OPTICAL EFFICIENCY OF RICHARDSON IMAGE SLICERS AT COUDE – A STATUS REPORT

Previous tests of the Richardson Image Slicers have shown that they pass only about one third of the flux incident upon them, whereas simple models suggest that they should pass roughly twice as much. This report summarizes efforts to date to understand these inefficiencies.

i) Sky coverage: The image slicers' effective sky coverage has been measured with an Abbé comparator. The effective sky coverage for each is listed in Table 1. Only the central 3 (DAO slicers) or 4 (CFH slicers) slit images result in slices which illuminate the collimator.

Richardson Image Slicers

Data Summary

Slicer	Sky coverage (measured)	Modelled efficiencies (seeing) 2"	1"	0.5"	Measured efficiencies July 20	previous
DAO Red	.79" x 1".57	22%	56%	83%		
DAO Blue	.83" x 1".56	22%	57%	84%	30%	28%
CFH Red	.76" x 1".89	23%	56%	81%		22%
CFH Blue	1.42" x 1".18	28%	67%	82%	33%	54%
CFH UV	0.84" x 1".95	26%	61.5%	90%		23%

Table 1

CFHT and DAO RICHARDSON IMAGE SLICER

DATA SUMMARY

Two alignment defects which could affect the slicer throughput have been noticed.

a) Inter slit gaps: The slices, when projected onto the collimator, are intended to have a central gap in order that the detector feed mirror does not block portions of the beam travelling from the grating to the collimator.

The slit images projected onto the sky should have no significant gaps, thus insuring more or less continuous coverage of a single star image. The CFH Red and Blue slicers and to some extent the DAO Red slicer have significant gaps on the sky, resulting in some flux loss at the collimator, but this probably amounts to something under about 20% of the output or roughly 7% of the incident flux. Internal alignment, not yet effected, should reduce this to a negligible value.

b) Non-conjugation: As seen from the sky, the vertical sides of the slits are formed by the exit slit mirrors, while the ends of the slits, top and bottom, are produced by the upper and lower edges of the entrance slot. As seen from the sky through the front cylindrical lens, the top, bottom, and vertical slit edges, should be in conjugation; they should come to focus simultaneously. In fact, for several of the slicers there is a non-conjugation of roughly 3 mm between the sides and the ends. For a star focused in the vertical plane of the entrance slot, this implies a defocus on the exit slit of something on the order of 150μ or roughly one half arc second. The problem can be fixed either by repositioning the cylindrical lens or, if necessary, replacing the lens. Moving the lens causes the illuminated slit length to vary, and this will be looked into carefully before being pursued. The expected improvement in throughput would not exceed about 10% of the incident flux.

ii) Ideal slicer throughput: Given the geometry of the entrance slit arrays projected on the sky, the fraction of the stellar flux passed by the slicer has been calculated as a function of the FWHM of a Gaussian star. A summary is given in Table 1. Although it is a fairly strong function of seeing, the efficiency should be something on the order of 60% efficiency for these slicers under conditions of 1 arcsecond seeing. This is a factor of 2 better than has been observed.

As a check on the quality of the seeing for the night of 20 July, the signal from a star as seen by the spectrograph exposure meter was measured through a simple slit at several widths. The data are plotted in Figure 1 together with curves for modelled Gaussian stars of 200, 250, and 300 microns FWHM. The observed FWHM of roughly 250 microns

