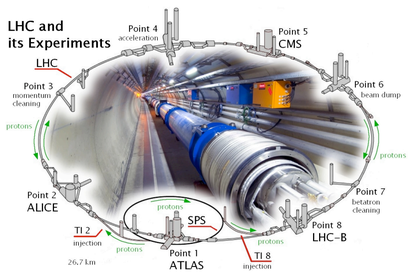
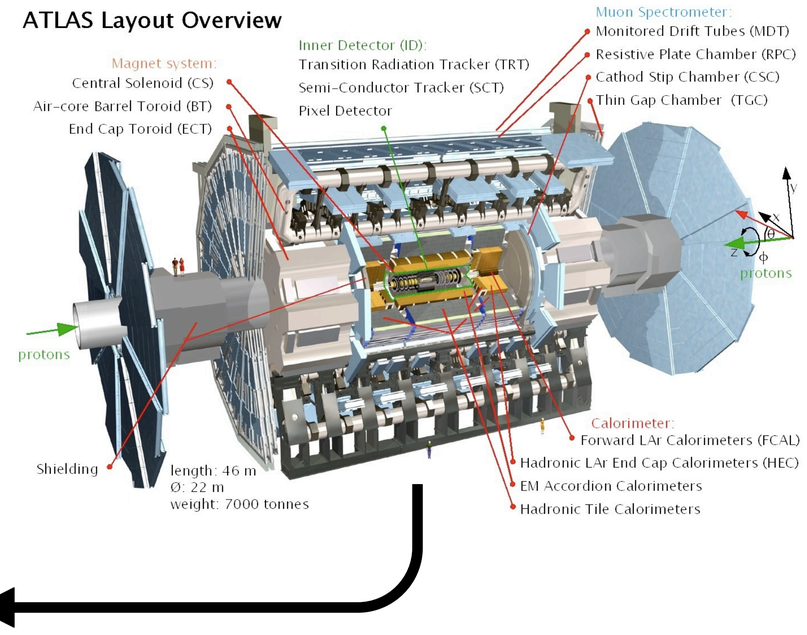
The Control System of the ATLAS Inner Detector

The **LHC** accelerator is at the France-Swiss border near Geneva.
Four experiments will measure the products of hadron-hadron collisions at very high energy, maximum at 14 TEV: **ATLAS**, **CMS**, **ALICE** and **LHC-B**.

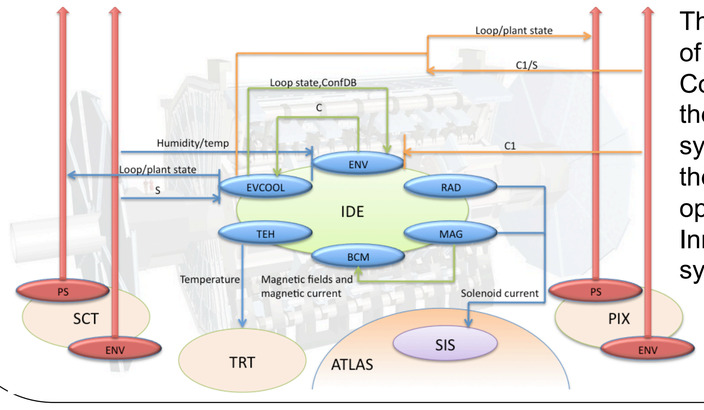


ATLAS is the biggest detector at the LHC, its size is 46m length, 22m height with 7000 tons. There are about 110 DCS (Detector Control System) to control all the sub-detectors.
The innermost part of ATLAS, the one very close to the collision point, is called “Inner Detector” and contains three sub-detectors: PIXEL, SCT (Semiconductor Tracker) and TRT (Radiation Tracker).

