Possible optics for NIKA-2

Samuel Leclercq, 4/12/2012

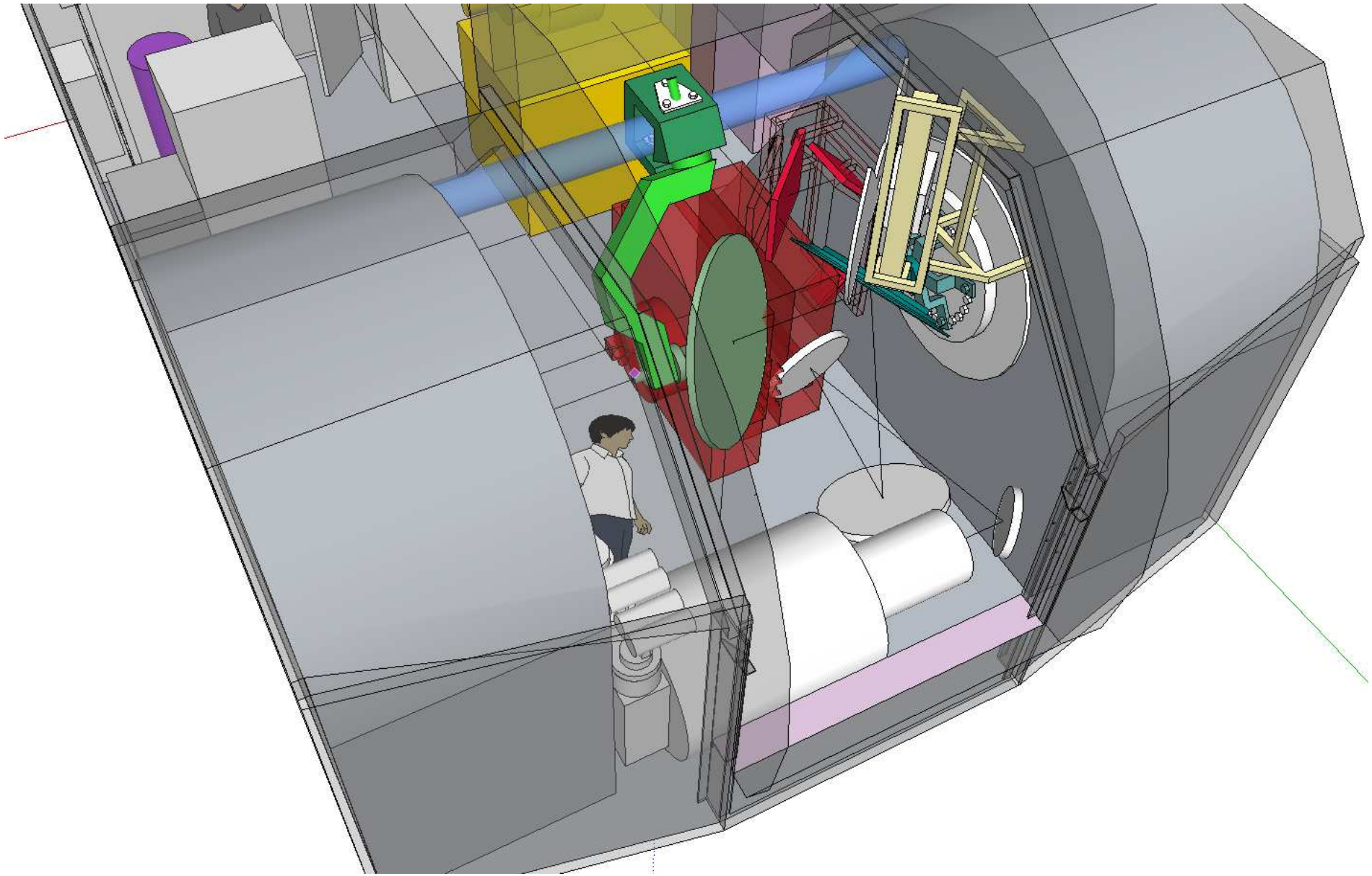
This document presents two possible optical designs for NIKA-2, resulting from a drastic selection among many other possible designs modeled with Zemax. The modeling was based on many constraints such as spacing, number bands, optical elements properties, cryogenics, stray light mitigation and optical performances.

The 2 designs pre-selected by Samuel Leclercq and Alain Benoit have still several degrees of freedom so that they can be modified to satisfy possible additional constraints resulting from the contribution of other members of the NIKA collaboration in the conception of the instrument.

