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Bringing FORS into the ELT era: control software and electronics

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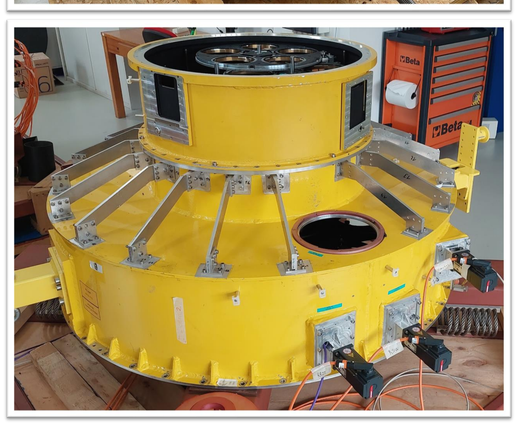
FORS-Up

FORS2 (*FOcal Reducer/low dispersion Spectrograph*) is a multi-mode (imaging, polarimetry, long slit and multi-object spectroscopy) optical instrument mounted on the Cassegrain focus of the UT1 of ESO's *Very Large Telescope* (**VLT**) in Chile. Despite its 24 years of operation, it is still one of the most requested VLT instruments. To ensure its long-term operation, an upgrade project was launched: its decommissioned twin FORS1 is now undergoing a complete refurbishment at INAF-OATs. Once the upgrade is finished, FORS1 will replace FORS2 at the VLT.



FORS1 Top Section, Collimator Unit and Filter/Camera Section in the integration hall of INAF-OATs.

Control Software

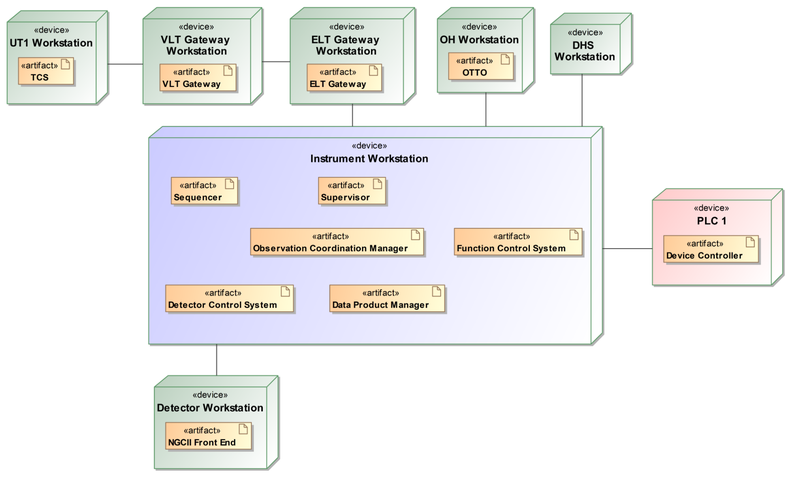
Despite being a VLT instrument, FORS1 will transition from the VLT software to the new ELT *Instrument Control Software Framework* (**ELT-IFW**), the standard foundation for implementing the control software system for all future instruments that is currently under development at ESO.

The *Instrument Workstation* (**IWS**) runs the main high-level processes, with several subsystems to manage and monitor the instrument and the data acquisition.

A Beckhoff **PLC** runs the low-level software to control the hardware devices; communication between the IWS and the PLC exploits the OPC UA Protocol.

A dedicated *Detector Workstation* (**DWS**) running the *New General Controller 2* (**NGC2**) software (provided by ESO) will control the scientific detector.

