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Proposed Single Open Reflector for the GALILEO Mission

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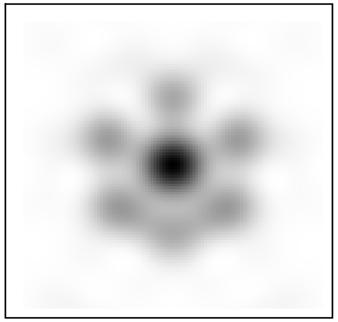
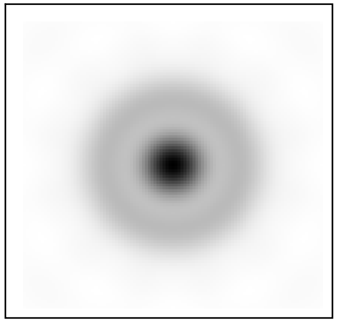
Far Field of the GALILEO Prism Array

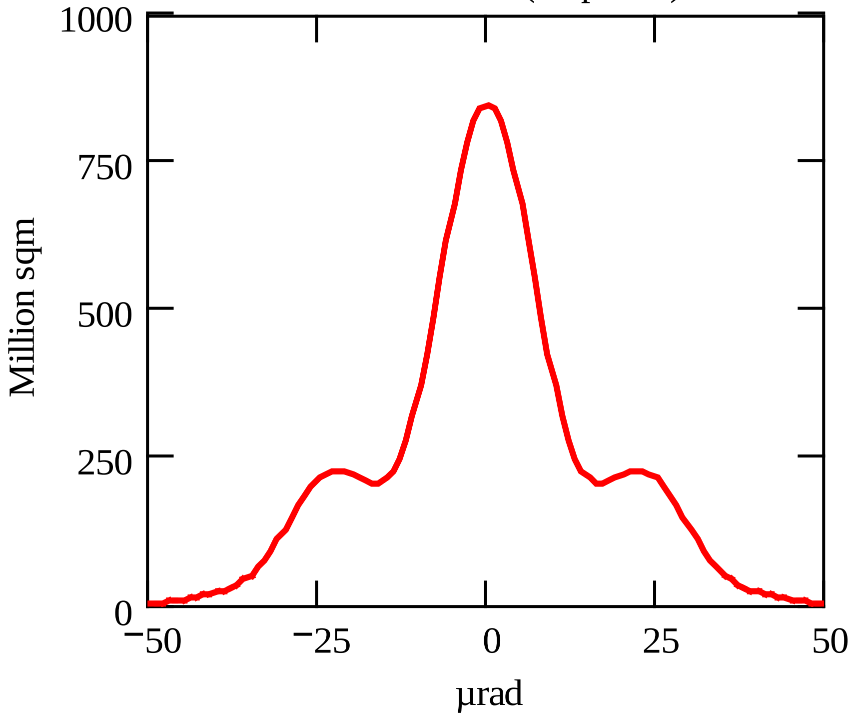
velocity aberration 23.7....24.2 µrad

Single prism



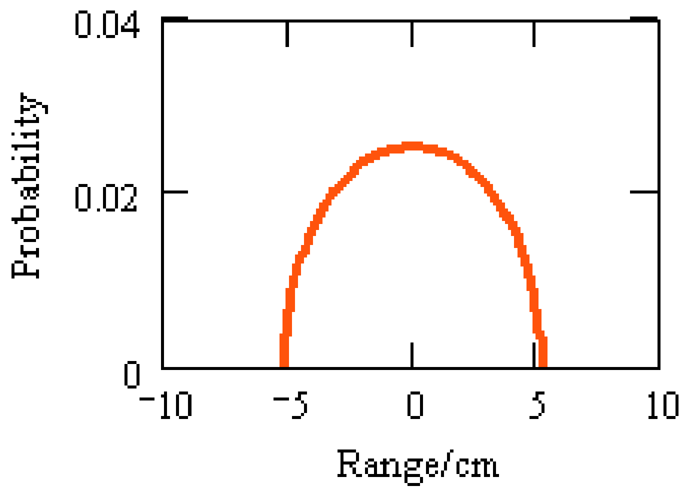
Average





Expected Signature of the GALILEO Array

circular array, radius R=25cm, angle of incidence: α=12°



Single shot precision:

