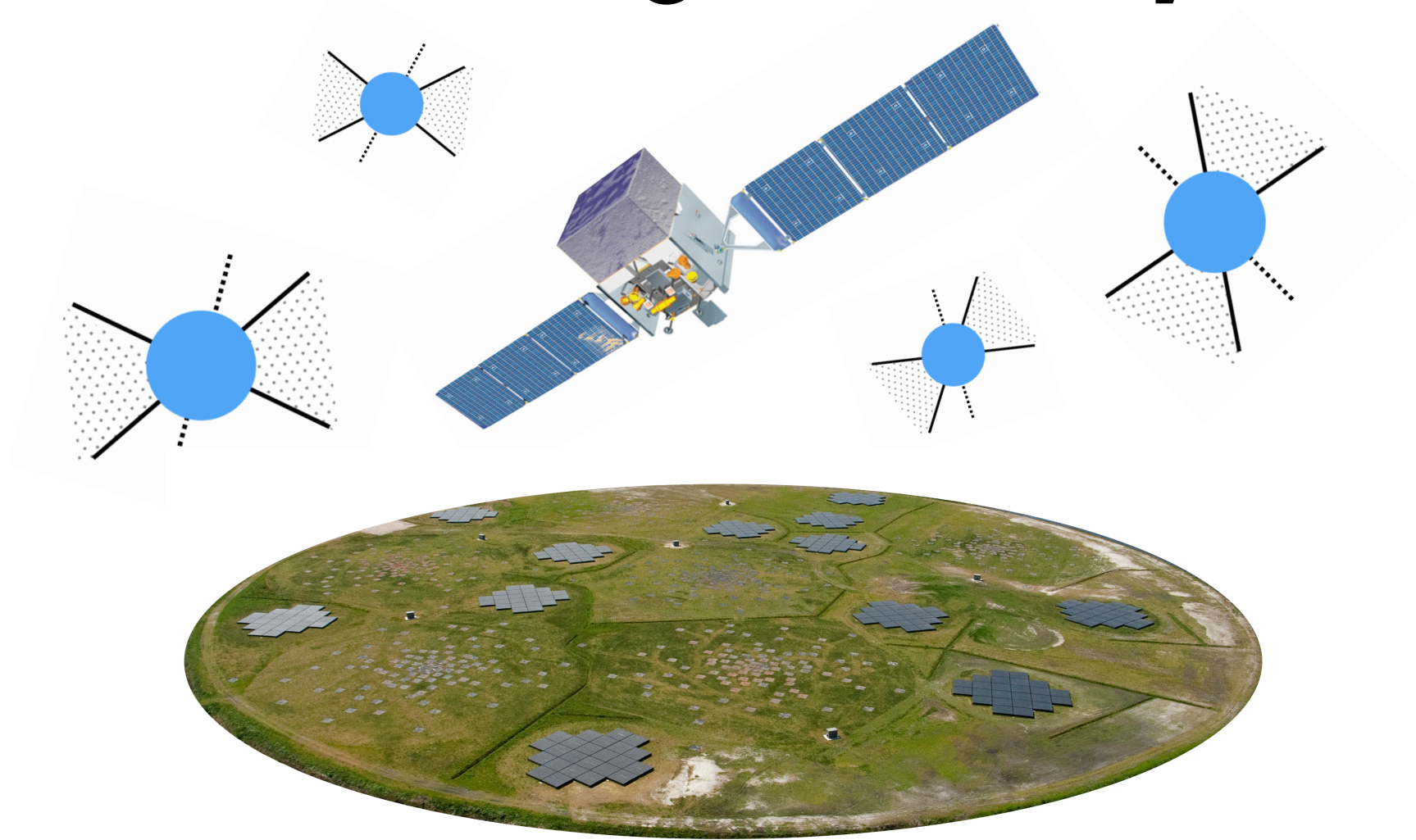


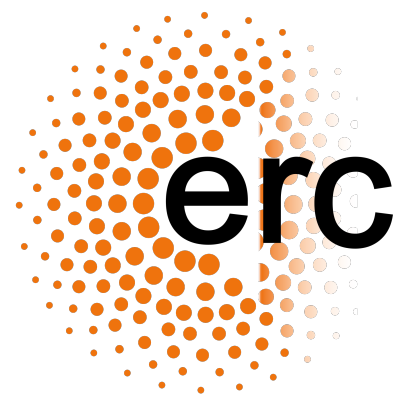
LOFAR survey for millisecond pulsars in *Fermi* gamma-ray sources



Ziggy Pleunis (API, UvA)

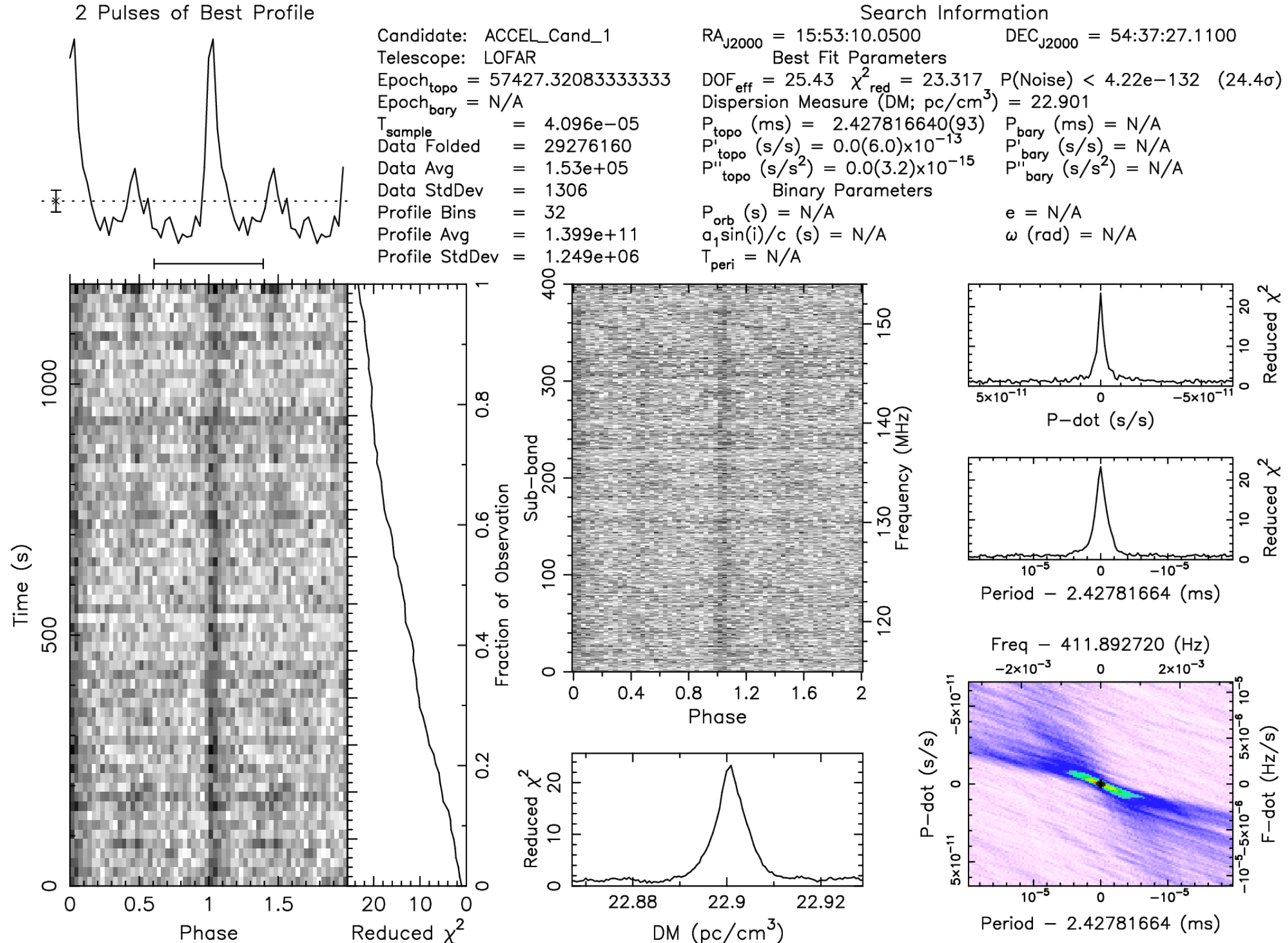
in collaboration with **Jason Hessels, Cees Bassa, Vlad Kondratiev, Sotiris Sanidas, Daniele Michilli**
and **Alexander van Amesfoort**

LOFAR Science Workshop, April 6, 2016



First LOFAR millisecond pulsar discovery!

