Yebes Laser Ranging Station (YLARA) Development Status 2019

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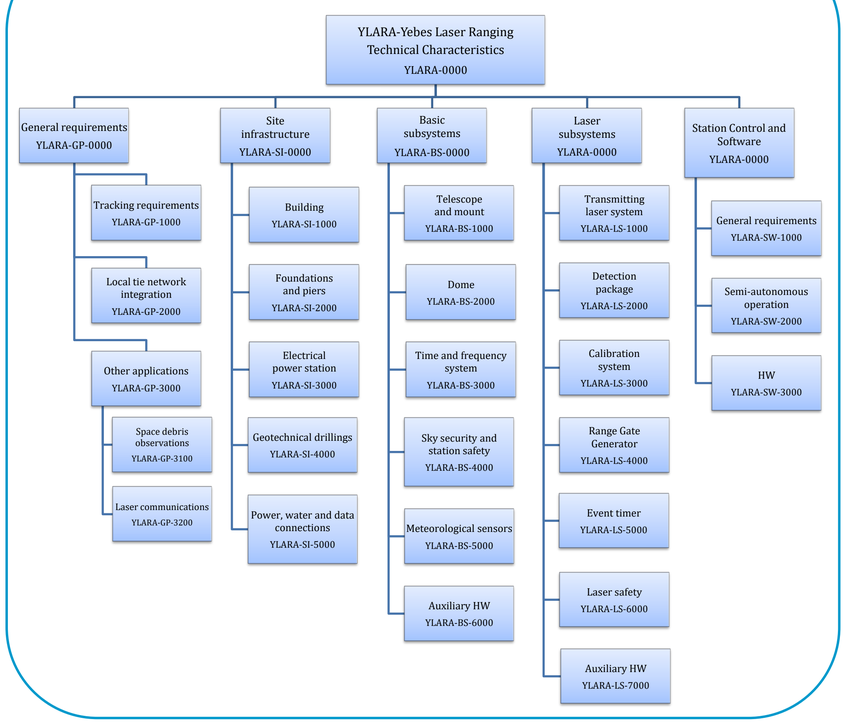
YLARA –Category Tree



YLARA Objectives and Basic Design

Main Objective: Observations to satellites equipped with retro-reflectors (mainly geodetic satellites and GNSS), turning Yebes Observatory into a Geodetic Fundamental Station

Location

- Yebes Observatory, Guadalajara
  - 3.08°W/40.52°N
  - 915 m height, good sky visibility
  - Humidity ≤70%
  - Mean of average speed 5.8 km/h
  - Mean of maximum speed 32 km/h
  - Near the main road ⇨ easy access
  - Near offices and laboratories buildings

Future YLARA Station Location

Site infrastructure

- Building
  - 75-110 m^2
  - Control and Coudé/laser room, AC/electricity room, toilet, warehouse space, dome access, roof access
- Foundations and piers
  - Isolated from the building
  - Anchored to bedrock
  - For the telescope mount and optical benches
  - Free inner space for Coudé path elements and access
- Electrical power station: 230/400 VAC, 50 Hz, SAI included, AC system
- Geotechnical drilling has been performed
- Power, water and data connections available

General requirements

- Tracking requirements
  - Satellites observations from 300 – 42.000 km (night and day)
  - Fulfilling GGOS requirements
  - Fulfilling ILRS Pass Performance Standard
  - Modular and flexible design
- Local tie integration
  - Invariant point AZ/EL intersection
  - Network extrapolation <1 mm
  - 2 new pillars
- Other applications / Improvements
  - Space debris observations

Basic Subsystems

- Telescope and mount
  - Biaxial telescope, AZ-EL mount, several foci
  - Receiving system 50-80 cm
  - Transmitting system 7-15 cm
  - Beam pointing accuracy 1-5''
  - High slew rate
  - Minimum tracking elevation 10º - 15º
  - Two possible configurations: Coudé path and piggyback solution
- Dome
  - 4-6 m diameter
  - Slit-type
- Time and frequency system: H-Maser (EFOS_C, T4 Science SA), GNSS Synchronization system (Meinberg Lantime M3000)
- Sky security and station safety: Radarcape ADS-B, FLARM AT-1 receiver, OMEA-8C all sky camera, Boltwood could sensor
- Meteorological sensors: temperature, humidity and pressure sensors, rain detector, pyranometer, etc.

