V139a Optical system design for the 22, 43 and 86 GHz simultaneous observations on the Tianma 65 m radio telescope

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Simultaneous multi-frequency VLBI observations above 22 GHz are gaining attention worldwide, including KVN (ST. Han et al. 2017) and SRT (A. Navarrini et al. 2022), for improving measurement accuracy, especially through using frequency phase transfer techniques, which enable correction of high-frequency phase fluctuations using low-frequency phase information. We present the optical system design developed in collaboration between Osaka Metropolitan Univ. and SHAO for the Tianma 65 m telescope, enabling simultaneous K (18–26 GHz), Q (33–50 GHz), and W (80–116 GHz) band observations.

The optical system employs two quasi-optical filters (Komoto et al. this ASJ) to separate the three bands. The mirror's focal lengths are optimized to achieve nearly collimated beams at the filter positions. Given the limited space of the dewar, the reflector size and Gaussian beam edge taper were carefully optimized using the quasi-optical equations to reduce the spillover at each reflector. Electromagnetic simulations, excluding mirror surface errors and sub-reflector blockage, yield aperture efficiencies of 71–84% for K-band, 71–85% for Q-band, and 77–80% for W-band. Further evaluation including the alignment tolerances is planned. And the three-band receiving system will be soon commissioned at Tianma telescope.