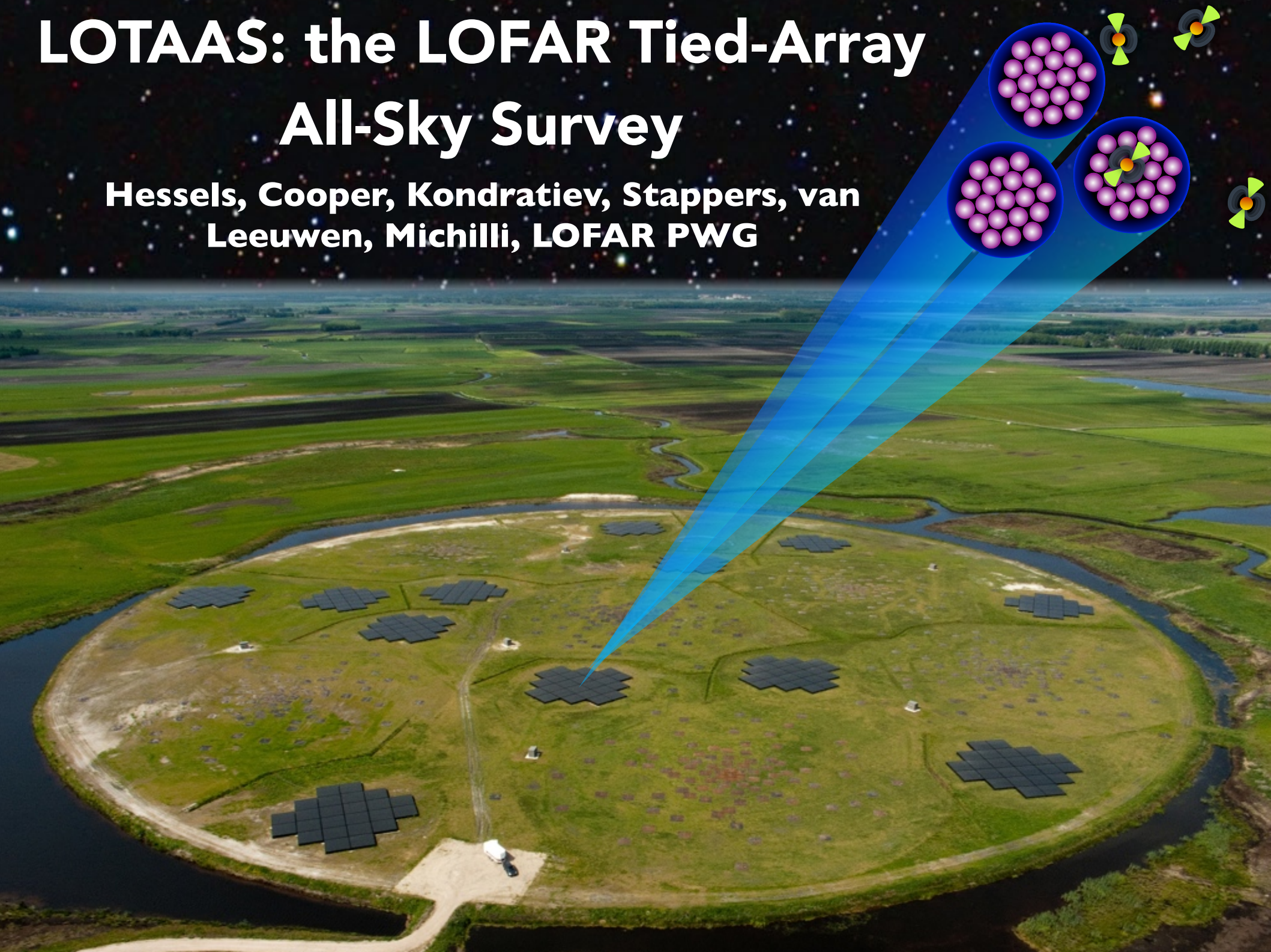
LOTAAS: the LOFAR Tied-Array All-Sky Survey

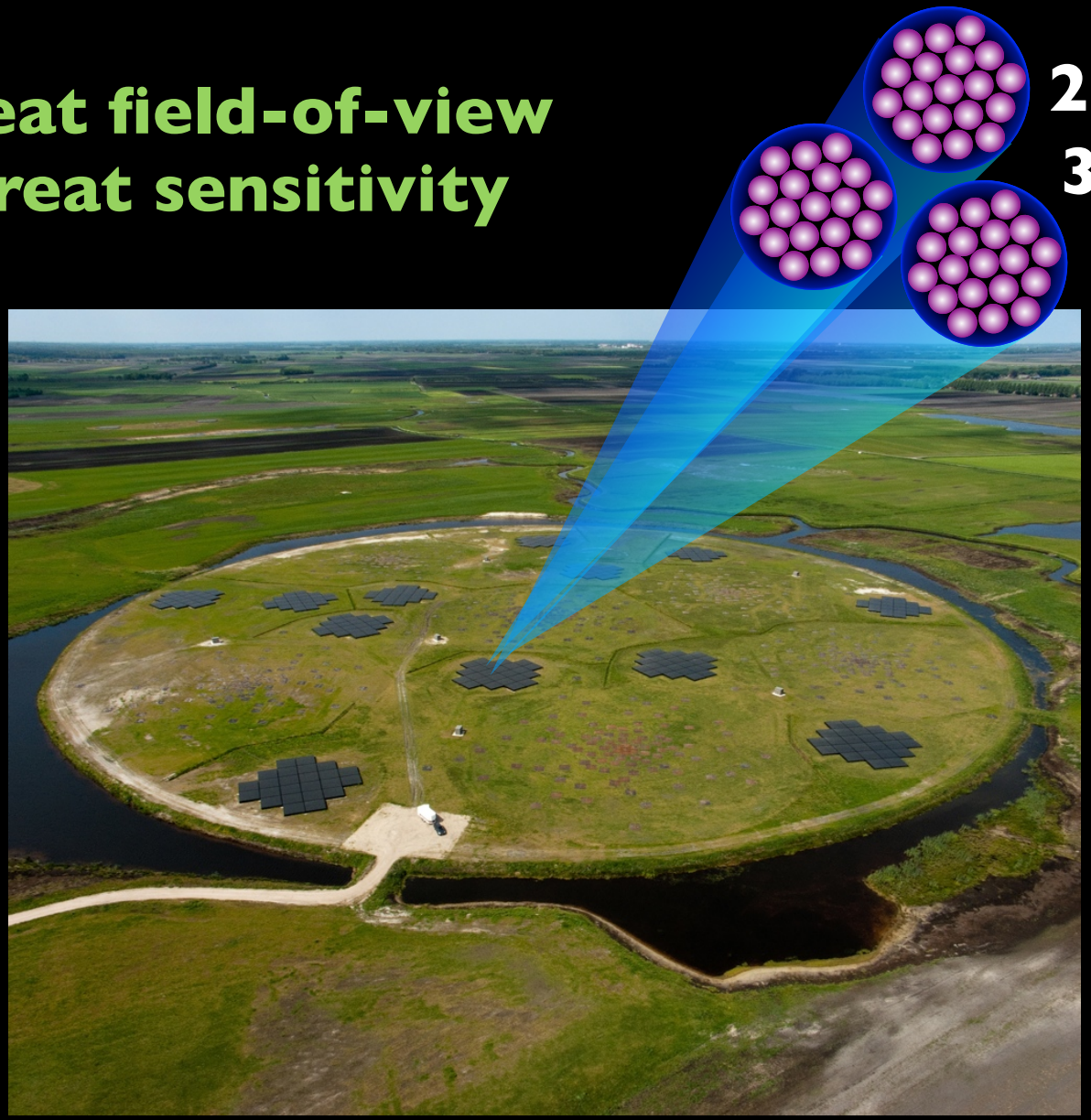
Hessels, Cooper, Kondratiev, Stappers, van Leeuwen, Michilli, LOFAR PWG



