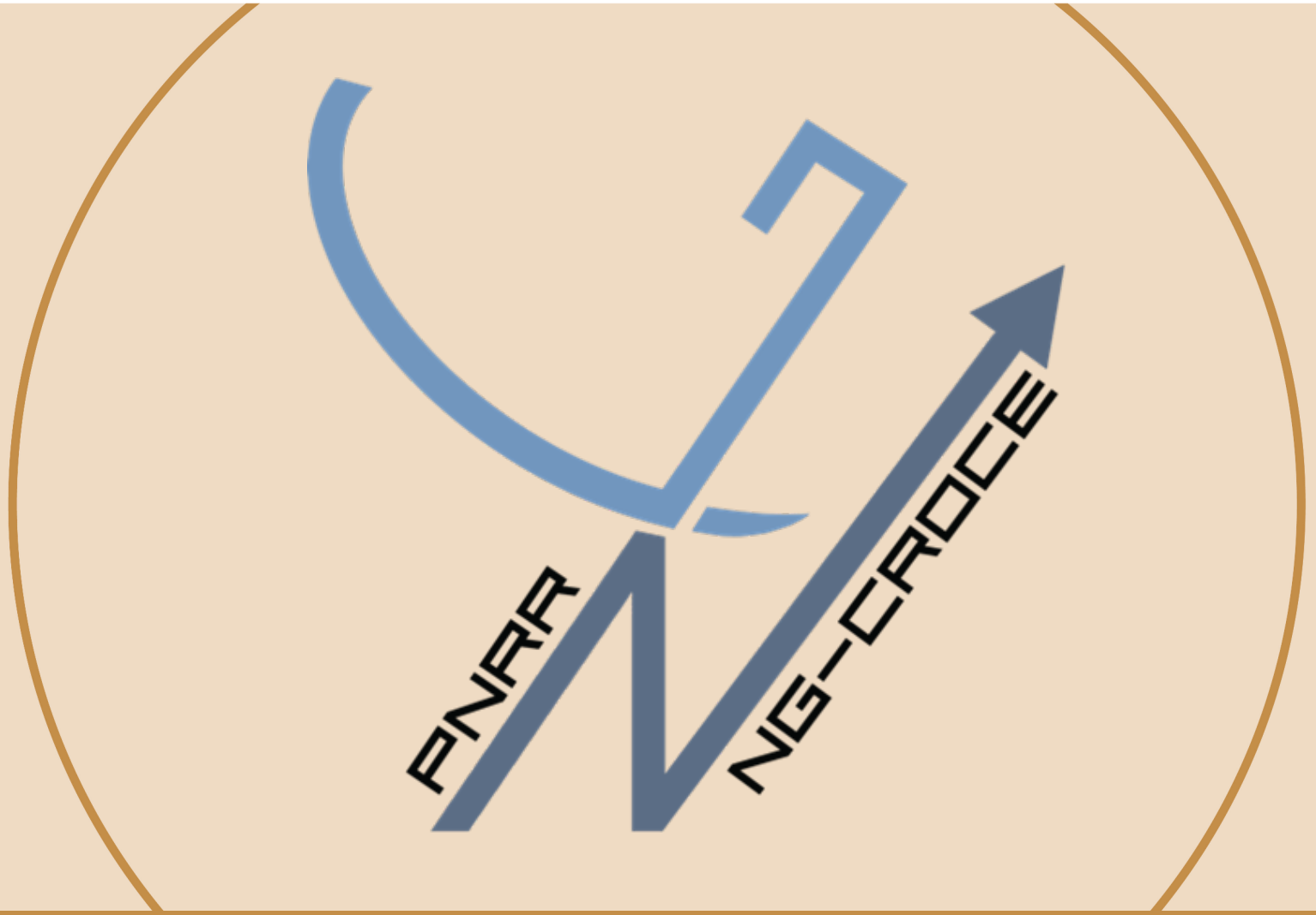
Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INAF ISTITUTO NAZIONALE DI ASTROFISICA

A catalogue of FRB hosts and the way forward to CHORD discoveries

Training Meeting NG-Croce

Lunedì 12 Maggio - Giovedì 15 Maggio



Radiotelescopi di Medicina
IRA - Bologna

Matteo Cinus

The FRB HOSTS catalogue

A compilation of data gathered from the literature, developed in collaboration with

- Luciano Nicastro - OAS
- Eliana Palazzi - OAS
- Davide Pelliciari - IRA
- Sandra Savaglio – UniCal
- T. Eftekhari - NW Uni., IL
- M. Glowacki - Curtin Uni., AUS
- J. X. Prochaska - UC Santa Cruz, CA

frb-hosts.org (work in progress)

https://github.com/FRBs/FRB

Host association

- **Why?**
  - Constrain FRB progenitors
  - Study the environment in which they are produces
  - Measure FRB redshift

How?

