The New Small Wheel Low Voltage Power supply DCS for the ATLAS experiment

ICALEPCS Conference, October 14-22 2021, Shanghai, China

C.Paraskevopoulos[1,2]

on behalf of the ATLAS Muon Collaboration

[1]National Technical University of Athens, [2]BrookHaven National Laboratory

Introduction

ATLAS is the largest high-energy physics detector ever built by man. The LHC delivers millions of collisions each second, that take place in the heart of ATLAS. In order to monitor and control the operation of the detector, a framework has been devised, which allows for remote supervision and intervention in the detector and its sub-systems: The Detector Control System (DCS), used daily, in the ATLAS Control Room. It is also used by the detector experts to guarantee a safe and efficient Physics run. The main task of the DCS is to enable the coherent and safe operation of the full detector by continuously monitoring its operational parameters and its overall state. The NSW consists of two detector technologies Micromegas and sTGC.

FSM Hierarchy

The NSW DCS projects closely follow the existing look, feel and command structure of MUON DCS, which facilitates the shifter and expert operations. WinCCOA is a highly modular, device oriented product with an event driven architecture. The back-end system, used by all the four LHC experiments, is implemented using this commercial Supervisory Control and Data Acquisition (SCADA) package. The projects are mapped onto a hierarchy of Finite State Machine (FSM) elements using the Joint COntrols Project (JCOP) FSM toolkit. The FSM is conceived as an abstract machine that is able to be in only one of a finite number of states at a time. The state can change when initiated by a triggering event or condition (transition state). The top node of both MMG and sTGC will propagate its state and receive commands from the ATLAS overall DCS. Shifters will mainly use the DCS FSM and DCS Alarm Screen(Figure 2).

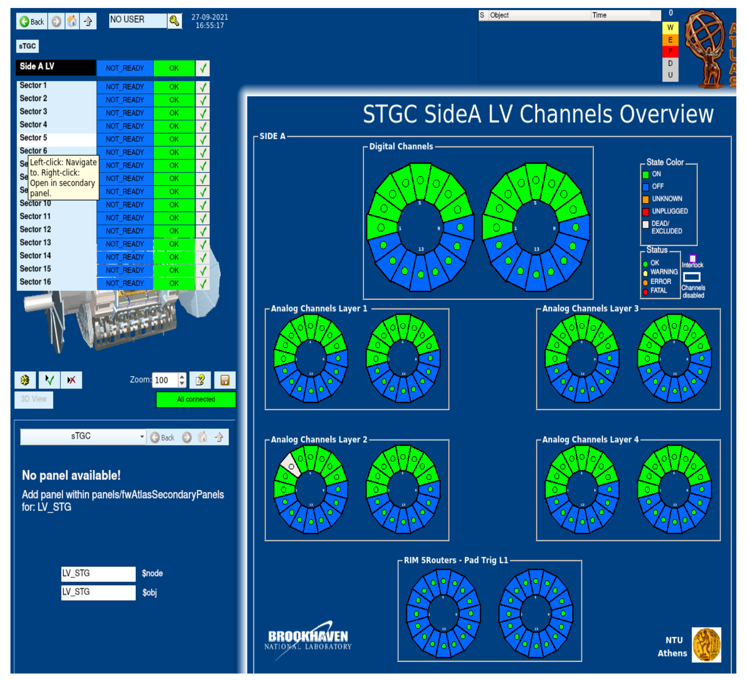

Figure 1: The STGC LV FSM, Side A Panel

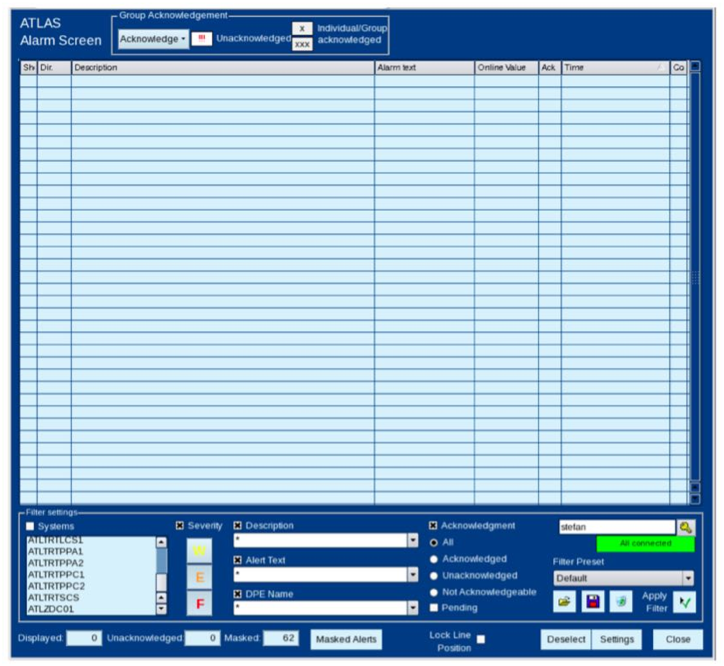

Figure 2: The DCS Alarm Screen

NSW LV DCS : Architecture and Hardware

Low voltages for MMG and sTGC are supplied by the widely used CAEN system, which is developed for the LHC experiments. Among its core features are.

- Remote control
- Split of radiation sensitive parts from parts that can be housed in a hostile area
- Compatibility with operation under radiation and magnetic field as in the ATLAS cavern

NSW will be installed at both Side A and C ATLAS End Caps. The CAEN Open Platform Communication Unified Architecture (OPC UA) servers are also partitioned into Side A and C, deployed to the equivalent host servers. The OPC UA clients address space of the individual channel parameters and transmit them to the projects. Two CAEN mainframes of type SY4527, installed in the ATLAS Service area (USA15), control the NSW LV. Each mainframe houses 9 A1660 branch Controllers, connected with the Low Voltagea Intermediate Conversion Stage (ICS) modules. In total 34 ICS crates will provide the LV for the readout cards, two of which are needed for powering the trigger electronics of sTGC detectors. The ICS crates are powered from primary generators called NGPS-30300. 34 NGPS primary gen- erators are allocated inside the NSW racks in US15.

