HBA station calibration

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Dwingeloo, 9 December 2009

Calibration hierarchy

S.J. Wijnholds et al., IEEE SPM, January 2010, in press

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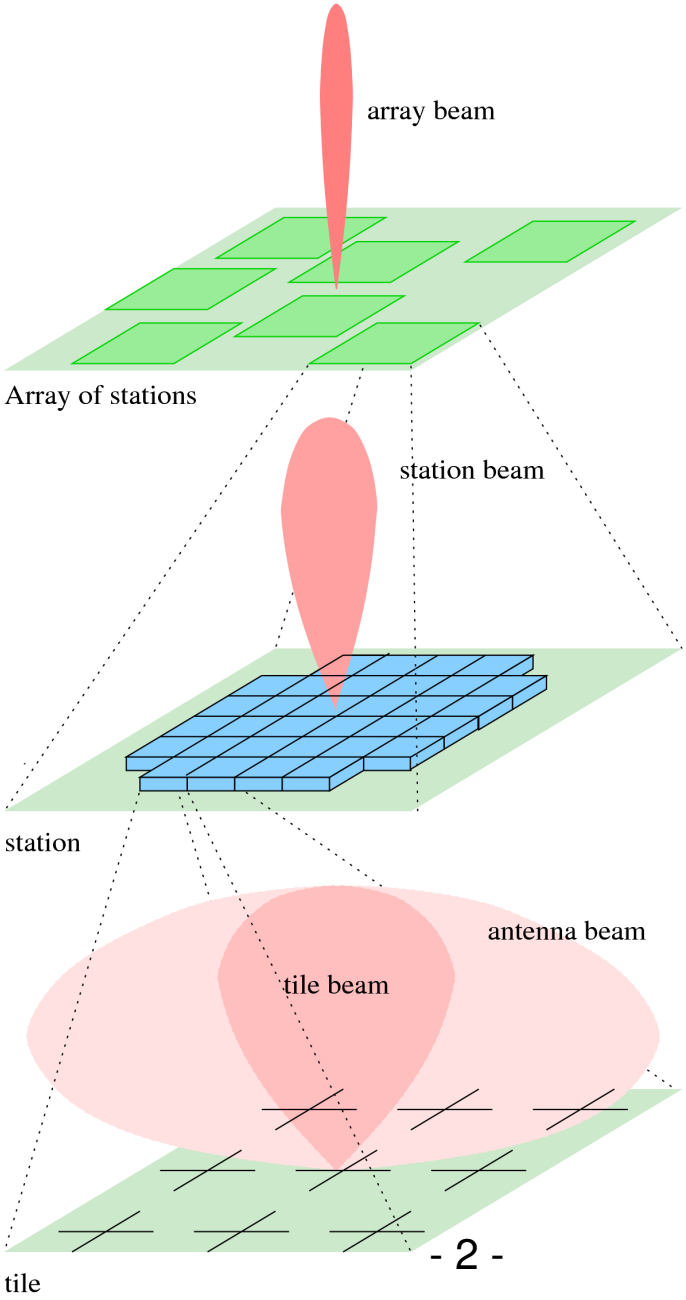
Three levels

- characterization of the tiles
  - currently: single delay table
  - future upgrade: table per tile
- **station calibration**
  - topic of this presentation
- array calibration
  - selfcal at CEP



Redundancy calibration

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

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

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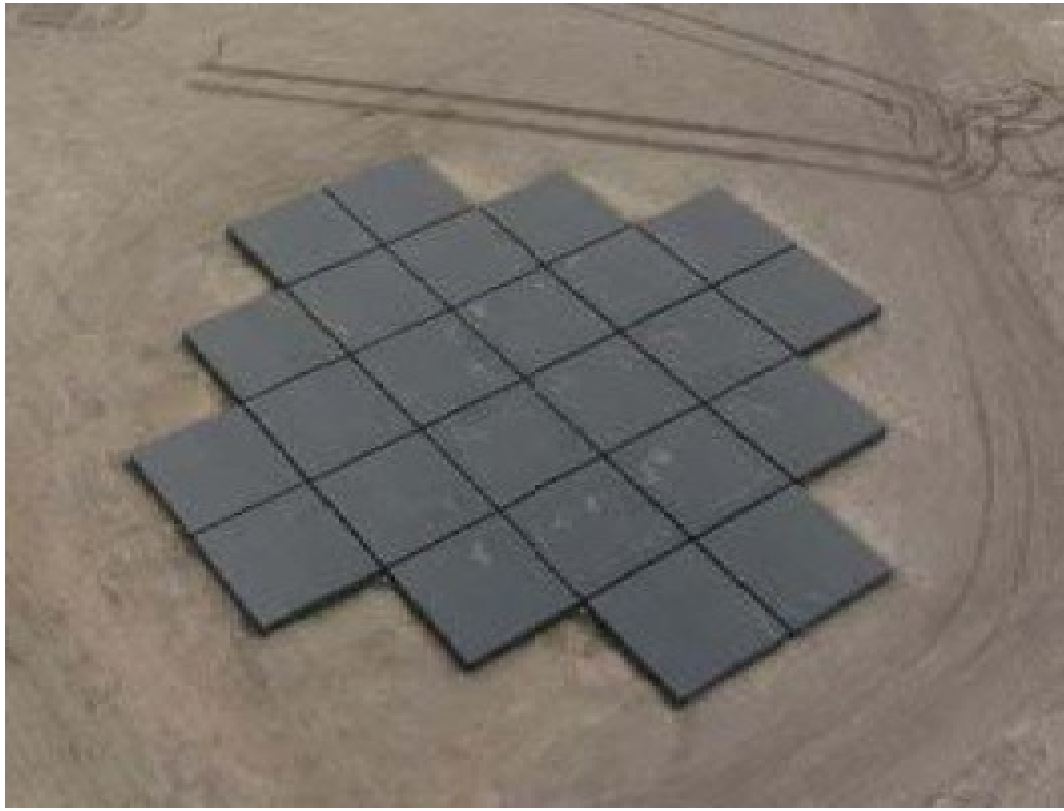
Redundant baselines measure the same visibilities

- **Therefore**

$$V_{ij} = g_i g_j V_{0k} + n_{ij}$$

for all (*i, j*) that form

redundant baseline *k*



- **Implementation**
  - Take logarithm
  - real part: amplitude calibration (linear equation!)
  - imag. part: phase calibration (linear equation!)

