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Investigating Ground planes for EDGES Low

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This report analyses the different ground planes (in shape and size) below the EDGES blade antenna and summarises its effect on the beam chromaticity. For each case, I plot the beam derivative plot and the residues to a 5 term loglog fit. In most cases, in the residue plots, I show the curves corresponding to either the 10m X 10m or extended GP for comparison. All the simulations are done with EDGES low band panels and soil parameters: permittivity=3.5; conductivity = 0.02S/m.

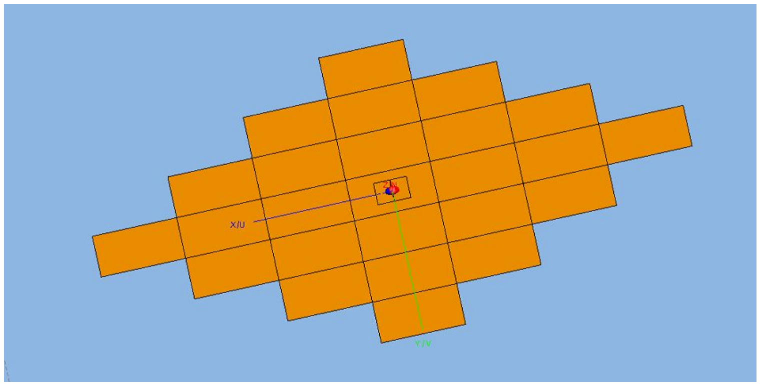
This table summarizes the average RMS of the residues on fitting a 5 term lolog foreground model to the simulated spectra from each case. The fit was done on 2 hr GHA binned spectra. The residues were averaged and the rms was calculated for this averaged residues.

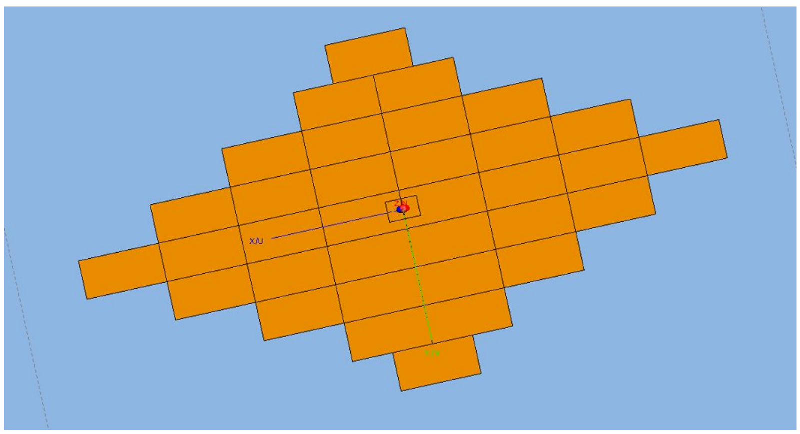
UPDATES:

- Added a different chromaticity metric to each plot. Average RMS - This is the average of the RMS that was calculated for each 1 hour block of averaged data. Up until now, the residues from each 1 hour fit was averaged and then the RMS was calculated
- A new table was created with this metric
- To make one on one comparisons with Alan's analysis in report #317, one case was replicated:
    - EDGES 3 from #300 over the 48.8m by 48.8 ground plane with a soil conductivity of 2e-3. The simulation was carried out from 60 to 120 MHz. On fitting a 5 term loglog model to each one hour block of data and average all of the RMS to get a value of 81mK Vs 86 mK quoted in #317.

Size/ Configuration	Avg RMS (LogLog) (52-98MHz)	Area(m^2)	Freq Res (MHz)	Avg RMS (LinLog) (52-98MHz)
10x10m (old ground plane)	280 mK	100	2	220 mK
10x10m (old ground plane)	340 mK	100	1	330mK
30x30m perforated	60 mK	600	2	40 mK
30x30m perforated	71 mK	600	1	40 mK
Circle 4.9m radius	370 mK	75.43	2	300mK
Circle 9.8m radius	170 mK	301	2	180mK
Circle 15m radius	70 mK	706	2	80mK
Hexagon 5m sides	140 mK	64.95	1	130mK
Hexagon 7.5m sides	200mK	146.14	1	200mK
Hexagon 15m sides	94 mK	584.57	1	50mK
Hexagon 17m sides	59mK	750.84	1	40mK
Square 50x50m	70mK	2500	2	40mK
Perforated 30m X 30m;(5/side)	67 mK	600	1	30mK
Perforated 40m X 40m; (6/side)	78mK	1200	1	30mK
Perforated 49.2 X 49.2m; (3/side)	90.3 mK	1476	1	40 mK
Staggered 7 by 7	108mK	312.5	1	60 mK
Staggered 8 by 9	57mK	425	1	30 mK
Staggered 7 by 9	89mK	562.5	1	60mK

Size/ Configuration	**Avged RMS (LogLog) (52-98MHz)**	**Area(m^2)**	**Freq Res (MHz)**	**Avged RMS (LinLog) (52-98MHz)**
10x10m (old ground plane)		100	2	
10x10m (old ground plane)		100	1	
30x30m perforated		600	2	
30x30m perforated	291 mK	600	1	238 mK
Circle 4.9m radius		75.43	2	
Circle 9.8m radius		301	2	
Circle 15m radius		706	2	
Hexagon 5m sides		64.95	1	
Hexagon 7.5m sides		146.14	1	
Hexagon 15m sides	393 mK	584.57	1	345 mK
Hexagon 17m sides	334 mK	750.84	1	285 mK
Square 50x50m		2500	2	
Perforated 30m X 30m;(5/side)	279mK	600	1	220 mK
Perforated 40m X 40m; (6/side)	246 mK	1200	1	186 mK
Perforated 49.2 X 49.2m; (3/side)	245 mK	1476	1	182 mK
Staggered 7 by 7	401 mK	312.5	1	331 mK
Staggered 8 by 9	333 mK	425	1	279 mK
Staggered 7 by 9	395 mK	562.5	1	345 mK
Case replicated; 60-120MHz; EDGES 3	94 mK	1405	1	81 mK


X/U
Y/V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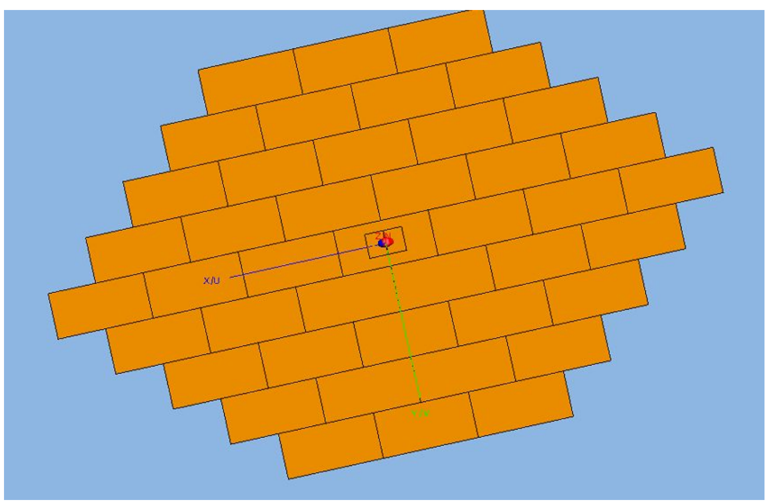
X/U

1.) <u>Simple Circle - 4.9 m radius (area<10m X 10m GP)</u>

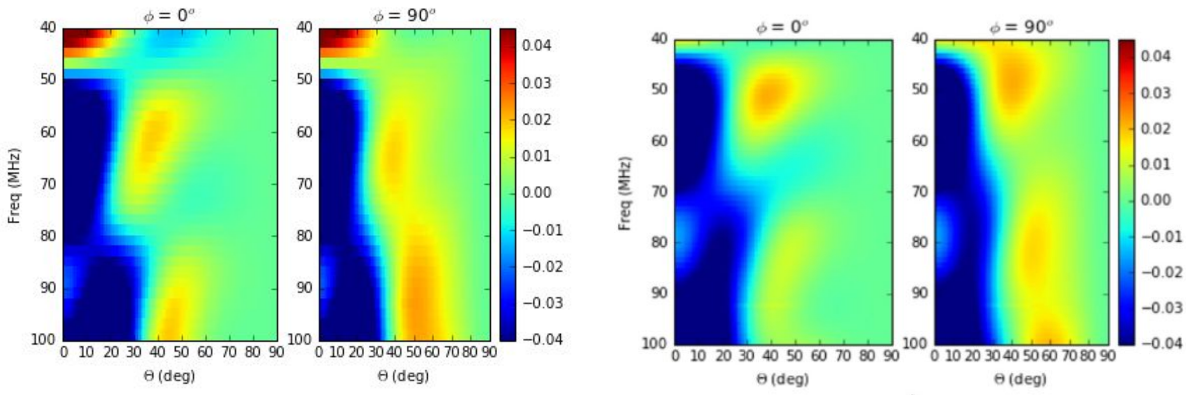

Fig1: Gain derivative Vs Frequency for a circular ground plane with radius of 4.9m. (Right): The Gain vs derivative plot for the 10m X 10m GP for comparison.

