode optical readout. The microphone is composed of a compliant, platinum coated, sapphire diaphragm bonded over a cavity containing a single optical fiber. The diaphragm deflection is detected via intensity modulation due to the motion of the reflective platinum coated sapphire diaphragm. The optical signal is routed via the high temperature sapphire fiber to a remote photo-diode allowing for insulation of the electronics from the harsh environment.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015
■ ■ □	■ ■ ■ ■	■ □ □ □	□ □ □ □	□ □ □ □

Partners

Partner	Division	Primary
Space Florida		●
University of Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UF-003	$50,000.00
1/1/2012	12/31/2012	2011	10-C-CST-UF-005	$60,000.00
1/1/2013	5/31/2013	2012	10-C-CST-UF-008	$87,000.00
5/31/2013	5/31/2014	2012	10-C-CST-UF-014	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-UF-015	$60,000.00
5/31/2013	5/31/2014	2013	10-C-CST-UF-016	$15,000.00
6/1/2014	8/30/2015	2015	10-C-CST-UF-018	$0.00
Total				$272,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
David Mills	Mech and Aero Eng.	Mechanical Engineering	●	Ph.D.	5/1/2014

Deliverables

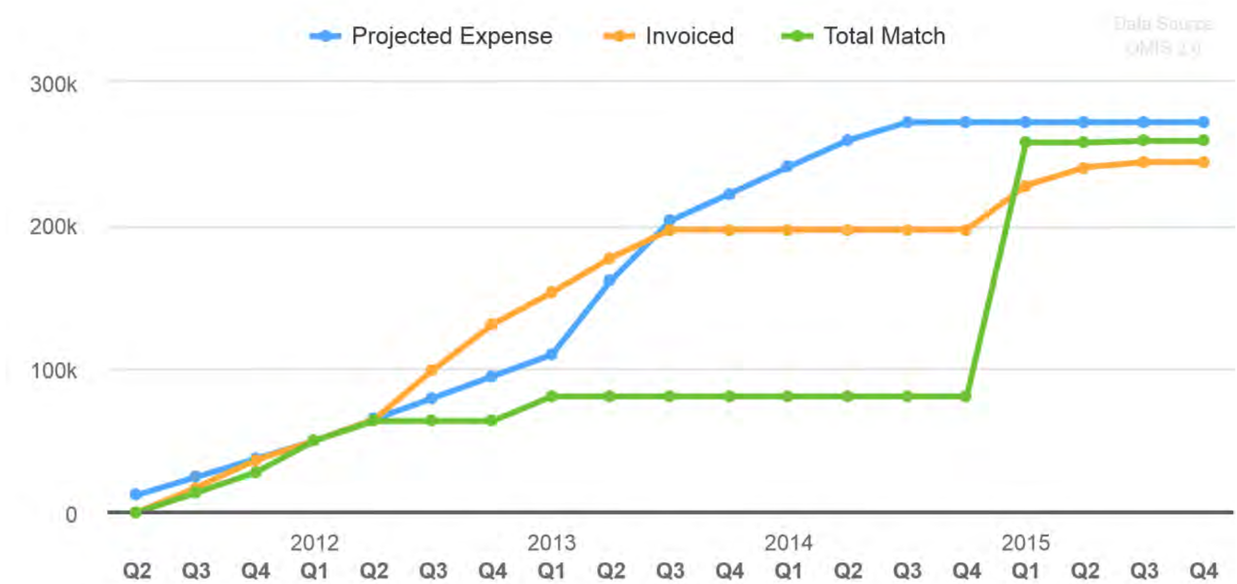
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final	1/3/2011	8/30/2015	

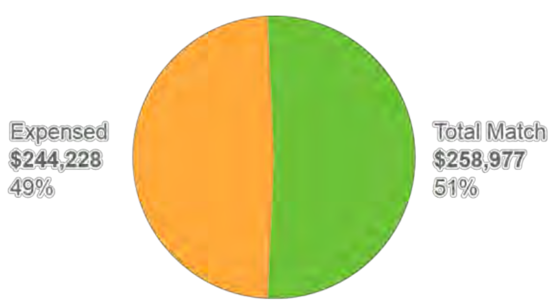
	invoice.				

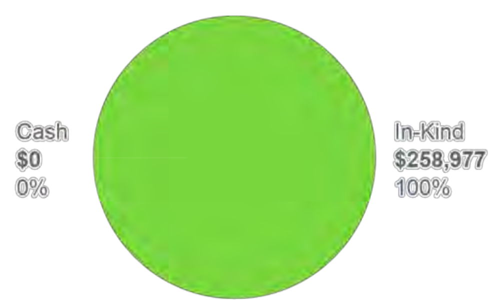
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

FY2011 Q3 (Apr-Jun)	$17,355.30	$17,355.30	$0.00	$0.00	$13,674.00	$13,674.00
FY2011 Q4 (Jul-Sep)	$19,059.91	$36,415.21	$0.00	$0.00	$14,278.16	$27,952.16
FY2012 Q1 (Oct-Dec)	$13,634.22	$50,049.43	$0.00	$0.00	$22,097.27	$50,049.43
FY2012 Q2 (Jan-Mar)	$14,657.94	$64,707.37	$0.00	$0.00	$13,674.00	$63,723.43
FY2012 Q3 (Apr-Jun)	$34,933.57	$99,640.94	$0.00	$0.00	$0.00	$63,723.43
FY2012 Q4 (Jul-Sep)	$31,412.65	$131,053.59	$0.00	$0.00	$0.00	$63,723.43
FY2013 Q1 (Oct-Dec)	$22,301.05	$153,354.64	$0.00	$0.00	$17,185.17	$80,908.60
FY2013 Q2 (Jan-Mar)	$24,229.96	$177,584.60	$0.00	$0.00	$0.00	$80,908.60
FY2013 Q3 (Apr-Jun)	$19,514.40	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2013 Q4 (Jul-Sep)	$0.00	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2014 Q1 (Oct-Dec)	$0.00	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2014 Q2 (Jan-Mar)	$0.00	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2014 Q3 (Apr-Jun)	$0.00	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2014 Q4 (Jul-Sep)	$0.00	$197,099.00	$0.00	$0.00	$0.00	$80,908.60
FY2015 Q1 (Oct-Dec)	$30,834.45	$227,933.45	$0.00	$0.00	$176,959.00	$257,867.60
FY2015 Q2 (Jan-Mar)	$12,722.65	$240,656.10	$0.00	$0.00	$0.00	$257,867.60
FY2015 Q3 (Apr-Jun)	$3,571.74	$244,227.84	$0.00	$0.00	$1,108.90	$258,976.50
FY2015 Q4 (Jul-Sep)	$0.00	$244,227.84	$0.00	$0.00	$0.00	$258,976.50
Total	$244,227.84		$0.00		$258,976.50	

TASK 241-FSU: High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles-FSU

Lead University

Florida State University

Team

Name	Role	Primary
William Oates	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Yolanda Lopez	Fiscal Admin	●

Research Area

2.0 Space Transportation Vehicles

Project Description

The study of hypersonic boundary layers is critical to the efficient design of hypersonic vehicles for rapid global and space access. The harsh environment makes conventional instrumentation unsuitable for timeaccurate, continuous, direct measurements. The development of a high temperature sensor for direct measurement of pressure is vital to the understanding of shock-wave/boundary layer interactions which directly influence critical vehicle characteristics such as lift, drag, and propulsion efficiency.

Project Outcomes

• Component testing of the sapphire pressure transducer will be conducted in the characterization facility at FSU. This will focus on analysis of the diaphragm and thermocompression bonding interface assembly. First, a mechanical load will be cycled quasi-statically on the diaphragm to determine its mechanical stiffness and linearity using aMTS load frame. Second, the sensor components will be exposed to high temperature in Oates' furnace at temperatures that can reach 1600°C. The furnace will be modified to allow for in situ mechanical loading of the sapphire diaphragm at elevated temperatures. A series of test will be conducted under different mechanical cyclic loads (quasi-static) and temperatures to quantify any changes in diaphragm stiffness and hysteresis.

• The benchmark diaphragm test will be compared to a fully functional sapphire pressure sensor in the hot jet facility. The sensor will be compared to commercial high temperature Kulite pressure transducers. These comparisons will first be conducted at room temperature. We will also use either an IR camera or thermocouples to monitor the temperature in the vicinity of the pressure transducers. Through these measurements we will obtain performance characteristics that describe the achievable pressure range and bandwidth as a function of temperature.

• Measurements will be carried out on a typical reentry capsule module both in the normal impingement and glancing flow.
COE

Summary of Output

Design a fiber optic lever pressure sensor with a remote photo-diode optical readout. The microphone is composed of a compliant, platinum coated, sapphire diaphragm bonded over a cavity containing a single optical fiber. The diaphragm deflection is detected via intensity modulation due to the motion of the reflective platinum coated sapphire diaphragm. The optical signal is routed via the high temperature sapphire fiber to a remote photo-diode allowing for insulation of the electronics from the harsh environment.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Florida State University		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-FSU-004	$41,310.00
1/1/2012	3/31/2012	2011	10-C-CST-FSU-006	$30,000.00
4/1/2012	5/31/2012	2012	10-C-CST-FSU-009	$21,000.00
6/1/2012	5/31/2013	2012	10-C-CST-FSU-011	$86,853.00
5/31/2013	5/31/2014	2012	10-C-CST-FSU-015	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-FSU-021	$60,000.00
5/31/2013	5/31/2014	2013	10-C-CST-FSU-022	$15,000.00
6/1/2014	5/31/2015	2014	10-C-CST-FSU-026	$0.00
6/1/2015	5/31/2016	2015	15-C-CST-FSU-01	$79,763.00
Total				$333,926.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Harman Bal	Mechanical Engineering	experimental mechanics and aerodynamics	●	Masters	12/6/2015
Justin Collins	Mechanical Engineering	Materials Science and Mechanics	●	Masters	12/6/2015

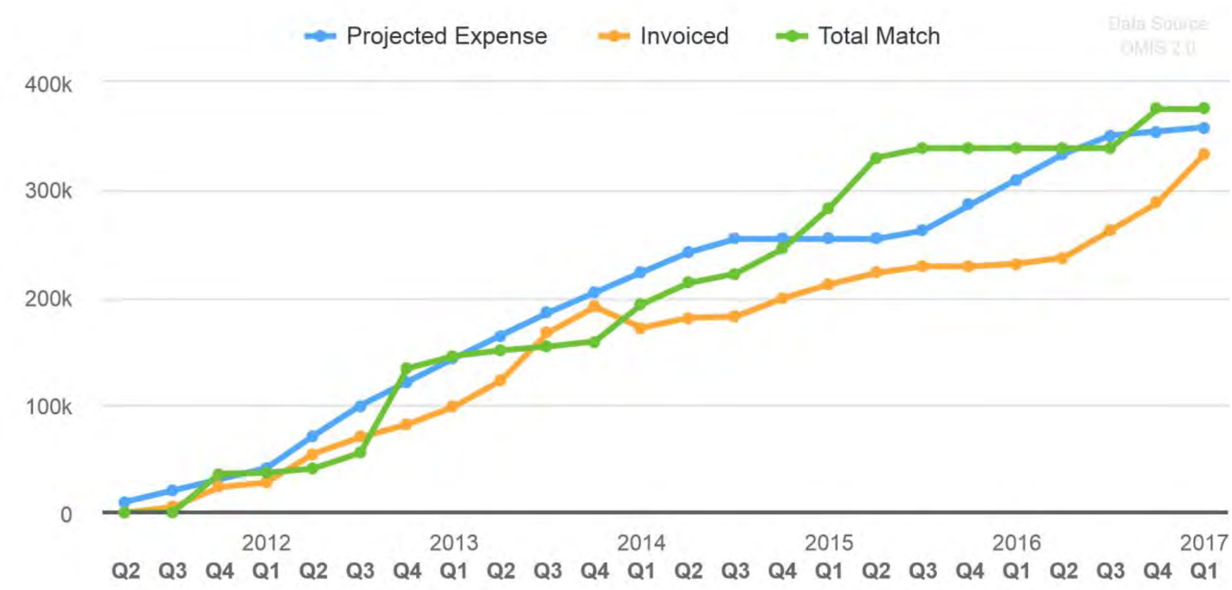
Deliverables

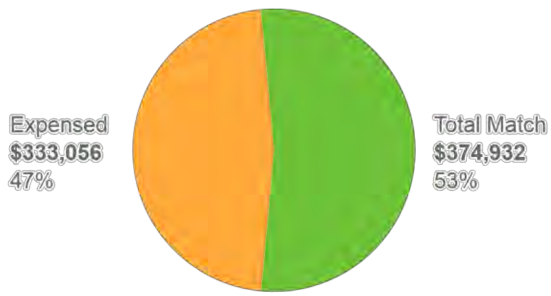
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	8/27/2018	

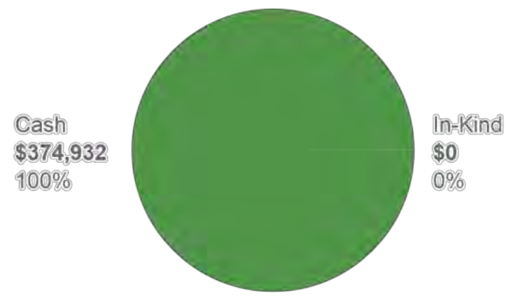
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$4,785.80	$4,785.80	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$18,747.68	$23,533.48	$36,045.63	$36,045.63	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$4,296.82	$27,830.30	$791.09	$36,836.72	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$26,721.55	$54,551.85	$4,003.87	$40,840.59	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$15,312.56	$69,864.41	$14,565.38	$55,405.97	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$11,915.30	$81,779.71	$78,424.93	$133,830.90	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$16,631.22	$98,410.93	$11,623.77	$145,454.67	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$24,238.96	$122,649.89	$5,196.83	$150,651.50	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$44,377.23	$167,027.12	$3,550.23	$154,201.73	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$23,944.32	$190,971.44	$4,736.63	$158,938.36	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	-$19,346.13	$171,625.31	$34,454.26	$193,392.62	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$9,285.53	$180,910.84	$19,875.54	$213,268.16	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$1,101.62	$182,012.46	$8,655.36	$221,923.52	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$16,821.02	$198,833.48	$22,816.21	$244,739.73	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$13,194.43	$212,027.91	$38,373.83	$283,113.56	$0.00	$0.00

FY2015 Q2 (Jan-Mar)	$10,512.34	$222,540.25	$46,587.40	$329,700.96	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$6,177.14	$228,717.39	$8,879.63	$338,580.59	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.78	$228,718.17	$0.00	$338,580.59	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$2,410.79	$231,128.96	$0.00	$338,580.59	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$5,775.99	$236,904.95	$0.00	$338,580.59	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$25,222.36	$262,127.31	$0.00	$338,580.59	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$25,967.90	$288,095.21	$36,351.06	$374,931.65	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$44,961.18	$333,056.39	$0.00	$374,931.65	$0.00	$0.00
Total	$333,056.39		$374,931.65		$0.00	

TASK 244-UF: Autonomous Rendezvous and Docking for Space Debris Mitigation-UF

Lead University
University of Florida

Team

Name	Role	Primary
Norm Fitz-Coy	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Tonya Lewis	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Launch vehicles are nonlinear dynamic systems that require skill to maneuver in tight spaces as required for docking and berthing maneuvers (DBMs). This problem is akin to the difficult task of parallel parking for ground vehicles. However, whereas the latter task can be based on a simple kinematic model, DBMs for space vehicles require the use of more complex dynamic models due to the need to model the less precise actuators (e.g., thrusters) and to explicitly consider the inertia of the vehicle due to the lack of friction or environmental resistance.

Project Outcomes

The motion planning will be based on Sampling Based Model Predictive Control (SBMPC), which is a synergy between the Model Predictive Control (MPC) paradigm used by control researchers and engineers and the sampling based planning methodologies popularized by robotics and artificial intelligence researchers. SBMPC, like MPC, uses dynamic models in planning and treats the inputs to the system as the optimization parameters. However, unlike MPC, it optimizes uses sampling and A*-type optimization, which enables it to avoid local minimum and be used for real-time planning and control.

Summary of Output

This project will develop the technology needed to automate DBM.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016

Partners

Partner	Division	Primary
Space Florida		●
University of Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UF-002	$30,000.00
1/1/2012	5/31/2012	2012	10-C-CST-UF-006	$31,500.00
6/1/2012	12/31/2012	2012	10-C-CST-UF-009	$0.00
6/1/2012	5/31/2013	2012	10-C-CST-UF-011	$100,000.00
6/1/2013	4/30/2014	2012	10-C-CST-UF-013	$0.00
5/1/2014	4/30/2015	2014	10-C-CST-UF-017	$0.00
4/30/2015	8/31/2015	2014	10-C-CST-UF-019	$0.00
4/30/2015	8/31/2015	2014	10-C-CST-UF-020	$14,000.54
9/1/2015	12/31/2015	2015	15-C-CST-UF-01	$0.00
Total				$175,500.54

Students

Name	Department	Discipline	Funded	Degree	Graduation
Kathryn Cason	Mechanical & Aeospace	Aerospace Engineering	●	Ph.D.	
Takashi Hiramatsu	Mech & Aero	Aerospace	●	Ph.D.	5/5/2012
Shawn Johnson	Mechnical and Aerospace	Aerospace	●	Ph.D.	5/5/2012
Tristan Newman	Mech & Aero	Aerospace	●	Masters	8/27/2015
Bungo Shiotani	Mech & Aero	Aerospace	●	Ph.D.	8/1/2016

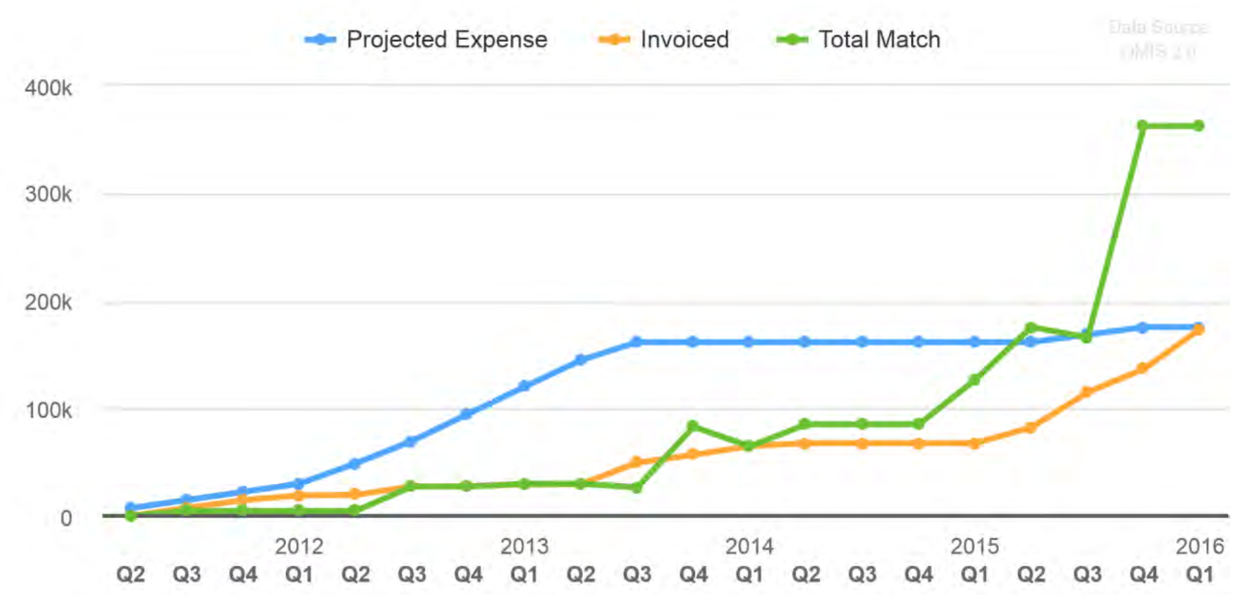
Deliverables

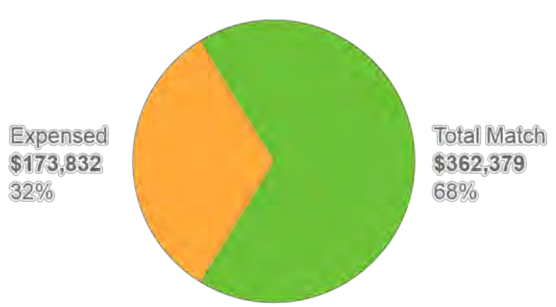
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	12/31/2015	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$7,419.60	$7,419.60	$0.00	$0.00	$4,667.00	$4,667.00
FY2011 Q4 (Jul-Sep)	$7,225.22	$14,644.82	$0.00	$0.00	$0.00	$4,667.00
FY2012 Q1 (Oct-Dec)	$4,469.20	$19,114.02	$0.00	$0.00	$0.00	$4,667.00
FY2012 Q2 (Jan-Mar)	$446.93	$19,560.95	$0.00	$0.00	$0.00	$4,667.00
FY2012 Q3 (Apr-Jun)	$7,907.14	$27,468.09	$0.00	$0.00	$22,801.09	$27,468.09
FY2012 Q4 (Jul-Sep)	$0.00	$27,468.09	$0.00	$0.00	$0.00	$27,468.09
FY2013 Q1 (Oct-Dec)	$1,803.94	$29,272.03	$0.00	$0.00	$2,406.80	$29,874.89
FY2013 Q2 (Jan-Mar)	$249.86	$29,521.89	$0.00	$0.00	$0.00	$29,874.89
FY2013 Q3 (Apr-Jun)	$19,965.71	$49,487.60	$0.00	$0.00	-$3,264.12	$26,610.77
FY2013 Q4 (Jul-Sep)	$7,299.05	$56,786.65	$0.00	$0.00	$56,263.53	$82,874.30
FY2014 Q1 (Oct-Dec)	$8,115.28	$64,901.93	$0.00	$0.00	-$18,265.38	$64,608.92
FY2014 Q2 (Jan-Mar)	$2,826.76	$67,728.69	$20,516.14	$20,516.14	$0.00	$64,608.92
FY2014 Q3 (Apr-Jun)	$0.00	$67,728.69	$0.00	$20,516.14	$0.00	$64,608.92
FY2014 Q4 (Jul-Sep)	$0.00	$67,728.69	$0.00	$20,516.14	$0.00	$64,608.92
FY2015 Q1 (Oct-Dec)	$0.00	$67,728.69	$0.00	$20,516.14	$41,357.35	$105,966.27
FY2015 Q2 (Jan-Mar)	$14,483.24	$82,211.93	$0.00	$20,516.14	$49,019.00	$154,985.27
FY2015 Q3 (Apr-Jun)	$32,794.37	$115,006.30	$0.00	$20,516.14	-$9,458.58	$145,526.69
FY2015 Q4 (Jul-Sep)	$21,744.60	$136,750.90	$196,336.50	$216,852.64	$0.00	$145,526.69
FY2016 Q1 (Oct-Dec)	$37,081.14	$173,832.04	$0.00	$216,852.64	$0.00	$145,526.69
Total	$173,832.04		$216,852.64		$145,526.69	

TASK 253-UCF: Ultra High Temperature Composites For Thermal Protection Systems

Lead University
University of Central Florida

Team

Name	Role	Primary
Jihua Gou	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Heliana Forero	Fiscal Admin	●
Nagy Youssef	Fiscal Admin	●
Yeliza Burleson	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

The objective of this proposed project is to develop a low-cost nanostructured hybrid composites TPS. The proposed new TPS system will consist of porous “skeleton” based on polymer derived ceramic (PDC) matrix composites and nano-modified ablator (nano-modified phenolic or cyanate ester). Extensive ground-based testing on the composites TPS will be conducted at UCF and FSU FCAAP.

Project Outcomes

• Development of ceramic composites porous “skeleton” based on PDC composites (Q1)
• Development of nanostructured ablator (phenolic and cyanate ester) (Q2)
• Development of hybrid composite TPS (Q3)
• Oxyacetylene torch test and shock tube test (Q2 & Q3)
• Hot jet exhaust test (Q4)

Summary of Output

The proposed work will provide a rigorous scientific methodology for development of multifunctional, nanostructured, light-weight, thermal protection systems (TPS) for high-speed air-breathing vehicles which have encountered many daunting challenges in various areas spanning thermal management, hypersonic aerodynamics, aerothermodynamics and aero-propulsion integration.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Space Florida		●
University of Central Florida	Mechanica, Materials & Aerospace Engineering	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
2/15/2011	2/14/2012	2010	10-C-CST-UCF-002	$89,090.00
2/15/2011	2/14/2013	2010	10-C-CST-UCF-005	$0.00
1/1/2012	5/31/2012	2012	10-C-CST-UCF-006	$42,000.00
6/1/2012	5/31/2013	2012	10-C-CST-UCF-008	$114,000.00
5/31/2013	12/31/2013	2012	10-C-CST-UCF-010	$0.00
12/31/2013	5/31/2014	2013	10-C-CST-UCF-011	$10,000.00
12/31/2013	5/31/2014	2013	10-C-CST-UCF-012	$27,000.00
6/1/2014	4/30/2015	2014	10-C-CST-UCF-013	$0.00
5/1/2015	5/31/2016	2015	15-C-CST-UCF-01	$35,000.00
6/1/2016	5/31/2017	2015	15-C-CST-UCF-04	$0.00
Total				$317,090.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Cassandra Carpenter	Mechanical and Aerospace Engineering	Mechanical Engineering	●	Masters	5/10/2014

Chris Harris	Mechanical and Aerospace Engineering	Mechanical Engineering	●	Masters	5/1/2017
Jeremey Lawrence	Industrial Engineering	Manufacturing Engineering	●	Bachelors	5/1/2013
Donovan Lui	Mechanical and Aerospace Engineering	Mechanical Engineering	●	Masters	5/10/2014
Xin Wang	Materials Science and Engineering	Materials Science and Engineering	●	Ph.D.	8/5/2017
Hongjiang Yang	Mechanical and Aerospace Engineering	Mechanical Engineering	●	Ph.D.	5/5/2017

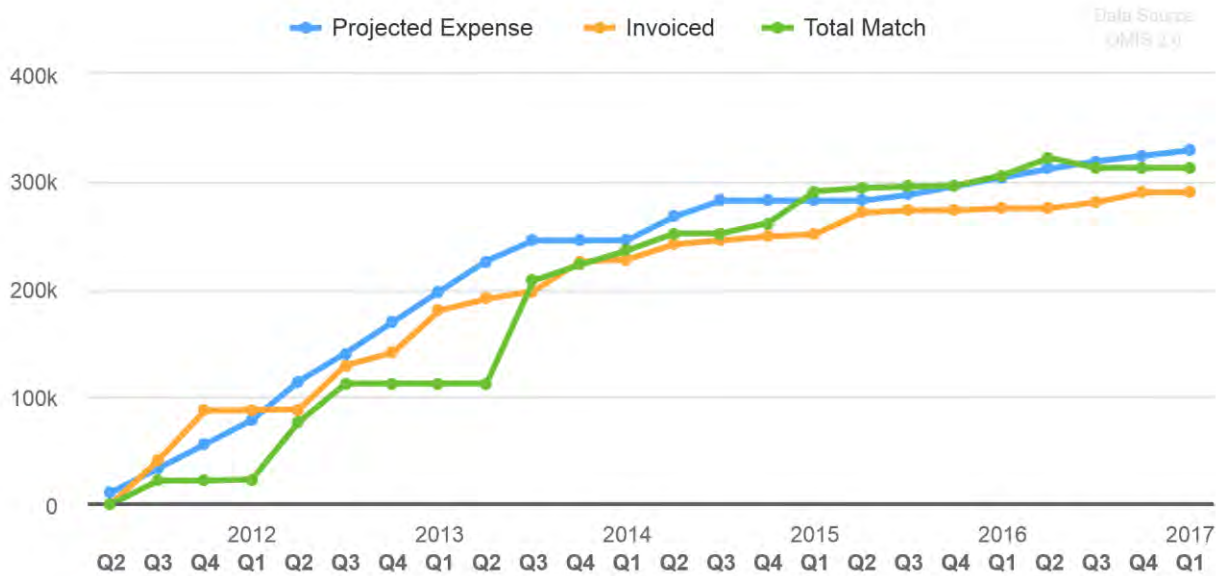
Deliverables

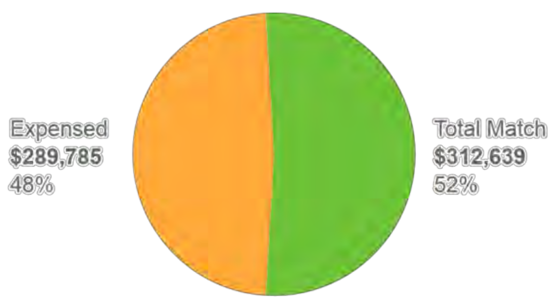
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	2/15/2011	7/31/2018	
1	Report results of thermal ablation testing and analysis of ultra-high temperature composites for thermal protection systems in liquid rocket engine plume. MS Type: NARP MS Year 2018A	2/15/2011	7/31/2018	

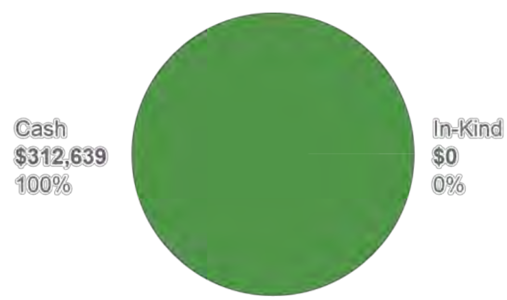
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$40,761.24	$40,761.24	$21,937.26	$21,937.26	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$46,122.56	$86,883.80	$0.00	$21,937.26	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$682.20	$87,566.00	$1,144.05	$23,081.31	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$489.87	$88,055.87	$53,362.76	$76,444.07	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$41,151.70	$129,207.57	$35,727.00	$112,171.07	$0.00	$0.00

FY2012 Q4 (Jul-Sep)	$11,481.00	$140,688.57	$0.00	$112,171.07	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$39,326.00	$180,014.57	$0.00	$112,171.07	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$10,765.06	$190,779.63	$0.00	$112,171.07	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$7,237.49	$198,017.12	$95,604.24	$207,775.31	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$27,528.05	$225,545.17	$14,846.73	$222,622.04	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$1,957.94	$227,503.11	$13,156.42	$235,778.46	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$13,966.74	$241,469.85	$15,895.87	$251,674.33	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$3,790.18	$245,260.03	$0.00	$251,674.33	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$3,466.93	$248,726.96	$9,691.03	$261,365.36	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$2,121.03	$250,847.99	$29,442.46	$290,807.82	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$20,076.91	$270,924.90	$3,114.72	$293,922.54	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$2,179.11	$273,104.01	$1,150.65	$295,073.19	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$273,104.01	$1,144.05	$296,217.24	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$1,938.10	$275,042.11	$9,468.92	$305,686.16	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$275,042.11	$16,208.41	$321,894.57	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$5,592.27	$280,634.38	-$9,255.66	$312,638.91	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$9,150.31	$289,784.69	$0.00	$312,638.91	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$289,784.69	$0.00	$312,638.91	$0.00	$0.00
Total	$289,784.69		$312,638.91		$0.00	

TASK 297-FSU: Technical Oversight and OMIS Integration

Lead University
Florida State University

Team

Name	Role	Primary
Farrukh Alvi	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Yolanda Lopez	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Florida State University (FSU) through the Florida Center for Advanced Aeropropulsion (FCAAP) is a core partner of the FAA Center of Excellence for Commercial Space Transportation (CoE) and as such is tasked with coordination and management of research programs conducted by and for the partners and other stakeholders of the CoE. The proposal requests funding to license for an additional year the Orion OMIS web based management software system.

Project Outcomes

COE CST Management

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
Florida State University	Mechanical Engineering	●
Orion America Technologies		●

Space Florida		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/1/2011	8/31/2014	2011	10-C-CST-FSU-008	$49,821.96
6/1/2012	5/31/2013	2012	10-C-CST-FSU-012	$50,000.00
6/1/2012	5/31/2013	2012	10-C-CST-FSU-014	$5,000.00
5/31/2013	5/31/2014	2012	10-C-CST-FSU-017	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-FSU-024	$0.00
Total				$104,821.96

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

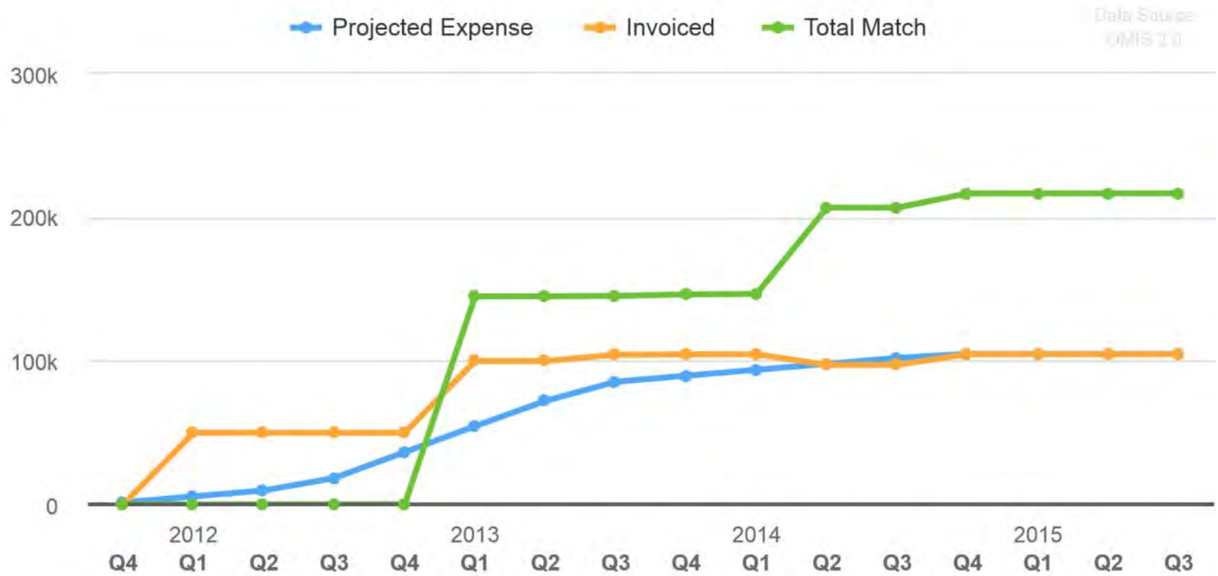
Deliverables

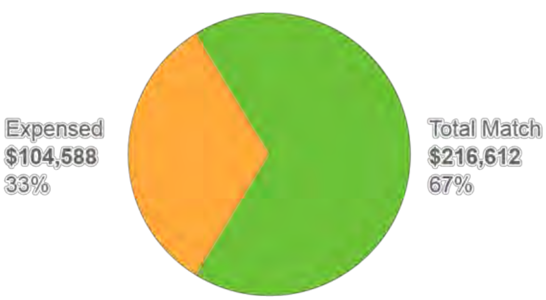
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/1/2011	5/31/2015	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$49,821.96	$49,821.96	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$0.00	$49,821.96	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$49,821.96	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$49,821.96	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$50,000.00	$99,821.96	$34,871.31	$34,871.31	$110,000.00	$110,000.00

FY2013 Q2 (Jan-Mar)	$0.00	$99,821.96	$0.00	$34,871.31	$0.00	$110,000.00
FY2013 Q3 (Apr-Jun)	$4,402.72	$104,224.68	$352.51	$35,223.82	$0.00	$110,000.00
FY2013 Q4 (Jul-Sep)	$213.22	$104,437.90	$1,020.27	$36,244.09	$0.00	$110,000.00
FY2014 Q1 (Oct-Dec)	$82.42	$104,520.32	$306.38	$36,550.47	$0.00	$110,000.00
FY2014 Q2 (Jan-Mar)	-$7,421.22	$97,099.10	-$15,884.26	$20,666.21	$76,003.20	$186,003.20
FY2014 Q3 (Apr-Jun)	$54.95	$97,154.05	$0.00	$20,666.21	$0.00	$186,003.20
FY2014 Q4 (Jul-Sep)	$7,433.58	$104,587.63	$9,942.46	$30,608.67	$0.00	$186,003.20
FY2015 Q1 (Oct-Dec)	$0.00	$104,587.63	$0.00	$30,608.67	$0.00	$186,003.20
FY2015 Q2 (Jan-Mar)	$0.00	$104,587.63	$0.00	$30,608.67	$0.00	$186,003.20
FY2015 Q3 (Apr-Jun)	$0.00	$104,587.63	$0.00	$30,608.67	$0.00	$186,003.20
Total	$104,587.63		$30,608.67		$186,003.20	

TASK 299-NMT: Nitrous Oxide Composite Tank Testing

Lead University
New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Seok Bin Lim	Principal Investigator	●
Andrei Zagrai	Principal Investigator	
Yvonne Tran	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

The objective of the proposed research activity is to investigate the fracture and fragmentation behavior of composite fuel tanks in commercial space vehicles. In this proposed effort, a tank consisting of an aluminum liner with a composite outer wrap will be pressurized to failure. A tank approximately 18 in. long and 6 in. diameter with a carbon fiber wrapped aluminum inner liner will be evaluated. The tank represents a current space-industry grade fuel tank. Two of these tests are planned to demonstrate repeatability and the capability for prediction using available computational programs.

Project Outcomes

The project is divided into two tasks. Task 1 includes two tests to failure of a full tank consisting of a carbon fiber wrapped aluminum inner liner and Task 2 is development of the computational simulation model. Once Task 2 is completed, a numerical simulation of full tank tests with reasonable accuracy will be available.

