LOBOS: The Long Baseline Calibrator Survey

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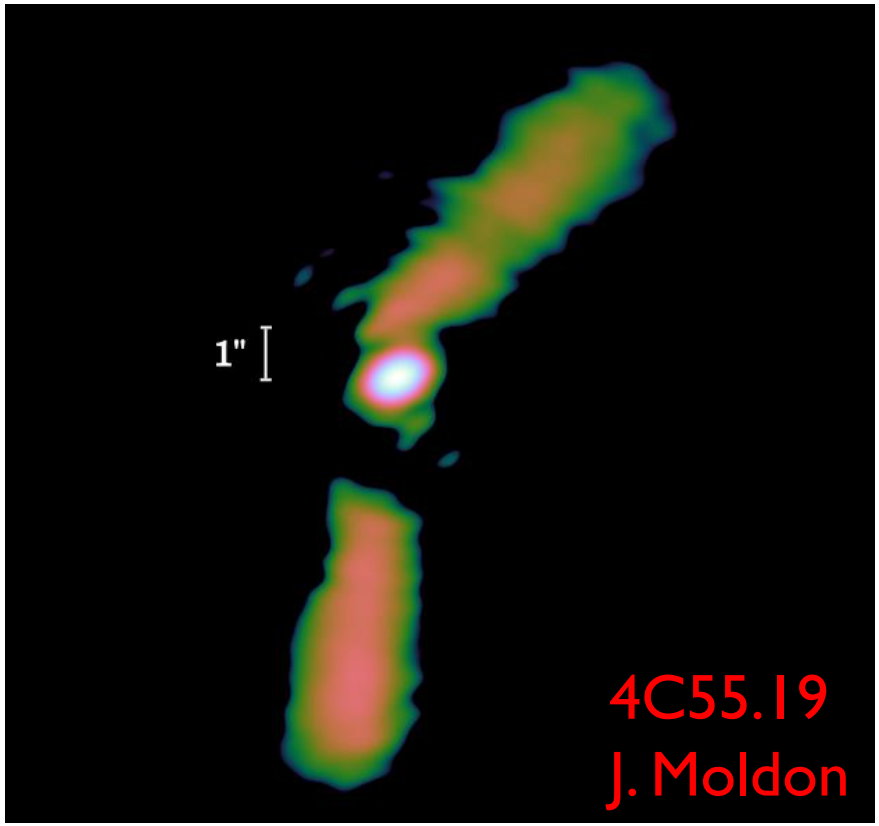
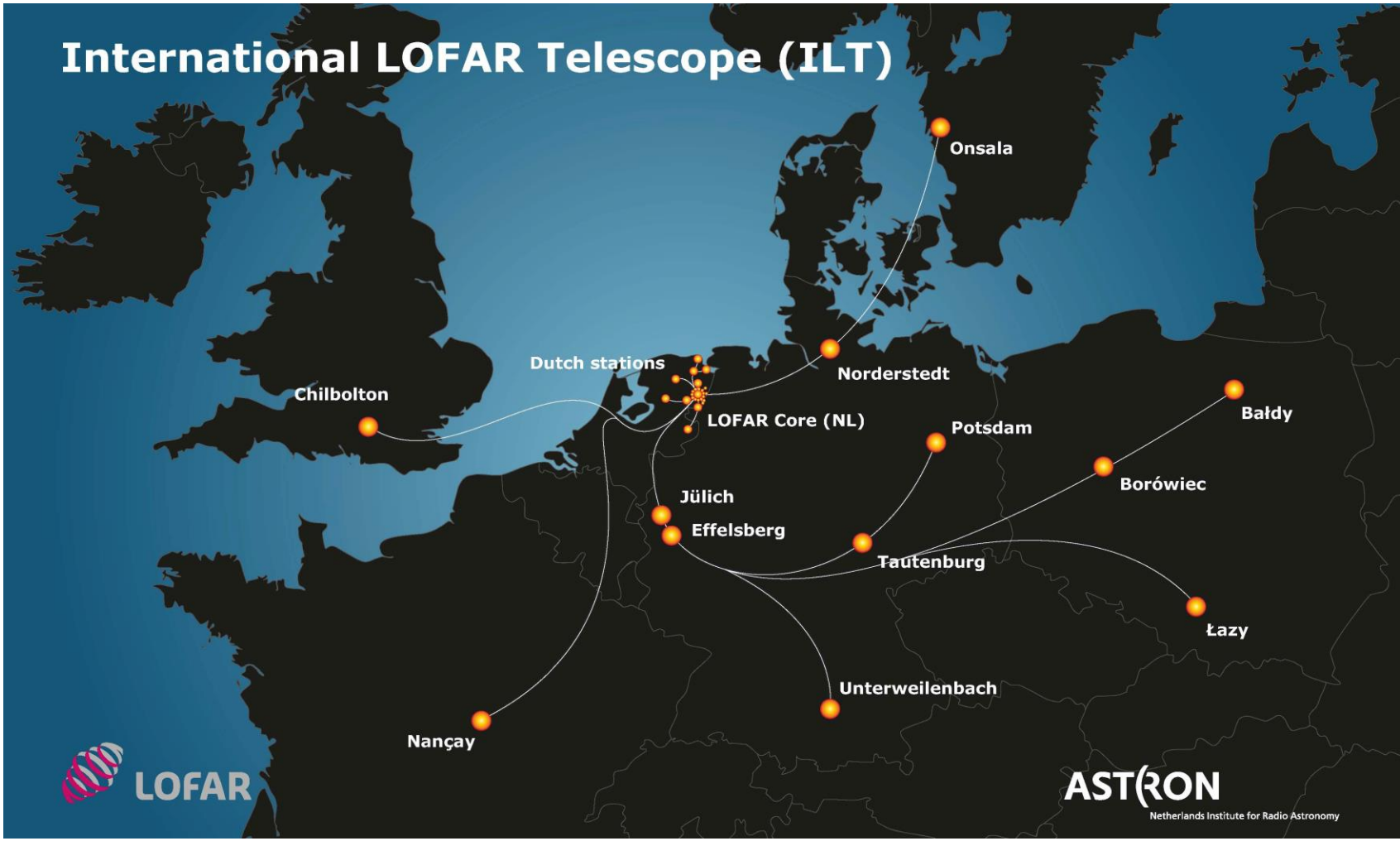


