Homologous Deformation of the Effelsberg 100 m Telescope determined with a Total Station

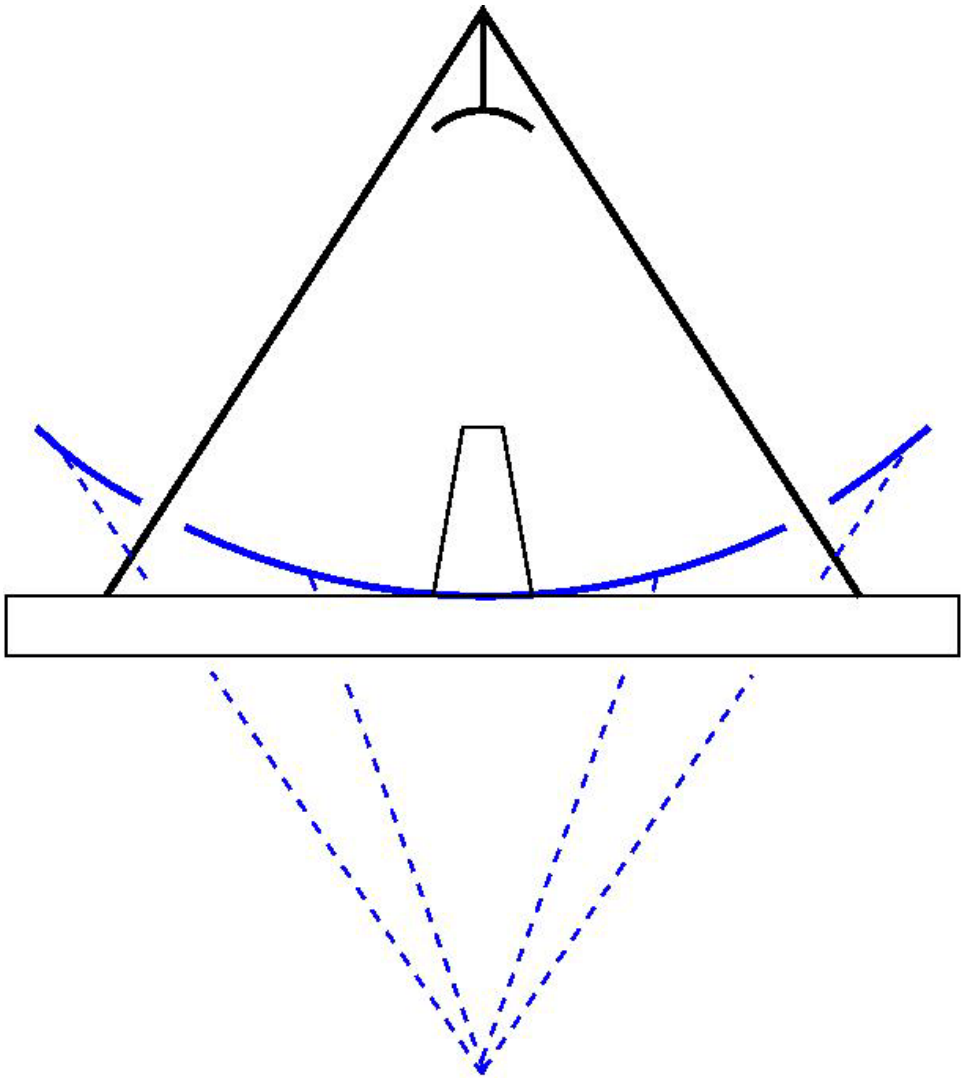
Axel Nothnagel, Judith Pietzner, Christian Eling, Claudia Hering
Institute of Geodesy and Geoinformation
University of Bonn

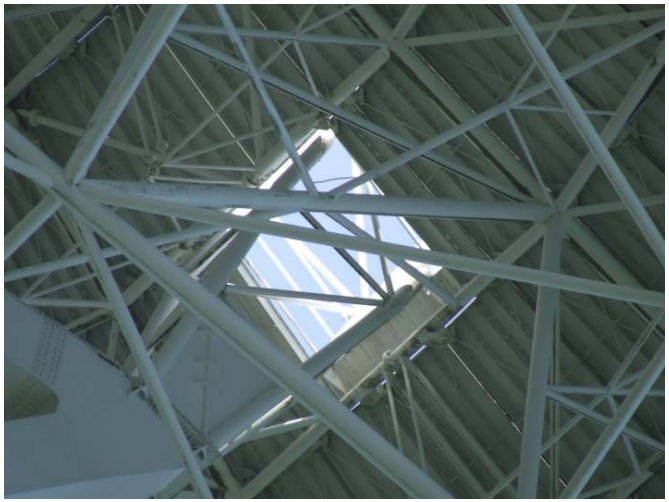
Content

- Effelsberg 100 m telescope characteristics
- Measurement setup
- Analysis
  - Support leg deformation model
  - Movements of instrument
  - Movements of survey points on main reflector
  - Fits of paraboloid parameters
  - Path length variations

