Surrounding effects and sensitivity of the CODALEMA experiment

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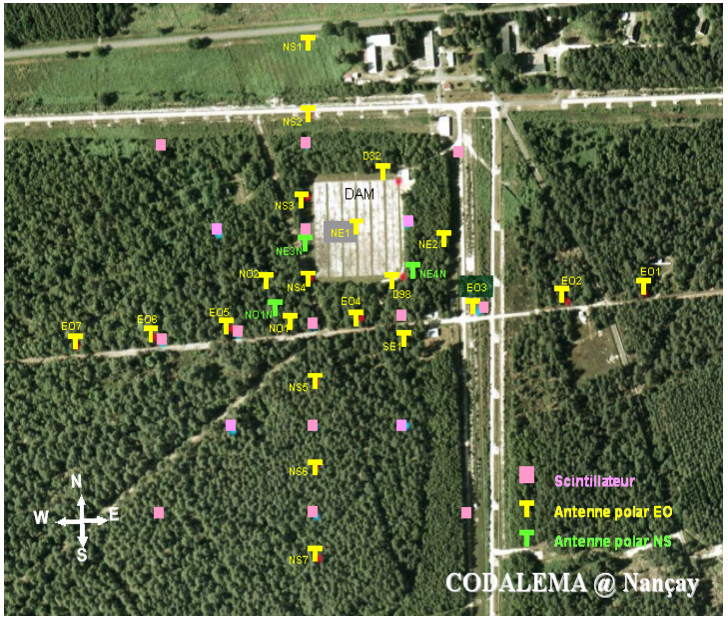
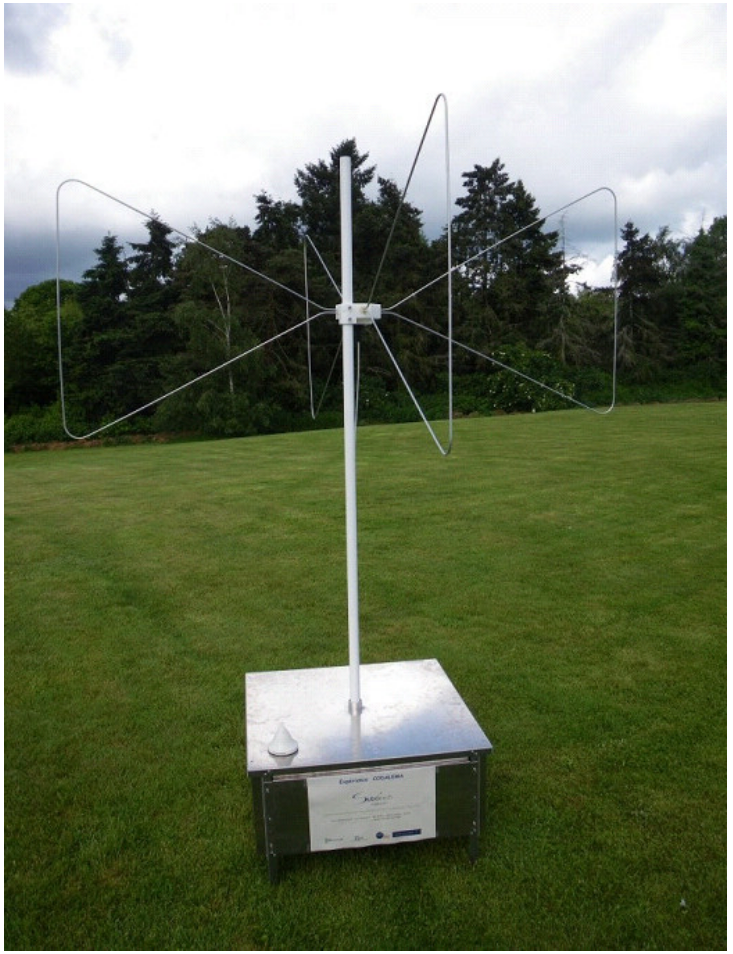
SUBATECH

