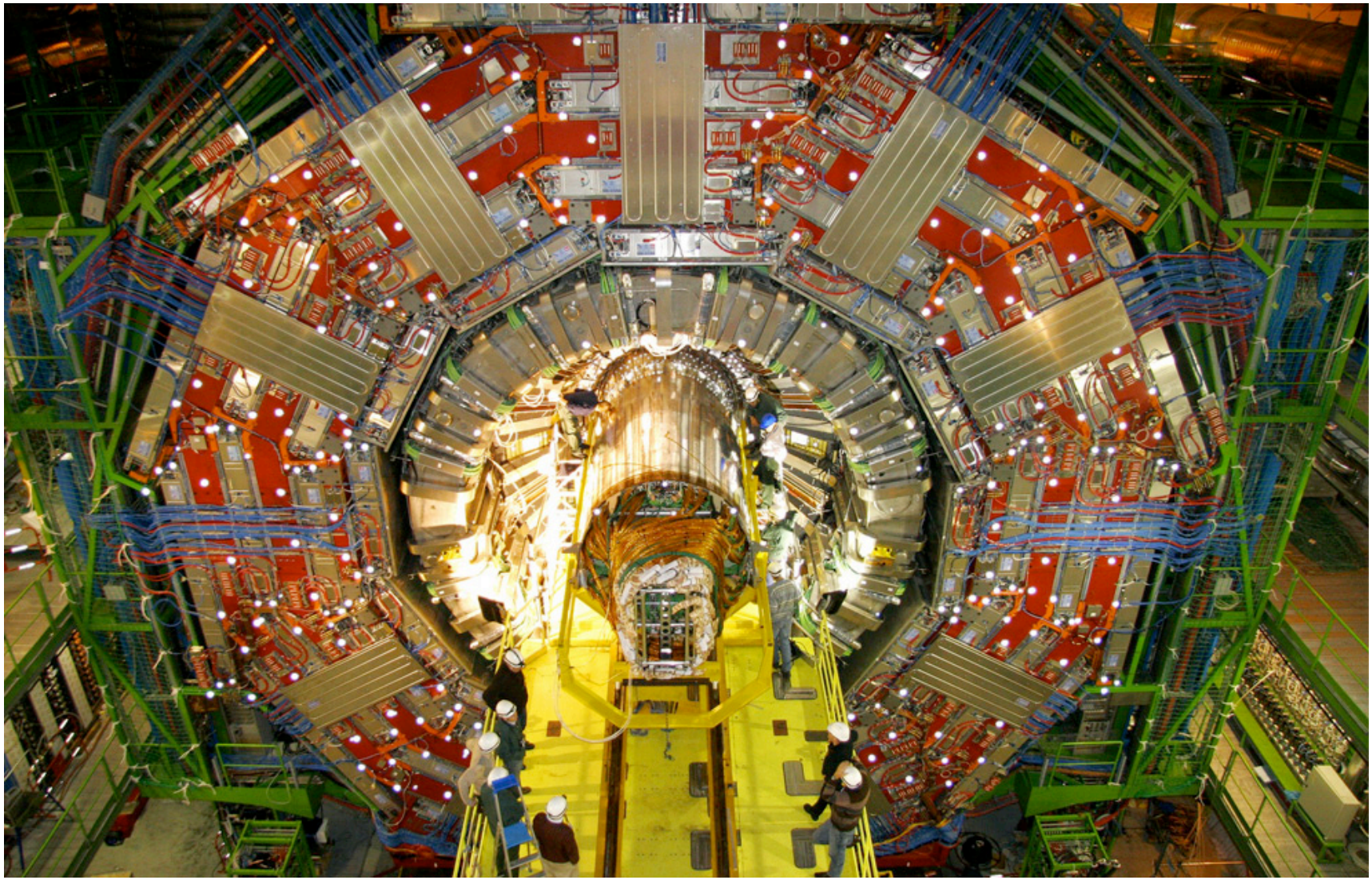
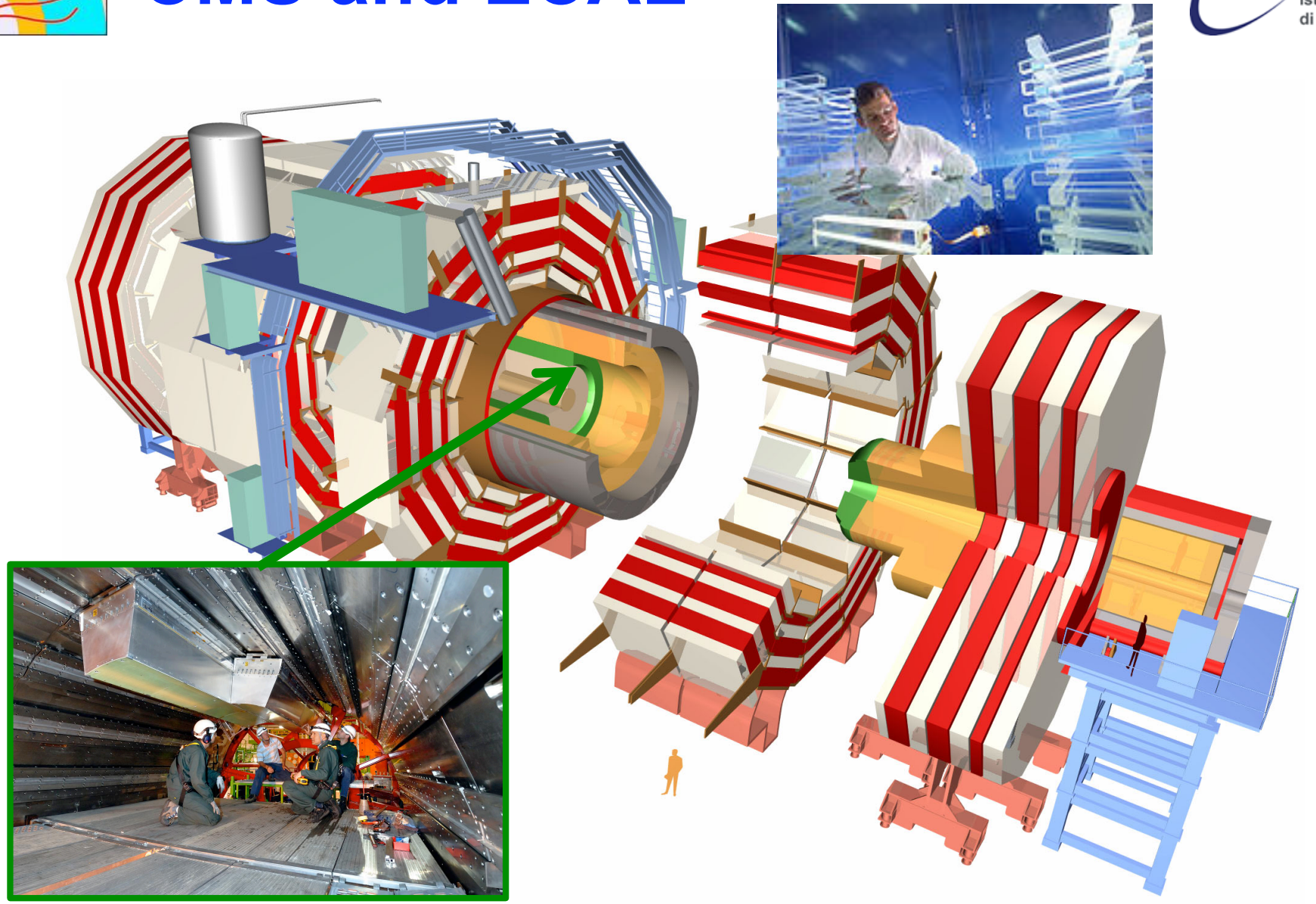
The CMS ECAL Database Services for Detector Control and Monitoring