Feasibility study

P. Noorishad, SKADS-conference, Limelette, 4-6 Nov 2009

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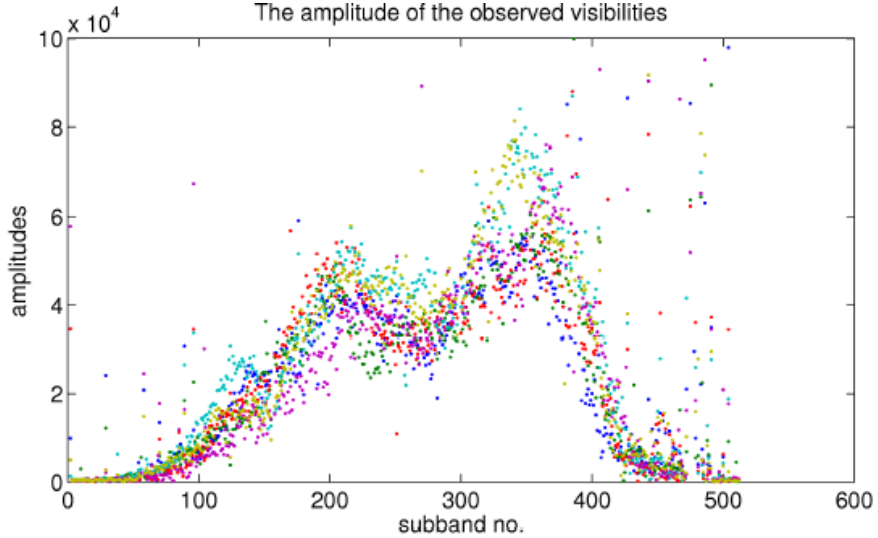
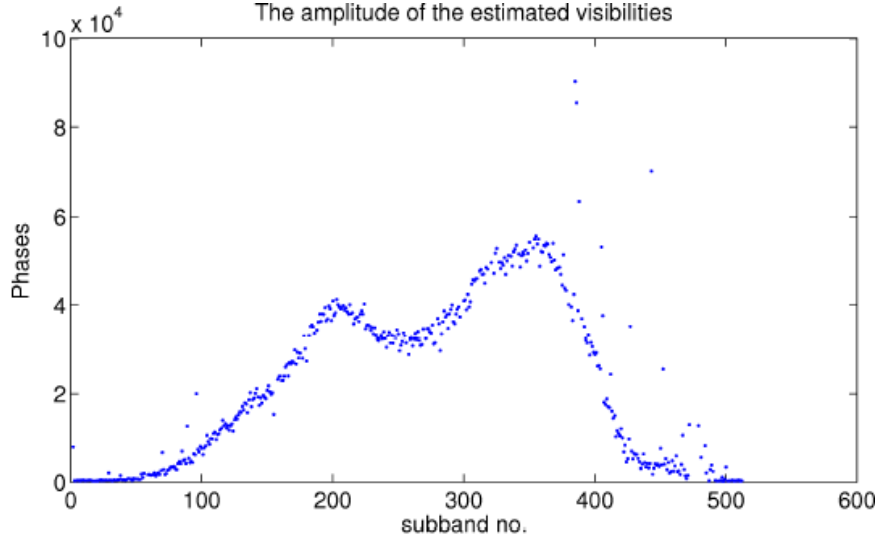
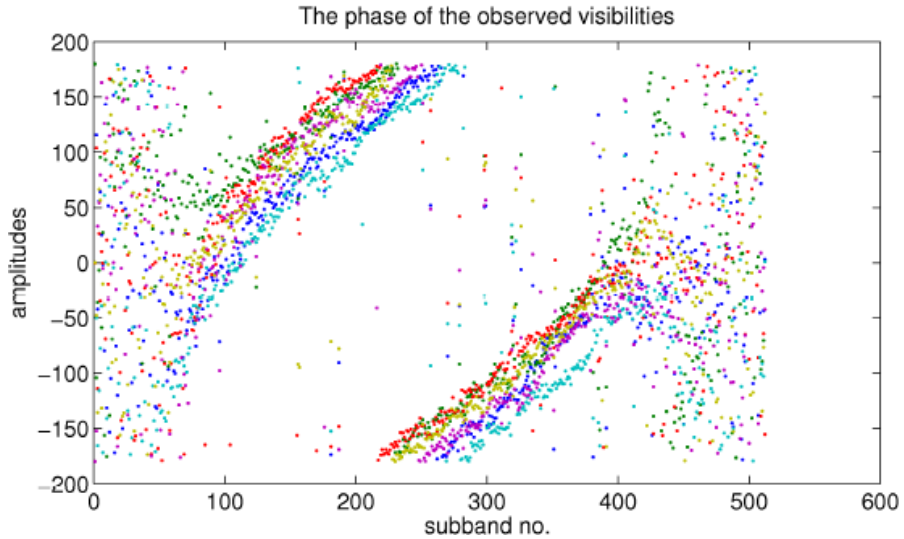
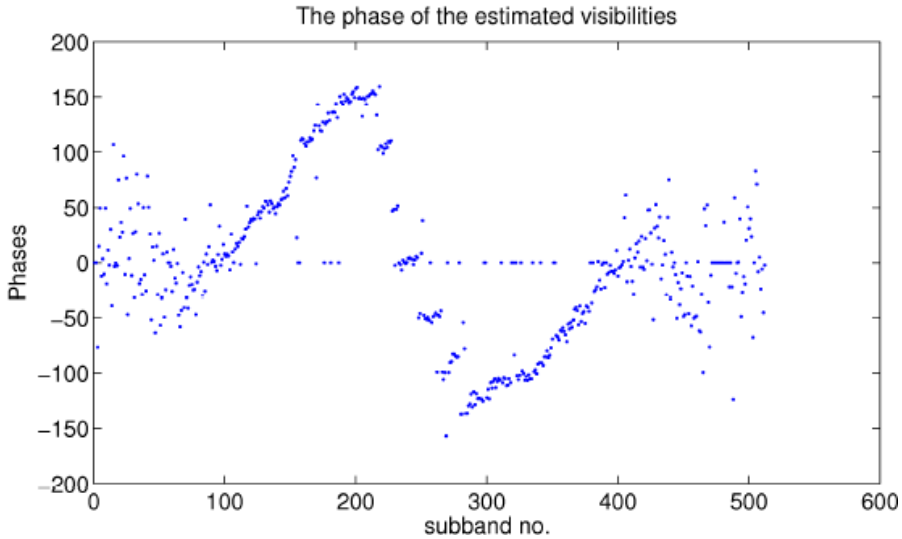




