Overview of performance of European VLBI Geodetic Network in the Europe campaigns in 1998

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Abstract:

Six VLBI sessions have been carried out in 1998 under the program "Measurement of Vertical Crustal Motion in Europe by VLBI". From 6 to 9 stations took part in each experiment. The data were correlated at the Bonn correlator. This report summarize the problem disclosed during analysis of these experiments. The range of variation of the system temperature at zenith for each antenna is shown and our judgment about the system performance is presented. An analysis of the presence of spurious signals in the phase calibration signal is made.

1 Introduction

Six VLBI sessions have been carried out in 1998 under the program "Measurement of Vertical Crustal Motion in Europe by VLBI". From 6 to 9 stations took part in each experiment. Transportable 6 meter antenna TIGO has been included in this network since December 1997 for testing its performances before it will be moved to another place. The radiotelescope Yebes did not participate in observations in 1998 due to malfunction of the formatter. Magnetic tapes with recorded signal were sent to Bonn for processing at the correlator of Max-Plank-Institut für Radioastronomie and for consecutive parametric analysis using CALC/SOLVE software.

Dates of the experiments during 1998 and the list of stations successfully participated in observations are presented in table 1.

Experiment	Date	Stations
Europe41	02-Feb-98	Cri-Mad-Mat-Med-Not-Nya-Ons-Tig-Wet
Europe42	20-Apr-98	Cri-Mat-Med-Not-Nya-Ons-Tig
Europe43	22-Jun-98	Cri-Mat-Not-Nya-Ons-Tig-Wet
Europe44	17-Aug-98	Cri-Mat-Med-Nya-Ons-Tig-Wet
Europe45	12-Oct-98	Cri-Mad-Mat-Med-Not-Nya-Ons-Wet
Europe46	14-Dec-98	Cri-Efl-Mad-Mat-Med-Not-Nya-Tig-Wet

Table 1: Experiments under program "Europe" in 1998.

Detailed reports about each experiment are available at Web:

`http://giub.geod.uni-bonn.de/vlbi/experiments/experiments.html`

2 Summary of the problems

The following problems were detected during the correlation and parametric data analysis:

- No fringes were found in some channels. Some experiments had massive channels losses what led to appearance of group delay subambiguities due a false detection of sidelobes in delay resolution function. Such data were processed by a special procedure REFRINGE developed by A. Nothnagel what allowed to recover substantial part of data.

- Phase calibration amplitude recorded at some stations was sometimes too weak. If the phase calibration amplitude is lower than 1% of the noise level then it cannot be used in data analysis. Manual phase calibration is used in such cases as a last resort. When manual phase calibration is applied we lose information about phase fluctuations in individual video converters what may considerably degrade accuracy of measurements of group and phase delays.

- Local radio interference affected S-band at some stations.

- Incorrect frequency setup before the begging the session due to mistake of an operator. It is an expensive mistake! It is absolutely impossible to use such data.

- Incorrect heads setup before the begging the session. Sometimes it was possible partly to recover the data by the price of substantial degradation of the performance.

- Some channels have fringe amplitude lower than 50% the average fringe amplitude probably due to radio interference?

- Unfortunately all station are affected by spurious signals in phase calibration. This problem was reported in early MARK-III observations in late 70-s and is not yet solved.

  Influence of spurious signals is seen in the plots of dependence of normalized phase calibration amplitude versus phase of phase calibration signal (in rad). We can classify a pattern on these plots according to three main categories: one cycle periodicity (fig. 1) due to the presence of an additive coherent signal; two cycle periodicity due to a band filter imperfection (fig. 2) and peculiar variability (fig. 3). Spurious signal in phase calibration results in appearance of systematic errors in group and phase delay.

