Protecting detectors in ALICE

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The Detector Control System (DCS) in ALICE uses four main mechanisms to protect the subsystems against adverse beam conditions.

The SAFE and SUPERSAFE states

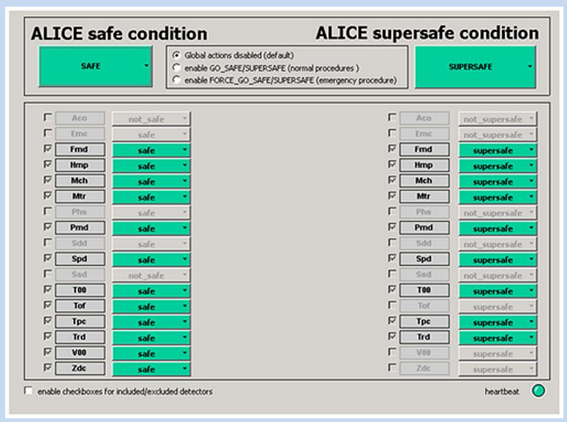

Fig. 1: The SAFE/SUPERSAFE panel.

ALICE consists of many detectors integrated via a distributed PVSS project. Certain LHC operations require subsystems to be in a compatible, so called SAFE condition. During the LHC Injection, TI2 setup or beam adjust, the sensitive detectors typically lower their voltages to protect the electronics against excessive charge deposits.

During certain operations (such as testing of new LHC filling schema etc.) the detectors put even more restrictions on their settings. This condition is called SUPERSAFE.

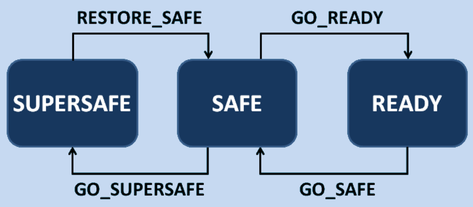

Fig. 2: States of the detectors.

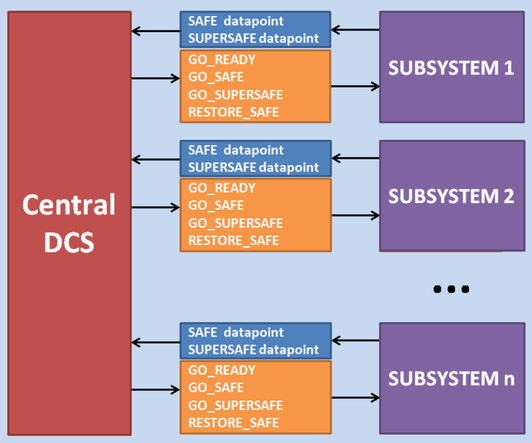

Fig. 3: The interface between central DCS and the subsystems.

Preparing for the data taking

When the beam condition requiring the SAFE/SUPERSAFE state is not present anymore, the detectors are sent to the READY state to start the data taking. Different detectors will switch on the HV in different phases of the beam operation.

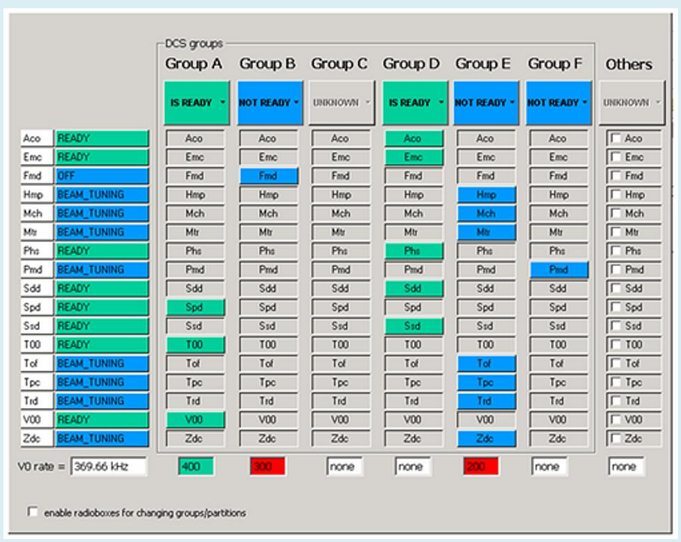

Fig. 4: The GO_READY panel.

The V0 rate

The risk of HV trips and potential subsystems damage can be estimated using the V0 sub-detector. The V0 can detect both beam-beam and beam-gas collisions, thus providing separate numbers of collisions (rates) for luminosity and background. The sum of these rates lets the experiment monitor the amount of charged particles crossing the sub-detectors. If the sum of luminosity and the background rates is above a fixed threshold for some sensitive gaseous detectors then they should not be sent to READY until the V0 rates decrease below the threshold.

Beam Condition Monitor

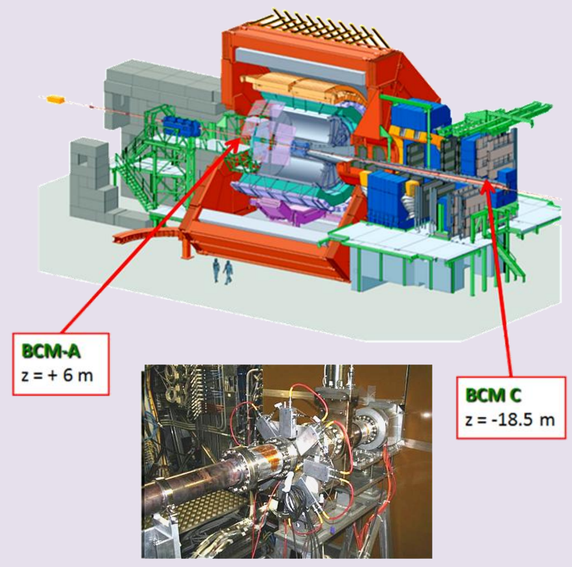

Fig. 5: The position of the BCM stations.

