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Upgrades to the VLBI capabilities of the upgraded GMRT

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The upgraded GMRT (uGMRT) operates as an interferometer in the 100-1460 MHz frequency range with near-seamless frequency coverage. The upgrade resulted in wide instantaneous bandwidths, leading to improved sensitivity [1], while better time and frequency standards have enabled participation of uGMRT in Very Long Baseline Interferometry (VLBI) experiments. The GMRT can be used both in single dish mode as well as in tied array mode for VLBI observations. The latter provides a very high sensitivity facility for VLBI. Importantly, the unique geographical location of the GMRT allows it to add long baselines to VLBI arrays in Europe, east Asia, Australia and Africa. Initial test observations in 2022-2023 resulted in fringes at L-Band with EVN (Europe) and LBA (Australia), as well as the first VLBI image in conjunction with EVN, as has been reported earlier [2].

In the recent past, several significant improvements have been made to our VLBI capabilities, such as e.g. enhanced post-processing algorithms to translate GMRT's native observatory format baseband data to correlation-ready VDIF data through a series of signal processing steps, aided by GPU acceleration. Also there is now improved flexibility in extracting the desired frequency band from the native GMRT data to match VLBI requirements. In addition, several new VLBI test experiments have been successfully conducted, including (a) fringes between GMRT and Usuda-64m at 1450 MHz (see Figure 1), (b) fringes between GMRT and Ooty Radio Telescope (ORT, India) and Iitate (Japan) at 325 MHz, (c) several successful fringe detections routinely between GMRT and ORT. Details of the improvements to the instrumentation as well as the results from the fringe tests will be presented.

Looking to the future, with GMRT having frequency overlap with both SKA-Low and SKA-Mid, we have plans for active participation in VLBI in the SKA era. Further, with NCRA also expanding to higher frequencies by installing high-frequency antennas (1.5 to 10 GHz) at the GMRT observatory, the promise of enhancing VLBI capabilities from this unique geographical location is very bright. Some of these aspects will also be highlighted.

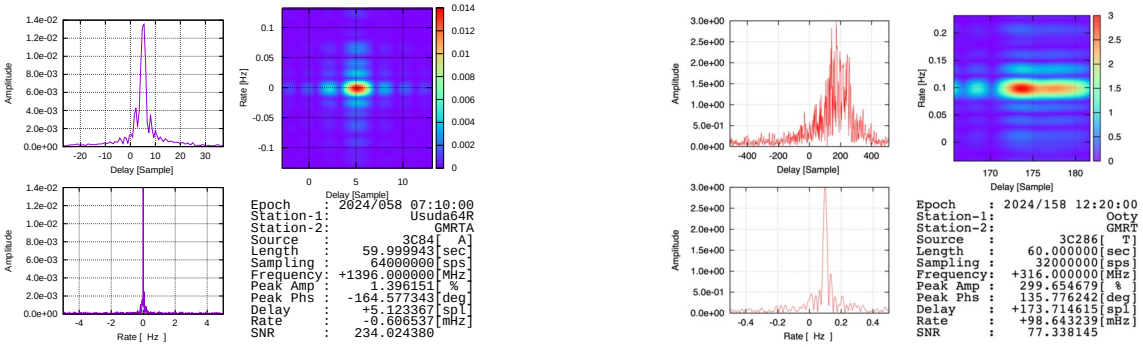

Figure 1. Successful fringe detection between the GMRT tied-array beamformer and (*left*) the Usuda-64 m (Japan) at 1450 MHz on 27-Feb-2024 and (*right*) ORT on 6-Jun-2024 at 325 MHz. *Courtesy: Kazuhiro Takefuji, JAXA.*

1. Y. Gupta, B. Ajithkumar, H. S. Kale, S. Nayak, S. Sabapathy, S. Sureshkumar, R. V. Swami, J. N. Chengalur, S. K. Ghosh, C. H. Ishwara-Chandra, B. C. Joshi, N. Kanekar, D. V. Lal and S. Roy, "The upgraded GMRT: opening new windows on the radio Universe", *Current Science*, **113**, August 2017, pp. 707–714, doi: 10.18520/cs/v113/i04/707-714.

2. V. R. Marthi, P. Kharb, H. Reddy, S. Kudale, S. Choudhari, P. Hande, A. Kumar and Y. Gupta, "Enabling VLBI for the upgraded GMRT", *Proceedings of URSI GASS 2023, Sapporo, Japan*, 19-26 August 2023, doi: 10.46620/URSIGASS.2023.2931.NOZP1545.