



# DAQ@LHC

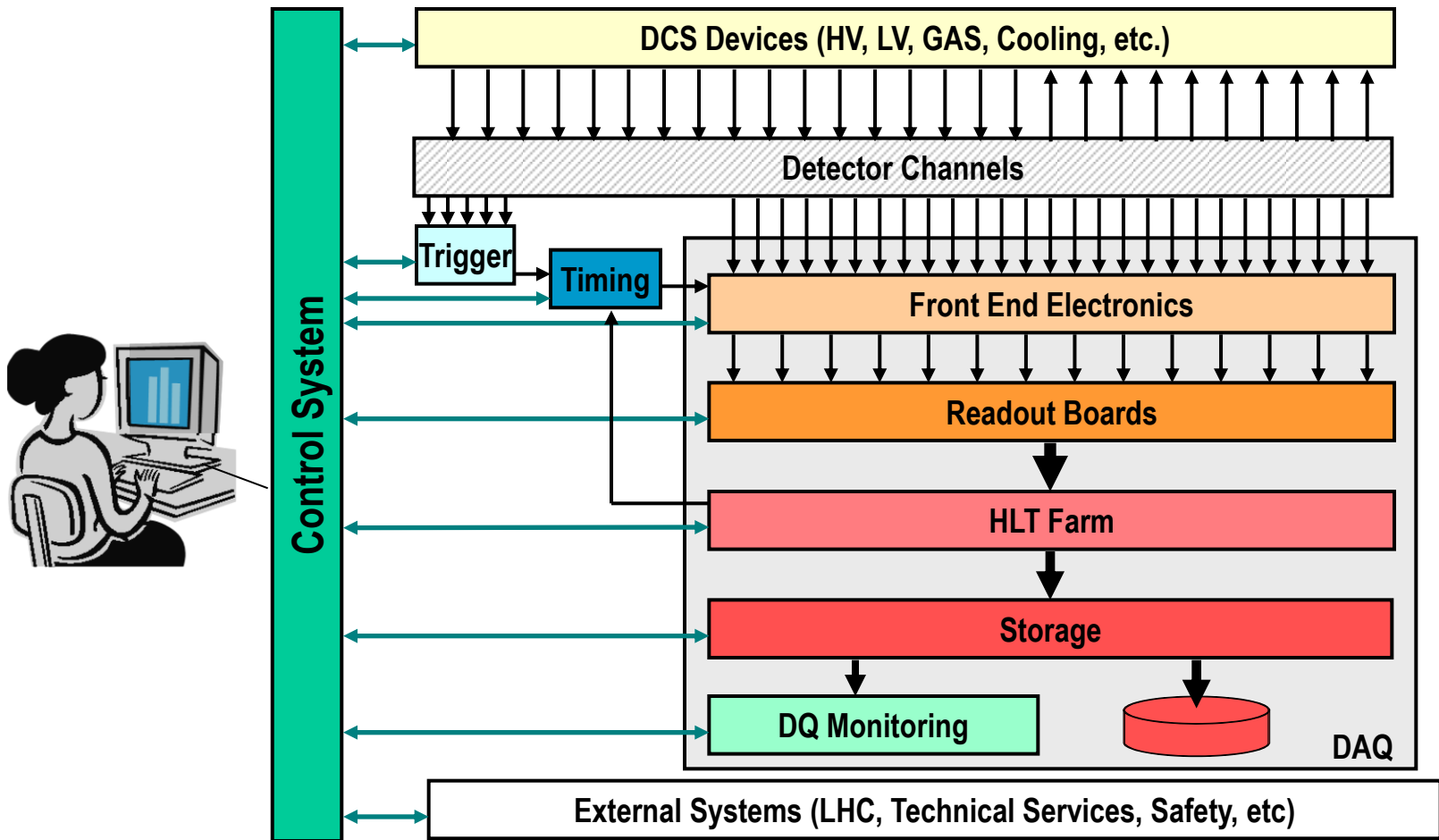
## Control Systems

*Clara Gaspar, March 2013*

*Thanks to: Franco Carena, Vasco Chibante Barroso,  
Giovanna Lehmann Miotto, Hannes Sakulin  
and Andrea Petrucci for their input*



# Control System Scope





# Control System Tasks

## ■ Configuration

- Selecting which components take part in a certain “Activity”
- Loading of parameters (according to the “Activity”)

## ■ Control core

- Sequencing and Synchronization of operations across the various components

## ■ Monitoring, Error Reporting & Recovery

- Detect and recover problems as fast as possible
  - Monitor operations in general
  - Monitor Data Quality

## ■ User Interfacing

- Allow the operator to visualize and interact with the system



# Some Requirements

- **Large number of devices/IO channels**
  - ➔ Need for Distributed Hierarchical Control
    - | De-composition in Systems, sub-systems, ... , Devices
    - | Maybe: Local decision capabilities in sub-systems
- **Large number of independent teams and very different operation modes**
  - ➔ Need for Partitioning Capabilities (concurrent usage)
- **High Complexity & (few) non-expert Operators**
  - ➔ Need for good Diagnostics tools and if possible Automation of:
    - | Standard Procedures
    - | Error Recovery Procedures
  - ➔ And for Intuitive User Interfaces

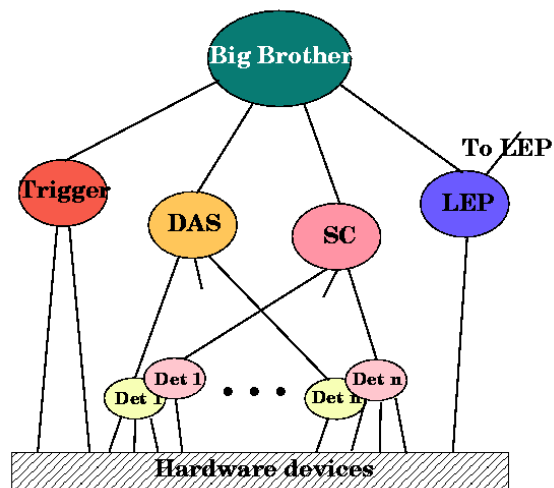


# History

## ■ None of this is new...

- Ex.: Both Aleph and Delphi Control Systems:
  - | Were Distributed & Hierarchical Systems
  - | Implemented Partitioning
  - | Were highly Automated
  - | Were operated by few shifters:
    - | ALEPH: 2 (Shift Leader, Data Quality)
    - | DELPHI: 3 (Run Control, Slow Control, Data Quality)

## LEP Experiments



The DELPHI experiment control system, 1995

### 6 Conclusions

The Control and monitoring System of a large physics experiment involves constraints of operating efficiency, automation and reliability.

The possibility of describing the experiment in terms of objects, using SMI, makes it possible to automate DELPHI operations to a maximum.

