ROT54 Antenna at 1.65, 10 and 36 GHz

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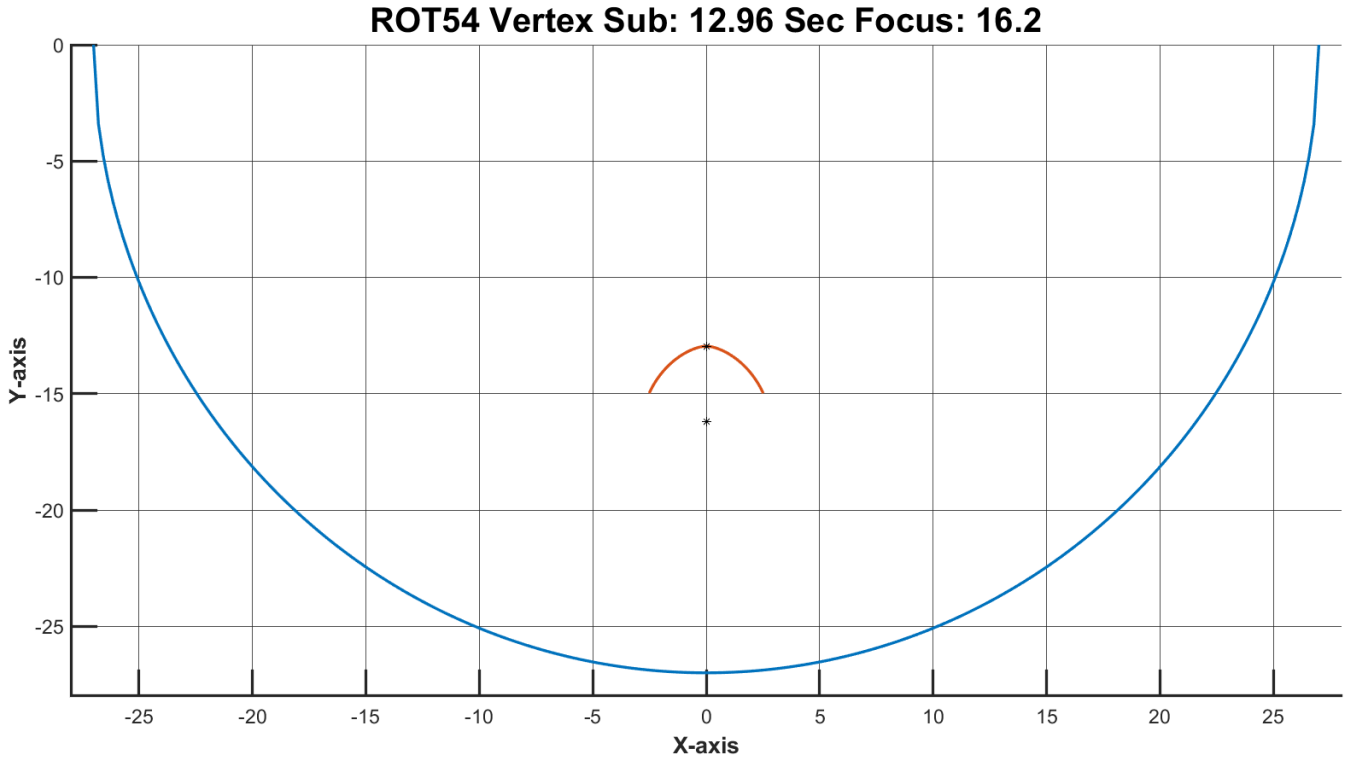
- “ XXIII Conference on Radio Telescopes and Radio Interferometers”,
- “Virtually in Yerevan “
- 18 sept.2020”

ROT54 Radio-telescope, Preliminary pattern calculation

- Pattern calculations made using physical optics for both main- and sub-reflector
- No blockage and multiple reflection in analysis (“does not fit on my notebook…”),
- A comparison with a measured pattern (relative, linear scale) at 10 GHz is reasonable,
- A gain near to 69 dBi is predicted at 10 GHz
- 1 dB reduction in gain (1 λ lateral feed displacement.
- Measured gain is 8*10^6 or 69 dBi (measured by P.M. Herouni, **see presentation** of Dr Arevik Sargsyan in **Granada, EVN**)
- Gain comparison: a coincidence, given a totally different feed, absence of multiple reflection and blockage not considered…..

ROT54 Radio-telescope, Preliminary pattern calculation



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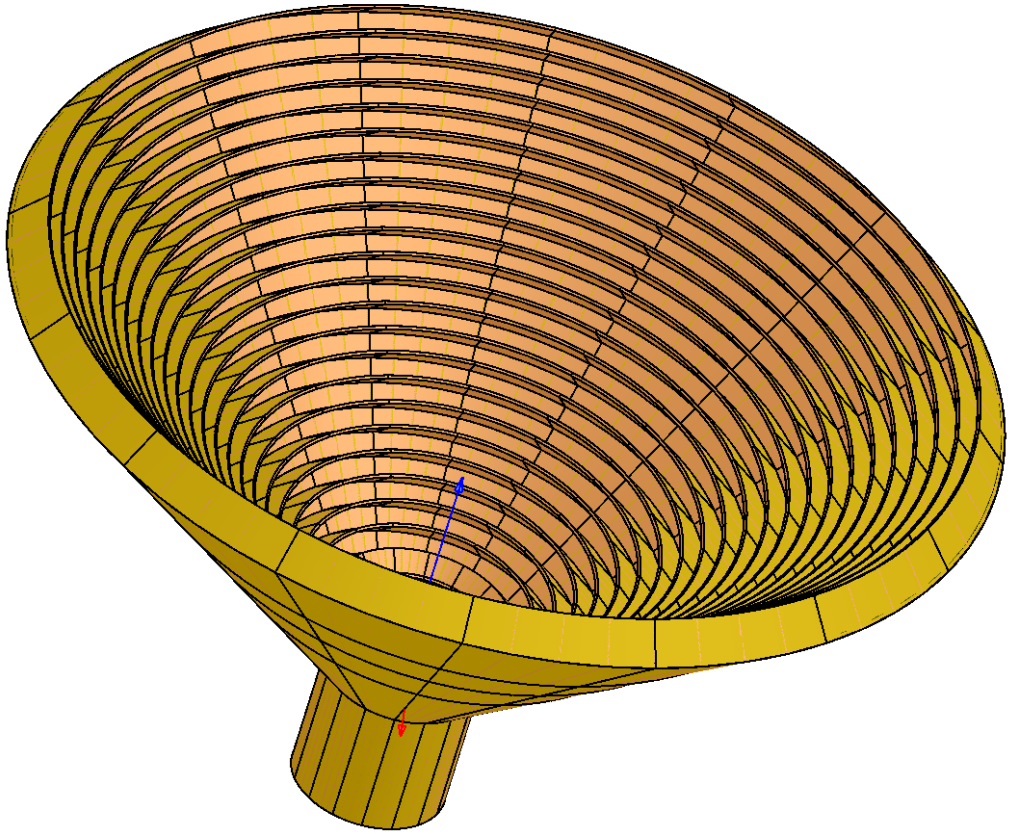
- Antenna geometry parametrized, known and assumed data:
  - R-main =27 meter,
  - R-sub = near to 5 meter,
  - Vertex subreflector and feed location assumed (respectively 12.96 m and 16.2m in this case) ,
  - Just as an example…