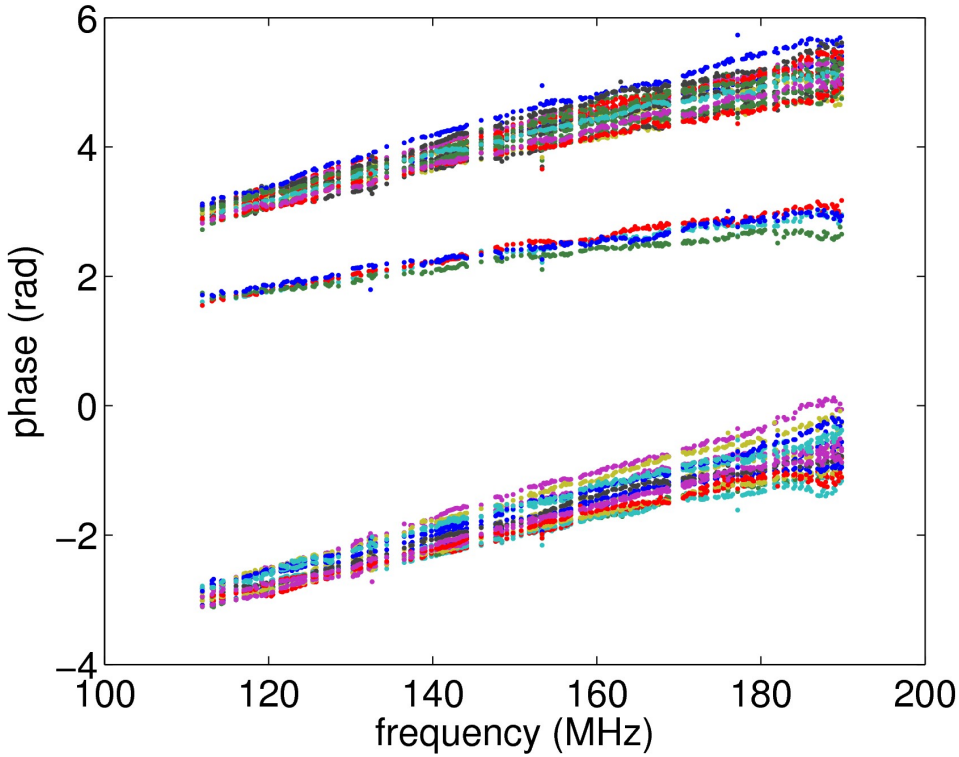




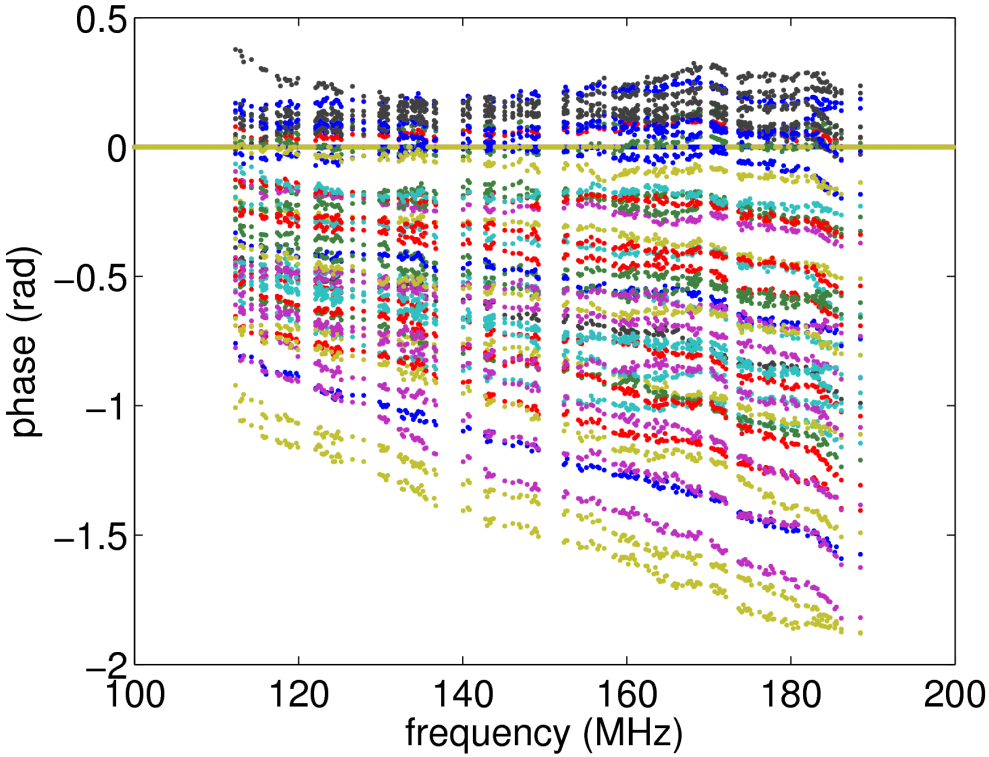
Phase ambiguities (1)

