The Palomar BSERVER

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Palomar Observatory

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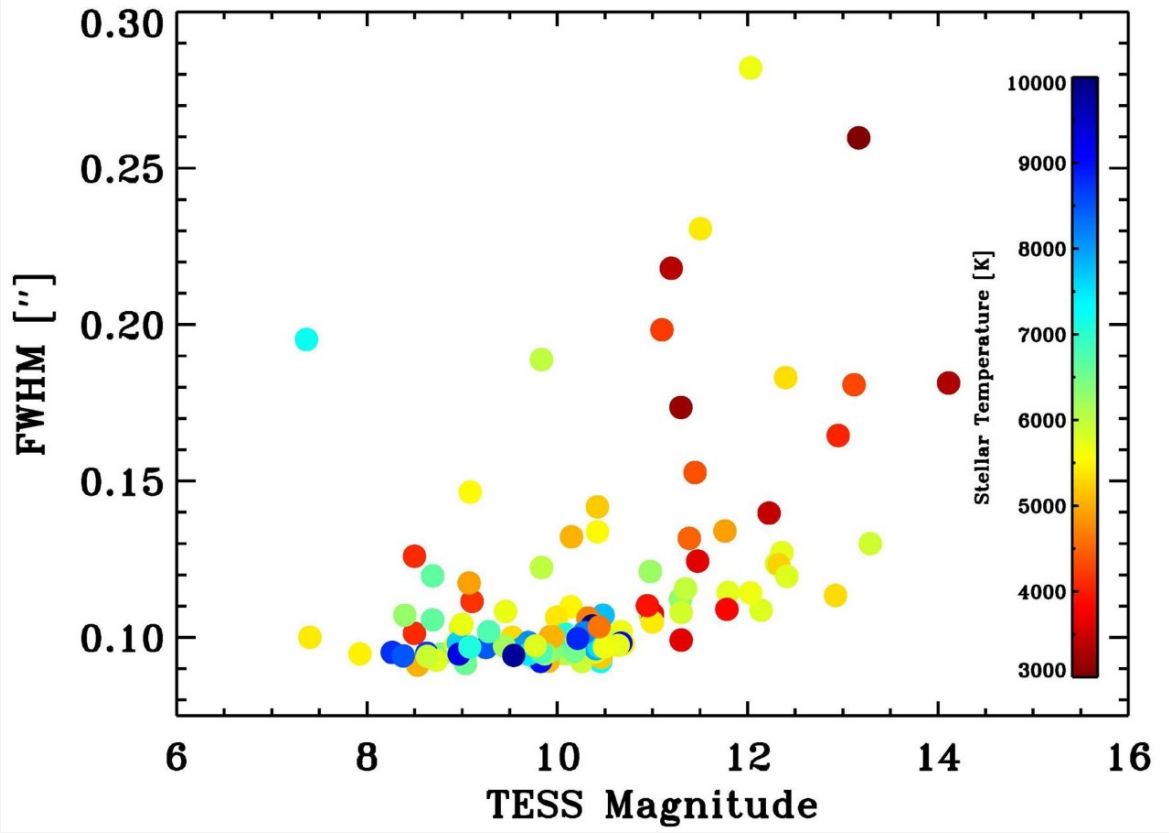
Big Performance Improvement from the Upgraded P200 Adaptive Optics (PALM-3000)

By Seth Meeker and Michael Warner (JPL)



The plot shows the image quality (Full-Width-Half-Maximum) as a function of star's brightness. The images were taken in the narrow-band Br-gamma filter, with the upgraded P3K AO system plus PHARO near-IR imaging camera. These data show clearly that the upgraded P3K has improved the sensitivity limits by 1 - 2 magnitude in comparison with the old system. (D.Ciardi/IPAC)

The history of adaptive optics (AO) correction on the Hale goes back to the mid-1990s, but the present two-stage system (PALM-3000—so named because of the 3000+ actuator “high-order” deformable mirror) has been in service since 2010. As relevant technologies have progressed the opportunity to improve PALM-3000 performance, reliability, and automation became viable. Since 2018 the observatory consortium, led by the Jet Propulsion Laboratory, have been developing and deploying a series of staged enhancements to enhance Hale AO capabilities.

Following a wavefront sensor and real-time control upgrade in 2019B, the upgraded facility adaptive optics system PALM-3000 (now officially dubbed P3K-II) has returned to regular science use for the last couple semesters. The upgrade has extended the performance of the default 64x mode to offer reliable correction spanning the full range of the pre-upgrade system’s available modes (64x, 32x, and 8x), where each mode is designated by the number of sub-apertures across the pupil in the wavefront sensor.

