ACAM - A New Imager / Spectrograph for the William Herschel Telescope

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ACAM is a new wide-field imager/spectrograph, to be mounted permanently at a folded-Cassegrain focus of the 4.2-m William Herschel Telescope, from early 2009. It's expected that ACAM will be used for a broad range of high-impact science programmes requiring rapid response (e.g. supernovae, gamma-ray bursts), or awkward scheduling (e.g. exoplanet transits), or the use of specialised filters (e.g. narrow-band H_α imaging of low-red shift galaxies). We present here the optical and mechanical design.

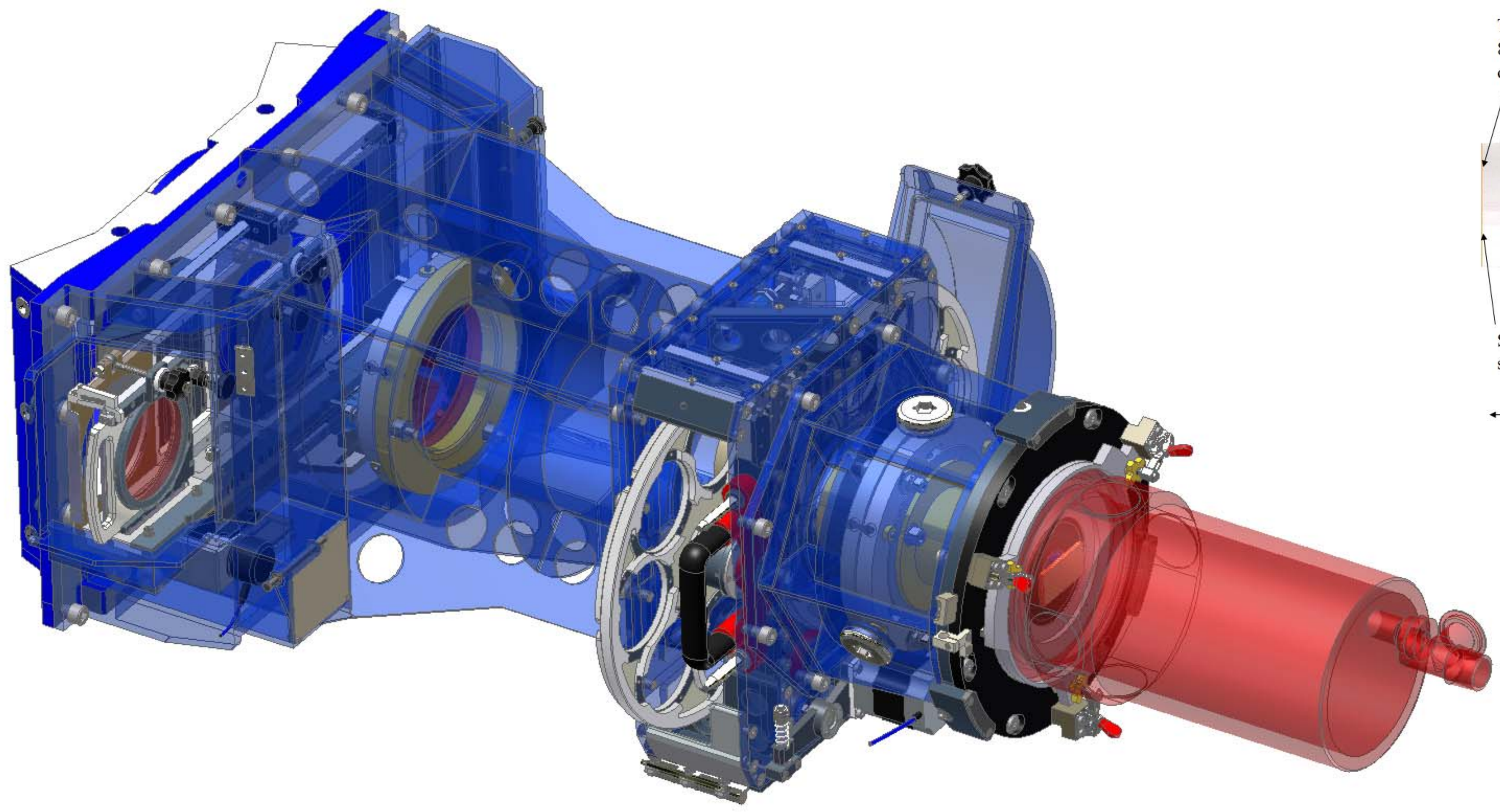


Fig. 5. General layout of ACAM. The total length of the instrument (blue) plus cryostat (red) is 1100 mm and it weighs 110 kg. The mechanical design is driven largely by constraints on size, weight and flexure, together with the requirement that changing filters and grisms in the wheels should be straightforward (and quick). For robustness, and ease of alignment, lenses 2 to 6 (Fig. 1) are mounted in one lens barrel.

