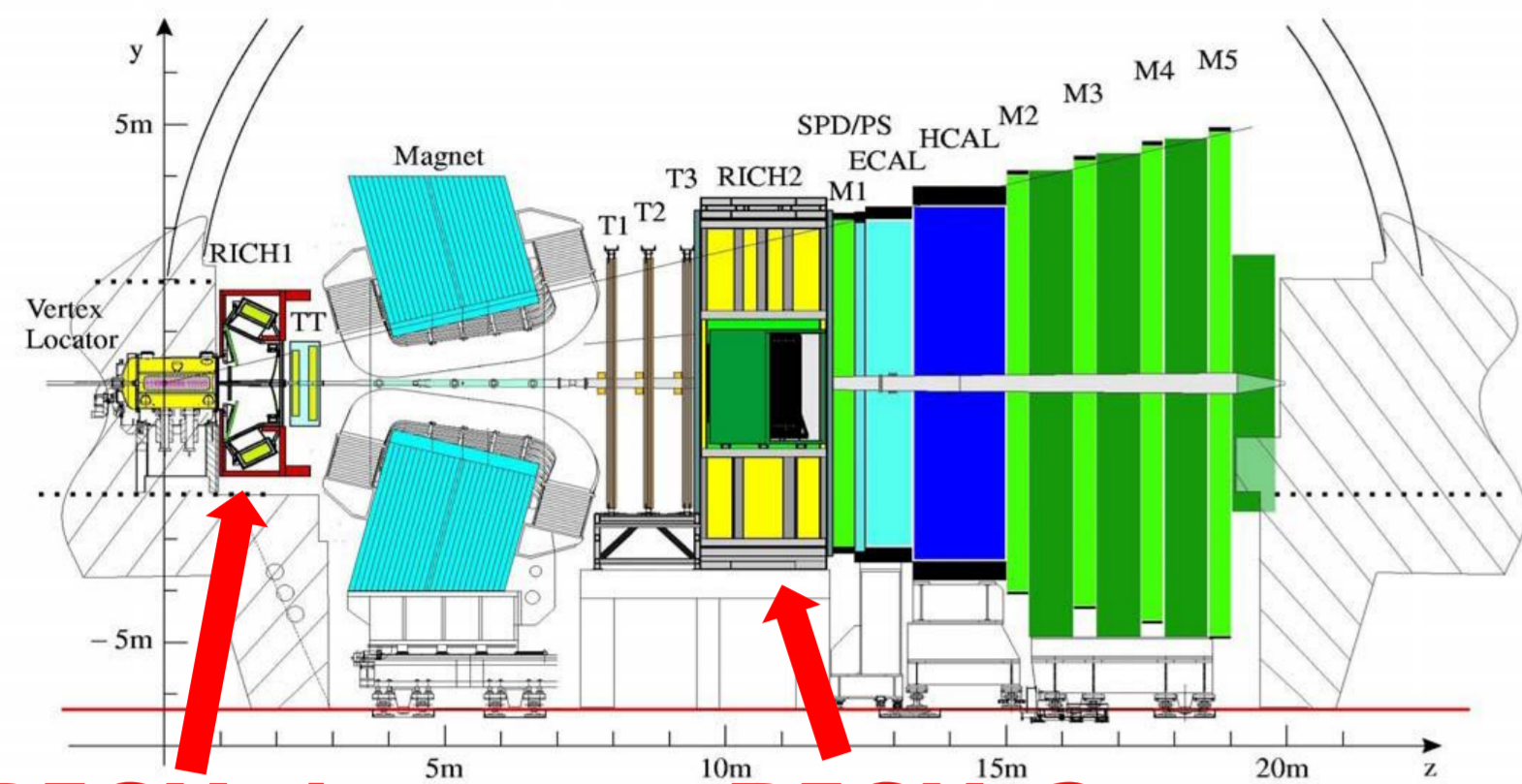
