Earth Orientation Parameters (EOP´s) using Satellite Laser Ranging data from ILRS 7406 Station at San Juan - Argentina

OAFA San Juan - Argentina

A. Pacheco[1], R. Podestá[1], Z. Yin[2], S. Adarvez[1], W. Liu[2], L. Zhao[2], H. Alvis Rojas[1], E. Actis[1], J. Quinteros[1] & J. Alacoria[1]

[1]- Félix Aguilar Astronomical Observatory, San Juan University, Argentina
[2]- National Astronomical Observatory of China, Chinese Academy of Sciences, Beijing, China

ABSTRACT

It is already known that space geodetic techniques as VLBI, SLR and GNSS collaborate with IERS in permanent monitoring of Earth rotation through studies of Earth Orientation Parameters (EOP´s).

In this paper we show the first estimations of EOP´s calculated from Satellite Laser Ranging data (SLR) obtained by ILRS 7406 Station of Observatorio Astronómico Félix Aguilar (OAFA) at San Juan – Argentina. We process results of SLR observations of LAGEOS 2 satellite by means of NAOC – SLR software, whose principal objective is precise determination of orbits, but also allows estimation of other parameters such as EOP´s.

Finally we show the little differences we fond between our results and those given by IERS for the same epochs.

Figure 1 : ILRS 7406 San Juan station

Classic study of Earth rotation considers separately the movement of rotation axe in the Earth and in the space. For routinely determination of Earth orientation, five quantities called "Earth Orientation Parameters" (EOP) are evaluated. Technically they are the measures that give rotation of International Terrestrial Reference Frame (ITRF) in International Celestial Reference Frame (ICRF).

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{ICRS} = R_{EOP} \begin{bmatrix} x \\ y \\ z \end{bmatrix}_{ITRS}$$

These parameters are: Precession and Nutation corrections to Celestial Pole (dPsi, dEps), Universal Time (UT1), or the equivalent Day Length (LOD), and Coordinates of the Pole (x, y).

$$R_{EOP}(t) = P(t)\ N(t)\ R_3(-\theta)\ R_1[y_p(t)]\ R_2[x_p(t)]$$

SLR technique gives IERS determination of short period parameters DUT1 and Coordinates of the Pole [1]

The telescope we are using in this task is the SLR system placed at OAFA accomplishing International Cooperation Agreement between Universidad Nacional de San Juan and Chinese Academy of Sciences. This last generation instrument is working continuously from 2006 providing excellent results, becoming the station one of the most important on ILRS global net. [2].The successful test period of SLR at OAFA allows our processing of station observational data from tree years ago. Obtained results make this first experience useful to enhance the cooperation that OAFA traditionally gives to international services ILRS, IERS and NASA. (Figure 1)

DETERMINATION OF EOP's

Observations performed with ILRS 7406 Laser Telescope were processed by means of NAOC – SLR Software that allows, between several other objectives, determinate DUT1 and coordinates of the Pole with extremely high precision.

The reference frame, measurement and force models basically follow the IERS conventions.

(a) Force models. In the development of force models, the following perturbation factors are considered: (1) lunar and solar gravity perturbations, (2) solid Earth tide, (3) ocean tide (CSR4.0), (4) the GGM02C Earth gravity field model, (5) solar and Earth radiation pressure (Cr and derivative Cr adjusted), (6) the drag-like perturbation (Cd and derivative Cd adjusted), (7) thermal radiation imbalances from the Earth and sun, (8) general relativistic perturbation, and (9) Earth's rotation deformation perturbation.

To improve the precision of the orbital determination, the empirical perturbations due to periodic empirical radial and transverse accelerations are also considered.

