

Quality assessment

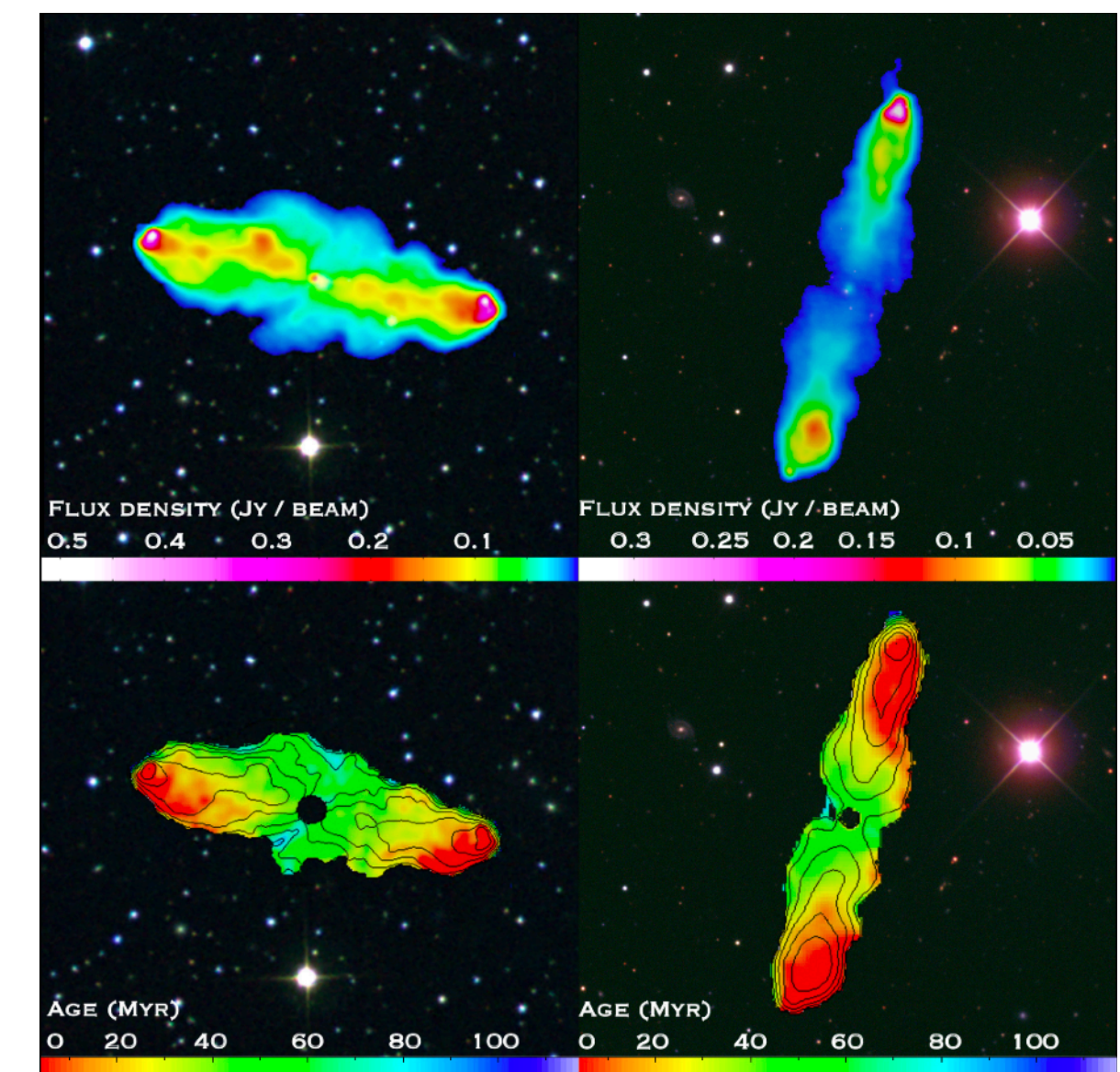
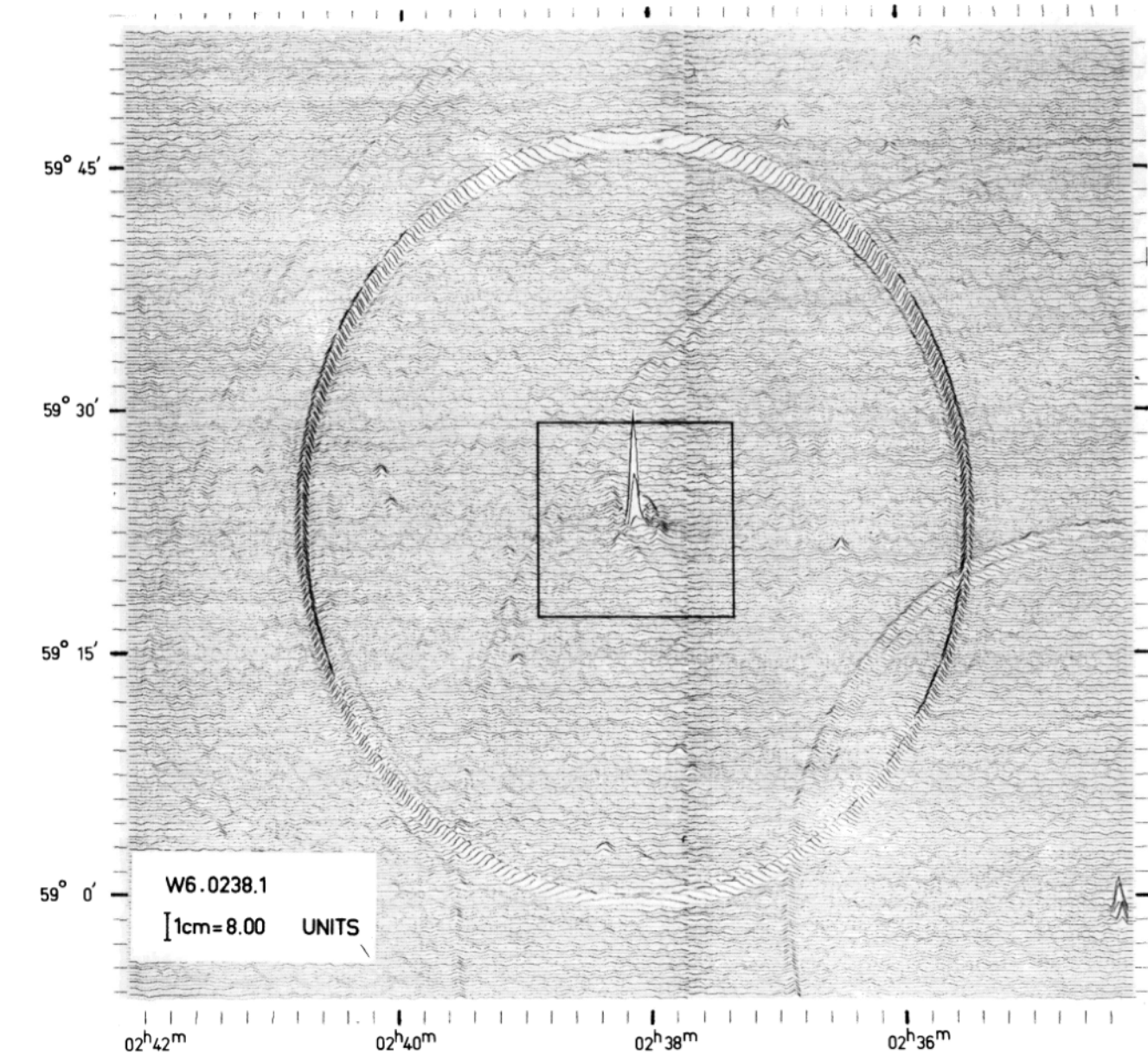
How to make decisions on the quality of LOFAR data

Vanessa Moss

ASTRON

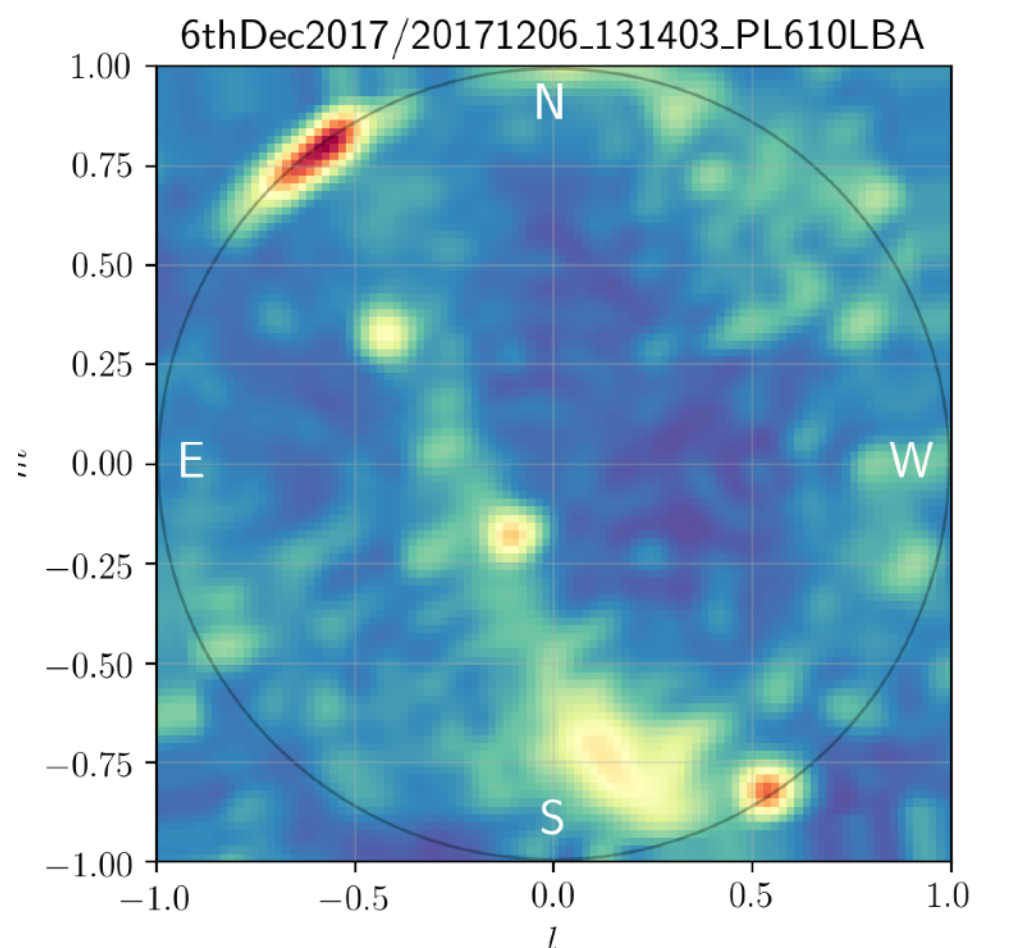
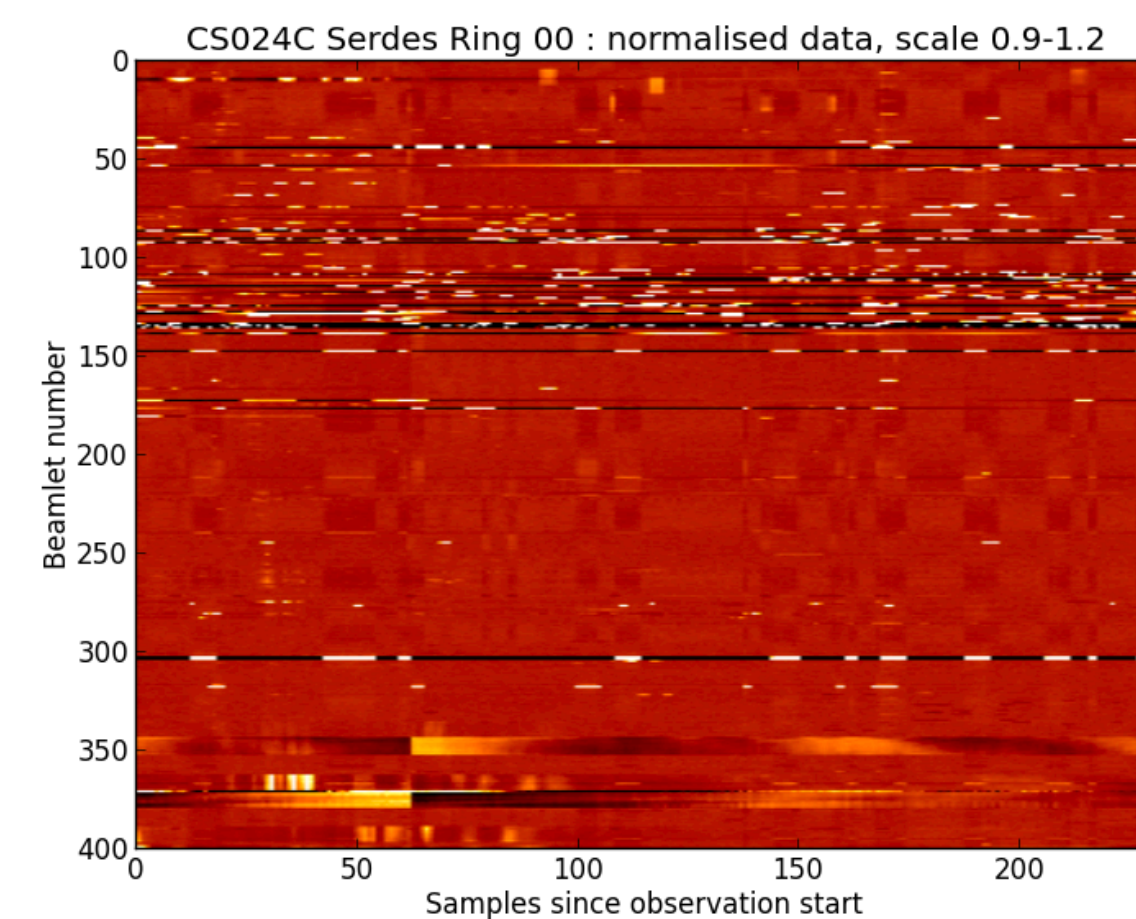
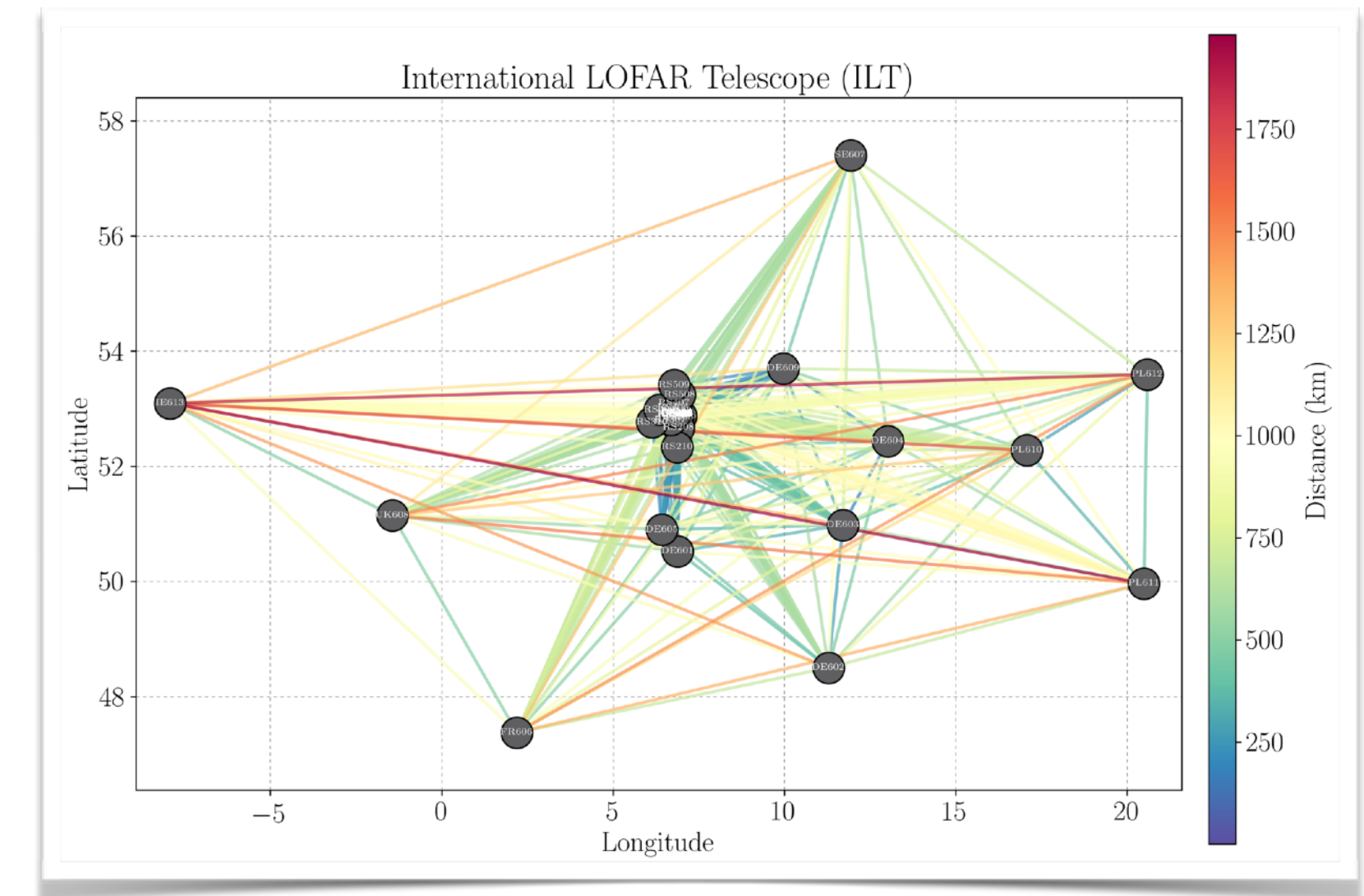
What is data quality?

- Data quality checks involve the **assessment** of a data-set (which in our case is astronomical) to determine how well it **meets requirements**
- LOFAR/astronomy case: how affected is the data-set by anything that could **potentially impact** the science goals in a **negative** way?
- Data-sets in astronomy have gotten **incredibly complex** in the last decade: size, baselines, bandwidth, sensitivity, spectral/time resolution
- We conduct data quality assessments as part of our role in **SOS** - but we need users too!

