

Reaching the thermal noise near A-team sources: the Sausage cluster case

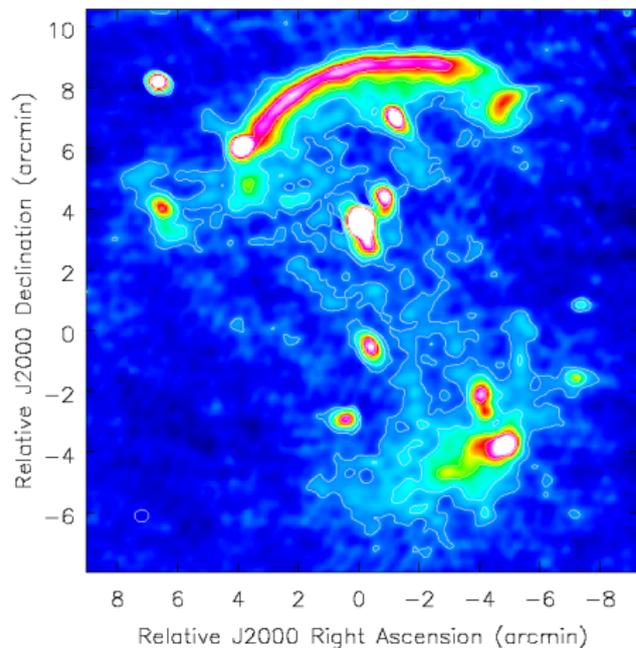
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LOFAR Status Meeting
ASTRON

March 2, 2016

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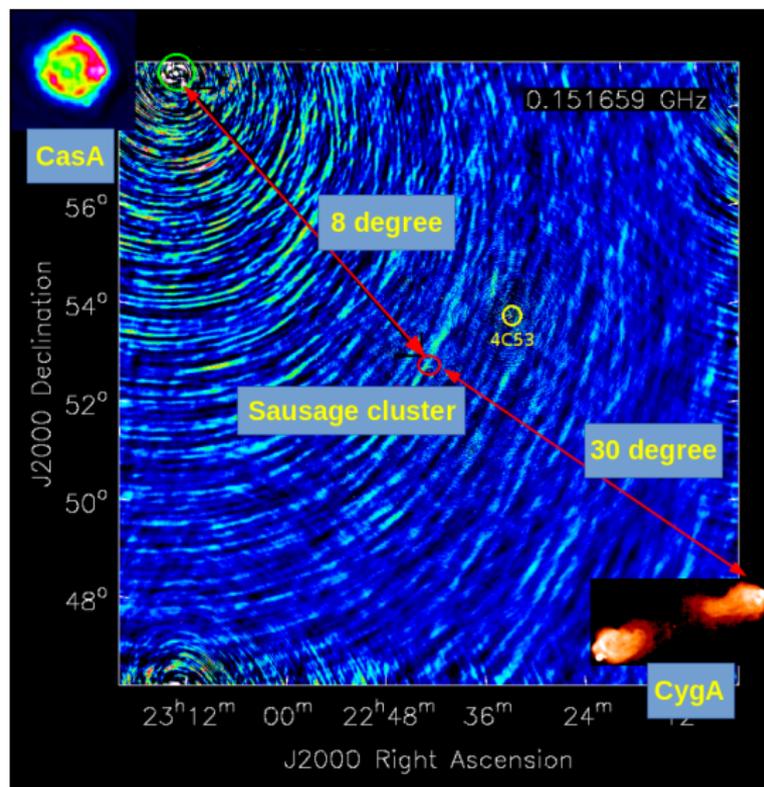
The Sausage cluster



The Sausage cluster with GMRT
153 MHz:

- Resolution: ~ 25 arcsec
- Noise RMS: 1.5 mJy/beam

The Sausage field



The Sausage field:

- CasA: 13 000 Jy (150 MHz), 8° away
- CygA: 10 900 Jy (150 MHz), 30° away
- The Sausage cluster (all sources): < 5 Jy

