The Expanding International LOFAR Telescope

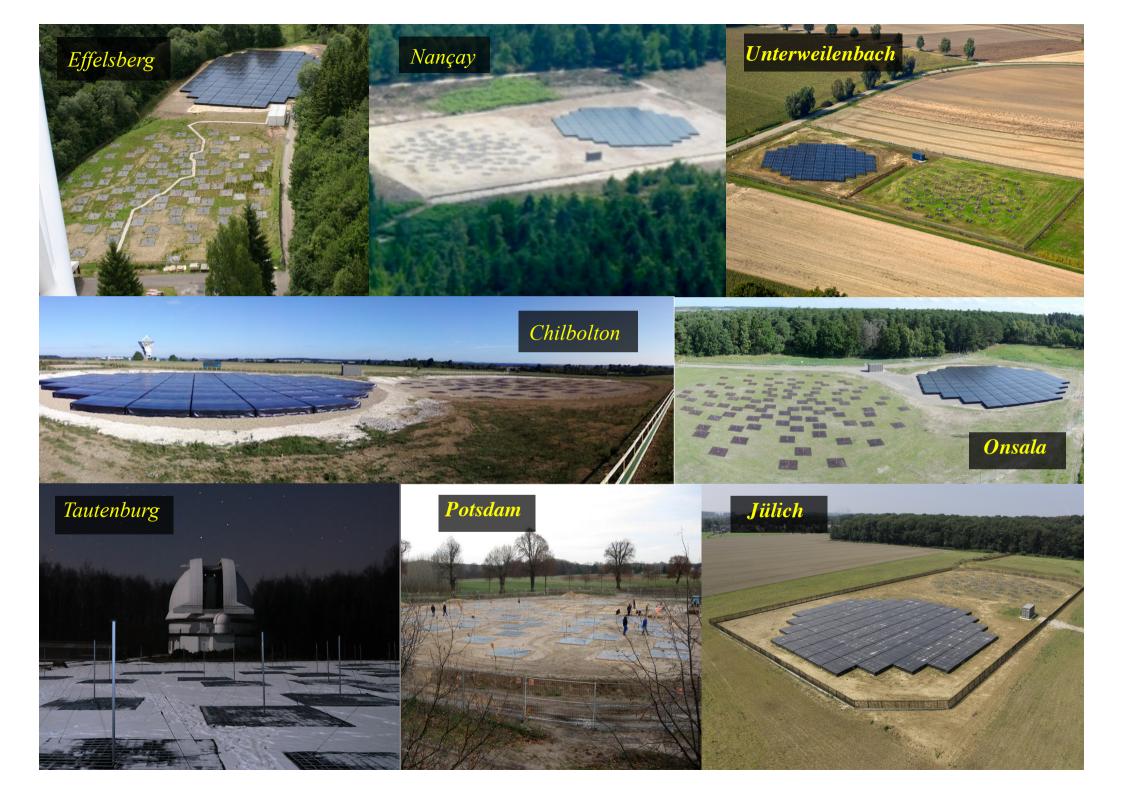
René Vermeulen Director International LOFAR Telescope (ILT) Director Radio Observatory at ASTRON

