Experiment Control System

…A Brief History

And the path to Operations…

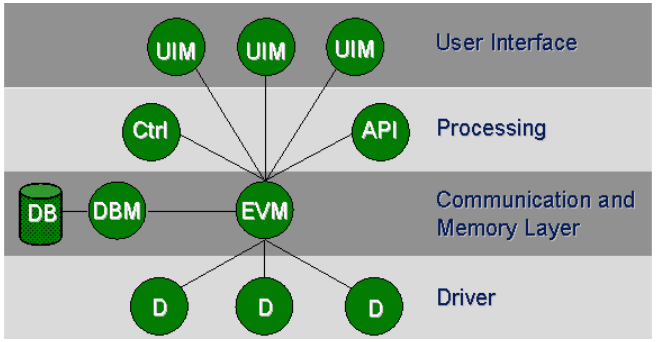
Clara Gaspar, November 2018

The JCOP Project

- **Joint COntrols Project**
  - Between the 4 LHC Experiments and a CERN Support Group: IT -> EN -> BE
  - Created in December 1997
  - First tasks
    - Gather Requirements from Experiments
    - In-depth Technological Survey
      - SCADA – Supervisory Control and Data Acquisition (commercial and “home-made”)
    - WinCC-OA (PVSS at the time) chosen
    - Define the Architecture, Develop the Framework

The SCADA tool

- **Why WinCC-OA?**
  - Technical (& Financial) Reasons
    - Windows & Linux (not so common)
    - Distributed & Open Architecture
      - Could scale to very large distributed systems
      - Could integrate external tools (FSM, etc.)
    - Many tools and interfaces:
      - Graphic Editor, Archiving, Alarm Handling, Drivers, etc.
    - Many man-years of development for a small price
  - "Sociological" reasons
    - Standard Interfaces: The same concepts everywhere (The datapoint mechanism, the scripting language, Gedi, etc.)
      - Can share resources within and outside the experiment.
      - Not perfect at everything, but a coherent and integrated set of tools

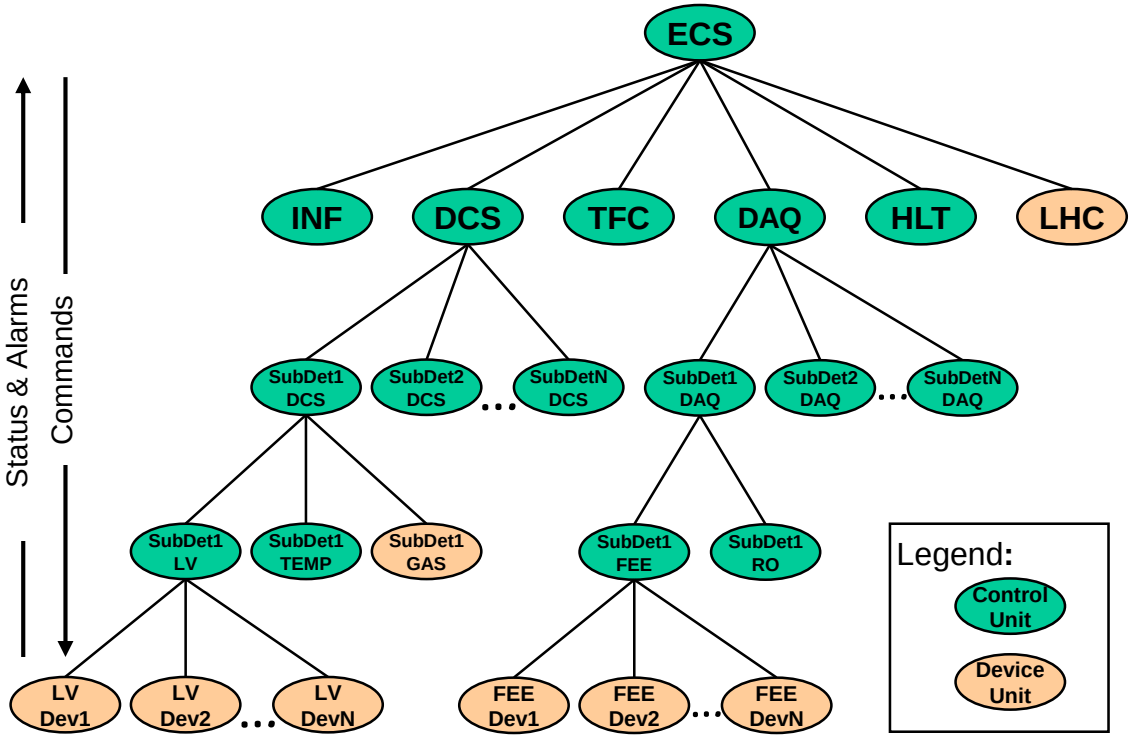


The JCOP Project

- **Today:**
  - Still extremely active
    - Meetings (almost) every week
    - Several FW components being revised and improved:
      - Archiving, Alarm handling, Device access, etc.
    - Provide Support & Training
- **JCOP Tools Usage:**
  - LHCb use the JCOP Concepts throughout ECS
    - DAQ/RunControl, DCS/BigBrother, etc.
  - While the other LHC Experiments only for DCS
    - NA62 and ProtoDUNE more like LHCb
  - Other CERN domains also use it:
    - Magnets, Cryogenics, Electricity, Cooling, Vacuum, etc.

LHCb Upgrade ECS

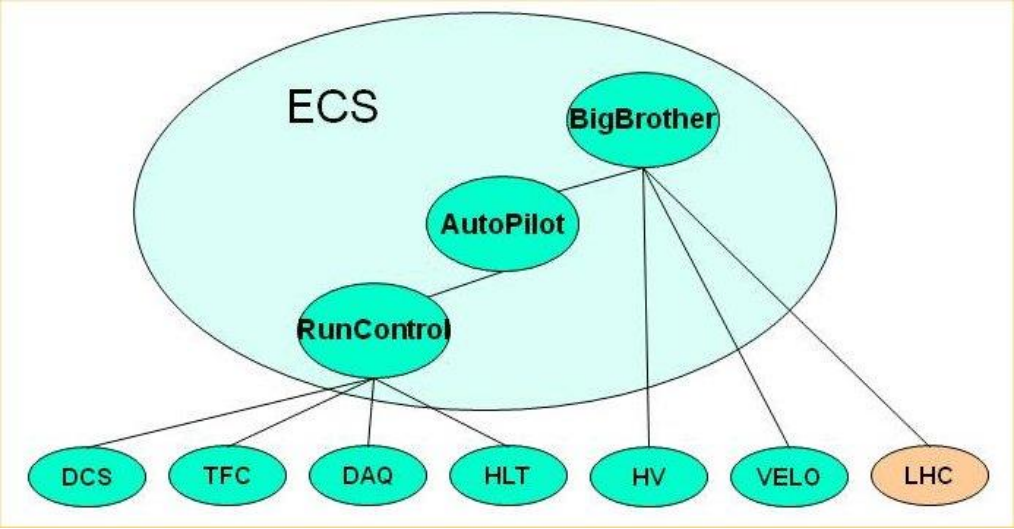
- **Same Architecture & Concepts as current system**



- **Selected Concepts:**
  - **Integration & Homogeneity**
  - **Partitioning & Automation**
  - **Promote HW Standardization**
    - Same board (PCIE40) for:
      - DAQ R/O (TELL40)
      - TFC + ECS (SOL40)
    - CAEN, Wiener, Iseg, ELMBs…
  - **Separate Data/Control paths**
  - **Promote SW Uniformity**
    - Guidelines, FW Components, FSM Templates
  - **Small number of Operators**
    - 1 Operator +1 Data Manager

