The Call for Proposals and proposal-related information, such as available instruments and updates, is no longer included in the NOAO Newsletter. All information specifically related to proposing for telescope time via the NOAO Time Allocation Process is available through the NOAO “Proposal Information” web pages and links (see below). The NOAO website is the definitive location for the most current information available to proposers. The Semester 2016A NOAO Call for Proposals will be posted and open on the NOAO website on 1 September 2015. We note that the NASA-NSF Exo-Planet Observational Research (NN-EXPLORE) program will continue in semester 2016A on the WIYN 3.5-m telescope. Please see the 2016A Call for Proposals for the details.

Help with proposal preparation and submission is available via the Web addresses below:

**Proposal Preparation and Submission Help**

- Web proposal materials and information: [www.noao.edu/noaoprop/](http://www.noao.edu/noaoprop/)
- TAC information and proposal request statistics: [www.noao.edu/gateway/tac/](http://www.noao.edu/gateway/tac/)
- Request help for proposal preparation: noaoprop-help@noao.edu
- Gemini-related questions about operations or instruments: gemini-help@noao.edu
- CTIO-specific questions related to an observing run: ctio@noao.edu
- KPNO-specific questions related to an observing run: kpno@noao.edu

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**NOAO Proposal Preparation Information and Submission Help for Semester 2016A**

Verne V. Smith & Dave Bell

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**First Light for TS4-ARCoIRIS: Installation and Commissioning, April–June 2015**

David James, Terry Herter & Everett Schlawin (Cornell University)

NOAO has recently taken receipt of its new, moderate-resolution, facility-class infrared spectrograph to be called TS4-ARCoIRIS—the Astronomical Research using the Cornell Infrared Imaging Spectrograph—which was constructed by a partnership between Cornell University (PI: Dr. Terry Herter) and NOAO, funded through a Renewing Small Telescopes for Astronomical Research (ReSTAR) award from the NSF. The instrument arrived on Cerro Tololo on 24 April 2015, and after undergoing post-shipping testing, instrument preparation, and software link-up, it was installed at the f/8 Cassegrain focus of the Blanco 4-m telescope on April 29 (Figure 1). First light was achieved the same night with spectra acquired from a 20-seconds, AB-nod sequence of the V=8 A0V star, HD 139295 (Figures 2a and 2b). NOAO’s ARCoIRIS instrument is a cross-dispersed, single-object spectrograph, containing no moving parts, based on an updated design of the three existing TripleSpec spectrographs installed on the 3.5-m telescope at Apache Point Observatory, on the 5-m Hale telescope, and on the 10-m Keck II telescope. ARCoIRIS features a fixed slit with width and length of 1.1 arcsec and 28 arcsec, respectively, and is accompanied by two flanking outriggers, which are 1.1-arcsec-square slit boxes some 4 arcseconds offset from the main slit aperture. These outriggers can be used for better defining a spatial-spectral wavelength calibration (in the X–Y plane), allowing a better interpolation of the spectrum background. Spectrograms are fixed-format images, recorded by a 2048 x 2048 Hawaii-2RG HgCdTe array having 18µm pixels, covering the entire z'YJHK

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continued
First Light for TS4-ARCoIRIS continued

Figure 1: On 29 April 2015, ARCoIRIS was installed at the Cassegrain focus of the Blanco 4-m telescope on Cerro Tololo. In attendance were David James (ARCoIRIS Project Scientist, NOAO, front right), Everett Schlawin (graduate student, Cornell University, middle right) and Chuck Henderson (mechanical engineer, Cornell University, back right). (Image credit: Terry Herter/Cornell University.)

Figure 2a: A raw first-light spectrum from ARCoIRIS for HD 138295, a V=8 mags. A0V calibrator star. In photometric terms, one can think of each spectral order as being approximately equivalent to 2MASS-like JHK filters, the Y-filter, and a Sloan-like z’ filter, viz., K=3, H=4, J=5, Y=6, and z’=7. For each spectral order, we provide start- and end-point wavelengths.

Figure 2b: An extracted first-light ARCoIRIS spectrum of HD 138295 is plotted, in counts vs. wavelength (in microns) space, where each of the spectral orders are color coded. The exposure consists of an AB-sequence of 20 seconds per nod.

