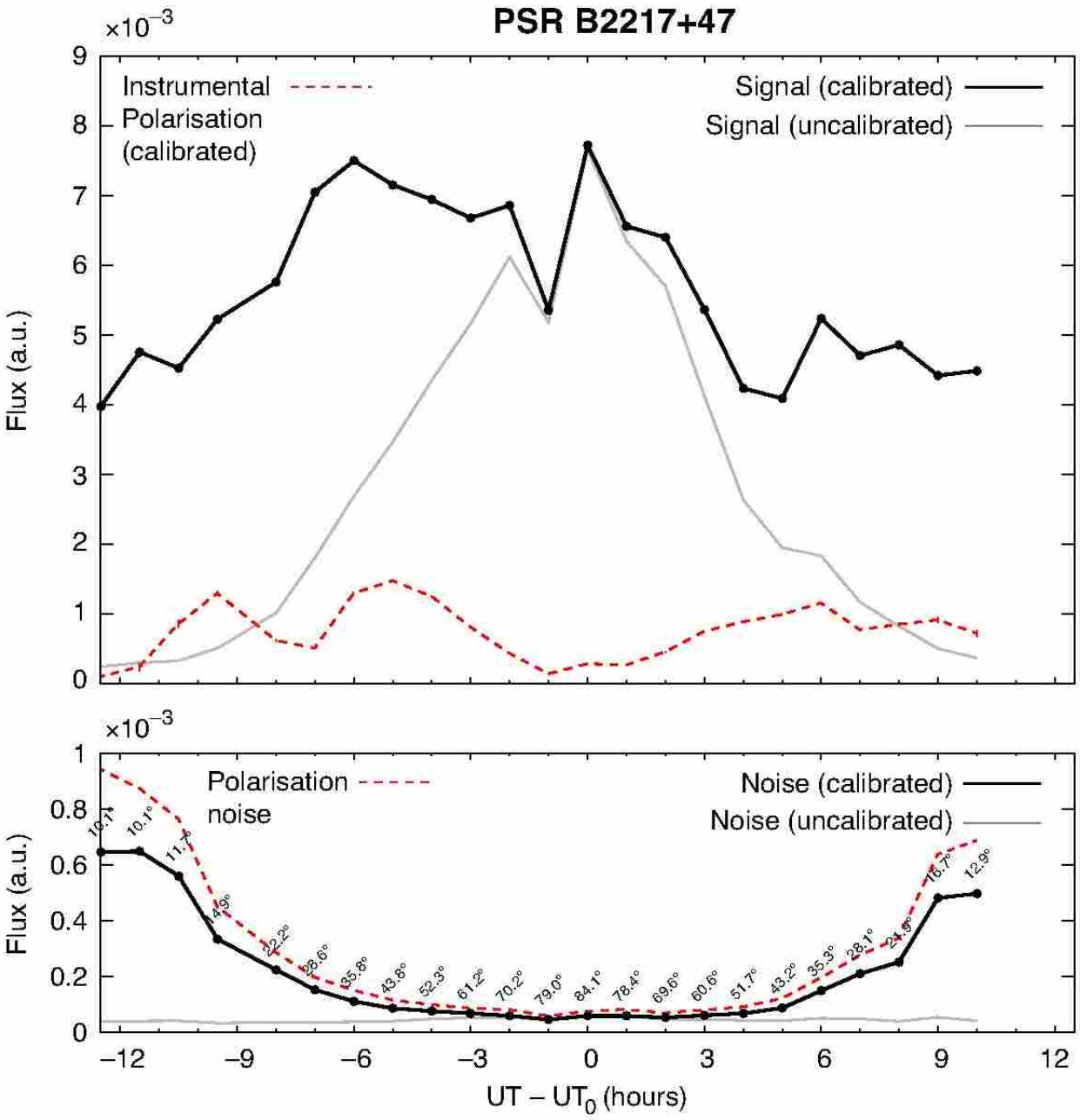
**Discussion about The Beam in the Imaging Busy Week, mid-June**

