

One year of LOFAR2.0 Commissioning

Flash results

Commissioning team

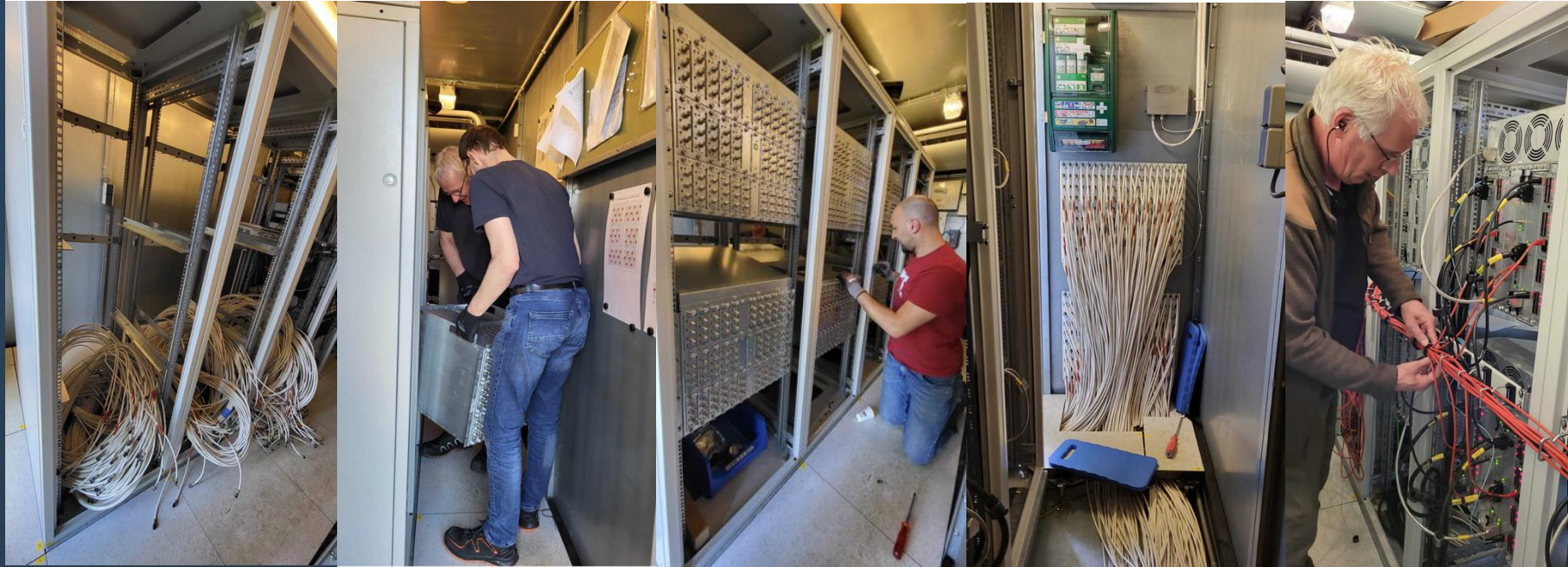
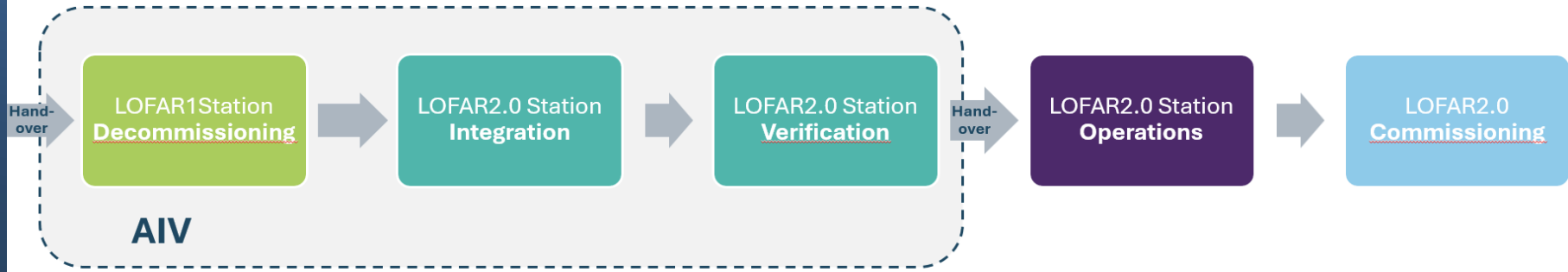
Outline

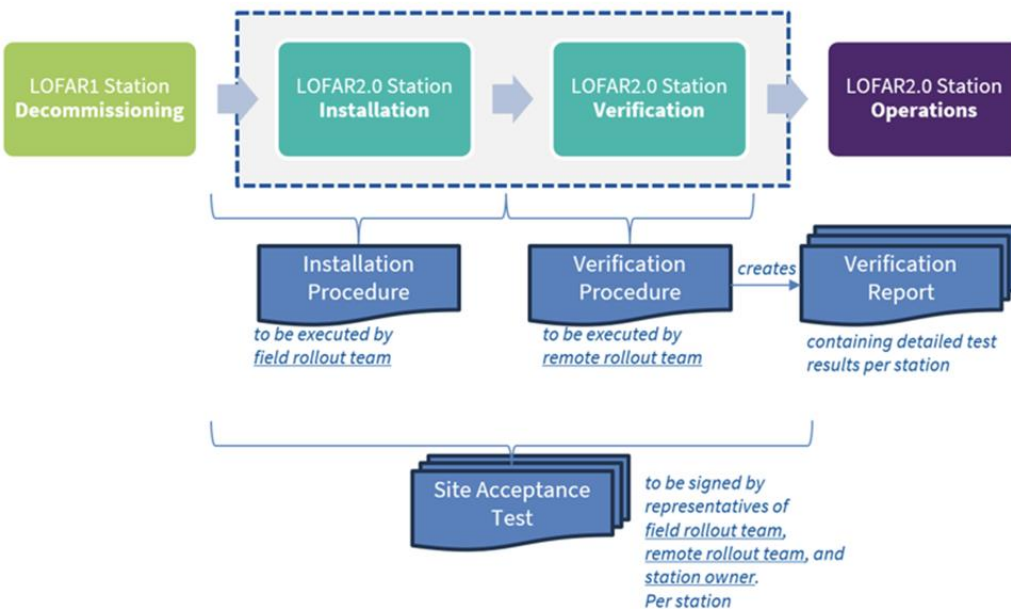
Verification and validation during rollout	Menno
Grafana monitoring (stations, antennas..)	Bernard
Automated post-rollout procedures	Aida
Transient buffer mode	Sander
Station calibration	David
SEFDs	Cristina
Array calibration (delays)	Cristina
RFI situation then and now	Aleksandar
Core coherence tests - I	Vlad
Pulsar pipelines	Vlad
core-resolution uncalibrated movie	Noa
First LOFAR2.0 images LBA+HBA (or LBA or HBA)	Henrik Noa



From LOFAR to LOFAR2.0

SE607





Chapter 2: test_2_3_6_check_APSC_TCB_NUMBER

stat/apsc/h0: FAILED APSC_TCB_NUMBER_R no match with APSC-202514-00140	stat/apsc/h1: FAILED APSC_TCB_NUMBER_R no match with APSC202517-00158	stat/apsc/l0: FAILED APSC_TCB_NUMBER_R no match with APSC202514-00142	stat/apsc/l1: PASSED
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Chapter 3: test_3_7_2_check_ANTENNA_LBA_OUTPUT_VOLTAGE

stat/recvl/l0: FAILED RCU_PWR_ANT_VOUT_R at [[6 [7 [80 [81]]] ((0.00910493 0.0089264 0.00856934 0.00928346)) was too low, should be above 7.5	stat/recvl/l1: PASSED
---	-----------------------

Chapter 3: test_3_7_3_check_ANTENNA_LBA_OUTPUT_CURRENT

stat/recvl/l0: FAILED RCU_PWR_ANT_IOUT_R at [[6 [7 [80 [81]]] ((0.00554813 0.00556186 0.00556644 0.00565799)) was too low, should be above 0.14	stat/recvl/l1: PASSED
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2 Test Results

Table 2: Compliance Summary of Verification Tests

Test Ref.*	Test Title*	Remarks (optional, e.g. conditional pass or fail condition)	Pass	Fail
2	Clock distribution system	Typo apsc boards. No issue		
3	Power distribution system			
4	Configuration			
5	RCU Control			
6	Crosslet statistics (XSTs)	LBA3 swapped		
7	Beamformer performance			
8	All sky imaging			

*Test reference and title as in the verification procedure [RD.3].

ALL TESTS PASSED

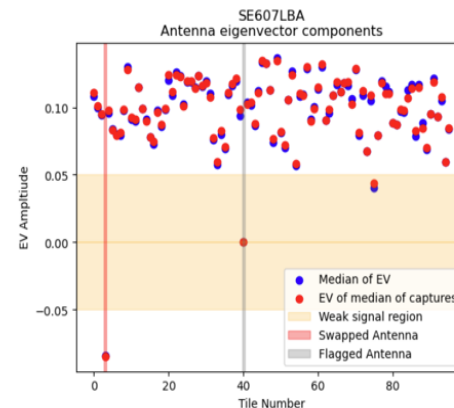
3 Antenna Status

The issues with the antennas have been found during the checks on the systems. These are the major errors we see in a quick check. It is far from complete but a first check. The broken antennas need to be repaired in the next maintenance visit. This is not part of the AIV responsibility. Only to give an indication!

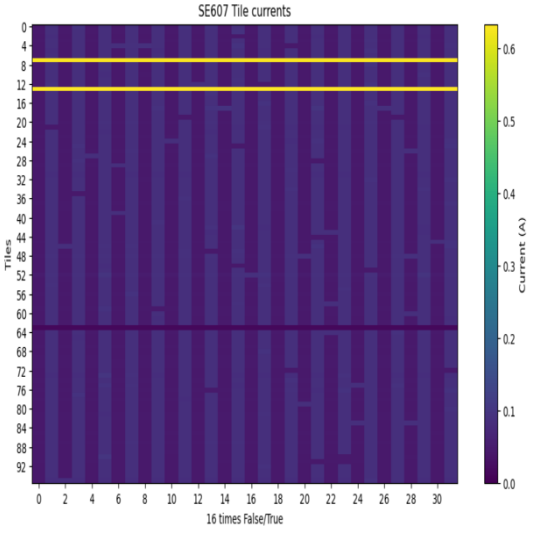
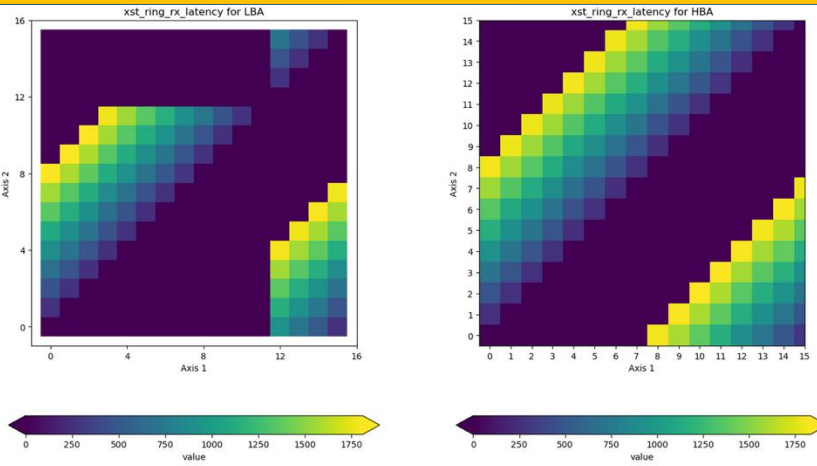
LBA

LBA03 has a polarisation swap between X and Y. Can be checked/fixed by local staff.
LBA40 has a short in the X polarisation (We think in the LBA head)

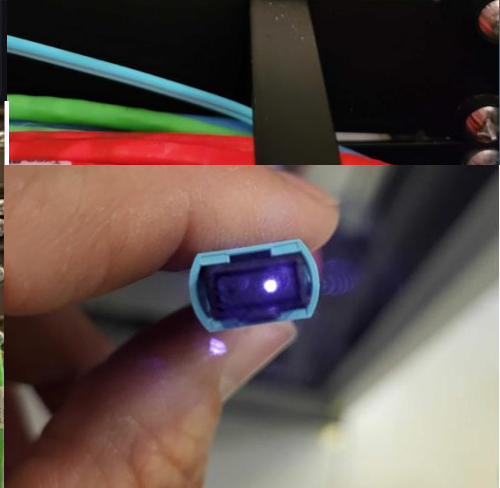
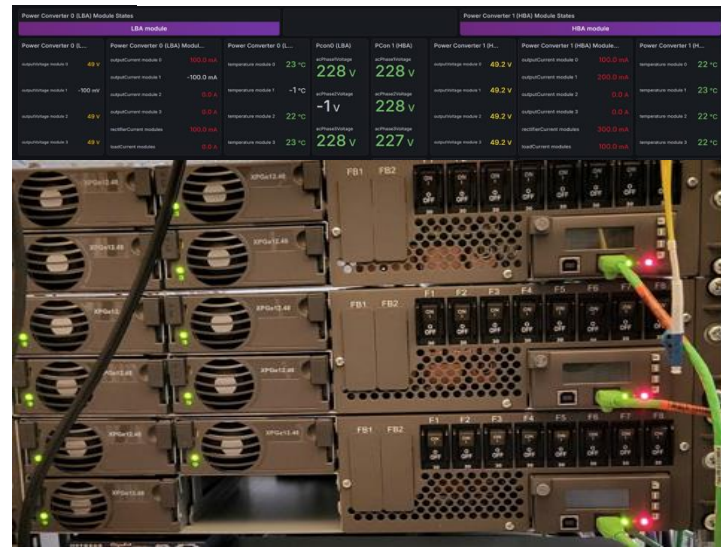
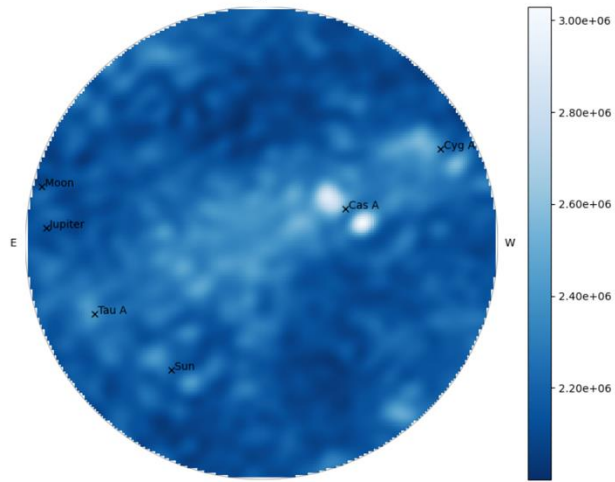
Broken LBA [40]



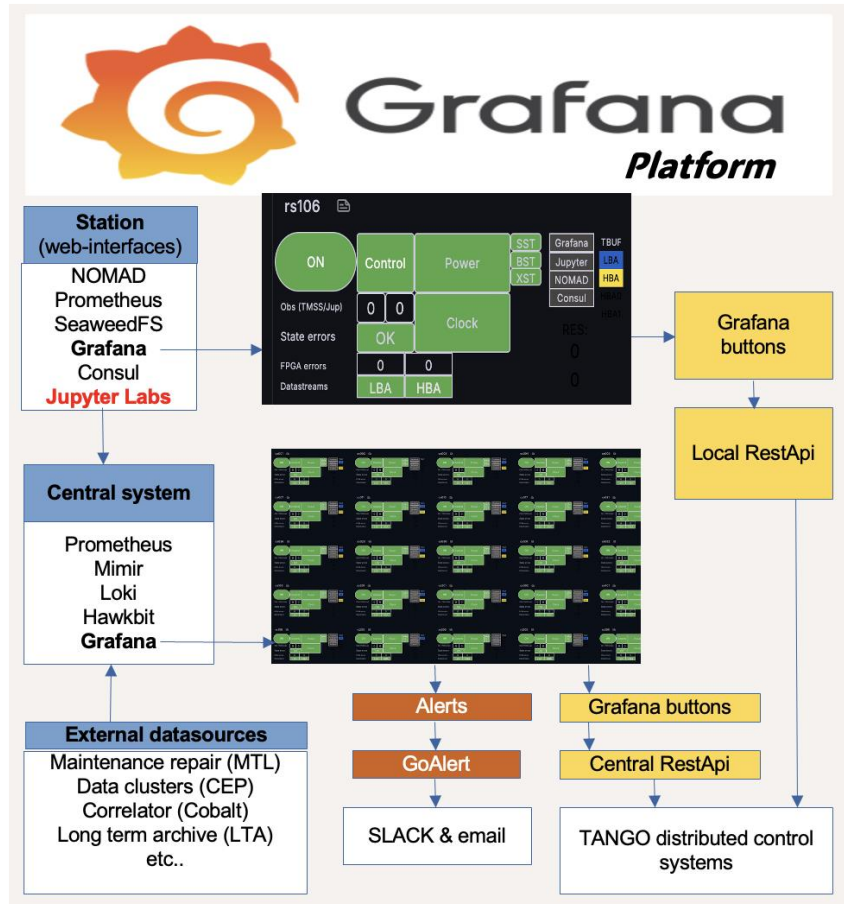
Some of the issues we found on SE607



All-sky image for SE607LBA
SB300, 58.594 MHz, 2026-05-21T09:33:27
N



LOFAR2 Monitoring & Control: Unified Observability Architecture



Using Grafana for monitoring and control: what do we get ?

- ✓ Centralized visibility of system health and performance
- ✓ Real-time system monitoring for status information
- ✓ Faster troubleshooting capabilities
- ✓ Automated alerting system
- ✓ Improved operational efficiency
- ✓ Better decision-making through historical trends especially for maintenance
- ✓ Scalable and evolvable

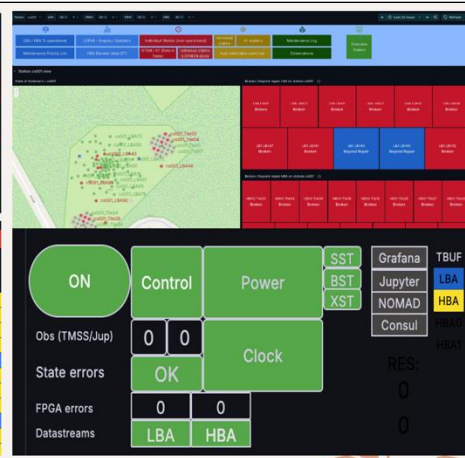
- ❖ **Monitoring with Grafana:** collect and visualize metrics, logs, and status information to understand how the system is performing.
- ❖ **Control with Grafana:** integrated dashboards with automation and external systems so that operators can initiate actions or workflows directly from a unified interface.
- ❖ **Grafana itself is not a control framework.** Its primary role is visualization, monitoring, alerting, and observability. It had been integrated with **control framework and automation systems** (e.g., RestApi & TANGO) to create the unified operations dashboards

System Overview: Seeing the Array at a Glance



Bird's-Eye View Dashboard:

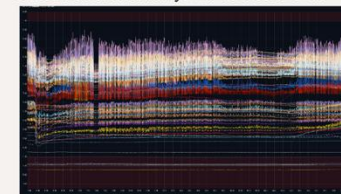
- ✓ The dashboard offers a quick overview of the entire LOFAR2 array's operational state using key indicators or icons.
- ✓ Status of stations and antennas: ST/RTSM info
- ✓ COBALT and CEP data streaming and usage
- ✓ UNIB2 software & firmware versions/issues
- ✓ Live statistics plots: SST, BST & XST
- ✓ Applies stations calibration files/info
- ✓ Station LCU uptimes and TANGO version info
- ✓ Overview of PCON/Modules
- ✓ Stations Cabinets temperature: EC
- ✓ And many more



Live plotting (station above, individual LBA antenna x / y pol below)



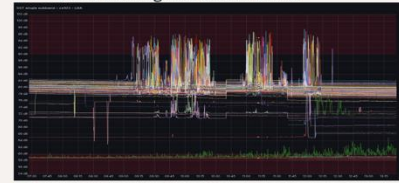
RS205 electric fence badly installed effect on LBA



Single Subband SST (filtering out issues / broken antenna)



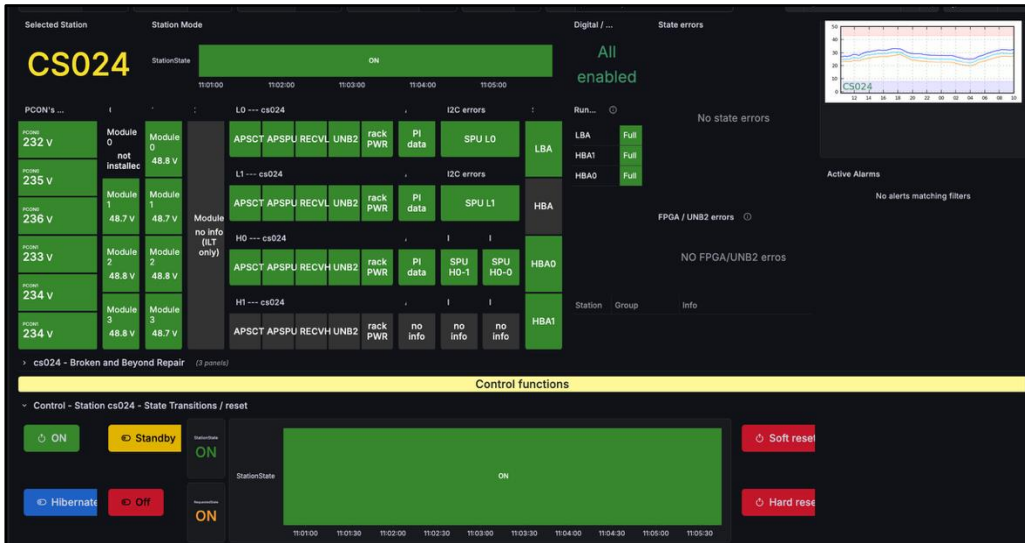
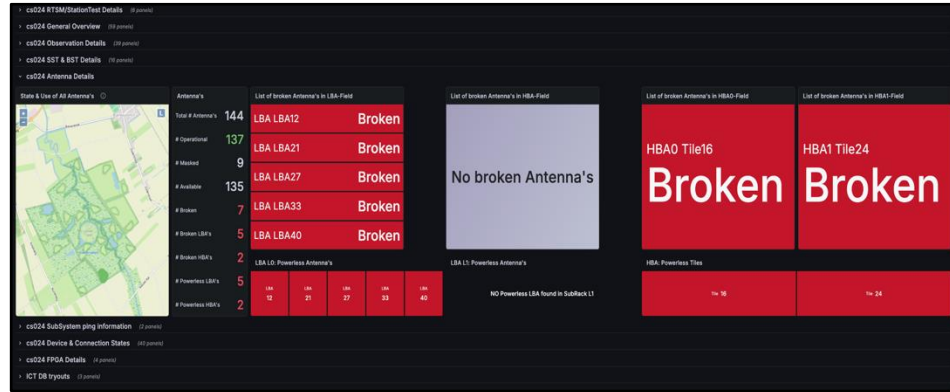
Lawn-mowing near station: effects



System control: one web interface to control the system

What can we do ? With the right system rights, one can:

- ❖ Toggle the status of stations
- ❖ Power up or down stations
- ❖ Start-up firmware
- ❖ Disable broken antennas/tiles
- ❖ Flag suspicious hardware
- ❖ Etc



LOFAR2.0 observing system: compared to LOFAR1

- ✓ Real-time System Health Monitoring
- ✓ Absolute visibility of the entire observing system at a glance
- ✓ Rapid Fault Diagnosis
- ✓ **High Level of Automation**
- ✓ **Ease of stations and system control**

What does this Mean for Astronomy/Science,
Operations & Maintenance: a huge win !!!

