CHIME

PROBING THE RADIO TRANSIENT UNIVERSE

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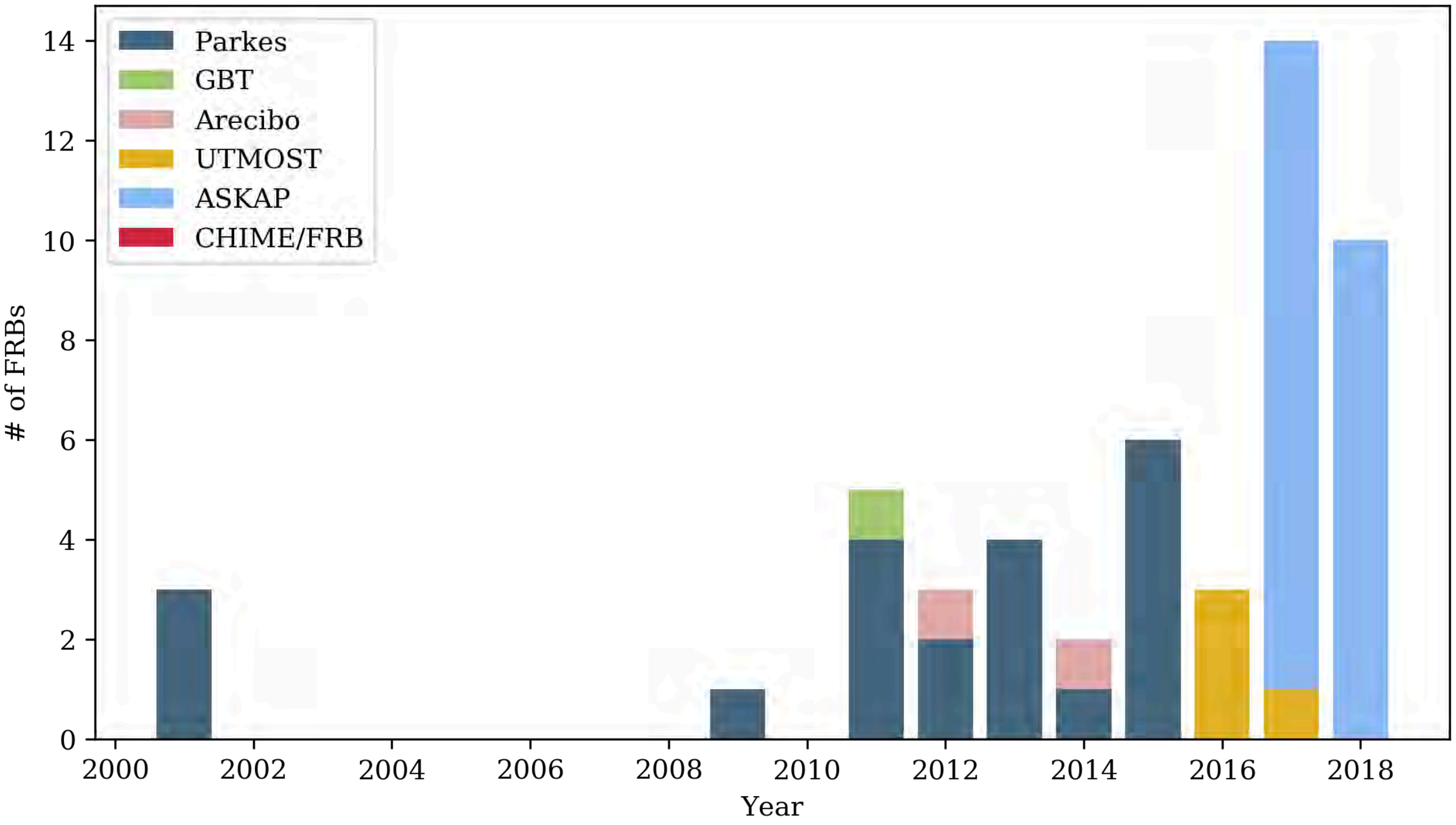
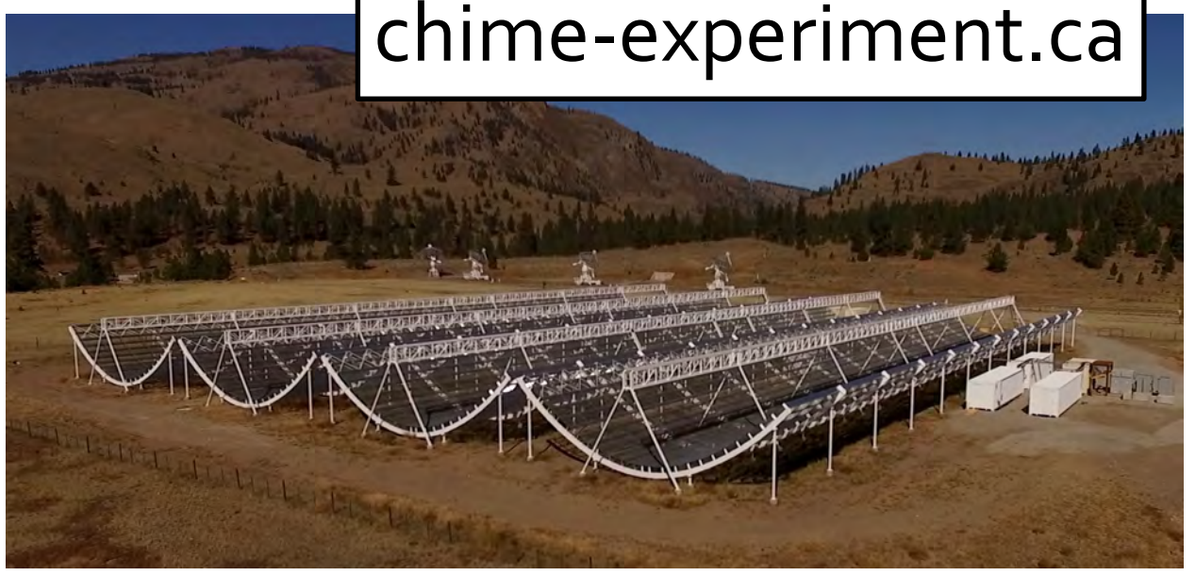

Parkes
GBT
Arecibo
UTMOST
ASKAP
CHIME/FRB
# of FRBs
0
2
4
6
8
10
12
14
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year

CHIME PARAMETERS

- 4 Cylinders - 20m x 100m each
- 1024 Dual Polarization Feeds

Bandpass	400 MHz	800 MHz
21 cm Redshift	2.5	0.8
Beam Size	0.52°	0.26°
E-W FoV	2.5°	1.3°
N-S FoV	~100°	
λ	0.75m	37.5cm



L0

1 Dish + 1D Interferometry on 256x4 feeds

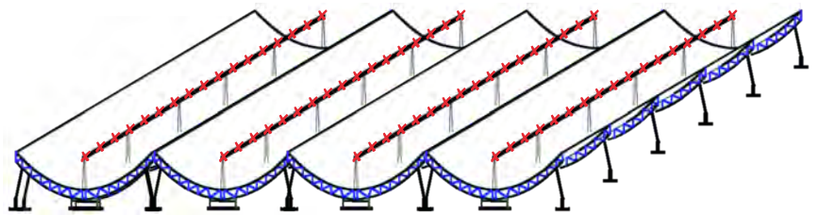
FFT Beam-forming (Tegmark & Zaldarriaga, 2008, 2010)

Hybrid Beam-forming (Cherry Ng et al. 2017, 1702.04728)

