ASTRON

Netherlands Institute for Radio Astronomy

The LOFAR Archive: The First 10 Petabytes

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LOFAR Project Scientist
(ASTRON / UvA)

IVOA Interoperability Meeting
May 20, 2014

ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

LOFAR

International LOFAR Telescope

Europe-wide radio interferometry array @ 10-270 MHz
Resolution: 2 arcmin - 0.3 arcsec

Onsala

Chilbolton

Hamburg
to come ...

Potsdam

Poland funded

Jülich

Effelsberg

Tautenburg

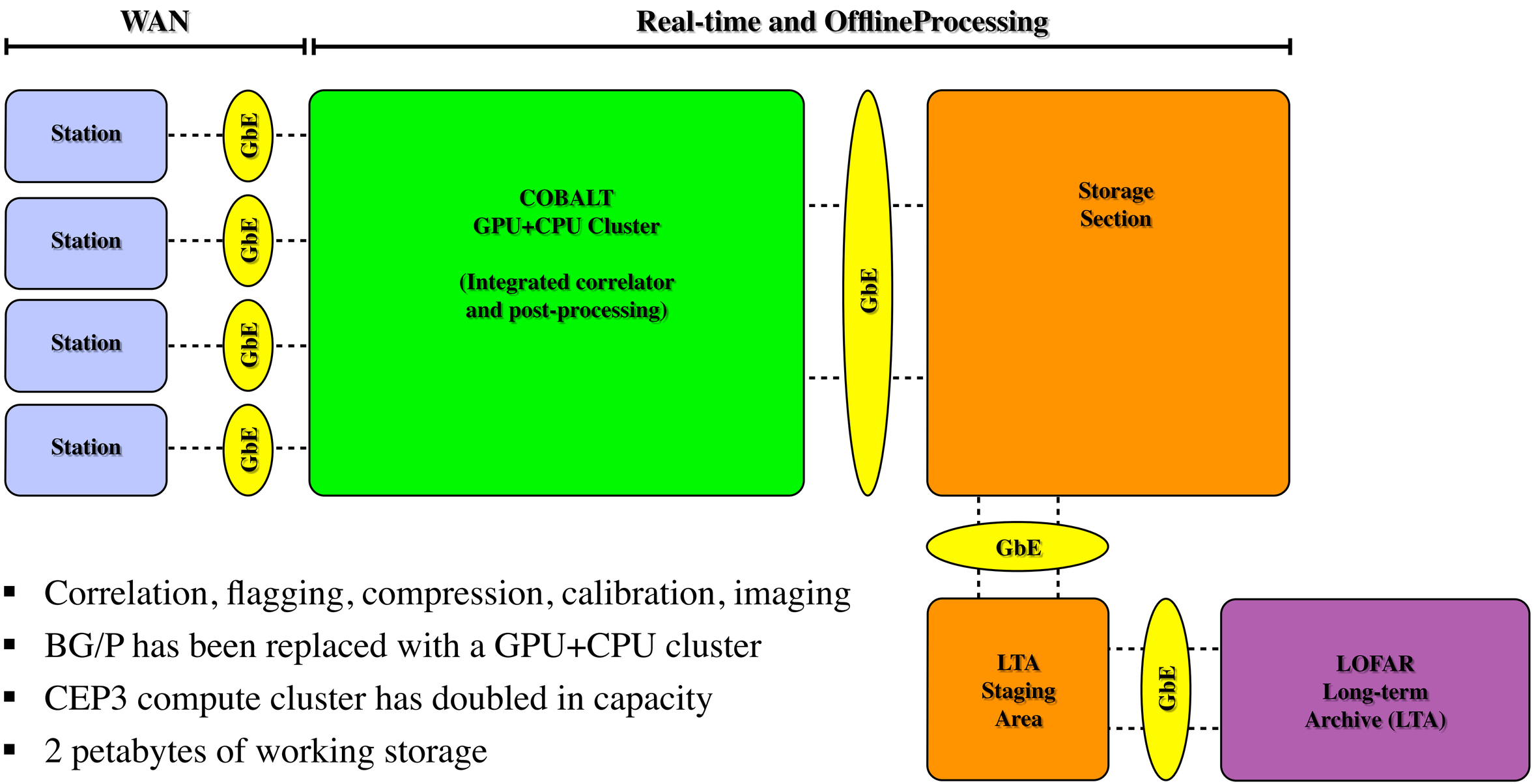
Nançay

Unterweilenbach

- *46 operational stations online*
- *38 NL stations, 8 international stations*
- *4 new stations funded in: Germany (1), Poland (3),*
- *Proposed stations: Ireland (1), Italy (1), Finland (1) , NL (2+)*

