

# The GIUB/BKG VLBI Analysis Center

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## 1. Overview

The GIUB/BKG VLBI Analysis Center has been established 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 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. The new software, which is called f-SOLVE, accelerates processing by additional automation procedures.

Both groups use HP9000 Series 700 computers with sufficient hard disk space and Internet connection for their analyses.

## 2. Data Analysis

The following sessions have been analysed at GIUB and BKG during the last year:

- **Measurement of Vertical Crustal Motion in Europe by VLBI (EURO)**  
(EU Project FMRX-CT960071)  
Six sessions per year with the stations NyÅlesund, Onsala, Wettzell, Simeiz, Madrid (DSS65), Yebes, Medicina, Matera and Noto. Effelsberg and TIGO-WTZL participated occasionally.
- **Polarization tests**  
In order to investigate polarization impurities two regular EURO 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.
- **Wettzell local ties (WTIES)**  
Two sessions between Wettzell 20-m telescope and TIGO-WTZL which are about 59 m apart.
- **International Radio Interferometric Surveying - South (IRIS-S):**  
Twelve sessions per year with the stations Wettzell, HartRAO, Fortaleza, Fairbanks and Westford.
- **Continuous Observations of the Rotation of the Earth - O'Higgins (CORE-OHIG)**  
with stations HartRAO, O'Higgins, Fortaleza, Hobart, Kokee and DSS45.
- **Annual Solution for Submission to IERS**  
In addition to the session by session analysis one combined solution is computed cooperatively every 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 are estimated in one global solution. Station coordinates, velocities and their covariances are converted into SINEX format which is the input format for contributions to the International Terrestrial Reference Frame maintained by the IERS.

### 3. Development of Technology of VLBI Data Analysis

- 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 of the 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 may, thus, 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.
- Algorithm GAMB for automatic group delay ambiguity resolution was developed and implemented in SOLVE. It serves four purposes: a) resolving group delay ambiguities at both bands; b) estimation of quadratic clock function; c) detection and removing of outliers; d) computation of ionosphere path delay.
- Algorithm ELIM has been developed and implemented in SOLVE for automatic outlier elimination and/or restoration of observations which may have been eliminated in earlier analysis steps. The automatic procedure finds the best candidate for elimination/restoration by least squares residual snooping and repeats the process until the predefined criteria are met. ELIM allows one to carry out the data editing process in an automatic and objective way providing fast and better results than manual editing.
- Algorithm PAMB for phase delay ambiguity resolution. Phase delays are roughly 40-fold more precise than group delays but are lacking the integer number of phase cycles. Algorithm PAMB allows one to resolve these phase delay ambiguities in semi-automatic mode for observing sessions which have to meet certain quality criteria.
- 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 starting in 1998.
- 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.

### 4. Research topics

- **Thermal expansion of radio telescopes**  
(in cooperation with Onsala Space Observatory)

In situ measurements of thermal expansion of the Wettzell and Onsala radio telescopes by invar wire are compared with model parameters. The most critical aspects are the temperature transfer into concrete and representative temperature measurements in a radome.

- **Geocentric relativistic VLBI formulation**

Although solar system barycentric and geocentric relativistic formulations of VLBI observations are equivalent, the development of a geocentric model bears some benefits. It includes a separate stellar model and it may be adapted and applied to other space geodetic techniques.

- **Determination of telescope displacements by local engineering work at Medicina and Effelsberg**

Both the Effelsberg and Medicina telescopes have been displaced slightly due to track repairs. Local surveys before and after the displacements are being analysed.

- **Joint least squares adjustment of GPS and VLBI observations**

(in cooperation with DGFI)

A combination of space geodetic measurements at the level of observables is being carried out at DGFI. 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.

- **Investigation of the influence of errors in phase calibration of group delay**

Initial steps of studying phase calibration errors have been carried out. In many cases phase calibration is corrupted by phase variations appearing as additive signals. A prototype of a procedure has been developed restoring the phase calibration signal by subtracting spurious signals.