EUROFLASH

Jason Hessels

McGill / UvA / ASTRON

Image credit: Futselaar & Hessels

McGill TSI

Affiliated with

UNIVERSITY OF AMSTERDAM
ANTON PANNEKOEK INSTITUTE

ASTRON

Research team

ASTROFLASH

Funded by

Canada Excellence Research Chairs
Chaires d'excellence en recherche du Canada

erc European Research Council

NWO


Image credit: Hessels
Merging Black Holes
Supernovae
Magnetars
Accreting Massive Black Hole
Super-giant Pulses
Interacting Binary
Microquasar
Evaporating Black Holes
Black Hole Battery
Cosmic Comb
Gamma-ray Bursts
"Blitzars"
Galactic
Extragalactic
Micro-quasars
Flare stars
ETI
Magnetars
Pulsars
We are here
(Potential) sources of coherent radio flashes
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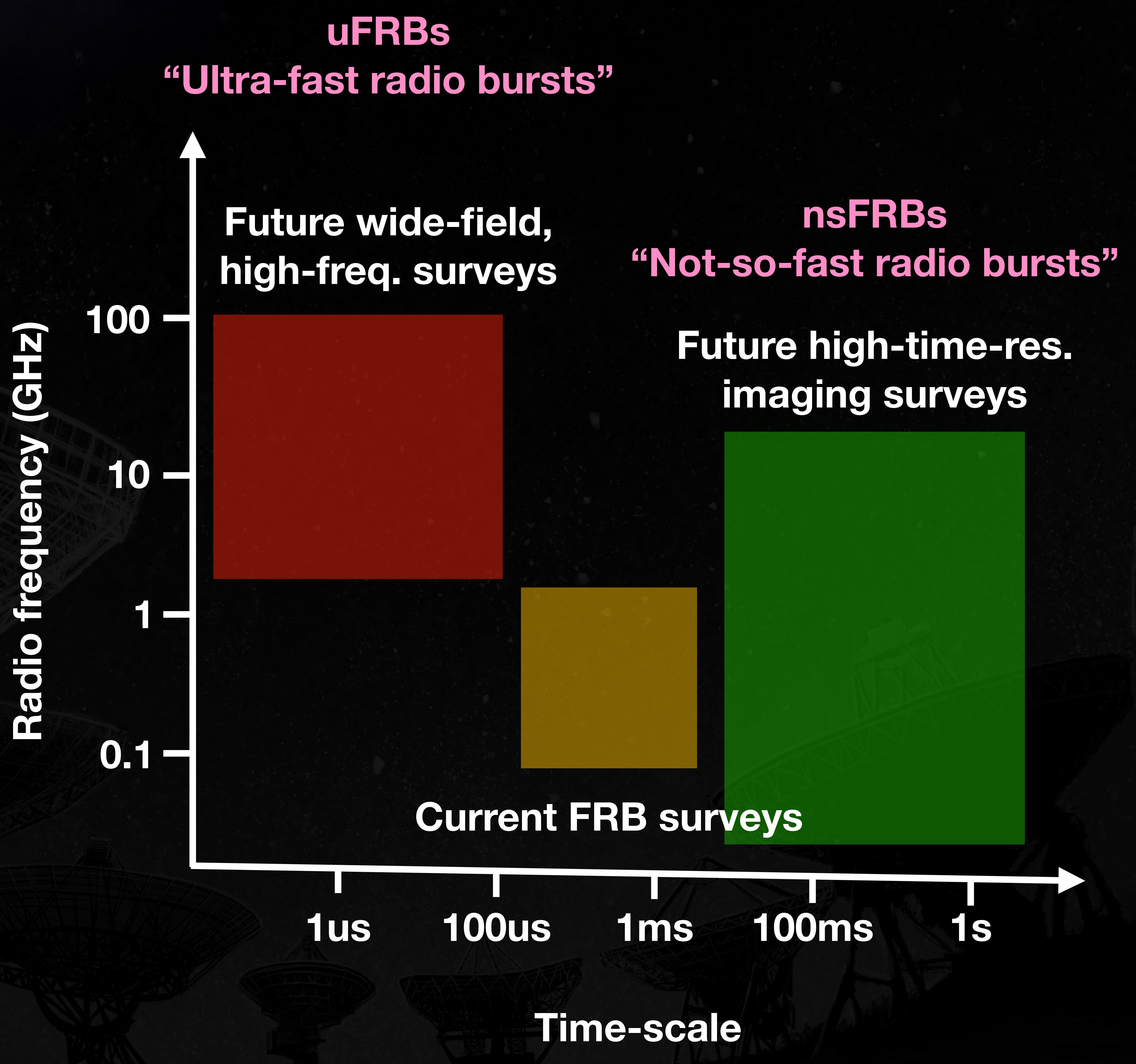
Boldly go where no telescope has gone before



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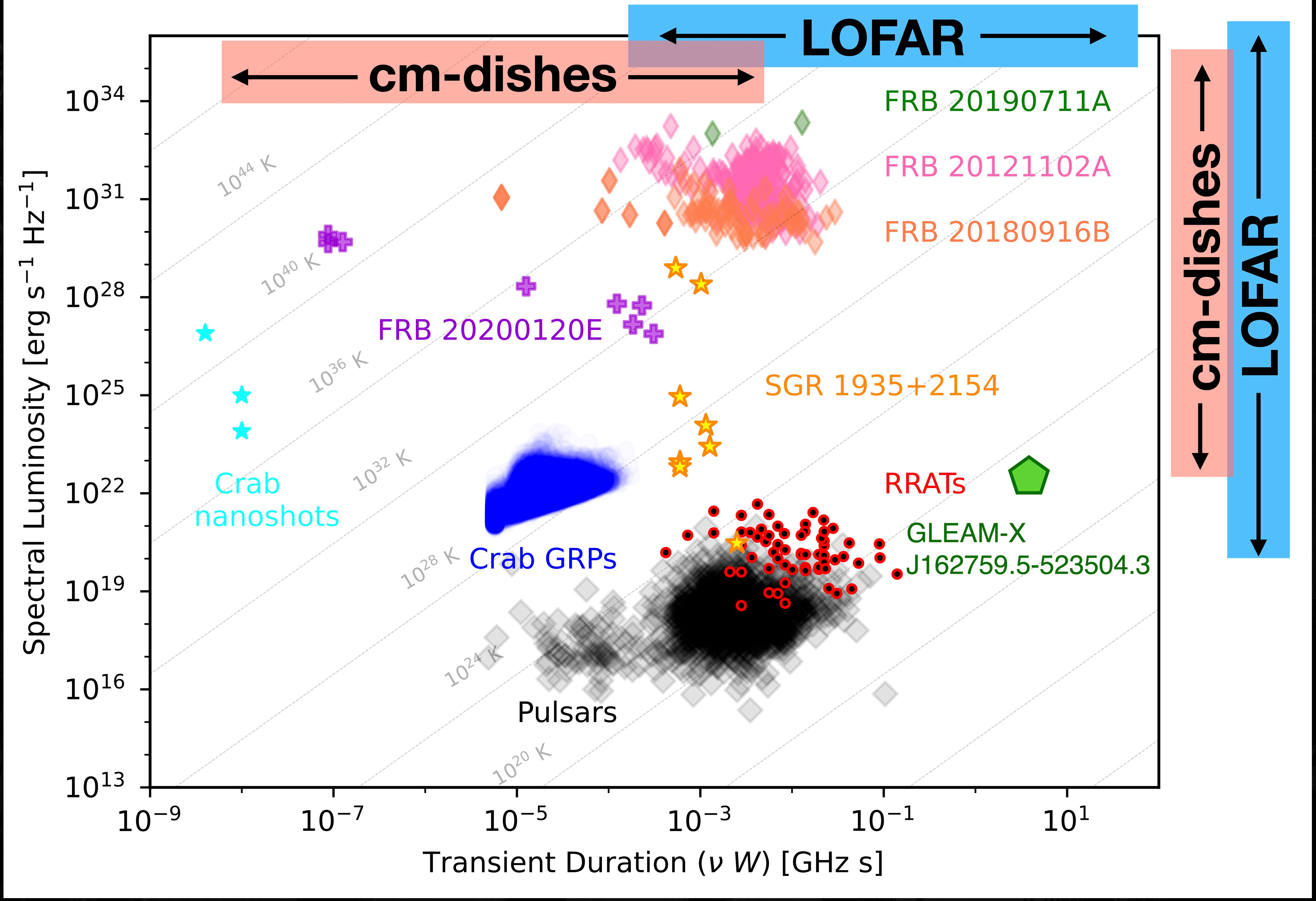

