EGU2009-5608 Development of a Compact VLBI System for Providing over 10-km Baseline Calibration and Its Implications to Geodesy and Precise Time Transfer

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ABSTRACT

We are developing a compact VLBI system with 1.6 m diameter aperture dish in order to provide reference baseline lengths for calibration. The reference baselines are used to validate surveying instruments such as GPS and EDM and maintained by the Geographical Survey Institute (GSI) of Japan. The compact VLBI system will be installed at both ends of the reference baseline. However, it is too insensitive to detect fringe between both stations using such compact dish. Thus, we have designed a new observation concept including one large dish station into the baseline observation.

We can detect two group delays between each compact VLBI system and the large dish station based on conventional VLBI measurement. A group delay between the two compact dishes can be indirectly calculated using a simple equation. We named the idea 'Multiple Antenna Radio-interferometry of Baseline Length Evaluation (MARBLE)' system (Figure 1). The compact VLBI system is designed to be assembled with muscle power simply in order to perform short-term (about one week) measurements at several reference baselines in Japan islands (Figure 2). The compact VLBI system is also capable to be used as a fiducial station of a local geodetic observation network at remote locations.

We have evaluated a front-end system with a wide-band quad-ridged horn antenna (QRHA) by installing it on the 2.4 m diameter dish at Kashima (Figure 3). We are developing this new front-end system based on VLBI2010 concept. The 2.4 m VLBI station is operated in order to test equipments which will be planed to install on the compact VLBI system. On December 5 of 2007, we have successfully detected first fringes of the 3C84 signal for S/X band using the new front-end system. Moreover, we have succeeded to perform two geodetic VLBI experiments on 54 km baseline between the 2.4 m dish equipped with the QRHA and the Tsukuba 32 m station of GSI. The results of determined baseline length between the 2.4 m station and Tsukuba 32 m station are almost identical with the previous results which are used by X-band feed only on the 2.4 m dish (Figure 4). On the other hand, the formal error of recent results are slightly worse due to low signal-to-noise ratio (SNR) of signal fringes caused by low aperture efficiency of the antenna.

On December 9, 2008, we installed the new 1.6m compact VLBI system on the top of the building nearby the Kashima 34 m antenna (Figure 5). The new 1.6 m dish is optimized for the new front-end (Figure 6). We have successfully detected the first fringe between the new 1.6 m dish and Kashima 34 m (Figure 7). At present, we are now developing the second compact VLBI system to realize the MARBLE concept. In this fiscal year, we have a plan to perform the first geodetic VLBI experiment using the two compact VLBI system with the Tsukuba 32 m of Geographical Survey Institute (GSI). In addition, we are now planning to use the system into the accurate time and frequency comparison between a separated locations (Figure 8).

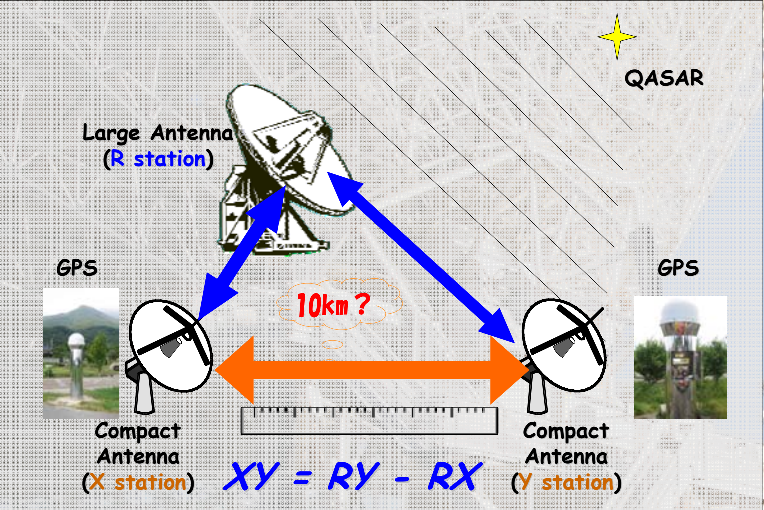


Figure 1 The MARBLE (Multiple Antenna Radio-interferometry of Baseline Length Evaluation) system.

