systems, and the observers gained in efficiency compared to the MARLIN or the UH/FOS. Observers reported that the quality of the data acquired was excellent.

MOS in its Fabry-Perot mode was first used by visiting observers September 4-8. Despite problems with the weather, good scientific data have been obtained.

From October 20 to November 1st, MOS was used intensively. A Canada-France collaboration obtained more than 450 spectra in six nights on faint galaxies with 8h+ integrations per slit. (See Figure 6.)

4. Final Commissioning

A first science evaluation run was conducted October 13 to 15. In bright moon, various data were taken in imaging, long slit and multi-slit. The Fabry-Perot science evaluation was done October 11 and 12.

One observing run December 27-30 (Dark time) remain on the schedule to complete a full commissioning of the MOS-SIS and fully assess the performances of the different modes. The formal instrument acceptance between DAO, OPM and CFHT will take place in December, with the respective PIs conducting the observing run together.

Figure 3 shows the total efficiency of MOS (atmosphere + telescope + MOS + CCD) with different CCDs and the V150 grism. This is among the top best transmission spectrographs in the world. Figure 4 shows an enlarged fraction of a MOS image, and Figure 5 shows a spectrum of the radio-galaxy 3C352 obtained in only 30 min.

5. Future Actions

We are in the process of re-designing the SIS guiding optics. A preliminary optical design has been produced at CFHT and is being finalized. It emphasizes maximum throughput and will use avalanche photodiodes as detectors. This project involves significant manpower from optical and mechanical staff, and should be completed within 6 to 9 months.

A CCD camera has been ordered 9 months ago to be used as a guide field acquisition camera, and possibly for guiding, with MOS. Unfortunately the vendor has not been able to fulfill its contract yet, and we are currently investigating alternate solutions.

The CCD hold time needs to be improved for CCD installed on MOS-SIS. An automatic refill system is being built, and should be ready by the end of 1992.

It is feasible to offer a Fabry-Perot mode for the SIS, which would then benefit from the stabilized images. This has to be tested, including the design of filter holders for the SIS focal plane.

Contacts have been made with A. Stockton for CFHT to design and built an image slicer for SIS. This would greatly complement the high spatial resolution capabilities.

O. Le Fèvre

CCD Mosaic Progress Report

The idea of a CCD mosaic camera proposed at last May's CFHT Users' Meeting has solidified into a real project. Staff at CFHT, Dominion Astrophysical Observatory (DAO), the Observatoire de Midi-Pyrénnées (OMP) and the Institute for Astronomy (IfA) are now participating in the development of the new camera — dubbed MOCAM. Most of the key personnel, including Chris Clark, Rick Murowinski, Gerry Luppino, Yannick Mellier(PI) and R. Arsenault met in Honolulu in September to finalize the details.

The focal plane of the camera will initially be made of a mosaic of four 2048 X 2048 CCDs with 15 micron pixels and separated by about 0.5 mm. In order to save both time and money, it will essentially be a copy of the mosaic being developed by Gerry Luppino at IfA. While a thinned, back-illuminated array is the goal, the first device offered to the CFH community will consist of thick, front illuminated CCDs. It is designed to operate at the prime focus, giving a scale of 0.2 arcsec per pixel and a field of 14 x 14 arcmin. If the camera is successful technically and scientifically, we hope to develop a larger array of CCDs in a subsequent camera.

Following are some highlights of the work plan for MOCAM:

- DAO and OMP have jointly ordered a batch of Loral 2Kx2K buttable CCDs. The purchase orders were issued last summer, and the batch should be ready for testing before the end of 1992. The wafers will be tested at Loral at room temperature and then packaged. They will be characterized cryogenically at DAO and shipped to Toulouse. DAO and Toulouse expect to keep 4 thick CCD for the first MOSAIC and 4 for future thinning. The remaining CCDs will be shared between DAO and Toulouse. However, Toulouse is aware of the strong CCD need for CFHT, and will provide at least 1 thick 2Kx2K of its own to CFHT. The total number which will be given depends on the number of good CCDs available on the batch.
- DAO has completed the design of the mechanical assembly which will house the shutter and filter wheel. The assembly is designed to fit onto the prime focus bonnette and support the dewar. It includes 5 filter positions, for which DAO will initially provide V, R, and I filters. Fabrication work is now under way.
- OMP will order a dewar for the mosaic from IfA (G. Luppino) of a similar design to the IfA large CCD mosaic.
- OMP will be responsible for the integration of the CCD camera with a GEN III controller outfitted with four hardware channels. After spending 3 months at CFHT working with Chris Clark on the Gen III controllers, Guy Delaigue (OMP) has just returned to Toulouse with a controller and workstation equipped with the Pegasus software.
- OMP is investigating on-line data reduction to avoid the disk congestion a large number of 32 Mbytes frames at the telescope would create.