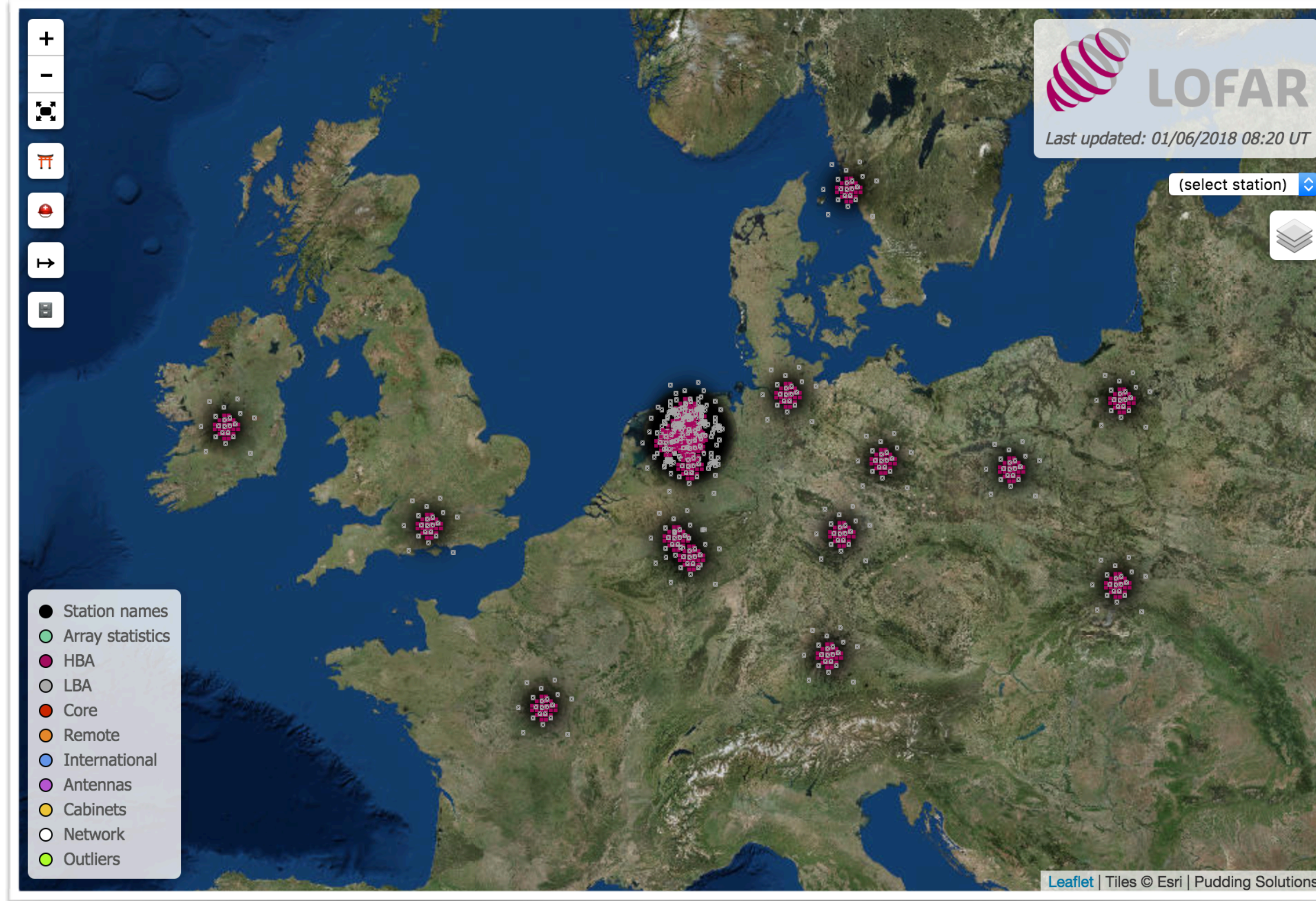


Data quality assessment

- LOFAR is a **complex** network
 - 38 Dutch stations (24 core, 14 remote)
 - 13 international stations
- What is the status of the **array**?
e.g. individual stations, cabinets
- What are the properties of the **data**?
e.g. data-loss, interference
- How is the **environment** around stations?
e.g. sources of RFI
- Given this info, was it **successful**?



Interactive LOFAR map



<http://astron.nl/lofartools/lofarmap.html>





How we assess a data-set

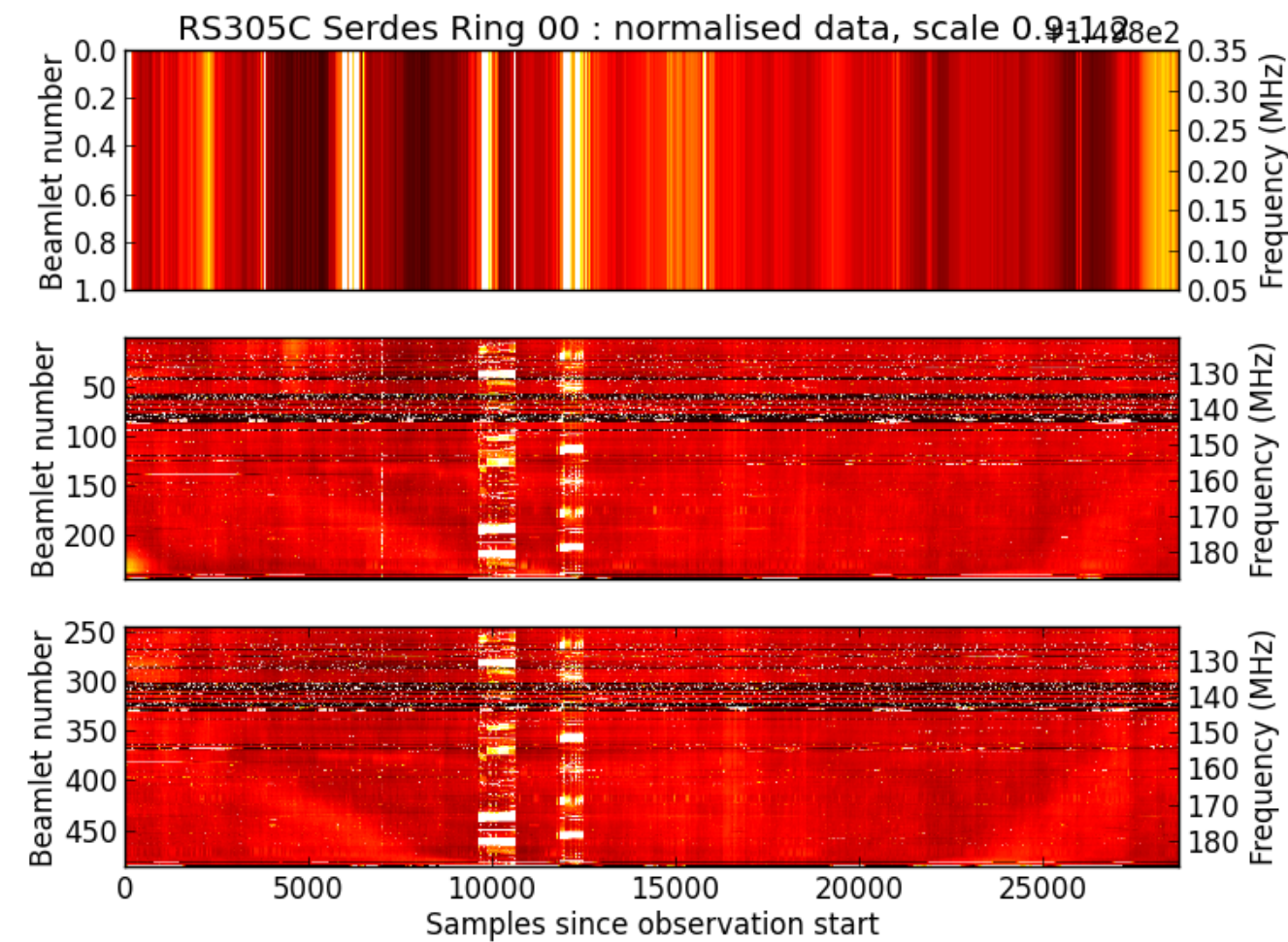
- We keep in mind the **mode** and **band** of the observation (e.g. HBA, 110-190 MHz)
- We look for **correlation errors**, giving us an insight into how CEP4 is doing
- We check for **data-loss** (e.g. network problems)
- We check the waterfall plots (**dynamic spectra**) to identify any station-local issues
- We look at **interferometric plots** to assess issues between stations or across network

LOFAR inspection plots

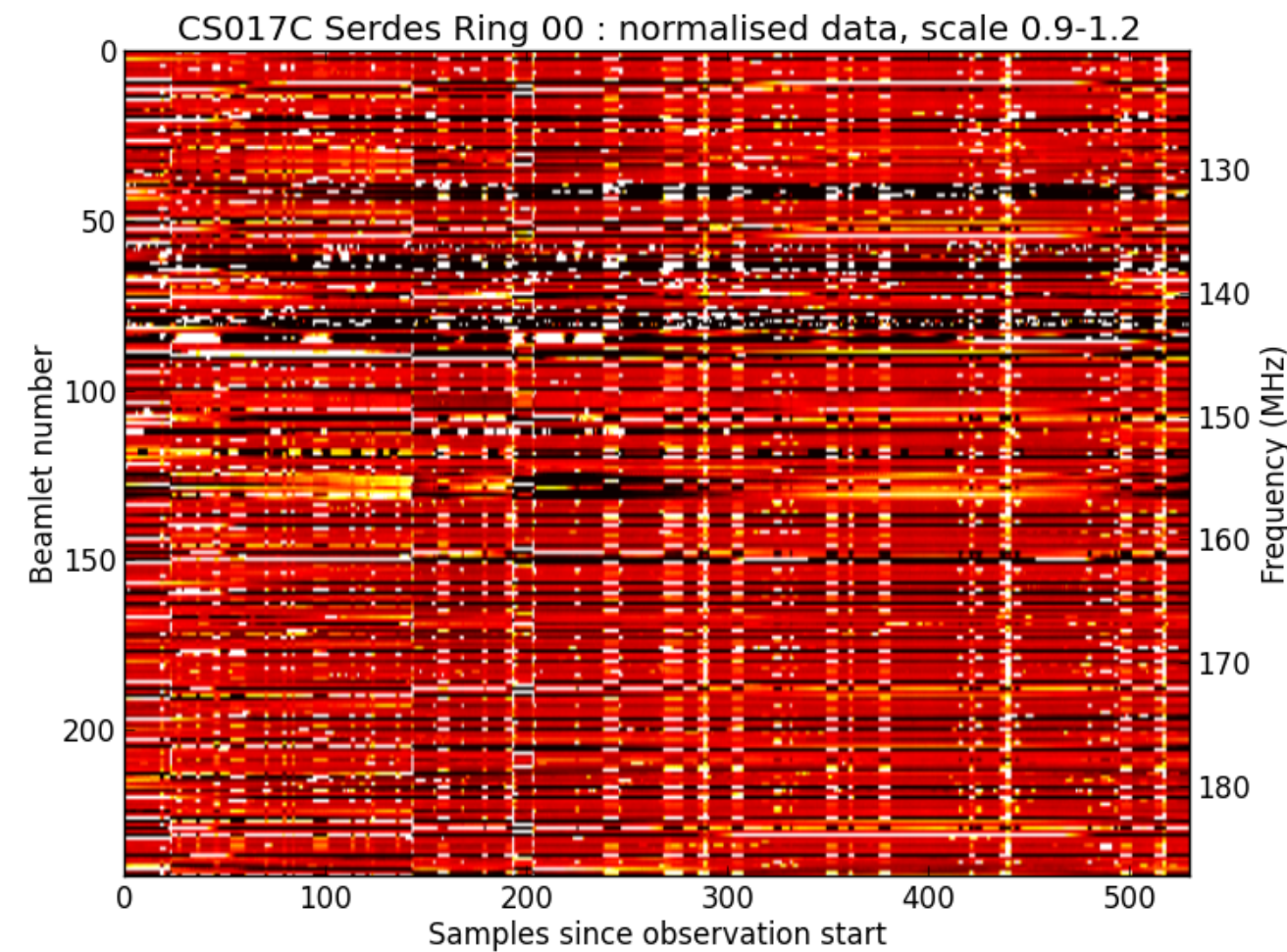
Last modified: Sun Sep 16 19:23:10 2018 UTC [Full list](#) [Ascii table](#)

SAS ID	Campaign	Target	DynSpec	Compl	Compl*	AntennaSet	Band	Start	End	Clock	Subb	Parset
L666014	LC9_023	LOTAAS-P1888C-SAPO	BST	100%	NA	HBA_DUAL	HBA_110_190	2018-09-16 16:33:00	2018-09-16 17:33:00	200	486	parset
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L666006	LC9_023	LOTAAS-P1339C-SAPO	BST	100%	NA	HBA_DUAL	HBA_110_190	2018-09-16 14:01:00	2018-09-16 15:01:00	200	486	parset
L661372	LC10_017	3C295	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-16 13:40:35	2018-09-16 13:50:35	200	243	parset
L661366	LC10_017	m82P147REF	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-16 05:39:35	2018-09-16 13:39:35	200	487	parset
L661362	LC10_017	3C147	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-16 05:28:35	2018-09-16 05:38:35	200	243	parset
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L666752	LC5_005	J032139+572951	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-14 02:20:39	2018-09-14 02:23:39	200	432	parset
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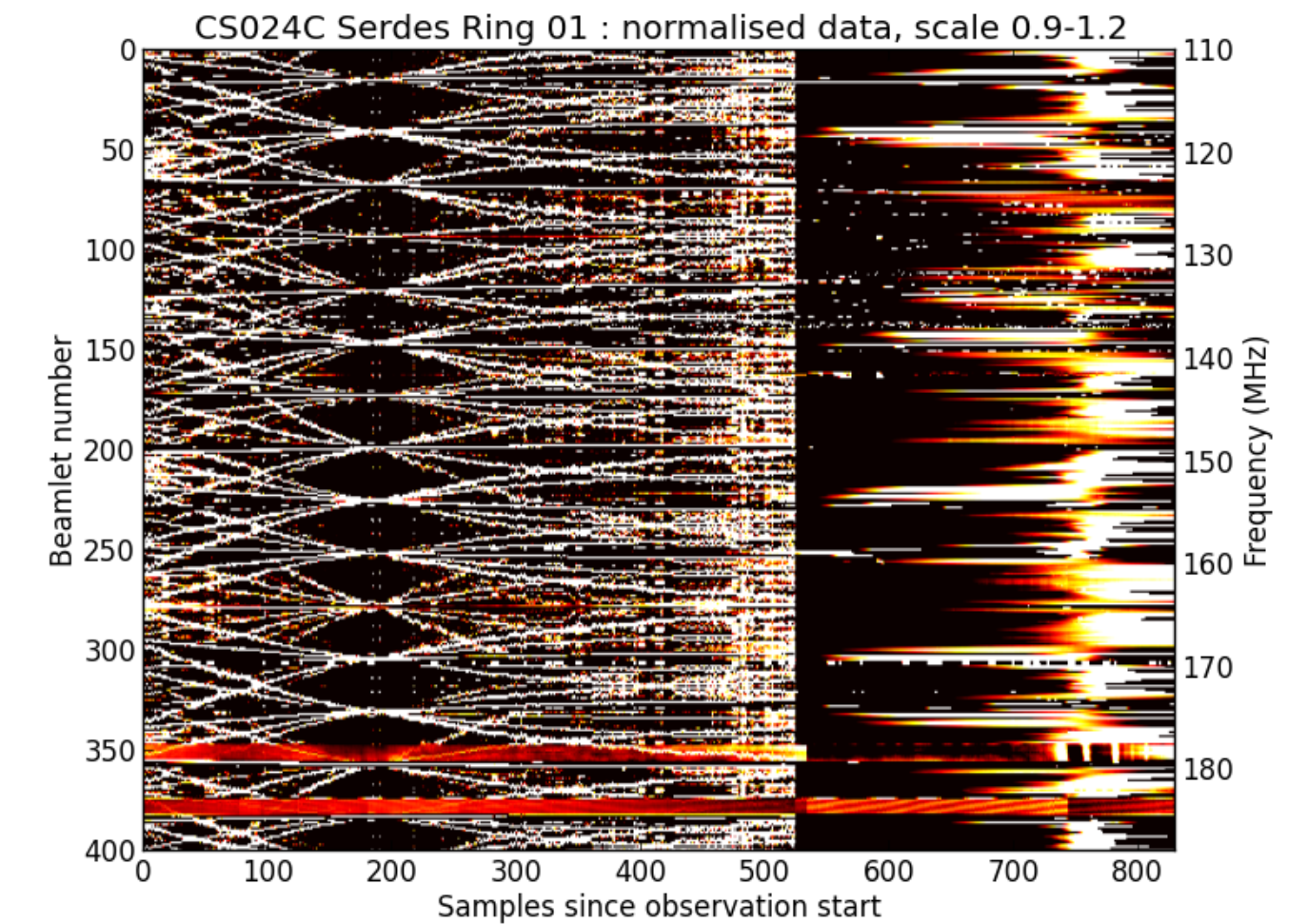
Dynamic spectra examples