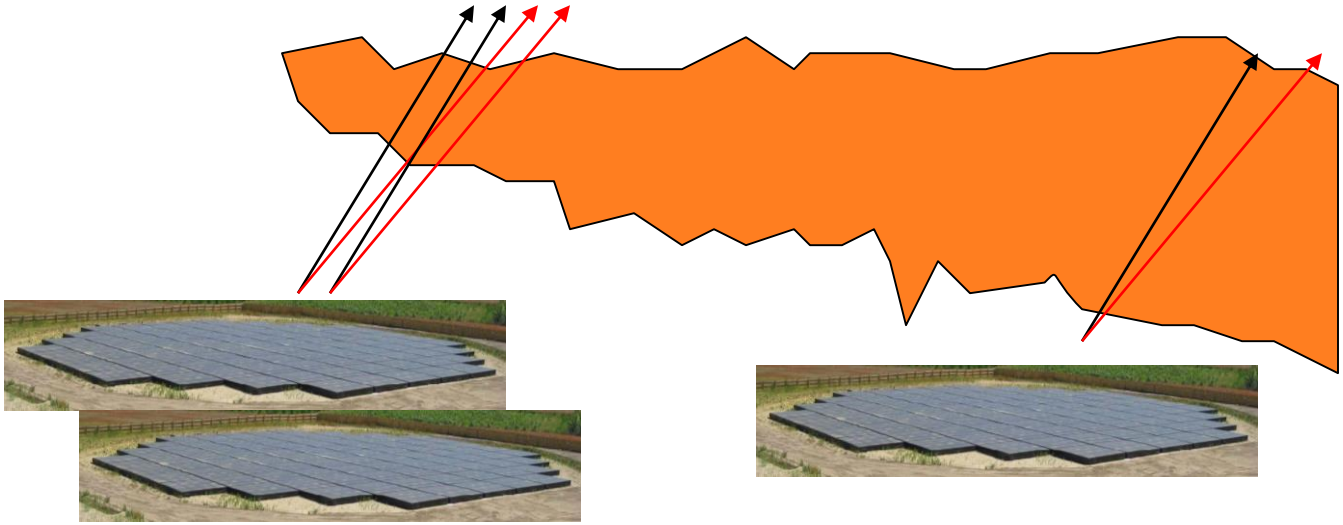
ASTRON

The Long Baseline Situation



The Long Baseline Problem, (1)

