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E3 Network Results

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Abstract

For the past four years the Canadian Technology Development Center has been coordinating and analyzing the IVS-E3 network. The E3 network uses the S2 VLBI system at 6 stations worldwide and its sessions are correlated at the Dominion Radio Astronomical Observatory. Analysis of the E3 observations for EOP and TRF are presented. Experience with the network has allowed for the use of new approaches to operations. The future of the network is discussed with an eye towards VLBI2010.

1. IVS-E3 Network History

The IVS-E3 network is an international VLBI network designed to provide additional EOP data to the IVS time series, and add unique points to the VLBI determined TRF. The monthly sessions are observed with the S2 VLBI system. The S2, developed by the Canadian Technology Development Center, also offers a check for bias between other VLBI systems. The E3 network has been operating since March of 2002.

1.1. E3 Network and Observations

Because Earth orientation determination at the level of the R4 series is one of the goals of the E3 network, and the S2 correlator can handle six stations without repeat passes, the network has expanded to six stations. Algonquin Park, Kokee, Svetloe, TIGO-Concepcion, and the Canadian Transportable VLBI Antenna (CTVA) located in St. John's, Newfoundland participate in E3 sessions year round. In the North American summer, Yellowknife observes while the winter sessions were handled by Gilmore Creek. With the recent mothballing of the Gilmore Creek antenna the E3 sessions will be concentrated between June and September to maximize the EOP determination and the Yellowknife position. Table 1 summarizes the participation of each station in E3 sessions.

Table 1. E3 observations by station.

IVS Station	Number of E3 Sessions (Jan. 06)
ALOGPARK	44
CTVASTJ	31
GILCREEK	5
KOKEE	32
SVETLOE	18
TIGOCONC	35
YLOW7296	10

The stations provide good extent in North-South and East-West baselines; however half the stations used are intended to be mobile, so limited sensitivity is an obstacle to the E3 network. The S2-DAS operates at 128 Mbps, observing 18 channels with 16-MHz bandwidth using 2-bit sampling, but recording only 2 channels at any given time. To compensate for the smaller antennas the E3 network is heavily dependent on the larger dishes: Svetloe and Algonquin. Scheduling is modified to maximize the small dish inclusion with one of the two larger dishes, and maximizes the integration times for scans by recording all "on source" time, guaranteeing maximum integration times and SNR. Recording is done using a modified set of 8 VHS video cassette recorders.

2. E3 Analysis

To ensure the utility of the E3 data, regular global solutions are run at NRCan using CALC/SOLVE. Solutions for EOP, site and baseline repeatability, and terrestrial reference frame are determined.

2.1. Station Positions

Two types of solutions are run to examine the station positions as determined by the E3 network. The first computes a single station position and rate at a given epoch. To evaluate the effect of the E3 data, a solution is run with and without the E3 sessions, and position and velocity differences are compared. As would be expected the additional E3 data modestly reduces the uncertainty of E3 stations. The IVS TRF is aided by E3 observations, which make up all of the observing in St. John's and the majority of observations in Yellowknife. The second type of solution is to examine the station and baseline repeatabilities by solving station positions at every session. In these solutions a subset of stations is used to constrain the solutions to No-Net Rotation with regard to ITRF2000. The NNR constraint tends to reduce the scatter of some stations in small networks. Baseline lengths, however, are independent of rotation, and offer the method of comparison of position determination. Baseline repeatabilities of the E3 network results are compared to a small set of R1 and R4 baseline lengths involving similar stations in Figure 1.

