

U.S. Naval Observatory VLBI Analysis Center

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Abstract

This report summarizes the activities of the VLBI Analysis Center at the United States Naval Observatory for calendar year 2011. Over the course of the year, Analysis Center personnel continued analysis and timely submission of IVS-R4 databases for distribution to the IVS. During the 2011 calendar year, the USNO VLBI Analysis Center produced one periodic global solution designated usn2011a. Earth orientation parameters (EOP), based on this solution and updated by the latest diurnal (IVS-R1 and IVS-R4) experiments, were routinely submitted to the IVS. Sinex files based upon the bi-weekly 24-hr experiments were also submitted to the IVS.

During the 2011 calendar year, Analysis Center personnel focused much of their efforts on both the DiFX software correlator implementation at USNO and on implementing a program of daily Intensive sessions to measure UT1–UTC using two stations of the Very Long Baseline Array (VLBA) operated by the National Radio Astronomy Observatory (NRAO). High-speed network connections were established to the Mauna Kea, HI and Pie Town, NM stations for the purpose of electronically transferring the data back to USNO for correlation and analysis.

1. Introduction

The USNO VLBI Analysis Center is supported and operated by the United States Naval Observatory (USNO) in Washington, DC. The primary services provided by the Analysis Center are the analysis of diurnal experiments, the production of periodic global Terrestrial Reference Frame (TRF) and Celestial Reference Frame (CRF) solutions, and the submission to the IVS of Intensive (EOP-I) and session-based (EOP-S) Earth orientation parameters based on USNO global TRF solutions. Analysis Center personnel maintain the necessary software required to continue these services to the IVS including periodic updates of the GSFC CALC/SOLVE software package. In addition to operational VLBI analysis, Analysis Center personnel are actively engaged in research related to future reference frames, the electronic transfer of VLBI data, and software correlation.

2. Current Analysis Center Activities

2.1. IVS Experiment Analysis and Database Submission

During the 2011 calendar year, personnel at the USNO VLBI Analysis Center continued to be responsible for the timely analysis of the IVS-R4 experiments, with the resulting databases submitted within 24 hours of correlation for dissemination by the IVS. Analysis Center personnel continue to be responsible for the analysis and database submission for the periodic IVS-CRF experiments. In 2011, USNO scheduled and analyzed 11 CRF related experiments including IVS-CRF62 through IVS-CRF66 and IVS-CRDS50 through IVS-CRDS55. The analyzed databases were submitted to the IVS. Analysis Center personnel also continued analyzing IVS Intensive experiments for use in the USN-EOPI time series.

2.2. Global TRF Solutions, EOP, and Sinex Submission

USNO VLBI Analysis Center personnel continued to produce periodic global EOP/TRF solutions over the course of the 2011 calendar year. This year a single solution (usn2011a) was produced and submitted to the IVS. Analysis Center personnel continued to submit the USN-EOPS series, which are now based upon the 2011a solution and are updated with new IVS-R1/R4 experiments. The updated EOPS series was submitted to the IVS twice weekly within 24 hours of experiment correlation and is included in the IERS Bulletin A. Analysis Center personnel also continued routine submission of Sinex format files based upon the 24-hr VLBI sessions. In addition to EOPS and Sinex series, USNO VLBI Analysis Center personnel continued to produce and submit an EOPI series based upon the IVS Intensive experiments.

2.3. Celestial Reference Frame (CRF)

During the 2011 calendar year, Analysis Center personnel continued work on the production of global CRF solutions. In 2011, a single solution (crf2011a) was produced for local use within USNO. The global CRF solutions produced are routinely compared to the current ICRF (ICRF2).

2.4. Software Correlator

Over the course of the 2011 calendar year, Analysis Center personnel continued the implementation, testing, and evaluation of the DiFX software correlator. The software correlator implementation at USNO currently consists of four nodes (workstations) with a total of 28 processing cores and two Mark 5 data playback units. The correlator nodes and Mark 5 units are connected through a 1 Gbps ethernet switch. Since April 2011, Analysis Center personnel have been regularly correlating one IVS-INT1 (Kk-Wz) Intensive session per week on the software correlator in parallel with the WACO hardware correlator. In addition, the post-correlation calibration path has been fully exercised with the DiFX output converted to traditional Mark IV-style correlator output using the difx2mark4 software developed at Haystack Observatory. The Mark IV output has been fringe-fitted and calibrated within FOURFIT/HOPS, and geodetic databases have been produced using DBEDIT.

Analysis Center personnel continue to interface with colleagues from various institutions within the DiFX consortium, and they attended the DiFX meetings in Bonn, Germany (March 2011) and at Haystack Observatory in Westford, MA (December 2011). To facilitate the smooth transition to the software correlator and to expand USNO's involvement in the DiFX consortium, a software engineer (Dr. John Spitzak) was hired to work on the development of a graphical user interface (GUI) for DiFX.

2.5. VLBA Intensive Experiments

Over the course of the 2011 calendar year, Analysis Center personnel made considerable progress with regard to the implementation of a new Intensive series using two stations of the VLBA. USNO contracted with NRAO and the University of Hawaii to install and maintain 1Gbps fiber links to the stations at Pie Town, NM and Mauna Kea, HI. These fiber links were in service on March 1, 2011 for PT and on July 15, 2011 for MK. In addition, both stations were outfitted with the network infrastructure and new Mark 5C units necessary to record the data and e-transfer it back to USNO. Both fiber links have been tested, and data have been transmitted at speeds up

to 400 Mbps from each station back to USNO via the links.

