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Demonstration of a Synoptic VLBI Technique for Localizing a Non-Repeating Fast Radio Burst with CHIME/FRB

Calvin Leung*[(1)(2)], Juan Mena Parra[(1)], Kiyoshi Masui[(1)(2)], P.J. Boyle[(3)(4)], Davor Cubranic[(5)], Victoria Kaspi[(3)(4)], Daniele Michilli[(3)(4)], Chitrang Patel[(6)(3)(4)], Andre Renard[(6)], Keith Vanderlinde[(6)(7)]

(1) MIT Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, USA

(2) Department of Physics, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, USA

(3) Department of Physics, McGill University, 3600 rue University, Montréal, QC H3A 2T8, Canada

(4) McGill Space Institute, McGill University, 3550 rue University, Montréal, QC H3A 2A7, Canada

(5) Department of Physics and Astronomy, University of British Columbia, 325 - 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada

(6) Dunlap Institute for Astronomy & Astrophysics, University of Toronto, 50 St. George Street, Toronto, Ontario, Canada M5S 3H4

(7) David A Dunlap Department of Astronomy & Astrophysics, 50 St George St, Toronto, Ontario, Canada, M5S 3H4

Fast radio bursts (FRBs) are bright, brief, extragalactic radio transients. Currently, their progenitors and production mechanism are unknown, and their millisecond-scale duration makes localization for multiwavelength followup extremely challenging. The Canadian Hydrogen Intensity Mapping Experiment-FRB Instrument [2] leads the field in FRB detection but its arcminute-precision localization is insufficient for host galaxy association. We have developed hardware and software for CHIME/FRB outrigger telescopes, which will provide more precise localizations through very long baseline interferometry (VLBI). We use the CHIME Pathfinder [1] as an outrigger testbed to demonstrate a synoptic VLBI calibration technique for CHIME/FRB. We demonstrate the interferometric detection of a single FRB between the Canadian Hydrogen Intensity Mapping Experiment (CHIME) and the CHIME Pathfinder while the two telescopes were operating independently and on separate clocks, as in a true VLBI observation. Using a simultaneous observation of the calibrator 3C 305, we measure the FRB's arrival time difference at the two telescopes with a precision of 15 picoseconds, meeting key hardware, software, and calibration requirements for performing VLBI with CHIME/FRB outriggers. Such outriggers will enable thousands of FRBs to be localized to milliarcsecond precision, enabling transformative studies of their host environments.

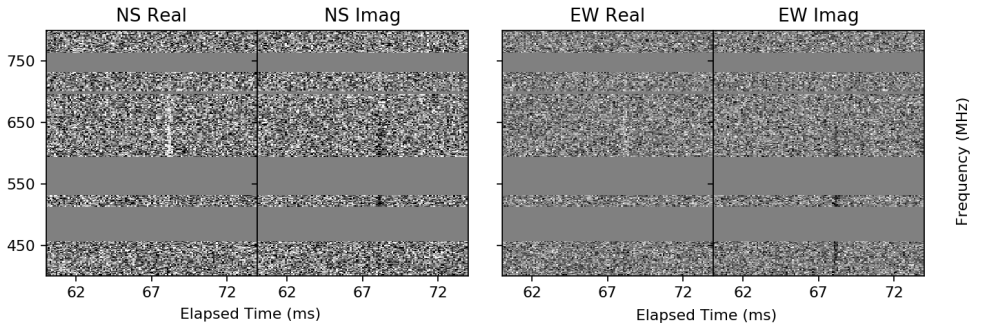

Figure 1. The real and imaginary parts of the visibility between CHIME Pathfinder and CHIME, in both the north-south and east-west polarizations, as a function of time and frequency. The FRB can be clearly seen in cross correlation between the two telescopes. Gray bands denote radio frequency interference. The phase of the visibility varies linearly with frequency and can be translated into a time delay for interferometric localization.

References

[1] K Bandura et al. "Canadian Hydrogen Intensity Mapping Experiment (CHIME) Pathfinder". In: *Ground-based and Airborne Telescopes V*. Vol. 9145. International Society for Optics and Photonics. 2014, p. 914522.

[2] CHIME/FRB Collaboration et al. "The CHIME Fast Radio Burst Project: System Overview". In: *The Astrophysical Journal* 863.1 (2018), p. 48.