High Cadence Monitoring of Repeating Fast Radio Bursts

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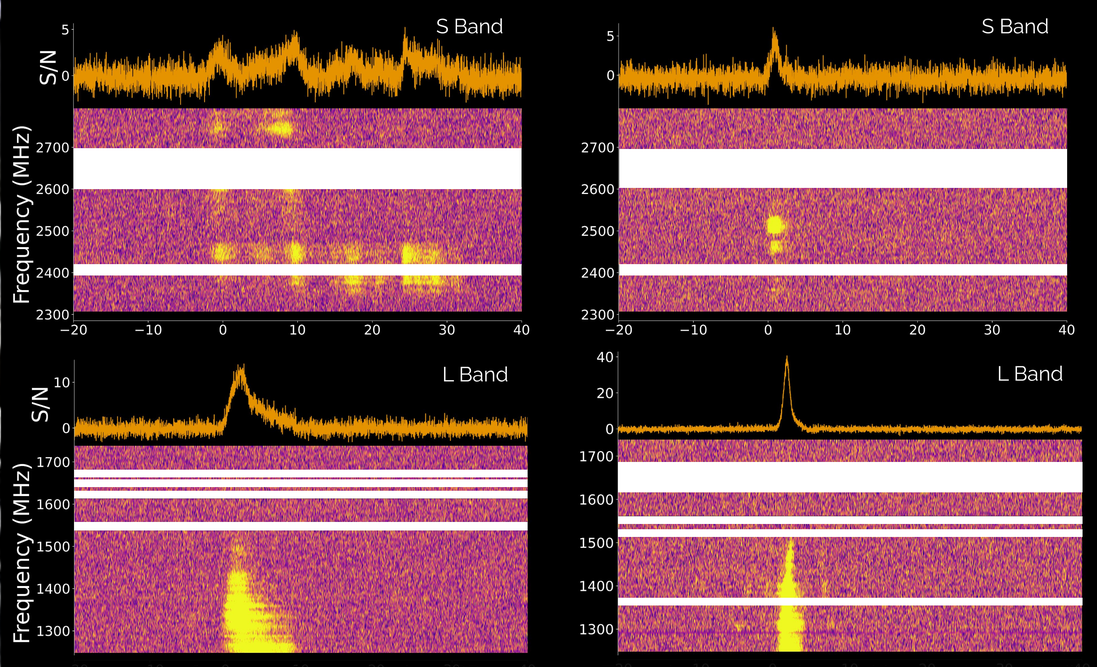
Fast Radio Bursts

Fast Radio Bursts (FRBs) are extremely bright and brief (~ms) radio transients of extragalactic origin. Over 3000 FRBs have been detected by CHIME/FRB and other radio telescopes with a mere ~2.6% observed to be repeating (CHIME/FRB Collaboration et al. 2023). Furthermore, repeaters have been observed to have impermanent activity and in the case of two repeaters, observed to have a periodic activity cycle (CHIME/FRB Collaboration et al. 2020, Pleunis et al. 2021b). Despite all of this, FRB emission mechanisms and progenitors still remain a mystery!