LOTAAS

LOFAR Tied-Array All-Sky Survey

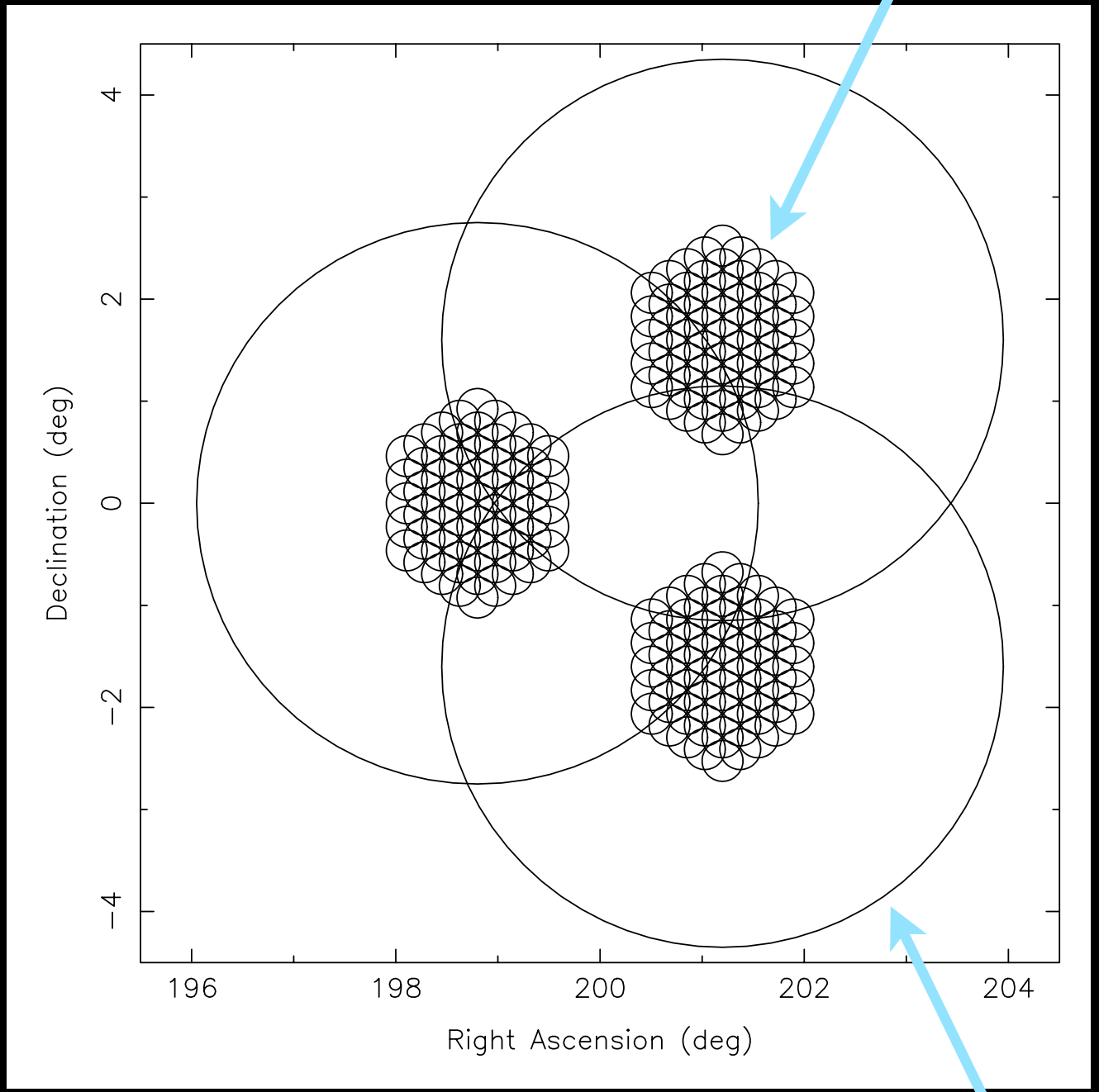
Great field-of-view
Great sensitivity



219 coh. beams
3 incoh. beams

← LOFAR "Superterp" (innermost 12 HBA sub-stations)

