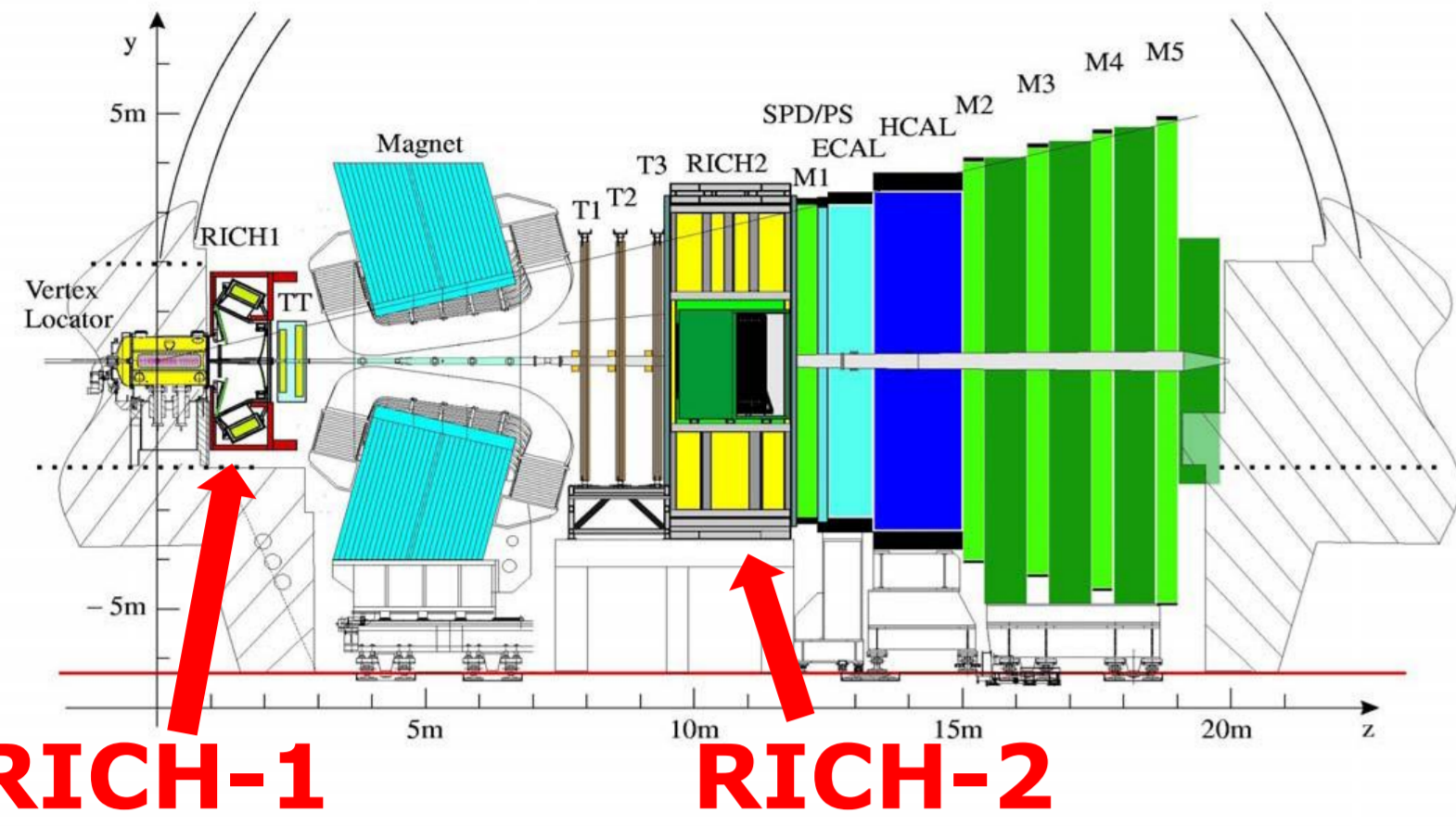
