Exploring optimal sub-arraying strategies for MeerKAT-VLBI

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Abstract

MeerKAT is a South African radio interferometer that is the most sensitive in its class until the operation of the Square Kilometre Array mid-frequency (SKA1-mid) array. Like SKA1-mid, MeerKAT's receptors are configured in a dense core for sensitivity as well as more extended spiral arms to provide higher angular resolution. The inclusion of the MeerKAT array into global VLBI networks will add significant sensitivity to existing VLBI networks (see **Figure 1**), especially in the longest baselines of >7000 km and strengthen the role of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) through better sampling and higher sensitivity in this part of the uv-plane. MeerKAT-VLBI will also extend VLBI coverage in the southern hemisphere which will be expanded even further by the African VLBI Network (AVN). We aim to systematically explore the scientific, technical, and financial trade-offs of MeerKAT sub-arrays and commensal observations, which is ultimately aimed at maximising the scientific utility of both MeerKAT and the VLBI networks it forms part of.

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MeerKAT Time Allocation

- Large Survey Projects (LSP) – 67%
- Open Time (OT) – 28%
- No guaranteed time for VLBI as yet

MeerKAT Array Release 6 Backend Flexibility

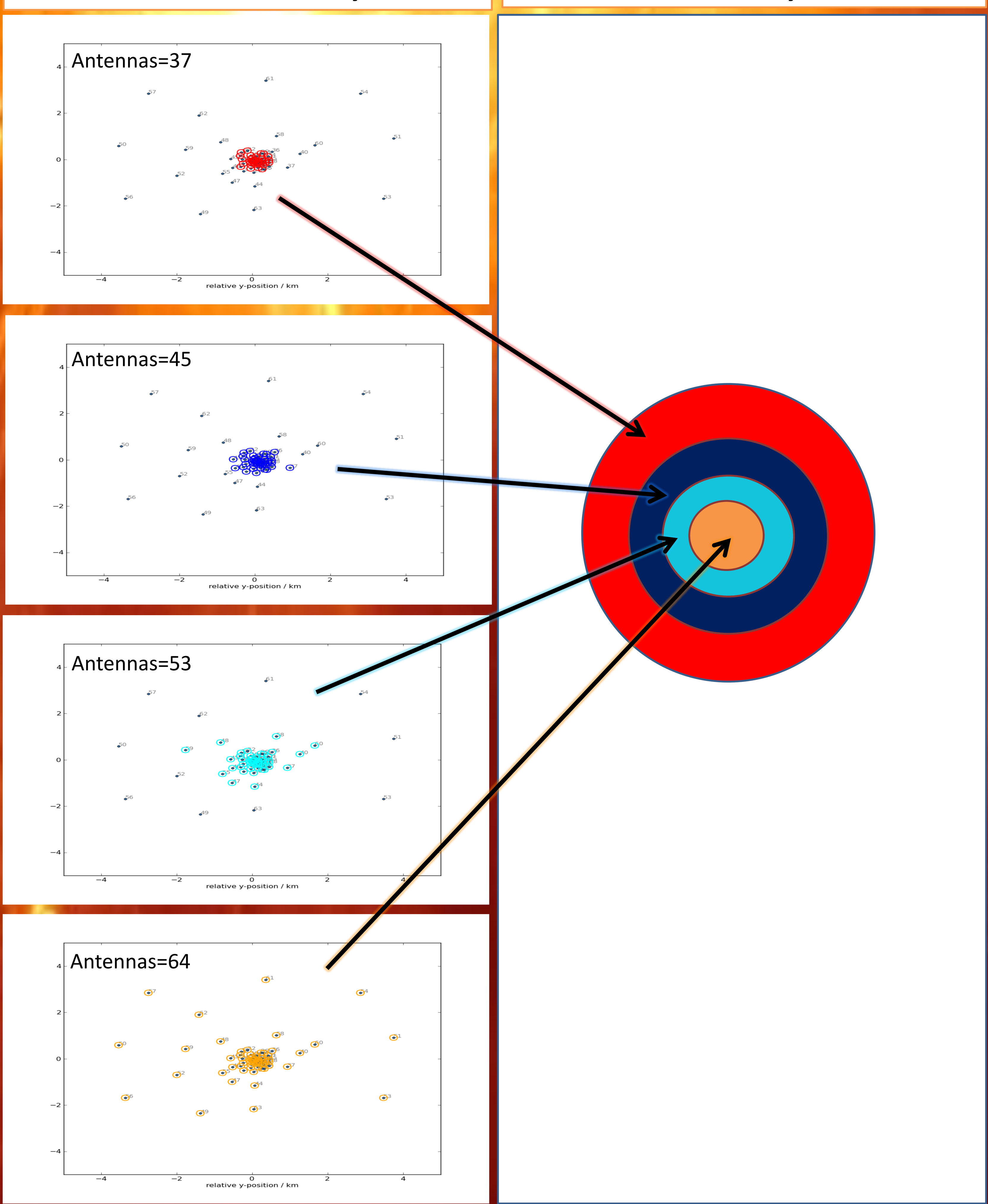
- MeerKAT's future ability to be split into sub-arrays and simultaneously generate interferometric and phased-array data products provides the opportunity to further increase its expected scientific output. This flexibility will be important for many science programmes, including VLBI experiments where a subset of antennas may potentially participate with the AVN, EVN and LBA.

