HFSS & FEKO beam comparisons with actual data

Lowband1 (10m X 10m ground)

Nivedita Mahesh
ASU

This report validates the beam models obtained from FEKO and HFSS-IE of the old lowband ground plane. This is done using the residuals from the simulated spectra and comparing it to the residues from the actual calibrated data.

DATA used

Model:

- Lowband. Real ground with 10m X 10m PEC.

Beams:

- HFSS-IE beam after fitting a 7 term polynomial. (*HFSS-IE_oldground_Simple-blade-imp.txt*)
- FEKO simulation I ran (*FEKO_oldground-updatedgap_Simple-blade.txt*)
- Kept the beam in the original frequency resolution as the simulation run. (FEKO: 2MHZ; HFSS-IE: 1 MHz). Didnt use a fourier series fitting to the beams.

Skymodel :

- Haslem sky map scaled down to 75 MHz

Actual data:

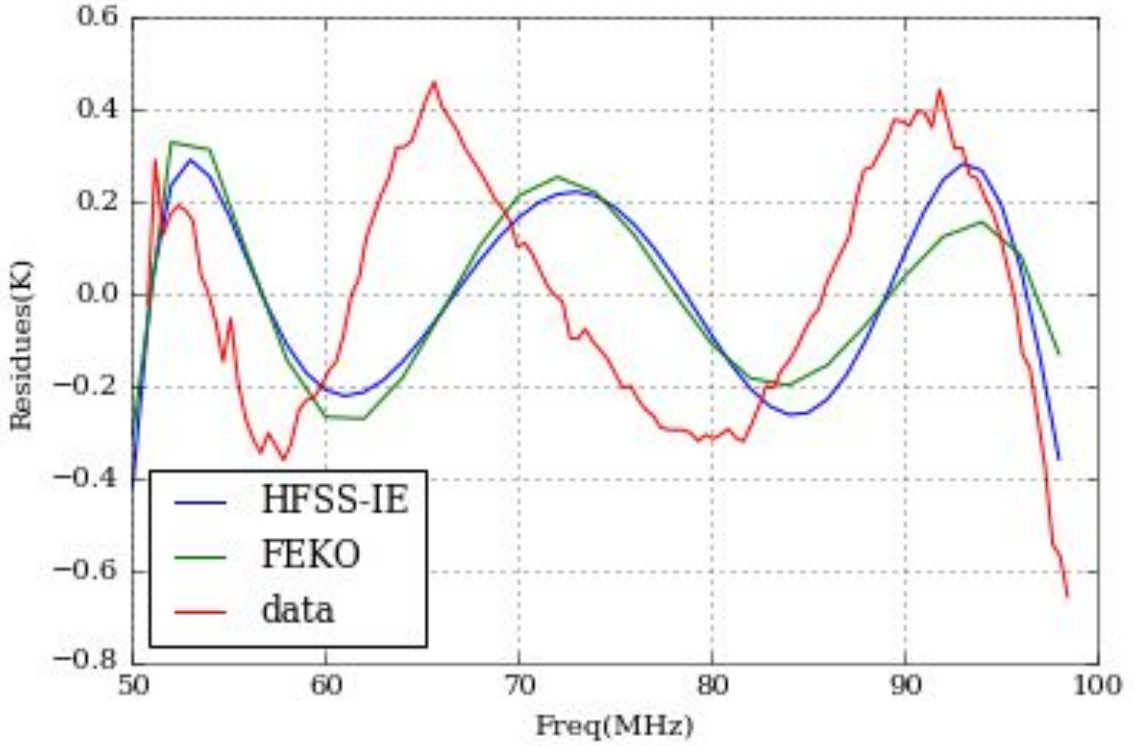
- Lowband 1 (10m X 10m) ground. Days 2015_286 to 2016_015. (*lowbandcase1_10x10_2015_286_2016_015.txt*)

Results:

Plot of lst-averaged residues vs frequency:

Frequency range: 51-98 MHz

Fitting to the simulated spectra & actual data: 5 term polynomial



Case	RMS (mK)
FEKO	187.02
HFSS-IE	189.9
Data	260.4

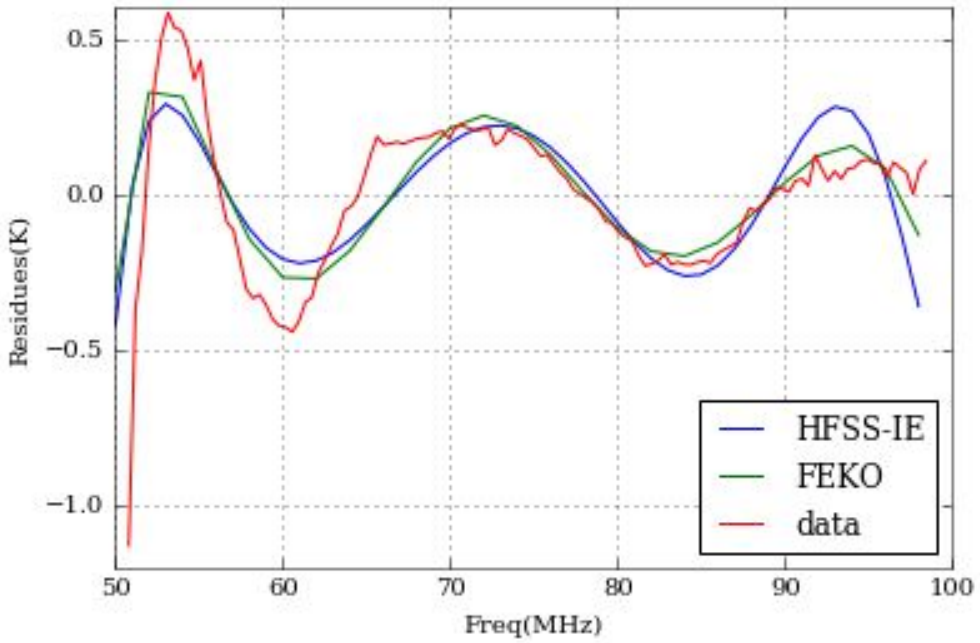
Results:

Plot of LST-averaged residues vs frequency:

Frequency range: 51 - 98 MHz

Fitting to the simulated spectra: 5 term polynomial

Fitting to the actual data: 5 term physical

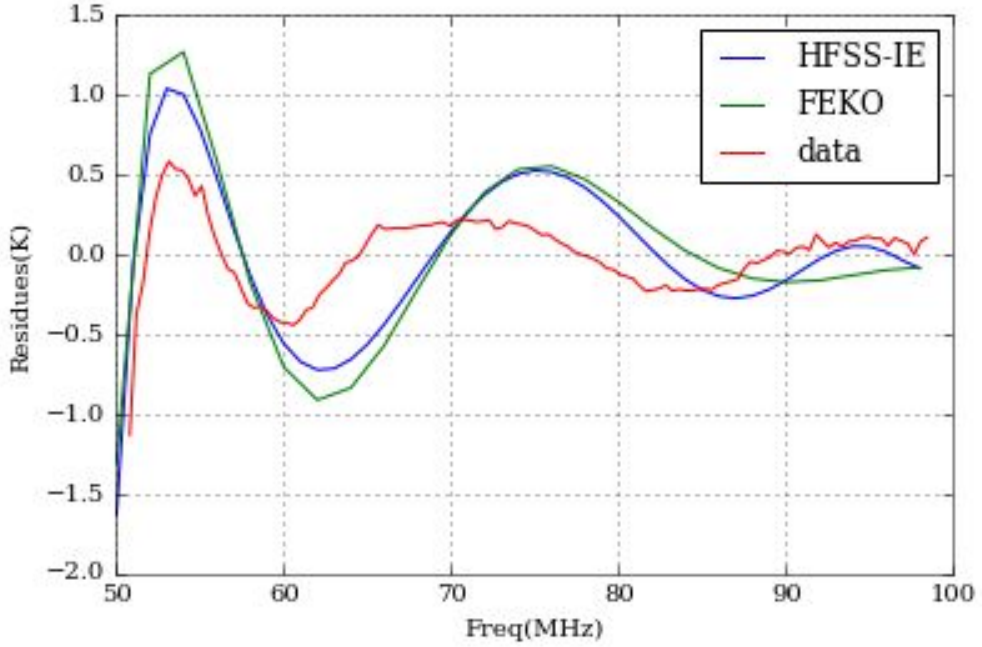


Case	RMS (mK)
FEKO	187.02
HFSS-IE	189.9
Data	239.1

Results:

Plot of LST-averaged residues vs frequency:

Fitting (51-98 MHz) to the simulated spectra & actual data: 5 term physical

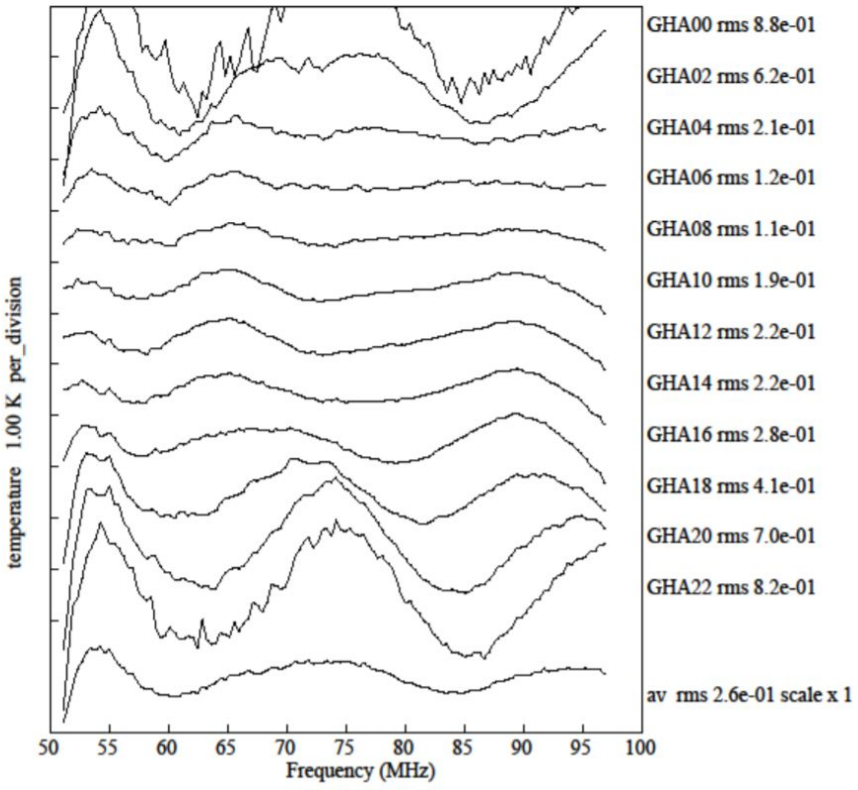


Case	RMS (mK)
FEKO	391.9
HFSS-IE	392.3
Data	239.1

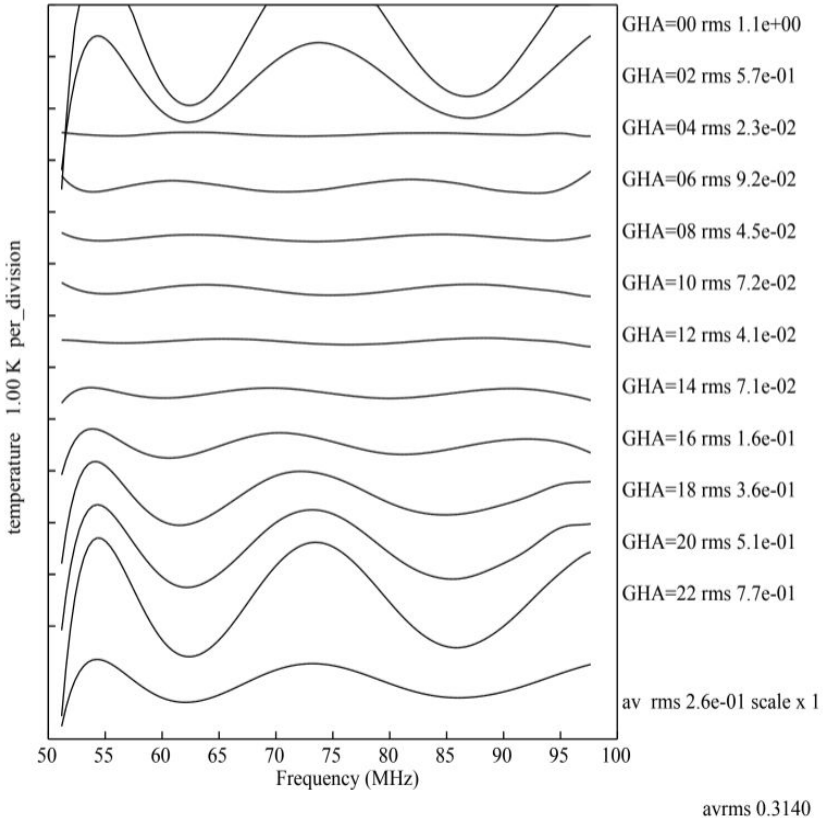
Checking with Alan's results

To understand this discrepancy, I compared them with results from Alan in Memo 188.

Residues to the same data set (2015_286 to 2016_015) after fitting a 5 term physical foreground model



Residues to simulated spectra using My FEKO model after fitting a 5 term physical foreground model

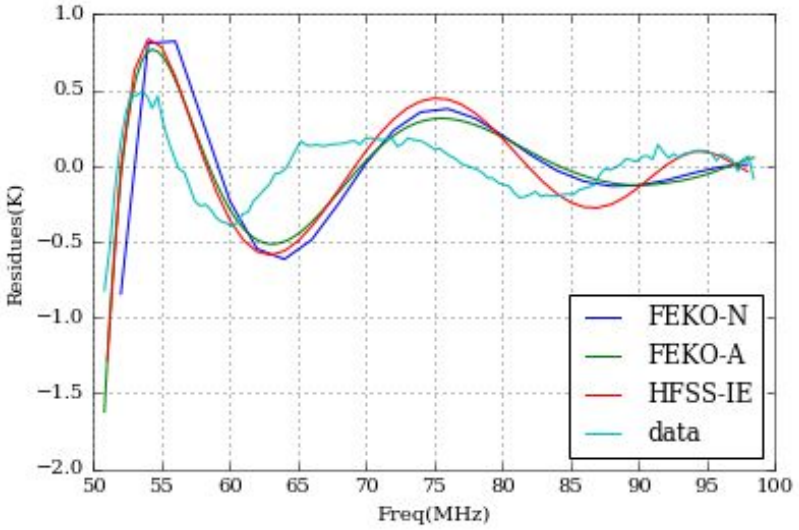


Alan obtains the same RMS of the LST-averaged residues (~260mK) between data and simulated spectra