Coherent “tied-array” beams

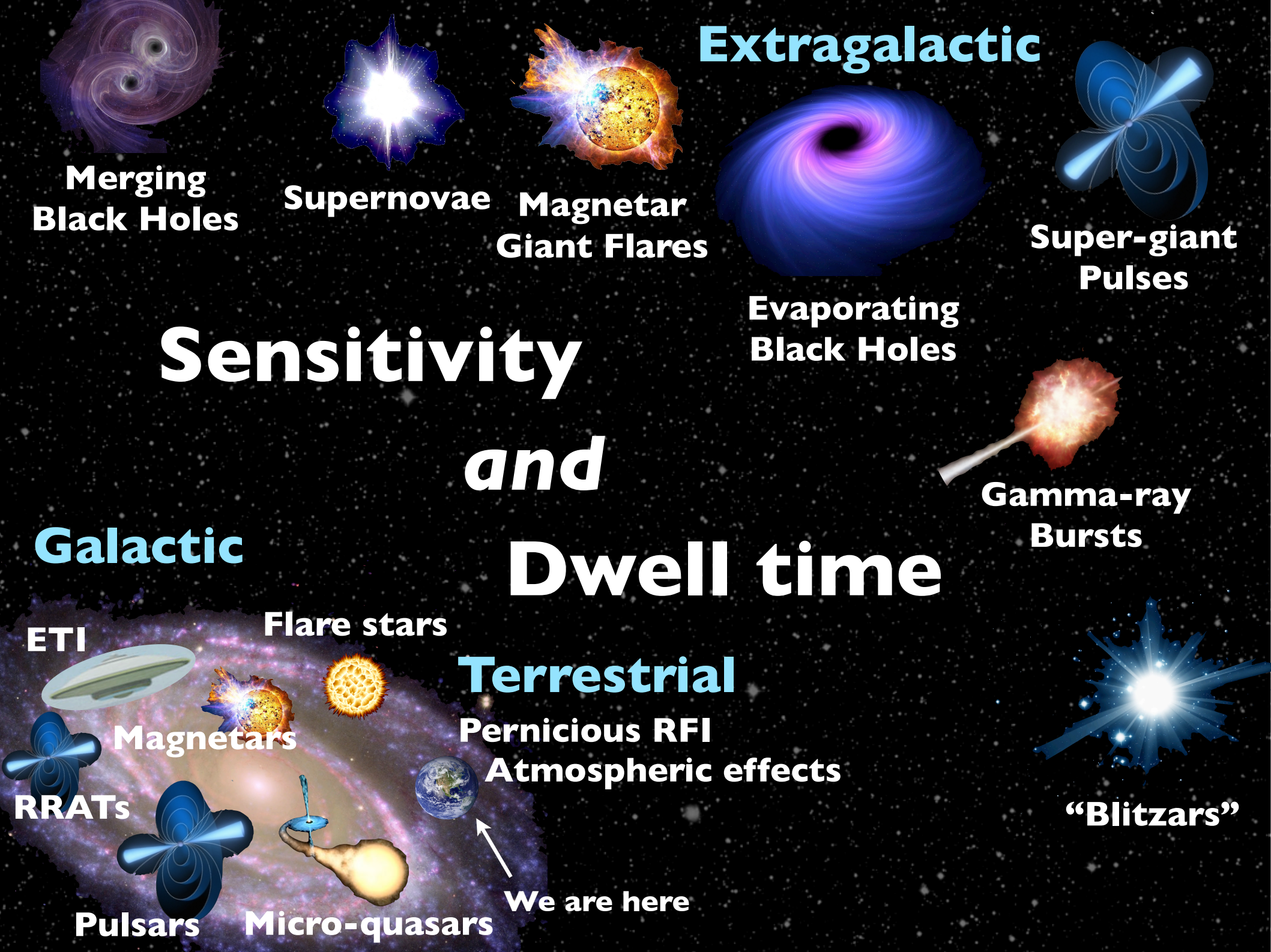


LOTAAS Single Pointing

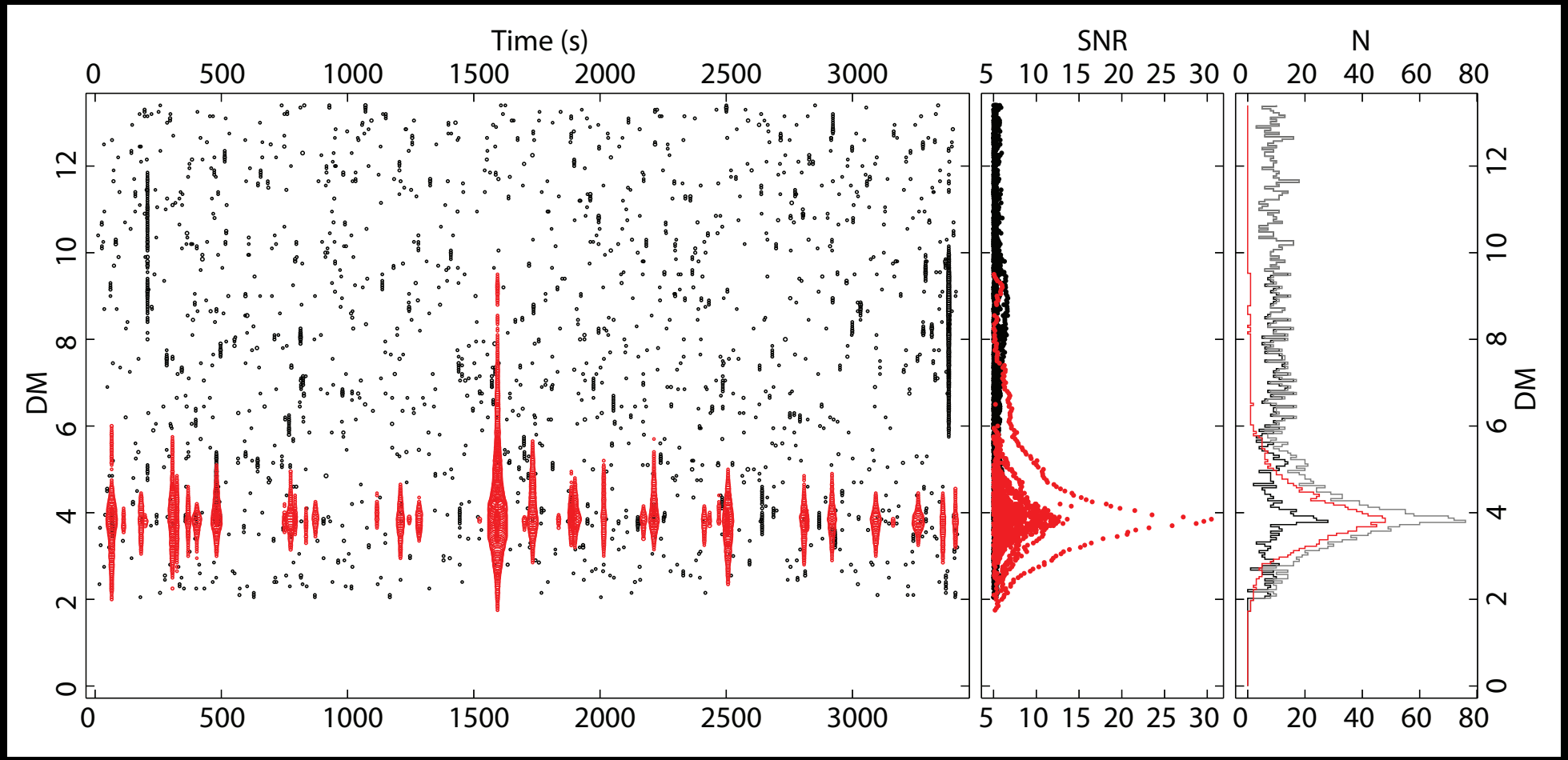
222 beams (FoVs) at once

First SKA-like pulsar survey

Incoherent “station” beam

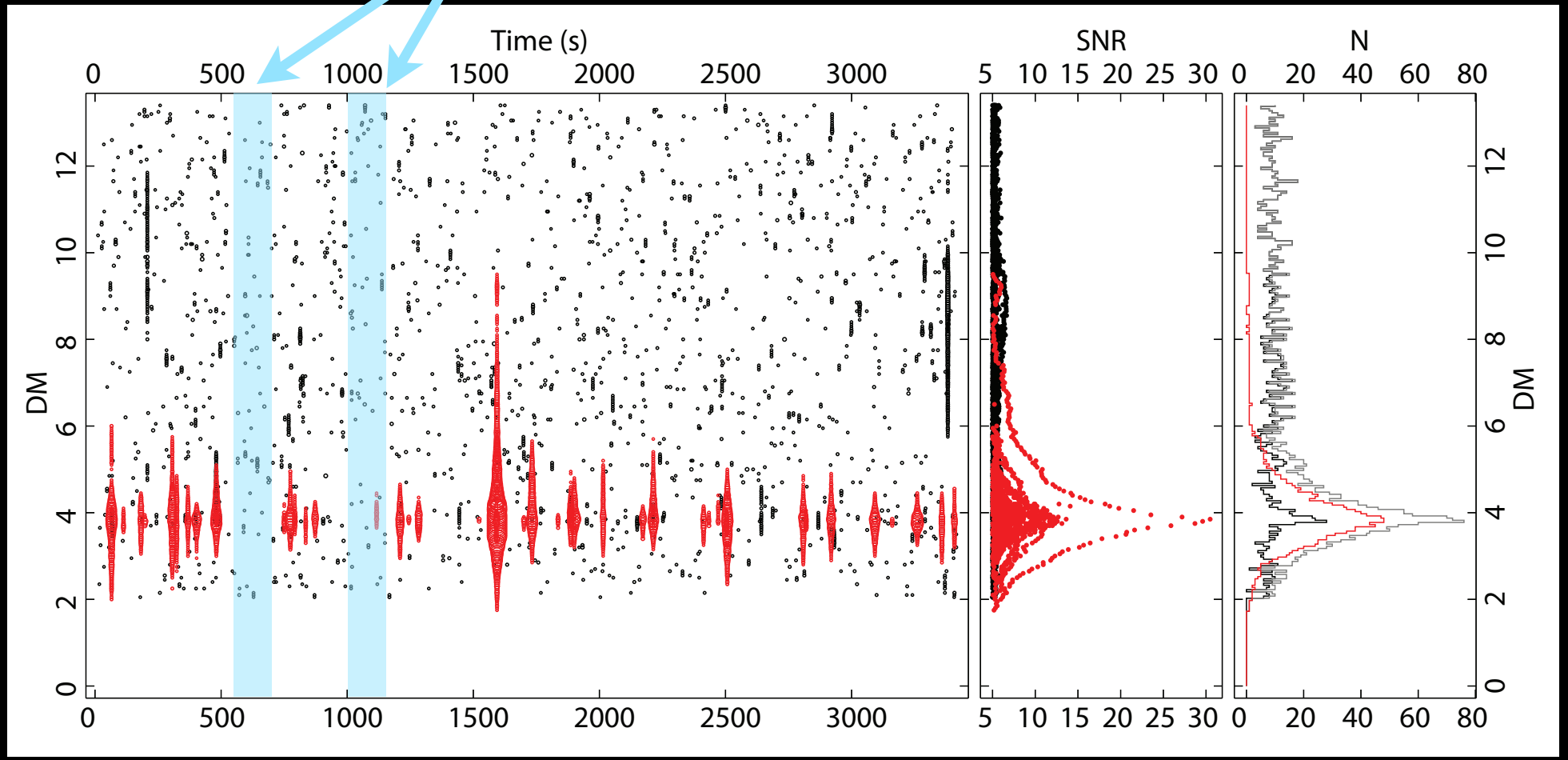

Extragalactic
Merging Black Holes
Supernovae
Magnetar Giant Flares
Super-giant Pulses
Evaporating Black Holes
Sensitivity
and
Dwell time
Gamma-ray Bursts