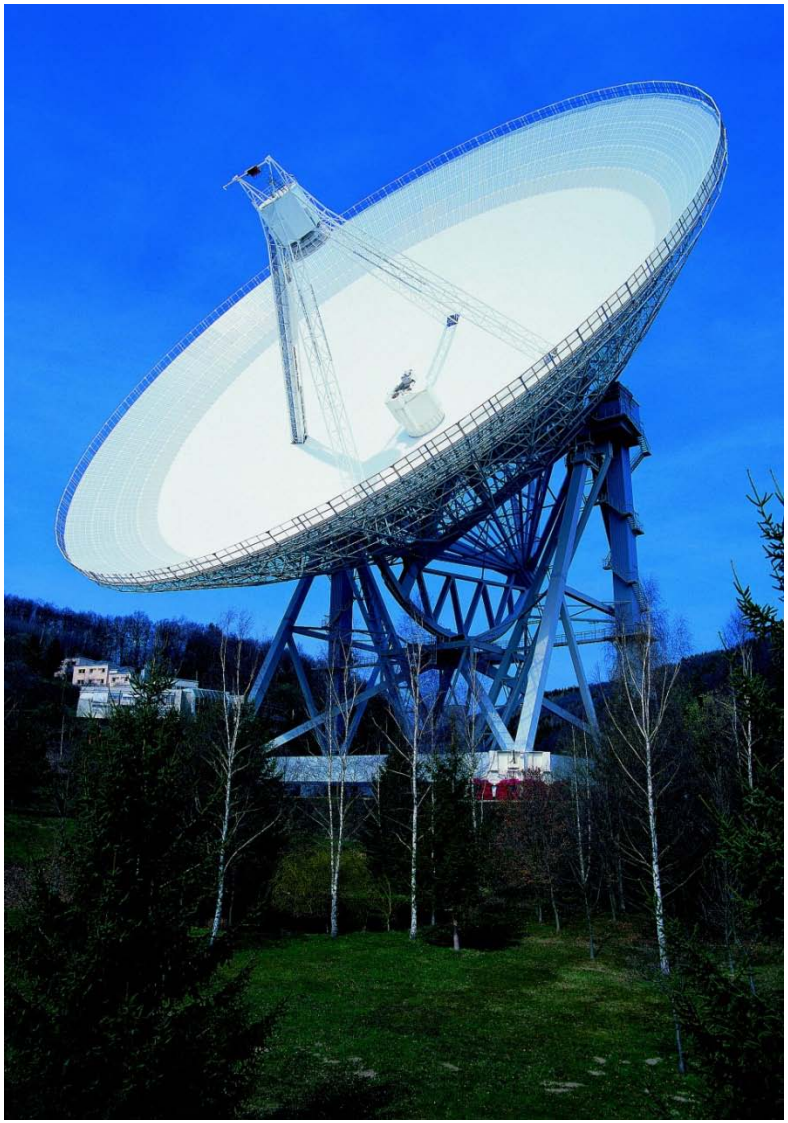
Effelsberg 100 m telescope

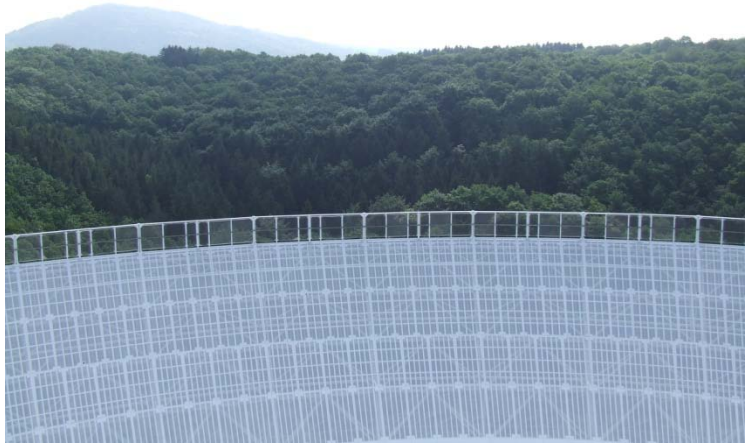
Homologous deformation





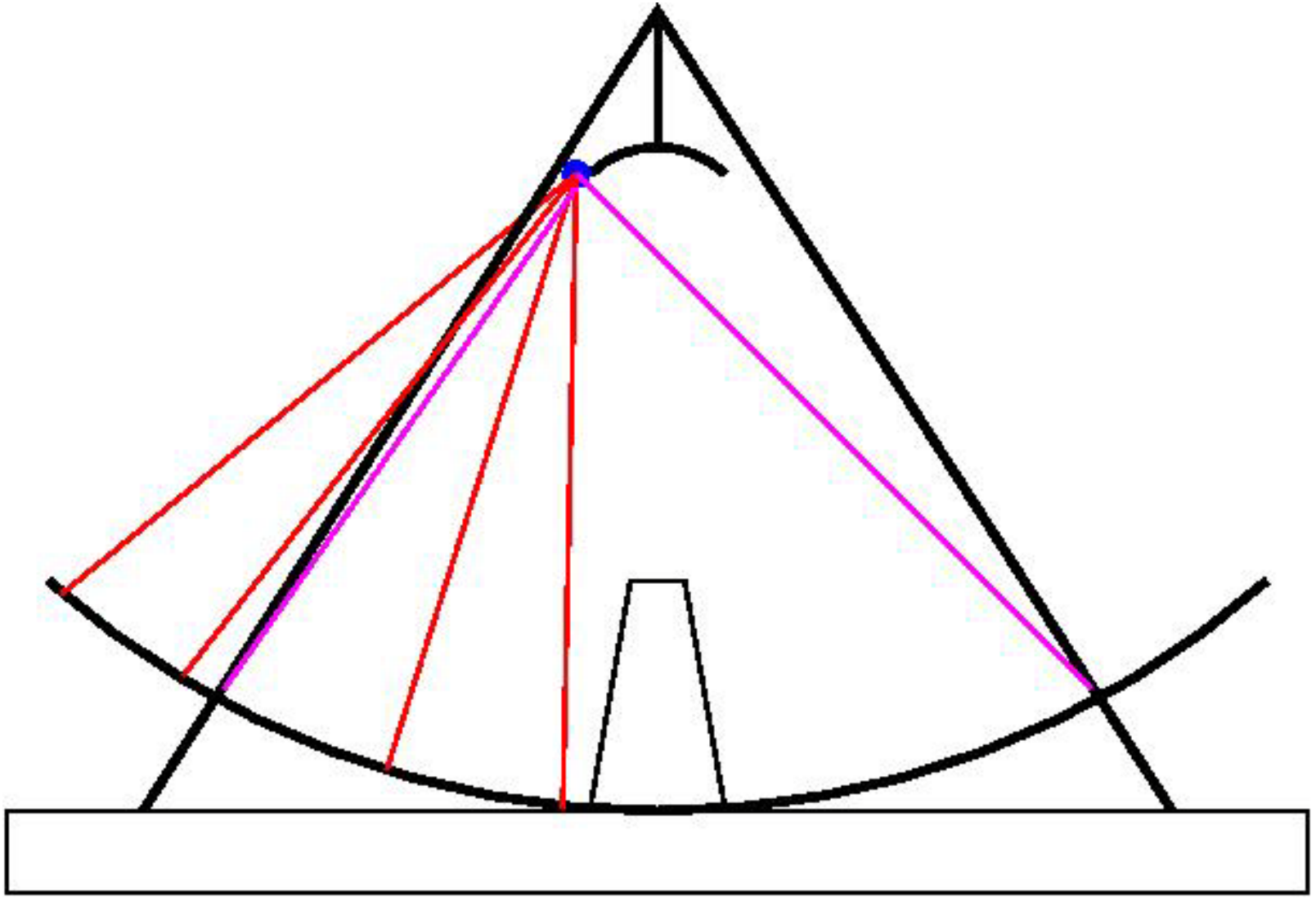
Effelsberg 100 m telescope





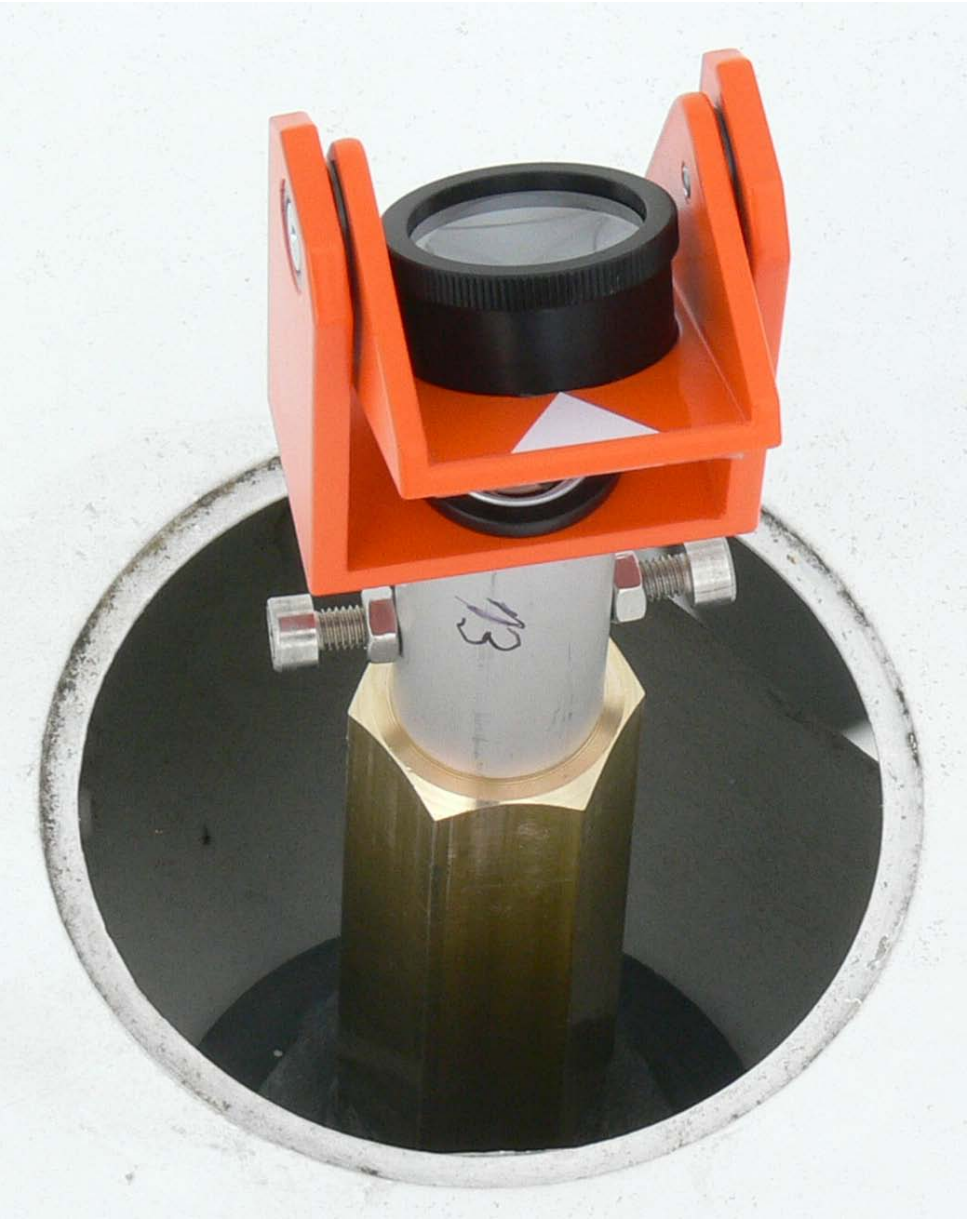
Courtesy
Max Planck Institute for Radio Astronomy, Bonn