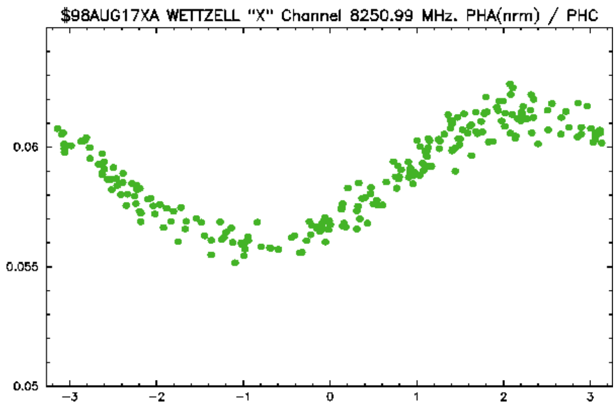

fig. 1

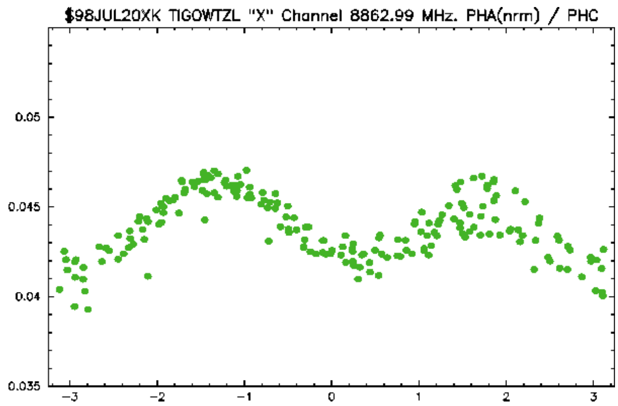

fig. 2

- Considerable variations of system temperature were found for some stations during experiments.

- Cable calibration was not available for some stations or was unrealistic.

3 Particular problems of stations

CRIMEA[1]

No fringes were found at all scans at channel ν=2292.99 MHz in Europe42, Europe43 and Europe44 sessions due to a wrong frequency setup.

[1] Alternative name: Simeiz.

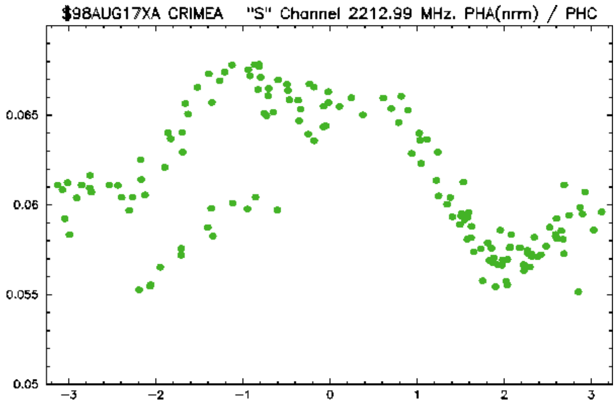

fig. 3

The single band delay was not stable in Europe41 and Europe45 sessions. Jumps in both single band and multi band group delay during Europe41 experiment occurred during power breaks. To find jumps in single band delay larger than 400 nsec requires substantial additional correlator resources.

System temperature records frequently had values in overflow at one or more channels, f.e. at the vc05 and vc06 (ν=8420.99, 8500.99 MHz) at X-band and at the vc12 (ν=2267.99 MHz) at S-Band, although fringe amplitude were normal what allows us to conclude that it was a failure in recording system temperature values.

Cable calibration unit was not switched on for all experiments and therefore cable calibration is not available.

DSS65[2]

Station did not participate in Europe42, Europe43 and Europe44 experiments. Only 4 hours of good data were collected in Europe46.

The phase calibration amplitude was generally too weak and lower than the minimum acceptable threshold. It was generally necessary to introduce a manual phase calibration.

There were two jumps in amplitude of phase calibration signal at X-band and at S-Band during Europe45 experiment.

No fringes were found at ν=2292.99, 8570.99 MHz for all scan in Europe41 session.

Cable calibration unit was not switched on for all experiments.

System temperature was not recorded in all experiments.

EFLSBERG[3]

This station took part only in Europe46 experiment. Sensitivity at S-band was 50% of expected.

Antenna failed to reach sources in time for 10 scans due to a wrong schedule setup.

MATERA

A fringe amplitude lower than the average was found at the channels ν=2212.99, 2227.99 and 2237.99 MHz. It was due to the presence of emitter of a television company RAI close to the station at azimuth 240 degree. A diagram of the distribution of all sources affected by a radio interference during Europe41 session is shown in fig 4. Letters are the source codes. Azimuths of

[2]Alternative name: Madrid.
[3]Alternative name: Effelsberg.

the sources seen from Matera are put at the horizontal axis and elevations are put at the vertical axis. It was noted that the amplitude of this interference was weaker in Europe44, Europe45, Europe46 experiments. The radio interference affected 10–20% scans.