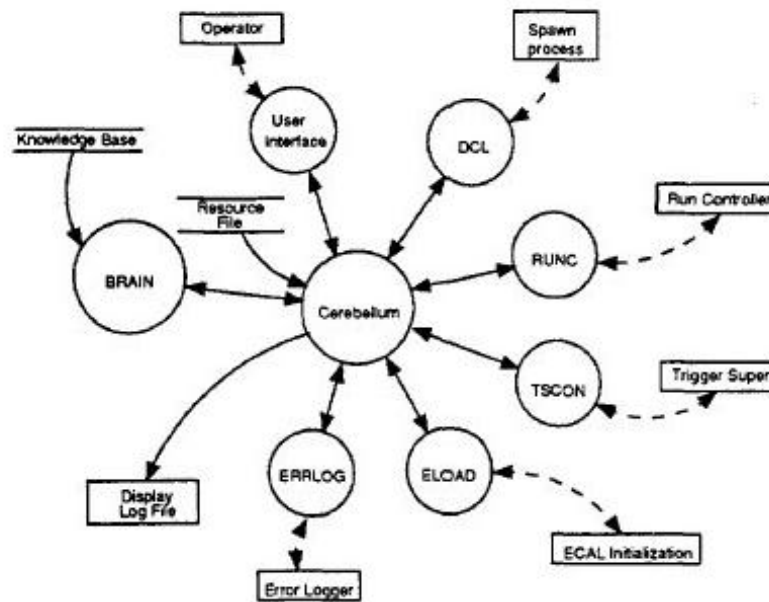


Figure 2 DEXPERT overall design

Applying object oriented, real time, and expert system techniques to an automatic read-out error recovery in the Aleph data acquisition system, 1992

### 3 Conclusions

The DEXPERT program has been in routine use since the beginning of the 1991 data taking period. It handles ~95 % of the possible errors during data-taking very efficiently (i.e. correctly and considerably faster than a human expert). This has permitted us to run the data acquisition system without requiring significant expertise on shift.



# History

**Delphi DAS Status**

TRIGGER: Inst. T2 Rate: 3.01 Hz, Inst. Livetime: 96.28 %  
DAS: RUN\_IN\_PROGRESS  
DATAFLOW: OK  
LEP: PHYSICS, Luminosity: 46.67  
BACKGROUND: LOW, Bg Si: 0.89  
FASTBUS: OK  
SC RUN REL: READY  
SLOW CONTROL: READY, DISALLOW\_CHANGE

**DAS**

Run Status: **RUN IN PROGRESS** (smiley face icon)

Run Number : 107340  
Run Time : 00:35:12  
Triggers : 5477

File Number : 2  
File Triggers : 1682

T2 Rate: 2.89  
File Status (%): 38.9

Update Time: 28-OCT-1999 19:29:58

Big Brother: DATA TAKING, Fill 6639

Auto Pilot: ON

Option Status: PHYSICS RUN, T4 ON, LOGGING

**TRIGGER**

Trigger Control: READY  
Trigger Mode: PHYSICS  
BCO/RF Type: LEP  
Nr. of Bunches: 4

Inst. T2 rate: 3.01 (Hz)  
Inst. live time: 96.3 (%)

Run T2 rate: 3.42 (Hz)  
Fill live time: 97.6 (%)

**Detector Status**

|      |      |      |      |      |      |      |      |     |      |
|------|------|------|------|------|------|------|------|-----|------|
| TP   | VD   | ID   | TPC0 | TPC1 | STC  | OD   | FCH  | EMF | HAC  |
| HPC0 | HPC1 | MUON | MUS  | RIB0 | RIB1 | RIF0 | RIF1 | TOF | VSAT |

**History**

```
--- 28-OCT-1999 18:55:34.15: Executing Command: START_NEW_RUN /GES executing BEGIN
--- 28-OCT-1999 18:55:50.29: Executing Command: GO /GES executing CONTINUE
```

- Delphi Run Control
- Voice Messages (recorded)  
most annoying: "DAS is not running even though LEP is in Physics"



# Design Principles

## ■ Design emphasis per experiment

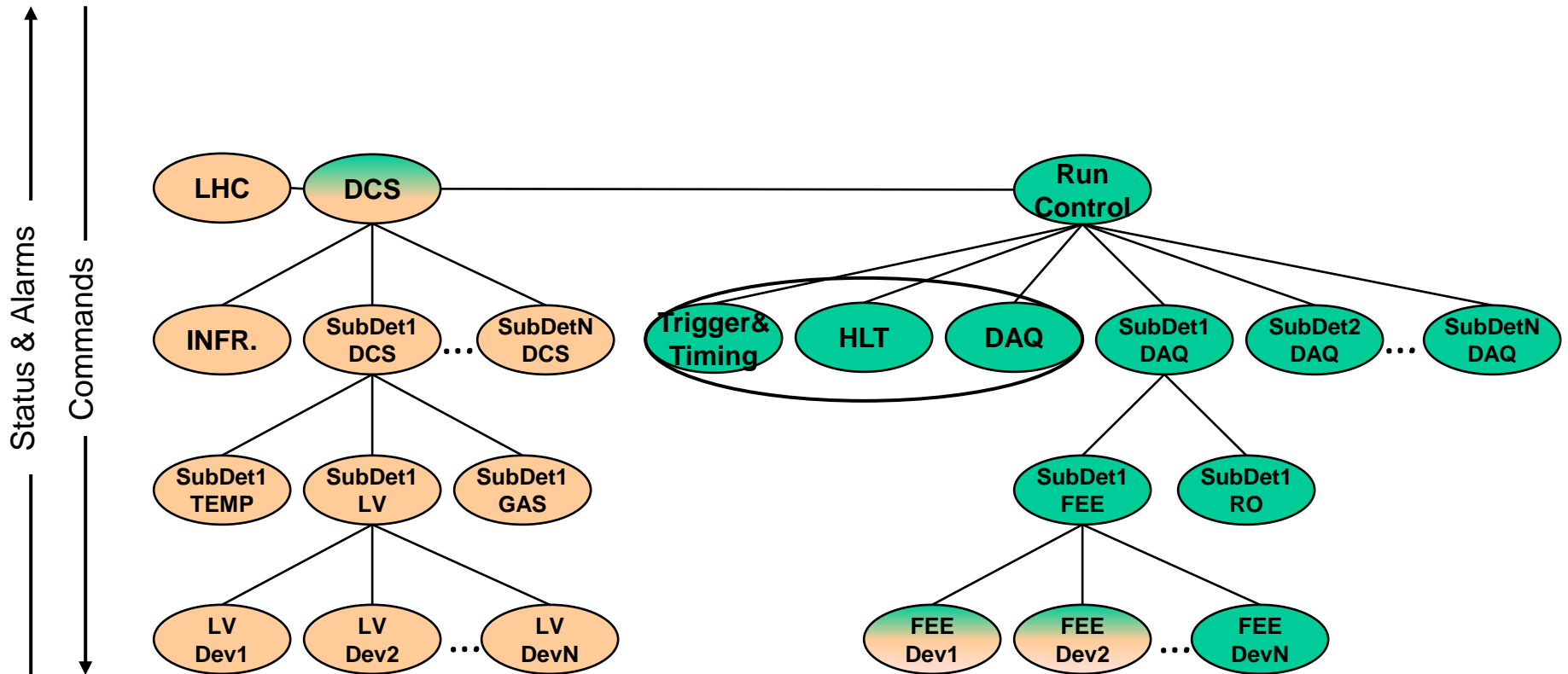
| Keywords     |              |               |                      |
|--------------|--------------|---------------|----------------------|
| <b>ATLAS</b> | Hierarchical | Abstraction   | Scalable             |
| <b>CMS</b>   | Web Based    | Scalable      | State Machine Driven |
| <b>ALICE</b> | Partitioning | Customization | Flexibility          |
| <b>LHCb</b>  | Integration  | Homogeneity   | Automation           |





