COSMIC RAY RADIODETECTION

A NenuFAR-CODALEMA joint venture?

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Ultra-High Energy Cosmic Rays
✓ Involves astrophysics & particle physics
✓ Community → needs for a new instrument
✓ Augmentation of statistics, discrimination of composition, energy resolution

Radio detection of cosmic rays
✓ Key method for the future ?
  ‣ French competence - great opportunity !
  ‣ CODALEMA and Nançay (includes LOFAR and NenuFAR) as a development base
✓ AERA : multi-hybrid on Auger - pertinence of the method, R&D difficult on site
✓ Still to find the composition-related radio observable
✓ A new way to observe very fast transients: potential new window in radioastronomy ?

Links with LOFAR and SKA
✓ High sensor (antenna) density: very fine shower profile
✓ Ability to discriminate showers on radio signal only (aim of compact array @ CODALEMA)
✓ From compact array to NenuFAR: see discussion tomorrow…
First interaction altitude and charge production maximum depend on CR mass

\[ FY \propto f(t) \]

\[ RY \propto \left[ \frac{\partial f(t)}{\partial t} \right] \]

\[ PY \propto f(t_0) \]

This is not a continuous, but a triggered observation ("snapshots" of few µs)
CODALEMA AND NENUFAR

1.6 km

x [m] -200 -100 0 100 200 300

y [m] -200 -150 -100 -50 0 50 100 150
IT COULD HELP… PROFILE

LOFAR/LORA (see talk of A. Nelles)

CODALEMA 3

LOFAR

CODALEMA 3 + COMPACT ARRAY

SELFAS
FIG. 7. The calculated value of $R$ (see Eq. (5)) and its uncertainty for the AERA24 data set as a function of the observation angle. The dashed line denotes $R = 0$. 

With C.XS

CODALEMA 2 / SELFAS

AERA 1

CODALEMA 3

IT COULD HELP... POLARIZATION
Rejection of noise events AND/OR selection of good events

Footprint, profile, direction…

Currently working at T2 level, being implemented at T1 level

From Diego Torres-Machado PhD
Cluster triggering for improvement of selectivity (depends on results of current CODALEMA compact array)
Phased antennas ➞ Improvement of sensitivity (large distance detection if externally triggered)
Large buffer, slow digitization rate ➞ Increasing data acquisition rate (offline selection of events)
OPTIONS - 1

Isolate 1 antenna in each mini array, external trigger

Extension of current CODALEMA
Phase each mini array as 1 antenna in 1 direction, the whole covering all the sky, externally triggered.

Powerful, but dedicated operation.
Use one of the mini arrays as composite trigger for the others, not externally triggered.

Is it possible? Also depends on current CODALEMA compact array results, but would be completely autonomous!
OPTIONS - 4 and more…

Any other idea?