Potential Observing Modes for MeerKAT-VLBI

- Dedicated MeerKAT-VLBI experiments in Open Time
- Commensal VLBI with LSPs and other Open Time projects
- **Sub-arraying potential in OT (focus of this project)**

- Through a suite of simulations of VLBI arrays including MeerKAT, as well as the stand-alone interferometric and phased up performance of MeerKAT with a range of imaging weights, this project will explore the potential of subarraying commensality in Open Time.

MeerKAT Subarray | **Phased Array FoV**



Enhancing the EVN with MeerKAT-VLBI

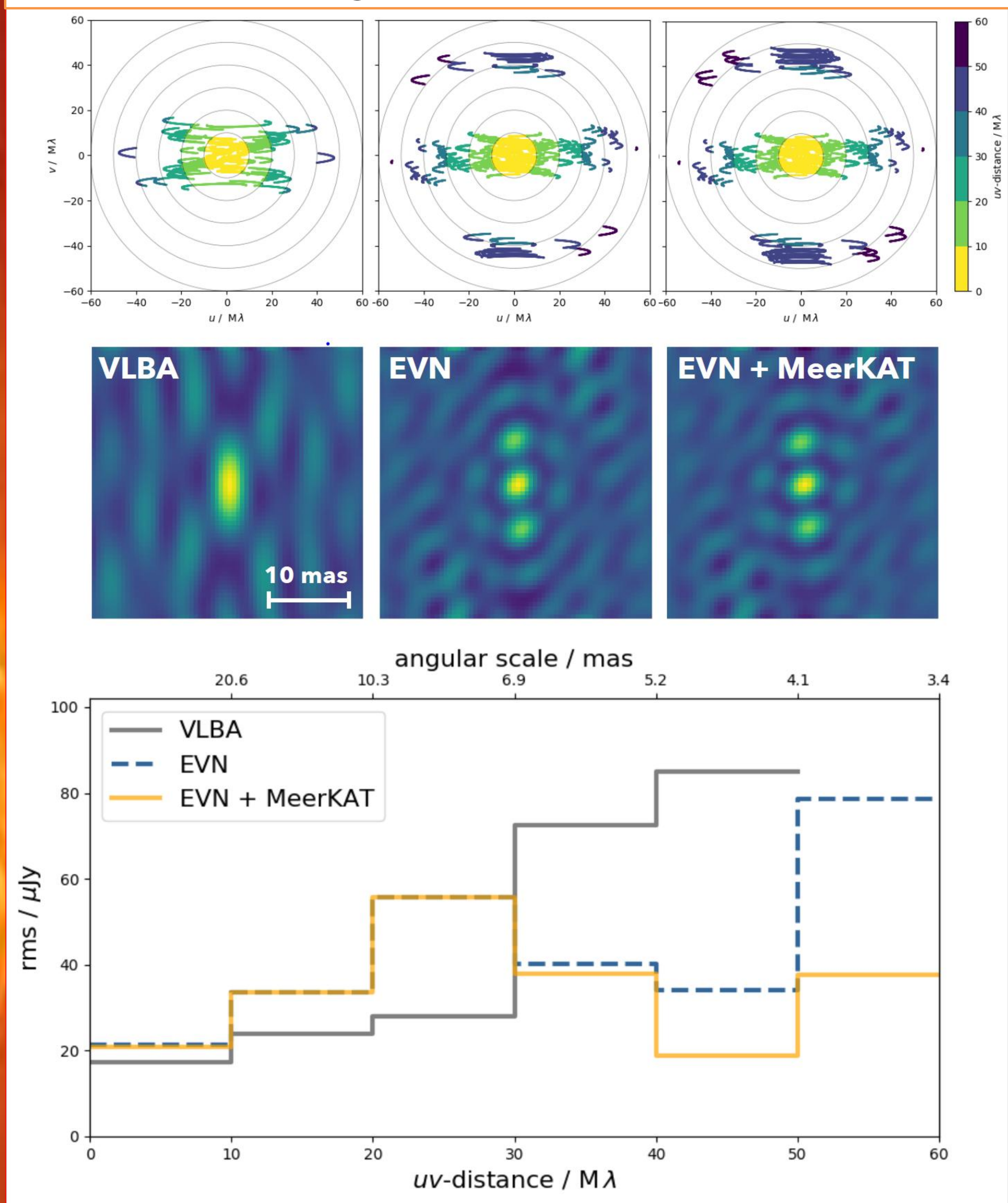


Figure 1: The image above shows a comparison of the VLBA, EVN, and EVN-MeerKAT performance. **Top panel:** Fourier coverage from a 24 hour track. **Middle Panel:** The resultant PSFs, each frame with extent 32 x 32 mas^2 and set to the same colour code. **Bottom Panel:** Sensitivity per *uv*-bin in 10 **λ** increments, demonstrating the major improvement in the ≥ 40 M **λ** spatial frequency range with the addition of MeerKAT.

