The MCAO module for the E-ELT

http://www.bo.astro.it/~maory

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On behalf of the MAORY Consortium

MAORY is the MCAO module for ELT => Diffraction Limit

We are doing our best….

Today workshop " Imaging at ELT"

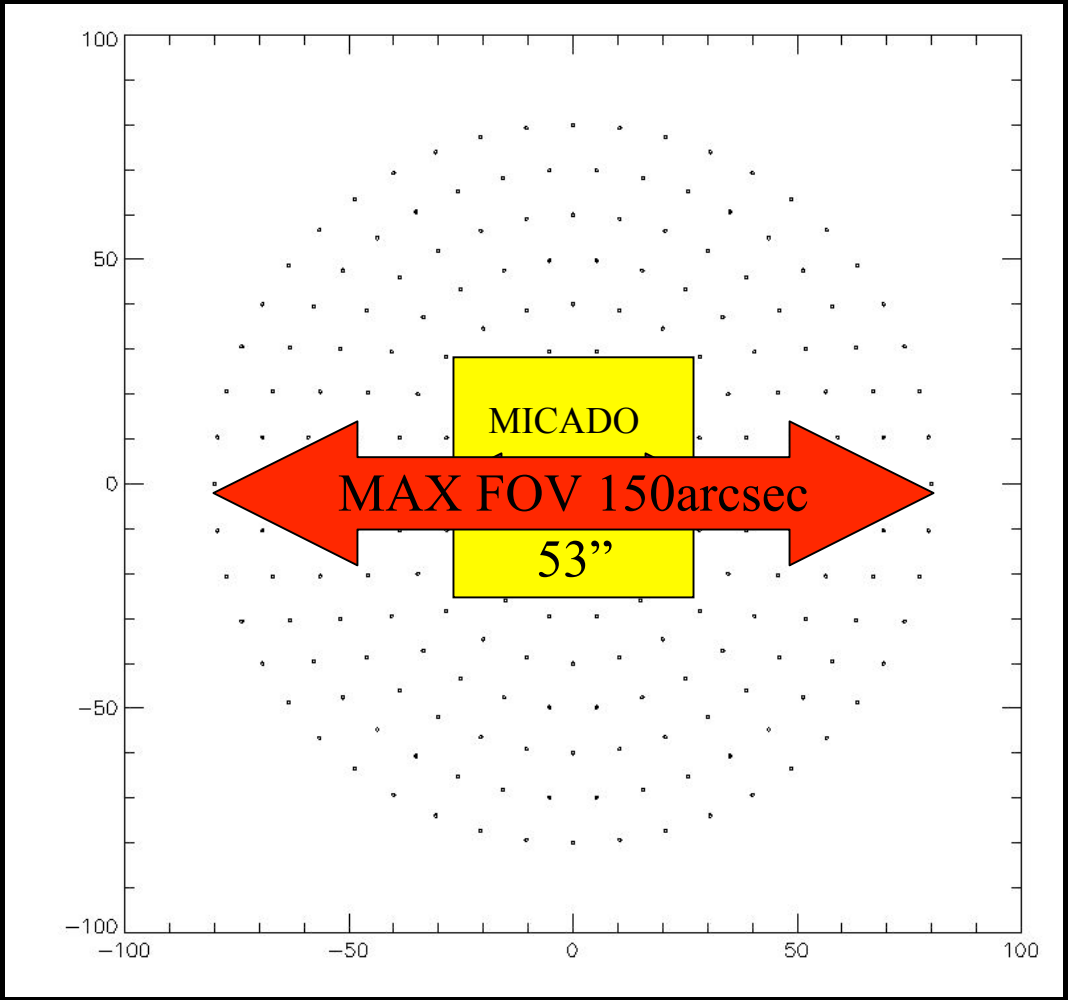
MAORY + CAMERA like MICADO

Report of Network 4 " Wide Field Imaging at ELT : from GLAO to diffraction limit"

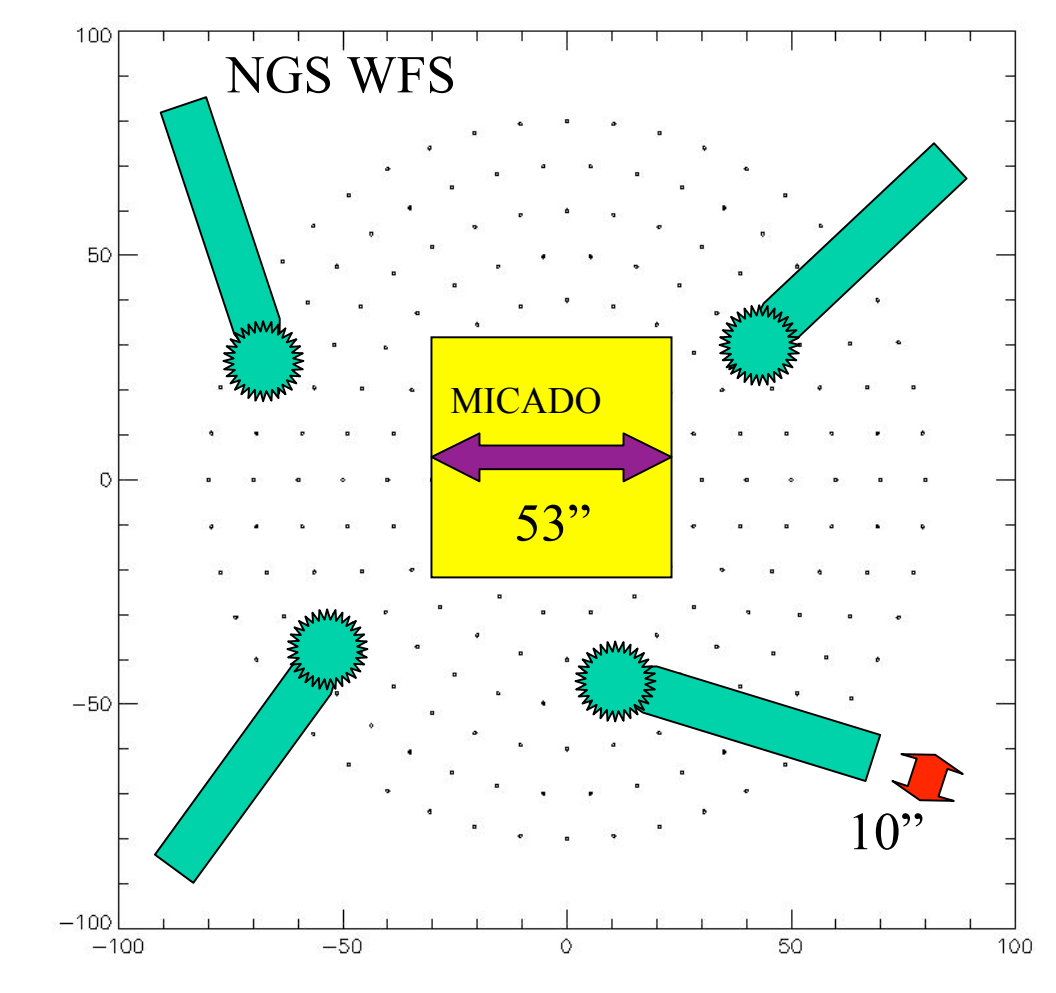
In this contest MAORY can play a role in the Diffraction Limit space

but if we speak of imaging at Diffraction Limit we must define what we mean for "WIDE FIELD"

