Telescope Rehabilitation and Exoplanet Confirmation

Data Analysis in the TESS Follow-Up Observing Program

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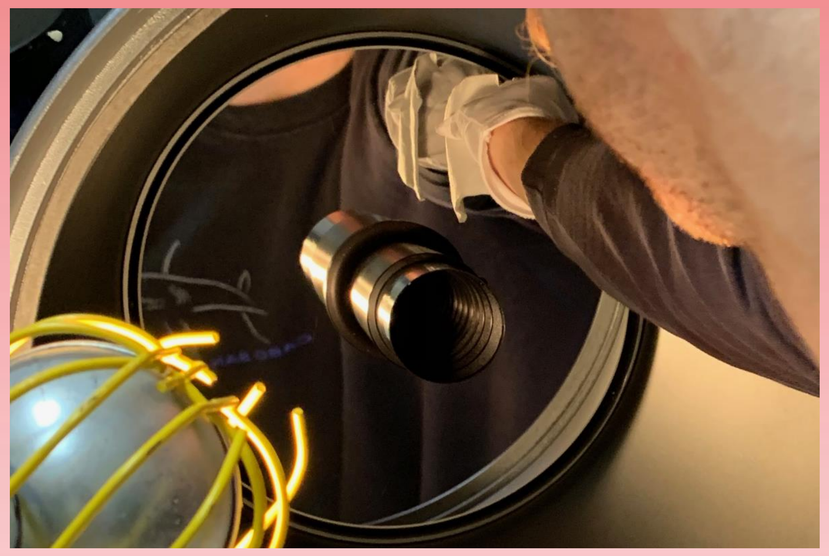
Telescopic Rehabilitation



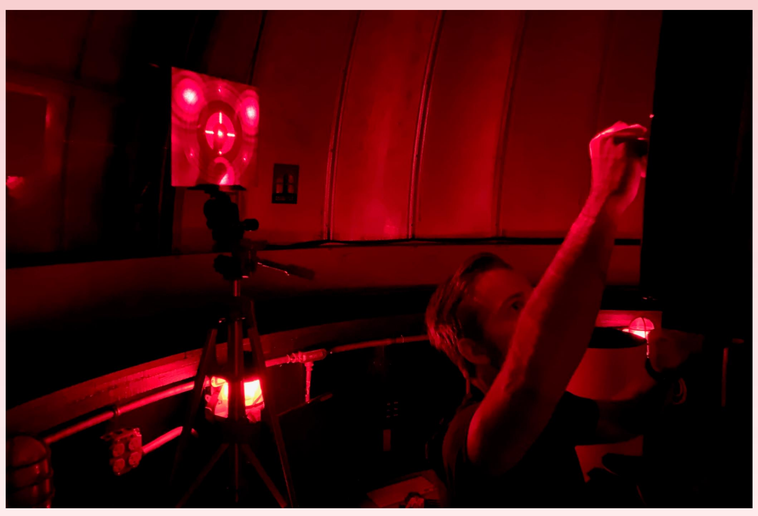
At the Beginning of the Summer,

the Geissberger Observatory had a major problem: its primary mirror was unable to be locked in, causing the mirror to "flop", ruining a few frames of data, causing all stars in frame to become unfocused, and often forcing an abort of a night's work. We:

- Removed the telescope weighing approximately 100 pounds.
- Disassembled it in our lab.
- Cleaned and reassembled it.
- Installed it in the dome.
- Enabled the mirror locking.
- Then began the detailed process of laser collimation of the optics with three highly parallel laser beams, shown below.

Cleaning a Telescope is much easier said than done.

Unlike your mirror at home, telescope mirrors are coated in a fine layer of silver <u>without</u> a sheet of glass in front of them to protect from fingerprints, dust, etc. This means that the slightest touch from a finger will leave oils and other residuals on the surface, which ultimately degrade the quality of the mirror. The utmost care was taken in cleaning and reassembling this telescope (note the cotton gloves being worn in addition to the cotton pad in cleaning the primary mirror above). After cleaning, the next step in the rehabilitation process was collimation.



Weather Station Overhaul

The Weather Station Tower failed in early June!

Furthermore, we discovered that the station had not been keeping any permanent records. We added a complete replacement of the weather station to our summer's work plan. We also connected the station to an internet cloud reporting service. It has been keeping records at 5-minute intervals since July 19, 2019. We are building a long-term record for use by EES, Biology, and other departments. Prof. Burley of the Chemistry Dept. is adding air pollution monitoring to the tower.

Scan QR Code for LIVE Geissberger Observatory Weather reports:

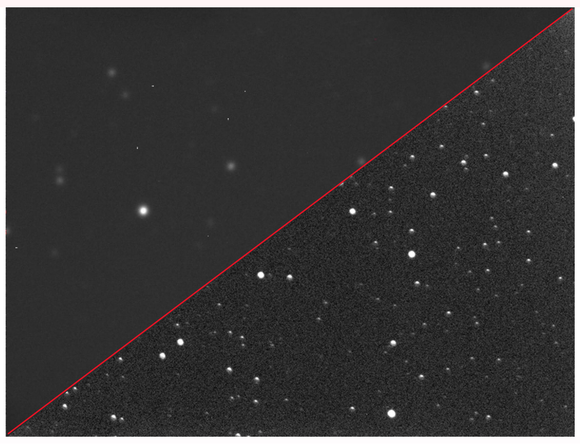
Imaging Comparison – 2018 vs. 2019

The Images Produced by Geissberger Observatory are better than they have ever been.