Adapted from Nimmo et al. 2022

Timescale
10,000,000,000x
Luminosity
1,000,000,000,000,000x

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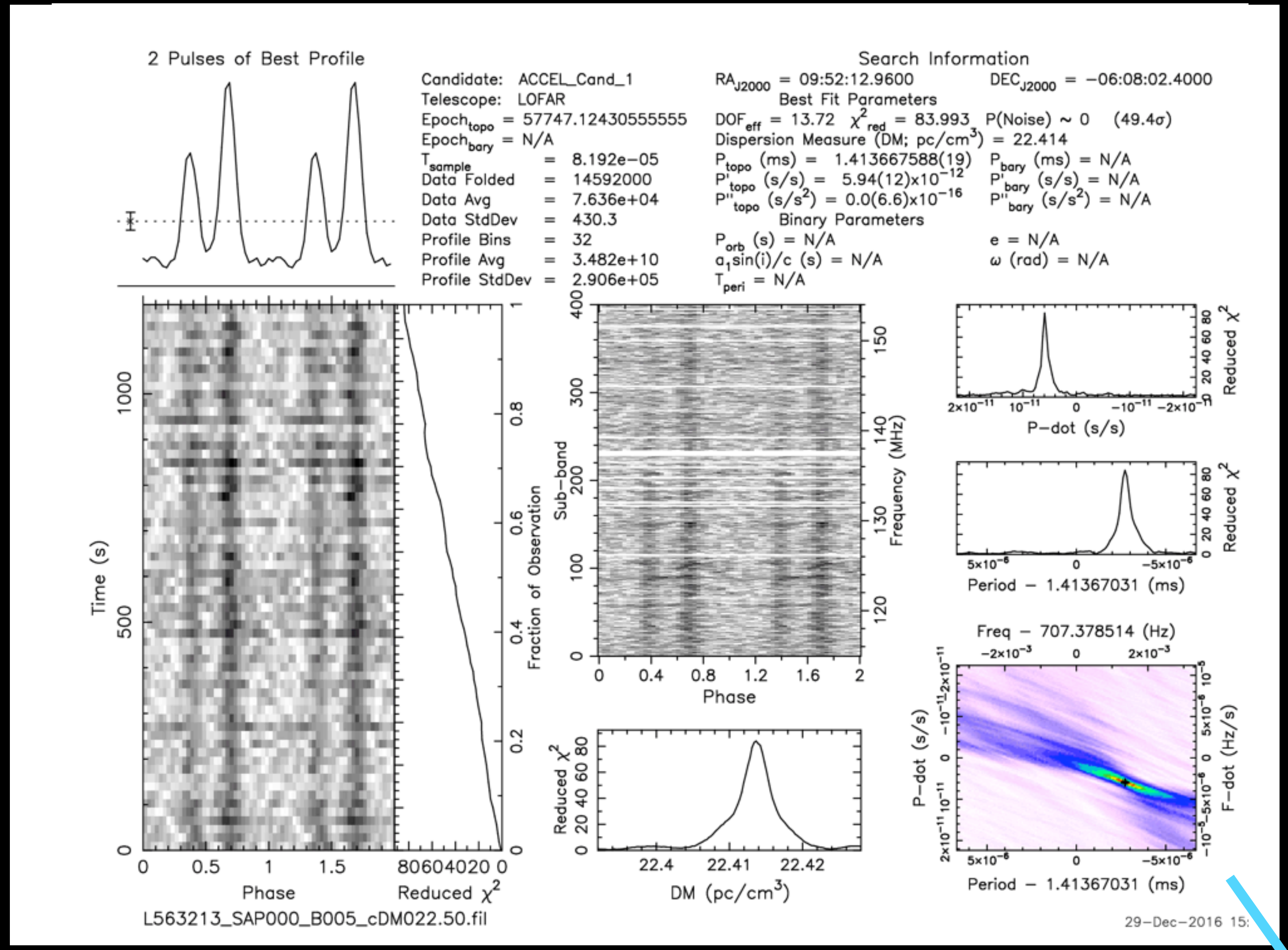
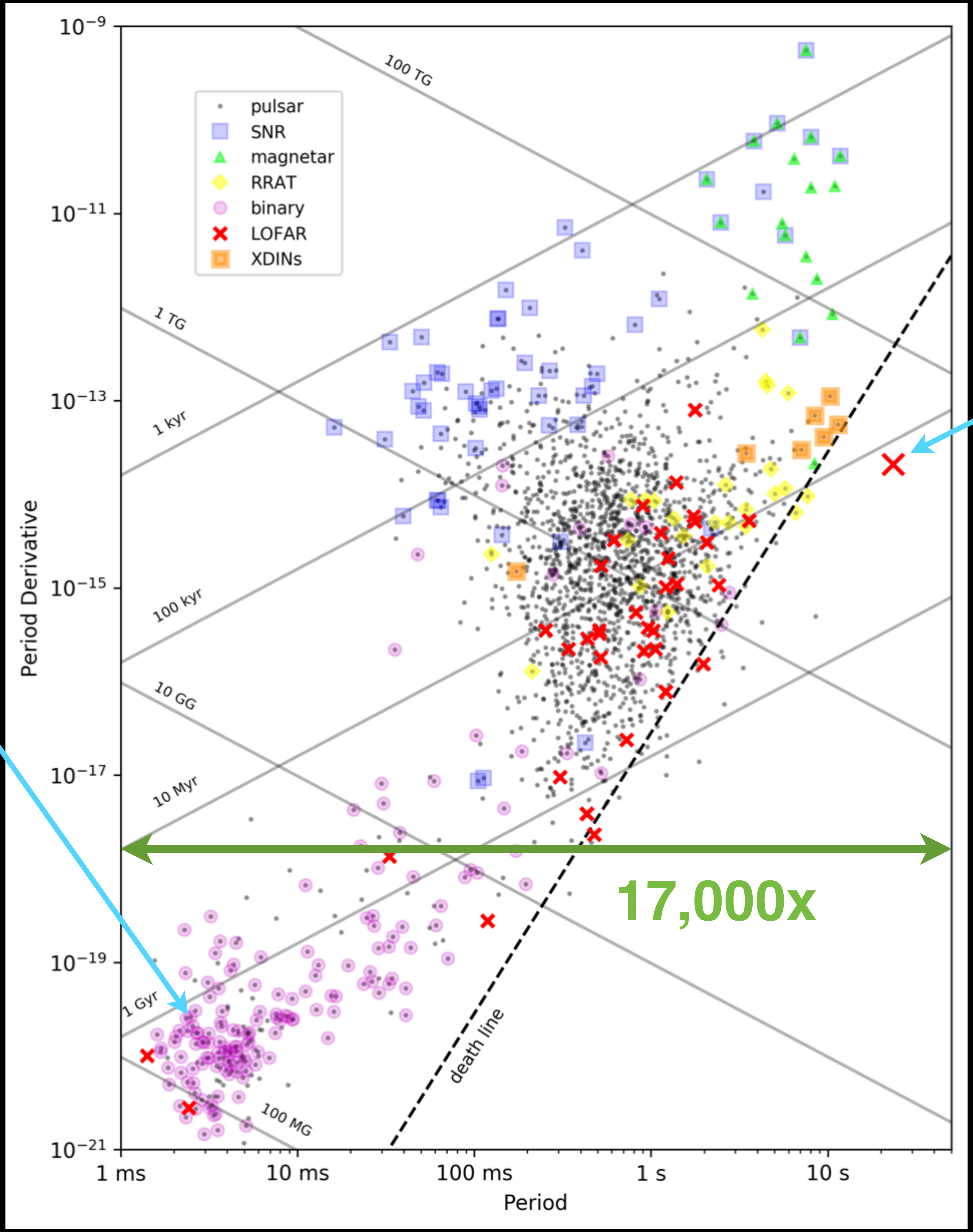
LOFAR on the P-Pdot

