The ever-increasing pressure for both high spectral and high angular resolution spectrograph imposes an increasing complexity on astronomical instrument control software, now a critical component in the instrument design. To achieve the accuracy required to maintain the image of the target within ±0.2 arcsec entrance slit, the Observation Control Software (OBS) of an astronomical instrument must take into account a number of optical phenomena (differential atmospheric refraction, distortion, etc.), some of them time dependent, even when observing an object moving at a rate different from the object used for auto-guiding. Four internal software control loops adjust the position of mechanical devices and/or the telescope in addition to the OBS standard functionalities (e.g. monitoring, exposure handling). Besides internal activities, the OBS must promptly response to sequential commands as well as simultaneous interruptions/adjustments from operator via GUI interface. The required advanced synchronization mechanisms are implemented as an extension to the OBS framework (a tool collecting the general features of all instrument OS) while allowing for maintainability and future generalization.

The generic functionalities are supported by the framework (actions) instructions of astronomers (given as sequential command series) in order to record astronomical images. The Observation Software (OS) of an astronomical instrument is the top level control software that carries out the observing an object moving at a rate different from the object used for auto-guiding. Four internal software control loops adjust the position of mechanical devices and/or the telescope in addition to the OBS standard functionalities (e.g. monitoring, exposure handling). Besides internal activities, the OBS must promptly response to sequential commands as well as simultaneous interruptions/adjustments from operator via GUI interface. The required advanced synchronization mechanisms are implemented as an extension to the OBS framework (a tool collecting the general features of all instrument OS) while allowing for maintainability and future generalization.

The VLT cryogenic high-resolution infrared echelle spectrograph (CRIRES)

The Very Large Telescope (VLT) is a system of four separate optical telescopes (the Antu telescope, the Kueyen telescope, the Melipal telescope, and the Yepun telescope) organized in an array formation, built and operated by the European Southern Observatory (ESO) at the Paranal Observatory on Cerro Paranal, a 2,635 m high mountain in the Atacama desert in northern Chile. Each telescope has an 8.2 m aperture. CRIRES (CRYogenic InfraRed Echelle Spectrograph) is one of the instruments mounted on the Antu telescope. It is assisted by adaptive optics and provides a resolving power of up to 100,000 in the infrared spectral range from 1 to 5 micrometers.

### Observation Software

- **Guiding**
- **Science Detector**
- **Instrument Cryogenic**
- **Instrument Warm**
- **Adaptive Optics System**
- **Telescope**

The Observation Software (OS) of an astronomical instrument is the top level control software that carries out the observations. The generic functionalities are supported by the framework BOSS.

### CRIRES specific requirements

- **CRIRES on**
  - track target star
  - off-nadir adaptive optics correction
  - adjust to guiding star
  - adjust to re-refraction
  - adjust to filter
  - set devotator angle
  - correct distortion
  - display positions of stars, hardware

### Analysis

**Event queue handling**

- **Basic functionalities of observation software**
- **Responsive system**
- **External loop**
- **Synchronous and asynchronous messages**
- **Delayed execution of some events during async. msg**
- **Interdependence**

**R E S I S T A N C E**

- **Developer**
- **Operator**
- **External loop**
- **External loop**

**Lesson learnt and Future Consideration**

One of the most challenging parts of the project was to identify the possible source of problems, that even if unhandled may remain hidden during tests, but can cause disturbance during operations. The system described above has been in operation for several months without any brake down, and offers an easy way for future updates (e.g. adding additional loops). The software design created can be also easily turned into a reusable framework.

The authors of this paper believe that CRIRES software might be just the first of its kind at ESO. The increasing resolution of the detector imposes higher demand on the control aiming to achieve (and/or not to loose) the level of precision that the new detectors are now allowing.

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**The Authors.**