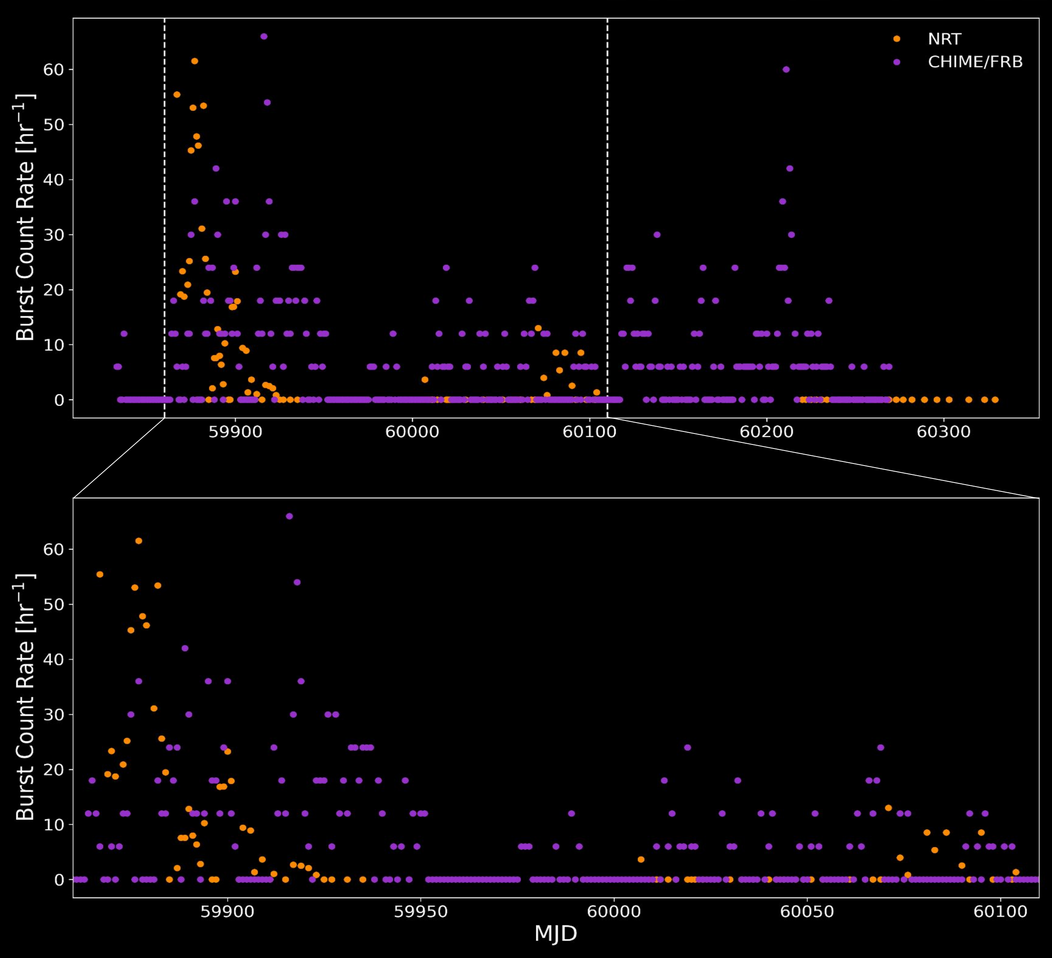
Nançay Radio Telescope FRB 20240124A Detections



Dynamic spectra of 4 bursts from repeating FRB 20240124A. These bursts were detected by the Nançay Radio Telescope as part of the ECLAT observing campaign (Hewitt et al. 2023). The top panels in each figure show the frequency-averaged time series and horizontal white lines indicate data removed due to RFI.
Top 2 plots are a subset of the first detections of FRB 20240124A at S-band (above 2GHz) (Hewitt et al. 2024).
Bottom 2 plots are bursts detected at between L-band (1.1GHz and 1.8GHz).