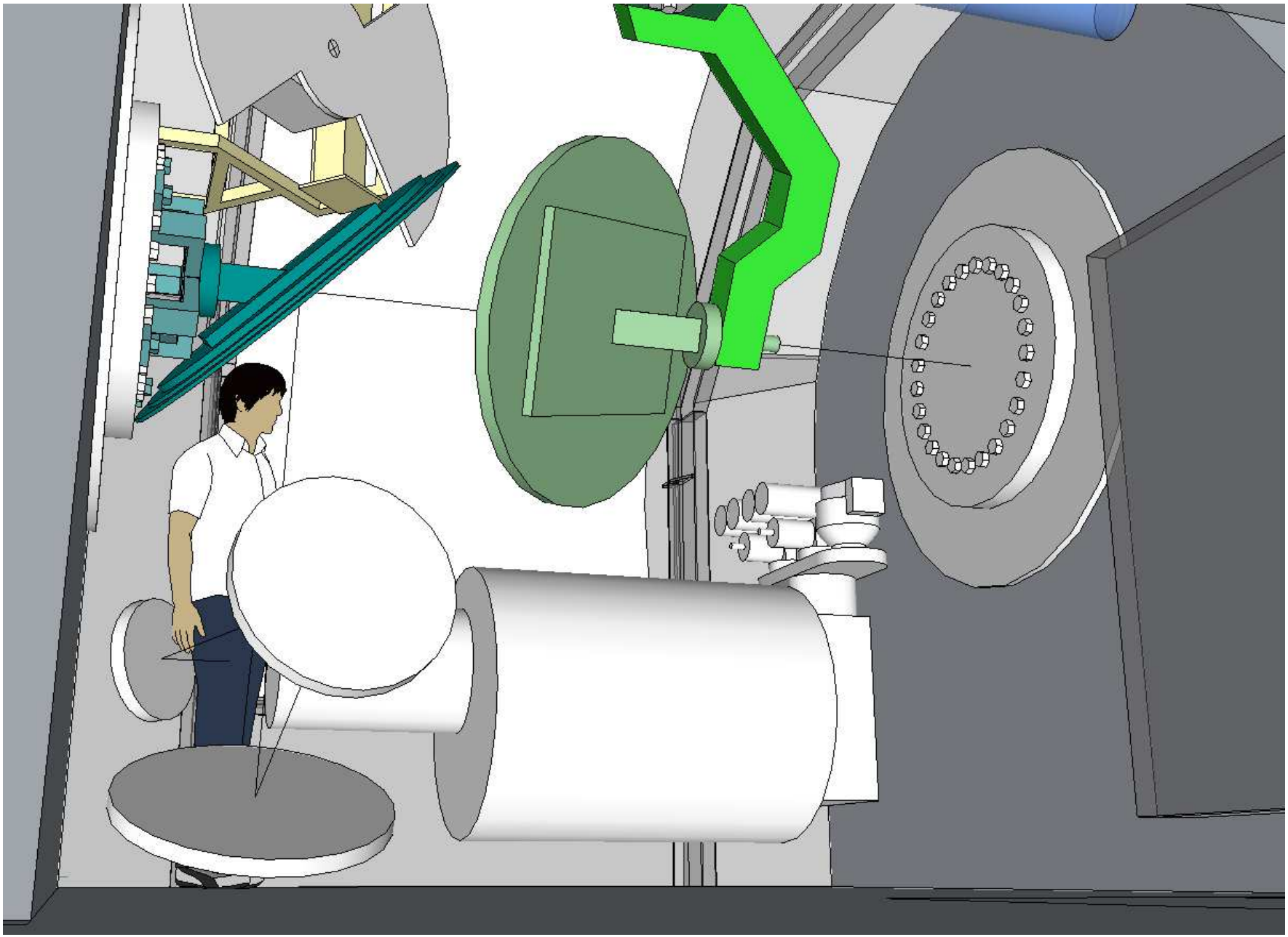
The next slides show a Google Sketchup simulations of one of the 2 designs in the 30m telescope cabin, including a realistic aspect of the NIKA-2 cryostat and a possible structure for the future Nasmyth optics (M3 and M4), hence allowing to visualize the general aspect of the instrument and the spacing constraints.

The following slides show some screen captures from the Zemax simulations of the 2 designs, with all the information fully describing them, from dimensions to optical performances.

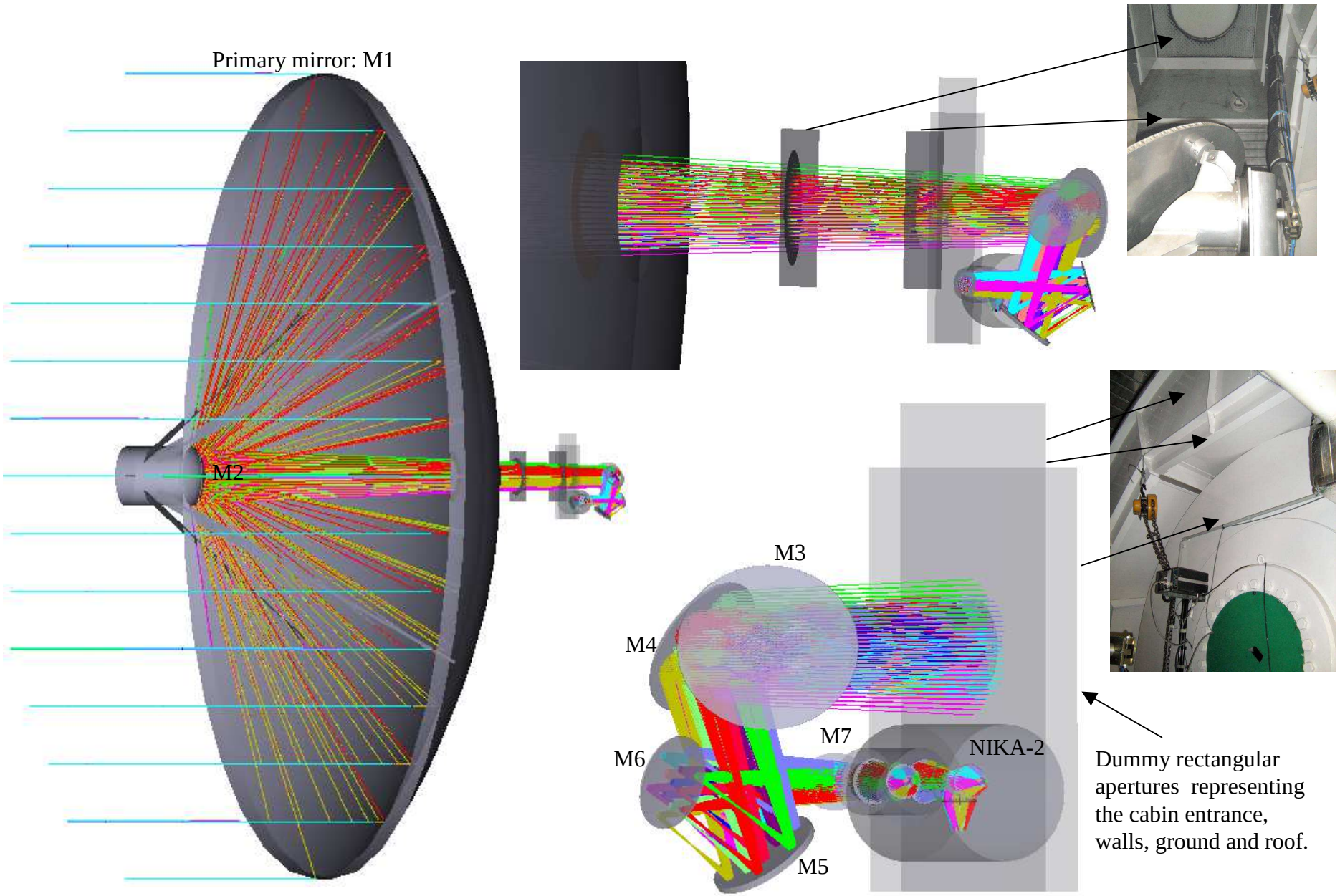
Sketch up of NIKA-2 in the 30m telescope receiver cabin



