COE CST Sixth Annual Technical Meeting

TASK 329. Tracking and Monitoring Suborbital Commercial Space Vehicles

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Las Cruces, NM

Center of Excellence for Commercial Space Transportation

Agenda

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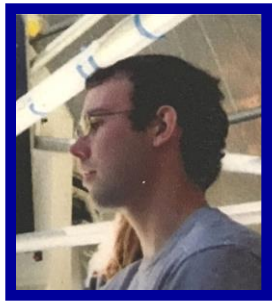
- Task Description
- Schedule
- Goals
- Results
- Conclusions and Future Work

Team Members

- Principal Investigators
  - Dr. William H. Ryan
  - Dr. Eileen V. Ryan

- Undergraduate: Jacob Schirer



- Organization:

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH • UNIVERSITY

MRO
Magdalena Ridge Observatory

New Mexico Tech (also providing matching funds)

Task Description

- Develop an asset ~100 km Northwest of **Spaceport America** in New Mexico that can be utilized to assess spacecraft health and assist in launch/re-entry anomaly resolution.

- Develop data products useful for mishap investigation for Commercial Space Vehicle launches.

- Facility: NM Tech's Magdalena Ridge Observatory **2.4-meter fast-tracking telescope.**

Schedule

- The period of performance for this work is December 2015 – December 2016.

The MRO 2.4-meter telescope (right) and support facility (left) located outside of Socorro, NM on Magdalena Ridge. The telescope is located within line-of-sight to NM Spaceport. Stratospheric balloons serve as good test targets for pointing and tracking-software development in preparation for commercial space vehicle launch monitoring.

Goals

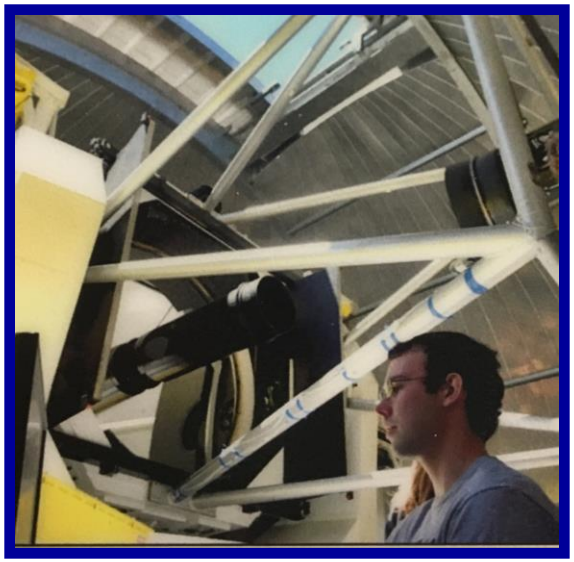
- Develop software to perform fully autonomous, closed-loop tracking using observational data collected via both the acquisition telescope (AT) and the 2.4-meter telescope imaging camera.

- Take 8 half-nights of observational tracking data using **weather balloons (or similar) as targets.**

- Analyze test tracking data, identify limitations, then improve algorithms for target tracking.

