Metsähovi Radio Observatory Network Station 2013 Annual Report

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Abstract In 2013, Metsähovi Radio Observatory, together with Finnish Geodetic Institute, observed seven IVS sessions, five T2 sessions, and two EUROPE sessions. Old analog BBCs and Mark 5A were retired during the year, and were replaced by a DBBC and a Mark 5B+. In September, Metsähovi participated in a 4 Gbps e-VLBI demo with a FlexBuff recorder and vlbi_streamer software that were both developed at the site. Both worked perfectly. A new axis offset for the antenna was calculated.

1 General Information

Aalto University Metsähovi Radio Observatory and Finnish Geodetic Institute (FGI) are two separate institutes which together form the Metsähovi IVS Network Station. Metsähovi Radio Observatory operates a 13.7 meter radio telescope on the premises of Aalto University at Metsähovi, Kylmälä, Finland, about 35 km from the university campus. In the same area near Metsähovi Radio Observatory, there is the Metsähovi Fundamental Geodetic Station of FGI.

2 Component Description

The Metsähovi Radio Observatory has been operational since 1974. The telescope was upgraded between 1992-1994. The radome was replaced with a new one, and new surface panels were installed. Metsähovi and FGI began observing IVS T2 sessions and EUROPE sessions in 2004. Approximately six to eight sessions are observed per year. The surface accuracy of the present telescope is 0.1 mm (rms). The speed of the Metsähovi antenna is 1.2 degrees per second.

Metsähovi is known for its long-term quasar monitoring. Astronomical VLBI observations are carried out with the 22 GHz receiver. The geodetic VLBI receiver of Metsähovi uses right circular polarization and 8.15-8.65 and 2.21- 2.35 GHz frequency bands.

2.1 Metsähovi Fundamental Station

Finnish Geodetic Institute is running the Metsähovi Fundamental Station. It is a part of the IAG GGOS Core station network. The instrumentation includes geodetic VLBI (in co-operation with Aalto University), Satellite Laser Ranging (SLR), DORIS, GNSS, and absolute and superconducting gravimeters. Currently, instrumentation is being renewed based on special funding from the Ministry of Agriculture and Forestry. During the next four years, the plan includes a new VGOS compatible radio telescope. FGI is committed to maintain and develop Metsähovi as a geodetic fundamental station.

1. Aalto University Metsähovi Radio Observatory
2. Finnish Geodetic Institute

Fig. 1 Metsähovi Radio Observatory (photo by Riku Pihlanto).

3 Staff

FGI is responsible for the geodetic VLBI observations and is the owner of the S/X receiver. The radio telescope is owned and operated by the Aalto University, and an annual agreement is made on its use for geodetic VLBI sessions. It is not possible to increase the number of annual sessions (currently six to eight) because the telescope is mainly used for astronomical observations. Operation during the geo-VLBI sessions and technical questions are handled jointly; all other technical work, telescope maintenance, and maintenance of instrumentation are done by the personnel of the radio telescope.

Metsähovi Radio Observatory personnel working with IVS observations are listed in Table 1. From June 2013 D.Sc.(tech.) Minttu Uunila has been in charge of IVS VLBI observations at Metsähovi replacing, Dr. Elizaveta Rastorgueva-Foi. The preparation, operation of IVS observations, and submission of data are provided by staff from FGI. The personnel engaged in the work are listed in Table 1.

4 Current Status and Activities

4.1 IVS Sessions

Metsähovi and FGI observed seven IVS sessions, five T2 sessions and two EUROPE sessions in 2013. The first session, T2089, was observed with two recording systems in parallel: the old system with analogue BBCs and Mark 5A and the new one with DBBC and Mark 5B. During the T2089, some problems with the DBBC in channels 05-08 were detected. The data with an analog system were of better quality and were used by correlators. All next sessions were recorded only with the new system (DBBC and Mark 5B). The problems with the DBBCs channels 05-08 continued throughout 2013. DBBC boards will be repaired in 2014 (see in BBC/DBBC status). Due to problems with DBBC and Mark 5 during session T2090, the amount of correlated data was only 40 %. T2093, EUR126 and T2094 were almost problem free. However, during some scans, the antenna was slewing.

Table 1 Staff at Metsähovi Radio Observatory and at FGI involved in geodetic observations during 2013.

Staff at Metsähovi Radio Observatory		
Name	Title	Responsibility
Dr. Juha Kallunki	Laboratory manager	VLBI equipment, NEXPReS
M.Sc.(tech.) Ari Mujunen	Laboratory manager	NEXPReS
Dr. Elizaveta Rastorgueva-Foi	VLBI friend	VLBI observations
D.Sc.(tech.) Minttu Uunila	post-doctoral researcher, IVS on-site technical contact	VLBI equipment, IVS observations
M.Sc.(tech.) Petri Kirves	Operating engineer	Receivers
Tomi Salminen	Research assistant (until 6/2013)	NEXPReS
Staff at Finnish Geodetic Institute		
Name	Title	Responsibility
Prof. Markku Poutanen	Head of the Department of Geodesy and Geodynamics	Metsähovi research station
Dr. Nataliya Zubko	Senior research scientist	IVS observations, analysis
M.Sc. Veikko Saaranen	Special research scientist	operation of IVS observations
M.Sc. Ulla Kallio	Senior research scientist	Local ties measurements
M.Sc. Simo Marila	Research scientist	operation of IVS observations
Dr. Diego Meschini	Research scientist	research on correlation
Dr. Jyri Näränen	Special research Scientist	Metsähovi infrastructure

4.2 Technical Activities and Issues

4.2.1 BBC/DBBC status

The old analog rack retaired in early 2013. The DBBC arrived in September 2012 with the stand-alone FILA10G. We had some issues with one group-of-four BBCs (BBC05-08) and the boards will be repaired in January 2014.