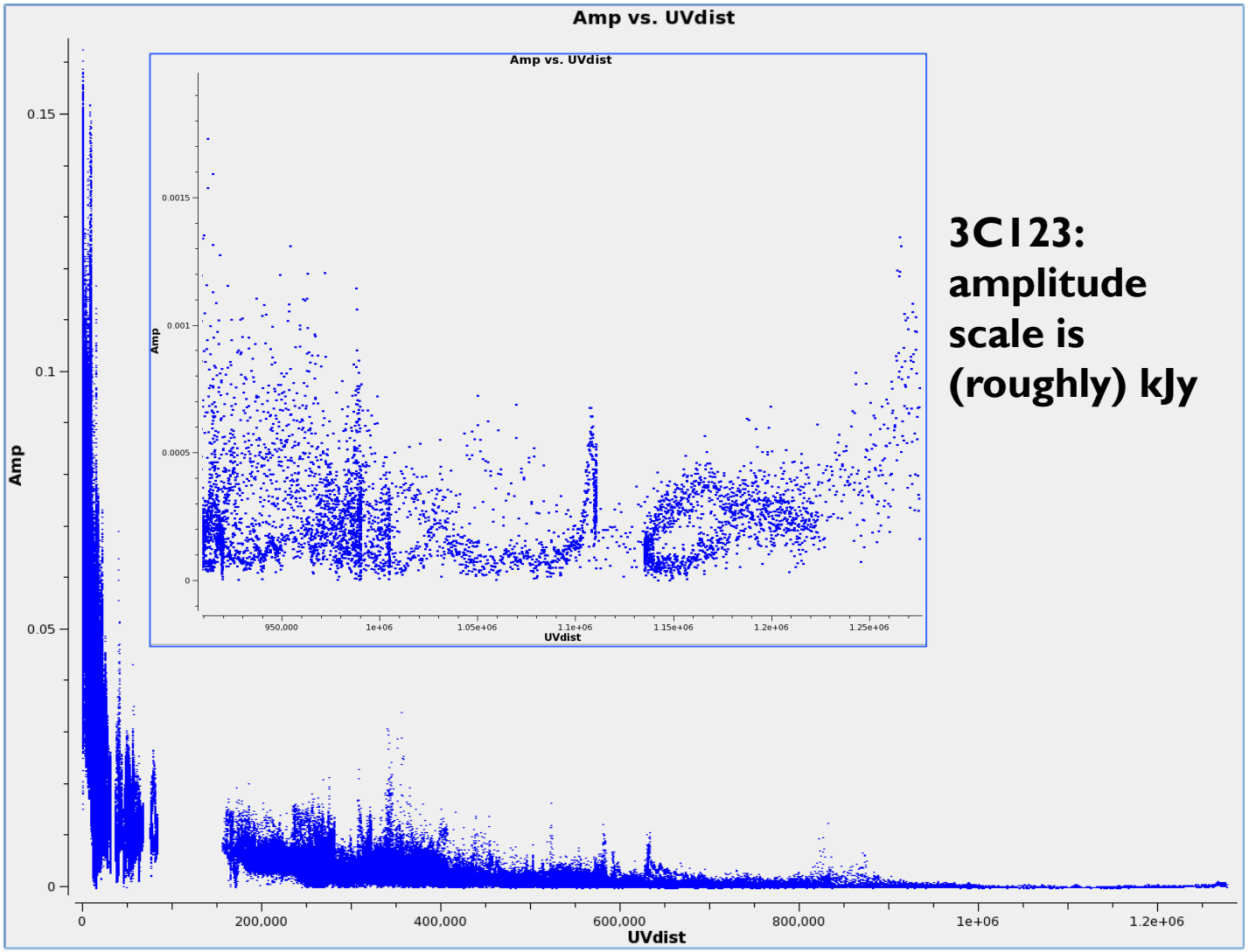
LOFAR enemy #1: Ionosphere



On a short baseline, the absolute ionospheric path delay difference is small, and the differential spatial gradients are small

On a long baseline, the absolute ionospheric path delay difference is **large** (phase changes rapidly with frequency) and the differential spatial gradients are **large** (phase changes rapidly with direction)

The Long Baseline Problem, (II)



3C123: amplitude scale is (roughly) kJy

The Long Baseline Problem

To summarise:

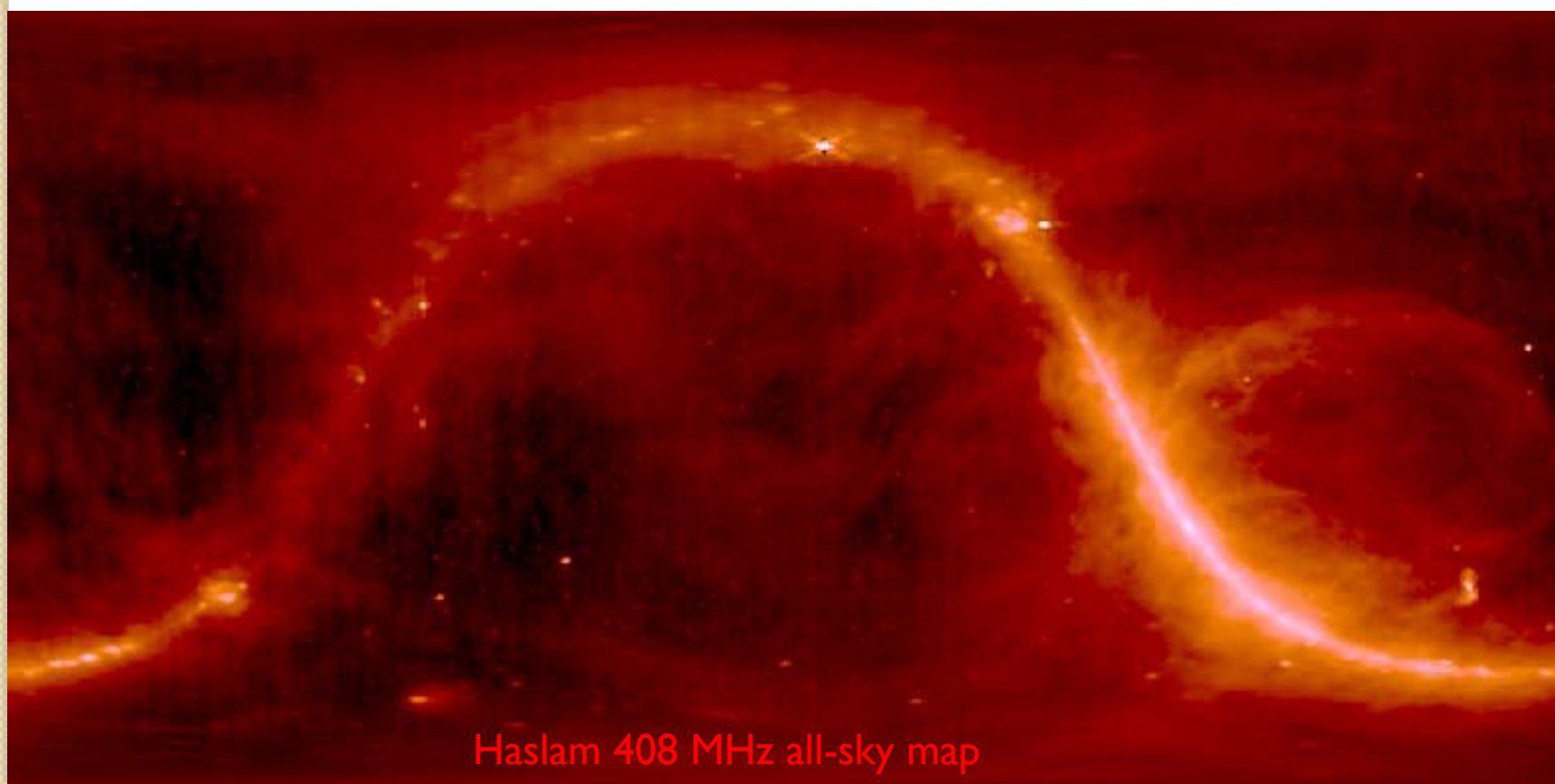
- Calibrators are (much) fainter/more complicated, and you can't even average in frequency to (partially) compensate
- The standard LOFAR data reduction approach will not work (except for maybe the brightest few sources in the sky)
- What do you need?