Summary of Output

- Tests have been performed with aluminum plates and with one composite plate material. Both tests showed shear failures of the plate material.
- The test of the composite material resulted in the delamination of the composite at approximately mid-thickness, even though failure was through shear at edge

Technical Status

FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology	Mechanical Engineering	●
Orion America Technologies		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-NMT-006	$121,227.00
6/1/2013	5/31/2014	2012	10-C-CST-NMT-008	$0.00
6/1/2013	5/31/2014	2012	10-C-CST-NMT-010	$0.00
6/1/2013	5/31/2014	2013	10-C-CST-NMT-016	$33,000.00
6/1/2013	5/31/2014	2013	10-C-CST-NMT-019	$9,000.00
6/1/2014	5/31/2015	2014	10-C-CST-NMT-024	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-NMT-027	$76,738.00
6/1/2015	5/31/2016	2014	10-C-CST-NMT-30	$7,756.00
6/1/2015	5/31/2016	2015	15-C-CST-NMT-05	$105,000.00
6/1/2016	5/31/2017	2016	15-C-CST-NMT-08	$0.00
6/1/2016	8/31/2017	2016	15-C-CST-NMT-10	$100,000.00
Total				$452,721.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Steven Bayley	Mechanical Engineering	Thermal/Fluids	●	Masters	

Antonio Garcia	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/1/2017
June Stanley	Mechanical Engineering	Explosives	●	Masters	5/15/2014
Jarrett Stotts	Mechanical	Mechanical	●	Bachelors	5/15/2014
Steven Sweeney	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/1/2017
Jessica Tobin	Mechanical		●	Masters	
Joshua carroll	Mining Engineering		●	Bachelors	

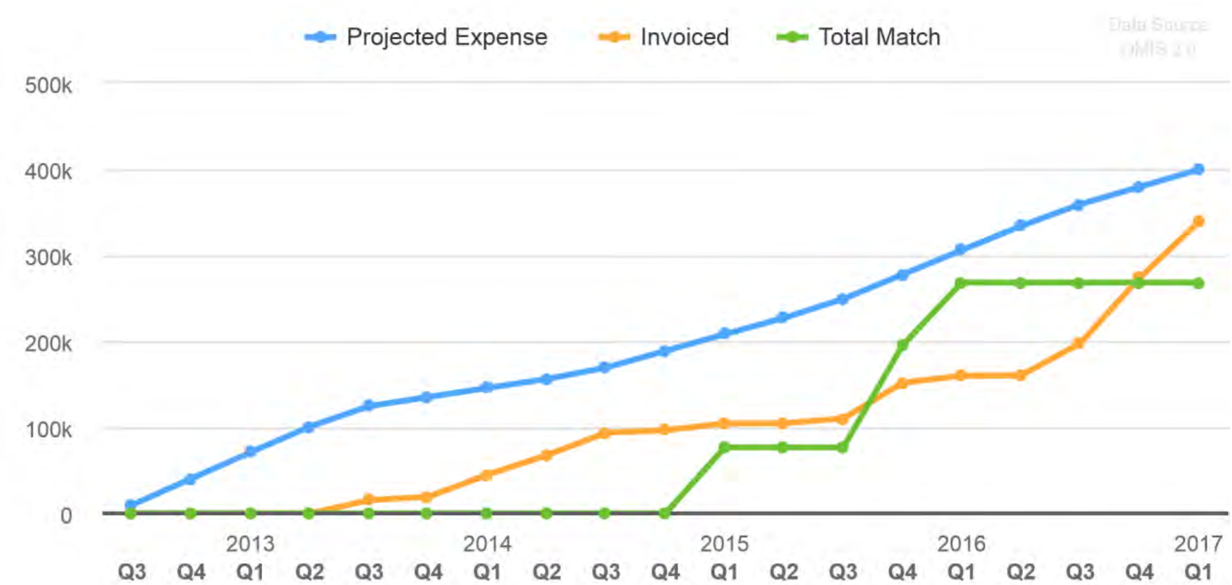
Deliverables

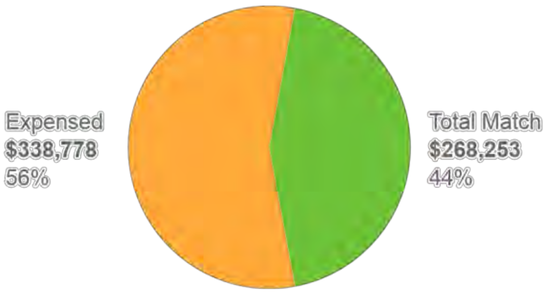
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2012	8/31/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$15,454.57	$15,454.57	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$3,862.59	$19,317.16	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$25,792.49	$45,109.65	$0.00	$0.00	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$22,589.32	$67,698.97	$0.00	$0.00	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$26,198.00	$93,896.97	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$2,740.89	$96,637.86	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$7,928.70	$104,566.56	$0.00	$0.00	$76,738.00	$76,738.00
FY2015 Q2 (Jan-Mar)	$234.14	$104,800.70	$0.00	$0.00	$0.00	$76,738.00
FY2015 Q3 (Apr-Jun)	$5,427.22	$110,227.92	$0.00	$0.00	$0.00	$76,738.00
FY2015 Q4 (Jul-Sep)	$41,570.97	$151,798.89	$118,515.00	$118,515.00	$0.00	$76,738.00
FY2016 Q1 (Oct-Dec)	$8,186.65	$159,985.54	$0.00	$118,515.00	$73,000.00	$149,738.00
FY2016 Q2 (Jan-Mar)	$288.82	$160,274.36	$0.00	$118,515.00	$0.00	$149,738.00

FY2016 Q3 (Apr-Jun)	$37,446.66	$197,721.02	$0.00	$118,515.00	$0.00	$149,738.00
FY2016 Q4 (Jul-Sep)	$76,160.39	$273,881.41	$0.00	$118,515.00	$0.00	$149,738.00
FY2017 Q1 (Oct-Dec)	$64,896.55	$338,777.96	$0.00	$118,515.00	$0.00	$149,738.00
Total	$338,777.96		$118,515.00		$149,738.00	

TASK 300-FIT: COE CST Collaboration Coordination

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Provide administrative coordination and to execute the third Annual Technical Meeting (ATM3) in Washington, DC on 28-30 October 2013.

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
□ ■	■ ■ □ ■	■ □ □ □	■ ■ ■ ■	■ ■ ■ ■	■

Partners

Partner	Division	Primary
CEAVCO	Audio Visual	●
Florida Institute of Technology		●
Orion America Technologies		●
Secor Strategies		●

Space Florida		•
NASA	Ames Research Center	

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-FIT-012	$120,000.00
6/1/2013	5/31/2014	2012	10-C-CST-FIT-015	$0.00
6/1/2013	5/31/2014	2012	10-C-CST-FIT-019	$0.00
6/1/2013	5/31/2014	2013	10-C-CST-FIT-020	$99,000.00
6/1/2013	5/31/2014	2014	10-C-CST-FIT-024	$34,349.00
6/1/2014	5/31/2015	2014	10-C-CST-FIT-025	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-FIT-026	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-FIT-027	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-FIT-028	$120,000.00
6/1/2014	5/31/2015	2014	10-C-CST-FIT-030	$40,260.00
6/1/2015	5/31/2016	2014	10-C-CST-FIT-031	$23,604.00
6/1/2016	5/31/2017	2015	15-C-CST-FIT-02	$0.00
9/16/2014	9/30/2018	2013	15-C-CST-FIT-029-004	$9,575.00
Total				$446,788.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

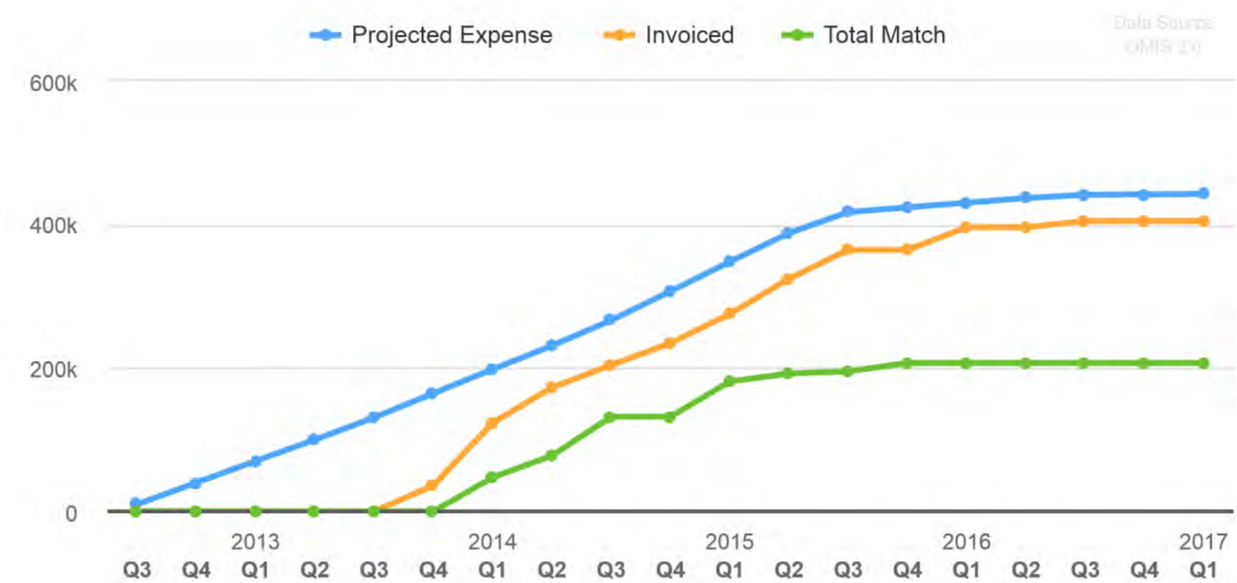
#	Deliverable	Start Date	Due Date	Accepted

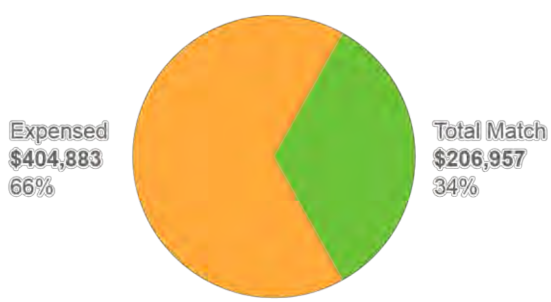
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2012	9/30/2018	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$36,274.72	$36,274.72	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$87,177.38	$123,452.10	$0.00	$0.00	$47,502.00	$47,502.00
FY2014 Q2 (Jan-Mar)	$49,450.99	$172,903.09	$11,250.00	$11,250.00	$19,000.80	$66,502.80
FY2014 Q3 (Apr-Jun)	$31,164.71	$204,067.80	$0.00	$11,250.00	$54,272.00	$120,774.80
FY2014 Q4 (Jul-Sep)	$30,629.95	$234,697.75	$0.00	$11,250.00	$0.00	$120,774.80
FY2015 Q1 (Oct-Dec)	$40,599.86	$275,297.61	$0.00	$11,250.00	$49,077.95	$169,852.75
FY2015 Q2 (Jan-Mar)	$49,250.81	$324,548.42	$0.00	$11,250.00	$11,227.75	$181,080.50
FY2015 Q3 (Apr-Jun)	$40,074.58	$364,623.00	$0.00	$11,250.00	$2,920.00	$184,000.50
FY2015 Q4 (Jul-Sep)	$0.00	$364,623.00	$0.00	$11,250.00	$11,706.78	$195,707.28
FY2016 Q1 (Oct-Dec)	$31,576.31	$396,199.31	$0.00	$11,250.00	$0.00	$195,707.28
FY2016 Q2 (Jan-Mar)	$0.00	$396,199.31	$0.00	$11,250.00	$0.00	$195,707.28
FY2016 Q3 (Apr-Jun)	$8,683.69	$404,883.00	$0.00	$11,250.00	$0.00	$195,707.28
FY2016 Q4 (Jul-Sep)	$0.00	$404,883.00	$0.00	$11,250.00	$0.00	$195,707.28
FY2017 Q1 (Oct-Dec)	$0.00	$404,883.00	$0.00	$11,250.00	$0.00	$195,707.28
Total	$404,883.00		$11,250.00		$195,707.28	

TASK 303-NMT: OMIS Integration and COE Program Support

Lead University
New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Andrei Zagrai	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area
5.0 Program Management

Project Description

Provide OMIS and COE program support

Project Outcomes

Summary of Output

Technical Status

FY2013	FY2014	FY2015	FY2016	FY2017
■ ■	■ ■ ■ □	□ □ □ □	□ □ □ □	□

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology	Mechanical Engineering	●
Orion America Technologies		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2013	5/31/2014	2012	10-C-CST-NMT-010	$50,000.00
3/1/2014	11/30/2014	2014	10-C-CST-NMT-021	$50,000.00
6/1/2014	5/31/2015	2014	10-C-CST-NMT-022	$0.00
7/18/2014	5/31/2015	2014	10-C-CST-NMT-025	$50,000.00
6/1/2015	9/30/2015	2015	10-C-CST-NMT-029 PW	$50,000.00
10/1/2015	5/31/2016	2015	15-C-CST-NMT-01	$50,000.00
10/1/2015	5/31/2016	2015	15-C-CST-NMT-02 P	$7,000.00
6/1/2016	5/31/2017	2016	15-C-CST-NMT-06	$50,000.00
Total				$307,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

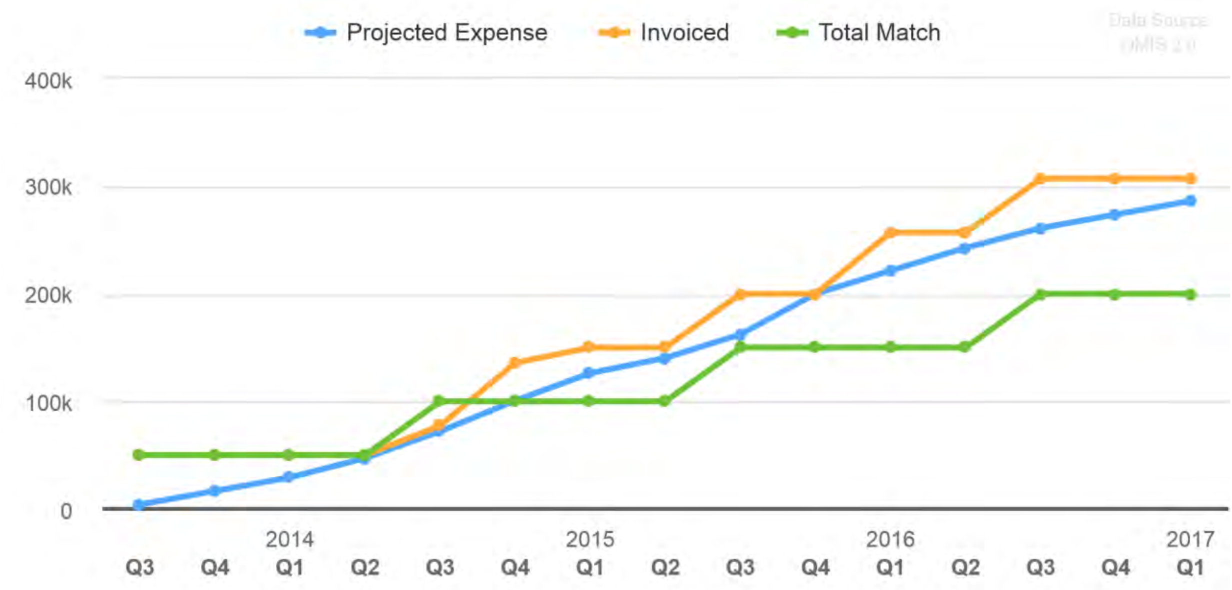
Deliverables

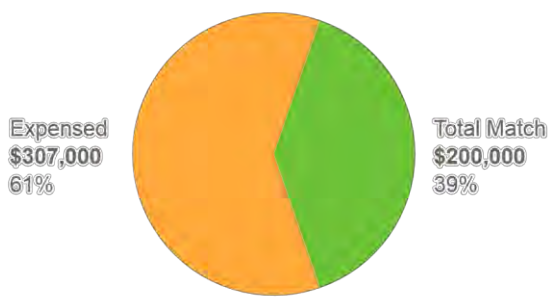
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2013	5/31/2018	

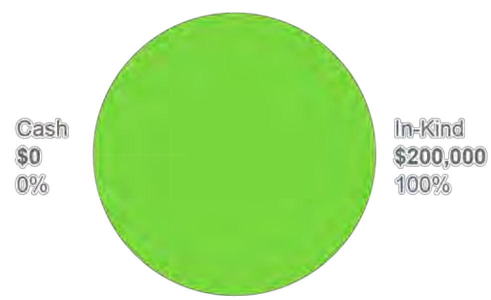
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2013 Q3 (Apr-Jun)	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00	$50,000.00
FY2013 Q4 (Jul-Sep)	$0.00	$50,000.00	$0.00	$0.00	$0.00	$50,000.00
FY2014 Q1 (Oct-Dec)	$0.00	$50,000.00	$0.00	$0.00	$0.00	$50,000.00
FY2014 Q2 (Jan-Mar)	$0.00	$50,000.00	$0.00	$0.00	$0.00	$50,000.00
FY2014 Q3 (Apr-Jun)	$27,549.00	$77,549.00	$0.00	$0.00	$50,000.00	$100,000.00
FY2014 Q4 (Jul-Sep)	$58,218.25	$135,767.25	$0.00	$0.00	$0.00	$100,000.00

FY2015 Q1 (Oct-Dec)	$14,232.75	$150,000.00	$0.00	$0.00	$0.00	$100,000.00
FY2015 Q2 (Jan-Mar)	$0.00	$150,000.00	$0.00	$0.00	$0.00	$100,000.00
FY2015 Q3 (Apr-Jun)	$50,000.00	$200,000.00	$0.00	$0.00	$50,000.00	$150,000.00
FY2015 Q4 (Jul-Sep)	$0.00	$200,000.00	$0.00	$0.00	$0.00	$150,000.00
FY2016 Q1 (Oct-Dec)	$57,000.00	$257,000.00	$0.00	$0.00	$0.00	$150,000.00
FY2016 Q2 (Jan-Mar)	$0.00	$257,000.00	$0.00	$0.00	$0.00	$150,000.00
FY2016 Q3 (Apr-Jun)	$50,000.00	$307,000.00	$0.00	$0.00	$50,000.00	$200,000.00
FY2016 Q4 (Jul-Sep)	$0.00	$307,000.00	$0.00	$0.00	$0.00	$200,000.00
FY2017 Q1 (Oct-Dec)	$0.00	$307,000.00	$0.00	$0.00	$0.00	$200,000.00
Total	$307,000.00		$0.00		$200,000.00	

TASK 305-FIT: Suborbital Commercial Transportation Industry Analyses

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Scott Benjamin	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

This proposal focuses on the suborbital commercial transportation industry including categories of tourism, payloads, and launch sites and spaceports. Analyses of new and existing industries utilize the academic framework of "Five Forces that Shape Industry Competition" developed by Michael E. Porter (1980). An additional analysis will be performed utilizing another of Dr. Porter's (1990) frameworks, the "Diamond Model." This model examines the advantage a nation, specifically here, the US, may have within a specific industry while looking at factor conditions, demand conditions, related and supporting industries, firm strategy, structure and rivalry, government, and chance.

Project Outcomes

- Industry structural analyses of suborbital commercial space transportation utilizing the academic framework of the "Five Forces" by Porter (1980). A comprehensive review of academic and practitioner literature in related fields will give the analysis the appropriate support.

- Competitive analysis from the US viewpoint of the suborbital commercial space transportation industry utilizing the academic framework of the "Diamond Model" by Porter (1990). A comprehensive review of academic and practitioner literature in related fields will give the analysis the appropriate support.

- Dissemination of ongoing information and findings via a maintained website with the intent of engaging stakeholders in dialogue.

Summary of Output

• Industry structural analyses of suborbital commercial space transportation utilizing the academic framework of the “Five Forces” by Porter (1980). A comprehensive review of academic and practitioner

literature in related fields will give the analysis the appropriate support.
• Competitive analysis from the US viewpoint of the suborbital commercial space transportation industry utilizing the academic framework of the "Diamond Model" by Porter (1990). A comprehensive review of academic and practitioner literature in related fields will give the analysis the appropriate support.
• Dissemination of ongoing information and findings via a maintained website with the intent of engaging stakeholders in dialogue.

Technical Status

FY2014	FY2015	FY2016

Partners

Partner	Division	Primary
Florida Institute of Technology		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/16/2014	10/31/2015	2013	10-C-CST-FIT-029	$30,000.00
9/16/2014	10/31/2015	2013	10-C-CST-FIT-029	$45,000.00
11/1/2015	5/31/2016	2015	15-C-CST-FIT-003	$0.00
9/16/2014	5/31/2016	2013	15-C-CST-FIT-029-004	($9,575.00)
Total				$65,425.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Arion Gray	Engineering	Aerospace	●	Bachelors	6/15/2017
Taylor Smith	Business	Business MBA	●	Masters	12/4/2015

Deliverables

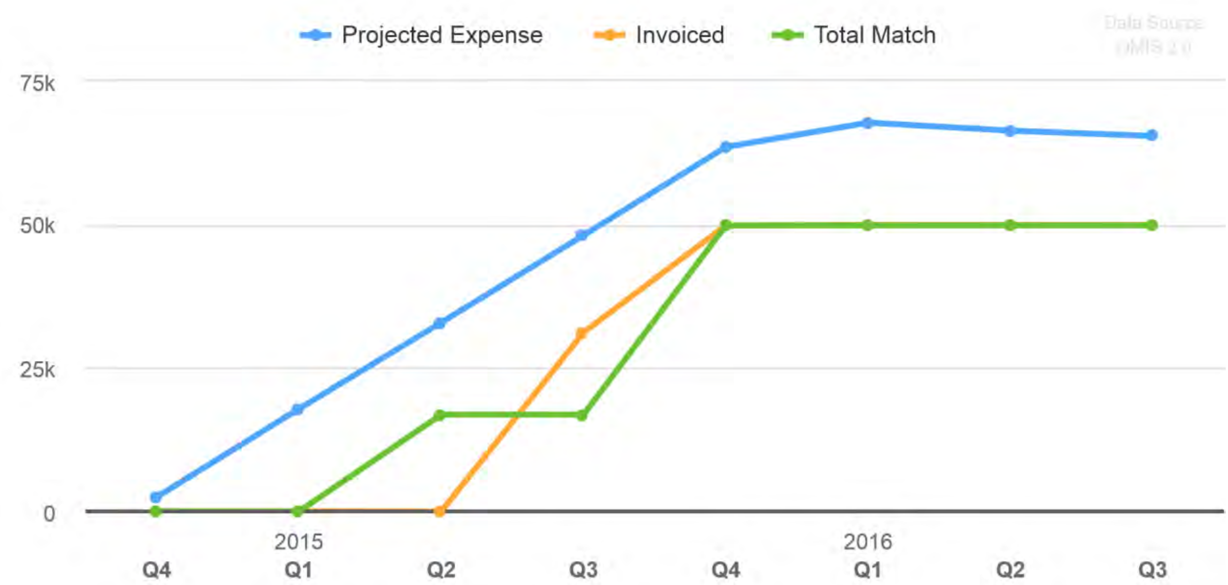
#	Deliverable	Start Date	Due Date	Accepted

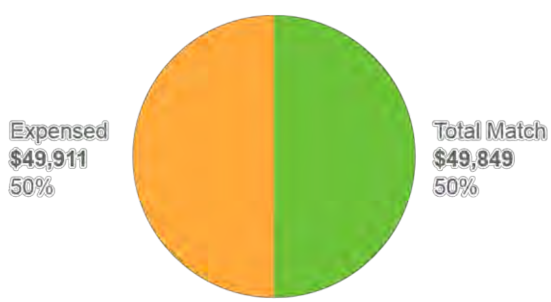
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/16/2014	9/30/2018	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2014 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$16,877.71	$16,877.71
FY2015 Q3 (Apr-Jun)	$31,204.26	$31,204.26	$0.00	$0.00	$0.00	$16,877.71
FY2015 Q4 (Jul-Sep)	$18,644.67	$49,848.93	$32,971.29	$32,971.29	$0.00	$16,877.71
FY2016 Q1 (Oct-Dec)	$62.00	$49,910.93	$0.00	$32,971.29	$0.00	$16,877.71
FY2016 Q2 (Jan-Mar)	$0.00	$49,910.93	$0.00	$32,971.29	$0.00	$16,877.71
FY2016 Q3 (Apr-Jun)	$0.00	$49,910.93	$0.00	$32,971.29	$0.00	$16,877.71
Total	$49,910.93		$32,971.29		$16,877.71	

TASK 308-UTMB: Suborbital SFP Anxiety Assessment

Lead University

University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Tarah Castleberry	Principal Investigator	
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area

3.0 Human Spaceflight

Project Description

Anxiety and psychological concerns may pose a challenge to future commercial spaceflight. Most of the psychological knowledge regarding humans in spaceflight is based upon studies of career astronauts selected under stringent medical and psychological standards. While there has been limited study regarding chronic medical conditions and commercial spaceflight participant tolerance of space vehicle acceleration profiles, there has been almost no investigation into anxiety and psychological elements related to commercial spaceflight. This is of concern, as spaceflight participants are not likely to participate in a prolonged training program prior to launch, leaving them potentially unprepared for the psychological stressors of flight. At the same time, there is currently little known regarding effective screening methods to identify those at the highest risk of experiencing psychological difficulty with the operational environment of spaceflight. This study proposes to utilize spaceflight simulations in a centrifuge to conduct training and evaluation of future spaceflight participants or laypersons that meet the same demographic pool in order to develop more effective psychological screening techniques, training modalities, and interventions to identify, treat, and mitigate anxiety or other psychological challenges that will be encountered during commercial space operations.

Project Outcomes

(1) a literature review evaluating prior studies in anxiety mitigation, operational impact, and training techniques that may provide insight to current concerns and efforts;
(2) a final report that will be completed at the end of the study outlining findings, techniques, and potential strategies, and
(3) the findings will also be submitted for presentation at an annual scientific meeting of the Aerospace Medical Association (AsMA). The final report may also be prepared
for submission for publication in Aerospace Medicine and Human Performance – the journal of AsMA.

Summary of Output

Anxiety and psychological concerns may pose a challenge to future commercial spaceflight. Most of the psychological knowledge regarding humans in spaceflight is based upon studies of career astronauts selected under stringent medical and psychological standards. While there has been limited study regarding chronic medical conditions and commercial spaceflight participant tolerance of space vehicle acceleration profiles, there has been almost no investigation into anxiety and psychological elements related to commercial spaceflight. This is of concern, as spaceflight participants are not likely to participate in a prolonged training program prior to launch, leaving them potentially unprepared for the psychological stressors of flight. At the same time, there is currently little known regarding effective screening methods to identify those at the highest risk of experiencing psychological difficulty with the operational environment of spaceflight. This study proposes to utilize spaceflight simulations in a centrifuge to conduct training and evaluation of future spaceflight participants or laypersons that meet the same demographic pool in order to develop more effective psychological screening techniques, training modalities, and interventions to identify, treat, and mitigate anxiety or other psychological challenges that will be encountered during commercial space operations.

Technical Status

FY2014	FY2015	FY2016	FY2017
■	■ ■ ■ ■	■ ■ ■ ■	■

Partners

Partner	Division	Primary
NASTAR Center		●
University of Texas Medical Branch		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/9/2014	8/17/2015	2014	10-C-CST-UTMB-031	$71,682.00
8/18/2015	5/31/2016	2014	10-C-CST-UTMB-036	$0.00

6/1/2016	8/17/2016	2015	15-C-CST-UTMB-04	$81,345.00
8/18/2016	8/17/2017	2016	15-C-CST-UTMB-08	$49,170.00
Total				$202,197.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Robert Mulcahy	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
James Pattarini	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
James Pavela	PMCH	Aerospace Medicine	●	M.D.	6/30/2018
Wilfredo Rodriguez-Jimenez	PMCH	Aerospace Medicine	●	M.D.	6/30/2018
Rahul Suresh	PMCH	Aerospace Medicine	●	M.D.	6/30/2018

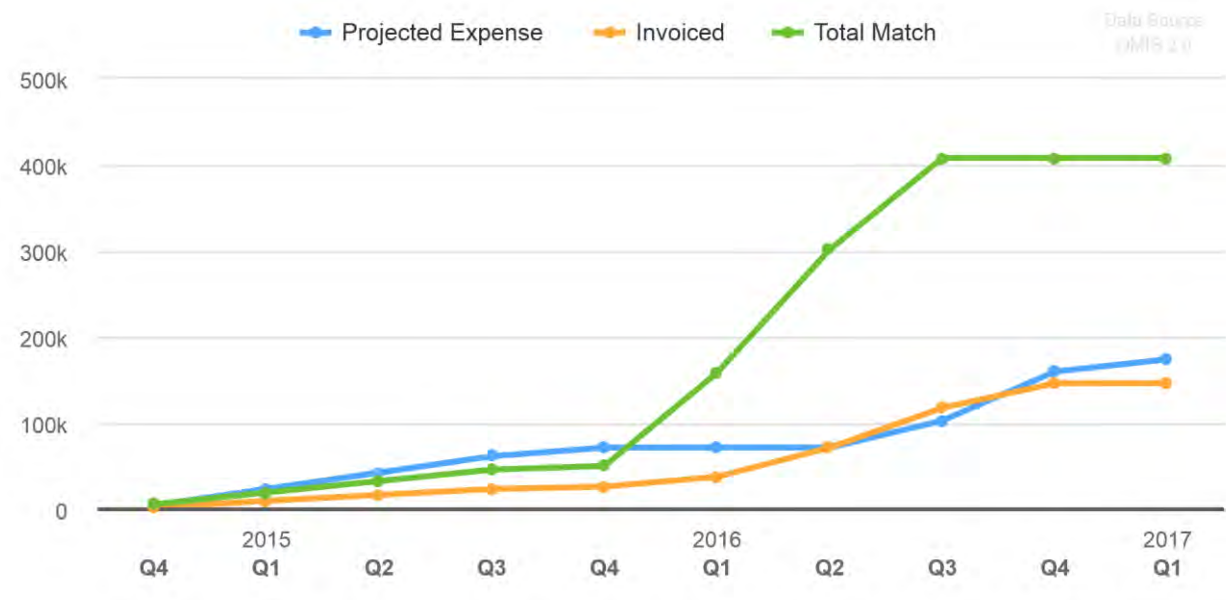
Deliverables

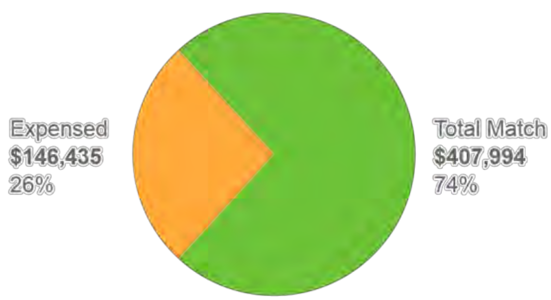
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice	9/9/2014	7/17/2018	
1	Assessment of screening and training requirements for pilots with repeated exposures to sustained high acceleration, as well as conduct aerobatic flights and National Aerospace Training and Research Center testing. MS Type: NARP MS Year: 2017B	9/9/2014	7/17/2018	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q4 (Jul-Sep)	$2,196.00	$2,196.00	$5,878.00	$5,878.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$7,682.14	$9,878.14	$13,694.00	$19,572.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$6,901.88	$16,780.02	$13,280.00	$32,852.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$6,848.22	$23,628.24	$13,252.00	$46,104.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$2,777.47	$26,405.71	$4,296.00	$50,400.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$11,440.47	$37,846.18	$6,257.00	$56,657.00	$102,000.00	$102,000.00

FY2016 Q2 (Jan-Mar)	$33,835.82	$71,682.00	$27,869.00	$84,526.00	$115,000.00	$217,000.00
FY2016 Q3 (Apr-Jun)	$46,210.27	$117,892.27	$14,468.00	$98,994.00	$92,000.00	$309,000.00
FY2016 Q4 (Jul-Sep)	$28,542.38	$146,434.65	$0.00	$98,994.00	$0.00	$309,000.00
FY2017 Q1 (Oct-Dec)	$0.00	$146,434.65	$0.00	$98,994.00	$0.00	$309,000.00
Total	$146,434.65		$98,994.00		$309,000.00	

TASK 309-UTMB: Suborbital Pilot Assessment

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Tarah Castleberry	Principal Investigator	
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

The advent of commercial suborbital spaceflight will introduce new exposures and stress profiles to both pilots and passengers unique to the commercial field, and thus not previously studied during the era of government spaceflight activities. Among these stressors is the exposure of the crew to sustained high Gx (front-to-back) and Gz (head-to-toe) acceleration in highly demanding flight profiles outside the common experience of even skilled pilots in tactical aircraft. Currently, flight crew medical standards are minimal, though many aerospace specialists are encouraging the adoption of more stringent medical and physiological requirements for flight crew expected to undergo repeat flights within a short period of time. Recommendations for such requirements are limited due to a current lack of experience on which to base predictions of pilot performance or the specific physiological demands of such repetitive stress scenarios. This study proposes to use multiple training modalities, including the NASTAR centrifuge and aerobatic flight profiles, to expose pilots to repeated high Gx and Gz sustained acceleration, assess their performance and physiological responses during serial simulated launch and re-entry profiles, and evaluate the impact of fatigue with repetitive exposures.

Project Outcomes

(1) a final report that will be completed by the end of the study and
(2) the findings will also be submitted for presentation at the annual scientific meeting of the Aerospace Medical Association (AsMA) to be held in May 2016. The final report may also be prepared for submission for publication in Aerospace Medicine and Human Performance – the journal of the AsMA.

Summary of Output

The advent of commercial suborbital spaceflight will introduce new exposures and stress profiles to both pilots and passengers unique to the commercial field, and thus not previously studied during the era of government spaceflight activities. Among these stressors is the exposure of the crew to sustained high +Gx (front-to-back) and +Gz (head-to-toe) acceleration in highly demanding flight profiles outside the common experience of even skilled pilots in tactical aircraft. Currently, flight crew medical standards are minimal, though many aerospace specialists are encouraging the adoption of more stringent medical and physiological requirements for flight crew expected to undergo repeat flights within a short period of time. Recommendations for such requirements are limited due to a current lack of experience on which to base predictions of pilot performance or the specific physiological demands of such repetitive stress scenarios. This study proposes to use multiple training modalities, including the NASTAR centrifuge and acrobatic flight profiles, to expose pilots to repeated high +Gx and +Gz sustained acceleration, assess their performance and physiological responses during serial simulated launch and re-entry profiles, and evaluate the impact of fatigue with repetitive exposures.

Technical Status

FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
NASTAR Center		•
University of Texas Medical Branch		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/9/2014	8/17/2015	2014	10-C-CST-UTMB-029	$38,885.00
8/18/2015	5/31/2016	2014	10-C-CST-UTMB-035	$0.00
8/18/2016	8/17/2018	2016	15-C-CST-UTMB-016	$0.00
6/1/2016	8/17/2016	2015	15-C-CST-UTMB-03	$36,290.00

8/18/2016	8/17/2017	2016	15-C-CST-UTMB-09	$71,500.00
Total				$146,675.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Alejandro Garbino	PMCH	Aerospace Medicine	●	M.D.	6/30/2017
Benjamin Johansen	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
Robert Mulcahy	PMCH	Aerospace Medicine	●	M.D.	6/30/2016

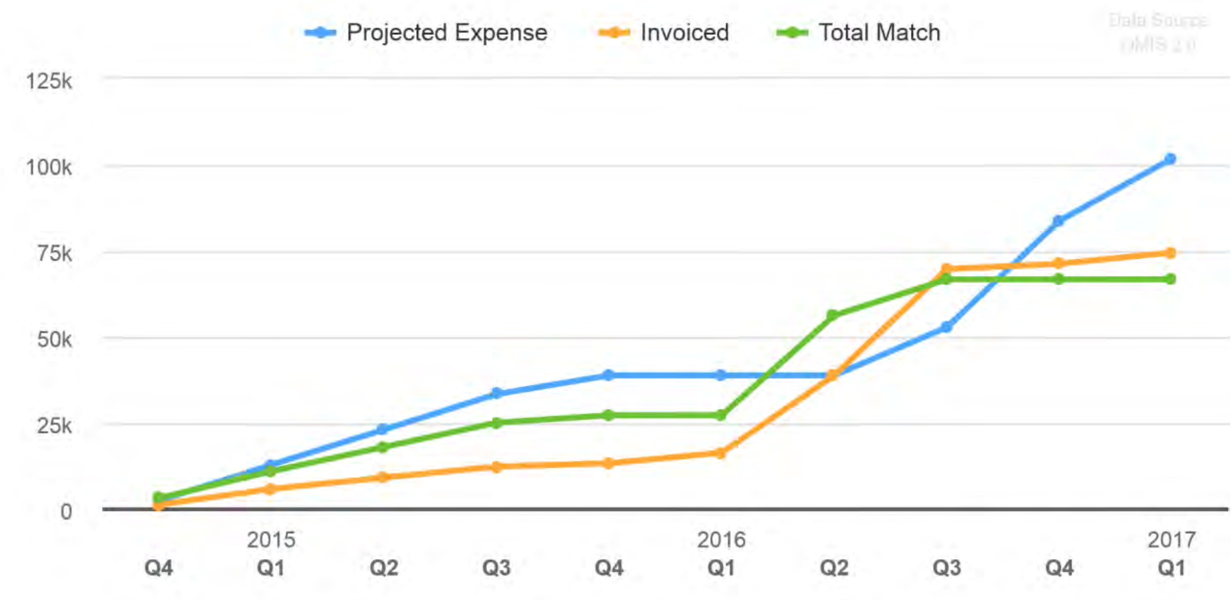
Deliverables

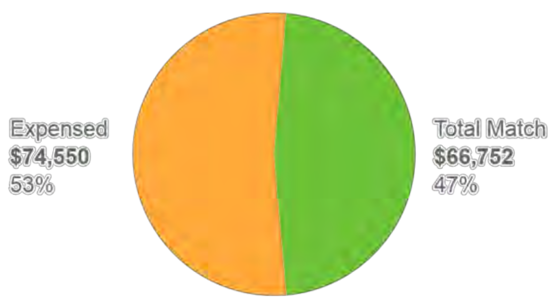
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/9/2014	8/17/2018	

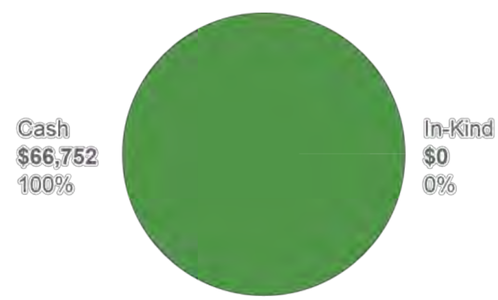
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q4 (Jul-Sep)	$1,335.00	$1,335.00	$3,274.00	$3,274.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$4,598.25	$5,933.25	$7,766.00	$11,040.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$3,284.54	$9,217.79	$7,070.00	$18,110.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$3,207.80	$12,425.59	$7,029.00	$25,139.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$941.65	$13,367.24	$2,182.00	$27,321.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$3,077.62	$16,444.86	$0.00	$27,321.00	$0.00	$0.00

FY2016 Q2 (Jan-Mar)	$22,440.14	$38,885.00	$28,976.00	$56,297.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$30,858.20	$69,743.20	$10,455.00	$66,752.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$1,524.71	$71,267.91	$0.00	$66,752.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$3,282.39	$74,550.30	$0.00	$66,752.00	$0.00	$0.00
Total	$74,550.30		$66,752.00		$0.00	

TASK 310-UTMB: Reducing Cabin Lethality in Commercial Spacecraft

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
Tarah Castleberry	Principal Investigator	●
James Vanderploeg	Principal Investigator	
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

We propose to continue a study to evaluate the methods, procedures, and technologies available for the protection of crew-occupied space in commercial spaceflight vehicles to identify recommendations for safety in both nominal and contingency manned aerospace vehicle operations. This includes a review of methods for the de-lethalization of the cabin environment, space vehicle crashworthiness, individual restraint systems, emergency evacuation systems, survival equipment, and related objectives. The review will include an analysis of historical vehicle capabilities and standards as well as a discussion of likely cabin configurations of the various commercial vehicles currently in development. Further, development of a systematic protocol designed to establish best practices towards the evaluation of a space vehicle airframe for any lapses in safety design for primary mishap prevention, as well as appropriate aeromedical response plans to be utilized in the case of an aerospace mishap, will be undertaken. The ultimate objective would be to provide a detailed summary of minimal standards that a crew cabin should meet to be considered safe for occupants in nominal and contingency spaceflight operations and the establishment of a detailed plan for mishap aeromedical response.

Project Outcomes

(1) a final report that will be completed by the end of the study, detailing the results of the literature review, the review of current technologies, and recommendations
regarding minimum safety standards and
(2) the findings will also be submitted for presentation at the annual scientific meeting of the Aerospace Medical Association (AsMA) to be held in May 2016. The final report may also be prepared for submission for publication in Aerospace Medicine and Human Performance – the journal of the AsMA.