David Ciardi from IPAC has collected observations of 120 TESS targets using the upgraded P3K-II AO systems in November 2019 and January 2020. The figure shows the image quality, Full-Width-Half-Maximum (FWHM) of the stars as a function of brightness (TESS magnitude). The data clearly demonstrates that P3K-II can routinely achieve a FWHM of 0.10 arcseconds all the way down to about 11th magnitude (at the diffraction limit). The knee around 11th magnitude is not unexpected and is tolerable from a scientific point of view, according to Ciardi. For comparison, prior to the upgrade, that knee in the same type of plot was only around 9th magnitude. So the sensitivity improvement from the new system is significant. This is important for astronomers to

validate many more candidate exoplanet systems identified by TESS, Kepler and K2. Ciardi notes that these observations were all done in 64x mode and seeing stability was poor during many of these nights (which is when the AO system historically would struggle the most). All of these data were taken in the narrowband Br-gamma filter using the PHARO camera.

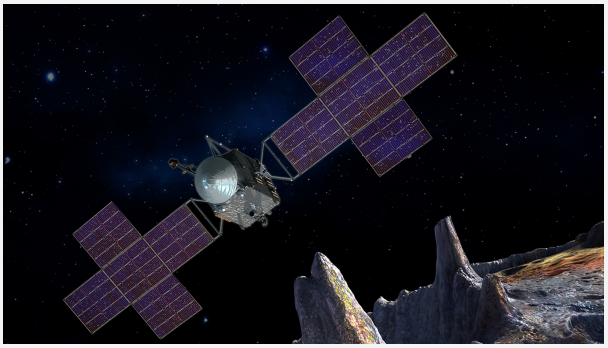
Since the Hale Telescope was shut down by the pandemic, the P3K+PHARO combination has not been in use. The P3K engineering team and COO/Palomar staff implemented new installation procedures and enabled remote operations for both instruments for the first time ever during the shutdown. The system was installed again on the P200-inch in the early of November 2020 for a successful demonstration of remote ops, returning P3K+PHARO to the list of available instruments during this P200 reduced operations phase.

In the course of those engineering nights, the other P3K-II mode, 16x, was also commissioned on-sky. Quantification of the performance versus 64x mode is underway, but initial results have already shown 16x to perform at least as well as 64x mode on faint targets, and it is now available for regular use. This mode is expected to extend the system's faint limit by two more magnitudes, while offering superior correction to the 64x mode for targets fainter than ~11th magnitude once fully optimized.

A JPL Technical Experiment at the Hale Telescope

By Michael Werner (JPL) and Lin Yan (Caltech)

Soon the Hale Telescope will participate in a novel optical communication experiment, and experiment preparations are well underway. The Psyche spacecraft is presently in route to the asteroid Psyche. Asteroid Psyche exhibits spectral signatures of an exposed metallic core—such cores are thought to be important in the planet formation process in the early Solar System.



The Psyche spacecraft. (JPL)

In addition to conventional radio-frequency communication with the Psyche spacecraft there is a novel optical transmitter that will be used to demonstrate deep-space high-bandwidth optical communication. The Hale will serve as the ground terminal for this technical demonstration to be conducted in 2022 and 2023.

An engineering team from the Jet Propulsion Laboratory (JPL) has been working with observatory staff to prepare the Hale for this demonstration. This JPL Deep Space Optical Communication (DSOC) team is developing a for-purpose receiver to mount at the telescope coudé focus. Further, the JPL/DSOC group has

worked with observatory staff to revitalize the coudé focus lightpath and infrastructure to support the experiment. The DSOC team has already had several engineering nights on the telescope, and confirmed the ability to track non-sidereal spacecraft motion at the required pointing accuracy. Continuing engineering effort is focused on bringing the communication receiver to the telescope and demonstrating its performance in preparation for the optical communication experiment, as well as enhancing telescope infrastructure to host the receiver.

Palomar Pandemic Operations

By Andy Boden

Contemplating the end of a turbulent 2020 I suspect that many of us share a sense of heightened fragility in our difficult times of continuing pandemic, civil unrest, and political turmoil. Many in our world have suffered greatly in these times, and our hearts go out to them. Even from my own fortunate perspective of relative safety, much of the routine we had grown accustomed to in our lives has been displaced by uncertainty and challenge to accommodate new and still evolving realities in our world.