During the first two (of four planned) commissioning and science verification observing runs, the instrument’s software and hardware performance, as well as its sensitivity, have been thoroughly characterized and tested. In Figures 3a and 3b, for instance, we show extracted ARCoIRIS spectra for the planetary nebulae NGC 7009 (Saturn nebula) and NGC 3918 that exhibit a substantial number of hydrogen (Brackett- and Paschen-series) and helium emission lines across the near-infrared z’YJHK region. This spectrum is qualitatively similar to previously published planetary nebula spectra in the near-IR and strongly resembles that of existing spectra. We further tested the instrument’s performance by obtaining spectra of Saturn’s moon Titan and of the dwarf planet Pluto (see Figures 4a and 4b, respectively). These two outer solar system objects exhibit very clear signs of atmospheric absorption by hydrocarbons in their spectra, especially by molecular methane. As the New Horizons space probe has recently demonstrated with its discovery of methane ice on Pluto’s north pole, even demoted solar system planets can reveal...
First Light for TS4-ARCoIRIS continued

remarkable and unexpected astrophysical phenomena, something to aspire to for ARCoIRIS users!

Initial analysis shows that the sensitivity of ARCoIRIS is qualitatively quite similar to that of the TripleSpec exemplar installed on the Hale 5-m telescope on Mt. Palomar, and in fact, the NOAO version of the instrument boasts considerably better sensitivity blueward of 1.2\mu m thanks to improvements in the anti-reflection coatings used on various optics. In time, we will create an exposure time calculator for the instrument, but for observation planning purposes, proposers can expect that for a V=15 A0V star, an AB-nod sequence totaling 100 seconds (Fowler16) yields a S/N of ~10 spectrum. NOAO is working in collaboration with Dr. Katelyn Allers (Bucknell University) in order to create an ARCoIRIS-specific reduction package (written in IDL), which we should have available in time for the 2016A semester, the first semester for which the instrument is available for community-wide use.

With this new acquisition of ARCoIRIS, the Blanco 4-m telescope now boasts three facility-class instruments. At the f/8 Richey-Chrétien Cassegrain focus, ARCoIRIS complements the COSMOS optical spectrograph, while the Dark Energy Camera (DECam) sits at the f/2.7 prime focus of the telescope. Operationally, choosing between Cassegrain and prime focus instruments leads to substantial scheduling restrictions for the observatory. Such instrument selection constraints are important because of the need to install the f/8 secondary mirror on the bottom of the DECam barrel (thereby rendering the camera inoperative) for Cassegrain instruments, an activity which occurs only during daylight hours, typically with a night of f/8 engineering to follow. Swapping in, or out, of the f/8 secondary mirror never occurs at night. In order to maximize observatory efficiency, NOAO community users should note that Cassegrain instrument time requests are generally serviced in contiguous blocks of time (especially near to the full Moon for ARCoIRIS); therefore, some scheduling limitations can be expected. If specific nights or observing epochs are required for executing an ARCoIRIS (or COSMOS) program during the semester, proposers should explicitly and specifically state their ephemeris requirements in their proposals.

![Titan spectrum](image1.png)

Figure 4a: An extracted ARCoIRIS spectrum for Saturn’s moon Titan is shown, in counts vs. wavelength (in microns) space. Massive broad-band absorption by hydrocarbon species (e.g., methane) is evident across the z’YJHK wavelength region. Observation is an ABBA sequence–acquired 2015-07-02, @10-seconds per nod.

![Pluto spectrum](image2.png)

Figure 4b: An extracted ARCoIRIS spectrum for the dwarf planet Pluto is shown, in counts vs. wavelength (in microns) space. An absorption triplet, observed in each of the YJH bands, arises due to molecular methane in Pluto’s tenuous atmosphere. Observation is an ABBA sequence–acquired 2015-07-02, @60 seconds per nod.
Robo-AO to Take Over Operation of the KPNO 2.1-m Telescope

Reed Riddle (California Institute of Technology) & Lori Allen

As the second major telescope to be constructed on Kitt Peak, the 2.1-m saw first light in 1964, and it has been in continual operation ever since. The history of the telescope includes many important discoveries in astrophysics, including the Lyman-alpha forest, the first gravitational lens, the first pulsating white dwarf, and the first comprehensive study of the binary frequency of solar-type stars. Following the Portfolio Review, the National Science Foundation (NSF) determined that it could no longer provide operational support for the 2.1-m telescope at Kitt Peak. Instead of shutting the telescope down, NSF and NOAO put out a call for proposals for parties interested in operating it. After a review process at both NOAO and NSF, a bid by Caltech to outfit the 2.1-m with Robo-AO and operate the telescope for the next three years was selected.