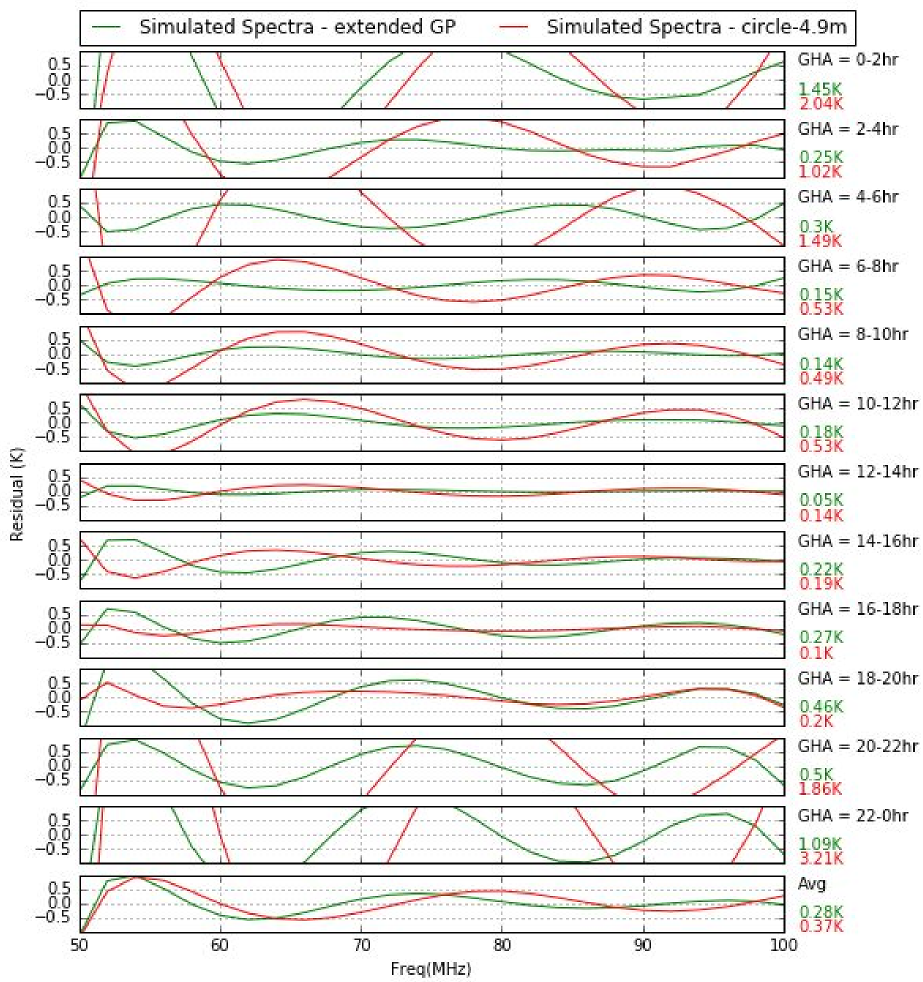

Fig2: Residues to a 5 term loglog foreground model Vs Frequency for the 10m X 10m GP and a 4.9m radius circular GP. The RMS of the averaged residues of the circular one is larger. The circular GP covers less area compared to the 10m X 10m GP.

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2.) Simple Circle - 9.8 m radius (area <extended GP)

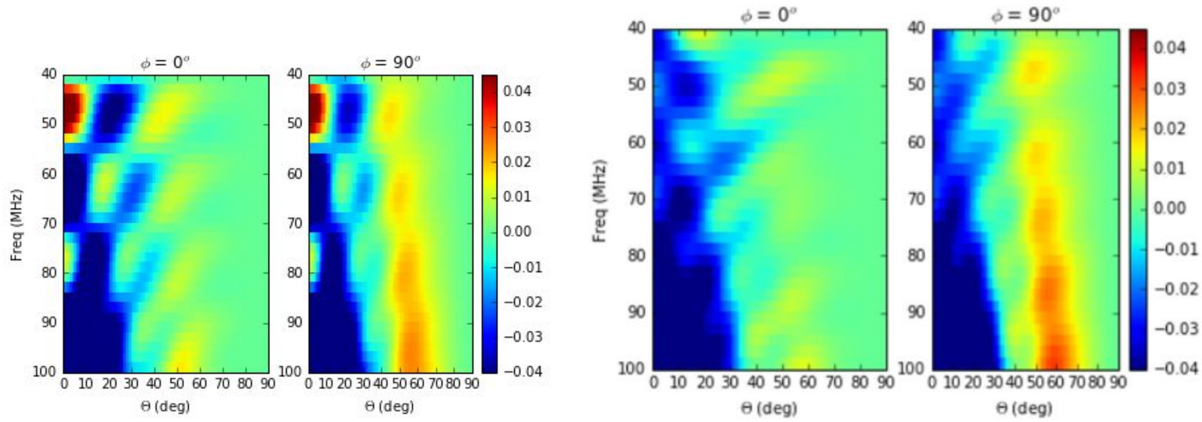

Fig3: Gain derivative Vs Frequency for a circular ground plane with radius 9.8m. (Right): The Gain vs derivative plot for the extended GP.

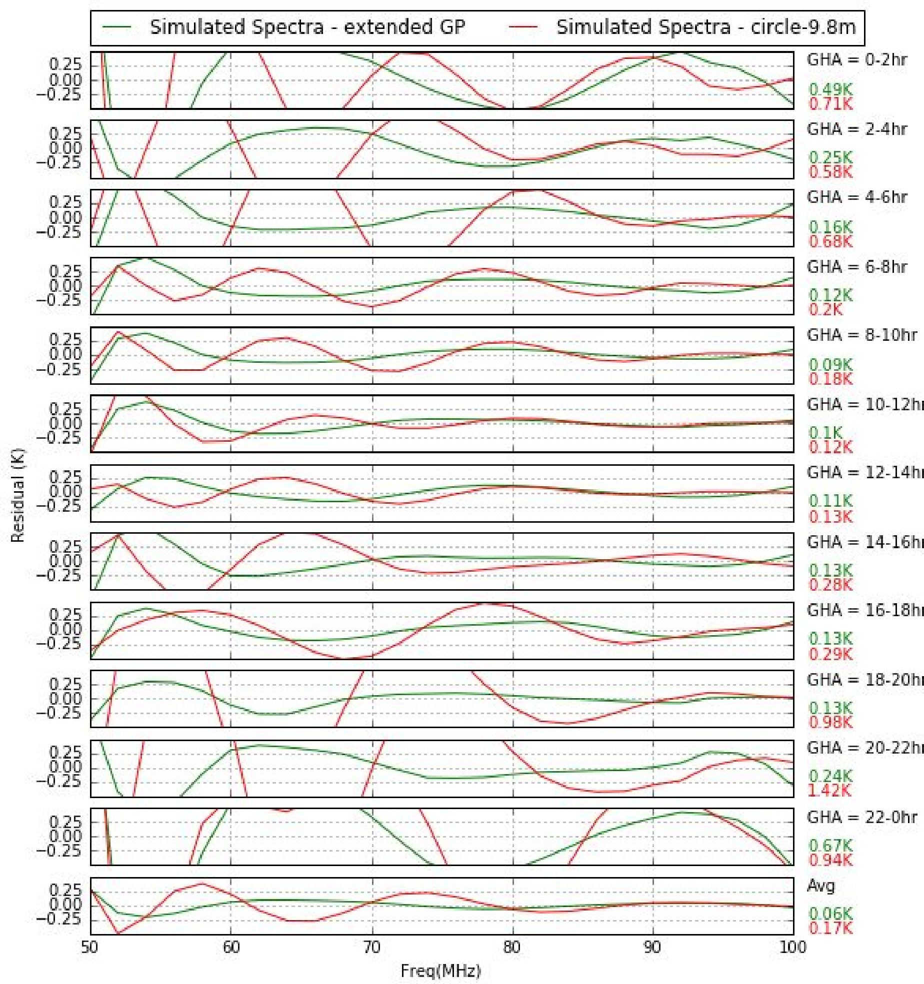

Fig4: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a 9.8m radius circular GP. The RMS of the averaged residues is 3 times higher for the circular GP. The circular GP covers roughly half the area as the extended GP.

3,) Simple Circle - 15 m radius (area~extended ground plane)

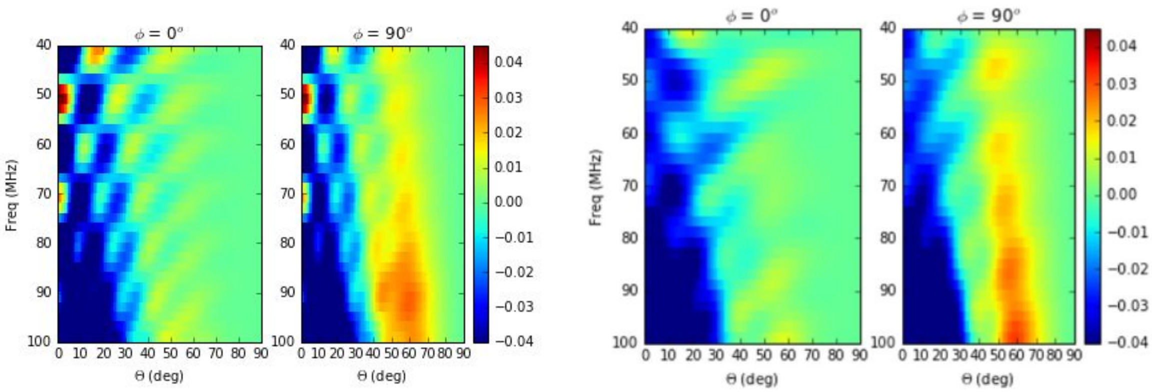

Fig5:(Left) Gain derivative Vs Frequency for a circular ground plane. (RIght): The Gain vs derivative plot for the extended GP.

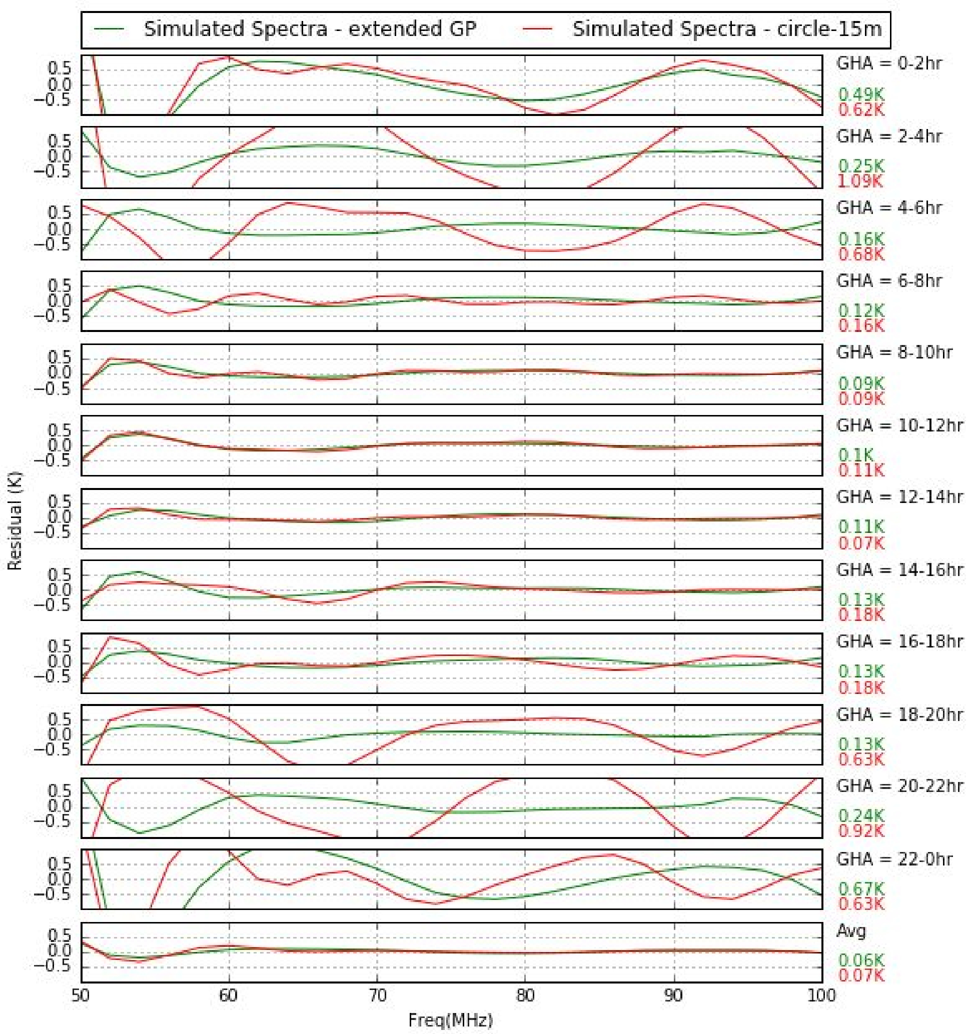

Fig6: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a 15m radius circular GP. The RMS of the averaged residues is roughly the same.

