Redundancy Cal. in phased arrays stations

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Introduction & Motivation

A very short introduction:

$$c_{ij}^{obs} = c_{ij}^{true} g_i g_j^* g_{ij} + c_{ij} + e_{ij}$$

$$c_{ij}^{obs} = c_{ij}^{true} g_i g_j^* g_{ij} + e_{ij}$$

$$c_{ij}^{obs} = c_{ij}^{true} g_i g_j^* g_{ij} (1 + \frac{e_{ij}}{c_{ij}^{true} g_i g_j^* g_{ij}})$$

$$\ln c_{ij}^{obs} = \eta_i + \eta_j + i(\varphi_j - \varphi_i) + \ln c_{ij}^{true} + \ln(g_{ij}) + \ln(1 + \frac{e_{ij}}{c_{ij}^{true} g_i g_j^* g_{ij}})$$

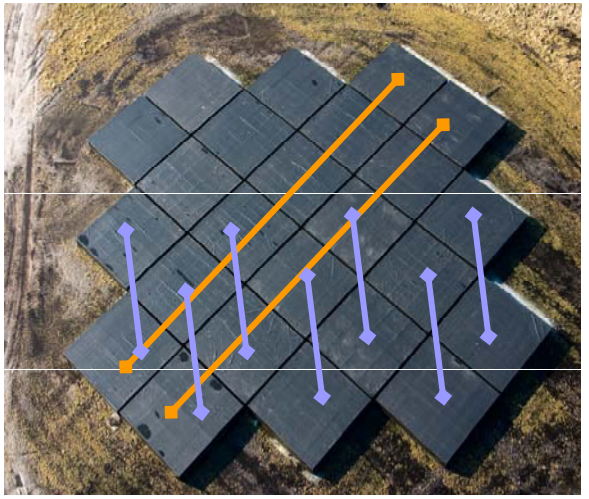
$$\ln c_{ij}^{obs} = \eta_i + \eta_j + r_{ij}^{true}$$

$$\psi_{ij}^{obs} = \varphi_j - \varphi_i + \psi_{ij}^{true}$$

$$\Sigma \eta_i = 0$$

$$\Sigma_{i=1}^{p} \varphi_i x_i = 0$$

$$\Sigma_{j=1}^{p} \varphi_j y_j = 0$$



J.E. Noordam & A.G. de Bruyn, Nature, 14 October 1982

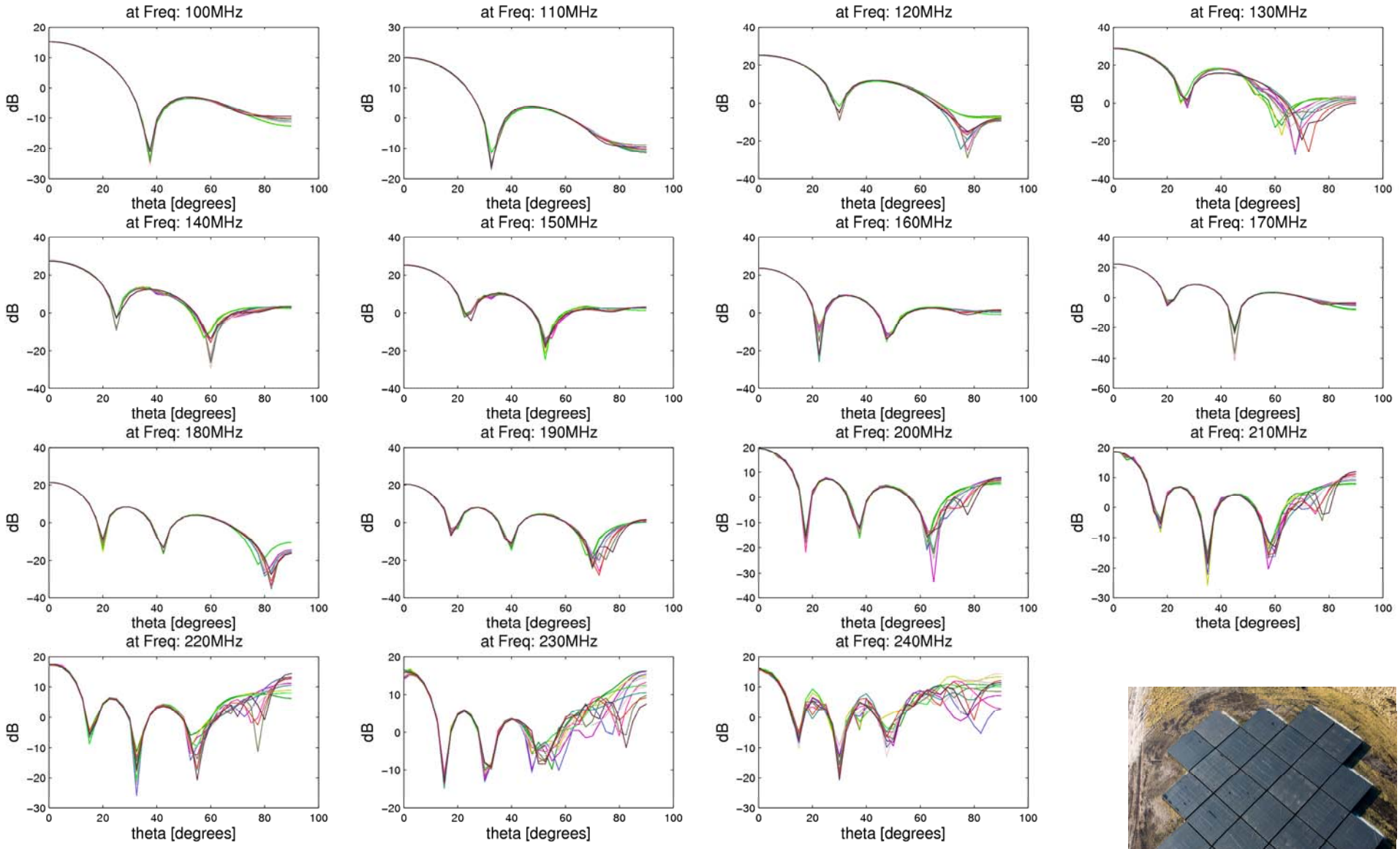
M. Wieringa, Ph.D. thesis, Leiden Univ., 1991