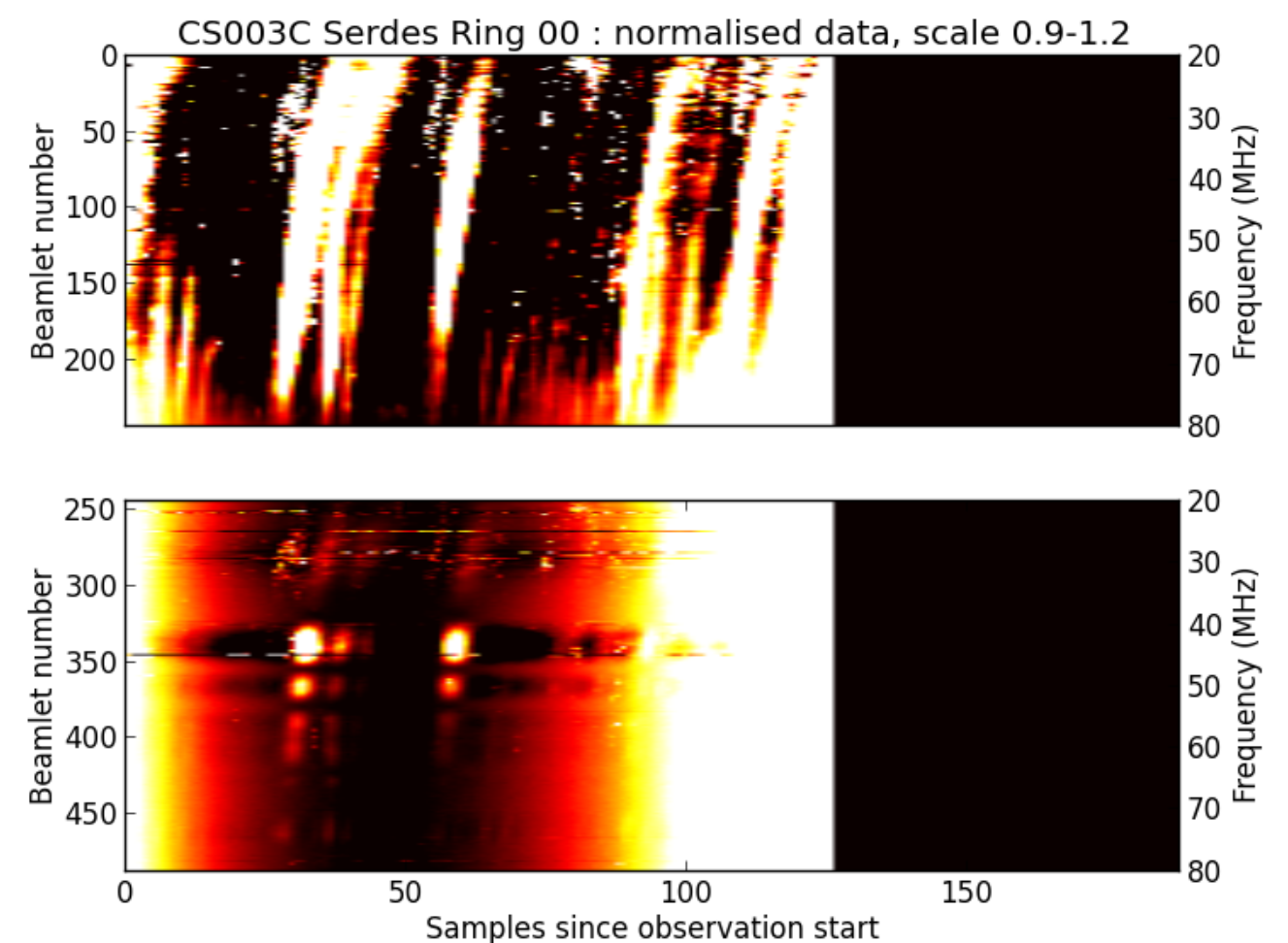
Mildly oscillating tile



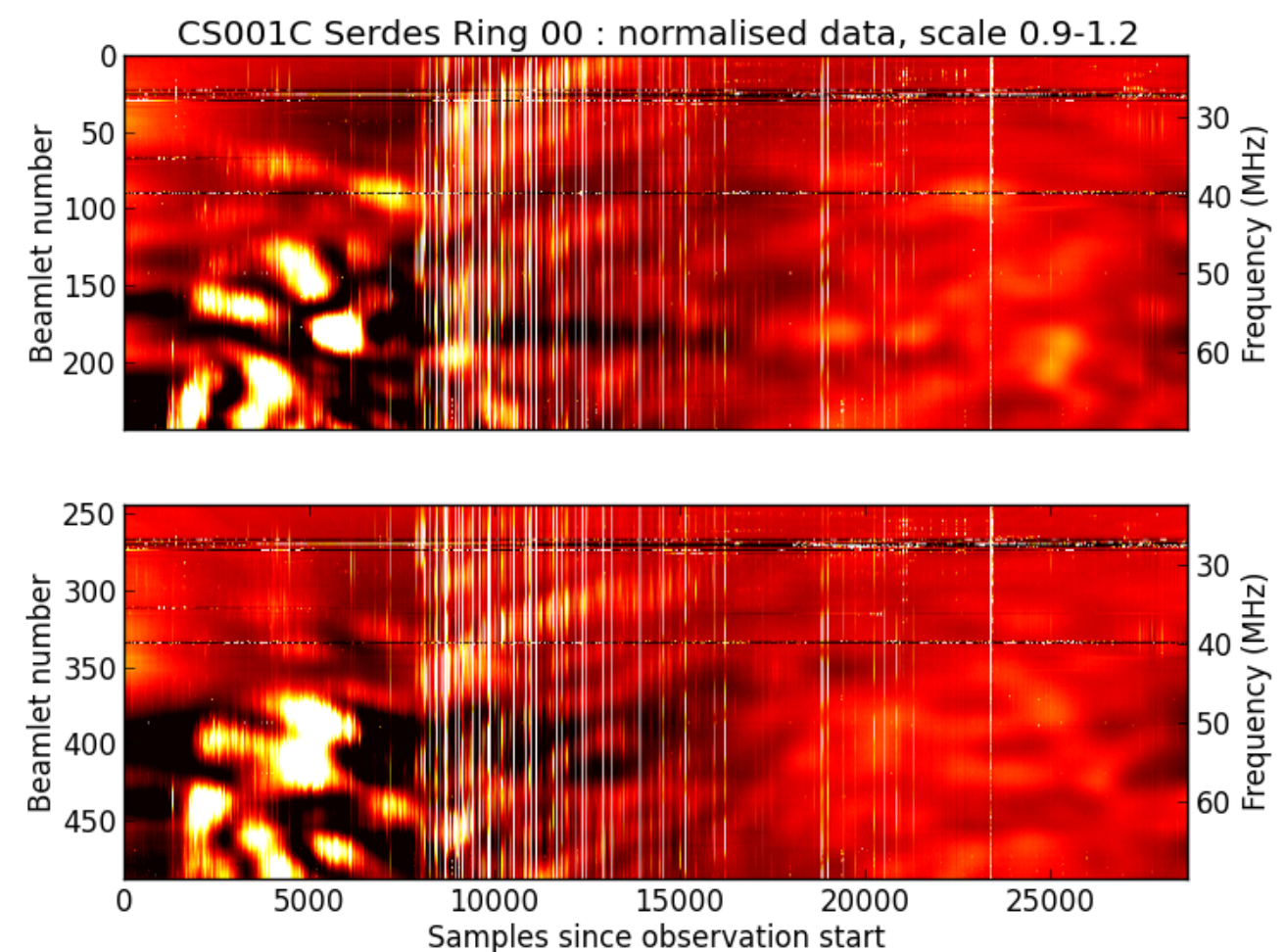
Oscillating tile



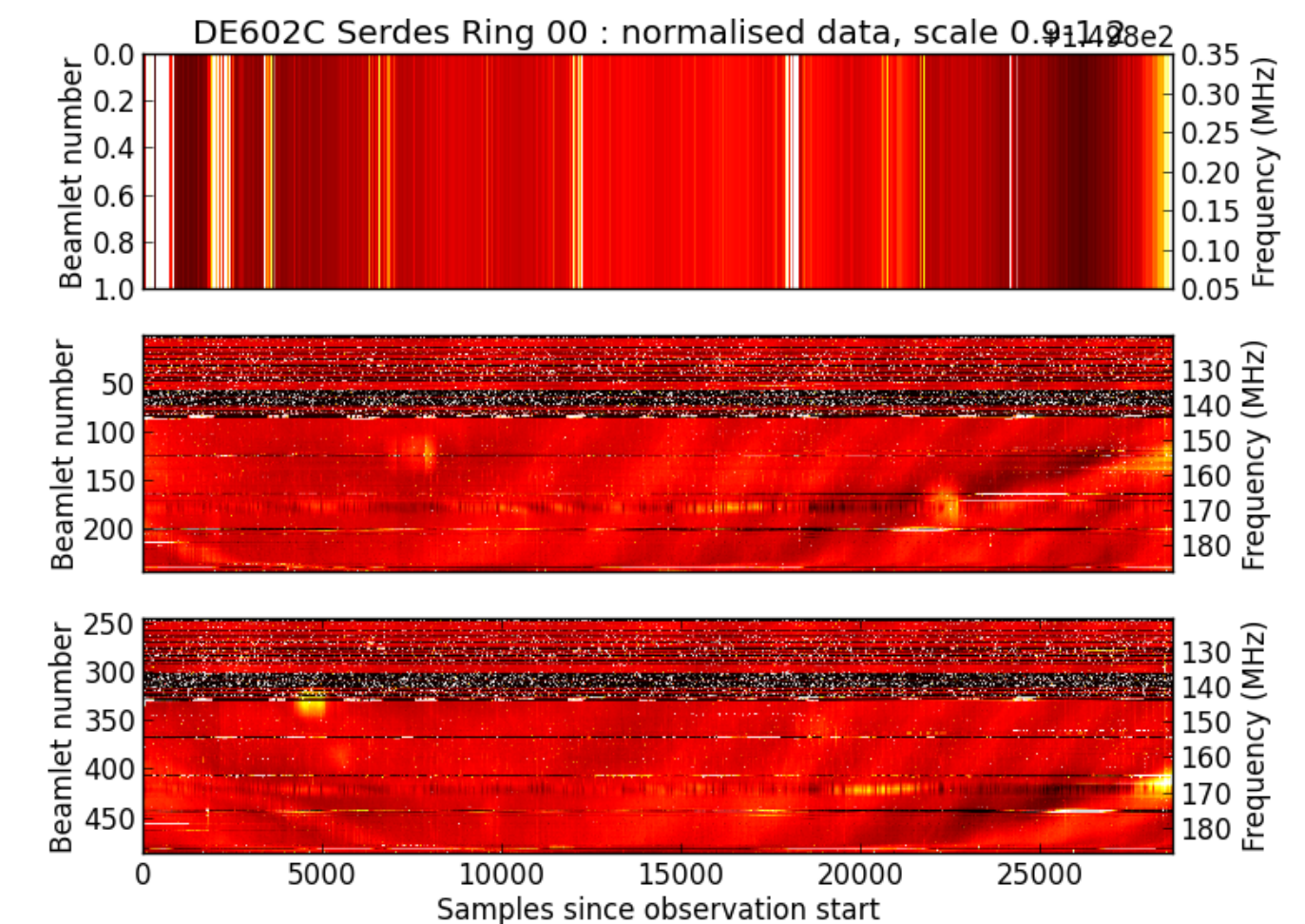
Really oscillating tile



Solar bursts

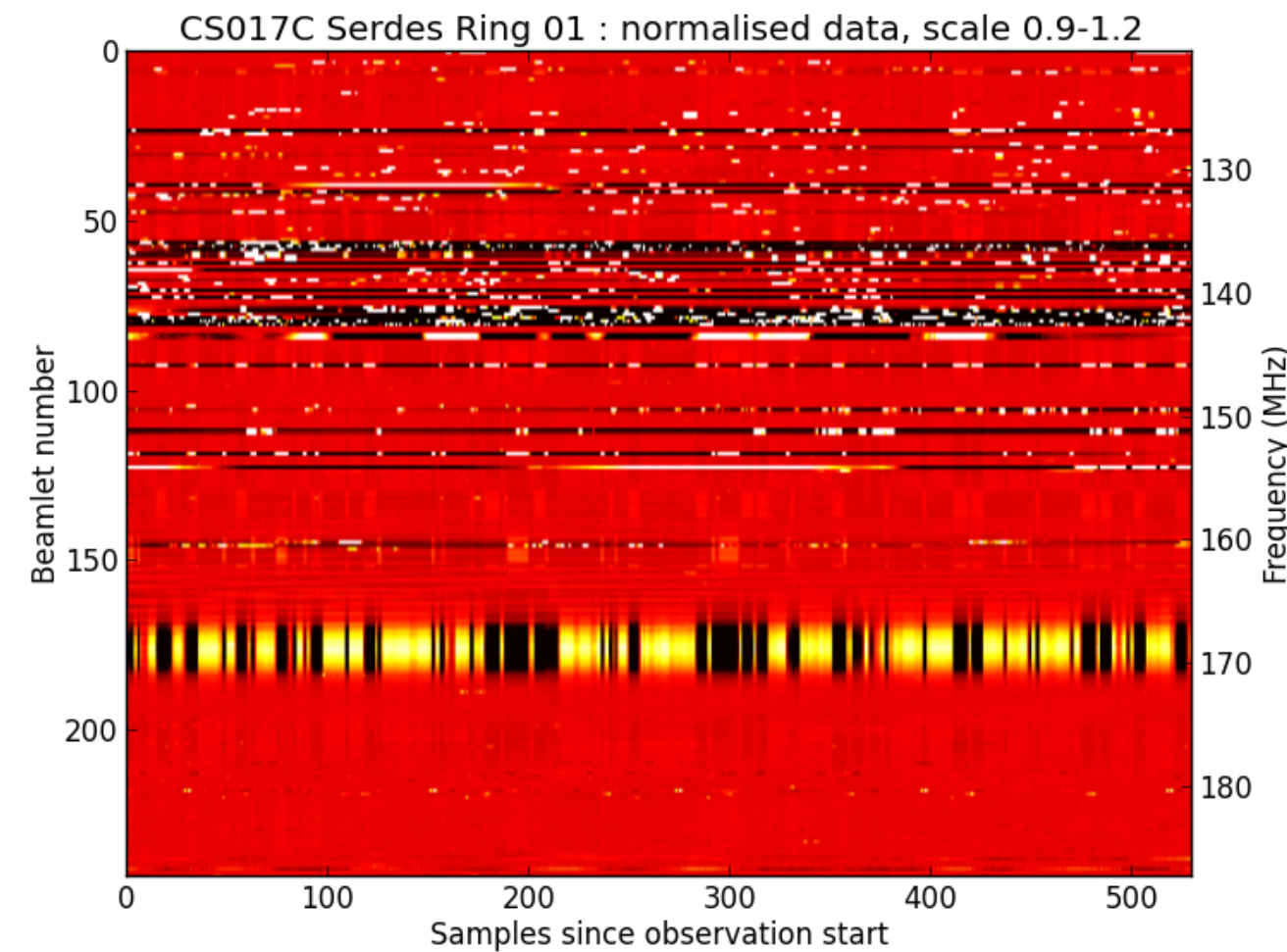


Lightning

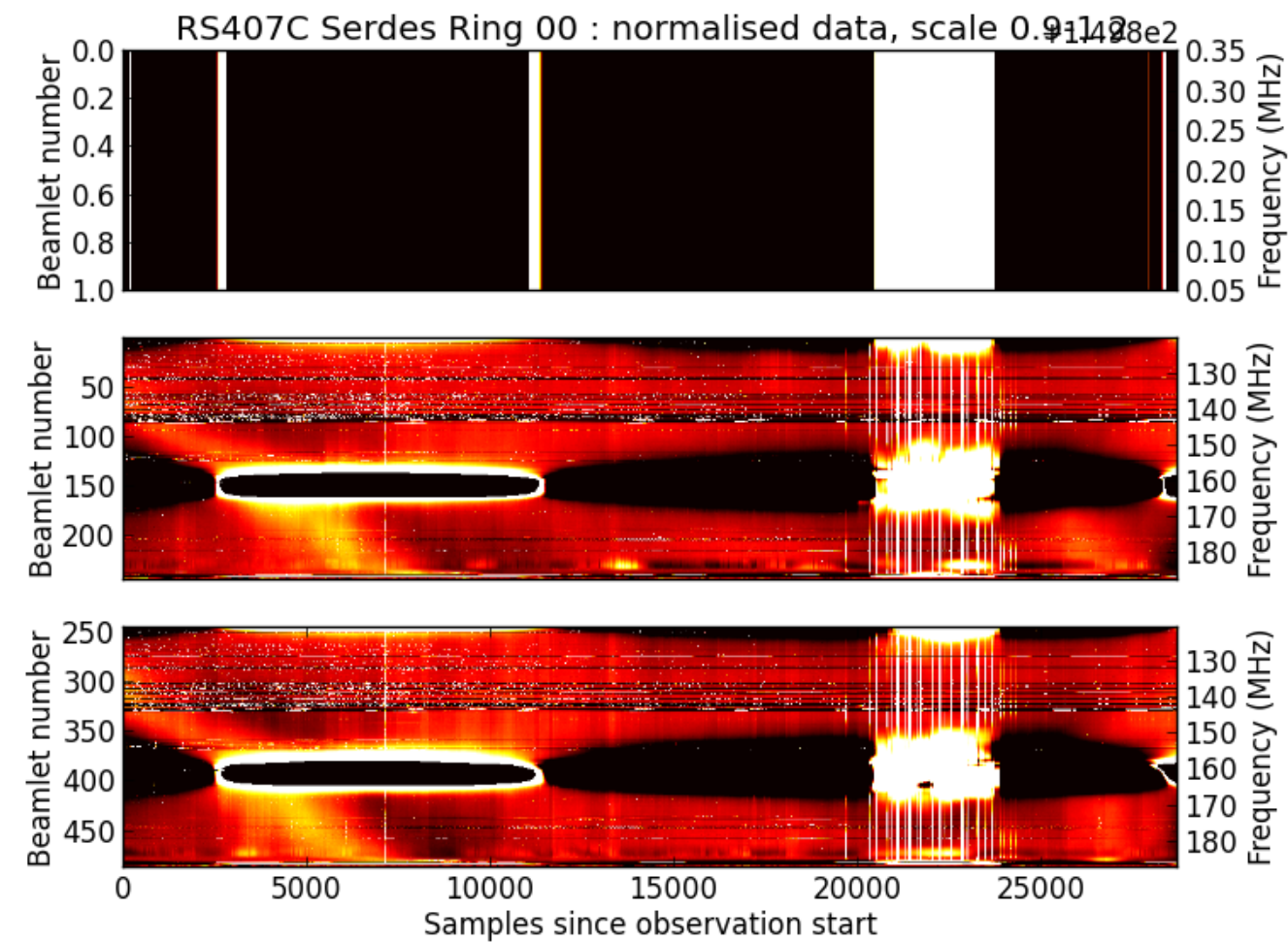


Interfering structure

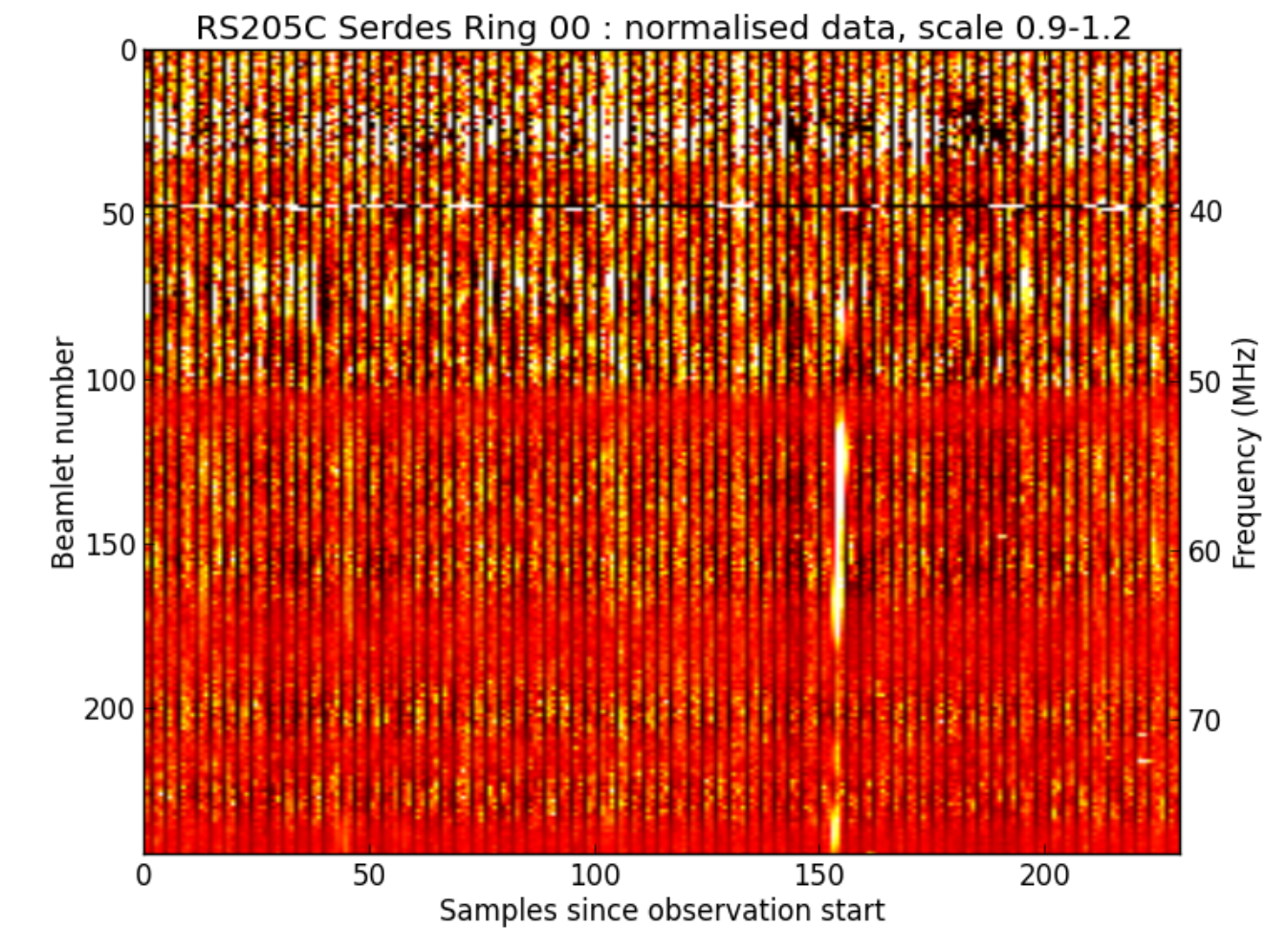
Dynamic spectra examples



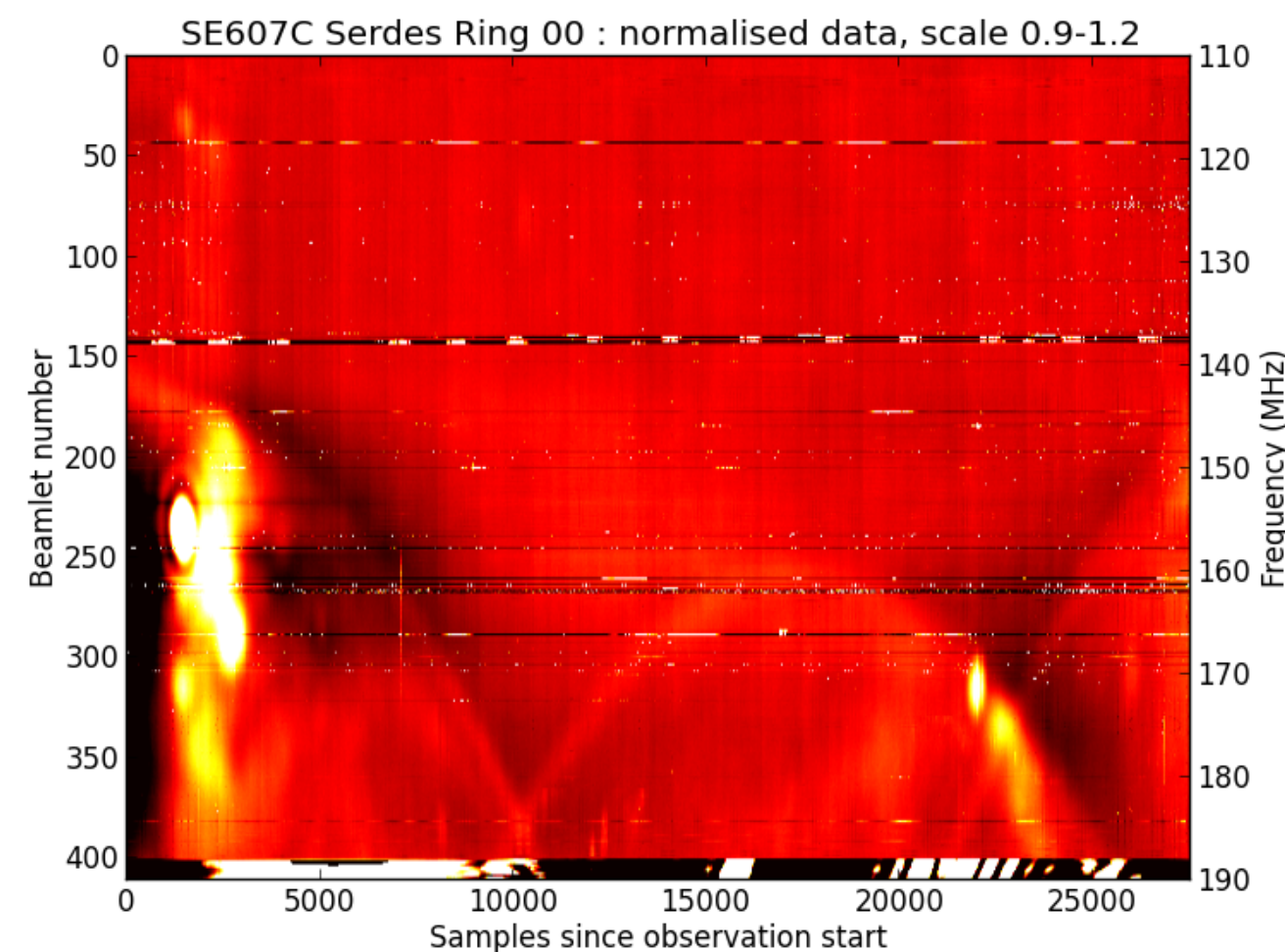
RFI (snakes)



