WIYN Observatory

Wisconsin Indiana Yale & NOAO

Newsletter

April 2008

Director's News

"Bumper Stickers"

Okay, so you're reading the front page of this *Newsletter*. Quick, go look at the last page. Yes, it's an ODI bumper sticker. Some of the WIYN staff (Gary Muller and Steve Howell) felt a passion to be creative in a new way, and I was not going to stop them. Actually, I tried to stop them, but I couldn't. This was a calling that was not to be denied. We've printed a limited number of these, so I hope you get one for your vehicle.

There are several layers of message here. First, the superficial one – ODI really is coming. We are about to conclude the last major procurement contract, for the CCD controllers. After that, there are a few purchases that are much less convoluted, then lots of fabrication, assembly, and testing. We are less than two years from completion!

Second layer: the people at WIYN. This is an amazingly dedicated bunch. You can't keep them from doing their job, even if they define part of it as designing bumper stickers. In just a few months, my term as Director ends, and I'm going to miss working with this crew – all of them!

Third layer: bumper sticker messages. We've all seen hundreds; some are amusing, some are deep and metaphysical; others make no sense at all. One of my favorite recent ones is a play on a classic religious one - "What would Escher do?"* And that, in anticipation of a new WIYN Director, brings me to a question that I'm often asked – what does the WIYN Director do? After eight years at this job, you'd think I would have a succinct answer, but I don't. My best response is that I do what needs to be done to advance WIYN as a facility and as a consortium. And, the set of activities required to succeed in that role changes from day to day.

During the next month, candidates for the WIYN Director will be interviewed. To whomever takes over, I wish the very best in figuring out what the job is, but I know that a great team is there to ensure success, and I know what the back end of their car will say. ***~George Jacoby***

**Actually, I saw this at http://xkcd.com/88/, but it should have been a bumper sticker!*

Science News

WIYN Instruments View the Universe, Near and Far
Steve B. Howell

The Near: One of the little known but most impressive instruments at WIYN is the WIYN SPECKLE camera built and used by Elliott Horch (Southern Connecticut State University). Elliott is one of the more technical users of WIYN, whereby he shows up, sets up his own instrument, and more-or-less has it run the telescope each night. Elliott has been using his cameras at WIYN for several years and is now implementing his third speckle imaging system. His new NSF-funded camera will obtain images in two colors simultaneously and its use of high QE, thinned CCDs will allow speckle observations to a far fainter limiting magnitude. The example results presented in the figures below reveal the fantastic results that WIYN and SPECKLE can achieve.

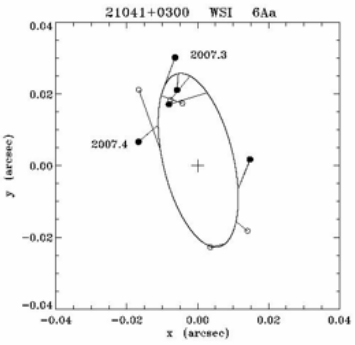


Figure 1: Recent astrometric observations of the metal-poor spectroscopic binary star HD 200580. The system was first resolved in HST Fine Guidance Sensor observations by Horch and collaborators (open circles), and has subsequently been observed at WIYN with the RYTSI speckle camera, the precursor to the Differential Speckle Survey Instruments (DSSI—filled circles). In the two most recent observations (2007.3 and 2007.4), one of the two DSSI backthinned CCDs was used as the detector with RYTSI. This result illustrates one of the prime reasons for building the DSSI instrument: the ability to characterize binaries below the diffraction limit with two-color speckle imaging. Image credit: Horch, E., private communication.

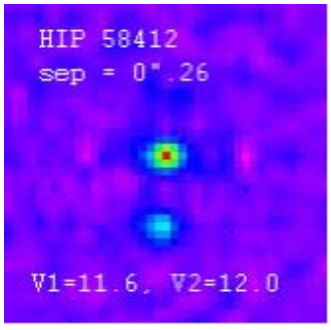


Figure 2: A speckle image reconstruction using one of the two DSSI CCD cameras with the RYTSI speckle optics package at WIYN. With the high-QE, low-noise DSSI chips, it is possible to obtain results on binaries approximately two magnitudes fainter than with the original RYTSI CCD chip. Image credit: Horch, E., private communication.