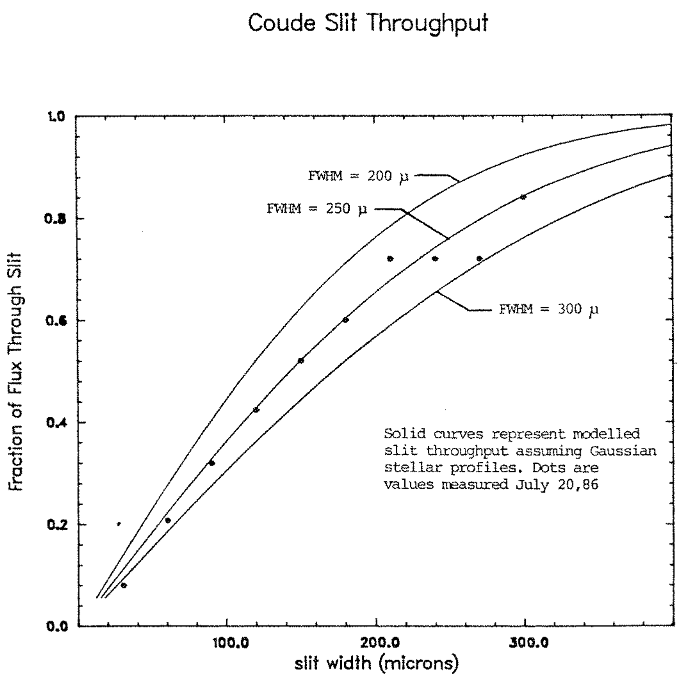

Figure 1

corresponds to 0.65 arcseconds. This excellent seeing is attributed, at least in part, to recently added insulation of the vertical optical path between the telescope and the 3rd floor Coudé room.

iii) <u>Collimator Illumination and Guiding:</u>

The uniformity of collimator illumination using the image slicers was checked in the hope that anomalies could be found. They were indeed, but have not been fully explained.

Illumination was checked by scanning a photometer vertically across the center of the collimator, with the output recorded on a chart recorder.

Two sources were used; one the standard spectrograph flat field lamp, the second the star Altair. A typical set of scans, using the CFH Red slicer, are shown in Figure 2.

The upper scan shows collimator illumination using the flat field lamp. The position of the collimator is indicated by the bar below the scan, with the top of the collimator to the right. As expected, clearly defined slices can be identified across the face of the collimator, with gaps between. The slices extending above and below are expected when using an extended light source. It is worth noting that each slice is an image of the vertical extent of the slicer entrance slot.

The lower scan shows collimator illumination while observing the star Altair. The much thinner slices are consistent with the excellent seeing since the star only partially fills the 2 arcsecond height of the entrance slot. Although the signal peaks have been truncated in these plots, there are several clearly obvious anomalies which are more or less evident with all the slicers.

i) The slicers are not evenly spaced. The central pair are crowded to the center, while the outer left (upper) slice is too high.

ii) Significant illumination is seen in the thin slices above and below the collimator (to the right and left on this plot).

iii) The bottom slice seen on the collimator using the flat field lamp (i.e. the right most on the collimator) contains no light when illuminated with the star. This is not due to a momentary error in guiding since the chart recorder output from the exposure meter was essentially constant throughout the scan.

The first problem, and possibly the second, indicates that the guide signal is maximized with the star decentered on the

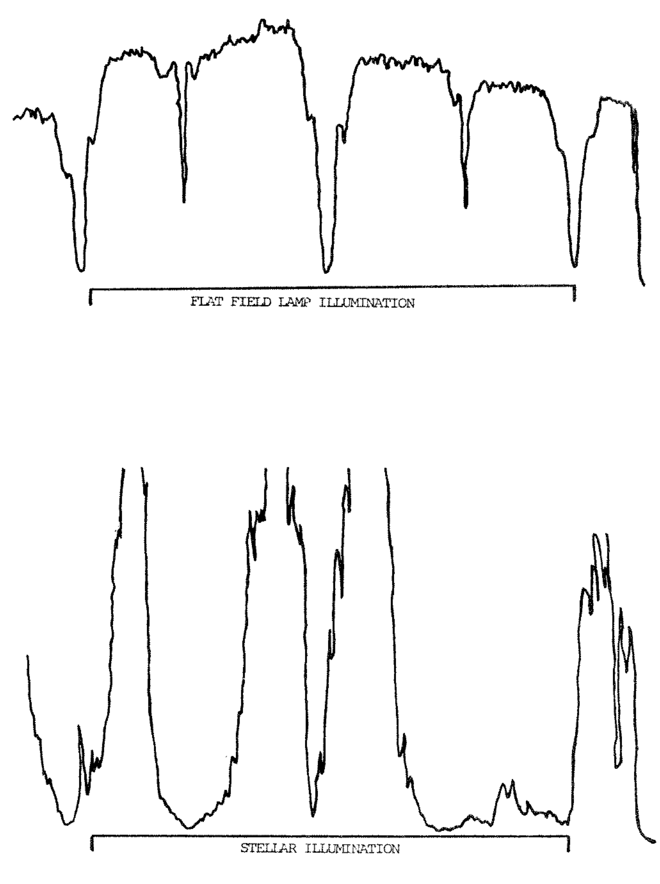

Figure 2

slicer entrance slot. Guiding is normally accomplished by maximizing the signal on the exposure meter which picks off a small fraction of the light immediately after the slicer. Comments by some observers subsequent to these tests indicate that a detected signal improvement by as much as a factor of two could be obtained by guiding at a star position significantly away from that which produced maximum exposure meter count rates. If verified, image slicer efficiencies approaching those predicted in Table 1 should be realized. Further tests on the sky are planned using a photomultiplier mounted at the spectrograph focal plane, beside the detector, as the exposure meter sensor.

