LBT OBSERVATORY NEWSLETTER

January 2023 Issue 2023.01

From the Director
Joe Shields

After seven months in the role of Director, I remain inspired by the unique capabilities of the Large Binocular Telescope, the exciting science it is producing, and the potential to do much more. I feel fortunate to work with the observatory's talented staff, and to have access to the incredible intellectual resources of its member institutions.

One message I have heard clearly from the LBT community is the need for the observatory to do a better job of communicating with its constituents, and to tell the observatory's story to a broader audience. This newsletter is one element of responding to this imperative. Items for inclusion were intended to be of general interest to the LBT user community. Given our interest in launching the newsletter in a timely manner, we are resorting to a simple pdf format with the intention of transitioning to a more versatile web-based format in the future. The goal is to distribute the newsletter on at least a quarterly basis.

Several other initiatives are underway to enhance communication. The observatory's science operations webpages were given a major update during fall 2022, and planning is underway for renovation of other parts of the website, including the front door. The intent is to provide enhanced access to information with a modern aesthetic.

If you have suggestions for topics you would like to see addressed in future newsletters, or you have other ideas for how to tell the LBTO story, please email me at jshields@lbto.org.

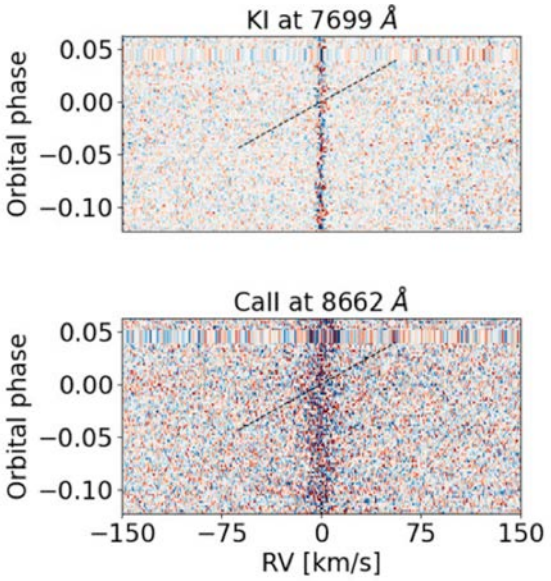
The items that follow provide updates on recent science as well as observatory scheduling, observing run planning, selected systems important for telescope performance, and new instruments. As detailed below, progress on LBTO's AO systems has benefitted greatly over the past 1.5 years from the leadership and guidance of the AO Tiger Team (ATT), consisting of Simone Esposito (INAF-Arcetri, Chair), Laird Close (U. Arizona), Sebastian Rabien (MPE), and William Rambold (Gemini Observatory). The ATT concluded their work at the end of 2022, and I would like to express my gratitude for their important contributions. The Observatory is committed to maintaining the focus and project management methods demonstrated by the ATT, to enable continued progress going forward.

LBT Science Highlights
PETS: the PEPSI Exoplanet Transit Survey

The PEPSI Exoplanet Transit Survey (PETS) takes advantage of the high-resolution, high-precision capabilities of the PEPSI instrument to carry out transmission spectroscopy of exoplanet atmospheres for a large sample of transiting systems. PETS is distinctive in representing a collaboration of scientists drawn from all of the LBT members and their associated allocations of observing time. The survey, conducted over the four semesters of 2021-2022, recently concluded with 28 targets successfully observed and an additional 11 sources with partial data.

Initial science results from PETS are now appearing, with a study of the super-earth 55 Cnc e published by Keles et al. in March

2022. Models for the exoplanet in this case, with mass of ~8.0 M_e, radius ~2 R_e, and orbital period of 0.66d, have suggested several alternatives for a potential atmospheric composition. The PETS data were used to place sensitive limits on the presence of various atmospheric silicate species (tracing elements including Fe, Ca, Mg, K) that would be expected in a heavy atmosphere, implying that a widely extended silicate envelope around this super-Earth can be excluded.



Example 2D maps of the Cnc e residual spectra at different orbital phases for KI and CaII lines, with the expected absorption trace shown by the dashed black line.