The Far: Using Hydra on WIYN, F. R. Marleau and collaborators conducted an optical spectroscopic survey of 24 micron and 1.4 GHz sources discovered in the Spitzer extragalactic First Look Survey (FLS). These researchers

Continued on Page 2

Science News, *continued*

obtained Hydra spectra for over 700 sources with IR flux densities greater than 0.15 mJy. The Hydra spectra (see examples in Fig. 3) reveal that the majority of the sources are emission line galaxies with substantial levels of star formation. The redshift distribution for the sources peaks near z = 0.02 with a range from z = 0.0 to <0.04. The authors find evidence for evolution in both the 1.4 GHz and 24 microns luminosity functions in this redshift range. The wide field and multi-fiber capability of Hydra remains a useful tool for astronomers. Complete results are reported in The Astrophysical Journal, 2007, Vol. 663, page 218.

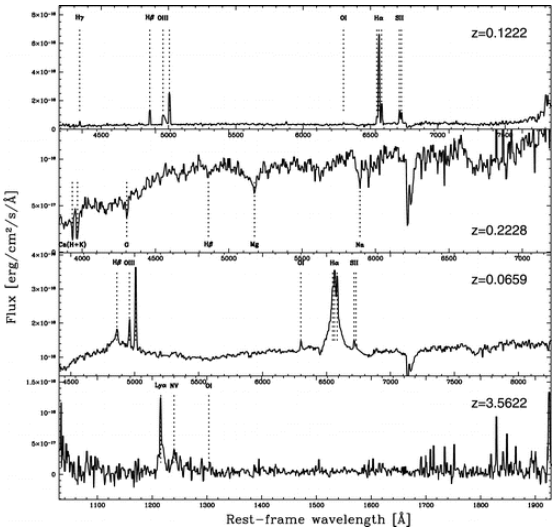


Figure 3: Example WIYN/Hydra spectra. From top to bottom, the spectra are an emission-line galaxy, an early-type galaxy, a broad emission line object, and a quasar. Image credit: Marleau, F.R., et al.

A "Pro Am" Project
George Jacoby

Four years ago, I received an email from an amateur astronomer, Dana Patchik, in which he claimed to have found a new planetary nebula (PN) on the digital sky survey (DSS). Dana asked me to take a picture with WIYN to verify his discovery. It's really easy to say "sure – no problem", and then forget all about it. But, I had a few minutes during twilight to take a snapshot that went far deeper than the DSS. Indeed, Dana had found a new PN.

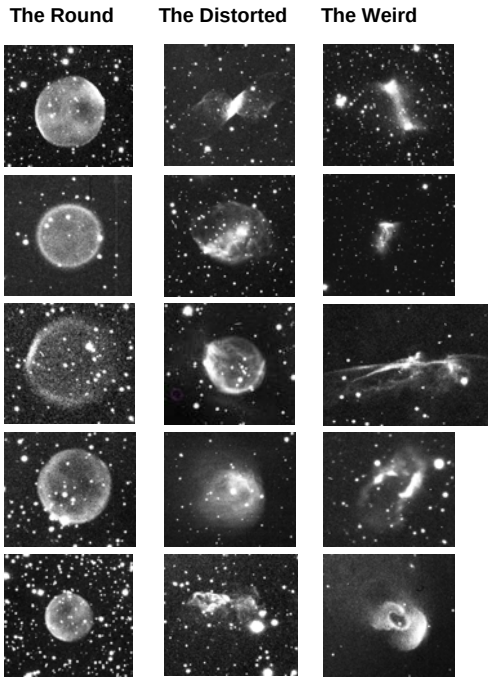
A year later, I heard from Dana again – another candidate PN, and another WIYN picture. Six months later, another 5 candidates. And, then, last year, I learned that Dana is one member of a team of highly advanced amateur astronomers called the "Deep Sky Hunters" (DSH), and they have a collection of about 50 candidate PNe! With the design of WIYN, I was able to observe half of these during the 20 minute Hydra setup times being used for another project. Of the 25 objects I observed, the majority appear to be real PNe. This sample served as a data set for a short paper at the Asymmetrical Planetary Nebula IV Symposium held at La Palma in June 2007.