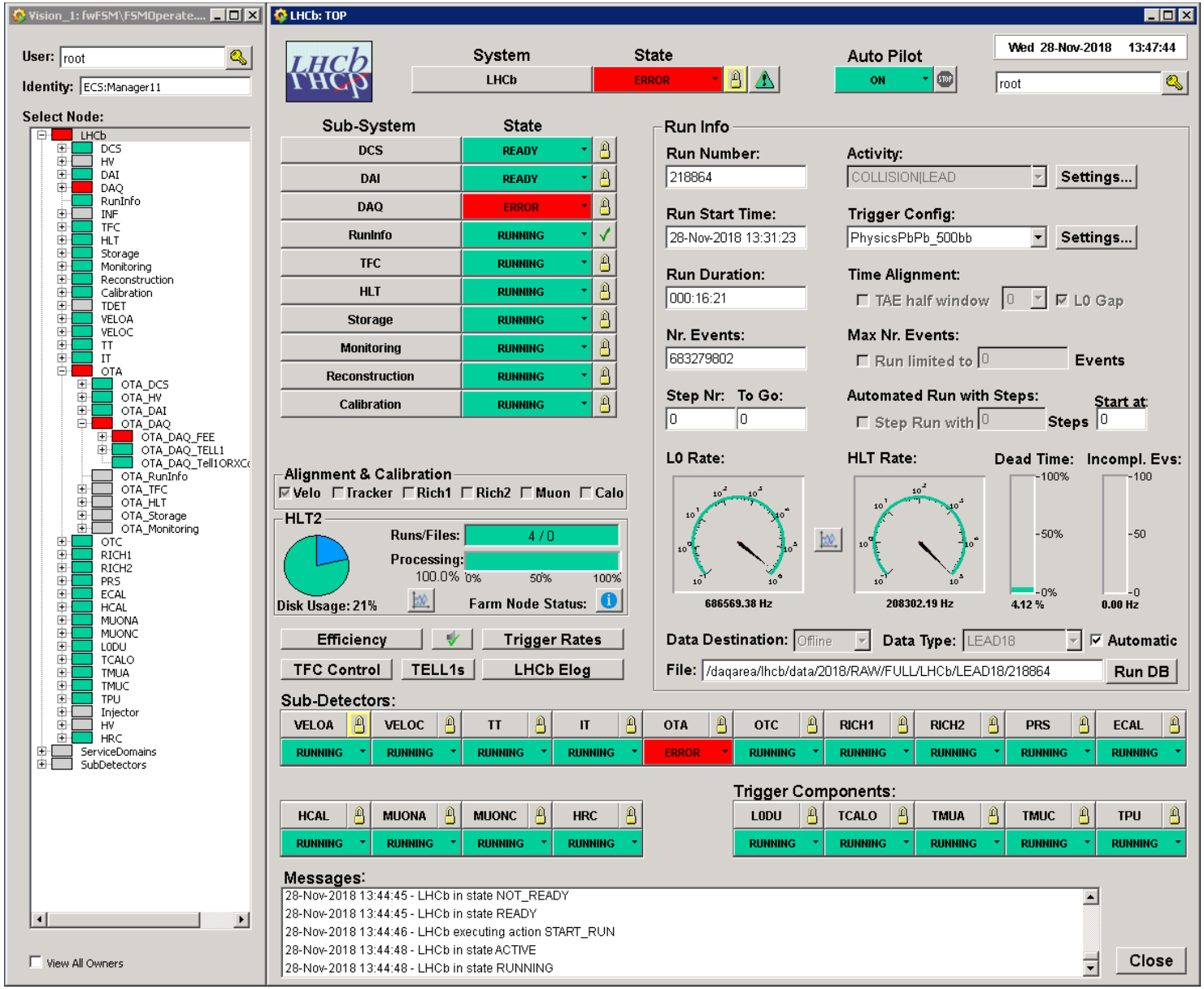
LHCb Operations

- **Main Tools:**



- **RunControl**
  - **Handles the DAQ & Dataflow**
  - **Allows to:**
    - **Configure the system**
    - **Start & Stop runs**
- **AutoPilot**
  - **Knows how to start and keep a run going from any state.**
- **BigBrother**
  - **Based on the LHC state:**
    - **Controls SD Voltages**
    - **VELO Closure**
    - **RunControl**

