REPLICATING UTC(NIM) REMOTELY FOR TIME AND FREQUENCY TRACEABILITY

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ABSTRACT

GPS time transfer is one popular method for remote comparison and calibration of time and frequency. In recent years, signals from new GNSS systems have become available. Through new GNSS systems, time and frequency transfer has been studied and implemented. Calibration uncertainties of the system for time and frequency have been evaluated as 6 ns and 2e-14 respectively averaging over one week. For the user who has no time scale or frequency standard, needs either or both of these and requires traceability to UTC(NIM), the Primary National Time and Frequency Standard of China, replicating UTC(NIM) could be a good way of meeting this requirement. We achieve this by providing a low-cost UTC(NIM) disciplined oscillator system with near real-time (16-minute latency) remote calibration through instant communication. We call this system NIMDO. Its performance have been verified and demonstrated referenced to UTC(NIM). NIMDO has been used at different sites and in several industries. The absolute values of the time and frequency differences from UTC(NIM) can be less than 1 ns and 5e-14 when averaged over one day, and the time and frequency stability can be better than 1 ns and 3e-14 respectively, averaged over one day.

Key words: GNSS, time and frequency transfer, disciplined oscillator, remote traceability.

I. INTRODUCTION

GPS time and frequency transfer (GPSTFT) and two way satellite time and frequency transfer (TWSTFT) are the most accurate and precise methods on very long baselines. At the same time, thanks to its easy receiving of GPS signals, GPS time transfer is the most popular method for remote time and frequency transfer. In the only international key comparison for time and frequency, which is CCTF-K001. UTC and also called TAI cooperation piloted by the BIPM (International Bureau of Weights and Measures, in Sèvres, France) charged by CCTF (Consultative Committee for Time and Frequency), GPS time and frequency link is used by all the participating laboratories. With the quick development of GLONASS (GLObal Navigation System), BDS (BeiDou Navigation Satellite System) and Galileo, GNSS (Global Navigation Satellite System) time and frequency transfer and time and frequency transfer with the combination of multiple GNSS measurements becomes more and more significant. GNSS gives us the convenience of remote calibration for time and frequency. With the techniques of modern network communication, remote calibration based on GNSS time and frequency transfer in real-time is feasible.

The time and frequency standard plays a very important role in metrology. Based on GNSS time and frequency transfer in near real time through instant communication, a low-cost oscillating system, NIMDO (UTC(NIM) Disciplined Oscillator), has been built at the NIM (National Institute Metrology, in Beijing, China) and is in operation. In legal sense, we should have the time and frequency standard directly traced to UTC(NIM), for the completion of the civil time tracing hierarchy. NIMDO has instant and direct traceability to UTC(NIM) when powered on and in stable running and

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might be fit for the user who needs the time scale or frequency standard where time or frequency should be legally traceable to UTC (Coordinated Universal Time). Instead of operating precise continuously running atomic clocks and calibrating them periodically against UTC, NIMDO can be used resulting in significant reduction of manpower and material resources use and saving time. NIMDOs have been used at different sites in several industries. The absolute values of the time difference and the frequency difference could be better than 1 ns and 5e-14 respectively averaged over one day, and the time stability and the frequency stability averaged over one day could be better than 1 ns and 3e-14 respectively.

II. REMOTE TIME AND FREQUENCY TRANSFER VIA GNSS

There are two general types of GNSS time transfer depending on which signals are used: Psuedo-range code and carrier phase. The basic principle is shown in Fig. 1. In the following sections, we focus on the code measurement, particularly the measurement based on the CGGTTS (Common Generic GNSS Time Transfer Standard) data generated by the receivers themselves.

In Fig. 1, the GNSS time and frequency transfer receivers $R1$ and $R2$ separately referenced to the corresponding local time and frequency standards $LTR1$ (the reference standard) and $LTR2$ (the standard to be tested) are used in the reference station and test station. The methods how time and frequency signals from the standard are related to the receiver time may be different in terms of the operation modes of the receivers (see details in [1]). The time differences $\Delta T1$ and $\Delta T2$ that is the difference between the local time and frequency standard for each station and GNSS system time (GNSST) may be obtained by the two receivers and the time and frequency transfer results can be calculated as (1) - (3). That is to say, the difference between $LTR1$ and $LTR2$ is calculated by the difference between $\Delta T1$ and $\Delta T2$.

