LOFAR Beams

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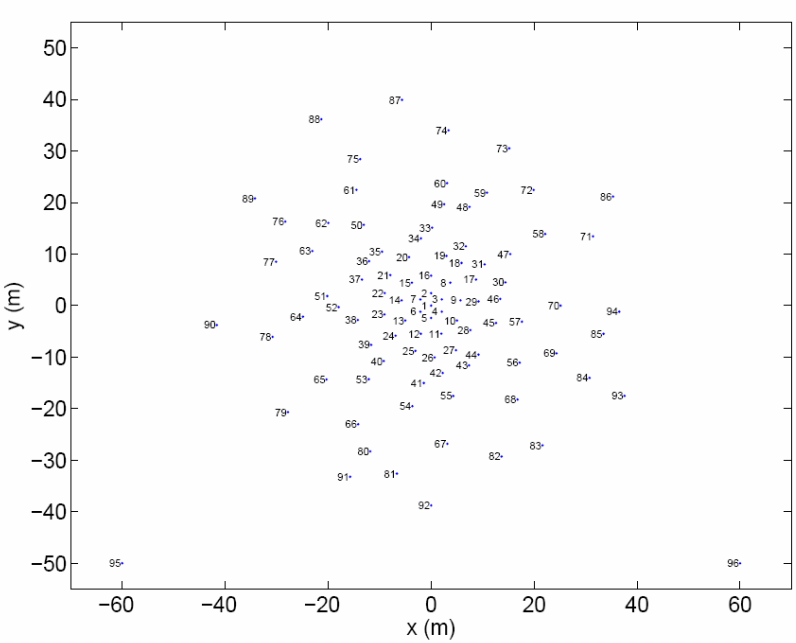
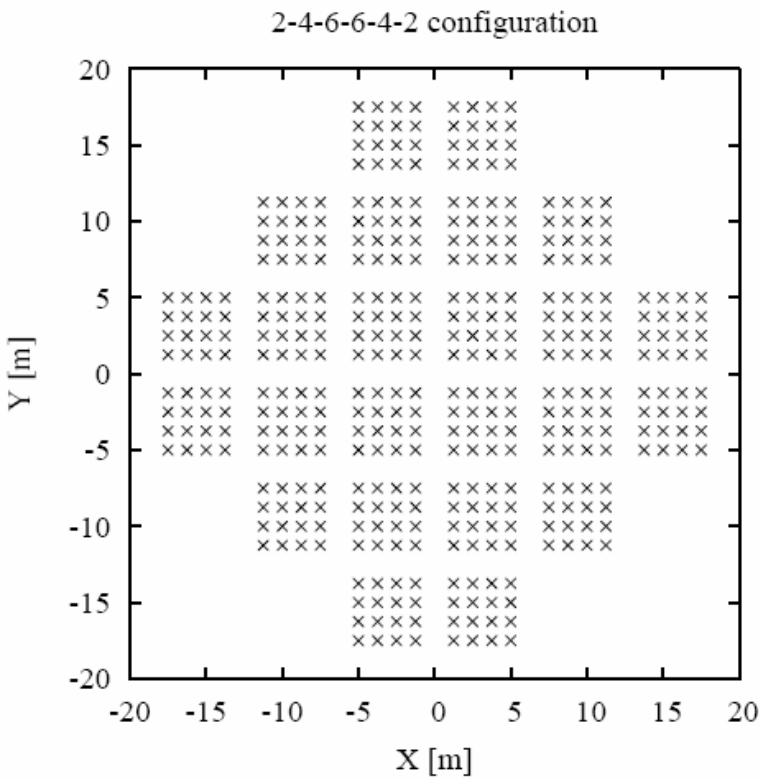
LBA Configuration