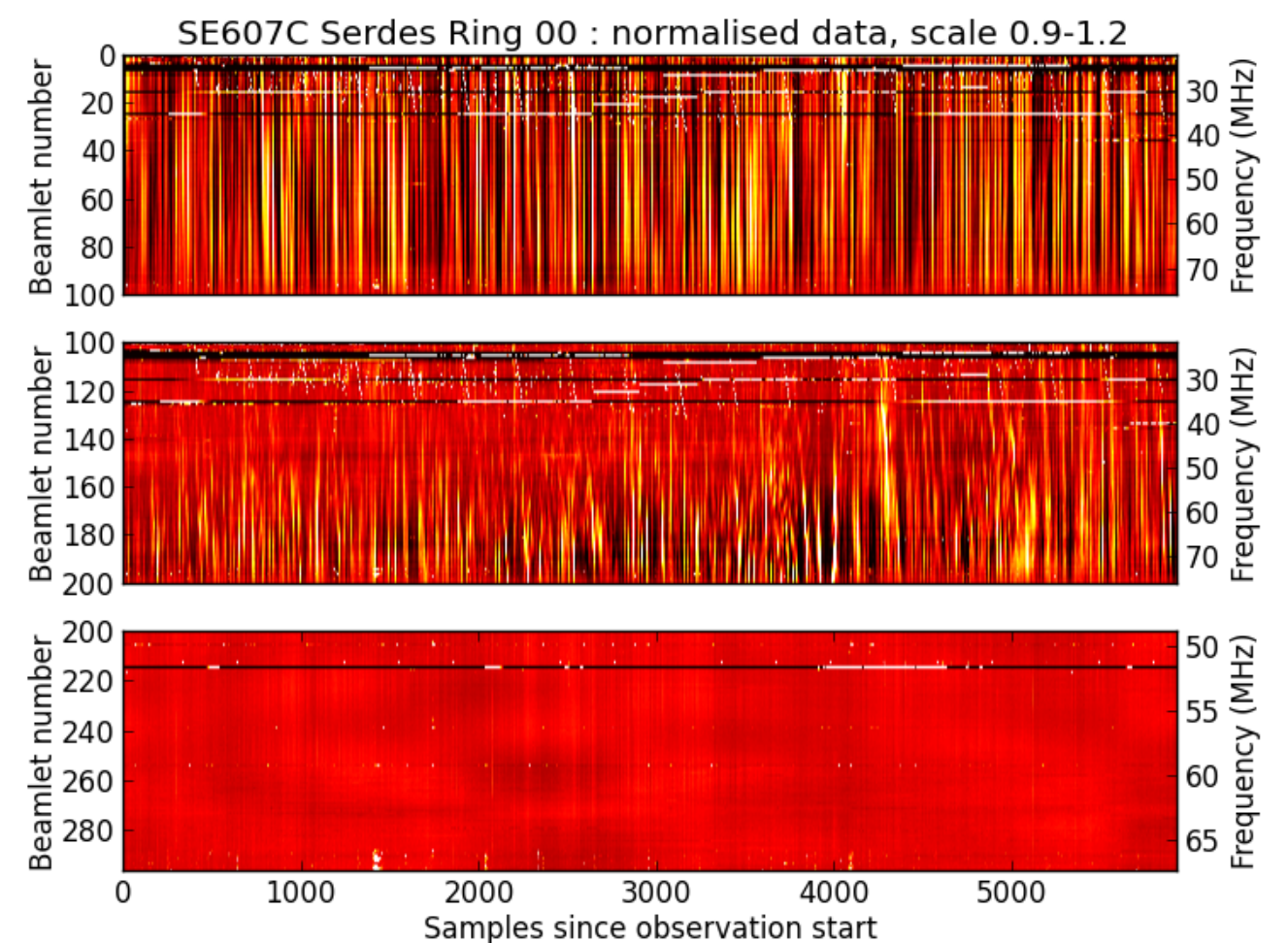
RFI (broadband)



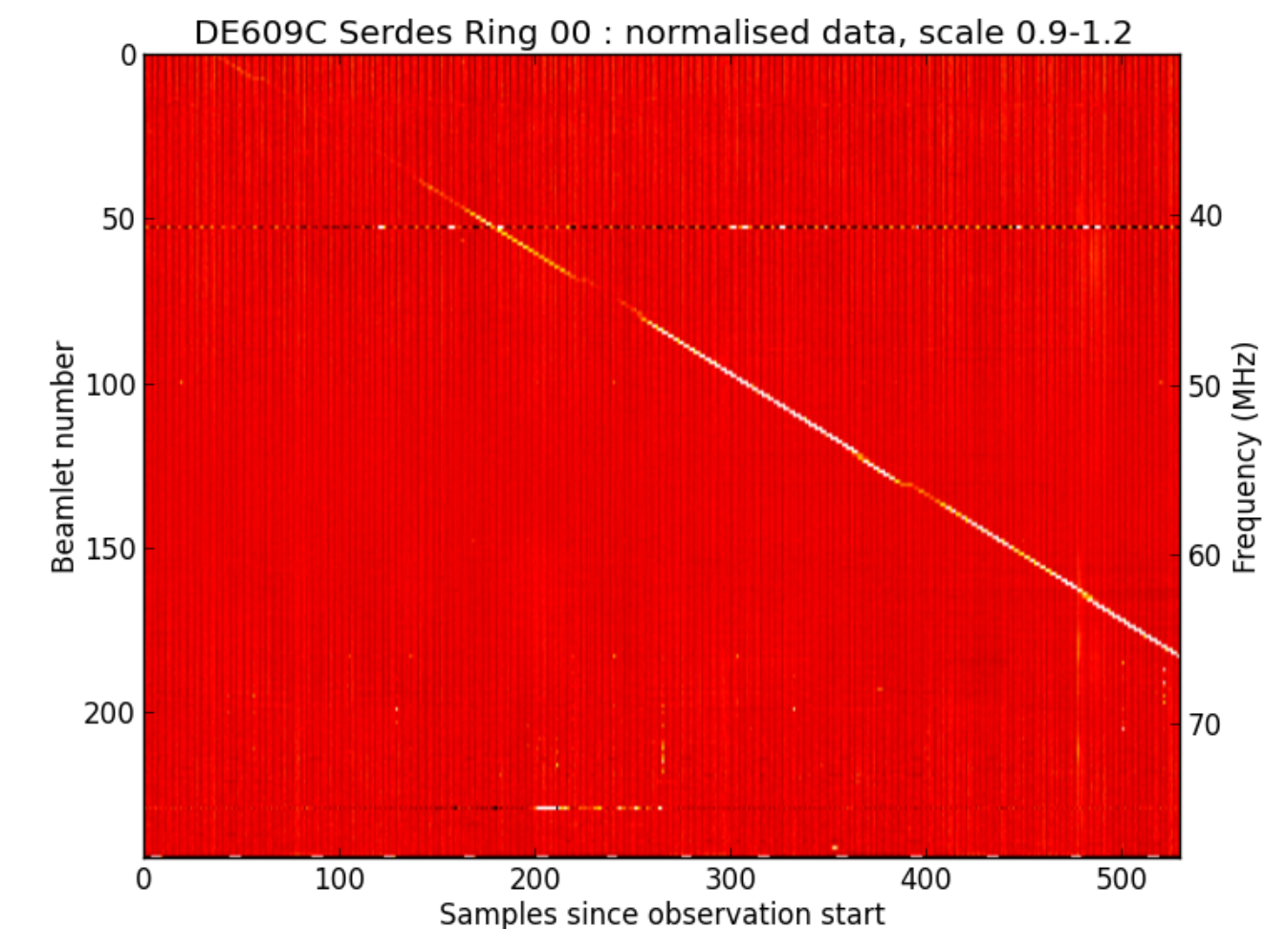
Electric fence



Bright sidelobes

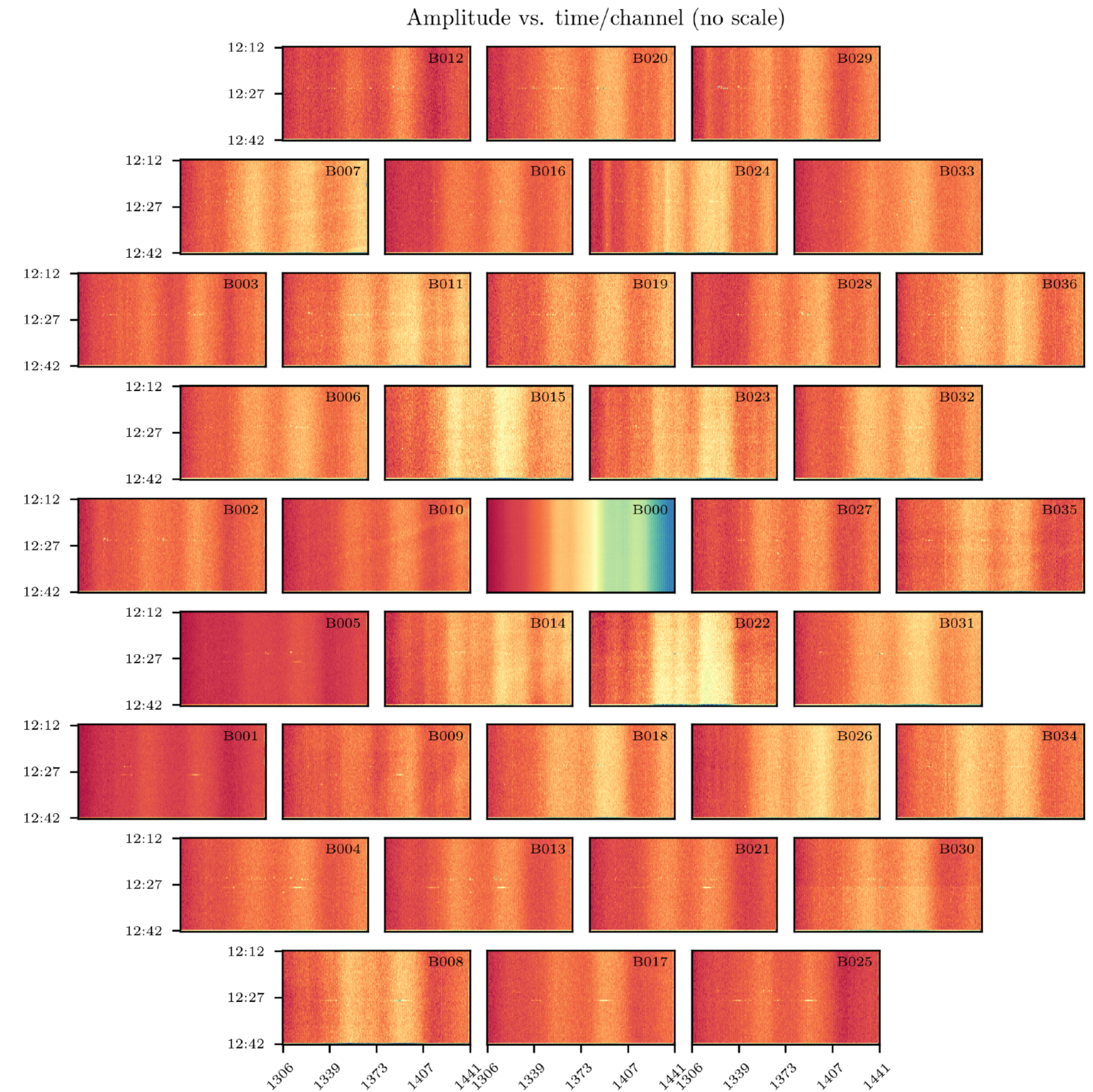
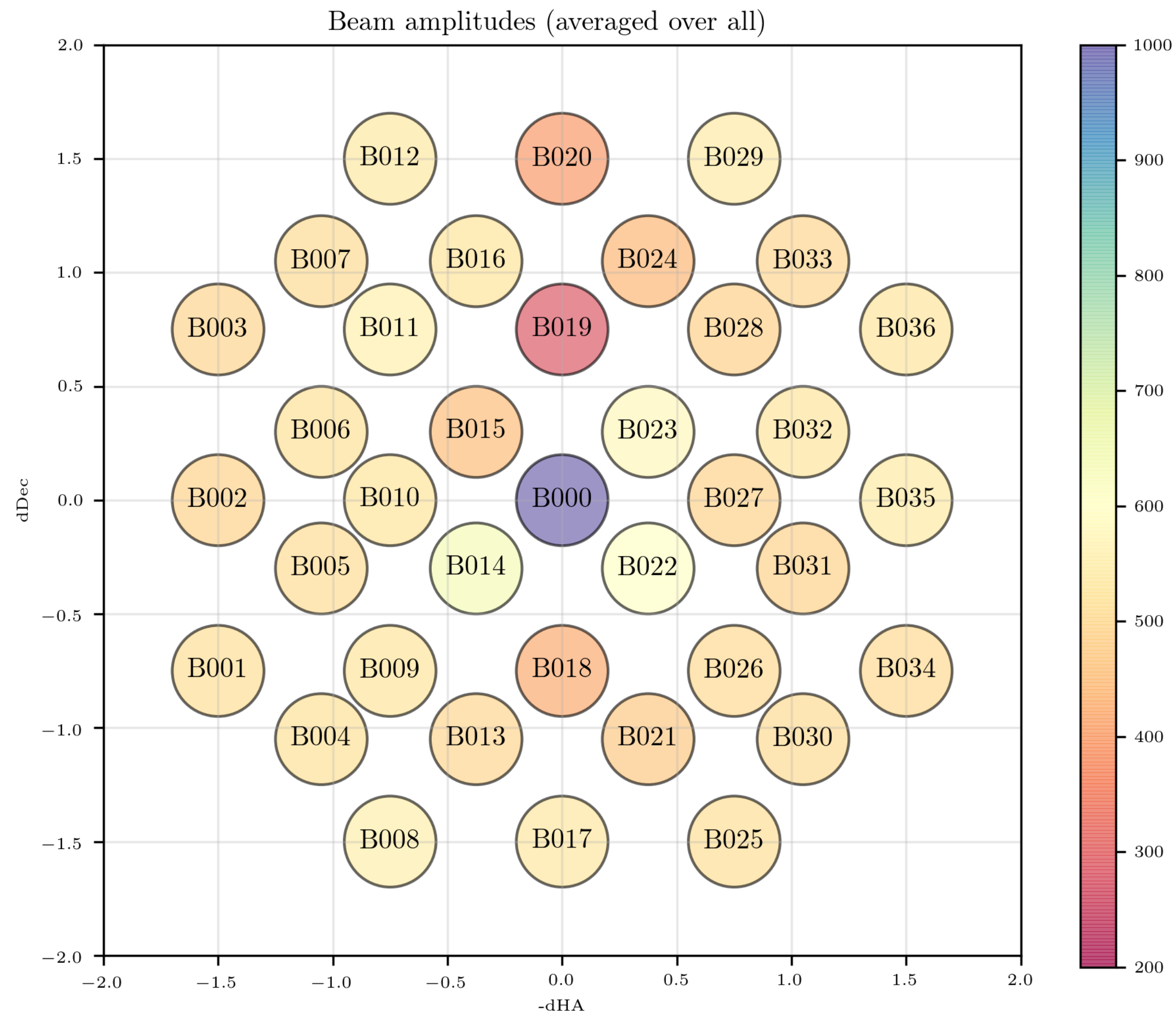


