2° Forum della Ricerca Sperimentale e Tecnologica

Telescopes with resilient astrometric response

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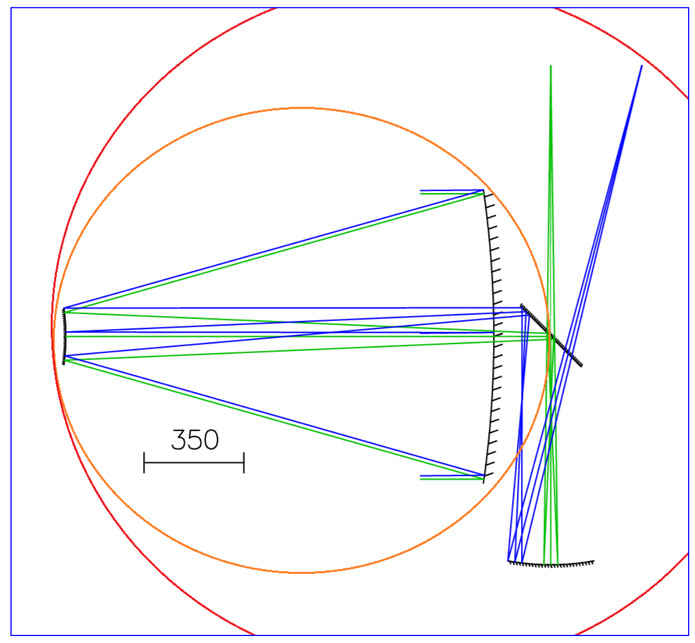
Science applications:

- **Exoplanets**
- **Astrophysics**
- **Gravitation / Gravitational Waves**

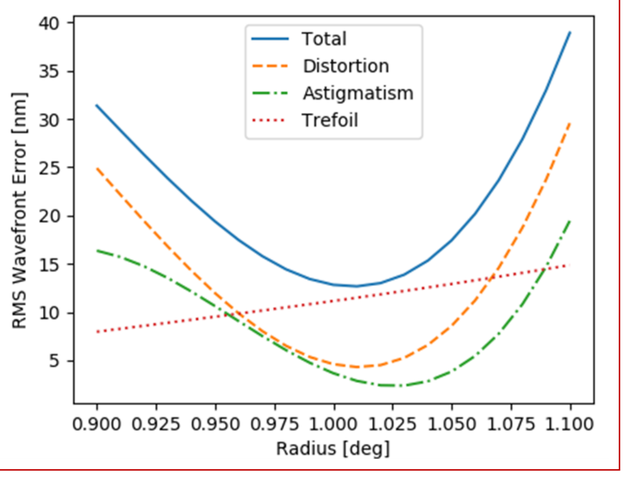
Remarks:

- **Designs mostly based on conic surfaces**
- **Curved focal planes**
- **Significant central obscuration**