LOFAR FWHM: 3.8° at 150 MHz

Observations with LOFAR HBA 150 MHz

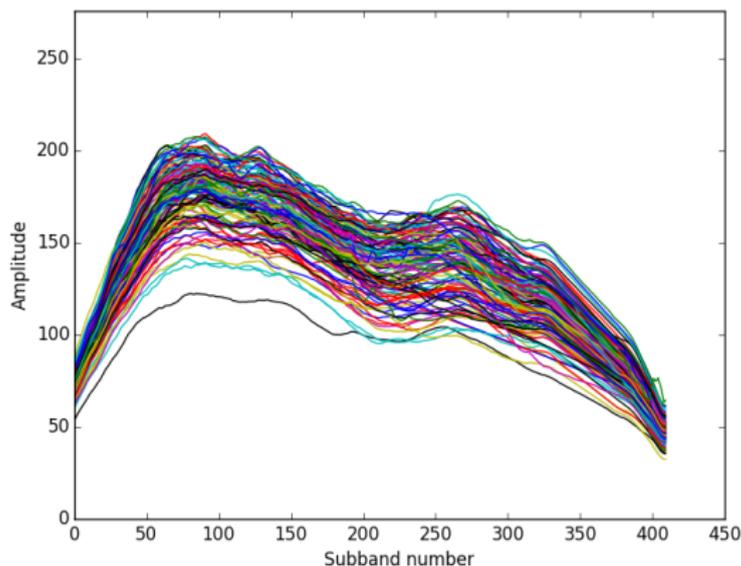
- Target: Sausage cluster
- Simultaneous observation: CasA
- Calibrator: 3C196
- Total observing time: 9.6 hours (Sausage, CasA), 10 minutes (3C196)
- Frequency range: 115 - 179 MHz (bandwidth 64 MHz)
- Resolutions: 64 channels/SB, 1 second integration
- Stations: 60 (46 split cores + 14 remotes)
- Correlations: XX, XY, YX, YY
- Daytime observations (Feb. 21, 2015)

Data reduction strategy

- Flag RFI contamination/bad stations
- Remove Ateam sources:
 - demix CasA (8° , used high resolution skymodel ($10''$))
 - clip CygA (30°), TauA (80°), HerA (85°)
- Non-directional calibration:
 - Amplitude calibration
 - Clock-offset correction
 - XX-YY phase offset correction
 - Non-directional phase calibration (GMRT 150 MHz skymodel)
- Directional calibration
 - Facet calibration scheme (Weeren et al. 2015, Williams et al. 2015)

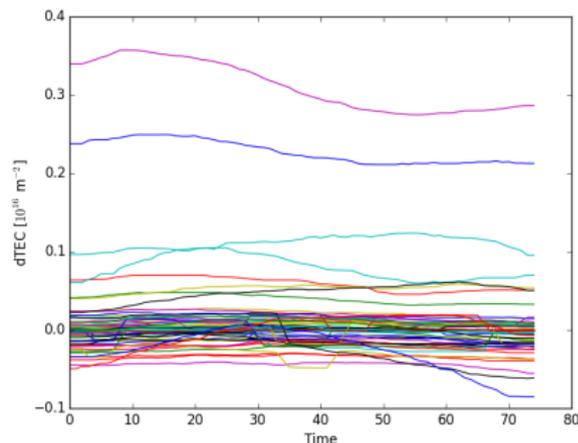
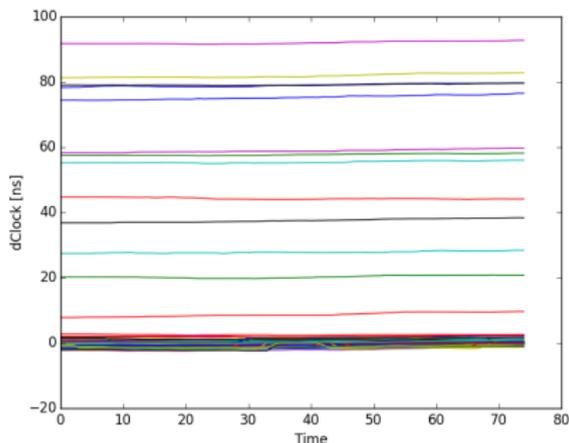
Non-directional calibration: amplitude