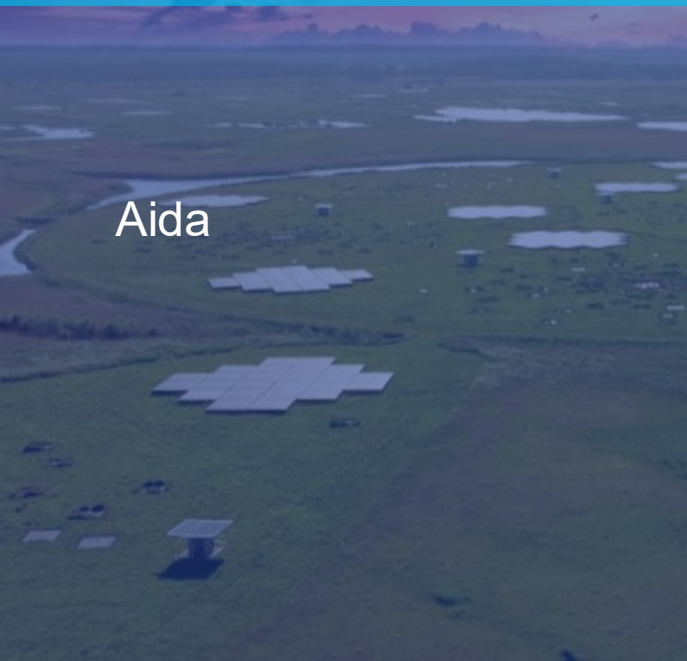
NB: Credit to Team Rub and the Operators for this work

Post-rollout procedures

Series of observations and diagnostic plots to verify system status after major changes in both hardware & software

Goal is to catch regressions and to ensure that major control points still work (e.g. pointing, filter changes, TMSS, COBALT, clocks)

- Initially performed after new stations were delivered
 - Now being performed more routinely as changes to software are more frequent
 - (Mostly) automated
-



Aida

Post-rollout Procedure Overview

- Short imaging observations on a calibrator (few SBs)
 - Verify observation success (TMSS, data on CEP)
 - Verify success of pre-processing pipeline
 - Verify success of ingest to LTA

TMSS view

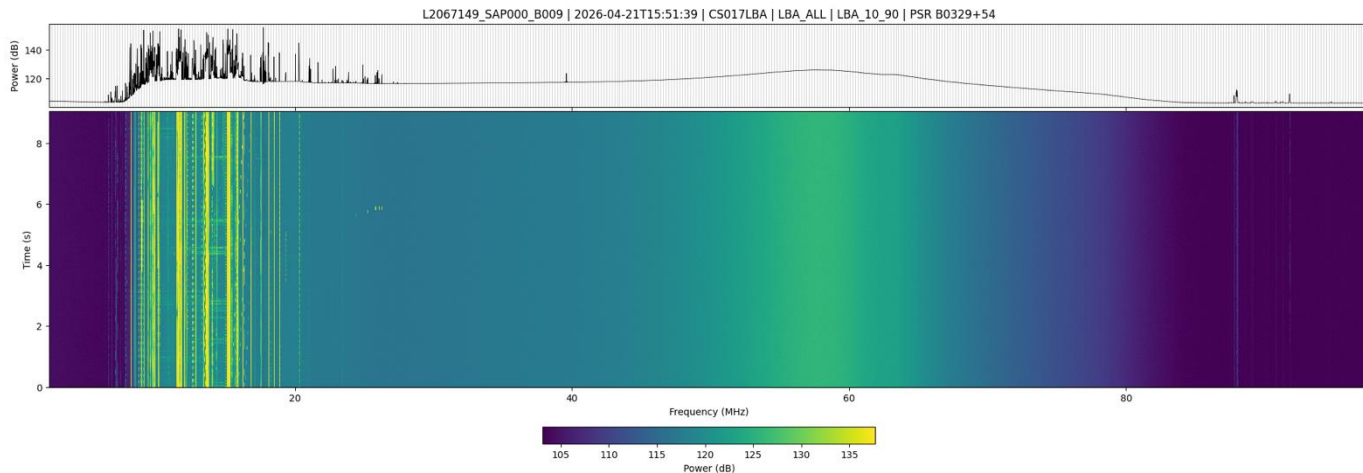
Status ↑↓	Name ↑↓
Status ▼ 	 
on hold	Ingest
finished	Observation
finished	Pipeline
schedulable	Cleanup

Post-rollout Procedure Overview

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- Short Fly's Eye observations of a pulsar with all HBA/LBA filters to verify filter switching works and get an overview of single station data

TMSS view

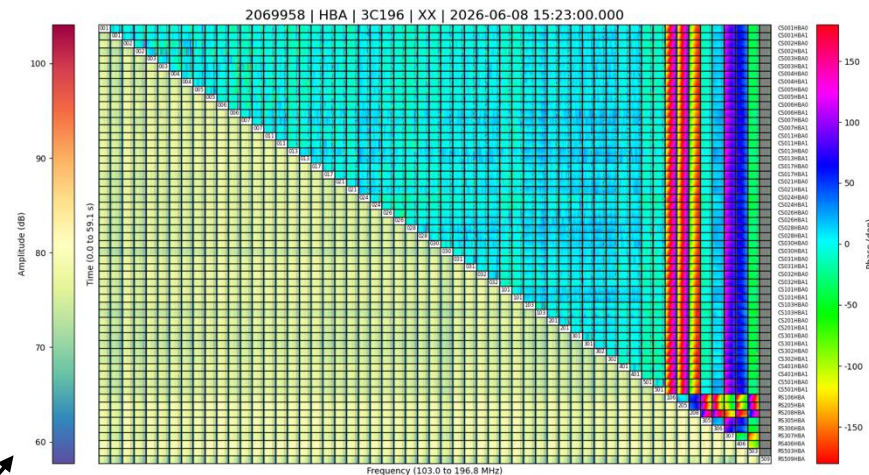
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Status ▼	
on hold	Ingest
finished	Observation
finished	Pipeline
schedulable	Cleanup



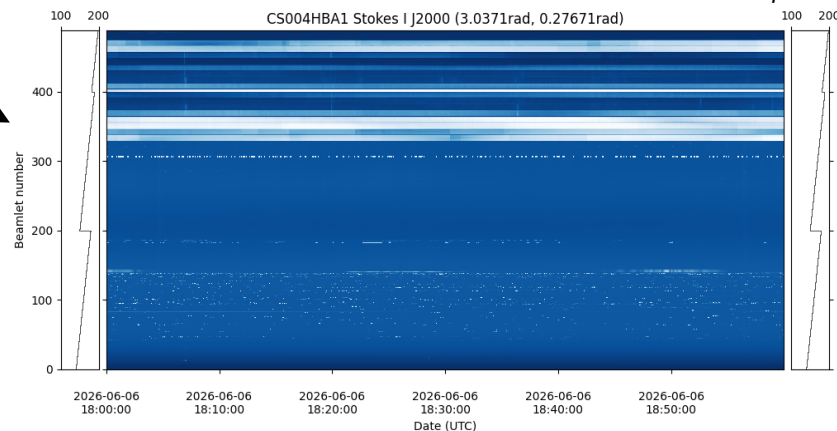
Post-rollout Procedure Overview

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- Short Fly's Eye observations of a pulsar with all HBA/LBA filters to verify filter switching works and get an overview of single station data
- Imaging observations on a bright calibrator (1-min)
 - Check the coherence between stations (MS inspection plots)
 - absence of coherence could indicate clock, synchronization, pointing, calibration issues
 - Check the status of statistics recording, beamlet statistics (BST) plots for quick views of
 - filter changes
 - RFI conditions
 - temporal archive of station behaviour

MS inspection plot

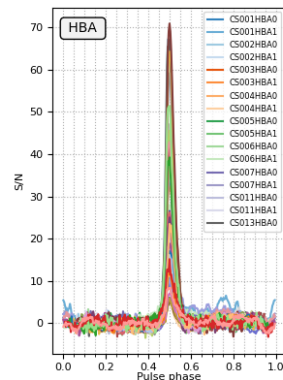


BST plot



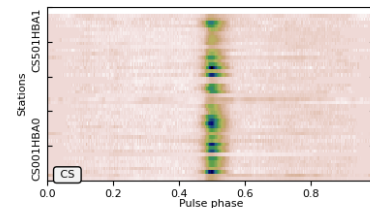
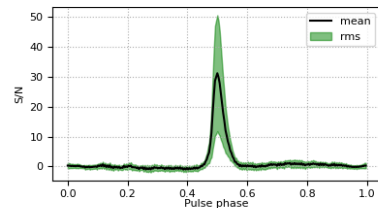
Post-rollout Procedure Overview

- Fly's Eye (FE) observations of a pulsar
 - Run FE pipeline to measure and compare sensitivity of each station through pulsar SNR
- Beamform observations of a pulsar
 - Verify Pulp2 folding pipeline runs successfully
 - Check validity of beamformer
 - Verify the presence of astrophysical pulsar signals in data and pulsar SNR
 - Upcoming: ingest verification



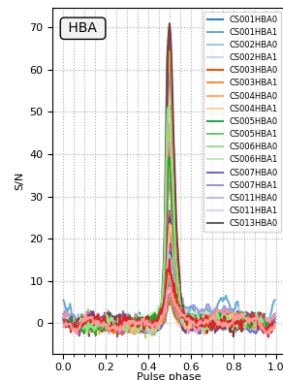
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pipeid	undef
name	J0814+7429
coord	08:14:59.500+74:29:05.70
source coordinates	61193.622215
UTC start date/time	2026-06-02T14:55:59.376
Observation duration (s)	299.97662208
length	48 / 0 / 0
obsmode	Fly's Eye or (In)Coherent
nstat	Number of stations (core / remote / international) = 48
nbin	Number of pulse phase bins
nchan	Number of frequency channels
npol	Number of polarizations (I)
nsubint	Number of sub-integrations
period	Topocentric folding period (s)
dm	Dispersion measure (pc/cm ³)
rm	Rotation measure (rad/m ²)
freq	Centre frequency (MHz)
bw	Bandwidth (MHz)
dmc	Dispersion corrected
rmc	Faraday Rotation corrected
polc	Polarization calibrated
site	Telescope name
rcvr.name	Receiver name
be.name	Name of the backend instrument
elevation	Elevation (in deg) at the start / mid-point / end
azimuth	Azimuth (in deg) at the start / mid-point / end
transit	Hour angle (in min) at the start / mid-point / end

FE folding pipeline summary plot



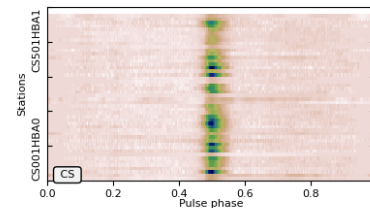
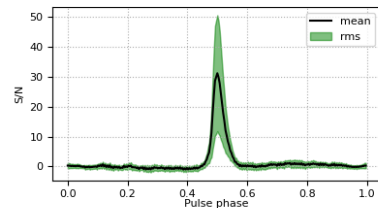
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obsid	2069230
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source coordinates	61193.622215
UTC start date/time	2026-06-02T14:55:59.376
Observation duration (s)	299.97662208
length	256
obsmode	Fly's Eye
instat	Number of stations (core / remote / international) = 48
nbin	48 / 0 / 0
nchan	6400
npol	1
nsubint	30
period	1.2922833440095
topocentric folding period (s)	5.75069999694824
dm	-14
rotation measure (rad/m ²)	148.919677734375
freq	78.125
bandwidth (MHz)	False
dispersion corrected	False
Faraday Rotation corrected	False
polc	False
site	LOFAR
rcvr.name	Receiver name
be.name	unknown
elevation	COBALT
elevation (in deg) at the start / mid-point / end	68.4 / 68.4 / 68.4
azimuth (in deg) at the start / mid-point / end	1.3 / 0.8 / 0.4
transit	Hour angle (in min) at the start / mid-point / end
	-7.15 / -4.65 / -2.14

FE folding pipeline summary plot



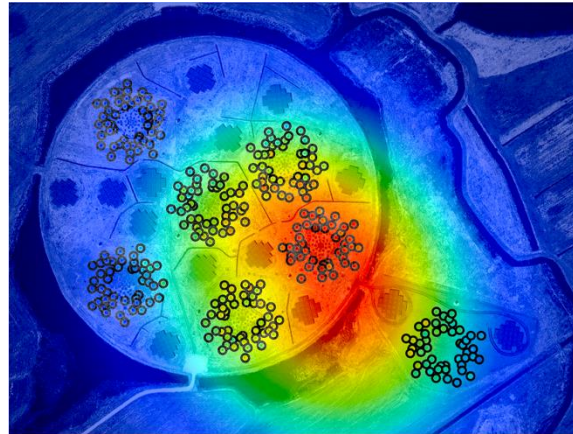
Outlook

- Procedure is actively being expanded and automated as more functionality becomes available
- Important inspection plots are currently automatically uploaded on Slack to allow quick assessment and troubleshooting by the development and commissioning teams
- In the future the procedure will ideally become part of standard operational workflow to be performed after major maintenance made on hardware and software

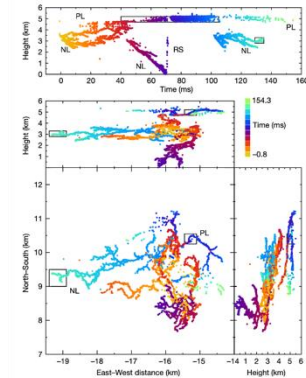
Transient buffer mode

Re-instating antenna data capture for nanosecond bursts

Sander



Cosmic ray illumination
of Superterp



Lightning 3-D imaging,
see Marten Lourens,
Thursday 16:00

OBSERVATION



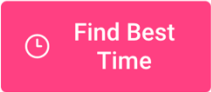
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☐		3 ▼ 🔍	🔍	Name 🔍	D 🔍	🔍	🔍	🔍	🔍
☐		scheduled	2069770	Observation	Transient Buffer Observation for LIFT	TBuf Obs	2026-06-04 14:29:13	2026-06-04 15:01:05	00:31:52

Dump Start Time

06/04/2026 16:48:53

Dump End Time

06/04/2026 16:48:54



Station	Antenna Field	State	First Recorded	Last Recorded
CS002	LBA	Frozen	04/06/2026, 14:48:52.993	04/06/2026, 14:48:57.011
CS003	LBA	Frozen	04/06/2026, 14:48:52.993	04/06/2026, 14:48:57.011
CS004	LBA	Frozen	04/06/2026, 14:48:52.994	04/06/2026, 14:48:57.012
CS005	LBA	Frozen	04/06/2026, 14:48:52.992	04/06/2026, 14:48:57.011
CS006	LBA	Idle	-	-
CS007	LBA	Frozen	04/06/2026, 14:48:52.992	04/06/2026, 14:48:57.011



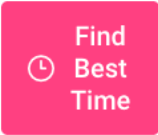
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☐		▼ ⌵	⌵	Name ⌵	D ⌵	⌵	⌵	⌵	⌵
☐		started	2069770	Observation	Transient Buffer Observation for LIFT	TBuf Obs	2026-06-04 14:29:13	2026-06-04 15:01:05	00:31:52

Dump Start Time

Dump End Time

06/04/2026 16:31:00

06/04/2026 17:01:00



Station	Antenna Field	State	First Recorded	Last Recorded
CS002	LBA	Recording	04/06/2026, 14:31:03.600	04/06/2026, 14:31:07.619
CS003	LBA	Recording	04/06/2026, 14:31:03.945	04/06/2026, 14:31:07.964
CS004	LBA	Recording	04/06/2026, 14:31:03.423	04/06/2026, 14:31:07.442
CS005	LBA	Recording	04/06/2026, 14:31:03.667	04/06/2026, 14:31:07.687
CS006	LBA	Recording	04/06/2026, 14:31:03.568	04/06/2026, 14:31:07.587
CS007	LBA	Recording	04/06/2026, 14:31:03.904	04/06/2026, 14:31:07.923

Transient Buffer Dump



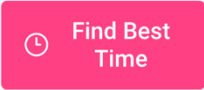
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☐		3 ▼ 🔍	🔍	Name 🔍	D 🔍	🔍	🔍	🔍	🔍
☐	👁	started	2069770	Observation	Transient Buffer Observation for LIFT	TBuf Obs	2026-06-04 14:29:13	2026-06-04 15:01:05	00:31:52
☐	👁	started	2069771	tbuf_dump_b2390468-724b-4dc4-a363-a866a6f78cf6	transient buffer dump added at 2026-06-04 14:33:23.700570+00:00	tbuf dump	2026-06-04 14:33:26	2026-06-04 14:48:00	00:14:33

Dump Start Time

Dump End Time

06/04/2026 16:48:54

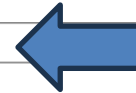
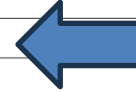
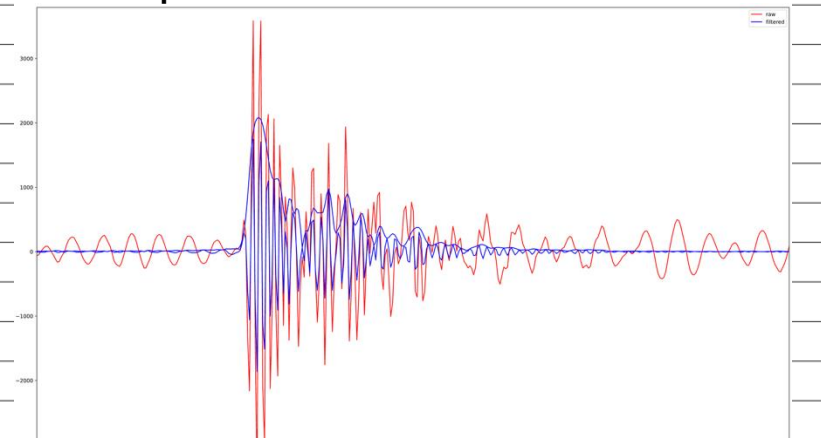
06/04/2026 16:48:55



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CS002	LBA	Frozen	04/06/2026, 14:48:52.993	04/06/2026, 14:48:57.011
CS003	LBA	Frozen	04/06/2026, 14:48:52.993	04/06/2026, 14:48:57.011
CS004	LBA	Frozen	04/06/2026, 14:48:52.994	04/06/2026, 14:48:57.012
CS005	LBA	Dumping	04/06/2026, 14:48:52.992	04/06/2026, 14:48:57.011
CS006	LBA	Frozen	04/06/2026, 14:48:52.992	04/06/2026, 14:48:57.011
CS007	LBA	Dumping	04/06/2026, 14:48:52.992	04/06/2026, 14:48:57.011

A pulse in transient buffer data

Station	Antenna	Key
cs001	hba	cs001/L D20260518T131617.000Z cs001 HBA0 R1 tbb.h5
cs001	lba	cs001/L D20260529T145017.000Z cs001 LBA R1 tbb.h5
cs001	hba	cs001/L D20260602T190655.000Z cs001 HBA0 R1 tbb.h5
cs001	lba	cs001/L D20260604T090700.000Z cs001 LBA R1 tbb.h5
cs001	lba	cs001/L D20260604T121500.000Z cs001 LBA R1 tbb.h5
cs001	lba	cs001/L D20260604T121501.000Z cs001 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T090700.000Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T123207.744Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T123208.744Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T124852.994Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T124854.994Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T124855.994Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T144853.994Z cs002 LBA R1 tbb.h5
cs002	lba	cs002/L D20260604T144854.994Z cs002 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T090700.000Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T123207.744Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T123208.744Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T124852.994Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T124854.994Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T124855.994Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T144853.994Z cs003 LBA R1 tbb.h5
cs003	lba	cs003/L D20260604T144854.994Z cs003 LBA R1 tbb.h5



2026-06-04T15:58:41.373Z	0.02
2026-06-04T14:54:19.381Z	0.02
2026-06-04T16:04:38.363Z	559.93
2026-06-04T16:08:13.427Z	559.93
2026-06-04T11:33:36.001Z	0.02
2026-06-04T14:33:33.628Z	0.02
2026-06-04T14:46:26.324Z	0.02
2026-06-04T16:06:36.939Z	0.02
2026-06-04T15:58:41.325Z	0.02
2026-06-04T14:54:19.436Z	0.02
2026-06-04T16:04:38.278Z	546.91
2026-06-04T16:08:13.118Z	546.91