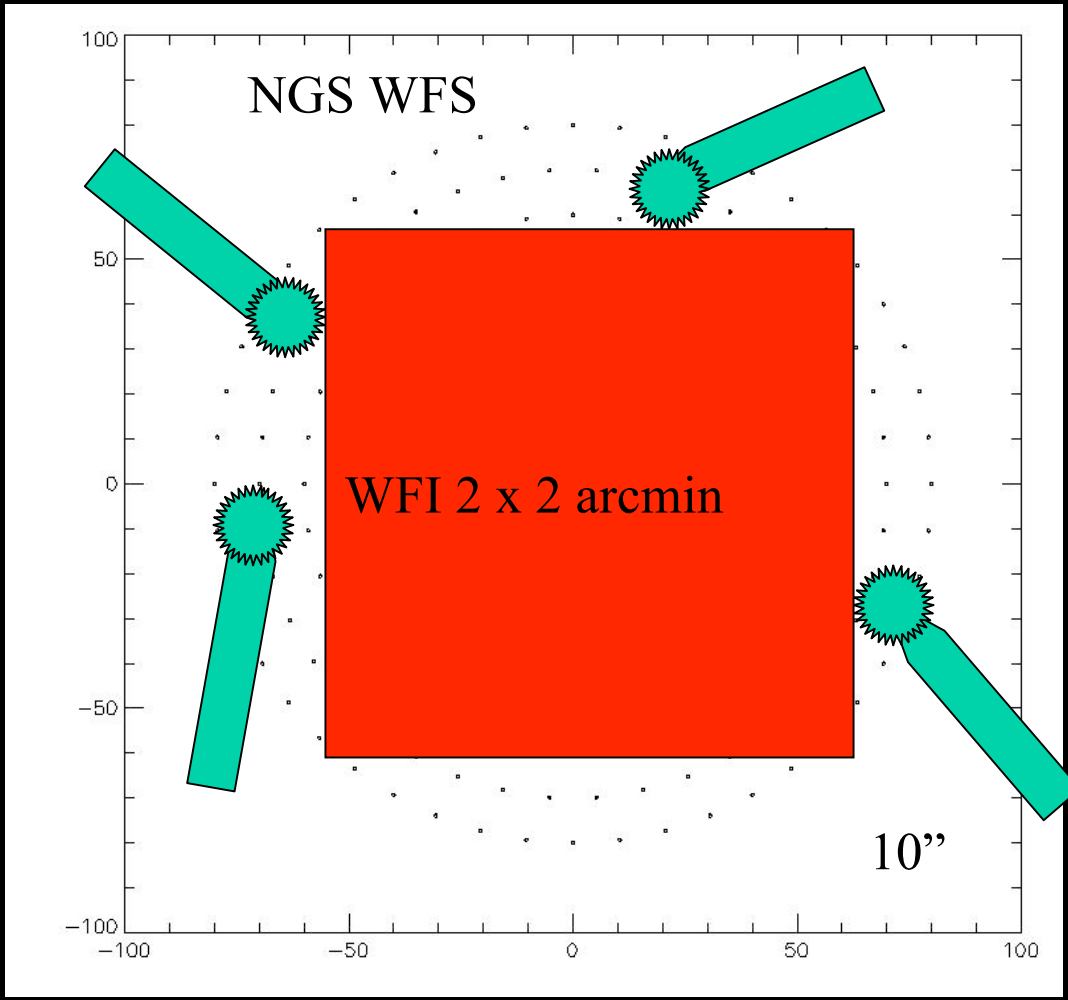
MAORY field of view



MAORY field of view



MAORY field of view



..so a reliable DL WFI could be 2.0 X 2.0 arcmin

=> more than 2 x 2 MICADO !!

Of course we can increase pixel size :

pixel size 10 mas => 3x3 4K detectors to cover 2x2 arcmin

pixel size 15 mas => 2x2 4K detectors to cover 2x2 arcmin

If we consider “Wide Field Imager” with FOV ~ 5x5 arcmin

==> we must move on the GLAO space not in the DL - MCAO space

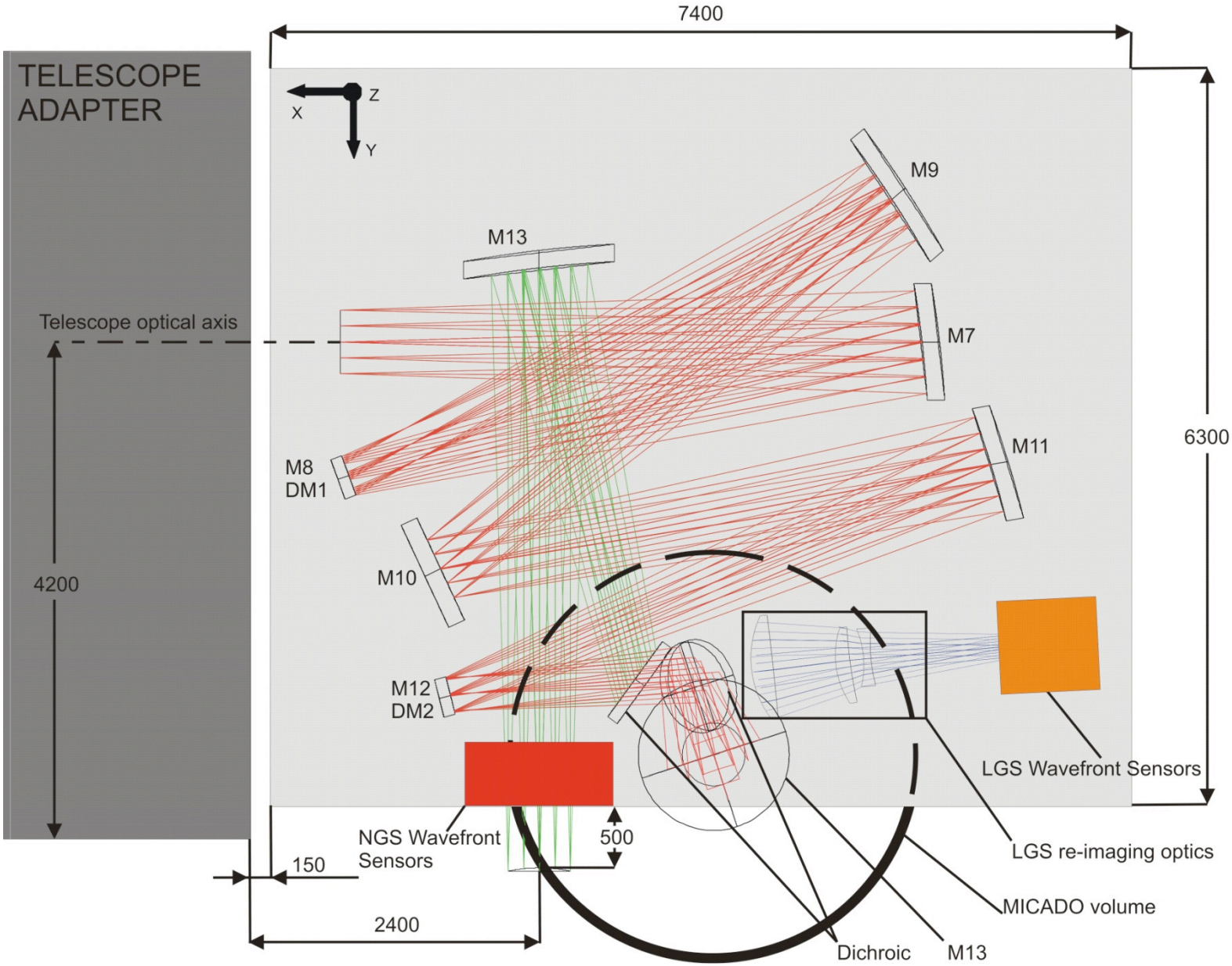
in the Diffraction Limit MCAO space

- The mirror size scale with corrected FOV ==> huge dimension of the module
- number of pixels : impossible !!!
- huge cost (module and detectors)