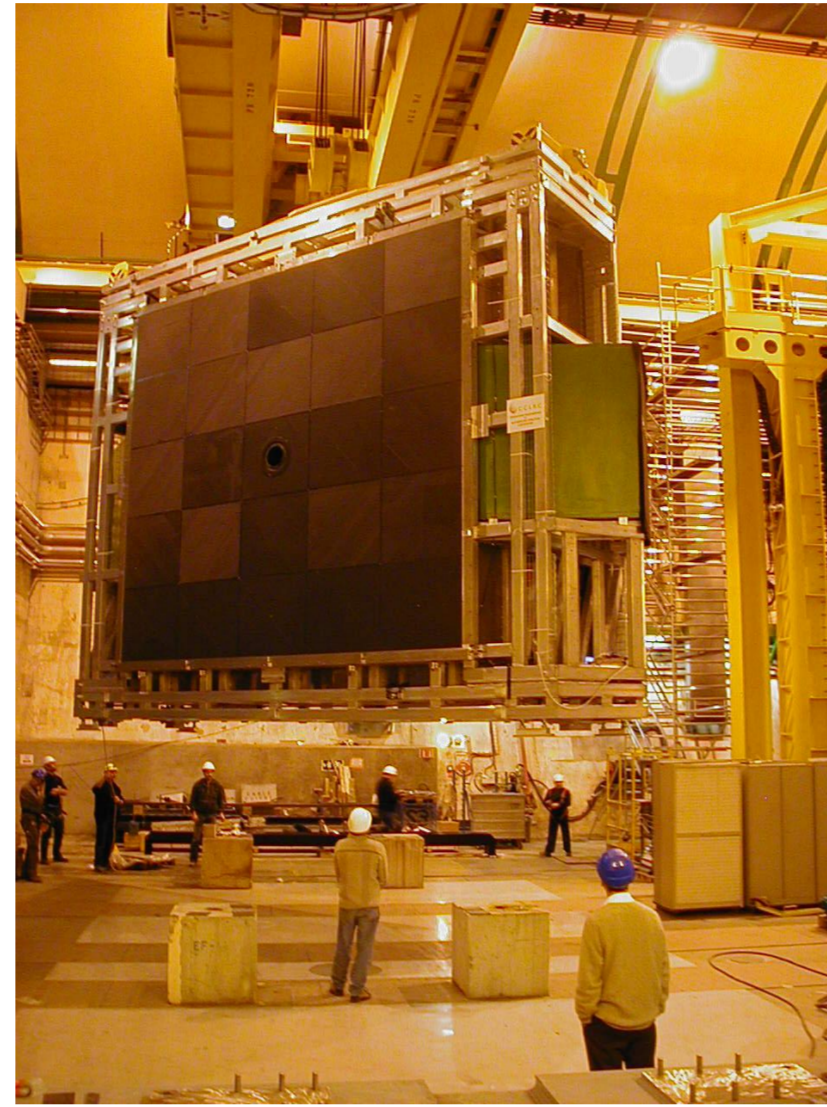


