LENSS

LOFAR Enhanced Network for Sharp Surveys

ASTRON

Netherlands Institute for Radio Astronomy

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netherlands eScience center

University of Twente.

SURF

JUPYTER JSC

rijksuniversiteit groningen

PSNC


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TO MAKE DISCOVERIES IN RADIO ASTRONOMY HAPPEN
... FOR THE BROADEST POSSIBLE COMMUNITY BY LOWERING THE BARRIERS OF ACCESS TO RADIO ASTRONOMY DATA
... AND RETURNS GREATEST VALUE TO ALL CIRCLES OF OUR COMMUNITY AND ENVIRONMENT THROUGH SOCIETAL, SUSTAINABLE SCIENCE.
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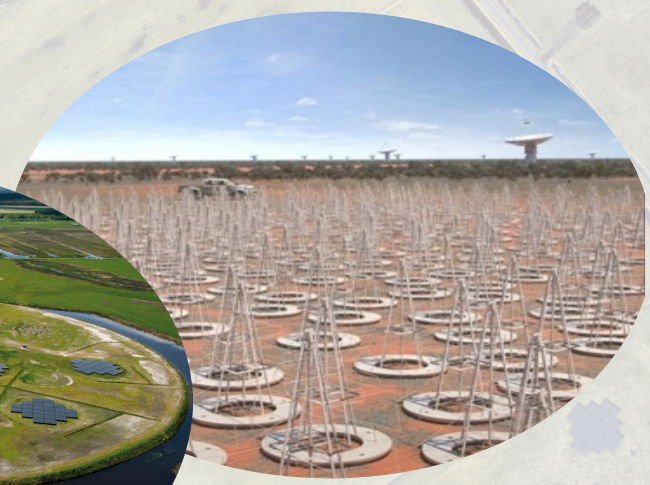
The ASTRON edge

OPPORTUNITY FROM
OVERLAPPING DEVELOPMENT

1956

1970

2010



2030

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2030s' Radio renaissance: Big data, big partnerships

LOFAR and JIVE remain key Dutch investments for the 2030s

SKA (mid-) and (low) will bring the deep and high resolution radio universe into focus

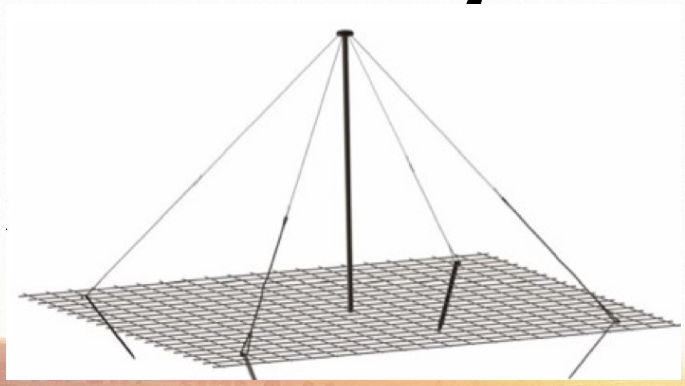
LOFAR and LENSS must lead the solutions to solving the data deluge

Future impacts for the community enhanced by expertise in big data, science ready products, technology developments