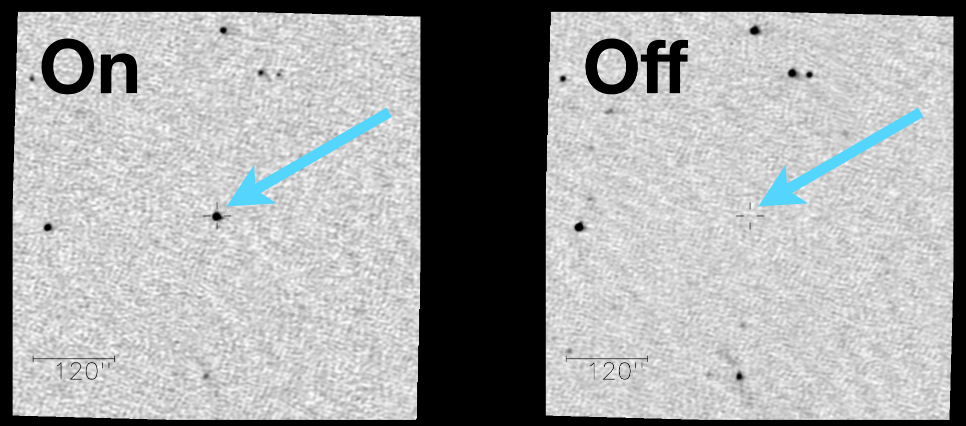


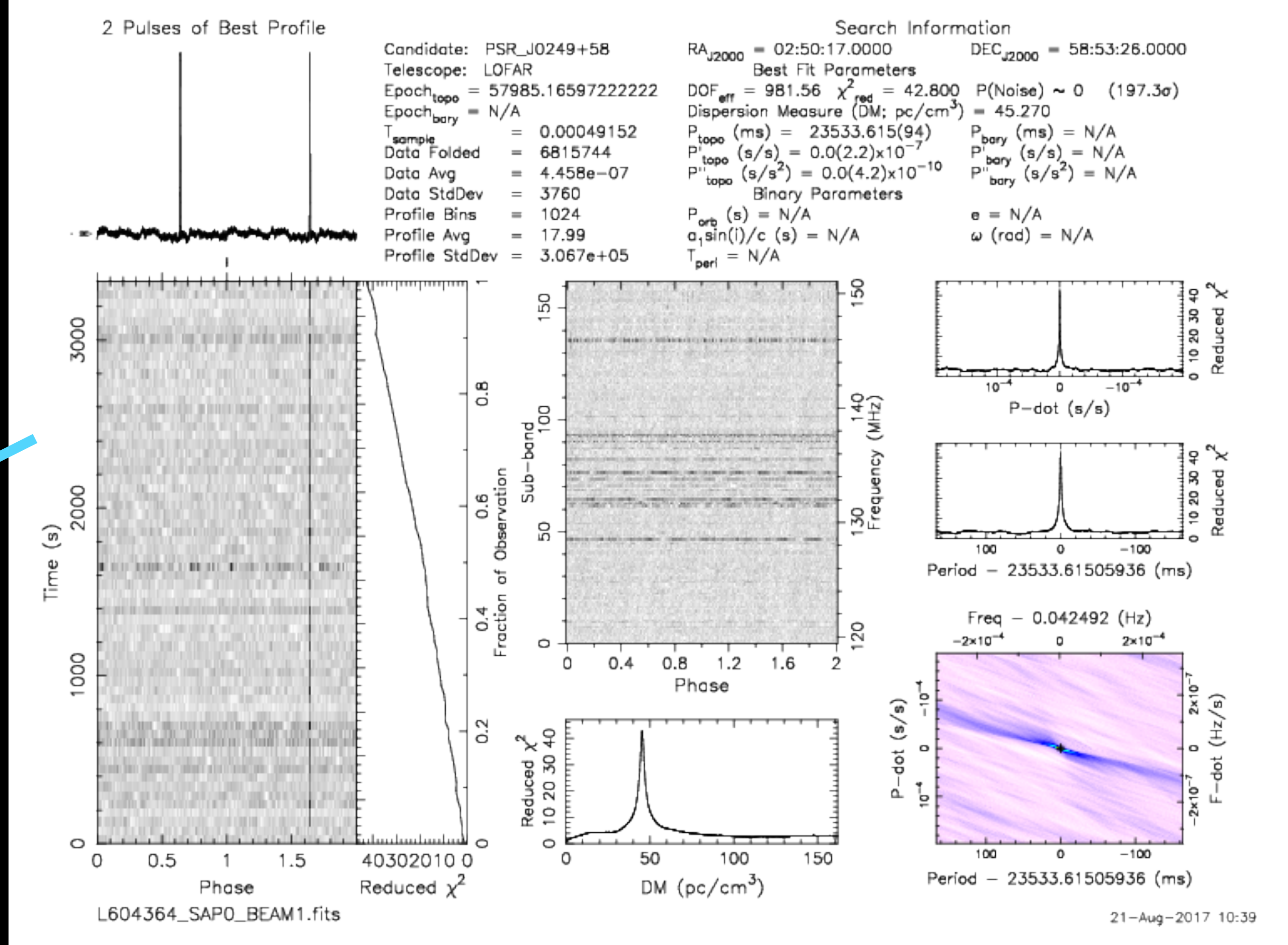
Bassa et al. 2017

707Hz

1.41ms







Tan et al. 2018

0.042Hz

23,533.6ms

Cooper - see also van der Wateren et al. 2023

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FRBs with LOFAR

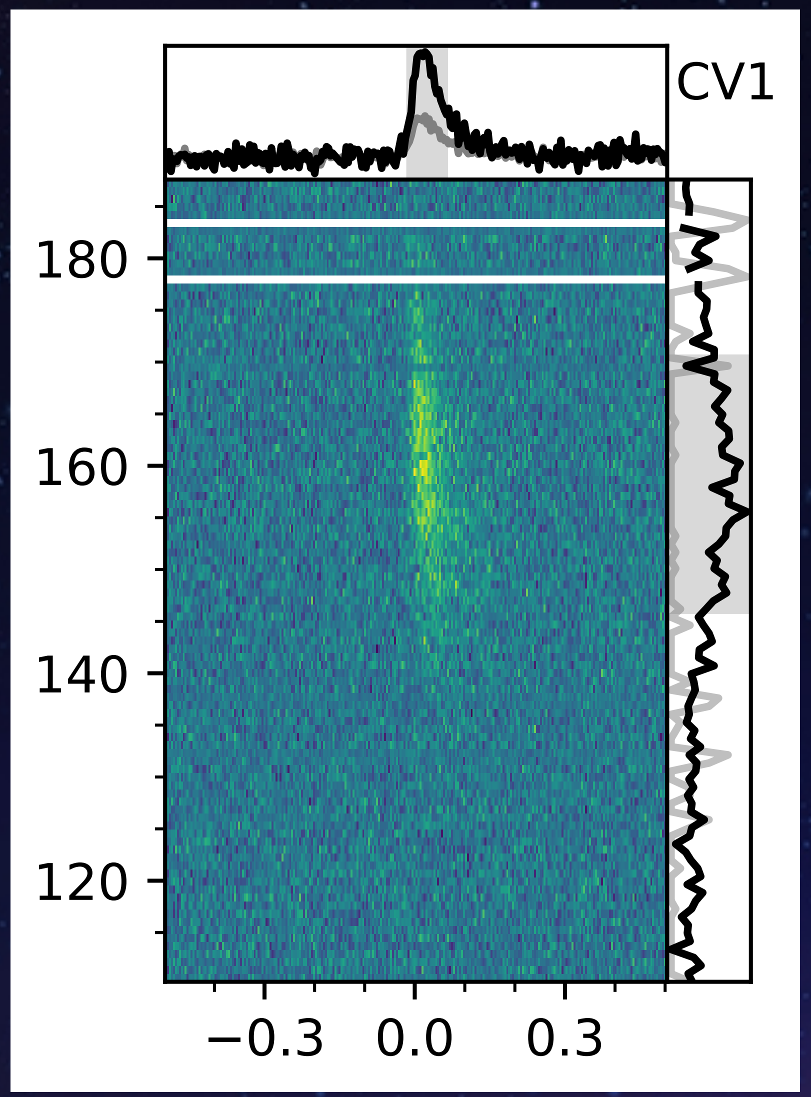

Figure credit:
Pleunis et al. 2021

Image credit: Daniëlle Futselaar / ASTRON

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LOFAR ERIC
Commensal multi-cast of LOFAR UDP station data
EUROFLASH
Head
BF & XC
001
002
032
DS
SURF
LOFAR Stations
2x24 core / 14 remote / 14 international
76 * 2 * 3Gb/s = 456 Gb/s
LOFAR CEP Network
(in Groningen)
EuroFlash Network
(in Groningen)
EuroFlash Beamformer & Correlator
(GPU-based; clone of COBALT)
EuroFlash Single-pulse searcher
(CPU-based; runs Astro-accelerate code)
EuroFlash Dynamic-spectrum searcher
(GPU-based)
SURF Long-term Archive + Post-processing
(on Spider, Snellius, etc.)
EUROFLASH is a 24/7 commensal search machine for (not-so) fast radio transients
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LOFAR2.0 Large Programmes
Transients

Slow(er) Transients (LORAX)

Rowlinson, Wijers et al.

Submission: LOFAR2.0 Large Programmes — Full proposal

LOFAR2.0 Observations of Radio Astrophysical eXplosions (LORAX)

Antonia Rowlinson[1,2], Ralph A.M.J. Wijers[2] and full team in Table 2

[1]ASTRON – Netherlands Institute for Radio Astronomy
[2]Anton Pannekoek Institute for Astronomy, University of Amsterdam

Abstract

Keywords
transients, surveys, radio astronomy, coherent radiation

LOFAR International LOFAR Telescope

Pulsar & Fast Transient Surveys (PFTS)

Hessels, Bassa, Pilia, Sobey, Stappers et al.

Submission: LOFAR2.0 Large Programmes — Full proposal

LOFAR2.0 Pulsar & Fast Transient Surveys