4.) Rectangle (20m across); + Saw tooth(20 triangles)

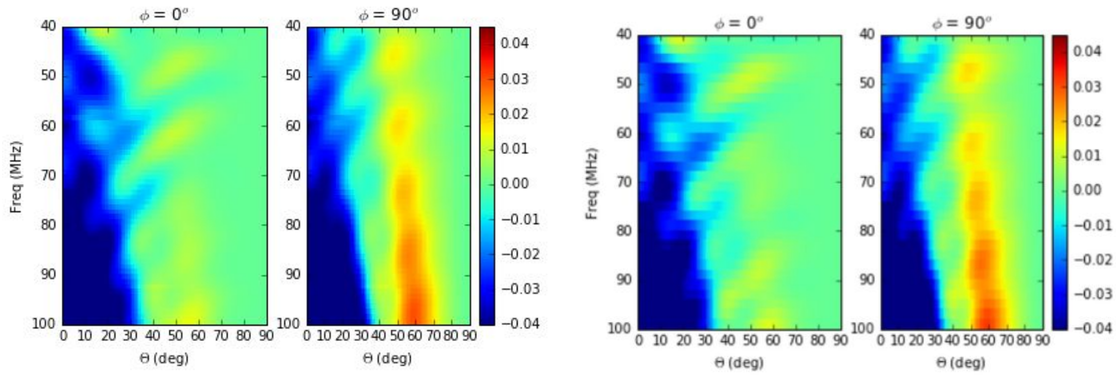

Fig7:(Left) Gain derivative Vs Frequency for the extended GP with more triangles. (Right): The Gain vs derivative plot for the extended GP.

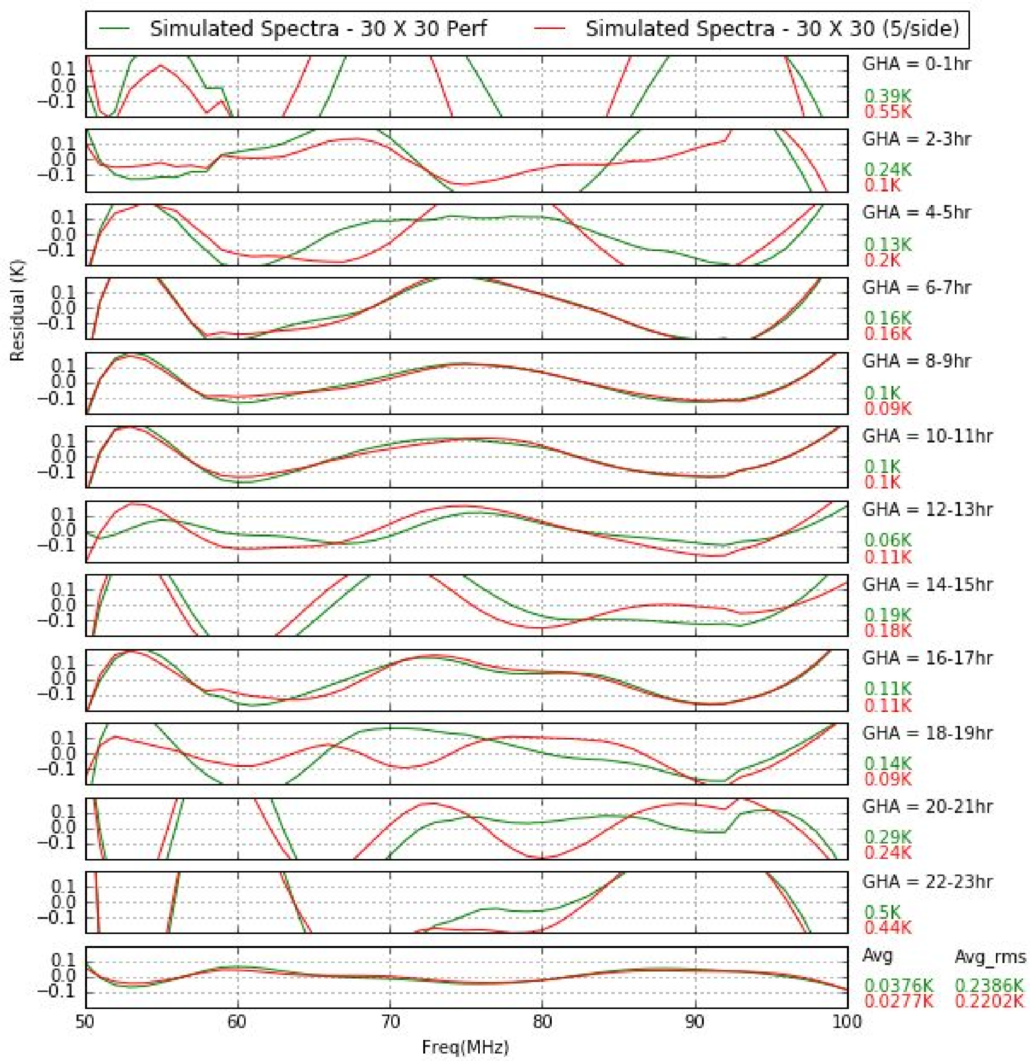

Fig8: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and the extended one with more triangles. The RMS of the averaged residues is almost the same. Adding more triangles helped a little.

5.) Hexagon - 5m edge (area < 10m x 10m) 65m^2 Vs 100m^2

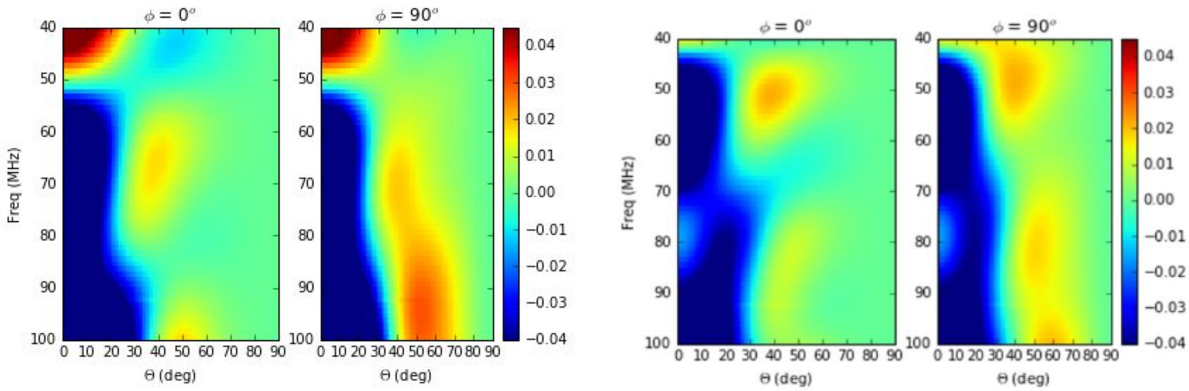

Fig9:(Left) Gain derivative Vs Frequency for a Hexagon shaped GP with edge side of 5m. (Right): The Gain vs derivative plot for 10m X 10m.

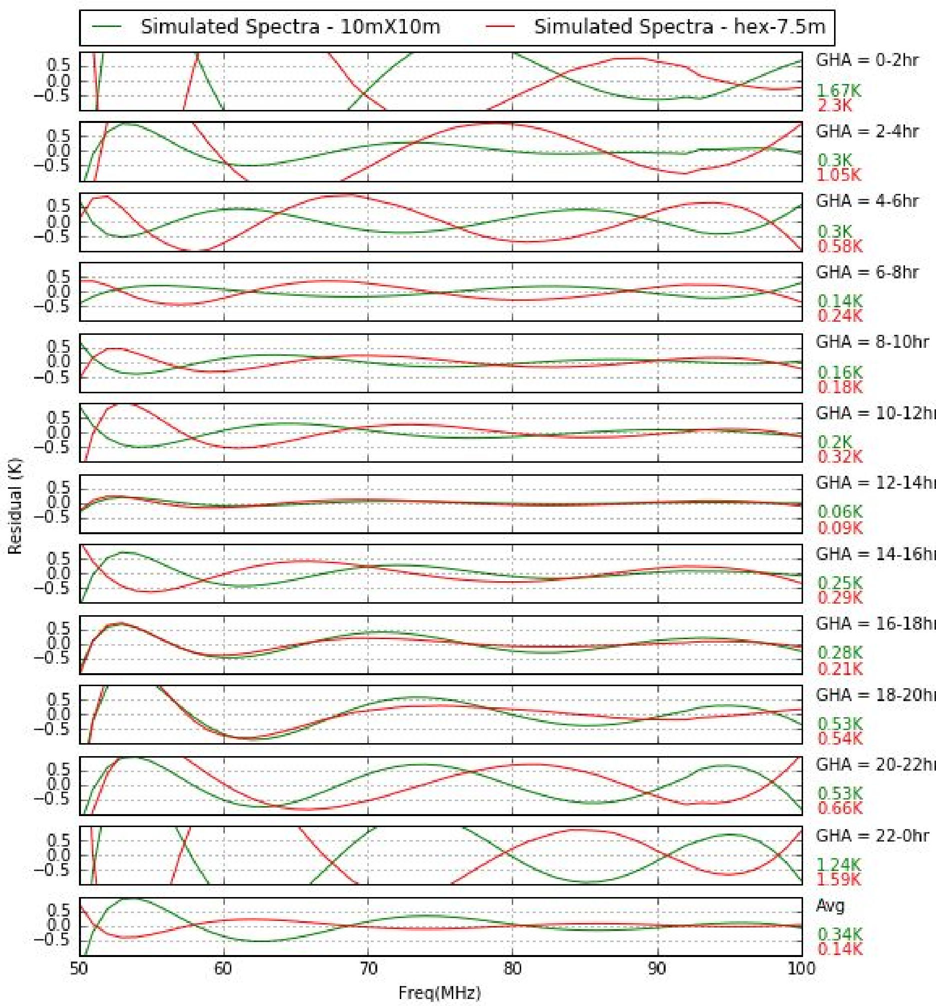

Fig10: Residues to a 5 term loglog foreground model Vs Frequency for the 10m X 10m GP and a hexagon (5m) GP. The RMS of the averaged residues is lower!. The hexagon GP covers roughly the lower area than the 10m X 10m!!.

