LHCB's

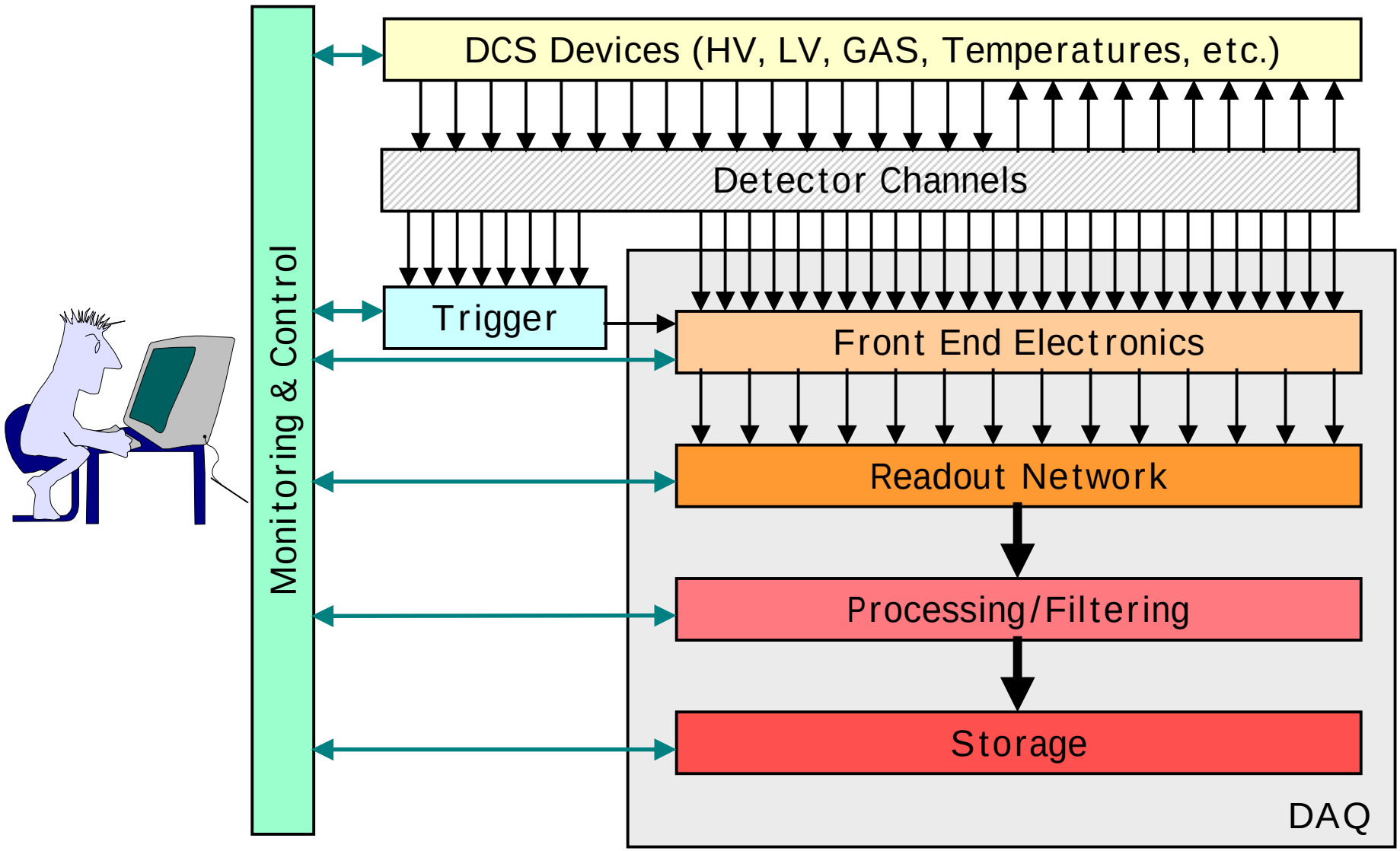
Experiment Control System

Clara Gaspar, September 2001

Experiment Control

- **In charge of the Control and Monitoring of:**
  - Detector Operations (ex Slow Controls)
    - GAS, HV, LV, temperatures...
  - Data Acquisition and Trigger
    - FE Electronics, Event building, EFF, etc.
  - Experimental Infrastructures
    - Cooling, ventilation, electricity distribution, ...
  - Interaction with the outside world
    - Magnet, accelerator system, safety system, etc.

ECS Scope


DCS Devices (HV, LV, GAS, Temperatures, etc.)
Detector Channels
Trigger
Front End Electronics
Readout Network
Processing/Filtering
Storage
DAQ
Monitoring & Control

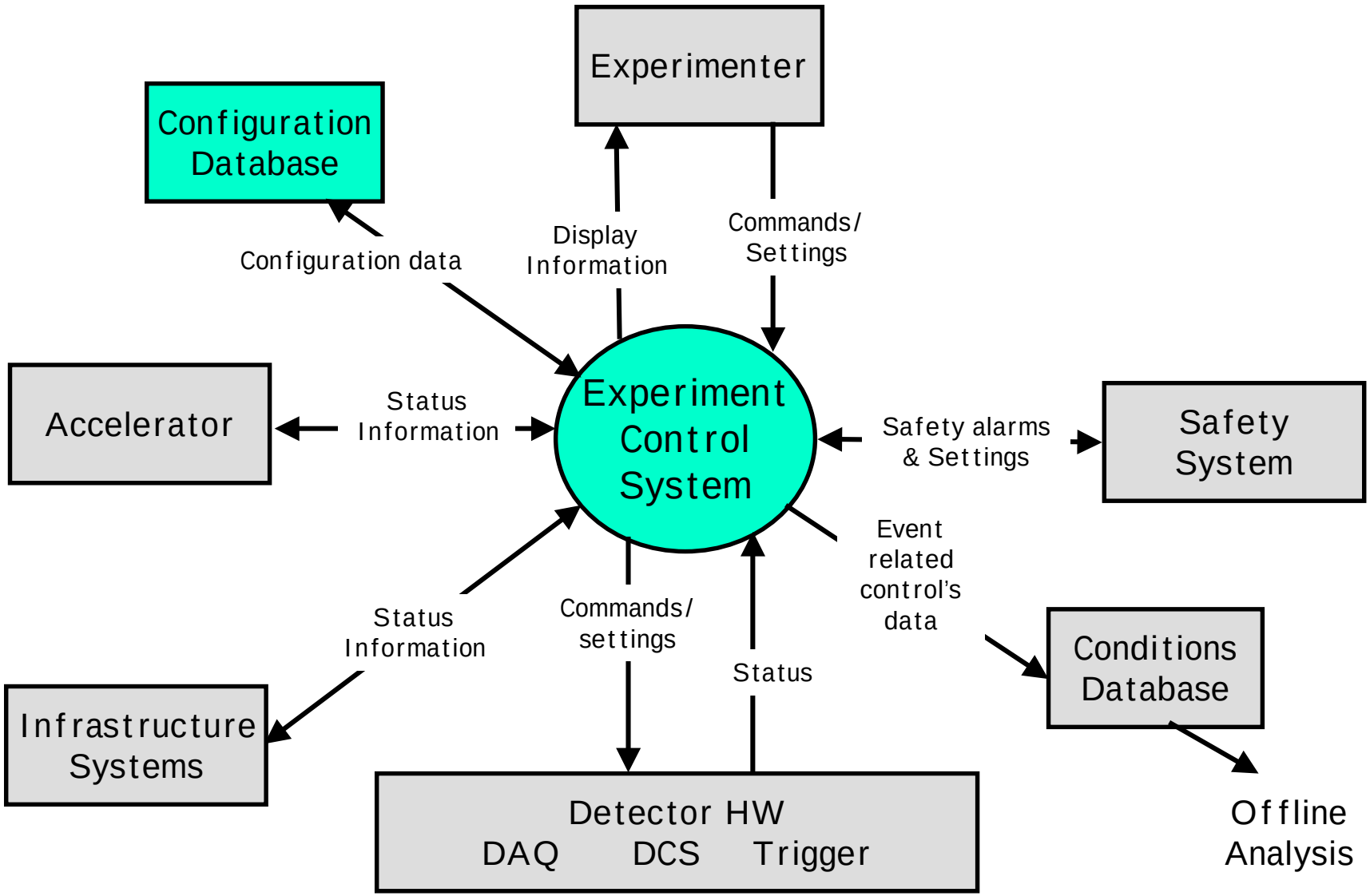
ECS Requirements

- **Integrate the different activities**
  - Such that rules can be defined (ex: Stop DAQ when DCS in Error)
- **Allow Stand-alone control of sub-systems**
  - For independent development and concurrent usage.
- **Automation**
  - Avoids human mistakes and speeds up standard procedures
- **Easy to operate**
  - Two to three operators (non-experts) should be able to run the experiment.
- **Scalable & Flexible**
  - Allow for the integration of new detectors
- **Maintainable**
  - Experiments run for many years