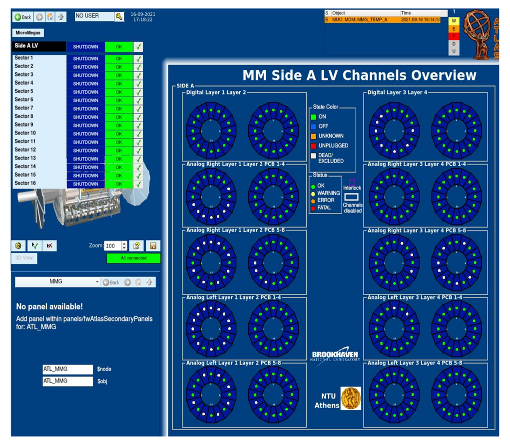

Figure 3: Side A sTGC, Low Voltage monitoring

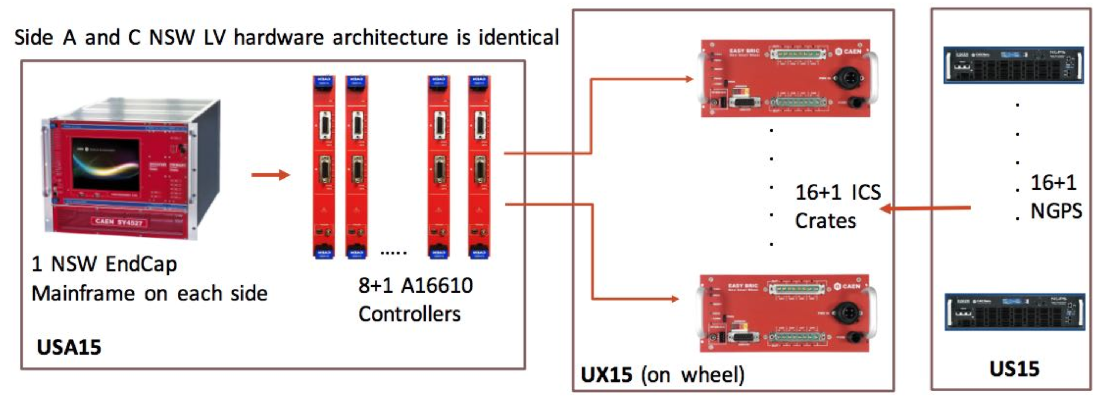

Figure 4: NSW LV hardware allocation

Interfacing NSW projects

The LV FSM will have to interface with other FSMs of NSW, the most important of which are the electronics and the temperature monitoring. Values and alarms from these FSMs are directly connected with the LV. In case of alarms incoming from temperature value flags that indicate an increased temperature, the LV FSM will have to automatically power off the connected devices for safety reasons.

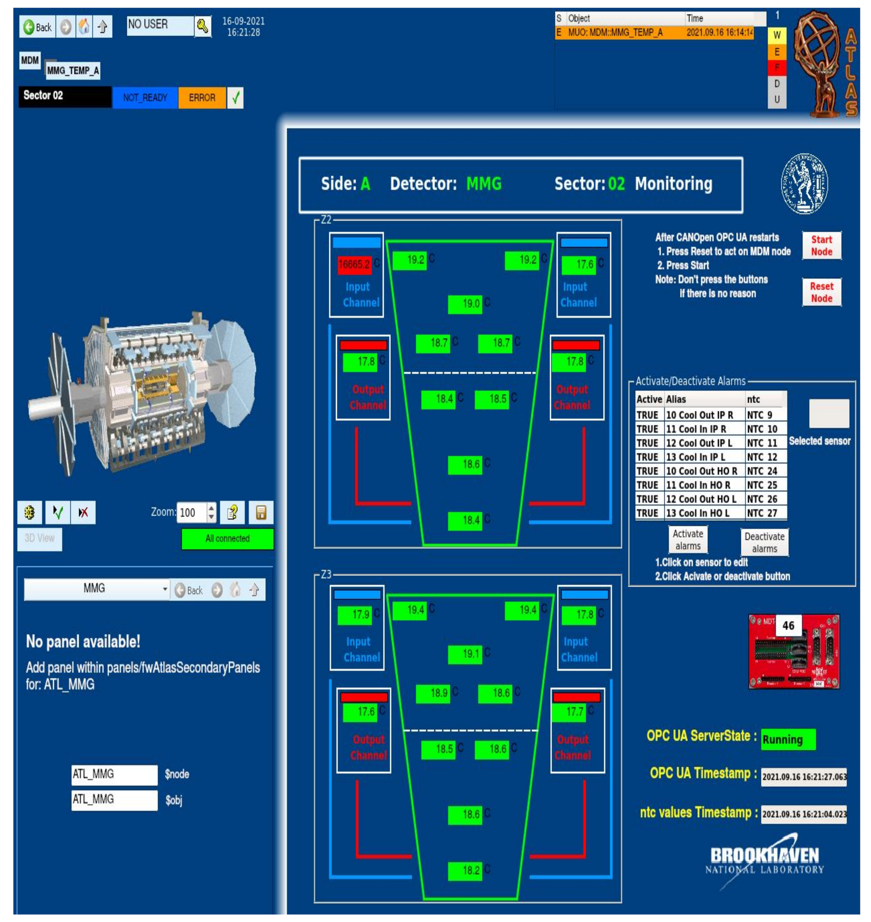

Figure 5: Sector Temperature monitoring

Low Voltage FSM Design

Three different FSM structures and designs were necessary for the NSW LV DCS: The Low Voltage Channel OverView, NSW NGPS Controller and The ICS module Controller. The Device Unit (DU) is the base of the FSM and the nodes of this type correspond to a device instance and are used to interface to it. Channel controls, monitoring and conditions can be monitored on the panel. The State and Status of the DU depends on the status data point element of each ICS channel and the communication validity of the OPC UA server. The design of the ICS Controller FSM DU is based on the channel DU adjusted to accommodate the "virtual" channel error bits.

