MagAO-X PDR

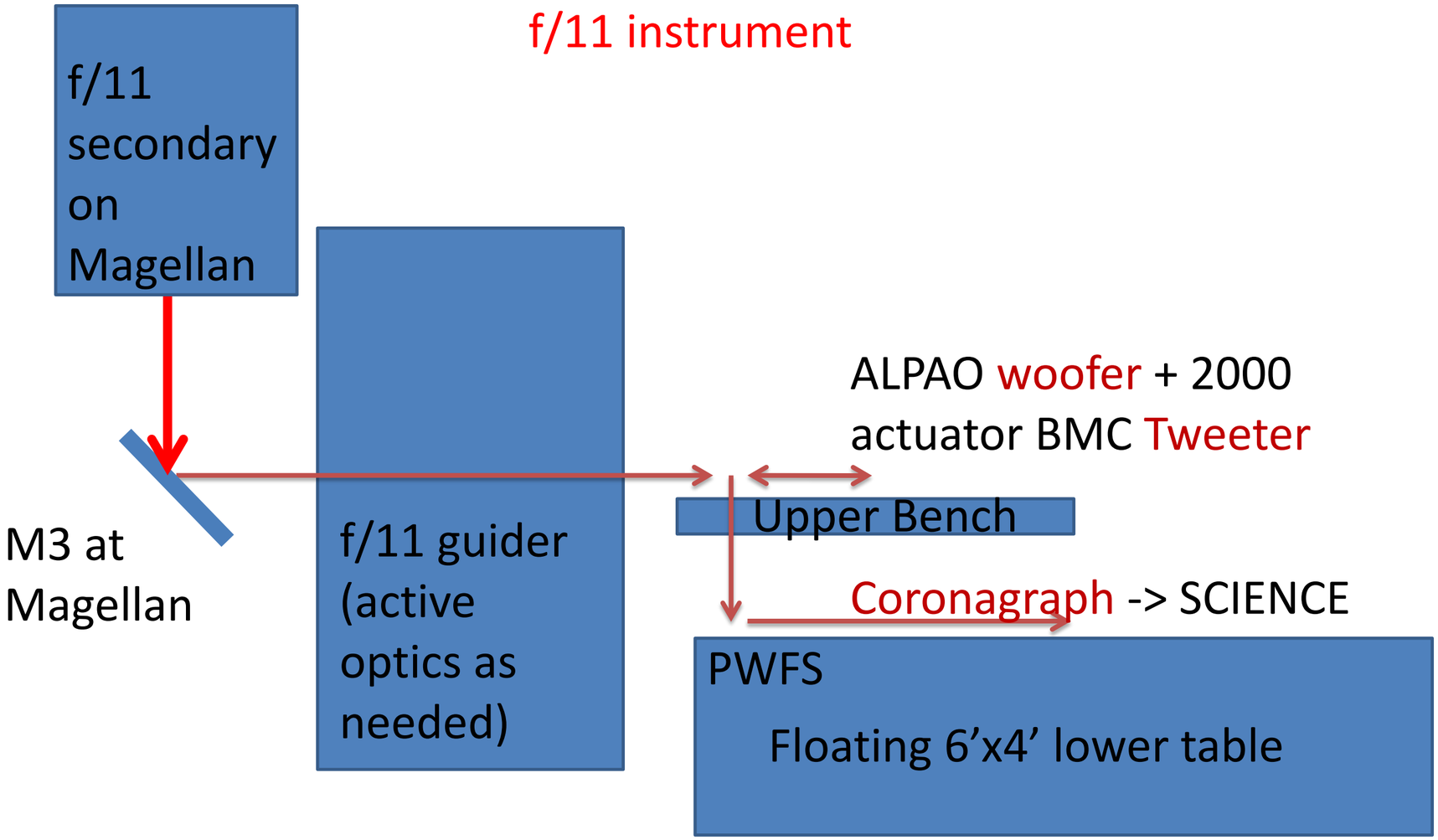
Appendix A1: Optical interface to Magellan

Laird Close

4/18/2017

Conceptual design of f/11 MagAO-X optics with Coronagraph

MagAO-X in its f/11 mode is a normal f/11 instrument

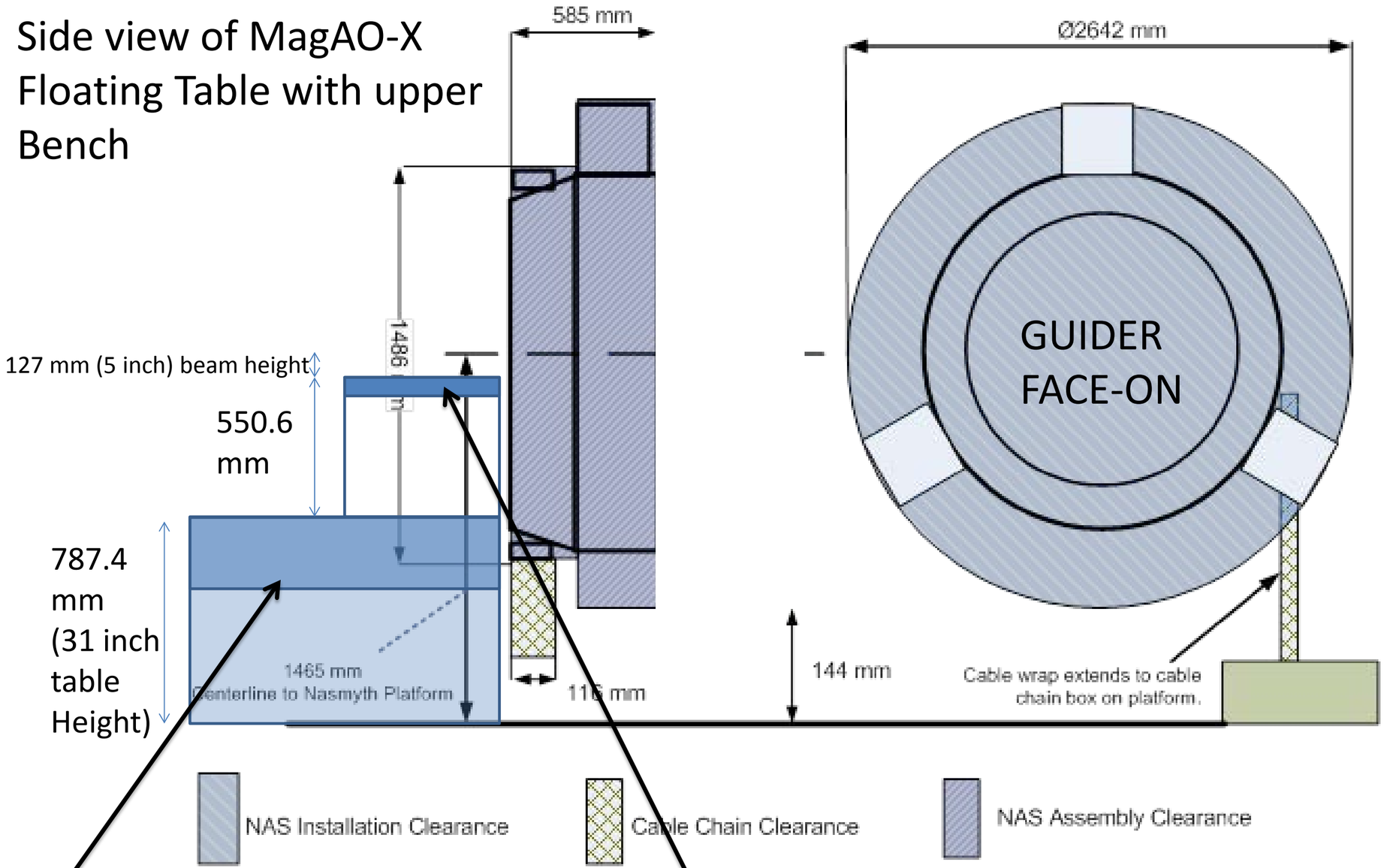


MagAO-X Summary:

~80% Strehl at 0.65 microns + PIAACMC coronagraph with **Contrasts of 10^{-5}-@50 mas and 10^{-6} @150 mas** on a 5th mag star in median conditions.
Also can feed MKID or RHEA IFS R=60,000 (PI Ireland)

9.6mm air gap between table and f/11 guider for 125mm back focal dist.

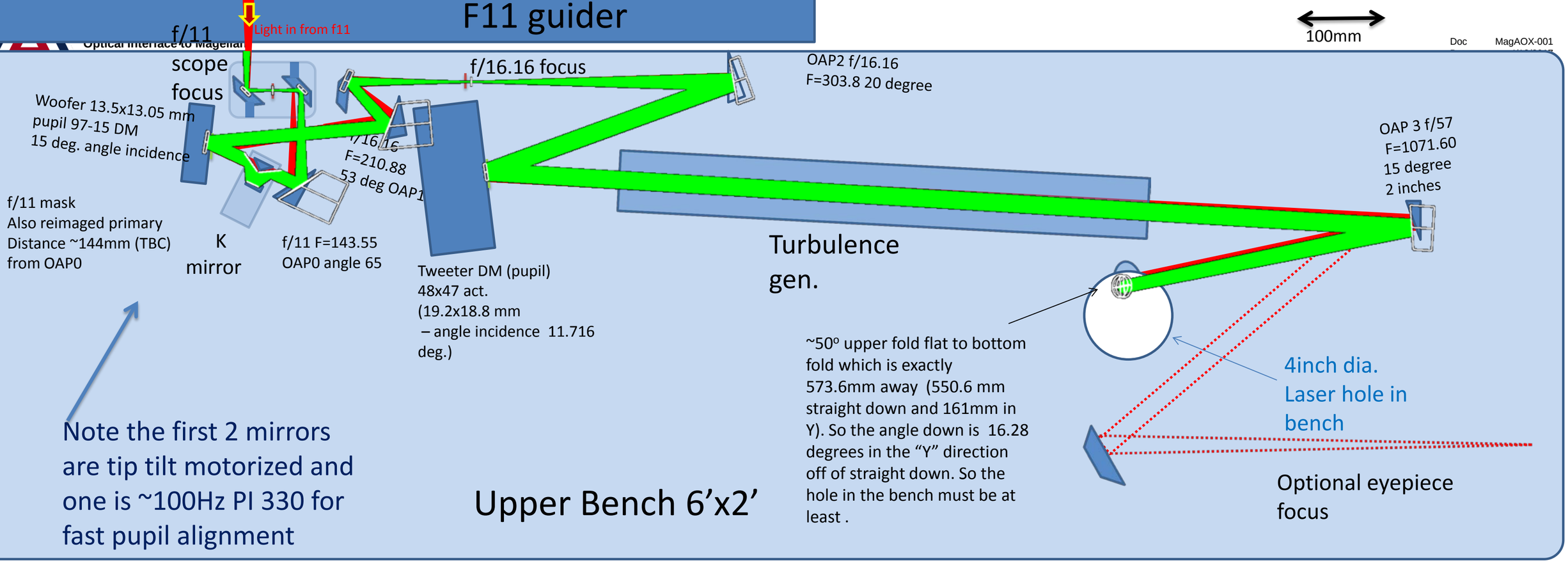
Side view of MagAO-X Floating Table with upper Bench