The ALICE BCM design was based on the Beam Condition Monitor system of the LHCb experiment. Beam losses are continuously monitored by diamond sensors. The readings from these sensors are digitized by CFC (current-to-frequency converter) cards and then sent to a TELL1 board via optical links. The TELL1 board calculates running sums with integration times of 40 μs (RS1), 80 μs (RS2) and 1.28 ms (RS32). In addition "RS32 Sums" are calculated by summing up the RS32 values of 5 out of 8 sensors of one station discarding the two highest values and the lowest value.

Interface to LHC Beam Interlock System (BIS)

ALICE provides three flags to the BIS:

- Beam permit
- Two injection permits

A beam dump is triggered by the TELL1 firmware via removal of the beam permit if values of monitored running sums exceed defined thresholds. The injection permits are controlled by the central DCS and they are set when ALICE is prepared for incoming beam.

Dynamic thresholds

The values of the thresholds are changed dynamically depending on the state of the most sensitive ALICE sub-detectors and a "beam mode" published by the CERN Control Centre. The more strict limits are activated before turning on the selected subsystems.

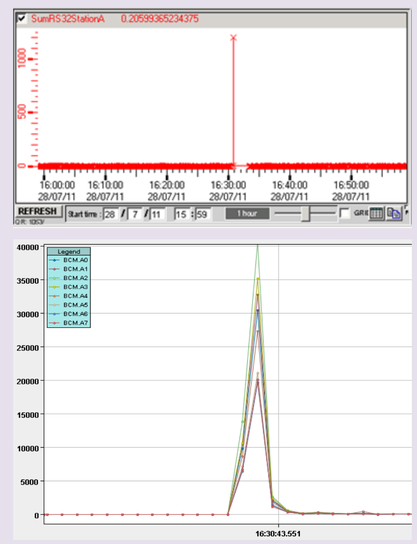

Fig. 6: Beam loss as seen by the BCM. Top: RS32 Sum (nA). Bottom: RS1 (nA).

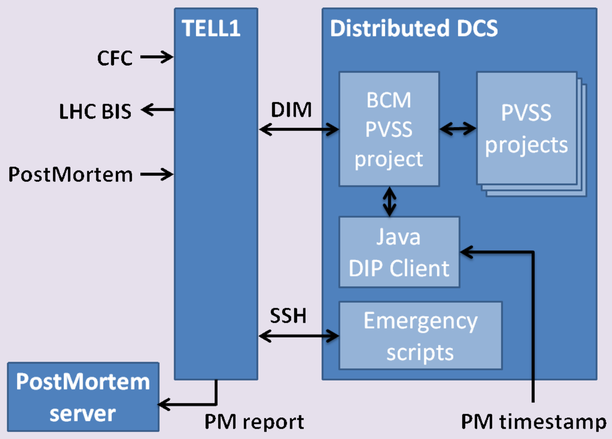

Fig. 7: The control layer of the BCM.

Post Mortem

The incoming data stream from the CFC cards is written into a circular buffer on the TELL1 board. This buffer is frozen when a Post Mortem (PM) signal is received via the LHC machine timing system.
The content of the circular memory buffer is marked using the published timestamp of the latest PM event and then sent to the LHC central PM server, from where it can be further analyzed.

The Handshake

The Handshake is a communication protocol between the CERN Control Centre and the LHC experiments. From the point of view of safety, the most critical are Injection Handshakes. Their main purpose is to make all the subsystems SAFE (and if required SUPERSAFE) and grant the injection permits.

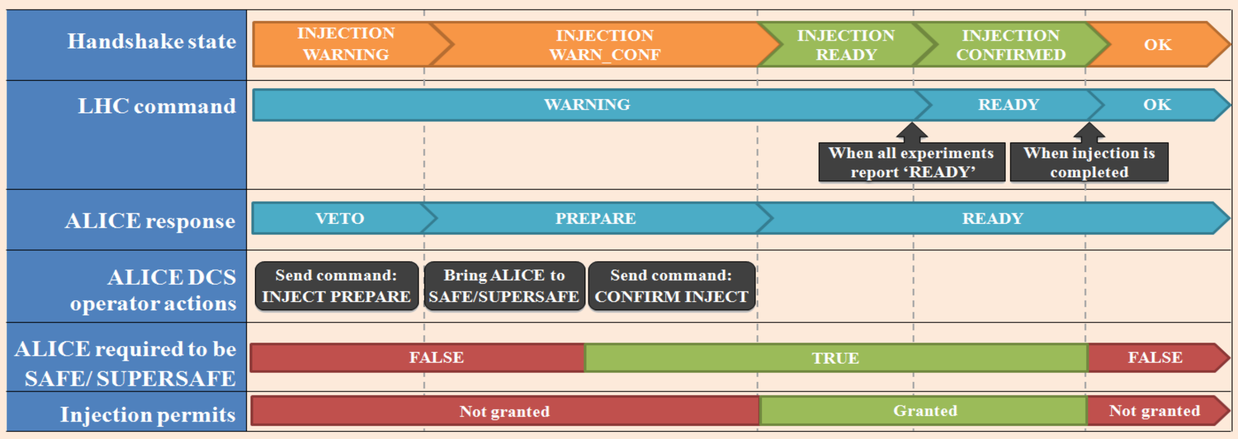

Fig. 8: The Injection Handshake procedure in ALICE.

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