Experiment Control

- **Keyword: Homogeneity**
  - A Common Approach in the design and implementation of all parts of the system:
    - Facilitates inter-domain integration
    - Makes it easier to use:
      - Standard features throughout the system (ex: partitioning rules)
      - Uniform Look and Feel
    - Allows an easier upgrade and maintenance
    - Needs less manpower

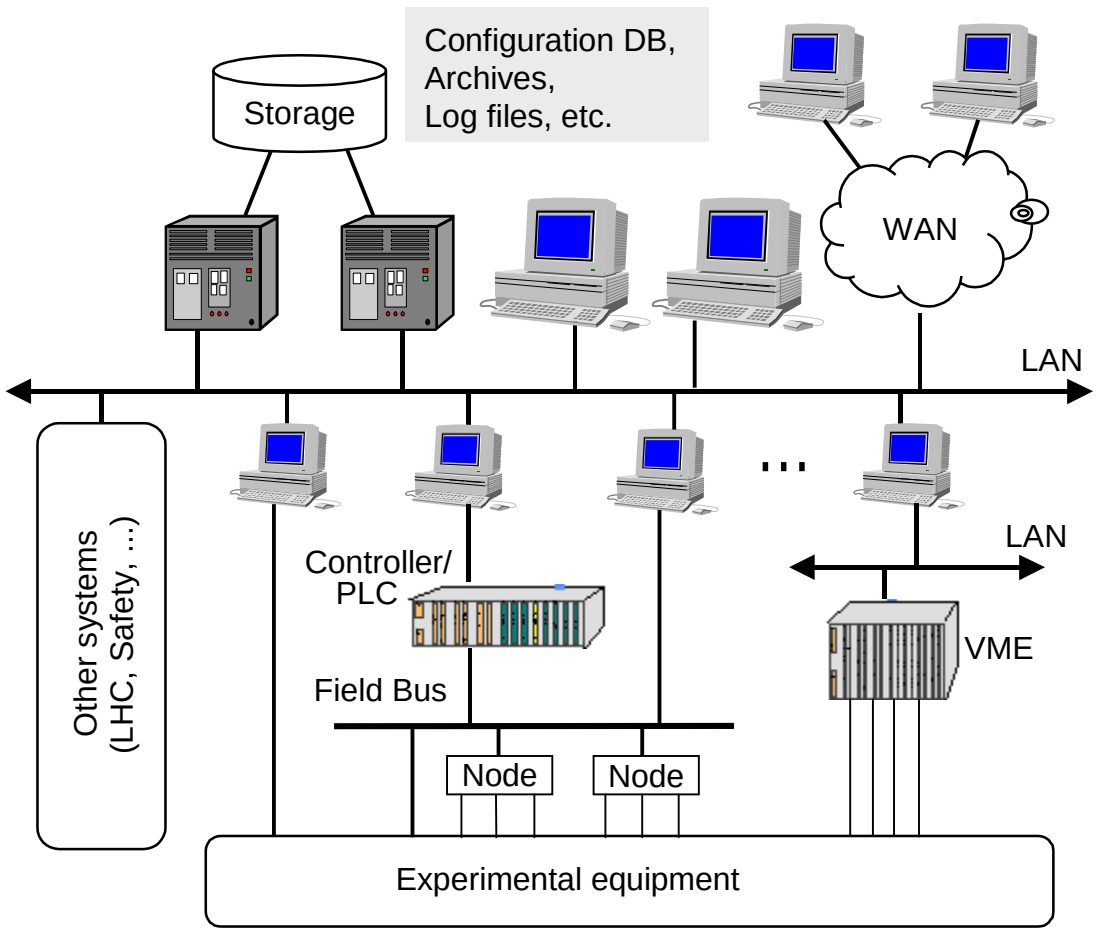
ECS Context Diagram

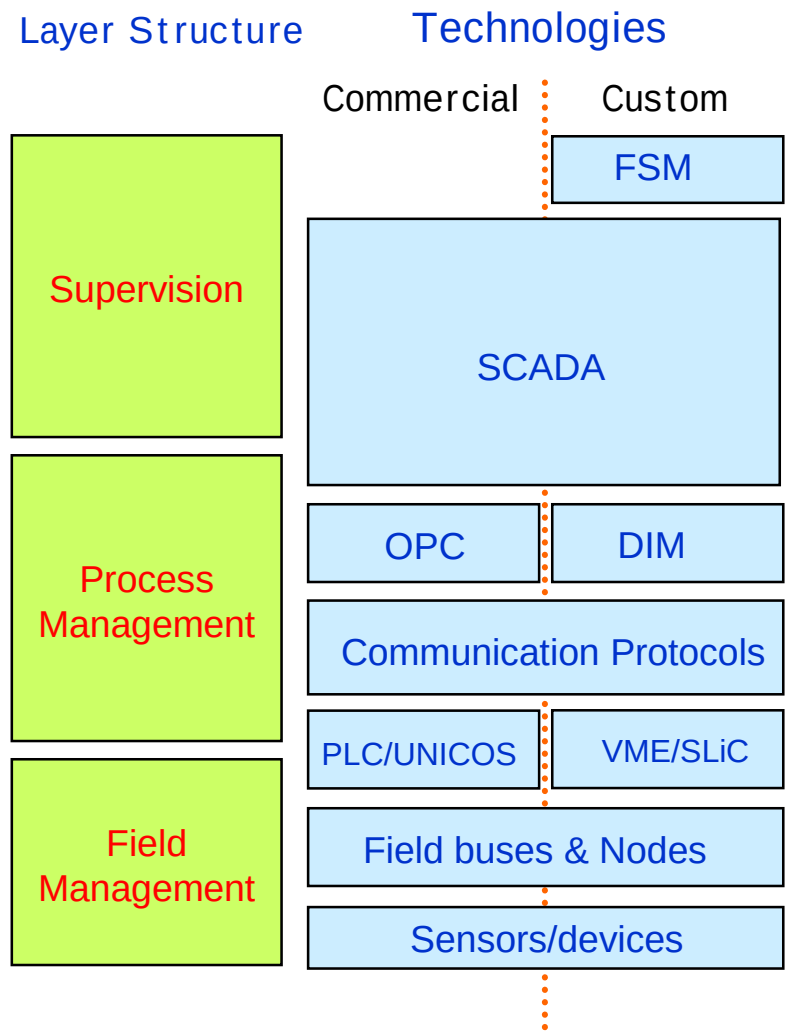


ECS design

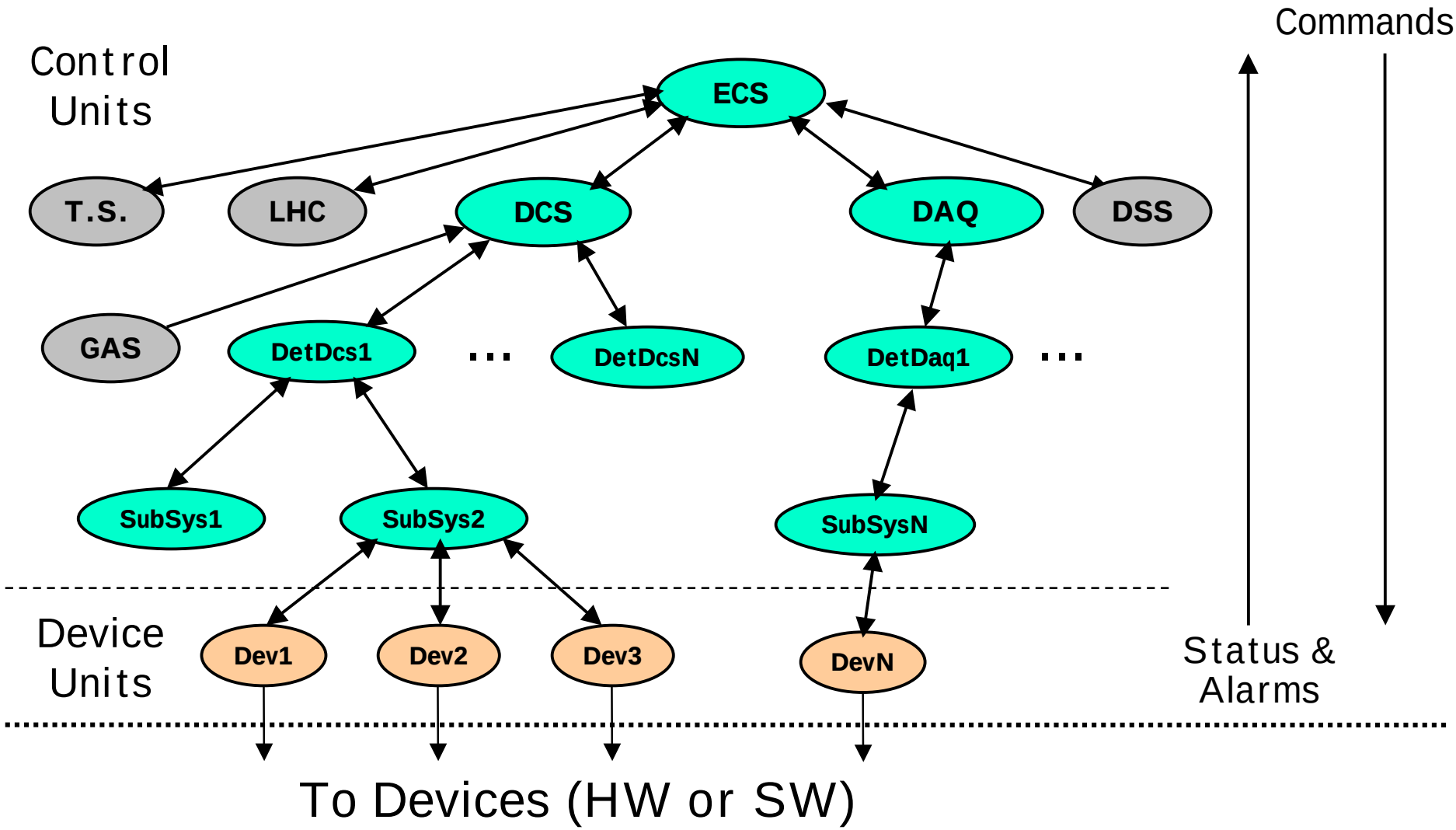
- **Integrated approach from design phase**
- **An Architecture**
  - That can handle all aspects of the monitoring and control of the Experiment
- **A framework**
  - A collection of tools and mechanisms that allow the implementation of the architecture