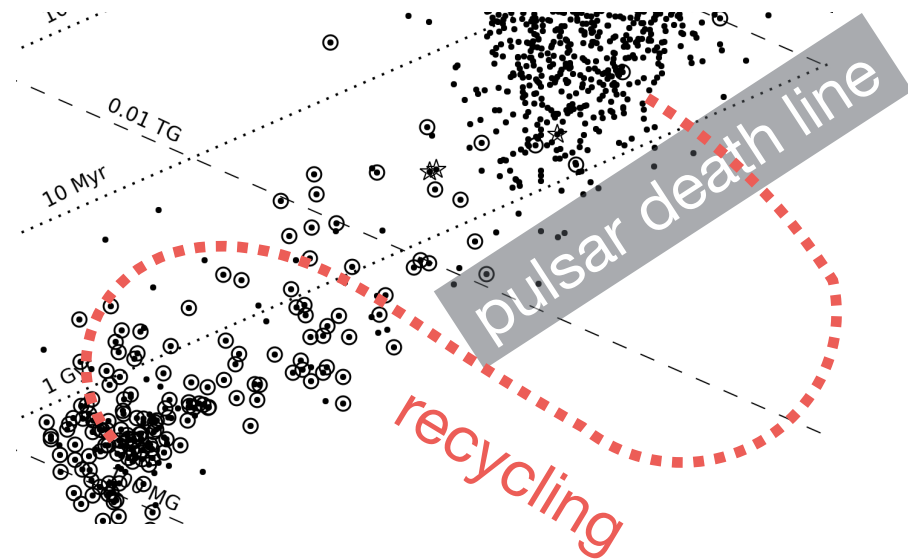
Pleunis et al., in prep.



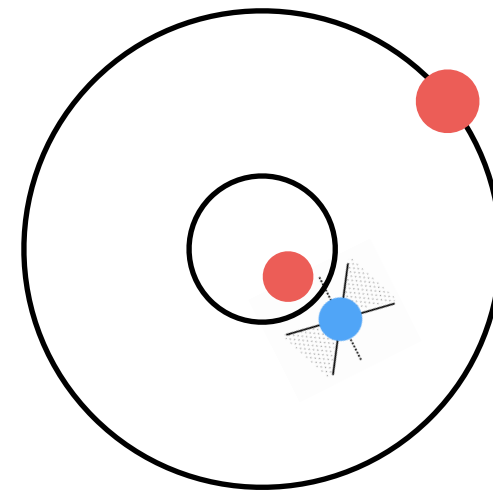
L430860_SAP000_B005_cDM022.50.fil

Survey for millisecond pulsars

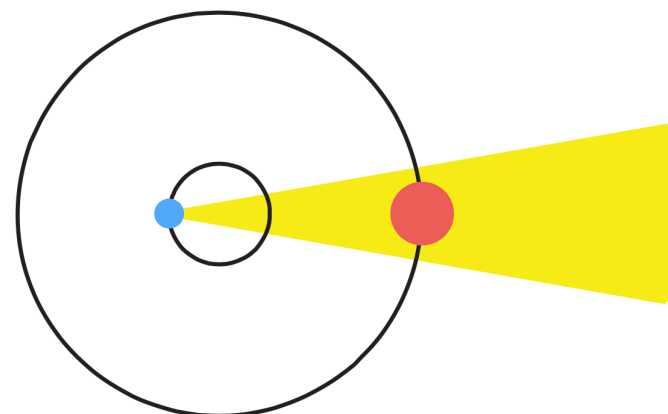
Binary Stellar Evolution
e.g. Tauris (2011)



Exotic new
Millisecond Pulsars
e.g. Ransom et al. (2014)

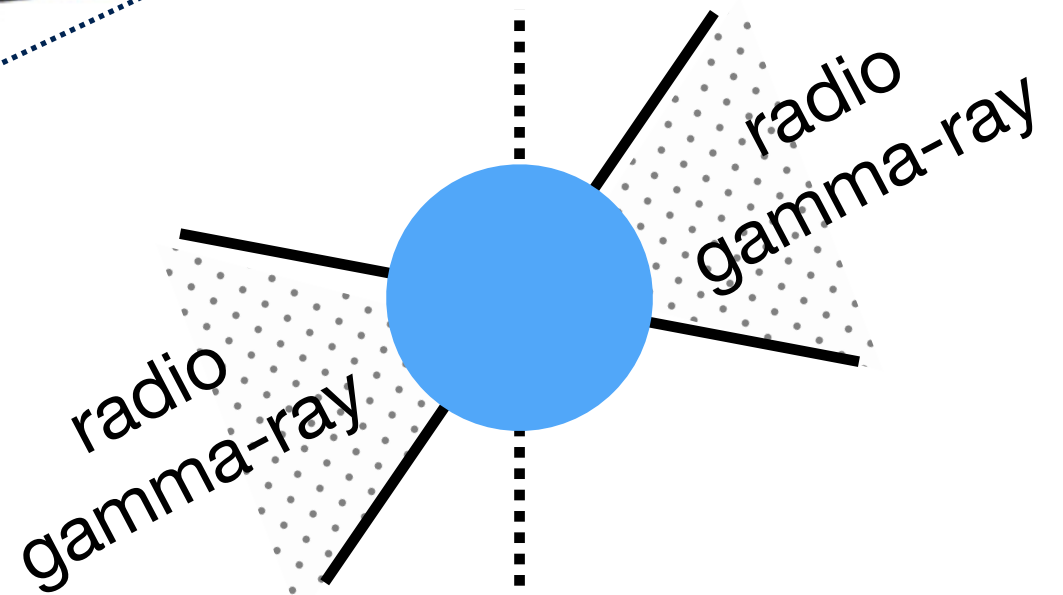
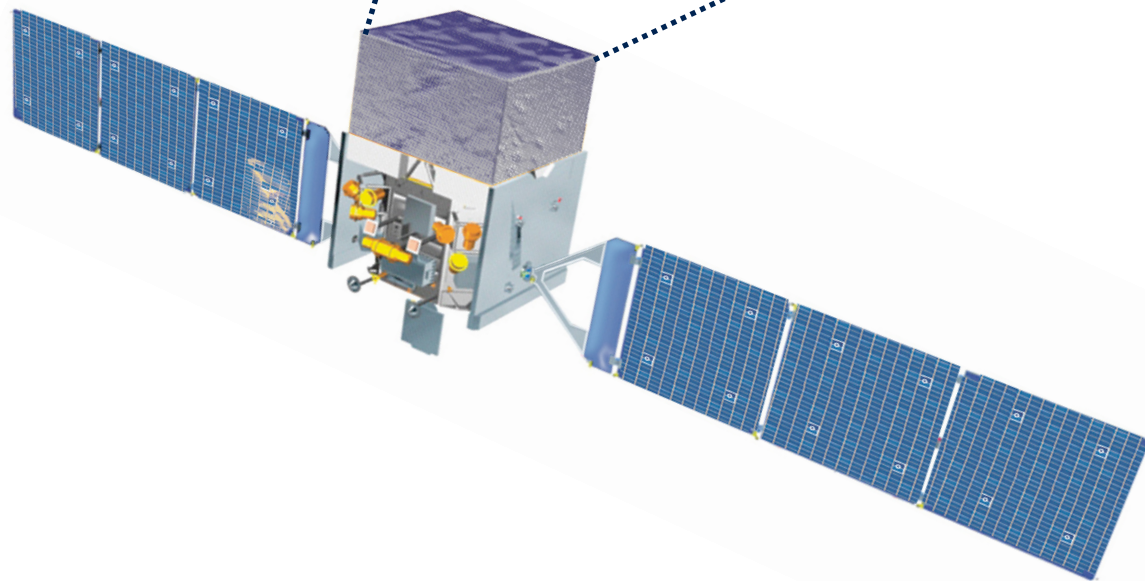
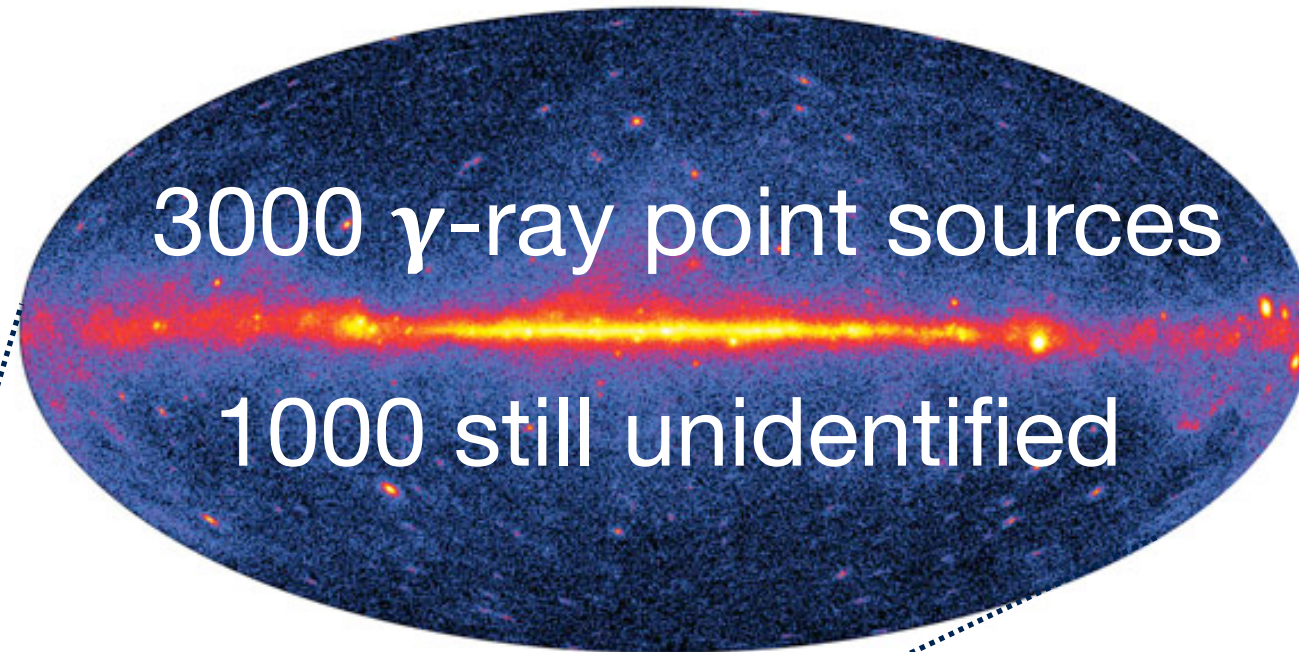


