



## **NOAO Annual Management Report Adaptive Optics Development Program (AODP)**

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## 1. Project Participants

### 1.1. Senior Personnel

- 1) Dan Eklund  
Worked more than 160 hrs. Yes  
Contribution to Project:  
Steve Strom  
Worked more than 160 hrs. Yes  
Contribution to Project:
- 2) Post doc
- 3) Graduate Student
- 4) Undergraduate Student
- 5) Technician, Programmer
- 6) Other Participant
- 7) Research Experience for Undergraduates

### 2.2. Organizational Partners

None

### 2.3 Other Collaborators or Contacts

None

## 2. Management Activities and Findings

### 3.1 UC Berkeley:

A Noiseless Imaging Detector for AO with KiloHertz Frame Rates". The initial statement of work included producing a working vacuum tube containing the GaAs photocathode and Medipix2 anodes. The project continues to be delayed arising from problems in achieving a high vacuum in the tube. There have been leaks associated with the brazing of the tubes. The current work plan includes rebuilding the tube using a He leak checker at each stage of fabrication. Some success was achieved in proving that the Medipix2 chip will survive the 350 deg bakeout cycle in the tube complete with the wire bonds. The electronics readout has also been successfully demonstrated.

A no-cost extension was requested and has been authorized contingent upon the successful completion of the work for year 3, to proceed with performance of the work for year 4 beginning September 1, 2007 and concluding on March 31, 2008. Of the total award of 900,233, UC Berkeley has received the full amount.

### 3.2 CARA:

"Development of the Next Generation Optical Detectors for Wavefront Sensing". CARA has been granted a 1 year no-cost extension for the effort to end on 12/31/07. The project had been delayed with MIT/LL so the detectors could be piggy-backed onto another development project.

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The phase 1 devices with the planar JFET amplifier (CCID-56) took longer than expected to complete back side processing. Two wafers were selected for thinning and then the QE was pinned using a MBE process. These parts are on a wafer run with some x-ray imagers (for the Constellation X satellite project), and for which no AR coating is wanted. As a result, these parts had to be masked off when AR coating the CCID-56b parts. When the AR coating was done the masking was incompletely removed over the parts and the AR coating was poor as a result. MIT/LL decided to remove the AR coating using an acid etch and try again. They also had some problems with the light shield mask, and as a result did not complete packaging of the back side parts until the end of 2006. Parts were finally shipped to the CCD lab at UCO/Lick and to SciMeasure in March 2007.

Richard Stover was able to test the first CCID-56b part and discovered that the QE was very poor and the dark current elevated. After discussing this with MIT/LL they admitted (somewhat sheepishly) that the acid etch to remove the bad AR coating had probably destroyed the MBE layer, resulting in the poor QE, and this had also created defects on the back side layer that resulted in the elevated dark current.

This is a significant set back to testing of what is believed to be a very low noise device. MIT/LL has been able to obtain permission from the primary wafer customer (the Constellation X project) to take two more wafers from the lot and process them for this project without masking off the x-ray imagers (effectively sacrificing those imagers). This process will take approximately 2 more months.

Some CCID-56 parts with the planar JFET amplifier were also placed on a PanStarrs wafer run that was done late last year. These parts are designated the CCID-56d because of an additional signal (a no connect pin on the CCID-56b) that is used to deplete the substrate, a feature of the PanStarrs device design. These parts are on a wafer with imagers that have very similar QE requirements, so there is no masking needed, and there are some wafers that have been backside processed and AR coated. Some of these parts are being packaged and should ship to the CCD lab and SciMeasure for testing.

In summary, the project is still waiting for confirmation of the low noise performance of the front side devices on usable backside parts, but this should take place shortly.

A readout system and cryostat are ready to use with the device, and it is planned to characterize this complete system at WMKO with the intention of installing it on the Keck I AO system when the new guide star laser is installed at the end of this year.

The phase 2 design has benefited from further work with the CfAO on the system level design of the polar coordinate detector. The project team has been working with Sandrine Thomas, a CfAO post doc, and with Don Gavel, director of the Laboratory for Adaptive Optics, on this activity. Sandrine will be giving a paper on this work at the OSA meeting in Vancouver in June.

The phase 2 design has been refined to include adjustment of the number of pixels in the elongation direction as a function of sub-aperture offset from the center of the telescope aperture (also the center of laser projection) and also to employ Sean Adkin's original concept for the readout architecture which is to "snake" the shift register from sub-aperture to sub-aperture instead of using multiplexing. Since charge shifting is essentially noiseless, and the multiplexer is not, and since readout speed is very important due to the TMT's wavefront computation needs, the design needs to balance readout speed and noise, and it turns out that the snaked shift register offers the best performance.

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We are planning to begin final layout of this device, and hope to get on a PanStarrs wafer run planned for this summer.

### 3.2 Lawrence Livermore National Labs:

"Pulsed Fiber Laser for Guide Stars". LLNL has been waiting for delivery of a replacement amplifier after one failed last fall due to a faulty switch in the system. No recent work has been completed. The amplifier arrived in early June, but the signal combiners have been delayed until the first week of July. The effort will be re-started with the arrival of the signal combiners. It is expected that within the next 6 months, the system will be field hardened and a control system added so that the system can be deployed to Lick Observatory sometime late this calendar year or early next. Of the total award of 1.5 million, LLNL has received 1,086,969.

### 3.5 Coherent Technology, Inc.

"Compact Modular Scalable Versatile LGS Architecture for 8-100 m Telescopes". LMCTI has been waiting delivery of replacement waveguide power amplifiers so no progress has been made on the higher power levels desired. Meanwhile, they have begun testing of the delivery fiber. They have tested it with low power cw (2.5W) at 589 nm and have achieved about 40% efficiency. They are continuing optimization of the coupling and the beam. Power through the 100 meter fiber has been increased to about 6W up to the SBS limits. By reducing the length of the fiber to a more practical length of 30 meters, a 10W signal should be achieved. This effort is continuing and a report will be released by mid-summer. The team will be working on setting up both legs of the laser and a higher power demonstration should be completed in early fall. A no-cost 6 month extension was requested and has been authorized contingent upon the successful completion of the work for year 3 to August 31, 2007, with performance of the work for year 4 beginning September 1, 2007 and concluding on March 31, 2008. Of the total award of 2,812,781, CTI has received 1,858,584.

## 4. Journal Publications

## 5. Books or Other One-time Publications

## 6. Contributions

### 6.1. Contributions within Discipline

All of the AODP projects are contributing significantly to the astronomy community. The detector development is leading to better WFS for use on future larger telescopes. The laser development from both LLNL and LMCTI are leading to more compact LGS systems that will be safer than previous dye laser systems and coupled with the engineering research for fiber development will significantly enable multi beam systems required for the larger telescope systems.

### 6.2 Contributions to Other Disciplines

The development of the more compact higher power fiber laser systems from LLNL is leading into investigations of using these to pump higher power lasers. NASA has expressed interest into the possibility of using the 938 micron laser to study water vapor absorption. The system from LMCTI using the waveguide amplifiers could be used for wind LIDAR systems and for atmospheric sensing. The on going detector development efforts at Berkeley are leading to using the same Medipix chip in photon limited IR applications as well as using it behind neutron sensitive micro-channel plates for high rate neutron tomography.

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6.3 Contributions to Human Development: None

6.4 Contributions for Research and Education: None

6.5 Contributions Beyond Science and Engineering: None

## **7. Special Requirements**

7.1 Special Reporting Requirements: None

7.2 Change in Objectives or Scope: None

7.3 Unobligated funds: None

7.4 Animal, Human Subjects, Biohazards: None

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