$$\Delta T1 = LTR1 - GNSST \tag{1}$$

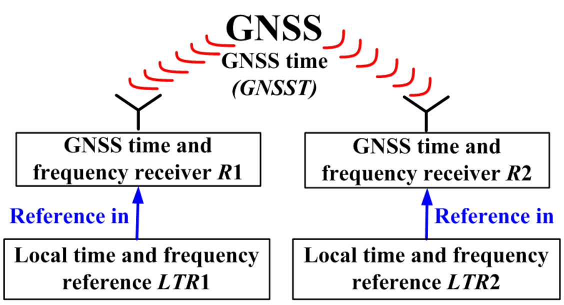

Fig. 1 Time and frequency transfer technique by GNSS.

$$\Delta T2 = LTR2 - GNSST \tag{2}$$

$$LTR1 - LTR2 = \Delta T1 - \Delta T2 \tag{3}$$

The transmission of the GNSS signals is influenced by ionospheric delay, tropospheric delay, relativistic effect caused by relative motion between the satellite and the receiver, satellite orbit, satellite clock error and so on, and these need to be modeled or measured to be compensated in time and frequency transfer calculation, which is described in section VI.

At present, the four GNSS systems could be used for time and frequency transfer. The basic principles via different GNSS systems are similar. GPS is the most popular system for time and frequency transfer due to its successful pioneering role and its ease of use. Since 2012, with the improvement of GLONASS system, GLONASS links for time transfer have been used in the computation of UTC.

In recent years, new GNSS systems have been developed fast. Since 27th Dec 2012, BDS (BeiDou Navigation Satellite System) Signal in Space Interface Control Document-Open Service Signal B1I (ICD, Version 2.1) has been released and since then BDS system with coverage on part of the Asia-Pacific area has provided official service and can be used for time and frequency transfer in this area. In fact, there are 14 satellites including 5 GEO, 5 IGSO and 4 MEO satellites [2] for use of position, navigation and timing. The global constellation is nearly complete. In December, BDS started providing global service. Galileo [3] is the global navigation satellite system (GNSS) that is being created by the European Union (EU) through the European GNSS Agency (GSA). As of July 2018, 26 of the planned 30 active satellites are in orbit. The complete 30-satellite Galileo system (24 operational and 6 active spares) is expected by 2020. The BDS B1I and B2I signals with the carrier frequencies of 1561.098 MHz and 1207.140 MHz respectively and Galileo E1 and E5a signals with the carrier frequencies of 1575.42 MHz and 1176.450 MHz respectively have been included in the latest CGGTTS version 2e (see details in [4]) and employed for remote time and frequency transfer.

III. REPLICATING UTC(NIM) AT A REMOTE SITE

NIMDO is the significant extension of GNSS time and frequency that is shown in Fig. 2. If the GNSS time transfer data from the reference station in Fig. 1 can be acquired through some kind of near real-time communication method by the test station in Fig. 1, with the data from the test station, the steerable oscillating system in the test station may be steered to the reference, such as UTC(NIM), by time and frequency results between two stations. When the oscillating system is operated continuously, it is a time scale disciplined by and traced to

UTC(NIM), that is NIMDO. In the whole process, there should be GNSS time and frequency transfer system which is the most important part and used for the measurements of the time and frequency transfer data, the suitable oscillator which can be steered and is used to provide frequency with 10 MHz and 1PPS (Pulse Per Second) signals, the steering algorithm and one industrial computer as the controller in NIMDO as illustrated in Fig. 2.

One implementation of NIMDO is shown in Fig. 3. In this specific case, NIM-TF-GNSS-3 type time and frequency transfer system has been selected because it is developed by NIM and can easily be adapted to our special use. For not only the general performance but also low cost and small size of the clock, the Rubidium clock is selected as the compromise in this case. User interface of the GNSS time and frequency transfer system referenced to the Rubidium clock can mainly generate and show the results of time and frequency transfer for the single station that stand for the difference between the Rubidium clock and GNSST and so on.

One steering program is used to keep the Rubidium clock operated in a controllable way as to ensure its time and frequency output are stable and reliable using the steering algorithm in near real-time. Thus, NIMDO works in being steered by calibrating the Rubidium clock referenced to UTC(NIM) with the time and frequency differences between the Rubidium and UTC(NIM).

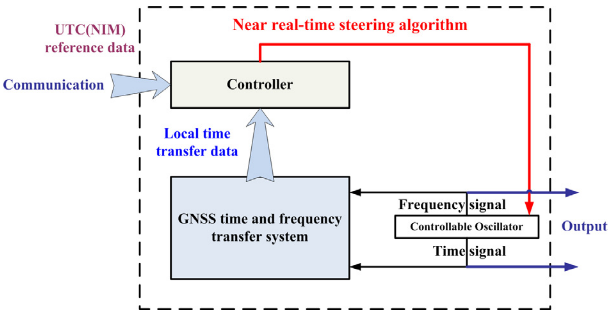

Fig. 2 Principle of NIMDO.

