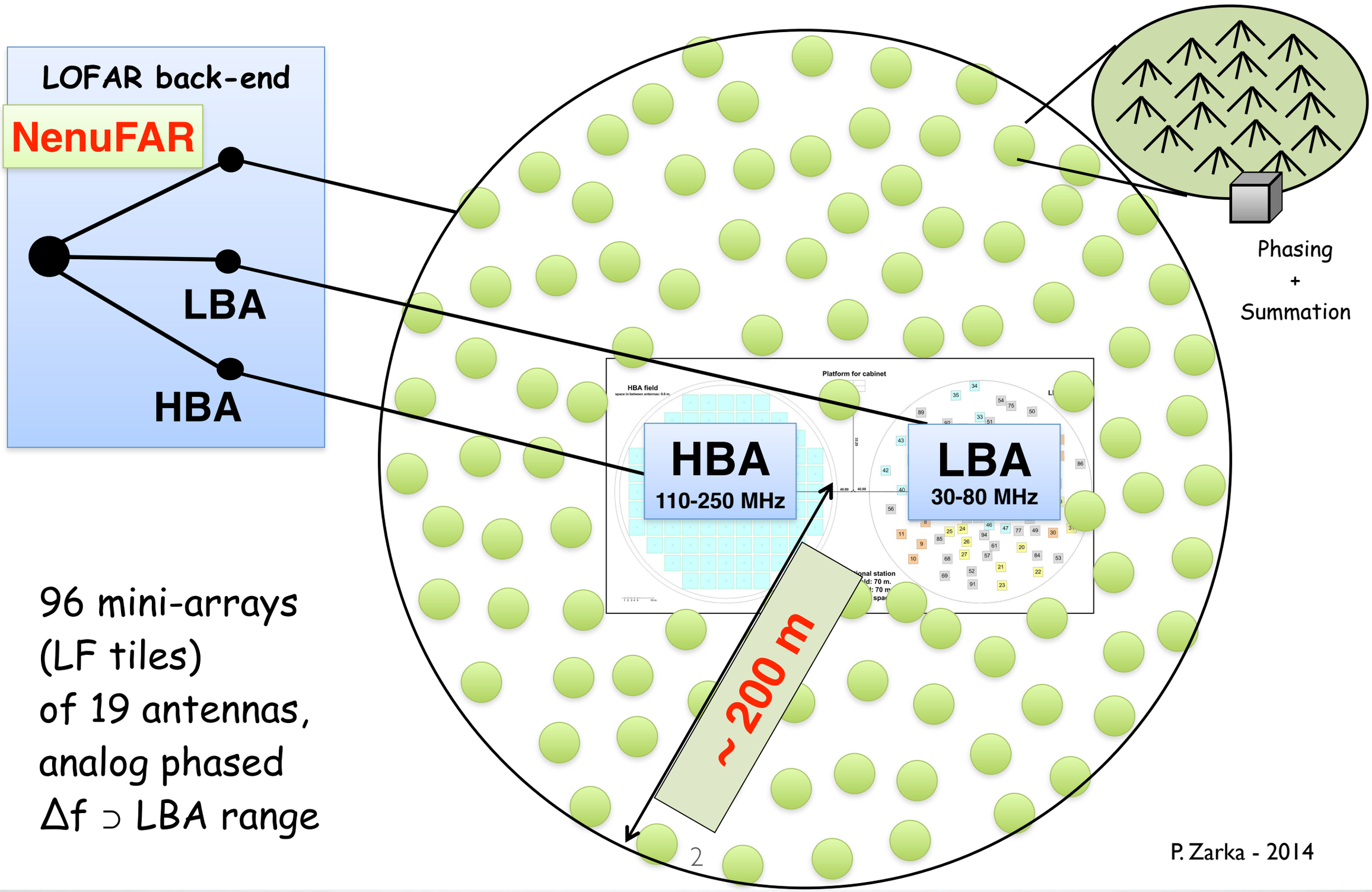
NENUFAR & CODALEMA

New Extension in Nançay Upgrading LOFAR

Richard Dallier
Subatech, CNRS/IN2P3 - Ecole des Mines de Nantes - Université de Nantes

NENUFAR as a LOFAR Super Station (LSS)

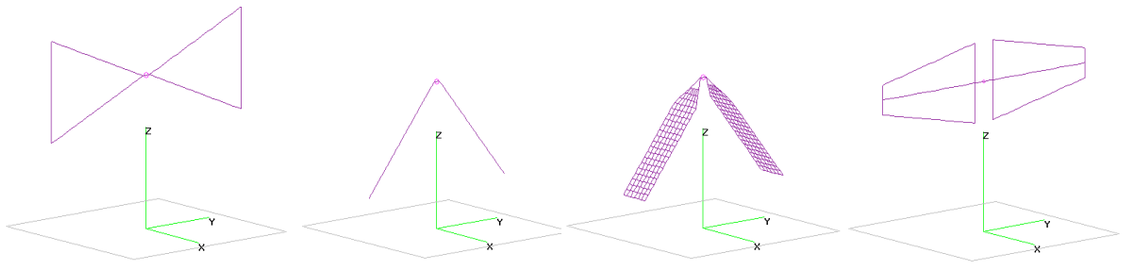
The LOFAR Super Station (LSS) concept : giant local phased array + interferometer

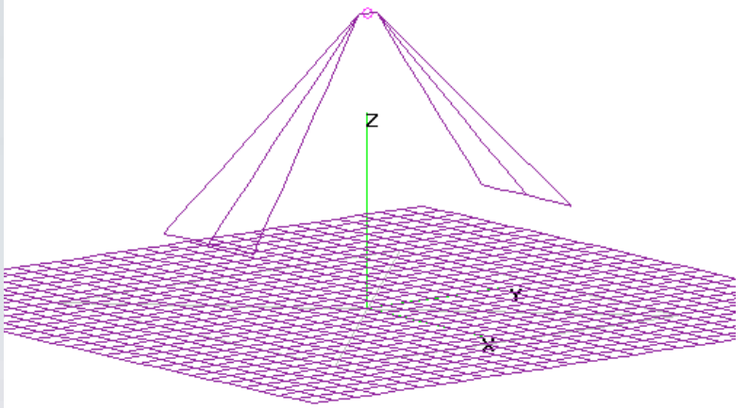


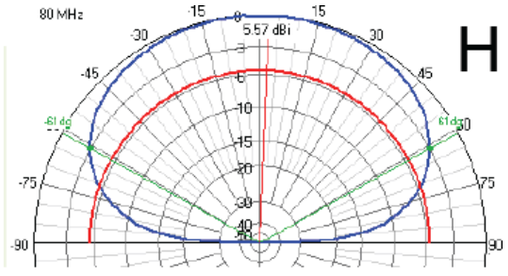
96 mini-arrays
(LF tiles)
of 19 antennas,
analog phased
$\Delta f \supset$ LBA range