- Solve for gain solutions (XX, YY) using the primary calibrator 3C196 (also correct for Faraday rotation effect)



Non-directional calibration: initial clock offset

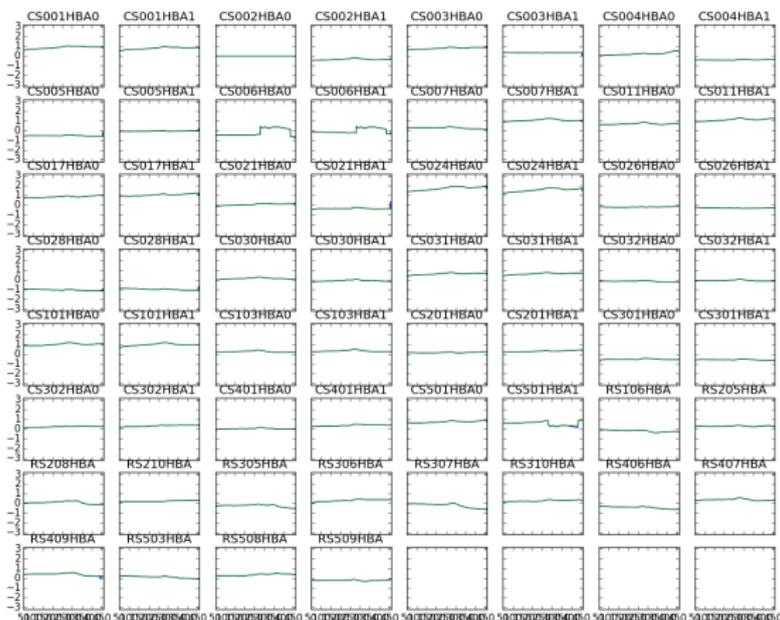
- $phase\ difference(\nu, t) = 2\pi p_0(t)\nu - \frac{8.448 \cdot 10^9 p_1(t)}{\nu} [rad],^1$
where p_0 : clock difference, p_1 : TEC difference



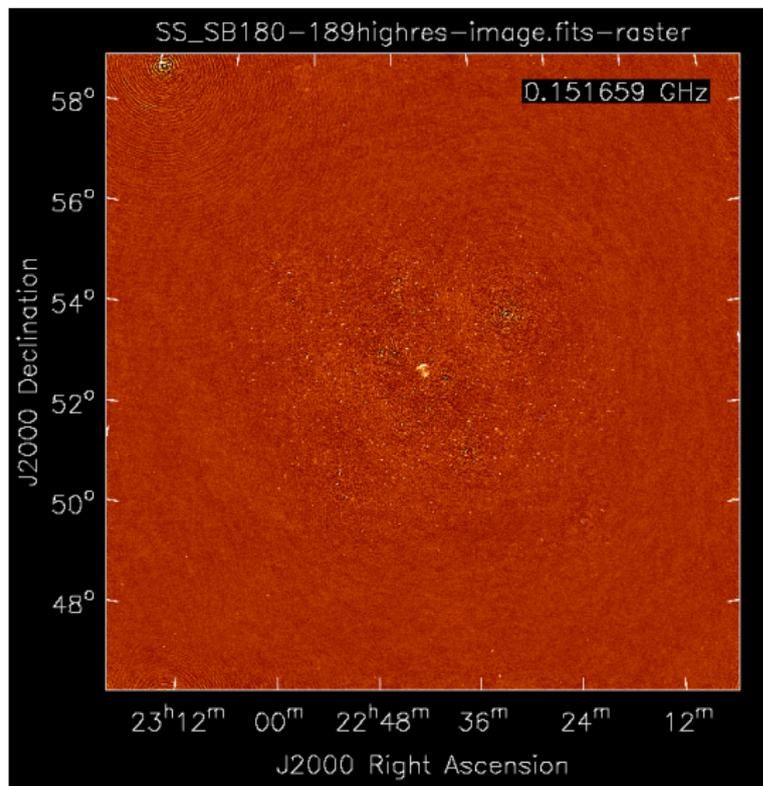
¹Weeren et al. 2015

Non-directional calibration: XX-YY offset

- The XX-YY offset is estimated as the median phase difference between the XX and YY phases for each station.



