The GIUB/BKG VLBI Analysis Center

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Abstract

This report describes the activities of the GIUB/BKG VLBI Analysis Center during the reporting period. Data analysis activities and the development of data analysis technology are described. Past and on-going research topics are reported. Finally, center personnel are listed.

1. Overview

The GIUB/BKG VLBI Analysis Center has been estabished jointly by the Bundesamt für Kartographie und Geodäsie (BKG), Leipzig, and by the Geodetic Institute of the University of Bonn (GIUB). Both institutions closely cooperate in the field of geodetic VLBI maintaining their own analysis groups in Leipzig and Bonn. The responsibilities include data analysis and software development.

Both groups use the Mark III/IV data analysis software CALC/SOLVE/GLOBL which originated at NASA/GSFC. At GIUB the basic SOLVE/GLOBL software has been modified extensively to increase its computational speed and to add several new features.

2. Data Analysis Activities

At BKG the CALC9.11/f-SOLVE package is being used for routine VLBI data processing. The software has been installed on a HP 9000/D280/1 computer (HP UX 10.20 operating system) with about 190 GByte disc space.

The following sessions have been analysed jointly at GIUB and BKG since the beginning of March 1999:

- **Measurement of Vertical Crustal Motion in Europe by VLBI (EUROPE sessions)** (EU Project FMRX-CT960071)
  Six sessions in 1999 and 7 sessions in 2000 with the stations NyÅlesund, Onsala, Wettzell, Simeiz, Madrid (DSS65), Yebes, Medicina, Matera and Noto have been processed. Effelsberg participated once per year and the mobile unit TIGO-WTZL participated at several occasions during its testing phase.

- **Polarization tests**
  In order to investigate polarization impurities two regular EUROPE sessions were extended in which several stations swapped polarization from right circular polarization (RCP) to left circular polarization (LCP) while other stations continued to observe RCP. Fringes at all cross-polarization scans were detected and the analysis was completed.

- **International Radio Interferometric Surveying - South (IRIS-S):**
  Twelve sessions per year with the stations Wettzell, HartRAO, Fortaleza, Fairbanks and Westford were processed.

- **Continuous Observations of the Rotation of the Earth - O'Higgins (CORE-OHIG)**

Nine sessions with stations HartRAO, O'Higgins, Fortaleza, Hobart, Kokee and DSS45 have been analyzed in 1999 and 2000.

- **Annual Solution for Submission to IERS**
  In addition to the session by session analysis one combined solution is computed cooperatively each year which comprises most of the dual frequency fixed station Mark III data available worldwide. This solution is the basis for the annual submission to the IERS. Station coordinates and velocities, radio source positions and Earth orientation parameters (EOP) are estimated in one global solution. The solution types are bkgtra99 for the Terrestrial Reference Frame and bkgira99 for the Celestial Reference Frame and the Earth orientation parameters are available from the IVS Data Centers. Station coordinates, velocities and covariances of the TRF solution were converted into SINEX format and submitted to the ITRF Section of IERS as a contribution to the ITRF2000 realization.

- **Processing of correlator output**
  The BKG group generated calibrated databases for most of the sessions correlated at the Bonn Astro/Geo Mark III/IV Correlator and subsequently submitted them to the IVS Data Centers for distribution.

- **IVS EOP time series**
  After the preprocessing of the individual VLBI sessions which includes inspection of the residuals and procedures for outlier elimination the databases and related files are uploaded to the incoming area of the BKG IVS Data Center and into the local data area.

  The final processing of individual VLBI sessions (IRIS-S, EUROPE, COHIG, NEOS, CORE) at BKG is the basis for producing two EOP time series regularly submitted to the IVS Data Centers:

  - bkg00001.eops generated from 2360 24h VLBI sessions between 1984 and 2000
  - bkgint01.eopi generated from UT1 intensive sessions between 1999 and 2000

Table 1. Mean formal errors for 24 h sessions

Component	1984-2000	1999-2000
σ_{xwob}	0.618 mas	0.223 mas
σ_{ywob}	0.641 mas	0.213 mas
σ_{ut1}	33.8 μs	13.6 μs
$\sigma_{d\psi}$	0.764 mas	0.212 mas
$\sigma_{d\epsilon}$	0.256 mas	0.085 mas

The corresponding values for the time span from 1999 to 2000 have improved by a factor of approximately three. The mean formal error for the intensive experiments between 1999 and 2000 is 22.0 μs. The features of the solutions are described in the respective technical descriptions which are available in the IVS Data Centers in the directory ivsdocuments.

