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## LOFAR2.0 development status and plans

Wim van Cappellen

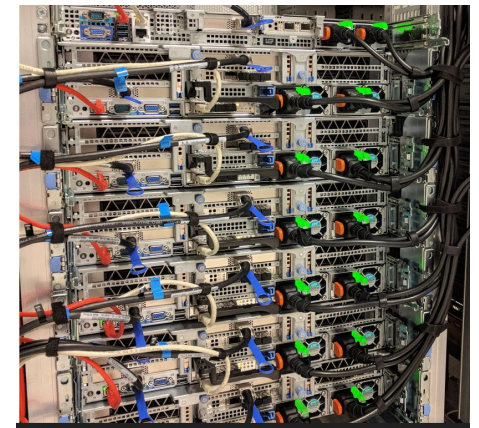
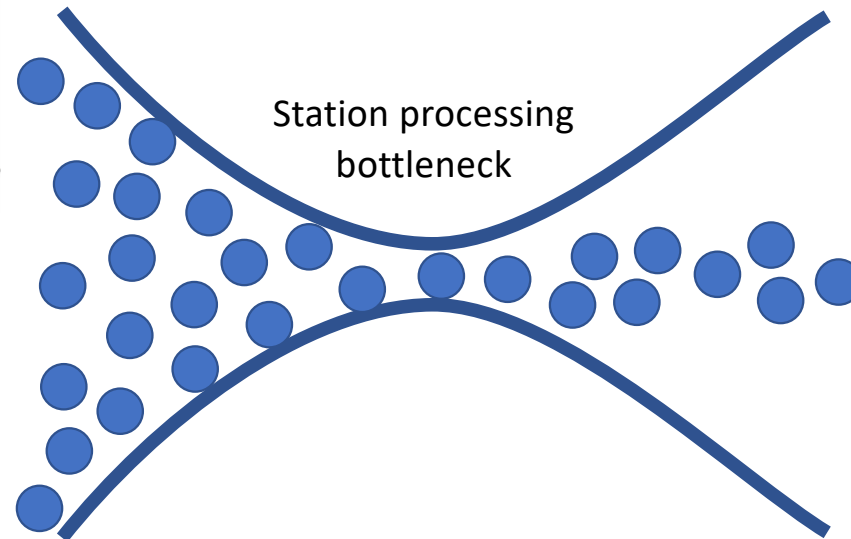
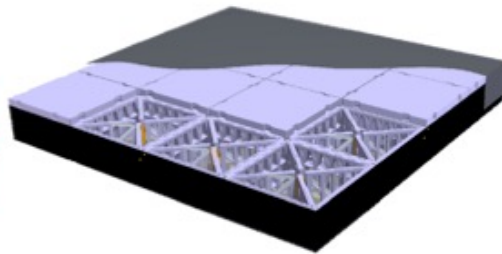
2023/06/12



# LOFAR1



**Antennas  
LBA/HBA**



**COBALT**



# LOFAR2.0 capabilities

- More receivers and processing capacity at the stations, enabling simultaneous LBA-HBA observing

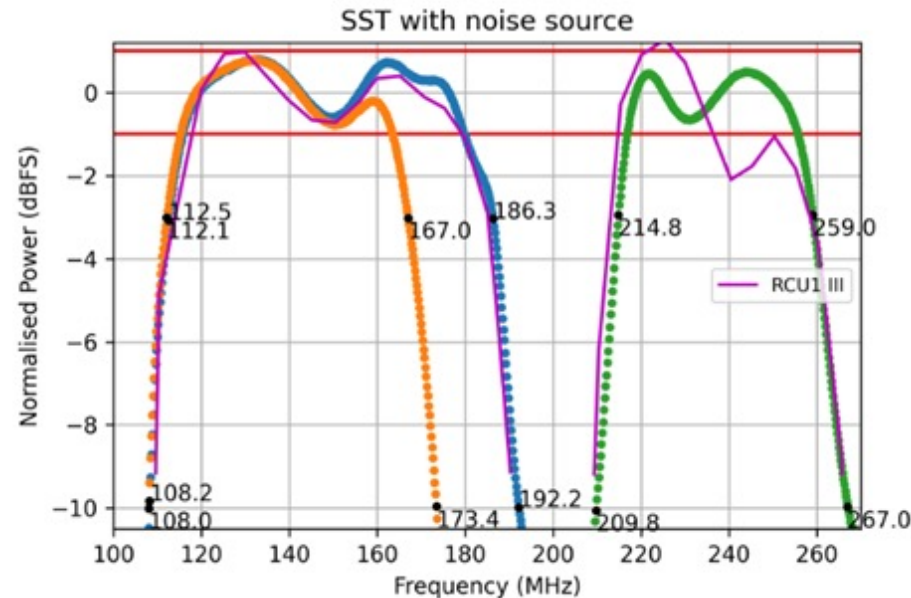
Station capability	LOFAR1	LOFAR2.0
NL	48 LBA or 48 HBA	96 LBA and 48 HBA
International	96 LBA or 96 HBA	96 LBA and 96 HBA