HW Architecture





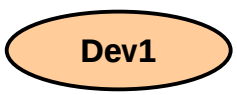
Generic SW Architecture



The Framework

- **An integrated collection of guidelines, tools and components**
- **Should be provided to sub-system developers in order to:**
  - Allow the development of each component coherently in view of its integration in the complete system.
  - For the two types of components:

Control Units

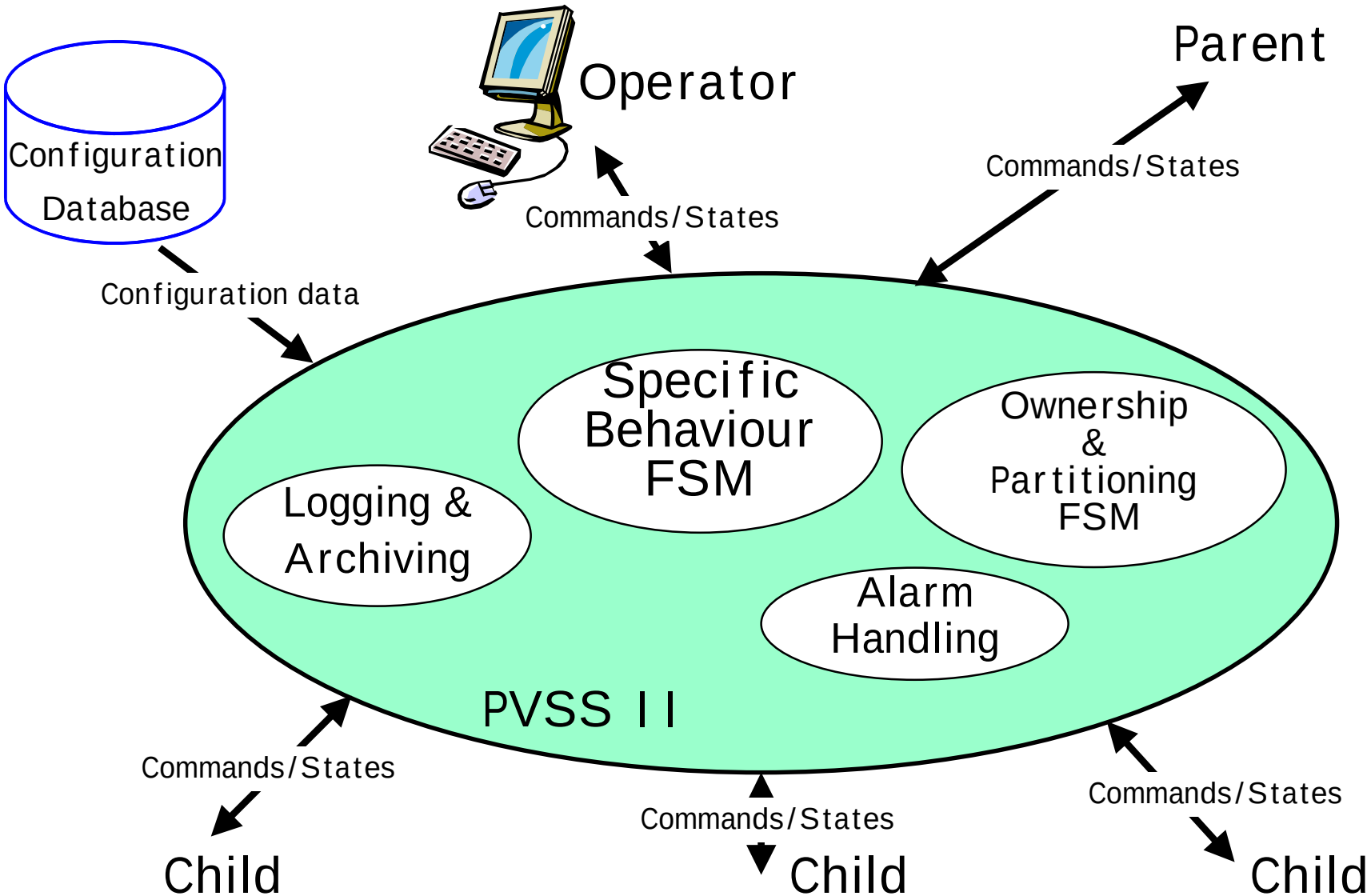


Device Units

Control Units

- **Each CU is inherently able to:**
  - Configure, monitor and control its children
    - Sequence & Automate operations
    - Recover errors
  - Handle Alarms
    - Filter and display alarms
  - Partition
    - Exclude one or more of its children
  - User Interfacing
    - Present information and receive commands

