SOXS CRYOGENIC DESIGN

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DESCRIPTION

The SOXS cryo-vacuum control system is based on a Siemens PLC Simatic S7-1500. The PLC attends to all the operations related to the vacuum and the cryogeny, managing all the devices (pumps, valves, heating resistors) and sensors (pressure gauges and temperature sensors). The Lakeshore controller manages the active cool down and the warm up of the NIR detector and keeps both detector at their operating temperature, once they are cold. The Lakeshore sends also alarms related to its functions to the Siemens. Finally, all cryo-vacuum parameters and settings and all the sensors reading are exposed to the external world through an OPC-UA interface.

The Siemens S7-1500 sub-rack box contains the electronics to control the cryo-vacuum system: the PLC-CPU, the power supply, and all the digital and analog I/O to control the system. Eight custom electronics boards act as an interface between the PLC and the hard-ware. Each board is connected to a backplane that then goes to the PLC modules. The boards perform the interfacing between the PLC and the instrumentation, improving the monitoring. Apposite drivers work on the power circuits.

The Siemens PLC is then directly connected through Profibus to the turbomolecular pump and to the pressure gauges controller.

Evacuation Time: < 6 hr from atmospheric pressure to 10^{-4} mbar.

Vacuum Pressure: Pressure shall be maintained at < $3x10^{-6}$ mbar when the instrument is cold over periods of 6 months or more.

Cool-down time: < 30 hr from start of cool-down to operational condition.

Warm-up time: < 24 hr until the instrument can be opened.

Temperature of CCD detector: 173K (–100°C) with an accuracy of ±0.01K.

Temperature of the NIR optical bench: 150K with an accuracy of ±2K.

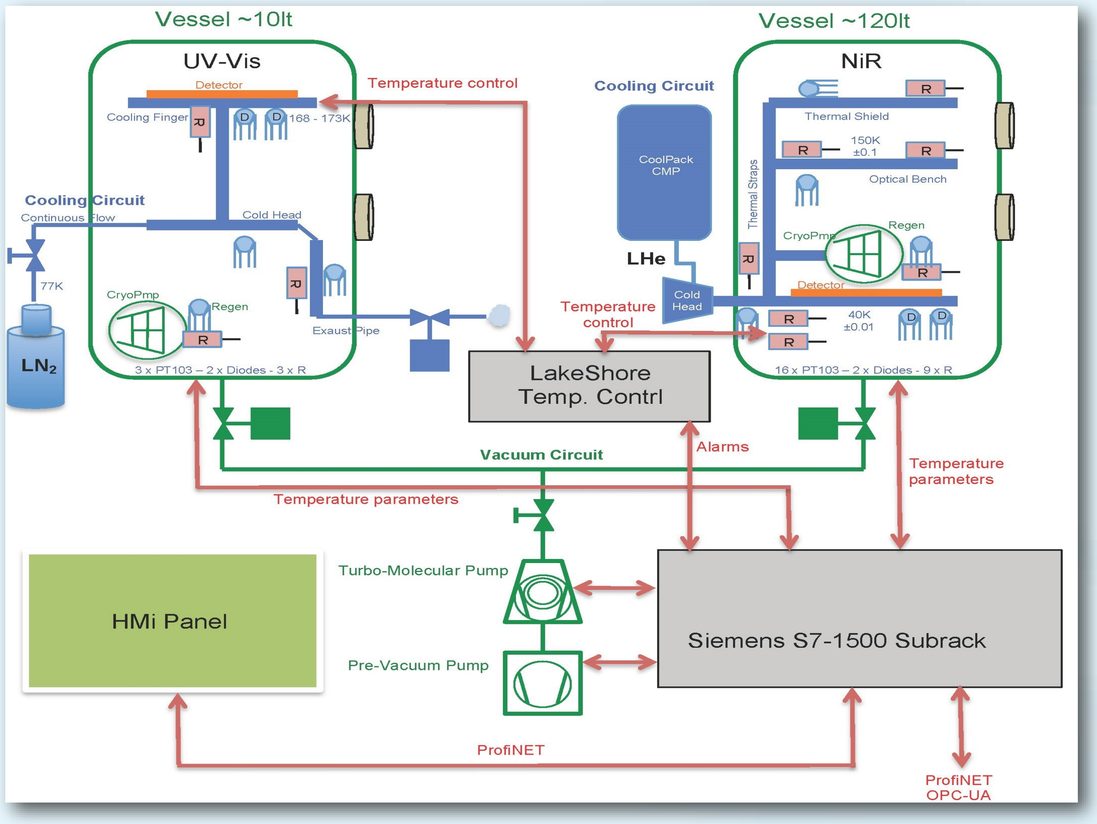
Temperature of the prisms assembly: 150K with an accuracy of ±0.1K.