Long Baseline observations need:

- A custom approach:
  - Form "super-station" TS001 by summing core
  - Borrow tools from VLBI: solve **delay** and **rate**
- Compact calibrators
  - Significant flux on scales < 0.3 arcseconds
- Close calibrators
  - Experience says within 0.5-1 degrees
- What you need is: **LOBOS**

What is LOBOS?

HBA commissioning project to identify 20000+ long baseline calibrators (~1/sq. deg.) at dec >0° (+*30*°)

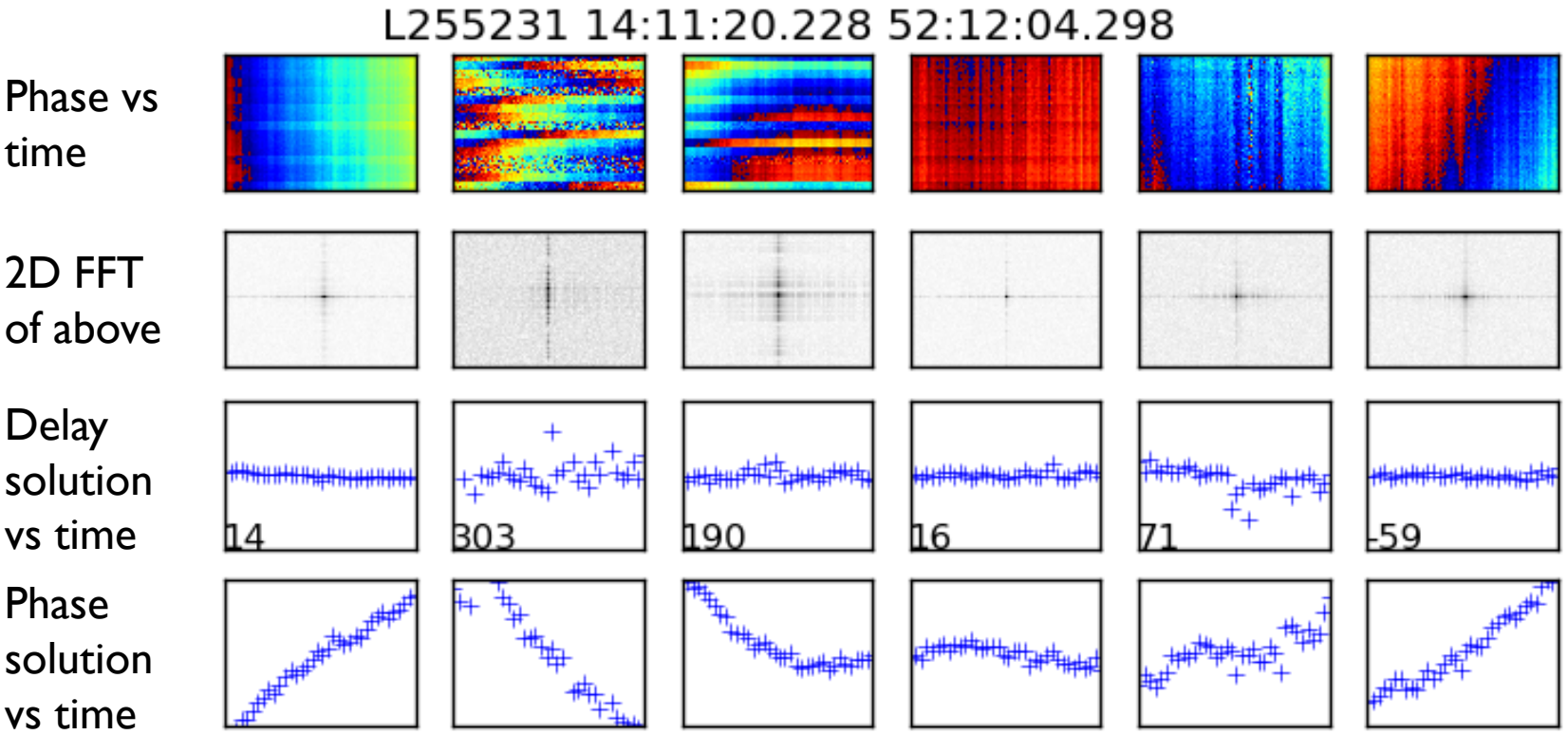


Haslam 408 MHz all-sky map

LOBOS setup

- Based on "snapshot" survey (Moldon et al., 2015, A&A, 574, 73)
- Observe sources with S_{150MHz} > 100 mJy
- 16 subbands = 3 MHz / beam
- 3 minute scans, 30 beams / scan
- **300 sources inspected per hour**
- Long baseline pipeline eases logistics
- No *uv* shifting/widefield mapping means simple/fast processing, smaller data volumes