Robo-AO is the only autonomous laser guide star adaptive optics (AO) instrument; it robotically operates a telescope, laser, AO system, and science camera to observe several different classes of astronomical objects (Baranec et al., 2014). Robo-AO was developed by Caltech and the Inter-University Centre for Astronomy and Astrophysics in Pune, India (IUCAA).

Robo-AO was installed on the automated Palomar Observatory 1.5-m telescope in 2011 for initial testing, with first science and robotic operations occurring in the summer of 2012. Robo-AO has executed more than 18,000 robotic observations at the ~0.12" visible-light diffraction limit during 141 scheduled nights over three years; Robo-AO observes at a cadence of ~20 targets per hour for 1- to 3-minute science observations. With a 25- to 40-second overhead after telescope slew, the robotic observing system is able to observe targets far more efficiently than any other AO system currently available.

Robo-AO science highlights include the largest single survey of nearby companions to Kepler exoplanet host candidates (Law et al., 2014), helping to discover the second known case of an exoplanet in a quadruple star system (Roberts et al., 2015; https://www.nasa.gov/jpl/planet-reared-by-four-parent-stars) and surveys of solar-type dwarfs (Riddle et al., 2015), among several other science results already published or in press. More information about Robo-AO can be found at wwwifa.hawaii.edu/Robo-AO/.

Robo-AO KP will transform the 2.1-m into a dedicated adaptive optics observatory, which will enable routine high-angular-resolution imaging with an acuity of ~0.08 arcseconds in the visible and ~0.17 arcseconds in the near infrared (with a guide star magnitude limit of m ~17). By transferring the Robo-AO system to the 2.1-m telescope, it will be able to take advantage of the larger aperture as well as Kitt Peak’s much more favorable observing conditions to routinely acquire much-sharper and higher-contrast images than on the 1.5-m telescope at the Palomar Observatory. Perhaps more importantly, Robo-AO KP will be the only instrument mounted on the 2.1-m telescope and will be used year-round to support long-duration observing campaigns not currently possible at the heavily oversubscribed 1.5-m telescope.

Community access was not a requirement to take over 2.1-m operations. However, the Robo-AO KP team will contribute one-sixth of the observing time each year to give the US astronomical community access to this unique capability. This time will be allocated through the standard NOAO TAC process. More information on the available instrument suite and performance will be included in a call for observation proposals for 2016A that will be released once Robo-AO KP is operational.

Robo-AO KP is a collaboration among Caltech, the University of Hawai’i, and IUCAA. The Robo-AO KP team are Prof. Shri Kulkarni (PI, Caltech); Dr. Reed Riddle (Project Scientist, Caltech); Prof. Christoph Baranec (Robo-AO PI, U. Hawai’i); Dr. Dmitry Duev (Data Scientist, Caltech); and Prof. A. N. Ramaprakash (Detector Scientist, IUCAA). Please contact Dr. Riddle (riddle@caltech.edu) for more information.

The future of the Coudé Feed? The Coudé Feed has been one of the most productive telescopes at KPNO. The Robo-AO KP team has not made any plans for it, and the team would be interested in discussions and collaborations with others who would be interested in putting the Feed to good use.
COSMOS Begins Regular Science Operations

Sean Points

The first science result of the Cerro Tololo Ohio State Multi-Object Spectrograph (COSMOS) was a spectrum of Nova LMC 2015 that was obtained by Dr. Frederick Walter of Stony Brook University. This nova was discovered in the All-Sky Automated Survey for Supernovae (ASAS-SN; www.astronomy.ohio-state.edu/~assassin/index.shtml) and first reported as ASASSN-15fd and proposed to be a nova in the LMC in The Astronomer’s Telegram #7269 and #7313 (www.astronomerstelegram.org/?read=7269 and www.astronomerstelegram.org/?read=7313), respectively. Dr. Walter confirmed that identification using the Chiron echelle spectrograph on the SMARTS/CTIO 1.5-m telescope (www.astronomerstelegram.org/?read=7350).

