FABRA-ROA TELESCOPE AT MONTSEC

FROM EARLY SATELLITE TRACKING AGE TO SPACE SURVEILLANCE

FABRA-ROA TELESCOPE AT MONTSEC (TFRM)

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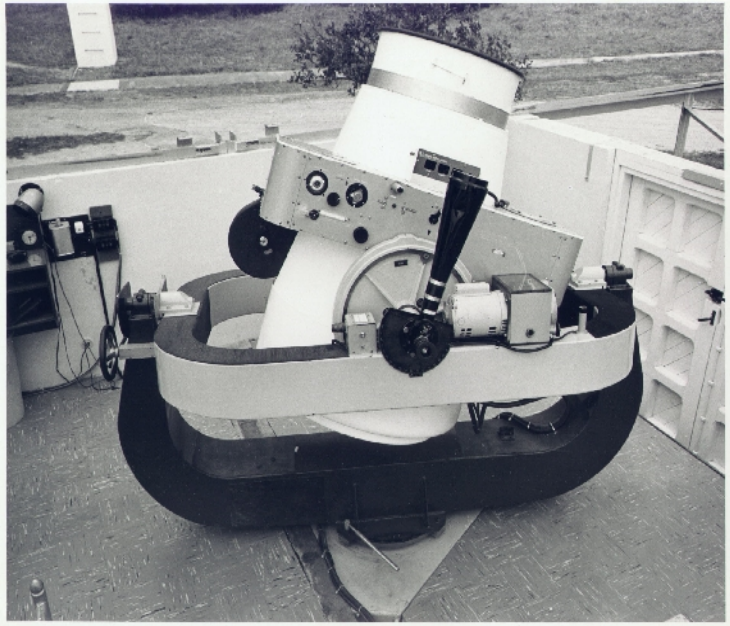
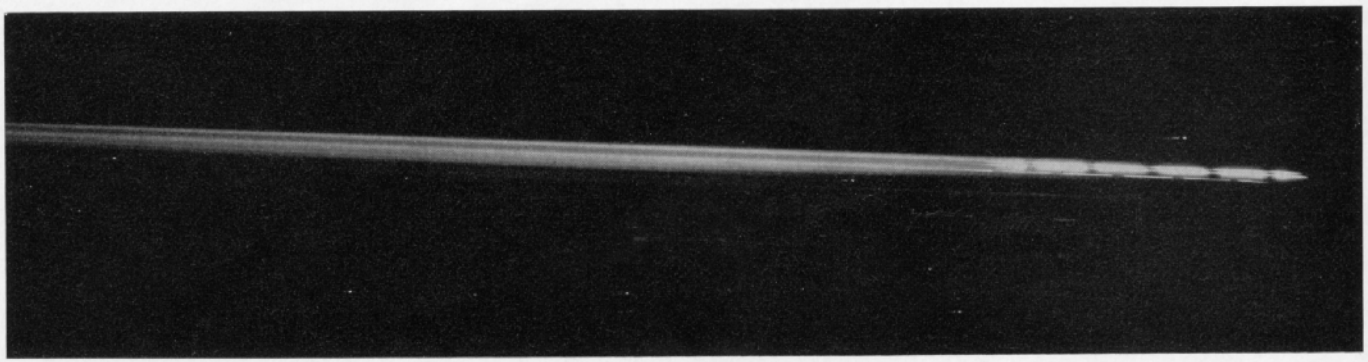
TFRM – THE EARLY SPACE AGE