Motivations:

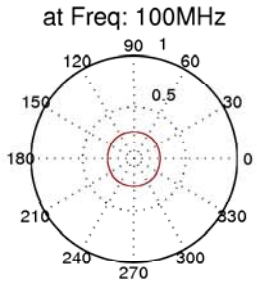
- Redundancy cal. is independent of sky model,
- It is computationally cheap and fast,
- Less sensitive to RFI as compared to the model-based cal.,
- Regular arrangement in the phased array stations e.g. HBA, EMBRACE, provides plenty of redundant baselines.

Redundancy in HBA

Tiles' power pattern at the el. of 90 (looking at the zenith)



CAESAR: Computationally Advanced and Efficient Simulator for ARrays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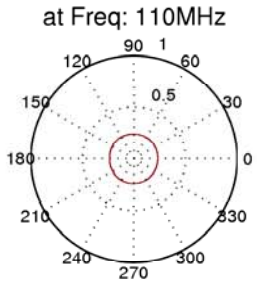
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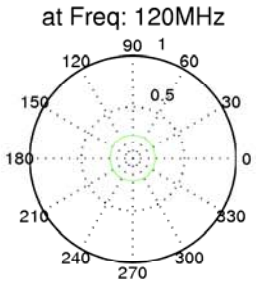
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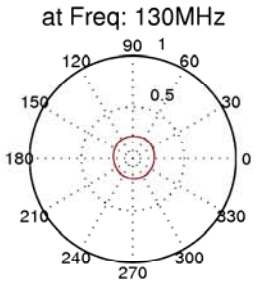
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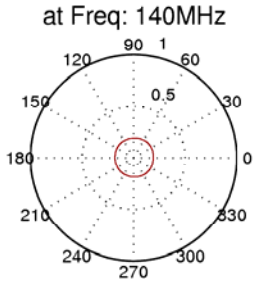