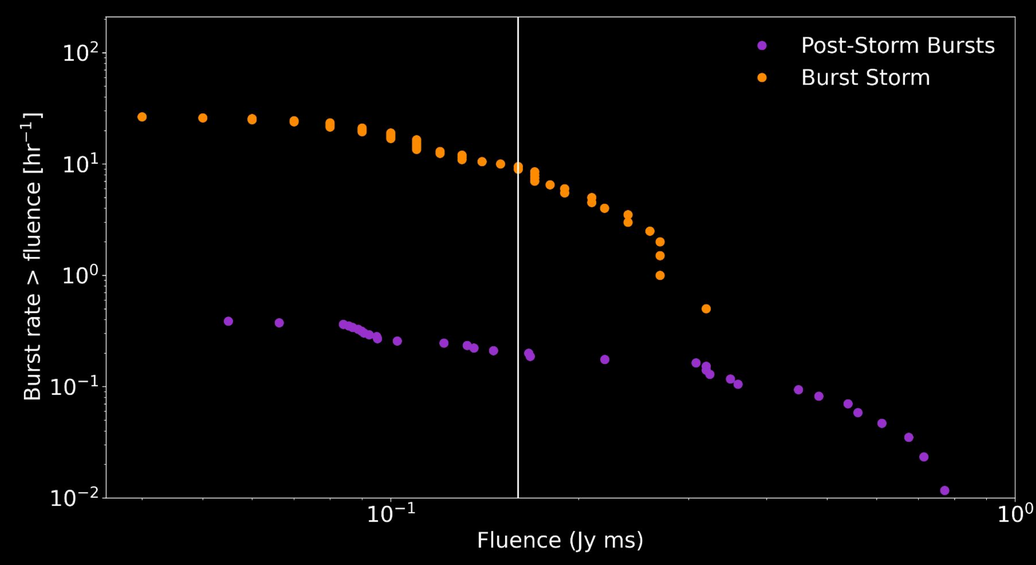
FRB 20220912A Burst Activity Comparison

Here we compare the burst activity of FRB 20220912A as seen by Nançay Radio Telescope (NRT) (1.1GHz-1.8GHz) and CHIME/FRB (400MHz-800MHz). The repeater spikes in activity first in higher frequencies from NRT, then subsequently transitions to lower frequencies. After the high activity spike is over, it remains preferentially emitting at lower frequencies.



Burst Activity of FRB 20220912A in Burst Rate per Hour as a function of Modified Julian Date. As indicated in the legend, different coloured markers represent bursts detected by Nançay Radio Telescope (NRT) and CHIME/FRB. The top panel displays all observations of FRB 20220912A from NRT as part of the ECLAT campaign (Hewitt et al. 2023, Konijn et al. in prep) and all published detections by CHIME/FRB. Non-detections dates where the telescopes were on-target were included. **Bottom panel** shows only dates where NRT detected bursts.

