SPADE: Small Phased Array Demonstrator for Solar Radio Astronomy Observations

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Humain Radio Astronomy Station

Relative location of the Humain Radio-Astronomy Station in Belgium

- The Solar Physics department of the Royal Observatory of Belgium (ROB) operates a solar radio-astronomy station in Humain, south-east of Belgium.
- Since May 2008, a *CALLISTO* receiver through a log-periodic antenna is monitoring the Sun in the frequency range of 45 – 437 MHz, contributing to the worldwide *eCALLISTO* network operated by ETH Zurich Institute.
- An instrument based on Software Define Radio (SDR) technology has been added to the observational equipment. The *Humain Solar Radio Spectrograph* (HSRS) uses a 6 m dish antenna and covers the frequency range of 275 – 1493 MHz.
- Since March 2010 an *automatic burst detection feature* has been added to the Solar Radio Observation services.

The real time availability and the large frequency range observed (45 – 1493 MHz) makes Humain radio observations unique in Europe

SPADE

Small Phased Array Demonstrator

SPADE in brief

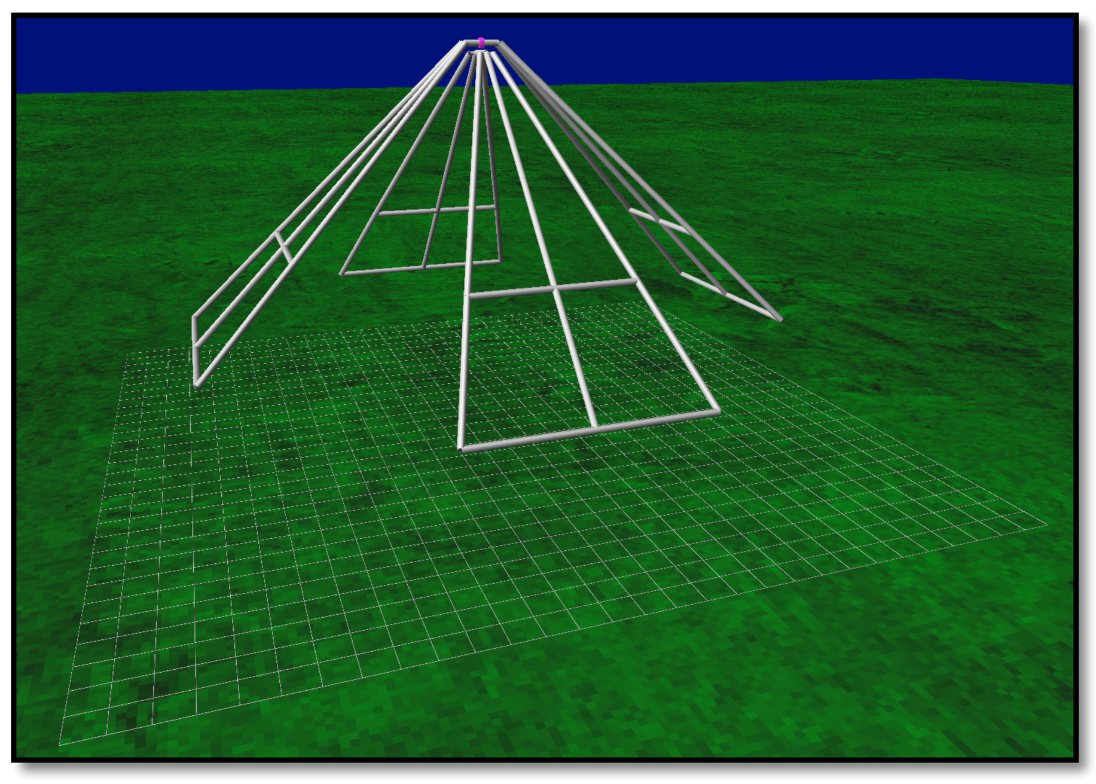
- Small array of 8 antennas
- LF Band: 20 — 80 MHz
- Main goal: Dynamic spectra (not imaging)
- SDR-based receivers
- Beam-forming will be carried out *digitally*

Benefits

- No mechanical parts
- Digital post-processing allows high flexibility
- Near-realtime dynamic spectrum observations

Antenna Element

- Cross *thick inverse vee*
- Additional conductive grid underneath
- Dual polarisation available
- Similar to *Nançay NenuFAR* project in France