Galactic
ETI
Flare stars
Terrestrial
Magnetars
Pernicious RFI
Atmospheric effects
RRATs
"Blitzars"
We are here
Pulsars
Micro-quasars

LOTAAS Blind Detections



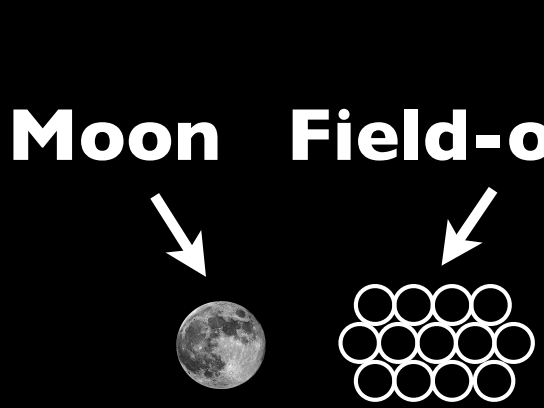
Highly sporadic emission from nearby source

LOTAAS Blind Detections



Highly sporadic emission from nearby source

Fast radio transient factories

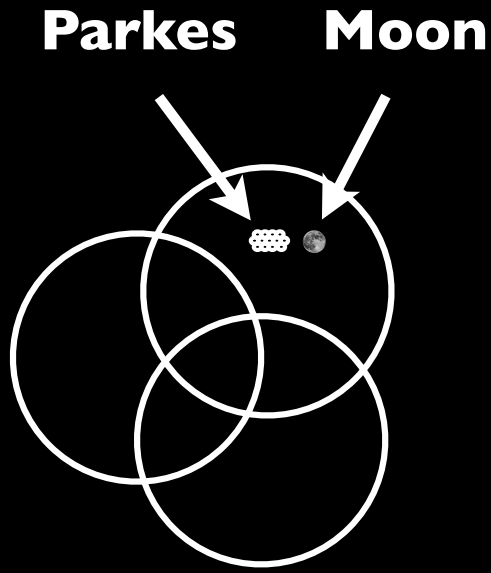


Parkes

0.6 sq. deg.