This morning Miska shows the performace for a GLAO WFI over 5 arcmin

….. Now I will show the MCAO performance for “WFI” over 2 arcmin

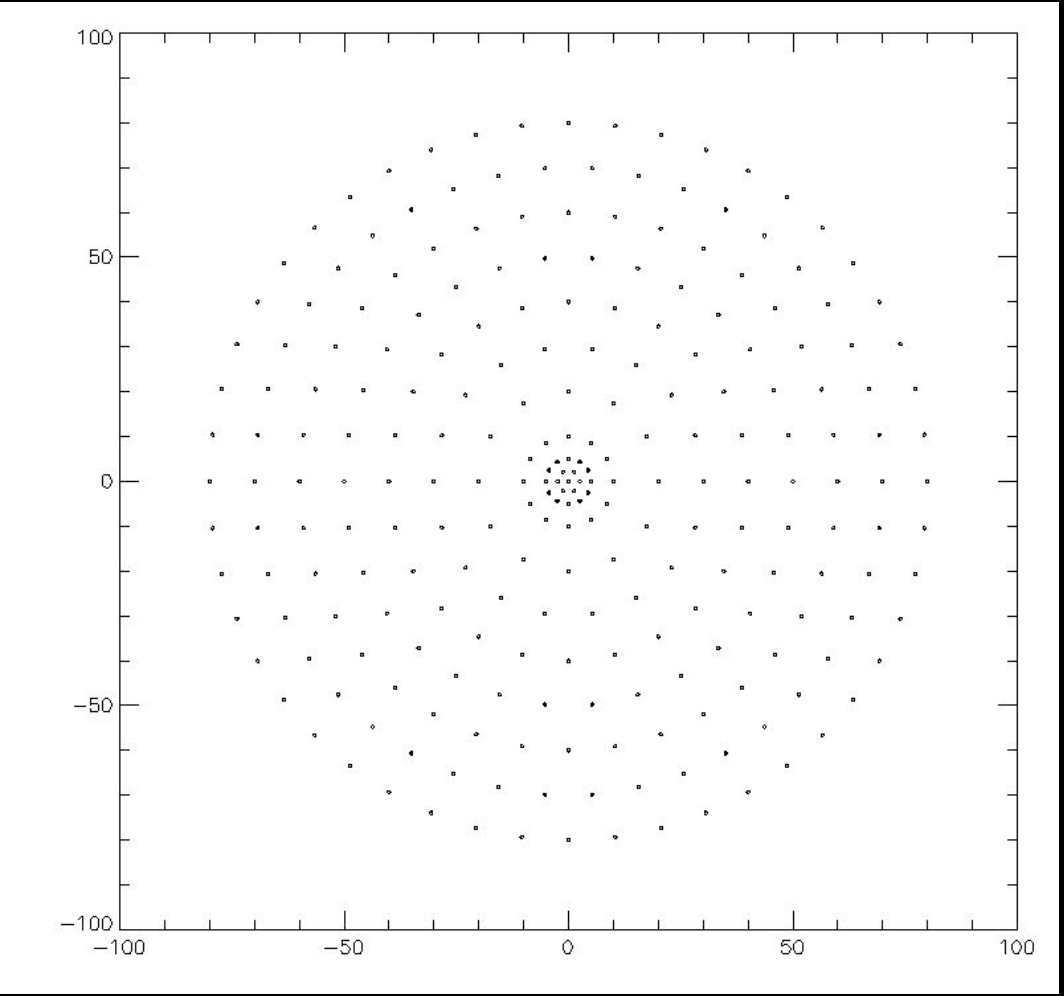
PRELIMINARY LAYOUT AND DIMENSIONS



SIMULATED PSF
from ONERA team (C. PETIT, J.M. CONAN)

- ANALYTIC MODEL
- Turbulence profile with 9 layers : 0 → 18 Km
- Seeing 0.80 and 0.6 arcsec at 5000 Å
- Central obstruction 0.3 on the diameter
- 6 Laser Guide Stars on 2 arcmin ring
- 3 Deformable Mirrors conjugate at 373 m (M4) 4 Km and 12.7 Km
- 84 actuators across M4 diameter

SIMULATED PSF DISTRIBUTION



241 PSFs

on a field of 2.6'

with LGS on

Ø 120 arcsec

19 PSFs Ø 10 arcsec
(spacing 2.5 arcsec)

19 PSFs Ø 20 arcsec
(spacing 5 arcsec)

37 PSFs Ø 1 arcmin
(spacing 10 arcsec)

127 PSF Ø 2 arcmin
(spacing 10 arcsec)

217 PSF Ø 2.5 arcmin
(spacing 10 arcsec)

STREHL RATIO VALUES

The PSF have been obtained from the residual power spectral density of the atmospheric turbulence. They do not include some error sources that can only be accounted for by means of correction factors.

LGS CONE EFFECT (POSITION AND WAVELENGTH)