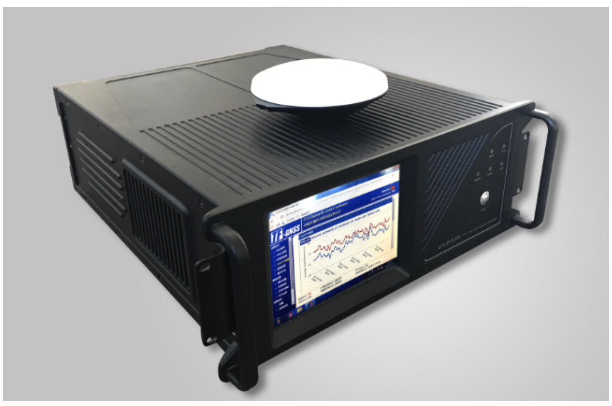

Fig. 3 NIMDO outlook.

It is necessary that there is one reference measured by one GNSS time and frequency system. In legal sense, UTC(NIM) that is based on an ensemble of 10 active Hydrogen masers and 7 Cesium clocks is the well qualified candidate since it is the national primary metrology standard for time and frequency in China, kept by NIM who is national metrology institute (NMI) of China. NIMDO calculates the time and frequency difference between NIMDO and UTC(NIM) for the steering of NIMDO to UTC(NIM). For several or multiple NIMDOs, one reference could be used for all of them.

At the same time, it is significant for NIMDO to transfer time accurately. The time transfer link based on the GNSS time and frequency transfer systems in the link between NIMDO and UTC(NIM) must be calibrated correctly so that the NIMDO time can be traced to UTC(NIM) with the suitable combined standard uncertainty that should be 2 ns~3 ns ns after correction for the time link calibration.

The steering algorithm must be stable and reliable so that NIMDO can keep its accuracy and precision for days, weeks, or even months. The time and frequency differences between NIMDO and UTC(NIM) are calculated and the adjustment values are estimated from the above information using some kind of PD (Proportion and Derivative) control. The adjustment interval should be set properly so that the noise level of the Rubidium clock and time link stability are matched to each other. When the time difference is in some predefined range, the adjustment to NIMDO will be less frequent to guarantee the stability. In addition, some delays, such as network delay, should be considered as well and the linear combination of many elements forms the main time difference estimation equation to get more accurate time difference in terms of (4).

$$\Delta T_i = \Delta t_i + \frac{(\Delta t_i - \Delta t_{i-1})}{\tau} \times \frac{(\tau + t_{\mathrm{d}})}{2} \tag{4}$$

ΔT_i: total time difference between NIMDO and UTC(NIM) during the steering process in the *i*-th cycle;

Δt_i: time difference between NIMDO and UTC(NIM) obtained by GNSS time transfer from two sites in the *i*-th cycle;

Δt_{i-1}: time difference between NIMDO and UTC(NIM) obtained by GNSS time transfer from two sites in the (*i*-1)-th cycle;

τ: sampling period, such as, 10 minutes;

t_{d}: estimated time delay, such as data transmission via network.

For the steering, phase adjustment and frequency adjustment could be used according to the different circumstances. When the time difference between NIMDO and UTC(NIM) is large, the phase of Rubidium clock could be adjusted in the steering algorithm in terms of ΔT_i from (4). However, phase adjustment is a direct but not an optimal way for stability of a time scale. Frequency adjustment could maintain NIMDO in a smooth way. According to the relationship between time difference and relative frequency deviation, the frequency adjustment value can be obtained using (5).

$$\frac{\Delta f}{f_{\mathrm{UTC(NIM)}}} = \frac{f_{\mathrm{Rb}} - f_{\mathrm{UTC(NIM)}}}{f_{\mathrm{UTC(NIM)}}} = \frac{\Delta T_i - \Delta T_{i-1}}{\tau} \tag{5}$$

Δf : frequency deviation between NIMDO and UTC(NIM)

f_{Rb} : frequency of the local rubidium clock;

$f_{\mathrm{UTC(NIM)}}$: frequency of UTC(NIM)

IV. EVALUATION RESULTS

The experiments have been done for performance verification and evaluation of NIMDO. We use some results including time and frequency difference with reference to UTC(NIM) by GPS (Global Positioning System) CV to verify the time and frequency accuracy and use some of their statistics such as TDEV (Time Deviation) and MDEV (Modified Allan Deviation) (see details for TDEV and MDEV in [5]) for the proof of the time and frequency stability. The direct comparison with the free-running Rubidium clock and the Caesium clock by one phase comparator were implemented for the characterization of the advantages of steering.

