An off-the-shelf guider for the 200-inch

Reaching the seeing-limit with SWIFT

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The Problem

SWIFT is designed to work with the P3K AO system, and therefore never had it's own guide camera. In reality, SWIFT spends a large amount of it's time not using the AO system, as there aren't bright enough guide stars available. Unfortunately, we found in December 2011 that the **200-inch tracking is poor with P3K mounted** (fig 1).

To make SWIFT usable for non-AO observations, we needed to implement an independent guider.

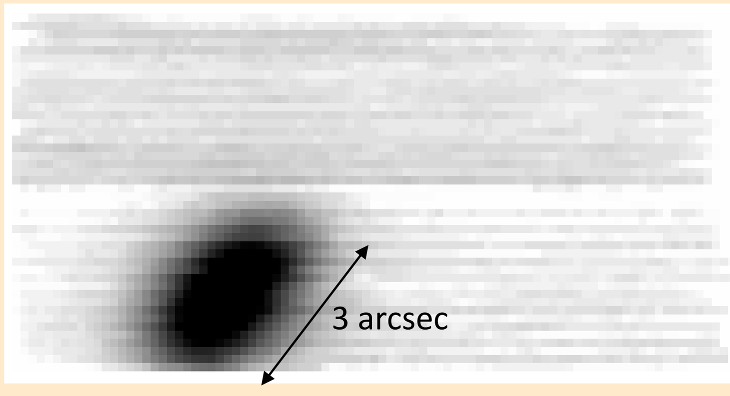

Fig 1 : 900s exposure of a Quasar without guiding. The 200-inch is drifting at about 12" per hour with P3K mounted.

Guider Design

The SWIFT guider uses only COTS parts. The FLI CCD camera was an (unused) acquisition camera already in SWIFT. A 2:1 reimaging system with stock lenses (Fig 2) provides ~0.25"/pixel sampling on the detector and a 1-arcmin diameter field located 4-arcmin off-axis. The volume available on the top-side of AO bench was very limited; only 350x200x200mm. The guider fits comfortably inside this, and is easily removable if needed (Fig 3). The camera is mounted on a linear stage to allow it to be co-focused with SWIFT.