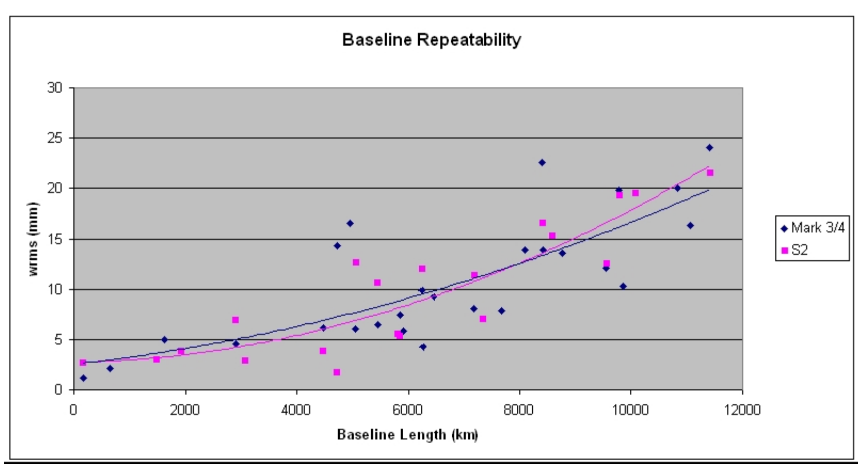
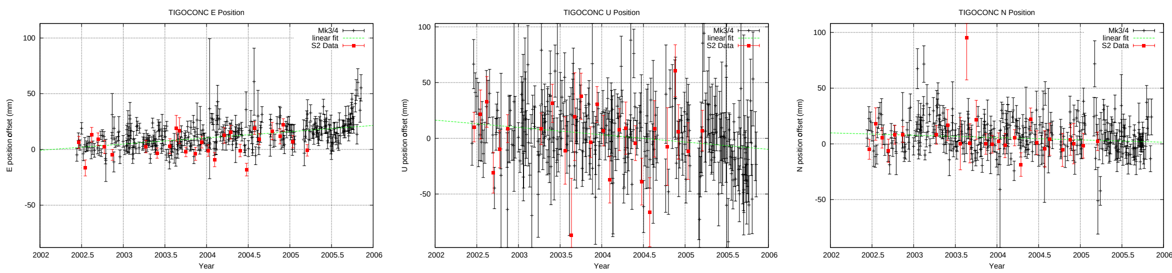


Figure 1. Baseline repeatabilities for E3 and R1/4 sessions

E3 baselines repeatability compares well with the standard IVS Rapid series, though the baseline repeatability tends to grow faster on longer baselines in the E3. This is due to having many mobile antennas throughout the network, which tends to increase scatter, especially on longer baselines. Similarly, repeatabilities for the E3 stations are regularly monitored against positions determined by the R1 and R4 sessions. E3 data shows slightly larger sigma values, but no bias compared to the more standard sessions.



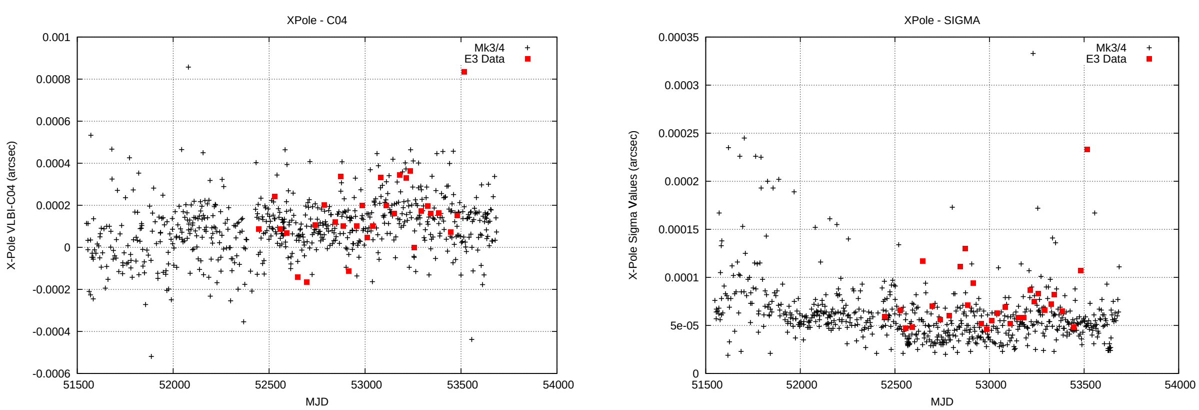
Tigo North Offset | Tigo Up Offset | Tigo East Offset

Figure 2. TIGOCONC position repeatability.

In Figure 2 there is no significant difference between the site positions determined with the S2 or Mark IV/5. This is typical of the E3 stations.

2.2. Earth Orientation Parameters

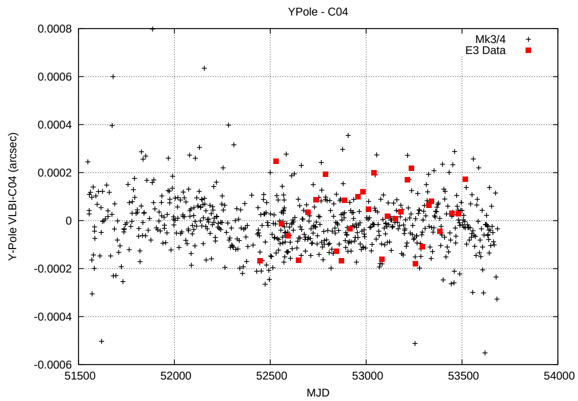
The goal of the E3 series is to provide additional EOP determinations to the IVS product. Though the network is small and sensitive to antenna loss, Earth orientation can be determined from most sessions. Following global solutions, the EOP determined from the IVS Rapid sessions and the E3 sessions are compared to the IERS C04 EOPs.



