# Fringe-rate filtering of interferometer baselines

Hugh Garsden
## SKA January 2023

The basics – a scenario

- Simulation

  – East-west baseline at the equator

  – One sky source with DEC=0

  – Goes overhead horizon to horizon

  – Uniform telescope beam

- Phase of complex visibility rotates

- Frequency of rotation changes (fringe-rate)

- Can remove source based on fringe-rate. Fourier filter.

Visibility over time
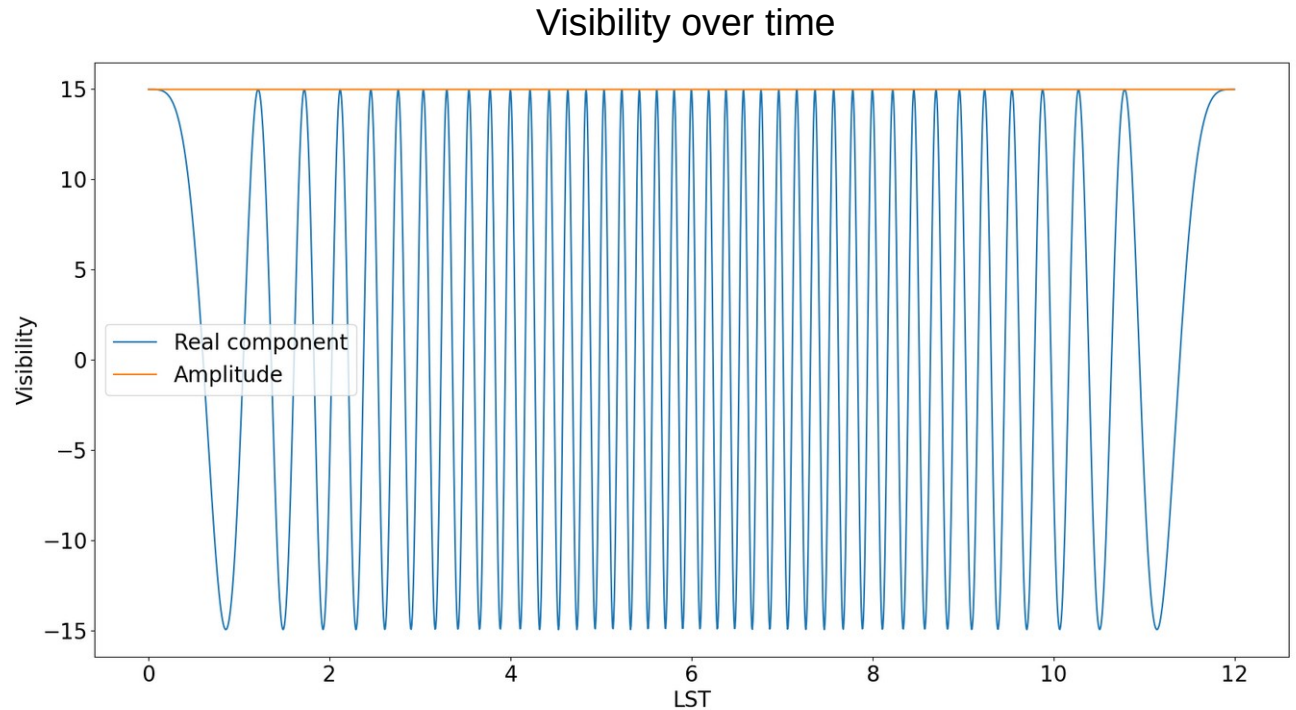
After fringe-rate filtering