Giovanni Organtini
Sapienza Università di Roma
& INFN-Sez. di Roma

The CMS experiment



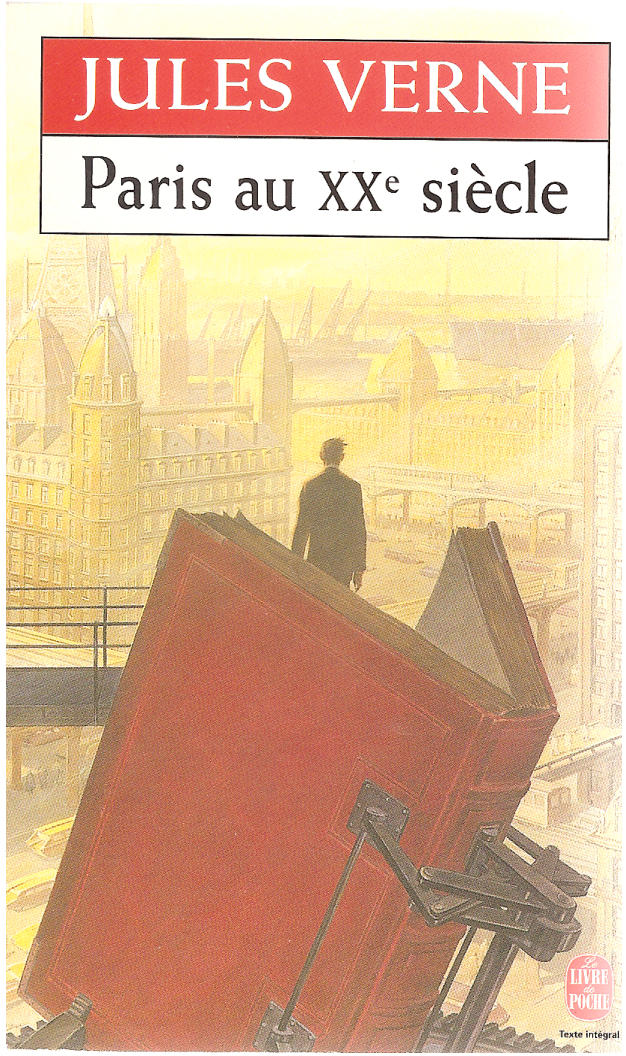
CMS and ECAL



ECAL figures of merit

- 75848 PWO Scintillating Crystals coupled with a photodetector
- Barrel (36 SM)
  - 61200 × 2 avalanche photodiodes for light detection
  - 1224 HV channels
  - 684 LV channels
  - 61200 optical fibers for transmission monitor
  - 6120 temperature sensors
- Endcaps (18 sectors)
  - 14648 vacuum phototriodes for light detection
  - 52 HV channels
  - 160 LV channels
  - 14648 optical fibers for transmission monitor

The database project



Michel arriva dans une salle immense surmontée d'un dôme en verre dépoli; au mielieu, et sur un seul pied, chef d'œvre de mécanique, se dressait le Grand Livre […].
Il avait vingt pieds de haut; un mécanisme intelligent permettait de le diriger comme un télescope, […] un systèm de légères passerelles, ingénieusement combiné, s'abaissait ou s'élevait suivant les besoins de l'écrivain. Sur les feuillets blancs, larges de trois mètres, se déeroulaient en lettre de trois pouces, les opérations journalières de la maison. […]Quant aux chiffres, superbement superposés dans les colonnes d'addition, les francs se détachaient en rouge écarlate, et les centimes, poussés jusqu'à la troisième décimale, ressortaient en vert foncé.

Aims of ECAL DB Project

- Storing construction data
  - Quality Control data and preliminary calibrations
  - Crystal/photodetector/read-out channel association(s)
- Bookkeeping of detector conditions (DCS)
  - Monitor of HV/LV status, temperature, etc.
- Bookkeeping of global run conditions
  - DAQ/Trigger configuration and setup
  - Pedestals, constants, HV status, Low Voltage (LV) status
- Bookkeeping of local run conditions
  - DCU: measurement of front end electronics parameters
  - Pedestal: measurement of electronic pedestals
  - Laser: measurement of the transparency of the crystal

Detector monitoring

LHC fill (20 h)

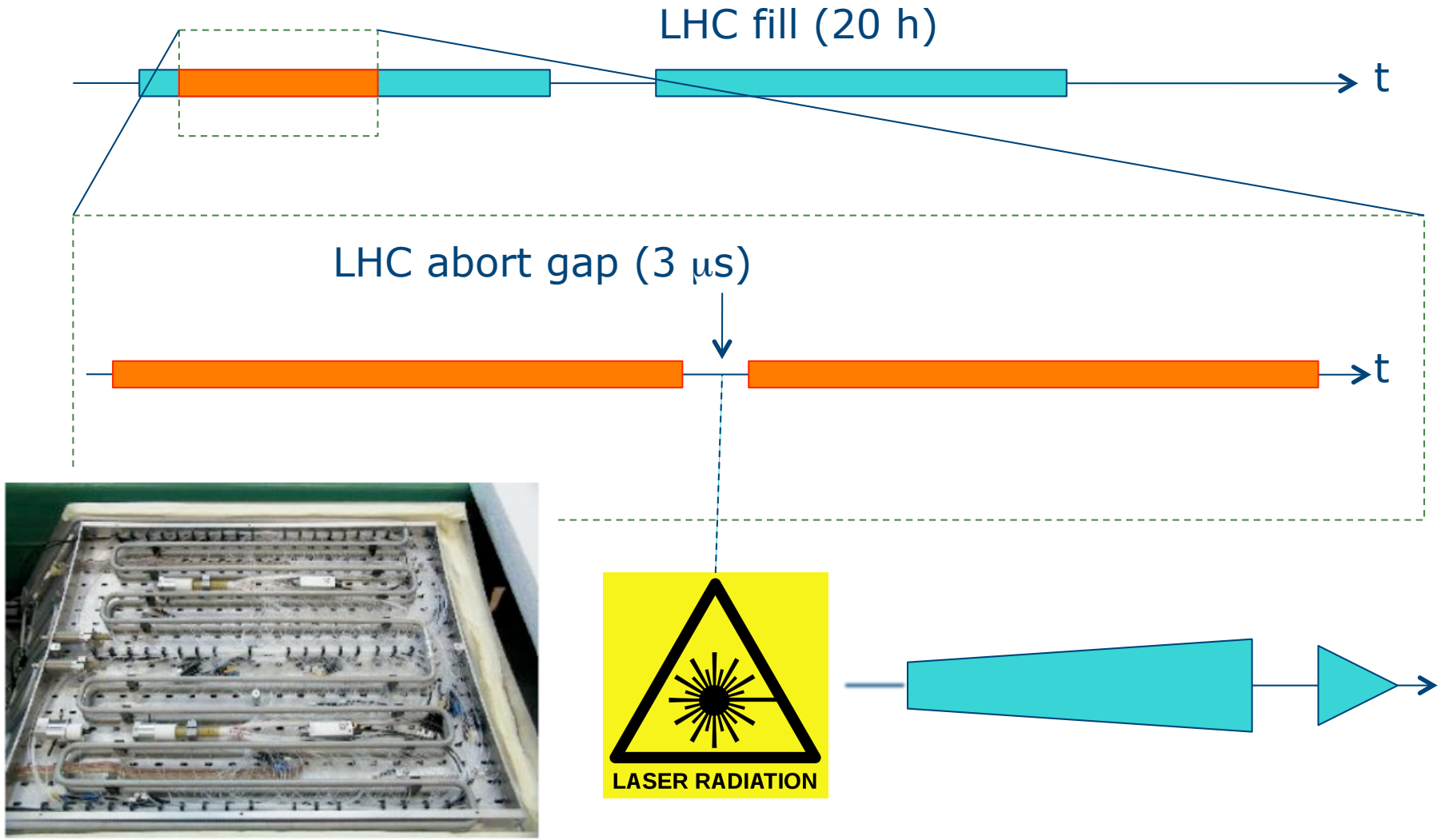
DCU: detector control unit
Taken (daily) between runs
Measure FE parameters (gains, temperatures, dark currents, voltages)