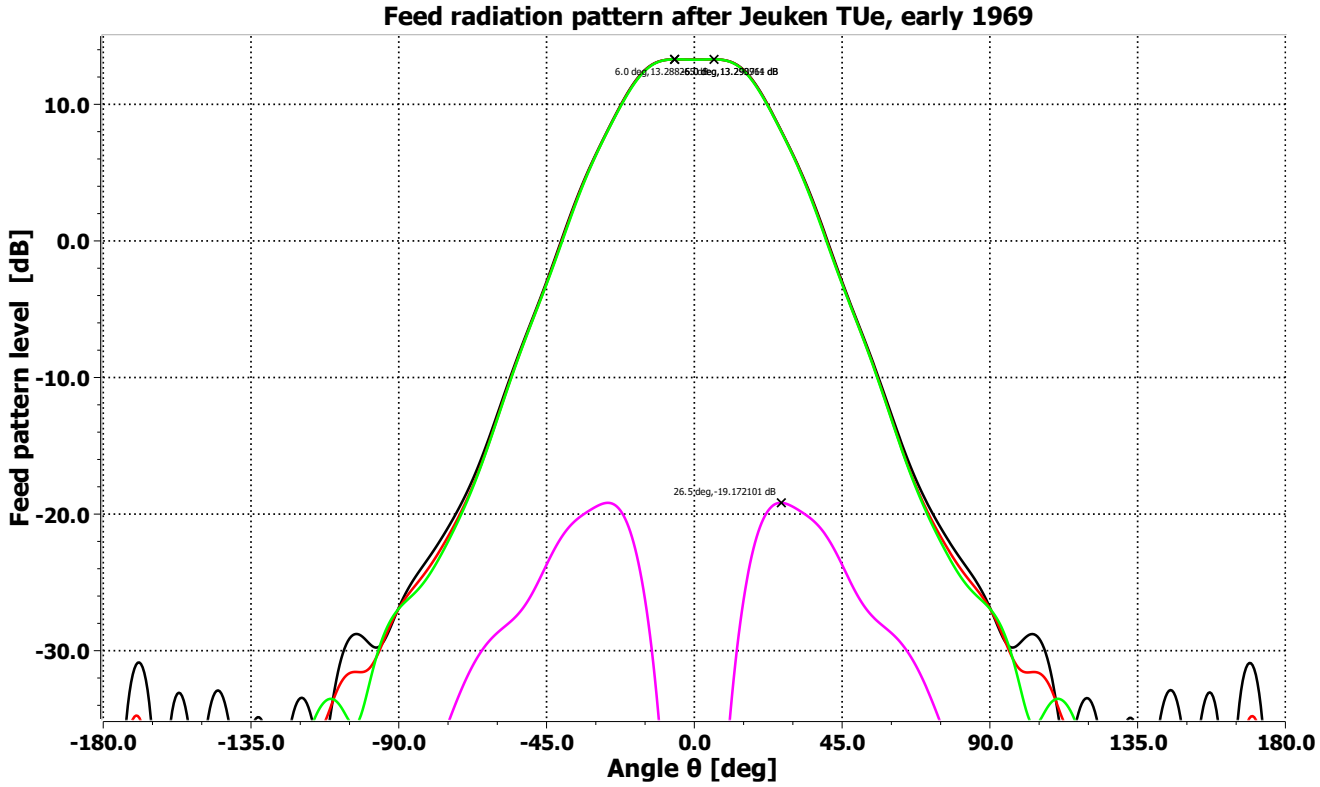
ROT54 Radio-telescope, Preliminary pattern calculation

- Corrugated scalar feed horn using an old known feed model, slightly adapted.
- Comparable feed-horns were developed for Dwingeloo and Westerbork antennas by Technical University Eindhoven **(by Jeuken, Knoben, Lambrechtse <1969).**
- Spherical wave expansion used, illuminating the sub reflector



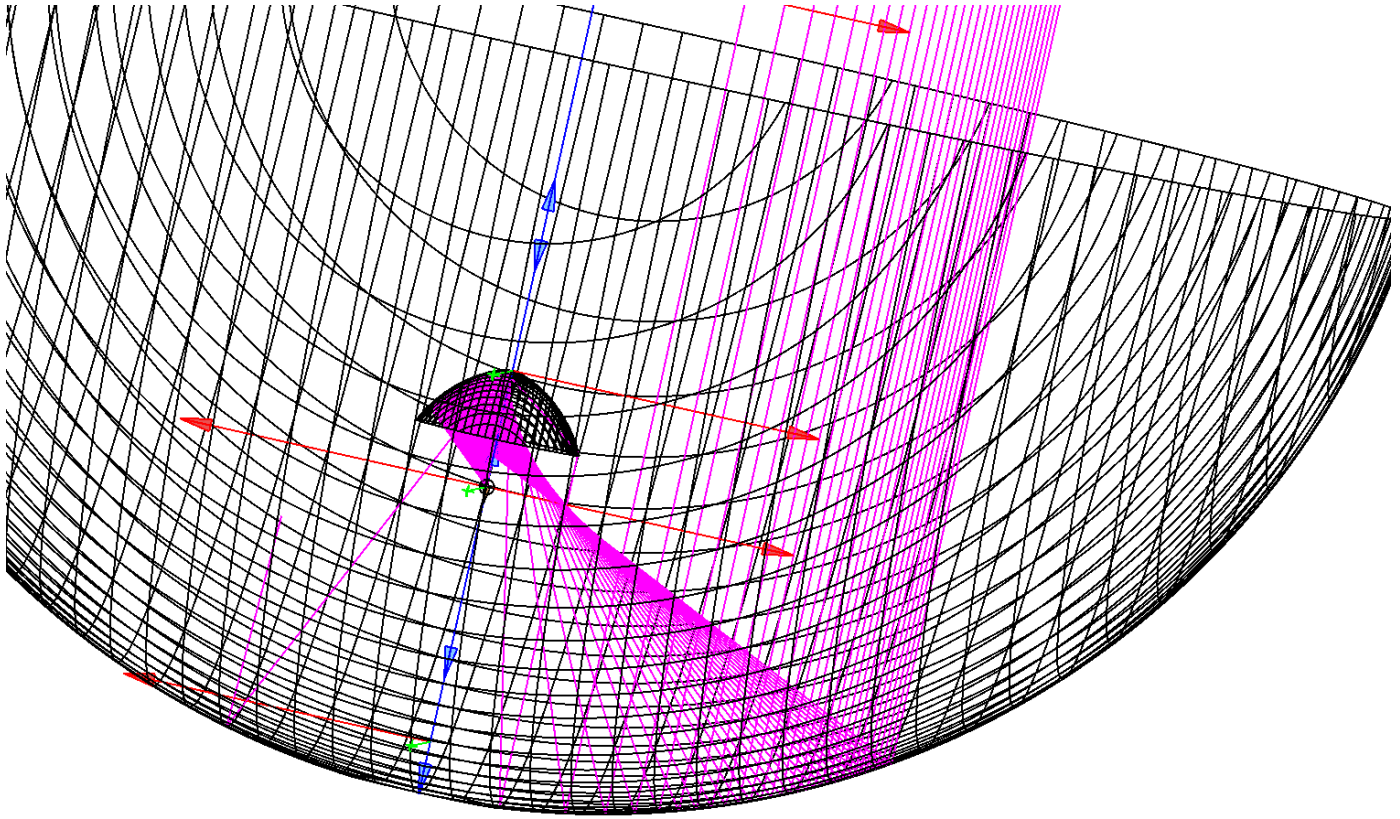
ROT54 Radio-telescope, Preliminary pattern calculation

