Keynote Presentation
- Synergy aspects of AOV and IVS -

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IVS Terms of Reference

[1]The International VLBI Service for Geodesy and Astrometry (IVS) is an international collaboration of organizations which operate or support Very Long Baseline Interferometry (VLBI) components.

Collaborations

- IVS components
- IVS regional organizations such as AOV or EVGA
- IVS global community
- Global VLBI community including astronomers

→ Synergies by sharing observing and analysis resources, know-how and experience

→ Self-organisation

IVS Terms of Reference

[2]IVS provides a service which supports geodetic and astrometric work on

- Reference systems,
- Earth science research, and
- Operational activities.

→ Scientific and operational customers

Service aspect is important

(users do not always see the work of the IVS and its components)

The IVS and regional groups such as AOV
- Realistic interactions and optimistic expectations -

- Support of global IVS activities
  - observations, correlations, analysis, research and development
- Regional stabilization of the VLBI reference frame
  - dedicated observing campaigns
  - dedicated analyses
- Exploration of close-range interactions between participants
  - observations++ for research and development activities
- Public relations
- Triggering activities related to the Global Geodetic Reference Frame (GGRF) of the UN-GGIM initiative (on national grounds)
- Solve open issues of geodetic and astrometric VLBI, possibly by intense collaborations within AOV

Open issues 1/5

Observations

- Inherent precision of observables
- Phase stability beyond phase calibration, i.e. maser link to 5 MHz distributor
- Manual vs. genuine phase calibration
- Delay calibration
- Proper T_{sys} monitoring

Open issues 2/5

Auxiliary information

- Measurements and documentation of met sensor locations
- Documentation and application of ΔP (sensor - ref. Point)

- Radio telescope surveys for
  - Stability monitoring
  - Local ties to other sensors
  - Paraboloid deformation surveys [see later]

Open issues 3/5

Correlation and fringe fitting

- Systematic investigations in phase calibrations
- Multi tone phase cal - which frequencies to exclude
- Bandpass calibration
- Amplitude calibration
- Alternatives for HOPS fourfit

Open issues 4/5

Analysis

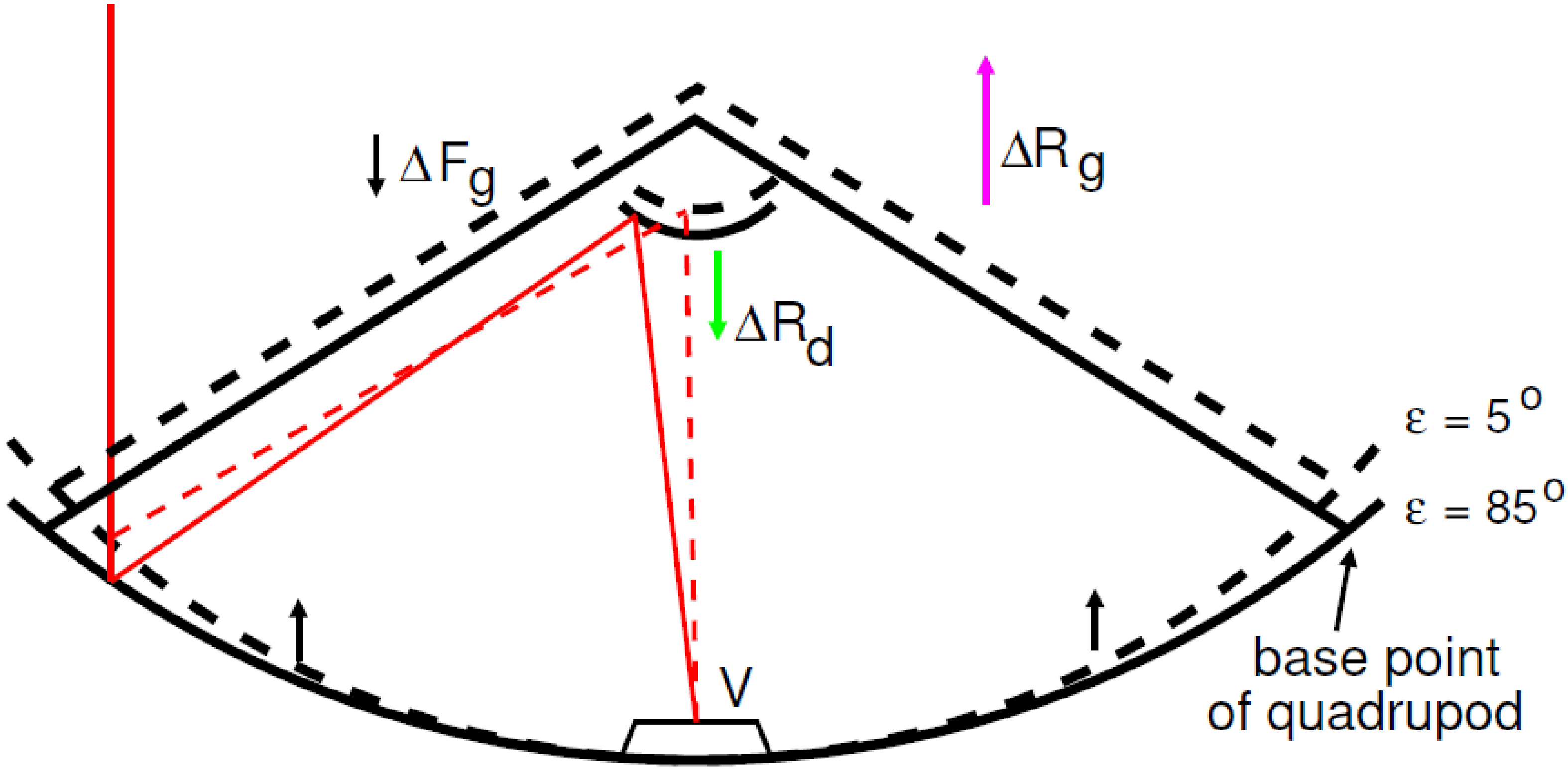
- Systematic investigations in
  - Effects of bandwidths and recording rates on results
  - phase and cable cal effects (missing, manual)
  - effects of missing channels
  - network effects on results
  - handling of sub-ambiguities
- Polar motion comparisons with GPS on a network by network basis
- Proper determination of frequencies for ionosphere calibration
- Apply existing in-situ calibration measurements for thermal expansion (Wettzell, Onsala ?)
- Investigations in modern WVR observations
- Fully populated covariance matrix with turbulence model (Halsig et al.)

