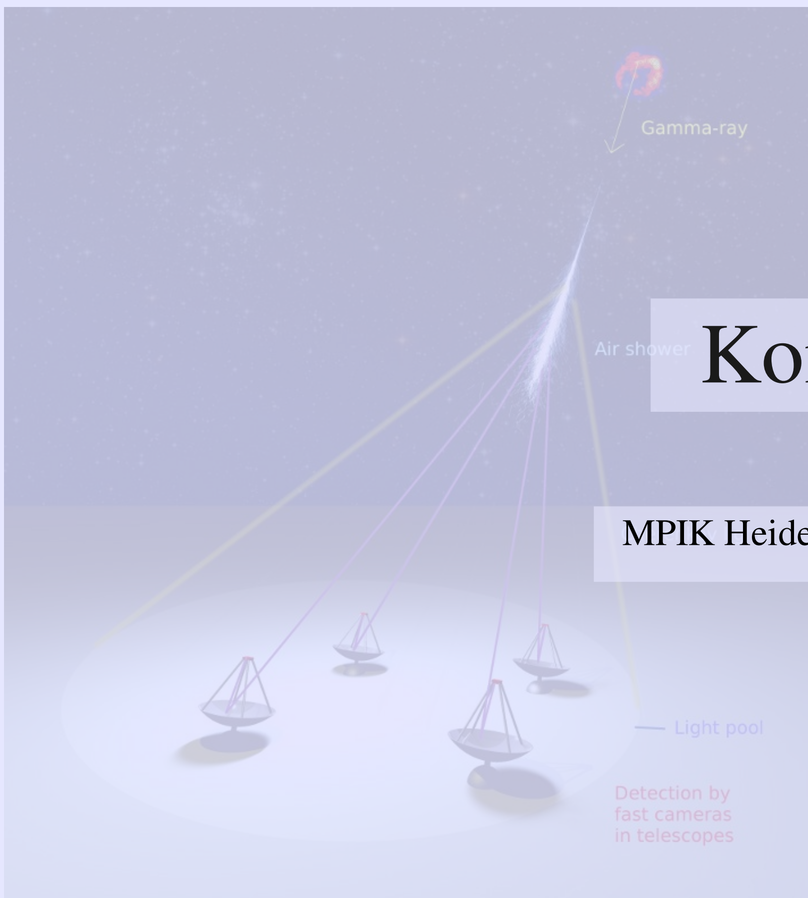
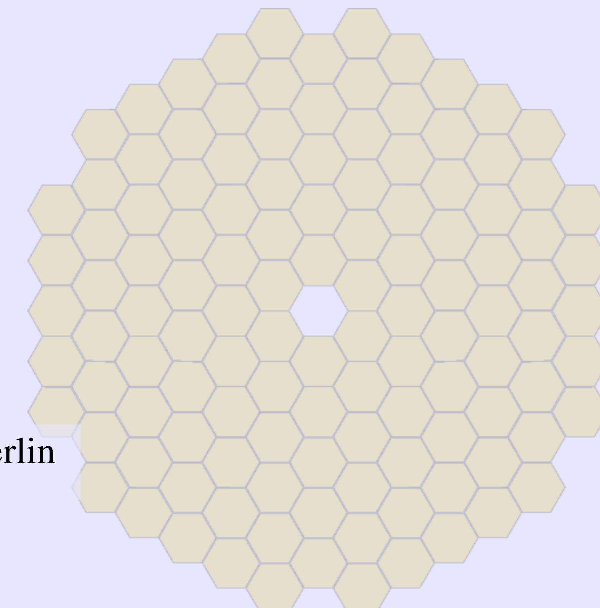
Davies Cotton for the CTA-SST
The MC configuration and comparisons



by

Konrad Bernlöhr

MPIK Heidelberg & Humboldt University Berlin



The beginnings of CTA-SST designs

In the first “HE” designs we had 7° and 8° f.o.v. cameras with 0.25° and 0.3° pixels, settled for 10° f.o.v. (reduceable after simulation) and 0.25° pixels.

