Deployment of a novel interferometer architecture on the LWA-Sevilleta station

Nithyanandan Thyagarajan*[1], Adam P. Beardsley[2], Judd D. Bowman[2], Greg B. Taylor[3], Jayce Dowell[3], and Miguel F. Morales[4]

[1] National Radio Astronomy Observatory, Socorro, NM 87801, USA
[2] Arizona State University, Tempe, AZ 85287, USA
[3] University of New Mexico, Albuquerque, NM 87131, USA
[4] University of Washington, Seattle, WA 98195, USA

Two of the frontier sciences that define the major efforts in radio astronomy this decade include the evolution of gas and large-scale structure in the early Universe and the characterization of mysterious explosive phenomena in the Universe through time-domain studies. High sensitivity and time-resolution are essential prerequisites to achieve these goals. Rapid advances in radio instrumentation and signal processing have raised hopes of achieving success in these domains. Modern radio telescopes such as the Hydrogen Epoch of Reionization Array (HERA), Square Kilometre Array (SKA), Long Wavelength Array (LWA), and Murchison Widefield Array (MWA) are adopting an approach of achieving large collecting areas through hundreds to thousands of small antennas. However, this poses serious challenges to processing data because current methods rely on correlating data between antennas, for which the computing cost scales as the number of antennas squared, $N_{\rm a}^2$. I will present the E-field Parallel Imaging Correlator (EPIC), which implements a versatile and efficient algorithm (MOFF) for direct imaging. For large compact arrays, the computational cost scales much less strenuously as $\sim N_a \log_2 N_a$, producing calibrated images at no extra cost while accommodating arbitrary layouts and even heterogeneous arrays. By design, it can operate at the Nyquist speed of incoming digitized data and can produce images even on microsecond timescales. Thus, it provides an ideal platform for building image-based fast transient search and monitoring systems for Fast Radio Bursts (FRB), millisecond pulsars (MSP), and other mysterious astrophysical events. EPIC holds significant advantage and promise for most modern compact radio interferometer arrays such as HERA, LWA stations, CHIME, and cores of MWA and SKA1-low. Following the software demonstration of calibration and imaging of real data from the LWA1 (New Mexico) and the Owens Valley LWA stations, EPIC has been recently funded by the NSF ATI division to deploy a real-time GPU-version on the LWA station in Sevilleta (New Mexico). I will discuss the instrument at the LWA-Sevilleta station, resource requirements, deployment plan, and potential for expanding the scope to other telescopes.