Solar storm

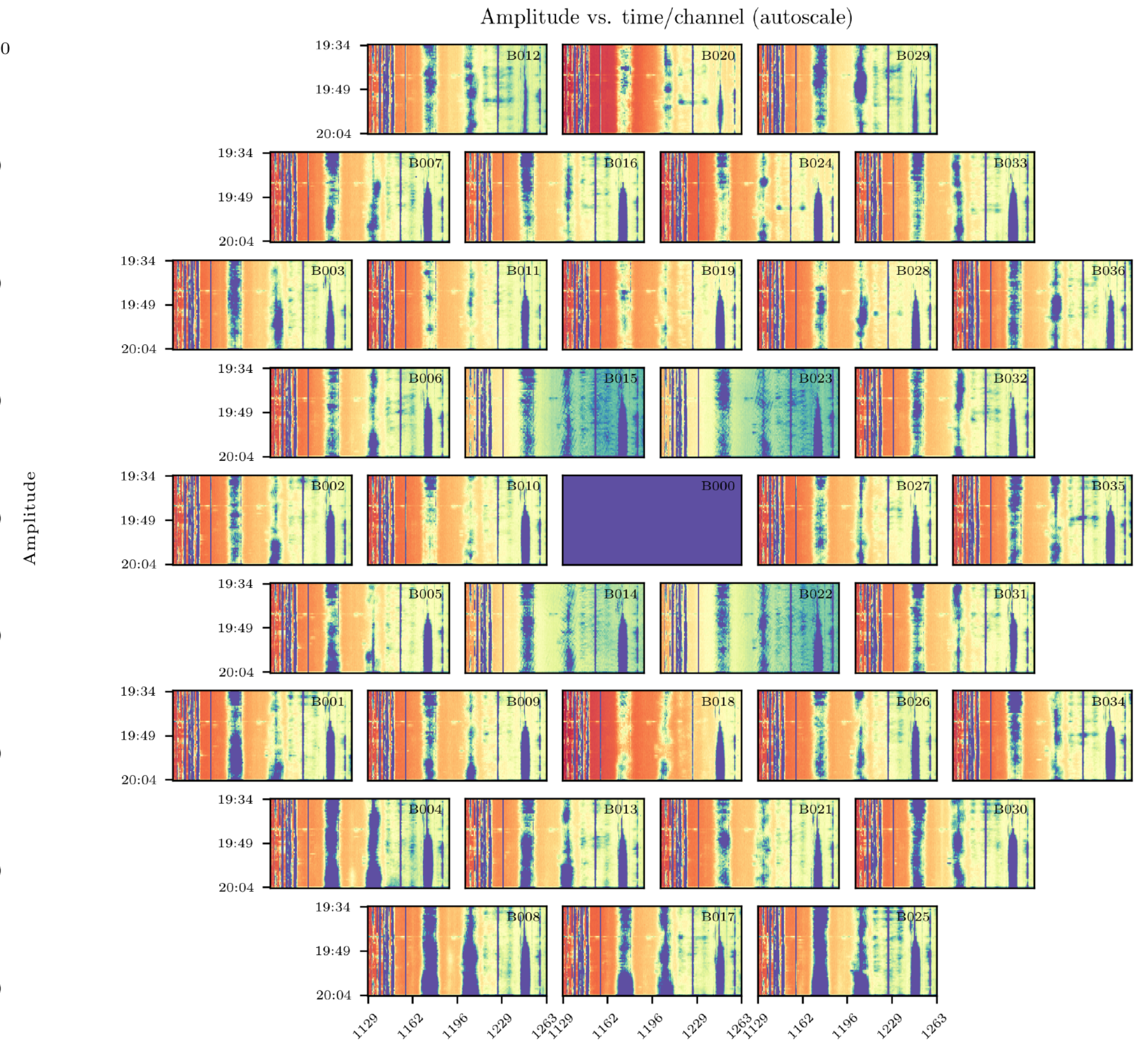
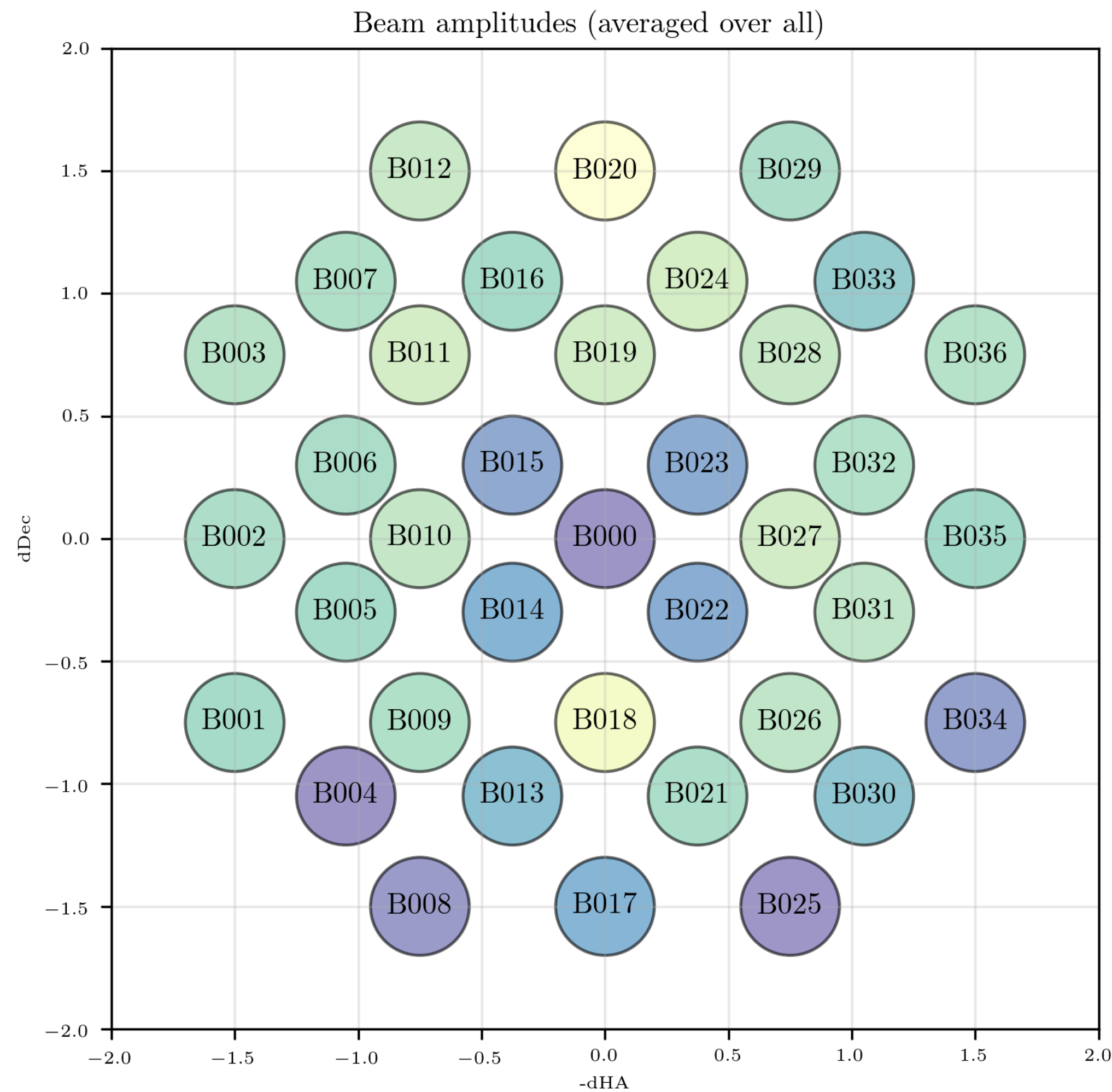


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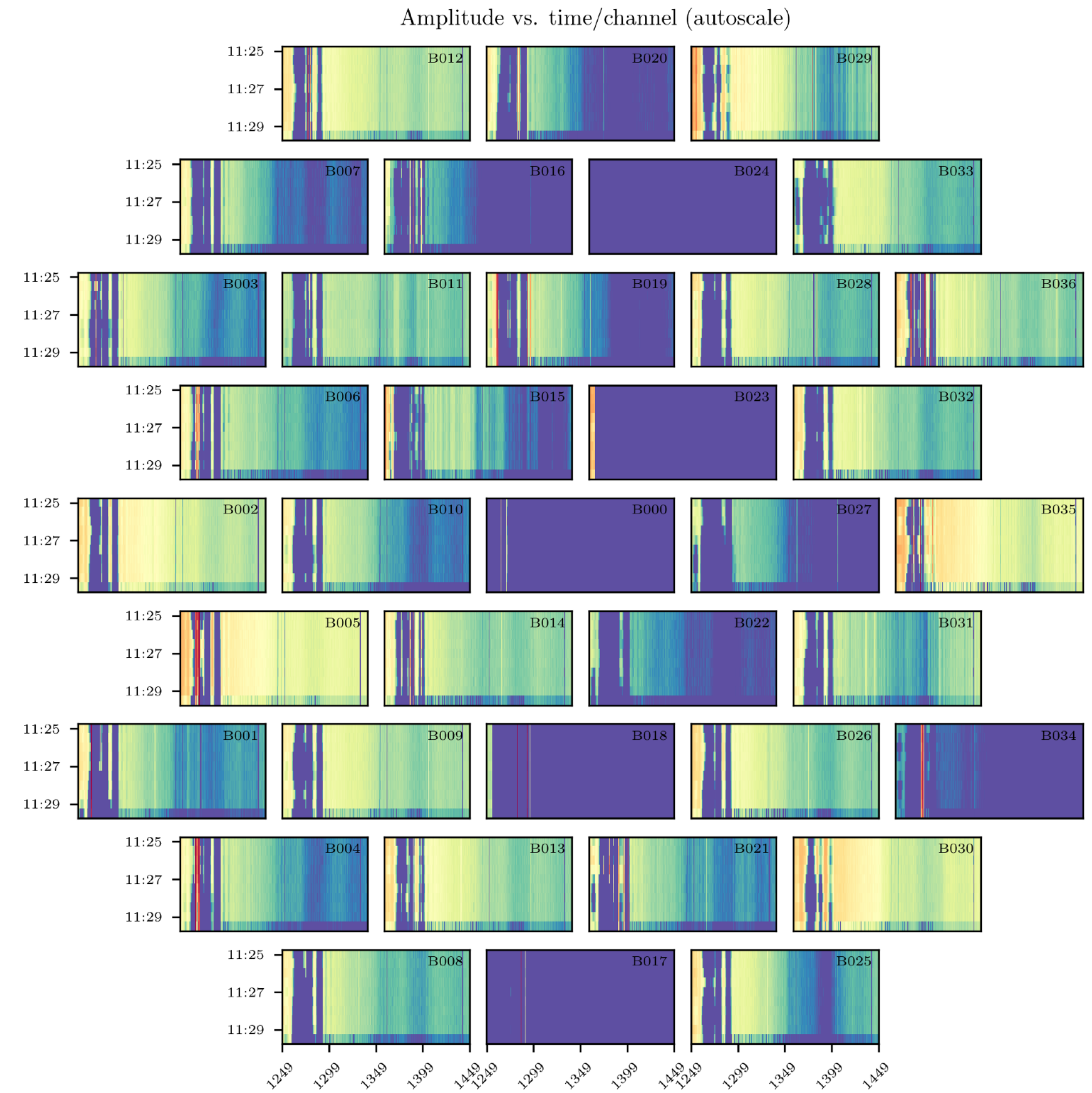
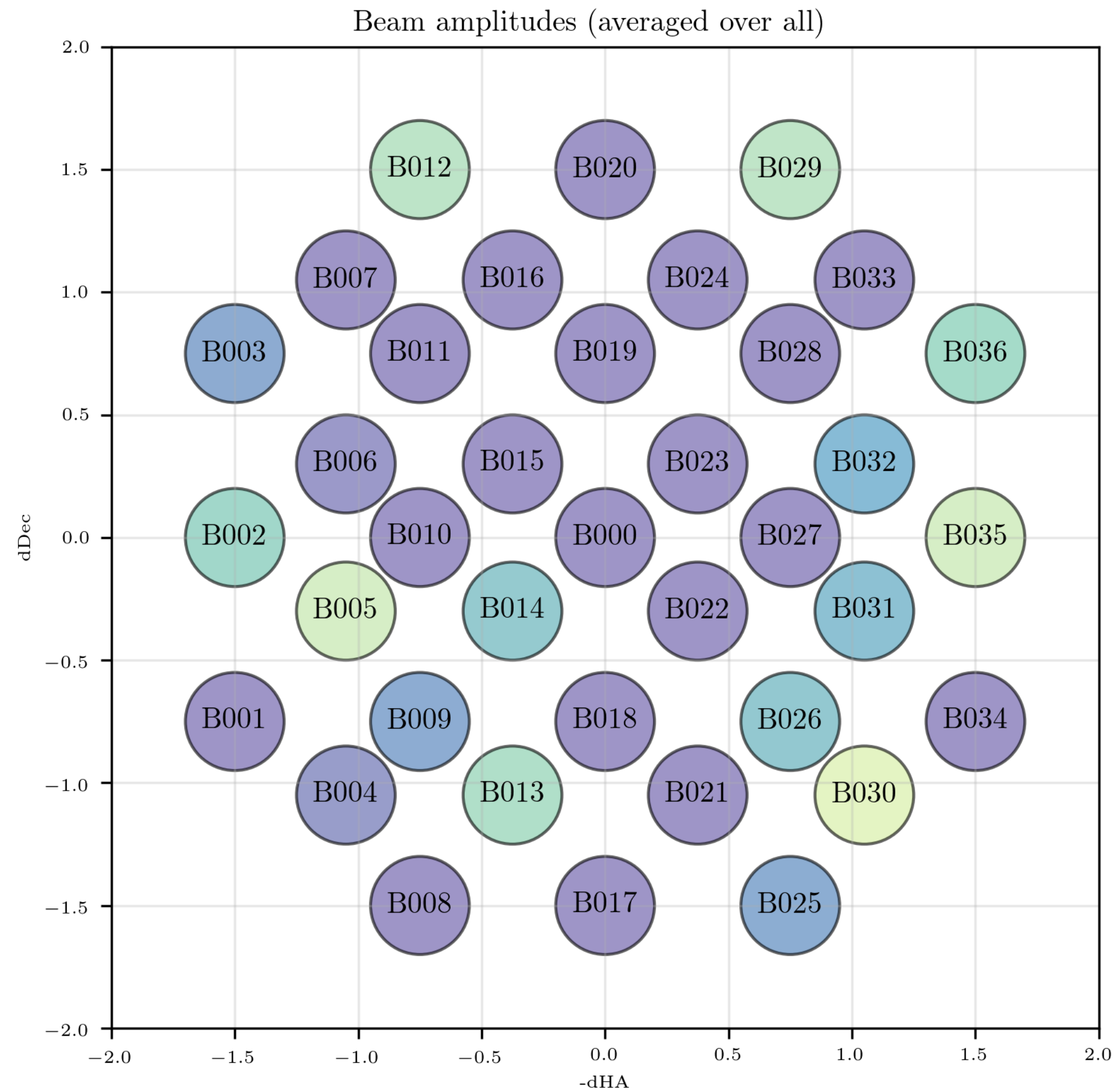
Guest star: APERTIF!



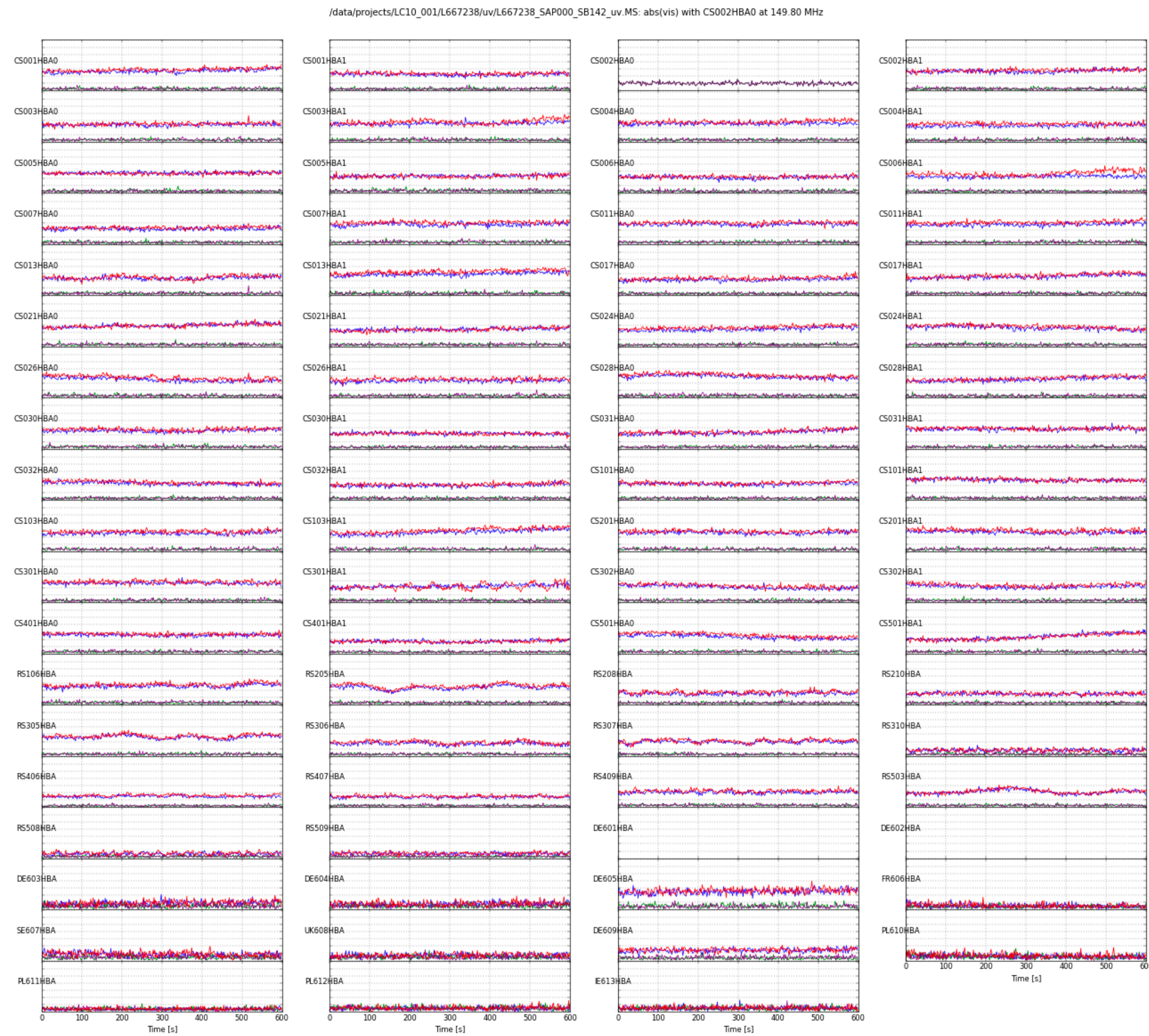
Guest star: APERTIF!



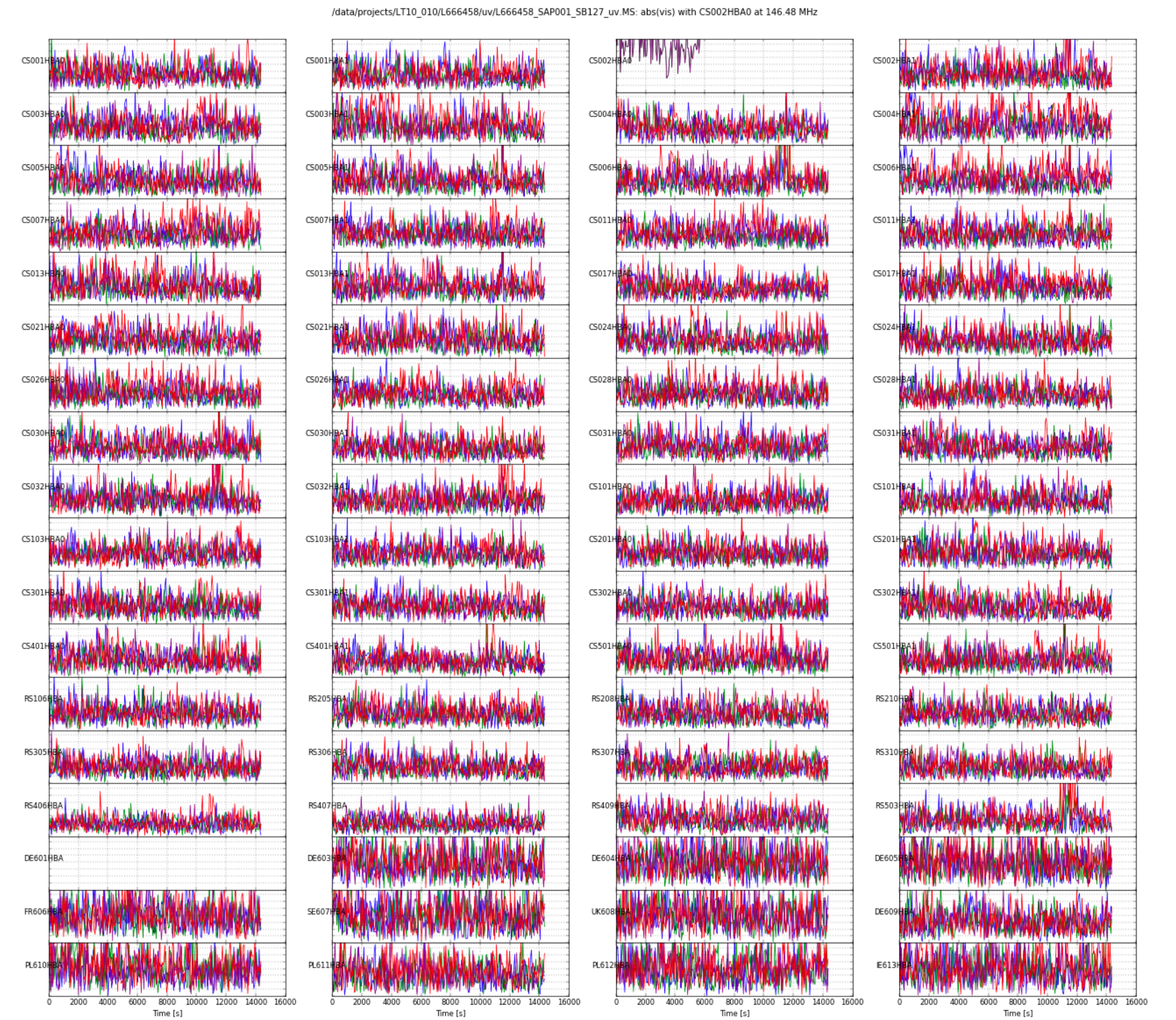
Guest star: APERTIF!



