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LOFAR observations of radio burst source sizes and scattering in the solar corona

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Introduction

- Low frequency radio wave propagation in the solar corona is not fully understood.
- Scattering of radio waves off of density inhomogeneities plays a key role in the observed source sizes of radio bursts.
- Directly fitting interferometric visibilities to determine radio burst size and position.
- Can this lead to better understanding of scattering/turbulence?

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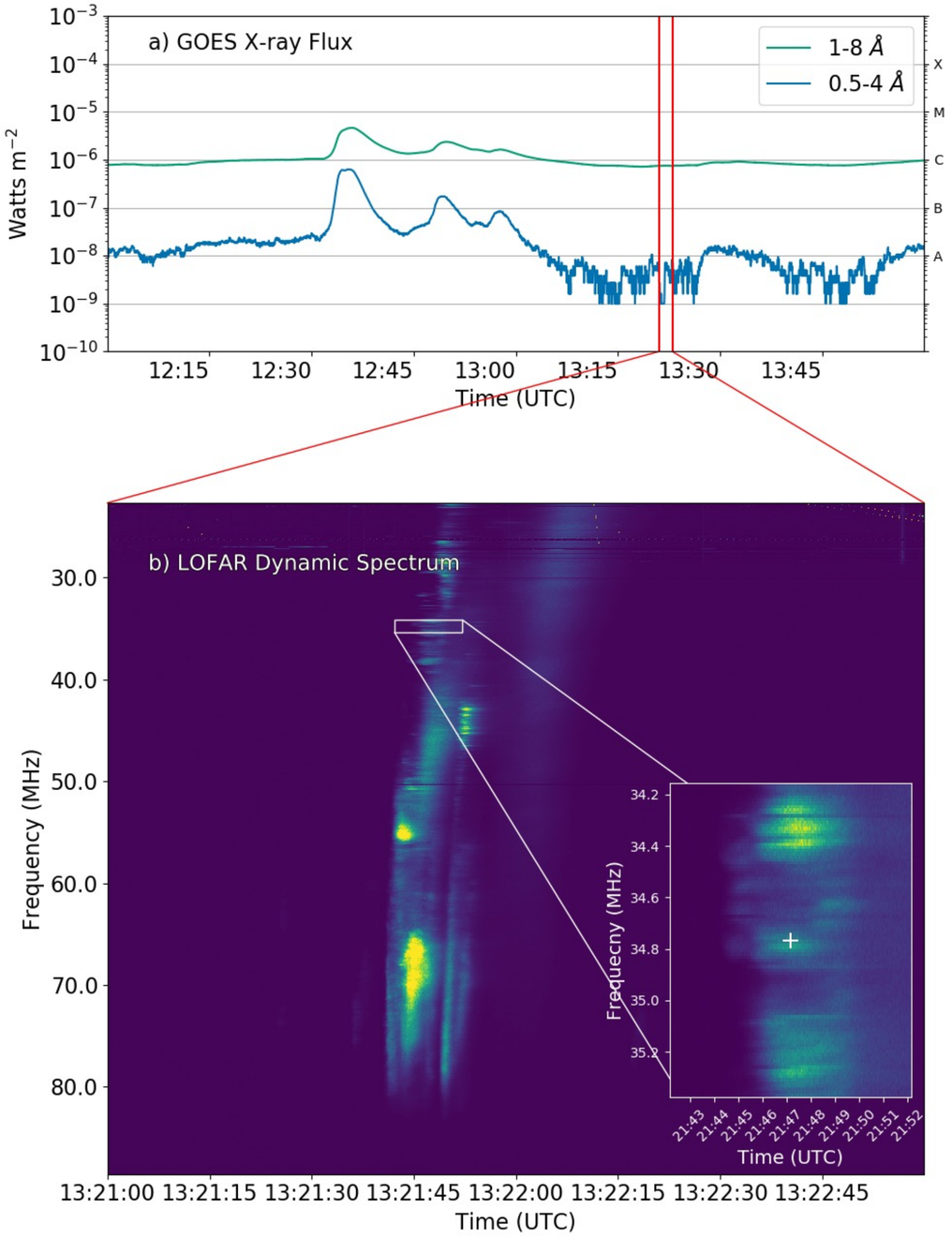
Observation