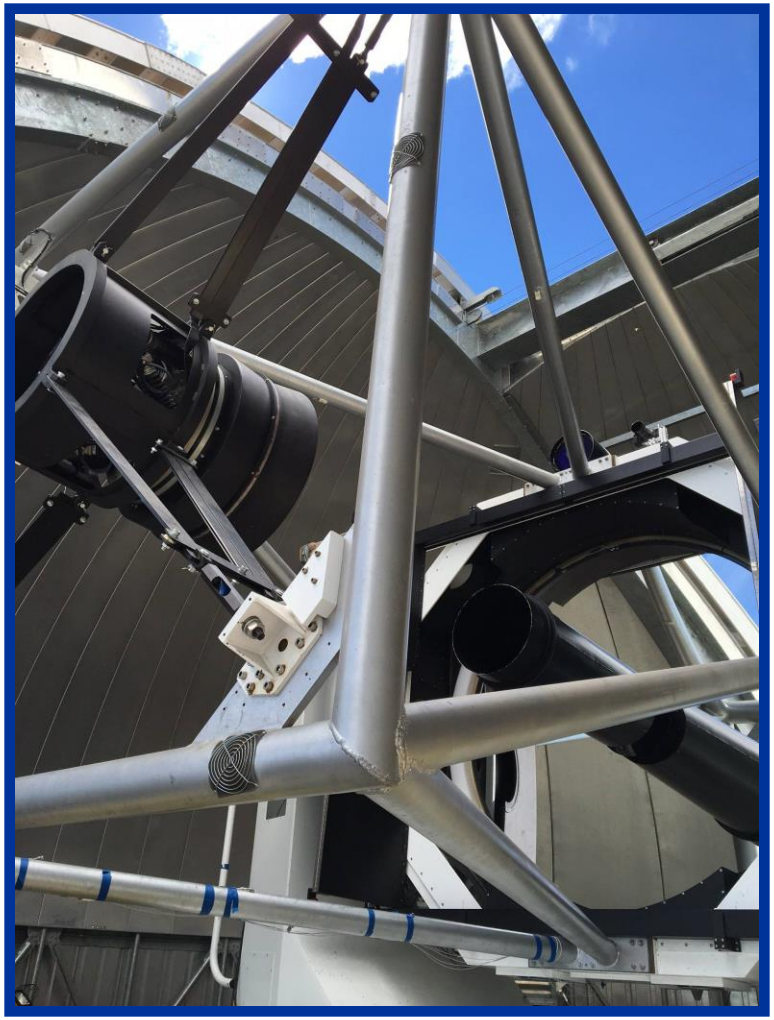
Student Software Project

- An undergraduate student in mechanical engineering at NM Tech spent the Summer 2016 developing a Python program to grab target positional information and then interface with and point the telescope to acquire the target.