For the first large-scale MC production (with “ultra3” configuration) we had aimed to

- share technologies across telescope types,
- in particular physical pixel sizes,
- front-end electronics, …

The “ultra3” telescope types

	Large	Medium	Small	Medium	10 m
		normal		wide-field	wide-field
				('BK')	('SB')
Diameter, max. (m)	24.0	12.3	7.4	12.3	10.4
Dish shape	parab.	DC	DC	DC	DC
Mirror area (m²)	412	100	37	100	73
Mirror tiles	594	144	120	144	108
Tile diam. (m)	0.90	0.90	0.60	0.90	0.89
Focal length (m)	31.2	15.6	11.2	16.8	10.0
f/D (“D” def.?)	1.30	1.27	1.51	1.37	0.96
F.o.v. diam (deg.)	5	8	10	10	10.5
Camera diam. (m)	2.8	2.2	2.0	3.0	1.8
No. of pixels	2841	2765	1417	1417	931
Pixel diam. (deg)	0.09	0.18	0.25	0.25	0.30
Pixel diam. (mm)	49 (50)	49 (50)	49 (50)	74 (75)	52 (57)

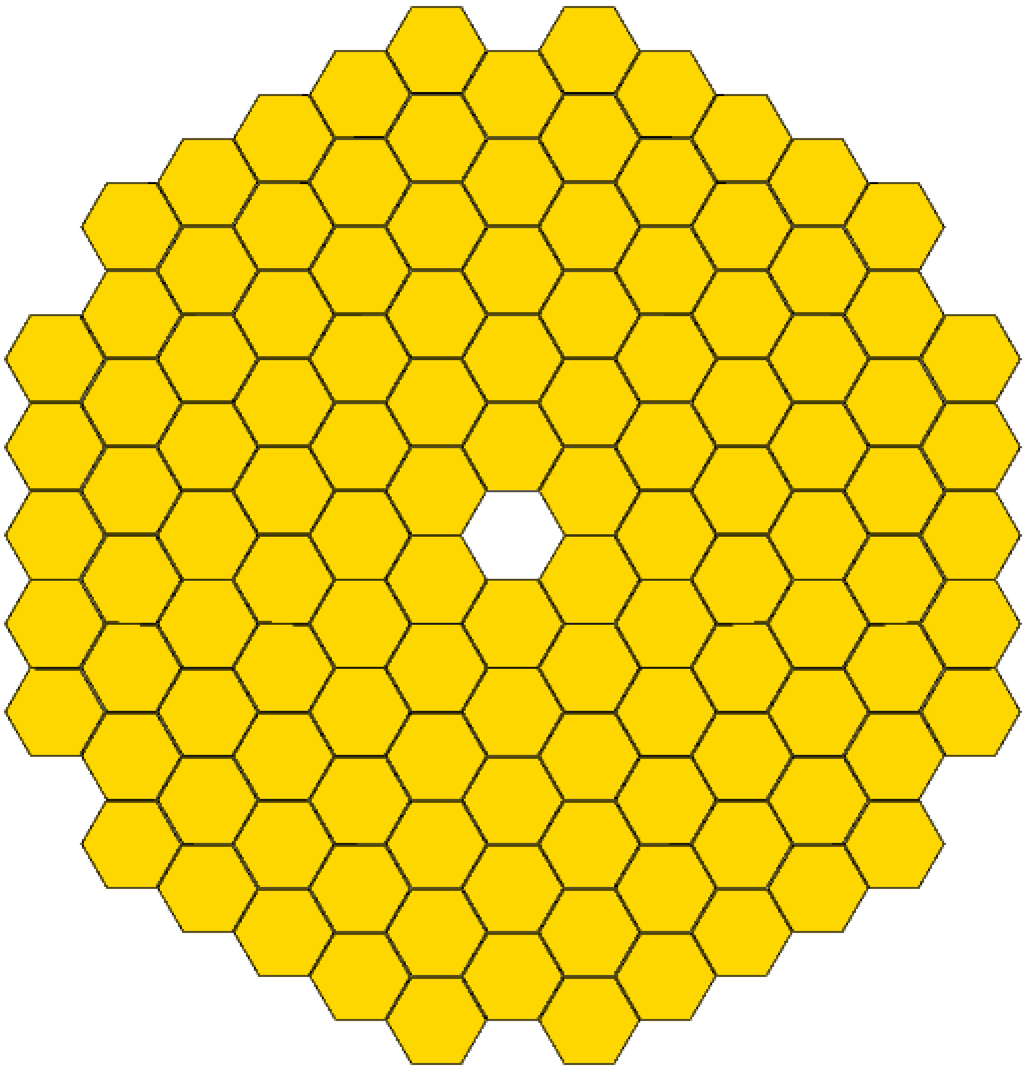
The “ultra3” telescope types

	Large	Medium	Small	Medium	10 m
		normal		wide-field	wide-field
				('BK')	('SB')
Diameter, max. (m)	24.0	12.3	7.4	12.3	10.4
Dish shape	parab.	DC	DC	DC	DC
Mirror area (m^2)	412	100	37	100	73
Mirror tiles	594	144	120	144	108
