



# Radiation Pattern Calculation ROT54 Antenna at 10 GHz

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Input to first meeting ROT54 advisory group



# ROT54 Radio-telescope, Preliminary pattern calculation

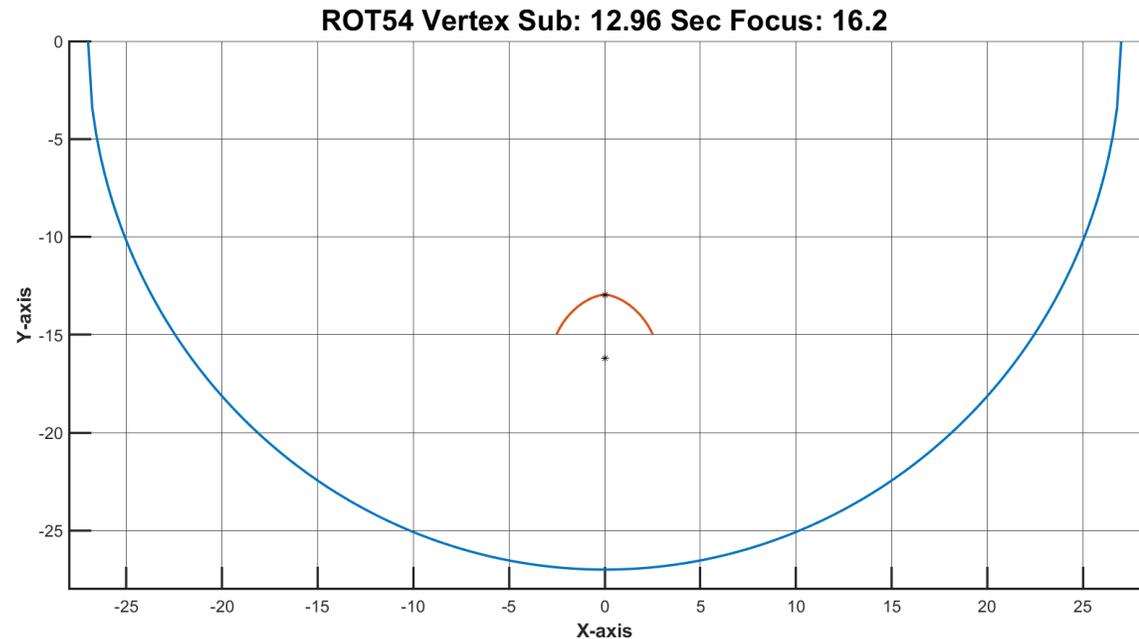
- A pattern calculation has been made based on physical optics for both main- and sub-reflector
- No blockage and multiple reflection in analysis (“does not fit on my notebook...”),
- A comparison with a measured pattern (relative) at 10 GHz is reasonable,
- A gain of 69.03 dBi is predicted at 10 GHz.
- The measured gain is  $8 \cdot 10^6$  or 69.04 dBi (measured by P.M. Herouni, see presentation of Dr Arevik Sargsyan)
- Gain comparison: a coincidence, given a totally different feed, an absence of multiple reflection and no blockage considered.....