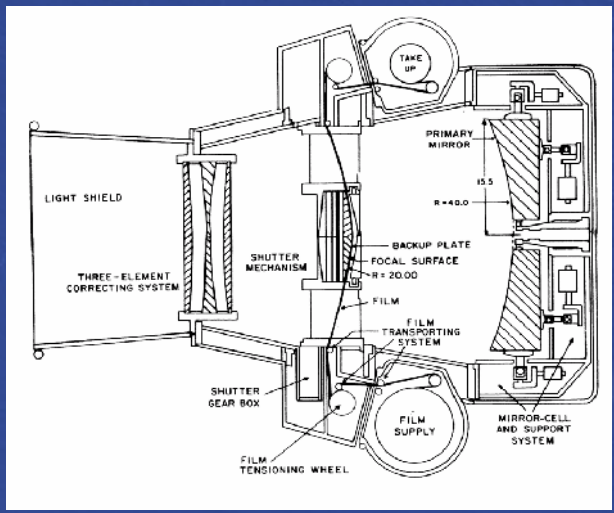
- The Baker-Nunn Cameras (BNC) were built by the Smithsonian Institution at the beginning of the space age as the American solution to track the first artificial satellites.
- The U.S. built around 20 of these cameras and were placed in different countries to have global coverage. One of them was installed in San Fernando (ROA), southern Spain.
- Extremely high quality telescope optics and mechanics. Huge FoV (30 deg x 5 deg) over a curved photographic film.





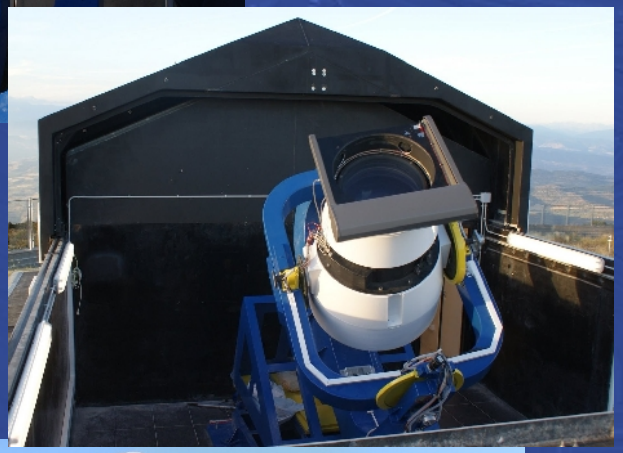
The fiery reentry and breakup of the rocket body that launched the Soviet satellite Cosmos 197, as seen during the beginning of the carrier's last revolution around the earth. This photograph was taken by Francisco Cano on the morning of January 8, 1968, with the Baker-Nunn camera at the Smithsonian Astrophysical Observatory's satellite tracking station at San Fernando, Spain. Breaks in the image were caused by the rotating shutter of the camera. A smoke train was visible for more than a minute. Final decay was probably halfway around the world in the South China Sea.

222 SKY AND TELESCOPE, *April, 1968*



TFRM – A PROJECT ACCOMPLISHED

Once the refurbishments were finished and after a testing period carried out in San Fernando, the BNC was definitely moved and installed in the Observatori Astronòmic del Montsec (OAdM), Catalonia's Prepyrenees.