# Scope & Architecture

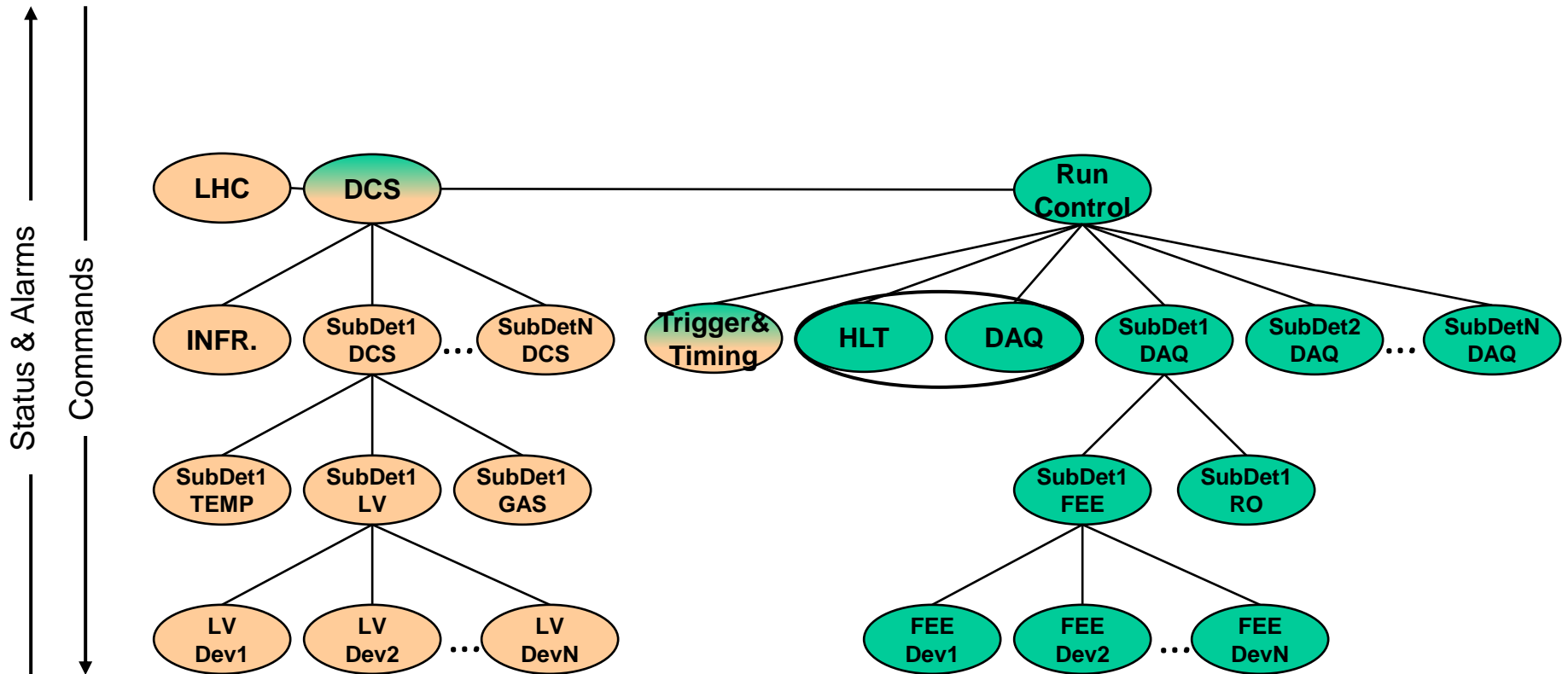
## ■ ATLAS





# Scope & Architecture

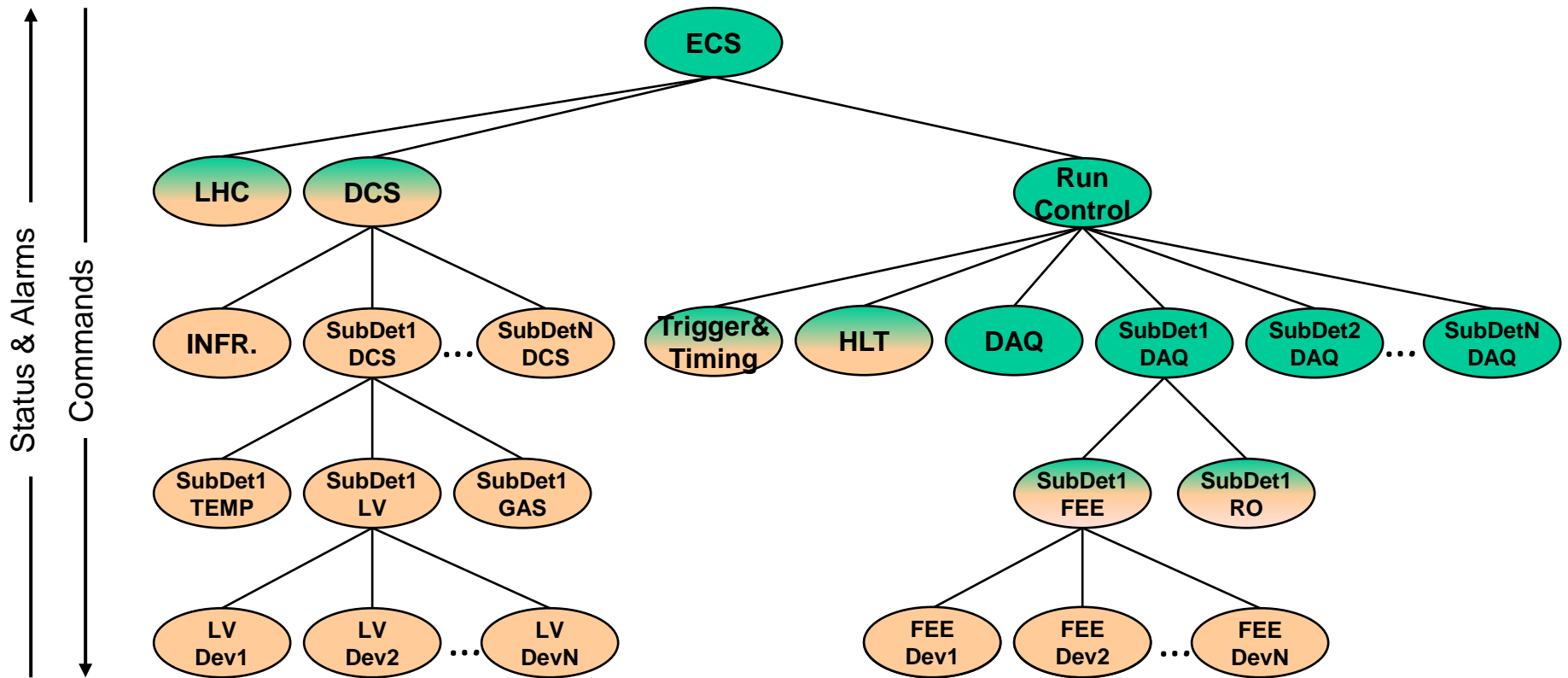
## CMS





# Scope & Architecture

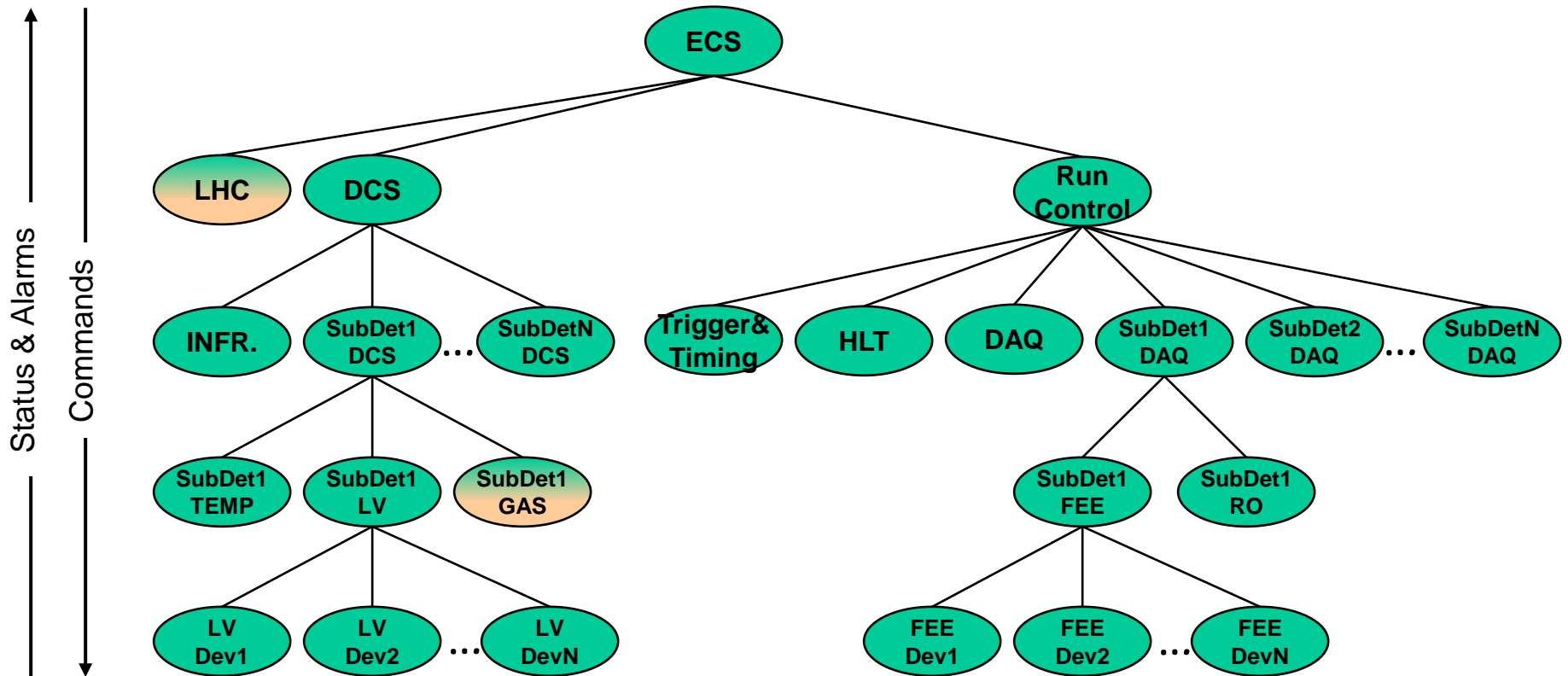
## ALICE





# Scope & Architecture

## LHCb





# Tools & Components

## ■ Main Control System Components:

### ■ Communications

- | Message Exchange between processes

### ■ Finite State Machines

- | System Description, Synchronization and Sequencing

### ■ Expert System Functionality

- | Error Recovery, Assistance and Automation

### ■ Databases

- | Configuration, Archive, Conditions, etc.

### ■ User Interfaces

- | Visualization and Operation

### ■ Other Services:

- | Process Management (start/stop processes across machines)
- | Resource Management (allocate/de-allocate common resources)
- | Logging, etc.



# Frameworks

## ■ ALICE

- DAQ: DATE (Data Acquisition and Test Environment)
  - | Comms, FSM, UI, Logging, etc.

## ■ ATLAS

- Sub-Detectors: RodCrateDAQ;
  - | Comms, FSM, UI, Configuration, Monitoring, HW Access libraries

## ■ CMS

- Control: RCMS (Run Control and Monitoring System)
  - | Comms, FSM, UI, Configuration
- DAQ: XDAQ (DAQ Software Framework)
  - | Comms, FSM, UI, Hw Access, Archive

## ■ LHCb

- Control: JCOP(Joint COntrols Project)/LHCb FW (Dataflow: Gaudi “Online”)
  - | Comms, FSM, UI, Configuration, Archive, HW Access, UI builder



# Sub-System Integration

- **Sub-Systems use common Framework and tools**
  - ALICE
    - | No interface needed: all done centrally
    - | Configuration via DCS for most Sub-Detectors
  - ATLAS
    - | Interface: FSM + tools & services
    - | Configuration via DCS for some Sub-Detectors
  - CMS
    - | Interface: FSM in RCMS + XDAQ FW
  - LHCb
    - | Interface: FSM + JCOP FW + guidelines (color codes, etc.)



# Communications

## ■ All experiments chose one

- ALICE: DIM (mostly within the FSM toolkit)
  - | Mostly for Control, some Configuration and Monitoring
- ATLAS: CORBA (under IPC and IS packages)
  - | IPC (Inter Process Comm.) for Control and Configuration
  - | IS (Information Service) for Monitoring
- CMS: Web Services (used by RCMS, XDAQ)
  - | RCMS for Control
  - | XDAQ for Configuration
  - | XMAS (XDAQ Monitoring and Alarm System) for Monitoring
- LHCb: DIM (and PVSSII, within the JCOP FW)
  - | DIM & PVSSII for Control, Configuration and Monitoring