Given the large commitment CFHT has to other projects, OMP and DAO are assuming as much of the development and integration of the system as possible at this stage. One implication of this is that users cannot expect to have full CFHT interface and data analysis facilities available at first light. The initial plan is to treat each 2K x 2K image as a unit, and not try to display or manipulate 4K x 4K images. It is expected that we could see first engineering use of the camera as early as the fall of '93. The PI's are eagerly waiting to use it for studies of various aspects of gravitational lensing and high redshift quasar surveys where large fields are essential. For more information contact:

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MOS/FP or the Succession of Palila

MOS/FP, the Fabry-Perot interferometric mode of MOS has been thoroughly tested recently, in the course of 2 engineering runs. Here follows some results of these tests and general information about this configuration.

The Fabry-Perot module is physically a box that replaces the MOS Grism/Filter wheels box. It can be inserted either on the MOS or SIS side of the instrument, depending on the spatial resolution desired. However, one must keep in mind that photons will be sparse at a sampling of some 0.08 arcsec/pixel (SIS). The exchange is done easily but must be done in daytime by CFHT staff. The MOS mask slide is used as filter holder for 3 inch circular or 2 inch square interference filters. Therefore, the available field is limited by the entrance filter; 7'45" for the former and 5'41" for the latter. The LICK CCDs offer the more flexibility although PHX1, and SAIC1 can also be used. The scale is 0.31" per 15 µm pixel, and a raster of 1500 pixel covers the field defined by a 3 inch filter. A 2x2 binning provide a more reasonable pixel size (0.62") for this type of application (low flux). Larger binning can also be used, if flux is critical, to the detriment of spatial resolution. However, care should be taken not to use too high a binning which would result in undersampling the external interference ring of the Fabry-Perot. This effect is critical only for high interference order etalons. For instance, at the edge of the field defined by a 3 inch interference filter, the outer ring of the etalon p=1162 is sampled by 4 pixels of 1.24" (4x4 binning of LICK2). Notice also that the read-out of a high number of pixels (large raster at high spatial resolution) reduces the observing efficiency of a scan. A 1500x1500 pixel read-out takes some 3 minutes.

Flexures are very small (see Bulletin No 27, p. 9) but we found out that 2 CFHT etalons (CFHT#1 and CFHT#3) produce important rings shift when the telescope is pointed at high hour angle. The problem lies with some etalon only and they are being shipped to Queensgate for inspection.

Fringing is low with LICK2, of the order of 2 % at 6598 Å (notice that it gets a lot worse above 7000 Å; ≈ 10-15 %).

For some applications, the observer may prefer to use a tilted etalon, to insure that internal reflections are not superimposed on the object (the Queensgate etalon, usually a low interference order one, is then mounted on a 2.4 degrees wedge). The tilted etalon must be used in conjunction with a mask that further reduces the field. These masks have been fabricated with the LAMA machine and obstruct about 25 % of the 2 inch field (the mask edge is a diameter going through the center of the interference rings; notice that less than half the field is obstructed, since the ring center is offset with the wedge).

Internal flat fields are currently used in the Fabry-Perot mode, because of the very low bandwidth of the system. To this effect a very bright flat field lamp (Halogen Spectral) has been installed in the calibration lamps unit.

R. Arsenault

CFHT AO Bonnette Progress Report

On August 15 1992, representatives of Laserdot (France), Dominion Astrophysical Observatory, Observatoire de Paris-Meudon and the Institute for Astronomy, met at CFHT to discuss and review the work accomplished by each parties. This meeting officially ended the Phase A study.

The end of 1992 is used to start writing the contracts and review and update the technical specifications of the AO Bonnette, in view of the performance expected. The basic concept is kept ie: piezo-stacked array deformable mirror (Laserdot; 44 actuators), curvature wavefront sensor (19 sub-apertures), separate tip-tilt mirror (OPM), and modal control. The mechanical is thought of as an intermediate stage between telescope Cassegrain Bonnette and instrument.

Recent developments on the realization of bimorph mirror have led CFHT to emphasize, to Laserdot in particular, the development of a flexible control algorithm, that could easily adapt to different type of deformable mirror.

CFHT expects to issue the contracts for fabrication for the beginning of 1993.

Some thoughts have been given to the first generation of instruments for the AO Bonnette. For imagery, it is envisioned that FOCAM could probably be adapted with very few modifications to the AO Bonnette. If higher sampling is required CFHT could acquire a 4Kx4K 7.5 um pixel CCD or adapt MOCAM with a focal enlarger.

The infrared camera, Red-Eye, could also be installed on the AO Bonnette, although the rough sampling will not be appropriate due to the larger pixel size, and better image quality attainable in the near IR. We hesitate between 2 solutions: a different re-imaging optics for Red-Eye (with higher magnification) or a focal enlarger behind the AO Bonnette. The final choice may depend on the next generation of array detectors available in the 1-2.5 um range. Concerning spectroscopy, integral field spectrography seems a logical option. This will not suffer from a competition with the Hubble Space Telescope, and will cover two-dimensionally the object features investigated, while minimizing positioning problems. The integral field spectrograph(s) must also have a long-slit option (MOS/SIS as a integral unit exceeds the weight and torque limits).

The official acronym of this instrument will be PUEO. PUEO is the name of a typical Hawaiian owl. It stands for: Probing the Universe with Enhanced Optics.

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