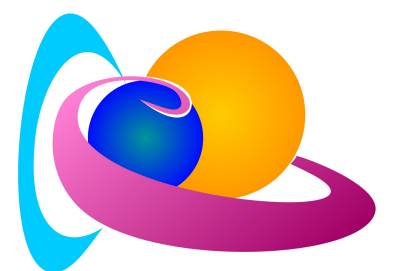


# Type II Burst in High-Resolution

## Capturing a Solar Shockwave with SPADE



Revealing fine-scale structures with a compact, cost-effective array

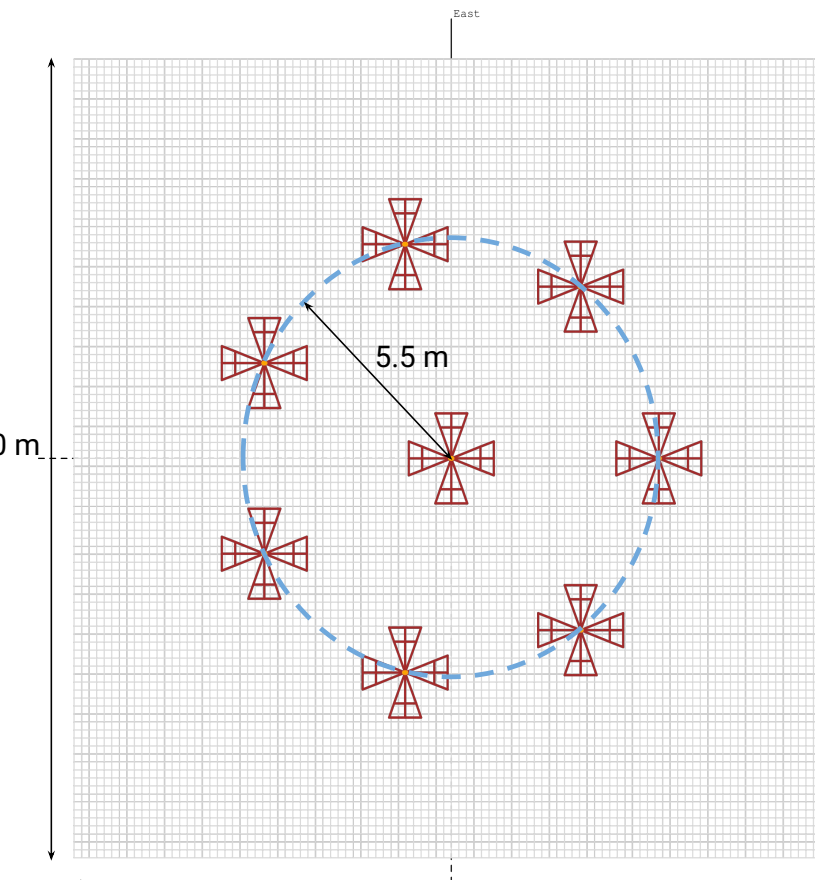
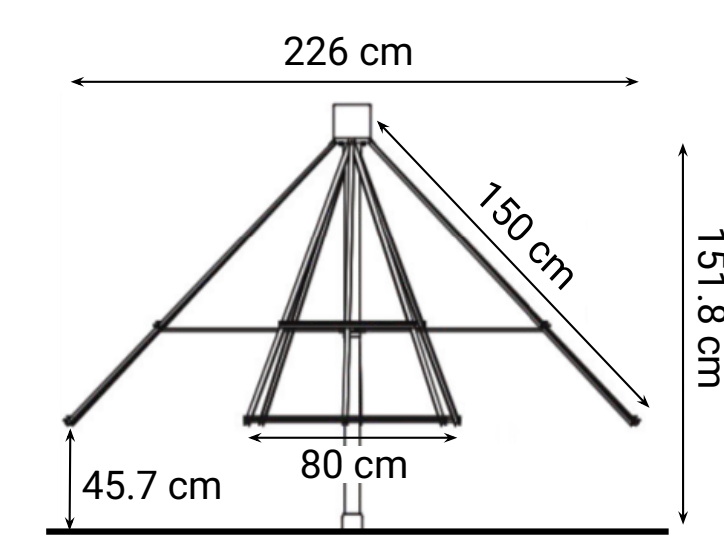
### Small Phased Array Demonstrator : SPADE ♠



General view of the SPADE antenna array at the Humain Radio-Astronomy Station in Belgium.