Run Control



- **Matrix**

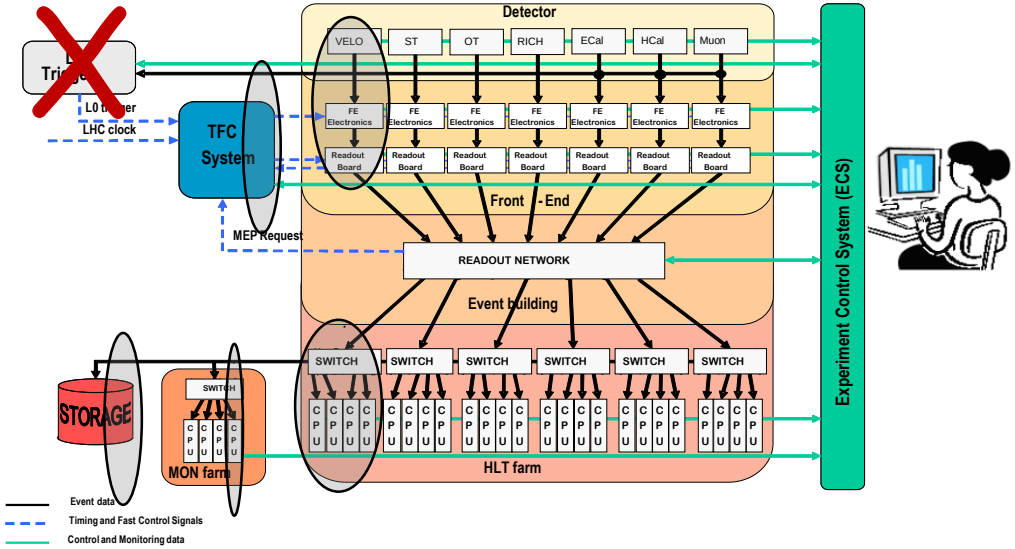
Domain

x

Sub-detector

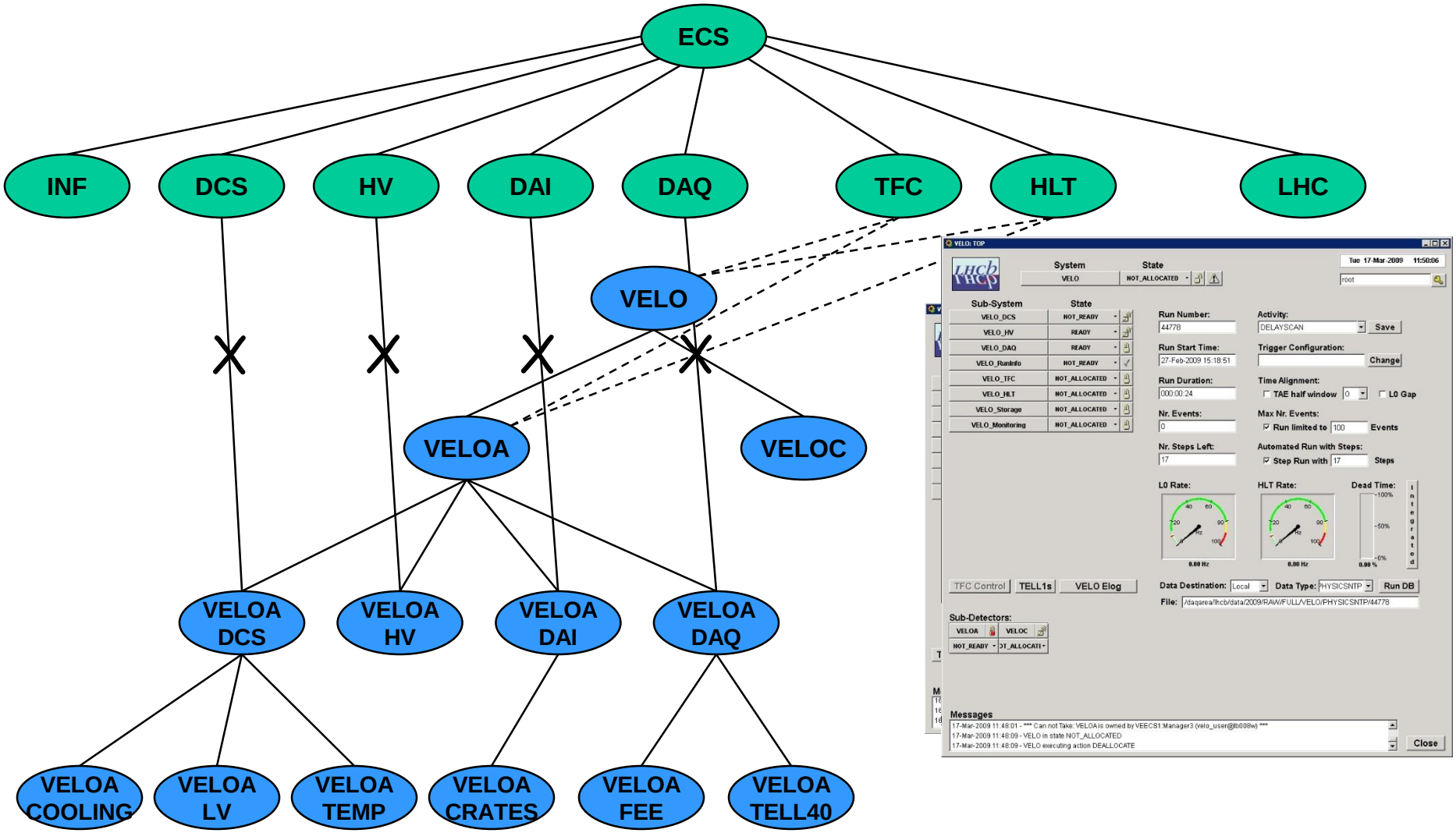
DAQ Partitioning

- **Partition:**
  - Part of the system that can run independently and concurrently with the others (LHCb, VELO, RICH1, etc.)
- **Some resources are shared:**
  - TFC
  - HLT
  - Storage
  - Monitoring
  - Reconstruction

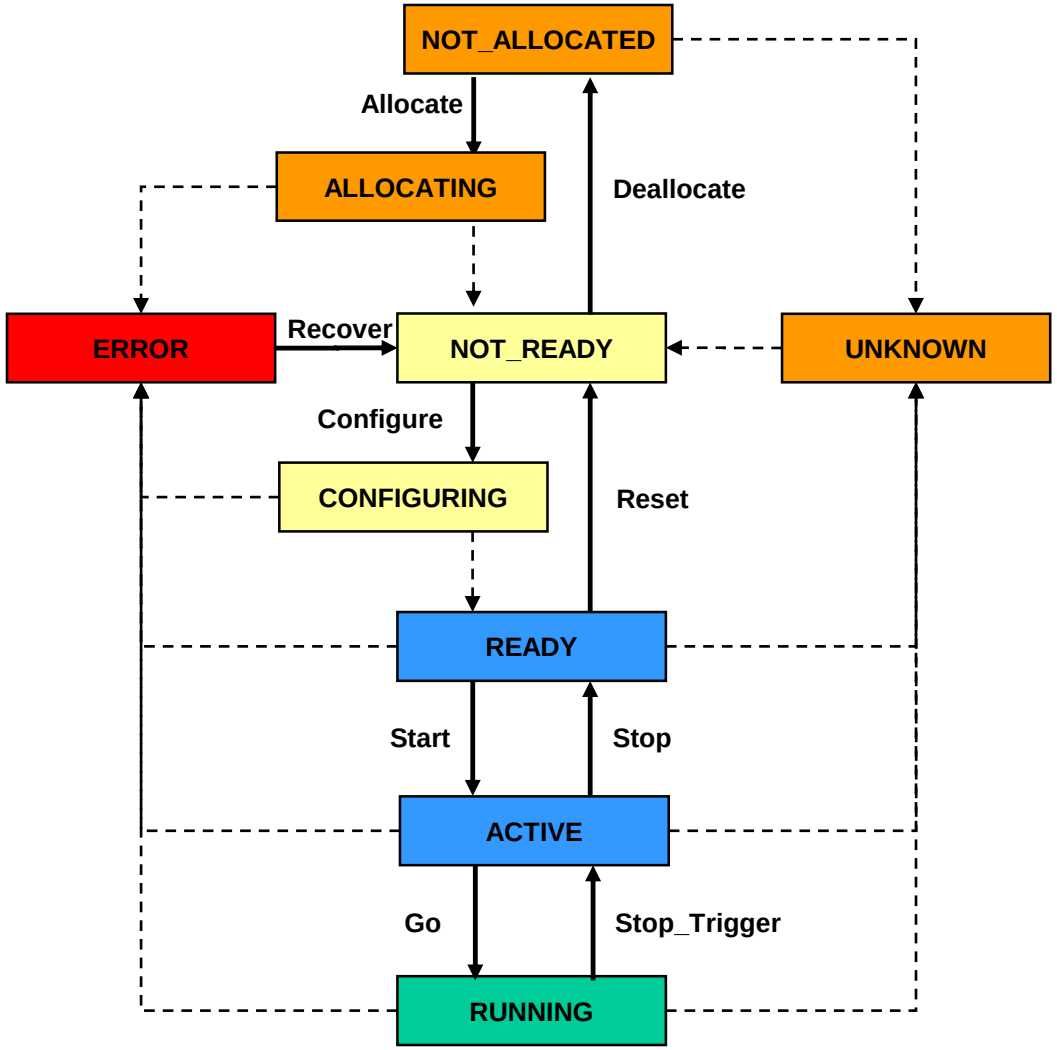


- **Need to "Allocate"**
  - In order to define the resources needed by a partition:
  - For example the number of HLT sub-farms

Sub-Detector Integration

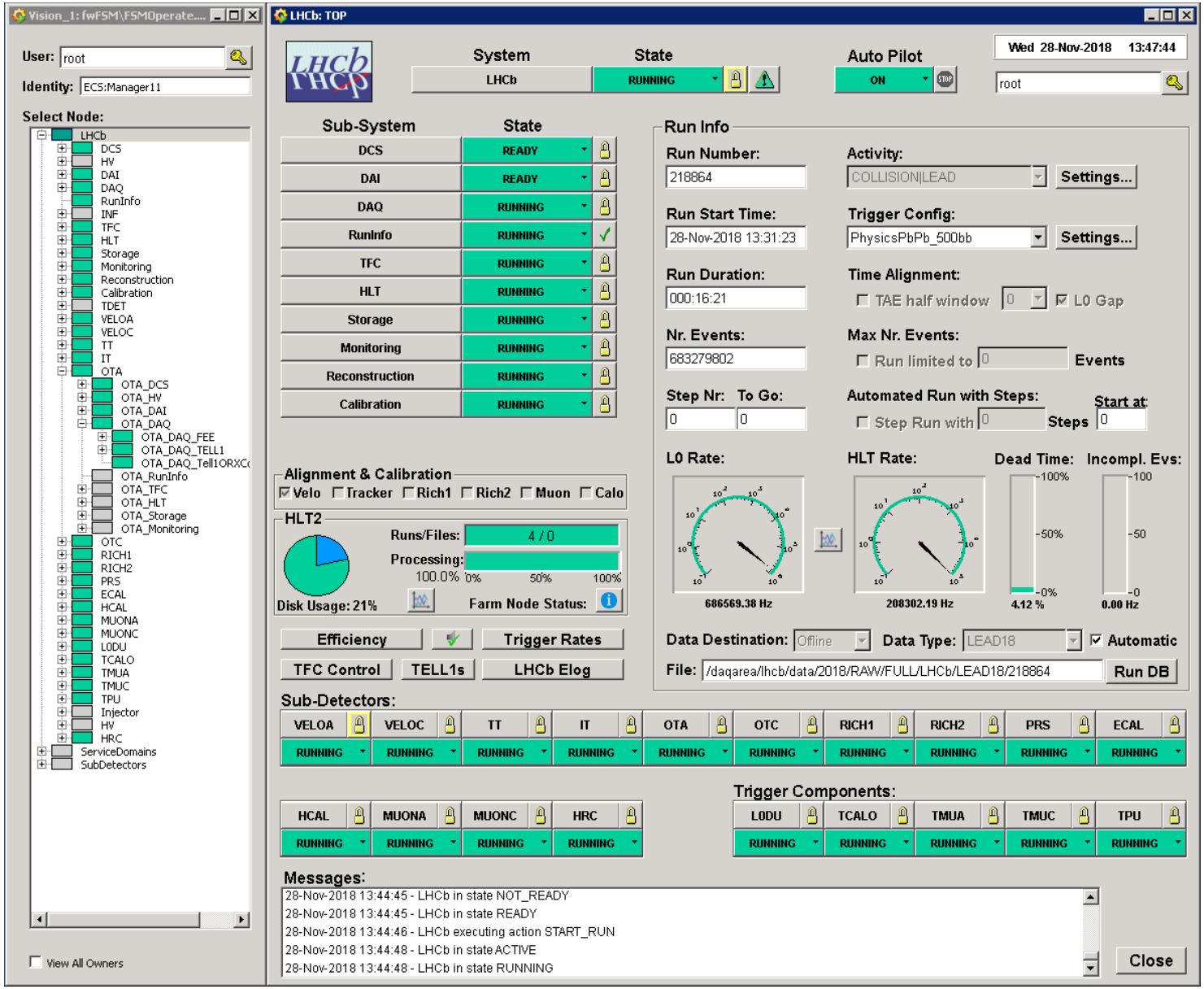


Run Control FSM



- **Steps:**
  - Allocate resources
  - Configure Sub-systems:
    Apply Electronics settings
    prepare DAQ/HLT jobs
  - Start:
    Prepare to acquire data
  - Start Trigger:
    TFC only