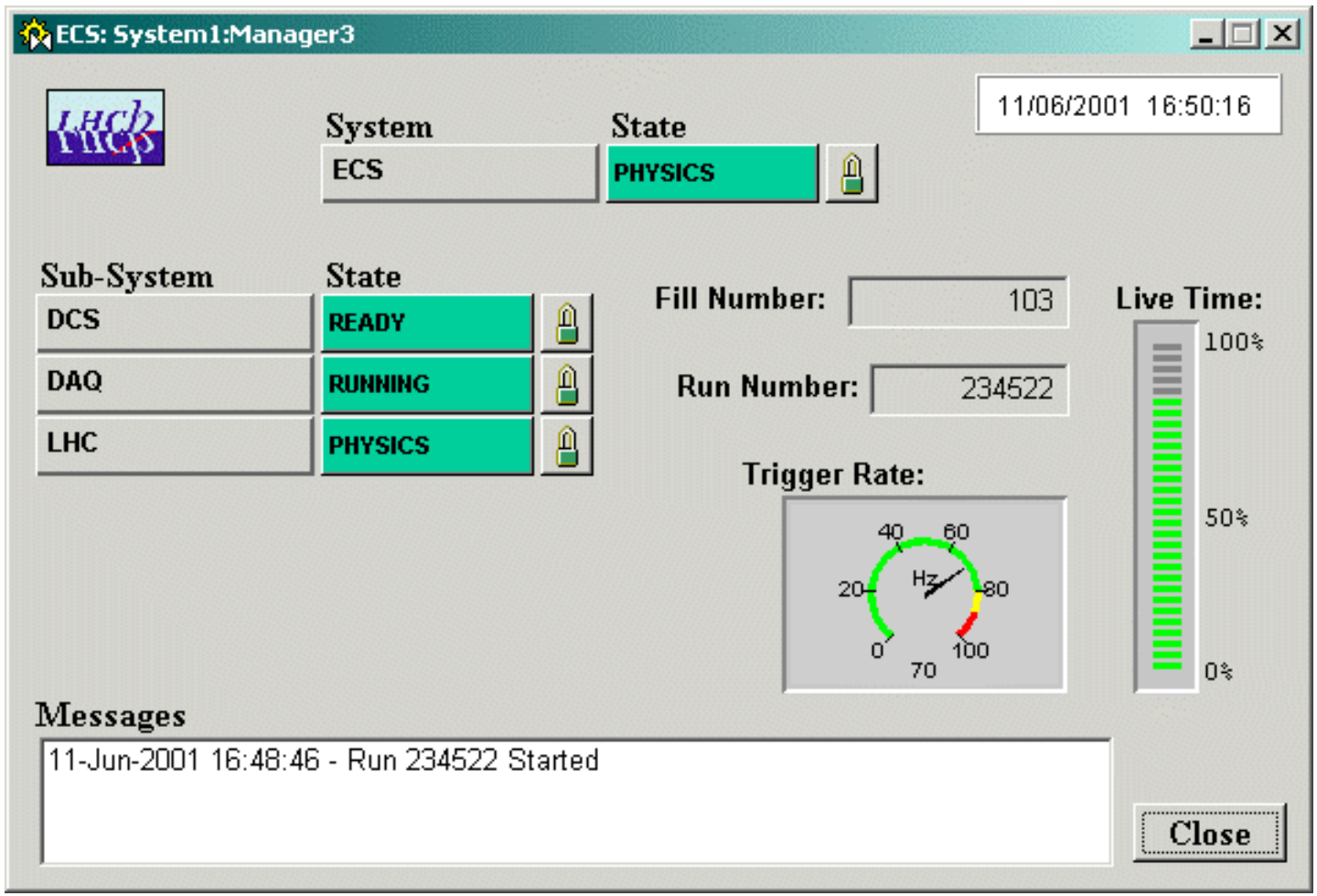
Control Units (cont.)



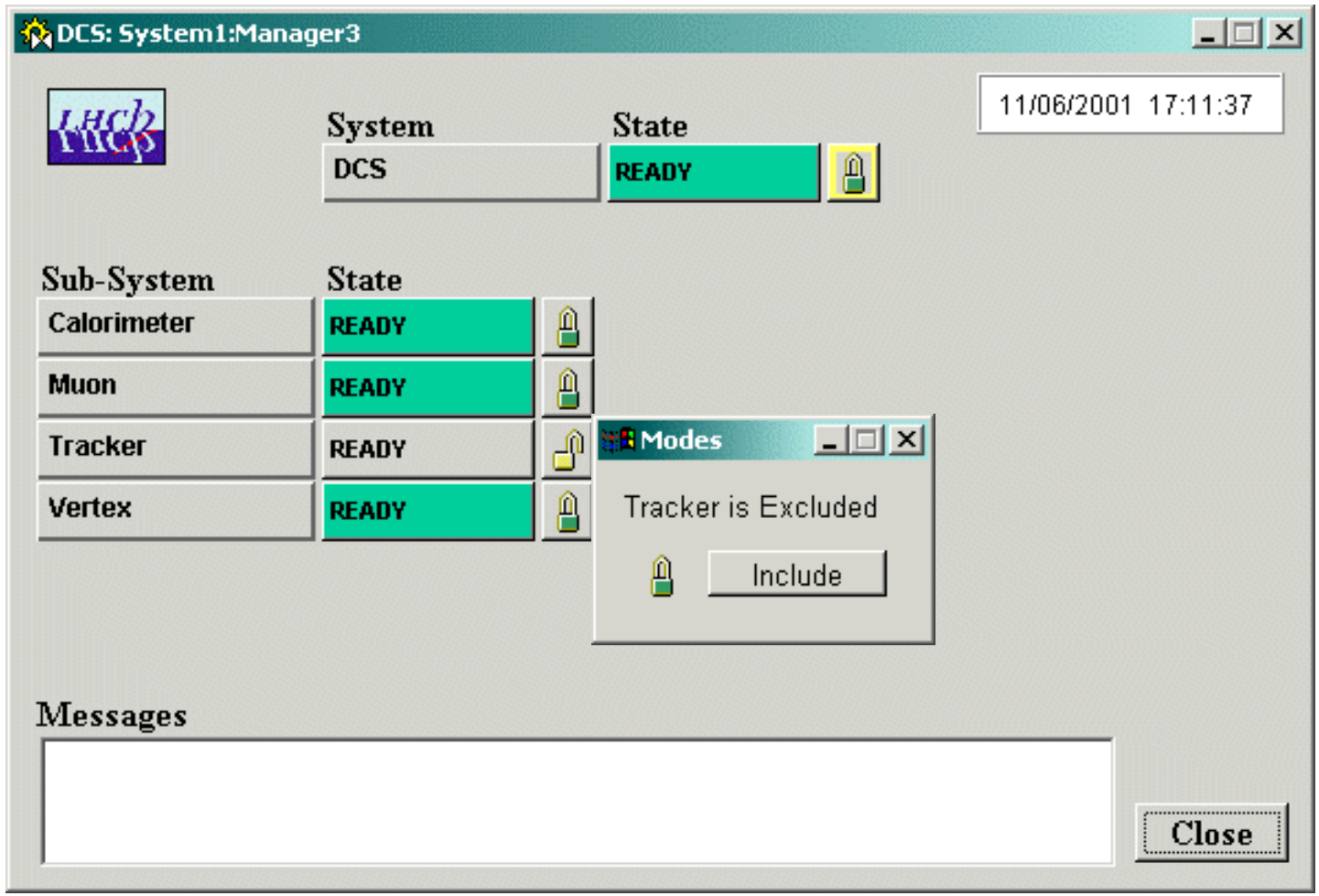
Run Control

- **Each Control Unit (and its sub-tree)**
  - Can run in stand-alone
  - Can be controlled independently
    (by an authorized User Interface)
- **Run Control**
  - Is a particular instance of a user interface:
  - ➡ It is the interface to the Root of the tree
  - ➡ If the tree is partitioned there can be several Run Controls.