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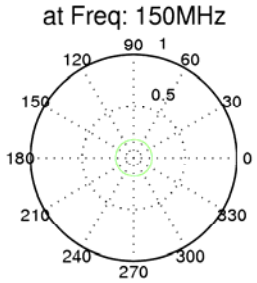
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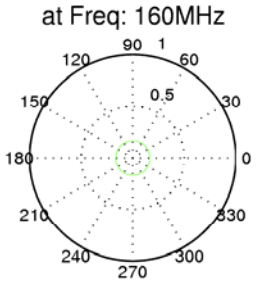
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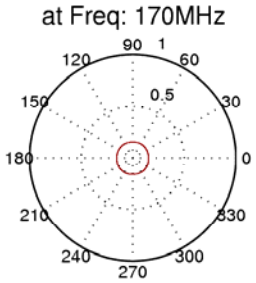
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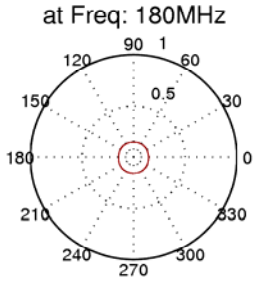
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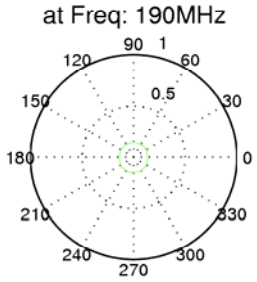
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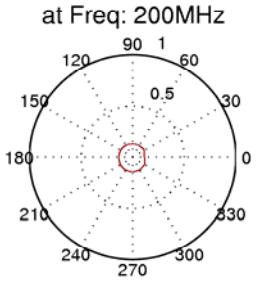
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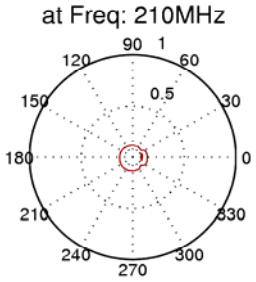
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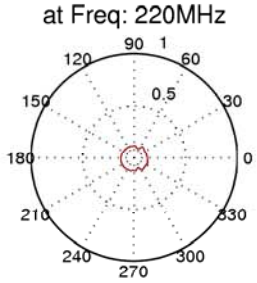
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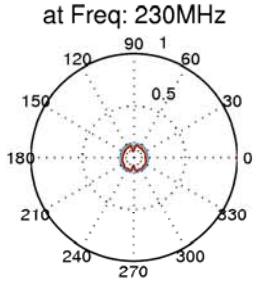
