Determination of Earth Orientation Parameters by SLR in MMC SSTF FSUE VNIIFTRI

E. Tcyba[1], O. Volkova[2]

All-Russian Scientific Research Institute of Physical Technical and Radiotechnical Measurements (FSUE VNIIFTRI) [1]

Mosengineering Group LLC[2]

Introduction

At the end of 2014, the MMC SSTF completed the development of a program for determining the parameters of the Earth's rotation (EOP) by SLR. On the basis of new software developments in 2015 regular operational calculations of pvz with the accuracy corresponding to modern requirements are organized.

Purpose and structure of the software

The software is designed to solve two main tasks:

Prediction of satellite orbits (LAGEOS 1 and LAGEOS 2)

Calculate Earth orientation parameters (Xp ,Yp, LOD).

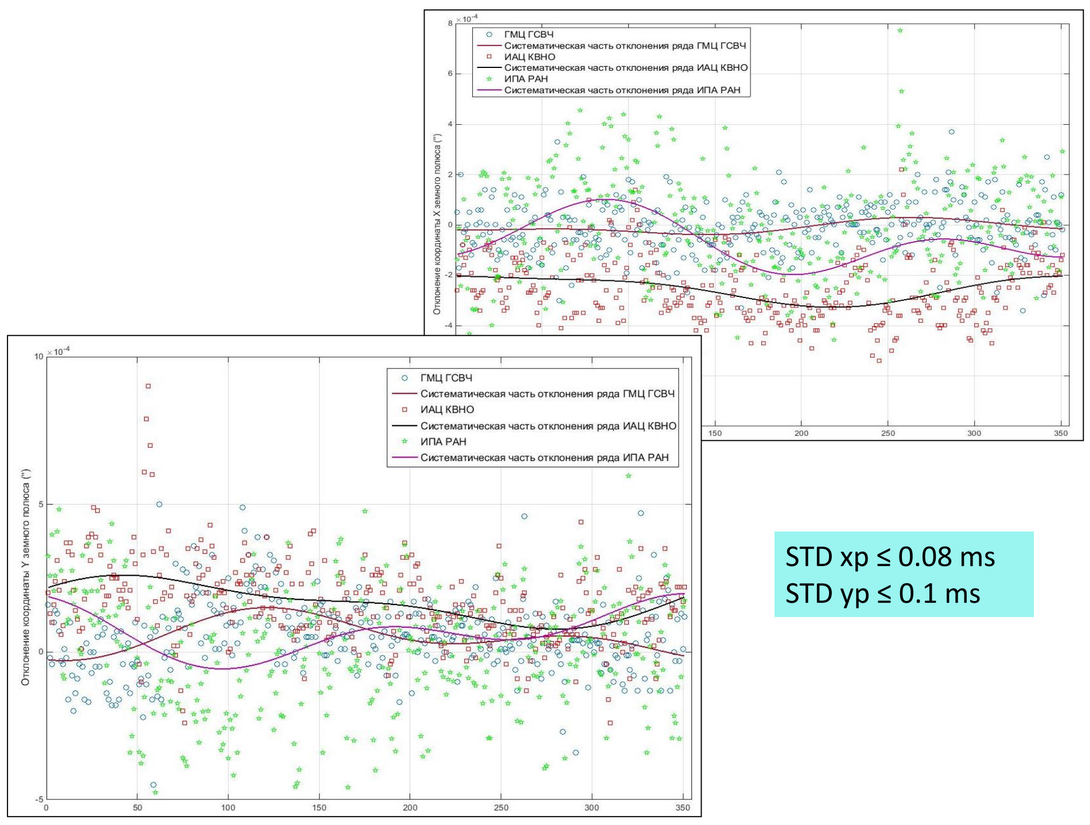
Structurally the software consists of four blocks:

1. Collection and preparation of files necessary for correct operation, testing of input data, formation of resulting files.
2. Processing observations of one or more orbital arcs.
3. The formation and solution of the normal equations matrix.
4. Orbit prediction.