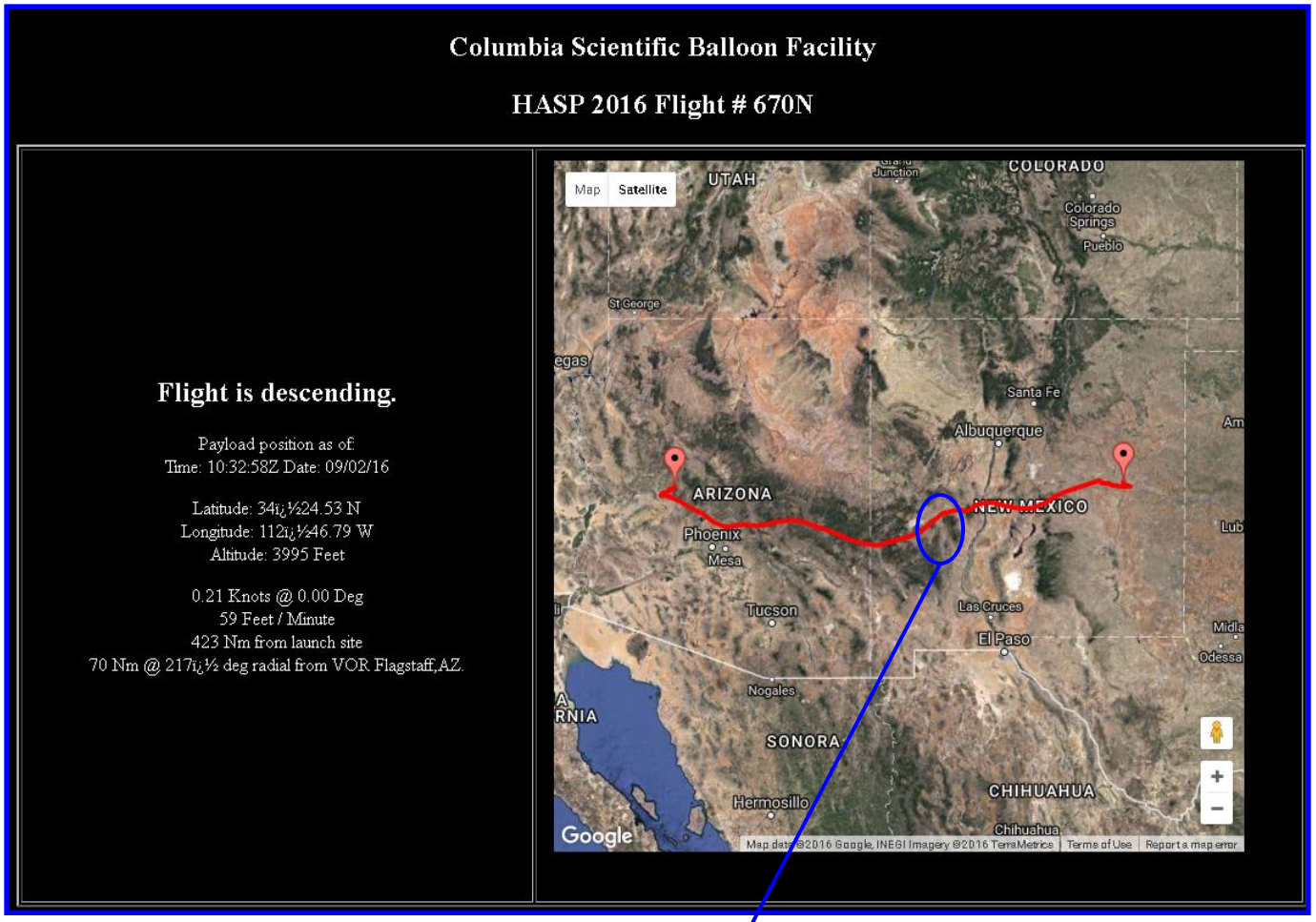
The pointing software was successfully tested on balloons launched from Ft. Sumner, NM in September 2016.

HASP Float Track: Directly Overhead



The first balloon target (HASP) was launched during monsoon wind patterns and floated West from Ft. Sumner directly toward us. Bad weather, but data collected on pointing accuracy at ~30º telescope elevation.