Measurement concept



Leica TCRP1201

Minireflectors

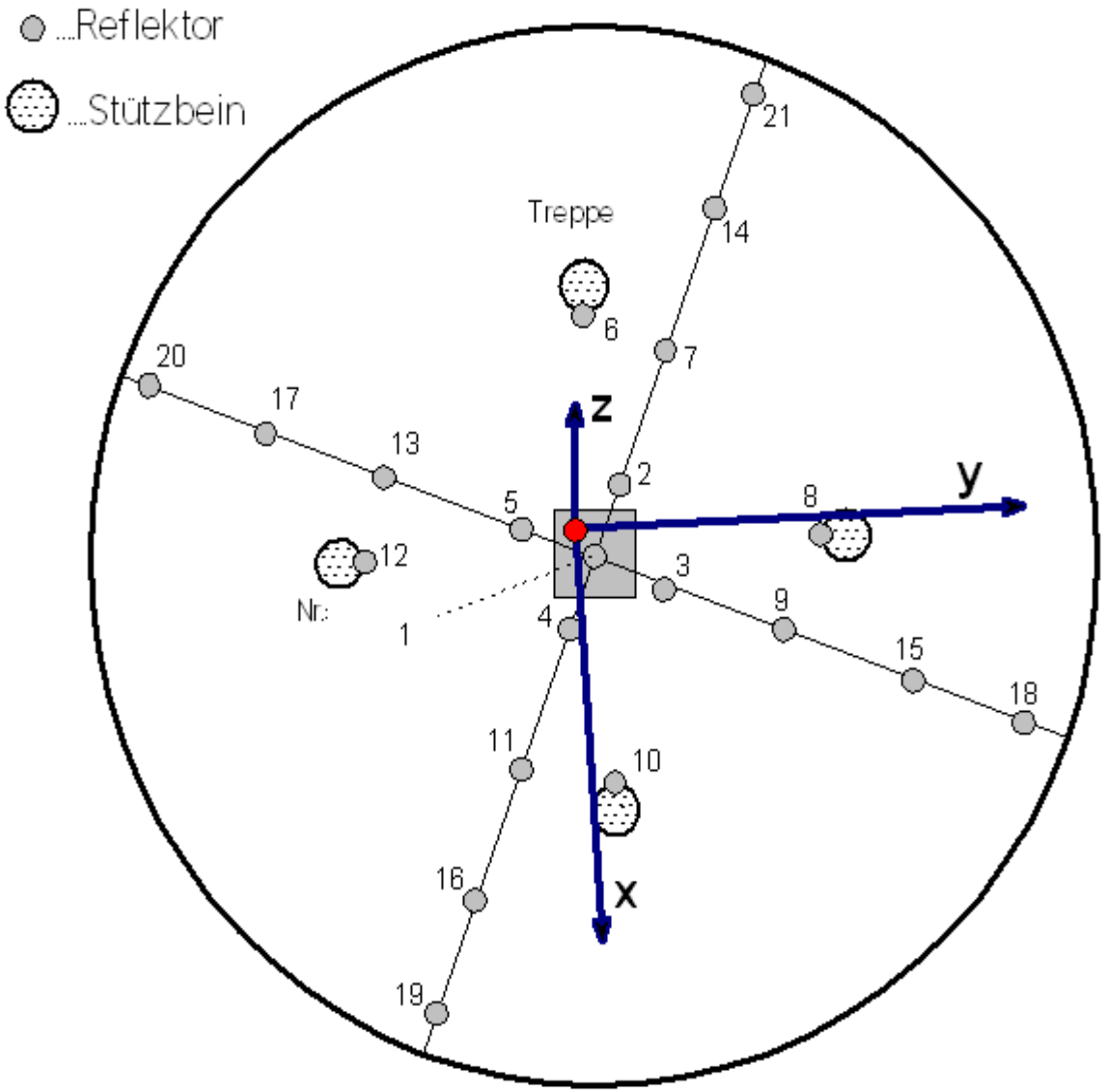


Inner ring

Minireflectors along meridians

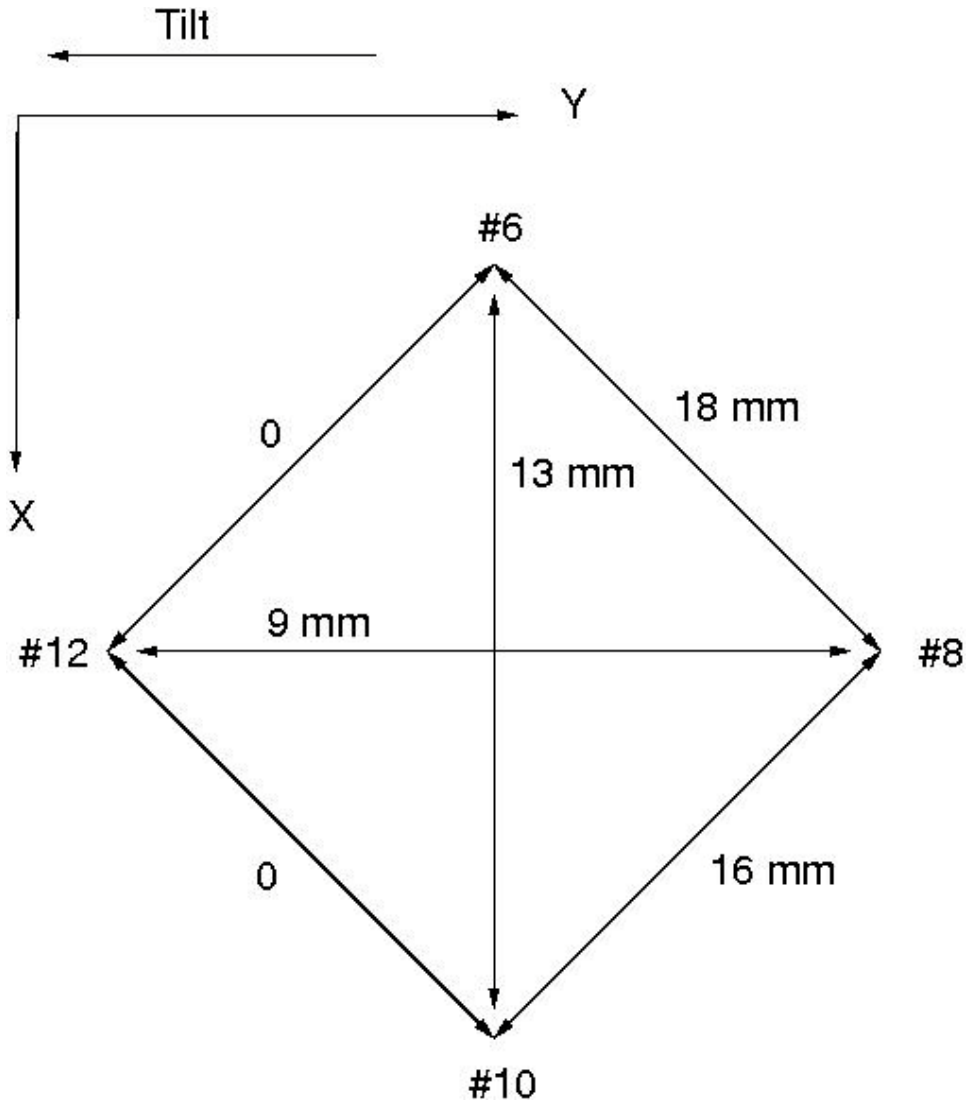
Outer ring

Distribution of reflectors

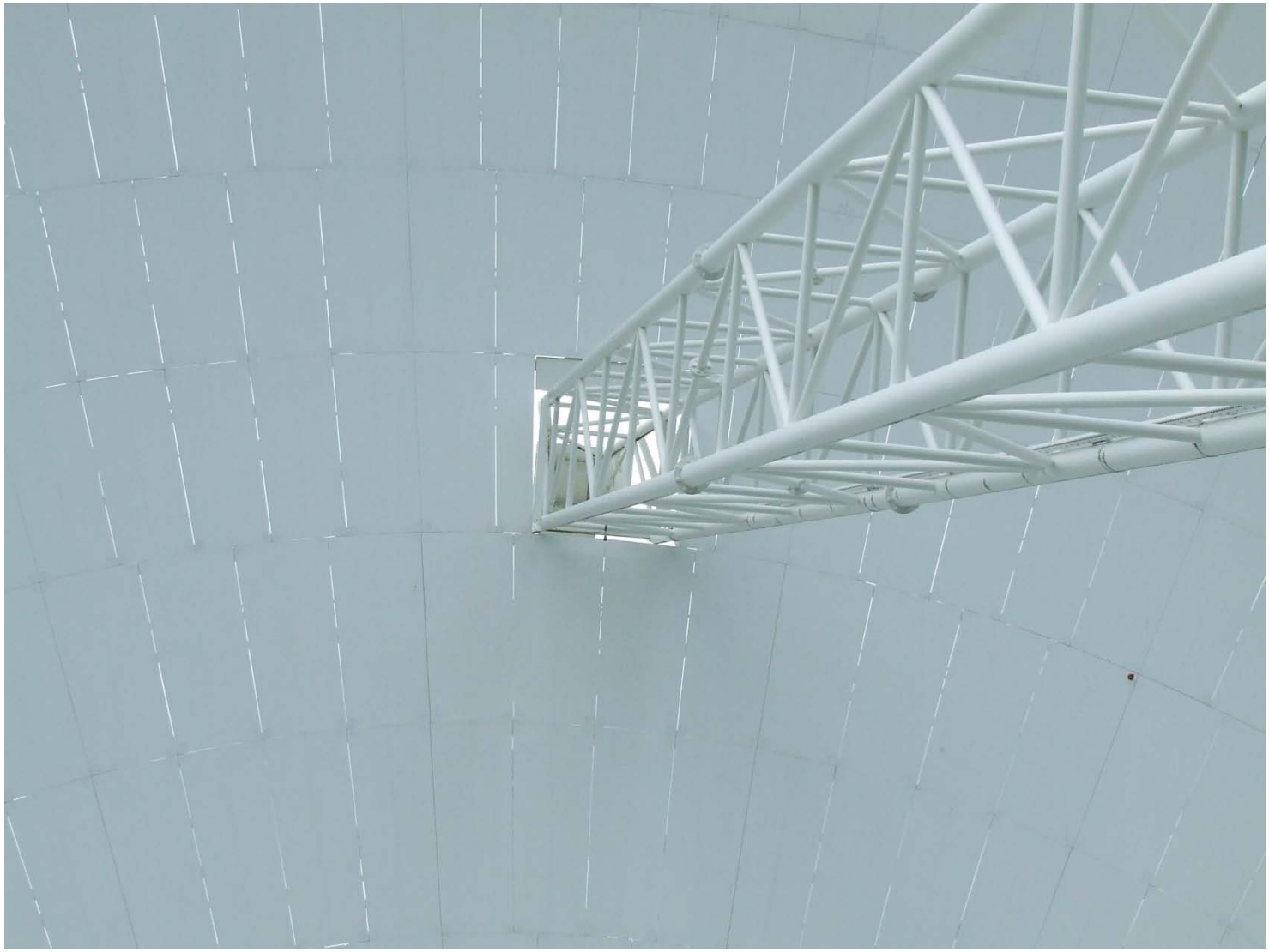


Invariant points?