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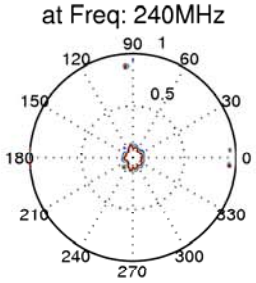
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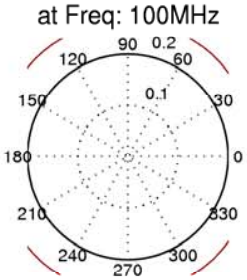
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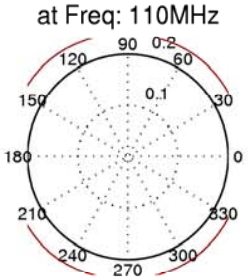
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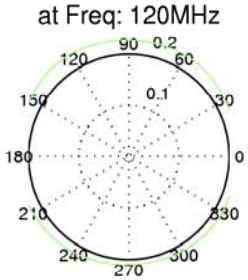
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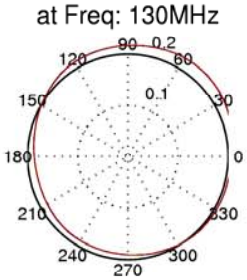
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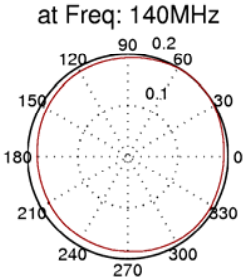
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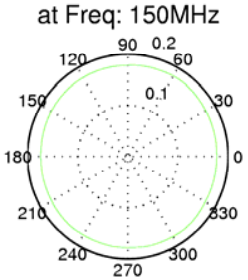
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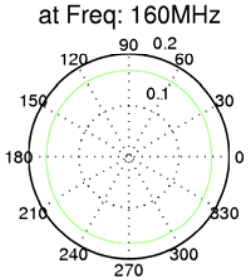
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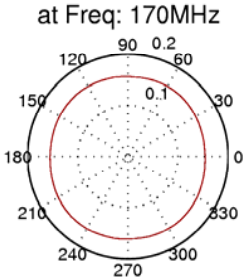
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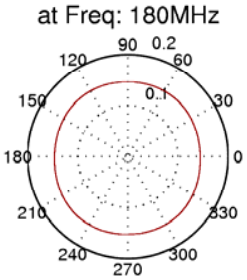