Some 20 participants

Presentations by

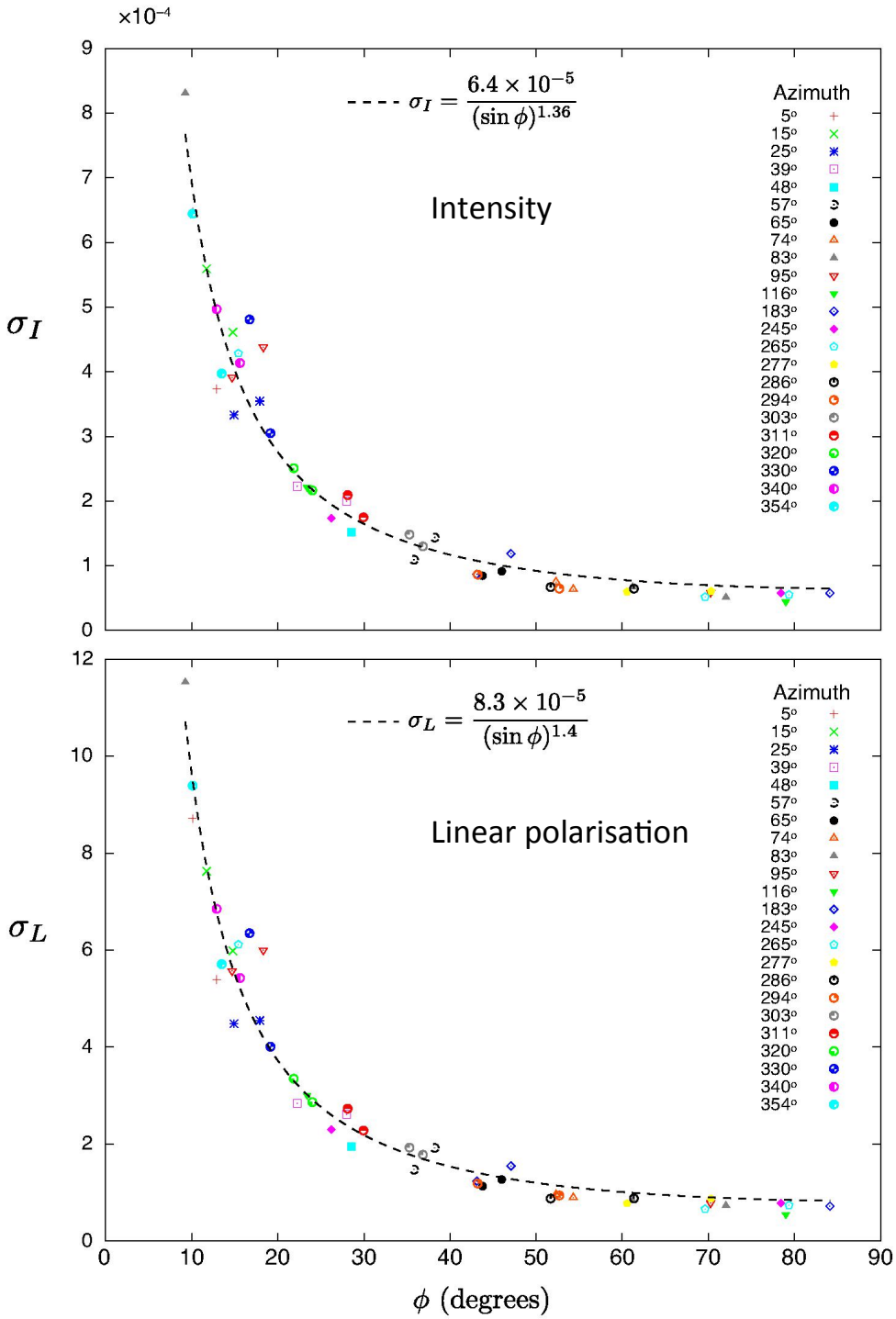
- Pulsar group:
  - Comparisons of model and observations
- Tasse:
  - Beam corrections in imagers
- Jelic:
  - Effect of beam corrections on depolarisation
- High-energy group Nijmegen:
  - Fine-tuning of the LBA beam model
  - Octocopter observations
- Carozzi:
  - Doubts about software correctness (coordinate systems, signs)
- more ...?