An Intra-Station Calibration Update

David McKenna,
Cristina-Maria Cordun,
Cees Bassa,
Michiel Brentjens

Background

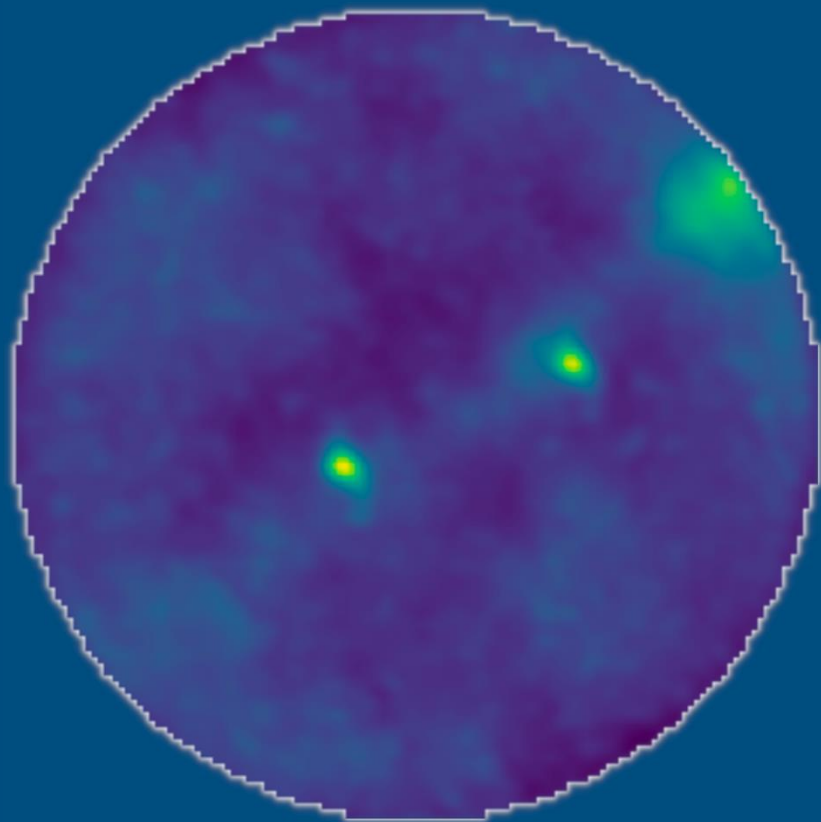
We live in an imperfect world

Manufacturing tolerances

Cable delays aren't fine enough to be
precisely correct

European weather, flora and fauna
have not been kind to the array

We aspire to correct for that



Background

We live in an imperfect world

We aspire to correct for that

- Take a perfect model

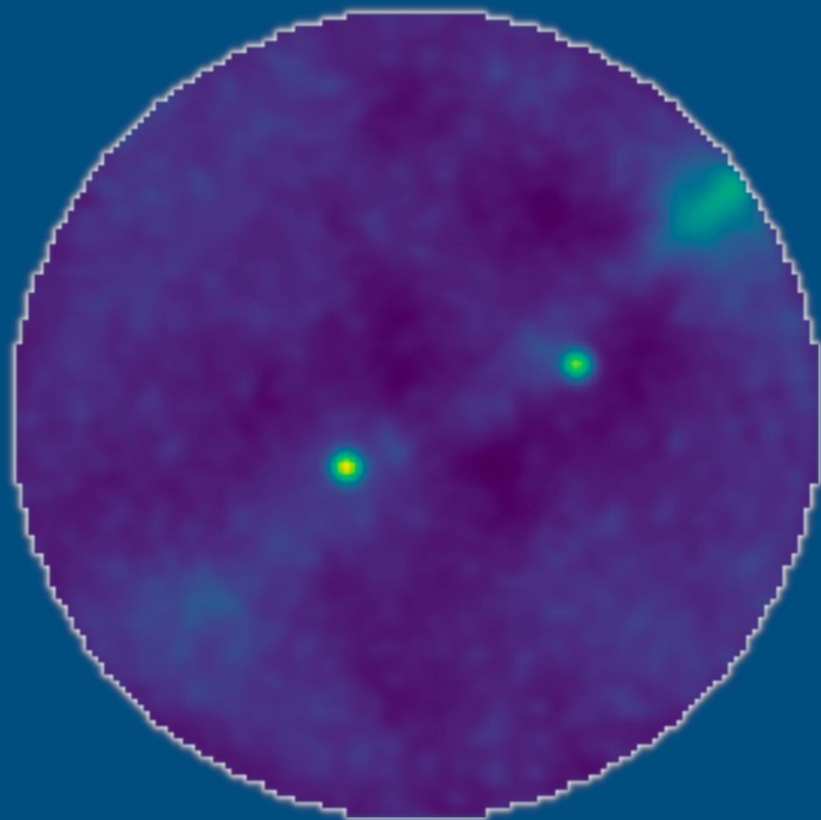
- Corrupt it to represent our

- “expected” result for our telescope

- Iteratively fit a correction factor until

- we reach some stopping criteria

- Reach a per-antenna amplitude and
phase/fitted delay solution



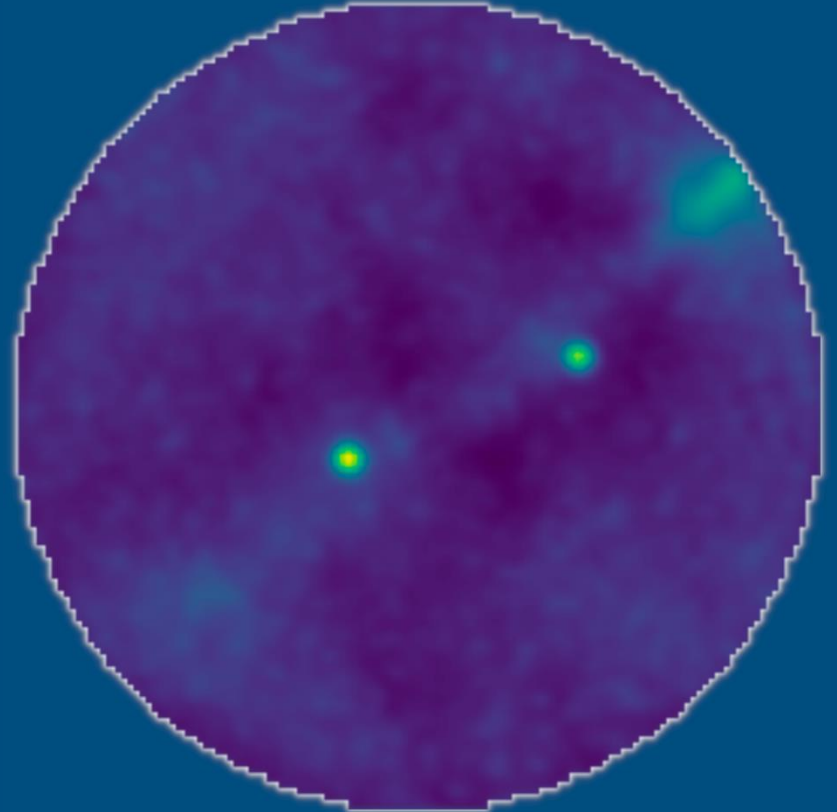
Background (LOFAR1)

LBA

24 hour dedicated observations
A-team sources

HBA

2-8 hour dedicated observations
Single point source



HBA Calibration

Point the analogue beam at Cas A

Simple gain/phase calibration

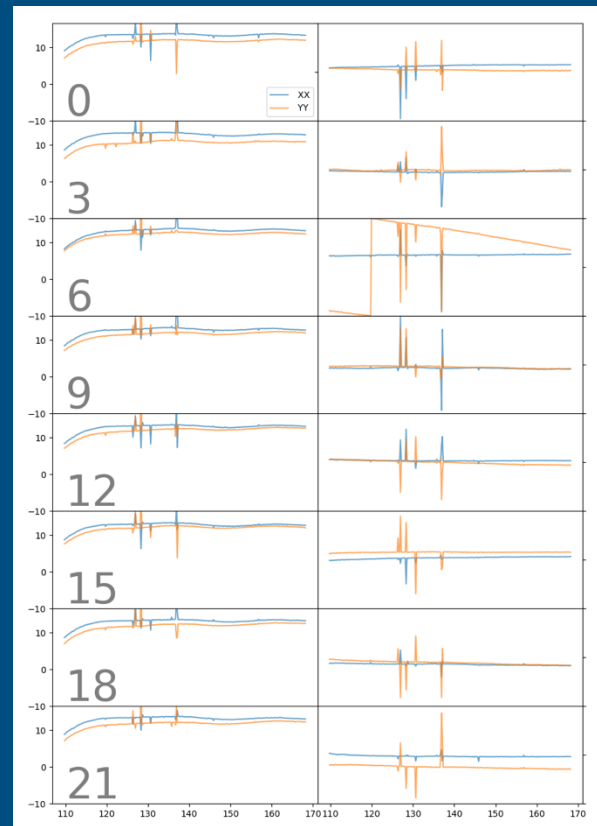
Single point source reference model

Hamaker antenna model corrections

Completes in less than 2 minutes

It just works[†]

[†] Most of the time, issues twice+ a day if the Sun or Cygnus A pass through the sidelobes and at extremely low elevations



HBA Calibration

Point the analogue beam at Cas A

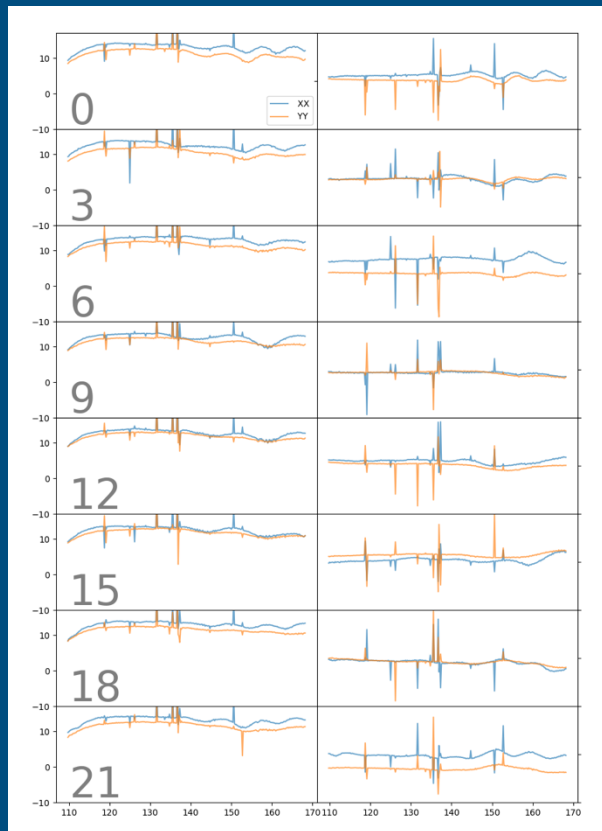
Full Jones solve for stability, X/Y solutions applied

Single point source reference model

Hamaker antenna model corrections

Observing completes in less than 2 minutes

It just works

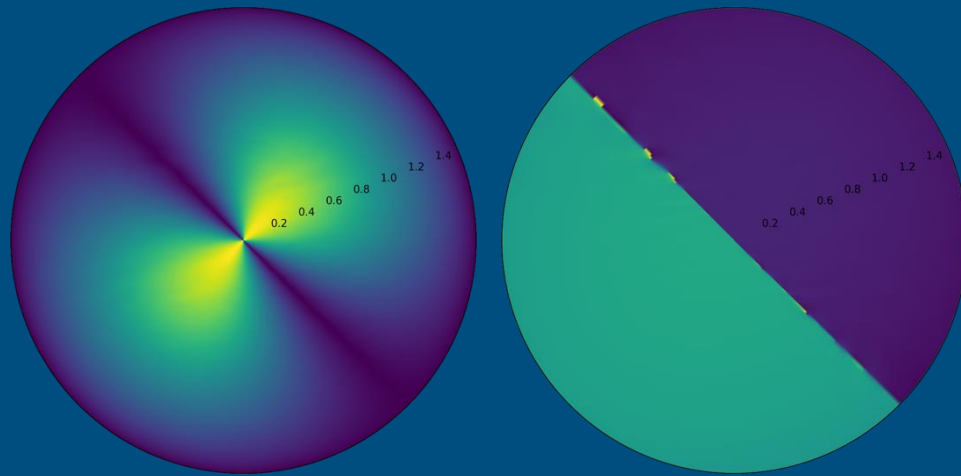


LBA Calibration

Passive data collection with LOFAR2.0 outputs
Full Jones solve for stability, X/Y solutions applied

Nside=32 Healpix map of diffuse
galactic emission

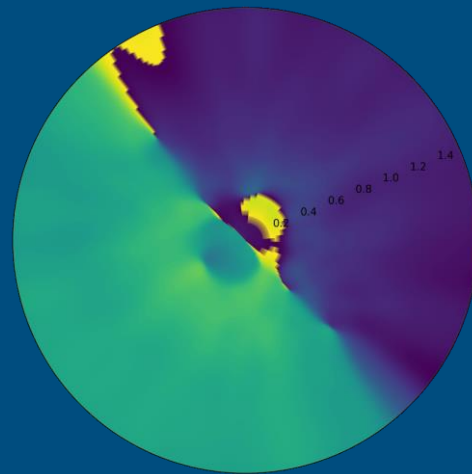
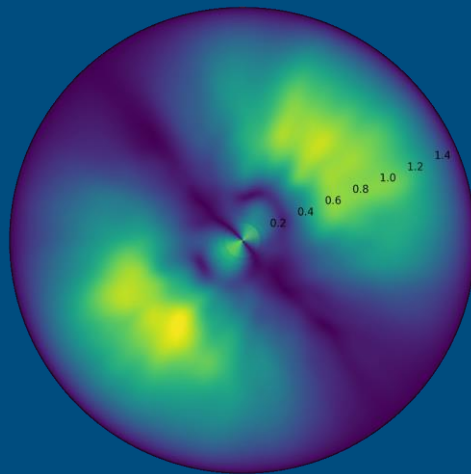
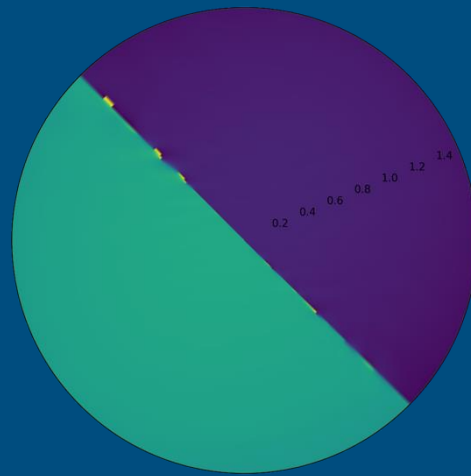
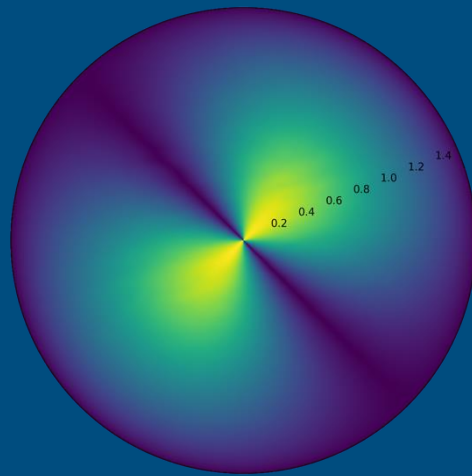
Embedded element patterns
corrections



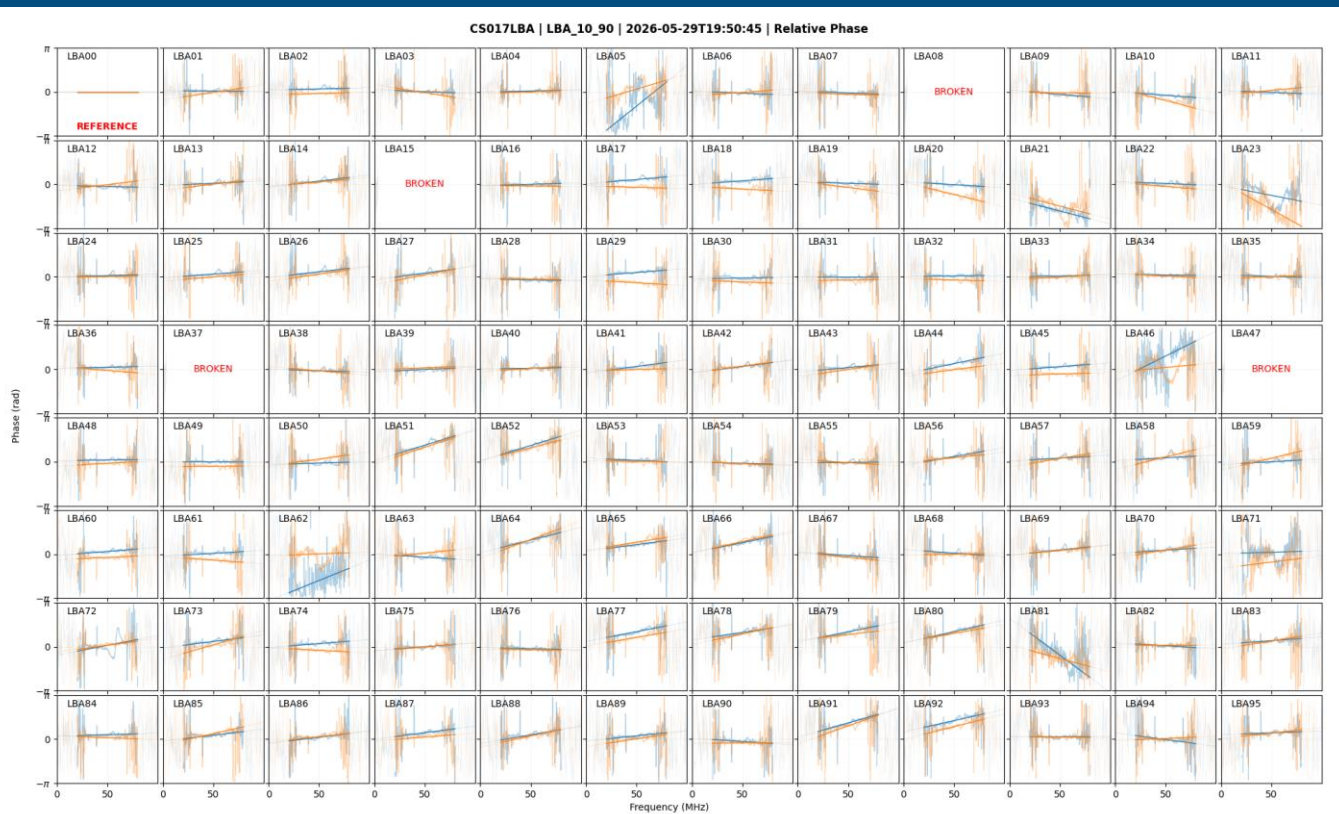
LBA Calibration

Passive data collection with LOFAR2.0 outputs
Full Jones solve for stability, X/Y solutions applied

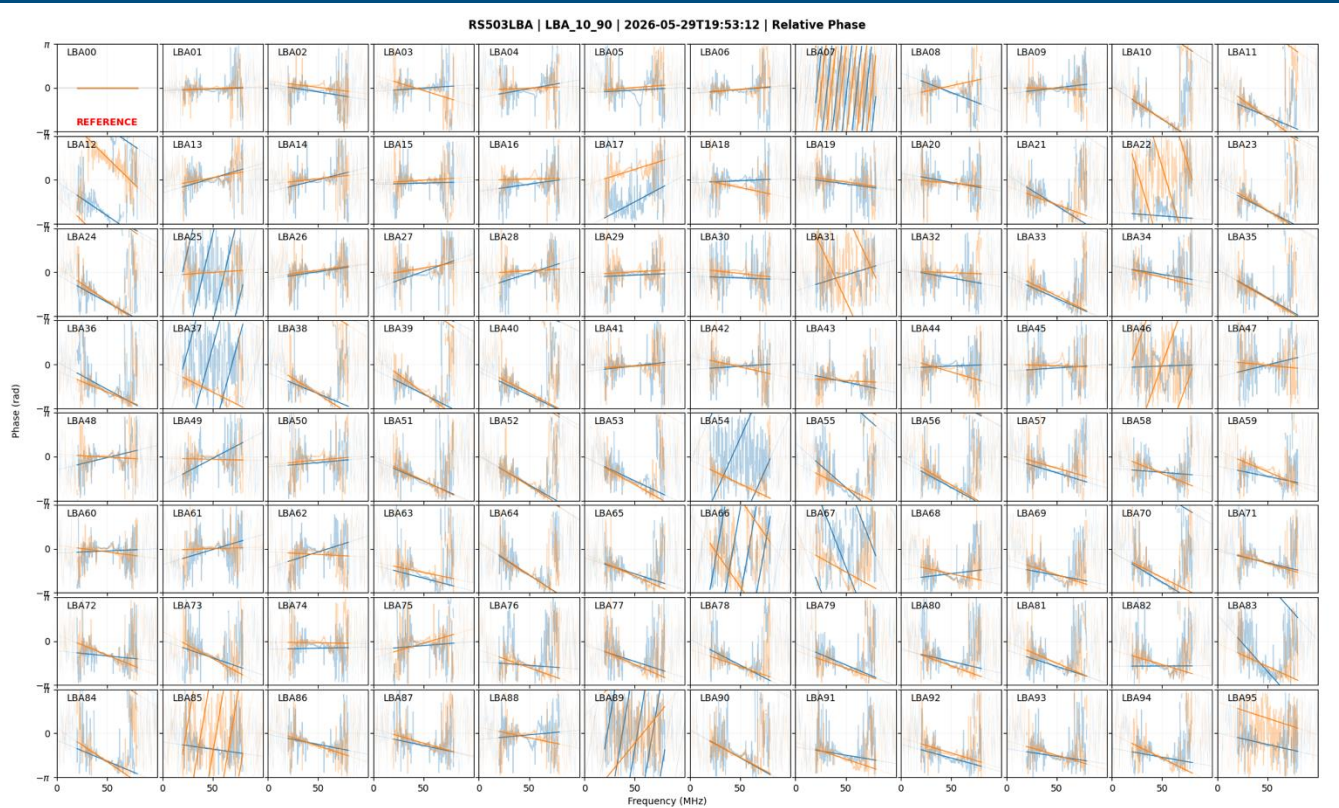
Nside=32 Healpix map of diffuse
galactic emission
Embedded element patterns
corrections



It Works!



... unless it doesn't



... or infra falls over



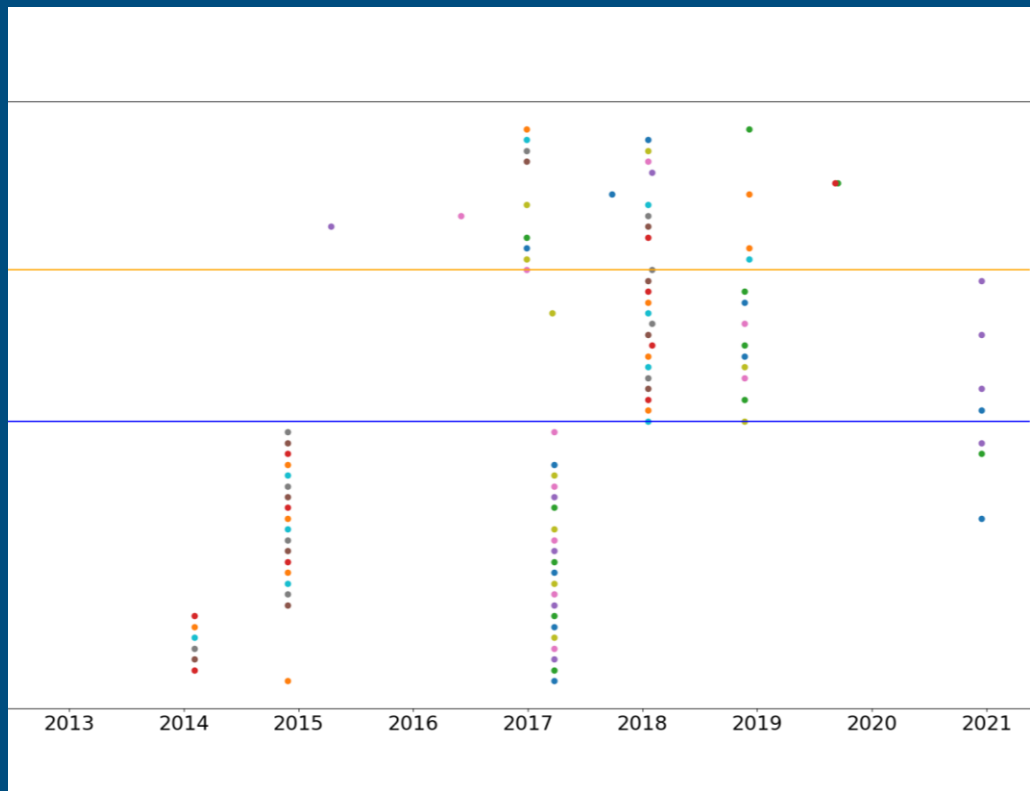
Tables Deployed to Most of the Array

Cees deployed a set of tables to all available stations in November/December 2025

Kept constant while commissioning for AR-C and follow-up investigations are on-going
Daily calibration observations indicate minor variations in delays, or have picked up on bigger issues

Tables Deployed to Most of the Array

- Cees deployed a set of tables to all available stations in November/December 2025
- Kept constant while commissioning for AR-C and follow-up investigations are on-going
- Daily calibration observations indicate minor variations in delays, or have picked up on bigger issues



Improved TAB Performance?

~ 6 hours of observing attempts at obscure
hours
4 attempts at manual per-station uploading of
calibration tables
0 smooth executions

I'm sure this'll appear at a LOFAR Forum
whenever things are more stable.

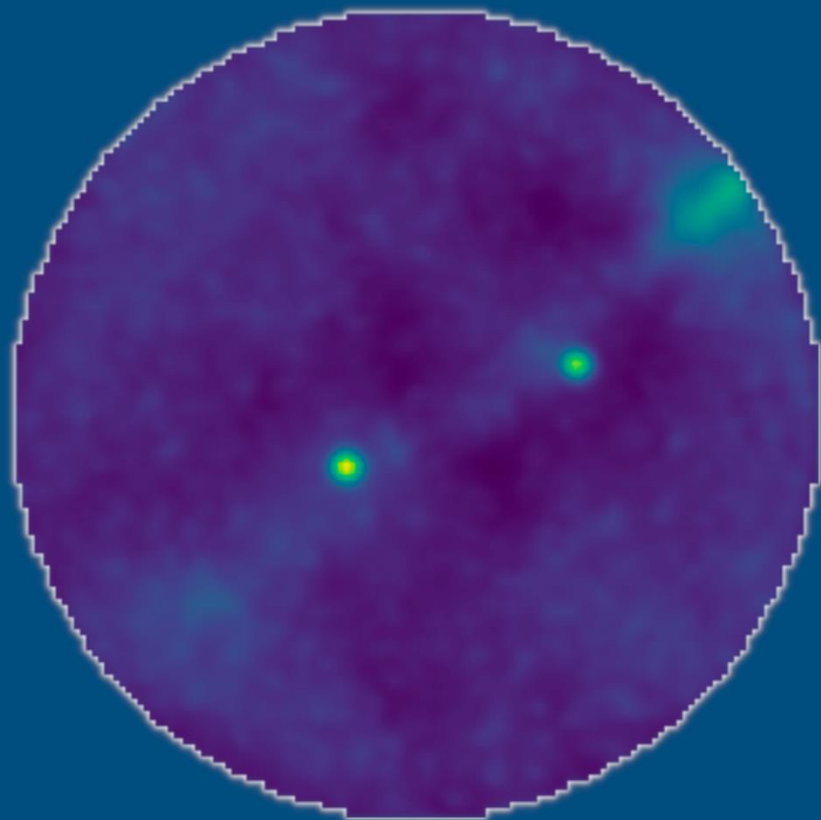
Where To Next?

