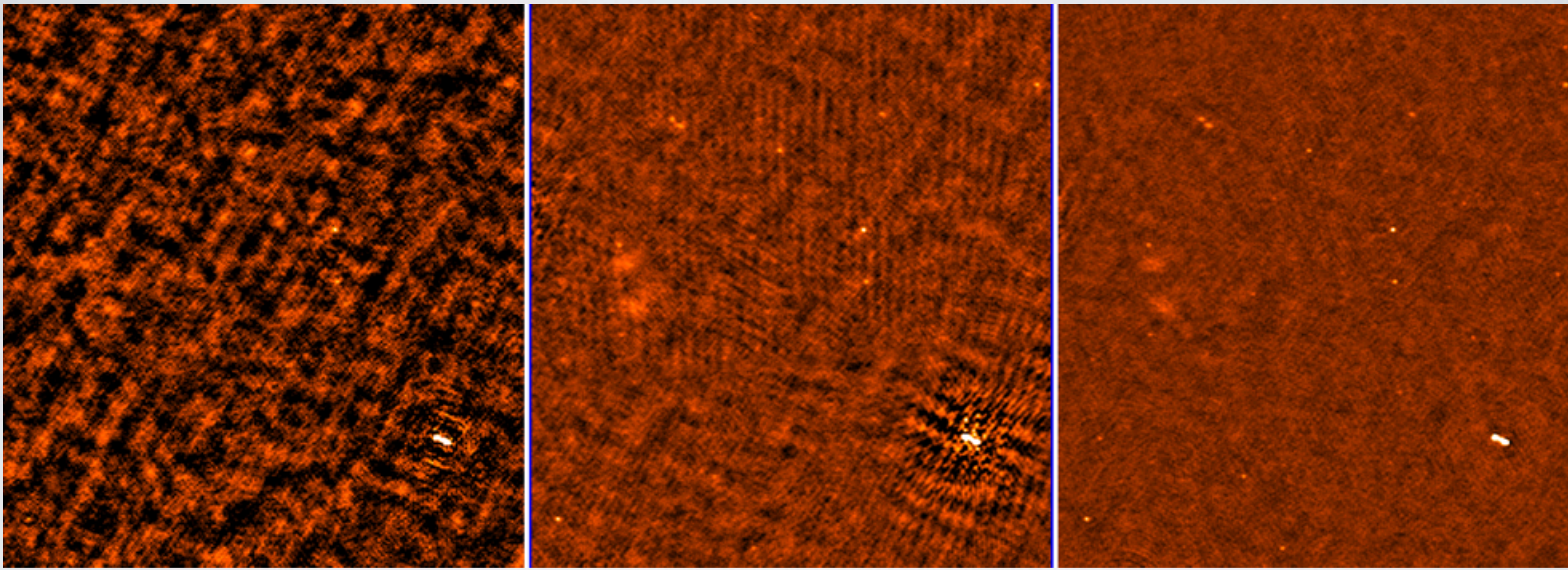
DEEP HBA IMAGING



many rounds of selfcal

direction dependent calibration
40 directions

direction dependent calibration
~80 directions

REINOUT VAN WEEREN (CFA)

THE GOAL

Make deep images (close to thermal) noise in HBA

- Goal a bit different than for the EoR project (EoR signal vs source science)
- Investigate what steps are required to make deep images

The Problem

- "Selfcal"/direction independent calibration is the obvious first step
- BUT at some point direction dependent calibration becomes important
- Two different direction dependent effects: (1) beam (2) ionosphere
- Beam (errors) vary on slow timescales 5+min
- Ionospheric phases can vary on 10s timescales on 100 km baselines

WANT: solve in many directions at sufficient time resolution

The Data

- 120-170 MHz HBA dataset for Toothbrush galaxy cluster field
- 10 hr continuous track (8 hr usable), 24 MHz on joint calibrator
- First Cycle 0 cluster observations
- Good quality data ! (most stations working)

DEGREES OF FREEDOM & SOLUTION TIME INTERVAL

Make use of the fact that:

- only the phases vary on short (10 sec) timescales
- the phases over the entire HBA band can be described with only 3 parameters (phase offset, TEC, clock)
- amplitude solutions for neighboring subbands are almost identical

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Full Jones : 100 × 350 × 8 = 280000 (1 solution interval, cannot fully track ionosphere)

#SB   Full Jones

Gain:1:1& 0:0

Alternative scheme: 100 × [(3 × 60) + (35 × 4)] = 32000 (have 60 × 10s solutions for ionosphere)

#directions

35 groups of 10SB

Clock, TEC, StokesI-phase

10s solution intervals (=60 intervals in 5min)

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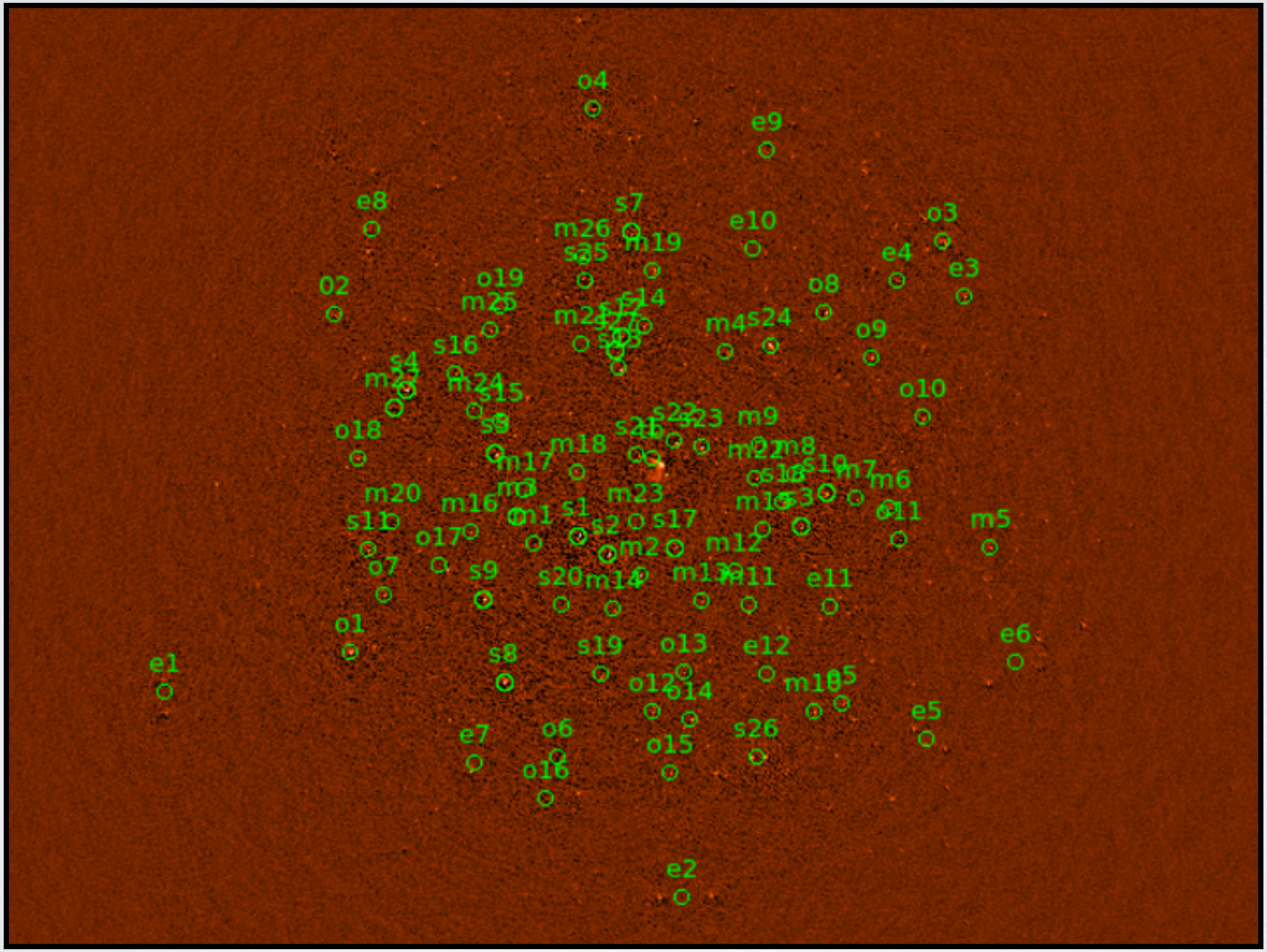
INGREDIENTS:

- BBS & NDPPP
- CASAPY
- PyBDSM
- motivated by SPAM & SAGECAL results

DEFINE DIRECTIONS

All compact sources above ~ 0.1 Jy & bright extended sources



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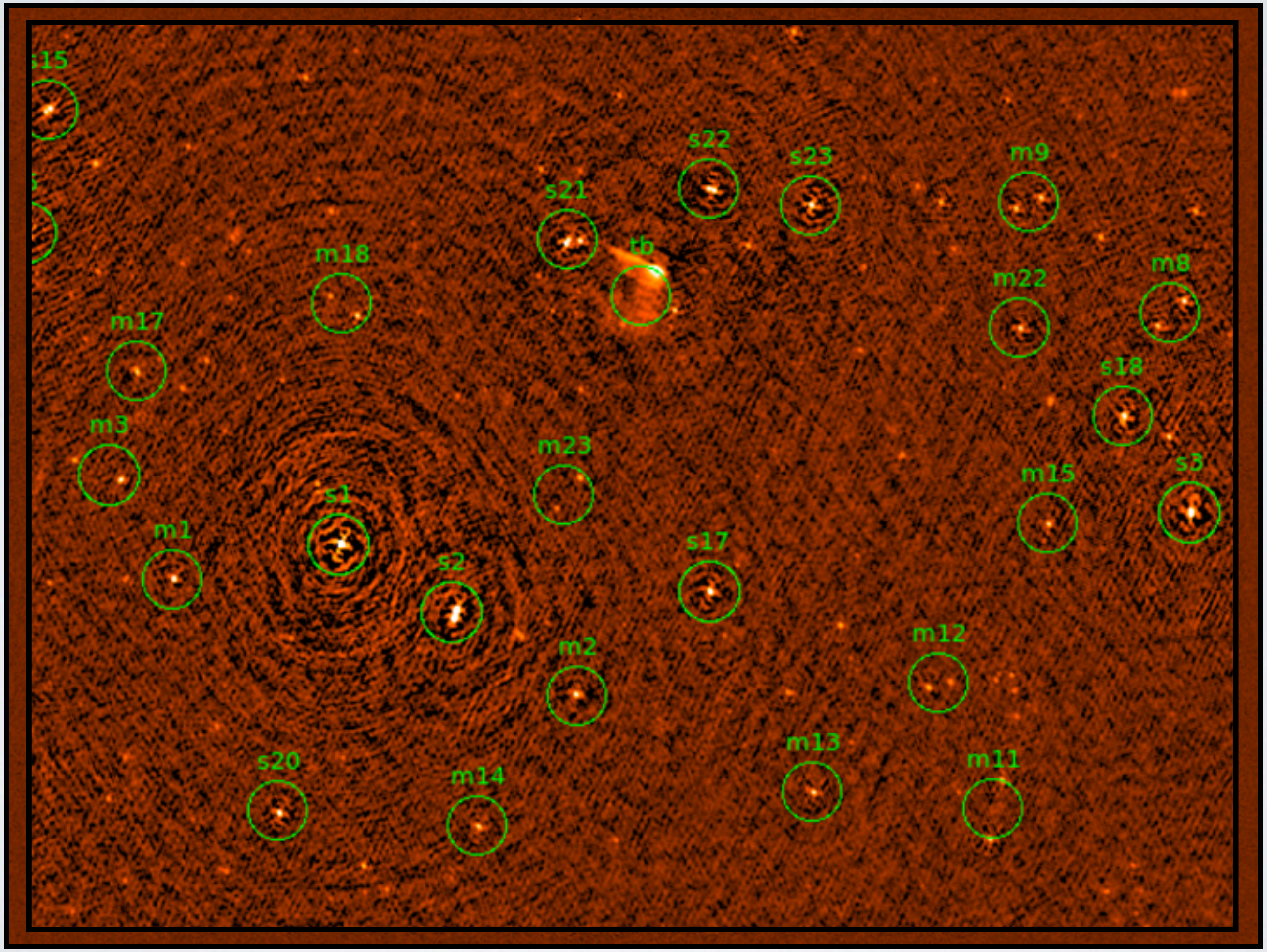

DDE SOLUTIONS

- 1. Solve for phase-offset, TEC, clock using all SB on 10s timescale
- 2. Apply the fast "phase-solutions"
- 3. Solve for slow (5-20 min) varying amplitudes in groups of 10SB
- 4. Loop and update source model

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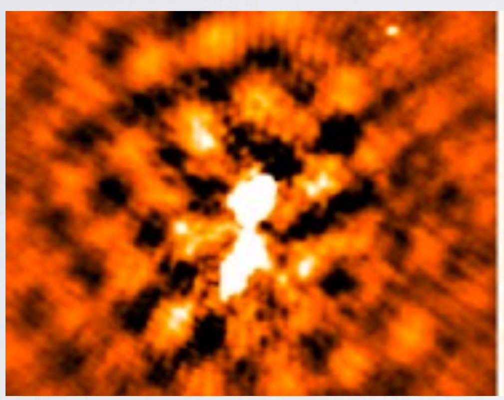
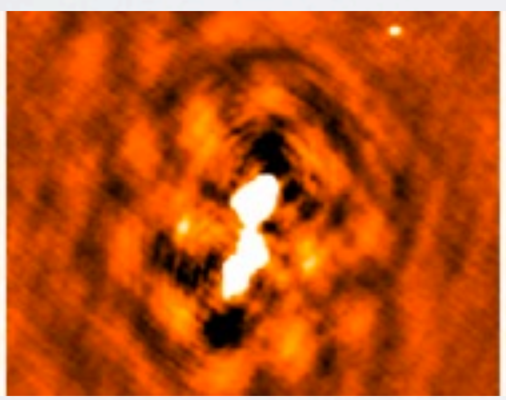
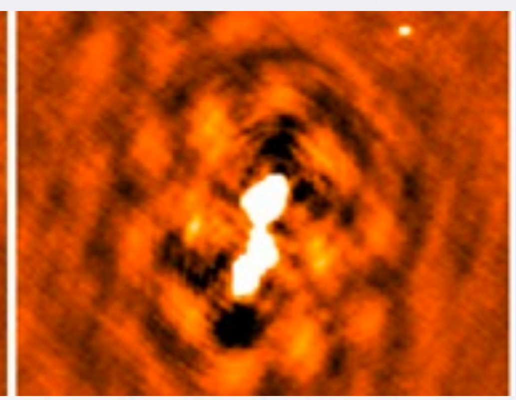
from selfcal