- Type IIIb burst on 2015-10-17 from 13:21UTC
- Observed with LOFAR core and remote stations
- 86 km baseline, sub-arcminute resolution (~ 22 arcseconds at ~ 30 MHz)
- Expected source size ~ 3.18’’



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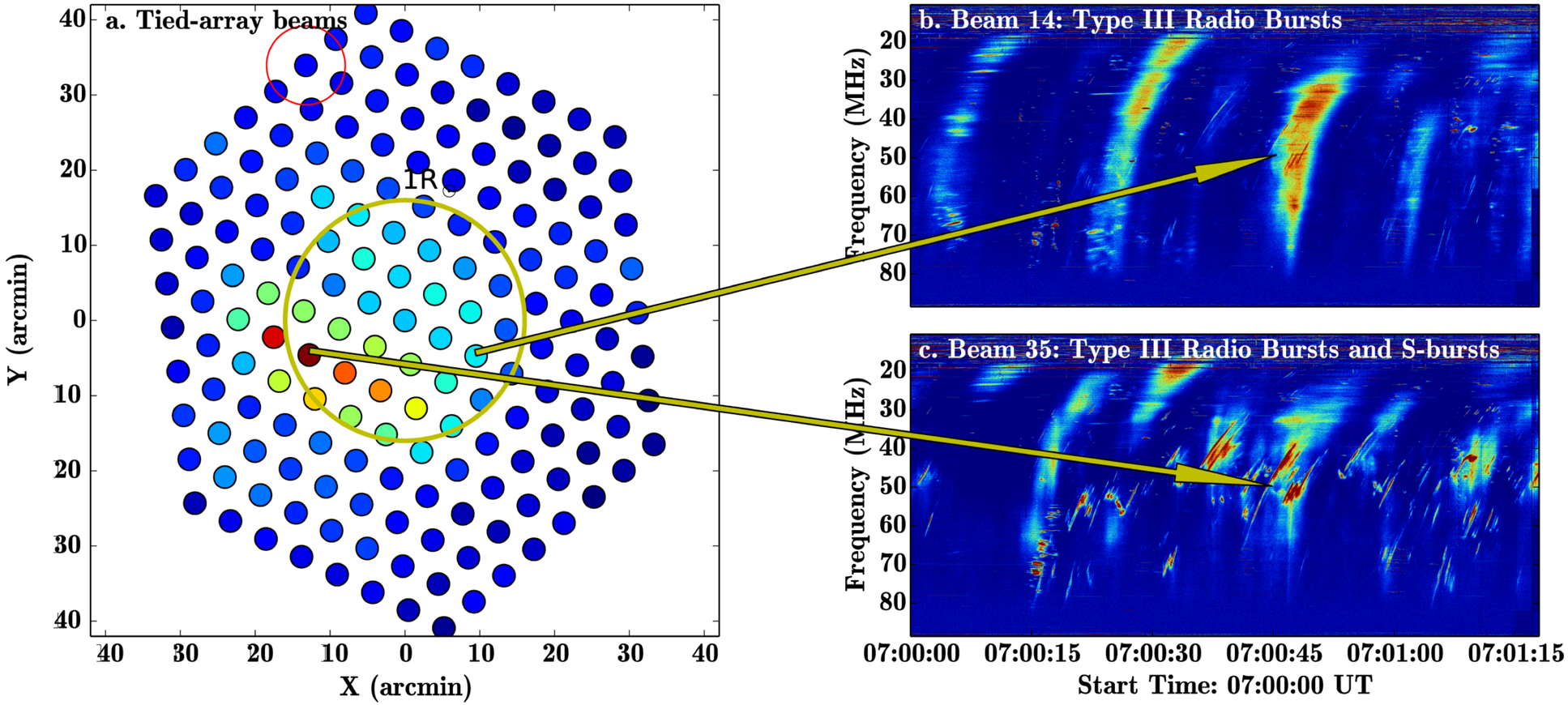
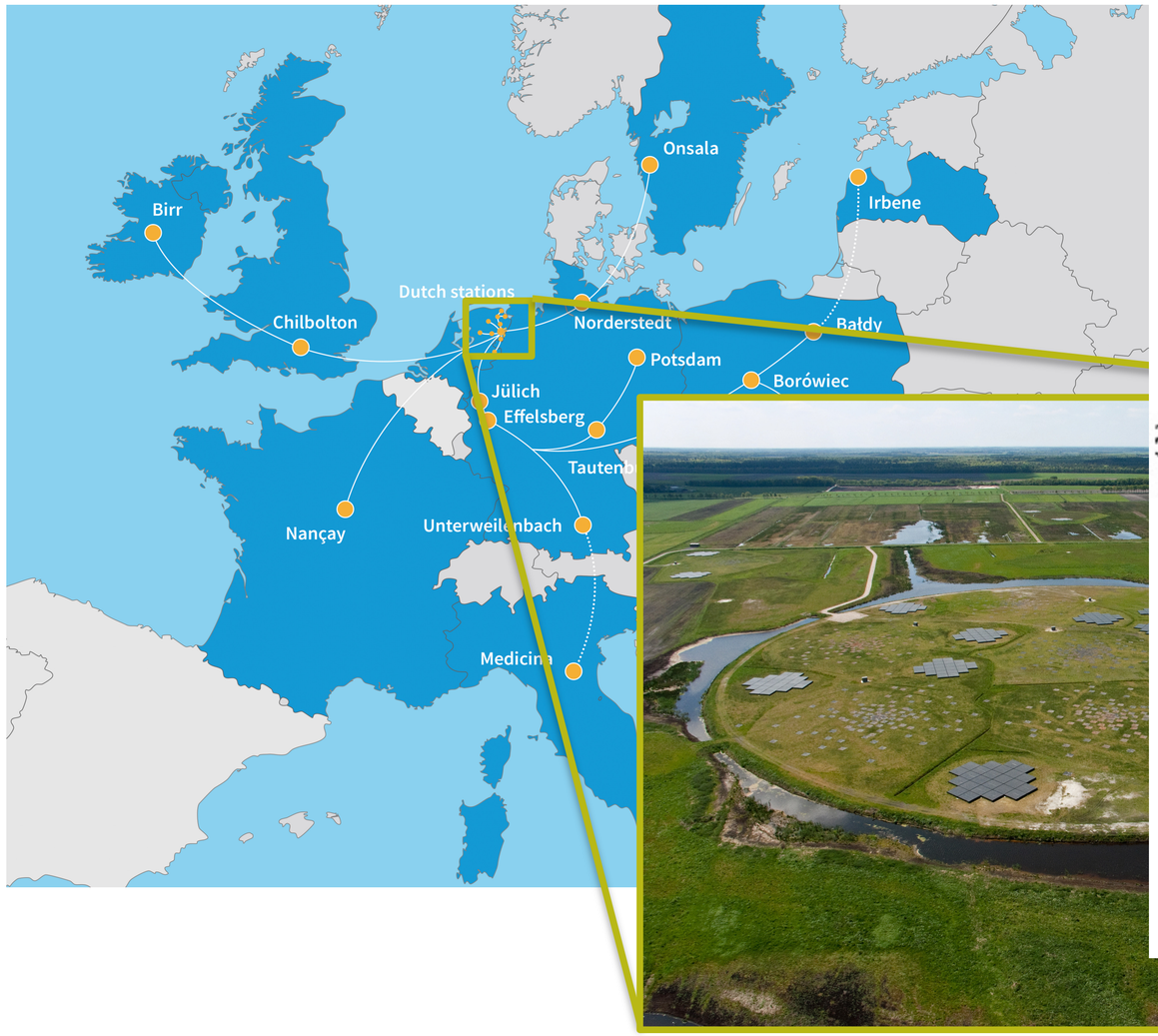
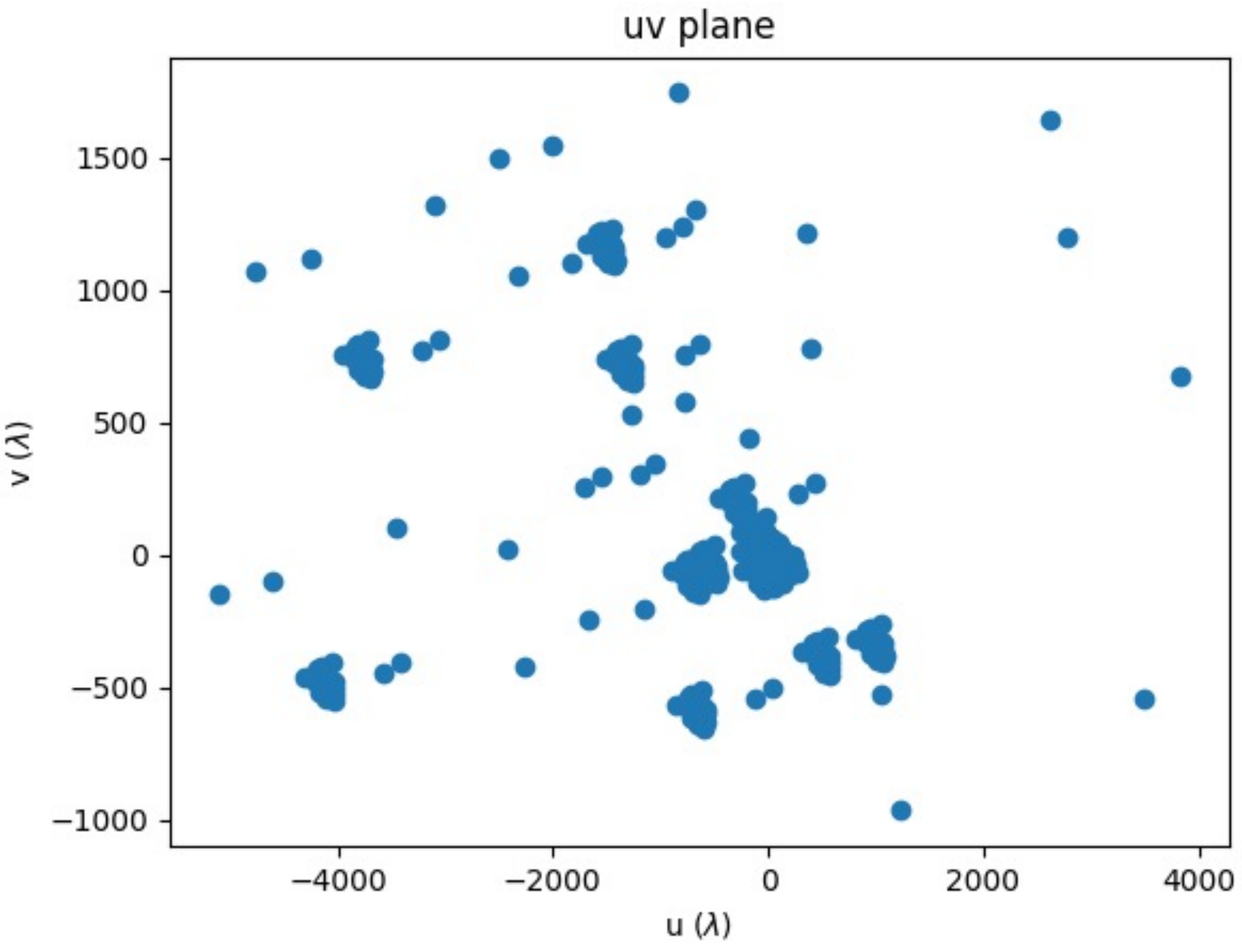
Interferometry vs Tied-Array