Interferometric examples

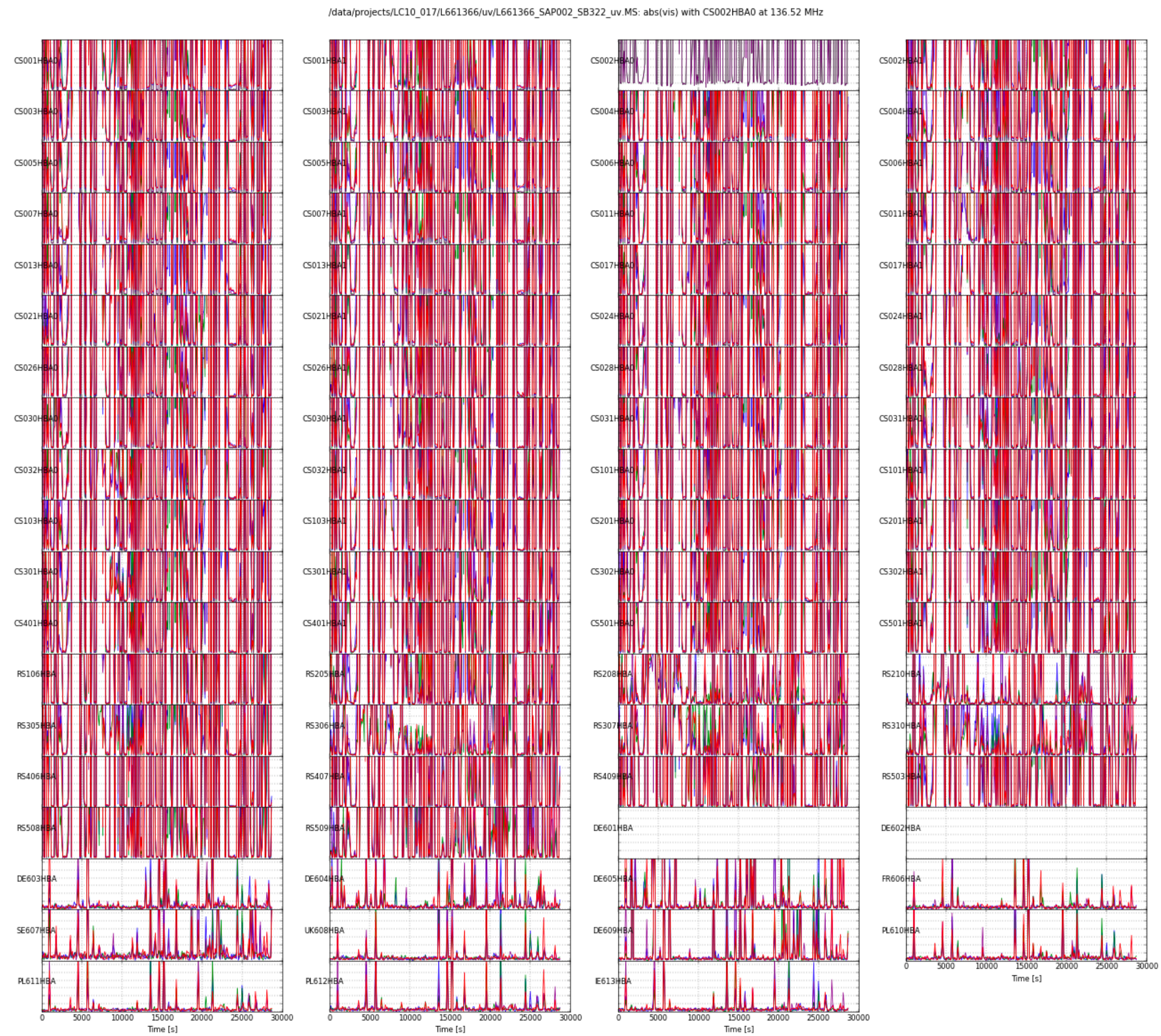


Bright calibrator

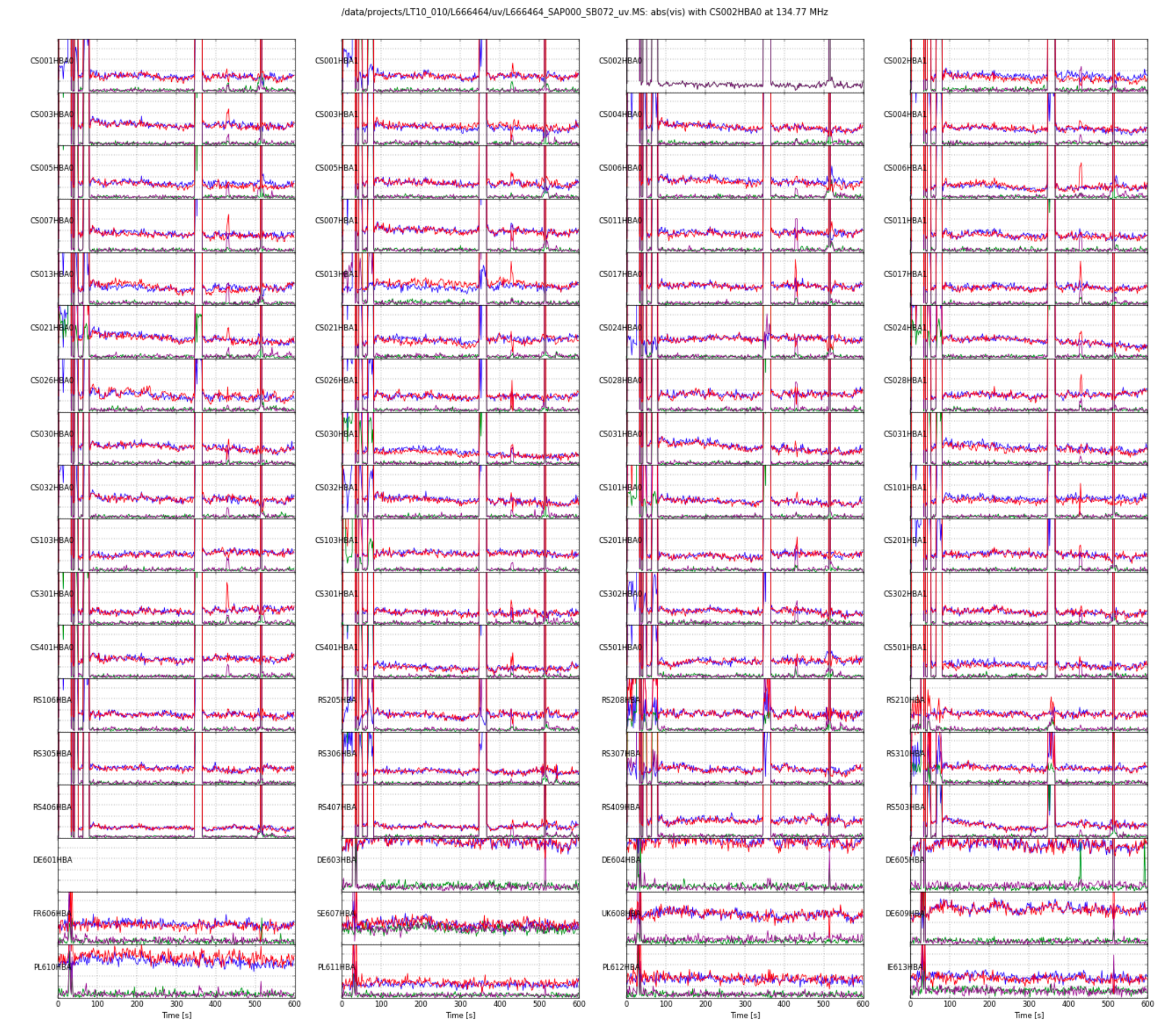


Faint target field

Interferometric examples



Awful RFI

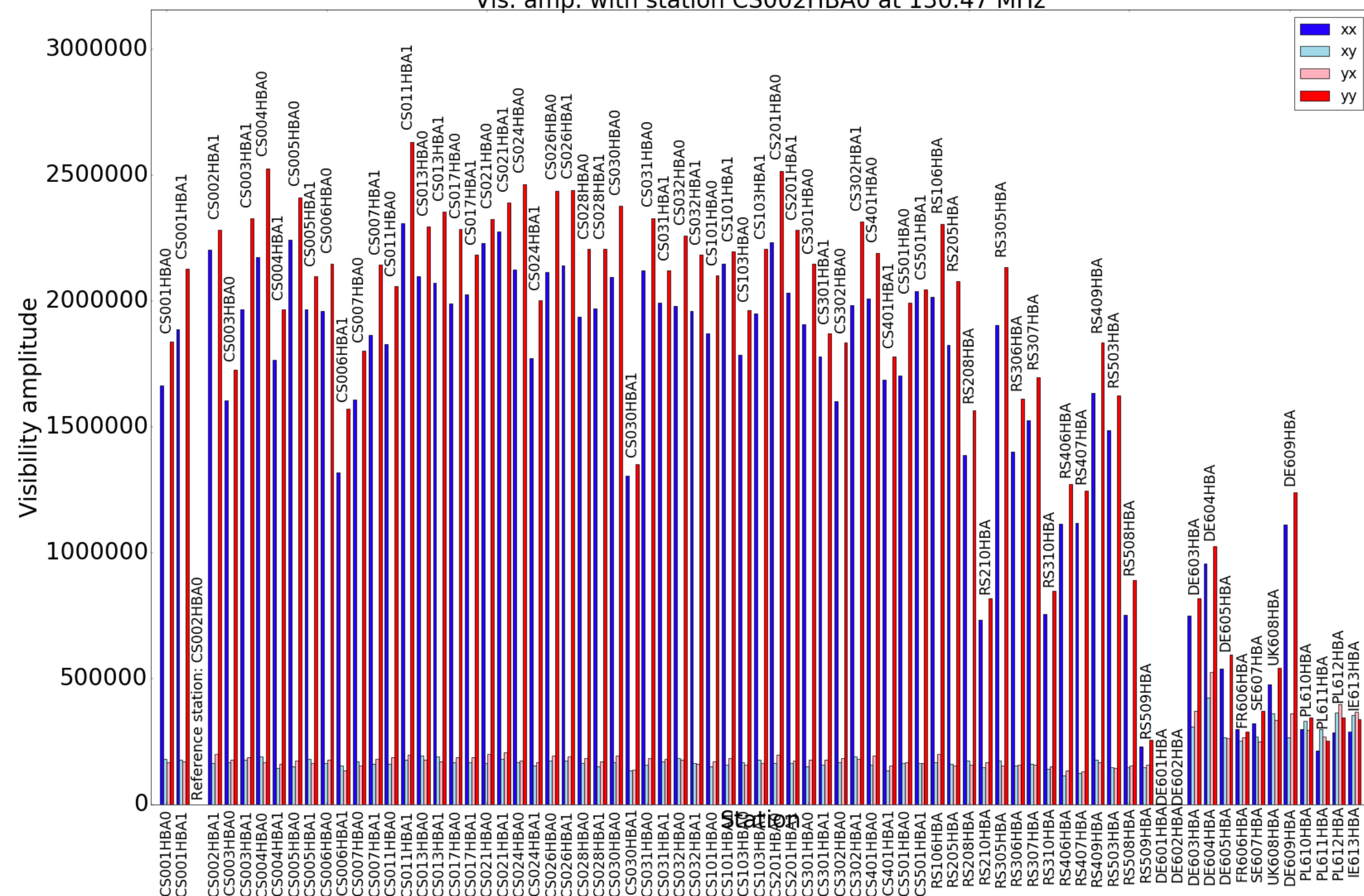


Significant RFI

Interferometric examples

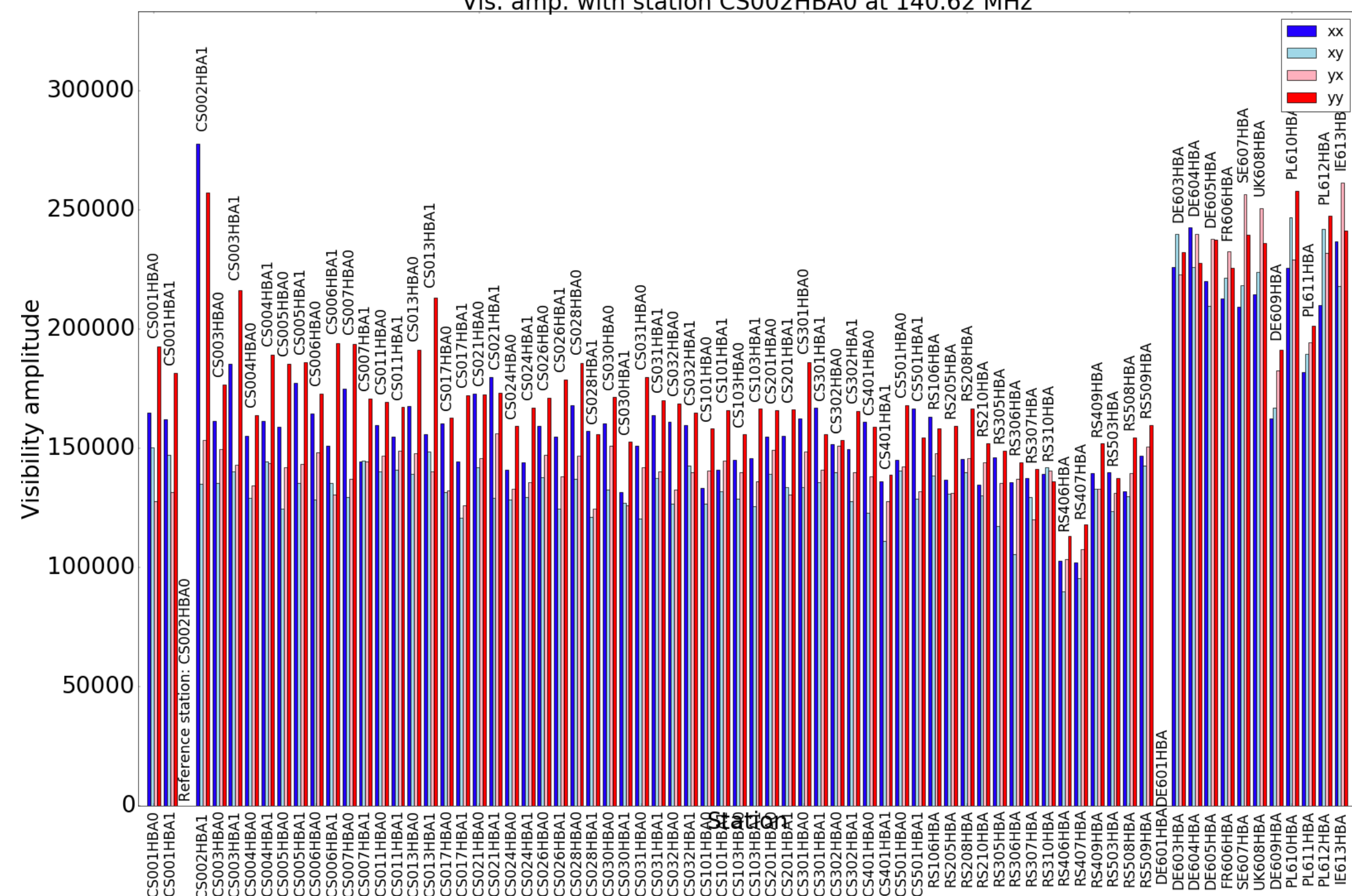


/data/projects/LC10_001/L667238/uv/L667238_SAP000_SB051_uv.MS:
Vis. amp. with station CS002HBA0 at 130.47 MHz



Resolved calibrator

/data/projects/LT10_010/L667550/uv/L667550_SAP001_SB100_uv.MS:
Vis. amp. with station CS002HBA0 at 140.62 MHz