$$\sigma = \frac{R}{2} \cdot \sin(\alpha)$$

$$\sigma = 2.6\text{cm} \quad (12°)$$

Normal point precision: $\sigma_{res} = \frac{\sigma}{\sqrt{N}}$

25 measurements required to get 5mm precision

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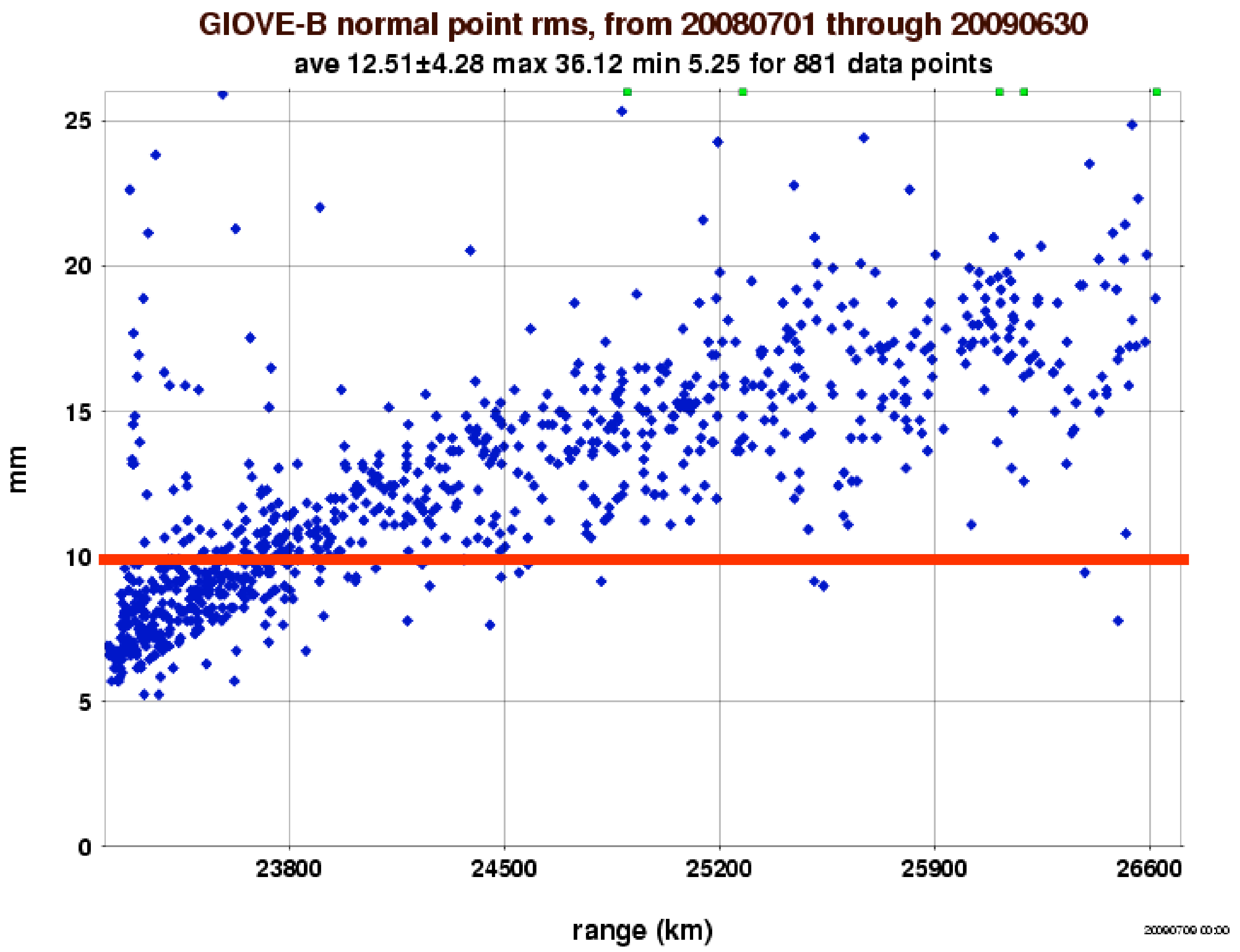
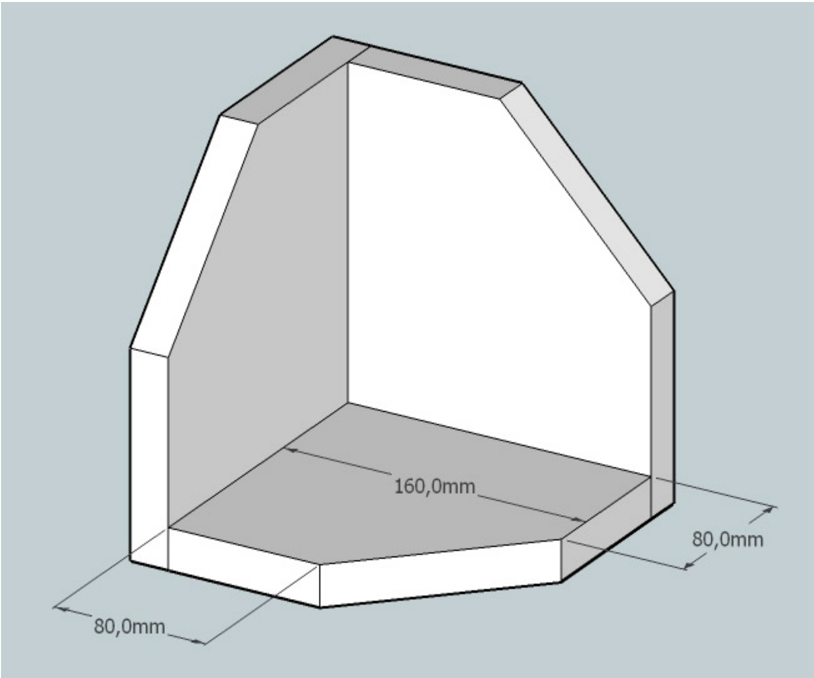
Zimmerwald, Switzerland 7810