Science at Low Frequencies II

02-04 December 2015 Albuquerque USA







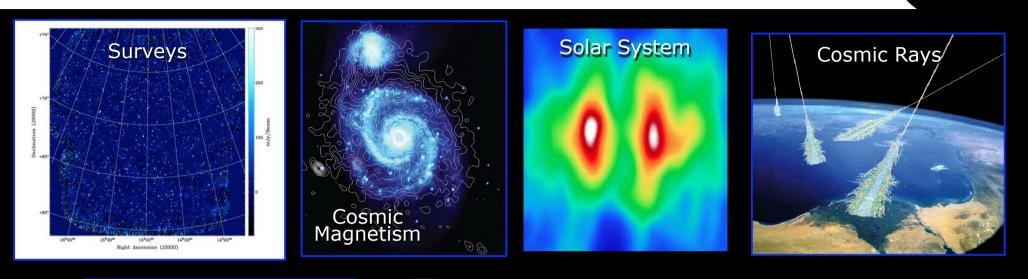


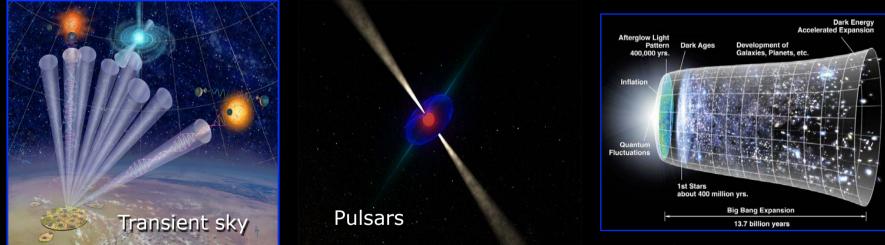


Operating since 1-1-2015

IDFAR LOFAR Key Science Projects

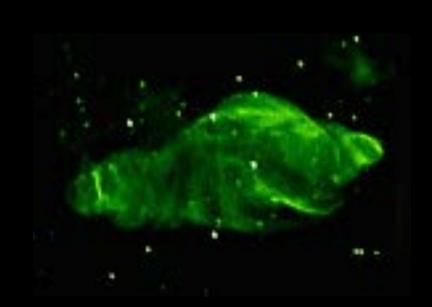
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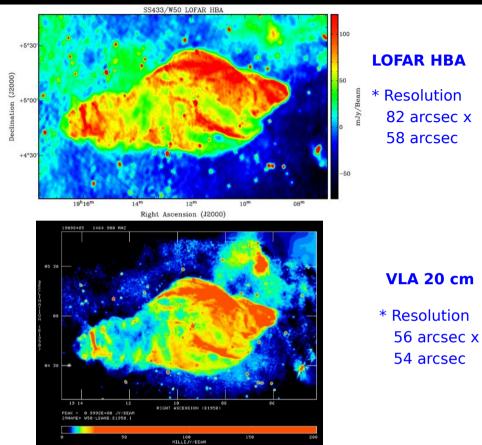
Epoch of Reionization

SS433 and W50



Broderick et al. 2015

High Fidelity LOFAR Imaging





Artist's rendition Lightning & Cosmic Rays: Astroparticlegeophysics

Solar Eclipse of 20 March 2015 The Netherlands is fully cloudy LOFAR to the rescue!

Brentjens et al. 2015

LOFAR was opened on 12 June 2010 by H.M. queen Beatrix



Attendance of the Chairmen of the (inter)national LOFAR consortia



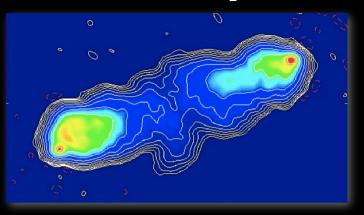
International LOFAR Telescope

ILT is foundation under NL law

Annual central operations budget ~ 4.4 M€

Constitution prescribes:

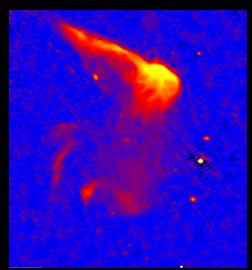
- Participants are National Consortia (+ASTRON)
- Highest authority: Board (supervisory) + Director (executive)
- Board sets overall policies (incl. time shares, budgets, contributions)
- Separate ownership of resources (≥ 10% station time retained for owner)
- Participants contribute annually to central ILT operations



ILT Observatory Model

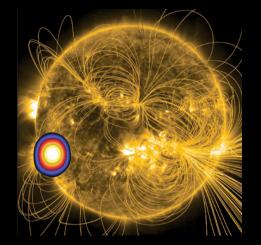
Individual user groups

- Focus on their own research topics
- Collaborate in styles to fit science and taste
- Propose for observing & processing time
- Inter)national Consortia and institutions organise
 - Operations: stations, networks, processors, archives
 - Science policies
 - Review & allocation of user proposals for time
- ASTRON coordinates
 - Central Observatory & Staff

