

# Automated Voltage Control in LHCb



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LHCb is an LHC experiment and needs proper LHCb – LHC coordination to record useful data. In order to acquire the data from the experiment, LHCb has an infrastructure composed of several sub-detectors to record different parameters of the events.

In order to ensure the safety of the detector and to maximize efficiency, LHCb needs to coordinate the voltage configuration of the different sub-detectors, according to the accelerator status.

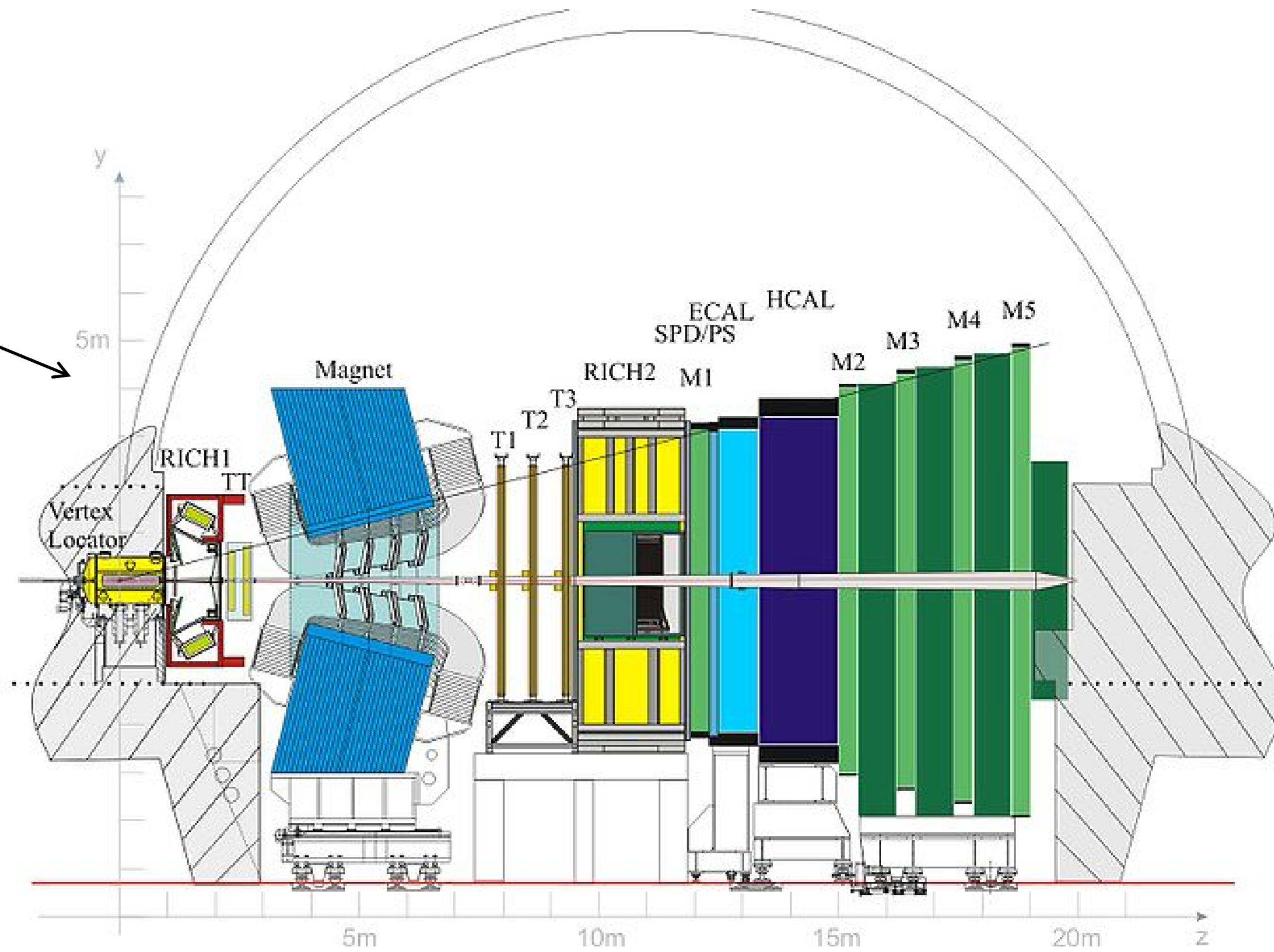


Fig 1. LHCb and its sub-detectors

LHCb subscribes to the LHC data and computes the state of the LHC accelerator, using this data; The LHC state is modelled into discrete states which can be used to drive the voltage system.