Galactic Plane Survey (L2GPS)

Arias, Rajwade, Hajduk et al.

Submission: LOFAR2.0 Large Programmes — Full proposal

The LOFAR 2.0 Galactic Plane Survey (L2GPS)

Maria Arias[1], Kaustubh Rajwade[2], Marcin Hajduk[3] and the L2GPS collaboration[4]

Abstract

Keywords

LOFAR International LOFAR Telescope

Pulsar & Fast Transient Monitoring (PURR)

Tiburzi, Bassa, Hessels, Janssen, Keane et al.

Submission: LOFAR2.0 Large Programmes — Full proposal

PURR – PUlsars and Repeaters Research, a Pulsar and Fast Transient Monitoring Project

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Goals

- Uncover origin(s) of fast radio bursts (FRBs)
- Discover new FRB-like transients
- Probe extreme astrophysical processes
- Probe intervening magneto-ionised medium

Image credit: Futselaar & Hessels

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- Uncover origin(s) of fast radio bursts (FRBs)
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- **Probe extreme astrophysical processes**
- Probe intervening magneto-ionised medium

Image credit: Futselaar & Hessels

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Goals

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Image credit: Futselaar & Hessels

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Observing modes

Localisation in time

20 μs - 10 ms:
targeted searches using semi-coherent dedispersion

1ms - 100 ms:
incoherent sum of ~14 International stations

10ms - 1000 ms:
~1000 tied-array beams from Core

1s - 100 s:
fast difference imaging from Core

Localisation in space

buffer Remote + International station data

Image credit: Classy Girl Cupcakes

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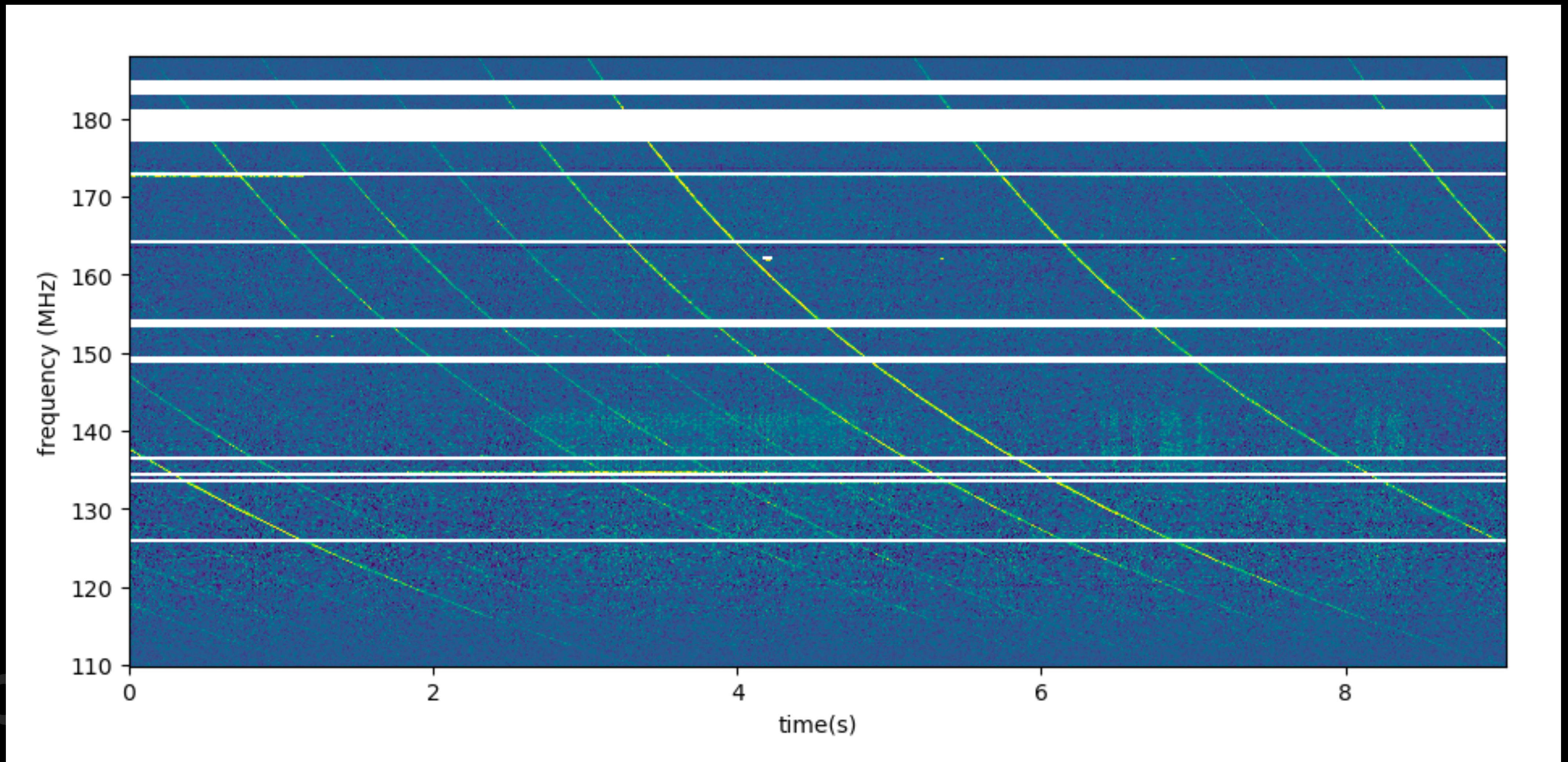

10-ms visibilities from COBALT2.0!