The CODALEMA experiments

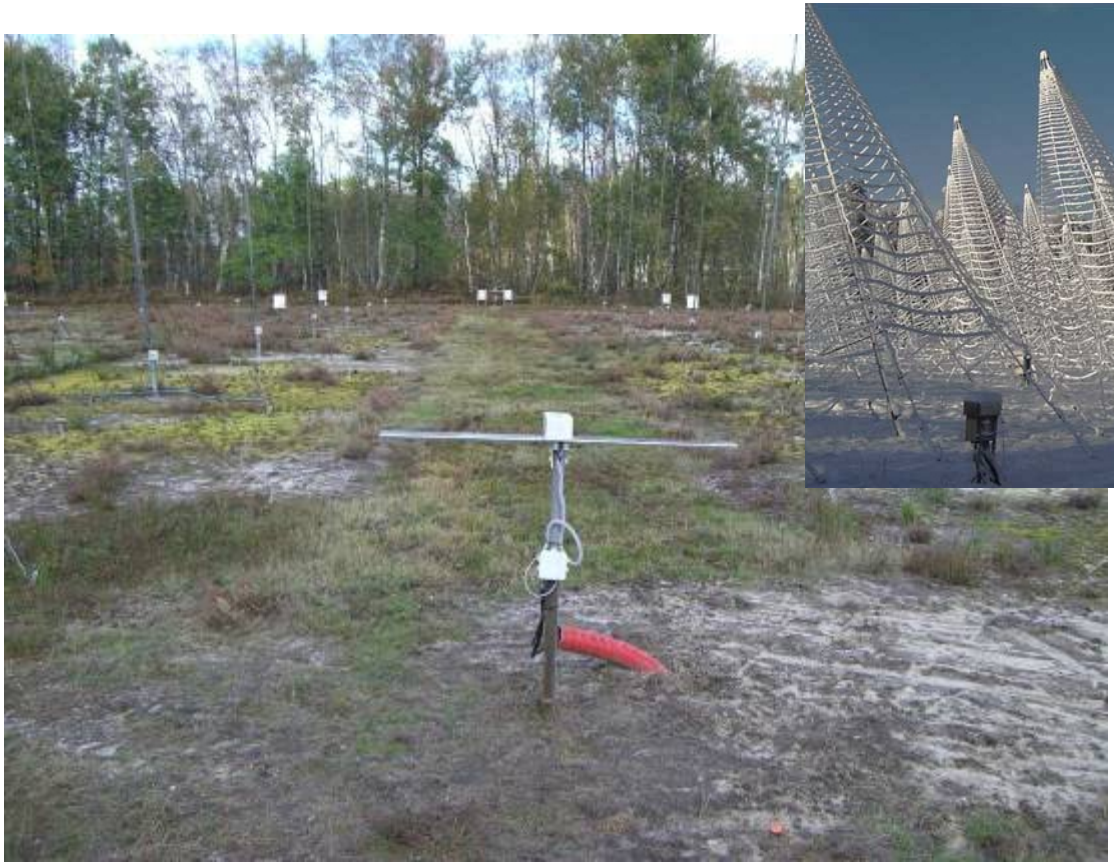
- **The cabled arrays**

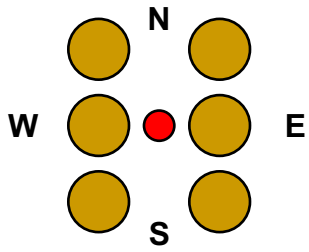


- **Autonomous stations**



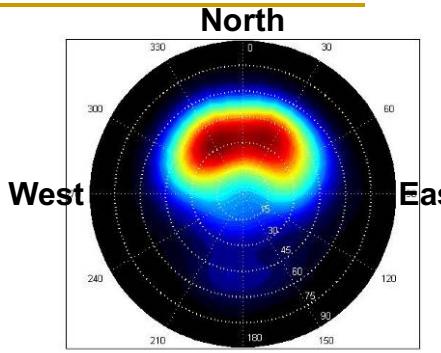
Screening and surrounding effects



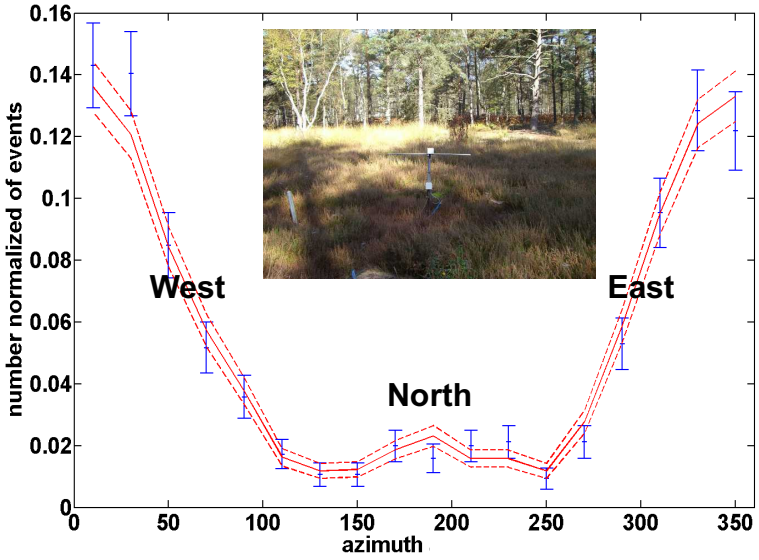


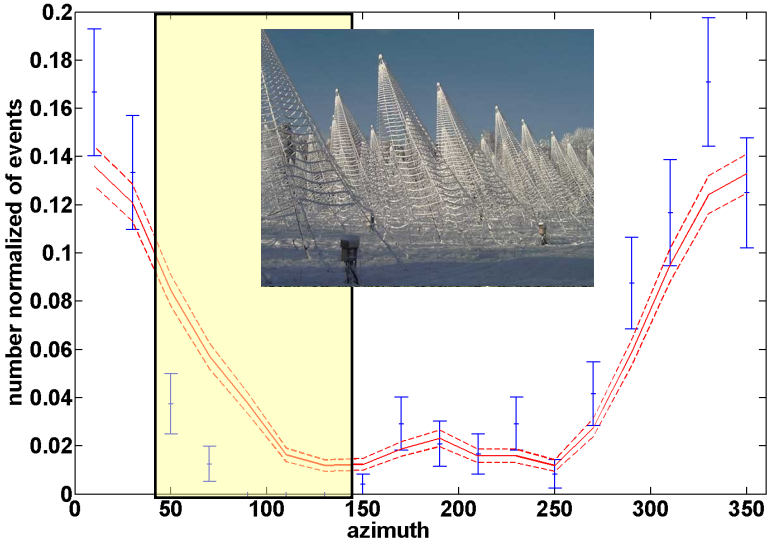
- **The CODALEMA antennas or any future large autonomous array may have to face various vicinities. What is their impact on the radiodetection?**

Screening and surrounding effects



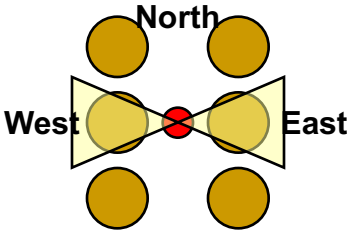
- **Selected events: cosmic ray events in coincidence between particle detectors and at least three antennas**





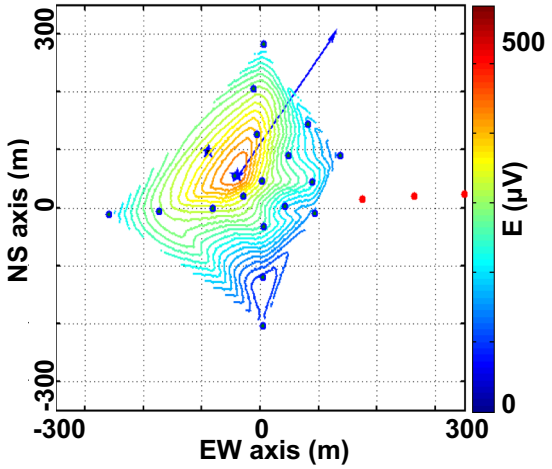
- **acceptance effect**

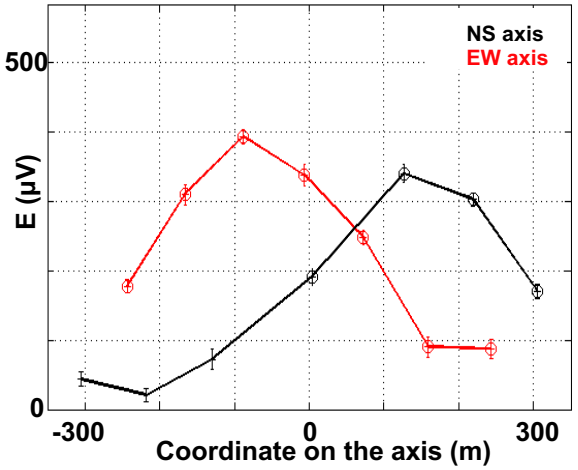
- **No noticeable screening effect. Even a specially unfavourable vicinity seems to have no impact on the detection of cosmic rays.**