**Pulsar observations calibrated with beam model**

What do the variations mean?

Elevation 19 - 84 deg



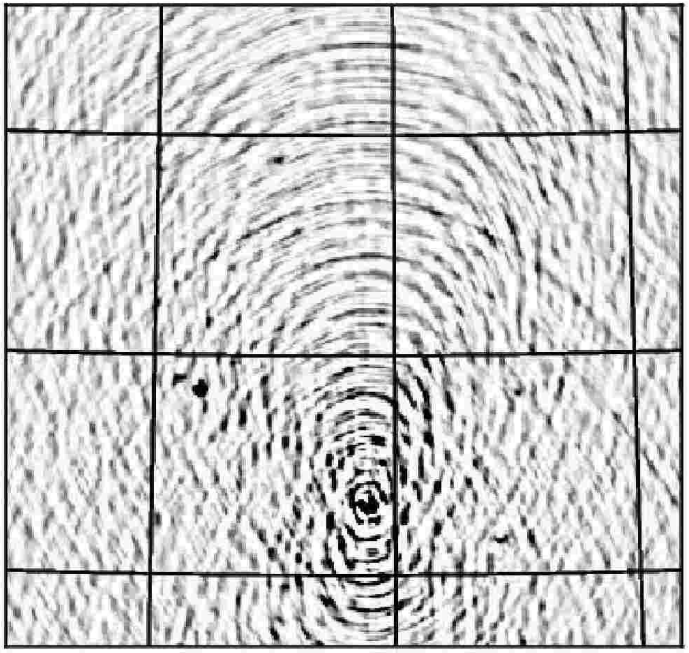

**B2247+17**
**Noise vs elevation**

sin(za) $^{1.4}$

The fits are pretty, but does the function mean anything?

Can the patterns be explained?

W-term only (Casa)



## Effect of applying beam models in CASAimager

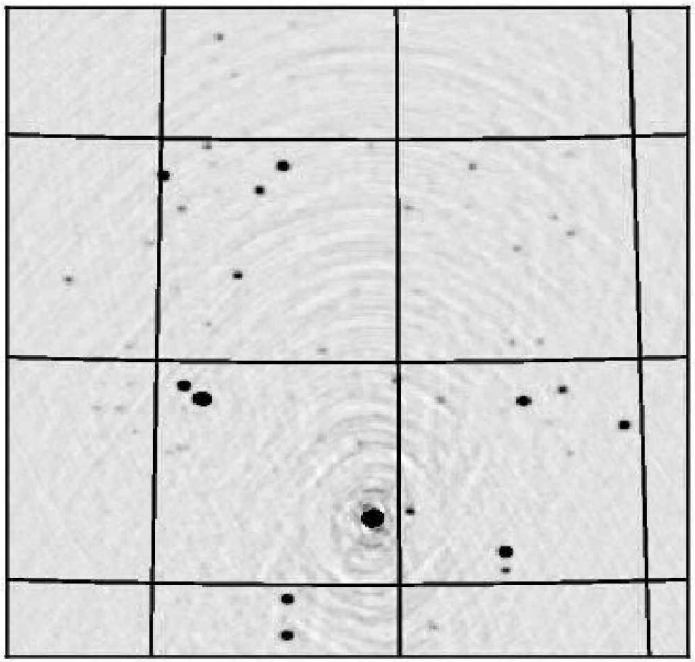
Simulated field:

**100 sources with flux density following NVSS 1.4 GHz source counts**

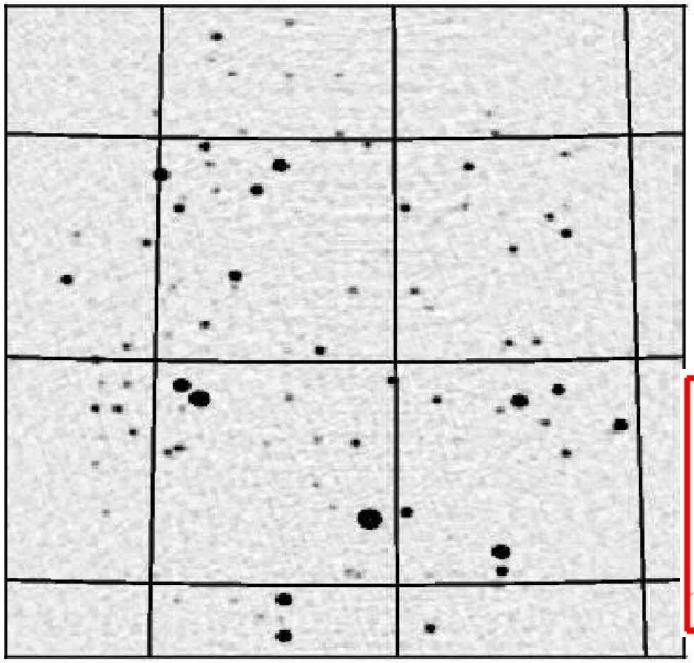
Intensity images (?)
Are the scales comparable?

"diagonal" beam only corrects the gains of all four Stokes prmters: here only the Intensity beam Is relevant

