Detector Control System

DCS Workshop

J. Varela, April 3rd 2006

Outline

1. Architecture
2. Components
3. Integration
4. Organization and plans

Architecture

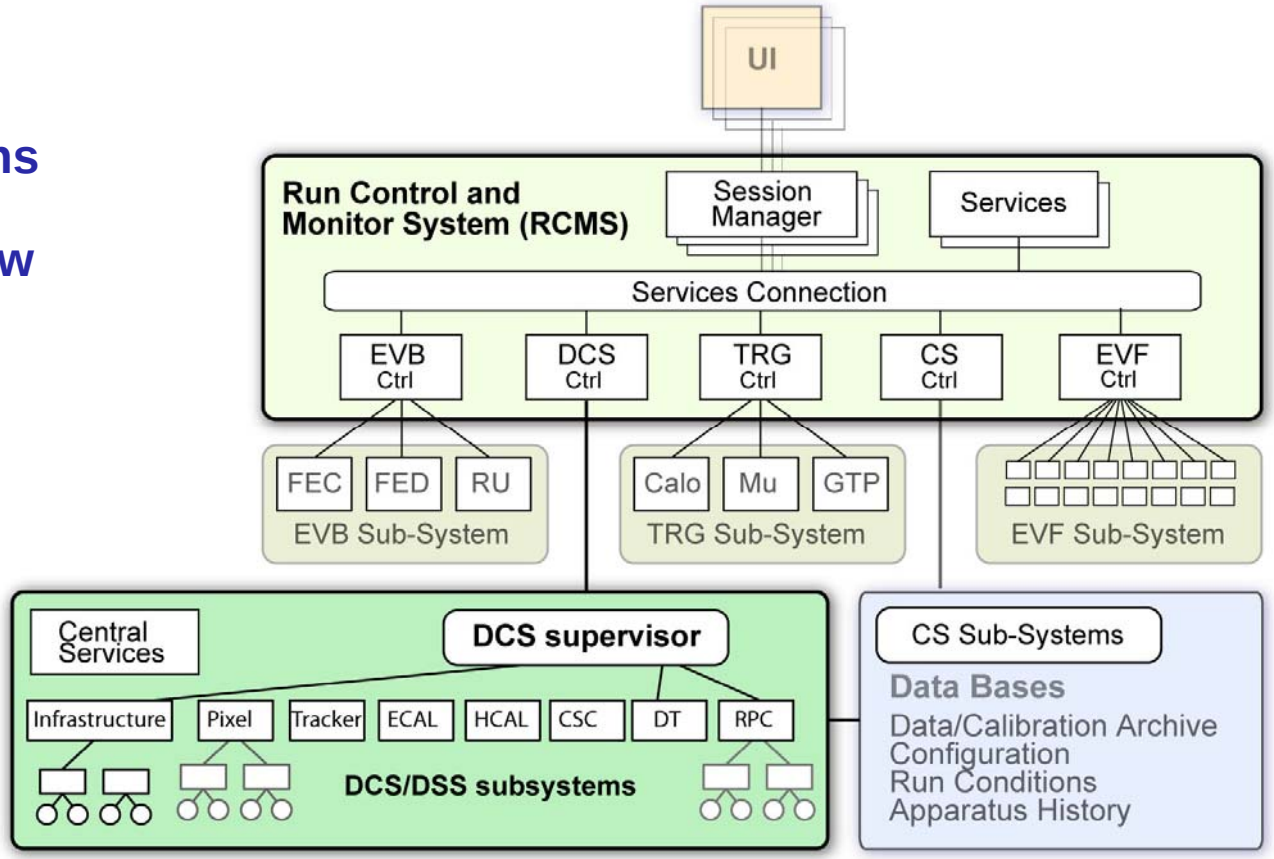
Experiment Controls

Run Controls (RCS):

Configure and operate all local/global data taking sessions
Monitor and protect the measurements and the data flow

Detector Controls (DCS):

Setup and monitor the detectors and the environment
Monitor and protect the apparatus equipment



RCS and DCS Domains

RCS: Data Acquisition Systems
-Run Control and Monitor
-Local/Global DAQ systems
-FrontEnd Electronics Configuration
-Readout Electronics Configuration
-PC clusters and applications control
-Local/Remote Data Archive

DCS: Classic Control
-Central supervision
-Racks/Crates power
-HV/LV supplies
-Cooling and environment
-Gas and fluids
-Alarms
-External system communication
-Detector Safety

Databases:
-Run Condition Data Base
-Equipment, Configuration Data Bases

Detector specific monitoring and calibration tasks
User applications mainly based on XDAQ with direct interfaces with local/central DCS systems
-On detector electronics sensors (temperatures, currents, …)
-FrontEnd electronics test and commissioning procedures
-Calibration (source, LED, Laser) sessions

RCS and DCS Frameworks

Online software framework

- *CMS software packages XDAQ and RCMS*
- *Based on standard protocols (SOAP, I2O, XML, e-tools etc.)*

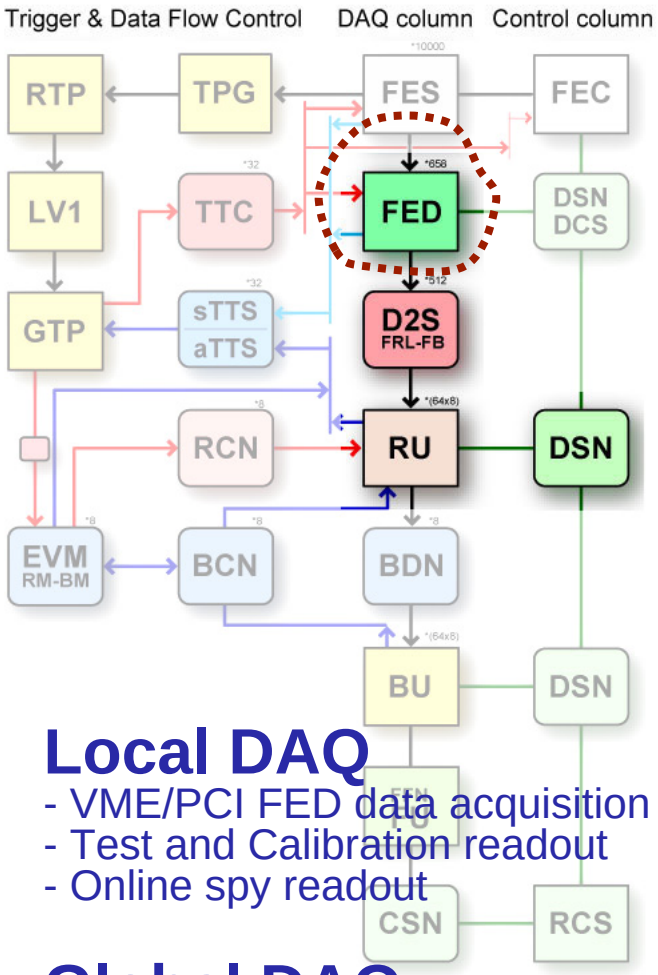
DCS subsystems and supervision

- *PVSS and JCOP supported tools*
- *Based on industry standards (PVSS, PLC, field buses etc.)*

Common features between the two systems:

- *XDAQ-PVSS interface (PSX package based on SOAP messages)*
- *Access to data bases for run conditions and experiment configuration*

Detector Data Taking (DAQ systems)

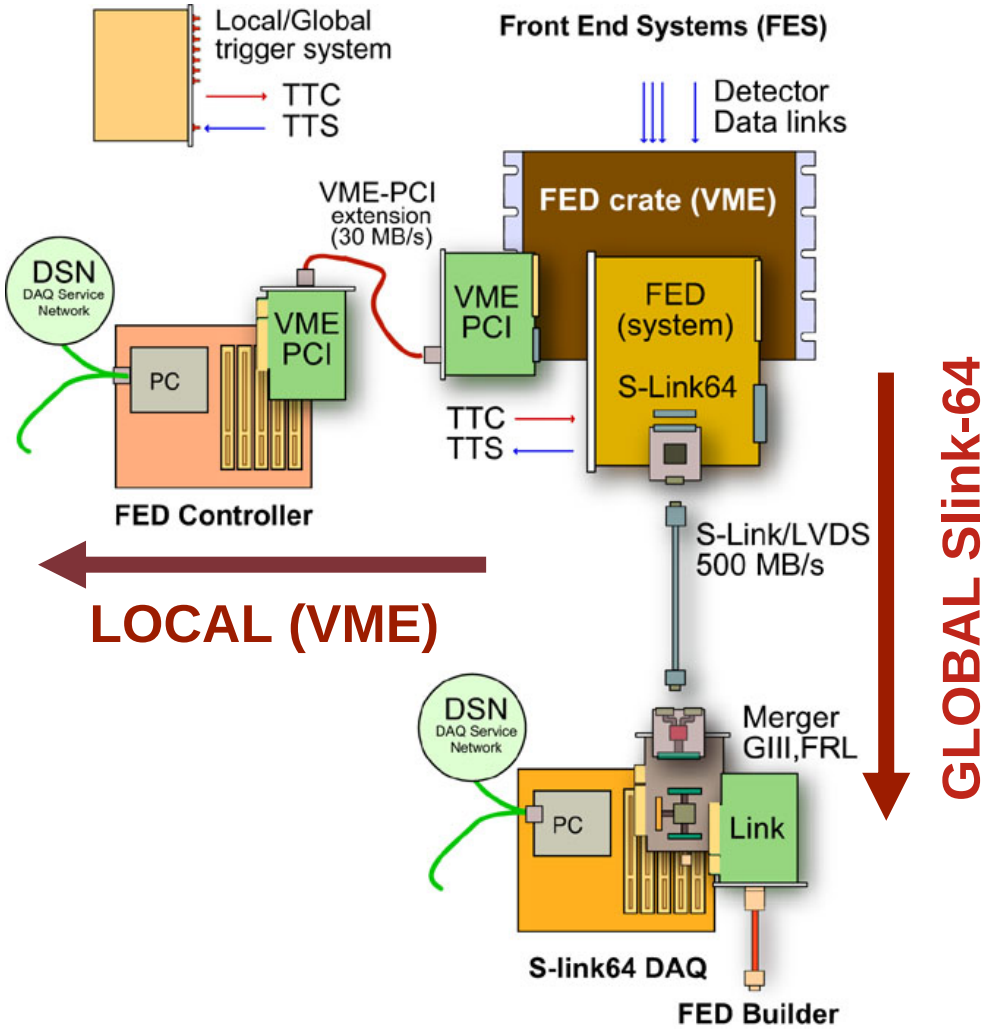


Local DAQ

- VME/PCI FED data acquisition
- Test and Calibration readout
- Online spy readout

