Memorandum
Gemini 8m Telescopes Project

To: Matt M., Jim O., Dave R., Rick. M., Fred G., Charles J. (via FAX @ RGO)
From: Doug Simons
Date: September 6, 1994
Re: Impact of Telescope Offset Errors on Slit Throughput

I have modeled the throughput of various slits for an AO corrected PSF at the Gemini focal plane as a function of telescope offsetting accuracy. These Monte Carlo simulations stem from the code written to support the dither tests described in my memo on August 25, 1994 and I refer you to that report for a detailed description of the overall procedure. In this case, an AO corrected PSF with 50% strehl at 1.6 µm (supplied by Brent) is used to create an image in the spectrograph's slit plane. The steps used to assess slit throughput from there are:

1. The PSF is placed in the slit with a mean offset position that is centered on the slit but with a Gaussian positional error.

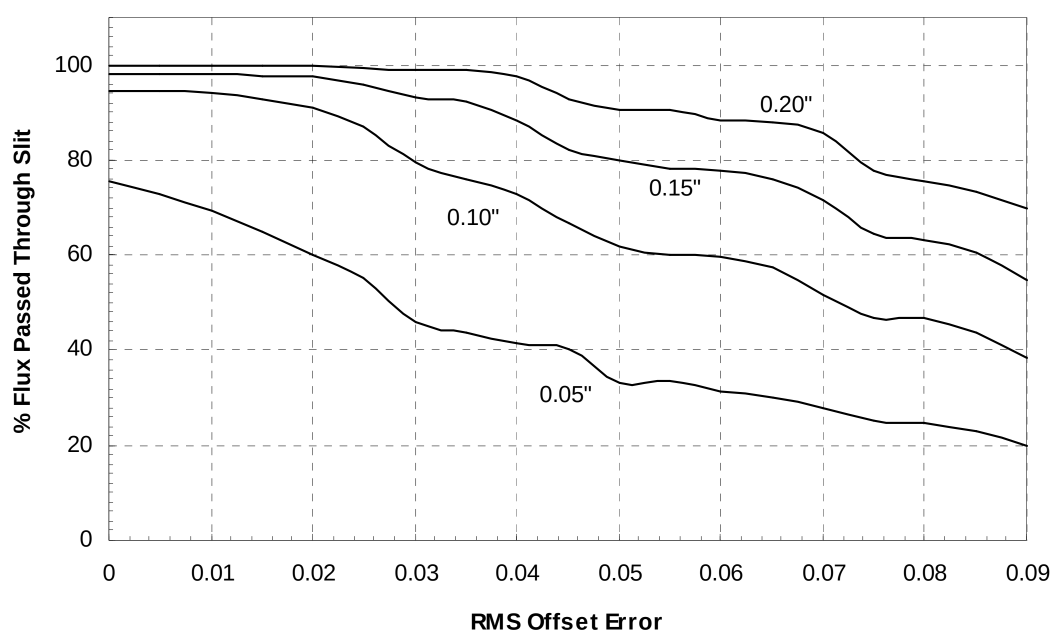

Figure 1 - A plot of rms offset error versus throughput for slit sizes of 0.05", 0.10", 0.15", and 0.20" is shown. All values are normalized with respect to the maximum throughput of the 0.20" slit.

2. Next the total throughput is measured.

3. Steps 1 and 2 are repeated a total of 100 times with a Gaussian positional error (but with a fixed rms value) and each time the throughput is evaluated and stored.

4. After 100 offset images are created and throughputs measured the mean throughput is evaluated and stored.

5. The rms offset error is increased by 0.005” and another 100 frames are created, repeating steps 1 through 4.

Tests were completed for four different slit widths and final results are shown in Figure 1. Note that the error is two dimensional, i.e., it is distributed radially from the nominal PSF location in the center of the slit. The low frequency ripples in the throughput are no doubt due to the diffraction rings in the AO corrected image passing in and out of the slit. Since the greatest difference between the analytical PSF used here and Brent’s AO corrected PSF is in the amount of energy in the outer diffraction rings such low amplitude variations in throughput are probably not reliable and should be smoothed-over while assessing slit throughput. Aside from these low amplitude ripples in throughput the simulation should be accurate.

This completes 2 of the 3 simulations I have planned to test offsetting accuracy needed by the telescope in order to support instrumentation and observing modes anticipated for Gemini. While my last analysis indicated that reconstructed image quality from a series of AO corrected dithered images is independent of offsetting error, this analysis clearly indicates that the use of 0.10” slits will tightly constrain the allowable tolerance of offsetting errors (which is not much of a surprise). The next simulation I have planned will address offsetting errors and the use of the near infrared coronagraph with the AO module. A fair amount of new code will be needed to properly model an optimized coronagraphic mask but I hope to have those results available by the A&G PDR.