The Proposed Open Reflector Geometry

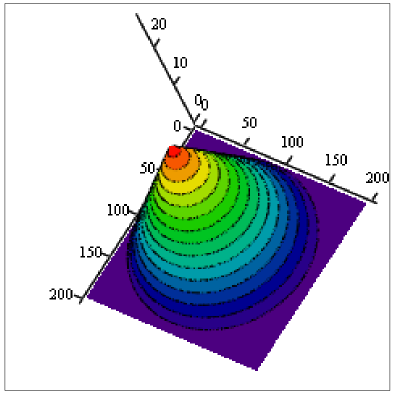


Main Features of the Reflector:

- no pulse spreading
- high effective radar cross section
- small (up to 20cm diam. front face)
- low weight

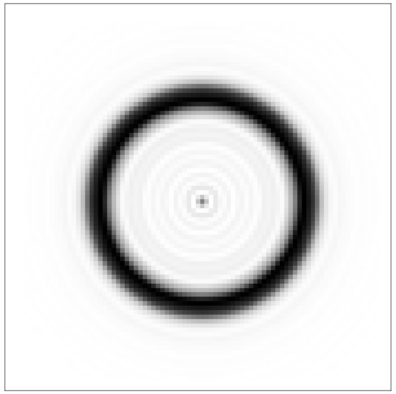
Far Field of the Open Reflector with Conical Wave Front