Current state-of-the-art

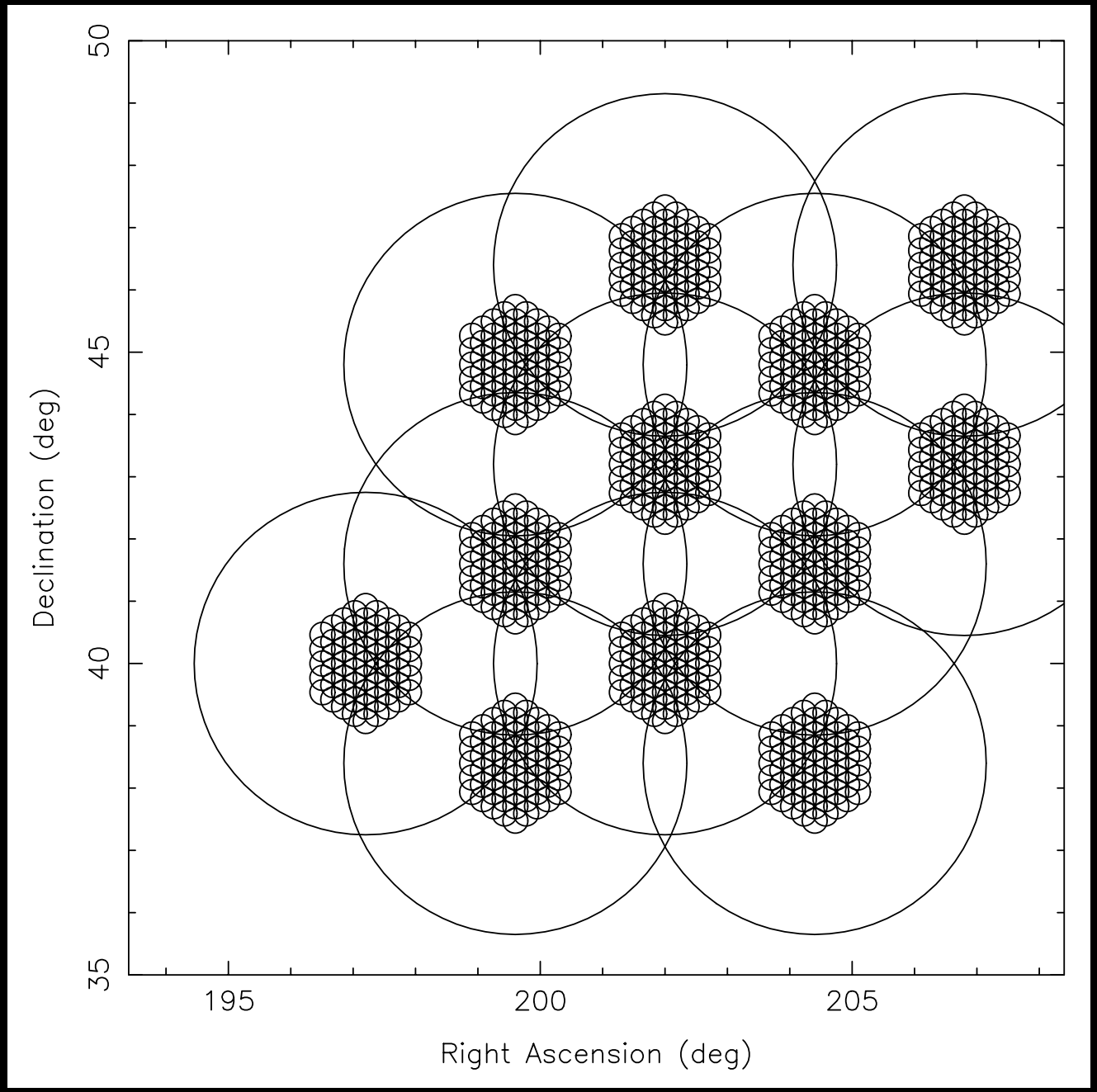
100x



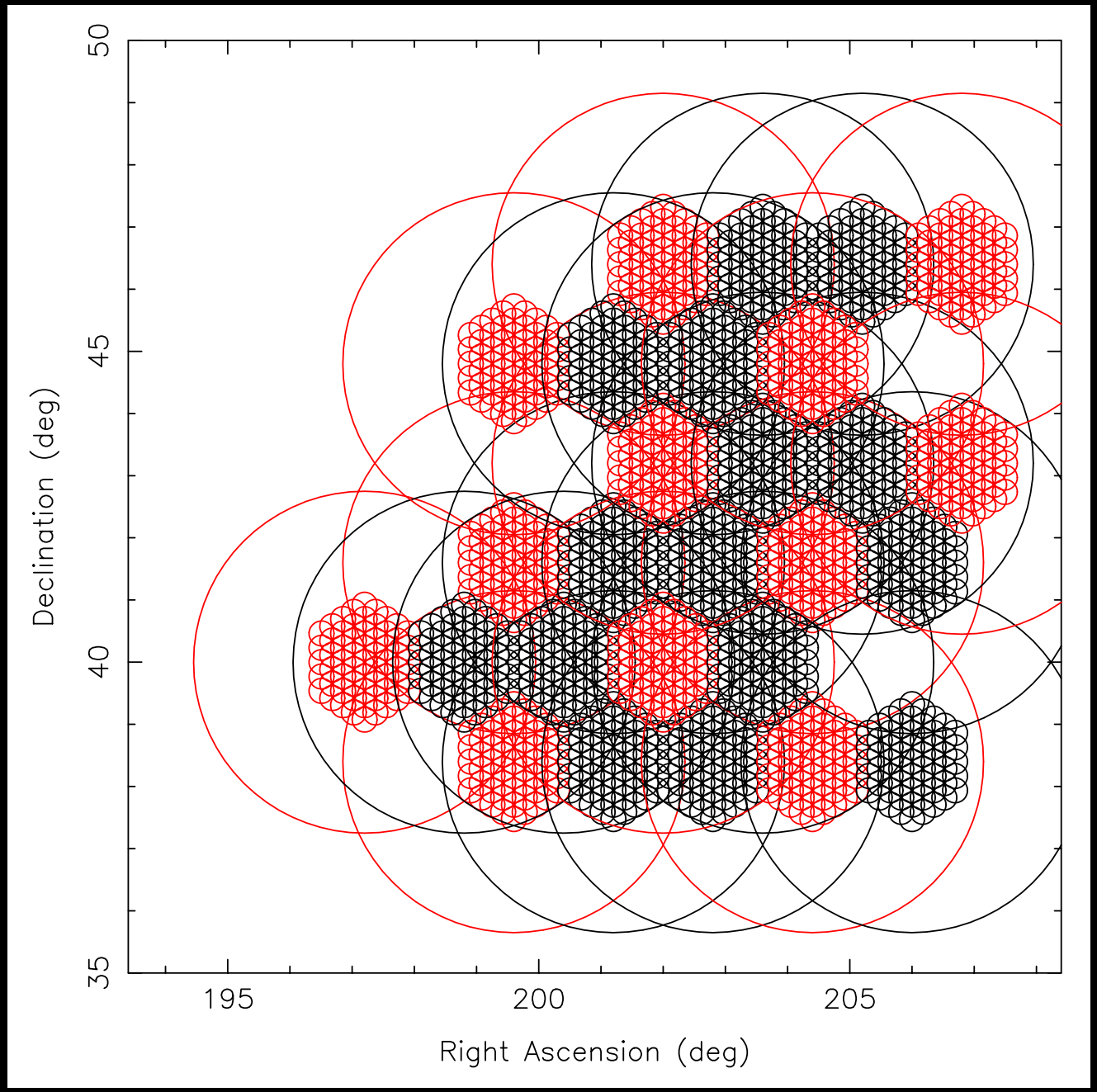
LOFAR

Field-of-view

60 sq. deg.



