Detector Control System of the ATLAS Tile Calorimeter

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Introduction

We describe the implementation of the Detector Control Systems (DCS) for the ATLAS/Tile Calorimeter detector [1]. The DCS is responsible for the safe and coherent detector operation. All ATLAS sub-systems have their own local DCS whose detailed architecture strongly depends on the structure of the general DCS system of the ATLAS experiment [2] and on the electronics architecture and the mechanical issues of the sub-detector itself. The DCS provides control and monitoring of the main systems of the Tile Calorimeter detector, which are the High Voltage distributor system and the Low Voltage Power Supply (LVPS) system. In addition, the DCS is also responsible for interactions with detector calibration and data acquisition systems, and monitoring the detector infrastructure related systems namely the water cooling and rack control systems.

The LVPS system

The LVPS system provides the necessary voltages and currents for the Tile Cal FE electronics operation. It's a two-stage system:

(a) First stage converts 400V AC to 200V DC. This is done by the devices called 200V Bulk PS, located at the detector Back-End (BE) area.

(b) The second stage, placed on the detector, converts 200V DC into 8 independent levels of lower voltages in the range (-15V; +15V) used to power the detector Front End (FE) electronics.

The HV Distribution system

The energy deposited in the the TileCal is read out through 10,000 photomultiplier tubes (PMTs). The gain of these PMTs depends on the high voltage applied to them. For technical and cost reasons, it is impossible to have a supply for each PMT, thus one supply per Tile Cal Module was used. It includes up to 48 PMTs, the effective number depending on the location on the detector. The distribution system allows adjusting the high voltage locally on each PMT, to achieve best performance.

Databases

Two types of databases are used in the Tile Cal DCS - configuration and conditions databases:
- The configuration database is used to store the nominal High and Low Voltages, calibration parameters for the LVPS system.
- Conditions database is used to store voltages, current and temperatures measured at the detector FE and BE electronics (data size: **300MB/day).**

References

[1] ATLAS Collaboration, Tile Calorimeter Technical Design Report, CERN/LHCC 96-42, CERN, 1996.

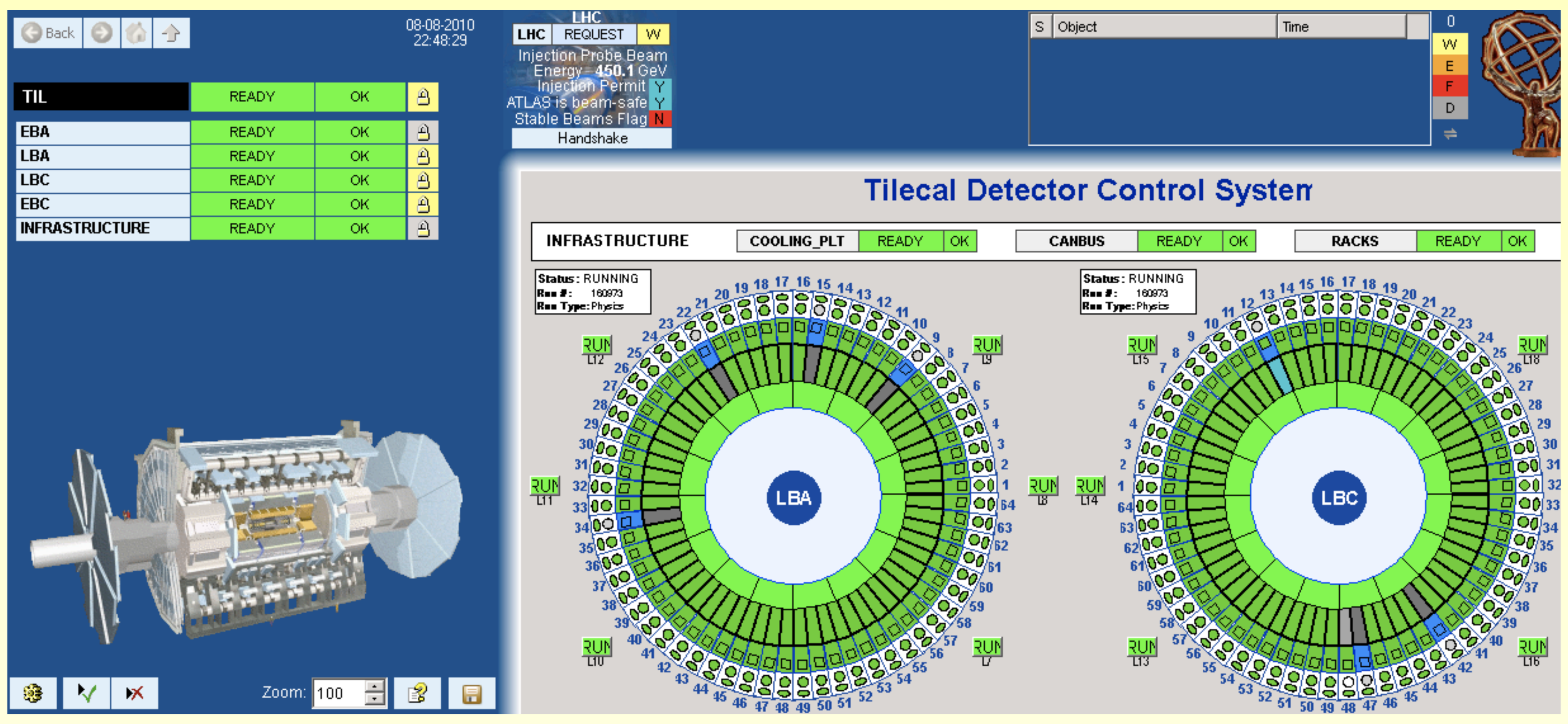
[2] A. Barriuso Poy et al., The detector control system of the atlas experiment, JINST 3 (2008) P05006