Open issues 5/5

Documentation and outreach

- Documentation of issues and solutions
- Public relations and advertising
- Flyer, Video

Deformations of radio telescopes due to gravitational bending and their effect on VLBI results

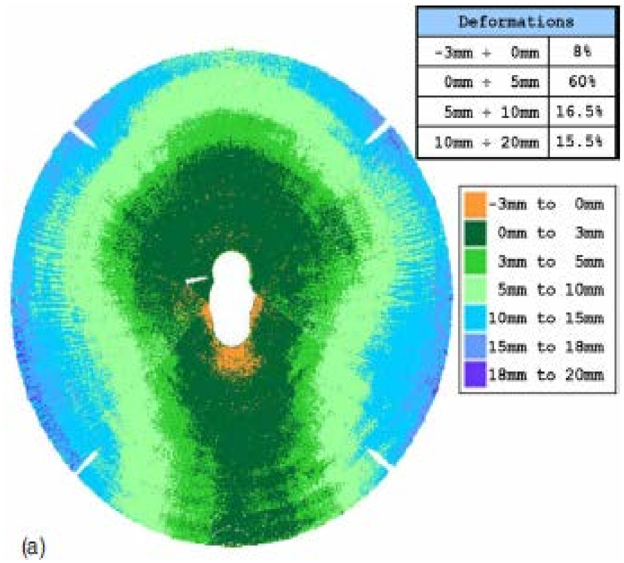


When tilted towards the horizon

- Main reflector folds inwards
- Focal length of main reflector reduces
- Leg bases of quadrupod move upwards
- Subreflector moves upward by same distance

Medicina 32 m telescope (Italy)

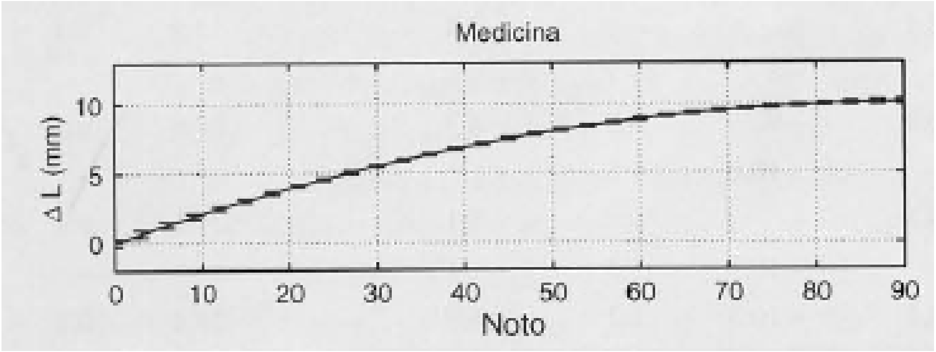
Terrestrial Laser Scanning (TLS)