Lower 6’x4’x1’ TMC research grade optical top

Upper 2’x6’x4” TMC research grade optical breadboard (aligned with Table)

F11 guider

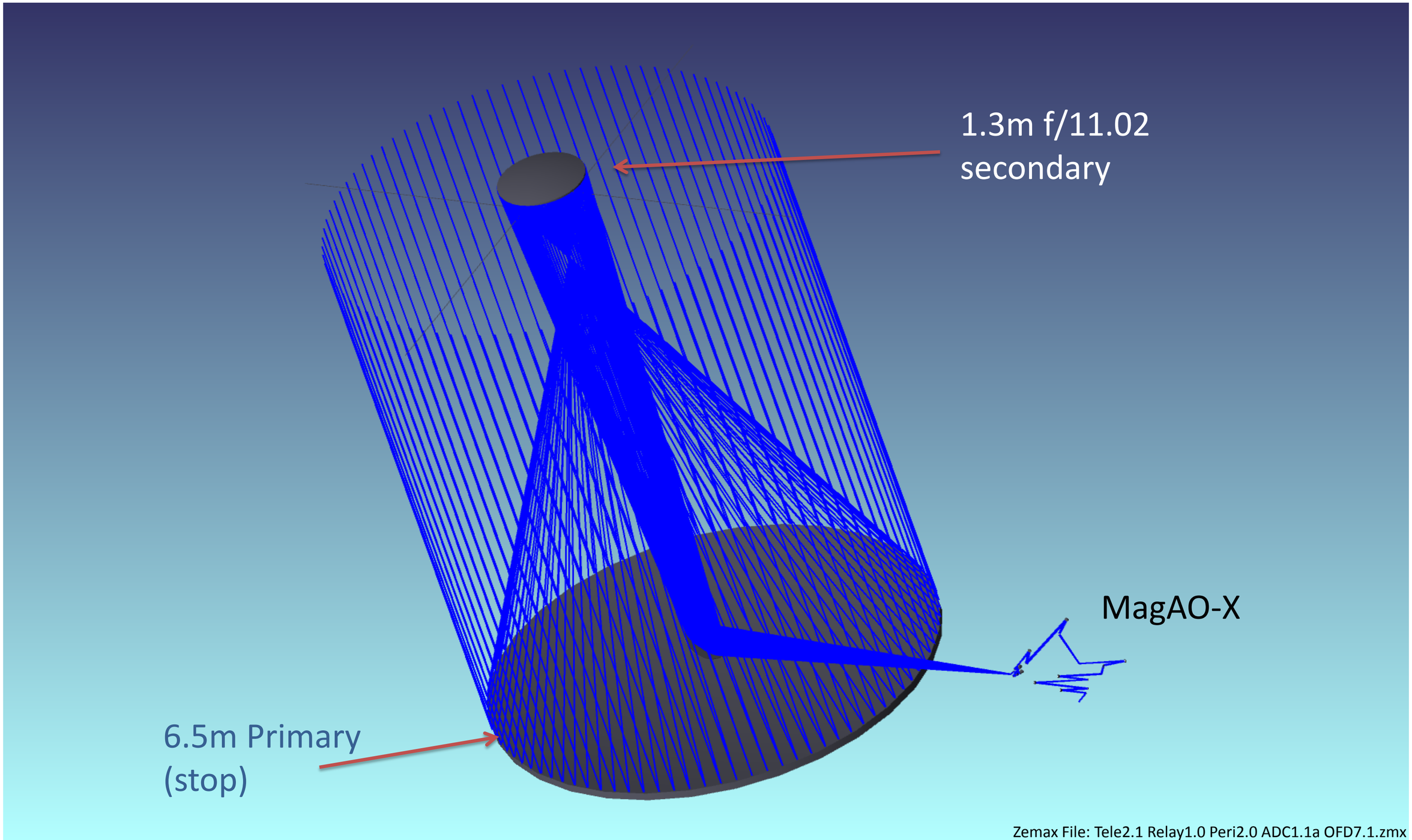


Zemax design in Green – agrees with our analytical optical design, OAPs and pupils correct in ZEMAX.

OPTICAL DESIGN

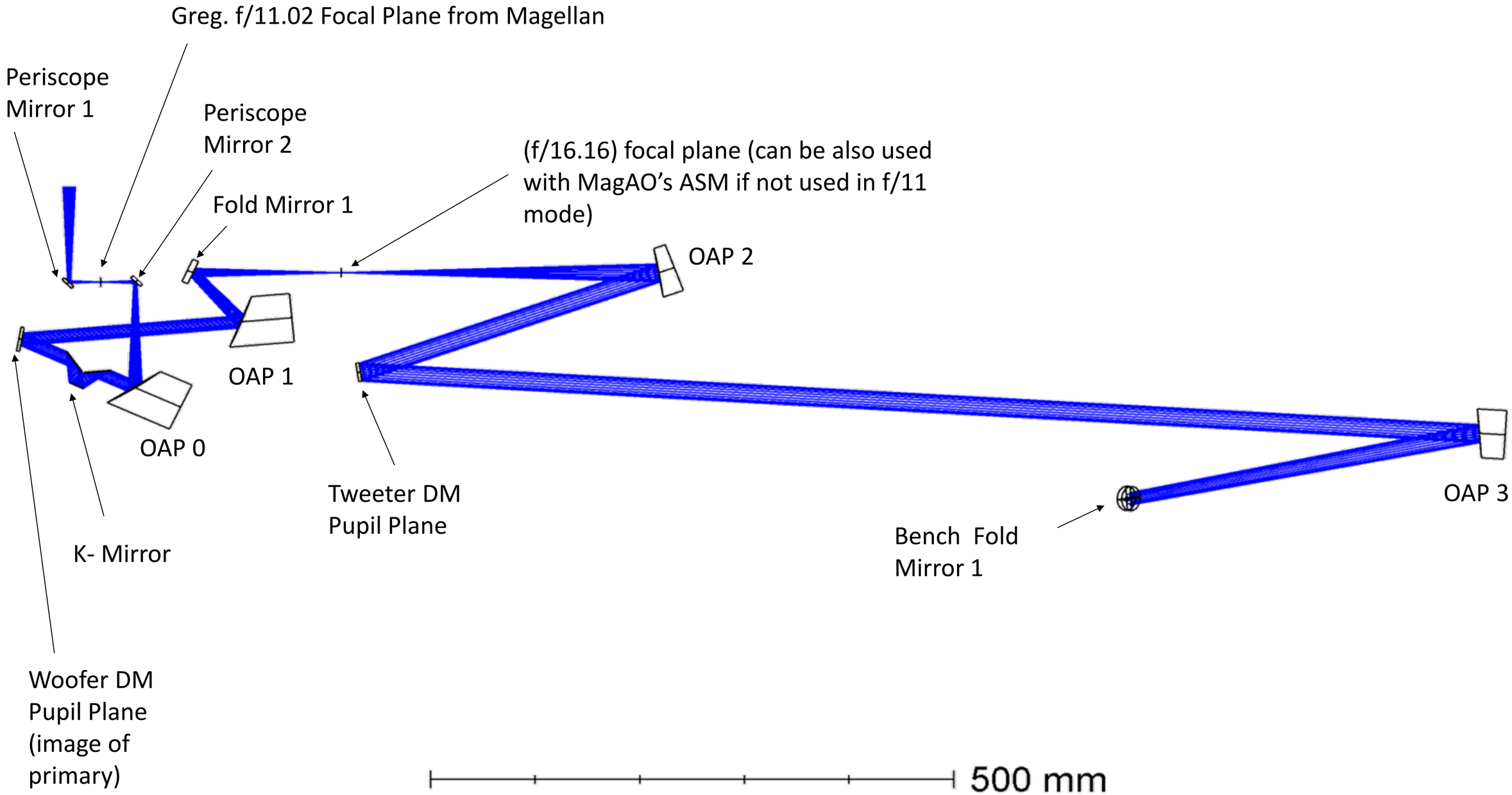
- Zemax design by Oli Durney (Senior Optical Engineer Steward Observatory) from initial analytical design
- The design is all reflective (save the ADCs)
- All the powered optics are OAPs (eliminates ghosts and chromaticity)
- The ADC design is diffraction-limited from 1-2 airmasses and from 0.6 to 1.8 microns. The ADC is commonpath with the PWFS and the science cameras.
- The design was first analytically done by Laird Close and then done with zemax by Oli Durney. Both designs are in excellent agreement.
- The true aperture stop (the primary mirror) is relayed to the Woofer pupil to the Tweeter pupil to the first coronagraphic pupil to the Lyot stop.
- The first coronagraphic focal plane is f/67 and is the location of the coronagraphic mask
- The final focal plane is after the Lyot stop and is also f/67 yielding a 6mas/pixel platescale on the Ultra 888 science camera.
- The optical quality of the on-axis beam has a Strehl 100% (with perfect optics) over any broad band astronomical filter that we would use (such as r’,i’,z’,J, H).

Shaded Model of f/11 + MagAO-X



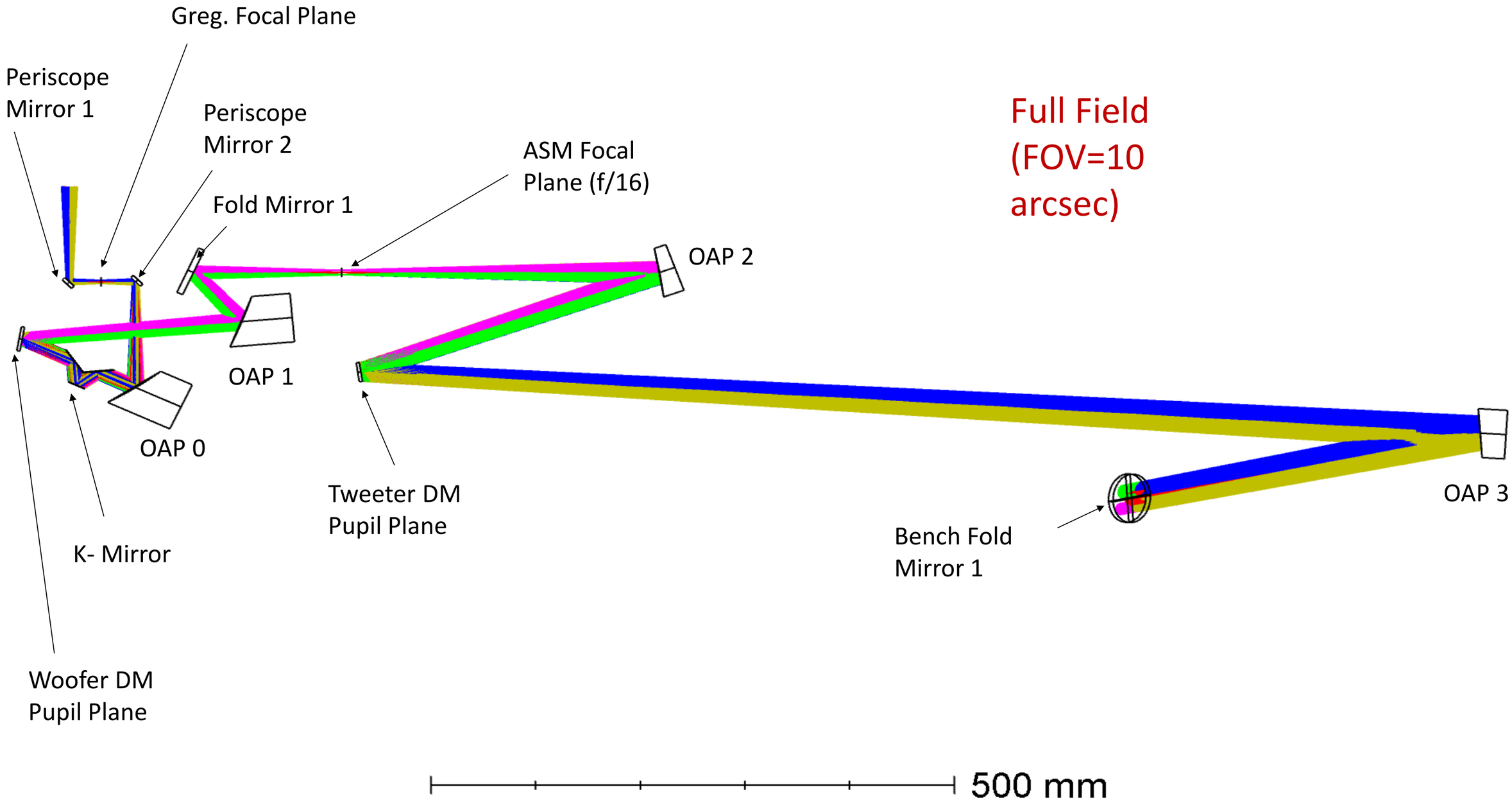
Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

