ANNUAL REPORT
by chairman of TC 1.11 "Time and Frequency"

I. The general characteristic of the work:

For the period elapsed the work on 5 themes was carried out on the subject " Time and Frequency". They are:

1. 12/RU-a/92 "ERP determination on the basis of the data from the observatories of COOMET countries" (permanent metrology work);
2. 15/RU-a/92 "Intercomparisons of the National time scales" (permanent metrology work);
3. 17/RU-a/92 "Research into the primary caesium frequency standards" (permanent metrology work)
4. 174/RU-99 "The state of affairs in time and frequency standards of the COOMET members".
5. COOMET.TF-K001.UTC "A comparison of National standards for time and frequency using National time scale of Russia" (pilot project)

In the 2010 year a special meeting of COOMET Technical Committee TC 1.11 "Time and Frequency" was to be held at National Scientific Centre "Institute of Metrology"(13-16th July, 2010, Kharkov, Ukraine).

II. The CMC review

Review of CMCs has been made for South Africa. The inter-regional reviewing for Republic of Belarus is completely finished, for Republic of Kazakhstan – is going to the final stage of consideration.

III. Review on the fulfilled work:

Theme 12/RU-a/92

"ERP determination on the basis of data from observatories of COOMET countries"

(permanent metrology work)

Similarly with previous years, in 2010 the observatories in Russia, Ukraine, Uzbekistan, Bulgaria, Poland, Czechia continued to make routine star and satellite observations and then

transmitted the observation data to the ERP processing and calculating centre at FGUP "VNIIFTRI". An exchange of ERP observing data and calculating results was made between the countries-participants and the International and National Centers for ERP determination. The calculations of the pole coordinates and duration of the day by the results of GPS observations at the stations on the territory of Russia were made on a regular basis. The accuracy of ERP determination by means of all the techniques of the countries-participants was about 0,0002″ and 0,02 ms with regard to the pole coordinates and to the Universal Time, correspondingly. These values closely approach to the accuracy of products of the International Earth Rotation Service (IERS).

Theme 15/RU-a/92

"Intercomparison of the National Time Scales"

(permanent metrology work)

Comparisons of the UTC(SU) - Russia with the UTC(BY) - Republic of Belarus, UTC(GUM) - Poland and UTC(UA) – Ukraine, and UTC (KZ) - Republic of Kazakhstan were made in 2010. A mutual exchange of measuring data was performed.

To perform intercomparisons the specialists of FGUP "VNIIFTRI" used the following receivers: a multi – channel receivers GPS/LONASS TTS-3 after calibration procedure in the 2009 year using BIPM etalon-receiver.

The comparisons between UTC(SU) and UTC(BY) were made using GPS common-views method (daily average data in the CGGTTS.V1 format). The a multi – channel receiver GPS/LONASS 001 06 is used for that purpose.

During the period under review five time scale corrections in UTC(BY) were made: on the 23th March at MJD=55219, 100 ns; on the 11th April at MJD=55297; on the 2June at MJD=55349; on the 14th September at MJD=55454; on the 9th December at MJD=55539.

Comparisons between UTC(SU) and UTC(GUM) were performed by using the GPS common-views receiver (in the CGGTTS.V2 format). An 8-channel TTS-2 receiver is used in GUM.

Comparisons of UTC(SU) with UTC(UA) were made by GPS common-views (daily average data) method and using receiver TTS-2. The specialized multi-channel receiver GPS/GLONASS/GALILEO TTS-4 is used at GNPO "Metrologia".

During the period under review two time scale corrections in UTC(UA) were made: on the 4th October at MJD=55473, 100ns; on the 3th December at MJD=55533, - 100ns.

The comparisons between UTC(SU) and UTC(KZ) were made under GPS common-views (daily average data in the CGGTTS.V2 format). The a multi – channel receiver GPS/LONASS TTS-3 is used in KazInMetr Centre.

During the period under review two time scale corrections in UTC(KZ) were made: on the 12th January at MJD=55208, -2400ns; on the 22 September at MJD=55461, - 1000ns.

The figure 1 below demonstrates an interposition of time scales of the COOMET-Laboratories in 2010 with regard to the International UTC time scale obtained by GPS signal comparisons.