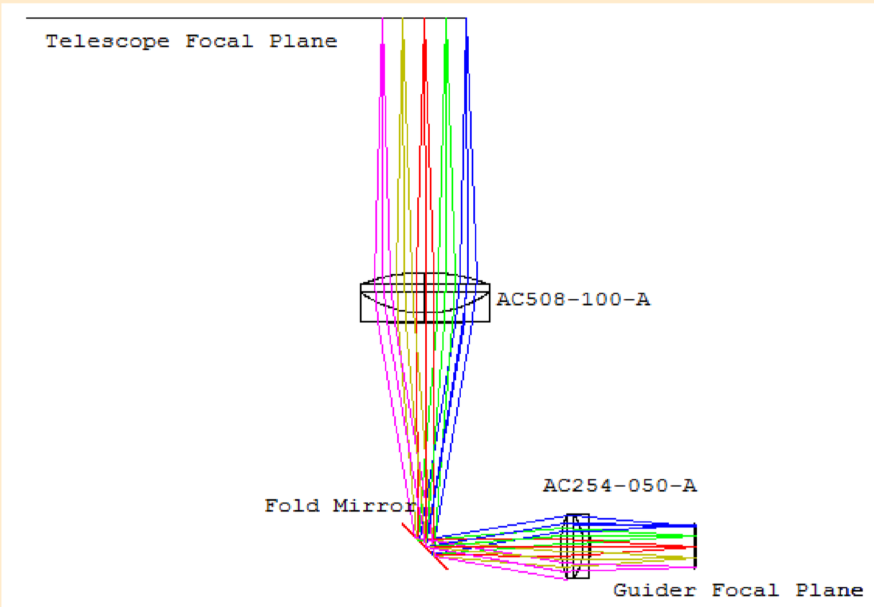

Fig 2: Guider 2:1 reimaging optics

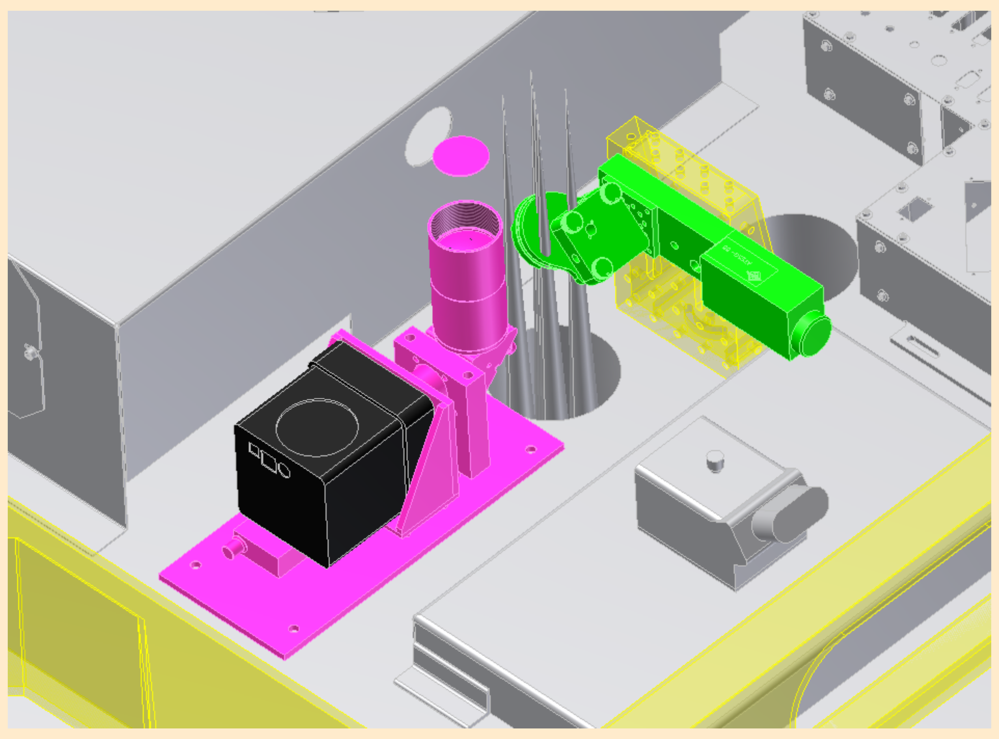

Fig 3 : Model of guider (pink for clarity) mounted on the top-side of AO bench. The guider baseplate is 300x130mm (12"x5")

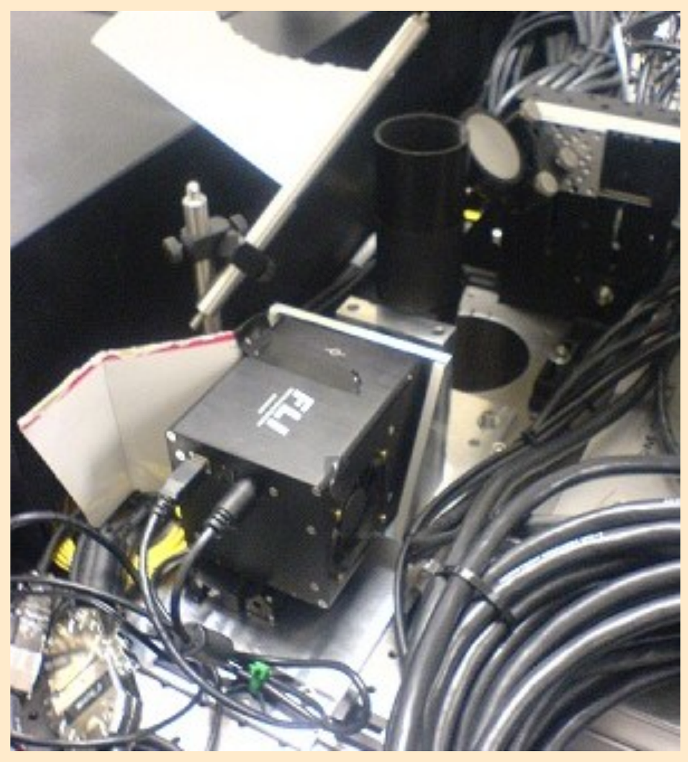

Fig 4 : The guider mounted on top of the AO bench. An optics mounting bar was placed at the calculated telescope focus to focus the guider in the lab. The guider did not need to be refocused on sky.