First unwrap per baseline, then correct offsets

redundant visibilities



phase solutions first iteration



Phase ambiguities (2)

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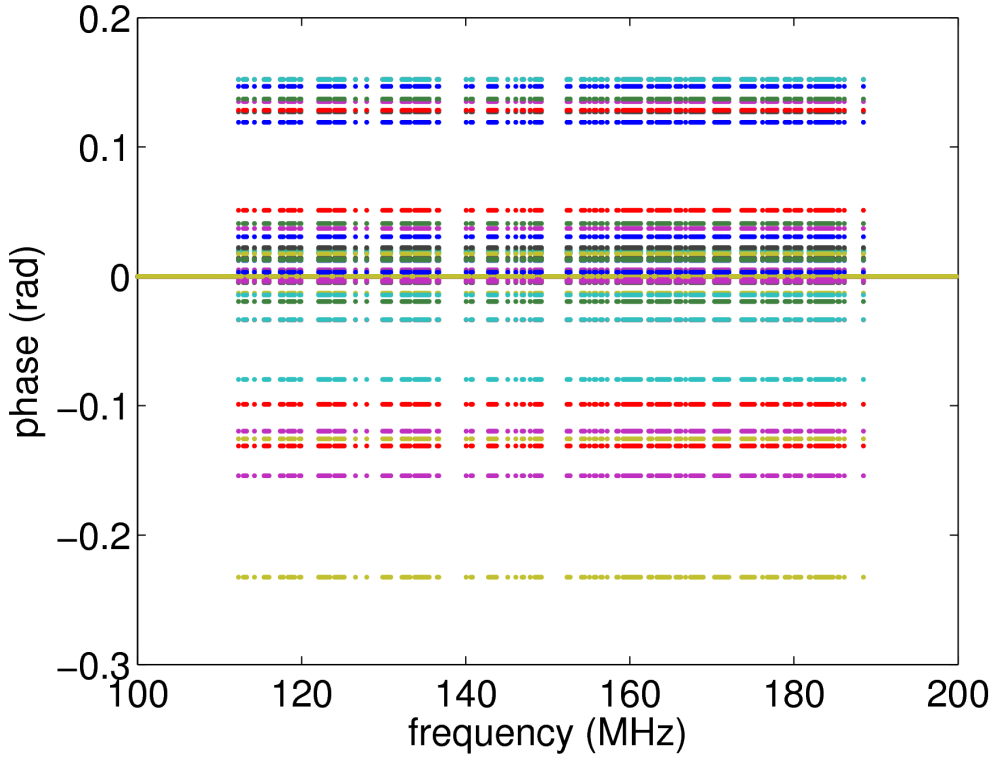
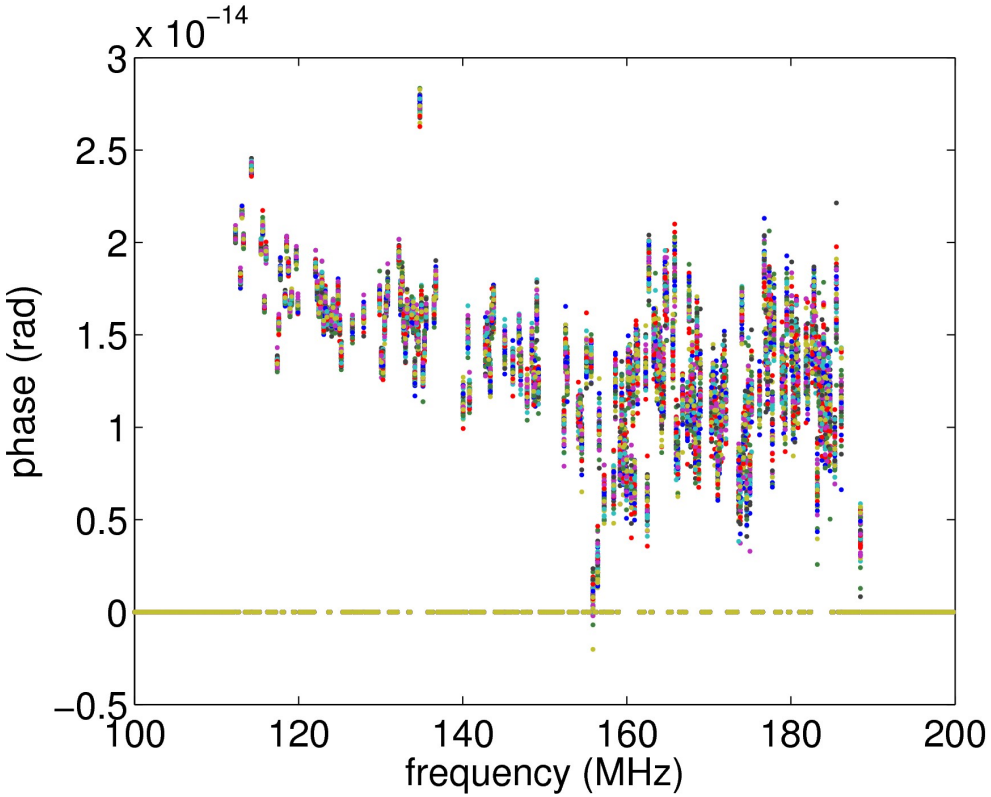
left: phase solution second iteration