LOFAR2.0

A new Observatory

Dual-band



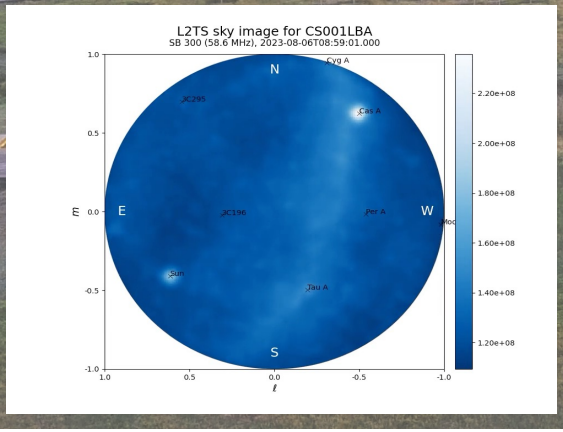
Low: 10 - 90 MHz

Enhanced Timing and in- band performance

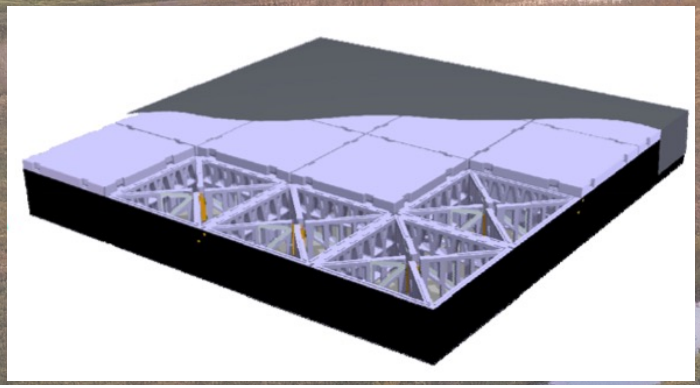
Upgraded hardware, new correlator

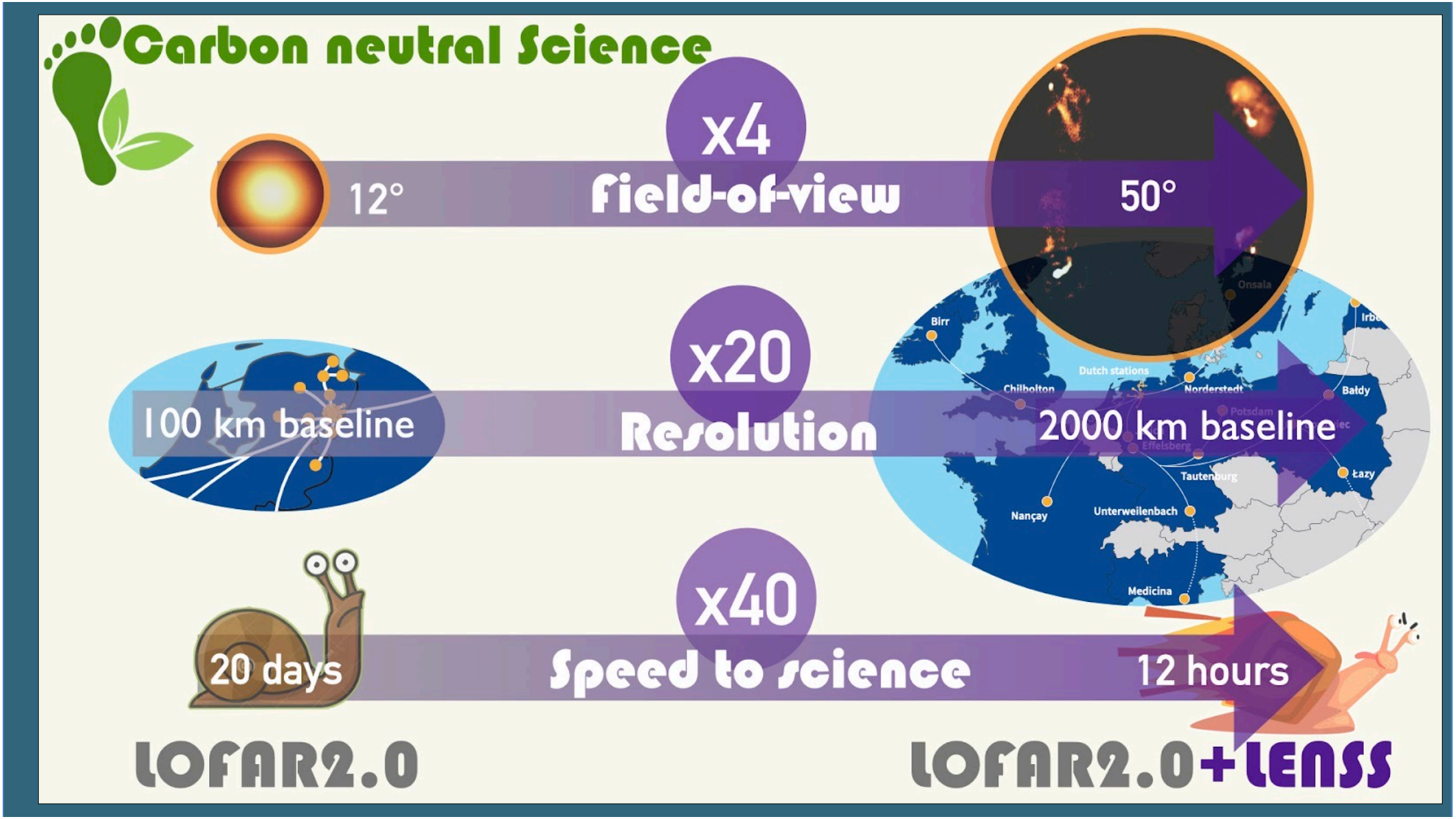
Entire operations systems overhaul

