State Scientific Center
of the Russian
Federation

VNIIFTRI

National Research Institute for
Physical-Technical and Radio Engineering Measurements

National time scale UTC(SU) and GLONASS system time scale: current status and perspectives

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Legal basis for calculation and transferring of the National Time Scale UTC(SU)

Federal Law "On the calculation of time» № 107-FZ of 04.03.2011

National Time Scale of the Russian Federation - an ordered sequence of numbers of units of time, reproduced and stored by the State Service of Time, Frequency and Earth's Orientation Parameters on the basis of the State primary standard of time, frequency, and the National Time Scale.

Interface control document GLONASS ICD 05.01, March 2008

Reference time scale for the GLONASS system is the national coordinated time scale UTC(SU).

Government Decree № 323 of 30.04.2008

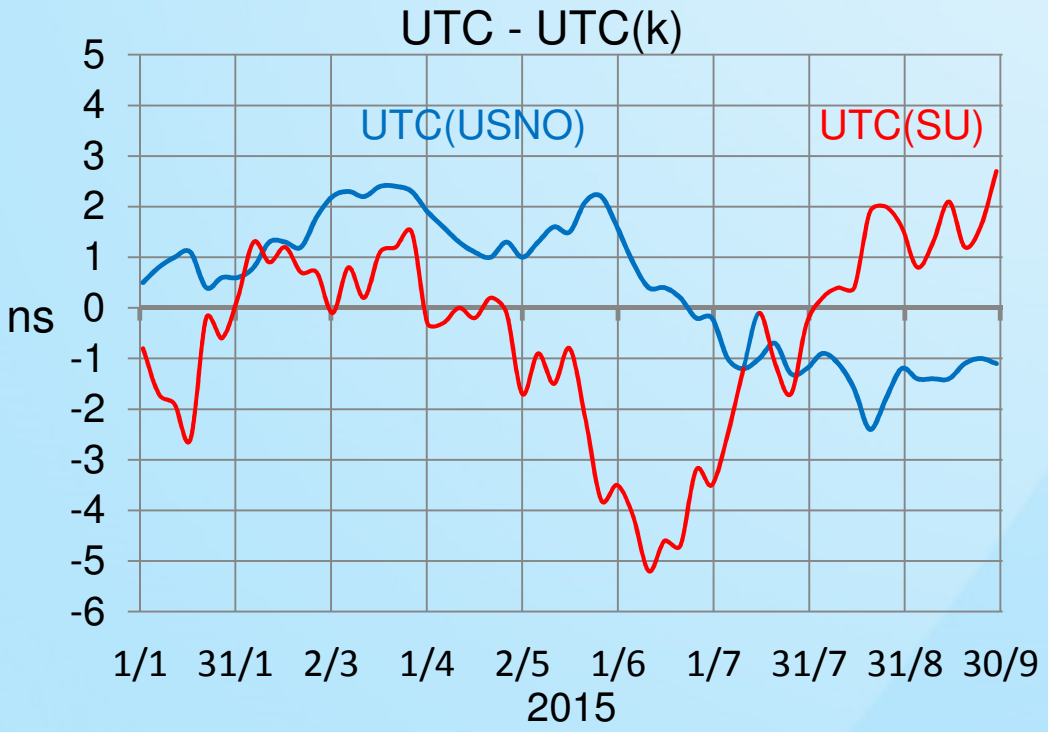
Federal Agency for Technical Regulation and Metrology carries out support for GLONASS reference values of time and frequency, the National Time Scale and the Earth's Orientation Parameters data.

Progress at the State Time and Frequency Standard of Russia

TA(SU) calculated on the basis of the frequency difference measurements of Cs Fountain vs H-Masers

UTC(SU) calculated on the basis of TA(SU) and steering for providing UTC - UTC(SU) ≤ 7 ns