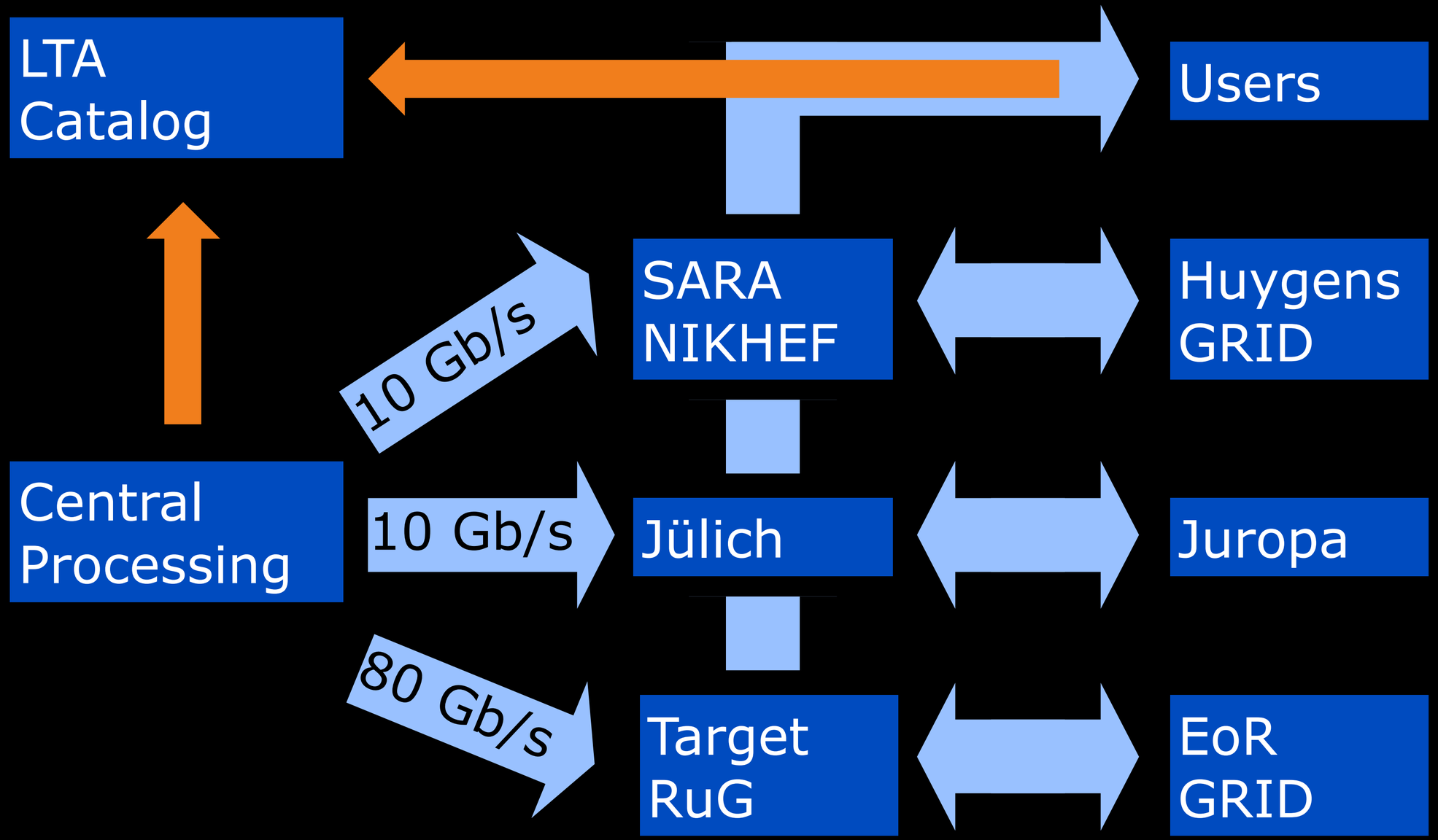
2010-2012: Commissioning phase
Dec. 2012: Cycle 0 observing cycle
Sep. 2013: Correlator upgrade
Dec. 2013: Cycle 1 observing cycle
May 2014: Cycle 2 observing cycle