#### Antenna Element

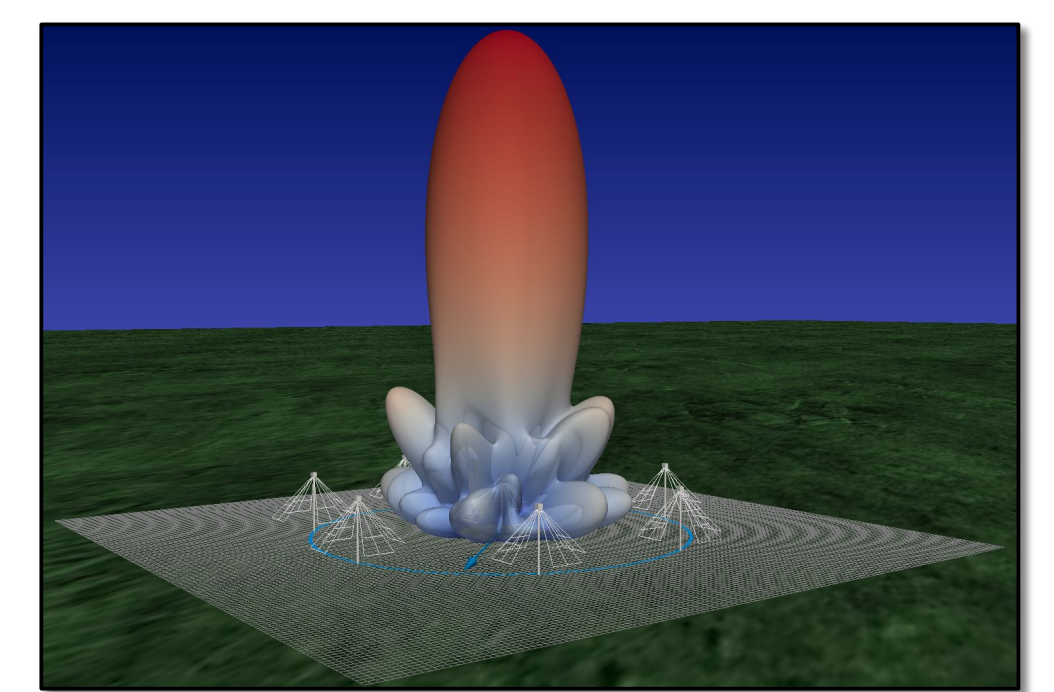
- Inverted *Fat Vee*.
- Dual polarization.



