

Fast Radio Burst with CHIME



Cherry Ng-Guihéneuf

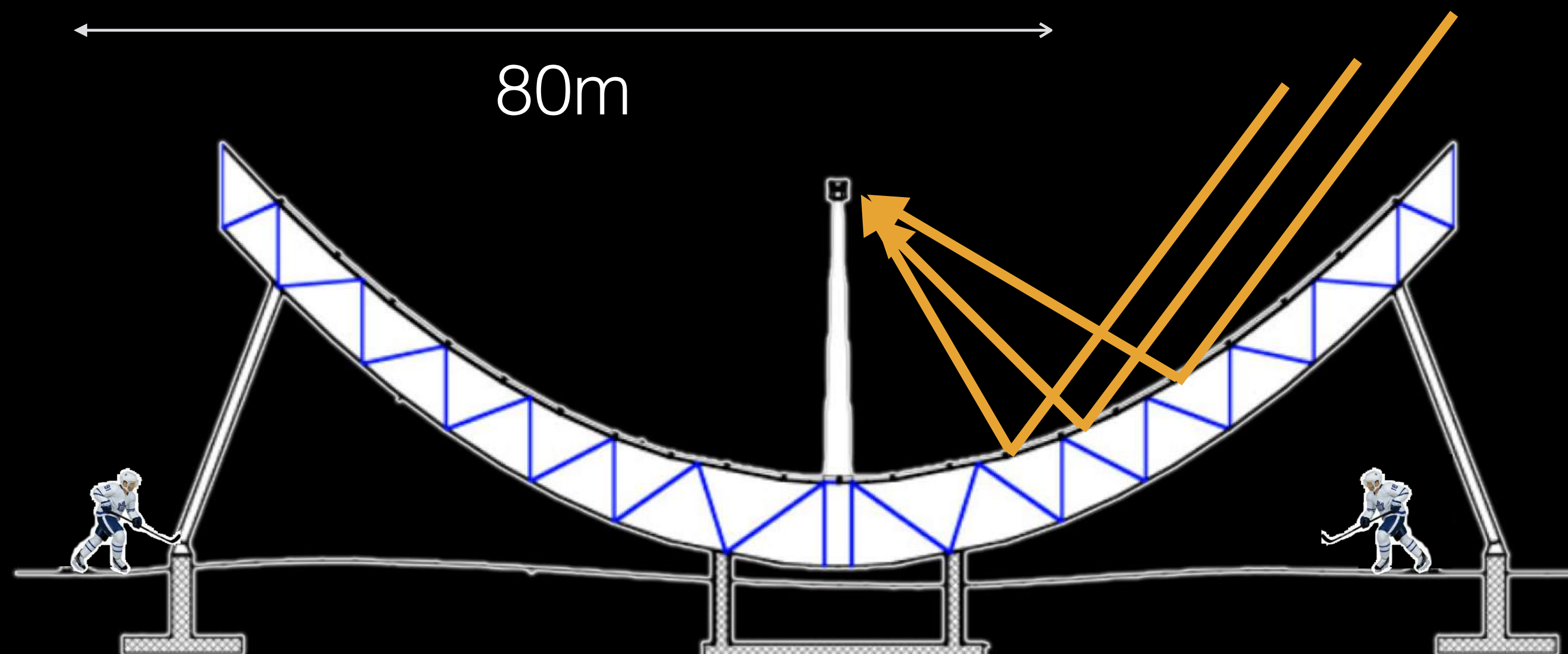
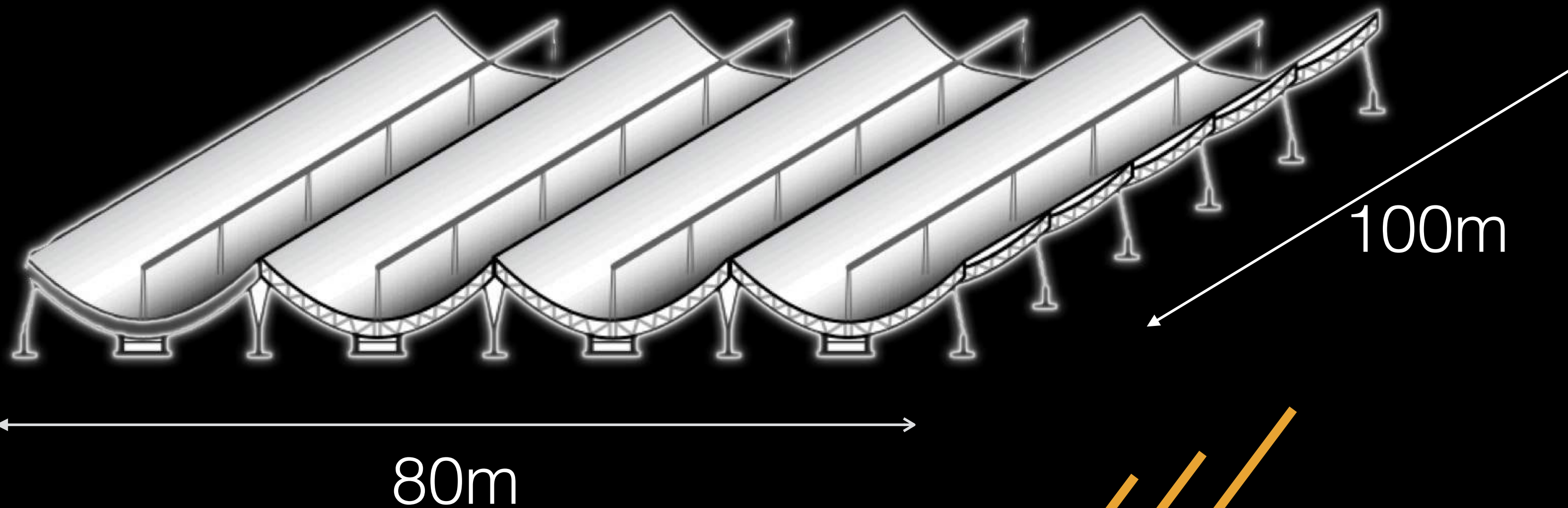
Dunlap Institute for Astrophysics & Astronomy
University of Toronto

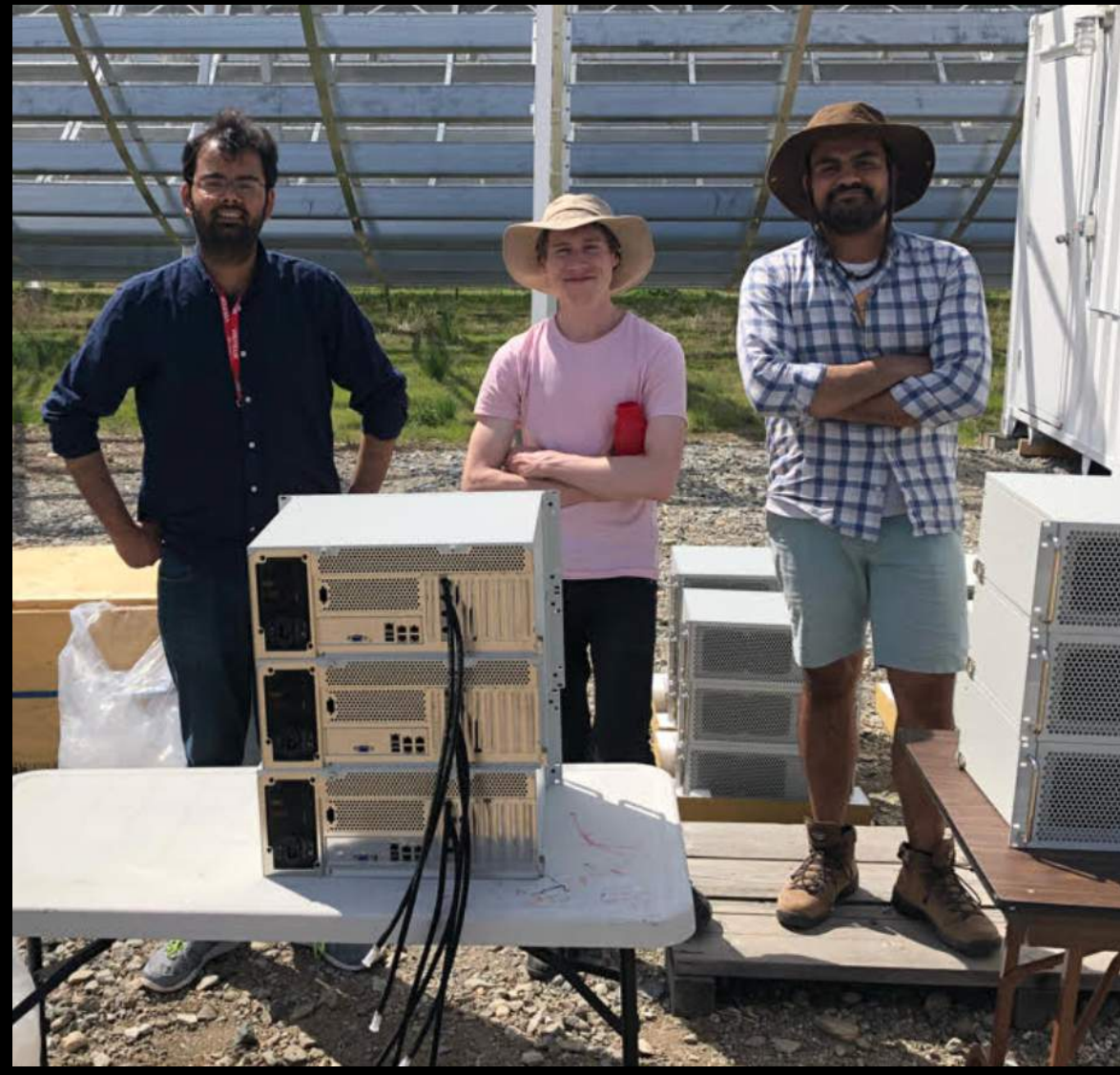
10 June, 2021 @SF2A S18 (remote talk)