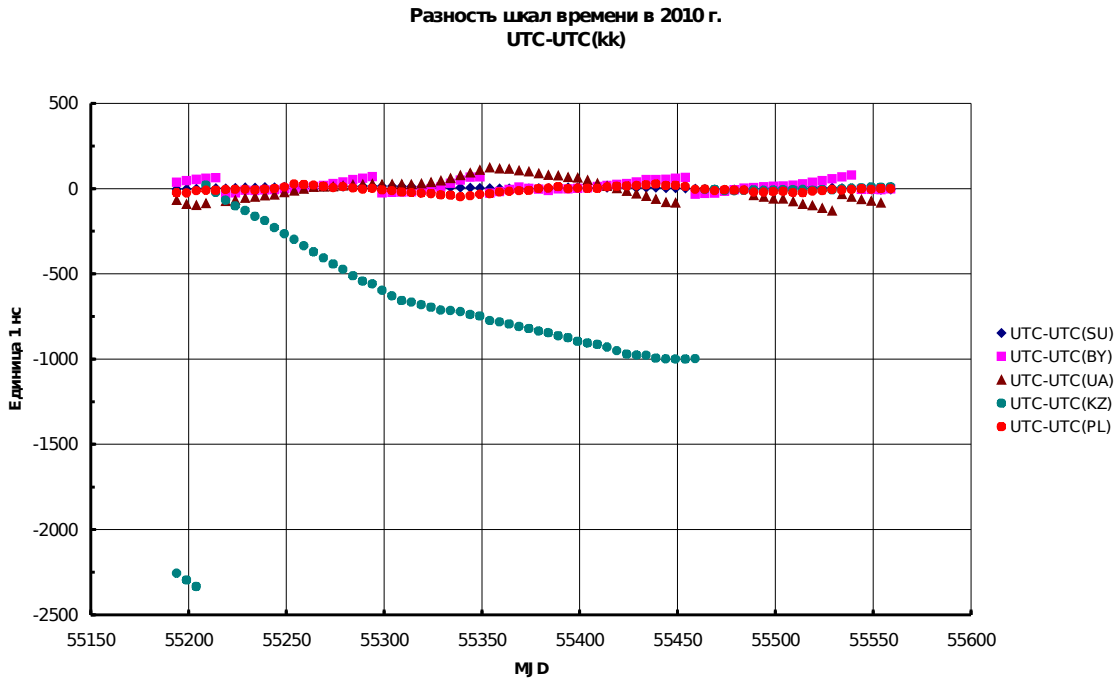

Fig. 1. An interposition of time scales of the COOMET-laboratories in 2010 year with regard to the international UTC time scale obtained by GPS signal comparisons.

The below table 1 shows a status of time scales and frequency units for the COOMET - participants with regard to the UTC scale, performed corrections and also an information of the time links used.

Table 1. An information about values of units of the time

	BY	KZ	PL	**SU**	**UA**
	1	**2**	**3**	**4**	**5**
Time scale difference **UTC - UTC(i)** (ns) for 29.12.2010, MJD = 55559	**-3.1**	**10.0**	**-1.6**	**-6.7**	**-83.9**
Normalized frequency difference Δf/f[UTC - UTC(i)] (in units × 10^{-14})	**1.46**	**-3.59**	**0.07**	**-0.01**	**-0.36**
Type **A** uncertainty of time comparison (ns)	**≤7.4**	**≤20.2**	**≤5.4**	**≤5.4**	**≤6.6**
Time comparison links	**GPS**	**PS**	**PS**	**GPS**	**GPS**

Up to now, no measuring data from time services of Bulgaria and Slovakia was not received.

K001.UTC "A comparison of National standards for time and frequency using National time scale of Russia" (pilot project)

During period under review (2010 year) the work on the finishing of pilot project was continued. A comparison apparatus for the work 15/RU-a/92 is used. The results of comparison are presented on the figure 2 (the notations are equally to ones used in the work 15/RU-a/92).

The comparisons for the time scale between UTC(SU) and UTC (AA)(KazInMetr Centre, Alma-Ata, republic of Kazakhstan) were made using GPS common-views method (in the CGGTTS.V1 format).

The one-cannel GPS receiver VP ONCORE SSG01147318 1998 is used in KazInMetr Centre, which was calibrated at FGUP VNIIFTRI in 30th December 2008 year.

In the 2011 year we plan to finish the pilot-stage of this project and to start the permanent metrological work for that key-comparison.