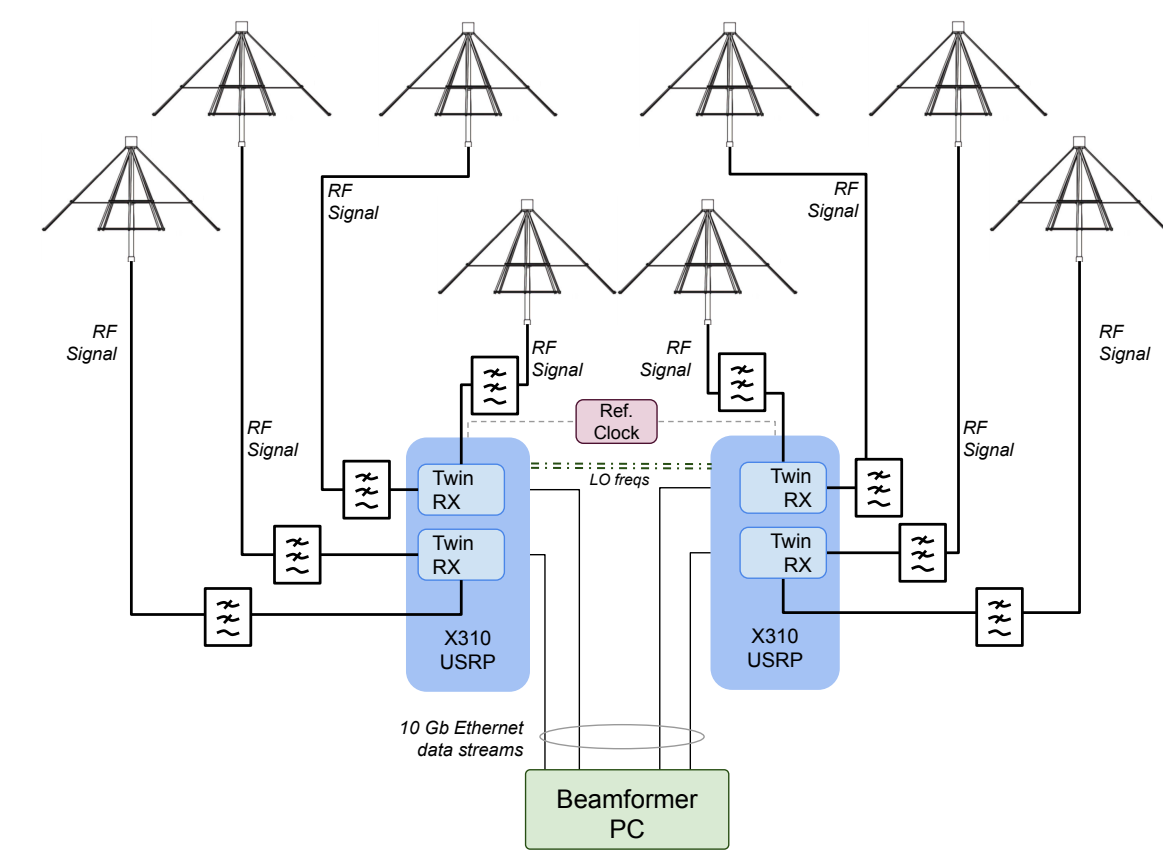
SPADE antenna field layout.

#### Antenna Field

- Eight antenna elements.
- Circular distribution with a center element.
- Conductive mesh ground.
- SW controlled (Python) beamforming @ 50 MHz.



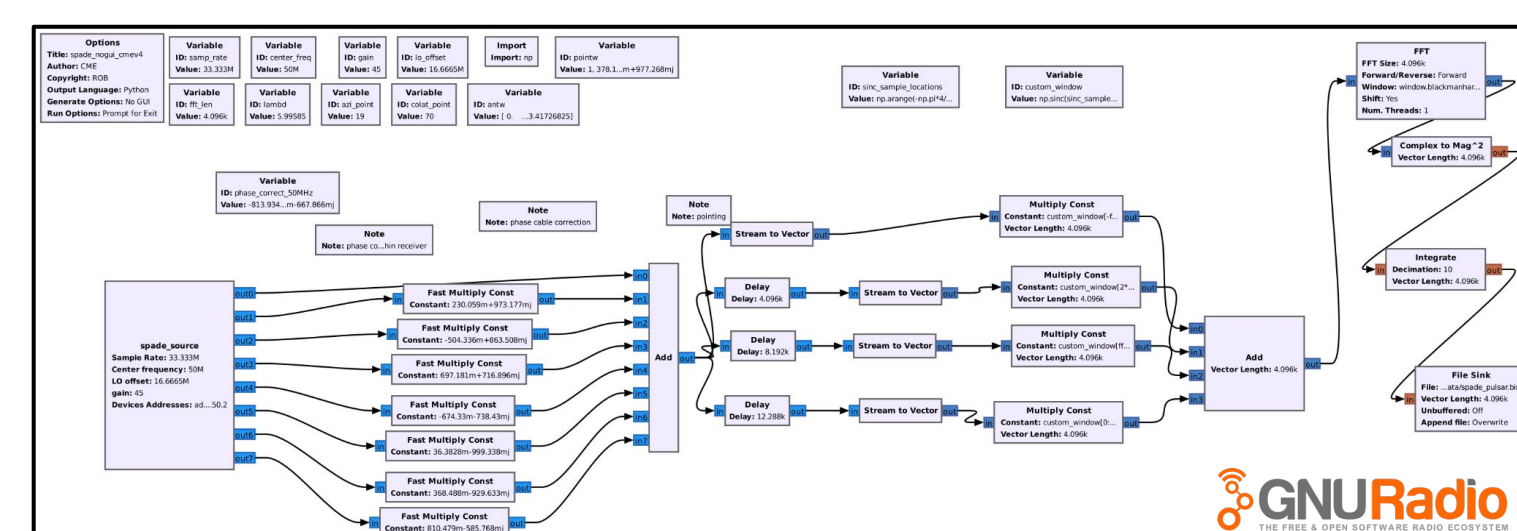
3D visualization of the SPADE array pattern for  $f = 50$  MHz.