Upper Bench Optical Design (on-axis)



Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

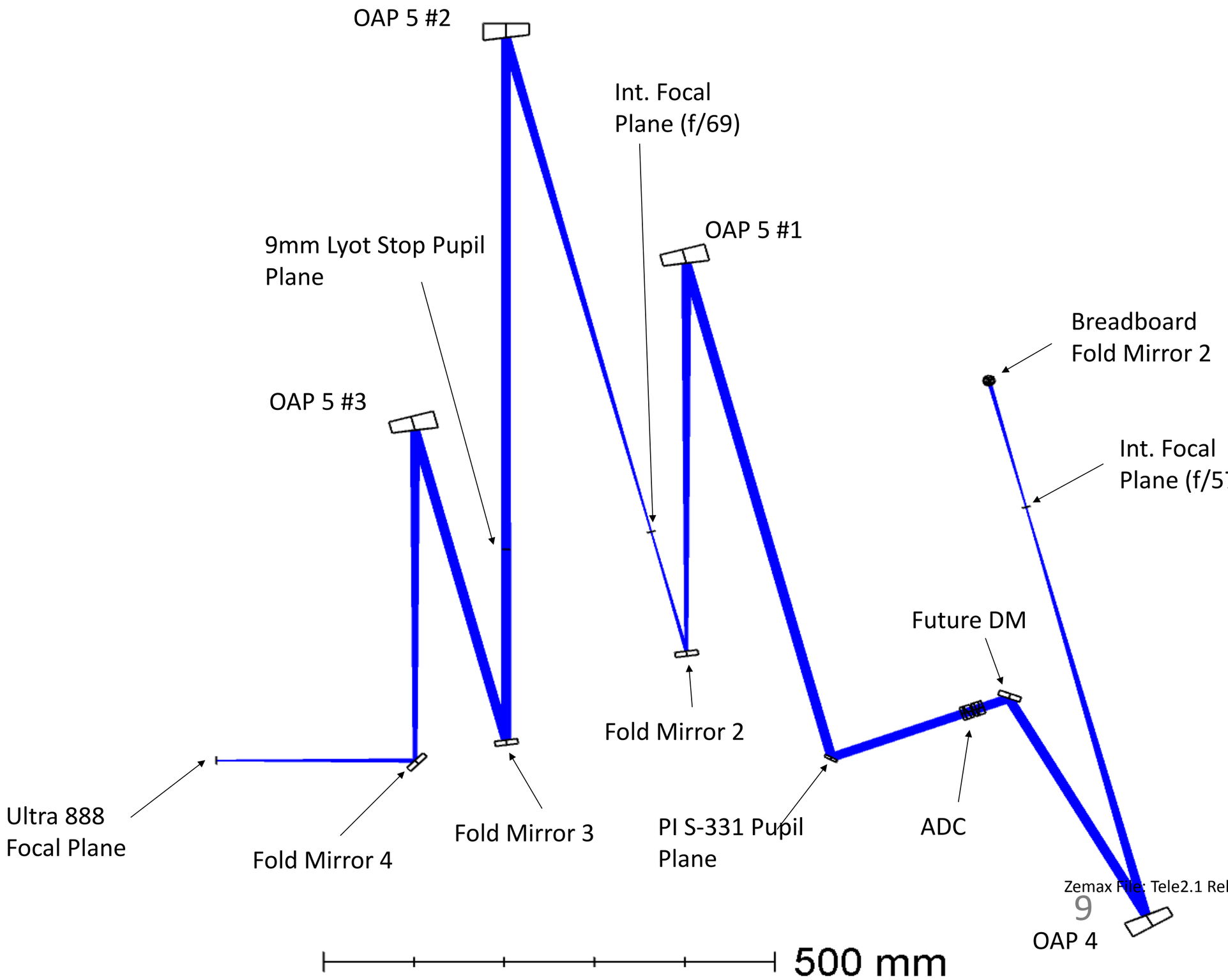
Upper Bench Optical Design (10” FOV)



Full Field (FOV=10 arcsec)

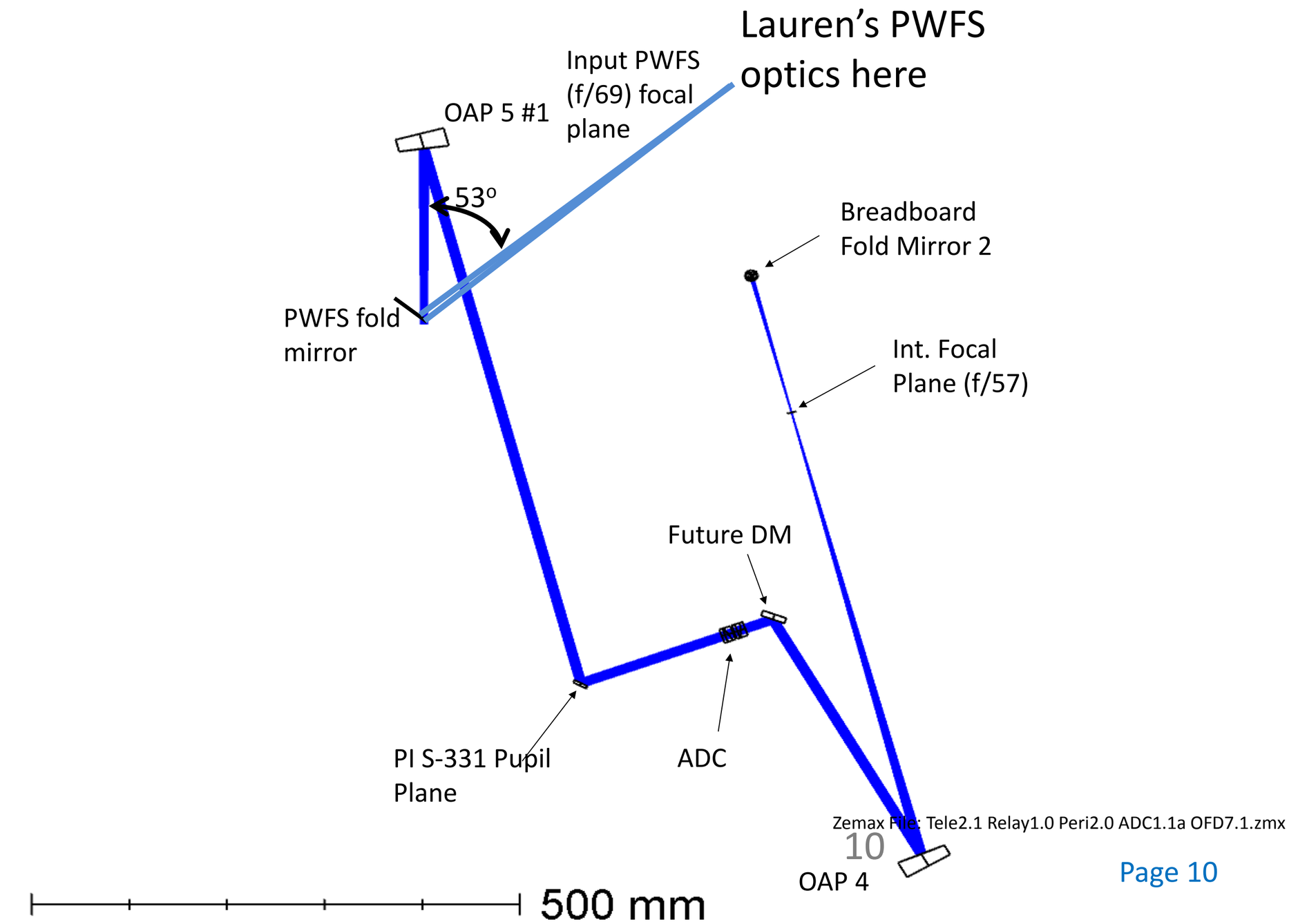
Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

