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Experimental VLBI with NCRA-15m Antenna, GMRT and ORT

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Abstract

VLBI achieves high angular resolution by linking radio telescopes separated by vast distances. We explore the potential of obtaining interferometric fringes on extended baselines, utilizing the NCRA-15m antenna and the GMRT array at L-Band, as well as the Ooty Radio Telescope and the GMRT at 325 MHz. The NCRA-15m - GMRT 80-km baseline results in an angular resolution of about 0.6", while the 1000-km GMRT-ORT enables an angular resolution of ~ 0.25". Since the ORT-GMRT baseline is oriented roughly north-south, the greatest east-west projection is approximately 285 km at transit. Both the GMRT-ORT as well as GMRT-NCRA baselines are of intermediate length, and could provide an important measurement at sub-arcsecond scales, which is a sweet spot between the 2" (1400 MHz) /10" (325 MHz) resolution of the GMRT and the few-milli-arcsecond resolutions of intercontinental VLBI.

Typically, VLBI stations use independent time and frequency standards. Therefore, the phase stability of the reference standard is crucial. The GMRT and Ooty Radio Telescope use atomic Hydrogen Masers (AHM) as their frequency standards, while the NCRA-15m antenna uses an Oven-controlled Crystal Oscillator (OCXO). All stations utilize GPS-disciplined Rubidium standards for clock references. We characterize the relative stability of the standards between NCRA-15m and GMRT to estimate the duration over which coherence can be maintained. We measure a relative sampling clock drift of ~ 17 ns/hr, believed mostly to be contributed by the frequency drift and phase noise of the OCXO. This constrains the longest stretch of observations between GMRT and NCRA-15m to a few minutes to ensure coherence. Additionally, we have measured the clock offsets and implemented the clock correction at NCRA-15m.

We are in the process of correlating the experimental signals between GMRT and NCRA-15m as well as between GMRT and ORT. Achieving the first fringe detections will help us resolve some of the unknown delays and offsets, and we will repeat these tests to better characterize the systematic effects.

Keywords: VLBI, Frequency standard, Phase stability.