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Ultra-rapid dUT1 Measurements on Japan-Fennoscandian Baselines – Application to 24-hour Sessions

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Abstract

GSI, NICT, OSO, and MRO have been engaged in Ultra-rapid dUT1 experiments since 2007 aiming at the technological possibility of real-time dUT1 results using the e-VLBI technique. We have already successfully determined dUT1 in less than four minutes after the end of an experimental Intensive session in 2008, and at present we routinely get the results within 30 minutes for regular Intensives. In 2009 we applied the technique to 24-hour sessions and continuously obtained dUT1 values by processing and analyzing Tsukuba–Onsala data in near real-time. It showed a detailed behavior of UT1 variations, which could be very valuable for scientific study as well as for precise prediction of UT1-UTC.

1. Introduction

In 2008, GSI, NICT, Onsala Space Observatory (OSO), and Metsähovi Radio Observatory (MRO) achieved almost real-time UT1 measurements by utilizing fast network connection, software correlator and automatic analysis, and in particular obtained dUT1 in less than four minutes after the session on the Tsukuba–Onsala baseline in February 2008 [1]. In our continuing efforts we applied the method to regular 24-hour VLBI sessions to obtain a series of UT1 values for the whole experiment. We report here the outline of our experiments and the results.

2. Ultra-rapid Intensives

After the success of ultra-rapid measurement in the experimental Intensive sessions, we have arranged to apply it to regular Intensive sessions. As of early 2010, the INT2 sessions, which observe the baseline Tsukuba–Wettzell, are routinely executed as ultra-rapid sessions. Table 1 shows the status as of February 2010 of the Intensive sessions in terms of data-transfer and latency of results.

3. Ultra-rapid 24-hour Sessions

In applying our method to 24-hour experiments, we chose the sessions in which both Tsukuba and Onsala were participating. Figure 1 is a schematic diagram of 24-hour ultra-rapid data processing. Basically the same set-up as for the Intensives [2] was adapted; only, some modifications of data handling scripts and analysis strategy were done.

Table 1. Present Status (February 2010) of IVS Intensive Sessions.

Session	**Data transfer**	**Latency**	**Stations**	**Correlator**
INT1	Physical shipment	3-5 days	Kokee Wettzell	Washington
INT2	Network Quasi real-time	30 minutes	Tsukuba Wettzell	Tsukuba
INT3	Network Post observation	Few hours	Tsukuba Wettzell Ny-Ålesund	Bonn

The observed data (common to both Onsala and Tsukuba) from Onsala are e-transferred in real-time to GSI at Tsukuba. The Onsala data are converted in near real-time from Mark 5 to K5 format and correlated, and a VLBI database is created. Analysis is executed once 35 good scans have been accumulated in the database, and dUT1 is estimated automatically. The process is repeated so that the analysis is always on the latest 35 scans with each new scan in and the oldest one out. Each result is e-mailed to relevant addresses.

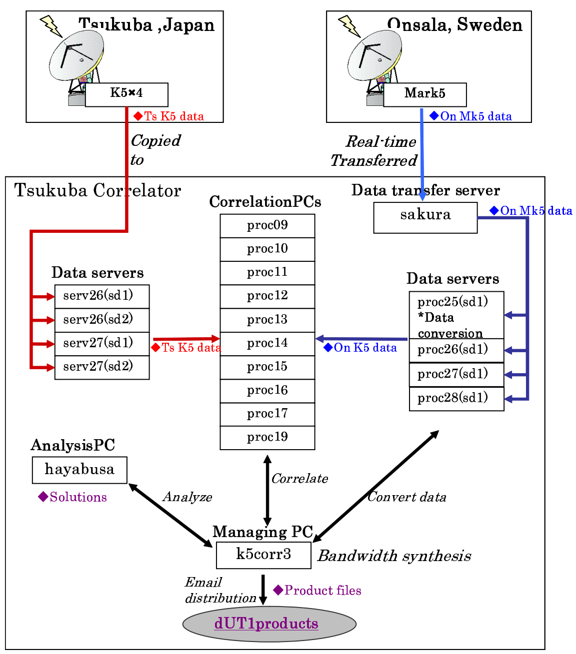

Figure 1. Data transfer and processing for a 24-hour session.