Pedestal: measure pedestal and noise

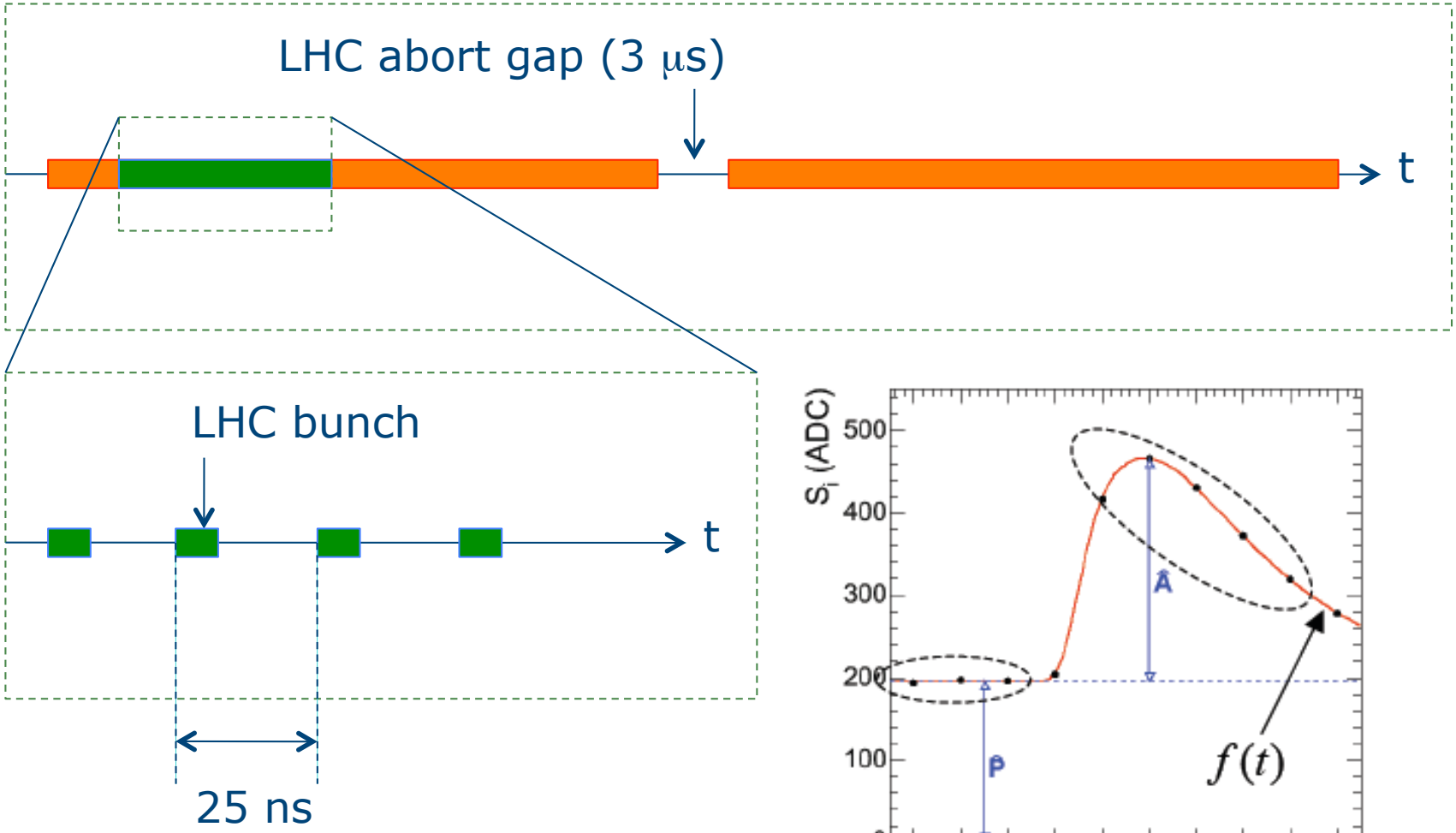
Laser: measure detector response to laser light injected in crystals (monitor transparency)