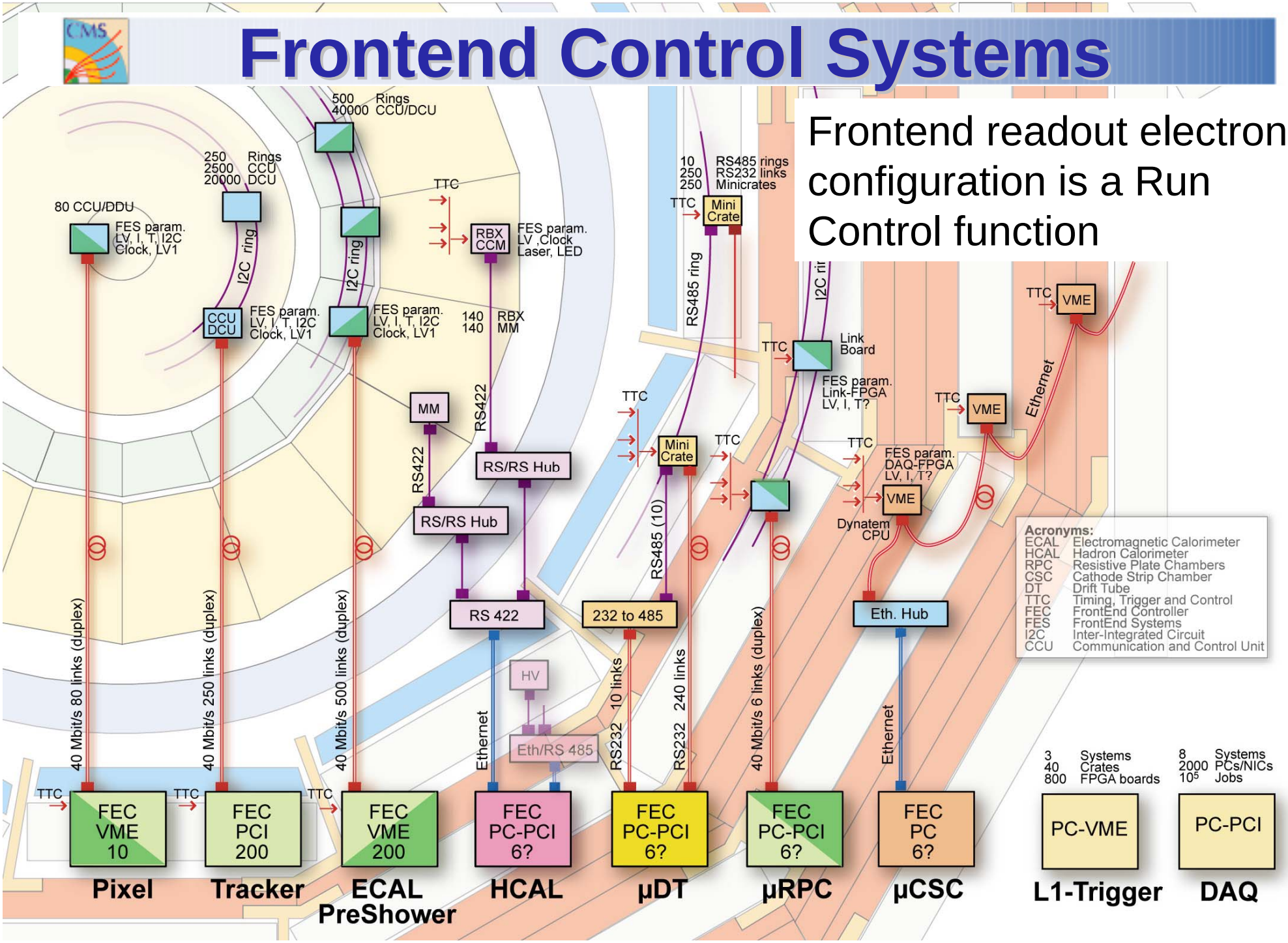
Global DAQ

- Main DAQ data stream
- Fast links to Event Builder Switch

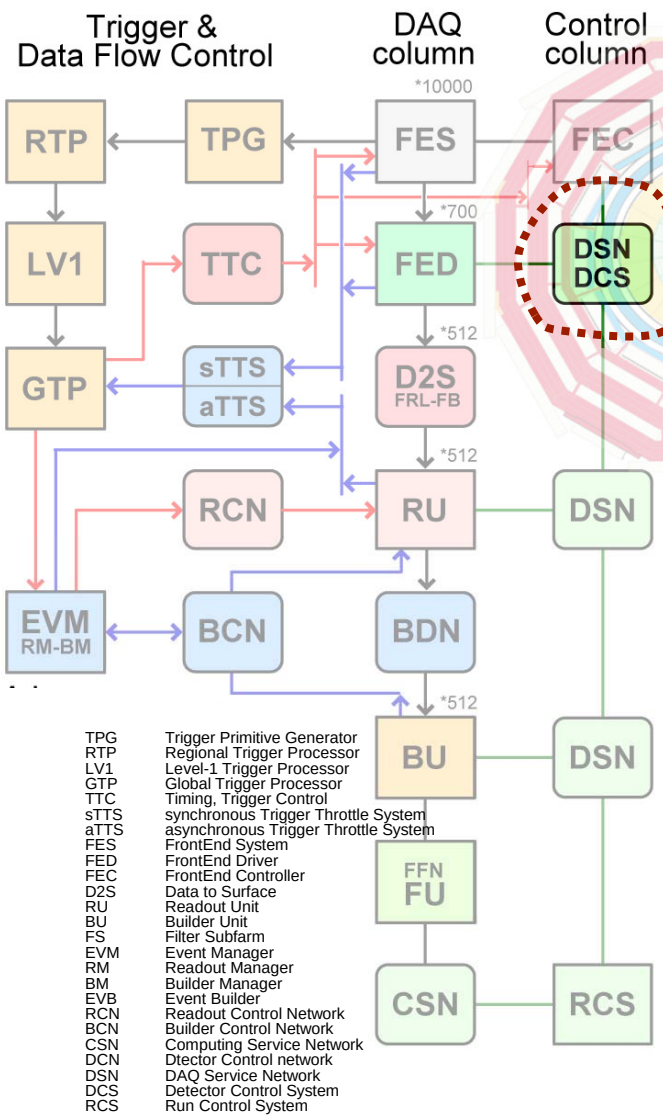


Frontend Control Systems

Frontend readout electronics configuration is a Run Control function



DCS and DSS systems

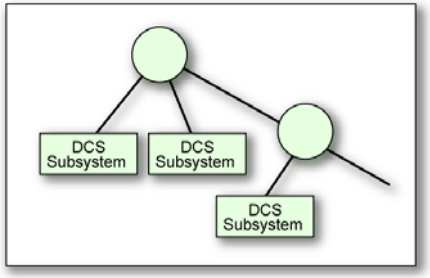


TPG	Trigger Primitive Generator
RTP	Regional Trigger Processor
LV1	Level-1 Trigger Processor
GTP	Global Trigger Processor
TTC	Timing, Trigger Control
sTTS	synchronous Trigger Throttle System
aTTS	asynchronous Trigger Throttle System
FES	FrontEnd System
FED	FrontEnd Driver
FEC	FrontEnd Controller
D2S	Data to Surface
RU	Readout Unit
BU	Builder Unit
FS	Filter Subfarm
EVM	Event Manager
RM	Readout Manager
BM	Builder Manager
EVB	Event Builder
RCN	Readout Control Network
BCN	Builder Control Network
CSN	Computing Service Network
DCN	Dtector Control network
DSN	DAQ Service Network
DCS	Detector Control System
RCS	Run Control System

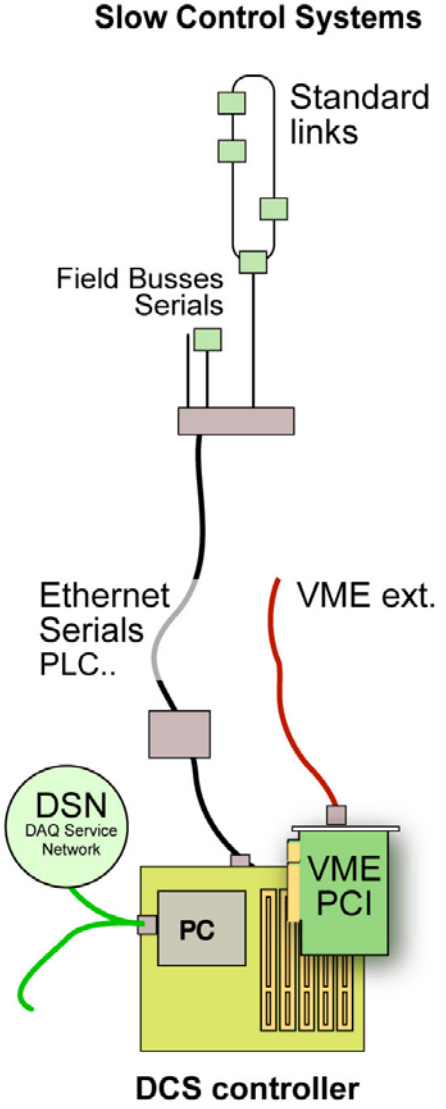
Detector subsystems
- -HV/LV
- -Fluids and environment
- -Cooling
- -Racks/Crates
- -Temperatures
- -Infrastructures
- -Test systems (Laser, LED, alignment camera etc..)

Detector safety (DSS)
- -Temperature
- -Gas
- -Radiation

Experiment supervision
- -DCS Resources handling
- -Alarm and loggings
- -History data base
- -External systems communication.



Supervisor structure



DCS controller

DAQ partitioning

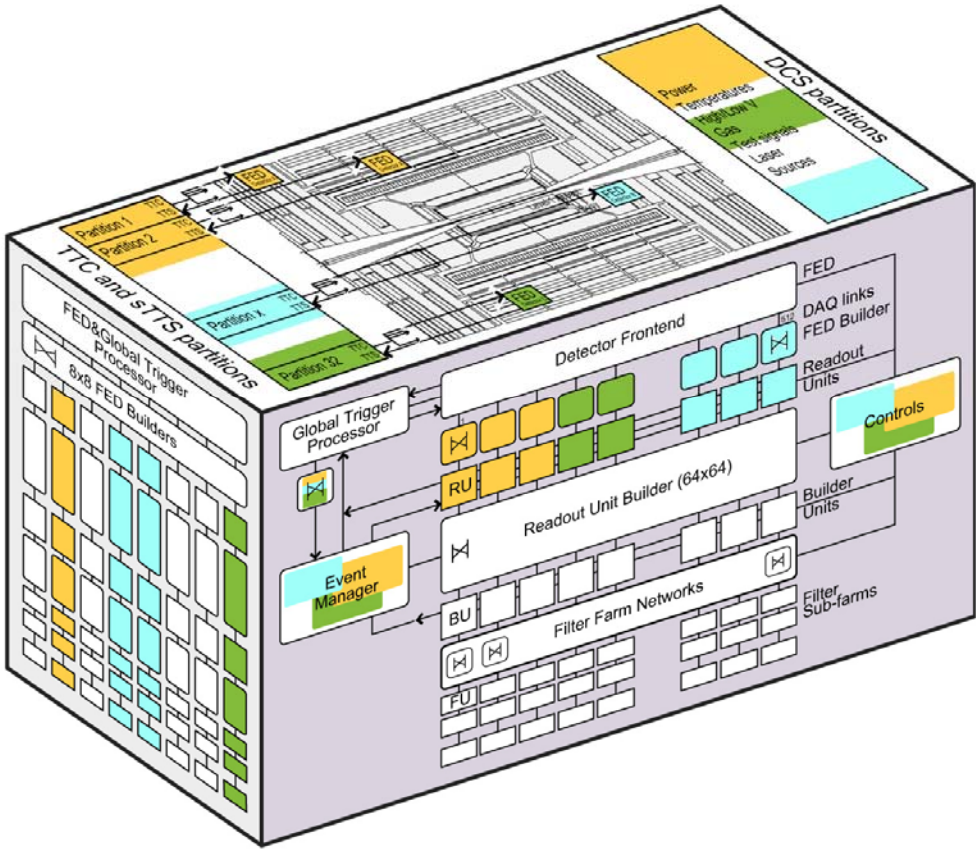
CMS can run up to 8 independent DAQ partitions

Mode 1) FED-RU builder partition

The EVM of each DAQ slice, using the trigger type contained in the GTP record, broadcasts the read command only to the RUs associated to that trigger type. All active DAQ slices result partitioned in the same way.