right: phase solution fourth (and final) iteration





Model based calibration

S.J. Wijnholds & A.J. van der Veen, IEEE TrSP, Sept. 2009

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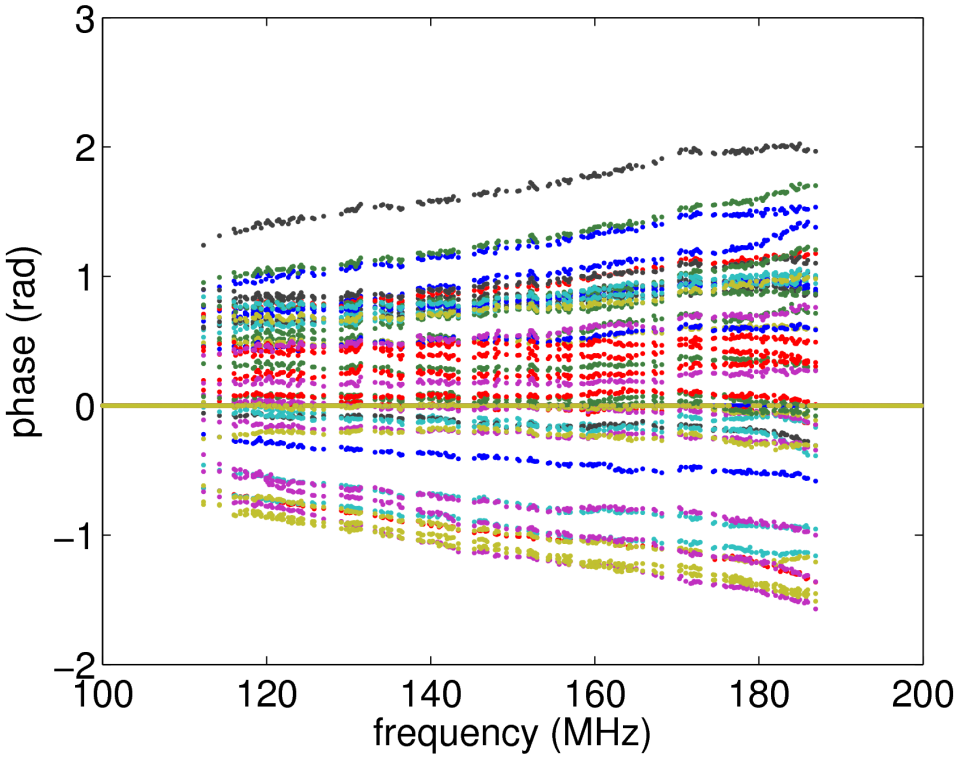
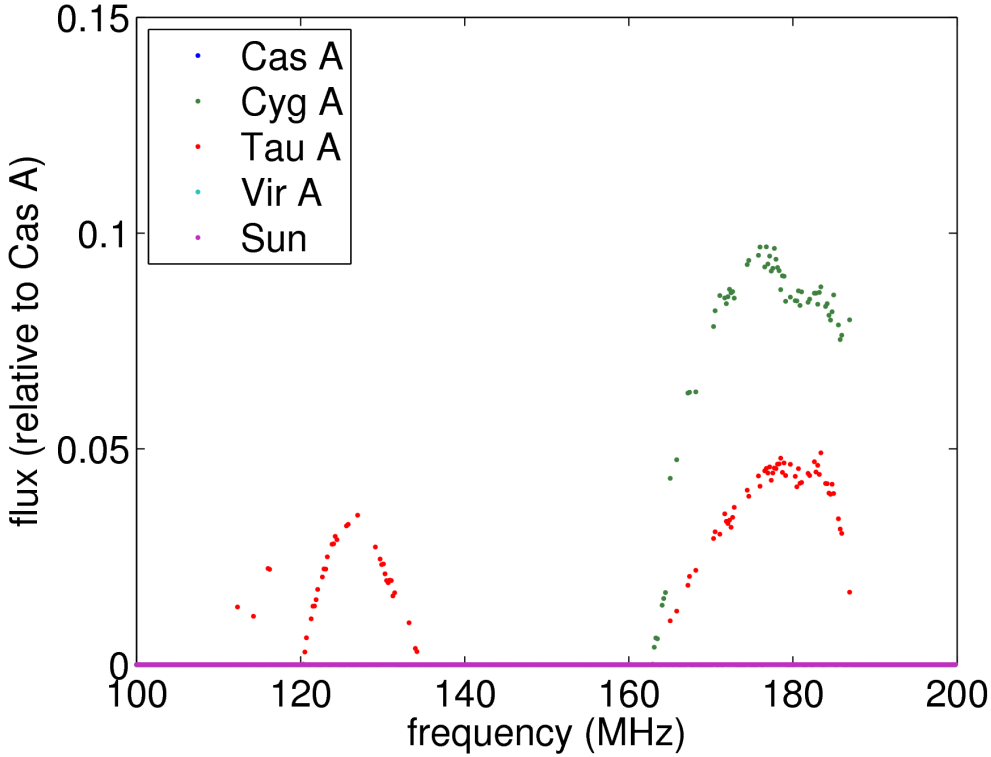
left: tile based phase solutions

right: apparent fluxes (Cas A normalized to 1)