First PointingTest: HASP Balloon



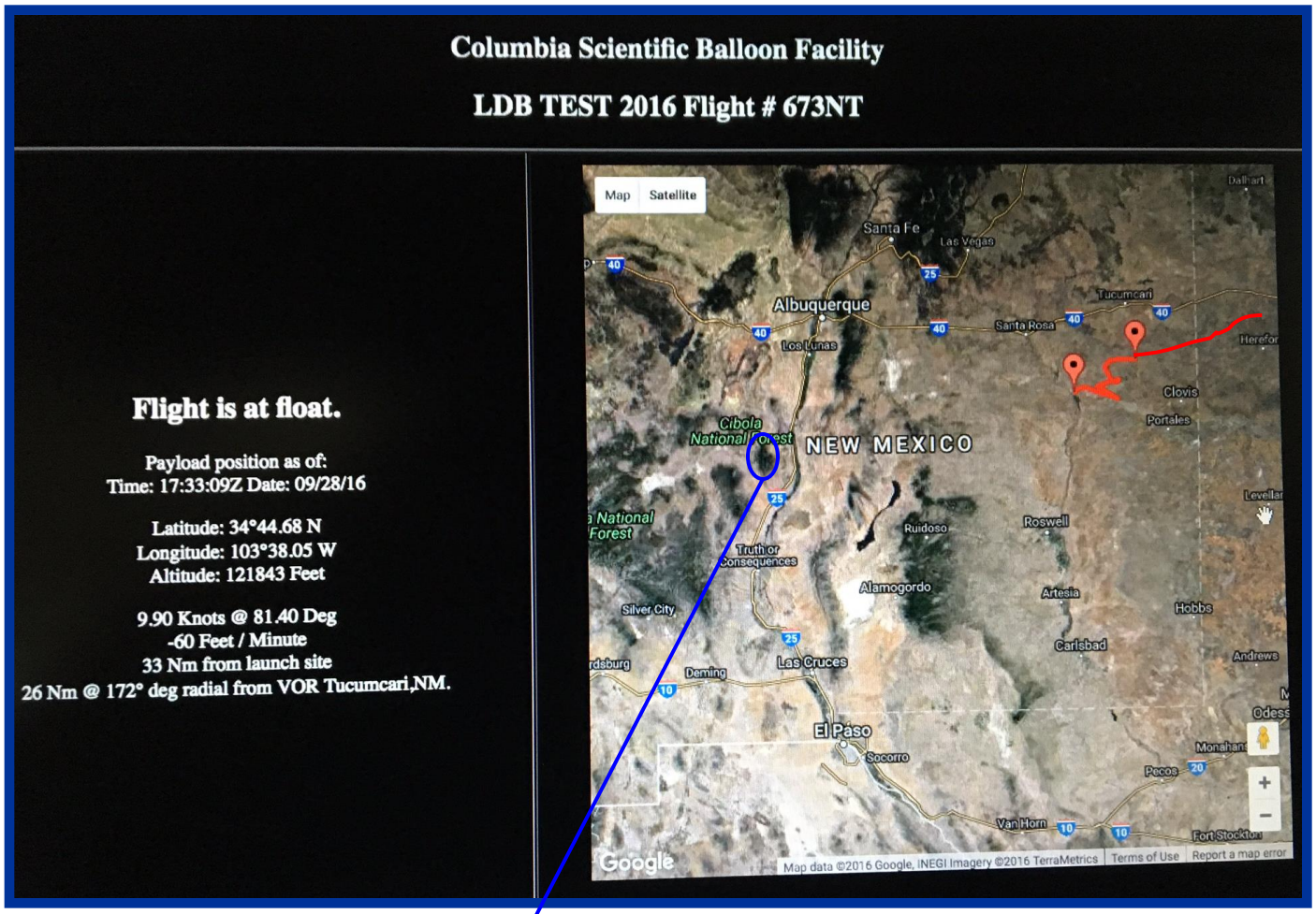
HASP overhead at MRO 2.4-meter telescope site at ~5:00 pm MDT

HASP Balloon (launched 10:10 am MDT) imaged through the 2.4-meter telescope's acquisition tracking camera on 09/01/16.

“Test Flight” Weather

Cloudy weather persisted, but we acquired data on 2 balloons to test tracking in late September. Wind patterns had already shifted such that the balloons floated East, away from the facility. Data was collected on tracking accuracy at ~3º telescope elevation, on targets “JPL Remote” and “Test Flight”.

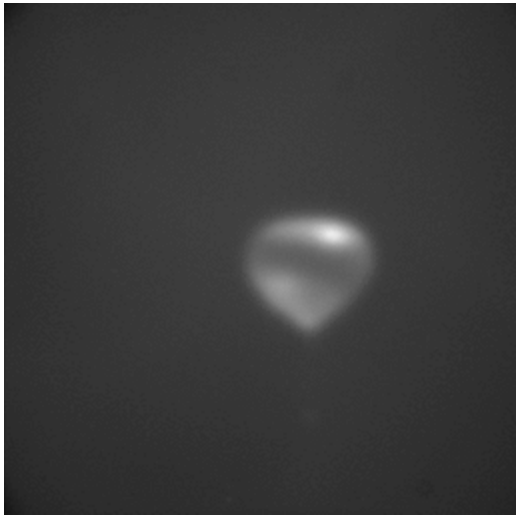
“Test Flight”