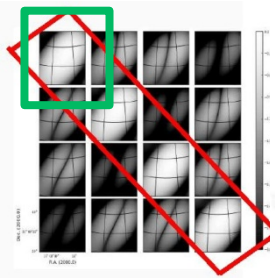
Wterm + Scalar /diagonal beam

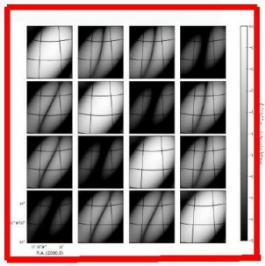


Wterm + full beam Mueller matrix

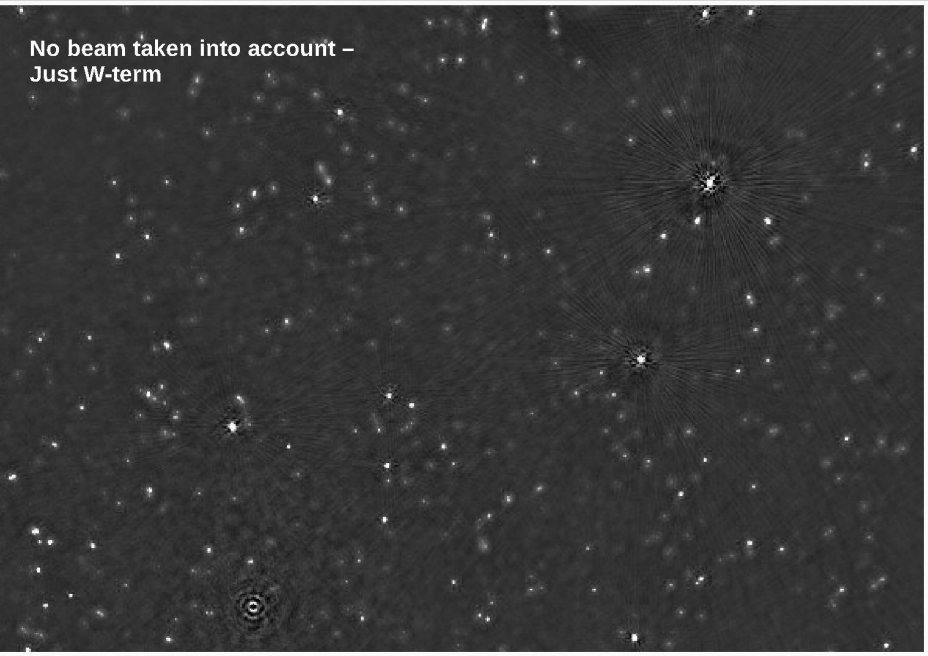


Full beam also corrects the leakage between Stokes Parameters: Apparently the leakage is substantial





## Tests on real data (3C295 observation)

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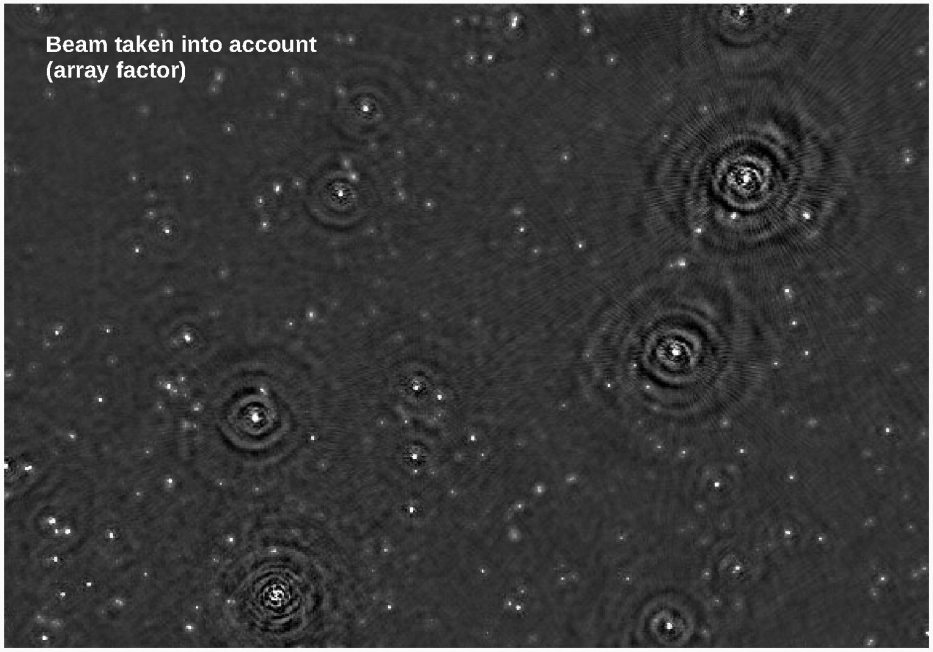



Only the array-factor beam is accounted for.

(Is there any relation to the previous simulations?)

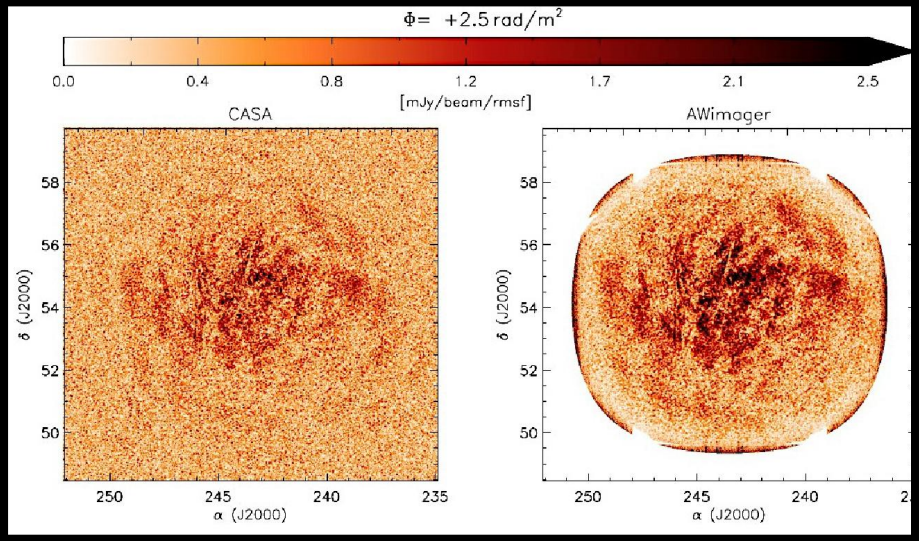
How does the array-beam-only corrupt the image???