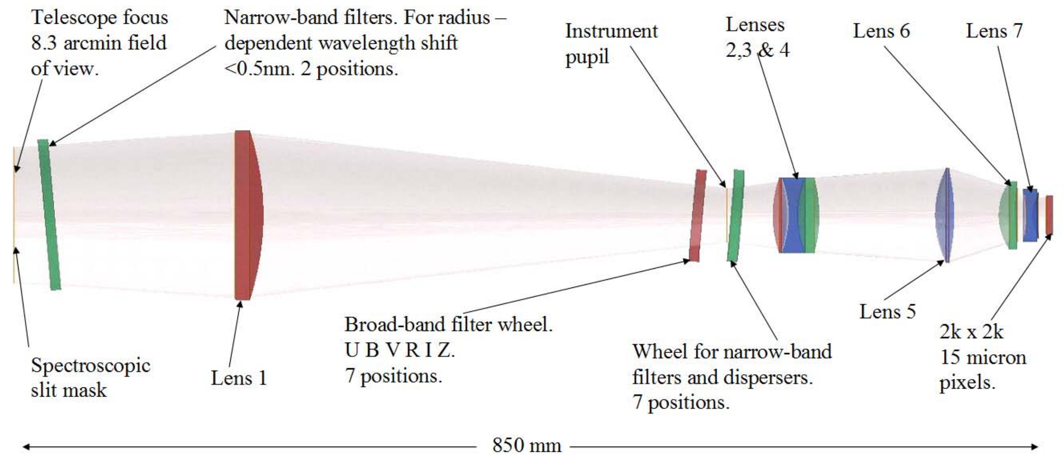


Fig. 1. Optical layout of ACAM, from the telescope focal plane at left, to the detector at right. Narrow-band filters can be mounted either in the 7-position filter wheel before lens 2 or, to minimise the radius-dependent shift of central wavelength across the field, in a slide near the focal plane.

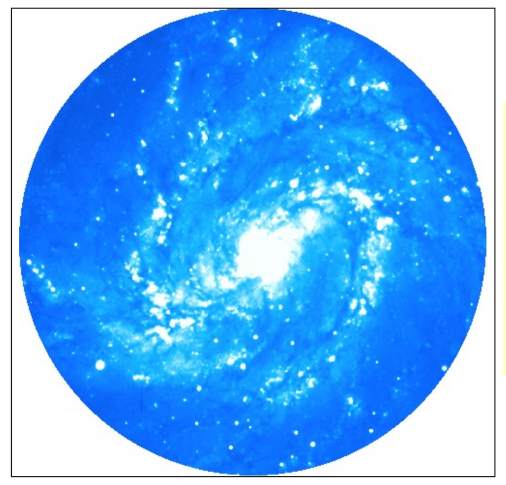


Fig. 2. M81, as it would be imaged by ACAM. The field of view is 8.3 arcmin at a scale of 0.25 arcsec pixel^{-1}, which adequately samples the best La Palma seeing (0.5 arcsec). This field of view fits on 2k × 2k pixels.