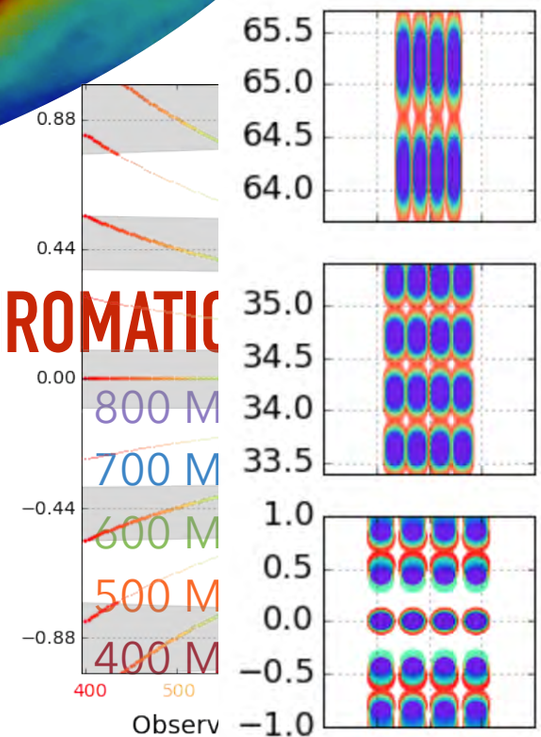
Primary Beam of Single Feed

Analogue Beam-forming

Sky Coverage ~250 sq. Degrees



@Cherry Ng



Realtime Backends

CHIME/Cosmology

- Full N^2 visibility matrix
- 10s cadence
- 210 TB/day
- Real time flagging & gain calibration
- Data compression through redundant baselines (1 TB/day)

CHIME/Pulsar

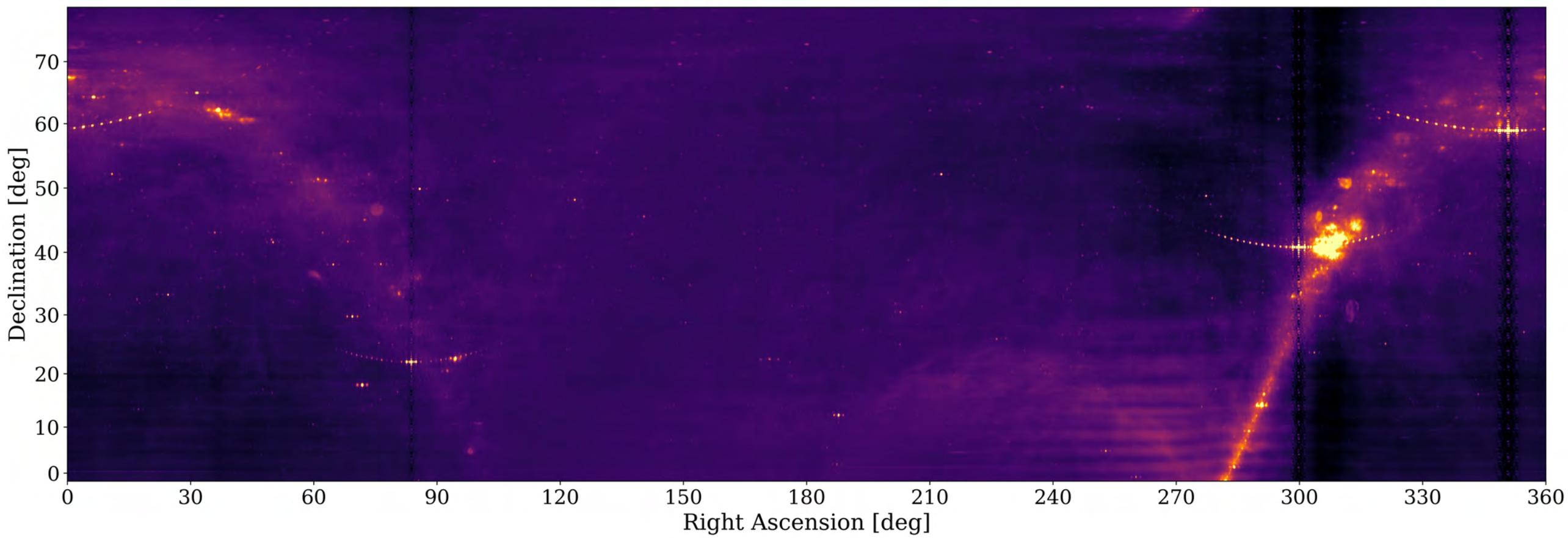
- 10 tracking beams
- Track galactic pulsars daily
- 2.56 μs cadence, 1024 freq. channels, 2 polarizations
- 10 x 6.4 Gbps
- Data compression though folding – 672 GB/day

CHIME/FRB

- 1024 FFT-formed stationary intensity beams
- 0.983 ms cadence
- 16384x 24.4 kHz channels
- 130 Gb/s (intensity)
  800 GB/s (baseband)
- 1.5 PB/day

Realtime Backends

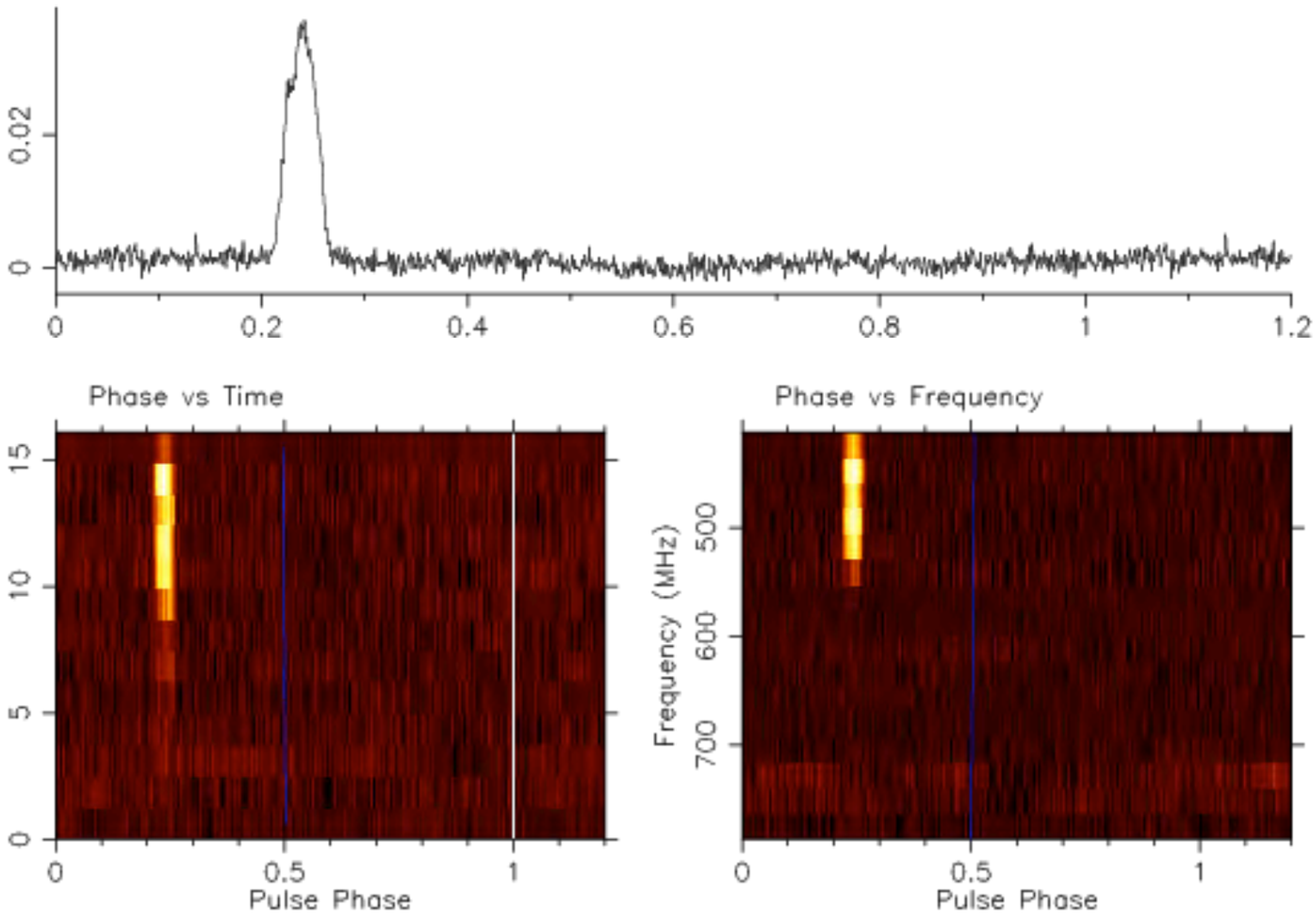
CHIME/Cosmology | CHIME/Pulsar | CHIME/FRB