Tile diam. (m)	0.90	0.90	0.60	0.90	0.89
Focal length (m)	31.2	15.6	11.2	16.8	10.0
f/D	1.30	1.27	1.51	1.37	0.96
F.o.v. diam (deg.)	5	8	10	10	10.5
Camera diam. (m)	2.8	2.2	2.0	3.0	1.8
No. of pixels	2841	2765	1417	1417	931
Pixel diam. (deg)	0.09	0.18	0.25	0.25	0.30
Pixel diam. (mm)	49 (50)	49 (50)	49 (50)	74 (75)	52 (57)

The “ultra3” telescope types

	Large	Medium	Small	Medium	10 m
		normal		wide-field	wide-field
				('BK')	('SB')
Diameter, max. (m)	24.0	12.3	7.4	12.3	10.4
Dish shape	parab.	DC	DC	DC	DC
Mirror area (m^2)	412	100	37	100	73
Mirror tiles	594	144	120	144	108
Tile diam. (m)	0.90	0.90	0.60	0.90	0.89
Focal length (m)	31.2	15.6	11.2	16.8	10.0
f/D	1.30	1.27	1.51	1.37	0.96
F.o.v. diam (deg.)	5	8	10	10	10.5
Camera diam. (m)	2.8	2.2	2.0	3.0	1.8
No. of pixels	2841	2765	1417	1417	931
Pixel diam. (deg)	0.09	0.18	0.25	0.25	0.30
Pixel diam. (mm)	49 (50)	49 (50)	49 (50)	74 (75)	52 (57)

Optical configuration in MC

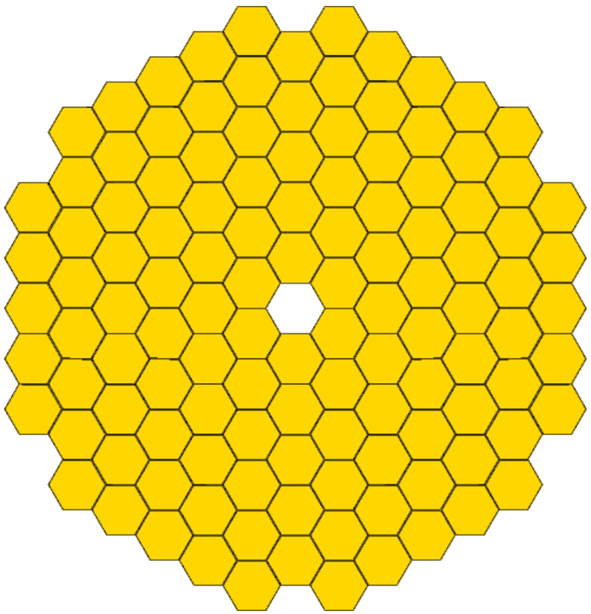


120 mirrors of 60 cm diameter. Mirror area (37 m²) is larger than really necessary but at little extra cost (camera dominates).