Lower Table Optical Design On-Axis



Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

Lower Table Optical Design with PWFS



Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

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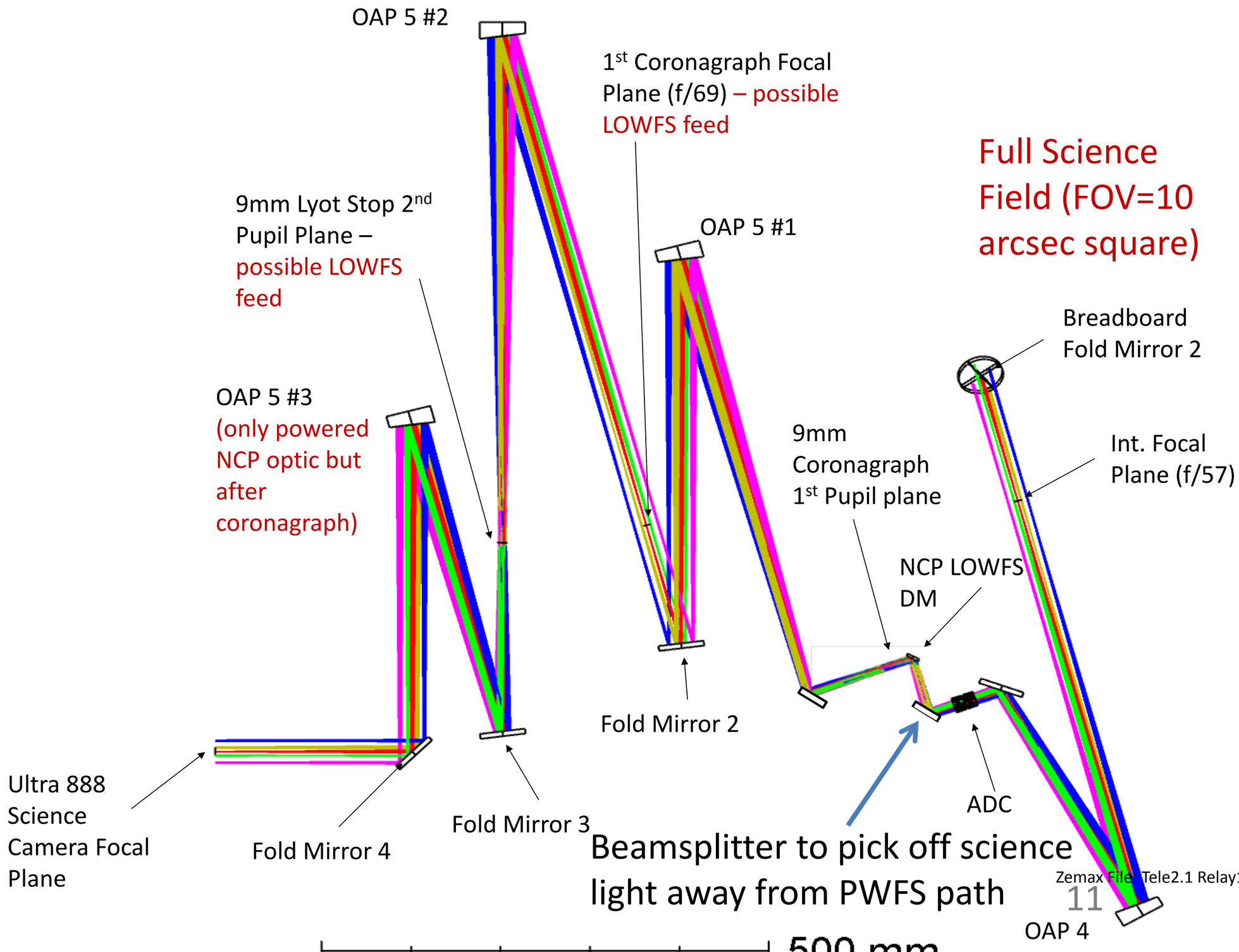
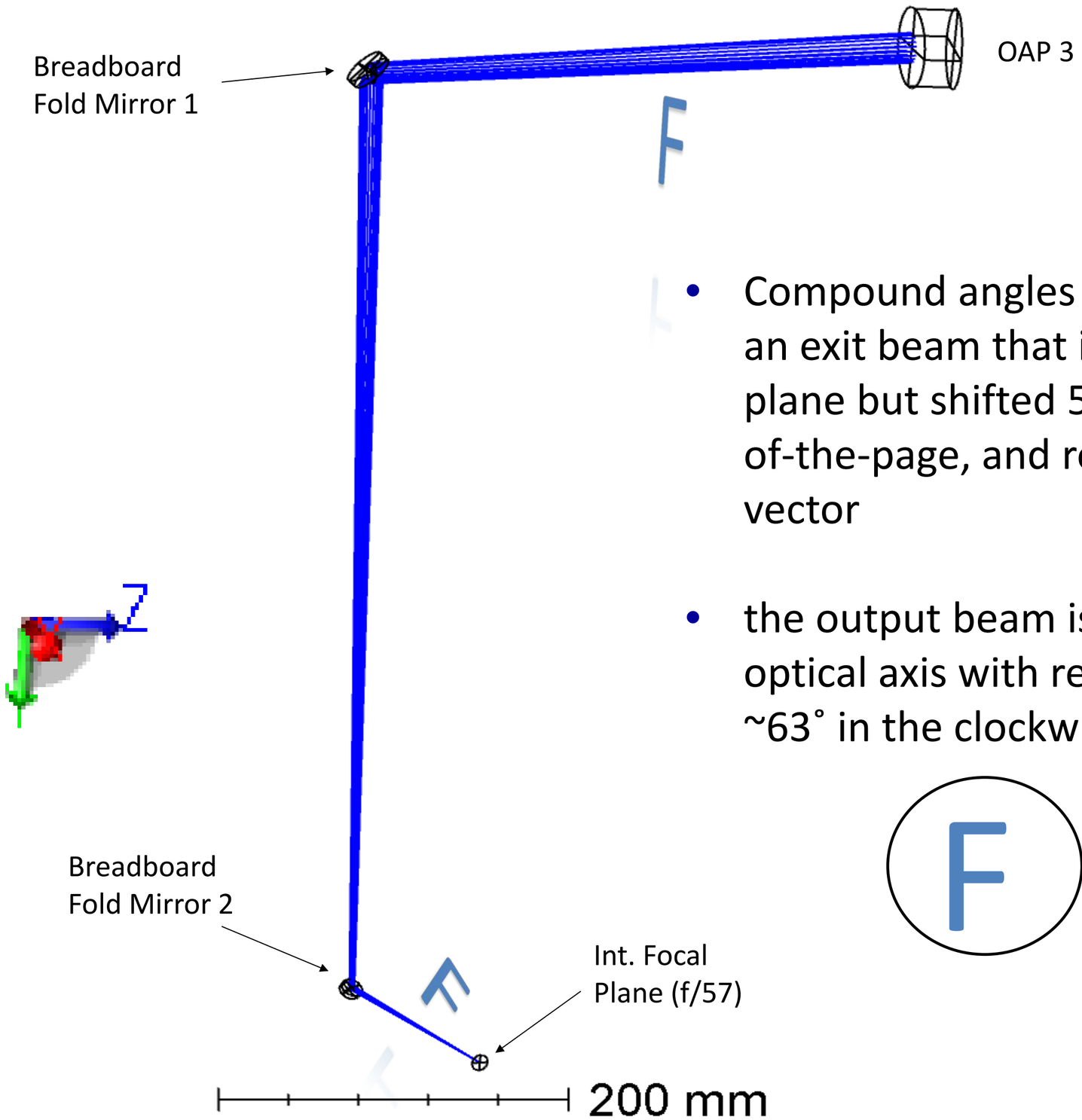
Date: 4/18/2017
Status:Draft v. 21

Lower Table Science Full FOV



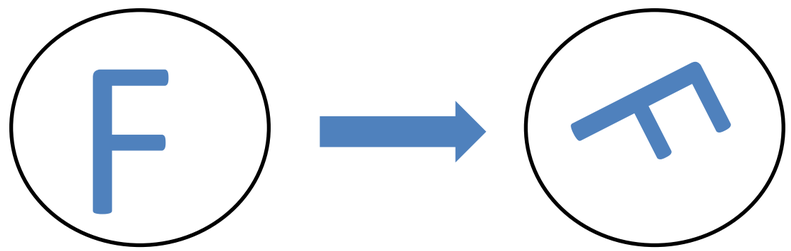
Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

Bench to Table Periscope



- Compound angles for both BBFM1 & 2 result in an exit beam that is parallel with the input beam plane but shifted 550.6 mm lower, 161 mm out-of-the-page, and rotated in its output direction vector

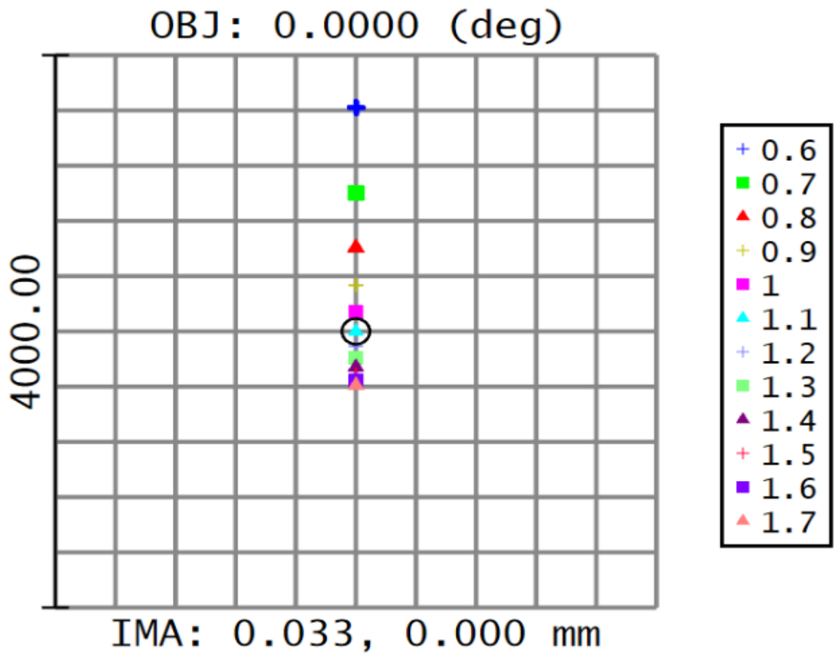
- the output beam is also rotated about the optical axis with respect to the input beam by ~63˚ in the clockwise direction.



Zemax File: Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD7.1.zmx

Spot Diagrams for Zenith Z=40° w/ ADC

No ADC Correction



Surface IMA: Ultra 888 Focal Plane

Spot Diagram

Magellan With f/11 Secondary
2/16/2017
Units are µm. Airy Radius: 92.64 µm. Legend items refer to Wavelengths
Field : 1
RMS radius : 620.382
GEO radius : 1635.77
Scale bar : 4000 Reference : Chief Ray

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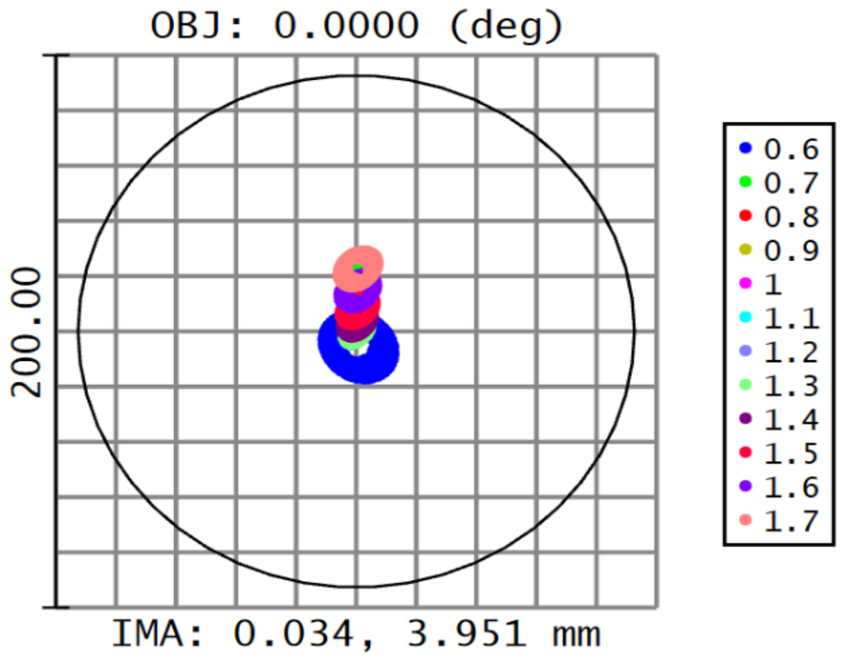
Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD5.5.zmx
Configuration 7 of 7

ADC Correction (Current Design)



Surface IMA: Ultra 888 Focal Plane

Spot Diagram

Magellan With f/11 Secondary
2/16/2017
Units are µm. Airy Radius: 92.65 µm. Legend items refer to Wavelengths
Field : 1
RMS radius : 12.594
GEO radius : 30.627
Scale bar : 200 Reference : Chief Ray

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Tele2.1 Relay1.0 Peri2.0 ADC1.1a OFD5.5.ZMX
Configuration 7 of 7