CHIME Cosmology Dirty Map

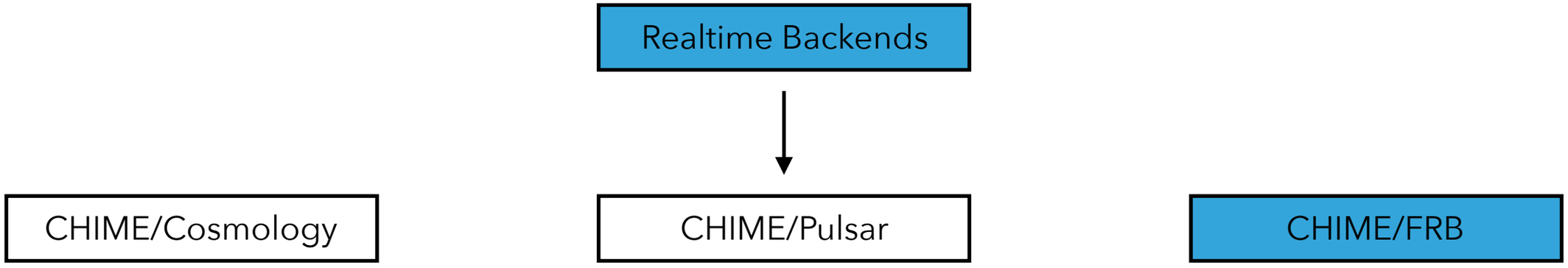
Realtime Backends

CHIME/Cosmology | CHIME/Pulsar | CHIME/FRB



See Arun Naidu's talk 11:55 am tomorrow

Cycle through all the Northern Hemisphere pulsars in ~10 days!

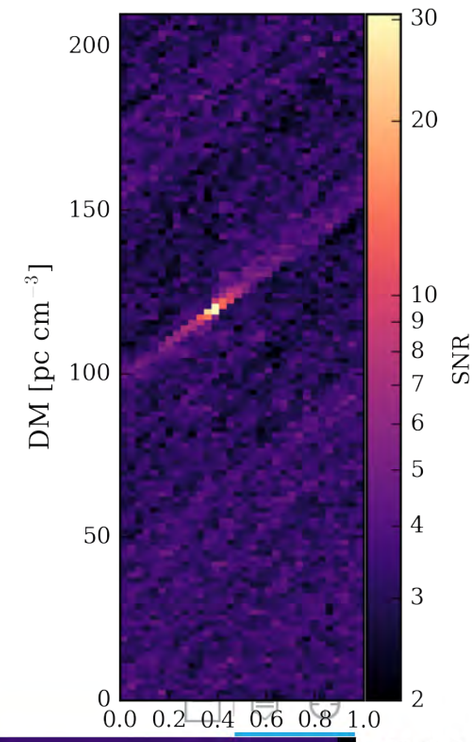


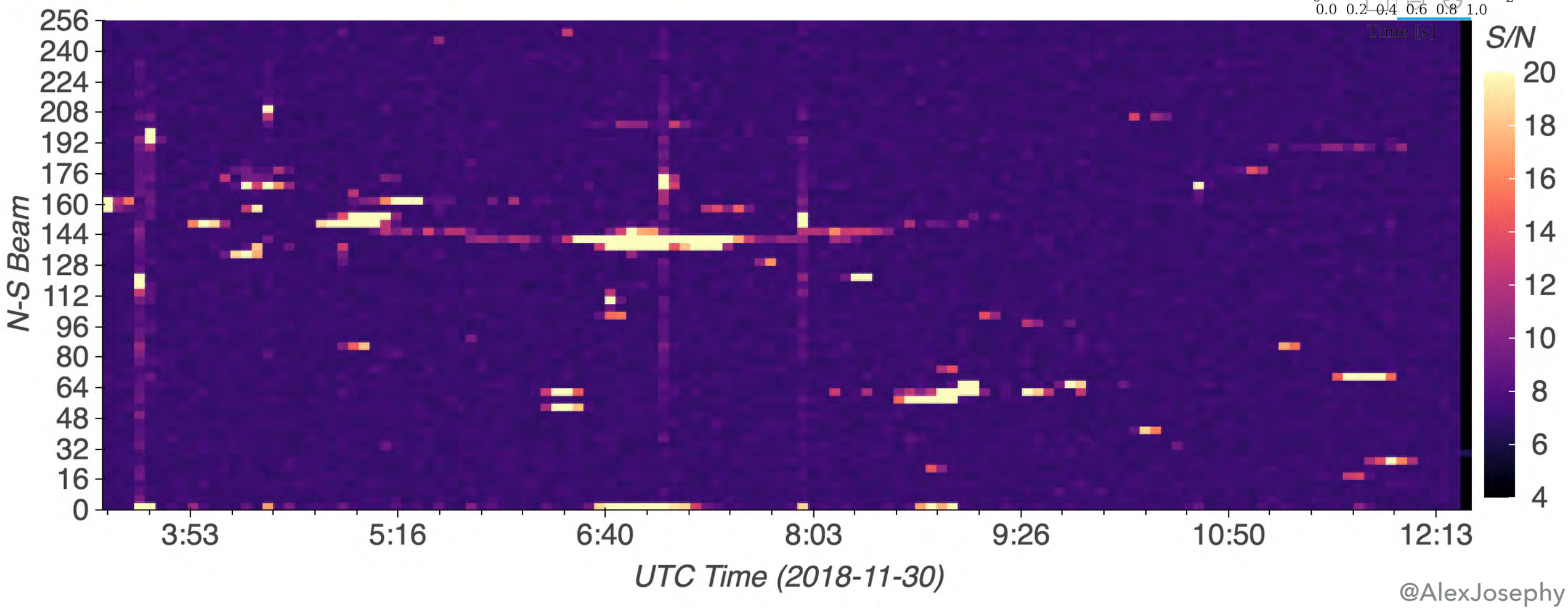
L0	FFT Beamforming + Upchannelization
L1	RFI Excision + Incoherent Dedispersion
L2-L3	MultiBeam Analysis + Science Actions
L4	Databases + Offline Processing

L2-L3

SCIENCE PIPELINE

- Manage 268.43 Billion Triggers/s
- Find the one trigger which is the FRB!