OAdM

Lat = 42º 03' 06" N

Long = 00º 43' 45" E

Height = 1570 m MSL

Official TFRM opening
September 16, 2010

TFRM – A FULLY REMOTE AND ROBOTIC TELESCOPE

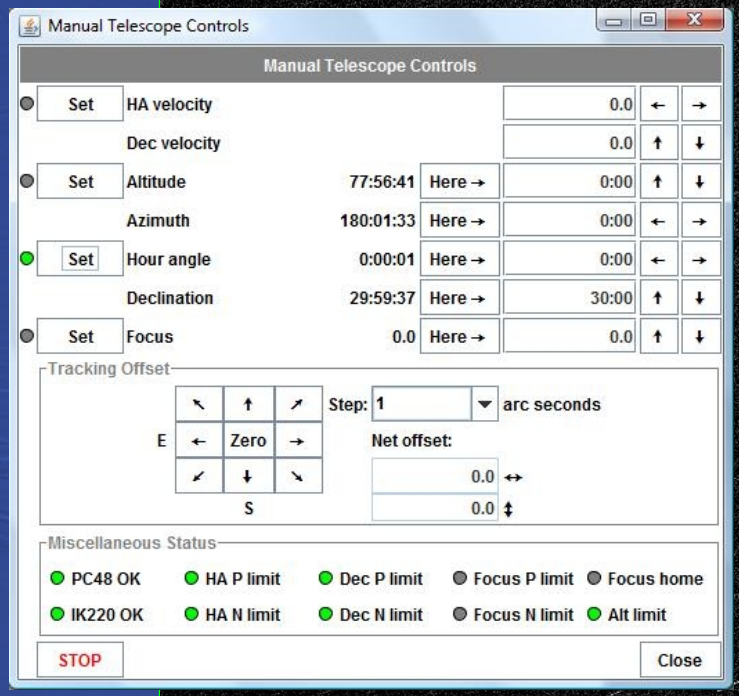
TELESCOPE MAIN FEATURES

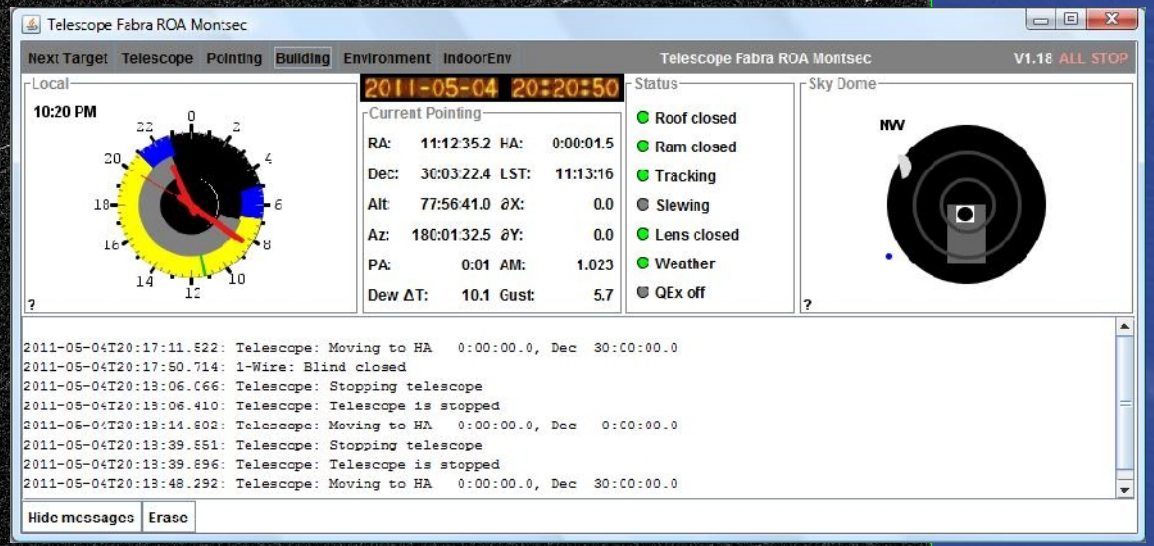
- Modified Schmidt Telescope; 3 corrector lenses.
- 50 cm aperture; f/1; 80 cm diameter mirror.
- FLI Proline CCD camera; 4k x 4k; 9 microns pixel size.
- 4.4 deg X 4.4 deg flat FoV; 3.9 arcs/pixel.

CONTROL SOFTWARE

- Based on the neutral protocol for communication between devices (INDI), developed by Elwood C. Downey (Clear Sky Institute, Inc.).
- It allows remote handling and scheduling of all the telescope system, e.g., roof, camera, HA and DEC movements at different rates (tracking targets, all kind of orbits surveillance), camera cooler...