1 pps UTC(SU) generated in real-time



CsFO2 included in calculations TAI
uB < 5 E-16

8 H-Maser CH1-75A used for keeping TA(SU)
σ_y(1 day) < 5 E-16

TWSTFT link VNIIFTRI / PTB :
uA 0.5 ns uB 1.1 ns
BIPM CI 281

uB < 0.5 ns

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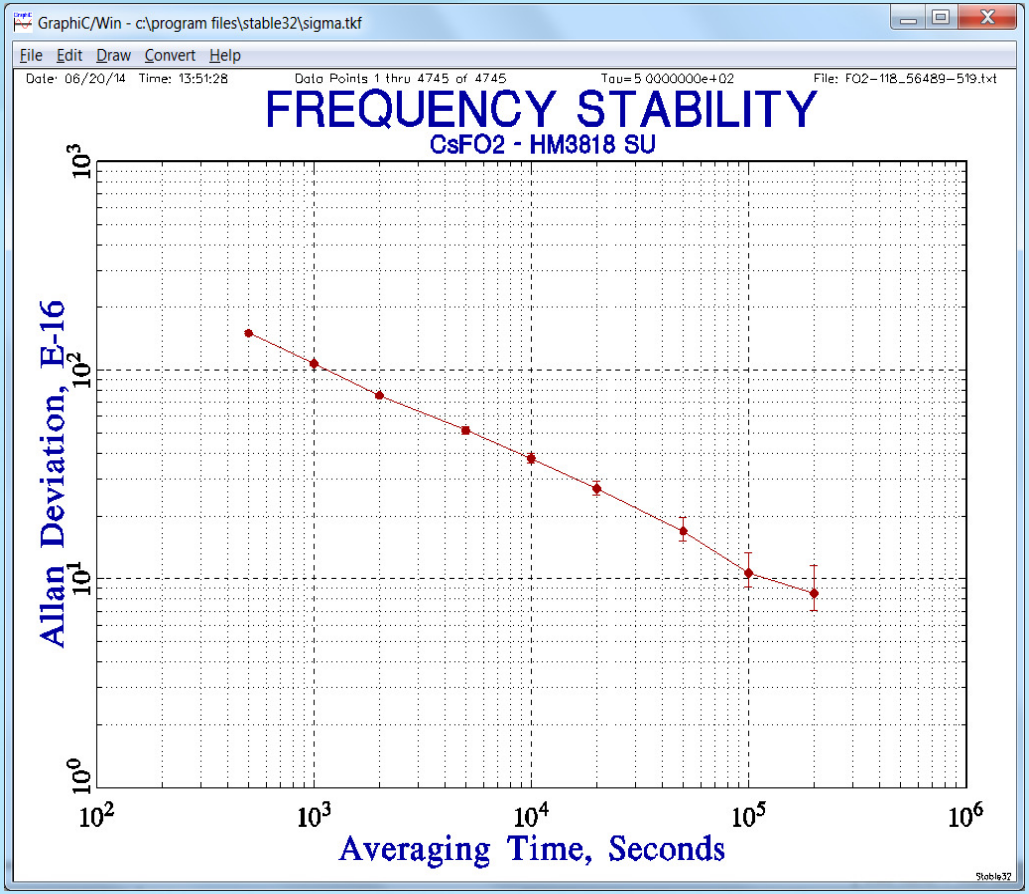
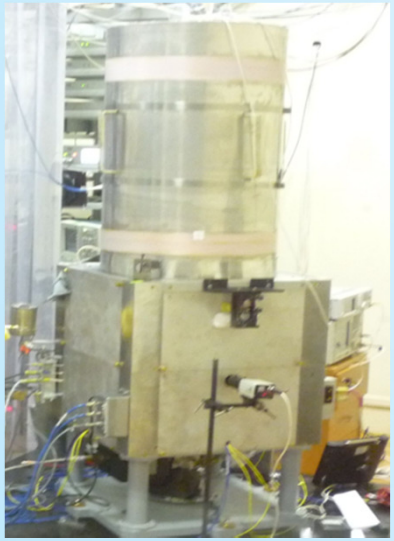
National Time and Frequency Standard

CsFO2 characteristics





CsFO2
uB < 5 E-16

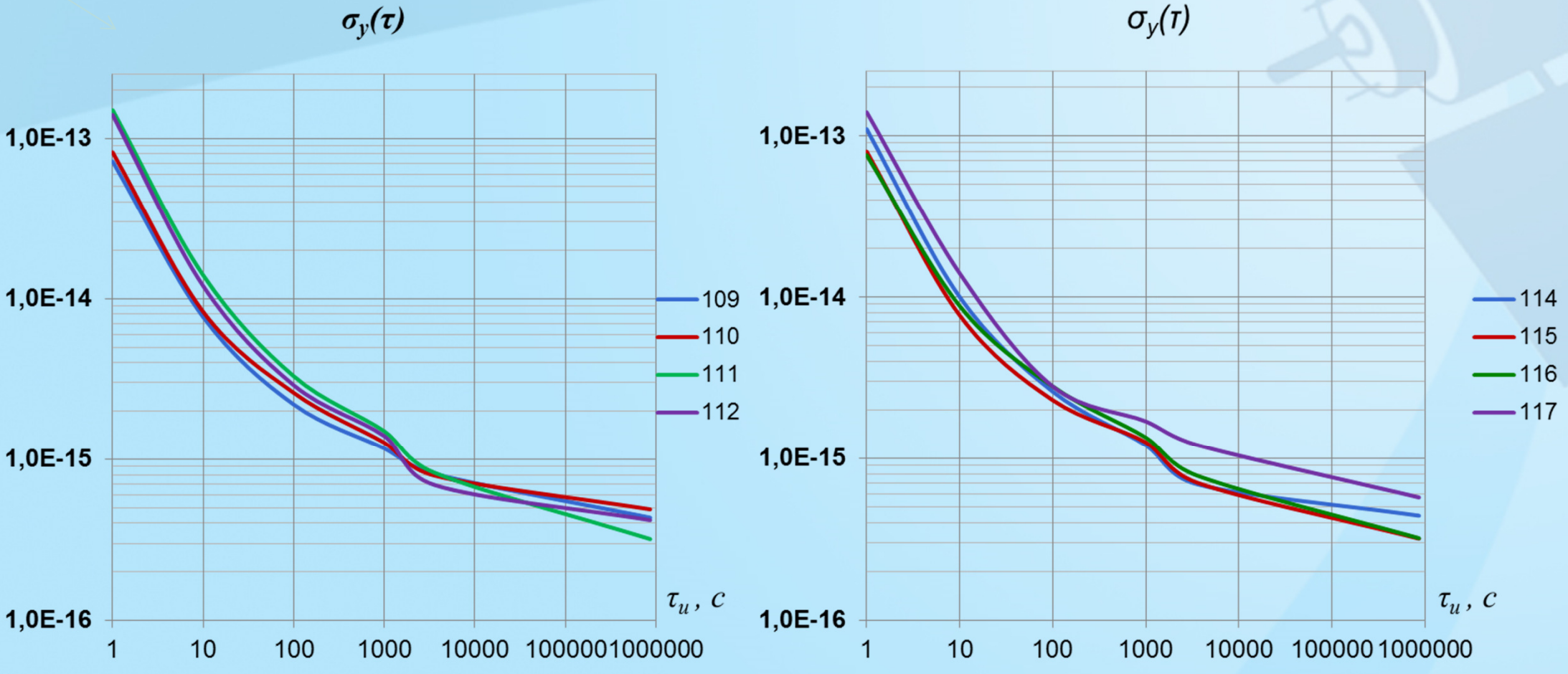
Standard	Period of Estimation		d	uA	uB	ul/Lab	ul/Tai	u
PTB-CS1	57264	57294	-6.23	6.00	8.00	0.00	0.07	10.00
PTB-CS2	57264	57294	-3.91	3.00	12.00	0.00	0.07	12.37
IT-CsF2	57269	57289	-0.02	0.30	0.30	0.10	0.28	0.52
NIST-F1	57264	57289	-0.01	0.37	0.31	0.16	0.23	0.56
SYRTE-FO2	57264	57289	0.39	0.20	0.28	0.10	0.23	0.43
SYRTE-FORb	57264	57289	0.16	0.20	0.28	0.10	0.23	0.43
PTB-CSF1	57264	57294	0.48	0.08	0.69	0.02	0.07	0.70
SU-CsFO2	57264	57294	-0.30	0.21	0.25	0.10	0.59	0.68