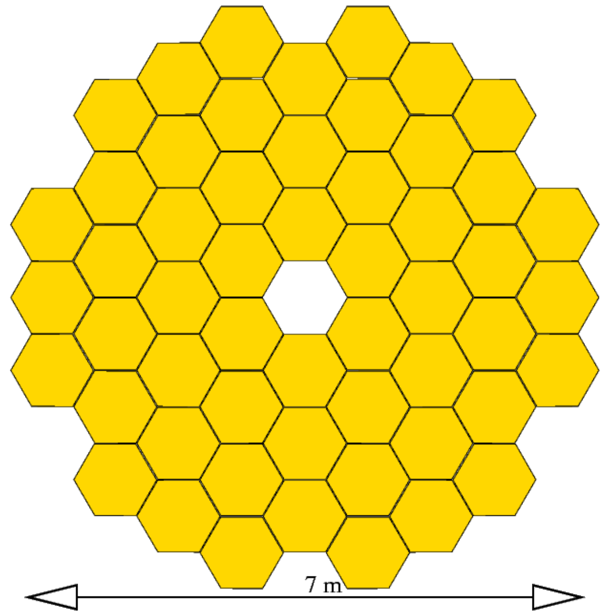
Focal length of 11.2 m in order to have same physical pixel size (50 mm pitch) as for larger telescope types.

If pixel size compatibility is dropped, a mirror area of 25 m² may seem more “natural” (400/100/25), with a focal length of 7 to 8 m.

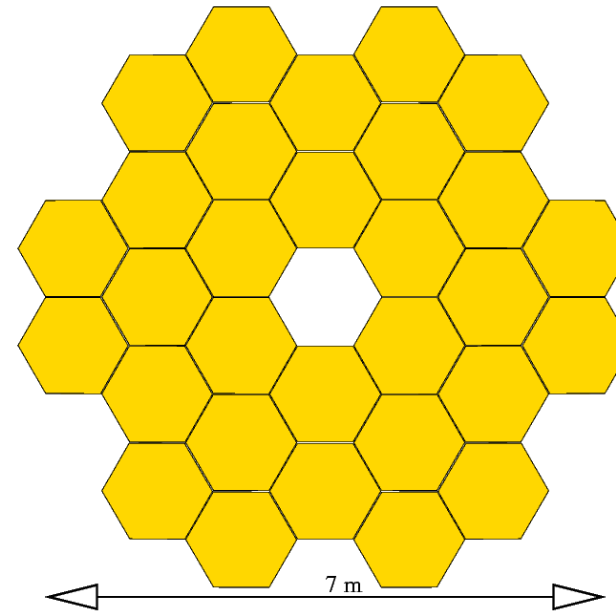
Larger mirror segments?