Figure credit: Akshatha Gopinath

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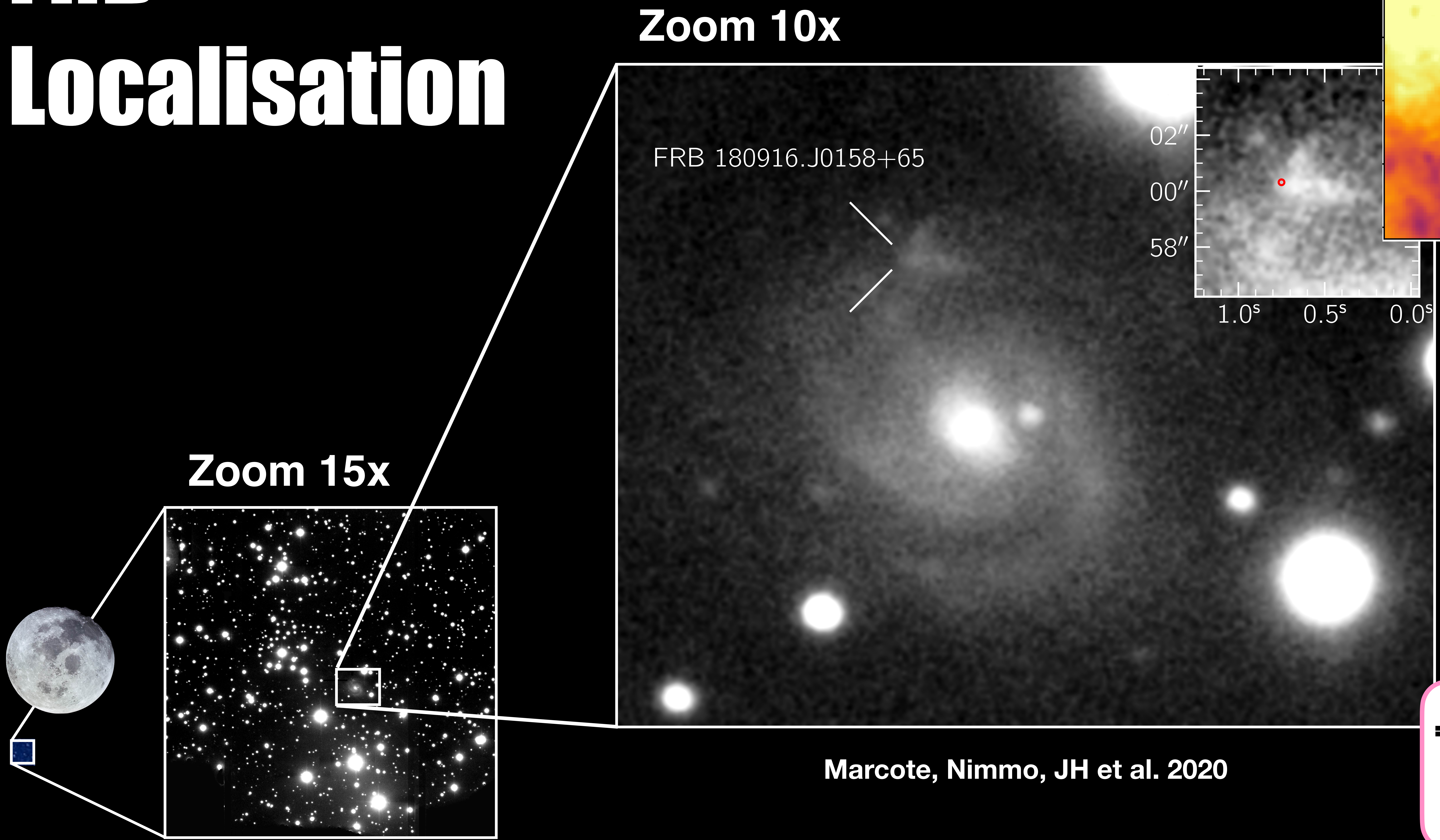
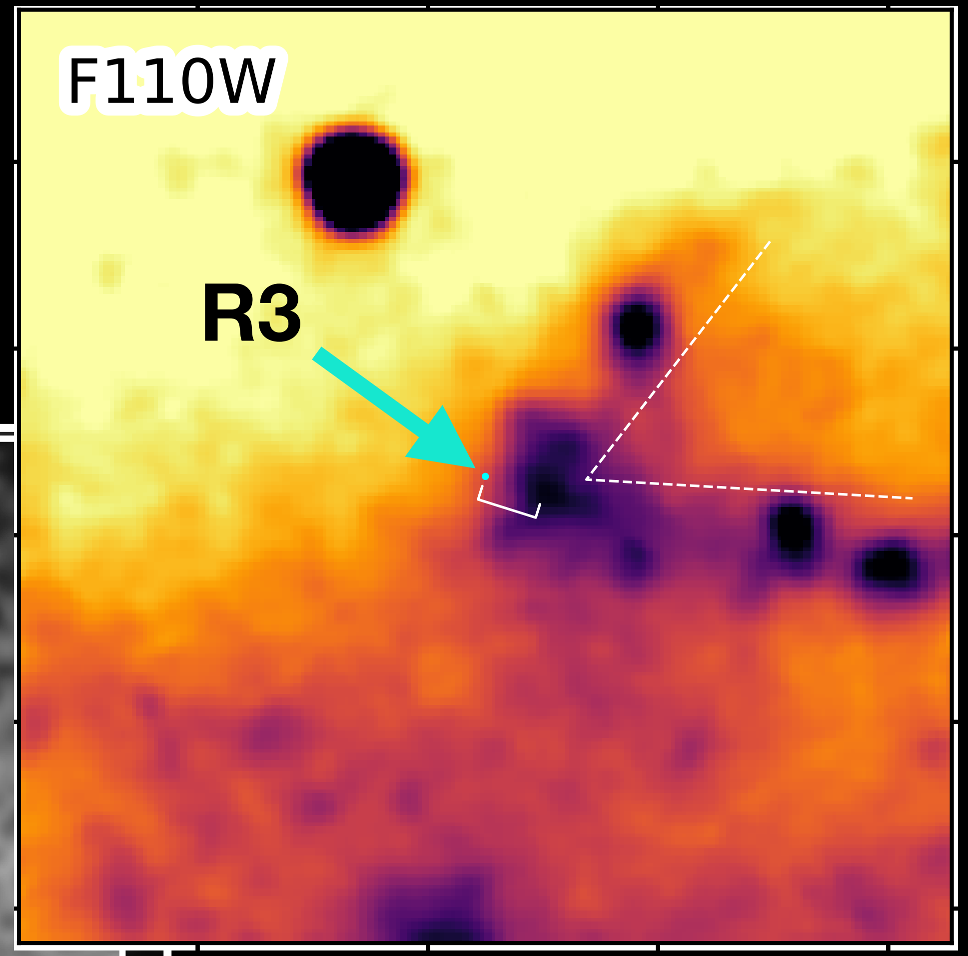
FRB Localisation



Marcote, Nimmo, JH et al. 2020



Tendulkar, Gil de Paz, Kirichenko, JH et al. 2021

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Challenges

RFI & baseline variations:
beam `flat-fielding’

