exit pupil located after M7 is within a circle of diameter 6 mm, with a maximum hysteresis of 2 mm for telescope motions between 4 hrs East and West of the zenith. The M5 turret and platform are still known to contribute 3.0 mm of pupil motion and 2.7 mm of hysteresis. This contribution is reduced to 2.2 mm of pupil motion and 0.9 mm of hysteresis by removing the M5 mirror pad and mirror clamping system. Roughly half of this remaining pupil motion (about 1.6 mm) is from the M5 turret itself. The contribution to the flexure of the M6 turret and platform is small, corresponding to about 0.5 mm of pupil motion, while the field lens provides a negligible contribution. The M4 turret contributes about 1 mm of pupil motion and along with its platform may contribute a comparable amount to that of the M5 system. The remaining flexure probably comes from the telescope itself.

Both the M4 and M5 turrets need to be finalized. Presently, they each hold one mirror and the two turrets do not have automatic covers. Train changes therefore require manual removal and installation of mirrors rather than simply a turret rotation. The lack of an automatic cover requires that the Telescope Operator uncover and recover the mirrors at the beginning and end of each night. These are functions which were originally designed into the turrets, but which had to be removed in order to prevent turret rotation and permit reinforcement of the turret base and baseplate. These two features should be built back into the M4 and M5 turrets along with sturdier mirror pads and mirror clamping systems.

P. Wizinowich

COUDE EFFICIENCY IMPROVEMENT WITH A POLARIZATION DEVICE

A proposal for a Polarizer at Coudé was written in September, 1985. Since then, optics have been purchased, mechanics designed and built, and an initial test performed. Basically, unpolarized light input into the spectrograph is separated by this device into components with polarizations parallel and perpendicular to the grating grooves. One of these components then has its polarization rotated to match that of the more efficient grating polarization mode. In this manner, all light incident on the grating is linearly polarized either parallel to or perpendicular to the grating grooves. Since the efficiency of a grating depends upon the direction of polarization of the incident light, the device could result in significant gains in spectrograph efficiency.

The device uses a polarizing beamsplitter cube to separate the two orthogonal components. A right-angle prism is used to make the two beams parallel and to vary the optical path length of one of the beams to match the other. A half-wave Fresnel Rhomb Retarder is used to rotate the polarization vector of one of the beams parallel to the other. The beams, unfortunately, cannot be recombined and are displaced with respect to each other by about 4 mm in the detector plane. This is too high for the 0.75-mm height of the Reticon, but is well within the 9-mm height of the 320 x 512 RCA1 CCD. With 2-d detectors a spectral line from the two beams can be placed on the same vertical column allowing for integration of the line upon readout.

A series of exposures was taken with the RCA1 CCD at the coudé focus on December 13, 1985. The CFH red slicer and 830 l/mm mosaic grating were used. The polarization device was placed directly behind the image slicer and the Th-Ne lamp was used for focussing. For both polarizations, the two paths of the device could be focussed simultaneously on the CCD to produce line profiles of less than one pixel (30 µm). The flat field lamp was used for relative efficiency measurements. Use of area detectors such as the new RCA2 CCD (15 µm pixels) which permit on-chip summing before readout is essential if real gains in S/N are to be achieved.

The following table gives the efficiency of the device (oriented for each of the two cases of polarization), relative to the throughput with no polarizer in place, for several wavelengths:

Wavelengths	E (Par.)	E (Perp.)
4000 Å	0.70	----
5000	1.28	0.34
6000	1.23	0.48
7000	1.02	0.68
8000	0.78	0.88

With the device oriented for polarization parallel to the grating grooves, the spectrograph efficiency was improved at 5000 Å by 28%! Note that this device was designed for the wavelength range of 4000-7000 Å, beyond which the beamsplitter cube becomes a much less efficient polarizer. The transmission of the beamsplitter is $\geq$ 97% in the range of 5000-7000 Å and $\geq$ 85% in the range of 4000-5000 Å. The Fresnel Rhomb Retarder is an effective rotator from 3300-10,000 Å, while the anti-reflection coating on the right-angle prism is better that 2% in the range 4200-7500 Å. This implies that a different beamsplitter and prism will be required for other wavelengths.

This test has shown (at least for the 830 ℓ/mm grating) that the polarization device in its parallel mode can produce substantial improvements in spectrograph efficiency, once on-chip signal summing with area detectors becomes available. For gratings with more rulings, the improvement in efficiency should be even larger.

P. Wizinowich