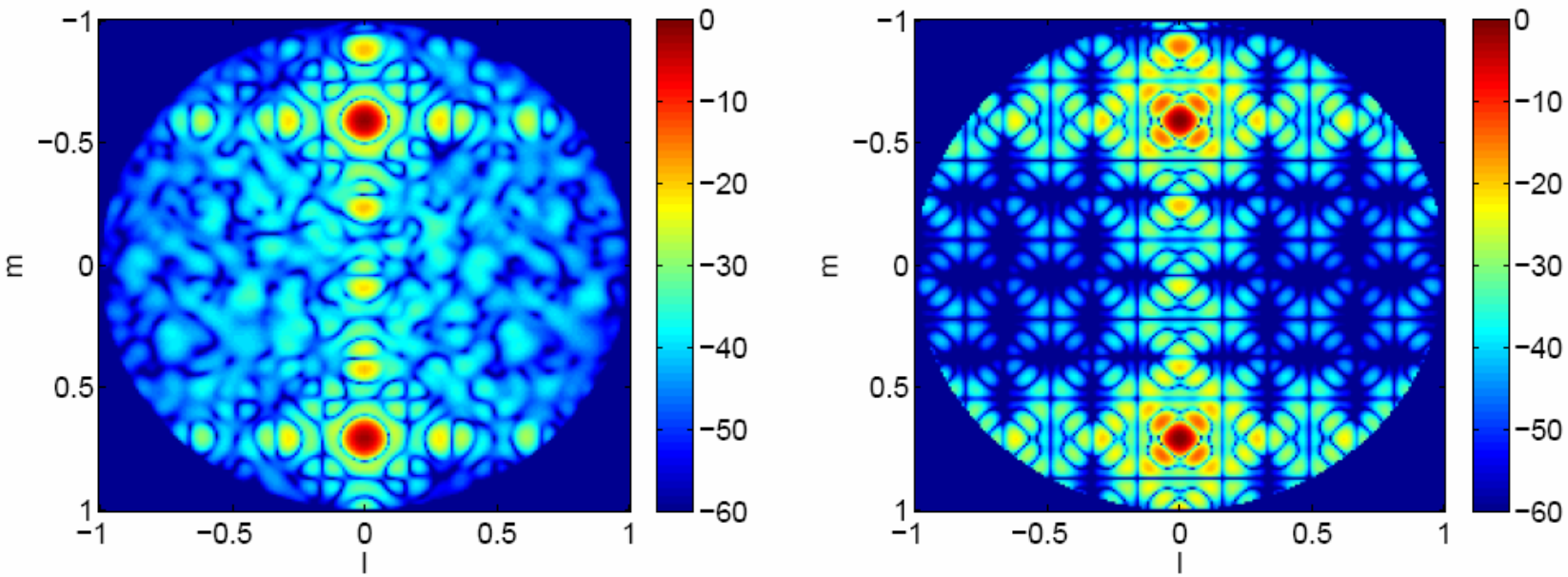
- 96 dipole random placed antennas within a 82.5 m diameter circle (EU 65 m)
- Core and remote stations equal
- Dutch station: select 48 to be used in observation
- E.g.: 30 m at 60 MHz and 82.5 m at 30 MHz

HBA configuration



- Core: 24 tiles per “half station”
- Remote: 48 tiles
- EU: 96 tiles
- Tile: 4 x 4 dipoles in 5 m x 5 m box
- Inter – tile spacing set at 15 cm
- Core station diameter: 31 m
- Remote station diameter: 41 m
- EU station diameter: 51 m
- Tapering needed to suppress station beam sidelobes
- LOFAR20: taper to 30 m station

Suppression of sidelobes

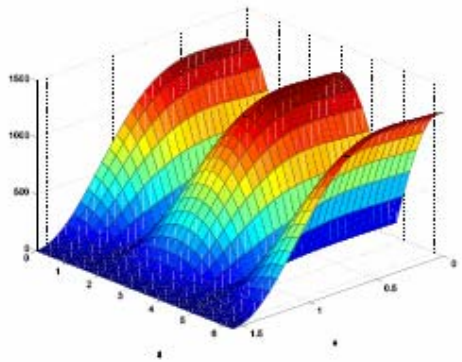


Left: tapering of a 24 tile station having 12.5 cm alleys; right: no tapering (180 MHz)

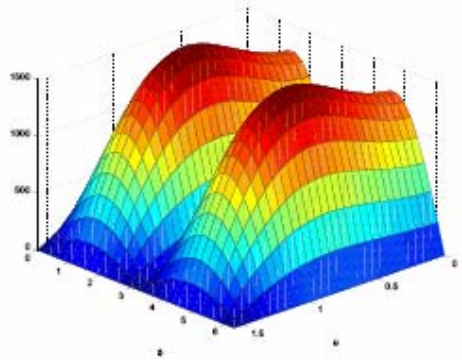
- Tapering suppresses the inner sidelobes
- Station rotation suppresses the outer sidelobes (also for LBA)
- Station rotation suppresses the grating lobes