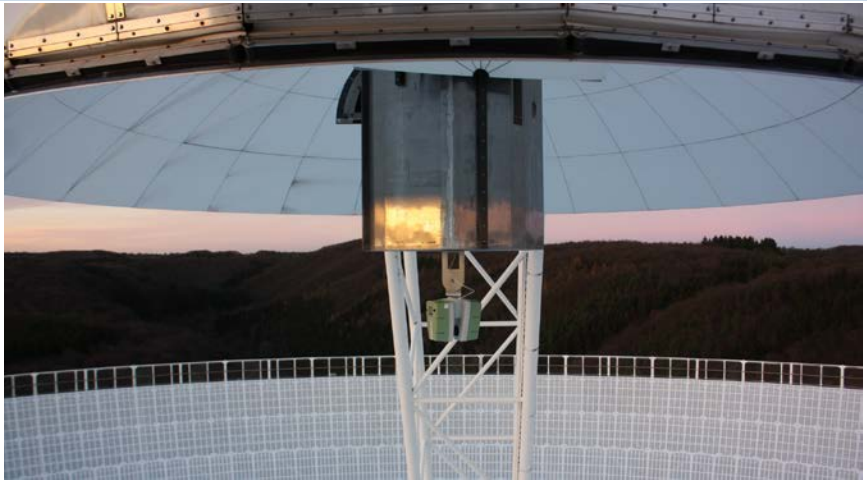
Medicina and Noto
32 m telescopes

Sarti, Abbondanza, Vittuari 2009b (J Geod)

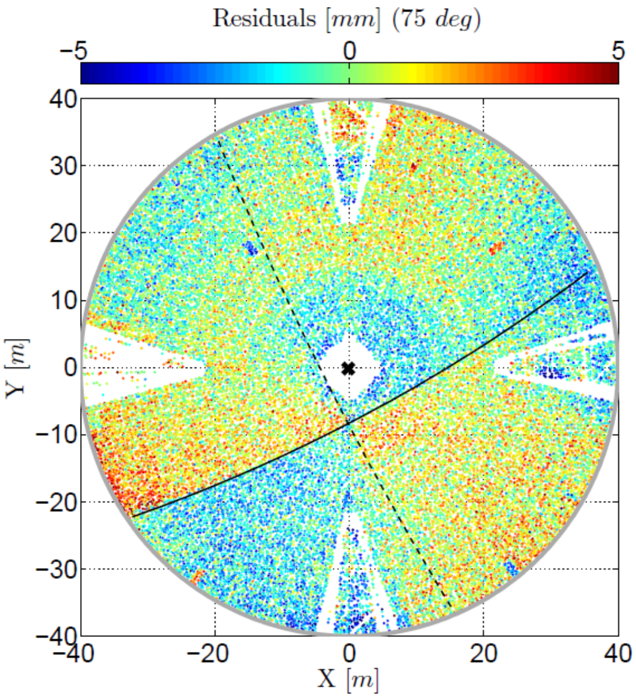
Sarti, Abbondanza, Petrov, Negusini 2011 (J Geod)



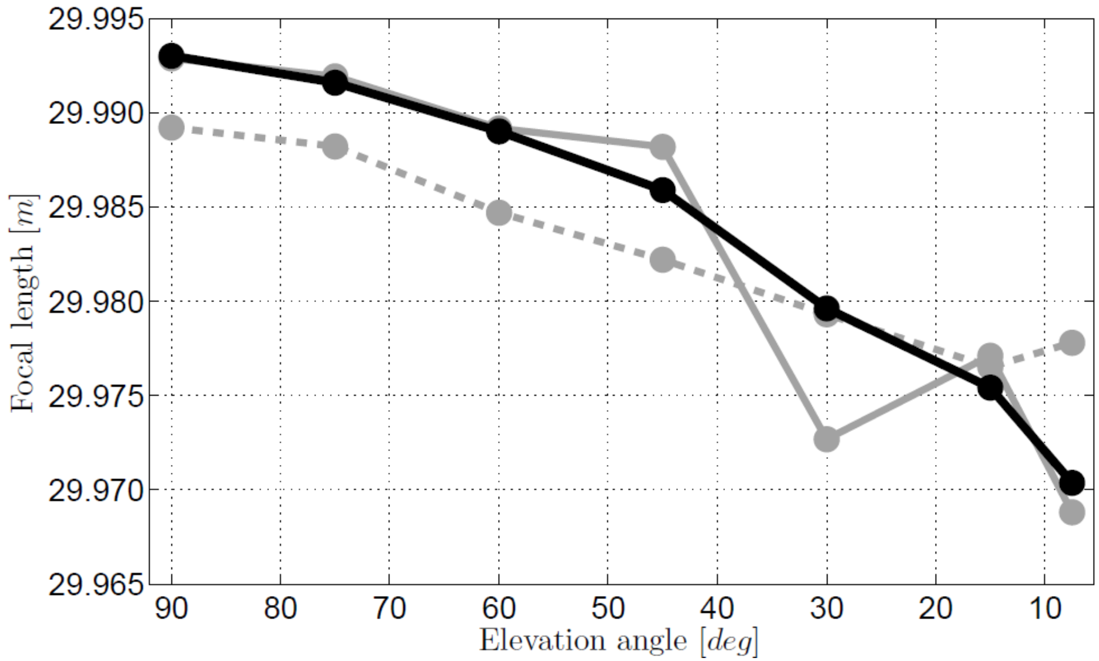
Effelsberg 100 m telescope (Germany)