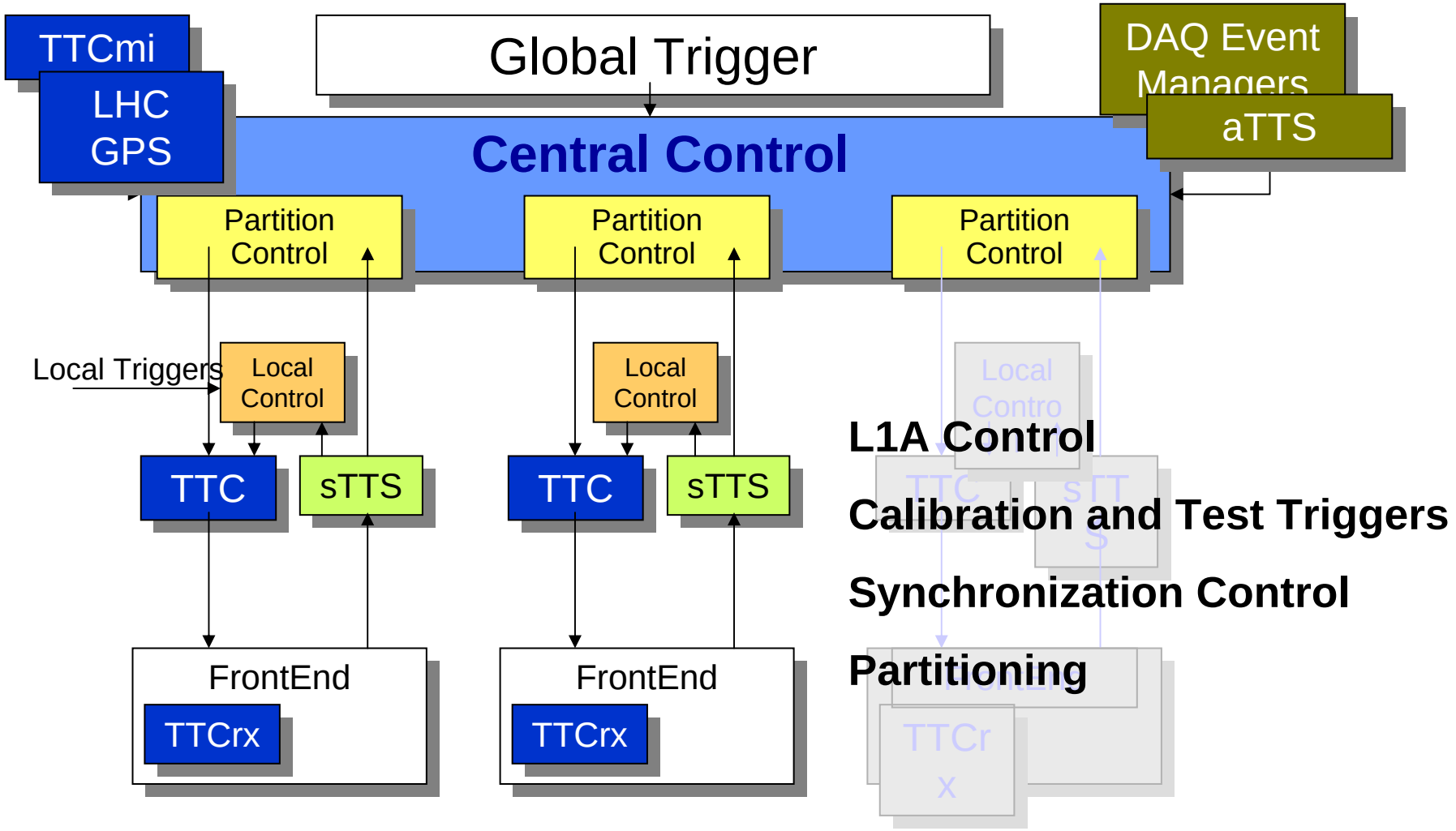
Mode 2) FED-DAQ slice partition

Each set of FED-FRLs associated to a given TTC partition (trigger type) is programmed to send the event fragments always to the same DAQ slice.

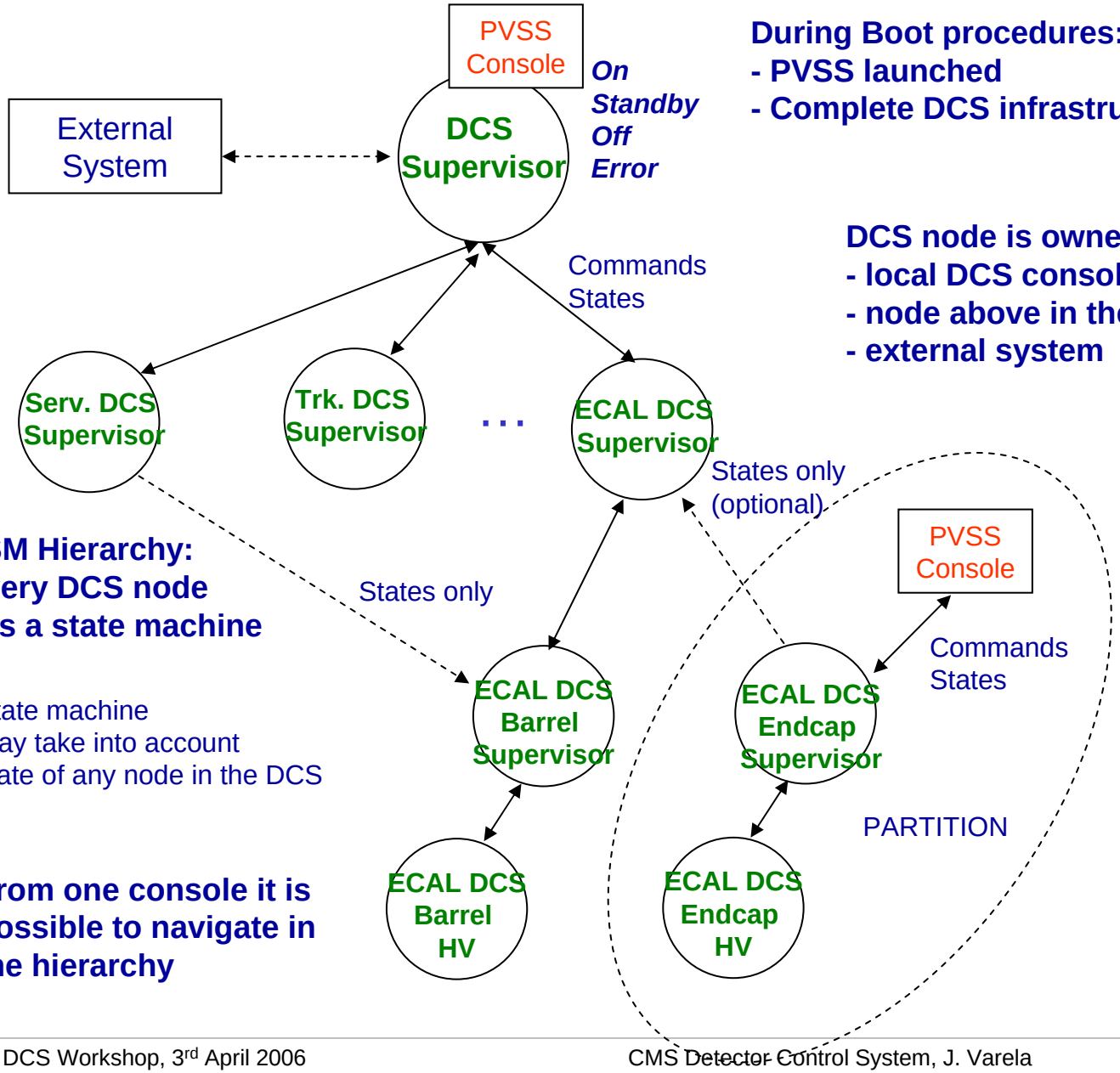


Trigger Partitioning

Dedicated triggers distributed to DAQ partitions



DCS JCOP Model



During Boot procedures:
- PVSS launched
- Complete DCS infrastructure is in place

DCS node is owned by a user_id through:
- local DCS console
- node above in the DCS tree
- external system

Ownership can be gained with commands Take/Release send to DCS systems

FSM Hierarchy:
Every DCS node has a state machine

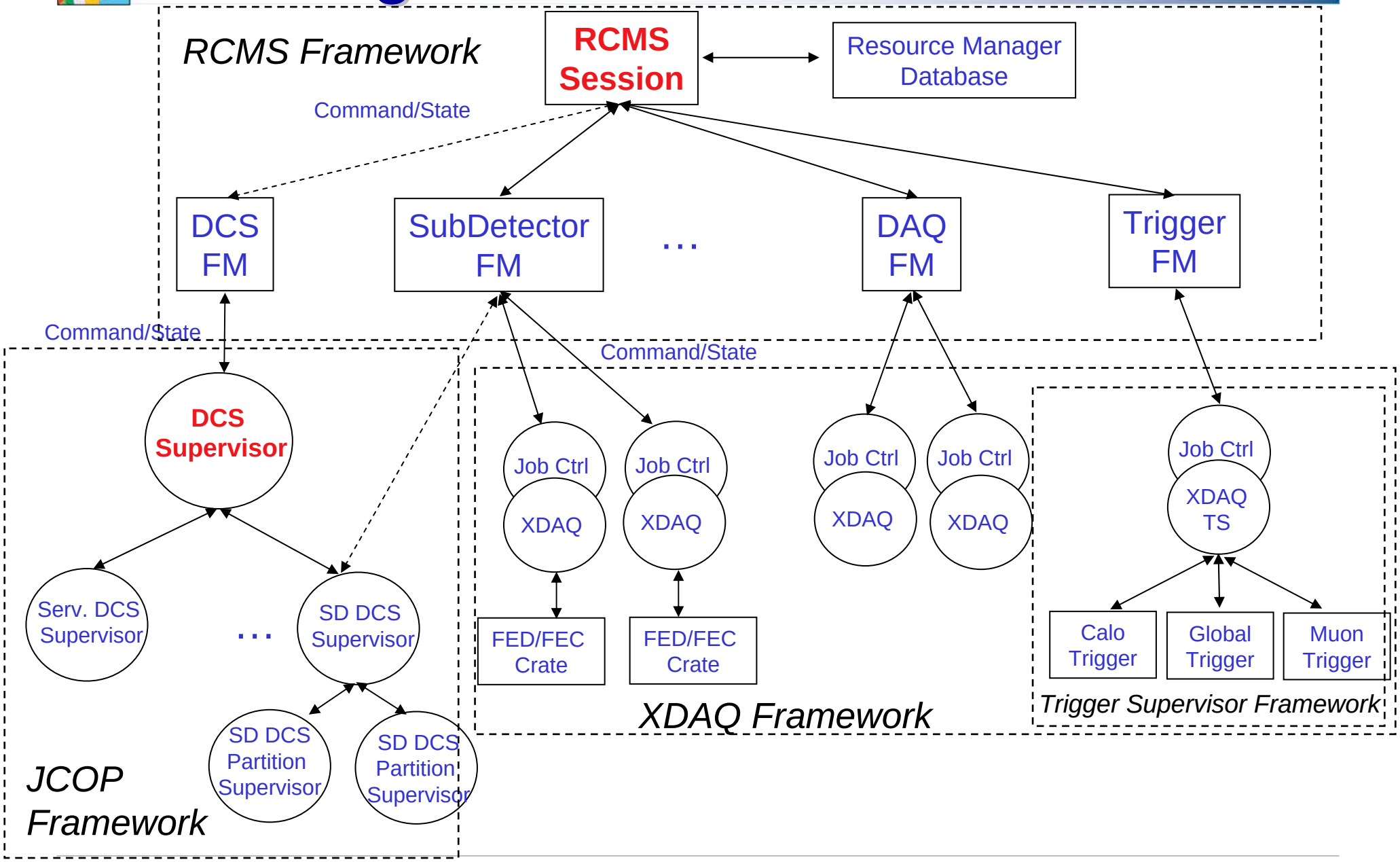
State machine may take into account state of any node in the DCS

