Onsala Space Observatory – IVS Technology Development Center

Rüdiger Haas, Leif Helldner, Miroslav Pantaleev, Johan Löfgren, Gunnar Elgered

Abstract

This report summarizes the technical development related to the geodetic VLBI activities that were performed at the Onsala Space Observatory during 2008. Most of the tasks planned for the year were addressed, and some new tasks were initiated. The focus was on: (1) tests of an analog fiber link for the transfer of VLBI IF-signals, (2) a contribution to the project to develop a dual-polarized broadband Eleven feed for VLBI2010, (3) the superconducting gravimeter, and (4) the development of a GNSS-based tide gauge.

1. Test of Analog Fiber for Transfer of VLBI IF-signals

For test purposes an analog fiber link between the receiver in the telescope cabin of the 20 m telescope and the IF-distribution in the VLBI-rack in the control room was installed. Several tests to characterize the fiber link were performed. This included static measurements of attenuation versus frequency and dynamic tests to investigate amplitude and phase variations in the fiber as a function of telescope orientation. Figure 1 shows as an example of phase variations as a function of telescope azimuth and elevation angle, for both the analog fiber and the coaxial cable that is normally used for VLBI. The comparison shows that the analog fiber is more robust with respect to mechanical influences due to telescope motion than the coaxial cable. However, the measurements also showed that the fiber has a temperature dependence that needs to be calibrated. Thus, a calibration device has to be developed before the analog fiber can be used routinely in VLBI observations.

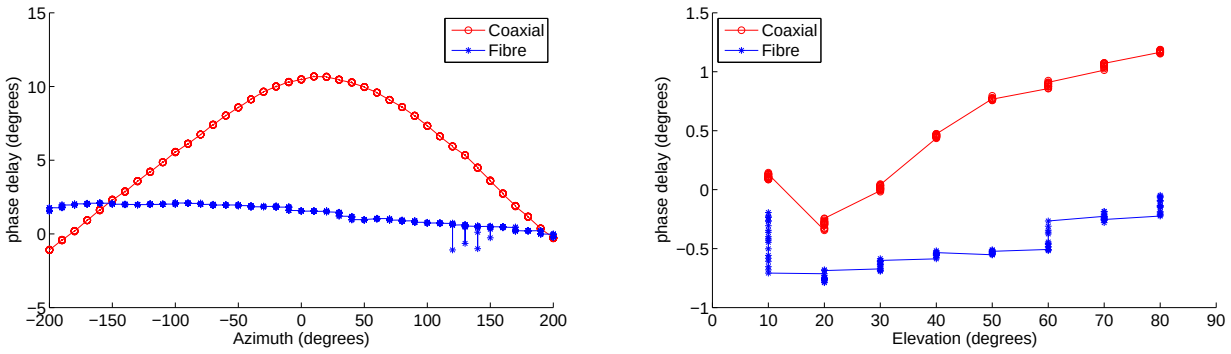

Figure 1. Phase variations as a function of telescope orientation: versus azimuth (left) and versus elevation (right). Red circles show the phase delays for the present coaxial cable, and blue stars represent the results for the analog fiber.

2. Mechanical and Thermal Design of an Eleven Feed for VLBI2010

The collaboration with the Antenna Group at the Chalmers University of Technology was intensified during 2008. The intention is to provide the mechanical and thermal design of a prototype for a cooled version of an Eleven Feed [1] that can be used for VLBI2010. The current electrical design covers the frequency range between 2 and 14 GHz. The project includes the mechanical design of the miniature power combiners and impedance transformers located at the center of the antenna and their interface to the low-noise amplifiers. Figure 2 shows examples of the mechanical design and the thermal analysis of Eleven Feed prototypes for VLBI2010. The diameter of the prototype feeds is about 18 cm.