LOFAR Beam modeling & CS1

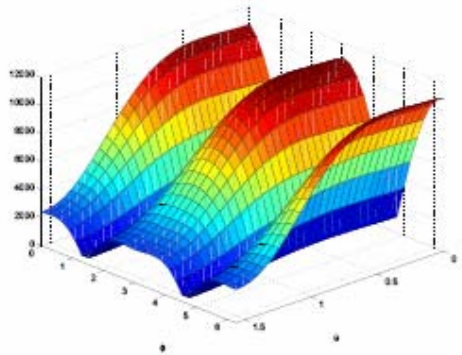
Dipole Beamshapes



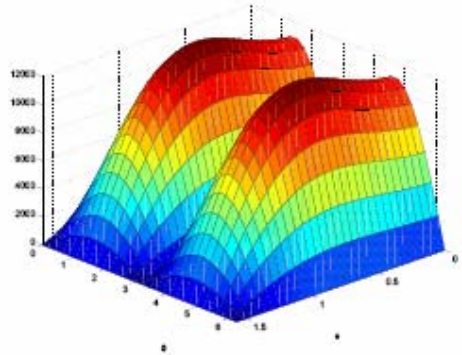
LBA $|E_\theta|$, 80 MHz



LBA $|E_\phi|$, 80 MHz

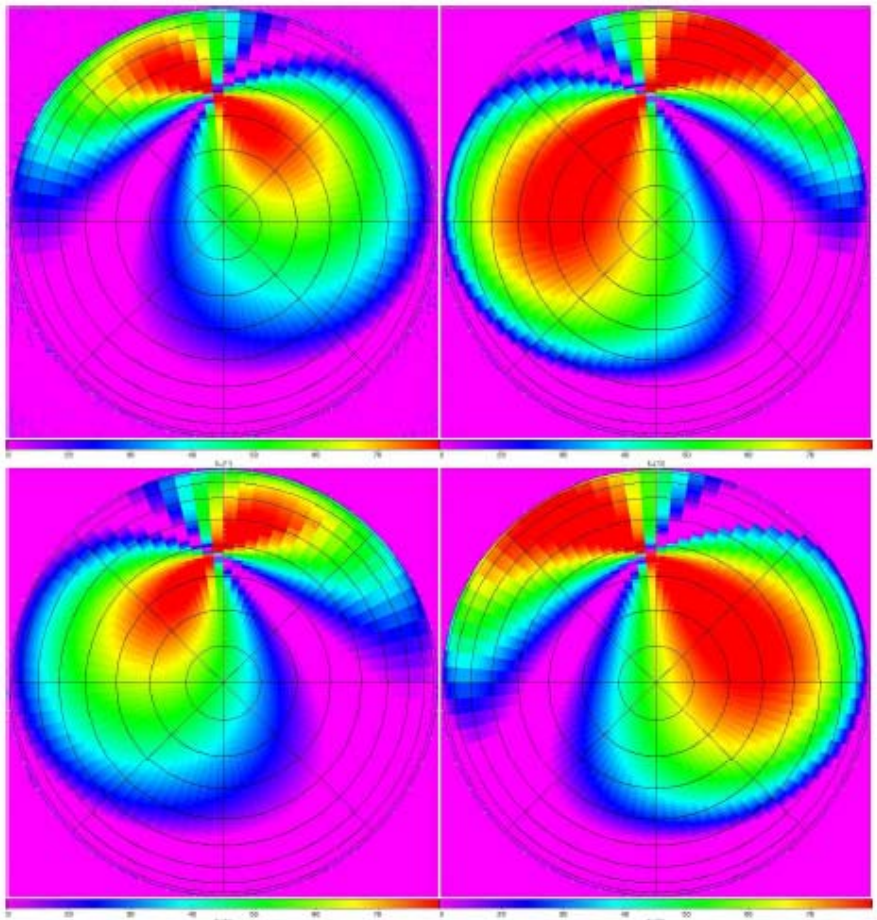


HBA $|E_\theta|$, 240 MHz



HBA $|E_\phi|$, 240 MHz

Dipole beam and the sky



Magnitude of $\mathbf{E}$ Jones matrix projected onto the sky, 10 min time, NCP image, zenith on top