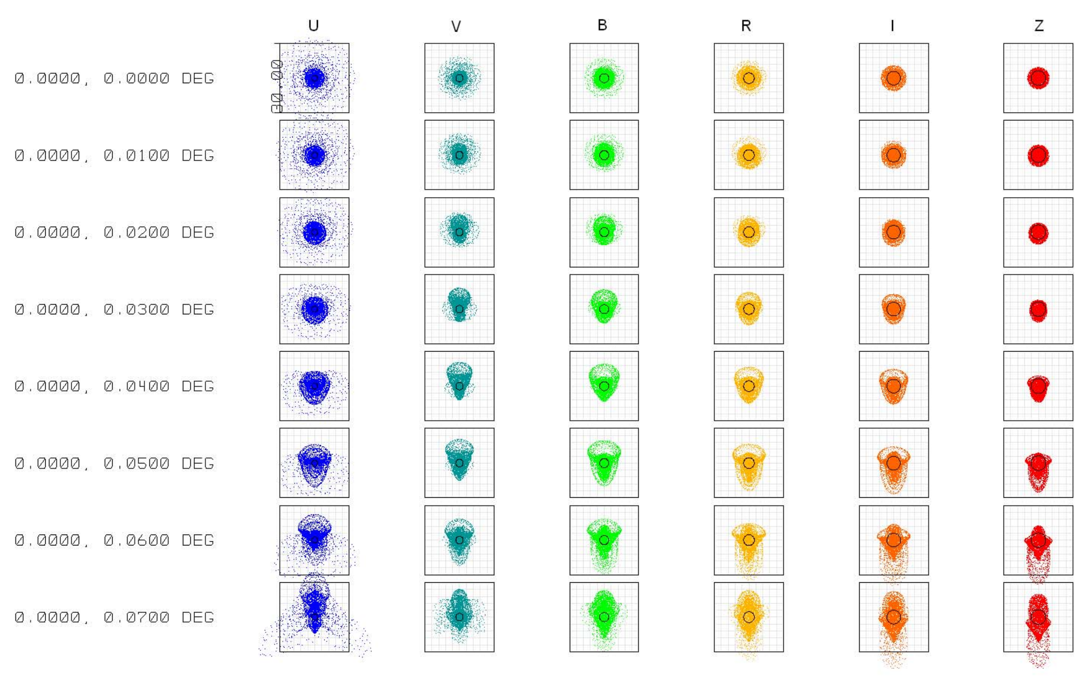


Fig. 3. Predicted image quality as a function of wavelength (U B V R I Z bands, left to right) and radius in the field of view (0 to 4.2 arcmin, top to bottom). The box sizes are 0.5 arcsec. The black circles indicate the size of the Airy disk.

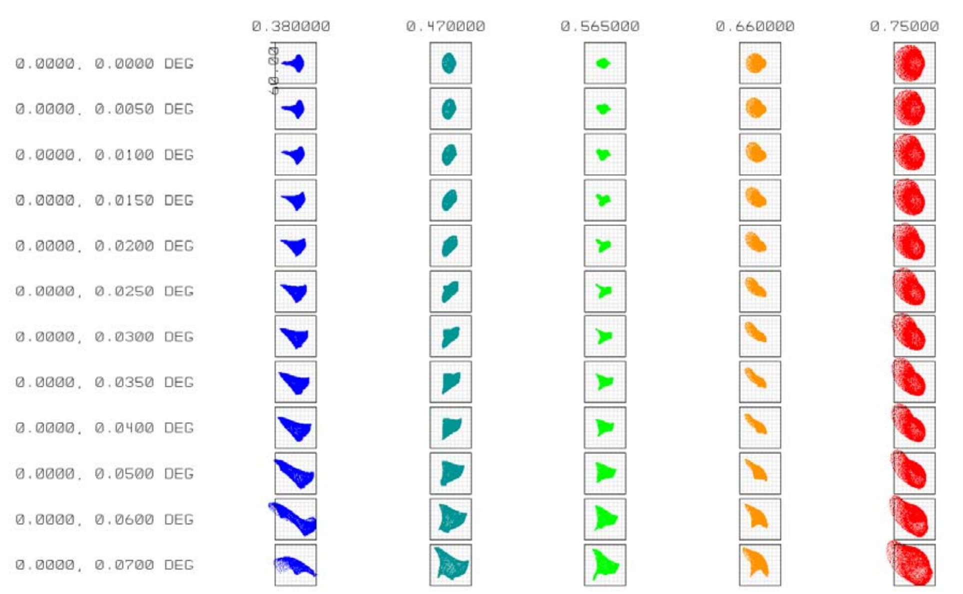


Fig. 4. Predicted spot diagrams for spectroscopic mode, using a 400 lines mm^{-1} VPH grating in the near-pupil, for different wavelengths (left to right, labelled in microns). The box size is 1 arcsec. For slit width 1 arcsec, the implied on-axis spectroscopic resolutions are 290, 430 and 570 for wavelengths 380, 565 and 750 nm respectively.