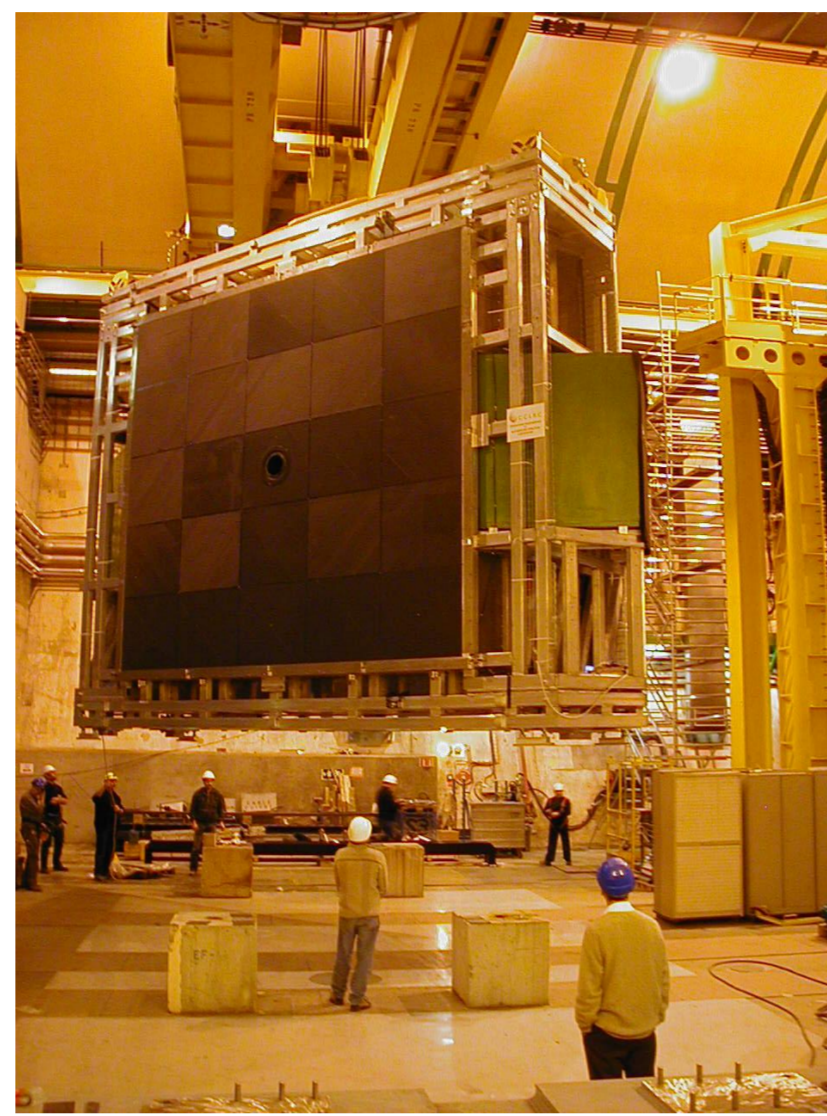


