The Detector Control Power System of the Monitored Drift Tubes of the ATLAS Experiment

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TWEPP08
September 17, 2008
Naxos, Greece

Outline

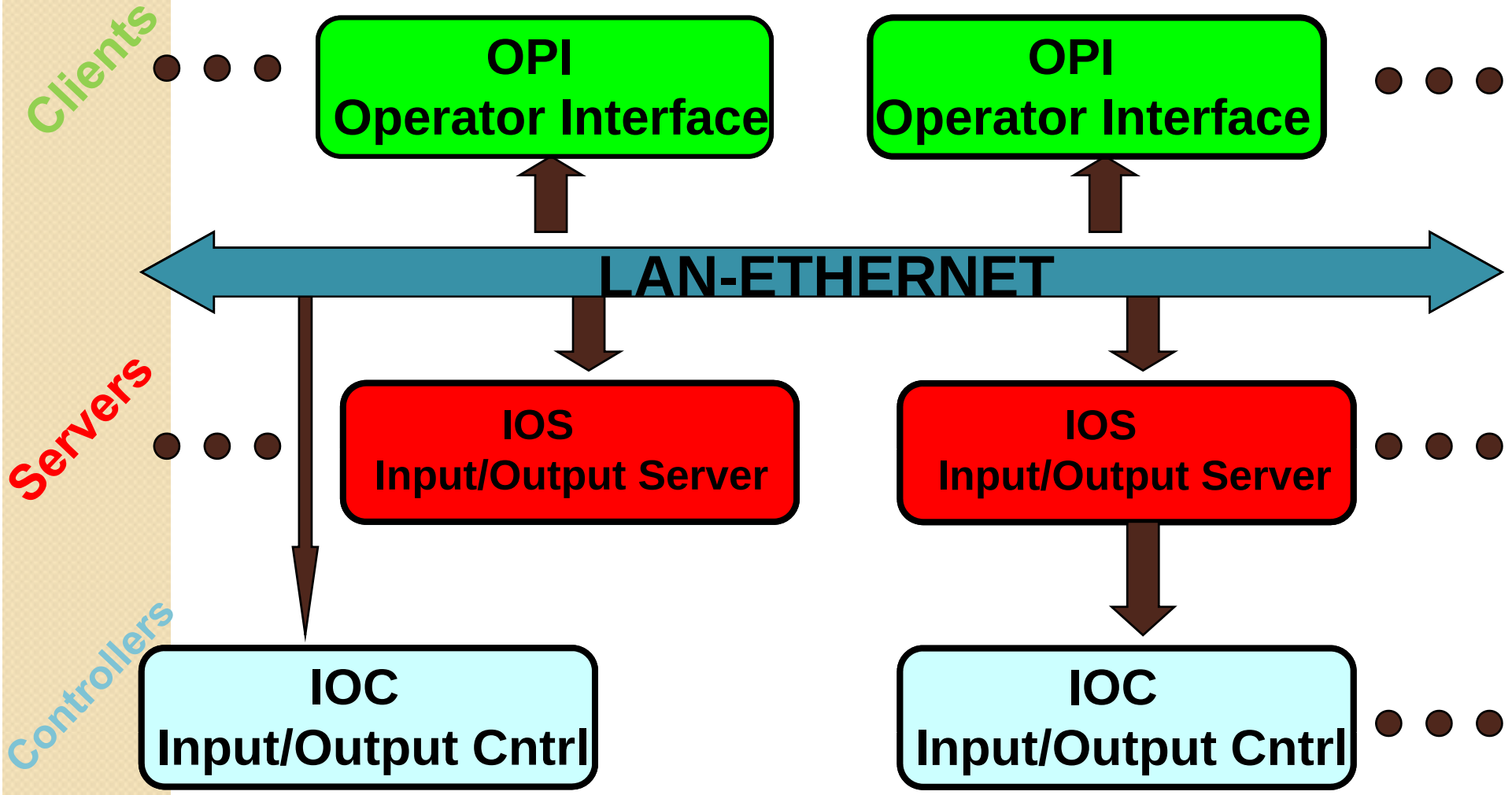
Detector Control System (DCS)

- **Introductory Remarks about DCS**
- **MDT in ATLAS Experiment**
- **Structure of DCS**
- **Power Systems for MDT**
- **Summary**

DCS - Introduction

- **Detector Control Systems**
  - Systems to control (via computers) the operation of a HEP experiment
  - Appeared in 1980's
  - Increasing Complexity of the Experiments
  - Control of a large amount of parameters
  - Check of the smooth operation of the experiment
- **Characteristics**
  - Operators don't need to be sub-detector experts
  - Operation procedures become very easy
  - Automatic Error Recovery procedures can be implemented

Standard DCS Model (Client-Server Model)

