

LHCC Meeting, CERN Poster Session 18 November 2021

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

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 k Ω . 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 \rightarrow 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 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 conversion	ons:						
Unsigned integer		gned Calibrat Constar	Wagneric				

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

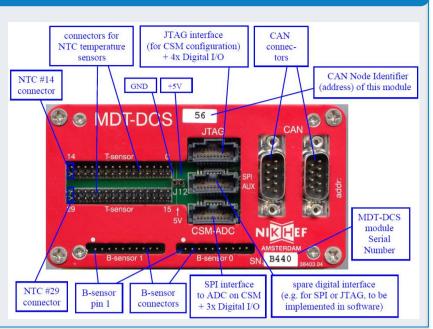


The control system follows the Finite State Machine (FSM) hierarchy scheme

B-Sensor Control System

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





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

the expert panels.

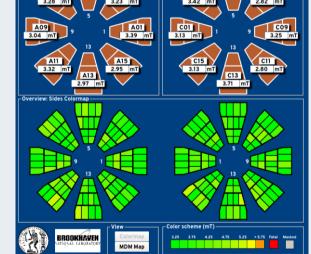
The control system features:

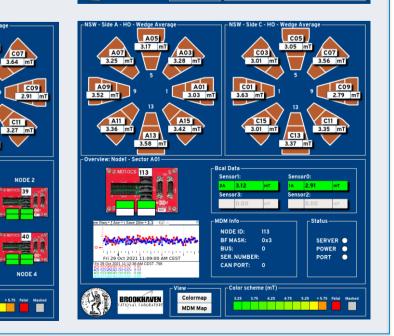
- A copy mechanism to get the data from the information server
- Average value per sector monitoring
- Colormap of all the B-Sensors for both sides
- Per sector monitoring panel
- Per MDM monitoring panel