Summary of Output

We propose a study to evaluate the methods, procedures, and technologies available for the protection of crew-occupied space in commercial spaceflight vehicles to identify recommendations for safety in both nominal and contingency manned aerospace vehicle operations. This includes a review of methods for the de-lethalization of the cabin environment, space vehicle crashworthiness, individual restraint systems, emergency evacuation systems, survival equipment, and related objectives. The review will include an analysis of historical vehicle capabilities and standards as well as a discussion of likely cabin configurations of the various commercial vehicles currently in development. The ultimate objective would be to provide a detailed summary of minimal standards that a crew cabin should meet to be considered safe for occupants in nominal and contingency spaceflight operations.

Technical Status

FY2014	FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
University of Texas Medical Branch		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/9/2014	8/17/2015	2014	10-C-CST-UTMB-030	$26,487.00
8/18/2015	5/31/2016	2014	10-C-CST-UTMB-034	$0.00
6/1/2016	8/17/2017	2016	15-C-CST-UTMB-010	$24,334.00
6/1/2016	8/17/2018	2016	15-C-CST-UTMB-015	$0.00
6/1/2016	8/17/2016	2015	15-C-CST-UTMB-02	$19,375.00
Total				$70,196.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Natcha Chough	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
Alejandro Garbino	PMCH	Aerospace Medicine	●	M.D.	6/30/2017
Benjamin Johansen	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
Dana Levin	PMCH	Aerospace Medicine	●	M.D.	6/30/2018
Robert Mulcahy	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
Derek Nusbaum	PMCH	Aerospace Medicine	●	M.D.	6/30/2017
James Pattarini	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
James Pavela	PMCH	Aerospace Medicine	●	M.D.	6/30/2018
Wilfredo Rodriguez-Jimenez	PMCH	Aerospace Medicine	●	M.D.	6/30/2018
Rahul Suresh	PMCH	Aerospace Medicine	●	M.D.	6/30/2018

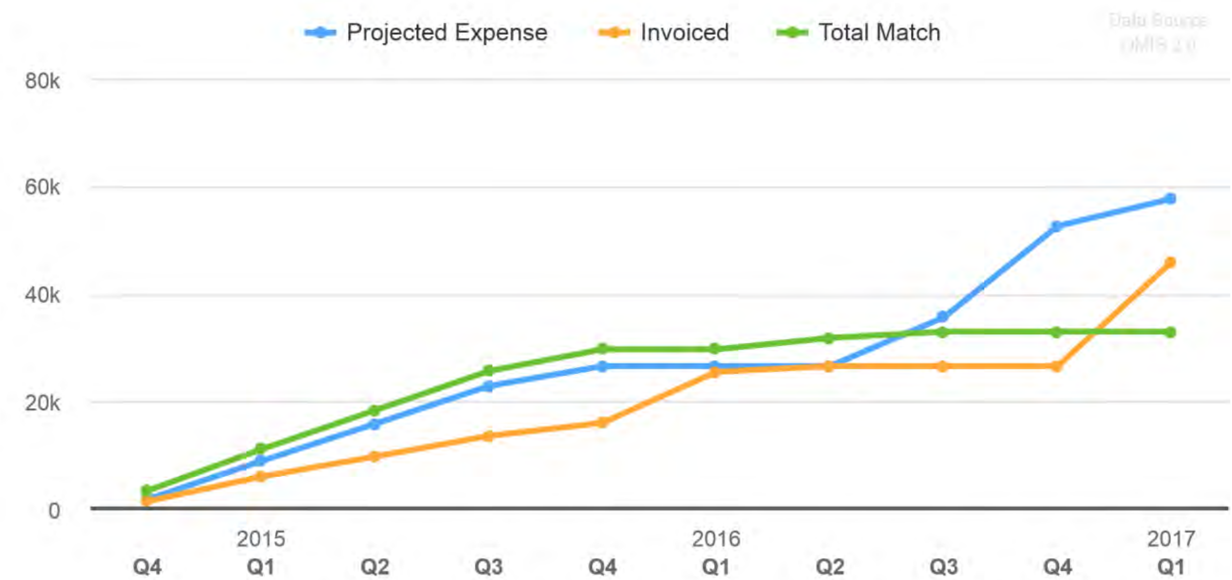
Deliverables

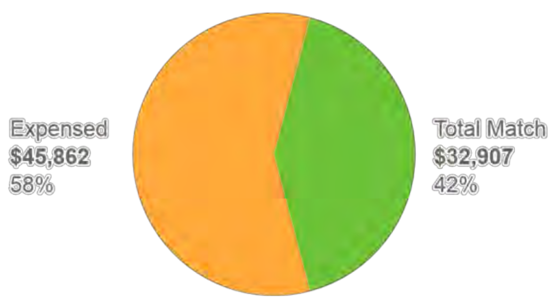
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/9/2014	8/17/2018	
1	Assessment of methods, procedures, and technologies available for Protection of Spaceflight Participants in commercial spaceflight vehicles, as well as compare cabin designs with historical precedents for safety. MS Type: NARP MS Year: 2021C	9/9/2014	8/17/2018	

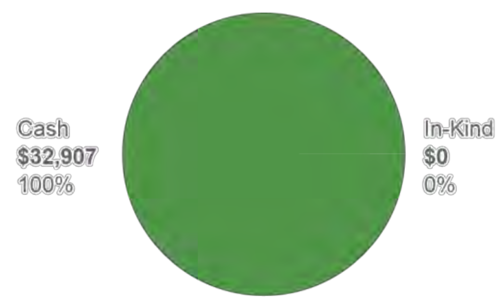
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q4 (Jul-Sep)	$1,325.00	$1,325.00	$3,291.00	$3,291.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$4,604.66	$5,929.66	$7,714.00	$11,005.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$3,721.15	$9,650.81	$7,246.00	$18,251.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$3,856.99	$13,507.80	$7,318.00	$25,569.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$2,427.81	$15,935.61	$4,047.00	$29,616.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$9,493.25	$25,428.86	$0.00	$29,616.00	$0.00	$0.00

FY2016 Q2 (Jan-Mar)	$1,058.14	$26,487.00	$2,120.00	$31,736.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$26,487.00	$1,171.00	$32,907.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$26,487.00	$0.00	$32,907.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$19,375.00	$45,862.00	$0.00	$32,907.00	$0.00	$0.00
Total	$45,862.00		$32,907.00		$0.00	

TASK 311-UCF: LED-Based Low Cost Gas Sensor for Crew and Vehicle Safety

Lead University

University of Central Florida

Team

Name	Role	Primary
Subith Vasu	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Heliana Forero	Fiscal Admin	●
Nagy Youssef	Fiscal Admin	●
Yeliza Burleson	Contract Admin	●

Research Area

2.0 Space Transportation Vehicles

Project Description

• CO/CO2 measurements are relevant to the health and safety of the crew.
• CO is toxic, even in concentrations as low as 50ppm
• Time-resolved measurements of CO can be used as early indicator of fires
• CO2 concentrations must be monitored in crew cabin for safety
With compact, low-cost, low-power sensors that are able to continually monitor important gases that are characteristic of burning materials, a distributed sensor array could be implemented on space vehicles that would allow early detection of fires, gas leaks, or other critical events. With careful selection of targeted gases it may be possible to identify the material that is burning/smoldering which will better inform the crew so that they may respond and prioritize high emergency events. Current sensor design targets CO/CO2 which are traces gases that increase in the presence of smoldering/burning materials. Future iteration will extend to target additional gases such as HCN, hydrocarbons, and polymer vapors.

Project Outcomes

• Design and produce a sensor for evaluation testing in high altitude environment
• Must be autonomous
• Operable in cold, low-pressure environment
• Scalable to final product (compact design)
• Characterize sensor performance in relevant conditions
• High altitude balloon flight evaluation

Summary of Output

Bench scale development and testing. We will conduct tests to establish the sensor sensitivity (minimum detection limit), time-response, and stability.
• We will develop quantitative spectroscopic models that can be used to accurately derive concentration information based on absorption.
• Models for heat transfer will be developed and utilized to minimize radiation effects that could impair the sensor to function properly. Such models will be implemented in commercially available software (e.g., ANSYS)
• Sensor design and housing design must be optimized for spacecraft environment. This would require a caged design that will house every component keeping the weight to the allowable values. We will use Zemax software to arrive at the best design which will maximize sensor sensitivity.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Space Florida		●
University of Central Florida	Mechanical & Aerospace Engineering	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
10/1/2014	8/30/2015	2014	10-C-CST-UCF-014	$40,000.00
10/1/2014	8/30/2015	2014	10-C-CST-UCF-015	$2,520.00
10/1/2014	8/30/2015	2014	10-C-CST-UCF-016	$2,520.00
10/1/2014	8/30/2015	2014	10-C-CST-UCF-REV10	($2,520.00)
6/1/2016	7/31/2017	2016	15-C-CST-UCF-005	$98,603.00
9/1/2015	5/31/2016	2015	15-C-CST-UCF-02	$49,000.00
9/1/2015	5/31/2016	2015	15-C-CST-UCF-03	$3,650.00
Total				$193,773.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Akshita Parupalli	Mechanical and Aerospace Engineering		●	Masters	
Joseph Lopez	Mechanical and Aerospace			Masters	5/5/2017
Erik Ninnemann	Mechanical and Aerospace Engineering			Bachelors	
Owen Pryor	Mechanical and Aerospace			Ph.D.	
Kyle Thurmond	Mechanical and Aerospace			Masters	5/1/2016
Michael Villar	Mechanical and Aerospace			Masters	5/5/2017

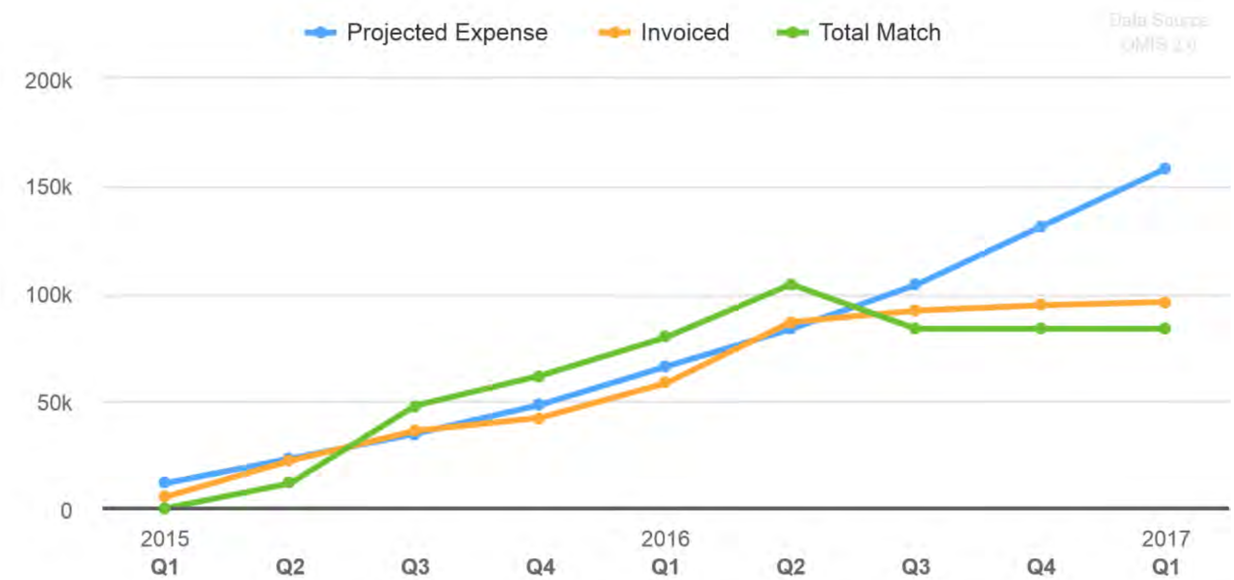
Deliverables

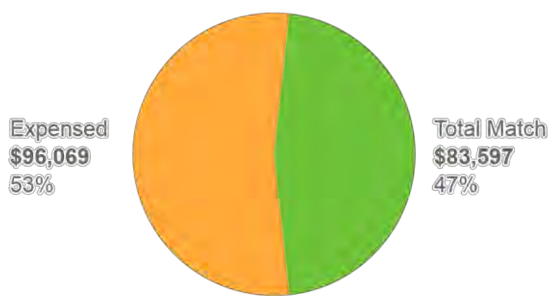
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	10/1/2014	7/31/2018	

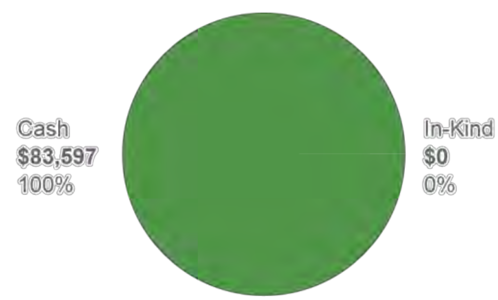
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2015 Q1 (Oct-Dec)	$5,367.04	$5,367.04	$43.50	$43.50	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$16,837.49	$22,204.53	$11,663.24	$11,706.74	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$13,950.28	$36,154.81	$36,147.82	$47,854.56	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$6,064.79	$42,219.60	$13,973.61	$61,828.17	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$16,024.57	$58,244.17	$17,721.19	$79,549.36	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$28,492.00	$86,736.17	$24,727.95	$104,277.31	$0.00	$0.00

FY2016 Q3 (Apr-Jun)	$5,293.97	$92,030.14	-$20,680.54	$83,596.77	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$2,499.53	$94,529.67	$0.00	$83,596.77	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$1,538.96	$96,068.63	$0.00	$83,596.77	$0.00	$0.00
Total	$96,068.63		$83,596.77		$0.00	

TASK 319-UF: DebriSat Panel Preparation and Fragment Characterization

Lead University
University of Florida

Team

Name	Role	Primary
Norm Fitz-Coy	Principal Investigator	●
Paul Wilde	Tech Monitor	●
Tonya Lewis	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Space debris presents a major risk to the success of space missions. At orbital velocity, a collision with a fragment as small as 1 cm in size can cause catastrophic damage. Fragmentation debris is of particular importance because it makes up over forty percent of the rapidly increasing number of catalogued objects orbiting the Earth. Satellite breakup models are used to make predictions regarding fragments that are too small to be tracked from the ground, yet are large enough to pose a risk to satellites. However, the 2009 collision between Iridium-33 and Cosmos-2251 demonstrated the need to update the current NASA satellite breakup model. This model, which is based on a hypervelocity impact of a 1960s Navy satellite, failed to accurately predict the debris field produced by the newer Iridium satellite. The failure of the model was attributed to the newer materials and construction techniques used in the fabrication of the Iridium-33 satellite.

The DebriSat project was conceived as a mechanism to update the current satellite breakup model. The DebriSat satellite was a 50-kg satellite designed and fabricated with modern materials and procedures to be representative of satellites found in low Earth orbit (LEO). The DebriSat satellite was subjected to a hypervelocity impact test at Arnold Engineering Development Center (AEDC) where the test chamber was lined with foam panels to preserve the fragments resulting from the impact. These panels were collected and shipped to the University of Florida where they are being processed to extract the fragments which are then characterized and catalogued. This task focuses on the database used to catalogue the fragments.

Project Outcomes

Specific activities include the following:

- Research viable database engines and storage methods.
- Install and configure new database engine.
- Define and document structure of new database engine and subsequent relational tables.
- Begin modification of the existing DCS front-end layer.

- Complete modification of the existing DCS front-end layer.
- Implement new image and file storage structure.
- Begin addition of “3D” imaging system fields and formats.
- Complete addition of “3D” imaging system fields and formats.
- Documentation of upgrade process and maintenance protocols.

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Florida		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
4/14/2017	8/31/2017	2016	15-C-CST-UFL-002	$75,000.00
4/14/2017	8/1/2018	2016	15-C-CST-UFL-003	$0.00
Total				$75,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	Identify improved methods for determining the probabilistic fragment size and mass distributions due to satellite collisions. MS Type: NARP MS Year: 2022A	4/14/2017	8/31/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 320-UC: Commercial Spaceflight Risk Assessment and Communication

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
David Klaus	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
3.0 Human Spaceflight

Project Description

The success of commercial human space flight depends in part on establishing an efficient and reliable approach for appropriately regulating the safety of commercially operated launch vehicles and spacecraft. It is recognized that in order to ensure proper regulations are implemented, all parties must be in agreement on the terminology and definitions used to describe the scenarios. A number of critical terms in the literature have been found to have conflicting definitions, which can result in differing interpretation of regulatory statements, thus complicating enforcement and opening up potential legal challenges. Beyond the analysis and mitigation of risk, the outcome must also be verified and effectively conveyed to commercial passengers
in an understandable manner. This work will provide a systematic framework for the FAA to use going forward, with results to be published for public and industry consideration and discussion.

Project Outcomes

1) a systematic framework for characterizing risk assessment as a function of phase of spaceflight in terms of the range of scenarios from nominal operations to catastrophic failures as described above;
2) an assessment of risk prediction along with suggestions from prior spaceflight and more common terrestrial analogies for effectively communicating the risk of space transportation to the public in a balanced, informing manner;
3) characterization of verification processes aimed at ensuring the defined level of reliability (risk mitigation) is achieved for a given vehicle.

Summary of Output

The success of commercial human space flight depends in part on establishing an efficient and reliable approach for appropriately regulating the safety of commercially operated launch vehicles and spacecraft. It is recognized that in order to ensure proper regulations are implemented, all parties must be in agreement on the terminology and definitions used to describe the scenarios. A number of critical terms in the literature have been found to have conflicting definitions, which can result in differing interpretation of regulatory statements, thus complicating enforcement and opening up potential legal challenges. Beyond the analysis and mitigation of risk, the outcome must also be verified and effectively conveyed to commercial passengers in an understandable manner. This work will provide a systematic framework for the FAA to use going forward, with results to be published for public and industry consideration and discussion.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2015	5/31/2016	2015	15-C-CST-CU-01	$74,275.00
6/1/2016	5/31/2017	2015	15-C-CST-CU-03	$2,234.00
6/1/2016	5/31/2017	2016	15-C-CST-CU-05	$42,193.00
Total				$118,702.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Robert Ocampo	Aerospace Engineering Sciences		●	Ph.D.	5/7/2016

Deliverables

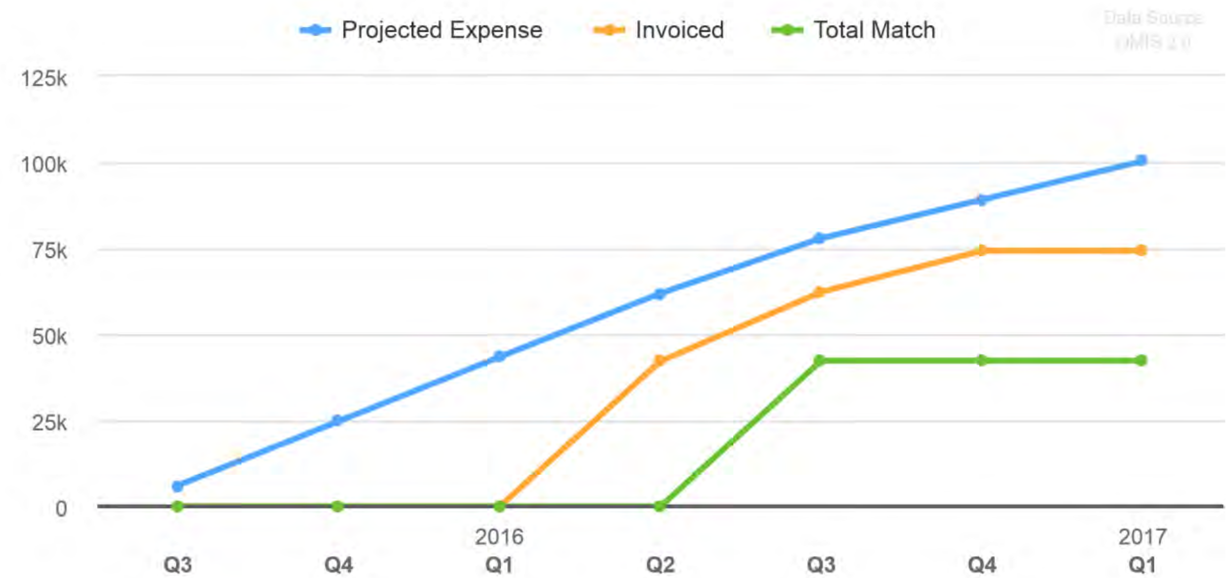
#	Deliverable	Start Date	Due Date	Accepted

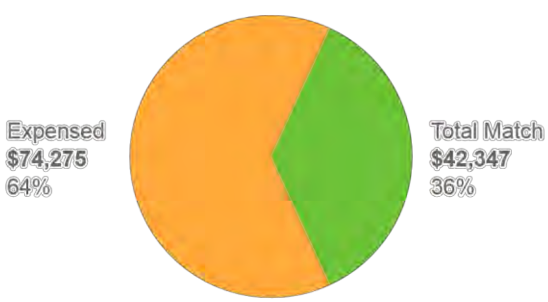
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2015	5/31/2017	

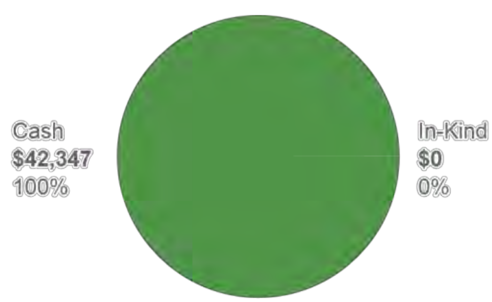
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$42,198.61	$42,198.61	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$20,114.79	$62,313.40	$42,346.94	$42,346.94	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$11,961.60	$74,275.00	$0.00	$42,346.94	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$74,275.00	$0.00	$42,346.94	$0.00	$0.00
Total	$74,275.00		$42,346.94		$0.00	

TASK 323-NMT: Structural Health Monitoring Framework

Lead University
New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Andrei Zagrai	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

Develop structural health monitoring (SHM) framework for CST vehicles, payloads and components. The framework encompasses sensors, electronics, signal processing and automatic decision making as integral part of methodologies enabling structural condition assessment, continuous monitoring, and system prognosis. It is envisioned that SHM framework will serve as a key component of a future spaceflight recorder ("black box") that reports vehicle's health information and could facilitate re-certification for the next flight. Building on SHM system knowledge and expertise obtained in 2 successful spaceflights, we will explore fundamental aspects of structural monitoring in space, adapt existing sensors to launch/space/reentry operation, develop compensation routines for unfavorable influences of space environment, infer signal processing schemes and automatic decision support for SHM methodologies suitable to space applications. Practical examples of SHM of space system (planned through NASA FOP or other flight opportunity) will be demonstrated and system architecture compatible with "black box" will be explored. Planned collaboration with commercial launch providers will allow to tune SHM to specific launch vehicles and/or payloads.

AST GOALS: This task is aimed at improving safety and affordability of commercial spaceflights. In this capacity it supports AST's mission to ensure protection of the public and property and to carry out safety responsibilities. Safety inspection is an AST core function and as such structural health monitoring task will directly support AST's mission.

Project Outcomes

SHM framework for CST vehicles, payloads and components, studies on space effect on sensors and SHM architecture, algorithms to compensate for space effects in damage diagnosis, guidelines for integrating SHM with spaceflight recorder ("black box") technical publications and conference presentations .

Summary of Output

This task is estimated to be of high criticality to the successful fulfillment of the AST goals described above because safety inspection is an AST core function. SHM is viewed as enabler of safety inspections for structures and hence is aimed to improve safety of spaceflight. In addition, implementation of SHM system will likely reduce operation costs for CST vehicles because components could be replaced on as needed basis in contrast to regular flight hours consideration.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology		•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2016	12/31/2017	2016	15-C-CST-NMT-013	$0.00
6/1/2015	5/31/2016	2015	15-C-CST-NMT-03	$50,000.00
6/1/2016	5/31/2017	2016	15-C-CST-NMT-07	$0.00
6/1/2016	5/31/2017	2016	15-C-CST-NMT-09	$40,000.00
Total				$90,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Mary Anderson	Mechanical Engineering	Mechatronics Systems Engineering	•	Ph.D.	
David Hunter	Mechanical Engineering	Mechatronics Systems Engineering	•	Masters	

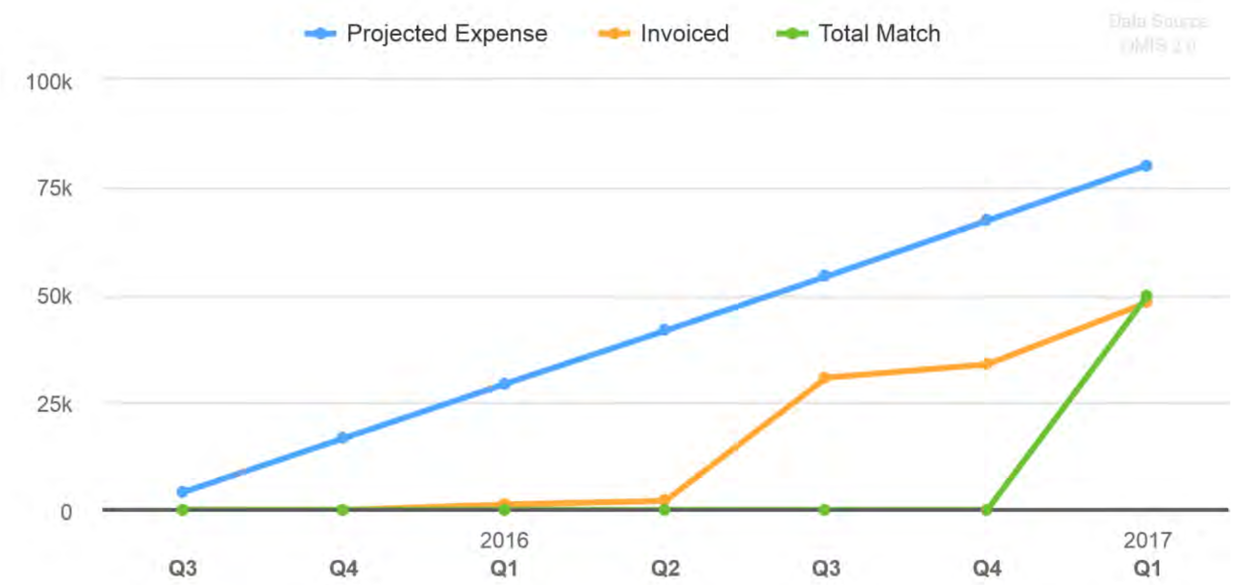
Deliverables

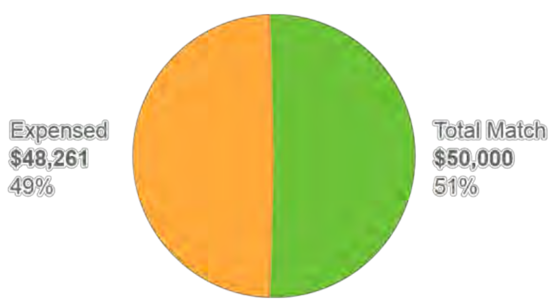
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

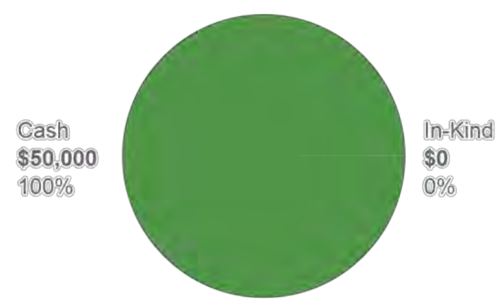
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$1,243.56	$1,243.56	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$881.07	$2,124.63	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$28,601.46	$30,726.09	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$3,081.85	$33,807.94	$0.00	$0.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$14,452.83	$48,260.77	$50,000.00	$50,000.00	$0.00	$0.00
Total	$48,260.77		$50,000.00		$0.00	

TASK 324-SU: Space Commercialization Strategies from the Internet Experience

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Ward Hanson	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

One of the most successful U.S. innovation projects was the public investment in the Internet, followed by deregulation and a transition to the private sector. This research documents this process, and adapts these lessons for the emerging commercial space industry.

Project Outcomes

A technical report, along with detailed supporting material and timelines, will be the primary deliverables for this research.

• Constructing a detailed timeline of U.S. Internet deregulation activities between 1990-2000.
• Constructing a detailed timeline of U.S. commercial Internet developments between 1990-2000, with special focus on the rise of venture capital, the growth of Internet users, and investments in Internet infrastructure.
• Preparation of a research report on the important lessons learned from the Internet transition for the commercial space industry.

Summary of Output

This research seeks to document the applicable lessons from the Internet transition for commercial space.

Technical Status

FY2015	FY2016

Partners

Partner	Division	Primary
Leland Stanford Junior University	Stanford Institute of Economic Policy and Research	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/4/2015	5/31/2016	2015	15-C-CST-SU-01	$22,071.00
Total				$22,071.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

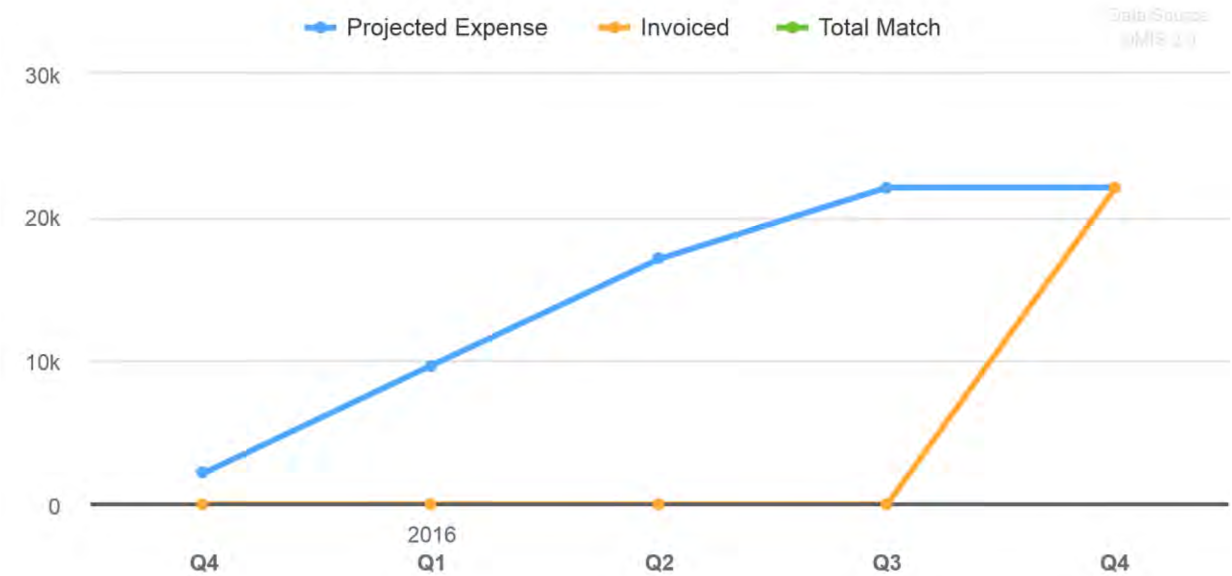
Deliverables

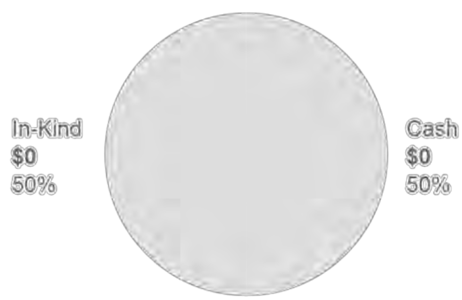
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/4/2015	5/31/2016	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$21,988.00	$21,988.00	$0.00	$0.00	$0.00	$0.00
Total	$21,988.00		$0.00		$0.00	

TASK 325-FSU: Optical Measurements of Rocket Nozzle Thrust and Noise

Lead University
Florida State University

Team

Name	Role	Primary
Rajan Kumar	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Yolanda Lopez	Fiscal Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

The high-temperature, high-speed exhaust from the propulsion systems of commercial systems, such as the SpaceX Falcon vehicles, impinges on the launch pad surface (see Space X, Merlin Engine in figure). This results in very high unsteady pressure loads and extremely high fluctuating thermal loads in the vicinity of the impingement region which leads to structural vibrations that can compromise efficiency and operational safety. The aeroacoustic loads due to rocket plume impingement and vehicle leading edge and boat-tail interactions will be experimentally examined in our jet, rocket and aerodynamic facilities. We will develop, test and refine promising Active, Passive and Hybrid flow control methods. Based on our results we will identify the most promising method(s) in light of: flow unsteadiness reduction efficacy and full-scale implementation practicality.

Project Outcomes

1. In year 1 the focus will be on developing a research plan based on state-of-art active flow control techniques and discussion with NASA scientists and commercial launch engineers to ensure the smooth transition of technology from laboratory to full-scale implementation.
2. Design and develop steady and pulsed microjet based control system and characterize its performance at controlled conditions.
3. Design of a scaled rocket nozzle to simulate realistic temperature and pressure conditions of the jet exhaust and carry out thrust and noise measurements in the FSU hot jet lab.
4. In the subsequent years, the control system will be refined and tested over a wide range of test conditions. A feedback control loop will be designed and implemented for optimal performance.
5. Develop scaling laws and system integration studies for large scale implementation.

Summary of Output

The proposed research will be very useful for the design of future launch and reentry space systems and hypersonic vehicles. The improved aerodynamic performance and propulsion system will help increase payload capacity and safety for many government and commercial space transportation programs.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Florida State University	Mechanical Engineering	●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/3/2015	5/31/2016	2015	15-C-CST-FSU-02	$40,000.00
6/1/2016	5/31/2017	2016	15-C-CST-FSU-04	$58,435.00
Total				$98,435.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Griffin Valentich	Mechanical Engineering		●	Masters	4/30/2016
Rohit Vemula	Mechanical Engineering		●	Masters	

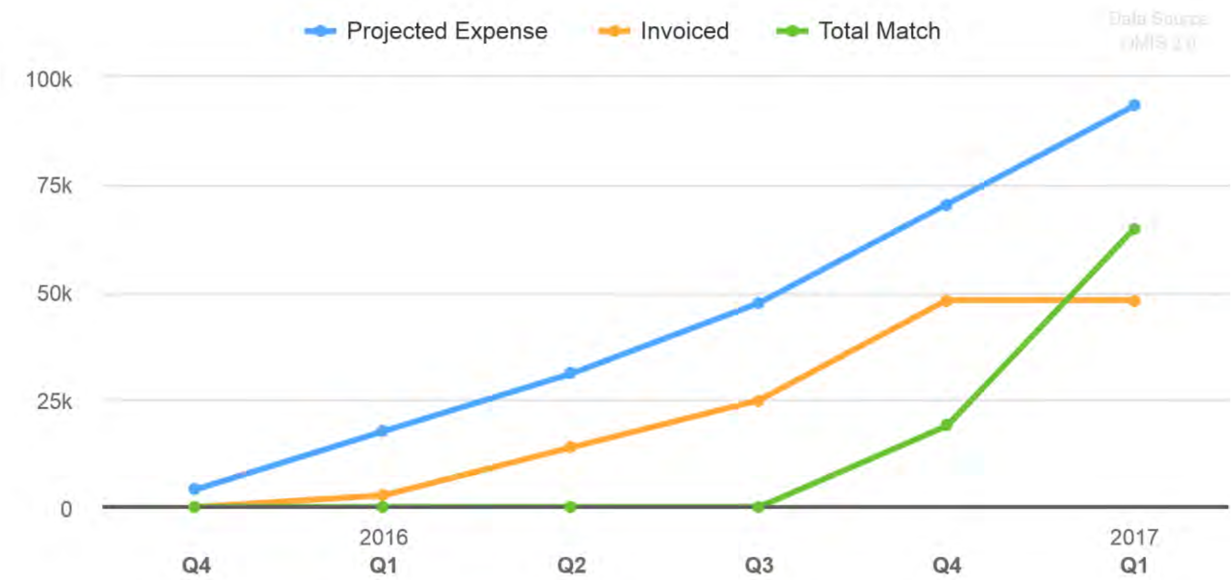
Deliverables

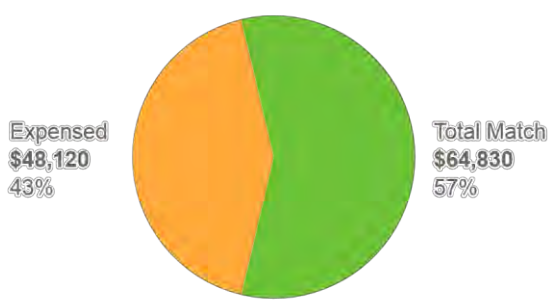
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	9/3/2015	7/30/2018	

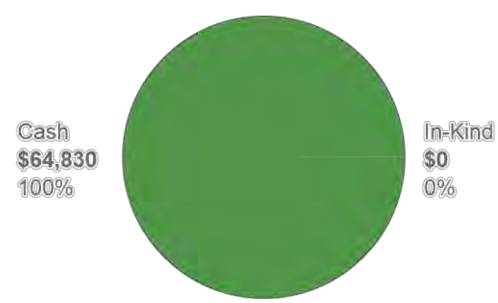
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$2,723.26	$2,723.26	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$11,166.32	$13,889.58	$0.00	$0.00	$0.00	$0.00

FY2016 Q3 (Apr-Jun)	$10,970.92	$24,860.50	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$23,259.50	$48,120.00	$18,868.81	$18,868.81	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$48,120.00	$45,961.00	$64,829.81	$0.00	$0.00
Total	$48,120.00		$64,829.81		$0.00	

TASK 329-NMT: Tracking and Monitoring Suborbital Commercial Space Vehicles

Lead University

New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Eileen Ryan	Principal Investigator	●
Andrei Zagrai	Principal Investigator	
Nick Demidovich	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area

1.0 Space Traffic Management & Spaceport Operations

Project Description

Monitoring the launch and on-orbit health of space-based assets will enhance and improve existing capabilities for safe and successful use of the near-Earth environment for scientific, military, and commercial purposes. This task will also help build a body of knowledge to assist in the development of the appropriate regulatory requirements for the commercial space industry.

Project Outcomes

The goal of this task is to provide monitoring capabilities to space vehicles operating from Space Port America in New Mexico and other commercial space assets from LEO to GEO orbit zones. This goal is related to AST mission to protect public and property.

DELIVERABLES: High-resolution, fast-frame rate position and photometric coverage of the launch of vehicles into Earth orbit as well as on-orbit monitoring.

Task 1: Refine the tracking and pointing capabilities of the MRO 2.4-meter telescope for observing fast-moving terrestrial objects.
Task 2: Develop algorithms for analysis of photometry and spectroscopy data obtained of monitored orbital and sub-orbital space vehicles.
Task 3: Acquire and utilize real-time observational data of space vehicles or stratospheric balloons to demonstrate monitoring feasibility and associated benefits.

Summary of Output

The task involves providing high-resolution, fast-frame rate position and photometric coverage and monitoring of suborbital space vehicles, stratospheric balloons and other assets operating from Spaceport America in New Mexico. The 2.4-meter telescope can slew and track at a rate of 10 degrees per second.. This task is moderately critical because of AST commitment to protect public and property.