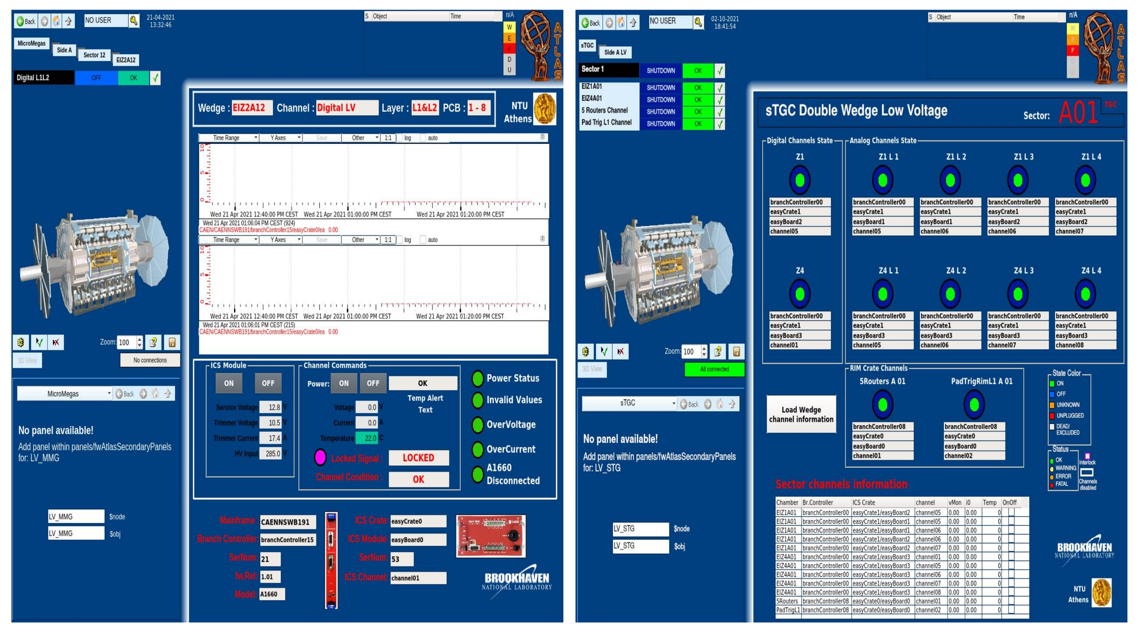

Figure 6: The LV channel node and the sTGC Sector monitoring, accommodating the control panesl

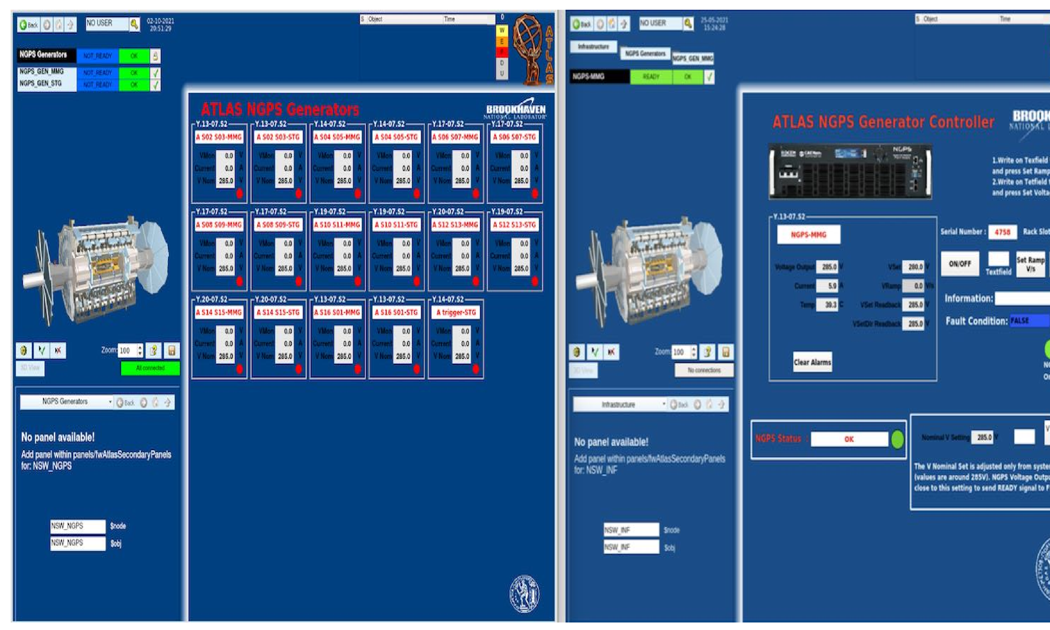

Figure 7: Among others the NGPS DU panel includes: On/Off button, Control of Ramp and Set voltage, Clear Alarms function, Vnominal set, Slot and Serial number indications

Introduction and FSM Hierarchy

In order to monitor and control the operation of the detector, a framework has been devised, which allows for remote supervision and intervention in the detector and its sub-systems: The Detector Control System (DCS) .The DCS is simply a Supervisory Control And Data Acquisition (SCADA) system equipped with User Interfaces (UIs), automated scripts and control/monitor functionality. This control scheme is used daily, in the ATLAS Control Room. It is also used by the subdetector experts to guarantee a safe and efficient Physics run. The main task of the DCS is to enable the coherent and safe operation of the full detector by continuously monitoring its operational parameters and its overall state.