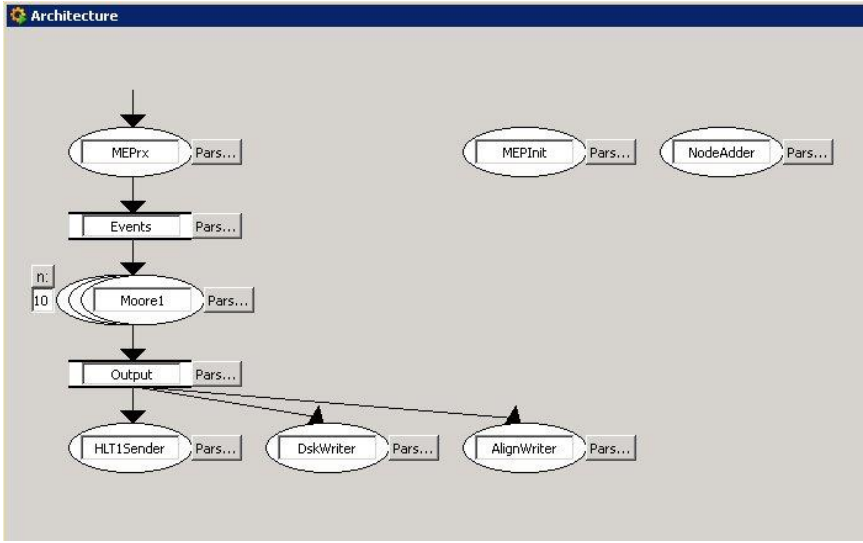
Run Control



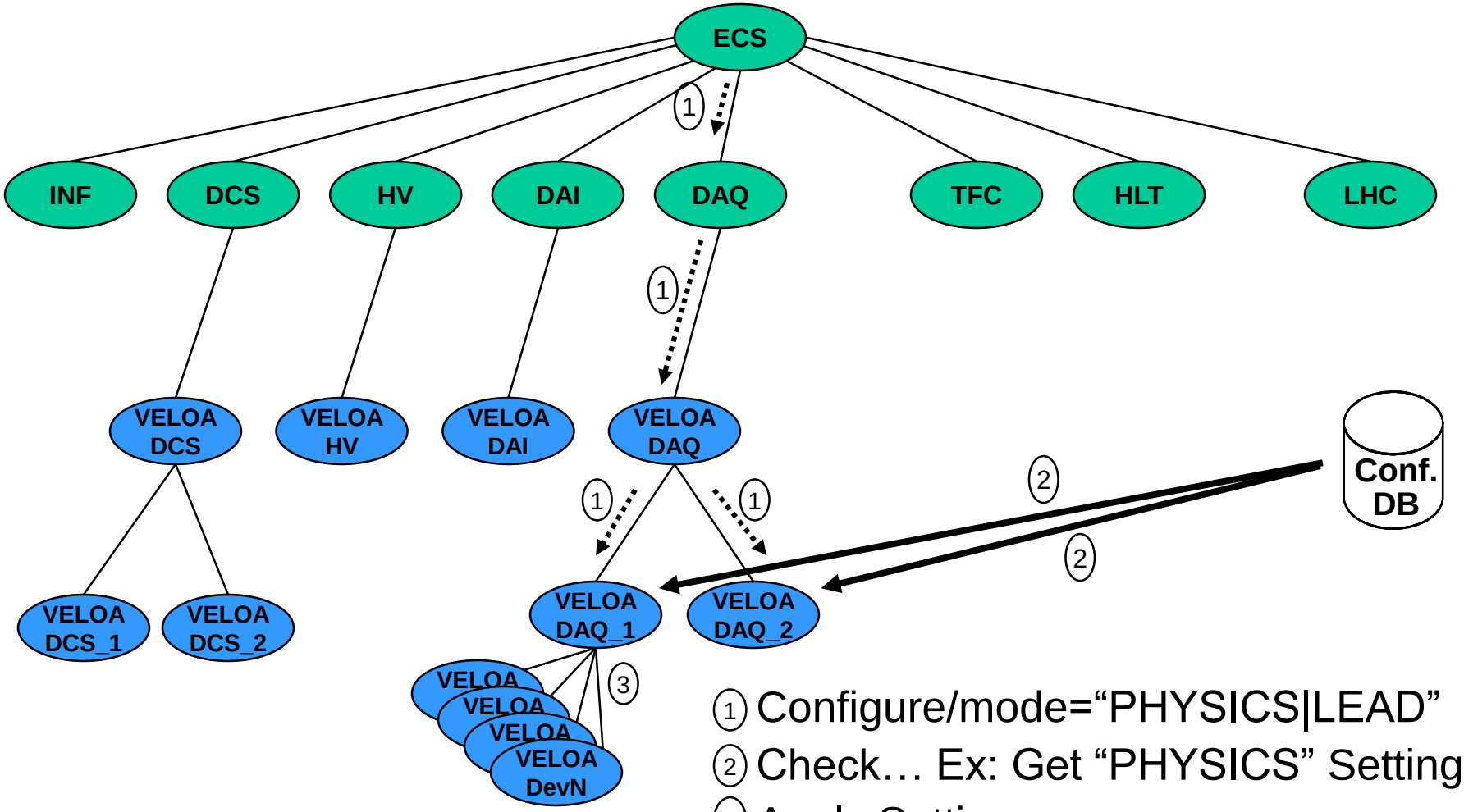
- **Matrix**
  Domain
  x
  Sub-detector
- **Activity**
  Driven

Run Control Activities

- **Activity**
  - "Activity" defines the "recipe" which will be applied by all sub-systems on CONFIGURE
    - Ex.: PHYSICS|LEAD
      Will try to apply "PHYSICS|LEAD" everywhere, if not existing will try "PHYSICS", if not existing "DEFAULT"
  - "Activity" also contains the global run settings:
    - Architecture for farm nodes ->
    - Nr. Sub-farms
    - Trigger Config. (TCK)
    - Data Type & Destination:
      - Local, Castor, Offline
    - Calibration "Step Runs"
      - TAE flag, nr. events, nr. steps