Sketch up of NIKA-2 in the 30m telescope receiver cabin

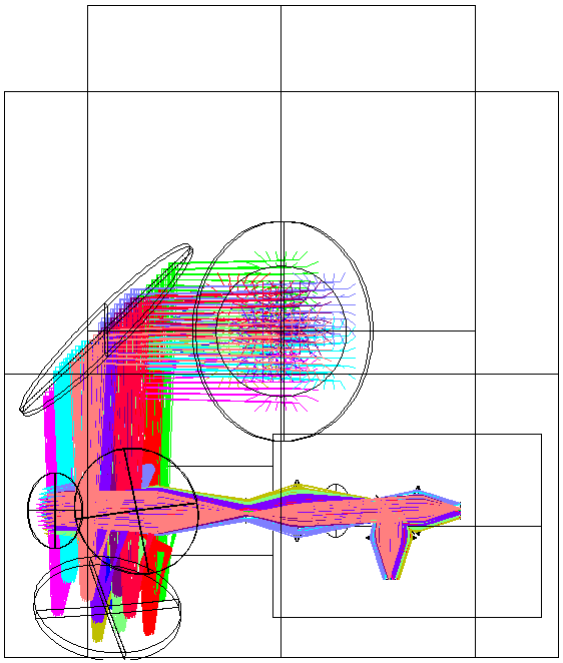


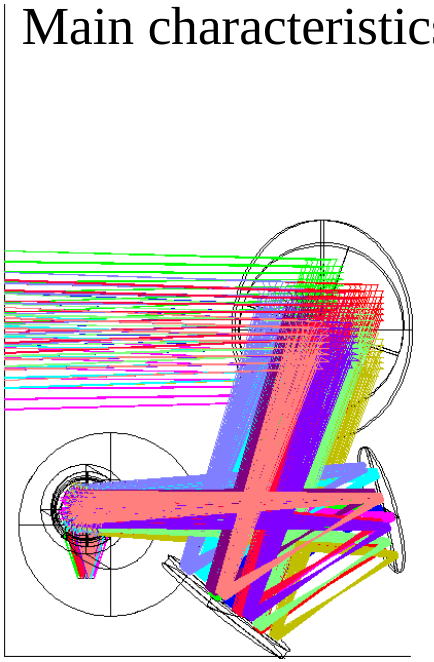
Zemax model of NIKA-2 at the 30m telescope

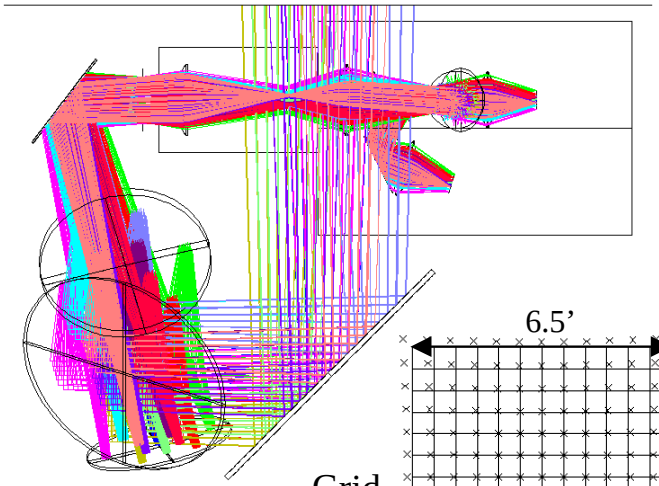


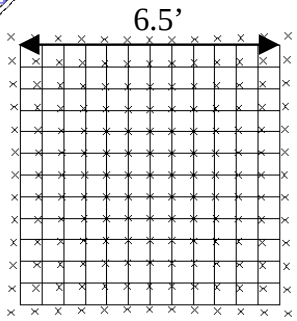
1st model: 2 ambient powered mirrors and 2+1x3 bands cold HDPE lenses