Riga ET and Lantime M3000

Sky security (aircraft detection) and station safety

Laser subsystems

- Transmitting laser system
  - Repetition rate ≥ 1000 Hz (adjustable)
  - Pulse width < 25 ps
  - Wavelength 532/1064 nm (Nd:YAG – Nd:Van)
  - Energy 0.5 - 5 mJ
  - Adapted optic to 532 and 1064 nm (laser wavelengths)
- Detection package
  - CSPAD (QE 30%), telescope location
  - CCD Camera
  - Flexible to add other detectors
  - Field of View 10-60"
  - Daylight filter bandwidth 0.15-0.5 nm
- Calibration system: accuracy < 1mm
- Range Gate Generator: 50-1000 ns width
- Event timer: Riga A033-ET/USB.
  - Resolution 3-4 ps / Precision ≈ 5 ps
- Laser safety: glasses, warning signs, secure windows and doors, warning lights, SW and HW on/off control, etc.

Station Control and Software

- General requirements
  - Command and control of all station hardware and security components in real-time.
  - Ability to support a wide range of hardware types and configurations: telescope, laser, range gate, detectors, dome, weather station, security systems, time and frequency systems...
  - Intuitive user interface to monitor and perform all SLR operations.
  - Possibility of introducing easily new modules and functionalities. Ability to extend the software in a future to carry out completely automatic observations and for the realization of observations of space debris.
- Semi-autonomous operation of the SLR station

ERDF Funds – ICTS Infrastructures

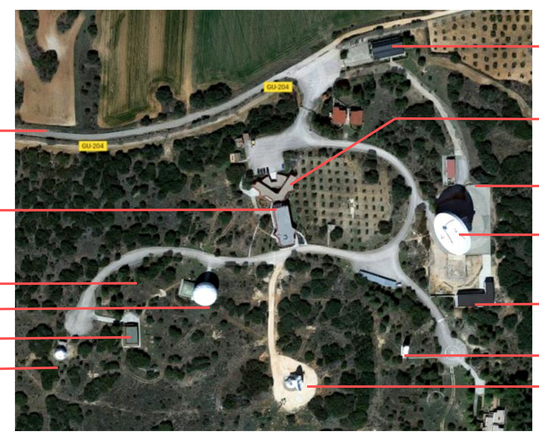
- **Yebes Observatory is one of the Singular Scientific and Technological Infrastructures (ICTS)** in Spain, and the only one in the Castilla-La Mancha Region

⇒ **ERDF Funds, Operational Programme Smart Growth 2014-2020 - Ministry of Economy, Industry and Competitiveness of Spain** (FICTS1420-11-12)

⇒ **Operation:** Development Infrastructures and Laboratory Activities for Space Geodesy at Yebes Observatory (YDALGO)

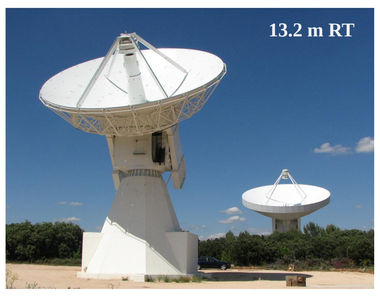
YLARA station working plan	2018				2019				2020				2021				2022			
Building and site infrastructures			X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Telescope system and dome					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Time and frequency subsystems			X	X	X				X	X	X	X	X							
Security systems and sky monitoring			X	X	X				X	X	X	X	X							
Optical Subsystem (laser, detector, etc.)						X		X	X	X	X	X	X	X	X	X	X	X	X	X
Measurement System (RGG, ET, etc.)			X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Software package and control systems					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
System Engineering, Integration and Commissioning									X	X	X	X	X	X	X	X	X	X	X	X
Technical and Scientific Management and Quality Assurance					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Promotion			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staff (2 engineers)						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

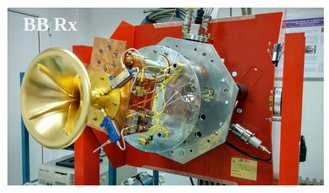
Yebes Observatory Overview



Core Site Status - Available Techniques

13.2 m VGOS Radio Telescope





- **Broadband Receiver (from 2 to 14 GHz)**
  - Dual lineal polarization, noise temperature under 25 K
  - Using a quadruple-ridged flared horn (QRFH) from Caltech
  - Installed in February 2016 for VGOS Broadband observations
- Yebes Low Noise Amplifiers: broadband for VGOS
- Signal conditioning modules for backends (Yebes design)
- Phase and noise calibration modules (Yebes design)

GNSS Receivers

Spanish Network ERGNSS

EUREF Permanent Network

Local tie

- The complete network is composed by 24 vertex including on it the radio telescopes and the GNSS antennas.
- Pillars are made of concrete and iron and compose by a 30 cm diameter cylinder inside a protector tube
- Network accuracy below 1 mm

Gravimetry pavilion

- Seven pillars for instrument installation and intercomparisons
- Two absolute gravimeters (A10 & FG5)
- OSG Superconducting gravimeter (Feb - 2012)
- Participation in IGETS - International Geodynamics and Earth tide Service
- One SILEX Accelerometer