60 cm



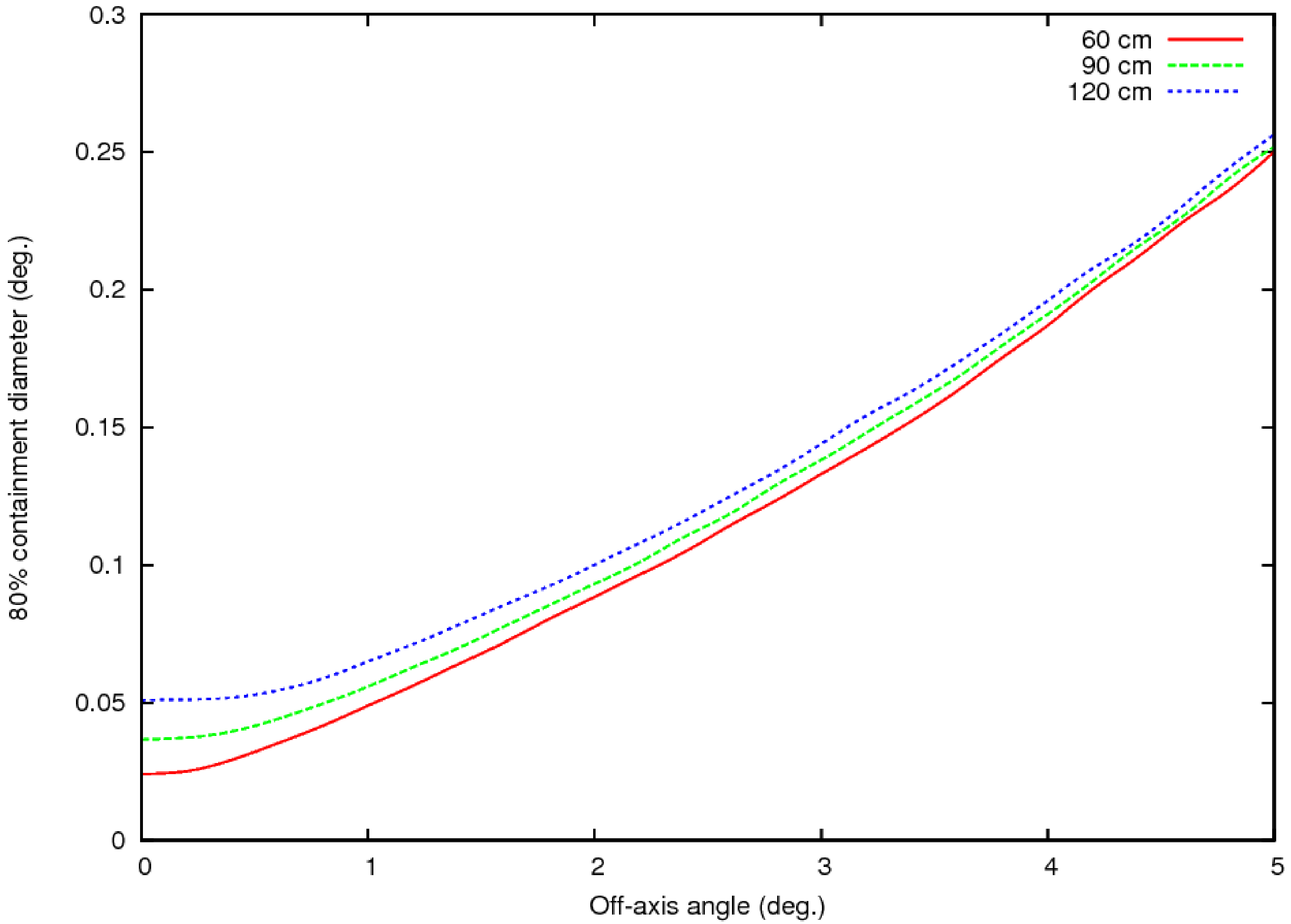
90 cm



120 cm

Larger mirror segments result in inferior on-axis PSF.
60 cm is near optimal, 90 cm may be still OK, 120 cm seems rather big (for f=11.2 m).