ADC Prism Design Layouts

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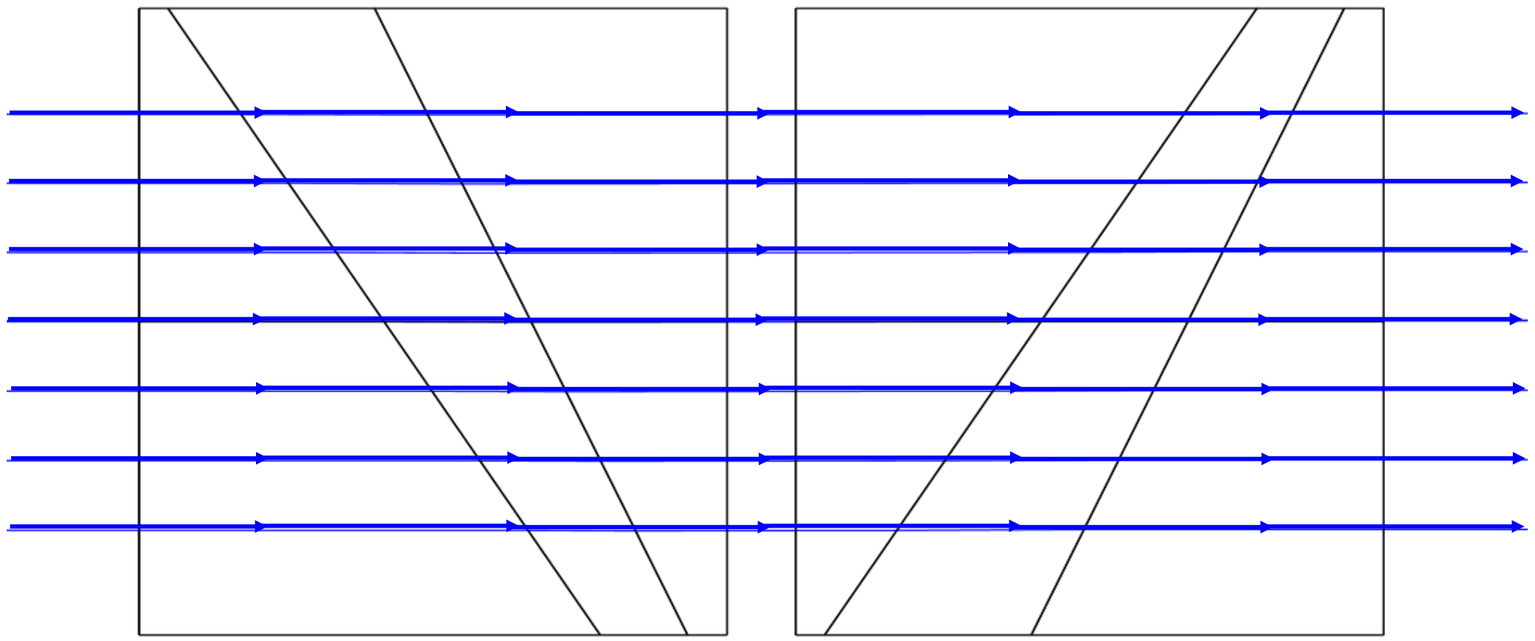
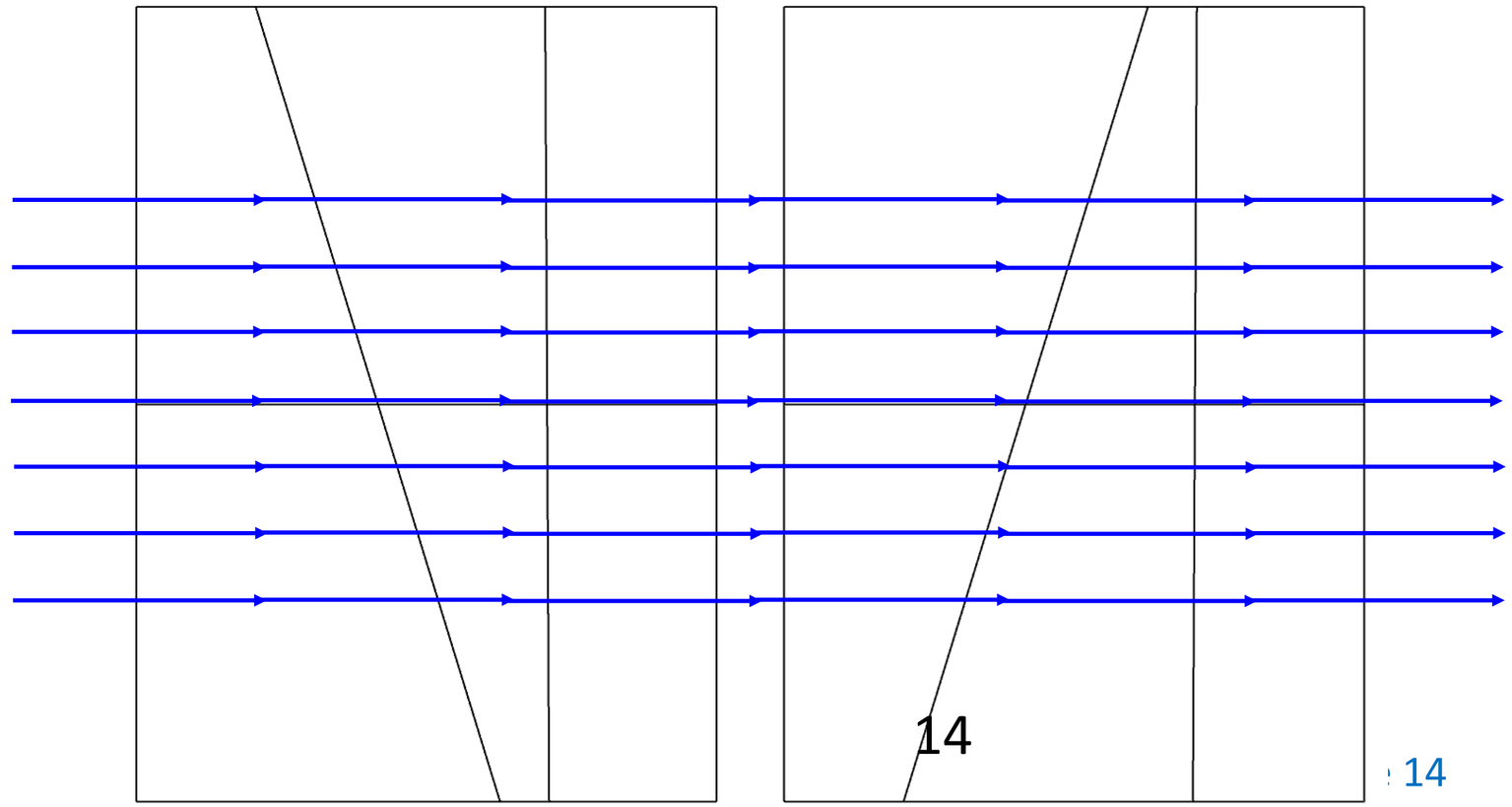
Current ADC Design

- ϕ = 14 mm
- S-PHM53, S-TIM8, N-KZFS4
- CT = 5.0, 3.0, 4.0 mm
- θ = 57.785°, 65.474°



New ADC Design

- ϕ = 18 mm
- S-PHM53, S-TIM8, N-KZFS4
- CT = 5.0, 3.5, 3.5 mm
- θ = 73.687°, 0.260°