A. Local comparison

Since NIMDO could be regarded as a time scale traced to UTC(NIM), the most important specification, i.e., the accuracy of NIMDO referenced to UTC(NIM), has been evaluated through local time difference measurement reference to UTC(NIM) by time interval counter (TIC, type SRS 620, see details in [6]). The time differences with 1s sampling interval for one day are as Fig. 4 shows. The average (mean value) is about -2.9 ns and the absolute values of the maximum deviation from UTC(NIM) is less than 10 ns.

At the same time, with reference to UTC(NIM), NIMDO was measured by one phase comparator (Symmetricom 5125A, see details in [7]). After several days, analysis of the measurements acquired shows that ADEV (Allan Deviation) as the frequency stability between NIMDO and UTC(NIM) was about 3e-14 and was compared to the factory specifications of two kinds of Caesium clocks (Symmetricom 5071A, see details in [8]) with standard tube and with high performance tube as Fig. 5 shows. The results show that NIMDO traced to UTC(NIM) in near real time is similarly stable to the Caesium clock with high performance tube at the averaging time of about one day.

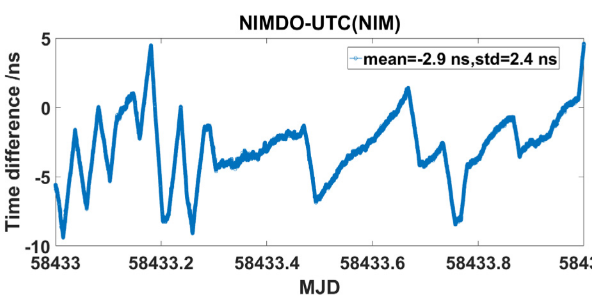

Fig. 4 Local time differences of NIMDO at Changping campus.

B. Remote comparison

Generally, considering its application, NIMDO works at a remote site far away from UTC(NIM) at NIM Changping campus. In our experiments, one NIMDO is located at NIM Hepingli campus, about 40 km far away from Changping campus. The remote time transfer results between NIMDO and UTC(NIM) are acquired based on CGGTTS data via GPS C/A code measurements in common view (CV) mode. The time and frequency differences during twelve days from MJD 58477 to 58488 are shown in Fig. 6 and 7. Compared to UTC(NIM), the absolute values of the daily time and frequency differences are mostly within 1 ns and 5e-14 respectively and the average values during this period are 0.3 ns and 7.0e-15 respectively.

Fig. 8 and 9 illustrate that TDEV as the time stability and MDEV as the frequency stability for one day are about 0.5 ns and 9.6e-15 respectively. And when the averaging time is longer than two days these values approach 150 picosecond and low 10^{-15} level.

C. Operation over longer baselines for a long period

For the further verification over the longer baseline for longer periods, several pilot NIMDO sites have been constructed in Guiyang, Urumqi, and Harbin. Since the reference UTC(NIM) is at the NIM in Beijing, the baselines from Guiyang, Urumqi and Harbin are relatively long with distances of more than 1700 kilometers, 2400 kilometers and 1000 kilometers respectively. Three NIMDOs, IM04 in Guiyang, IM08 in Urumqi and IM10 in Harbin are built with Rubidium clocks. As Fig. 11 shows, the NIMDOs via GPS measurements have been operated continuously since mid-2015. All the results in Fig. 10 are based on GPS C/A code measurements. For Guiyang and Harbin the results are calculated in CV

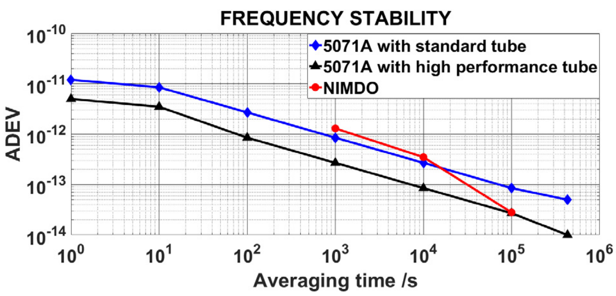

Fig. 5 Frequency stability comparison of NIMDO against Caesium 5071A.

