



SAN FERNANDO LASER STATION UPDATES AND NEW IMPROVEMENTS

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ABSTRACT

The laser station of the Royal Observatory of the Spanish Navy has been working on artificial satellite tracking since early 1980s. Nowadays, these observations serve a dual purpose. First, our tracking data on active artificial satellites **contribute to the International Laser Ranging Service (ILRS)** in order to improve the definition of their orbits, and to define the International Terrestrial Reference Frame (ITRF). Besides, this activity is complemented by **space debris tracking**.

Regarding the second mission, it is well-known that the number of non-collaborative objects has increased rapidly, particularly in LEO where the probability of collision can reach an alarming level in next few years. This situation poses a risk for manned and unmanned space missions, with devastating consequences in some cases.

In order to participate in this highly demanding type of activity, we have performed severe modifications and technical developments. These modifications has led to: a) the incorporation of a new laser almost 100 times more powerful than the previous one; b) to develop an air safety system; and c) to substitute optical and electronic components that improves the signal-to-noise ratio.

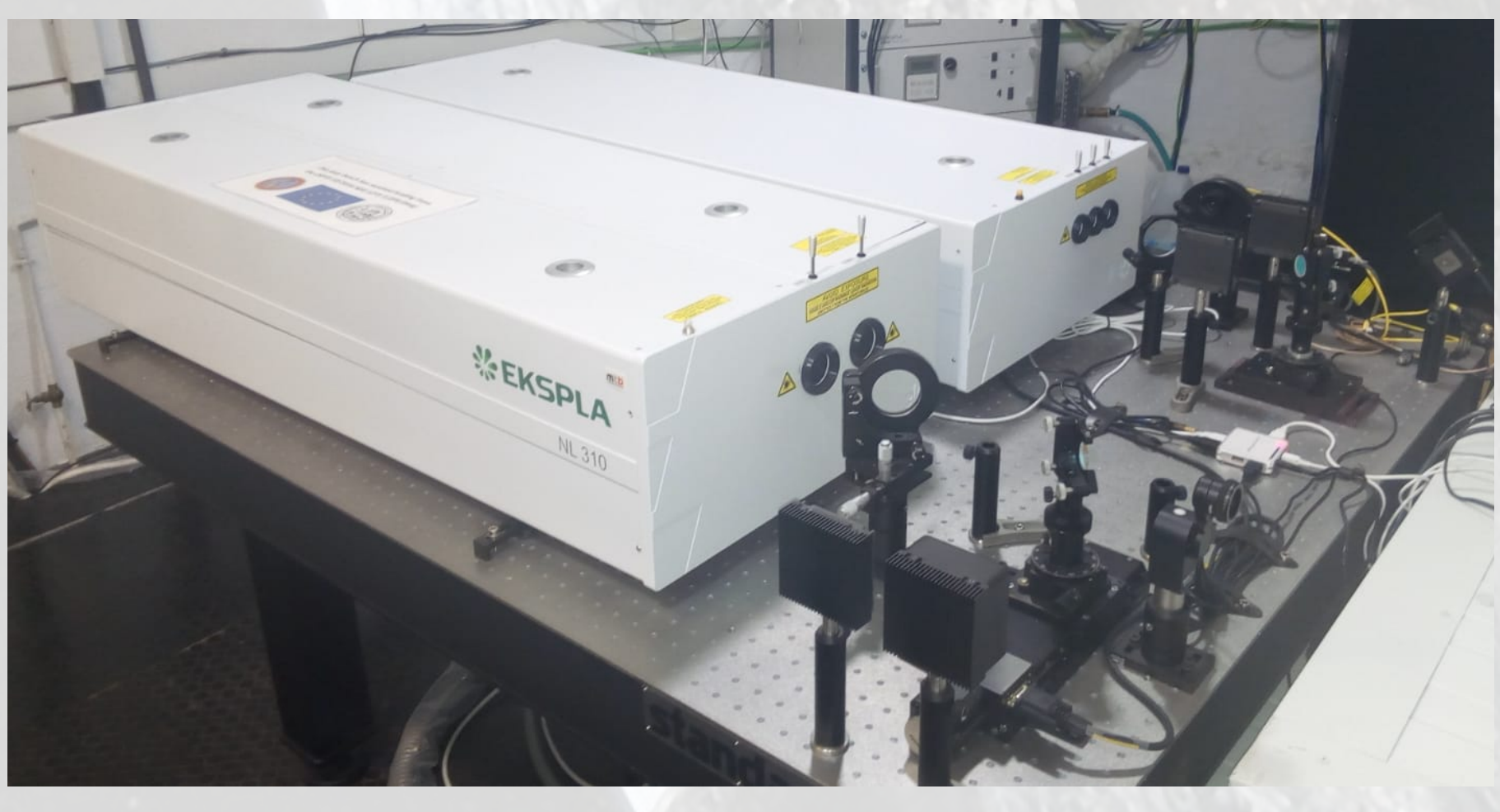
Besides that, a new laser bench is nowadays operative. This new laser (30 ps pulse width) transmits 50 mJ per pulses, and it is in charge of the "leitmotiv" that justifies the appearance of this technique at ROA, that is tracking active collaborative satellites.