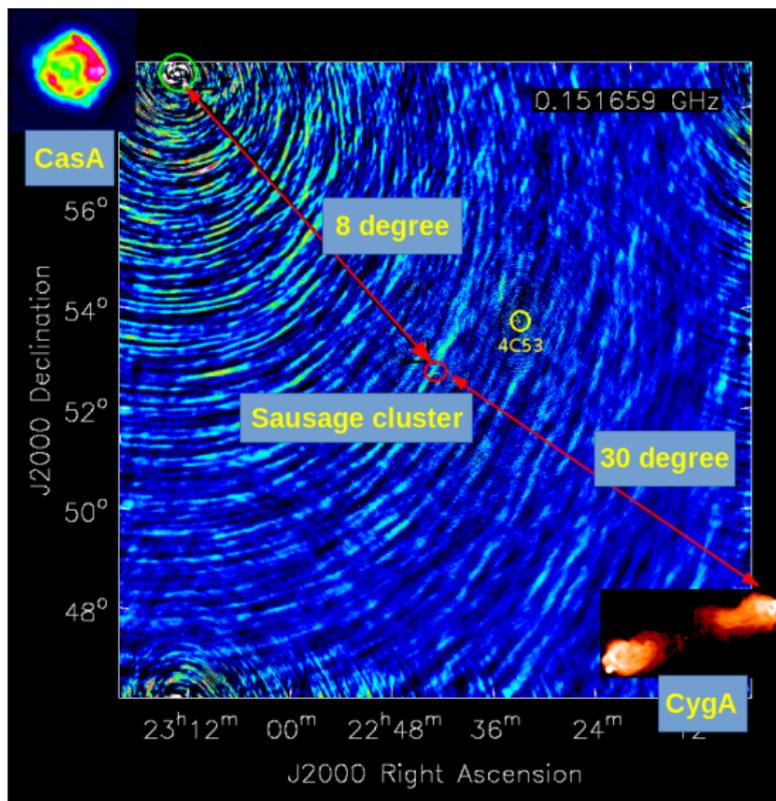
Non-directional calibrated image



Compare with expectations

- noise RMS: 2-4 mJy/beam ($\approx 40 - 80$ times the thermal noise)
- resolution: ~ 25 arcsec (≈ 5 times the expected resolution)

Comparison: the Sausage field (with CasA)



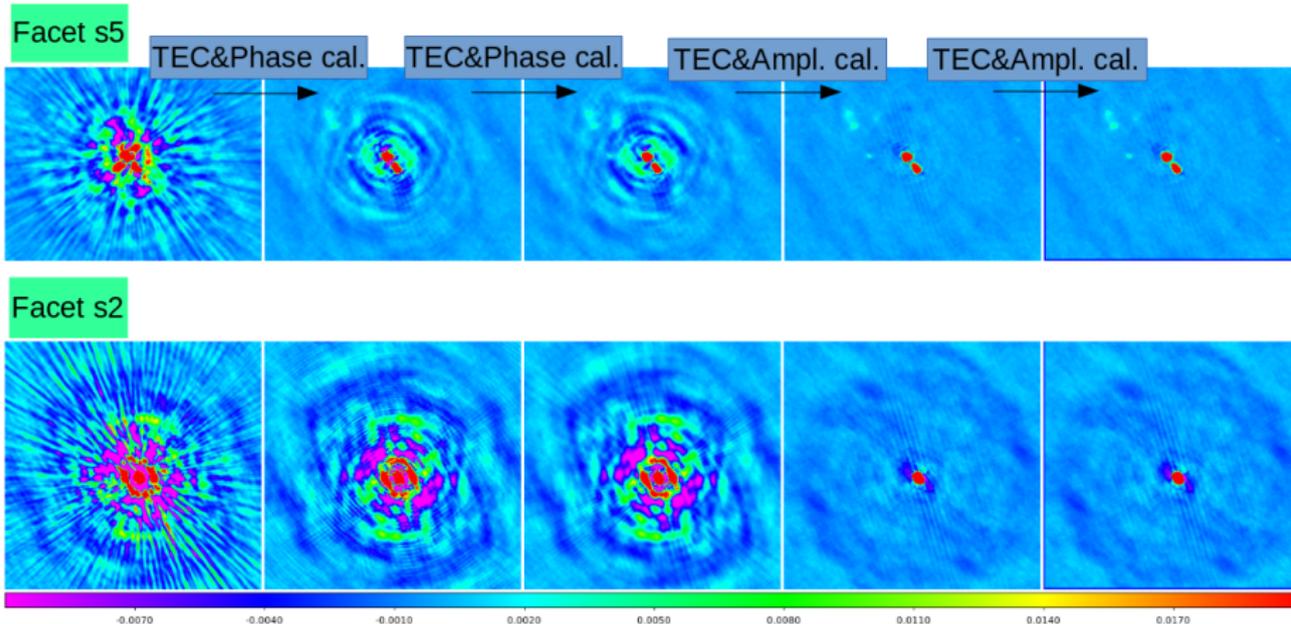
Directional calibration: facet calibration scheme²