Canadian Hydrogen Intensity Mapping Experiment

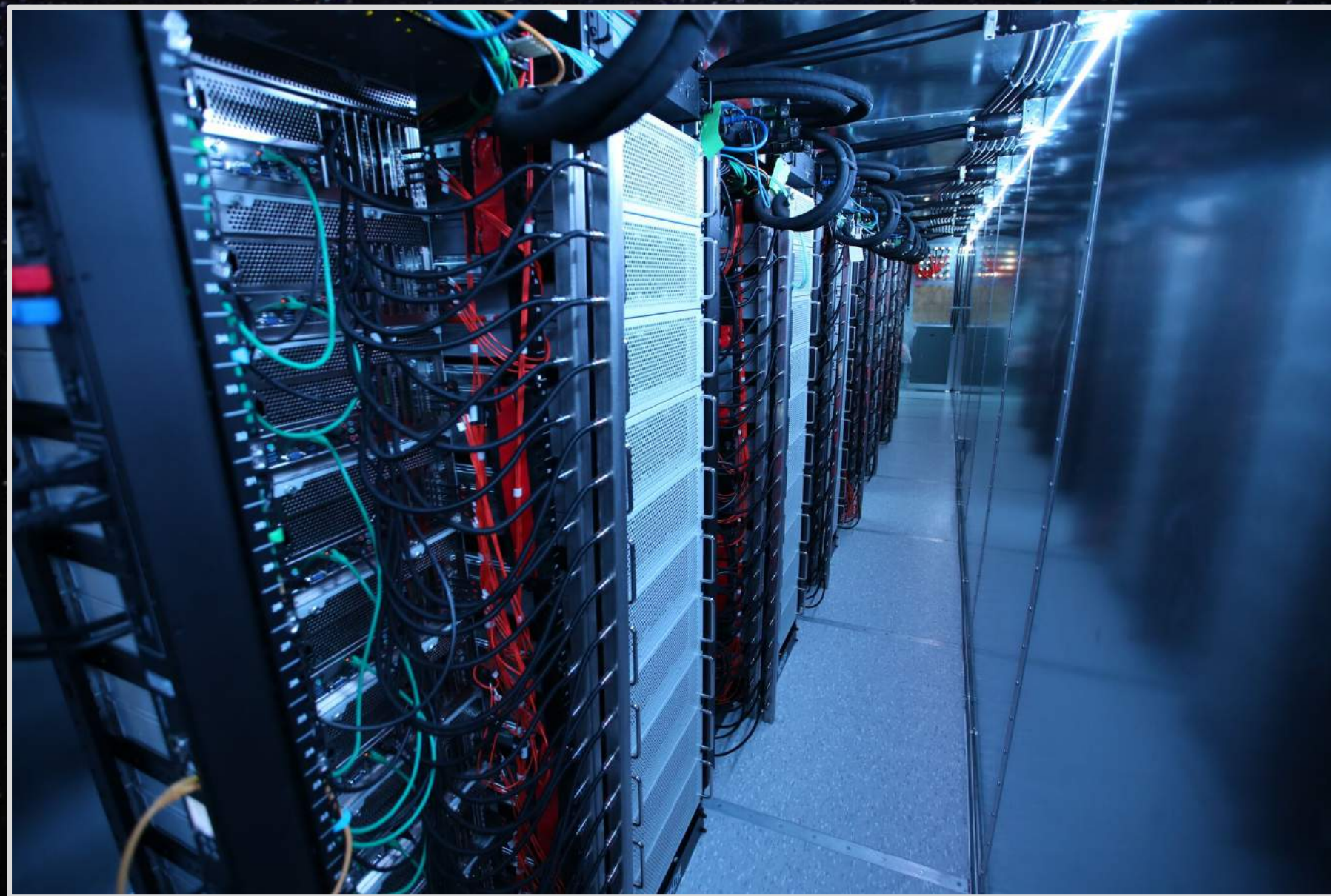




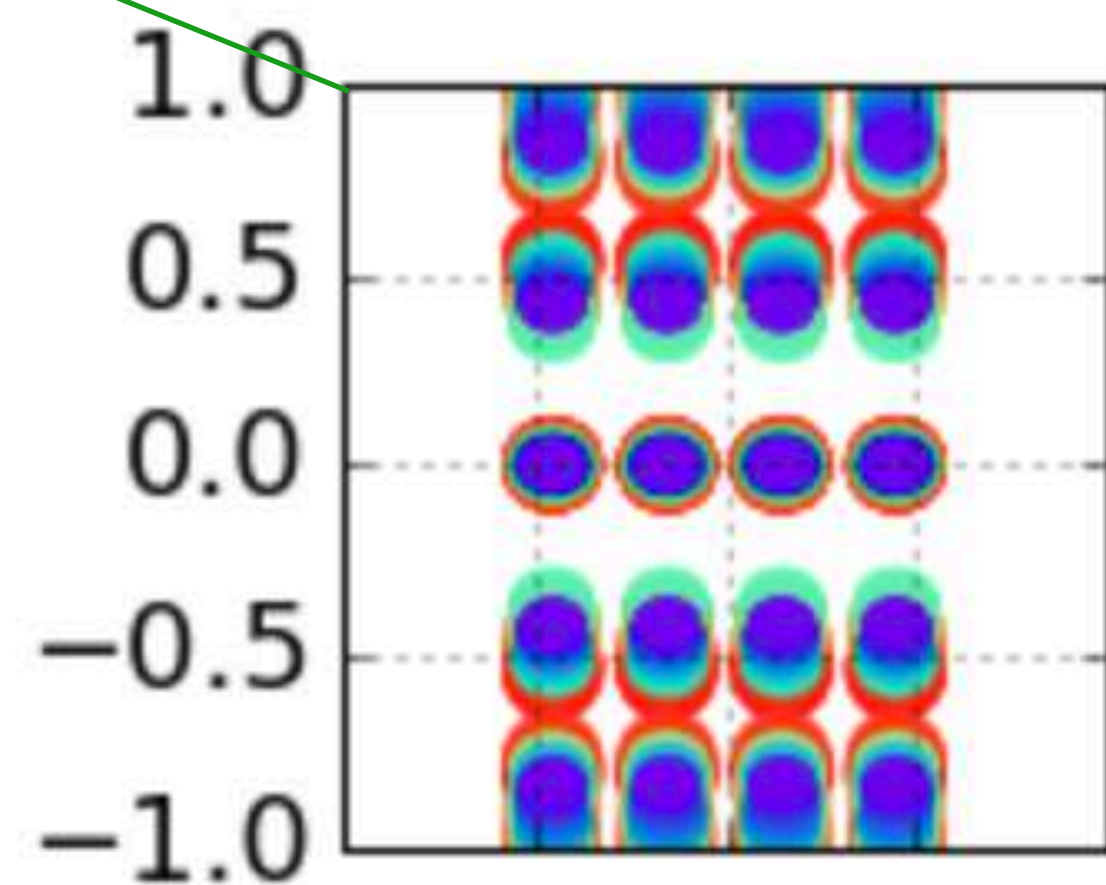
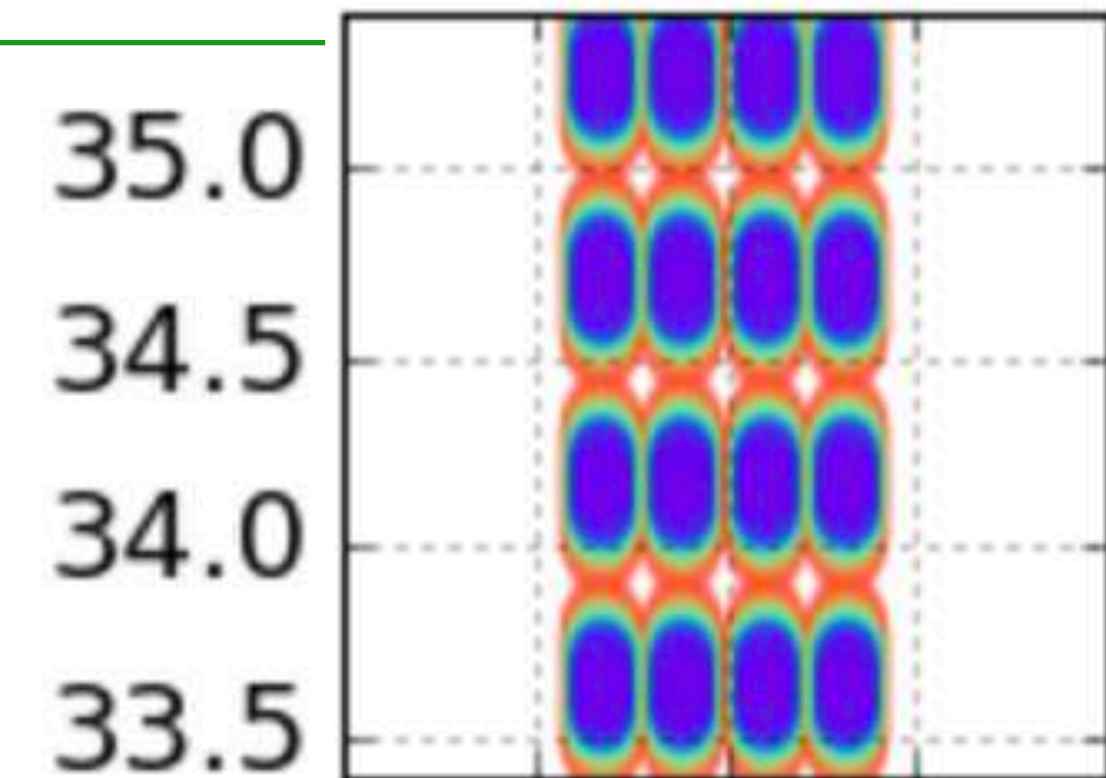
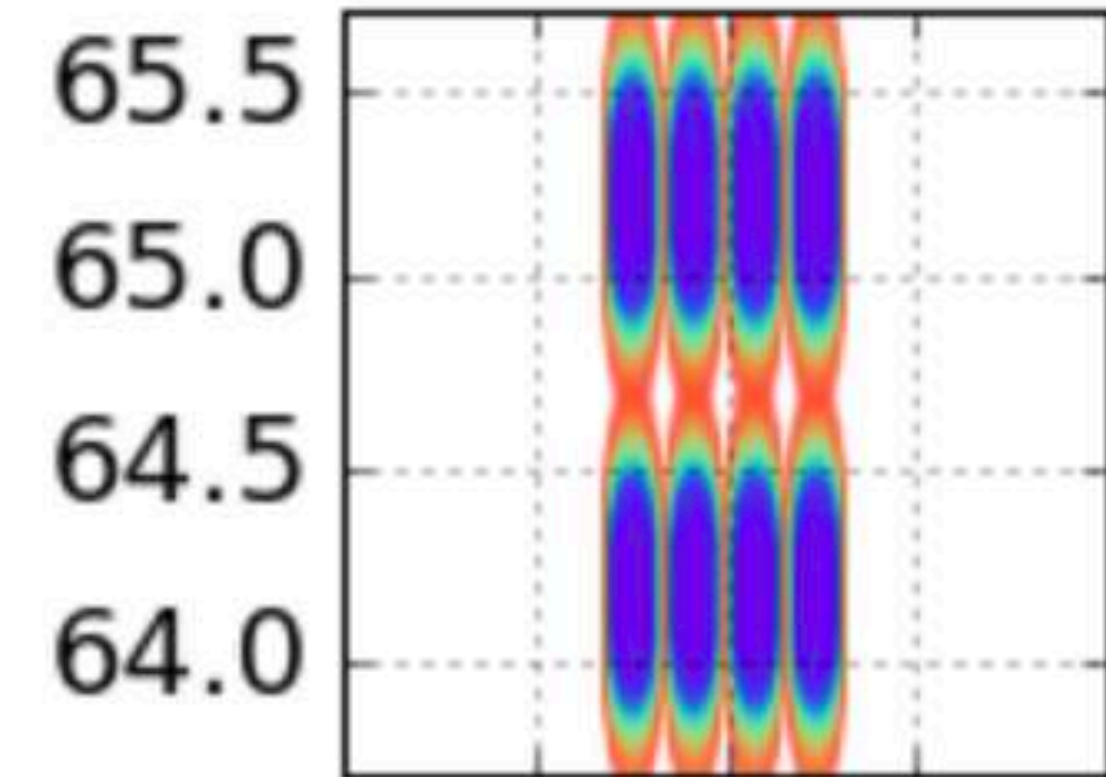
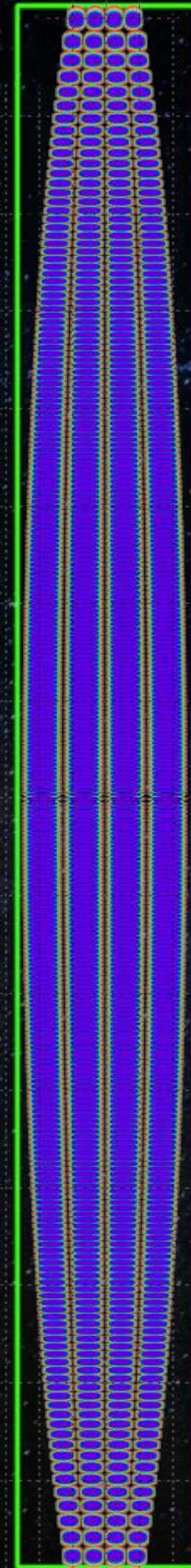
GPU Beamforming algorithm