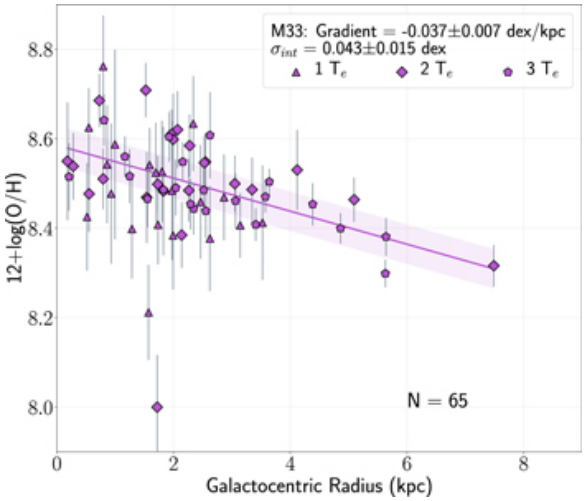
Additional results from PETS are currently submitted for publication and in preparation. The PETS collaboration was organized by Klaus Strassmeier at AIP-Potsdam.

LBT Science Highlights

Large-Scale Abundance Structure in M33

Spiral galaxies are known to display gas-phase abundances of heavy elements that typically decrease with increasing radius, and the abundance gradient and scatter at a given radius contains important information on the chemical evolution and mixing processes in the overall system. The scatter in particular is a potentially important indicator of the degree to which local enrichment is important in driving chemical evolution, as opposed to large-scale mixing processes resulting, for example, from supernovae and stellar winds.

Rogers et al. (2022, ApJ, 939, 44) have recently presented results based on new LBT measurements that constitute the authoritative study of nebular abundances in the local group spiral M33. The ability to derive such abundances and their dispersion as a function of radius for M33 and other galaxies has been limited in past studies by sparse spatial sampling, inhomogeneous data and data quality, and sensitivity to poorly determined nebular temperatures, among other factors.



Oxygen abundance gradient in M33, with symbol type indicating the number of directly measured temperatures used in calculating the abundance, derived from MODS spectra.

The new study utilizes spectra of ~100 HII regions to derive abundances from emission-line measurements. The high sensitivity, coverage of the full optical bandpass, and data homogeneity allowed direct determination of temperatures from multiple temperature-sensitive line ratios. The findings indicate a small intrinsic dispersion in abundances at a given radius, implying that the interstellar medium in M33 is chemically well-mixed and homogeneously enriched from inside out.

2023A Semester Schedule

Jenny Power and Joe Shields

The LBT 2023A observing schedule was recently finalized and posted, with several items of note this semester.

- Given the current status of the pandemic, a number of observers have expressed interest in returning to Mt Graham for in-person observing. We have consequently made an effort to expand observing run lengths where possible for efficiency of long-distance travel.
- The SX adaptive secondary will be removed at the end of May because of significant deterioration of reflectivity. The rigid secondary will be installed on SX for the remainder of 2023A to increase throughput for seeing-limited observations. The expectation is that monocular AO operations will continue on DX after removal of the SX adaptive secondary. Planning is underway for recoating of the SX adaptive thin shell after removal of the secondary unit, with the goal of returning it to service at the conclusion of the 2023 summer shutdown.
- Due to very limited requests, the PEPSI polarimetry units will not be installed during 2023A.
- The PEPSI detectors will be removed on approximately June 23 for an upgrade, with the expectation that the instrument will be functional again at the conclusion of summer shutdown.

Winter Driving at Mt Graham

David Carroll

As we all adapt to life with COVID-19 and an increasing number of observers are returning to the telescope, the Observatory would like to remind everyone about guidance for vehicle travel on Mt Graham during the winter months (Nov 15 – April 15).

