CMS Database Project for HCAL / EMU / PIXEL detectors

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U of Maryland / CMS HCAL group

6-Oct-2003

Introduction

LHC & CMS detector

CMS Database

Plan & Manpower

Request to FNAL CD

Introduction

Goal:

- **To build a coherent database system for HCAL, EMU and PIXEL detectors in CMS.**
  - The system covers both online and offline.
  - The system also covers hardware information from the construction phase.
  - The system is expandable to other detectors in CMS.

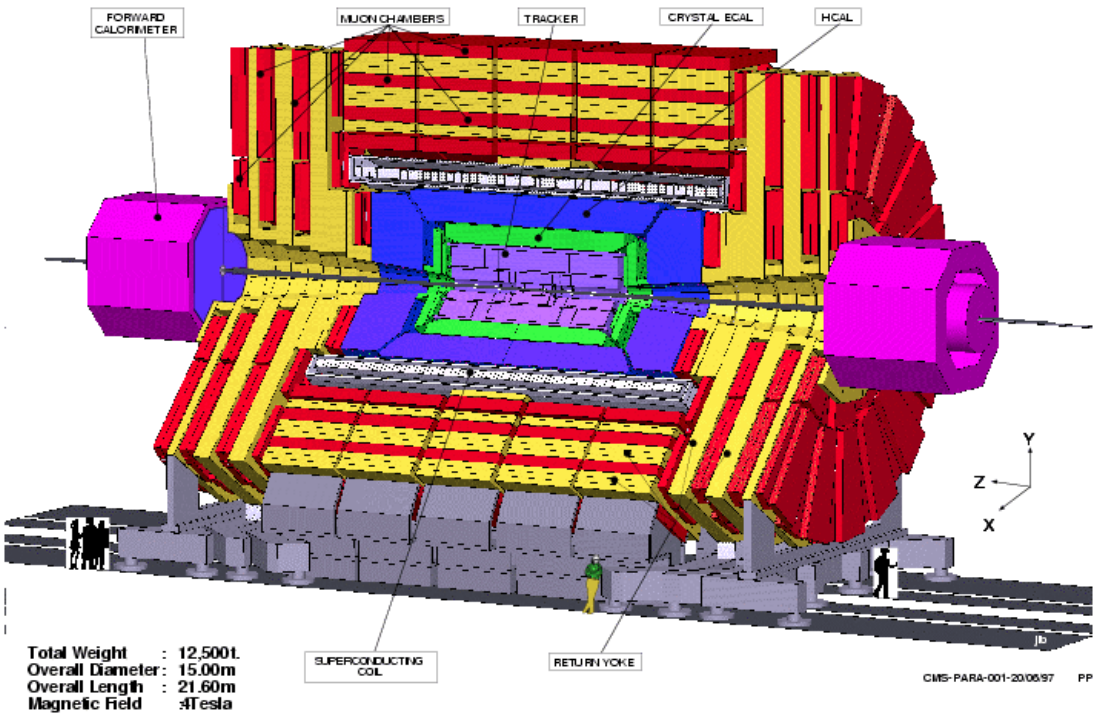
Plan:

- **Build a prototype for the slice test/DC04 in 2004 and evaluate.**
- **Upgrade the prototype to fully functional product in 2005/2006.**

General request to CD:

- **Provide us a strong guideline for design, implementation and operation of the DB system.**
- **Take a leading role in CMS in the DB development as a part of the base program support at Fermilab.**

The CMS detector



Toal weight	12500 t
Overall diameter	15 m
Overall length	21.6 m

All silicon tracker x
- micro strips (10M ch)
- pixel (70M ch) ←
- (5.4m long, 2.4m Φ: |η| <2.4)

Hermetic calorimeter x
- ECAL: PbWO4 crystal
- HCAL: brass+scinti. ←
- (|η| <3.0)