6.) Hexagon - 7.5m edge (area > 10m x 10m) 146m^2 Vs ~100m^2

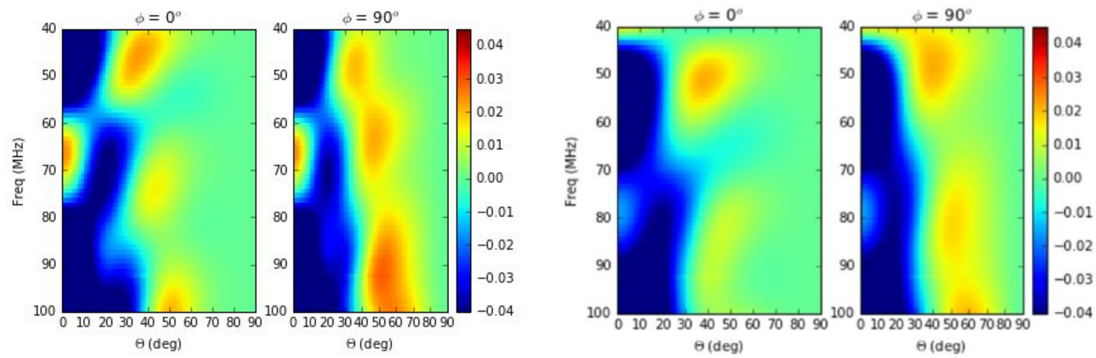

Fig11:(Left) Gain derivative Vs Frequency for a Hexagon shaped GP with edge side of 7.5m. (Right): The Gain vs derivative plot for the 10m X 10m GP.

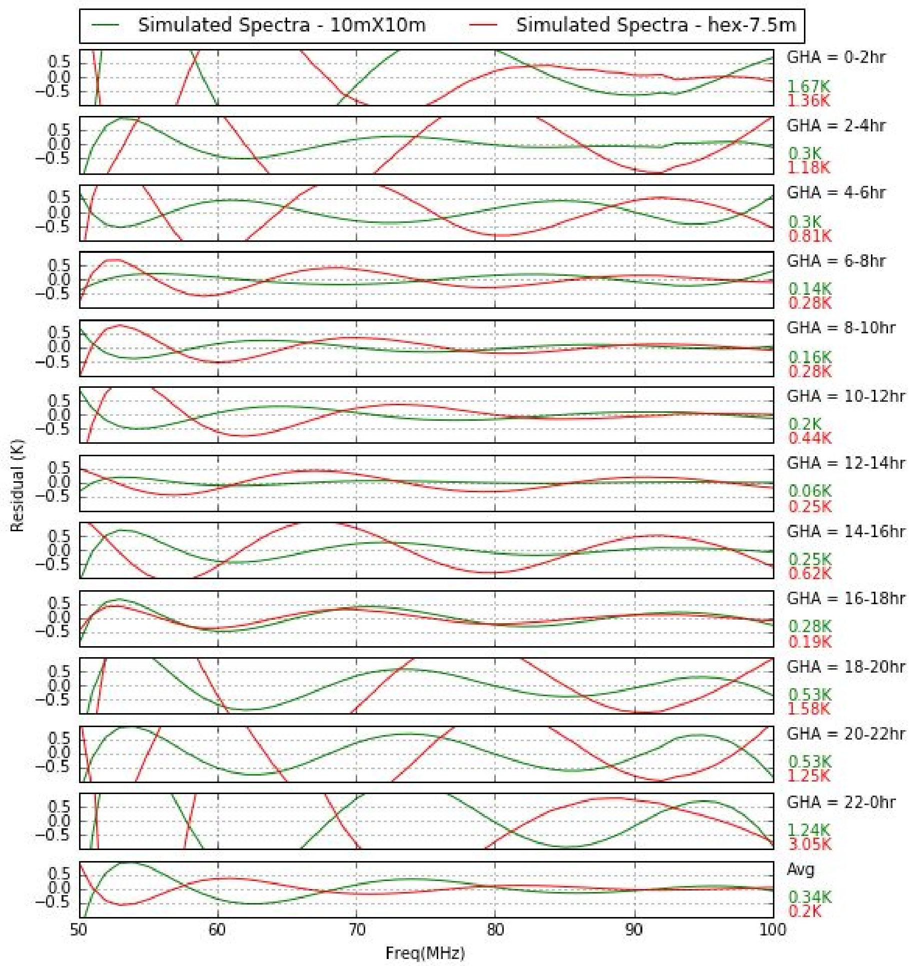

Fig12: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a hexagon (7.5m) GP. The RMS of the averaged residues is larger than the 10mX10m GP.

7.) Hexagon - 15m edge (area < 30m x 30m) 586m^2 Vs ~600m^2

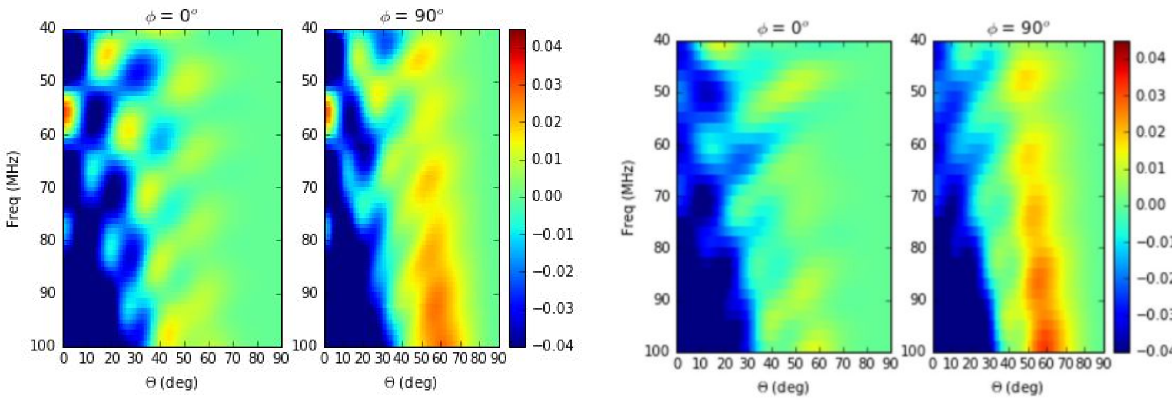

Fig13:(left) Gain derivative Vs Frequency for a Hexagon shaped GP with an edge side of 15m. (Right): The Gain vs derivative plot for the extended GP.

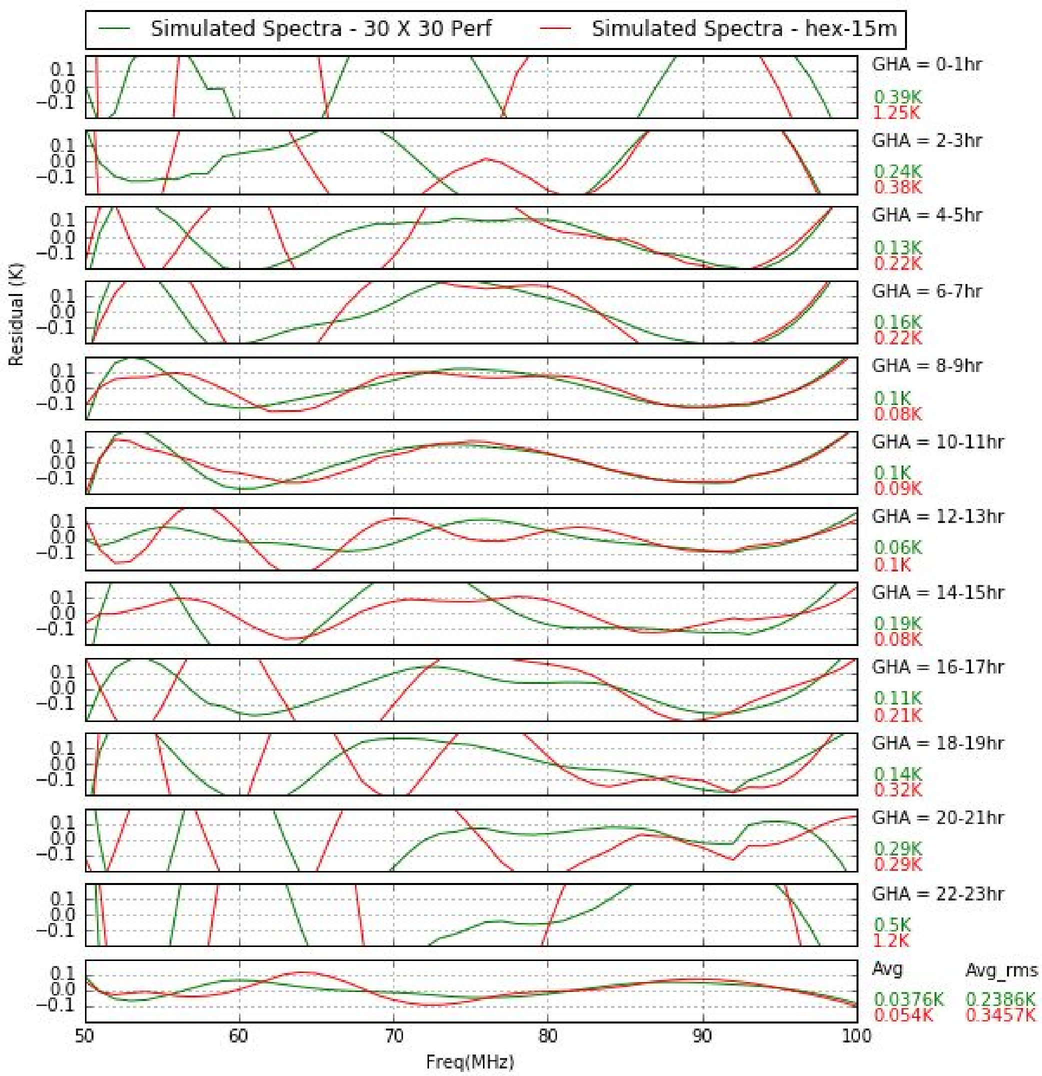

Fig14: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a hexagon (15m) GP. The RMS of the averaged residues is a little larger than the extended.