1. CURRENT EQUIPMENT CONFIGURATION

- SST activity:**
 - EKSPLA NL317
 - Energy @ 532 nm: 2.5 J
 - Pulse width: 8 ns
 - Beam diameter: 21 mm
- Geodesic activity:**
 - EKSPLA PL2251C
 - Energy @ 532 nm: 50 mJ
 - Pulse width: 30 ps
 - Beam diameter: 12 mm

2. OPTICS

Relevant updates in the optical framework were accomplished to increase the efficiency and return of SLR telescope. Specifically, several optical elements were rearranged and/or fine-tuned. Most of them replace with modern high-efficiency components that improves the signal-to-noise ratio.



3. SOFTWARE DEVELOPMENT

Currently, it is one of the most important development focuses in our team. The latest tools created are:

- CPF Manager
- Prediction Generator
- Space Object Database Manager
- Air Safety Alert System

3.1. AIR SAFETY ALERT SYSTEM

Provide a system which acts as an interface between the observer and the laser station software system.

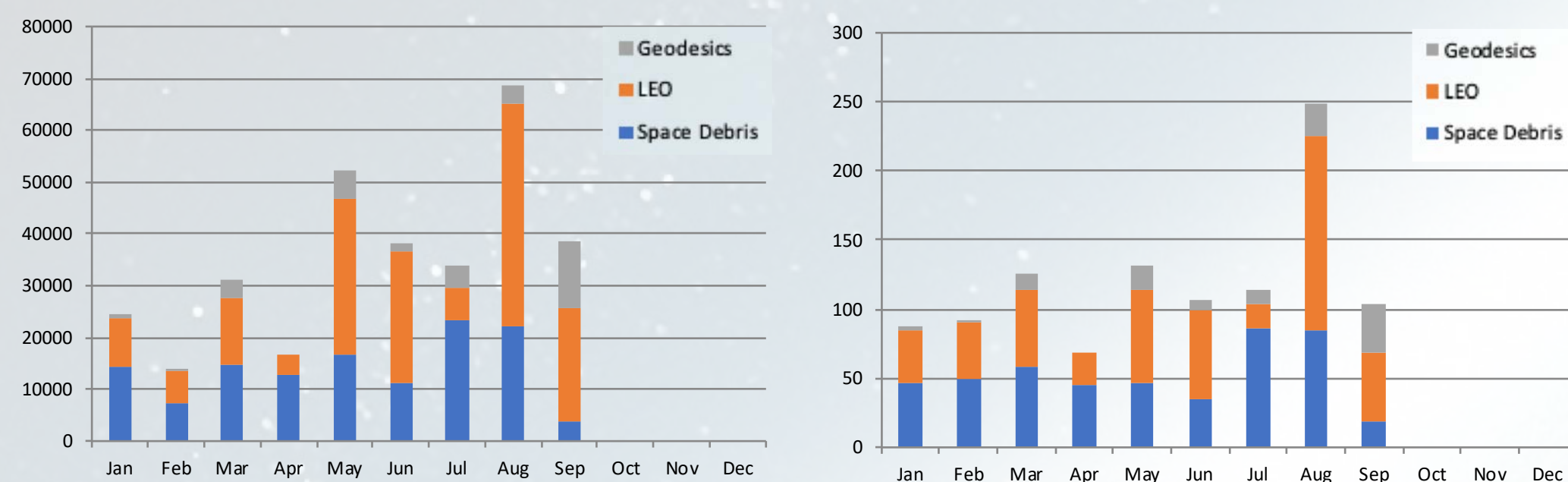
- Software developed in C++, QML and Java Script.
- Controlled under a cross-platform application framework under Qt.
- It analyses the commercial air traffic and provides alerts
- Obtain information in ADS-B format.

