State Scientific Center
of the Russian
Federation

VNIIFTRI

National Research Institute for
Physical-Technical and Radio Engineering Measurements

Laser ranging in Main metrological center of the Russian State service of time, frequency and the Earth rotation parameters determination.

I. Blinov, I. Ignatenko

IgIg@vniiftri.ru

Federal State Unitary Enterprise (FSUE) “National Research Institute for Physical-Technical and Radio Engineering Measurements” (VNIIFTRI) is subordinated to Federal Agency on technical regulation and metrology of Russia, has the status of the State scientific metrological center and is one of the main Centers of the State standards of Russia.

At present, VNIIFTRI supports and improves 38 State standards, 19 secondary standards, 23 rigs of highest accuracy, over 120 working standards and calibration rigs for various fields of measurement.

VNIIFTRI performs the duties of the Main metrological center of the State service of time, frequency and the Earth rotation parameters determination (SSTF).

The East-Siberian branch of FSUE «VNIIFTRI» is an autonomous structural subdivision of FSUE «VNIIFTRI» and acts in accordance with The Rules of FSUE «VNIIFTRI», The Branch Regulations and Russian legal system. The major aim of foundation of the East-Siberian branch is carrying out of technical-scientific activity of measurement assurance either in the territory of Eastern Siberia or the whole country.

141570 Mendeleevo, Moscow region, Russia, VNIIFTRI.
664056, The Russian Federation, Irkutsk, Borodina st., 57.
http://vniiftri.ru/eng
http://www.en.vniiftri-irk.ru/

VNIIFTRI

National Research Institute for Physical-Technical and Radiotechnical Measurements (VNIIFTRI) has a working SLR station “Mendeleevo-1874” and created a new SLR station in the East-Siberian Branch of

VNIIFTRI in the city of Irkutsk in Jule of 2013.

VNIIFTRI

SLR-stations “Mendeleevo” and “Irkutsk” are included Main metrological center of the State service of time, frequency and the Earth rotation parameters determination of Russian Federation

These stations have the similar equipment, in particular:

- The laser location system produced by Company «Research-and-Production Corporation «Precision Systems and Instruments» (Moscow);
- Time and frequency standards (H-masers);
- Precise gravimeters;
- GPS/GLONASS receivers;
- Local Geodetic Network.

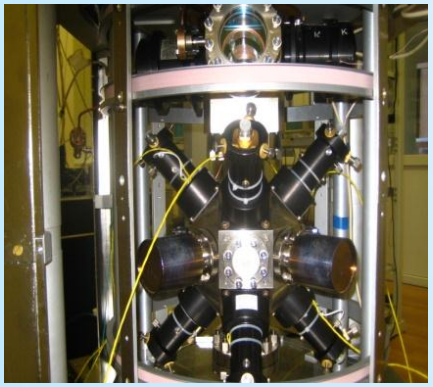
The challenges facing stations:

- Metrological support of GNSS GLONASS;
- Support of reference line Mendeleevo – Irkutsk (~ 4200 km);
- Earth rotation parameters determination;
- Time transfer;
- Work on the global SLR Network.

VNIIFTRI

The main achievements of the State Time and Frequency Standard

- The primary Cs fountain standard;
- Two operational ensembles each of four H-masers in environmentally controlled chambers;
- New clock's model for timescale generation;
- Free Atomic Time Scale;
- The secondary laboratories in Irkutsk, Petropavlovsk, Khabarovsk;
- New instruments and calibration activity in operational time transfer system
- Mobile laboratory with mobile TWSTFT station and activ H-maser;
- Fixed TWSTFT station in Mendeleevo



Laboratory of Irkutsk is composed of:

• 3+1 active H-masers in thermo stabilized chamber;

• T&F clock comparison system;

• TTS3 & TTS4 time transfer system (all systems have been calibrated).