SPADE general signal architecture.

#### Receiver

- 2x Ettus USRP X310.
- 2x TwinRX boards per USRP.
- SW developed in GNU Radio open platform.
- Data stream transfer via 10Gb Ethernet.

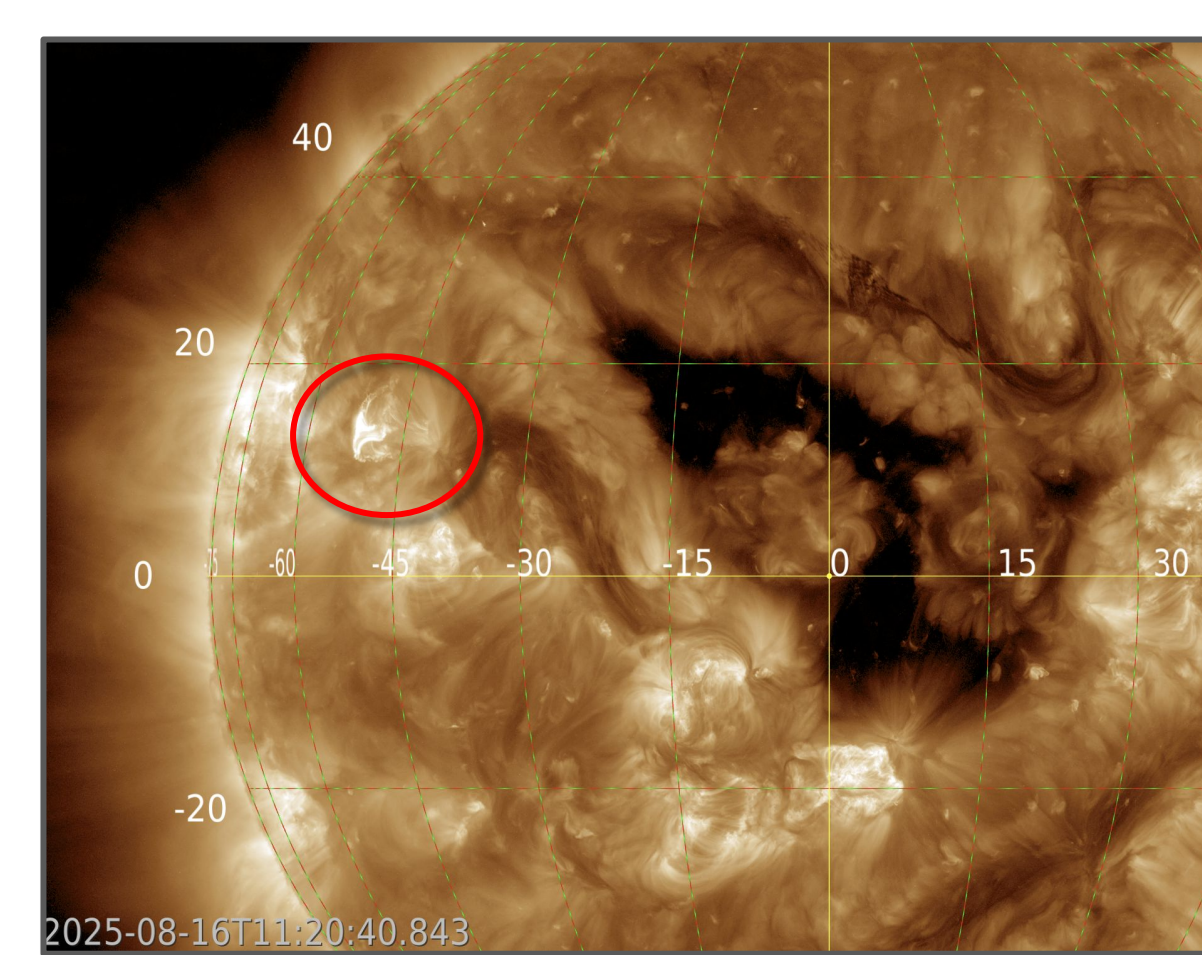
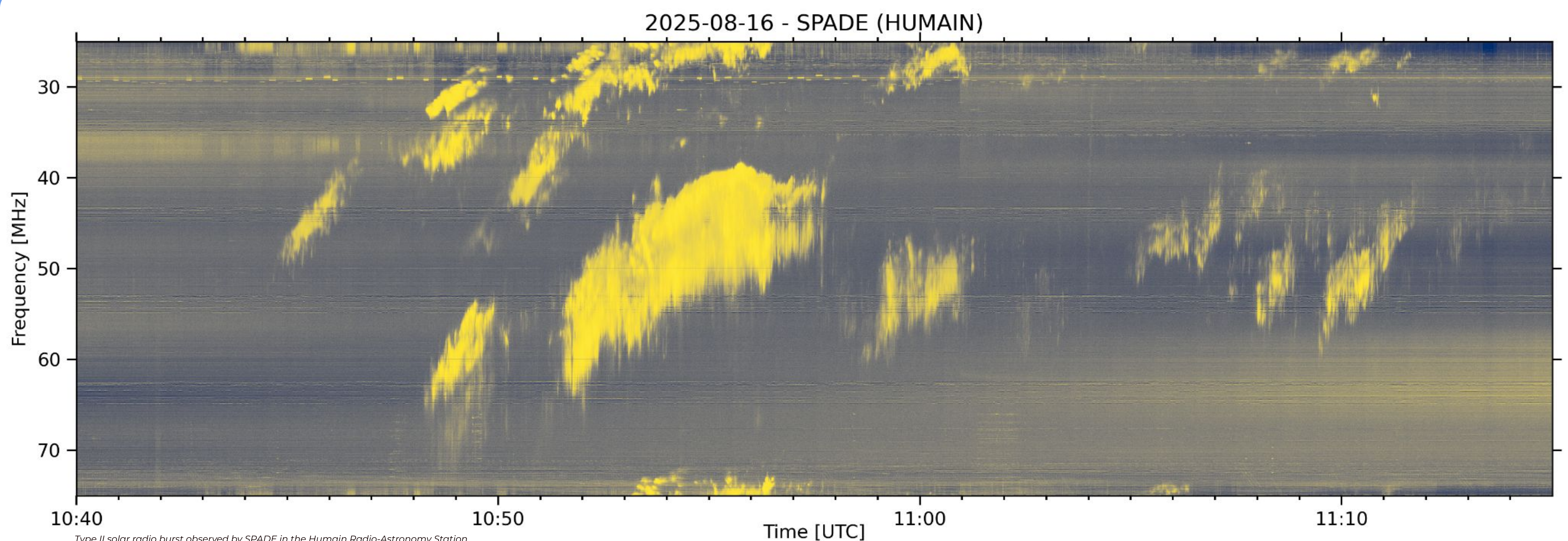


Example of a GNU Radio companion workflow for SPADE.