# Communications

- **All Client/Server mostly Publish/Subscribe**
  - Difficult to compare (different “paradigms”)
    - | DIM is a thin layer on top of TCP/IP
    - | ATLAS IPC is a thin layer on top of CORBA
      - | Both provide a simple API, a Naming Service and error detection & recovery
    - | CMS RCMS & XDAQ use WebServices (XML/Soap)
      - | Remote Procedure Call (RPC) like, also used as Pub./Sub.
    - | ATLAS IS, CMS XMAS and LHCb PVSSII
      - | work as data repositories (transient and/or permanent) to be used by clients (UIs, etc.)



# Communications

## ■ Advantages and drawbacks

### ■ DIM

- ✓ Efficient, Easy-to-use
- ✗ Home made, old...

### ■ CORBA

- ✓ Efficient, Easy-to-use (via the ATLAS API)
- ✗ Not so popular anymore...

### ■ WEB Services

- ✓ Standard, modern protocol
- ✗ Performance: XML overhead



# Finite State Machines

## ■ All experiments use FSMs

- In order to model the system behaviour:
  - | For Synchronization, Sequencing, in some cases also for Error Recovery and Automation of procedures
- ALICE: SMI++
  - | FSM for all sub-systems provided centrally (can be different)
- ATLAS: CHSM -> CLIPS -> C++
  - | FSM for all sub-systems provided centrally (all the same)
- CMS: Java for RCMS, C++ for XDAQ
  - | Each sub-system provided their own code (Java/C++)
- LHCb: SMI++ (integrated in PVSS II)
  - | FSM provided centrally, sub-systems modify template graphically

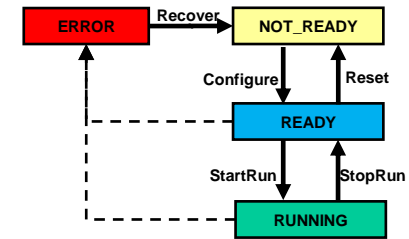
## Two Approaches:

### Few, coarse-grained States:

- Generic actions are sent from the top
  - Each sub-system synchronizes its own operations to go to the required state
- The top-level needs very little knowledge of the sub-systems
- Assumes most things can be done in parallel

### Many, fine-grained States

- Every detailed transition is sequenced from the top
- The top-level needs to know the details of the sub-systems





# FSM Definitions

## ■ Top-level FSM from “ground” to Running

### ■ ATLAS

| None -> Booted -> Initial -> Configured -> Connected -> Running

### ■ CMS

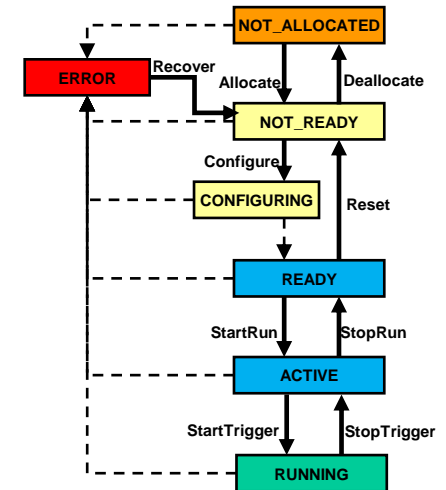
| Initial -> Halted -> Configured -> Running (+intermediary states)

### ■ LHCb

| Not Allocated -> Not Ready -> Ready -> Active -> Running

### ■ ALICE

| Many: 20 to 25 states, 15 to get to Running





# Expert System Functionality

- **Several experiments saw the need...**

- Approach:

- | “We are in the mess how do we get out of it?”
- | No Learning...