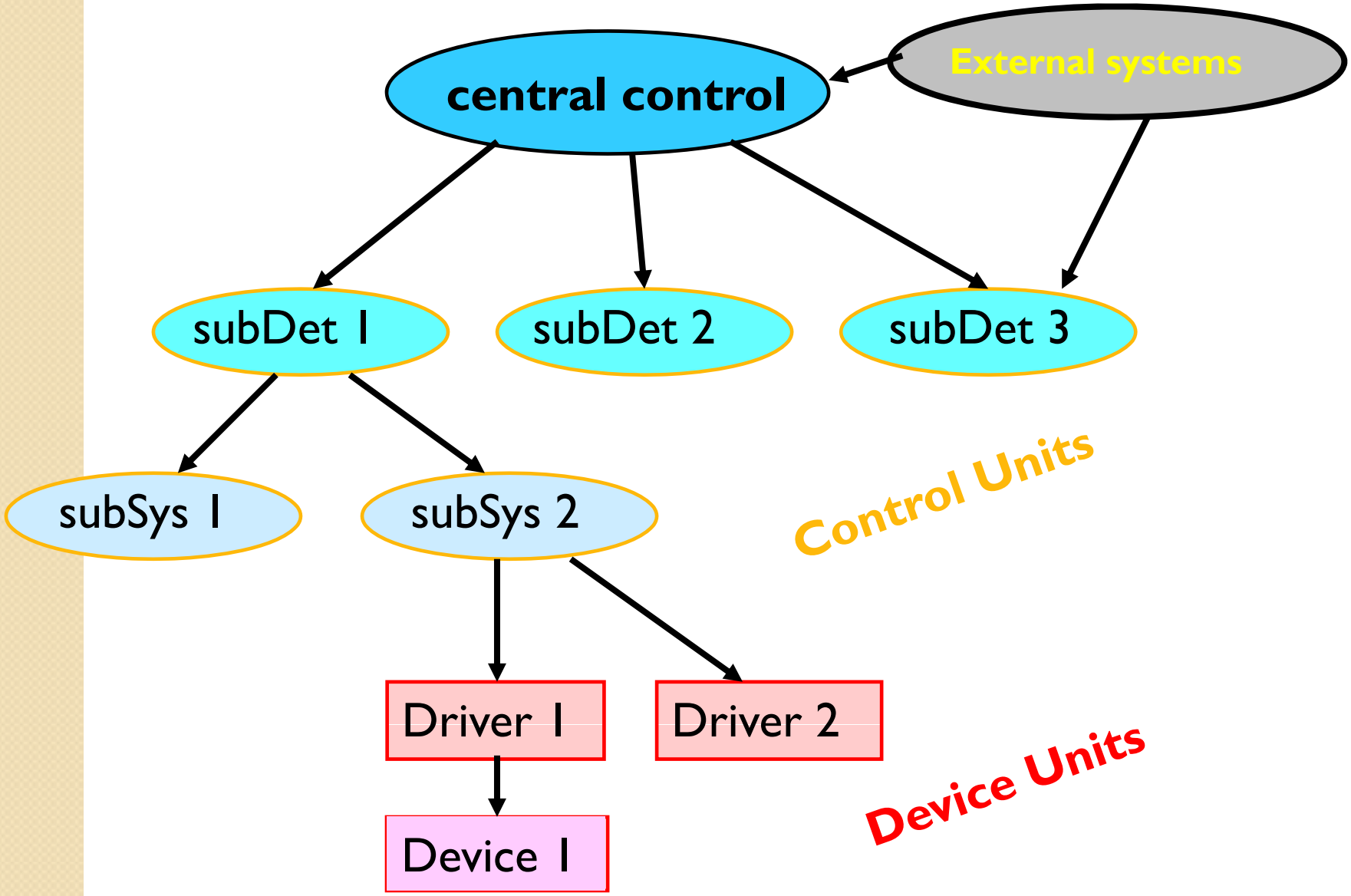


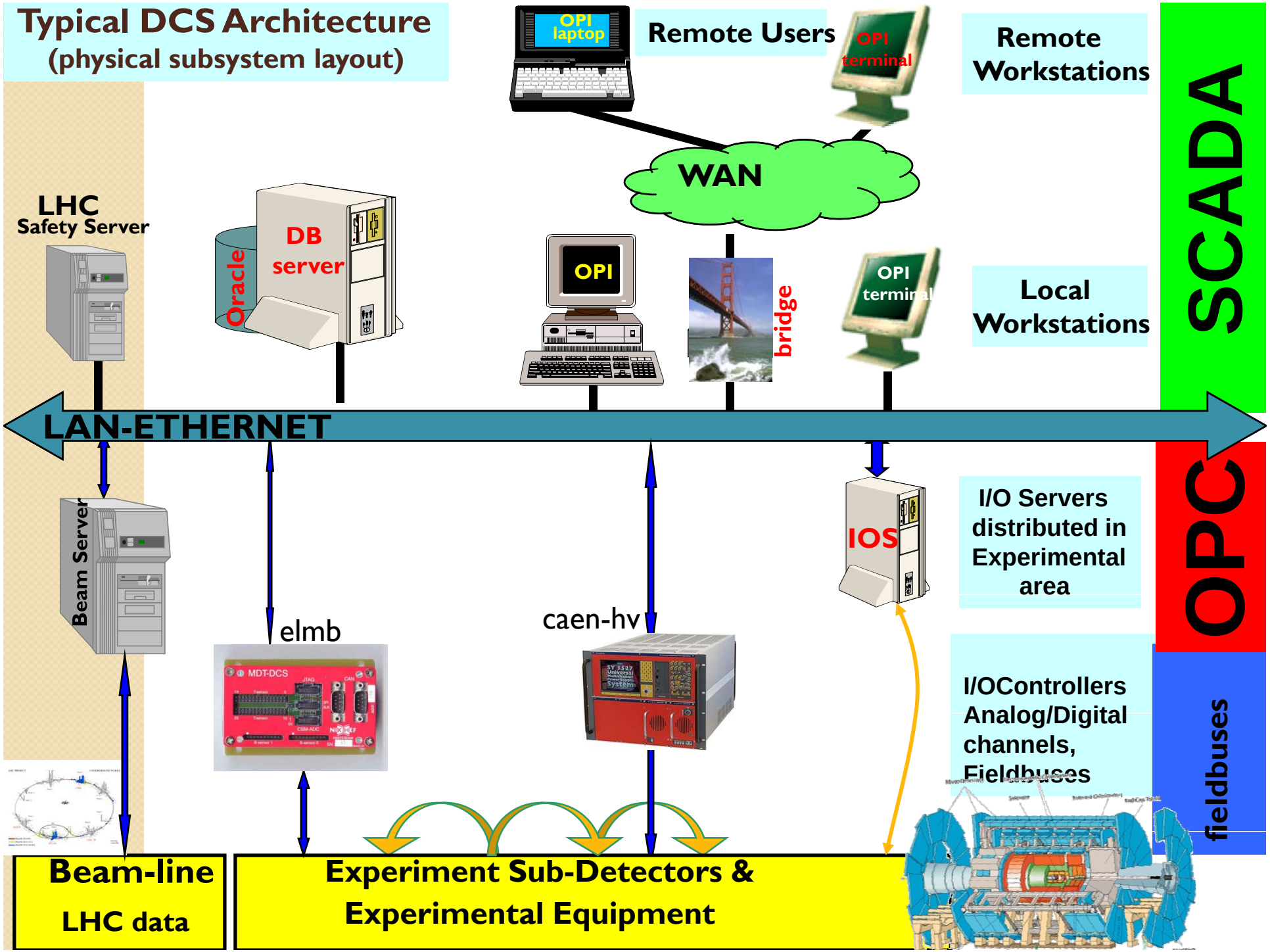
OPI: Operator Interface , IOC: Input/Output Controller, IOS: Input/Output Servers

What does DCS involve?

- Control, Configuration, Readout, Monitoring of Hardware devices
  (but not readout of event data)
- Monitoring of external systems
  (LHC, Safety, Electrical, Gas, etc)
- Communication with DAQ
- Logging of data, status, storage in database
- Implementation of Finite State Machine behavior
- Partitioning

DCS Architecture




Typical DCS Architecture
(physical subsystem layout)
OPI laptop
Remote Users
OPI terminal
Remote Workstations
SCADA
WAN
LHC
Safety Server
DB server
Oracle
OPI
bridge
OPI terminal
Local Workstations
LAN-ETHERNET
OPC
Beam Server
IOS
I/O Servers distributed in Experimental area
elmb
caen-hv
MDT-DCS
I/OControllers Analog/Digital channels, Fieldbuses
fieldbuses
Beam-line
LHC data
Experiment Sub-Detectors &
Experimental Equipment

Supervisory Control And Data Acquisition System: PVSS

Commercial product PVSSII from ETM, Austria

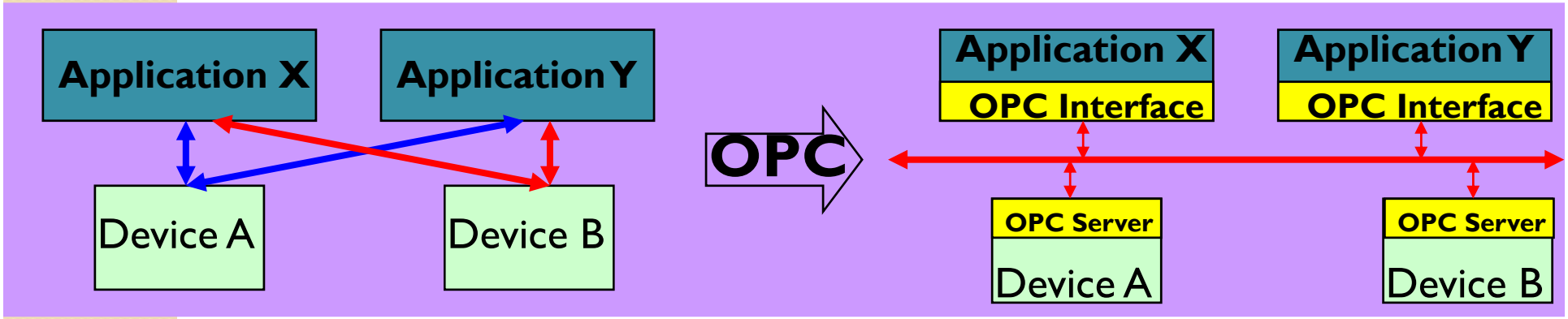
LHC wide decision

- **Can be distributed over many stations**
- **Flexible and open architecture**
- **Basic functions for automatisation**
- **Standardized interface to the hardware**
- **Application programming interfaces**

What is OPC?

- OPC defines a standard to interface programs (SCADA, HMI) and hardware devices in a control system.
- OPC provides a multi-vendor interoperability.

No more specific drivers needed for each client



- OPC (OLE for Process Control) is based on the MS object model COM/DCOM (Component Object Model).
- OPC includes 3 interface specifications:
  - ⇨ Data Access
  - ⇨ Alarm and Event Handling
  - ⇨ Historical Data Access