ERRORS DUE TO THE NGS WFS

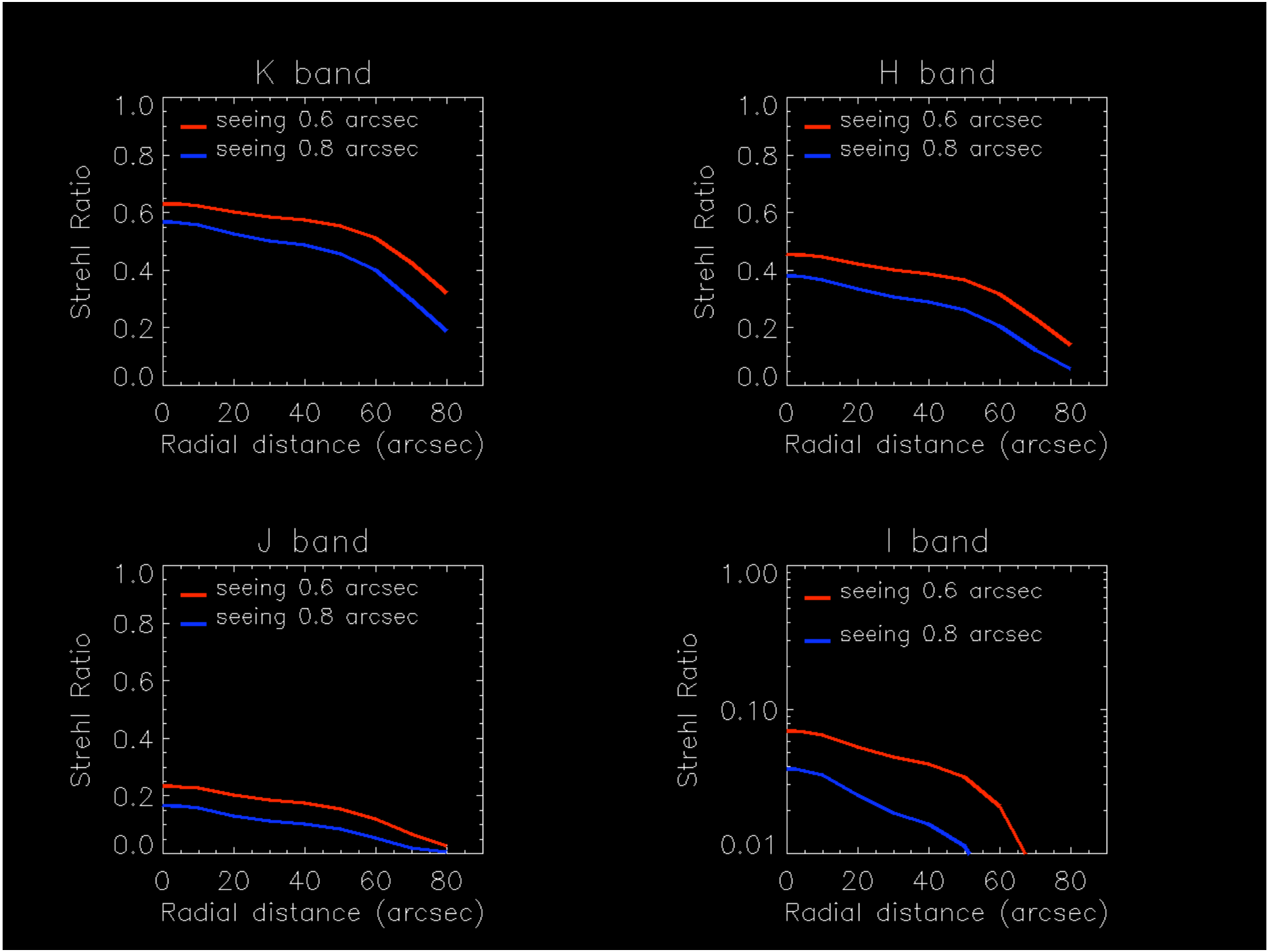
THE UNCORRECTED OPTICS ERRORS } **WAVELENGTH**

AO CALIBRATIONS ERRORS

ALL THE STREHL RATIO PRESENTED HERE INCLUDE THE ABOVE ERROR SOURCES IN ORDER TO HAVE SR WITH A COMPLETE ERROR BUDGET

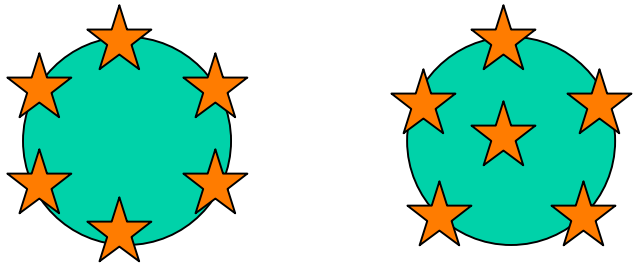
Correction uniformity in terms of RMS variations with respect to the average Performace

	K band		H band		J band		I band	
	SR rms	TLR	SR rms	TLR	SR rms	TLR	SR rms	TLR
2’	<0.1	0.13	<0.1	0.13	<0.1	N/A	<0.1	N/A
1’	<0.1	0.06	<0.1	0.17	<0.1	0.07	<0.1	N/A
20’’	<0.01	0.02	<0.01	0.02	<0.01	0.02	<0.01	0.01
10’’	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01


K band
H band
J band
I band
seeing 0.6 arcsec
seeing 0.8 arcsec
Strehl Ratio
Radial distance (arcsec)
0
20
40
60
80
0.0
0.2
0.4
0.6
0.8
1.0
0.01
0.10
1.00