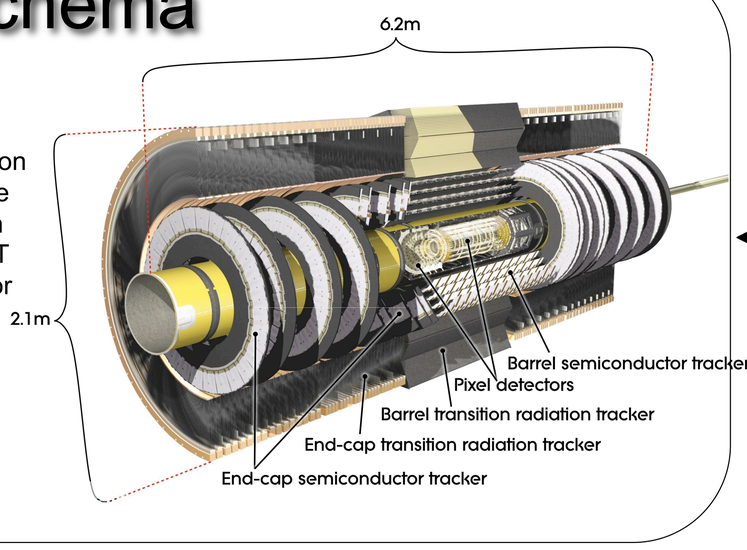


Inner Detector interaction schema

The Inner Detector DCSs communicates each other to share important information of the common infrastructure and detectors behaviors.

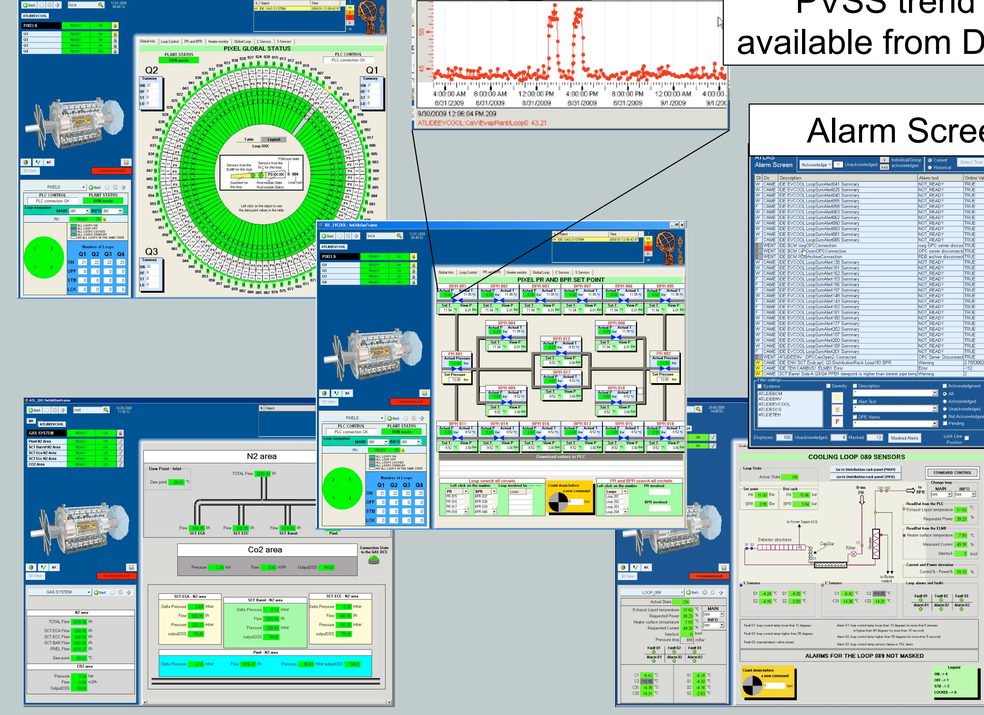


The communication of the Evaporative Cooling DCS with the Pixel and SCT systems is vital for the optimal operation of the Inner Detector systems.



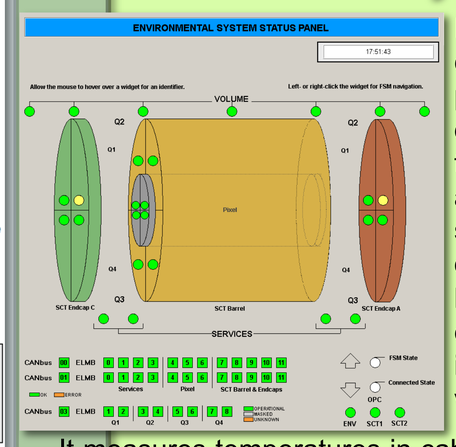
Evaporative Cooling system

All the silicon modules need to be cooled to remove the heat coming from the electronic boards ad to keep the silicon sensors at low temperature to avoid reverse annealing.An Evaporative Cooling system has been built with 204 independents loops to permit the SCT and Pixel to work at a stabilized temperature.The coolant is the C3F8 used in a liquid form and cooled down to maximum -25°C.