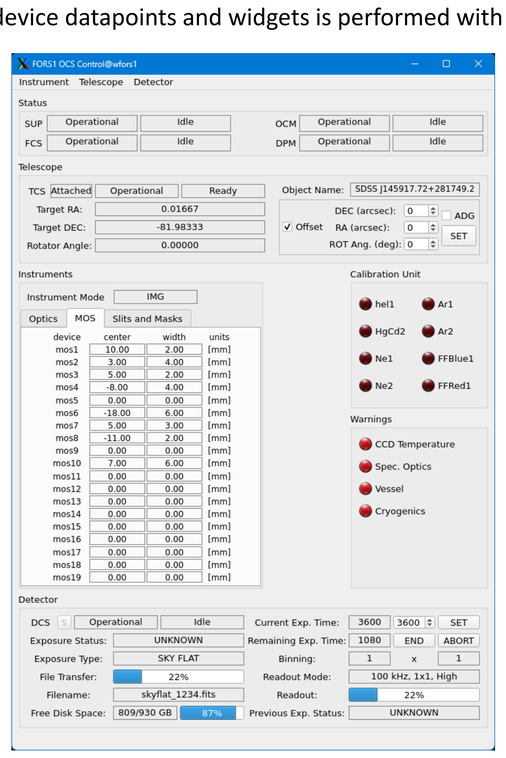
FORS1 will communicate with the VLT via the **ELT-VLT Gateway**, that forwards telescope commands from the IWS to the VLT *Telescope Control System* (**TCS**) and returns telescope status and data products from the TCS to the IWS.



The control software architecture of the upgraded FORS1.

Graphical User Interfaces

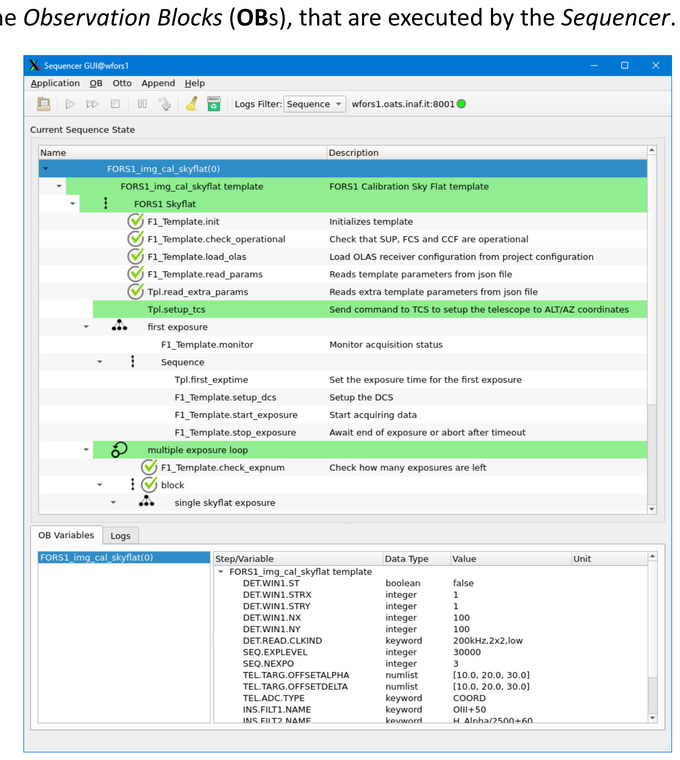
The development of *Graphical User Interfaces (**GUI**s)* makes use of the *Control User Interface Toolkit* (CUT) provided by ESO, to ensure a similar appearance to the GUIs of other instruments. Graphical applications are created using *Qt* and *Python*, while data binding between device datapoints and widgets is performed with *Taurus*.