Morosan et al. 2015

LOFAR in Fourier Space





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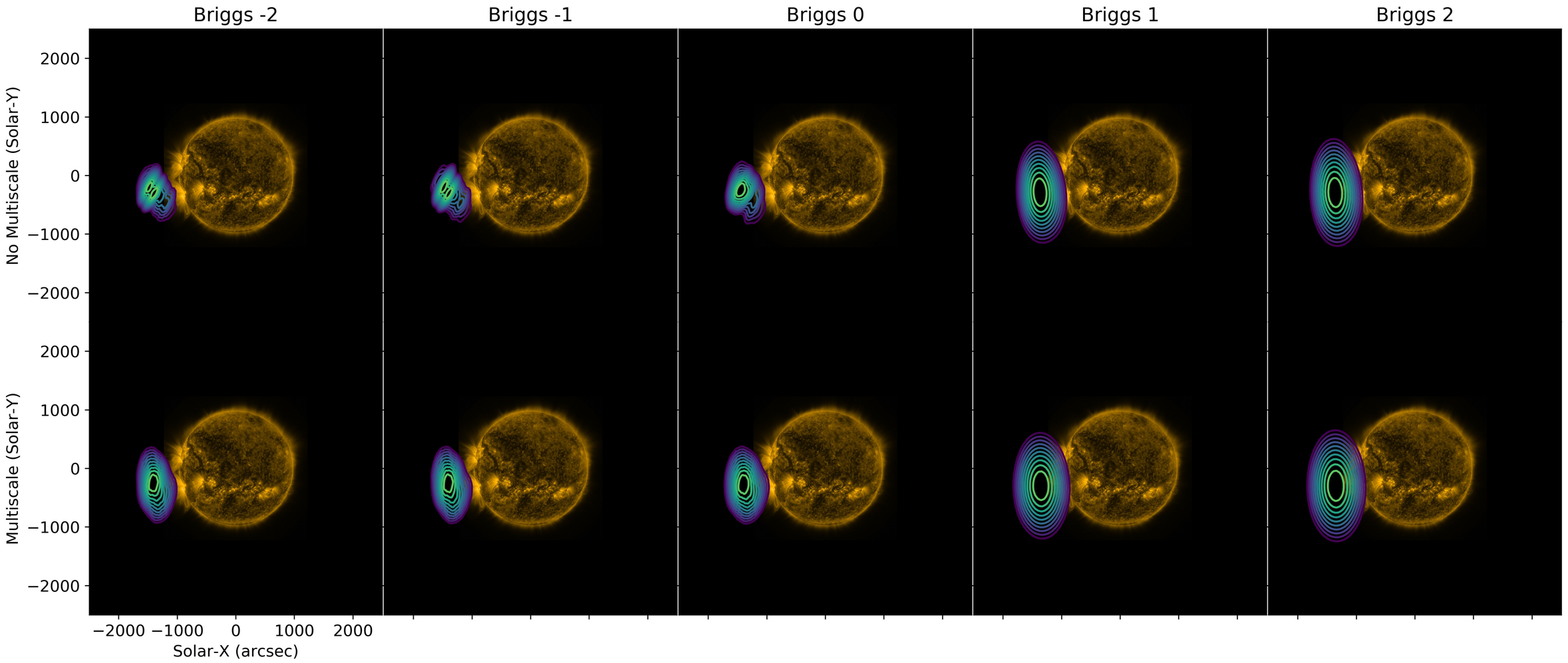