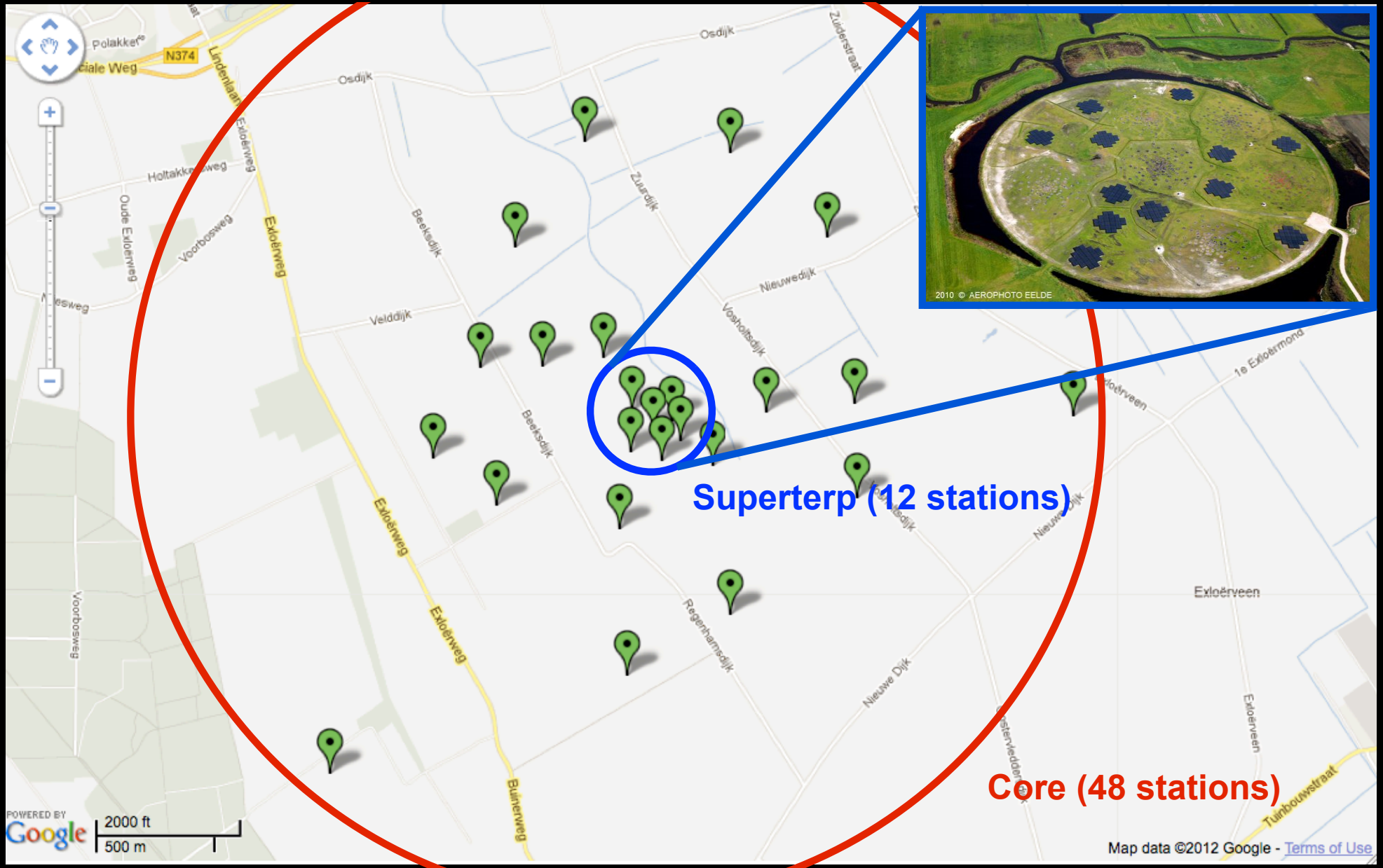
LOTAAS Sparse Sampling



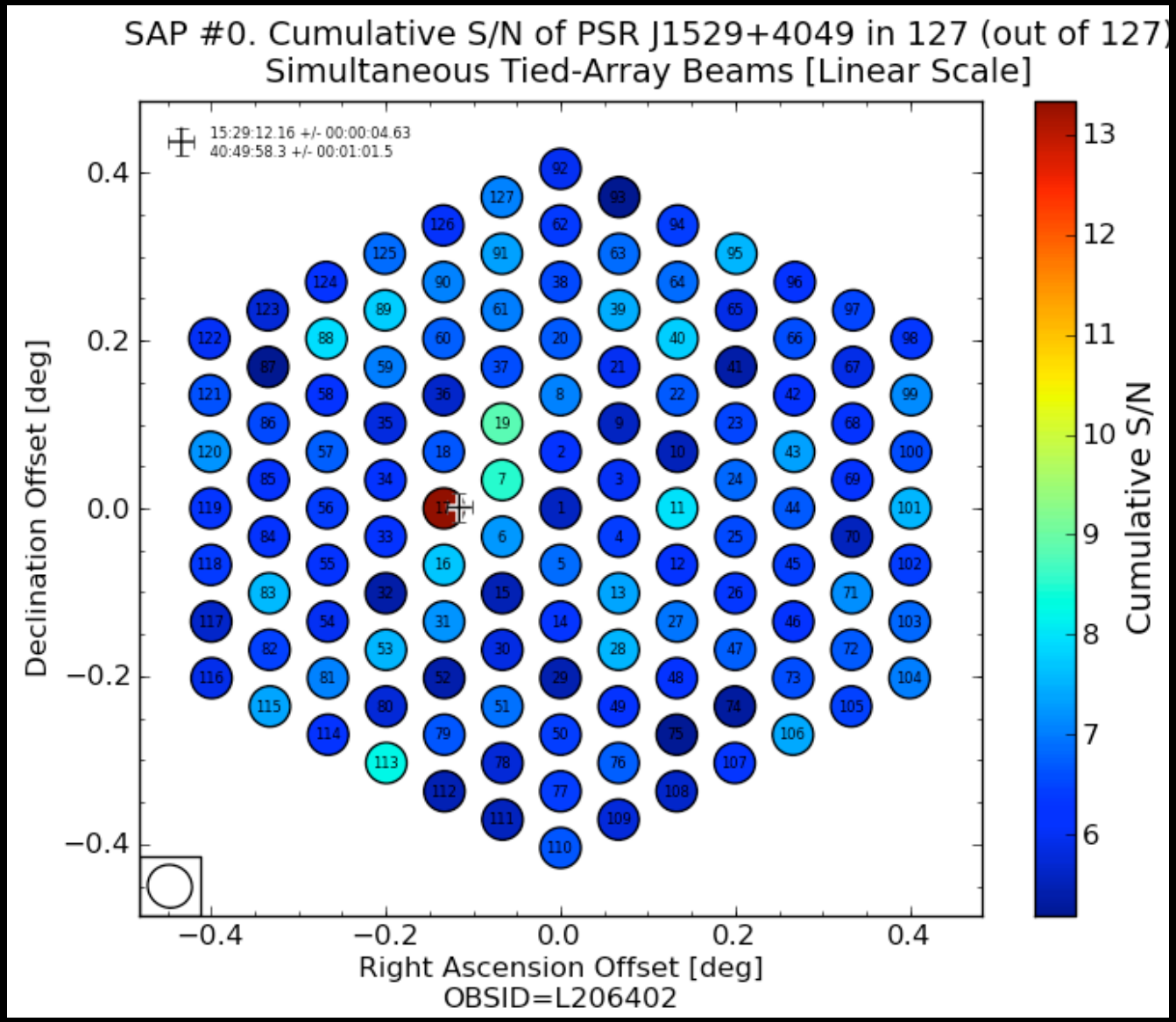
LOTAAS Sparse Sampling

Each sky position gets 3 observations

The LOFAR Core



Localizing LOTAAS Sources



Also localize transients

LOTAAS vs. GBNCC

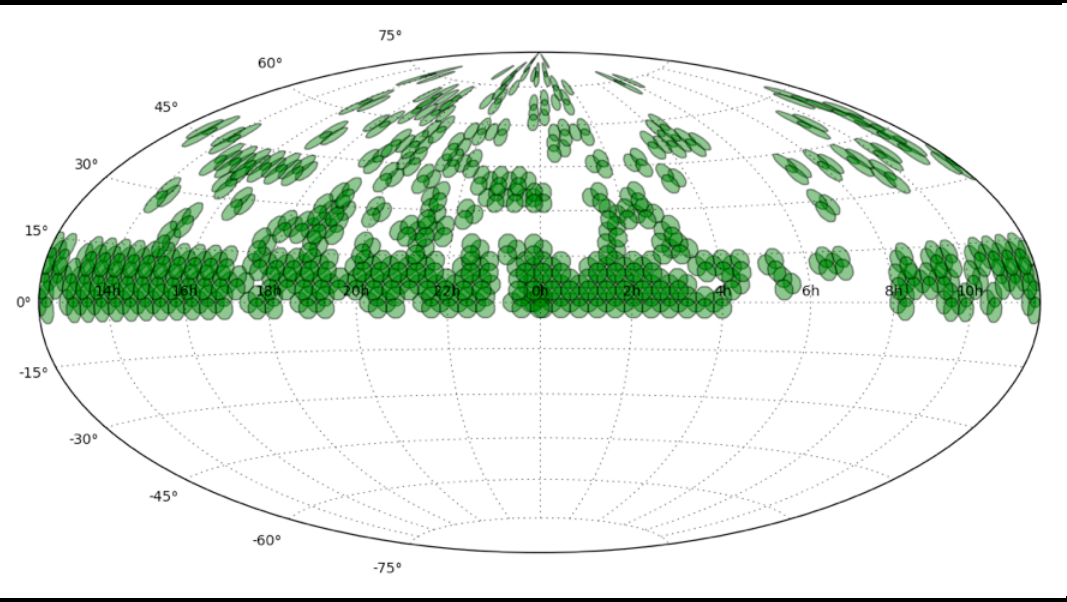
(GBNCC = GBT Northern Celestial Cap Survey at 350MHz)

Compare with state-of-the-art

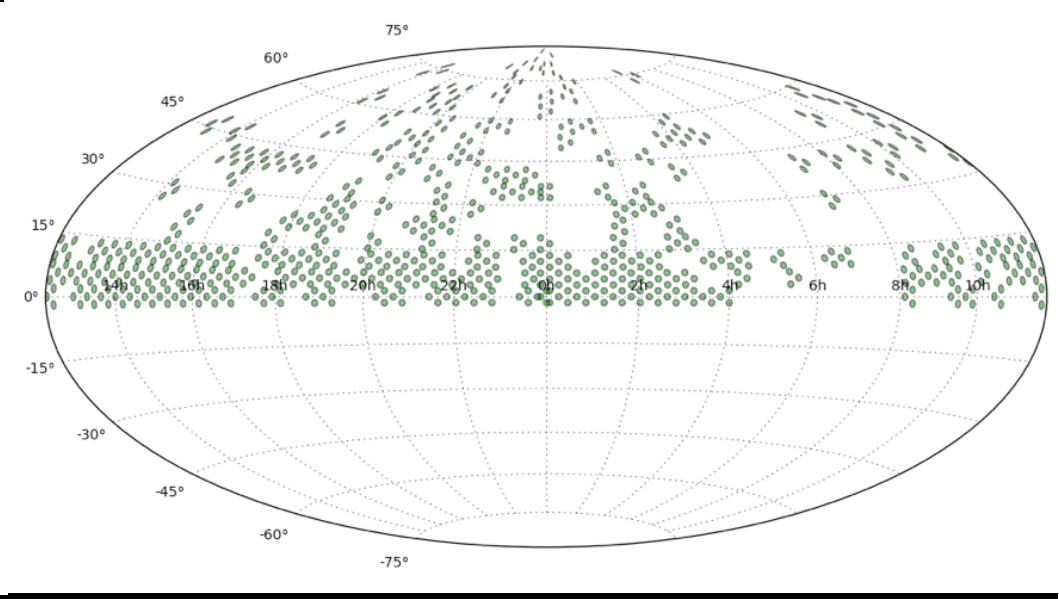
- LOTAAS at 135MHz vs. GBNCC at 350MHz.
- LOTAAS ~25x the data rate vs. GBNCC
- LOTAAS > 30x the field-of view of GBNCC.
- LOTAAS 30x the dwell time of GBNCC.
- LOTAAS ~2x the cumulative sensitivity of GBNCC.
- LOTAAS lower time resolution and significantly worse at finding (high-DM) millisecond pulsars.
- LOTAAS likely better at finding intermittent srcs though instantaneous sensitivity is ~2.5x lower than GBNCC.