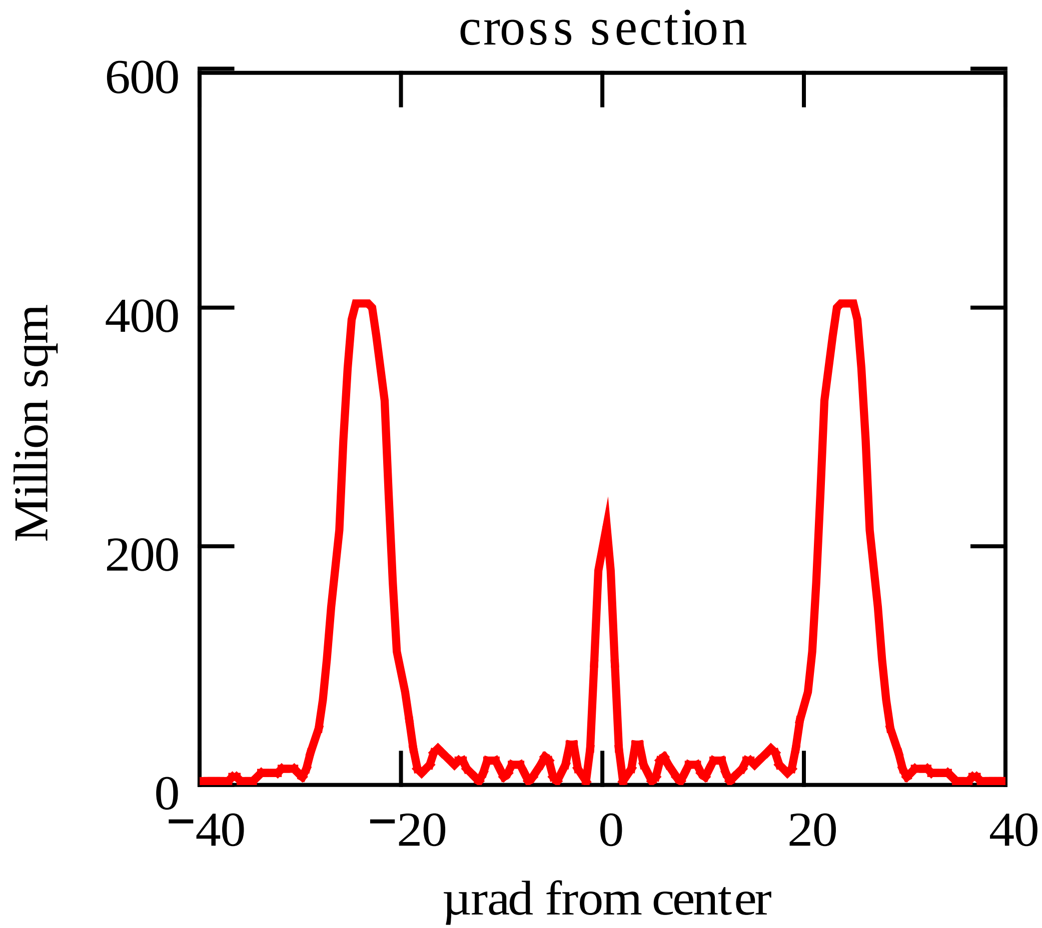
Wave front



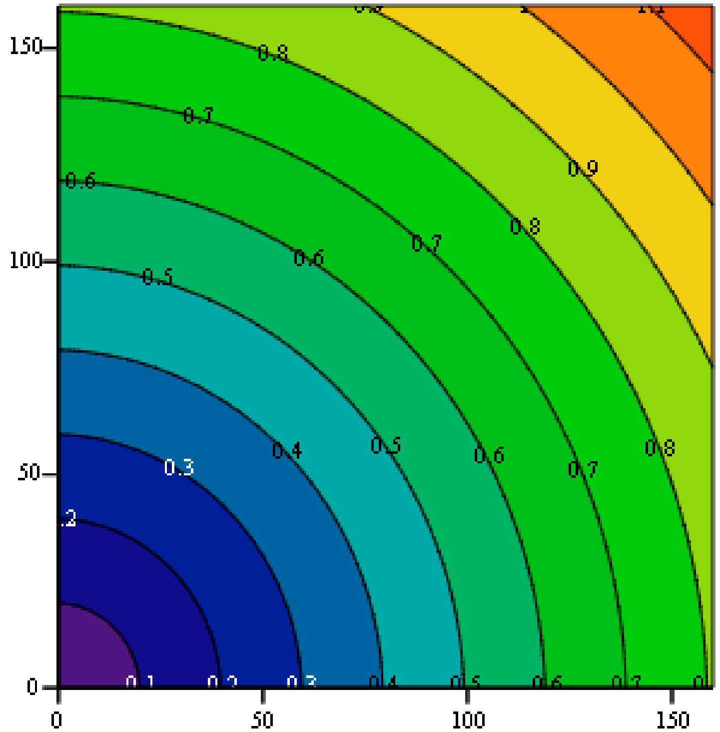
F

Far Field



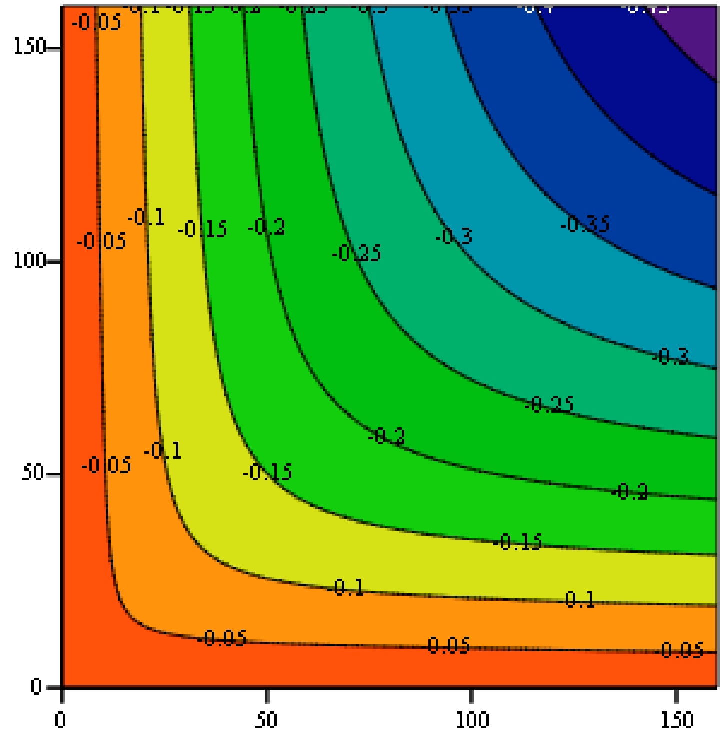