False positives & completeness:
machine learning classifiers & injections

Dispersive delay:
for DM = 1000pc/cc, Δt = 141s

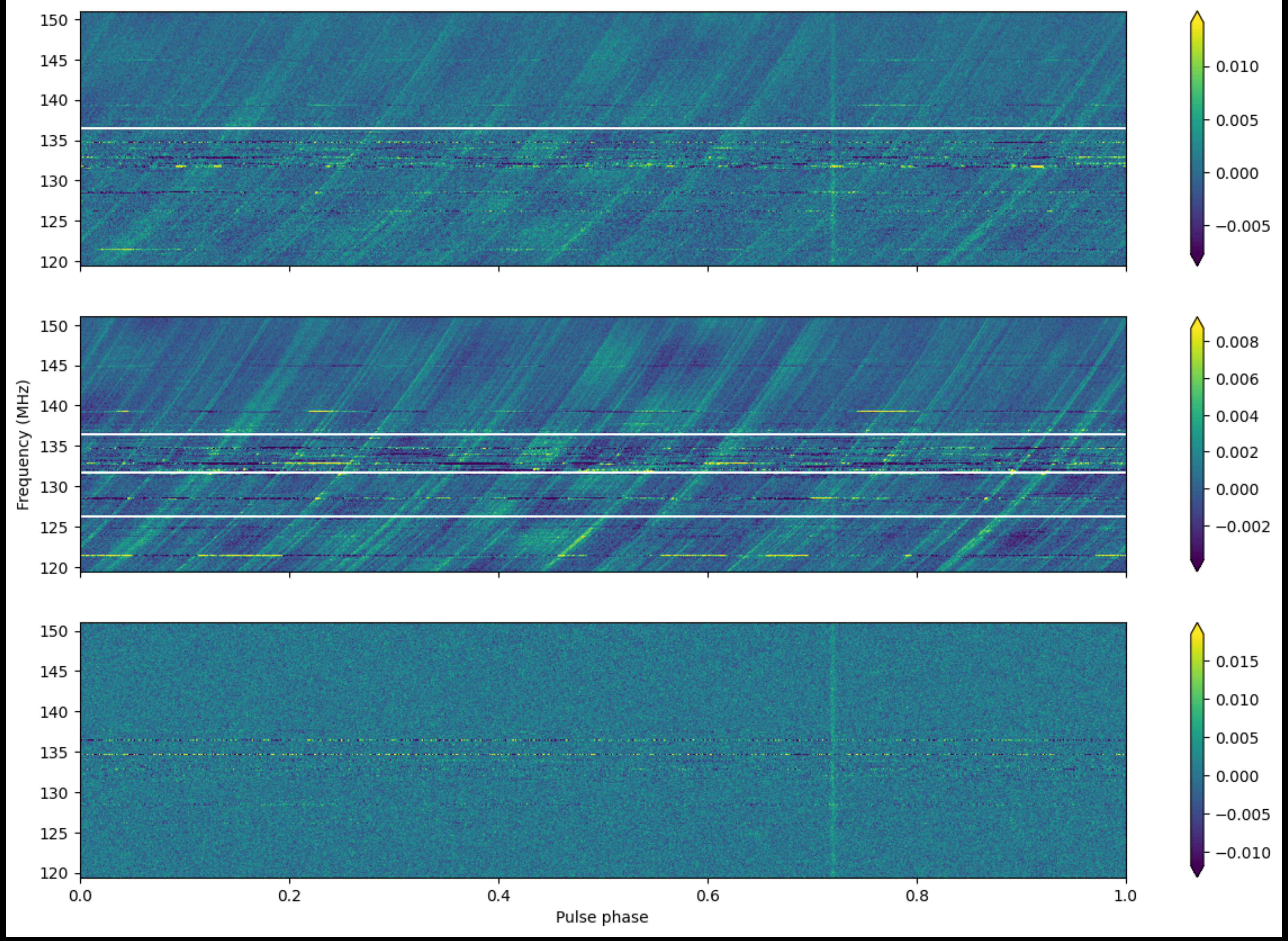

Figure credit: Cees Bassa

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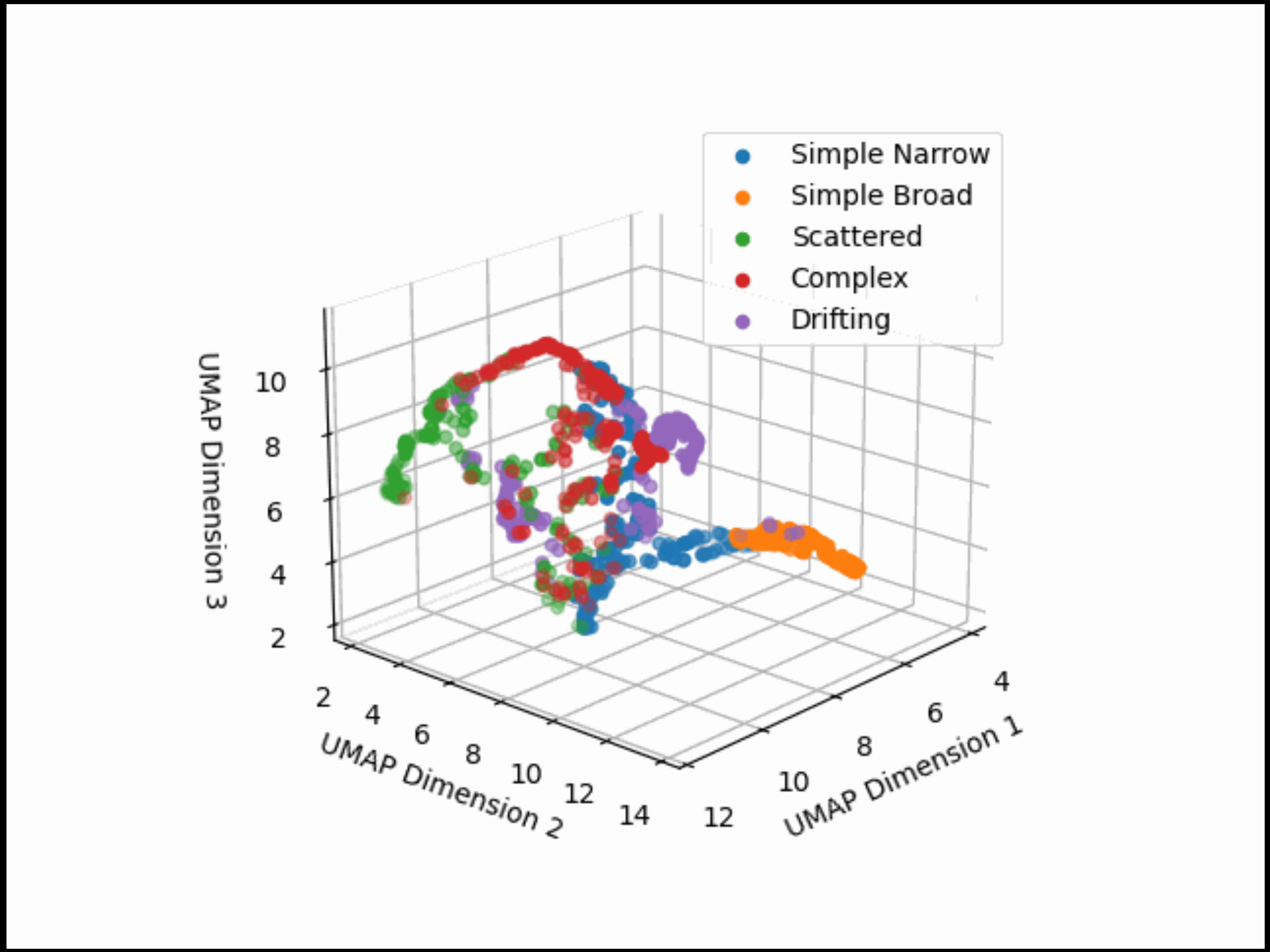