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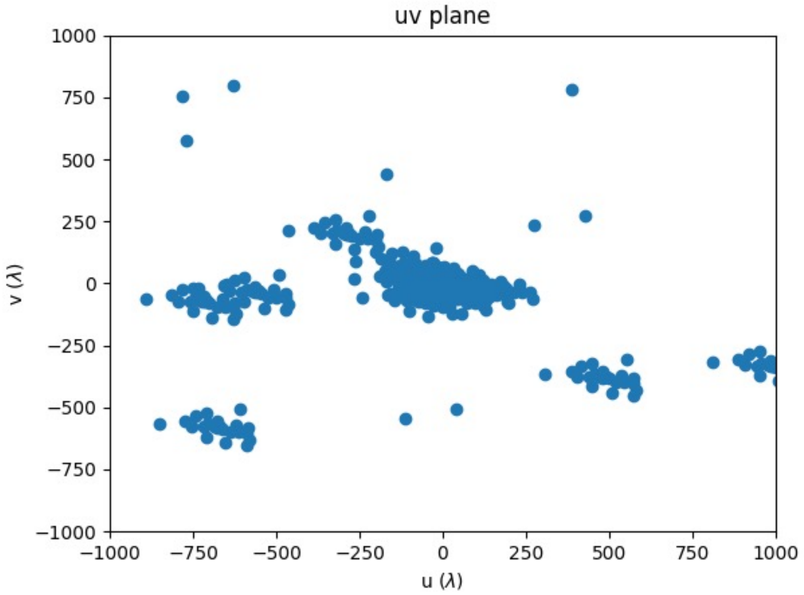
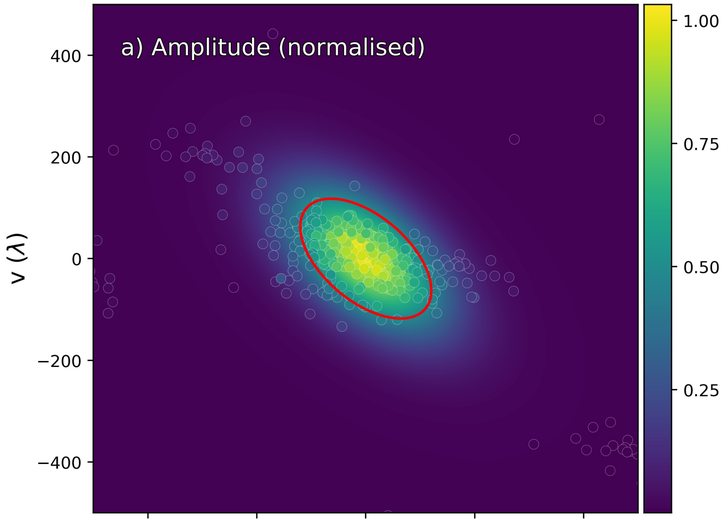
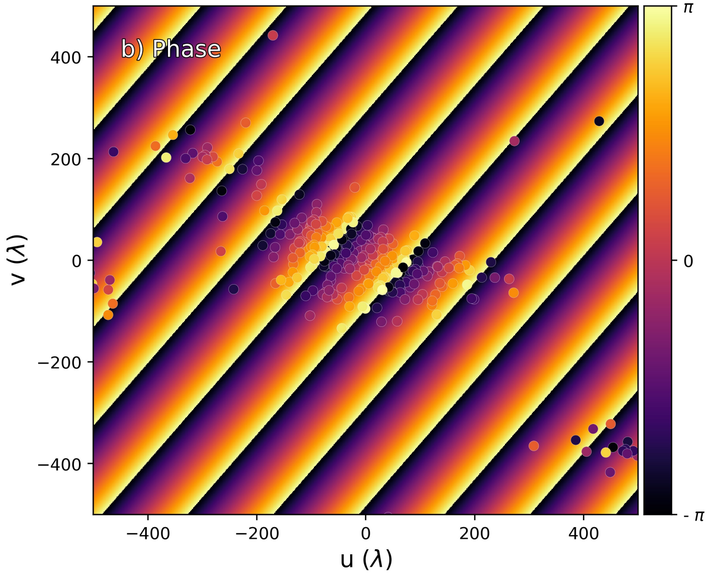
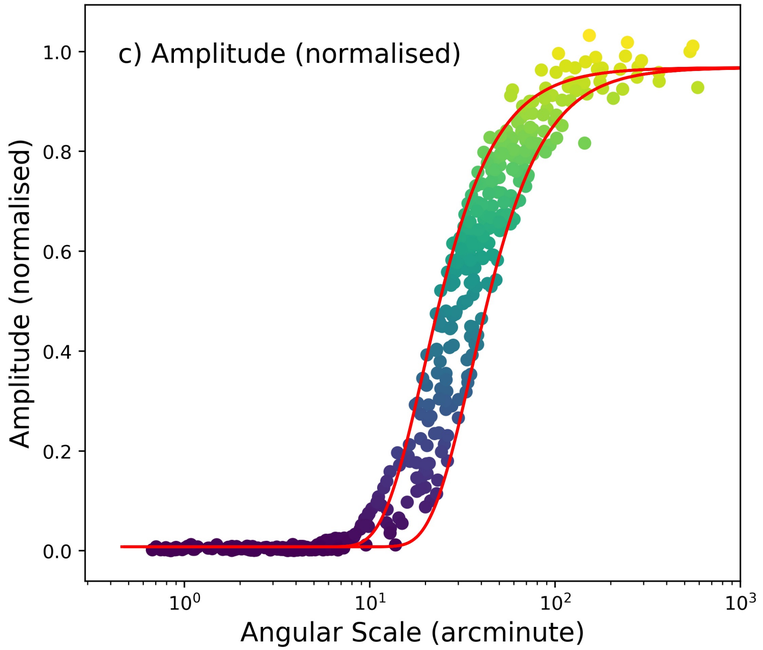
Direct fitting visibilities









