Calibration and Imaging Considerations in the Design of Large-N Arrays

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This paper considers the role of post-processing considerations in the design of large-N arrays, from the perspective of their feasibility for the targeted science goals for these arrays, their cost, and their critical impact on array design parameters and choices. Post-processing in this context includes calibration and imaging in both continuum and spectra-line observing modes, and analysis of time-domain data for both transients and pulsars.

For large-N array designs within the Square Kilometer Array (SKA) program, calibration and processing are recognized as a substantial area of design risk and project cost. These issues play a particularly important role as a result of the science need for large field-of-view and high sensitivity, and diverse considerations that drive digitization much closer to the receptors in contemporary radio interferometer designs, making calibration and processing costs an increasingly dominant design and cost driver. It is expected that calibration and processing costs will be large enough to influence the overall cost optimization and thus will influence the diameter, D, and number of antennas, N, amongst other design parameters, in large-N array designs.

The design cost of calibration and imaging for large-N arrays is determined both by the computational scalability of post-processing algorithms to the large number of processor cores that will be required by the SKA telescope, the mapping of these algorithms to contemporary high-performance computing platforms and hardware architectures, the need for custom hardware accelerators, and the projected cost of these high-performance computing systems on the time-scale of SKA construction. We examine these considerations against the science goals of current SKA large-N designs.