Observing Status

Coverage incoherent beams

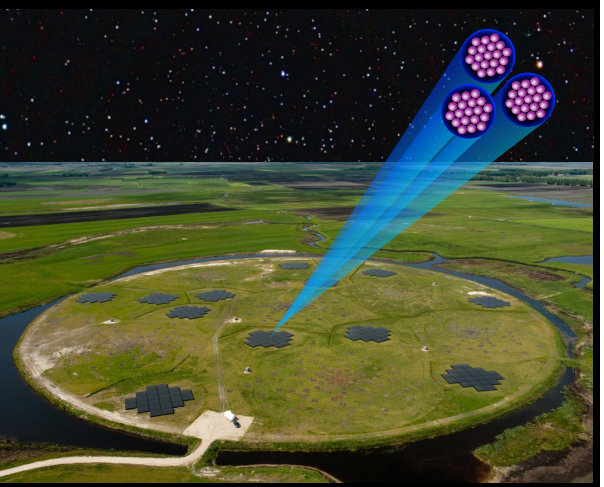


Coverage coherent beams

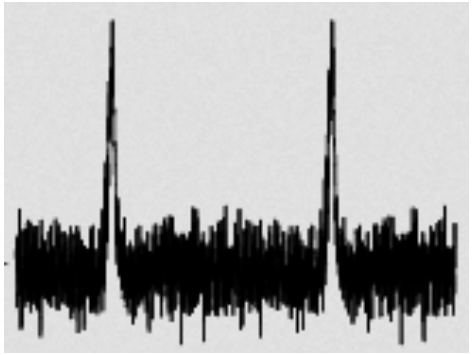


- 273 pointings observed so far; 110 processed.
- 6750 sq. deg. incoherent / 2025 sq. deg. coherent
- 651 pointings needed for sparse pass of Northern Hemisphere.