SYSTEM REQUIREMENTS

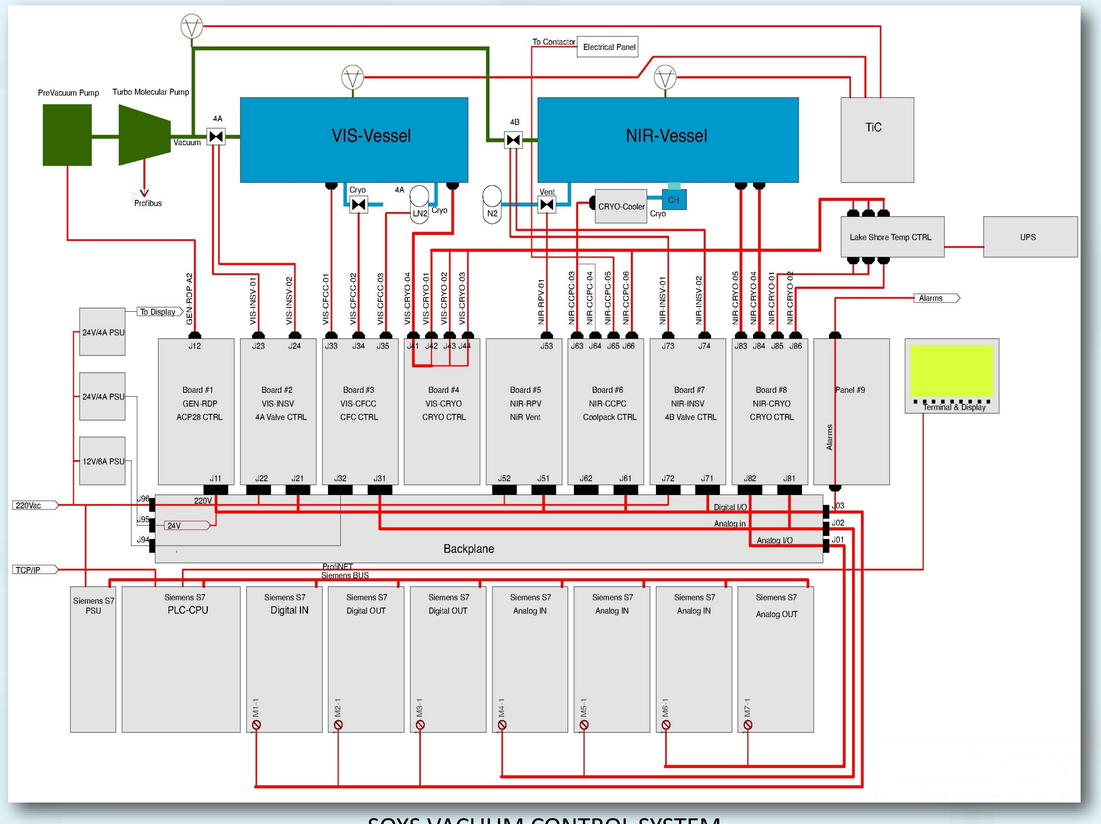
The control electronics shall support foolproof execution of following operations by technical personnel:

1. **Evacuate** the CCD cryostat and/or the NIR cryogenic vessel; i.e. start pumps, open/close valves etc. in the proper sequence.
2. **Regenerate** the sorption pumps inside the vessels.
3. **Re-pressurize** the vessels to atmospheric pressure.
4. **Cool-down** of the CCD cryostat and/or the NIR cryogenic vessel to cryogenic temperature at a controlled rate.
5. **Cold** (the normal operating condition of the instrument).
6. **Warm-up** of the CCD cryostat and/or the NIR cryogenic vessel from the operating temperature to room temperature at controlled rate.