Driving scene on Mt Graham Jan 2023 – photo courtesy of Elliott Solheid

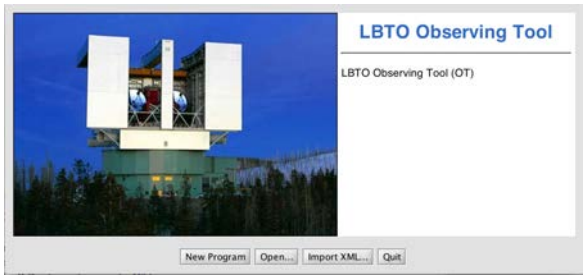
Because of its altitude, the upper parts of the mountain routinely receive snowfall and ice that can make driving hazardous. Observers have several options for avoiding this risk: 1) Take advantage of the continued option of C-19 (service) observing from home; 2) Use the remote observing room at the LBTO Headquarters in Tucson; 3) Park at the MGIO Base Camp and ride up and down the mountain with observatory staff; 4) Rent and drive a vehicle appropriate for winter mountain road conditions.

We encourage observers to take advantage of the first three options. Note that riding up and down the mountain with observatory staff requires advance arrangements, and travel may only be possible on weekdays. Please feel free to contact Observatory Manager Pat Hartley to discuss options (phartley@lbto.org).

If you plan to drive yourself, please refer to the LBTO guidance on *Vehicle Travel during Winter Weather* for specifics regarding appropriate vehicles and protocol once you arrive at the MGIO Base Camp. Even with a suitable vehicle and emergency gear, it is important to remember that mountain driving in the presence of ice and snow presents distinct challenges, and observers who are not experienced in driving under such conditions should exercise particular caution or choose one of the other options.

LBTO Observing Tool Update

Alex Becker



The LBTO Observing Tool GUI.

The LBTO Observing Tool (OT) is used for generating observing scripts based on science requirements for an observation sequence. A new version of the OT was released in early October 2022. The software upgrades were focused on implementing observation modes that required manually editing scripts in the past and an improved support for AO observations. Notable changes include:

- **LUCI**: The telescope rotator can be set into parallactic mode for Angular Differential Imaging (ADI) observations
- **LUCI**: A subframe/sub-window option was added to the detector configuration. Selecting any of the predefined subframes will insert pauses for target acquisition into the LUCI script. The different subframe sizes can be visualized in the Position Editor to aid the PI planning the observation. However, the selected size of the subframe is not part of the LUCI script and still has to be set manually during the acquisition phase.
- **LUCI**: For AO observation a +1.2 magnitude offset is added to the R-Band magnitude of the AO reference star to convert the R-Band magnitude into the WFS magnitude.
- **LUCI**: The AO patrol field has been re-measured and updated.
- **LUCI**: The guide star patrol field shows a 5" warning area at the border of the field where the guide star visibility can be affected by differential refraction. We also added a visualization of the patrol field area that is accessible from all dither positions to aid guide star selection.
- **LBC**: A mixed-mode scripting option was added to automatically insert the script alterations necessary for heterogeneous binocular observations with MODS or LUCI.
- **LBC**: The Guide Stars Selection in the Position Editor was extended to include a search for co-pointing and collimation stars. While the recommended magnitude range is automatically set the used filter has still to be set manually.
- **General**: The Observing Condition Tab now includes Image FWHM, Strehl Ratio, and S/N ratio as possible observing constraints.
- **General**: The error handling and warning messages in the Problems Section were revised and updated.
- **Library**: The script libraries were updated. The new libraries also include templates for ADI, sub-framing, and mixed-mode observations.

This new version of the OT is backward compatible with the 2020A version of the OT, and scripts created with the previous version should seamlessly be ingested into the new version. It is also still possible to create scripts with the 2020A version of the OT. However, the changes in the LUCI AO patrol field position were significant enough that we deemed it necessary to deactivate the script creation for LUCI AO observations with OT versions older than OT 2022B V1.1.0.