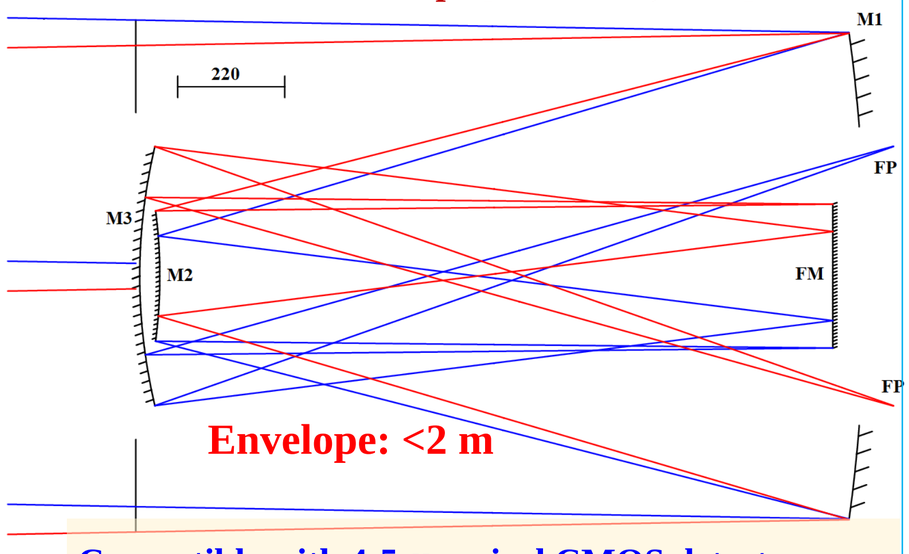
Abstract: Building on the concept of **Three-Mirror Anastigmats**, we deploy a family of telescopes with aperture diameter in the range **D = 1 m to 2 m**, focal length **EFL = 15 m to 30 m**, and **field of view ~0.2-0.5 square deg**, for astrometry.
The design is compatible with **4 micron CMOS** or **10 micron CCD** pixels, operating in the visible and/or near IR.
Circular symmetry is design enforced, ensuring **uniform optical response** over the field of view, thus easing calibration and reducing the sensitivity to perturbations. Manufacturing, alignment and monitoring issues (e.g. by onboard metrology) are also alleviated.
The **compact layout** ensures that the largest size payload may fit on top of a given size spacecraft.



Aberrations usually depend on powers of field radius



RAFTER telescope [Riva et al., 2020]



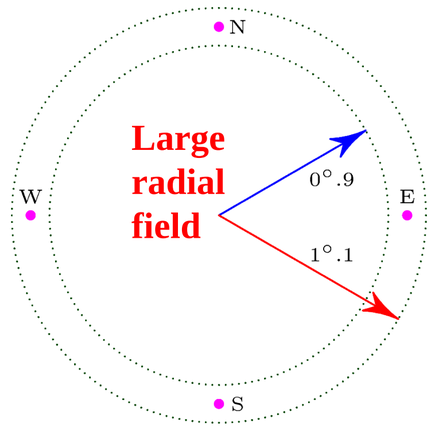
Envelope: <2 m

Compatible with 4-5 μm pixel CMOS detectors

PSF symmetric (zero skewness) vs. any radial axis

Rationale of symmetric configurations:

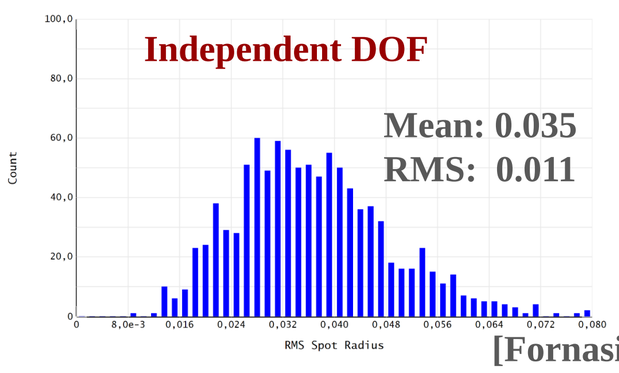
- **Larger telescopes in given size payload**
- **Stable symmetric structure**
- **Symmetric optical response eases calibration**
- **Compatible with monitoring/metrology systems**