#### SPADE Key Features

- Frequency: 25 – 75 MHz
- Time resolution: ~49 ms
- Frequency resolution: 3.052 kHz
- Nbr of frequencies: 16384

## Observations

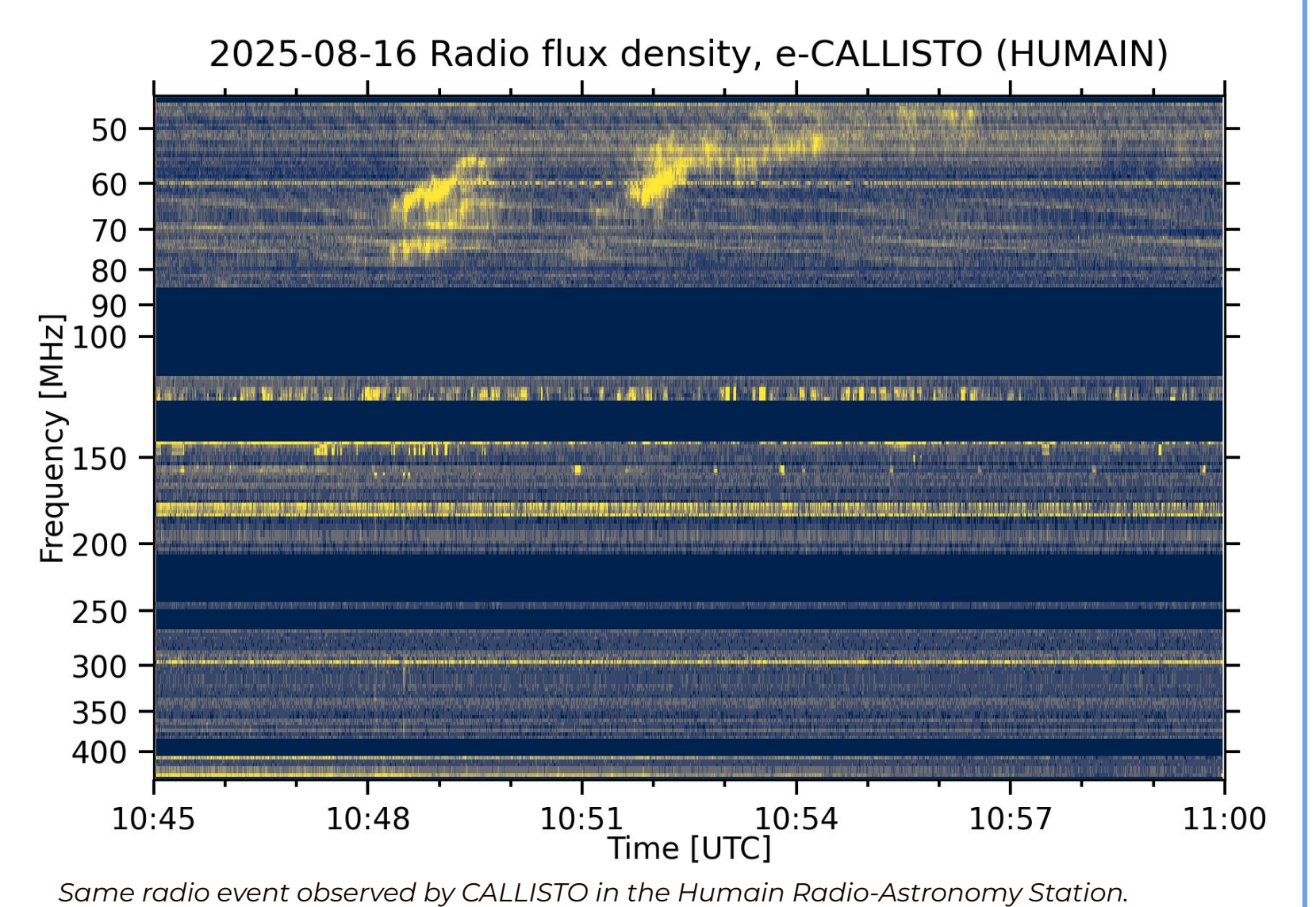


Same radio event observed by the Solar Dynamics Observatory.

### Type II Burst

The dynamic spectrum shows a complex Type II radio burst observed by SPADE. This event exhibits multiple emission lanes and numerous fine structures. The well-defined fundamental and harmonic bands show clear band splitting, herringbones features and several fine structures.