ILRS station list

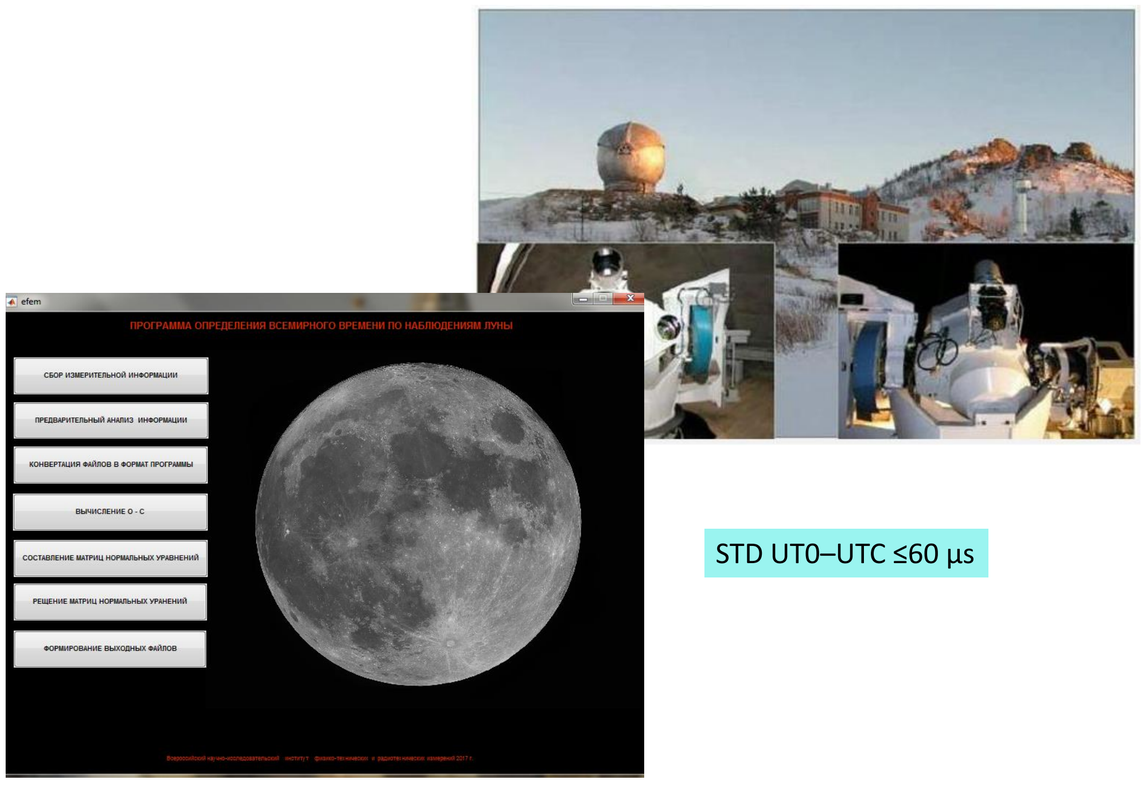
№	ID	SITE	№	ID	SITE
1	1824	Golosiv, Ukraine	20	7249	Beijing, China
2	1868	Komsomolsk, Russia	21	7308	Koganei, Japan
3	1873	Simeiz, Russia	22	7358	Tanegashima, Japan
4	1874	Mendeleevo 2, Russia	23	7403	Arequipa, Peru
5	1879	Altay, Russia	24	7405	Concepci_on, Chile
6	1884	Riga, Latvia	25	7406	SanJuan, Argentina
7	1886	Arkhyz, Russia	26	7501	Hartebeesthoek, SouthAfrica
8	1887	Baikonur, Kazakhstan	27	7810	Zimmerwald, Switzerland
9	1888	Svetloe, Russia	28	7821	Shanghai, China
10	1889	Zelenchukskya, Russia	29	7824	SanFernando, Spain
11	1890	Badary, Russia	30	7825	MtStromlo, Australia
12	1893	Katzively, Crimea	31	7838	Simosato, Japan
13	7080	McDonaldObservatory, Texas	32	7839	Graz, Austria
14	7090	Yarragadee, Australia	33	7840	Herstmonceux, UK
15	7105	Greenbelt, Maryland	34	7841	Potsdam, Germany
16	7110	MonumentPeak, California	35	7845	Grasse, France
17	7119	Haleakala, Hawaii	36	7941	Matera, Italy
18	7124	Tahiti, FrenchPolynesia	37	8834	Wettzell, Germany
19	7237	Changchun, China			

EOP from satellite laser ranging (SLR) Lageos 1,2 (2018)



STD xp ≤ 0.08 ms
STD yp ≤ 0.1 ms

UT0–UTC from Lunar Laser Ranging (LLR)



STD UT0–UTC ≤60 μs

In 2017, the development of new software/ software module for determining EOP according to SLR and LLR, as well as GNSS using neural network models (***gray-box models***) was completed. The software module made it possible to increase the accuracy of determining EOP by SLR and GNSS data by 12-20% (tests were carried out according to the FSUE VNIIFTRI, IAA (Institute of Applied Astronomy) and IAC (Information and Analytical Center of the Russian Space Agency) and satellite orbit.

Satellite orbit determination

Satellite	Orbit measurement (STD(cm))
Lageos 1,2	< 2.0
Etalon 1,2	< 3.5
GNSS	<1.7
LEO	< 12

EOP determination

Methods	STD (dXp, dYp)
SLR	0,06 – 0,08 mas
GNSS	0,04 – 0,06 mas

At the moment, a new software package is used in MMC SSTF FSUE VNIIFTRI for solving problems of geology, geophysics and geodynamics using satellite methods.

References

1. *Tsyba E., Kaufman M* . Improvement of the software Bernese for calculation of the Earth rotation parameters according to the data of satellite laser ranging (Lageos 1, Lageos 2) in the Main Metrological Centre of the State Time and Frequency Service //Materials of the Conference Journees 2014: Pulkovo Observatory, 22-24 September 2014, St. Petersburg, Russia.
2. *Кауфман М. Б., Цыба Е. Н.* Вычисление параметров вращения Земли в ГМЦ ГСВЧ по данным спутниковой лазерной дальнометрии // Метрология времени и пространства. 6-ой международный симпозиум: материалы конференции.– Менделеево, 17-19 сентября 2012.–С. 287–288
3. *Urschl C., Beutler G., Gurtner W., Hugentobler U., Schaer S.*GPS/GLONASS orbit determination based on combined microwave and SLR data analysis. University of Bern, 2005.
4. Bernese GPS Software Version 5.0, Users guide, AIUB, 2007, edited by *Rolf Dach, Urs Hugentobler, Pierre Fridez and Michael Meindl*.
5. *Цыба Е. Н* Вычисление параметров вращения Земли по результатам спутниковой лазерной дальнометрии международной сети ILRS// Труды Института прикладной астрономии РАН, вып. 32, 2015