VNIIFTRI

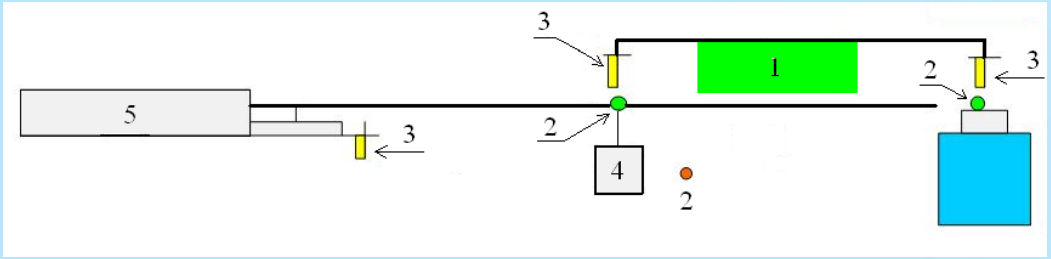
The Long Range Length Standard

New Length Standard for ranges up to 60 m.
The Meter realization according to the definition in SI.
The basis of the instrument is Michelson interferometer with unequal arms – the longest one more than 60 meters. Light source for interferometer – two mode laser. The intermode frequency is stabilized across primary standard.
At the moment the length standard is under metrology investigation.
Expected uncertainties:

type A ≤ 10 μm

type B ≤ (10 + 0.5 × L) μm

where L is basis length, m



1 - calibration standard of comparison , 2 - plate test Thorlabs R1L3S2P, 3 - microscope DinoXlite AM 13 T5.
4 - device alignment, 5 - carriage measuring

VNIIFTRI

The main activities of development of Means Complex of generation National time scale UTC(SU) for purpose of reaching required characteristics of GLONASS:

- National Time Scale storage complex upgrade for providing coordination UTC(SU) and UTC with error no more than ± 3 ns ;
- development of Rb Fountain with Uncertainty 1 – 2 $\times 10^{-16}$;
- development of optical time standard with Ub 1 $\times 10^{-16}$ – 1 $\times 10^{-17}$;
- development of high precision comparison resources for UTC(SU) with GLONASS and other labs includes USNO (Uncertainty ± 1 ns);
- development of fiber optic channels for Time and Frequency Transferring.

Key Targets indexes of GLONASS Federal Target Program realization activities in part of time scales coordination in nearest 10 years

- consumer time determination error in system time scale on account of space segment:

  2 ns in year 2016 1 ns in year 2020

- system time scale coordination error with national time scale UTC(SU):

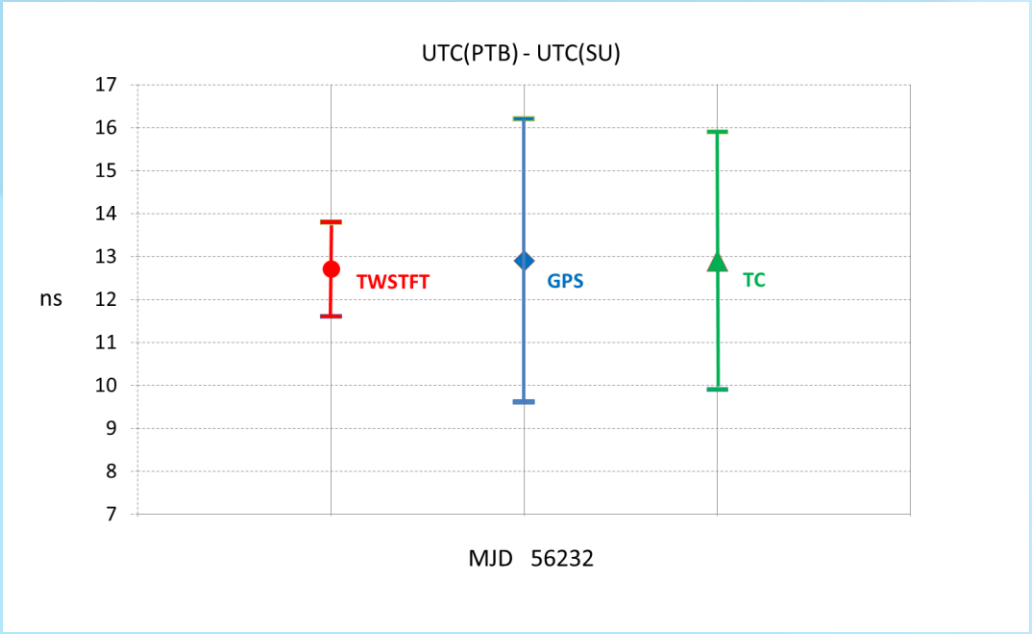
  20 ns in year 2016 г. 4 ns in year 2020

