ESPRESSO Instrument Control Electronics and Software: final phases before the installation in Chile

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INTRODUCTION

ESPRESSO, the Echelle SPectrograph for Rocky Exoplanet and Stable Spectroscopic Observations, passed the final testing phases before being shipped to Chile and installed in the Combined Coudé Laboratory (CCL) at the European Organisation for Astronomical Research in the Southern Hemisphere - Very Large Telescope site (ESO-VLT) (Figure 1).
The integration of the instrument took place at the Astronomical Observatory of Geneva. It included the full tests of the Instrument Control Electronics (ICE) and Instrument Control Software (ICS), designed and developed at the INAF - Astronomical Observatory of Trieste.
More detailed design of the scientific cases and of the technical aspects of the instrument are described in [1] and [2].

Figure 1 ESO - Very Large Telescope site (credits ESO)

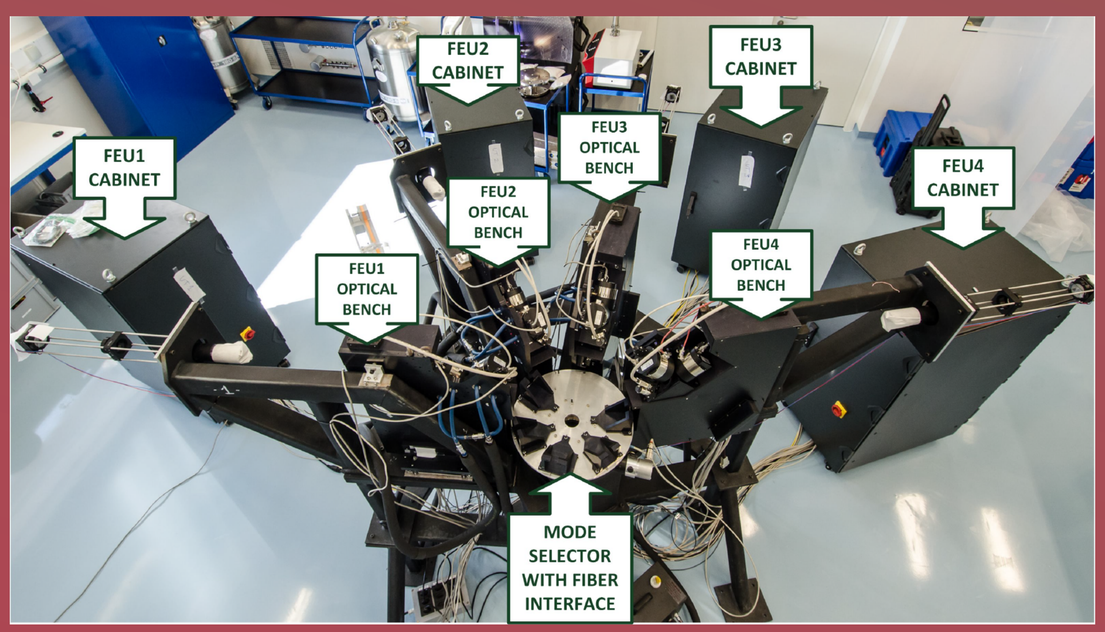

Figure 2 Front End Unit system with the ICE cabinets

CONTROL SYSTEM ARCHITECTURE

Most of the moving parts and sensors of ESPRESSO are controlled by the Instrument Control Electronics and Software. All these devices are controlled by two Beckhoff PLC CPUs placed in the Instrument Main Cabinet (IMC) ([3] and [4]). The CPUs belong to the CX2030 series, and support EtherCAT fieldbus. In each CPU the OPC-UA server is installed to allow the communication with the higher level software.
The first CPU controls all the moving parts and sensors of the Front End Unit (FEU), driving the Beckhoff modules placed in each FEU 1m high cabinet. These four cabinets are positioned near the FEU arm to control, as shown in Figure 2.
The second CPU controls all the functions of the other subsystems: Lakeshore temperature controllers placed in the Thermal Cabinet, motors, lamps and sensors placed in the Calibration Unit cabinet and drives the three shutters through the NGC-Shutter interface cabinet. Figure 3 shows the Beckhoff daisy chain.

CONTROL ELECTRONICS TESTS

The following tests were carried out for the Instrument Control Electronics during integration phases and Preliminary Acceptance Europe (PAE) activities:

- **General functioning and conformity test**
  - the correct visualization of the analog/digital sensors
  - the correct behaviours of all the PLC controlled devices
  - errors reporting in case of failures
- **Motion positioning verification**
  - TwinCAT Scope View allowed extensive tests on the motor positioning accuracy
- **Shutter-NGC interface test**
  - expecially the signal response of the shutter system after the opening command sent by the NGC was tested
- **Electrical test**
  - test on the alarm system functioning, cabinets power consumption, undevoltage and overtemperature protection were performed
- **EMC test**
  - conducted emission test from 150 kHz to 30 MHz, radiated RF field emission test from 30 MHz to 1 GHz, electrostatic discharge test, surge test on power supply lines and a partial radiated RF field immunity test

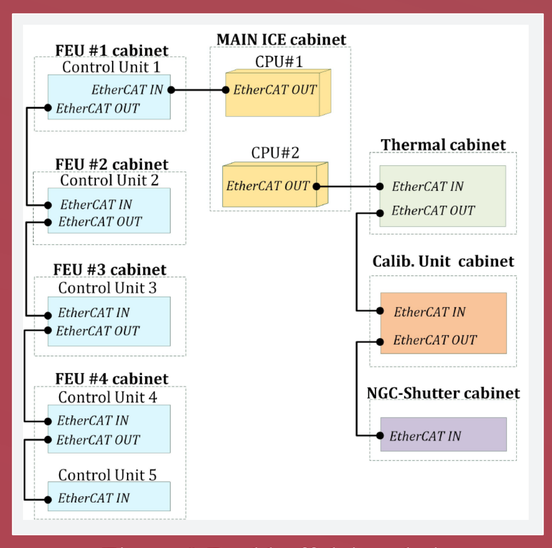

Figure 3 Beckhoff daisy chain

CONTROL SOFTWARE TESTS

During the implementation and integration phase ESPRESSO took advantage of the new continuous integration build and test infrastructure developed at ESO, based on Jenkins. Every night the source code is checked out from the SVN repository, and the whole build procedure and the suite of automatic tests are executed at ESO premises. Hence, all the ESPRESSO Control Software functionalities have been extensively tested, in particular the Observation Software (OS) for the observation coordination, the Instrument Control Software (ICS) for the low level device control, the Detector Control Software (DCS) for the scientific detectors control, and the whole suite of calibration and maintenance templates.

CONCLUSION

ESPRESSO successfully passed the Preliminary Acceptance Europe, where each subsystem has been fully tested together. The tests on the Instrument Control Electronics and Software have been intensive but succesfull. In particular general functioning tests, electrical tests, EMC verification and motor positioning accuracy verification were performed on the ICE system. The Control Software has foreseen functionalities test, in particular for the OS, ICS and DCS modules.
Final test will be done at the VLT site during the Chile integration in autumn to prepare ESPRESSO for its first light.

REFERENCES

[1] F. Pepe, V. Baldini et al., “ESPRESSO – An Echelle SPectrograph for Rocky Exoplanets Search and Stable Spectroscopics Observations”, The Messen-ger, ESO, vol. 153, p. 6-16, 2013.
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[4] V. Baldini, et al., The Instrument Control Electronics of ESPRESSO Spectrograph @VLT – Melbourne, AUSTRALIA, ICALEPCS2015.