Finally, in September, I caved – I asked the DSH for all their candidates (now over 70) and dedicated a gray night at WIYN to complete the survey. The DSH selection criteria are summarized below:

- Objects between 5-10 (mostly) degrees from the Galactic plane (north or south)
- Must look like a PN (morphological requirement, if DSS is deep enough)
- Must appear on the DSS red, not in DSS IR (selects emission-line objects)
- Must not be in SIMBAD or other catalogs as a PN
- Preference for objects having a blue star near the center
- Candidates are checked for reality in other DSS colors

In all, I've observed 66 candidates – 33 are morphologically classified as PNe. Another 19 are probably PN, but distorted significantly due to ISM interactions, thereby making morphological classification unreliable. The remaining 14 are unlikely to be PN. Some of the latter are bizarre and curious objects worthy of further study (see pictures below). All of these are very faint, low surface brightness things that are nearly impossible to see on the DSS; I am amazed that the DSH team found them! A large fraction of the PNe are much, much rounder than the more commonly known, bright, younger PNe, which tend to be bipolar or elliptical. Round, bright PNe are exceedingly rare. Apparently, a subset of very old PNe have experienced a different set of physical processes than the great majority of young PNe– an unexpected new result from this study.

This professional-amateur (pro-am) collaboration is unusual in its highly international composition. Besides me, there are two other professionals – Agnes Acker (Strasbourg, France) and David Frew (Perth, Australia). The primary DSH team members are Dana Patchik (Petaluma, CA, USA), Matthias Kronberger (Geneva, Switzerland), Philipp Teutsch (Innsbruck Austria), and Jaakko Saloranta (Helsinki, Finland).~



A sampler of the PN (and a few non-PN) images is shown. Image credit: George Jacoby.

WHIRC

Patricia Knezek (WIYN, Co-I), Margaret Meixner (STScI, PI), & Dick Joyce (NOAO)

The WIYN High-Resolution Infrared Camera (WHIRC) continues to undergo commissioning tests on the WIYN telescope, with the most recent effort having taken place in January 2008. Integration of the software, computers, observing interface, and observer planning tool has been largely completed. Most of the functionality of the camera has now been tested, and it is anticipated that WHIRC will be available for its first set of shared-risk science runs in April 2008. A description of the instrument can be found at www.noao.edu/kpno/manuals/whirc/WHIRC_0708.htm.

The WHIRC image quality is excellent. Tests with the pinhole array at the WTTM input gave 0.17 arcsec images, demonstrating that the WHIRC/WTTM optics should not be a limiting factor to obtain the best on-sky image quality. The figure shows a comparison between a 2MASS image of the GLIMPSE GC-1 Galactic Plane Globular Cluster and a WHIRC image of the same field.

The commissioning runs so far have not included the testing of WTTM in active tip/tilt mode, although the combination was tested briefly in September, resulting in H band images as good as 0.35 arcsec. One remaining issue is determining the best operating mode for the detector. The linearity behavior and the number of "bad" pixels change depending on the bias voltage selected for operating. There is a tradeoff between voltage and full well. Data have been acquired to determine what the best tradeoff is, and analysis is underway. In addition, while most of the excess detector readout noise seen in early commissioning runs has been addressed, there is still some residual noise. NOAO engineer Maureen Ellis is leading the effort to resolve this remaining noise issue. Otherwise, the WHIRC camera is meeting, or close to meeting, all specifications.~

Figure: A comparison between a color 2MASS image of the GLIMPSE GC-1 Galactic Plane Globular Cluster (left panel) and a WHIRC image of the same field (right panel). The colors are J, H, K_s (represented by blue, green, and red) for both images. 2MASS images are ~8 seconds per band. The WHIRC image is a combination of 4x16-second dithers per band (plus an additional 4x32-second dithers at J-band). Due to heightened noise during this WHIRC run, the image is meant only to showcase the higher resolution relative to 2MASS, not the relative sensitivities. (Image credit: Matt Povich and Jennifer Stone*)

**"This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation."*

Bench Spectrograph Upgrade Moves Into High Gear

Matt Bershady (U. Wisconsin), Project Scientist & Patricia Knezek (WIYN), Project Manager

The Bench Upgrade Team successfully completed a Critical Design Review (CDR) of the collimator optical and mechanical design. The review was held in Tucson on 12 October 2007. The external panel was chaired by Gary Hill (U. Texas), and included David Vaughnn (NASA-Goddard), Myung Cho (NOAO), and Brian Cuerden (U. Arizona). WIYN is indebted to the panel for their service.