DCS: detector control system
temperature, humidity, RO status, HV, power, …

Monitoring within fills

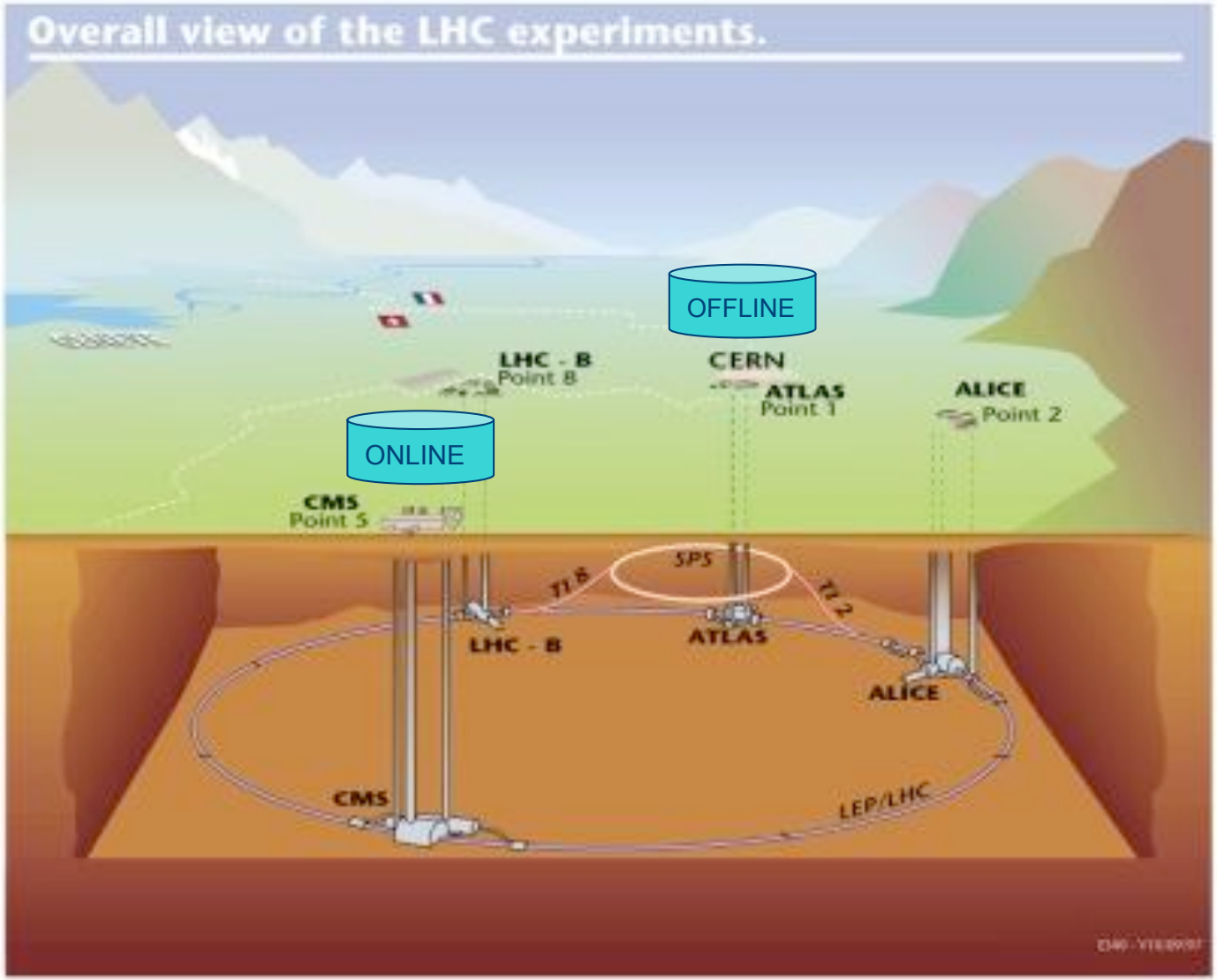


Monitoring during physics



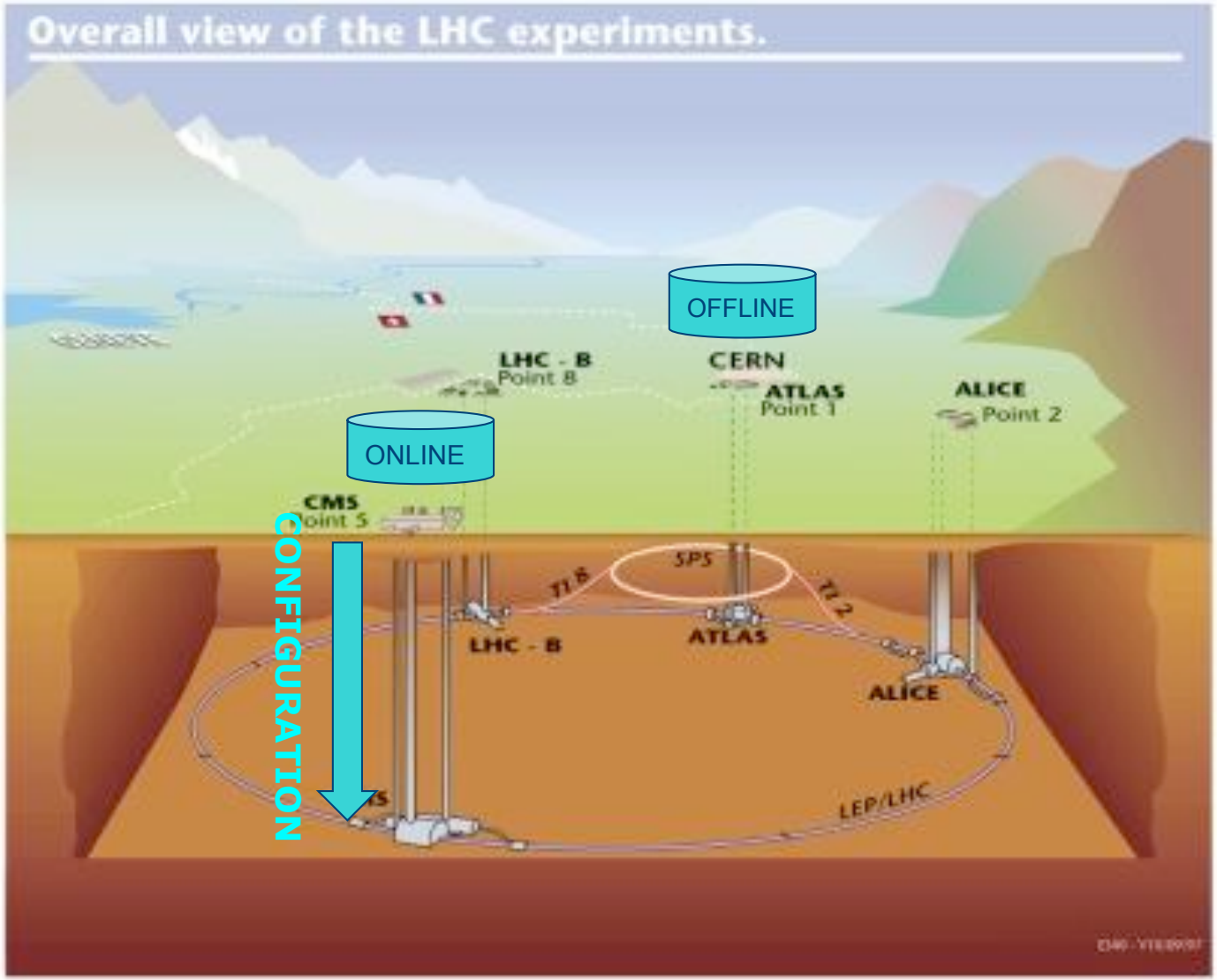
Data flow

There is an online database on the CMS site and an offline database at CERN site



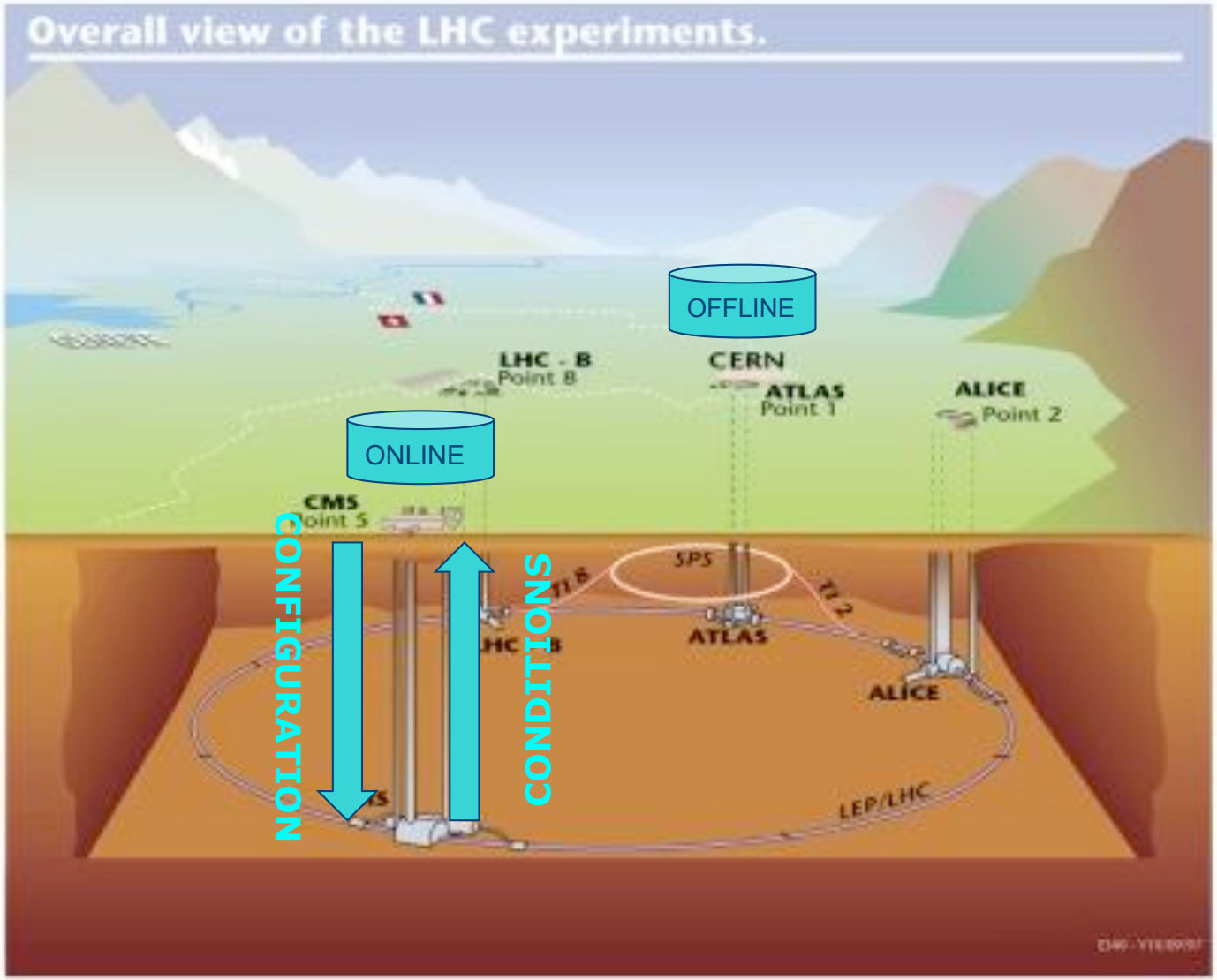
Data flow

DAQ/Trigger configuration sent to the detector read-out, is stored on the online DB



