

# Time Frequency & Length laboratory

The unit of length - “metre” and unit of time - “second” are one of seven base units of international system of units SI. The definition of “metre” and “second” according to SI brochure are shown below

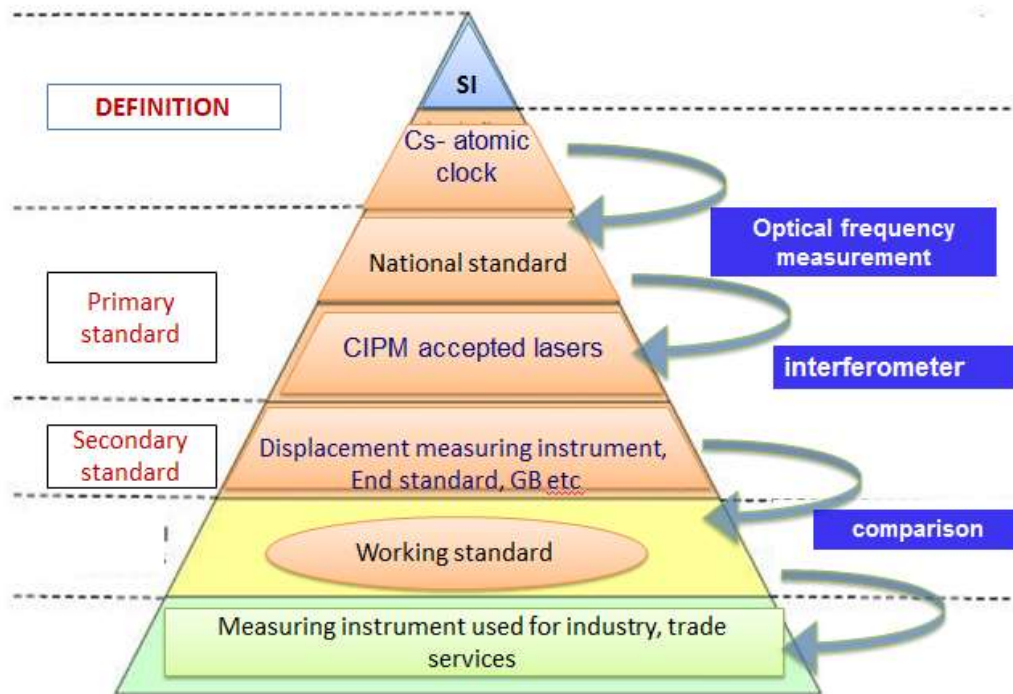
**s**

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of ground state of Caesium-133 atom.

**m**

The metre is the length of path travelled by light in vacuum during a time interval of  $1/299\,792\,458$  of a second.

## General Traceability Chart or Relationship between Time and Length



The length laboratory have joined with time and frequency laboratory in 2015 as for they have common traceability road.

The overall responsibilities of the length and time frequency laboratory are establishment, realisation of measurement standards as per definition of international system of units, R&D and maintenance of primary and secondary standards, dissemination its value to measuring instruments to ensure uniformity of measurement throughout the country.

The length laboratory is mainly responsible for maintenance and development of national primary standards of length, its dissemination to working standards, measuring instruments used in industry and trade.

The first state primary standard of length was approved in 1995 as of "0" grade steel gauge blocks which was manufactured in Russia (former Soviet Union). Also other measuring instruments such as contact-interferometers of accuracy 0.01 mm - 0.0001 mm, end standard comparator, vertical and horizontal optimeter and universal measuring microscope, glass scale etc were the foundation of length laboratory of MASM.

The project for the establishment of length measurement standard was implemented by the grant aid of the Government of Czech Republic between 2011-2013.

As a result, many modern length measuring instruments of high accuracy with software were supplied and state primary standard of length was established as per definition SI system of units.

### **The state primary standard of length " metre"**



The RWS-NL150 iodine stabilized Helium-Neon laser, which generates radiation of wavelength 633 nm (473 THz), was approved as the state primary standard of length by the Government of Mongolia in 2013.

(Wavelength:  $\lambda = 633$  nm, optical frequency:  $f = 473\,612\,353\,604$  kHz,  
Relative uncertainty:  $U = 5 \cdot 10^{-11}$ )

This RWS-NL150 is helium neon laser is a source of radiation of wavelength 633 nm (473 THz). The laser frequency (thus vacuum wavelength) is stabilized to one of well-defined hyperfine components of rotational – vibrational transition in  $^{127}\text{I}_2$  iodine molecule with precision of a few parts in  $10^{-11}$ .

