



SKA1 Polarimetry Requirements

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The SKA Observatory is being designed to enable a variety of extremely challenging scientific goals to be achieved. A good summary of the scientific needs is given in the top-level Science Requirements [1]. Very high values of the spectral, polarisation and brightness dynamic range (quantities that are defined in that document) must be achieved to allow the science objectives to be realised. What this implies in practise is that even the longest integrations (as long as 1000 hours per pointing) must still achieve essentially the theoretical thermal noise level, and not be limited by other effects. This is a challenging goal and one that is particularly difficult to verify in advance within a design. Subtle systematic errors may only become apparent after ten, one hundred or even one thousand hours of integration time.

We have developed a parametric model that allows prediction of polarimetric image quality within observations of arbitrary length that is tied to the calibration precision of a small number of key parameters. The methodology is described in more detail in [2] and builds on the earlier work in this area published previously in [3]. Error budgets have been developed for both the SKA1-Low and SKA1-Mid telescopes which quantify the calibration requirements that must be met. These requirements are illustrated in Figure 1. Residual errors in the primary beam shape model, ϵ_Q , must be kept below about $10^{-3.5}$ (SKA1-Low) and 10^{-4} (SKA1-Mid) of the on-axis response. Similar requirements apply to the spectral modulation, ϵ_B , the field source modelling precision, ϵ_M , and the depth of source modelling within the primary beam side-lobes, ϵ_S . The most stringent requirements apply to unmodeled systematic (as distinct from random) pointing errors of the SKA1-Mid dishes, which must be kept below about 0.1 arcsec ($P_{\text{deg}} = 10^{-4.5}$) at GHz frequencies. Random pointing errors are required to be ≤ 1 arcsec RMS.

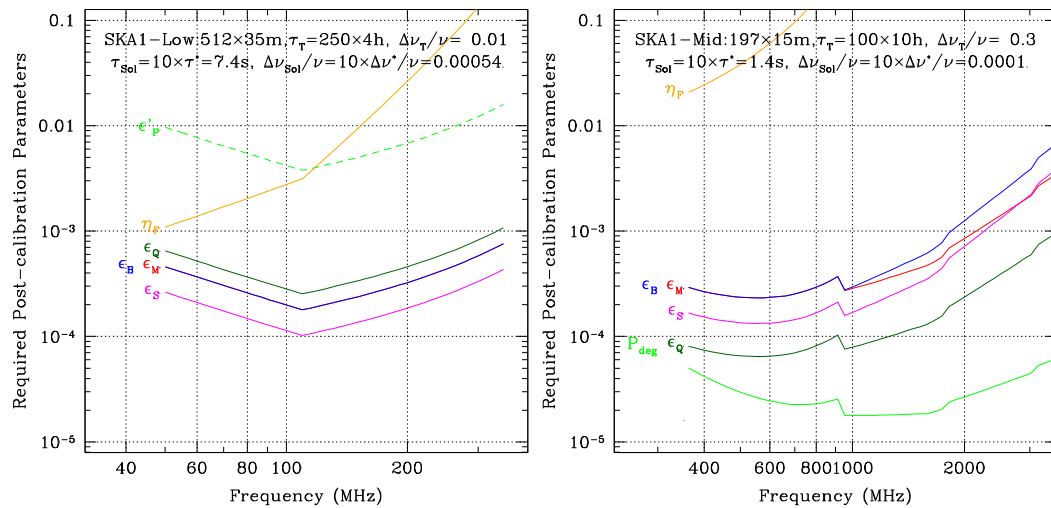


Figure 1. Requirements budget for a deep SKA1-Low spectral line (left) and SKA1-Mid broad-band continuum (right) observation as function of observing frequency. The various terms are colour coded and individually plotted. The thermal noise degradation, $\delta_N = 1.2$, is distributed equally over $n_V = 6$ random contributions.

1. R. Braun et al., “SKA1 Level 0 Science Requirements”, SKA-TEL-SKO-0000007-Rev02, 2015.
2. R. Braun et al., “SKA1 Error Budgets”, SKA-TEL-SKO-0000641, 2016.
2. R. Braun, “Understanding synthesis imaging dynamic range” A&A, 2013, 551, A91.