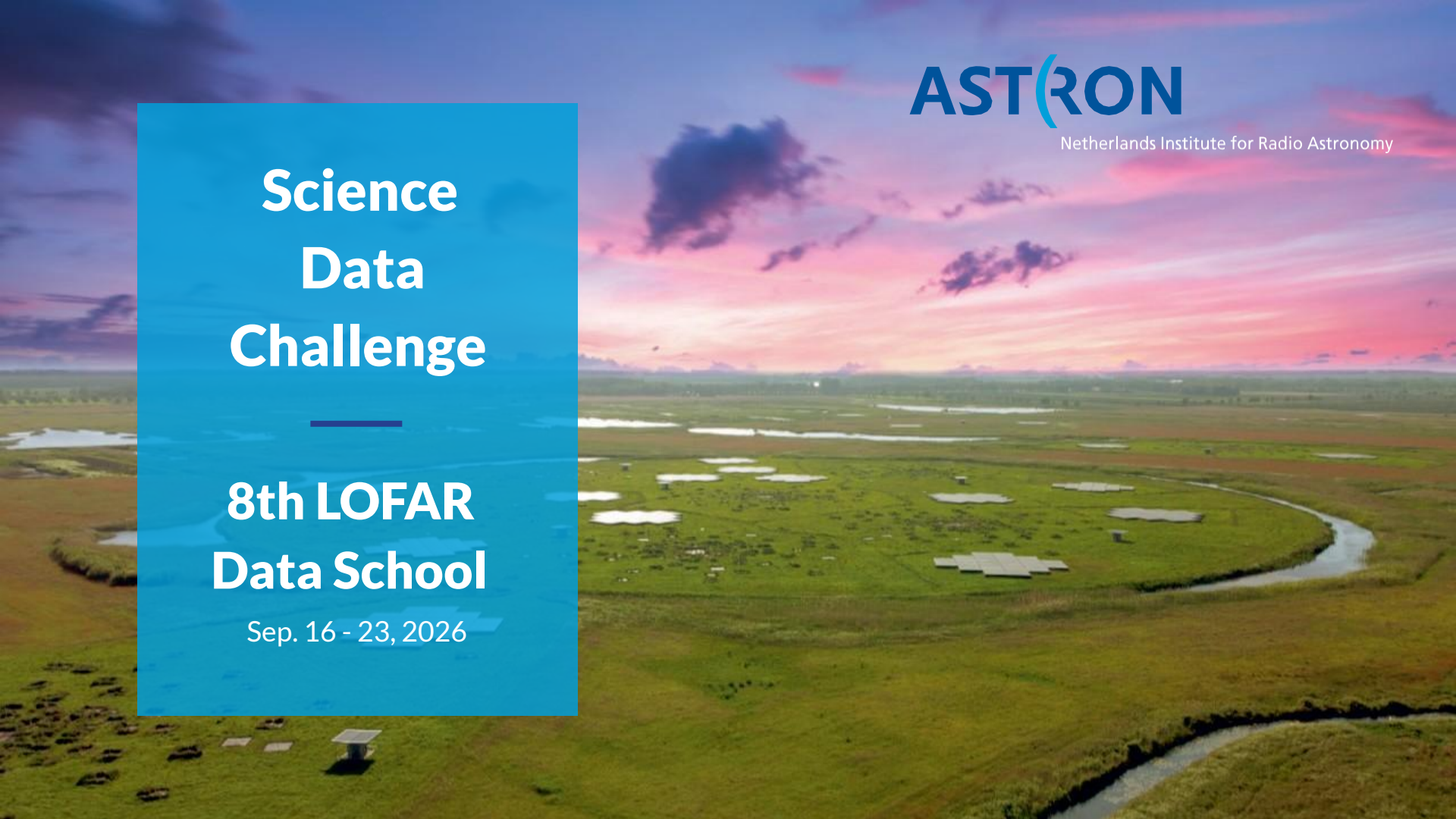

ASTRON
Netherlands Institute for Radio Astronomy
Science Data Challenge
8th LOFAR Data School
Sep. 16 - 23, 2026