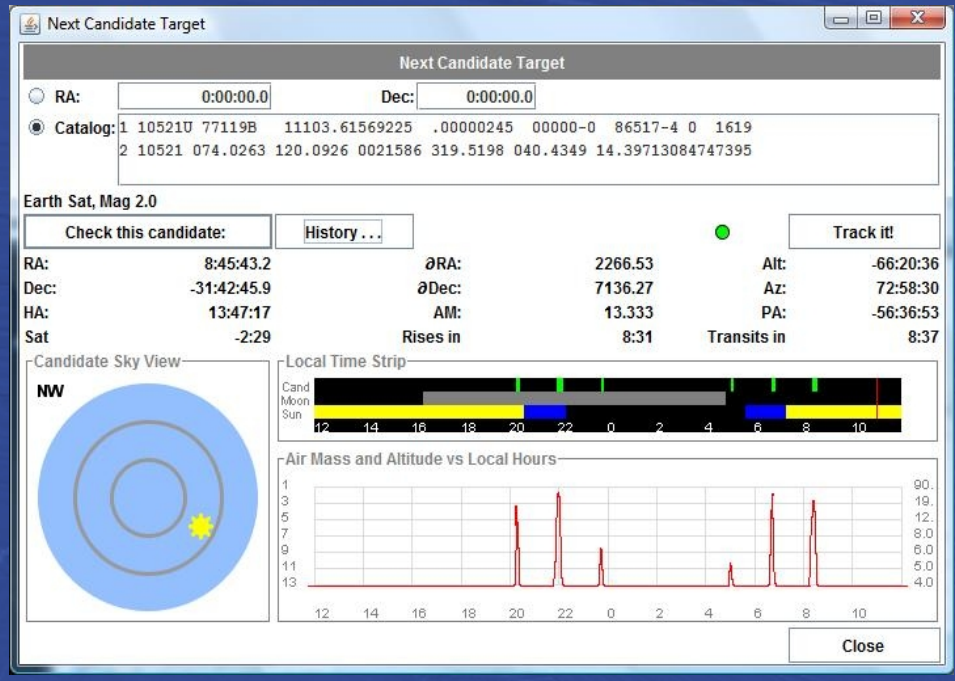
Robotic tracking of LEO Delta1 R/B
Orbit: 304 x 1,608 km, 89.1°
0.3 s exposure, 07 Feb 2011

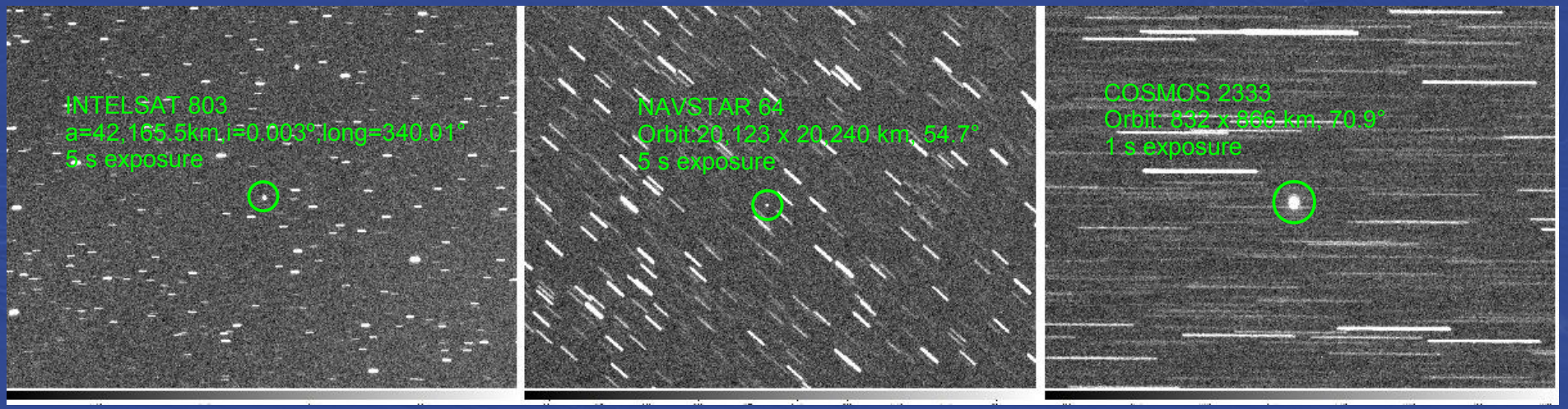




TFRM – CAPABILITIES

- The telescope is very well suited for sky surveys aiming to detect space debris, NEOs, asteroids, comets and extrasolar planets by transit.
- The TFRM can track objects in any orbit with just introducing their orbital elements, surveys in a given orbit can be scheduled and the software is able to control the camera shutter during an exposure.
- The timebase accuracy is assured below the ms by a LANTIME M200 GPS time server.
- Currently TFRM is in a commissioning period, expecting to collaborate soon in international SST programmes.

