

LOFAR.IT

THE COMPUTING INFRASTRUCTURE

Ugo Becciani, G. Taffoni

INAF – OACT/OATS



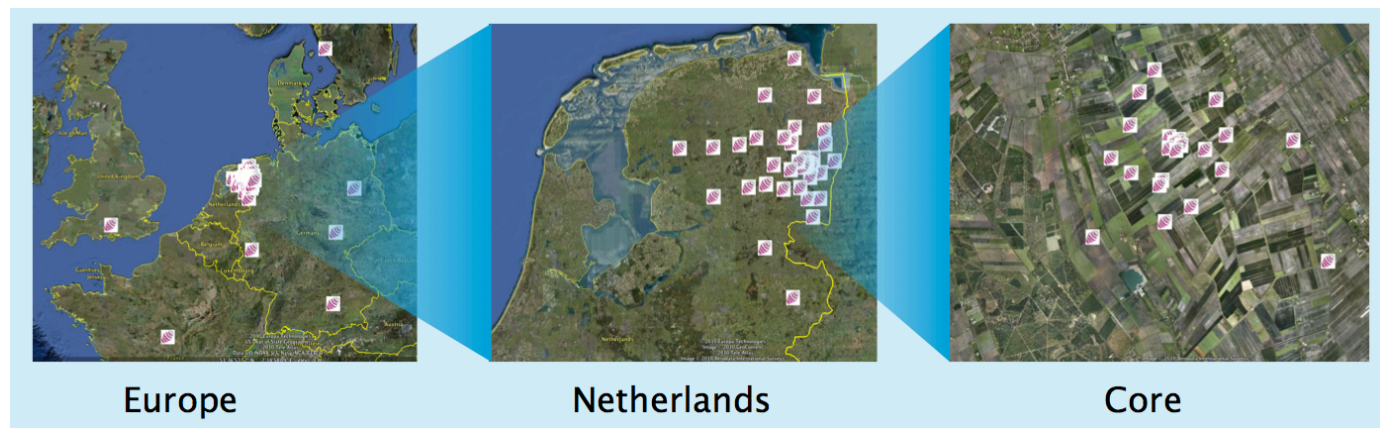
LOFAR



SA-EU Federated Cloud Pilot Project Meeting
Catania, 10-11 September

LOFAR - Radio Telescope

- **53 Stations (24 core (Exloo), 16 remote, 13 International)**
- A LOFAR core station consists of **96 Low Band Antennas (LBAs)**, operating from **10 to 90MHz** and **48 High Band Antenna (HBA)** tiles that cover the frequency range from **110 to 250 MHz**
- Remote stations in the Netherlands have the same number of HBA tiles, and LBAs
- International stations provide a single cluster of 96 HBA tiles and 96 LBAs (6 station in Germany, 3 in Poland, 1 in France, Ireland and UK, IT)



LOFAR is the only instrument today to **produce imaging with a resolution of a few arcsec** (.... potentially $<$ arcsec)

New scientific insight in low frequency radio Astronomy.

Potentially a **large community** is interested in LOFAR data.

Key Projects are the scientific groups that drive the evolution and technical knowhow in LOFAR data acquisition and analysis

SKA precursors/pathfinders drive frontier research

Offer to Italian researcher the possibility to improve knowledge on LOFAR data acquisition and analysis, to build a community of researchers.... ready for SKA.

LOFAR is the biggest SKA pathfinder (SKA-Low)

- Build a **LOFAR 2.0 station** in Medicina (2021-2022)
- Build a **LOFAR data analysis infrastructure**
- Implement a **technical and scientific collaboration with ASTRON**
- Develop a **community that is able to work with LOFAR data** (for science and technology)
- Participation of Italian community to **Key Projects** (surveys in particular)

Participation to the KPs, LOFAR guarantee time

Consortium for the participation to International LOFAR Telescope

Board: Gianfranco Brunetti (Coordinator INAF-IRA) Ugo Becciani (INAF-OA Catania) Segretario, Federica Govoni (INAF-OA Cagliari, UTG II), Francesco Massaro (UniTo), Jader Monari (INAF-IRA), Roberto Scaramella (INAF-OA Roma)