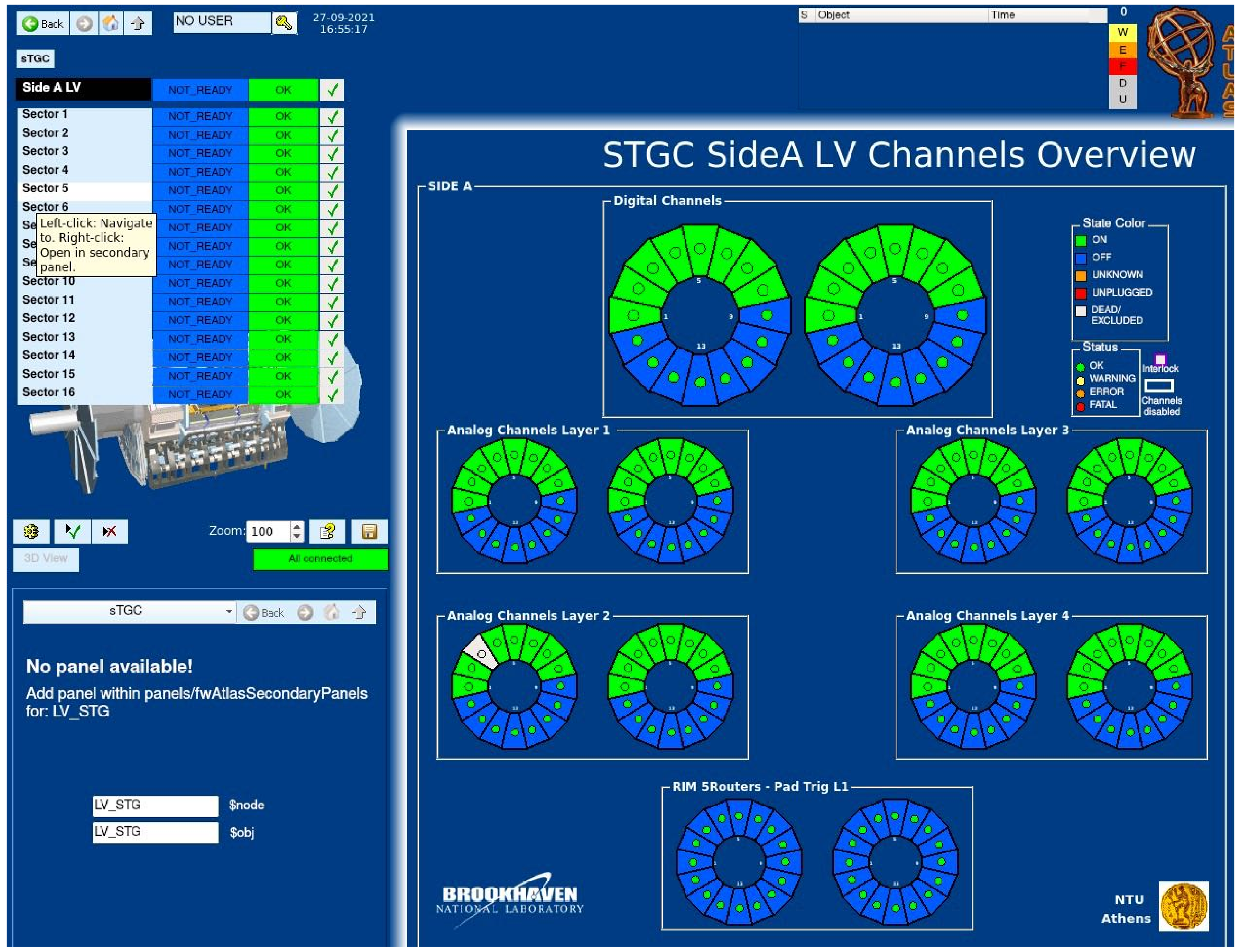

Figure 1

The back-end system, used by all the four LHC experiments, is implemented using this commercial SCADA package. On top of the SCADA package, a Joint Controls Project framework provides a set of software tools and guidelines and assures the back-end homogeneity over the different sub-systems, sub-detectors and LHC experiments.