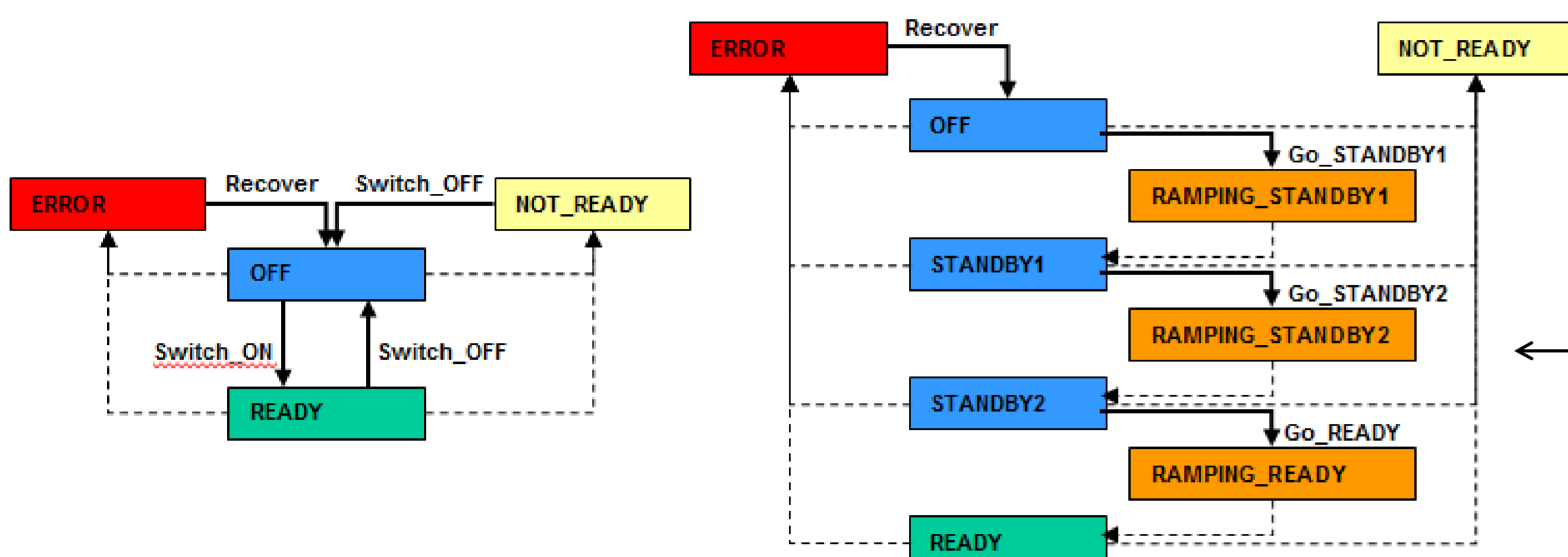


Fig 2. Simplified FSM Object Templates for Low and High Voltage

The voltage control of the LHC experiments is based on the PVSS SCADA system, which interfaces the drivers of the equipment to the Finite State Machine toolkit.

FSM object templates were created and distributed to the sub-detectors who implement them on their systems. These objects are then integrated in the global Experiment Control System

The Automated Voltage Control System acts as a proxy between the LHC state and the sub-detectors voltage FSM objects. It sets automatically the sub-detectors voltage settings according to a matrix LHC State <-> LHCb SD Voltage, sending the required action to the sub-detectors.

Sub-detector	Injection	S	I	Ramp	S	I	PhysAdjust	S	I	Physics	S	I	Adjust	S	I	Dump	S	I	NoBeam	S	I	MD	S	I	EOF	S	I
ECAL	STANDBY1	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY1	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
HCAL	STANDBY1	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY1	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
IT	STANDBY1	✓	✓	STANDBY1	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY1	✓	✓	STANDBY1	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
MUON	STANDBY1	✓	✓	STANDBY2	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY1	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
OT	OFF	✓	✓	STANDBY2	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY2	✓	✓	OFF	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
PRS	OFF	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	OFF	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
RICH1	OFF	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	OFF	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
RICH2	OFF	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	READY	✓	✓	OFF	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
TT	STANDBY1	✓	✓	STANDBY1	✓	✓	READY	✓	✓	READY	✓	✓	STANDBY1	✓	✓	STANDBY1	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓
VELO	OFF	✓	✓	STANDBY1	✓	✓	STANDBY2	✓	✓	READY	✓	✓	STANDBY2	✓	✓	OFF	✓	✓	ANY	✓	✓	OFF	✓	✓	STANDBY1	✓	✓

Fig 3. LHC State – LHCb Sub-detector voltage configuration matrix

Using the Automated Voltage Control it's no longer needed to send the GOTO\_<Req\_V\_State> to each sub-detector voltage system, but a single GOTO\_<LHC\_State> which can be sent to all the sub-detectors in parallel and correctly configure them.

**Current LHC State**: INJECTION

Sub-Detector	State	Requested	Settings
LHCb_LHC_HV&LV	OK	INJECTION	PHYSICS
Sub-Detector	Goto_INJECTION		
VELO_LHC_HV	OK	100.00	OFF
TT_LHC_HV	STANDBY1	100.00	STANDBY1
IT_LHC_HV	STANDBY1	100.00	STANDBY1
OT_LHC_HV	OFF	100.00	OFF
RICH1_LHC_HV	OFF	100.00	OFF
RICH2_LHC_HV	OFF	100.00	OFF
PRS_LHC_HV	OFF	100.00	OFF
ECAL_LHC_HV	STANDBY1	100.00	STANDBY1
HCAL_LHC_HV	STANDBY1	100.00	STANDBY1
MUON_LHC_HV	OK	99.00	STANDBY1

**Actions to drive the Voltage**

Fig 4. "Big Brother" – Main Voltage Control Panel

The Automated Voltage Control removes complexity from the system and improves the operation of the Experiment. There is no need to track the different voltage settings for each of the sub-detectors at the different LHC states. The safety of the detector is also assured as incorrect and unsafe voltage configurations can now easily be viewed and adjusted according to the current LHC state requirements.