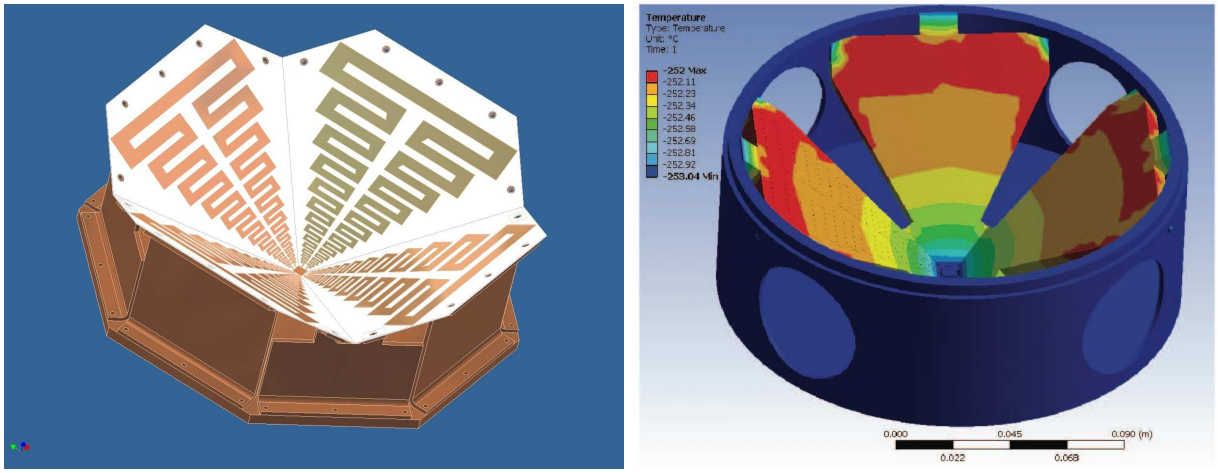

Figure 2. Left: mechanical design of a prototype for an Eleven Feed for VLBI2010. Right: thermal analysis showing the temperature distribution of the feed installed in 20 K cryostat. There is a temperature gradient of about 1 degree Celsius between the center of the feed (coldest) and the outer parts of the feed.

3. The Superconducting Gravimeter at Onsala

The construction plans for the measurement cabin of the new gravimeter had to be revised in order to minimize disturbing influences on the instrument and to reduce the amount of necessary ground work. A final construction plan was selected in the summer, and the start of the construction work was postponed until early 2009. The superconducting gravimeter was delivered to Onsala in August.

4. Development of a GNSS-based Tide Gauge

During 2008 a project was initiated to measure the local sea level and its variations using GNSS signals. The plan is to install a dual GNSS antenna assembly at the Onsala Space Observatory, one unit directed upward and the other one opposite toward the sea surface. The upward looking antenna is sensitive for right circularly polarized GNSS signals (the usual direction), while the downward looking antenna is sensitive for left circularly polarized GNSS signals. Thus, GNSS

