

# Towards an Operational Automatic VLBI Data Analysis Tool for INTENSIVE Sessions

*Wolfgang Schwegmann, Gerald Engelhardt, Volkmar Thorandt*

*Bundesamt für Kartographie und Geodäsie (BKG)*

*Contact author: Wolfgang Schwegmann, e-mail: [wolfgang.schwegmann@bkg.bund.de](mailto:wolfgang.schwegmann@bkg.bund.de)*

## Abstract

Currently the delay between the time of observation and availability of UT1 results from the INTENSIVE sessions is 2-5 days. Advances in e-VLBI technology promise to considerably shorten the latency resulting from the shipment of the tapes or discs from the VLBI stations to the correlators. To avoid the additional delay caused by the standard VLBI data analysis procedure the existing highly interactive analysis tools have to be automated to guarantee the availability of VLBI results in near real time.

Thus, an automatic VLBI data analysis tool is being developed by the VLBI group of the Federal Agency for Cartography and Geodesy (BKG). It is realized as a new tool within the Mark IV data analysis software CALC/SOLVE and based on a software system for the automation of any geodetic VLBI experiment. The system reads a database with correlator output, sets appropriate parameterization, eliminates outliers, solves the LSQ problem and generates a detailed report on the data analysis. The time needed to generate UT1 results starting from the correlator output is less than 10 minutes. 50 INTENSIVE experiments have been analysed and the results are comparable to the *EOP-I* products available at the IVS data centers.

## 1. Introduction

The delay between the time of observation and the availability of results is an important disadvantage of geodetic VLBI compared to other geodetic space techniques. One reason is the complicated and highly interactive analysis procedure, requiring well-founded expertise. While advances in e-VLBI promise to considerably cut the latency, automatic VLBI analysis tools still have to be developed to obtain VLBI results in near real-time.

Thus, an automatic VLBI data analysis tool for the operational analysis of INTENSIVE sessions is being developed by the VLBI group of the Federal Agency for Cartography and Geodesy (BKG). It is based on an experimental software package called IADA (Intelligent Assistant for VLBI Data Analysis [1]). IADA has been realized as an embedded *Expert System*<sup>1</sup> within the Mark IV data analysis software CALC/SOLVE and can be used to perform the whole VLBI data analysis procedure automatically. Based on IADA the tool for the automation of INTENSIVE sessions has been built as an additional module within SOLVE. This module is able to automate the analysis of INTENSIVE sessions without the use of an Expert System because the analysis of INTENSIVE sessions is less complicated than the analysis of 24-h sessions.

---

<sup>1</sup>Expert Systems are software systems to model the knowledge of qualified experts for a particular domain and to use this knowledge for solving a complex problem within this domain.

## 2. The Automatic VLBI Data Analysis Tool

The components of the Mark IV data analysis system have been extended in order to allow an automatic processing. New modules have been developed and existing modules in SOLVE have been modified. The system executes the following operations automatically:

1. download a database from a ftp-server and import it into the catalogue system (program GET\_DB, cf. figure 1);
2. run CALC, i.e. build the CALC control file, check all input data, start CALC and check the results (program XCALC, cf. figure 2);
3. download log-files, extract and check calibration data, save the data into calibration files and include the data into the database by calling program DBEDIT (program XLOG, cf. figure 3 and 4);
4. load the database into scratch files;
5. set a priori clock model;
6. resolve group delay ambiguities;
7. set parameterization;
8. find preliminary solution;
9. eliminate outliers;
10. find final solution;
11. generate detailed report on the data analysis (cf. figure 5)

The automatic data analysis is controlled by a new module within SOLVE. This module calls the appropriate program or SOLVE module for each of the above steps. To perform the automatic data analysis the analyst only has to specify the experiment name to be analysed and a configuration file containing all information necessary for the automatic data analysis.

## 3. Results and Outlook

The new tool for the automatic VLBI data analysis has been used to analyse 50 INTENSIVE sessions between September 2002 and April 2003. All experiments could be processed automatically without any problems with an average processing time of about 10 minutes. The results have been compared to those from the *EOP-I* products of the IVS Analysis Centers (BKG, GSFC, IAA, SPU) available at the IVS Data Center. Figure 6 shows the differences from each series to the average of all series. The results of the automatic tool (IADA) are comparable to those of the IVS Analysis Centers.

To use the new tool for an operational automatic VLBI data analysis some tasks have still to be solved. After loading the databases into the scratch files an initial quality control has to be done and at the end of the analysis methods of quality control have to be developed. As soon as these tasks have been solved an operational automatic VLBI data analysis of INTENSIVE sessions will be possible.