Ng et al., 2017 (1702.04728)

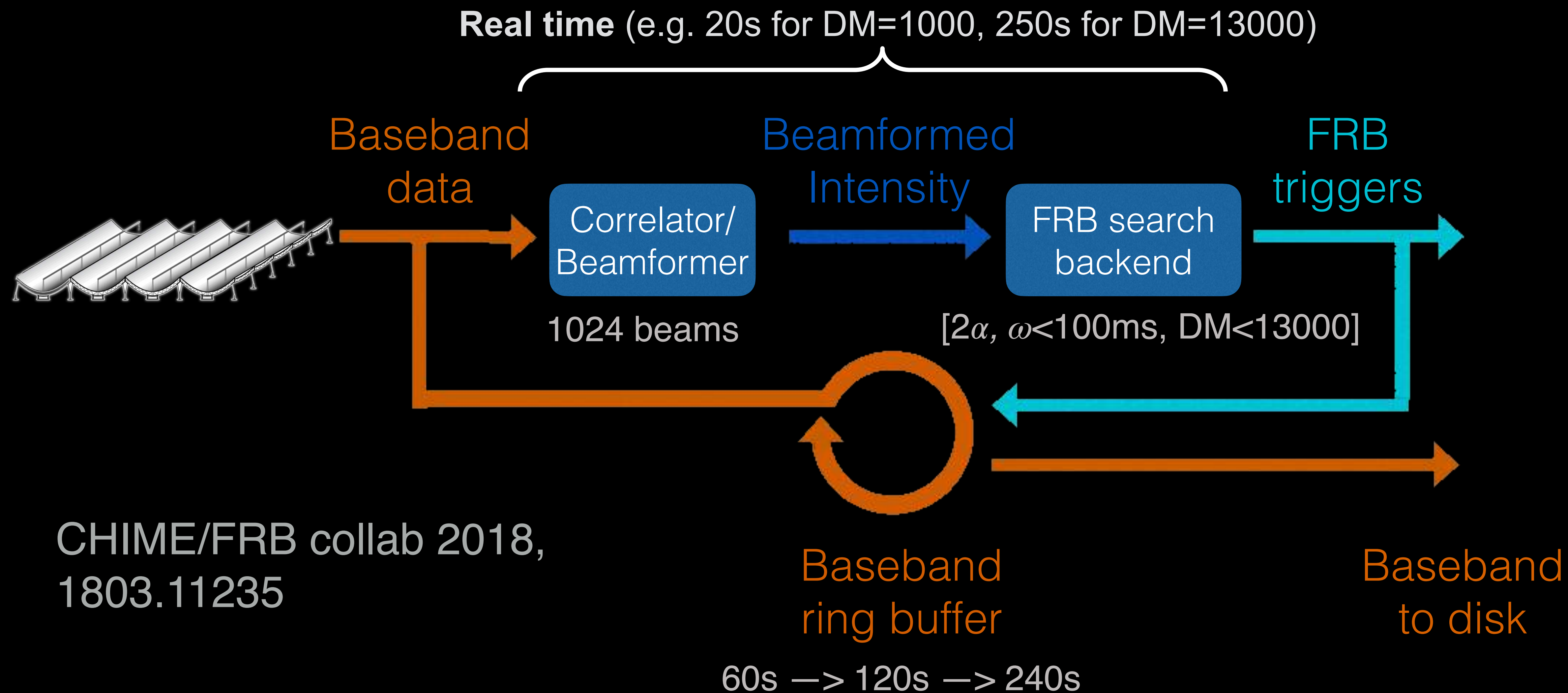
Masui et al., 2019



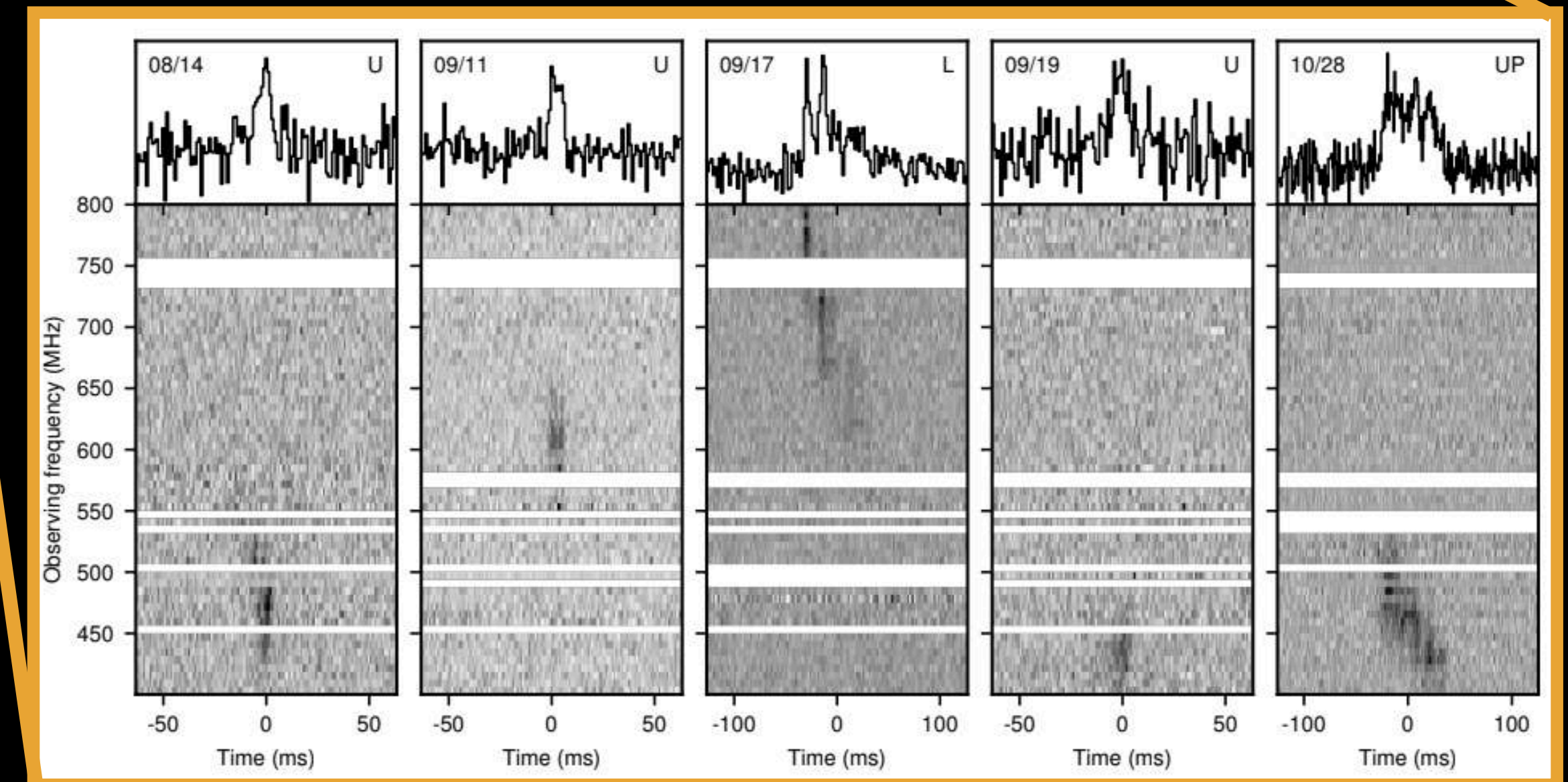
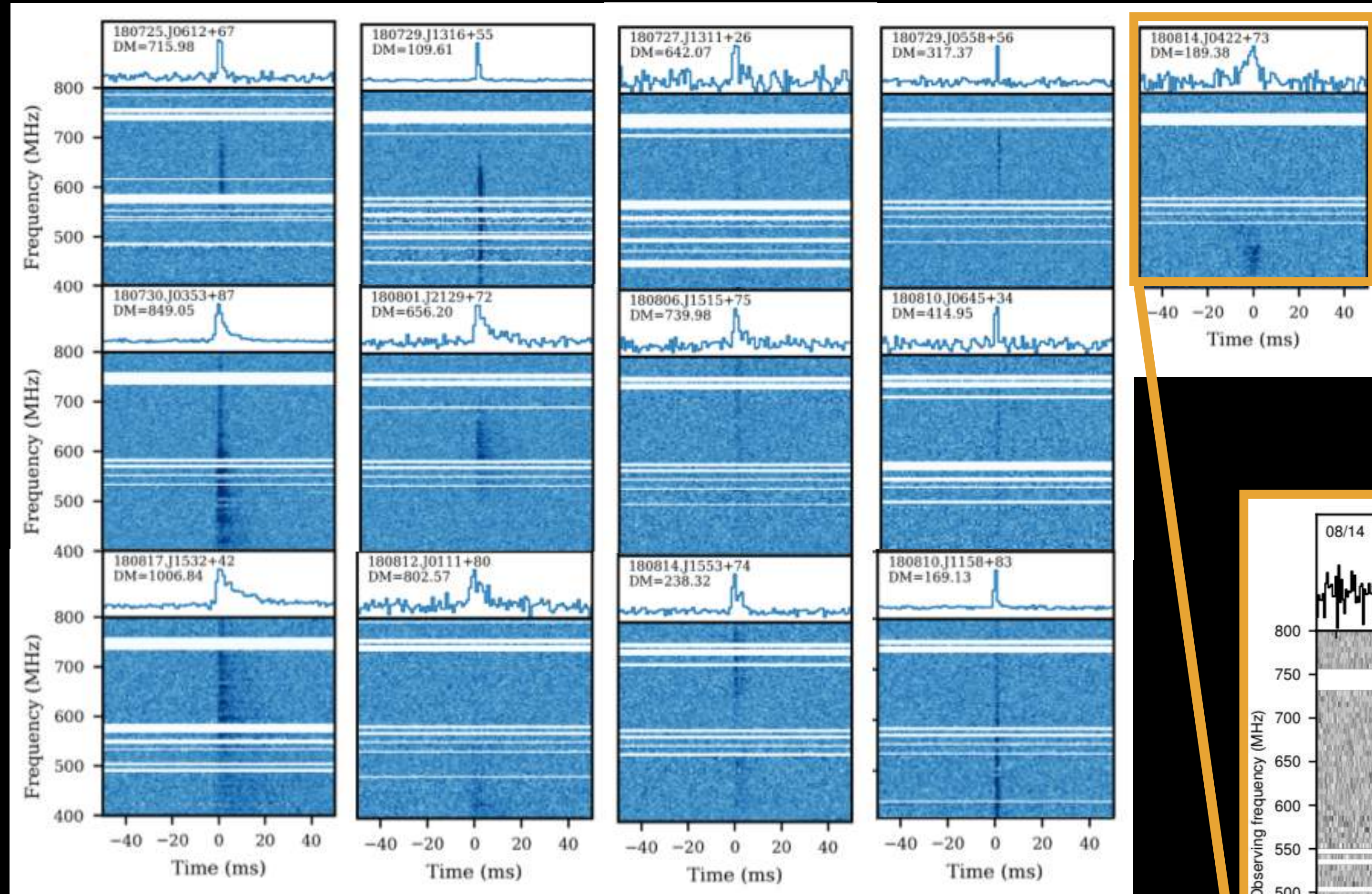
- data rate 13 Tb/s
- 1024 GPU correlator