Getting broken automation fixed and missing functionality implemented for operations

Automatic visibility/sky based RFI flagging

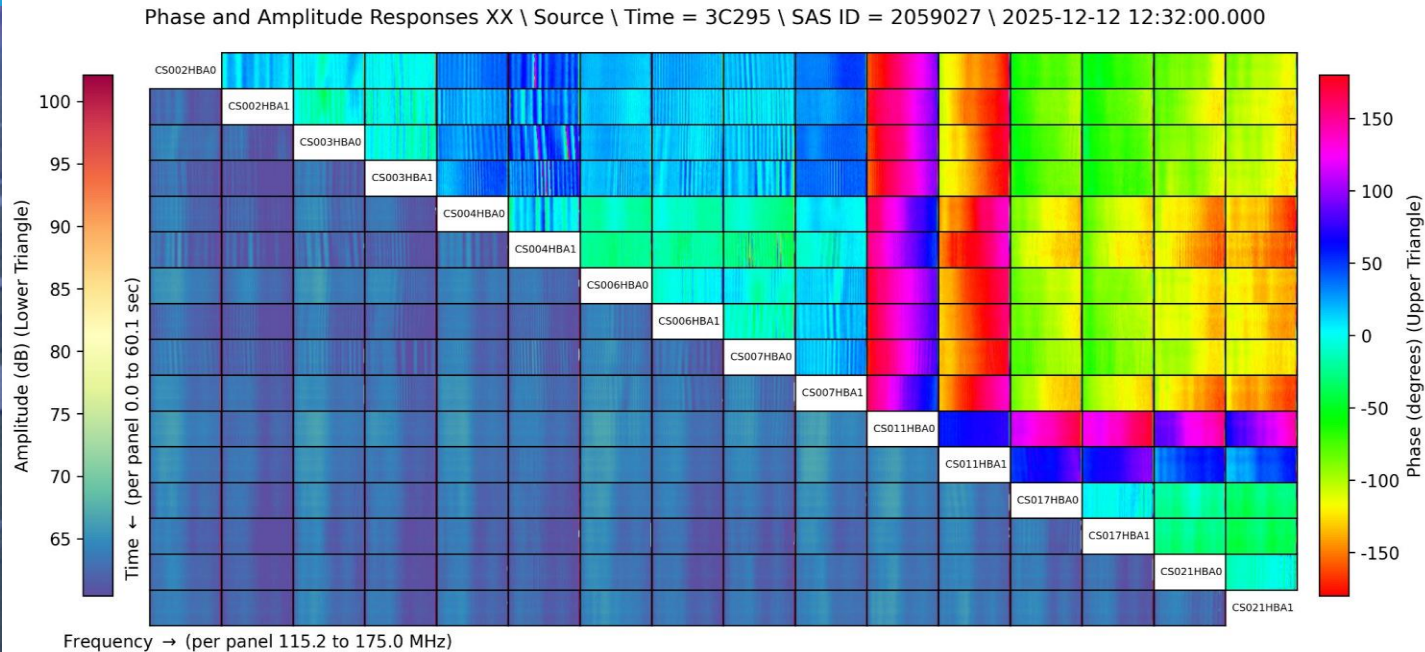
Testing on the new LOFAR2.0 ILT stations

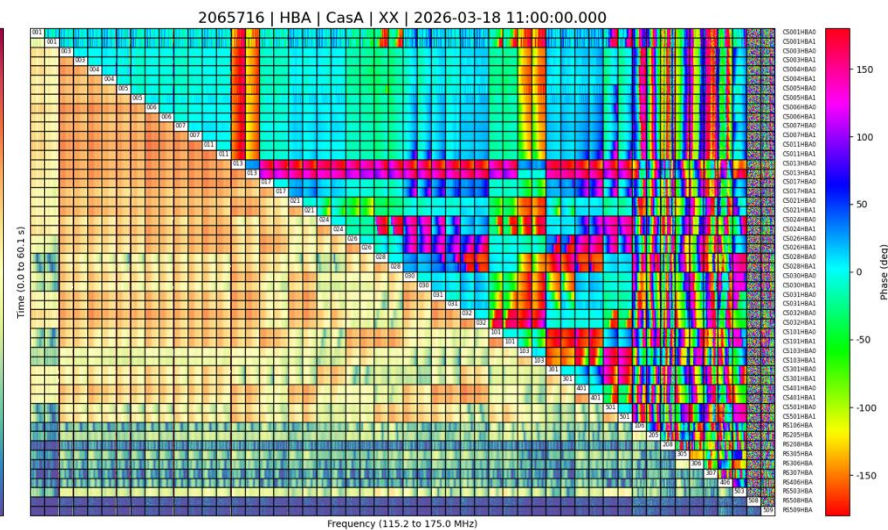
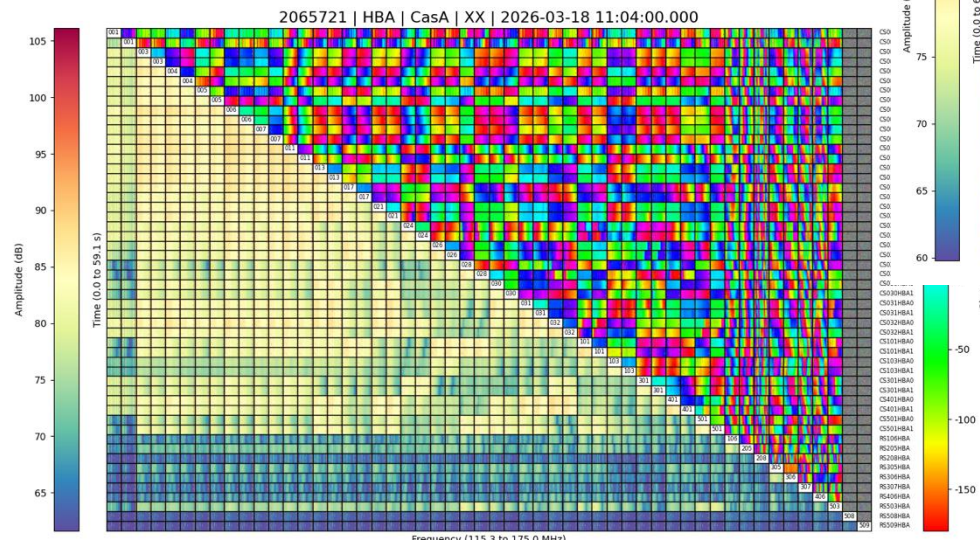
SE607LBA has shown us lessons from
the core do not apply to their layout



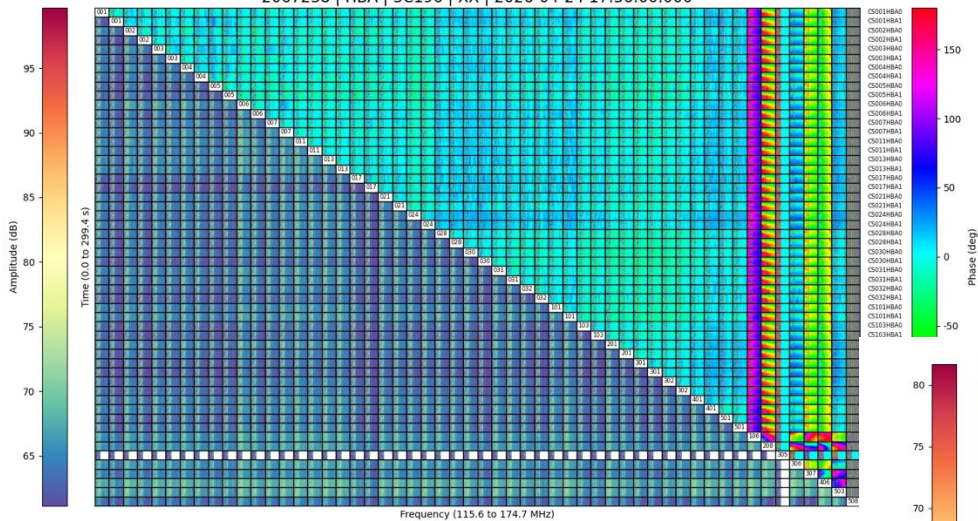
Array calibration (delays)

Cristina, Maaijke, Henrik

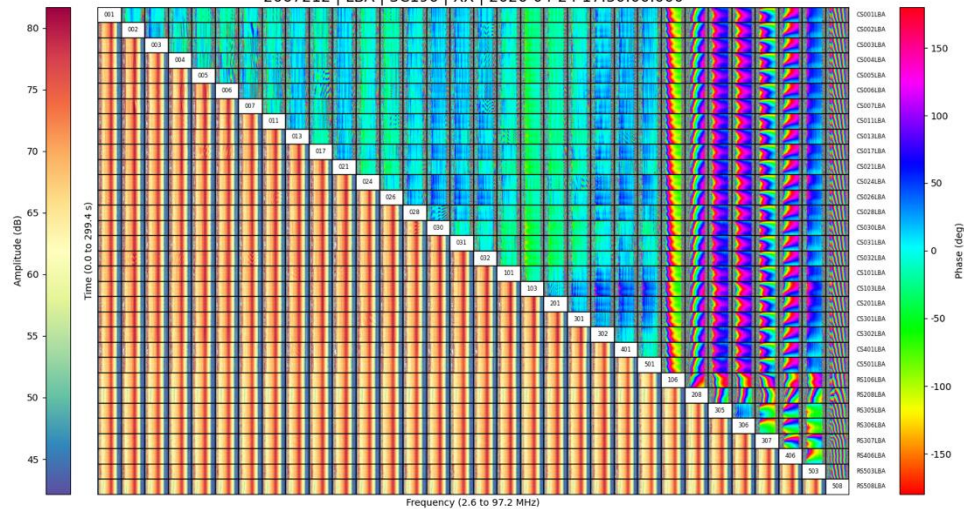




2067238 | HBA | 3C196 | XX | 2026-04-24 17:36:00.000



2067212 | LBA | 3C196 | XX | 2026-04-24 17:30:00.000

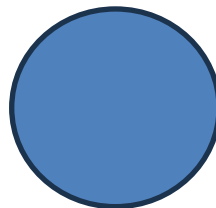


SEFDs

Cristina

- SEFD = System Equivalent Flux Density
- How bright would a source need to be to match my telescope's noise?

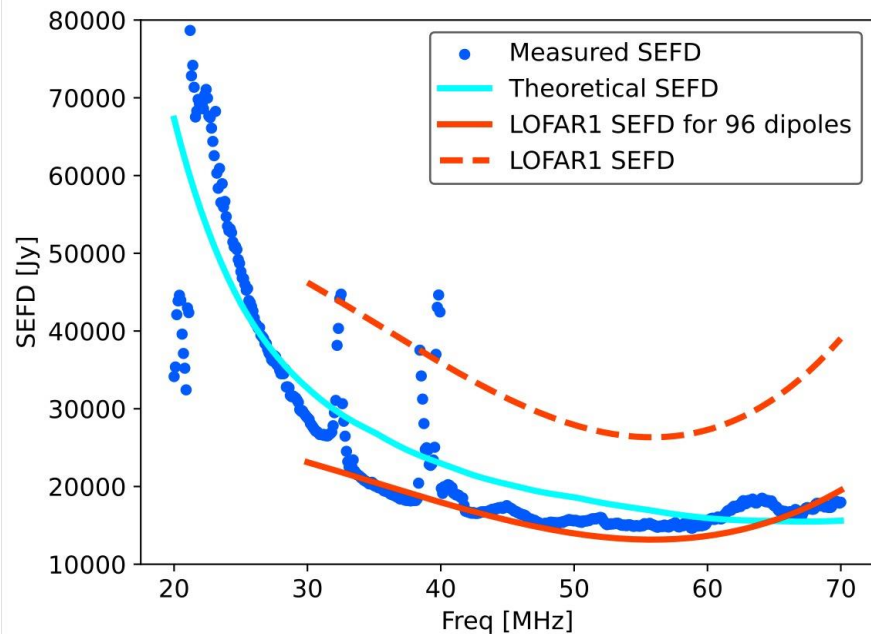
High SEFD



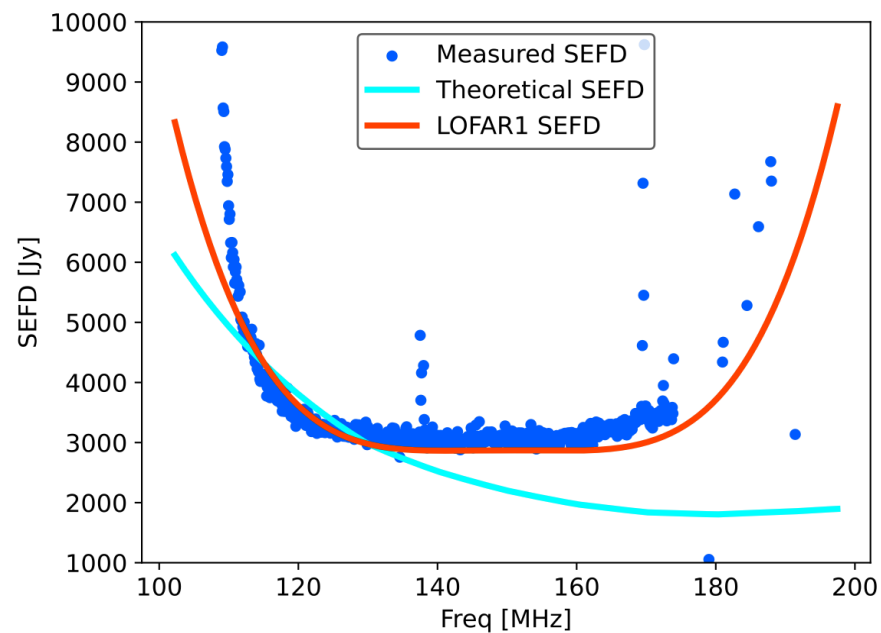
Low SEFD



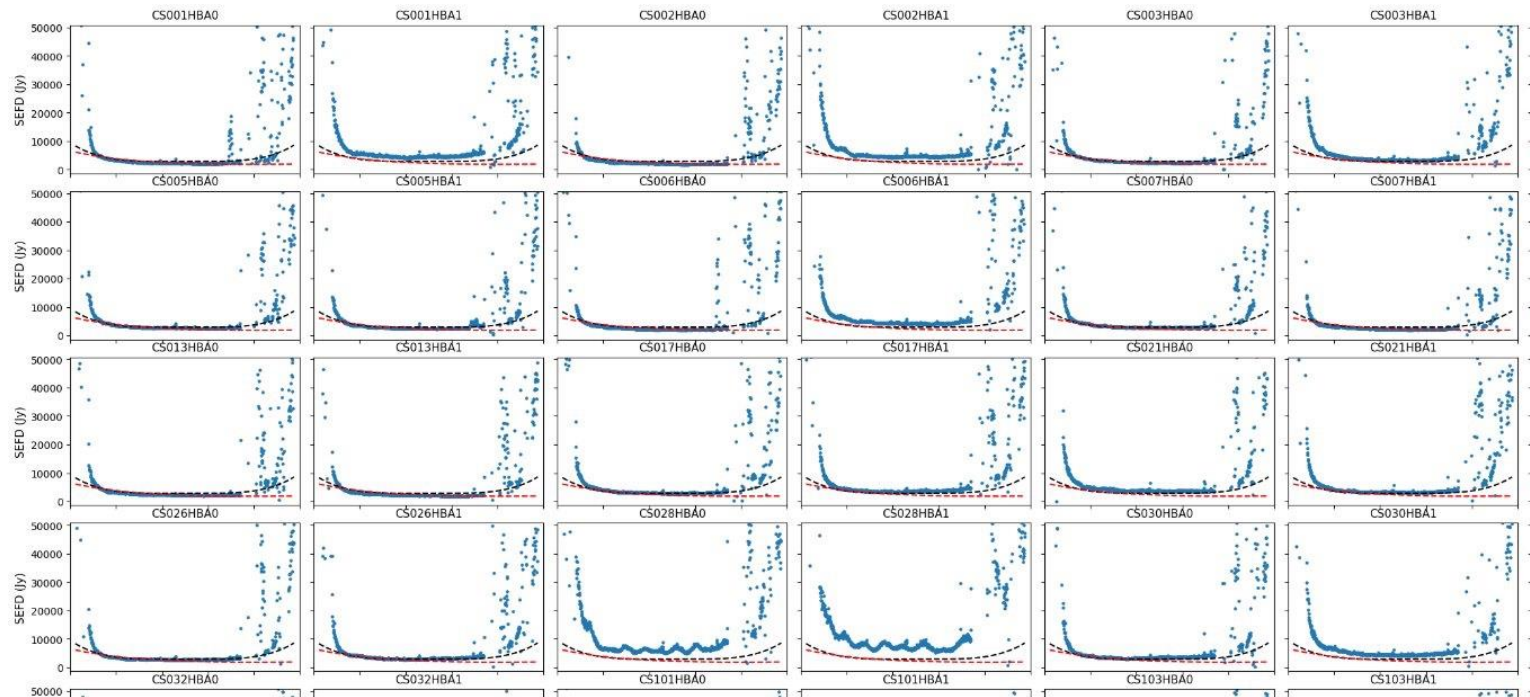
LBA



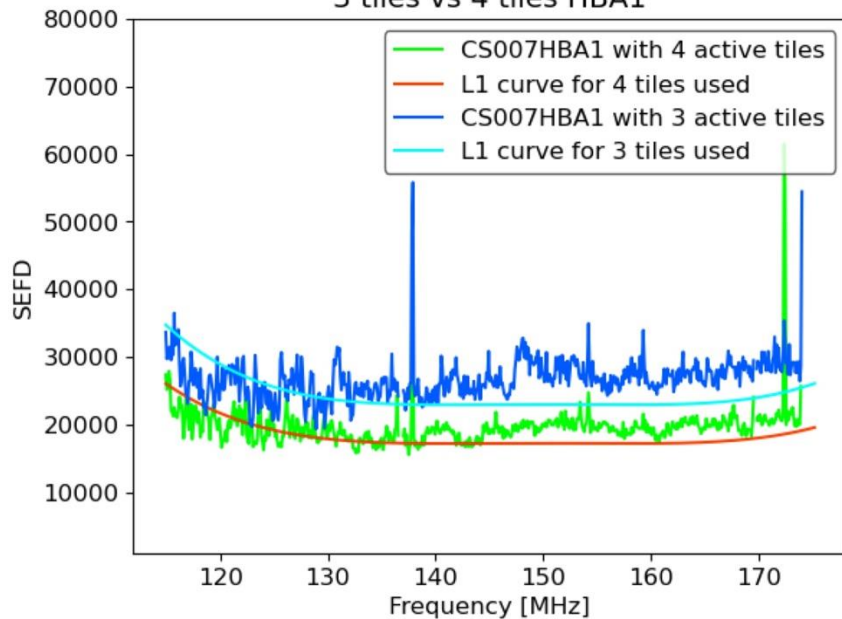
HBA



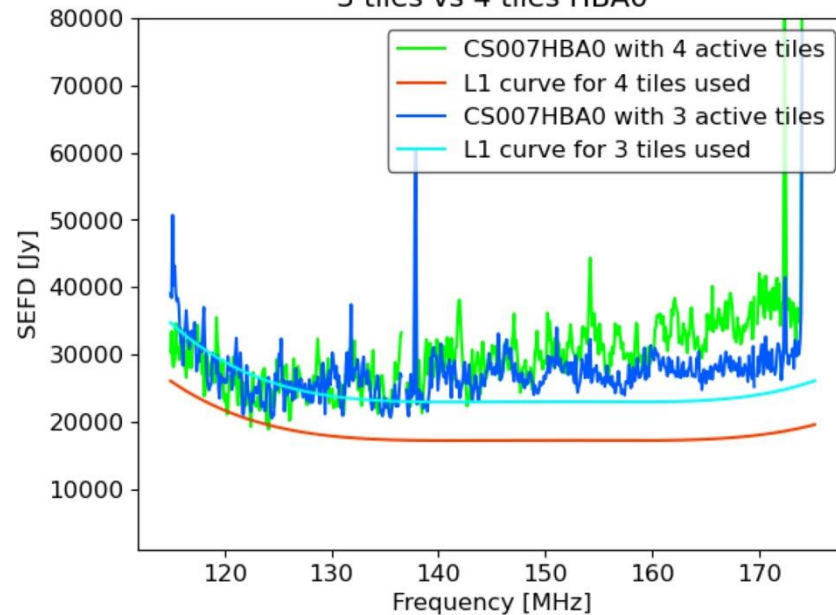
SEFD per station



3 tiles vs 4 tiles HBA1



3 tiles vs 4 tiles HBA0

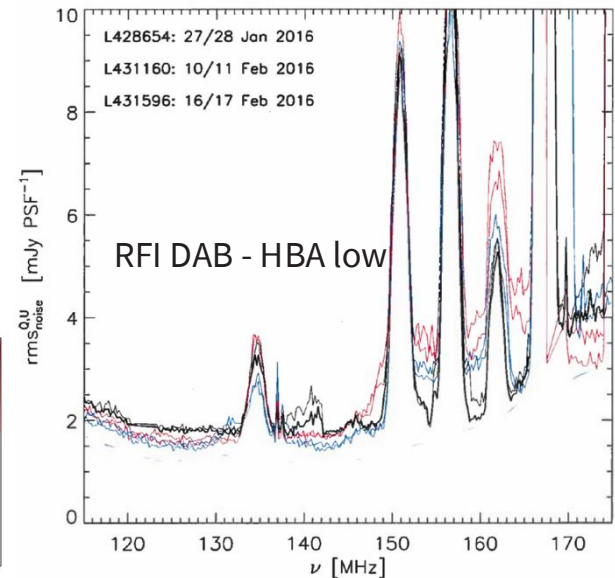
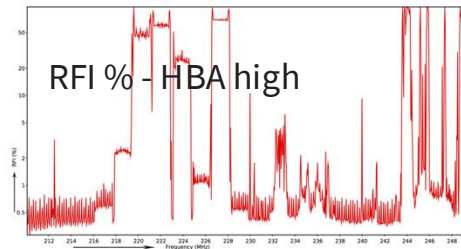
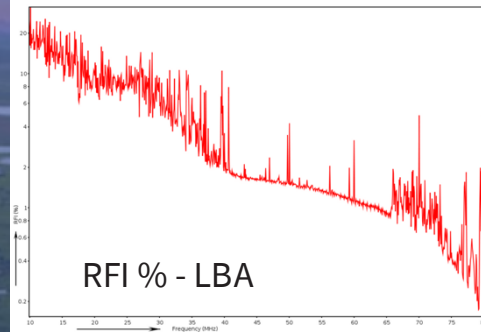


RFI situation then and now

Aleksandar

Then

The RFI environment was characterized in the past and we aim to continue monitoring it into LOFAR2.0 operations

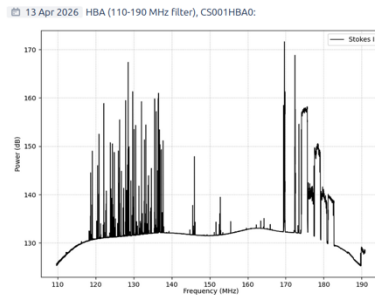
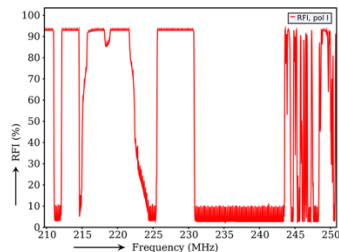
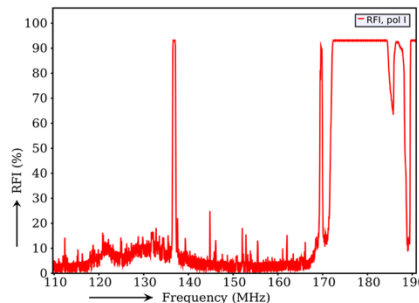
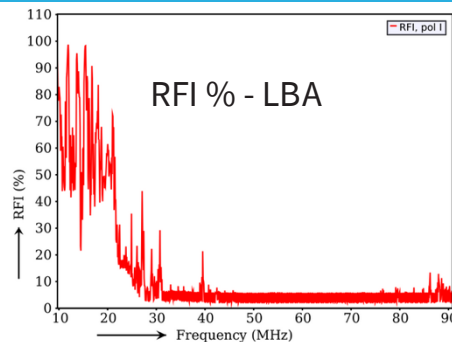


RFI situation then and now

Aleksandar

Now

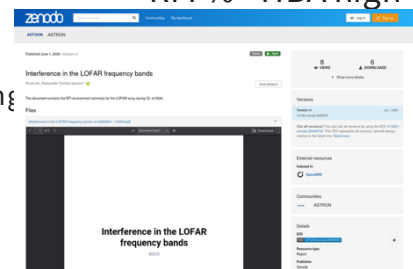
The RFI characterization will be continuous.
Shown are a few sample short test observations



RFI % - HBA low

We aim for a series of
versioned reports allowing
users to refer to the RFI
properties at the time of
publication.