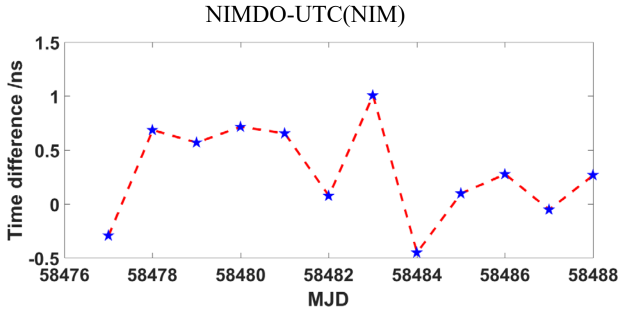

Fig. 6 Daily time differences of NIMDO at NIM Hepingli campus.

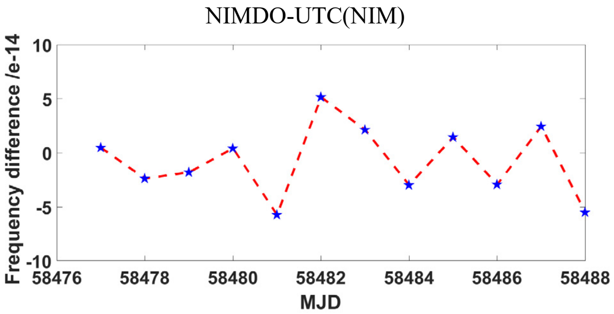

Fig. 7 Daily frequency differences of NIMDO at NIM Hepingli campus.

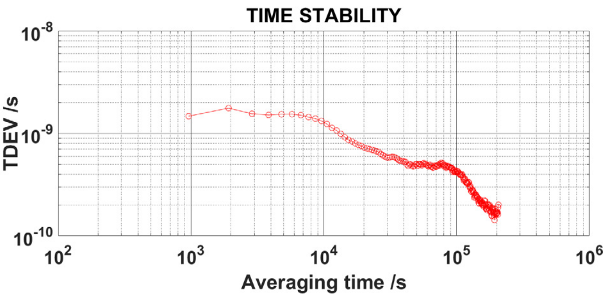

Fig. 8 Time stability of NIMDO at NIM Hepingli campus.

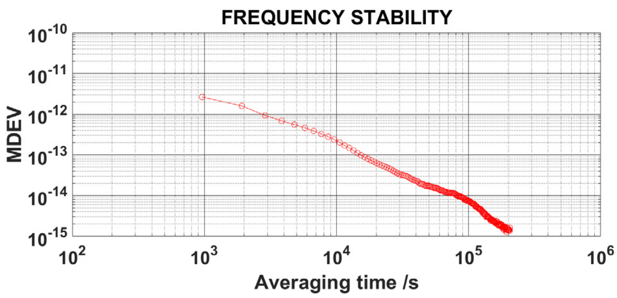

Fig. 9 Frequency stability of NIMDO at NIM Hepingli campus.

mode, and for Urumqi all-in view (AV) (see details in [9]) mode is set. However, due to lack of UPS (Uninterruptable Power Supply) support, sometimes the power blackout happened and led to data gaps. Sometimes the network for NIMDO communication with UTC(NIM) failed, and some big bumps were observed since NIMDO lost lock and the time differences were increased outside the limits.

From Table 1, about 90% of the absolute values for the time differences between NIMDO and UTC(NIM) are less than 10 ns. Frequency differences in Fig. 11 are calculated through time differences, and the statistics are listed in Table 2. The absolute values are within 1e-13 for 85% to 90% of the time.

For the time stability, in Fig. 12, the three NIMDOs show similar results to those in Subsection B, and the TDEV for one day averaging is about 0.5 ns and could reach nearly 100 ps level over tens of days. In Fig. 13, the MDEV shows that the frequency stability could almost reach 10^{-15} level after one day averaging and continue decreasing with increasing averaging time. From all the results above, the three NIMDOs show general agreement with one another.

D. Preliminary implementation with Cs clock and H-maser

For better performance, the Rubidium clock could be replaced by a Caesium (Cs) clock or Hydrogen-maser (H-maser). The Cs clock provides better accuracy and

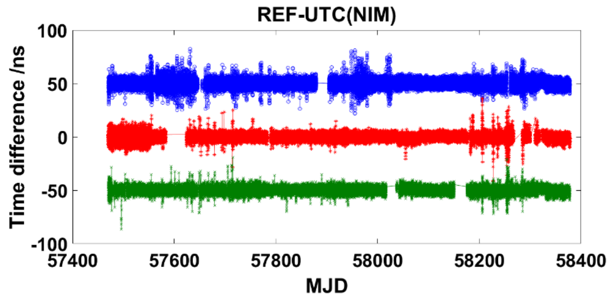

Fig. 10 Time differences of NIMDOs over longer baselines.