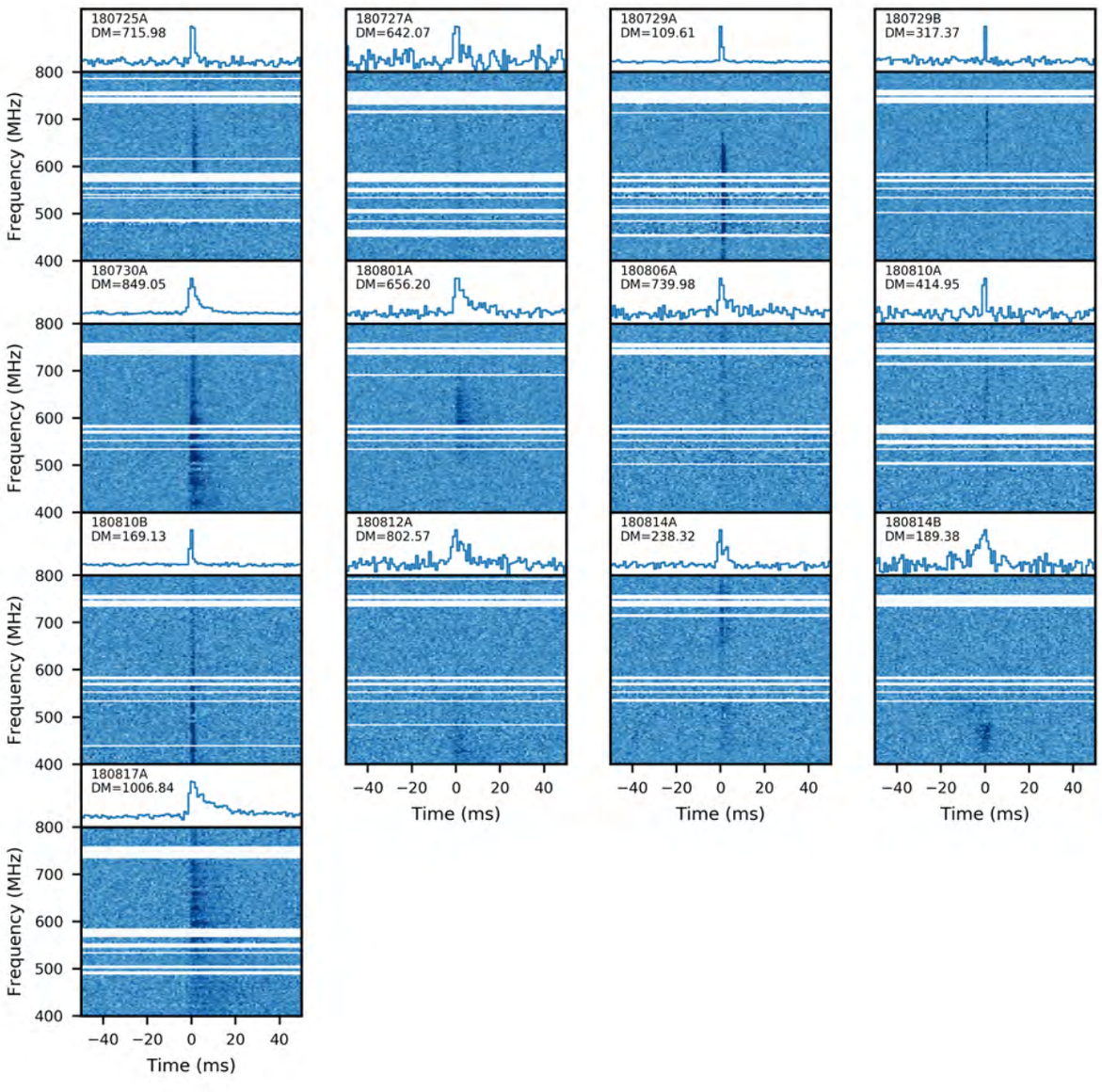


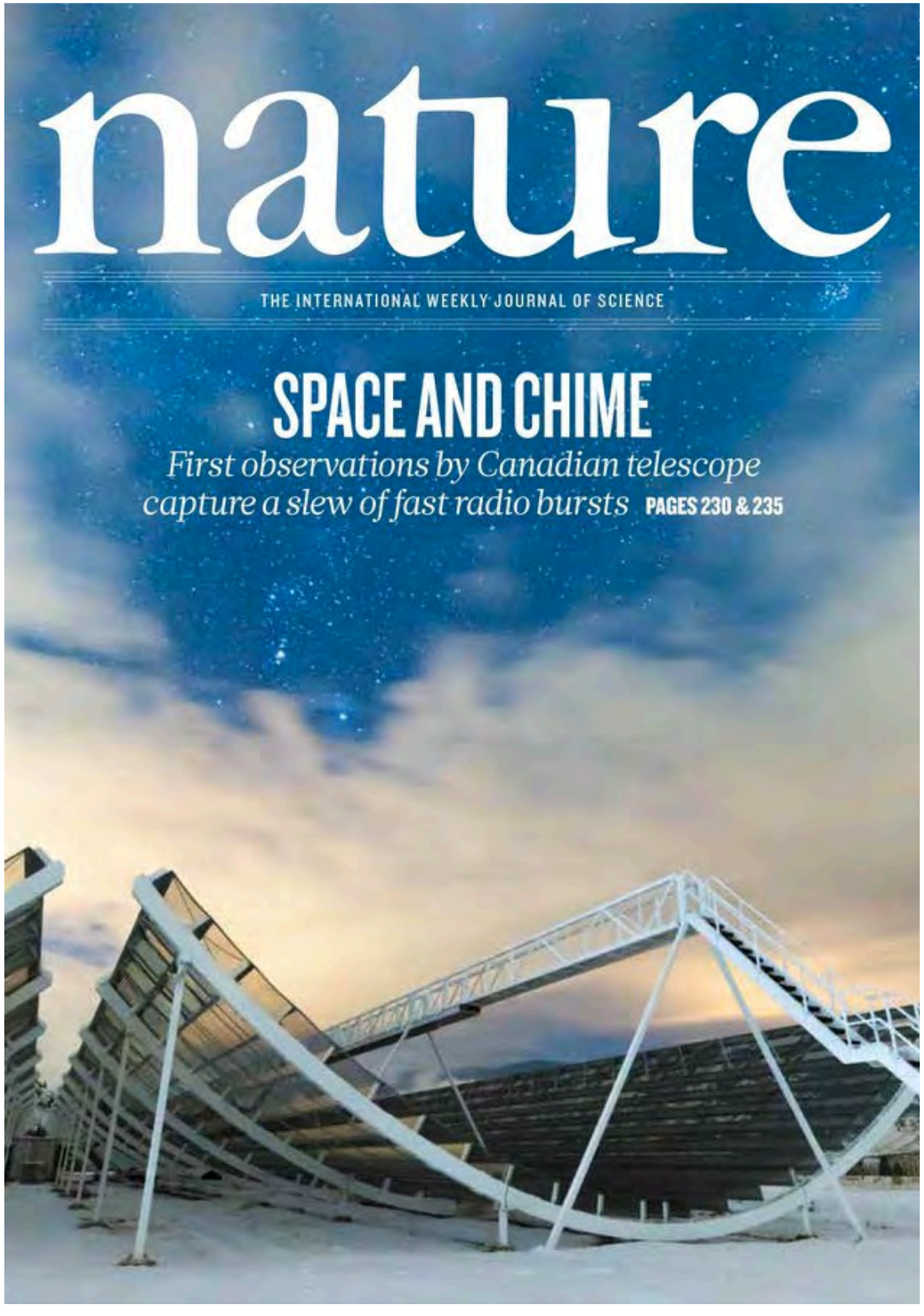


@AlexJosephy

SCIENCE RESULTS

13 NEW FRBS



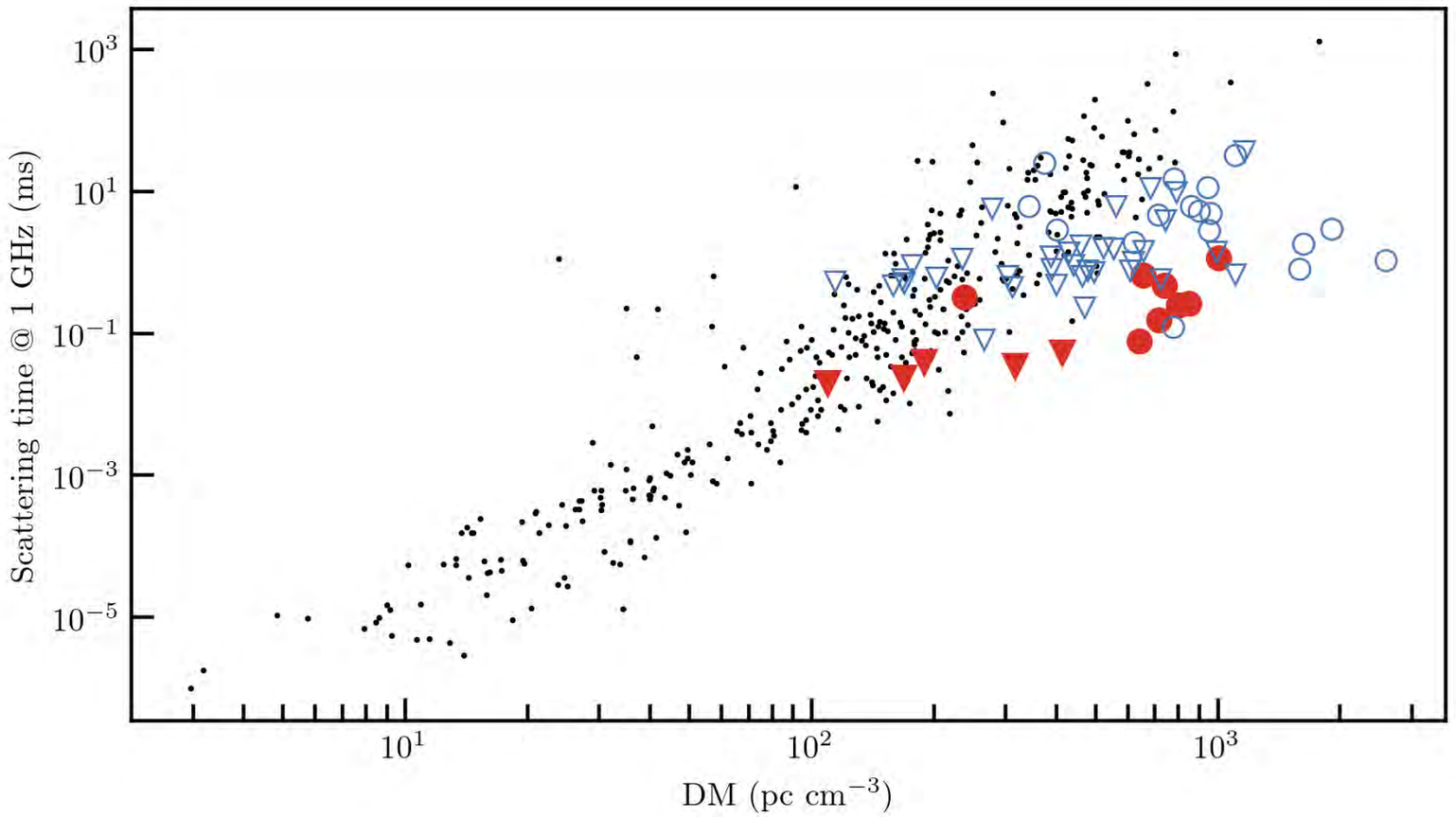


CHIME/FRB Collaboration, 2019