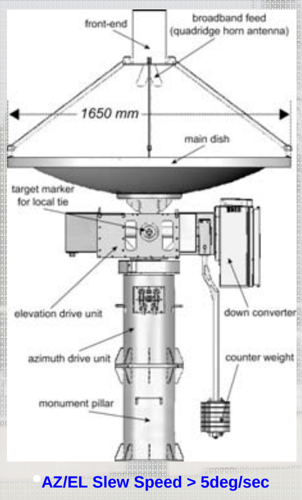


Figure 2 Schematic image of the MARBLE compact VLBI system.

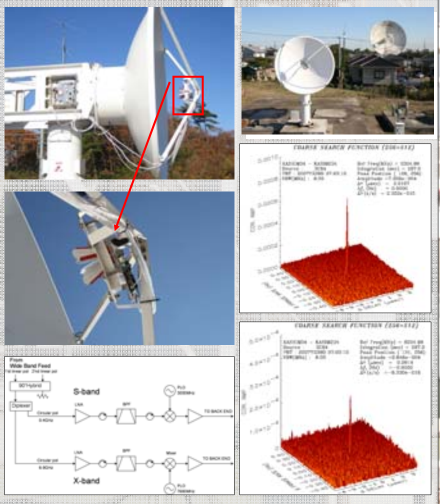


Figure 3 2.4 m antenna test-bed for developing the new front-end system using a broadband dual-polarized quad-ridge horn antenna (type 3164-05 ranging 2 GHz - 18 GHz) made by ETS-Lindgren.

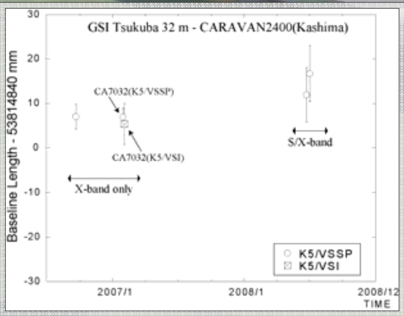


Figure 4 Geodetic VLBI experiments using 2.4 m dish for evaluating the new front-end system

Figure 5 Installation of a first prototype of the compact VLBI system on the top of the 34 m antenna building on December 9, 2008 at Kashima.

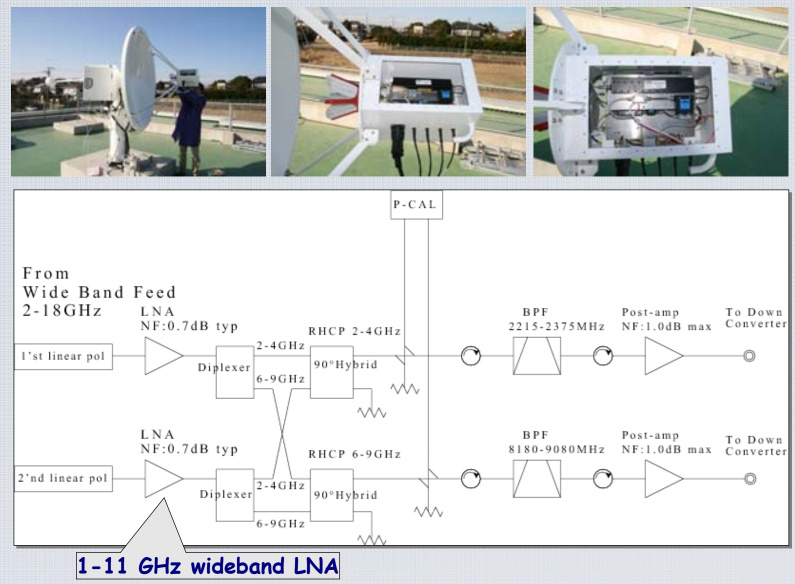


Figure 6 Modified front-end using a wideband LNA was equipped on the first prototype of the compact VLBI system.