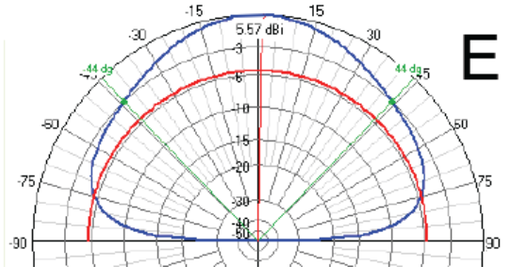
P. Zarka - 2014

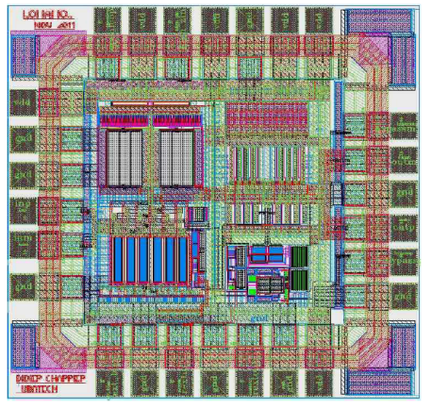
Antenna radiator & preamplificator

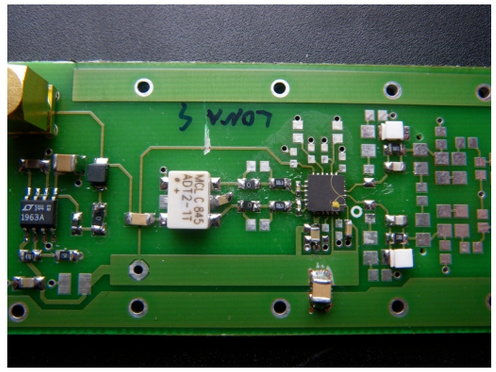


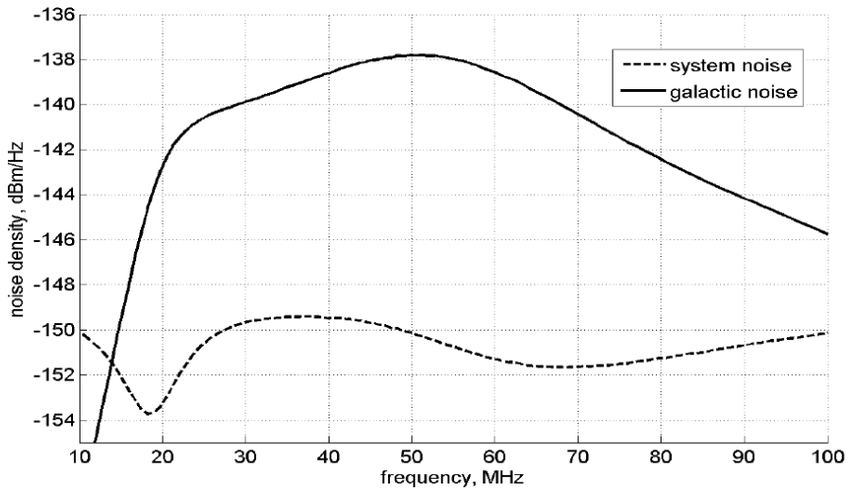


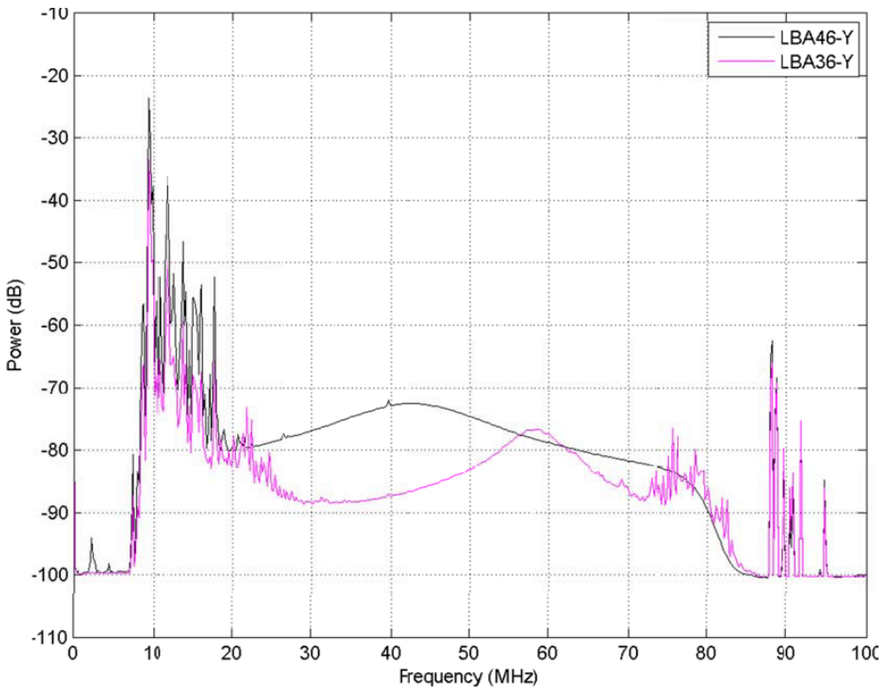












P. Zarka - 2014

NENUFAR MODES

- With LOFAR backend for LSS mode
- With a dedicated backend in standalone mode
- Both can be operated at the same time, but if in LSS mode then FoV is reduced to a single mini-array FoV (60°-8° @ 10-80 MHz)
- Transient Buffer Board (TBB) of LOFAR backend for each mini-array

Technical characteristics of NenuFAR

https://nenufar.obs-nancay.fr/

- Giant LOFAR-compatible phased array & interferometer
- 1824 antennas : 96 mini-arrays of 19 antennas each
- Diameter ~400 m
- Collective area ~ 62 000 m^2 @ 30 MHz ($\propto\lambda^2$)
- Frequency range = 10-85 MHz (λ=3.5-30m)
- Broad FoV (8°-60°), pointing -23° → +90°
- Resolution ~ 1° (Standalone) - 0.1 " (LSS)
- Resolutions <1 msec × 1-100 kHz, Full polarization (4 Stokes)
- Sensitivity <10 mJy (10^{-28} $Wm^{-2}Hz^{-1}$) [+confusion]
- SKA-Low pathfinder