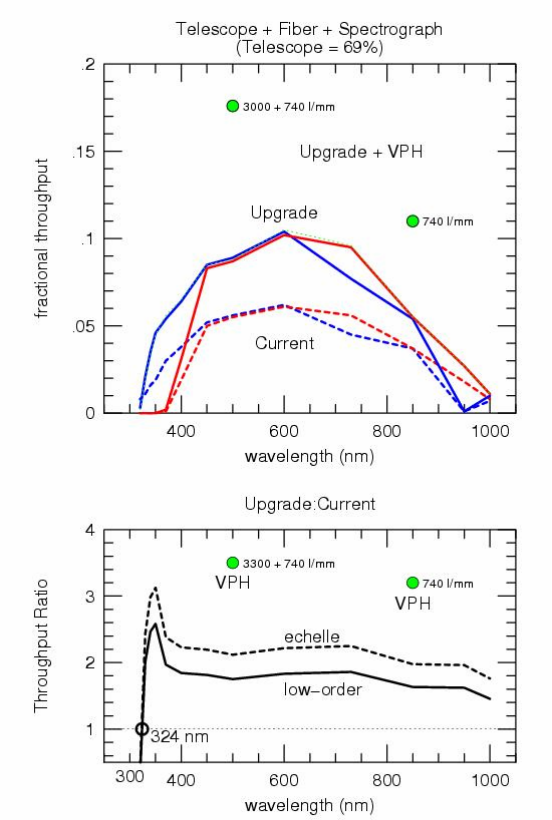


Figure 1: Throughput gains expected from the Bench Spectrograph Upgrade. The top panel shows the current and anticipated absolute throughput (blue and red curves for blue and red Hydra fibers). The bottom panel shows the ratio of the upgraded to current system for different grating configurations. Factors of two are expected for conventional surface-relief gratings, and up to 3-3.5x gains using the new VPH gratings. This calculation assumed Solgel coatings for all collimator optics. Our post-CDR design, based on the recommendation of the panel to review risks associated with Solgel, will use a slightly lower-performance, but durable multi-layer coating optimized between 350-950 nm. (Image credit: Matt Bershady)

Overall, the panel commended the team on putting together a design that achieved the throughput and instrumental resolution goals, while maintaining the project scope. They also commented on the excellent optical design and concept to re-integrate the Acquisition TV (ATV) system.

The predicted performances presented at the CDR are shown here in figure 1 (throughput) and figure 2 (instrumental resolution). Several detailed points and recommendations were made by the CDR panel regarding the mechanical design, the lens bonding, the lens coatings, the testing, and the layout. The project team has considered and evaluated in detail all of the points brought forward by the CDR panel, and has modified their design accordingly. The team then submitted a formal response documenting their considerations and changes.

Since CDR, the project has ramped into high gear with the procurement of optical blanks and is contracting with vendors for figuring and coating the optics. A contract for PBL25Y, a flint-glass with a long lead-time, and critical to the all-refractive design, was expedited while the remaining bid process unfolded. After evaluating a detailed analysis matrix of various fabrication and coating options with the CDR panel comments in mind, we recently awarded the contract for most of the work to SESO. This company has had extensive experience with astronomical optics, including several instruments for the VLT. They are also the contractor for the optics for ODI.

SESO will figure and polish all four collimator lenses, as well as bond and coat the 330-mm fused-silica/PBL25Y doublet. The two smaller collimator lenses will be coated by another vendor to be determined. After a successful kick-off meeting with SESO in December 2007, the contract was formally started in mid-February 2008. We are pleased to report that the long-lead PBL25Y has already been safely shipped to SESO.

Mechanical design of the collimator sub-assembly is essentially complete, except for final tweaks that will be made once the optics are received and evaluated (see figure 3). Mechanical fabrication of the collimator cells and sub-bench began on 4 February 2008 at the NOAO shop, and is expected to conclude by 1 June 2008. Assembly and integration of the collimator in the lab is scheduled for late summer 2008, or as soon as the optics arrive from SESO and the other coatings vendor.