Effelsberg results



Scanners have instrumental errors

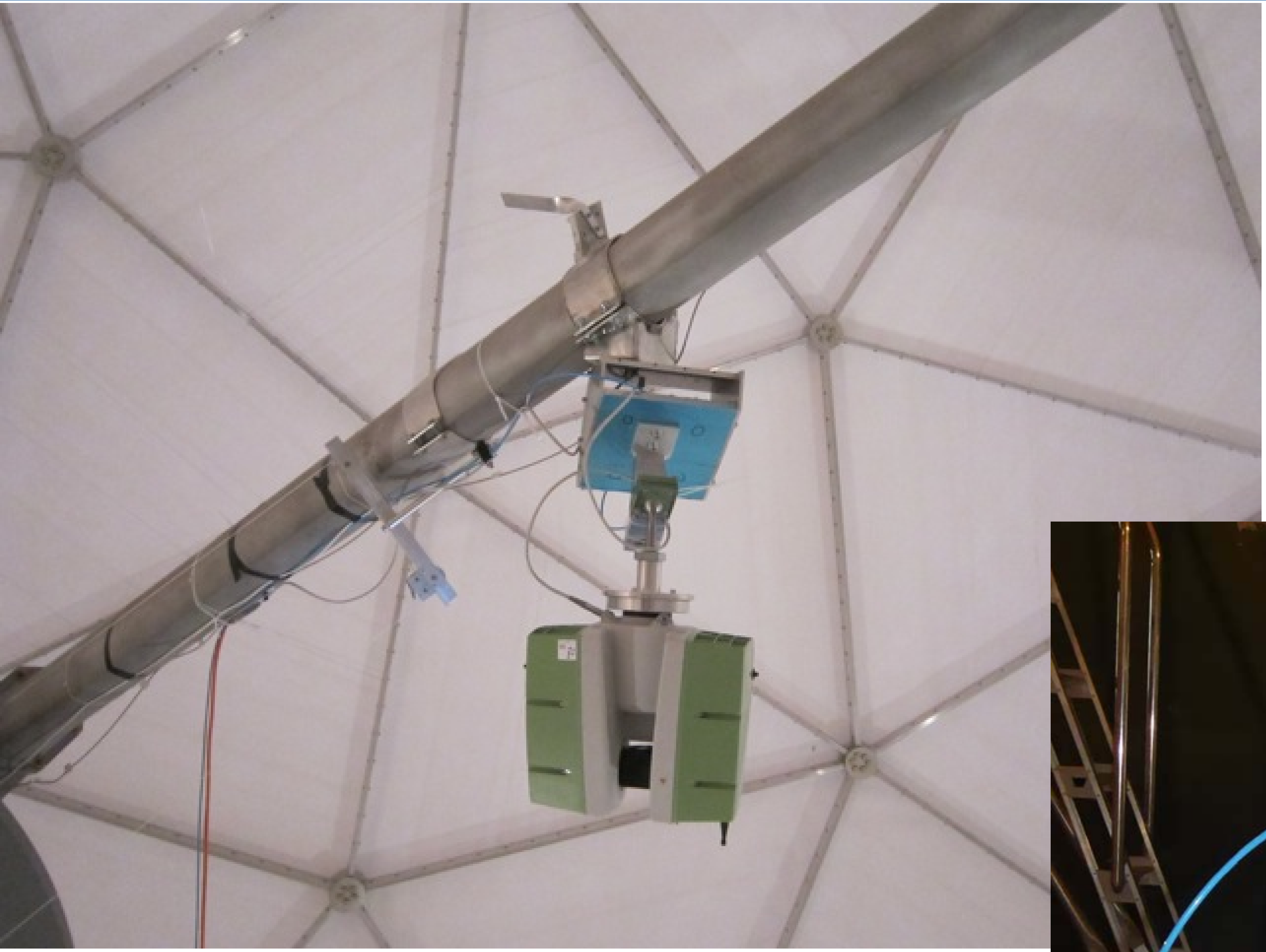


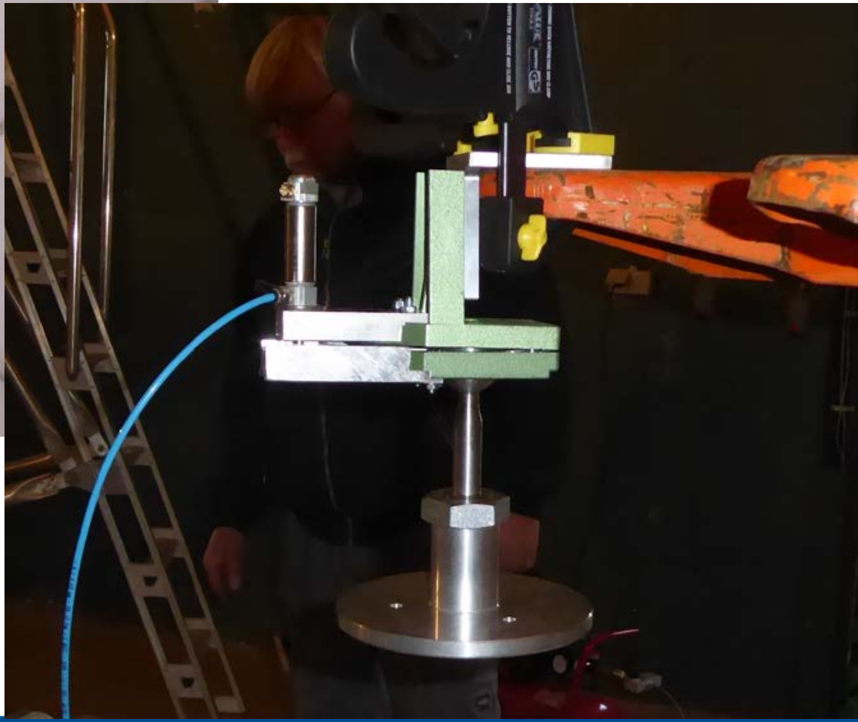
dashed = 2010, grey = 2013 raw, black = 2013 corrected