- Distribution of a central clock to all NL stations (White Rabbit)



# Other LOFAR2.0 changes

- 160 MHz clock (i.e. HBA MID 170 – 230 MHz) is no longer available
- Extra filter to include or exclude 170 – 190 MHz in HBA LOW (110 – 190 MHz)
- FR606 will be able to observe with NenuFAR mini-arrays

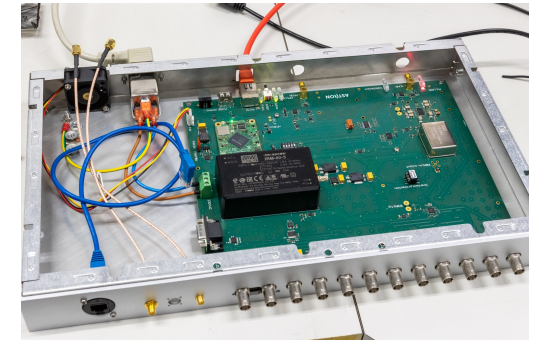
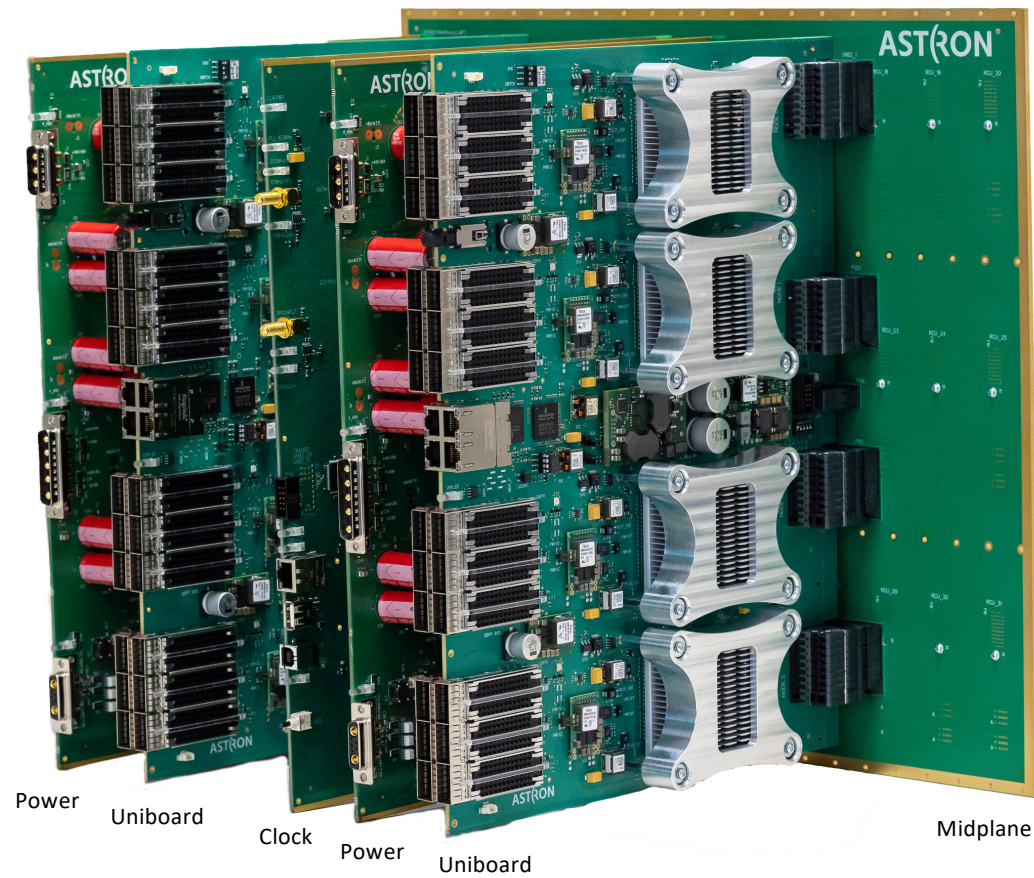