Technical Status

FY2016	FY2017

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/1/2016	12/31/2016	2015	15-C-CST-NMT-04	$25,000.00
Total				$25,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Jacob Schirer	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/8/2016

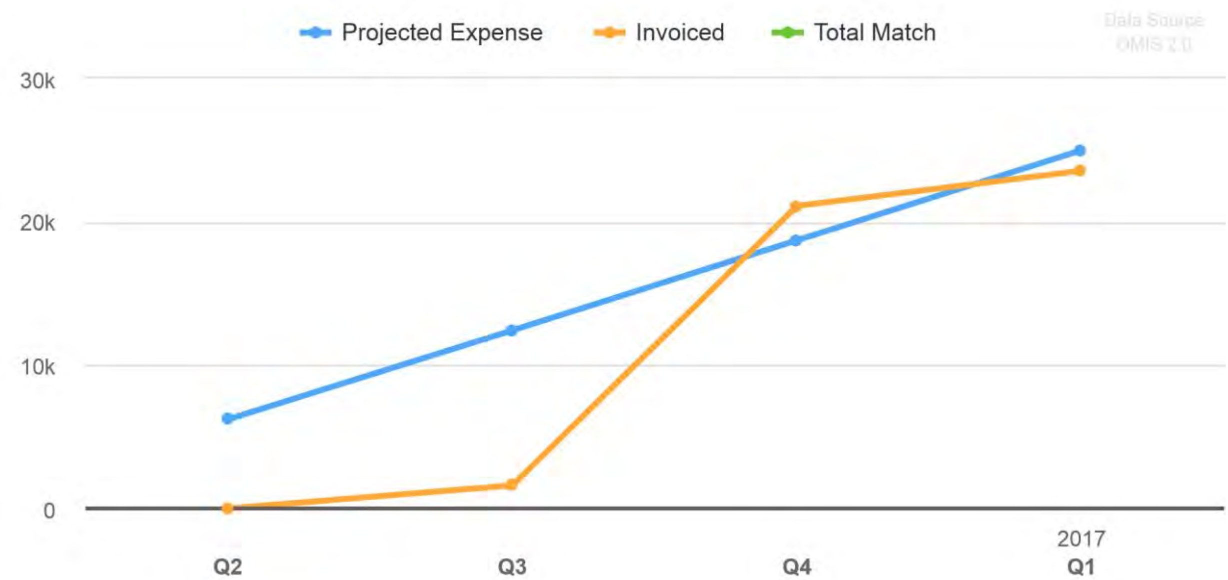
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/1/2016	12/31/2016	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2016 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$1,614.50	$1,614.50	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$19,502.21	$21,116.71	$0.00	$0.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$2,446.73	$23,563.44	$0.00	$0.00	$0.00	$0.00
Total	$23,563.44		$0.00		$0.00	

TASK 330-UTMB: UTMB Administrative Support

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
5.0 Program Management

Project Description

Coordinated efforts by the Orion Group are aimed towards a number of technological advances and interfaces. Orion Group provides technologies aimed towards management of information, data capture, and web management for the FAA COE for Commercial Space Transportation. These technologies are intended to help monitor and track multiple ongoing projects within the FAA COE to ensure that they are meeting objectives, delivering products, and staying within budgeted cost constraints. Data will be captured automatically and made readily accessible to appropriate parties. Orion will provide a centralized transparent means of reporting and for data capture, with cost effectiveness, to standardize reporting requirements. This model eliminates the need for additional administrative personnel within each university that would be required to learn FAA COE administrative standards. The organizational structure provided is simple and designed to facilitate executive business operations and sound management strategies. Further, Orion can lead and coordinate activities of the COE CST member universities by conducting periodic teleconferences to communicate and organize COE CST activities, including setting the agenda, organizing teleconferences, and recording and distributing minutes of all in-person and teleconference meetings, including the annual technical and administrative meetings. In these ways, Orion will provide an organizational mechanism and structure to accomplish streamlined business planning, effective coordination and collaboration of projects, and the ability to secure a continuing stream of federal and private funding to sustain the program.

Project Outcomes

Summary of Output

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Orion America Technologies		●
University of Texas Medical Branch		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2015	5/31/2016	2015	15-C-CST-UTMB-01	$119,972.00
6/1/2016	5/31/2017	2016	15-C-CST-UTMB-05	$133,841.00
6/1/2016	5/31/2017	2015	15-C-CST-UTMB-06	$26,531.00
6/1/2016	5/31/2017	2015	15-C-CST-UTMB-07	$2,918.00
6/1/2016	5/31/2017	2016	15-C-CST-UTMB-11	$7,665.00
6/1/2016	5/31/2017	2016	15-C-CST-UTMB-12	$12,190.00
Total				$303,117.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

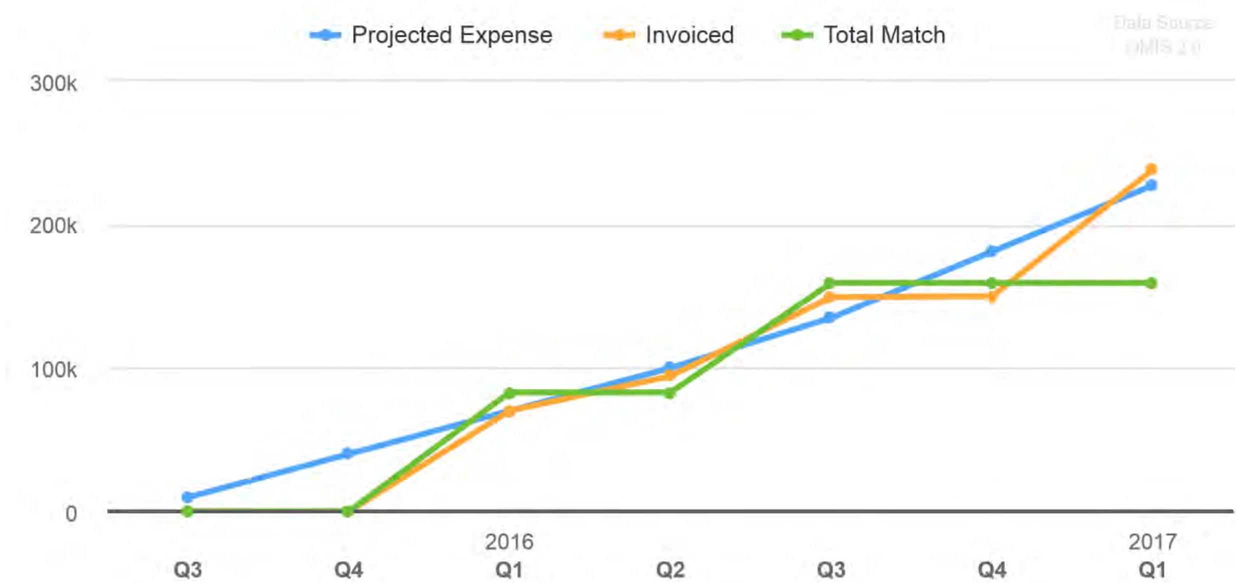
#	Deliverable	Start Date	Due Date	Accepted

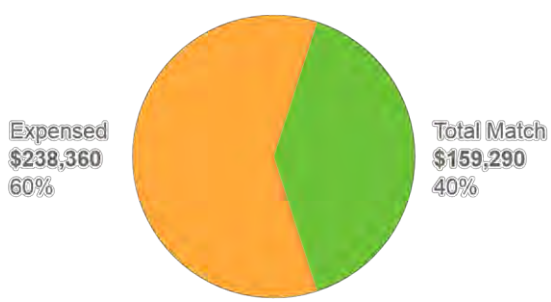
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2015	5/31/2018	

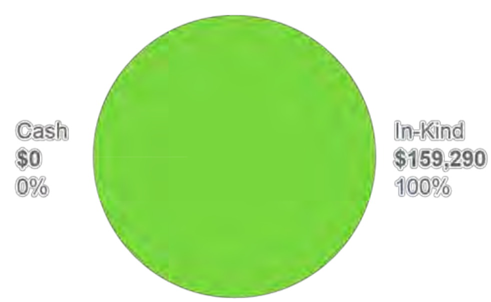
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$70,175.50	$70,175.50	$0.00	$0.00	$82,945.20	$82,945.20
FY2016 Q2 (Jan-Mar)	$24,151.47	$94,326.97	$0.00	$0.00	$0.00	$82,945.20
FY2016 Q3 (Apr-Jun)	$55,084.12	$149,411.09	$0.00	$0.00	$76,345.00	$159,290.20
FY2016 Q4 (Jul-Sep)	$512.90	$149,923.99	$0.00	$0.00	$0.00	$159,290.20
FY2017 Q1 (Oct-Dec)	$88,435.70	$238,359.69	$0.00	$0.00	$0.00	$159,290.20
Total	$238,359.69		$0.00		$159,290.20	

TASK 331-SU: Advanced 4D Special Use Airspace Research

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Mykel Kochenderfer	Principal Investigator	●
Juan Alonso	Principal Investigator	
Gunther Smiley	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

This research project will attempt to better understand the dynamic response process to accidents / incidents in CST operations, and how such dynamic capabilities of the NAS (including air traffic control and the aircraft themselves) might be utilized to safely continue to separate air and space vehicles while minimizing the nominal operations impact on the commercial air traffic. This research will (1) incorporate a variety of models for true wind variability and wind measurement uncertainty (for selected sites) into our modeling strategy, (2) develop distributions of accident/incident debris size and their time-accurate locations so that a model of debris tracking accuracy can be generated that can then be used for assessment of the safety of the proposed dynamic evasion procedures, (3) supply dynamic 4D compact envelopes for varying levels of wind/debris tracking capabilities (e.g. with and without real-time debris tracking or wind measurements) and safety buffer sizes, (4) "With input from FAA ATC SMEs, develop notional operational procedures for implementing Compact 4D Envelopes in nominal scenarios, and (5) support the evaluation of the impact of these advanced procedures on air traffic flow using NASA's FACET tool.

The work in this proposal is classified as long-term research: our work is at the point of trying to understand the major parameters and methodologies that might lead to a far more efficient use of the airspace than what we have today. For this reason, the level of modeling applied is appropriate to the early stage of this research: while the major parameters are all accounted for, there are a number of specific assumptions that will need to be revised and refined as the research transitions to a later phase, when a potential implementation may be considered.

Project Outcomes

1. Continue and complete the ongoing NAS impact simulation work,
2. Initiate additional work to study the outstanding research questions of the use of 4D envelopes (real-time separation criteria and methods, etc.),

3. Support the work that will be pursued by Stanford and MIT Lincoln Labs (starting on October 1, 2014 and in collaboration with Prof. Mykel Kochenderfer, Stanford University, and Dr. James Kuchar, MIT LL) on suborbital debris modeling, surveillance requirements, etc. to enable dynamic decision making in accident/incident situations in the NAS.
4. Reverse uncertainty propagation studies to inform the licensing process.

Summary of Output

The projected growth in demand for the use of the traditional airspace by commercial space transportation entities will make it increasingly hard to accommodate launches on a Special Use Airspace (SUA) basis. A better approach is required that is able to: (i) adapt to the fluctuating frequency of launches, (ii) accommodate uncertainties in the timing and the ascent and descent/entry trajectories of the space vehicles, (iii) ensure proper separation and safety at all times, and (iv) integrate with the FAA's NextGen system. The three main objectives for this project are: (i) to develop plausible architectures for an Integrated Airspace Management System, (ii) to research and develop the foundation of such a system so that, from the outset, time-space probabilistic trajectories and safety assessments can be incorporated, and (iii) to create a prototype implementation for a proof-of-concept of the system that may be further developed in a follow-on project. The impact on air traffic of space operations can be significant and without approaches and procedures to minimize it, a significant negative impact on commercial space transportation will be felt.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Leland Stanford Junior University	Department of Aeronautics and Astronautics	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
12/15/2015	12/31/2015	2014	15-C-CST-SU-03	$50,000.00
12/15/2015	12/31/2015	2015	15-C-CST-SU-04	$10,000.00
1/1/2016	9/30/2016	2016	15-C-CST-SU-05	$0.00
12/15/2015	6/30/2017	2016	15-C-CST-SU-07	$106,343.00
12/15/2015	6/30/2017	2016	15-C-CST-SU-08	$5,000.00
1/1/2016	12/31/2017	2016	15-C-CST-SU-09	$0.00

Total	$171,343.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Rachael Tompa	Aeronautics and Astronautics		●	Ph.D.	

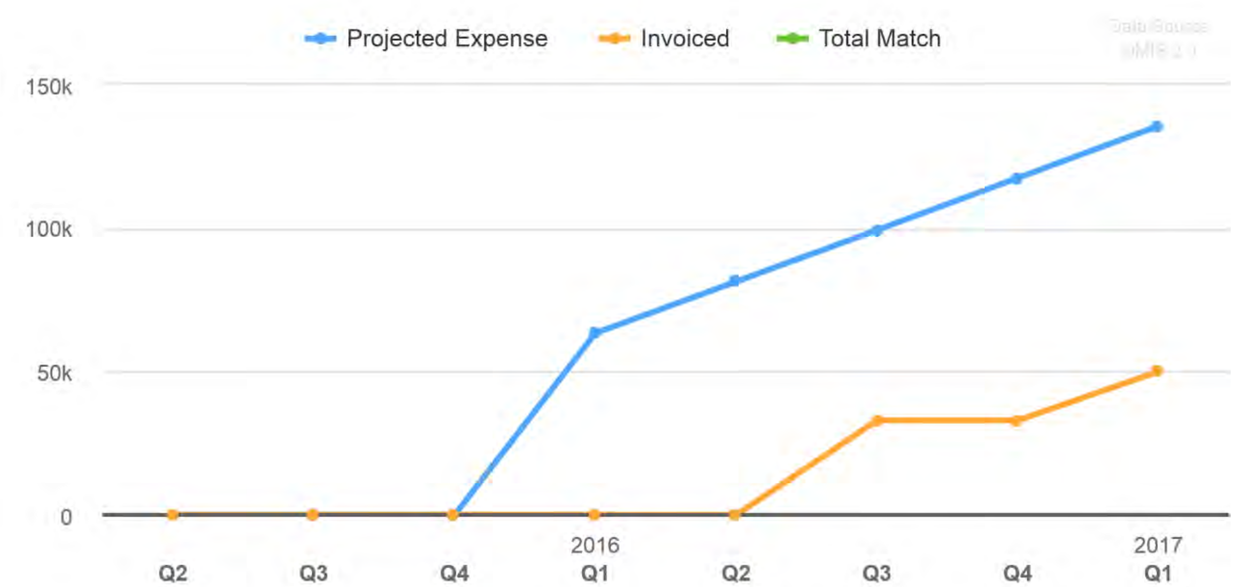
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	2/15/2015	12/31/2017	
1	Develop and assess separation standards for improved airspace management of launch/reentry vehicles, such as hybrids and manned stratospheric balloons, during non-explosive phases of flight. MS Type: NARP MS Type: 2020B	2/15/2015	12/31/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2015 Q2 (Jan-Mar)		$0.00		$0.00		$0.00
FY2015 Q3 (Apr-Jun)		$0.00		$0.00		$0.00
FY2015 Q4 (Jul-Sep)		$0.00		$0.00		$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$32,950.58	$32,950.58	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$32,950.58	$0.00	$0.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$17,049.42	$50,000.00	$0.00	$0.00	$0.00	$0.00
Total	$50,000.00		$0.00		$0.00	

TASK 333-FIT: Onboard Context-Sensitive Informational System

Lead University

Florida Institute of Technology

Team

Name	Role	Primary
Guy Boy	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area

3.0 Human Spaceflight

Project Description

This proposal presents a possible solution for an onboard context-sensitive information system for Commercial Space Operations (OCSIS-CSO) that would be useful and usable for commercial space transportation (CST). It is an alternative to paper-based onboard documentation systems for operations in a spacecraft cockpit. We propose to use aeronautics research and practice on onboard information systems (OIS), and design a generic OCSIS-CSO. Our commercial aircraft experience, associated to our space background and environment (Florida Space Coast), is an insightful and useful background for this kind of research effort.

Project Outcomes

• Task 1 will be devoted to the analysis of current state of the art and needs of commercial spacecraft systems (with emphasis on safety, efficiency, comfort). We will
study their specificity and common features from an operational point of view. We will use our aeronautical operational knowledge and knowhow on onboard information systems (OIS). A synthesis will be made, including recommendations for further OIS design.
• Task 2 will be devoted to the study of the various operational contexts (i.e., generic situations and scenarios) to demonstrate OIS usefulness and usability. We will work with astronauts and aerospace engineers to elicit this kind of experience-based knowledge. A synthesis will be made, including recommendations for further OCSIS design.
• Task 3 will be devoted to the creation of a first OCSIS for commercial space operations (CSO). We will call it OCSIS-CSO. We propose to develop OCSIS-CSO on a tablet and head-up display (HUD) that will be configurable and adaptable with regards to cognitive and physical ergonomics within a spacecraft simulator. Later on, we test the integration of this device into the cockpit as a fixed instrument. The development of OCSIS-CSO will be done in an agile manner (i.e., using the latest human-systems integration methods and tools that support incremental design-test phases).
• Task 4 will be devoted to demonstrations, reviews and tests within the CST community in order to

deliver the functional and feasible OCSIS-CSO concept. This task will lead to possible future joint projects for the development and manufacturing of more specific OCSIS-CSO.

Summary of Output

To identify the relevant human parameters, their value range, and thresholds of adequate safety, for all four critical areas.

Technical Status

FY2015	FY2016	FY2017

Partners

Partner	Division	Primary
Florida Institute of Technology		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
12/23/2015	10/1/2017	2015	15-C-CST-FIT-01	$75,000.00
Total				$75,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
De Vere Kiss	School of Human-Centered Design, Innovation and Art	Human-Centered Design	●	Ph.D.	
Yash Mehta	School of Human-Centered Design, Innovation and Art	Human-Centered Design	●	Ph.D.	

Deliverables

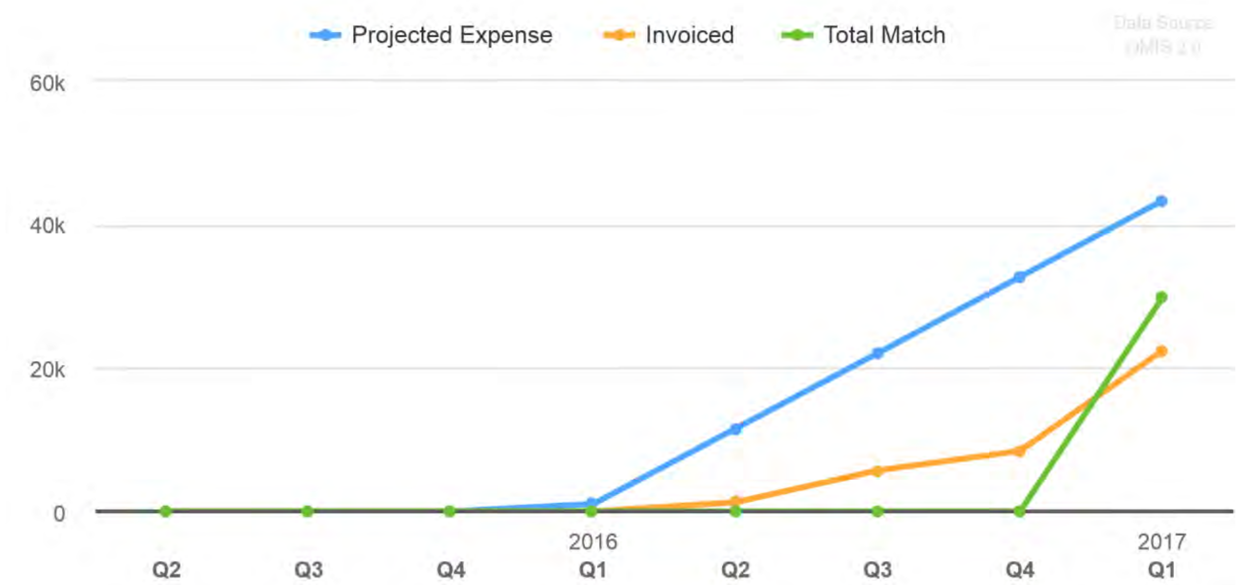
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	2/23/2015	10/1/2017	

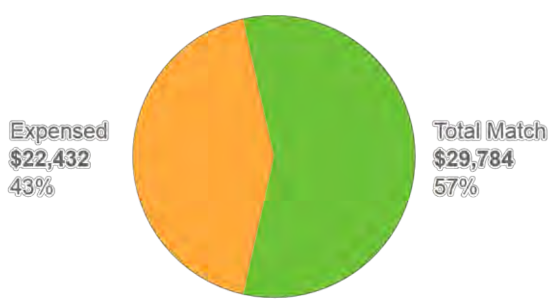
1	Identify draft recommended practices for crew human factors for suborbital winged commercial spaceflight vehicles. MS Type: NARP MS Year: 2019A	2/23/2015	10/1/2017	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2015 Q2 (Jan-Mar)		$0.00		$0.00		$0.00
FY2015 Q3 (Apr-Jun)		$0.00		$0.00		$0.00
FY2015 Q4 (Jul-Sep)		$0.00		$0.00		$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$1,275.00	$1,275.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$4,443.79	$5,718.79	$0.00	$0.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$2,720.00	$8,438.79	$0.00	$0.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$13,993.50	$22,432.29	$0.00	$0.00	$29,784.00	$29,784.00
Total	$22,432.29		$0.00		$29,784.00	

TASK 353-UC: Human Factors - Vehicle Design Focus - CU

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
David Klaus	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation

No Students

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 353-FIT: Design and Ops Considerations for Human Space Flight Occupant Safety - FIT

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Ondrej Doule	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
Florida Institute of Technology	School of Human-Centered Design, Innovation and Art	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

Total						

TASK 359-NMSU: Feasibility Study to Use Commercial Geostationary Communications Satellites to Relay Data to the Earth from Low Earth Orbit Satellites

Lead University
New Mexico State University

Team

Name	Role	Primary
Brian Kopp	Principal Investigator	●
Pat Hynes	Principal Investigator	
Ken Davidian	Tech Monitor	●
Nick Demidovich	Tech Monitor	
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

This study will explore the technical parameters and performance capabilities of various configurations of LEO satellite orbits and GEO communication satellite constellations and also identify the global regulatory issues associated with introducing this new type of communications service into the commercial satellite communications industry. A cost-benefit analysis will then examine these results to determine to what extent such a communications system is feasible.

Project Outcomes

The commercial satellite communications industry has approximately 290 operational satellites currently in geostationary orbit [2]. These satellites provide communications services to fixed and mobile satellite terminals on, or near, the surface of the earth. These services involve the use of one of the parallel communications relay devices on board a communications satellite called a transponder. Together this inventory of communications satellites and their transponders offer a significant availability of communications services around the entire earth. This study proposes that these existing GEO communication satellite services can be used to communicate with new LEO satellites, potentially increasing a typical LEO satellite mission capability by providing more communications resources and potentially reducing the cost to operate the LEO satellite by reducing or eliminating the need for new ground stations.

Summary of Output

The study has several objectives. To determine if the hypothesis is feasible one objective is to define the necessary technical parameters to operate such a system. Another objective is to define the performance capabilities of such a system. A third objective is to define the global regulatory steps needed to introduce a new type of satellite communications into the Fixed Satellite Services market. The final object is to assess the technical parameters, performance capabilities, and regulatory steps, under the lens of the current market for commercial satellite communication service to complete a cost benefit analysis.

Technical Status

Partners

Partner	Division	Primary
New Mexico State University	NM NASA EPSCoR	●
University of North Florida	Electrical Engineering Department	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 367-UC: CubeSate Cluster Deployment Tracking

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
Penina Axelrad	Principal Investigator	●
David Klaus	Principal Investigator	
Stephen Earle	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

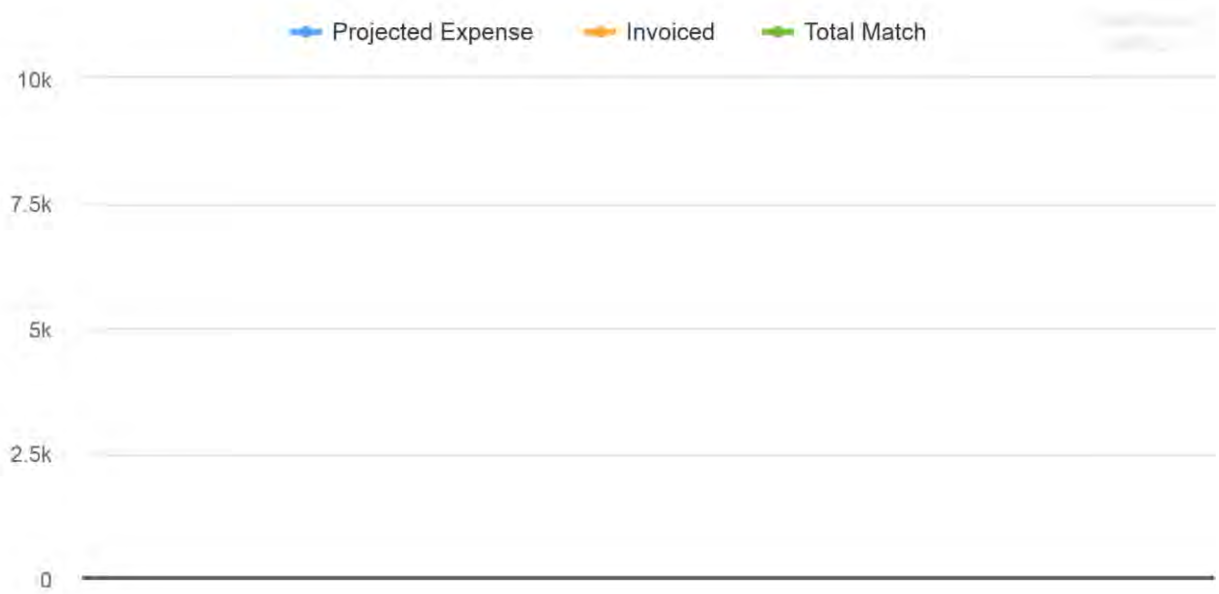
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 368-UCF: RA2 Workshop Event

Lead University
University of Central Florida

Team

Name	Role	Primary
Subith Vasu	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Heliana Forero	Fiscal Admin	●
Nagy Youssef	Fiscal Admin	●
Yeliza Burleson	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Central Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation

Akshita Parupalli	Mechanical and Aerospace Engineering		•	Masters	

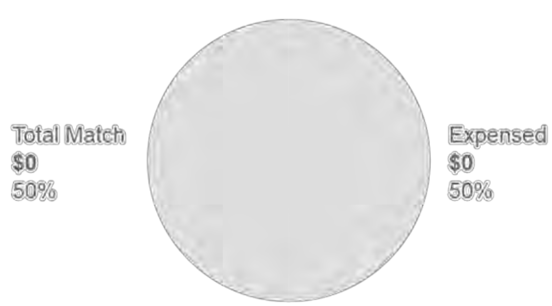
Deliverables

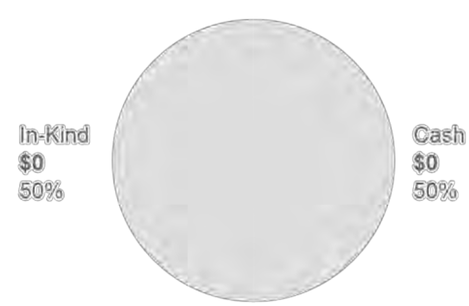
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 371-NMSU: Space Object Database

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Stephen Earle	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

The ultimate goal of this research project is to develop a method that combines and uses space situational awareness (SSA) observations from multiple sources. Establishment and implementation of this method poses a number of questions and challenges that this research project intends to address in multiple phases.

Project Outcomes

1. The methodology we hope will evolve a group of colleagues to enable us to use an open architecture, with the capability to accept observations from multiple sources, use interchangeable software modules to compute orbital parameters and populate a master catalog, and allow alternate approaches to predict and analyze potential conjunctions. This group of collaborators from government, industry and academia, is needed now as this is a long term solution to an already difficult problem facing the commercial space transportation industry's ability to assure successful, safe, space operations.

2. The approach will be designed to maximize the use of commercial capabilities.

3. Transparency is a key principle; however, classified and/or sensitive U.S. space operations will be protected appropriately, both by technical means and via operational procedures.

Summary of Output

Each phase of this research project will address the questions posed, and challenges encountered, in pursuit of this program's ultimate goal.

Phase 1 will identify the context and boundary conditions of this research task, including an exhaustive literature and program search to identify

(a) prior theoretical and practical work in this area,
(b) the characteristics of the different sources and types of information to assess its suitability, or the extent of conditioning that would be required to make it useable,
(c) the limitations and challenges that the different types of data poses, and possible ways to overcome these hurdles,
(d) the differences and challenges posed through the use of the STM system for research or operational use, and
(e) current sentiments, reservations, and support for this work as expressed in archival data sources and through primary data collection (e.g., interviews, conferences, workshops, and other forms of primary data collection that can address questions regarding data transparency and openness).

Phase 2 of this project will begin the process of developing a support mechanism for combining and exploiting SSA observations that have inherently different types of uncertainty and rigorously quantify the utility of any given algorithm or S&T method.

Technical Status

Partners

Partner	Division	Primary
New Mexico State University		●
University of Texas - Austin	Department of Aerospace Engineering and Engineering Mechanics	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 372-UC: Resident Space Object (RSO) System Mechanics

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
Dan Scheeres	Principal Investigator	●
David Klaus	Principal Investigator	
Stephen Earle	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 373-UC: RA3 Workshop Event-CU

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
David Klaus	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation

No Students

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

TASK 376-FIT: The Legal Issues Concerning Scheduled and Unscheduled Cross-Border Suborbital Flights

Lead University

Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area

4.0 Space Transportation Industry Viability

Project Description

To identify the relevant laws and regulations that would affect cross-border sub-orbital flights in scheduled and unscheduled scenarios. To determine how the existing legal framework will affect the commercialization of such activity and how the laws can be adapted to cultivate an industry that extend beyond the US market.

Project Outcomes

To identify the relevant laws and regulations that would affect cross-border sub-orbital flights in scheduled and unscheduled scenarios. To determine how the existing legal framework will affect the commercialization of such activity and how the laws can be adapted to cultivate an industry that extend beyond the US market.

Summary of Output

Under current international law, if a US suborbital vehicle were to land in another country, the receiving party's responsibilities would depend on its characterization of the landing craft (aircraft or spacecraft) and the manner in which the craft landed. If the receiving party characterized the suborbital vehicle as an aircraft, and it did so as part of a regularly scheduled flight, there would be no issue so long as it followed the established bi-lateral agreement; if this was not a regularly scheduled flight, the response would depend on whether this was an intentional or accidental landing and would likely be seen by the receiving State as a violation of their complete and exclusive jurisdiction. If the receiving party characterized the suborbital vehicle as a spacecraft, a scheduled arrival would require some form of agreement between the two States; an unscheduled arrival (if owing to accident, distress, emergency or unintentional landing) would require the receiving party to promptly rescue and return the astronauts and the spacecraft to the US.

Technical Status

Partners

Partner	Division	Primary
Florida Institute of Technology		•
McGill University	Institute of Air and Space Law	•

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
Total						

COMPLETED PROJECTS

TASK 181-UTMB: Medical and Physiological Database System

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013
□ □ □	■ ■ ■ ■	■

Partners

Partner	Division	Primary

University of Texas Medical Branch		●
Wyle Integrated Science and Engineering Group		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2012	2010	10-C-CST-UTMB-007	$25,190.00
1/3/2011	12/31/2012	2010	10-C-CST-UTMB-008	$20,646.00
1/3/2011	12/31/2012	2010	10-C-CST-UTMB-019	($5,178.42)
Total				$40,657.58

Students

Name	Department	Discipline	Funded	Degree	Graduation
Jennifer Law	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
Charles Mathers	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
David Reyes	PMCH	Aerospace Medicine	●	M.D.	8/15/2014

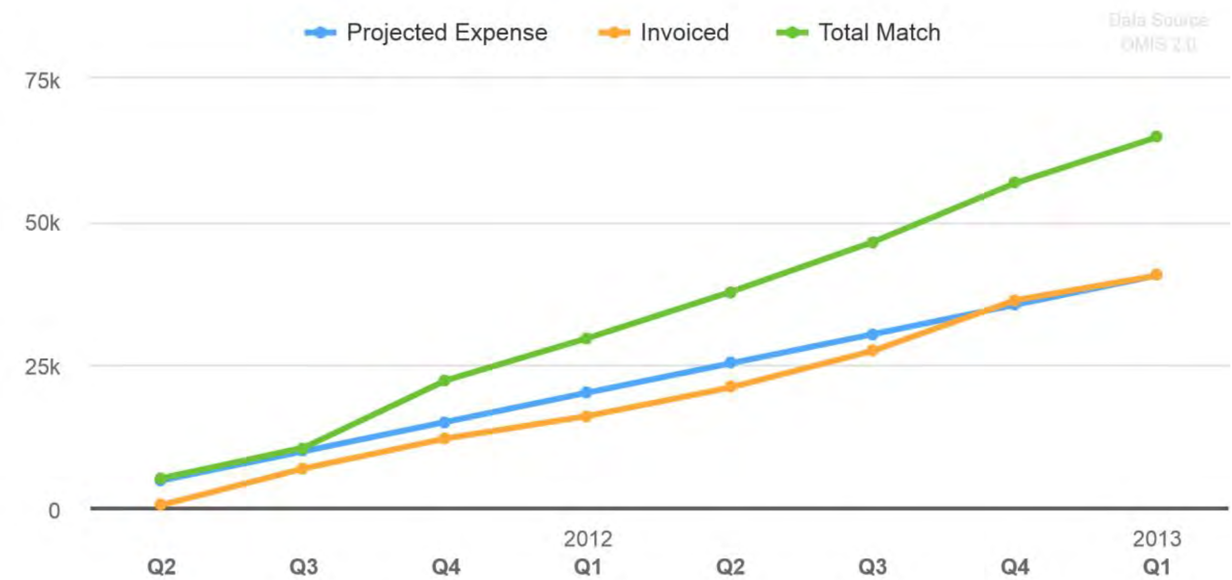
Deliverables

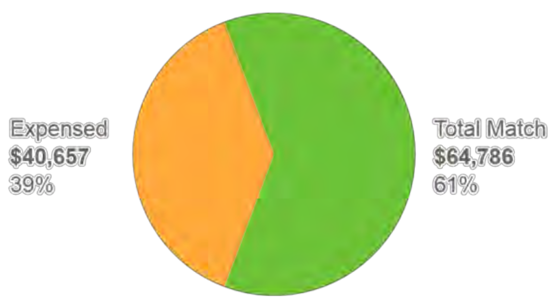
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

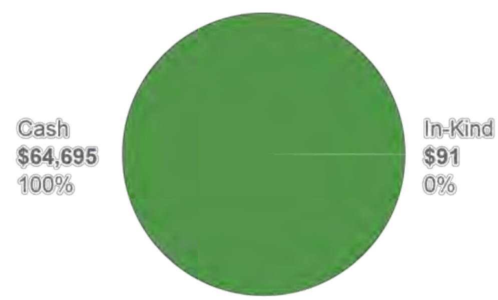
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$603.11	$603.11	$5,286.00	$5,286.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$6,387.74	$6,990.85	$5,338.00	$10,624.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$5,226.45	$12,217.30	$11,735.00	$22,359.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$3,939.61	$16,156.91	$7,397.00	$29,756.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$4,956.45	$21,113.36	$7,936.00	$37,692.00	$90.53	$90.53
FY2012 Q3 (Apr-Jun)	$6,387.82	$27,501.18	$8,694.00	$46,386.00	$0.00	$90.53

FY2012 Q4 (Jul-Sep)	$8,820.07	$36,321.25	$10,275.00	$56,661.00	$0.00	$90.53
FY2013 Q1 (Oct-Dec)	$4,336.00	$40,657.25	$8,034.00	$64,695.00	$0.00	$90.53
Total	$40,657.25		$64,695.00		$90.53	

TASK 182-UTMB: Human System Risk Management Approach to CST

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012

Partners

Partner	Division	Primary
University of Texas Medical Branch		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UTMB-003	$25,190.00
Total				$25,190.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Jennifer Law	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
Charles Mathers	PMCH	Aerospace Medicine	●	M.D.	6/1/2012

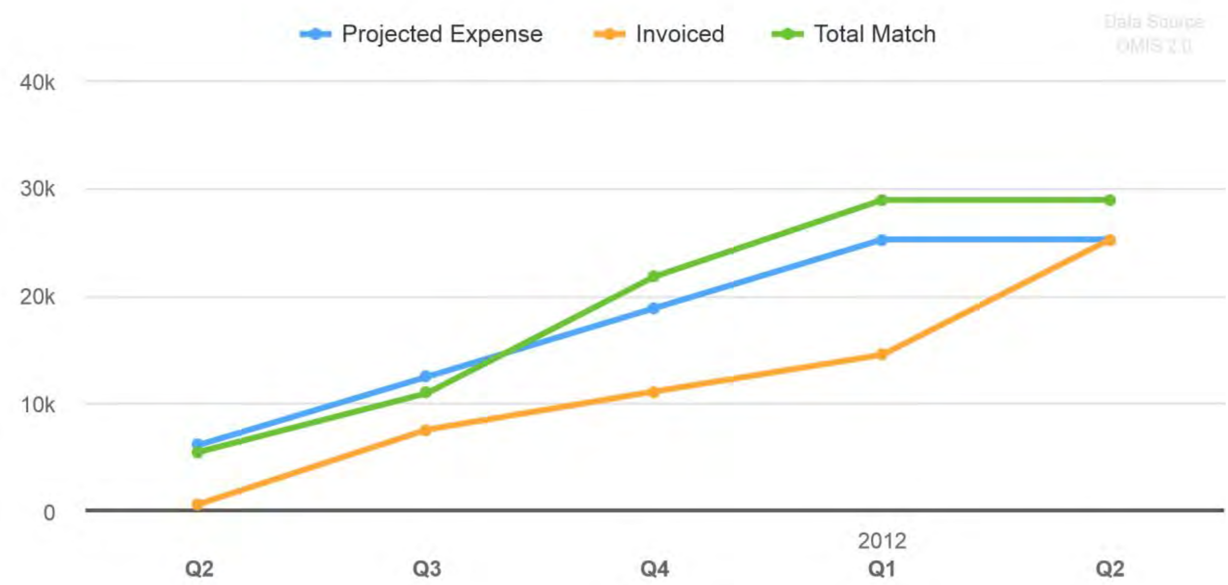
Deliverables

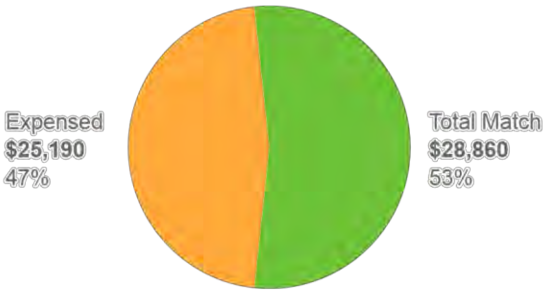
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