### **The secondary standard of length:**

LIMTEK – LMS

Laser interferometer for displacement measurement.

wavelength:  $\lambda = 632,9908$  nm,

measuring range: x axi 40 m, other axi 10 m,

readability: 1,25 nm ,

relative uncertainty:  $U = 2 \cdot 10^{-8}$



### **The secondary standard of length :**

End standard – steel gauges

Mitutoyo K<sup>00</sup> grade set of steel gauge blocks

0,5 – 100 mm, 125 – 1000 mm



### **Standard equipment -**

Laser frequency comparison system BFMU

Gauge block comparator for mechanical measurement

range: 0,5 – 100 mm, readability 0,01  $\mu\text{m}$ , uncertainty 0,03  $\mu\text{m}$

Dial gauge testing equipment

readability: 0,0001  $\mu\text{m}$ , uncertainty 0,3  $\mu\text{m}$

### **Contact**

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## TIME & FREQUENCY LABORATORY

Time and Frequency laboratory is responsible for establishment, maintenance and R&D of state primary and secondary standard and its dissemination to ensure uniformity of measurement through calibration service for frequency and radio measuring instruments.

Time and Frequency laboratory was founded in 1979 with Rubidium atomic clock and quartz frequency generator. Caesium-133 atomic clock was installed, approved as state primary standard of time in 1988.

In 2007 and 2011 new time comparison system has been installed for the purposes of upgrading of laboratory equipment.

The project was implemented by the grant aid of the Government of Czech Republic and Czech development agency in 2013 and installed new Caesium-133 atomic clock to improve national time reference with  $10^{-15}$  accuracy.

In 2014 Time and Frequency laboratory of MASM became 74<sup>th</sup> member contributing laboratory for generating UTC and started to participate in continuous comparison with TAI's.

Also we're frequently participate CCTF-K001 international on-going comparison coordinated by BIPM.

In order to disseminate the unit of time, we are collaborating with Mongolian Communications Regulatory Commission and successfully installed network time server to synchronize time signal through internet address of which is "time.icctime.mn".

### Primary reference of "second"-



CAESIUM -133 atomic clock: CS-5071A- C001  
Accuracy  $10^{-15}$ ,  
Frequency 5 MHz, 10 MHz  
Stability  $5 \times 10^{-15}$

### Time comparison system



Rubidium frequency reference x2 – F275  $5 \times 10^{-11}$   
Uncertainty 20 ns  
Single channel GPS receiver – NCR-40A  
Frequency counter – Agilent 53132A

### Radio and Pulse frequency doubler - Timetech



NTP time server – Meinberg Lantime M600  
IP 202.21.117.218, slave.time.mn

### Contact

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**Calibration service in dimentional measurement**

<b>Calibration item</b>	<b>Payment /tugrik/</b>	<b>Calibration item</b>	<b>Payment / tugrik/</b>
Tapemeter: - up to (2 – 10) m	10000	Vernier caliper: - up to 200 mm	86000
Tape meter with sinker with range of $\geq 10$ m	15000	- up to 200 – 1000 mm	10000
Gauge blocks of grade 0, 1, 2	2550 per piece	Determination of internal diameter of heat gauge	10000
Micrometer: - up to 200 mm	8000	Depth vernier caliper with range of $\geq 200$ mm	10000
- $\geq 200$ mm	10000		
Dial indicator	7200	Geometry of workpiece	17400
Hole micrometers	13000	Metal ruler	4000
Angle measuring ins.	8000	Lasermeter	20000
Setting gauge	5500	Telescopic meter	9500
Ruler	17800	Clearance gauge	2100
End standard for angle	2550	Hole – caliper	18200
Electric optical distance measuring instrument	35000	Level	9000
Geometry of heat pipe	40000	Ultrasonic tiickness meter	13000

**Calibration service in radio frequency measurement**

<b>Calibration item</b>	<b>Measuring range</b>	<b>Payment / tugrik/</b>
Atomic clock /Cesium, Rubidium/	$5 \times 10^{-15}$	240 000
GPS receiver		220 000
Electronic frequency counter up to 10MHz		160 000
Generator with range less than $1 \times 10^{-12}$ Hz frequency loss	$1 \times 10^{-13}$	150 000
Frequency generator	$1 \times 10^{-13}$	230 000
Oscilloscope	Single channel	25 000
	Multi channel	35 000
Stopwatch	Electronic	20 000
	Mechanic	8 000