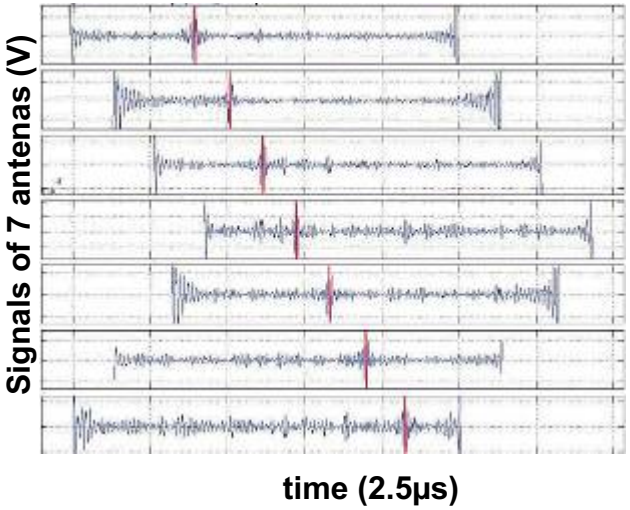


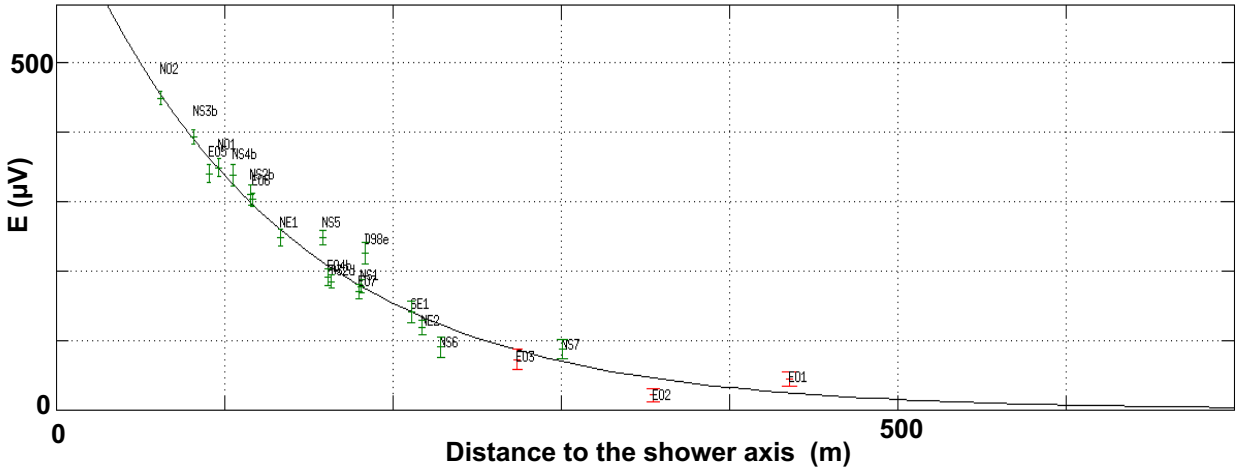
A sensitive detector

- **Despite various environments, CODALEMA obtains high quality results**





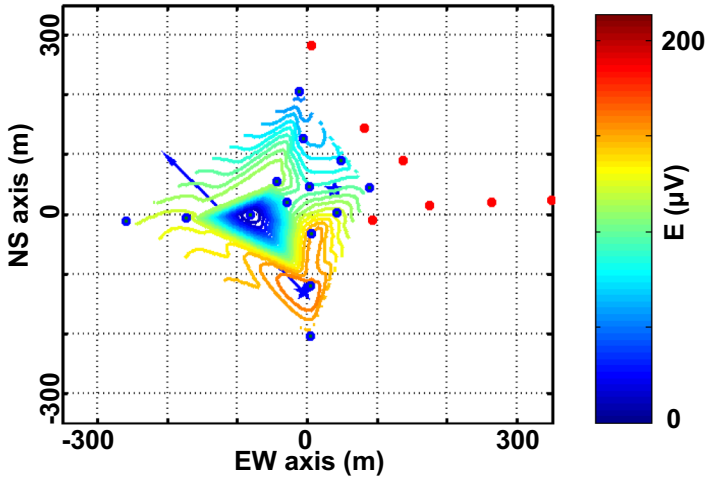


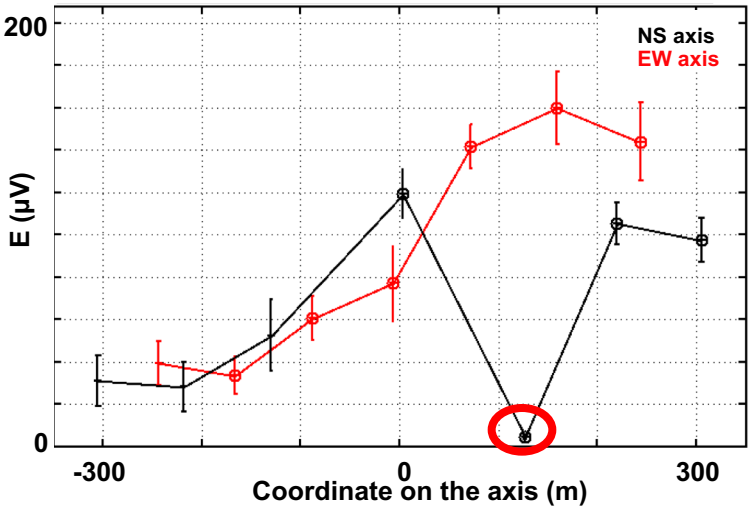


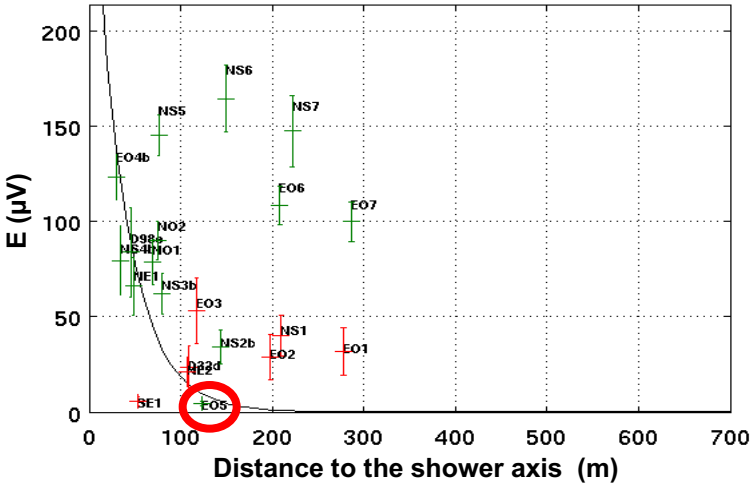
- **Accurate LDF (well fitted by an exponential function) and arrival direction reconstruction**

