The Commissioning of CAFE

The CAssegrain Fiber Environment

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As people are starting to know, CAFE provides a fiber feed from the Cassegrain to the Coude focus of the CFHT, replacing the red mirror train, and increasing the versatility of our high-resolution spectrograph Gecko.

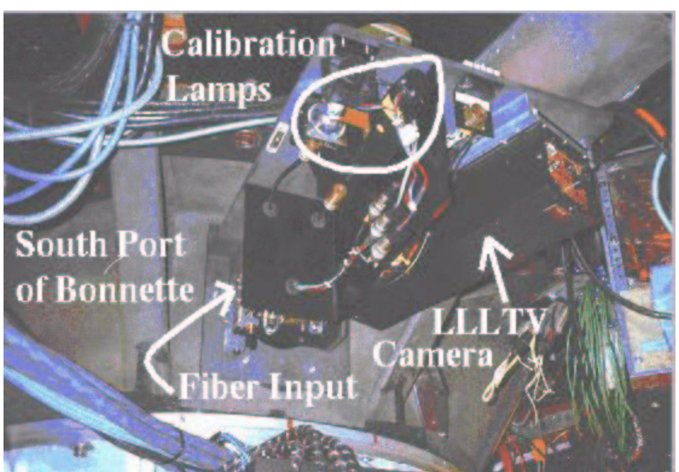
Less than a year after CAFE was initially received at CFHT and tested at the summit of Mauna Kea in October 1999 (see Bulletin #41), CAFE has already been used with great success during the last Gecko run, in July 2000, using a new thin CCD, EEV1.

The final phases of testing

To get there, CAFE was first sent back to France so that electronics and software could be finished and modified according to suggestions and ideas from both CFHT staff and our French colleagues. The earlier October tests proved to be an essential part of the commissioning process, by allowing us to find problems and possible sources of failure, different solutions, and making the French staff familiar with the conditions of operations at CFHT (temperature, humidity, maintenance, noise, resources shared with other instruments, etc.). After those modifications, and while still in France, CAFE was extensively tested one last time using scripts before being shipped again to Hawaii.

In May 2000, CAFE was received in Hawaii and sent to the summit for extensive and thorough testing of the unit itself and all of its spare components (cards, cables, optical fiber, mechanical component).

In June and July, tests performed during the day and during engineering nights allowed us to install CAFE at the telescope for the first time, align it with the telescope and spectrograph, use it on the sky and characterize it.



Some characteristics of CAFE/Gecko

First light of CAFE occurred in the early evening of June 21, 2000, on a bright star, after numerous setup and alignment operations.

CAFE uses the LLLTV "field view" camera previously used with Gecko. The circular field of view of 40 arcsec is smaller than before, but it was found to be sufficient. The position of the hotspot (the position on the TV screen to put a star so that the counts are maximum at the Exposure Meter, and thus in the spectrograph) has been determined and found to be independent of telescope position. In addition to field acquisition, this camera is used for guiding, and an appropriate procedure for guiding has been found.

Alignment procedures were done to align CAFE with the telescope pupil and the image slicer with the gratings. Flexure tests were also performed and no flexure problem was detected.

The route found for the optical fibers, from the Cassegrain bonnette to the 3rd floor slit room has proven to be safe for the fibers, at all telescope positions.

The Gecko session was modified by the CFHT staff to include the few modifications introduced by CAFE. After thorough testing and extensive use in real scientific conditions, the session is now operational, efficient and user-friendly.

More importantly, two extensive series of measurements were conducted to verify the quality of the data coming out of CAFE/Gecko (modal noise tests) and measure CAFE's performance (throughput measurements).

Modal noise tests

The so-called modal noise problem has been known for years in the communications world. Briefly, the propagation of different modes in an multimode optical fiber whose shape or positioning changes with time will degrade the S/N ratio of the output signal. Some laboratory tests suggest a degradation that could be as high as a factor of 2 to 4 for high-resolution fiber-fed spectrographs, like Gecko (for more details, see for example Baudrand et al. 1998, "Use and Development of Fiber Optics on the VLT" in Optics in Astronomy III, ASP Conference Series, Vol. 152, 32). Tests were performed on CAFE using flat field exposures taken at different telescope positions. Although these tests showed a possibly slight, but significant degradation (up to 30%) of the S/N ratios, they could not reproduce the factor of 2-4 in degradation seen in laboratory tests. Nonetheless, and again following the results of laboratory tests, the CFHT staff came up very quickly and on very short notice with an elegant, simple and functional "fiber agitator" (which agitates the optical fiber with an amplitude of 1 mm and a frequency of 30 Hz), to prevent modal noise and the S/N degradation associated with it.

Throughput measurements

Thanks to photometric sky conditions during some of the engineering nights, it was possible to measure the throughput of CAFE + EEV1 and compare some of the measurements with previous ones taken with the mirror train. Initially, we found out a few more photons (0-20% more) in the blue (450-620nm) than with the Coude train + EEV2, but fewer (up to 20% less) in the red (620-780nm). However, tests performed in September and using the flat field lamp with the spare optical fiber showed 25% more flux than with the fiber that had been used so far.