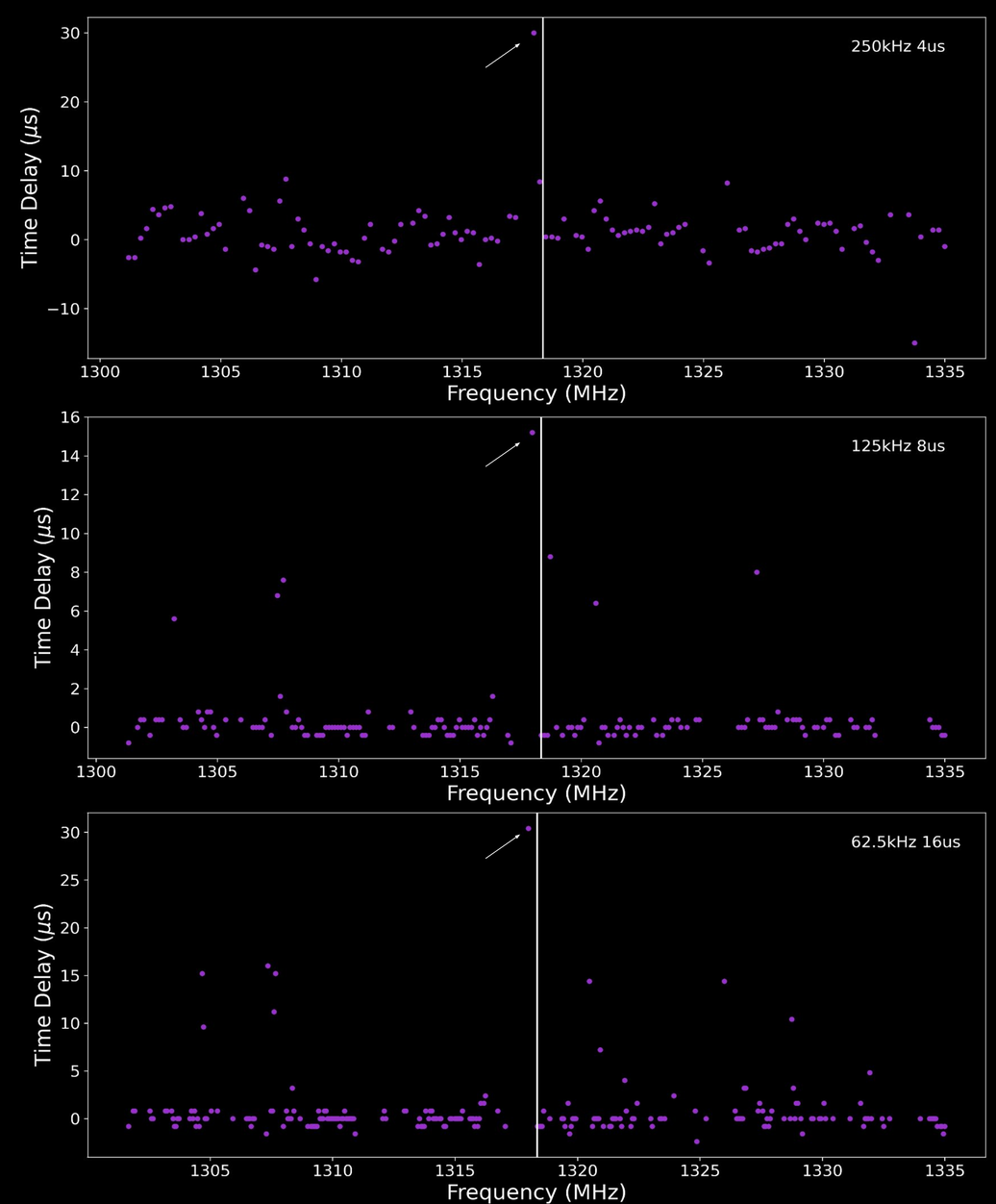
Effelsberg 100-m Radio Telescope FRB 20200120E Detections



Comparison of the distribution of fluences between the FRB 20200120E "burst storm" from Nimmo et al. 2023 on Jan 24th 2022 and all (36) subsequent "post-storm" detections until Dec 16th 2023 with the Effelsberg Telescope at 1.4GHz.
Vertical white line indicates the fluence threshold of 0.16 Jy ms.

Hydrogen Line Detection using FRBs

Current efforts to determine redshifts of FRB sources require follow-up or simultaneous observations at higher resolutions, often with VLBI. Here we present a proof of concept for an independent measurement of redshift from the bursts themselves. Jenet et al. 2009 presented that neutral hydrogen (HI) cause time delays in signal propagation from pulsars at the HI line frequency.



Top, Middle and Bottom panels present the time delay when using different time/frequency resolutions as annotated in the plots. The white line indicates the expected HI line with a redshift of 0.0771, the known redshift of FRB 20220912A.
The time delay between each frequency channel of a FRB 20220912A burst detected by the Westerbork RT1 Telescope. To calculate the time delay, a burst template was created using a bright component from the frequency-averaged profile, and cross-correlation between the template and each burst channel was calculated.

Background Image Credit: Daniëlle Futselaar / ASTRON

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References

Jenet, F. et al. 2010, ApJ, 710, 1718
CHIME/FRB Collaboration et al. 2020, Nature, 582, 351
CHIME/FRB Collaboration et al. 2023, ApJ, 947, 83
Pleunis, Z,. et al. 2021b, ApJ, 923, 1
Hewitt, D., et al. 2023, MNRAS, 526, 2039
Nimmo, K., et al. 2023, MNRAS, 520, 2281
Hewitt, D., et al. 2024, Atel #16597
Konijn, D., et al. 2024, in prep