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IMPORTANT NOTICE: The Bench Upgrade Team has created a Web page to provide important information to observers about the status of the Bench Upgrade over the coming months. The information contained there will focus on details needed for planning a successful observing program, such as characteristics of the new CCD and when it will be available, impact of the collimator change on the 2008B schedule (when known), etc.

Please see http://www.wiyn.org/instrument/bench_upgrade.html.

Bench Spectrograph Upgrade, *continued*

Other activity has included:

VPH Gratings: The bid process for the AR coating of the large 3300 l/mm grating has concluded. As expected, this was a challenging bid that pushes the envelope in coating technology, just as the grating itself was a technological first. The good news is that we received several technically excellent bids. However, all bids exceeded what is budgeted at the current time by a considerable amount. Since significant improvement in

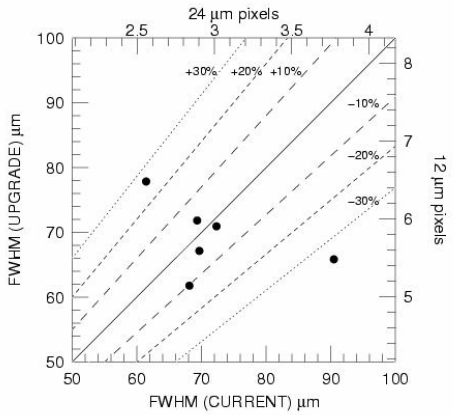

Figure 2: Instrumental resolution change (from the Bench Spectrograph Upgrade CDR). The monochromatic FWHM (in microns, left and bottom; and in pixels, right and top) is shown for the current and upgraded system, using 200 micron fibers, for 6 configurations: the 600@10.1 l/mm surface-relief grating (1st order); the 316@7 l/mm surface-relief grating (1st order); the echelle (off-order 8, 9, and on-order 11); and the 740 l/mm VPH grating (2nd order). Despite the modest image magnification of the new all-refractive collimator, because of its spectacular optical design, the collimator is able to compensate for aberrations in the cameras such that the delivered image-quality is as good or marginally (10%) better than in the current system. Two configurations stand out: The very lossy (vignetted), extreme off-order 9 echelle configuration suffers 26% degradation, but the VPH 740 l/mm configuration improves by over 30%. This means that for most users who want the highest spectral resolution with Hydra, the Bench Upgrade will increase throughput, while not degrading (and possibly improving) spectral resolution. (Image credit: Matt Bershady)

throughput can be achieved with advanced AR coating, our plan will be to pursue coating of this grating in the future, once we have secured the necessary funding package. In the meantime, we note that *un*coated grating already appears to have twice the diffraction efficiency of the on-order echelle. Further quantification of the grating performance will take place in March 2008.

CCD subsystem: A new dewar window with excellent broad-band coatings from Infinite Optics (IO) was received and installed. These coatings have <1% reflection per surface between 330-1000 nm (0.75% on average), and are substantially better than previous windows, enhancing throughput and minimizing ghosting. The first commissioning run of the new CCD system on the Bench took place 15-18 March 2008. Some software issues are still being resolved, but overall things went very well. Laboratory tests of the STA-1042 devices with a MONSOON controller indicate this will be a superior system with lower read-noise, faster read-time, and higher QE than T2KA. (See the Bench Upgrade status Web page for the actual values.)

Supporting optics: The rear element for the Bench Spectrograph Camera (BSC) will be replaced as well to optimize the field-flattening for the new flat CCD, and to complement the optical design of the all-refractive collimator. This element will also have the excellent coatings from IO and will be a major improvement over coatings in the existing BSC optics. Replacement will take place when the new collimator is installed; we have already verified the replacement procedure.