P. Zarka - 2014

	antenna	Mini-Array	NenuFAR
• Phasing / scale :			
• Beaming :	~2 π	8° - 60°	0.5° - 4°

NENUFAR vs SKA-EAS specs

SKA-EAS (Tim's talk)

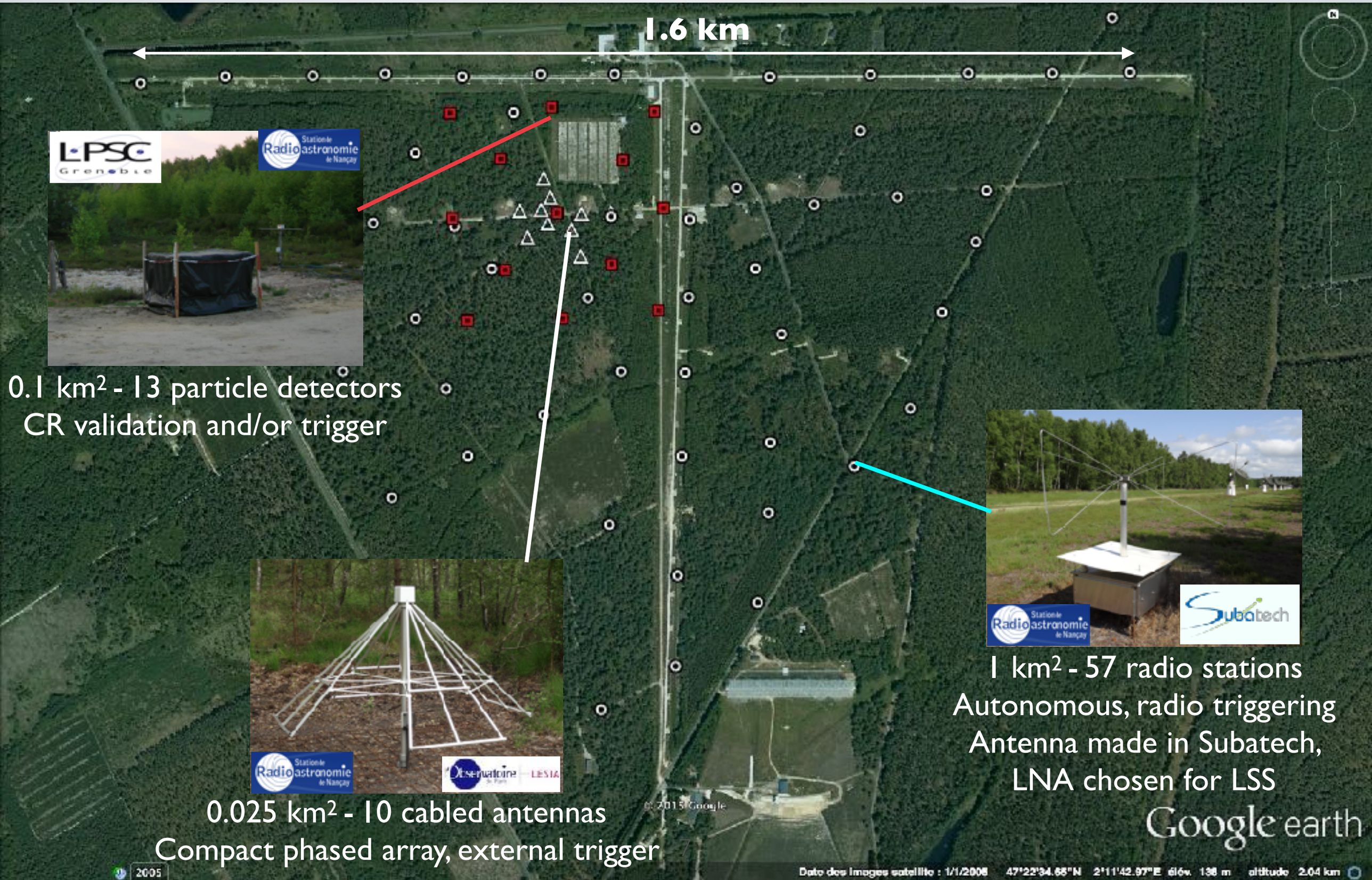
8 bits effective (12 bits)
1 ns time calibration
50 - 350 MHz
Raw waveforms
10 ms buffer (TRG latency)
50 µs readout window
10-20 m grid