# LOFAR2.0 development

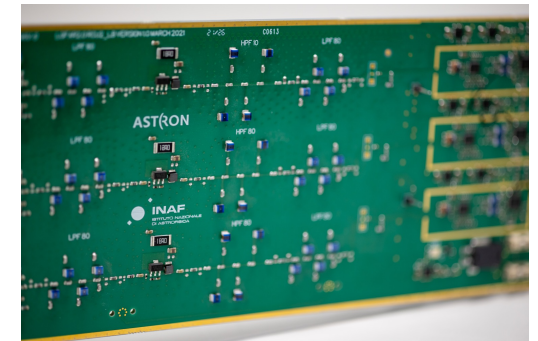
## Design



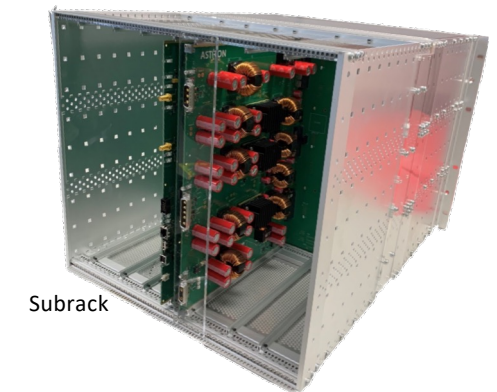
# LOFAR2.0 Test Station hardware



