THE READOUT AND DETECTOR CONTROL SYSTEMS FOR THE TEMPERATURE AND MAGNETIC FIELD MONITORING IN NEW SMALL WHEEL PHASE I UPGRADE OF ATLAS DETECTOR

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New Small Wheel in ATLAS Experiment

To overcome the High Luminosity upgrade of the LHC, the ATLAS detector is also undergoing an upgrade to handle the significantly higher data rates. The muon end-cap system upgrade in ATLAS consist in the replacement of the Small Wheel. The New Small Wheel (NSW) is expected to combine high tracking precision with upgraded information for the Level-1 trigger. To accomplish this, small-strip Thin Gap Chamber (sTGC) and Micro-Mesh Gaseous Structure (MMG) detector technologies are used.

Following the installation of NSW in ATLAS, temperature and magnetic field monitoring will be accomplished by the MDT Detector Control System Module (MDM). The Embedded Local Monitor Board are used by the Monitored Drift Tube (MDT) detectors to monitor temperature and magnetic field sensor values.

A New Small Wheel sector is layered with two Micromegas detectors in the middle and two sTGC detectors on the outside. T-Sensors are mounted on both technologies to monitor the temperature of the detectors. The B-Sensor modules are located at the outermost sTGC, close to the End-Cap toroid magnet to monitor the magnetic field.

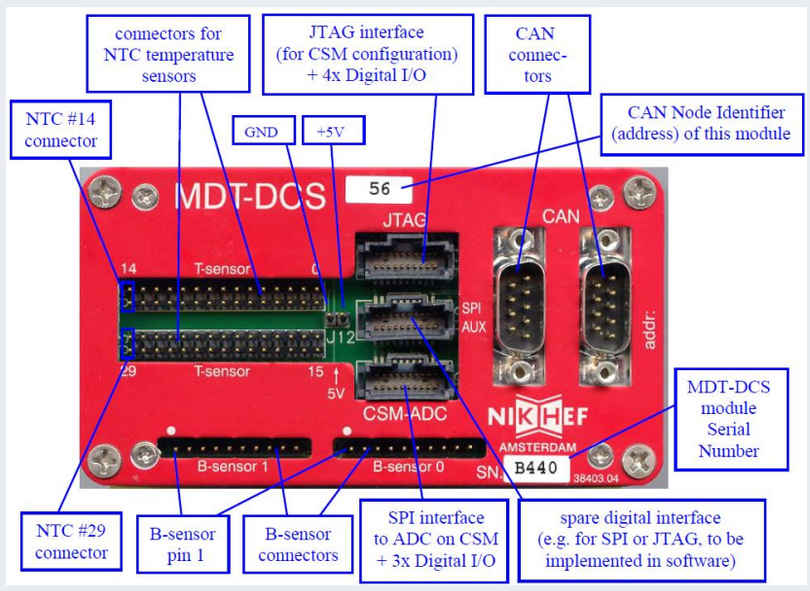
The MDT DCS Module for temperature and magnetic field monitoring

The MDT DCS Module (MDM) has been successfully used in previous runs by the MDT detectors. The same Embedded Local Monitor Board will be used in NSW. The MDM features:

- Radiation and magnetic tolerant electronics, may be reliable for years
- User programmable microcontroller
- Analog/Digital connectors (CSM-ADC, JTAG interface, CANbus interface)

Each NSW side is made up of 8 Small Sectors and 8 Large Sectors. Four MDMs will be installed behind each Large NSW Sector. In total:

- 32 MDMs will be attached on each wheel
- 4 Power Supply Units per wheel will provide power to the CANbus interface
- 96 B-Sensor and 832 T-Sensor modules will be monitored per wheel



The T-Sensor module

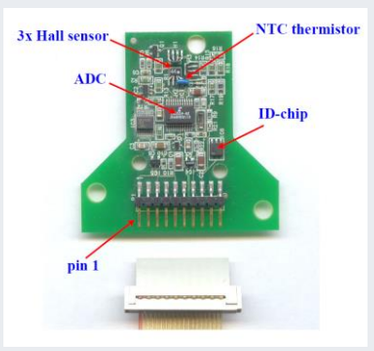
The T-Sensor is an NTC thermistor, *Thermometrics* type, with a nominal resistance of 5 kΩ. Conversion functions are applied by the MDM firmware to the ADC readings to enable the temperature readout which initially is set to millidegrees centigrade.