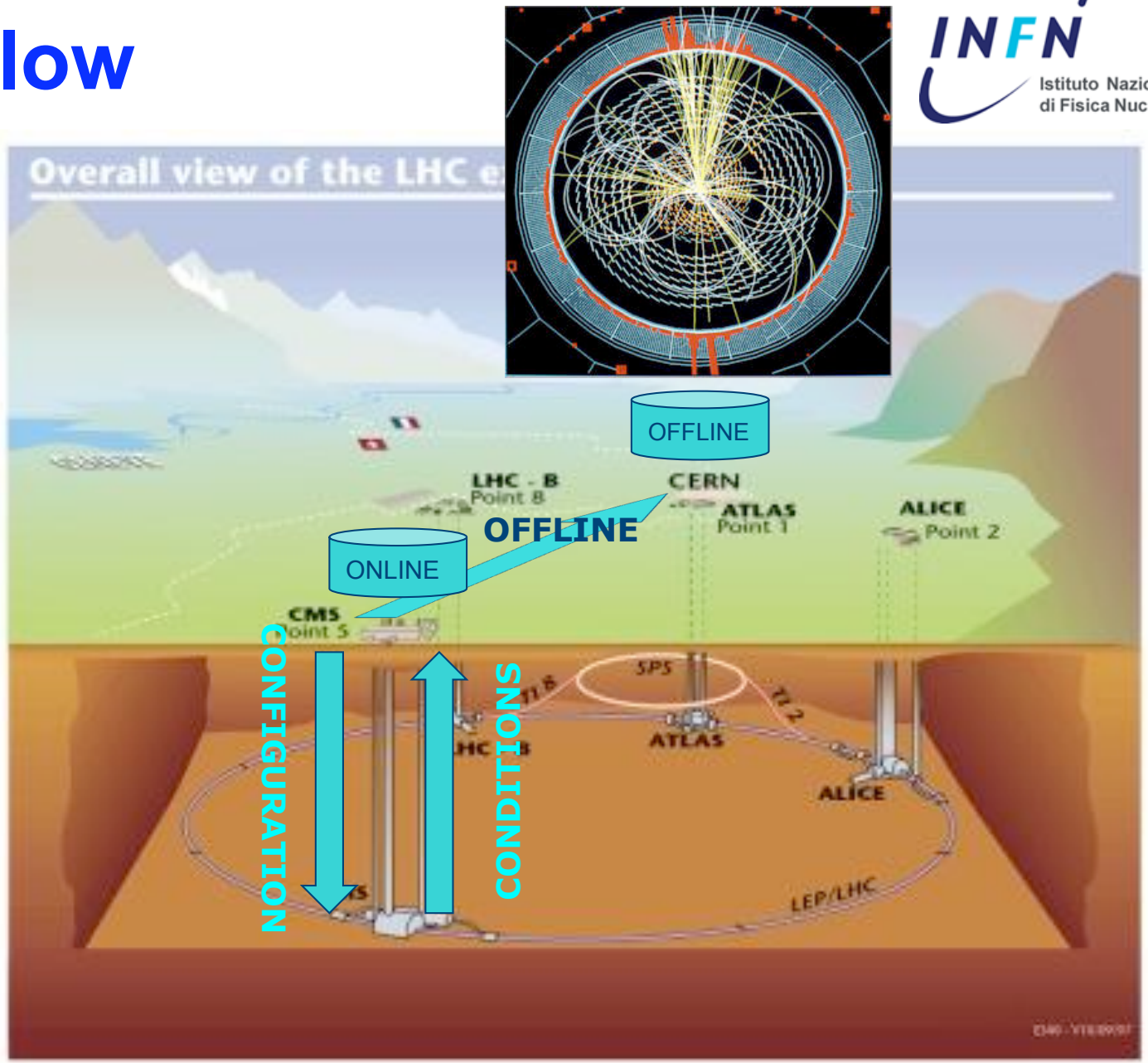
Data flow

Conditions measured during runs (non event data) or in local runs are stored on the online DB



Data flow

Online data are automatically (partially) copied on the offline DB for physics reconstruction



DBMS & Tools

ORACLE database 10g Enterprise Ed. 10.2.0.4.0 64bit

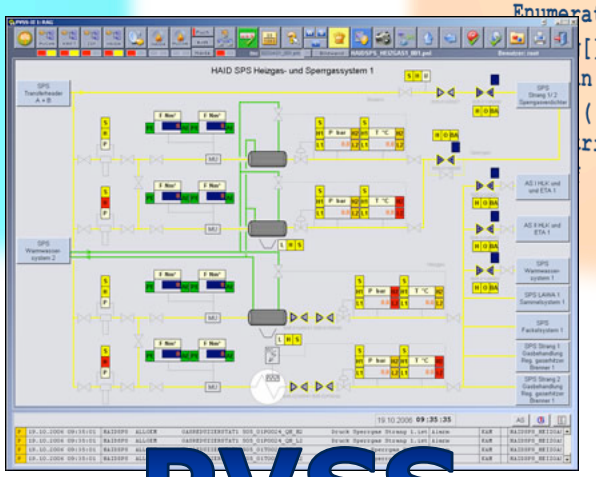
```
#include <math.h>
#include "OnlineDB/EcalCondDB/interface/EcalCommon.cc"

int EcalCommon::crystalToTriggerTower(int xtal)
  throw(runtime_error) {
  if (xtal < 1 || xtal > 1700) {
    throw(runtime_error("ERROR: crystal no. out of
range"));
  }
  int i = (int) floor((xtal - 1)/20.0);
  int j = (xtal -1) - 20.0*i;
  int tti = (int) floor(i/5.0);
  int ttj = (int) floor(j/5.0);
  int tt = ttj + 4*tti + 1;

  return tt;
}
```