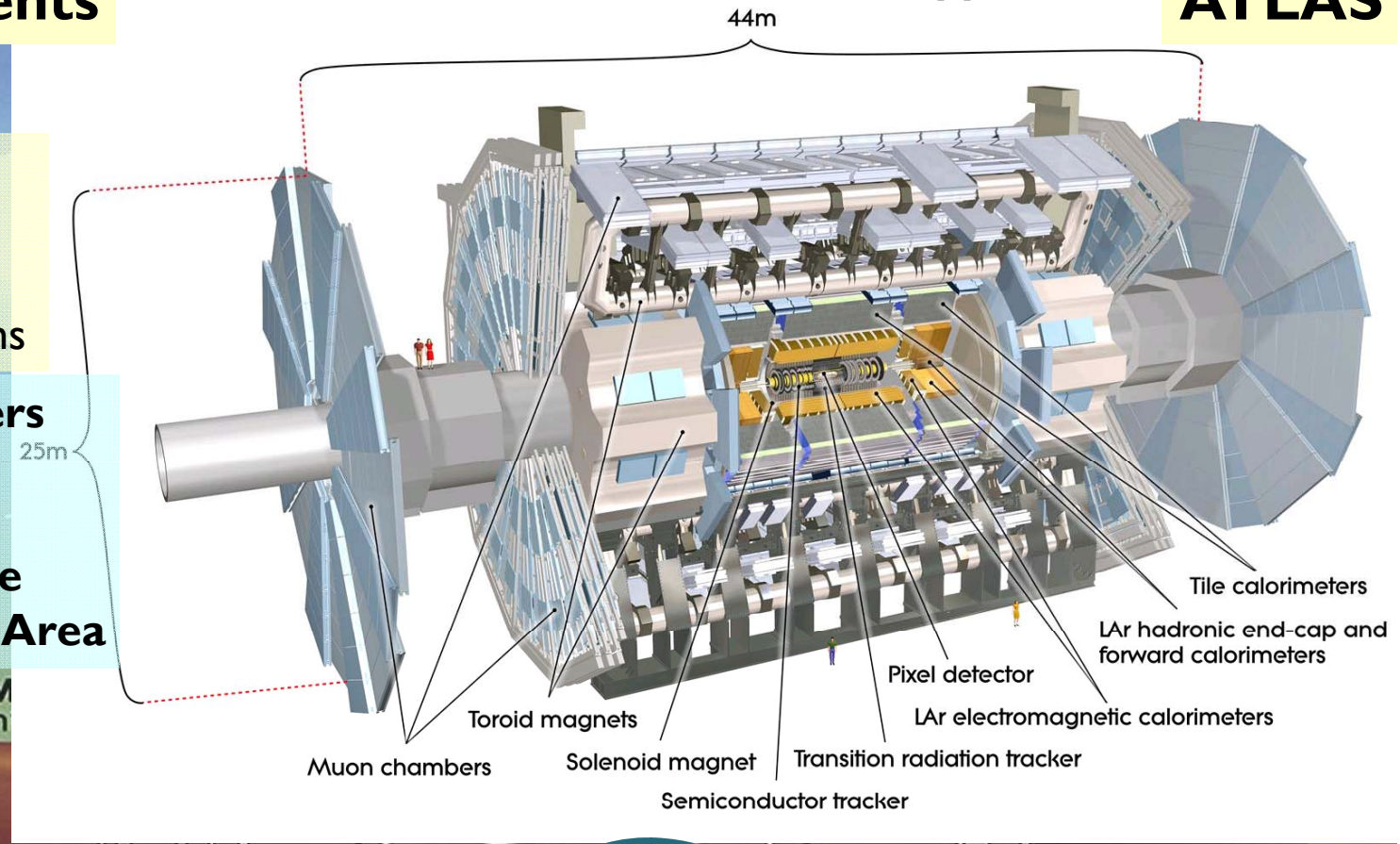
LHC Experiments

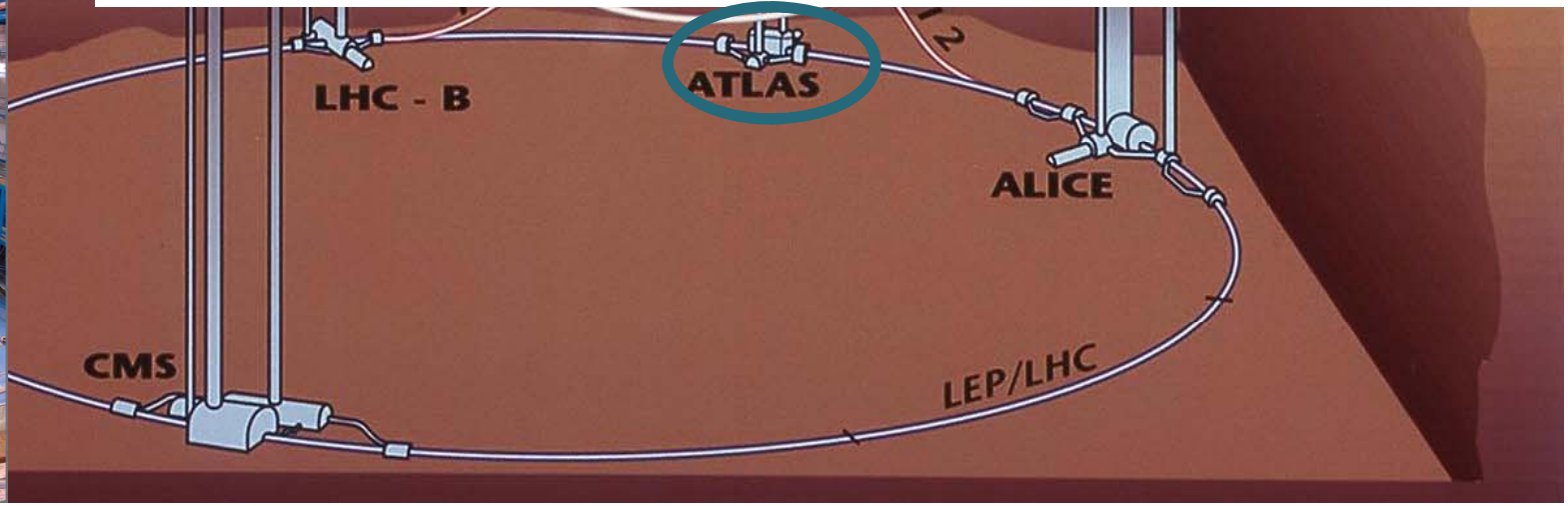
A **Toroidal** LHC **ApparatuS**

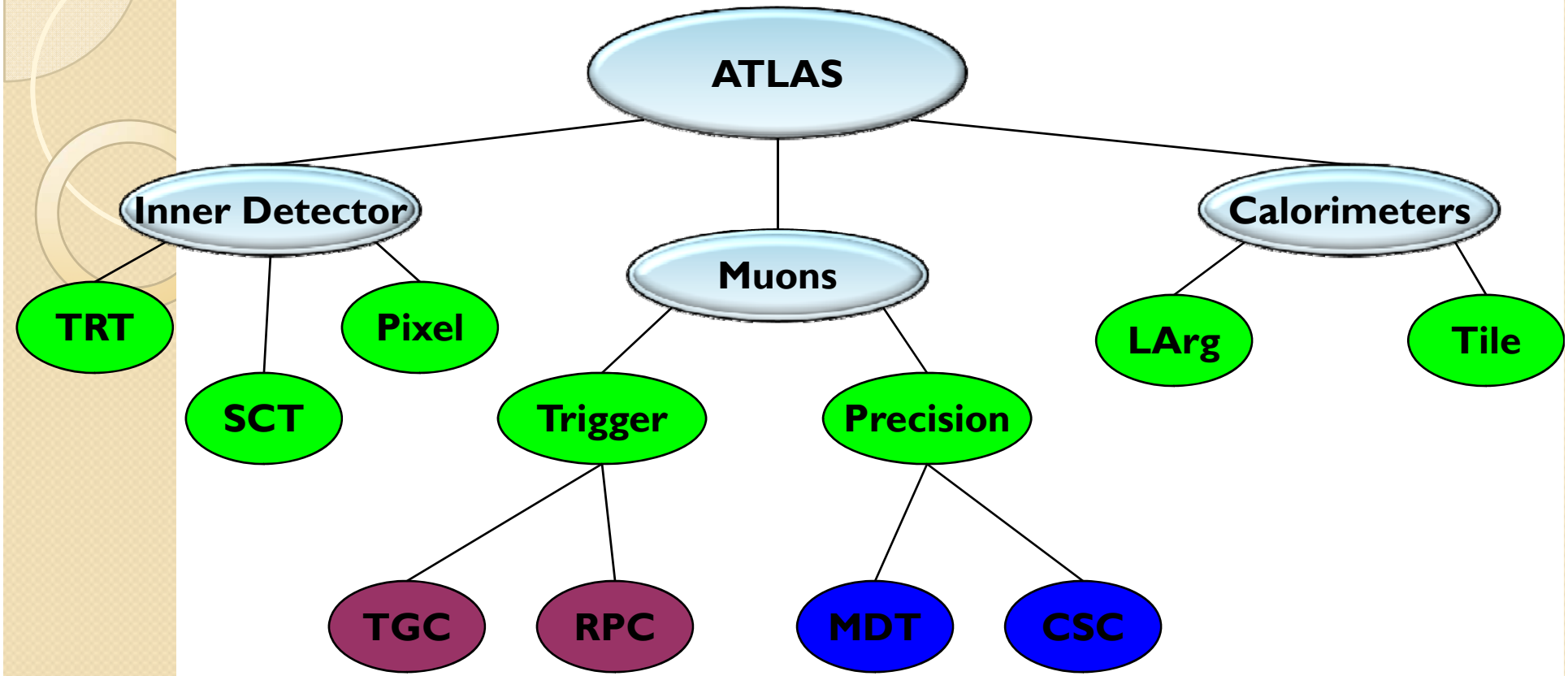
ATLAS

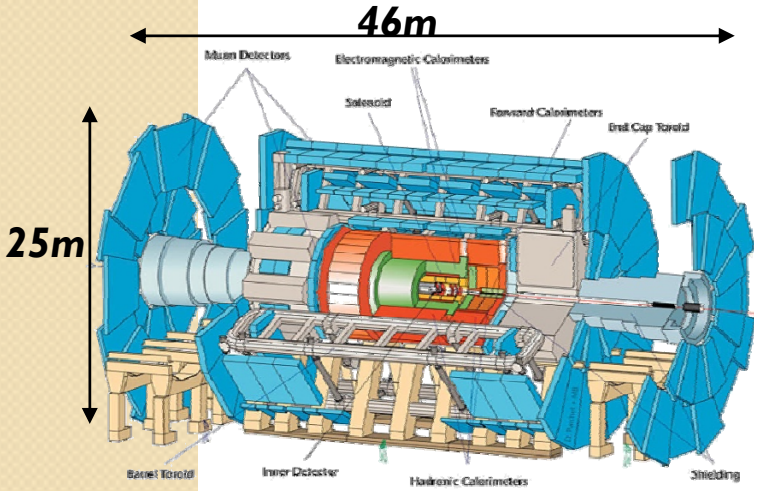
Diameter: 25 m
Length: 44 m
Weight: 7 kT
~100 M electronic chs

1150 MDT chambers
354 384 Tubes
214 Tonnes
725 m³ Gas Volume
5520 m² Chamber Area



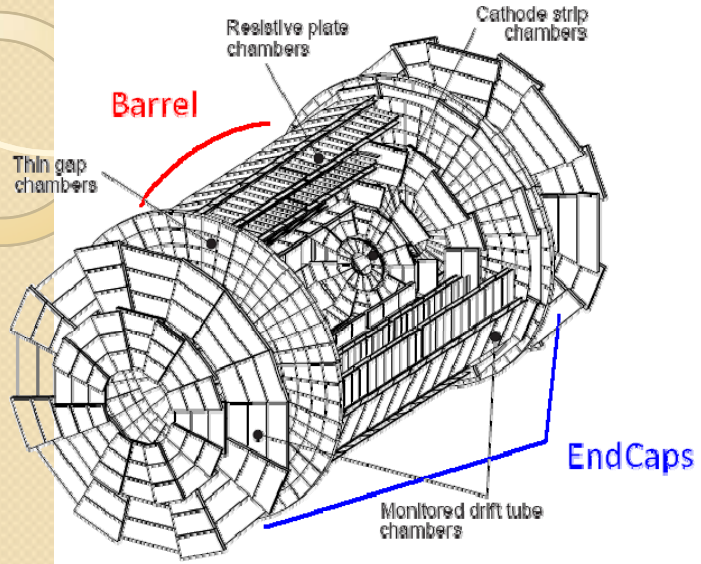




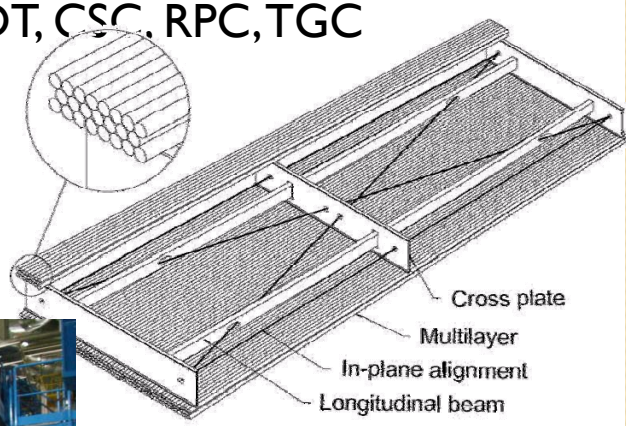


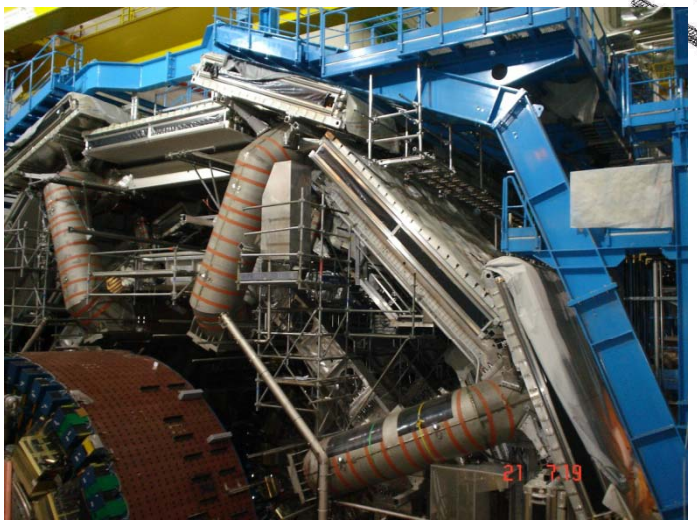
TRT: Transition Radiation Detector
SCT: Silicon Central Tracker
TGC: Thin Gap Chamber
RPC: Resistive Pad Chamber
MDT: Monitored Drift Tubes
CSC: Cathode Strip Chamber