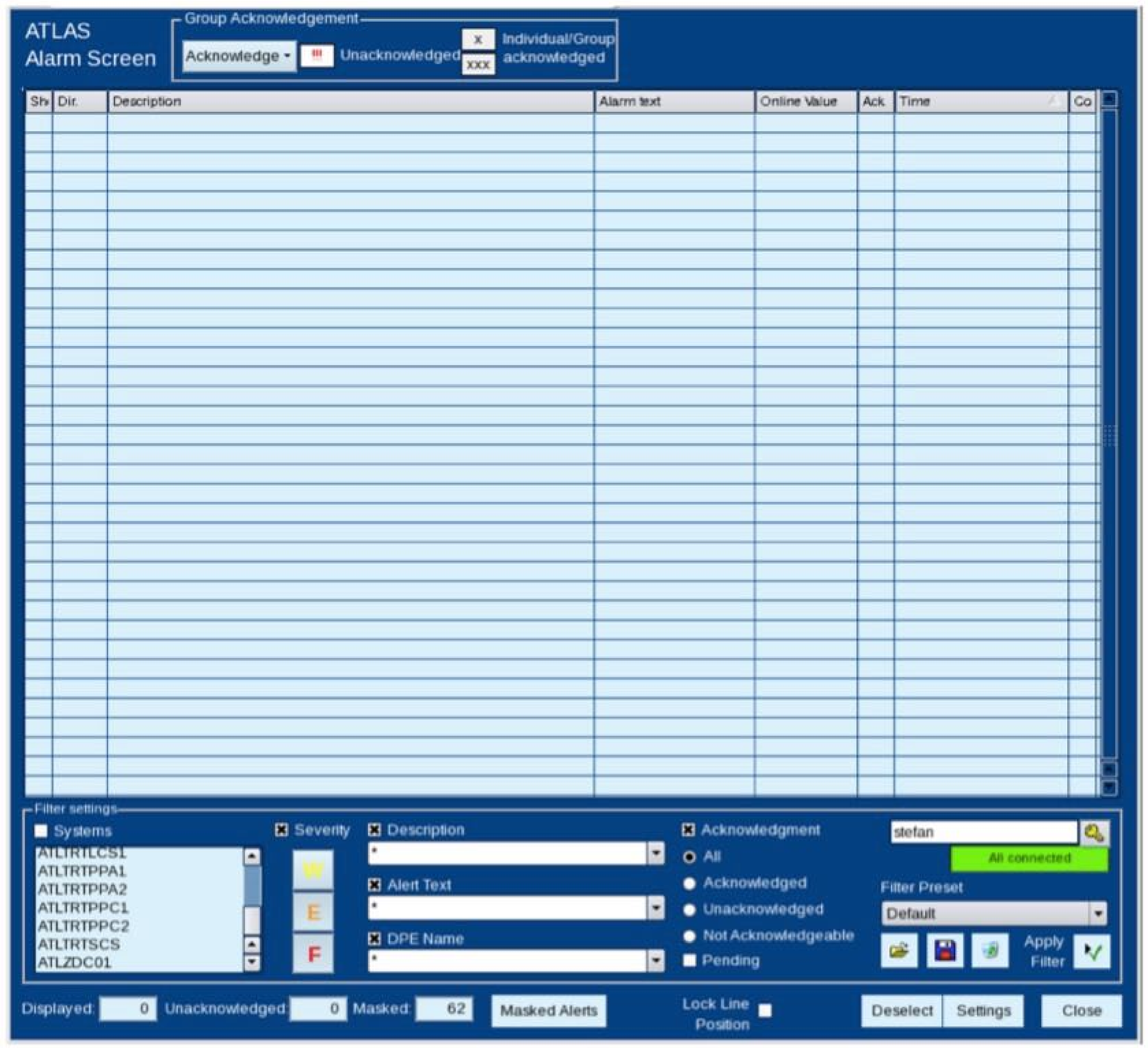

Figure 2

The projects are mapped onto a hierarchy of Finite State Machine (FSM) elements using the Joint COntrols Project (JCOP) FSM toolkit .

The FSM is conceived as an abstract machine that is able to be in only one of a finite number of states at a time. The state can change when initiated by a triggering event or condition (transition state).

Interfacing NSW projects

The NSW LV project will have to interface with the rest of the projects while all being monitored by the Supervisory Control System. The most important interfacing however is the electronics and the temperature monitoring projects. NSW separate configuration/monitor, readout and trigger path consists of 2.4 million readout channels that result in 100.000 DCS parameters. NSW on-detector and cooling temperature monitoring relies on 64 MDT Device Modules (MDM), 32 on each wheel. These devices will monitor the detector temperatures and magnetic field. So the electronics powering and then the temperature values are directly connected with the LV FSM. In case of alarms incoming from a raised temperature value flags, the LV FSM will have to automatically power of the connected devices to avoid failures within the system.