ACAM replaces the WHT's current auxiliary-port imager, which offers a field of view of only 1.8 arcmin, and a limited range of filters. The goal is to (1) exploit better the large field of view available at the WHT Cassegrain focus (up to 15 arcmin), (2) allow the use of a wide range of broad-band and narrow-band filters, and (3) offer low-resolution spectroscopy on-axis. ACAM will be mounted permanently on the telescope, and only a few minutes will be required to switch from using another instrument to using ACAM.

Initial modelling with ZEMAX showed that it is not possible to design an imager which delivers good PSF across a 15-arcmin field, for all wavelengths UV to near-IR, without incorporating many optical surfaces, and this would unacceptably compromise the throughput. We therefore optimised the design (Fig. 1) for an 8.3-arcmin field of view (Fig. 2).

The predicted PSFs are shown in Fig. 3. They will not significantly degrade the natural seeing, even at the edge of the field of view. The predicted throughput of the optics is approximately 0.8 at all wavelengths.

The central wavelength transmitted by a narrow-band filter, installed in one of the wheels, varies by up to 1.6 nm with radius in the field of view. For programmes using very narrow-band filters, and requiring the full field of view, an alternative location has therefore been provided for the filters, near the focal plane (Fig. 1), where the wavelength shift is small.

For spectroscopy, a VPH grism will be inserted in one of the near-pupil filter wheels, delivering an on-axis spectroscopic resolution ~ 500 (Fig. 4).

The mechanical design is illustrated in Figs. 5, 6 and 7.

ACAM will be commissioned on-sky early in 2009.

Fig. 6. The filter box houses two wheels, for filters and dispersers. It has been designed so that both the wheels and the contents of the wheels can be changed in a few minutes.

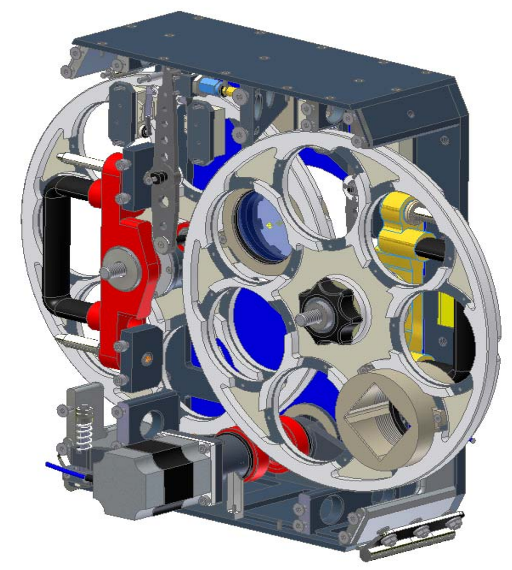
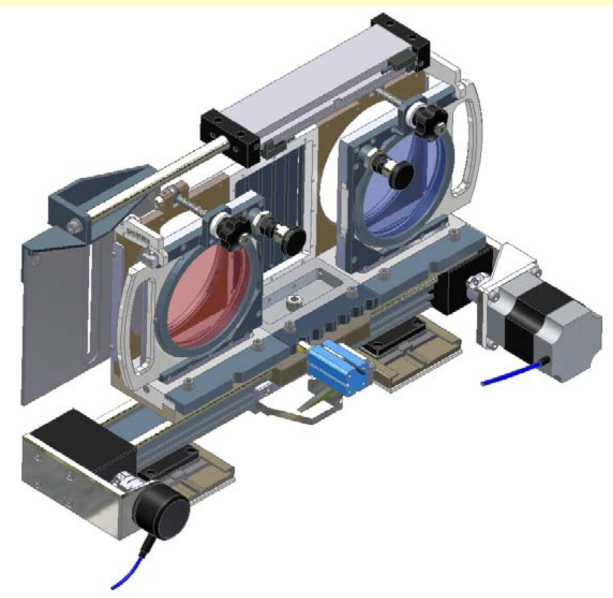


Fig. 7. Slit unit, showing the slit mask (at back mounted on a linear slide), with a pre-slit mask behind it (which allows light to enter only that slit which has been positioned on-axis). The unit also includes two mounts (at the front) for narrow-band filters, with a manual tilt mechanism for fine-tuning the effective central wavelength.



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