A sensitive detector

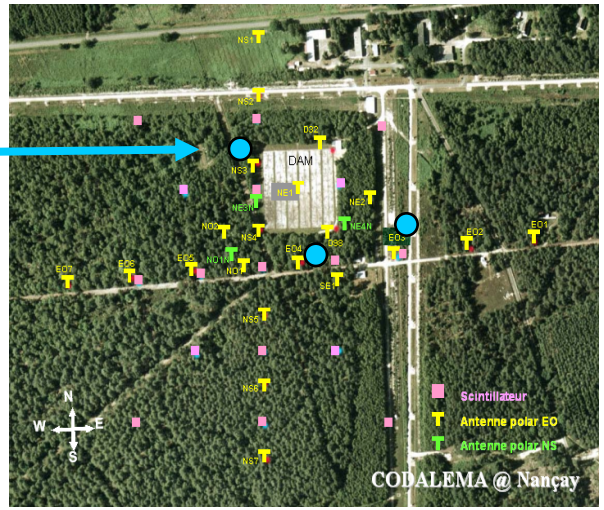
- **Unusual LDF can reveal a breakdown of one antenna**



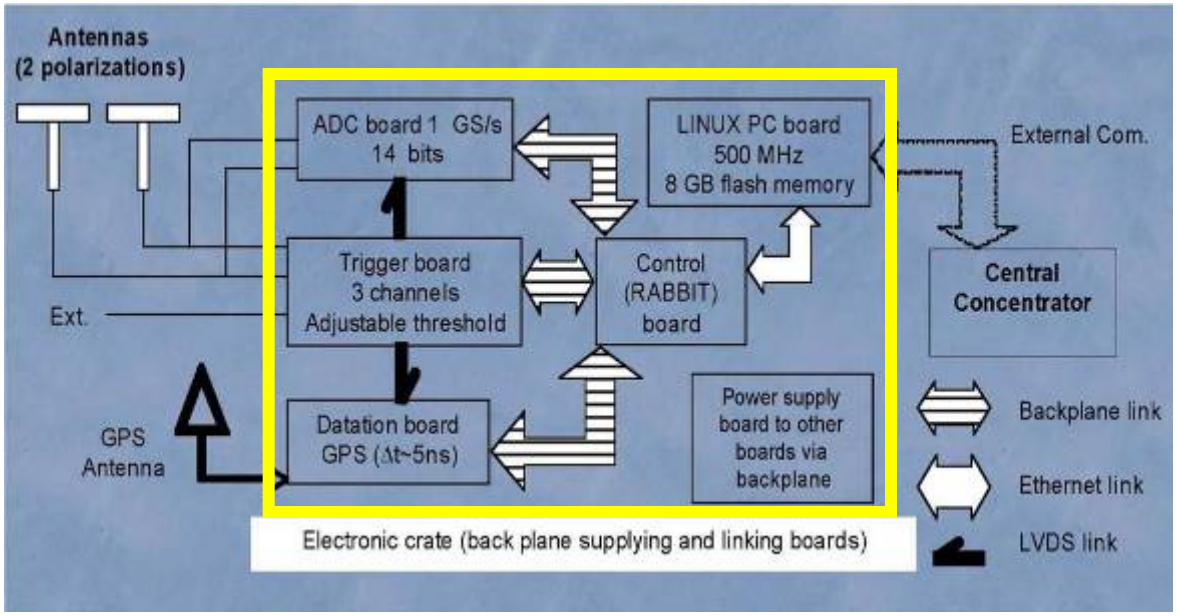


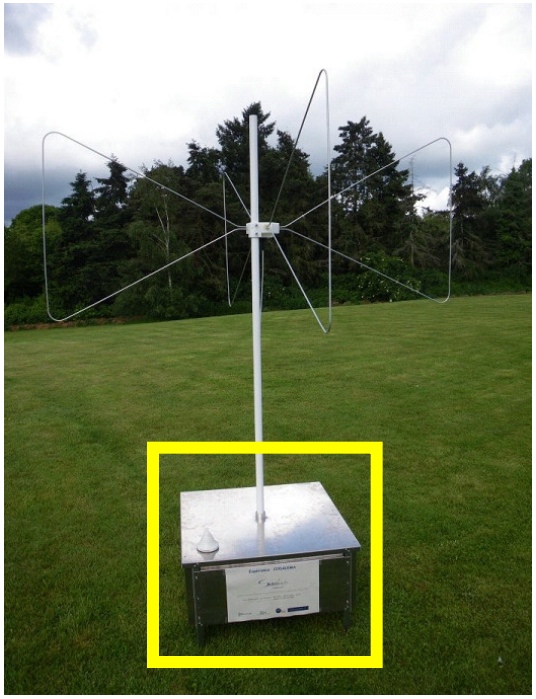


Autonomous detection

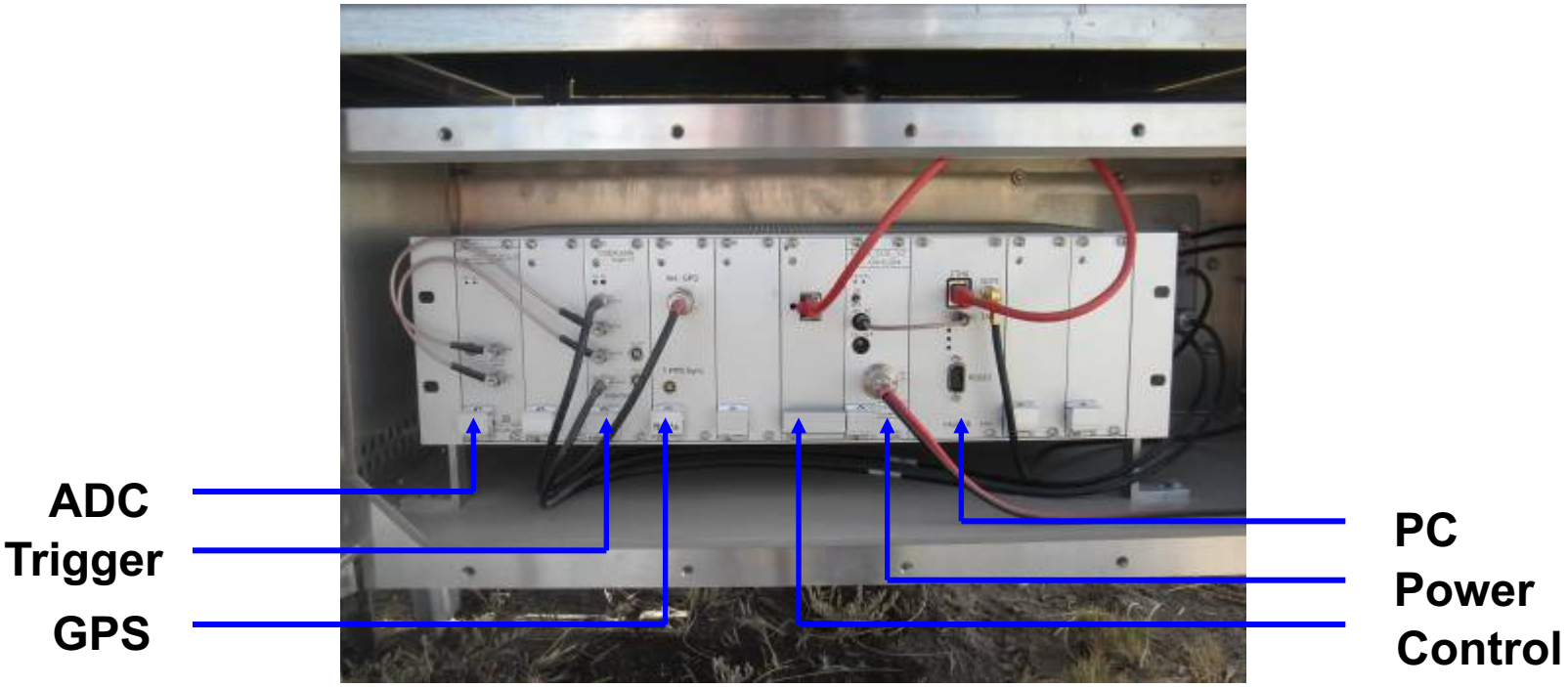


- **Goal : 100% autonomous system (trigger, power supply and acquisition), robust, compact, cheap**
- **Prototype station at Nancay : antenna, ADC, trigger , GPS, PC and control boards**