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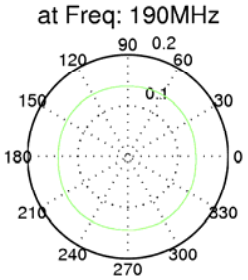
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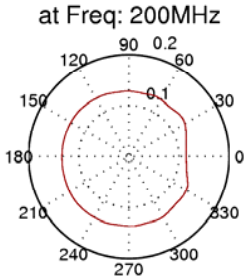
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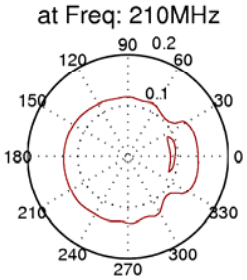
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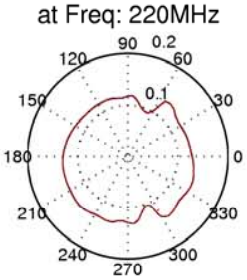
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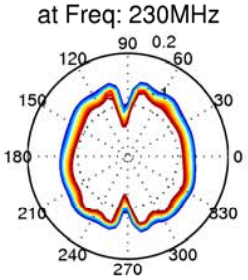
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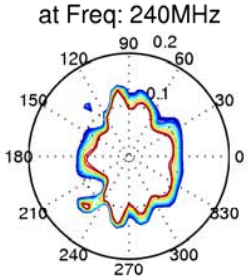
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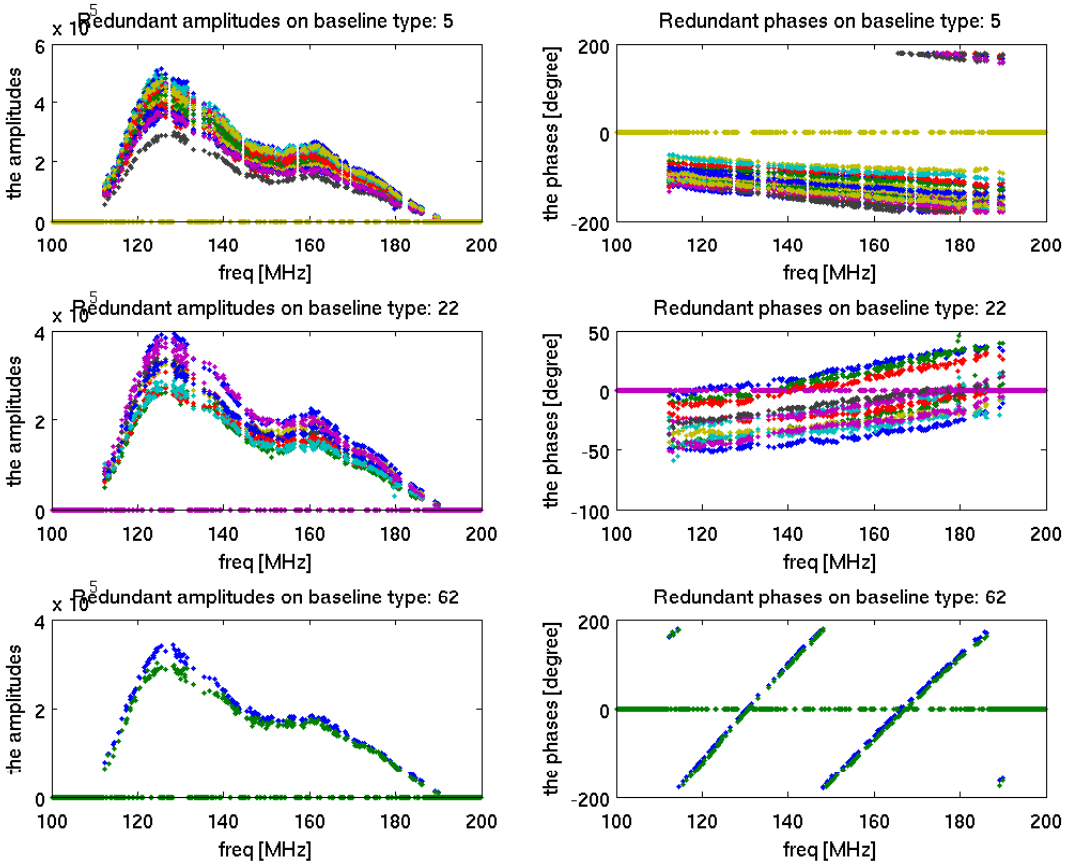
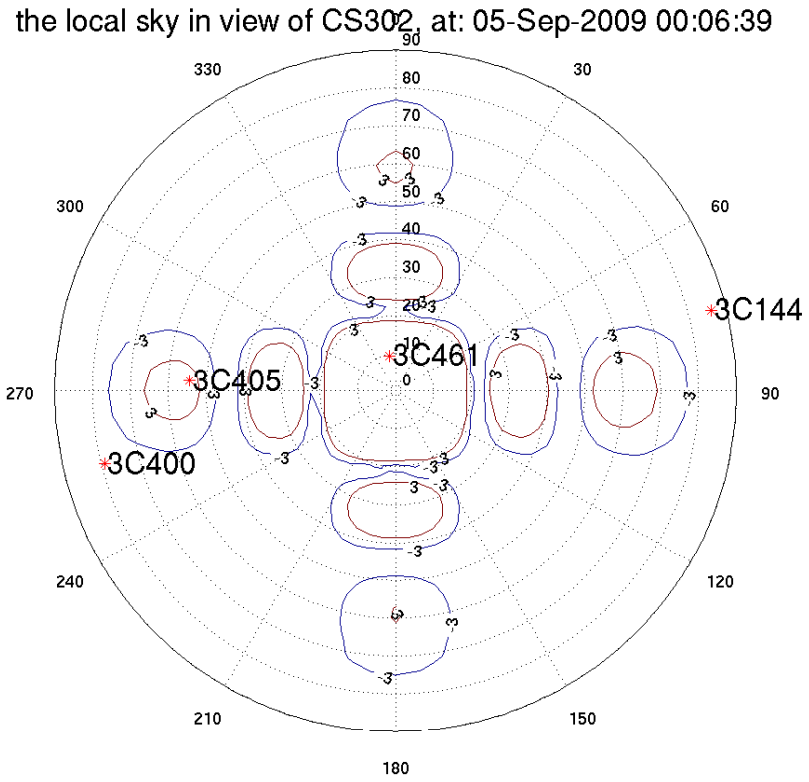
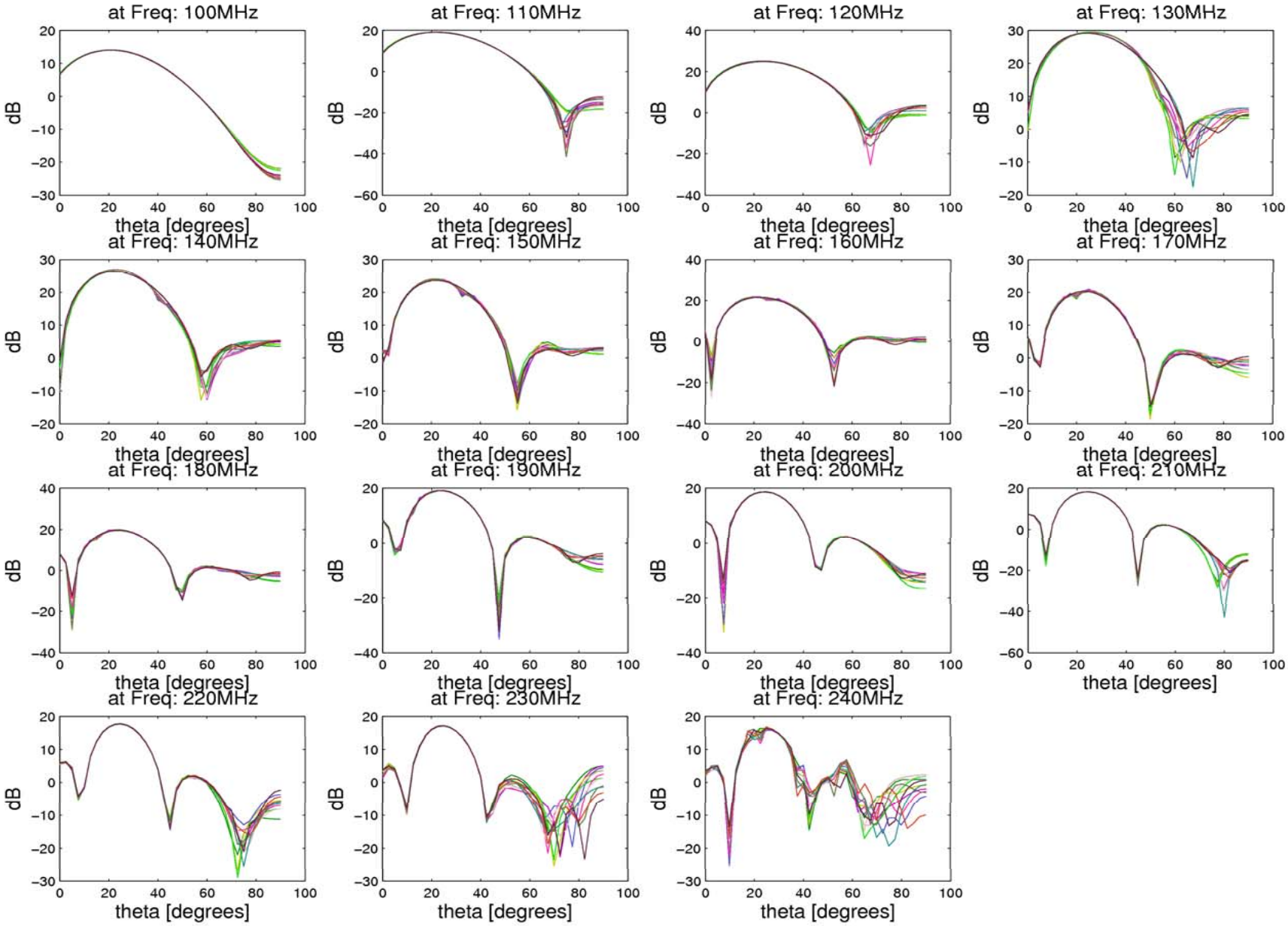
Redundancy monitoring: 24h observation at CS302, the beam is formed at the zenith.