- Flat top pattern convenient. Gives 1 dB more gain compared to simple open-ended circular waveguide with one or two corrugations
- Cross-polarization feed <-30 dB,
- Sensitivity to the back <-30 dB,
- And there is more: bandwidth and pattern performance stability.
- Feed can be simplified somewhat for example using less corrugations, if needed for accommodation, at cost of “flat-top” tbd.
- Other feeds considered, also so-called “Wohlleben feed” known from Effelsberg telescope-antenna. **But then:**
  - pattern not stable with frequency (it depends..)
  - cross-polarization much worse.



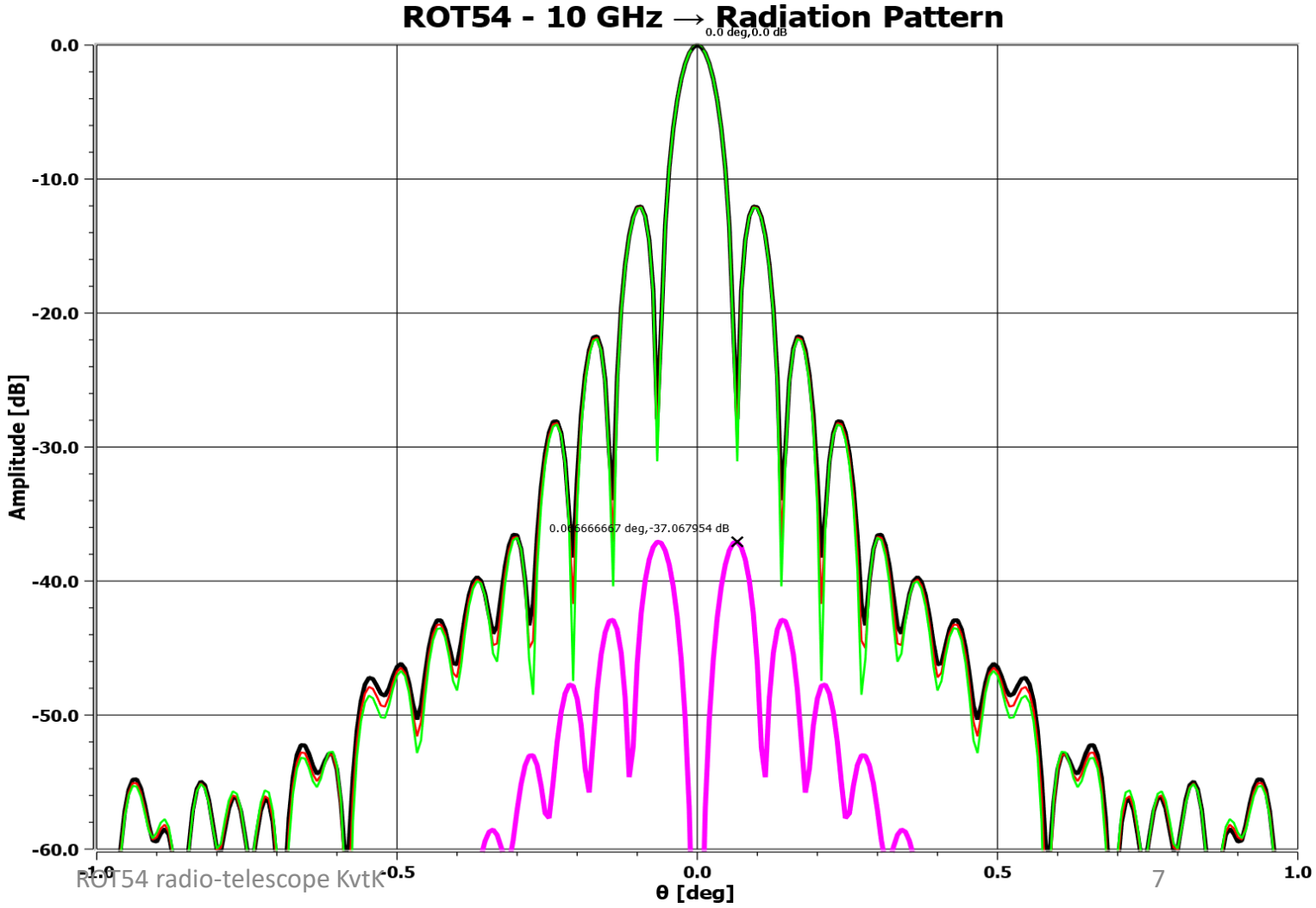
ROT54 Radio-telescope, Preliminary pattern calculation

- Spherical wave expansion used, full vectorial. Illumination of parametrized sub reflector.
- Physical optics used on shaped sub-reflector, subsequently on the spherical main-reflector
  - Blockage and multiple reflections not taken into account,
  - Both possible, but not needed now, takes computational time, so left to the reader with better computational facility..