- **Science Advisory Committee:** Andrea Ferrara (Chair), Matteo Murgia, Mauro Messerotti, Grazia Umam, Gianni Bernardi, Ettore Carretti, Isabella Prandoni, Laura Pentericci, Marta Burgay, Rossella Cassano, Andrea Chiavassa (UniTO)
- **Technological joint WG ASTRON-INAF:** Established on March 2018 . Led by Astron. Primary objective: joint development of RCU for LOFAR 2.0 and eventually LBA2.0.
- **Data WG:** Giuliano Taffoni (INAF-OA Trieste) - Chair, Alessandro Costa (INAF-OA Catania), Francesco Bedosti (INAF-IRA), Cristina Knapic (INAF-OA Trieste), Manuela Magliocchetti (INAF-IAPS Roma), Annalisa Bonafede (UniBo, Associata INAF IRA)

KP involvement (rapidly evolving with time):

Survey KP → 17 full members + 1 Executive Body member (3rd contributing country)

Magnetism KP → 4 members + 1 core member

Transient KP → 3 members

Solar KP → 2 members

Proposals submission: about 90 h requested/cycle
(last 3 cycles)

Science:

2018: 17 papers (2 IT PI)

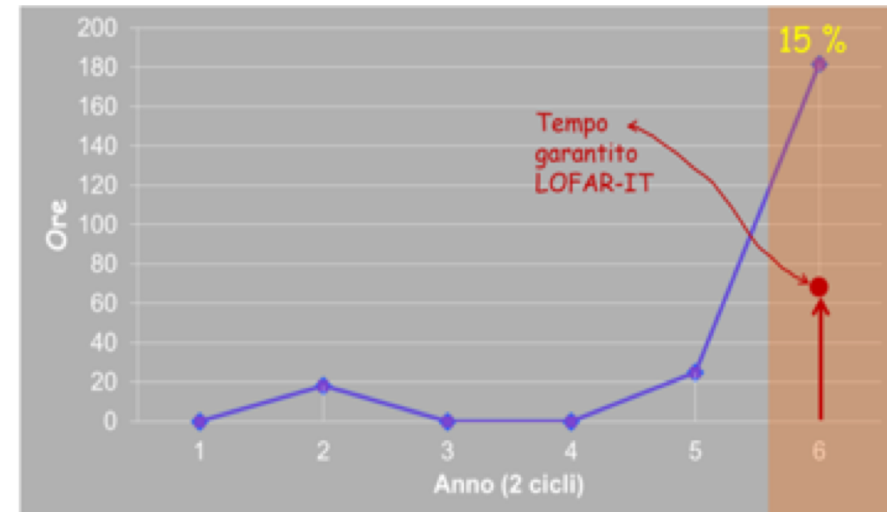
2019: more than 25 (4-6 IT PI)

Technology :

Build a distributed data reduction and analysis infrastructure and user support.

Involvement in LOFAR 2.0 RCU

pipeline and software for calibration and imaging optimization/development

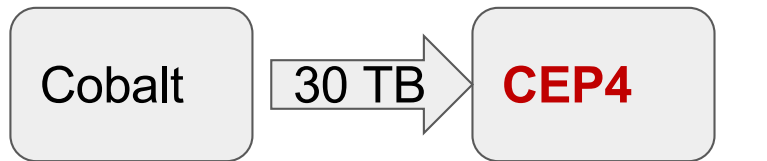


LOFAR COMPUTING MODEL.

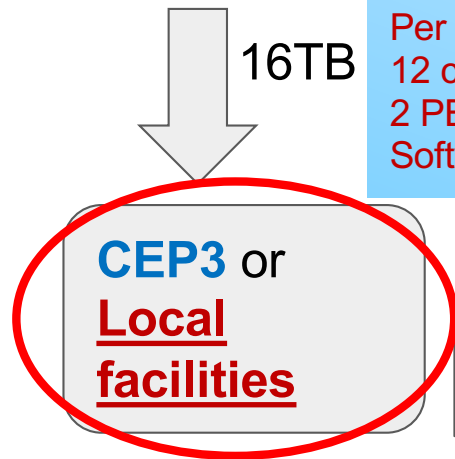
Central Processor System: Post-Processing

Two central processing (CEP) clusters in Groningen (i.e. near the correlator). Pipelines use locally-developed generic framework.