Current NenuFAR

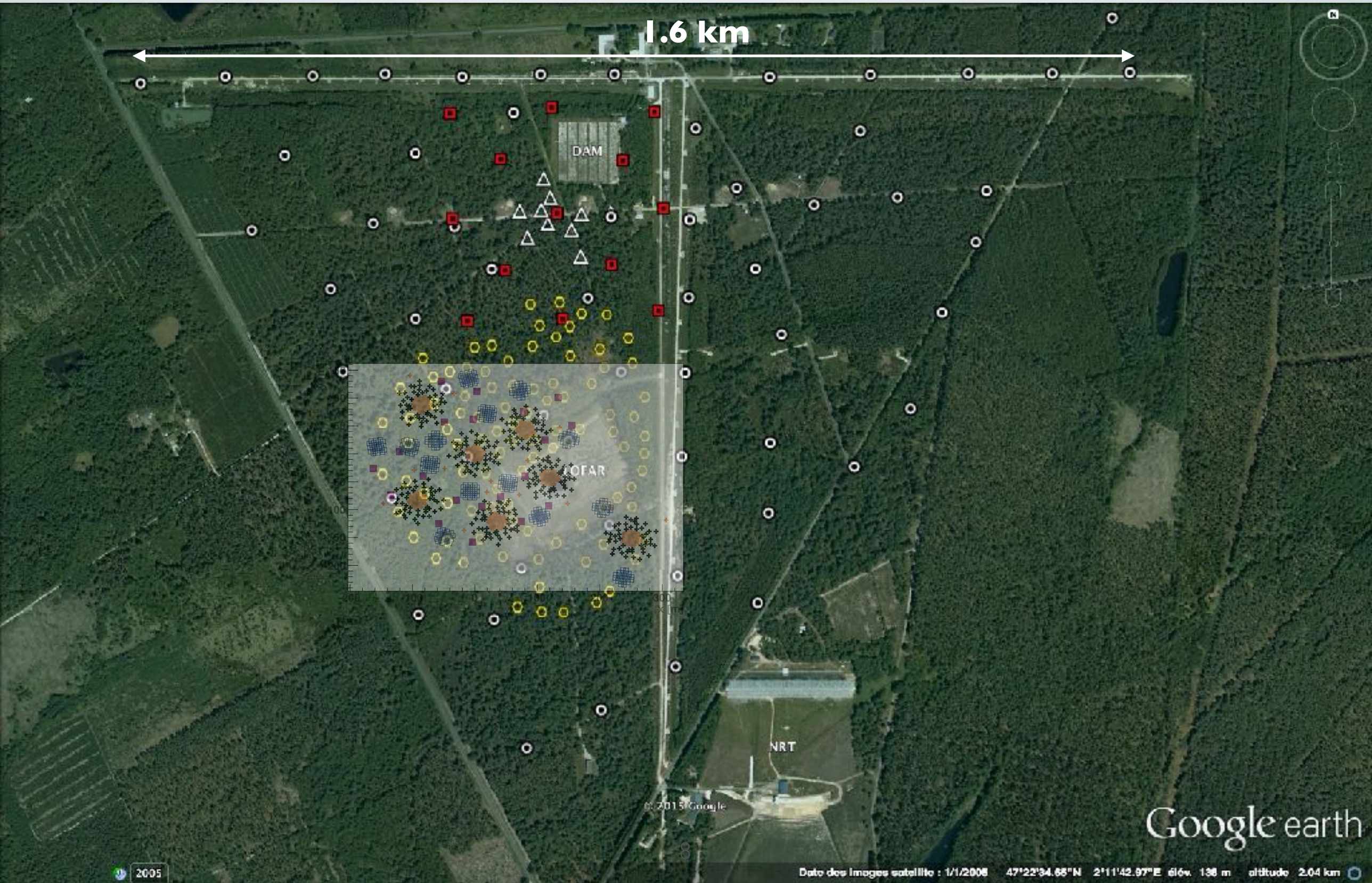
SM: >10 bits effective (14 bits)
LM: TBB: 5 ns time calibration
10 - 85 MHz
Raw waveforms: 1/mini-array
? (TRG latency)
SM: 10 µs (δf=100 kHz)
27.5 m grid between M.A.

SM: Standalone Mode
LM: LOFAR Mode

CODALEMA

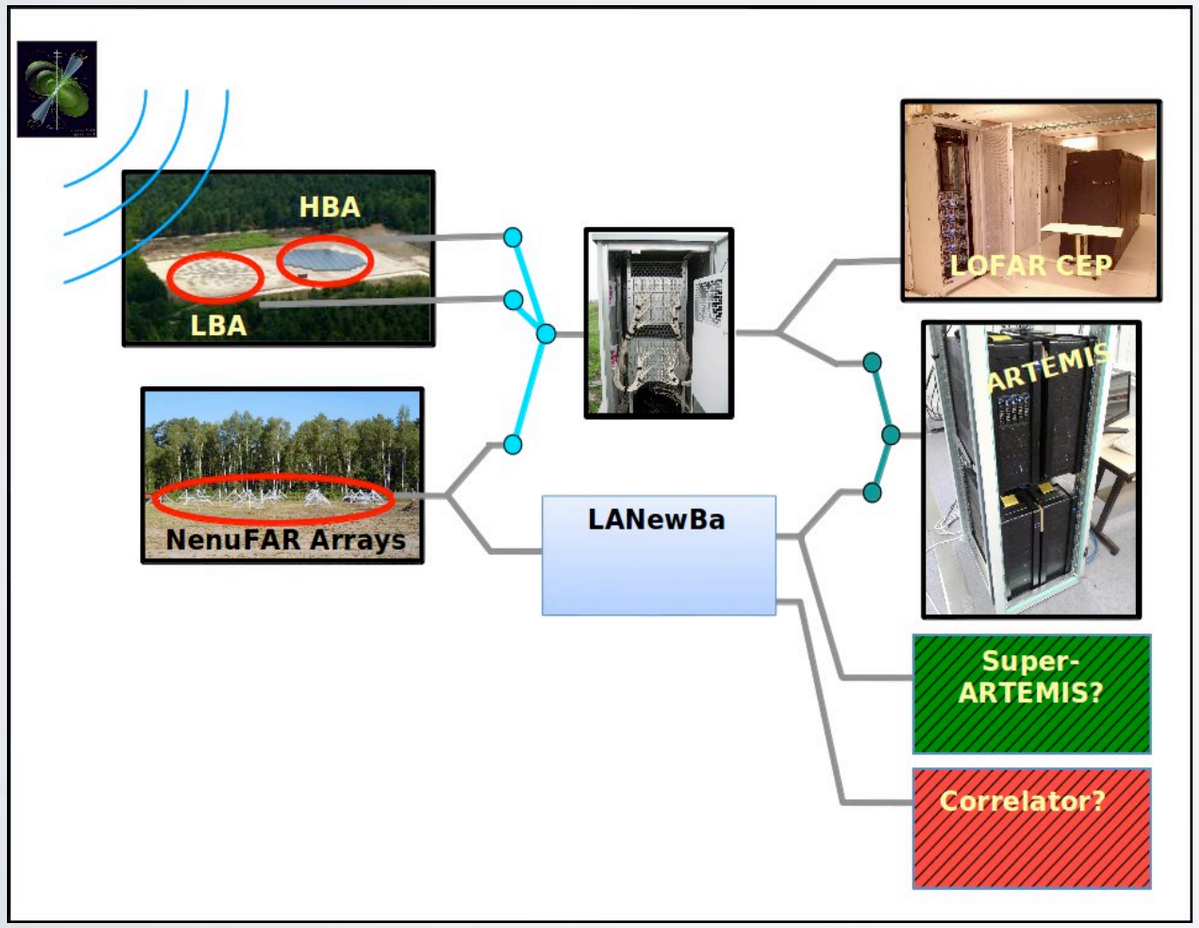

1.6 km
0.1 km² - 13 particle detectors
CR validation and/or trigger
0.025 km² - 10 cabled antennas
Compact phased array, external trigger
1 km² - 57 radio stations
Autonomous, radio triggering
Antenna made in Subatech,
LNA chosen for LSS
Google earth