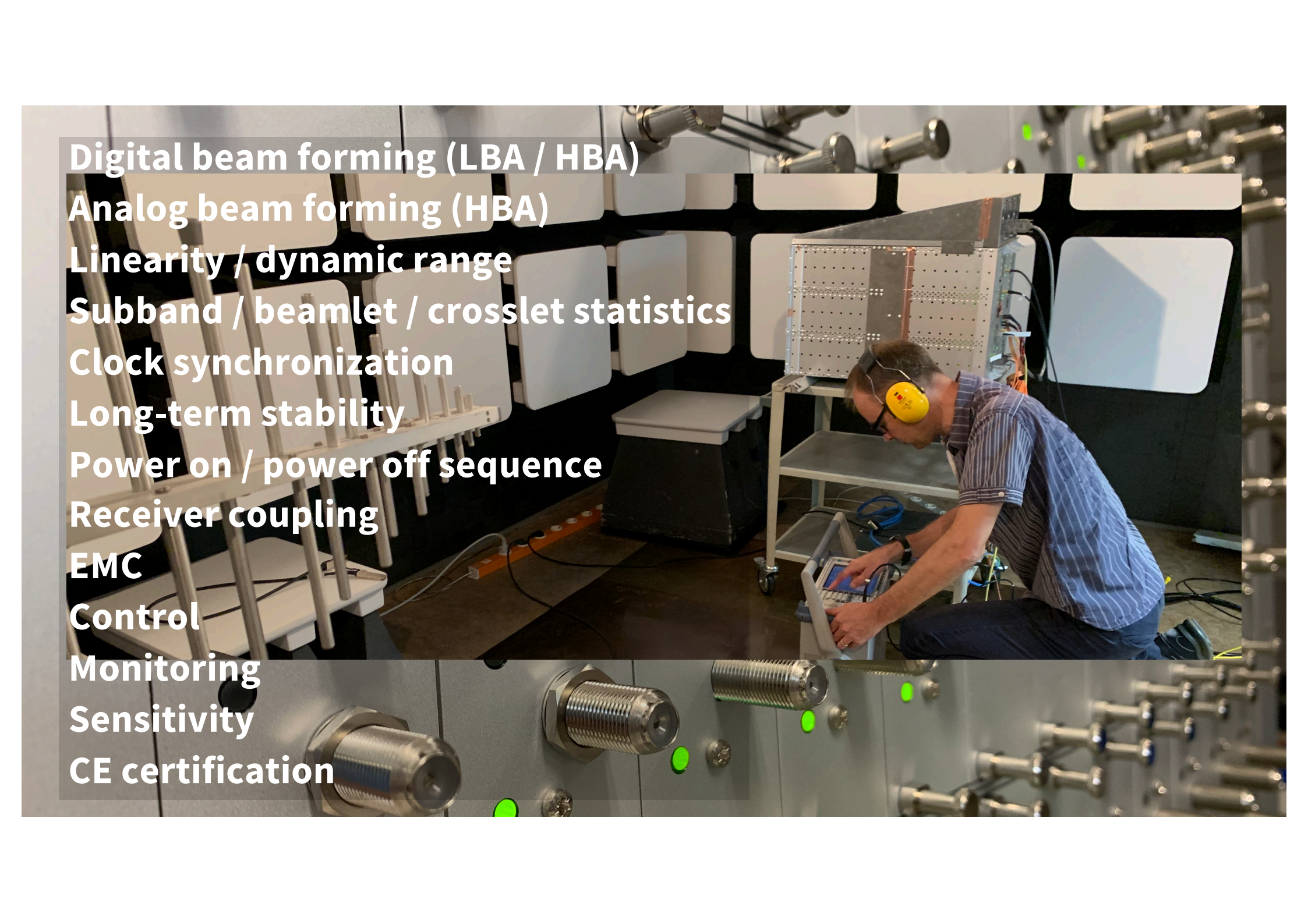
Clock Distribution



RCU



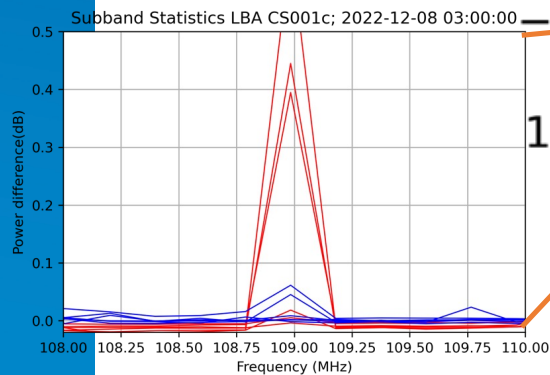
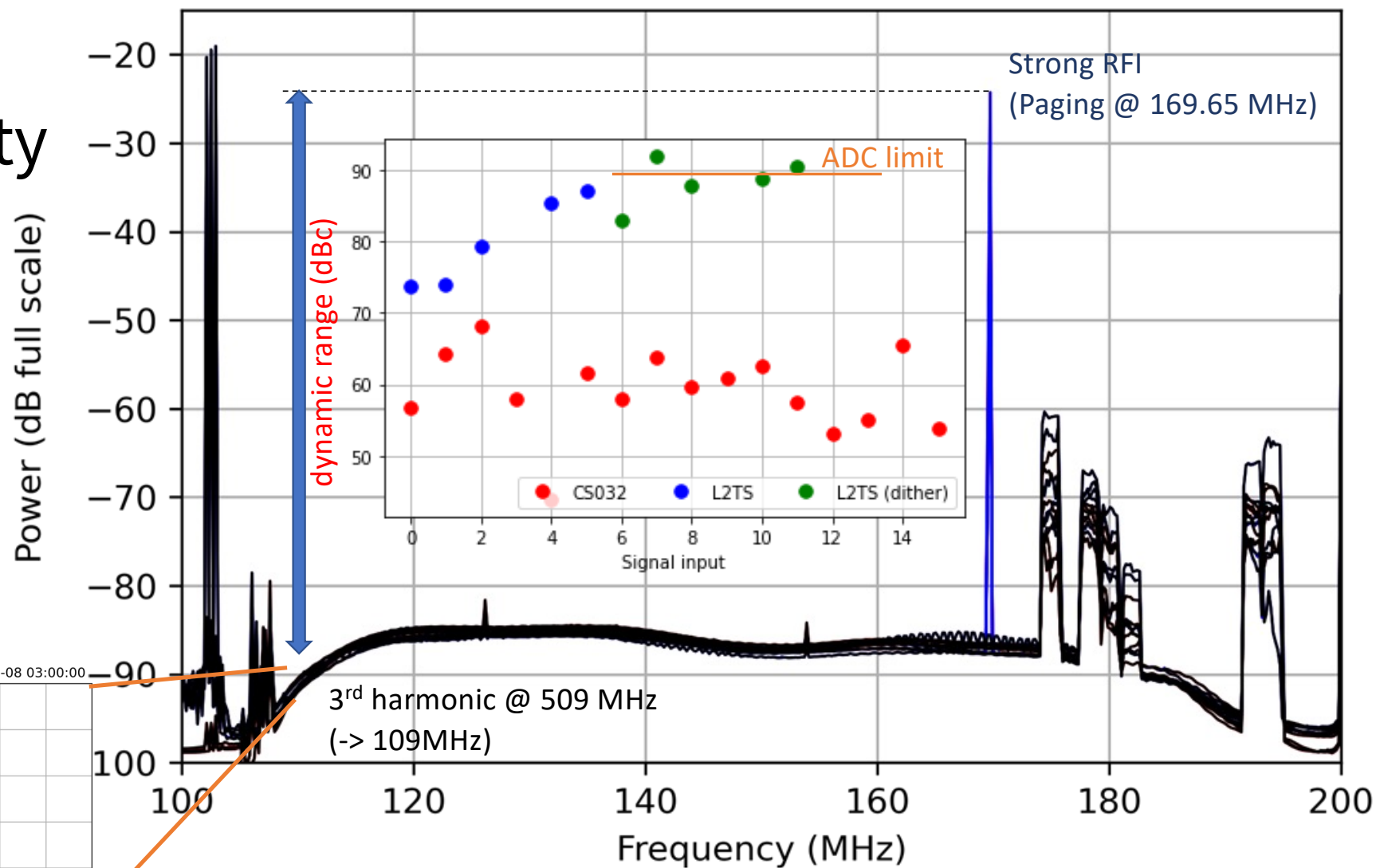
Subrack