LGS CONFIGURATIONS

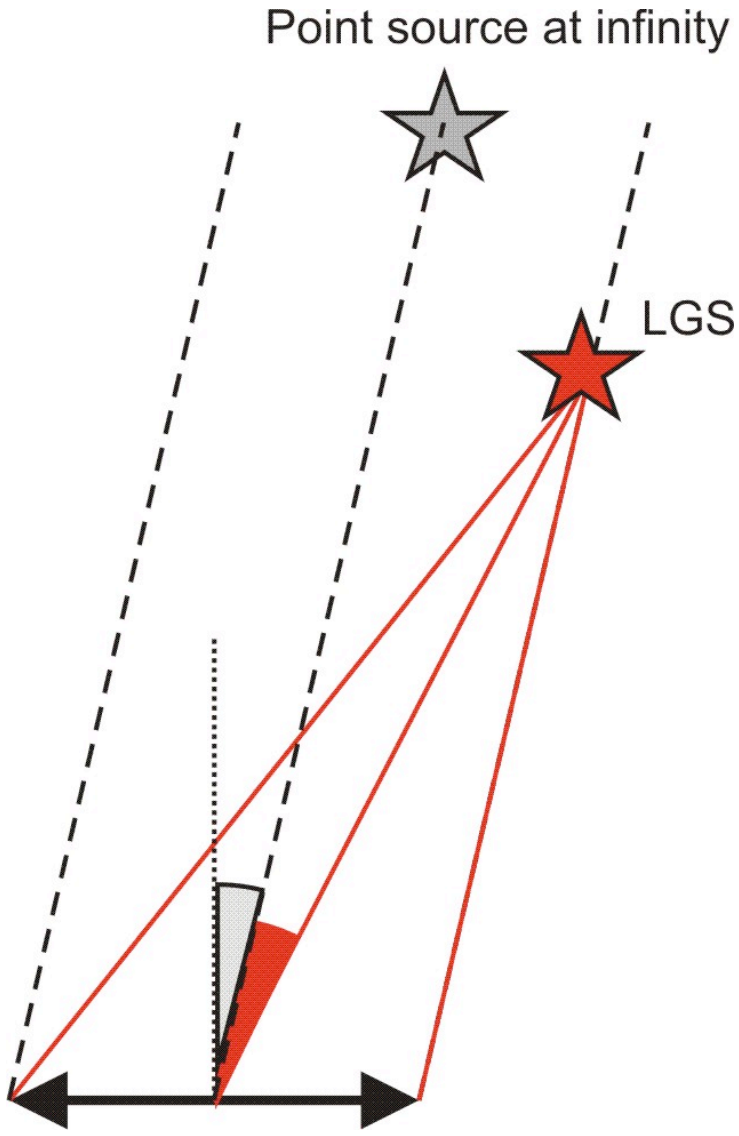
Which configuration => open question



However not closer than

2 arcmin to avoid tomografy

error due LGS cone effect



SKY COVERAGE

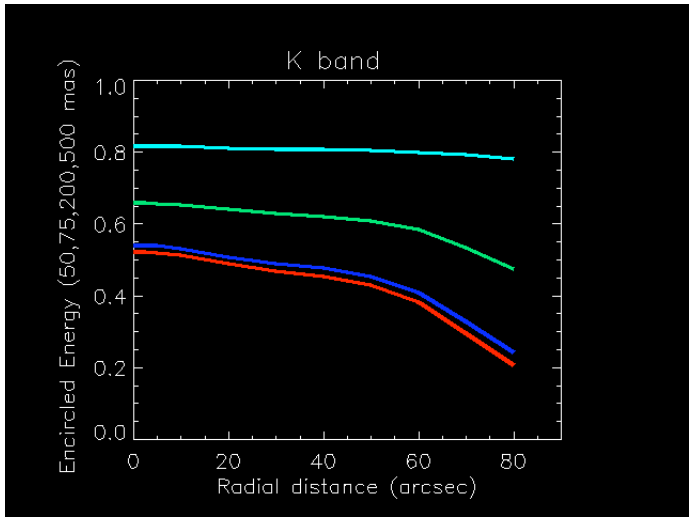
SR values for 1 arcmin field

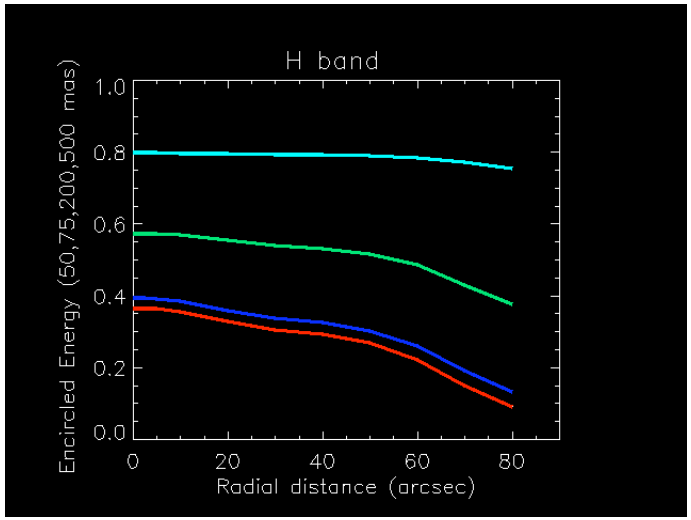
SEEING	K	H	J	I	SKY COVERAGE
0.8 arcsec (best performance)	0.53	0.33	0.13	0.03	26%
0.8 arcsec	0.48	0.28	0.09	0.02	38%
0.8 arcsec	0.41	0.21	0.06	0.01	48%
0.6 arcsec (best performance)	0.60	0.42	0.20	0.05	33%
0.6 arcsec	0.54	0.35	0.14	0.03	48%
0.6 arcsec	0.46	0.27	0.06	0.01	57%

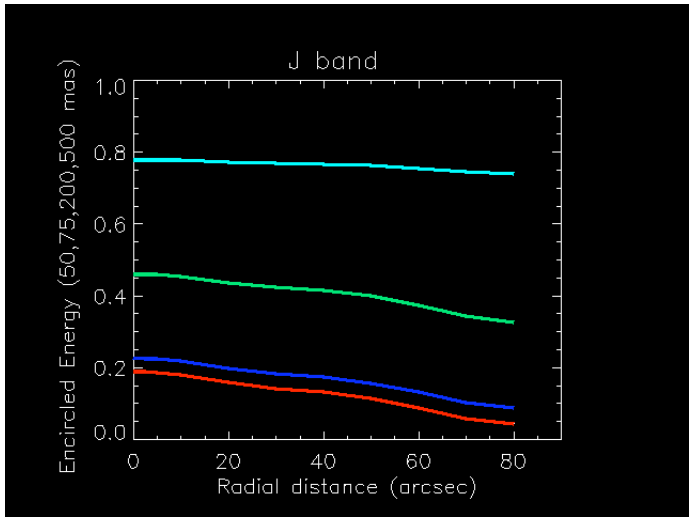
ENCIRCLED ENERGY

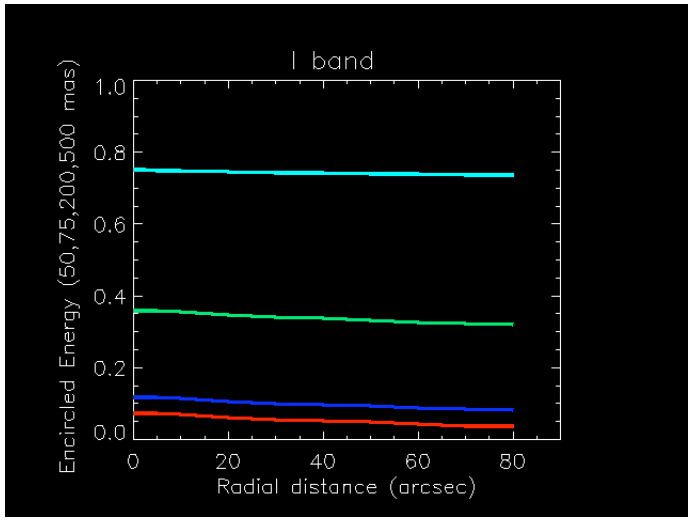
The EE has been calculate as the fraction of the PSF energy enclosed in a circle of 50 mas diameter (as required in the TLR document) and using circles of 75, 200 and 500 mas diameter thinking to other potential EELT instrument coupled with MAORY