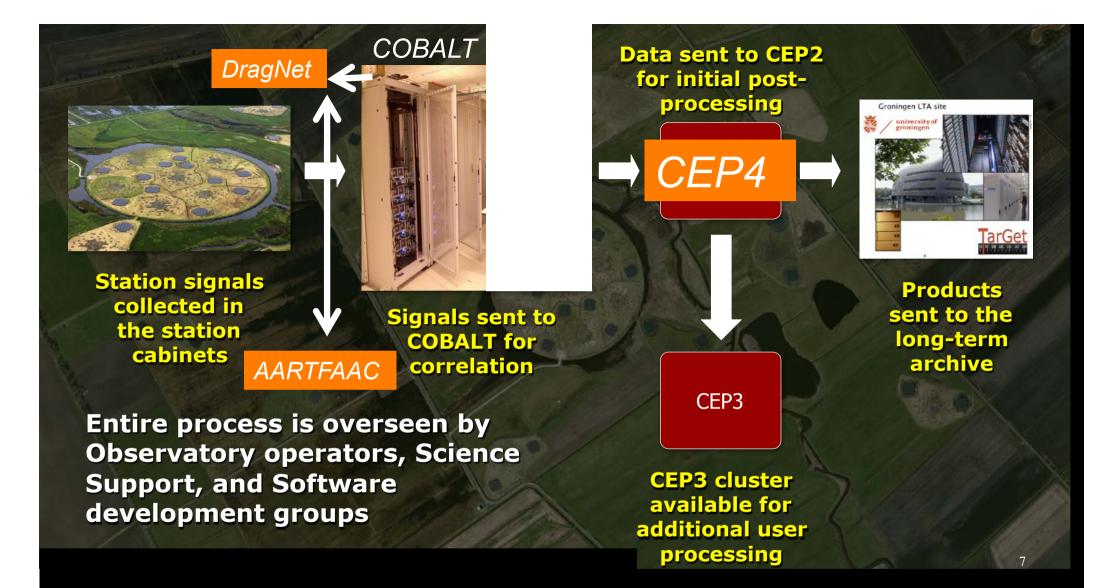


ILT Observatory

- sciencesupport@astron.nl
- Cycle 5 now; Open skies fraction 45%
- Next proposal deadline 9 March 2016



• Next LOFAR data processing school September 2016

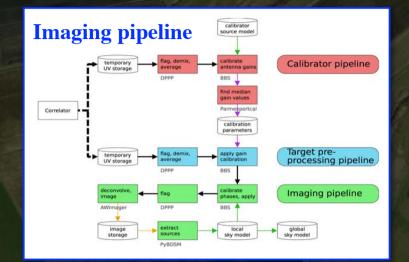


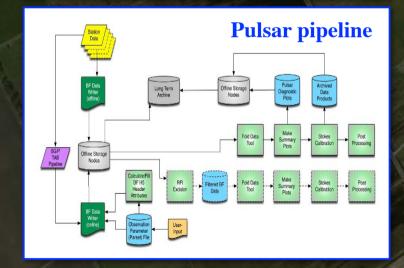
CEP4

50 compute nodes, 256 GB memory
4 GPU nodes, 320 GB memory Tesla K40C GPU (each 2880 cores; 4.3 Tflops single, 1.4 Tflops double precision) 2x6 TB internal storage
Lustre file system 18x storage server + 18x storage array,

60x4 TB each, total usable capacity 3 PB

MLOFAR LOFAR Data Processing





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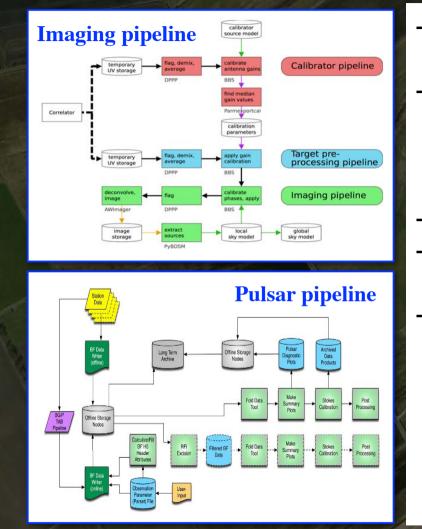
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- Supports multiple data pipelines for different science products
- Scheduler oversees the entire end-to-end processing
- Maintains overview of the storage and computational resources
- Dynamic scheduling system currently under development

New flexible pipeline framework coming!

MLOFAR LOFAR Data Processing

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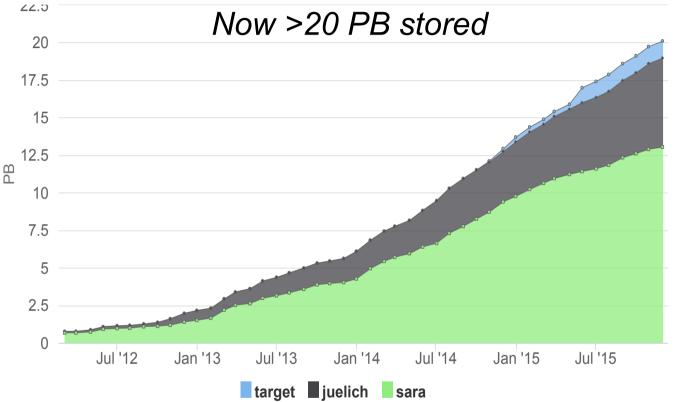