Sub-detector Configuration



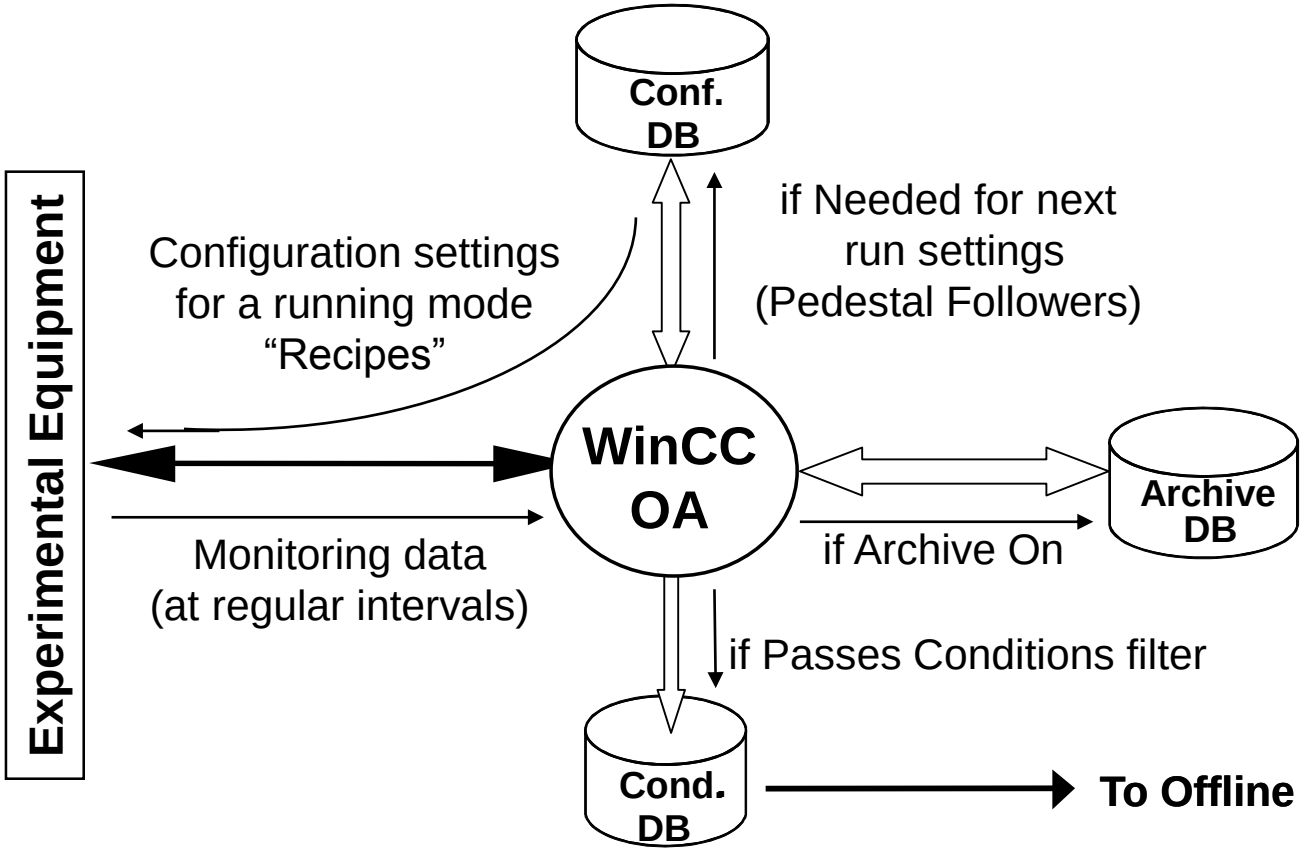
1 Configure/mode="PHYSICS|LEAD"

2 Check… Ex: Get "PHYSICS" Settings

3 Apply Settings

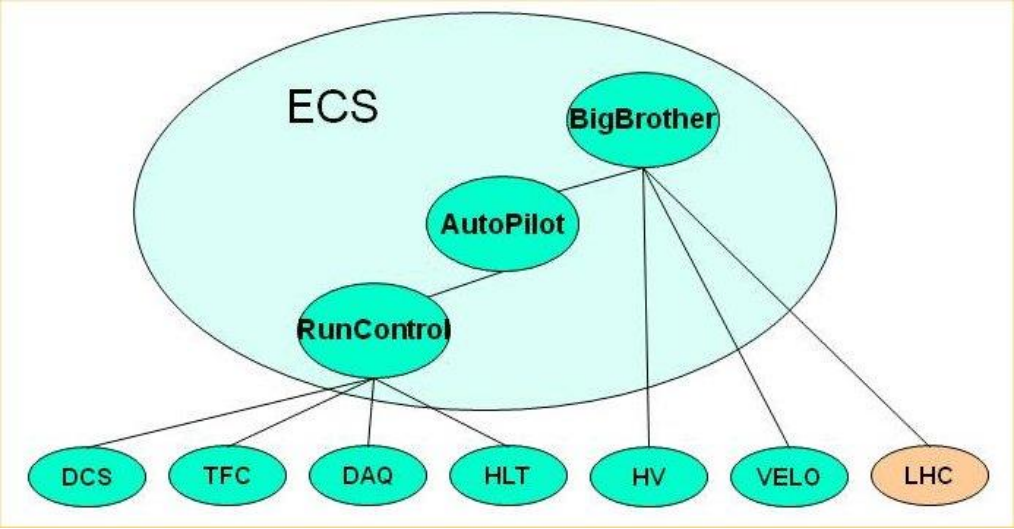
ECS Databases

WinCC-OA (Project) Data Base Context



LHCb Operations

- **Main Tools:**



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  - **Based on the LHC state:**
    - **Controls SD Voltages**
    - **VELO Closure**
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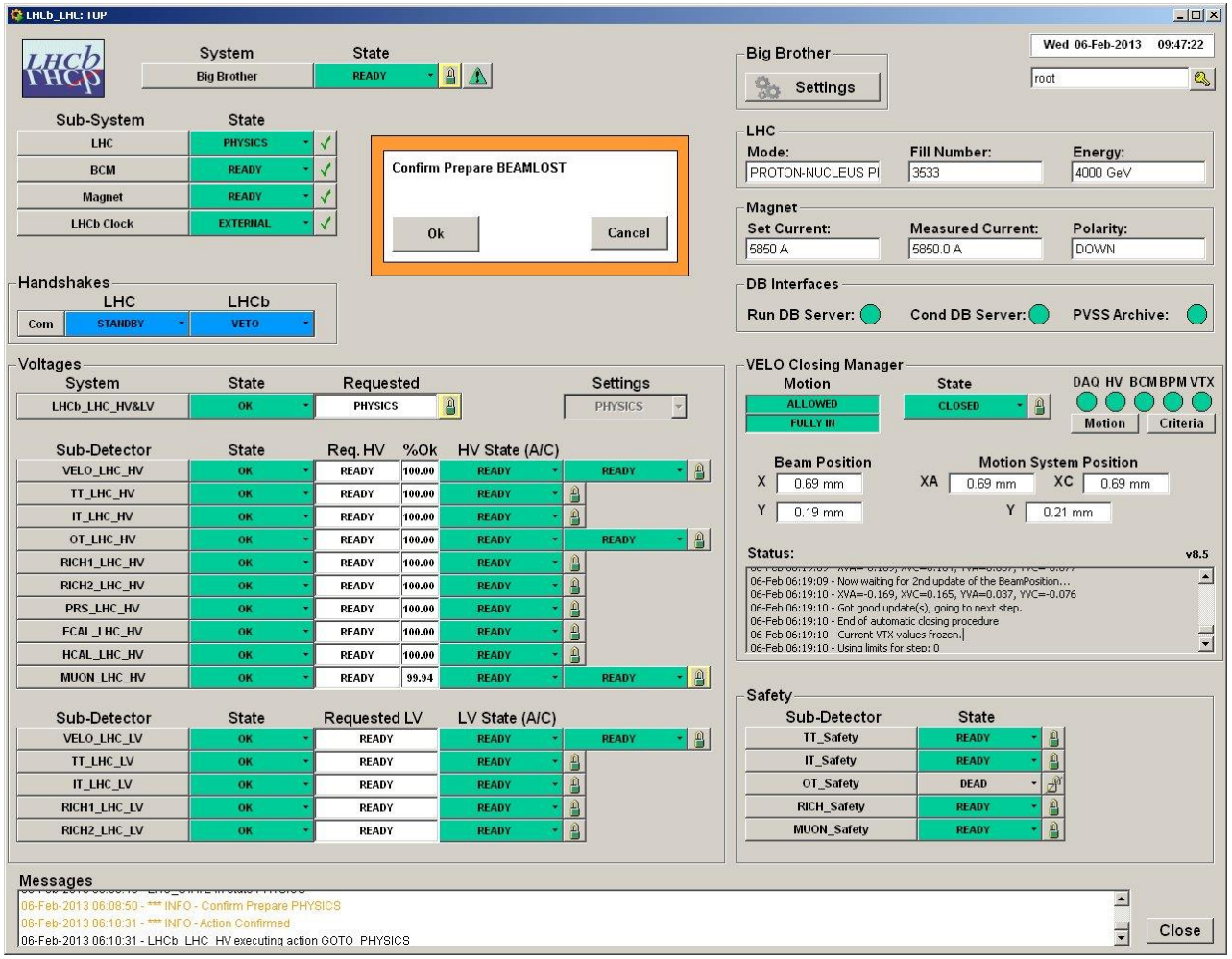
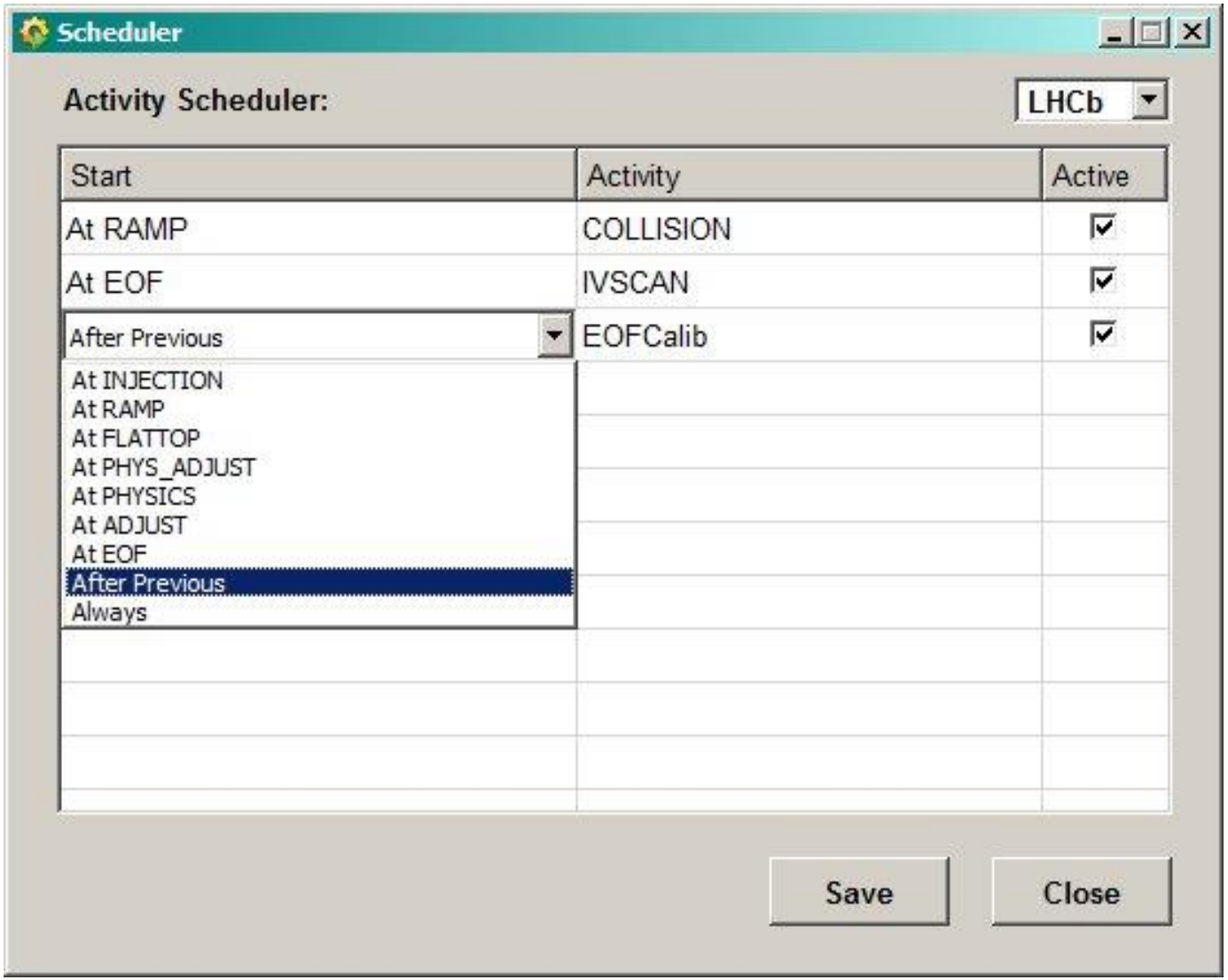
Big Brother