The background image shows a man wearing a blue and white striped shirt and yellow safety headphones, kneeling in a laboratory or industrial setting. He is working on a piece of equipment on a metal cart. The room is filled with various technical components, including a large array of white rectangular panels mounted on a wall, and several green indicator lights. The overall scene suggests a high-tech environment focused on testing or development.

- Digital beam forming (LBA / HBA)
- Analog beam forming (HBA)
- Linearity / dynamic range
- Subband / beamlet / crosslet statistics
- Clock synchronization
- Long-term stability
- Power on / power off sequence
- Receiver coupling
- EMC
- Control
- Monitoring
- Sensitivity
- CE certification

# ADC Linearity

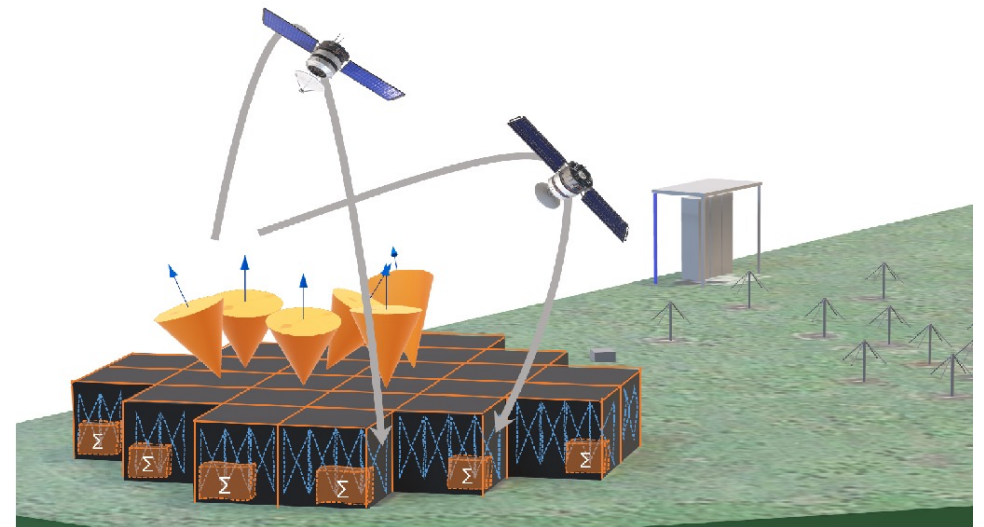
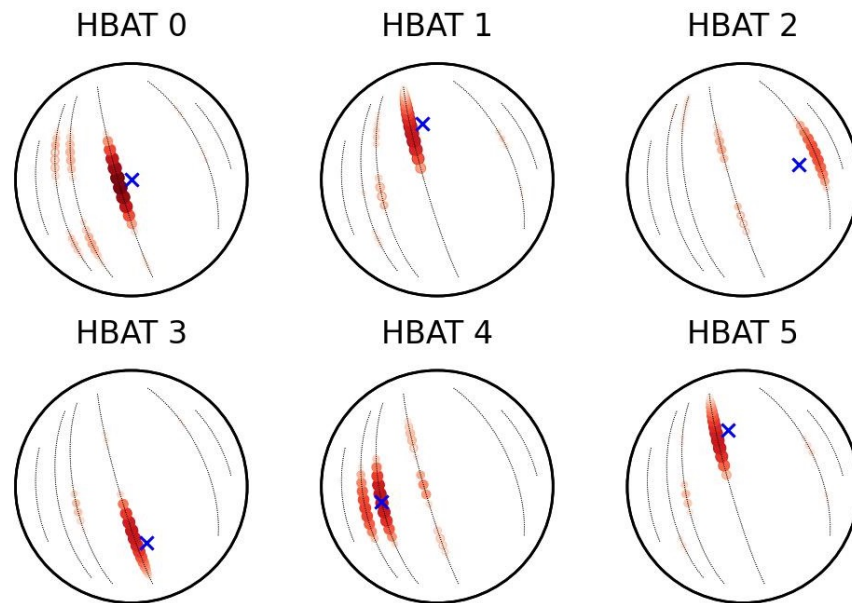


**ASTRON**

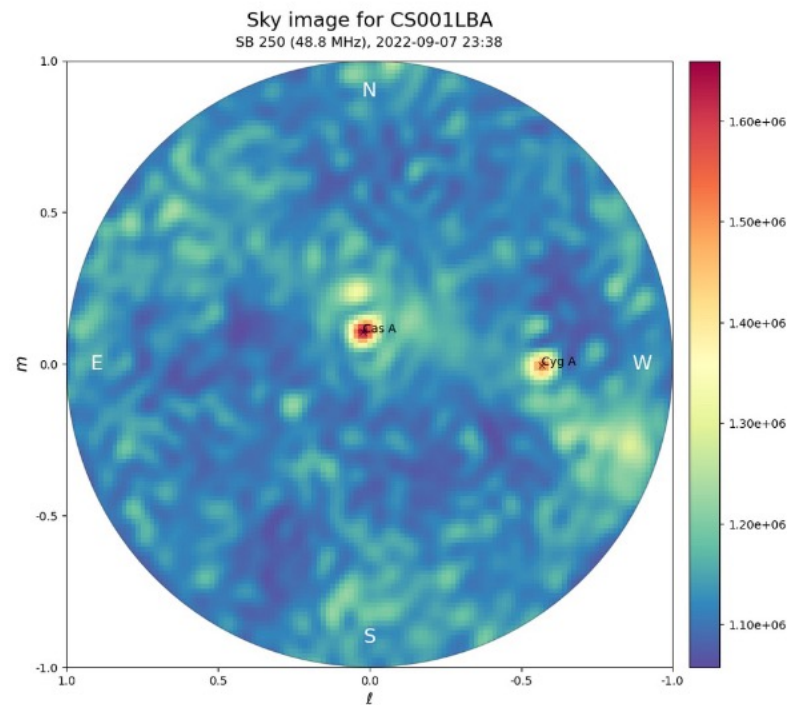
Netherlands Institute for Radio Astronomy