- National Time Scale UTC(SU) coordination error with International Time Scale UTC:

  7 ns in year 2016 3 ns in year 2020

VNIIFTRI

UTC(PTB) and UTC(SU) time scales comparison results

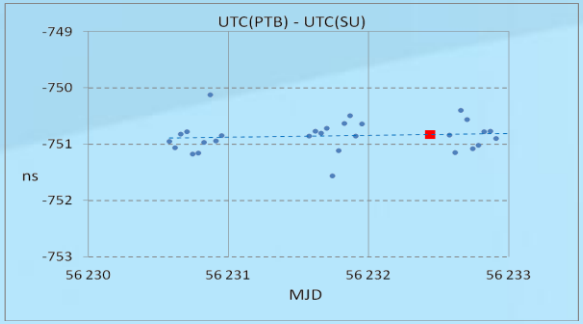


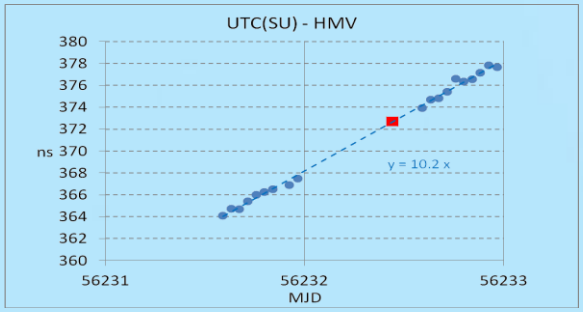
	UTC(PTB) – UTC(SU) ns		
	Mobile TWSTFT station SU02	GNSS receiver TTS-3	Transportable H-Maser CH1-76A
MJD 56231.50		13.5	
MJD 56232.44	12.7	12.9	12.9
MJD 56233.43	13.0	12.4	14.1
u_A	≤ 0.3	≤ 1.4	≤ 0.1
u_B	≤ 1.0	≤ 3.0	≤ 3.0
u	1.1	3.3	3.0

PTB03 – SU01 TWSTFT link calibration with the mobile TWSTFT station SU02, a transportable GNSS receiver and a transportable H-Maser have been successfully completed.

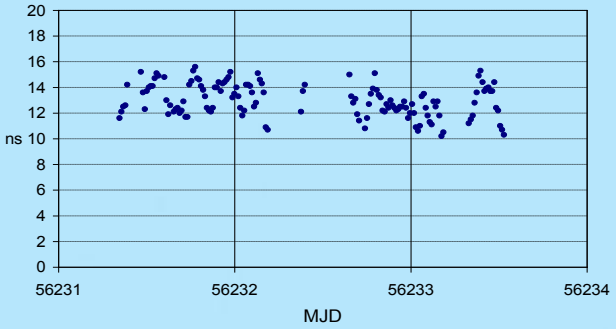
During this experiment calibration corrections CALR for the SU01 station relatively to PTB03 station were obtained which amount to 764.0 ns and an uncertainty u of less than – 1.1 ns. This result obtained with SU02 station was confirmed with the two other independent methods, although these were less accurate. The result was registered in BIPM and have identification CI 281.