MDT-DCS module → Host

COB-ID	Data Byte 0	Data Byte 1-3
280h + NodeID	NTC Number	Temperature $[m^0C]$

- Every NSW Sector will have in total 52 NTC T-Sensor modules (26 per detector Technology). 36 will be installed on the detector surface while 16 will monitor the detector cooling channels.
- NSW setup is integrated to the current ATLAS DCS scheme as it follows already existing design standards. OpcUaCanOpenServer is used to monitor the Information from the MDMs

The B-Sensor module



The B-Sensor is a magnetic field monitoring board utilizing the Hall Effect. Each B-Field sensor module houses:

- 3 Hall effect magnetic field sensors + 1 NTC thermistor
- 24-bit ADC
- ID chip
- 10-pin IDC flat cable connector
- SPI communication interface

Up to four B-Sensors can be monitored at once. Data is being read out as a PDO message through the CANOpen protocol:

MDT-DCS module → Host

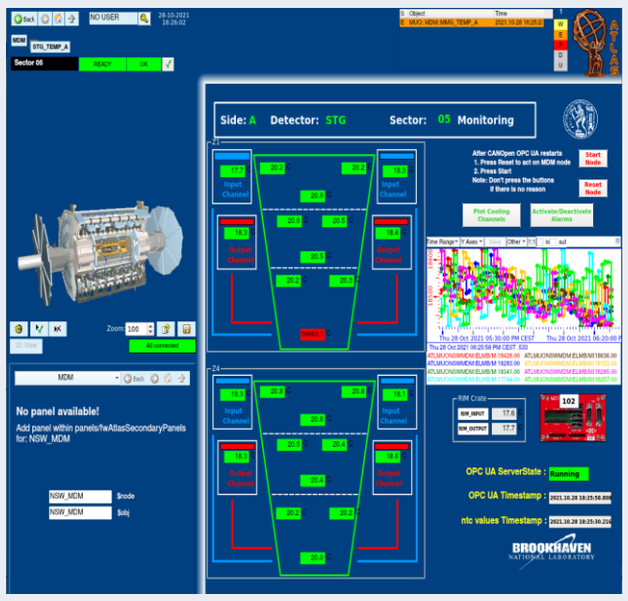
COB-ID	Data Byte 0	Data Byte 1	Data Byte 2-4
480h+NodeID	Channel number	ADC-config	24-bit ADC value

Data conversions:

Unsigned integer → **24-bit conversion** → **Signed integer** → **Calibration Constants** → **Magnetic Field**

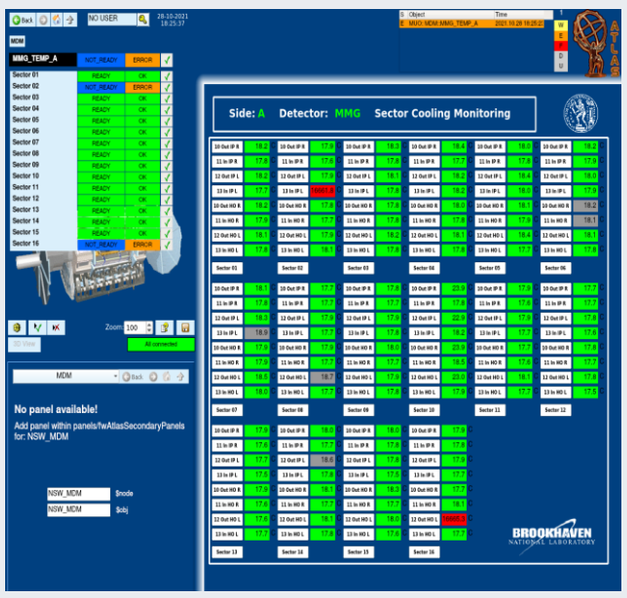
Each NSW Large sTGC sector will host 12 B-Sensor modules. 2 Sector MDMs will monitor 2 B-Sensors and the remaining 2 will monitor 4 B-Sensors each.

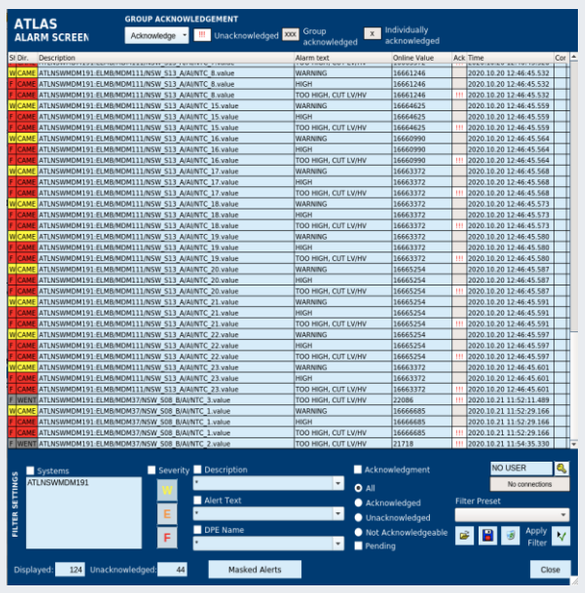
T-Sensor Control System



The control system follows the Finite State Machine (FSM) hierarchy scheme which features:

- States depending on Alarm configurations of the NTC sensors in addition with Active Alarms.
- Lower level nodes that consider information in parallel only from Cooling Channels for status decision.
- Side panels that contain the information for the Side Cooling channels of all Sectors. This immediately gives an overview to the shifter crews.
- ATLAS alarm screen





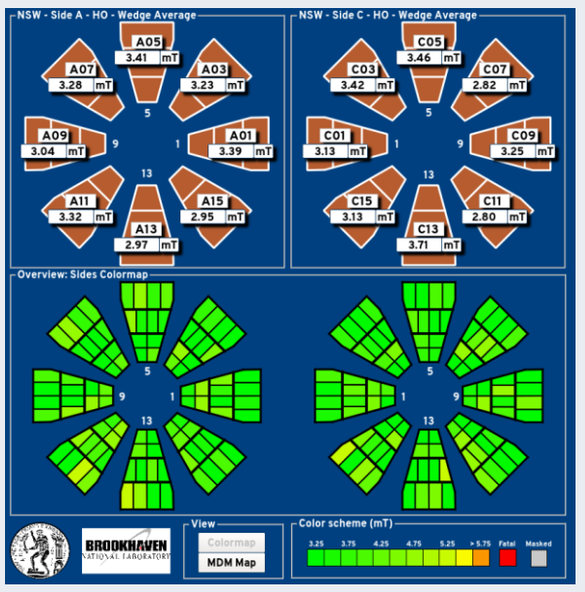
B-Sensor Control System

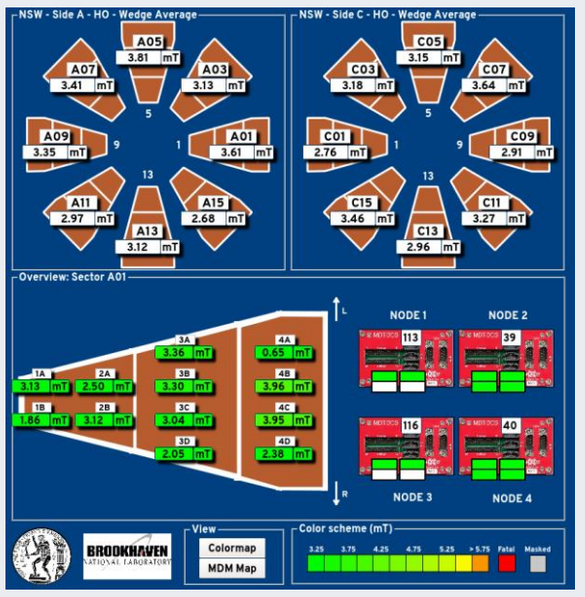
The magnetic field monitoring will not follow the FSM concept and it will be part of the expert panels.

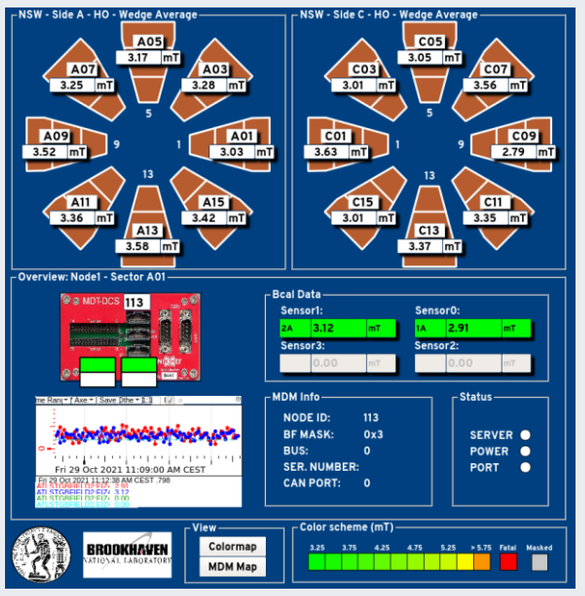
The control system features:

- A copy mechanism to get the data from the information server
- Average value per sector monitoring
- Colormap of all the B-Sensors for both sides
- Per sector monitoring panel
- Per MDM monitoring panel

Statuses of the B-Sensors are being calculated by the MDM and are displayed through a color scheme.







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