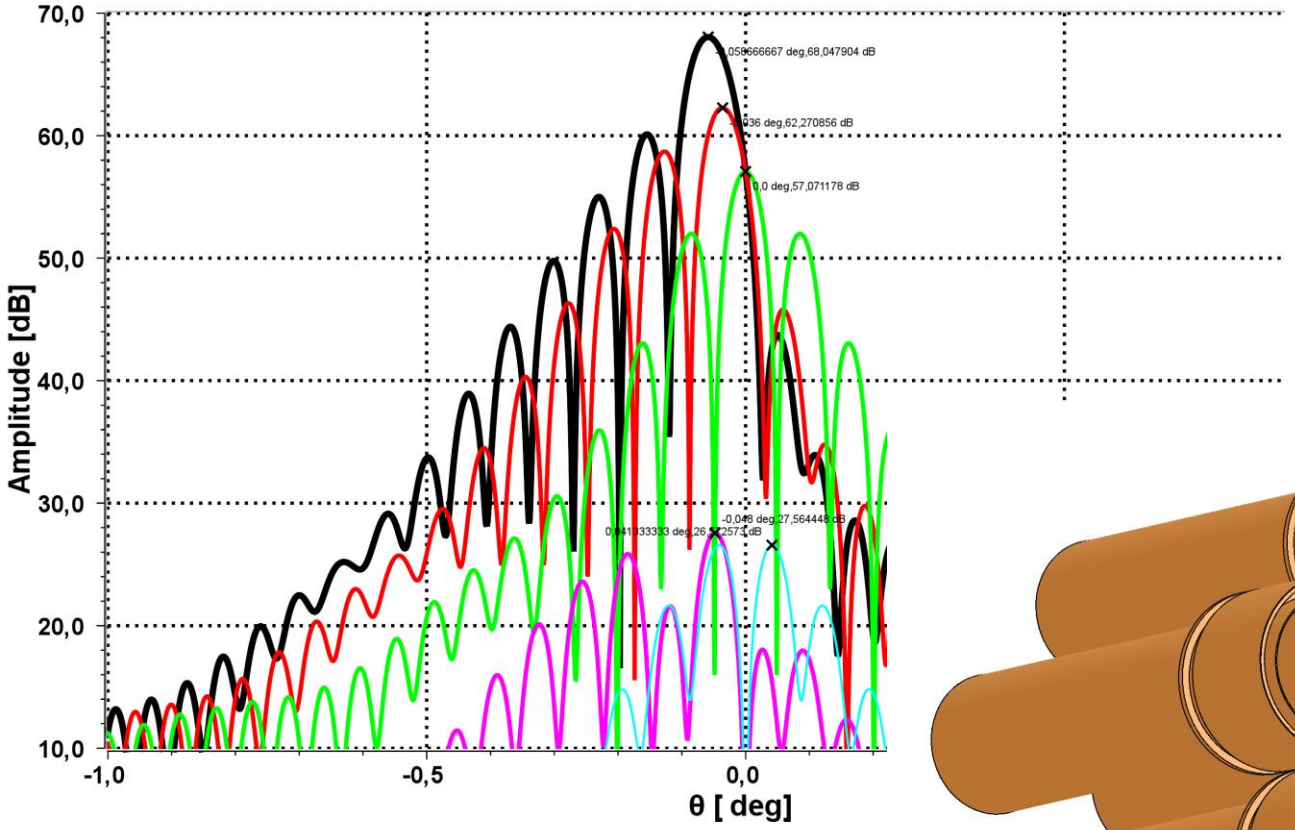


ROT54 Radio-telescope, Preliminary pattern calculation

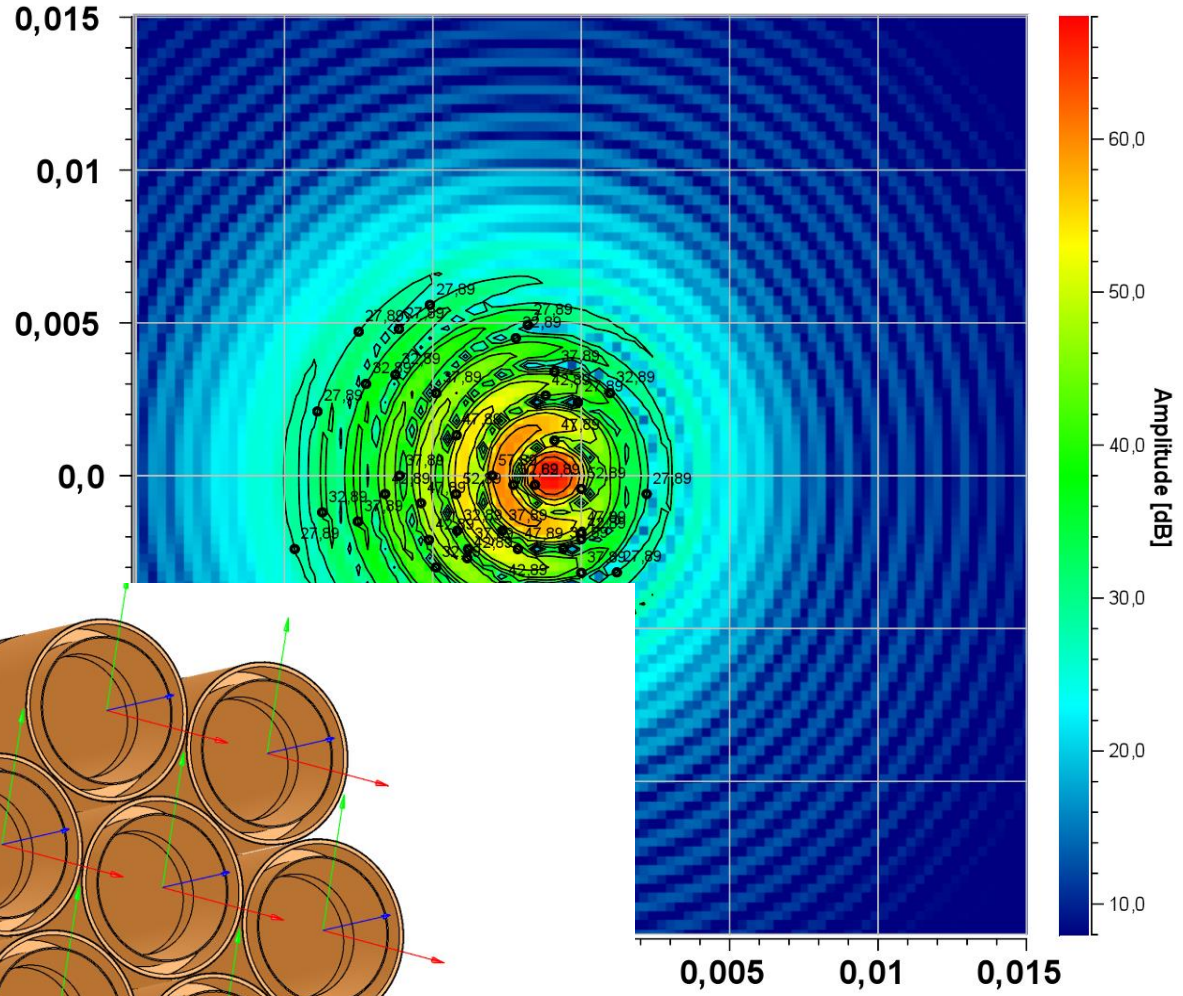
- Radiation pattern with high first sidelobes, as anticipated.
- Low far-out level for $|\theta| > 1°$.
- Spillover feed pattern confined within (metal) spherical reflector, and reflected into free space
- ➔ Spill-over never reaches warm Earth, so **low noise**