Blue: IM04, average time difference= 0.1 ns, standard deviation=3.4 ns, relative frequency difference= -6e-19.
Red: IM08, average time difference= 0.1 ns, standard deviation=2.9 ns, relative frequency difference= -6.8e-18.
Green: IM10, average time difference= 0.2 ns, standard deviation=2.7 ns, relative frequency difference= -3.3e-18.

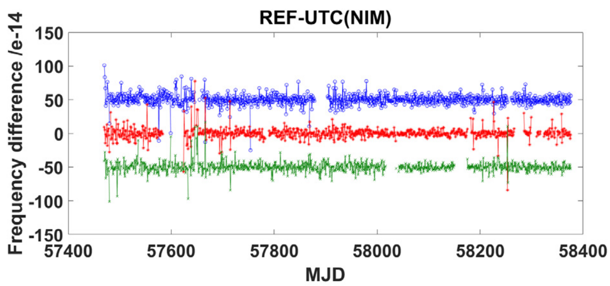

Fig. 11 Frequency differences of NIMDOs over longer baselines.

Table 1 Time difference statistics for 3 NIMDOS over longer baselines.

Reference Station	Observation	0<|**|<5 ns	5 ns<|**|<10 ns	10 ns<|**|<15 ns	15 ns<|**|<20 ns	|**|>20 ns
IM04	71870	65064	5877	625	203	101
		90.53%	8.18%	0.87%	0.28%	0.14%
IM08	68001	62874	4632	368	82	45
		92.46%	6.81%	0.54%	0.12%	0.07%
IM10	72288	67512	4506	184	55	31
		93.39%	6.23%	0.25%	0.08%	0.05%

Table 2 Frequency difference statistics for 3 NIMDOS over longer baselines.

Reference Station	Observation	0<|**|<5 e-14	5 e-14<|**|<1 e-13	1 e-13<|**|<2 e-13	|**|>2 e-13
IM04	839	503	222	87	27
		59.95%	26.46%	10.37%	3.22%
IM08	800	548	171	51	30
		68.50%	21.38%	6.37%	3.75%
IM10	839	531	218	69	21
		63.29%	25.98%	8.22%	2.51%

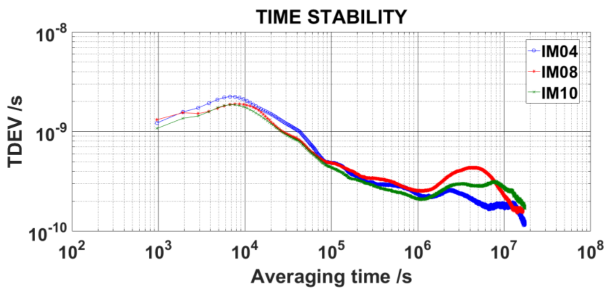

Fig. 12 Time stability of NIMDOs over longer baselines.

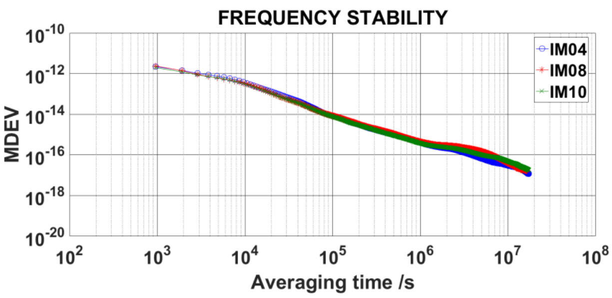

Fig. 13 Frequency stability of NIMDOs over longer baselines.

stability at the long term so that the steering process will be easier. And the H-maser is much more precise and stable at short time intervals so that NIMDO could provide much better performance in the short term where a Rubidium clock cannot be controlled effectively due to the time link noise. Cs clocks and H-masers have been used in the experiments and as well one Rubidium (Rb) clock that has been used for comparison.

For this part of the experiment, NIMDOs have been constructed with Cs clocks and H-masers using the principles and structures shown for NIMDO in Section III. For the time transfer, GPS and BDS links between two NIM campuses were selected. Four receivers IM07, TF07, IM13 and IM14 at NIM Hepingli campus were employed for experiments as Table 3 lists. The steering algorithm is nearly the same as described in Section III.