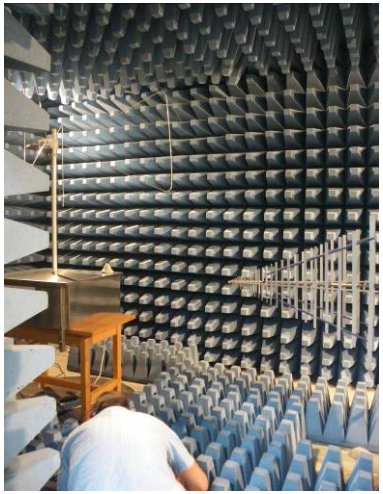
Autonomous detection

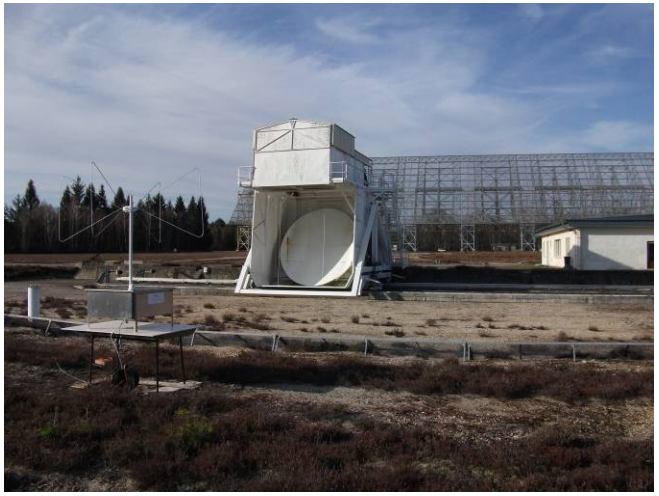


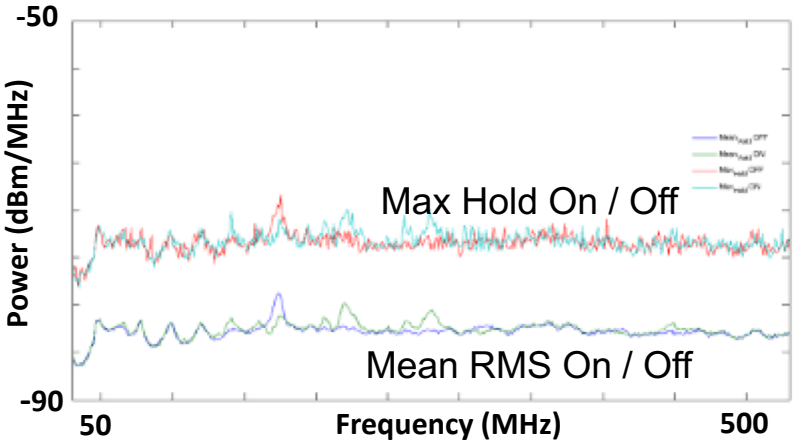
- **2 challenges: no self-induced triggering, no noise generation for other instruments of the Observatory (large and sensitive radio-telescopes)**

Electromagnetic compatibility (EMC)

- **Tests of noise produced by the autonomous station : anechoic chamber, radioheliograph array and radiotelescope measurements**