Science Data Challenge Concept & Guidelines



Gain hands-on experience working with LOFAR data and data processing and analysis tools

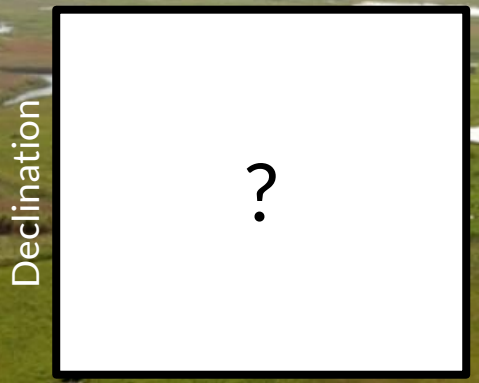
- 10 diverse projects have been designed with varying levels of difficulty
- Work in groups of 3-4 under guidance of lecturers
- Duration: ~1 day in total, spread across the school period (mostly next week)
- Each group will present their work on the last day of school

Materials for all challenges can be found at https://lofar-dr.grid.surfsara.nl/LDS2026/challenge/

Sign up for your project of interest by the registration desk!

Science Data Challenge 1

During the VLBI tutorial you will obtain a high-resolution radio continuum image of a radio source:



VLBI tutorial image analysis

Supervisors: Roland Timmerman (roland.timmerman@durham.ac.uk), Frits Sweijen (frits.sweijen@durham.ac.uk)

The focus of this science data challenge is:

What are we physically looking at?

To better understand this, we will

- Analyze the `.fits` image
- Calculate the physical properties of the radio source
- Interpret the various components that are visible in the image

Practices many techniques commonly used in radio astronomy!

Science Data Challenge 2

Detect faint compact emission in VLBI image

Supervisors: Roland Timmerman (roland.timmerman@durham.ac.uk), Frits Sweijen (frits.sweijen@durham.ac.uk)



The weird radio source on the left has no clear optical counterpart. In this challenge you have to:

- **Manually perform calibration like in the VLBI tutorial** (although now on a more difficult data set)
- **Apply these solutions to the target data set and try to detect faint compact emission**
- **Interpret the 6" LoTSS image together with your 0.3" LOFAR-VLBI image and figure out which galaxy is producing this structure →**

NB: This is a relatively challenging project.
Recommended for those who enjoy calibration

Science Data Challenge 3

Transient data analysis

Supervisors: Antonia Rowlinson (rowlinson@astron.nl)



Time domain image plane radio astronomy is a hot topic at the moment, especially given the recent discovery of Long Period Radio Transients (LPTs).

In this Data Challenge, you will learn how to make your own snapshot images with WSClean, process them with the LOFAR Transients Pipeline, search for transient and variable sources in the field, and compare your sources to catalogue data.

Extension task: you can learn how to create subtraction images for fast transient searches.

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Science Data Challenge 4



8th LOFAR Data School – Sep. 16 - 23, 2026

Locating Lightning with Transient Buffer Data

Supervisors: Brian Hare (hare@astron.nl)

- LOFAR has ability to save antenna voltages with no digital processing
  - called transient buffers
- Useful for:
  - Extremely wide field of view
  - Extremely impulsive time-domain science
- Science cases:
  - Terrestrial Lightning
  - Cosmic ray

In this project you will analyze transient buffer data to locate lightning

Instructions and data found here:
https://www.astro.rug.nl/~hare/public/other/LOFAR_dataSchool/