- Localise the FRB
- Identify candidate hosts in the field of view
- Calculate host association probability: PATH

The number of localised FRBs and host galaxies will rapidly increase with telescopes like CHORD

Data in the catalogue

FRB parameters

- Coordinates
- DM
- RM
- Repeater: y/n

Host parameters

- Coordinates
- Redshift
- Host association probability
- Morphology
- Photometry
- Spectroscopy

Host derived parameters

- Stellar mass
- Star formation rate
- Metallicity
- Distance
- Age

Studying host galaxies now

Low redshift FRB

FRB detection

↓

Localisation

↓

Host association

High redshift FRB

FRB detection?

Studying host galaxies with CHORD

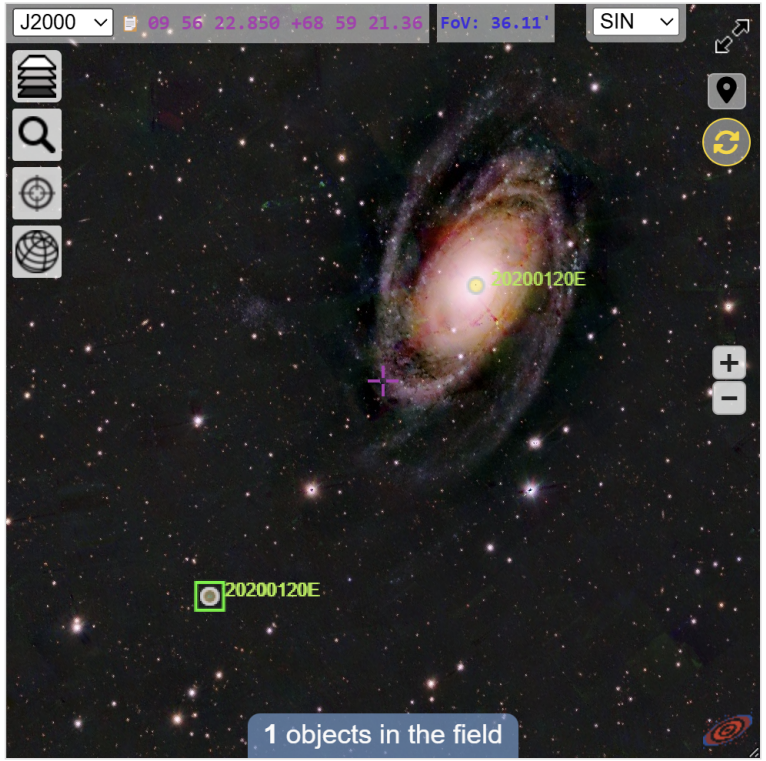
Low redshift FRB

FRB detection
↓
Localisation
↓
Host association
↓
Precise localisation within host

High redshift FRB

FRB detection
↓
Precise localisation
↓
Host association

Nearest extragalactic FRB know, in globular cluster in M81



Hosts full params · FRBs params · Initial host galaxies
Hosts+FRB full params · Hosts Main table

Base image layer quick selection

DSS color · SDSS9 color · 2MASS · AllWISE · Spitzer
Pan-STARRS DR1 · DECaPS DR2 · DESI-LS DR10 · BASS DR3

Ref. Cat. FRBs params · Options

Max objects 10000

Multi Cat. view · HiPS Cats · Reg. shown · Lab. shown
TabFld names · Manual Refresh · HPX barycenter
HPX borders off

Toggle columns · Sky view follows pointer

Show 10 entries Search:

Label	RA	Dec	DM	Sep
20200120E	149.477914	68.816904	87.7527	14.16

Showing 1 to 1 of 1 entries Previous 1 Next

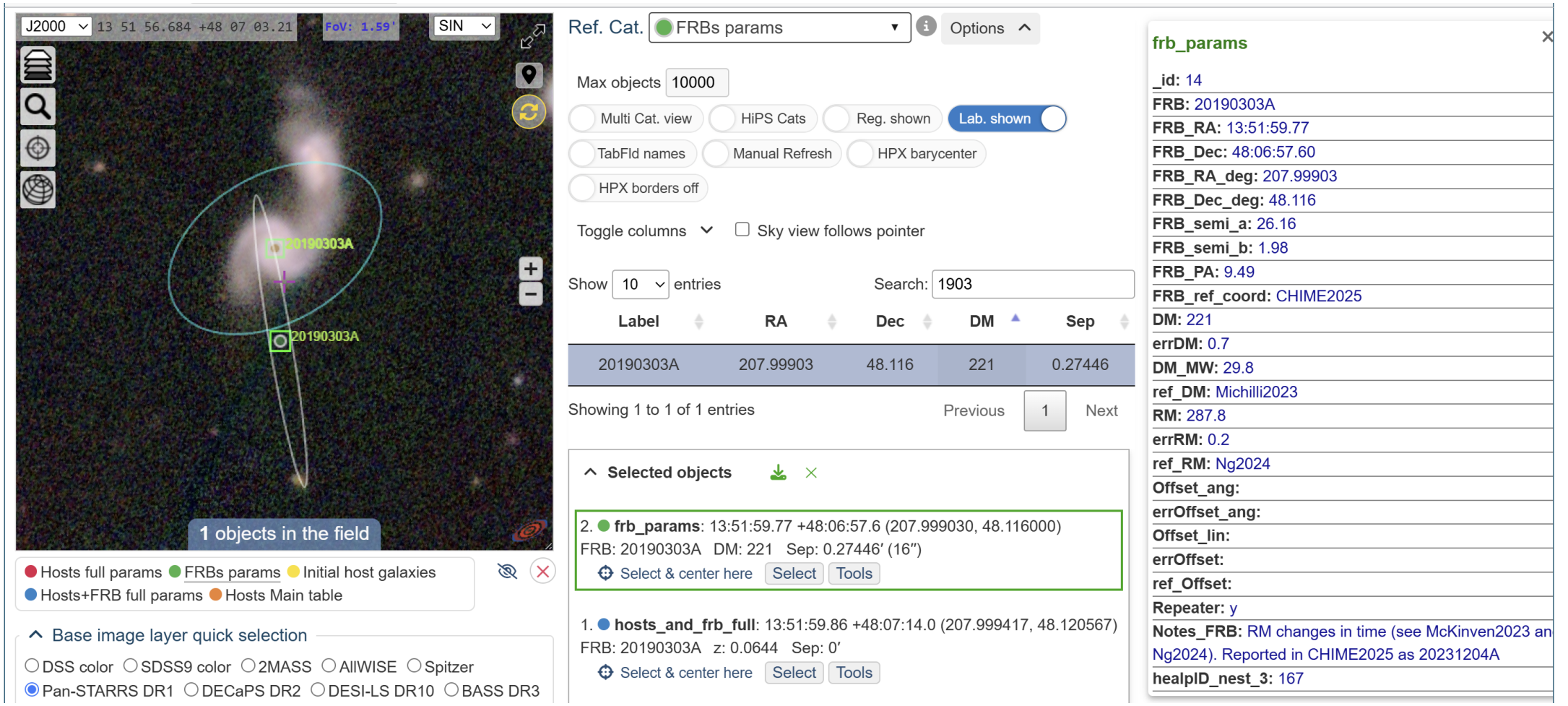
Selected objects

1. **frb_params**: 09:57:54.70 +68:49:00.9 (149.477914, 68.816904)
FRB: 20200120E DM: 87.7527 Sep: 14.16′
Select & center here · Select · Tools

