

# Conceptual design of a two-degree field corrector and ADC for prime focus at the 4.2m WHT

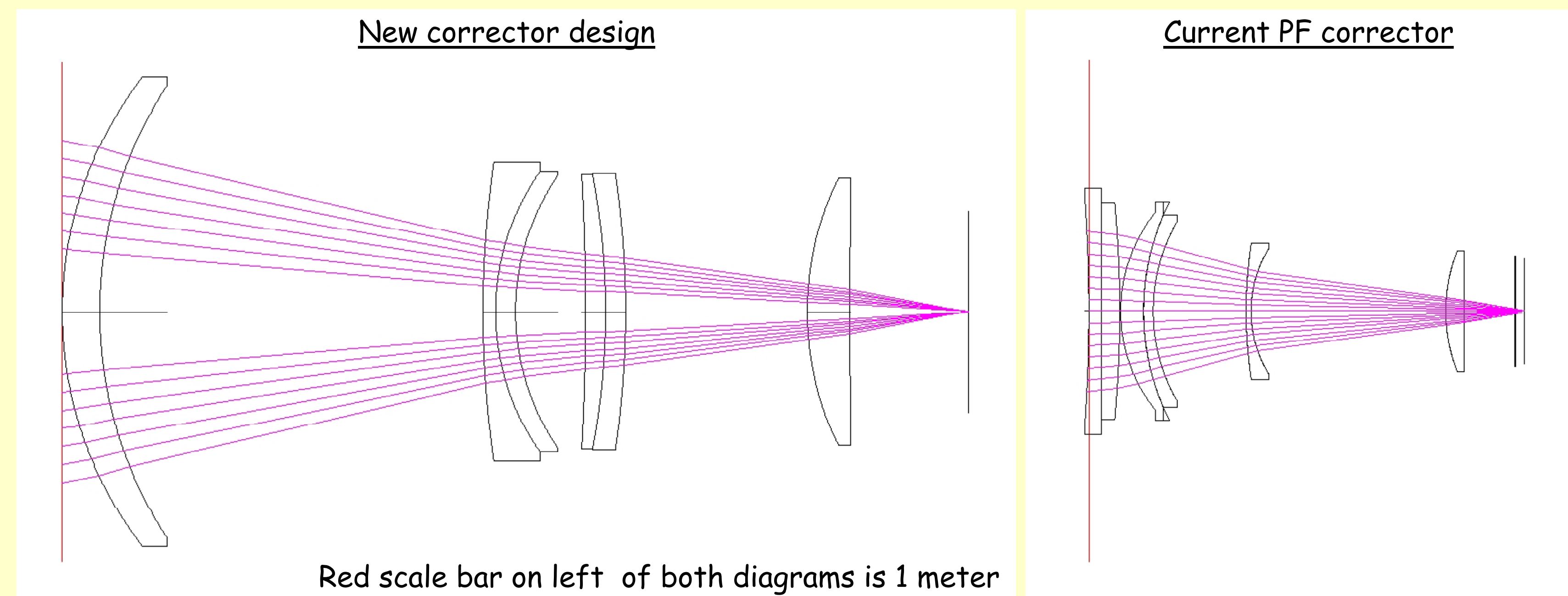
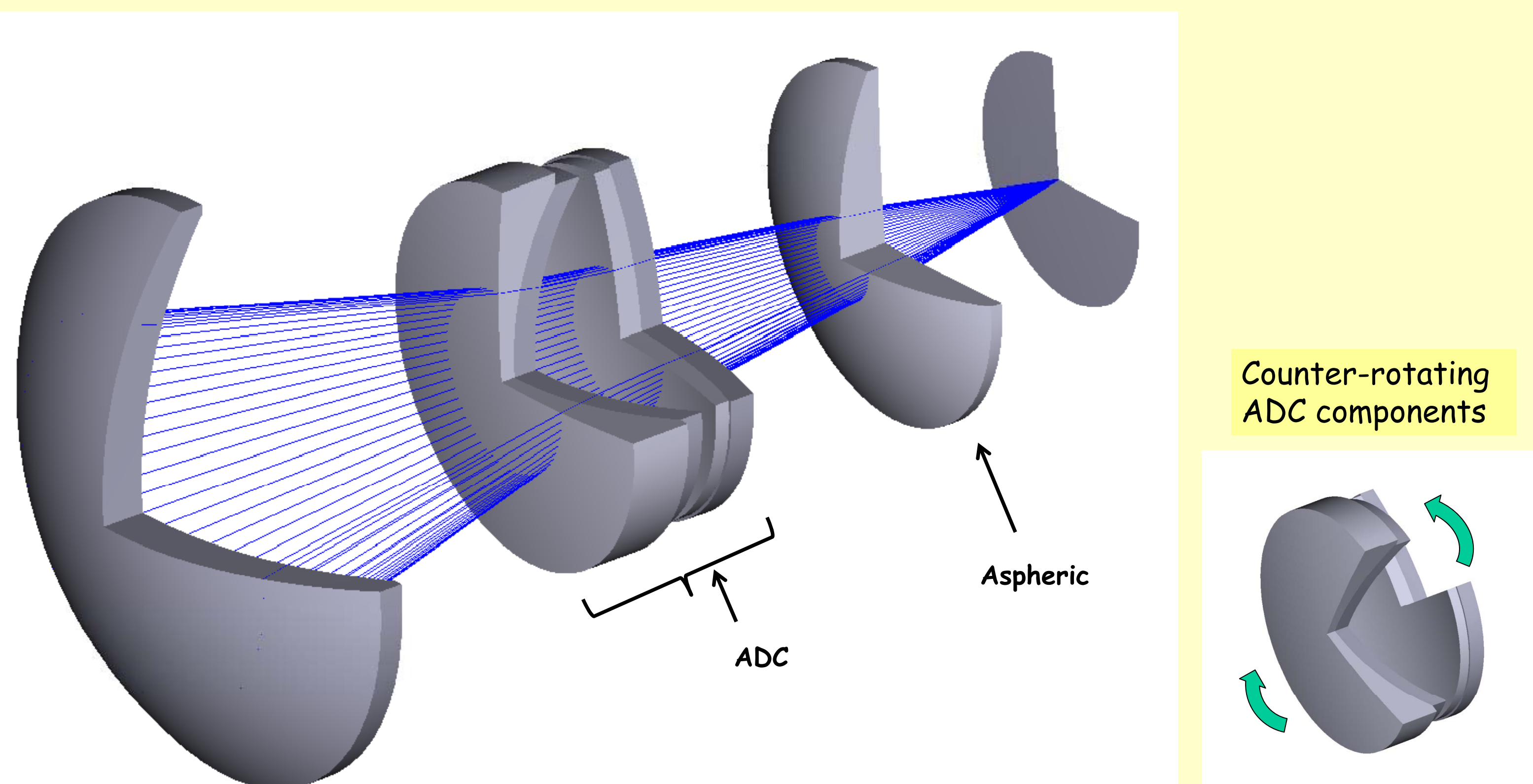
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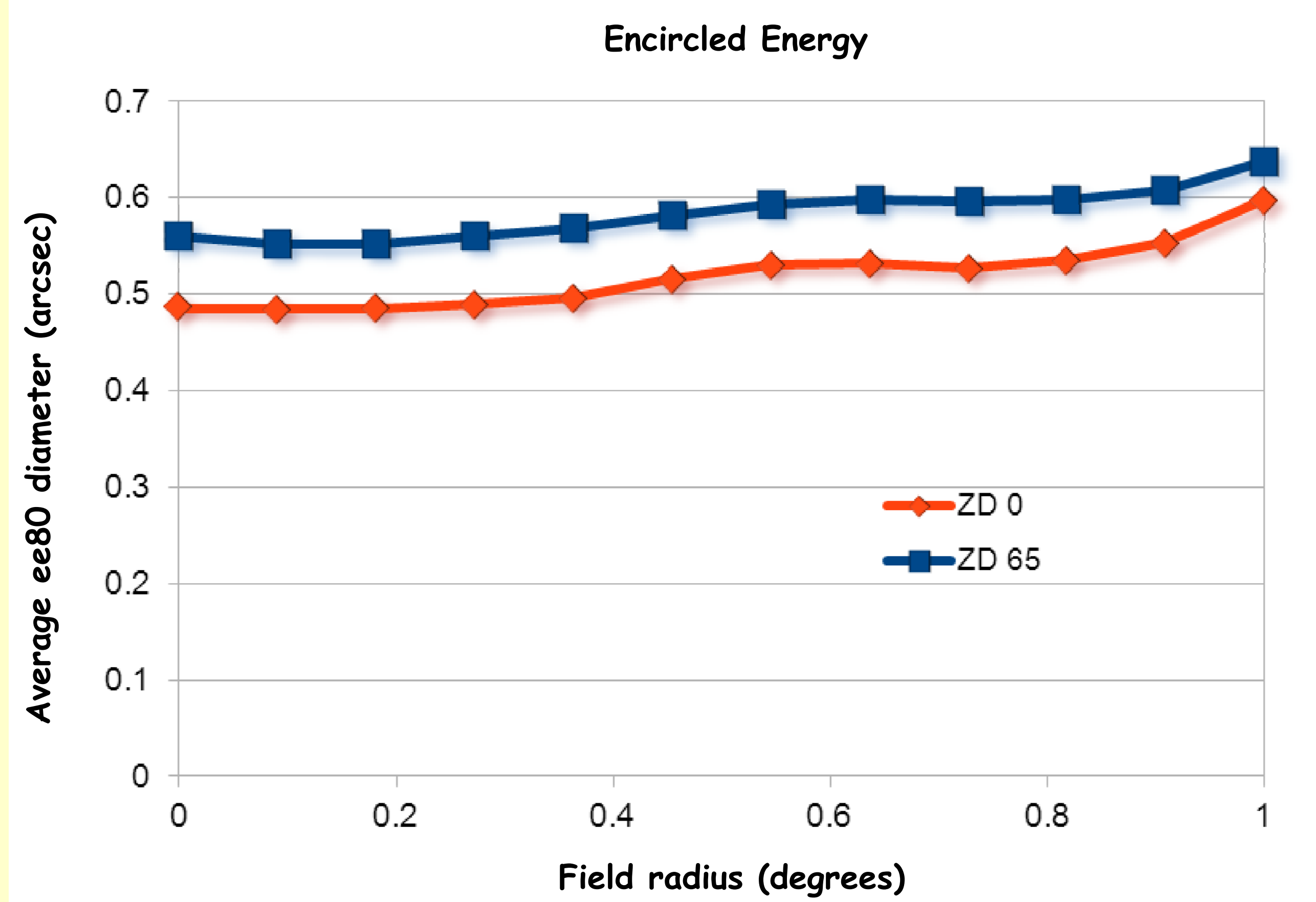
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We present a conceptual optical design for a new refractive corrector for the prime focus of the 4.2m William Herschel Telescope, optimised to allow wide-field multi-object spectroscopy. The proposed design incorporates a counter-rotating cemented-doublet pair acting as Atmospheric Dispersion Corrector (ADC). It satisfies the demanding requirement that the PSF be no larger than 0.5 arcsec (80% encircled energy) over a wavelength range of 370 - 1000 nm, with a two degree FOV. This version of the design has evolved from those previously published (Agócs, 2010) and models an extended secondary obscuration, as well as taking into account the coupling of light into optical fibres at the image plane. This is achieved by constraining the image plane to be flat and ray intercepts to stay as close as possible to the normal.