Frequency stability CsFO2 @ HM 3818 SU

σ_y(1 day) ≈ 1 E-15

Circular T 333 BIPM

National Time and Frequency Standard frequency stability HM CH-75A



Frequency stability HM CH-75A σ_y(1 day) ≤ $5{,}0 \cdot 10^{-16}$

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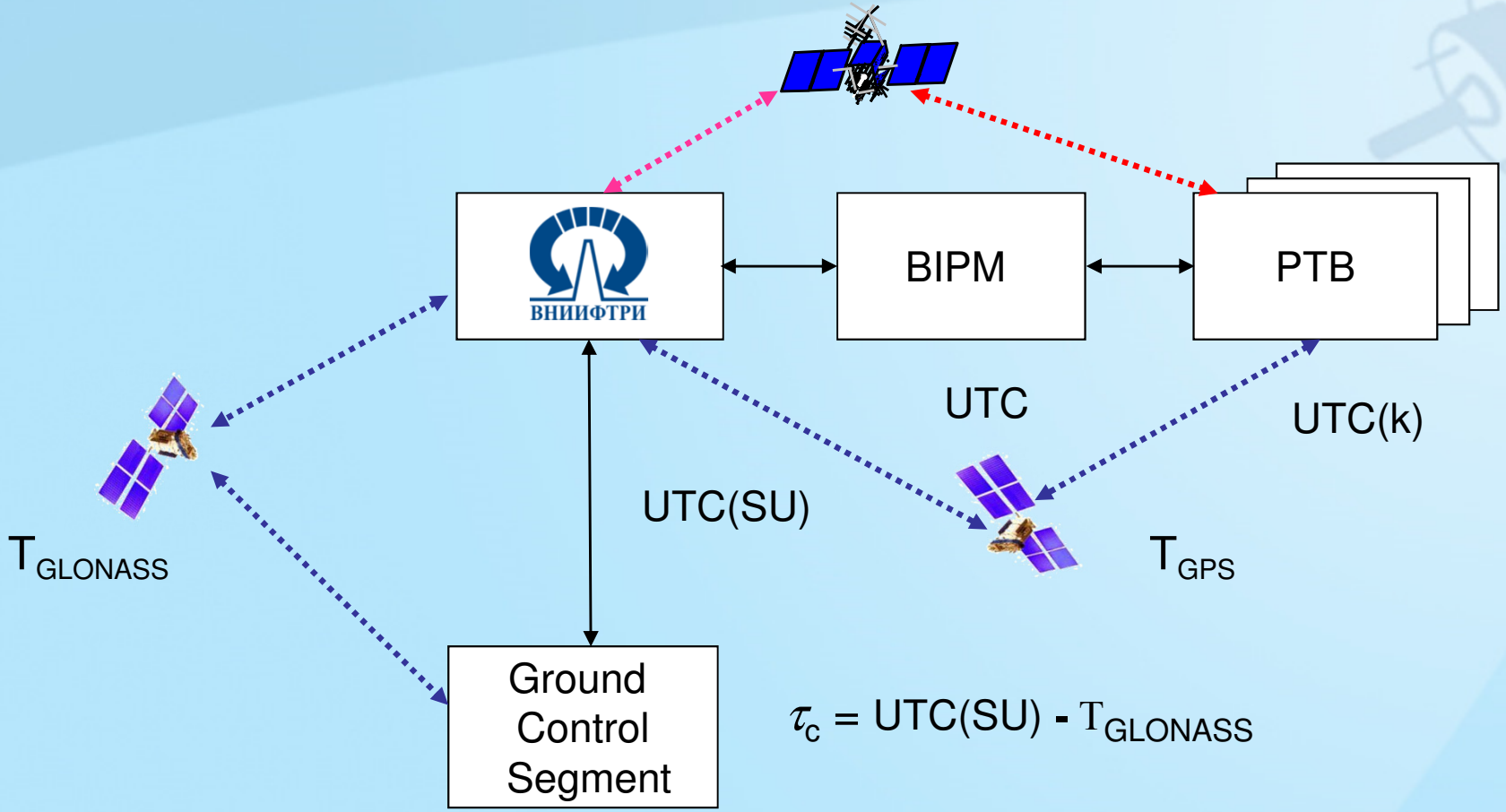
UTC(SU) time scale generating and transferring in GLONASS