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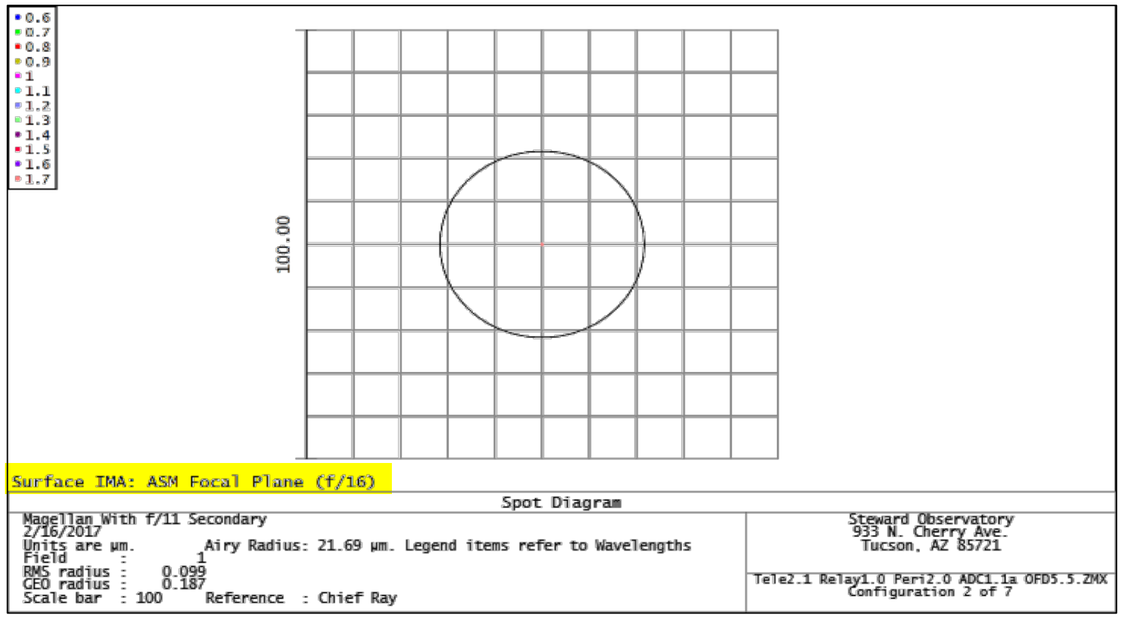
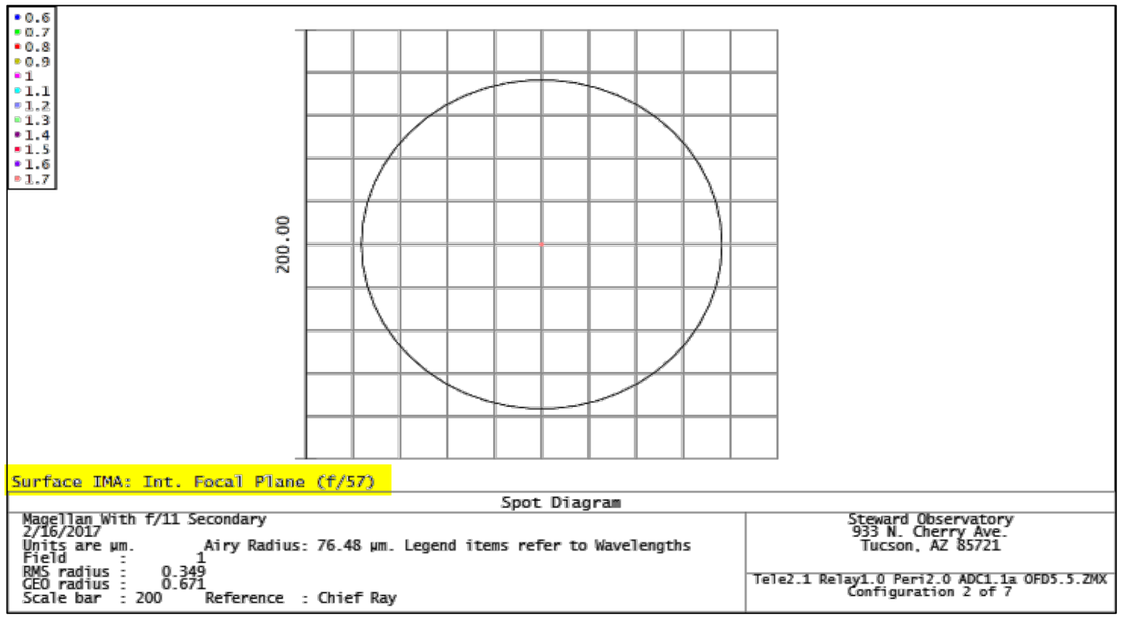
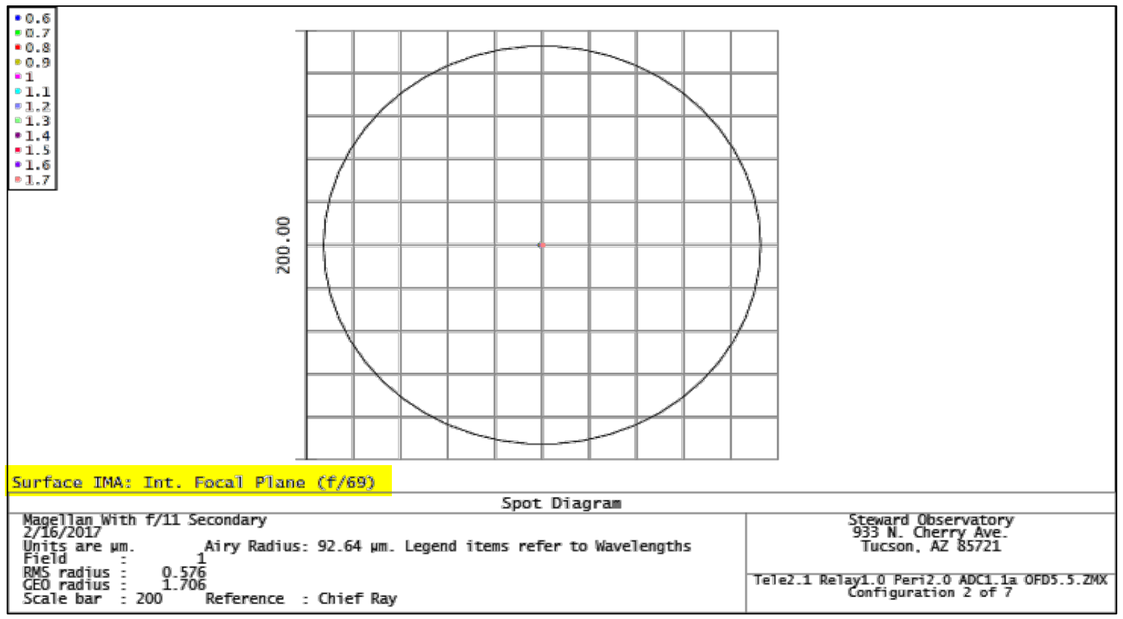
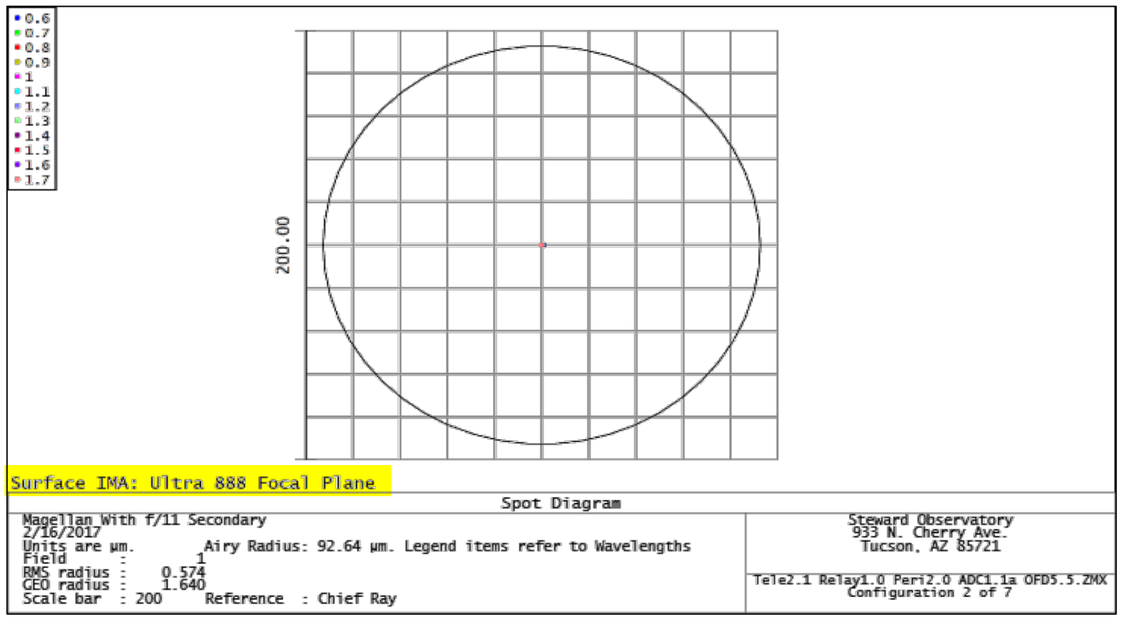
Spot Diagrams at Focal Planes