4. Experiments and Results

We conducted six experiments from June 2009 through early 2010. Figure 2 shows the ultra-rapid results from three sessions (R1409, RD0910, and R1413) plotted with USNO finals. The

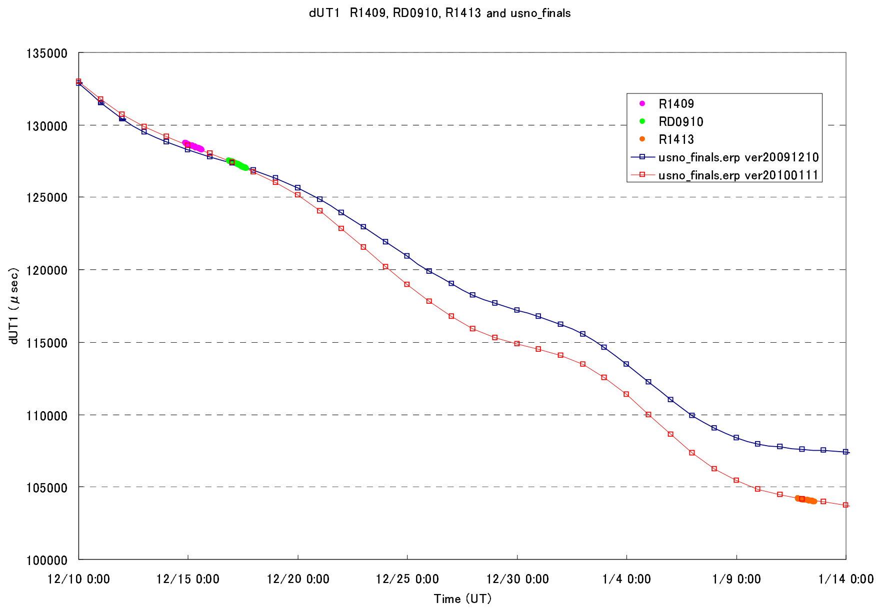

Figure 2. Ultra-rapid results, December 10 – January 14, comparison with USNO finals.

dUT1 results follow well the curve of USNO final values at 20100111.

As an example, for the R1413 session (Jan. 11–12), we e-transferred and processed the following data:

# of channels: S:6, X(USB):8, X(LSB):2

Sampling rate: 16 Mbps/ch, 256 Mbps in total

# of scans: Tsukuba: 514, Onsala: 425 (common to both: 194)

In this session, the processing started about nine hours after the start, and in the latter half of the experiment we could catch up with the observation and get dUT1s within 20 minutes after the latest scan with formal errors of ∼10 μs (Figures 4 and 5).

As predicted dUT1 values tend to diverge from the actual final values in as short as a day, ultra-rapid results could put constraints to improve the prediction (see Figures 3–5). These figures also suggest that our results successfully captured the details of short-term variations of dUT1 around the averaged final values. From a scientific point-of-view, sub-daily, continuous dUT1 values offer valuable data for the study of earth rotation and dynamics.

5. Conclusions and Future Prospects

We successfully demonstrated continuous, near real-time dUT1 measurements for 24 hour sessions. If we expanded our network to include north-south baselines, it would enable a real-time determination of polar motion parameters, and one of the goals of VLBI2010—continuous EOP determination—would be well within our reach using current technologies.

For scientific studies, the short-term variation of dUT1 would be a very valuable piece of information in the study of earth dynamics. For practical purposes, the prediction of dUT1 can