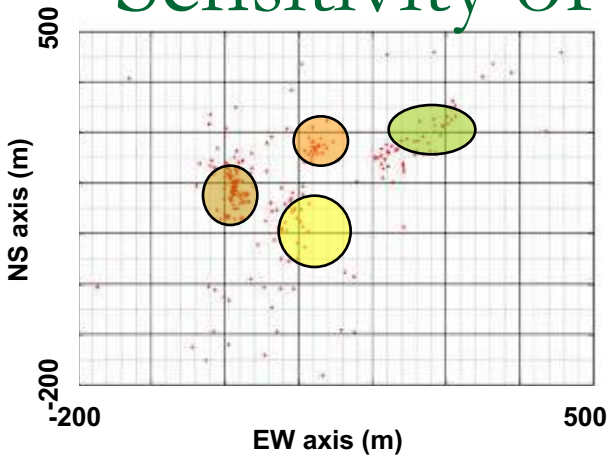




- **No noise radiated between 10 MHz and 4 GHz**
- **No self-induced triggering**

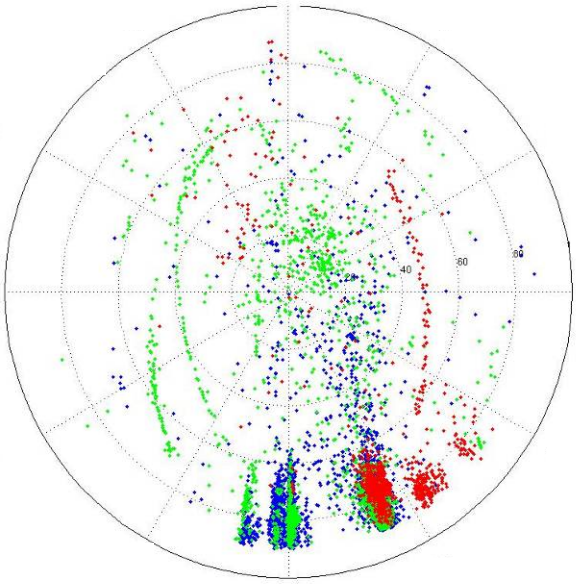
⇨ **Green light for installation @ Nançay**

Sensitivity of the autonomous detection

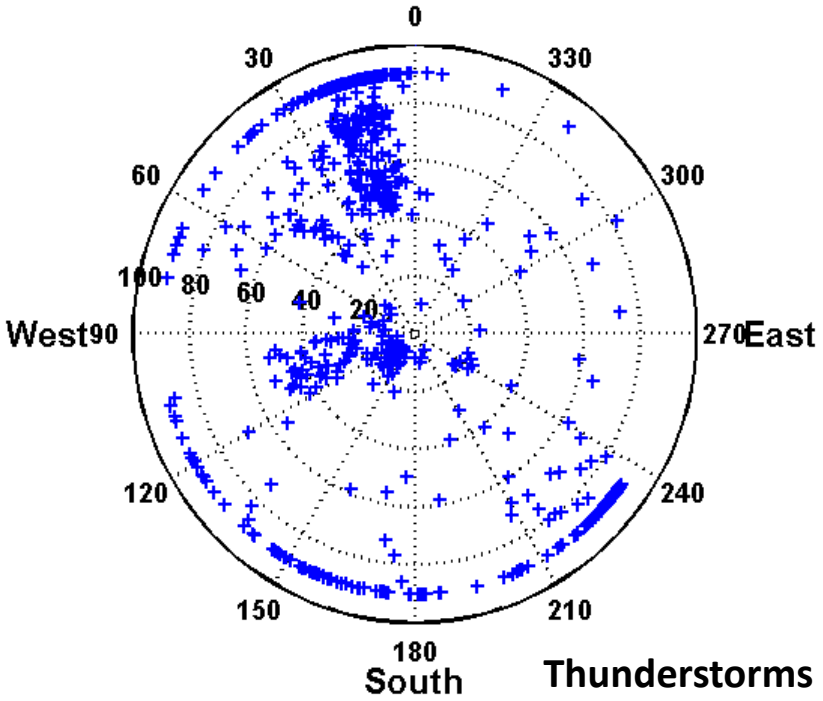


Radio Frequency Identification by the stations:

- **evaluation of the quality of the autonomous detection**
- **mapping of noise sources**
- **determination of the optimal trigger threshold**



Distant transmitters, planes

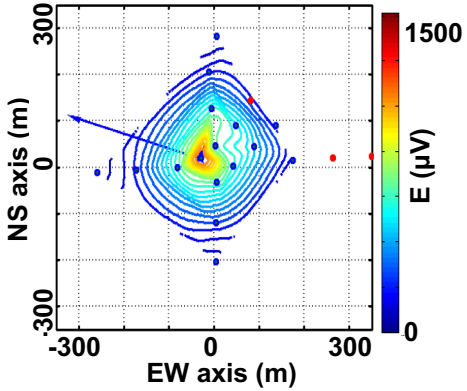


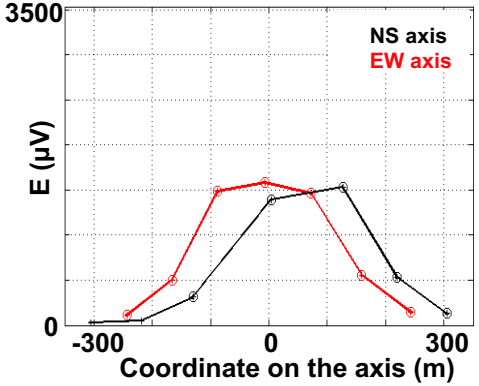
Thunderstorms

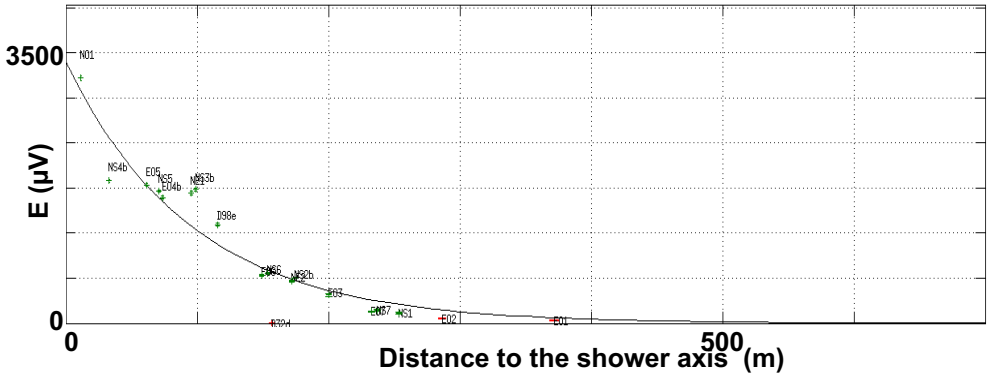
Sensitivity of the autonomous detection

- **Events observed in coincidence with the cabled array confirm the feasibility of autonomous radio-detection: ~10 coincidences in few weeks, one 2-fold coincidence few days after installation of the 3 antennas array.**