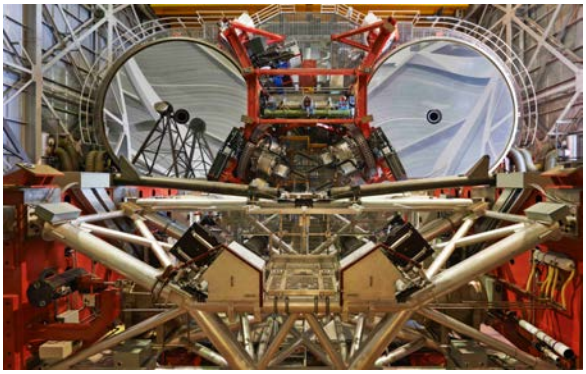
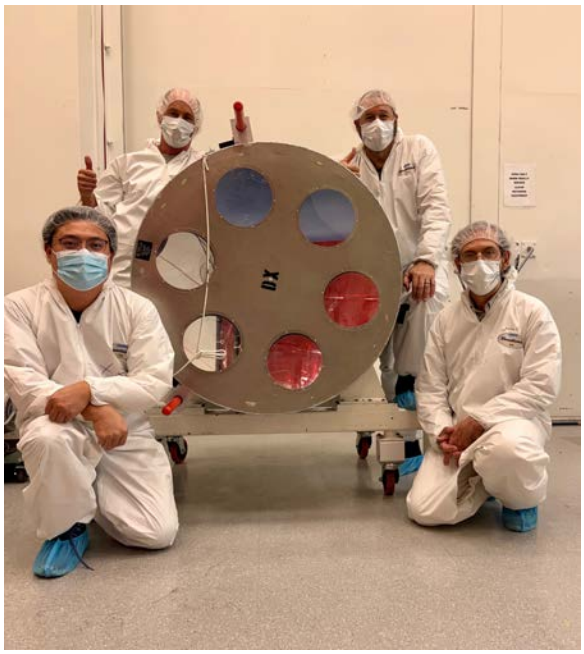


Photo credit: E. Sacchetti

Adaptive Optics Update
Mark Smithwright and Joe Shields

The LBT Adaptive Optics systems continue to see progress in their performance and functionality, thanks to the efforts of observatory personnel and guidance from the LBT AO Tiger Team (ATT).

Several developments involve the LBT Adaptive Secondary Mirrors (ASMs):



Xianyu Zhang, Michael Lefebvre, Mike Wagner, and Guido Brusa with the DX ASM at the conclusion of summer shutdown.

- Thanks to the diligent efforts of our staff during 2022 Summer Shutdown, the DX Adaptive Secondary Mirror was returned to regular service in September. Work included regluing of detached magnets on the thin shell, and replacement of vibration isolators in the electronics crates on both DX and SX.
- In November Engineering Head Mark Smithwright and Director Joe Shields visited our industry partners ADS and Microgate in Italy, to discuss the current state of the LBT ASMs and options for future enhancement of performance.
- Planning is now underway for recoating of the SX thin shell during summer 2023, to improve reflectivity.
- A larger planning exercise is now underway with the goal of ensuring the LBT maintains a complement of high-performing ASMs supporting its scientific goals for the next 5 years and beyond.

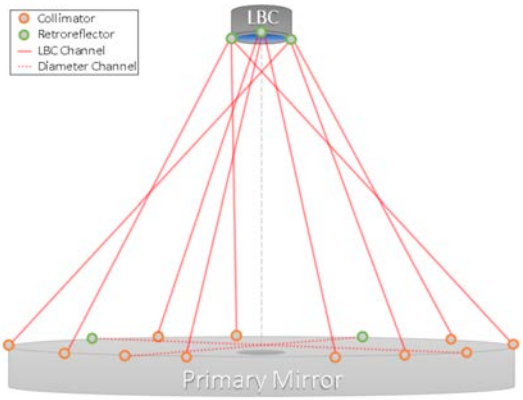
The SOUL upgrade for single-conjugate AO observations has also achieved significant progress in recent months. The system is implemented with separate wavefront sensors at the LUCI and LBTI focal stations on both sides, with technical leadership from Arcetri Observatory.

- The SOUL-SX-LUCI system passed a formal acceptance review in September 2022.
- The SOUL-SX-LBTI system passed a formal acceptance review in December 2022.
- SOUL-DX-LBTI commissioning activity is complete and an acceptance review is planned for 2023 Q1.
- SOUL-DX-LUCI commissioning is continuing in the 2023A semester, with acceptance anticipated in 2023 Q2.

