PMD Analysis Center 2013 Annual Report

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Abstract This report summarizes the activities of the *Politecnico di Milano* (PMD) IVS Analysis Center during the year 2013 and outlines the planned aspects of work for 2014. The main focuses in 2013 were in the framework of the IAG WG 1.4.2 on *Co-location on Earth and in Space for the determination of the Celestial Reference Frame*. Studies carried out concern e.g. simulations for some European VLBI antennas performed to investigate if the VLBI phase referencing technique can be used for precise determination of GNSS state vectors. Furthermore, investigations into possible deformations introduced by the change to ICRF2 [1] were also made for the processing of 24-hour observational sessions.

Fig. 1 2013 marked the 150^{th} year of the establishment of the *Politecnico di Milano*.

Fig. 2 People celebrating the 150^{th} anniversary of the *Politecnico di Milano*.

1 General Information

Throughout 2013, Milan University of Technology (Politecnico di Milano) celebrated the 150^{th} anniversary of its establishment with several events, see Figure 1 and Figure 2; some of these events are listed in [2].

The department, supporting activities of the PMD IVS Analysis Center, changed since January 2013. The new one is called Department of Civil and Environmental Engineering (DICA) [3]. Therefore the name of the Analysis center PMD stands for Politecnico di Milano Dica now. This new department belongs, like the previous one (called Diiar), to Milan University of Technology. It deals with plentiful research areas in civil and environmental engineering, enhancing an integrated approach among them.

Politecnico di Milano, Department of Civil and Environmental Engineering (DICA), Geodesy and Geomatic area

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The research area called Geodesy and Geomatic hosts and operates the PMD IVS AC and IGeS (International Geoid Service), an official Service of the International Association of Geodesy (IAG), see [4]. PMD started officially its activity in October 2010 [5]. DICA supplies hardware equipment, software licenses and assistance, and the personnel necessary to manage it.

2 Staff

During 2013, the following persons contributed to the PMD activity:

1. Vincenza Tornatore — team coordinator, project developer, data analysis;
2. Cinzia Vajani — software maintenance;
3. Daniele Passoni — data processing.

3 Current Status and Activities

During 2013, the main activities developed by the PMD IVS Analysis Center were addressed to studying if the observing technique called *phase referencing* (largely used for high precision VLBI astrometry, see e.g. [6] and [7]) could be applied to observing GNSS satellites with the aim of improving the precision of the determination of the satellite state vector and of obtaining satellite positions directly in ICRF. It is well known that the strong power emitted by the satellites compared to the very low emission of natural radio sources (calibrators) could represent a limiting factor, because the satellite signal can be easily detected through near sidelobes when observing, at the same satellite frequency, the natural calibrator in the main beam.

To get an indication of this problem, some preliminary investigations were carried out. We ran some simulations, in collaboration with the University of Milan (Physics Department), using GRASP (General Reflector antenna Analysis Software Package) v.10, to assess the relative power contribution of satellites in the near sidelobes when observing in L-band a natural calibrator in the main beam. For each examined station, we evaluated the minimum angular distance between the satellite and the calibrator to avoid near-sidelobe stray-light contamination from the satellite emission when the calibrator is tracked.

Three European VLBI antennas, Medicina, Noto and Onsala85, were considered. All three antennas have a Cassegrain configuration with a parabolic primary dish and a hyperbolic secondary dish. The L-band receiver is mounted at the primary focus only at Medicina, while for Noto and Onsala85 it is at the secondary focus. Figure 3 shows the GRASP 3D model of the optics of the three antennas, while the corresponding beam patterns are shown in Figure 4.

Detailed results and discussions on this work have been published in [8]. To briefly summarize, we can write that the key role in avoiding calibrator signal contamination due to a strong satellite signal seems to be played by the telescope optical configuration, with better results obtained for Medicina (with the L-band receiver at the primary focus), than for Noto and Onsala85 (with the L-band receiver at the secondary focus).

During 2013, another subject tackled by PMD AC concerned investigations into possible deformations introduced by the change to ICRF2. In tight collaboration with the VIE IVS Analysis Center and the PUL IVS AC, 27 years of suitable VLBI experiments, measured in 24-hour sessions, were analyzed. The starting year was 1984. IERS (International Earth Rotation and Reference Systems Service) [9] and IVS conventions on VLBI data [10] were followed in the data processing. Session-wise solutions were computed with the Vienna VLBI Software VieVS [11]. Results are going to be published, after an in-depth analysis and complementary studies are completed.