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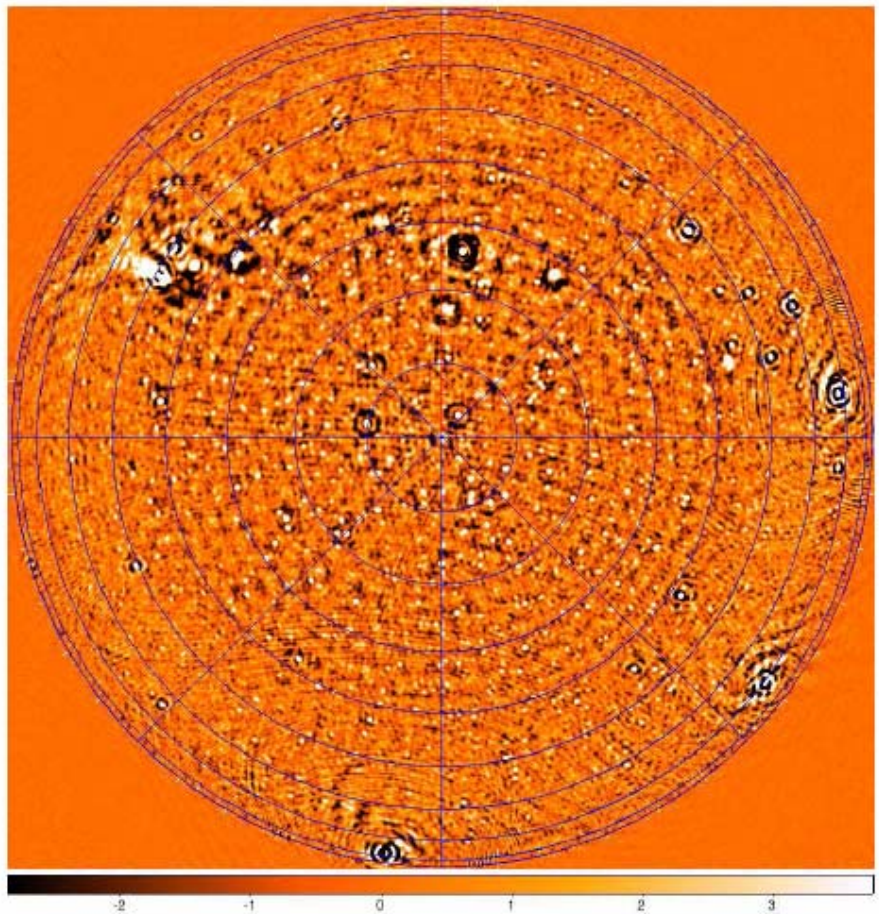
Correcting for the beam

- Correction for phase errors only get source positions right
- Each pixel of the image has a unique amplitude and phase error due to the beam
- Sky flux changes in amplitude and polarization due to the beam

Correction for the beam: start simple and improve

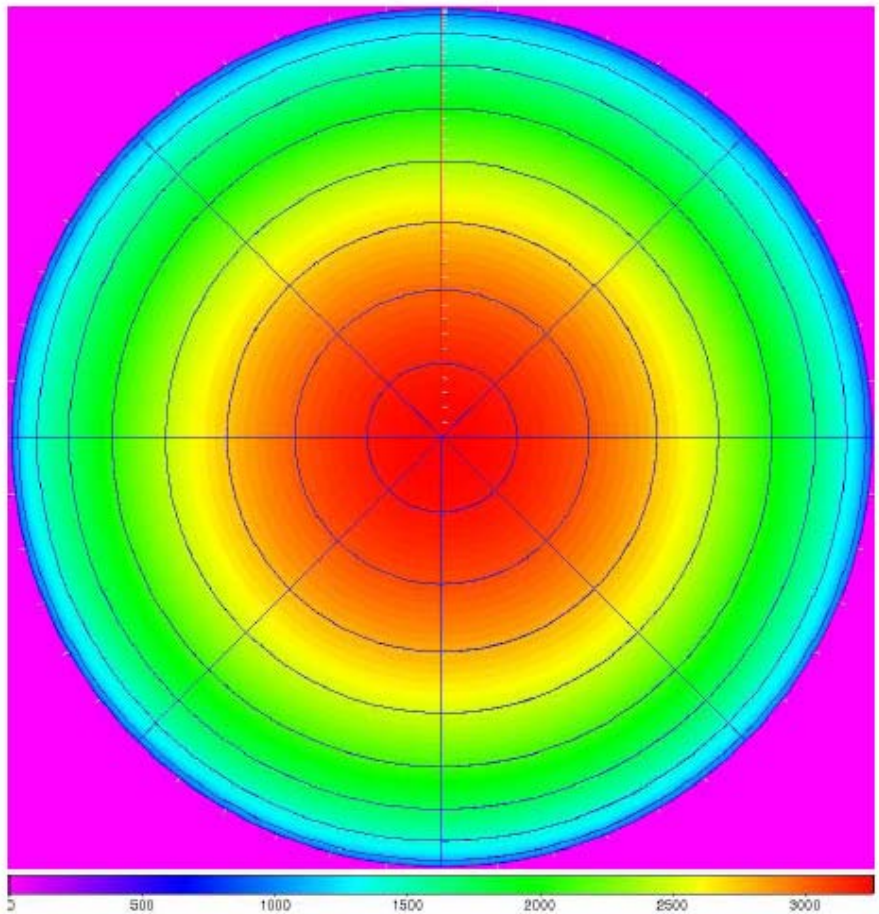
- Correction for average beam, assuming sources are unpolarized scalar correction
- Correction in the image plane, by making snapshot images, small amount of time, beam variation is small matrix correction full polarization
- Correction per interferometer, before making images, for each direction (facet imaging)