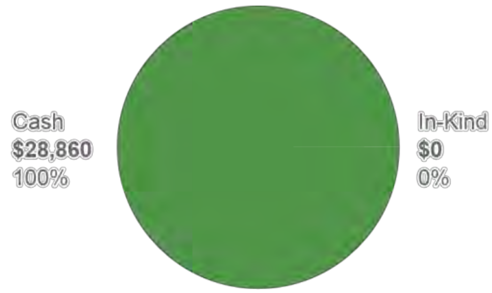
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$603.80	$603.80	$5,448.00	$5,448.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$6,907.24	$7,511.04	$5,451.00	$10,899.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$3,548.94	$11,059.98	$10,845.00	$21,744.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$3,410.50	$14,470.48	$7,116.00	$28,860.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$10,719.52	$25,190.00	$0.00	$28,860.00	$0.00	$0.00
Total	$25,190.00		$28,860.00		$0.00	

TASK 183-UTMB: Spaceflight Crew Medical Standards And Participant Acceptance Criteria

Lead University

University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area

3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013

Partners

Partner	Division	Primary
University of Texas Medical Branch		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UTMB-004	$33,284.00
1/1/2012	12/31/2012	2011	10-C-CST-UTMB-012	$35,000.00
1/1/2012	12/31/2012	2011	10-C-CST-UTMB-018	($3,516.18)
1/1/2012	12/31/2012	2011	10-C-CST-UTMB-019	($15,761.79)
Total				$49,006.03

Students

Name	Department	Discipline	Funded	Degree	Graduation
Leigh Lewis	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
Charles Mathers	PMCH	Aerospace Medicine	●	M.D.	6/1/2012

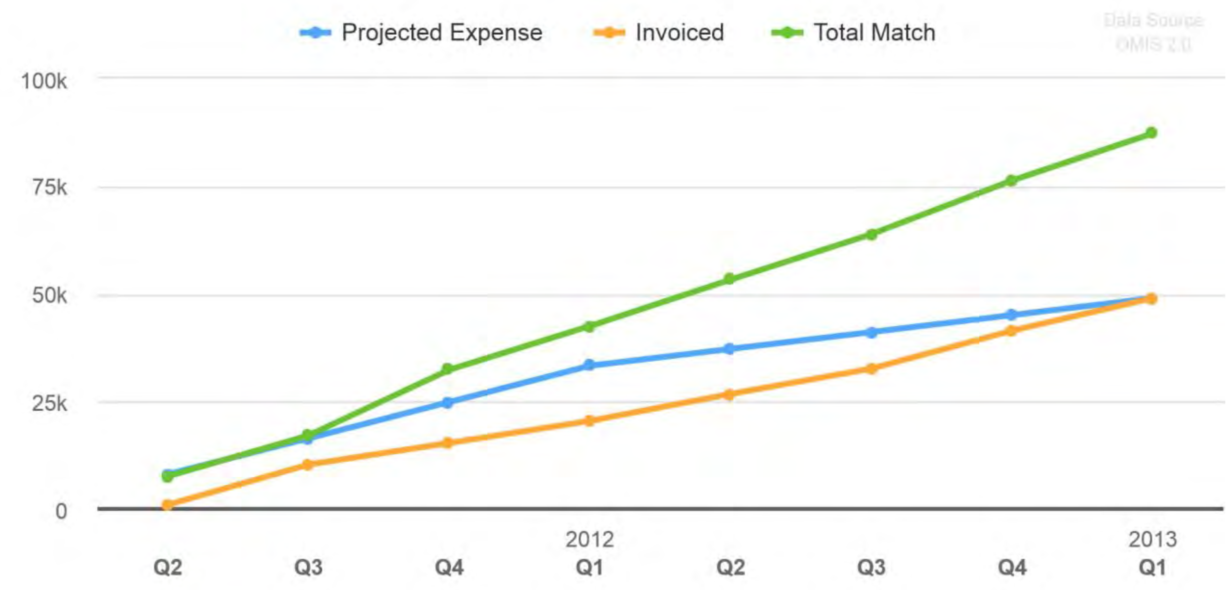
Deliverables

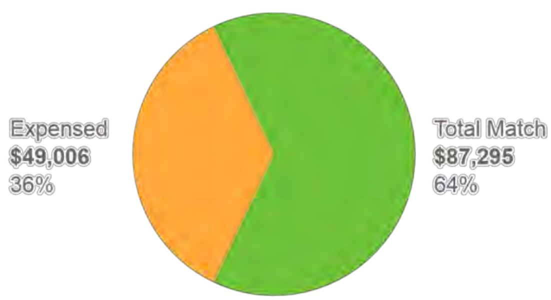
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

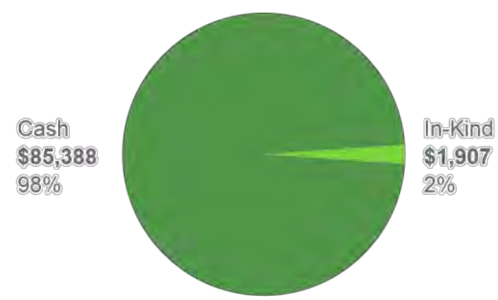
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$966.07	$966.07	$7,593.00	$7,593.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$9,346.97	$10,313.04	$7,588.00	$15,181.00	$1,907.00	$1,907.00
FY2011 Q4 (Jul-Sep)	$5,021.63	$15,334.67	$15,249.00	$30,430.00	$0.00	$1,907.00
FY2012 Q1 (Oct-Dec)	$5,132.64	$20,467.31	$10,176.00	$40,606.00	$0.00	$1,907.00
FY2012 Q2 (Jan-Mar)	$6,268.24	$26,735.55	$10,778.00	$51,384.00	$0.00	$1,907.00
FY2012 Q3 (Apr-Jun)	$5,880.85	$32,616.40	$10,572.00	$61,956.00	$0.00	$1,907.00

FY2012 Q4 (Jul-Sep)	$8,836.15	$41,452.55	$12,479.00	$74,435.00	$0.00	$1,907.00
FY2013 Q1 (Oct-Dec)	$7,553.00	$49,005.55	$10,953.00	$85,388.00	$0.00	$1,907.00
Total	$49,005.55		$85,388.00		$1,907.00	

TASK 184-UC: Human Rating of Commercially Operated Spacecraft

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
David Klaus	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2011	5/31/2012	2010	10-C-CST-UC-007	$79,542.00

6/1/2012	5/31/2013	2012	10-C-CST-UC-017	$52,350.00
6/1/2012	5/31/2013	2012	10-C-CST-UC-023	$50,000.00
5/31/2013	12/31/2013	2013	10-C-CST-UC-025	$19,000.00
12/31/2013	5/31/2014	2013	10-C-CST-UC-029	$19,000.00
6/1/2014	12/31/2014	2014	10-C-CST-UC-037	$0.00
6/1/2014	12/31/2014	2015	10-C-CST-UC-038	$15,390.00
Total				$235,282.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Christine Escobar (nee Chamberlain)	Aerospace Engineering Sciences	Aerospace Engineering Sciences	●	Ph.D.	
Christine Fanchiang	Aerospace Engineering Sciences	Aerospace Engineering Sciences	●	Ph.D.	5/1/2017
Roger Huang	Aerospace Engineering Sciences	Aerospace Engineering Sciences	●	Masters	12/20/2014
Robert Ocampo	Aerospace Engineering Sciences		●	Ph.D.	5/7/2016
Stefan Neis	Aerospace Engineering Sciences	Aerospace Engineering Sciences		Masters	

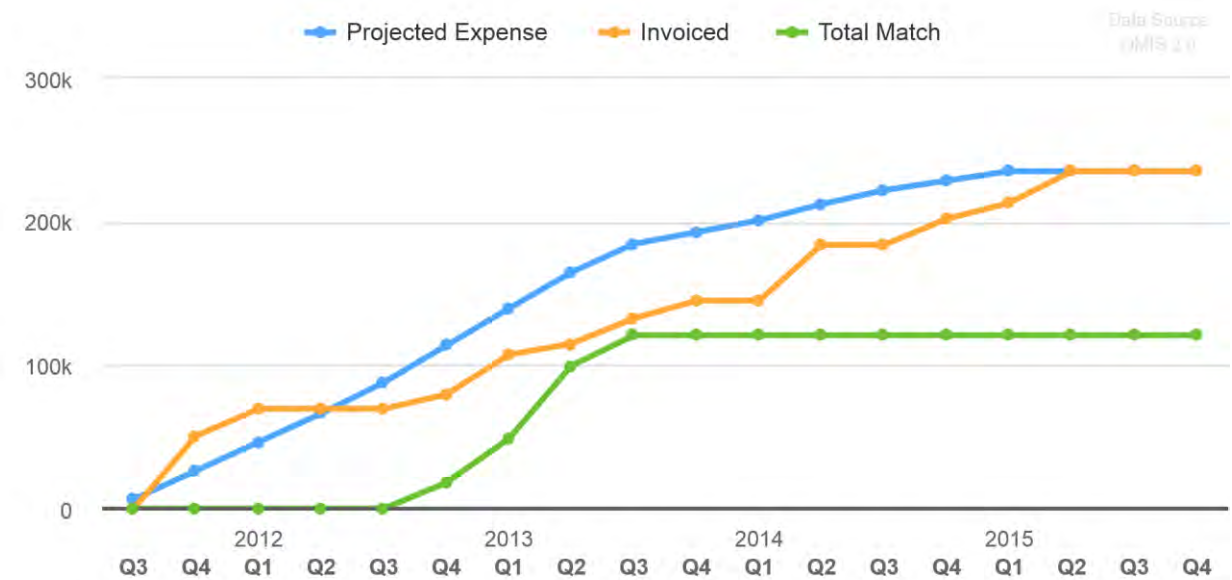
Deliverables

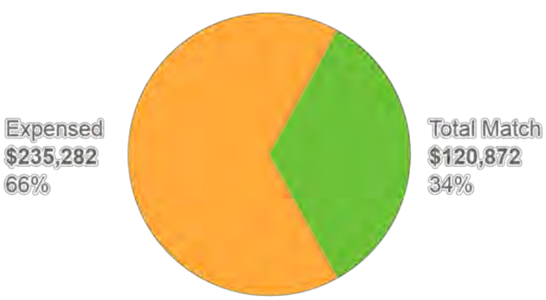
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$50,738.77	$50,738.77	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$18,901.58	$69,640.35	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$0.00	$69,640.35	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$69,640.35	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$9,901.65	$79,542.00	$18,154.45	$18,154.45	$0.00	$0.00

FY2013 Q1 (Oct-Dec)	$27,856.60	$107,398.60	$30,630.95	$48,785.40	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$7,660.00	$115,058.60	$21,498.74	$70,284.14	$29,333.70	$29,333.70
FY2013 Q3 (Apr-Jun)	$17,592.81	$132,651.41	$21,254.55	$91,538.69	$0.00	$29,333.70
FY2013 Q4 (Jul-Sep)	$12,381.15	$145,032.56	$0.00	$91,538.69	$0.00	$29,333.70
FY2014 Q1 (Oct-Dec)	$0.00	$145,032.56	$0.00	$91,538.69	$0.00	$29,333.70
FY2014 Q2 (Jan-Mar)	$38,869.59	$183,902.15	$0.00	$91,538.69	$0.00	$29,333.70
FY2014 Q3 (Apr-Jun)	$0.00	$183,902.15	$0.00	$91,538.69	$0.00	$29,333.70
FY2014 Q4 (Jul-Sep)	$18,145.19	$202,047.34	$0.00	$91,538.69	$0.00	$29,333.70
FY2015 Q1 (Oct-Dec)	$11,074.20	$213,121.54	$0.00	$91,538.69	$0.00	$29,333.70
FY2015 Q2 (Jan-Mar)	$22,158.75	$235,280.29	$0.00	$91,538.69	$0.00	$29,333.70
FY2015 Q3 (Apr-Jun)	$0.00	$235,280.29	$0.00	$91,538.69	$0.00	$29,333.70
FY2015 Q4 (Jul-Sep)	$1.71	$235,282.00	$0.00	$91,538.69	$0.00	$29,333.70
Total	$235,282.00		$91,538.69		$29,333.70	

TASK 185-SU: Unified 4D Trajectory Approach for Integrated Management

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Paul Wilde	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	□ □ □ □	□ ■ □ □	□

Partners

Partner	Division	Primary
Leland Stanford Junior University		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-SU-005	$60,000.00
1/1/2012	12/31/2012	2011	10-C-CST-SU-012	$50,000.00
1/1/2013	5/31/2013	2012	10-C-CST-SU-019	$17,416.00

1/1/2013	5/31/2013	2012	10-C-CST-SU-021	$580.00
5/31/2013	5/31/2014	2013	10-C-CST-SU-025	$130,000.00
5/31/2013	5/31/2014	2013	10-C-CST-SU-032	$3,000.00
6/1/2014	6/30/2015	2014	10-C-CST-SU-046	$0.00
6/1/2014	12/31/2015	2014	10-C-CST-SU-047	$140,000.00
6/1/2014	12/31/2015	2014	10-C-CST-SU-049	$50,000.00
6/1/2014	12/31/2015	2014	10-C-CST-SU-051	$0.00
1/3/2011	12/31/2015	2015	15-C-CST-SU-03	($50,000.00)
Total				$400,996.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Thomas Colvin	Aeronautics & Astronautics	Aerospace Engineering	●	Ph.D.	6/1/2015

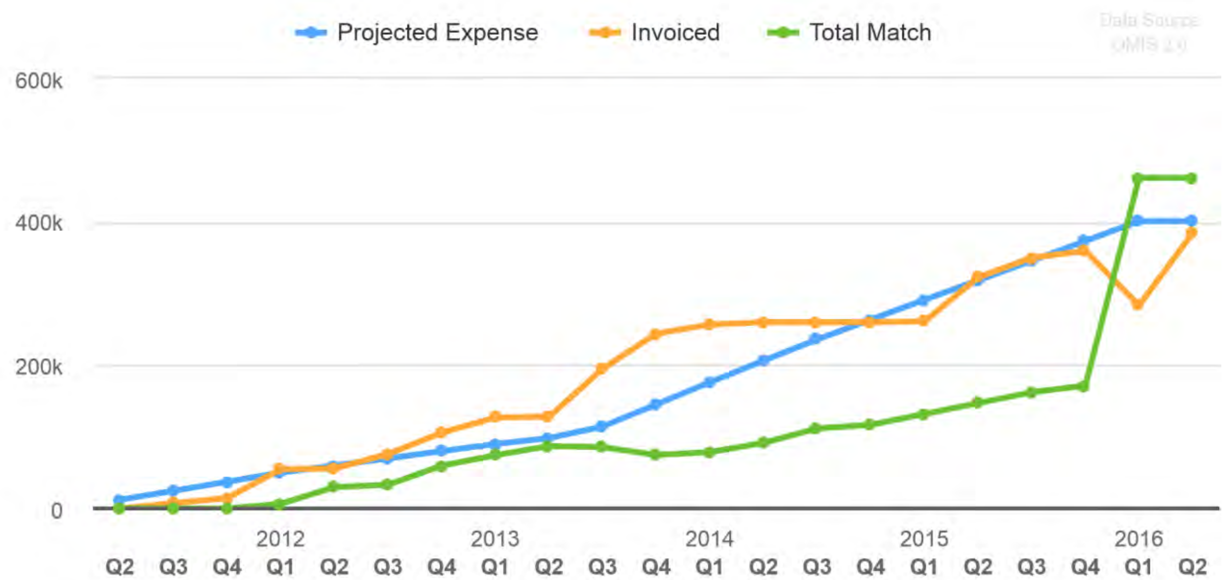
Deliverables

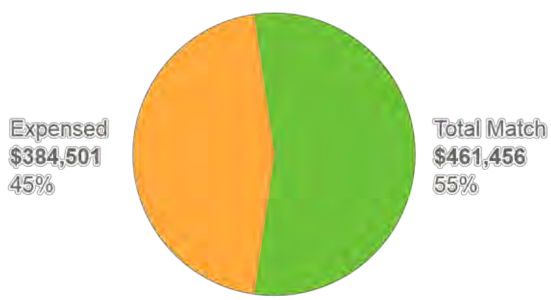
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	12/31/2015	

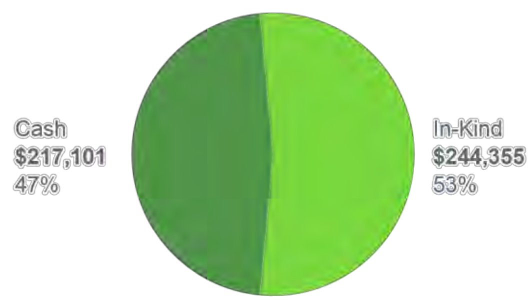
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$7,364.90	$7,364.90	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$7,236.83	$14,601.73	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$40,148.99	$54,750.72	$6,468.00	$6,468.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$1,111.41	$55,862.13	$18,292.37	$24,760.37	$5,123.64	$5,123.64
FY2012 Q3 (Apr-Jun)	$20,182.02	$76,044.15	$3,234.00	$27,994.37	$0.00	$5,123.64

FY2012 Q4 (Jul-Sep)	$29,619.56	$105,663.71	$21,535.02	$49,529.39	$5,128.54	$10,252.18
FY2013 Q1 (Oct-Dec)	$21,355.26	$127,018.97	$11,694.91	$61,224.30	$2,847.50	$13,099.68
FY2013 Q2 (Jan-Mar)	$977.02	$127,995.99	$9,369.10	$70,593.40	$3,417.00	$16,516.68
FY2013 Q3 (Apr-Jun)	$66,739.55	$194,735.54	$203.04	$70,796.44	-$1,770.99	$14,745.69
FY2013 Q4 (Jul-Sep)	$49,157.69	$243,893.23	-$5,720.37	$65,076.07	-$5,123.64	$9,622.05
FY2014 Q1 (Oct-Dec)	$12,735.50	$256,628.73	$3,940.00	$69,016.07	$0.00	$9,622.05
FY2014 Q2 (Jan-Mar)	$3,362.90	$259,991.63	$7,414.00	$76,430.07	$5,523.59	$15,145.64
FY2014 Q3 (Apr-Jun)	$0.00	$259,991.63	$16,356.00	$92,786.07	$3,682.40	$18,828.04
FY2014 Q4 (Jul-Sep)	$0.00	$259,991.63	$4,753.27	$97,539.34	$460.31	$19,288.35
FY2015 Q1 (Oct-Dec)	$1,004.37	$260,996.00	$12,233.76	$109,773.10	$2,883.07	$22,171.42
FY2015 Q2 (Jan-Mar)	$61,469.54	$322,465.54	$12,233.76	$122,006.86	$2,883.07	$25,054.49
FY2015 Q3 (Apr-Jun)	$27,531.82	$349,997.36	$12,233.76	$134,240.62	$2,883.07	$27,937.56
FY2015 Q4 (Jul-Sep)	$9,412.33	$359,409.69	$6,529.27	$140,769.89	$2,883.07	$30,820.63
FY2016 Q1 (Oct-Dec)	-$76,128.98	$283,280.71	$76,331.46	$217,101.35	$213,534.45	$244,355.08
FY2016 Q2 (Jan-Mar)	$101,220.30	$384,501.01	$0.00	$217,101.35	$0.00	$244,355.08
Total	$384,501.01		$217,101.35		$244,355.08	

TASK 193-SU: Role of the COE-CST in Encourage, Facilitate and Promote-SU

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Gunther Smiley	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

"The current environment favors such initiatives conceptually, but the business case for them is difficult to close. Unless they have a specific interest in the hosted technology, commercial launch users are reluctant to give up even a few kilograms of launch mass at prices supportable by research institutions and small commercial startups.

RELEVANCE TO COMMERCIAL SPACE INDUSTRY
In our recent research road-mapping effort, identifying and characterizing the space transportation market was identified as a priority research task for the Center of Excellence. In order to find a tractable focus area, we took our industry partners' suggestion of investigating secondary and hosted payloads (SHP's). SHP's represent a unique opportunity to achieve low cost access to space, yet are rarely used. Our task will work to identify the barriers to SHP's and how they can be overcome.

Project Outcomes

The objectives of this project are to provide training in and to construct, analyze and optimize a business model that fosters a favorable environment for flying many research and operational payloads either as rideshares deployed from commercial launches or as hosted payloads aboard commercial spacecraft.

Summary of Output

Near-Term: Develop a COE CST commercial space transportation research road-map by conducting workshops.
● Far-Term: Implement the strategy for commercial space transportation EFP using analysis tools and techniques at the intersection of engineering and business.

Technical Status

FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
□	■■■■	■■■■	■■■■	■■■■	□□□

Partners

Partner	Division	Primary
Futron		●
Leland Stanford Junior University		●
Lockheed Martin Space Systems Company		●
Orbital Sciences Corporation		●
Pennsylvania State University	College of Engineering	●
Scitor Corporation	Launch and Space Sector	●
Space Systems/Loral		●
The Boeing Company	Boeing Space Exploration	●
United Launch Alliance		●
Wyle Integrated Science and Engineering Group		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	4/30/2011	2010	10-C-CST-SU-002	$95,038.00
5/1/2011	12/31/2011	2010	10-C-CST-SU-009	$0.00
8/18/2010	12/31/2011	2010	10-C-CST-SU-011	$0.00
1/1/2012	5/31/2012	2012	10-C-CST-SU-015	$73,000.00
6/1/2012	5/31/2013	2012	10-C-CST-SU-018	$140,123.00
5/31/2013	5/31/2014	2013	10-C-CST-SU-027	$71,284.00
5/31/2013	5/31/2014	2013	10-C-CST-SU-035	$45,000.00

5/31/2013	5/31/2014	2013	10-C-CST-SU-039	$4,000.00
5/31/2013	5/31/2014	2014	10-C-CST-SU-040	$0.00
6/1/2014	5/31/2015	2014	10-C-CST-SU-041	$200,000.00
6/1/2015	6/30/2015	2014	10-C-CST-SU-050	$0.00
Total				$628,445.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Jonah Zimmerman	Aeronautics and Astronautics		●	Ph.D.	6/1/2015

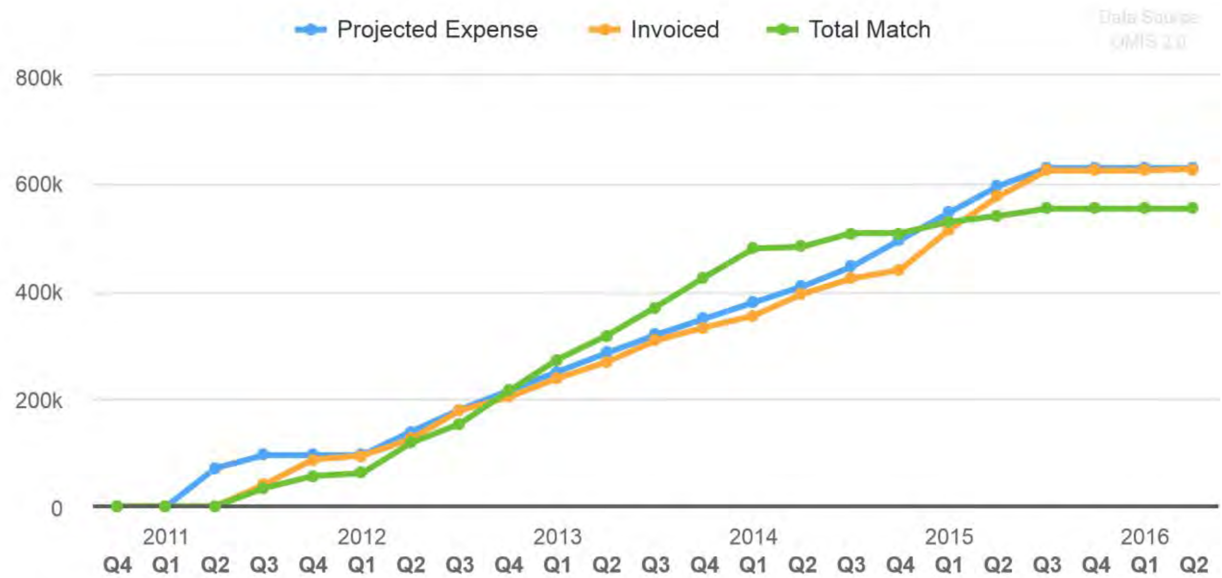
Deliverables

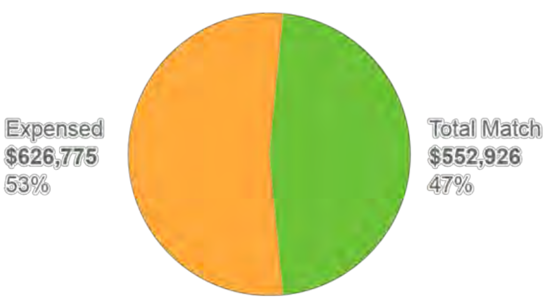
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	8/8/2010	6/30/2015	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2010 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$40,581.94	$40,581.94	$11,843.22	$11,843.22	$22,147.23	$22,147.23
FY2011 Q4 (Jul-Sep)	$46,415.48	$86,997.42	$3,425.00	$15,268.22	$18,990.57	$41,137.80
FY2012 Q1 (Oct-Dec)	$7,158.54	$94,155.96	$3,377.95	$18,646.17	$1,911.92	$43,049.72

FY2012 Q2 (Jan-Mar)	$30,649.78	$124,805.74	$35,777.47	$54,423.64	$20,250.08	$63,299.80
FY2012 Q3 (Apr-Jun)	$53,284.80	$178,090.54	$32,661.63	$87,085.27	$3,047.02	$66,346.82
FY2012 Q4 (Jul-Sep)	$24,880.48	$202,971.02	$36,855.72	$123,940.99	$24,309.88	$90,656.70
FY2013 Q1 (Oct-Dec)	$35,113.93	$238,084.95	$47,574.43	$171,515.42	$10,996.97	$101,653.67
FY2013 Q2 (Jan-Mar)	$30,271.60	$268,356.55	$12,420.65	$183,936.07	$31,635.24	$133,288.91
FY2013 Q3 (Apr-Jun)	$39,367.05	$307,723.60	$43,732.42	$227,668.49	$9,002.00	$142,290.91
FY2013 Q4 (Jul-Sep)	$24,982.03	$332,705.63	$43,351.06	$271,019.55	$12,421.19	$154,712.10
FY2014 Q1 (Oct-Dec)	$21,360.42	$354,066.05	$47,484.09	$318,503.64	$5,686.27	$160,398.37
FY2014 Q2 (Jan-Mar)	$40,696.92	$394,762.97	$2,037.85	$320,541.49	$1,392.89	$161,791.26
FY2014 Q3 (Apr-Jun)	$28,042.28	$422,805.25	$16,131.84	$336,673.33	$9,130.62	$170,921.88
FY2014 Q4 (Jul-Sep)	$16,681.58	$439,486.83	$0.00	$336,673.33	$0.00	$170,921.88
FY2015 Q1 (Oct-Dec)	$74,536.13	$514,022.96	$6,965.28	$343,638.61	$13,942.35	$184,864.23
FY2015 Q2 (Jan-Mar)	$61,662.73	$575,685.69	$6,965.37	$350,603.98	$3,942.40	$188,806.63
FY2015 Q3 (Apr-Jun)	$48,101.66	$623,787.35	$8,630.37	$359,234.35	$4,884.78	$193,691.41
FY2015 Q4 (Jul-Sep)	$0.00	$623,787.35	$0.00	$359,234.35	$0.00	$193,691.41
FY2016 Q1 (Oct-Dec)	$0.00	$623,787.35	$0.00	$359,234.35	$0.00	$193,691.41
FY2016 Q2 (Jan-Mar)	$2,987.65	$626,775.00	$0.00	$359,234.35	$0.00	$193,691.41
Total	$626,775.00		$359,234.35		$193,691.41	

TASK 244-FSU: Autonomous Rendezvous and Docking for Space Debris Mitigation-FSU

Lead University
Florida State University

Team

Name	Role	Primary
Emmanuel Collins	Principal Investigator	●
Paul Wilde	Tech Monitor	●
Yolanda Lopez	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Launch vehicles are nonlinear dynamic systems that require skill to maneuver in tight spaces as required for docking and berthing maneuvers (DBMs). This problem is akin to the difficult task of parallel parking for ground vehicles. However, whereas the latter task can be based on a simple kinematic model, DBMs for space vehicles require the use of more complex dynamic models due to the need to model the less precise actuators (e.g., thrusters) and to explicitly consider the inertia of the vehicle due to the lack of friction or environmental resistance.

Project Outcomes

The motion planning will be based on Sampling Based Model Predictive Control (SBMPC), which is a synergy between the Model Predictive Control (MPC) paradigm used by control researchers and engineers and the sampling based planning methodologies popularized by robotics and artificial intelligence researchers. SBMPC, like MPC, uses dynamic models in planning and treats the inputs to the system as the optimization parameters. However, unlike MPC, it optimizes uses sampling and A*-type optimization, which enables it to avoid local minimum and be used for real-time planning and control.

Summary of Output

This project will develop the technology needed to automate DBM.

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
□ □ □	■ ■ ■ ■	■ ■ ■ ■	□ ■ □ ■	■ ■ ■ □	□ □ □ □

Partners

Partner	Division	Primary
Florida State University		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-FSU-003	$24,830.00
1/1/2012	5/31/2012	2011	10-C-CST-FSU-007	$45,000.00
6/1/2012	5/31/2013	2012	10-C-CST-FSU-013	$94,038.00
5/31/2013	5/31/2014	2012	10-C-CST-FSU-016	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-FSU-018	$10,000.00
5/31/2013	5/31/2014	2013	10-C-CST-FSU-020	$15,000.00
5/31/2013	5/31/2014	2013	10-C-CST-FSU-023	$37,000.00
6/1/2014	5/31/2015	2014	10-C-CST-FSU-025	$0.00
5/31/2015	8/31/2015	2015	10-C-CST-FSU-027	$60,000.00
5/31/2015	8/31/2015	2015	10-C-CST-FSU-028	$10,580.00
5/31/2015	8/31/2015	2015	10-C-CST-FSU-029	$5,502.00
1/3/2011	8/31/2016	2015	15-C-CST-FSU-03	$0.00
Total				$301,950.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Griffin Francis	Mechanical Engineering	Dynamics , Control and Robotics	●	Ph.D.	
Aneesh Sharma	Computer Science	Robotics	●	Ph.D.	

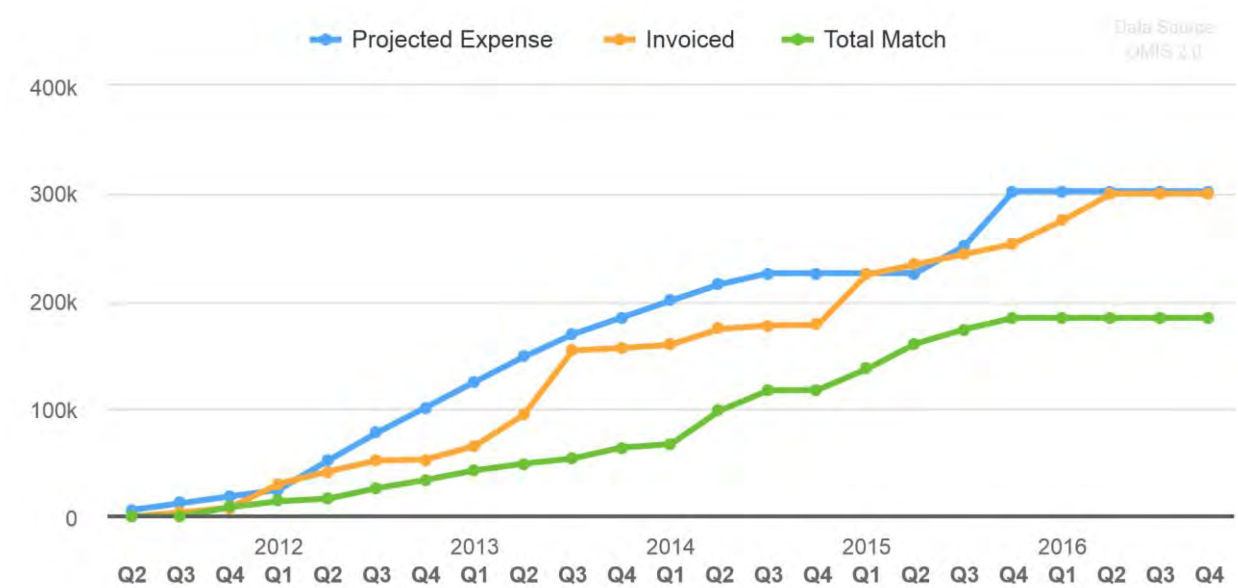
Deliverables

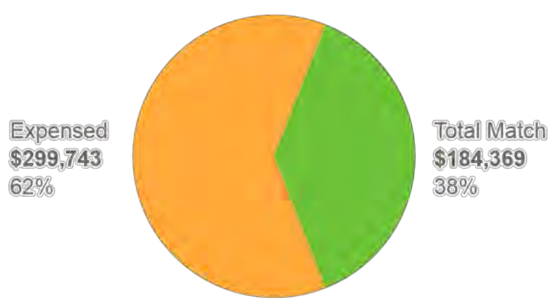
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/3/2011	8/31/2016	

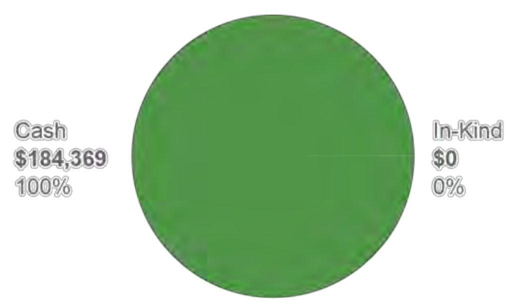
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$3,546.32	$3,546.32	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$4,696.81	$8,243.13	$8,537.12	$8,537.12	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$21,850.80	$30,093.93	$5,537.62	$14,074.74	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$11,590.49	$41,684.42	$2,351.48	$16,426.22	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$10,102.38	$51,786.80	$9,710.26	$26,136.48	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$1,058.93	$52,845.73	$7,756.31	$33,892.79	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$12,551.21	$65,396.94	$8,856.21	$42,749.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$29,038.03	$94,434.97	$6,224.77	$48,973.77	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$59,742.16	$154,177.13	$4,779.66	$53,753.43	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$2,129.88	$156,307.01	$10,202.73	$63,956.16	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$3,137.28	$159,444.29	$3,063.78	$67,019.94	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$14,564.22	$174,008.51	$31,174.22	$98,194.16	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$3,446.84	$177,455.35	$18,778.44	$116,972.60	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$322.54	$177,777.89	$438.20	$117,410.80	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$46,651.12	$224,429.01	$19,375.77	$136,786.57	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$9,658.34	$234,087.35	$23,522.98	$160,309.55	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$9,398.20	$243,485.55	$13,509.91	$173,819.46	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$9,676.05	$253,161.60	$10,544.00	$184,363.46	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$21,554.21	$274,715.81	$5.54	$184,369.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$25,027.23	$299,743.04	$0.00	$184,369.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$299,743.04	$0.00	$184,369.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$299,743.04	$0.00	$184,369.00	$0.00	$0.00

Total	$299,743.04		$184,369.00		$0.00	

TASK 244-SU: Autonomous Rendezvous and Docking for Space Debris Mitigation-SU

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Sigrid Close	Principal Investigator	●
Stephen Earle	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
Leland Stanford Junior University	Department of Aeronautics and Astronautics	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-SU-004	$40,000.00
1/1/2012	12/31/2012	2011	10-C-CST-SU-014	$40,000.00

1/1/2013	5/31/2013	2012	10-C-CST-SU-024	$22,128.00
5/31/2013	9/30/2013	2013	10-C-CST-SU-028	$0.00
9/30/2013	6/30/2014	2013	10-C-CST-SU-034	$18,000.00
9/30/2013	6/30/2014	2013	10-C-CST-SU-037	$11,000.00
6/30/2014	9/30/2015	2014	10-C-CST-SU-042	$0.00
6/30/2014	9/30/2015	2014	10-C-CST-SU-044	$0.00
Total				$131,128.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Gabe Charalambides	Aero and Astro	Dynamics and Control	●	Ph.D.	
Marcus Hammond	Aeronautics and Astronautics	Estimation and Control	●		
Jose Padial	Aeronautics and Astronautics	Estimation and Control	●	Ph.D.	
Andrew Smith	Aeronautics and Astronautics	Estimation and Control	●	Ph.D.	