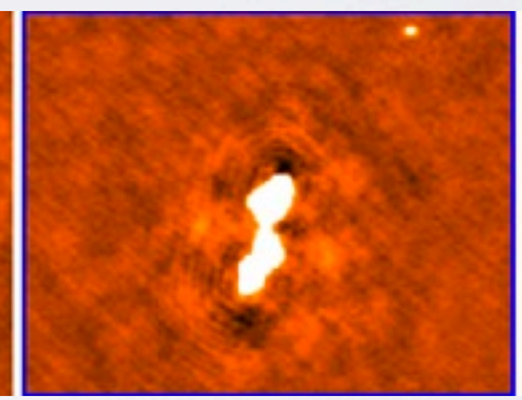
DDE 10s phases



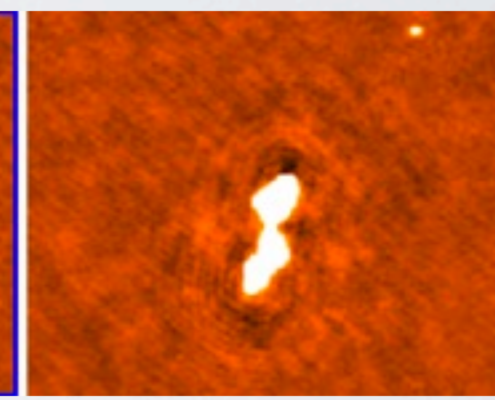
DDE 10s phases



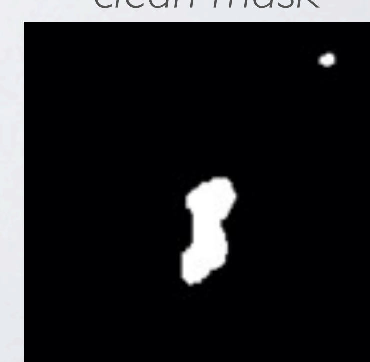
DDE 10s phases+ 10 min amplitudes



DDE 10s phases+ 10 min amplitudes



clean mask



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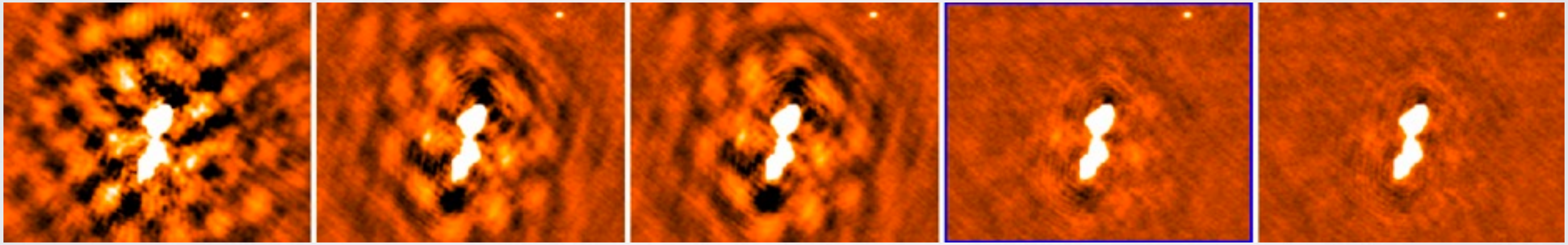
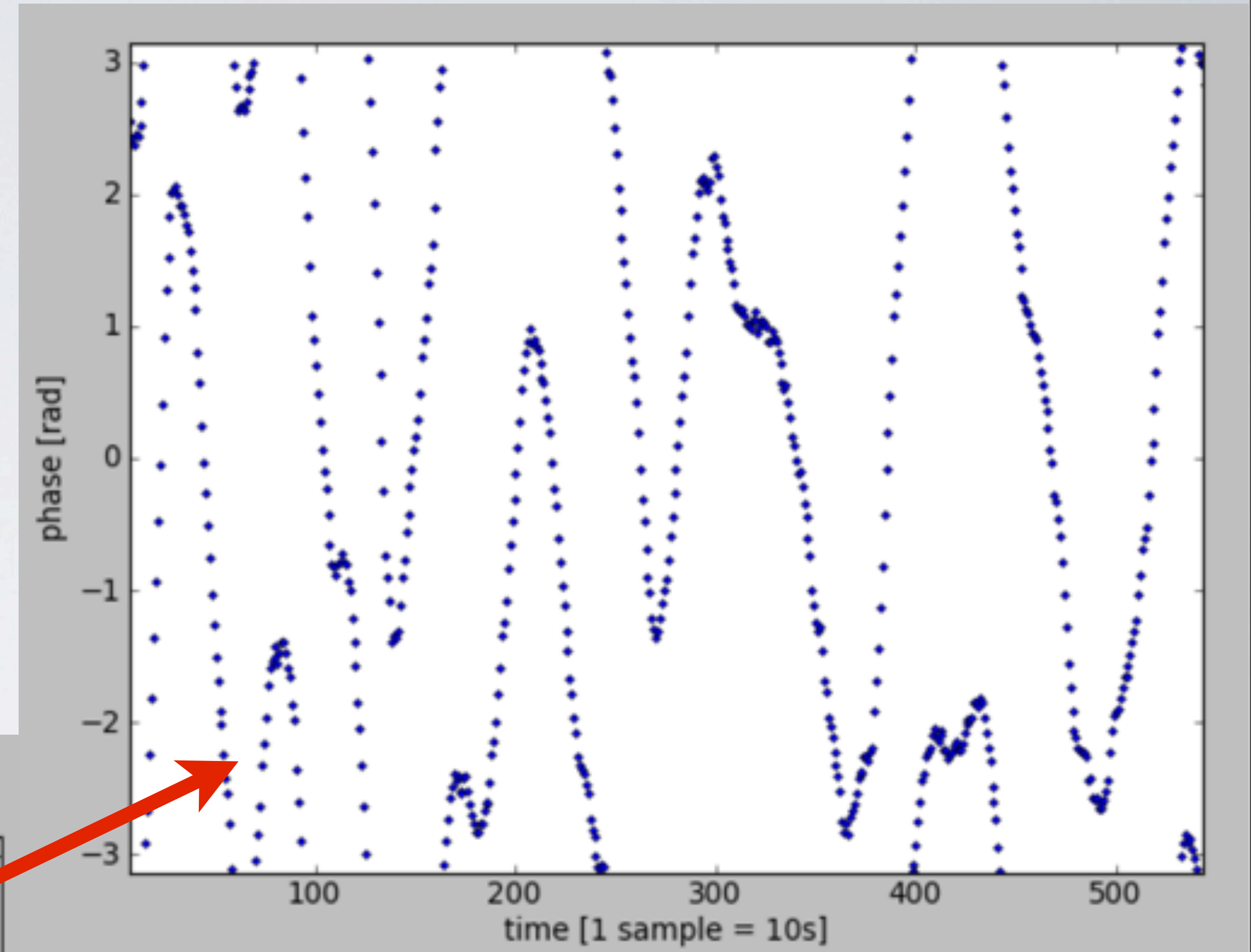
from selfcal | *DDE 10s phases* | *DDE 10s phases* | *DDE 10s phases+ 10 min amplitudes* | *DDE 10s phases+ 10 min amplitudes*