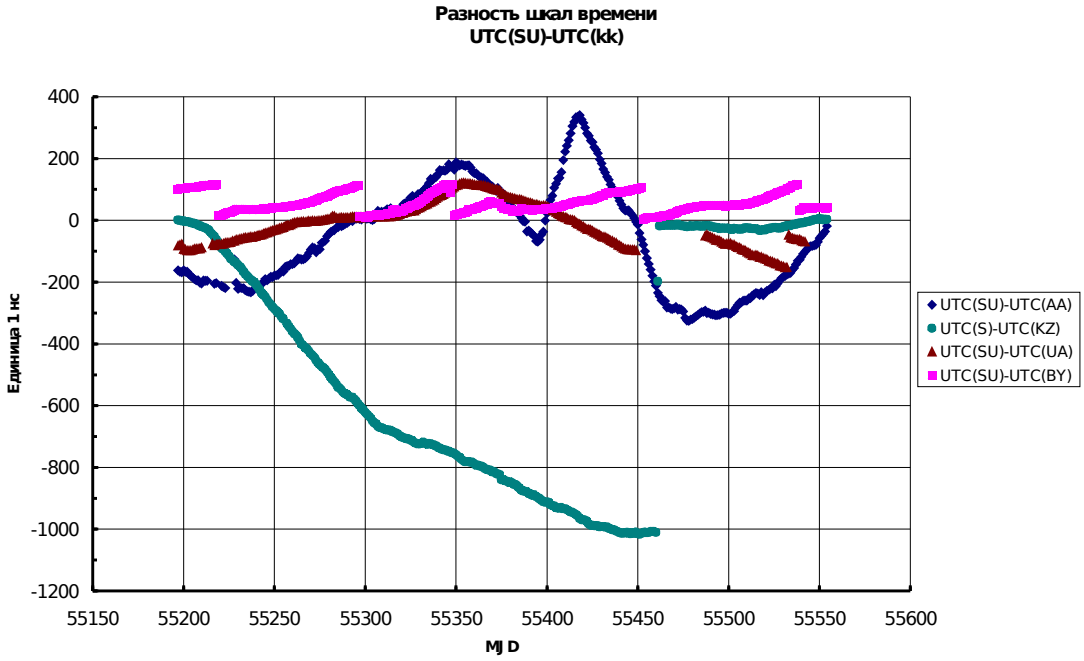

Fig.2. Results of comparisons for the time scales differences UTC (SU) and UTC (kk).

Theme 17/RU-a/92

"Research into the Primary Caesium Standards"

In 2010 at "VNIIFTRI" (Russia) as in the previous years the work on the primary frequency standards was carried out in two basic lines: effective maintenance of the primary caesium frequency standard on thermal atoms MCS -102 and development of a caesium fountain standard.

The stated type B uncertainty for the MCS 102 is estimated to be 3.0×10^{-14} as in the previous year. In this estimation we taken into account an inhomogeneous of C-field, uncertainties of electronics, microwave leakage, Rabi and Ramsey pulling, microwave spectrum, etc. As a result, an RMS normalized frequency deviation for month overlapped intervals from the mean one per year was $(0.7 \pm 0.9)\times10^{-14}$.

Table 2 contains the relative differences for unit of frequency for the best cesium standards in 2010 year.

Table 2. Averaged (per month) values for the relative differences for unit of frequency reproduced by cesium standards in TAI scale for 2010 year.

Units 1×10^{-14}

MJD СРЕДНЯЯ	PTB Cs1	PTB Cs2	NMIJ-F1	SYRTE-JPO	SYRTE-F01	SYRTE-F02	NIST-F1	BIPM Estimete	МЦР 102
55216	0.29	-0.76	–	-0.39	-0.49	-0.55	–	-0.46	0.5
55243	0.65	-0.63	–	-0.37	–	-0.46	-0.52	-0.46	-0.6
55271	0.42	-0.19	–	-0.53	–	-0.48	–	-0.49	-1.4
55302	0.52	-0.02	–	-0.74	-0.48	-0.56	-0.64	-0.52	1.0
55332	0.18	-0.51	–	-0.78	-0.51	-0.63	–	-0.52	1.3
55363	-0.57	-0.14	-0.35	-0.4	–	-0.64	-0.80	-0.68	-0.2
55393	0.36	0.10	–	-0.28	–	–	–	-0.48	1.8
55424	-0.01	-0.54	–	0.01	–	-0.51	-0.56	-0.52	–
55455	0.08	–	-0.67	-0.79	–	–	-0.71	-0.56	0.0
55485	0.19	–	–	–	-0.58	-0.69	–	-0.64	0.1
55516	-0.30	–	-0.53	–	–	–	-0.64	-0.69	0.5
55546	0.44	–	-0.50	–	-0.58	-0.66	-0.64	-0.56	0.3
$\Delta f/f)_{ср}$	0.2	-0.3	-0.5	-0.5	-0.5	-0.6	-0.6	-0.55	0.3
СКО(δ_M)	0.3	0.3	–	0.2	–	0.1	0.1	0.06	0.9
n	12	8	4	9	5	9	7	12	11

Figure 3 demonstrated the relative differences for unit of frequency averaged (per month) for two years period of observations for PTB Cs1, PTB Cs2, МЦР102 cesium standards.