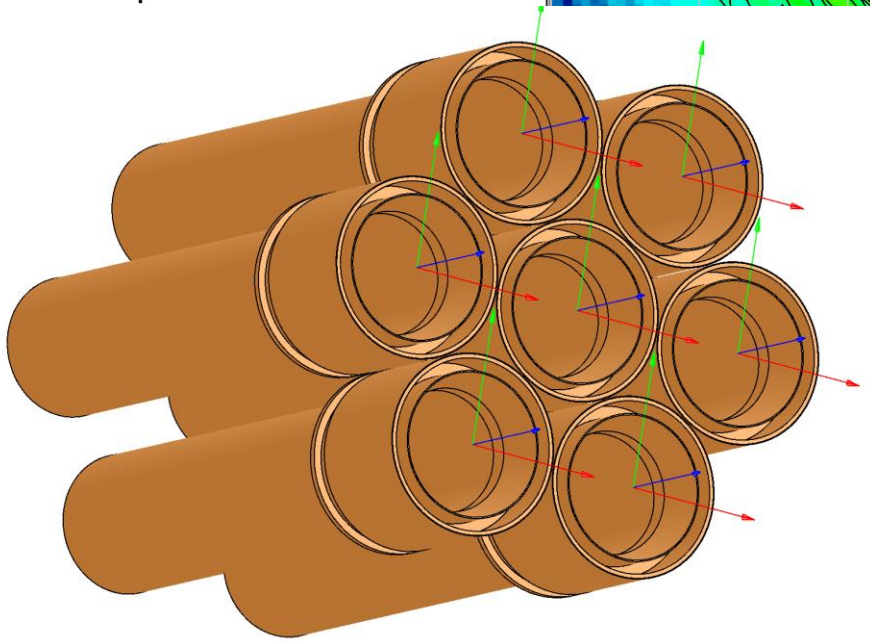


10 GHz, feed 1 labda laterally displaced → Radiation Pattern



Feed Laterally Displaced 1 labda → 10,0 GHz





ROT54 Radio-telescope, (cont'd) measured pattern

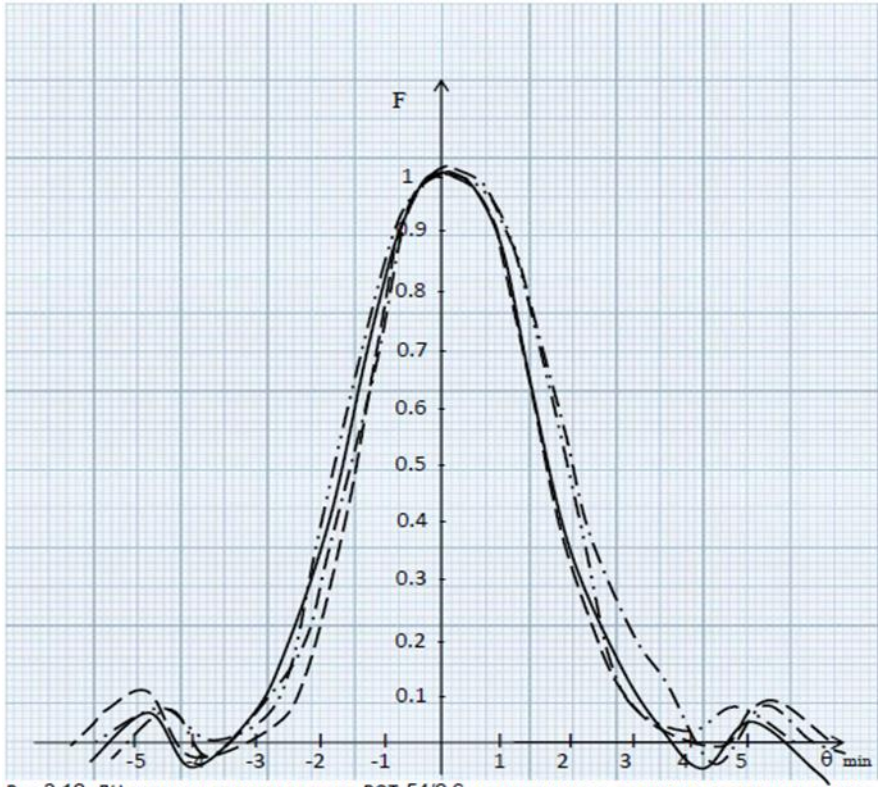


Рис.3.12. ДН антенны радиотелескопа РОТ-54/2.6, измеренные с помощью геостационарного спутника Горизонт VI.

___ конический рупор,

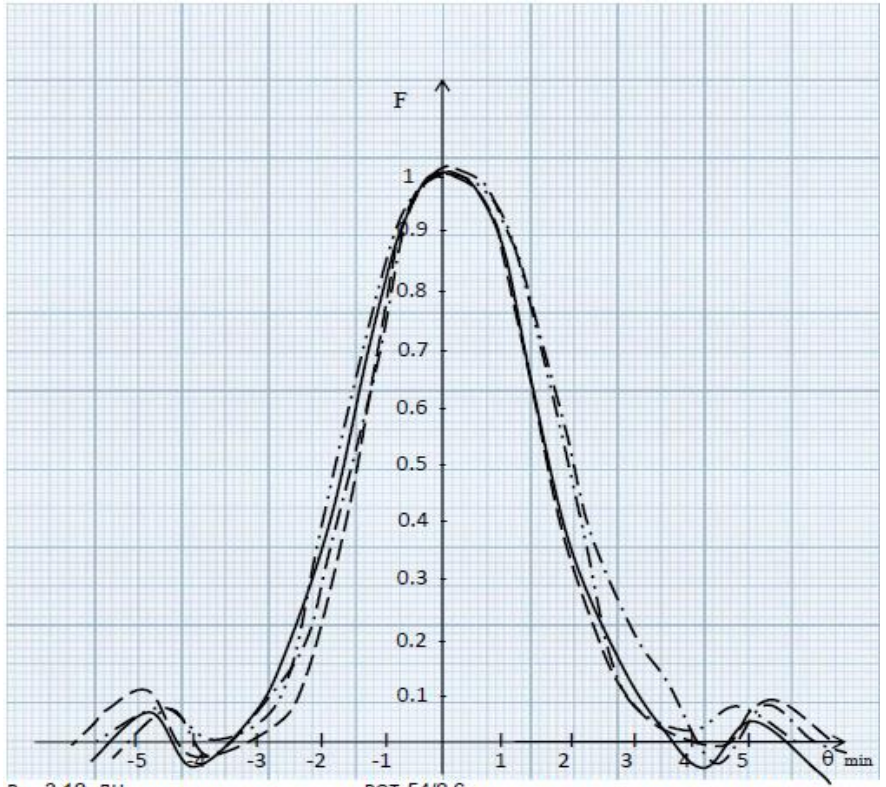
------ открытый конец волновода,

-..-..-..- открытый конец волновода с тефлоновой втулкой с вибратором,

- - - - пирамидальный ступенчатый рупор.

