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The DSA-2000: Status and Design

Francois B. Kapp*(1) and the DSA-2000 collaboration,
(1) Owens Valley Radio Observatory, Department of Astronomy, California Institute of Technology, 1200 East California Boulevard, Pasadena, CA 91125, USA; e-mail: fkapp@caltech.edu

The Deep Synoptic Array 2000 (DSA-2000) is a 2048 element array, optimized for surveys in a band from 700MHz to 2 GHz, that is currently in development. The DSA-2000 will address three major science cases: Multimessenger Astronomy, Our Cosmic History, and the Time Domain Sky. These science cases will be addressed by performing a cadenced, all sky survey, including spectral line and full polarization imaging; the ability to commensally detect and localize fast radio transients; dedicated pulsar timing; and rapid follow-up of compact object mergers detected by other gravitational wave observatories.

The array will span an area of 19 km × 15 km in Nevada, achieving 3.3 arcsecond spatial resolution. In an initial five-year survey, the DSA-2000 will image ~33,000 deg2 repeatedly over sixteen epochs, producing a combined full-Stokes sky map with 500 nJy/beam rms noise. During the survey, the array is expected to detect more than 10,000 Fast Radio Bursts, more than 10,000 pulsars, and more than 1 million slow transients, with sub-arcsecond localization for host galaxy identification.

The DSA-2000 will also be a leading instrument for the discovery and characterization of the electromagnetic counterparts to neutron-star mergers found by ground-based Gravitational Wave (GW) detectors. The multi-year timing of radio pulses from 200 pulsars will enable the detections of nanoHertz GWs from individual binary supermassive black holes (SMBHs) in galaxy mergers.

The key enabling factors for the DSA-2000 include:

1. Access to a radio quiet site
2. An optimized layout that can be serviced in a cost-effective manner
3. The development of low cost 5m diameter antennas, that can be manufactured in volume and on site
4. The availability of uncooled receivers that enable a system temperature below 25K over the full operational temperature envelope expected over the lifetime of the instrument
5. The development of the Radio Camera capability, which enables efficient pipeline imaging without iterative visibility plane processing

Substantial progress has been made in all these areas, with subsystem maturity at appropriate levels for the risk and novelty involved.

The System Engineering is being developed concurrently with the technology maturation described above, and these engineering activities feed into funding proposals currently in progress. The project is currently in the Preliminary Design Phase, with a view to commence construction in 2024. The project held a Concept Design Review in 2022 and is currently preparing for a Preliminary Design Review during 2023, prior to a Final Design Review before construction.

The DSA-2000 is being designed to have a survey speed at least an order of magnitude better than any other instrument in existence or planned.

In this presentation, we provide an up-to-date status of the project and the key enabling technologies from an engineering perspective.

References

[1] G. Hallinan, et al, “The DSA-2000 – a Radio Survey Camera,” Astro2020 APC White Papers Bulletin of the AAS Volume 51, Number 7, 17, July 2019, https://arxiv.org/abs/1907.07648