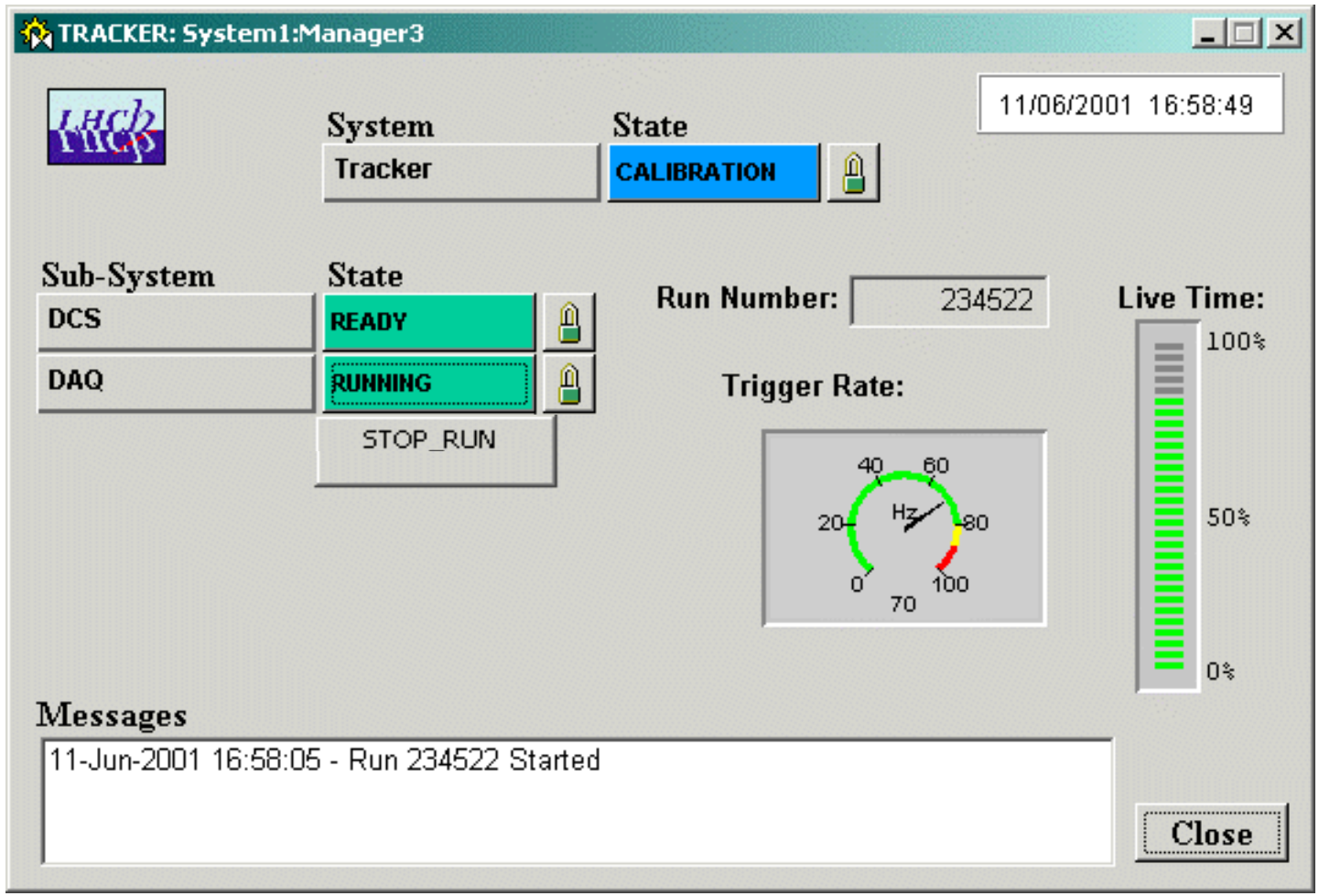
Run Control


ECS: System1:Manager3
11/06/2001 16:50:16
System
ECS
State
PHYSICS
Sub-System
State
DCS
READY
DAQ
RUNNING
LHC
PHYSICS
Fill Number:
103
Run Number:
234522
Live Time:
100%
50%
0%
Trigger Rate:
0
20
40
60
80
100
70
Hz
Messages
11-Jun-2001 16:48:46 - Run 234522 Started
Close