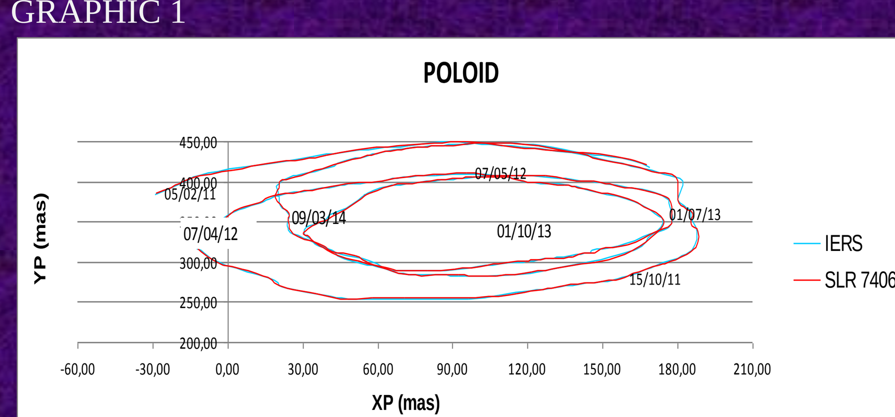
(b) Measurement models. Measurement models are considered as follows: (1) the Marini-Murray refraction model, (2) the offset correction about the center of mass of Lageos-2, (3) station displacement from solid Earth tides, (4) the influence of ocean loading at each site, (5) the influence of permanent tide deformation at each site, and (6) rotational deformation due to polar motion.

(c) Reference frame. The reference frame utilizes (1) the mean equinox (*X*-direction) and equator (*X-Y* plane) of J2000.0, (2) the precession constants of IAU 1976, (3) the nutation coefficients from the IAU 1980 theory of nutation and the celestial pole offset of IERS, (4) the DE403/LE403 planetary ephemeris, and (5) the initial values of station coordinates from ITRF2000.

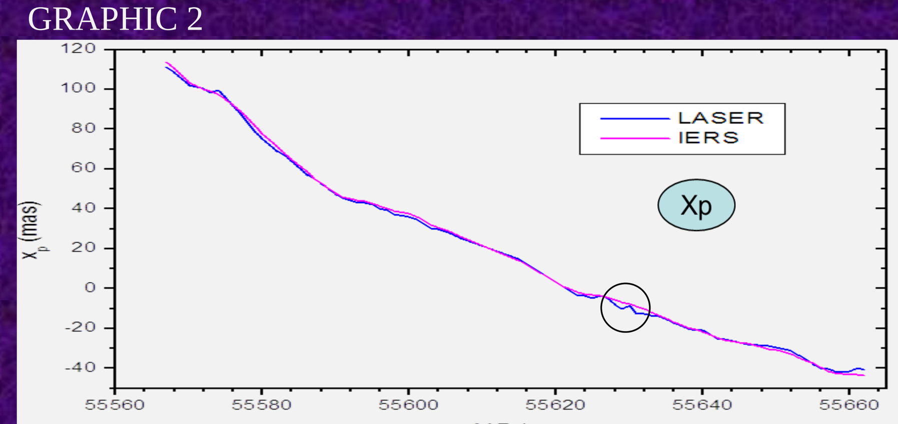
Graphic 1 shows the Poloid obtained with SLR data from ILRS 7406 Station and the given by IERS from February 2011 to July 2014.

Graphic 2 ,3 and 4 show the major differences between SLR and IERS values correspondent to march 9 and 11, 2011, surprising coincident on time (Epoch 55630 mjd) with the strong earthquake with epicenter in Miyagi, Japan (Mw = 9.0).