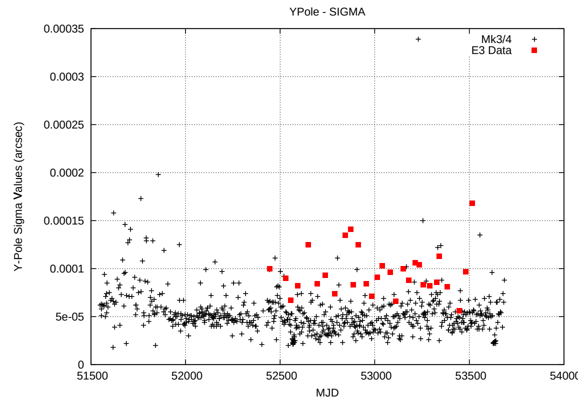
Compared to C04 | Sigma Values

Figure 3. X-Pole Comparison

It can be seen that when all stations of the E3 network are operating, sigma levels are compara-

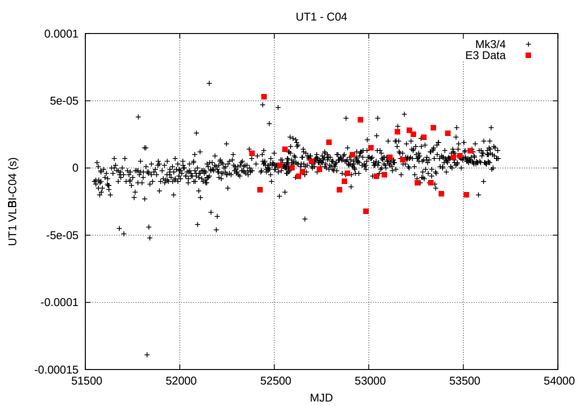


Compared to C04

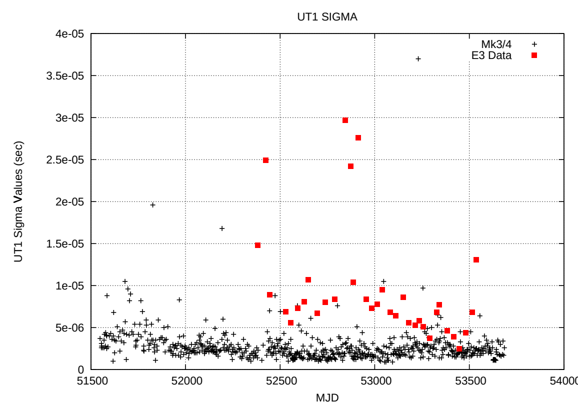


Sigma Values

Figure 4. Y-Pole Comparison



Compared to C04



Sigma Values

Figure 5. UT comparison.

ble with the R4 series; however the E3 network is very sensitive to station failures. On average EOP uncertainties are 10-30 percent greater for the E3 network, but in sessions with 5 or 6 participating stations there is less than a 10 percent difference.

3. Future Plans

Recently, an XM terrestrial repeater was activated in St. John's and saturated the S-Band front end of the CTVA. As a result, it is hoped that the antenna will be relocated in 2006. As the S2 recorders age, both the correlator and stations have begun experiencing problems with the tape recorders. Preliminary development work has begun on a disk based replacement for the recording system. At the same time, NRCan has been granted a license for the NICT Software Correlator package which may provide support to our small correlator staff. Work continues to make observations as automated as possible, reducing the demand for observers. It is hoped that some of the experiences in automation and equipment development are useful in the realization of the VLBI2010 vision.

4. Conclusions

The results of the E3 VLBI sessions have been presented and compared against routine IVS operations. It has been shown that when the network is fully operational it performs at a level comparable to the standard sessions. Inclusion of E3 data to VLBI determined TRF solutions will maintain the Yellowknife point and add a point at St. John's, Newfoundland. There are currently many obstacles facing the E3 network. Aging equipment, RFI, and human resources all pose challenges which will require innovative solutions which may aid in the realization of VLBI2010.