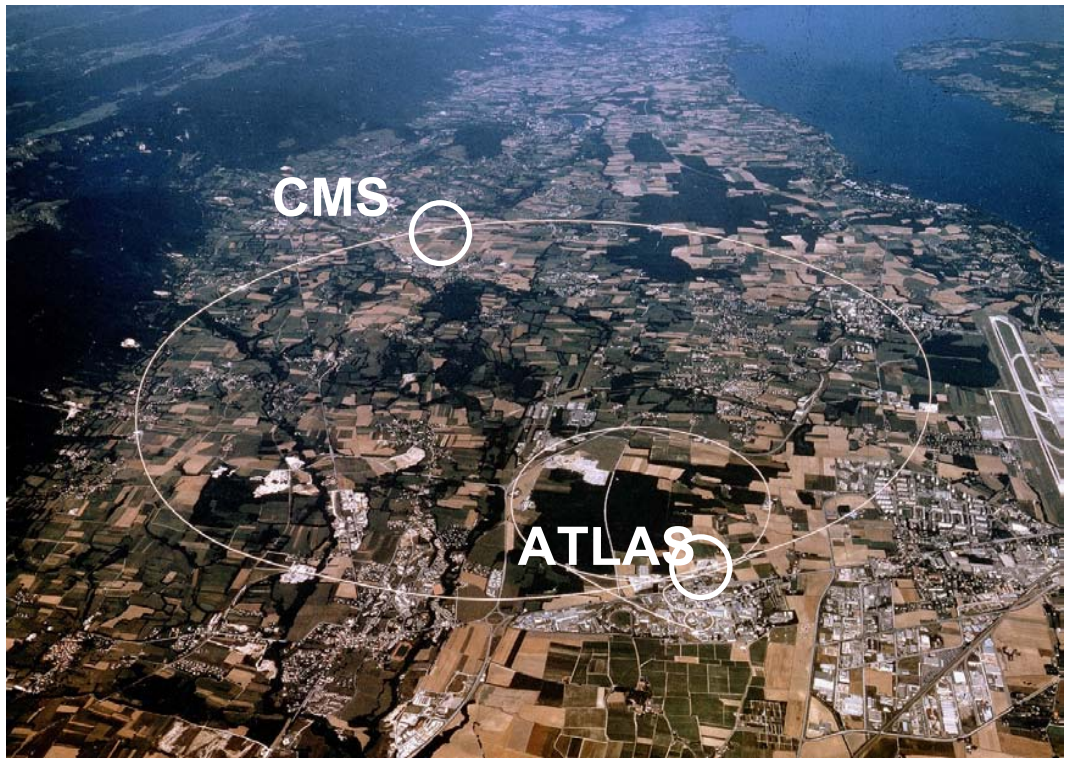
in 4 Tesla solenoid
- (12.5m long, 6m Φ in)

Robust muon system x
- DT+RPC (barrel)
- CSC+RPC (endcap) ←
- (in iron yoke: |η| <2.4)

Fast cerenkov calor. ←
- quartz fibber
- (3<|η|<5)

Trigger x

The LHC

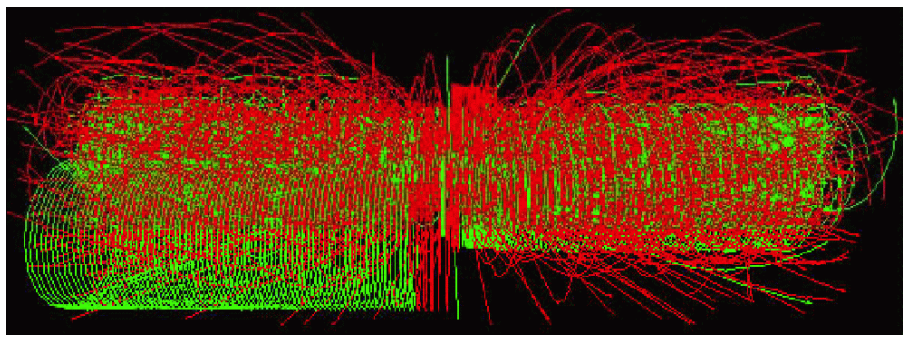


R = 4.5 Km
E = 7+7 TeV (pp)

crossing rate
=40MHz
(25nsec)