Focal length change 13 mm, 100 m Ø

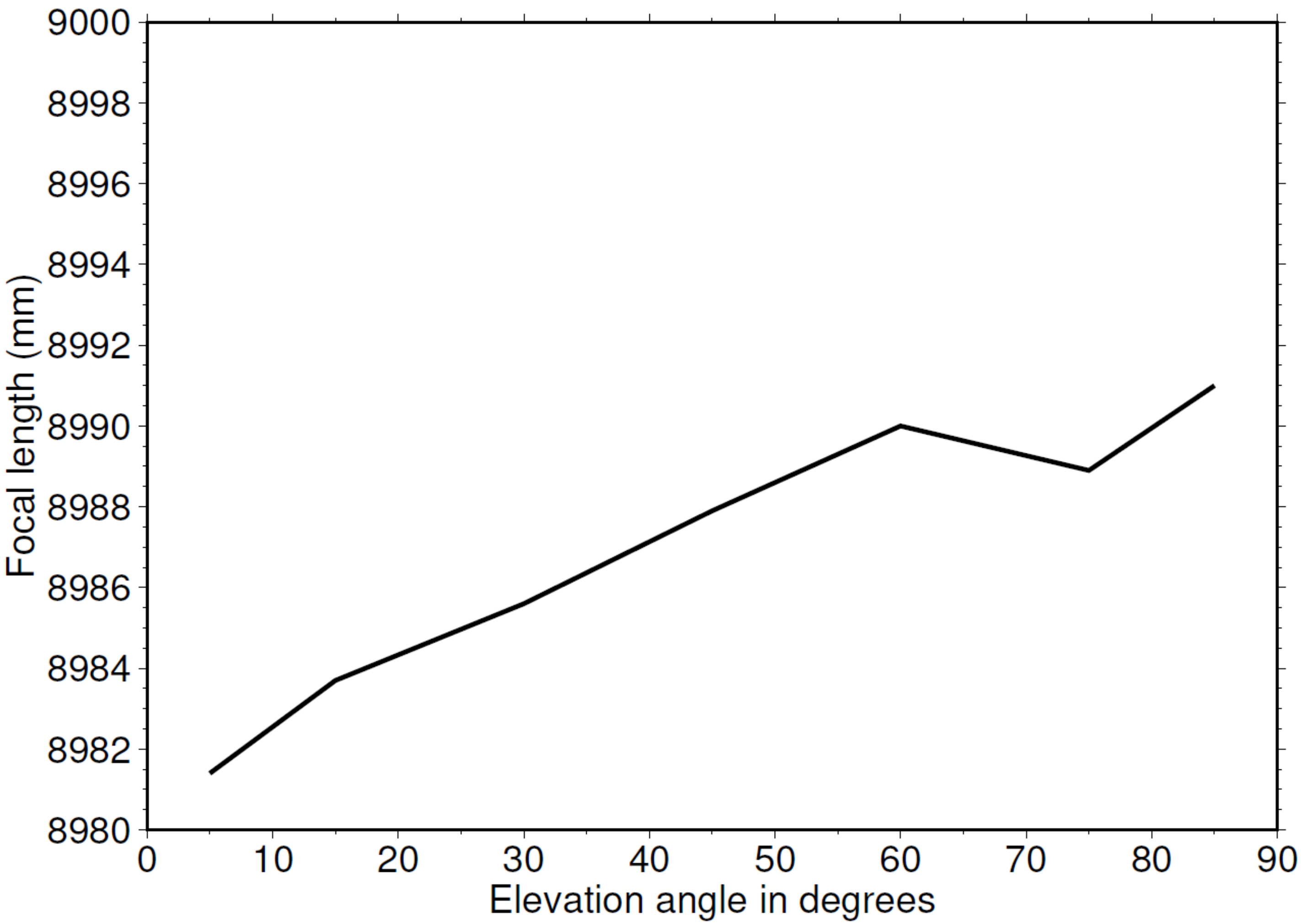
Onsala 20 m Telescope

Onsala 20 m Telescope



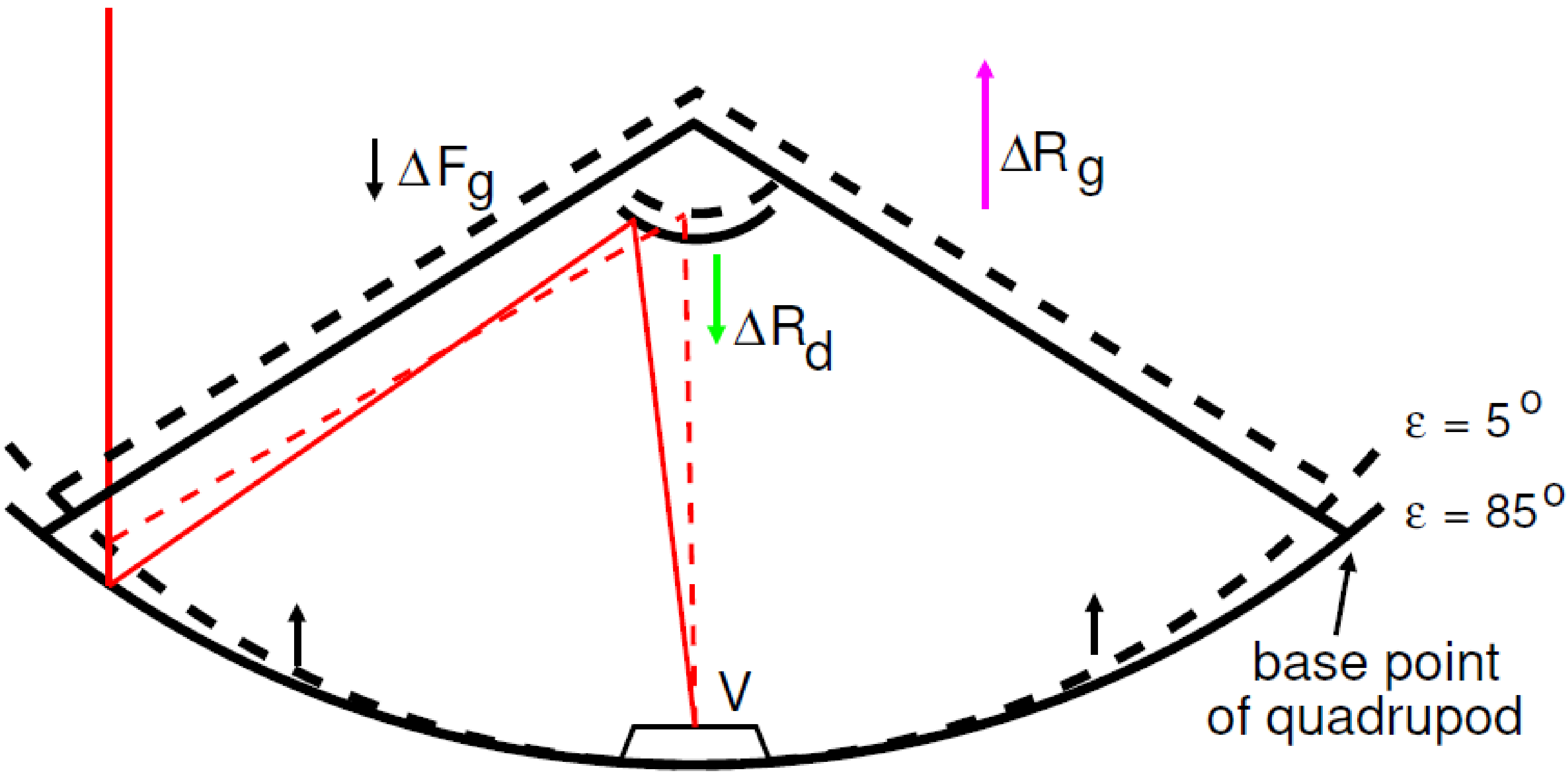


Onsala: estimated focal length



Focal length change 10 mm, 20 m Ø

Telescope deformations



When tilted towards the horizon

- Main reflector folds inwards
- Focal length of main reflector reduces (path length effect factor ~ minus 1/8)
- Leg bases of quadrupod move upwards
- Subreflector moves upward by same distance (path length effect factor ~2)