3. Development of VLBI Data Analysis Technology

- One of the responsibilities of the GIUB analysis group is the preparation of correlator data for export in the form of Mark III data analysis system databases for the sessions correlated at the Bonn Astro/Geo correlator center. In most cases this task is straightforward but sometimes it requires some extra efforts. The main reason for additional interaction is radio frequency interference which may saturate individual channels causing some of the delay observables to be corrupted. In this case the fringe fitting process may select the wrong peak of the delay resolution function and produce an incorrect delay observable. However, this fact can only be detected when a least squares solution is computed with the program SOLVE. In a subsequent step the residuals of the SOLVE run can be used to narrow the search window in a repeated fringe fitting process. A semi-automatic procedure for this task is available at GIUB.

- Semi-automatic Web-presentation of data analysis results is being developed. Detailed reports of all VLBI data processed at the GIUB/BKG Analysis Center have been displayed on the Web between 1998 and the middle of 2000. This task will be resumed when additional man-power becomes available.

- Internal logic of the software SOLVE was updated in order to reduce overhead, to speed up data processing and to expand the capabilities of the analysis system.

- In order to make the analysis processes more effective the BKG group developed its own program environment around the CALC/SOLVE software automating the post interactive part for establishing the two EOP series mentioned above.

4. Research Topics

- **Determination of telescope displacements by local engineering work at Medicina**
  The Medicina telescope has been displaced slightly in 1996 due to track repairs. The local surveys before and after the displacements were analysed (NOTHNAGEL AND BINNENBRUCK 2000).

- **Footprint measurements at Ny Ålesund**
  In the framework of a footprint project local measurements were carried out at Ny Ålesund in order to determine the coordinates of the antenna's VLBI reference point relative to a local network of concrete pillars. Preliminary analysis of the measurements has occurred, and local eccentricities between the VLBI antenna and the IGS GPS antennas will be computed when the Norwegian Mapping Authority will have completed its GPS analysis.

- **Joint least squares adjustment of GPS and VLBI observations**
  At DGFI a combination of space geodetic measurements at the level of observables is being carried out. Special VLBI data preprocessing and solutions are performed at GIUB in support of this research.

- **Investigation of the feasibility of using phase delays in geodetic VLBI**
  An extended set of VLBI sessions has been re-analyzed for resolving phase delay ambiguities. Conditions when ambiguities can be resolved as well as differences between group delay and phase delay solutions were investigated.

- **Correlator comparison**

  In order to investigate in greater detail the MK III/MK IV correlator performance, a 4-station IRIS-S session has been correlated both at the old MK IIIa and at the new MK IV correlator. In fact, before the definitive closing down of the MK IIIa correlator, two complete and fully independent correlations of the same IRIS-S sessions were carried out to establish the noise floor of the old system. First results of the comparison have been published (MÜSKENS et al. 2000).

5. Personnel

Table 2. Personnel at GIUB/BKG Analysus Center

Klaus Börger	GIUB	until 11/2000
Gerald Engelhardt	BKG	
Axel Nothnagel	GIUB	
Leonid Petrov	GIUB	until 4/2000
Christoph Steinforth	GIUB	
Volkmar Thorandt	BKG	
Dieter Ullrich	BKG	

References

Müskens A., K. Börger, M. Sorgente, J. Campbell (2000): *Comparison of Mk III and MK IV Correlation Using a 4-station IRIS-S experiment*; Proc. of the 14th Working Meeting on European VLBI for Geodesy and Astrometry, Castel San Pietro Terme, 125-136

Nothnagel, A., B. Binnenbruck (2000): *Determination of the 1996 Displacement of the Medicina Radio Telescope by Local Surveys*; Proc. of the 14th Working Meeting on European VLBI for Geodesy and Astrometry, Castel San Pietro Terme, 61-66; available under http://giub.geod.uni-bonn.de/vlbi/publications