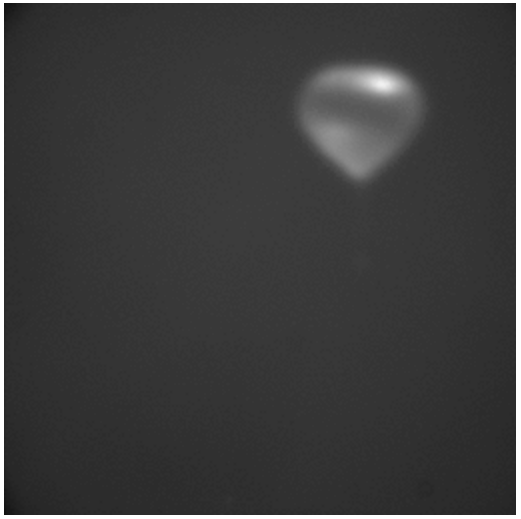
“Test Flight” Balloon (imaged at 02:33 pm MDT) by the 2.4-meter telescope on 09/29/16.

“Test Flight” 400 km away and 3° above horizon from MRO 2.4-meter telescope site

Tracking Results



Static tracking of the "JPL Remote" balloon target launched from Ft. Sumner on 09/28/16.



Dynamic tracking of the "JPL Remote" balloon target launched from Ft. Sumner on 09/28/16.

Conclusions and Future Work: Task 329

PROJECT AT-A-GLANCE

•UNIVERSITY: New Mexico Tech

•PRINCIPAL INVESTIGATOR(S): William H. Ryan & Eileen V. Ryan

•STUDENT(S): Jacob Schirer

RELEVANCE TO COMMERCIAL SPACE INDUSTRY

- Develop an asset ~100 km Northwest of Spaceport America in New Mexico that can be utilized to assess spacecraft health and assist in launch/re-entry anomaly resolution.
- Develop data products useful for mishap investigation for Commercial Space Vehicle launches.

STATEMENT OF WORK

- Develop software to perform fully autonomous, closed-loop tracking using observational data collected via both the acquisition telescope and the 2.4-meter imaging camera.
- Take 8 half-nights of observational tracking data using weather balloons (or similar) as targets.
- Analyze test tracking data, identify limitations, then improve algorithms for target tracking.

The MRO 2.4-meter telescope is a fast-tracking instrument located within line-of-sight to NM Spaceport. Stratospheric balloons serve as good test targets for pointing and tracking-software development in preparation for commercial space vehicle launch monitoring.

BALLOON TRACKING USING 2.4-M TELESCOPE

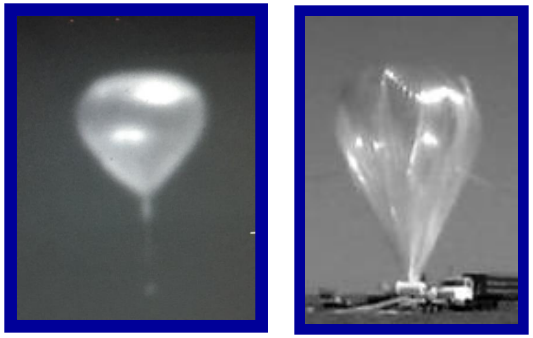


Image (left) taken with the MRO 2.4-meter telescope of “Test Flight” on 09/29/16. Telescope was pointed at an elevation of 3.1º and slant range to balloon was 400 km. Actual balloon (right).

STATUS

- An undergraduate student in mechanical engineering developed a Python program to grab positional information on balloon targets from the data posted by Ft. Sumner in order to point the telescope. The pointing software was tested successfully on the HASP balloon on 09/02/16.
- Additional software was developed to open-loop track the target and was tested successfully on two additional targets.

FUTURE WORK

- Test and perfect closed-loop auto-tracking using night-time, lighted targets.
- Potentially improve resolution with a fast-framing CCD camera and selected image reconstruction post-processing.