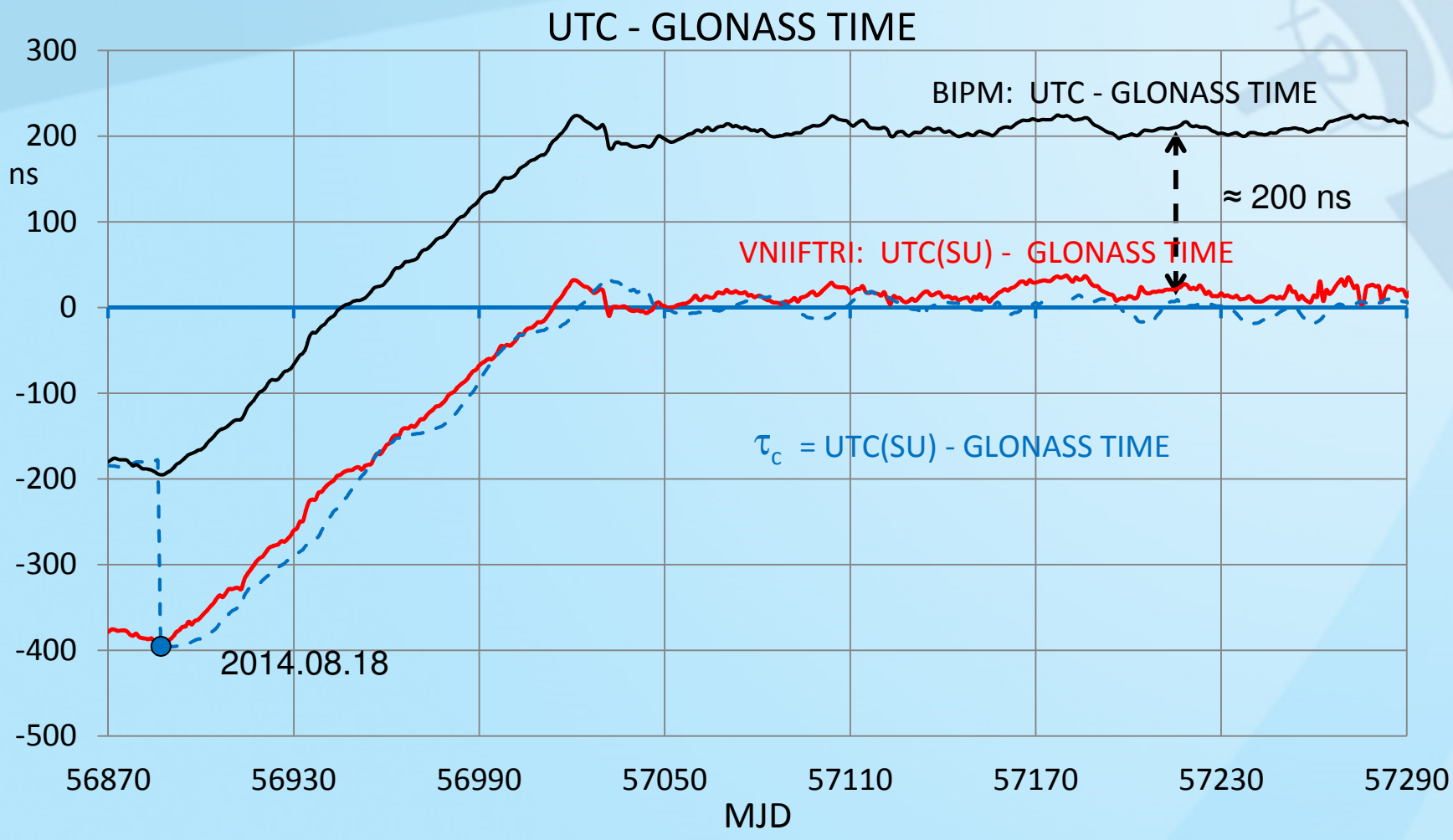


Time Transfer Link:

GNSS

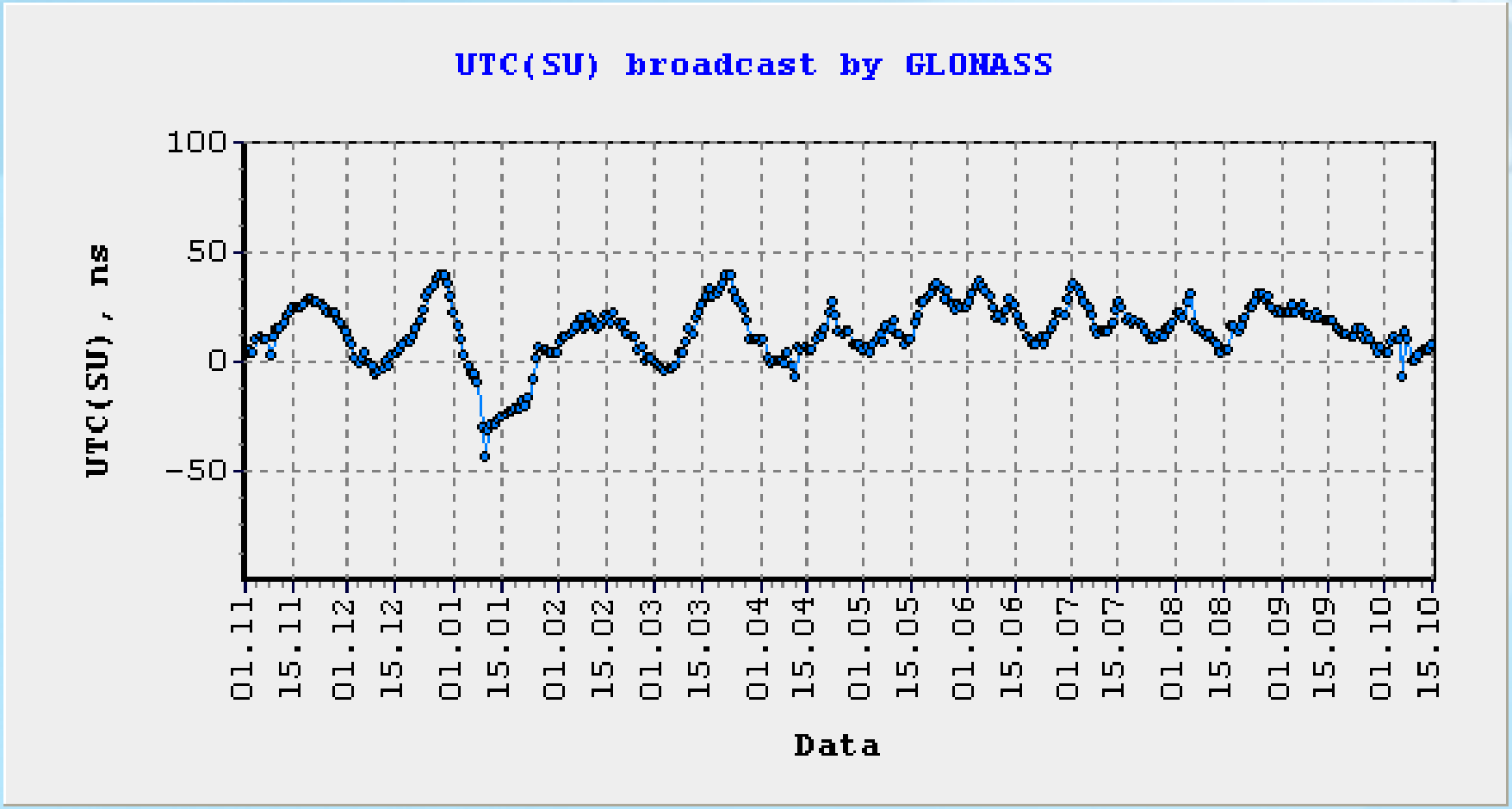
TWSTFT

GLONASS Time correction



18.08.2014 the values of offsets [UTC(SU) - GLONASS TIME], broadcast by GLONASS satellites, were updated. The difference in the estimates offsets of the GLONASS time published by BIPM and measured in VNIIFTRI is about 200 ns .

UTC(SU) transferring by the means of GLONASS



Now the error of broadcast corrections for GLONASS Time – UTC(SU) offset does not exceed 10 ns (rms).

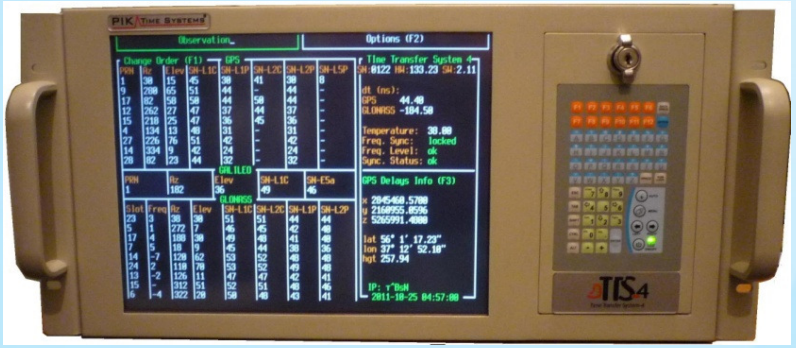
The Agreement on absolute calibration receiver TTS-4 BIPM

Agreement on calibration
M- 9/14
« 28 **»** 07 **2014**

The **International Bureau of Weights and Measures (BIPM)**, an intergovernmental organisation, the headquarters of which are located Pavillon de Breteuil, 92312 Sèvres Cedex, FRANCE, represented by Director, Dr Martin Milton (hereinafter "the BIPM"),

and

Federal State Unitary Enterprise "Russian Metrological Institute of Technical Physics and Radio Engineering"(the FSUE VNIIFTRI), the headquarters of which are located MLB, urban settlement Mendeleevo, Solnechnogorsk district, Moscow region, 141570, RUSSIA, represented by General Director Sergey Donchenko, (hereinafter "the FSUE VNIIFTRI"), acting in accordance with the company rules. The Parties, noting the existence of the Arrangement on the Mutual Recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes (CIPM MRA), the fact that the FGUP VNIIFTRI is a participant in the Key Comparisons and the necessity to calibrate regularly time links used for these purposes,
have concluded this Agreement as follows:



1. Subject of the Agreement
The BIPM accepted the FSUE VNIIFTRI offer to carry out free of charge absolute calibration complete set of TTS-4 receiver (hereinafter the Receiver). The FSUE VNIIFTRI agrees to undertake all procedures to calibrate the Receiver and to issue a calibration Certificate. The FSUE VNIIFTRI will use the receiver for mutual time link calibration which results will released by the BIPM in the BIPM report.