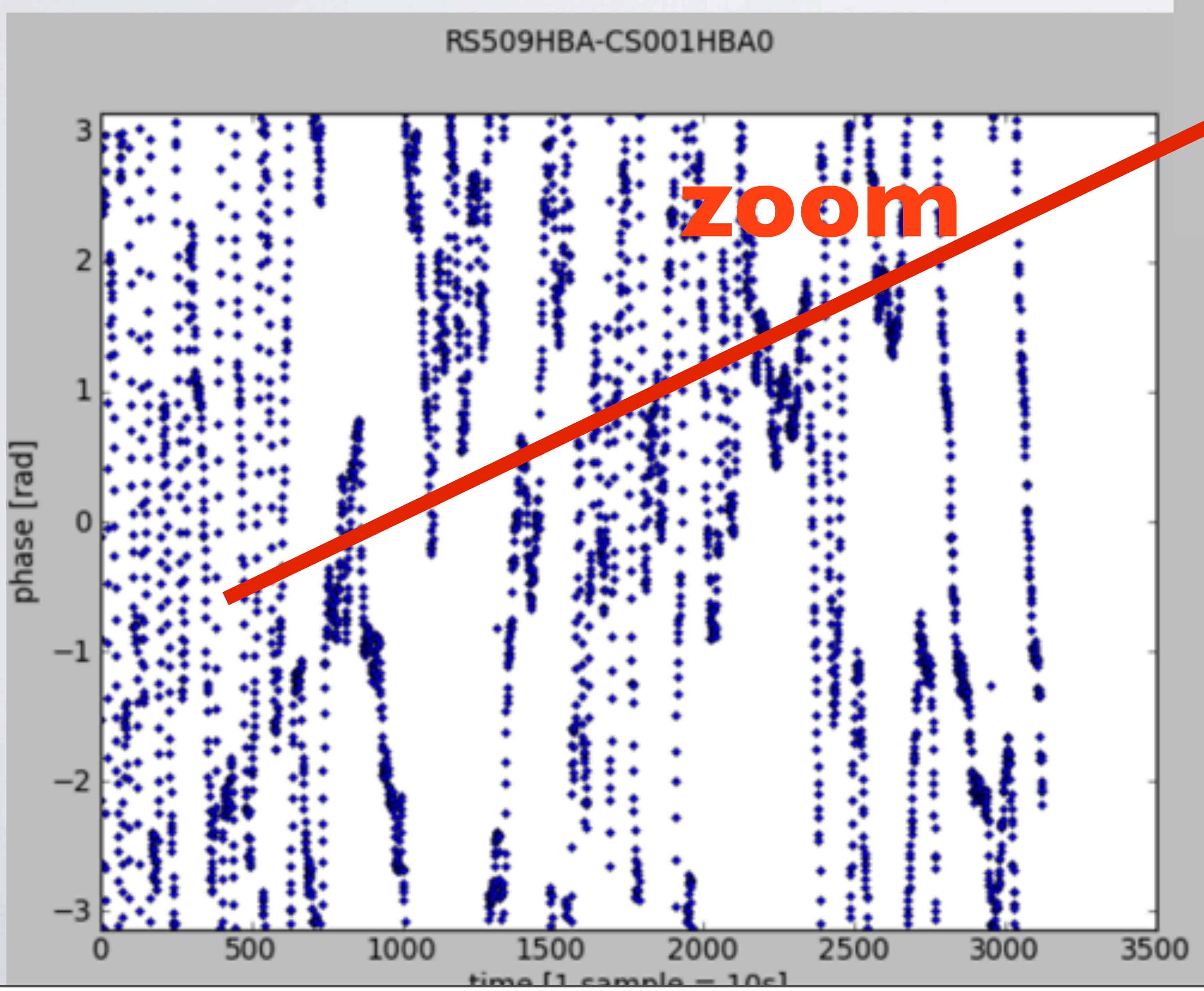


Then proceed with the next DDE source

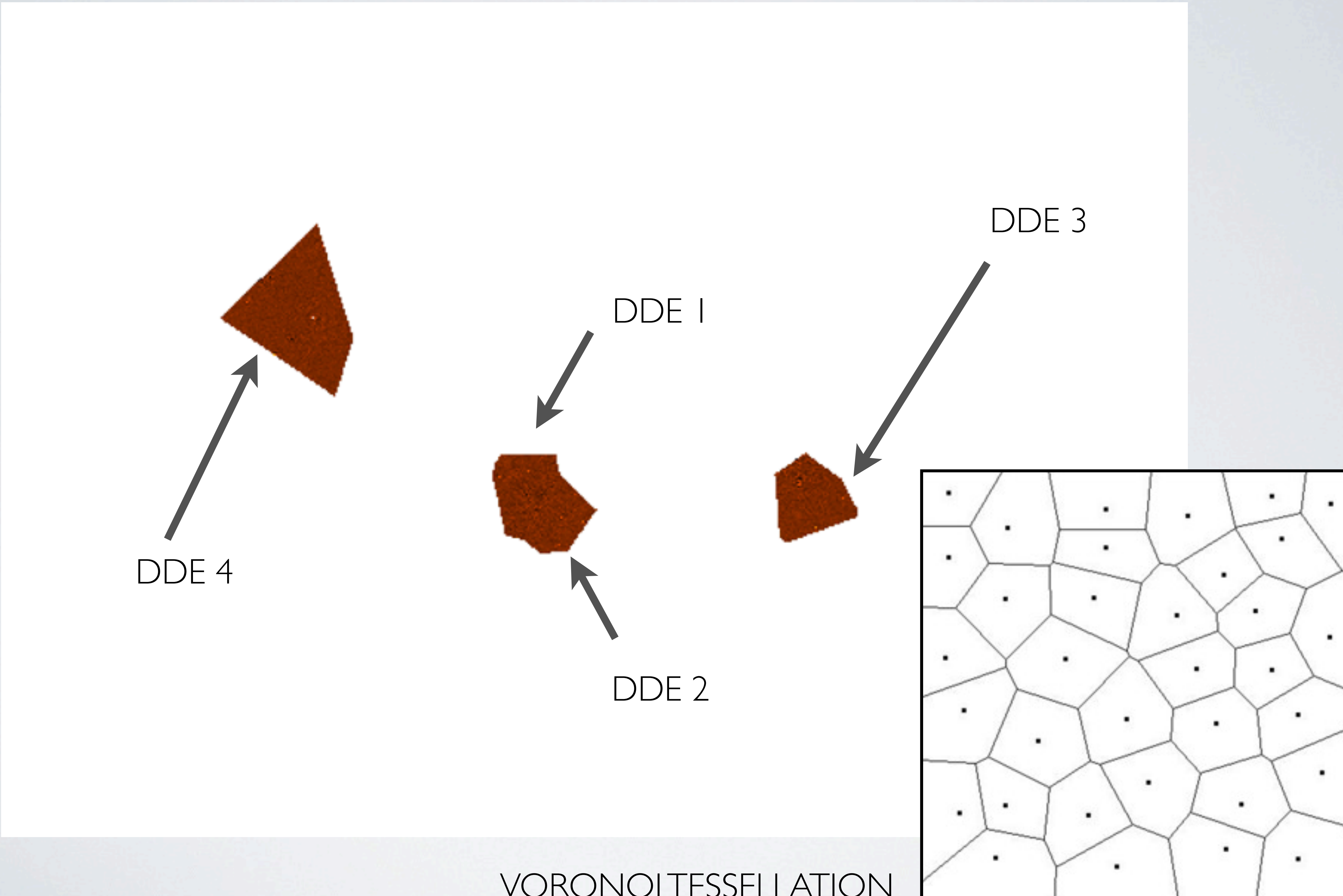
clean mask

SOLUTIONS


phase [rad]
time [1 sample = 10s]