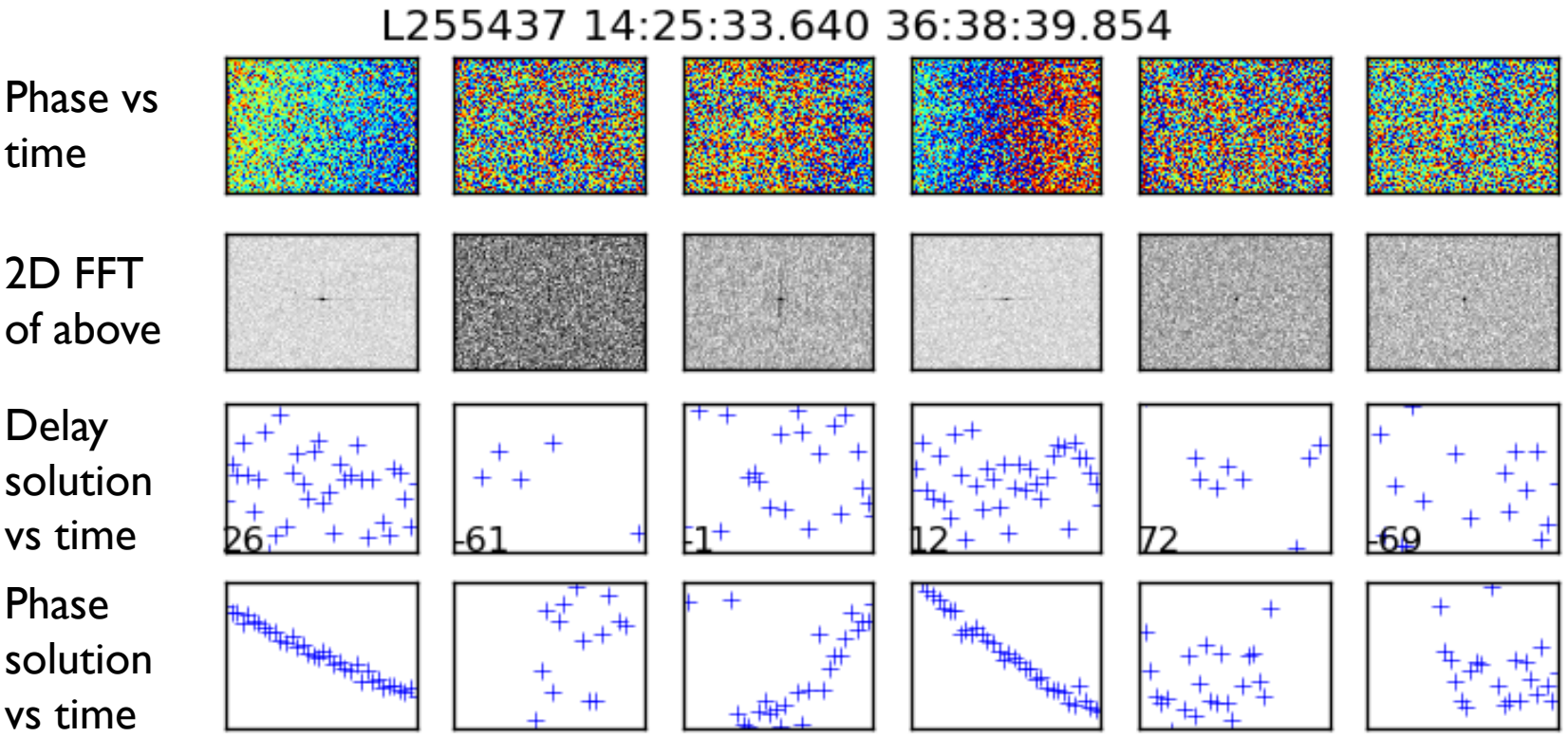
Example results



“Very good” source

Images courtesy N. Jackson

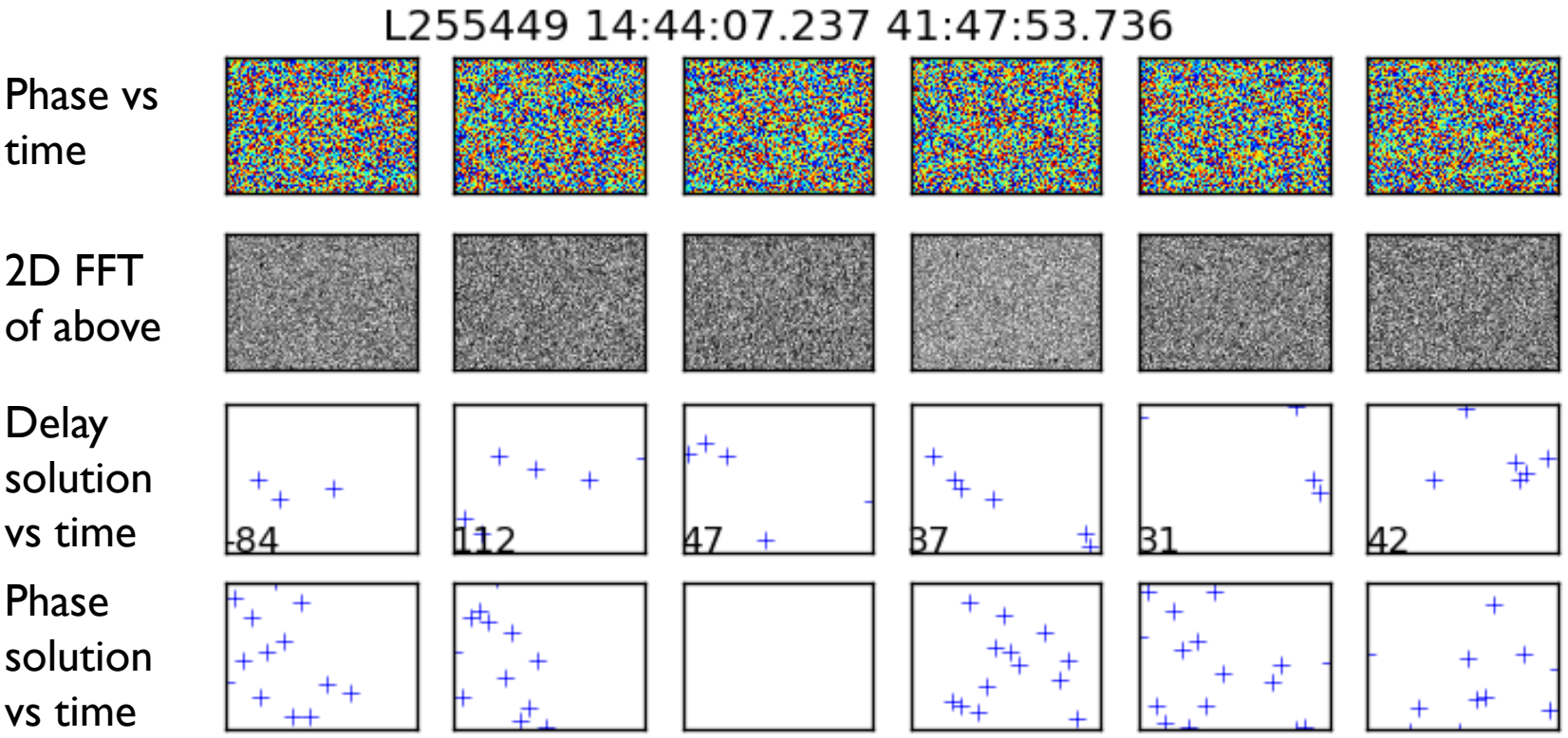
Example results



"Marginal" source

Images courtesy N. Jackson

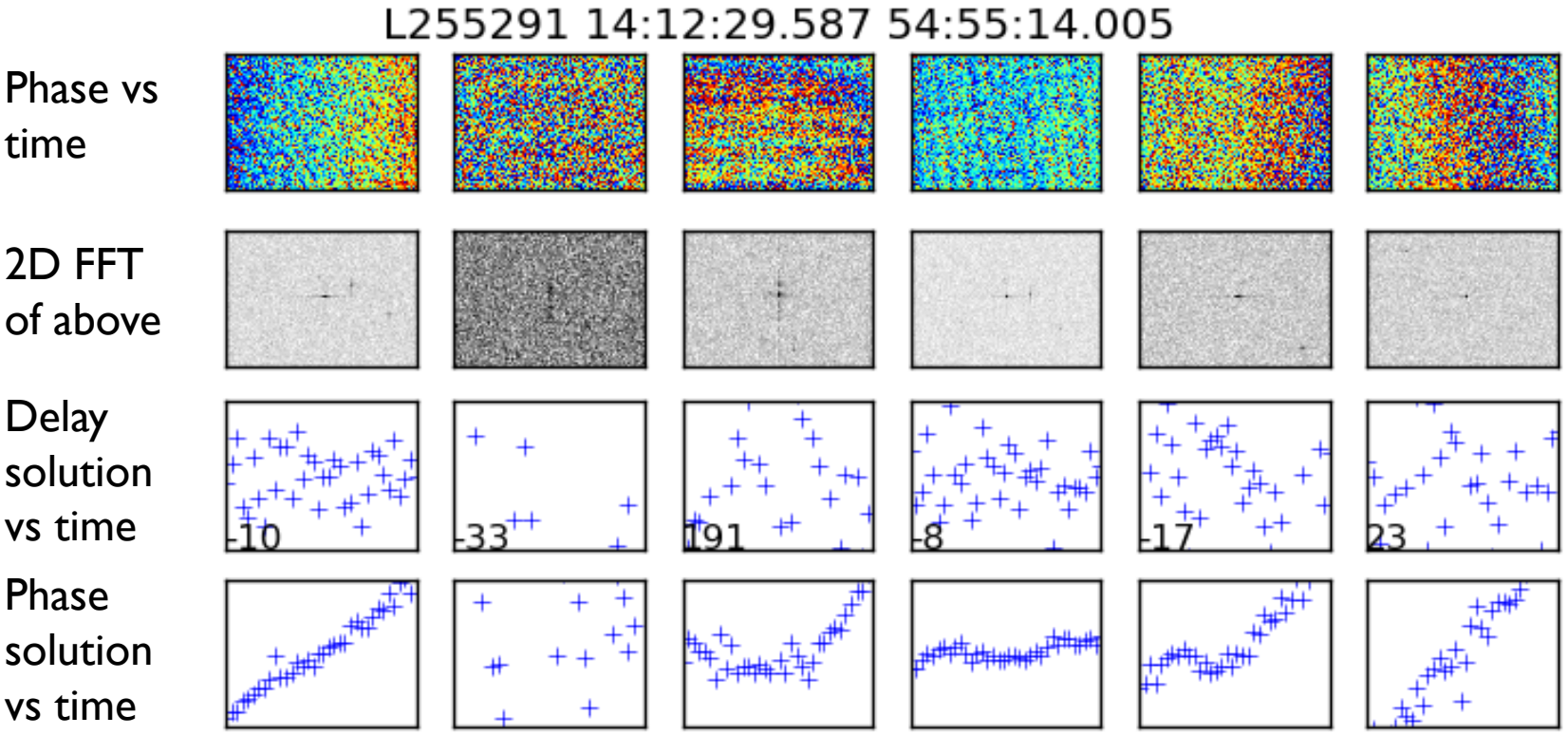
Example results



"Useless" source