Muon Spectrometer



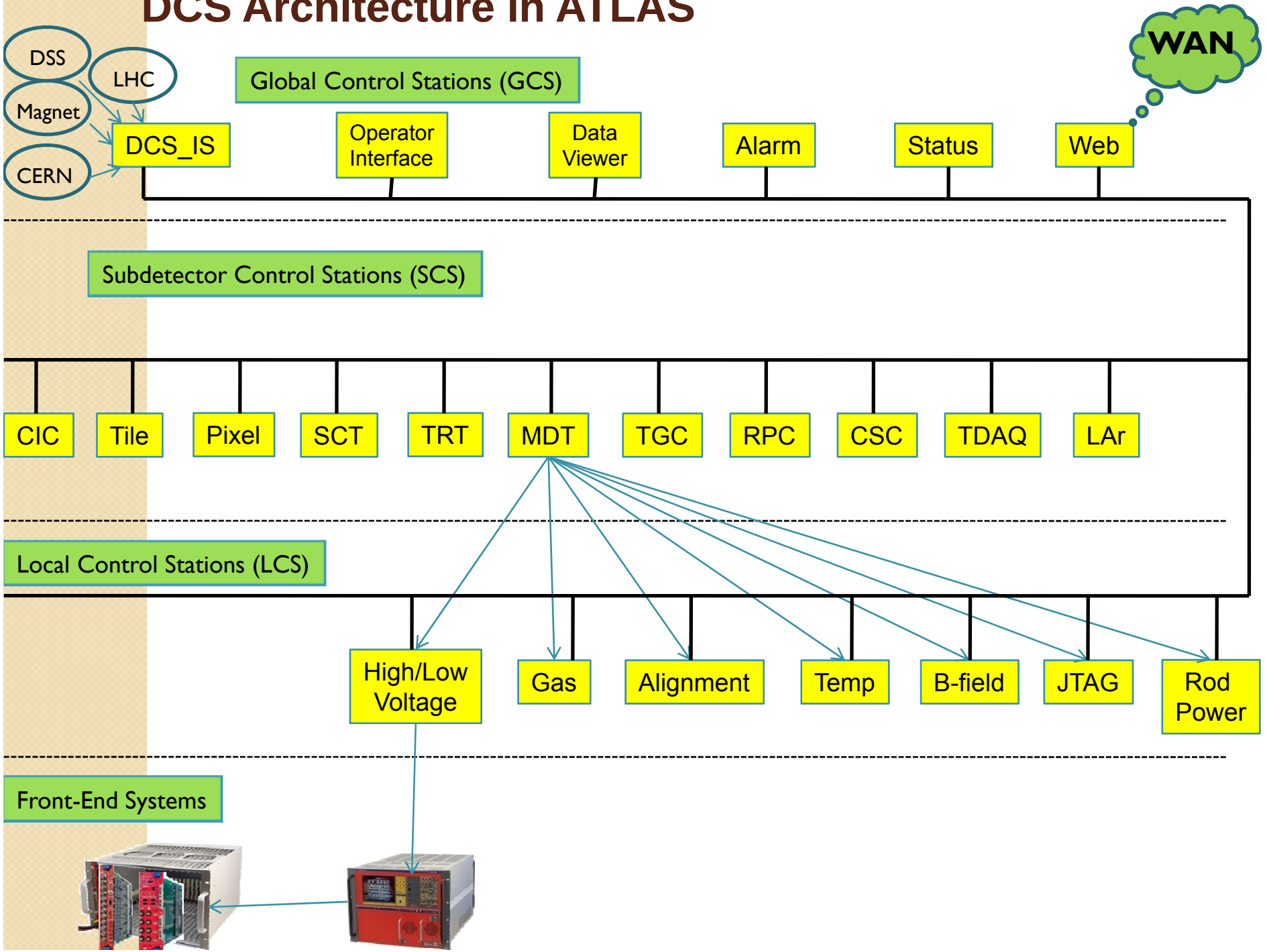
- Two Basic parts
  Barrel και EndCap:
  - Barrel: 3 cylinders (inner-middle-outer)
  - EndCap: 3 disks
- Chambers: MDT, CSC, RPC, TGC



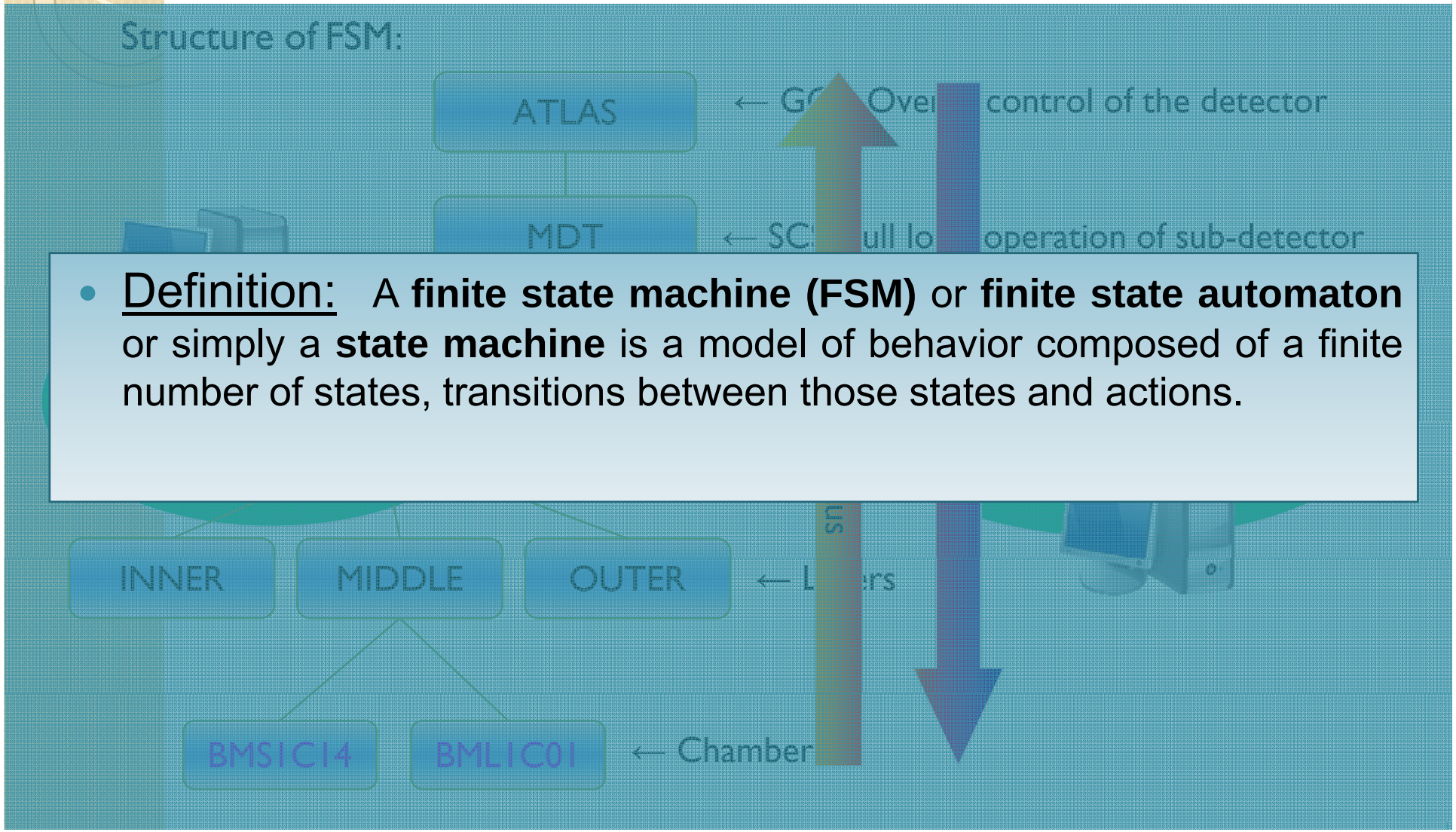


1150 MDT chambers
354 384 Tubes
214 Tones
725 m³ Gas Volume
5520 m³ Chamber Area

DCS Architecture in ATLAS



Finite States Machine (FSM)