8.) Hexagon - 17m edge (area > 30m x 30m) 750m^2 Vs ~600m^2

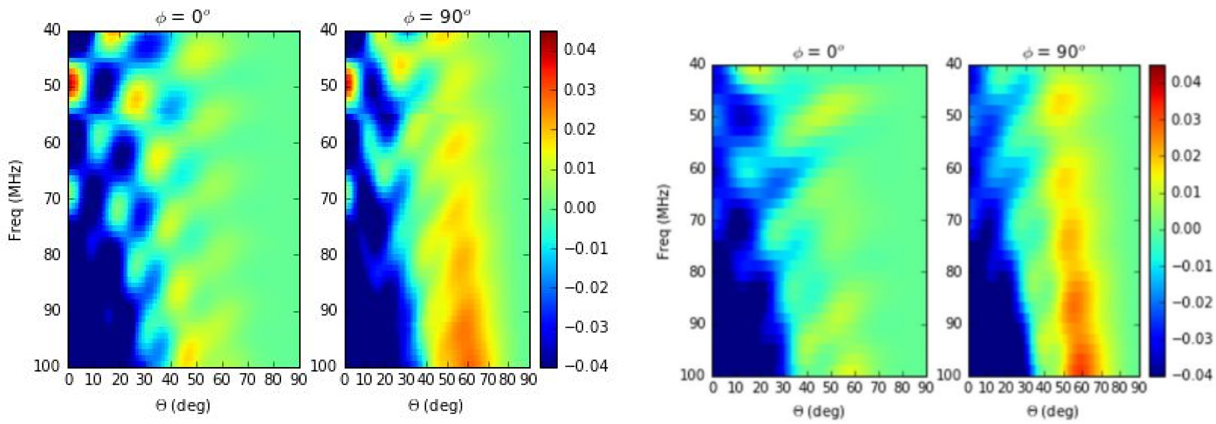

Fig15:(Left) Gain derivative Vs Frequency for a Hexagon shaped GP with edge side of 17 m. (Right): The Gain vs derivative plot for the extended GP.

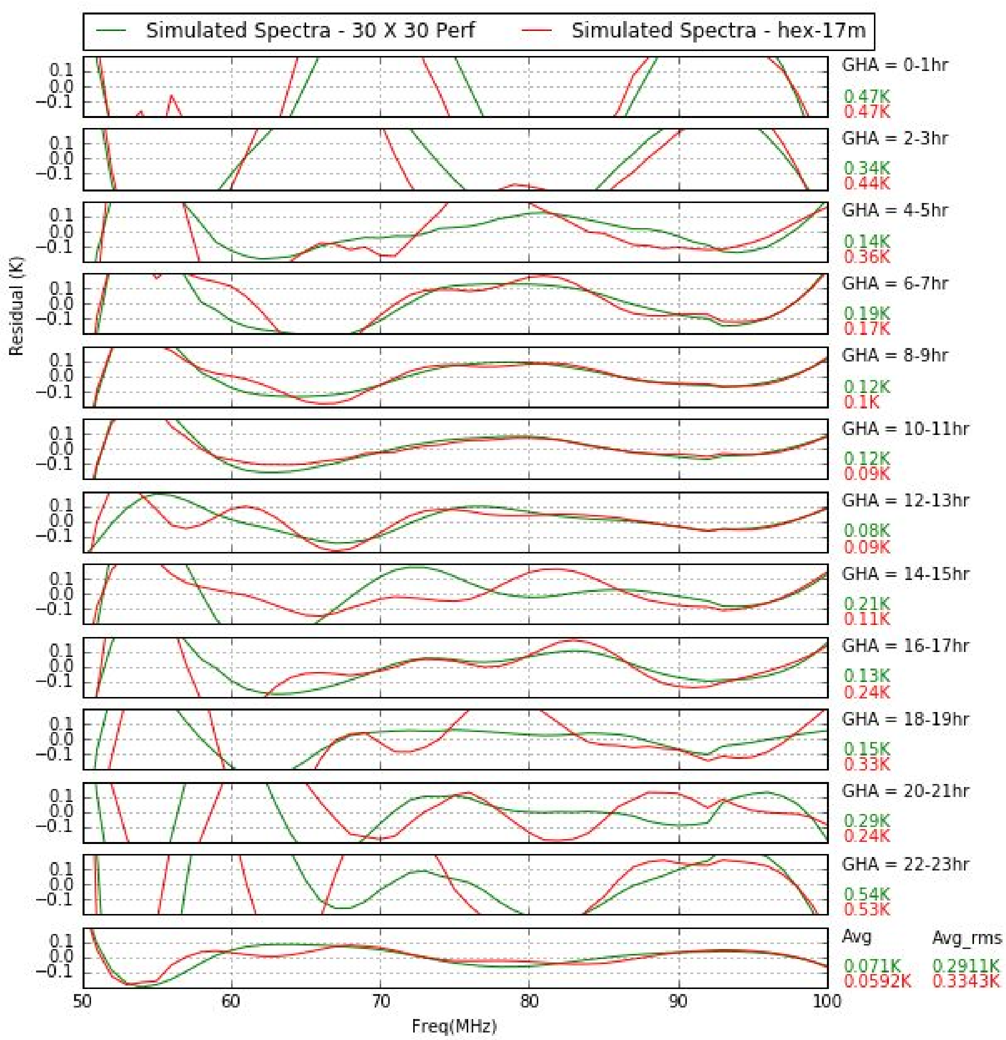

Fig16: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a hexagon (17m) GP. The RMS of the averaged residues of the hexagon is lower than the extended.

9.) Square - 50m side (area > 30m x 30m) 2500m^2 Vs ~600m^2

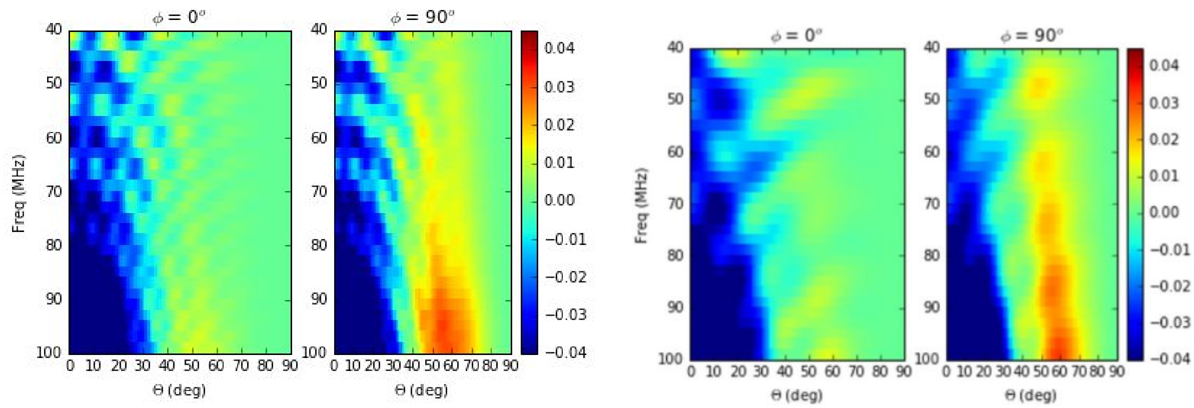

Fig17:(Right) Gain derivative Vs Frequency for a 50m X 50m square GP. (Left): The Gain vs derivative plot for the extended GP.

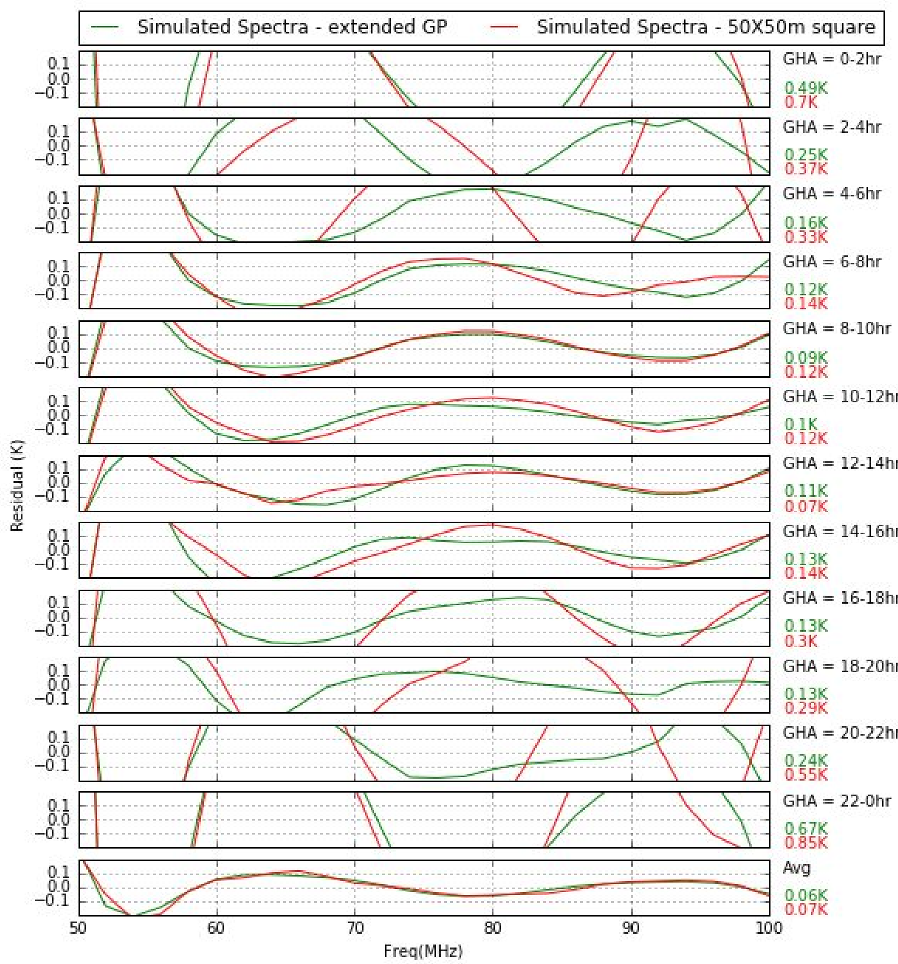

Fig18: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a square 50m X 50m GP. The RMS of the two are roughly the same

10.) Perforated- 40m (6triangles/side) (area > 30m x 30m) 2500m^2 Vs ~600m^2

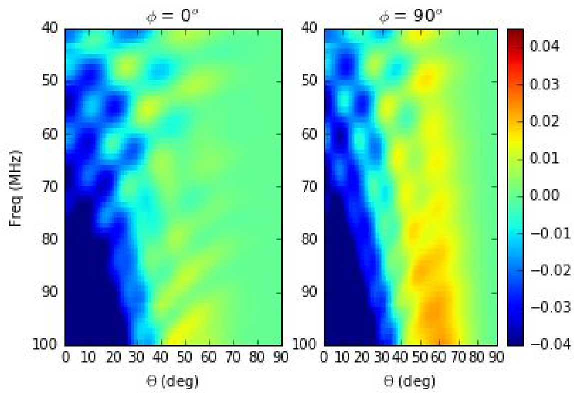

Fig19:Gain derivative Vs Frequency for a perforated 40m X 40m.