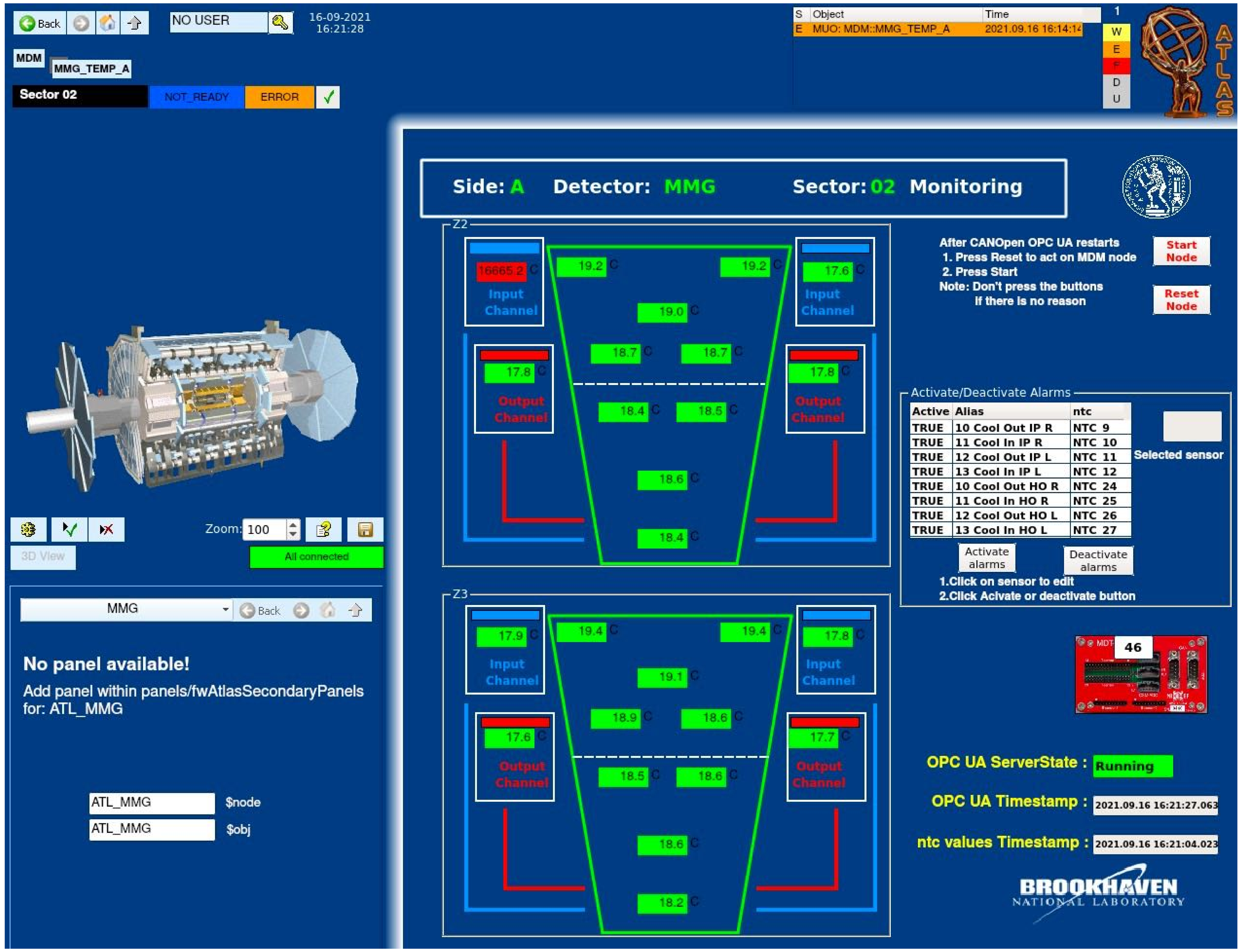

Figure 3

NSW LV DCS : Architecture and Hardware

Low voltages for MMG and sTGC are supplied by the widely used CAEN system, which is developed for the LHC experiments.

Among its core features are.

- Remote control

- Split of radiation sensitive parts from parts that can be housed in a hostile area

- Compatibility with operation under radiation and magnetic field as in the ATLAS cavern

NSW will be installed at both Side A and C ATLAS End Caps. The CAEN Open Platform Communication Unified Architecture (OPC UA) servers are also parti- tioned into Side A and C, deployed to the equivalent host servers. The OPC UA clients address space of the individual channel parameters and transmit them to the projects. Two CAEN mainframes of type SY4527, in- stalled in the ATLAS Service area (USA15), control the NSW LV. Each mainframe houses 9 A1660 branch Con- trollers, connected with the Low Voltagea Intermediate Conversion Stage (ICS) modules. In total 34 ICS crates will provide the LV for the readout cards, two of which are needed for powering the trigger electronics of sTGC detectors. The ICS crates are powered from primary generators called NGPS-30300. 34 NGPS primary gen- erators are allocated inside the NSW racks in US15.

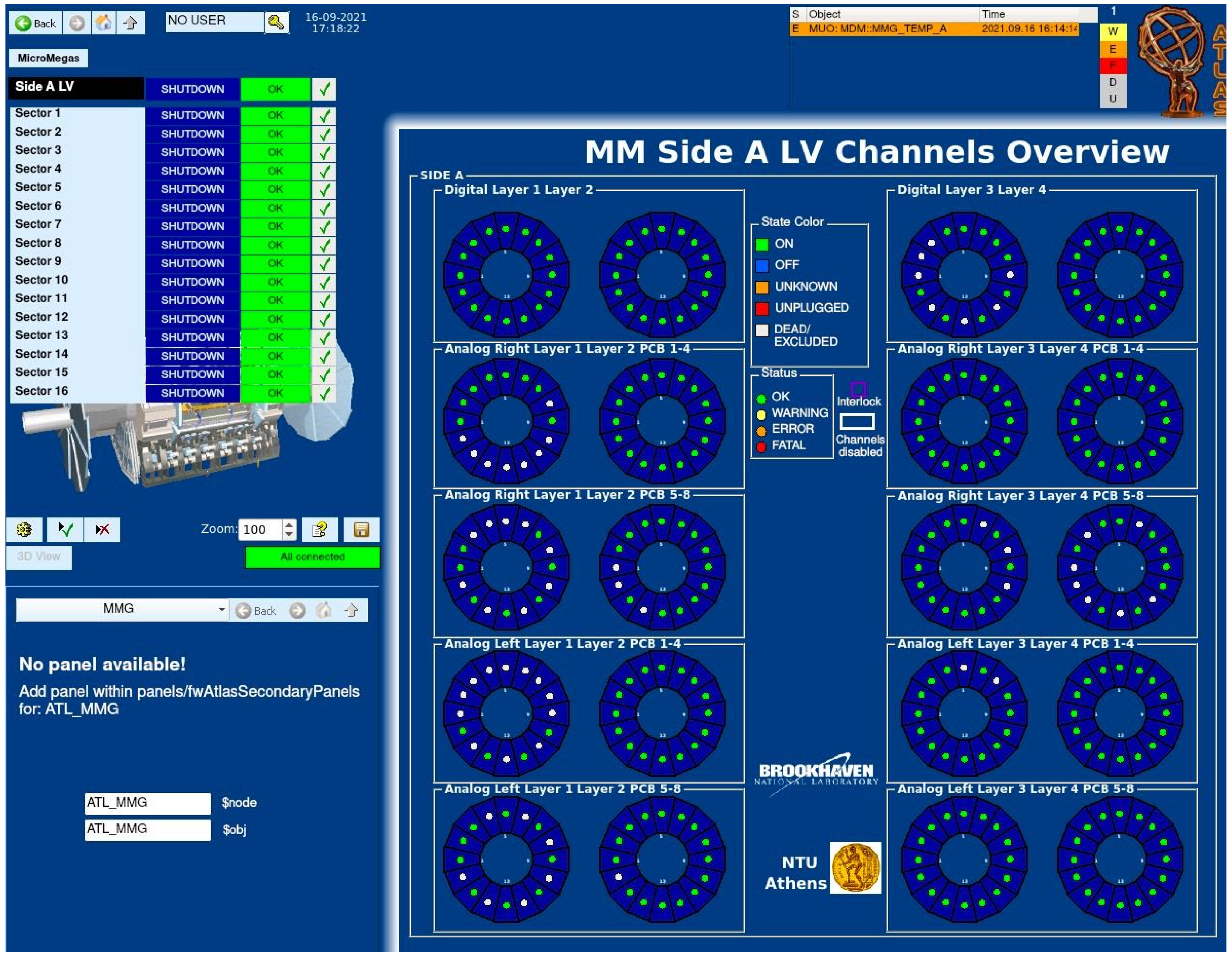

Figure 3

Each LV controller is connected with two ICS crates, 16 in total for each side. The ICS crates power two adjacent sectors of each sub-detector technology each, providing the low voltage for the readout cards. Also two extra ICS are needed for powering the trigger electronics of sTGC detectors.Each Crate hosts 4 modules while every module has 8 output channels, adjusted output channel voltage is 9-11V and output current 0-17A.There is also one "virtual" internal channel for general board settings.