C++

ORACLE DATABASE

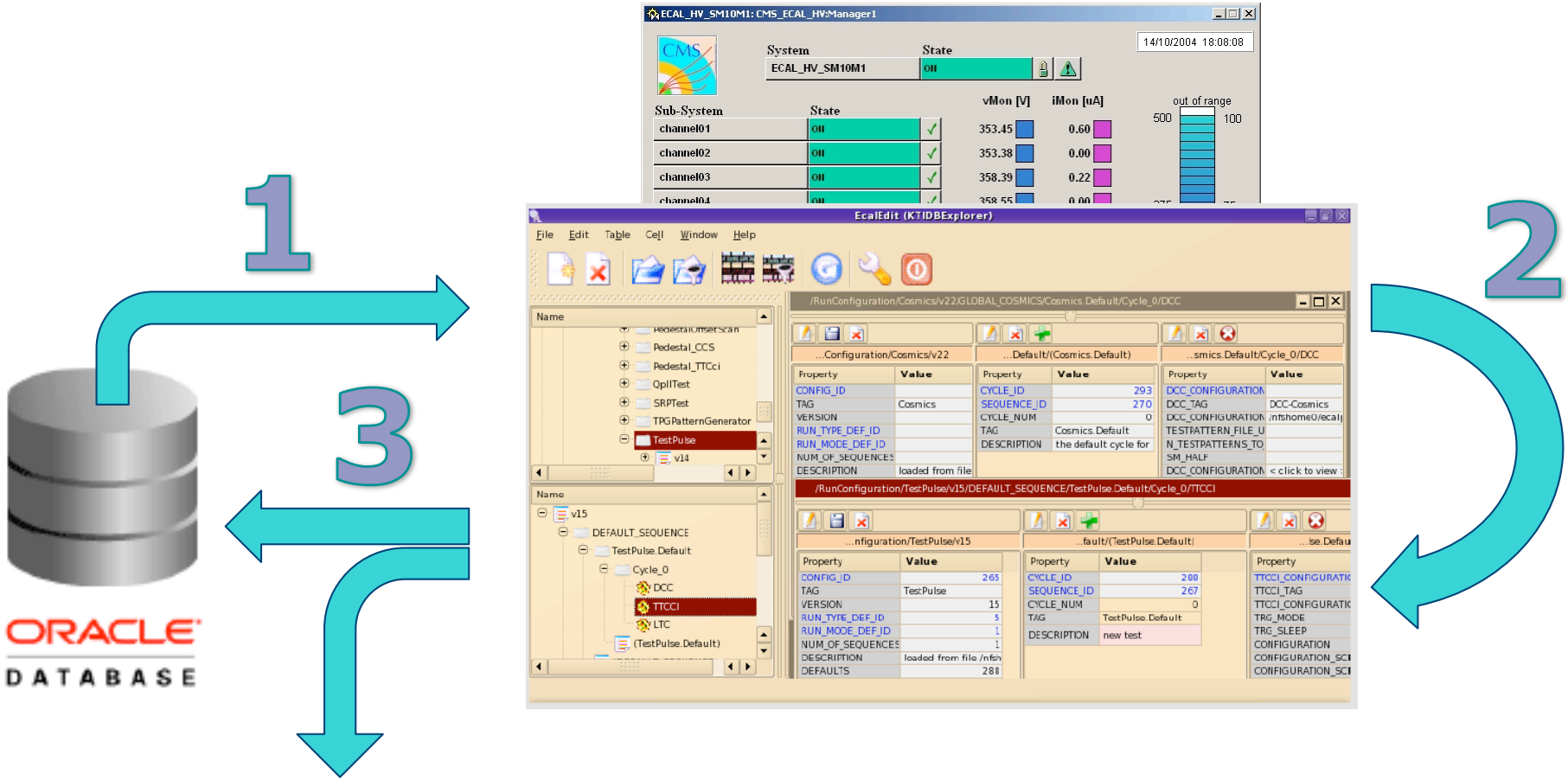
```
public class ECALSummary extends ECALCommon
{
    static public ECALQuery eq = null;
    static public String version = "5.0";

    public String[] getRunTypes()
        throws IOException, ServletException {
        return getMultipleSelection("RUN_TYPES");
    }

    public String[] getMultipleSelection(String selectionName)
        throws IOException, ServletException {
        Enumeration n = request.getParameterNames();
        [] selection = null;
        n loop = true;
        ((n.hasMoreElements()) && (loop)) {
        ring name = (String)n.nextElement();
         (name.equals(selectionName)) {
          String[] values = request.getParameterValues(name);
```

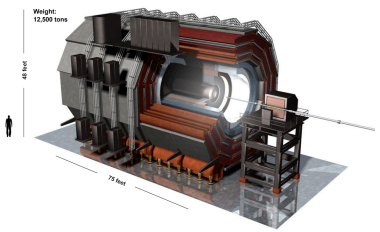
JAVA



PVSS

Use case: configuration



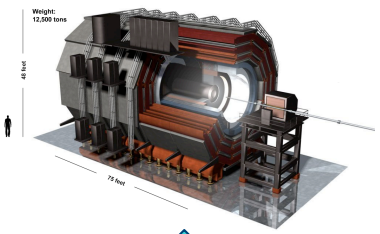


Run configuration (Run Control)
Detector configuration (configuration editor)
DCS: HV/LV Settings (PVSS)

Use case: monitoring

Data Quality Monitor, Laser monitoring
Local runs (pedestals, DCU, Laser)

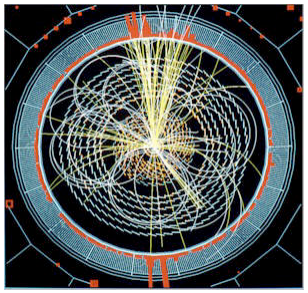
2



```
0000000 2f2f 2f0a 202f 6946 656c 2020 203a 4345
0000010 4c41 6853 776f 6c50 746f 6a2e 7661 0a61
0000020 2f2f 4120 7475 6f68 3a72 4720 6f69 6176
0000030 6e6e 2e69 724f 6167 746e 6e69 4069 6f72
0000040 616d 2e31 6e69 6e66 692e 2074 3228 3030
0000050 2938 2f0a 202f 6556 7372 202e 203a 2e31
0000060 0a31 2f2f 0a20 2f2f 5320 6f68 2077 6c70
0000070 746f 6620 6f72 206d 6164 6174 7420 6261
0000080 656c 2f0a 0a2f 2f2f 4820 7369 6f74 7972
0000090 2f0a 202f 2d2d 2d2d 2d2d 0a2d 2f2f 3120
00000a0 302e 203a 6966 7372 2074 6574 7473 7620
00000b0 7265 6973 6e6f 2f0a 202f 2e31 3a31 7220
```