Image without beam correction



NCP, 1 day observation without beamcorrection

Average beam



NCP, average beam, 1 day observation

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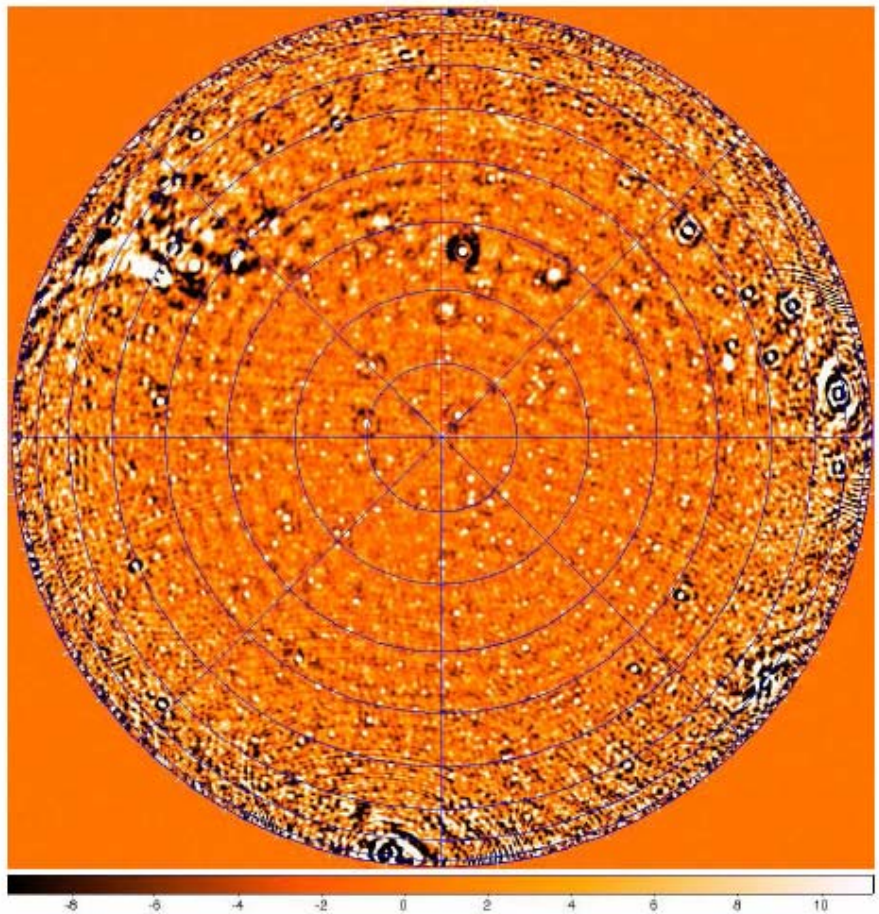
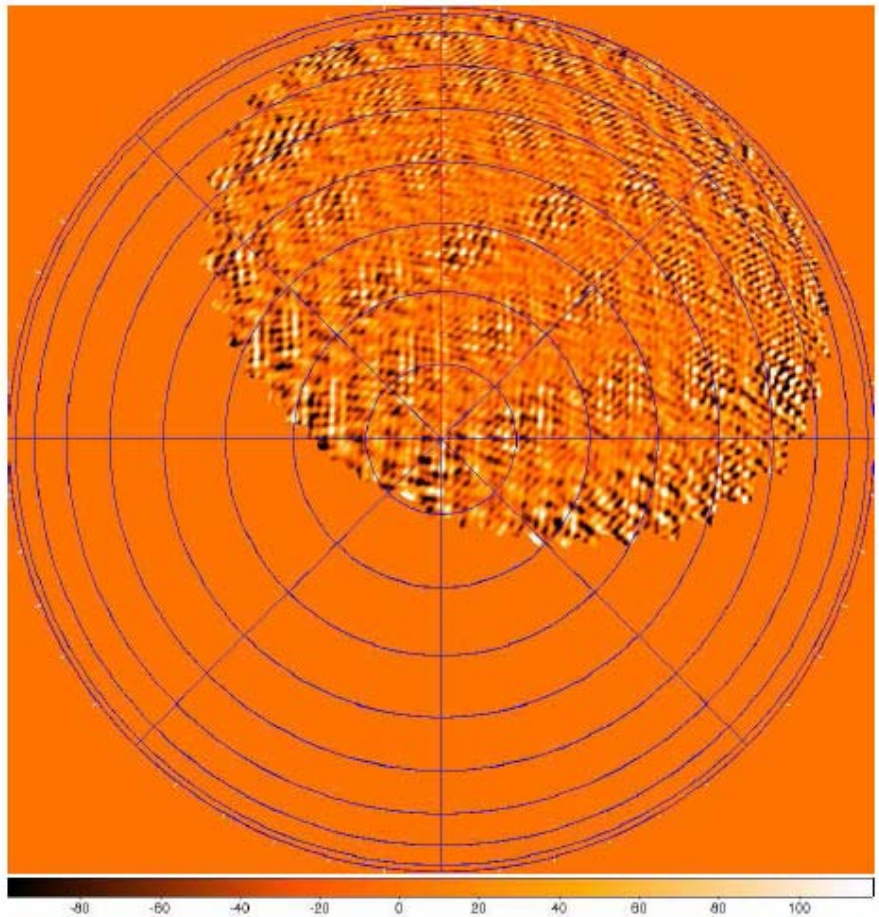
Beam correction: method 1