Comparison: phase solutions

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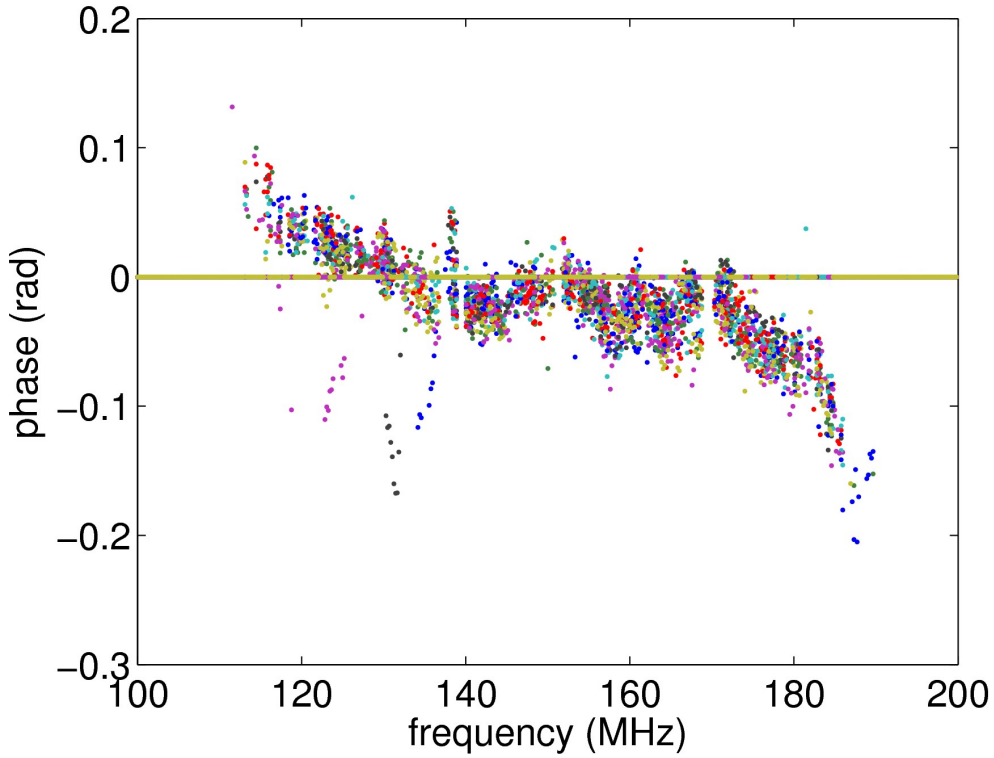
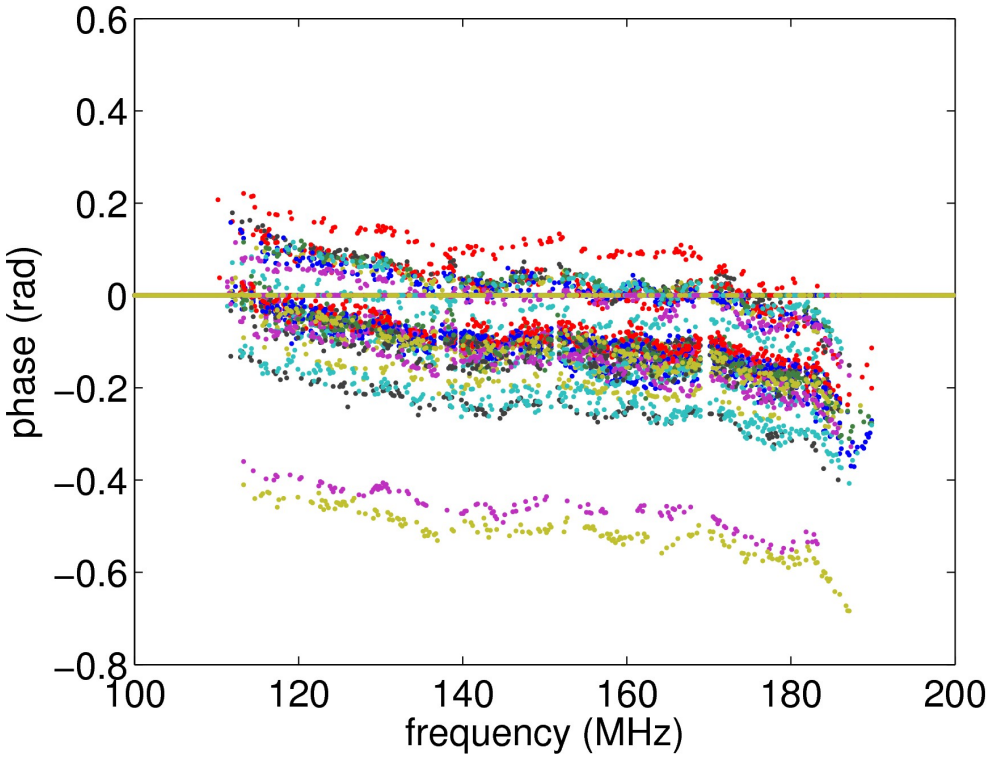
Phase solution for tile 4x over time