FRB search pipeline



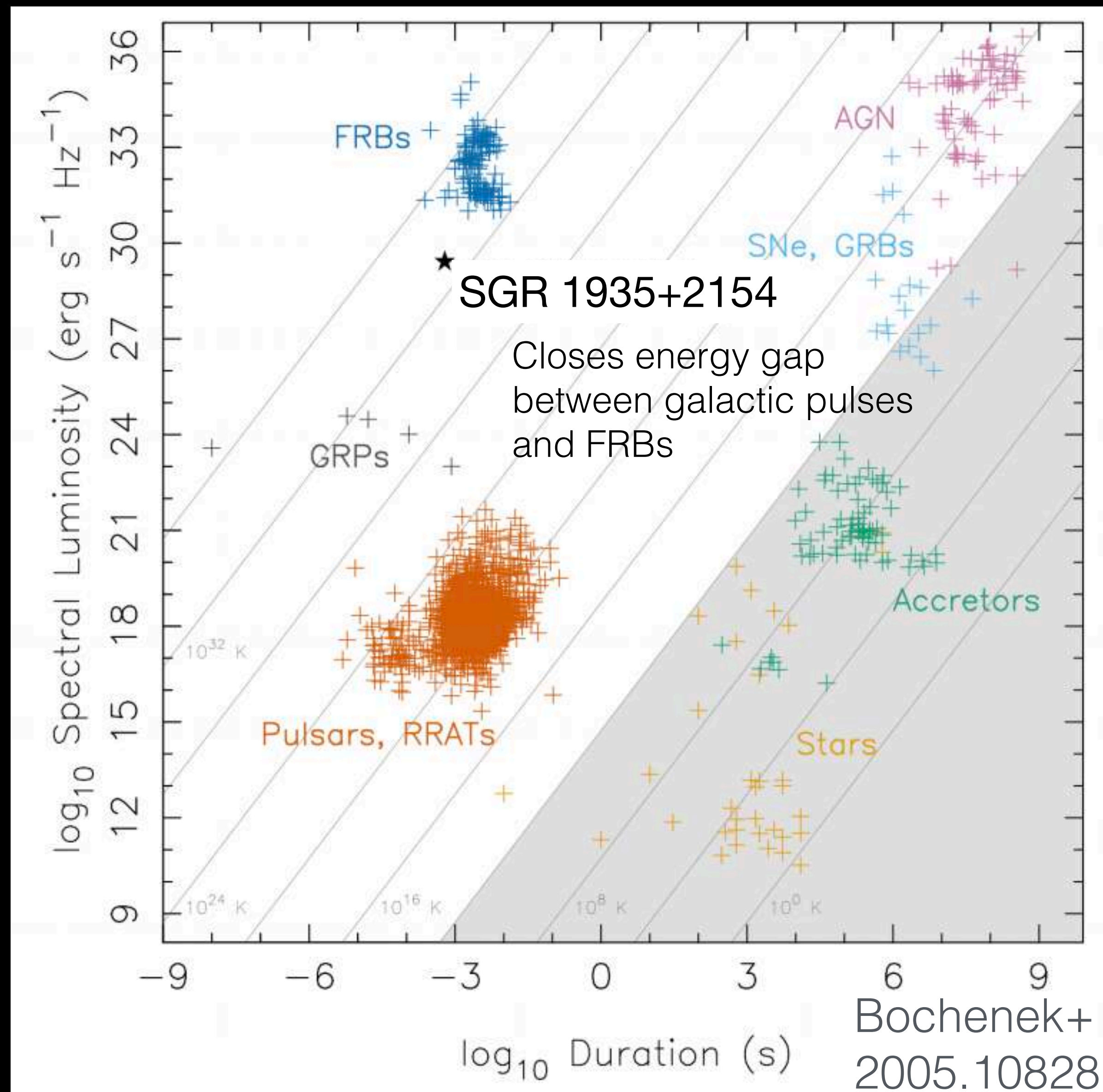
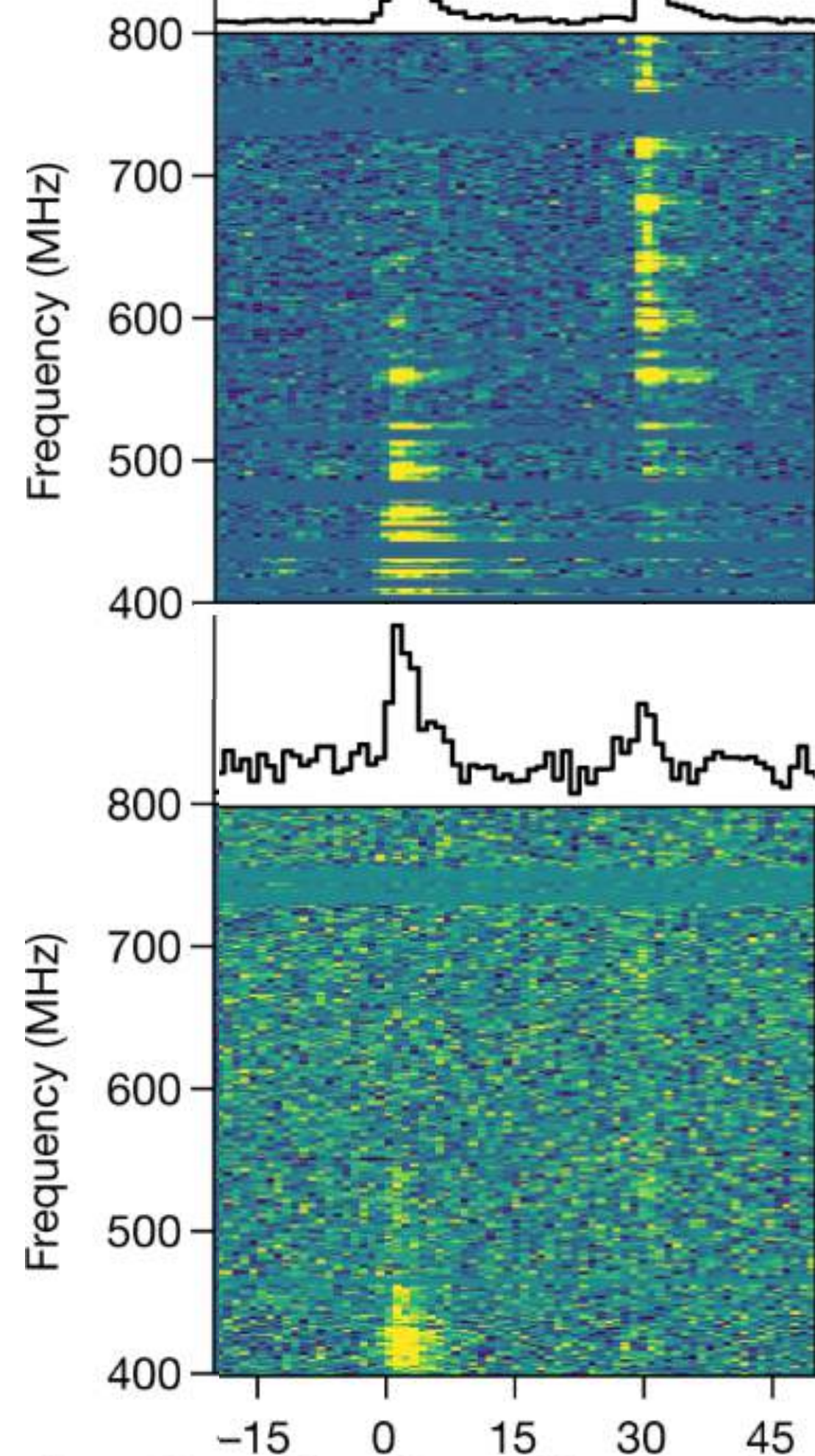
13 FRBs and 1 repeater



CHIME/FRB collaboration, 2019a,b
(1901.04524, 1901.04525)

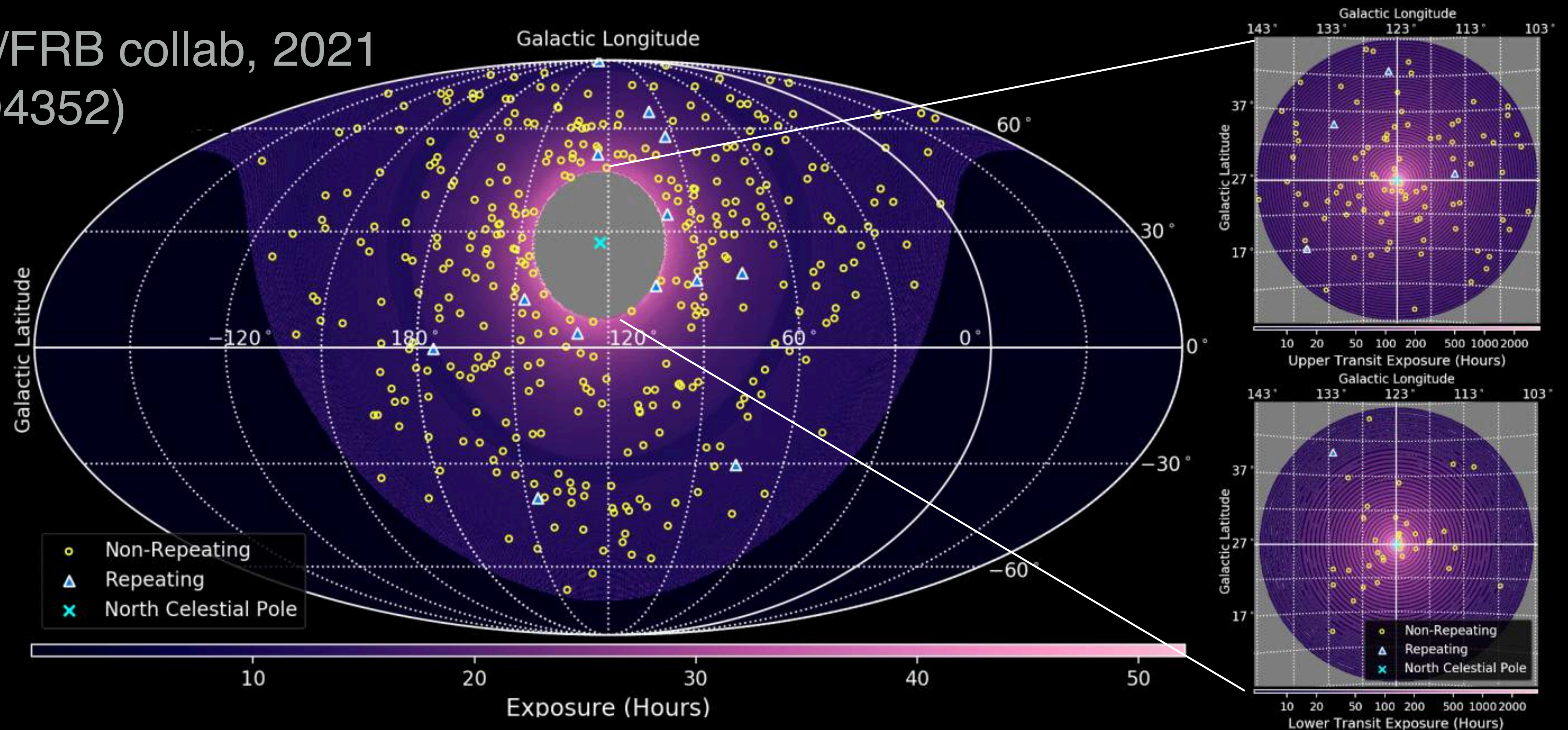
FRB from a Galactic magnetar

CHIME/FRB collab,
2005.10324



Catalog 1

CHIME/FRB collab, 2021
(2106.04352)



- 535 FRBs detected between July 2018 and July 2019
- 61 bursts from 18 repeating sources

Fast Radio Bursts in realtime

Last Updated:

This data is provided to you by the CHIME/FRB collaboration. If you use this data, please use the following acknowledgement:
We acknowledge use of the CHIME/FRB Public Database, provided at <https://www.chime-frb.ca/> by the CHIME/FRB Collaboration.