Power (dB) - HBA low



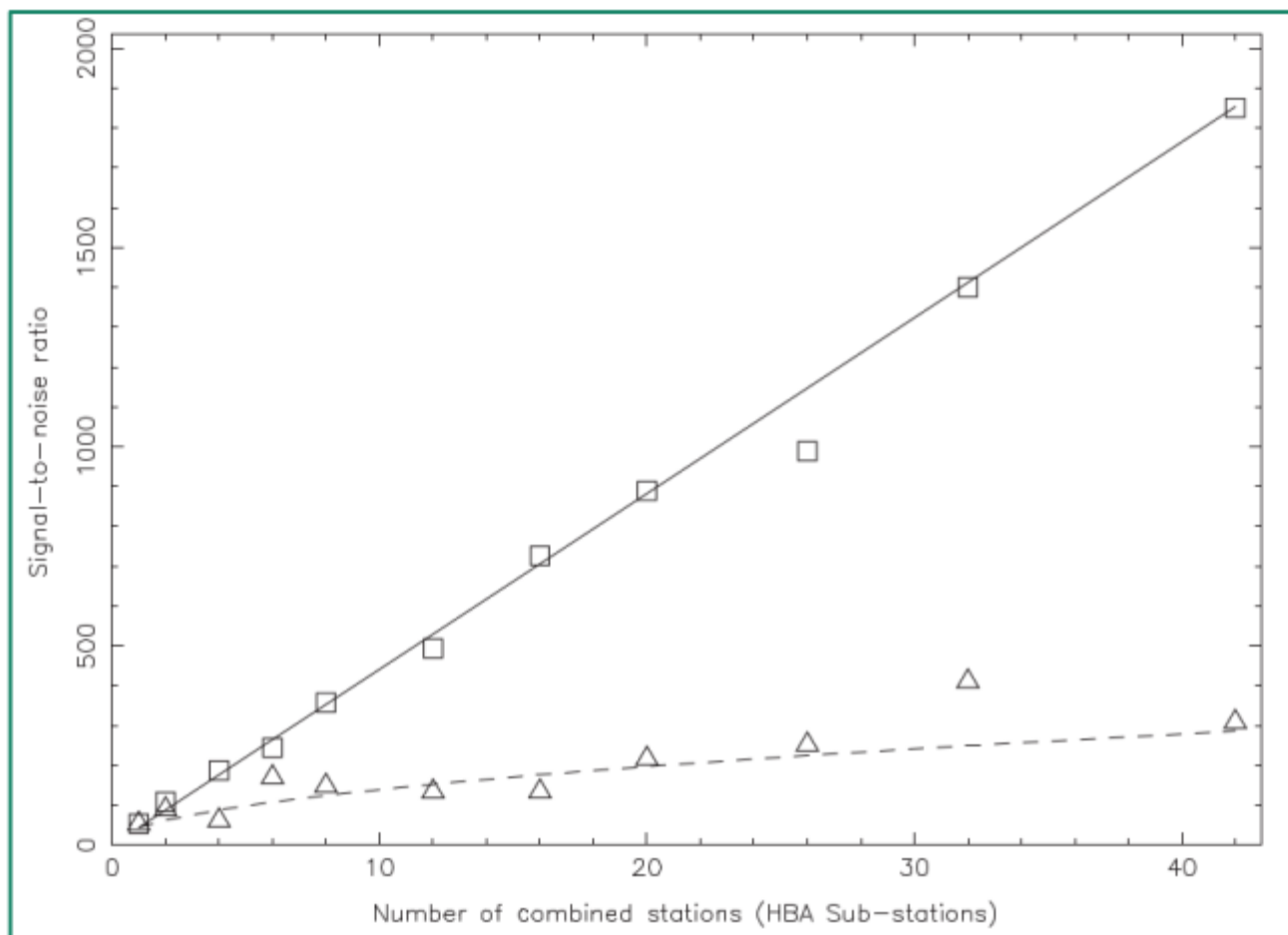
RFI % - HBA high

LOFAR2 Core coherence tests — I



Vlad

LOFAR1: coherent vs incoherent addition of stations

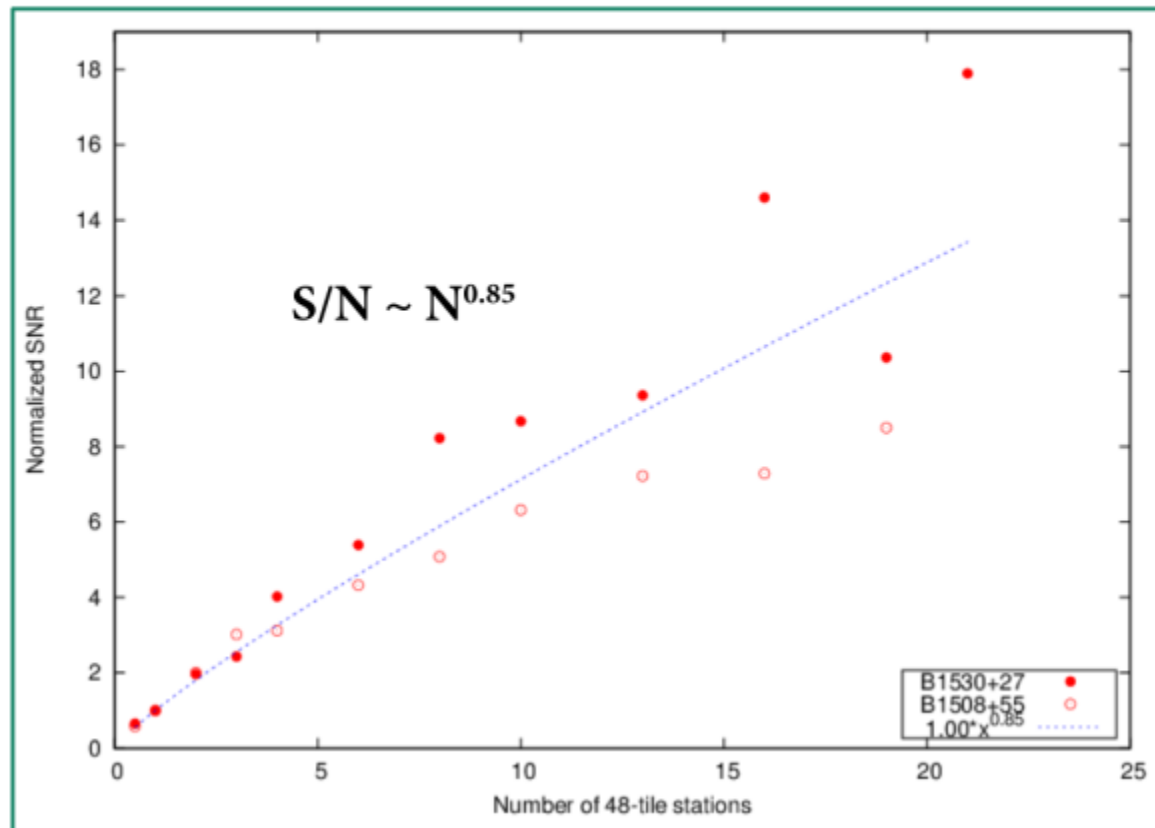


- Coherent: $S/N \sim N_{\text{stat}}$
- Incoherent: $S/N \sim N_{\text{stat}}^{1/2}$

van Haarlem et al. (2013)

LOFAR1: core coherence

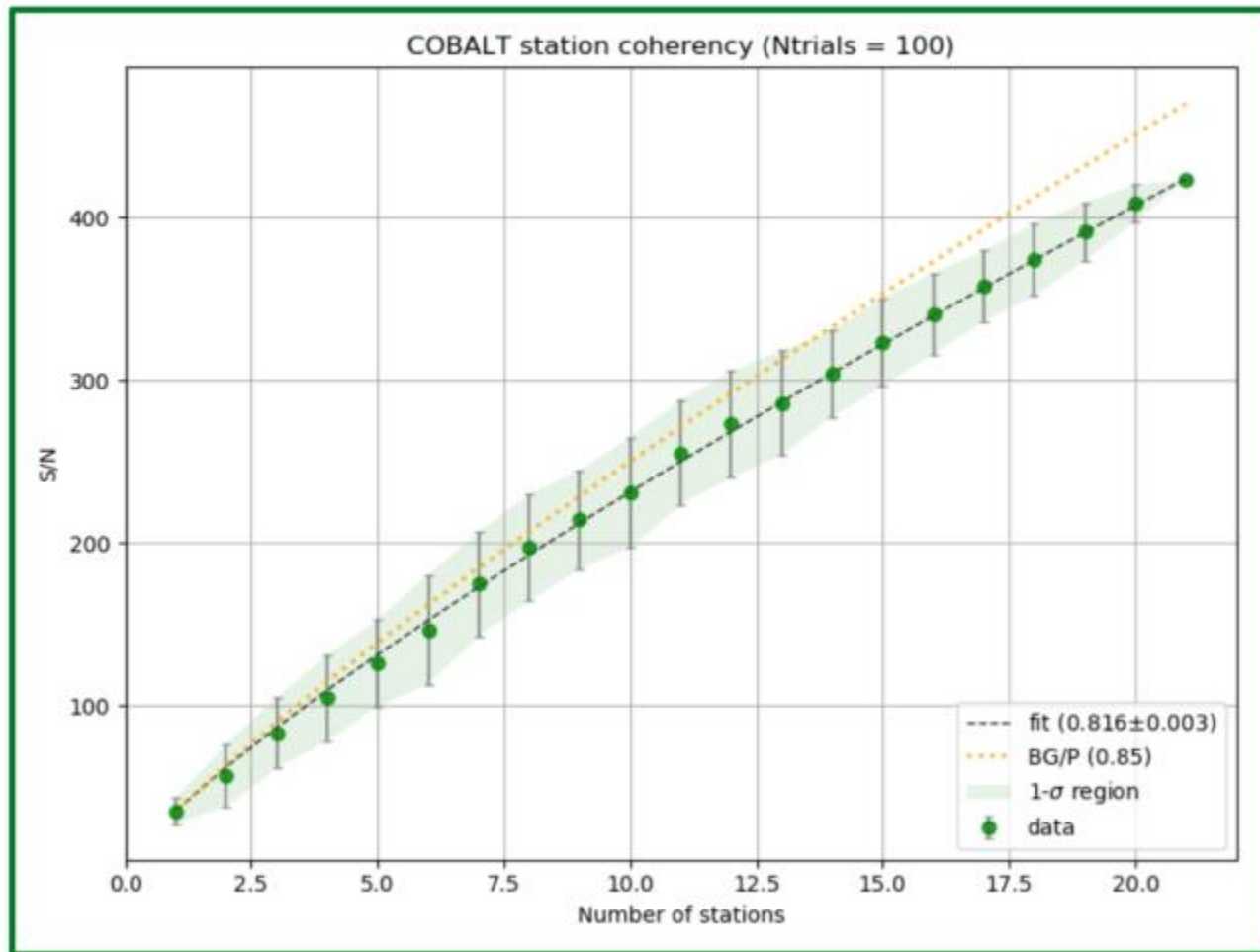
BG/P



Kondratiev et al. (2016)

LOFAR1: core coherence

COBALT / UDP data



$$S/N \sim N^{0.816}$$

S/Ns are corrected for

- RFI fraction
- fraction of bad tiles

«S/N» plotted here
is actually **Profile
Significance**:

$$\Sigma(S/N)_i / \sqrt{W_{eq}}$$

(LK, p. 167)

Flux calibration

In general (see e.g. Lorimer & Kramer 2005):

$$\Delta S_{\text{sys}} = \frac{T_{\text{sys}}}{G \sqrt{n_p t_{\text{obs}} \Delta f}} = C \sigma_p,$$

C = SEFD





$$\text{SEFD} = \frac{2\beta k [T_{\text{inst}}(f) + T_{\text{sky}}(f, \text{GL}, \text{GB})]}{N_s^{\gamma} A_{\text{eff}}(f, \text{EL}) [1 - \xi] \sqrt{n_p [1 - \zeta(f)] (\frac{T_{\text{obs}}}{\text{nbins}}) \Delta f}}$$

β — digitization factor = 1

GL, GB — Galactic longitude and latitude

γ — coherence factor ≈ 0.85

N_s — number of stations used

n_p — number of polarizations (2)

A_{eff} — effective area of a 48-tile station

ξ — average fraction of bad/flagged dipoles/tiles

ζ — RFI fraction

nbins — number of bins in the profile

T_{obs} — observation length (s)

Δf — frequency channel width (Hz)

LOFAR2: core coherence tests

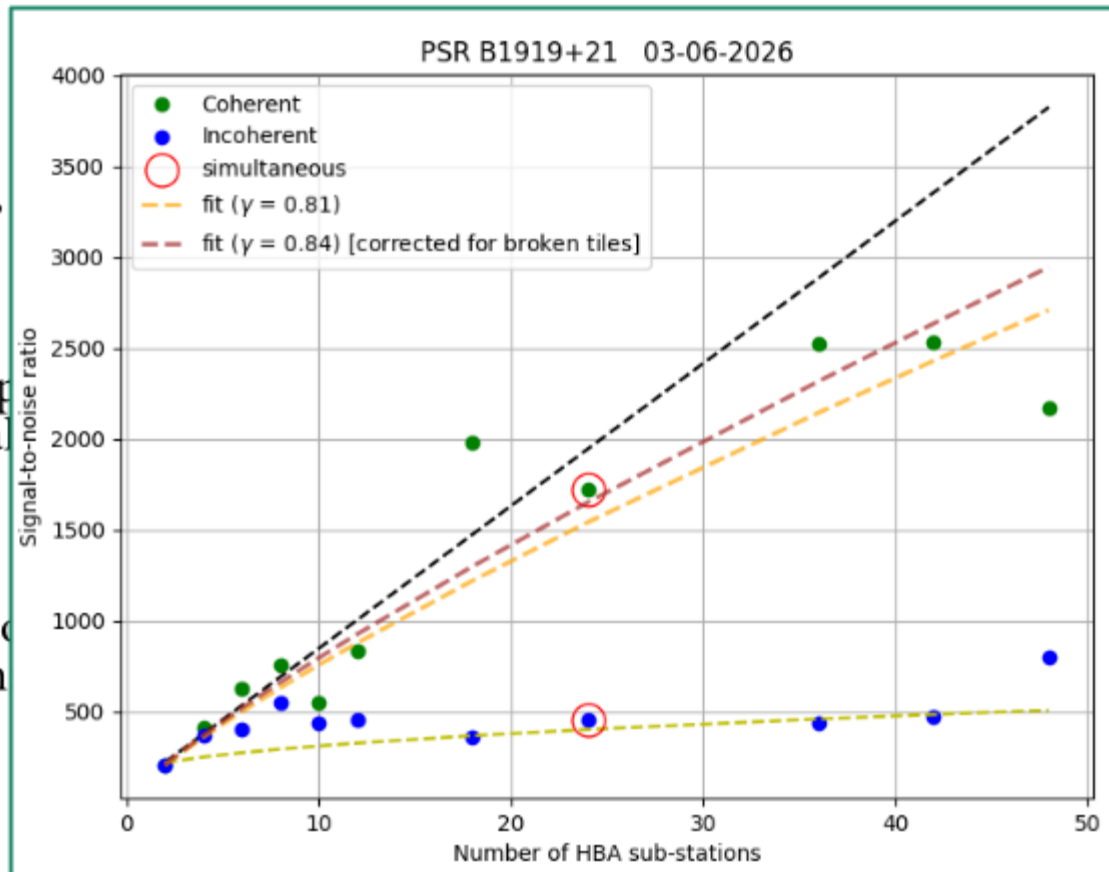
What can we do with LOFAR2?

- Cobalt3 UDP data
 - requires TBs of raw station data, offline beamformer, dedicated processing
 - not yet, eventually
- Multiple beamformer pipelines
 - same observation, different setups
 - not at the moment – some Cobalt issues – Jira's [LOIS-287](#), [LOIS-288](#), [LOIS-299](#)
 - very soon
- Original LOFAR1 approach
 - series of short sequential pulsar observations
 - cons: non-simultaneous → intrinsic variability, scintillation, varying RFI, EL change

LOFAR2: core coherence tests

What can we do with LOFAR2?

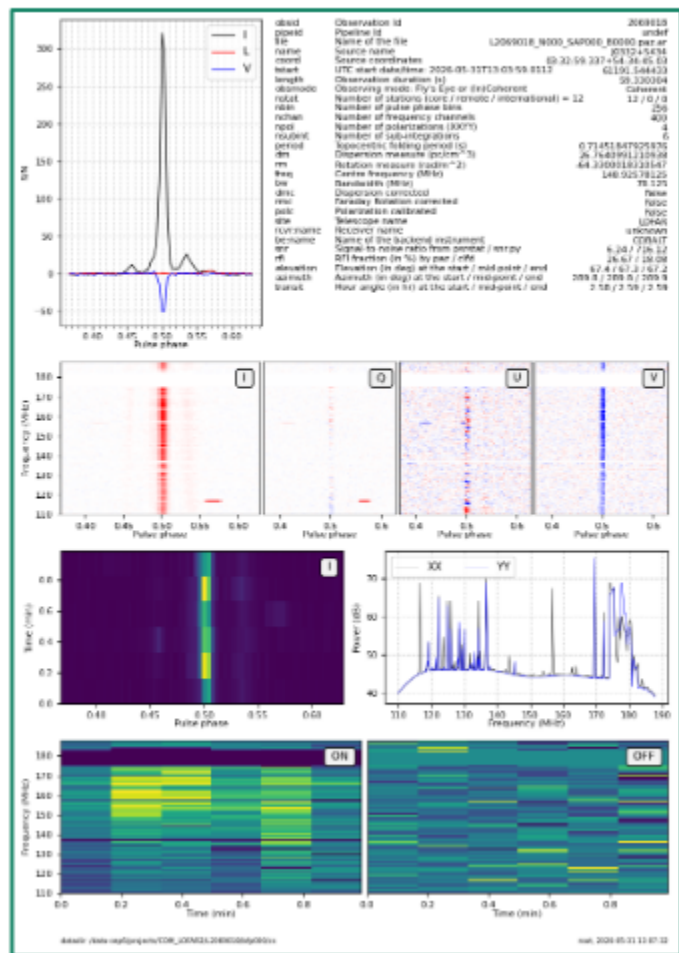
- Cobalt3 UDP data
 - requires TBs of raw station data,
 - not yet, eventually
- Multiple beamformer pipelines
 - same observation, different setups
 - not at the moment – some Cobalt3
 - very soon
- Original LOFAR1 approach
 - series of short sequential pulsar observations
 - cons: non-simultaneous $\rightarrow$ intrinsic



LOFAR2: superterp

vs.

core

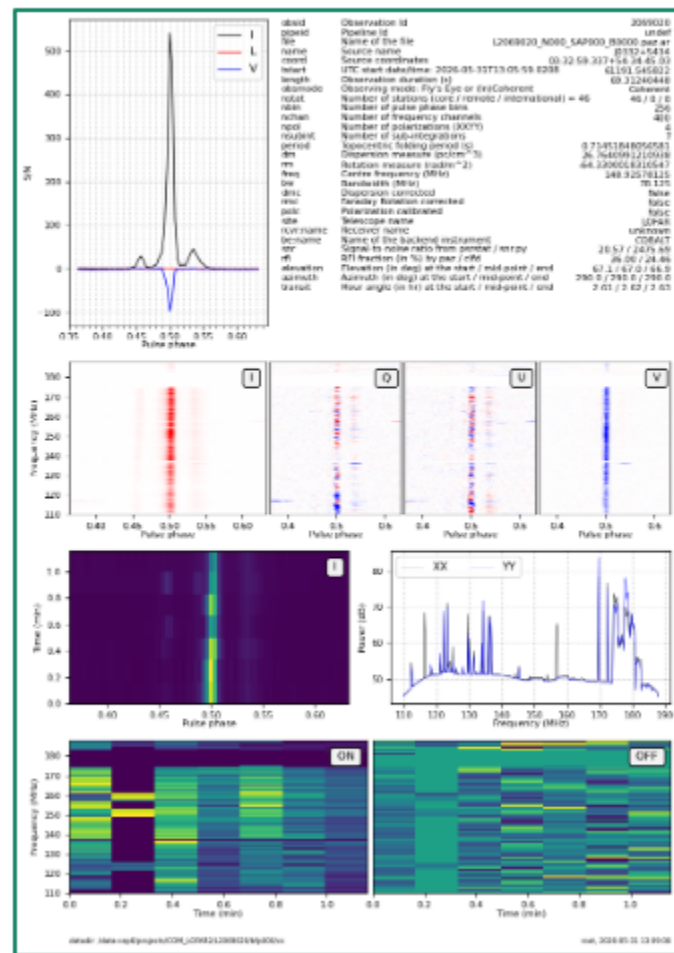


PSR B0329+54

1-min obs, 1 min gap

12 Nstat 46
 716 S/N 2475.7

x3.46 (46/12 → ~3.83)



LOFAR2: superterp

vs.

