4.3 WFS Pixel Scale

4.3.1 The Calculation

At the Altair PDR, we were asked to revisit the calculation of the optimal WFS pixel scale, taking into account the effects of moonlight. While performing these calculations, we realised that several other effects needed to be considered that had not been folded into the original calculation (pixel-edge-blurring on the WFS CCD and also blurring of the WFS spots by errors in the lenslet array). In order to do this calculation properly, we had to repeat the calculations previously provided to us by Brent Ellerbroek, which determined the quad cell throughput (TP) and the atmospheric blur angle (θ_B) including a calculation of the effects of leaving out the WFS ADC. We also performed a more detailed calculation of the signal as a function of wavelength expected for the WFS. To this we have added:

- A calculation of the expected count rates from moonlight as a function of angle to the moon and phase.
- A calculation of the resulting Noise Equivalent Angle (NEA) as a function of the pixel scale, the seeing, the guide star magnitude and the amount of moonlight. In this calculation we have added the effects of pixel blurring from the CCD and lenslet blurring.
- An approximate analytic scaling of this NEA to give the delivered Strehl as a function of the above parameters and also wavelength, using an approach mapped out for us by M. Chun (IGPO).

These calculations are fully documented in the three MathCAD files:

1. 'Eller_chk9.mcd': calculates TP and θ_B.
2. 'Bad_lenslet.mcd': calculates the NEA and the Strehl.
3. 'Nea_Strehl.mcd': plots some cases not covered in 'Bad_lenslet.mcd'.

All of these MathCAD files are included as Appendices 33-35 in the CDR documentation.

4.3.2 The Results

A summary plot produced by the 'Bad_lenslet.mcd' file is given below (Figure 4.9). This plots out the Strehl ratio at 1.6 μm produced by Altair (N.B. without including the Strehl degradation produced by the uncorrectable errors from the telescope, or that of the scientific instrument). The cases plotted are with a 14th magnitude guide star (i.e., fairly faint), and shows curves for 3 different seeing values (10%, median and 90%), and also

shows the effect of trying to observe within 10 degrees of the full moon. From this we draw the following conclusions:

- For reasonable pixel sizes and guide star magnitudes, moonlight has a negligible effect on the Strehl ratio delivered by Altair.
- The expected pixel blurring from the CCD has a significant effect on the delivered Strehl ratio as one moves towards coarser pixel scales, and as a result one is driven toward fine (<0.5 arcsec) pixel scales.
- The expected lenslet blurring also causes a minor but significant decrease in the delivered Strehl ratio.

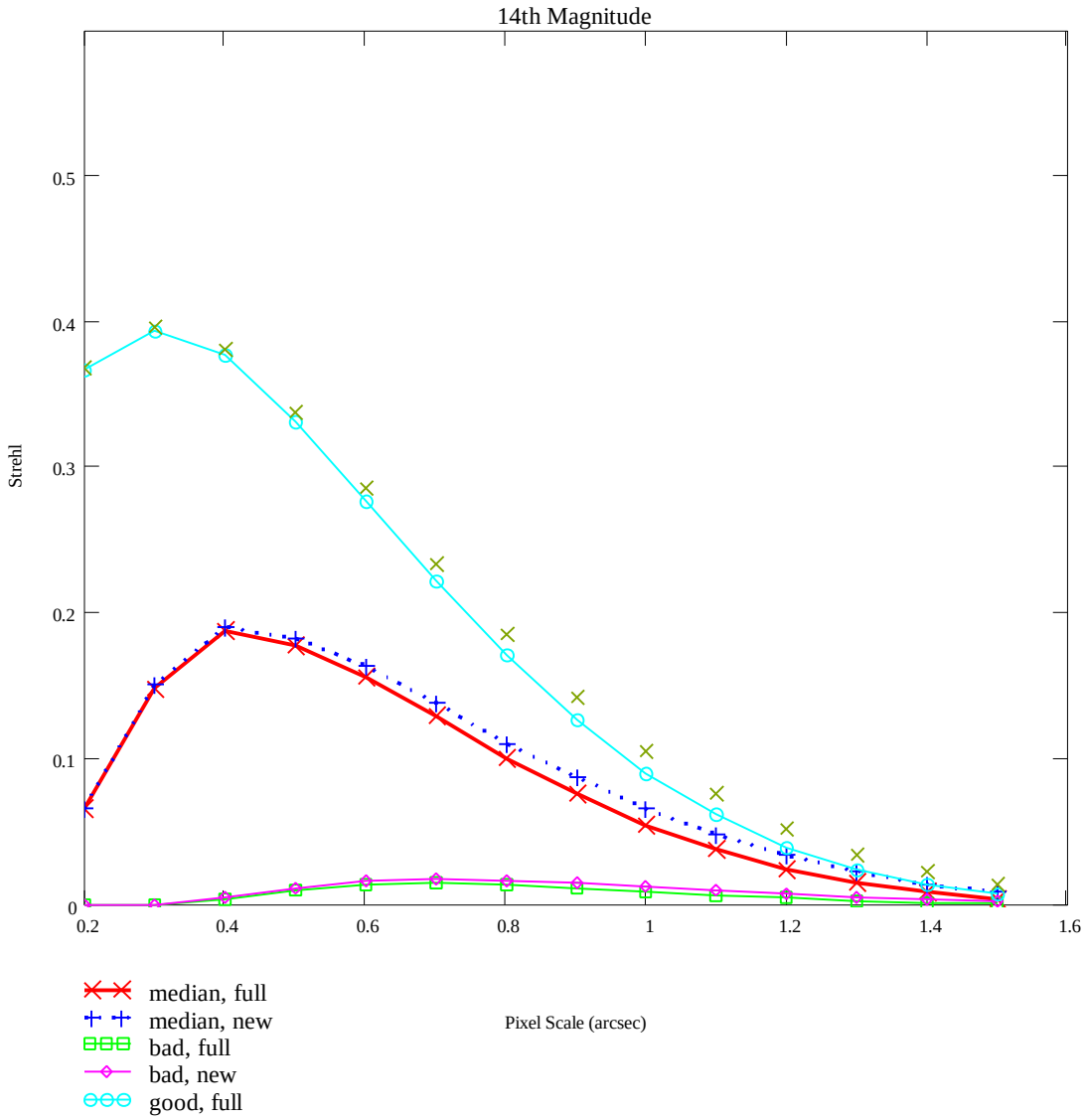

Figure 4.9 - Delivered Strehl as a Function of WFS Pixel Scale

Based on the curves plotted above, we have settled on a NGS AOWFS pixel scale of 0.4 arcseconds. This decision was reviewed at a meeting between the Altair team and the IGPO on the 26th of February 1998, at which time the pixel scale was fixed.