4. STATISTICS 2019

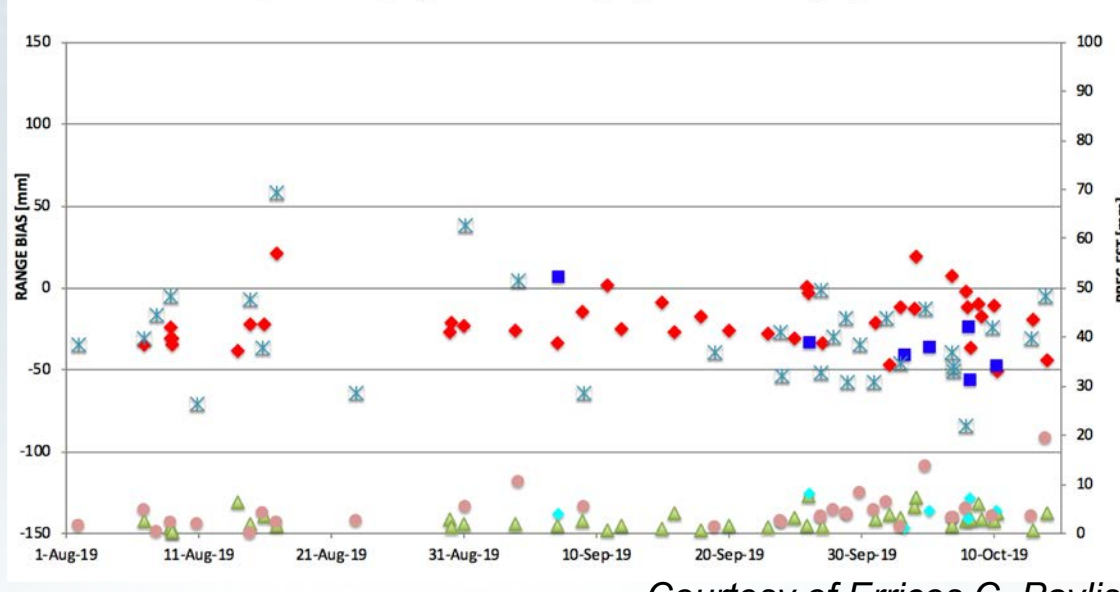
Both laser are fully operative and contribute as an asset to the **Spanish SST** (European Union SST programme). Currently, after completing the modifications we are immersed in the evaluation period to leave the quarantine and return again as an active member of the **ILRS**.