- ROT54 measured pattern using **<u>Gorizont</u>** 10 GHz signal (geostationary) (ref: PhD thesis Dr. Sargsyan).
- In that reference: Four different feeds
  - Conical horn
  - Open ended waveguide
  - Open ended waveguide with a dipole and teflon sleeve
  - Pyramidal stepped horn
- **NOTE** narrow beam: (remember this…)
  - **<u>Half-power beam-width ~3.7 ' (0.062 deg)</u>**

ROT54 Radio-telescope, Measured and calculated pattern (linear scale)



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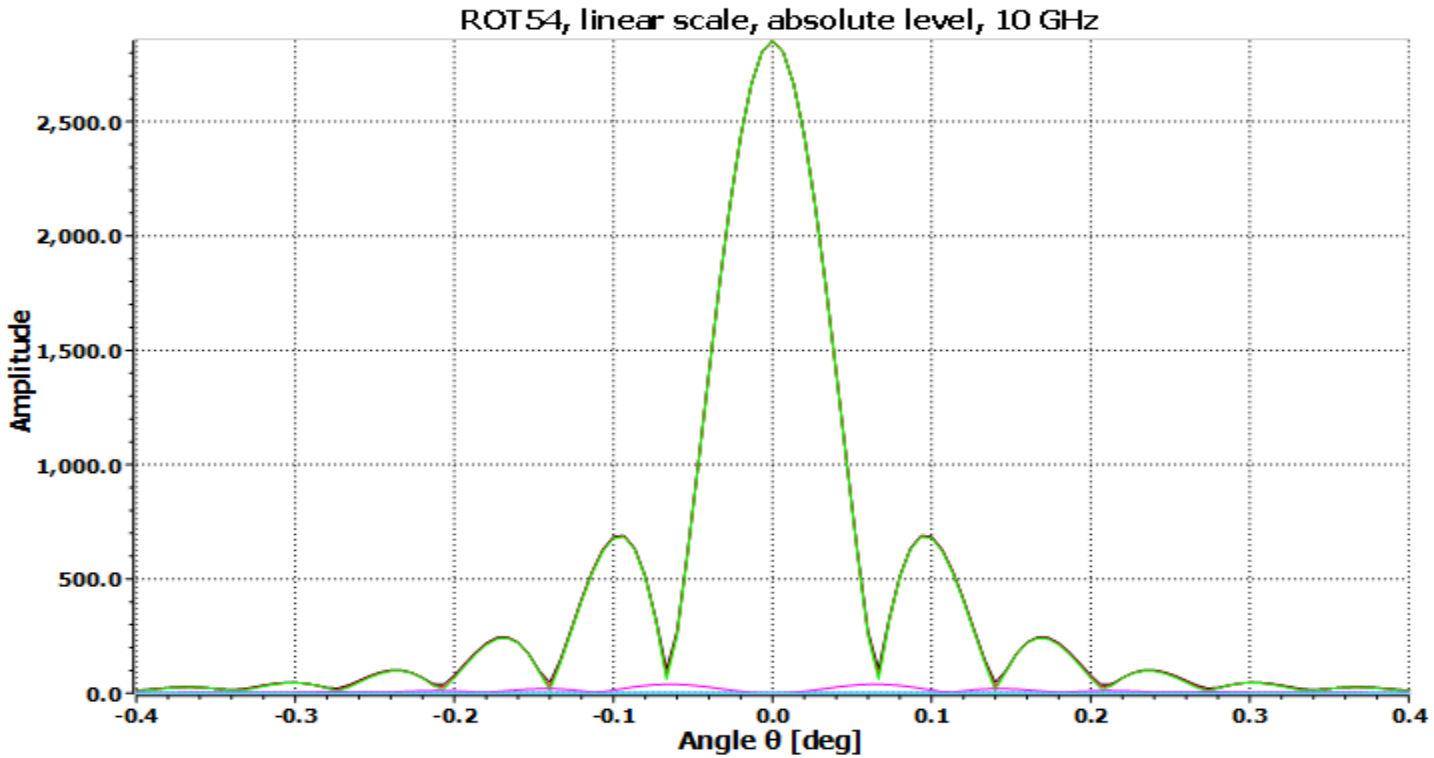
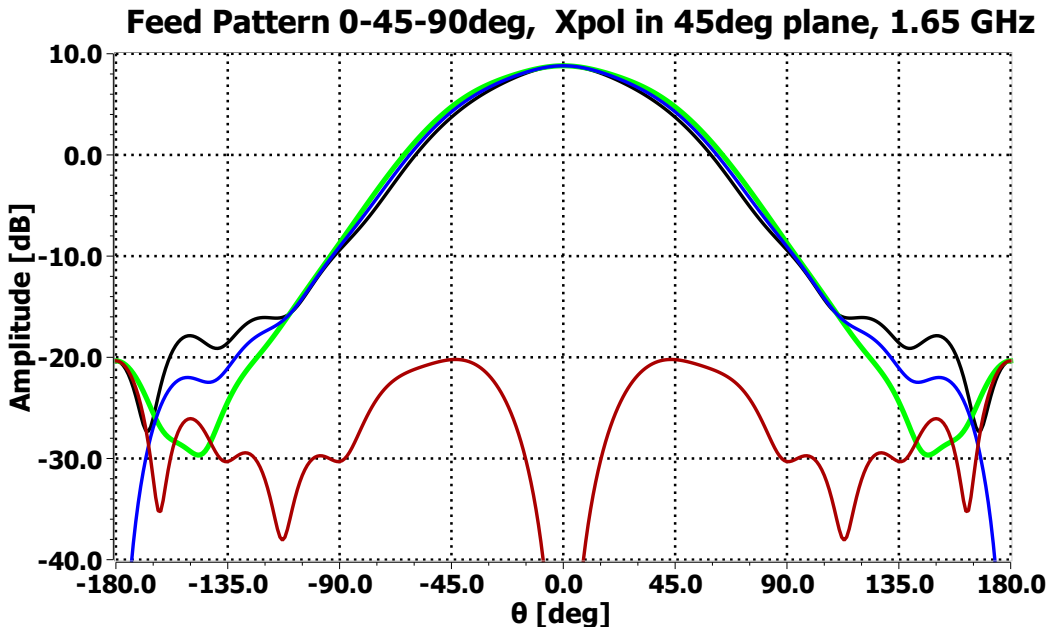


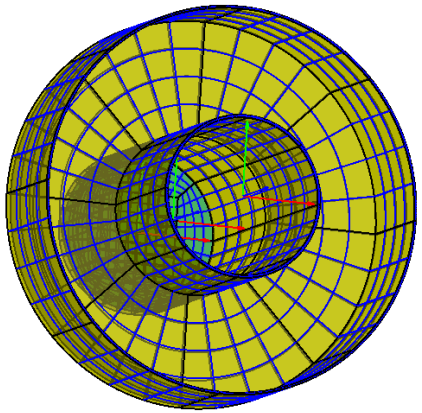
Predicted halfpower beamwidth different…: 0.08 deg (4.8')