[3] H. Boterenbrood, B.I. Hallgren, The Development of Embedded Local Monitor Board (ELMB) ATL-DAQ-2003-053

[4] R. Chadelas... Final SEE tests on the HV Distributor system of the TileCal ATL-TILECAL-2002-013

User Interface

Offers a comprehensive set of commands, and monitors critical parameters of the systems, in order to have flexible detector control and to provide real-time detector status. Figure below, on the left, displays the Graphical User Interface (GUI) of the detector operation tool, showing the state and status of the individual detector Device Units. From the most inner to outer part: 200V Bulk PS (BE), HV distributor (FE), LV Power Supply (FE) and the temperature status of HV and LV electronics at the detector FE.



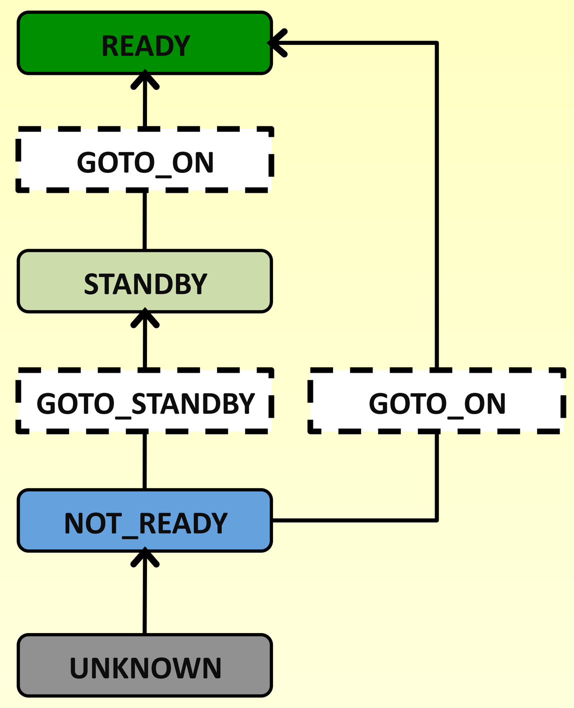


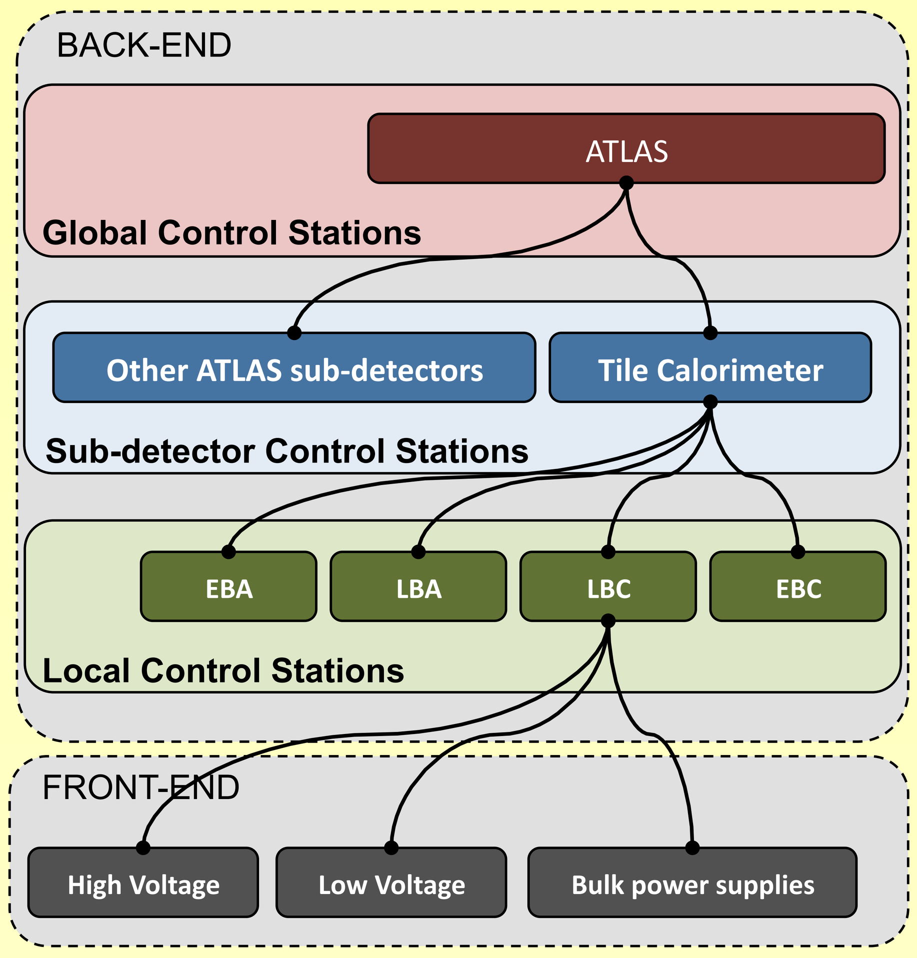
Figure on the right shows state diagram for the Tile Cal detector, where dashed lined boxes correspond to the implemented commands and the colored boxes represent allowed states. The arrows indicate allowed transitions between states.