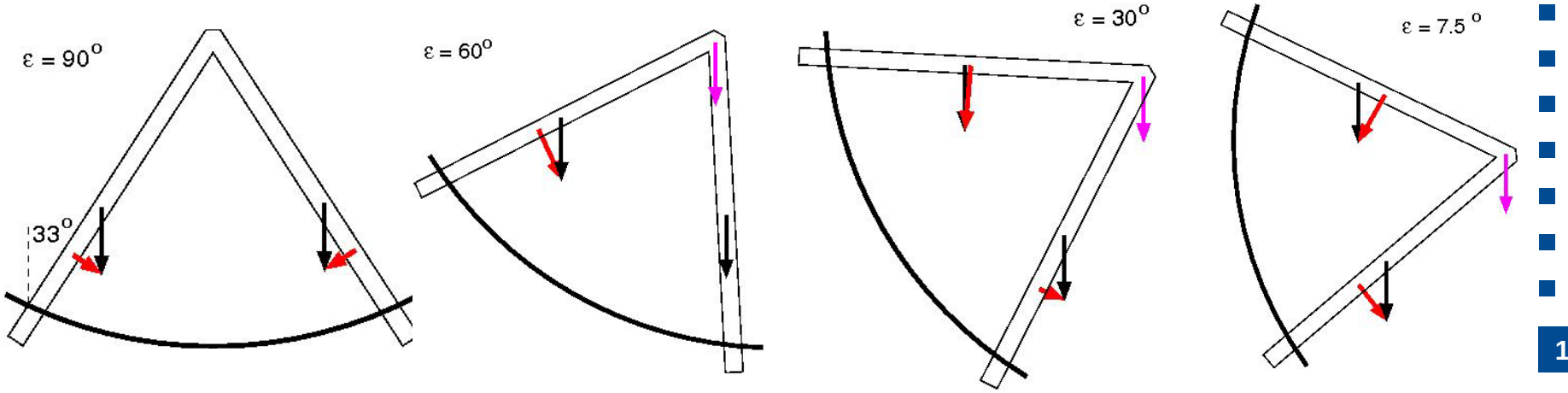
Deformation between 90 and 7 degrees

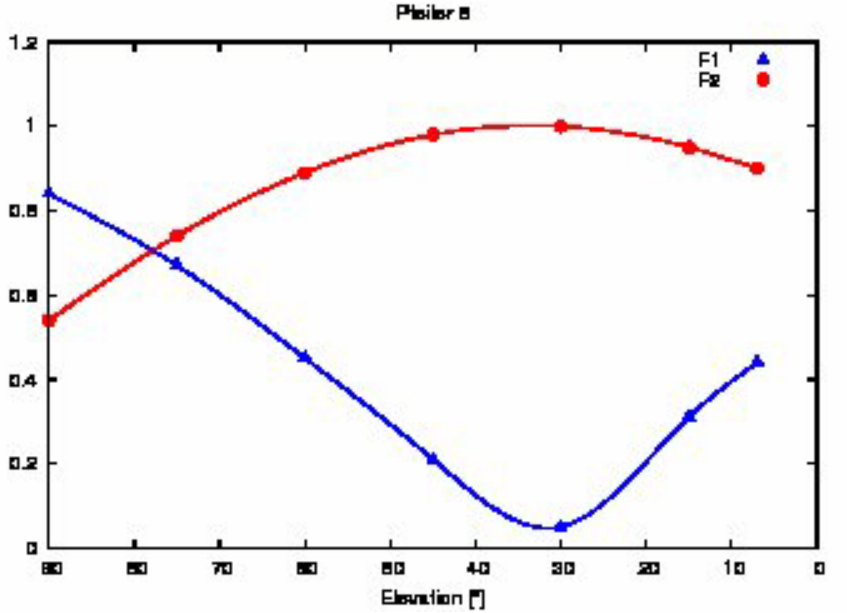


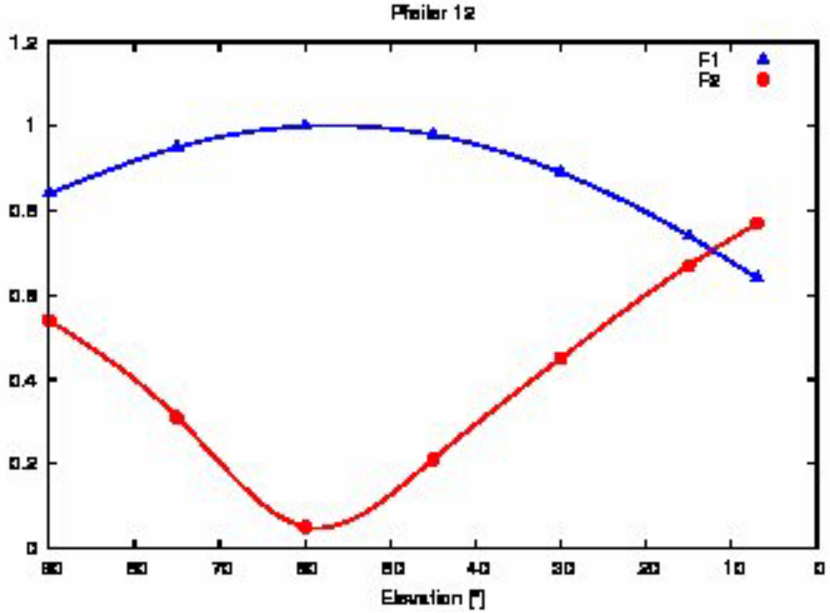
Bending effects of legs



Gravitational forces on upper + lower leg



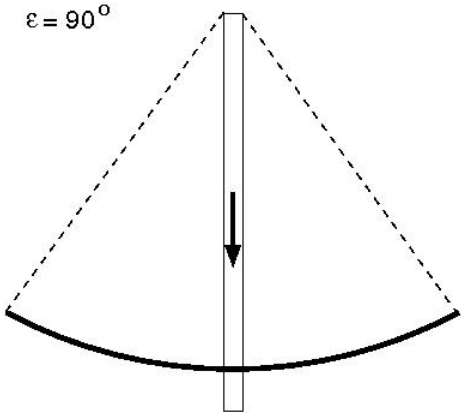


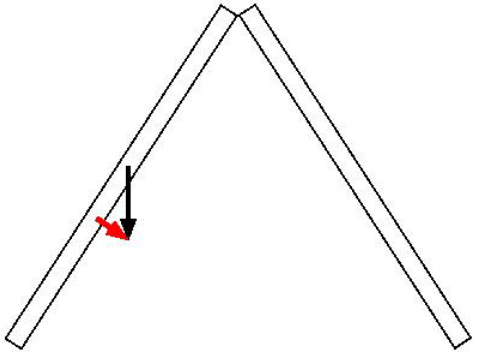