# ROT54 Radio-telescope, Preliminary pattern calculation

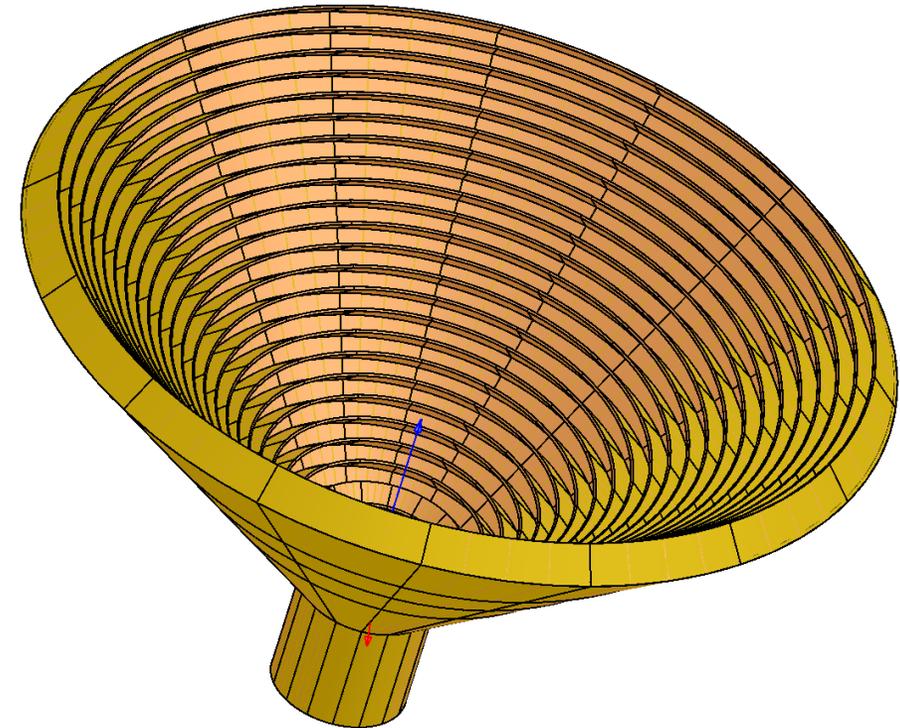
- Antenna geometry is parametrised with known and assumed data:
  - R-main = 27 meter,
  - R-sub = near to 5 meter,
  - Vertex subreflector and feed location assumed (respectively 12.96 m and 16.2m) ,
  - Just as an example.





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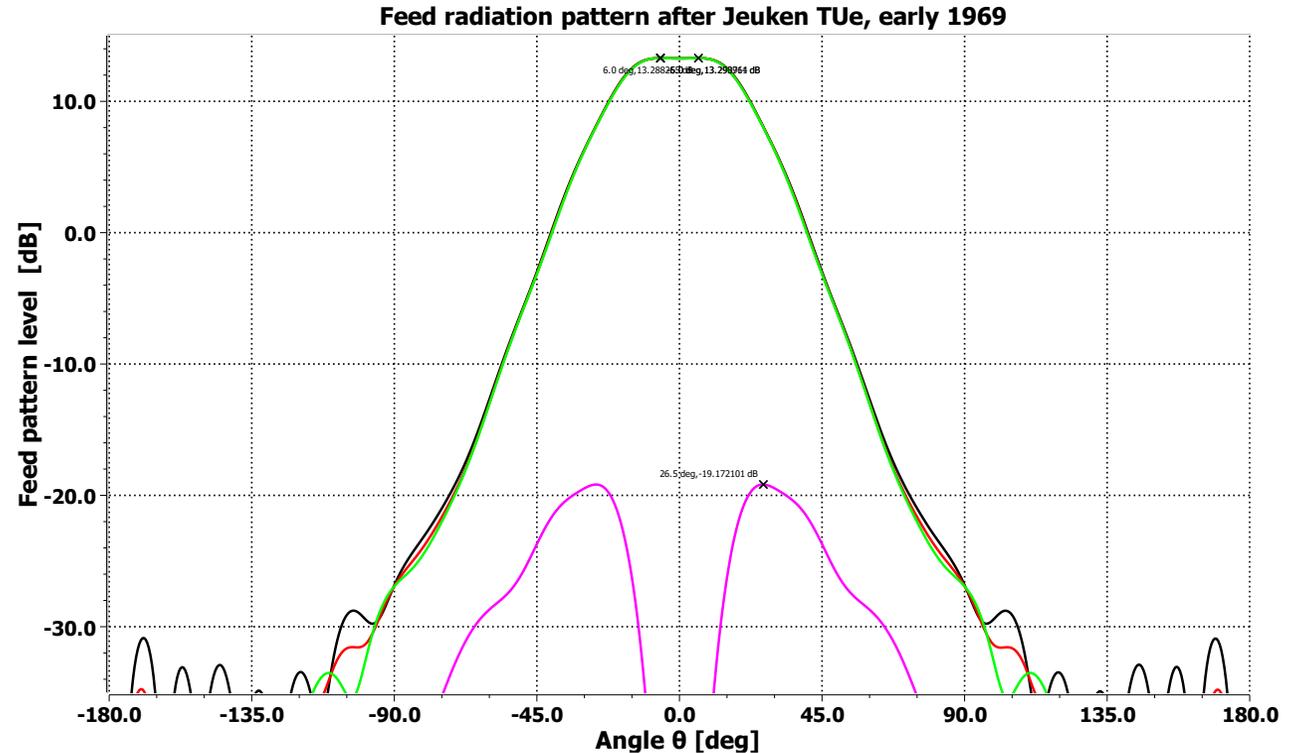
- Corrugated scalar feed horn assumed, using an old known feed model, slightly adapted.
- Comparable feed-horns were developed for Dwingeloo and Westerbork antennas by Technical University Eindhoven (by Jeuken, Knoben, Lambrechtse <1969).
- Spherical wave expansion is used, illuminating the sub reflector