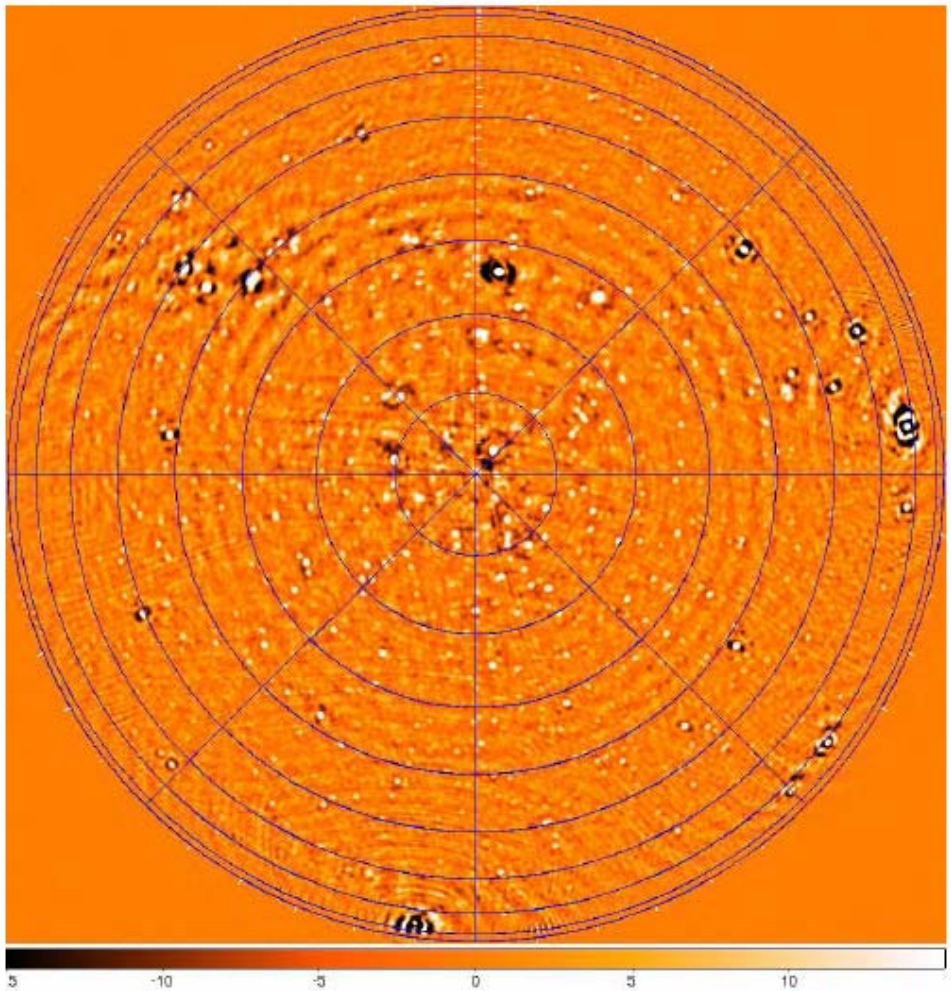
NCP, 1 day observation after average beamcorrection

