FRB121102: First detection at 8-GHz and Broadband Properties

Vishal Gajjar*[1], Andrew P. V. Siemion[1], Steve Croft[1], David DeBoer[1], Emilio Enriquez[1,2], Griffin Foster[1,3], Greg Hellbourg[1], Jack Hickish[1], Brian Lacki[1], Matt Lebofsky[1], David MacMahon[1], Danny Price[1,4], Dan Werthimer[1], Gerry Zhang[1]

(1) UC Berkeley, CA
(2) Radboud University, Nijmegen, NETHERLANDS
(3) University of Oxford, Oxford, UNITED KINGDOM
(4) Swinburne University, Melbourne, AUSTRALIA

The Fast Radio Bursts (FRBs) are some of the most energetic and rare events in the Universe. The origin of these sources is among of the most challenging questions of the modern-day astrophysics. As many of the future radio telescopes will be spending a significant amount of resources and observing time to study and detect more FRBs, it is imperative to understand the nature of these bursts across a range of radio frequencies. Among the known FRBs, FRB121102 is the only source known to show repeated bursts [Spitler et al., Nature, 531, 7593 202-205, 2016], which can allow a detailed investigation of various origin models.

We conducted observations of FRB 121102 using the Breakthrough Listen Digital Backend with the C-band receiver at the Green Bank Telescope. We recorded baseband voltage data across 5.4 GHz of bandwidth, completely covering the C-band receiver's nominal 4-8 GHz band [MacMahon et al. arXiv:1707.06024v2]. The recorded data were searched for dispersed pulses consistent with the known dispersion measure of FRB 121102 (557 pc cm^{-3}). We detected around 20 bursts above our detection threshold of 6 sigmas in the first 60-minutes. These are the highest frequency and widest bandwidth detection of bursts from FRB 121102 (or any other FRB) obtained to-date. We note that bursts show marked changes in spectral extent, with characteristic spectral structure in the 100 MHz - 1 GHz range. We obtained dynamic spectra of these bursts to estimate the first ever characteristic scintillation bandwidth and its correlation time-scale for this FRB at such high frequencies. We also found distinctive temporal structures in three of the strongest bursts with each sub-structure exhibiting different frequency features.

Breakthrough Listen backend instrument is very unique and one its kind as it allows high-time (0.3 μsec) and frequency resolution (1 Hz) data across such a wide bandwidth from the Green Bank Telescope. Due to intriguing frequency structures observed within the 4-GHz of bandwidth from the 20 detected bursts, we are going to highlight that an instrument operating at a smaller bandwidth would only be able to catch half of them. We are also going to discuss that it is essential for the future radio telescopes, conducting searches for new FRBs, to implement such wider instantaneous bandwidths capabilities.