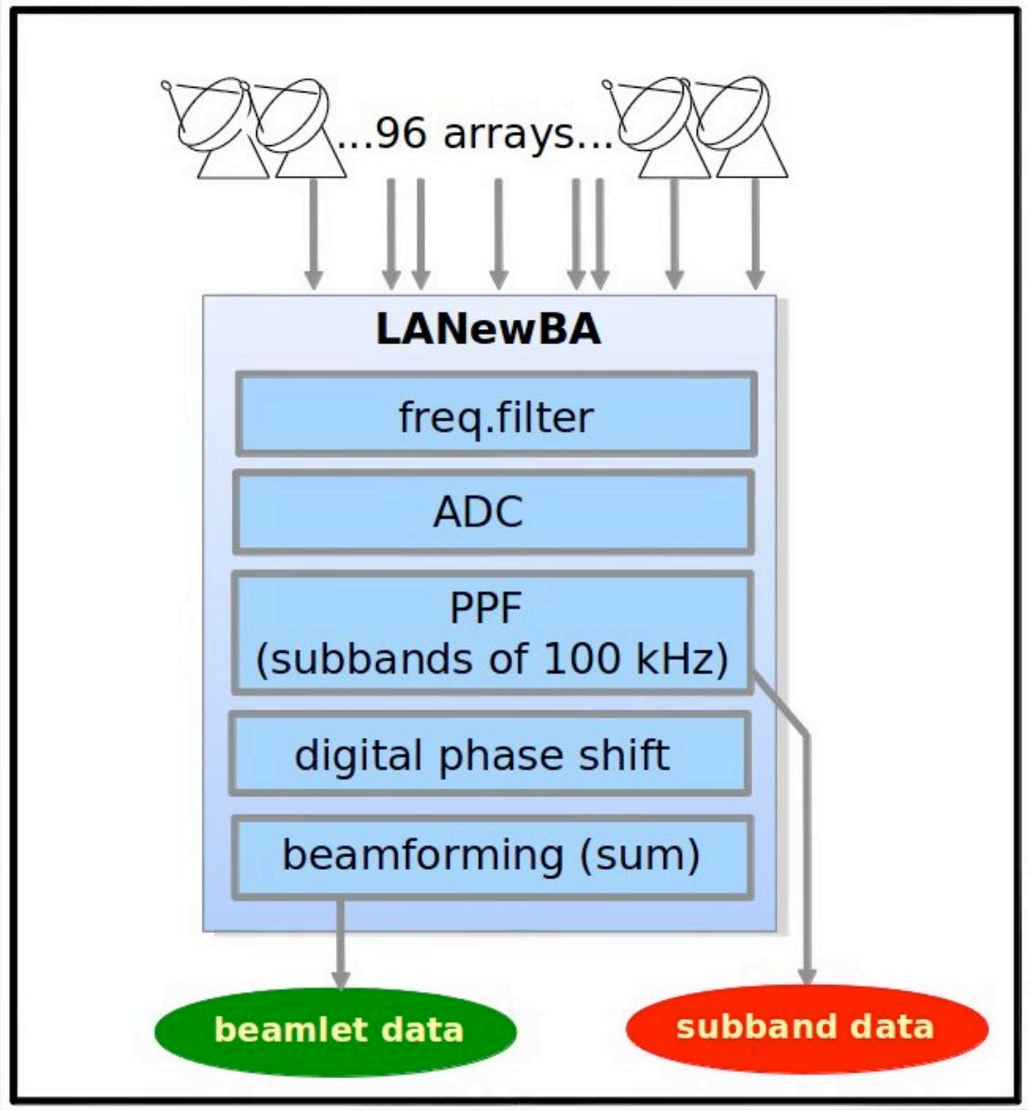
CODALEMA AND NENUFAR



NENUFAR-LUNAR MODE

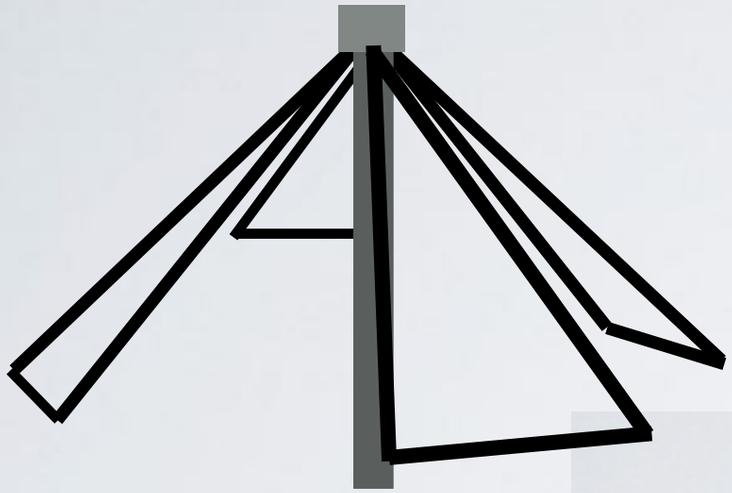
- Standard operation of the standalone instrument, provided an ARTEMIS-like post-backend is used - either with LOFAR (exists) or local backend (TBD)
- Just need to request observing time / write a proposal for an observation programme
- You're welcome to do it !