From one console it is possible to navigate in the hierarchy

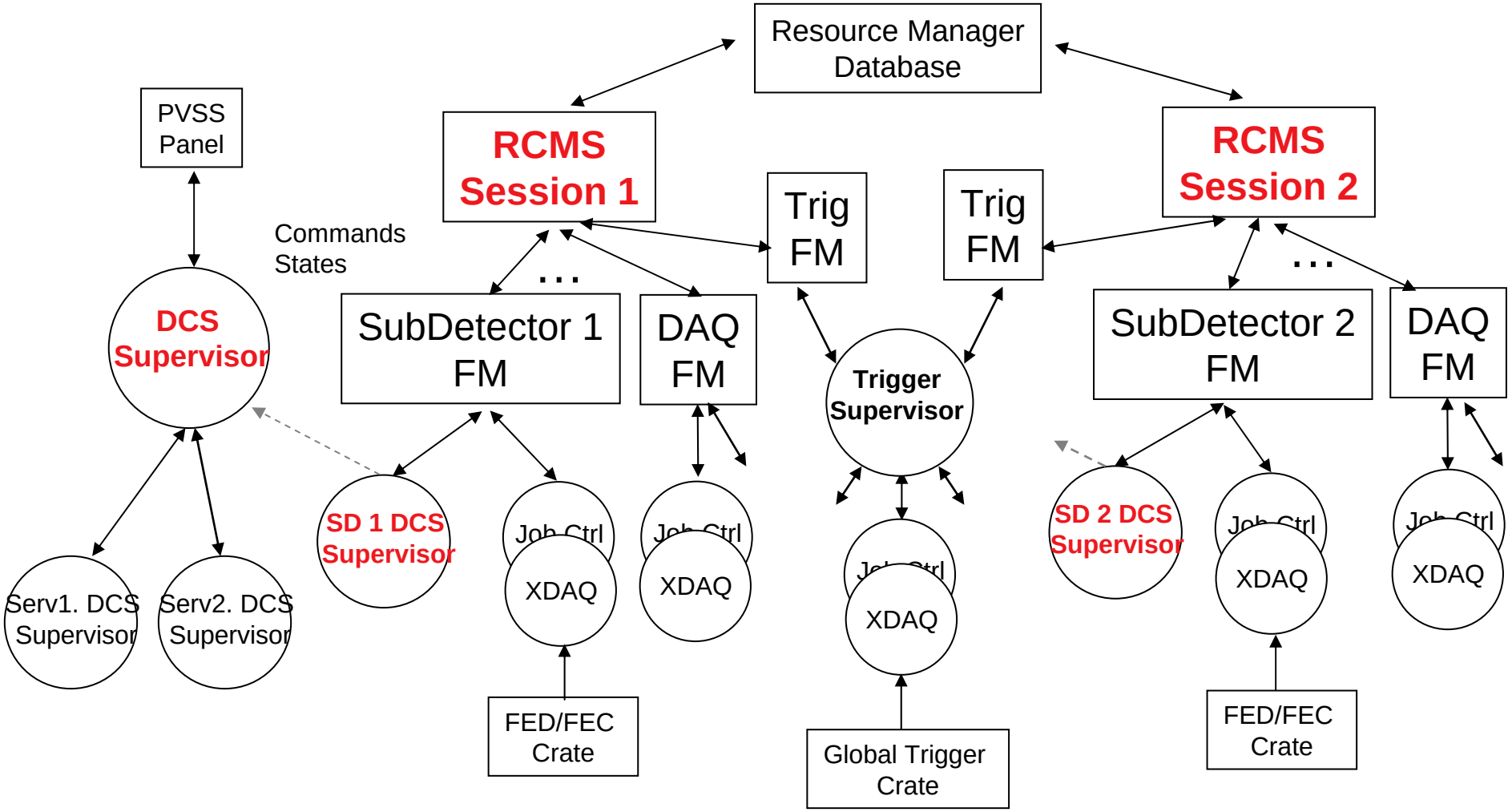
Partitioning is built-in

Any node may get the partitioning state of the tree below (to be implemented)

Integration with Run Control



Partition Mode



Integration DCS – RCMS

- RCMS/XDAQ and PVSS/FW models are integrated in a coherent system
- Allows command/states to be propagated from Run Control to DCS
- Allows independent DCS operation in beam-off periods
- Allows integration of DCS partitions with DAQ partitions
- Allows Local DAQ-DCS operation

Components

JCOP Framework

- **FSM:**
  - Redesigned version
  - Hierarchy improvements and increased flexibility
  - New features will be needed…
- **Data visualization**
  - Trending tool was improved
  - Physicists have not used it extensively yet
  - Complemented by Conditions DB + Root
- **Online Help**
  - Recently available
- **DIP**
  - LHC Data Interchange Protocol
  - Not used yet
- **Access control**
  - Still to be implemented
- **Alarms**
  - Improvements are expected

DCS and Online Data Bases

- DCS data is stored in Conditions DB (Oracle):
  - CMS specific interface was developed
- DCS configuration data is stored in Configuration DB
  - using JCOP configuration tools
- Starting now to get experience with these tools
- Performance issues

Rack Control System

JCOP Rack Application developed by CMS:

- Two software layers: hardware dependent layer and supervisor layer.
- Interface to Equipment Management DB
- Communication with PH/ESS Monitoring Board
- Communication with TS/EL PLC for power control

Installed in CMS Electronics Integration Center (~60 racks):

- Difficult interaction with TS/EL (documentation, version control, etc.)
- Hardware problems with monitoring boards

Installed in ATLAS cavern

Issues:

- Interface with TS/EL PLC still has problems
- Integration with Crate Control to be done

Detector Safety System

Front-end

- JCOP/DSS system for CMS delivered and installed
- Not much experience yet
- Rack Safety System installed in Electronics Integration Center

Back End

- Used at Electronics Integration Center

Comments

- System in operation in EIC since a few months
- Interface DCS-DSS not yet implemented/tested
- More experience will be gained at the Magnet Test and Cosmic Challenge (MTCC) in P5

High and Low Voltages

- CAEN and Wiener power supplies are integrated in the DCS Framework

- CMS requests were taken in to account:
  - CAEN Muons DT High-Voltage
  - CAEN EASY System (Low voltage system)
  - Wiener Marathon OPC server

- Power supplies are in use by all sub-systems
  - Test Beams (e.g. ECAL,…)
  - Integration and test centers (e.g. Muons DT, Tracker, RPCs)
  - Detector installation and commissioning at P5 (CSC, HCAL, DT, RPC)

- Issues:
  - Integration in FW of custom HV supplies (HCAL, CSC)
  - Few standard components still missing (CAEN AC/DC Converter, ADC module, Alignment PS)
  - Not yet a realistic large scale hardware and software integration

Gas Control System

- LHC Experiments GCS framework will be used
- Three systems (DT, CSC, RPC)
- Functionality and operation model well defined
- Waiting installation of gas systems and software deployment

- Issues:
  - Effort required for integration in CMS

Cooling Systems

- Architecture and responsibilities agreed in Sept 05
- Cooling system is a TS/CV responsibility
- PVSS Cooling Supervisor is IT/CO responsibility
- Subdetector specific cooling systems (e.g. ECAL) is an Experiment responsibility
- Waiting installation of cooling systems and software deployment

- Issues:
  - Effort required for integration in CMS

Integration

DCS Guidelines

- **CMS DCS Guidelines are documented**
- **Integrated and homogeneous control system**
- **Naming conventions**
- **FSM conventions**
- **Detector Framework Components**
- **Production system guidelines**
- **Central repository**

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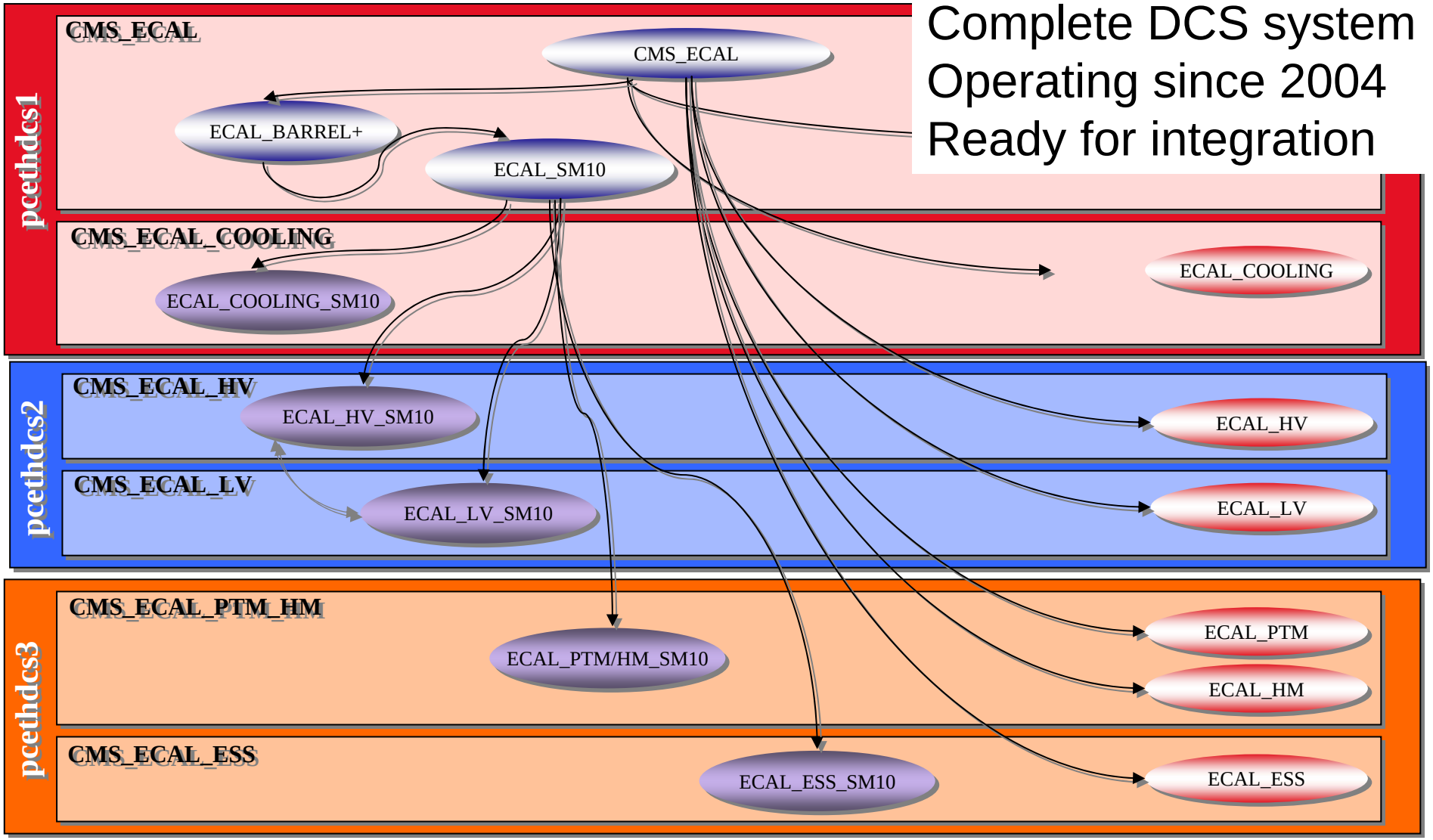
DCS Integration Status

- First version of the Central DCS Supervisor is running
- All sub-detectors have DCS teams in place and are implementing DCS systems with PVSS/JCOP-FW tools
- All subdetectors have prototypes of FSM Control Hierarchies implemented

