INSTRUMENTATION PLANS FOR
1024 × 1024 HgCdTe DETECTOR ARRAYS
AT THE UNIVERSITY OF HAWAII

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Abstract. The U.S. Air Force Phillips Laboratory will build the 3.63 m Advanced Electro
Optical System (AEOS) telescope on Haleakala, Maui. The Institute for Astronomy will
participate in this project and will develop astronomical instruments optimized for using
the AEOS telescope in survey projects. As part of this instrument development program
1024 × 1024 HgCdTe near-infrared detector arrays will be developed at the Rockwell
International Science Center.

Key words: Telescopes – Infrared Instruments – Infrared Detector Arrays

1. Introduction

The U.S. Air Force Phillips Laboratory is planning to construct a 3.63 m telescope as part of their Air Force Maui Optical Station (AMOS) on Haleakala, Maui. This telescope, called AEOS, will be of the Mersenne type with confocal paraboloids as primary and secondary mirrors. It will deliver a collimated beam of approximately 25 cm diameter with an angular magnification of about 16 to the instrument ports that are located at the bent-Cassegrain, Nasmyth, and coudé stations. It is planned that this instrument be equipped with a laser guide star adaptive optics system capable of delivering near-diffraction-limited images in the optical and near-infrared spectrum. Phillips Laboratory has funded the Institute for Astronomy (IfA) to develop instruments for the AEOS telescope, and the IfA will receive approximately 30% of the telescope time for astronomical observations.

2. Instrumentation Concept

We expect to primarily use one of the coudé stations of the AEOS telescope. Given that the light at these stations has passed six or more mirrors (if using the adaptive optics system), we want to concentrate on the spectral region from 0.4 to 2.5 μm. Depending on the operational requirements of the Air Force, our observing time may get allocated on short notice and in blocks of only a few hours, so that the best way of utilizing this telescope will be a queue-scheduled service observing mode in which the astronomer will usually not be present during the observations. Observations requiring a lot of judgement in the data acquisition process may not be feasible under these conditions. We plan to build instruments suitable for survey projects...
or follow-on studies. Such surveys may include galaxy evolution, supernovae, star-forming regions, and solar system studies.

3. Detector Array Development Project

One key area in our instrumentation plans is the development of both new optical CCDs and new, large-format infrared detector arrays for the wavelength region up to 2.5μm. We have now begun the development of such detector arrays at the Rockwell International Science Center. The 1024 × 1024 HgCdTe arrays will be based on the successful technology developed by Rockwell for the NICMOS project. However, the goal is to improve the performance above the level demonstrated by the NICMOS3 devices now in common use. In particular, we plan to address the two main performance limitations of these devices, the residual excess dark current and the output amplifier glow. The Rockwell 1024 × 1024 devices with 2.5μm cutoff wavelength will be optimized for operation under low-background conditions in spectrographs. They will be designed with four electrically independent quadrants, each with 512 × 512 pixels and one output amplifier. With speed not being a design driver for this device, we expect that read-out rates of 2μs per pixel will be possible. The pixel size will be 19μm. This size was chosen in an effort to maximize the expected production yield of the silicon multiplexers. The read-noise in double correlated mode is expected to be between 10 and 20 electrons rms, while multi-sampling techniques should result in less than 10 electrons noise. The dark current at an operating temperature of 77 K is expected to be below 0.1 electrons/s with a full-well capacity of around 100,000 electrons. In the trade-off between higher cross-talk and higher fill-factor, we favor fill-factor to increase the photometric precision of the device and the area averaged quantum efficiency. Given that typical instruments have stellar profile wings due to atmospheric effects, optical imperfections, and scattering, a cross-talk of up to 10% seems acceptable. Antireflection coating of the sapphire front surface of the PACE1 material will be studied to further improve the quantum efficiency. The devices developed under this program will be commercially available from Rockwell after the successful completion of the development phase.

4. The AEOS Astronomical Spectrographs

The first instrument we plan to build for the AEOS telescope is a combination of a simple near-infrared camera with limited grism spectroscopic capability and a low-resolution optical spectrograph equipped with a slit-viewing optical CCD camera. This system will thus provide the basic tools for follow-on studies of surveys, while still being simple enough for an astronomical commissioning instrument for the AEOS telescope. The instrument