3C

2B

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





										D U	Y	SID	-
Sector 01 READY OK 🗸										_			AME AME
Sector 02 NOT_READY ERROR V													IME
Sector 03 PEADY CK 🎸										1 /3	18.94		AME
Sector 04 READY OK 🗸	Side:	A Dete	ctor:	MMG	Secto	r Coolir	ng Mo	nitoring	1	6	MI -	E C	IME
Sector 05 PEADY CK 🗸										V 1	<u>1</u>	FO	AME
Sector 05 FEADY CK V		_	_				_		_	·		wo	AME
Sector 08 PEADY CK V	10 Out IP R	8.2 C 10 Cut IP	a 17.9	C 10 OM IP R	18.3	C 10 Out IP R	18.4	0 33 OM IP R	18.0	C 10 Dut IP R	18.2 C	F C	ME
Sector 09 PEADY CK J	11 in IP 8	7.8 C 11 m P #	17.6	Clinps	17.8	C 11 In PR	17.7	C II In P.R.	17.8	C 11 In PR	17.9 C	E C	AME
Sector 10 PEADY CK J	12 Out 19 L	8.2 C 12.0#19	17.9	C 12 Out IP L	18,1	C 12 Out IP L	18.2	0 12 Over IP L	18.4	C 12 Out IP L	18.0 C	wo	AME
Sector 11 Praty CK /					17.8	G 13 In IPL	18.2	0 1316191	18.0	C 11 In IP1	17.9 C	FO	AME /
Sector 12 PEADY CK				G 33161PL				_					AME .
Sector 13 BEADY CK	10 Out HO R	8.2 C 10 Out HD	ĸ 17.8	C 10 Out HO R	17.8	C 10 Out HD R	18.0	C 10 Out HO R	18.1	C 10 Dut HD R	18.2 C	WC	AME
Sector 14 PEADY CK	11 in H0 R	7.9 C 11 in HD	17.7	C 11 in HO R	17.8	C 11 In HD R	17.8	C 11 In HOR	17.9	C 11 In HD R	18.1 C		AME A
Sector 15 READY OK	12 Ovt H0 L	8.1 C 12 Out HD	4 17.9	C 12 Out HO L	18.2	C 12 Out HD L	18.1	C 12 Out HD L	18.4	C 12 Out HO L	18.1 C		ME
Sector 16 NOT_READY ERROR V		7.8 C 13 In HD		C 13 in H0 L	17.8	C 13 In HOL	17.8	C 13 In HOL	17.7	C 13 In HOL	17.8 C		LMI I
	13 16 160 1	13 IN HO	18.1	13 IN HOL	17.8	0 13 IN HOL	17.8	13 IN H0 L	17.7	13 H H0 L	17.8	EC	ME
	Sector 01	Sector 62		Sector 03		Sector 04		Sector 05		Sector 06		wic	AME A
												F C	AME
	10 Out IP R	8.1 C 10 Out IP	a 17.7	C 10 Out IP R	17.8	C 10 Out IP R	23.9	D 30 Out IP R	17.9	C 10 Dut IP R	17.7 C	EC	AME
	11 in 19 8	7.8 C 11 in PS	17.7	6 11 in P #	17.7	C 11 in PR	17.8	C II In P.R.	17.6	C 11 is PR	17.7 C	WC	AME
	12 Ove 19 L	8.3 C 12.0#1P	17.9	C 12 Out IP L	17.9	C 12 Out IP L	22.9	0 12 Over 10 L	17.9	C 12 Out IP L	17.8 C	FO	AME
📵 💱 🗰 Zoom 100 😂 😰 🔂		8.9 C 13 in P1		C 13 In IP1	17.8	C Displ	18.2	0 13 In IP1	17.7	C BinPL	17.6 C		NME
3D View All connected						_				_			AME
	10 Out HO R	7.9 C 10 Out HD	R 17.9	C 10 Dut HO R	18.0	C 10 Out HD R	23.9	C 30 Out HO R	17.7	C 10 OVE HD R	17.8 C		AME
	11 in H0 R	7.9 C 11 in HD	e 17.7	C 11 in HO R	17.7	C 11 In HD R	18.5	C 11 In HOR	17.6	C 11 In HO R	17.7 C		AME .
MDM • Q Back 🔘 🟠 🛧	12 Out HO L	8.5 C 12 Out HD	L 18.7	C 12 Out HO L	17.9	C 12 Out HD L	23.0	C 12 Out HD L	18.1	C 12 Out HO L	17.8 C	E C	ME.
	13 in #0 L	8.0 C 13 In HO	17.7	C 13 in H0 L	17.8	C 13 In HOL	17.9	C 13 In HOL	17.7	C 13 In HOL	17.5 C	EC	AME A
	13 HINGT	500 G 13 IN NO		1311 1011	17.8	13 11 10/1	17.8	1311 10/1	17.3	1311 101	11.0	E W	ENT
No panel available!	Sector 07	Sector D		Sector 09		Sector 10		Sector 11		Sector 12		WC	AME
Add panel within panels/fwAtlasSecondaryPanels						_						10	AME.
for: NSW MDM	10 Out IP R	7.9 C 10 Out IP	a 18.0	C 10 Out IP R	18.0	C 10 Out IP R	17.9					F C	AME.
	11 in 17 8	7,6 C 11 m P #	17.7	C 11 in P 8	17.8	C 11 In PR	17.8					F W	ENT
	12 Out IP L	7.7 C 12 Out IP	18.6	C 12 Out IP L	17.8	C 12 Out IP L	17.9						
	33 In IPL 1	7.5 C 13 la IP 1	17.8	G 33 In IP L	17.5	C 13 to IP1.	17.7						
												SETTINGS	ATL
NSW_MDM \$node	10 Out HO R	7.9 C 10 Out HD	r 18.1	C 10 Out HO R	18.3	C 10 Out HD R	17.7					E	
NSW MDM Sobi	11 in HO R	7.6 C 11 in HD	t 17.7	C 11 in HO R	17.7	C 11 In HD R	18.1						
	12 Out H0 L	7.6 C 12 Out HD	4 18,1	C 12 Out H0 L	18.0	C 12 Out HD L				_		FILTER	
	13 in #0 L	7.7 C 13 In HD	17.8	C 13 in HO L	17.6	C 13 In HOL	17.7		RRC	OKHA	VEN	5	
									NATIO	HL LABOR	ATORY	-	
	Sector 13	Sector 14		Sector 13		Sector 16							
												Di	splay



Stamatios Tzanos (National Technical University of Athens) Christos Paraskevopoulos (National Technical University of Athens/Brookhaven National Laboratory) On behalf of ATLAS Collaboration