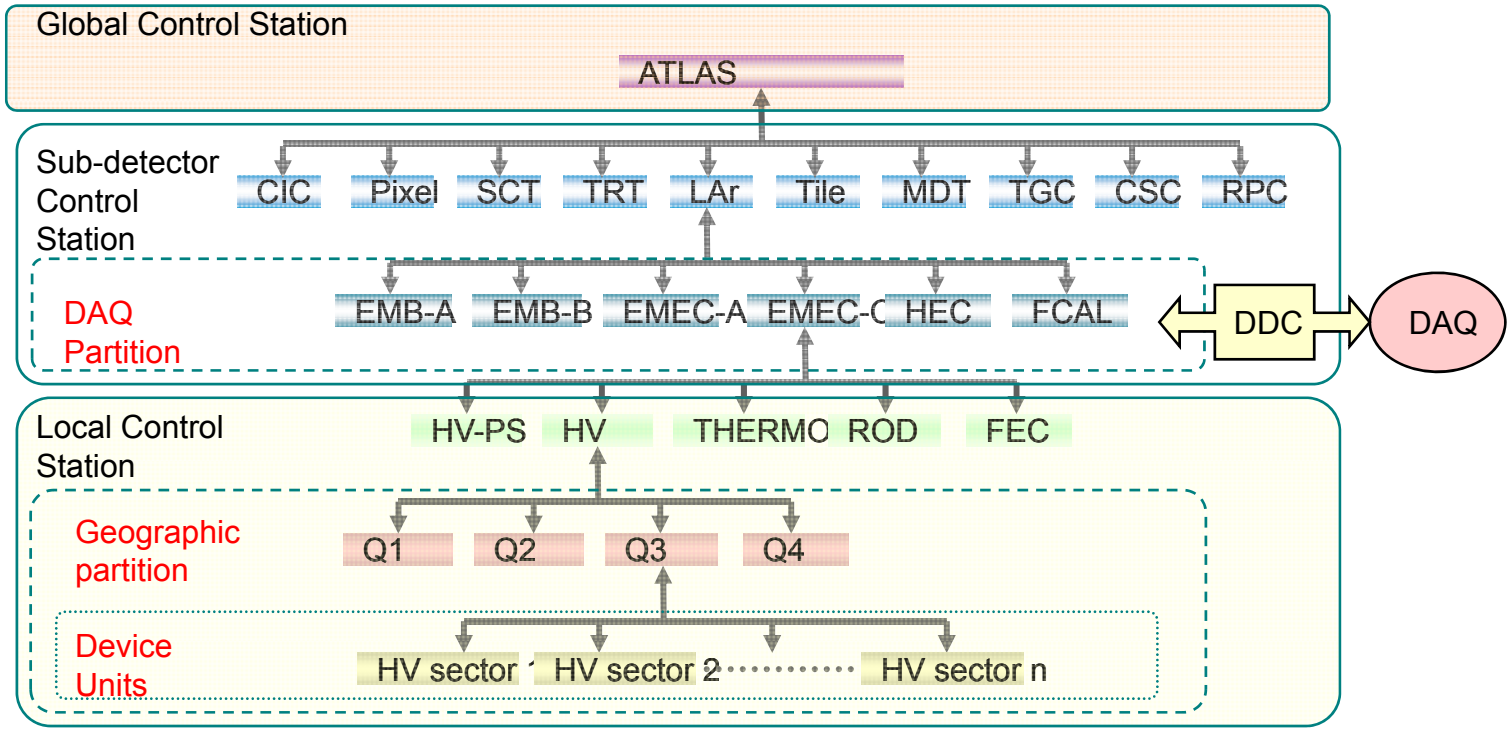


- Definition: A **finite state machine (FSM)** or **finite state automaton** or simply a **state machine** is a model of behavior composed of a finite number of states, transitions between those states and actions.

Operator Interface

Finite State Machine (FSM) Architecture

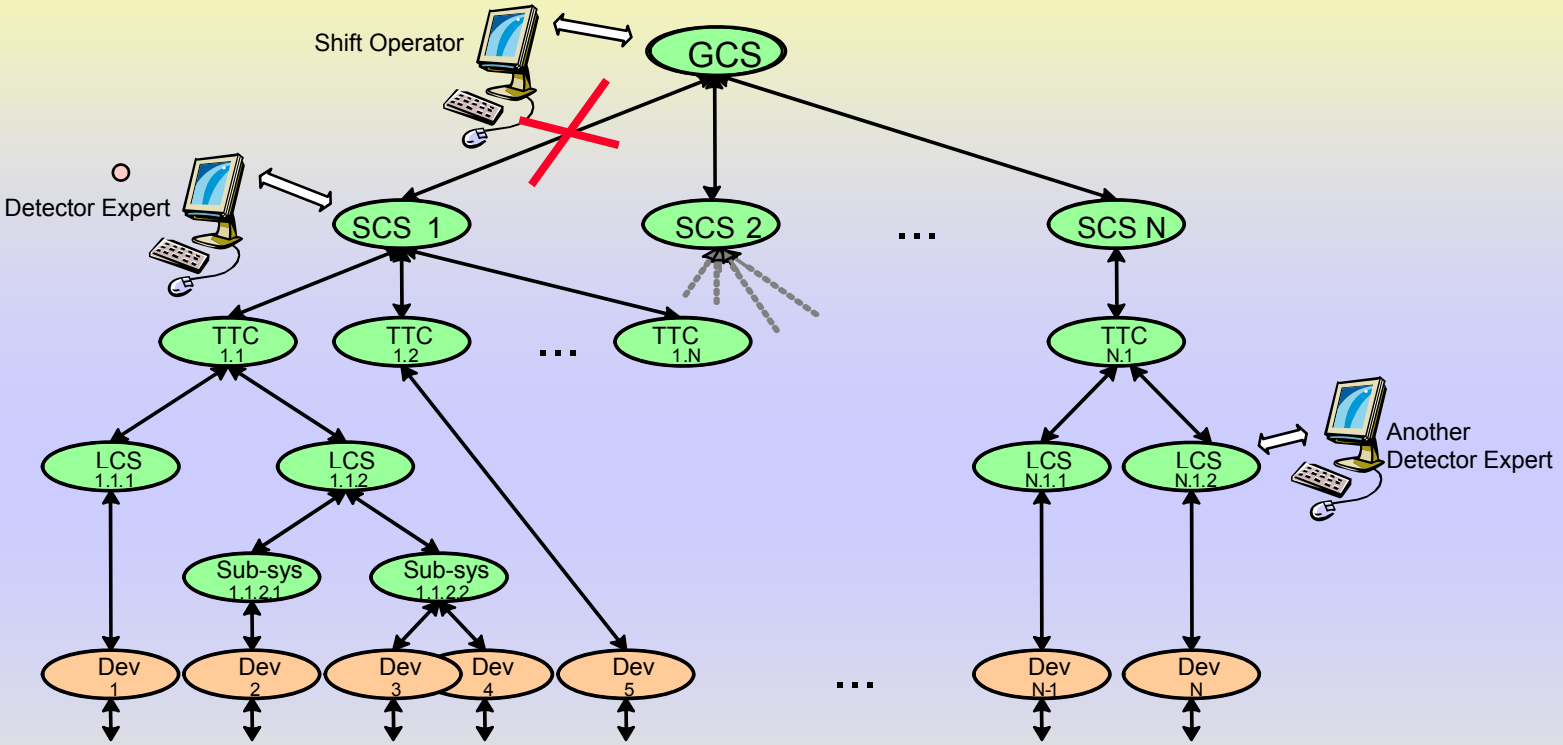
- The FSM (part of the JCOP Framework) is the main tool for the implementation of the full control hierarchy in ATLAS DCS
- It is envisaged that the shift operators will operate DCS ONLY through the Operator Interface (based on the FSM) and the PVSS alarm screen



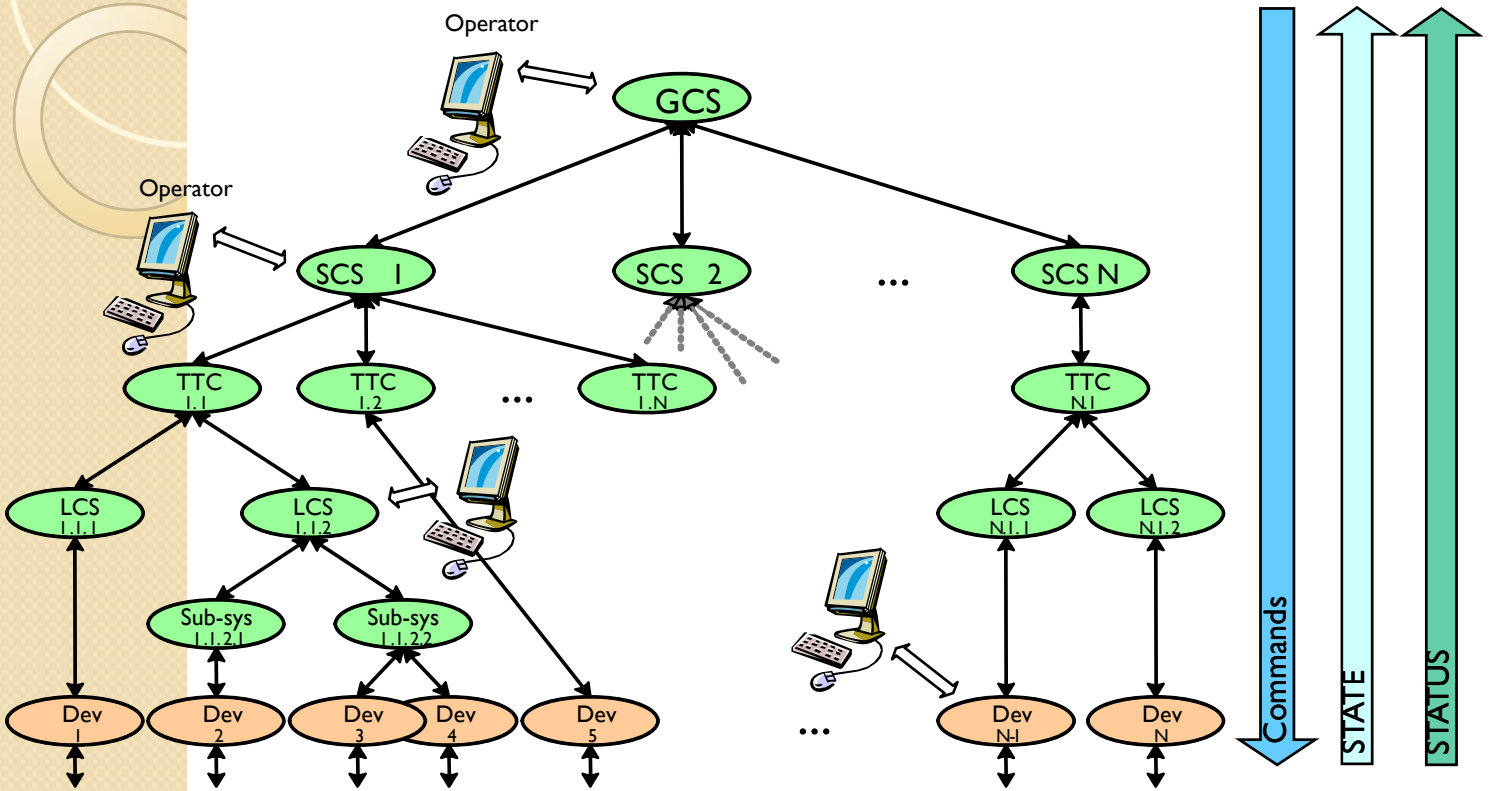
JCOP: Joint Controls Project

Operator Interface
FSM (Partitioning)