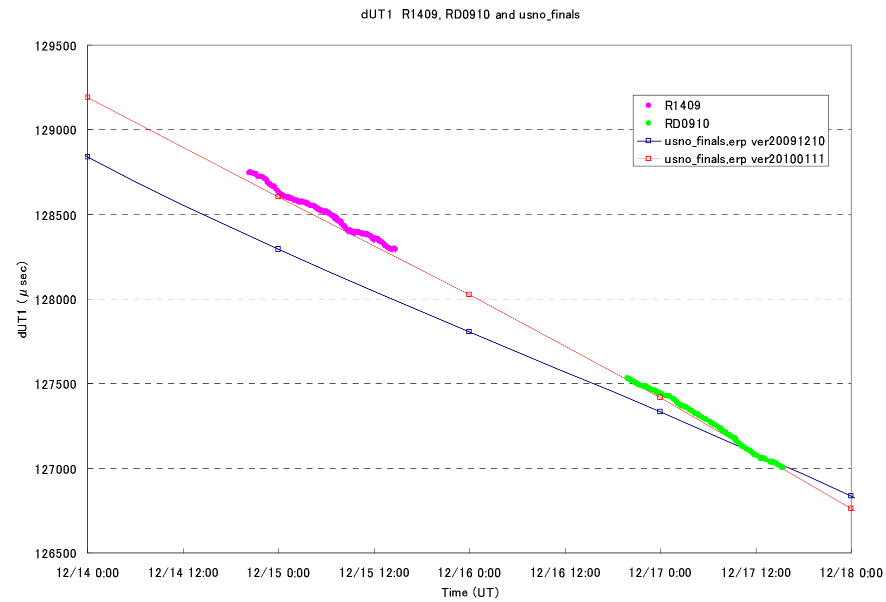

Figure 3. Detailed view of Figure 2 for December 14–18.

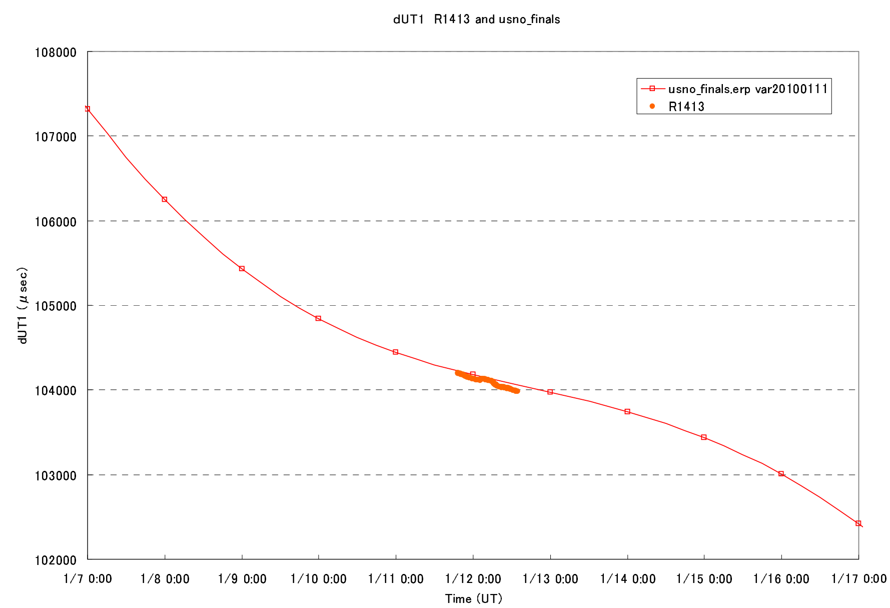

Figure 4. Ultra-rapid results, January 11–12.

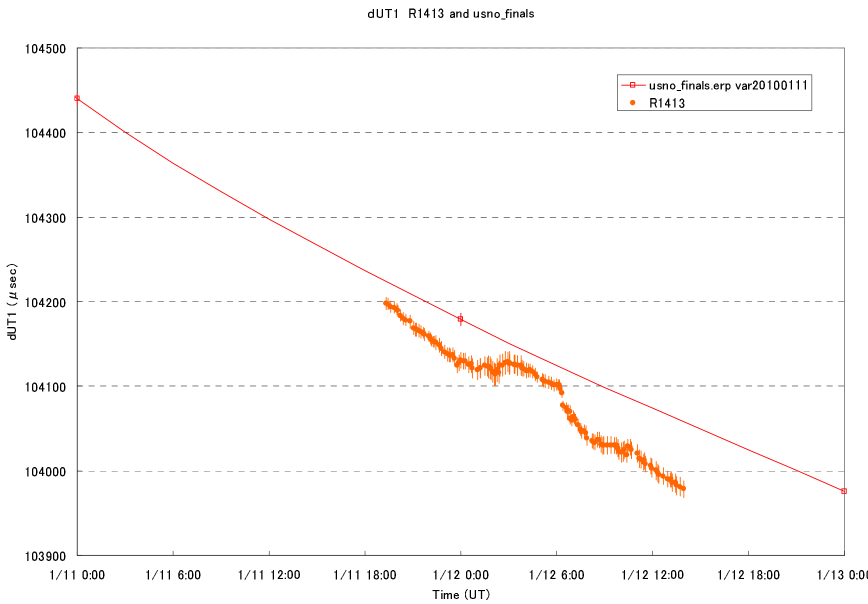

Figure 5. Detailed view of Figure 4 for January 11–12.

be improved with the consideration of continuous values.

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