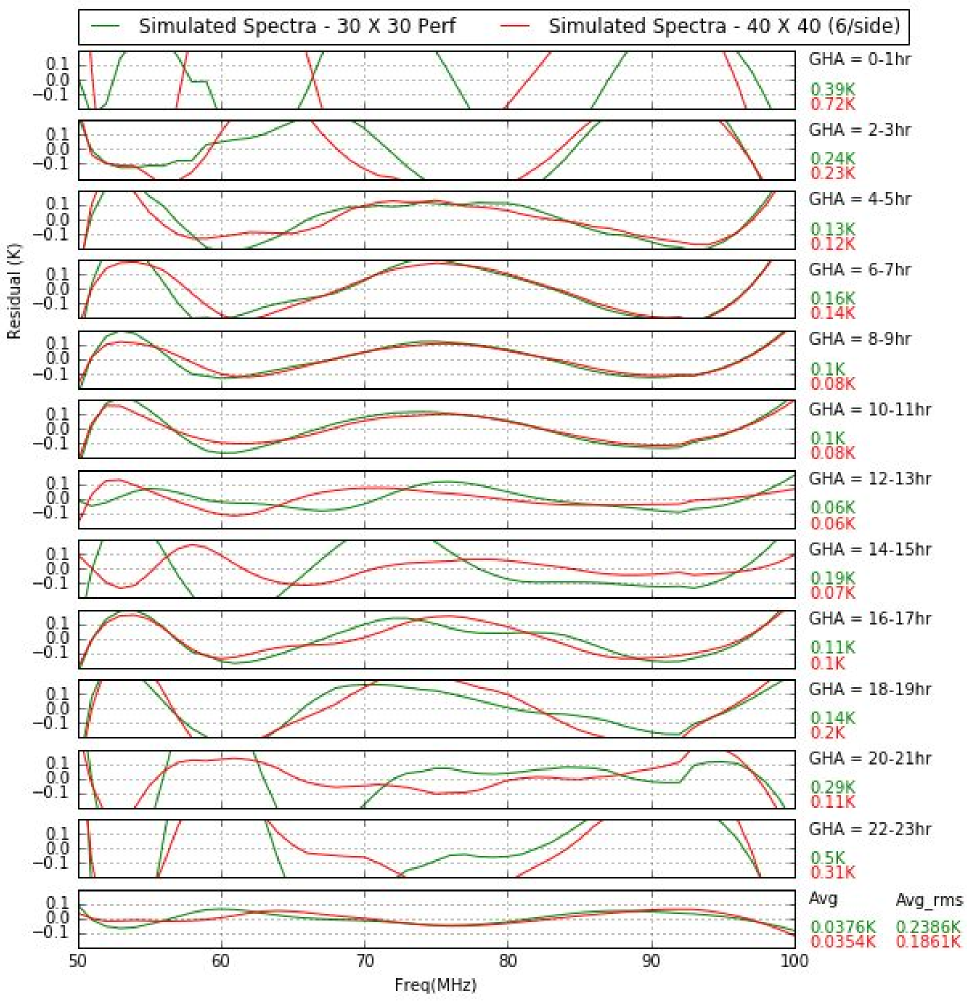

Fig20: Residues to a 5 term loglog foreground model Vs Frequency for the extended GP and a perforated 40m X 40m GP. The RMS of the two are roughly the same.

11.) Staggered - 7by7 (area ~ 30m x 30m) 700m^2 Vs ~600m^2

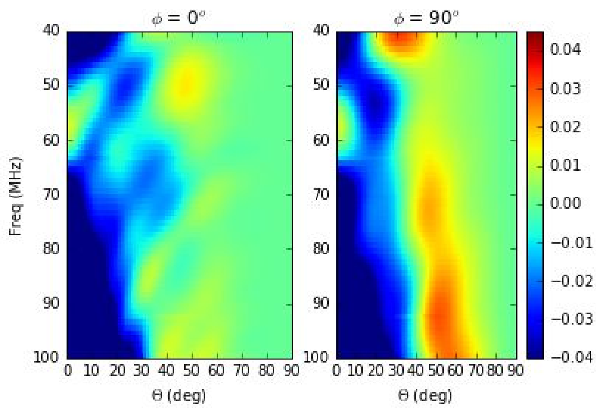

Fig21: Gain derivative Vs Frequency for a Staggered GP with 7 titles and 7 rows.

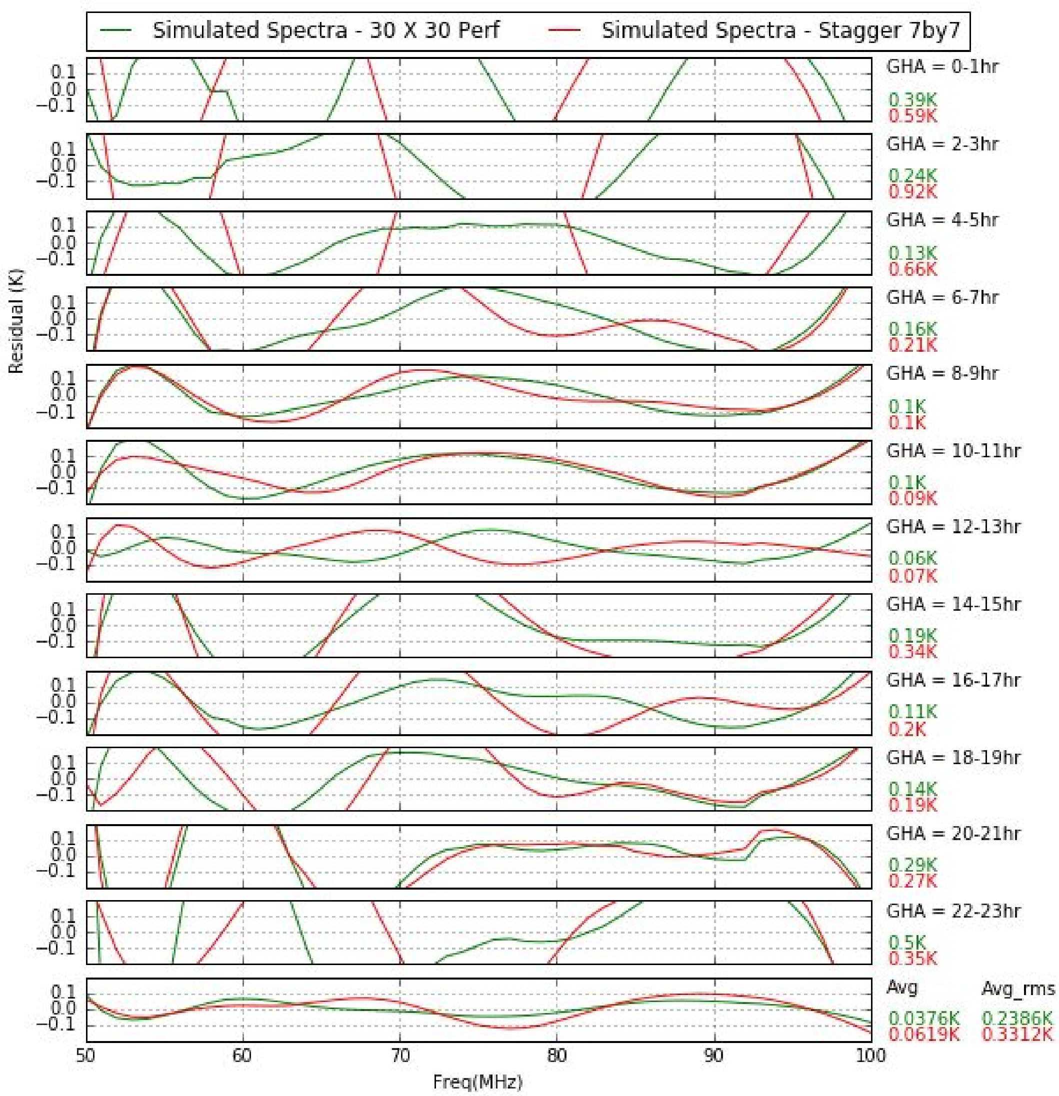

Fig22: Residues to a 5 term linlog foreground model Vs Frequency for the extended GP and a staggered 7by 7 GP.

12.) Staggered - 8 by 9 (area < 40m x 40m) 900m^2 Vs ~1200m^2

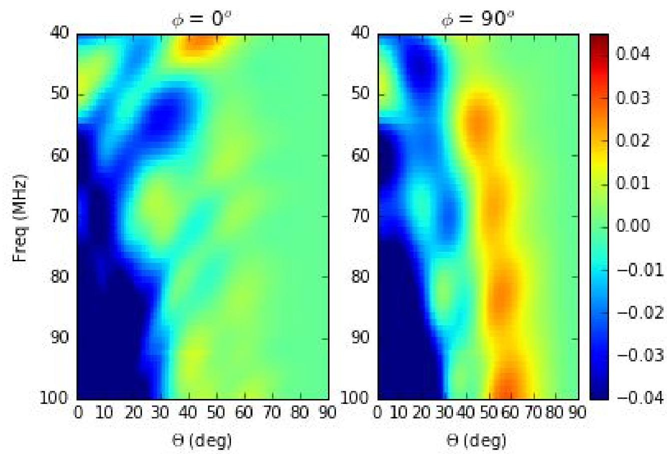

Fig23: Gain derivative Vs Frequency for a Staggered GP with 8 titles and 9 rows.