rest of the core

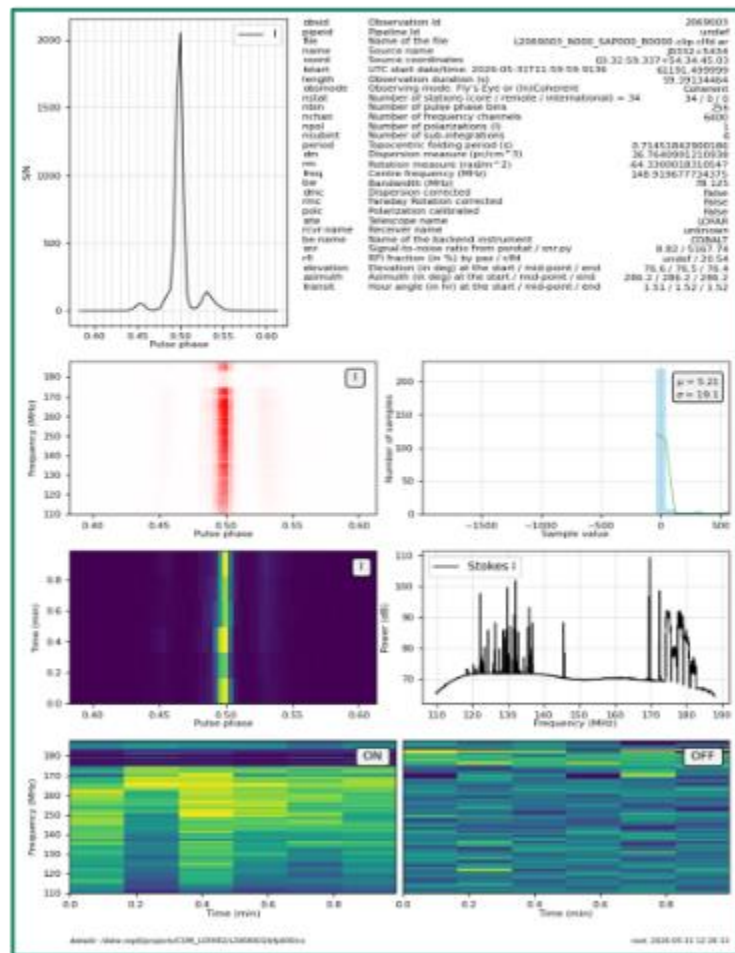
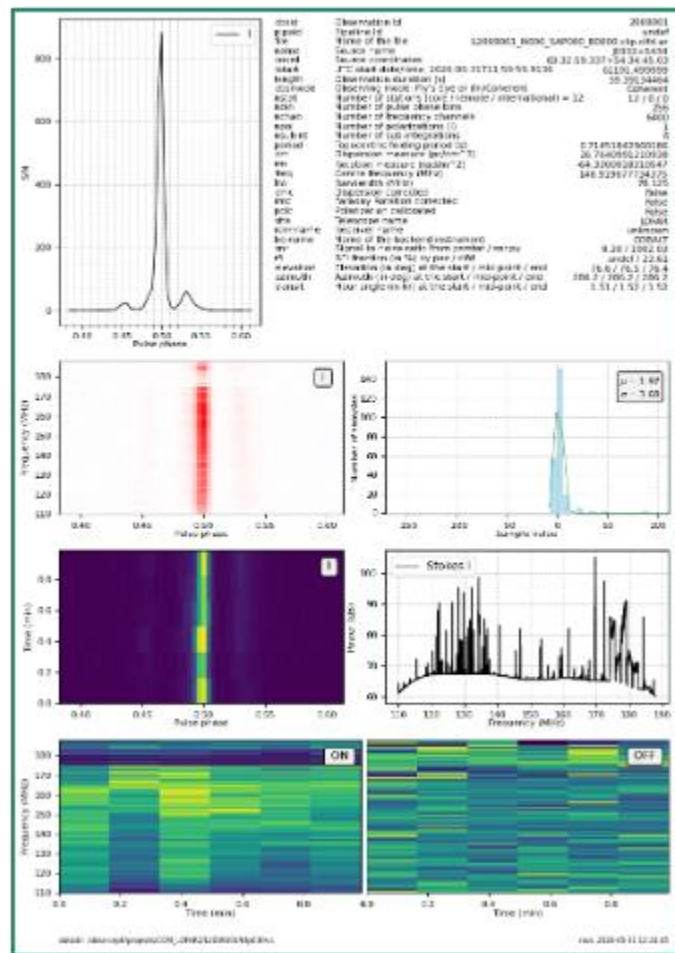
simultaneously

PSR B0329+54

1-min observations

12 **Nstat** 34
1902 **S/N** 5168

X2.72 (34/12 $\rightarrow$ ~2.83)



LOFAR2: first MSP observation

J2145-0750

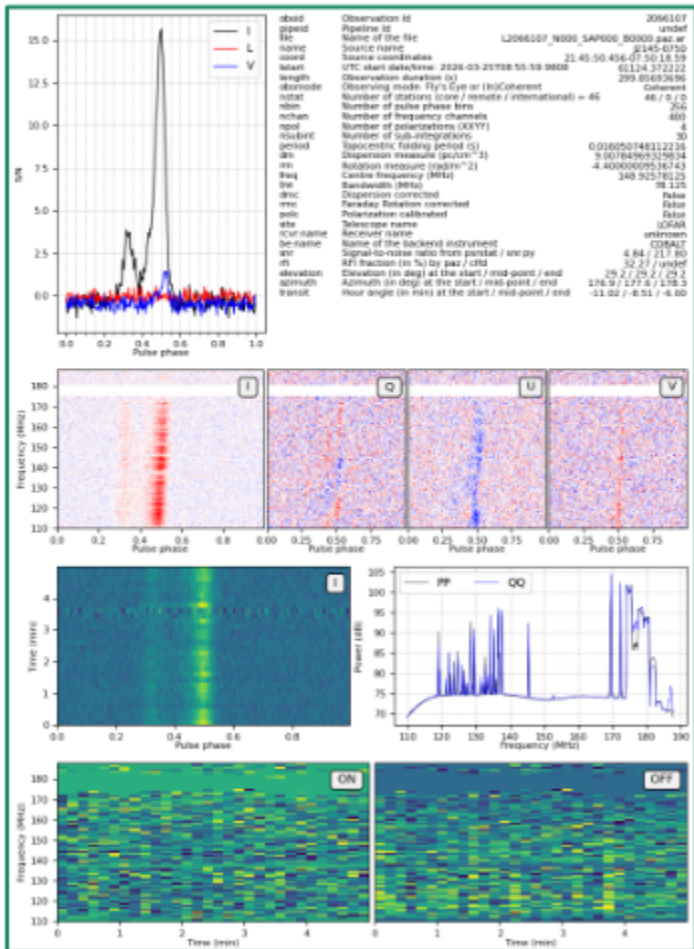
P0 = 16 ms

DM = 9.01 pc/cm³

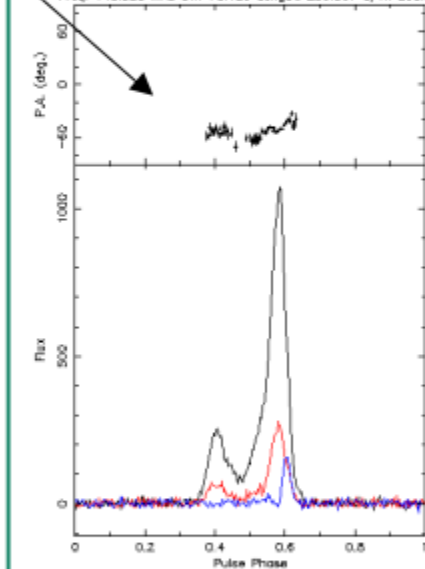
RM_{cat} ~ -4.4 rad/m²

LT5_003

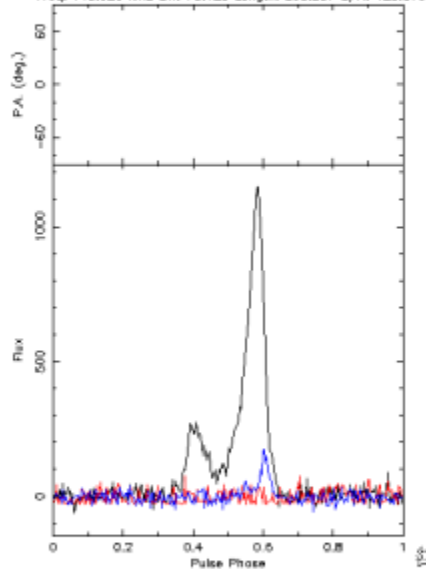
Nov 5, 2016



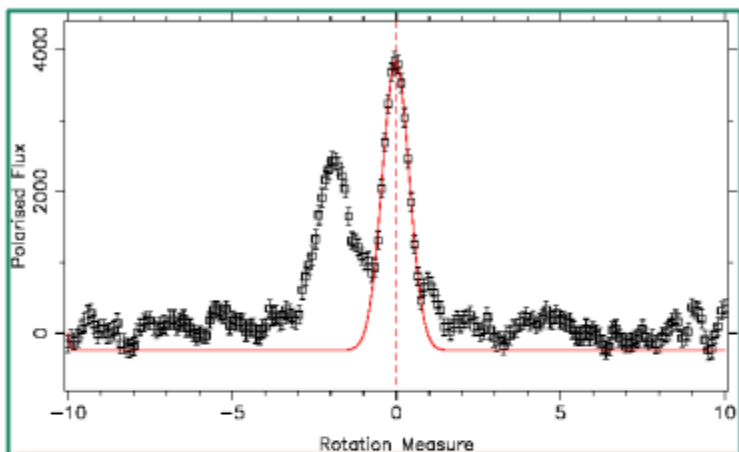
J2145-0750 J2145-0750_L567368_SAP0_BEAM0.paz.tscr.pdmp.nbin256.ar
 Freq: 148.926 MHz BW: 78.125 Length: 299.857 S/N: 290.803



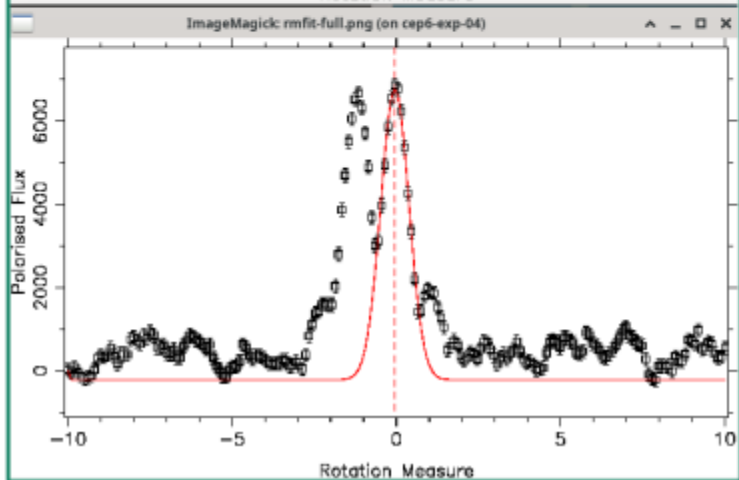
J2145-0750 L2066107_N000_SAP000_B0000.paz.pdmp.ar
 Freq: 148.926 MHz BW: 78.125 Length: 299.857 S/N: 128.870



LOFAR2: first MSP observation

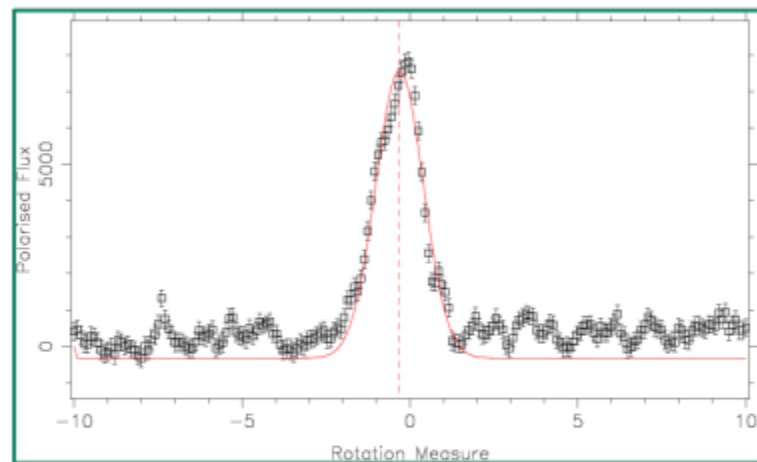


28-04
 $\text{RM}_{\text{meas}} = -1.88$



30-04
 $\text{RM}_{\text{meas}} = -1.17$

J2145-0750
 $\text{RM}_{\text{cat}} \sim -4.4 \text{ rad/m}^2$
 $\text{RM}_{\text{LOFAR}} = +4.4$



02-05
 $\text{RM}_{\text{meas}} \sim 0$

LOFAR2: first MSP observation

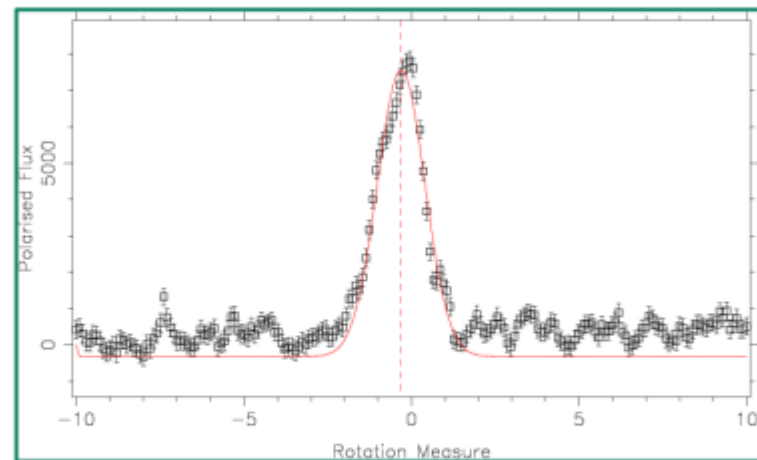
J2145-0750

$\text{RM}_{\text{cat}} \sim -4.4 \text{ rad/m}^2$

$\text{RM}_{\text{LOFAR}} = +4.4$

28-04

$\text{RM}_{\text{meas}} = -1.88$



02-05

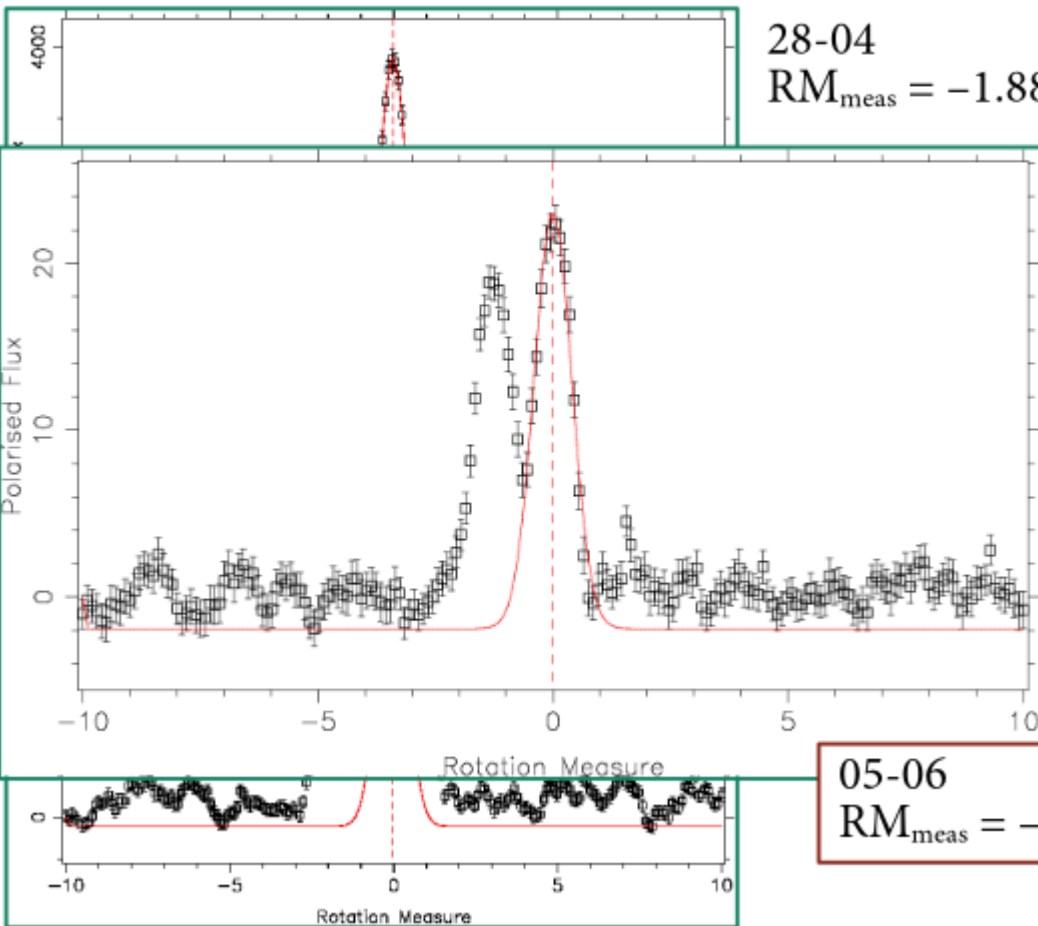
$\text{RM}_{\text{meas}} \sim 0$

Polarization calibration:

See talk by **Caterina Tiburzi**
on Thu morning

05-06

$\text{RM}_{\text{meas}} = -1.25$



LOFAR2

Pulsar pipelines

Centrally run on CEP6:

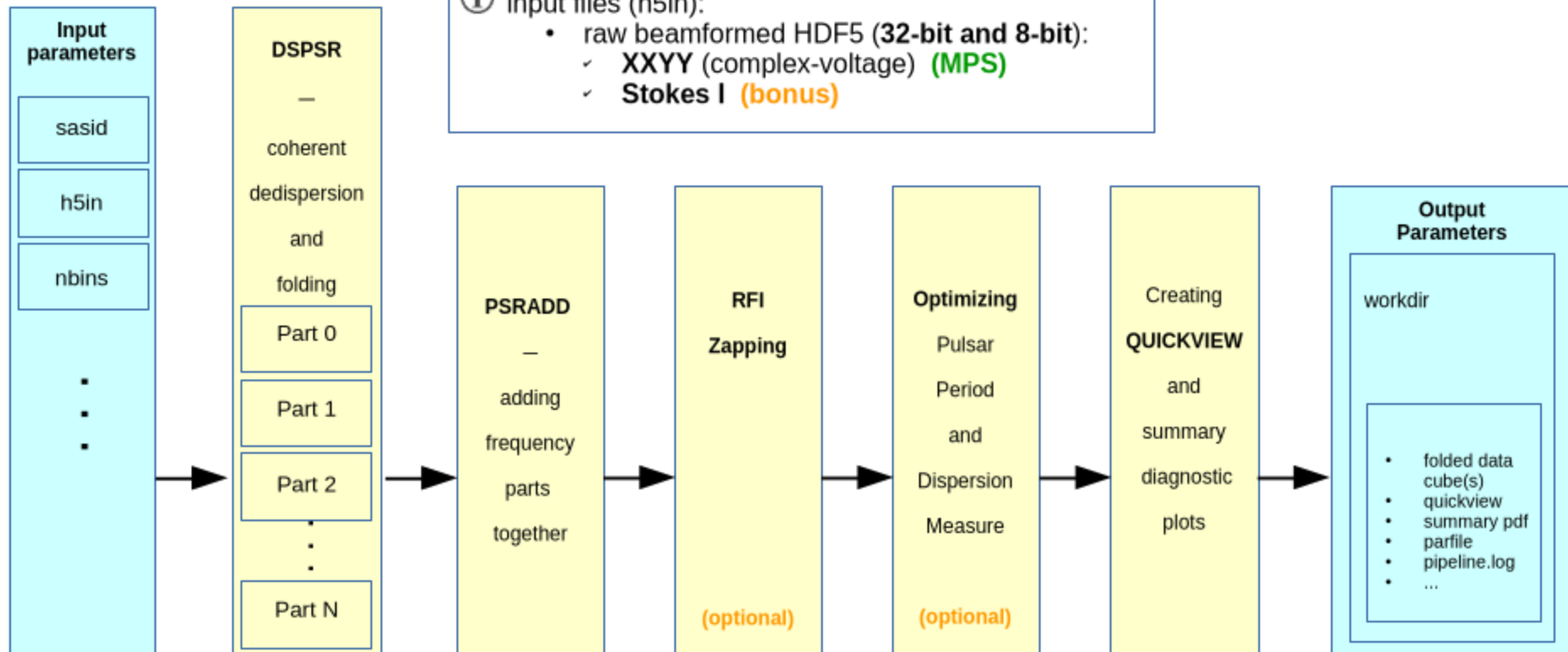
- Pulsar Folding
- Fly's Eye (FE)
- Re-digitization
- PSRFITS
- Gridding
- Dynspec

Vlad / Team Raphtor

Pulsar Folding pipeline

 pipeline runs per TAB

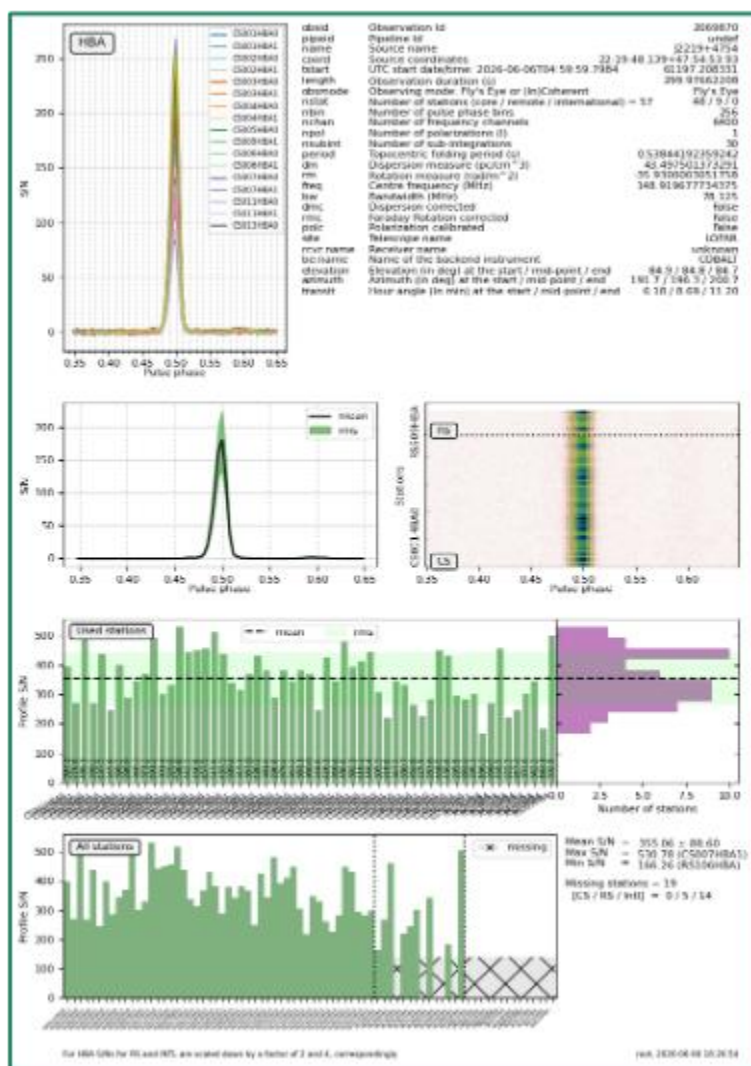
-  input files (h5in):
- raw beamformed HDF5 (**32-bit and 8-bit**):
 - ✓ **XXYY** (complex-voltage) (**MPS**)
 - ✓ **Stokes I** (**bonus**)



Fly's Eye (FE) pipeline



- Extension of the Pulsar folding pipeline for FE observations with multiple station beams:
 - runs folding pipeline for each station beam
 - creates FE diagnostic plot
- To check quickly the station's health during commissioning and operations
- Development — **done**
 - <https://git.astron.nl/RD/pulp2-cwl-folding>
- Integration in TMSS — **not yet (later this year)**



 COMMON
WORKFLOW
LANGUAGE

- Development — **not finished yet**
 - <https://git.astron.nl/RD/pulp2-cwl-psrfits>
- Integration in TMSS — **not yet (when: TBD)**

- better selection of quantization levels depending on data distribution
- diagnostics



- Development — **done**
 - <https://git.astron.nl/RD/pulp2-cwl-redigitization>
- Integration in TMSS — **not yet (when: TBD)**



pulp2-cwl-redigitization

[Pulp2](#)
[CWL](#)
[Redigitization](#)

[Pulp2](#)
[CWL](#)
[Redigitization](#)

[Find file](#)
[Code](#)

[Issues](#)
[Pulls](#)
[Wiki](#)

a number of small changes to improve the test and also give link to re-digitization repo

View repository on GitHub

[3rd150f](#)
[History](#)

Name	Last commit	Last update
 Dockerfile	modified back Dockerfile but also prep...	1 year ago
 Data	update documentation to reflect the cha...	1 year ago
 Scripts	replaced assert statement with Rethrow E...	1 year ago
 Steps	updated workflow and digitize step to us...	1 year ago
 Tests	BAP-800: addressed comments from MR...	1 year ago
 Workflows	fixed type in the path for CWL steps file	1 year ago
 Dockerignore	updated dockerignore and .gitignore file	1 year ago
 Gitignore	updated dockerignore and .gitignore file	1 year ago
 Gitlab-ci.yml	input .JSEM is commented out from cwlts...	1 year ago
 Prepwork	modified back Dockerfile but also prep...	1 year ago
 Readthedocs.yml	BAP-800: styling up, removed obsolete ...	1 year ago
 License	Create initial project structure	1 year ago
 README.md	a number of small changes to improve th...	1 year ago

[README.md](#)

Project Information

LOFAR2 Beamformed Re-digitization Pipeline (Pulp2-CWL-Redigitization) in CWL implementation

[LOFAR2](#) [Pulp2](#) [Redigitization](#)

→ 3 repos

→ 10 commits

→ 2 branches

→ 0 tags

→ README

→ GNU General Public License v3.0 or later

Created on
January 05, 2025

LOFAR2 Beamformed Re-digitization Pipeline

This is a Common Workflow Language (CWL) pipeline to convert LOFAR raw beamformed complex-voltage (XXYY) 32-bit HDFS data to 8-bit HDFS data. This pipeline represents the CWL implementation of existing LOFAR functionality in the Pulp Pipeline (Pulp) by means of the digitization script written by Wouter van Herpen can be found in the LOFAR operations framework. The script itself was slightly modified to run in Python3. Please note, that the pipeline is still in development, so some changes in the workflow and documentation might happen in the future.