ECAL DCS

ECAL FSM Structure @ H4 Beam



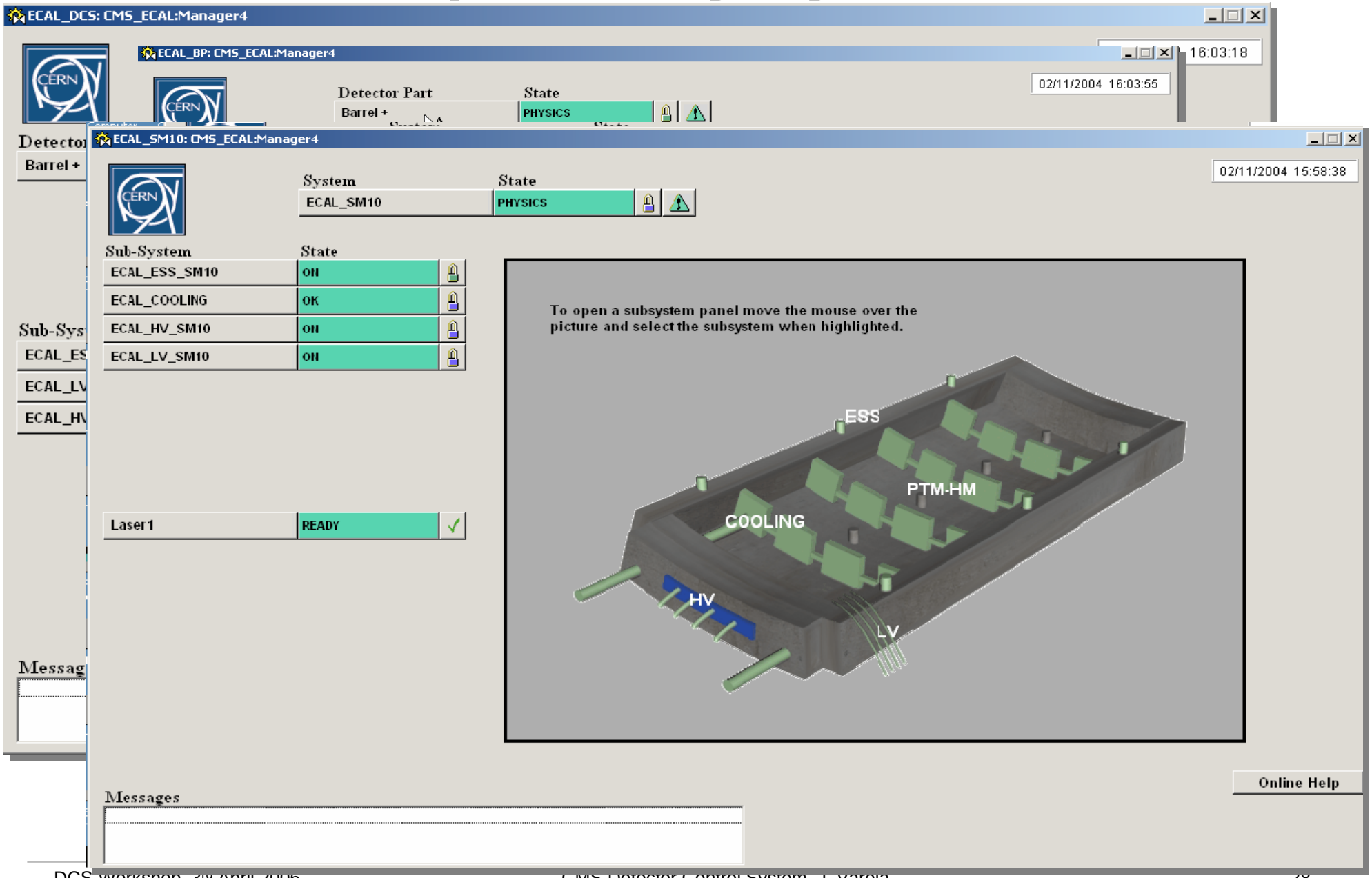
ECAL

Complete DCS system

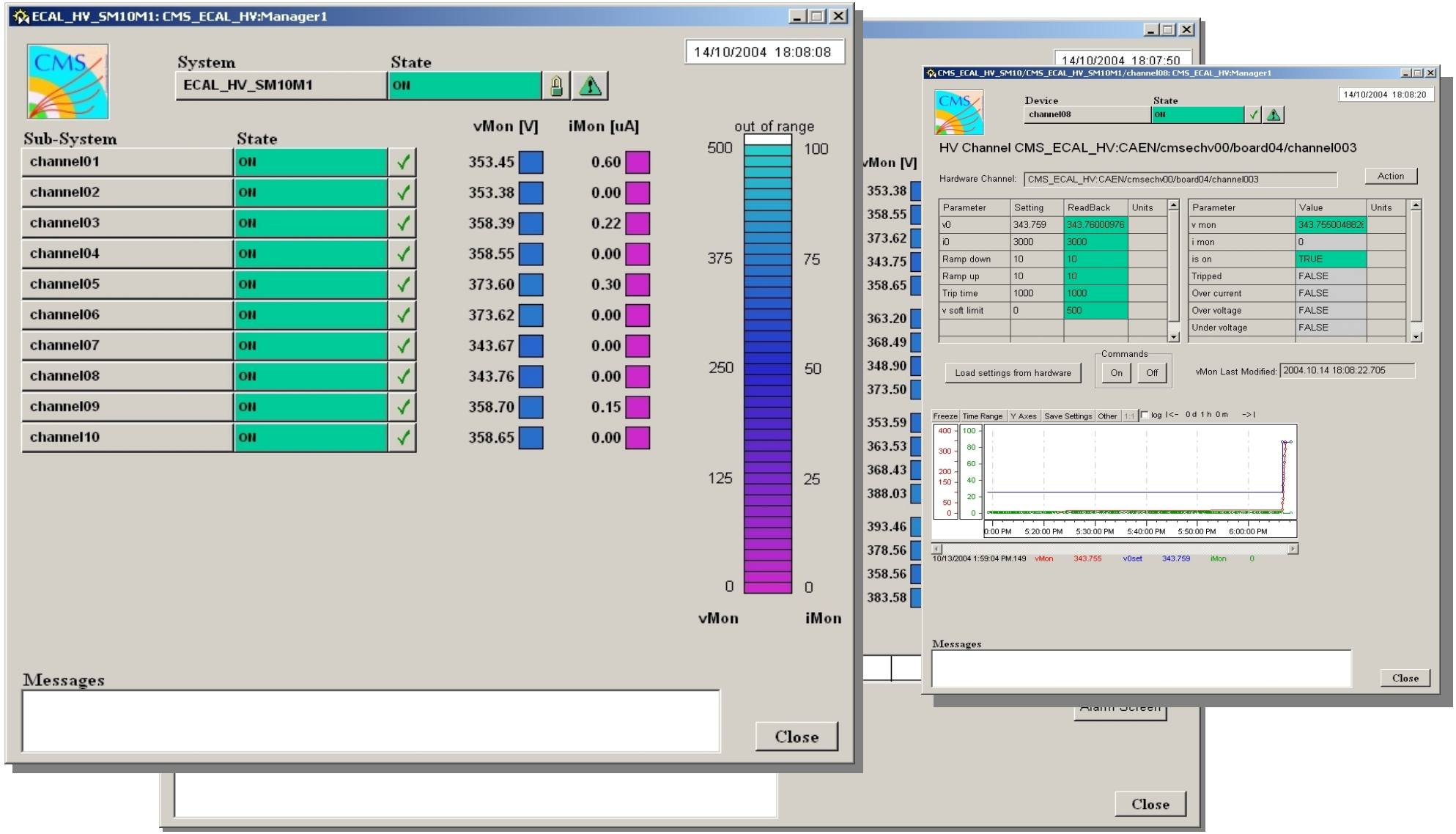
Operating since 2004

Ready for integration

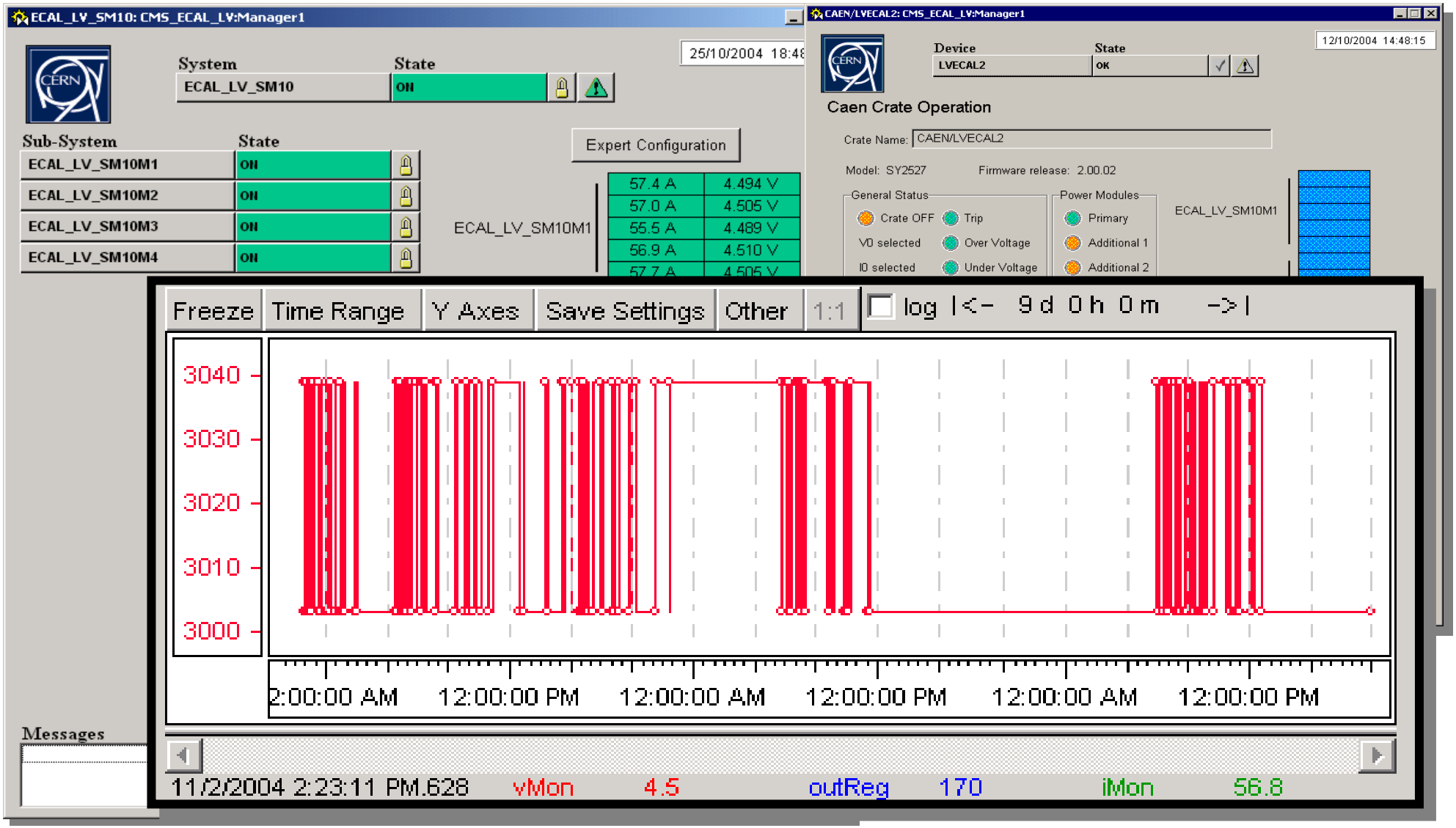
Supervisory System



HV Application