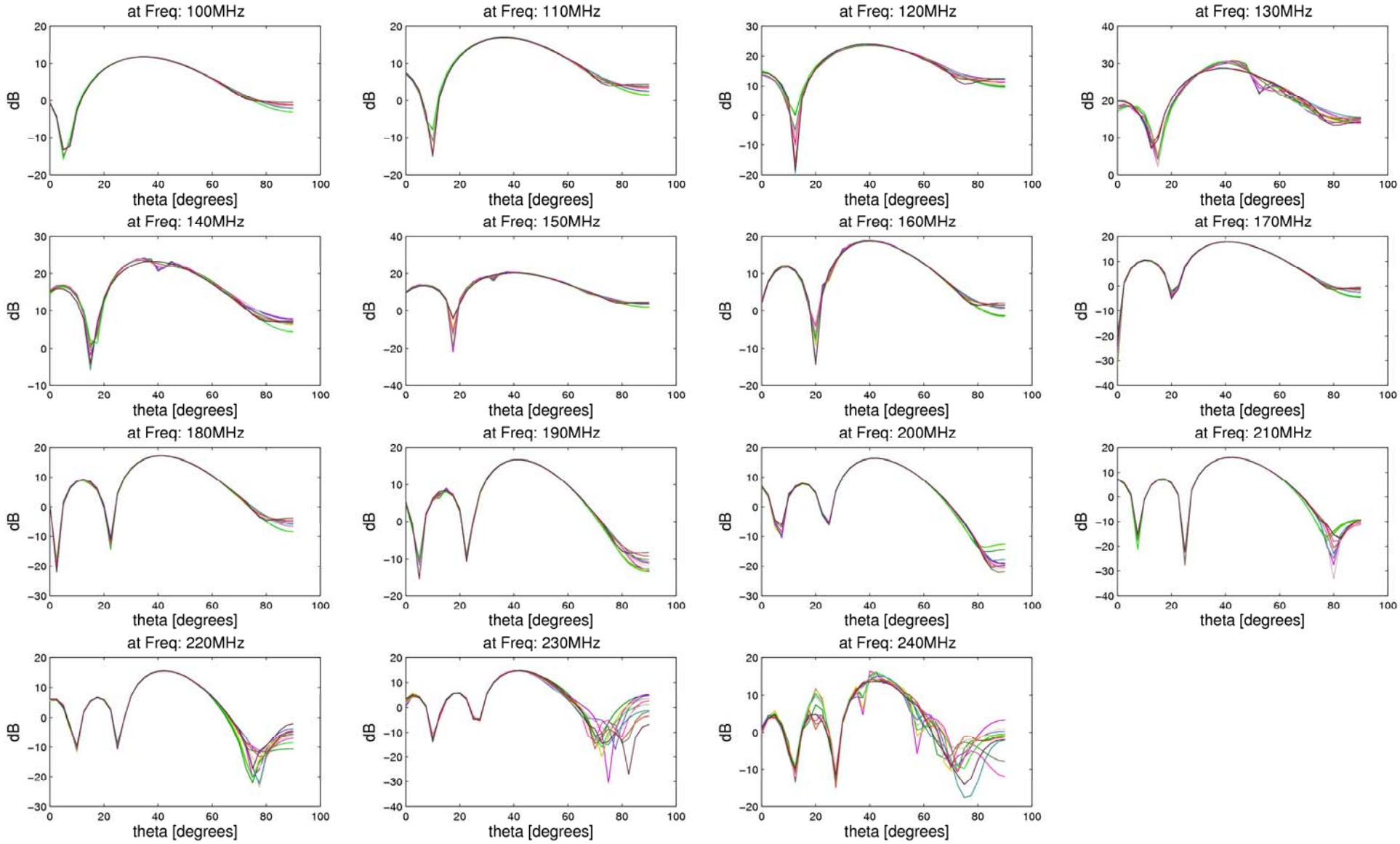




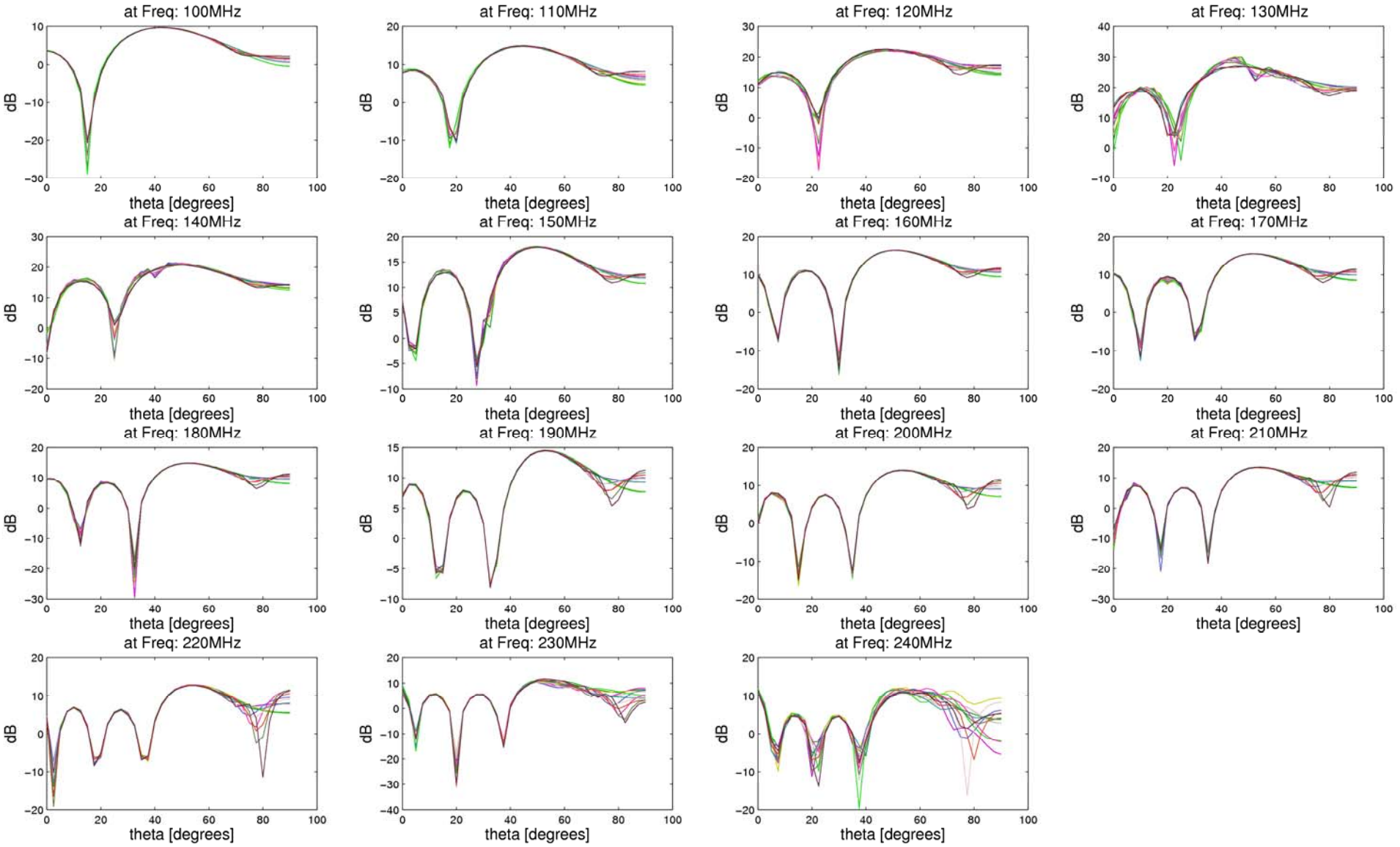
Tiles' power pattern at the el. of 65



Tiles' power pattern at the el. of 45

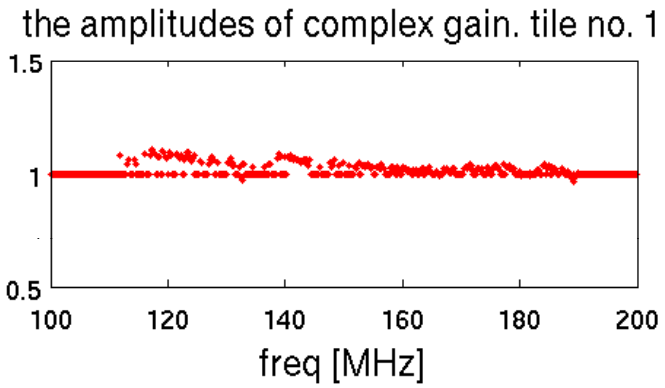


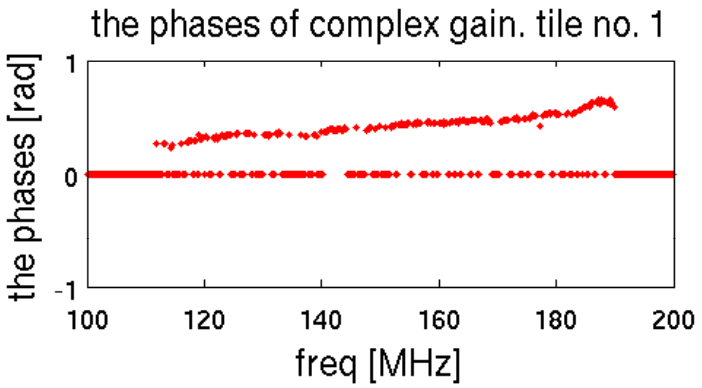
Tiles' power pattern at the el. of 30

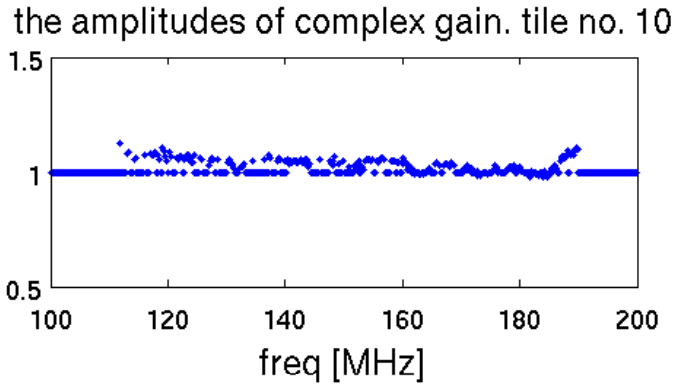