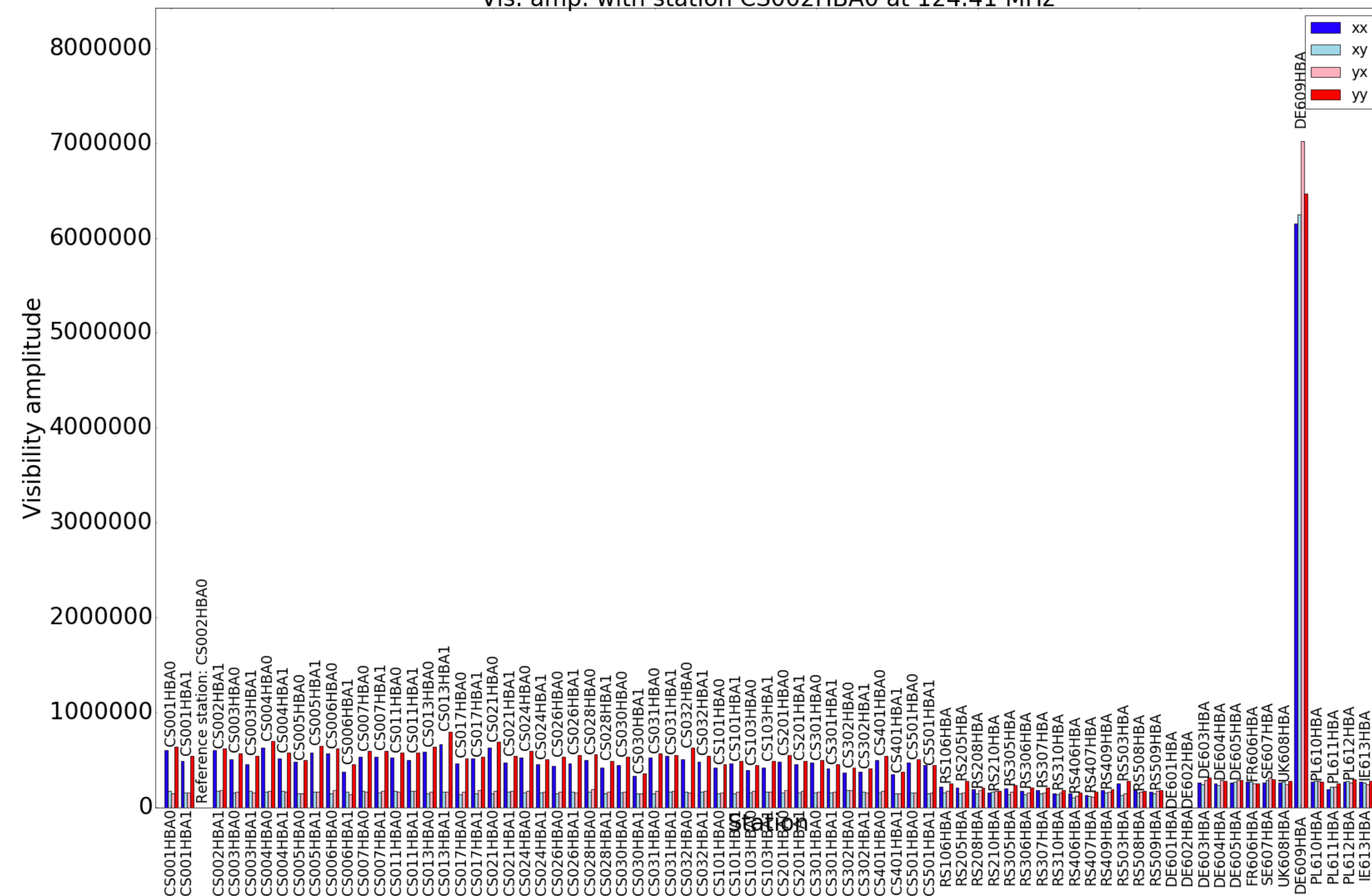


Target field, low amplitude

Interferometric examples

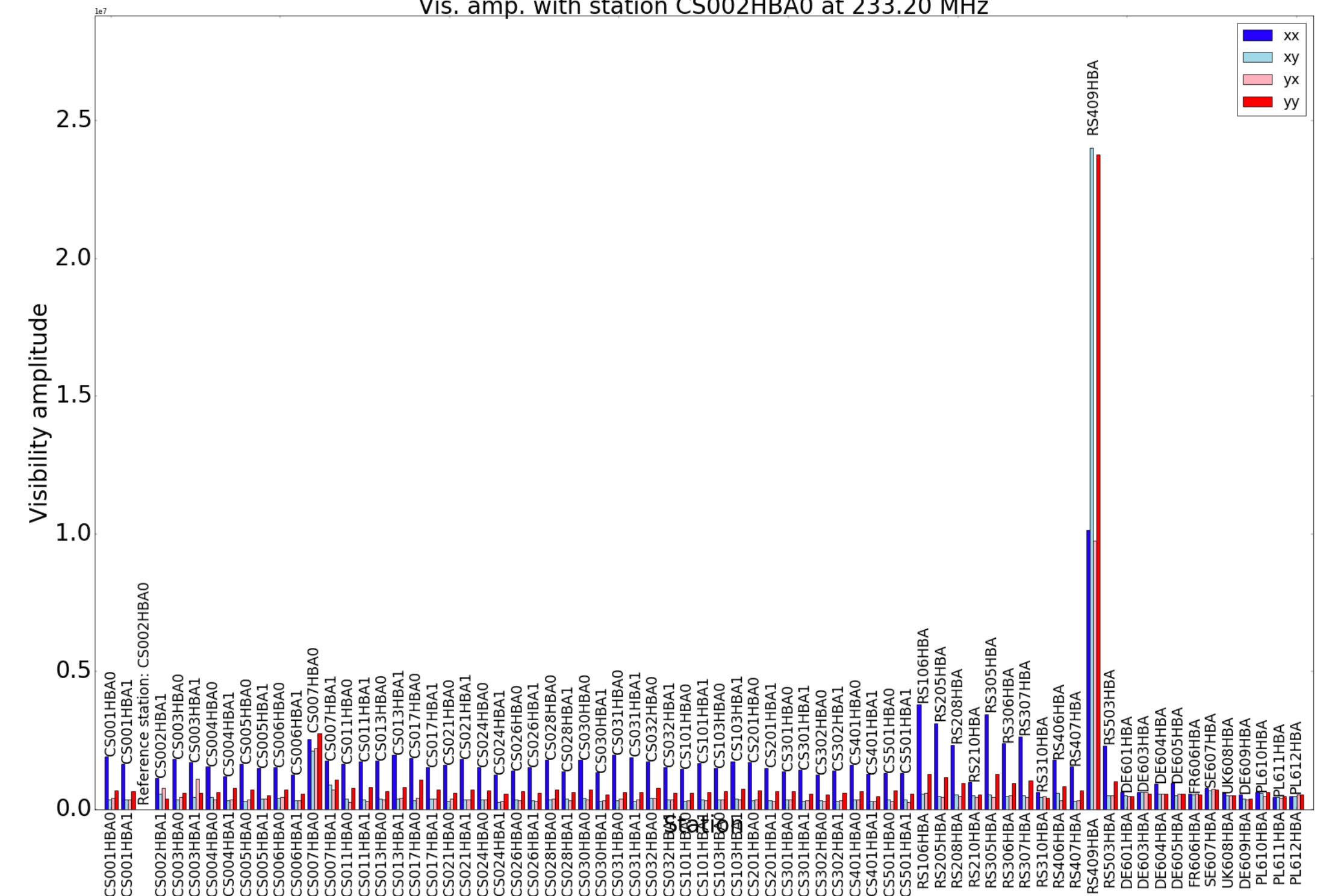


/data/projects/LC10_017/L661366/uv/L661366_SAP001_SB022_uv.MS:
Vis. amp. with station CS002HBA0 at 124.41 MHz



DE609 having a bad day

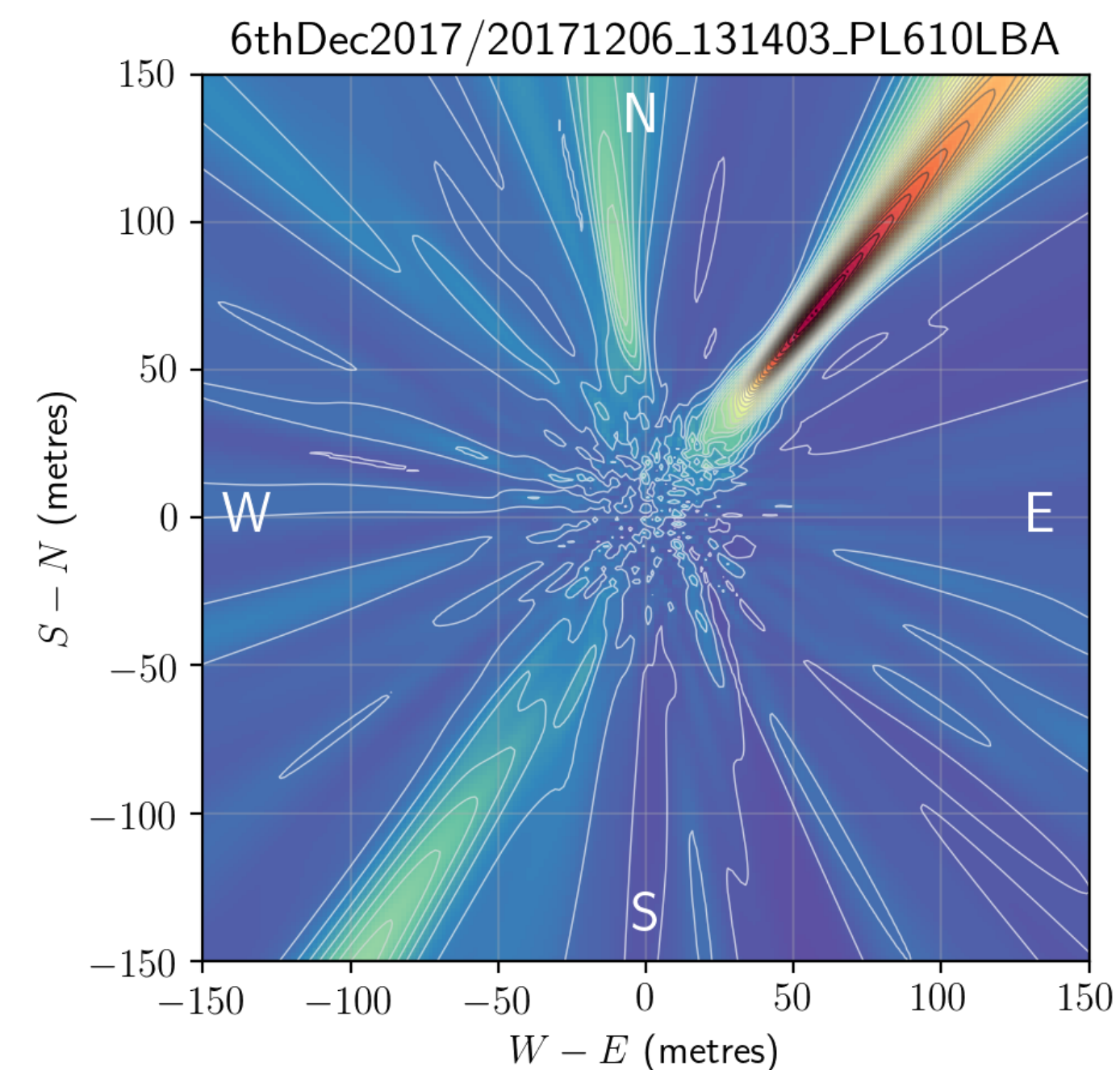
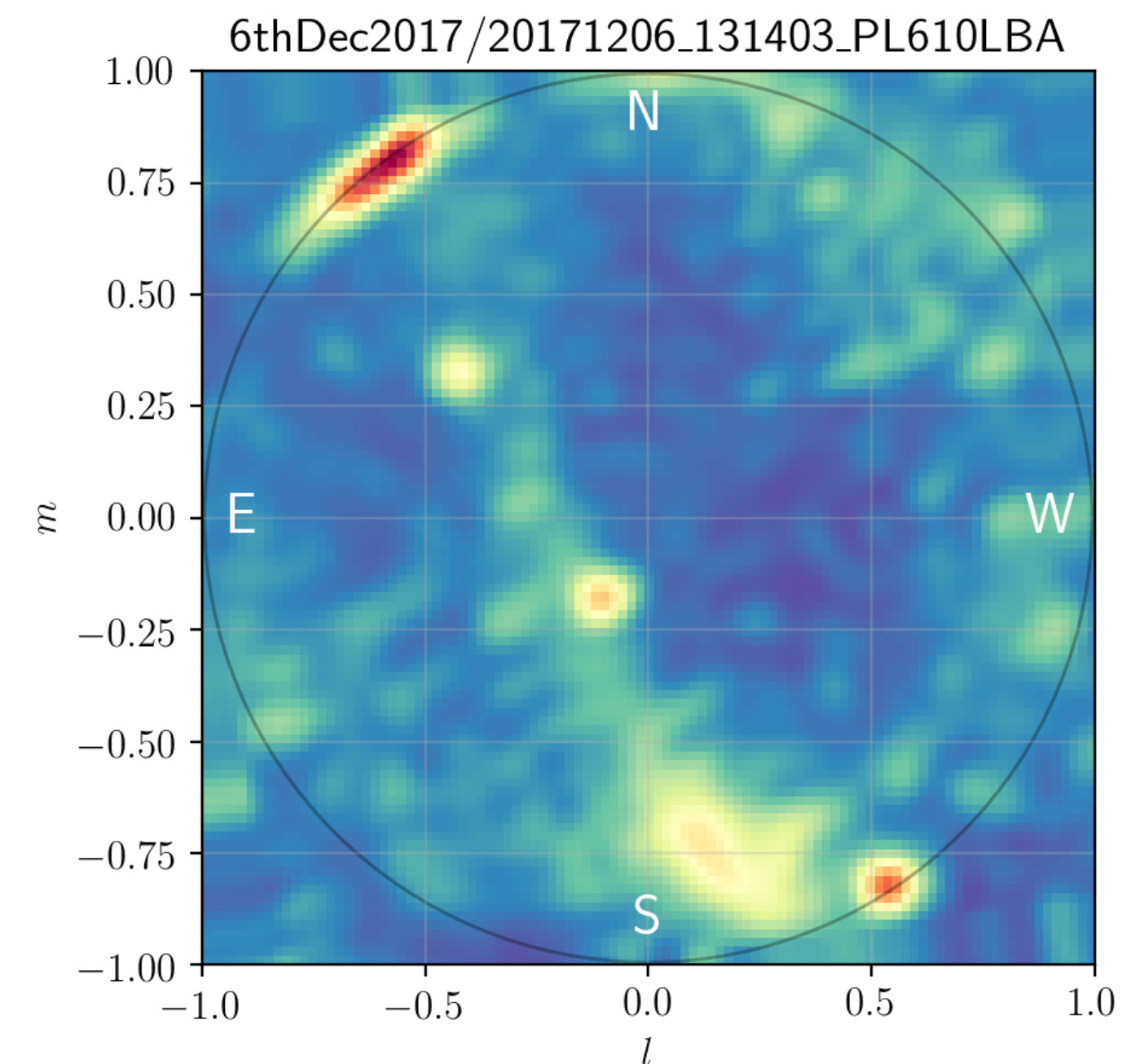
/data/projects/2018LOFAROBS/L667192/uv/L667192_SAP000_SB118_uv.MS:
Vis. amp. with station CS002HBA0 at 233.20 MHz



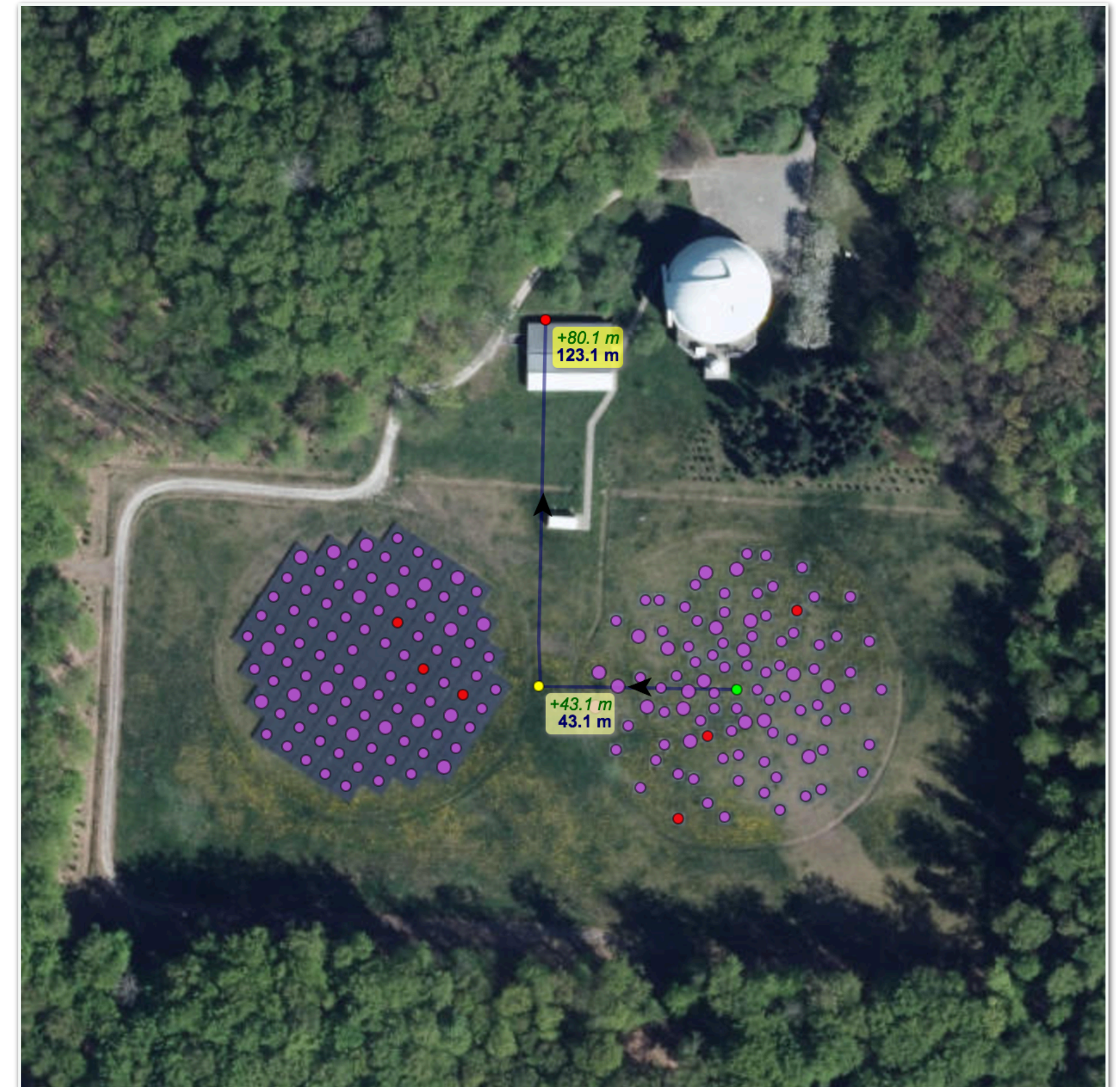
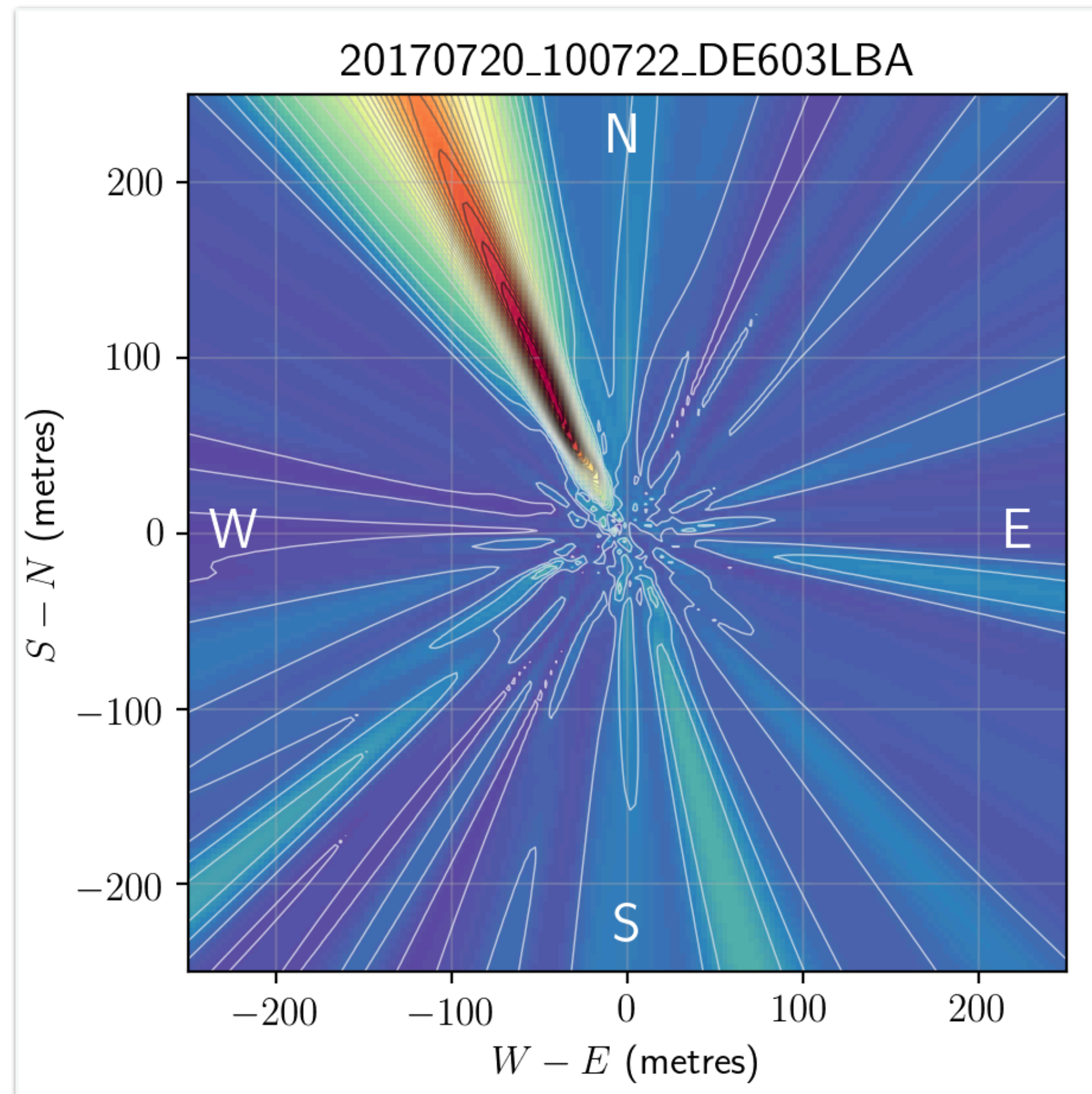
Polarised RFI, Smilde

