**Lenslet alignment discussion** **wht-naomi-40**

Once again the co-alignment of lenslets is under discussion.

The scheme for operating the WFS assumes that the lenslet to CCD alignment is set up for quad cell reading even if the spot pattern will not be read out in quad cell mode.

For quad cell operation the spots must fall onto the grid of pixels on the CCDs to within ?1.2 ?m across the field. This translates to a ?6.0 ?m tolerance on the lenslet positioning in X and Y and 1/100$^{th}$ of a degree in rotation. The CCD is a fixed reference to which all lenslet arrays must map. This mapping must be maintained as the carriages move up and down the WFS rails and not just for a fixed position.

The rails have a running parallelism specification of approximately 4 ?m per 100 mm. The mounting of the rails will probably degrade the parallelism, but by how much will not be known until the carriages have been mounted and tested. To measure this scale of error reliably is beyond the scope of the co-ordinate measuring machine, so interferometric methods will be required. That means measuring tilts of a mirror at discreet points along the travel and curve fitting to find displacements. The extremes of travel of the carriages following the pick-off between the calibration source and the far edge of the field is roughly 60 mm, so we can expect to have lost half the allowance for positioning error of the lenslets.

Lenslet alignment involves the manipulation of the lenslet arrays in an XY?-stage to position it in its holder correctly aligned to the CCD. Once in position it has to be fixed in place. In order not to disturb this level of alignment precision the lenslet will be fixed by bonding using a UV curing cement. Hopefully curing stresses in the adhesive will be sufficiently low, or symmetrical, that upon releasing the lenslet after the curing of the adhesive it will not drift.

An alternative approach is to mount the lenslets, reticule and full aperture doublet into a plate. All four lenslets must be orientated in rotation, but their positions are nominal. The plate is mounted onto an actuator driven XY-stage of 50 x 25 mm travel. When a lenslet is required it is selected and there will be a positioning procedure in which the spots on the CCD formed by a calibration source will be read of and the lenslets repositioned in a closed loop system to obtain quad cell operation alignment.

There may need to be a look-up table of corrections for offsets to the lenslets to accommodate out of straightness of the rails, but at least this would be possible with an XY-stage. Calibration for this would be done here or at Durham. As things stand, if offsets are required that's just too bad.

The XY-stage would also be useful for white light flattening of the DM as the required ½ X ½ subaperture offset could be dialled up at the lenslet. That would mean we could leave out the offset array giving one unobstructed aperture in the lenslet plate which would be a great help for alignment checks. It would still be useful as a spare for the preferred quad cell mode.

**Required changes for implementation**

The wheel would be discarded and replaced by a pair of stages mounted for XY motion, the 50 mm travel stage being flat on the carriage where the base of the wheel now mounts. The lenslets themselves would be mounted in a plate with a 3 X 2 grid of holes at 24.5 mm pitch.

From the point of view of the mechanics and alignment there would be a probable saving in time over the current system, but there would be a knock on for the software. It may be that the code could be obtained from Electra or the Keck group and modified. The current VME

cards could be juggled to accommodate stages with encoders as the slots for the ADC prisms do not need their currently allocated capacity for reading encoders.

The specification for the stages would be driven by repeatability required for implementing offsets. This would be 3?m approximately. There are at least 2 options for stages/motors from different suppliers that would more than meet the requirements and fit in the space available.