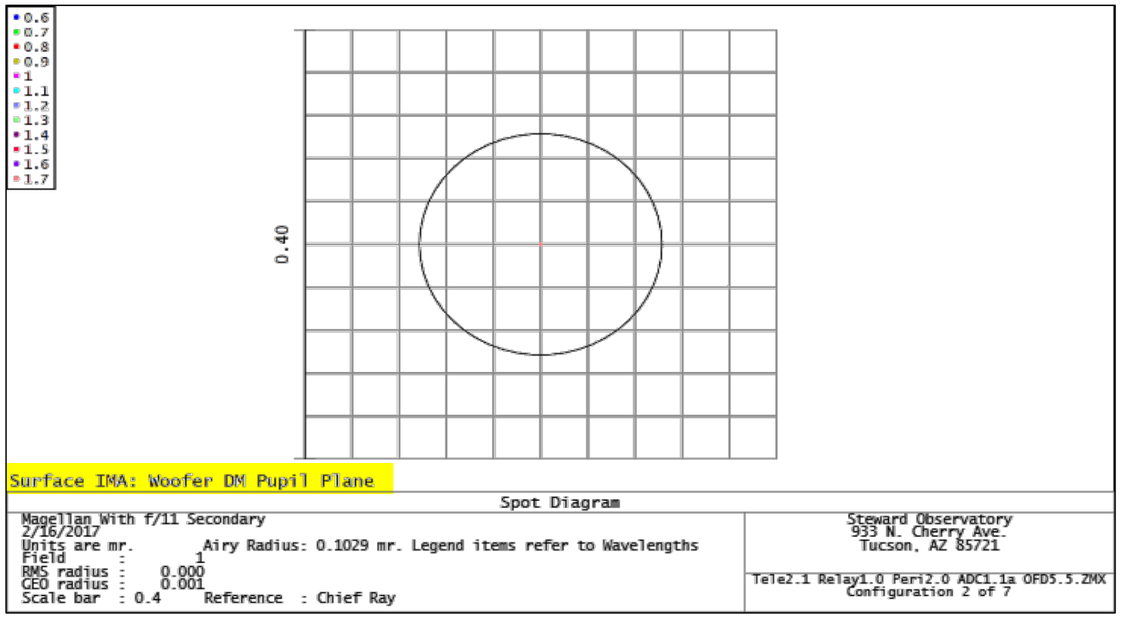


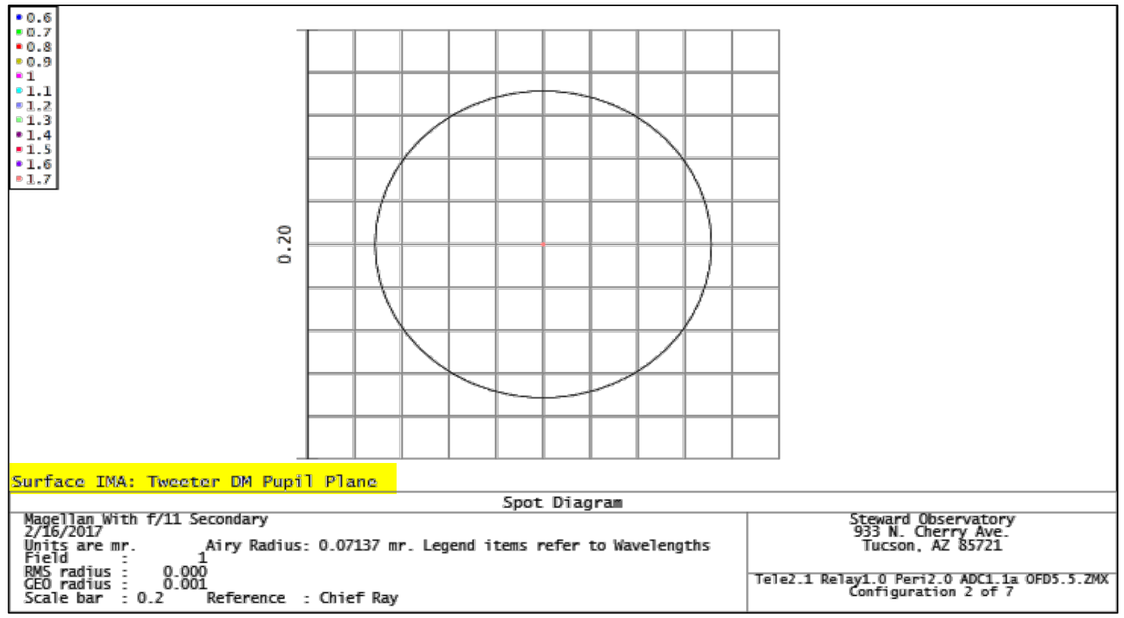


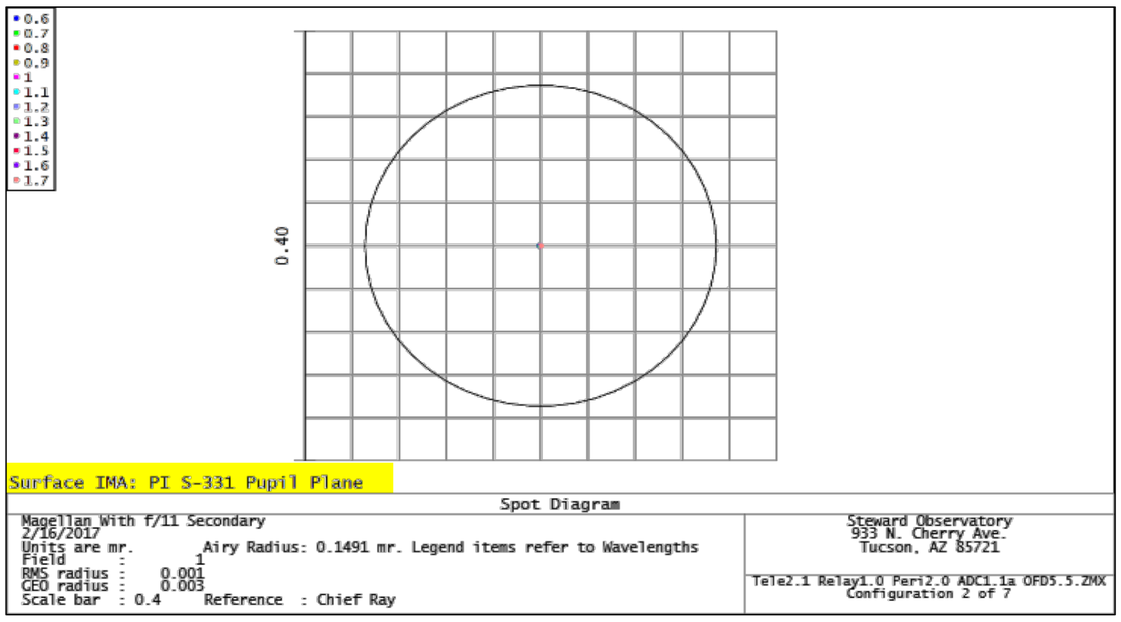


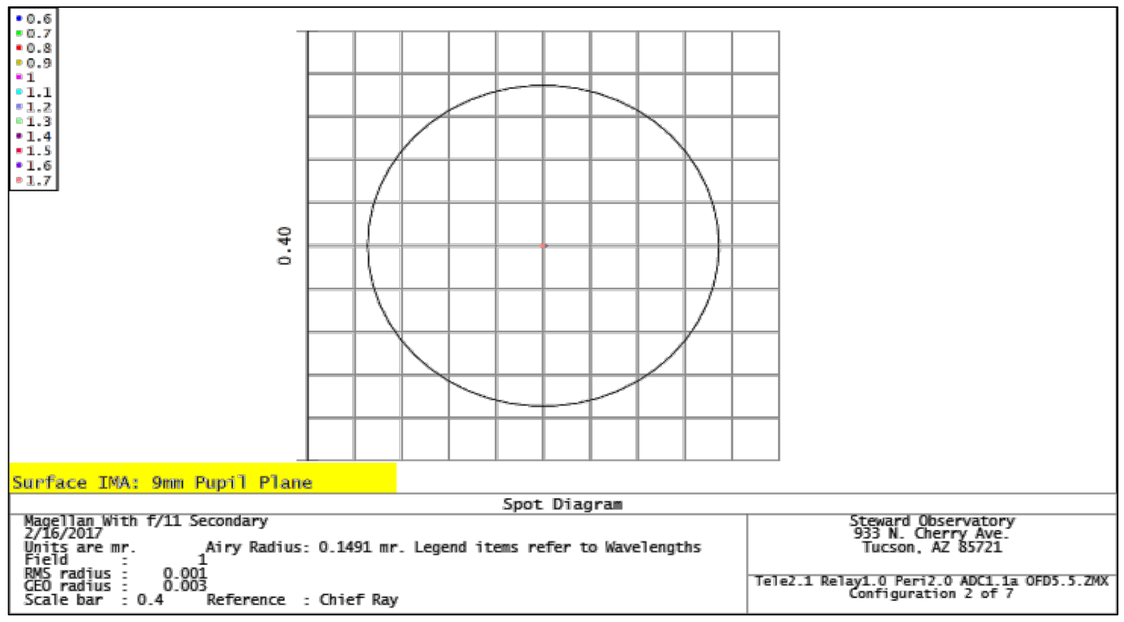


Spot Diagrams at Pupil Planes

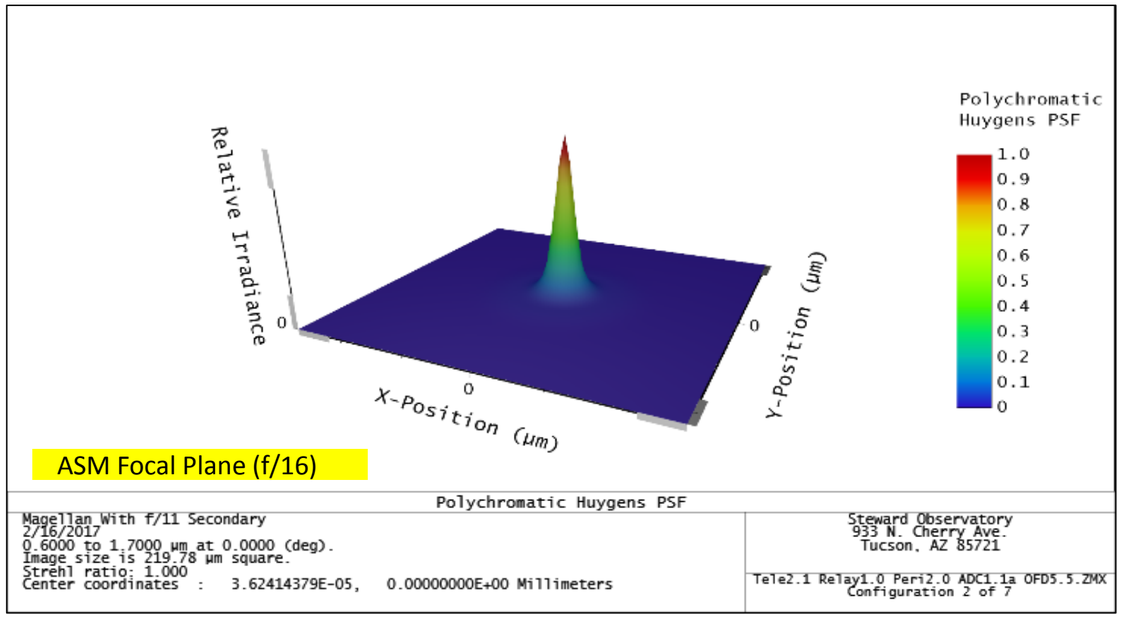




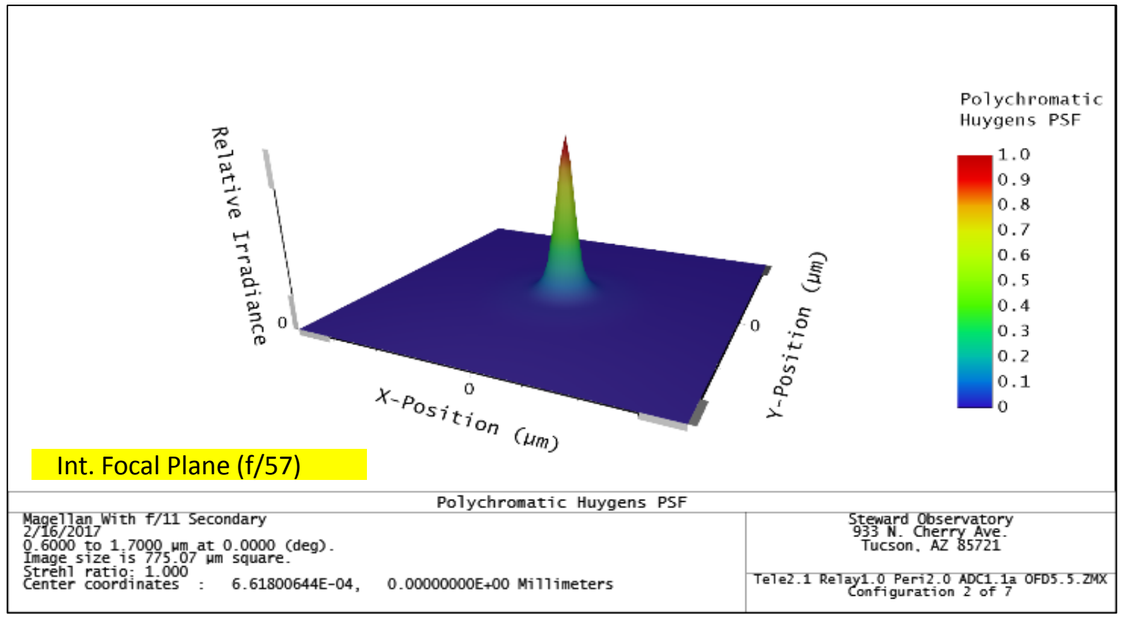




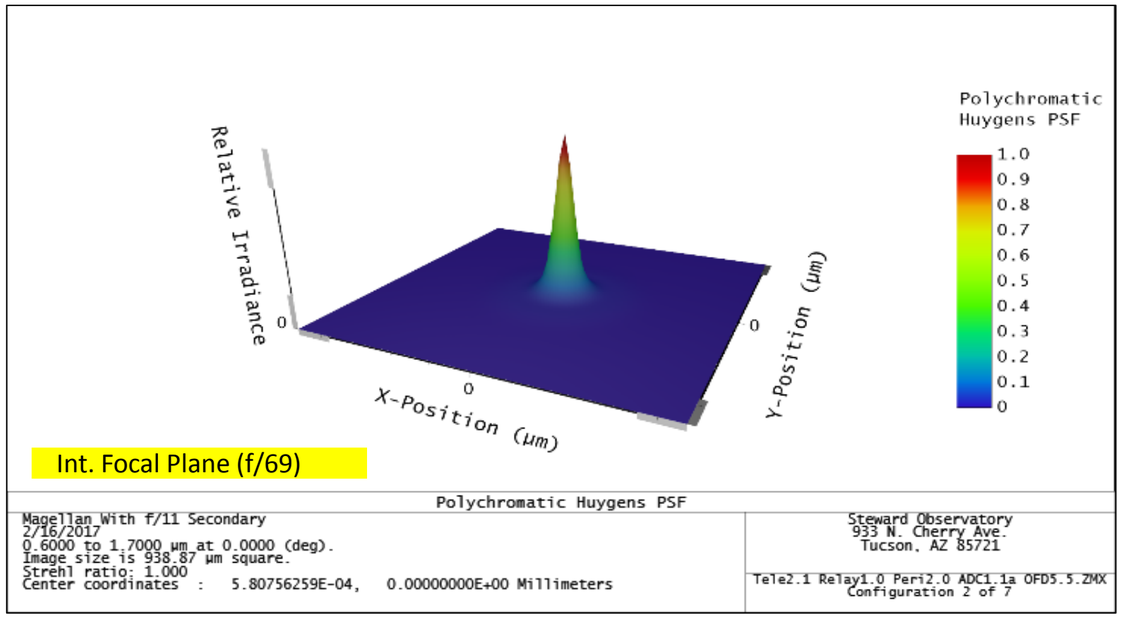
PSF at Focal Planes



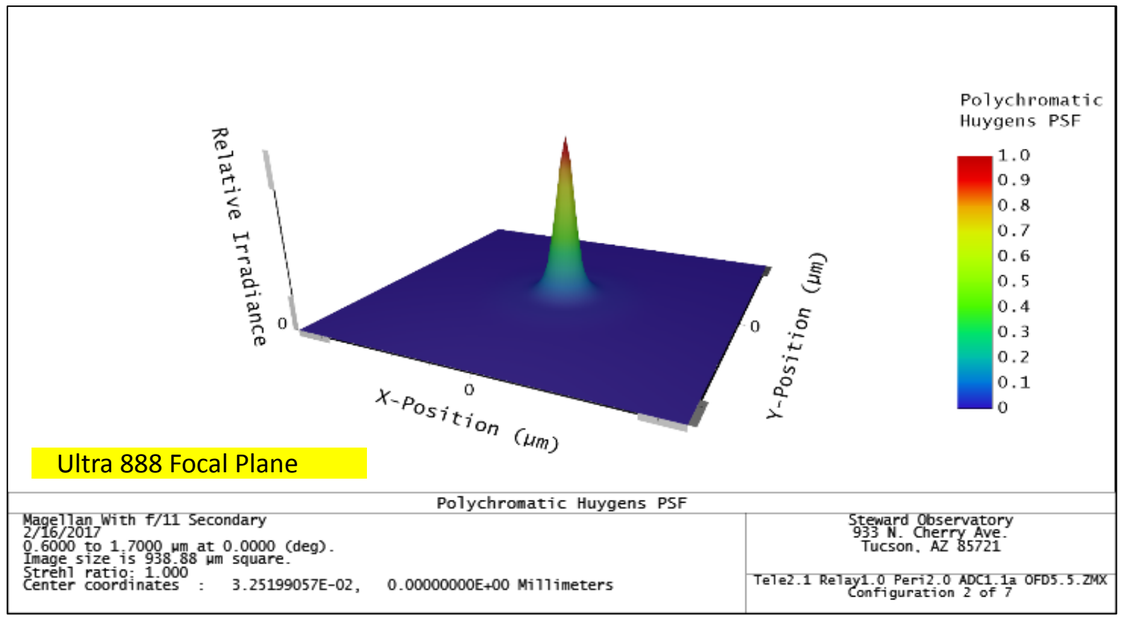