The results of absolute calibration of BIPM GLONASS/GPS receivers TTS-4 in VNIIFTRI

Table 1 GPS L1 C/A

Receiver TTS–4	INT DLY, ns	Diff, ns
OLD	-34.6	0.8
NEW	-33.8	

Table 2 GLONASS L1 C/A

Receiver TTS–4	INT DLY, ns	Diff, ns
OLD	- 242.2	203.6
NEW	– 38.6	

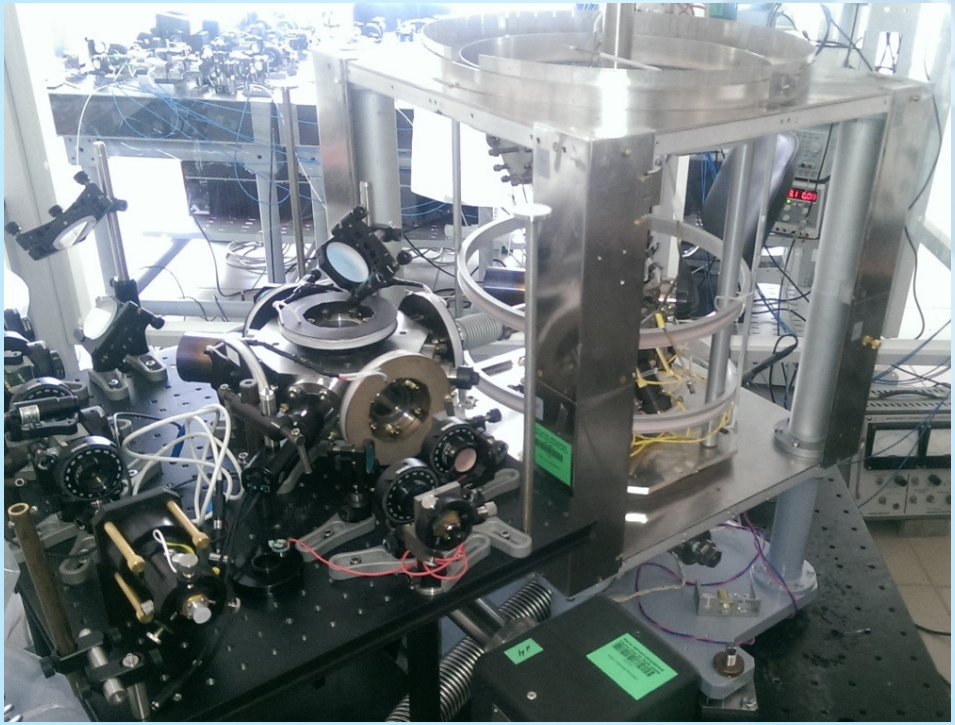
We hope that upon completion of the BIPM receiver TTS-4 calibration GLONASS Time estimation of BIPM will be equal to VNIIFTRI estimation.

Directions of development for UTC(SU) time scale generating and transferring in GLONASS

- National time scale UTC(SU) system of the generation and storage modernization
- Creation of time and frequency standard based on the Rb-fountain
- Development of optical frequency standards on 87 Sr
- Development of high-precision comparisons system of national time scale with GLONASS time
- Investigation of transferring time and frequency signals over a fiber optic link