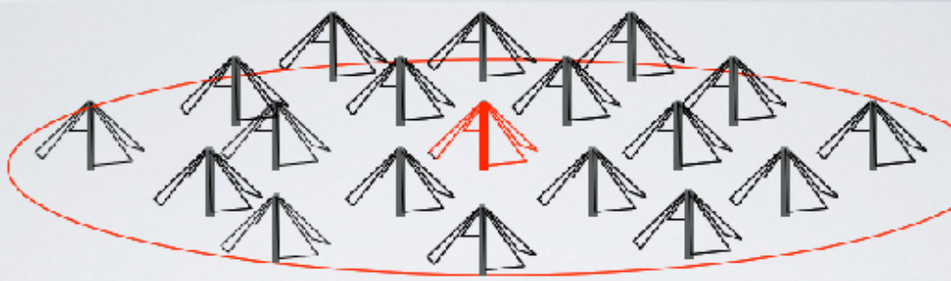


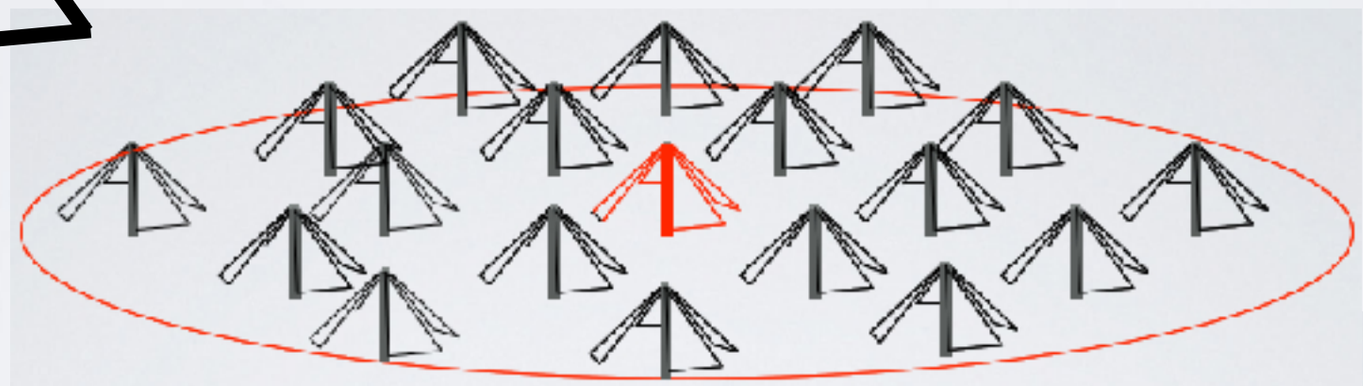


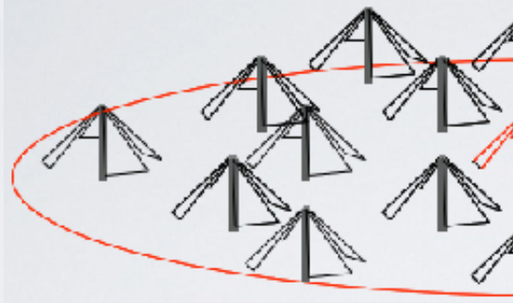
NENUFAR-EAS - OPTION 1

- Isolate 1 antenna in each mini array, external trigger

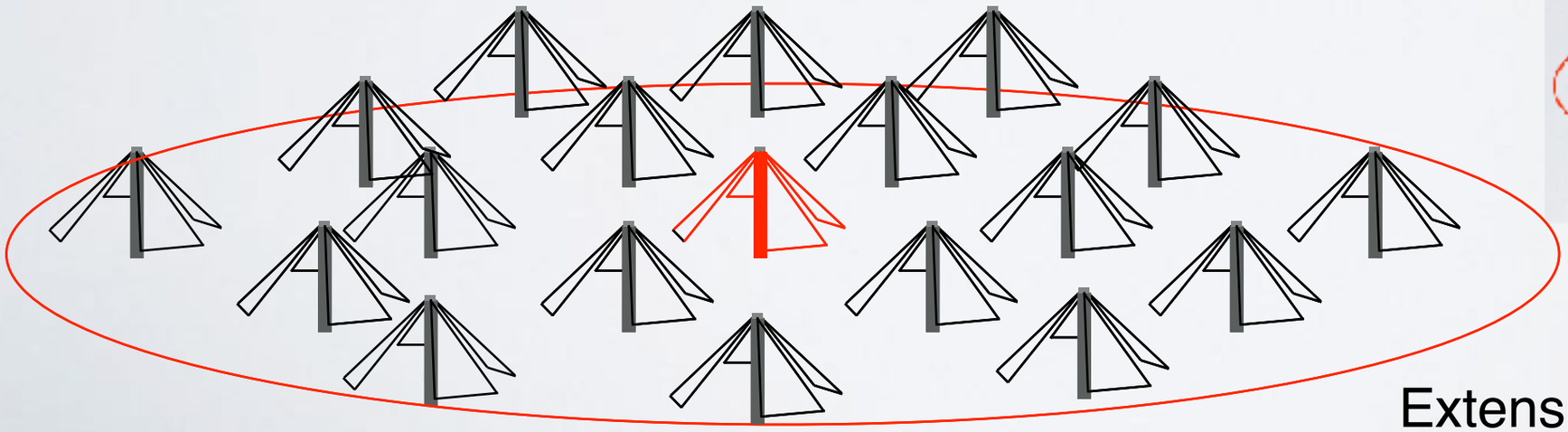








Wide beam

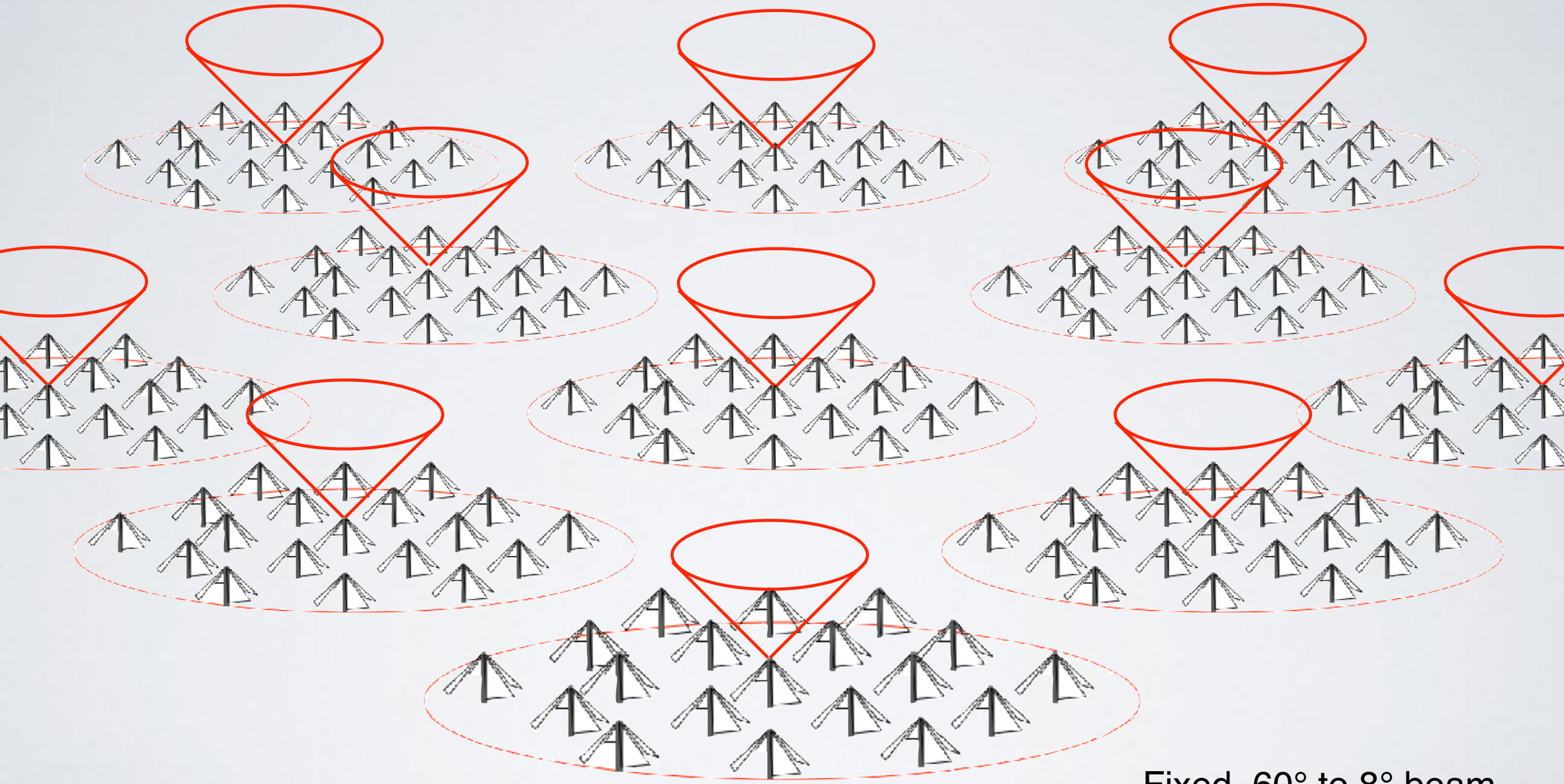


Extension of current CODALEMA

NENUFAR-EAS - OPTION 2

- Use TBB at the scale of 1 mini-array, on each M.A.