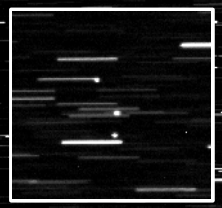




Detail of robotic tracking images of GEO, MEO and LEO satellites.

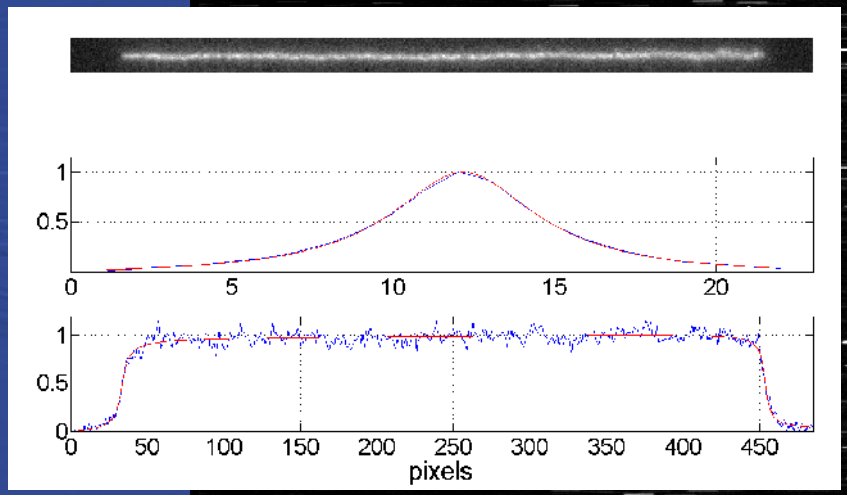
TFRM – TRAILED IMAGE REDUCTION

Detail of Hispasat GEO slot 30º W



ROA has developed an accurate reduction of astronomical trailed images software, based on fitting specific functions to the PSF (PASAGE project).

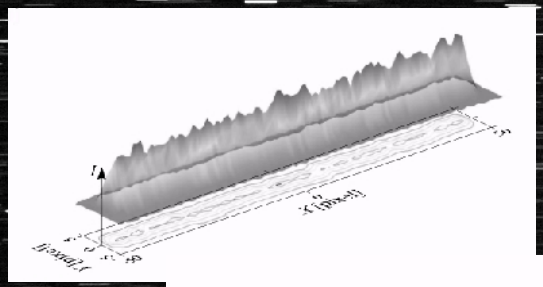
Montojo F.J., López-Moratalla T. Abad C., *Astrometric positioning and orbit determination of geostationary satellites.* Adv. Space Res. 47, 1043-1053, 2011.

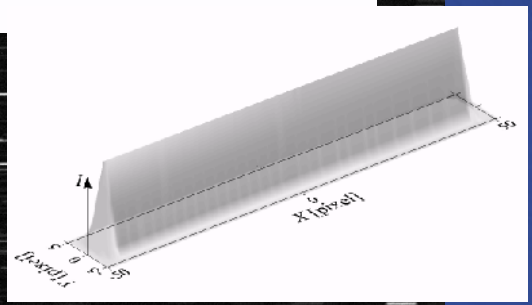


The Central (Pulkovo) Observatory of the Russian Academy of Sciences has developed an advanced software (APEX II) especifically designed for detection and astrometric positioning of faint GEO object.

Kouprianov V. *Distinguishing features of CCD astronomy of faint GEO objects*. Adv. Space Res. 41, 1029-1038, 2008.