Conical Shape of the Mirrors



A

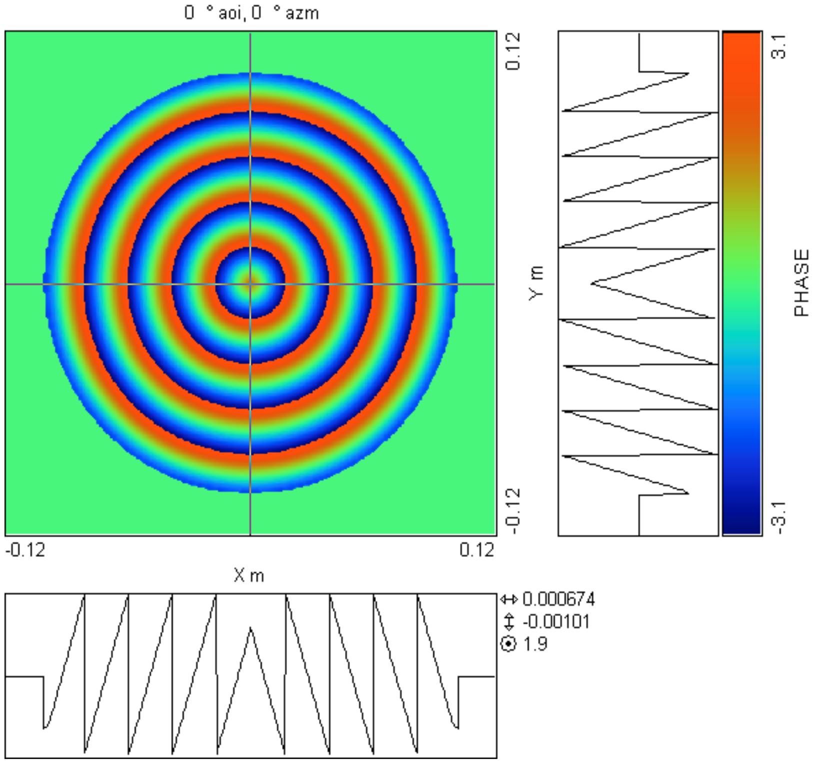
difference to perfect LRR
in µm