Central Processing System



- Correlation, flagging, compression, calibration, imaging
- BG/P has been replaced with a GPU+CPU cluster
- CEP3 compute cluster has doubled in capacity
- 2 petabytes of working storage

Data Flow to LOFAR Archive



LOFAR Science Drivers

Key Science Projects

Epoch of Reionization

Transients and Pulsars

High Energy Cosmic Rays

Surveys and the Distant Universe

Cosmic Magnetism

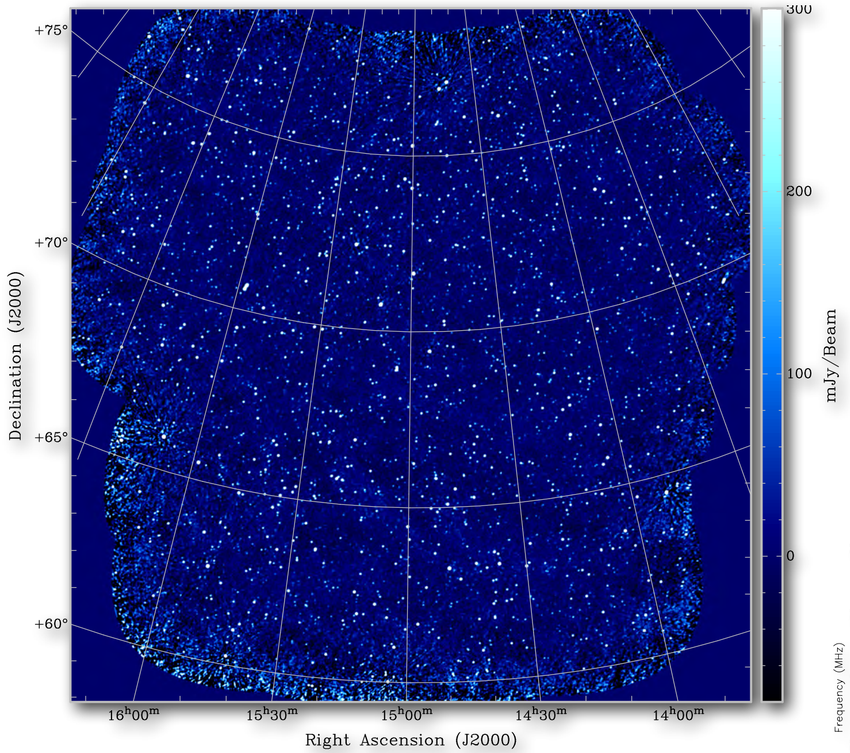
Solar Physics and Space Weather

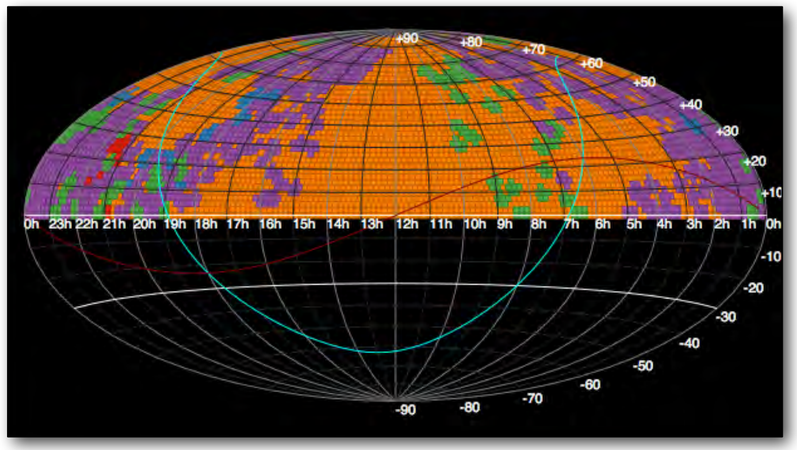
⇒ Range of science goals lead to specialized observing modes