ASM Focal Plane (f/16)



Int. Focal Plane (f/57)

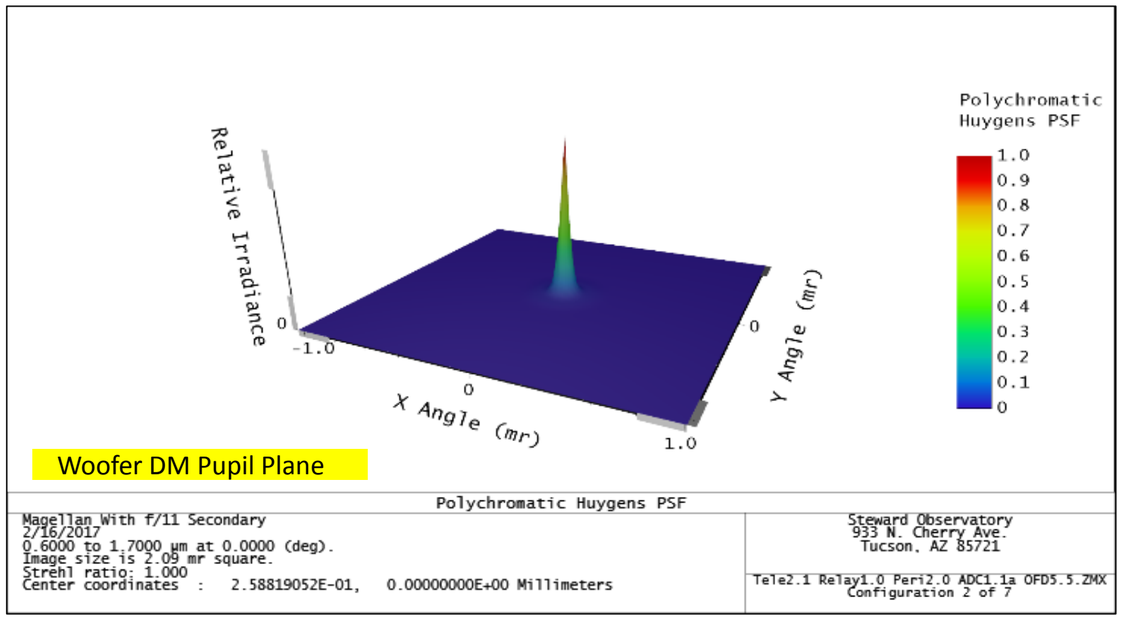


Int. Focal Plane (f/69)

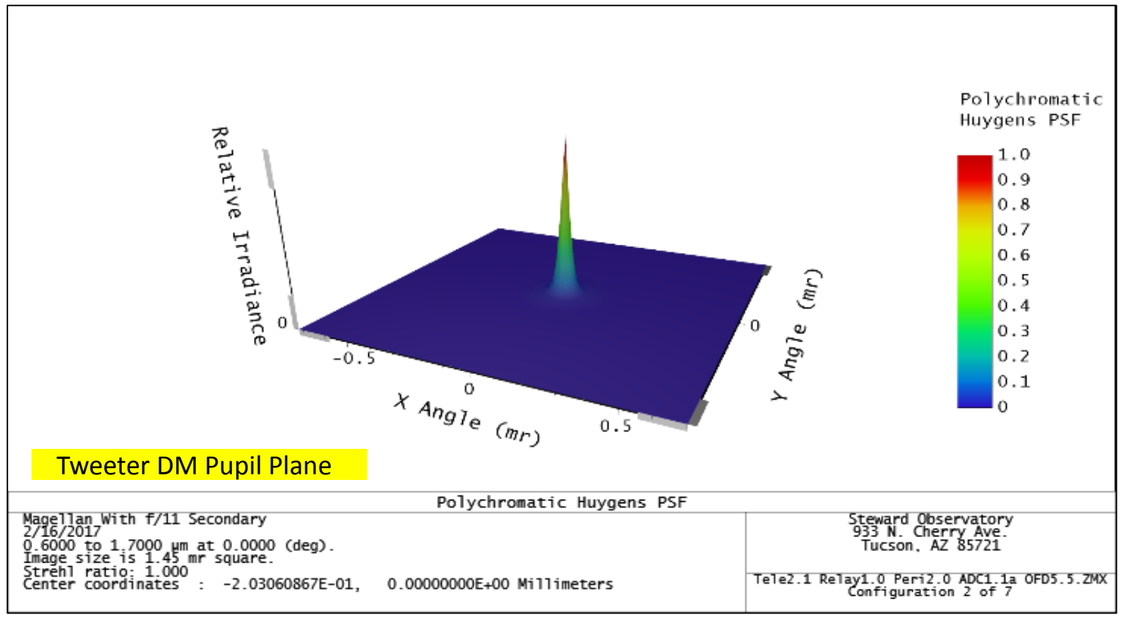


Ultra 888 Focal Plane

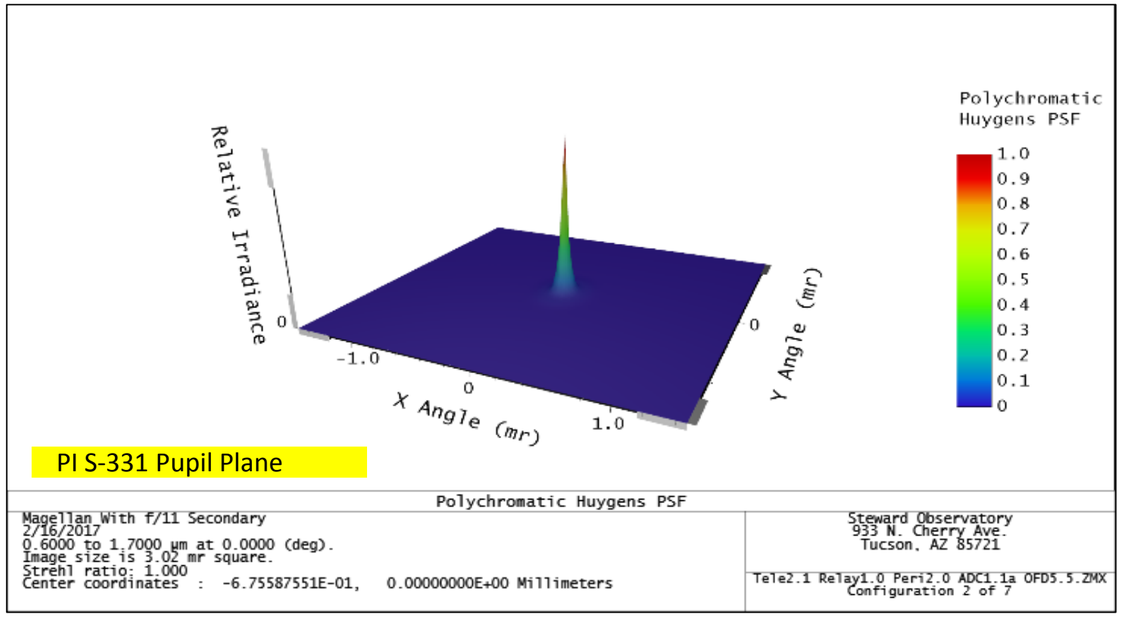
PSF at Pupil Planes



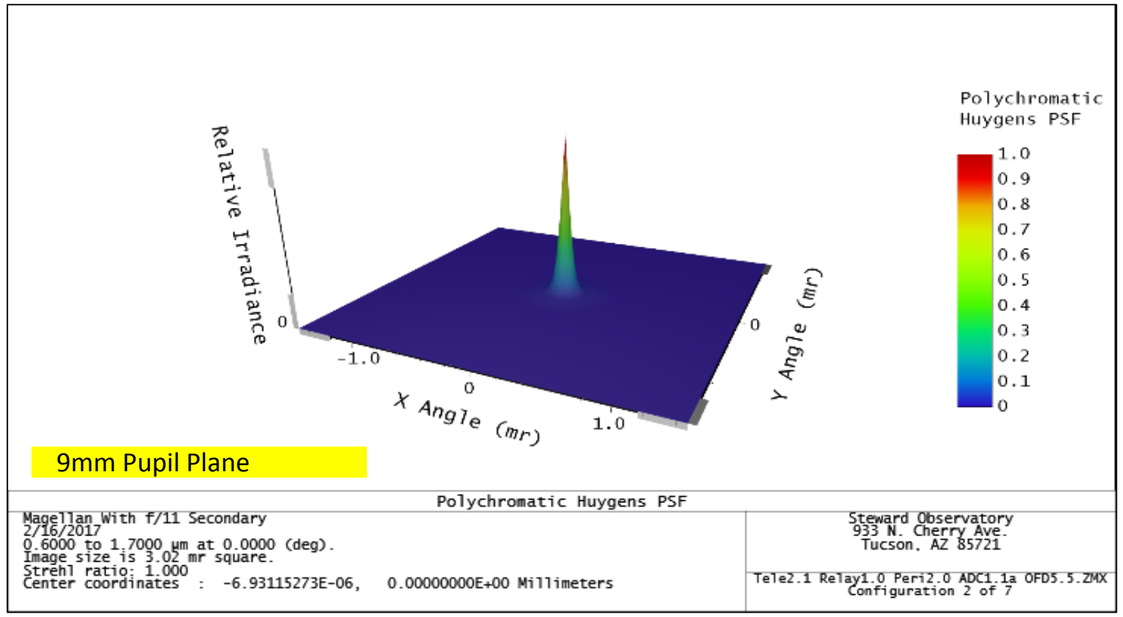
Woofer DM Pupil Plane



Tweeter DM Pupil Plane



PI S-331 Pupil Plane



9mm Pupil Plane