Images courtesy N. Jackson

Example results



"Good" and "interesting" source

Images courtesy N. Jackson

LOBOS status

- 31 hours (>7,000 sources) observed, about half reduced
  - Big thanks to RO+Michiel: much manual work!
  - Detection rate >30%
  - Data has been affected by incorrect BBS parset which reduced sensitivity (now fixed)

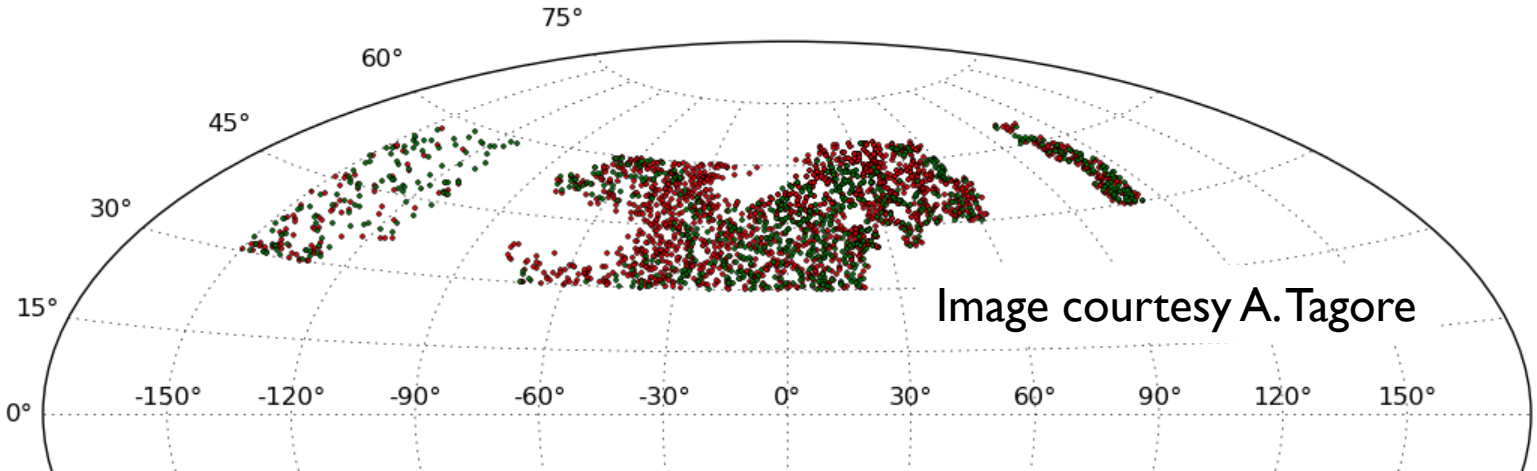


Image courtesy A. Tagore

What next?

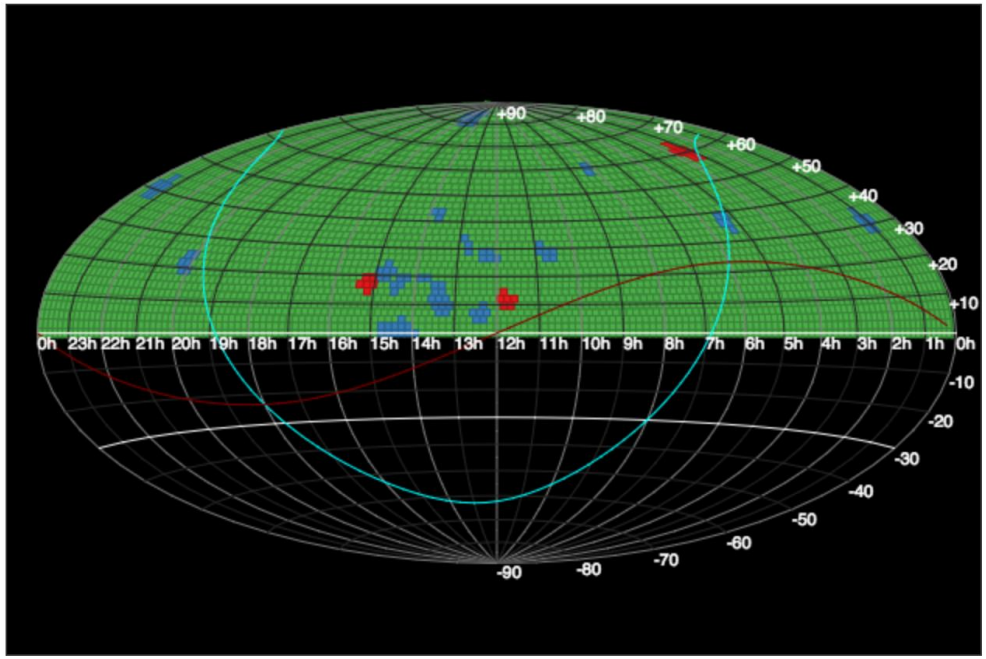
- Finish observing (next few months)
- Make results available
  - Ideally: via the infrastructure in place for MSSS