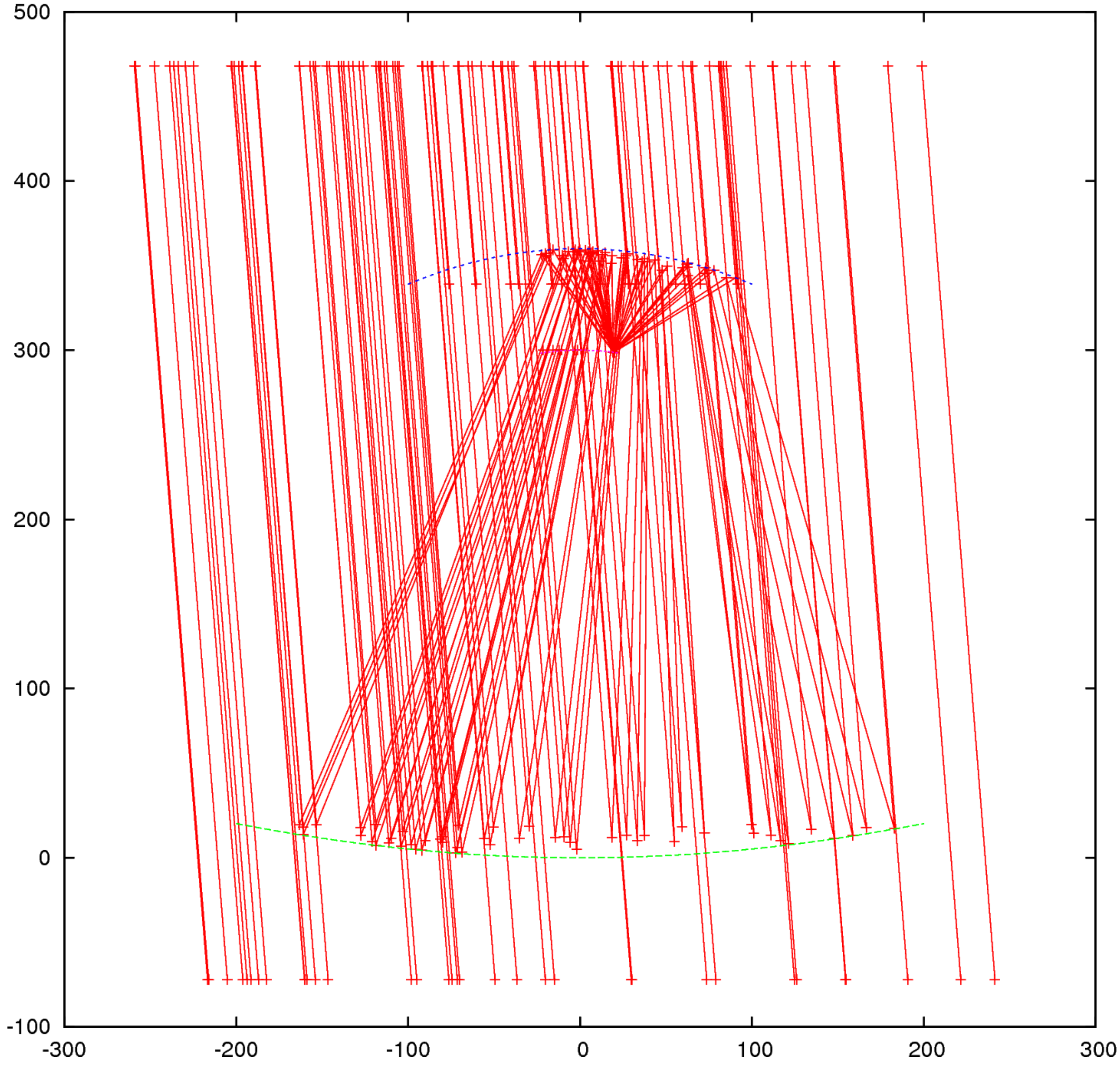
PSF comparison for f=11.2 m



A comparison of different designs

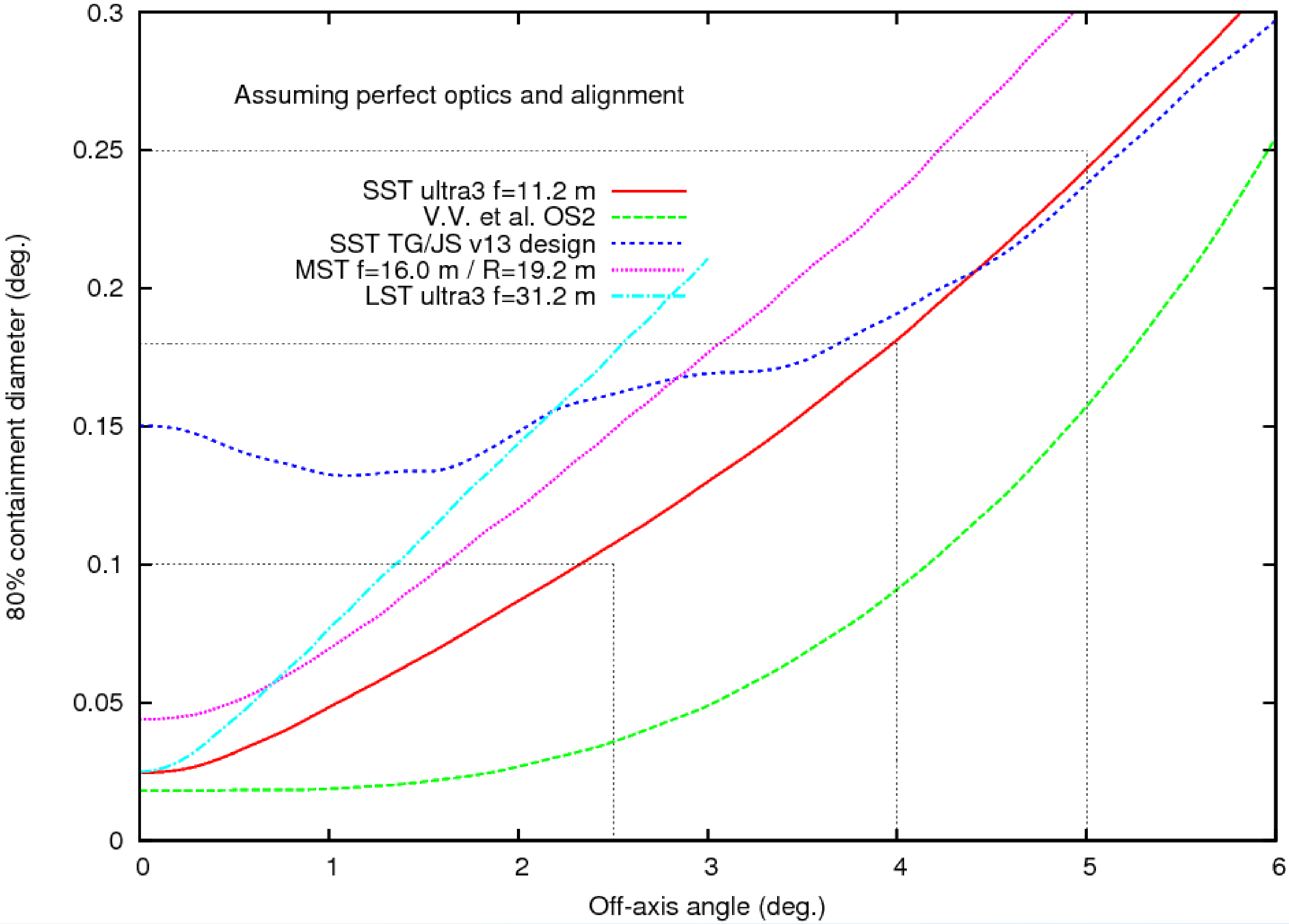
In sim_telarray ray-tracing, the following optical designs have been compared:

- 23 m LST (from “ultra3” f=31.2 m)
- 12 m MST (intermediate shape f=16.0 m, R=19.2 m)
- 7 m SST (from “ultra3” f=11.2)
- 4 m secondary mirror optics design v13 (after unit conversion, hopefully done right)
- 9.4 m secondary mirror OS2 by Vassiliev et al.



Ray-tracing of dual mirror optics with sim_telarray.

PSF comparison different designs



Conclusions

- The initial SST-DC design was strongly influenced by
  - compatible camera components across telescope types,
  - cost model saying that camera costs would dominate.
- Optical PSF of DC design with large f/D is perfectly OK for the 0.25° pixels and a 10° f.o.v.
- If camera components compatibility is given up, the mirror area and focal length would get smaller. For A=9.4 m^2 (like 4 m dual mirror design) it would be much smaller (half the current size, f~5 m).