Repeating FRBs (Total: 20 sources)

Repeaters that have a burst in the past 10 days are highlighted in red

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« < 1 2 > »

Download Repeaters

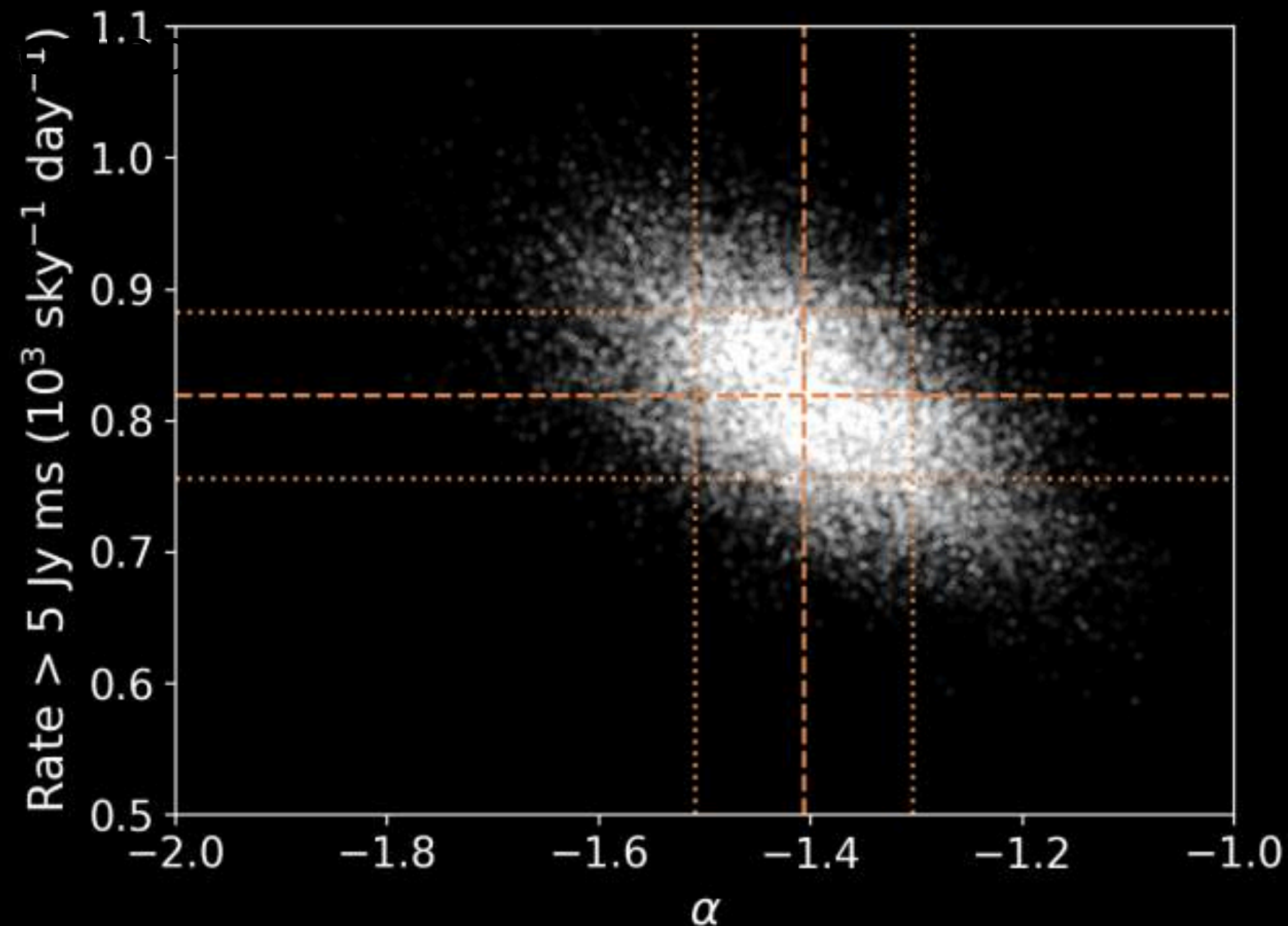
Filter:

ID	Previous Name	Latest Event	DM (pc cm ⁻³)	RA	Dec	Events	Arxiv Link	Host
FRB20190303A	190303.J1353+48	2021-06-06 04:42:02.997504	223.8 (3.0)	13:53	+48:15	20	2001.03595	
FRB20201124A		2021-05-27 20:44:49.536276	414.0 (1.5)	05:08	26:03	33		
FRB20180916B	180916.J0158+65	2021-05-23 17:55:23.829196	349.7 (2.3)	01:58	+65:44	73	1908.03507	spiral
FRB20200120E		2021-04-30 03:19:02.400583	88.3 (0.9)	09:57	+68:49	7	2103.01295	
FRB20190417A	190417.J1939+59	2021-04-24 13:26:45.507038	1379.1 (1.2)	19:39	+59:24	12	2001.03595	
FRB20190212A	190212.J18+81	2021-04-10 01:01:36.991027	302.1 (2.5)	18:24	+81:26	10	2001.03595	
FRB20190208A	190208.J1855+46	2021-02-03 17:58:11.178281	578.9 (2.4)	18:55	+46:58	7	2001.03595	
FRB20181119A	181119.J12+65	2020-12-04 15:49:20.254679	366.6 (3.7)	12:42	+65:08	8	1908.03507	
FRB20180814A	180814.J0422+73	2020-09-03 13:20:33.303715	189.4 (5.0)	04:22	+73:40	22	1901.04525	
190907.J08+46		2020-07-29 19:42:05.772016	309.1 (1.2)	08:09	+46:16	5	2001.03595	

<https://www.chime-frb.ca/repeaters>

Catalog 1: Euclidean sky distribution

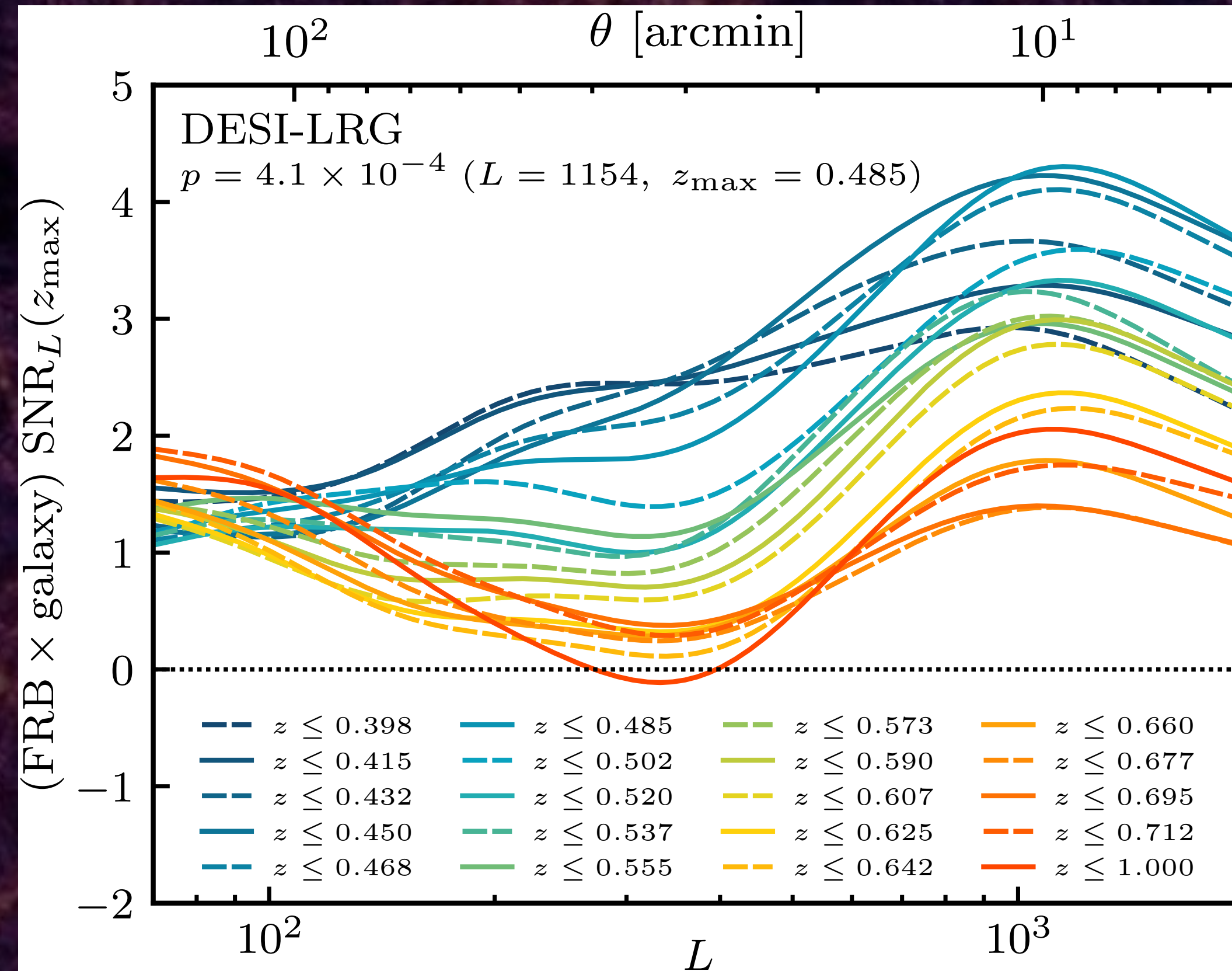
CHIME/FRB collab,
2021 (2106.04352)



- FRB luminosity function is consistent with a power law with $\alpha = -1.40 \pm 0.11$, which is consistent with Euclidean.
- Overall sky rate is 818 ± 64 / sky / day, considering FRBs with fluence ≥ 5 Jy-ms, $DM \geq 100$ pc cm⁻³, scattering time $\tau_{600} \leq 10$ ms.