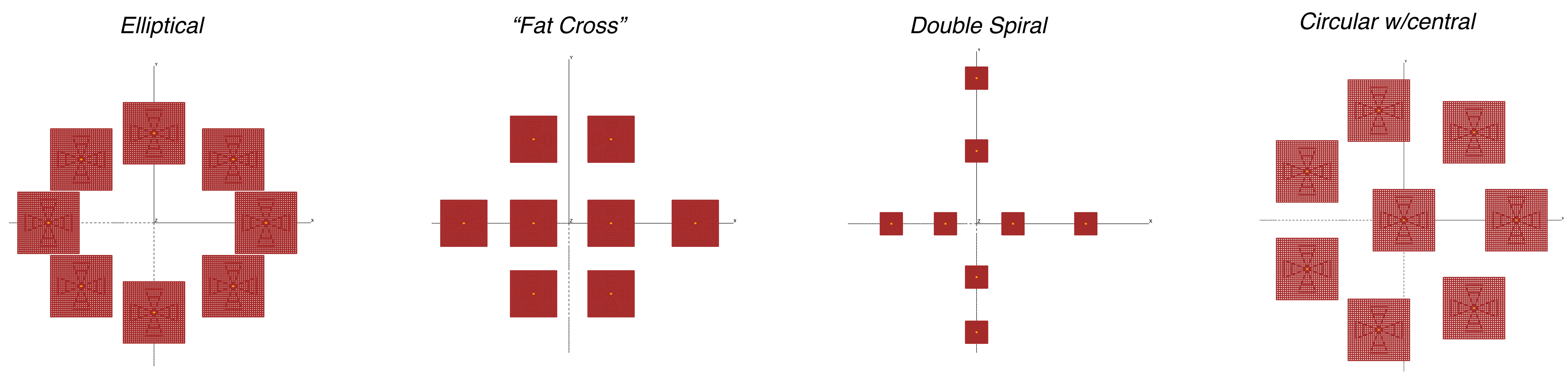


3D visualization of the antenna element

Array Configuration

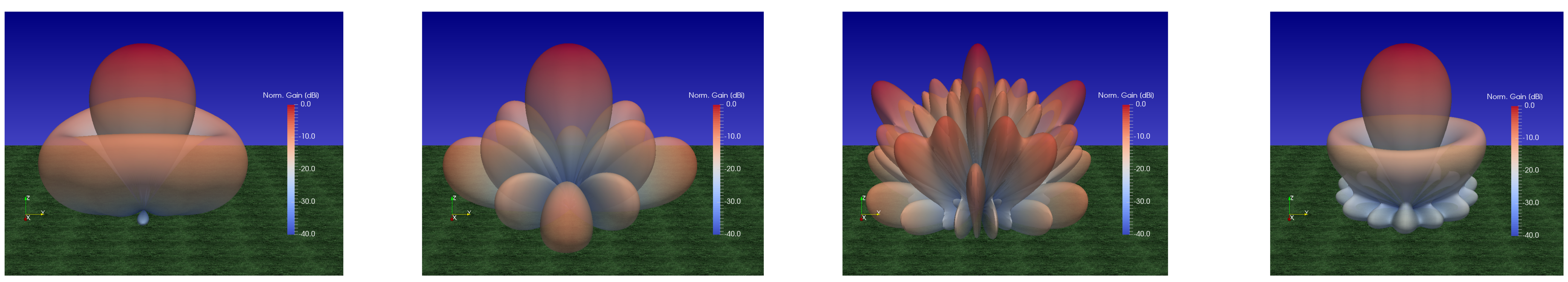
- The layout of the array must provide a symmetric beam with low side lobe levels
- Irregular distribution is not an advantage with low antenna count

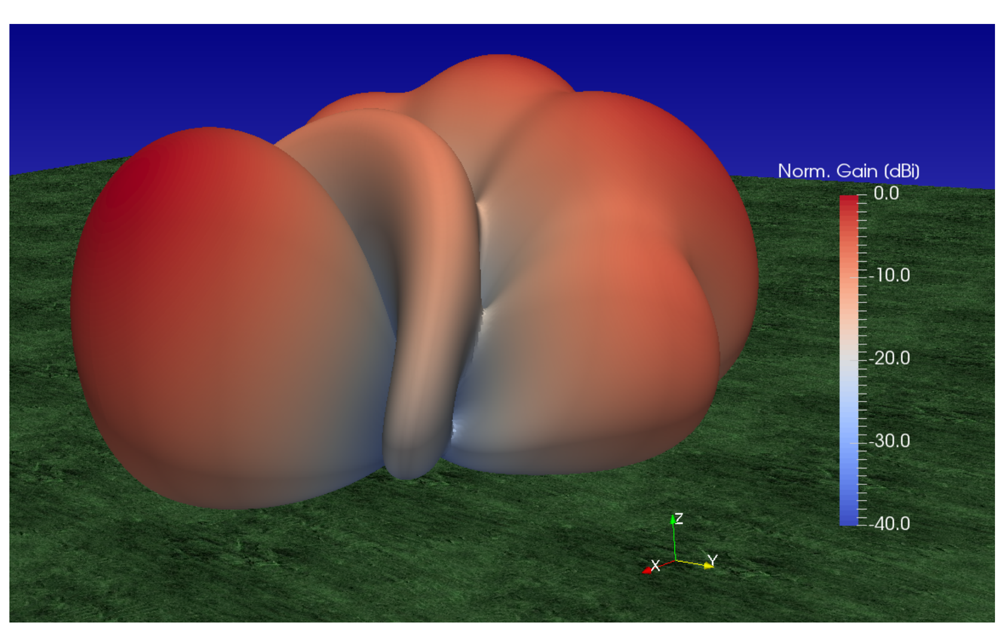
Regular spaced dipoles — d = 5.5 m



Numerical Simulations

- Software: NEC2^{++}
- Loaded elements (aluminum)
- Real ground (incl. ε & σ)





3D visualization of the array directional pattern (Log scale) for a circular configuration with central element steered to 60° in elevation

The circular distributed array with central antenna element shows a good balance in total gain and reduced side lobes levels, even in steering mode simulations.

Currently, the site in Humain is being prepared and on-going work on filter design is already pointing to a final solution.

Expected first light: before end of 2017