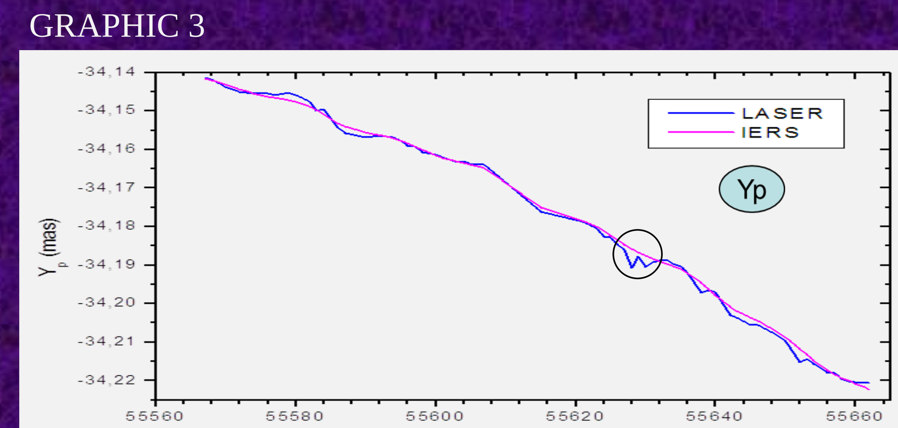
GRAPHIC 1



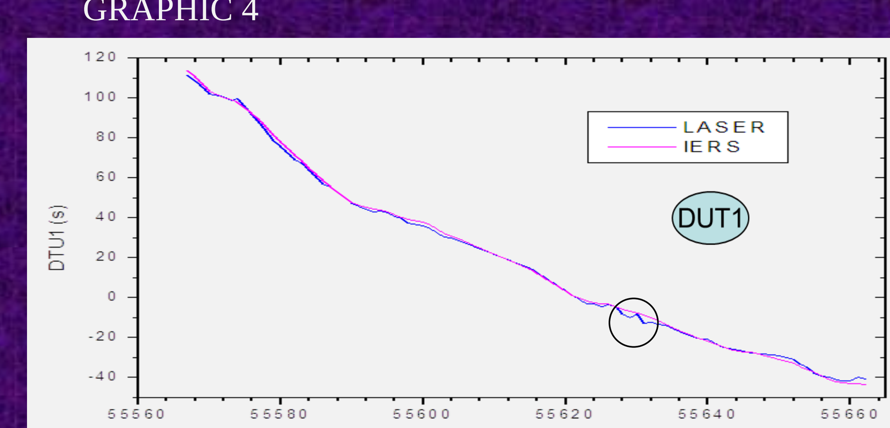
GRAPHIC 2



GRAPHIC 3



GRAPHIC 4

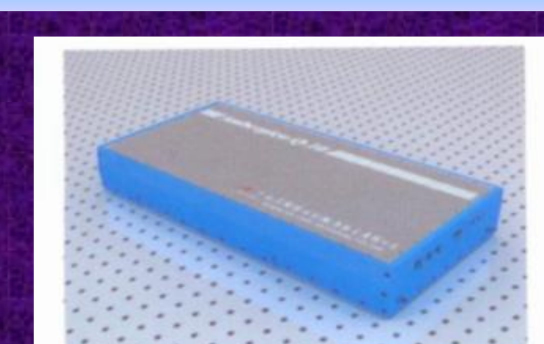


Futures Expectations

In a near future important parts of hardware and software of the Satellite Laser Ranging will be renewed, allowing day and night satellite ranging and increasing also the number of pulses emited by the telescope to the order to khz.

We hope observation precision improve significantly.

New System:
Semiconductor Laser Diode



Event Timer AO33LATVIA

CONCLUSIONS:* *NAOC – SLR software allows a high precision estimation of astronomic and geodetic parameters and, as one can deduce from graphics 1, 2, 3 and 4, results of EOP´s obtained from SLR observation are fully consistent with values given by IERS for the same epoch. We note that differences LASER – IERS for Pole Coordinates and DUT1 is usually about 0.5 mas. The greater differences between IERS and LASER values are just for Japan earthquake (March 11, 2011), and for the strong seismic activity occurred two days before (March 9, 2011). For that epoch differences Laser – IERS on Pole coordinates varied from 0.5 mas to 4 mas for X and to 7 mas for Y. Obtained results show that SLR System satellite observations are very sensitive and clearly detect changes in the Earth rotation axe when they are caused by important seismic events of the planet.

Ref. [1] : Inter-technique combination based on homogeneous normal equation systems including station coordinates and Earth Orientation. Scientific Technical Report STR08/15 GFZ
Ref. [2] : : San Juan Satellite Laser Ranging. Perfomance and Precission in the Observations XII Reunión Latinoamericana de Astronomía. Venezuela (2007)