- Get rid of the source (mostly) when near horizon

- We have modified the telescope beam
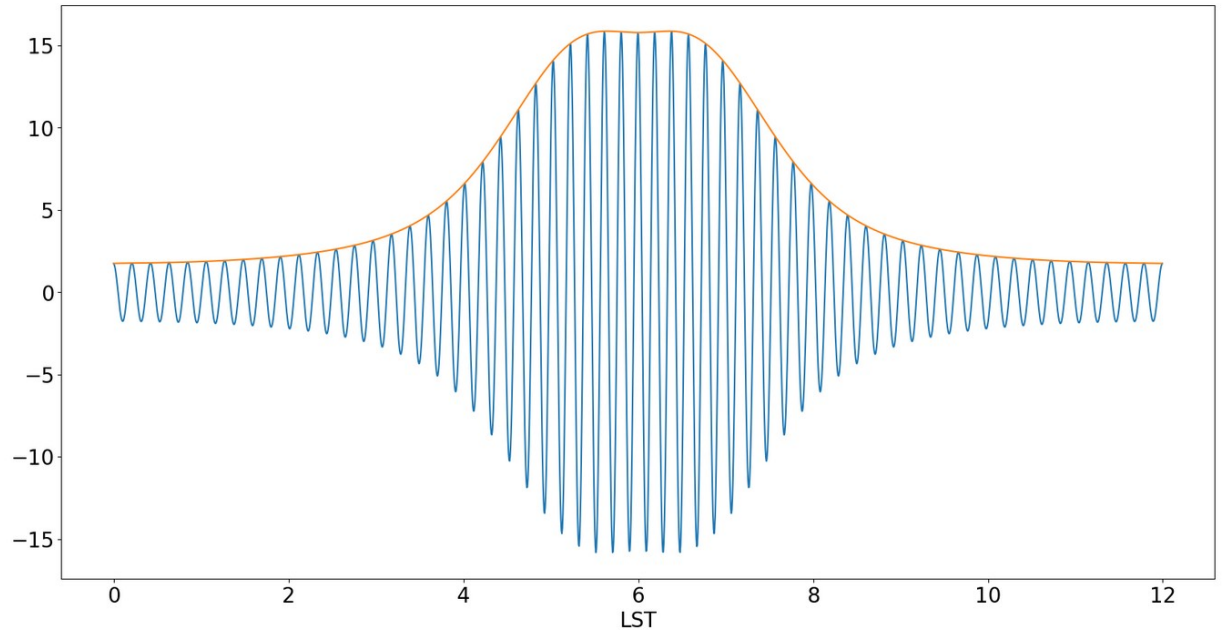
Beam sculpting

- OPTIMIZED BEAM SCULPTING WITH GENERALIZED FRINGE-RATE FILTERS, Aaron R. Parsons et al, 2016
    - Complicated: take into account baseline orientations and how sky rotates over them

- Applications:
    - Minimizing Thermal Noise Errors in Power Spectrum Measurements
    - Minimizing Instrumental Systematics and Off-axis Foregrounds
    - Minimizing Polarization Leakage

Remove beam sidelobes

Simulation. Random imaging telescope. Dirty images.
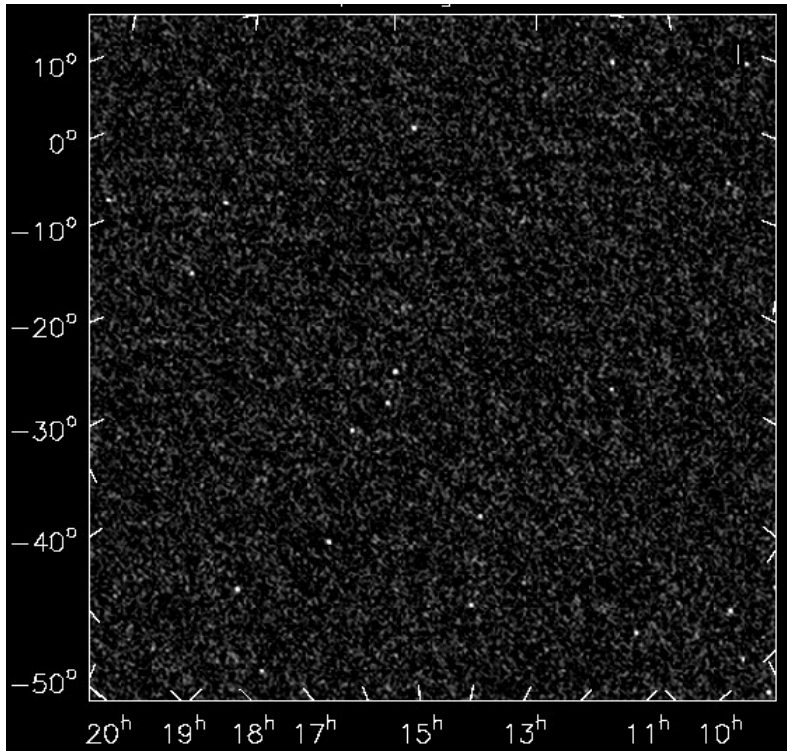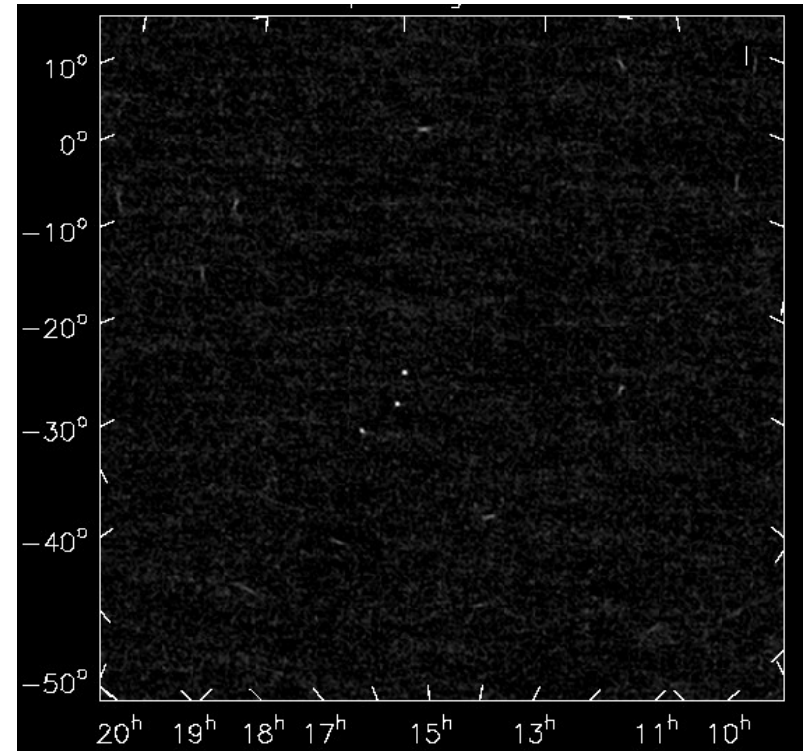
Before FRF