Palomar has seen its share of challenges this year. As most of you know we suspended Hale Telescope operations mid-March, and of course we resumed limited operations in late May. My topic today is to report on the many efforts made by the observatory community in general and the staff in particular to resume Hale operations and discovery at Palomar

When Hale operations resumed in May we did so cautiously at reduced duty factor (four nights on/three nights off) and with a single instrument set: the facility optical spectrograph (DBSP) at the telescope Cassegrain focus, and the near-IR imaging camera (WIRC) at prime focus. In typical times instruments are changed at one or both of these foci every few days, driven by the diverse Hale science portfolio. But in pandemic conditions the safety imperative is paramount, and careful attention to proper social distancing in the Palomar environment became our new guiding principle. As better understanding of COVID-safe protocols emerged we were gradually able to increase the duty factor (five on/two off) and add instruments to the available set: CHIMERA and WaSP and NESSI have been added at prime focus, and TripleSpec and most recently the facility adaptive optics (AO) system and the diffraction-limited near-IR imaging camera (PHARO) are now available at Cassegrain. As I write this I am excited to report that we have just completed our first successful extended AO run; the installation of the complex AO system posed particularly difficult distancing issues to think and work through. Each step in this progression of increasing science capability required us to reassess our operating procedures to emphasize safety over efficiency, and balance the demands of science programs with staff protection. We are very proud of our observatory staff led by Site Superintendent Rick Burruss for how they have reimagined Palomar operations to restore Hale observations and meet the safety challenges posed by the pandemic.

At the same time, pandemic realities have changed how we schedule Hale science observations. In normal times we go through telescope time allocation cycles twice yearly, and the schedules are set six months at a time and infrequently changed. But

first the March operations suspension, and then reduced duty factor and instrument availability when operations resumed forced us to abandon this typical scheduling model and reimagine how we bring science programs to the Hale. Hopeful of adding increasing science capability over time, we adopted an ad-hoc, month-by-month scheduling model in May that could adapt to evolving operations capabilities. This has been my role: interfacing with our Hale science partner contacts at the Jet Propulsion Laboratory (JPL), Yale University, and National Optical Observatories of China (NAOC) to schedule programs that are the best match between partner priorities and evolving operations capabilities on the telescope. We are very grateful to our Hale partner contacts (Marla Geha at Yale, Sophia Dai at NAOC, and Mike Werner at JPL) who have extensively coordinated with me every few weeks to make sure that all our constituencies' interests remain fairly represented. While I do look forward to the time when we can revert to our traditional scheduling construct, for now I am satisfied that we are doing our best to responsibly manage the important telescope time resource entrusted to us.

Finally our astronomer community has had to adapt to new realities using the Hale for their research. The observatory remains closed to all outside personnel (except under carefully controlled circumstances—I myself have not been back to Palomar since February). So all Hale observations are now conducted remotely, with only the telescope operator in the data room, and both researchers and support astronomers connecting to instruments and videoconference remotely. Further, with our own Caltech campus remote observing rooms largely closed most of these observing sessions are being conducted from alternate locations such as home. We jokingly call this construct “pajama observing,” but it acknowledges a new reality as the pandemic grinds on into its second year. I know I speak for my colleagues when I say that we all greatly miss traveling to Palomar, staying at the Monastery, being in the wondrous Hale dome, and seeing our friends in person...

In addition to these operational adaptations to pandemic challenges, the observatory compound closure necessitated significant modifications to the Palomar public engagement program. In an article written for our Friends of Palomar newsletter, colleague Steve Flanders describes our 2020 pandemic public outreach strategies.

Faced with the challenges of resuming Hale operations during pandemic conditions, the observatory community has come together to support both safety and discovery. Truly everyone has had to find new ways to keep the observatory productive while keeping our colleagues safe, and it has been wonderful to see the spirit of commitment and ingenuity to address the issues that arise one by one. Still, we are reminded of the many wonderful times spent at Palomar with our friends and colleagues, and look forward to a time—hopefully soon—when we can all be together there again.

Wishing you health, safety, and every happiness in the new year.

-Andy

The All New Palomar Observatory Gift and Book Store

Promotional video for the new online store. (Palomar Observatory/Caltech)

We are excited to share that the Palomar Observatory Gift and Book Store is online at store.palomar.caltech.edu. For many years the gift store in the Observatory's Greenway Center has offered Palomar and astronomy-themed merchandise for our visitors, astronomers, and staff. Updating the gift store in a modern e-commerce context will greatly enhance our ability to serve Palomar enthusiasts near and far with a variety of apparel, books, graphics, and gifts. So if you're like us and your favorite Palomar logowear is looking a bit worn and in need of replacement, check out the online store and order new merchandise and gifts for yourself and all the astronomy enthusiasts in your life.

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