FRB SCATTERING TIMESCALES

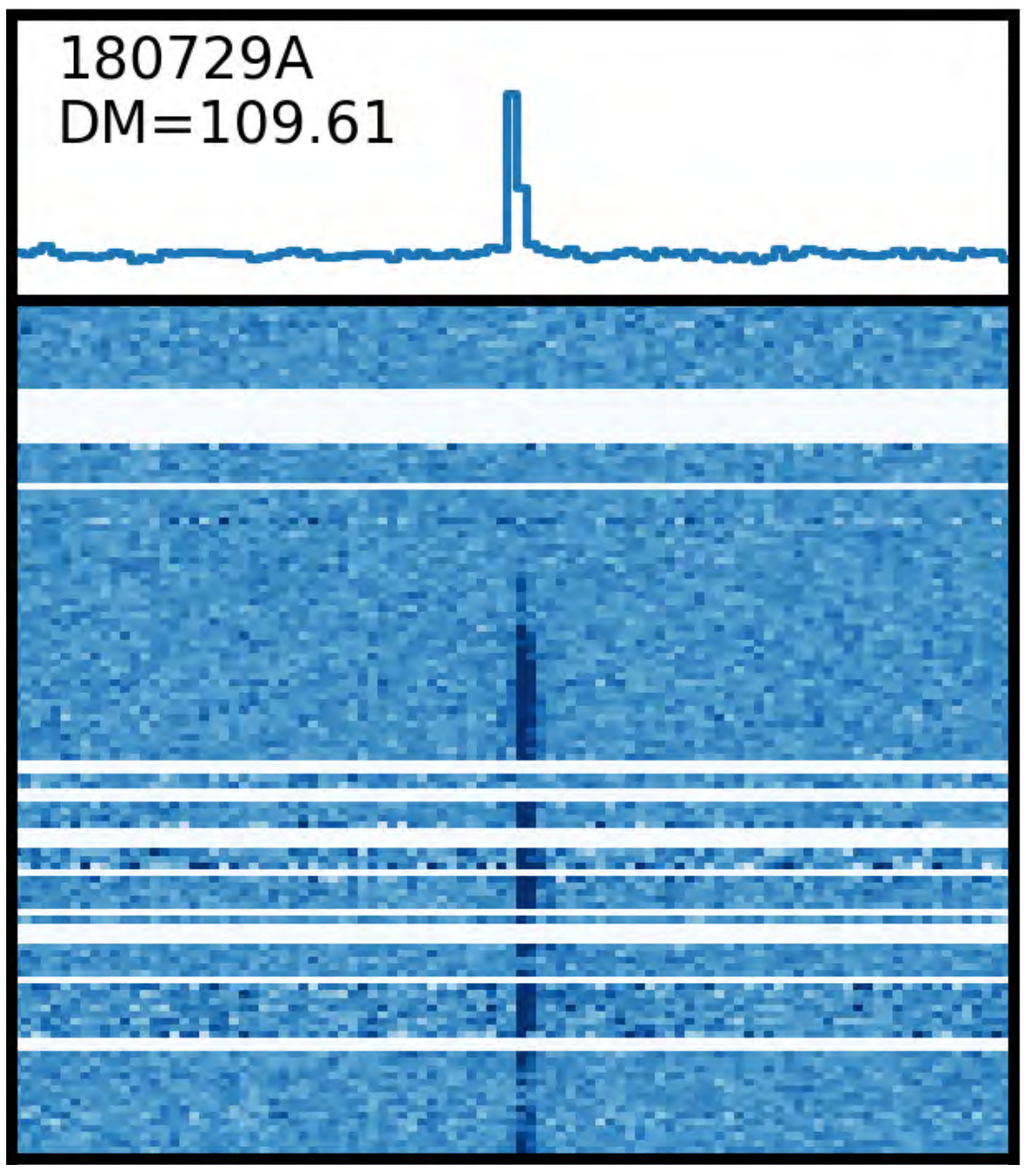
7/13 have t_{scatt} > 1 ms

Scattering hard to explain with just spiral arms –> Needs extra scattering sources