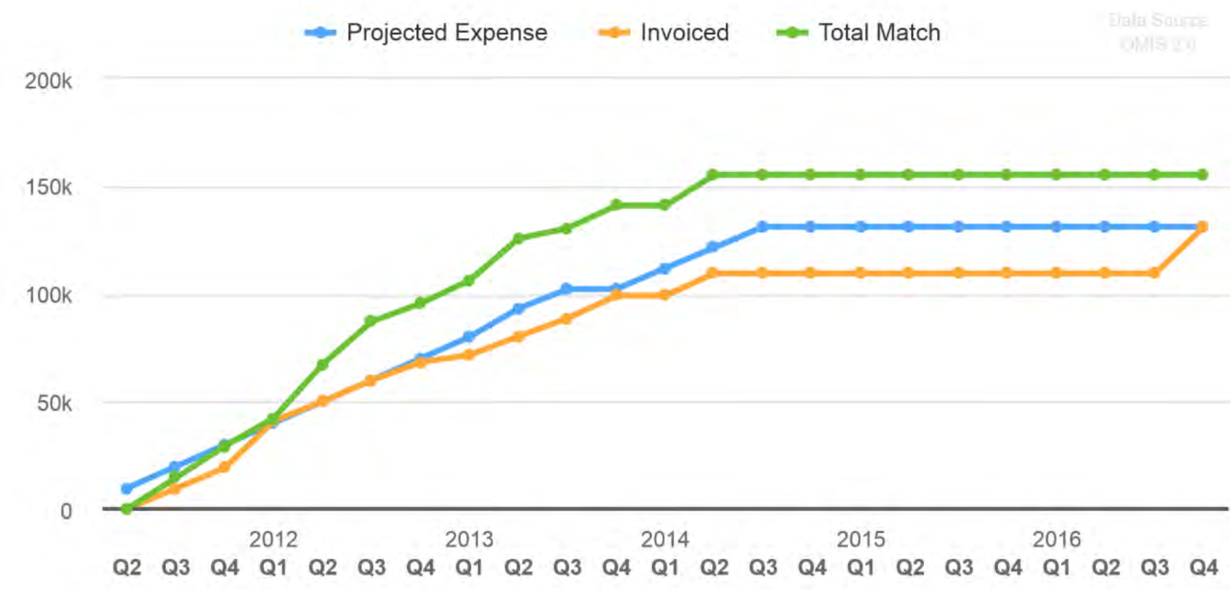
Deliverables

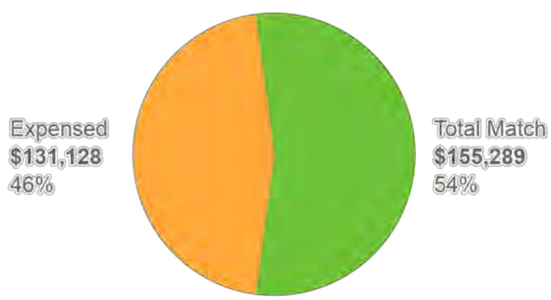
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

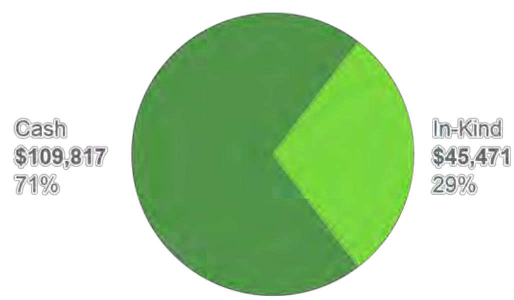
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$9,508.30	$9,508.30	$11,421.43	$11,421.43	$3,052.68	$3,052.68
FY2011 Q4 (Jul-Sep)	$9,636.52	$19,144.82	$11,578.02	$22,999.45	$3,141.31	$6,193.99
FY2012 Q1 (Oct-Dec)	$21,807.43	$40,952.25	$9,548.67	$32,548.12	$3,574.10	$9,768.09
FY2012 Q2 (Jan-Mar)	$9,024.21	$49,976.46	$16,858.83	$49,406.95	$8,068.23	$17,836.32
FY2012 Q3 (Apr-Jun)	$9,833.59	$59,810.05	$13,155.95	$62,562.90	$6,709.34	$24,545.66

FY2012 Q4 (Jul-Sep)	$8,396.76	$68,206.81	$5,832.50	$68,395.40	$2,564.26	$27,109.92
FY2013 Q1 (Oct-Dec)	$3,343.51	$71,550.32	$6,862.62	$75,258.02	$3,884.24	$30,994.16
FY2013 Q2 (Jan-Mar)	$8,700.90	$80,251.22	$12,903.38	$88,161.40	$6,544.31	$37,538.47
FY2013 Q3 (Apr-Jun)	$8,343.20	$88,594.42	$3,048.96	$91,210.36	$1,725.71	$39,264.18
FY2013 Q4 (Jul-Sep)	$10,553.52	$99,147.94	$7,008.42	$98,218.78	$3,545.10	$42,809.28
FY2014 Q1 (Oct-Dec)	$0.00	$99,147.94	$0.00	$98,218.78	$0.00	$42,809.28
FY2014 Q2 (Jan-Mar)	$10,320.54	$109,468.48	$11,598.40	$109,817.18	$2,662.12	$45,471.40
FY2014 Q3 (Apr-Jun)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2014 Q4 (Jul-Sep)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2015 Q1 (Oct-Dec)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2015 Q2 (Jan-Mar)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2015 Q3 (Apr-Jun)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2015 Q4 (Jul-Sep)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2016 Q1 (Oct-Dec)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2016 Q2 (Jan-Mar)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2016 Q3 (Apr-Jun)	$0.00	$109,468.48	$0.00	$109,817.18	$0.00	$45,471.40
FY2016 Q4 (Jul-Sep)	$21,659.52	$131,128.00	$0.00	$109,817.18	$0.00	$45,471.40
Total	$131,128.00		$109,817.18		$45,471.40	

TASK 244-UC: Autonomous Rendezvous and Docking for Space Debris Mitigation-CU

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
Penina Axelrad	Principal Investigator	●
Stephen Earle	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
University of Colorado at Boulder	Aerospace Engineering Sciences	●
Ball Aerospace	Mission Systems Engineering	

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2011	12/31/2011	2010	10-C-CST-UC-009	$17,000.00
1/1/2012	5/31/2013	2012	10-C-CST-UC-021	$94,467.00
6/1/2013	5/31/2014	2012	10-C-CST-UC-024	$0.00
6/1/2013	5/31/2014	2013	10-C-CST-UC-028	$5,000.00
6/1/2013	5/31/2014	2013	10-C-CST-UC-033	$5,000.00
6/1/2014	5/31/2015	2014	10-C-CST-UC-036	$0.00
6/1/2011	5/31/2015	2013	15-C-CST-CU-03	($2,234.00)
Total				$119,233.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Holly Borowski	Aerospace Engineering Sciences	Aerospace	●	Ph.D.	5/5/2016
Steven Gehly	Aerospace Engineering Sciences	Aerospace	●	Ph.D.	9/30/2016
Homer Phillips	Aerospace Engineering Sciences	Aerospace	●	Masters	
Caleb Lipscomb	Aerospace Engineering Sciences			Bachelors	
Heather LoCrasto	Aerospace Engineering Sciences	Systems Engineering		Masters	

Deliverables

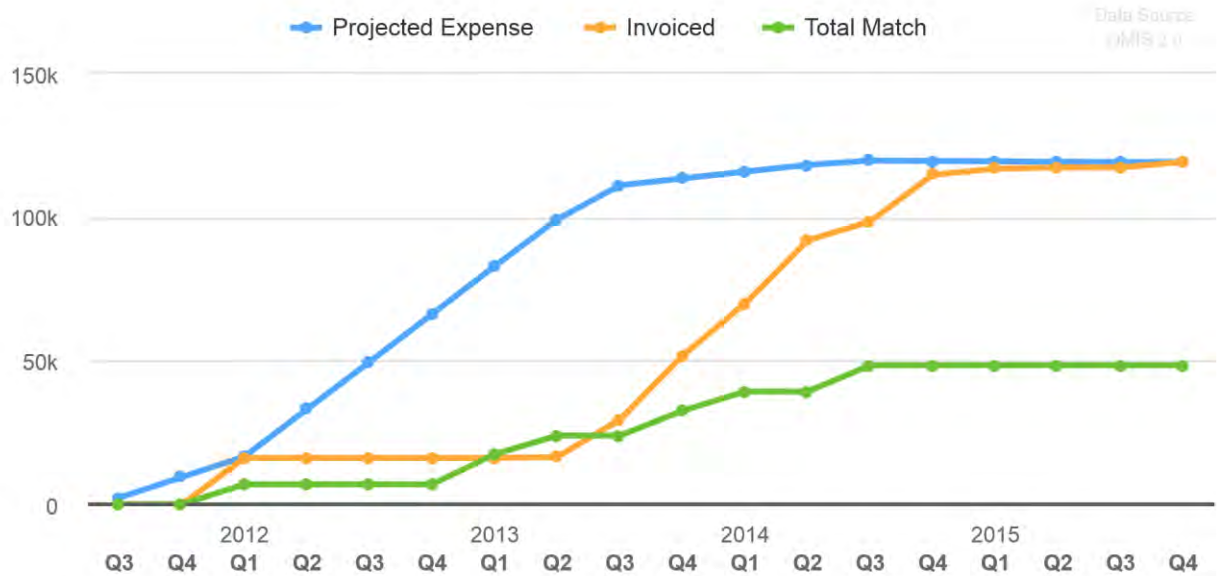
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

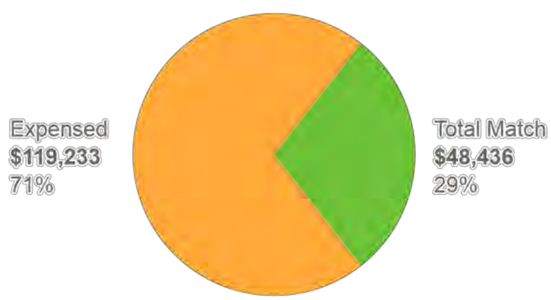
Milestones

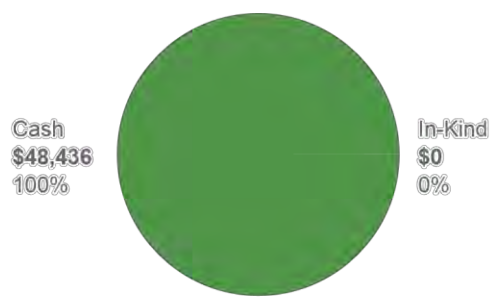
#	Milestone	Start Date	Due Date	Accepted

No Milestones

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$16,158.52	$16,158.52	$7,000.00	$7,000.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$0.00	$16,158.52	$0.00	$7,000.00	$0.00	$0.00

FY2012 Q3 (Apr-Jun)	$0.00	$16,158.52	$0.00	$7,000.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$16,158.52	$0.00	$7,000.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$16,158.52	$10,476.78	$17,476.78	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$343.13	$16,501.65	$6,490.78	$23,967.56	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$13,033.38	$29,535.03	$0.00	$23,967.56	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$22,222.72	$51,757.75	$8,625.94	$32,593.50	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$18,246.33	$70,004.08	$6,711.71	$39,305.21	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$21,935.39	$91,939.47	$0.00	$39,305.21	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$6,590.56	$98,530.03	$9,130.94	$48,436.15	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$16,285.04	$114,815.07	$0.00	$48,436.15	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$2,090.07	$116,905.14	$0.00	$48,436.15	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$454.83	$117,359.97	$0.00	$48,436.15	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$117,359.97	$0.00	$48,436.15	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$1,872.76	$119,232.73	$0.00	$48,436.15	$0.00	$0.00
Total	$119,232.73		$48,436.15		$0.00	

TASK 247-FIT: Air and Space Traffic Control Considerations for Commercial Space

Lead University

Florida Institute of Technology

Team

Name	Role	Primary
Nathaniel Villaire	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area

1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014

Partners

Partner	Division	Primary
Florida Institute of Technology	College of Aeronautics	●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

1/3/2011	12/31/2011	2010	10-C-CST-FIT-002	$89,486.00
1/1/2012	3/31/2012	2010	10-C-CST-FIT-004	$0.00
4/1/2012	5/31/2012	2010	10-C-CST-FIT-005	$17,000.00
6/1/2012	1/31/2013	2010	10-C-CST-FIT-007	$23,526.00
6/1/2012	1/31/2013	2012	10-C-CST-FIT-008	$26,566.00
2/1/2013	5/31/2013	2012	10-C-CST-FIT-010	$40,000.00
5/31/2013	8/31/2013	2012	10-C-CST-FIT-016	$0.00
8/31/2013	12/31/2013	2012	10-C-CST-FIT-021	$0.00
12/31/2013	5/31/2014	2013	10-C-CST-FIT-022	$45,000.00
12/31/2013	5/31/2014	2013	10-C-CST-FIT-023	$30,000.00
5/31/2014	5/31/2014	2013	10-C-CST-FIT-029	($30,000.00)
5/31/2014	5/31/2014	2013	10-C-CST-FIT-029	($45,000.00)
Total				$196,578.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Nicholas Kasdaglis	Aeronautics		●		
Nicole Maillet	Aeronautics		●	Masters	5/1/2012
Sebastian Reiner	Computer Engineering	Computer Science	●	Bachelors	
Dennis Wilt	Aeronautics	Aviation Safety	●	Masters	

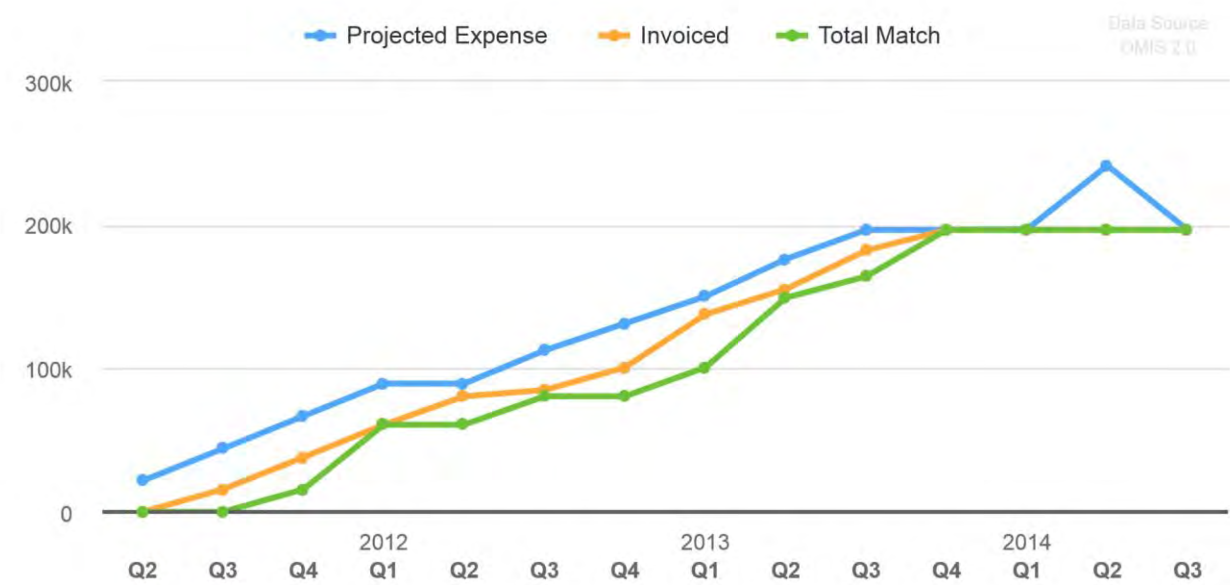
Deliverables

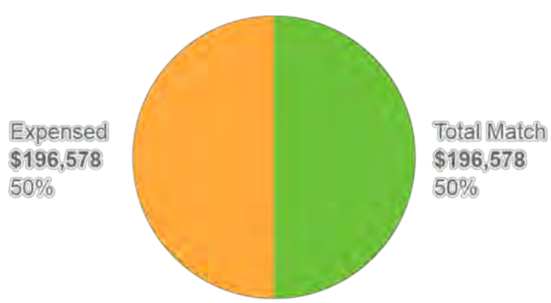
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

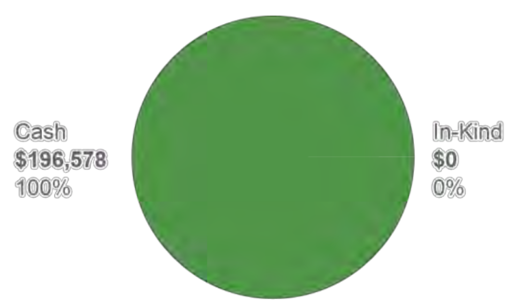
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$15,779.80	$15,779.80	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$22,316.33	$38,096.13	$15,799.80	$15,799.80	$0.00	$0.00

FY2012 Q1 (Oct-Dec)	$22,722.77	$60,818.90	$45,019.10	$60,818.90	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$19,785.24	$80,604.14	$0.00	$60,818.90	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$4,397.54	$85,001.68	$19,785.24	$80,604.14	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$15,740.95	$100,742.63	$0.00	$80,604.14	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$37,003.42	$137,746.05	$20,138.95	$100,743.09	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$17,595.48	$155,341.53	$48,605.68	$149,348.77	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$26,915.16	$182,256.69	$14,808.90	$164,157.67	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$14,320.99	$196,577.68	$32,420.41	$196,578.08	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$196,577.68	$0.00	$196,578.08	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$196,577.68	$0.00	$196,578.08	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$0.00	$196,577.68	$0.00	$196,578.08	$0.00	$0.00
Total	$196,577.68		$196,578.08		$0.00	

TASK 255-UTMB: Wearable Biomedical Monitoring Equipment for Spaceflight Participants

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Tarah Castleberry	Principal Investigator	
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014
□ □ □	■ ■ ■ ■	■ ■ ■ ■	■

Partners

Partner	Division	Primary

NASTAR Center		●
University of Texas Medical Branch	UTMB Aerospace medicine Residency	●
Wyle Integrated Science and Engineering Group		●
NASA	Johnson Space Center	

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UTMB-005	$59,025.00
1/1/2012	12/31/2012	2010	10-C-CST-UTMB-009	$34,896.00
1/1/2013	6/30/2013	2010	10-C-CST-UTMB-017	$0.00
1/1/2013	6/30/2013	2011	10-C-CST-UTMB-018	$3,516.18
6/30/2013	9/30/2013	2011	10-C-CST-UTMB-022	$0.00
9/30/2013	12/31/2013	2013	10-C-CST-UTMB-024	$15,000.00
Total				$112,437.18

Students

Name	Department	Discipline	Funded	Degree	Graduation
Rebecca Blue	PMCH	Aerospace Medicine	●	M.D.	6/1/2013
Jennifer Law	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
Anil Menon	PMCH	Aerospace Medicine	●	M.D.	6/1/2012
Robert Mulcahy	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
James Pattarini	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
David Reyes	PMCH	Aerospace Medicine	●	M.D.	8/15/2014

Deliverables

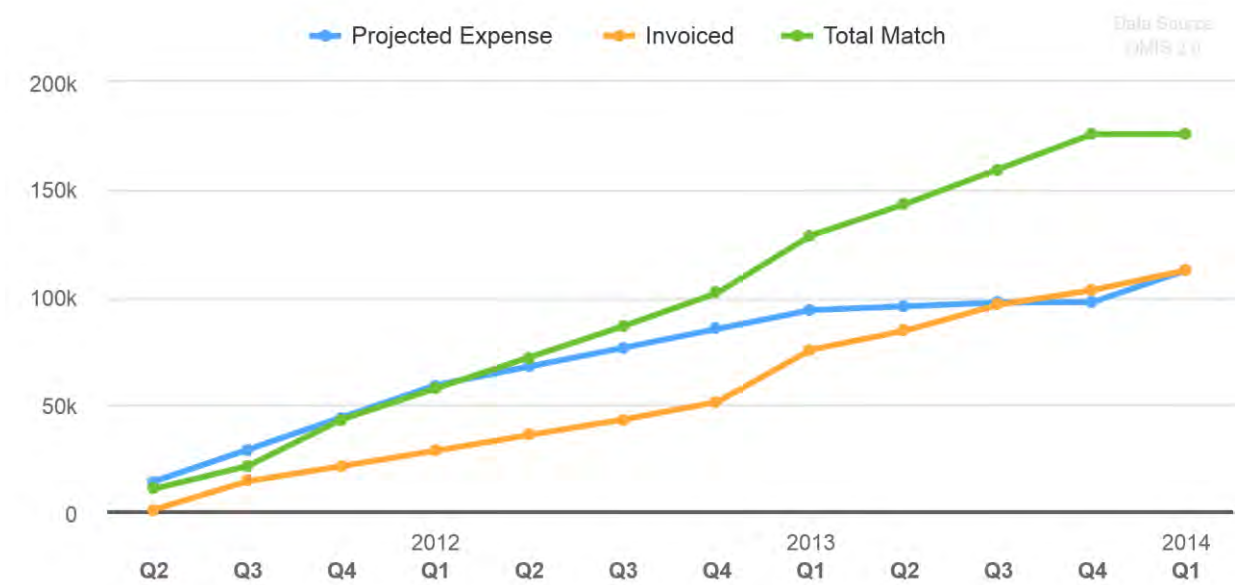
#	Deliverable	Start Date	Due Date	Accepted

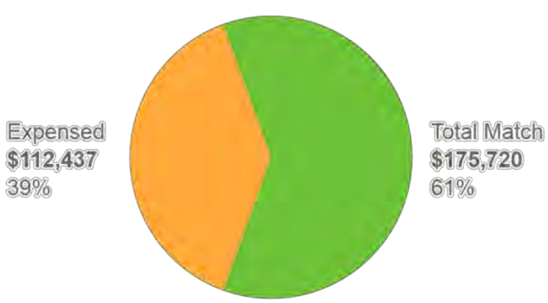
No Deliverables

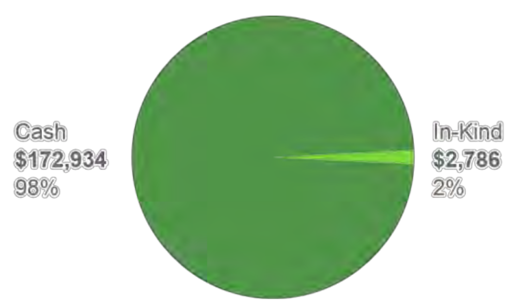
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$1,207.58	$1,207.58	$10,871.00	$10,871.00	$0.00	$0.00

FY2011 Q3 (Apr-Jun)	$13,213.99	$14,421.57	$10,607.00	$21,478.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$6,984.74	$21,406.31	$21,630.00	$43,108.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$7,124.25	$28,530.56	$14,393.00	$57,501.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$7,347.10	$35,877.66	$14,511.00	$72,012.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$7,197.72	$43,075.38	$14,432.00	$86,444.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$8,111.79	$51,187.17	$15,426.00	$101,870.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$24,333.00	$75,520.17	$23,925.00	$125,795.00	$2,786.00	$2,786.00
FY2013 Q2 (Jan-Mar)	$8,802.11	$84,322.28	$14,566.00	$140,361.00	$0.00	$2,786.00
FY2013 Q3 (Apr-Jun)	$12,108.54	$96,430.82	$16,318.00	$156,679.00	$0.00	$2,786.00
FY2013 Q4 (Jul-Sep)	$6,756.45	$103,187.27	$16,255.00	$172,934.00	$0.00	$2,786.00
FY2014 Q1 (Oct-Dec)	$9,249.91	$112,437.18	$0.00	$172,934.00	$0.00	$2,786.00
Total	$112,437.18		$172,934.00		$2,786.00	

TASK 256-UTMB: Centrifuge Testing/Testing and Training of Personnel and Hardware in High-G Profiles using the NASTAR Center Centrifuge

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
NASTAR Center		●

University of Texas Medical Branch		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UTMB-006	$31,525.00
1/1/2012	12/31/2012	2010	10-C-CST-UTMB-010	$32,396.00
1/1/2013	6/30/2013	2010	10-C-CST-UTMB-016	$0.00
1/1/2013	6/30/2013	2011	10-C-CST-UTMB-019	$15,761.79
1/1/2013	6/30/2013	2010	10-C-CST-UTMB-019	$5,178.42
6/30/2013	9/30/2013	2010	10-C-CST-UTMB-023	$0.00
9/1/2014	7/31/2015	2013	10-C-CST-UTMB-025	$30,000.00
9/1/2014	7/31/2015	2013	10-C-CST-UTMB-026	$43,000.00
9/30/2013	8/31/2014	2014	10-C-CST-UTMB-027	$0.00
9/1/2014	7/31/2015	2012	10-C-CST-UTMB-028	$1,663.77
9/1/2014	7/31/2015	2012	10-C-CST-UTMB-028	$2,188.88
9/1/2014	7/31/2015	2015	10-C-CST-UTMB-032	$0.00
9/1/2014	7/31/2015	2014	10-C-CST-UTMB-033	$5,099.00
Total				$166,812.86

Students

Name	Department	Discipline	Funded	Degree	Graduation
Rebecca Blue	PMCH	Aerospace Medicine	●	M.D.	6/1/2013
Natcha Chough	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
Robert Mulcahy	PMCH	Aerospace Medicine	●	M.D.	6/30/2016
James Pattarini	PMCH	Aerospace Medicine	●	M.D.	6/30/2015
David Reyes	PMCH	Aerospace Medicine	●	M.D.	8/15/2014

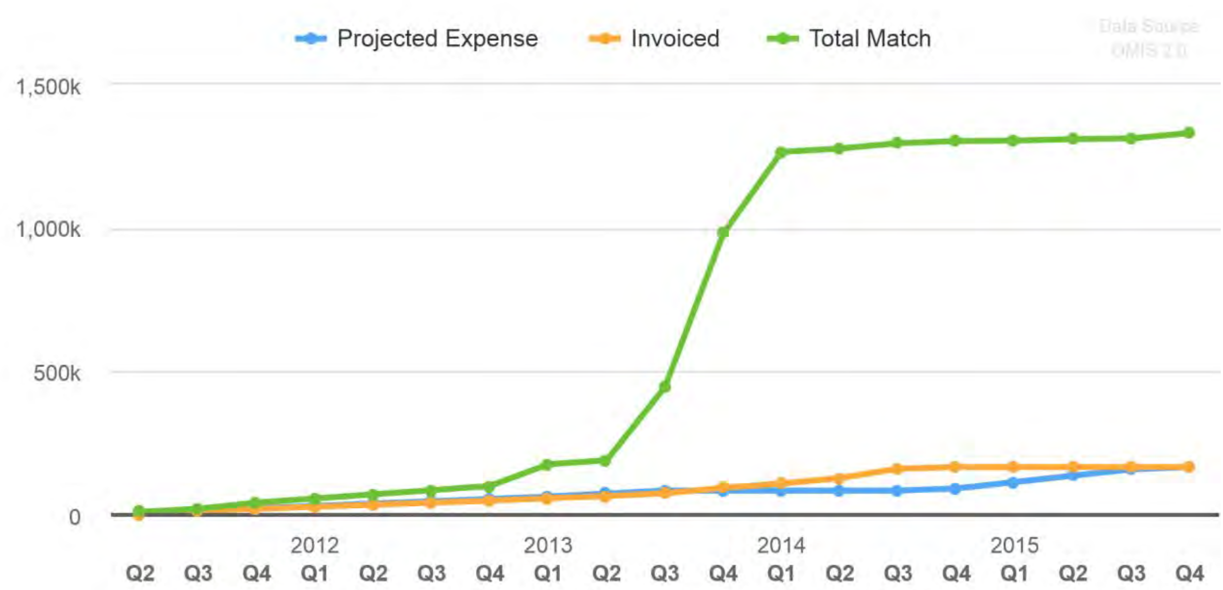
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match

FY2011 Q2 (Jan-Mar)	$1,207.58	$1,207.58	$10,739.00	$10,739.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$13,197.96	$14,405.54	$10,732.00	$21,471.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$7,003.19	$21,408.73	$21,640.00	$43,111.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$6,820.93	$28,229.66	$14,232.00	$57,343.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$7,374.60	$35,604.26	$14,526.00	$71,869.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$7,224.87	$42,829.13	$14,446.00	$86,315.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$6,883.93	$49,713.06	$14,775.00	$101,090.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$8,488.00	$58,201.06	$15,527.00	$116,617.00	$60,000.00	$60,000.00
FY2013 Q2 (Jan-Mar)	$7,683.56	$65,884.62	$13,973.00	$130,590.00	$0.00	$60,000.00
FY2013 Q3 (Apr-Jun)	$9,528.20	$75,412.82	$14,951.00	$145,541.00	$240,000.00	$300,000.00
FY2013 Q4 (Jul-Sep)	$18,962.11	$94,374.93	$25,396.00	$170,937.00	$510,000.00	$810,000.00
FY2014 Q1 (Oct-Dec)	$14,802.91	$109,177.84	$14,613.00	$185,550.00	$270,000.00	$1,080,000.00
FY2014 Q2 (Jan-Mar)	$19,575.10	$128,752.94	$11,681.00	$197,231.00	$0.00	$1,080,000.00
FY2014 Q3 (Apr-Jun)	$32,387.36	$161,140.30	$18,487.00	$215,718.00	$0.00	$1,080,000.00
FY2014 Q4 (Jul-Sep)	$5,672.56	$166,812.86	$7,415.00	$223,133.00	$0.00	$1,080,000.00
FY2015 Q1 (Oct-Dec)	$0.00	$166,812.86	$1,764.00	$224,897.00	$0.00	$1,080,000.00
FY2015 Q2 (Jan-Mar)	$0.00	$166,812.86	$4,968.00	$229,865.00	$0.00	$1,080,000.00
FY2015 Q3 (Apr-Jun)	$0.00	$166,812.86	$2,634.00	$232,499.00	$0.00	$1,080,000.00
FY2015 Q4 (Jul-Sep)	$0.00	$166,812.86	$18,468.00	$250,967.00	$0.00	$1,080,000.00
Total	$166,812.86		$250,967.00		$1,080,000.00	

TASK 257-UC: Masters Level Commercial Space Operations Instruction

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
George Born	Principal Investigator	●
David Klaus	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●
Andy Wang	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
University of Colorado at Boulder	Aerospace Engineering Services	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

1/3/2011	12/31/2011	2010	10-C-CST-UC-003	$25,024.00
1/1/2012	12/31/2012	2011	10-C-CST-UC-011	$50,000.00
1/1/2013	5/31/2013	2012	10-C-CST-UC-022	$33,486.00
5/31/2013	5/31/2014	2013	10-C-CST-UC-030	$20,000.00
6/1/2014	8/31/2015	2013	10-C-CST-UC-043	$0.00
Total				$128,510.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Bradley Cheetham	Aerospace Engineering Sciences	Aerospace Engineering	●	Ph.D.	
Juliana Feldhacker	Aerospace Engineering Sciences		●	Ph.D.	
Jon Herman	Aerospace Engineering Sciences	Aerospace Engineering	●	Ph.D.	5/1/2015
Ryan Mcgranaghan	Aerospace Engineering Sciences	Aerospace Engineering	●		

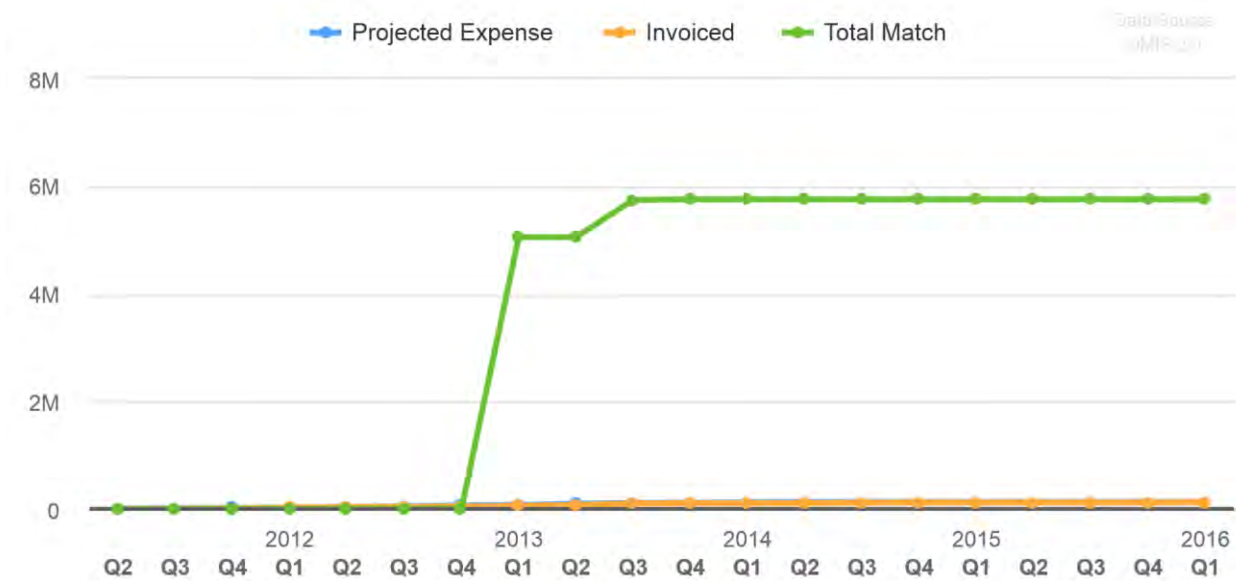
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$6,358.21	$6,358.21	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$9,674.79	$16,033.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$8,991.00	$25,024.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$13,129.35	$38,153.35	$0.00	$0.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$1,111.57	$39,264.92	$0.00	$0.00	$0.00	$0.00

FY2012 Q4 (Jul-Sep)	$6,169.60	$45,434.52	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$10,979.12	$56,413.64	$61,564.30	$61,564.30	$4,989,333.00	$4,989,333.00
FY2013 Q2 (Jan-Mar)	$17,026.43	$73,440.07	$0.00	$61,564.30	$0.00	$4,989,333.00
FY2013 Q3 (Apr-Jun)	$29,031.20	$102,471.27	$0.00	$61,564.30	$692,420.04	$5,681,753.04
FY2013 Q4 (Jul-Sep)	$6,038.73	$108,510.00	$12,258.29	$73,822.59	$0.00	$5,681,753.04
FY2014 Q1 (Oct-Dec)	$0.00	$108,510.00	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2014 Q2 (Jan-Mar)	$0.00	$108,510.00	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2014 Q3 (Apr-Jun)	$7,683.35	$116,193.35	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2014 Q4 (Jul-Sep)	$5,885.22	$122,078.57	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2015 Q1 (Oct-Dec)	$0.00	$122,078.57	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2015 Q2 (Jan-Mar)	$0.00	$122,078.57	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2015 Q3 (Apr-Jun)	$0.00	$122,078.57	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2015 Q4 (Jul-Sep)	$0.00	$122,078.57	$0.00	$73,822.59	$0.00	$5,681,753.04
FY2016 Q1 (Oct-Dec)	$6,431.43	$128,510.00	$0.00	$73,822.59	$0.00	$5,681,753.04
Total	$128,510.00		$73,822.59		$5,681,753.04	

TASK 258-SU: Multi-Disciplinary Analysis of Launch Vehicle Safety Metrics

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Paul Wilde	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
Leland Stanford Junior University	Department of Aeronautics and Astronautics	●
NASA	Ames Research Center	

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-SU-008	$50,000.00
1/1/2012	5/31/2012	2012	10-C-CST-SU-016	$24,000.00

6/1/2012	5/31/2013	2012	10-C-CST-SU-020	$51,288.00
5/31/2013	9/30/2013	2013	10-C-CST-SU-029	$0.00
9/30/2013	5/31/2014	2013	10-C-CST-SU-036	$15,000.00
9/30/2013	5/31/2014	2013	10-C-CST-SU-038	$24,000.00
6/1/2014	3/31/2015	2014	10-C-CST-SU-046	$0.00
4/1/2015	6/30/2015	2015	10-C-CST-SU-048	$0.00
Total				$164,288.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Francisco Capristan	Aeronautics & Astronautics	Aerospace Engineering	●	Ph.D.	6/1/2015

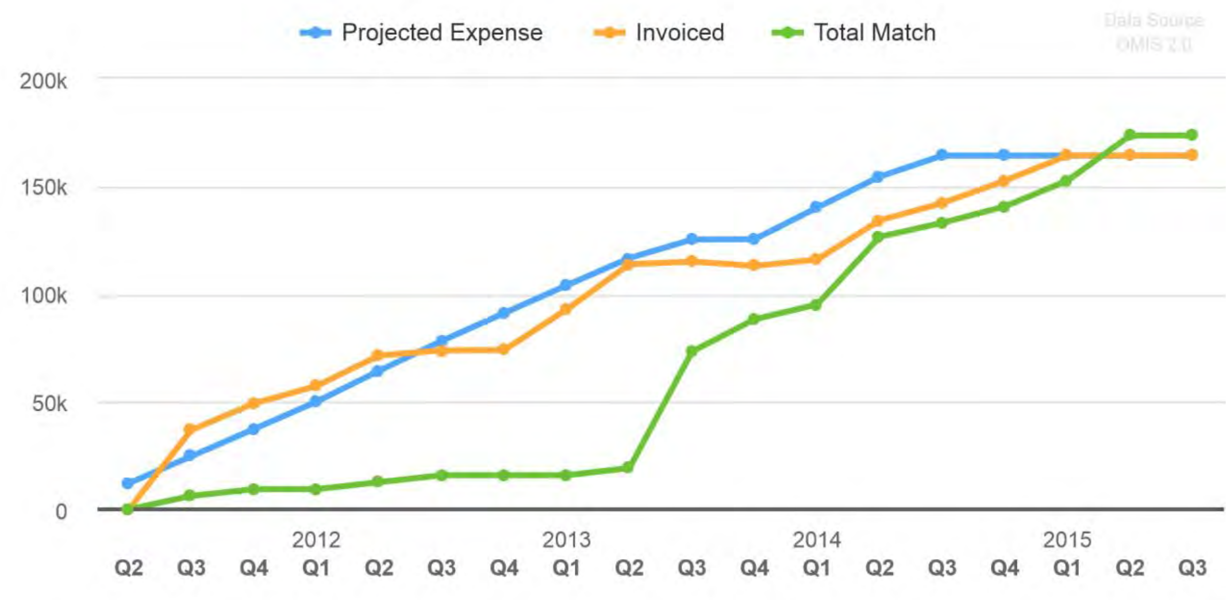
Deliverables

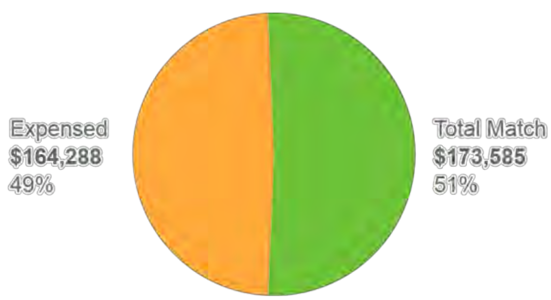
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$36,845.68	$36,845.68	$6,250.00	$6,250.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$12,353.94	$49,199.62	$3,125.00	$9,375.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$8,081.36	$57,280.98	$0.00	$9,375.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$14,176.00	$71,456.98	$3,234.00	$12,609.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$2,362.67	$73,819.65	$3,234.00	$15,843.00	$0.00	$0.00

FY2012 Q4 (Jul-Sep)	$180.35	$74,000.00	$0.00	$15,843.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$18,919.66	$92,919.66	$0.00	$15,843.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$20,907.80	$113,827.46	$3,332.00	$19,175.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$1,224.06	$115,051.52	$34,532.07	$53,707.07	$19,545.15	$19,545.15
FY2013 Q4 (Jul-Sep)	-$1,994.61	$113,056.91	$11,906.12	$65,613.19	$3,101.75	$22,646.90
FY2014 Q1 (Oct-Dec)	$2,955.00	$116,011.91	$6,895.00	$72,508.19	$0.00	$22,646.90
FY2014 Q2 (Jan-Mar)	$18,237.53	$134,249.44	$25,893.93	$98,402.12	$5,523.55	$28,170.45
FY2014 Q3 (Apr-Jun)	$7,975.43	$142,224.87	$4,640.50	$103,042.62	$1,841.20	$30,011.65
FY2014 Q4 (Jul-Sep)	$10,416.30	$152,641.17	$4,879.50	$107,922.12	$2,761.80	$32,773.45
FY2015 Q1 (Oct-Dec)	$11,646.83	$164,288.00	$8,161.96	$116,084.08	$3,807.18	$36,580.63
FY2015 Q2 (Jan-Mar)	$0.00	$164,288.00	$14,512.23	$130,596.31	$6,408.05	$42,988.68
FY2015 Q3 (Apr-Jun)	$0.00	$164,288.00	$0.00	$130,596.31	$0.00	$42,988.68
Total	$164,288.00		$130,596.31		$42,988.68	

TASK 259-SU: Flight Software Validation and Verification for Safety

Lead University

Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Paul Wilde	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area

2.0 Space Transportation Vehicles

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012

Partners

Partner	Division	Primary
Leland Stanford Junior University	Department of Aeronautics and Astronautics	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-SU-006	$5,110.00
Total				$5,110.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

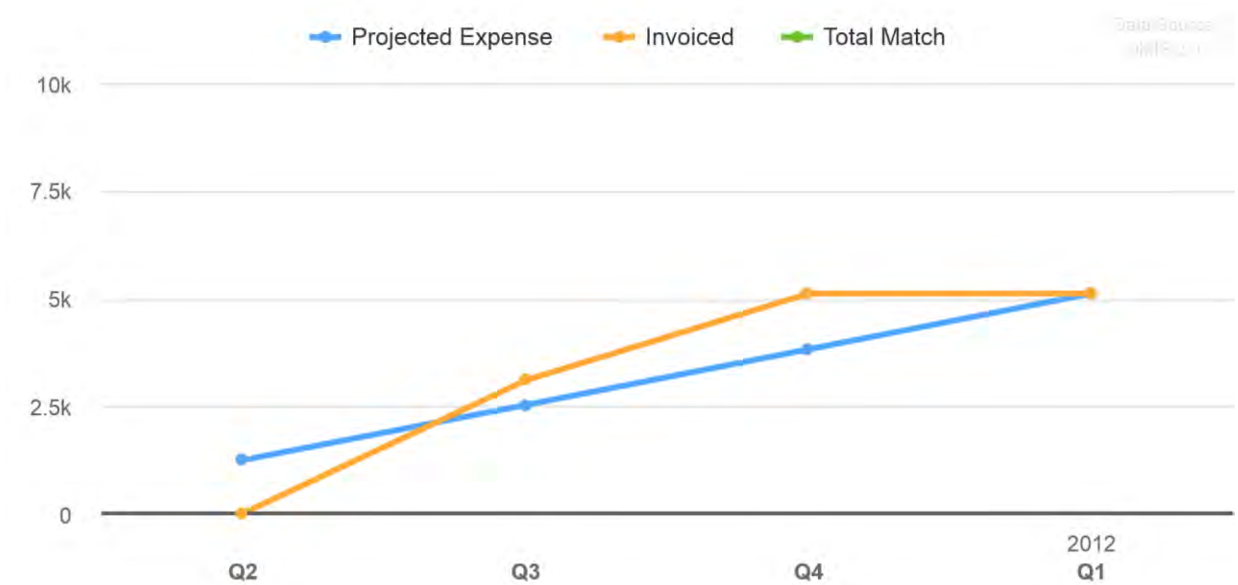
Deliverables

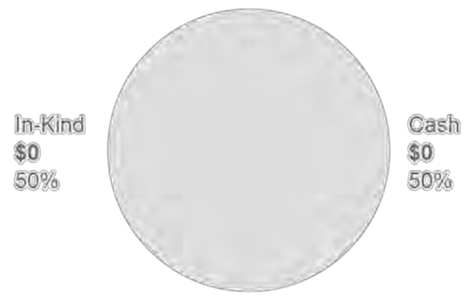
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$3,093.19	$3,093.19	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$2,016.81	$5,110.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$0.00	$5,110.00	$0.00	$0.00	$0.00	$0.00
Total	$5,110.00		$0.00		$0.00	