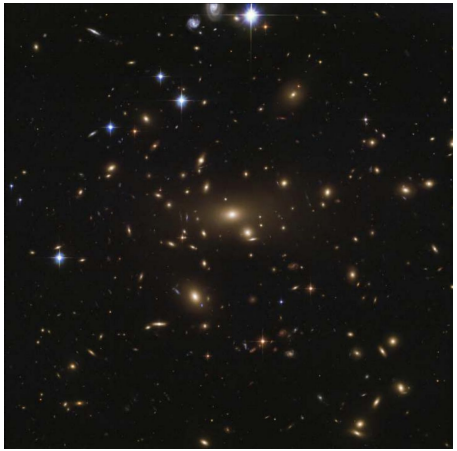
Science Data Challenge 5

Abell 665 data analysis

Supervisors: Andrea Botteon (andrea.botteon@inaf.it)



- Find out what kind of object this is
- Produce images at different resolutions (the FoV of the observation is 20’ x 20’)
- Subtract emission of discrete sources
- Measure the properties of the diffuse emission and compare them to similar objects



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Science Data Challenge 6

Finding a pulsar in a LOFAR dynamic spectrum

Supervisors: Cees Bassa (bassa@astron.nl)



Pulsar signals stand out in radio astronomy due to their periodicity and frequency dependent dispersion.

In this challenge you are tasked with determining the spin period and dispersion measure (DM) of a mystery pulsar in a 60s dynamic spectrum taken with the HBA antennas of the LOFAR Superterp stations.

Using standard python libraries like numpy, scipy, matplotlib and h5py, you'll learn to read LOFAR data, search for periodic signals using power spectra, and search over DM.

Science Data Challenge 7

Measuring and correcting for Faraday rotation in pulsar single pulses

Supervisors: Cees Bassa (bassa@astron.nl)



Linearly polarized signals undergo Faraday rotation as they travel through the ionized interstellar medium.

In this challenge you are tasked with determining and correct for the rotation measure of single pulses from a bright pulsar from complex voltage data from the LOFAR HBA Core stations.

You'll learn how to channelize voltage data, construct the Stokes parameters, and determine RM from the rotation of Stokes Q and U with frequency, and correct the data for it.

Science Data Challenge 8

Listening to FM radio with LOFAR

Supervisors: Cees Bassa (bassa@astron.nl)



While the LOFAR LBA and HBA bands avoid the FM radio stations that transmit between 88 and 108MHz, the signals are still detectable.

In this challenge you are tasked to identify FM signals in LOFAR observations of a single station, and demodulate the complex voltages to an audio signal.

You'll learn how to mix, filter, resample and visualize LOFAR voltages to audio with standard python libraries (numpy, scipy, matplotlib etc.)

Science Data Challenge 9

Making a Station Beam Science Ready

Supervisors: David McKenna (mckenna@astron.nl)



A LOFAR station produces 3Gb/s of raw beam voltages that we need to capture and convert into a useable format for science.

Starting with network packets and a data specification, in this challenge your goal will be to convert a minute of bright pulsar into a format of you choice, allowing you to further explore

- Channelisation (FFT, PFB)
- Detection (Stokes IQUV)
- Dedispersion
- Outreach outputs (ridge line plots, sonification, etc)
- Common data formats (Sigproc, DADA, PSRFITS)
- Pulsar Folding

Science Data Challenge 10

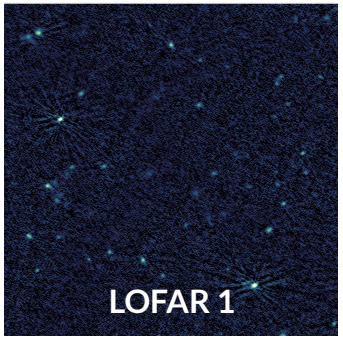
LBA frequency comparison between LOFAR 1 and LOFAR 2

Supervisors: Jort Boxelaar (j.boxelaar@ira.inaf.it)
Christian Groeneveld (c.groeneveld@ira.inaf.it)



How will LOFAR 2 improve image quality for comparable observation time and bandwidth?

- You will use LiLF to calibrate LBA data for both LOFAR 1 and commissioning data for LOFAR 2!
- Check image quality and compare flux densities of sources in the field



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LOFAR 2