Main characteristics

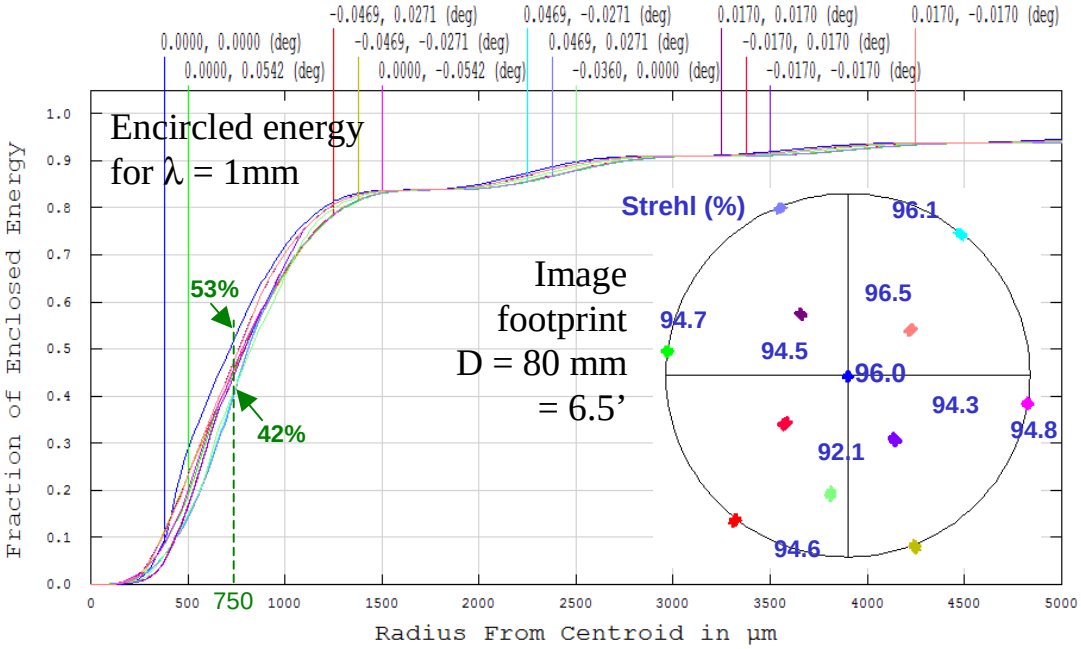






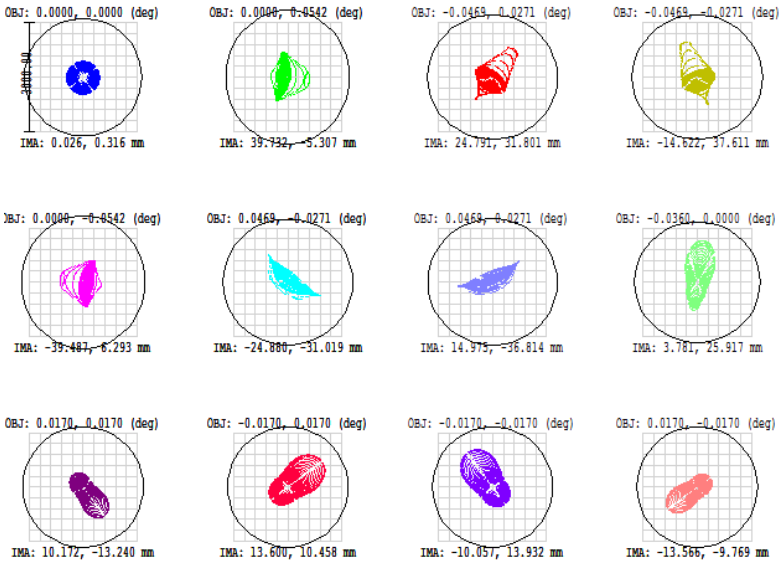


Grid Distortion
max = 6.9 %



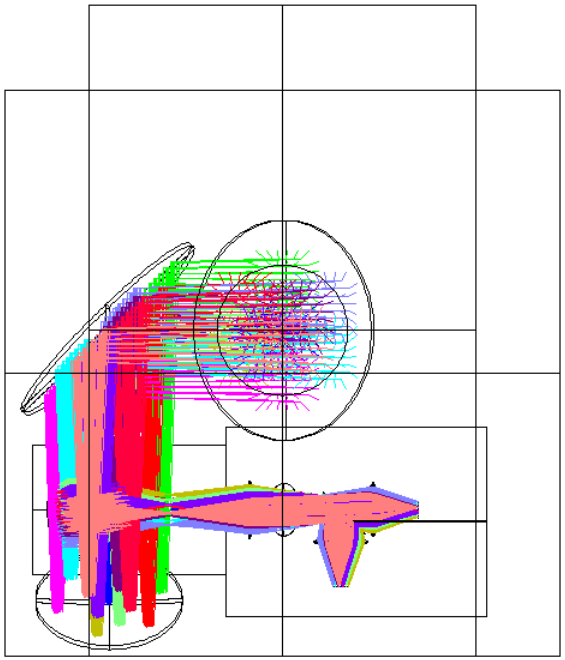
Spot diagram for λ = 1mm:

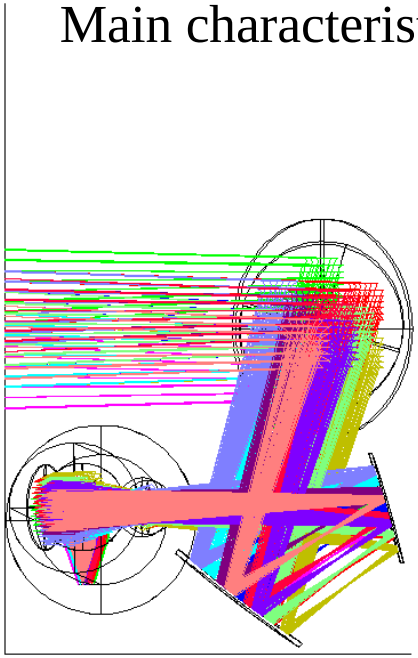
PSF = Ray trace aberrations (color) * Airy Dark ring (circle)

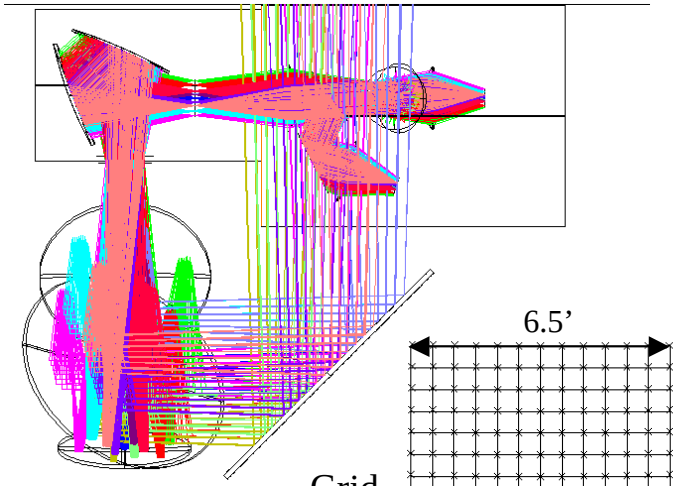


2nd model: 2 ambient & 2 cold powered mirrors and 1+1x3 bands cold HDPE lenses

Main characteristics

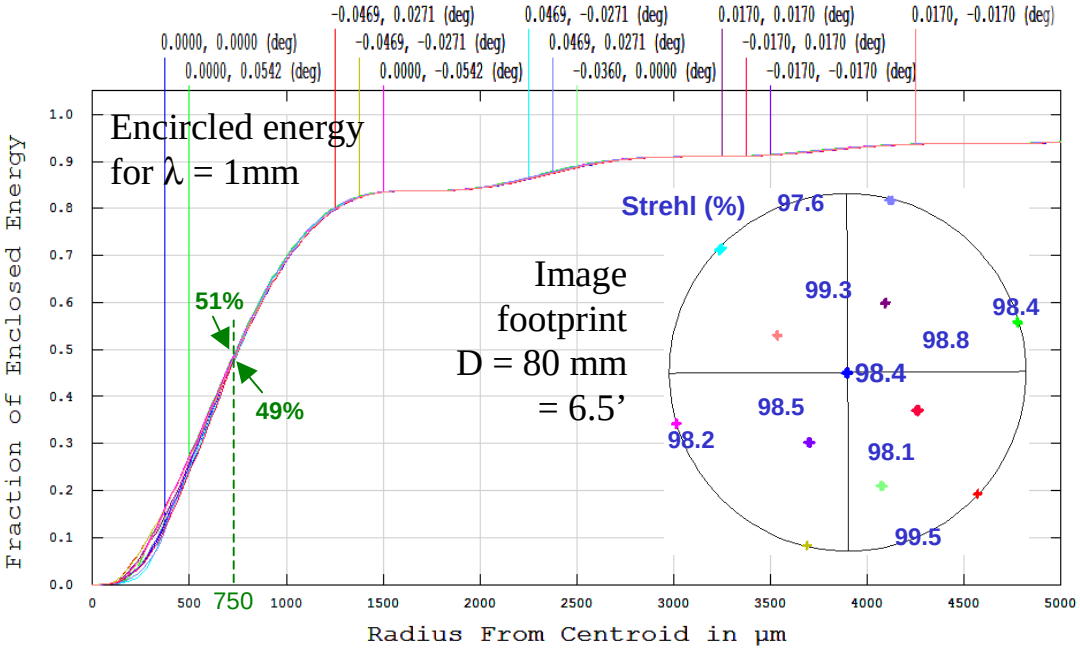






6.5’