N LMC 2015 was a ToO observed during a program to observe fainter, older novae. The large (3500–10,000Å) spectral range is ideal for observing novae because of the wide range of phenomena visible, and because the broad spectral coverage includes lines with a large range of ionizations and excitations, this aids the dissection of the various parts of the nova environment. Furthermore, the nova had faded to V ~ 13 magnitude by the time of the COSMOS observations, making the continuum and the weak lines hard to detect with CHIRON. The spectrum shown in the figure is the mean of four 100-second integrations taken through the 3-pixel (0.9") red slit with the red disperser. This instrument configuration covers the wavelength range between 6100Å and 10000Å. The strongest line seen in this figure is Hα. The spectrum also shows strong lines of He I 6678Å and 7065Å. To the far red end lies the Hydrogen Paschen series Pa-δ through Pa-13. Other lines visible include O I 8446Å and the Ca II near-IR triplet. The deep absorption features in the figure are the telluric Fraunhofer A and B bands of O2.

SOAR News

2015 SOAR External Review

Every five years during the course of observatory operations, SOAR holds an external review—roughly the equivalent of a visiting committee at universities. SOAR held its second such review this past June 24–26 in La Serena and on Cerro Pachón. In addition to hearing presentations from the director, the board, and the Science Advisory Committee, the committee visited the telescope.

At the end of the review, the committee provided an initial debrief, and its final report has now been provided to the board for its consideration.

External review committee at SOAR. From left to right, Walter Maciel (U. São Paulo), Darren DePoy (Chair, Texas A&M), Jean Brodie (UC Santa Cruz) and René Rutten (Gemini). Note the quarter moon in the upper center! (Image credit: Jay Elias/SOAR.)
Instrument News—Goodman HTS Improvements
Jay Elias (SOAR)

The Goodman high-throughput spectrograph is the most heavily used instrument at SOAR, so even modest gains in efficiency have an impact on the observatory. Two recent projects are nearing completion, both of which should help many observers.

Red Camera
Last year, the SOAR Board authorized the purchase of a second CCD dewar for the spectrograph, to be equipped with an e2v CCD similar in characteristics to those used in Mosaic 1.1, COSMOS, and KOSMOS. The project plan also included modification of the spectrograph to allow both dewars to be installed, though not for simultaneous use. Switching between the CCDs will normally be a day-time operation, requiring manual operation of a fold mirror (“in” for the red camera, “out” for the blue camera). There will be separate computers for each dewar, and the current Goodman detector computer will be upgraded; this means that the computer systems act as “hot spares” for one another, reducing potential down time. Most of the red camera work is being carried out at the University of North Carolina at Chapel Hill (led by Chris Clemens and Erik Dennihy).

Once the upgrades have been installed and tested (probably midway through the 2015B semester), we will offer the red camera to users who might benefit. For future users, the following characteristics are relevant:

• Over most of the spectral range, there should be little difference between the two CCDs.

• In the blue/ultraviolet, the current Fairchild CCD (“blue camera”) should have higher quantum efficiency than the e2v CCD.

• In the red/far-red, the e2v CCD (“red camera”) should have higher quantum efficiency than the Fairchild CCD, as well as reduced fringing.

Acquisition Camera
We have also purchased a small commercial CCD camera that will be fed by a newly added flip-in mirror that goes behind the spectrograph slit. This camera will view the focal plane through the slit (or with the slit removed) to allow acquisition of objects without the need to move gratings or change camera angles, which substantially reduces observing overheads. As shown in the figure, the imaging performance for the acquisition camera is quite good for short exposure times. This project is being led by Andrei Tokovinin (NOAO South).

While this camera should save significant time for some programs, for others it will not help much, and users should plan to use Goodman imaging mode for acquisition. Specifically:

• The limiting magnitude is around magnitude 18 for reasonable exposure times; in general, the camera is not recommended for targets fainter than 17th magnitude. Goodman itself can take much longer images and can therefore go considerably deeper.

• The field of view is roughly 1 x 1.5 arcminutes; this means that the camera cannot be used for multislit mask alignment, and it is not recommended for fields where the target cannot be unambiguously identified within such a small field.

• Programs that can use the acquisition camera are therefore those with bright, single targets. These are typically programs where the actual exposure times are short, so savings in overheads provide a greater proportional gain in efficiency.

Although the camera has been tested on the spectrograph, it is still lacking the safety interlocks to allow it to be used by regular observers without risk to the spectrograph optics. These will be added, probably on a similar timescale to the red camera commissioning. Once the acquisition camera is cleared for general use, it will be offered to scheduled observers.