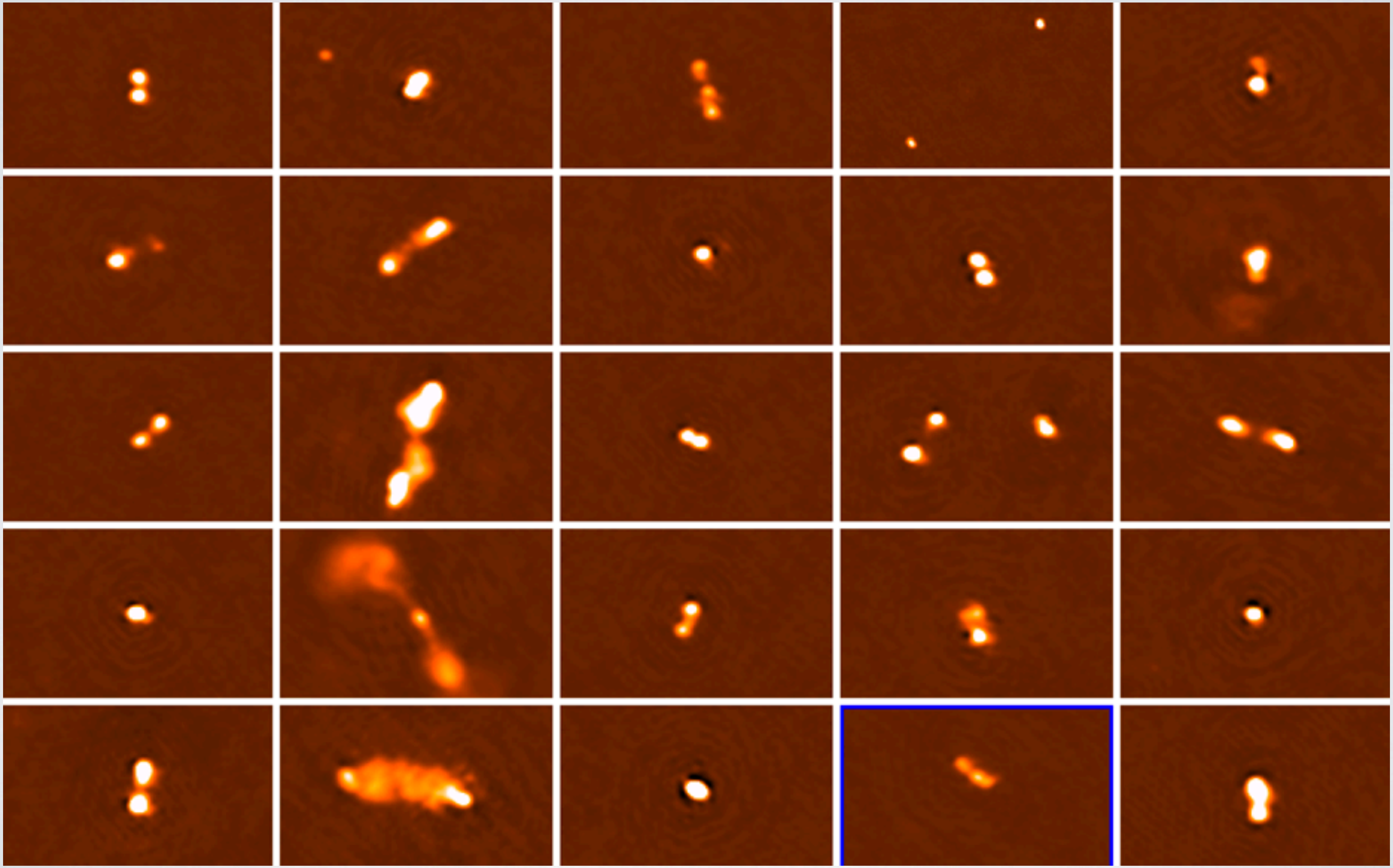

RS509HBA-CS001HBA0
zoom
phase [rad]