TASK 281-UC: Technical Oversight - CU

Lead University
University of Colorado at Boulder

Team

Name	Role	Primary
David Klaus	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Jennifer Huettl	Fiscal Admin	●
Stephanie Rosario	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012

Partners

Partner	Division	Primary
University of Colorado at Boulder		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UC-005	$34,884.00
1/1/2011	8/31/2012	2010	10-C-CST-UC-014	$0.00

Total	$34,884.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

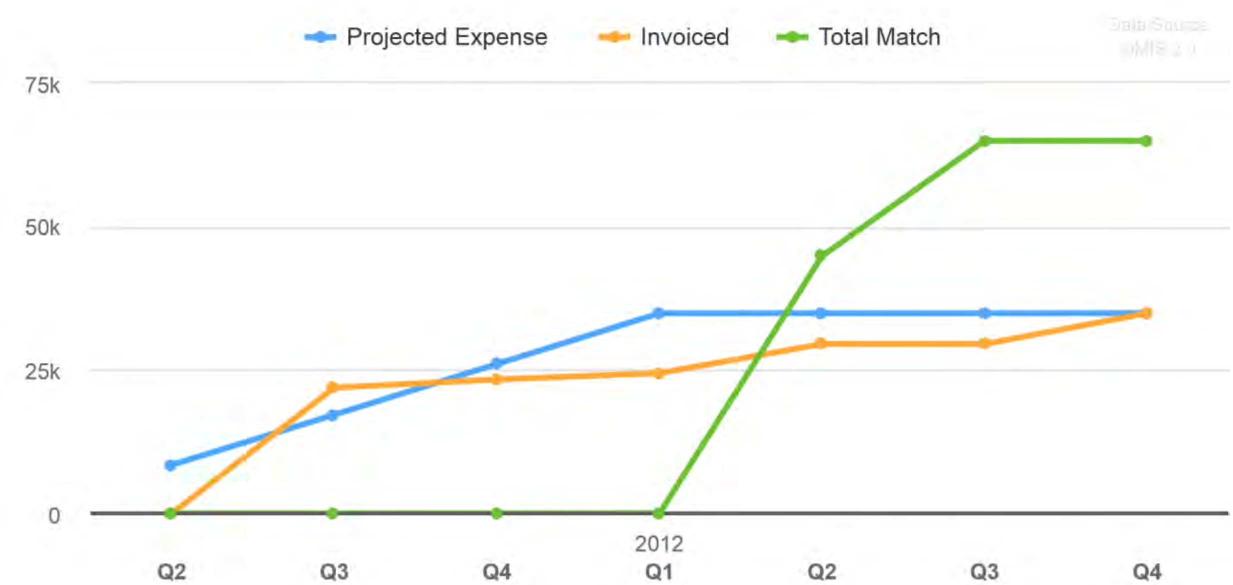
Deliverables

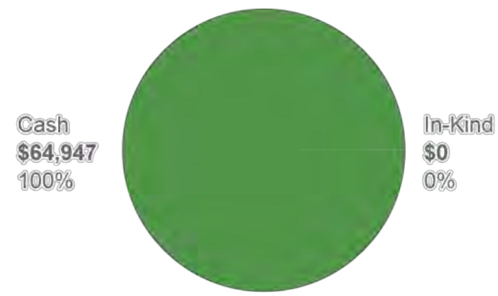
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$21,920.63	$21,920.63	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$1,424.02	$23,344.65	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$1,111.24	$24,455.89	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$5,066.00	$29,521.89	$44,860.00	$44,860.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$29,521.89	$20,087.04	$64,947.04	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$5,362.11	$34,884.00	$0.00	$64,947.04	$0.00	$0.00
Total	$34,884.00		$64,947.04		$0.00	

TASK 282-FIT: Technical Oversight - FIT

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Dan Kirk	Principal Investigator	●
Tristan Fiedler	Principal Investigator	
Evelina Bern	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012

Partners

Partner	Division	Primary
Florida Institute of Technology		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

1/3/2011	12/31/2011	2010	10-C-CST-FIT-003	$19,988.00
Total				$19,988.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

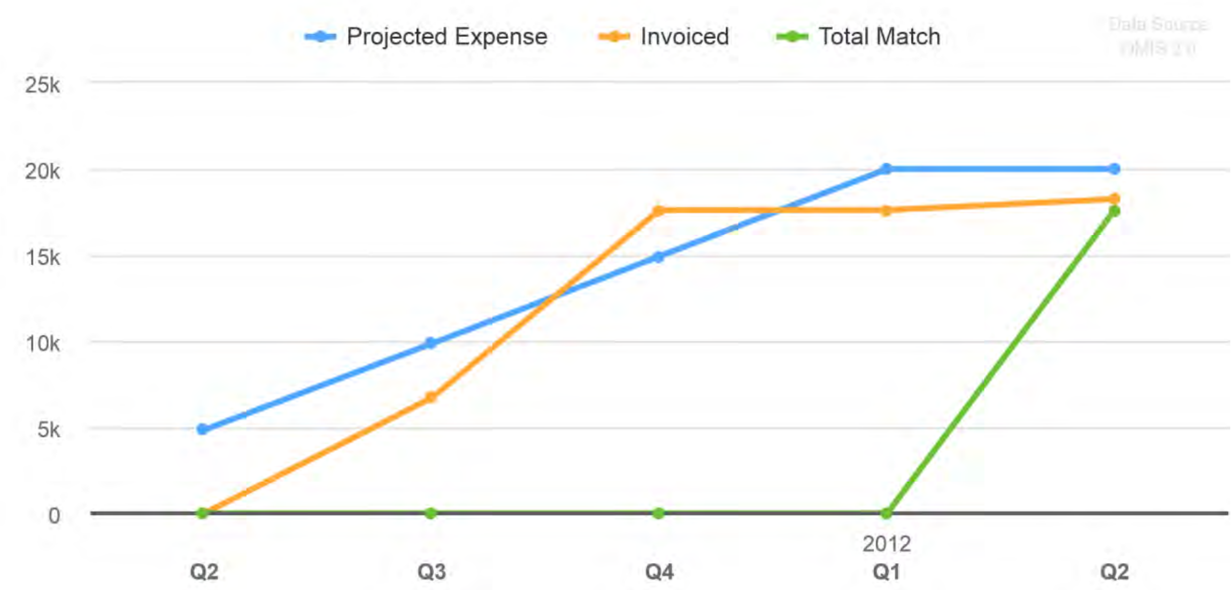
Deliverables

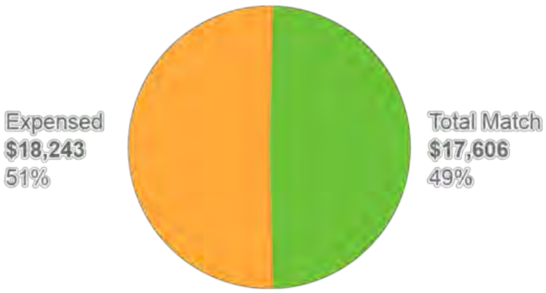
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

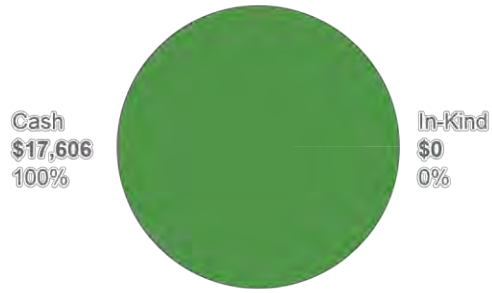
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$6,708.06	$6,708.06	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$10,897.98	$17,606.04	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$0.00	$17,606.04	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$637.23	$18,243.27	$17,606.00	$17,606.00	$0.00	$0.00
Total	$18,243.27		$17,606.00		$0.00	

TASK 283-FSU: Technical Oversight - FSU

Lead University
Florida State University

Team

Name	Role	Primary
Farrukh Alvi	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Yolanda Lopez	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013

Partners

Partner	Division	Primary
Florida State University	Mechanical Engineering	●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	8/31/2011	2010	10-C-CST-FSU-002	$26,969.00
9/1/2011	3/31/2012	2010	10-C-CST-FSU-005	$6,891.00

4/1/2012	5/31/2013	2010	10-C-CST-FSU-030	$0.00
Total				$33,860.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

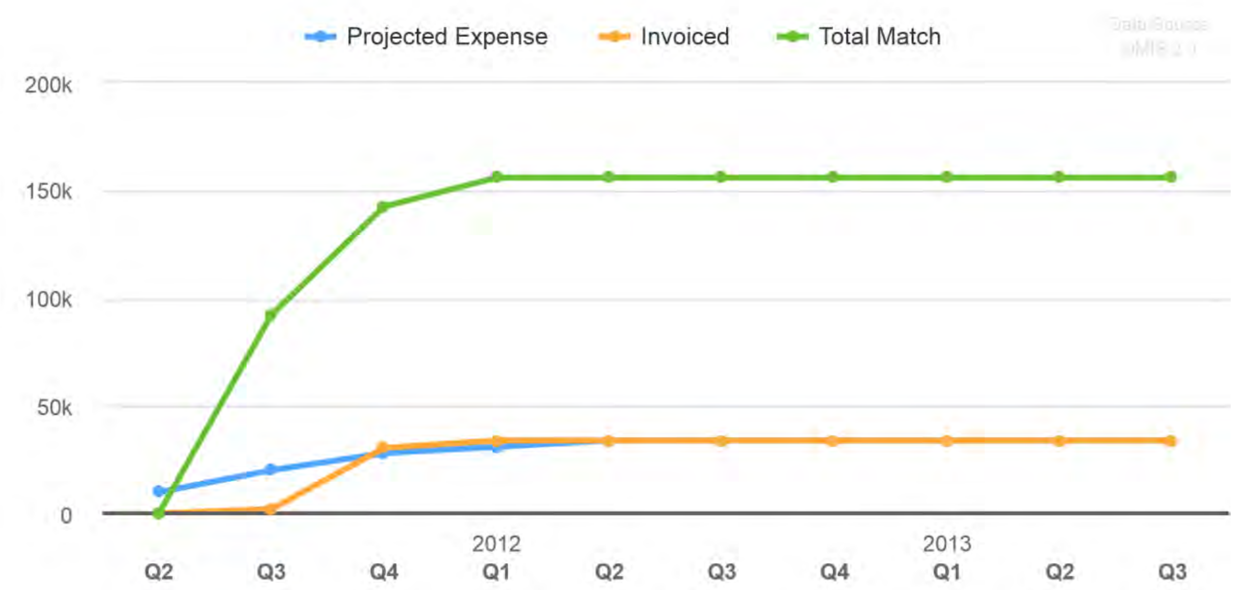
Deliverables

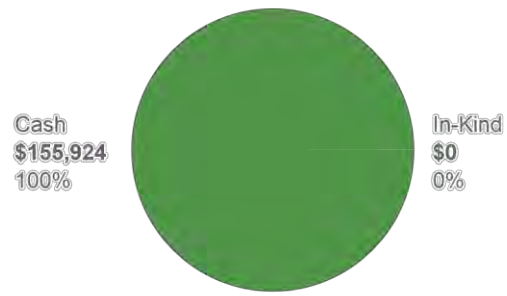
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$1,957.81	$1,957.81	$92,201.00	$92,201.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$28,443.78	$30,401.59	$50,274.17	$142,475.17	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$3,458.41	$33,860.00	$13,448.51	$155,923.68	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$0.00	$33,860.00	$0.00	$155,923.68	$0.00	$0.00
Total	$33,860.00		$155,923.68		$0.00	

TASK 284-NMSU: COE CST Admin Lead Activities

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2010	FY2011	FY2012
□	■ ■ ■ □	■ ■ ■ □

Partners

Partner	Division	Primary
ATK		●
NMSU Space Development Foundation		●
New Mexico State University		●
Spaceport Sweden	Swedish Institute of Space Physics	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
8/18/2010	8/17/2012	2010	10-C-CST-NMSU-003	$297,640.00
8/18/2010	5/31/2012	2010	10-C-CST-NMSU-006	($26,310.00)
Total				$271,330.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

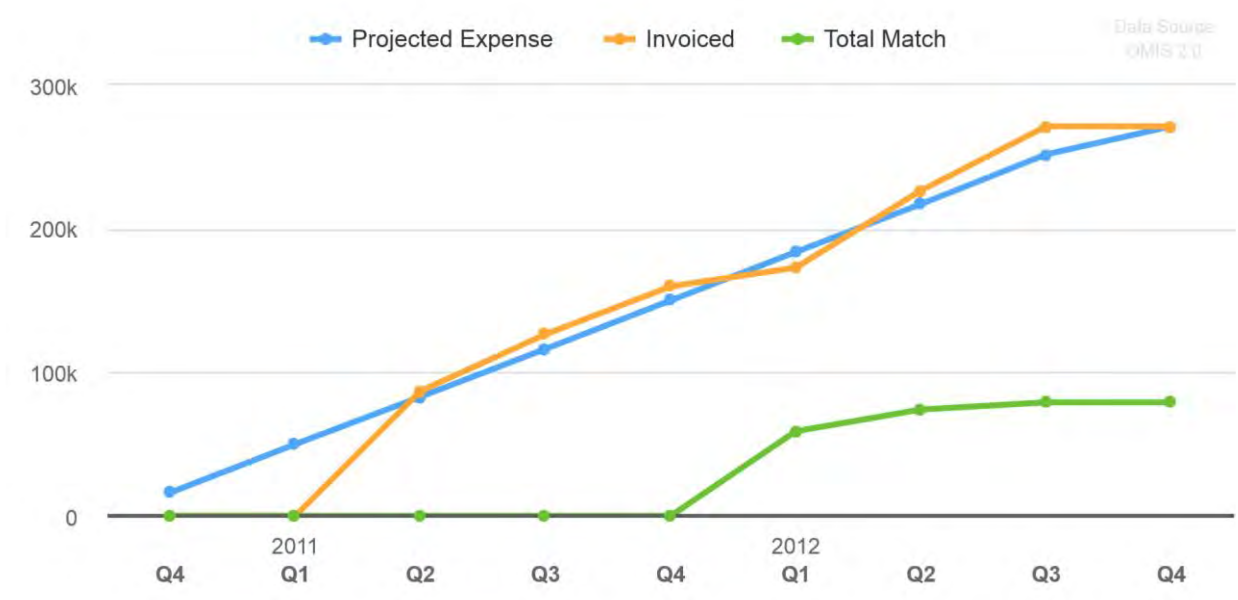
Deliverables

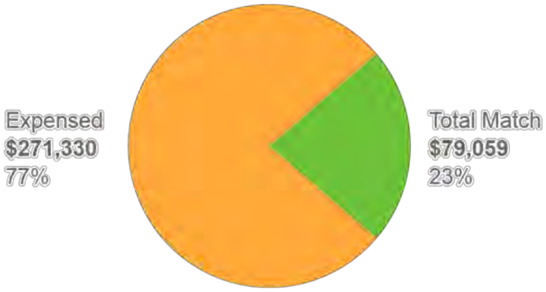
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

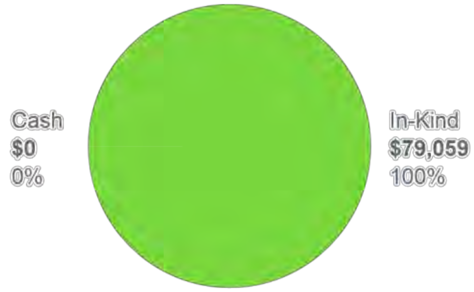
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2010 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q2 (Jan-Mar)	$86,940.87	$86,940.87	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$39,548.02	$126,488.89	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$33,352.98	$159,841.87	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$13,072.00	$172,913.87	$0.00	$0.00	$58,979.07	$58,979.07
FY2012 Q2 (Jan-Mar)	$53,766.32	$226,680.19	$0.00	$0.00	$15,079.68	$74,058.75
FY2012 Q3 (Apr-Jun)	$44,649.81	$271,330.00	$0.00	$0.00	$5,000.00	$79,058.75
FY2012 Q4 (Jul-Sep)	$0.00	$271,330.00	$0.00	$0.00	$0.00	$79,058.75
Total	$271,330.00		$0.00		$79,058.75	

TASK 286-SU: Technical Oversight - SU

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2010	FY2011	FY2012

Partners

Partner	Division	Primary
Leland Stanford Junior University		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-SU-007	$100,000.00
8/18/2010	12/31/2011	2010	10-C-CST-SU-010	$0.00
Total				$100,000.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

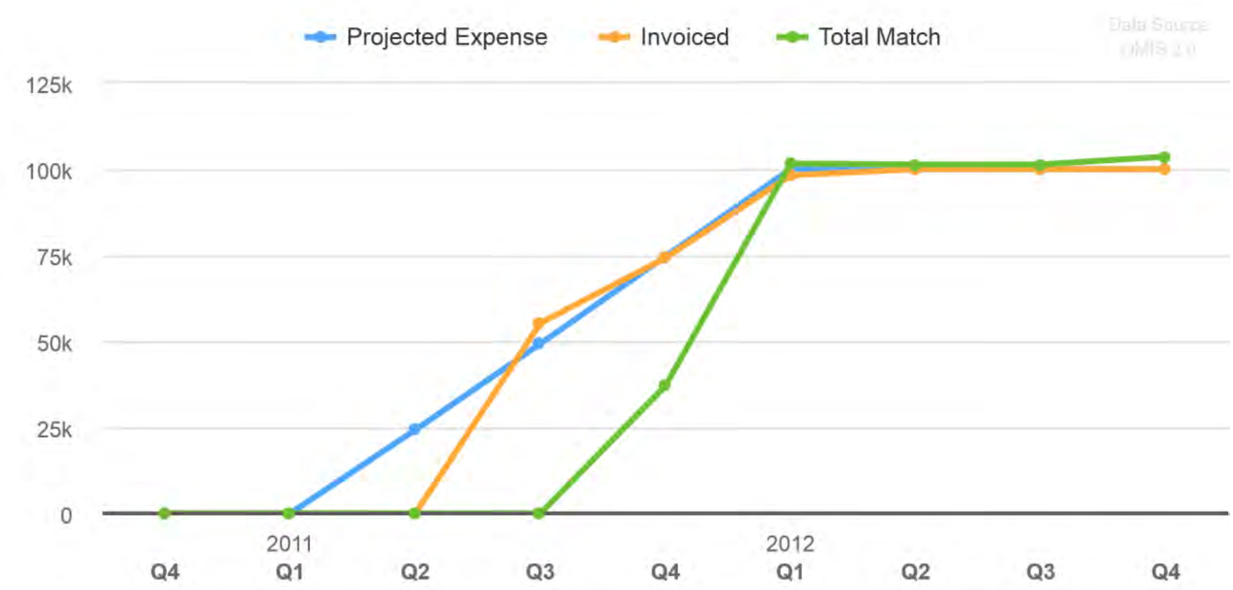
Deliverables

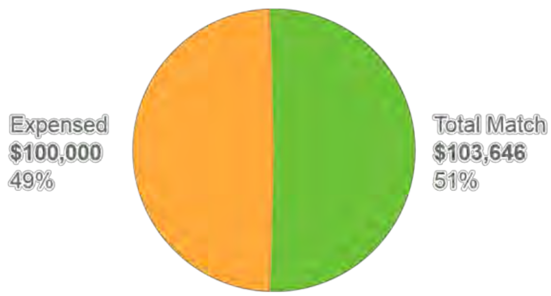
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

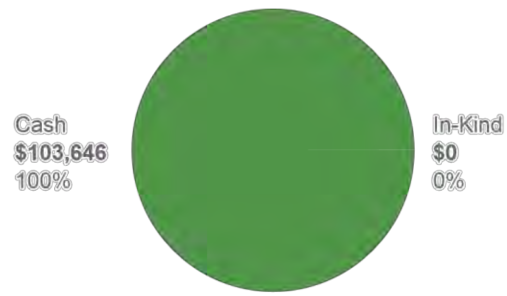
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2010 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$55,289.10	$55,289.10	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$18,926.05	$74,215.15	$37,074.32	$37,074.32	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$23,994.71	$98,209.86	$64,562.41	$101,636.73	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$1,790.14	$100,000.00	-$272.81	$101,363.92	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$0.00	$100,000.00	$0.00	$101,363.92	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$100,000.00	$2,282.48	$103,646.40	$0.00	$0.00
Total	$100,000.00		$103,646.40		$0.00	

TASK 287-UCF: Technical Oversight - UCF

Lead University
University of Central Florida

Team

Name	Role	Primary
Jay Kapat	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Heliana Forero	Fiscal Admin	●
Nagy Youssef	Fiscal Admin	●
Yeliza Burleson	Contract Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013
□ ■ ■ □	■ ■ ■ □	□ □

Partners

Partner	Division	Primary
Space Florida		●
University of Central Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

11/1/2010	9/30/2011	2010	10-C-CST-UCF-003	$10,910.00
10/1/2011	9/30/2012	2011	10-C-CST-UCF-004	$10,000.00
9/30/2012	3/20/2013	2011	10-C-CST-UCF-009	$0.00
Total				$20,910.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

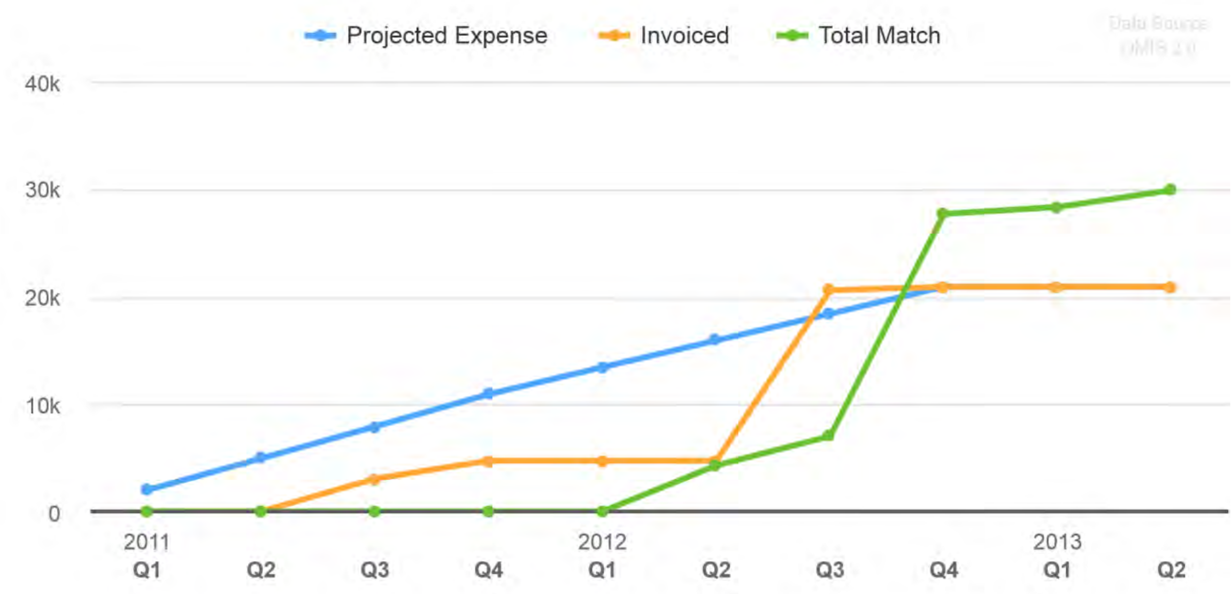
Deliverables

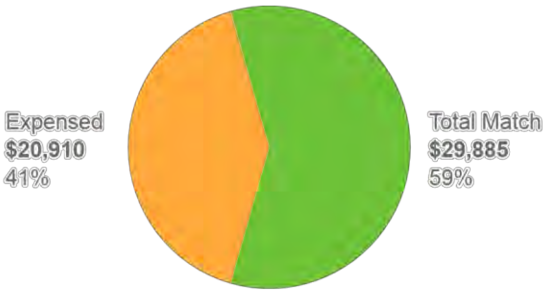
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

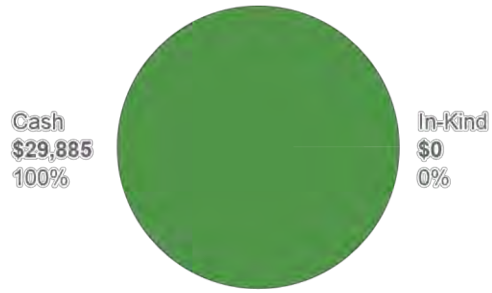
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$3,049.64	$3,049.64	$0.00	$0.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$1,679.03	$4,728.67	$0.00	$0.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$0.00	$4,728.67	$0.00	$0.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$0.00	$4,728.67	$4,284.83	$4,284.83	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$15,846.59	$20,575.26	$2,722.70	$7,007.53	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$334.74	$20,910.00	$20,677.00	$27,684.53	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$20,910.00	$640.00	$28,324.53	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$20,910.00	$1,560.35	$29,884.88	$0.00	$0.00
Total	$20,910.00		$29,884.88		$0.00	

TASK 288-UF: Technical Oversight - UF

Lead University
University of Florida

Team

Name	Role	Primary
Norm Fitz-Coy	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Tonya Lewis	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2011	FY2012	FY2013

Partners

Partner	Division	Primary
Space Florida		●
University of Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/3/2011	12/31/2011	2010	10-C-CST-UF-004	$20,000.00
1/1/2012	12/31/2012	2010	10-C-CST-UF-010	$0.00

1/1/2012	12/31/2012	2012	10-C-CST-UF-020	($14,000.54)
Total				$5,999.46

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

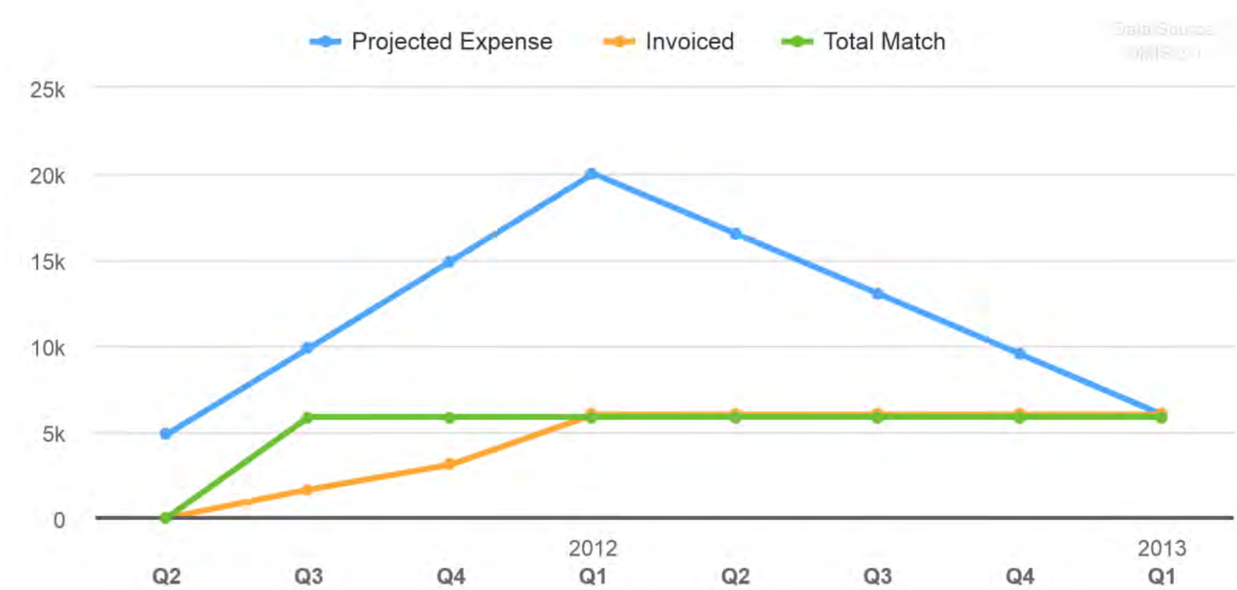
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2011 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$1,647.01	$1,647.01	$0.00	$0.00	$5,870.40	$5,870.40
FY2011 Q4 (Jul-Sep)	$1,450.07	$3,097.08	$0.00	$0.00	$0.00	$5,870.40
FY2012 Q1 (Oct-Dec)	$2,902.38	$5,999.46	$0.00	$0.00	$0.00	$5,870.40
FY2012 Q2 (Jan-Mar)	$0.00	$5,999.46	$0.00	$0.00	$0.00	$5,870.40
FY2012 Q3 (Apr-Jun)	$0.00	$5,999.46	$0.00	$0.00	$0.00	$5,870.40
FY2012 Q4 (Jul-Sep)	$0.00	$5,999.46	$0.00	$0.00	$0.00	$5,870.40
FY2013 Q1 (Oct-Dec)	$0.00	$5,999.46	$0.00	$0.00	$0.00	$5,870.40
Total	$5,999.46		$0.00		$5,870.40	

TASK 289-UTMB: Technical Oversight - UTMB

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2010	FY2011	FY2012
□	■ ■ □ □	■ ■ ■ ■

Partners

Partner	Division	Primary
University of Texas Medical Branch	Aerospace Medicine Residency	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
9/15/2010	9/14/2011	2010	10-C-CST-UTMB-002	$23,907.00
9/15/2011	8/17/2012	2010	10-C-CST-UTMB-011	$13,941.00
Total				$37,848.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

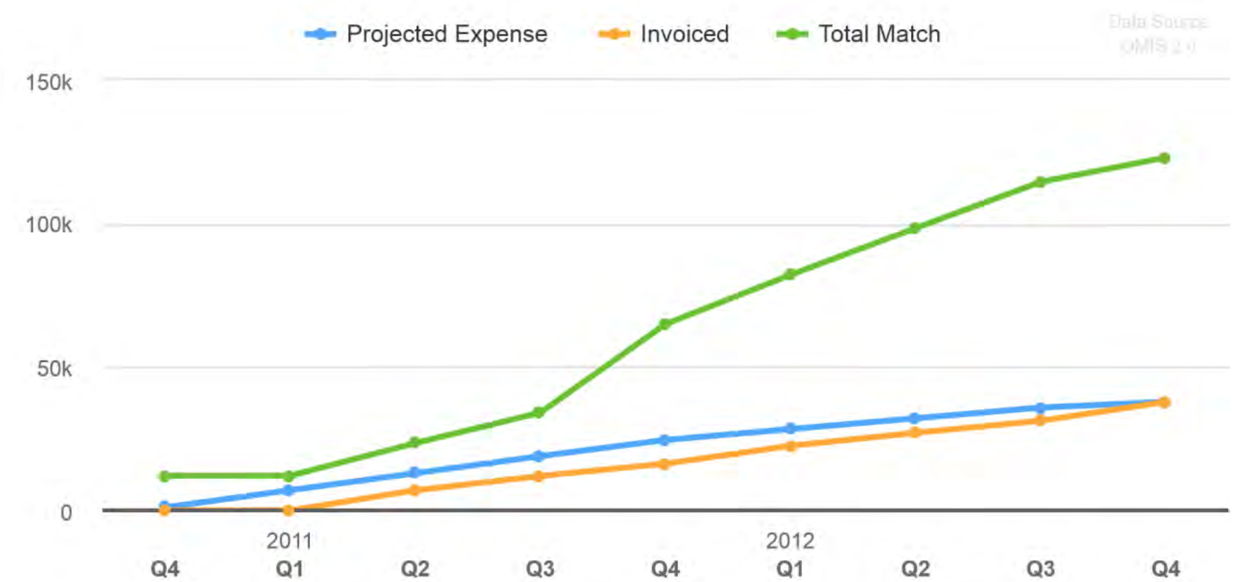
Deliverables

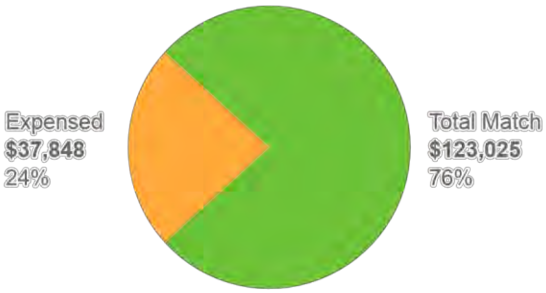
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

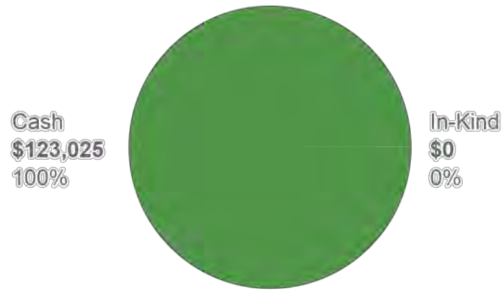
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2010 Q4 (Jul-Sep)	$0.00	$0.00	$12,078.00	$12,078.00	$0.00	$0.00
FY2011 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$12,078.00	$0.00	$0.00
FY2011 Q2 (Jan-Mar)	$7,014.87	$7,014.87	$11,381.00	$23,459.00	$0.00	$0.00
FY2011 Q3 (Apr-Jun)	$4,995.67	$12,010.54	$10,643.00	$34,102.00	$0.00	$0.00
FY2011 Q4 (Jul-Sep)	$4,304.12	$16,314.66	$30,836.00	$64,938.00	$0.00	$0.00
FY2012 Q1 (Oct-Dec)	$6,218.06	$22,532.72	$17,184.00	$82,122.00	$0.00	$0.00
FY2012 Q2 (Jan-Mar)	$4,532.95	$27,065.67	$16,291.00	$98,413.00	$0.00	$0.00
FY2012 Q3 (Apr-Jun)	$4,193.81	$31,259.48	$16,112.00	$114,525.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$6,588.52	$37,848.00	$8,500.00	$123,025.00	$0.00	$0.00
Total	$37,848.00		$123,025.00		$0.00	

TASK 293-NMT: Reduced-Order Non-Linear Dynamic System Models

Lead University
New Mexico Institute of Mining and Technology

Team

Name	Role	Primary
Dongheon Ryu	Principal Investigator	●
Andrei Zagrai	Principal Investigator	
Nick Demidovich	Tech Monitor	●
Danielle Monette	Fiscal Admin	●
Lisa Oty	Fiscal Admin	●
Gayle Bailey	Contract Admin	●

Research Area
2.0 Space Transportation Vehicles

Project Description

The structural integrity of commercial launch platforms must be assessed for each mission, i.e. safety certification or recertification. A significant amount of structural response data must be collected in order to state confidence bounds on the computed safety margins. Experimental data will very likely need to be supplemented with data generated by numerical simulations of the structural response of the launch platforms to the anticipated flight environments. Efficient, cost-effective methods for generating non-linear structural models of CST platforms will result from this effort.

Project Outcomes

Modal extraction codes have been validated by physical testing of beam structure.

Summary of Output

- Solicit Industrial Working Group feedback to guide implementation of system computational assembly methods.
- Generate non-proprietary code to extract relevant structural features from experimental test data i.e. modal extraction software using rational fractional polynominals (RFP)
- Provide Matlab™ scripts for combining finite element modelled components with experimentally defined (modal) components in structural assemblies.
- Provide help to commercial companies desiring to use modal extraction an assembly codes.