SOXS BLOCK DIAGRAMS

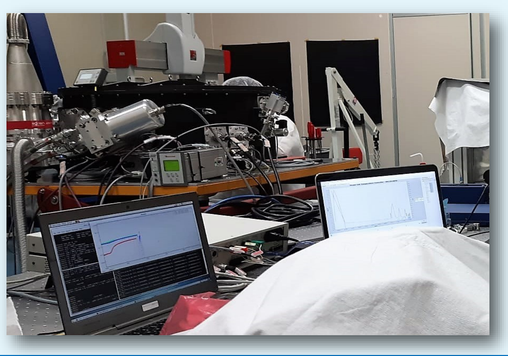


SOXS CRYO VACUUM SYSTEM

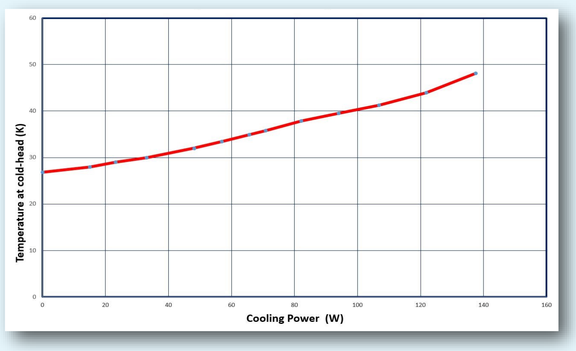


SOXS VACUUM CONTROL SYSTEM

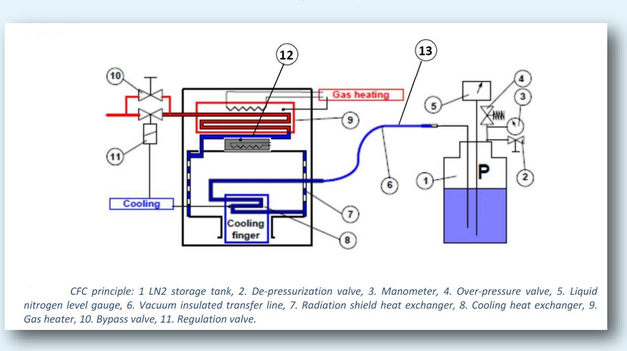
NIR spectrograph



Cold Head Temperature vs Power

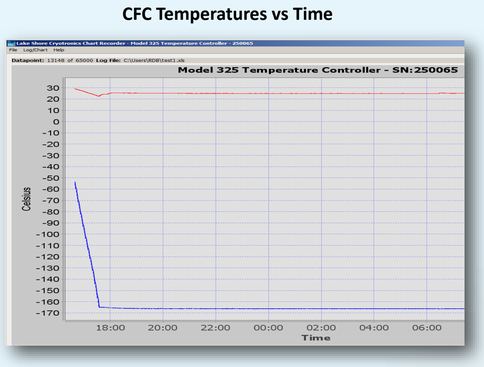


Continuous Flow Cryostat (CFC)



CFC principle: 1 LN2 storage tank, 2. De-pressurization valve, 3. Manometer, 4. Over-pressure valve, 5. Liquid nitrogen level gauge, 6. Vacuum insulated transfer line, 7. Radiation shield heat exchanger, 8. Cooling heat exchanger, 9. Gas heater, 10. Bypass valve, 11. Regulation valve.

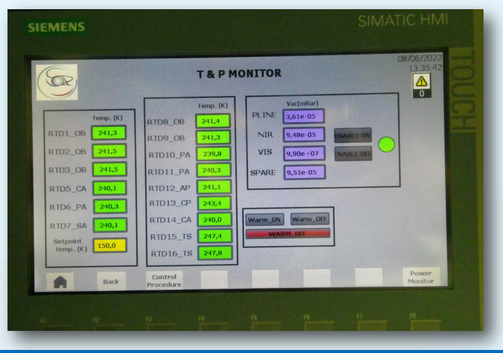
CFC Temperatures vs Time



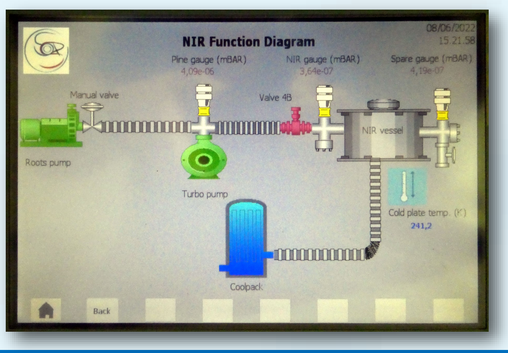
PLC Subrack (front view)

PLC Subrack (rear view)

Temperature & Pressure Monitor



NIR Synoptic Frame



SOXS NIR Integration in Merate