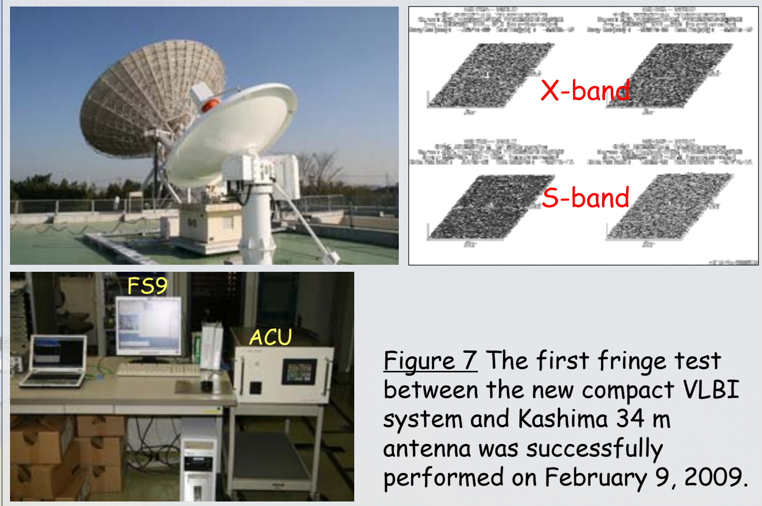
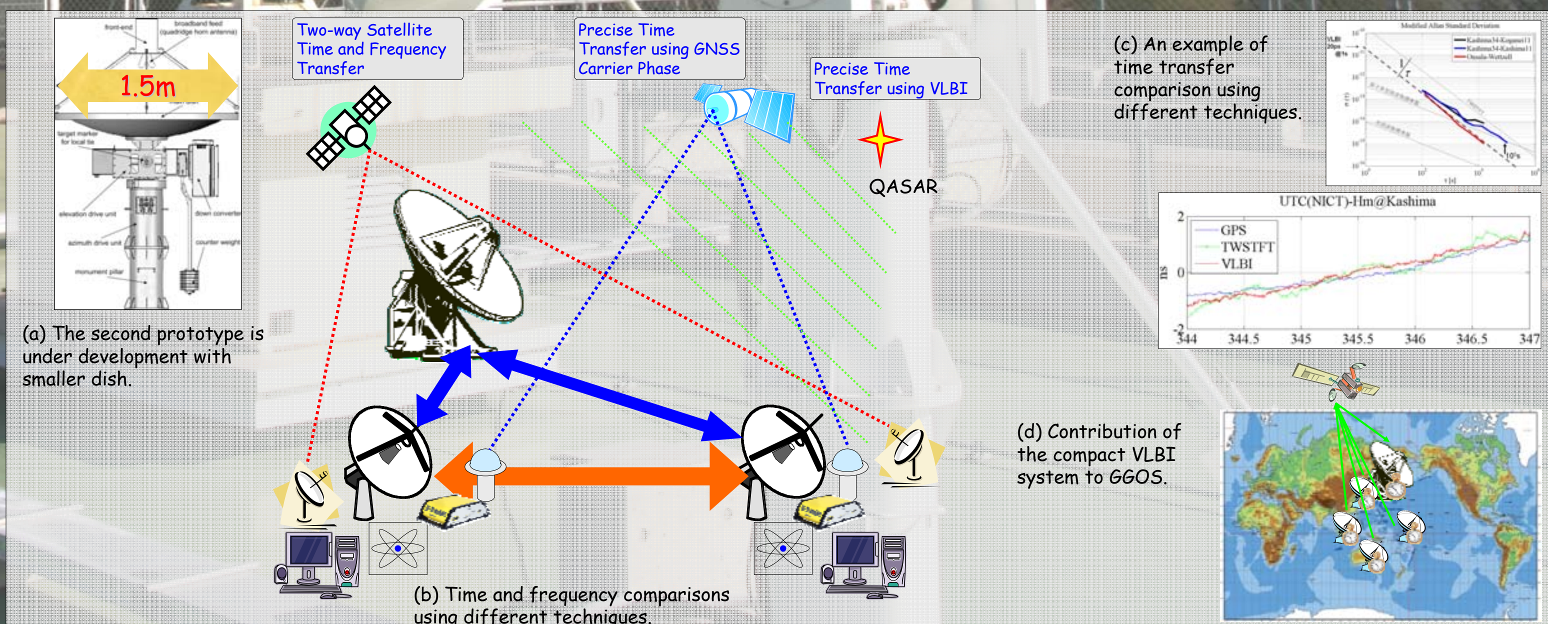


Figure 7 The first fringe test between the new compact VLBI system and Kashima 34 m antenna was successfully performed on February 9, 2009.



(a) The second prototype is under development with smaller dish.

(b) Time and frequency comparisons using different techniques.

(c) An example of time transfer comparison using different techniques.

(d) Contribution of the compact VLBI system to GGOS.

Figure 8 Plan of the accurate time and frequency comparison experiments between separated compact antennas.