- Based on LHC state, controls:
  - Voltages
  - VELO Closure
  - Run Control
- Can sequence activities, ex.:
  - End-of-fill Calibration
- Handshake Confirmation
- Voice Messages

Big Brother Scheduler



- **Scheduler: Provides complete Run Control Automation**

Big Brother Voltage Table

LHCb_LHC_HV_Info: TOP

Device: LHCb_LHC_HV_Info

State: OK

Tue 20-Sep-2011 15:55:58

root

HV Configuration

Subdetector	Injection	S	I	Ramp	S	I	PhysAdjust	S	I	Physics	S	I	Adjust	S	I	Dump	S	I	NoBeam	S	I	MD	S	I	EOF	S	I
ECAL	STANDBY1	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY1	☑	☐	_ANY_	☑	☐	OFF	☑	☐	STANDBY1	☑	☐
HCAL	STANDBY1	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY1	☑	☐	_ANY_	☑	☐	OFF	☑	☐	STANDBY1	☑	☐
IT	STANDBY1	☑	☐	STANDBY1	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY1	☑	☐	STANDBY1	☑	☐	_ANY_	☑	☐	OFF	☑	☐	STANDBY1	☑	☐
MUON	STANDBY1	☑	☐	STANDBY2	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY1	☑	☐	_ANY_	☑	☐	OFF	☑	☐	STANDBY1	☑	☐
OT	OFF	☑	☐	STANDBY2	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY2	☑	☐	OFF	☑	☐	_ANY_	☑	☐	OFF	☑	☐	OFF	☑	☐
PRS	OFF	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	OFF	☑	☐	_ANY_	☑	☐	OFF	☑	☐	OFF	☑	☐
RICH1	OFF	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
RICH2	OFF	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
TT	STANDBY1	☑	☐	STANDBY1	☑	☐	READY	☑	☐	READY	☑	☐	STANDBY1	☑	☐	STANDBY1	☑	☐	_ANY_	☑	☐	OFF	☑	☐	STANDBY1	☑	☐
VELO	OFF	☑	☐	STANDBY1	☑	☐	STANDBY2	☑	☐	READY	☑	☐	STANDBY2	☑	☐	OFF	☑	☐	_ANY_	☑	☐	OFF	☑	☐	OFF	☑	☐

LV Configuration

Subdetector	Injection	S	I	Ramp	S	I	PhysAdjust	S	I	Physics	S	I	Adjust	S	I	Dump	S	I	NoBeam	S	I	MD	S	I	EOF	S	I
IT	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
RICH1	OFF	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
RICH2	OFF	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
TT	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐
VELO	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	READY	☑	☐	_ANY_	☑	☐	OFF	☑	☐	READY	☑	☐