Therefore, with the spare fiber, the throughput for CAFE + EEV1 could possibly be equal or above the throughput for the train + EEV2.

UV transmission of CAFE

In September, an additional engineering night was used with Gecko's UV optics (collimator and camera) to check CAFE's transmission in the UV, below 400nm, out of the normal operating range of the optical fibers. It was found that CAFE will still transmit light down to 313nm, although at a level too low to be of any use. At 313nm, there are 4 times less photons compared to the UV mirror train, but this is mostly due to the known poor UV transmission of the optical fibers. At 404.7nm, and with the UV optics, there is a loss of about 50%, compared to the train and Red optics. CAFE might be an alternative to using the UV mirror train, which has not been used in years because the number of nights requested with the UV train could not justify the time and effort put by CFHT staff for its setup and alignment.

CAFE and science

After all the hard work provided by the Gecko team in June and July, it was decided to use CAFE for the Gecko July 2000 runs. During those 4 runs, CAFE has worked flawlessly, both mechanically and electronically; the software closely resembles the one used with the Coude mirror train, and observers felt rapidly comfortable using CAFE. During those commissioning runs, very good and excellent scientific data were obtained, and there was no sign of modal noise problems. In fact, spectra with unprecedented S/N ratios (well in excess of 3000!) were obtained on bright stars during one of the runs. Flat fielding seems to be considerably better than it was with the mirror train.

Although a few more things (mostly cosmetic) need to be done, CAFE has proven to be a great success. All this is good news for Gecko.

Finally, it is interesting to note that since the CAFE unit is permanently installed on the telescope, it can be used whenever the telescope is in its f/8 configuration (if the detector is kept cold). For example, if the seeing is so bad as to prevent imaging at the Cassegrain f/8 focus, spectroscopy could possibly be carried out. Furthermore, some projects could benefit from a rapid switch between AOB and CAFE, which only takes a few minutes, the time required to move the central mirror located in the bonnette.

WIRCAM

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With MEGACAM now firmly on its rails for first light in early 2002, attention within CFHT now increasingly turns towards offering our users its obvious complement, a wide-field near-IR mosaic. The scientific applications for this instrument are too numerous to enumerate in the space available here, but center around objects whose spectral energy distribution peaks beyond the CCD sensitivity window, either intrinsically (i.e. cool objects), or because it has been reddened by dust or by a cosmologic redshift. Such programs include, amongst many others, all applications of photometric redshifts (which beyond z=1 are poorly constrained from UBVRI alone), search for very high (z>7) redshift objects, studies of dark matter candidates in our galactic spheroid, and diagnostics of the star formation process. In fact, the difficulty (and cost) of producing large format near-IR detectors is the only reason why there aren't several large arrays already in use around the world. The availability of the 2K x 2K Hawaii2 array from Rockwell now makes them a real possibility.

To better identify the detailed technical boundary conditions for a wide-field near-IR imager on our telescope, CFHT contracted Klaus Hodapp (IfA Hilo) to carry out a conceptual design study. Klaus' design, while by no means final at this stage, is rather detailed. It clearly determines that the instrument is feasible within the contemplated budget, and establishes narrow ranges of optimal values for the main parameters of interest to users. A rather firm conclusion is that the final design should stick to a 4K x 4K focal plane, as wider mosaics (besides their financial implications...) would run into detector availability problems, as well as overfill our 30' unvignetted Cassegrain field of view (the chips are not buttable, so the field of view has gaps). The study includes optical designs for both 0.25" (field equivalent to a 17' square) and 0.30" (equivalent to a 20.5' square). The tolerance analysis demonstrates that the 0.25" plate is a very safe design, while the 0.30" scale would need tightly specified optical components to avoid degraded image quality. The larger plate scale also stretches the mass and torque limitations for an F/8 instrument. WIRCAM's platescale is therefore unlikely to significantly exceed 0.25", a value which also provides adequate sampling of our excellent near-IR seeing disk under most circumstances. Building upon characteristics of MEGACAM, the design includes a fast tip-tilt and automatic focus correction, ensuring that the instrument will take advantage of the excellent natural seeing at CFHT.

Work at present concentrates on assembling funding for this expensive intrument, and identifying the institutes in the three agencies that are interested in taking responsability for major subsystems of the instrument. We now feel that this effort is on the right track (a substantial part of the instrument's budget has been secured), and close to converging. We have high hopes that the next issue of the Bulletin will announce the formal kickoff of the WIRCAM project!

Making a Better Shutter

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ABSTRACT. Over a six year period several exposure control shutters and shutter like devices have been built by modifying existing products or custom machining in house. With each new shutter project , experience from the previous shutter design enhances development. This has resulted in the latest shutter, a magnetic latching , springless , low power , sensed exposure shutter to be used for CFHT-IR.

INTRODUCTION

One of the most important devices used for astronomy is an instrument shutter to control exposure times. Although shutters are considered to be simple devices, finding a reliable unit complying with aperture size, speed, power dissipation and open/close sensing is difficult. Over the years we have found it necessary to improve our stock of various vendor supplied shutters. This paper will describe the evolutionary process of building upon experience as each new shutter application presented itself.