EE radial profile

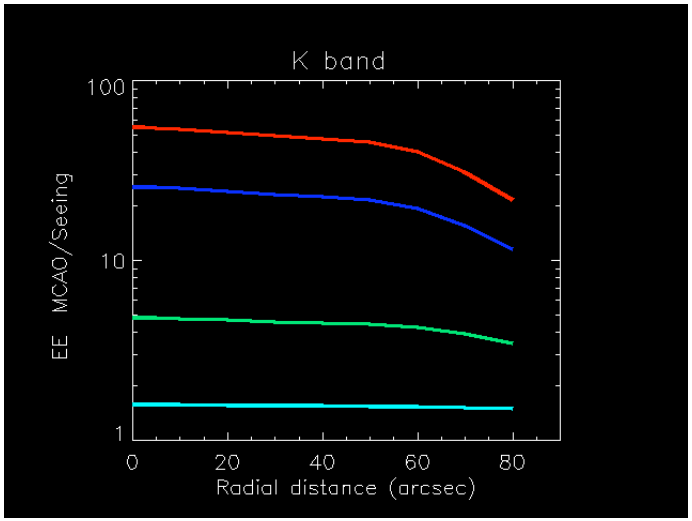


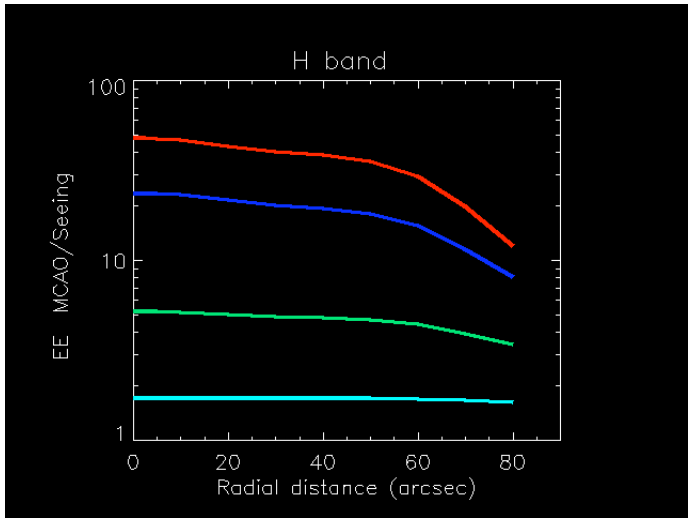


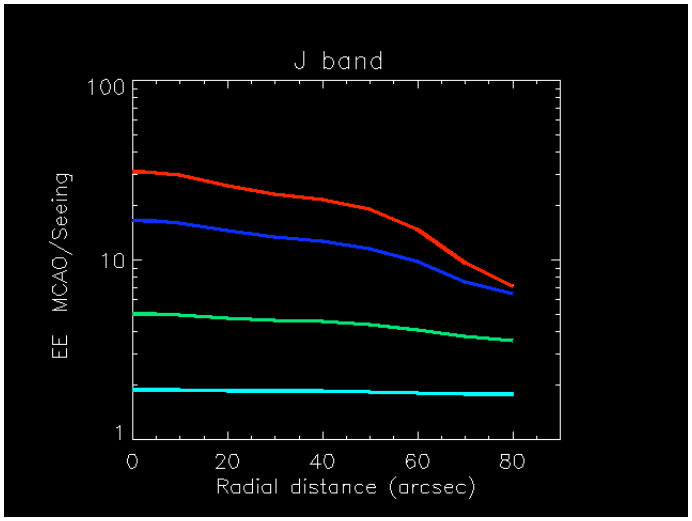


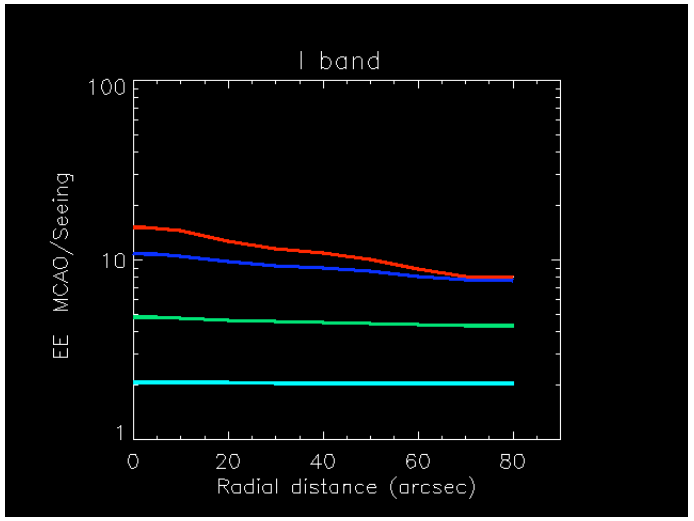


EE MCAO / Seeing radial profile

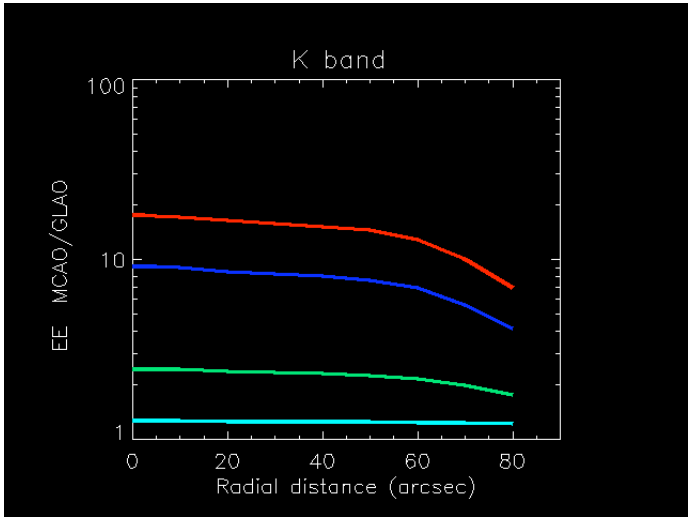


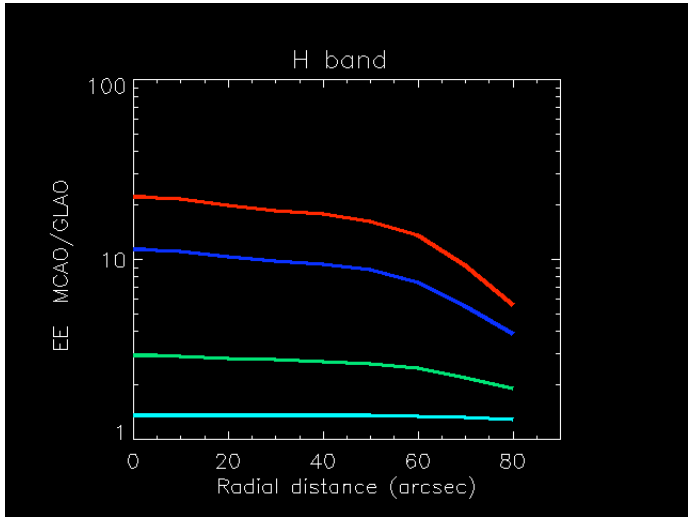


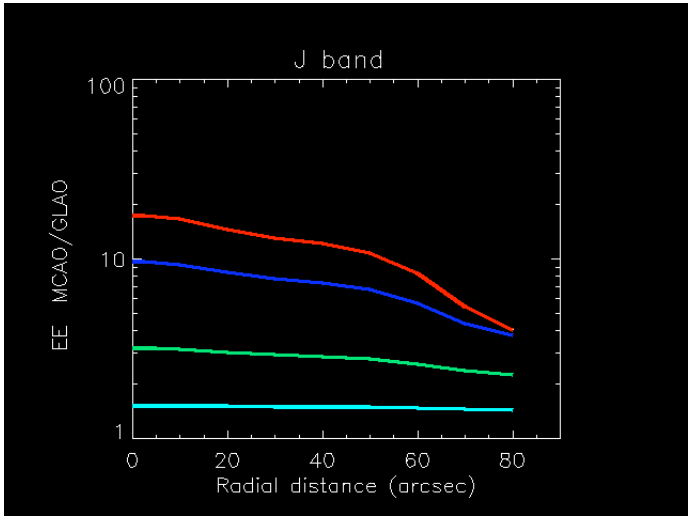


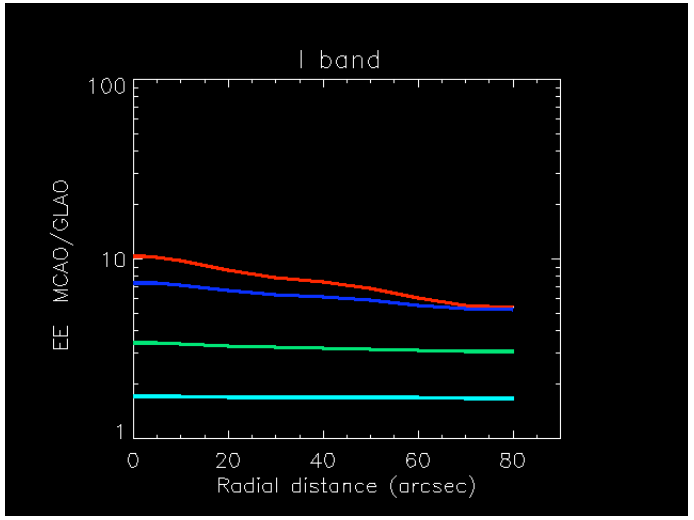


EE MCAO / GLAO radial profile



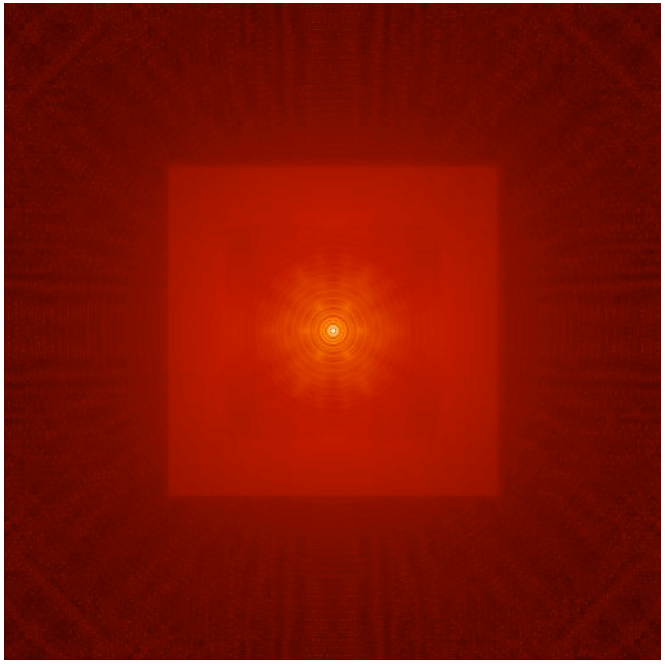






PSF model

K band PSF
SR ≈ 0.6
Image size = 2.7"