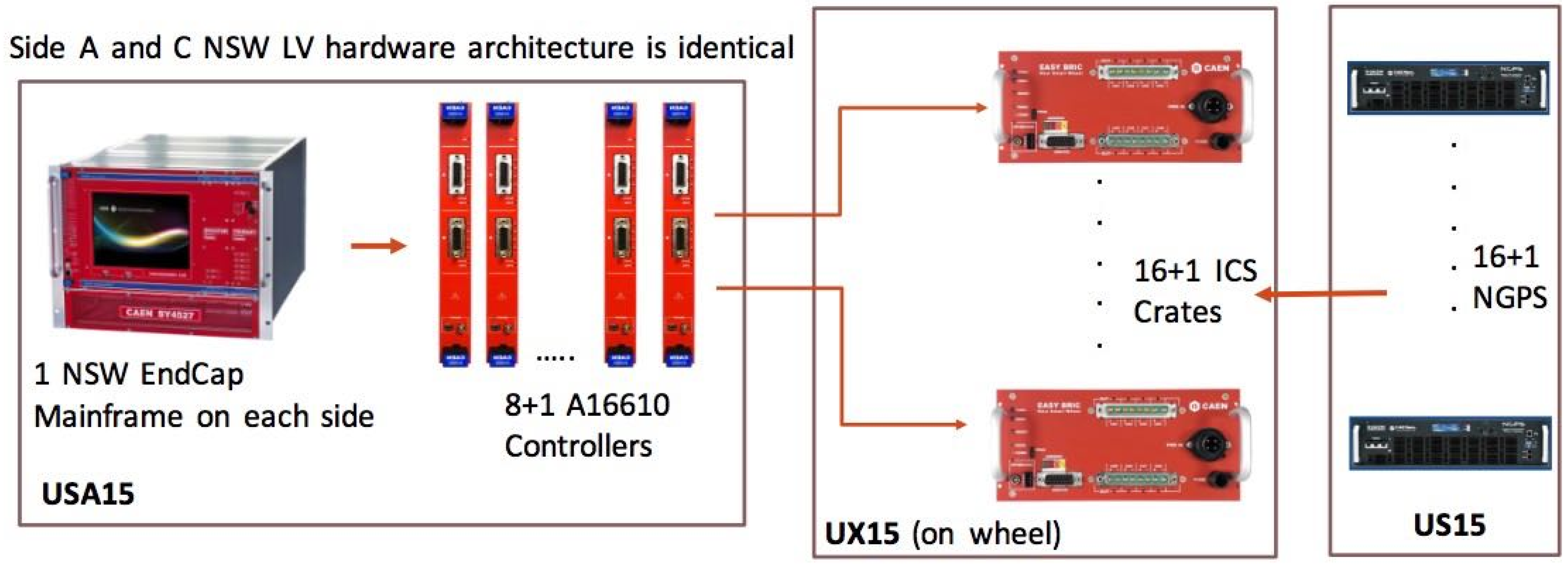

Figure 4

Low Voltage FSM Design

Three different FSM structures and designs were necessary for the NSW LV DCS: The Low Voltage Channel OverView, NSW NGPS Controller and The ICS module Controller.