Creation of time and frequency standard based on the rubidium fountain

Laser Optical System



Atomic spectroscopy

Planning frequency stability RbFO $\sigma_y(\tau)$ ≤ 2 E-16 in 2016

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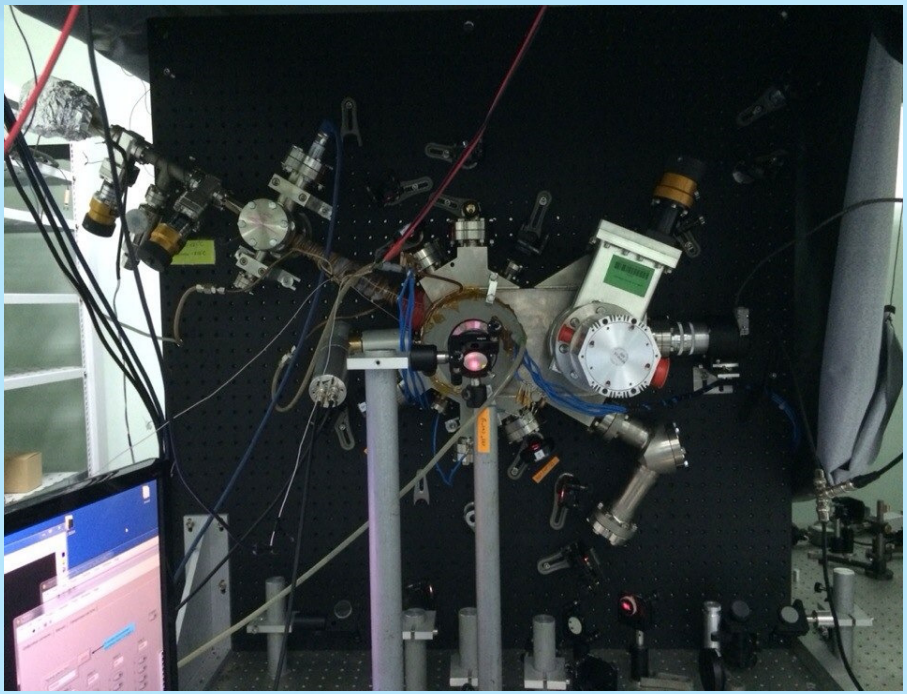
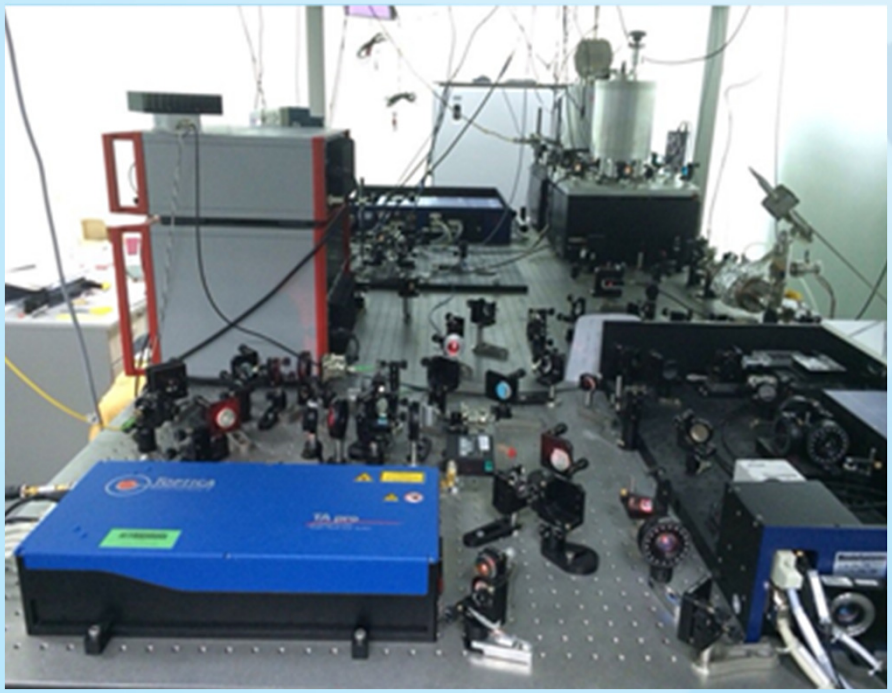
Development of optical frequency standards on 87 Sr



The experimental setup



System of secondary cooling

Experimental prototype: planning uB ≤ 1 E-16 in 2016

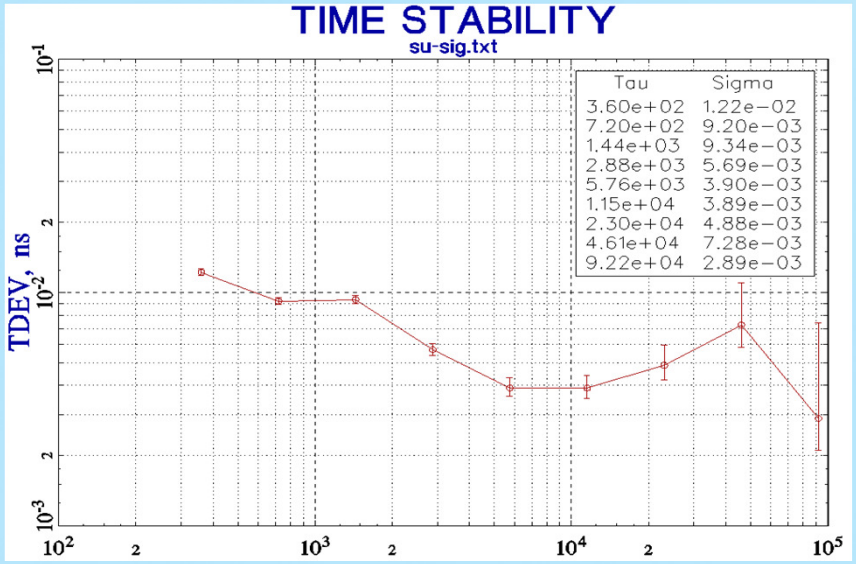
Improvement of clock comparison system on the base of SLR stations