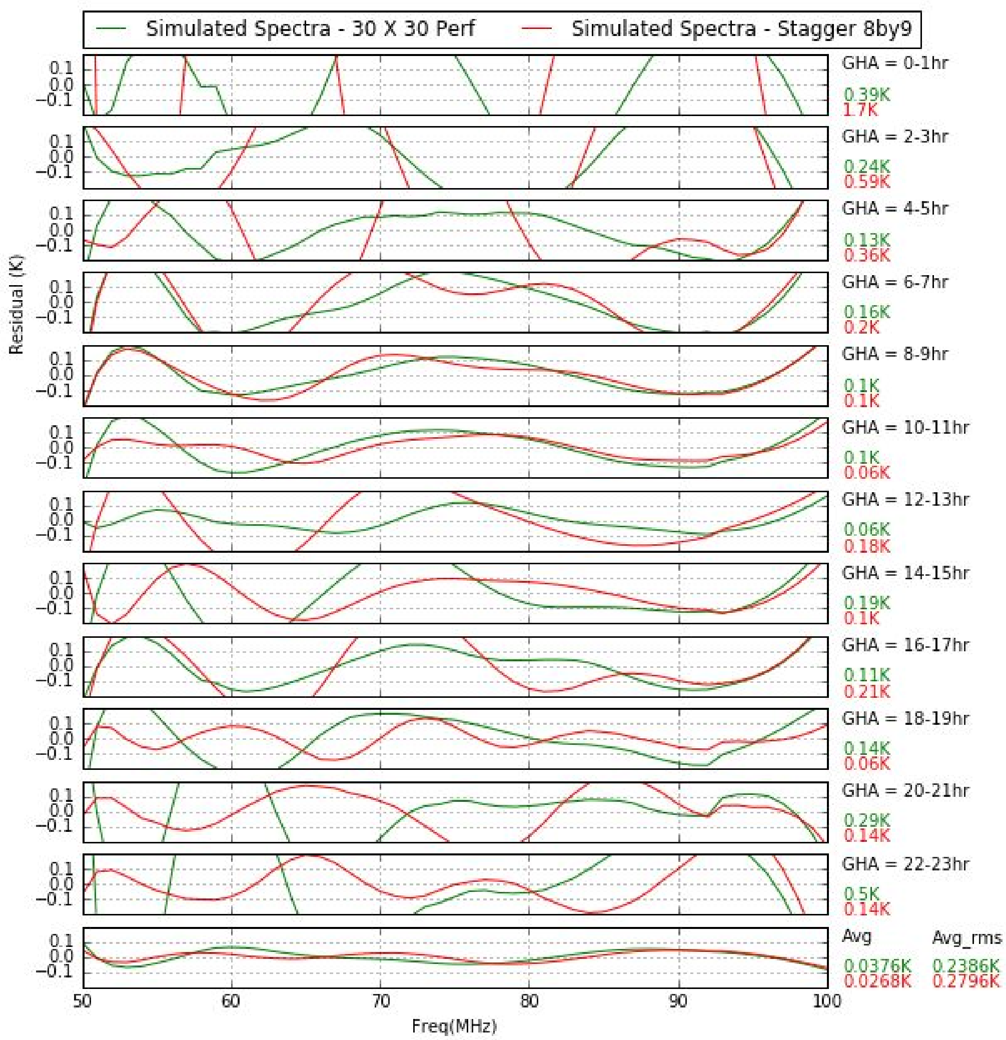

Fig24: Residues to a 5 term linlog foreground model Vs Frequency for the extended GP and a staggered 8 by 9 GP.

13.) Staggered - 7 by 9 (area < 40m x 40m) 787m^2 Vs <1200m^2

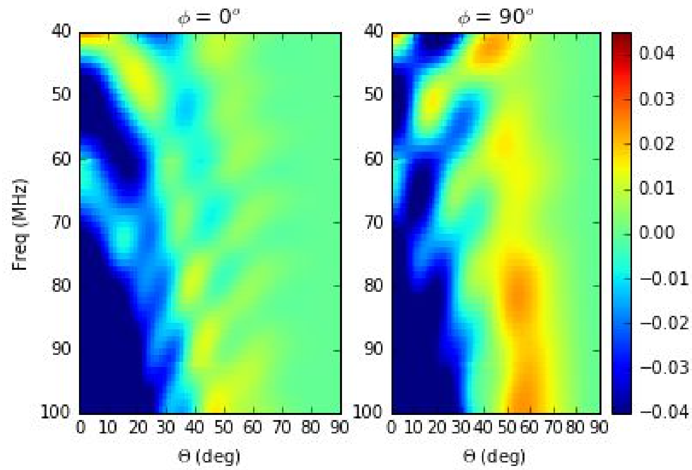

Fig25: Gain derivative Vs Frequency for a Staggered GP with 7 titles and 9 rows.

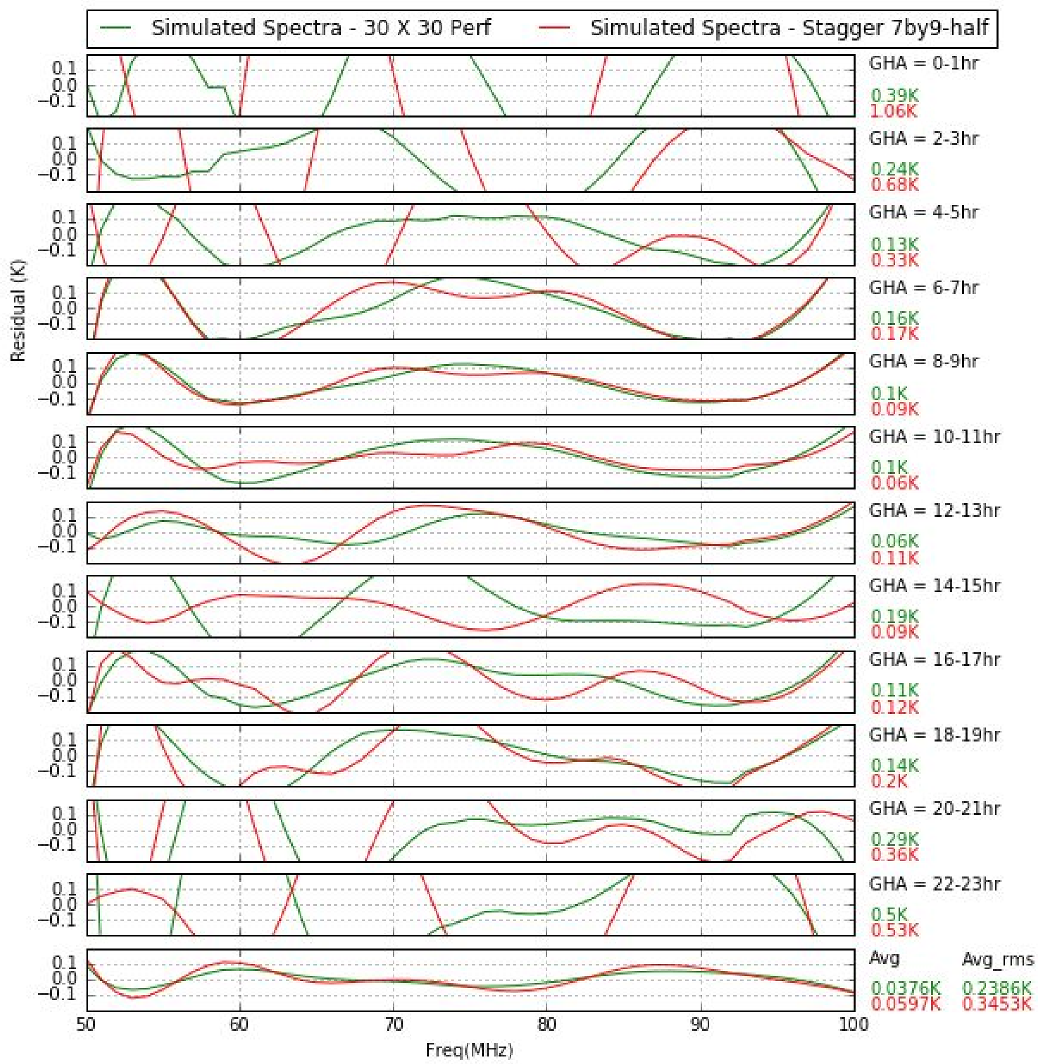

Fig26: Residues to a 5 term linlog foreground model Vs Frequency for the extended GP and a staggered 7 by 9 GP. The RMS of the two are roughly the same.

14.) Perforated 49.2 X 49.2 m (3 triangles/side) - inner square of 30m X 30m and triangles of 10m base and 9.6 m height

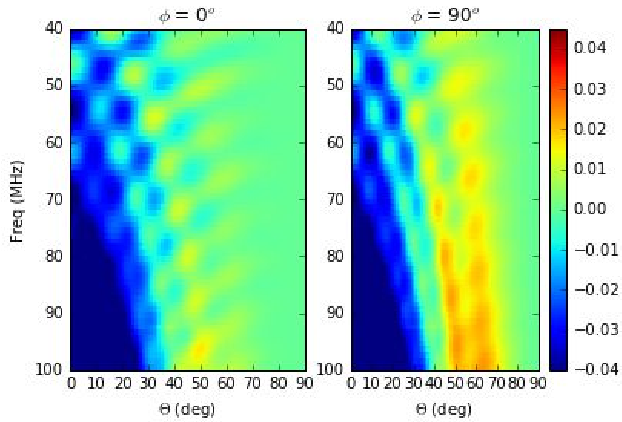

Fig27: Gain derivative Vs Frequency for a perforated ground with a central 30 X 30m and 3 triangles on each side of height 9.6m and base 10m .