## The LHCb RICH detectors



**RICH-1** **RICH-2**

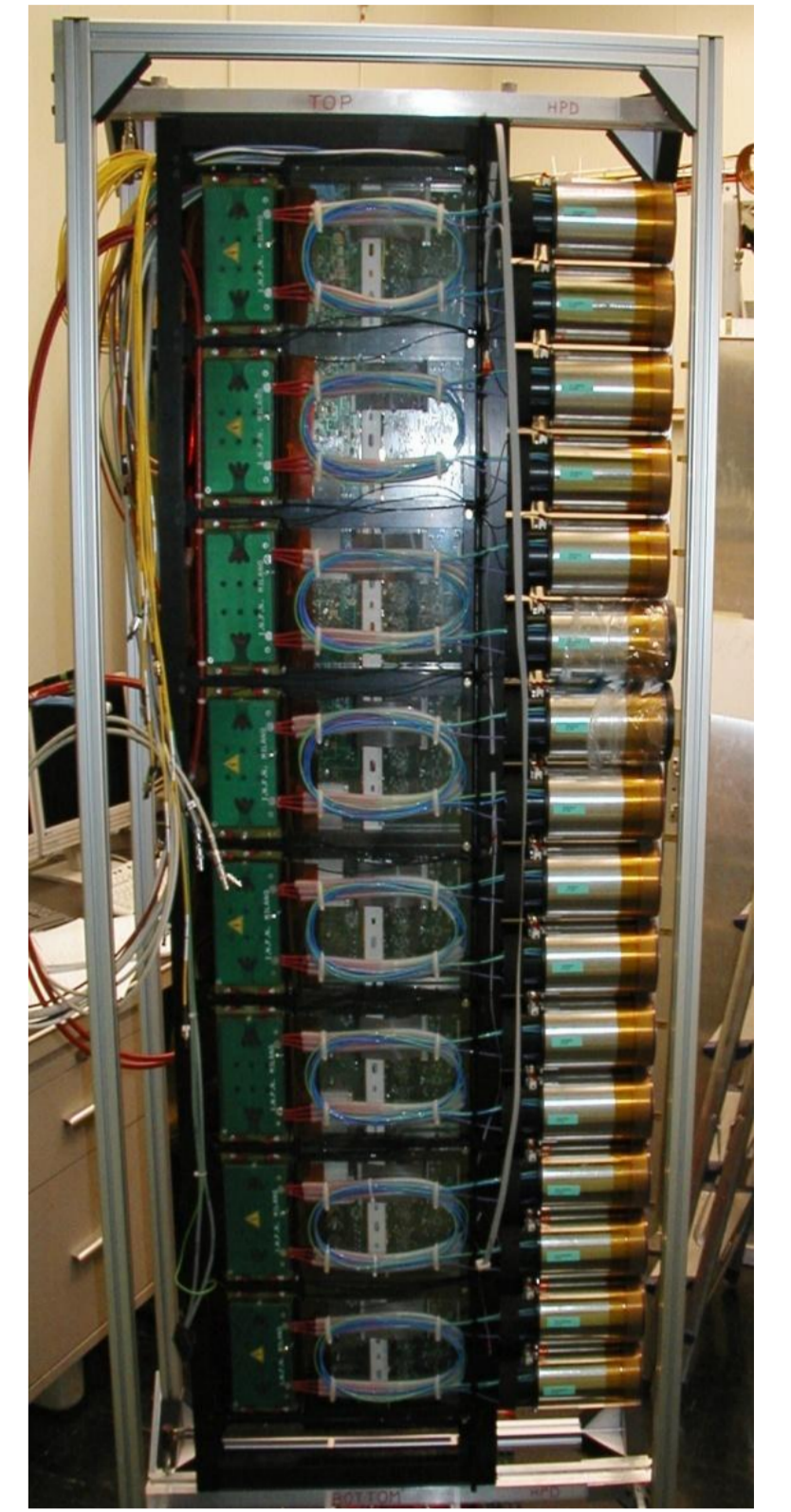
The LHCb experiment at the Large Hadron Collider (CERN) will study differences between matter and anti-matter by precise measurements of the decays of B particles.



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.