LV Application

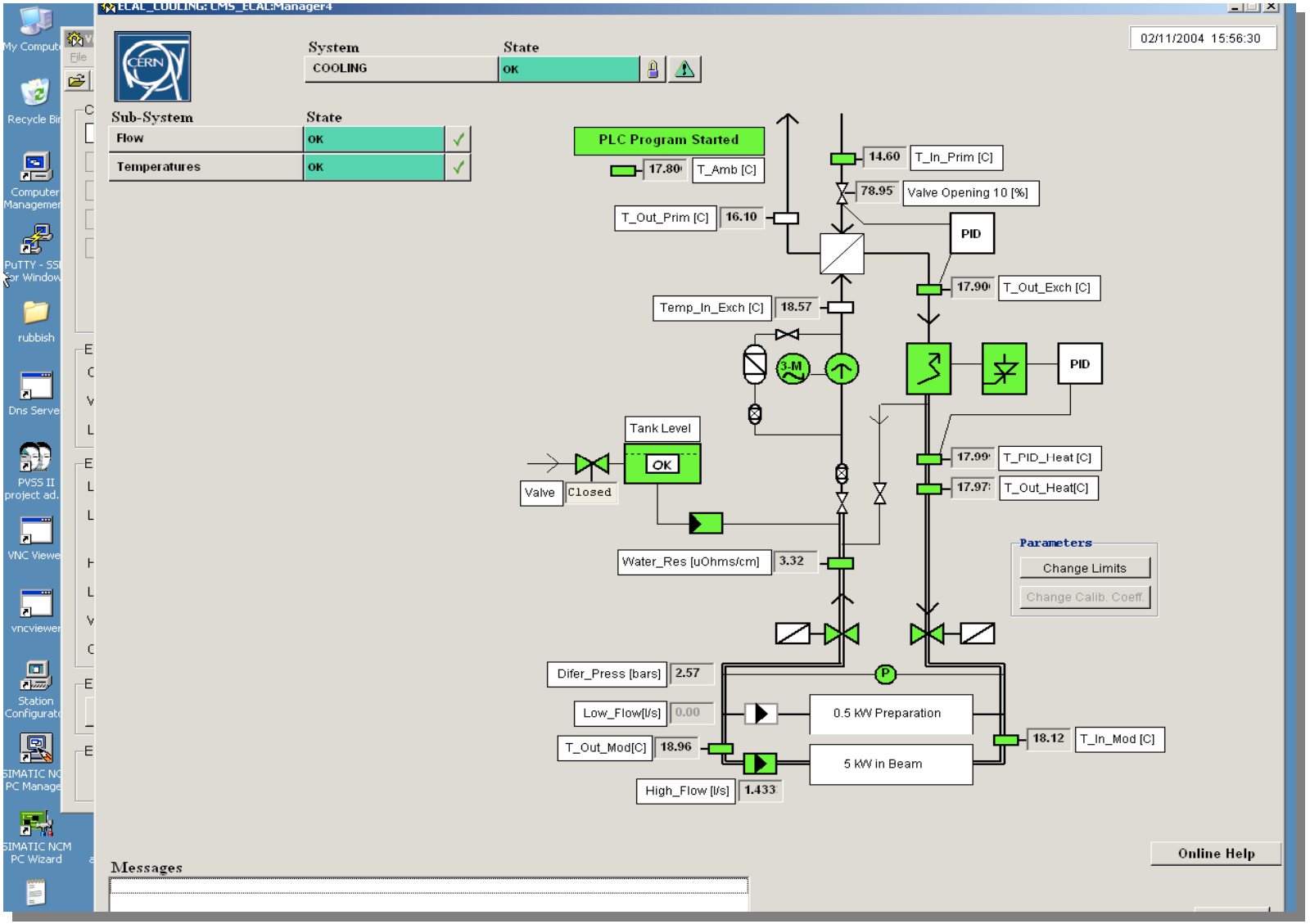


Cooling Application

Communication With cooling System via OPC

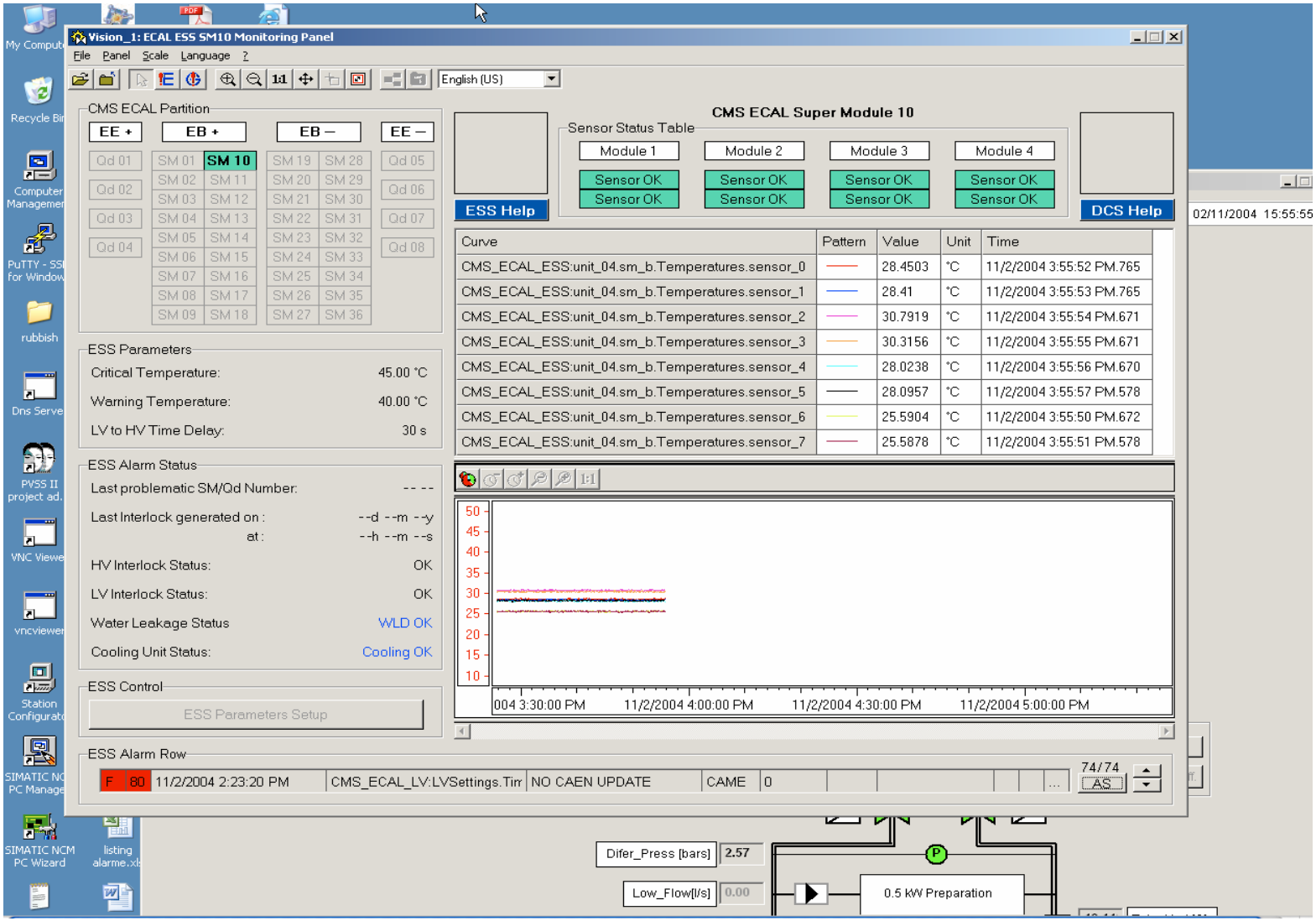
Note:
This application only monitors

user **can not** operate the cooling system from here !