Distributed system built using a co-design approach (we know the algorithms and we design the HW)



CEP3: time allocation to PIs based on proposal to do post-processing: 20 nodes
 Per node: 20 cores (2 x Xeon e5 2660v2) 128 GB memory
 2 x 10Gbps Ethernet interface
 22 TB space
 Standard LOFAR software



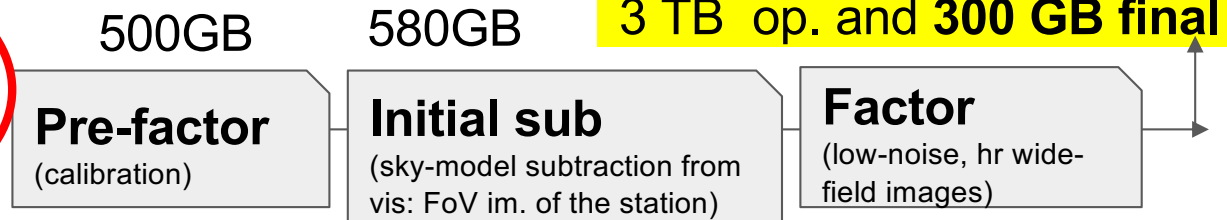
CEP4

Running observatory pipelines: reduction pipelines are used to further process the data into the relevant scientific data products depending on the specific type of observation

Strictly limited to the Radio Observatory -> ingest into LTA
 50 compute nodes (+ 4 with GPU; not used in production).

Per node:

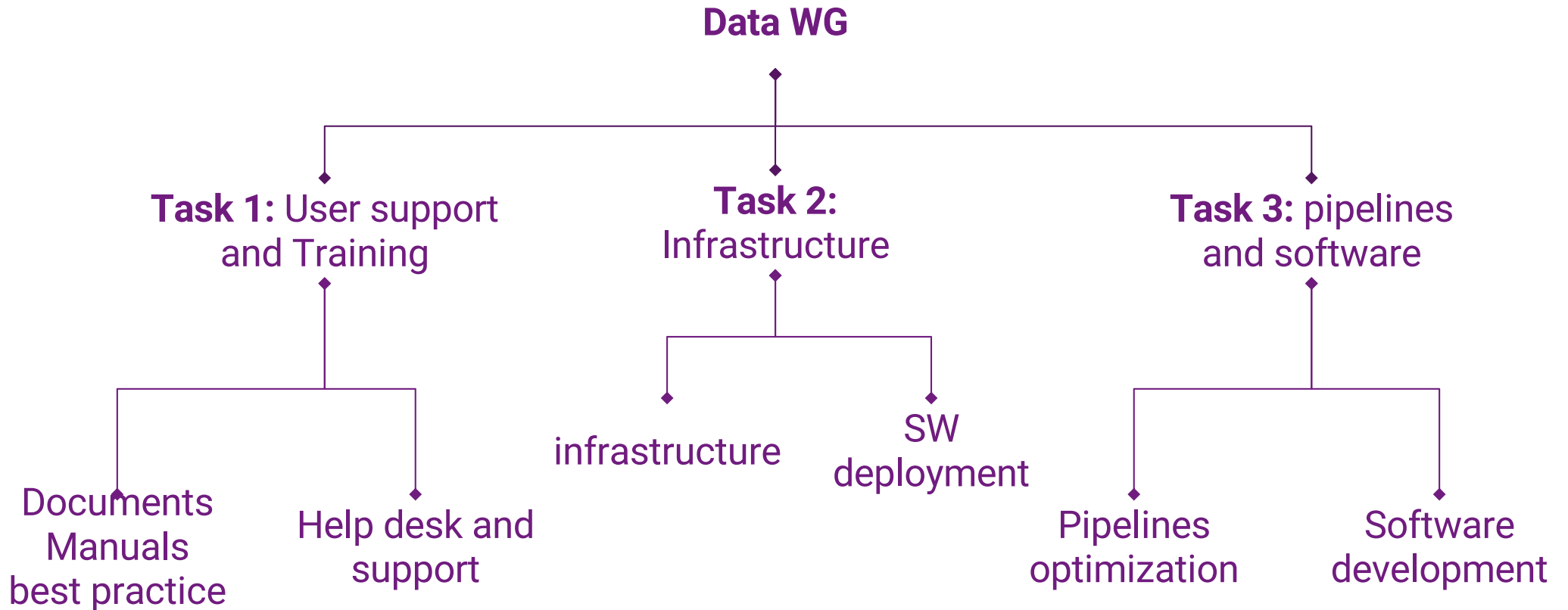
12 cores (Intel Xeon E5-2680v3 2.5 GHz), 256 GB memory
 2 PB LustreFS storage
 Software stack deployed using Docker.