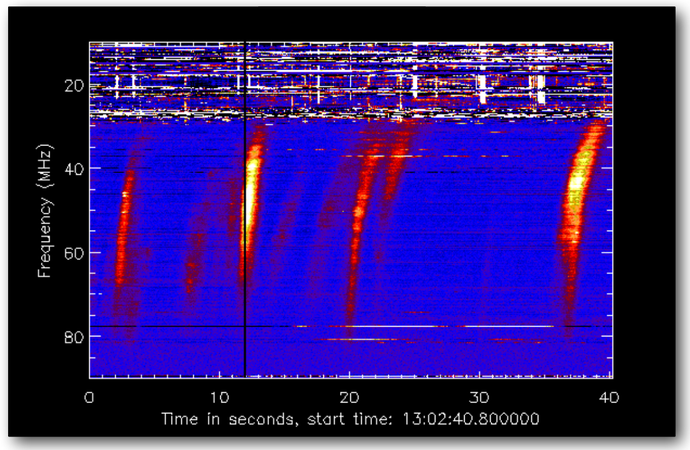
Variety of processing strategies lead to multiplicity of data products

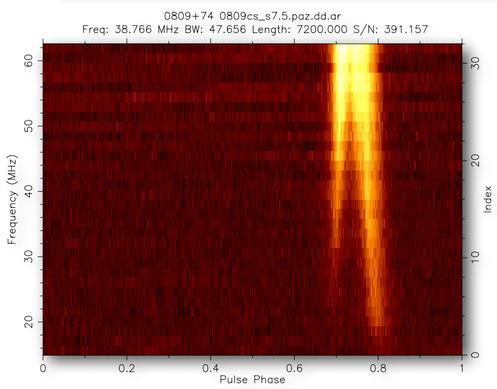
LOFAR Data Complexity

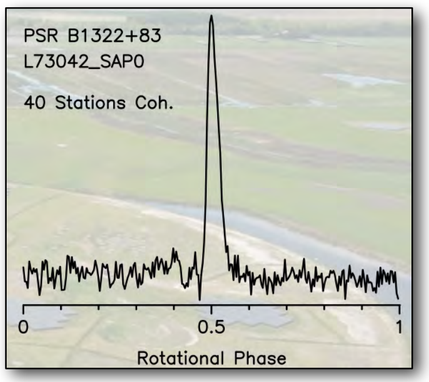
- Velocity *(Raw data rates of ~13 Tbits/s, correlated ~10 TB/hr)*
- Volume (*100 TB visibilities, 1 TB cubes, 1 PB catalogues*)
- Variety *(raw telemetry, uv data, beam-formed data, 2D-3D-4D-5D cubes, RM cubes, light-curves, catalogues, etc.)*