The third problem - that of a missing slice - is not fully understood.

iv) Conclusions:

A factor of two improvement in the Richardson image slicer efficiency may be possible. Although internal alignment of the slicer will likely give some gains, the largest increase in signal of the detector may come from improved guiding.

D. Salmon
T. Gregory

FTS IMPROVEMENTS

Over the past two years, we have made a number of significant improvements to the Fourier Transform Spectrometer, primarily in the detector systems. The first step was to replace the original InSb detectors with InSb detector/preamp hybrids from Cincinnati Electronics Corporation (Model IDH-100). These hybrids comprise the 0.5-mm detector element, the preamp FET, and the feedback resistor in one package. In additon to having lower noise, the new detectors are completely free of microphonics and do not require "J flashing". At the same time, the internal optics of the cryostats were entirely reworked from a design by Derrick Salmon to provide proper cold baffling. This has resulted in a large increase in sensitivity at wavelengths longer than 3 microns, where the dominant noise source is the thermal background. Included in the new optics are four cold aperture stops with diameters of 2.5, 5, 8, and 12 arcseconds. These can be selected by remote control.

In the last few months, we have increased the number of frequencies available for internal modulation from one to three in order to optimize the sensitivity over the entire range of object brightnesses. We are currently implementing a short-scan mode (symmetrical around zero-path-difference) for use on faint objects.

The FTS performed almost flawlessly during a two-week run in September.

R. McLaren

RECENT TECHNICAL ACTIVITIES

CFHT'S CAD SYSTEM

INTRODUCTION

It is now approaching the "paper anniversary" for the CFHT Computer-Aided-Drafting, i.e. CAD System, and it would seem appropriate to note our progress, describe what and how we have learned to use, yea, even to cope with, this ever-seductive, tantalizingly, superficially simple, yet devilishly complex tool, for the betterment of our Telescope Corporation.

In late fall, 1985, after surveying some of the affordable systems available (primarily concentrating on the 16-bit Personal Computer versions), we decided to standardize on hardware of the PC-AT type (or compatible). We are currently using 4 Hewlett Packard (HP) Vectras (AT-compatible with 80286 CPU), each set up with 640K RAM, Sigma 400 (640x400) color video driver boards, each with 13" Mitsubishi color CRT display (non-interlaced), Intel 80287 math co-processor, 20 MB hard disk drive and one 1.2 MB floppy disk. Separately, as a less expensive option, but utilizing their good graphics display capabilities, we are using 2 NEC APC-III's which are partially IBM-PC compatible (640K RAM, 8087-2 co-processor, 20 MB hard disk drive, one 360K floppy drive, color graphics board and display (640 x 400)). Each work station has a Hitachi 11" x 11" digitizing tablet. One station also has an additional large, backlighted digitizer, Hitachi 36" x 48" for inputting up to "E-size" drawings. Output devices are HP "Thinkjet" dot-matrix printers for draft copies, two 8-pen color plotters, one HP 7550 for A and B size drawings and one HP 7586 for up to "E-size" drawings. This hardware has given us the potential to follow a number of options for software.

Although the PC-CAD market had blossomed in the early '80's, it was soon clear to us that the most practical choice was to go with the strength of an "open" system, such as "AutoCAD". This package comes as a "basic" part, plus up to two levels of sophistication. In addition, AutoCAD has, within the past 3 years, become adopted as the standard for PC-based CADS, offering good support and incorporating users' suggestions for improvements (through a sort of "wish-list"). The price is very reasonable: about $1,000 for the Basic Level, and $2,000 for the full-blown system. By comparison, rather elementary CADS programs for the VAX 750, begin around $7,000, and although there is the illusion of potentially faster CPU speed, and larger RAM access, these in fact tend not to be realizable on a multi-user system such as found at CFHT.