An Easy Software Interface

Several guiding software options are available for the 200-inch, but we decided to minimise development time by utilising existing amateur camera interface/guiding software ("MaximDL"). Almost all amateur astronomy software now supports the ASCOM interface protocol; a defined set of generic commands to abstract client software from hardware drivers. All that we needed to develop was a driver for the 200-inch to convert guiding requests from Maxim to offset requests to the telescope. The ASCOM provided templates made this a quick and easy process. Fig 5 shows the software architecture of the guider.

The ASCOM P200 driver is freely available to anyone who wants to use it.

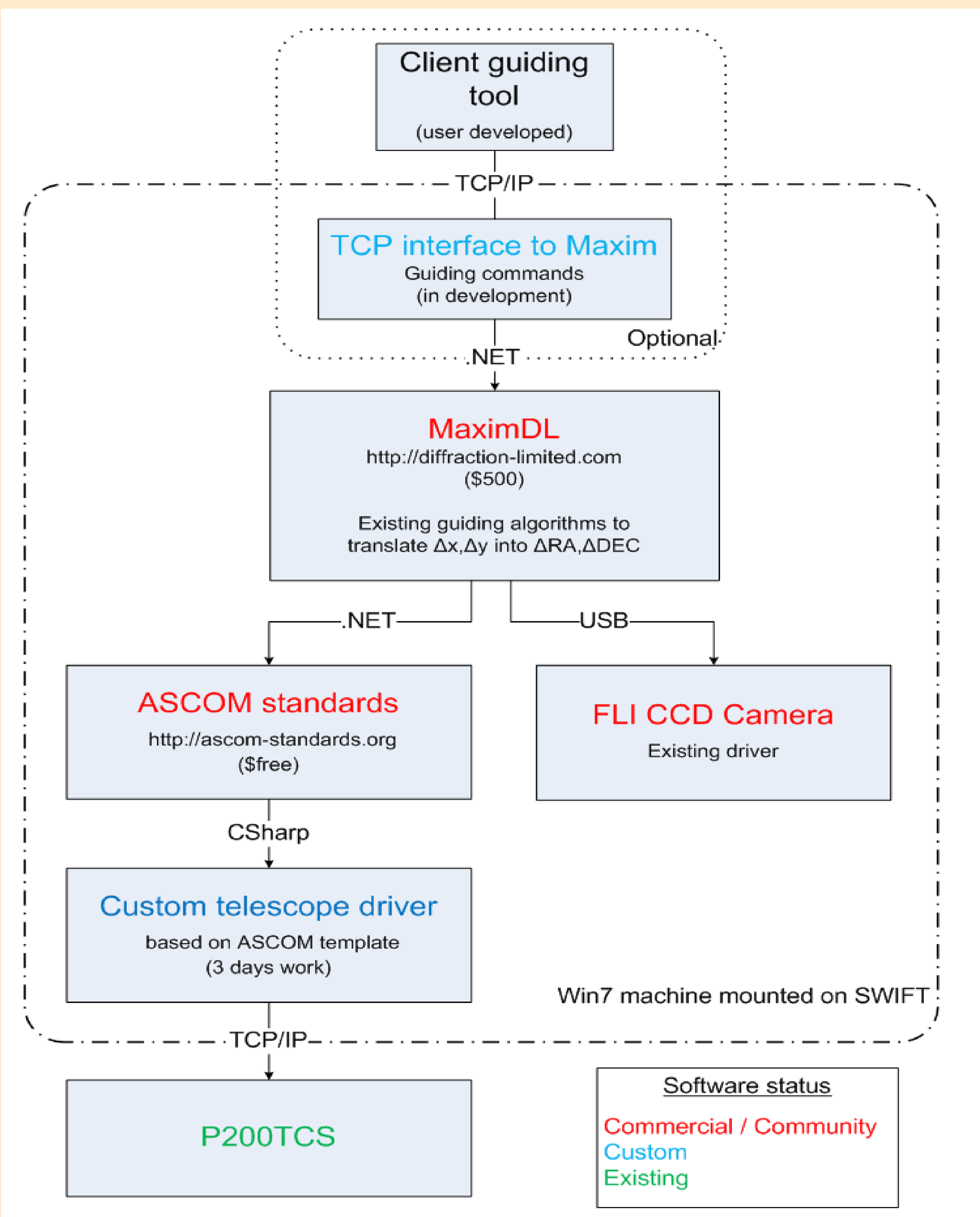

Fig 5: Software architecture for SWIFT guider. The core software runs on a Win7 machine mounted on SWIFT (near the guide camera hardware). A TCP/IP interface is in development to allow non-windows clients to control the guider.

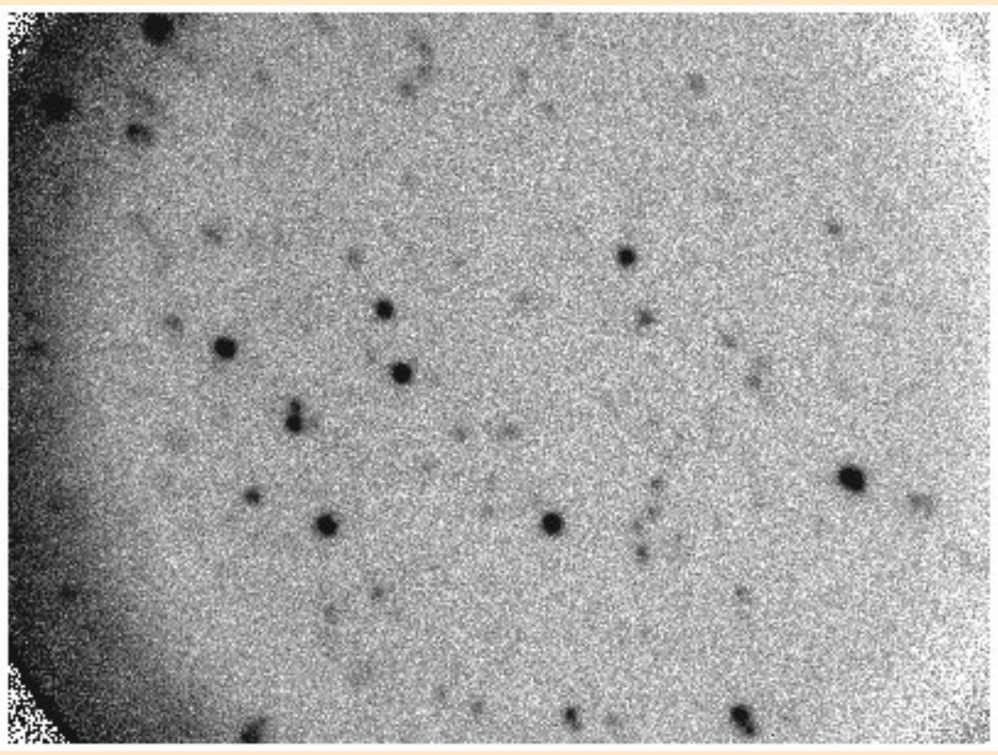

Fig 6 : Guider image of the outskirts of M15 showing the 1-arcmin illuminated field of view (after flat fielding) and the degraded PSF outside this. IQ is <0.8" in the central region.

Performance & Results

On-sky commissioning only took 10 minutes. The focus determined in the lab was correct for the telescope, and image quality is <0.8" in the centre of the field (Fig 6). The MaximDL software provides a function to automatically calibrate a guider (the relation between Δx, Δy and ΔRA, ΔDEC), and once locked the guider quickly (~4—5 iterations) stabilised to <0.2" residuals (Fig 7).

The guider field of view is only 1-arcmin, but we can guide on objects as faint as R~20.5 with 60s exposures (depending on moon/seeing). Even with guide stars this faint, the system delivers <1.0" image quality on SWIFT over long durations (Fig 8). It also provides useful "astrometric reference" images to help align long sequences of observations of objects too faint to detect in individual exposures.