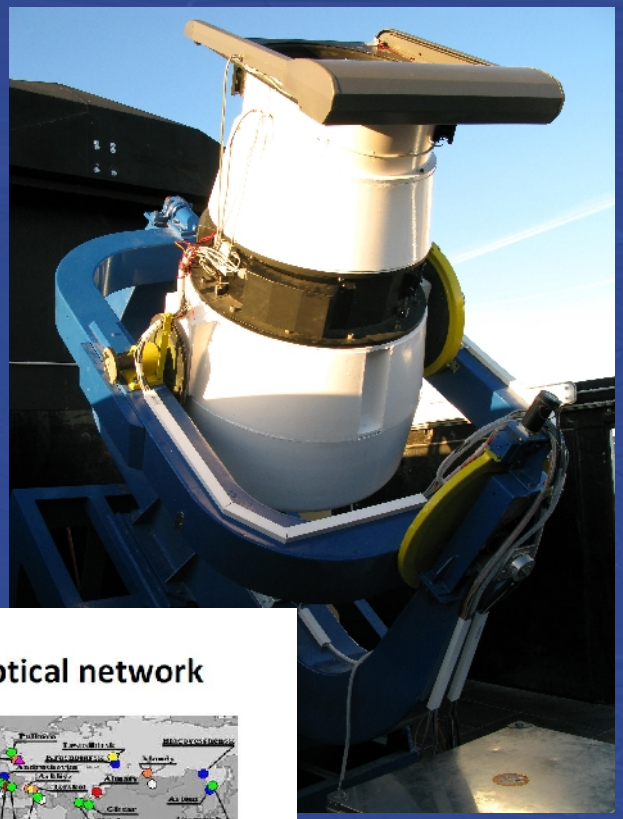
Devyatkin A.V., Gorshanov D.L.,Kouprianov V.V.; Verestchagina I.A. *Apex I and Apex II software packages for the reduction of astronomical CCD observations.* SoSyR 44, 68-80, 2010.

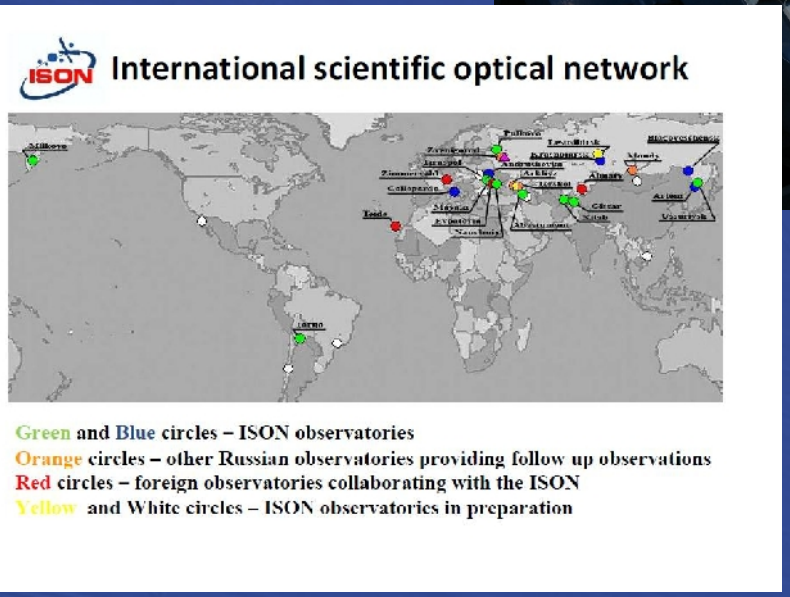




TFRM – INTERNATIONAL COOPERATION IN SPACE SURVEILLANCE & TRACKING

- ✓ Although the telescope has multiple astronomical applications, we intend to devote a significant part of observing time to space surveillance programs. In fact, the TFRM is now one of the asset with which Spain contributes to the ESA for the future SSA / SST Programme.
- ✓ We thought it might be perfectly compatible to open a line of collaboration with the successful International Scientific Optical Network (ISON).





СПАСИБО ЗА ВНИМАНИЕ
MUCHAS GRACIAS POR SU ATENCIÓN

First robotic observation.
18 FEB 2011, Full Moon.
Snapshots taken from the OAdM IP cameras.