The Neutron Star
Equation of State
e.g. Demorest et al. (2010)



Shapiro
delay

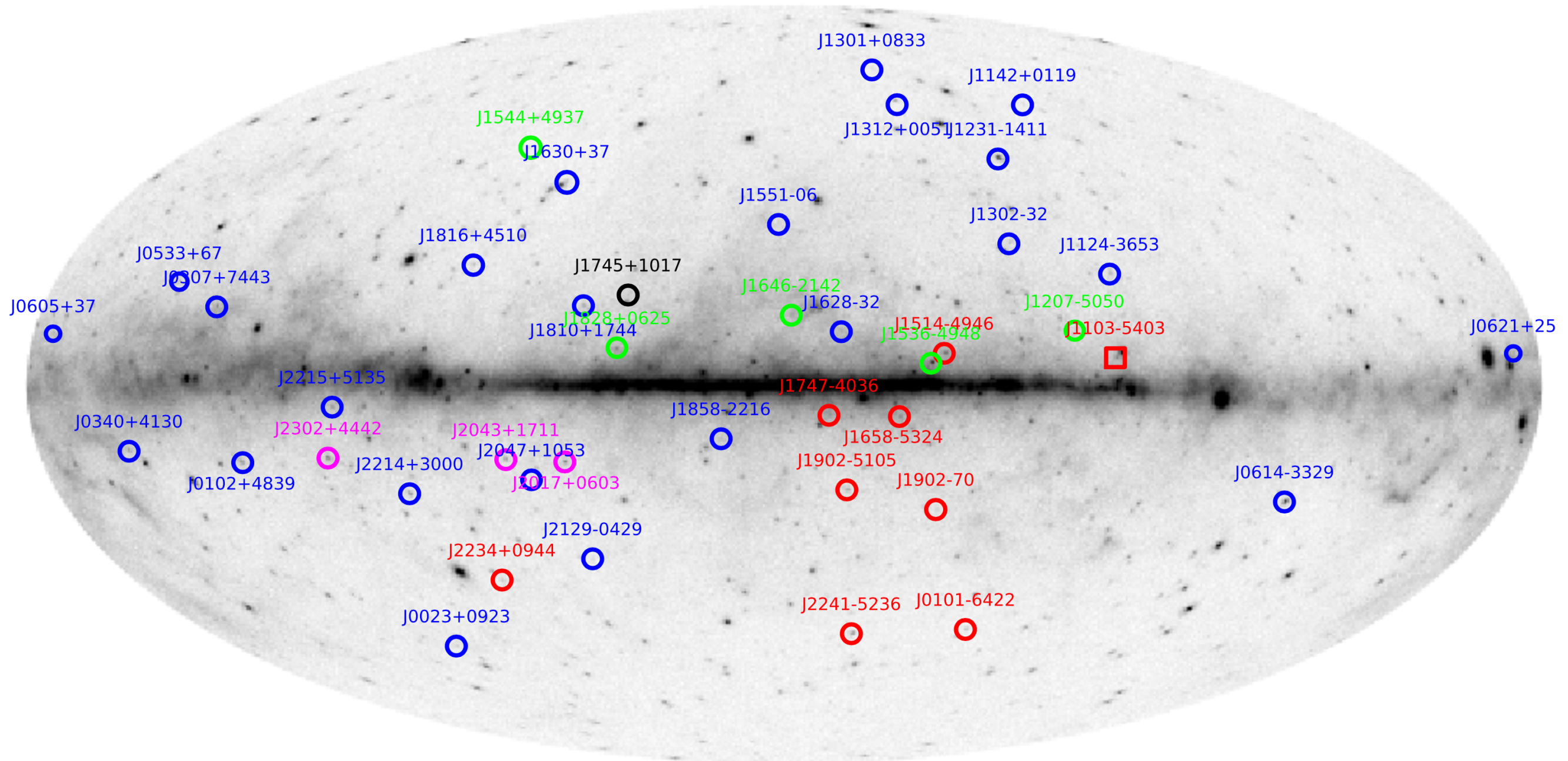
Fermi unidentified sources



Gamma-Ray Pulsars

e.g. Grenier & Harding (2015)