CHIME/FRB Collaboration, 2019

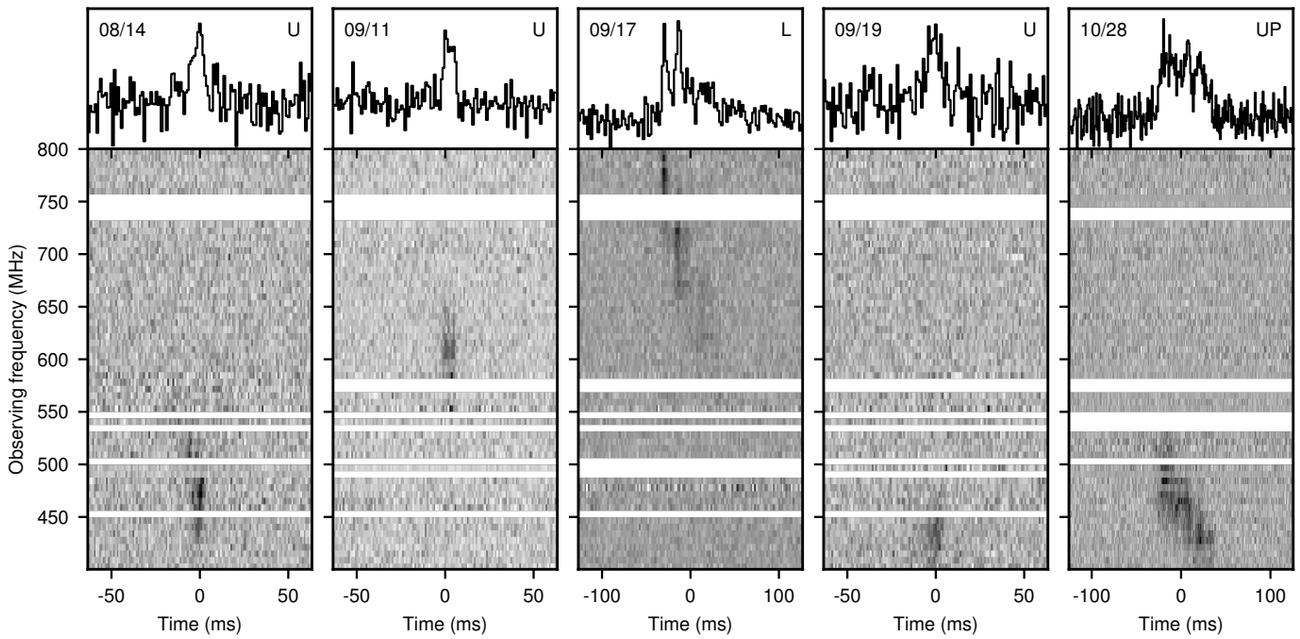
LOWEST DM FRB



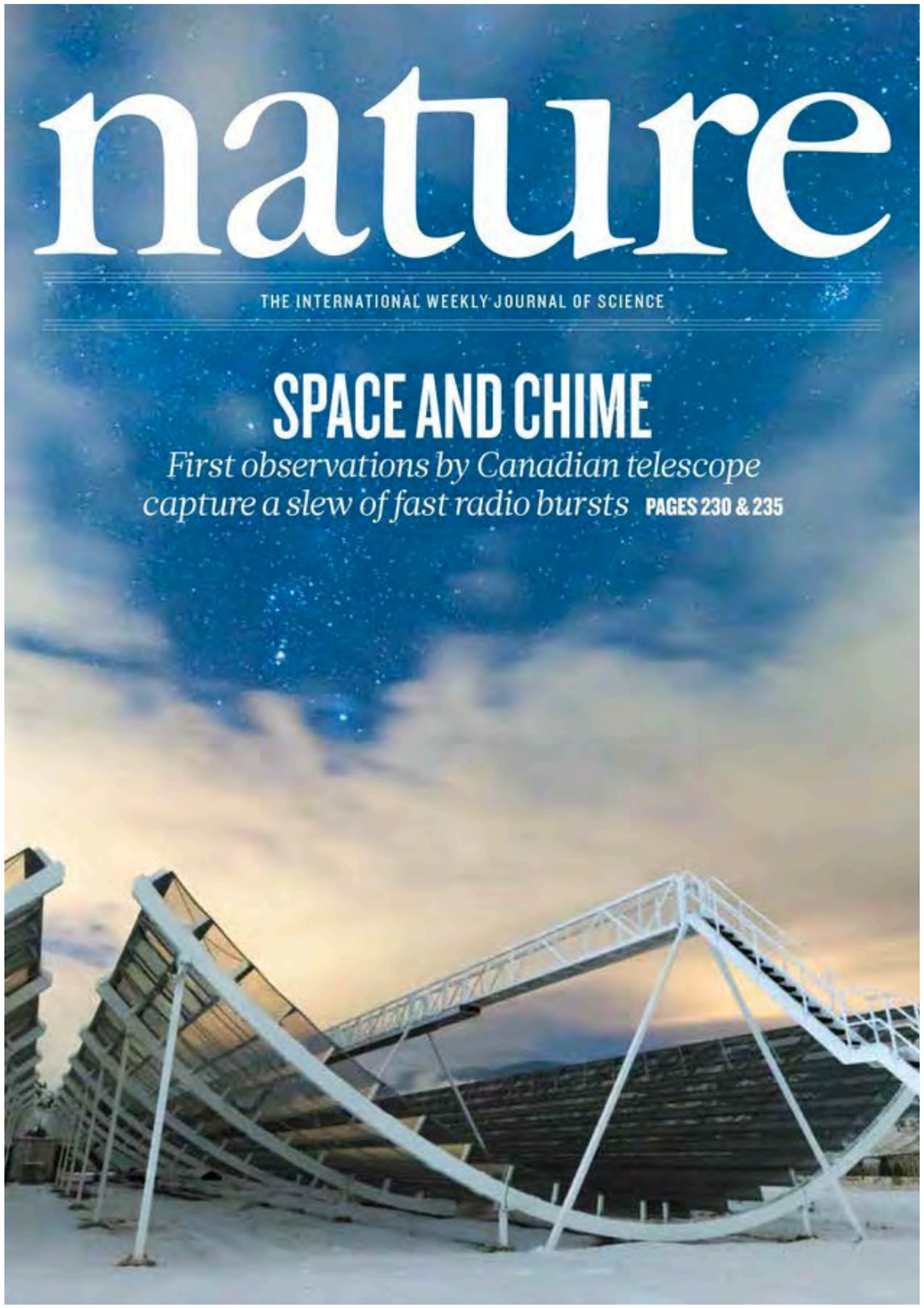
- DM = 109 pc/cm^{-3}
- MW: 23-30 pc/cm^{-3}
- No scattering
- Z<0.1, d<440 Mpc
- Assume Host DM~45 pc/cm^{-3}, z~0.017, d~75 Mpc
- Many plausible galaxy counterparts, some with radio sources, no bright galaxy

CHIME/FRB Collaboration, 2019

CHIME REPEATER (R2)

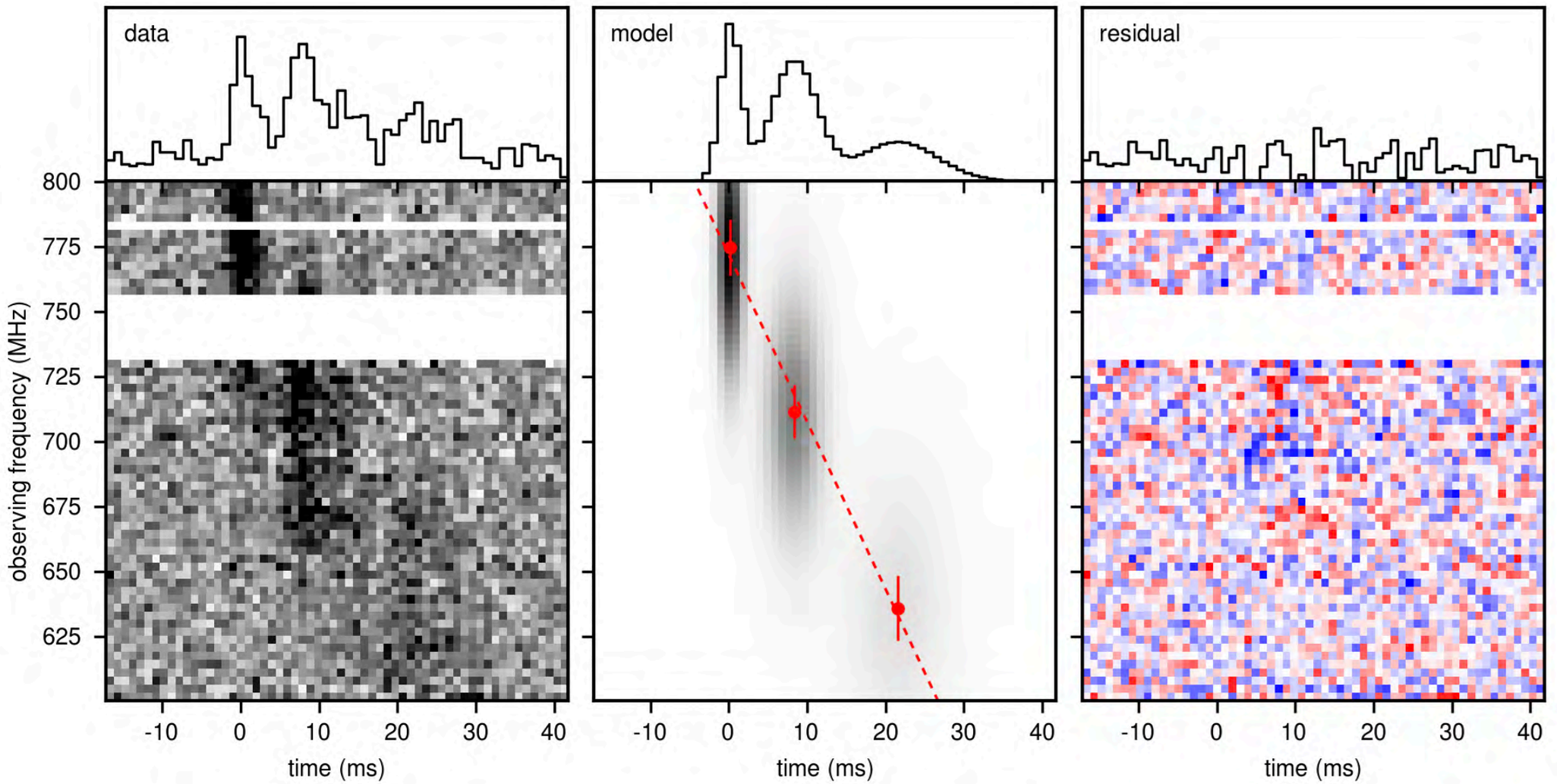


RA	DEC	DM pc cm^{-3}	Fluence Jy ms	DM(Gal) pc cm^{-3}
63°4h22m	+73°	189.4	3-60	~80 - 100