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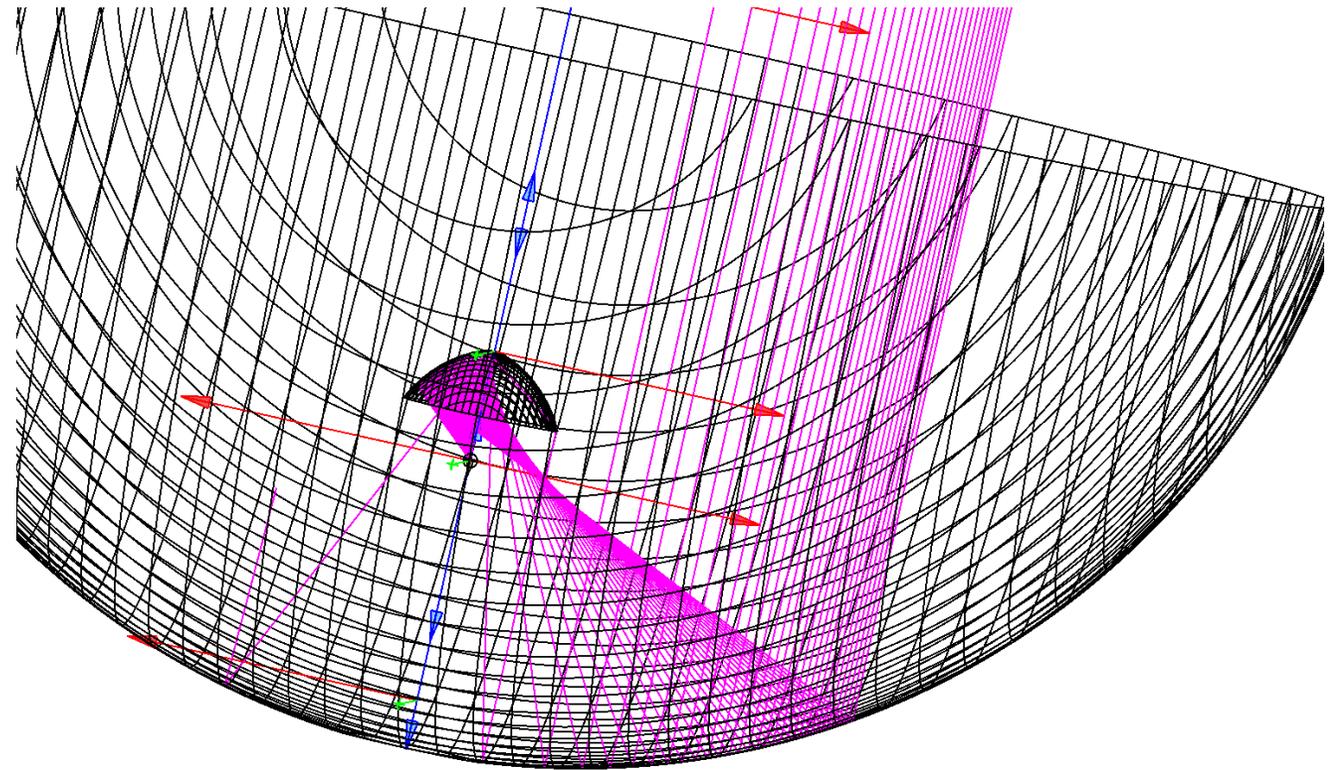
- Flat top pattern convenient initially,
- Cross-polarization feed is  $<-30$  dB,
- Sensitivity to the back is  $<-30$  dB,
- There is more: bandwidth and pattern performance stability.
- Feed can be simplified somewhat for example using less corrugations, if needed for accommodation, tbd.
- Other feeds considered, also so-called “Wohlleben feed” known from Effelsberg telescope-antenna. But then:
  - pattern stability with frequency and cross-polarization much worse.





