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Comparisons of Correlations Using Disk-Transfer and e–VLBI-Transfer

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Abstract. In May 2007 in the EURO87 session, the station at Metsähovi recorded the VLBI data in parallel on a Mark 5A disk module and on a Linux RAID system (PCEVN). The Mark 5A disk module was shipped to the correlator and the data from the raid system were transferred to a Linux RAID system in Bonn by e–VLBI using the UDP-based protocol Tsunami. In Bonn the data were then copied onto a Mark 5A disk module for correlation. Both data streams were correlated as if they came from different sites. At S-band there are noticeable differences in the delay observables of up to 400 ps for which the origin is not yet discovered.

1. Introduction

For some time now, transfer of raw VLBI data via electronic data transmission and, in particular, via the Internet has become common, however not routine practice, e.g. [5, 3, 2]. Today, the main hurdle to take is that not all stations are yet capable of sustaining reasonable data rates (i.e. > 100 Mbps) for long periods of time. In order to evaluate the actual quality of the electronic transfer in the current Internet environment, a test has been carried out with the data of the Metsähovi Observatory observed within the Europe-87 VLBI session [1].

At Metsähovi, the digitized data from the sampler have been recorded simultaneously on a Mark 5A recording system and on a PCEVN [4] (Fig. 1). The Mark 5A disk module has been shipped to the Bonn MPIfR/BKG correlator by courier service while the data from the PCEVN system were electronically transferred to a Linux PC with a RAID (VIOLA) at the correlating facility using the UDP based protocol TSUNAMI. The average transfer rate was 605 Mbit/s and the 524 GB of data were succesfully transferred in about 1h 47m. Here, the data were copied using the EGAE (Experimental Guided Adaptive Endpoint Architecture) software to another Mark 5A system.

From this point onwards, the two data streams have been treated completely independently. For a better separation, the data which has been transported along the traditional path was assigned to the standard station name METSAHOV while for the data which was transferred electronically a new station name SUOMI was introduced.

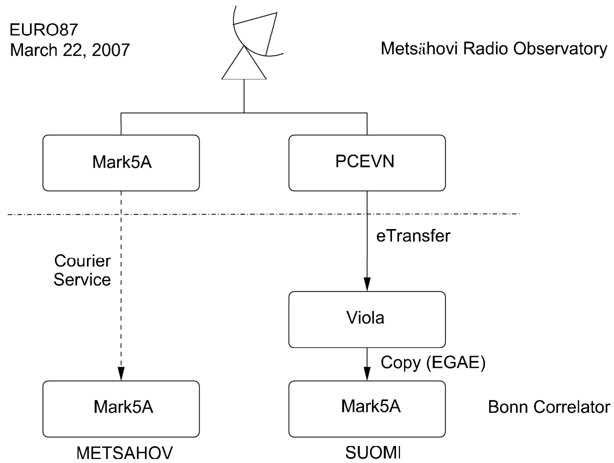

Figure 1. Data flow of Metsähovi VLBI data within test experiment

2. Data Processing

In the correlation process, the two data sources have been treated as two different stations with correlations being performed on all baselines of the network including those to SUOMI and even on the METSAHOV–SUOMI zero-length baseline. In this post correlation analysis we compare and discuss the differences of the delay observables which have been determined for METSAHOV and SUOMI to all other stations in the network.

The first fringe fitting process carried out using HOPS (Haystack Observatory Postprocessing Software) had been set up with slightly different sets of additive phase offsets of the individual channels for SUOMI and METSAHOV. While at X-band this oversight had hardly any effect on the resulting delay determinations, the S-band delays were affected quite significantly. The reason is that at S-band on some baselines only very few common channels, 3 - 4 out of 6, remained and the delay fit ($d\phi/dt$) reacted quite sensitively to these small phase offsets. Noticeable were the non-zero delays on the zero-length baseline SUOMI – METSAHOV (16 ps). By re-fringe fitting the session applying the same manual phase cal to both METSAHOV and SUOMI the problem disappeared.

In Fig. 2, the differences of the delay observables from the two different

Metsähovi data streams at S-band are depicted for all baselines versus epoch of observation. It becomes immediately obvious that in the first five hours of the session some peculiarities surface because the delay differences reach up to 400 ps in magnitude. Remarkable, though, is the fact that these large differences are not present at X-band where they are always below 5 ps with a hand-full exceptions of up to 13 ps.