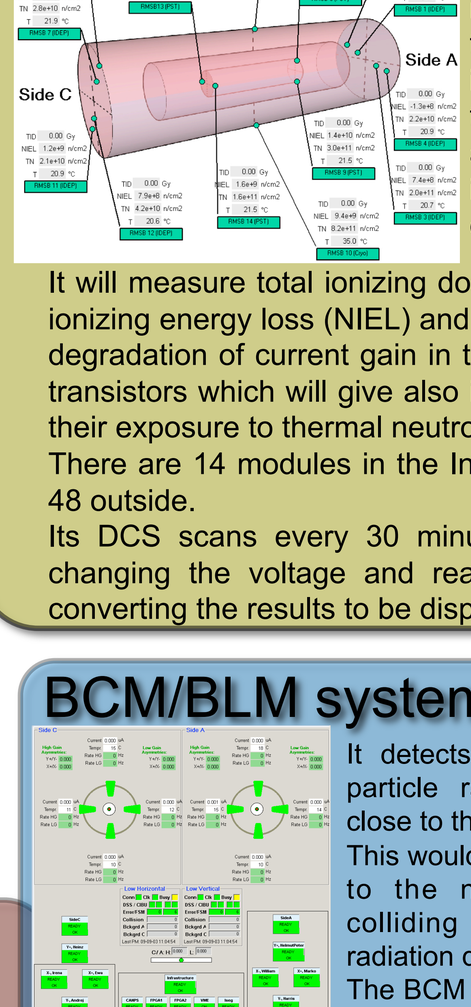
The evaporative cooling control system is based on PVSS, a SCADA platform, and permits to control and monitor the plant with graphical interfaces, panels. Each project contains tens of panels, each of them has a specific control or monitoring function.

Environmental system



For all the 204 cooling circuits this project reads and displays out 738 temperature sensors and 408 pressure sensors. It also reads out temperatures and humidities (40 of each) for the general inner detector volume.
It measures temperatures in cable trays and service racks and reads data from others SCADA systems about the status of the cooling plant.

RAD system

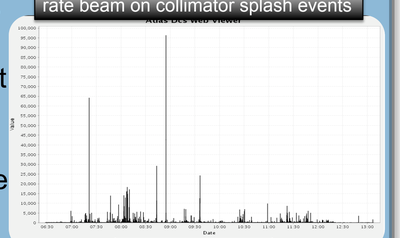


The purpose of the radiation monitor is to provide online information about the radiation dose at various locations in the ATLAS detector.
It will measure total ionizing dose (TID) and non ionizing energy loss (NIEL) and it will monitor the degradation of current gain in the DMILL bipolar transistors which will give also information about their exposure to thermal neutrons.
There are 14 modules in the Inner Detector and 48 outside.
Its DCS scans every 30 minutes the sensors changing the voltage and reading the current converting the results to be displayed.

BCM/BLM system

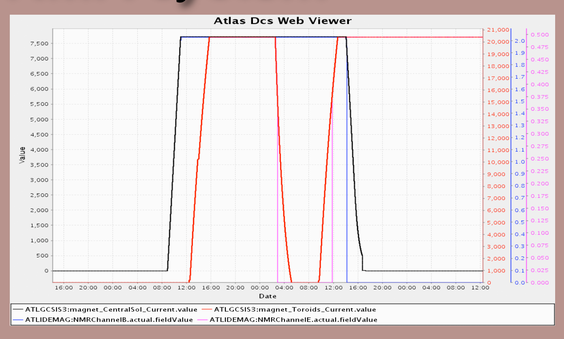
It detects anomalously high particle rate at low angle, close to the beampipe.
This would cause background to the normal events of colliding protons, or high radiation dose.
The BCM reads out 8 double-sided diamond detectors,
so the PVSS system has to deal with just 16 LV and 8 HV channels, in total around 500 parameters are controlled. In addition, the DCS system provides threshold voltages for the discriminators, low voltages for the readout board and monitors the particle counting rate, which is uploaded every second from a FPGA board. The controls for this subdetector have to be particularly reliable, because a LHC beam abort signal is produced when a too high particle rate is detected, so the BCM is part of the active protection of the Silicon-based detectors against beam accidents. The system has been functioning for one year, and the so-called “splash events” of 450 GeV proton beam on a collimator were recorded as an increase of rate in BCM.

rate beam on collimator splash events



BLM is also based on diamond detectors, but it is read out with a longer time constant and is better integrated with the LHC beam loss monitor system.