AFTER 4 DDE/PEELING CALIBRATORS

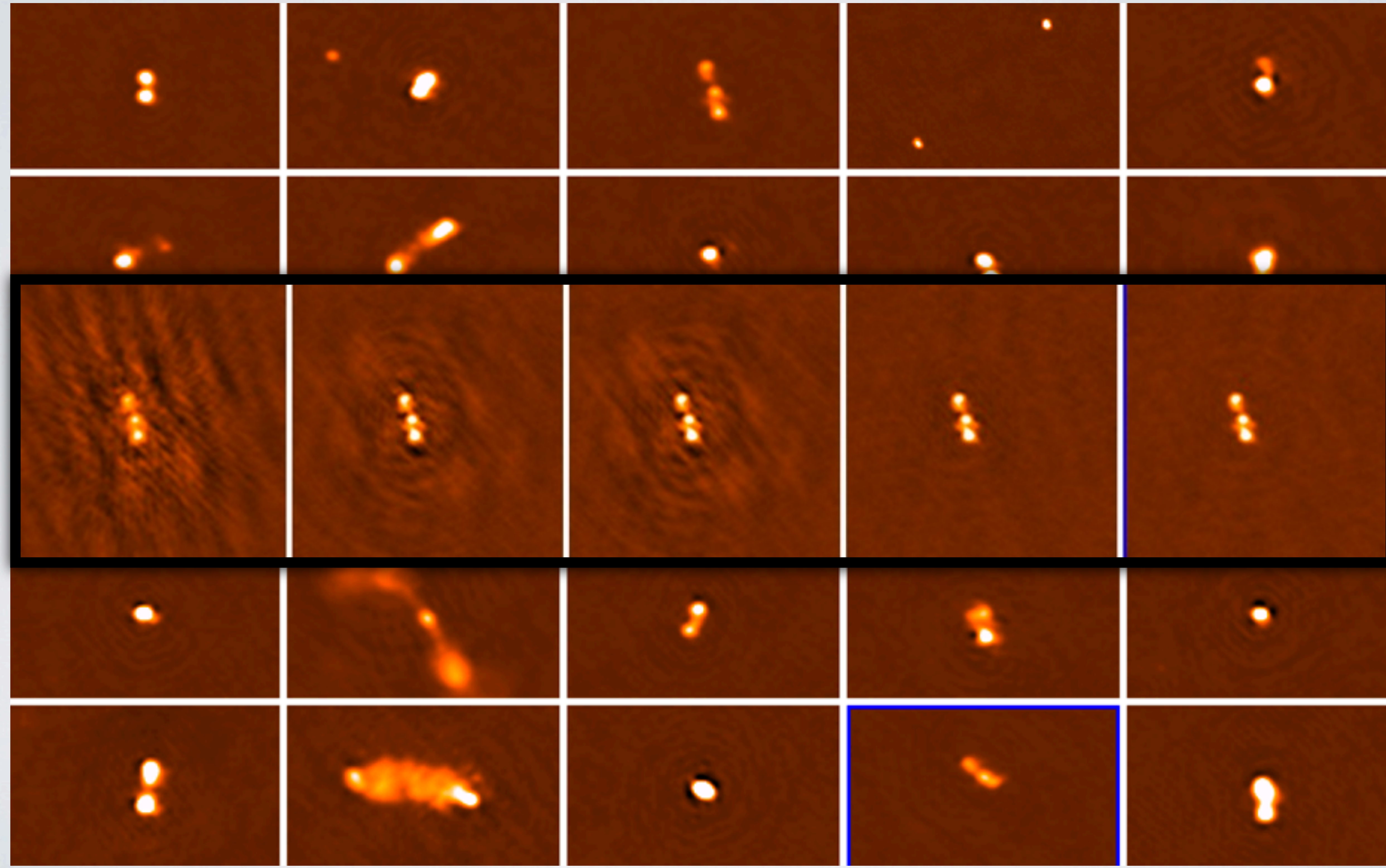


VORONOI TESSELLATION

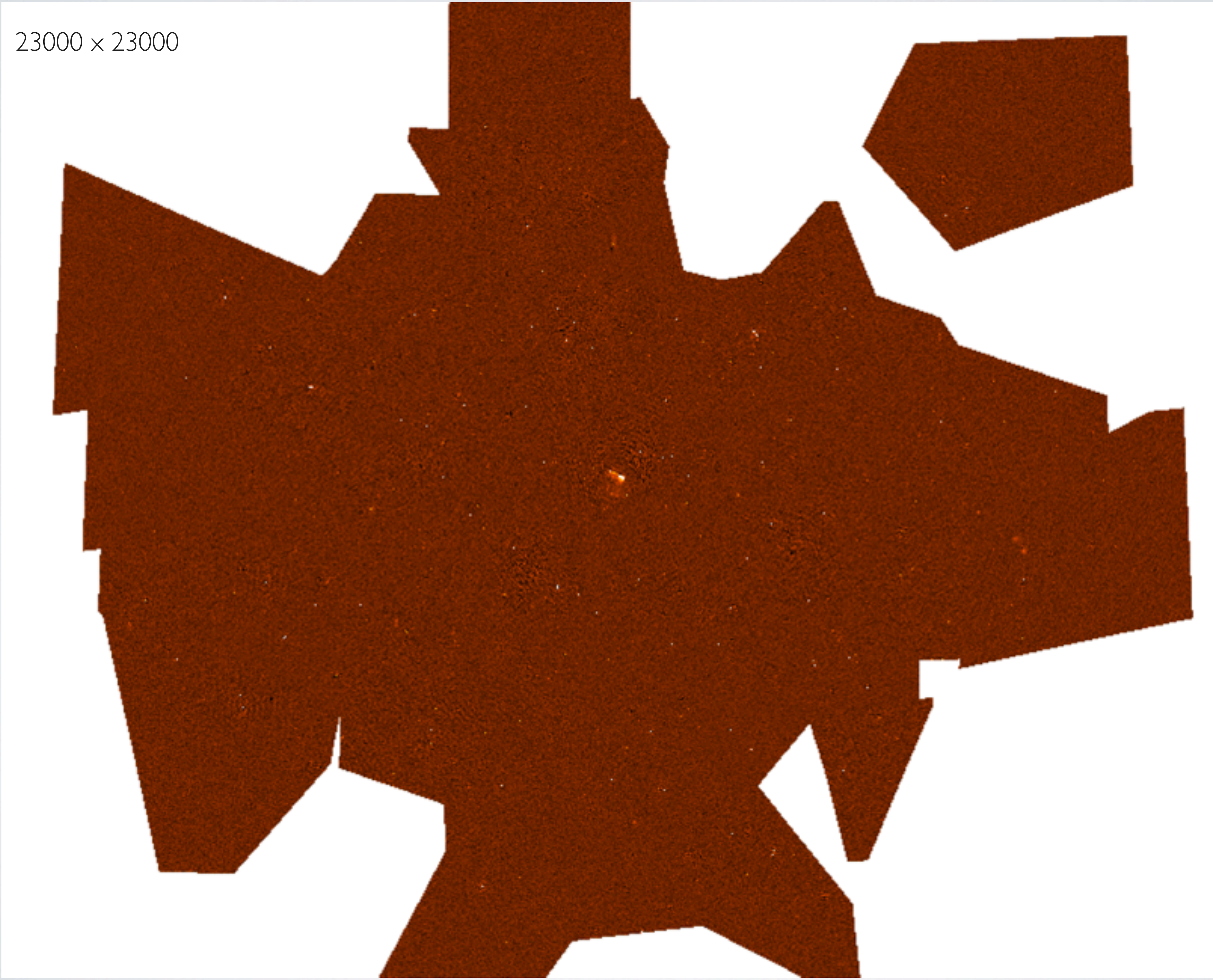
DDE CALIBRATORS



DDE CALIBRATORS



AFTER ~80 DDE CALIBRATORS



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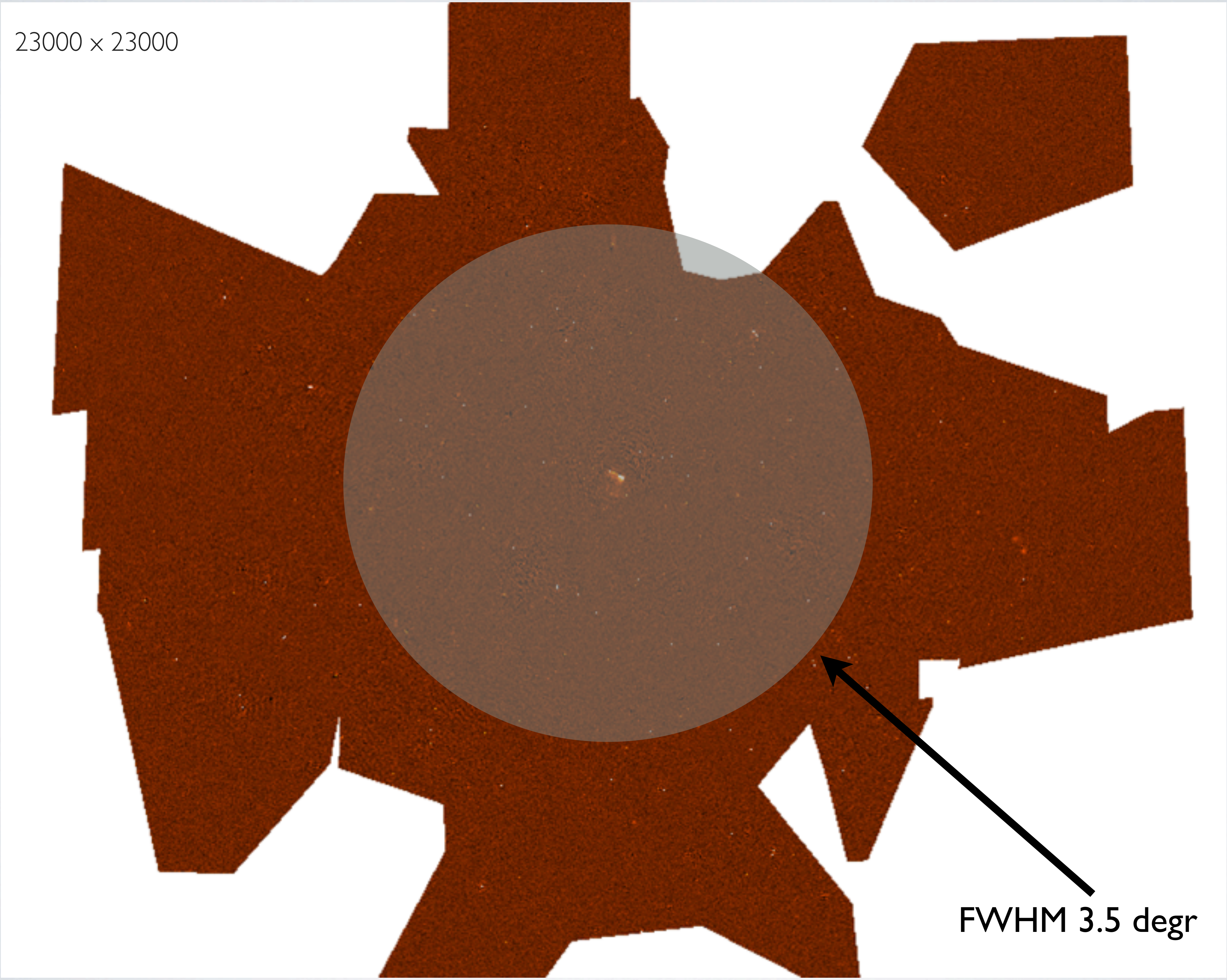
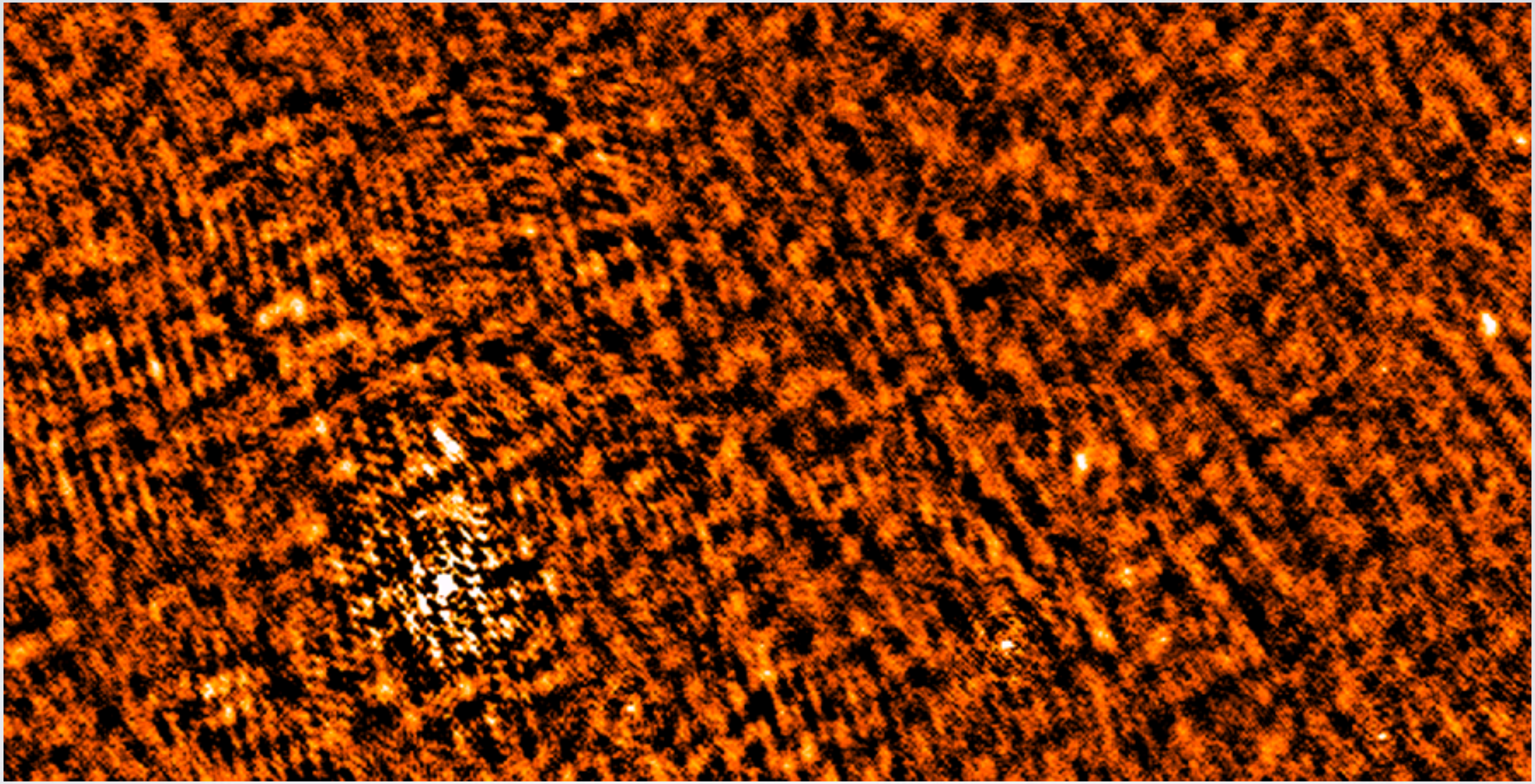