Complicated filtering!

After FRF

Remove systematics

- In HERA, antenna mutual coupling can be isolated in fringe-rate and delay space
  - Not explaining delay-space here

- Build a model that allows its removal

Cross coupling systematic removal is done by applying a high-pass filter in fringe-rate space

Absolute Calibration Strategies for the Hydrogen Epoch of Reionization Array and Their Impact on the 21 cm Power Spectrum, Kern et al., 2020.
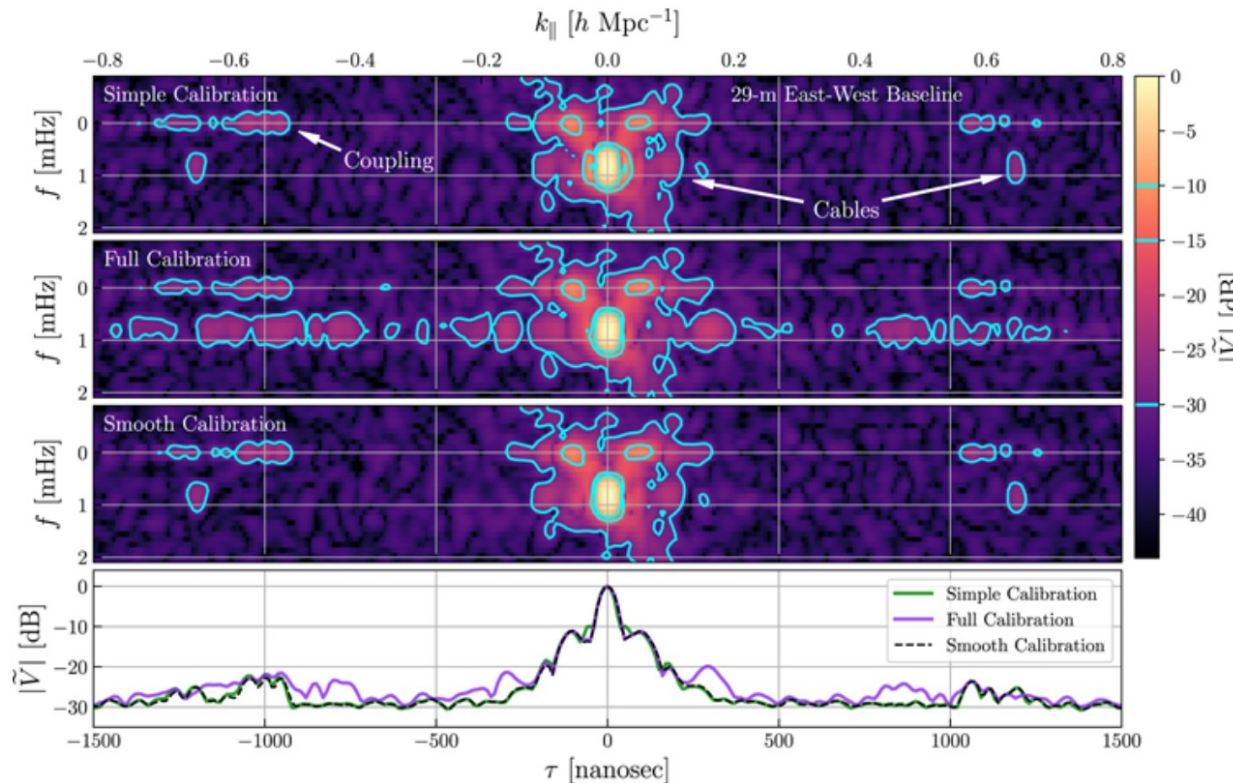
Conclusions

- Interesting technique

- Going into HERA Telescope 21cm power spectrum pipeline

- What does it do to the signal? Apart from anticipated benefits

  - Signal loss

  - Noise statistics modified. Error bars modified.