Figure credit: Dirk Kuiper

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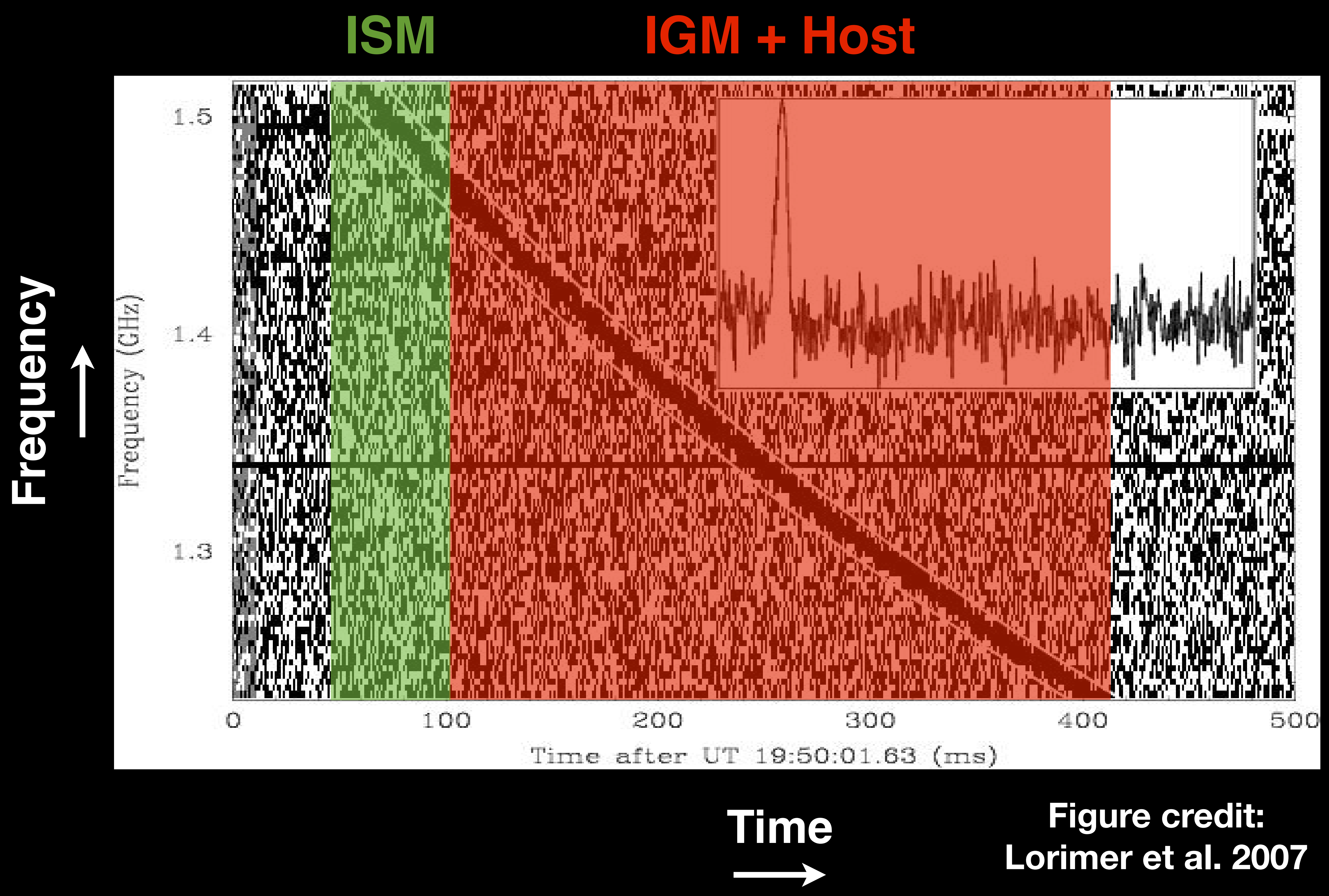

Figure credit:
Lorimer et al. 2007

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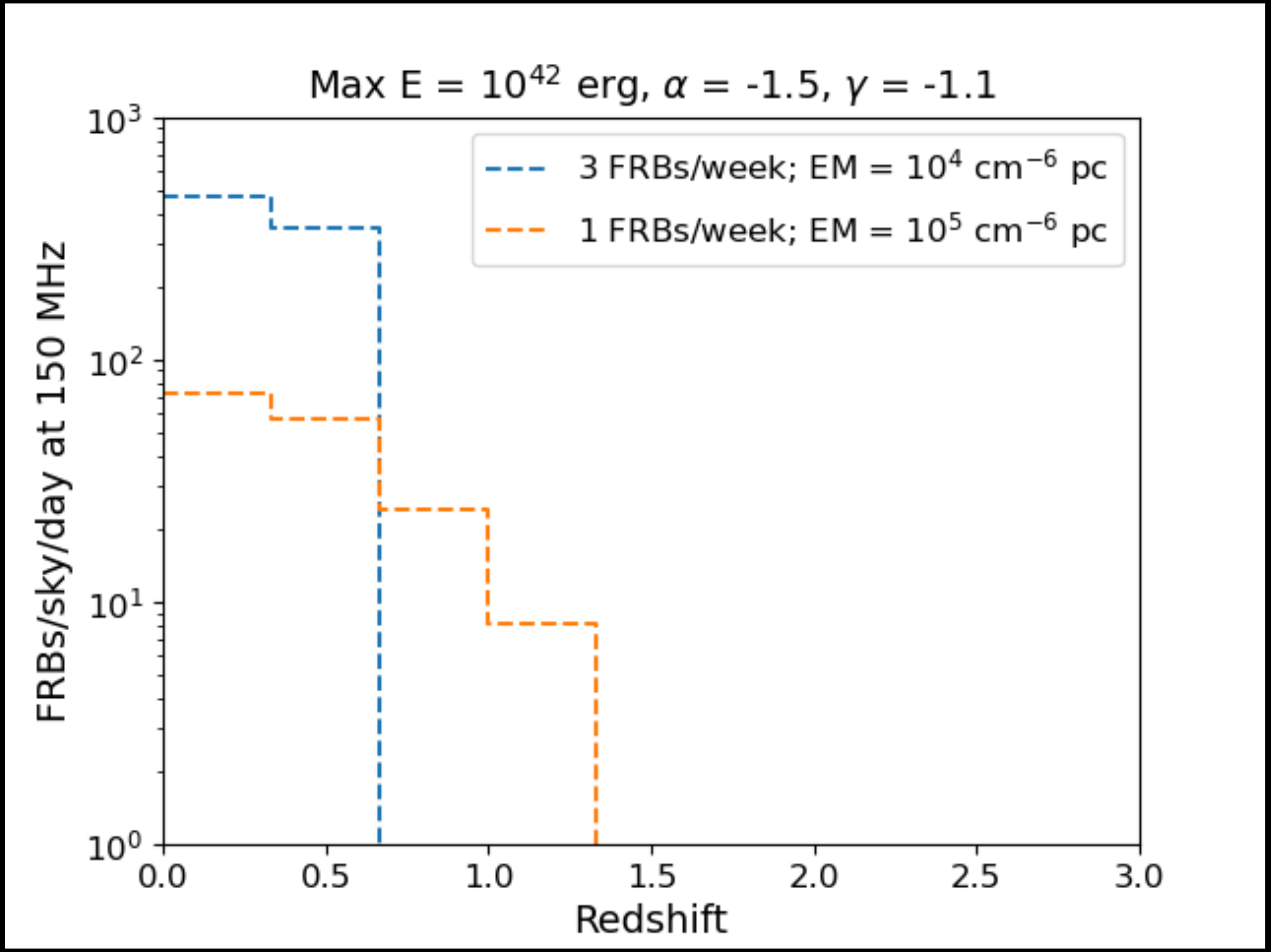
LOFAR FRB Rates