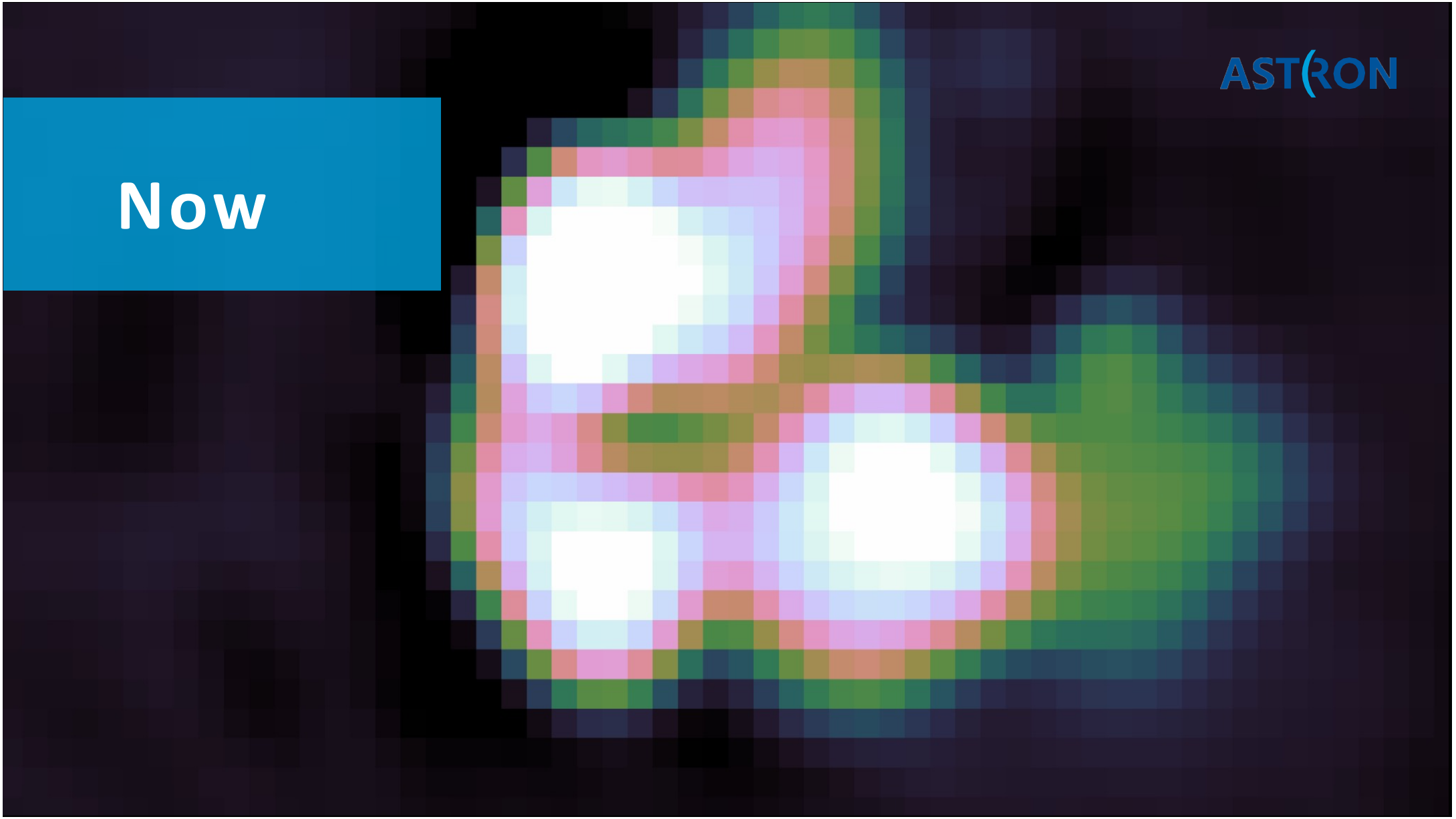
Observatory Science data products

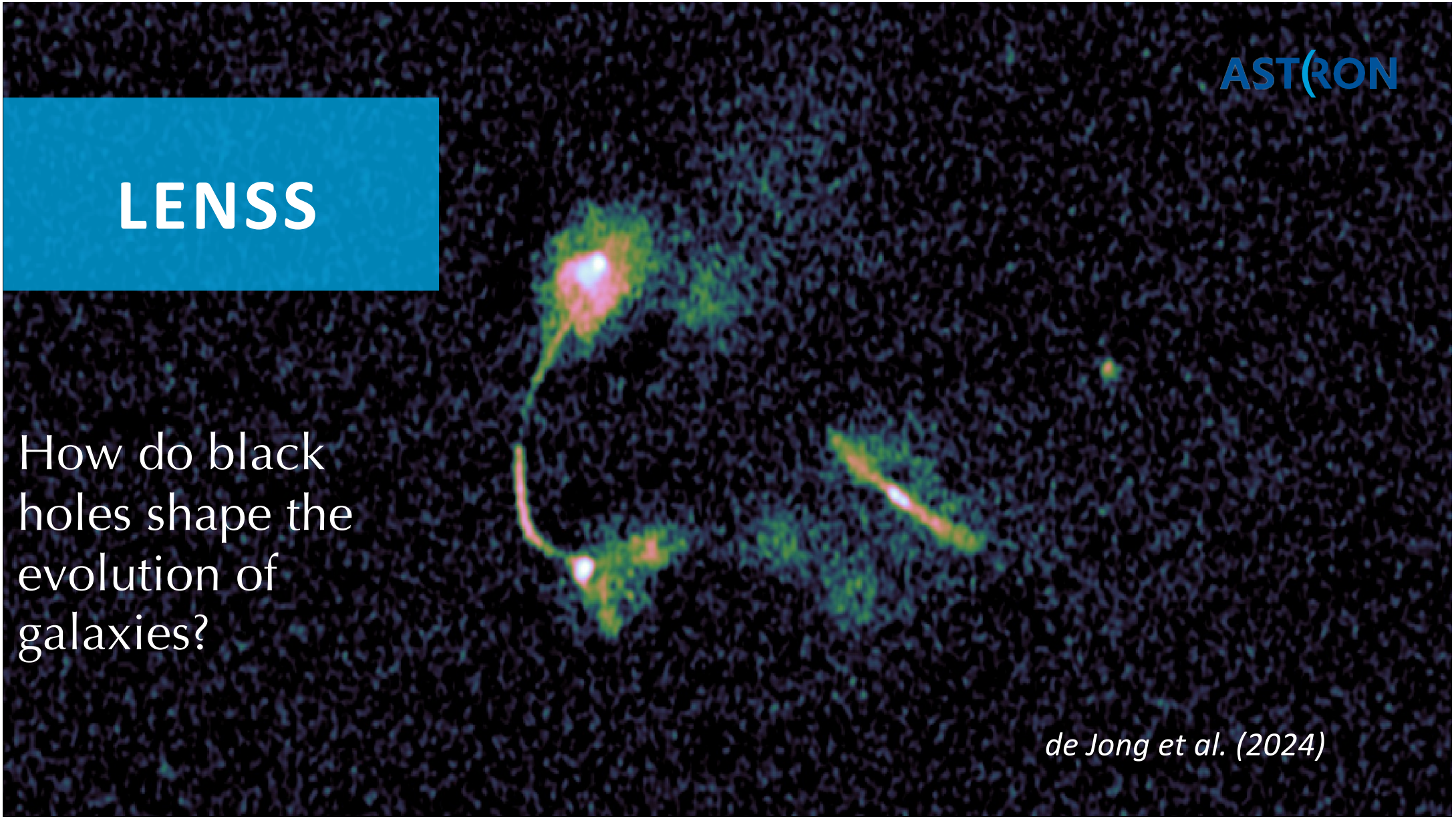


High: 110 - 250 MHz




Carbon neutral Science
x4
12°
Field-of-view
50°
x20
100 km baseline
Resolution
2000 km baseline
Onsala
Birr
Dutch stations
Chilbolton
Norderstedt
Baldy
Potsdam
Effelsberg
Tautenburg
Łazy
Nançay
Unterweilenbach
Medicina
x40
20 days
Speed to science
12 hours
LOFAR2.0
LOFAR2.0+LENSS


Now
ASTRON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How do black holes shape the evolution of galaxies?
de Jong et al. (2024)