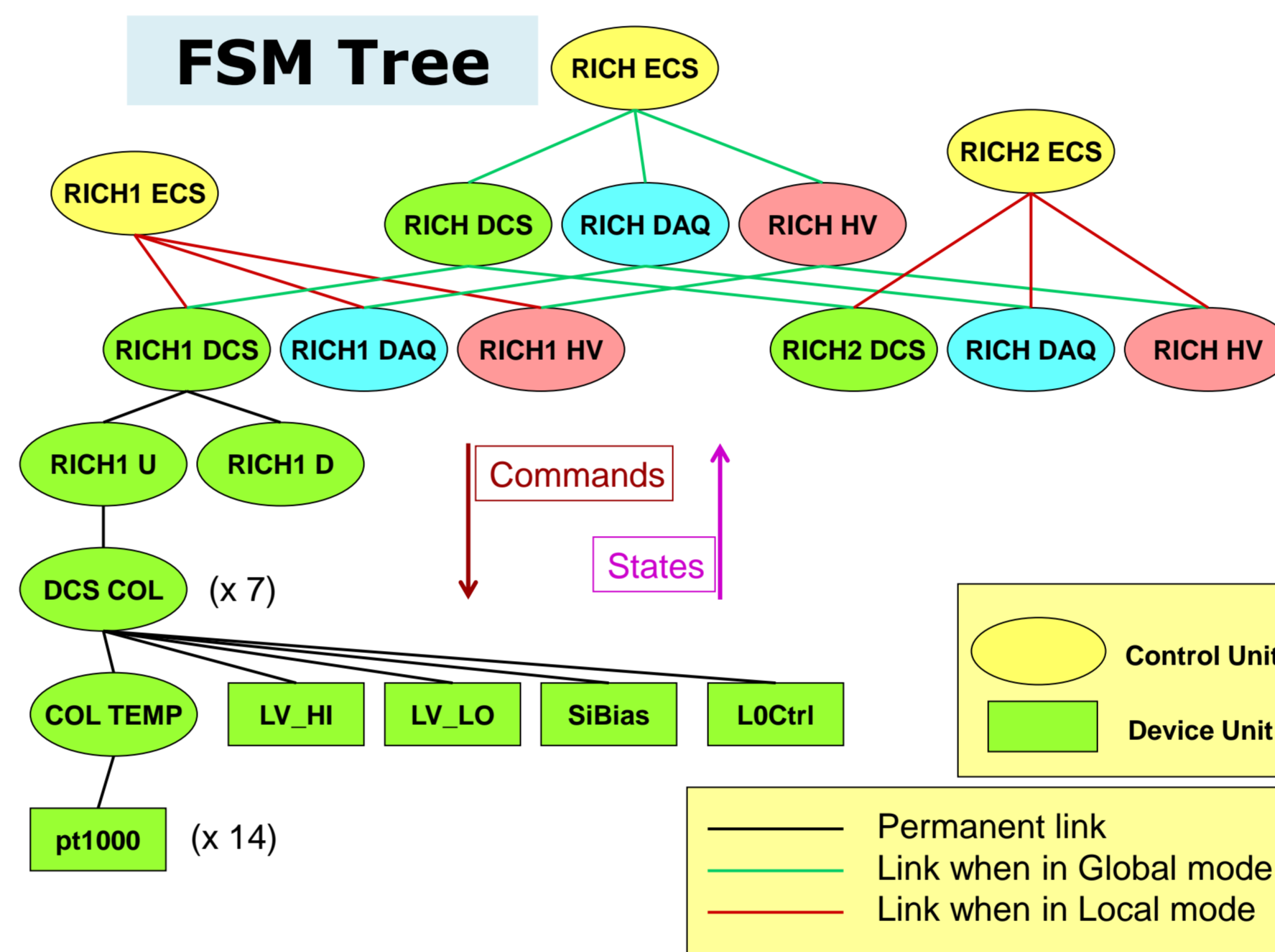


## The Detector Control System