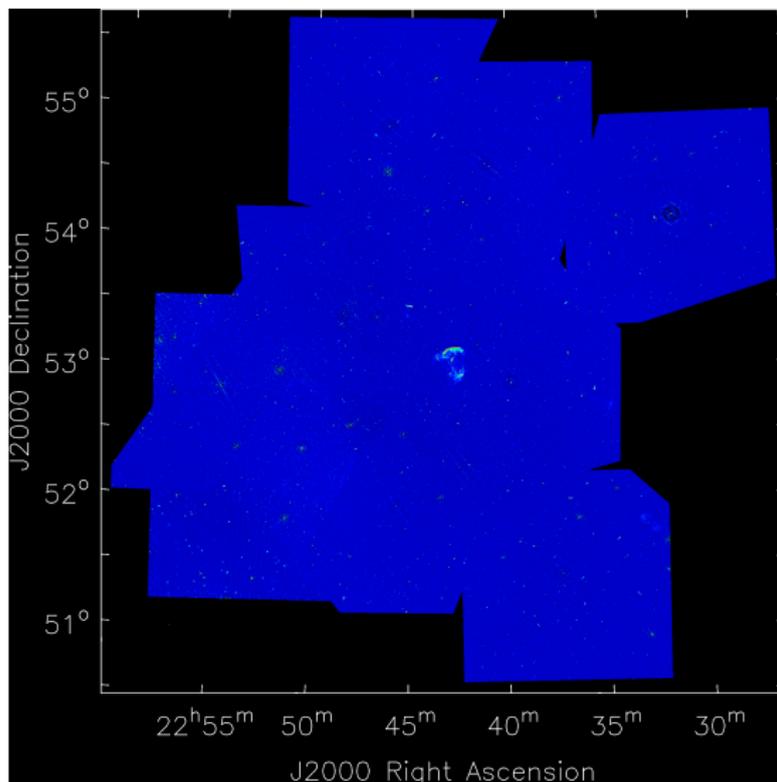
- the sky is divided into facets
- each facet has its own calibrator
- subtract all sources using non-directional gain (blank field)
- ...
- directional gain/TEC solutions are solved using the facet calibrators
- facet data are corrected using the facet directional gain/TEC solutions.
- image the facet
- subtract/update blank field
- ...