# HBA analog beamforming: Static beams

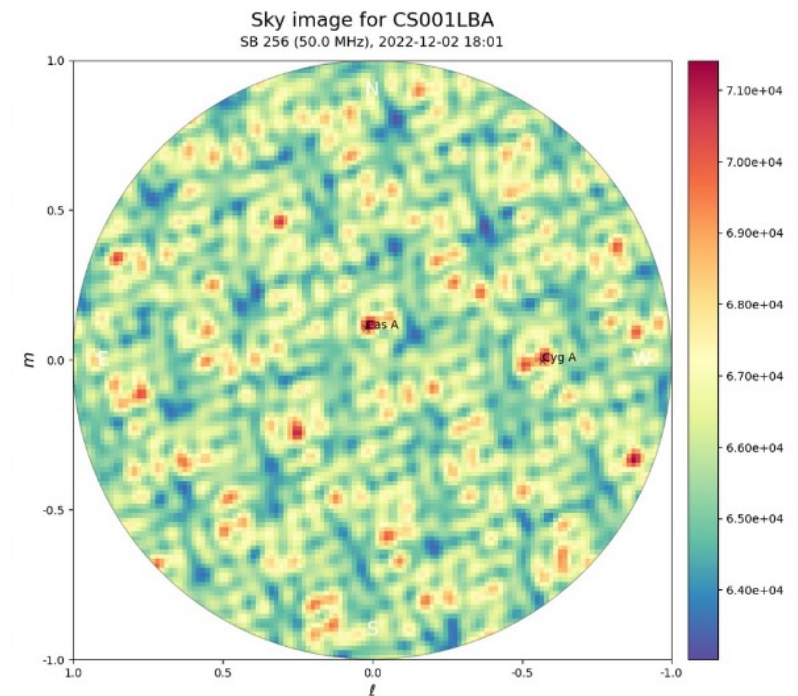
Beam validation with satellites



# Comparison with LOFAR1 CS001 reference observations



LOFAR1 LBA\_OUTER



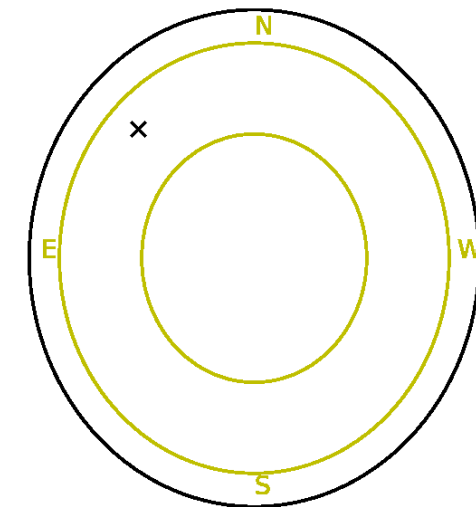
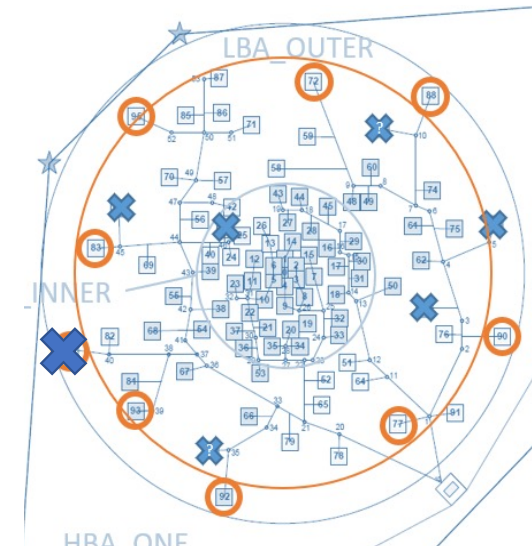
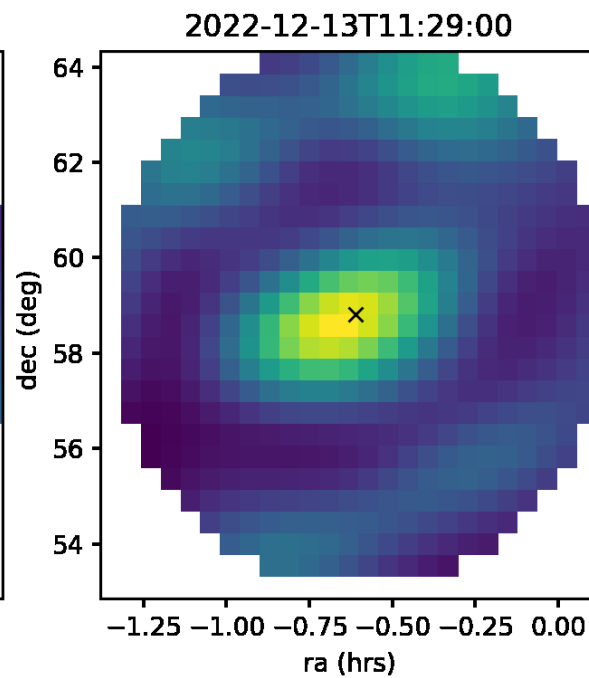
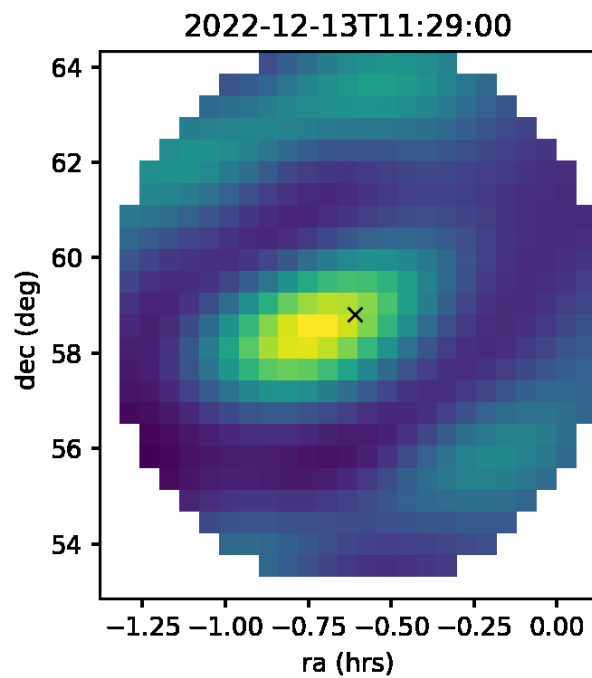
LOFAR2.0 L2TS

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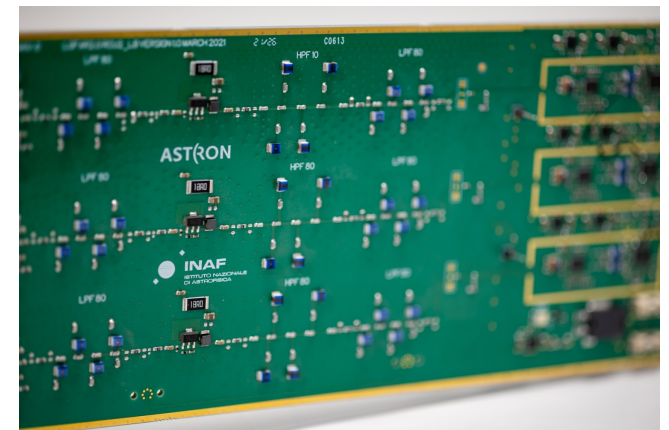
# Digital beamforming

- Tracking Cas A without LBA94



# LOFAR2.0 procurement

- Scope:
  - LOFAR2.0 hardware for 52 of the 54 stations (including BG and IT)
  - Collaborative purchase hardware for the remaining 2 stations
  - Spare parts
  - HBA subracks are purchased for 10 future dual-beam stations.
- June 2023: Contracts signed for €9.1M, 90% of the expected €10.1M total costs.





# Summary

- Final design verification in progress
- Performance looks good!
  - Bandpass & sky-noise level: Same as LOFAR1 (10-90 MHz & 110-190MHz)
    - Expect reduced ripple due to better termination in next RCU2-H version
  - Receiver sensitivity: Same as LOFAR1
    - Slightly better at band edges
  - ADC linearity: 20 – 30 dB better than LOFAR1

## Next important steps:

- Scaling-up to a full station
- Correlate with other stations