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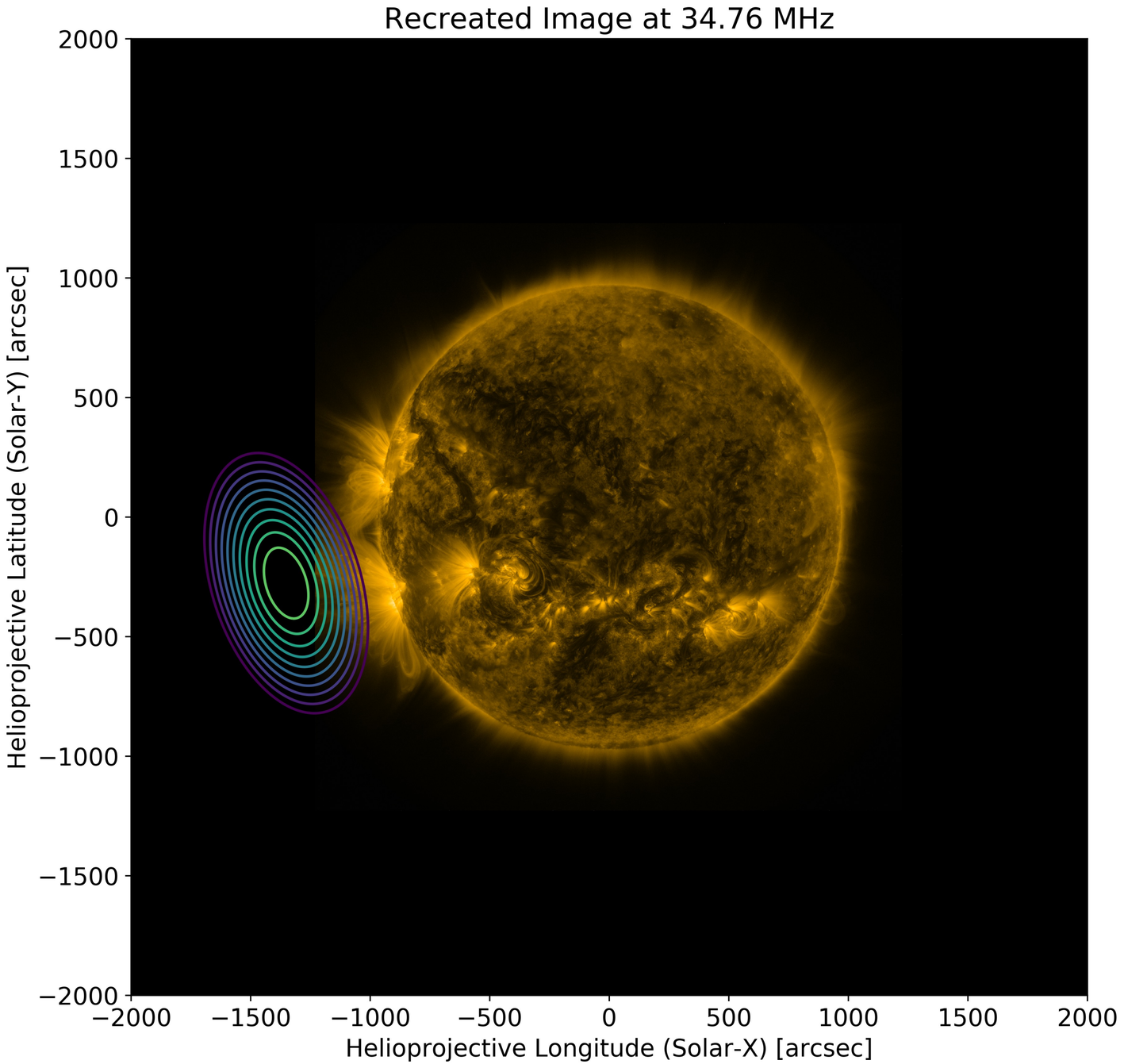