Measurement shows non-linearity in scale, but recall: **pointing criticality.**

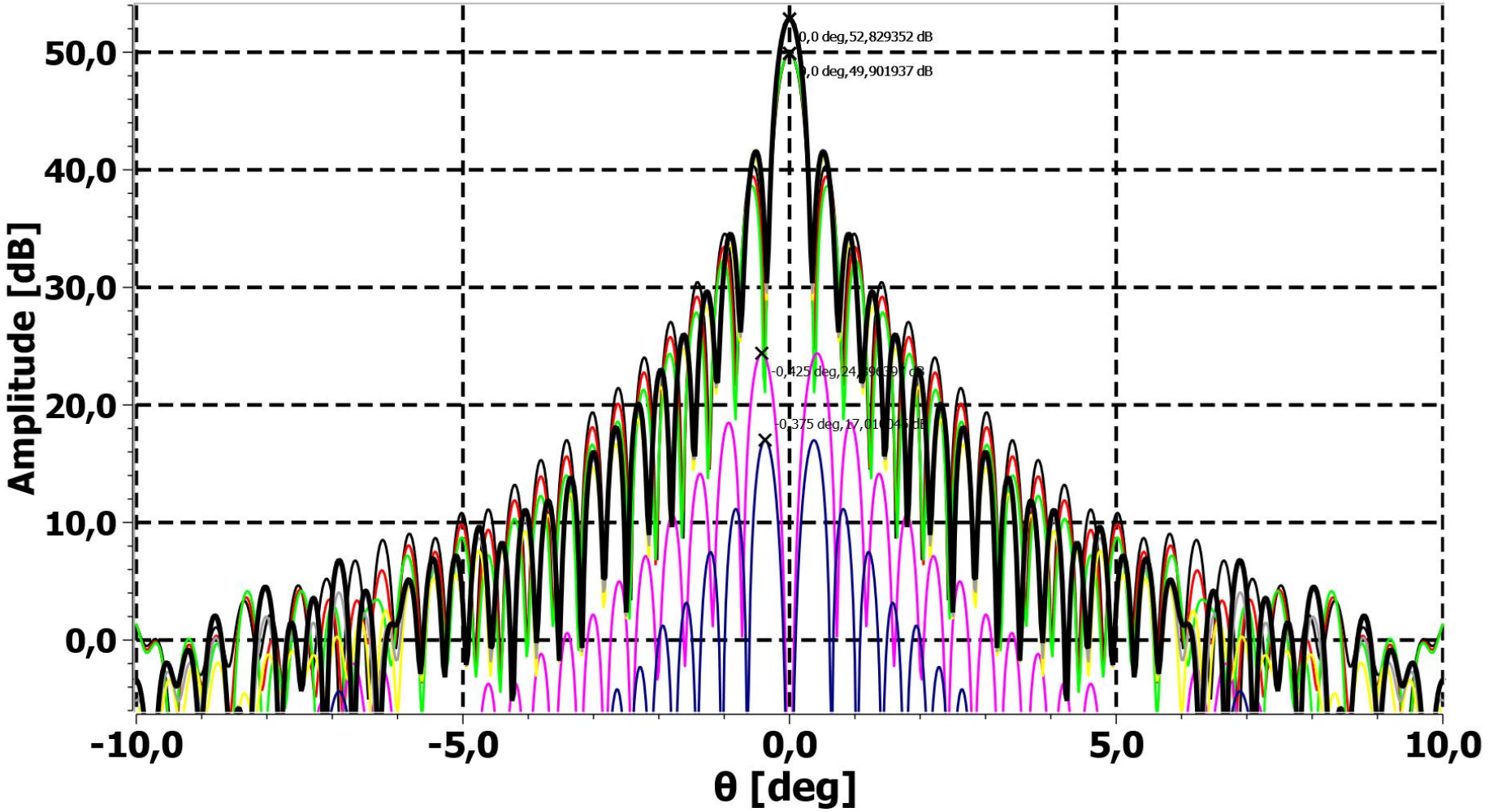
ROT54 Radio-telescope, 1.65 GHz feed in focus

- Feed assumed as some old feed in telescopes
  - →Effelsberg (D) (recall Wohlleben..)
  - →Interferometer at Radboud University (NL).
- Linearly polarized , 1.45 GHz and 1.65 GHz,
- High spill over, but not reaching a warm Earth,
- Feed: roughly ~ 25 cm axially, ~14 cm diam, etc.
- The feed can operate near H-line: 1.44 GHz,
  - But: worse performance shown at 1.45 GHz





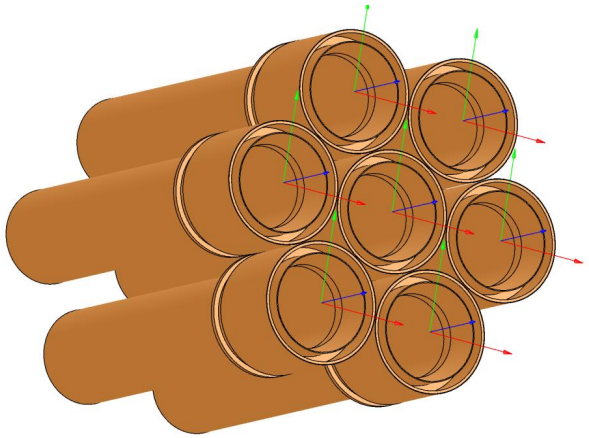
SWE Feed,1.45 and 1.65 GHz ==> ROT54 Radiation Pattern

