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Preparatory studies for the Africa Milimetre Telescope

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The Event Horizon Telescope (EHT) is a network of antennas across the globe currently used to image supermassive black holes (SMBHs) at a frequency of 230 GHz. Since the release of the image of M87*in 2019 and, subsequently, that of Sgr A* in 2022 by the EHT collaboration, the focus has shifted towards dynamically imaging SMBHs. This has led to a search for potential sites to extend and fill the gaps within the EHT network. The Gamsberg Mountain and the H.E.S.S. site are both located within the Khomas highlands and have been identified as potential sites for the Africa Millimetre Telescope (AMT). Precipitable water vapour (PWV) in the atmosphere is the primary source of opacity and noise from atmospheric emissions, when observing at millimetre to sub-millimetre wavelengths. This study aims to establish the PWV content and meteorological conditions at the potential sites of the AMT using Global Navigation Satellite System (GNSS) measurements. Using conservative specifications and potential dish sizes of 13, 14 and 15 m for the AMT, the System equivalent flux density (SEFD) and Signal to Noise ratio (S/N) to the reference stations ALMA and NOEMA were also assessed from simulated observations of M87*and Sgr A*. The EHT window PWV had a 25th percentile of 12.21 mm at the H.E.S.S. site and 7.54 mm at the Gamsberg Mountain. The simulated results of M87*and Sgr A* showed the 15 m and 14 m dishes at the Gamsberg Mountain to have the lowest SEFD, with the performance of the 13 m dish being slightly comparable to the 15 m dish at the H.E.S.S. site. For M87*and Sgr A* observations, the 13 m dish at Gamsberg Mountain achieved a higher average S/N output for the ALMA-AMT baseline than the 15 m dish at the H.E.S.S. site. For M87*, the S/N output from Gamsberg Mountain was higher for the NOEMA-AMT baseline, with the 13 m dish providing 41 additional minutes of S/N ≥ 4 compared to the 15 m dish at H.E.S.S. For Sgr A*, the AMT at Gamsberg Mountain achieved the highest S/N for the ALMA-AMT baseline, yielding an additional 1h32 of S/N ≥ 4 for the 13 m dish compared to the 15 m dish at the H.E.S.S. site. The PWV and simulation results indicate that the Gamsberg Mountain is the more suitable site for the AMT.

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