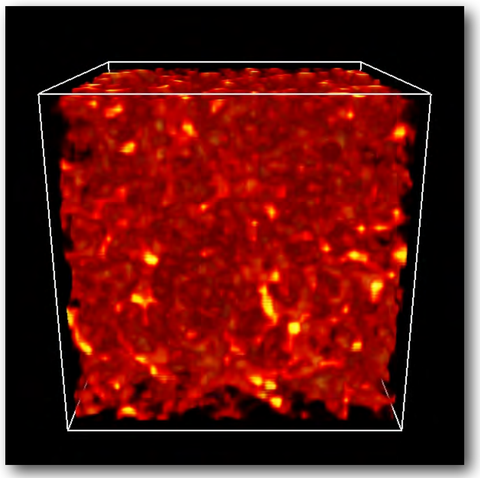




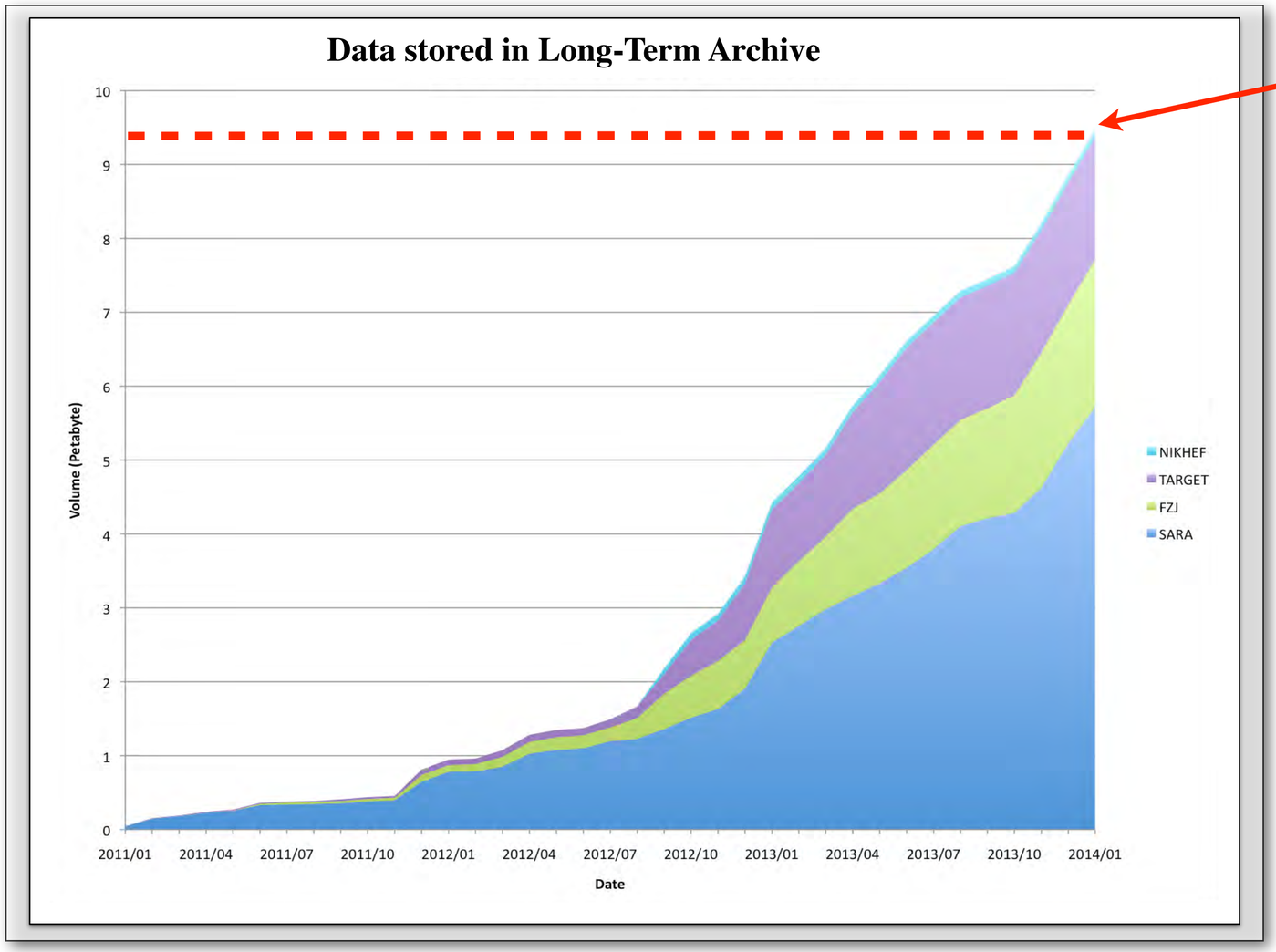








LOFAR Data Accumulation



9.4 PBytes as of Q1 2014

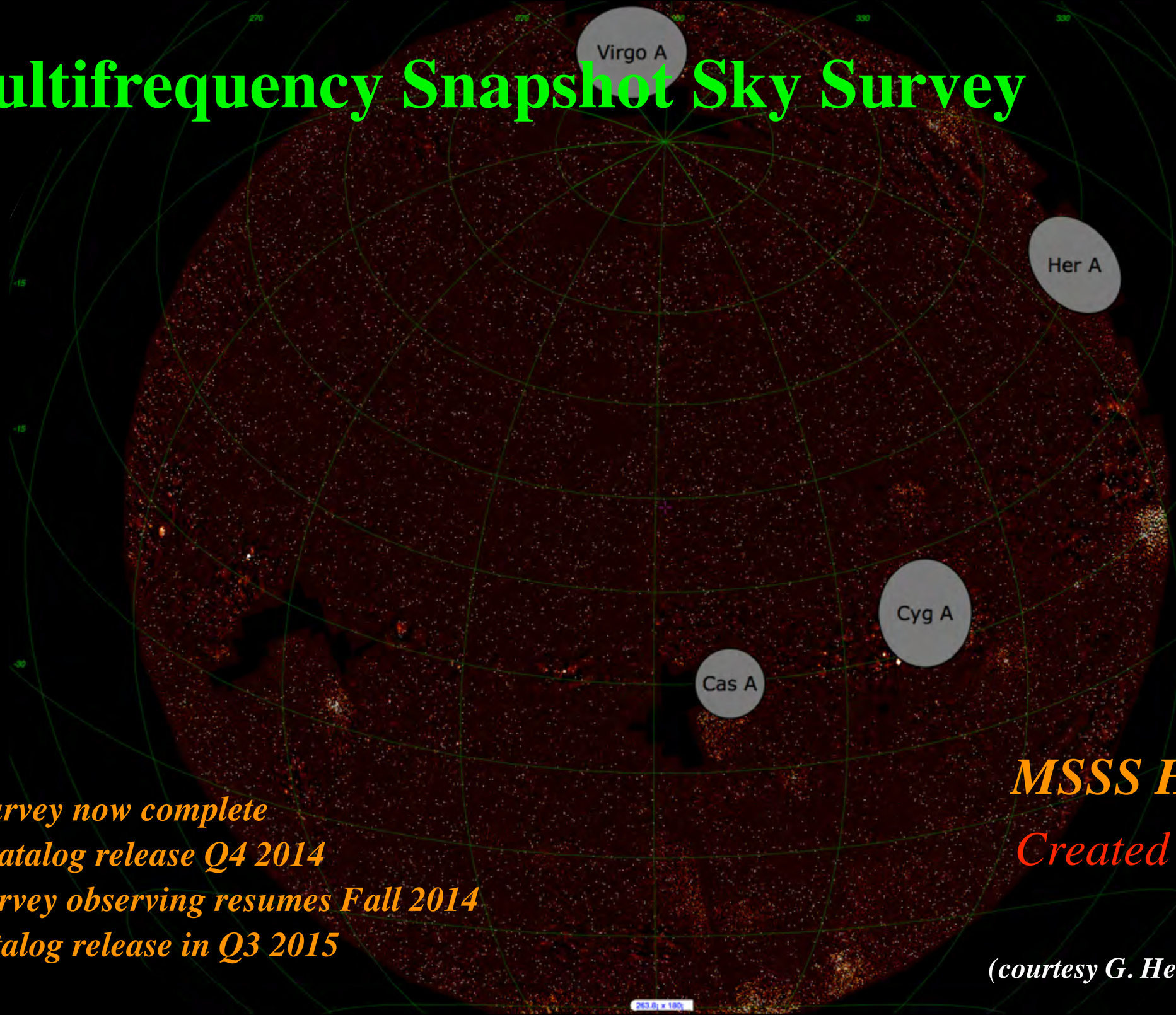
Total today: 11.3 PB

Visibilities, images, and BF data
Does not include raw visibility data
Does not include derived products

- 3 million data products
- 600 million files
- 11.3 Petabytes stored
  (5 sites, 2 countries)
- 500 TB per month archived
- 100 TB per month retrieved
- Eleven 10 Gb/s connections

LOFAR LTA team: G.A.Renting,
H.A.Holties, N.Vermaas, W.J.Vriend

Multifrequency Snapshot Sky Survey



HBA Survey now complete
Initial catalog release Q4 2014
LBA Survey observing resumes Fall 2014
LBA catalog release in Q3 2015

MSSS HBA Mosaic

Created with Aladin!

(courtesy G. Heald and MSSS Team)

MSSS VO Server

MSSS Image Archive

The Multifrequency Snapshot Sky Survey (MSSS) is the first major observing program to be carried out with LOFAR during its ongoing commissioning phase. The primary goal of MSSS is to produce an accurate and detailed low frequency sky model, which will be used as the basis of calibrating images produced in the future by LOFAR.

Position [deg]

ICRS Position, RA,DEC, or Simbad object (e.g., 234.234,-32.45)

Field size [deg] 0.5

Size in decimal degrees (e.g., 0.2 or 1,0.1)

Intersection type
- Image overlaps RoI
- Image covers RoI
- RoI covers image
- The given position is shown on image

Relation of image and specified Region of Interest.

Obs. Freq. (No selection matches all, multiple values legal.)
- ANY
- HBA Average
- 120 MHz
- 125 MHz
- 129 MHz
- 135 MHz
- 143 MHz
- 147 MHz
- 151 MHz
- 157 MHz

Table: Sort by | Limit to 100 items.