Technical Status

FY2012	FY2013	FY2014	FY2015	FY2016

Partners

Partner	Division	Primary
New Mexico Institute of Mining and Technology		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2010	10-C-CST-NMT-004	$37,500.00
5/31/2013	5/31/2014	2010	10-C-CST-NMT-007	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-NMT-012	$22,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMT-015	$8,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMT-018	$8,000.00
6/1/2014	5/31/2015	2013	10-C-CST-NMT-023	$0.00
6/1/2014	5/31/2015	2013	10-C-CST-NMT-031	$0.00
6/1/2015	12/31/2015	2013	10-C-CST-NMT-032	$0.00
Total				$75,500.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Lance Hernandez	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/1/2015
Joshua Mendoza	Mechanical Engineering	Mechanical Engineering	●	Masters	5/1/2013
Kevin Vedera	Mechanical Engineering	Mechanical Engineering	●	Bachelors	5/1/2016

Deliverables

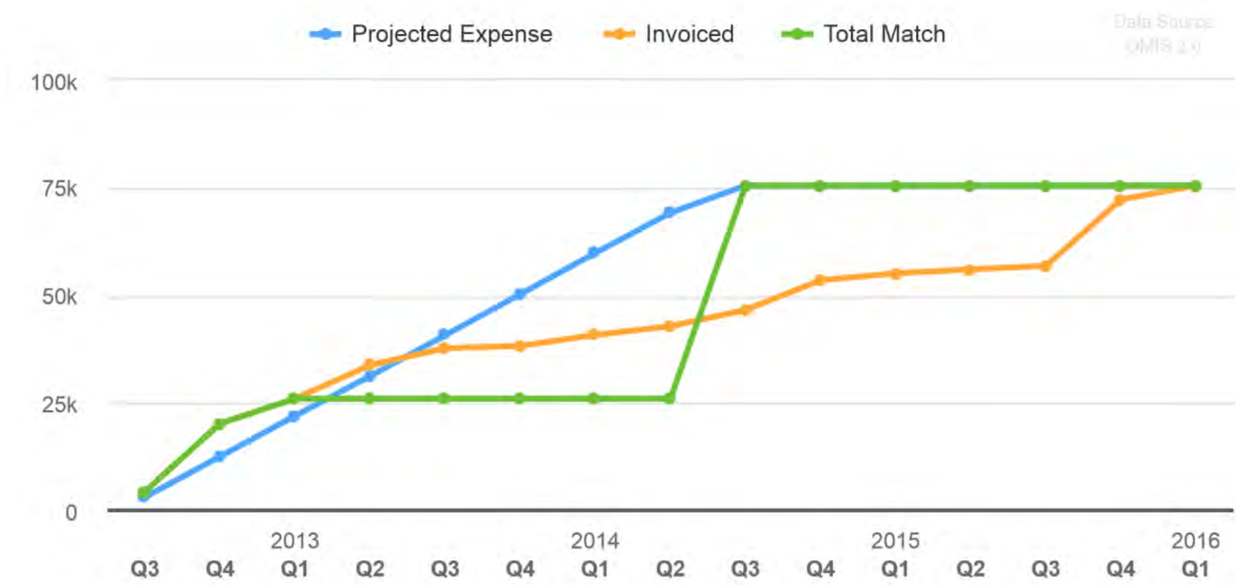
#	Deliverable	Start	Due Date	Accepted

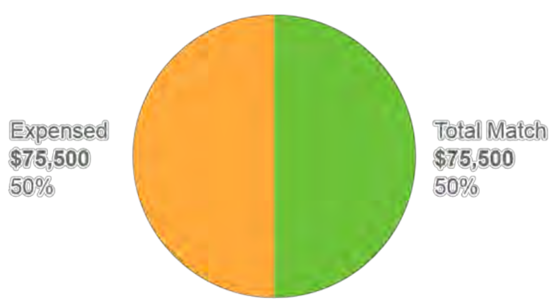
		Date		
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2012	12/31/2015	

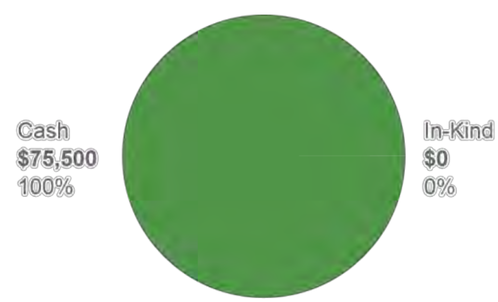
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind

						Match
FY2012 Q3 (Apr-Jun)	$4,397.48	$4,397.48	$4,397.48	$4,397.48	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$15,794.37	$20,191.85	$15,794.37	$20,191.85	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$5,793.00	$25,984.85	$5,793.00	$25,984.85	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$7,775.21	$33,760.06	$0.00	$25,984.85	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$3,933.22	$37,693.28	$0.00	$25,984.85	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$539.60	$38,232.88	$0.00	$25,984.85	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$2,556.38	$40,789.26	$0.00	$25,984.85	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$2,024.86	$42,814.12	$0.00	$25,984.85	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$3,784.00	$46,598.12	$49,515.00	$75,499.85	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$6,899.57	$53,497.69	$0.00	$75,499.85	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$1,597.14	$55,094.83	$0.00	$75,499.85	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$927.80	$56,022.63	$0.00	$75,499.85	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$821.63	$56,844.26	$0.00	$75,499.85	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$15,394.60	$72,238.86	$0.00	$75,499.85	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$3,261.14	$75,500.00	$0.00	$75,499.85	$0.00	$0.00
Total	$75,500.00		$75,499.85		$0.00	

TASK 294-UTMB: Development of Minor Injury Severity Scale for Orbital Human Space Flight

Lead University

University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area

3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013
■ ■	■ ■ ■

Partners

Partner	Division	Primary
University of Texas Medical Branch	Aerospace Medicine Residency	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-UTMB-014	$25,422.00
6/1/2012	5/31/2013	2014	10-C-CST-UTMB-028	($2,188.88)
Total				$23,233.12

Students

Name	Department	Discipline	Funded	Degree	Graduation
James Cushman	PMCH	Aerospace Medicine	●	M.D.	6/1/2013

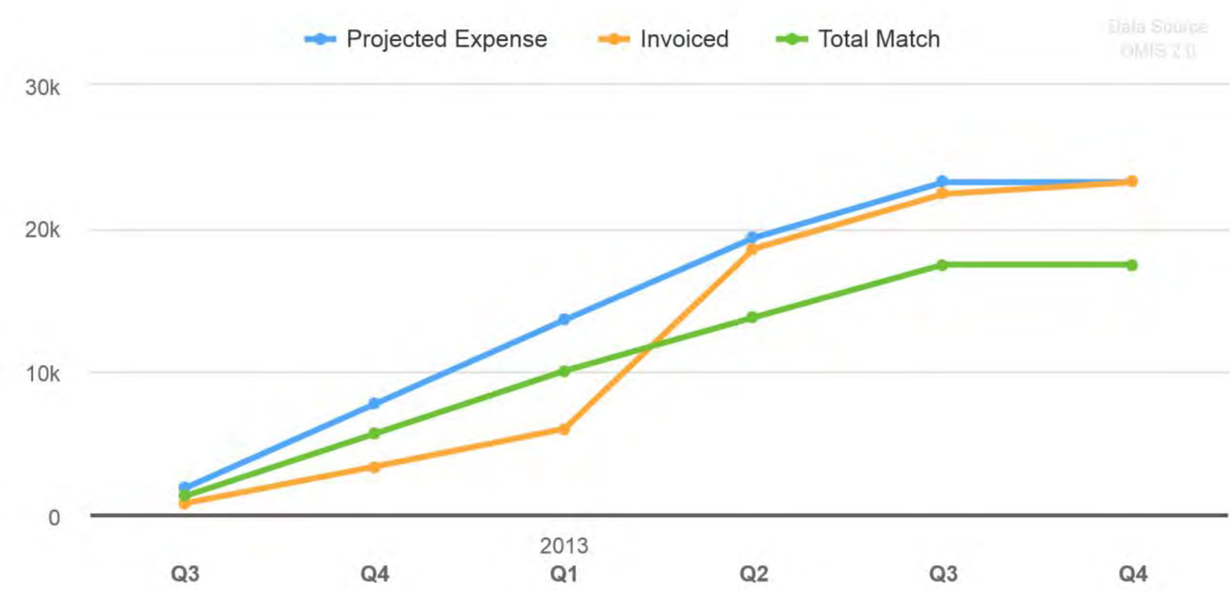
Deliverables

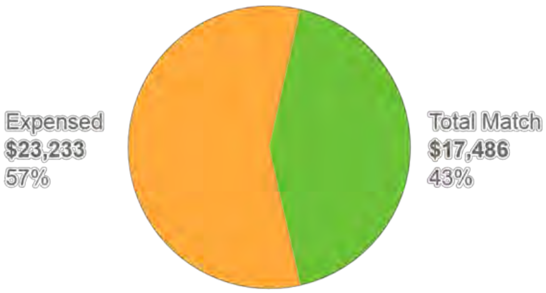
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

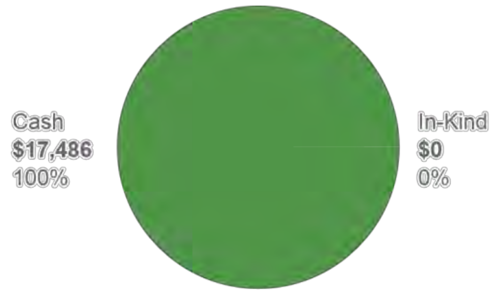
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$846.96	$846.96	$1,353.00	$1,353.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$2,558.15	$3,405.11	$4,343.00	$5,696.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$2,635.00	$6,040.11	$4,377.00	$10,073.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$12,556.89	$18,597.00	$3,737.00	$13,810.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$3,811.54	$22,408.54	$3,676.00	$17,486.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$824.58	$23,233.12	$0.00	$17,486.00	$0.00	$0.00
Total	$23,233.12		$17,486.00		$0.00	

TASK 295-UTMB: Effects of EMI and Ionizing Radiation on Implantable Devices

Lead University
University of Texas Medical Branch

Team

Name	Role	Primary
James Vanderploeg	Principal Investigator	●
Henry Lampazzi	Tech Monitor	●
Glenita Segura	Fiscal Admin	●
Jim Vanderploeg	Fiscal Admin	●
Ramona Carpenter	Fiscal Admin	
Mike Clark	Fiscal Admin	
Tara McElroy	Fiscal Admin	
Sharon Nguyen	Fiscal Admin	

Research Area
3.0 Human Spaceflight

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013
■ ■	■ ■ ■

Partners

Partner	Division	Primary
University of Texas Medical Branch	Aerospace Medicine Residency	●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-UTMB-015	$18,689.00
6/1/2012	5/31/2013	2014	10-C-CST-UTMB-028	($1,663.77)
Total				$17,025.23

Students

Name	Department	Discipline	Funded	Degree	Graduation
David Reyes	PMCH	Aerospace Medicine	●	M.D.	8/15/2014

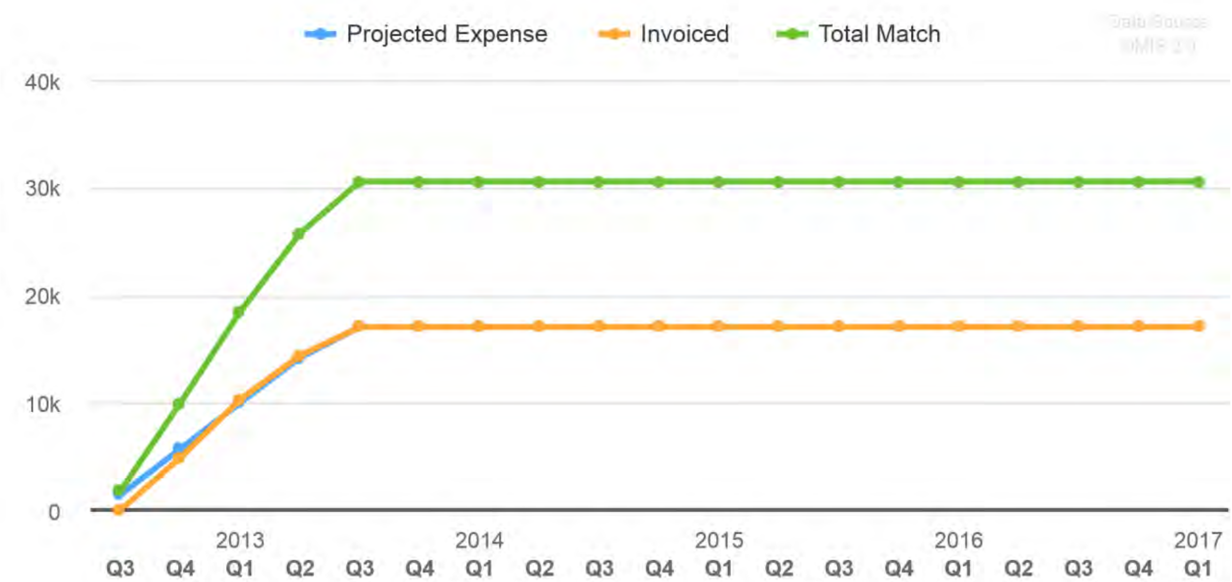
Deliverables

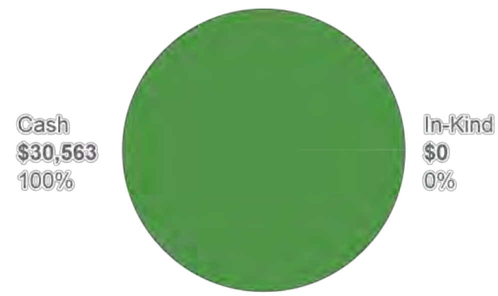
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials





Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$1,770.00	$1,770.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$4,868.78	$4,868.78	$8,181.00	$9,951.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$5,426.00	$10,294.78	$8,500.00	$18,451.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$4,081.40	$14,376.18	$7,290.00	$25,741.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$2,649.20	$17,025.38	$4,822.00	$30,563.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2015 Q4 (Jul-Sep)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00

FY2016 Q3 (Apr-Jun)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2016 Q4 (Jul-Sep)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
FY2017 Q1 (Oct-Dec)	$0.00	$17,025.38	$0.00	$30,563.00	$0.00	$0.00
Total	$17,025.38		$30,563.00		$0.00	

TASK 296-FIT: Outreach - Commercial Space Transportation

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Evelina Bern	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
5.0 Program Management

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013	FY2014

Partners

Partner	Division	Primary
Florida Institute of Technology		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-FIT-009	$24,650.00

6/1/2012	5/31/2013	2012	10-C-CST-FIT-011	$4,000.00
6/1/2013	5/31/2014	2012	10-C-CST-FIT-014	$0.00
Total				$28,650.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

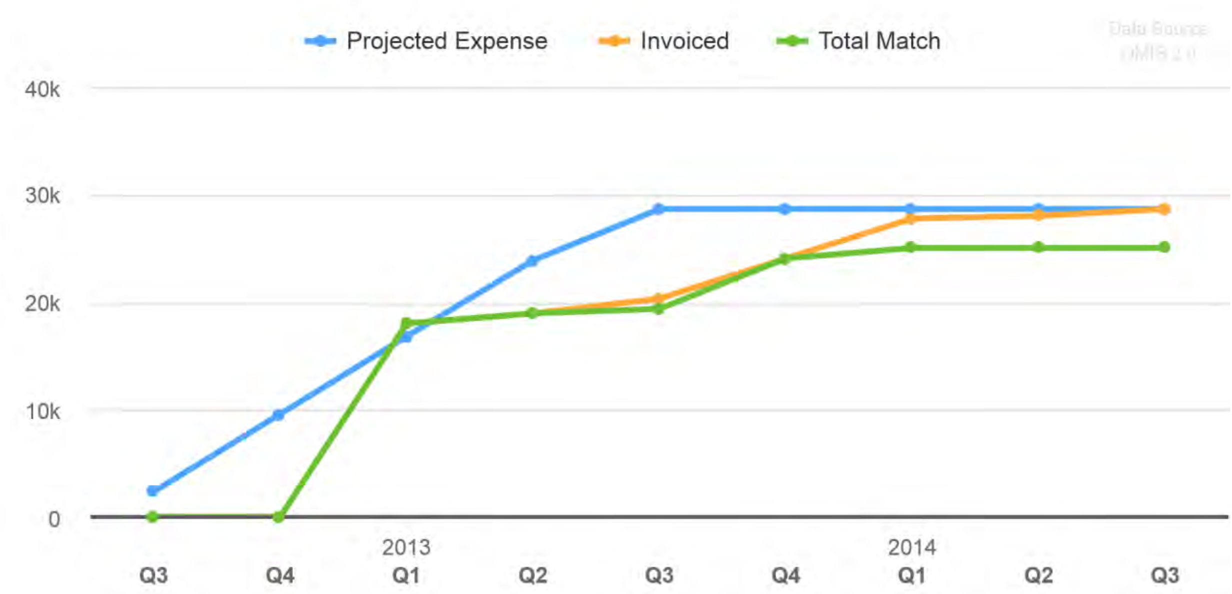
Deliverables

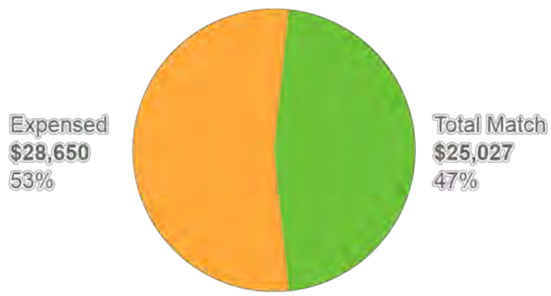
#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

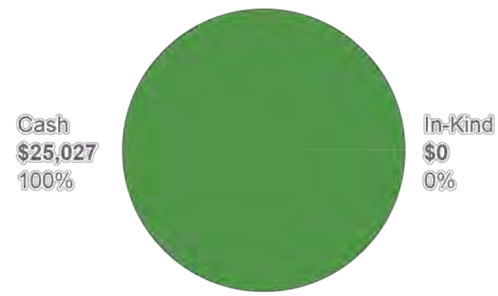
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$17,999.92	$17,999.92	$17,999.92	$17,999.92	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$939.46	$18,939.38	$939.46	$18,939.38	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$1,368.08	$20,307.46	$427.75	$19,367.13	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$3,746.63	$24,054.09	$4,686.96	$24,054.09	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$3,711.45	$27,765.54	$972.58	$25,026.67	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$243.66	$28,009.20	$0.00	$25,026.67	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$640.42	$28,649.62	$0.00	$25,026.67	$0.00	$0.00
Total	$28,649.62		$25,026.67		$0.00	

TASK 298-NMSU: Integration & Evaluation of ADS-B Payloads

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	

Research Area
2.0 Space Transportation Vehicles

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013	FY2014	FY2015

Partners

Partner	Division	Primary
ATK		●
Digital Solutions		●
Marketing Consultant		●
National Space Grant Foundation		●

New Mexico State University		●
SATWEST		●
Space News		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2013	2012	10-C-CST-NMSU-009	$61,191.00
5/31/2013	5/31/2014	2012	10-C-CST-NMSU-012	$0.00
5/31/2013	5/31/2014	2013	10-C-CST-NMSU-014	$14,000.00
5/31/2013	5/31/2014	2013	10-C-CST-NMSU-016	$4,000.00
6/1/2014	5/31/2015	2013	10-C-CST-NMSU-018	$0.00
6/1/2014	5/31/2015	2013	15-C-CST-NMSU-01 (from 016)	($6,184.91)
Total				$73,006.09

Students

Name	Department	Discipline	Funded	Degree	Graduation
Joshua Michalenko	ECE	ECE	●	Bachelors	5/1/2015

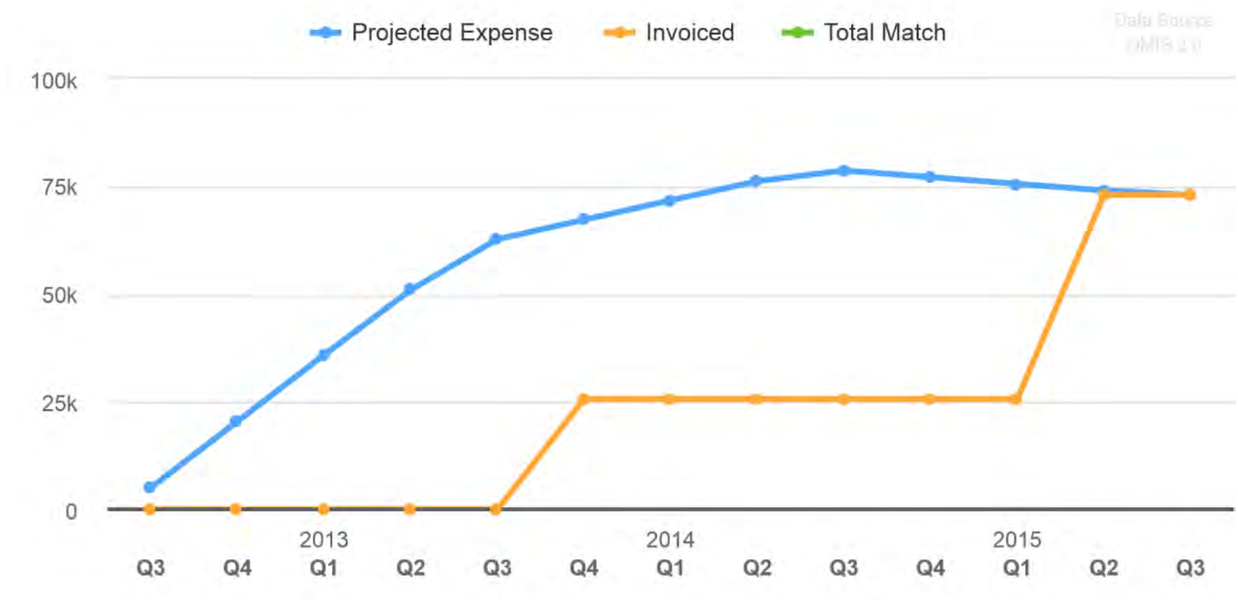
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$25,632.15	$25,632.15	$0.00	$0.00	$0.00	$0.00

FY2014 Q1 (Oct-Dec)	$0.00	$25,632.15	$0.00	$0.00	$0.00	$0.00
FY2014 Q2 (Jan-Mar)	$0.00	$25,632.15	$0.00	$0.00	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$0.00	$25,632.15	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$25,632.15	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$25,632.15	$0.00	$0.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$47,373.94	$73,006.09	$0.00	$0.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$73,006.09	$0.00	$0.00	$0.00	$0.00
Total	$73,006.09		$0.00		$0.00	

TASK 301-FIT: Spaceport Regulation in a Post Modern World

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013	FY2014

Partners

Partner	Division	Primary
Florida Institute of Technology		●
McGill University		●
Space Florida		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

6/1/2012	5/31/2014	2014	10-C-CST-FIT-017	$0.00
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Diane Howard			●	Ph.D.	

Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials

Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$27,350.00	$27,350.00
FY2014 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$27,350.00
FY2014 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$27,350.00
Total	$0.00		$0.00		$27,350.00	

TASK 302-FIT: International Commercial Space Regulations

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2012	FY2013	FY2014

Partners

Partner	Division	Primary
Florida Institute of Technology		●
McGill University		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2012	5/31/2014	2014	10-C-CST-FIT-018	$0.00

Total	$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

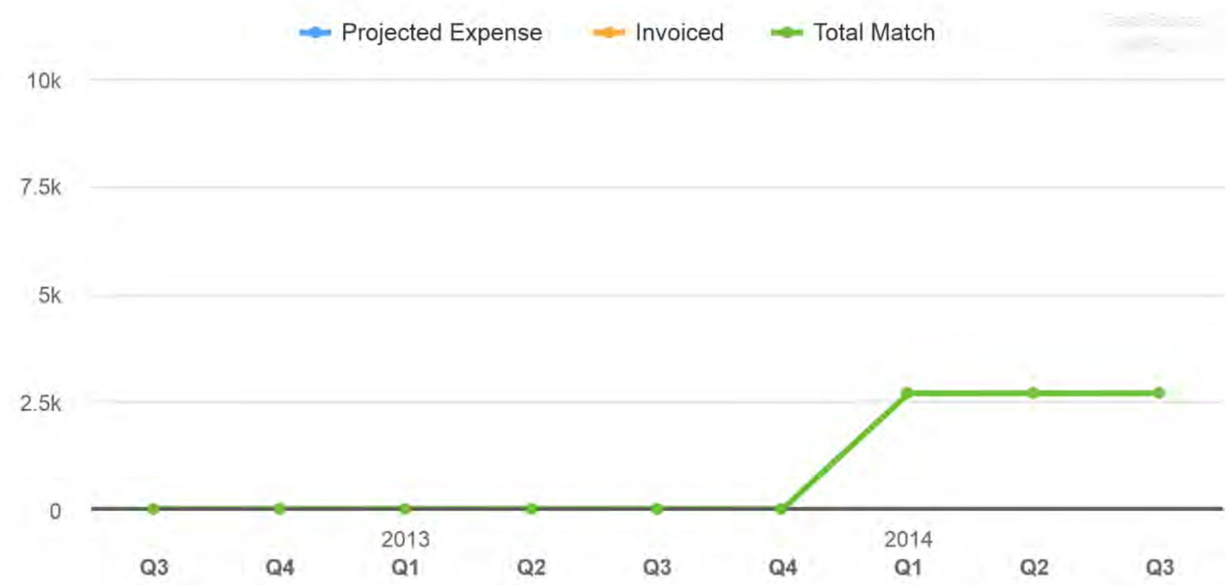
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
No Deliverables				

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2012 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2012 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2013 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$2,686.12	$2,686.12
FY2014 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$2,686.12
FY2014 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$2,686.12
Total	$0.00		$0.00		$2,686.12	

TASK 304-FIT: Insurers as Regulators of Space Safety and Sustainability

Lead University
Florida Institute of Technology

Team

Name	Role	Primary
Tristan Fiedler	Principal Investigator	●
Ken Davidian	Tech Monitor	●
Kelly Carnes	Fiscal Admin	●
Manfang Xu	Fiscal Admin	●

Research Area
4.0 Space Transportation Industry Viability

Project Description

PI: Prof. Ram Jakhu
Student Researcher: Andrea DiPaolo (PhD)

Task 304 is conducted by McGill University - Affiliate Member.

The Outer Space Treaty and all other international Space Law conventions are silent as to where outer space begins, and "[n]o rule of conventional or customary international law defines where airspace ends and outer space begins." In 1972, Judge Manfred Lachs of the International Court of Justice asked the questions: (1) where are the frontiers of outer space; and (2) given that said frontiers are not yet established, is there any real dilemma in their absence? The first question became relevant in 1959 with the launch of Sputnik, and was not treated with urgency. For decades, there has been a reluctance to define the boundaries of space for fear that too niggardly a limit would restrict development, use and exploration of space. Further, it was deemed desirable to wait until technology had evolved sufficiently to demonstrate both the need for a limitation, and provided a better understanding of where an appropriate limit should be set. This paper contends that given the accelerated contemporary development of emerging aerospace activities and technologies, many of which utilize near space for their activities, and a desire to foster continued commercial development of space, the time has come to find an agreeable solution to the question of the inner frontier of outer space, and the outer frontier of airspace. The paper will examine the legal, political and practical implications of setting the airspace/outer space boundary, particularly in the context of emerging modes of commercial space transportation and a recent decision by the FAA-AST to license an aerospace vehicle intended to operate at an altitude of 30 kilometers as a "space object".

Project Outcomes

Summary of Output

Technical Status

FY2014	FY2015	FY2016

Partners

Partner	Division	Primary
Florida Institute of Technology		●
McGill University		

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
1/16/2014	1/16/2016	0	10-C-CST-FIT/MU	$0.00
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
Andrea DiPaolo			●	Ph.D.	

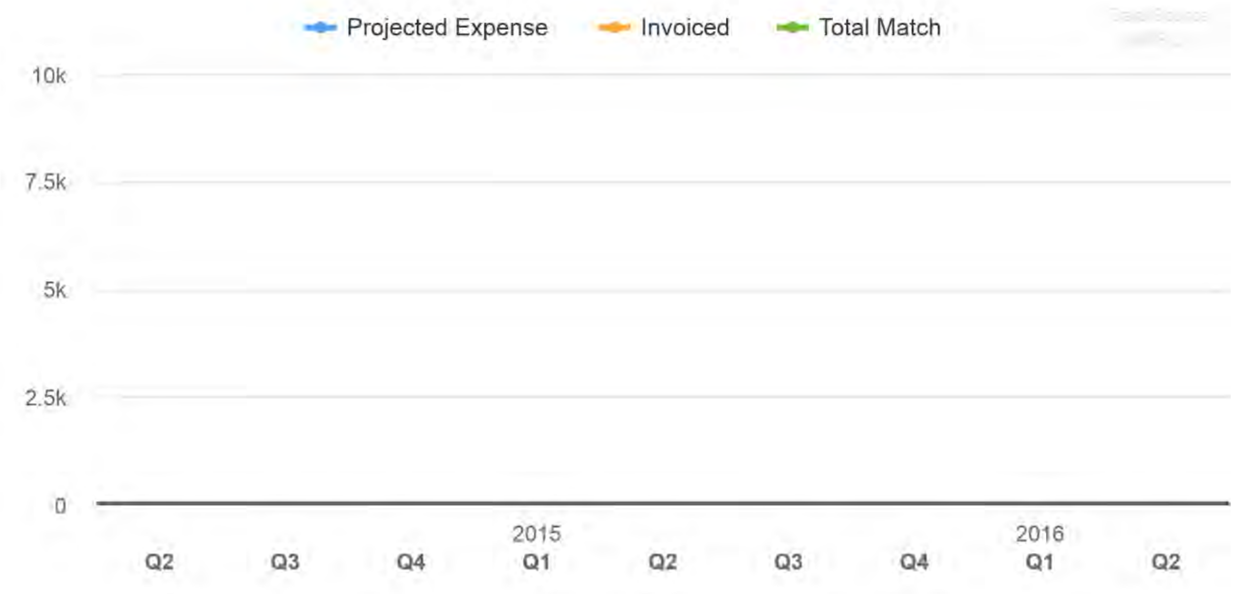
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	1/16/2014	1/16/2016	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00		$0.00		$0.00	

TASK 306-NMSU: Advanced ADS-B Prototype for Commercial Space: Status Update and Future Opportunities

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	

Research Area
2.0 Space Transportation Vehicles

Project Description

Support of suborbital reusable launch vehicles (sRLVs) for commercial space transportation requires considerations for safe integration into the national airspace system (NAS)

ADS-B technology is used for surveillance by air traffic control and situational awareness for pilots

Project Outcomes

This research presents the potential for adaptation of existing ADS-B technology to support operations for sRLVs operations exceeding current technology limits (primarily altitude, velocity and acceleration)

Summary of Output

Technical Status

FY2014	FY2015

Partners

Partner	Division	Primary

New Mexico State University		•
Embry-Riddle Aeronautical University		

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
6/1/2014	5/31/2015	2014	10-C-CST-NMSU-000	$0.00
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

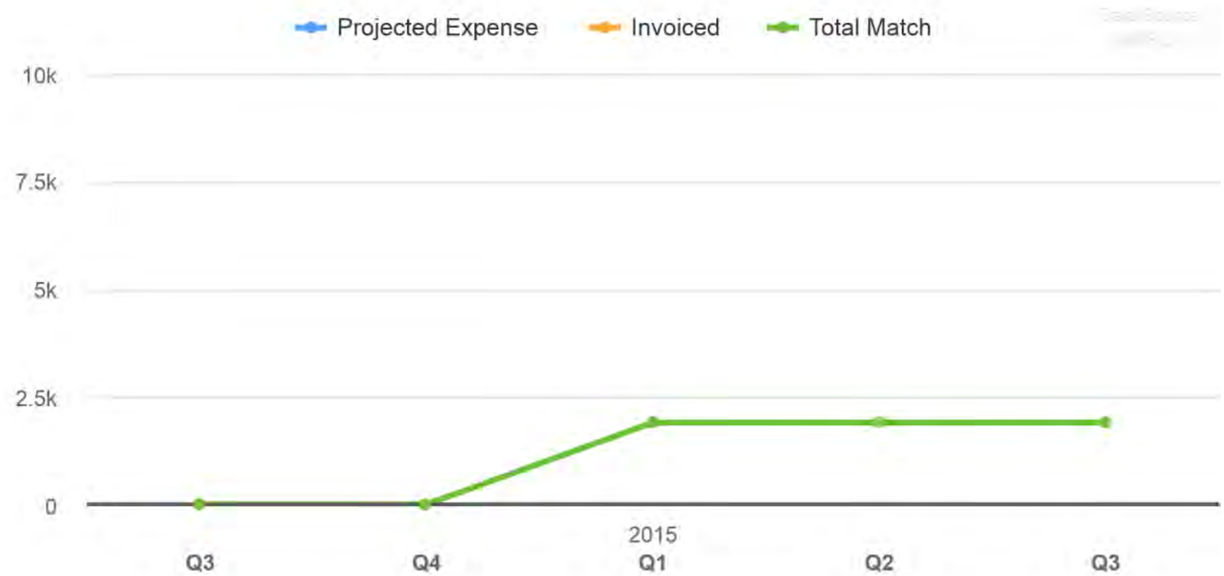
Deliverables

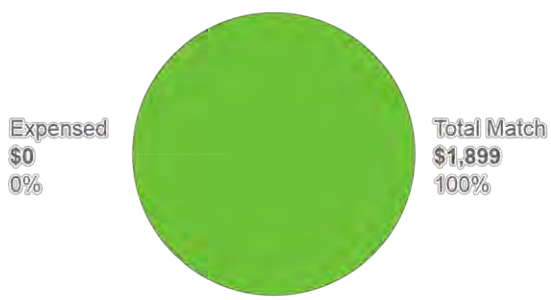
#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2014	5/31/2015	

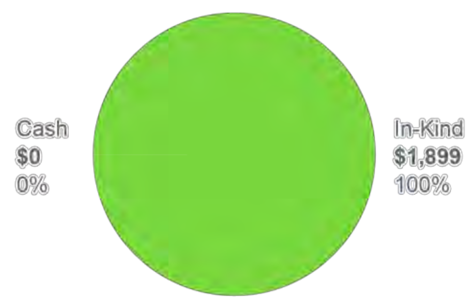
Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials







Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$1,898.97	$1,898.97
FY2015 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$1,898.97
FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$1,898.97
Total	$0.00		$0.00		$1,898.97	

TASK 307-NMSU: Test of COTS Satellite Communications Systems

Lead University
New Mexico State University

Team

Name	Role	Primary
Pat Hynes	Principal Investigator	●
Nick Demidovich	Tech Monitor	●
Crystal Luchini	Fiscal Admin	●
Patricia True	Contract Admin	●
Joylynn Watkins	Research Assistant	

Research Area
2.0 Space Transportation Vehicles

Project Description

Project Outcomes

Summary of Output

Technical Status

FY2014	FY2015

Partners

Partner	Division	Primary
New Mexico State University		
Solstar Communications		

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded

6/1/2014	5/31/2015	2014	10-C-CST-NMSU-000	$0.00
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

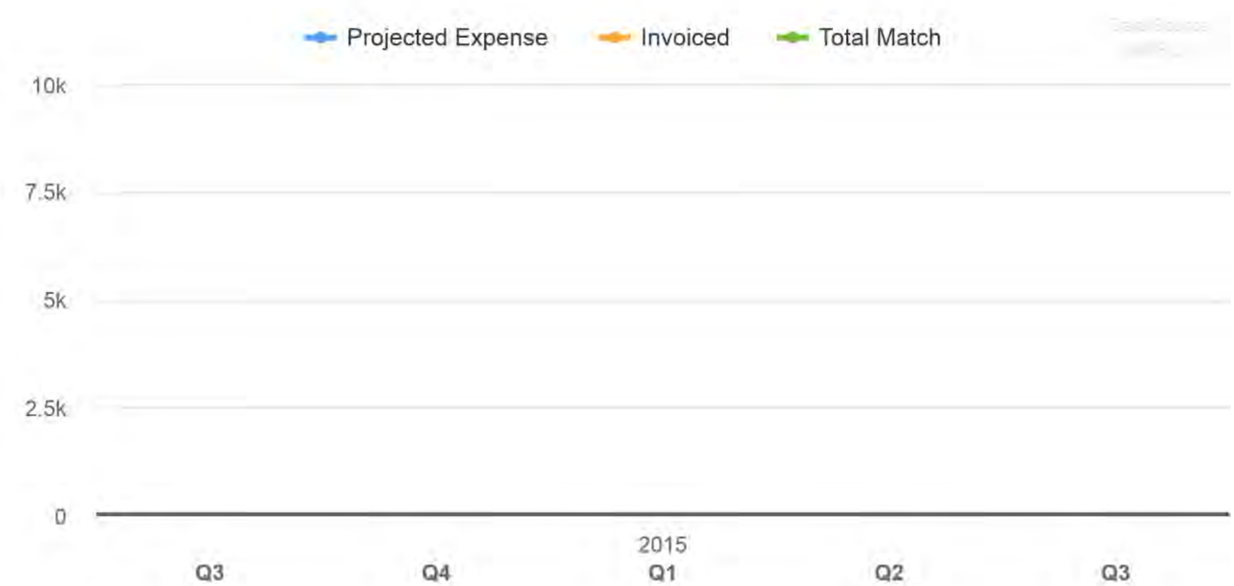
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	6/1/2014	5/31/2015	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2014 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2014 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2015 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00		$0.00		$0.00	

TASK 332-SU: Defining Class X Air Space

Lead University
Leland Stanford Junior University

Team

Name	Role	Primary
Juan Alonso	Principal Investigator	●
Gunther Smiley	Tech Monitor	●
Judy Kong	Fiscal Admin	●

Research Area
1.0 Space Traffic Management & Spaceport Operations

Project Description

Dr. Chris Draper and Dr. Aaron Santos
Simpson College, Indianola, Iowa

Examining and refining Draper-Santos Projections for defining airspace that could more efficiently enable safe reusable launch vehicle and unmanned aerial system operations from Regional or rural facilities.

This study will examine and refine the Draper-Santos projection methodology by using real world UAS and RLV data and model assumptions. Once examined and refined based on real world data for likely applications, Draper-Santos projections could be used to propose the creation of specific Class X airspace, as proposed in the attached Simpson College working paper, or some other mechanism that would increase the suitability of currently underused regional or rural facilities for RLV and UAS operations. The Draper-Santos projection methodology is based on current FAA AST exclusion-based protection strategies typically employed for RLV demonstration and testing.

This research would focus on both optimizing the fundamental assumptions used within the model (e.g. population data fidelity) and calibrating the model based on the various optimizations (e.g. testing risk threshold impacts based on casualty area inputs). The output of this work should be an iteratively improved model that should expand the number of facilities and communities that could benefit by safely expanding RLV and UAS operations.

Project Outcomes

Summary of Output

Technical Status

FY2015	FY2016

Partners

Partner	Division	Primary
Leland Stanford Junior University	Department of Aeronautics and Astronautics	●
Simpson College		●

Funding History

Start Date	End Date	FY Budget	Amendment Number	Amount Funded
8/25/2015	5/31/2016	0	AFFILIATE	$0.00
Total				$0.00

Students

Name	Department	Discipline	Funded	Degree	Graduation
No Students					

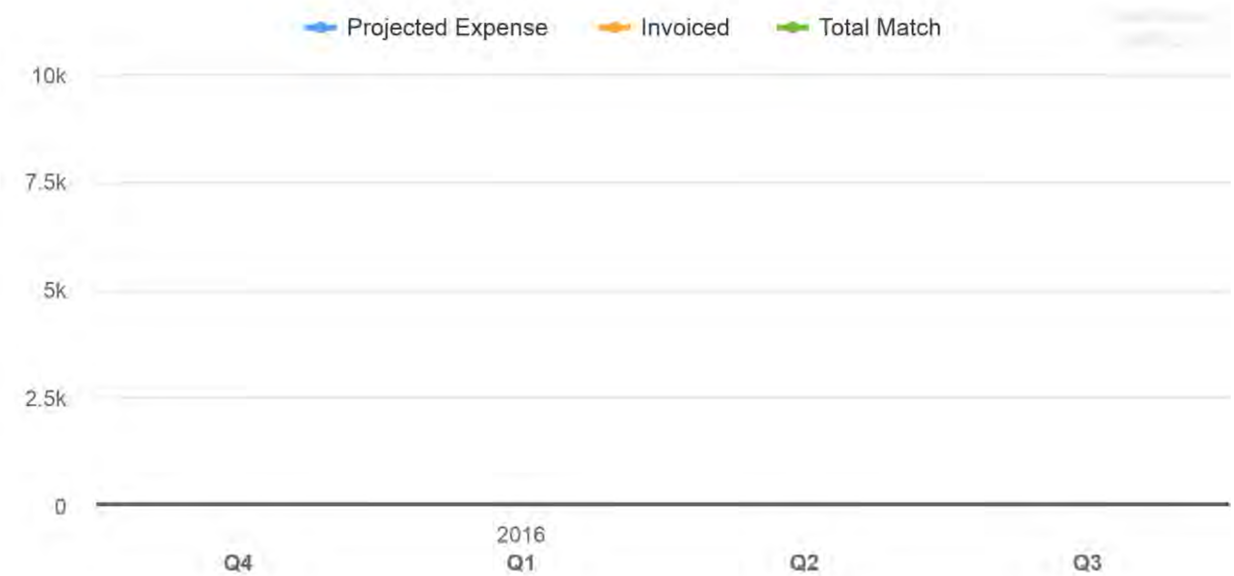
Deliverables

#	Deliverable	Start Date	Due Date	Accepted
1	FAA Final Project Report Form FAA9550. Form due at conclusion of project, with additional narrative where appropriate and with final invoice.	8/25/2015	5/31/2016	

Milestones

#	Milestone	Start Date	Due Date	Accepted
No Milestones				

Financials



Date	Expensed	Cumulative Expensed	Cash Match	Cumulative Cash Match	In-Kind Match	Cumulative In-Kind Match
FY2015 Q4 (Jul-Sep)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q1 (Oct-Dec)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q2 (Jan-Mar)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY2016 Q3 (Apr-Jun)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00		$0.00		$0.00	

COE CST

Center of Excellence for
Commercial Space Transportation