Grid Distortion
max = 1.9 %



Spot diagram for λ = 1mm:

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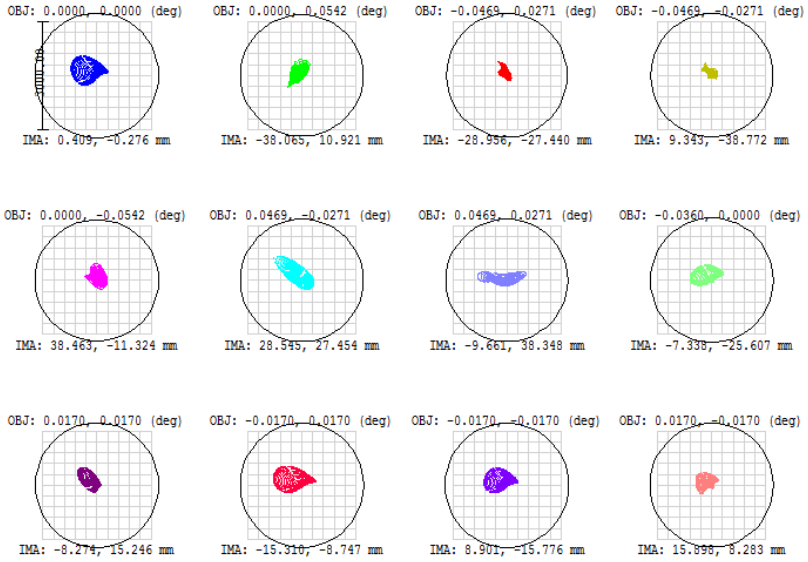
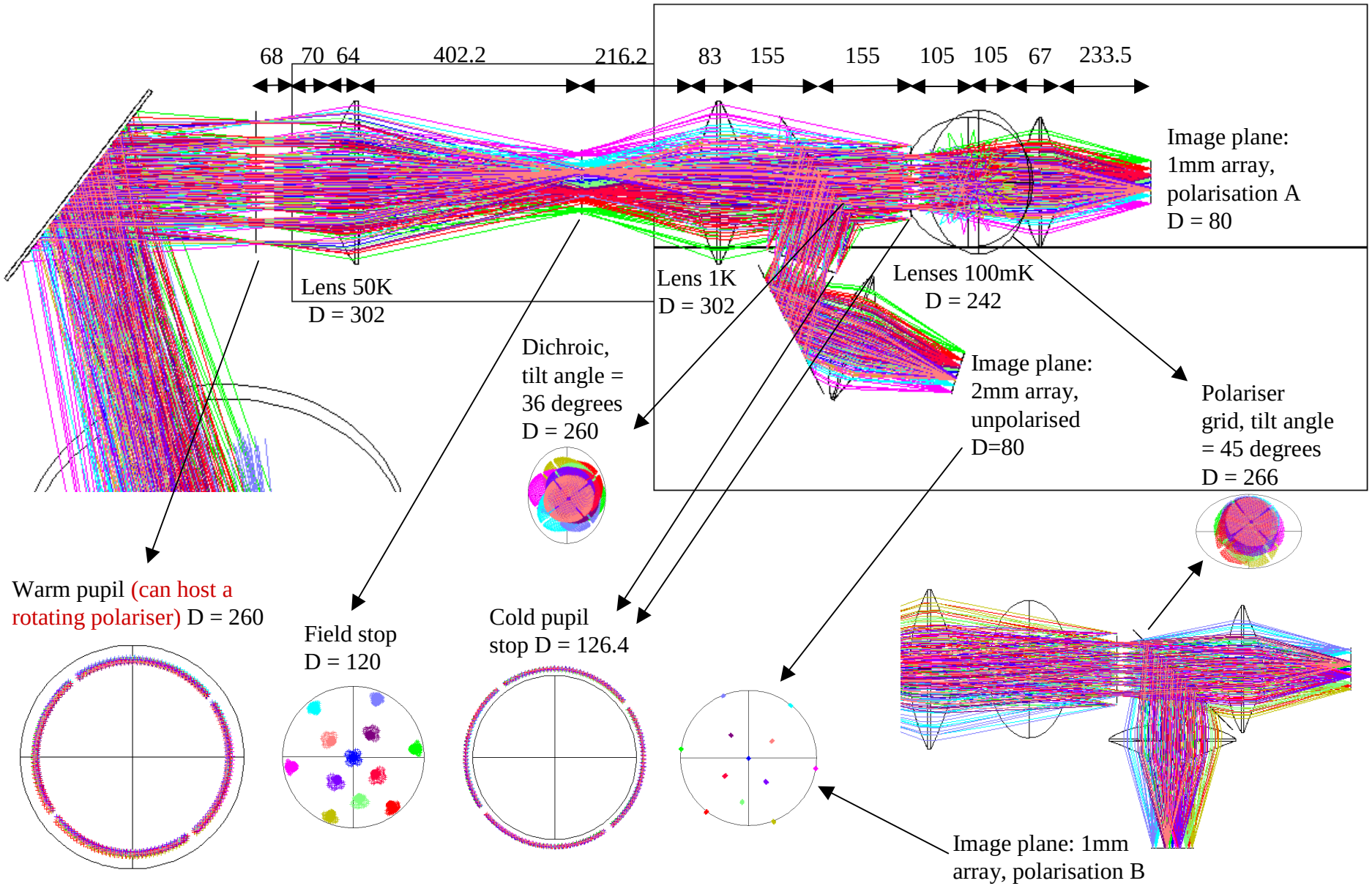
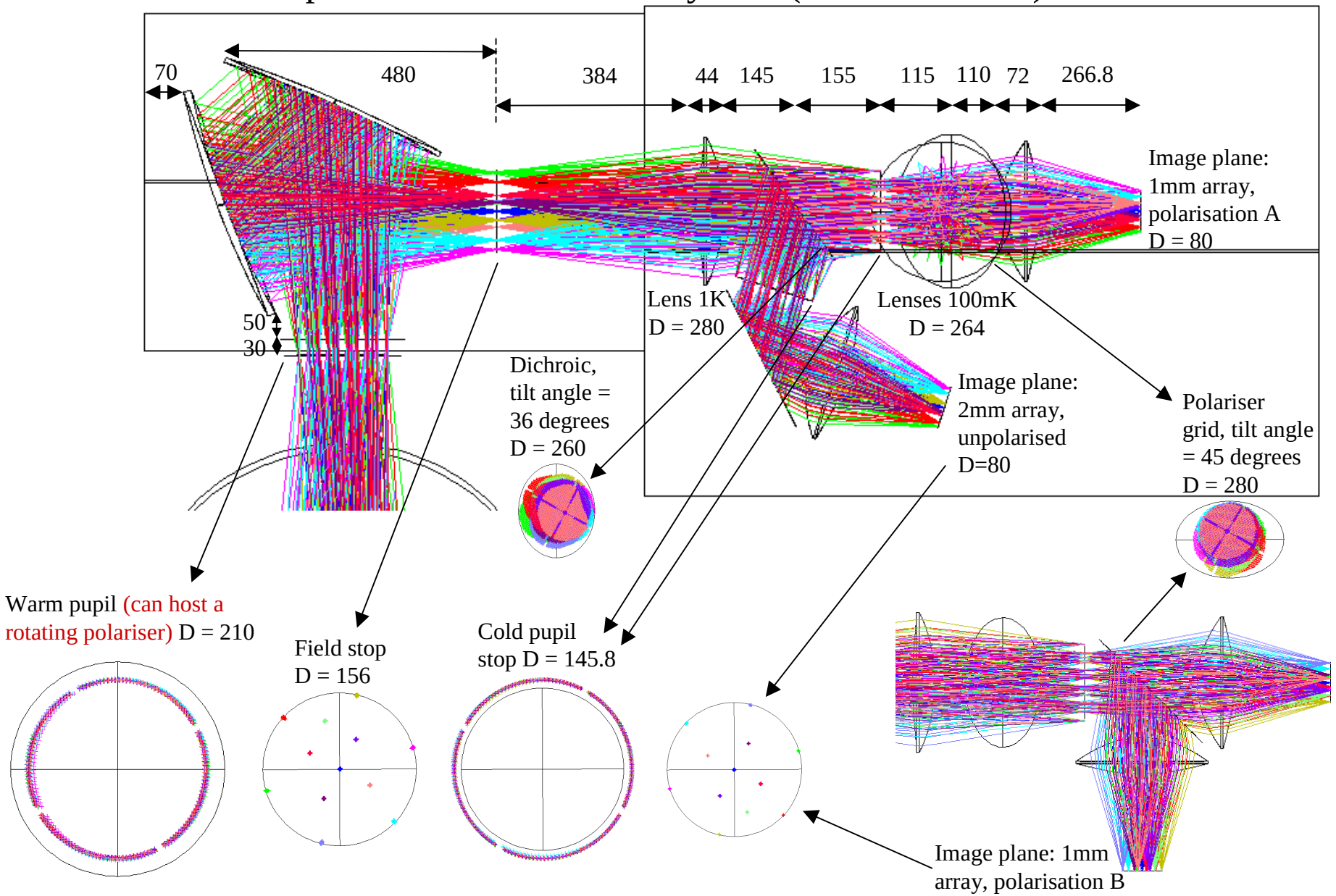