VNIIFTRI, Mendeleevo

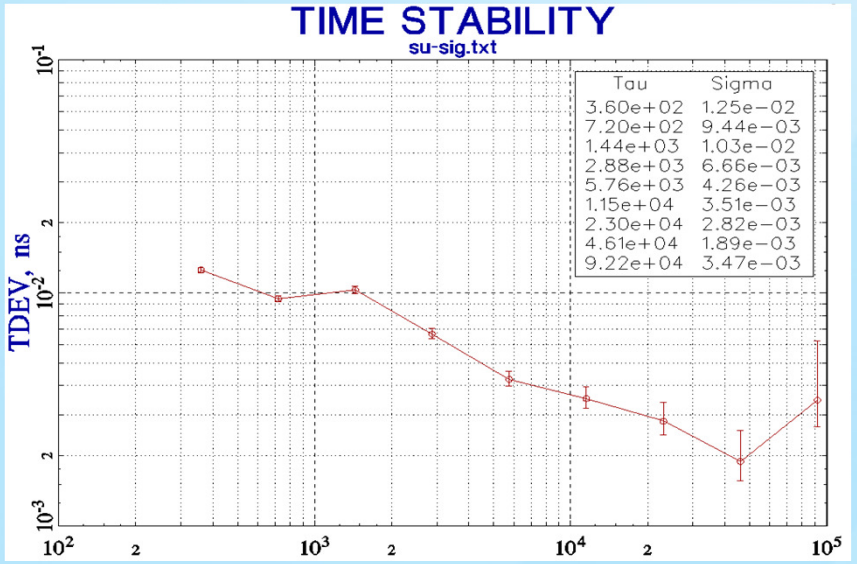
East-Siberian Branch of VNIIFTRI, Irkutsk

We upgrade SLR stations to ensure the time transfer. This will be used for time scales comparison and supporting the GLONASS Time. Planning uB ≤ 100 ps in 2017.

Investigation of transferring time and frequency signals channels over a fiber optic link

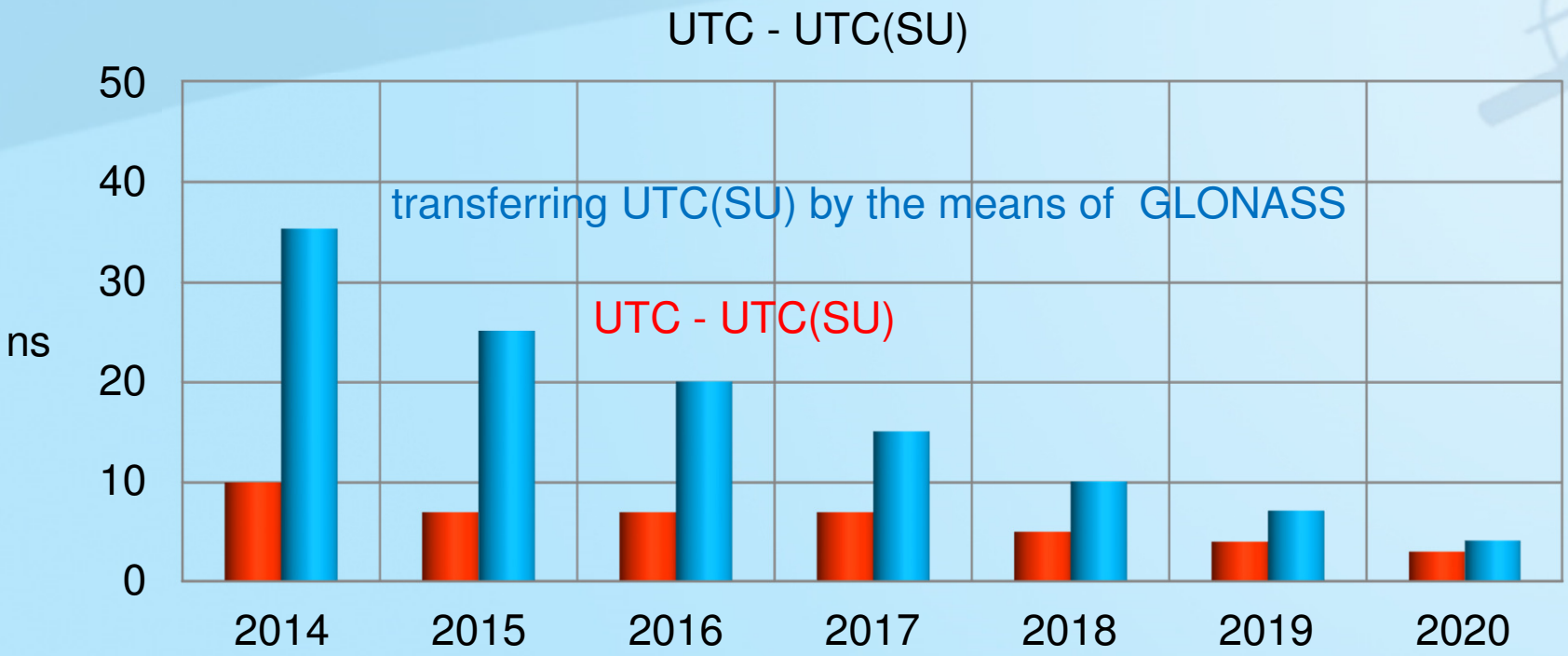


47.5 km uA ≤ 10 ps



95 km uA ≤ 10 ps

Main target characteristics of UTC(SU) and GLONASS time scales matching



Main target characteristics of UTC(SU) and GLONASS time scales matching	2016	2020
Accuracy of national time scale synchronization to the UTC	7 ns	3 ns
Accuracy of UTC(SU) transferring by GLONASS	20 ns	4 ns

Summary

- UTC(SU) realization is corresponding to requirements of CCTF;
- as a result of GLONASS time correction new level of UTC(SU) transferring was achieved;
- calibration problem of GLONASS receivers for transferring the national time scale UTC(SU) was resolved;
- directions of development for UTC(SU) time scale generating and transferring in GLONASS are presented.

Thank you for attention

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