Best selfcal vs DDE calibration



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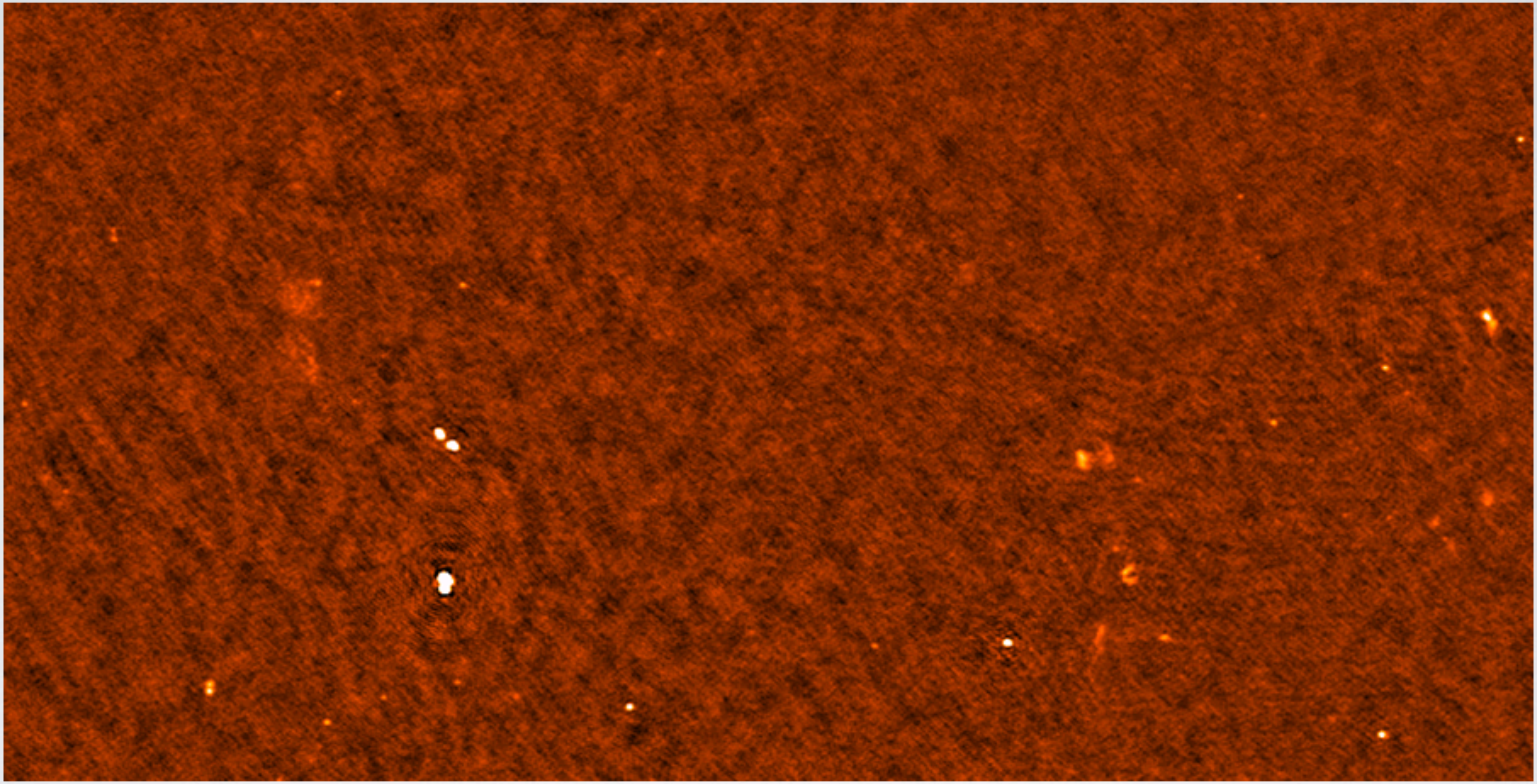
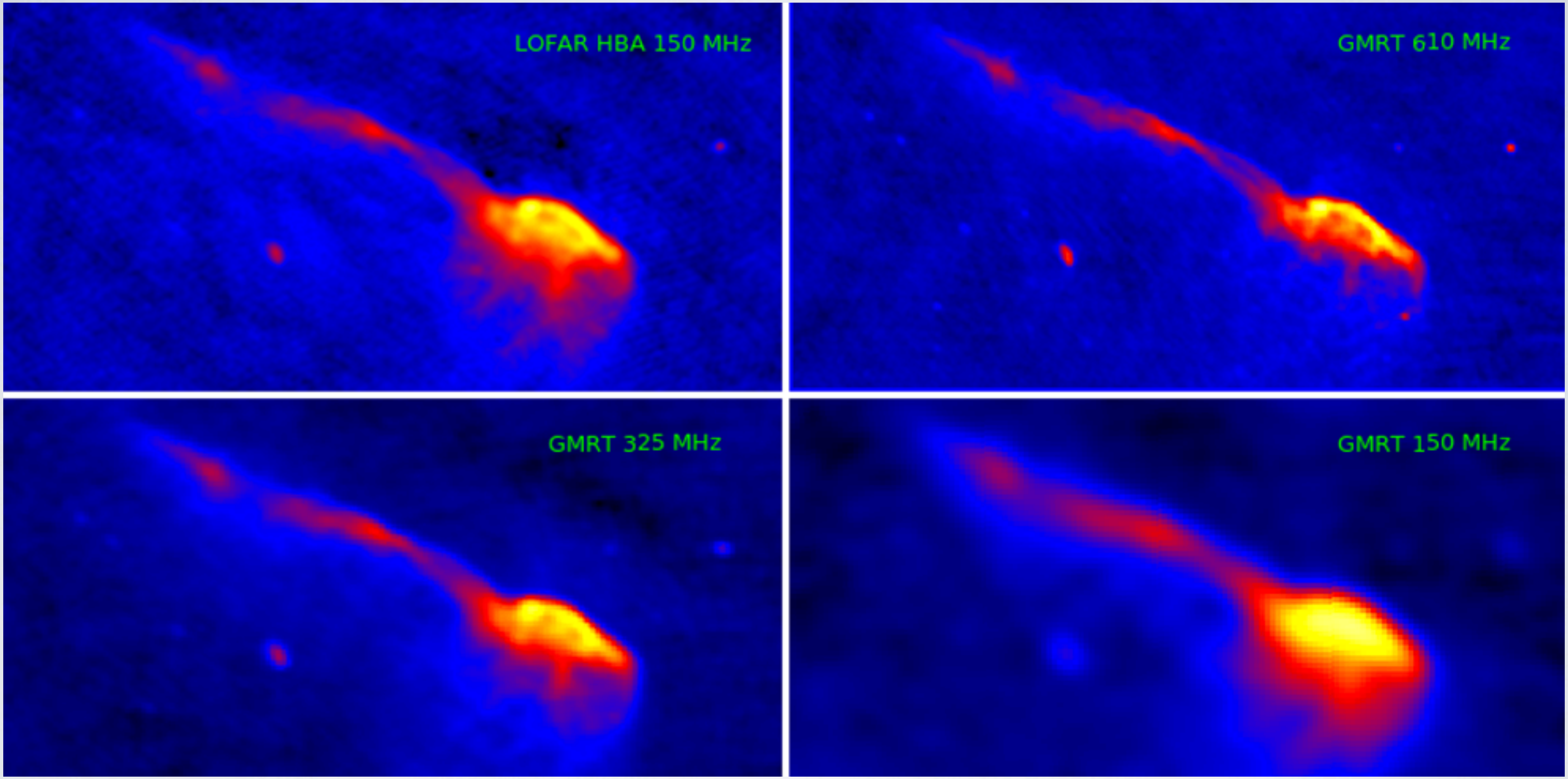
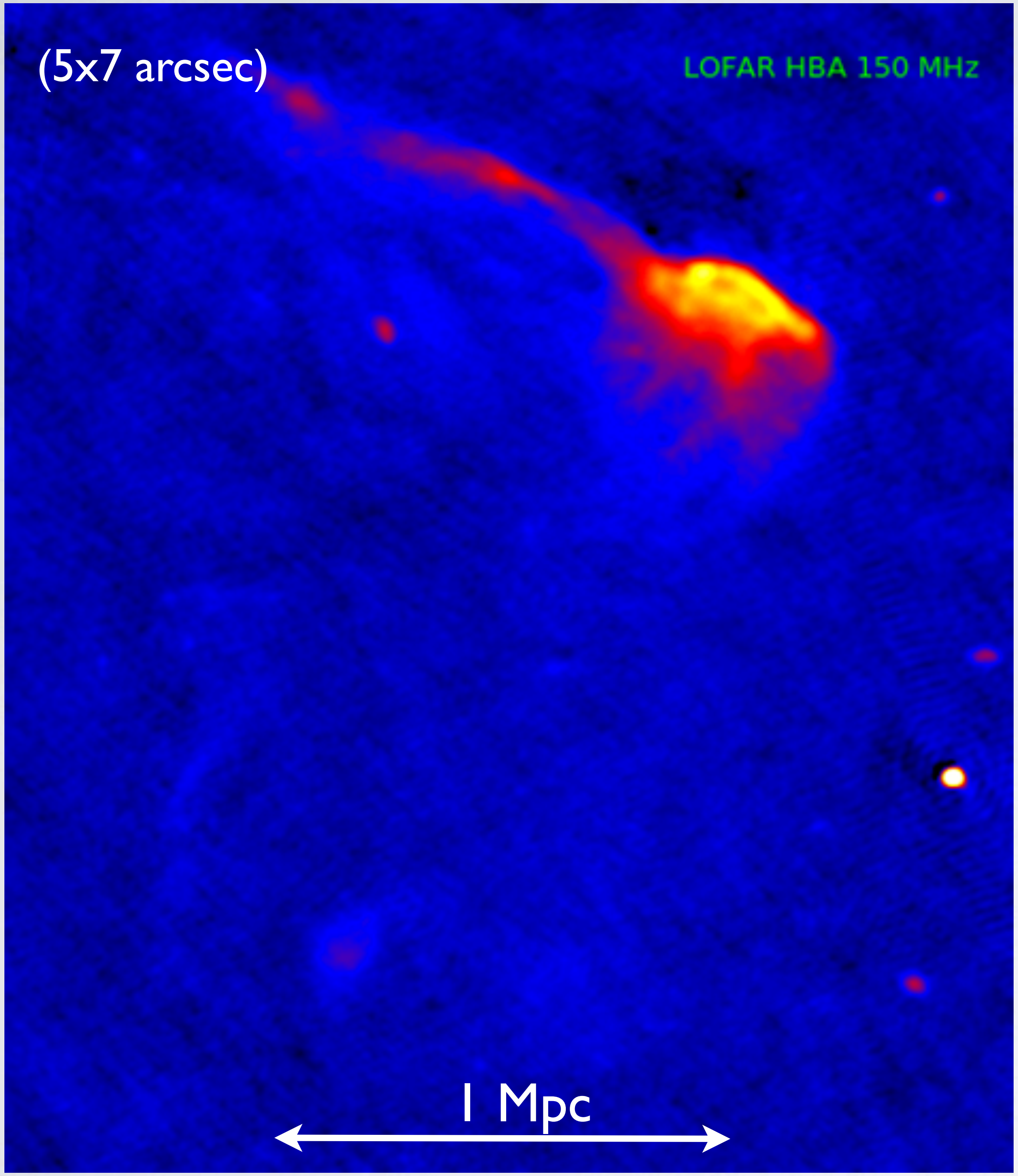