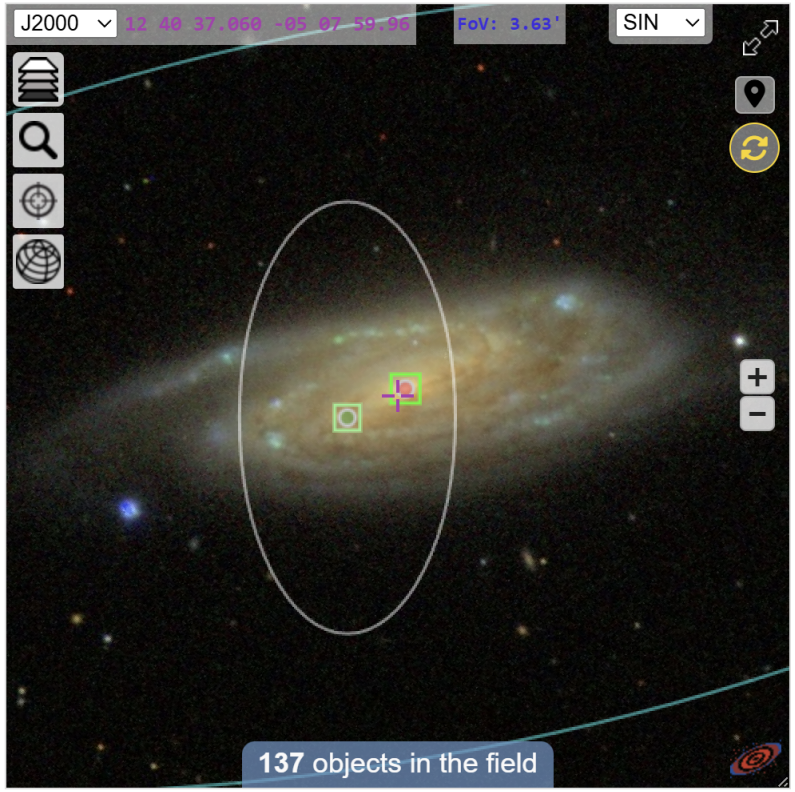
frb_params

_id: 28
FRB: 20200120E
FRB_RA: 09:57:54.69935
FRB_Dec: 68:49:0.8529
FRB_RA_deg: 149.477914
FRB_Dec_deg: 68.816904
FRB_semi_a: 0.0013
FRB_semi_b: 0.0012
FRB_PA: 90
FRB_ref_coord: Kirsten2022
DM: 87.7527
errDM: 3.000e-4
DM_MW: 40.7
ref_DM: Kirsten2022
RM: -24.45
errRM: 0.13
ref_RM: Ng2024
Offset_ang: 0.11
errOffset_ang: 0.002
Offset_lin: 0.00192
errOffset: 3.000e-5
ref_Offset: Dage2023
Repeater: y
Notes_FRB: The FRB offset is respect to the GC center
healpID_nest_3: 118

FRB associated with galaxy merger



FRB at z=0.0085 with ~50arcsec localisation



Ref. Cat. FRBs params Options

Show 10 entries Search: 200723

Label	RA	Dec	DM	Sep
20200723B	190.158333	-5.135	243.99	4027.1

Showing 1 to 1 of 1 entries (filtered from 137 total entries)

Previous 1 Next

Selected objects

2. **hosts_full**: 12:40:36.92 -05:07:58.0 (190.153830, -5.132769)
FRB: 20200723B z: 0.008469 Sep: 4027.4′ (67°)
Select & center here Select Tools

1. **frb_params**: 12:40:37.00 -05:08:06.0 (190.158333, -5.135000)
FRB: 20200723B DM: 243.99 Sep: 4027.1′ (67°)
Select & center here Select Tools

hosts_full

_id: 33
FRB: 20200723B
GalID: NGC 4602
RAJ2000s: 12:40:36.92
DEJ2000s: -05:07:58.0
RA_deg: 190.15383
Dec_deg: -5.132769
errRA: 0.0185
errDec: 0.0193
ref_coord: PanSTARRS
E(B-V): 0.0207
z: 0.008469
err_z: 1.500e-4
ref_z: NED
P_host: 0.985
ref_P_host: Shin2024
Semiaxis_a: 271
err Semiaxis_a: 10
Semiaxis_b: 102
err Semiaxis_b: 10
PosAngle: 100.73
errPosAngle: 1
Reff:
errReff:

FRB at z=0.553 with ~arcsec localisation

Ref. Cat. FRBs params Options

Show 10 entries Search: 2212

Label	RA	Dec	DM	Sep
20221219A	257.629792	71.626833	706.7	6841.4

Showing 1 to 1 of 1 entries (filtered from 137 total entries)

Previous 1 Next

Selected objects

2. **frb_params**: 17:10:31.15 +71:37:36.6 (257.629792, 71.626833)
FRB: 20221219A DM: 706.7 Sep: 6841.4′ (1.1e+2°)
Select & center here | Select | Tools