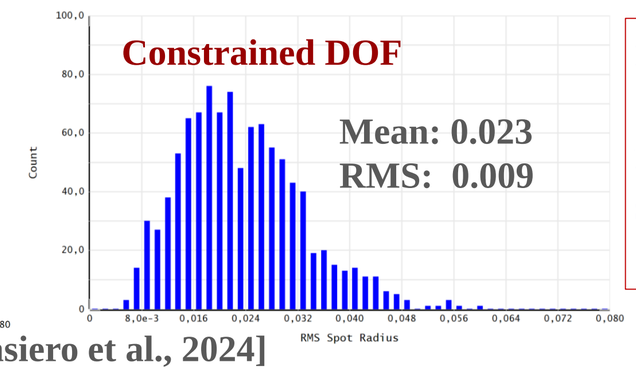


- **Diffraction limited field >1□.25**
- **Focal plane: 66 4k² CMOS, ~0□.26**

Annular field: reach large angle without filling pixels in-beteen

Mechanical perturbations: Montecarlo inverse sensitivity

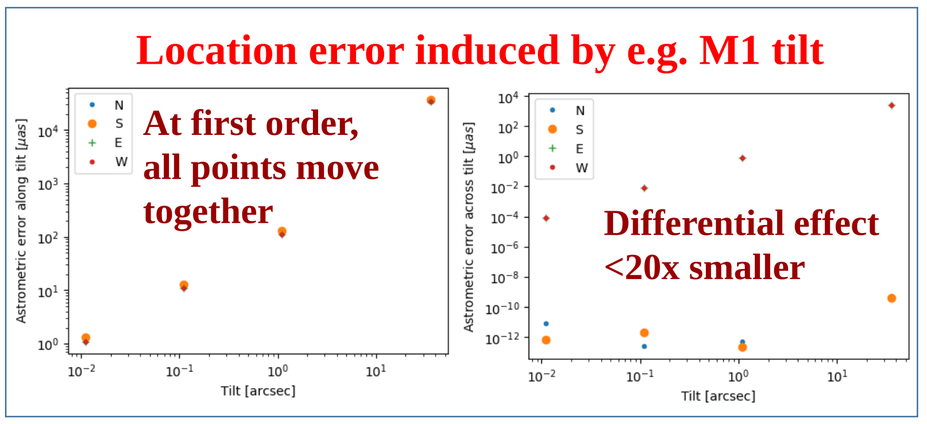




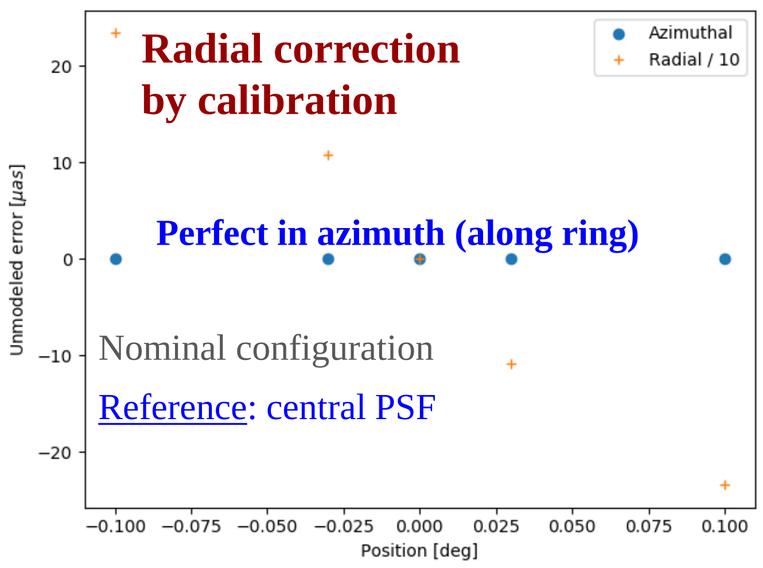
reduced # of degrees of freedom ⇒ smaller overall degradation

[Fornasiero et al., 2024]