1st model: 2 ambient powered mirrors and 2+1x3 bands cold HDPE lenses
Optics details inside the cryostat (all sizes in mm)



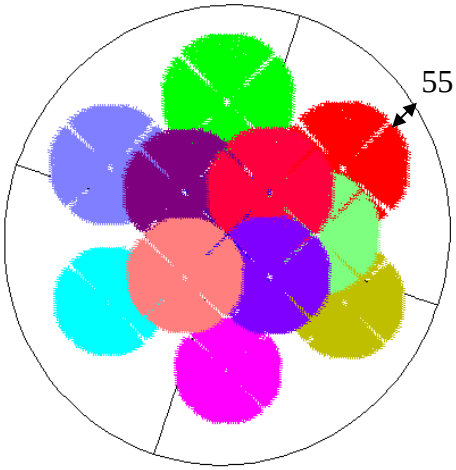
2nd model: 2 ambient & 2 cold powered mirrors and 1+1x3 bands cold HDPE lenses
Optics details inside the cryostat (all sizes in mm)



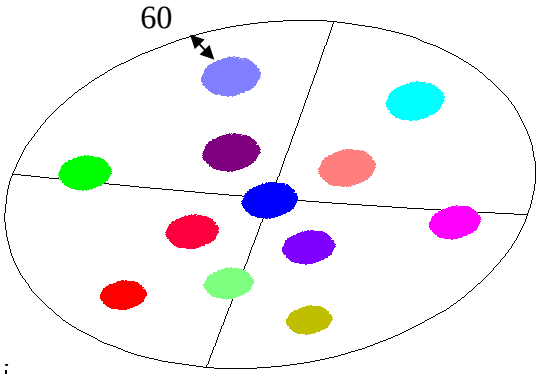
Footprints on mirrors

Mirrors identical in the 2 models

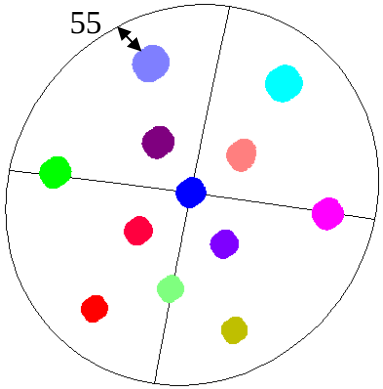
M4: 1180x800



M5: 720x780

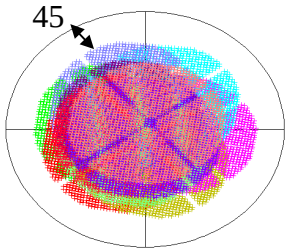


M6: 640x620



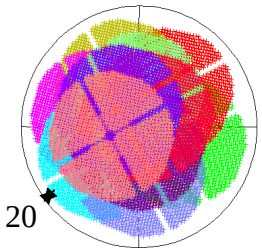
1st model (2+1x3 lenses)

M7: 440x370

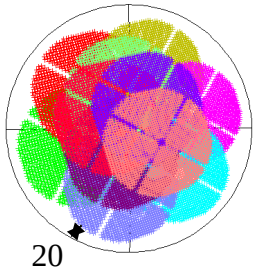


2nd model (1+1x3 lenses)