A series of test observations began in September 2011 using the upgraded MK and PT stations. The wide-band tests were conducted using the newly available digital backends with sixteen 32 MHz wide channels at a data rate of 2 Gbps. Intensives run for 40 minutes with approximately 12 seconds per scan on source resulting in roughly 30 – 35 scans per session. The 12-second scan length allows the data size to be ~ 100 GB per station per session, which makes for more manageable e-transfers. From the start, the VLBA Intensive tests have been correlated on the DiFX software correlator. Mark IV style output is generated using the difx2mark4 software, and the data are fringe-fitted using FOURFIT/HOPS. Geodetic-style databases are generated with DBEDIT and analyzed within SOLVE. The analyzed databases have been put into a SOLVE batch solution along with the other Intensive sessions for comparison. Figure 1 shows the differences between the VLBA MK-PT baseline UT1–UTC results and IERS C04 from October 2011 through January 2012. Differences between IERS C04 and the USN-EOPI and USN-EOPS series are also shown for comparison.

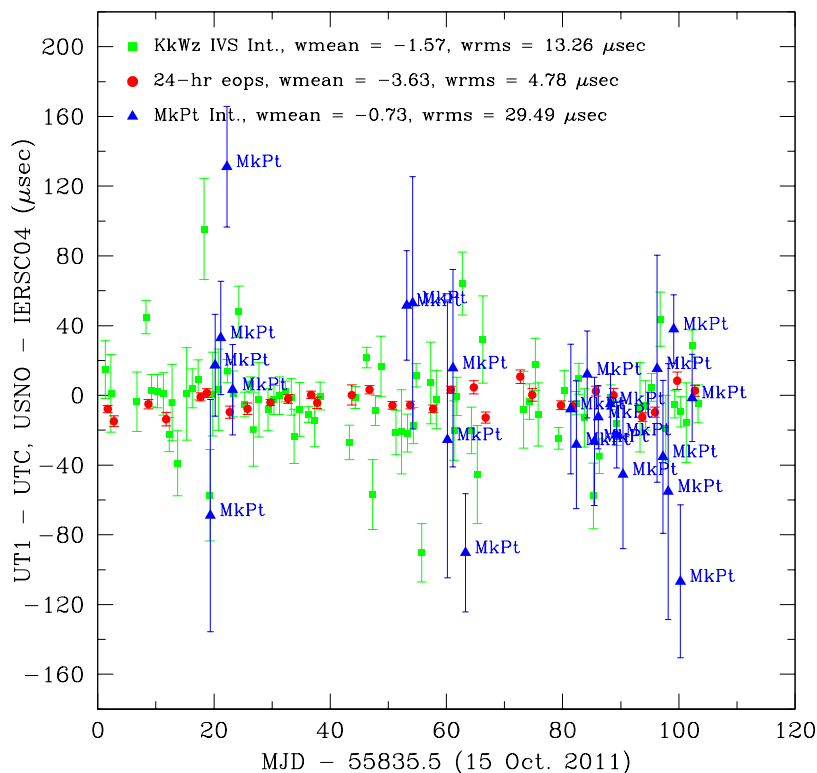


Figure 1. Differences in UT1-UTC between data from the VLBA Intensive test sessions using the MK-PT baseline and IERS C04. Also shown are differences between IERS C04 and both the USN-EOPI and USN-EOPS standard series for comparison. Error bars are 1σ formal uncertainties.

The plan is for these sessions to become operational in the summer of 2012. Once fully operational, they will be scheduled as IVS-INT4 Intensive sessions, and data will be released to the IVS

for community-wide distribution.

3. Staff

The staff of the VLBI Analysis Center is drawn from individuals in both the Astrometry and Earth Orientation departments at the U.S. Naval Observatory. The staff and their responsibilities are as follows:

Name	Responsibilities
David Boboltz	VLBA Intensive program; software correlator implementation; VLBI data analysis.
Alan Fey	Periodic global CRF/TRF/EOP solutions and comparisons; CRF densification research; software correlator implementation; VLBI data analysis.
Nicole Geiger	software correlator implementation; VLBI data analysis; EOP, database and Sinex submission.
Kerry Kingham	Hardware correlator interface; software correlator implementation; VLBI data analysis.
David Hall	Hardware correlator interface; software correlator implementation; VLBI data analysis.

4. Future Activities

For the upcoming year, January 2012 – December 2012, USNO VLBI Analysis Center personnel plan to accomplish the following activities:

- Continue testing and evaluation of the USNO implementation of the DiFX software correlator. Streamline pre- and post-correlation processing.
- Procure a new software correlator system to replace the current WACO hardware correlator.
- Continue testing the electronic transfer of VLBI Intensive data from the MK and PT VLBA stations with regular operations beginning summer 2012.
- Continue analysis and submission of IVS-R4 experiments for dissemination by the IVS.
- Continue the production of periodic global TRF solutions and the submission of EOP-S estimates to the IVS updated by the IVS-R1/R4 experiments.
- Continue submission of Sinex format files based on the 24-hr experiments and begin production of a Sinex series based upon the Intensive experiments.
- Continue the analysis of Intensive experiments and submission of EOP-I estimates to the IVS.
- Continue the scheduling, analysis, and database submission for IVS-CRF and IVS-CRDS experiments.
- Continue the production of periodic global CRF solutions.