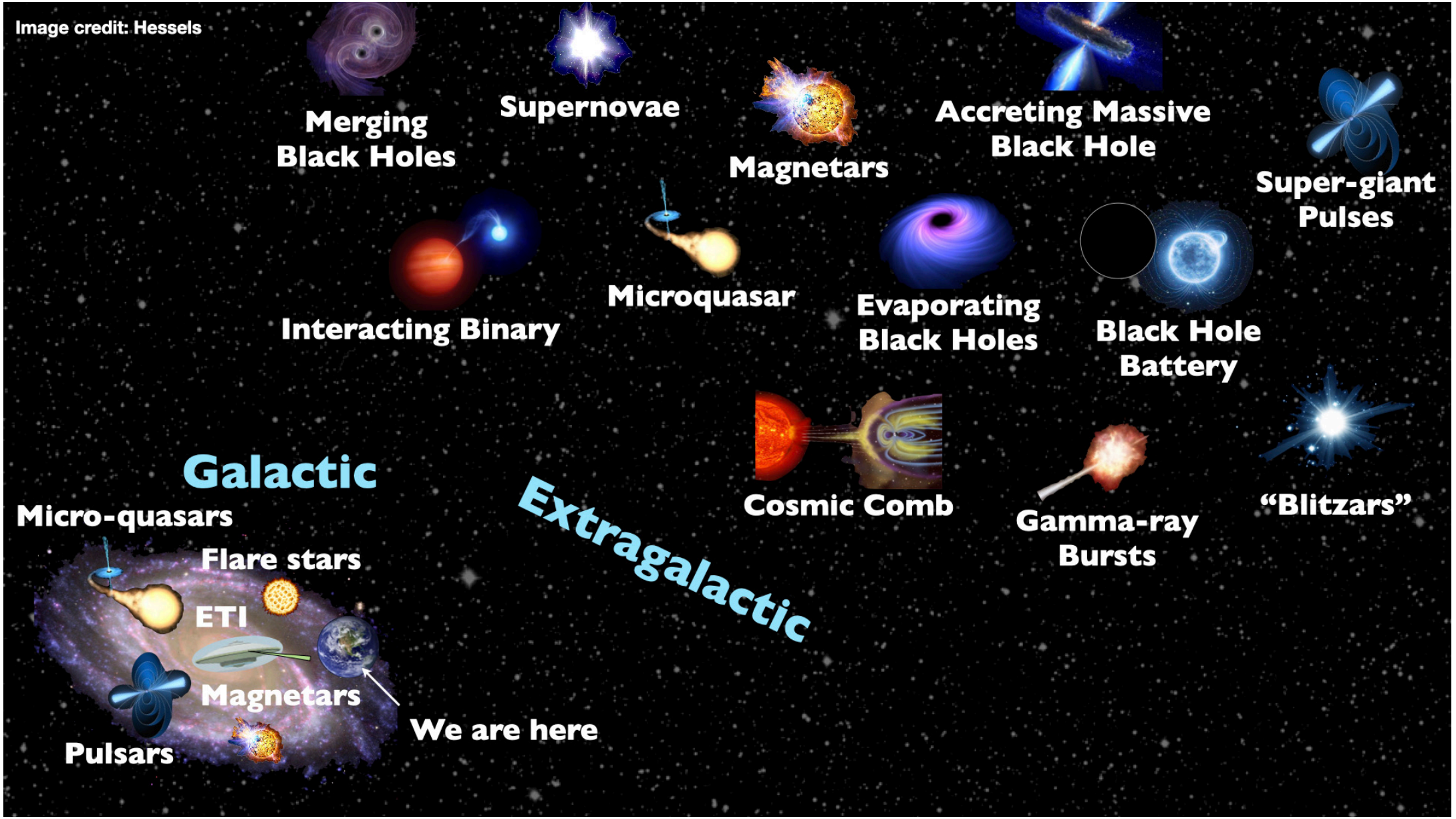