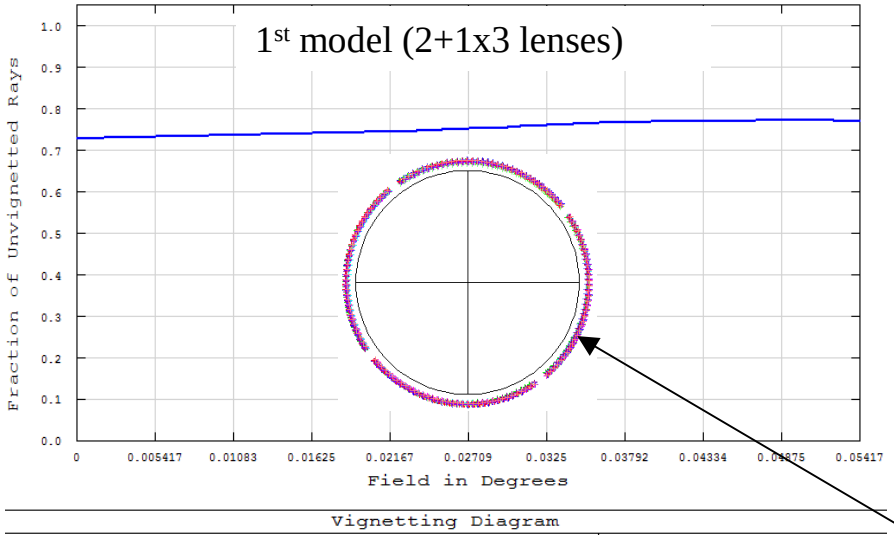
M7: 446x420

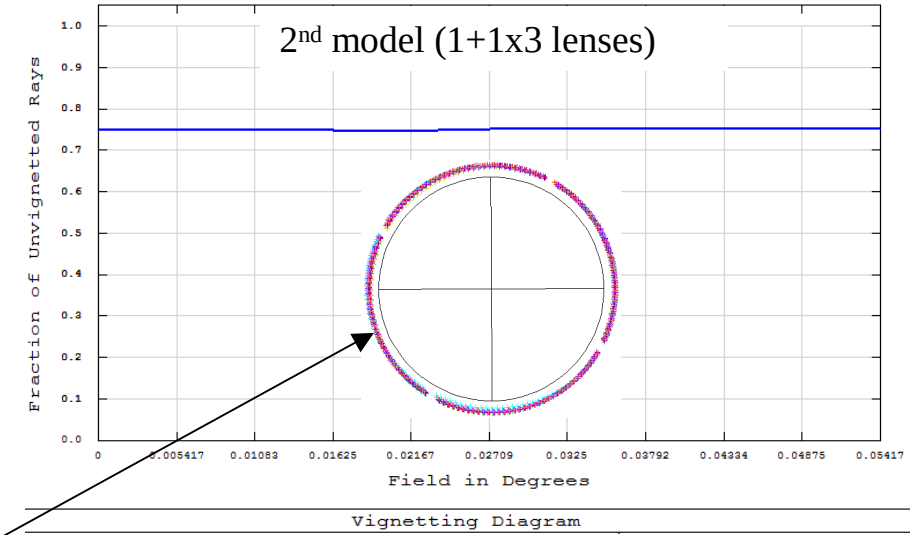


M8: 450x430

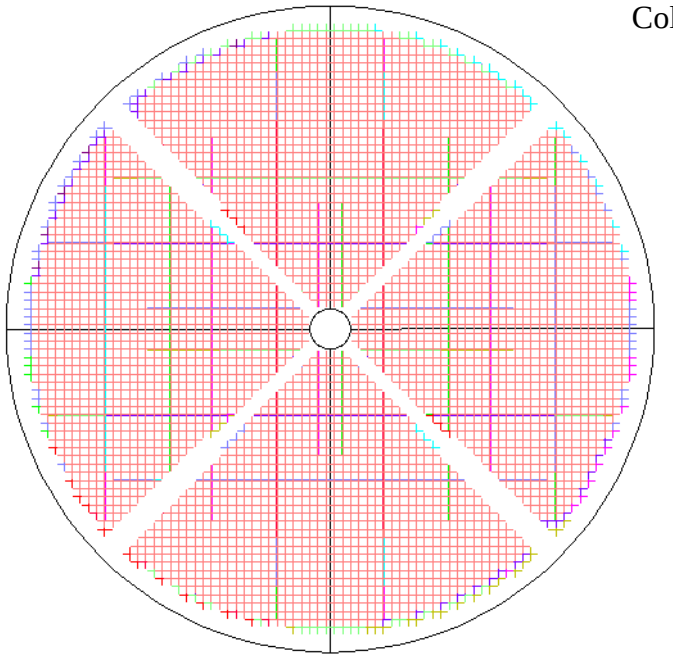


Spill-over mitigation: cold pupil stop vignetting on the primary

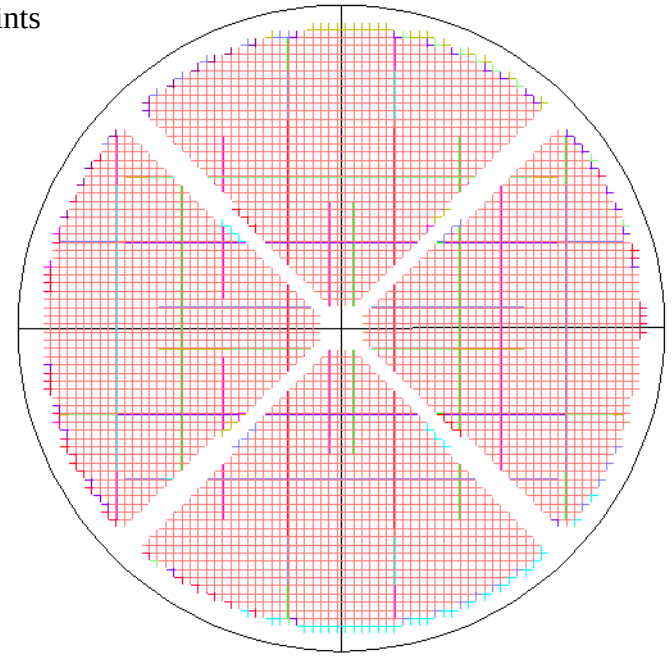




Cold pupil contour footprints



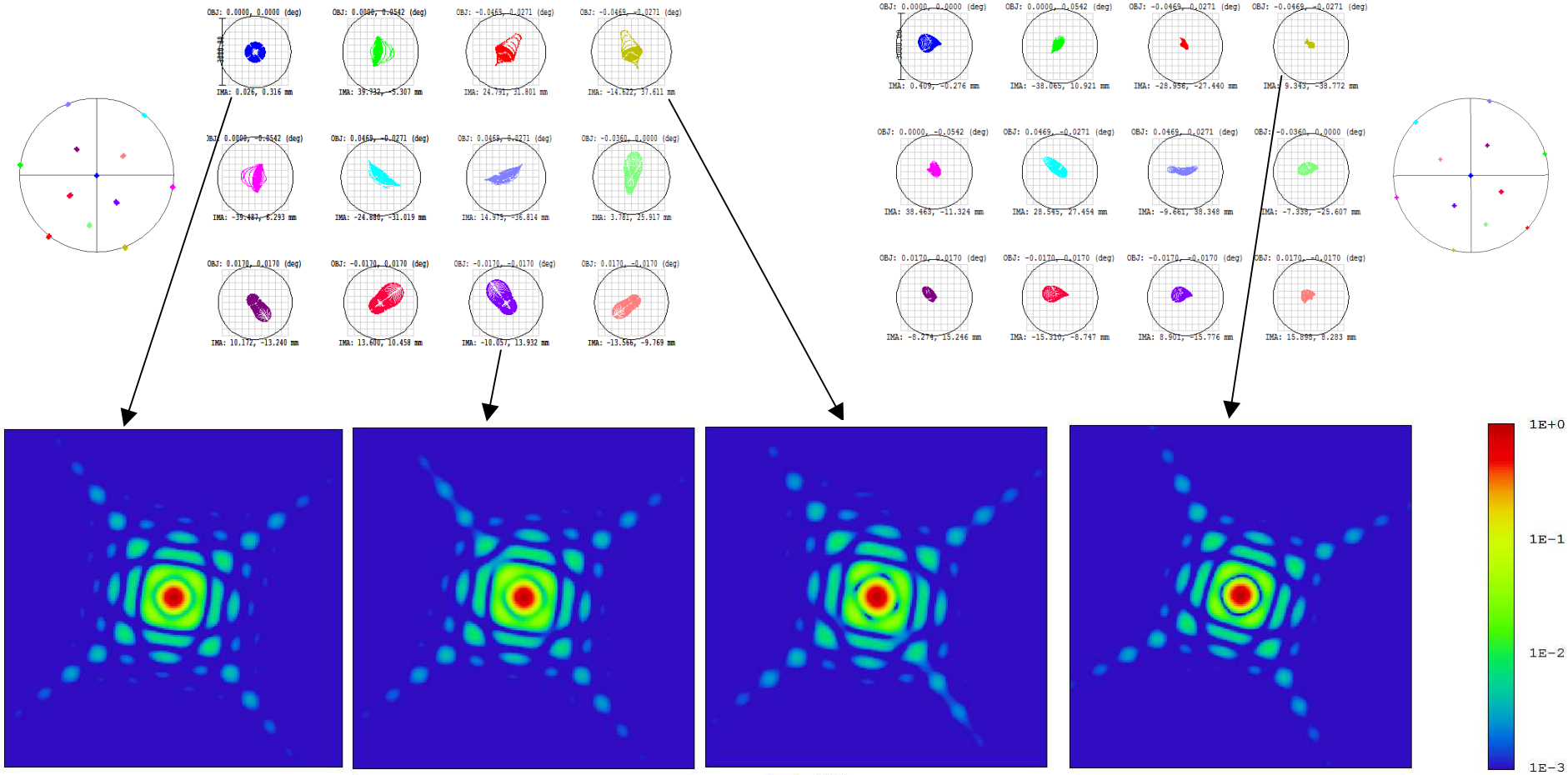
Primary
(M1 D=30m)
vignetted grid
footprints encircled
in 28m diameter



Remark: Fraction of Unvignetted Rays (FUR) = 90% without any pupil because of blockage from the secondary and the tetrapod

Examples of PSF illustrating the excellent optical quality of the models proposed.

Comparison between several PSF, including the best one and the one having the worst aberrations among the 2 modelss



PSF = Ray trace aberrations (color) * Airy Dark ring (circle)

(remark: the 4 legs on the PSF are caused by the diffraction on the telescope tetrapod between M1 and M2)

Addendum: examples of several variants for the 2 models proposed, illustrating the existence of margins to adapt the models to possible new constraints

The variants which names finish by B2 and C5 in the following list are the ones shown in the previous slides