1. **hosts_full**: 17:10:31.09 +71:37:35.9 (257.629542, 71.626642)
FRB: 20221219A z: 0.553 Sep: 6841.4′ (1.1e+2°)
Select & center here | Select | Tools

frb_params

_id	80
FRB	20221219A
FRB_RA	17:10:31.15
FRB_Dec	71:37:36.6
FRB_RA_deg	257.6297917
FRB_Dec_deg	71.6268333
FRB_semi_a	1.54
FRB_semi_b	0.93
FRB_PA	90
FRB_ref_coord	Sharma2024
DM	706.7
errDM	
DM_MW	44.4
ref_DM	Connor2024
RM	
errRM	
ref_RM	
Offset_ang	
errOffset_ang	
Offset_lin	5.92
errOffset	14.96
ref_Offset	Sharma2024
Repeater	n
Notes_FRB	
healpID_nest_3	183

High redshift FRBs for cosmology

$$DM = DM_{MW} + DM_{cosmic} + DM_{host}$$

Hubble constant
Address the Hubble tension

Fraction of baryon in the IGM
Changes as structures evolve

$$\langle DM_{cosmic} \rangle = \Omega_b \frac{3 H_0 c}{8 \pi G m_p} \int_0^{z_{FRB}} \frac{f_e(z) f_{IGM}(z)(1+z)}{\sqrt{\Omega_m (1+z)^3 + \Omega_\Lambda (1+z)^{1+w}}} dz$$