System layout: Based on the CDR panel comments, we have explored the possibility of increasing the Bench optical table length to do away with the second turret used in low-angle VPH grating configurations (currently needed for the popular 740 l/mm VPH grating). This would: increase throughput (one less reflection and better pupil placement); substantially reduce setup-time for low-angle VPH grating use (hence reducing long-term support for the Bench in keeping with the recent external-review committee recommendations); and eliminate the cost associated with optimizing the fold-flat coating and the second turret metrology. An additional 2.2 feet are required to use the existing 740 l/mm VPH grating down

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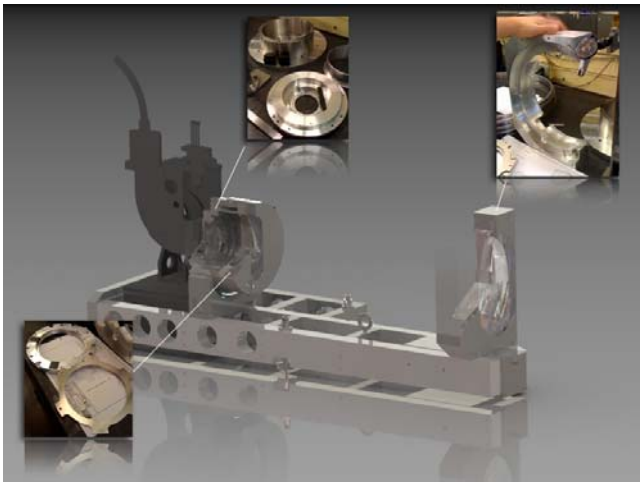

Figure 3: Solid model of the new all refractive collimator, with inset photos of some of the actual fabricated parts – shown in isolation from the rest of the bench. The cell to the right contains the large bonded fused-silica/PBL25Y doublet that forms the objective. The longer barrel contains the two other lenses forming the field lens and part of the corrector. The open structure on the bottom is the sub-bench that will be pre-assembled and tested – along with the optics – in the laboratory before shipment to Kitt Peak. The existing foot, foot mount, filter-insertion mechanism and ATV system (back side) are also shown as they will be used in the upgraded system. (Image credit: Joe Keyes)

Bench Upgrade Project, *continued*

to its useful limit of 15 degrees. In order to use low-order VPH gratings down to 10 degree incidence angles and avoid zeroth-order contamination, the additional length would need to be 3.2 feet. The scientific motivation for reaching such low angles is to put VPH gratings in a dispersion range where they can be used for abundance measurements for stellar, Galactic and extra-galactic studies, e.g., spanning a wavelength range from [OII]λ3727 to [OIII]λ5007, or from Hβ+[OIII] to Hα+[NII]. After a thorough analysis of pros and cons, the Project Team and the Observatory concluded that lengthening the table was desirable, but a significant undertaking due to the corresponding modifications to the Bench room itself. Thus it could not be done at the current time along with all of the other sub-system development and additional observatory projects. We plan to recommend this increase be considered as part of the envisioned full Bench Upgrade that would include a suite of VPH gratings.

System testing: Baseline testing of the existing system (with T2KA) took place in February 2008. Testing will continue throughout commissioning of the various Bench Upgrade sub-systems. This testing documents the throughput and image quality in several configurations that span a range of spectrograph use. The February 2008 T&E testing establishes the performance of the existing camera/collimator/CCD system. The March 2008 T&E testing will allow us to evaluate the performance enhancements due to the new CCD sub-system.~

PERSONNEL NEWS

Congratulations to **Gary Muller** (left), senior mechanical engineer and grand prize winner of the SolidWorks user contest. Gary won the prize for the design of the One-Degree Imager. He had won the grand prize previously for his design of GNIRS. Great job, Gary!

Welcome to **Hillary Mathis** (right), the new Site Manager of the WIYN 0.9-meter telescope. Hillary was an Observing Assistant for eight years and an EMT for six years at Kitt Peak. She is very happy to join the downtown WIYN team, and we are happy she is here!

Congratulations to **Heidi Schweiker Christopher** (right) on her promotion to the position of WIYN Operations Coordinator. Heidi was previously the Site Manager of the WIYN 0.9-meter telescope. Well done, Heidi!

Congratulations to **Patricia Knezek** on being elected a Fellow of the Association for Women in Science. This is an honor bestowed on only a select few. Way to go, Pat!

Condolences to WIYN Administrative Coordinator, **Sheryl Falgout**, on the death of her husband, Howard Lanning. Howard worked with the Data Products Program group at NOAO.~

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The *WIYN Newsletter*, contacts list, and miscellaneous information about WIYN Observatory may be viewed on our Website at *www.noao.edu/wiyn/*.