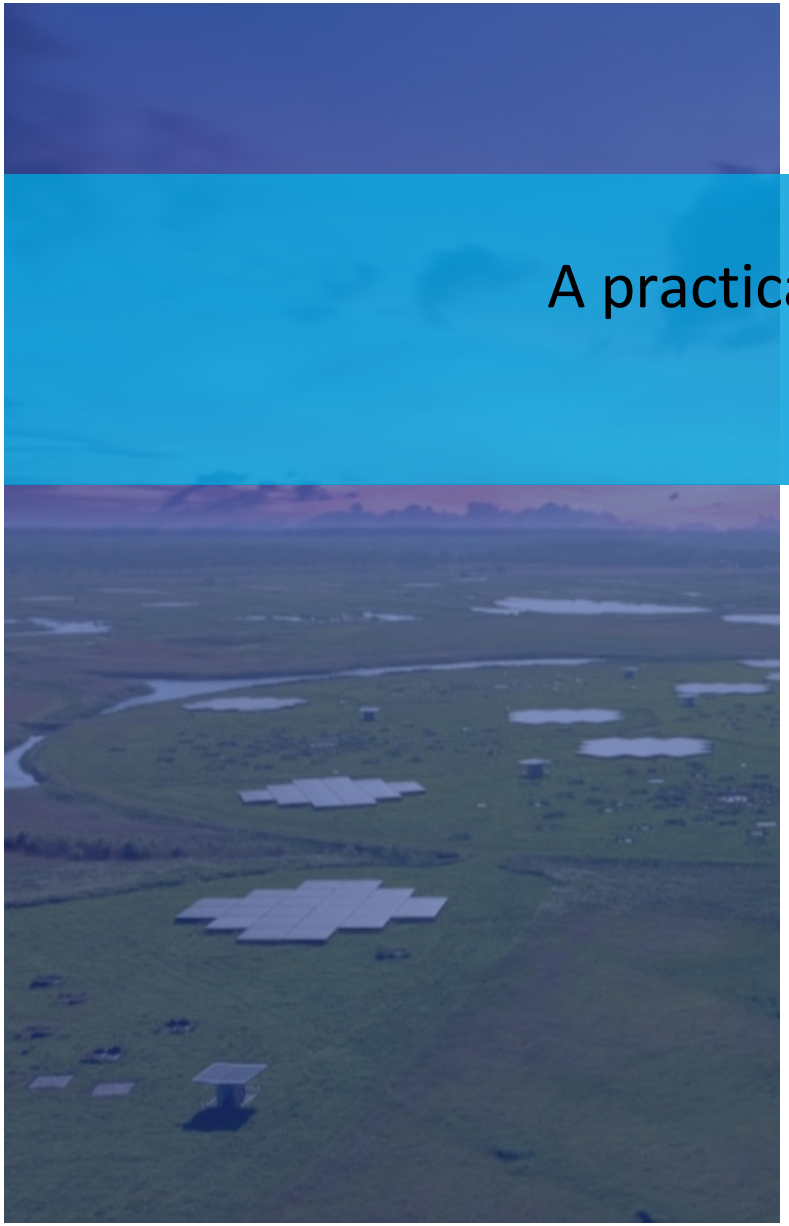