Clear Potential for Commensality / Subarraying Observation with Pinched Core Configuration of MeerKAT

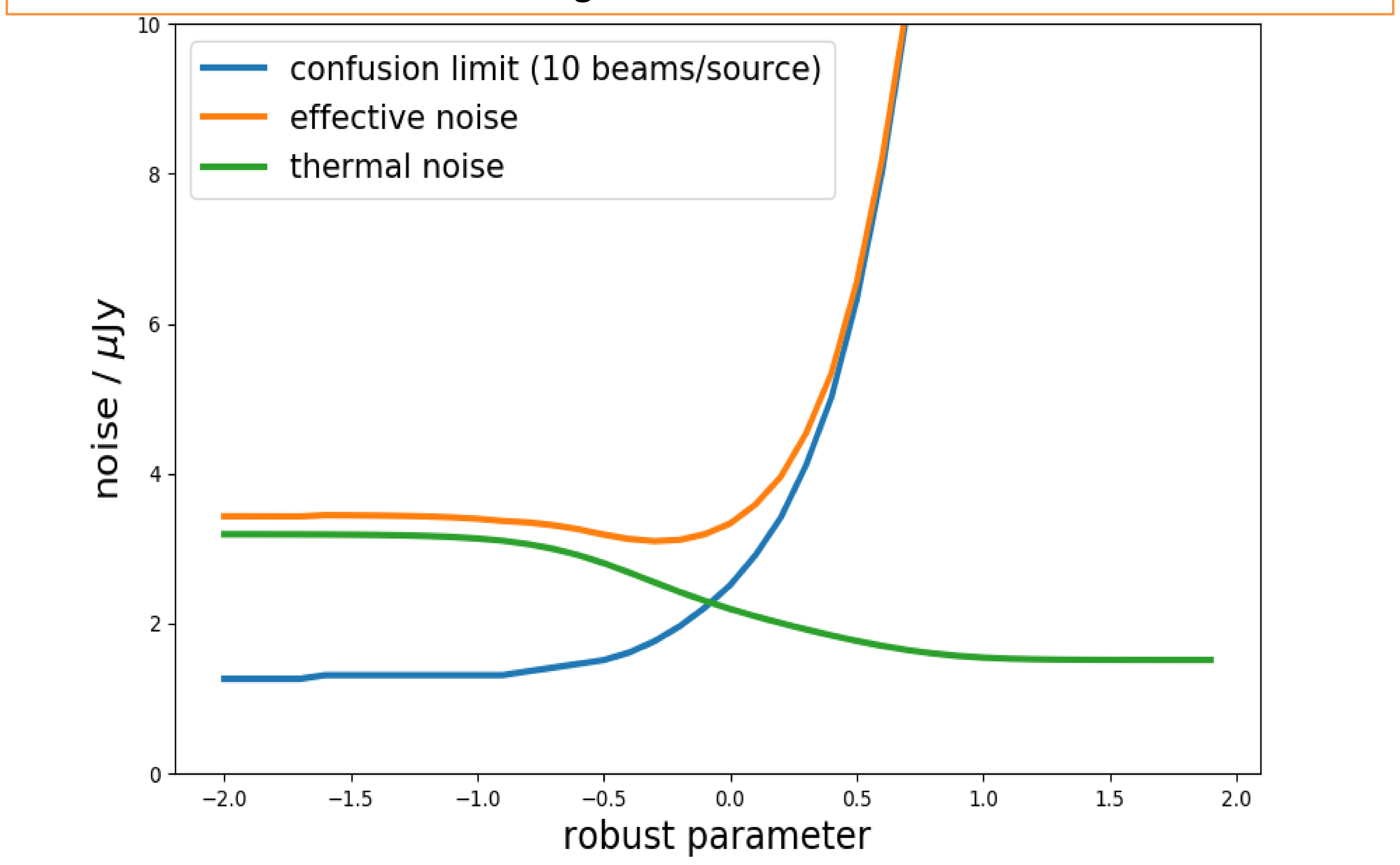


Figure 2: The plot shows how the thermal noise (given by the radiometer equation), confusion limit and effective noise [(thermal^2 + confusion^2)$^{1/2}$] changes with the robust parameter.