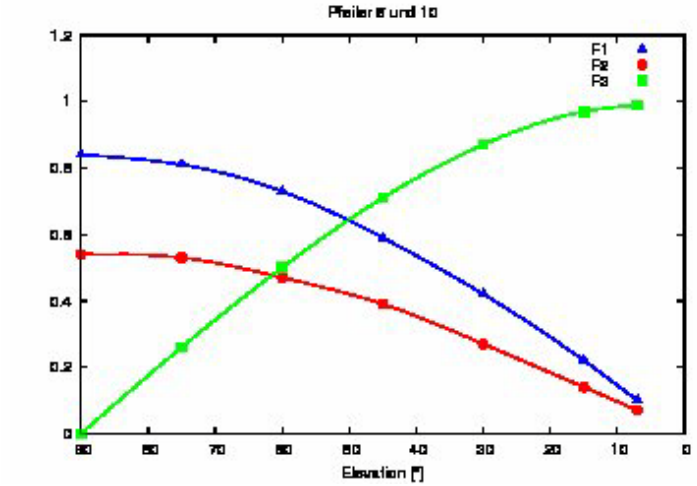
Upper leg

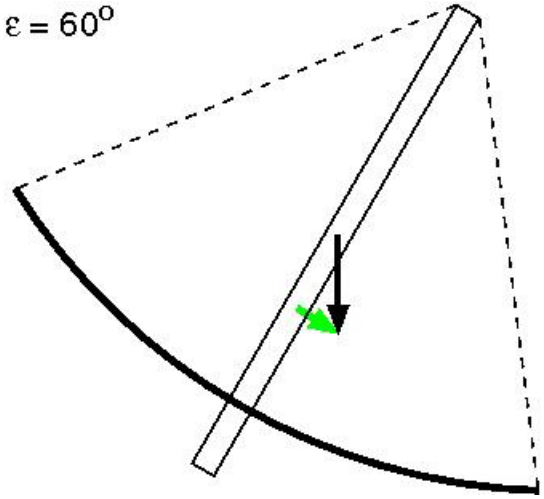
Lower leg

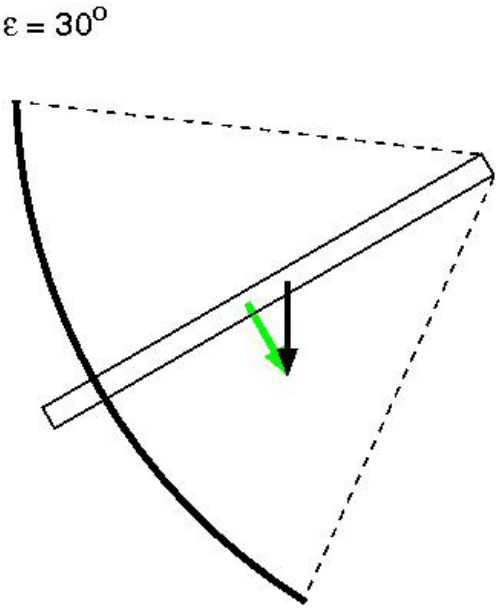
Side legs

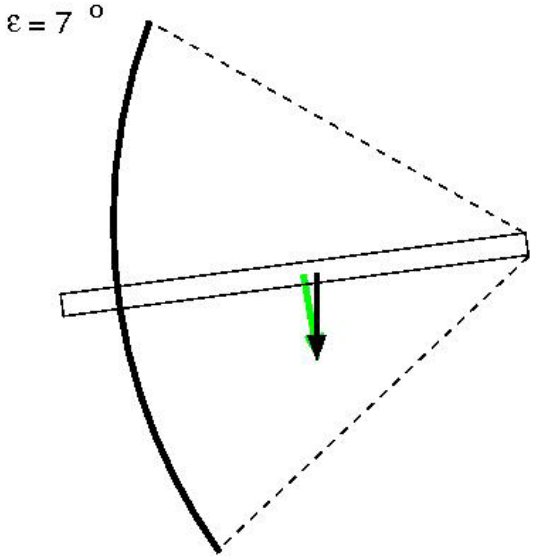

ε = 90°



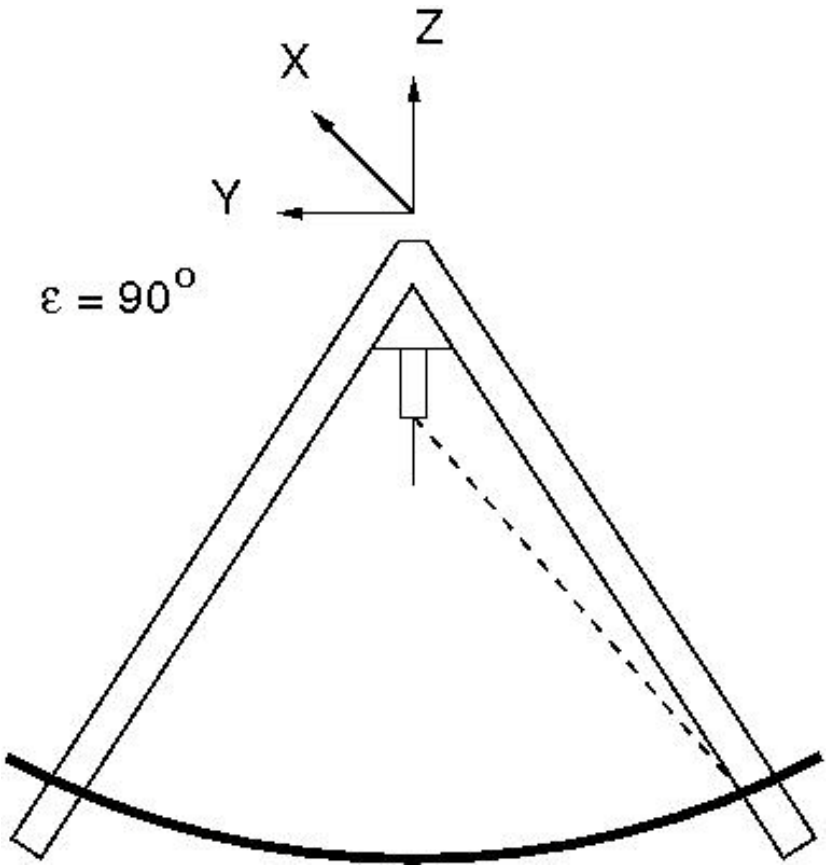

Pfeiler 8 und 10
F1
F2
F3
1.2
1
0.8
0.6
0.4
0.2
0
90
80
70
60
50
40
30
20
10
0
Elevation [°]