CHIME/FRB Collaboration, 2019

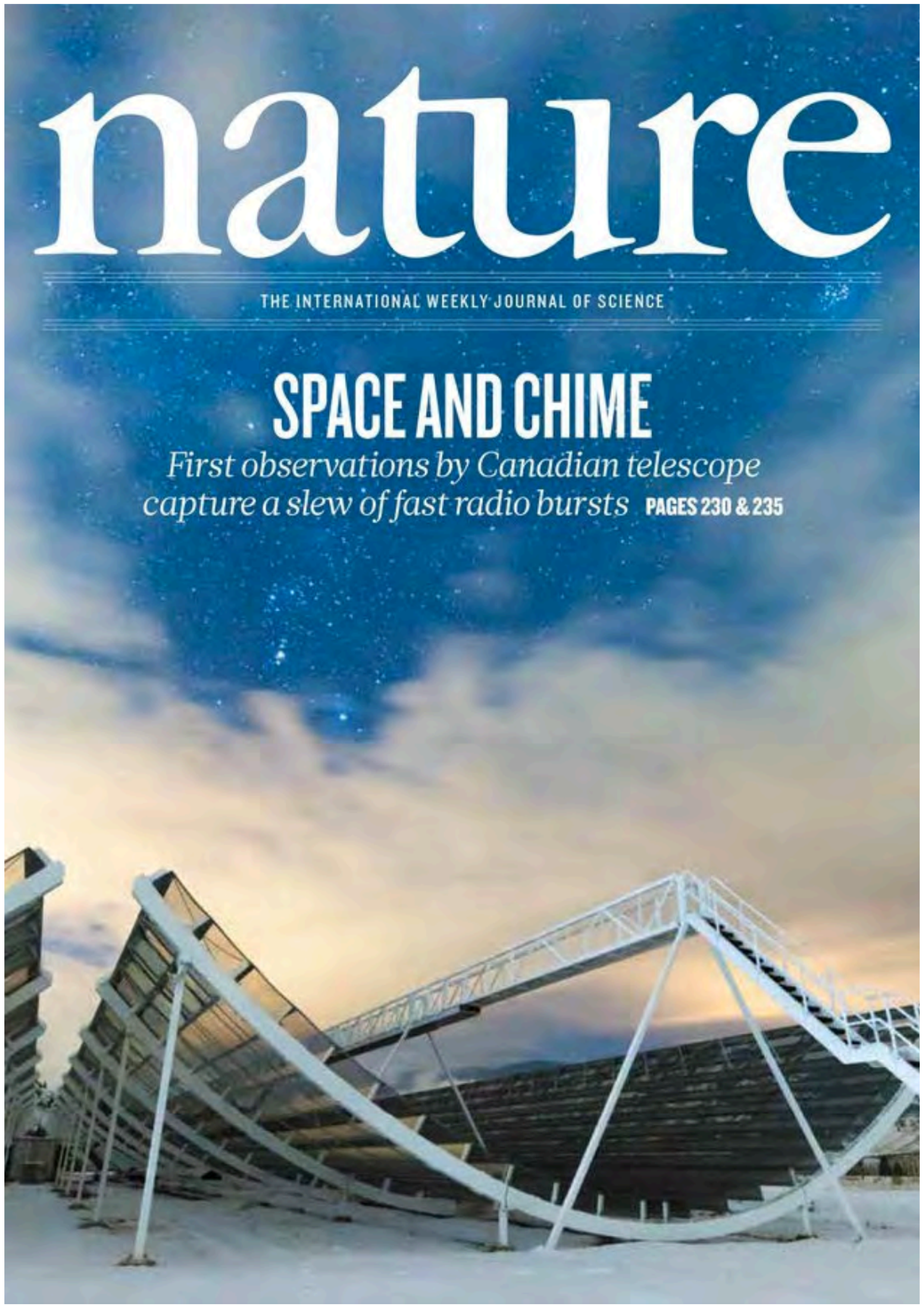
CHIME REPEATER



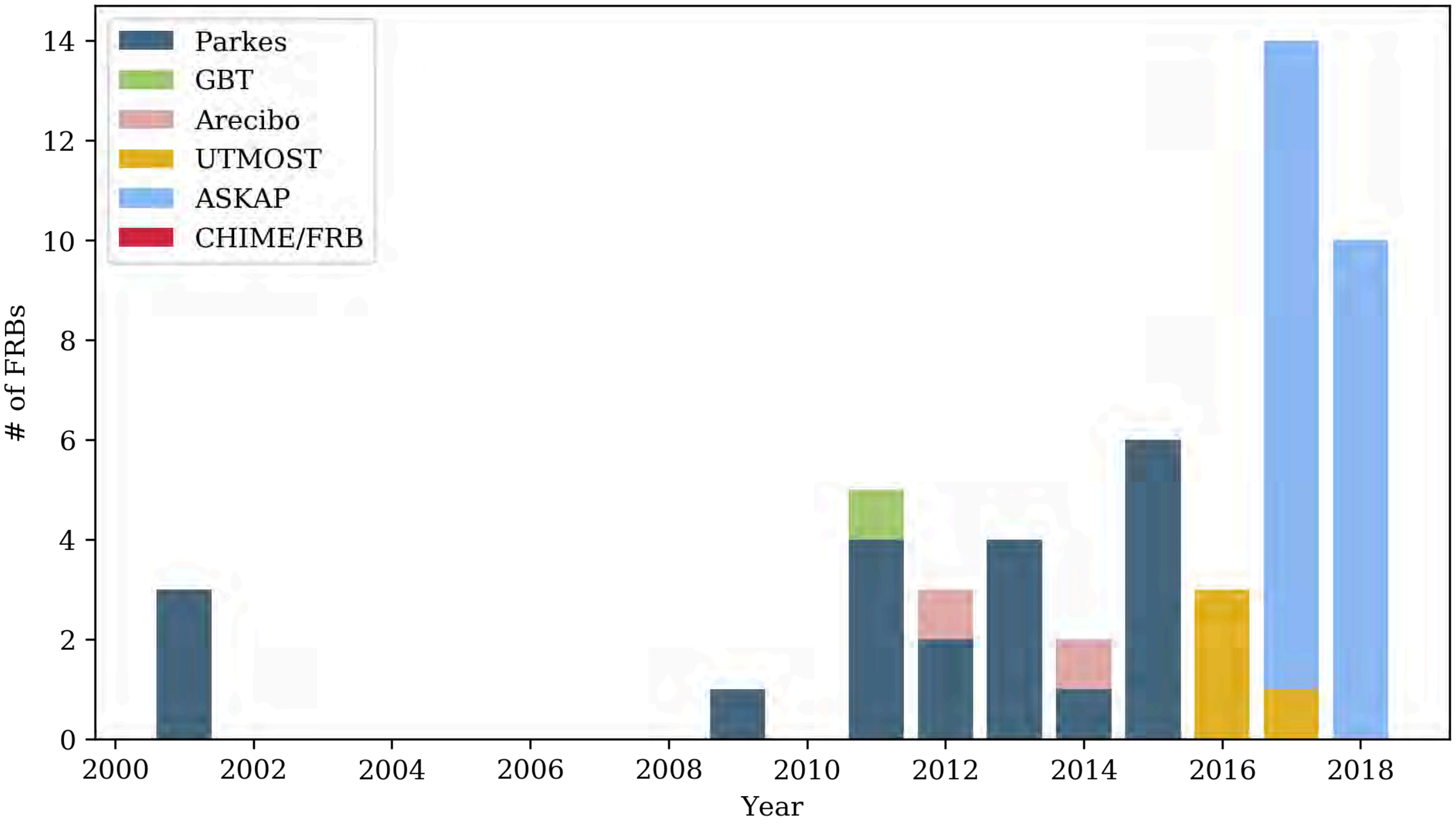
CHIME/FRB Collaboration, 2019

BUT, WAIT & NOTE

- Based on ~1 month of engineering data, at subscale capacity.
- No polarization data yet, uncalibrated, can’t measure absolute frequency spectrum.
- Angular resolution currently suboptimal
- Selection function not well characterized
- Instrument is still in commissioning!