Beam correction: method 2



NCP, 10 min snapshot, after correction for beam

Beam correction: method 2



NCP, 20 subbands, 1 day observation in full polarization

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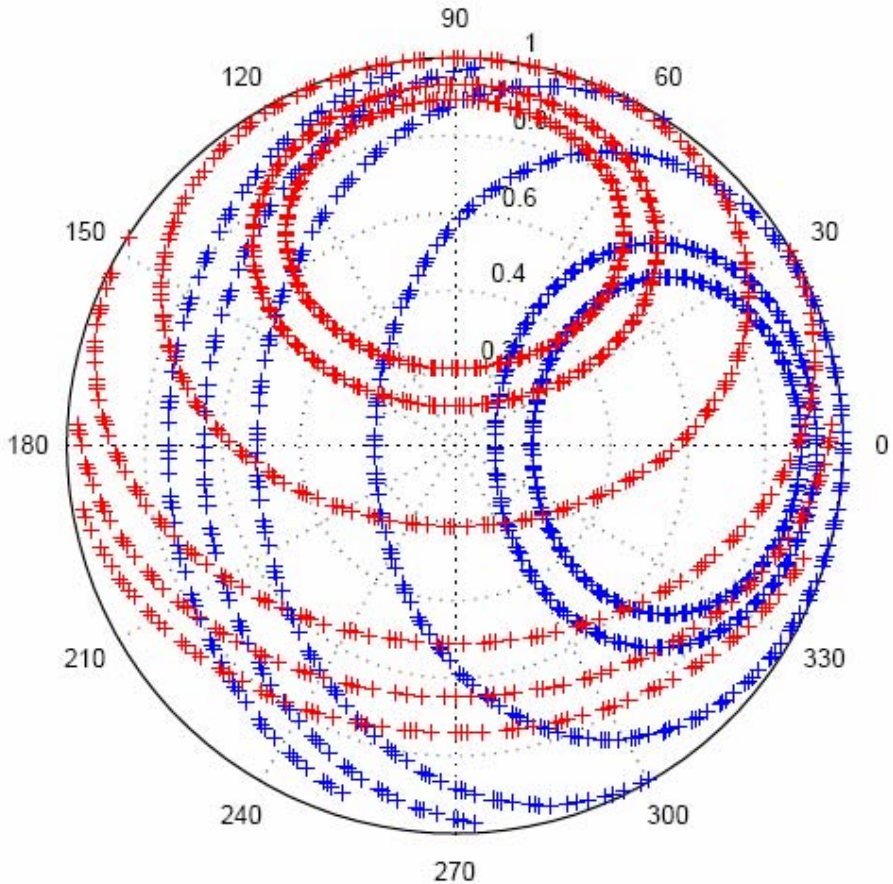
Beam Estimation: Trajectories



24hr, 4days, X,Y dipoles

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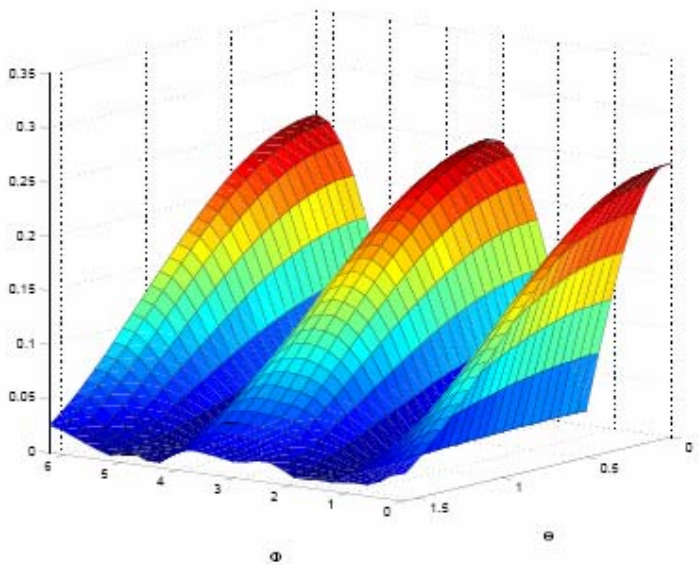
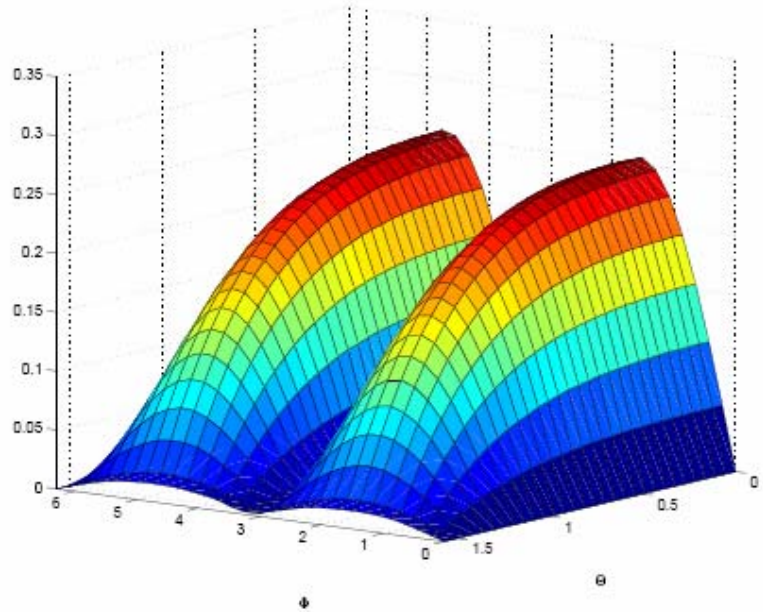
Initial Beam