Computation of effect on delays

$$\alpha''_R = 2\pi(F^2 - a^2)^2 \int_{t_1}^{t_2} I_n(t)\,\frac{t}{t^2F^2 - a^2}\,t\,dt \qquad (1)$$

with $t = r/2F$ and

$$\alpha''_F = 2 - 2\alpha''_R.$$

$$\Delta L_3(\varepsilon) = \alpha_F{}'' \cdot \Delta F(\varepsilon).$$

$$\Delta L_5(\varepsilon) = 2\,\alpha''_R \cdot \Delta R(\varepsilon)$$

$$\Delta\tau(\varepsilon) = \frac{1}{c}\,[\Delta L_3(\varepsilon) + \Delta L_5(\varepsilon)]$$

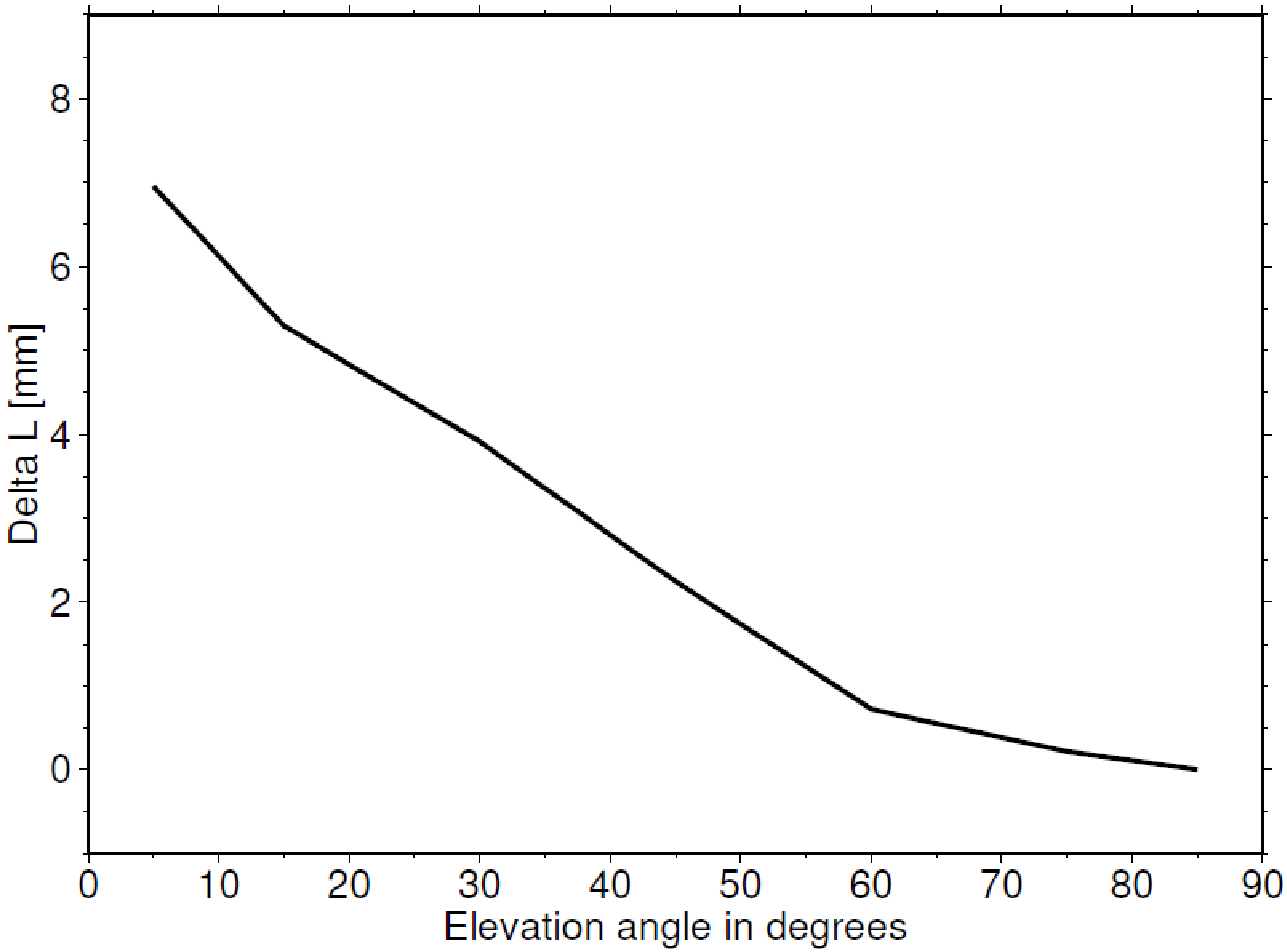
1. Illumination function
2. ΔF = -9.6 mm
3. α_F" = -0.1230
4. ΔL_3 = 1.18 mm