From Fig 14 and 15, the absolute values for the time and frequency differences of NIMDO are within 5 ns in 90% of cases and 1e-13 in more than 95% of cases respectively; for H-masers, they are within 5 ns in 95% of cases and 1e-13 in more than 95% of cases respectivley. The statistics for the time and frequency differences are listed in tables 4 and 5.

From Fig. 16 and 17, at short term, all the measurements are based on the standard CGGTTS sampling interval, there is just Rb clock that was really measured due to its poor short term stability, and for Cs clocks and H-masers results, the measurements show the behavior of the time links via GNSS code measurements. At long

Table 3 Receiver employed in the experiments.

Code	Type	Reference	GNSS systems
IM07	NIM-TF-GNSS-2J	Cs clock / Rb clock	GPS
TF07	NIM-TF-GNSS-3	Cs clock	BDS and GPS
IM13	NIM-TF-GNSS-3	H-maser	BDS and GPS
IM14	NIM-TF-GNSS-3	Cs clock	BDS and GPS

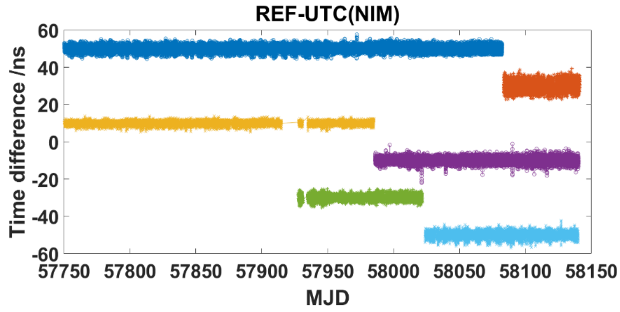

Fig. 14 Time differences of NIMDOs with Rudium, Caesium and H-maser via BDS and GPS.

Indigo: IM07, GPS , Cs; Red: IM07, GPS, Rb; Yellow: IM13, GPS, H; Purple: IM13, BDS, H; Green: TF07, BDS, Cs; Azure: IM14, BDS, Cs

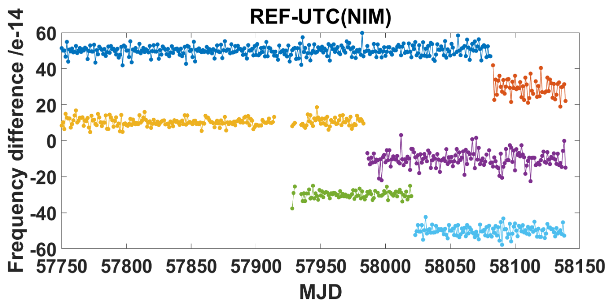

Fig. 15 Frequency differences of NIMDOs with Rudium, Caesium and H-maser via BDS and GPS.

Indigo: IM07, GPS , Cs; Red: IM07, GPS, Rb; Yellow: IM13, GPS, H; Purple: IM13, BDS, H; Green: TF07, BDS, Cs; Azure: IM14, BDS, Cs

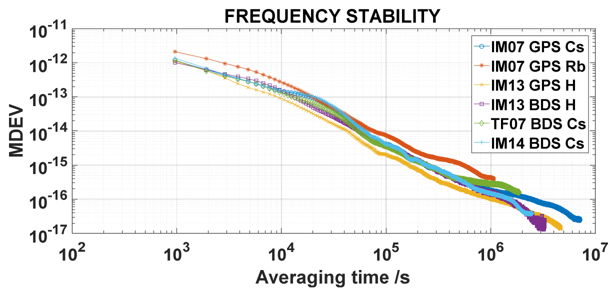

Fig. 16 Frequency stability of NIMDOs with Rudium, Caesium and H-maser via BDS and GPS.

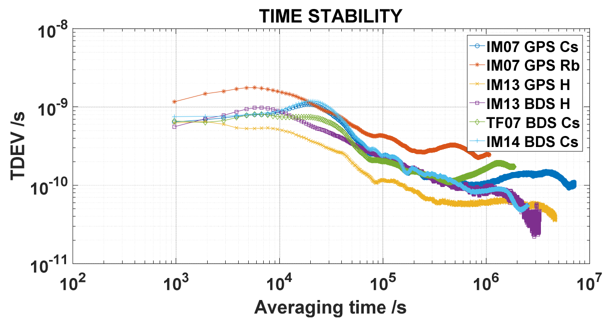

Fig. 17 Time stability of NIMDOs with Rudium, Caesium and H-maser via BDS and GPS.

term, especially after one day averaging, the stabilities for the NIMDOs with Cs clocks and H-masers are both better than that with Rb clock. However, these are just the preliminary results and the NIMDO implementation with these kinds of clocks should be studied further.