LOFAR Observation Database

MSSS HBA

Number of Targets	3616
Number of Calibrators	8
Start Date	8 Feb. 2013
Stop Date	11 May 2014
Completed Fields	3514 (97.2%)
Information collected	28 May 2014

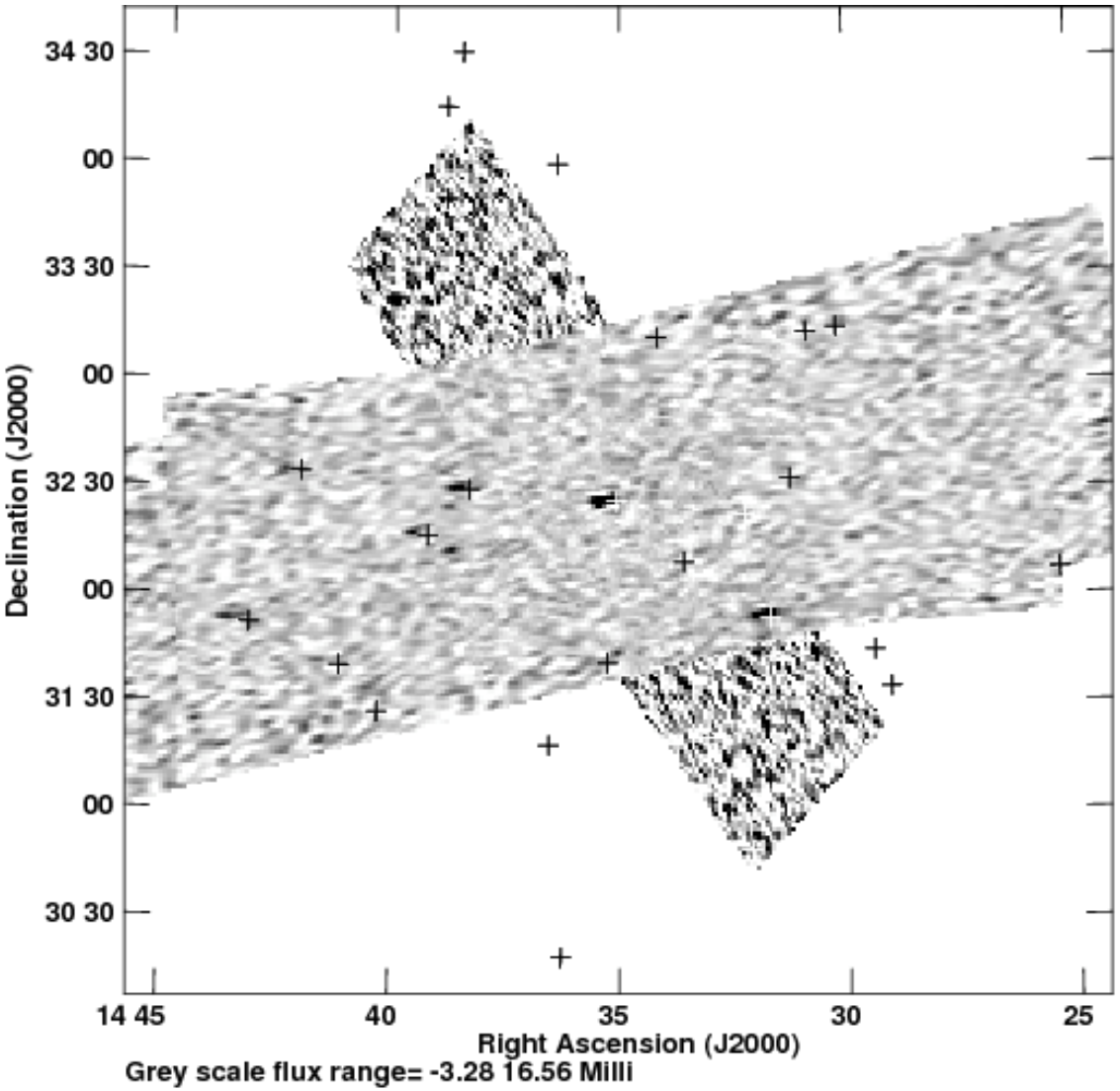
Show me the data »



What next?

- Finish observing (next few months)
- Make results available
  - Ideally: via the infrastructure in place for MSSS
- Publish (of course)
- Squeeze more science out of the data
  - Fringe rate mapping to locate more sources in the fields

Fringe rate mapping



N. Jackson;
Daily image
from 27-05-2015

Greyscale is
fringe rate map,
crosses are
WENSS sources

2D FFT (vis. vs time), rotate/scale baselines, sum

Can use to identify useful regions to image

Conclusions

- LOFAR long baselines are "coming of age"
  - Before end of 2015, you will be able to "just do" a HBA observation at dec >30°
  - Helped by LC4_036 (CSS "fringe finders")
- The data interface is the next big challenge (looking to partner with RO)
- Upcoming: LOFAR long baseline workshop, mid/late August
  - Busy week + advice to new players
  - Sign up for info: longbaselinelofar@astron.nl