left: model based, subject to interference

right: redundancy, affected by phase slope ambiguity





Comparison: amplitude solutions

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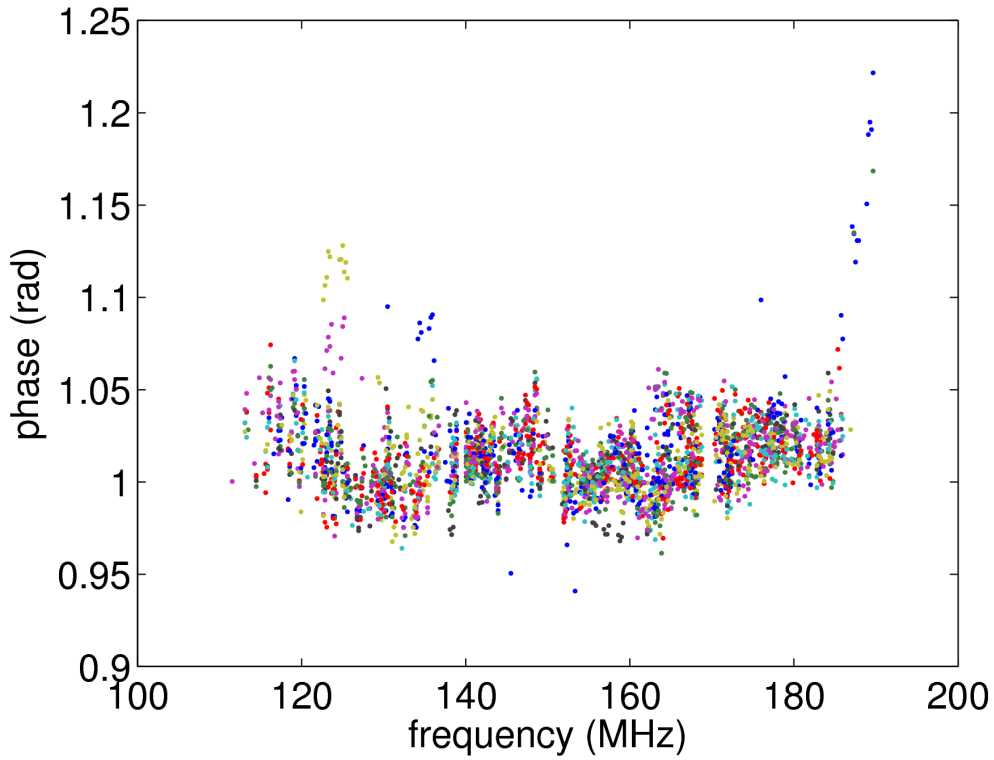
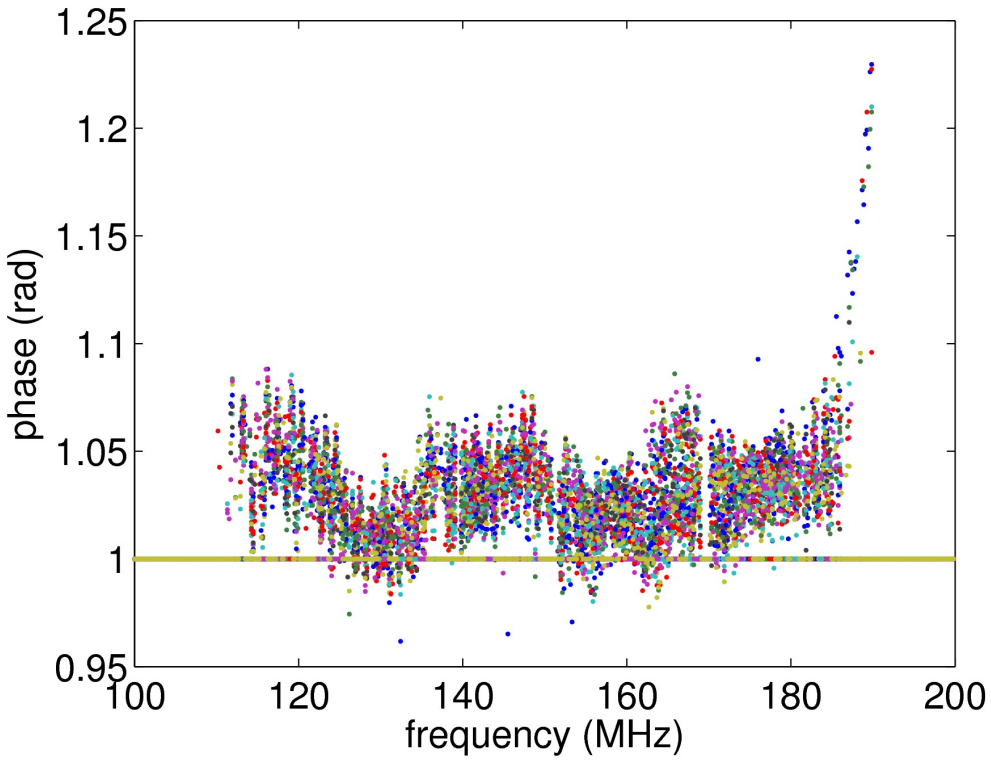
Amplitude solution for tile 4x over time

left: model based, right: redundancy calibration

Solutions agree, redundancy less affected by interference





Conclusions

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Functional tests: redundancy calibration works!

- phase slope ambiguity
  - can be fixed by selfcal
  - requires strong point source
- robust to modeling errors and interference
- useful as diagnostic tool (failing redundancy)?