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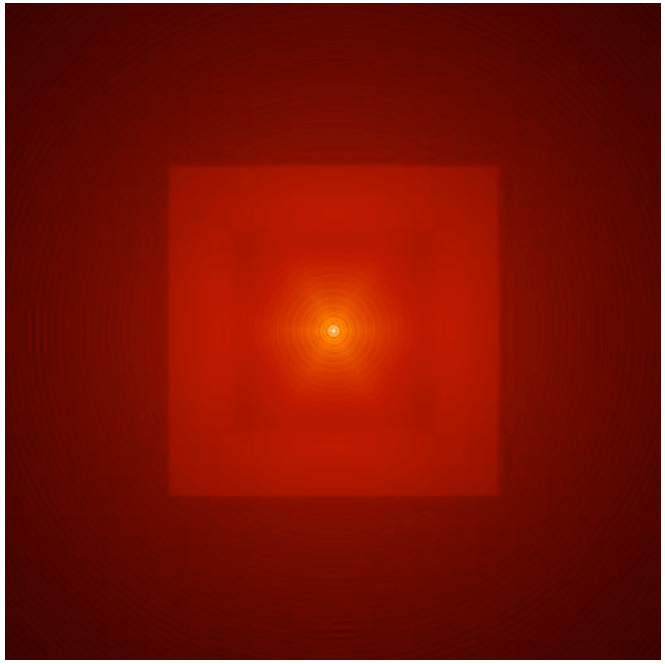
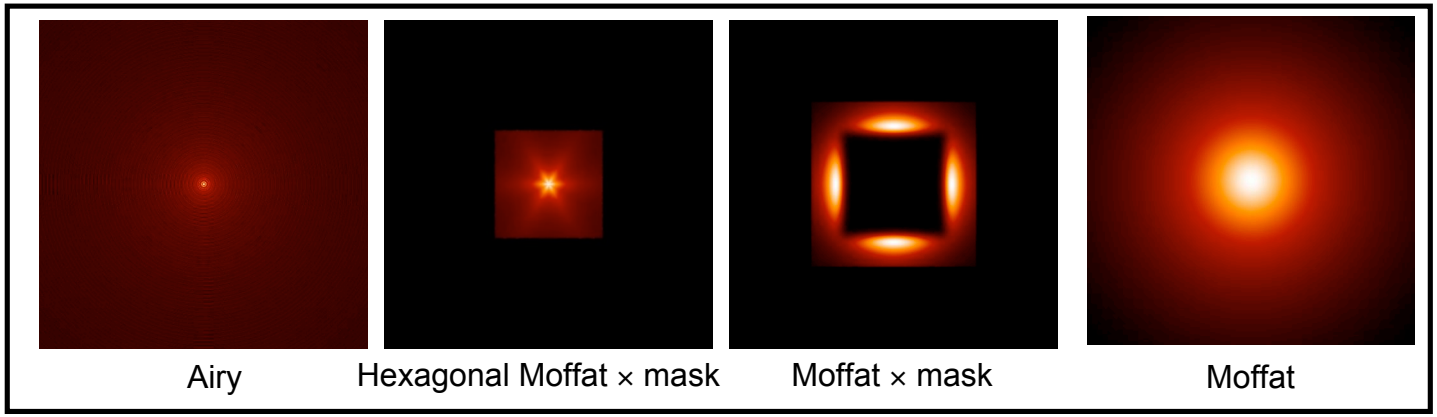
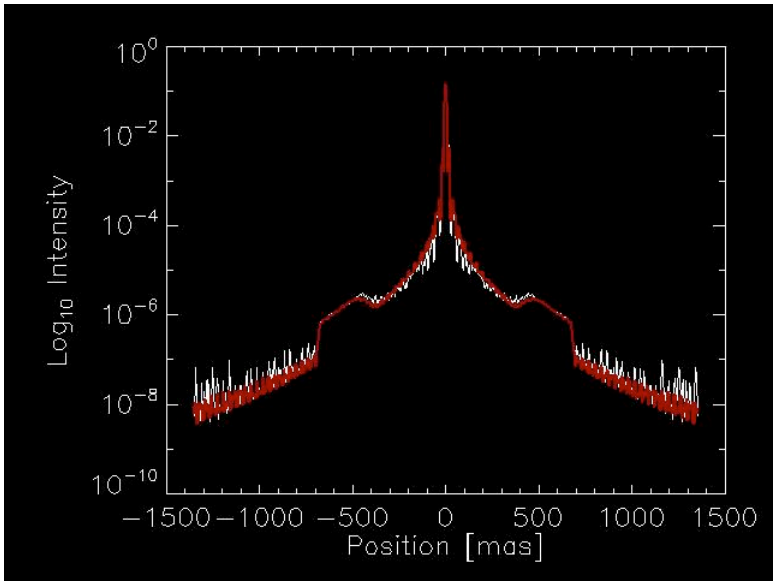
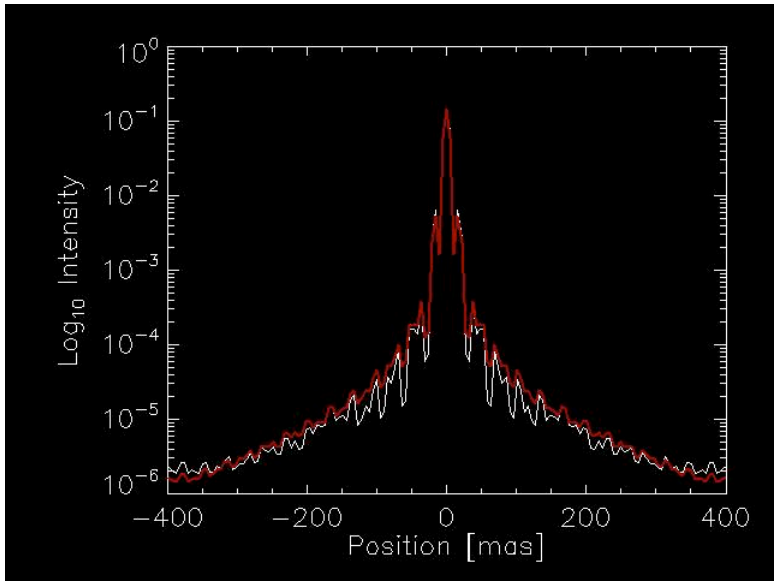