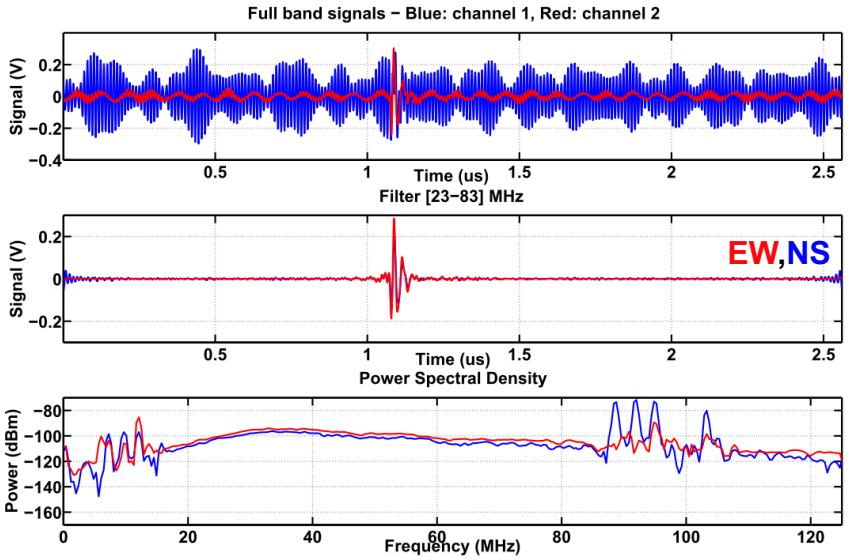
- **Cabled array**





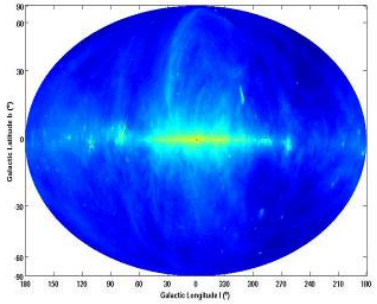


- **Autonomous stations**

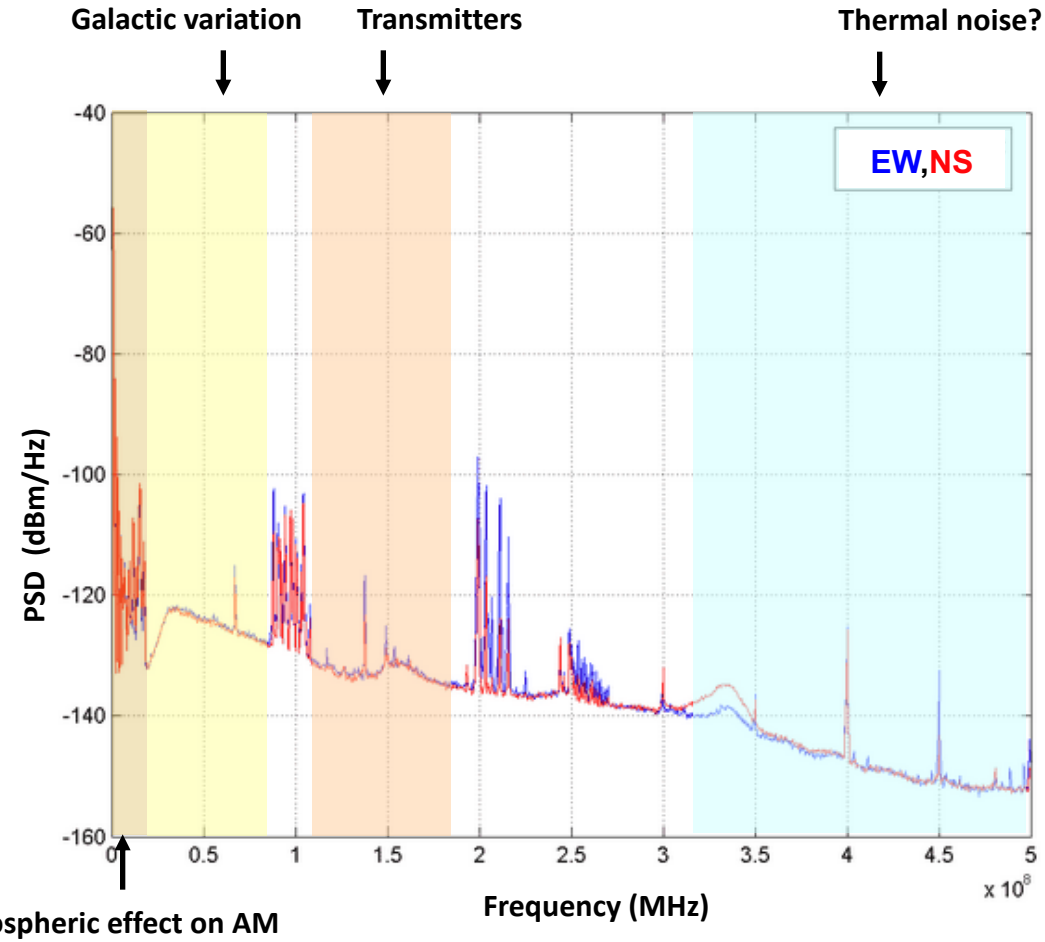


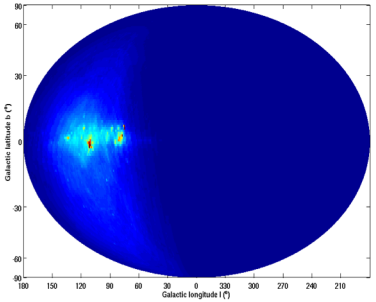
Sensitivity of the autonomous detection

- **Galactic background is the ultimate boundary for radio-detection: autonomous stations detect galactic background variations due to the Galaxy drift**