Catalog 1: Large Scale structure correlation

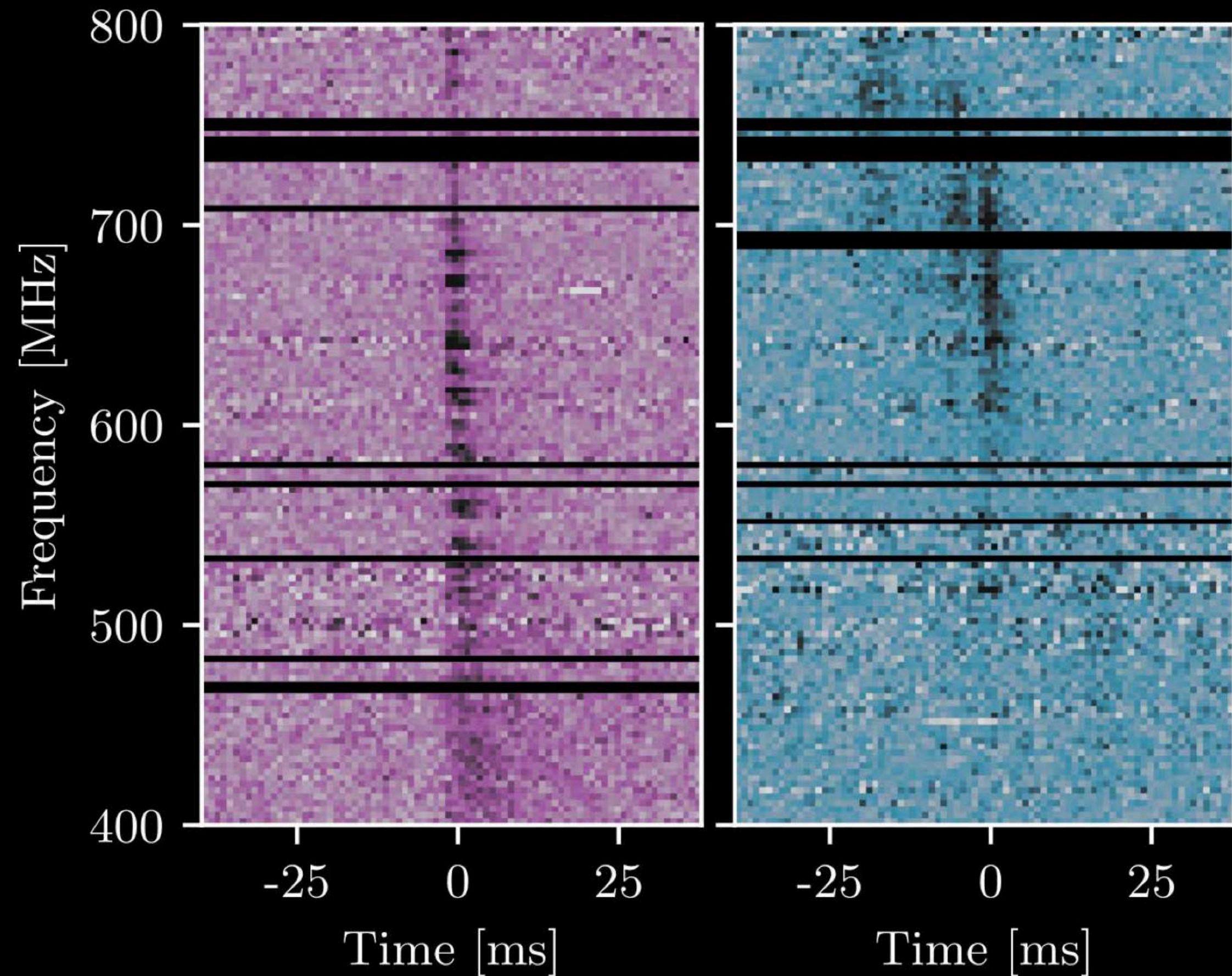
Background image: Millennium simulation



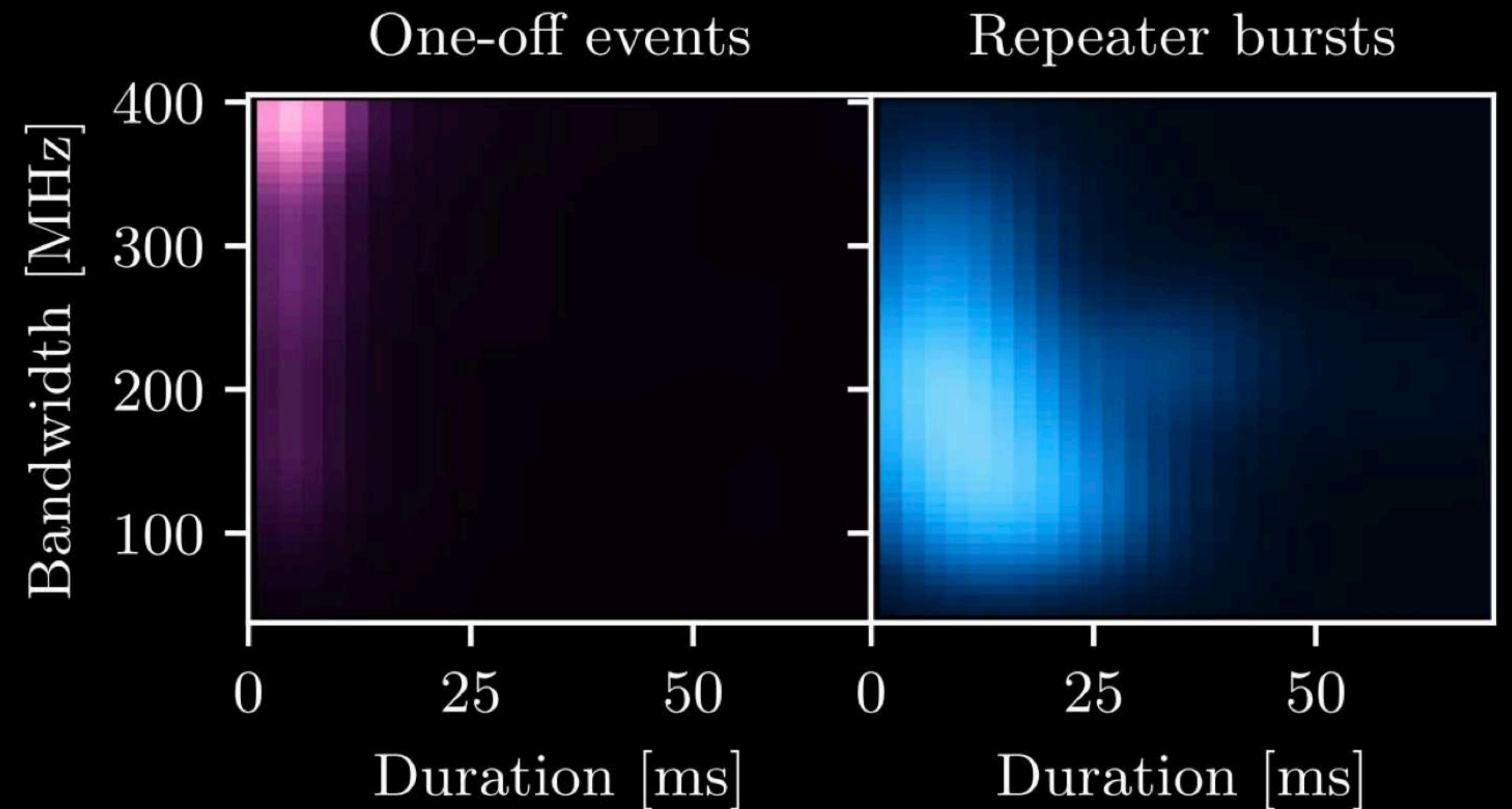
Rafiei-Ravandi et al.,
2021 (2106.04354)

- Significant correlation: p-value $\sim 10^{-4}$ after accounting for look-elsewhere effects in redshift and angular scale
- FRBs are correlated with galaxies, for a wide redshift range

Catalog 1: Multiple population

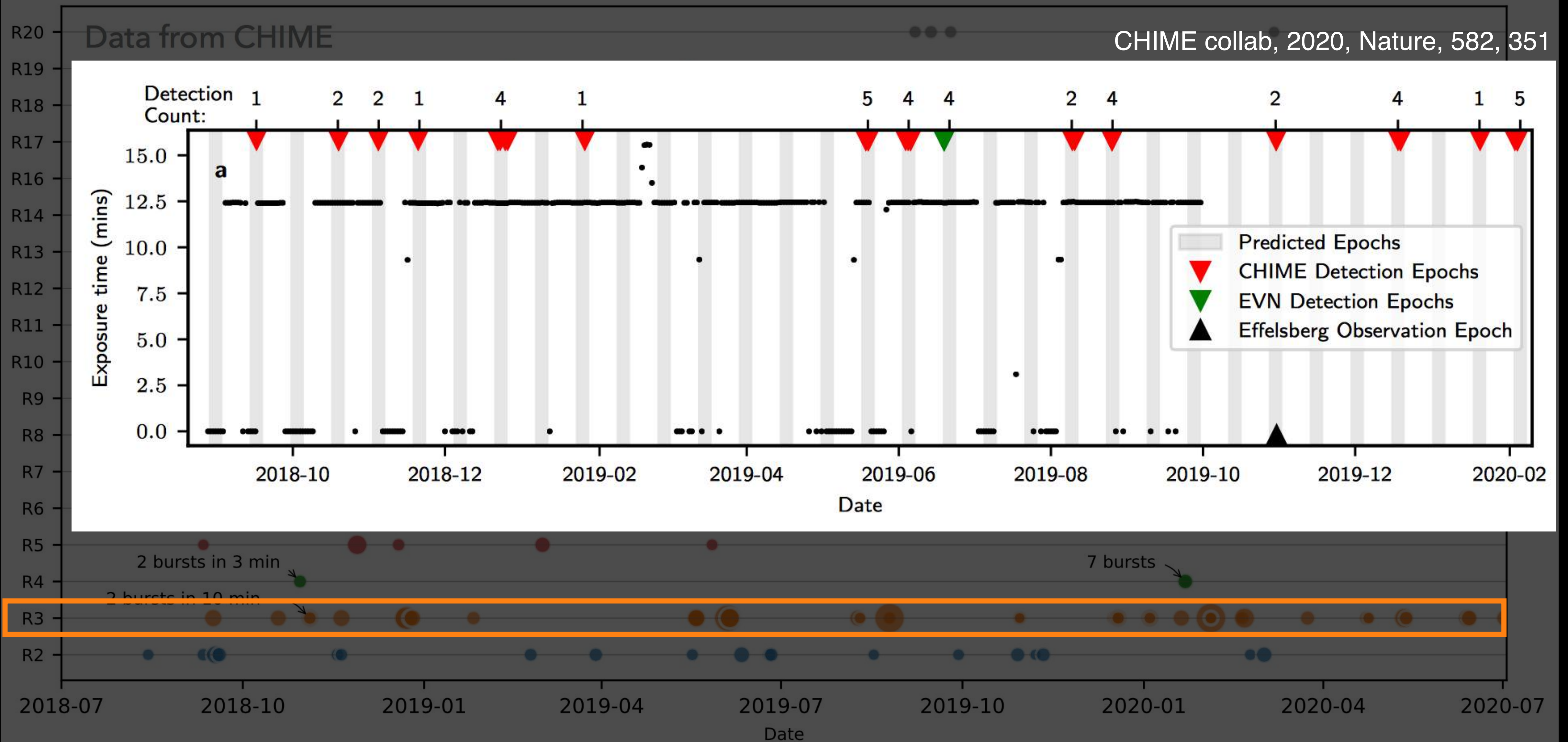


Pleunis+2021 (2106.04356)