For the accepted systems, efforts are continuing on the part of LBTO staff in consultation with Arcetri personnel, for improvement in system performance and robustness.

The LBT Telescope Metrology System

Olga Kuhn



Cartoon representation of a laser truss for one primary mirror – prime focus corrector pair, from Rakich et al. (2022).

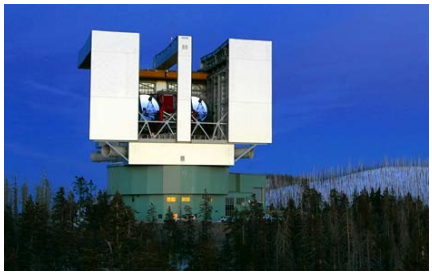
The LBT Telescope Metrology System (TMS) is a laser-truss-based metrology system that maintains the relative position and orientation of each primary mirror (M1) and its respective Large Binocular Camera (LBC) to within a few microns over slews and over time. TMS has been installed and commissioned for use with the LBCs through a collaborative effort between the Giant Magellan Telescope Observatory, the Wyant College of Optical Sciences at the University of Arizona, and the LBTO, with the dual goal of prototyping a TMS for use at the GMT and improving the image quality and efficiency when observing with the LBCs.

The system consists of a network of collimators, mounted along the edge of the primary mirror, and retroreflectors, mounted on the LBC hub, which create a truss with 9 collimator-retroreflector pairs, or channels (including 3 for redundancy) per side. Laser-interferometric absolute distance measurements along these channels are made every ~30 seconds and used to adjust the position of the primary mirror if the measurements meet certain criteria and the LBC shutter is closed. The laser, which operates at 1.5 microns, does not affect the LBC images.

Unlike the Gregorian instruments, the LBCs do not have off-axis wavefront sensors, and observations must be interrupted to focus and collimate; this procedure can take about 5-10 minutes. *TMS reduces the need to re-collimate after each slew or every ~30-40 minutes while tracking*. It also enables high-cadence time series that would otherwise be interrupted by the need to re-collimate. The TMS software operates with little user interaction: after focus and collimation, the user sets a reference and then starts the measurement loop, which runs continuously all night or until stopped to re-focus/re-collimate. In usage to date the system has been operated by LBTO personnel.

While TMS maintains the relative LBC-M1 position and orientation, it cannot correct for aberrations arising from thermal gradients across the primary mirrors (such as low and high order spherical, z11 and z22). It does, however, provide a reference frame for studying these. Currently the system uses data from thermocouples along the surface of M1 to correct for thermal focus (z4), and work is ongoing to correct for other thermally induced aberrations.

The TMS system was installed on the DX side in 2020 and on the SX side in April/May 2021. Since the fall of 2020, it has been used in 'passive' mode during LBC observations, making measurements but not adjusting the primary mirror. Since March 2022, TMS has been used in 'active' mode on a shared-risk basis during partner science observations with the LBCs. Further details regarding the TMS are presented in Rakich et al. 2022, Proc. SPIE 12182.



New Instruments Update
Al Conrad and Joe Shields

Three new PI instruments are reaching an advanced stage of development.

SHARK-NIR:
The SHARK-NIR instrument, built by a consortium led by INAF-Padua, is designed with coronagraphic and other capabilities to carry out high-angular-resolution, high contrast imaging and spectroscopy in the 0.96-1.7 micron bandpass.

SHARK-NIR passed its Preliminary Acceptance Europe (PAE) review in April 2022 and shipped to LBTO in June 2022. Installation on the telescope and daytime pre-commissioning activities were carried out during several runs during the 2022B semester, with a first night-time run successfully completed in January 2023. The instrument is installed on the SX side of the central bent Gregorian focal station and utilizes the SOUL-SX-LBTI AO system.

Installation of the dewar for the SHARK-NIR scientific camera, with assistance from LBTO staff member Tim Castro.