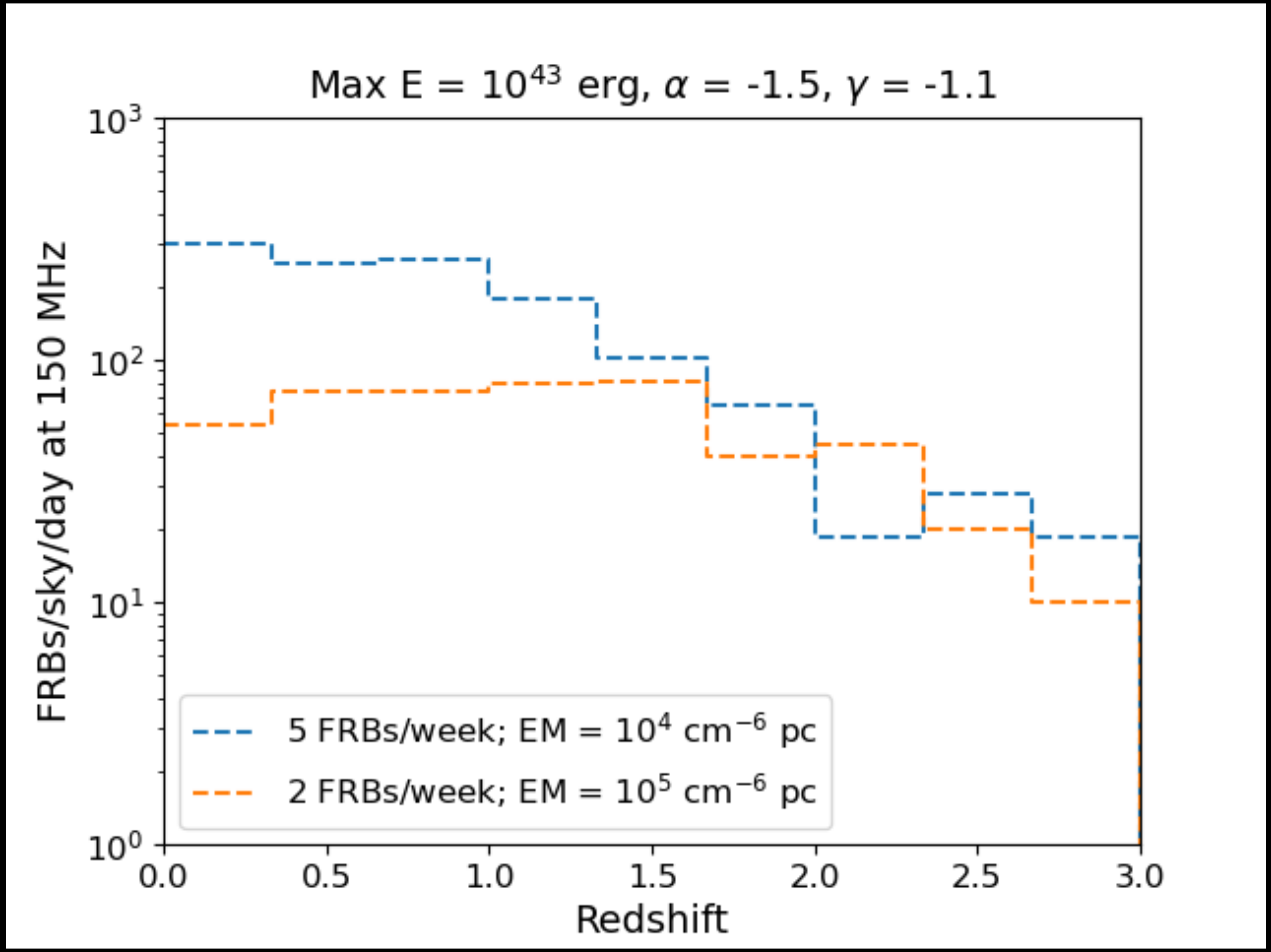


Figure credit: Pragya Chawla

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LOFAR FRB Rates

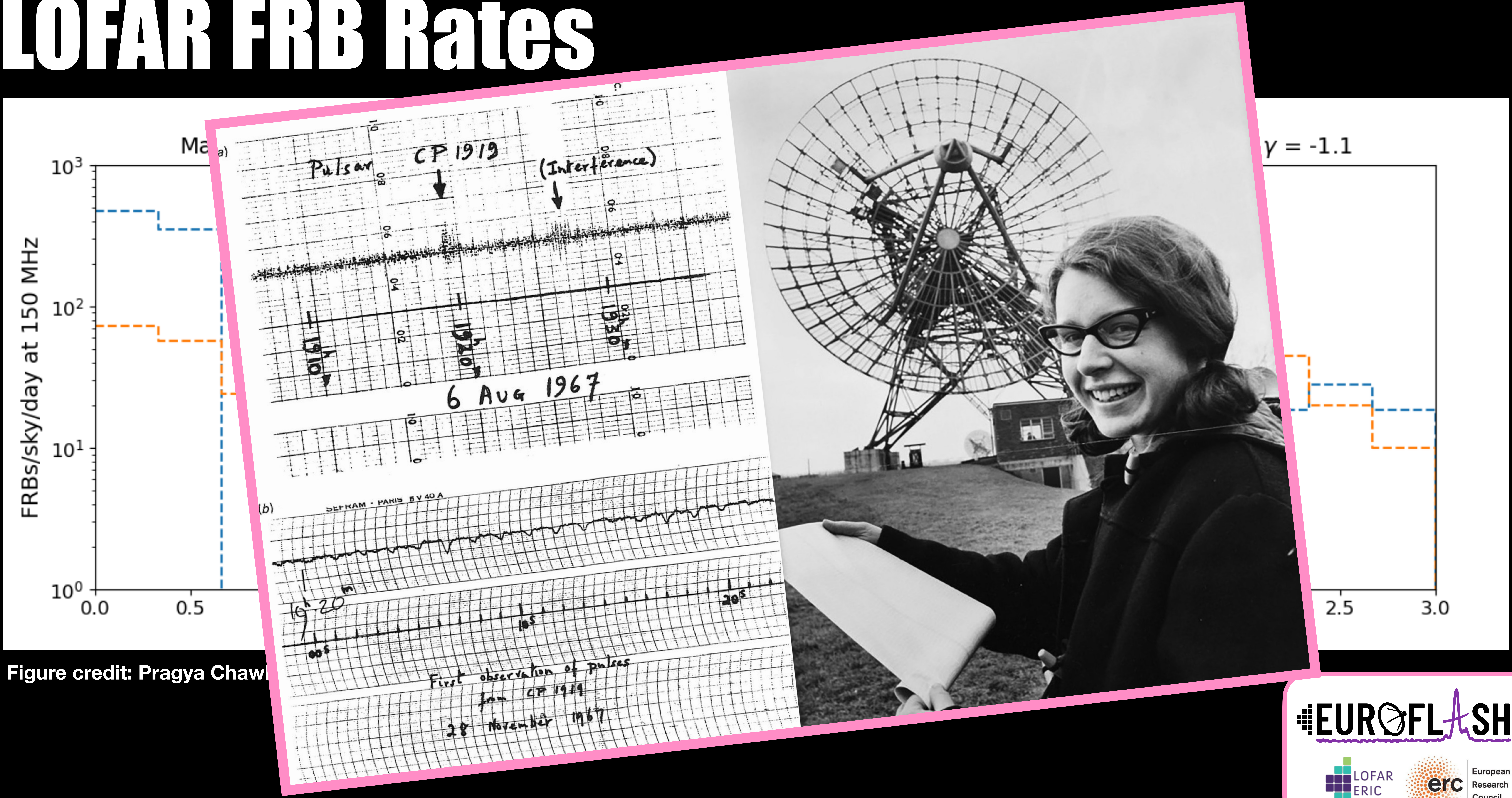

Figure credit: Pragya Chawl

Summary

EuroFlash is a 24/7 search for pulsars & fast radio transients

- Dedicated search machine in the LOFAR central network

Image credit: Daniëlle Futselaar / ASTRON

Summary

EuroFlash is a 24/7 search for pulsars & fast radio transients

- Dedicated search machine in the LOFAR central network
- **Search on timescales from 20 μs - 100 s (10^7x)**

Image credit: Daniëlle Futselaar / ASTRON

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Summary

EuroFlash is a 24/7 search for pulsars & fast radio transients

- Dedicated search machine in the LOFAR central network
- Search on timescales from 20 μs - 100 s (10^7x)
- **Decipher the extreme astrophysics of these sources and use them as precision probes**

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Image credit: Daniëlle Futselaar / ASTRON