Output format: HTML

Go

MSSS Image Archive

Parameters

- Field size: 0.5
- Output format: image/fits
- Position: 225.0 69.0

Result

Matched: 9

Send via SAMP | Quick Plot

Obs. Freq.	Product key	Owner	Embargo ends	Type	File size [byte]	Ctr. RA [deg]	Ctr. Dec [deg]	Title	Instrument	Obs. date	#axes	Axes Lengths [pix]	Scales [deg/pix
147 MHz		N/A	N/A	image/fits	12.4MiB	225.01	69.00	mosaic-band5_sub	LOFAR	N/A	4	[1799, 1799, 1, 1]	[0.005556 0.005556
143 MHz		N/A	N/A	image/fits	12.4MiB	225.01	69.00	mosaic-band4_sub	LOFAR	N/A	4	[1799, 1799, 1, 1]	[0.005556 0.005556

4,276 pointings
38,484 images
~200,000 sources
185 catalog entries per source

(courtesy M. Sipior & G. Heald)

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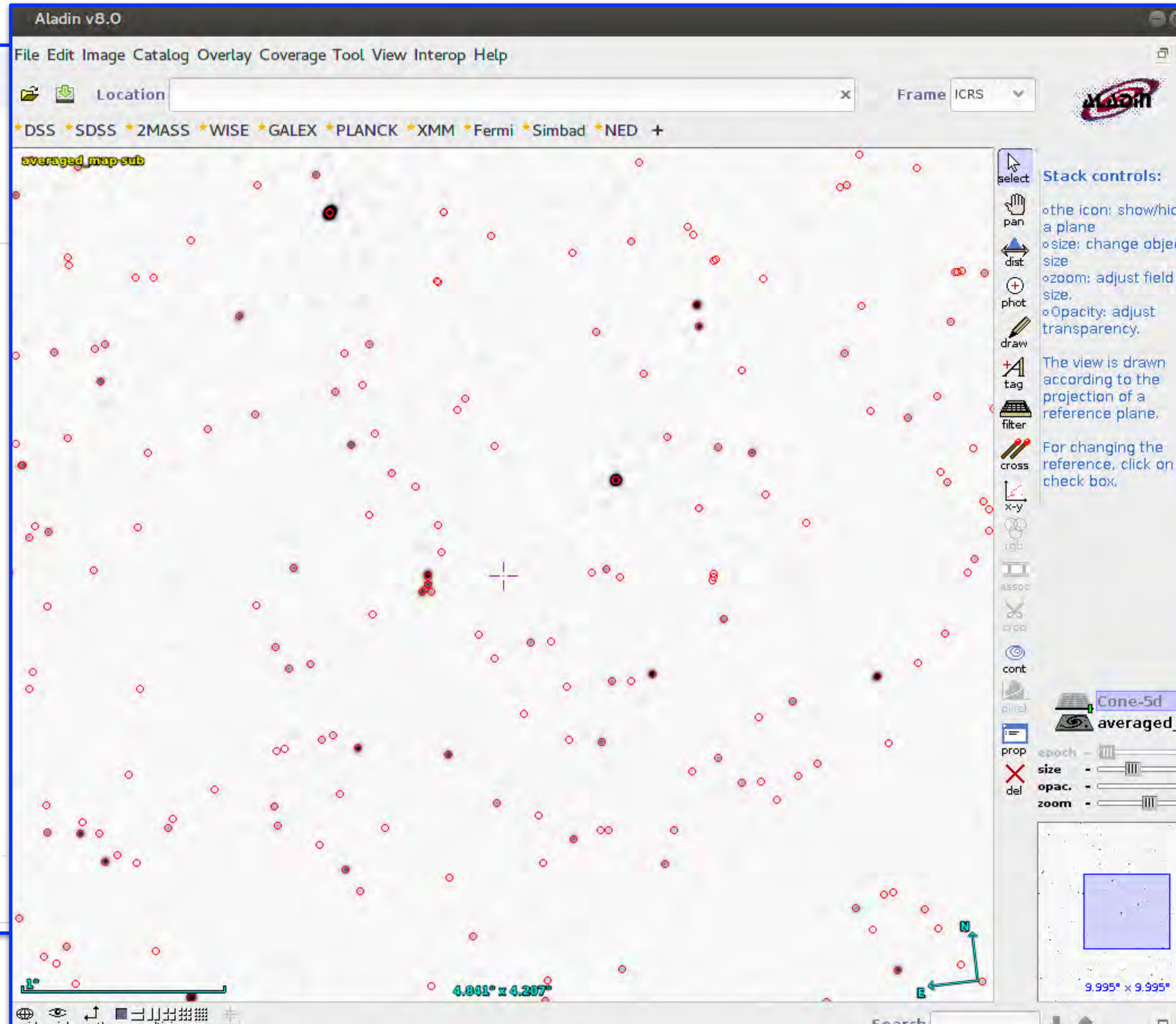

LOFAR

The End