Temperature of the galactic sky in galactic coordinates





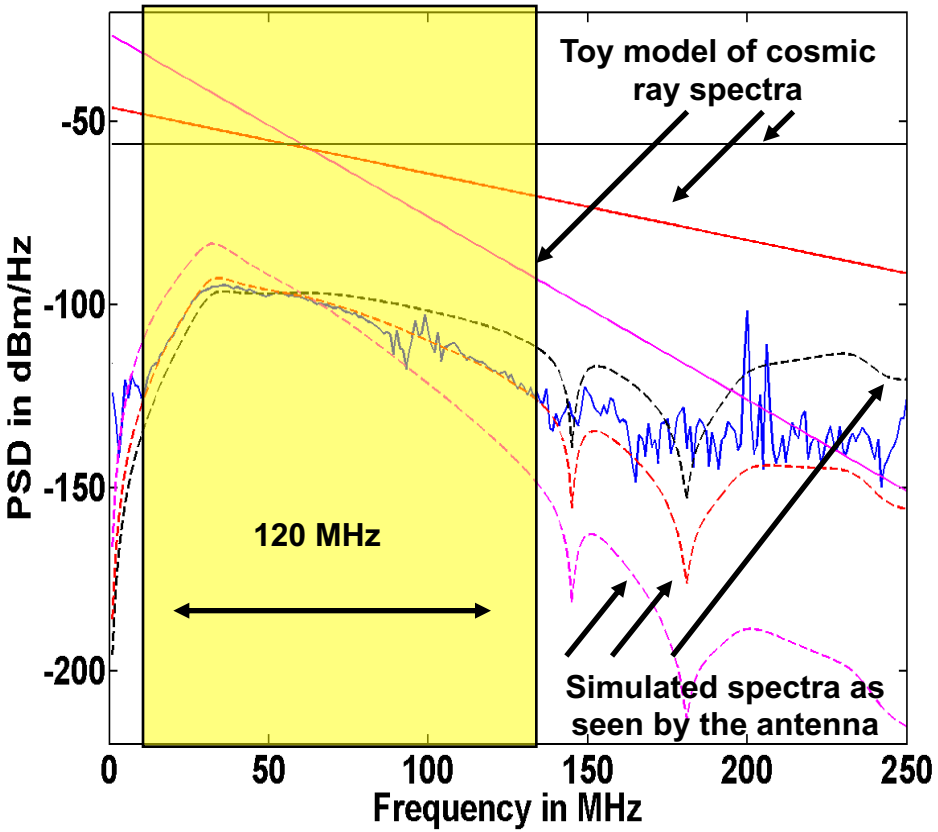
Temperature of the galactic sky seen by the antenna in galactic coordinates

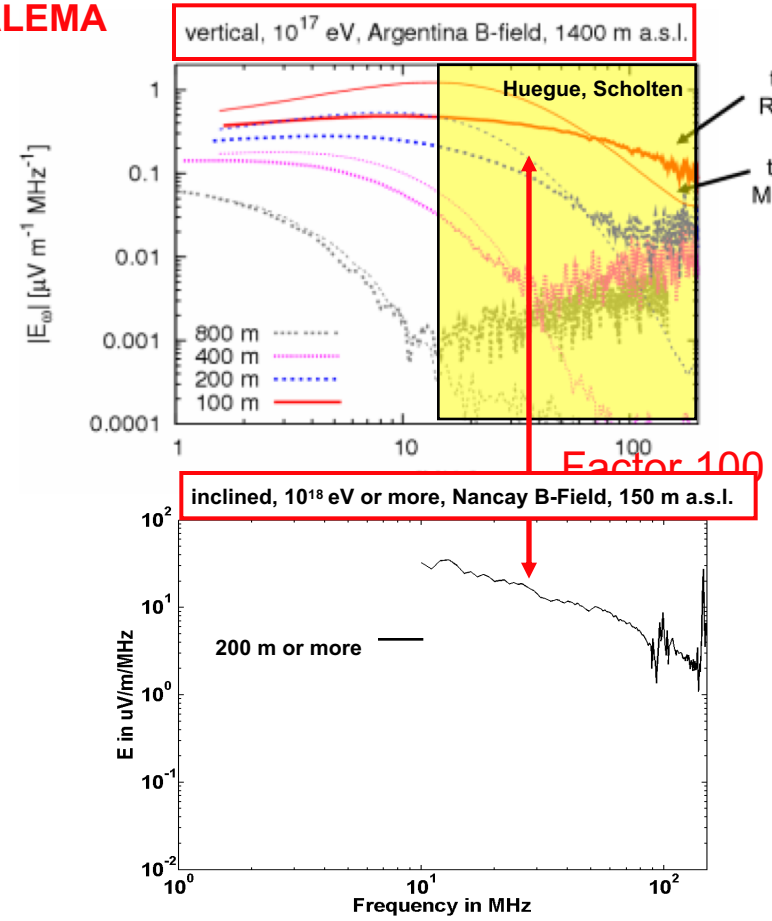
Spectra obtained in Argentina with a CODALEMA station, during 24 hours.

Towards accurate physics?

- **Thanks to large sensitivity and precise knowledge of the antenna response, it becomes possible to reconstruct the cosmic ray frequency spectrum over a very wide band**

Illustration with a powerful event (above 10^{18} eV) on CODALEMA



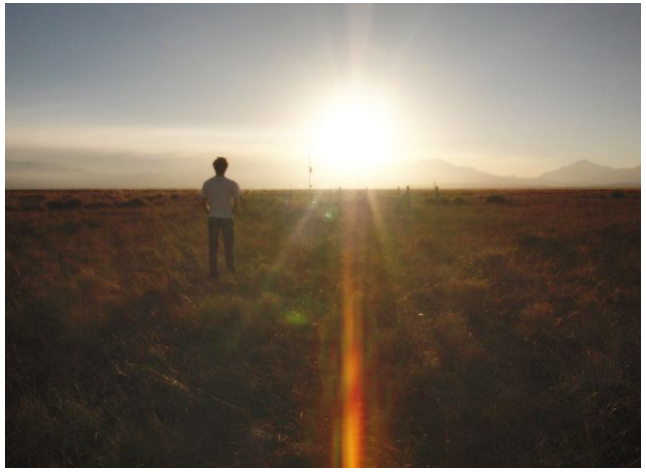


Conclusion and outlook

- **Screening effects (trees, other antennas) do not affect event detection statistics**
- **Antenna response is very well understood: simulations allows to understand and correct specific interference effects**
- **CODALEMA autonomous station is silent (no self-induced triggering, no outward noise)**
- **Sensitivity of the galactic background (ultimate noise) is reached. Large background variation observed during galactic transit.**
- **Well-known instrument: an accurate physics becomes possible, over a wide bandwidth (100 MHz)**
- **Ready for installation of large autonomous station arrays**







LOS HAROLDOS