The LHCb RICH detectors



RICH-1 **RICH-2**

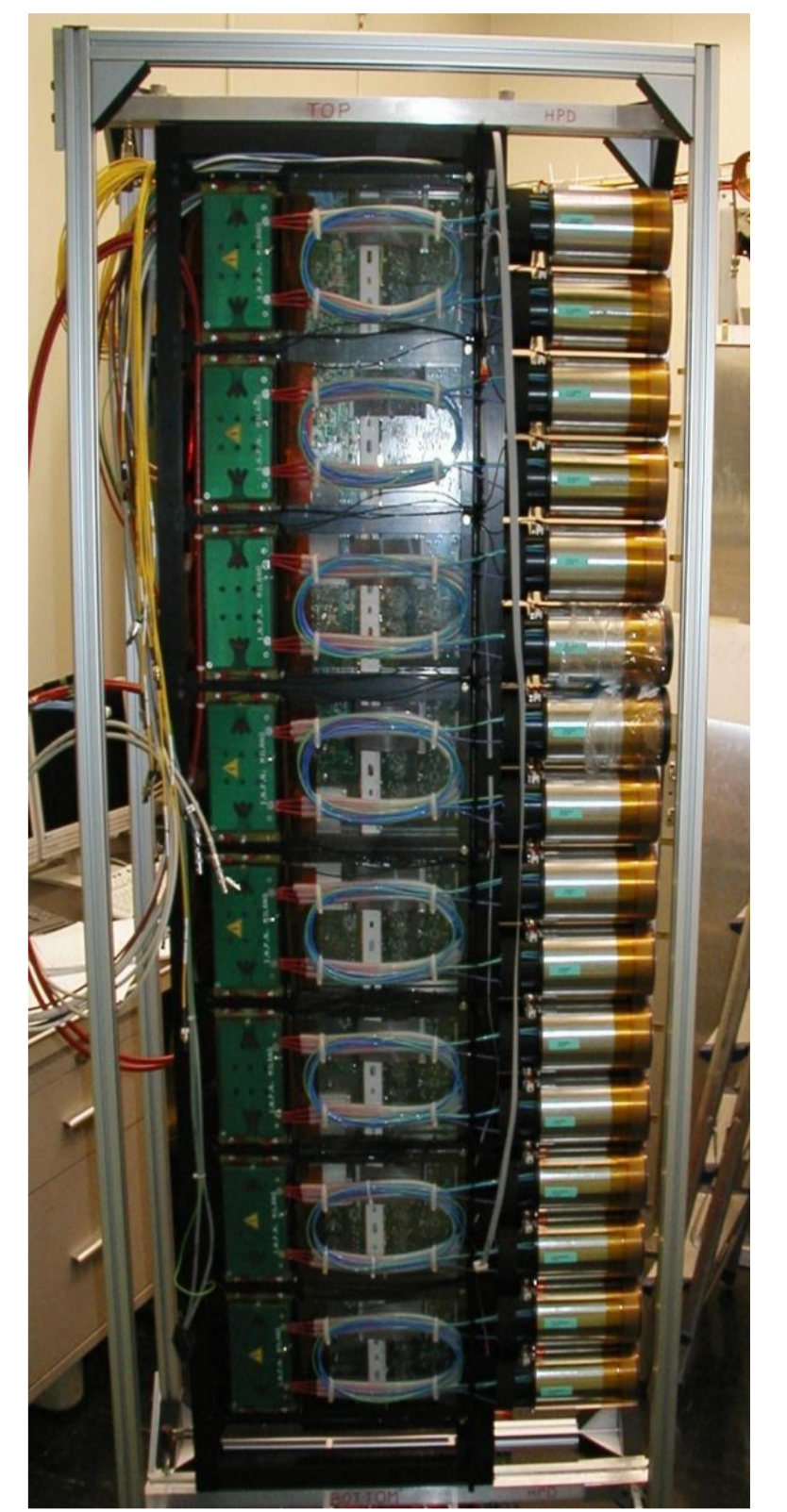
The LHCb experiment at the Large Hadron Collider (CERN) will study differences between matter and anti-matter by precise measurements of the decays of B particles.



The RICH-2 vessel being installed in the LHCb experimental area.

The RICH system (two RICH detectors and three radiators) provides particle identification by measuring the angle of Cherenkov light as charged particles pass through different radiators. This information can be used to differentiate between the various decay modes of the B hadrons.

The basic light sensitive detector unit is a Hybrid Photon Detector (HPD) column that accommodates 14 or 16 HPDs with all the required electronics for power, high voltage (18 kV) and Level0 trigger operation.



The Detector Control System

The RICH DCS has been built using:

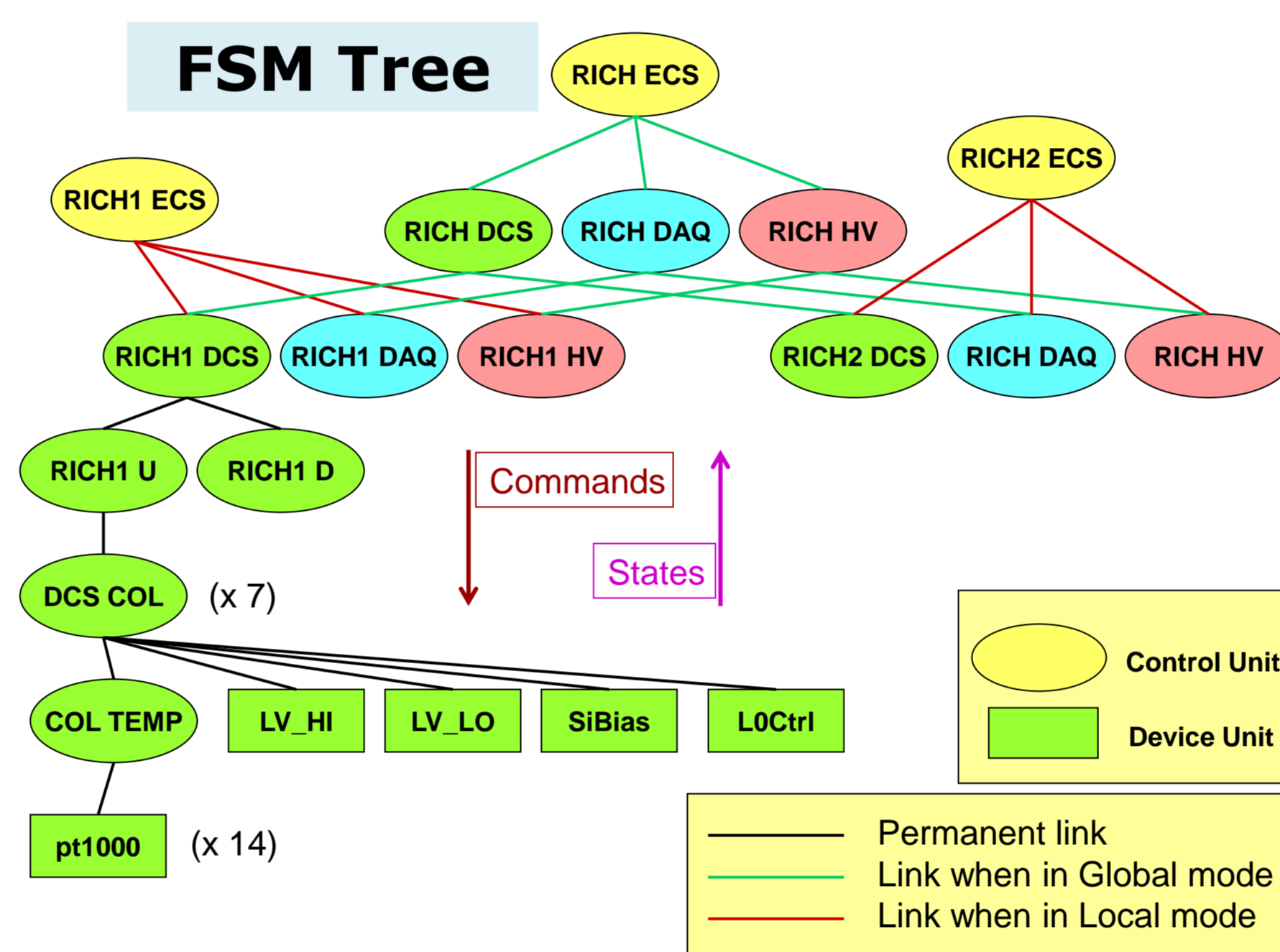
□ SCADA System - PVSSII for:

- Device Description (Run-time Database)
- Device Access (OPC, Profibus, drivers)
- Alarm Handling (Generation, Filtering, Masking, etc)
- Archiving, Logging, Scripting, Trending
- User Interface Builder
- Alarm Display, Access Control, etc.