ATLAS
DCS



Operator Interface
FSM (STATE and STATUS)



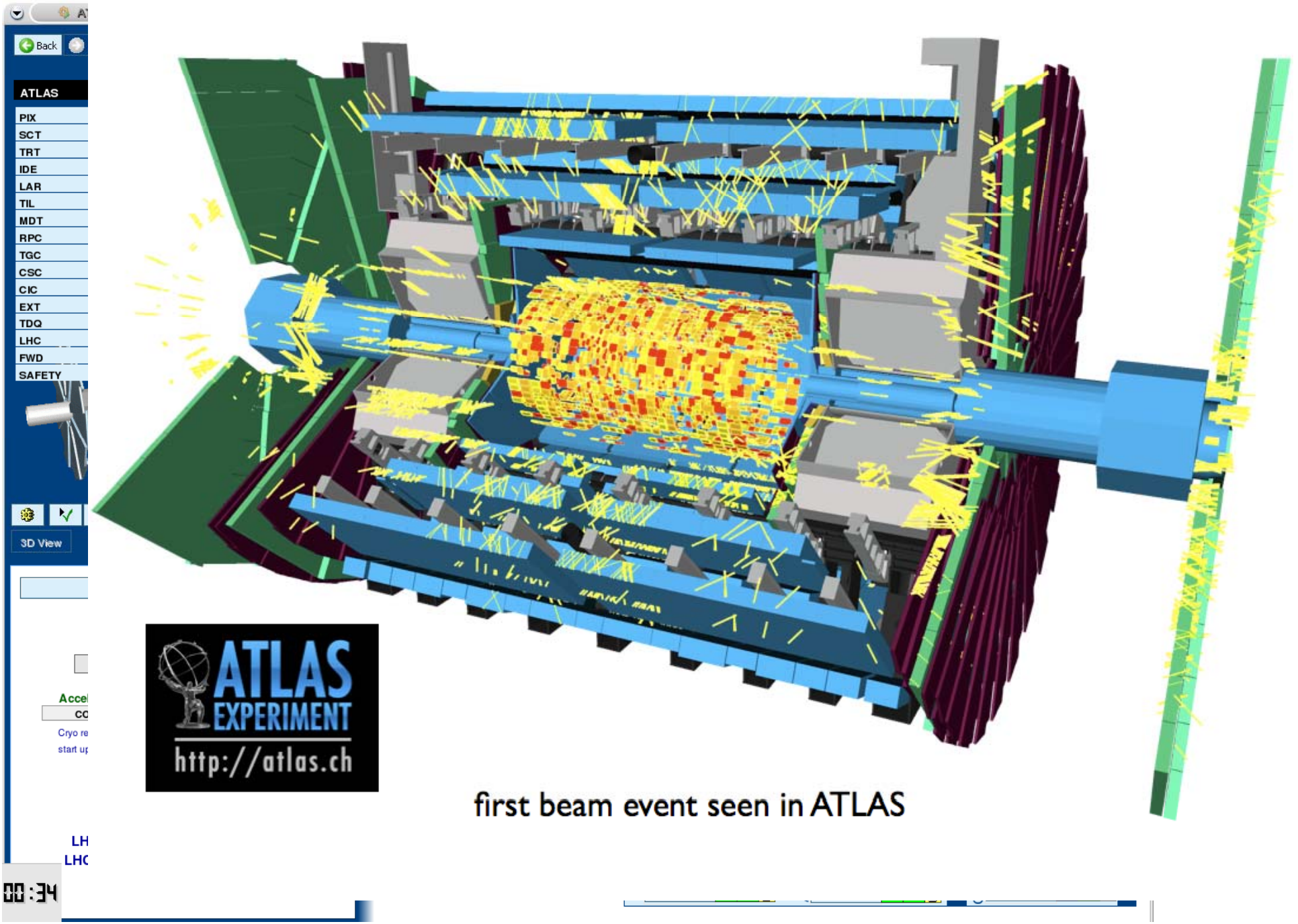
STATE
READY
NOT_READY
ON
STANDBY
RAMP_UP
….to be defined by the user

STATUS	
OK	System works fine
WARNING	Low severity. System can go on working.
ALARM	High severity. Serious error to be fixed ASAP
FATAL	Very high severity. The system cannot work.

Messages via a double Information Path – STATE & STATUS

- STATE defines the operational mode of the system (ON, OFF, etc)
- STATUS defines how well the system is working (OK, WARNING, ALARM, FATAL)
- Two parallel information paths. E.g. HV system is in RAMPING_UP state (which takes several minutes) and an error triggers. The error is propagated through the STATUS while keeping the same STATE

ATLAS DCS at First Beam Events



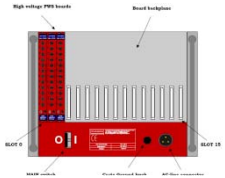
CAEN Power Supplies modules

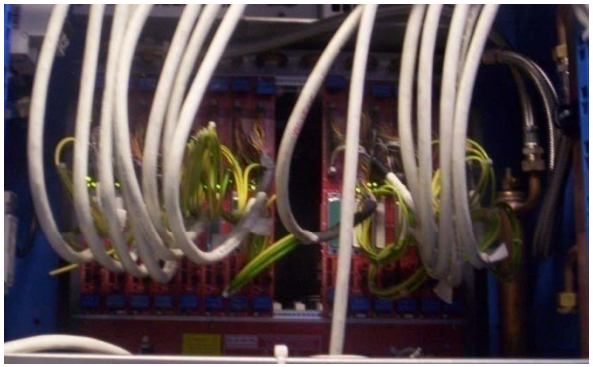
Mainframe
CAEN SY1527

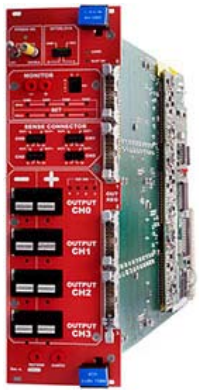
Branch Controllers
A1676

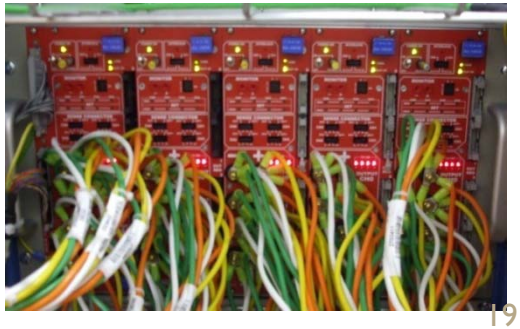
Crates

Boards
LV: A3025
& A3016
HV: A3540P

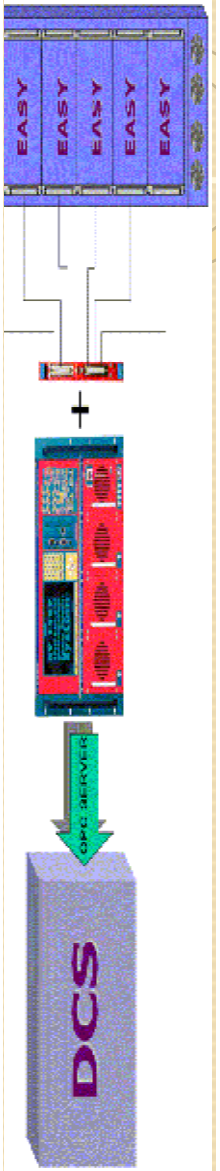








Structure of MDT PS



Eltx Room

SY1527 System mainframe

Branch Controller

Power Fail Use Interrupt

Control Bus

Power Line

P. Service Line

Experiment Area

Control Logic

Easy Module

Control Logic

Easy Module

64 Crates

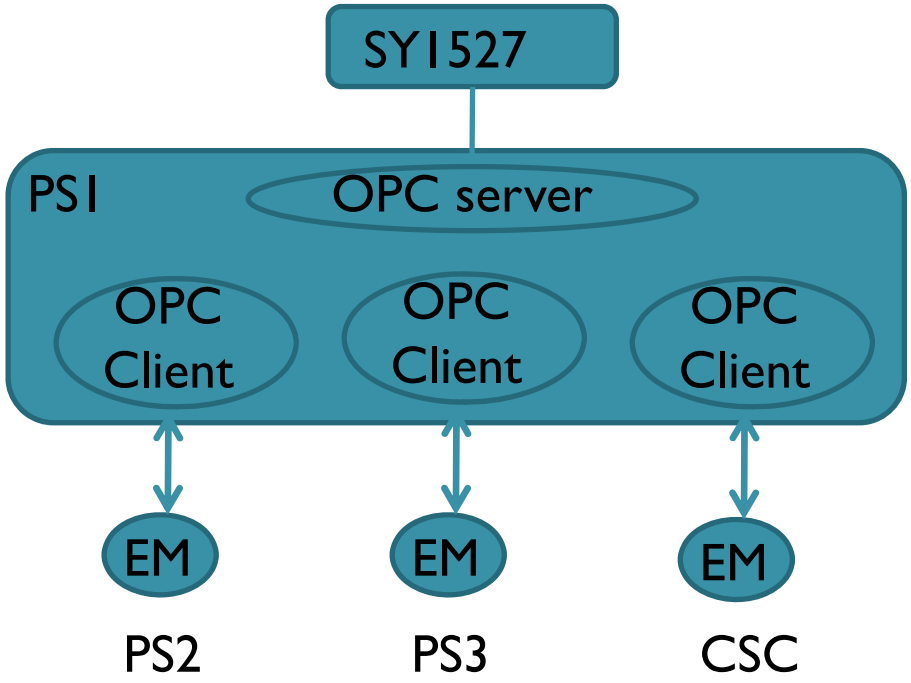
48V Power Source

48V Power Source

48V Backup Battery

PS OPC server

- Run a single OPC server on PS1 pc (scattered system)
- PS2 Barrel System
- PS3 EndCap System