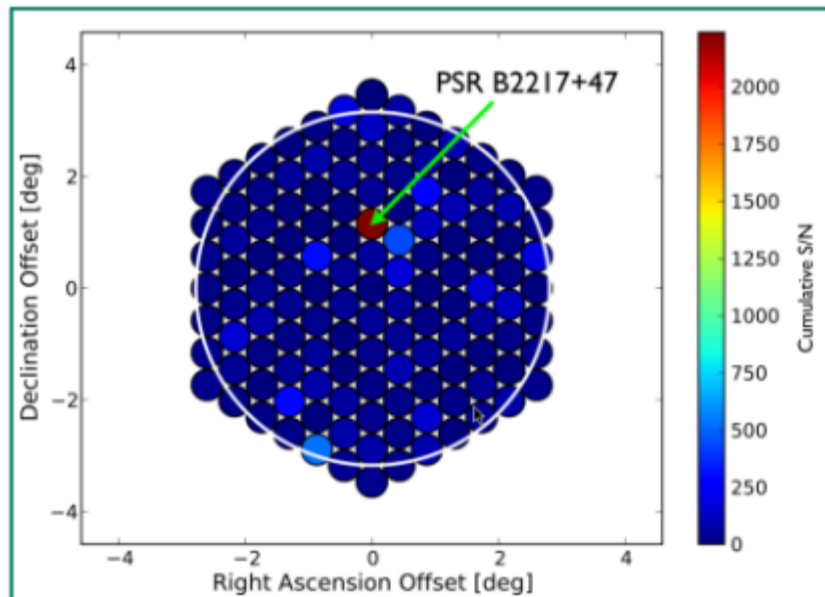
Gridding pipeline



extension of Pulsar Folding pipeline for multi-TAB observations

- Development — **later this year (TBD)**
 - will run folding pipeline for each TAB
 - will create tied-array heatmap for source localization

concept example



van Haarlem et al. (2013)

Dynspec pipeline

time-frequency averaged dynamic spectra of the raw beamformed data

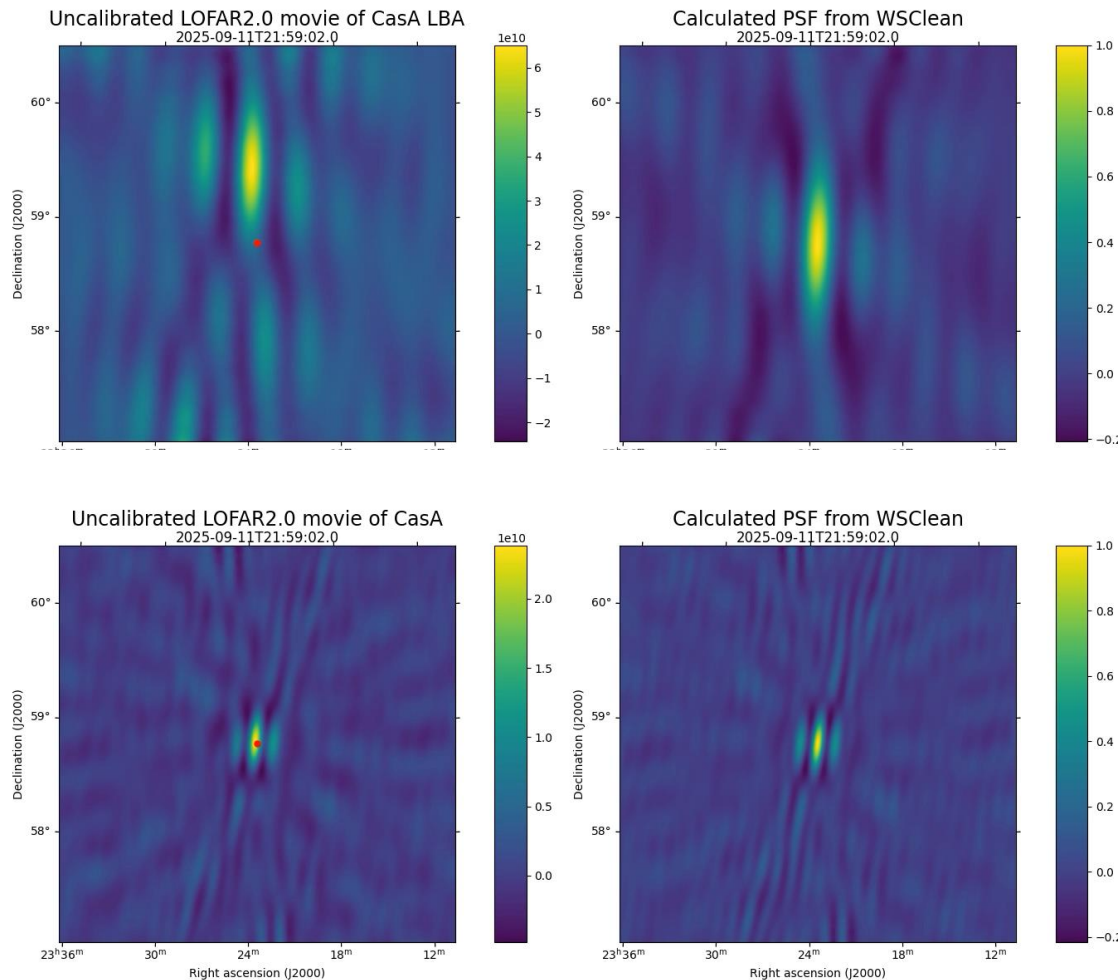
- Convert raw beamformed data (for LOFAR1 described by ICD3) to Dynspec data (described by ICD6 in LOFAR1)
- Successor of Dynspec Toolkit Container (DTC) developed by Nicolas Vilchez for LOFAR1
- Development — **TBD**

If you used Nicolas's DTC in the past,
your feedback is very welcome,
please come talk to me to discuss
needed functionality

Core-resolution uncalibrated movie

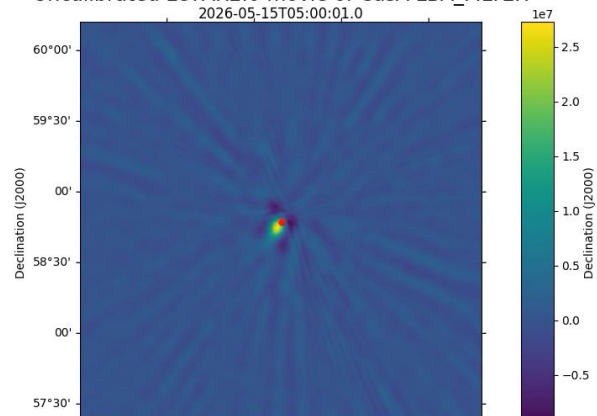
Noa

Flashback to
last year

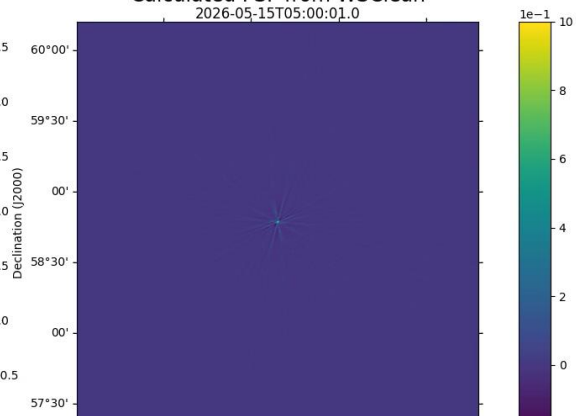


Dutch-resolution uncalibrated movie

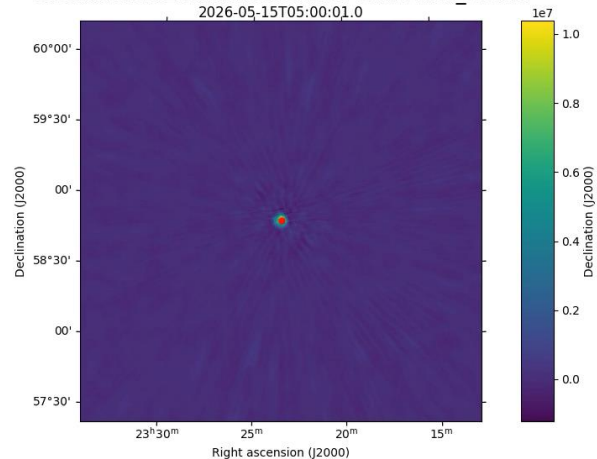
Uncalibrated LOFAR2.0 movie of CasA LBA_FILTER



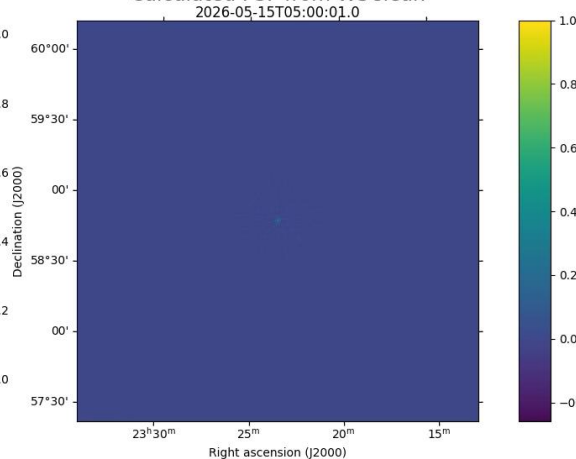
Calculated PSF from WSClean



Uncalibrated LOFAR2.0 movie of CasA HBA_FILTER

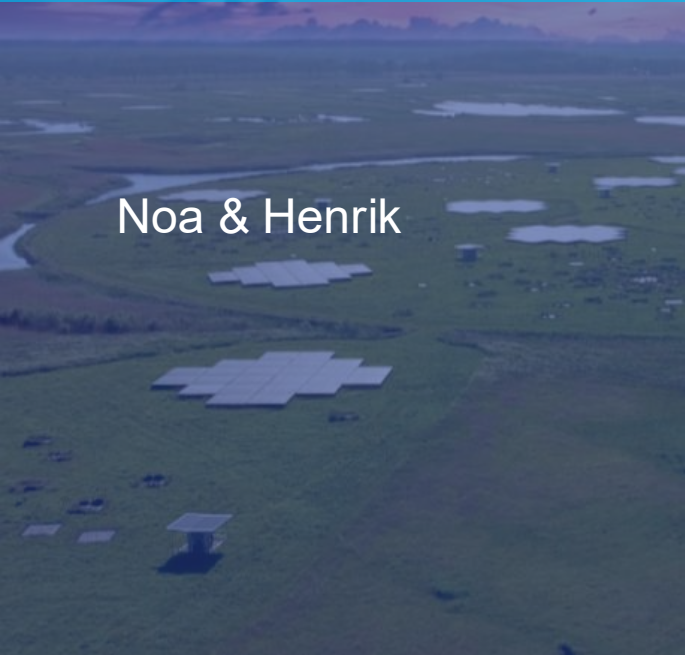


Calculated PSF from WSClean



32 stations (23CS & 9RS), 6 hrs, HBA 120-160 MHz, briggs -0.5

LOFAR2.0 first images



Noa & Henrik

First HBA & LBA images

HBA

- M33
- CIZA J2242.8+5301

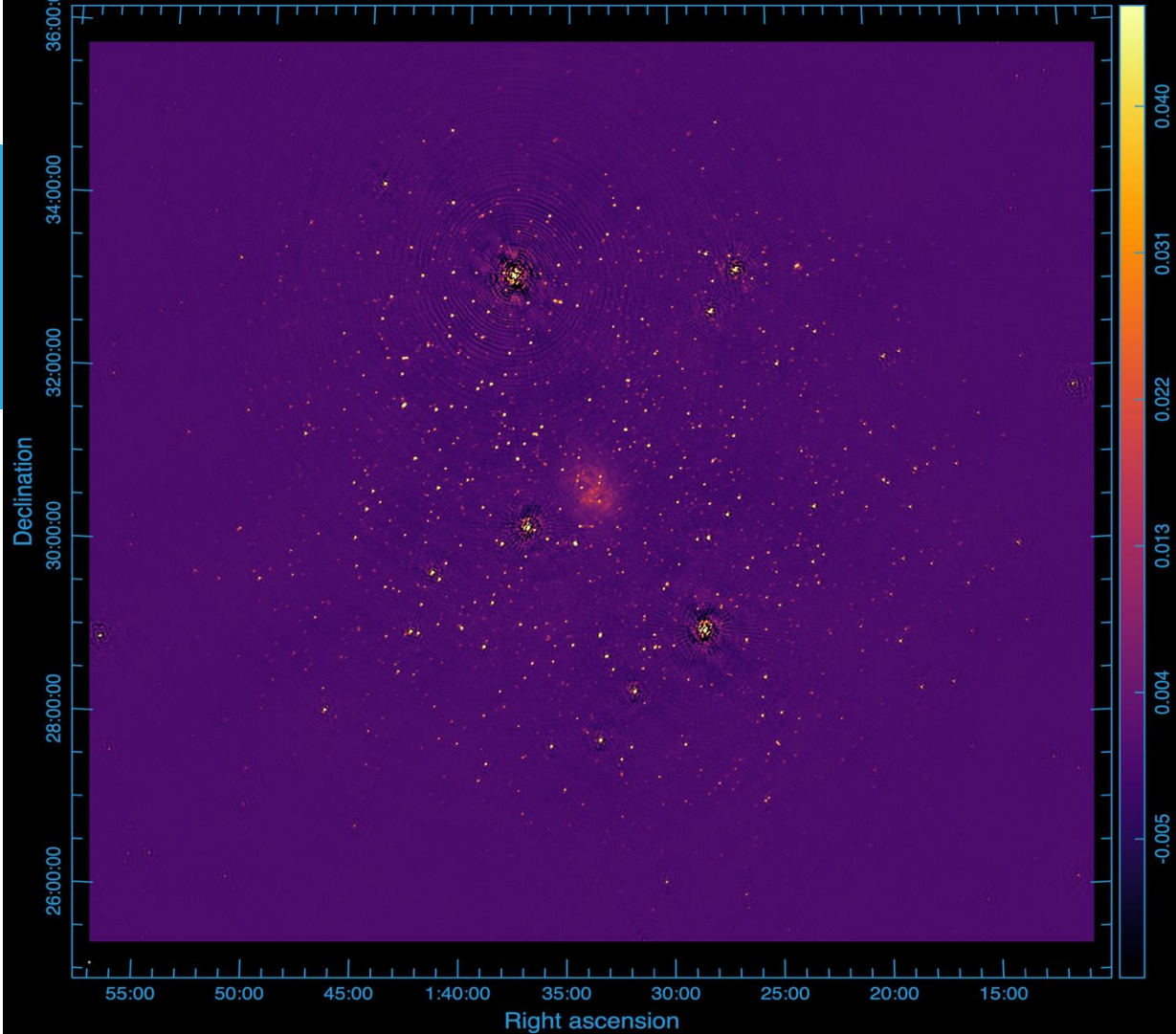
LBA

- M51
 - ELAIS-N1
-

LOFAR2.0 first images HBA – M33

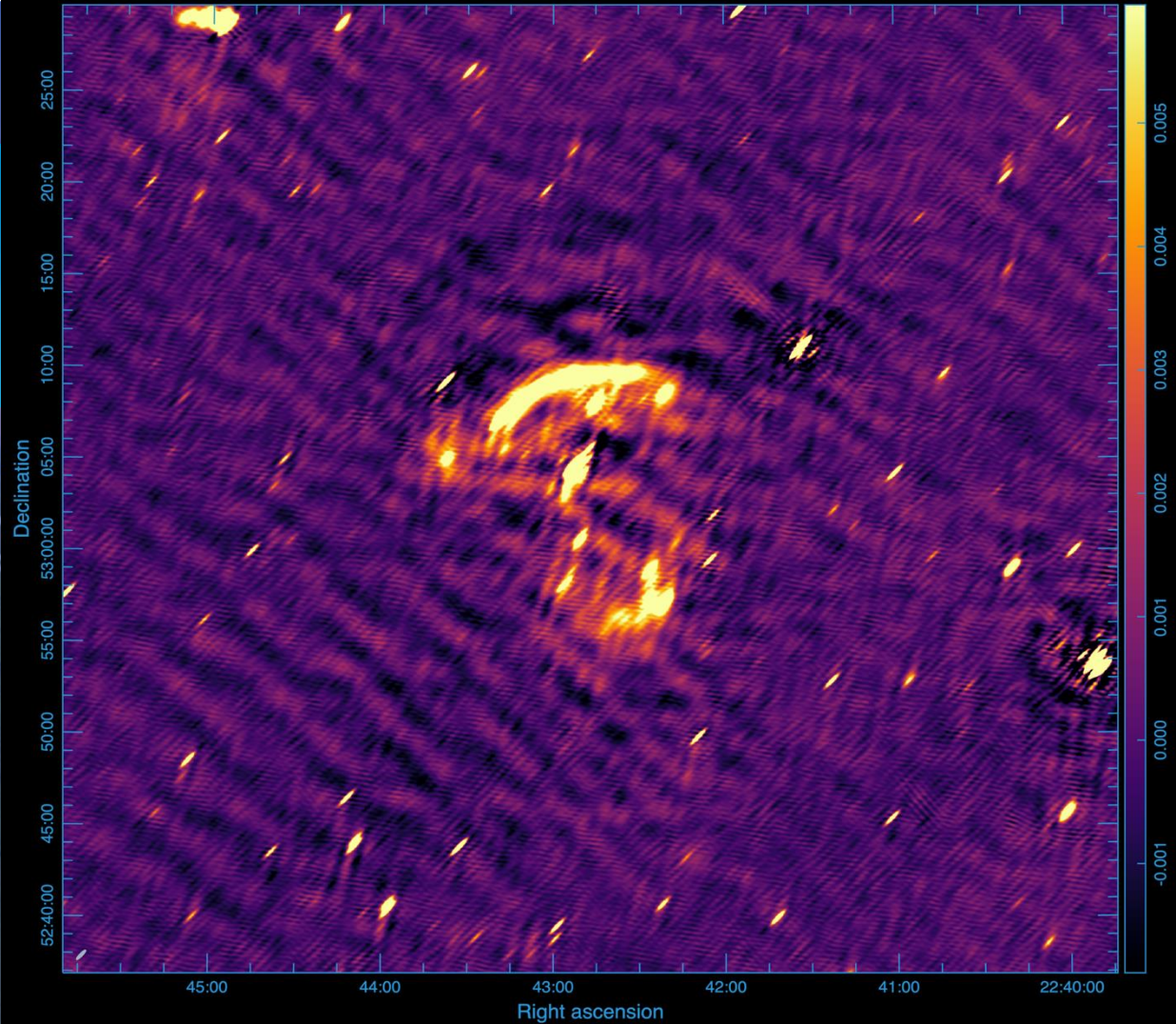
LINC-calibrated w/ 3C48
no demix,
HBA 115-175 MHz,
4h,
23CS + 8RS,
Gaussian taper 40asec,
Restoring beam = $60'' \times 46.3''$,
RMS (offsource) ~ 570 uJy/beam,
SNR ~ 250

