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# LOFAR follow-up of CHIME/FRB repeaters

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Fast radio bursts (FRBs) are sub-second radio flashes that can be detected over extragalactic distances [1]. Their origin remains unknown. The Canadian Hydrogen Intensity Mapping Experiment (CHIME), a new radio interferometer operating in the octave from 400–800 MHz, is running the CHIME/FRB experiment to increase the number of known FRBs by orders of magnitude. By revisiting the same stretch of sky every day as it drifts overhead, CHIME/FRB excels at finding repeating sources of FRBs. Indeed, the experiment has established repeaters as a class of FRBs by discovering dozens of them[1] – the vast majority of the currently reported repeaters. The repeating FRBs for which sufficiently many bursts have been detected show periods of activity lasting a few days, alternating with periods of inactivity lasting weeks to months. Two sources, FRB 20121102A and FRB 20180916B, show a periodicity in their activity of $\sim 160$ and $\sim 16$ days, respectively. We use CHIME/FRB detections to trigger Low-Frequency Array (LOFAR; 110–188 MHz) follow-up observations of active sources of repeating FRBs. We record complex voltage data from LOFAR, which allows us to coherently de-disperse the data and remove the effects of dispersive smearing. This increases the sensitivity of our search and permits us to study spectro-temporal structures and Faraday rotation of detected bursts in detail. We have detected bursts down to 110 MHz from FRB 20180916B, with the burst activity systematically delayed towards lower frequencies (see Figure 1) [2]. This low-frequency emission has lead to the best constraints on the free-free absorption of FRB emission local to the source. We are now observing FRB 20180916B over all activity phases to more robustly identify its burst activity window and phase center (see right panel in Figure 1). Moreover, we are targeting additional repeating sources to establish whether more of them are observable in the LOFAR band and to probe any frequency dependence in the burst rate by comparing LOFAR and CHIME/FRB detections.

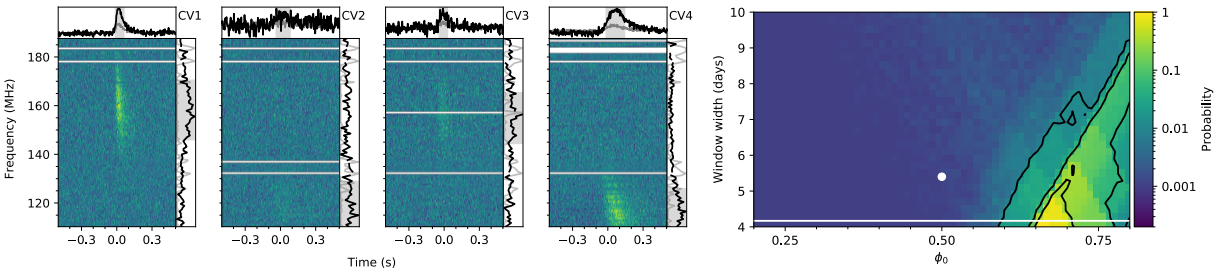


**Figure 1.** Left: Dynamic spectra of four LOFAR detections of FRB 20190816B, with emission extending all the way down to 110 MHz for some bursts (second and fourth panels). Right: Probability distribution of window width and phase center of the 16.3-day periodic activity of FRB 20190816B, as compared to CHIME/FRB (white dot). The burst activity is systematically delayed towards lower frequencies. Figures reproduced from [2].

## References

[1] Petroff, E., Hessels, J. W. T., and Lorimer, D. R., "Fast radio bursts", *Astronomy and Astrophysics Review*, vol. 27, no. 1, 2019. doi:10.1007/s00159-019-0116-6.

[2] Pleunis, Z., et al. "LOFAR Detection of 110–188 MHz Emission and Frequency-Dependent Activity from FRB 20180916B", *The Astrophysical Journal Letters*, submitted.

[1] https://www.chime-frb.ca/repeaters