Mode: Browse / Edit

Revert Changes | Apply Changes

Messages

Close

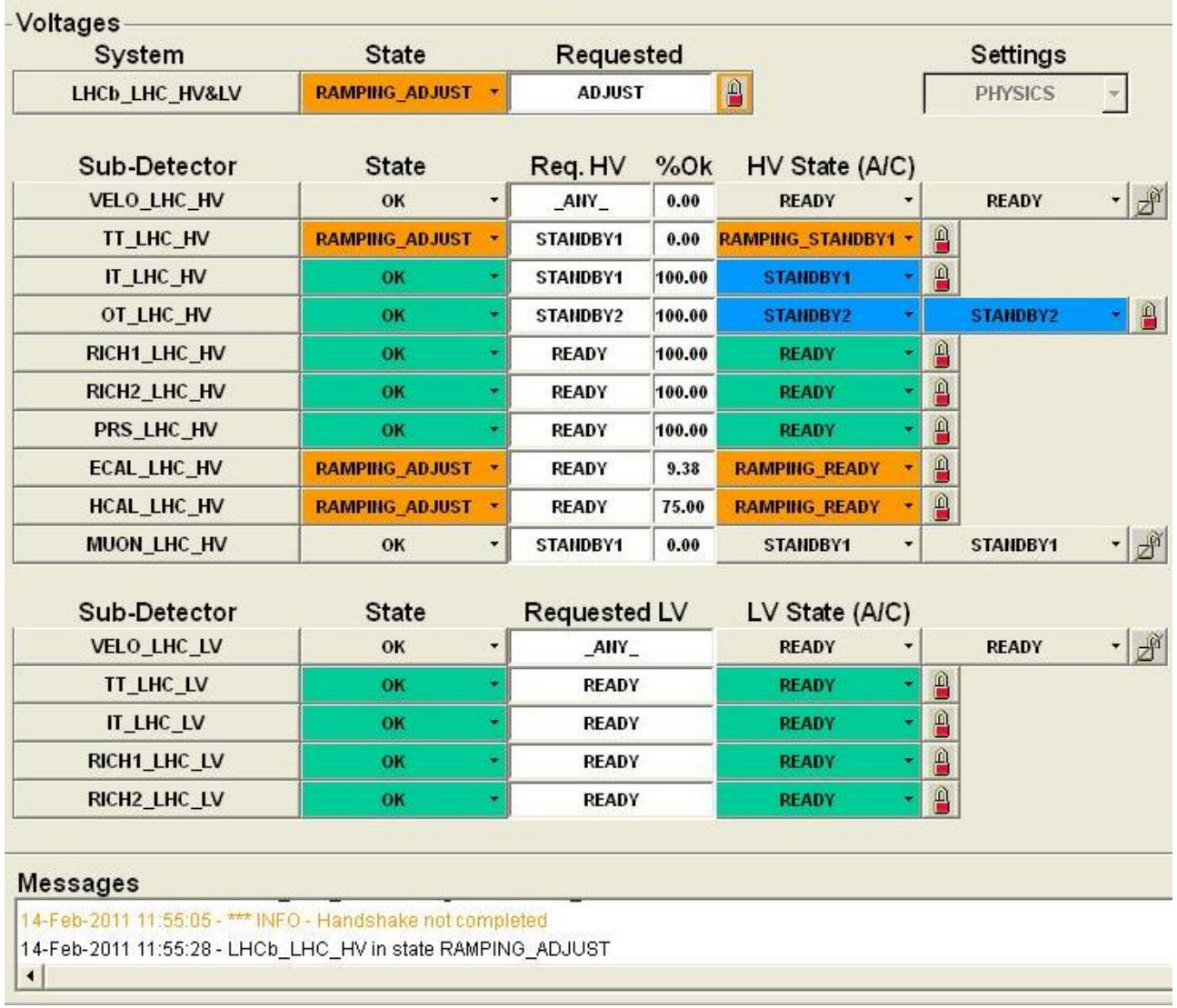
- **Matrix**

Sub-detector

X

LHC State

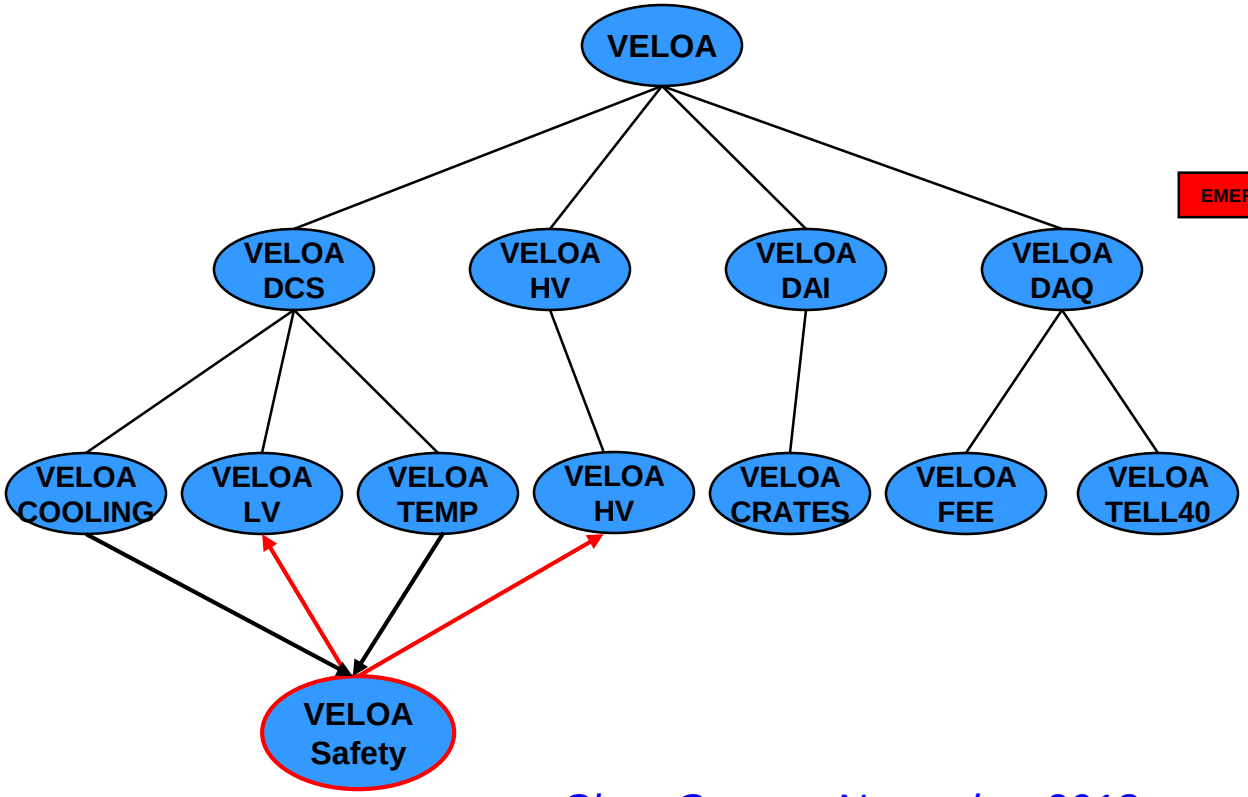
Voltage Control

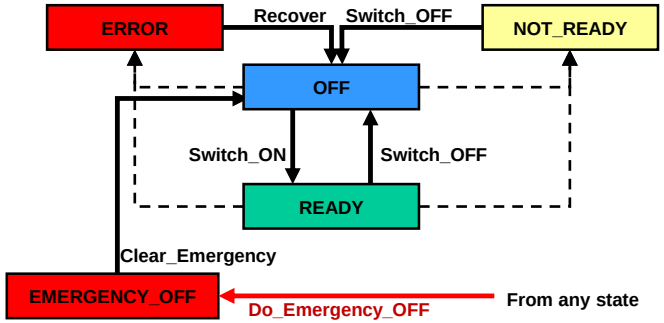


- State column
  (Current SD state regard. LHC state)
- Requested
  (SD target state)
- %Ok
- HV/LV State
  (SD Current state)

Safety Tree(s)