4.2.2 Recording systems

We developed a new DAQ system, the FlexBuff, using COTS components. Local UDP streaming performance tests were performed with wirespeed 10GE. Long (30 minute) tests demonstrated the ability to write at maximum wire speed with zero packet loss. Writing 34 disks without a network (using local machines), the architecture can handle 40 Gbps, and it can always handle $>$30 Gbps. A 4 Gbps e-VLBI demo in September proved that the FlexBuff and its recording software vlbi_streamer work impeccably. Also FILA10G was imployed in the test to enable 4 Gbps recording.

Our old Mark 5A was retired. We had problems with our Mark 5B+ Stream Stor board, but now at the end of the year we received it back from warranty repair by Conduant. We have loaned a Mark 5C StreamStor board from the Max Planck Institute for Radio Astronomy. 2014 will start with testing the repaired board.

We have switched to using JIVE's jive5ab instead of DIMino.

4.3 Data Analysis

In 2010, FGI and Metsähovi Radio Observatory received funding for four years from the Academy of Finland to start geodetic VLBI data analysis. In 2013, one doctoral dissertation was finished (M. Uunila: "Improving geodetic VLBI: UT1 accuracy, latency of results and data quality monitoring").

Data analysis at FGI is performed by N. Zubko. The project of source structure study and its influence on estimated geodetic VLBI parameters has been continued in cooperation with E. Rastorgueva-Foi. Diego Meschini is responsible for correlation.

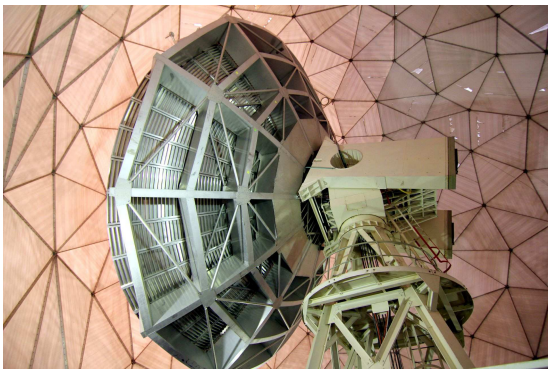

Fig. 2 Metsähovi radio telescope.

4.3.1 Axis offset calculations

The new value of the axis offset -3.6 mm was estimated from local tie measurements performed by Ulla Kallio during the geo-VLBI sessions since 2008. The offset is different from the earlier value +5.1mm estimated using the time delay observations. We investigated the effect of changing the offset on the coordinates by analyzing the geodetic VLBI campaigns with the old and the new axis offset values [1]. The difference between the old and new coordinates show that the agreement between the vectors from the IGS GPS point METS to the reference point of the VLBI telescope Metsahov calculated from ITRF coordinates and estimated from local tie data could improve when using the new value.

4.3.2 Local Ties between VLBI and GPS at Metsähovi

The local tie measurements between the co-located instruments at Metsähovi are provided by Ulla Kallio. A local tie between IGS station METS and the VLBI antenna reference point was regularly performed with kinematic GPS measurements during the geo-VLBI campaigns starting in 2008. Testing shows that a millimeter level accuracy can be achieved in local tie vector determination with the kinematic GPS method. In 2013, the influence of thermal deformations in the local tie vector were studied and taken into account in data processing. In June 2013, the GPS antennas were taken down and sent to Gottfried Wilhelm Leibniz Universitaet Hannover and Rheinische Friedrich-Wilhelms-Universitaet Bonn for calibration as a part of the EMRP SIB60 (European Metrology Research Programme, Metrology for long distance surveying). The antennas will be re-established in January 2014.

4.3.3 Meetings

An IVS training school on VLBI for Geodesy and Astrometry was organized at Aalto University in Espoo, Finland on March 2–5, 2013. The meeting was sponsored by IVS, the European Geosciences Union (EGU), Onsala Space Observatory (OSO), RadioNet, Aalto University and the Finnish Geodetic Institute. A total of 60 people participated in the School.

Fig. 3 Group photo of EVGA excursion to Metsähovi.

The school was followed by the 21st Meeting of the European VLBI Group for Geodesy and Astrometry (EVGA) and the 14th IVS Analysis Workshop on March 5–8, 2013. The number of participants was 70. A half-day trip to Metsähovi was made on the last day of the meeting.

5 Future Plans

In 2014, Metsähovi is scheduled to participate in three EUROPE sessions and four T2 sessions. Minttu Uunila will be EVN VLBI and technical friend for Metsähovi starting from January 2014 and will be in charge of all VLBI observations at Metsähovi Radio Observatory. The DBBC boards will be repaired in January 2014.

Acknowledgements

FGI and Metsähovi teams acknowledge support from the Academy of Finland (grant number 135101).

References

1. U. Kallio and N. Zubko. The effect of the systematic error in the axis offset value on the coordinates estimated in VLBI data analysis. Proceedings of the 21th Meeting of the EVGA, edited by N. Zubko and M. Poutanen, p. 237-241, 2013.