²Weeren et al. 2015, Williams et al. 2015

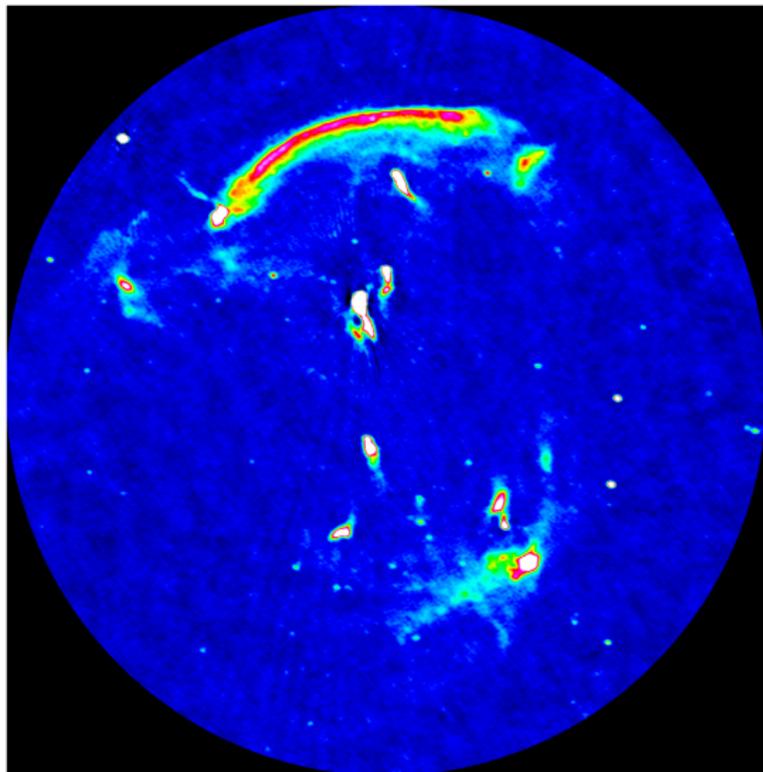
Directional calibration: facet calibrators



Directional calibration: mosaicing the field



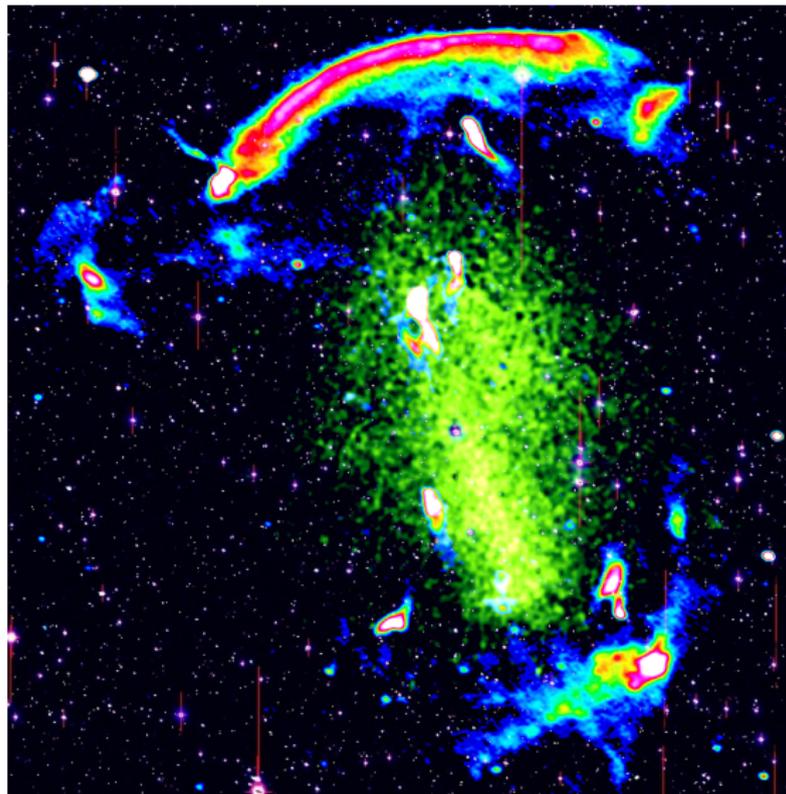
Results: the Sausage cluster with LOFAR HBA 150 MHz



The Sausage cluster with LOFAR HBA 150 MHz:

- Noise RMS: $150 \mu\text{Jy}/\text{beam}$
- Resolution: 6 arcsec

Results: the Sausage cluster with LOFAR HBA 150 MHz



Thanks for listening!