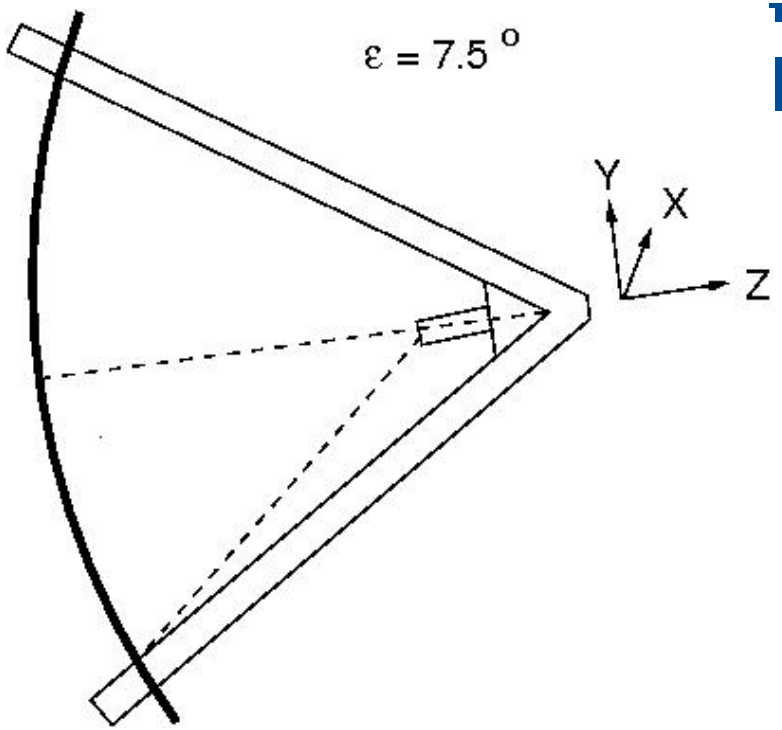

ε = 60°


ε = 30°

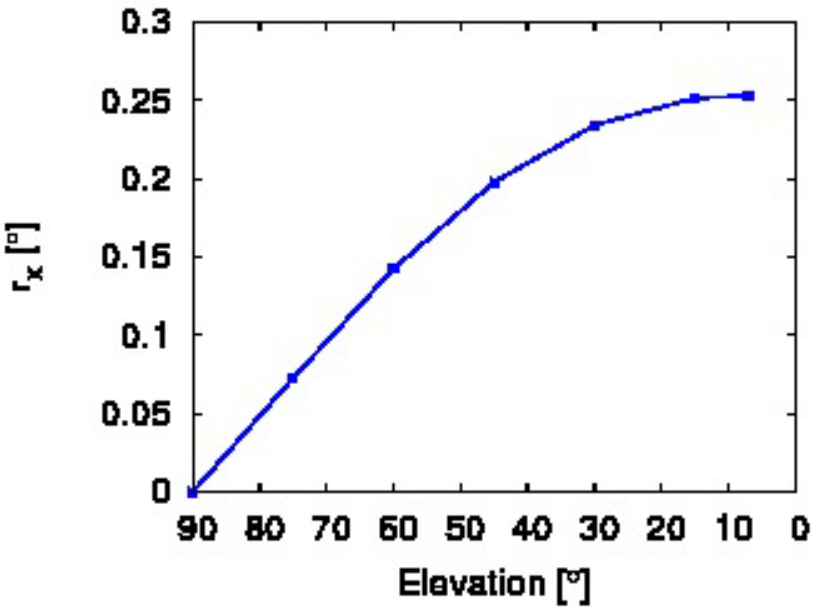

ε = 7 °

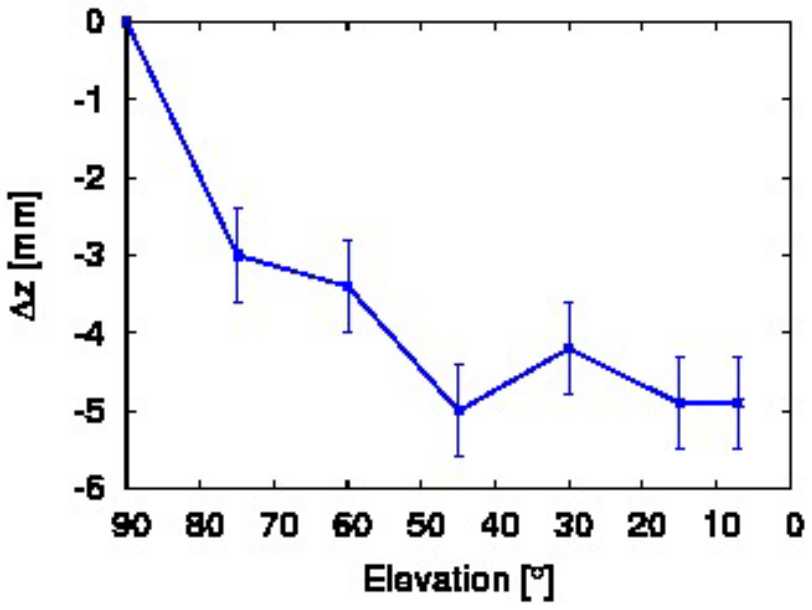
Displacement and tilt of instrument

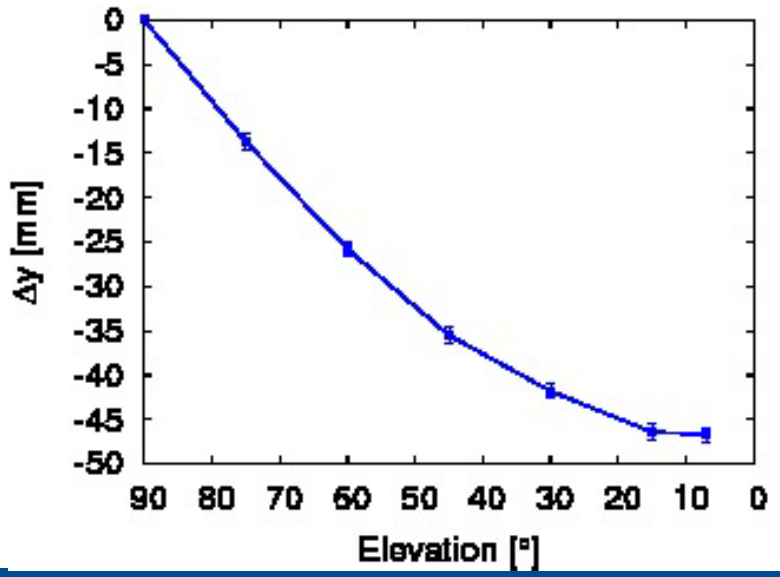




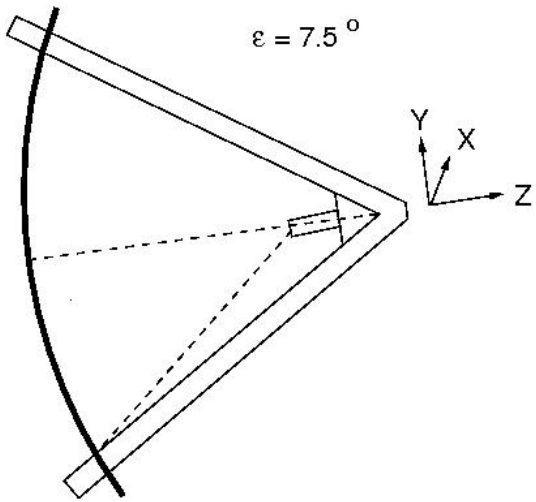
Translations and rotation of instrument







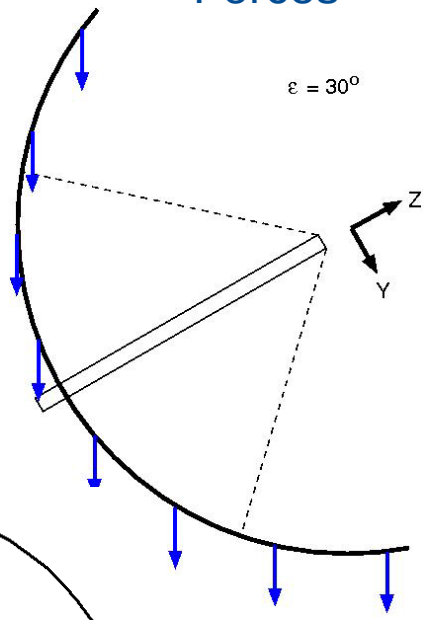
0.25^{o} = 1.1 mm

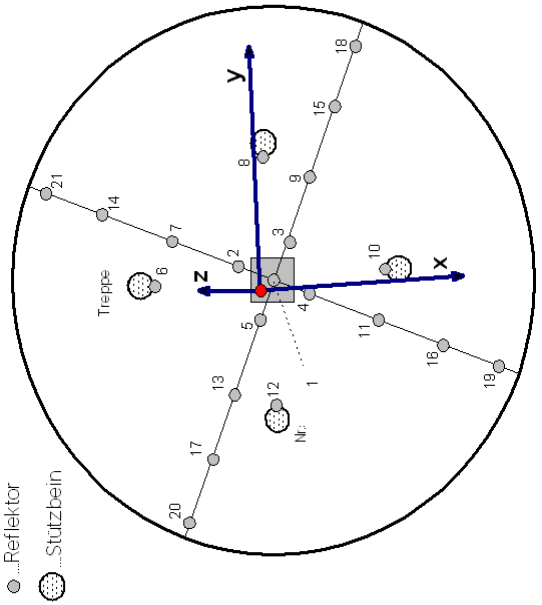


Forces on Paraboloid I

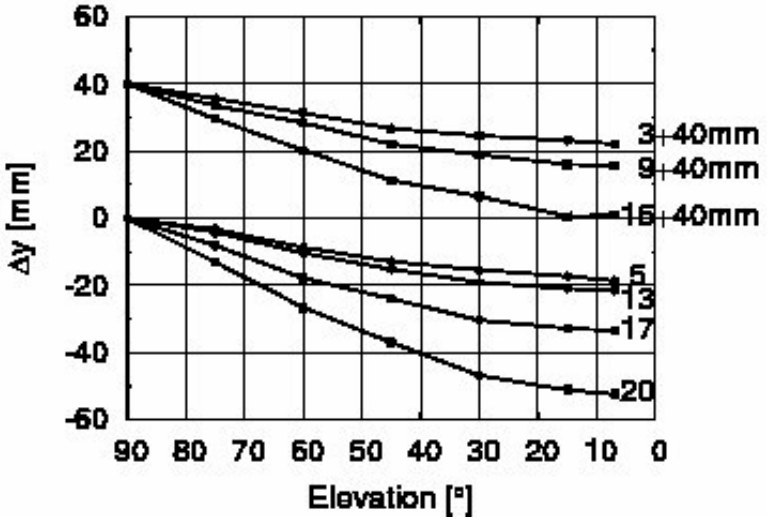
Vertical meridian

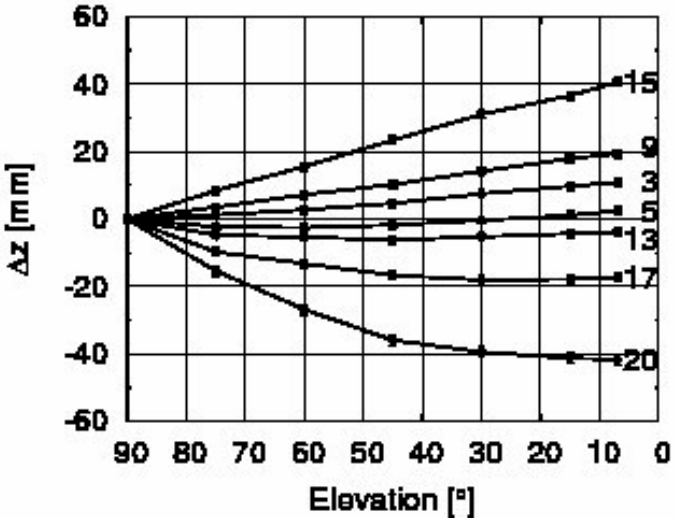
Forces



