

Italy INAF Analysis Center

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Abstract This report summarizes the activity of the Italian INAF VLBI Analysis Center. Our Analysis Center is located in Bologna, Italy and belongs to the Institute of Radio Astronomy (IRA), which is part of the National Institute of Astrophysics (INAF). IRA runs the observatories of Medicina and Noto, where two 32-m identical VLBI AZ-EL telescopes are located. This report contains the AC's VLBI data analysis activities and illustrates the latest experiments, involving the Italian antennas and correlator, carried out in the last two years.

1 Current Status and Activity

Following the installation of the software correlator DiFX in 2012 at Bologna, there have been a number of experiments to test the correlation pipeline for geodesy. These VLBI experiments were performed mainly on a single baseline, Medicina–Noto, and subsequently extended to Matera after seeking a collaboration with ASI, which manages the antenna facility. The VITA (ITALian VLBI network) project has been launched as a national pilot project, obtaining observing time at the stations. We have obtained first successful fringes on the three baselines in April 2015 and carried out eight 24-hour experiments until the end of 2020.

In these last years the group has been involved in the LIFT (Italian Link for Frequency and Time) project in collaboration with INRIM (National Insti-

tute of Metrology), which set up a distributed time and frequency optical link at Medicina. VLBI tests in a geodetic setup were performed, to verify the accuracy and reliability of their solution compared to standard maser clock timing in use at the antenna. After the first VLBI experiment, during EUR137 in 2015, VITA experiments have been set up to try to solve the issues raised after the first tests. There have been updates to the INRIM system at Medicina, so the infrastructure has become much more reliable. A detailed description of the optical fiber link is provided in [1, 2]. Results from this test have been published in [3].

On November 2018, the Matera antenna was connected to the distributed time and frequency link, thanks to the newly founded MeTGeSp (Metrology for Geodesy and Space) project. The link serves the Milan financial district, the Medicina observatory, the Italian Laboratory for Non-linear Spectroscopy (LENS) in Florence, the Telespazio Facility in the Fucino Plain, where one of the main stations of the European Galileo satellite network for global navigation is located, and the National Institute of Optics in Pozzuli, to reach finally the Matera fundamental geodetic station. In May 2019 the first common-clock geodetic VLBI experiment was carried out involving, besides Medicina and Matera, the Onsala and Yebes antennas. Data were successfully correlated, and a consistent solution was found. The best fit estimation of the clocks' parameters showed that, within the uncertainty, no difference is appreciable between the two clock signals delivered at Medicina and Matera [4].

Moreover, a new type of experiment (Timing VLBI) has been carried out with the aim of comparing the synchronicity of atomic clocks located at Italian and European stations by means of the interferometric phase rms noise statistics. VLBI clock timing should

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IVS 2019+2020 Biennial Report

be a valid alternative to satellite-based techniques such as Global Navigation Satellite System or Two-Way Satellite Time and Frequency Transfer. First results have been presented at the 2019 EVGA Meeting [5].

At the end of 2020 a new series of observations (geodetic and VT experiments with the optical link on/off) have been carried out, and the data is being analyzed.

The presence of the LIFT infrastructure linking Medicina to Turin, where an optical clock has been developed, allowed the installation of a Japanese small antenna (NICT's Marble 2.4-m antenna) with the aim of comparing optical clocks at the intercontinental scale via VLBI. Broadband VLBI observations between Medicina and the other Marble antenna located in Koganei, in conjunction with the Kashima 34-m antenna, were carried out between October 2018 and February 2019 [6]. INAF contributed to the VLBI solution that was used for successfully comparing the IT-Yb1 optical lattice clock (Turin) to the NICT-Sr1 optical lattice clock (Koganei) [7].

2 Data Analysis and Results

The IRA started to analyze VLBI geodetic databases in 1989, using the CALC/SOLVE package on an HP workstation first located at the Medicina observatory and later at the Bologna headquarters. Since 2007, Linux workstations have been set up for the migration of all of the VLBI data analysis, and Mark 5 Calc/Solve has been installed. During the last years, our Analysis Center had some internal problems, and we did not participate regularly in IVS activities. However, we continued to update the catalog, and we installed and tested the latest releases of CALC/SOLVE and vSolve.

References

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