Fermi unidentified sources

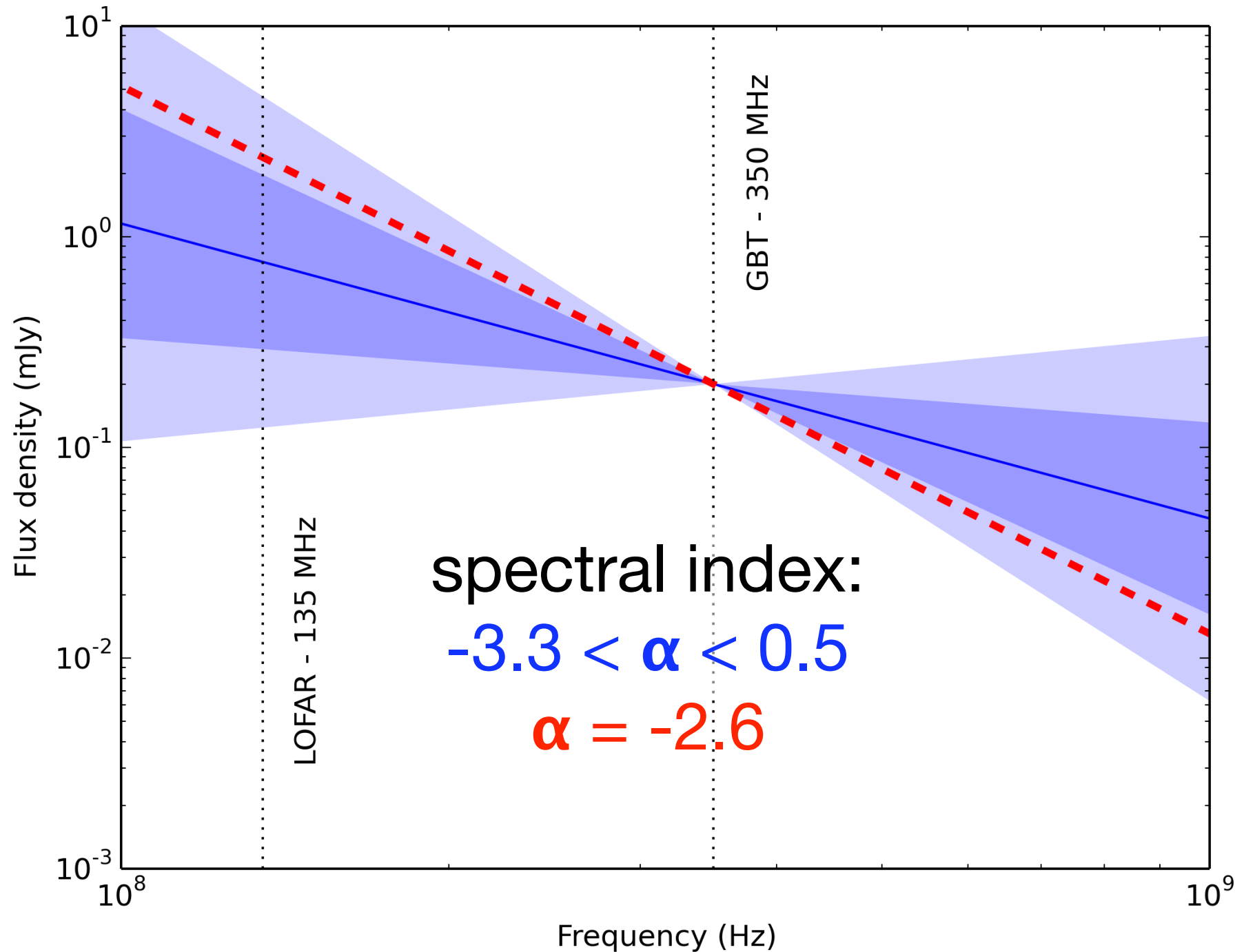


GBT, Parkes, GMRT, Nançay, Effelsberg
Ray et al. (2012)

LOFAR advantages

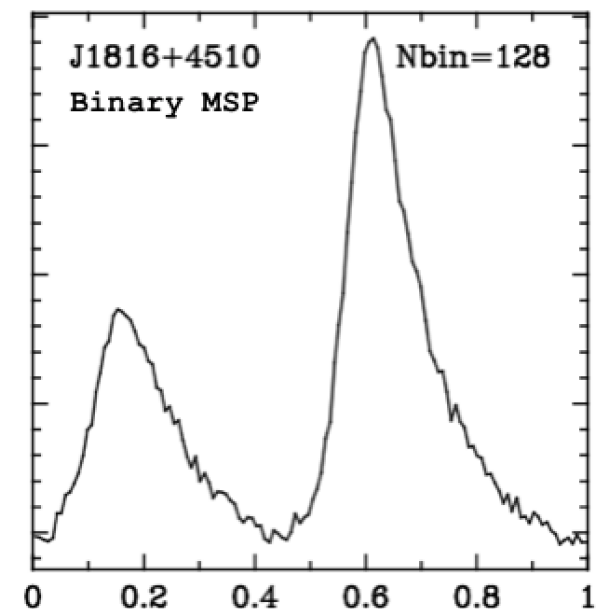
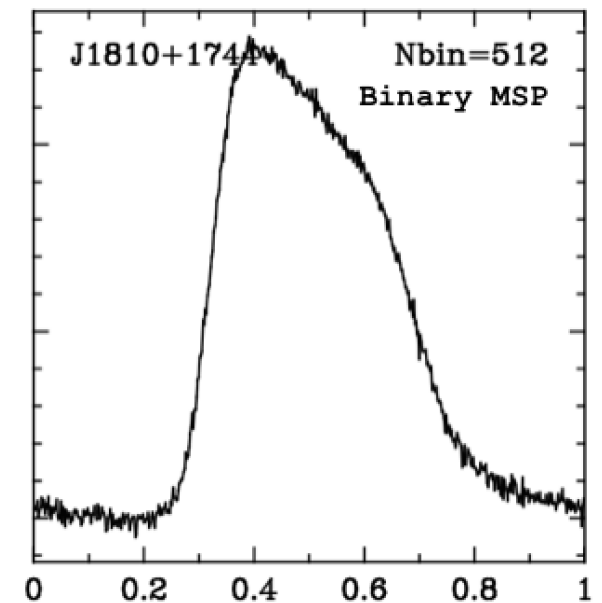
pulsars can have very steep spectra

Bates et al. (2013)



LOFAR profiles

Kondratiev et al. (2015)