- **Used for:**

- Advising the Shifter

- ➔ ATLAS, CMS

- Automated Error Recovery

- ➔ ATLAS, LHCb, ALICE (modestly)

- Completely Automate Standard Operations

- ➔ LHCb



# Expert System Functionality

## ■ ATLAS

### ■ Uses CLIPS for Error Recovery

- | Common and distributed, domain specific, rules
- | Used by experts only, sub-system rules on request

### ■ Uses Esper for “Shifter Assistant”

- | Centralised, global “Complex Event Processing”
- | Moving more towards this approach...

## ■ CMS

### ■ Uses Perl for “DAQ Doctor”

- | “Rules” are hardcoded by experts



# Expert System Functionality

## ■ LHCb

- Uses SMI++ for everything
  - | Distributed FSM and Rule based system
  - | Used by sub-systems for local error recovery and automation
  - | Used by central team for top-level rules integrating various sub-systems

## ■ ALICE

- Uses SMI++ too
  - | Some error recovery (only few specific cases)





# Expert System Functionality

## ■ Decision Making, Reasoning, Approaches

### ■ Decentralized

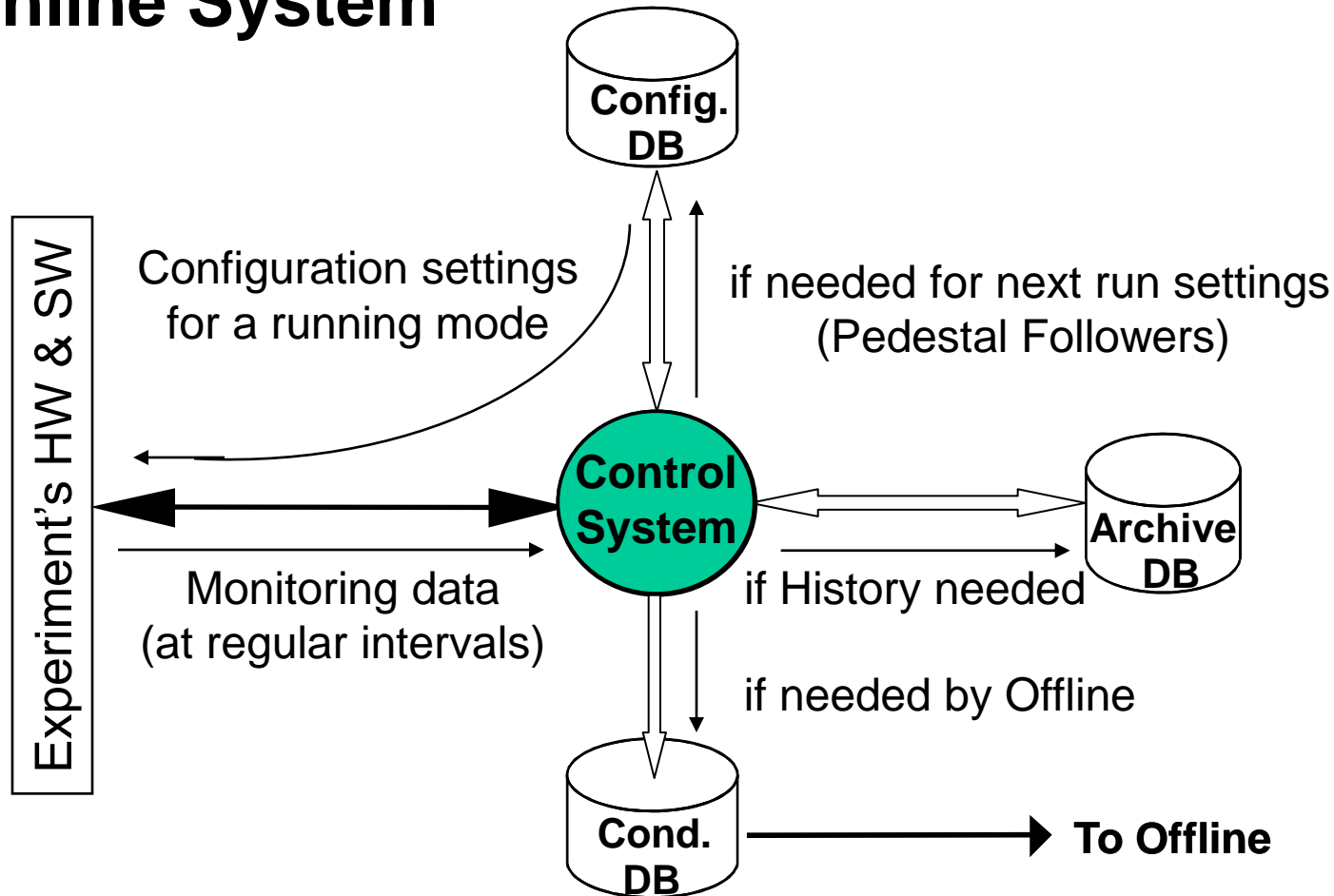
- | Bottom-up: Sub-systems react only to their “children”
  - | In an event-driven, asynchronous, fashion
- | Distributed: Each Sub-System can recover its errors
  - | Normally each team knows better how to handle local errors
- | Hierarchical/Parallel recovery
- | Scalable