As seen in the comparison slides below, typical images taken in 2018 featured stars that weren't quite circular, and the poorer quality images were often defocused and blurred. Both images were from the same night of observing on the same target star (at slightly different orientations). In 2019, after all rehabilitation processes were carried out, typical frames feature stars that are circular, and, on average, sharper than their 2018 counterparts. The difference in sharpness between the typical and excellent frames is subtle, but significant in data processing. No poor images were provided for comparison because the telescope no longer produces poor images! The improvements carried out this summer leads to more successful data runs, higher quality data, and an overall increase in the yield of confirmed targets Geissberger Observatory can submit to TFOP.

2018 Images

<u>Poor</u>



<u>Typical</u>

2019 Images

<u>Typical</u>

<u>Excellent</u>

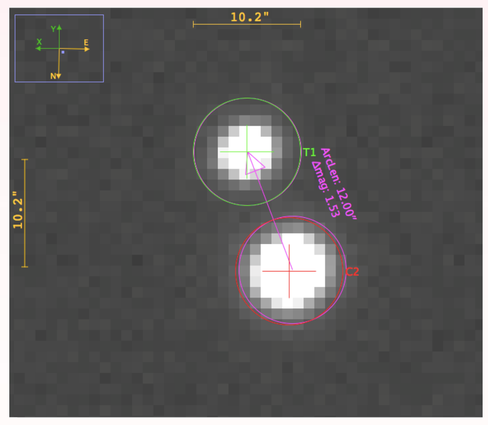
To see a video comparison at 100x the real data-taking rate, scan the QR code!

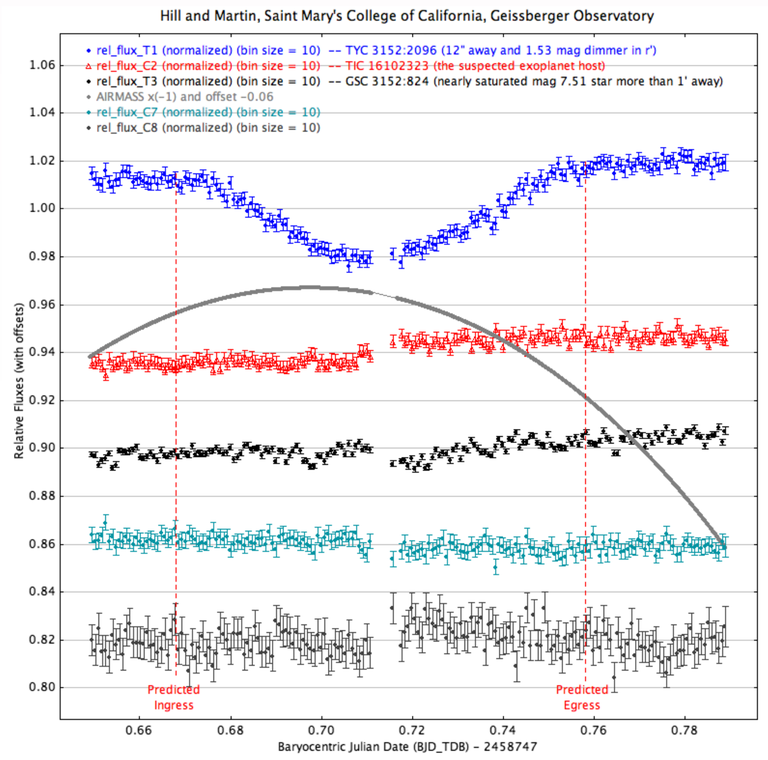
First TESS Follow-Up Observing Program Data Submission

TESS is the Transiting Exoplanet Survey Satellite.

It determines exoplanet candidates by measuring a star's brightness over time and correlating dips in brightness to a body, such as an exoplanet, passing in front of its host star. On Tuesday, Sep. 17, the TESS team sent out its first alerts for northern hemisphere exoplanet candidates. One was coming into our field of view on a night that was forecast to be clear on Friday, Sep. 20. It was a magnitude 9.4 star in the constellation Cygnus.* We took 1760 6-second exposures over the course of 3 hours and 20 minutes as the star transited overhead.

* Our results are embargoed for 6 months until the TESS team has time to utilize them. For this reason, further details on the specific target are redacted.





Our data analysis submitted to the TESS Follow-Up Observing Program (TFOP) on Sep. 23 showed that TESS had blurred two stars that are very near each other as shown above and to the right. The dip is actually on the dimmer star. Based on the shape of the curve, the candidate was determined to be a near-eclipsing binary, in other words a false-positive. This is a very common situation and is exactly the kind of information that TFOP team members like ourselves are expected to distinguish from actual exoplanet candidates.

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