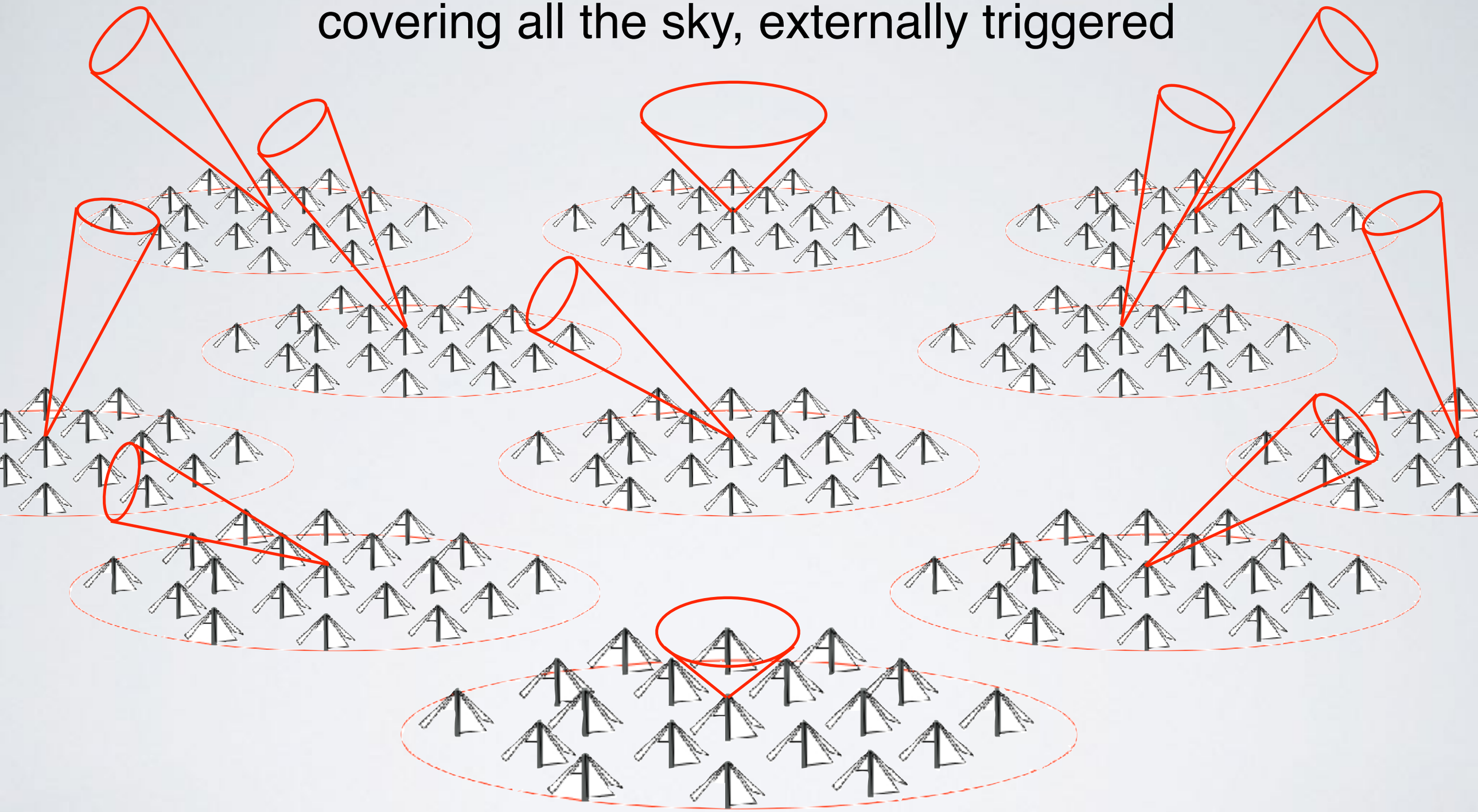
Externally triggered



Fixed, 60° to 8° beam depending on frequency and current observation

NENUFAR-EAS - OPTION 3

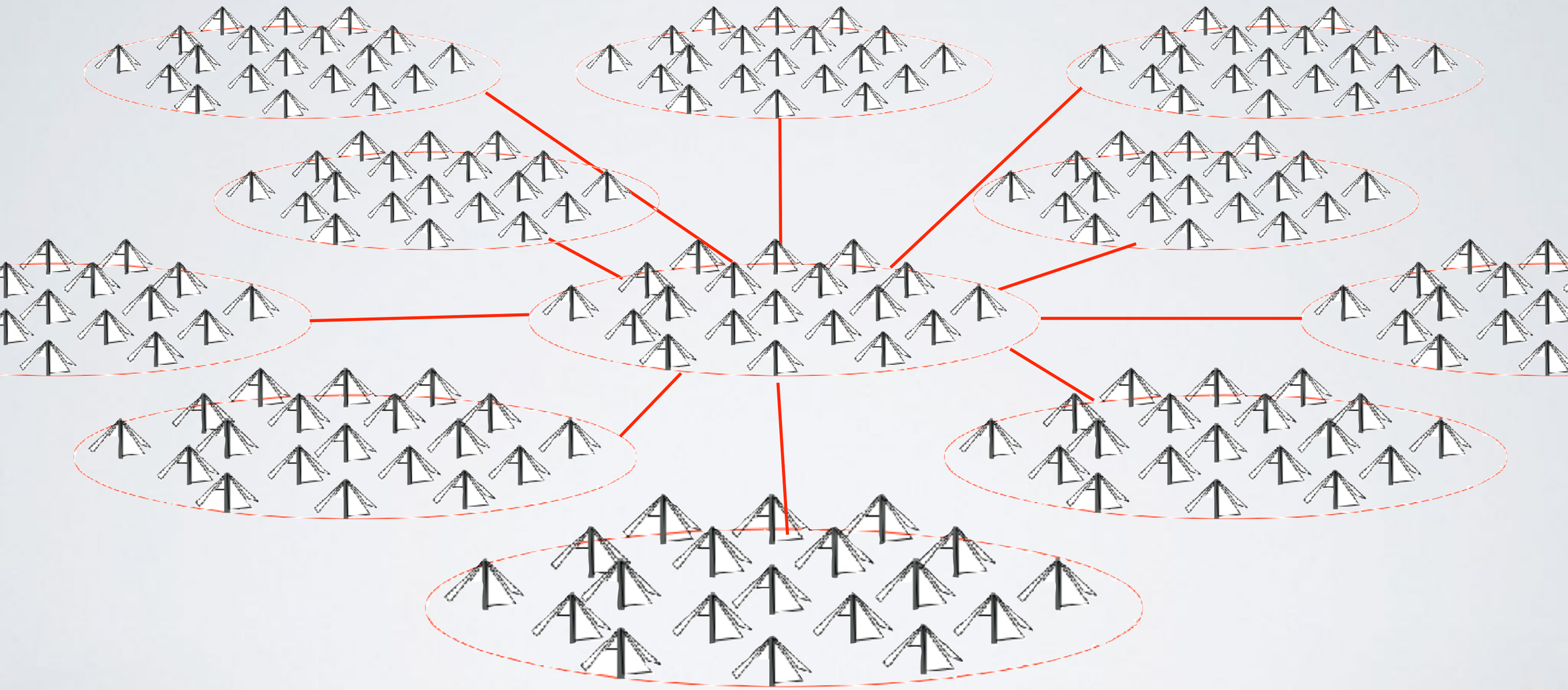
- Phase each mini array as 1 antenna in 1 direction, the whole covering all the sky, externally triggered



Powerful, but dedicated operation

NENUFAR-EAS - OPTION 4

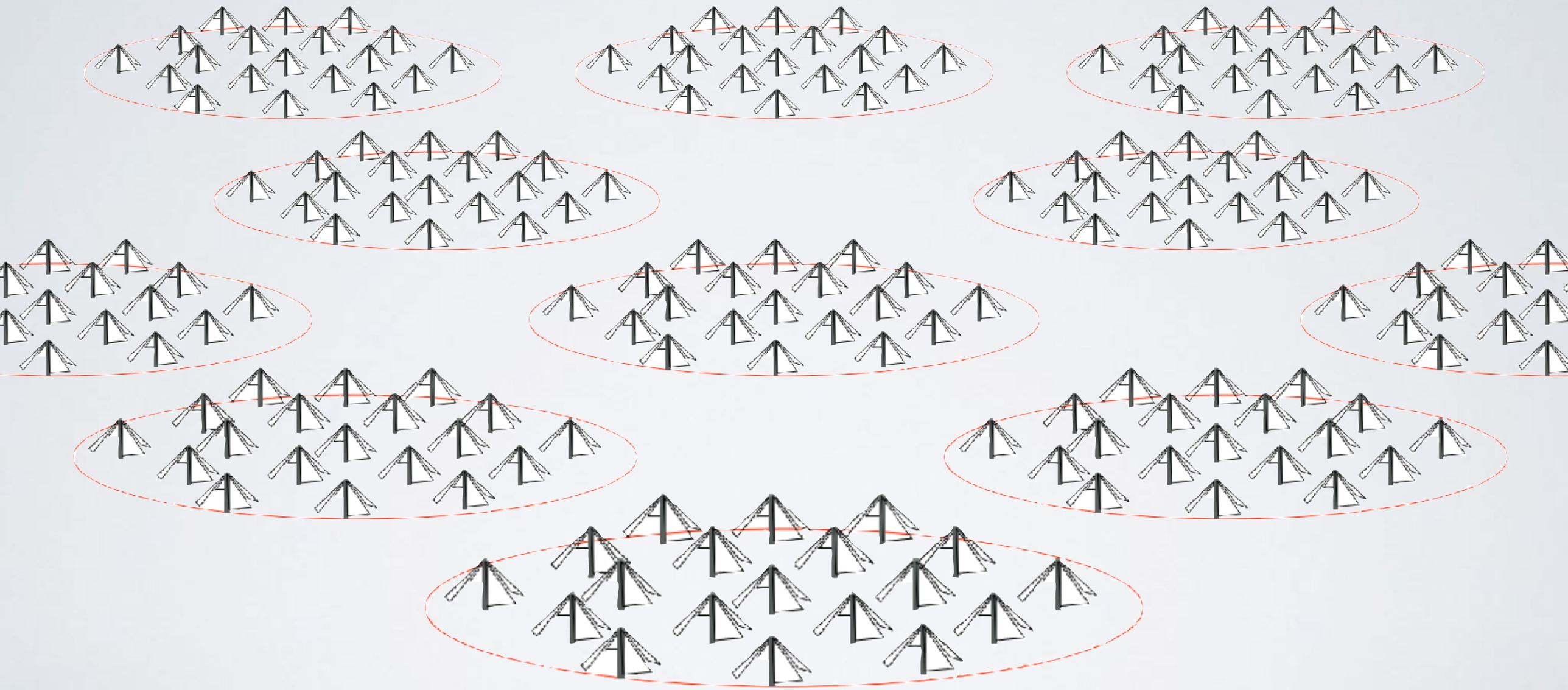
- Use one of the mini arrays as composite trigger for the others, not externally triggered



Is it possible ? also depends on current CODALEMA compact array results, but would be completely autonomous ! However, dedicated observation

NENUFAR-EAS - OPTION 5 ?

- Any other idea?



SO WHAT ?

- Lunar mode: “just ask” observing time
- EAS mode: we (Nantes) obviously need help to test and operate it, but it’s still time to do it
- Timeline: NenuFAR-1 completed 2015 (24 mini-arrays)
- Around half of 96 M.A. funded, expected 2016
- Completion late 2017 (?)

- Instrument description and science case available: should I send it ?