### ■ Centralized

- | All “rules” in the same repository

# Online Databases

## ■ Three main logical Database concepts in the Online System

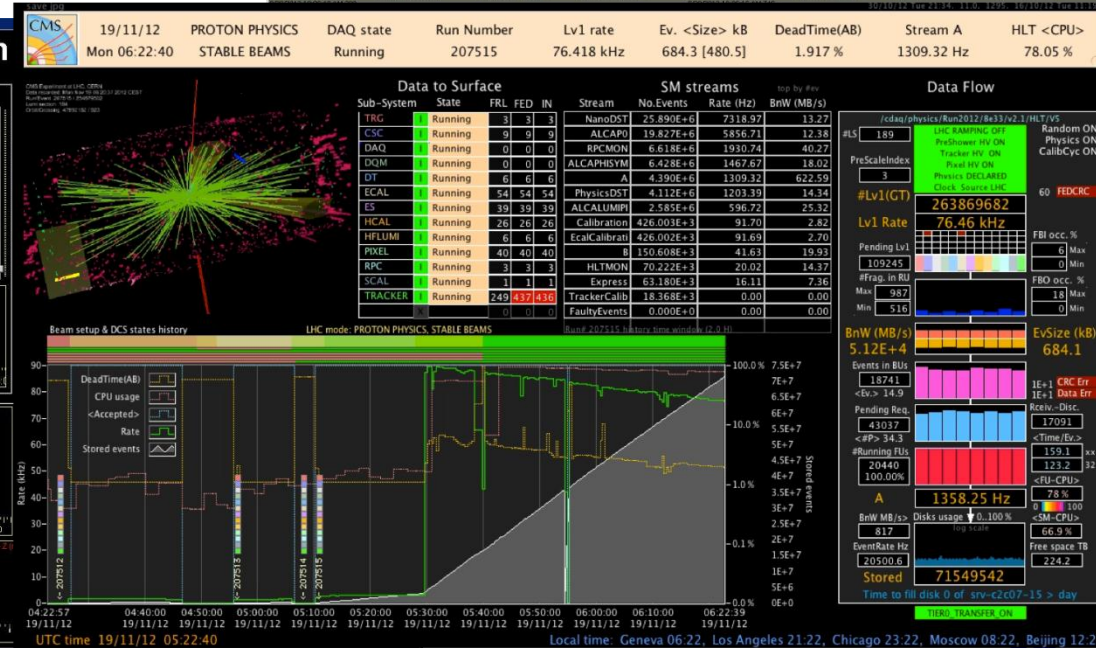
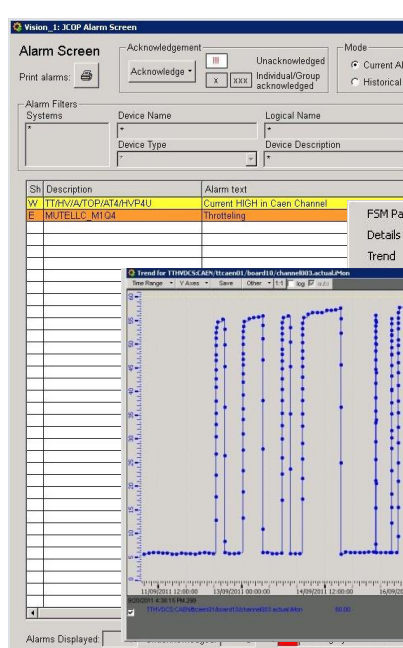
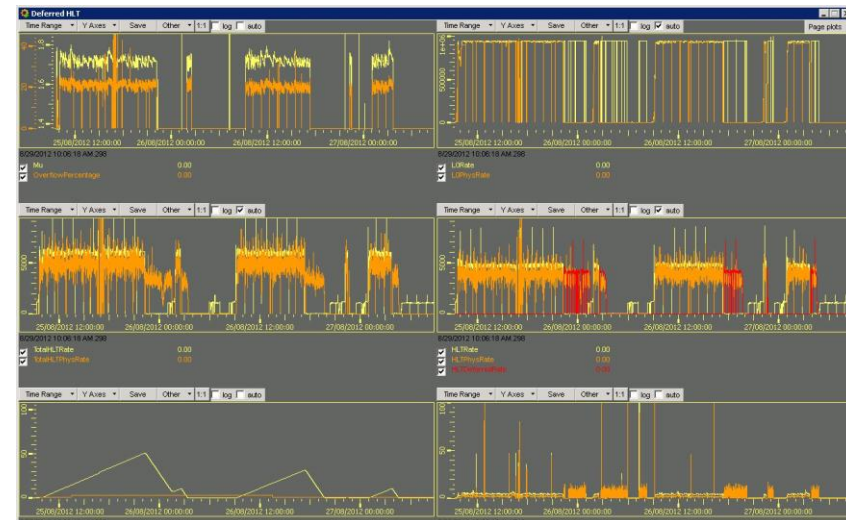




# User Interfacing

## Types of User Interfaces

- Alarm Screens and/or Message Displays
- Monitoring Displays
- Run Control





# ALICE Run Control+ECS

The screenshot shows the 'ALLPHYSICS\_1 DAQ - Run Control' window. It features a menu bar (File, View, Options, Windows) and a status bar (Status updated). The main area displays the ALICE logo, a lock icon, and the text 'ALLPHYSICS\_1 DAQ - Run Control'. Below this, it states 'HI running on aldaqecs01 with PID 20282' and 'RC running on aldaqecs01 with PID 7601'. There are three main sections: 'Disconnected Configuration', 'Connected Run Parameters', and 'Ready to start'. The 'Ready to start' section includes buttons for 'Start processes', 'Start', 'Stop', and 'Abort', along with dropdown menus for 'EDM', 'HLT: mode C', 'LDC: Local Recording OFF', and 'GDC: NO Recording'. A 'Data Taking' section is also visible. At the bottom, there is a 'RUN NUMBER : 196753' and 'Run Control Status : RUNNING'.

The screenshot shows the 'PHYSICS\_1 PCA Partition Control Agent' window. It features a menu bar (File, View, Options, Permissions) and a status bar. The main area displays the ALICE logo, a lock icon, and the text 'PHYSICS\_1 Partition Control Agent'. Below this, it states 'HI running on aldaqecs01 with PID 25309'. There are three main sections: 'PCA', 'TECHNICAL', and 'FERO READY: TRUE'. The 'PCA' section includes a 'More ...' button. The 'TECHNICAL' section includes a 'Taking data' indicator. The 'FERO READY: TRUE' section includes a 'More ...' button. Below these sections, there is a 'Global RUN number: 196753' and 'RUN type: TECHNICAL'. There are also sections for 'Parameters and Options for global operations', 'Access rights granted to the PCA (orange background if missing locks)', and 'Global operations 'allowed' / 'not allowed' by the online systems'. The 'Global operations' section includes a table with columns for 'HLT system', 'DCS system', 'DAQ system', and 'TRIGGER system'. The 'Access rights' section includes buttons for 'HLT ...', 'DCS ...', 'DAQ ...', and 'TRIGGER ...'. The 'Global operations' section includes a table with columns for 'HLT system', 'DCS system', 'DAQ system', and 'TRIGGER system'. The 'PCA info' section includes a 'Trace' area with a list of events and their timestamps.

■ Implemented in Tcl/Tk



# ATLAS Run Control

## IGUI

- Java
- Modular:
- Sub-systems can add their panels



# CMS Run Control

Running 00:15.0

Configuration: /toppro/Public/Global/levelZeroFM  
Run Number: **210658**

SID: 222881  
Seq Name: GLOBAL\_RUN  
Global Key: /GLOBAL\_CONFIGURATION\_MAP/CMS/CENTRAL\_GLOBAL\_RUN  
HWCFG5 Key: /cmsreq\_120503/RUN\_2012b\_all\_2012/outing2\_rev103020\_SprCSCLdp\_8SLW\_18665\_158BU\_18SM.0  
Level-0 Action: Tasks completed.  
Level-0 Error:

| DCS/LHC flag     | state | force        |
|------------------|-------|--------------|
| ES_HV_ON         | ON    | [FROM_DCS -] |
| PIX_HV_ON        | ON    | [FROM_DCS -] |
| TK_HV_ON         | ON    | [FROM_DCS -] |
| PHYSICS_DECLARED | ON    | [FROM_DCS -] |
| LHC_RAMPING      | ON    | [FROM_DCS -] |

| KEY TYPE                         | CURRENTLY APPLIED VALUE                                  | NEXT VALUE from LHC                    |
|----------------------------------|--|--|
| CMS Run Mode                     | N/A  | MANUAL collisions_lhc_clock autoselect |
| L1/HLT Trigger Mode              | collisions_2013_300b                                     | collisions_2013_300b                   |
| L1/HLT Key                       | /l1_hlt_collisions_2013_300b/v3                          |  |
| HLT Key from trigger mode        | /odaq/physics/Run2013PA/296Bunches/v1.1/LowerLumi/HLT/V2 | HLT Keys                               |
| L1 Trigger Key from trigger mode | L1_20130122_234838_6362                                  |  |
| TSC Key                          | TSC_20130122_002970_collisions_BASE                      |  |
| GT_RS Key                        | gtrs_2013_pPb_296Bunches_12                              |  |
| Clock source                     | LHC  | LHC autoselect                         |
| MI_KEY                           | beam1-manual-20110413                                    |  |

| Subsystem | PIXEL   | TRACKER | ES      | ECAL    | HCAL    | HFLUMI  | CASTOR  | DT      | CSC     | RPC     | TRG     | SCAL    | DAQ     | DOM     | DCS       |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|
| State     | Running | Running | Running | Running | Running | Running | Running | Running | Running | Running | Running | Running | Running | Running | Connected |
| Time:     | 00:05.9 | 00:02.1 | 00:01.9 | 00:09.0 | 00:06.1 | 00:04.8 | 00:00.9 | 00:05.2 | 00:06.1 | 00:00.2 | 00:02.0 | 00:00.6 | 00:00.0 | 00:01.7 | 00:01.3   |