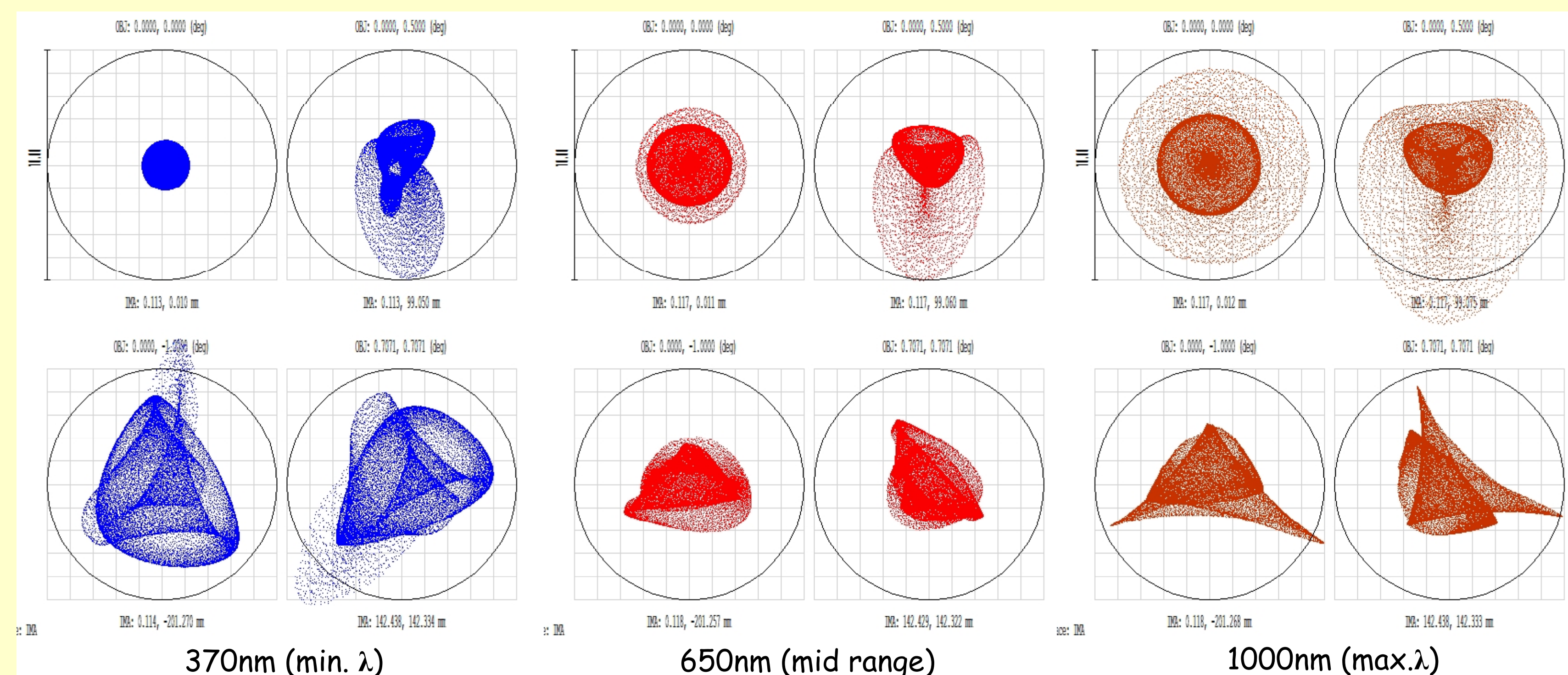


**Size comparison:** Proposed new corrector (left) vs. the PF corrector currently used on WHT (right). Each of the elements in the new design is larger than any in the current corrector; Lens1 is 940mm diameter, almost as large as the 1m scale bar (left of each diagram). The 2x cemented doublet structure of the proposed ADC is clear.