- Supports multiple data pipelines
 for different science data products
- Scheduler oversees end-to-end observing and processing resources, including stations, compute, storage
- New flexible pipeline framework coming
- Dynamic scheduling under development
- Expertise & experience will leverage formation of Science Data Centre (LOFAR, Apertif, SKA)

LOFAR LTA Data Accumulation

Poznan Supercomputing and Networking Centre (PSNC) involved as of 1-1-2016 adding to Target (Groningen, NL), Sara (Amsterdam, NL), FZ Jülich (DE)

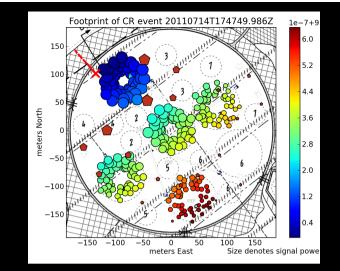
- Data Storage
 - -20.1 Petabytes
 - -6 PB/yr growth
 - -3 sites, 2 countries
 - 300 TB/month ingest
 - -100 TB/month staged
- Contents
 - -Over 5x10⁶ products
 - -10⁹ individual files
 - Visibilities, images, and BF data
 - -Does not include raw visibilities



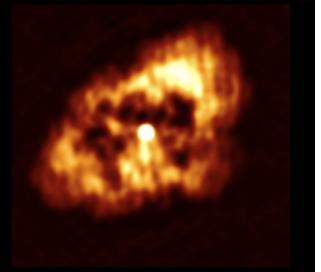
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LOFAR LTA team: H.A.Holties, G.A.Renting, Y. Grange, J. Schaap, N.Vermaas, W.J.Vriend

- Expand technical and scientific capabilities of LOFAR
 - Evolutionary process
 - Play to current strengths & future uniqueness
 - Leverage existing investments and infrastructure



Stress scientific impact, versatility
 Inroads into "the Cosmic Dawn"
 Tracing galaxies through cosmic time
 Cosmic Magnetism in the nearby Universe
 Characterizing the "Epoch of Reionization"
 Transients
 Serendipity



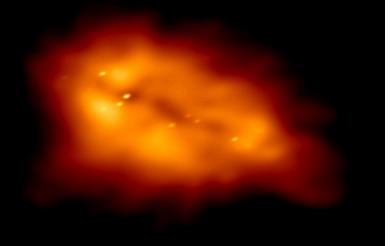
- Several possible options being pursued for next 3-10 years
 - Step-wise or combined development approach possible
 - Variety of funding sources may be sought

LOFAR I.n. 2.0 Double or triple station electronics

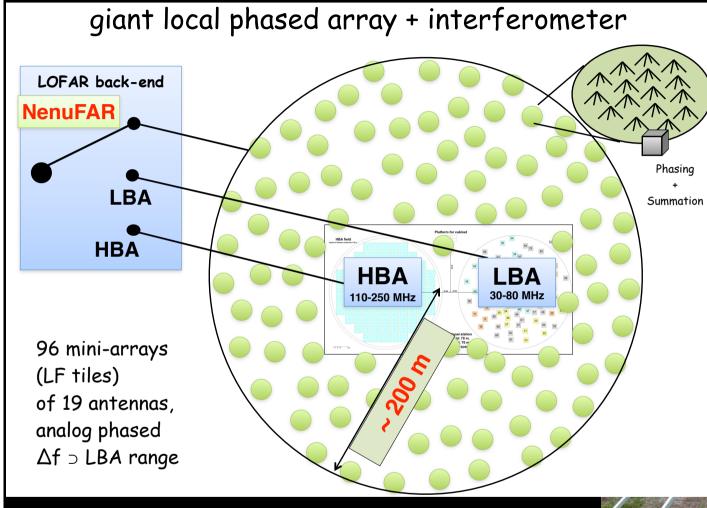
(e.g. with Uniboard²)

- Use all 96 LBAs; for calibration
- Joint LBA + HBA observing; ionospheric calibration
- Simultaneous LBA + HBA observing on different fields

- Replace LBA dipoles with different design (e.g. Nenufar)
 - More broadband response 10-90 MHz
 - Optimized at 30-50 MHz



Nenufar New Extension in Nançay Upgrading IoFAR



96 mini-arraysof 19 antennas;22 already built

Improved 30 MHz performance



LOFAR 2.0

Strategically placed new stations

- 10-300 km baselines, fill uv holes for deep high dynamic range imaging
- 300-3000 km baselines for <1 arcsec imaging
- Fill superterp as well (EoR, extended emission, complex fields)