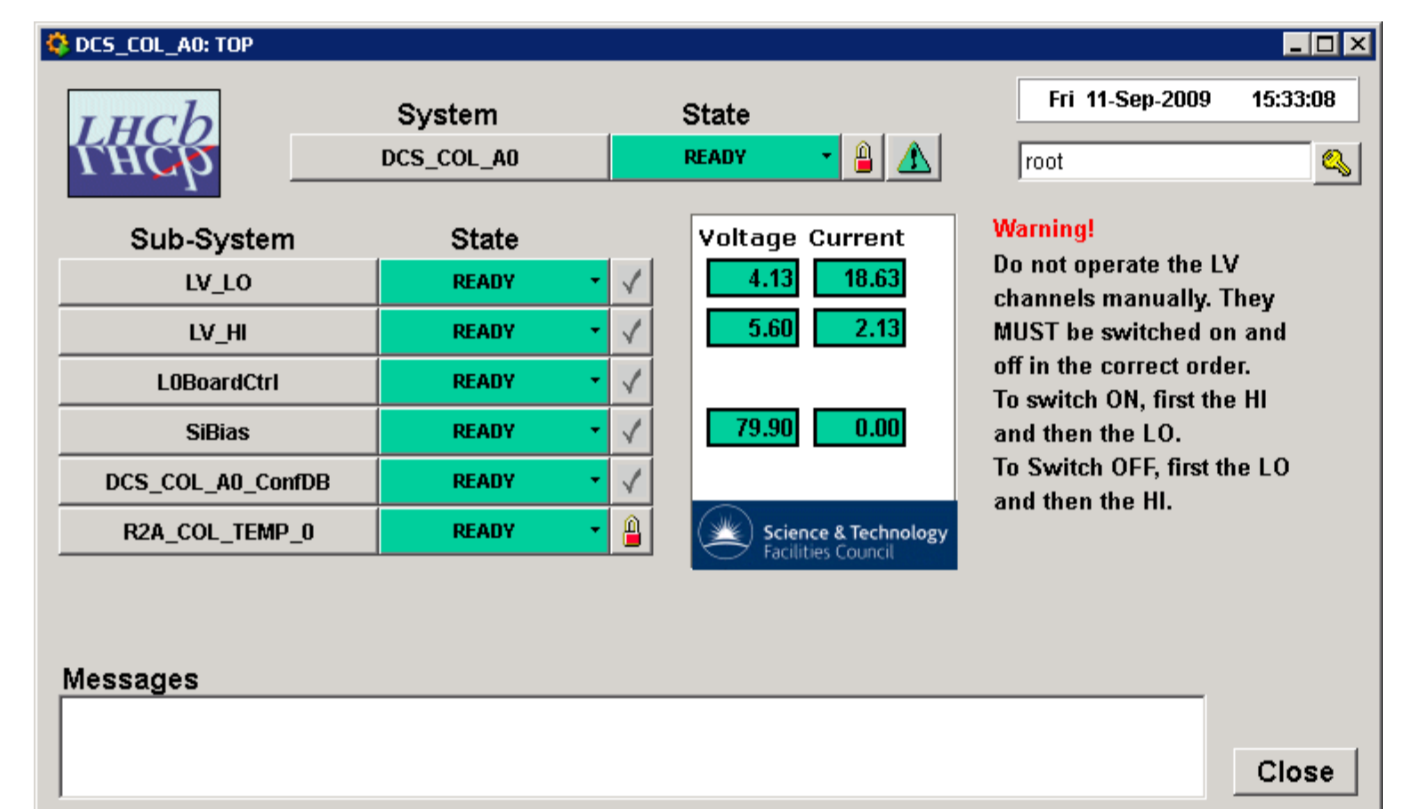
The RICH DCS has been built using:

- 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



### FSM operation panel



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

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

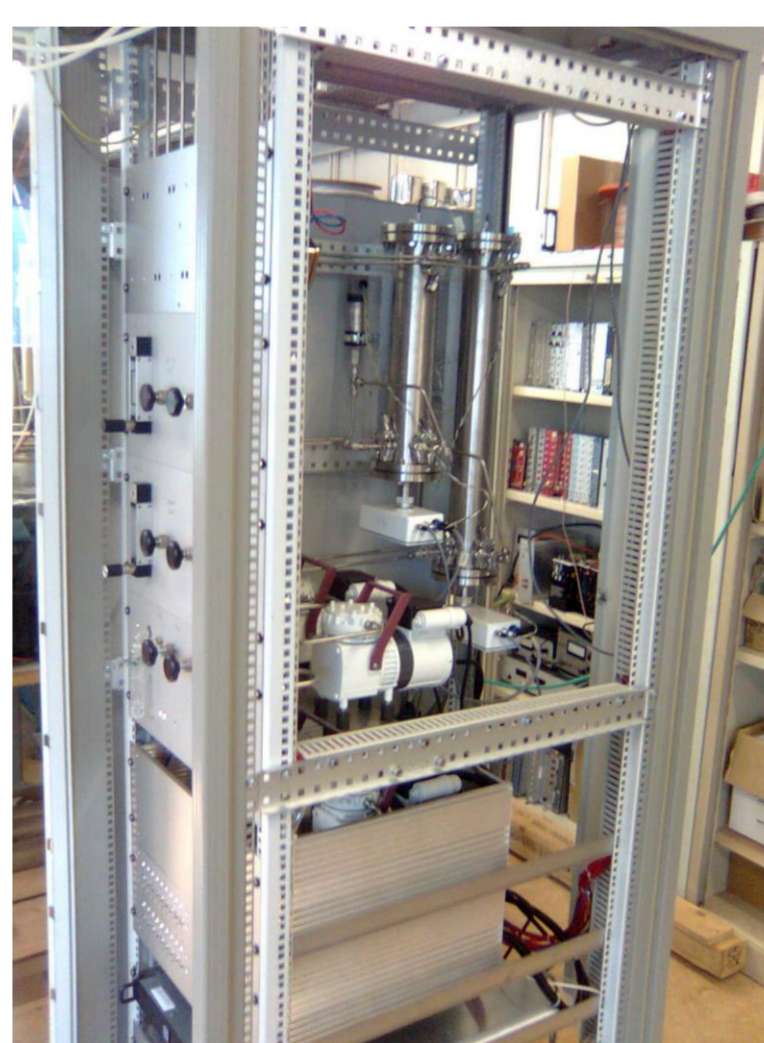
### Hardware interacting with the RICH DCS:

- 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).

## DCS responsibilities

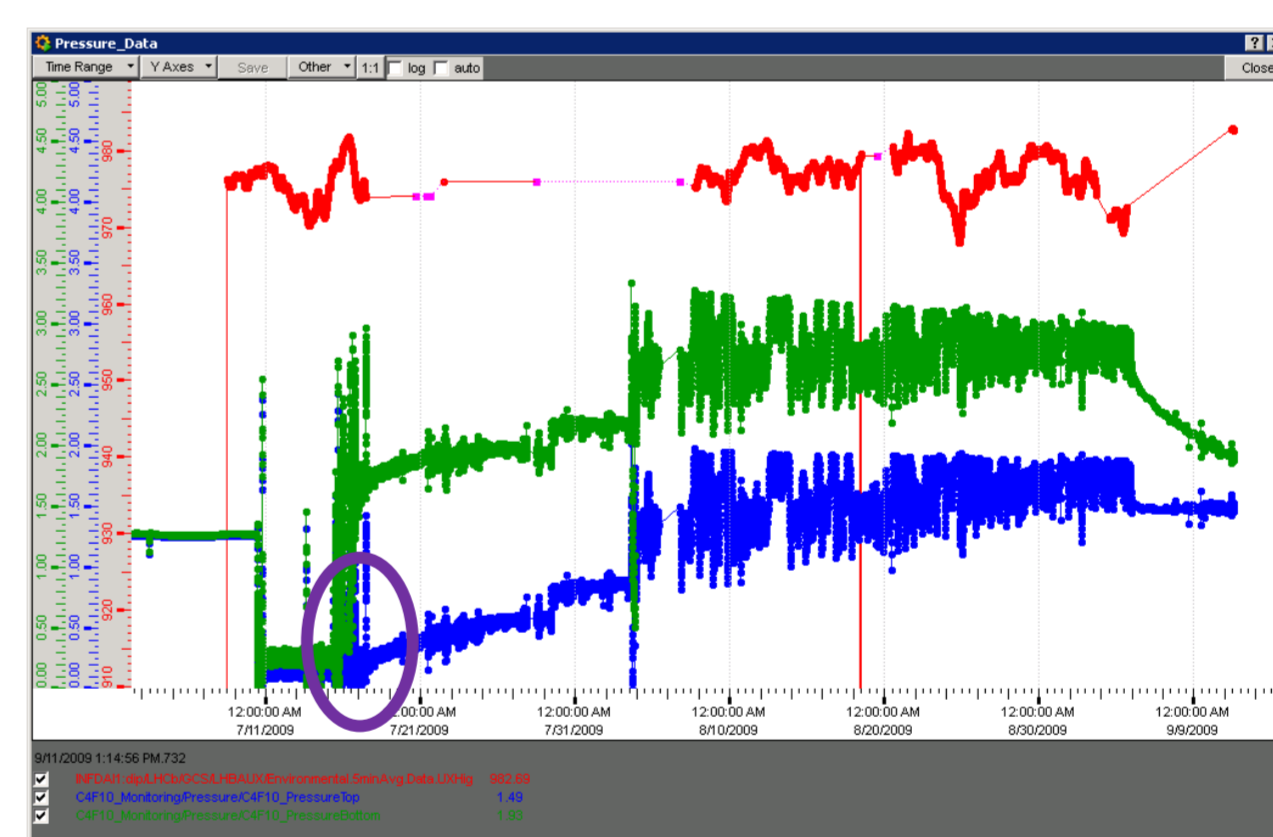
- **Switch the detector ON or OFF safely.**
- **Ensure the safety of the detector by:**
  - **Providing alerts to the operator**
  - **Taking automatic actions**
- **Monitor the condition of the electronics:**
  - **Voltage/Current/Temperature**
- **Monitor the conditions inside the photon detector enclosure:**
  - **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.**