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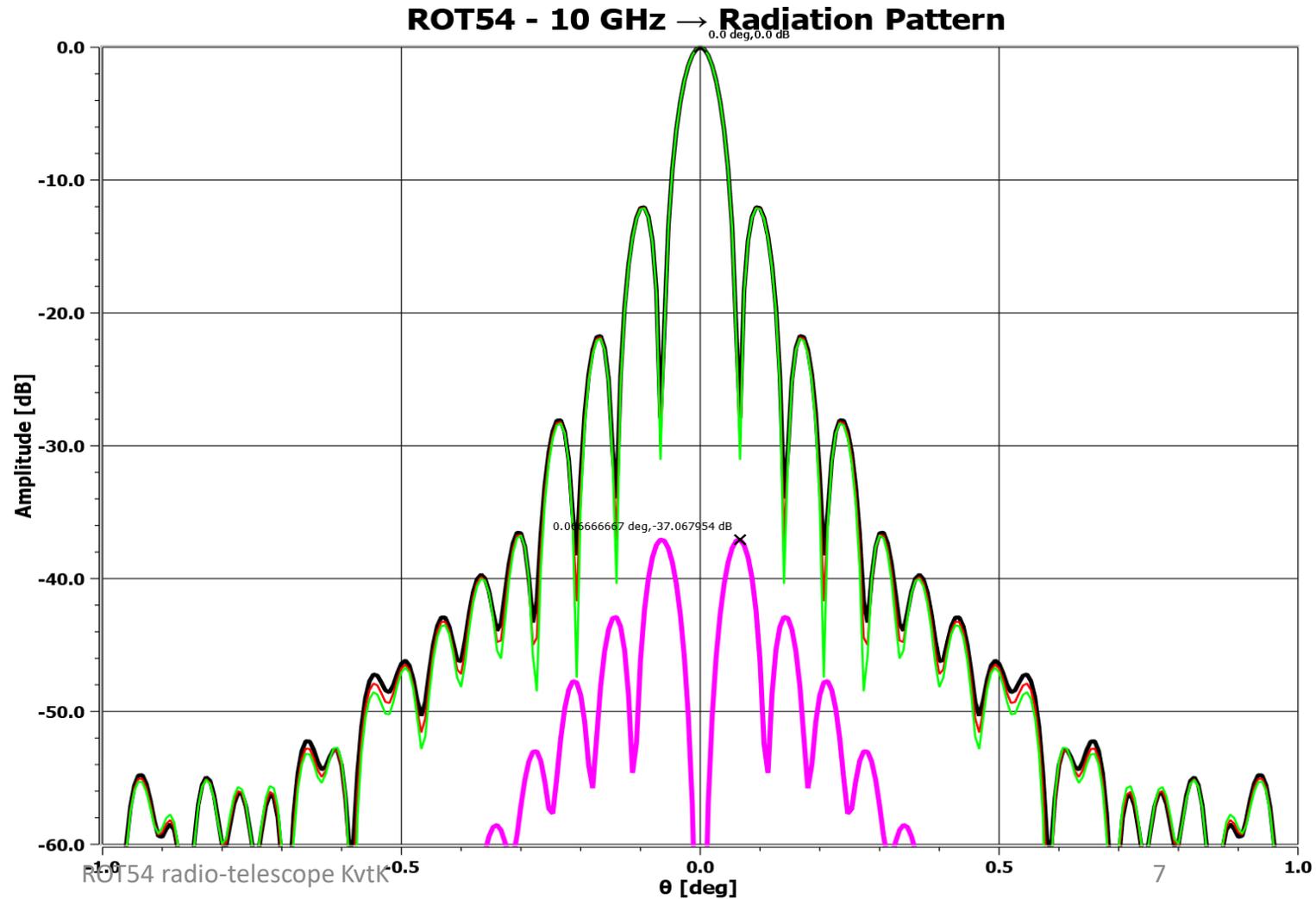
- Spherical wave expansion used, full vectorial. Illumination of synthesized sub reflector.
- Physical optics used on shaped sub-reflector and subsequently on the spherical main-reflector
  - Blockage not taken into account,
  - Multiple reflections not taken into account,
    - Both possible, not needed now, takes computational time, thus left to the reader..