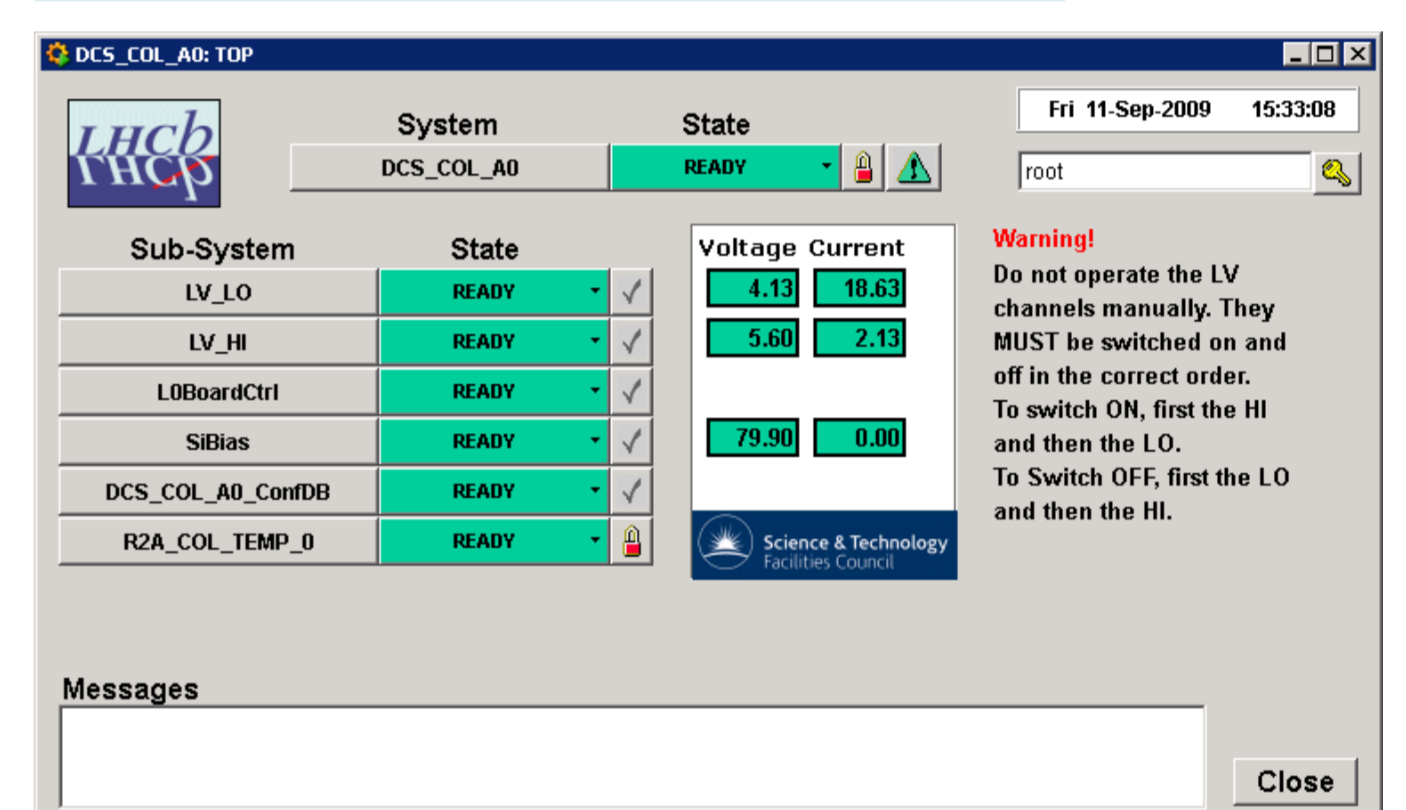
□ SMI++* providing:

- Abstract behavior modeling (Finite State Machines)
- Automation & Error Recovery (Rule based system)