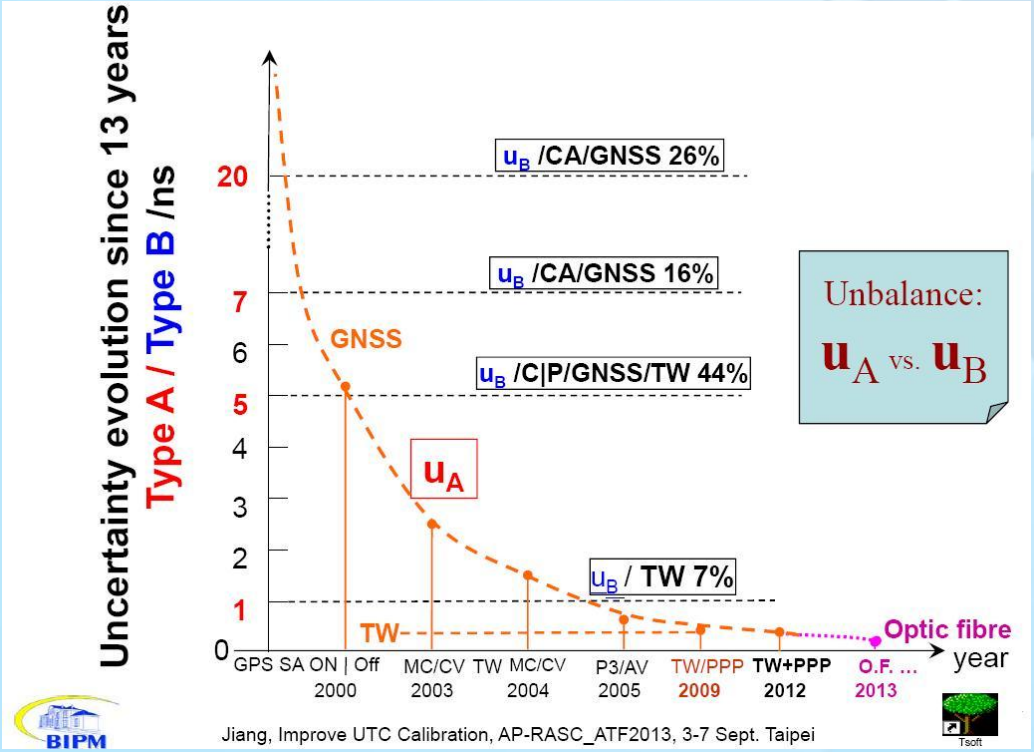
Time transfer





UTC(PTB) - UTC(SU)
TTS-3 (SU030) - TTS-3 (SU026)



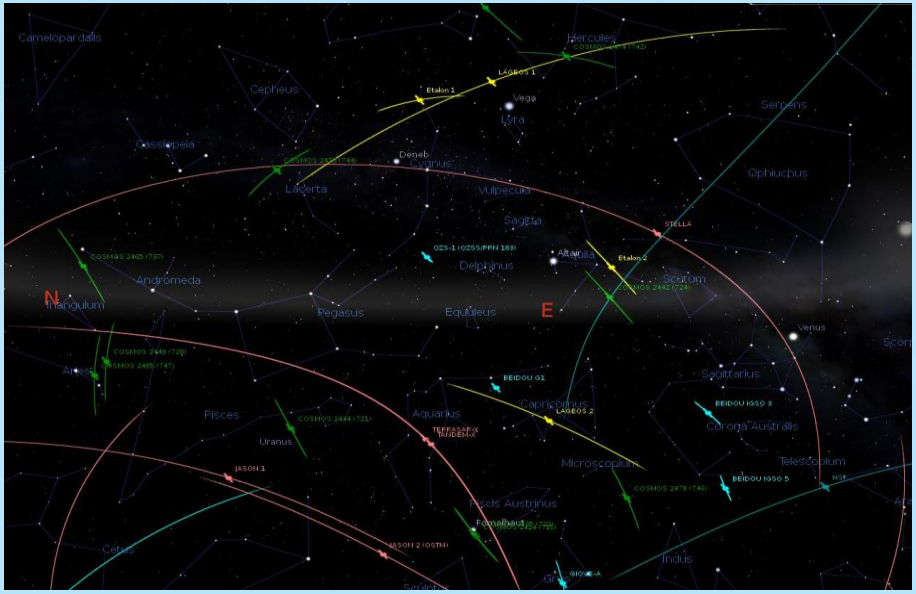


Uncertainty of UTC(PTB) and UTC(SU) time scales comparisons: $U_A \leq 0.3$ ns $U_B \leq 1.0$ ns

Plans and perspectives

Upgrade stations Irkutsk and Mendeleevo to ensure the transfer time.
This will be used for testing of methods of comparison standards of the time, support time scale of the GLONASS, experiment support atomic time, verification of microwawe systems.

Creating SLR-system of new generation together with Company «Research-and-Production Corporation «Precision Systems and Instruments». This system is specifically aimed at the transfer time and it will be made several copies.



Thanks!! ☺

Special gratitude to many of our colleagues, who participated in the discussion of the issues involved.

VNIIFTRI