ODI and QUOTA News

Daniel Harbeck & George Jacoby

QUOTA News

QUOTA has been hibernating for the winter, but is about to awaken with the coming of spring. Due to months of delays in the delivery of thinned science-grade OTA detectors, it became necessary to invoke the backup plan that the Board and SAC approved at their October 2007 meeting. This plan utilizes thick Lot 3 OTAs, which appear to work very well. They have excellent cosmetics, with Lumigen coatings to boost the blue quantum efficiency of the CCDs to about 20% (from near zero). While far from the high QE situation that we hoped to have for the upcoming June run, this backup plan allows the implementation of a version of QUOTA that lets us test key concepts needed for ODI (e.g., OT performance, tilted focus sensor, cooling strategies, data reductions and pipelines). If we wish, we can replace these detectors with thinned ones in the future. In the interim, QUOTA is expected to perform well enough to be effective for some science applications. It should, for example, be relatively immune to fringing in the near-IR, and will be capable of fast photometry (20 Hz or slower).

ODI News

In January, George Jacoby and Dan Blanco visited SESO to monitor the progress of the ODI optics fabrication. SESO has made good progress and they report that work is on schedule: all glass blanks were received, and grinding of the lenses and prisms has begun. All four Atmospheric Dispersion Compensator (ADC) prisms have been ground to their approximate wedge figure and several are nearing their final polished state. Dan and George will take advantage of their attendance at the SPIE conference in June to visit SESO again in order to witness the acceptance tests for these prisms before shipment to Tucson. In preparation for receiving these elements, Joe Keyes has been leading the effort to design, test, and evaluate procedures for bonding the two pairs of ADC elements. The first cementing test, performed with dummy parts made of aluminum and acrylic plastic, was very successful (see the picture). After a few small tweaks to the process (which will be repeated 2-3 more times for practice), Joe and Gary Poczulp (NOAO) will be experts in bonding large glass plates together.

The production of ODI's instrument support package is constantly progressing and is keeping the NOAO machine shop very busy. Gary Muller, our mechanical engineer, entered the ODI design into the annual SolidWorks user contest. SolidWorks is a very popular 3D mechanical design software package. Gary won the grand prize, which is perhaps not so surprising. He took first place once before for the GNIRS design. Congratulations to Gary!

The ODI Science Working Group (SWG), WIYN Science Advisory Committee (SAC), and Board discussed the benefits of using high-resistivity (4000 ohm-cm) wafer material for ODI's detectors during the fall 2007 Board meeting: this material has a ~25% throughput advantage over the conventional material in the z' band. Currently, the fourth lot of OTA production for ODI is under way, and we expect to receive the first wafers back from the foundry in mid-April. Mike Lesser, at the University of Arizona Imaging Technology Laboratory (ITL) is nearing completion of a new packaging scheme for the OTAs that will be cheaper and yield a flatter CCD. It was the complexity of this new package design that caused a delay in the QUOTA detector delivery schedule. But, it will significantly improve ODI performance and keep costs down.

Test of the ADC bonding process with dummy wedges.

A major ODI component that had not undergone an extensive evaluation process was the CCD controller system. In order to select the best controller for ODI, we conducted site visits at both potential vendors in November and December at the University of Hawaii (StarGrasp), and at NOAO (MONSOON). In early February, we solicited proposals for the ODI controller system via a formal RFP process, and we received a bid from Hawaii. As a reflection of the importance of this procurement, an external review committee was formed to advise the ODI team on the quality of the Hawaii proposal. The panel included Dennis Crabtree (Gemini), Richard Stover (Lick Observatory), and Greg Bredthauer (STA). In brief, the panel found the proposal to be well-matched to ODI's requirements, for a reasonable cost, and with an acceptable delivery schedule. With the endorsement of the WIYN Board, the ODI team is moving forward to formulate a contract with PanSTARRS.

As noted above, there is an astronomical instrumentation SPIE conference in June. It takes place in Marseille, about 20 km from SESO, our optics vendor. ODI will be represented by 4 papers: Daniel will present an ODI overview, George will present the optical design, Gary will describe the mechanical design, and Andrey will describe the software overview. ~

ODI is Coming! And so is the ODI Bumper Sticker. Limited quantities will be available soon. A few will be sent to each partner institution. For additional information, please contact Sheryl Falgout at sfalgout@wiyn.org.