PVSS datapoints

- Datapoints that correspond to hardware modules (channels, boards, crates, branch controllers, mainframe)
- Datapoints that correspond to the chambers
- Internal datapoints
  - ✓ for the FSM
  - ✓ for the OPC Server (communication with hardware)
  - ✓ for the RDB manager (archiving of datapoint elements)

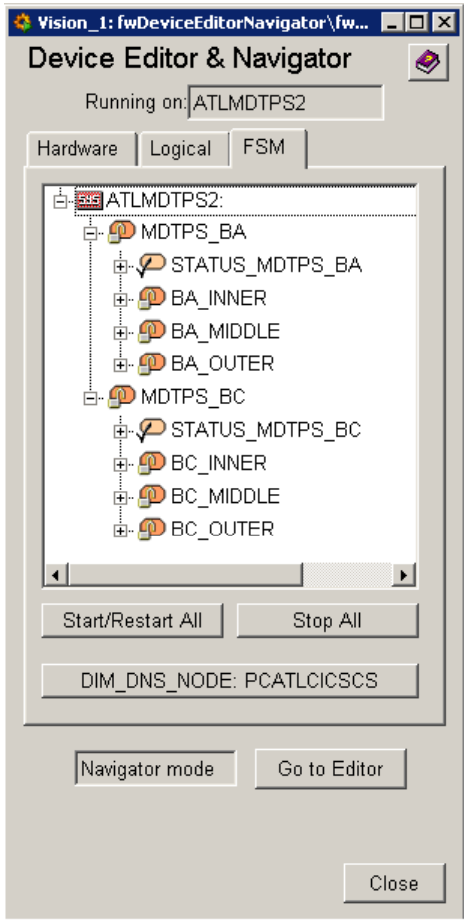
Alarms are activated for the datapoints and their elements

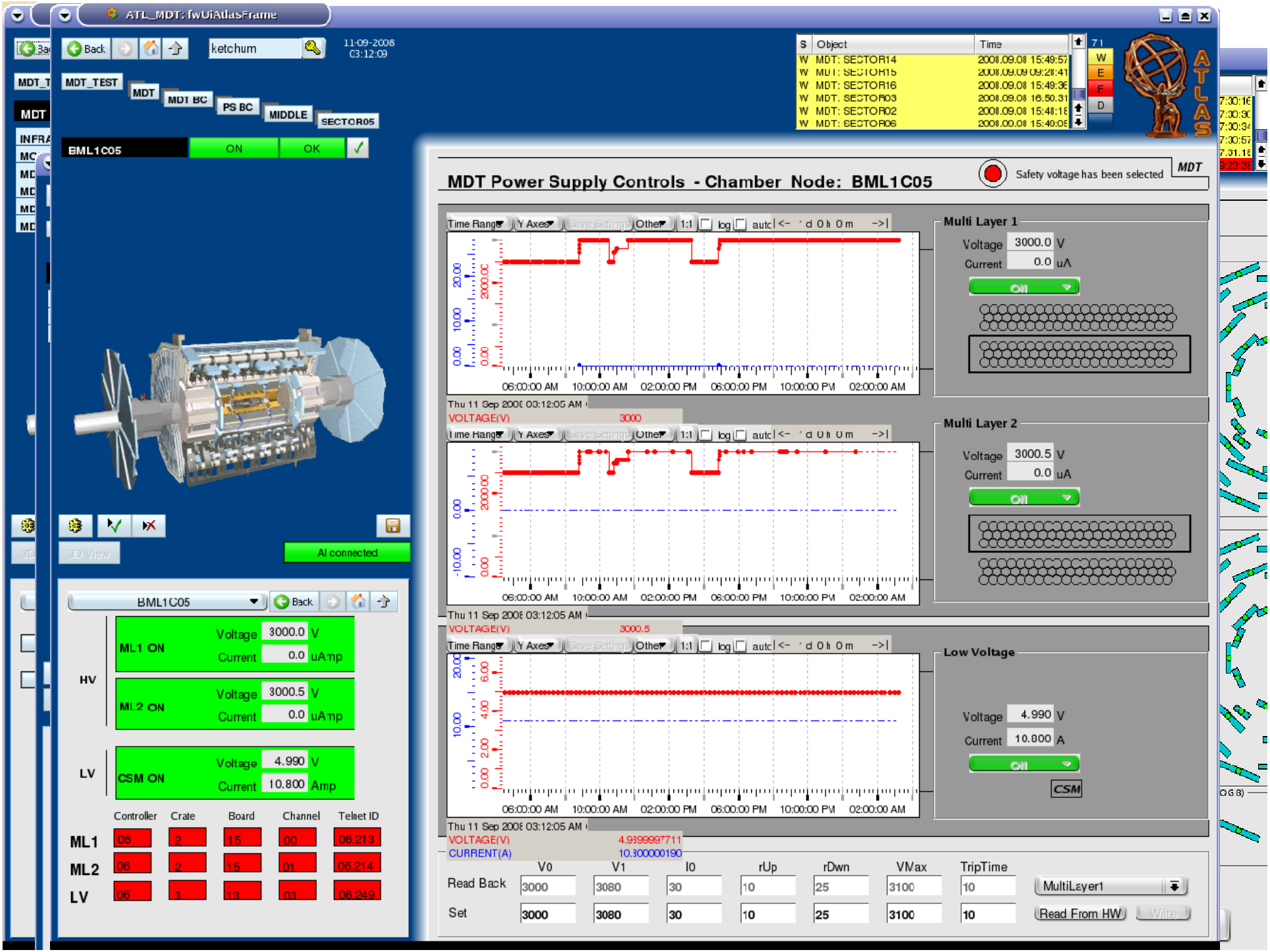
FSM trees

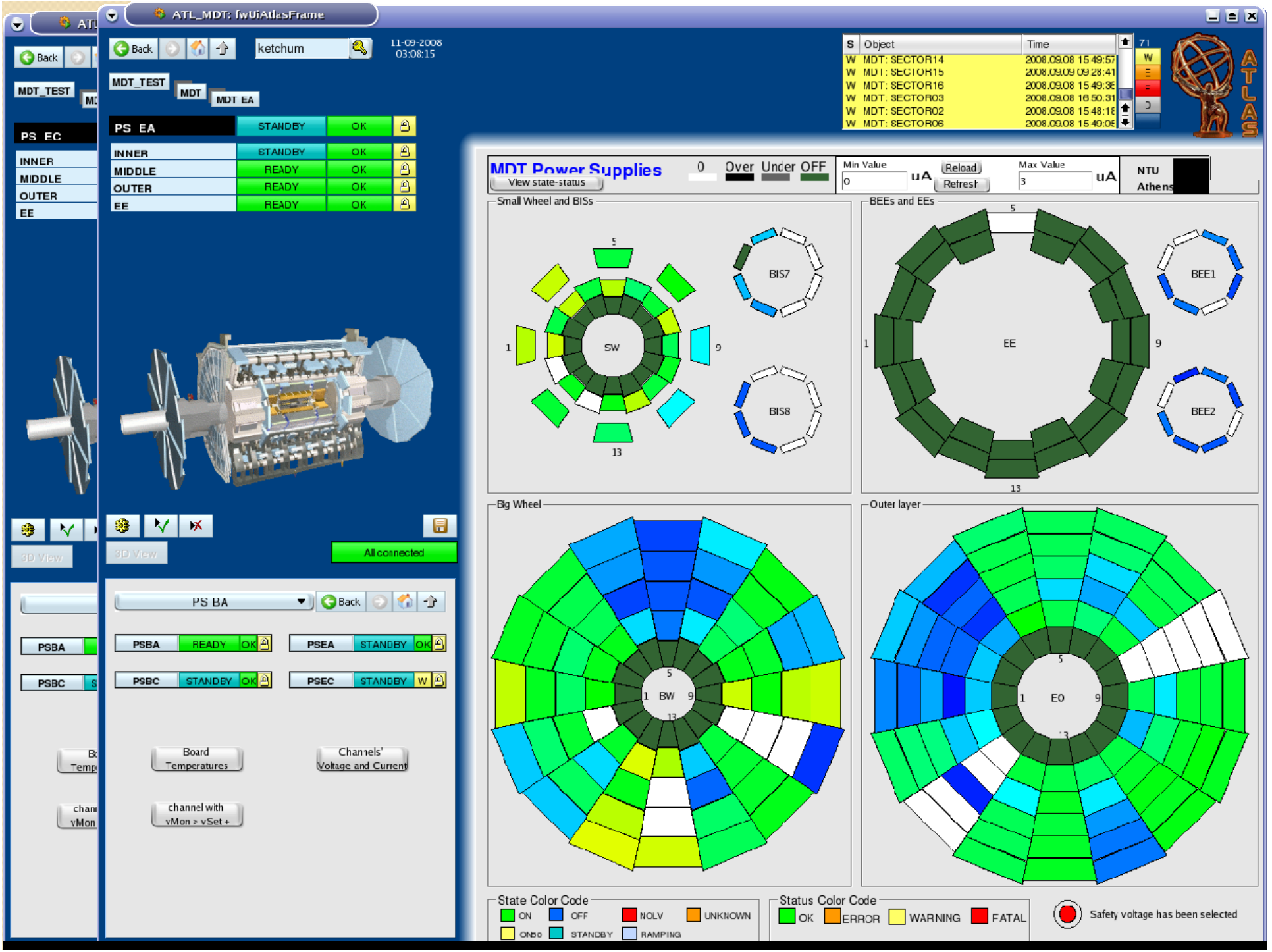
- One FSM tree is implemented for each partition

- Hierarchy is set for the parts of the system (nodes and their children)