CHIME/FRB Collaboration, 2019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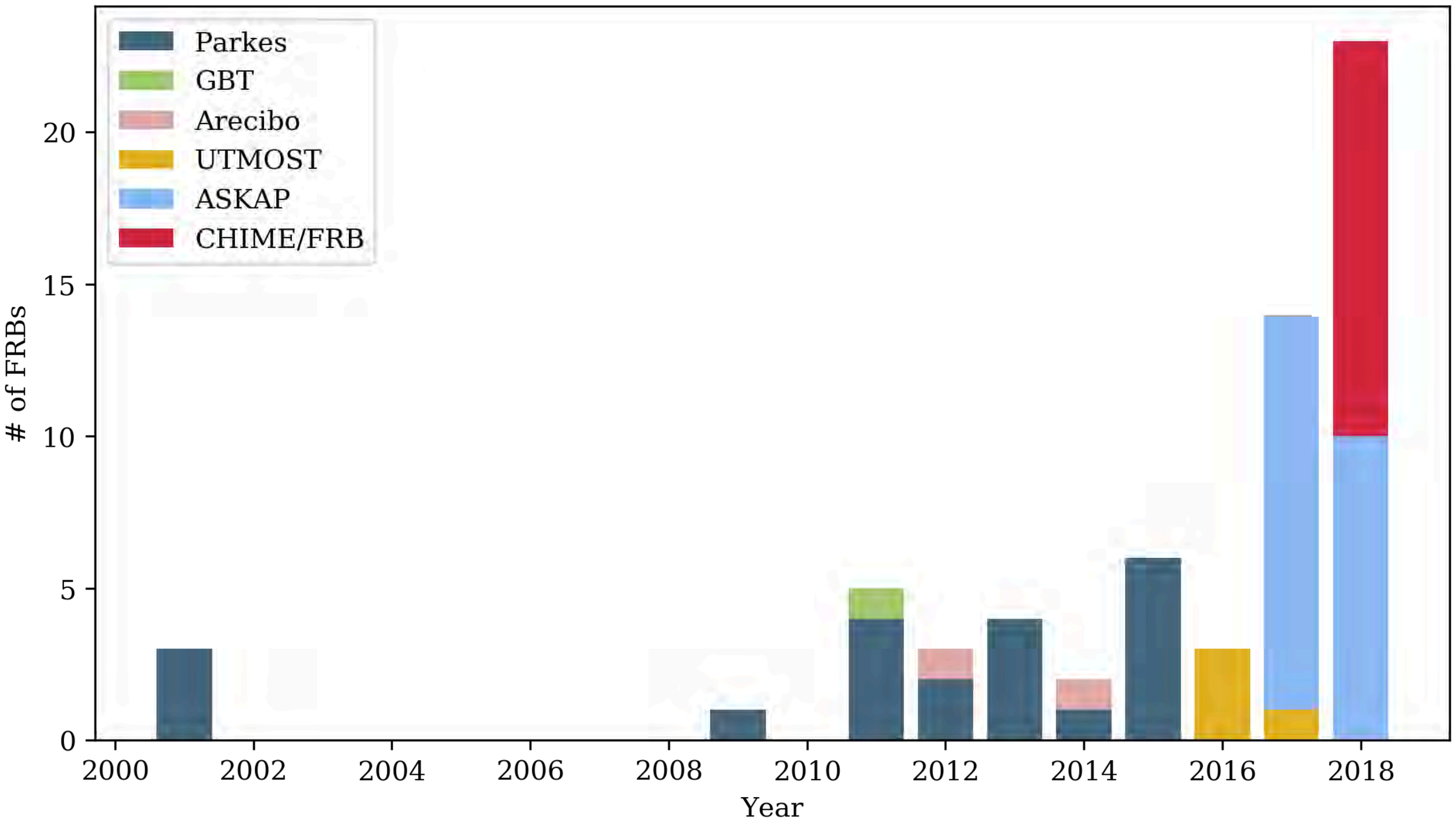
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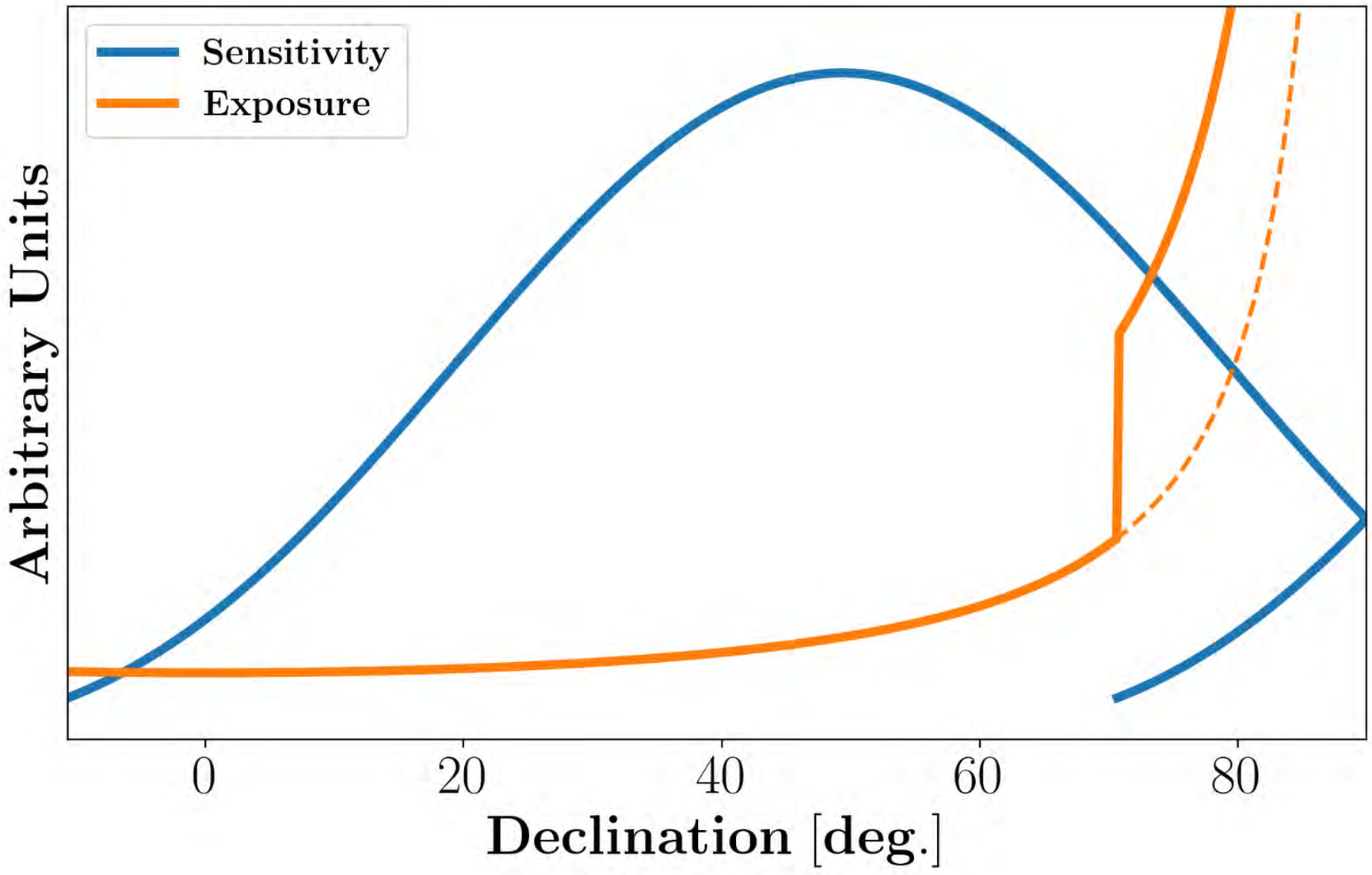
SENSITIVITY AND EXPOSURE



Note: sensitivity curve is just a toy model!

DM DISTRIBUTION

WHATS NEXT FOR CHIME/FRB?

- Finish commissioning & Start FRB rate experiment
- Study 250+ FRBs
  DM, Scattering, DM Index & Sky distribution
  Pulse Morphology
  Multi-wavelength counterparts
- 20+ new radio pulsars and RRATs!
- Commensal Slow Pulsar Search
- Outrigger Telescopes