Partitioning Sub-Systems



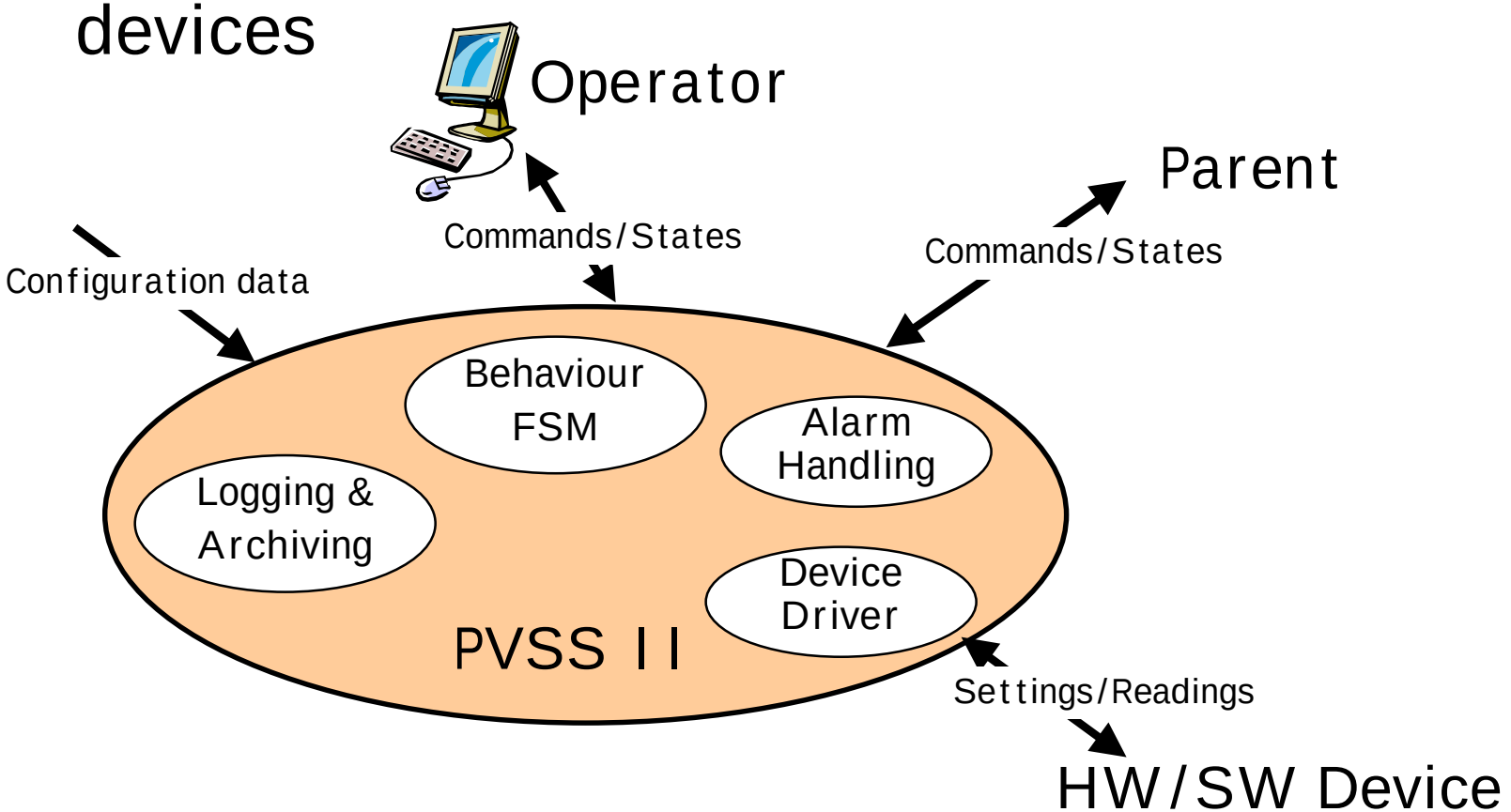
Sub-detector Control



Device Units

Device Units

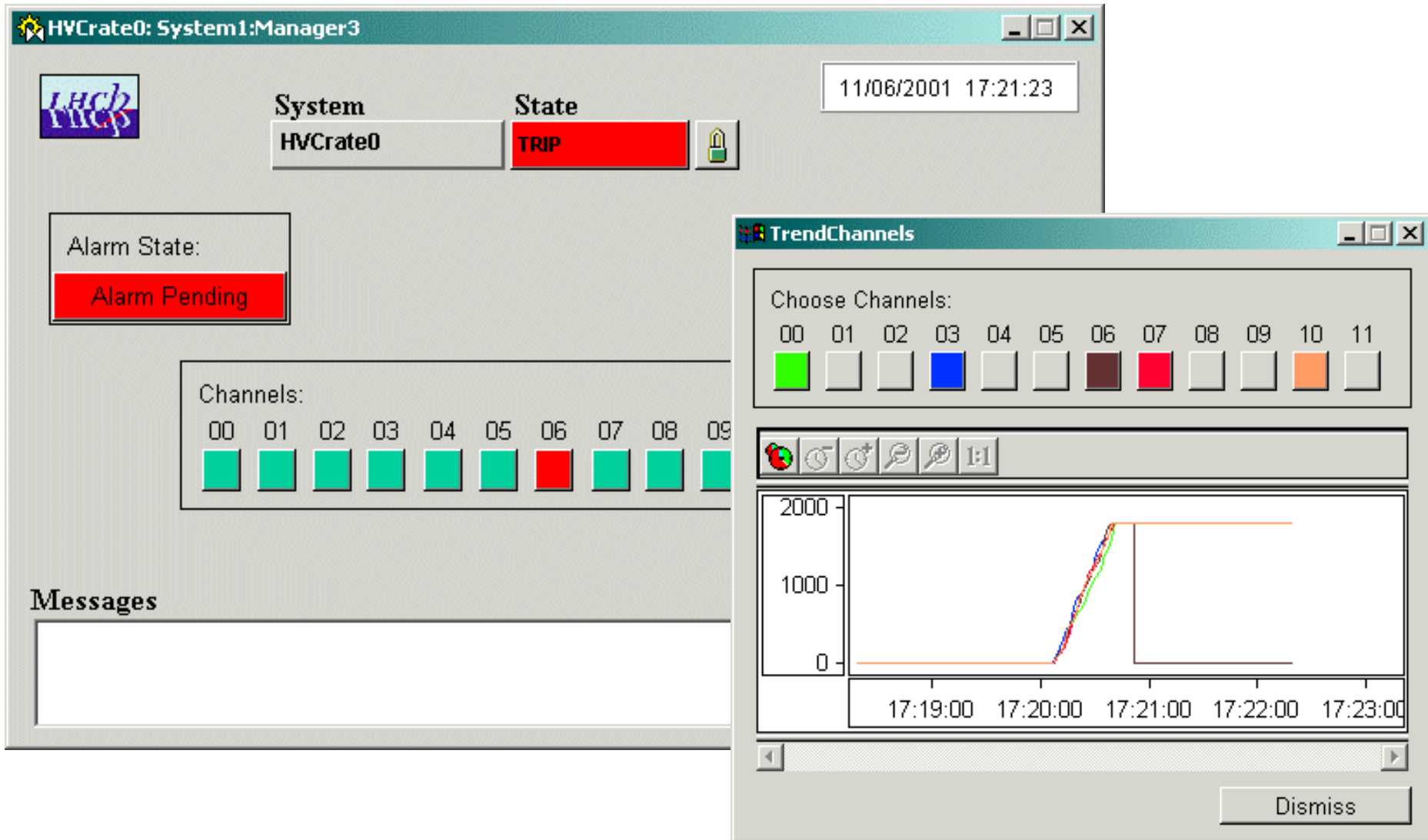
- Provide the interface to the different devices



DCS Devices

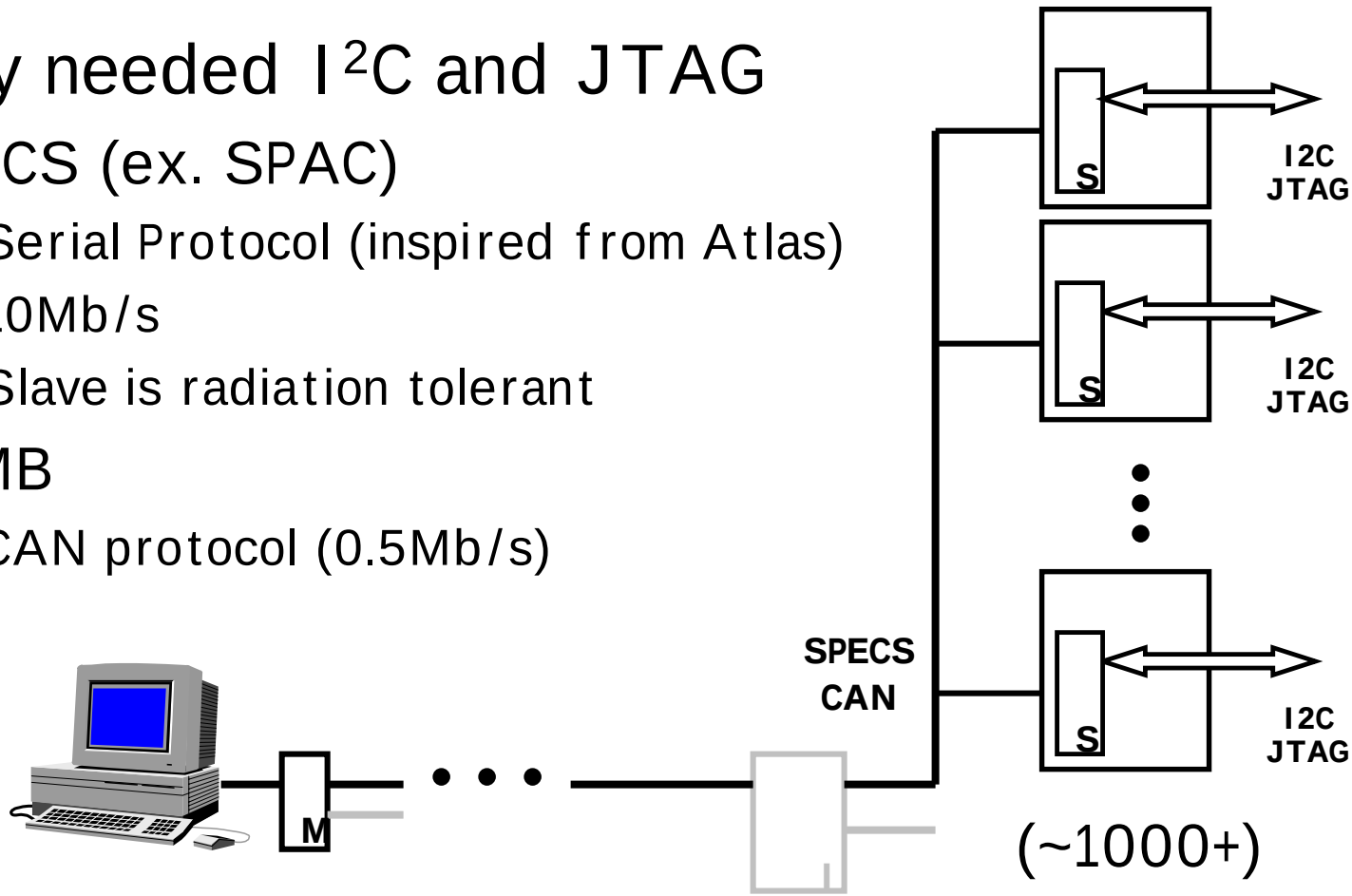
- High Voltages, Low Voltages, etc.
  - Try to use Commercial HW
  - Fieldbuses: CAN, Profibus, WorldFip, Ethernet
  - And OPC Servers (provided by manufacturer)
- Analog & Digital IO (temperatures, humidities, etc.)
  - Same as above, or
  - ELMBs / OPC Servers
- Others:
  - PLCs / OPC Servers
  - Home made / DIM or OPC Servers

HV Device


HVCrate0: System1:Manager3
11/06/2001 17:21:23
System
HVCrate0
State
TRIP
Alarm State:
Alarm Pending
Channels:
00 01 02 03 04 05 06 07 08 09
Messages
TrendChannels
Choose Channels:
00 01 02 03 04 05 06 07 08 09 10 11
2000
1000
0
17:19:00 17:20:00 17:21:00 17:22:00 17:23:00
Dismiss