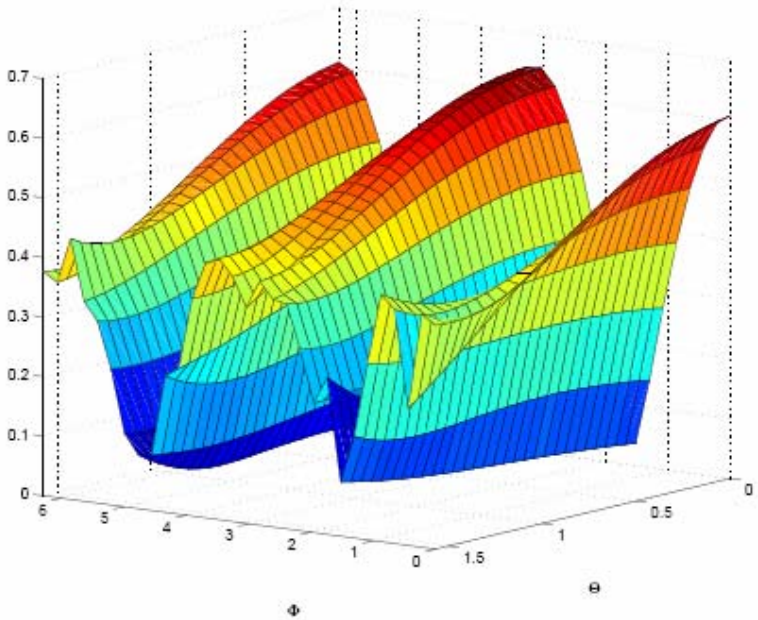


$|\mathbf{E}_\theta(\boldsymbol{\theta})|$

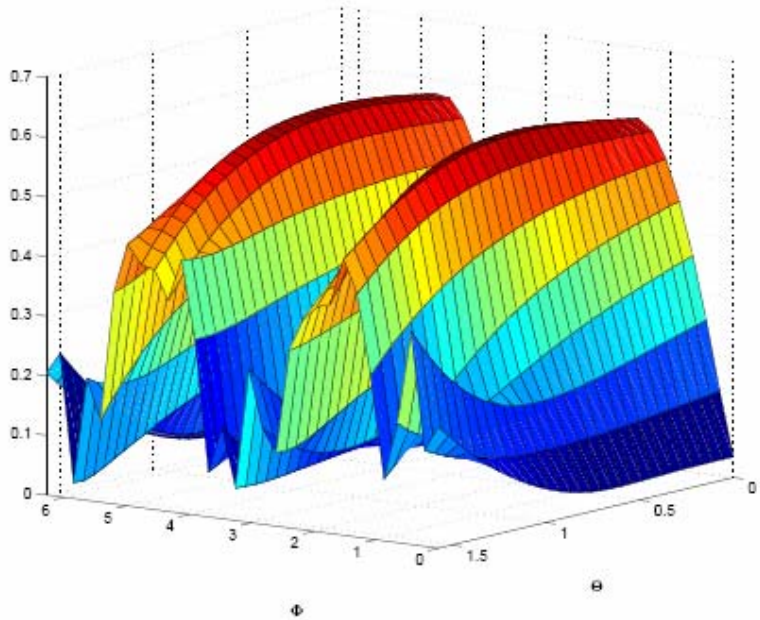


$|\mathbf{E}_\phi(\boldsymbol{\theta})|$

Solved Beam



$|\mathbf{E}_\theta(\boldsymbol{\theta})|$



$|\mathbf{E}_\phi(\boldsymbol{\theta})|$

solution not good below 10 deg elevation (yet!)

To do before 2009Q2

- LBA dipole selection / station size (freq. dependent)
- HBA station taper
- Validation of final beam models and their stability
  - In combination with WSRT-LFFE measurements on NCP?
  - Estimation of effect of mutual coupling
- Implementation in BBS
- Commissioning and testing