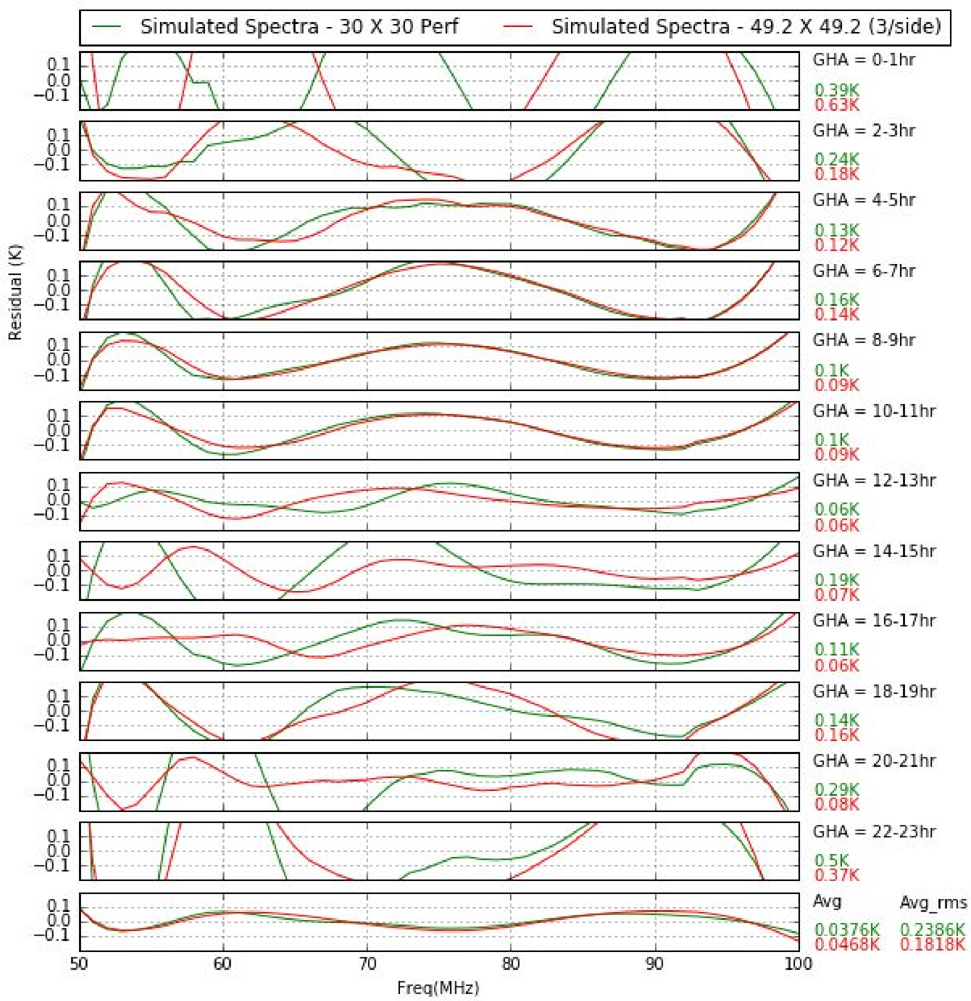

Fig28: Residues to a 5 term linlog foreground model Vs Frequency for the extended GP and a perforated 48.6 X 48.6 m. The RMS of the two are roughly the same.

15.) Perforated 49.2 X 49.2 m (3 triangles/side) - inner square of 30m X 30m and triangles of 10m base and 9.6 m height

Soil conductivity changed from 0.02S/m to 0.002S/m. And the simulation frequency from 50 to 100MHz to 60 to 120 MHz. The size is slightly different from memo 317.

One side of Inner square = ***2m + 6*5m = 32m***

2nd side of inner square = ***2m + 12*2.4m = 30.8 m***

If the triangles are 9.6 m tall on each side, the extents are = ***50m X 51.2,m ?***

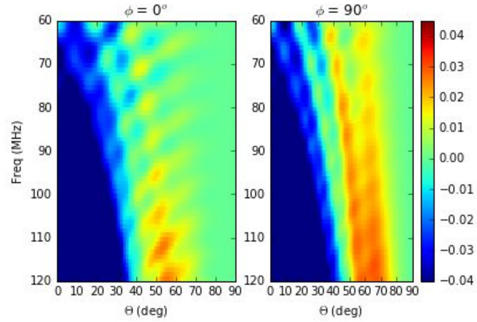

Fig29: Gain derivative Vs Frequency for a perforated ground with a central 30 X 30m and 3 triangles on each side of height 9.6m and base 10m with soil conductivity being 0.002S/m

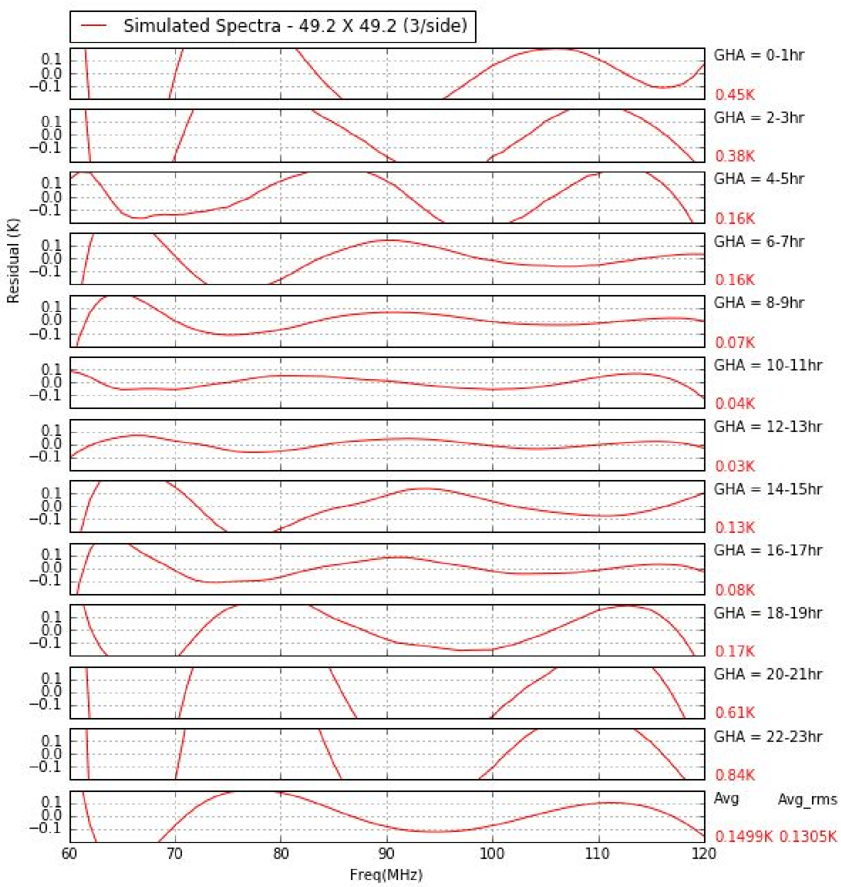

Fig30: Residues to a 5 term linlog foreground model Vs Frequency for the perforated 49.2 X 49.2m.

15.) Perforated 48.8 X 48.8m (3 triangles/side) - inner square of 30m X 30m and triangles of 9.6m base and 10 m height (replicating the case in memo 317)

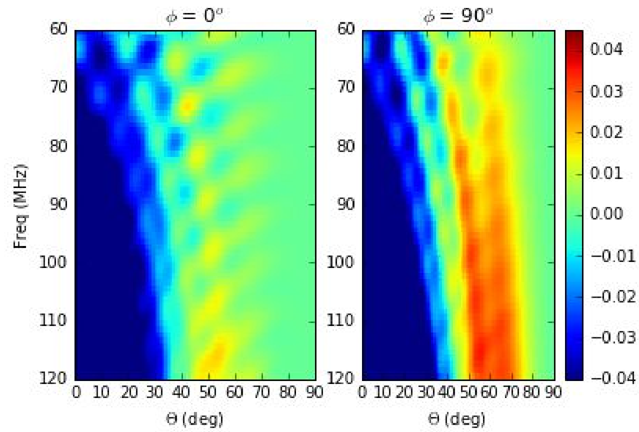

Fig31: Gain derivative Vs Frequency for a perforated ground with a central 30 X 30m and 3 triangles on each side of height 9.6m and base 10m with soil conductivity being 0.002S/m

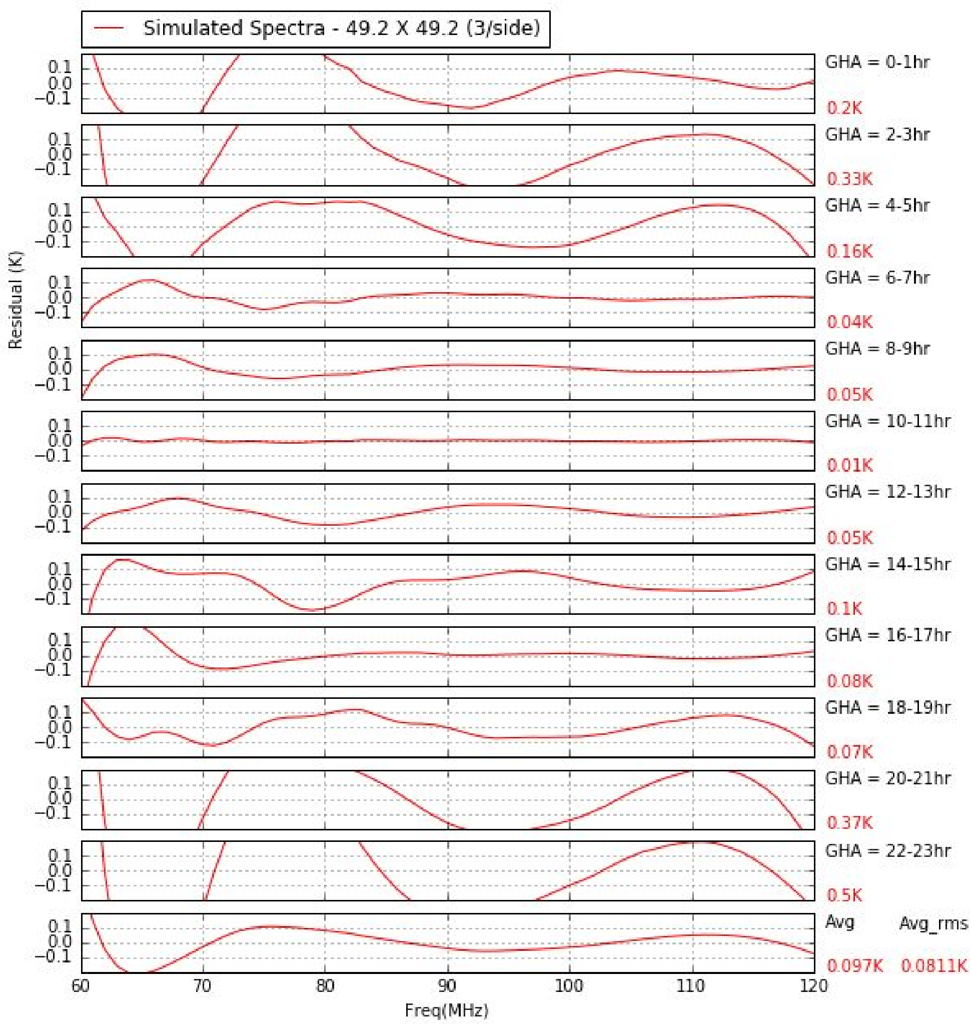

Fig32: Residues to a 5 term linlog foreground model Vs Frequency for the perforated 48.8 X 48.8m