Implications for HBA station calibration v1.0

- static weights using model based calibration or
- static weights from redundancy plus alignment step

Encore 1: sensitivity improvement

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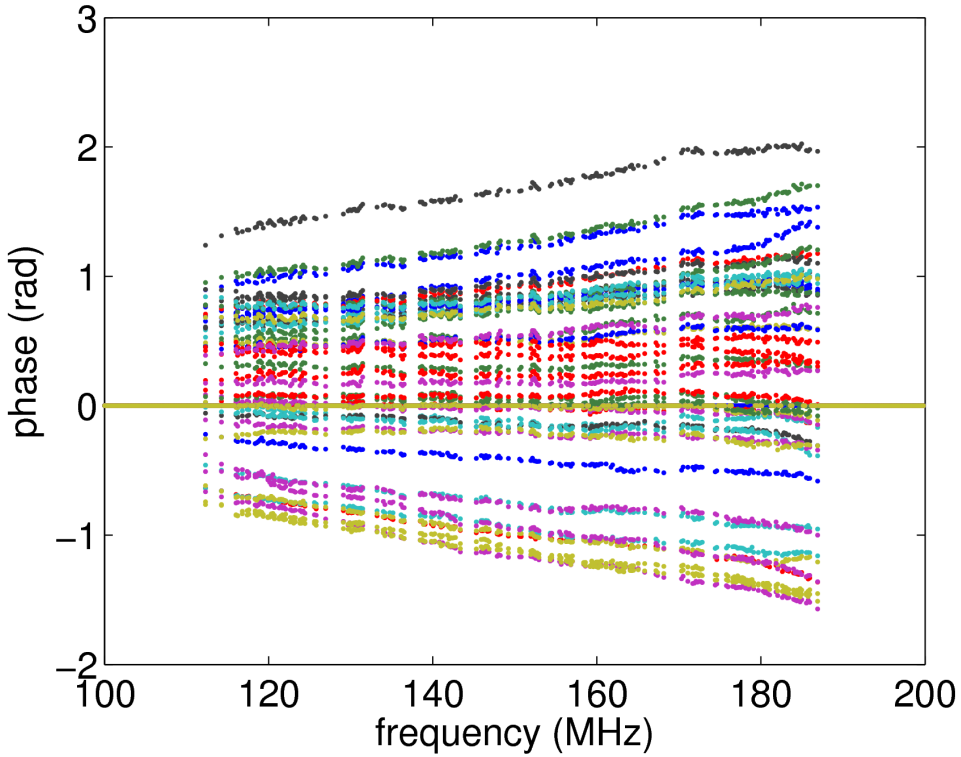
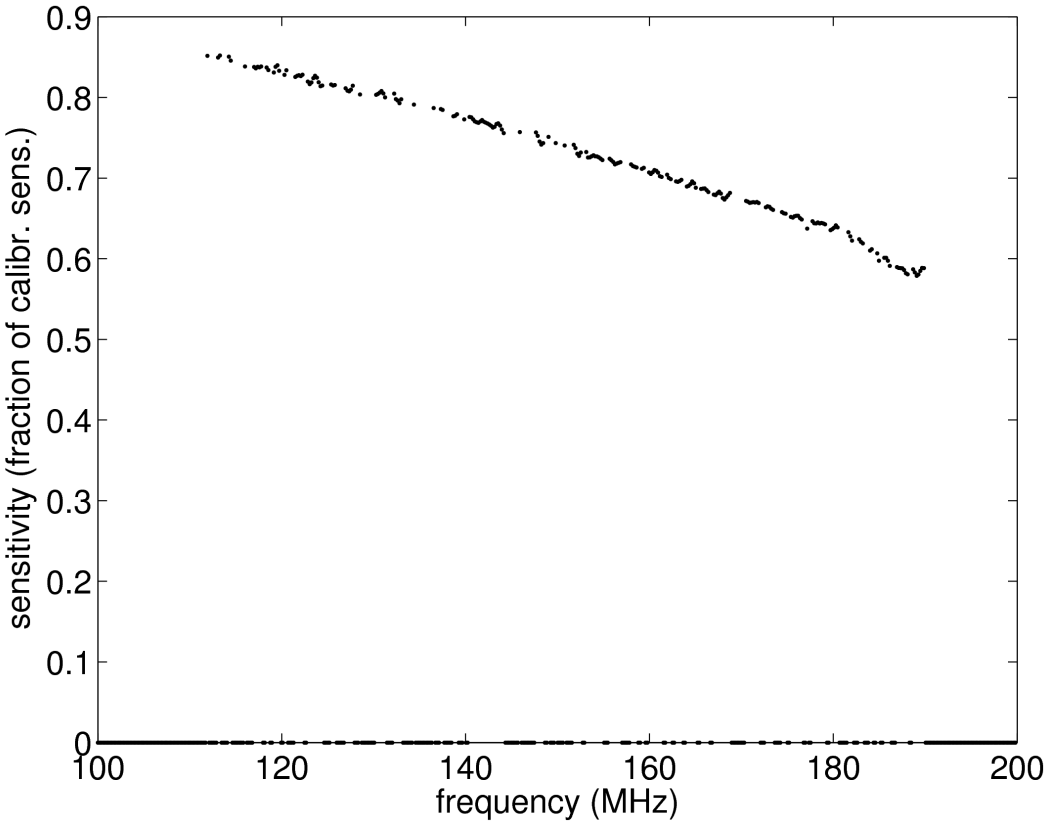
Gain loss due to ill alignment of phasors

15% loss @110MHz, increasing to 40% @180MHz





Encore 2: HBA sensitivity

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left: A/T per tile towards Cas A at transit (7° from zenith)

right: T_{sys} assuming $A_{eff} = A_{phys}$