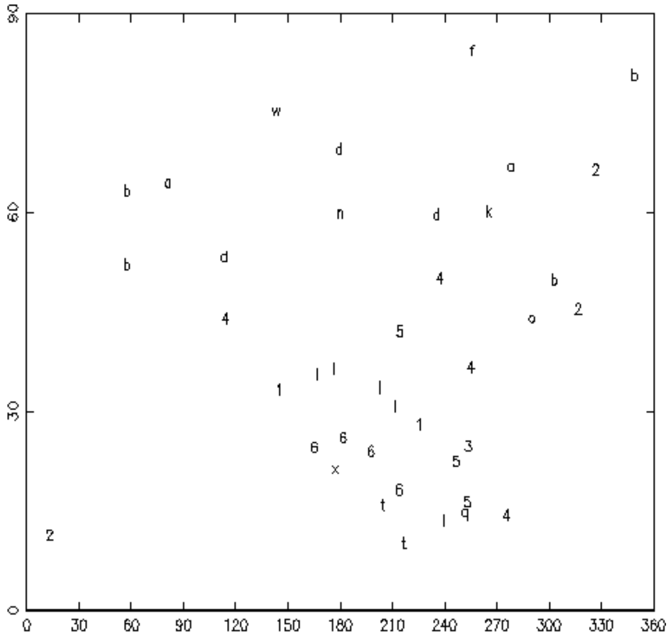

fig. 4 Interference in Matera due to TV emitter

Another source of radio interference was noticed in Europe44, Europe45 and Europe46 at the channel ν=2287.99 MHz. The average fringe amplitude at this channel was more than 50% lower than the average fringe amplitude in all scans. The origin of this new interference is not yet identified. Probably it doesn't have azimuth dependence. System temperature for this channel was in overflow.

MEDICINA

High error rate in data recording was found in Europe45 experiment. The higher threshold of allowable fraction of bytes in error was used for processing the data (0.1 instead of 0.01) what resulted in increasing scatting in fringe phases.

Cable calibration was wrong for all experiments and its usage would degrade fit considerably.

NOTO

The main problem which still is not solved is that phase calibration has a constant systematic offset about +25° and -10° at channels ν=8420.99 and 8570.99 MHz respectively. Additional phase offsets were introduced in fringing in order to compensate this error.

Incorrect triple cap heads setup in Europe41 and Europe42 experiments did not allow to register data correctly and high parity error rate was detected in reading the tapes. The threshold of allowable fraction of bytes in error was raised during fringing (0.1 instead of 0.01).

A tape with poor quality was used in Europe45. Probably checking the tape before the experiment was not adequate.

NYALES20[4]

Error parity rate was detected: (10^{-3}–10^{-4}) in all experiments except Europe41 instead of 10^{-5}.

No fringe and no phase calibration amplitude at frequencies ν=2212.99, 2287.99 MHz were found in Europe42 and Europe43 sessions in 60 scans. All these scans were recorded in forward passes.

Observed SNR at S-band was only 30% of expected in Europe46 experiment.

A big difference in the phase calibration amplitude at three channels: ν=2212.99, 2227.99 and 2237.99 MHz (about 150, 120 and 100 units arbitrary units respectively) with respect to three another channels ν=2267.99, 2287.99 and 2292.99 MHz (about 40, 60 and 60 units) was found.

ONSALA60[5]

Heads had wrong setup before the Europe42, Europe43 and Europe44 experiments and the signal was written in forward and reverse passes on the same tracks. The threshold of allowable fraction of bytes in error was raised from 0.01 to 0.1, but even this trick didn't help to recover all data.

The station did not take part in Europe46 experiment because the head assembly and the driver unit was under reparation.

System temperature varies up to 50% during experiments.

TIGOWTZL[6]

SEFD of TIGOWTZL at S-band is 13 000 Jy what is at one order of magnitude less than SEFD for other stations.

Not all baselines with TIGOWTZL were correlated in earlier experiments since predicted SNR was too low.