Credit: Aida Ahmadi



LOFAR2.0 first images HBA - CIZA J2242.8+5301

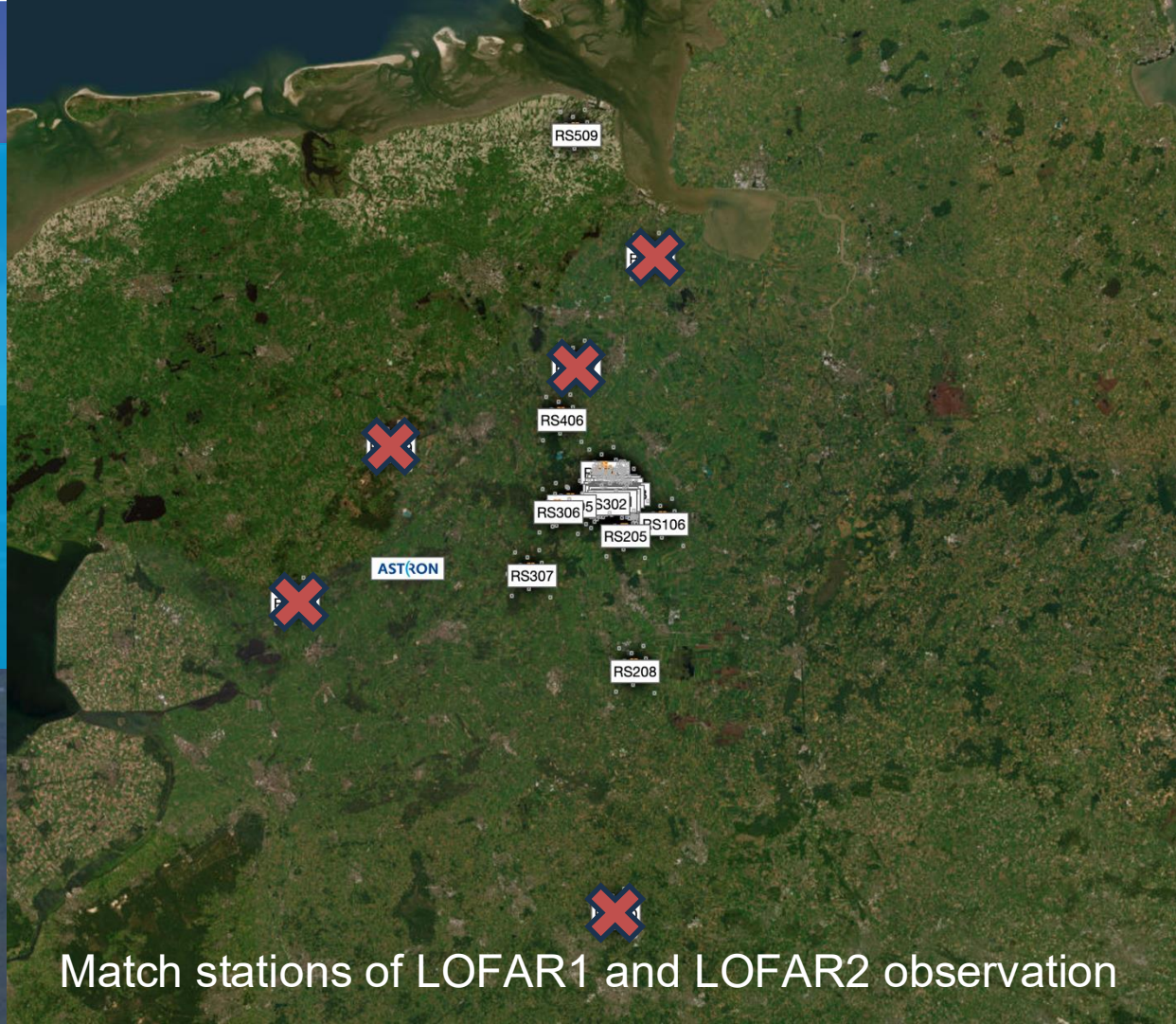
RAPTHOR-calibrated w/ 3C196
demixed CasA + CygA
HBA 102-198 MHz,
1h,
23CS + 8RS (less survived),
Restoring beam = $41'' \times 8''$,
RMS $\sim 326 \mu\text{Jy/beam}$,
SNR ~ 200

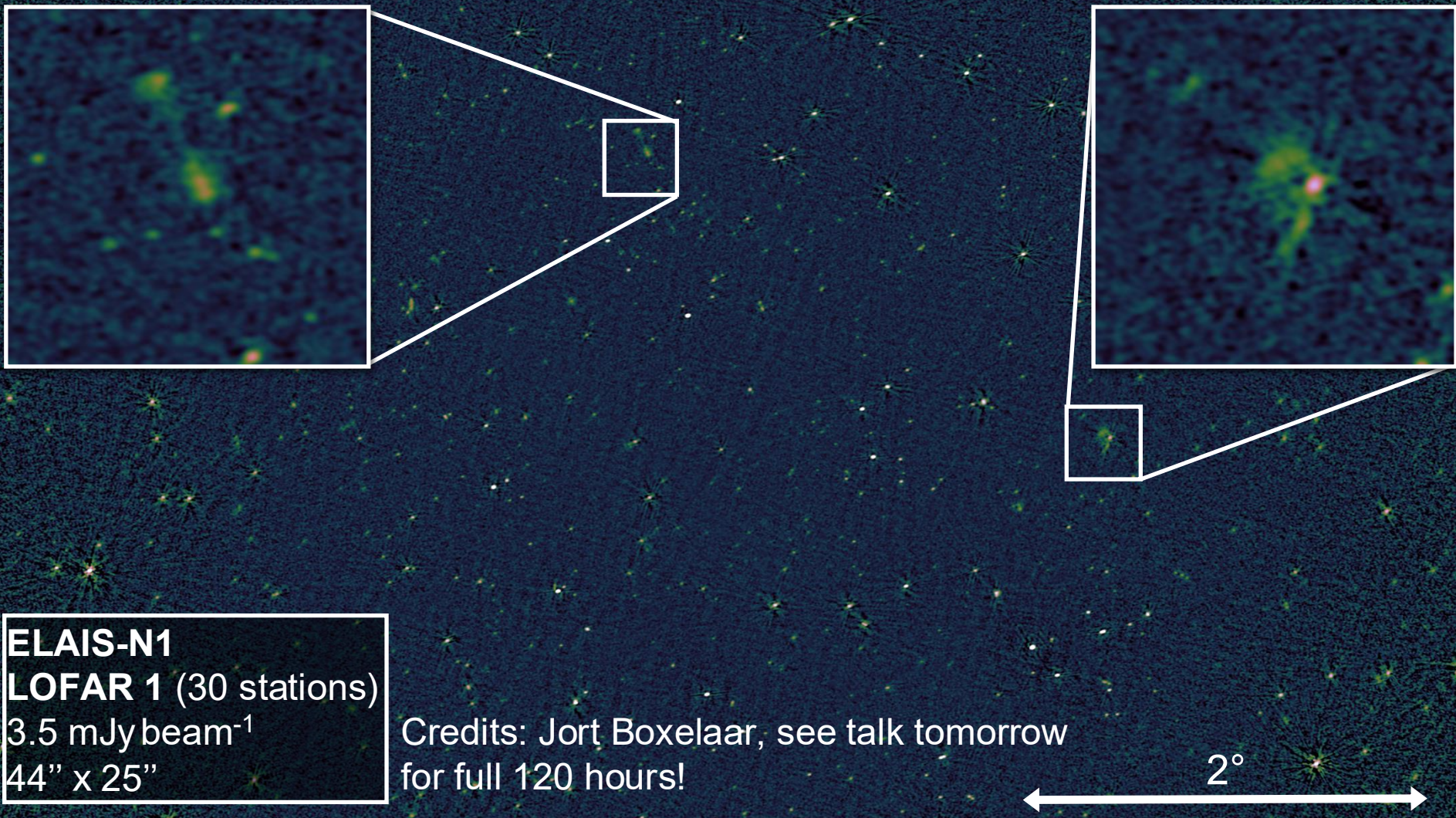


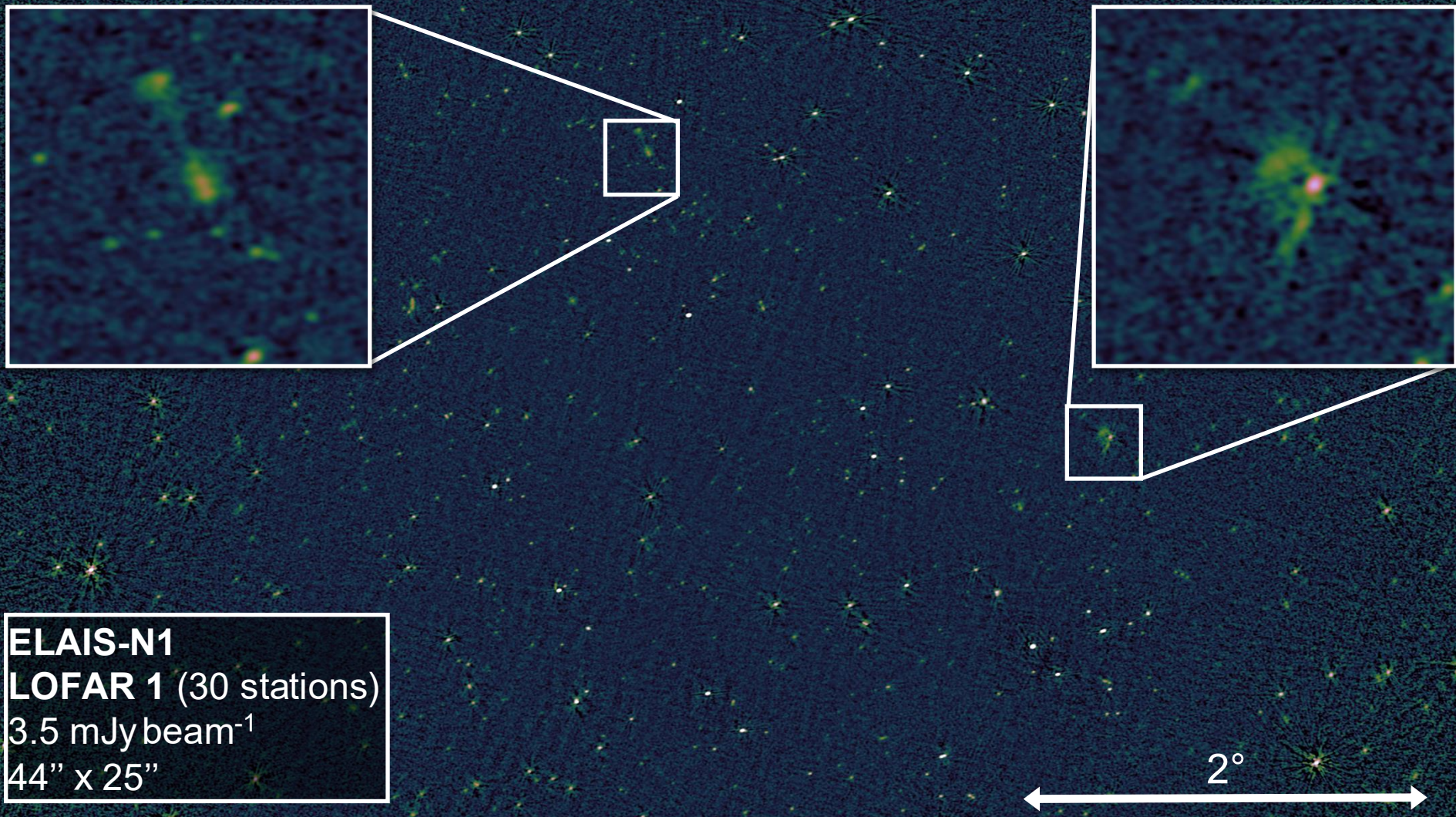
LOFAR 2.0 LBA Imaging Sensitivity

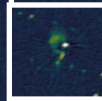
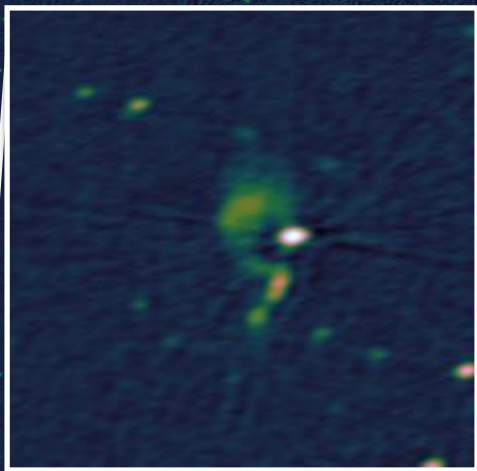
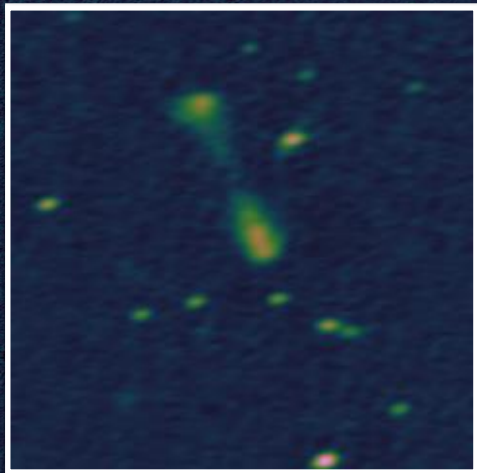
LOFAR 1 vs LOFAR 2

- ELAIS-N1 field
- 6h observation
- 32 MHz of bandwidth
- Fully LiLF DD-calibrated



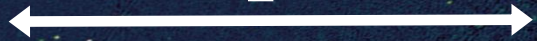




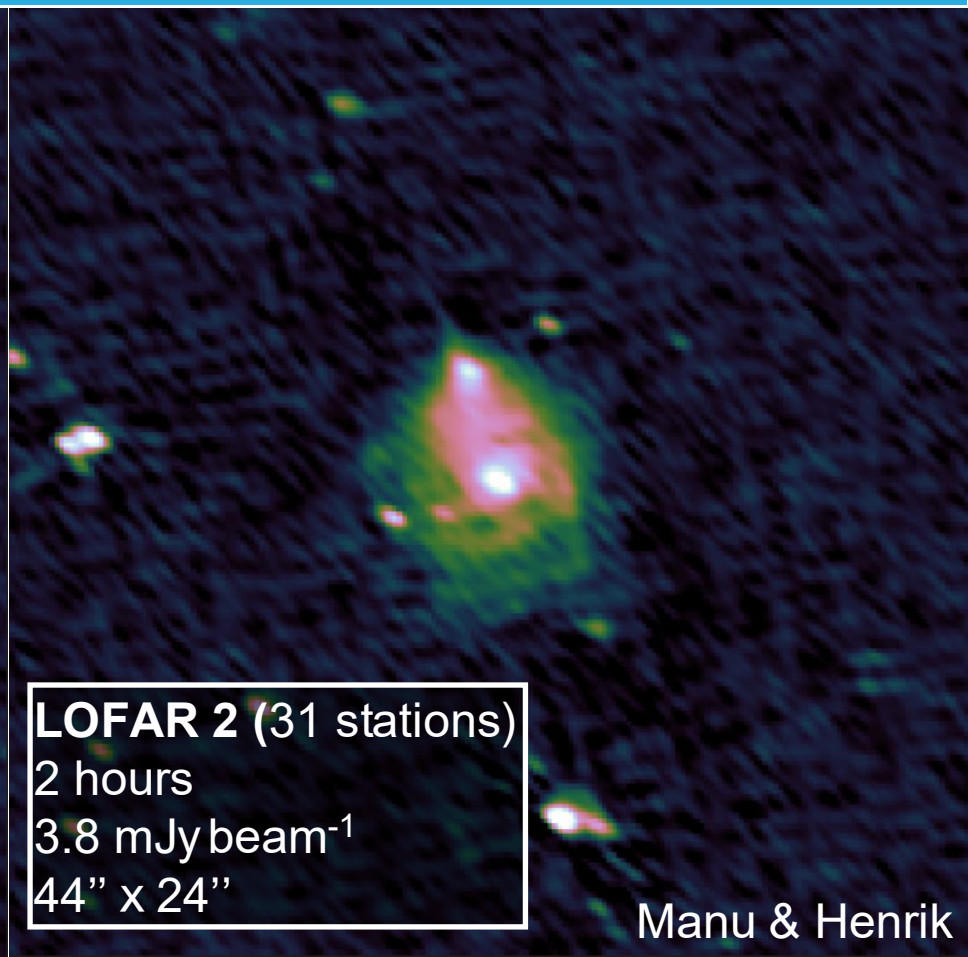
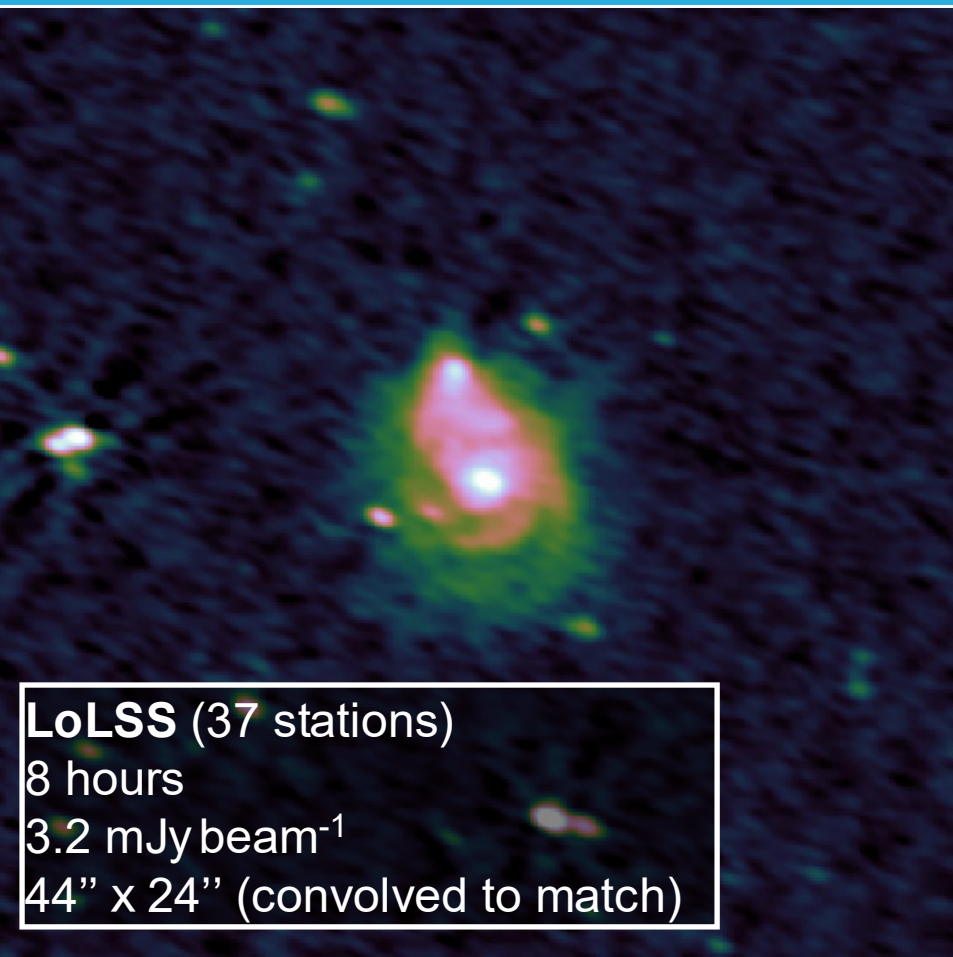


ELAIS-N1
LOFAR 2 (30 stations)
1.5 mJy beam⁻¹
44" x 25"

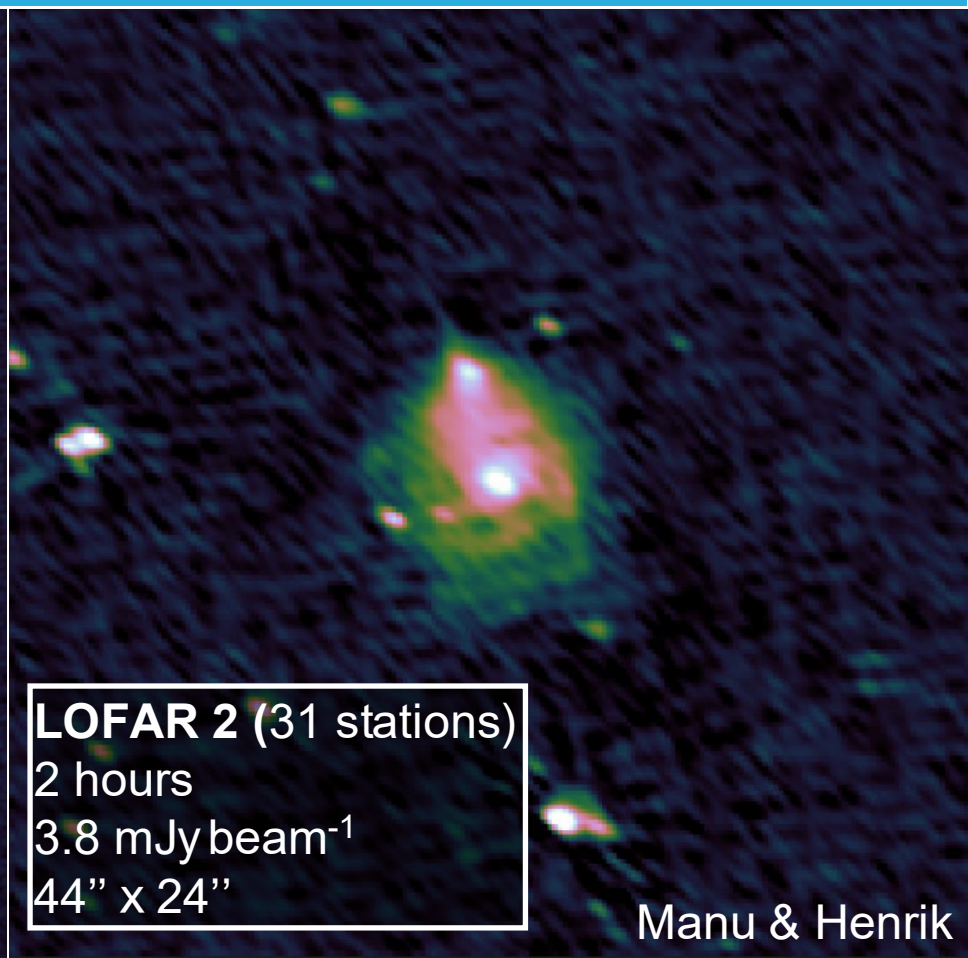
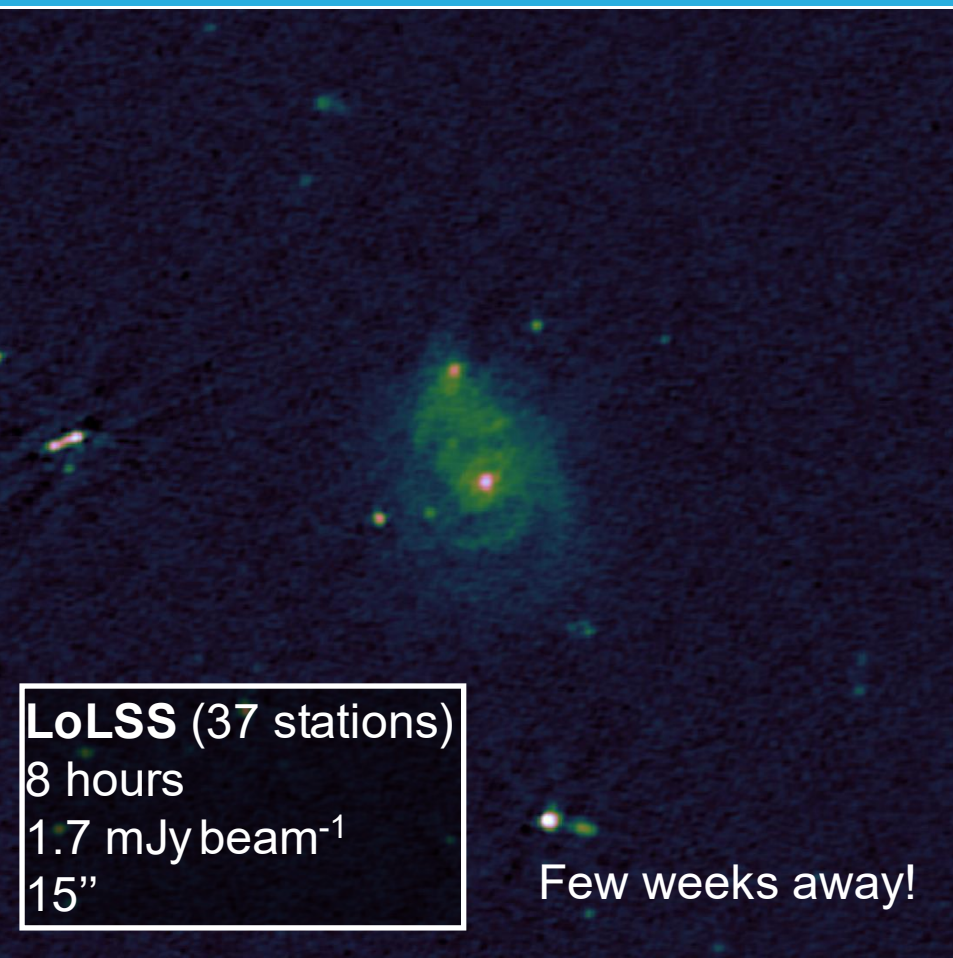
2°



LOFAR 2.0 Low-band imaging of M51



LOFAR 2.0 Low-band imaging of M51



Thanks!