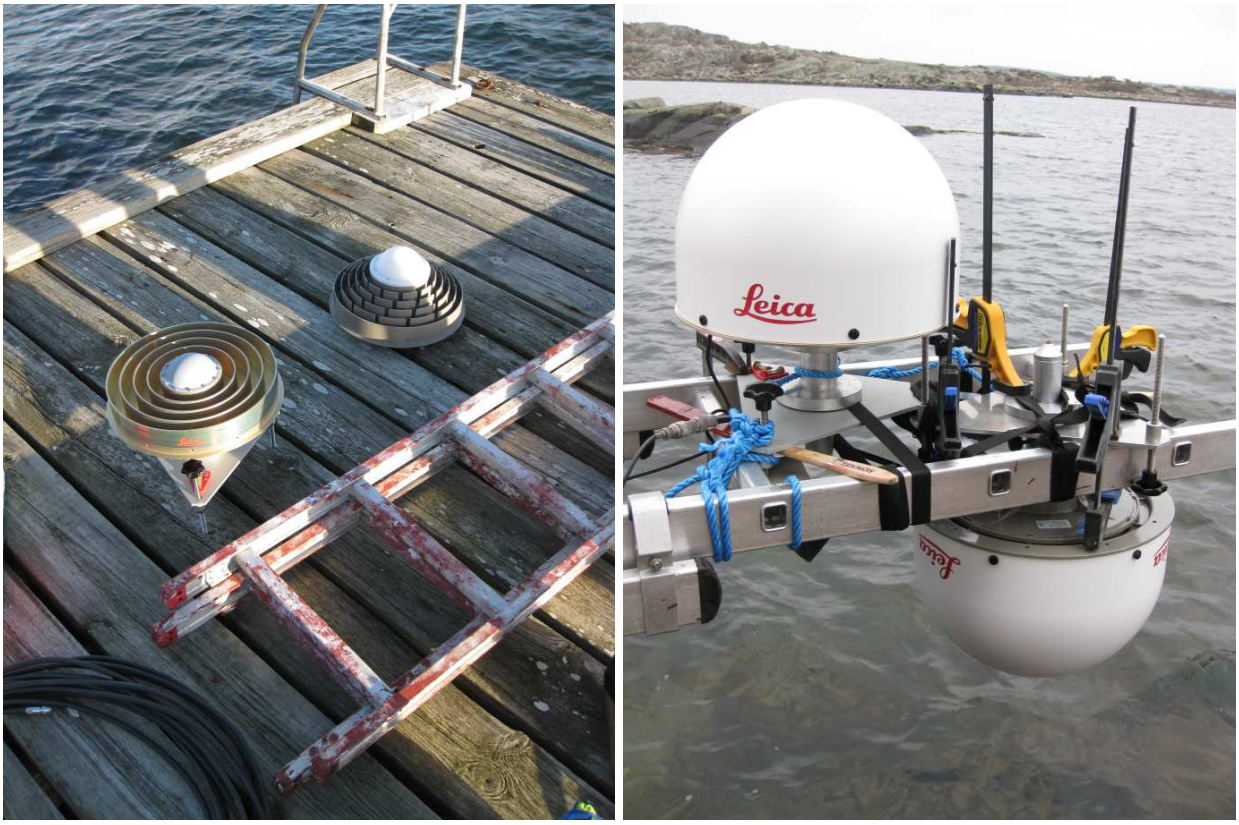

Figure 3. Left: the pair of GNSS antennas used for the GNSS tide gauge project. Right: experimental installation of the pair of upward and downward looking GNSS antennas, now equipped with protecting radomes.

signals from the same satellite are received arriving both directly and after reflection in the sea surface. The analysis of phase measurements performed with the corresponding GNSS receivers will estimate surface height and its variation. The first tests were performed in late 2008. Figure 3 shows the pair of GNSS antennas and their experimental test installation.

5. The Microwave Radiometers at Onsala

The microwave radiometer Astrid [2] performed reasonably well during 2008. There were only short periods with problems that were quickly fixed. The data transfer to a processing computer was automated, and a quick-look data analysis is done in an automated fashion. Data sets with a length of 24 hours are analyzed automatically, and the corresponding results are created and plotted automatically. This makes it easier to detect possible problems early.

Our second microwave radiometer Konrad [3] was, however, out of order for almost the whole year due to problems with its azimuth and elevation drives. An attempt to repair Konrad and perform observations at least during CONT08 failed. Konrad was activated for a short time, but the azimuth and elevation drives unfortunately failed for most of the CONT08 sessions. We are

considering carrying out a thorough repair and partial exchange of the drive system during 2009.

6. Outlook and Future Plans

- During 2009 we will continue to contribute to the development of a prototype for an Eleven feed for VLBI2010.
- We will install the GNSS-based tide gauge at the Onsala Space Observatory and develop an automated data flow and analysis.
- The new gravimeter house will be completed, and the superconducting gravimeter will be installed during 2009. We will also install various sensors to monitor environmental parameters such as ground water.
- We will try to develop the possibility of reading important parameters of the S/X-receiver directly with the FS.
- We will focus on an upgrade of the azimuth and elevation drives of the Konrad radiometer.
- We plan to equip the time-lab with a Cesium clock, and, in collaboration with the SP Technical Research Institute of Sweden, we plan to develop a time synchronization system via optical fiber.

References

[1] Olsson, R., Kildal, P.-S., and Weinreb, S.: The Eleven Antenna: A Compact Low-Profile Decade Bandwidth Dual Polarized Feed for Reflector Antennas, *IEEE Trans. Antennas and Propagation*, **54(2)**, 368–375, 2006.

[2] Elgered, G., and Jarlemark, P.O.J.: Ground-Based Microwave Radiometry and Long-Term Observations of Atmospheric Water Vapor, *Radio Science*, **33**, 707–717, 1998.

[3] Stoew, B., and Rieck, C.: Dual Channel Water Vapour Radiometer Development. In: W. Schlüter and H. Hase (Eds.): *Proceedings of the 13th Working Meeting on European VLBI for Geodesy and Astrometry*, 261–264, 1999.