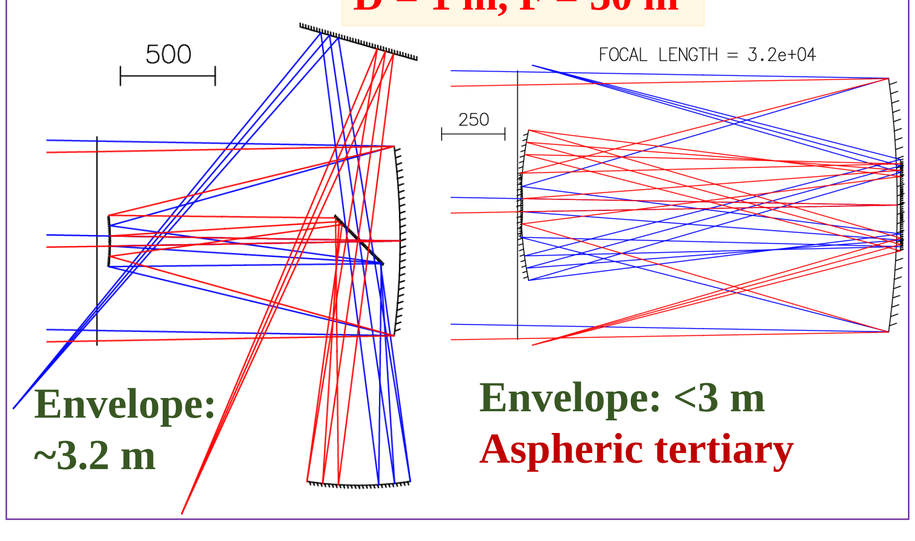
Location error induced by e.g. M1 tilt



Calibration curve: radial PSF variation



D = 1 m, F = 30 m



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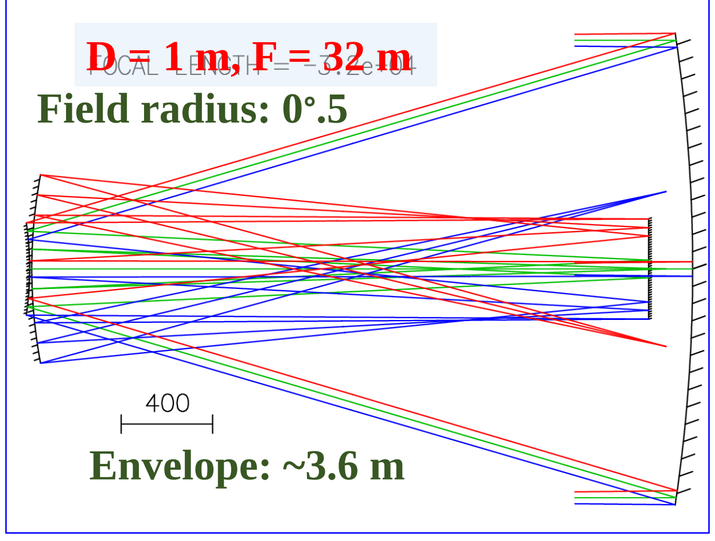
Aspheric tertiary

D = 1 m, F = 32 m

Field radius: 0°.5



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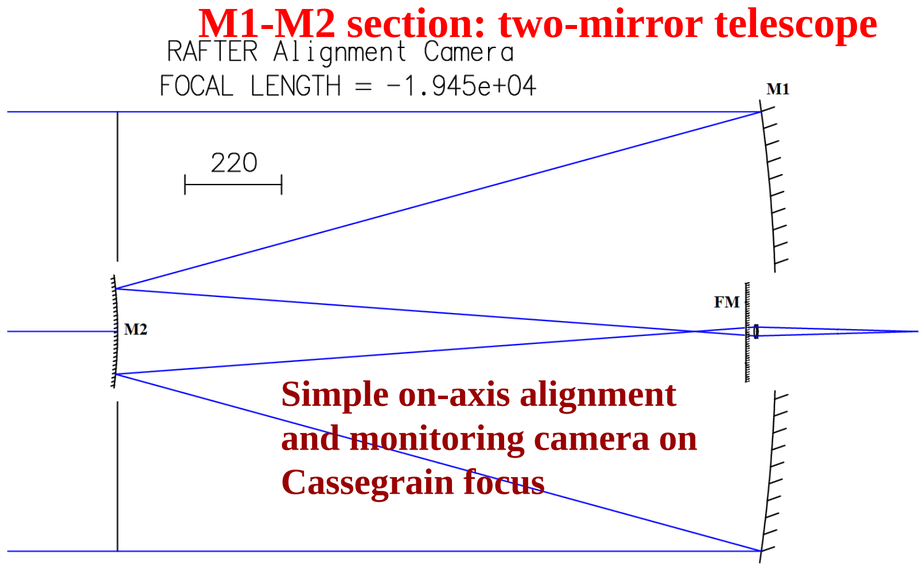
M1-M2 section: two-mirror telescope