V. SUMMARY AND PROSPECTS

UTC(NIM) disciplined oscillator, NIMDO, has been studied and implemented. During the experiments, in most cases, the time and frequency differences of NIMDO remained within 1 ns and 5e-14 against UTC(NIM) when averaged over one day, and the time stability and the frequency stability averaged over one day was mostly better than 1 ns and 3e-14 respectively. In other words, in general, its accuracy could be better than a Caesium clock such as the Symmetricom 5071A with high performance tube and its long term stability can obviously be improved compared to a free-running Rubidium clock. The time and frequency accuracy of NIMDO has been improved thanks to the high level reference time scale and steering algorithm and its long stability has been improved significantly due to the near real-time and short latency steering to UTC(NIM).

Four NIMDOs have been installed at four cities (Urumqi, Guiyang, Harbin, and Beijing) in China to reveal longer baseline effects. Based on some study, application on time and frequency transfer by BDS (BeiDou Navigation Satellite System) has been implemented for NIMDO. Certainly, on the basis of the present NIMDO principle, based on the Caesium clock, the Hydrogen maser, or some other atomic clock, the NIMDOs have been studied and constructed to meet the application with the higher level requirements, and the preliminary results show that the performance could be improved using the similar principle and steering algorithm.

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Table 4 Time difference statistics for R_B, cs and h-maser.

<table>
<tr><th>Reference Station</th><th>Observation</th><th>0<|**|<5 ns</th><th>5 ns<|**|<10 ns</th><th>10 ns<|**|<15ns</th><th>15 ns<|**|<20 ns</th><th>|**|>20 ns</th></tr>
<tr><td>IM07 GPS Cs</td><td>29523</td><td>28549</td><td>974</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>94.89%</td><td>5.11%</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>IM07 GPS Rb</td><td>4449</td><td>4100</td><td>349</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>91.94%</td><td>8.06%</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>IM13 GPS H</td><td>19462</td><td>18929</td><td>533</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>97.27%</td><td>2.73%</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>IM13 BDS H</td><td>13622</td><td>13179</td><td>440</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>96.75%</td><td>3.23%</td><td>0.2%</td><td>0</td><td>0</td></tr>
<tr><td>TF07 BDS Cs</td><td>7771</td><td>7253</td><td>518</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>93.33%</td><td>6.67%</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>IM14 BDS Cs</td><td>10392</td><td>9478</td><td>914</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>91.28%</td><td>8.72%</td><td>0</td><td>0</td><td>0</td></tr>
</table>

Table 5 Frequency difference statistics for R_B, cs and h-maser.

<table>
<tr><th>Reference Station</th><th>Observation</th><th>0<|**|<5 e-14</th><th>5 e-14<|**|<1 e-13</th><th>1 e-13<|**|<2 e-13</th><th>|**|>2 e-13</th></tr>
<tr><td>IM07 GPS Cs</td><td>331</td><td>287</td><td>44</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td>86.71%</td><td>13.29%</td><td>0</td><td>0</td></tr>
<tr><td>IM07 GPS Rb</td><td>55</td><td>36</td><td>16</td><td>3</td><td>0</td></tr>
<tr><td></td><td></td><td>65.45%</td><td>29.09%</td><td>5.46%</td><td>0</td></tr>
<tr><td>IM13 GPS H</td><td>235</td><td>192</td><td>40</td><td>3</td><td>0</td></tr>
<tr><td></td><td></td><td>81.04%</td><td>17.65%</td><td>1.31%</td><td>0</td></tr>
<tr><td>IM13 BDS H</td><td>153</td><td>124</td><td>22</td><td>7</td><td>0</td></tr>
<tr><td></td><td></td><td>81.06%</td><td>14.38%</td><td>4.6%</td><td>0</td></tr>
<tr><td>TF07 BDS Cs</td><td>88</td><td>67</td><td>15</td><td>6</td><td>0</td></tr>
<tr><td></td><td></td><td>76.14%</td><td>23.86%</td><td>0</td><td>0</td></tr>
<tr><td>IM14 BDS Cs</td><td>116</td><td>94</td><td>20</td><td>2</td><td>0</td></tr>
<tr><td></td><td></td><td>81.18%</td><td>16.95%</td><td>1.87%</td><td>0</td></tr>
</table>

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