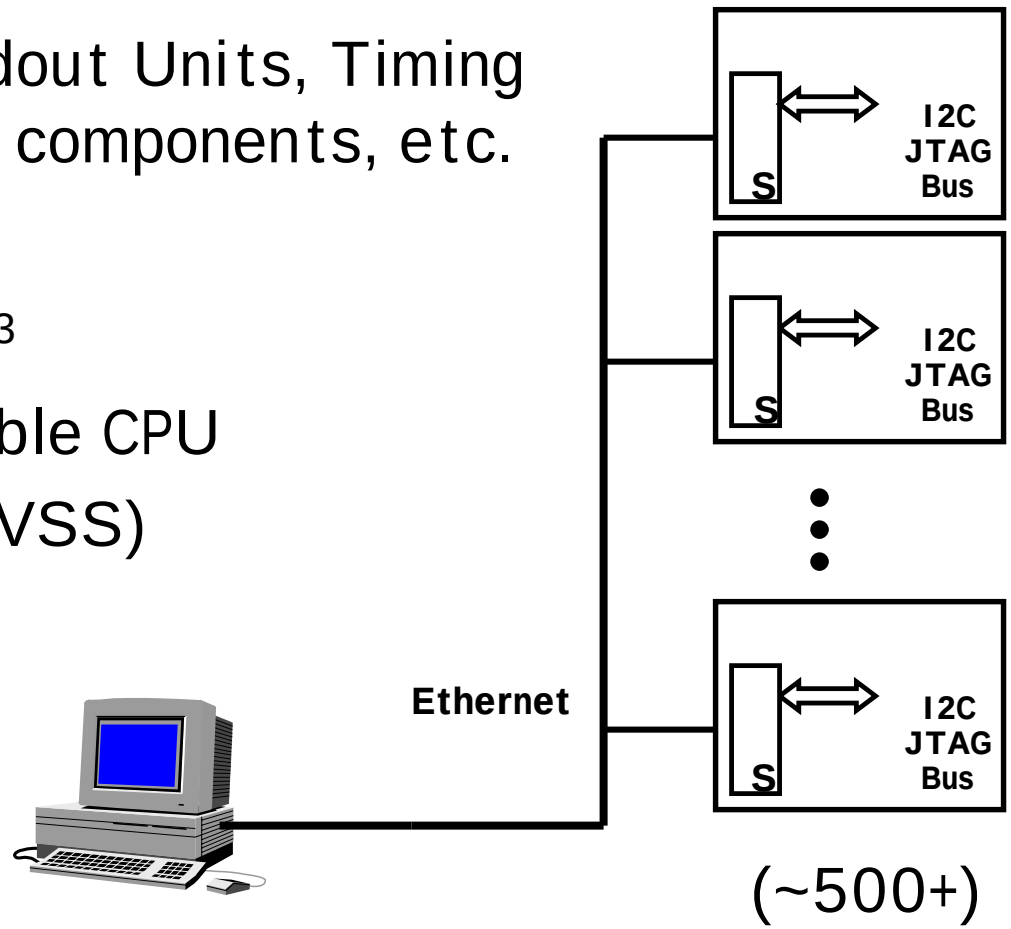
Front-End Electronics

- **In Radiation Areas**
  - Mainly needed I^2C and JTAG
    - SPECS (ex. SPAC)
      - Serial Protocol (inspired from Atlas)
      - 10Mb/s
      - Slave is radiation tolerant
    - ELMB
      - CAN protocol (0.5Mb/s)



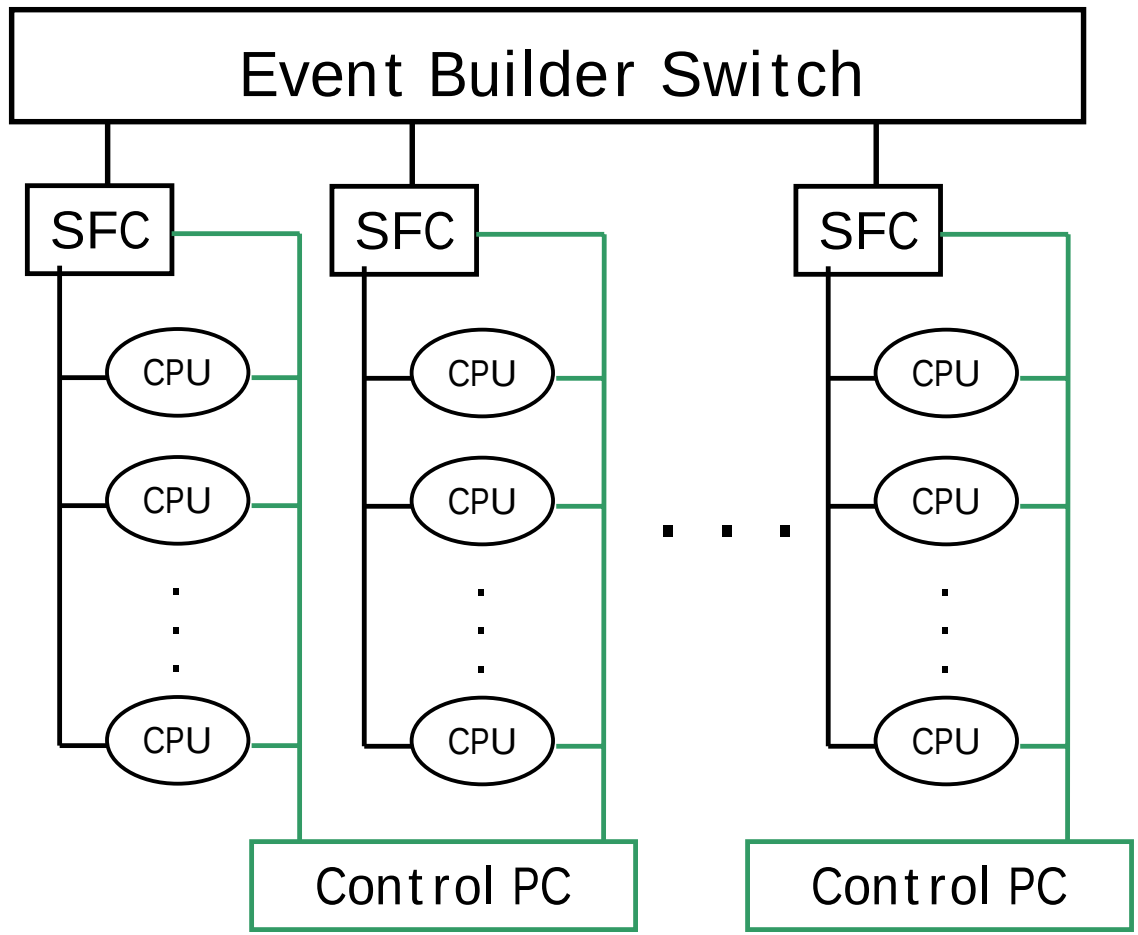
Board level electronics

- **Electronics in barracks**
  - Front-ends, Readout Units, Timing and Fast Control components, etc.
  - Credit Card PC's
    - $66 \times 85 \times 12$ mm^3
    - Pentium Compatible CPU
    - Linux/DIM (no PVSS)