Either the correction model may be wrong or incorrectly implemented (as suggested by Carozzi) ...

... or we do not understand the process

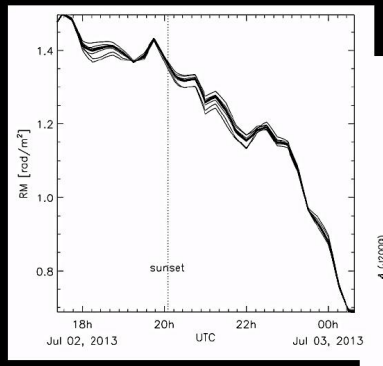
# Galactic polarised emission: Elais N1 field

## Elais N1 field: beam corrections

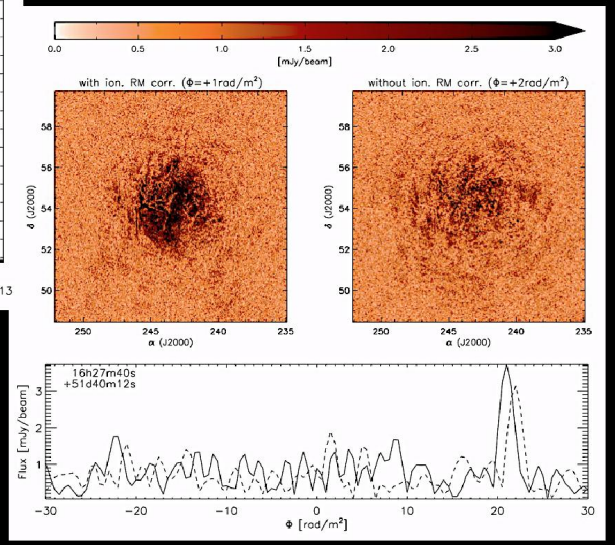





## Elais N1 field: ionospheric RM correction




***M. Mevius***






CASA AWimager.

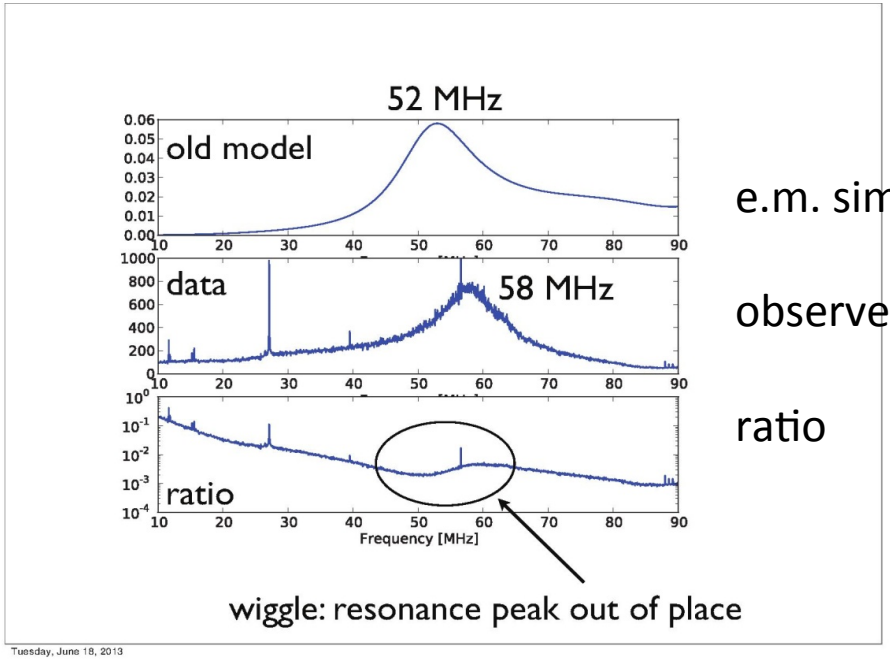
Whence the difference?