Image credit: Hessels
Merging Black Holes
Supernovae
Magnetars
Accreting Massive Black Hole
Super-giant Pulses
Interacting Binary
Microquasar
Evaporating Black Holes
Black Hole Battery
Cosmic Comb
Gamma-ray Bursts
"Blitzars"
Galactic
Extragalactic
Micro-quasars
Flare stars
ETI
Magnetars
Pulsars
We are here

A practical example of why we need LENSS



Let’s say you want to re-process LoTSS pointings with >11 intl stations

84% of 3,170 pointings = 2,663 pointings

wide-field:
~50,000 cpu hours per pointing
→ ***133 million cpu hours***

Targeted (>10 mJy):
~15,000 cpu hours per pointing
→ ***40 million cpu hours***

A practical example of why we need LENSS

Running continously on one 64-cpu node:

Wide-field: 237 years
Targeted: 71 years

Even if using e.g. 20 nodes and assuming 100% computational efficiency, this is still a processing-to-observing ration of ~ 2!

Let's say you want to re-process LoTSS pointings with >11 intl stations

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LENSS components

Enhanced Science Opportunity:
Network Upgrade: 10Gb/s - 100Gb/s

Data bottleneck Solution 1:
Station firmware and software upgrade and correlator

Data bottleneck Solution 2:
Telescope Manager, Automated pre-processing and QA, High-speed automated data calibration

Data bottleneck Solution 3:
Automated imaging algorithms, Data Processing Management System

System Requirements:
high-efficiency, low-energy, accessibility and ease of use

Energy efficient computing

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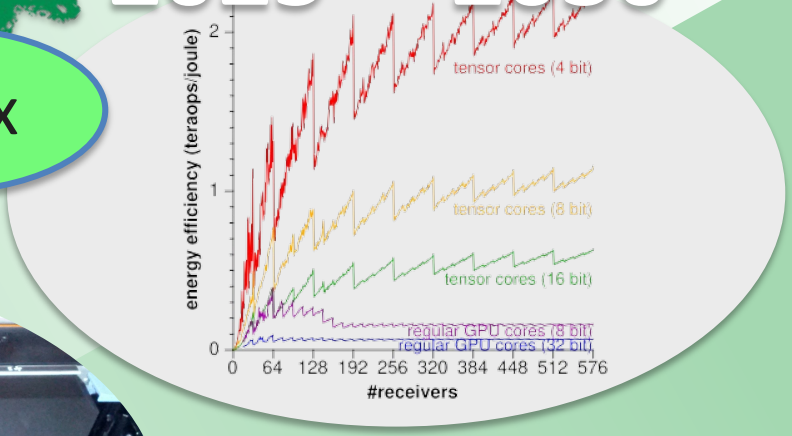
2025— 2030