ECAL Safety System

Comm. with PLC via OPC



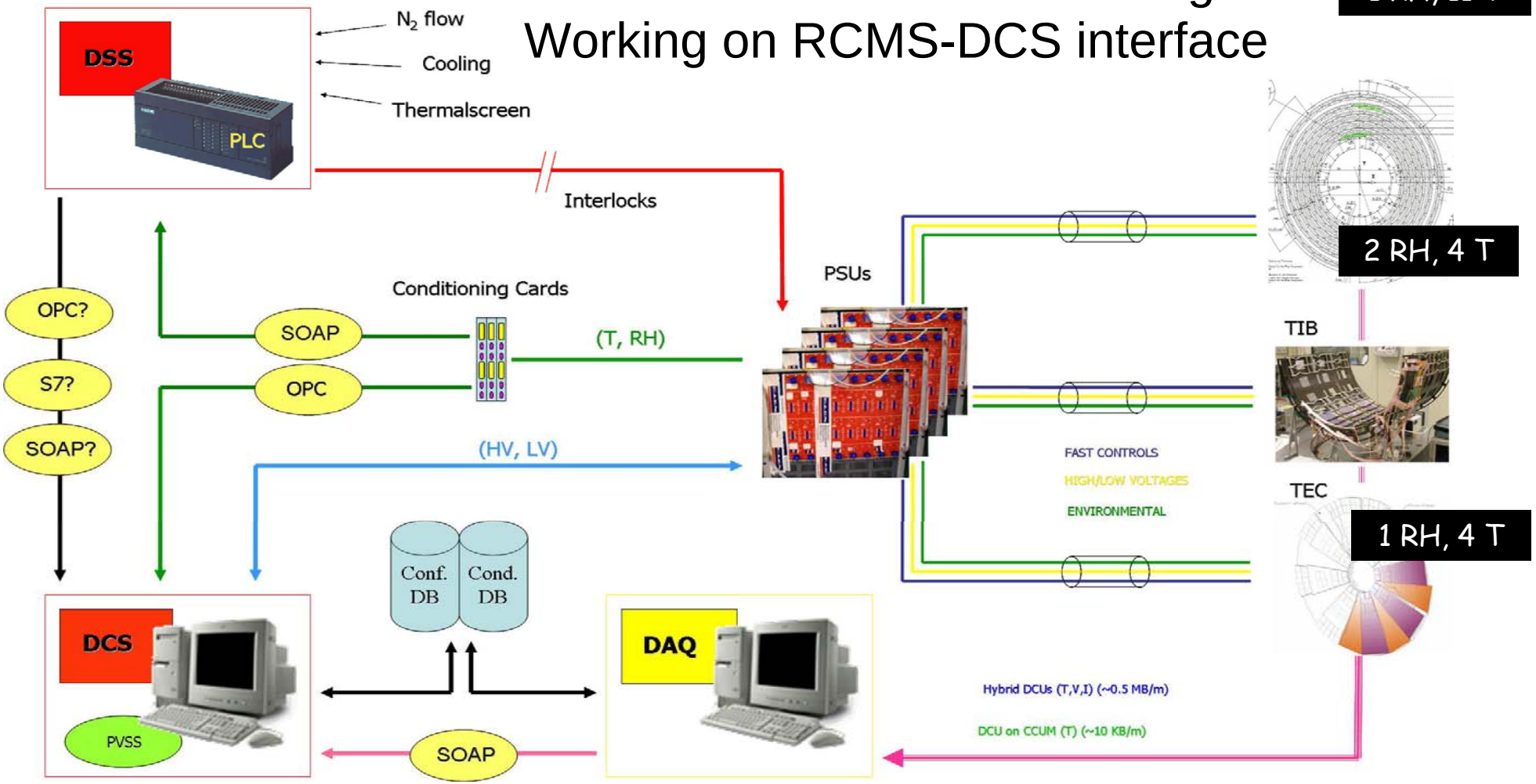
Tracker DCS/DSS for MTCC

TRACKER

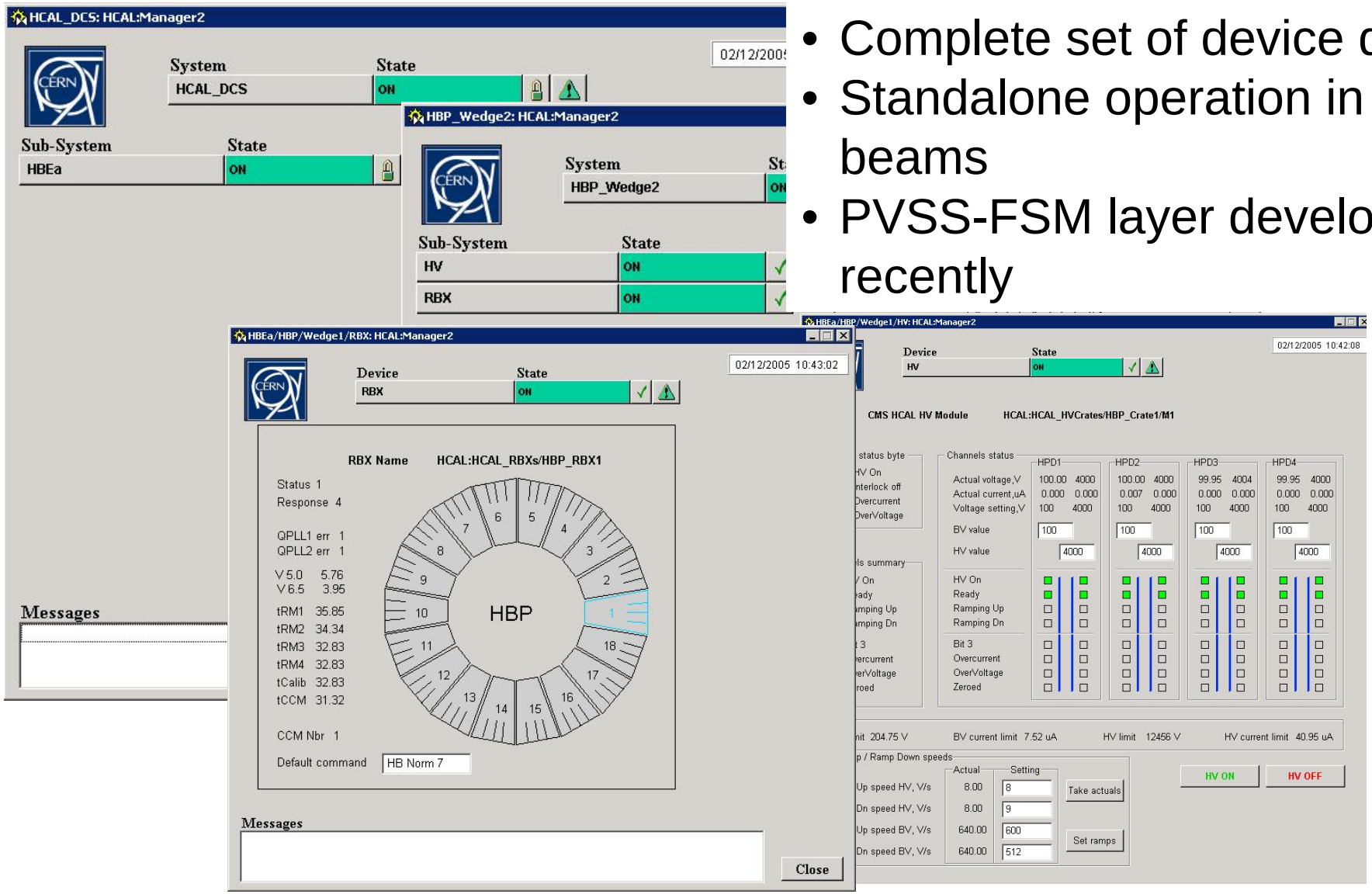
PVSS-FSM system for LV, HV

Interface PLC to PVSS running

Working on RCMS-DCS interface



HCAL DCS



HCAL

- Complete set of device drivers
- Standalone operation in test beams
- PVSS-FSM layer developed recently