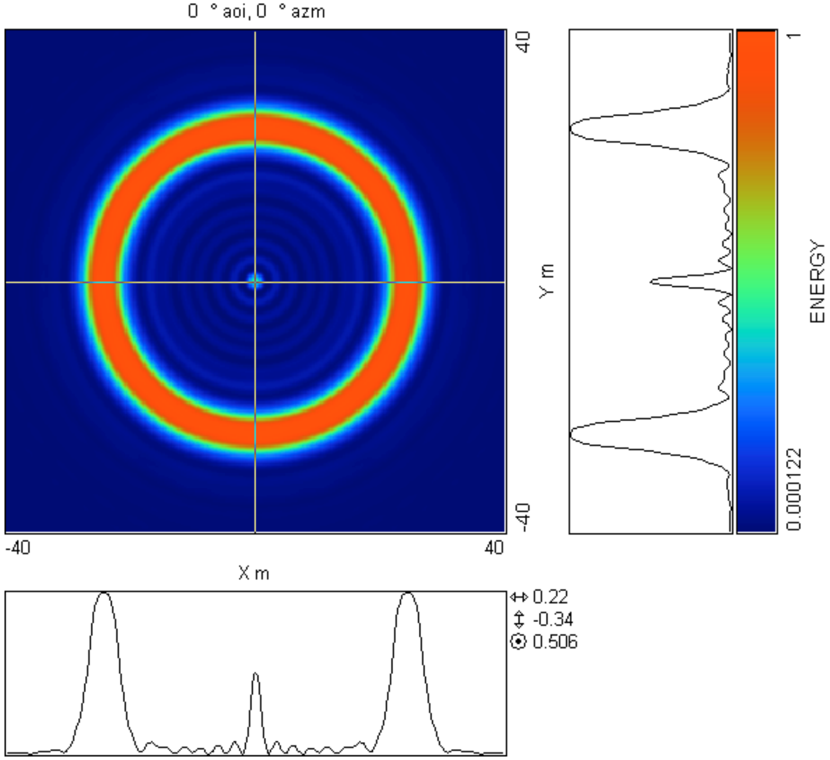


A – B

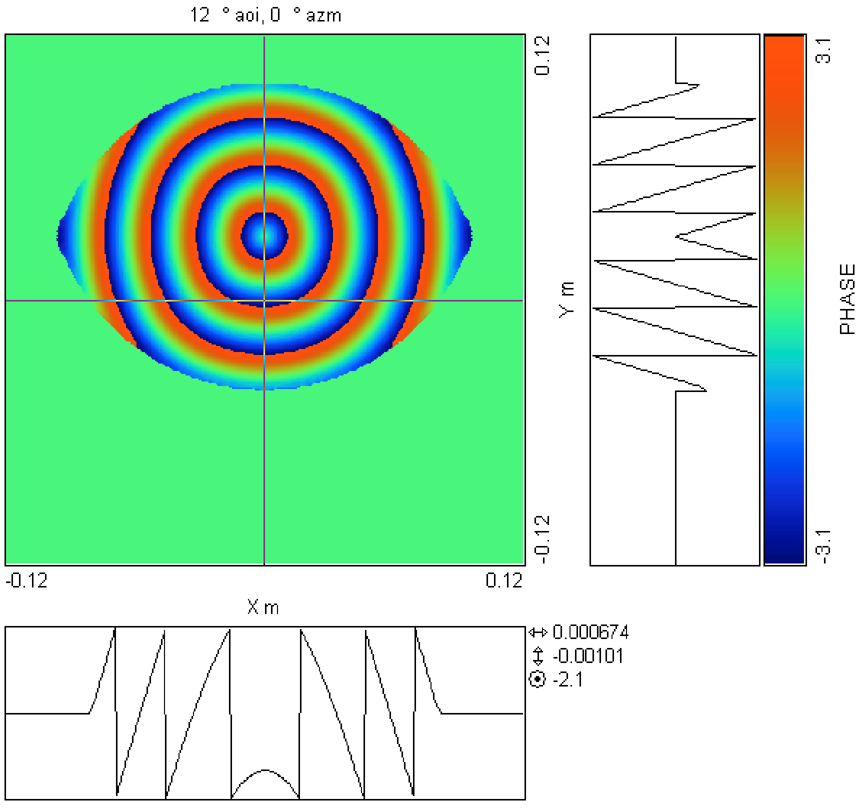
remaining deformation after
introducing 2.1arsec offsets