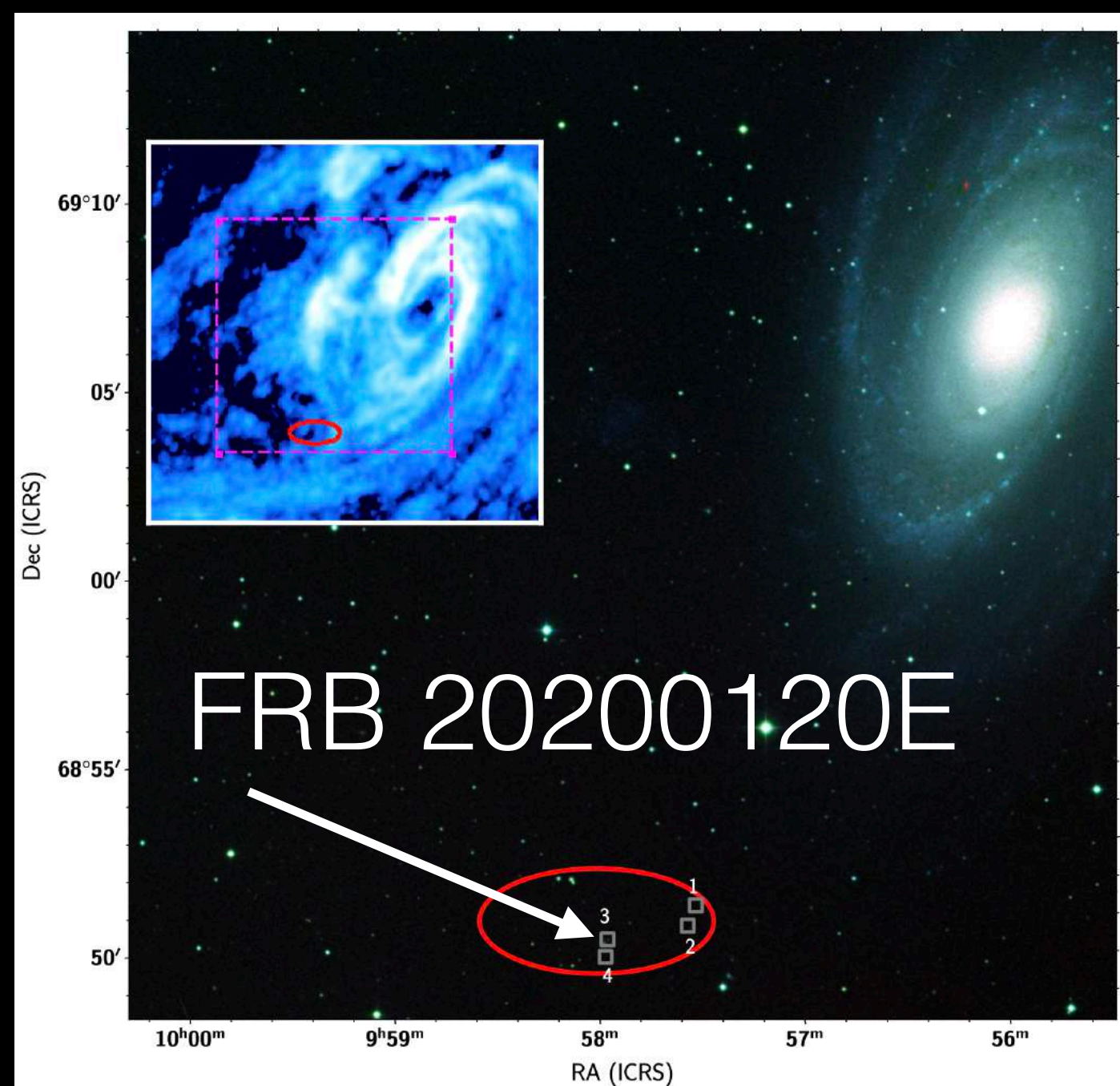


- Repeaters tend to have larger burst widths and smaller emission bandwidth compared to one-off FRBs.

Periodicity in repeater

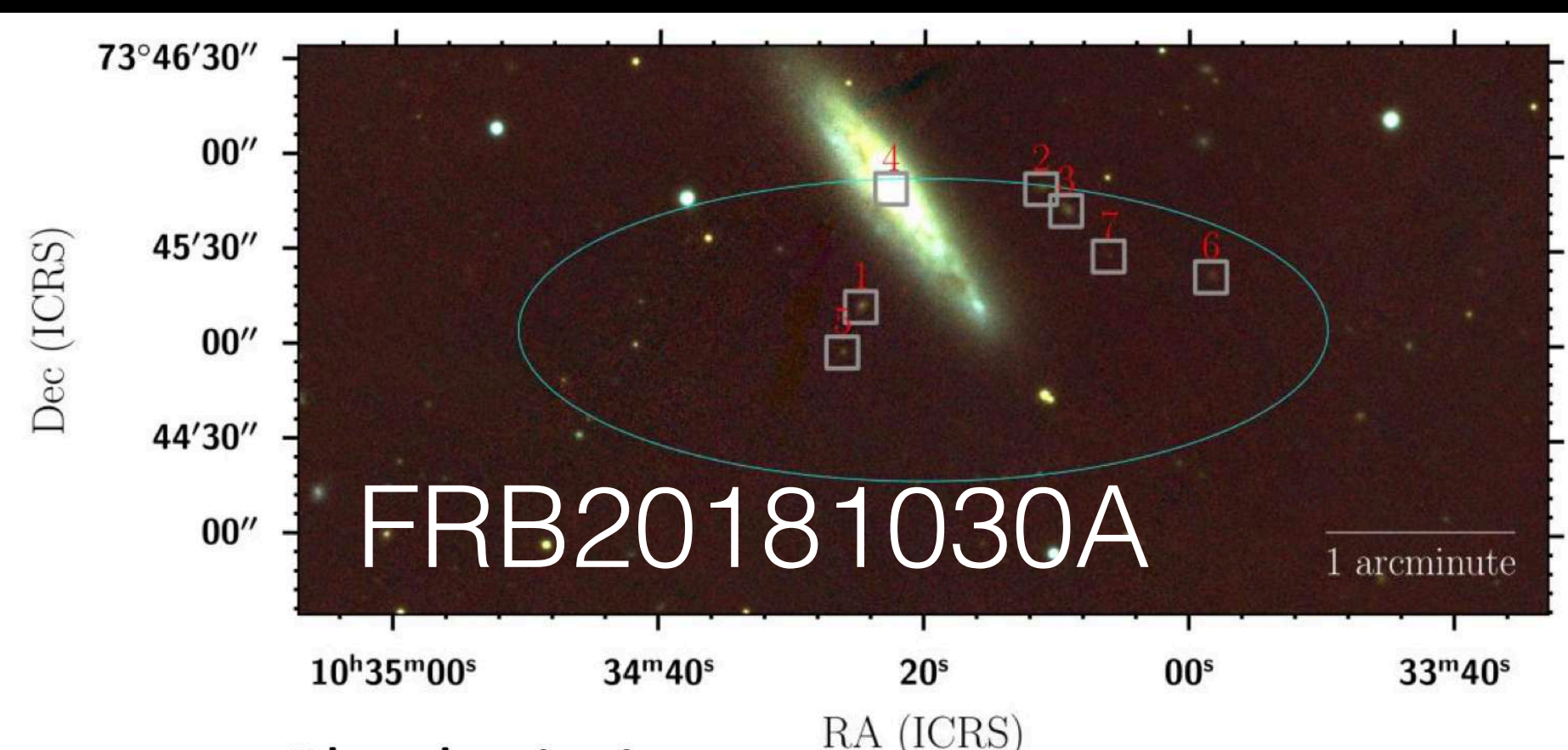


Low-DM FRB host associations



M81 – A spiral galaxy in the Local Volume at 3.6 Mpc (Bhardwaj+2103.01295)

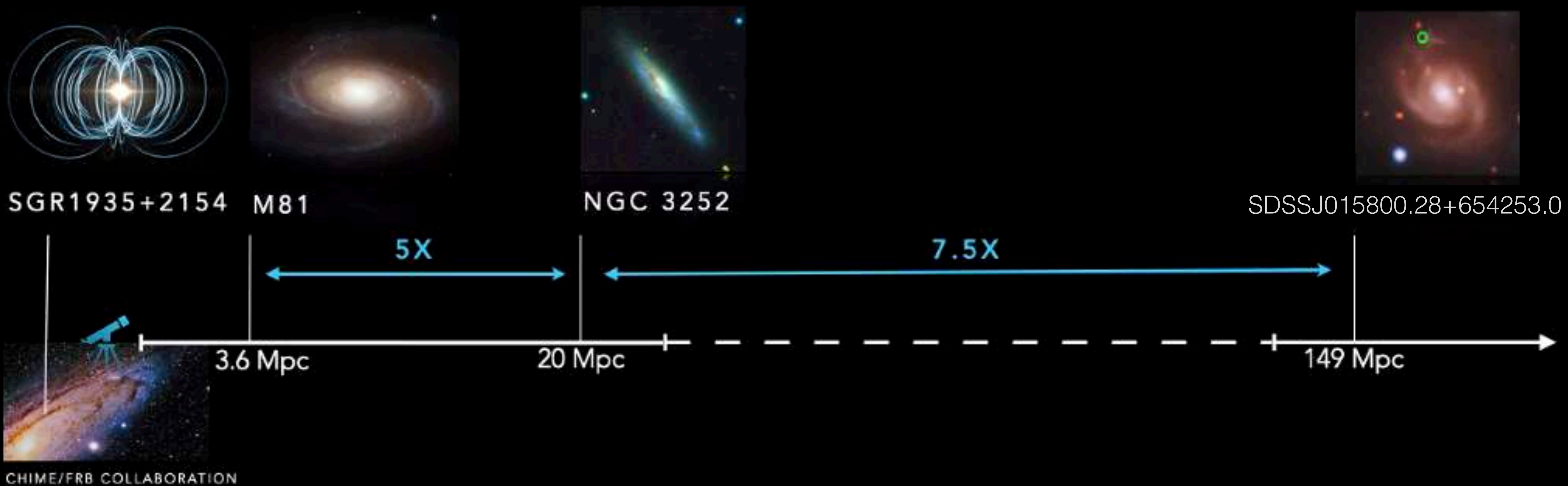
The Precise-EVN collaboration localized to an M81 Globular cluster (Kristen+2105.11445)