Comparing the Simulated Spectra

- I obtained simulated spectra from Alan, i.e, my Feko beam convolved with sky model.
- File - “memo_188_oldniv.txt”
- Shown in the plot here are residues from my simulated spectra and Alan’s simulated spectra.
  - They are similar ⇒ I am generating the same simulated spectra.
  - But my residues are higher than what Alan had (Shown in previous slide.)
  - Could I be using the wrong foreground model?
  - The foreground model used:

$$T(\nu) = a * \left(\frac{\nu}{\nu_o}\right)^{-2.5+b+c\log\left(\frac{\nu}{\nu_o}\right)} * e^{-d*\left(\frac{\nu}{\nu_o}\right)^{-2}} + e * \left(\frac{\nu}{\nu_o}\right)^{-2}$$



1.) Alan’s simulated spectra but my code for subtracting the foreground model.
2.) Alan’s complete calculation of residues. (Results from previous slide)

Observations:

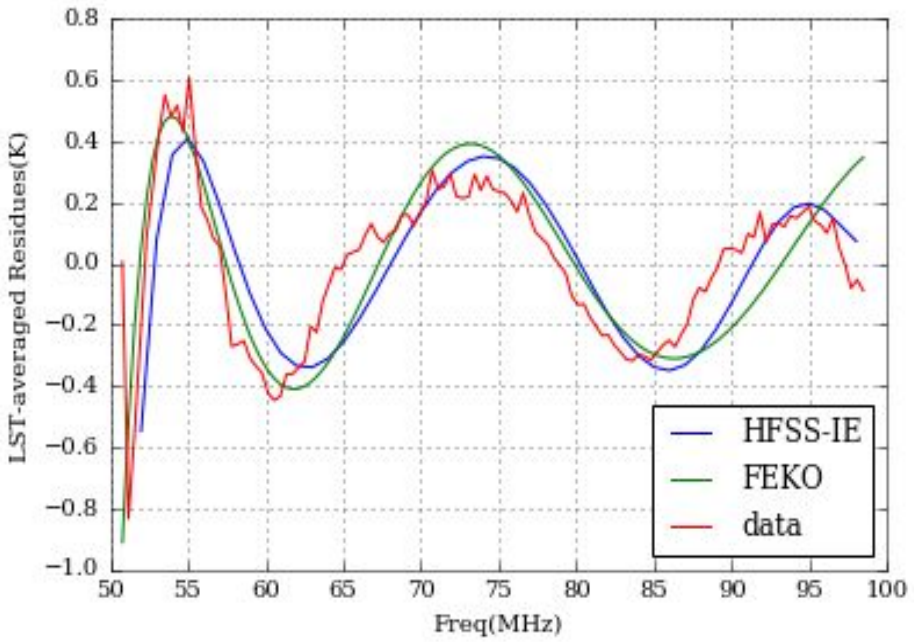
- For simulated spectra: I get residues higher than of Alan’s ~390 vs 260mK
- For the actual data: The residues I obtained are similar if not lesser than Alan’s. ~240mK vs 260 mK

Case	RMS (mK)
FEKO	391.9
1.)FEKO-A Residues -N	341.81
2.)FEKO-A Residues -A	260
HFSS-IE	392.3
Data	239.1
Data -A	260

Solved - Using the linearized form of the Physical model

- The issue was in the form of the physical model used
- On using the linearised form of the physical model:

$$a_o\left(\frac{\nu}{\nu_c}\right)^{-2.5} + a_1\left(\frac{\nu}{\nu_c}\right)^{-2.5}\log\left(\frac{\nu}{\nu_c}\right) + a_2\left(\frac{\nu}{\nu_c}\right)^{-2.5}\left(\log\left(\frac{\nu}{\nu_c}\right)\right)^2 + a_3\left(\frac{\nu}{\nu_c}\right)^{-4.5} + a_4\left(\frac{\nu}{\nu_c}\right)^{-2}$$



The residues from the data and the simulated spectra match better. The RMS of the residues are closer to what Alan got.

Solver	FoM(mK)
FEKO	255.4
HFSS-IE	254.8
Data	244.9