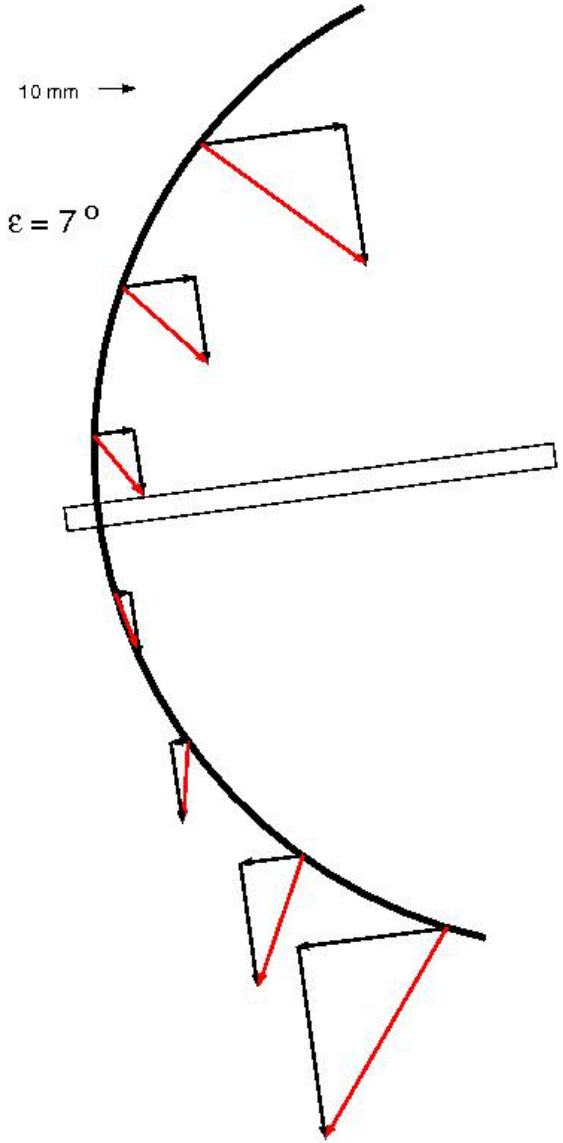


Measurements

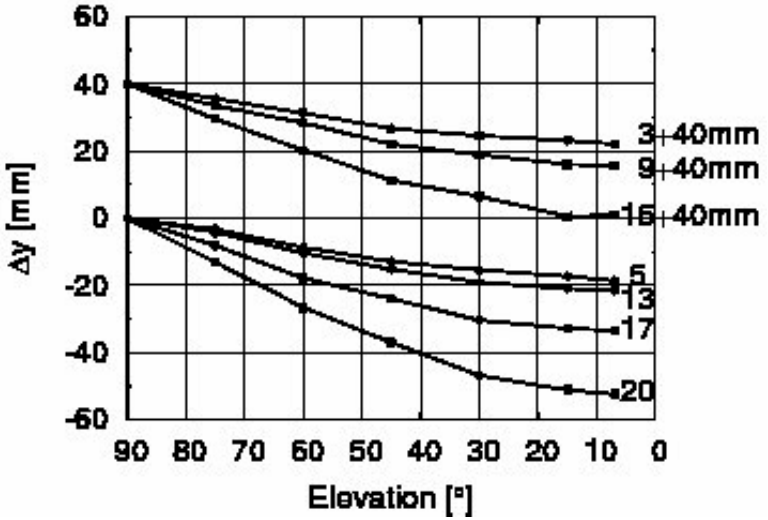


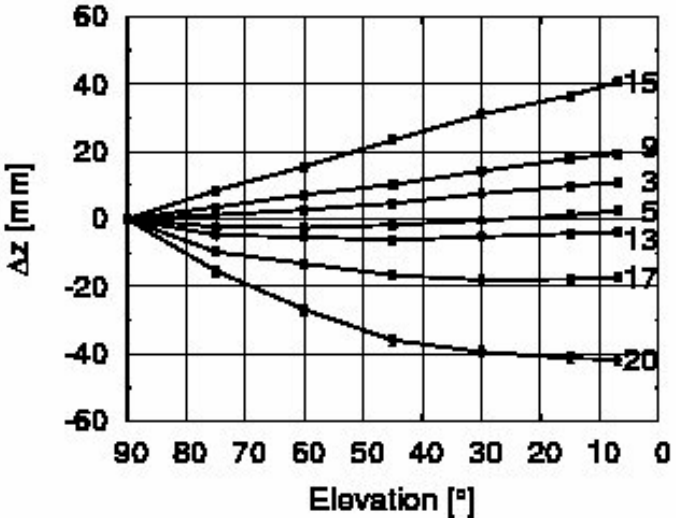


Paraboloid deformations



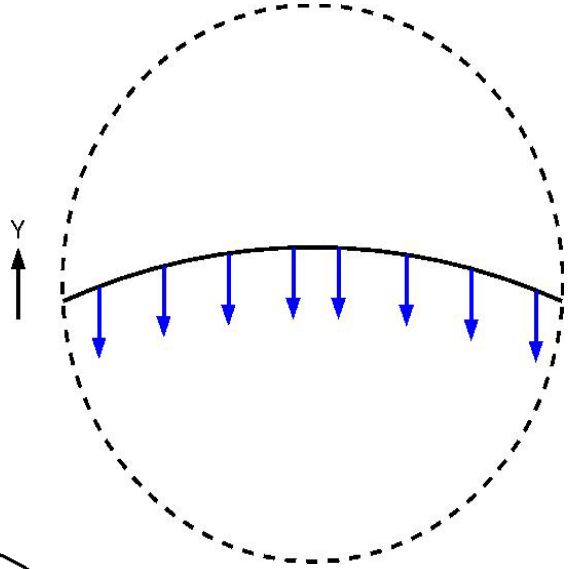
Measurements

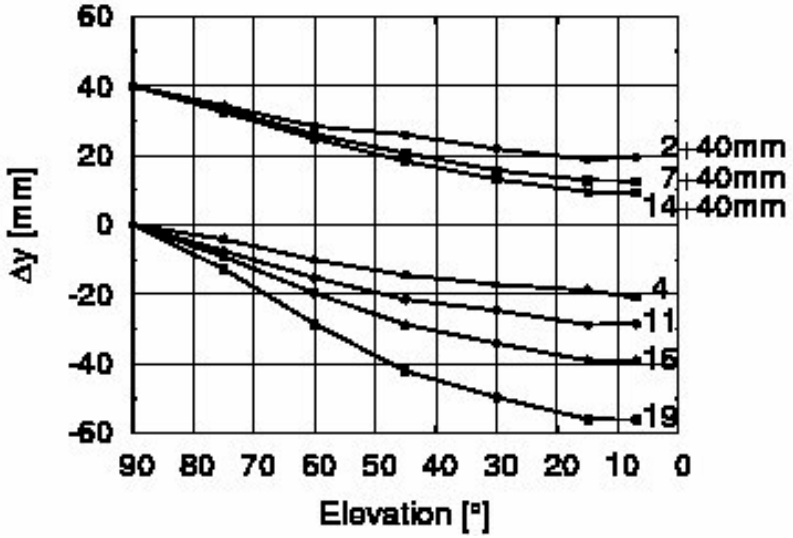


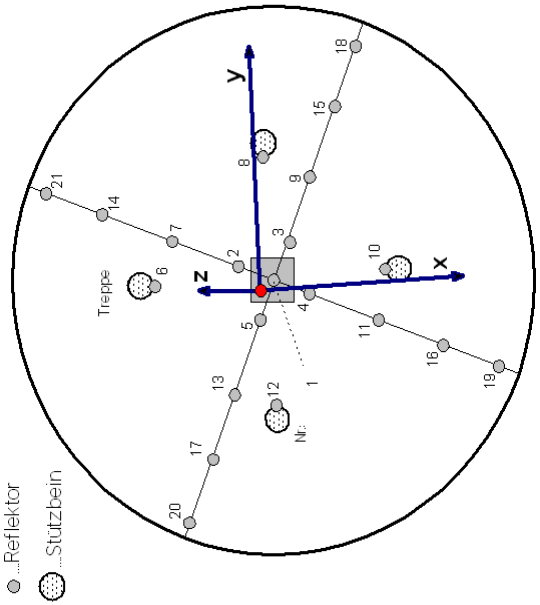


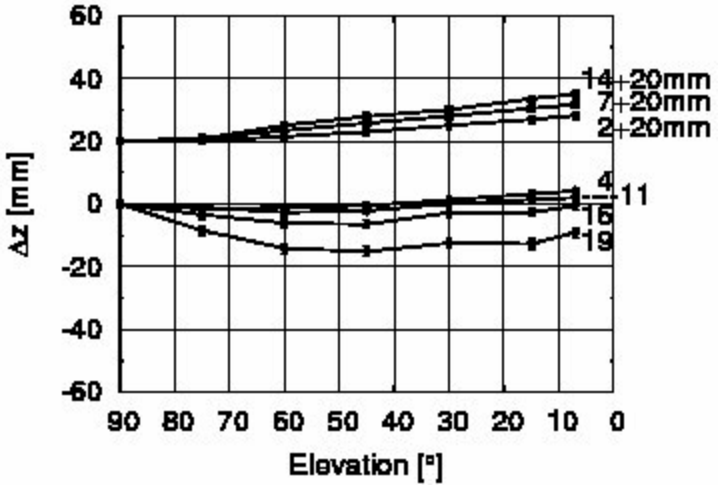
Forces on Paraboloid II

Horizontal meridian









Paraboloid estimates + path length effects

Estimate of paraboloid parameters for each elevation

$$\frac{(x-a)^2+(y-b)^2}{4f}+c-z=0$$

Determination of path length according to Sarti et al. 2009