## References

- [1] Schwegmann, W., Automation of the VLBI Data Analysis, In: Measurement of Vertical Crustal Motion in Europe, TMR Network FMRX-CT96-0071 Scientific Report 1996-2001, J. Campbell, A. Nothnagel and R. Haas (eds.), ISBN 92-894-0763-8, 140–145, 2002.

```

X hpterm
[miro]/diskA0/vlbi/schwegma/data > get_db -d 03APR18XU_V001 -c /diskA3/mk4/local/GIUB.iad -b -1
GET_DB: utility for automatic download and import of databases into catalog.
2001/08/30 W. Schwegmann

1. Check whether databases already exist in local catalogue ...
03APR18XU_V001
03APR185U_V001
DONE.

2. Downloading databases into directory
/diskA5/data5/ ...
DONE.

3. Import databases into catalog ...
DONE.

4. Checking catlg output file ...
DONE.

GET_DB: Number of skipped databases: 0/2
GET_DB: Number of downloaded databases: 2/2
GET_DB: Number of imported databases: 2/2

[miro]/diskA0/vlbi/schwegma/data >
    
```

Figure 1. Program GET\_DB.

```

X schwegma@pc353:~ <3>
[miro]/diskA0/vlbi/schwegma > xcalc -i 03JAN10XU -c /diskA3/mk4/local/GIUB.iad -b
XCALC: utility for automatic CALC'ing of databases
2001/08/30 W. Schwegmann

1. Check whether databases exist and whether
external input files contain all information ...
03JAN10SU
03JAN10XU
DONE.

2. Collecting information for CALC from master file
and generating CALCON file ...
03JAN10SU
03JAN10XU
DONE.

3. Running Calc ...
DONE.

4. Check for new version of the processed databases ...
03JAN10SU_V002 - OK.
03JAN10XU_V002 - OK.
DONE.

XCALC: Number of successfully processed databases: 2
XCALC: Total number of databases: 2

[miro]/diskA0/vlbi/schwegma >
    
```

Figure 2. Program XCALC.

```

X hpterm
XLOG run for experiment 102284
-----
Local time: 2004.02.04-13:16:04
Configuration file: /diskA3/mk4/local/GIUB-IDA.xlg
Protocol file: /diskA0/vlbi/schwegma/public_html/vlbi/sessions/2002/102284/
Stations file: /diskA0/vlbi/schwegma/mk4/props/xlog/xlog_stations.txt
LOG_DIR: /diskA0/vlbi/schwegma/data/logs/102284/
CAL_DIR: /diskA0/vlbi/schwegma/data/delogs/102284/
MASTER_DIR: /diskA0/vlbi/schwegma/mk4/master-old/

OPTIONS:
- extracting met.. and cable cal data from log-files
- DBCAL control file will be generated
  and DBCAL will be launched automatically
- GIF plots will be saved

- log-files have been downloaded from IVS data center

Hit 0 to quit program or any other key to continue >
    
```

Figure 3. Program XLOG – initialization window.

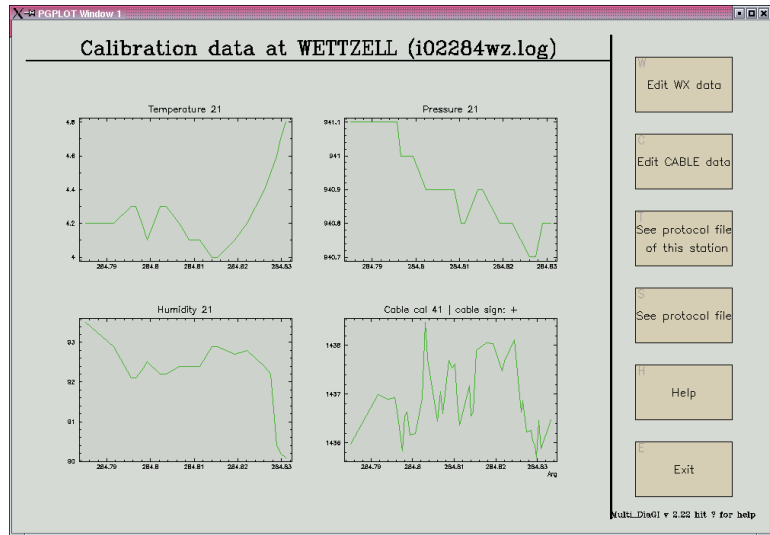


Figure 4. Program XLOG – data manipulation window.