Control Units
Device Units



FSM operation panel

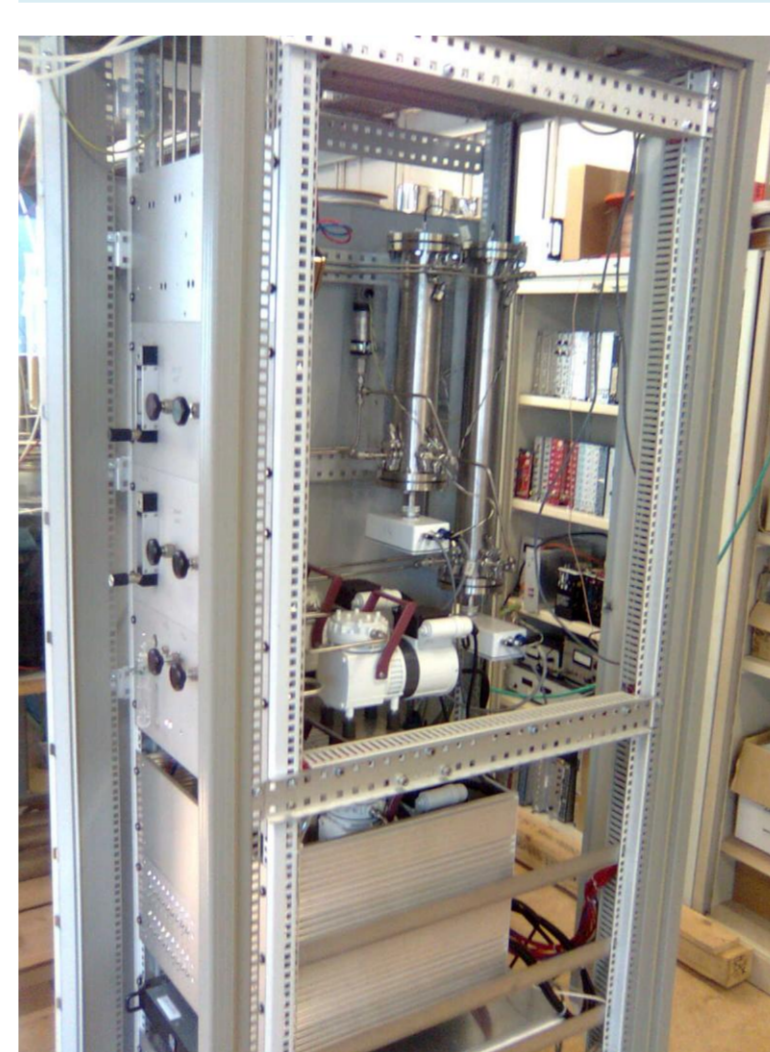


An FSM panel that allows the operation of a single HPD column, displaying voltage and current information.

Hardware interacting with the RICH DCS:

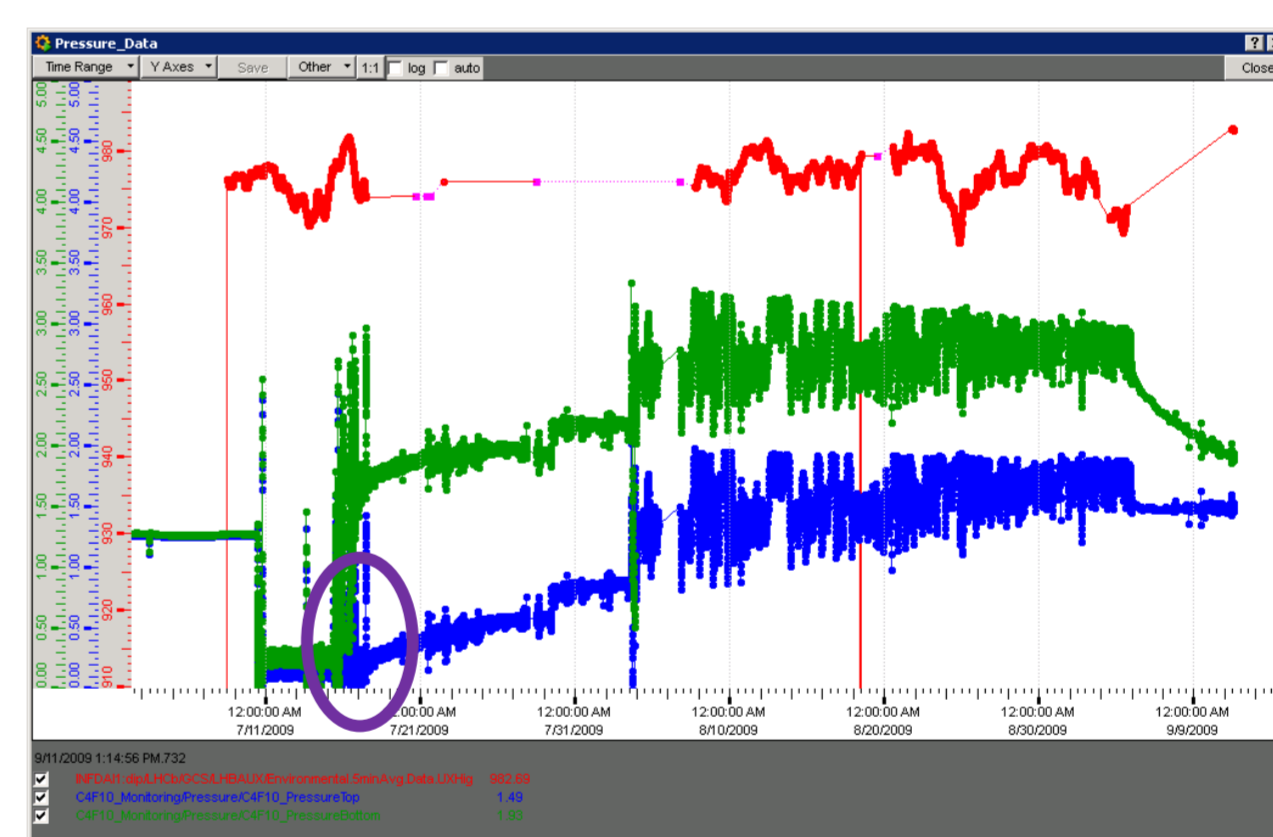
- Wiener Maraton power supplies.
- CAEN power supplies.
- Embedded Local Monitoring Boards (ELMB).
- Temperature, humidity and pressure sensors.
- Laser.
- Networked cameras.
- Video cameras.
- SPECS devices (Serial Protocol for the Experiment Control System)
- A variety of custom devices.
 - Speed of sound measurement (opposite).