NMR system



The NMR system monitors the magnetic field strength at 2 points at z=0 outside the SCT. It provides a precise field value which can be used to scale the field map. It is based on a Teslameter PT2025 which is read out via a RS232. The panel indicates the field values and the NMR latch condition. The DCS structure is very simple, the picture shows an example of the magnetic field compared with the magnet current.

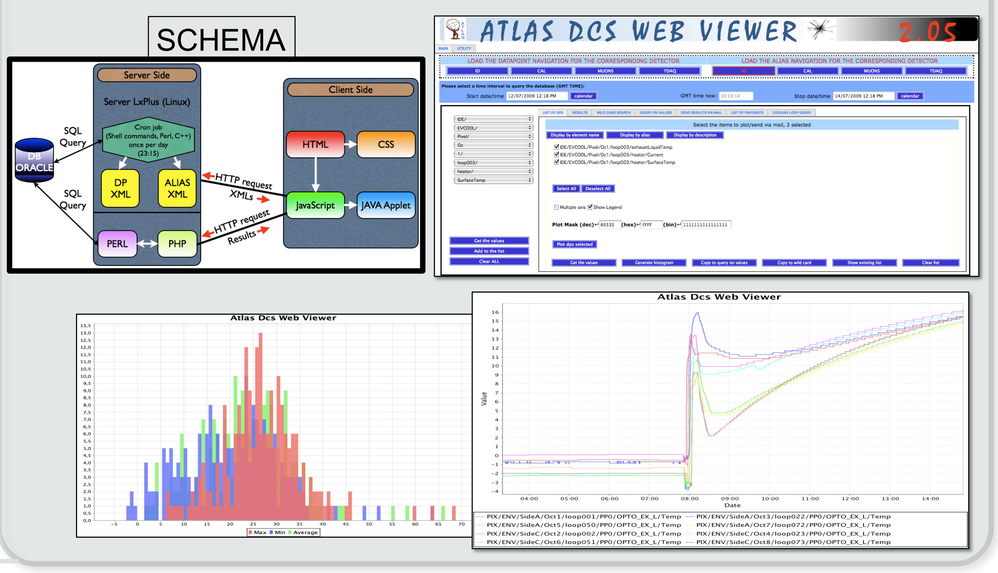
TEH system

Heater pads are used to thermally shield the TRT, which operates at 20°C from the SCT volume, which can be as cold as -25°C. The pads are instrumented with NTC which are used by an ELMB to regulate the current to the pads. The ELMBs run a PID-based regulating firmware. The DCS monitors the temperature values and deals with the alerts which can be generated by the ELMB or by the control system, supervises the turning on and off of single pads and performs the recovery procedure and interlock resets.

AtlasDcsWebViewer

The DCS data from the various ATLAS sub-detectors are stored to the Oracle database using an internal PVSS capability. All sub-detectors use the same schema. It’s a web-based tool to search the ATLAS DCS Oracle database and to display the results.

- *web-based: the plots and results should be available in a web browser, without installing dedicated software.*
- *possibility to make queries on values*
- *possibility to correlate variables contained in different projects*
- *possibility of saving the entries in a text file.*
- *possibility of overlapping trends from several Datapoint elements (DPEs).*
- *possibility of histogramming the max, min and average value in a given time interval for a list of DPs.*
- *possibility of navigating the Alias and DP structure.*
- *possibility of bit-AND (bit masking) operations on the results.*
- *possibility of query on value bits (BITAND).*
- *wild-card search for DP NAMES.*
- *storing pre-defined lists of DP, or results of a search.*
- *possibility of pre-defined queries (like: all DPs related to a given ID cooling loop)*



Evaporative Cooling DCS: **Luca Luisa**, University of Udine - Environmental DCS: **Ken Fowler**,UC Santa Cruz, **Ben Wynne,** University of Edinburgh - RAD DCS: **Jochen Hartert**, University of Freiburg
NMR DCS: **Manuel Kayl**, Nikhef Nederland - BCM/BLM: **Ewa Stanecka**, CERN- TEH DCS: **Auke-Pieter Colijn**, Nikhef Nederland - AtlasDcsWebViewer: **Luca Luisa, Saverio D’Auria** University of Glasgow
DCS Coordinator: **Saverio D’Auria** - IDE Coordinator : **Pippa Wells** CERN