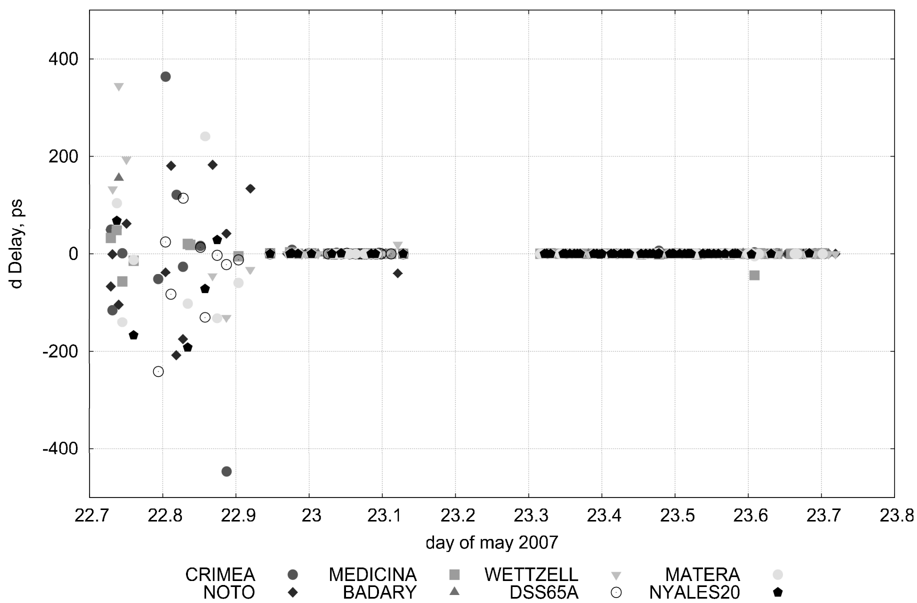

Figure 2. Delay differences versus time

In an attempt to figure out what may have caused these large discrepancies, we checked the number of samples (bits) which were used in the correlation process. It turned out that in the beginning of the session, i.e. when the large discrepancies actually happend, up to 200000 samples of roughly 20 million in each channel were missing. Fig. 1 depicts the delay differences versus percentage of difference in the correlated data for all baselines. In general, the integration times of the SUOMI data stream are slightly shorter by small fractions of a second because PCEVN starts recording at the edge of the one-pulse-per-second station synchronization signal, whereas the Mark 5A does not. This could explain some of the missing samples. However, this could not be proven yet. In addition, no further systematics could be detected.

In order to check whether a low level of SNR made the scans more prone to larger delay differences, we also looked at the delay differences versus SNR. As can be seen in Fig. 2 no clear systematic dependency of the delay differences from SNR can be found as well.

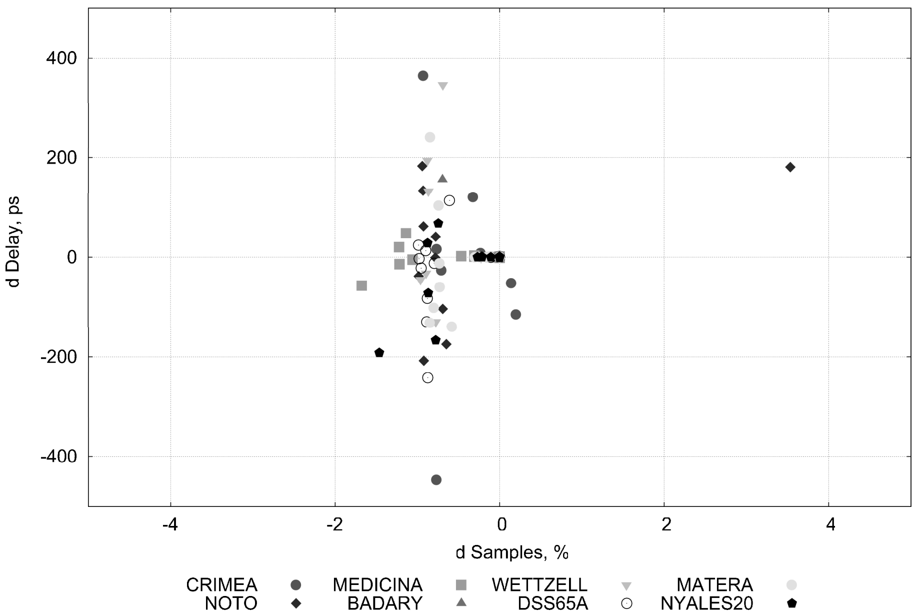

Figure 3. Delay differences versus sample differences in percent

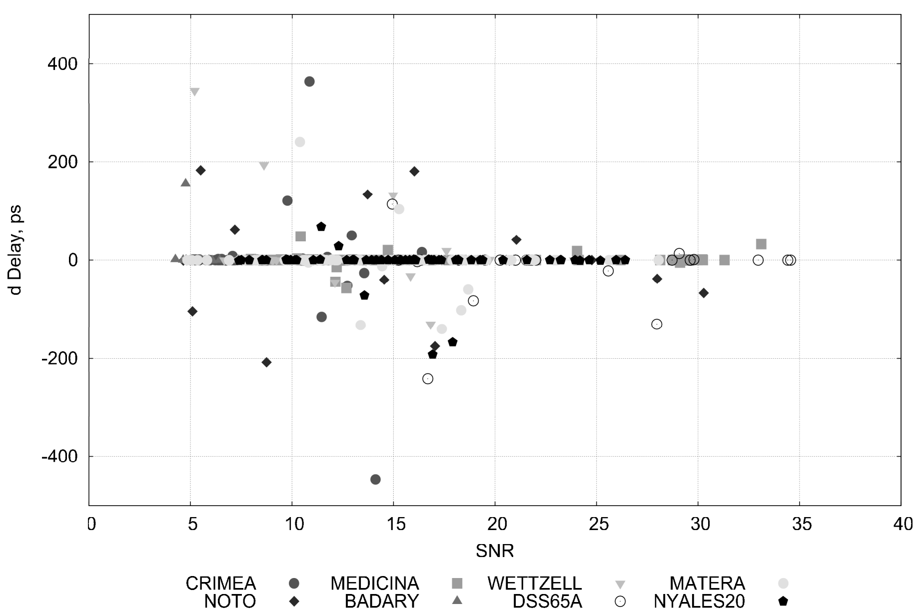

Figure 4. Delay differences versus SNR

3. Conclusions

So far, we were unable to find a clear reason for the delay differences and, thus, why the electronic transfer produced different delay results than the standard disk shipment procedure. The fact, that the discrepancies are only present at S-band but not at X-band casts some doubts on the assumption that the electronic transfer as such has caused the delays to change. Small differences in the integration times of less than 0.2 seconds should not cause such large changes in the delay determinations.

However, if the data had only been transferred electronically and processed in the normal way, the delay deviations had gone unnoticed and the ionosphere corrections had had serious deficiencies. For this reason these investigations are continued.

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