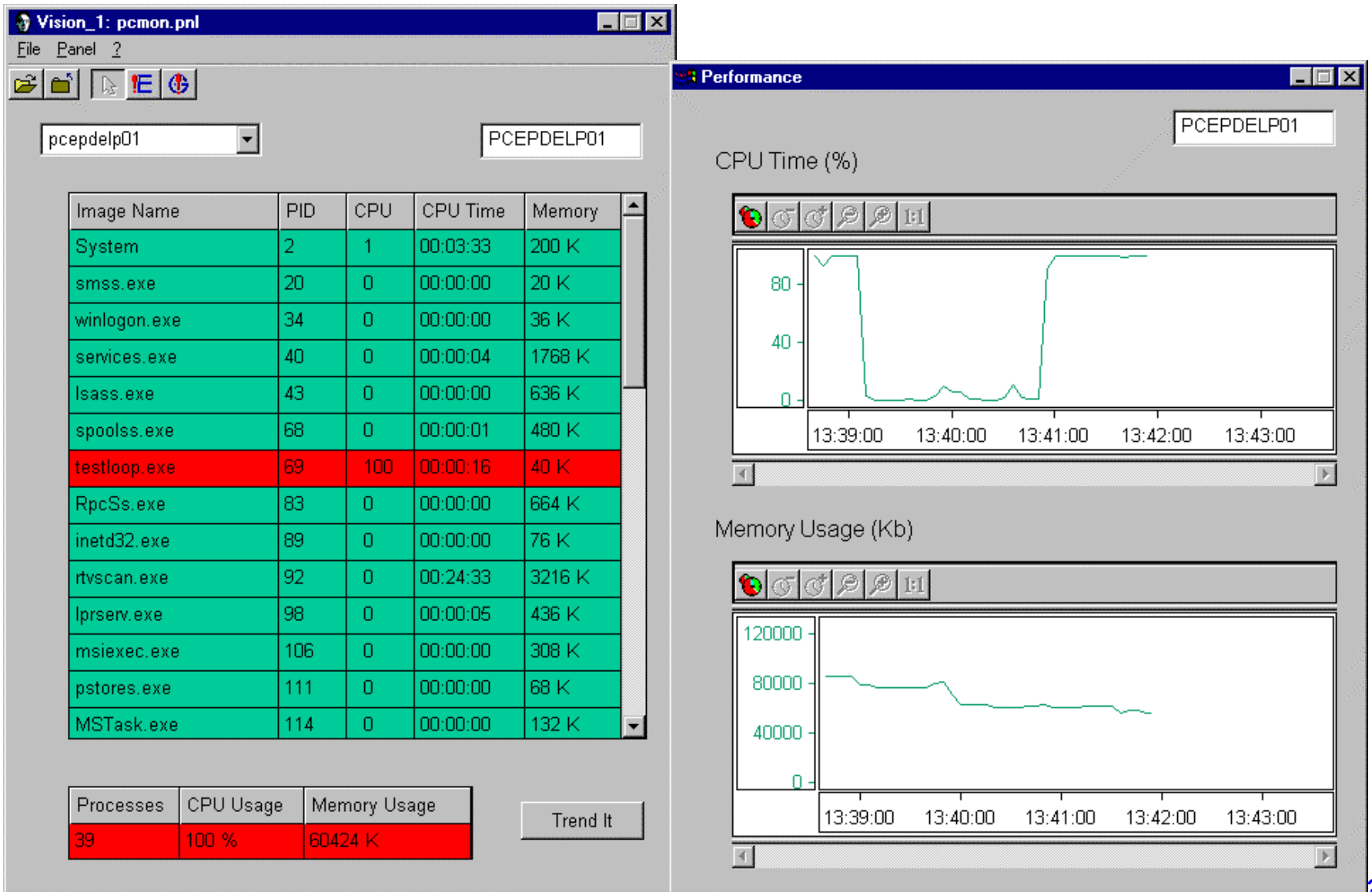


Event Filter Farm Control

- Remote Boot
  - SW download
- CPU Monitoring
  - CPU usage, memory, IO, etc.
- Processes (trigger algorithms)
  - Configure
  - Monitor
  - Start/Stop



CPU Monitoring Using PVSS II



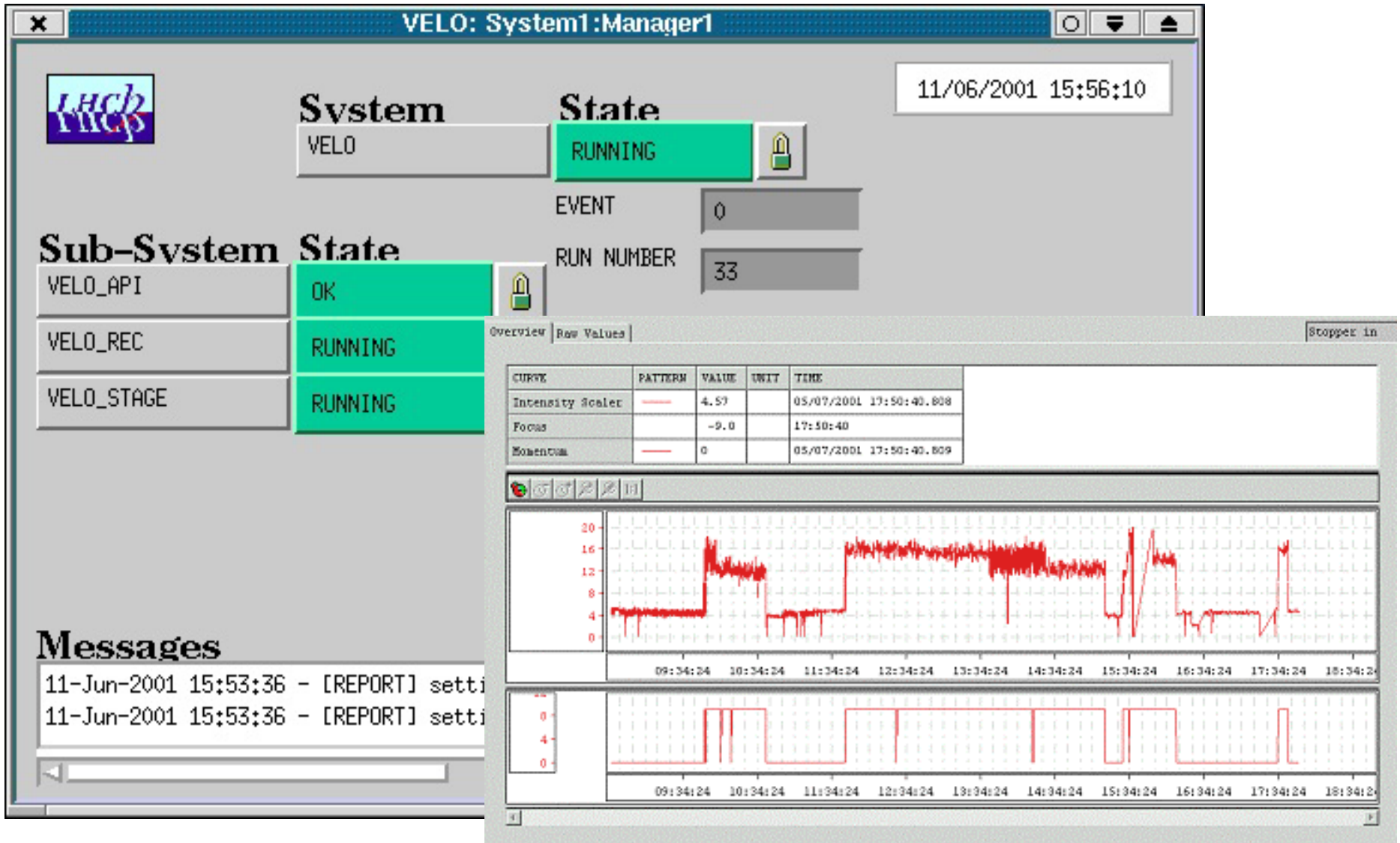
Control System Monitoring

- **The Monitoring of the Control System itself is very similar to the Monitoring of the CPUs in the Event Filter Farm:**
  - Controls PCs, Credit Card PC's, etc:
    - Remote Boot & SW download
    - CPU Monitoring
      - CPU usage, memory, IO, etc.
    - Processes (controls processes: PVSS, etc.)
      - Configure, Monitor, Start/Stop

Proof of Concept

- **TestBeam Setup:**
  - Run Control based on JCOP framework
    - Interfacing to Cascade DAQ
  - Integrated PS/(SPS) information
  - Started integrating DCS devices:
    - HVs
    - motors

Test Beam Run Control



Related Projects

- Our Control System relies on the success of the following (common) projects:
  - JCOP Framework
  - GAS Control Working Group
  - JCOV - Joint Cooling and Ventilation Control
  - DSS - Detector Safety System
  - Magnet Control
  - Rack Control
  - Data interchange Working Group (LHC,T.S.,Exps,etc.)

Conclusions (1)

- The best way to achieve an homogeneous and maintainable control system (and to save manpower) is:
  - To do the maximum in common
    - The Controls Framework is being developed and will be used by the 4 LHC experiments (Joint Controls Project)
    - New “Devices” should be developed in a re-usable way and included in the Framework
  - To Standardize on HW choices as much as possible
    - So that common SW can be used
- Please contact us for HW choices

(of potentially common items)

  - like: power supplies, temperature sensors, etc

Conclusions (2)

- In order to design and implement the LHCb Control System we have the following resources:
  - Clara Gaspar
  - Sascha Schmeling (fellow, prob. leaving soon)
  - Richard Beneyton (cooperand, leaving soon)
  - Boda Franek (Rutherford, at 25 %)
- We have many interesting projects to offer…