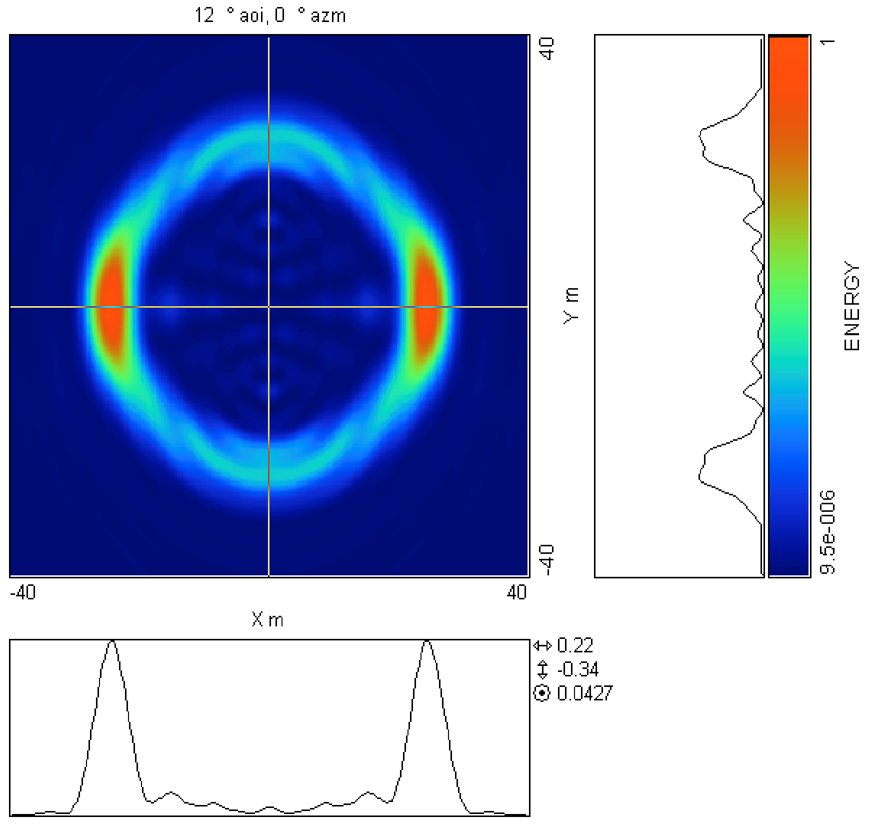
Wave Front and Far Field from ASAP, $\alpha=0°$