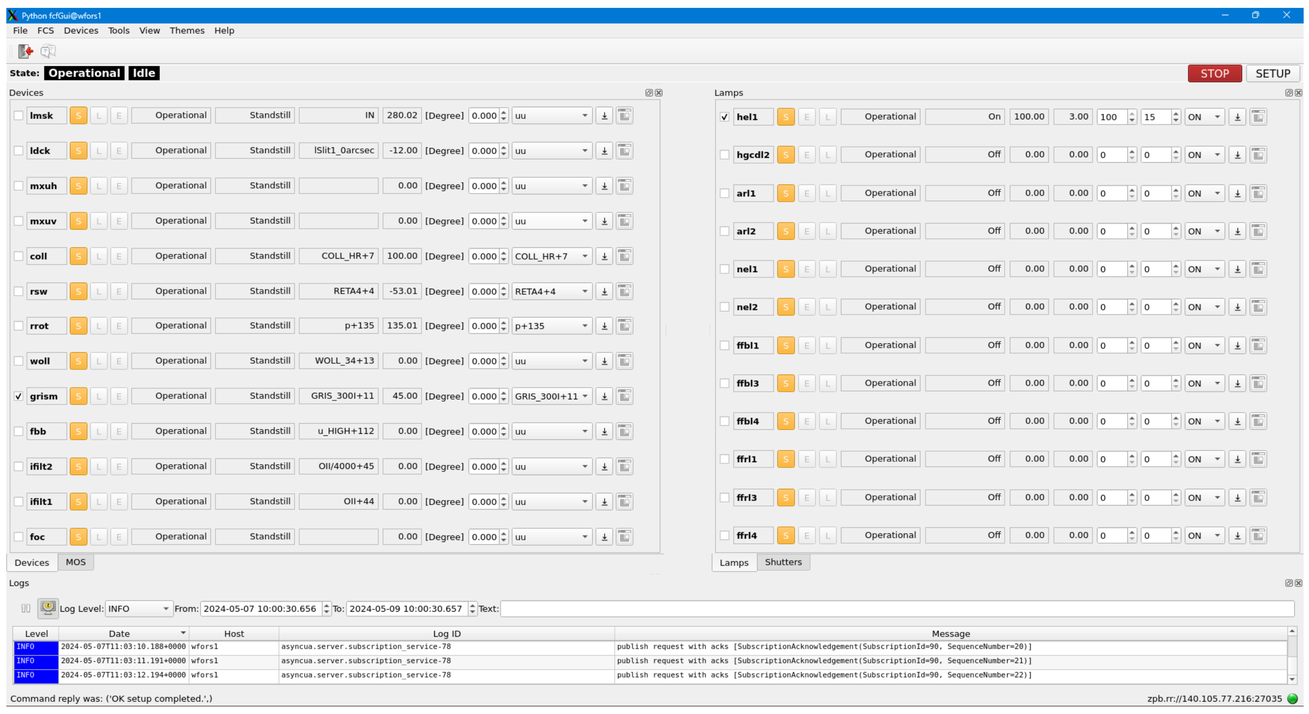
The first version of the *FORS1 OCS Control GUI*, designed to monitor the status of the instrument during regular science operations.

Templates

The execution of instrument procedures is organized into *templates*, namely *Python* scripts that operate individual instrument devices in the proper order, control detectors to gather scientific data and save them as FITS files on the IWS. Templates are the building units of the *Observation Blocks* (**OB**s), that are executed by the *Sequencer*.



The *Sequencer GUI*, designed by ESO, dispatching commands to the subsystems during the execution of a calibration OB.



The first version of the *FORS1 ICS GUI*, designed to allow in-depth control of all devices for engineering operations.

Control Electronics

The upgrade of the control electronic for FORS involves the replacement of all motors, sensors and cabling, as well as a redesign of the calibration unit. The new electronics architecture, based on the *Beckhoff PLC* platform, is composed of an embedded *CX2030* CPU with dedicated Beckhoff modules able to control all FORS functions, sensors and digital I/O. The embedded computer comes with the software *TwinCAT* and hosts the OPC UA server, enabling communication with the high-level software. Modules in the cabinets without a CPU are controlled via an *EtherCAT* connection and bus couplers. A custom low-level software library was developed to control the MOS unit and the exposure shutter.

Above: The control electronics architecture of the upgraded FORS1.

Left: The mechanism of the FORS1 exposure shutter, which is controlled by a single rotative motor and has a non-standard interface with the NGC2 detector controller.