First 10 LOFAR Pulsar Discoveries

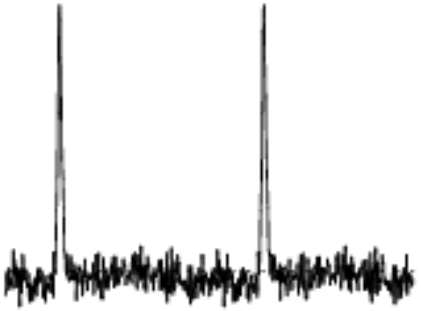


PSR J2336-01



P = 1029ms d = 910pc

PSR J0140+56

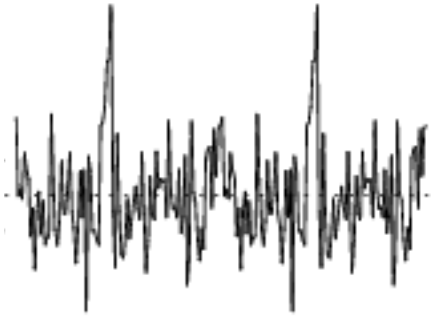


P = 1775ms d = 3700pc

PSR J0935+33

P = 961ms d = 670pc

PSR J2057+21



P = 1116ms d = 4720pc

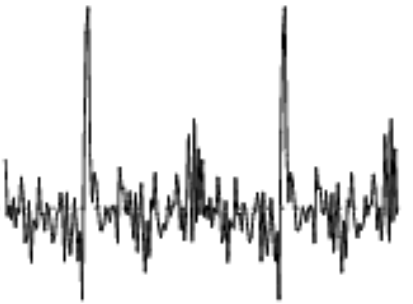
PSR J0613+37

P = 619ms d = 630pc

PSR J1529+40

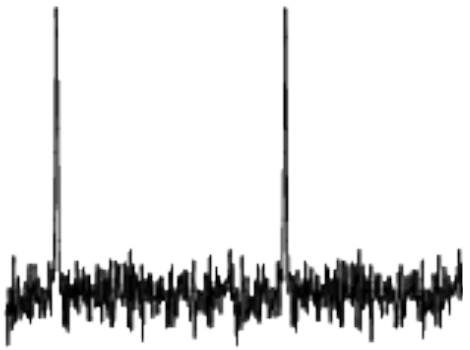
P = 476ms d = 680pc

PSR J0305+11



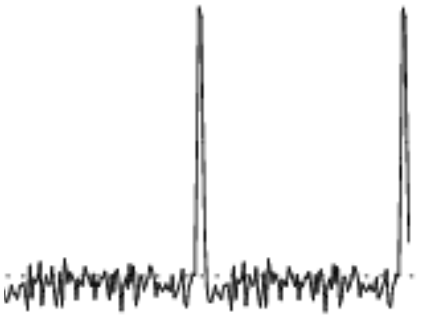
P = 862ms d = 1030pc

PSR J1809+17



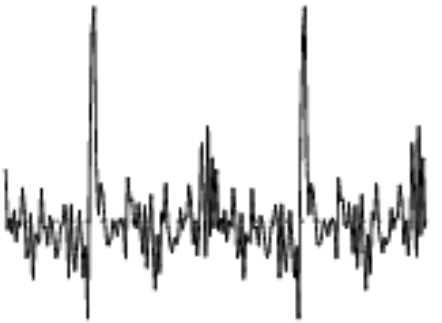
P = 2066ms d = 2200pc

PSR J2350+31



P = 508ms d = 2100pc

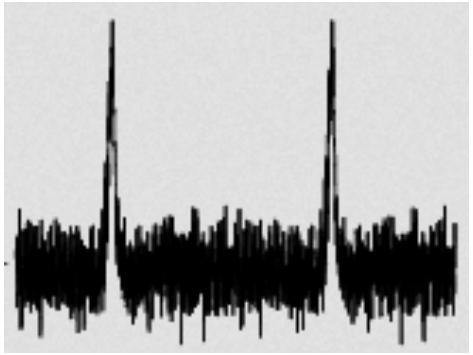
PSR J0317+13



P = 1974ms d = 470pc

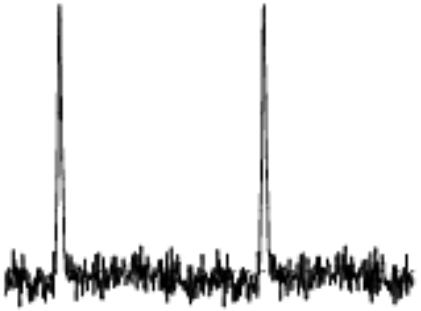
First 11 LOFAR Pulsar Discoveries

PSR J2336-01



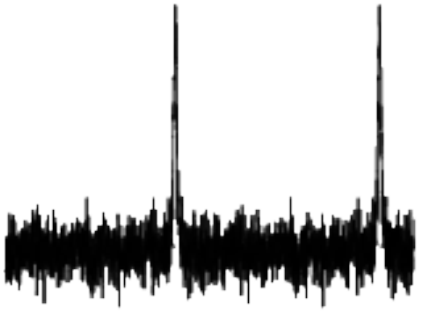
P = 1029ms d = 910pc

PSR J0140+56



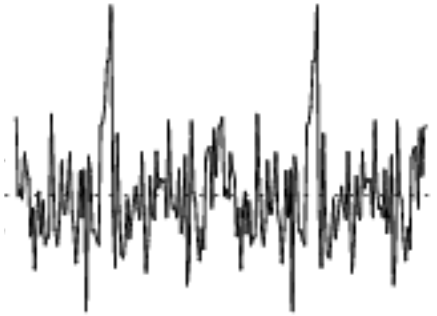
P = 1775ms d = 3700pc

PSR J0935+33



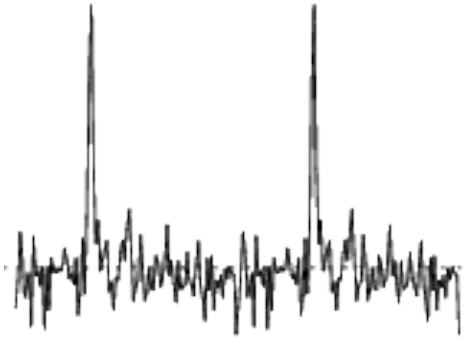
P = 961ms d = 670pc

PSR J2057+21



P = 1116ms d = 4720pc

PSR J1814+22



P = 253ms d = 3229 pc

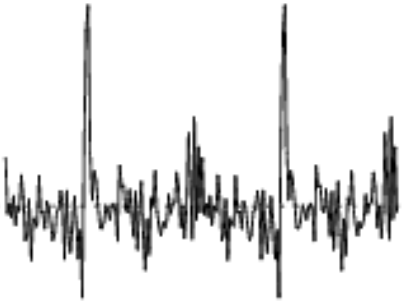
PSR J0613+37

P = 619ms d = 630pc

PSR J1529+40

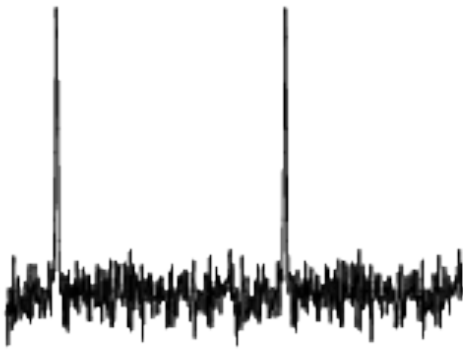
P = 476ms d = 680pc

PSR J0305+11



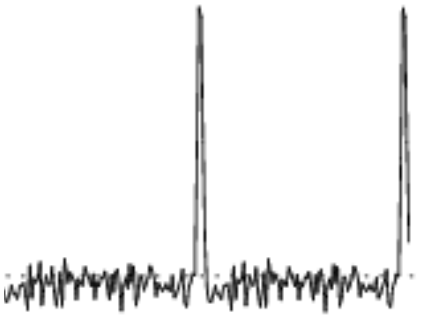
P = 862ms d = 1030pc

PSR J1809+17



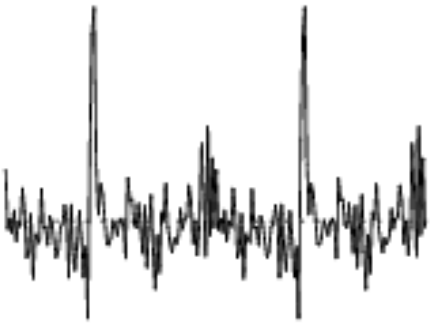
P = 2066ms d = 2200pc

PSR J2350+31



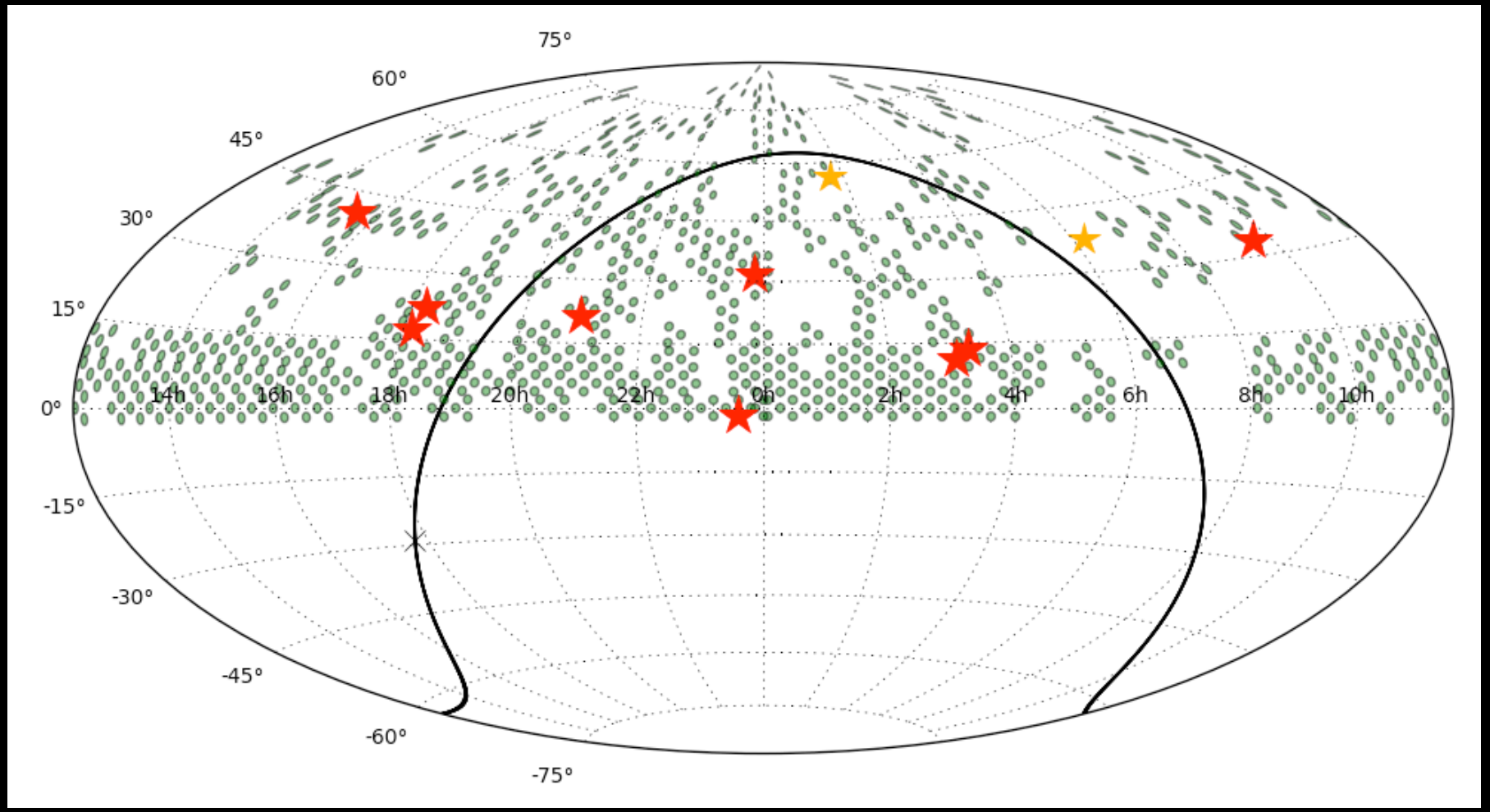
P = 508ms d = 2100pc

PSR J0317+13



P = 1974ms d = 470pc

Discovery Status



- Currently at ~1 discovery per 100 sq. deg. - as predicted.
- One new pulsar per 10hrs of observing time - very good.
- Single-pulse candidate sifting still to be done - more soon.