LOFAR & GMRT



Resolution 5x7 arcsec, 140-160 MHz, close to thermal noise (170-250 microJy/beam)

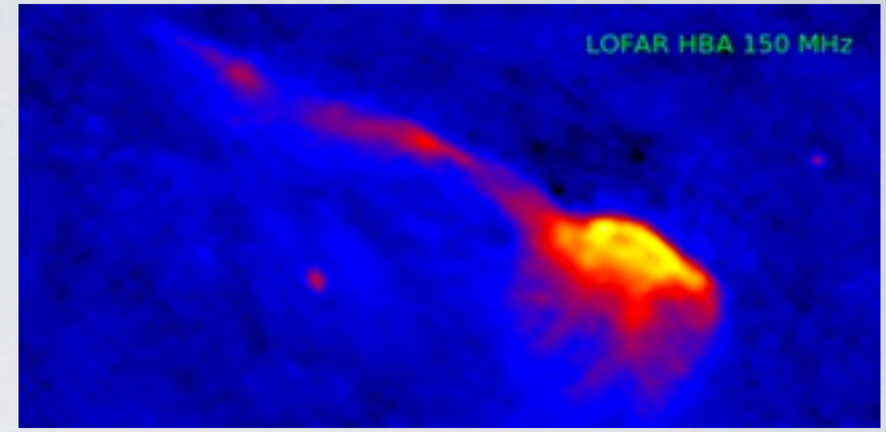
“Science image”

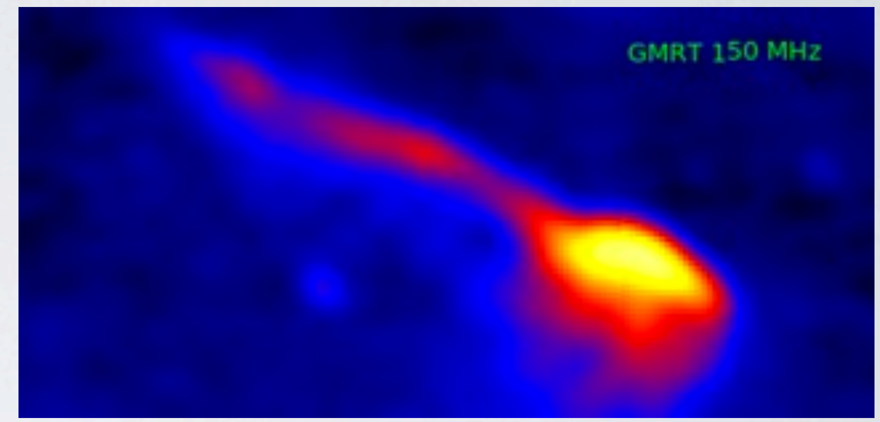


full resolution (5x7 arcsec), 140-160 MHz
close to thermal noise (190-250 microJy/beam)

only 30% of available bandwidth.....

LOFAR vs GMRT





emphasize large-scale emission with weighting