DT DCS

Connection to Oracle Condition DB

Conn

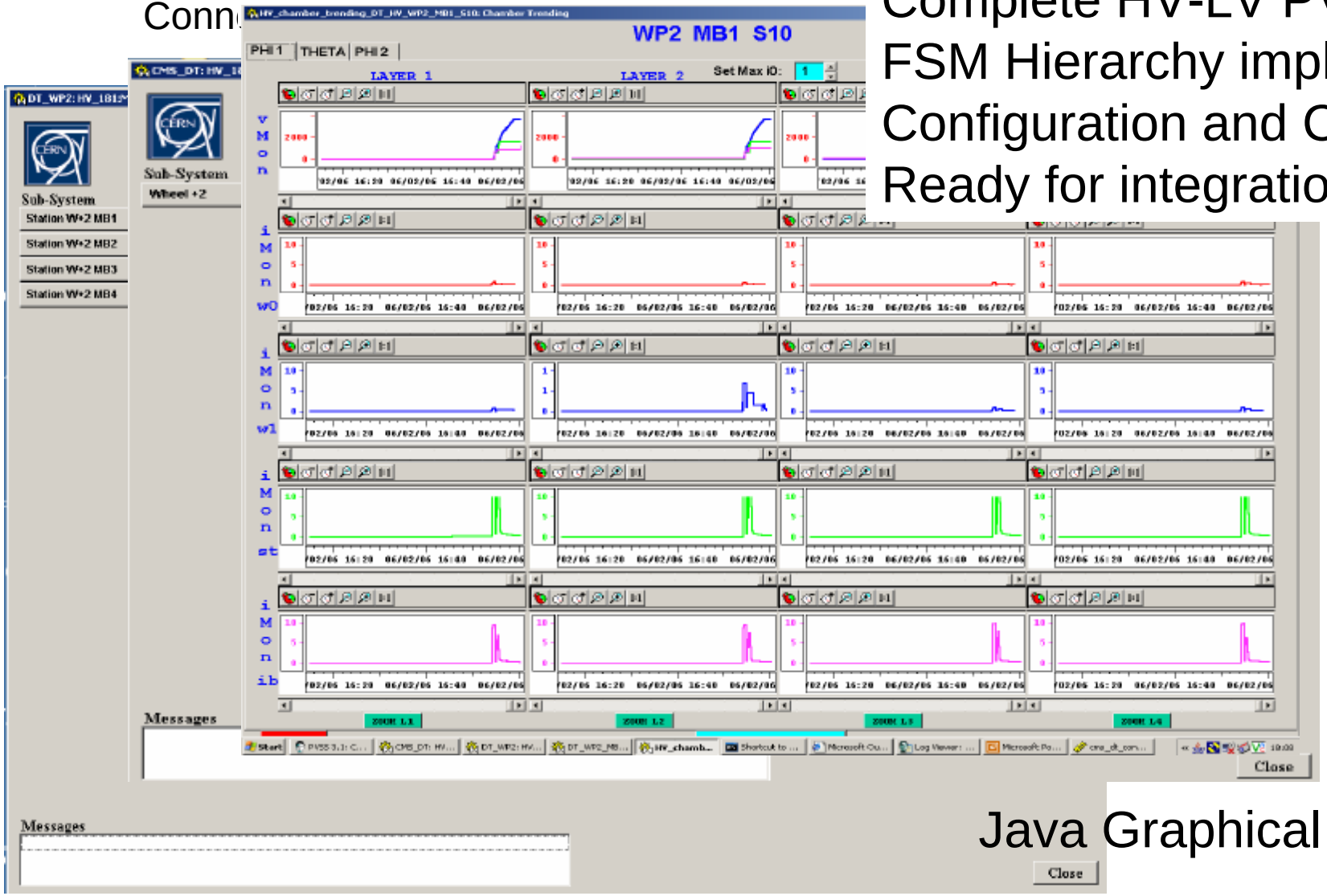
DT

Complete HV-LV PVSS System

FSM Hierarchy implemented

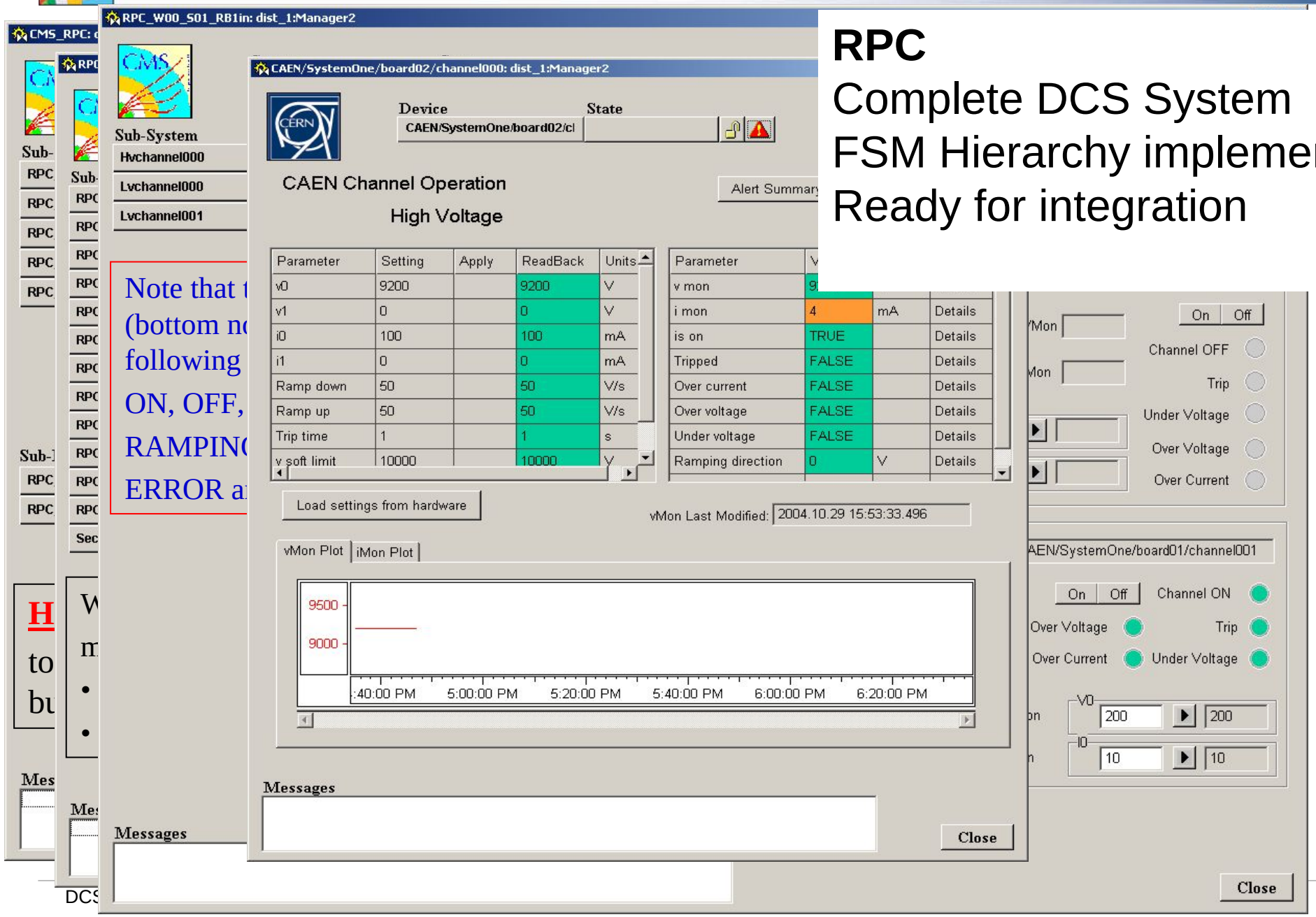
Configuration and Conditions DB

Ready for integration



Java Graphical Interface

RPC DCS



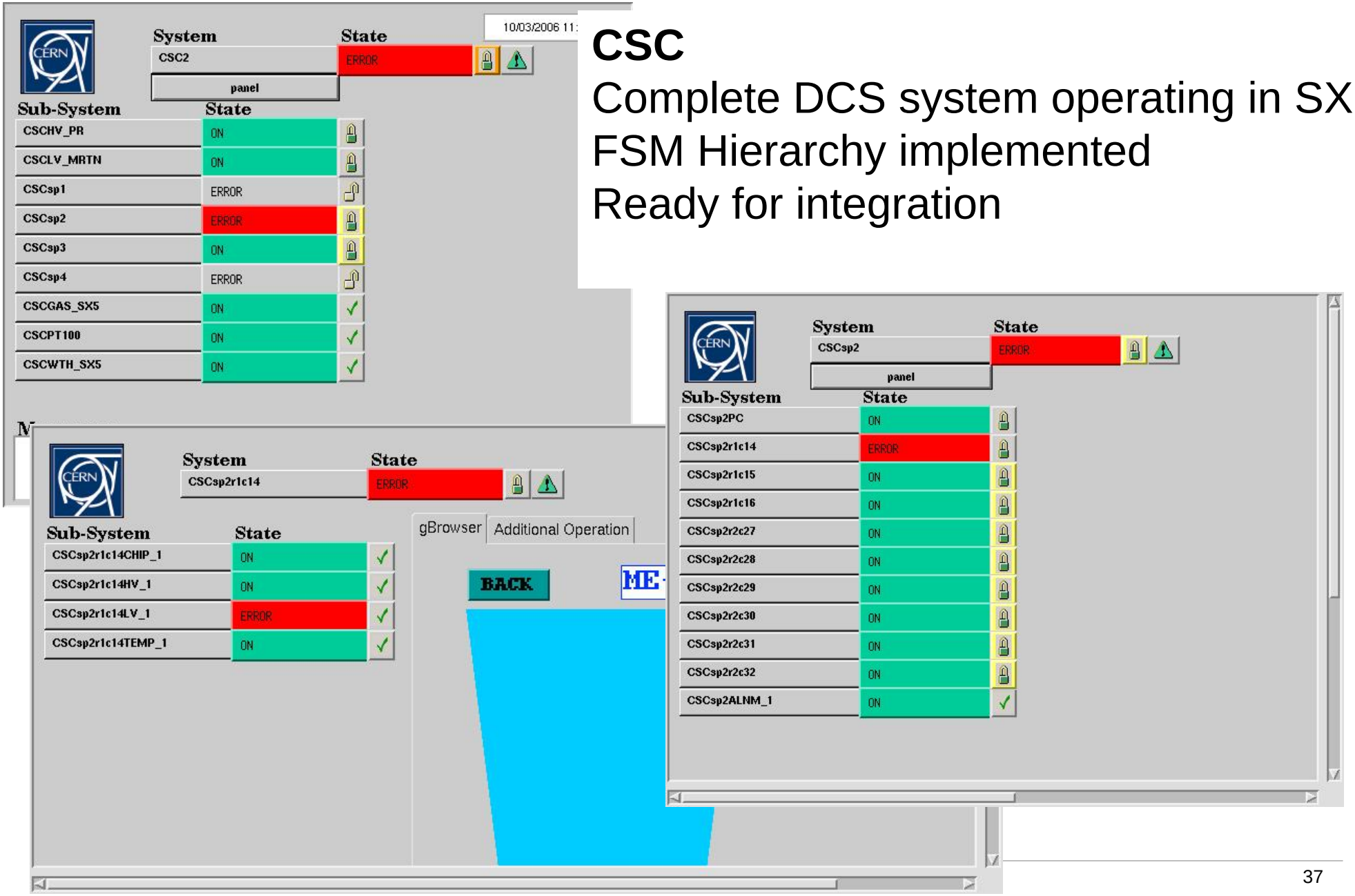
RPC

Complete DCS System

FSM Hierarchy implemented

Ready for integration

CSC DCS



CSC

Complete DCS system operating in SX5

FSM Hierarchy implemented

Ready for integration

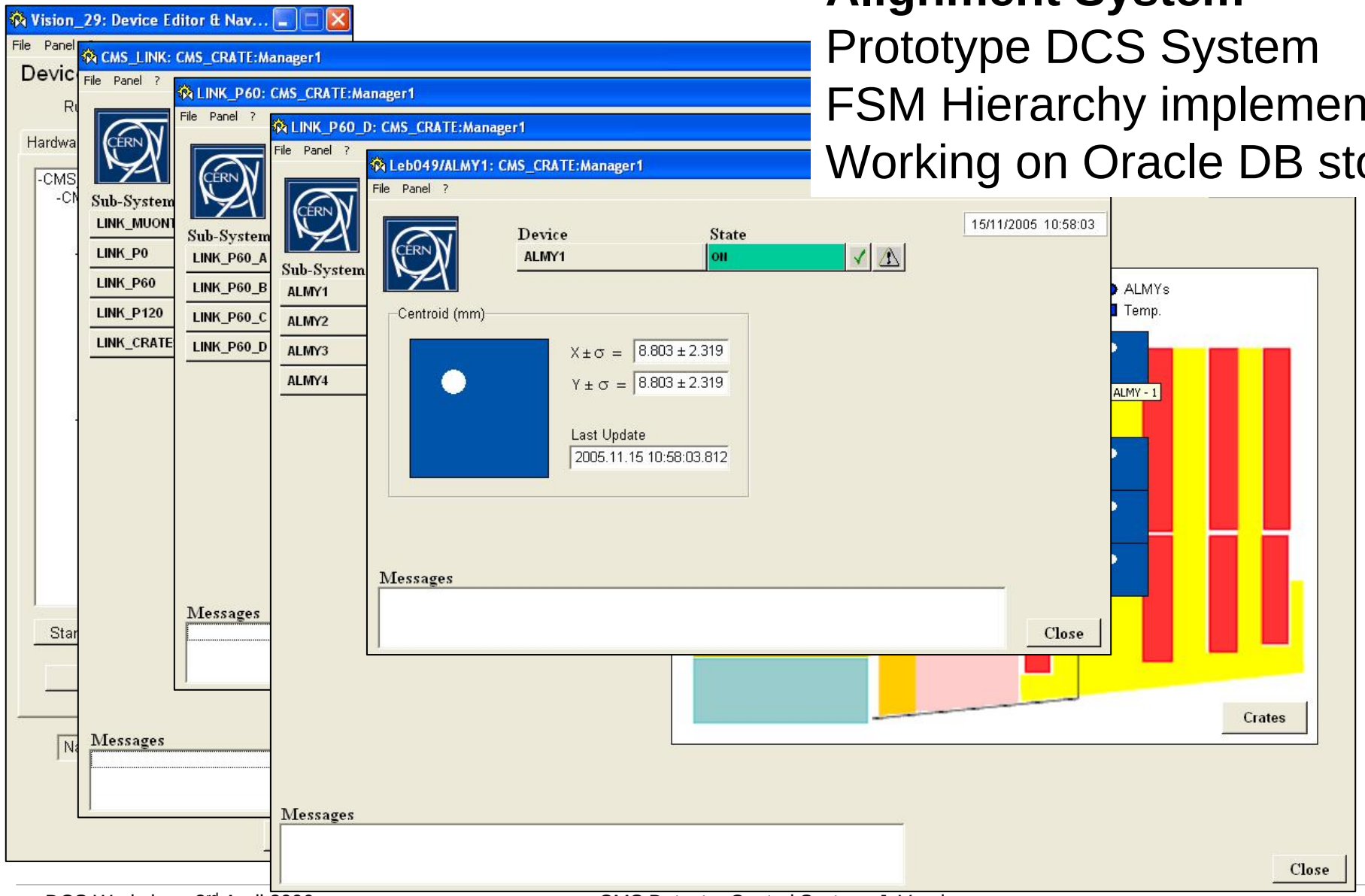
Alignment DCS

Alignment System

Prototype DCS System

FSM Hierarchy implemented

Working on Oracle DB storage



Comments on past experience

The continuous help by IT-CO was very helpful

Collaboration between Central Team and Sub-Detector Team is essential:

- **Guidelines**
- **Direct collaboration in sub-systems development**

Significant manpower effort was needed (1-2 FTE per sub-detector in the past three years)

Major Issues:

- **Playing still with small scale systems**
- **Manpower stability**

DCS Integration in MTCC

Magnet Test and Cosmic Challenge

- **MTCC will be the first large scale DCS integration exercise:**
  - **Magnet closed and operating; Interface to MCS**
  - **Sub-detectors (partially) installed: Tracker, ECAL, HCAL, DT, CSC, RPC, Alignment**
  - **Muon Trigger and final DAQ**

- **10% of CMS, 16 DCS PC's running in P5**

Goals for DCS Integration in MTCC:

1. **Integration of FSM Hierarchy; integration with RCMS**
2. **Central Control: Navigation through all subdetector panels and alarms display in central DCS console.**
3. **Experience with a production DCS system**
4. **Access to Configuration and Conditions DB**

Organization & Plans

DCS Organization

- DCS Coordinator, Deputy DCS Coordinator, SubDetector DCS coordinators
- Central Team: now 4 people including coordinators. 2007?
- DCS Coordination Board integrating representatives per sub-detector (meetings every 2 months)
- One-to-one program (2005): one month dedicated to each sub-detector for integration development
- Direct IT/CO support will become even more crucial
- JCOP Training was, is and will be essential

DCS Infrastructure

- Computers and Network are managed in common with DAQ
- SubDetector PCs are managed in common with central DCS PCs
- DCS central team responsible for common hardware (Rack and crate system, Can buses, environment monitoring, etc.)
- DCS central team is responsible for external interfaces (LHC, Technical Services) and DCS Services (Gas, Cooling)
- Sub-detectors are responsible for sub-detector DCS hardware
- Central DSS installation and operation is a responsibility of the CMS Integration Team.

Future Activities

- Install and operate DCS in MTCC
- System review after MTCC
- Crate System (remote control of VME crates) and integration with Rack system in Experimental Caverns (USC and UXC 55)
- Installation of PC infrastructure and DCS Production System in USC55
- Hands on Gas and Cooling Systems
- Interface to External Systems (LHC, etc.)

Subdetector DCS Milestones

Generic Milestones

First Prototype using PVSS framework	**Q4 03**	***OK***
First Integration with Central DCS	**Q4 04**	***OK***
Ready for MTCC Integration	**Q1 06**	***~OK***
Commissioning underground	**Q1 07**	

Central DCS Milestones

DCS Conventions and Interfaces Naming scheme, Commands, States	**Q2 03**	***OK***
Data Bases Specification Configuration, *Conditions,* Equipment, Archive	**Q3 03**	***OK***
Demonstrator Central DCS Including scaling tests	**Q4 03**	***OK***
First prototype of integrated DCS system Integration of ECAL as first experience Configuration Database DAQ interface	**Q4 04**	***OK***
DCS Integration in MTCC	**Q2 06**	
Commissioning final DCS system	**Q1 07**	

Priorities

Careful planning of further developments is needed

- Schedule is now a major issue
- Need to define priorities

CMS priorities in JCOP:

- Archival with Oracle
- Gas Application
- Cooling Application
- Access control
- Interface to Root

Prototype of integrated DCS system in CMS

- Integration of subdetector control systems in “Magnet Test/Cosmic Challenge” should provide final validation of DCS model