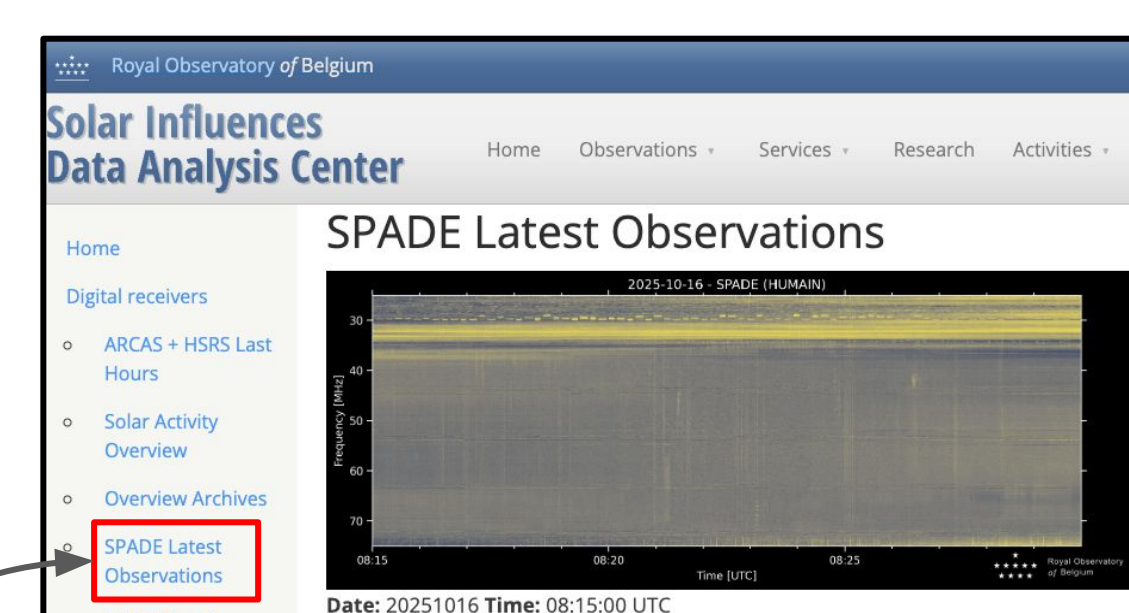
The same event, observed by CALLISTO, shows the type II burst emission as rather smooth and without fine structures. The comparison of the dynamic spectra clearly demonstrates SPADE's superior characteristics arising from the high temporal and frequency resolution and larger effective area.



Same radio event observed by CALLISTO in the Humain Radio-Astronomy Station.