# ROT54 Radio-telescope, Preliminary pattern calculation

- Radiation pattern with high first sidelobes, as anticipated.
- Low far-out level for  $|\theta| > 1^\circ$ .
- Spillover feed pattern confined within (metal) spherical reflector, thus reflected out into free space: It never reaches a warm ground, so **low noise**





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

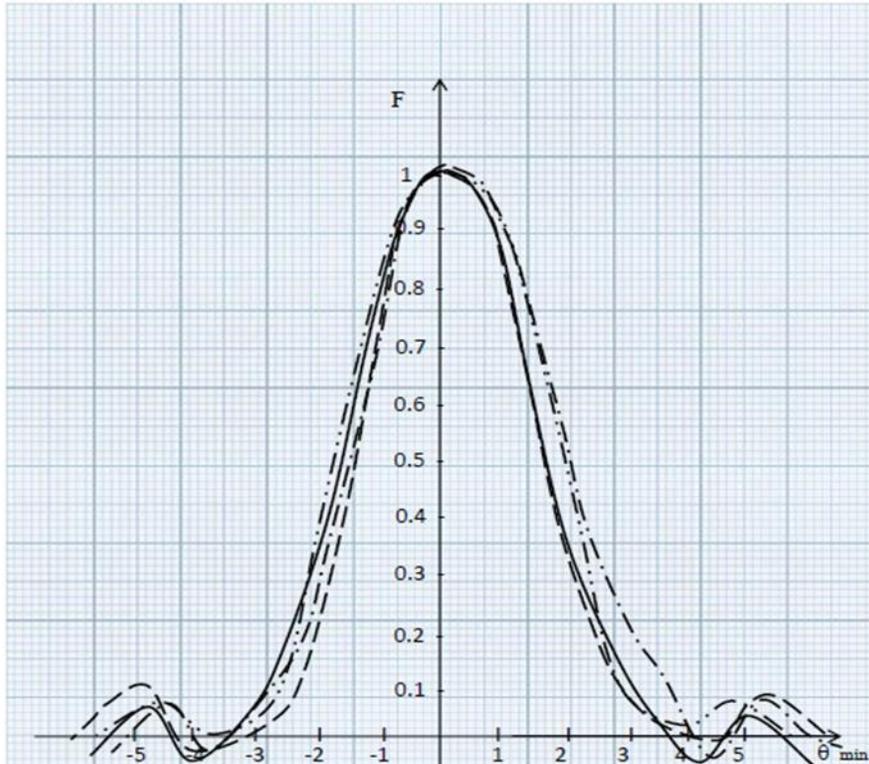


Рис.3.12. ДН антенны радиотелескопа ROT-54/2.6, измеренные с помощью геостационарного спутника Горизонт VI.