4 Future Plans

In 2014, the work of the PMD Analysis Center will focus on the following aspects:

- Co-location on Earth and in Space for the determination of the Celestial Reference Frame.
- Investigation into dedicated algorithms for tropospheric parameter estimation, particularly addressed to a territory not very broad, such as the Italian region.
- Continuation of investigations into ICRF2.

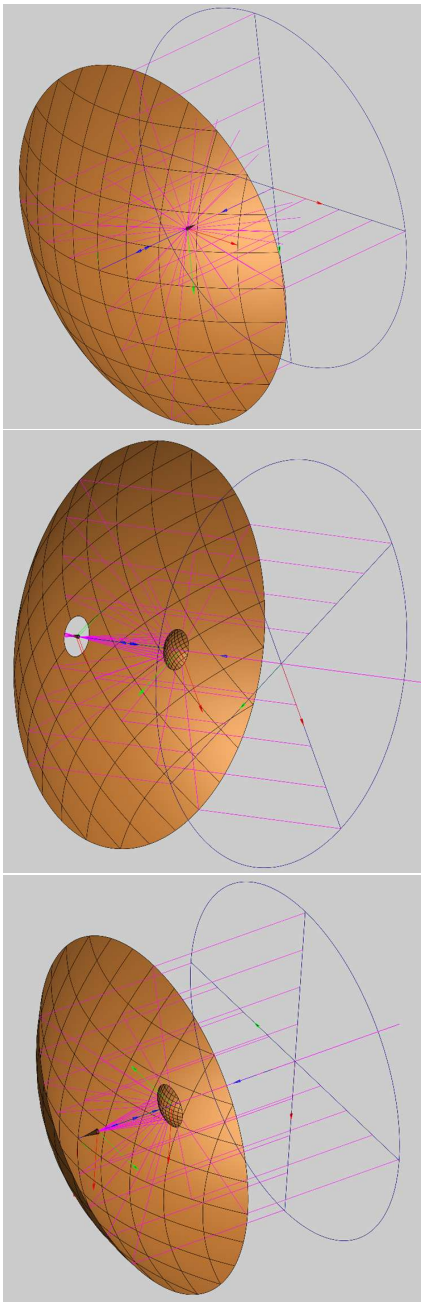

Fig. 3 VLBI radio telescope optics simulated with GRASP, in the order from top to bottom: Medicina, Noto, and Onsala85.

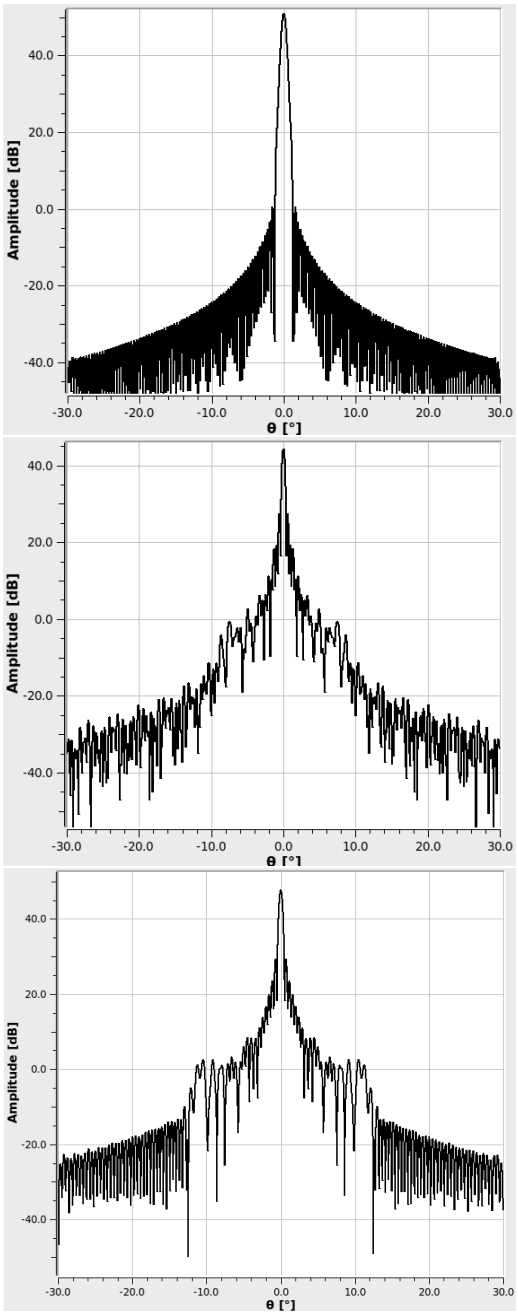

Fig. 4 VLBI radio telescope optics simulated with GRASP, in the order from top to bottom: Medicina, Noto, and Onsala85.

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