Enabled Slices: DAQ run Running

| Current Run Key | N/A | DEFAULT | GR_PhysLowGain | SelectiveReadout | ZS | ZS | N/A | N/A | N/A | N/A | Automatic | N/A | TIER0_TRANSFER_ON | pp_run | N/A |
|-----------------|-----|---------|----------------|------------------|----|----|-----|-----|-----|-----|-----------|-----|-------------------|--------|-----|
| New Run Key     |     | DEFAULT | GR_PhysLowGain | SelectiveReadout | ZS | ZS |     |     |     |     | Automatic |     | TIER0_TRANSFER_ON | pp_run |     |

Commander: [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select] [select]

PIXEL  
TRACKER  
ES  
ECAL  
HCAL  
HFLUMI  
CASTOR  
DT  
CSC  
RPC  
TRG  
SCAL  
DAQ  
DOM  
DCS

Rate: 55258.2 Hz (pgr=21488956 orbit=26183077 interval=5s)

DCS\_LHC\_FLAGS at 2013-01-23 11:08:51 CET: LHC\_RAMPING/false ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true PHYSICS\_DECLARED/true

Run History

2013-01-23 11:00:10 CET: LS= 100.50 Trg=20372644 Ev=29411907 Auto Resume ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true LHC\_RAMPING/false PHYSICS\_DECLARED/true  
 2013-01-23 11:08:58 CET: LS= 99.89 Trg=20372644 Ev=29411907 Auto Pause ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true LHC\_RAMPING/false PHYSICS\_DECLARED/true  
 2013-01-23 11:08:55 CET: LS= 99.84 Trg=20398393 Ev=2987748 Auto Resume ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true LHC\_RAMPING/false PHYSICS\_DECLARED/true  
 2013-01-23 11:08:50 CET: LS= 99.10 Trg=20398393 Ev=2987748 Auto Pause ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true LHC\_RAMPING/false PHYSICS\_DECLARED/true  
 2013-01-23 10:30:33 CET: LS= 1.00 Trg=0 Ev=0 Start Run 210658 ES\_HV\_ON/true TK\_HV\_ON/true PIX\_HV\_ON/true LHC\_RAMPING/false PHYSICS\_DECLARED/true

- Web tools: JavaScript+HTML
- Also LabView Monitoring



# LHCb Run Control

## JCOP FW

PVSS+SMI++

Like all UIs at all levels

Using a very convenient Graphic Editor

Very easy to modify

The screenshot displays the LHCb Run Control interface. At the top, the system is in a 'RUNNING' state, and the Auto Pilot is 'ON'. The interface is divided into several sections:

- System State:** LHCb is RUNNING, and the Auto Pilot is ON.
- Sub-System State:** A table showing the status of various sub-systems:
 

| Sub-System     | State   |
|----------------|---------|
| DCS            | READY   |
| DAI            | READY   |
| DAQ            | RUNNING |
| RunInfo        | RUNNING |
| TFC            | RUNNING |
| HLT            | RUNNING |
| Storage        | RUNNING |
| Monitoring     | RUNNING |
| Reconstruction | RUNNING |
| Calibration    | RUNNING |
| HV             | READY   |
- Run Info:** Run Number: 136863, Run Start Time: 07-Feb-2013 09:37:45, Run Duration: 000:15:03, Nr. Events: 15502054.
- Activity:** COLLISION|pA, Trigger Config: pA\_2013, Defer HLT: checked.
- Time Alignment:** TAE half window: 0, L0 Gap: checked.
- Max Nr. Events:** Run limited to 0 Events.
- Automated Run with Steps:** Step Run with 0 Steps.
- L0 Rate:** 17192.04 Hz (gauge).
- HLT Rate:** 5584.61 Hz (gauge).
- Dead Time: Overflow:** 0.78% (gauge).
- Deferred HLT Info:** LHCb\_Deferred: NOT\_ALLOCATED, Runs/Files: 0 / 0, Processing: 0%.
- Sub-Detectors:** A row of buttons for TDET, VELOA, VELOC, TT, IT, OTA, OTC, RICH1, RICH2, PRS, all in RUNNING state.
- Trigger Components:** A row of buttons for ECAL, HCAL, MUONA, MUONC, LODU, TCALO, TMUA, TMUC, TPU, all in RUNNING state.
- Messages:** Log of system events, including 'LHCb executing action START\_RUN', 'LHCb in state ACTIVE', 'LHCb in state RUNNING', and 'INFO - VELO Closed, Changing RUN...'.



# LHCb Big Brother

**LHCb\_LHC: TOP**

**System State**  
Big Brother: **READY**

**Sub-System State**

|            |          |   |
|------------|----------|---|
| LHC        | PHYSICS  | ✓ |
| BCM        | READY    | ✓ |
| Magnet     | READY    | ✓ |
| LHCb Clock | EXTERNAL | ✓ |

**Handshakes**

LHC: STANDBY | LHCb: VETO

**Voltages**

System: LHCb\_LHC\_HV&LV | State: OK | Requested: PHYSICS | Settings: PHYSICS

| Sub-Detector | State | Req. HV | %Ok    | HV State (A/C) |       |
|--------------|-------|---------|--------|----------------|-------|
| VELO_LHC_HV  | OK    | READY   | 100.00 | READY          | READY |
| TT_LHC_HV    | OK    | READY   | 100.00 | READY          |       |
| IT_LHC_HV    | OK    | READY   | 100.00 | READY          |       |
| OT_LHC_HV    | OK    | READY   | 100.00 | READY          | READY |
| RICH1_LHC_HV | OK    | READY   | 100.00 | READY          |       |
| RICH2_LHC_HV | OK    | READY   | 100.00 | READY          |       |
| PRS_LHC_HV   | OK    | READY   | 100.00 | READY          |       |
| ECAL_LHC_HV  | OK    | READY   | 100.00 | READY          |       |
| HCAL_LHC_HV  | OK    | READY   | 100.00 | READY          |       |
| MUON_LHC_HV  | OK    | READY   | 99.94  | READY          | READY |

| Sub-Detector | State | Requested LV | LV State (A/C) |       |
|--------------|-------|--------------|----------------|-------|
| VELO_LHC_LV  | OK    | READY        | READY          | READY |
| TT_LHC_LV    | OK    | READY        | READY          |       |
| IT_LHC_LV    | OK    | READY        | READY          |       |
| RICH1_LHC_LV | OK    | READY        | READY          |       |
| RICH2_LHC_LV | OK    | READY        | READY          |       |

**Messages**

```

06-Feb-2013 06:08:50 - *** INFO - Confirm Prepare PHYSICS
06-Feb-2013 06:10:31 - *** INFO - Action Confirmed
06-Feb-2013 06:10:31 - LHCb_LHC_HV executing action GOTO_PHYSICS
  
```

**Big Brother** | Wed 06-Feb-2013 09:47:22 | root

**Settings**

**LHC**  
Mode: PROTON-NUCLEUS PI | Fill Number: 3533 | Energy: 4000 GeV

**Magnet**  
Set Current: 5850 A | Measured Current: 5850.0 A | Polarity: DOWN

**DB Interfaces**  
Run DB Server:  | Cond DB Server:  | PVSS Archive:

**VELO Closing Manager**

Motion: ALLOWED | State: CLOSED | DAO HV BCMBPM VTX:

Beam Position: X: 0.69 mm, Y: 0.19 mm | Motion System Position: XA: 0.69 mm, XC: 0.69 mm, Y: 0.21 mm

**Status:** v8.5

```

06-Feb 06:19:09 - Now waiting for 2nd update of the BeamPosition...
06-Feb 06:19:10 - xVA=-0.169, xVC=0.165, yVA=0.037, yVC=-0.076
06-Feb 06:19:10 - Got good update(s), going to next step.
06-Feb 06:19:10 - End of automatic closing procedure
06-Feb 06:19:10 - Current VTX values frozen.
06-Feb 06:19:10 - Using limits for step: 0
  
```

**Safety**

|             |       |
|-------------|-------|
| TT_Safety   | READY |
| IT_Safety   | READY |
| OT_Safety   | DEAD  |
| RICH_Safety | READY |
| MUON_Safety | READY |

**Confirm Prepare BEAMLOST**

Ok | Cancel

Close

- Used by operator to confirm automated actions
- Voice Messages (synthesized)





# Access Control

## ■ What are we trying to achieve?

- Protect against “evil” attacks?
  - | We are “authenticated” and inside a protected network...
- Avoid Mistakes?
  - | Mistakes are often done by experts...
- Traceability and Accountability...

## ■ Types of Protection

- At UI Level
  - | LHCb, ALICE, CMS: Very basic: ownership (CMS: also Role based views)
- Everywhere (at message reception)
  - | ATLAS: Role Based



# Size and Performance

## ■ Size of the Control Systems (in PCs)

- ALICE: 1
- ATLAS: 32 + some for HLT control
- CMS: 12
- LHCb: ~50 DAQ + ~50 HLT + ~50 DCS

## ■ Some Performance numbers

|                              | ALICE | ATLAS | CMS | LHCb |
|------------------------------|-------|-------|-----|------|
| Cold Start to Running (min.) | 5     | 5     | 3   | 4    |
| Stop/Start Run (min.)        | 6     | 2     | 1   | 1    |
| Fast Stop/Start (sec.)       | -     | <10   | <10 | <10  |
| DAQ Inefficiency (%)         | 1     | <1    | <1  | <1   |



# Operations

## ■ Experiment Operations

### ■ Shifters:

- | ALICE: 4 (SL, DCS, RC, DQ+HLT)
- | ATLAS: 8 (SL, DCS, RC, TRG, DQ, ID, Muon, Calo)
- | CMS: 5 (SL, DCS, RC, TRG, DQ)
- | LHCb: 2 (SL, DQ)

### ■ Ex.: Start of Fill sequence

- | In general HV automatically handled
- | Run Control Shifter manually Configures/Starts the Run (apart from LHCb)



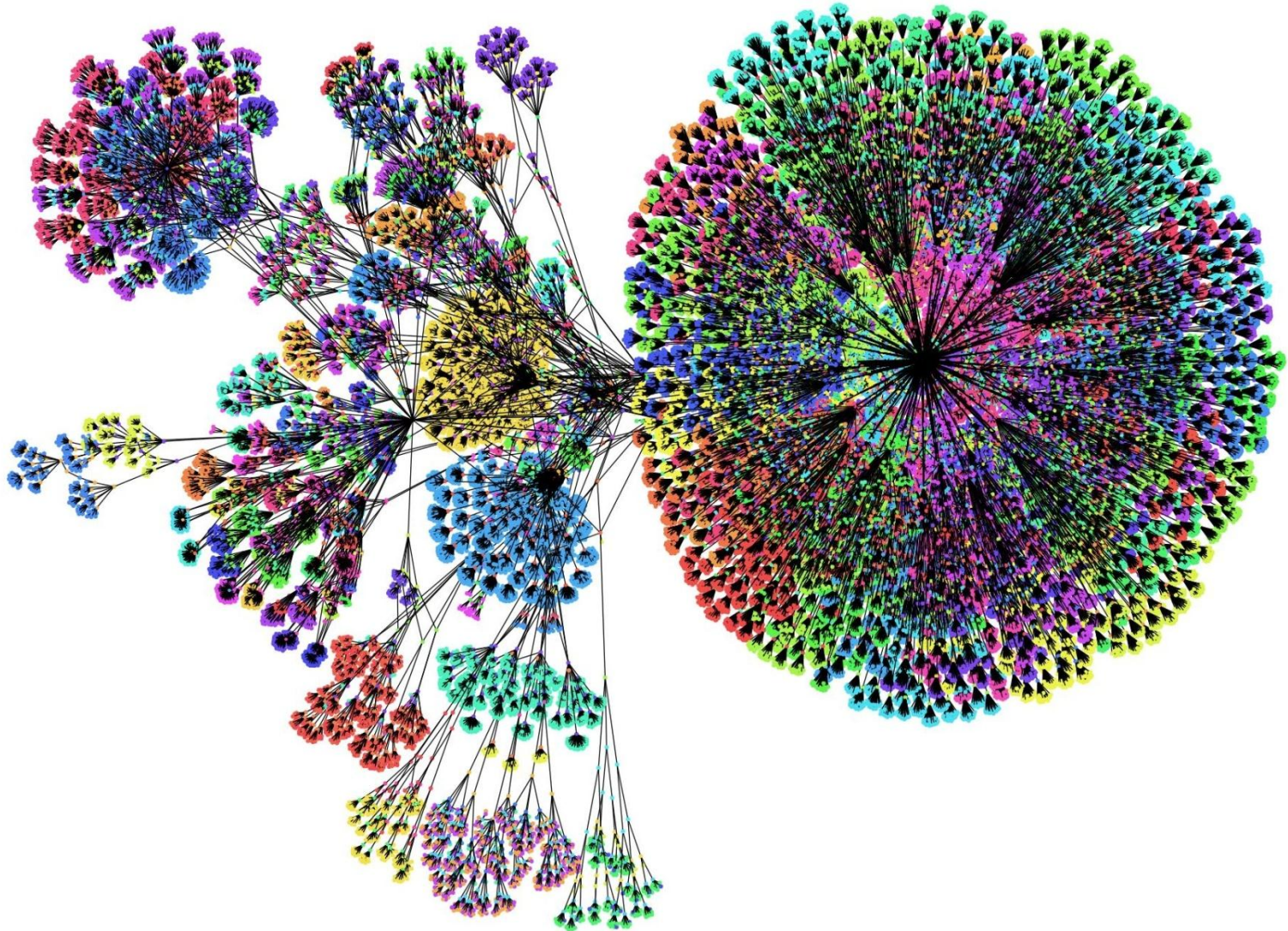
# Detector Control Systems

The collage features several key control system interfaces:

- ATLAS DETECTOR CONTROL:** Shows a 3D cutaway of the ATLAS detector and a status table with columns for components like PIX, SBT, TRT, IDE, LAR, TIL, MDT, TGC, RPC, CSC, CFC, EXT, TGG, LHC, and PWD, each with a status indicator.
- CMC DCS System Manager:** Displays a hierarchical tree of detector components and their operational states.
- LHCb RAMSES Radiation Monitoring:** Shows a schematic of the detector with radiation monitoring points and associated data.
- MTCC DCS:** Features a 3D detector model and a table of room temperatures and other environmental parameters.
- Alarm Screen:** Lists various system alarms with their descriptions and acknowledgment status.
- System Status:** Shows the overall state of the LHCb system, including run numbers, start times, and event counts.
- Temperature Monitoring:** Displays real-time temperature data for various parts of the detector.
- Control Panels:** Includes buttons for 'Auto Pilot', 'Trigger Configuration', and 'Time Alignment'.

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# LHCb Control System



■ Courtesy of CMS DCS Team

*Clara Gaspar, March 2013*