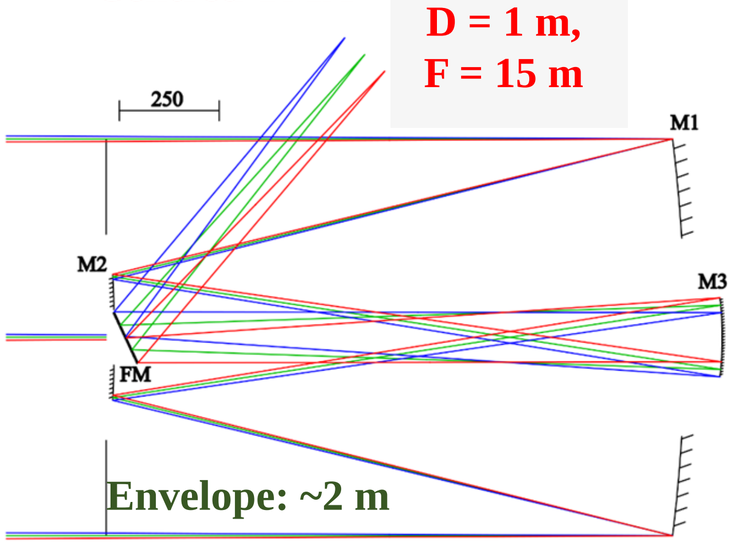


Simple on-axis alignment and monitoring camera on Cassegrain focus

(M2, M3) and (M1, FM): rigid sub-assemblies: alignment of M2 to M1 aligns whole telescope

Centred TMA

D = 1 m, F = 15 m



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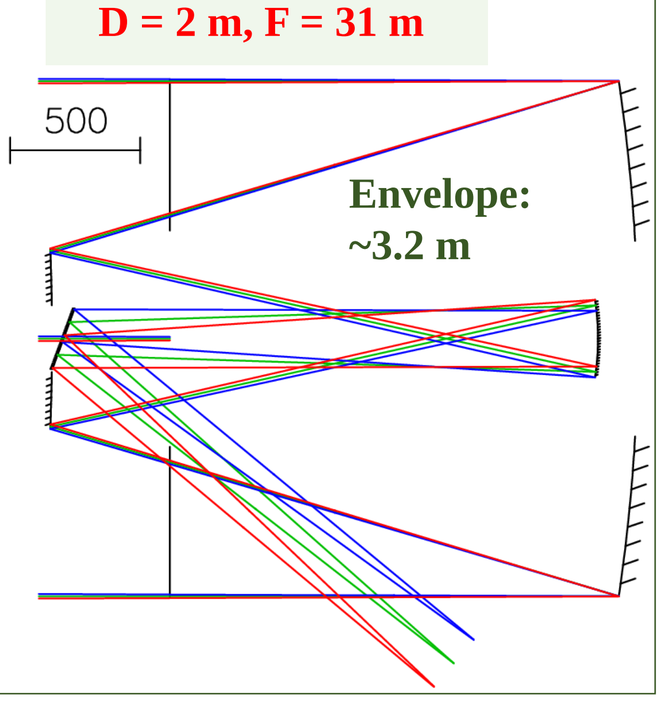
[Gai et al., 2020]

D = 2 m, F = 31 m



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