RFI near-field imaging

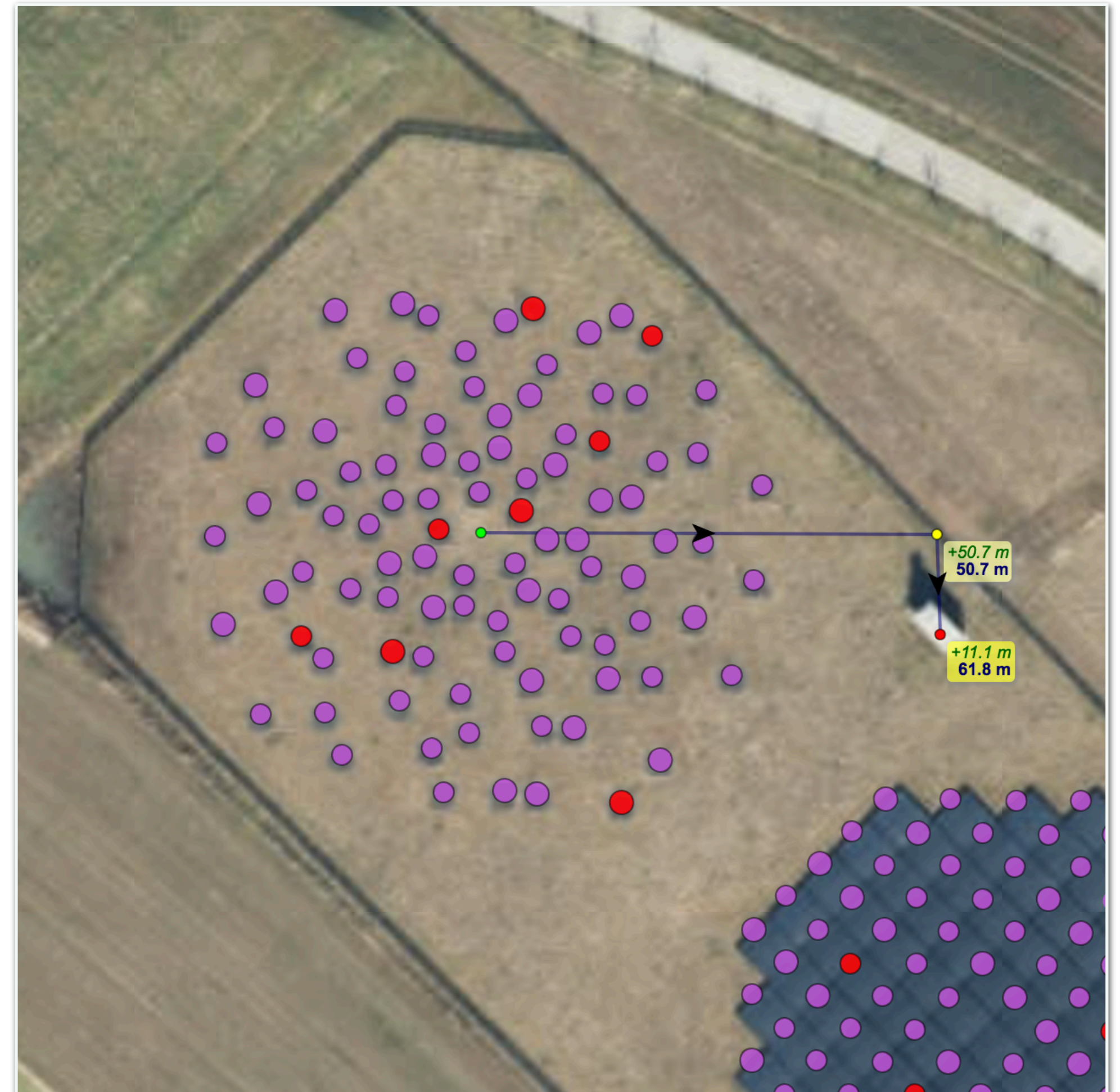
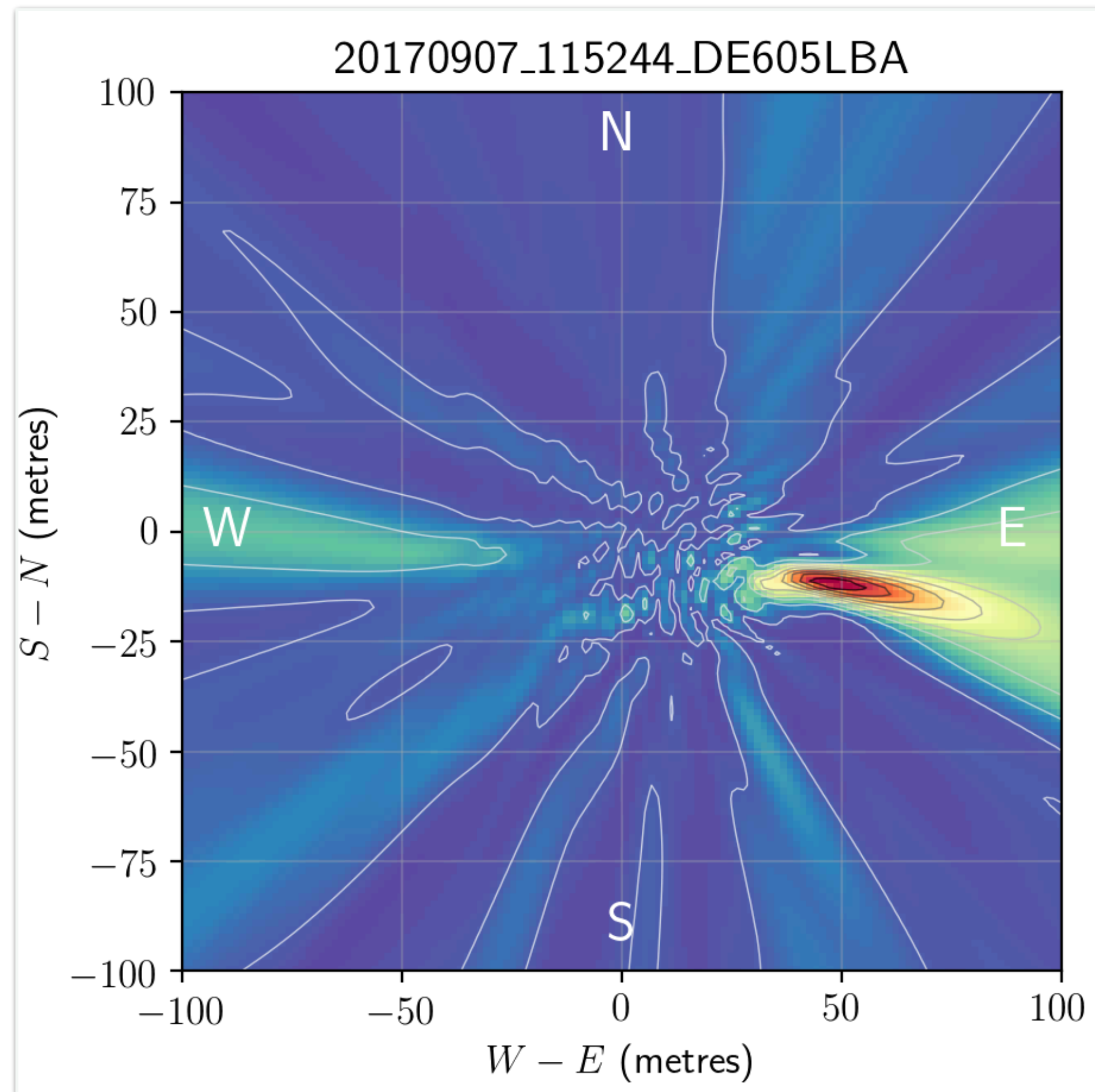
- Began as a tutorial on **basic imaging** of LOFAR data from Michiel Brentjens
- We record data from an individual station, in the form of the **cross-correlation matrix** and then image this using Python
- From this, it is possible to image **both the sky and the ground plane** - if there is RFI, we can hunt for its location!
- This is now one of my tasks in the **Data Quality Working group** - detailed field testing to come!



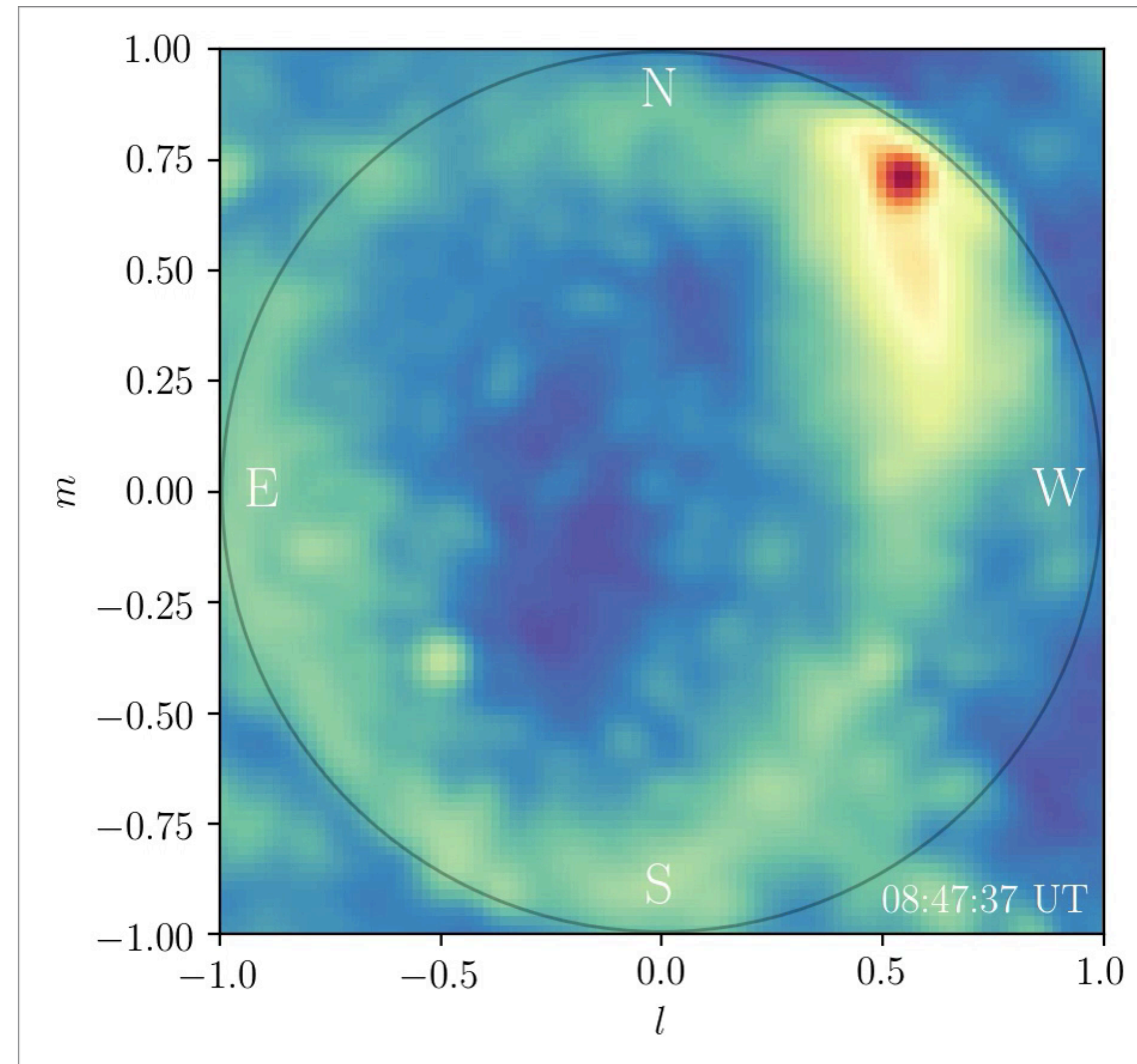
RFI near-field imaging



RFI near-field imaging



RFI near-field imaging





Your turn!

- The best way to get experience with assessing the quality of LOFAR data is to **have a go**
- Link to form: tinyurl.com/lofarDQ
- Link to plots: <https://proxy.lofar.eu/inspect/HTML/index.html>
- **Your task:** pick a LOFAR observation from the list of recent observations, and go through the form to analyse the various inspection plots
- You have **10 minutes** to do so!

LOFAR Data Assessment Practice

This form runs you through a checklist to assess a LOFAR observation for its data quality. You can select a dataset to assess from the main inspection plot page, as shown below.

*Required

<https://proxy.lofar.eu/inspect/HTML/index.html>

LOFAR inspection plots

Last modified: Thu Sep 13 19:51:51 2018 UTC Full list Ascii table

SAS ID	Campaign	Target	DynSpec	Compl	Compl*	AntennaSet	Band	Start	End	Clock	Subb	Parset
L666889	LCS_005	J182221+030906	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 18:44:03	2018-09-13 18:47:03	200	480	PACKET
L666682	LCS_005	3C295	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 18:42:02	2018-09-13 18:43:02	200	16	PACKET
L666676	LCS_005	J184706+073447	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 18:37:01	2018-09-13 18:40:01	200	464	PACKET
L666678	LCS_005	3C295	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 18:35:00	2018-09-13 18:36:00	200	16	PACKET
L667244	LT10_001	CrA	BST	66%	100%	N.A.LBA_OUTER	LBA_10_90	2018-09-13 16:55:00	2018-09-13 18:34:00	200	480	PACKET
L666569	LT10_005	LOFAAS-P1821C-SAPO	BST	100%	100%	N.A.HBA_DUAL	HBA_110_190	2018-09-13 15:53:00	2018-09-13 16:53:00	200	486	PACKET
L667222	LT10_012	3C295	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 15:06:12	2018-09-13 15:16:12	200	243	PACKET
L667216	LT10_012	lockmanP171REF	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 07:05:12	2018-09-13 15:05:12	200	487	PACKET
L667212	LT10_012	3C196	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 06:54:12	2018-09-13 07:04:12	200	243	PACKET
L667238	PipelineTests	3C196	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 06:20:00	2018-09-13 06:25:00	200	248	PACKET
L667436	PipelineTests	3C147	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 06:16:00	2018-09-13 06:18:00	200	248	PACKET
L667440	PipelineTests	3C196	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 06:10:00	2018-09-13 06:15:00	200	488	PACKET
L667456	PipelineTests	B0809+74	BST	100%	100%	N.A.HBA_DUAL	HBA_110_190	2018-09-13 06:01:00	2018-09-13 06:06:00	200	244	PACKET
L667434	PipelineTests	3C147	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 05:55:00	2018-09-13 06:00:00	200	240	PACKET
L667432	PipelineTests	3C196	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 05:52:00	2018-09-13 05:54:00	200	240	PACKET
L667430	PipelineTests	3C147	BST	100%	100%	LBA_OUTER	LBA_10_90	2018-09-13 05:46:00	2018-09-13 05:51:00	200	480	PACKET
L666498	LT10_010	3C147	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-13 05:34:22	2018-09-13 05:44:22	200	243	PACKET
L666502	LT10_010	P021P024REF	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-12 21:33:22	2018-09-13 05:33:22	200	487	PACKET
L666508	LT10_010	3C048	BST	100%	100%	HBA_DUAL_INNER	HBA_110_190	2018-09-12 21:22:22	2018-09-12 21:32:22	200	243	PACKET

What is the ID of the observation you are assessing? *

e.g. 666458

Your answer

What observational mode was LOFAR in? *

HBA_DUAL

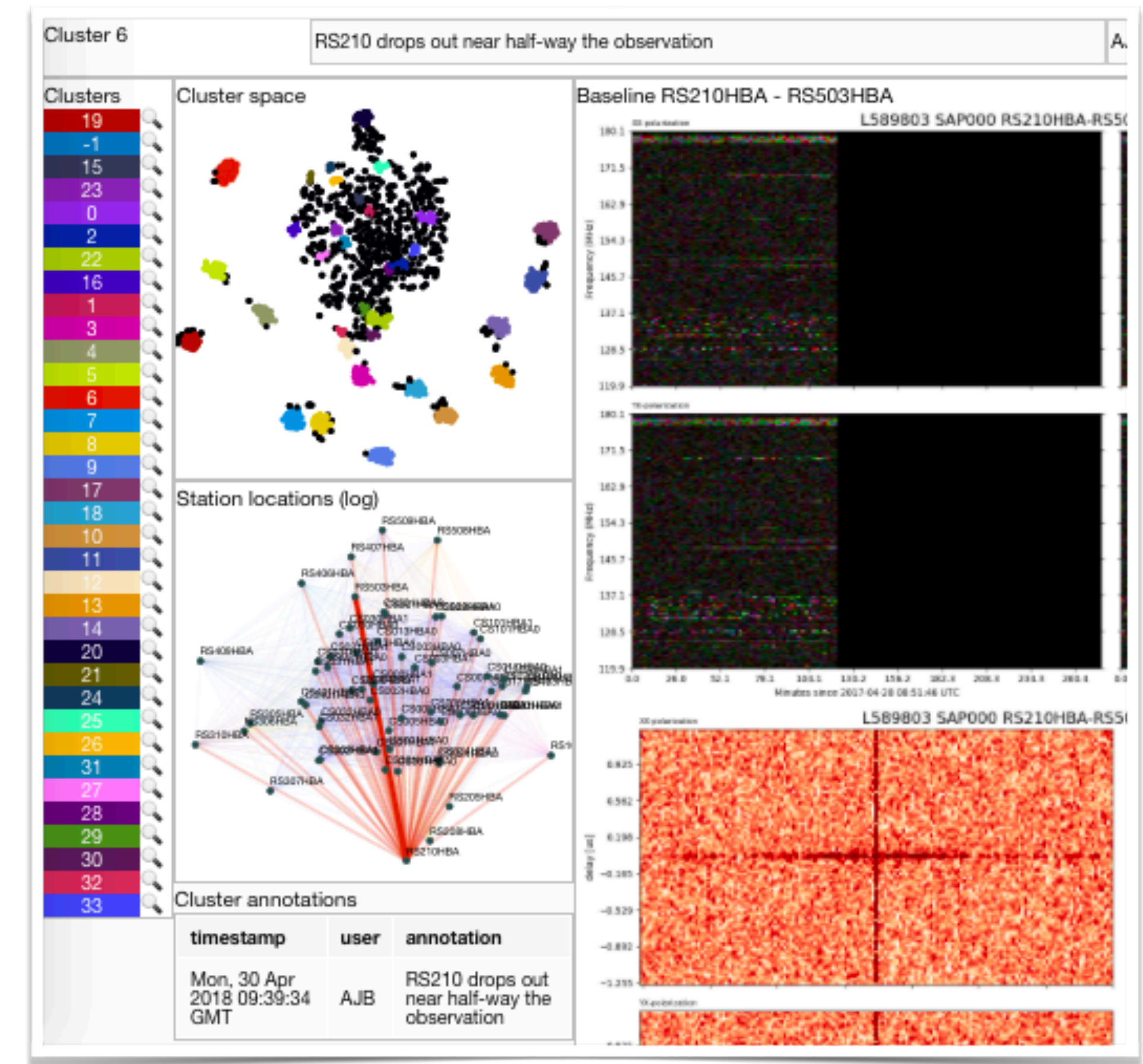
HBA_DUAL_INNER

LBA_INNER

LBA_OUTER

The future of inspection

- The current method of manual inspection is **very time-consuming**, especially if you aren't familiar with how to interpret plots
- We have a collaboration with the eScience Data Centre to apply **machine learning** to the data
- This project aims to **reproduce** what we do: assess all the data (**quickly!**) and look for **outliers**, with classification against historic data to determine what the issue might be
- Rolling out hopefully soon for LOFAR... but always look at your data, **you are the future!**



Summary

- Data quality only makes sense in the context of the **requirements** that data-sets need to meet
- In **SOS**, we assess data-sets based on a series of characteristics defining **generic data quality**
- We have a **policy** which helps us to determine whether a data-set is **successful** or not
- As a **LOFAR user**, it is your **responsibility** to help determine whether the final data is sufficient to meet your science goals
- The **future** of data quality assessment looms!