with without ionospheric RM correction

Uncorrected ionosphere depolarises

# The LBA resonance curve

Zenith gain vs frequency



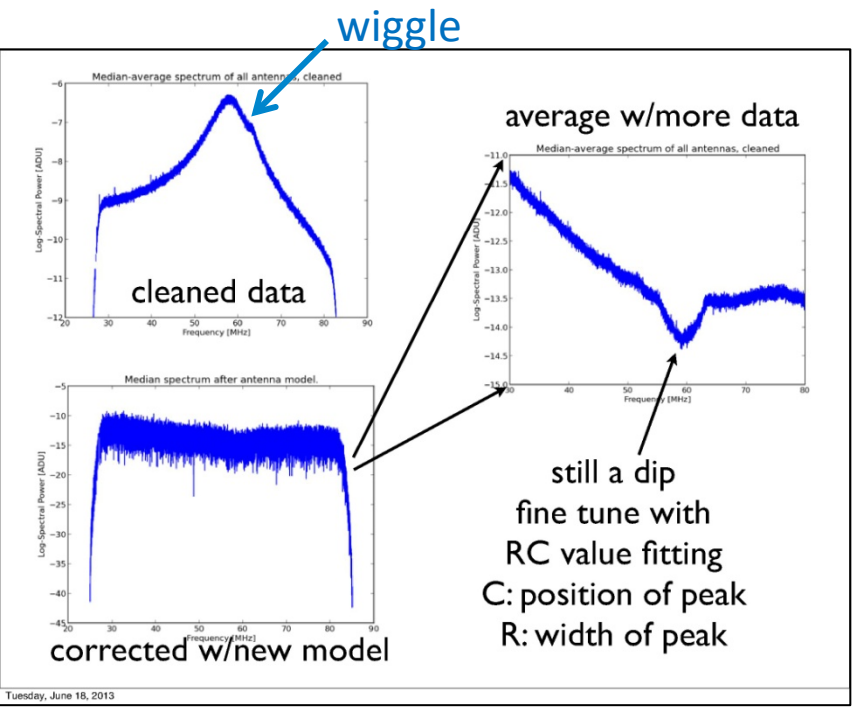

e.m. simulation

observed

ratio

the scales are inconsistent

100x difference between 10 and 90 MHz



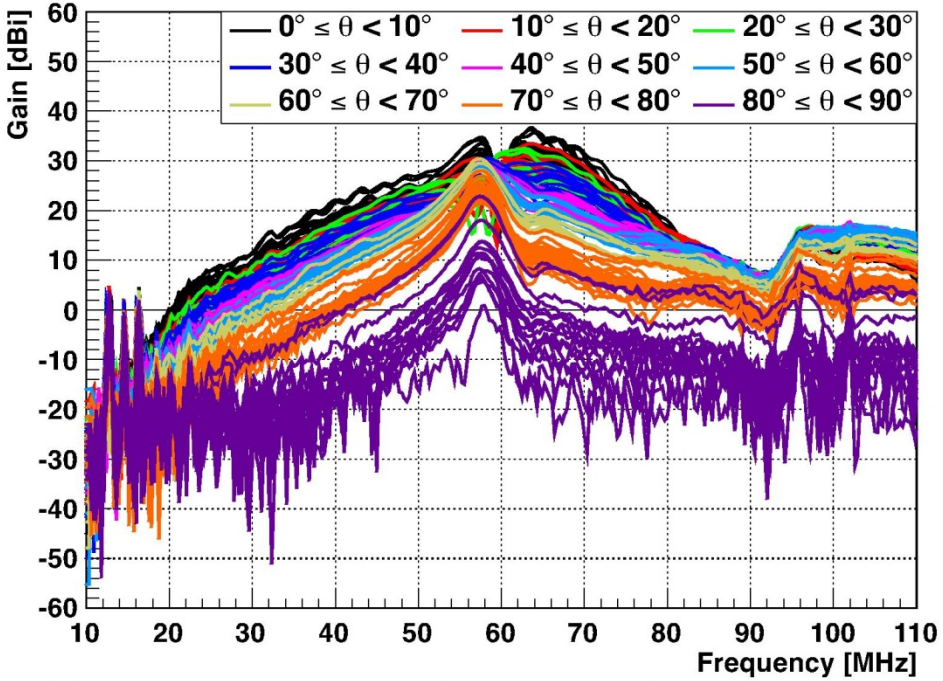

LNA input impedance is only roughly known.

Adjust assumed R,C values to shift the resonance.

OK, but arbitrary

**The best way to determine the resonance curve is by calibration on celestial sources**

## Octocopter measurements




LBA inner: crosstalk at small zenith angles
dip in resonance peak
(not seen in LBA outer)

(This is not the way to present
a complicated data set ...)

What this seems to show is
the responses of the individual antennas
to the octocopter signal.

The observers claim that there is a difference between the LBA inner and outer antennas, which they attribute to mutual coupling and also associate with the wiggle

**So what did the meeting achieve?**

Mostly one-way communication - Speaker → Audience
Each presentation has a complicated background
whose particulars are not shared by the audience

Superficial discussions - a few tentative suggestions

No progress - no action plans

Why are discussions on the Beam Problem so unproductive?

**LOFAR calibration** seeks to identify signal-chain stages through their characteristics:

Clock, ionosphere:

Phase and Faraday Rotation vs. Frequency

Station receivers:

Gain from calibrator observations

Beam

Models that we know are incomplete

This leaves a combination of beam-model errors and residuals of various sorts.

Nobody knows what to do with it.

EoR group to the rescue!

Straighten out the calibration process. E.g.:

An e.m. station model that takes mutual coupling into account. (PROBLEMATIC) *

A math model of the entire calibration process (not just little parts of it) *

Software to analyse observed variations of the beam with pointing direction. *

A major systematic simulation effort to test all calibration software *

A major campaign of dedicated test observations, processing and analysis. *

This would require specialist manpower (that ASTRON/LOFAR cannot afford)

## The EoR effort centered on SAGECAL

A model representing the whole of LOFAR in terms of parametrised elements of the signal chain. e.g.

Per station per 10-minute interval:
- Ionospheric delay and (differential) Faraday rotation
- Station-beam Jones matrices in 100+ pointing directions for many frequencies
  (or parameters of a functional time-dependent model beam accounting for antenna beam and projection broadening)
- Parametrised models of many sources (at known positions)

A model of 10.000s of parameters to be fitted to millions of data points

Iterative improvement of models (source models in particular)

Results to date look promising. What are the limits to their accuracy/correctness?

- Mathematical analysis – solution ambiguities
- Large-scale simulations
- Massive investment in person-years.

# Conclusion

The complexity of LOFAR engenders a very complex calibration problem.

Astrophysicists distributed over a continent

lack the interest, understanding and organisation to solve it

LOFAR/ASTRON have so far taken no responsibility or initiative

and probably will not (out of principle or for lack of funds)

It is fortunate that the EoR group has perforce taken up the challenge

Observers would do well to explore the use of SAGEcal.