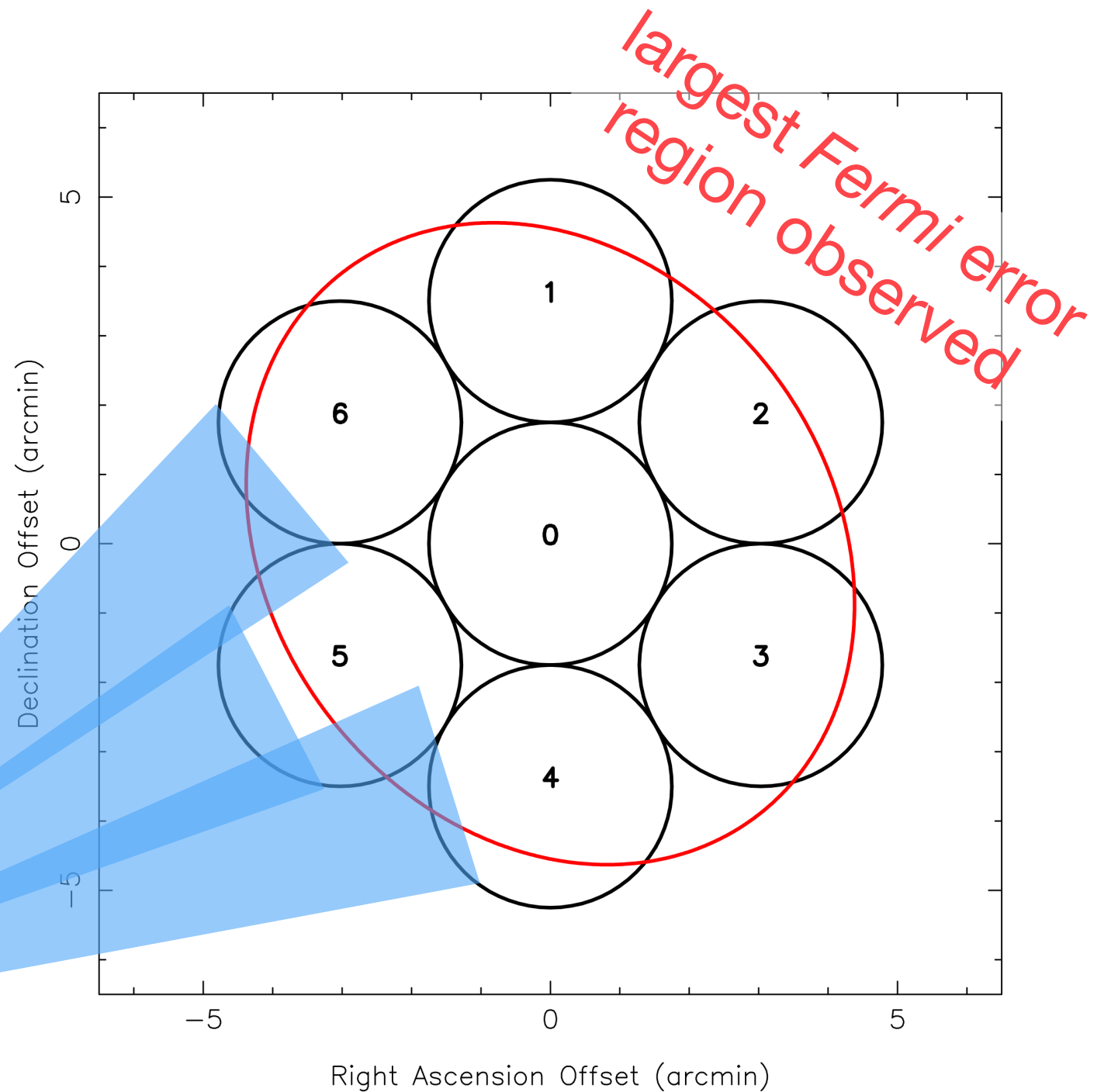
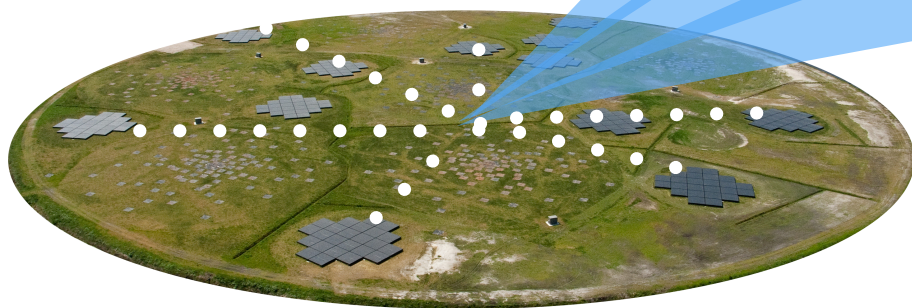


Survey setup

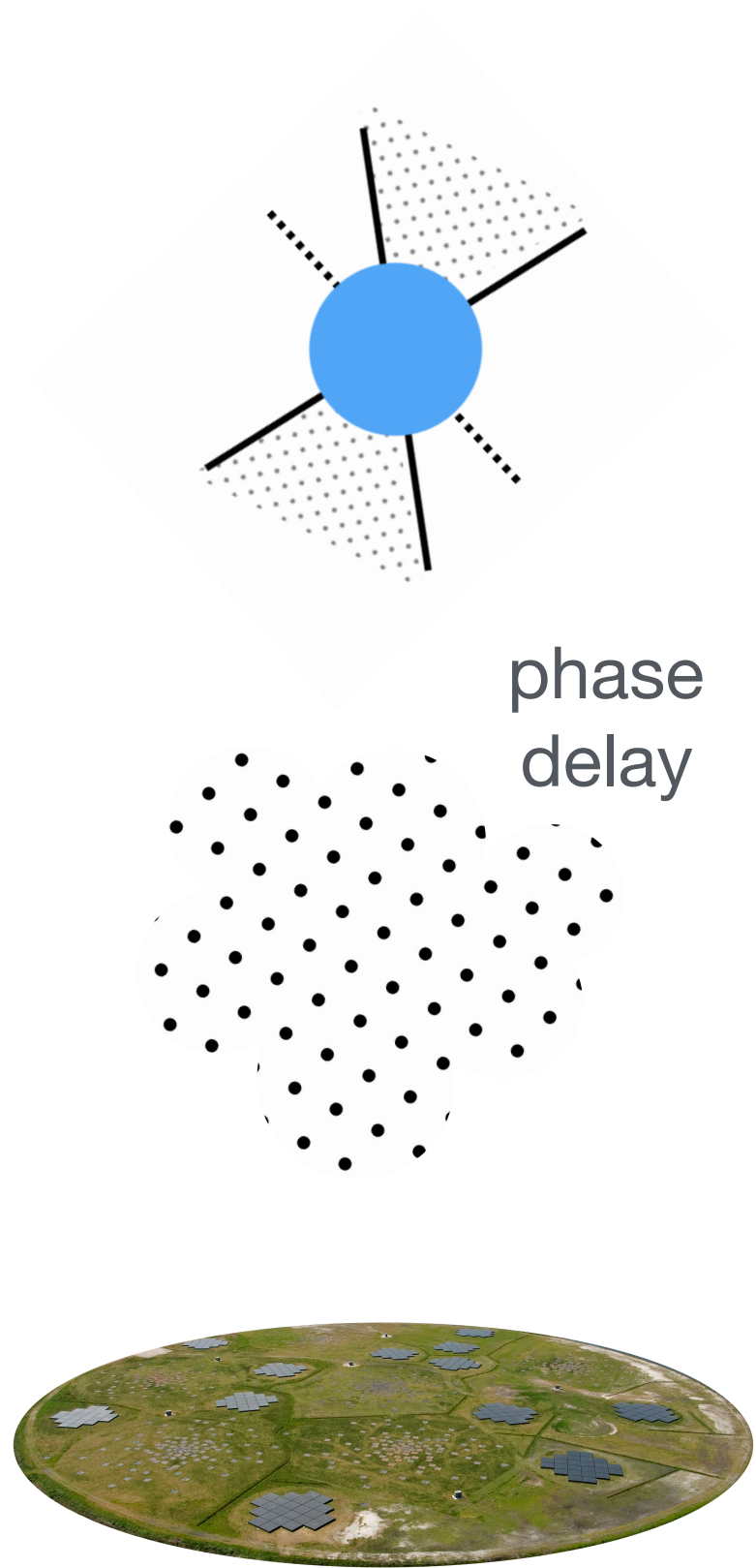
need complex voltage data;
want maximum data rate