3

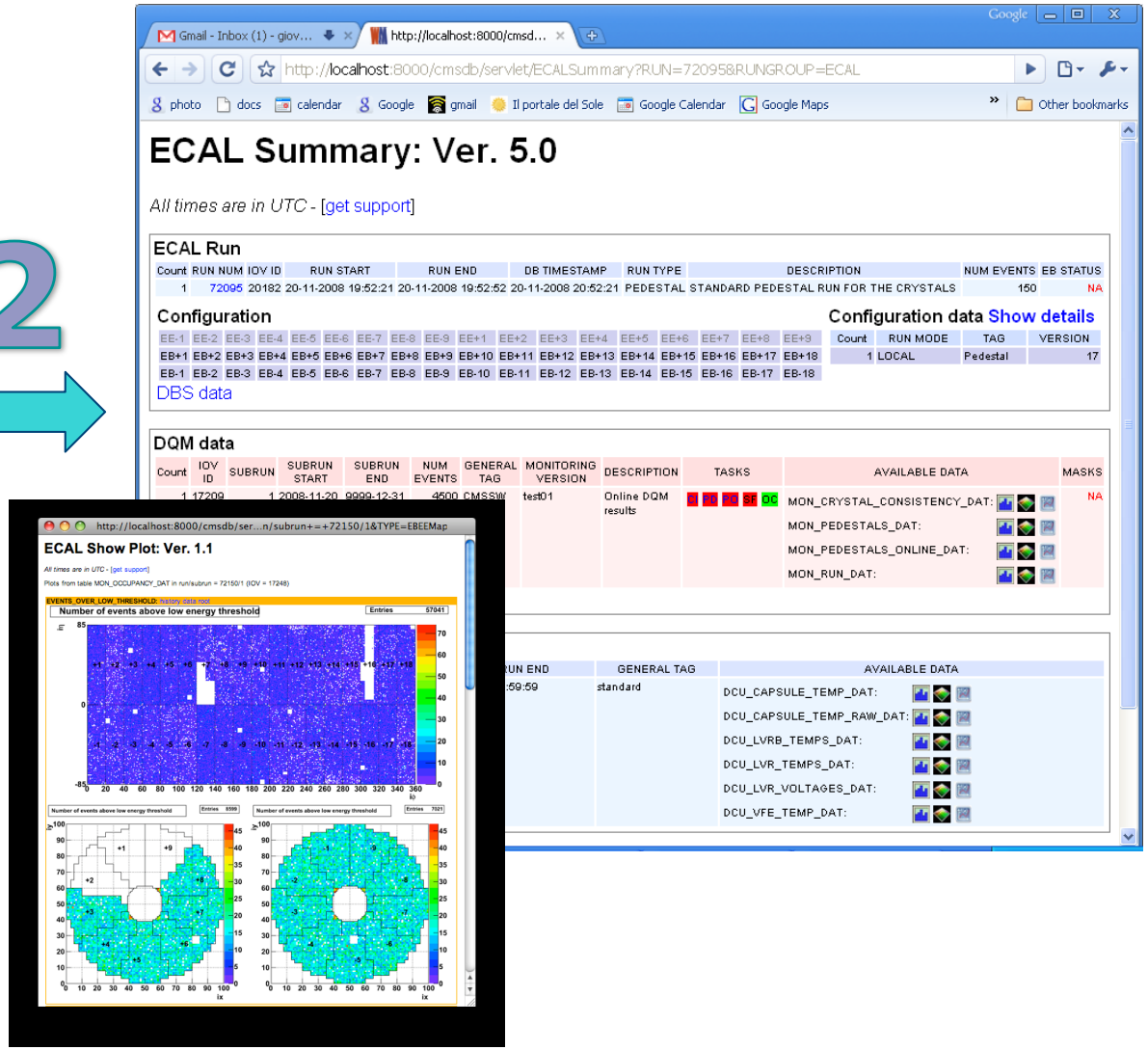
4



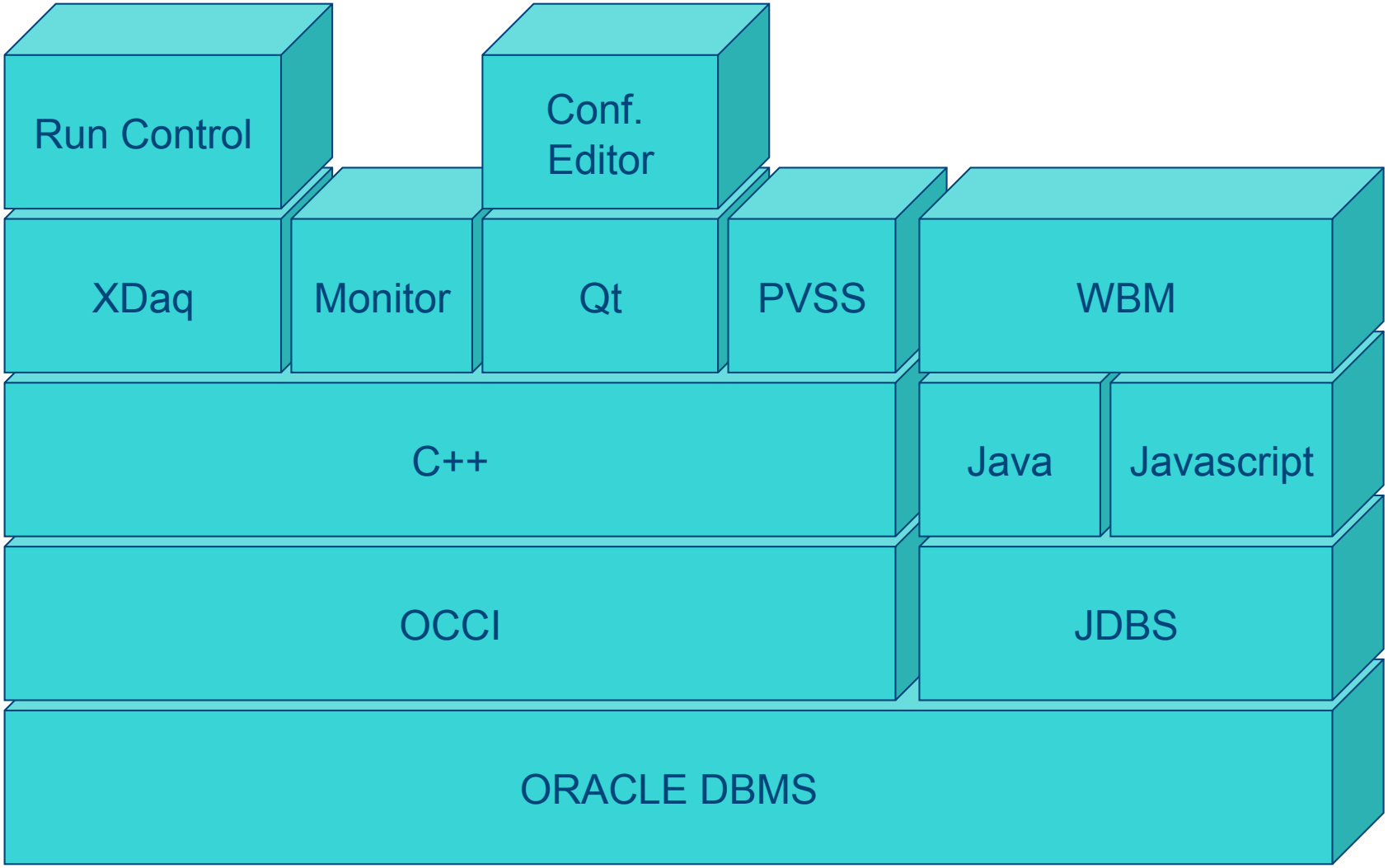
1

Use case: human browsing

Web Based Monitor (WBM)



Data access architecture



Database tables design

RUN_IOV

IOV_ID ✔
RUN_NUM
RUN_START
RUN_END

TASK_IOV

IOV_ID ✔
RUN_IOV_ID
FIELD1
FIELD2
…
FIELDn

FIELD_META

NAME ✔
TYPE
DESCRIPTION
MIN
MAX

TASK_XXX_DAT

IOV_ID ✔
LOGIC_ID
FIELD1
FIELD2
…
FIELDn

TABLE_META

NAME ✔
DESCRIPTION
LOGIC_ID_MAP

Database tables design

RUN_IOV

IOV_ID ✔
RUN_NUM
RUN_START
RUN_END

*MON*_IOV
*DCU*_IOV
*LASER*_IOV

TASK_IOV

IOV_ID ✔
RUN_IOV_ID
FIELD1
FIELD2
…
FIELDn

FIELD_META

NAME ✔
TYPE
DESCRIPTION
MIN
MAX

TASK_XXX_DAT

IOV_ID ✔
LOGIC_ID
FIELD1
FIELD2
…
FIELDn

TABLE_META

NAME ✔
DESCRIPTION
LOGIC_ID_MAP

Database tables design

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FIELD1
FIELD2
…
FIELDn

FIELD_META

NAME ✔
TYPE
DESCRIPTION
MIN
MAX

TASK_XXX_DAT

IOV_ID ✔
LOGIC_ID
FIELD1
FIELD2
…
FIELDn

TABLE_META

NAME ✔
DESCRIPTION
LOGIC_ID_MAP

MON_PED_DAT
MON_OCCUPANCY_DAT

Example

RUN_IOV	
IOV_ID ✔	126335
RUN_NUM	78546
RUN_START	12-03-09 08:00
RUN_END	12-03-09 11:34

MON_IOV	
IOV_ID ✔	728456
RUN_IOV_ID	126335
SUBRUN	1

FIELD_META		
NAME ✔	PED_MEAN	PED_RMS
TYPE	FLOAT	FLOAT
DESCRIPTION	PEDESTAL VALUE	PEDESTAL RMS
MIN	0.	0.
MAX	2048.	2048.

TABLE_META	
NAME ✔	MON_PED_DAT
DESCRIPTION	PEDESTALS
LOGIC_ID_MAP	CHANNEL

MON_PED_DAT	
IOV_ID ✔	728456
LOGIC_ID	1013450
PED_MEAN	234.2
PED_RMS	1.05

Example

RUN_IOV	
IOV_ID ✔	126335
RUN_NUM	78546
RUN_START	12-03-09 08:00
RUN_END	12-03-09 11:34

MON_IOV	
IOV_ID ✔	728456
RUN_IOV_ID	126335
SUBRUN	1

FIELD_META		
NAME ✔	**PED_MEAN**	PED_RMS
TYPE	FLOAT	FLOAT
DESCRIPTION	PEDESTAL VALUE	PEDESTAL RMS
MIN	0.	0.
MAX	2048.	2048.