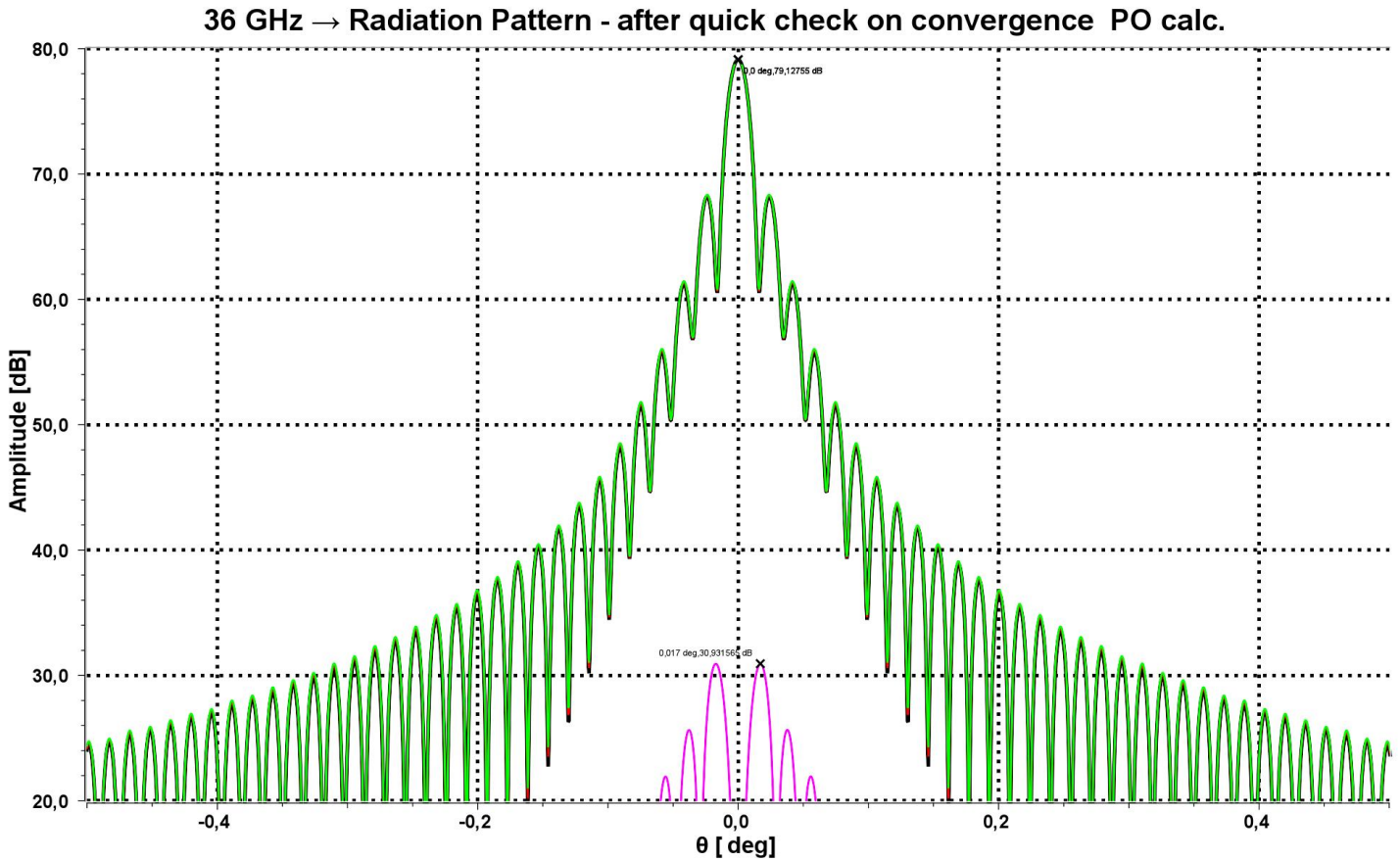


Note: 52.8 dBi gain @1.65 GHz, compare to “Herouni table” (53 dBi)

36 GHz….1 bottle of Ararat cognac

- Calculation with feed model, 1.1 λ, 1 choke
- Use of septet can assist pointing problematics for 1 arcmin beam….



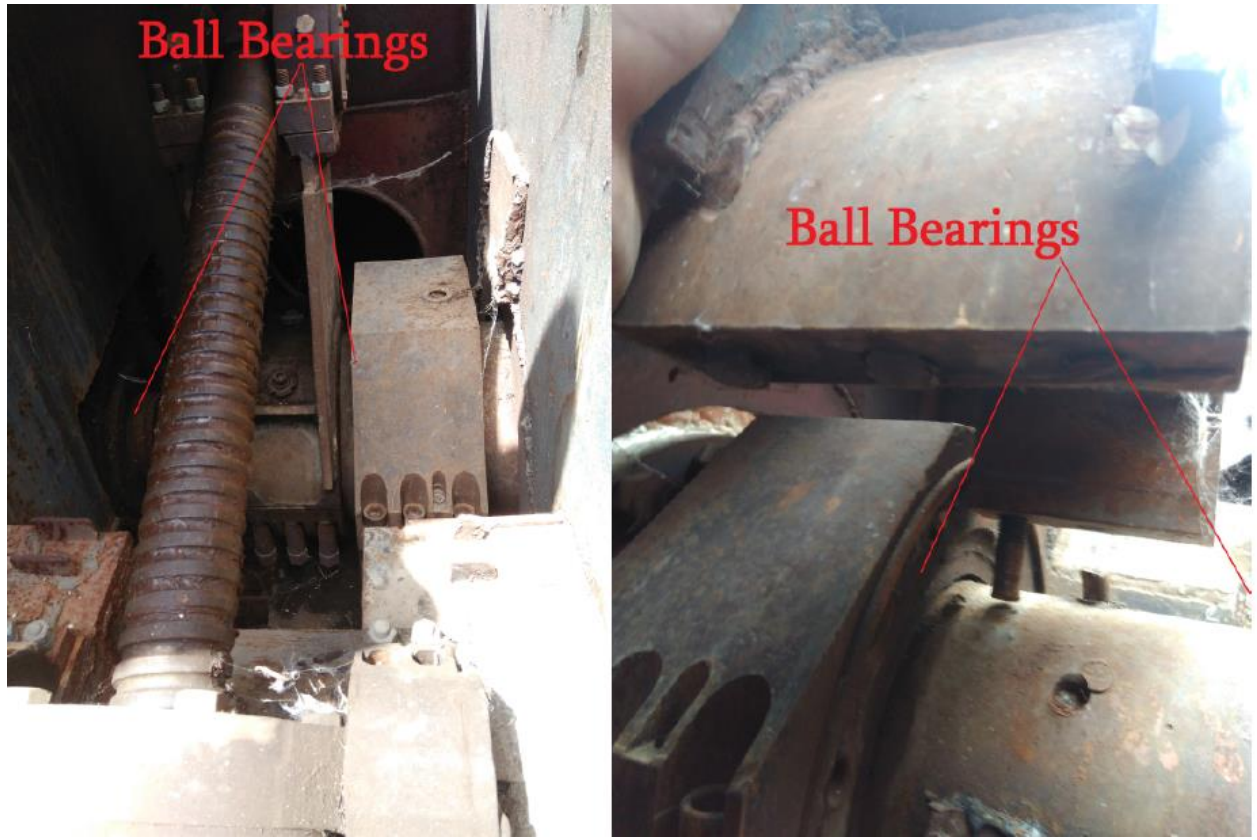


Parameter	Wavelength (mm)					
	200	30	8	3 (expected)	2 (expected)	1 (expected)
Beam width	25'	3.7'	1'	22''	14''	7'
Effective surface, m^2	560	560	540	520	482	350
Gain Herouni This prediction:	$02*1^5$ 53 dBi 52.8dBi	$8*10^6$ 69 dBi 69 dBi	10^8 80dBi 79.2 dBi	$7*10^8$	$1.5*10^9$	$4.4*10^9$
Efficiency	0.7	0.7	0.67	0.65	0.6	0.4
Self noises , K°	5	4	2.8	3	To be measured	
Sensitivity (ratio of Eff. Surf to self noises)	112	140	193	173	To be measured	

But Accurate Cardan Control Necessary

Beam pointing angular accuracy required…..!

- Pointing accuracy for **~4 arcmin**
- If ±1 arcmin allowed, a signal level ~±1 dB
- **For a lever length of 60 cm, the spindle axis movement to be controlled accurately, so:..**
- **±1 arcmin = ±0.175mm spindle movement (~10 GHz)**
- **And:**
  - **Smaller at 36 GHz…. (<±0.05mm)** …
- **Criticality: mechanical pointing control obvious…, additional to repair of Cardan**



Concluding Remarks, ROT54 Radio-telescope,

- Gain value compares with P. Herouni's table of results:
  - "too *good to be true ?"*
- *"It seems ok, see table for* ***1.65, 10 and 36 GHz****, (slight differences in labda)"*
- ***Prediction model confirmed (but not exactly identical configuration as real ROT54),***
- Beam-widths not direct comparable, illumination dependent,
- First sidelobe level in general high, not too much control capability with realistic illuminations

Concluding Remarks, ROT54 Radio-telescope

Work needed to be able to point..

- Accuracies, tolerancing, mechanical design→ (non-linear) lever-spindle movement,
- Accuracy to control the cardan **axes** for “few arcmin beamwidth”,
- First comparison illustrative for necessary pointing(-stability),
- Pointing stability and control, thermal stability, pointing knowledge,
- Effects in control scheme (“dommekracht- control” ?), idem for other actuators in control - scheme,
- →Tables and validity in pointing control.

No more time, no shadow, so over-time →

Շնորհակալություն

Acknowledgements to
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