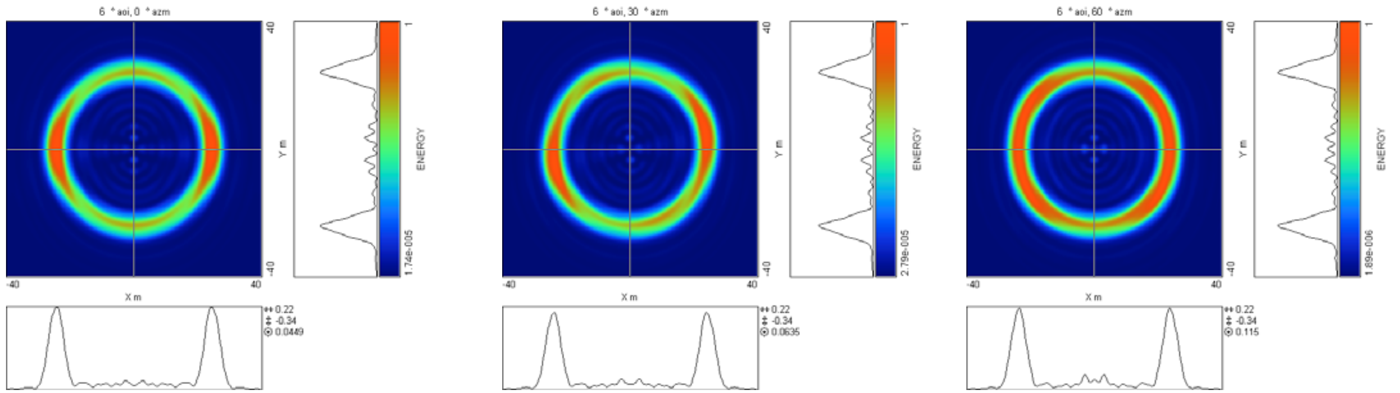


Wave Front and Far Field from ASAP, α=12°



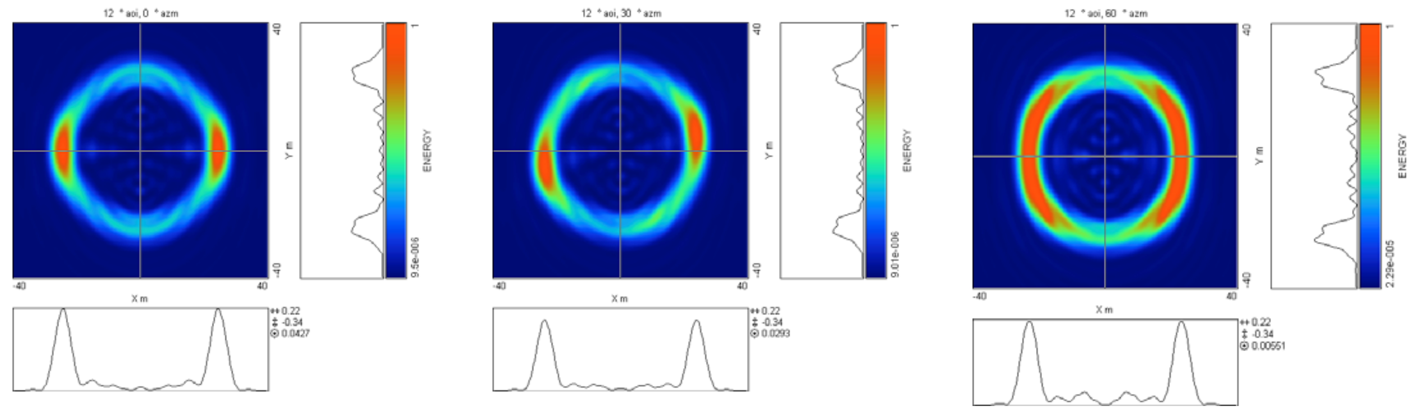


Far Field: Dependence on Orientation



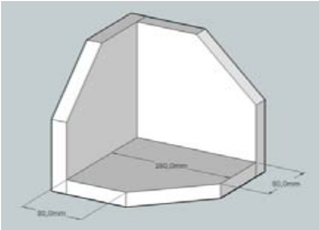
α=6°

0° 30° 60° Azimuth



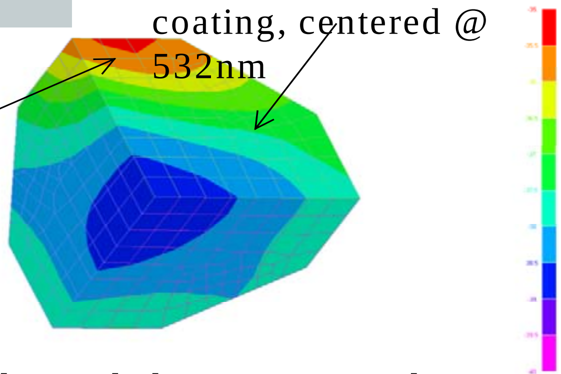
α=12°

Thermal Simulations of Orbital Heat Loads

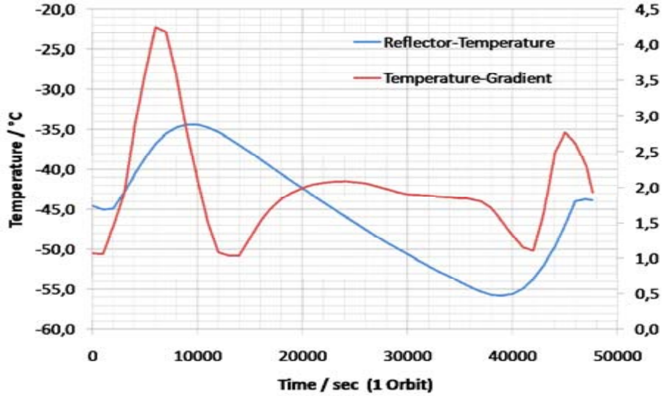


Zerodur mirror, high-reflective dielectrical coating, centered @ 532nm

Partial Sun Heating shortly after Eclipse



Color-coded temperature plot,
Red = -35°C
Blue = -39°C



Preliminary Results, Design will be further optimzed

• High transient variation of the average temperature is approx. 20°C (blue line)

• Low spatial variation of approx. 4.5°C at 6000sec shortly after eclipse phase from 45967sec to 1619sec (red line)

Conclusion

The proposed open reflector is advantageous compared to the standard prism array because of:

- no pulse spreading at all angles
- equal or higher effective cross section but smaller dimension (higher antenna gain)
- at low elevation (high angle of incidence) a single received photon is needed only to achieve the full resolution of the SLR system

Main problem area:

thermal distortion caused by sun heating should be kept small by the use of selected Zerodur substrate, dielectric coating and sun shield