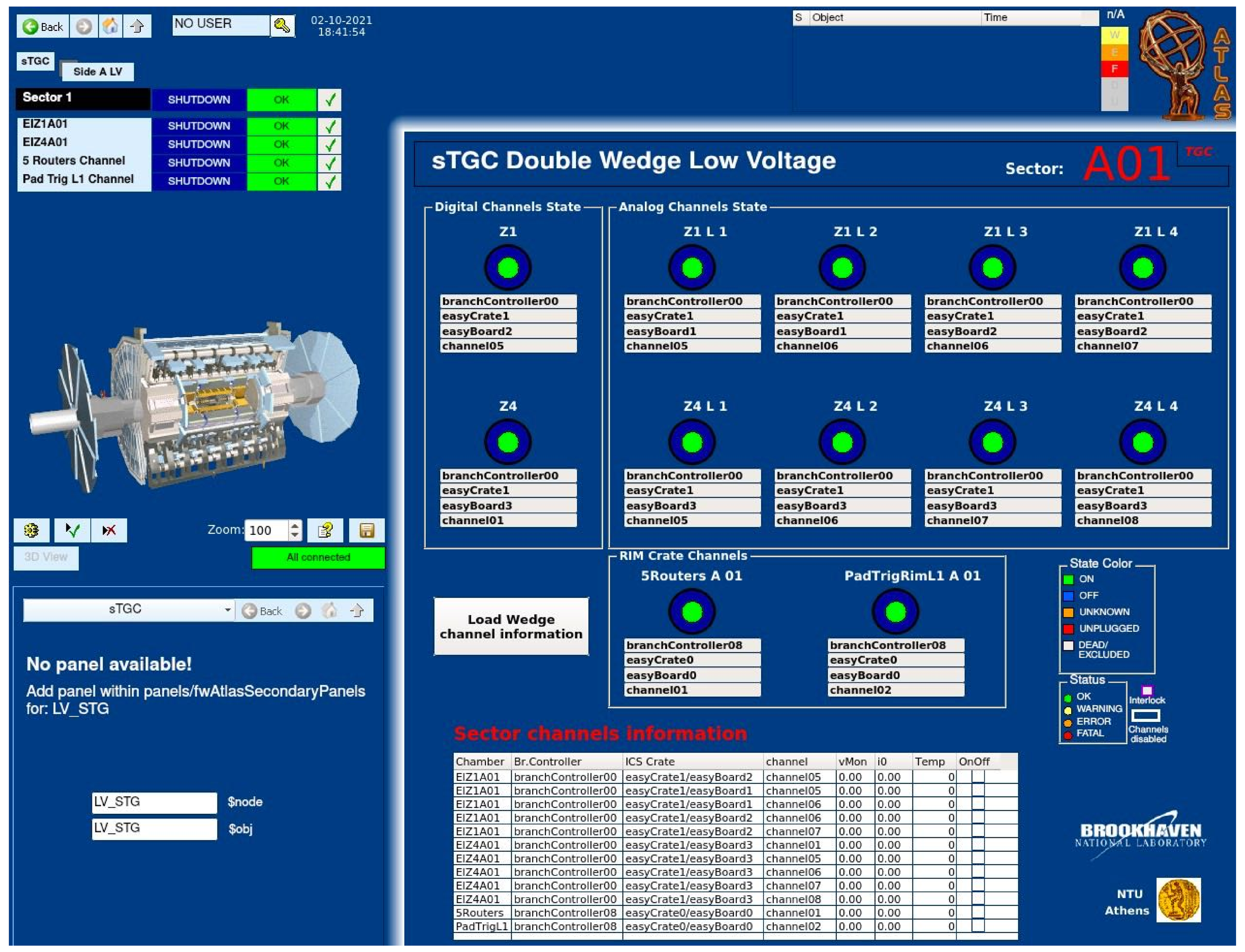

Figure 6

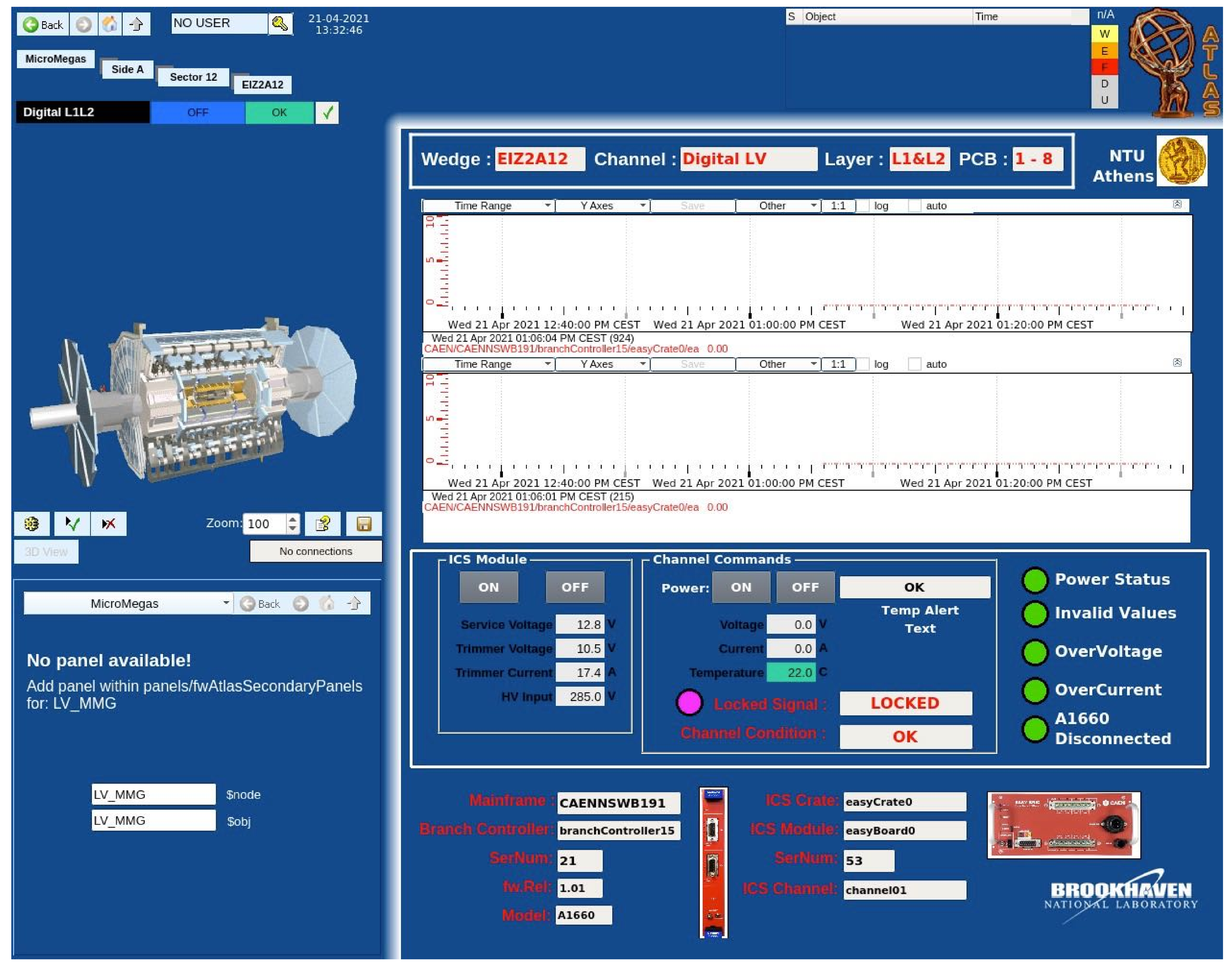

Figure 7

The Device Unit (DU) is the base of the FSM and the nodes of this type correspond to a device instance and are used to interface to it. Channel controls, monitoring and conditions can be monitored on the panel. Commands coming from their parents are translated to values, settings of the devices parameters and accordingly, the parameter's values define the node's state which propagates to the highest nodes. A Device Unit node of course cannot contain any children. In the case of the Low Voltage General FSM the DU is a NSW LV individual channel. Each channel controls, monitoring and conditions can be monitored on the panel.. The State and Status of the DU depends on the status data point element of each ICS channel and the communication validity of the OPC UA server.

The design of the ICS Controller FSM DU is based on the channel DU adjusted to accommodate the "virtual" channel error bits.