A peculiar interference was found during correlation the data of 60 meters baseline TIGOWTZL-WETTZELL at channel 2212.99 MHZ when the antennas looked in direction at azimuth about 0 and 180 degrees. The fringe amplitude was more than 80 higher than the average fringe amplitude. This frequency was discarded in the final fringing of this baseline. Since this problem affected only a short baseline its origin is probably some local source of coherent interference.

WETTZELL

The presence of strong additive spurious signals in phase calibration signal at some channels at X-band was detected.

4 System temperature performance

System temperature is written in log file and is available for analysis[7]. Measured system temperature varies with time and with elevation angle. The following model was used to represent system temperature:

$$T_{sys} = T_o\,(1 + a\,t)(1 + b_1\,m + b_2\,m^2 + b_3\,m^3)$$

here T_o, a, b_1, b_2, b_3 — parameters obtained in non-linear least square adjustments, $m(E)$ — is a number of air masses as a function of elevation. Chao wet mapping function [1] was used for computation of $m(E)$. Two typical cases of dependence of system temperature (in K) in zenith direction on time during an experiment are shown in plots 5–6.

[4] Alternative name: Ny Alesund.
[5] Alternative name: Onsala.
[6] Alternative name: TIGO.
[7] DSS65 and NYALES20 not always recorded system temperature.

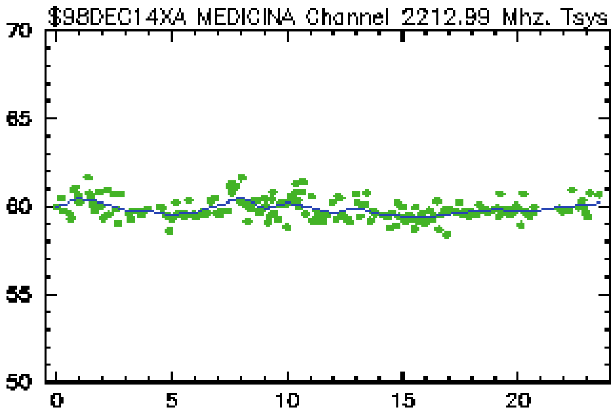

fig. 5

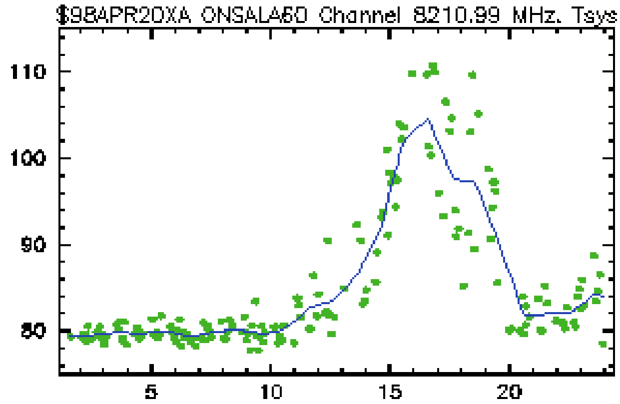

fig. 6

The lowest and the highest values of system temperature in zenith direction for each station are presented in table 2.

Station	T_{SYS} 8.2 GHz lower values	T_{SYS} 8.2 GHz higher values	T_{SYS} 2.3 GHz lower values	T_{SYS} 2.3 GHz higher values
CRIMEA	45	100	80	160
DSS65	45	90	50	120
EFLSBERG	40	55	140	160
MATERA	45	180	55	200
MEDICINA	40	45	60	85
NOTO	105	120	110	160
NYALES20	55	80	30	200
ONSALA60	75	140	55	120
TIGOWTZL	65	80	70	90
WETTZELL	55	90	40	50

Table 2: System temperature at zenith direction.

We see that system temperatures 40K are achievable but unfortunately rather higher values were obtained during the experiments. It is a reserve for improving performance.

5 Conclusions

Performance of the station is still far from ideal. In order to get the best performance a special care should be taken by personal before and during the experiment. Efforts for making correct frequency setup, correct heads setup, tapes checking, elimination of the sources of spurious signals in phase calibration, proper cooling receivers don't cost too much but may give considerable improvement in accuracy of the final results.

References

[1] Chao, C.C.: A model for tropospheric calibration from daily surface and radiosonde balloon measurements. Technical Memo, 391-350, Jet Propulsion Laboratory, 1972.