Name of Zemax file	*Strehl [%]*	*Enc Energy 750um [%]*		*Grid dist [%]*	*FUR with cold pupil cut at D=28m on M1 [%]*
1) 2 ambiant powered mirrors, 2+1x3 lenses	min	max	min	max	min
6m5_M5M6-4_p-Cfpd_HDPE_3b_2biconP4_B2	**92**	**53**	**42**	**6,9**	**73**
6m5_M5M6-4_p-Cfpd_HDPE_3b_2biconP4_B1	**92**	**54**	**41**	**7**	**70**
1) 2 ambiant & cold powered mirrors, 1+1x3 lenses					
6m5_M5M6-4_p-Cfpd_HDPE_3b_4biconP4_C3	**97**	**50**	**47**	**2,1**	**76**
6m5_M5M6-4_p-Cfpd_HDPE_3b_4biconP4_C4	**97**	**52**	**51**	**2,1**	**75**
6m5_M5M6-4_p-Cfpd_HDPE_3b_4biconP4_C5	**98**	**51**	**49**	**1,9**	**75**

sizes [mm] in cryostat: -distances- and Objects diameters	*ambiant pupil Dext/Dint*
(F=filed stop, L=lens, Dic=dichroic, Pup=cold pupil, Pol=polariser)	
402- F=114 -216- L2=302 -155- Dic=260 -155- Pup2=126,4 -105- Pol=266 -105- L3=240 -233	**1,064**
406- F=116 -217- L2=292 -135- Dic=266 -162- Pup2=121,2 -103- Pol=260 -100- L3=230 -222	**1,069**
409- F=159 -290- L1=240 -110- Dic=238 -145- Pup2=126,6 -115- Pol=281 -100- L3=257 -250	**1,138**
432- F=153 -384- L1=269 -145- Dic=260 -155- Pup2=147,2 -115- Pol=312 -110- L3=261 -260	**1,161**
480- F=156 -384- L1=270 -145- Dic=260 -155- Pup2=145,8 -115- Pol=292 -110- L3=266 -267	**1,102**