48 sources
(galactic longitude $> 10^\circ$)
+ 2 test pulsars

21 LOFAR
Core stations



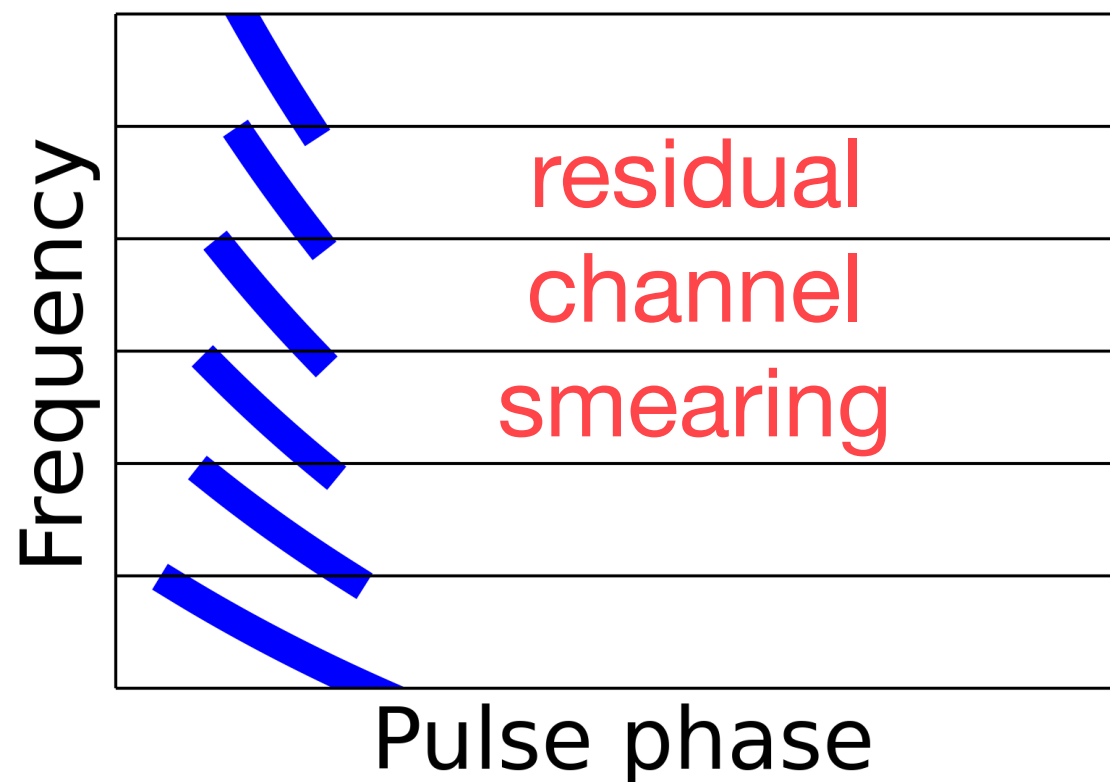
LOFAR challenge: correcting for the ISM



dispersive delay
a priori unknown

$$\tau_{\text{DM}} \propto \text{DM} \nu^{-2}$$

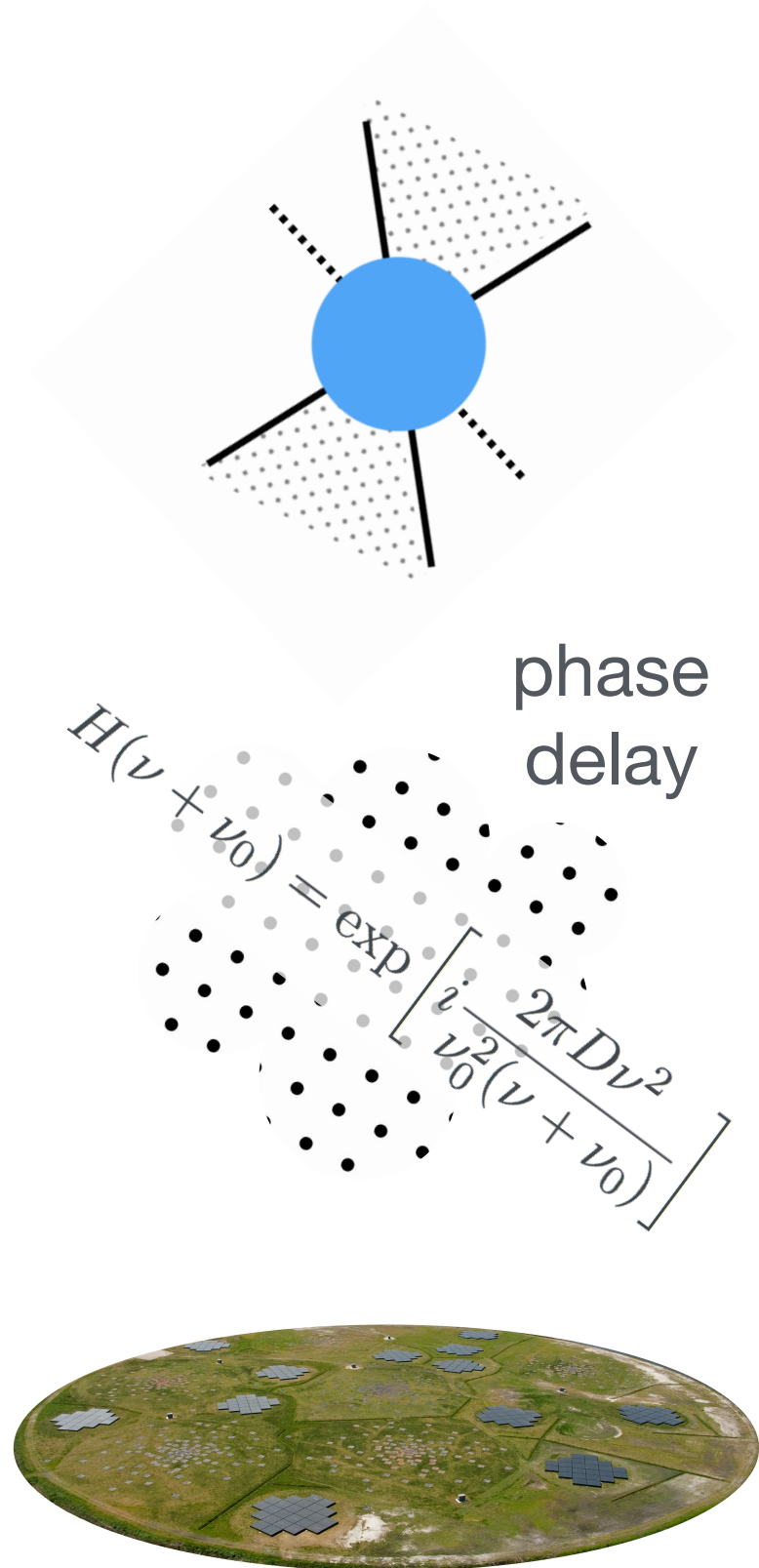
Incoherent dedispersion:



LOFAR challenge: correcting for the ISM

dispersive delay
a priori unknown

$$\tau_{\text{DM}} \propto \text{DM} \nu^{-2}$$

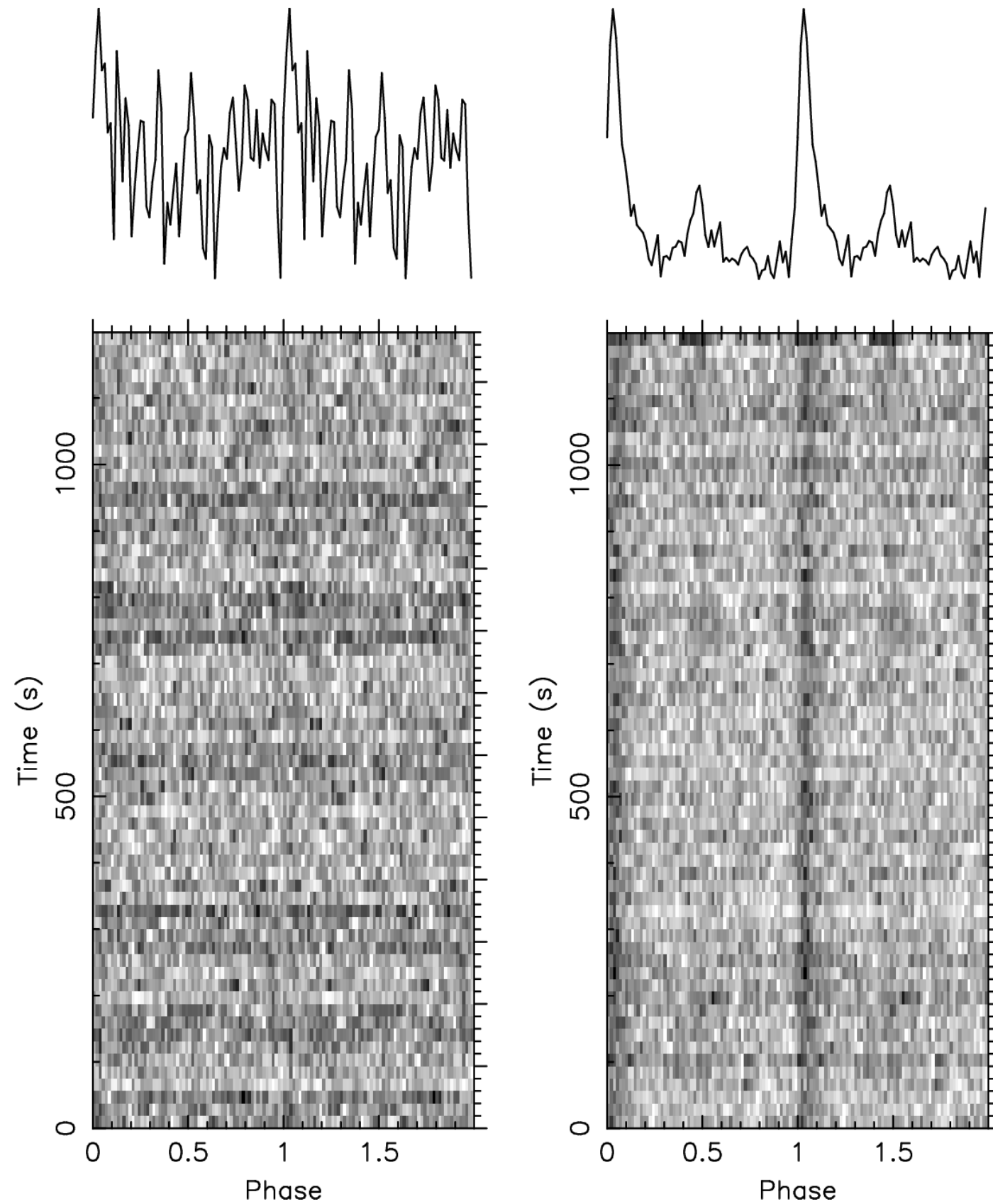


Coherent dedispersion:

e.g. Hankins (1971), Hankins & Rickett (1975),
van Straten (2003)

“the convolution of raw signal voltages with the inverse of the ISM transfer function”

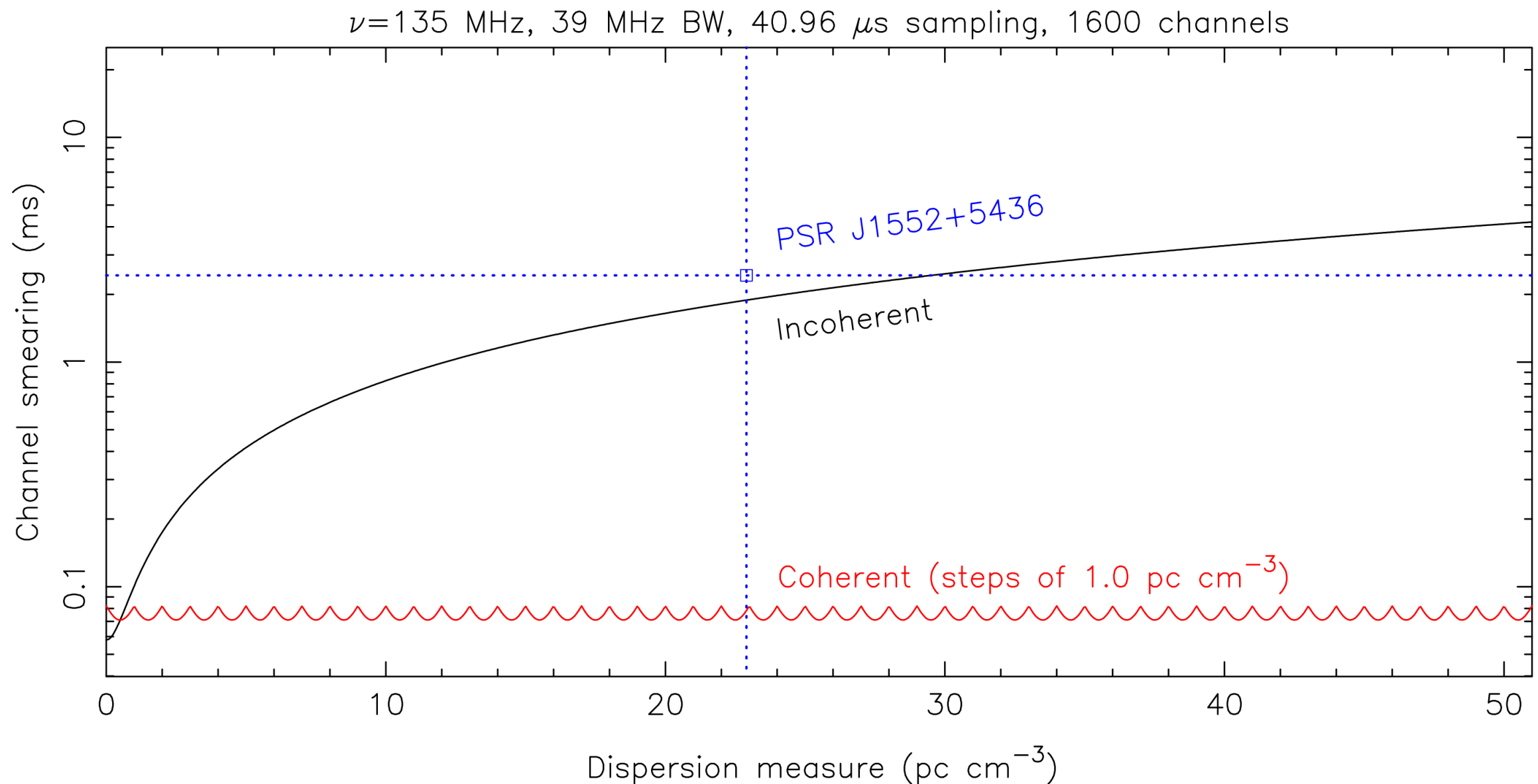
Incoherent vs. Coherent dedispersion



LOFAR (semi-)coherent dedispersion search

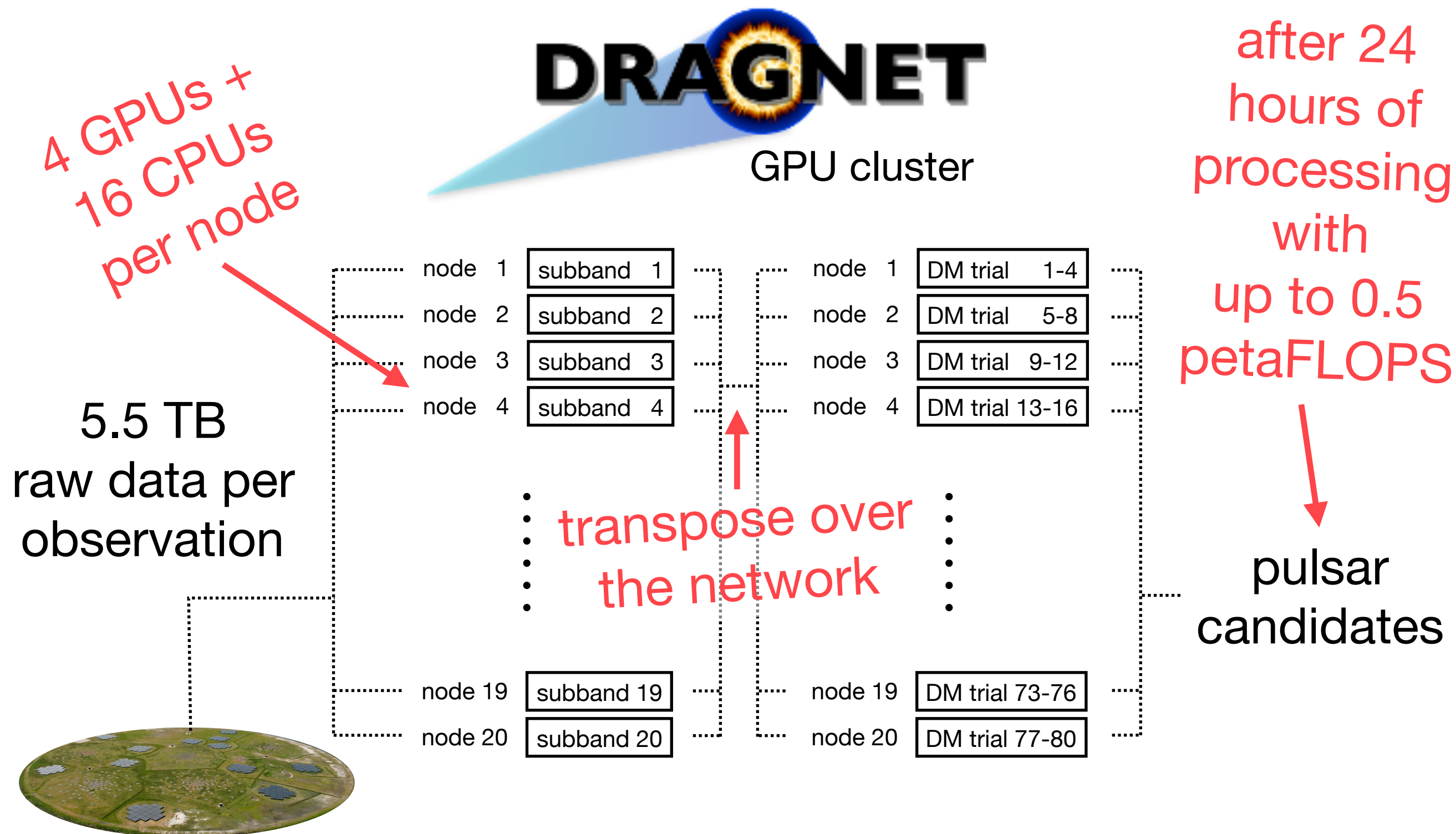
Bassa et al., in prep.