DIFFRACTION FITTING + ALIASING ERRORS SEEING



PSF model



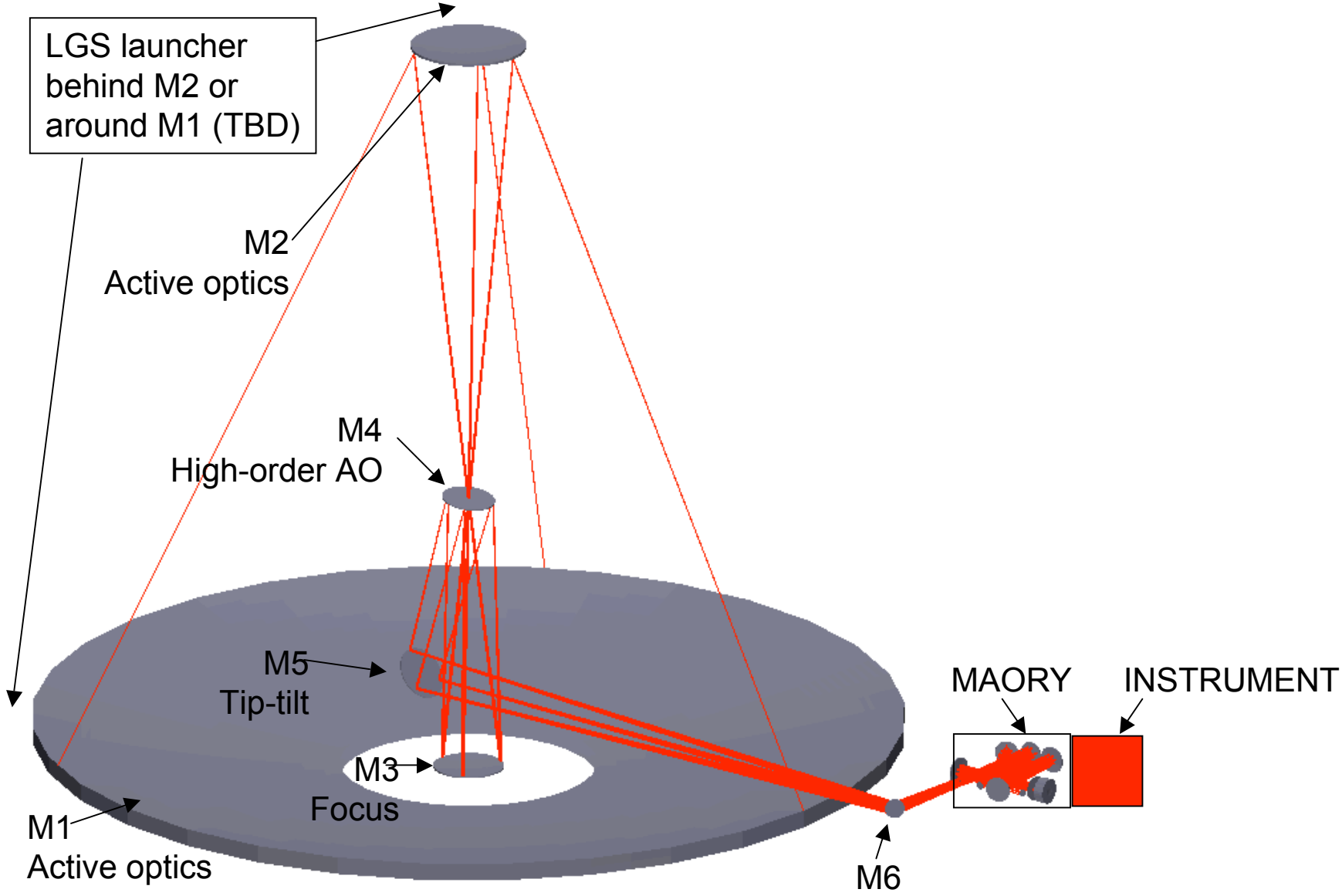


White lines: PSF. Red lines: PSF model.

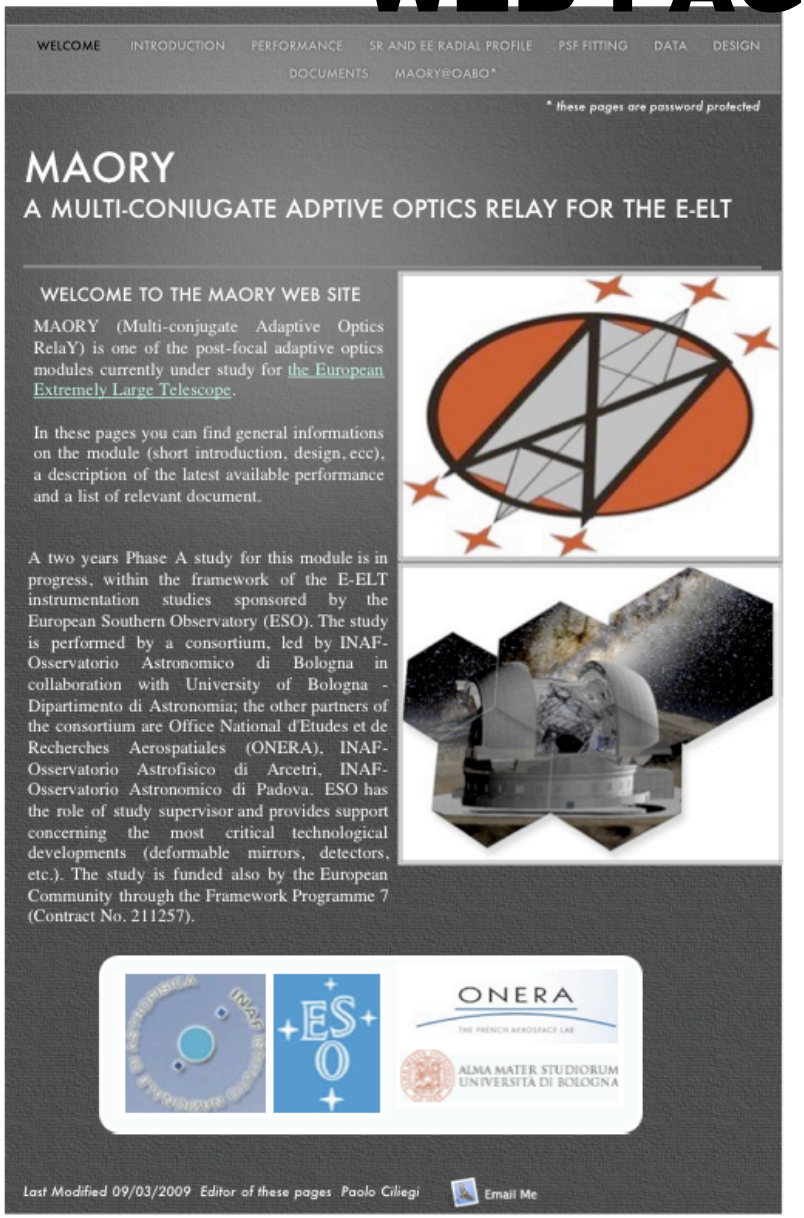
Next steps

- Refine modelling
- Find correlations of PSF parameters with Strehl Ratio and seeing
- Evalute PSF model accuracy for photometry and astrometry of crowded stellar fields

Sub-systems to control



WEB PAGE



http://www.bo.astro.it/~maory

MAORY DESCRIPTION

PERFORMANCE

(SR and EE)

PSF DATA

No password

Please send an email

for new PSF release