TABLE_META	
NAME ✔	MON_PED_DAT
DESCRIPTION	PEDESTALS
LOGIC_ID_MAP	CHANNEL

MON_PED_DAT	
IOV_ID ✔	728456
LOGIC_ID	1013450
PED_MEAN	234.2
PED_RMS	1.05

Example

RUN_IOV	
IOV_ID ✔	126335
RUN_NUM	78546
RUN_START	12-03-09 08:00
RUN_END	12-03-09 11:34

MON_IOV	
IOV_ID ✔	728456
RUN_IOV_ID	126335
SUBRUN	1

FIELD_META		
NAME ✔	PED_MEAN	**PED_RMS**
TYPE	FLOAT	FLOAT
DESCRIPTION	PEDESTAL VALUE	PEDESTAL RMS
MIN	0.	0.
MAX	2048.	2048.

TABLE_META	
NAME ✔	MON_PED_DAT
DESCRIPTION	PEDESTALS
LOGIC_ID_MAP	CHANNEL

MON_PED_DAT	
IOV_ID ✔	728456
LOGIC_ID	1013450
PED_MEAN	234.2
PED_RMS	1.05

Channel identification

RUN_IOV

IOV_ID ✔
RUN_NUM
RUN_START
RUN_END

MON_IOV

IOV_ID ✔
RUN_IOV_ID
FIELD1
FIELD2
…
FIELDn

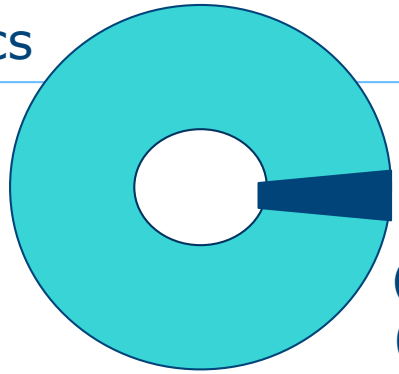
Unique readout channel id

Corresponding to many different views, depending on the context

- physics
- electronics

MON_XXX_DAT

IOV_ID ✔
LOGIC_ID
FIELD1
FIELD2
…
FIELDn



(η,ϕ) for physics
(SM#, address) for readout
(SM#, SU#, xtal#) for construction

Channel identification

RUN_IOV

IOV_ID ✔
RUN_NUM
RUN_START
RUN_END

MON_IOV

IOV_ID ✔
RUN_IOV_ID
FIELD1
FIELD2
…
FIELDn

CHANNELVIEW

NAME ✔
LOGIC_ID
ID1
ID2
ID3

MON_XXX_DAT

IOV_ID ✔
LOGIC_ID
FIELD1
FIELD2
…
FIELDn

VIEWDESCRIPTION

NAME ✔
DESCRIPTION
ID1NAME
ID2NAME
ID3NAME

Example

RUN_IOV	
IOV_ID ✔	126335
RUN_NUM	78546
RUN_START	12-03-09 08:00
RUN_END	12-03-09 11:34

MON_IOV	
IOV_ID ✔	728456
RUN_IOV_ID	126335
SUBRUN	1

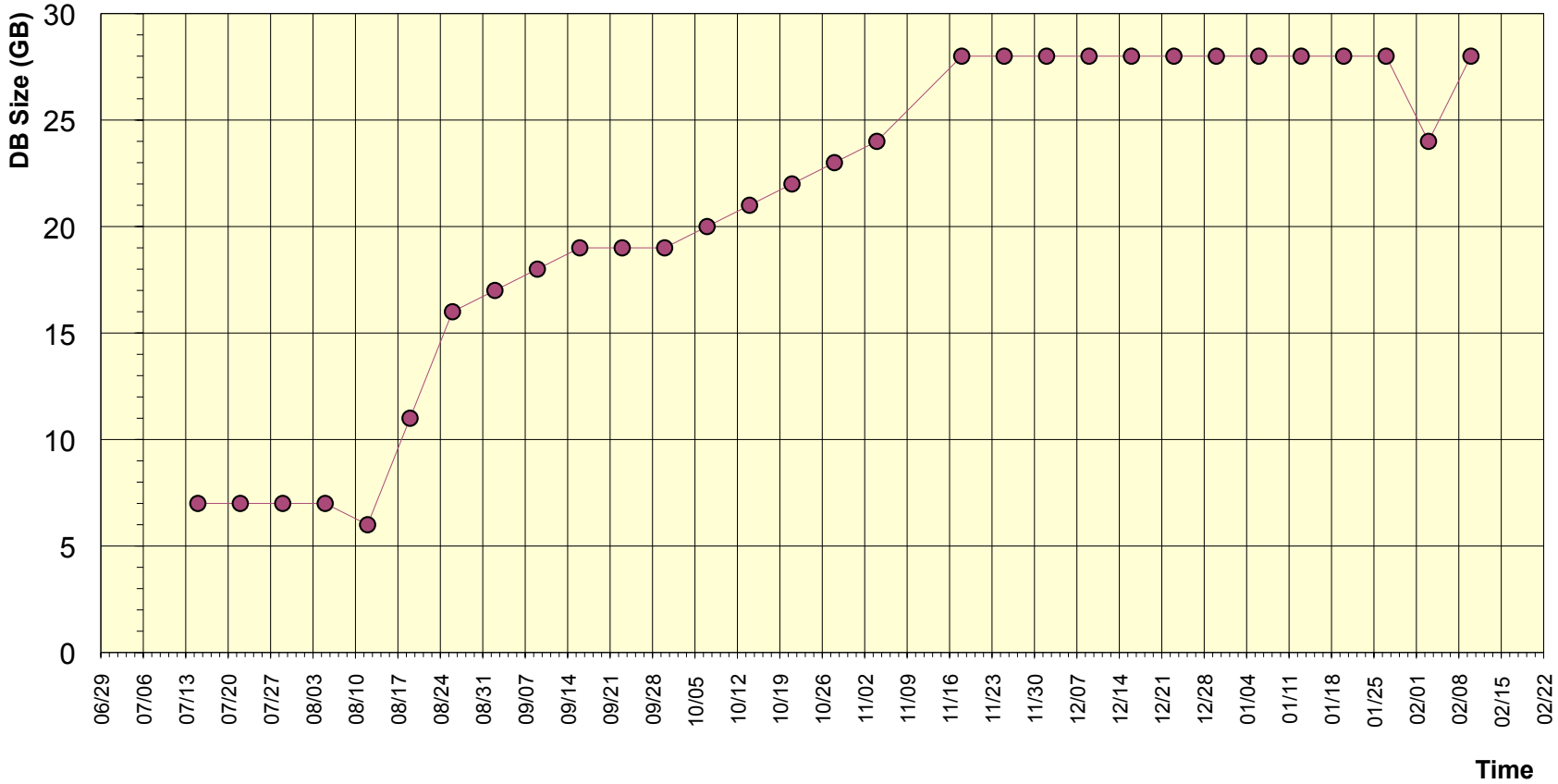
CHANNELVIEW		
NAME ✔	CRYSTAL	CHANNEL
LOGIC_ID	1013450	1013450
ID1	8	13
ID2	180	450
ID3	NULL	NULL

MON_PED_DAT	
IOV_ID ✔	728456
LOGIC_ID	1013450
PED_MEAN	234.2
PED_RMS	1.05

VIEWDESCRIPTION		
NAME ✔	CRYSTAL	CHANNEL
DESCRIPTION	PWO CRYSTAL COORDS	READOUT CHANNEL
ID1NAME	ETA	SM
ID2NAME	PHI	CHANNEL NO.
ID3NAME	NULL	NULL

Evolution of DB size

Data taking duty cycle ≈ 0.3-0.5 LHC duty cycle
dS/dt ≤ 10 GB/month



Conclusion

- ECAL DB Services well established
  - Almost ready for collisions
  - Full "end user" support
  - Variety of access methods/use cases
- Flexible and expandable
  - Thanks to careful "Item Description" design
- Compact
  - Fast retrieval of data