Echoes

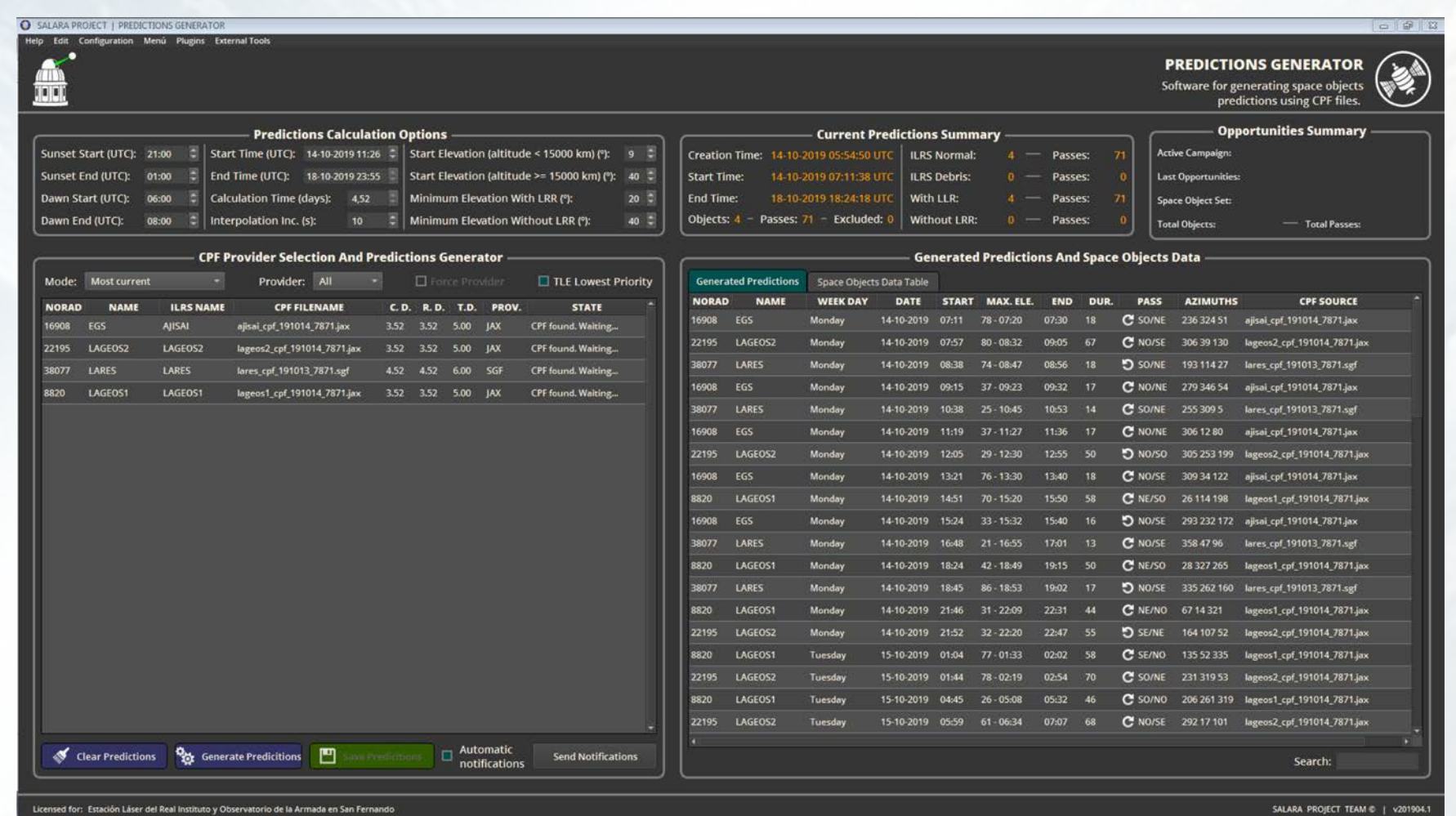
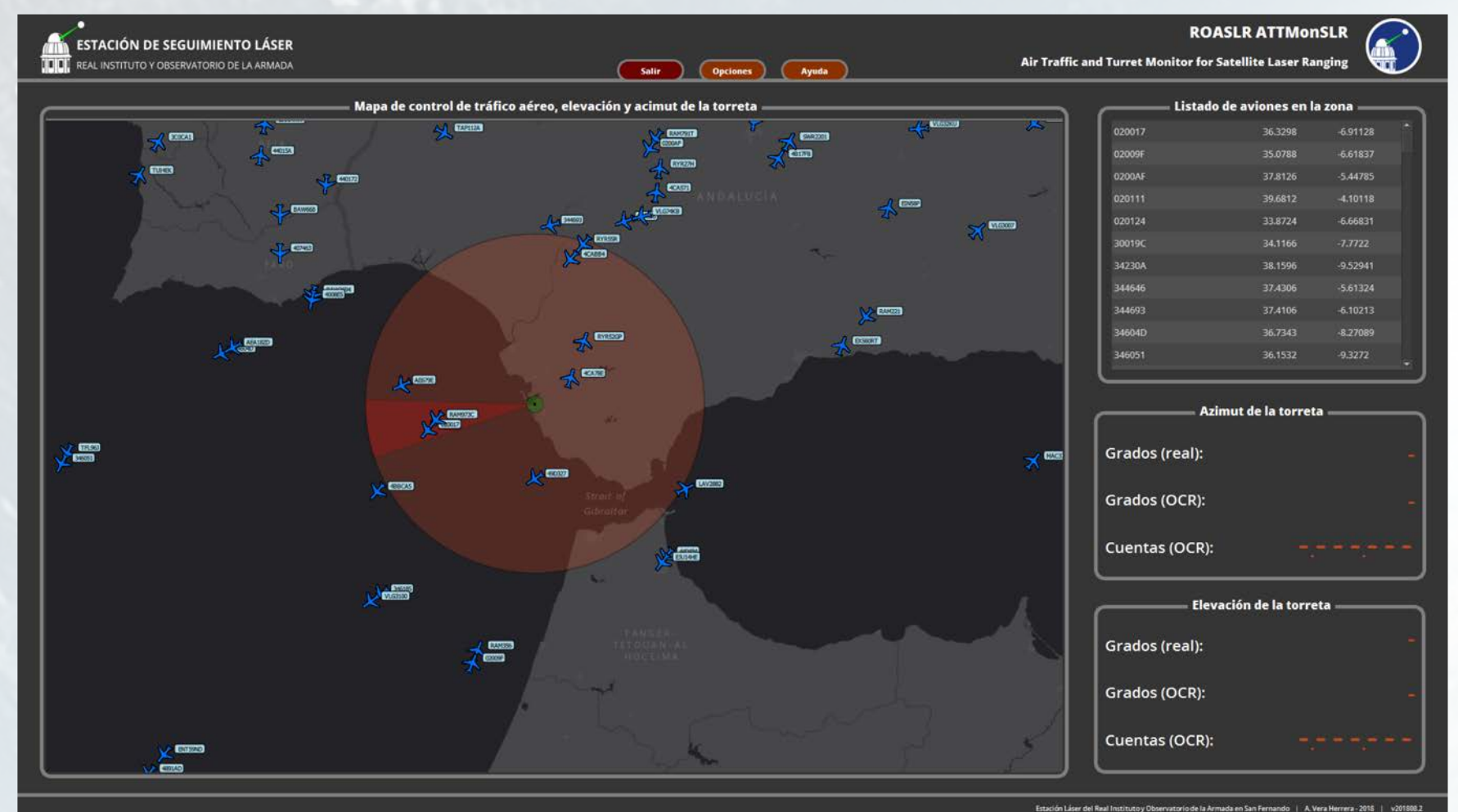
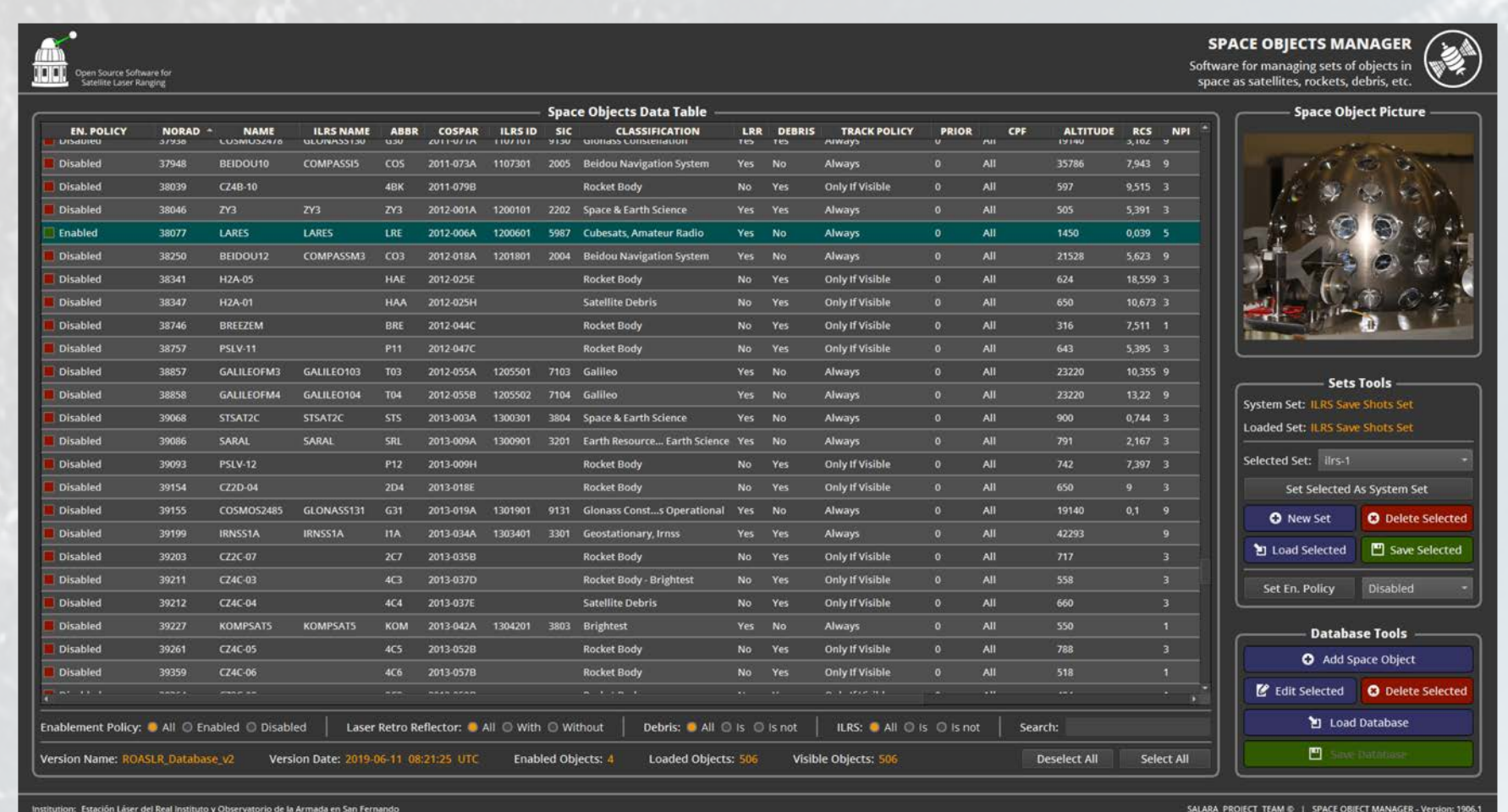
Trackings



Legend for Range Bias and Precision Error



Courtesy of Erricos C. Pavlis



5. CURRENT WORK AND FUTURE UPGRADES

- **New mount and pointing system** project to achieve a resolution of approx. 2 arcseconds.
- **Hardware & software** modifications: development of a whole new software package to control the SLR station operation based on FPGA Cyclone V SoC.