Additional commissioning runs are scheduled during the 2023A semester. The SHARK-NIR team can be contacted with questions regarding instrument capabilities and access (PI: J. Farinato, Jacopo.Farinato@inaf.it).

SHARK-VIS:
SHARK-VIS is an optical (400-900 nm) instrument for high-contrast and coronographic imaging, built at INAF-Rome. SHARK-VIS passed its PAE review in June 2022. The instrument is designed for installation on the DX side of the central bent Gregorian focal station. Shipment to the LBT remains contingent on formal acceptance of the SOUL-DX-LBTI AO system which is anticipated in 2023 Q1. Shipment of the instrument is consequently anticipated in 2023 Q2, with installation and commissioning activities following later in the year.

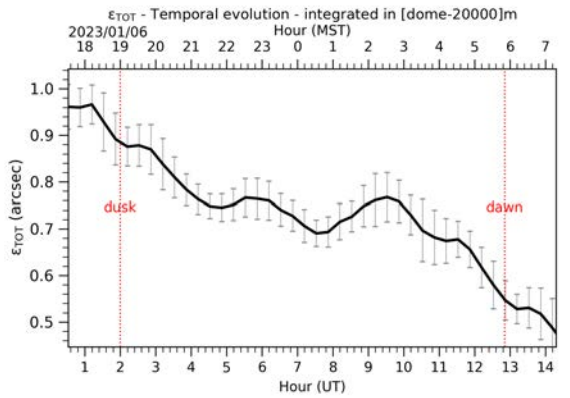
LBTO Director Joe Shields with undergraduate Nandini Sadagopan (Notre Dame) and Jonathan Crass (Ohio State) at their presentations on iLocater at the January 2023 American Astronomical Society meeting in Seattle.

iLocater:
iLocater is a high-resolution (R=190,500 median) near-infrared spectrograph designed to deliver extremely precise radial velocity measurements for exoplanet studies. The spectrograph will operate in a diffraction-limited regime with single-mode-fiber injection of light. The instrument is being built by the University of Notre Dame, and is currenting moving through key integration steps, with final delivery and integration with the cryostat system continuing through spring 2023. Shipment to LBT is anticipated in fall 2023.

ALTA – the Advanced LBT Turbulence and Atmosphere Center

Joe Shields and Christian Veillet

The ALTA Center is an initiative at the INAF-Osservatorio Astrofisico di Arcetri working in collaboration with LBTO to generate forecasts of optical turbulence and other atmospheric parameters at the LBT site, to inform observation planning. ALTA uses the Meso-Nh mesoscale atmospheric model developed by the Centre National de Recherches Météorologiques (CNRM) and Laboratoire d'Aérologie (LA) in Toulouse, France, for forecasting atmospheric parameters including temperature, relative humidity, wind speed, and wind direction, while the ASTRO-MESO-NH code developed by Elena Masciadri (INAF-Arcetri) is used to forecast optical turbulence and seeing.



Example of seeing predictions provided by ALTA.

Forecast are generated automatically and are available through the ALTA website. The ALTA predictions are reviewed as part of the daily planning meetings of LBTO staff, with particular attention to factors that may influence the ability to open the telescope enclosure (humidity, wind speed). Seeing predictions can be very valuable for observers planning target prioritization and sequencing, and determining whether use of AO is appropriate.

The ALTA Center depends on external partners for input data, and as with other astronomical resources, tracking of usage and impact is important for the continuation of this collaboration. LBT Observers who make use of ALTA predictions are consequently encouraged to include the following acknowledgement in any resulting publications:

Observations have benefited from the use of ALTA Center (alta.arcetri.inaf.it) forecasts performed with the Astro-Meso-Nh model. Initialization data of the ALTA automatic forecast system come from the General Circulation Model (HRES) of the European Centre for Medium Range Weather Forecasts.

Personnel Update: Nov – Dec 2022

Arrivals:

Michelle Aros	Business Affairs Mgr
Peter DeMars	Principal Engineer
Sam Neff	Junior Staff Technician
Jose Trujillo	Junior Staff Technician

Departures:

Barry Rothberg	Instr. Support Astronomer

Photo credit: E. Sacchetti