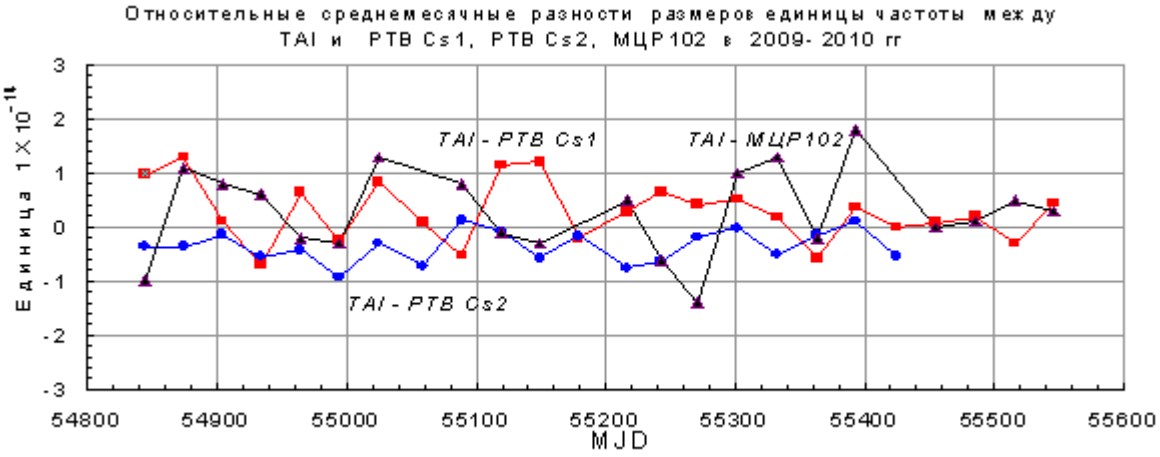

Fig.3. The frequency differences for the PTB Cs1, PTB Cs2, МЦР102 cesium standards.

Theme 174/RU-99

"THE STATE OF AFFAIRS IN TIME AND FREQUENCY STANDARDS OF THE COOMET MEMBERS"

No information on the changes in an apparatus structure of standard facilities has been received from the majority of the country – participants. For the time keeping and the regular comparison National time scale Ukraine has received and used in 2010 year the multi – channel receivers GPS/LONASS TTS-3 (made in Poland) and hydrogen maser produced in USA (SYMMETRICOM).

TC RECOMMENDATION FOR FUTURE ACTIVITY

TC Meeting (April 2008, Minsk, Republic of Belarus) recommended to start new projects: «A comparison for time and frequency domain" (In the final stage of progress , Suggested coordinator – VNIIFTRI).

IV. COLLABORATION WITH INTERNATIONAL AND REGIONAL ORGANIZATIONS

- Bureau Internationale on Poids et Mesures (**BIPM**), a regular data exchange to contribute to the TAI;

- Comite Consultatif du Temps et des Frequences (**CCTF**), participation in the work of the CCTF and its Working Groups;

- Consultative Committee on Length (**CCL**), participation in elaboration of recommendations on redefinition of a second;

- International Telecommunication Union (**ITU**), participation in the work of 7A Group;

- International Earth Rotation Service (**IERS**), a regular data exchange;

- International Geodetic Service (**IGS**), observation and processed data exchange;

- International Laser Ranging Service (**ILRS),** observation and processed data exchange.

Participation of FGUP VNIIFTRI on International Conferences and Forums in 2010 year:

1. European Forum on Time and Frequency (April-2010, Nordvik, Holland)
2. European Meeting on Applications of Optical Standards in Space and Space Navigation Systems (April-2010, Hannover, Germany)
3. International Conference on Atomic Physics(sections on Atomic Frequency Standards and Nuclear Frequency Standards, August-2010, Cairns, Australia)
4. International Meeting of Union of Telecommunications (October-2010, Geneva, Swiss)
5. International Meeting on research of ERP and geophysical processes (October-2010, Peking, China)
6. International Conference on Precise Time and Time Intervals (November-2010, Reston,USA)

Chairman of TC 1.11 "Time and Frequency" **V.G. Pal'chikov**