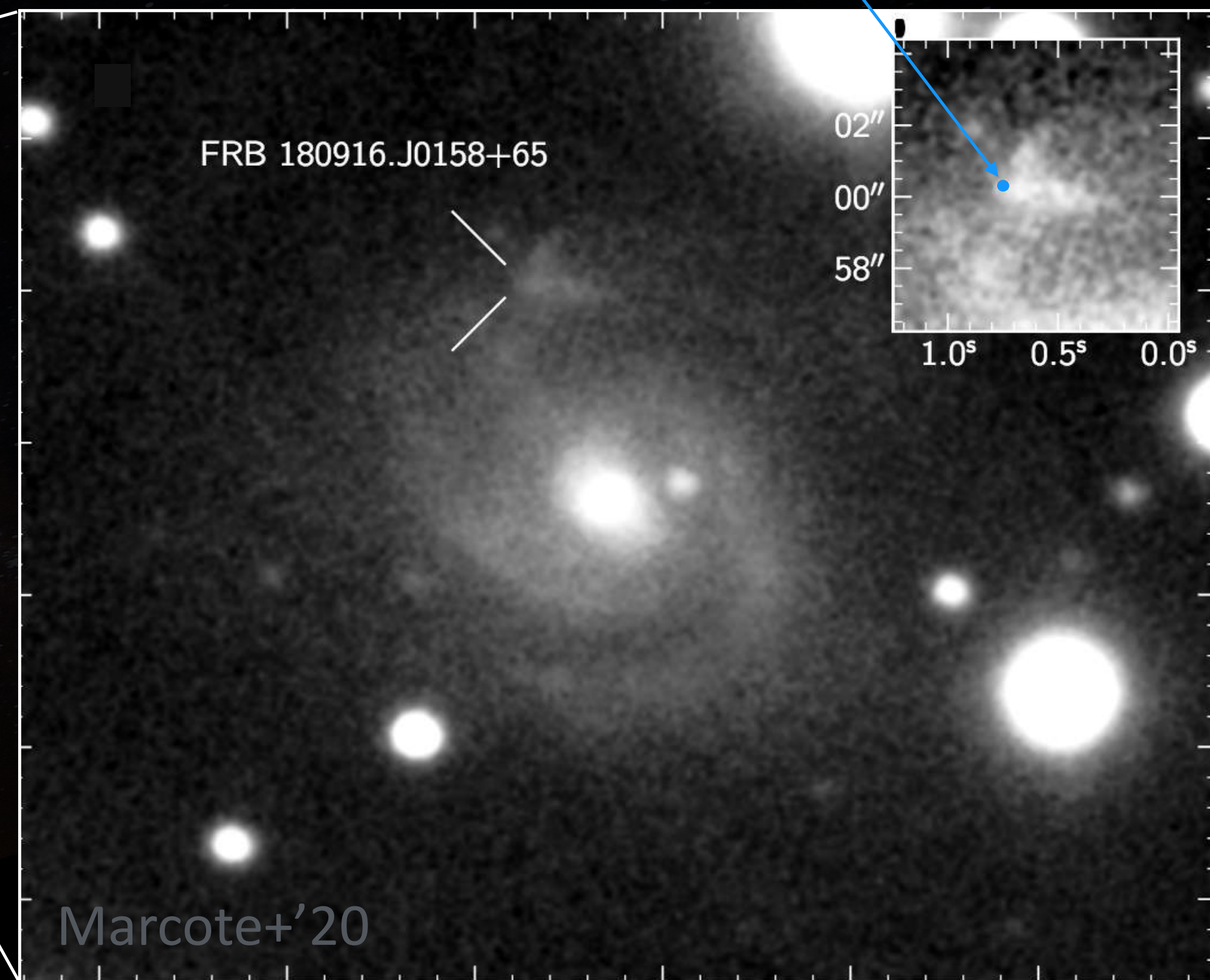
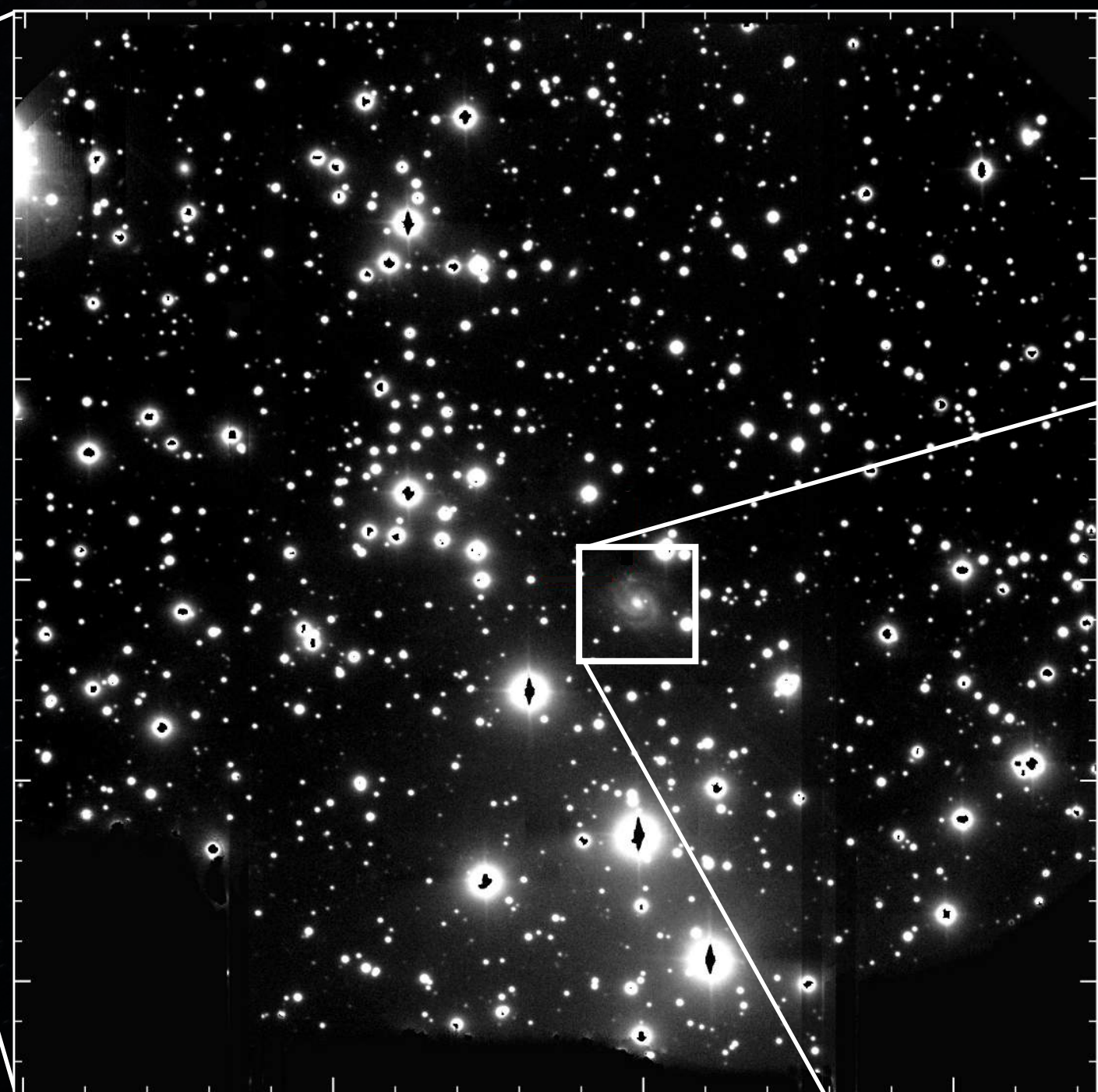
NGC3252 – A star-forming spiral galaxy at 20 Mpc, the second nearest FRB (Bhardwaj+, in prep)

Low-DM FRB host associations

Nearby FRBs might help uncover the origin of FRBs, thanks to the ease of multi-wavelength follow-up observations

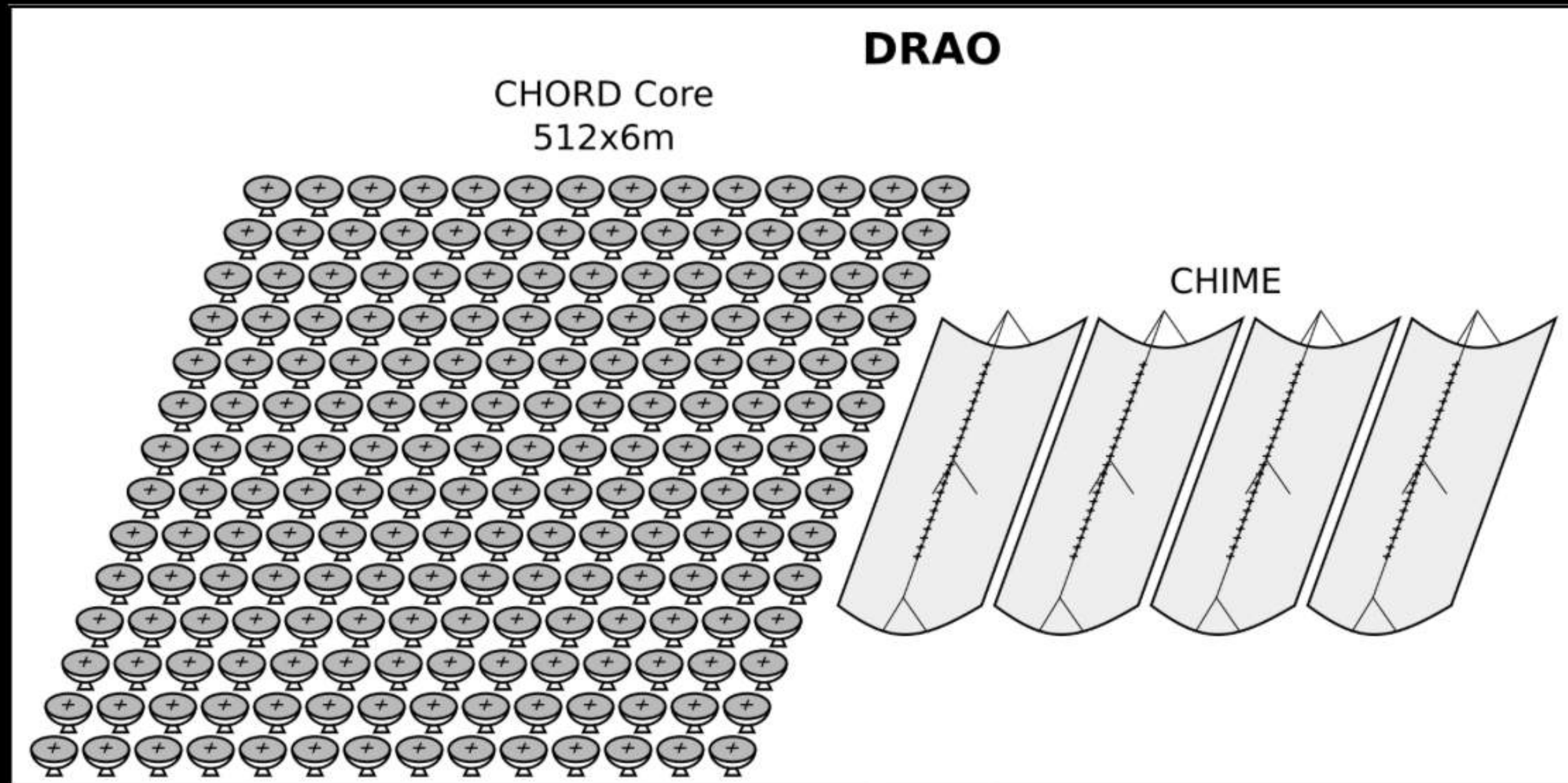


Localizing FRBs



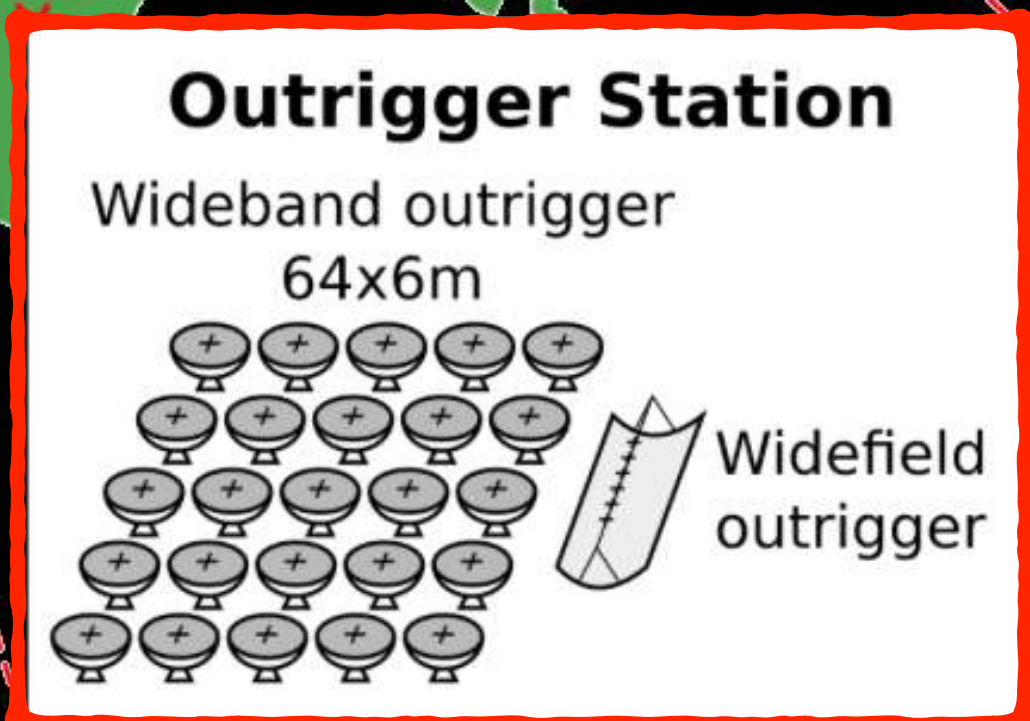
Milliarcsecond localization required

Localizing FRBs with outriggers and CHORD



Canadian Hydrogen Observatory and
Radio-transient Detector (CHORD)

Vanderlinde+2019 (1911.01777)



Summary

- Catalog 1 just published - 535 FRBs including 18 repeaters
- Euclidean distribution with ~ 800 bursts/sky/day
- FRB correlated with galaxies, for a wide redshift range
- Multiple population (one-offs vs repeaters)
- Periodicity in a nearby repeater
- FRB from Galactic magnetar
- Low-DM FRBs host association
- Next: CHIME/FRB outriggers and CHORD