$$\Delta L = \alpha_R \Delta R + \alpha_V \Delta V + \alpha_F \Delta F + \Delta F$$

Radius of telescope: r_0 = 50 m

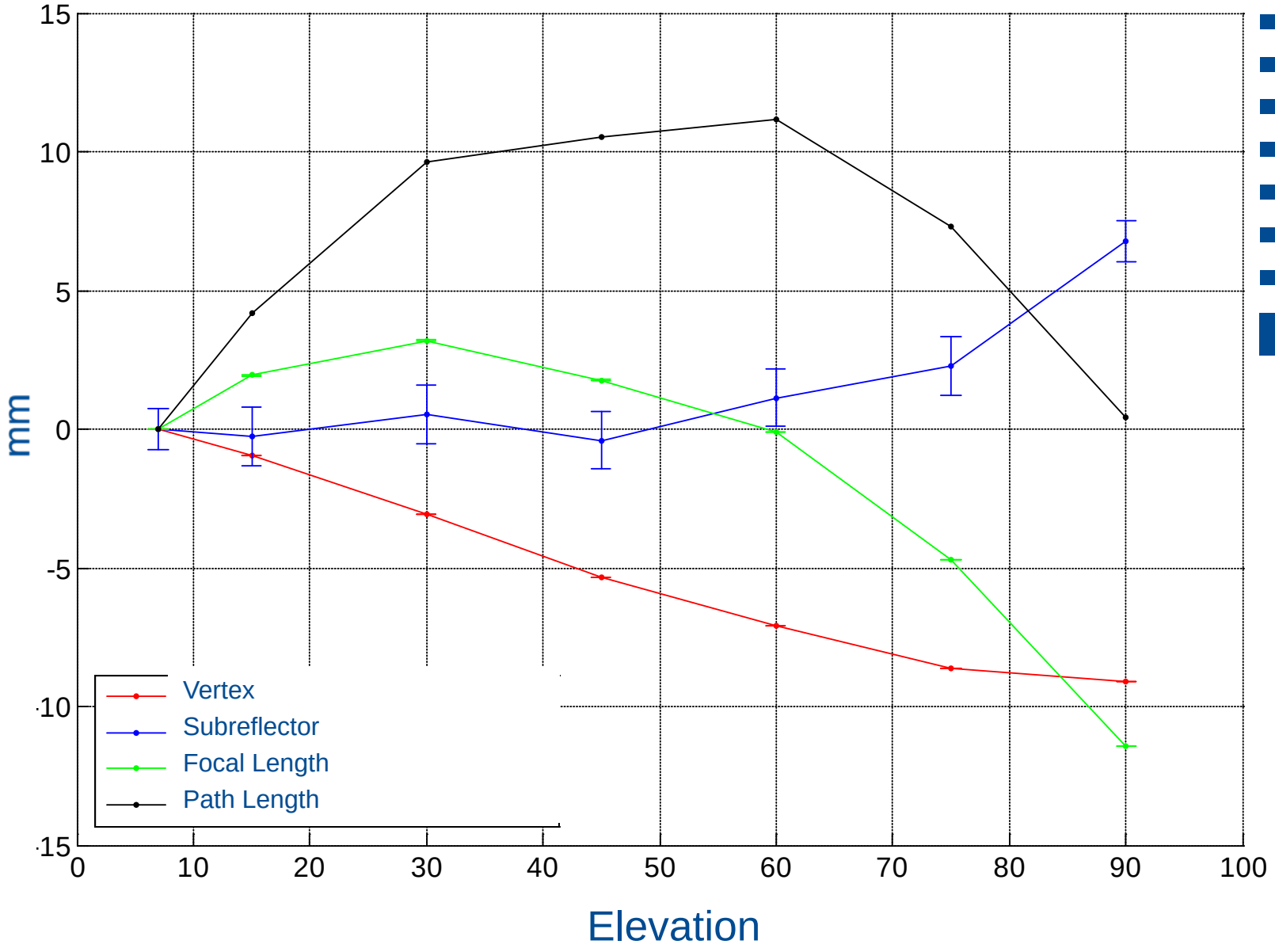
Focal length of telescope: f = 30 m

$$\alpha_R = \frac{8\cdot f^2}{r_0^2}\cdot \ln\left(1+\frac{r_0^2}{4\cdot f^2}\right)-1 = \frac{8\cdot 30^2}{50^2}\cdot \ln\left(1+\frac{50^2}{4\cdot 30^2}\right)-1 = 0.51878$$

$$\alpha_F = 1-\alpha_R = 1-0{,}51878 = 0{,}48122$$

$$\alpha_V = -1-\alpha_R = -1-0{,}51878 = -1{,}5188$$

Contributions to path length variations



Contributions to path length variations