coherent DM trial step size = 1 pc cm^{-3}
incoherent DM trial step size = 0.002 pc cm^{-3}



LOFAR (semi-)coherent dedispersion search

Bassa et al., in prep.

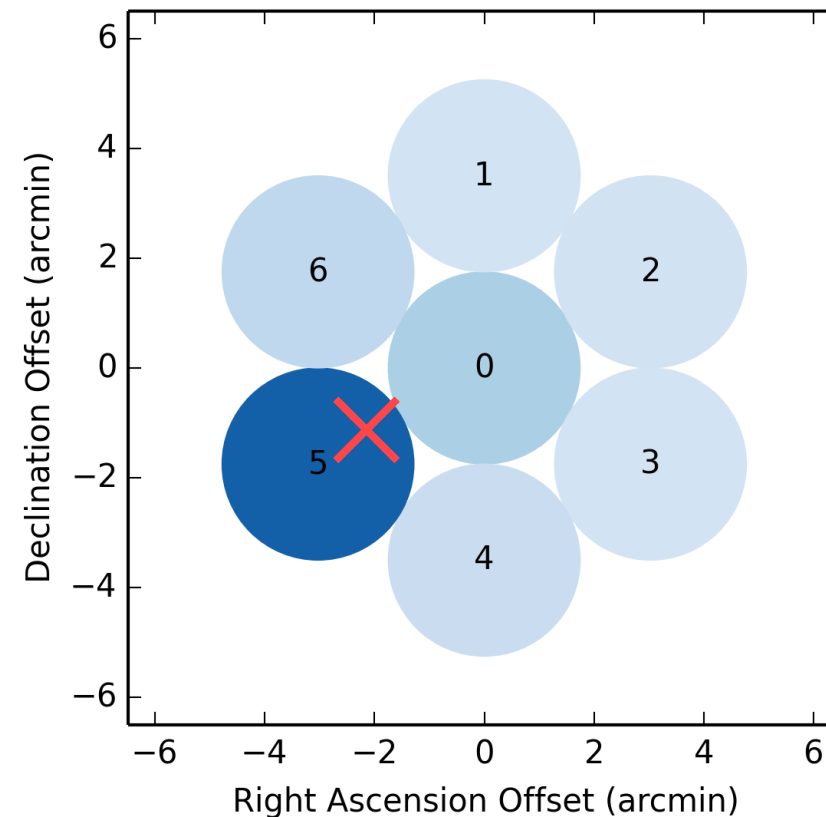
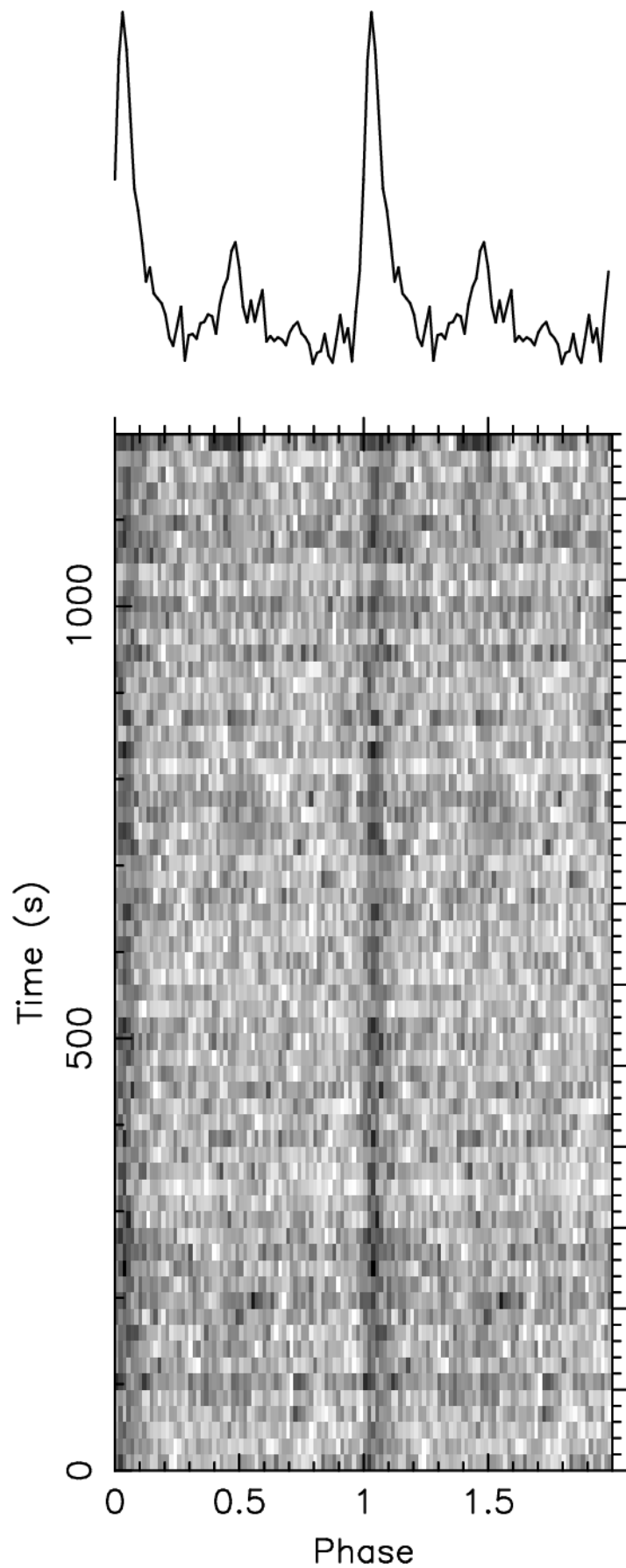


PSR J1552+5436

Pleunis et al., in prep.

first LOFAR millisecond pulsar
first aperture array millisecond pulsar
lowest observing frequency
at which an MSP is discovered

$p_s = 2.43$ ms; $DM = 22.9$ pc cm⁻³; $d = 1.225$ kpc
isolated or in a long period binary



Future prospects

PSR J1552+5436

non detections using Lovell and Nançay at L-band

LOFAR DDT proposal approved:
start timing and measure spectrum
millisecond pulsar discovered at the
lowest observing frequency

LOFAR survey for
Fermi gamma-ray
sources



Pulsar surveys with SKA-low for ultra-steep spectrum pulsars