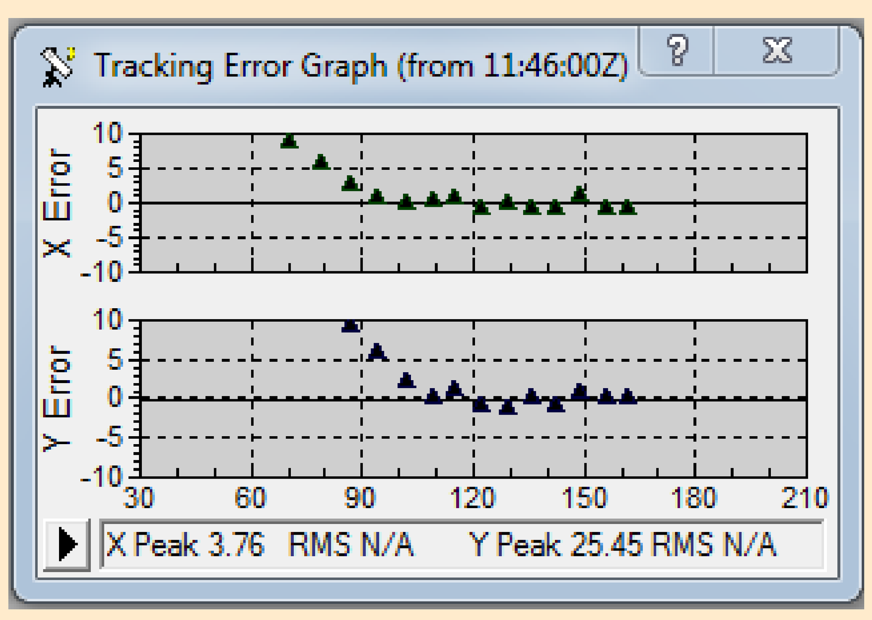

Fig 7 : Residual error on the *very first time* the guide loops were closed. Horizontal axis is time in seconds, and vertical box size is equivalent to +/-2 arcseconds. The guider quickly converged to <0.2" residuals.

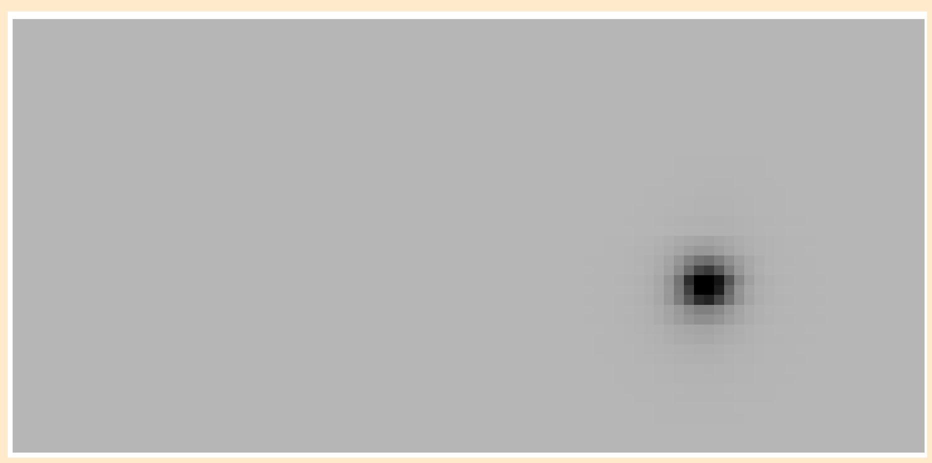

Fig 8 : 900s exposure of a small elliptical galaxy showing the vastly improved image quality achieved with the guider. FWHM of this image is ~0.7" (i.e. good seeing!)

Summary

SWIFT now has a guider which allows it to run effectively as a seeing limited spectrograph when AO guide stars are not available. With a throughput of 45%, SWIFT is attractive for faint/distant galaxies, as well as bright/nearby AO targets.

The guider is entirely off the shelf, and the ASCOM driver for the 200-inch should be an attractive option for other groups looking to implement a quick and easy guider solution on the telescope.