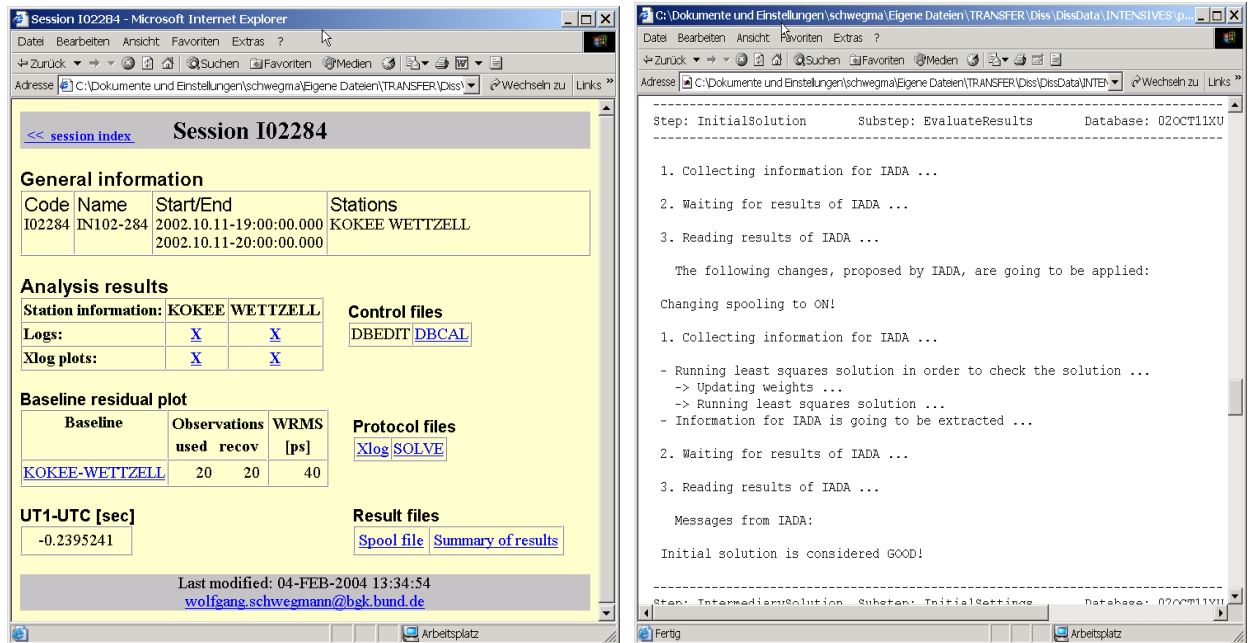


Figure 5. *Left:* Web-Site with detailed information on the data analysis; from this site all results of the analysis as well as several protocol files and plots can be viewed. *Right:* Protocol file containing all information with respect to the automatic data analysis.

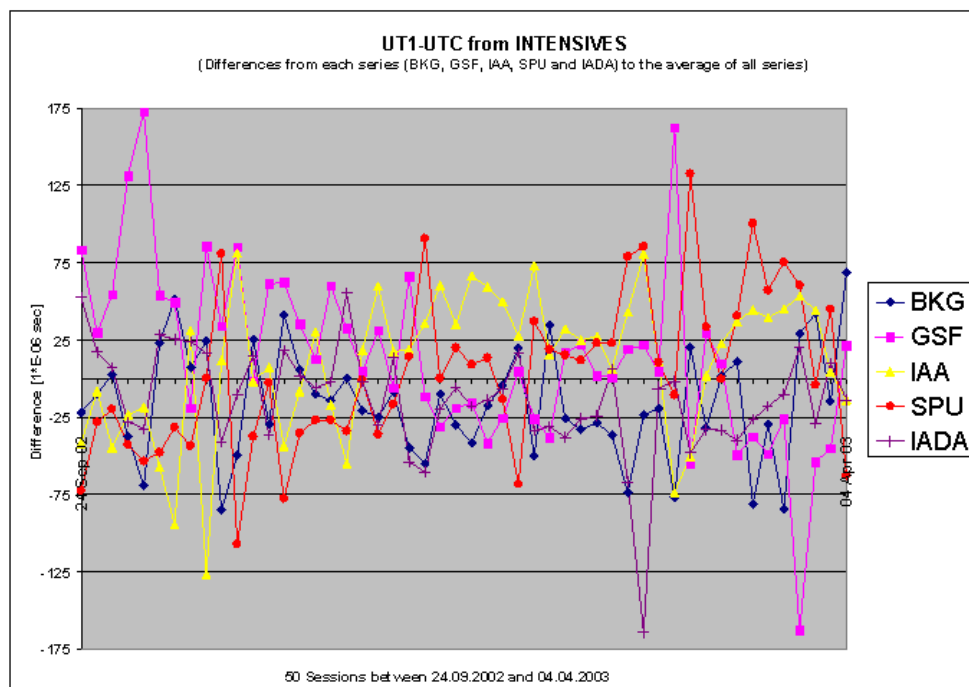


Figure 6. Results of the analysis of 50 INTENSIVE sessions obtained by the new automatic tool (IADA) compared to the EOP-I series of the IVS Analysis Centers.