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The DSA-2000: Building a Radio Camera

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The 2000-antenna Deep Synoptic Array (DSA-2000) is a proposed world-leading radio survey telescope and multi-messenger discovery engine operating in the 0.7 – 2 GHz band, with first light anticipated in 2026 (Hallinan et al. 2019). It will survey the sky at a rate ~200x the state of the art worldwide and ~6x any array in development (SKA1, ngVLA). The dense DSA-2000 configuration breaks through a barrier in imaging performance, with near complete sampling in the uv-plane, removing the need for visibility-based deconvolution (e.g. Cotton-Schwab CLEAN) and the associated expensive gridding/de-gridding from the pipeline, replacing it when necessary with image-based CLEAN, or forgoing it altogether for some other image reconstruction method such as compressed sensing.

The development of the algorithms and software necessary for the DSA-2000 radio camera approach commenced in March 2020, funded by Schmidt Futures, in a program called the Radio Camera Initiative (RCI). This program will develop a highly optimized high-throughput end-to-end pipeline for near real-time flagging, calibration and imaging making use of platforms that perform simple operations on high-speed streaming data at high efficiency (cost and energy), such as Graphics Processing Units (GPUs). The RCI will enable future large-N arrays (DSA-2000, SKA-2) to replace traditional correlators with a 'radio camera' - an integrated digital back-end that will produce the final image data in near real-time. Delivery of this platform to the entire community is a key goal of the RCI.

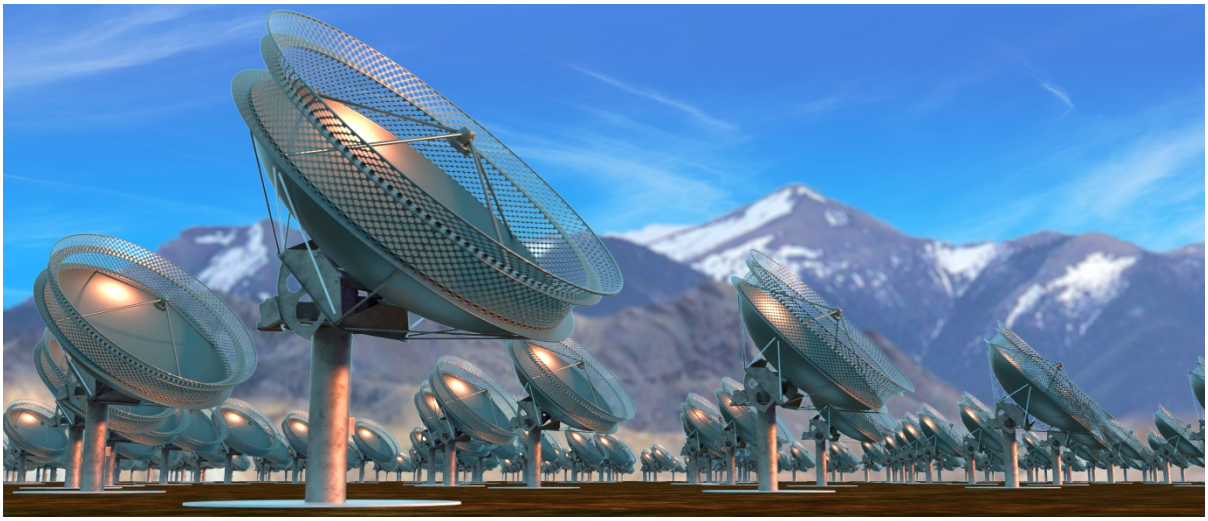

Figure 1. The DSA-2000 is proposed to be a world-leading radio survey telescope and multi-messenger discovery engine for the next decade. It will be the first true radio camera, outputting science-ready image data over the 0.7-2 GHz frequency range with a spatial resolution of 3.5 arcseconds and will detect a billion radio sources in a 5-year observing program.

References

[1] Hallinan, G; Ravi, V.; Weinreb, S.; Kocz, J.; Huang, Y.; Woody, D. P.; Lamb, J.; D'Addario, L.; Catha, M.; Law, C.; Kulkarni, S. R.; Phinney, E. S.; Eastwood, M. W.; Bouman, K.; McLaughlin, M.; Ransom, S.; Siemens, X.; Cordes, J.; Lynch, R.; Kaplan, D. Brazier, A.; Bhatnagar, S.; Myers, S.; Walter, F.; Gaensler, B.. "The DSA-2000 — A Radio Survey Camera", arXiv:1907.07648