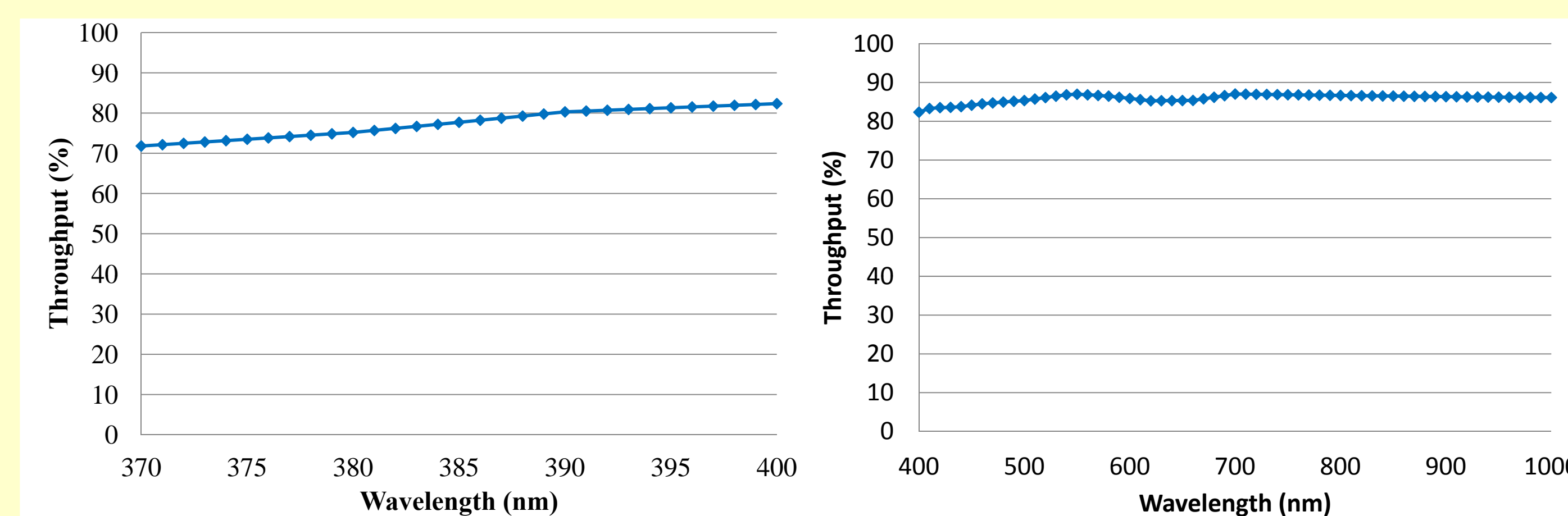
**LAYOUT:** 3D representation of the corrector design showing the on-axis beam. The first lens element has a diameter of 940 mm. On the right the counter-rotation of the two ADC components can be seen. Each component is a cemented doublet, whose surfaces are spherical, but the centre of curvature of these surfaces is displaced from the optical axis by a few millimetres.



**Image quality:** variation of the 80% encircled energy diameter with distance off axis (field radius) at zenith (red curve) and at an zenith distance of 65 degrees (blue curve). The degradation of image quality towards the very edge of the field is small. The graph shows the values for the latest design when optimised to minimise the 80% encircled energy diameter.



**Image Quality:** Spots formed by rays traced to the (flat) Image Plane at 4 positions in the field over the design wavelength range of the corrector, with the ADC correcting for a Zenith Angle of 15 degrees. The circles represent optical fibre cores of 70 microns or 1.2 arcsec diameter on the sky: the star images fall completely inside these in all but the least favorable conditions: edge of field (1 degree off axis) and wavelength extremes.



**THROUGHPUT** (left) Throughput for 370 - 400 nm (left) and 400 - 1000 nm (right). The first meniscus lens is single layer MgF<sub>2</sub> coated. The remaining surfaces have multi-layer anti-reflection coating

## CONCLUSIONS

We have presented the optical design now favoured as a new refractive corrector for the WHT prime focus, which is optimised to deliver good polychromatic images over a 2 degree field of view, meeting the science requirements for future projects such as WEAVE wide-field spectroscopy or PAUCAM photometric redshifts. The latest design is adapted to coupling into optical fibres, models secondary obscuration more accurately and has involved consultation with glass manufacturers throughout. These details bring the design closer to forming the basis for a realistic manufacturable system.

**Reference:** Agócs, T. "Two-degree FOV prime focus corrector and ADC concepts for the 4.2m WHT", Proc. SPIE 7735, pp. 773563-773563-11 (2010).