Ionisation fraction
Constrain the reionization history

Dark Energy Equation of state
Dynamical evolution of DE

CHORD to constrain the reionisation history and more

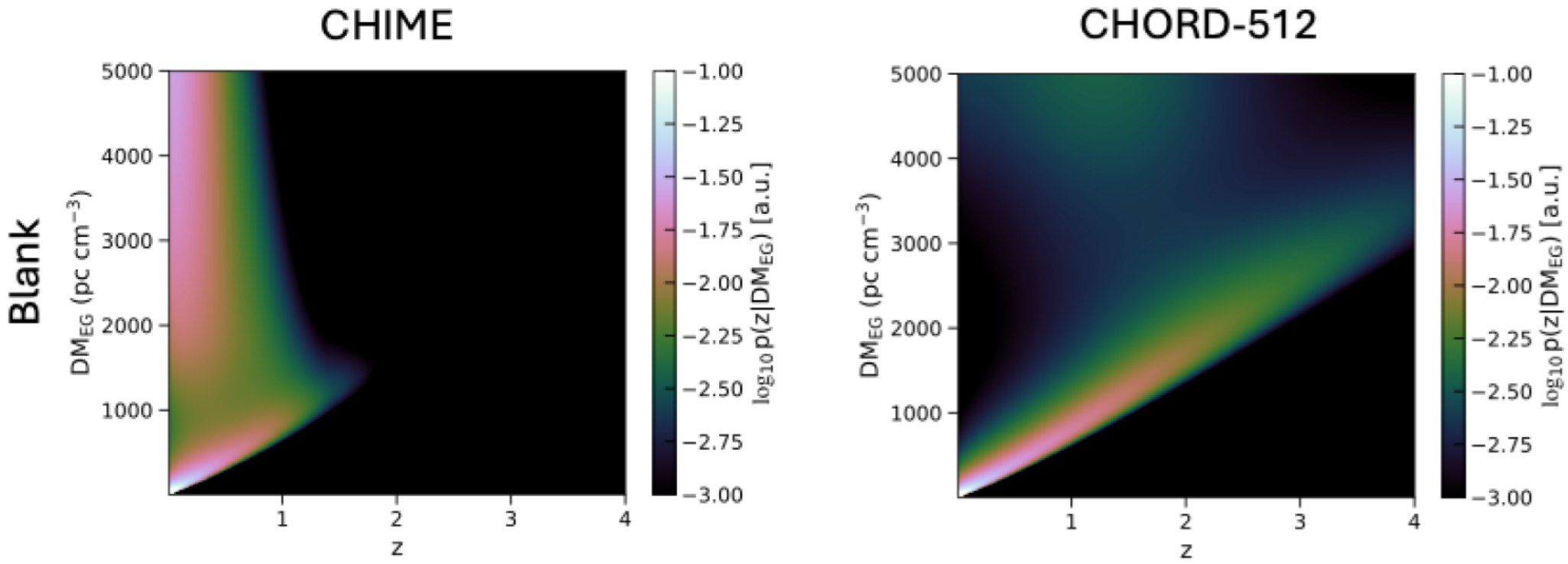
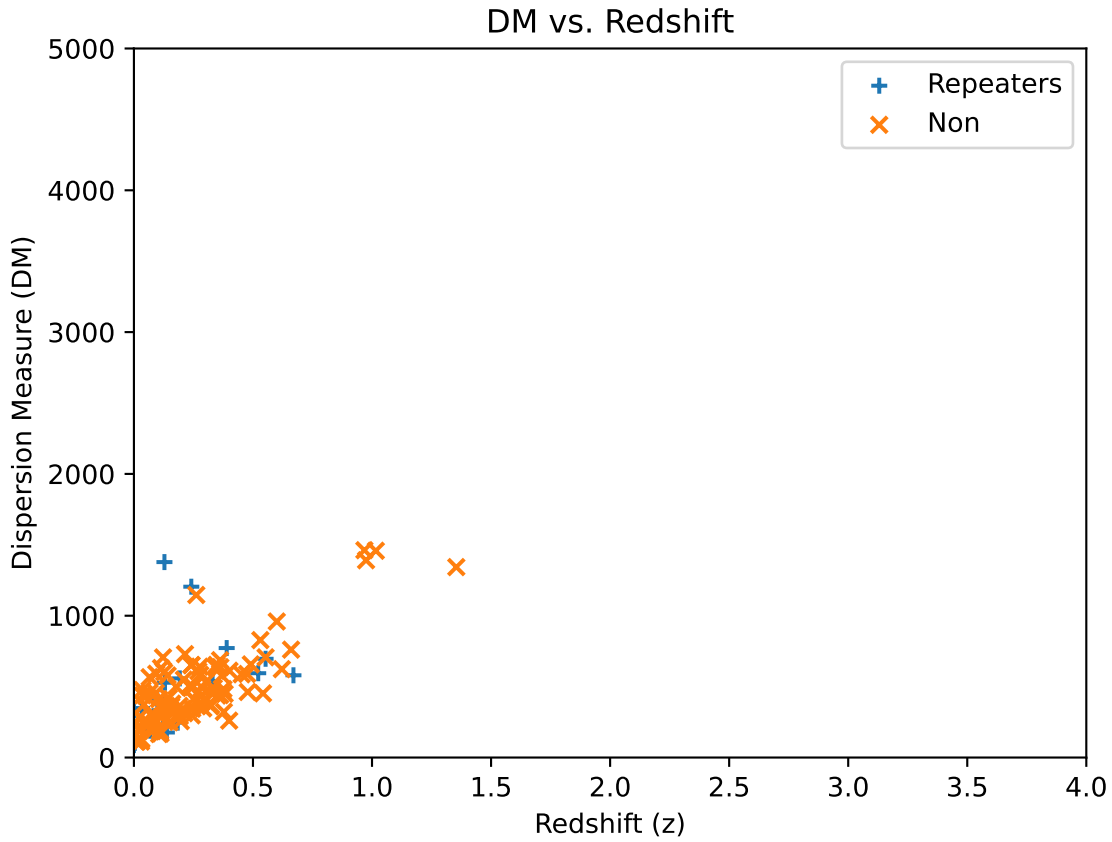


Image adapted from Sammons+2025

The population of localised FRBs today



Action picker for CHORD at order zero

Input data: Astrophysical source with DM, S/N ...

- DM check:
  - If $DM > DM_{MW}$, it is likely an FRB
- S/N check:
  - If S/N>12, save baseband data
  - If S/N<8.5, save intensity data

Example of a more complicated scenario: Dynamic thresholding

If the line of sight contains a cluster, the signal could be lensed so we lower the S/N threshold to save the data of a possible high redshift FRB

Summary

- Host association is important to constrain the nature of FRBs
- As more facilities like CHORD will come online, having a catalogue of FRB hosts will be increasingly more important
- Low redshift FRBs can be used to study the local environment of the FRB progenitor
- High redshift FRBs can be used to study the universe
- High redshift FRBs will still be difficult to detect, but lensing could make it easier
- We want to make sure we do not miss high redshift FRBs!