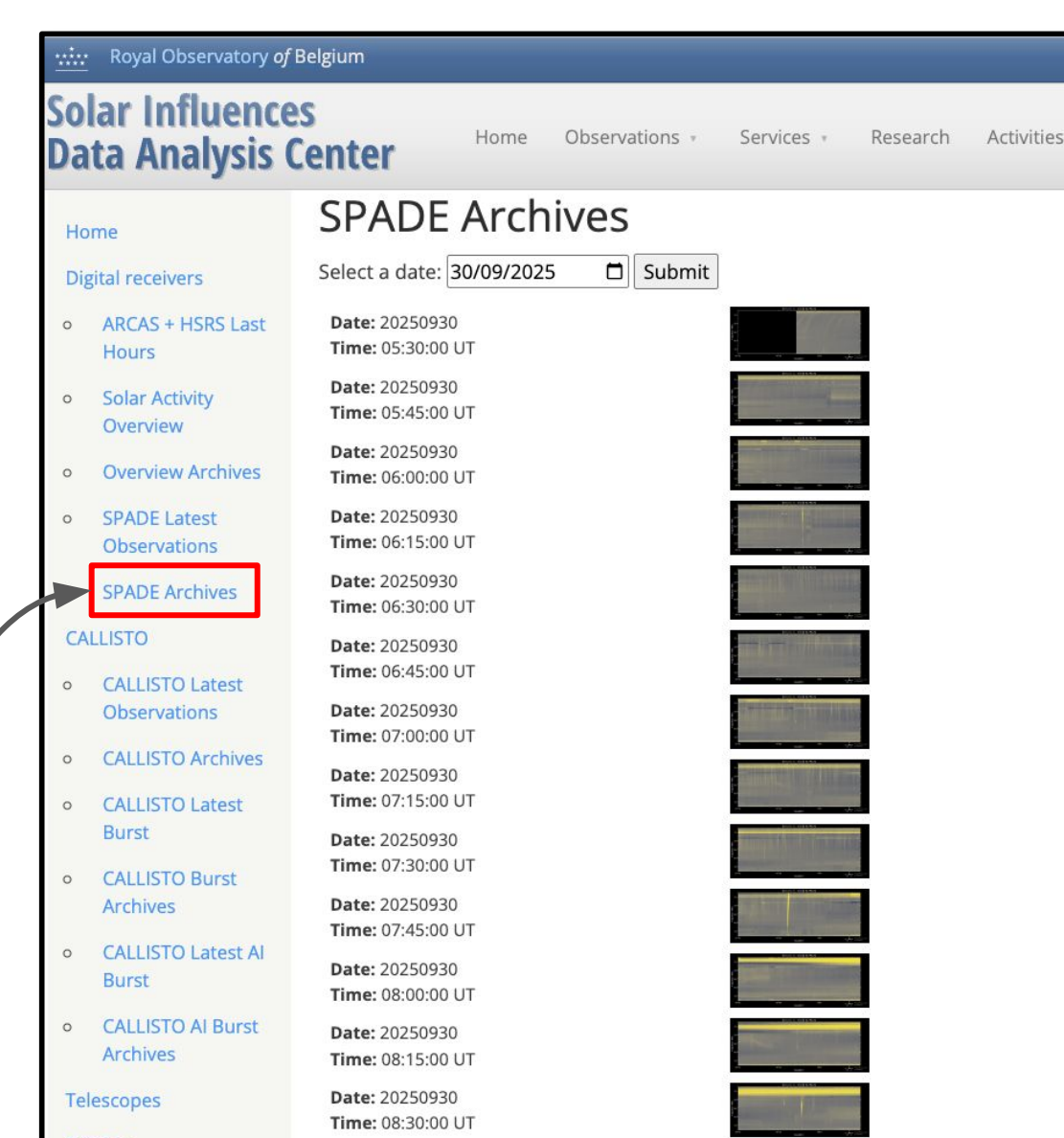
## Data production

- Currently, SPADE performs solar observations only.
- One data file generated every 10 minutes.
- Data stored in compressed (HDF-5) format.
- ~800 MB per file (~26 GB per day).
- Pipeline implemented since mid-September 2025.



SPADE latest observations page on the SIDC website.

- **Latest** and **archived** quicklook spectrograms are available on the SIDC website.

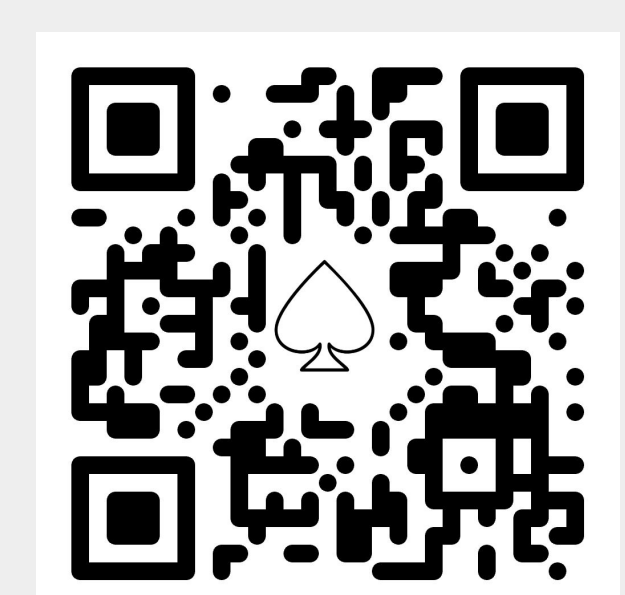


SPADE archive page on the SIDC website.

## Data Availability

### Dataset

Digital Object Identifier (DOI):



<https://doi.org/10.24414/86jw-dn13>