- конический рупор,
- открытый конец волновода,
- .-.-.-.- открытый конец волновода с тefлоновой втулкой с вибратором,
- ..... пирамидальный ступенчатый рупор.

- Measurement of pattern of ROT54 using Horizon 10 GHz signal (geostationary) (from PhD thesis Dr. Sargsyan).
- Four different feeds horns
  - Conical horn
  - Open ended waveguide
  - Open ended waveguide with a vibrator and teflon sleeve
  - Pyramidal stepped horn
  - Halfpower beamwidth
- Half-power beam-width  $\sim 3.7'$  (0.062 deg)



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

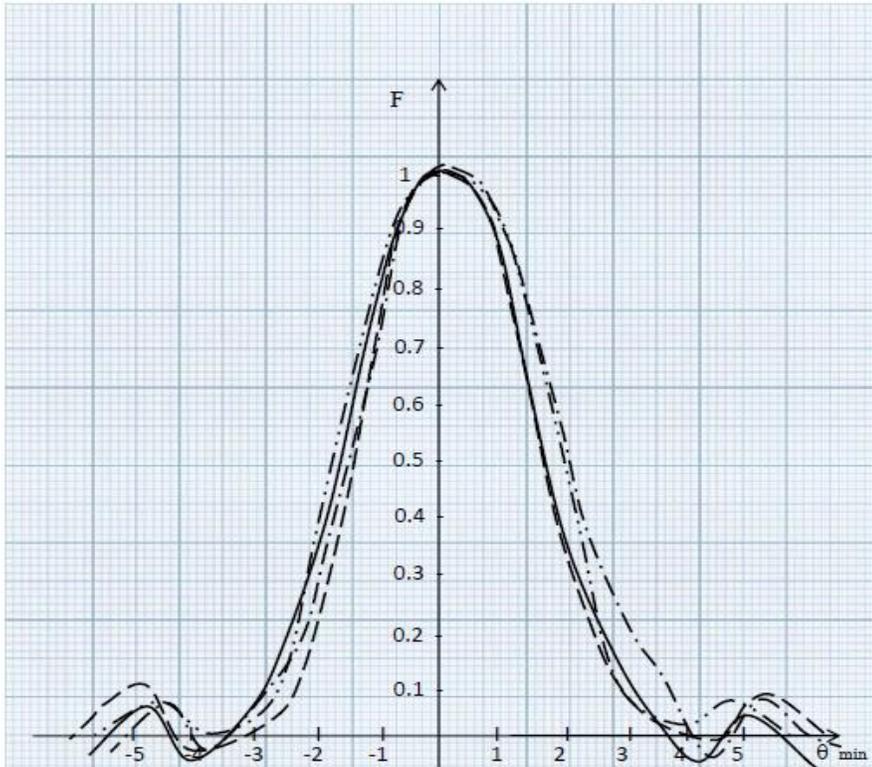
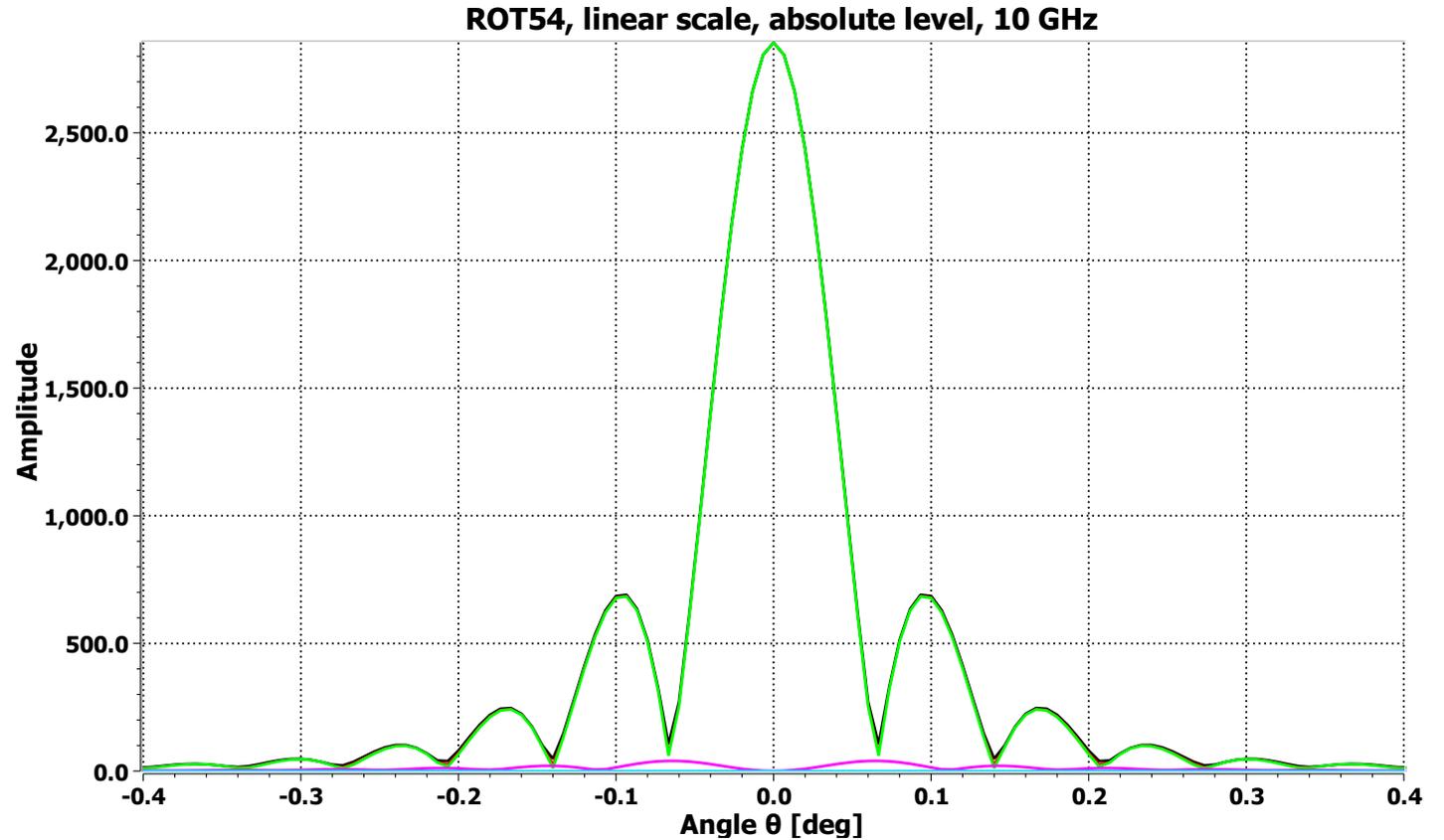


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тефлоновой втулкой с вибратором,
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24 August 2020



Predicted halfpower beamwidth different...: 0.08 deg (4.8')  
(measurement: non-linearity in scale and pointing aspects)

ROT54 radio-telescope KvtK



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

A calculation serves as a good understanding for the RF behavior of the ROT54 antenna

Comparison with measured diagram, (Horizont Geostationary Satellite, 10 GHz):

- Gain value predicted compares with P. Herouni's measured result ... *"too good to be true"*
- Beam-width not direct comparable, ~20%, but feed patterns different
- First sidelobe level lower in measurement

More work needed:

- First comparison already illustrative for pointing(-stability) requirements needed
- Pointing stability and pointing control, thermal stability and effects in control ("dommekracht control" ?), idem ditto for involvement of other actuators in control)
- Etc.