5-10x

2015— 2025

6.6x

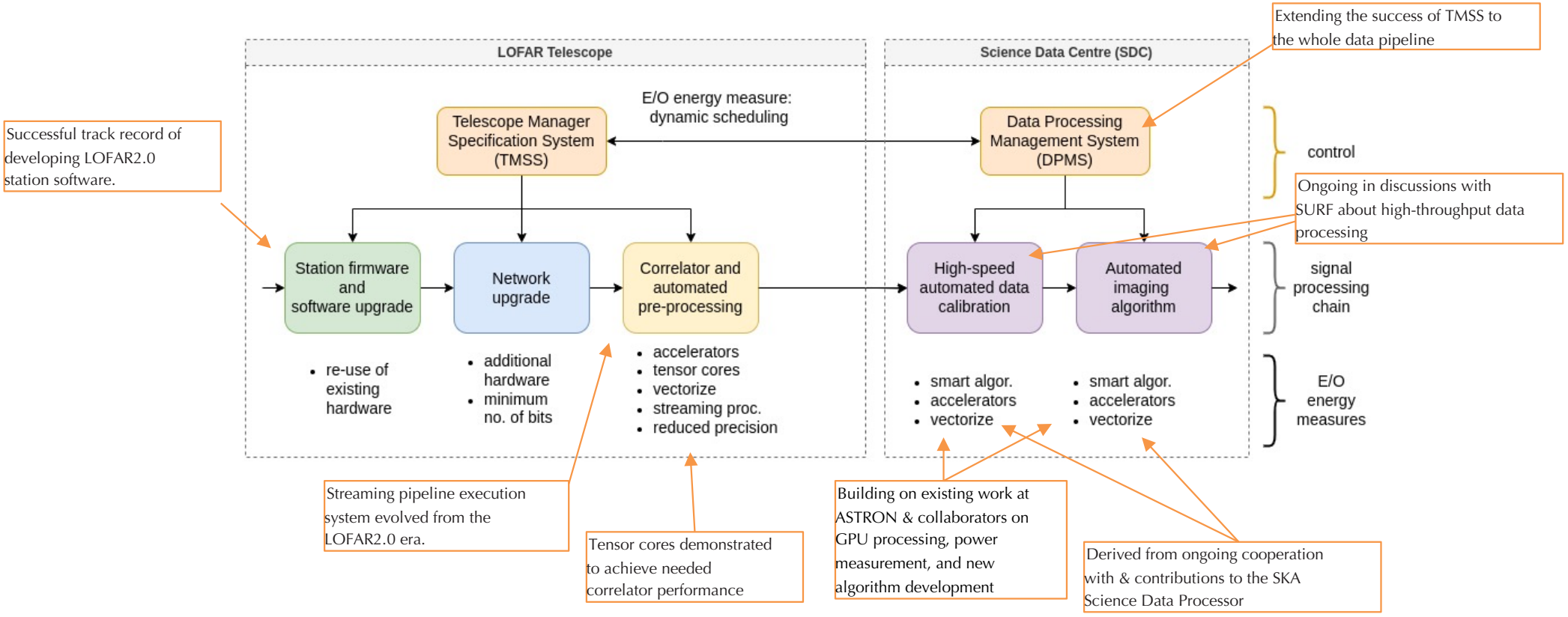
2010— 2015

Building on extensive experience with efficient use of highly complex systems in real-time domain

Valorise our experience with GPU and AI accelerators
Energy efficient, Sustainable, Accelerating time to science

New Software Development

- ASTRON manages development through an agile-derived (“SAFe”) process.
- LENSS draws on the institute’s established expertise and existing partnerships.
- All software released is under ASTRON’s Open Source Policy.



LENSS

LENSS proposes to **expand LOFAR's field-of-view by a factor of four**, thereby facilitating faster, sharper all-sky surveys and rapid responses to transient events.

To complement hardware enhancements, LENSS emphasises the **development of high-throughput data processing systems and innovative algorithms** on cutting-edge computing architectures.

LENSS will **minimise energy consumption, carbon footprint, and data inefficiencies.**

Automating science pipelines and enhancing user accessibility, LENSS aims to **democratise astronomical research, fostering a diverse and inclusive scientific community**.

LENSS represents a pivotal step in unlocking the transformative capabilities of LOFAR and advancing **sustainable, efficient, and impactful radio astronomy**

Additional Slides

Questions?

Conclusion

LENSS will quadruple LOFAR's survey speed

LENSS brutely optimizes the pipeline software efficiency (factor 40)

And all of that for the same carbon footprint

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