5. ΔR = 2.72 mm
6. α_R" = 1.0615
7. ΔL_5 = 5.77 mm

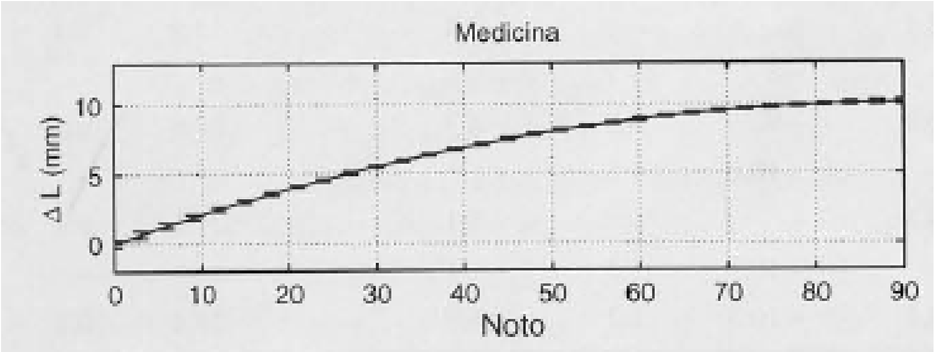
ΔL = 6.95 mm
(23.2 ps) at 5° elevation

Artz, Springer, Nothnagel; A complete VLBI delay model for deforming radio telescopes: The Effelsberg case, JoG, 2014

Onsala: Extra path length



First estimates



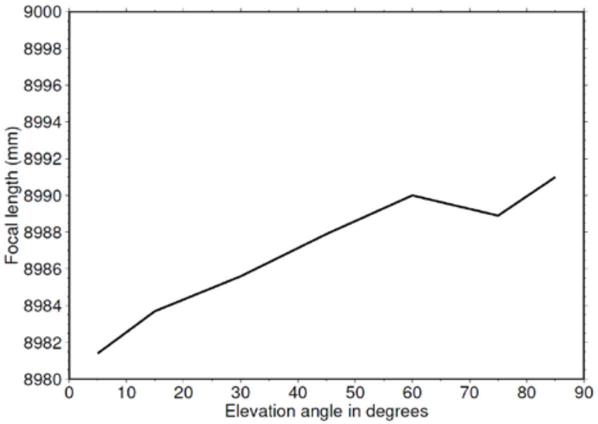
Medicina, Sarti et al 2011

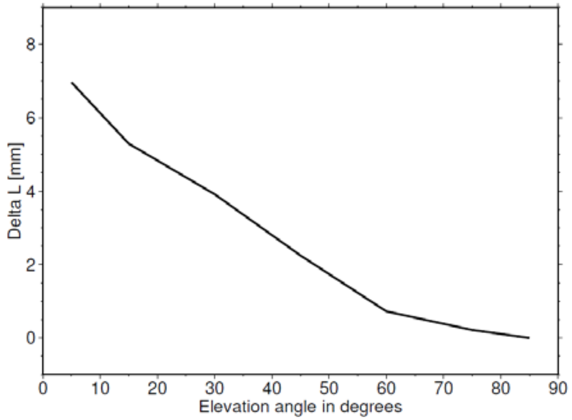
ΔU = deformed – corrected = 8.9 mm (up)

→ ΔU ~ 90% of max. ΔL with opposite sign

Applied to Onsala

ΔU = deformed – corrected = ~ - 6 mm (down)





Onsala

ITRF Tie Discrepancies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-----------------------------------------------------------------------------------------
GPS VLBI Tie Discrepancies
Id    DOMES      Soln Id   DOMES      Soln   East  North    Up   Tie
                                               mm     mm     mm
-------------------------------------------------------------------
ONSA 10402M004   2 7213 10402S002   1     1.5   -1.4   4.4   2014 DoY173
```

Conclusions

- **Surveys of all radio telescopes are needed for correcting deformation effects by gravitational bending**

Wettzell Geodetic Observatory

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Best wishes for a sucessful 2nd General Meeting of the AOV