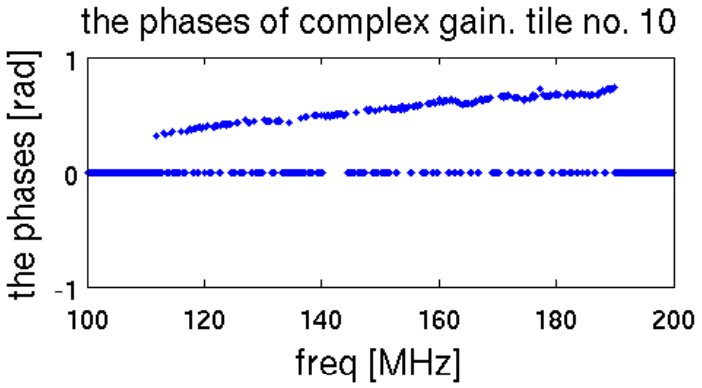
Redundancy cal. quality

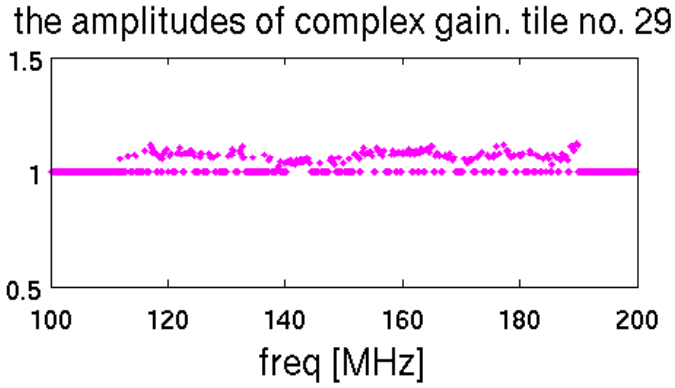
Observation time of: 24-Nov-2009 15:25:43

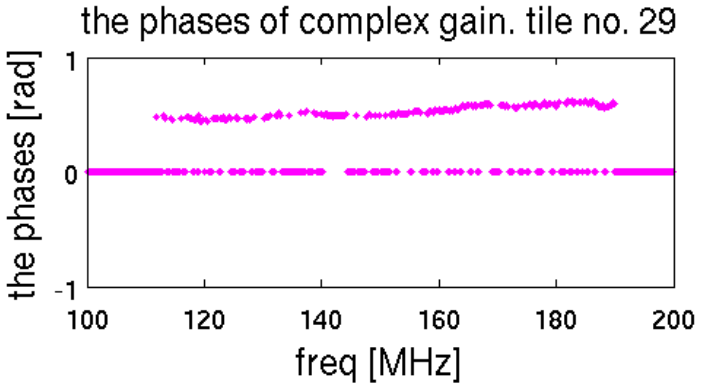












Summary and Conclusion

- Redundancy assumption holds for HBAs during a large fraction of times of observation although with different levels of SNR.
- For the lower SNR, we can go for longer than 1 sec/subband. integration time.
- When redundancy assumption holds for HBAs, its calibration algorithm works well.
- Mutual coupling and solution for it:
  - Measure it and disentangle it from the data from the beginning.
  - Solve for its contributing factors using the solutions from the best case scenario.