### 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  $C_4F_{10}$  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.

### PVSS monitoring panel

RICH 2									
	LV_LO		LV_HI		SiBias		HV_20 (kV)		Temperature
	V	A	V	A	V	uA	Up	Down	State
Col A0	0.04	0.27	0.05	0.27	0.20	0.0	0.00	0.01	READY
Col A1	0.03	0.28	0.07	0.27	0.00	6.0	0.00	0.01	READY
Col A2	0.05	0.28	0.06	0.28	0.10	0.0	0.00	0.00	READY
Col A3	0.07	0.30	0.03	0.30	0.00	1.0	0.01	0.01	READY
Col A4	0.07	0.30	0.05	0.30	0.10	0.0	0.00	0.00	READY
Col A5	0.06	0.31	0.08	0.32	0.10	0.0	0.00	0.01	READY
Col A6	0.05	0.28	0.04	0.28	0.20	0.0	0.00	0.00	READY
Col A7	0.07	0.31	0.03	0.30	0.00	0.0	0.00	0.01	READY
Col A8	0.05	0.28	0.02	0.30	0.30	0.0	0.00	0.00	READY
Col C1	4.12	18.15	5.60	2.17	80.00	5.0	18.04	18.01	READY
Col C1	4.13	18.47	5.50	2.33	80.00	6.0	18.15	18.07	READY
Col C2	4.13	18.48	5.61	2.30	80.00	52.3	17.95	18.02	READY
Col C3	4.11	19.21	5.50	2.27	79.90	11.3	17.74	17.77	READY_WARN
Col C4	4.11	18.41	5.50	2.11	80.10	23.2	17.89	17.88	READY
Col C5	4.12	18.38	5.59	2.05	79.90	7.0	17.90	17.94	READY
Col C6	4.12	17.95	5.50	2.00	79.90	17.0	17.98	17.94	READY
Col C7	4.13	18.48	5.57	2.48	79.90	56.1	17.90	17.92	READY
Col C8	4.11	18.25	5.57	2.32	79.80	32.0	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.