

Notes on PSF camera plate scales and first order optics

The input $f/\#$ from the first AO relay is 13.66. Further, assume that the pupil is at infinity (Reni design) or ~ 19 meters away (Peter design). Because we are using small fields ~ 3 - 5 arc seconds (sky reference) the pupil (just another image) depth of focus should be large, i.e. the pupil is weakly defined. Therefore assume that system is telecentric, that is the input pupil is at infinity.

Assume that first relay is as show in “ngaolgs_21207_pickoffop005.pdf” and reproduced in Figure 1 below.

From a study of the diagram, I am assuming that this is a 1 to 1 relay and has a total length of $4f$, i.e. a “ $4f$ ” telecentric relay. I estimate that the total length of the optical relay is 400 mm in the drawing although this exact dimension is not critical. This makes the beam diameter 7.320 mm ($4f=400\text{mm}$, $f=100\text{mm}$, 13.66 input $f/\#$). This first relay will be followed by a second “ $4f$ ” relay with a 32×32 MEMs DM with 400 micron actuator pitch. This relay has a focal length of 174.84 mm in order to achieve a pupil size of 12.8 mm diameter. For the PSF camera which will need a cold stop, we would have a third relay with a cold stop followed by selectable reimaging lenses that would give appropriate final plate scales.

Take the typical IR detector pixel size to be that of the Hawaii 2RG which is 18 microns. We would like to be have samplings of 2.5 pixels per λ/D (slightly more than Nyquist) at shortest wavelength of interest to science observations in the Near IR 1.0 micron (UKIDSS Z band). (I’m assuming that Matthew Britton can extrapolate for “visible science”, those wavelengths smaller than 1.0 micron).

Assuming that the PSF camera will have three plate scales that sample the PSF at 3 times, 2.5 times and 2 times the raw plate scales of (24 msec/pixel), this leads to plate scales of 7.8 msec/pixel, 9 msec/pixel, and 13 msec/pixel. These meet our sampling criteria for wavelengths of 1.0, 1.2 and 1.65 microns.

Assuming a final relay with a 10 mm pupil stop the focal lengths are $f_{\text{input}}=136.6$ mm, $f_{\text{ouput}} = 409.8$ mm (3x), 341.5 mm (2.5x), and 273.2 (2x). Optical parameters are summarized below in Table 1.

Relay Specifications	f in (mm)	pupil diameter (mm)	f out (mm)
first 1-1 relay	100	7.32	100
MEMS relay	174.84	12.8	174.84
Cold relay	1336.6	10	273
			341
			409

Table 1: Summary of three relays for PSF camera. The final Cold relay can select between 1 of 3 final plate scales.

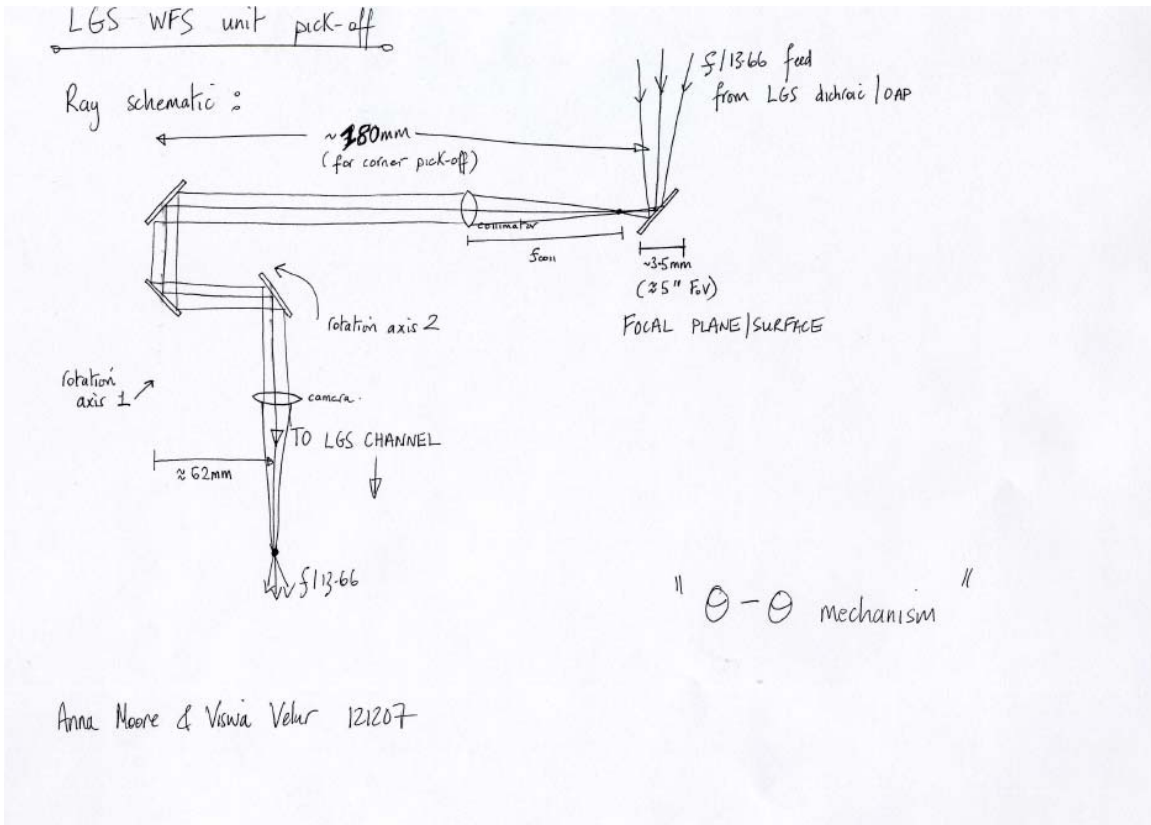


Figure 1: Suggested pickoff arms design for LGS (and LOWFS). Current design has space for 4 pick-offs, 2 for TT sensor, 1 for TTFA sensor and 1 for PSF camera.