- Commands and states propagate correctly



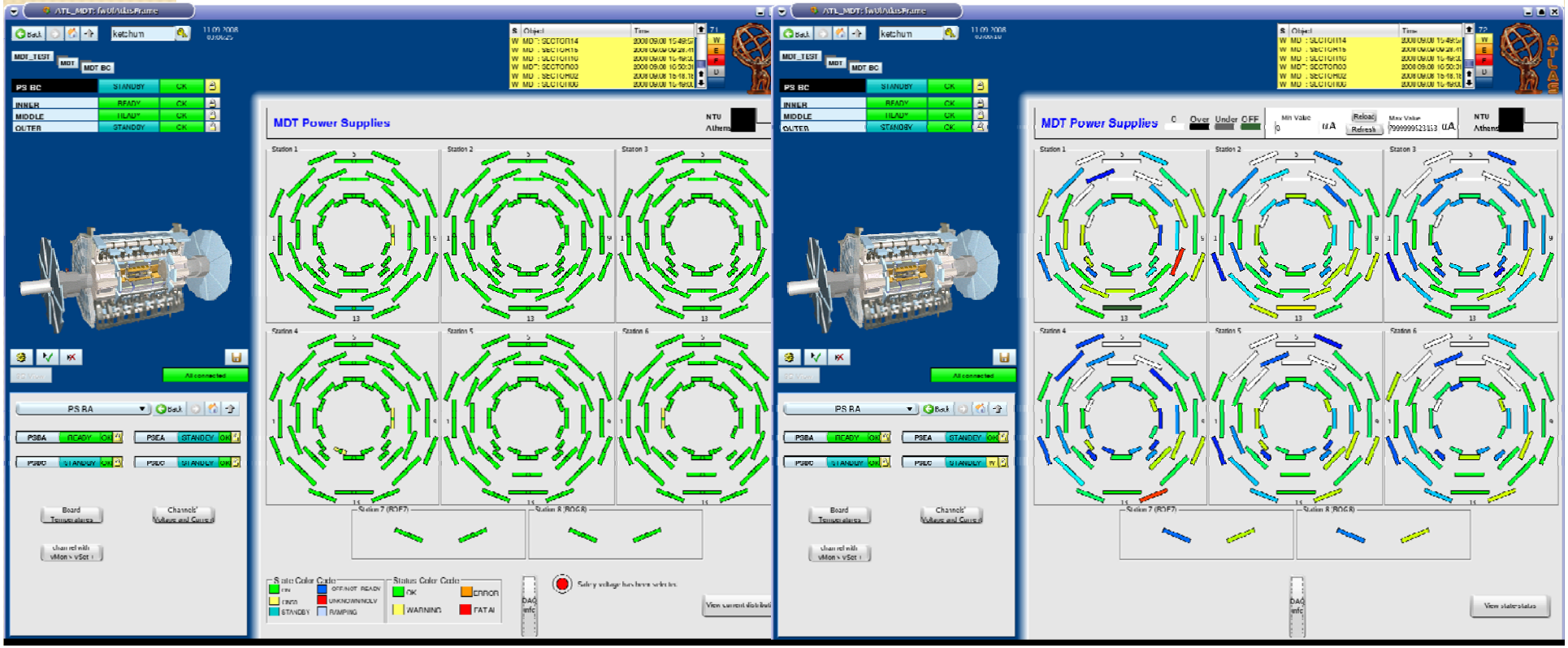

ATL_MDT: fwUiAtlasFrame
Back
ketchum
11-09-2008
03:12:09
MDT_TEST
MDT
MDT BC
PS BC
MIDDLE
SECTOR05
BML1C05
ON
OK
AI connected
S Object Time
W MDT: SECTOR14 2008.09.08 15:49:57
W MDT: SECTOR15 2008.09.09 09:28:41
W MDT: SECTOR16 2008.09.08 15:49:36
W MDT: SECTOR03 2008.09.08 16:50:31
W MDT: SECTOR02 2008.09.08 15:48:18
W MDT: SECTOR06 2008.09.08 15:40:05
W
E
F
D
ATLAS
MDT Power Supply Controls - Chamber Node: BML1C05
Safety voltage has been selected
MDT
Time Range
Y Axes
Save Settings
Other
log
auto
06:00:00 AM
10:00:00 AM
02:00:00 PM
06:00:00 PM
10:00:00 PM
02:00:00 AM
Thu 11 Sep 2008 03:12:05 AM
VOLTAGE(V) 3000
VOLTAGE(V) 3000.5
CURRENT(A) 4.9899997711
CURRENT(A) 10.300000190
Multi Layer 1
Voltage 3000.0 V
Current 0.0 uA
Multi Layer 2
Voltage 3000.5 V
Current 0.0 uA
Low Voltage
Voltage 4.990 V
Current 10.800 A
CSM
BML1C05
Back
HV
ML1 ON
Voltage 3000.0 V
Current 0.0 uAmp
ML2 ON
Voltage 3000.5 V
Current 0.0 uAmp
LV
CSM ON
Voltage 4.990 V
Current 10.800 Amp
Controller Crate Board Channel Telnet ID
ML1 06 2 15 00 06.213
ML2 06 2 15 01 06.214
LV 06 3 13 03 06.249
V0 V1 I0 rUp rDwn VMax TripTime
Read Back 3000 3080 30 10 25 3100 10
Set 3000 3080 30 10 25 3100 10
MultiLayer1
Read From HW
Write


ATL_MDT: fwUiAtlasFrame
Back
ketchum
11-09-2008
03:08:15
MDT_TEST
MDT
MDT EA
PS EA
STANDBY
OK
INNER
MIDDLE
OUTER
EE
READY
3D View
All connected
PS BA
PSBA
PSEA
PSBC
PSEC
Board Temperatures
Channels' Voltage and Current
channel with vMon > vSet +
S
Object
Time
W MDT: SECTOR14 2008.09.08 15:49:57
W MDT: SECTOR16 2008.09.08 15:49:3
W MDT: SECTOR03 2008.09.08 16:50:31
W MDT: SECTOR02 2008.09.08 15:48:18
W MDT: SECTOR06 2008.09.08 15:40:05
MDT Power Supplies
View state-status
Over
Under
OFF
Min Value
Max Value
Reload
Refresh
uA
NTU Athens
Small Wheel and BISs
SW
BIS7
BIS8
BEEs and EEs
EE
BEE1
BEE2
Big Wheel
BW
Outer layer
EO
State Color Code
ON
OFF
NOLV
UNKNOWN
STANDBY
RAMPING
Status Color Code
OK
ERROR
WARNING
FATAL
Safety voltage has been selected

Present status of PS system

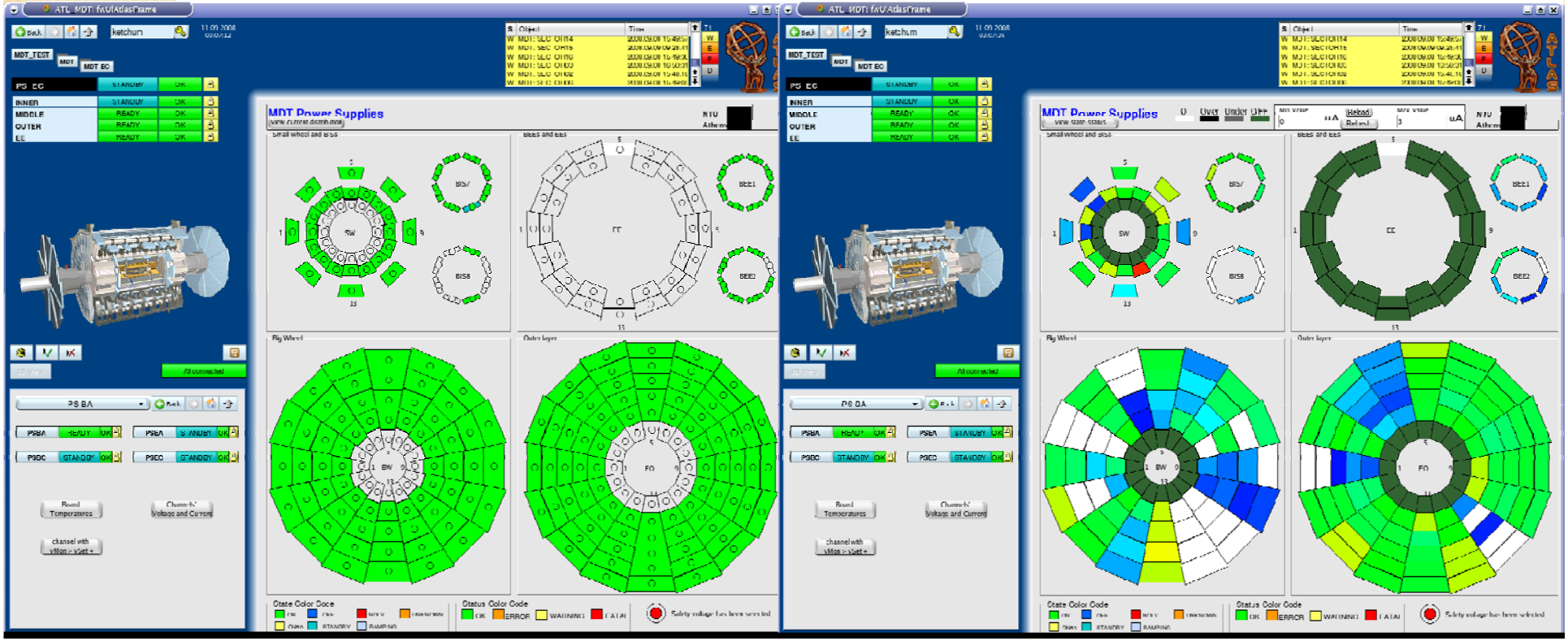
Barrel

- All chambers are incorporated in the system having LV modules
- HV modules for all chambers in all sectors



Endcaps

- Both Big Wheels and Small Wheels (one for each side) are incorporated to the system having both LV and HV modules



Summary

- **ATLAS PS MDT DCS is a Robust System**
- **Is being used…**
- **Delivered & Tested on Time**

Members of ATLAS NTU-Athens DCS group:
T. Alexopoulos, T. Argyropoulos, E. Gazis,
E. Mountricha, C. Tsarouchas, G. Tsipolitis

Ex-members
M. Bachtis, A. Iliopoulos