- **provide the design** of the hardware and software infrastructure for calibration and **data reduction in Italian LOFAR nodes** and coordination of the infrastructure itself;
- coordinate the **installation, configuration and management** of specific software and pipelines for the reduction of LOFAR data;
- provide **technical support** to users belonging to LOFAR IT through testing, verification, **optimization and development of pipelines** for LOFAR data reduction;
- collaborate with LOFAR developers for further code testing and optimization/parallelization of codes and data reduction pipelines (e.g DDFacet pipeline);



LOFAR.IT: Data Working Group New organization

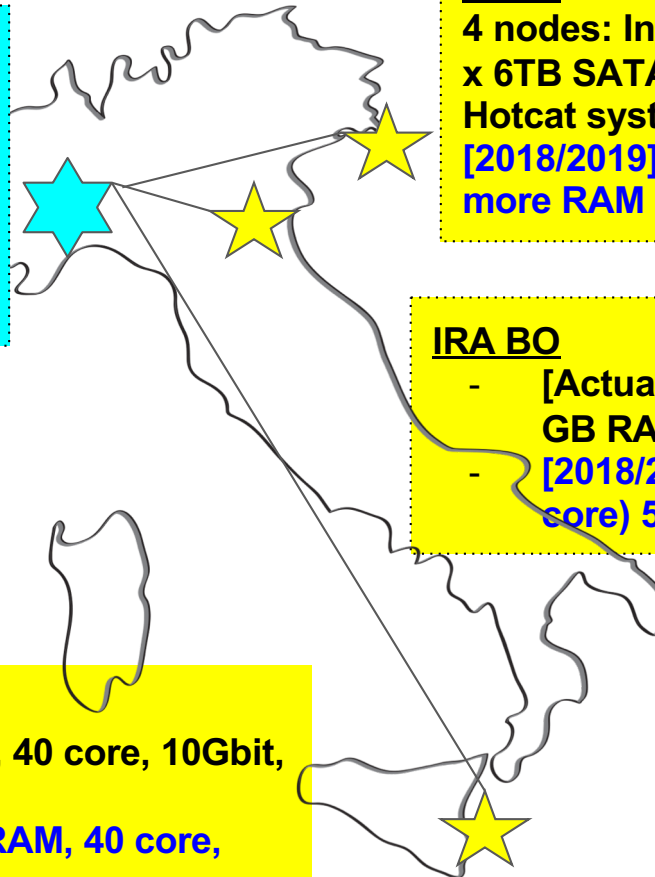




LOFAR.IT e-Infrastructure

UNITO

3 FAT node on OCCAM
4 x Intel Xeon (12 core)
RAM 768 GB DDR4, 1 SSD
800GB, 1 HDD 2TB, 2x10Gb



OATs

4 nodes: Intel Xeon, 256 GB RAM DDR3 6
x 6TB SATA, Infiniband ConnectX®-3 -
Hotcat system. 40 TB parallel FS
[2018/2019] more nodes more storage
more RAM

IRA BO

- [Actual] 2 nodes: Intel Xeon 384
GB RAM, 60 TB
- [2018/2019] 1 nodes: 2 socket (40
core) 512 GB RAM, 10gb ethernet

OACT

- [Actual] 2 nodes: 256GB RAM, 40 core, 10Gbit,
20 TB Storage
- [2018/2019] 1 nodes: 512 GB RAM, 40 core,
10gb ethernet 60 TB storage.

Alessandro Costa

Gianmarco Maggio

Sara Bertocco

Luca Tornatore

Eva Sciacca

Fabio Vitello

Simone Riggi

Francesco Cavallaro

Cristina Knapic

Francesco Bedosti

Annalisa Bonafede

Manuela Magliocchetti

Andrea Botteon

Marzia Rivi

Marisa Brienza

Etienne Bonnassieux