The DCS Overview

The Tile DCS Hierarchy:

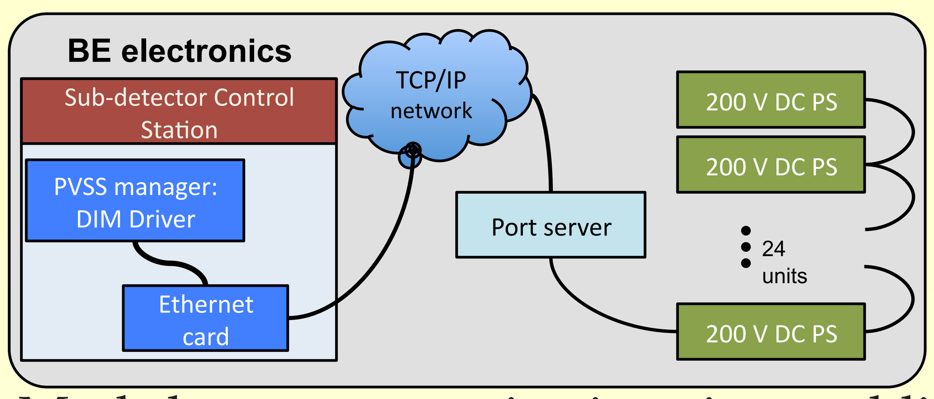
The Back-End (BE) system of the ATLAS experiment is organized in three levels of hierarchy. This allows the experiment to be divided in to independent partitions, which have the ability to operate in either standalone or integrated mode.

- **Global Control Stations** are in charge of overall detector operation. They provide high-level monitoring and control of all detectors.
- **Sub-detector Control Stations** represents the middle level of the hierarchy and controls the complete operation of the sub-detector. At this level of hierarchy, the connection with the Data Acquisition (DAQ) system, detector calibration and infrastructure systems takes place.
- **Local Control Stations** handle the low level monitoring and control of LV and HV systems and executes commands received from layers above.



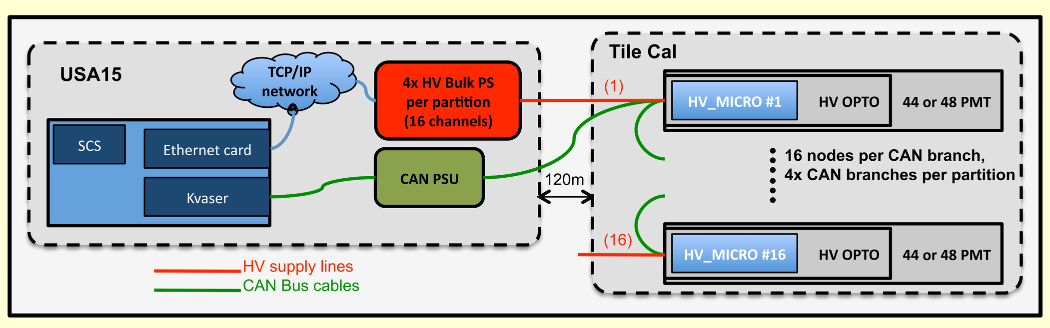
Used communication types:

The Tile Cal DCS makes use of the CAN Bus, mainly to control devices located at the detector Front-End (FE) area and the Mod Bus to control devices located at the BE area.



The Mod bus communication is established through the TCP/IP network, via the Port Server. The schematics of used Mod Bus readout chain is shown on the left Figure.

For the CAN Bus communication, the DCS makes use of the *ELMB* [3] and *HV_MICRO* [4], as the general purpose I/O processing unit. The maximum length of CAN Bus cables is 150m and the speed is 125KB/s and 250KB/s, for *ELMB* and *HV_MICRO* respectively. An example of CAN Bus readout chain is shown on Figure below:



Monitoring and alarm handling:

The DCS monitors 20800 Low Voltage, 18200 High Voltage and also 1100 infrastructure related parameters. Through the CAN Bus communication, the monitoring (i.e. readout) is established at the frequency of 10 sec. With the Mod Bus Communication protocol, the frequency is 20 sec.

The system critical parameters are continuously checked to see if they are within allowed range, otherwise a WARNING or an ALARM is triggered. The DCS takes automatic actions in case of device overheating and switches it OFF. In addition, it sends messages to experts through the Short Message Service (SMS).