Gas quality monitor



The quality of the radiator gases is monitored using a technique based on the speed of sound. The custom made devices used for the measurement of the speed of sound in the gases are shown in this picture. Both the input and the output of the gas enclosures can be sampled.

PVSS archiving



Seventy five days of pressure data from RICH-1. The introduction of C₄F₁₀ in the radiator area can be seen as the bottom sensor (green) registers higher pressure than the top sensor (blue). The atmospheric pressure data is in red.

DCS responsibilities

- **Switch the detector ON or OFF safely.**
- **Ensure the safety of the detector by:**
 - **Providing alerts to the operator**
 - **Taking automatic actions**
- **Monitor the condition of the electronics:**
 - **Voltage/Current/Temperature**
- **Monitor the conditions inside the photon detector enclosure:**
 - **Temperature/Cooling/Humidity**
- **Provide feedback to the High Voltage system.**
- **Collect information about the Cherenkov radiators:**
 - **Pressure/Temperature/Gas quality**
- **Collect and analyse images to monitor mirror stability**
- **Monitor the communication with the hardware via the SPECS protocol.**

PVSS monitoring panel

RICH 2									
	LV_LO	A	LV_HI	A	SiBias	uA	HV_20 (kV)	Temperature	State
Chl A1	0.04	0.27	0.05	0.27	0.20	0.00	0.00	18.01	READY
Chl A2	0.03	0.28	0.07	0.27	0.00	6.0	0.00	18.07	READY
Chl A3	0.07	0.30	0.03	0.30	0.00	1.0	0.01	17.77	READY
Chl A4	0.07	0.30	0.05	0.30	0.10	0.00	0.00	17.85	READY
Chl A5	0.06	0.31	0.08	0.32	0.10	0.00	0.00	17.85	READY
Chl A6	0.05	0.28	0.04	0.28	0.20	0.00	0.00	17.85	READY
Chl A7	0.07	0.31	0.03	0.30	0.00	0.00	0.00	17.90	READY
Chl A8	0.05	0.28	0.02	0.28	0.30	0.00	0.00	18.05	READY
Chl C1	4.12	18.15	5.60	2.17	80.00	5.0	18.04	18.01	READY
Chl C2	4.13	18.47	5.50	2.33	80.00	6.0	18.15	18.07	READY
Chl C3	4.13	18.48	5.81	2.30	80.00	52.3	17.95	18.02	READY
Chl C4	4.11	19.21	5.50	2.27	79.90	11.3	17.74	17.77	READY
Chl C5	4.11	18.41	5.50	2.11	80.10	23.2	17.85	17.88	READY
Chl C6	4.12	18.38	5.50	2.05	79.90	7.0	17.90	17.94	READY
Chl C7	4.12	17.95	5.50	2.00	79.90	17.0	17.90	17.94	READY
Chl C8	4.13	18.48	5.57	2.48	79.90	56.1	17.90	17.92	READY
Chl C9	4.11	18.25	5.57	2.32	79.80	32.8	17.92	18.05	READY

The RICH-2 Overview PVSS panel displaying voltage, current and temperature information for the whole of RICH-2. Colour coding allows easy identification of the state of the detector and parameters outside predefined limits.

* B.Franek and C.Gaspar, "SMI++ Object-Oriented Framework for Designing and Implementing Distributed Control Systems", IEEE TRANSACTIONS ON NUCLEAR SCIENCE, 52 (2005) 891