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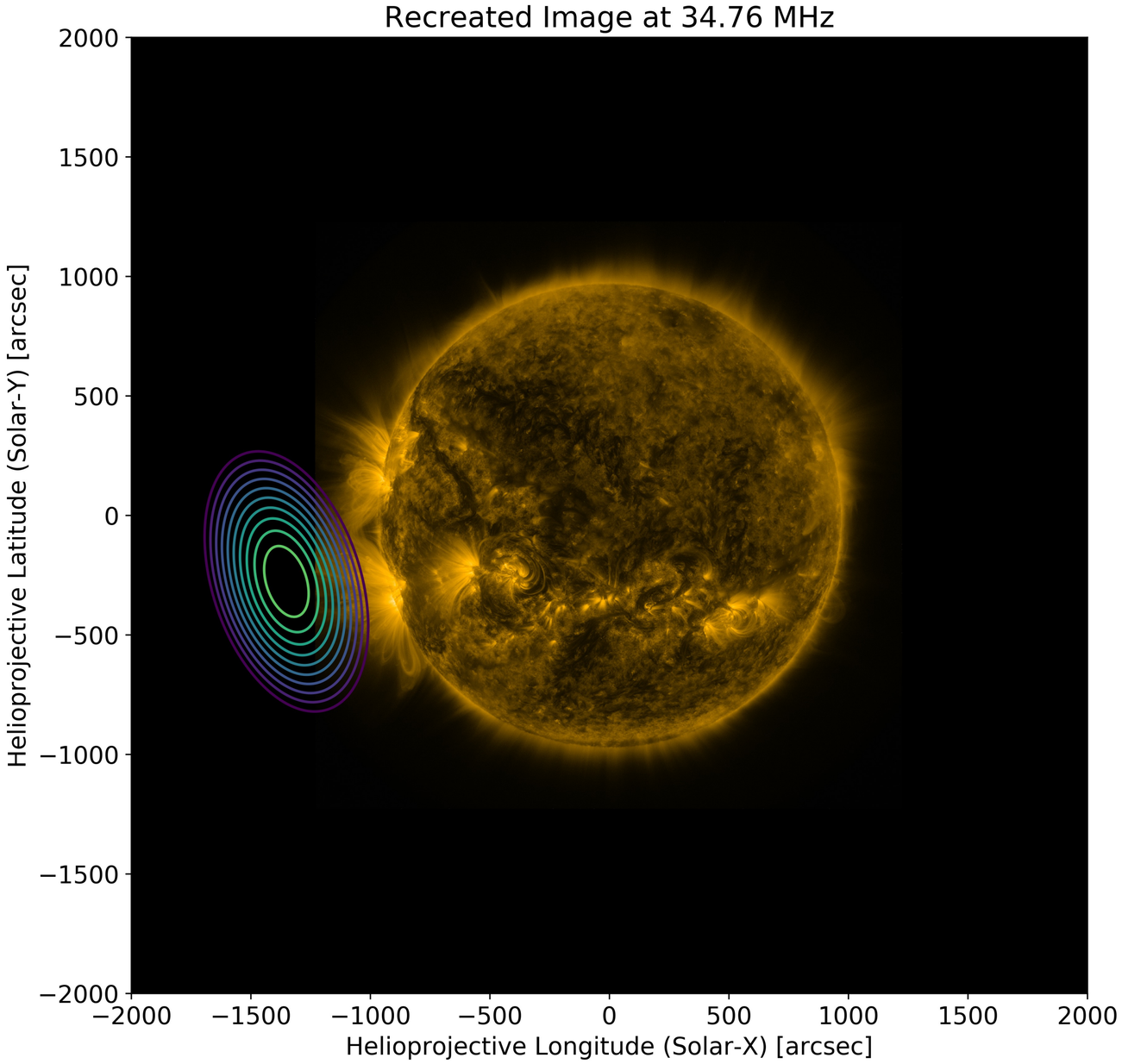
Results

- Major FHWM 18.8’ ± 0.1’
- Minor FWHM 10.2’ ± 0.1’
- Larger than expected from spectroscopy
- Smaller than previous tied array images



What does this mean?

- Scattering off turbulent density inhomogeneities causes large size.
- RMS density fluctuations may be smaller than determined from tied-array observations alone.
- Further comparisons between interferometric, tied-array and modelling needed.

Summary

- Type IIIb burst observed on 2015-10-17.
- Directly fitting in Fourier space avoids artefacts of deconvolution.
- Recreated image shows source larger than predicted.
- Source is still smaller than previous tied-array observations.
- Comparison of tied-array observations and modelling may overestimate the relative level of turbulent density fluctuations.