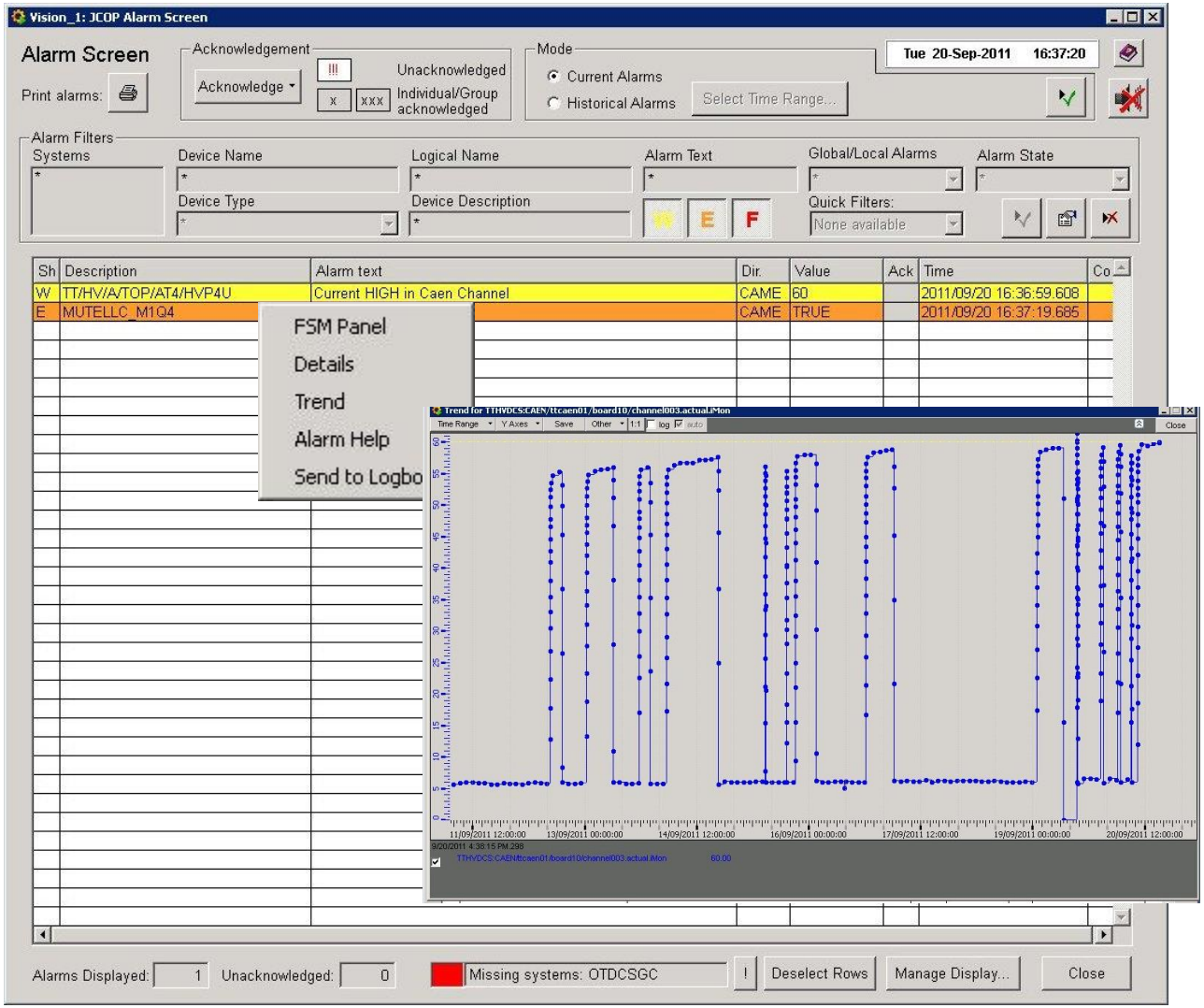
- **Sub-detectors can have a "parallel" Safety tree**
  - Does not replace HW/DSS interlocks





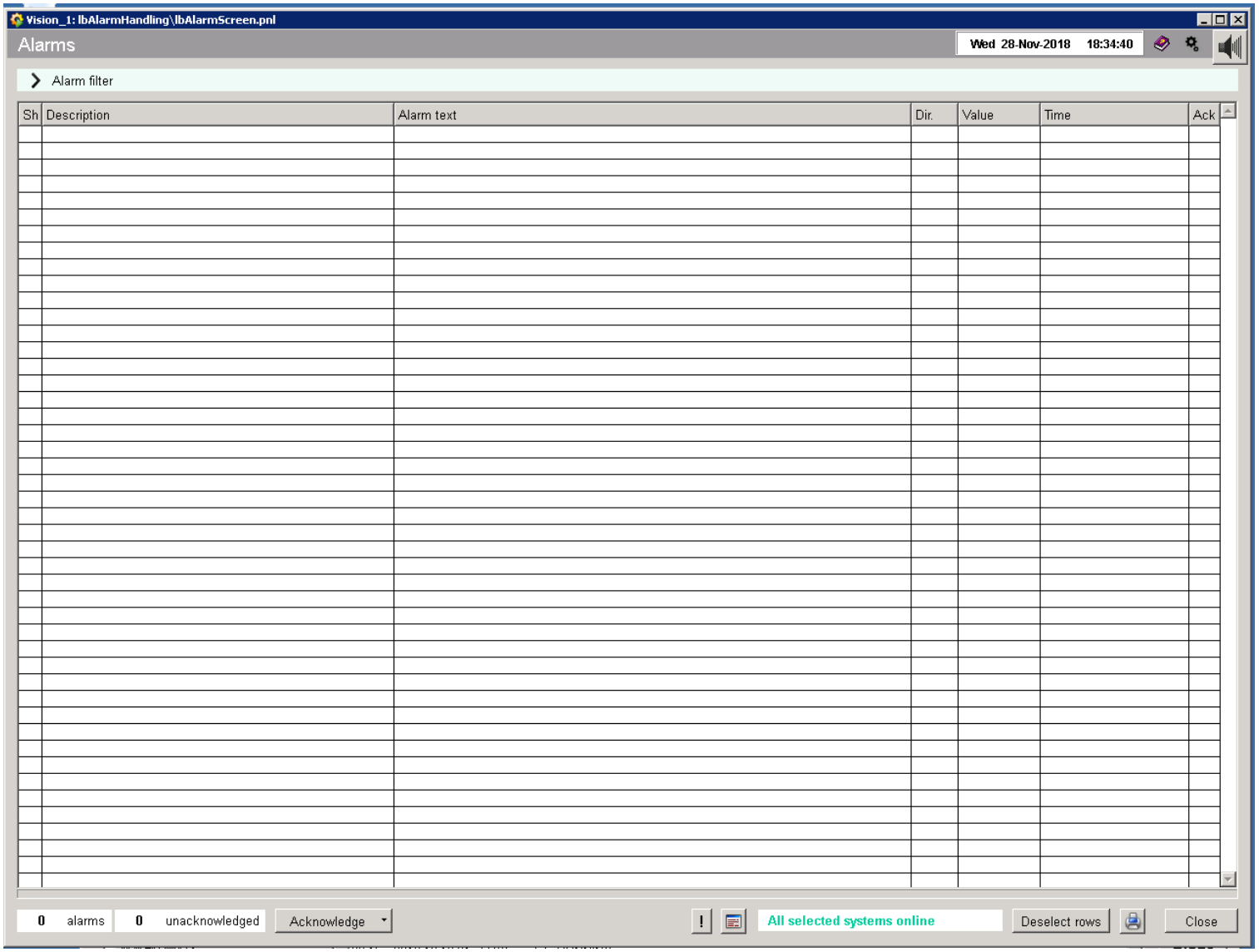
DCS FSM
(HV FSM Equivalent)

Alarm Screen



- Normally empty
- Every alarm should be followed up
- May also provide complementary information to FSM Errors
- Severities:
  - **Warning**
  - **Error**
  - **Fatal**

Alarm Screen (Yesterday)



Slide from Nov. 2006

	VELO	ST		OT	RICH		CALO			MUON	
		IT	TT		RICH1	RICH2	ECAL	HCAL	PRS/SPD		
DAQ											
FE	SPECS	SPECS	SPECS	SPECS	SPECS/J	SPECS/J	SPECS	SPECS	SPECS	ELMB	
TELL1/UKL1	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	CC-PC	
DCS											
LV	CAEN E	Wiener M	Wiener M	Wiener M	Wiener M	Wiener M	Wiener M	Wiener M	Wiener M	Wiener M	
Environ.	ELMB	SPECS	SPECS	SPECS	ELMB	ELMB			ELMB	ELMB	
Cooling	Nikhef	2 TC/CV	2 TC/CV	TC/CV	TC/CV	TC/CV	TC/CV	TC/CV	TC/CV	TC/CV	
Gas				GasWG	GasWG	GasWG				GasWG	
HV											
HV	ISEG	CAEN	CAEN	CAEN	CC-PC	CC-PC	SPECS	SPECS	SPECS	C	FL
DAI											
crates	CERN	CERN	CERN	CERN	CERN	CERN	CERN	CERN	CERN	CERN	

	VELO	ST		OT	RICH		CALO			MUON
		IT	TT		RICH1	RICH2	ECAL	HCAL	PRS/SPD	
Other										
VELO Posit.	PLC									
VELO Vacuum	PLC									
VELO Interlock	ELMB									
ST BP pos.		SPECS	SPECS							
IT RadMon		VME								
OT Pos. Mon										
OT RASNIK Al				PCI						
RICH Si. bias					CAEN	CAEN				
RICH Magfield					?	?				
RICH Laser Al										
RICH MagDist										
Calo LED							SPECS	SPECS	SPECS	
Calo source							CAN	CAN	CAN	

Legend:

- **Not yet started**
- **Development started (Tools identified)**
- **Under development**
- **Almost Ready (Prototype exists)**
- **Ready**

Conclusion

- **ECS "Readiness"**
  - Tools are better than in 2016, but:
    - Very short time
    - A lot to be done
    - (In 2008 we had an extra year…)

- **Don't hesitate to talk to us…**