design luminosity
= $10^{34}cm^{-2}s^{-1}$

~20 pp interactions
per crossing
at design luminosity



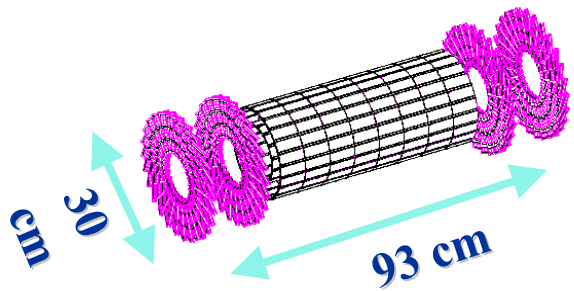
h → 4 μ with 20 min. bias evt.

Surface buildings and main shaft

Installation of the first muon chamber

EMU: CSC

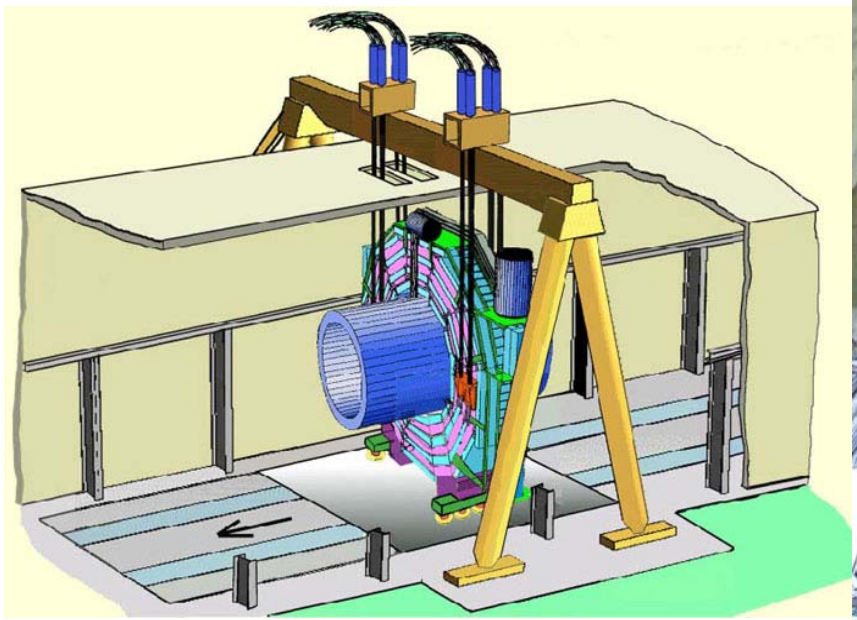
Pixel Tracker



66 10^6 pixels

16000 chips

Occupancy 10^{-4}



Transfer YB0 (2000t) in 2005

HCAL plan

2003 June-September

- **Calibration runs in the H2 testbeam at CERN**
  - All HCAL subdetectors: HB, HE, HF, HO + Crystals

2004 Summer-

- **Low energy testbeam at H2**
  - EC+HC response to low energy beam
  - hadron showers at low energy
- **Slice test with EMU, TRIG and DAQ at CMS.**
  - System test - hardware & software & operation **+ database**

2005

- **Transfer HCAL to the under-ground experimental hall.**

2006

- **Test beam (?)**
- **Integration and commissioning**

2007

- **Physics data taking**

Database in CMS

From:

Database meeting

25.06.2003

Frank Glege

- CMS Equipment Management DB manager/develper.
- CMS Online DB Working Group coordinator.
- CMS Conditions DB Working group coordinator.

Introduction

- Pere Matos “Proposal to bring Conditions DB into the LCG Applications area scope” has been accepted by the LCG SC2. Therefore David Stickland initiated a working group to look into conditions database issues in CMS. It was decided to inspect first the situation of databases in CMS and to identify required clarifications.
- Martin Liendl, Igor Vorobiev and Stephan Wynhoff kindly accepted to start this work together with me.
- The first step will be to write a note on CMS databases agreed by everybody involved.

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Database types

- We will have 4 kinds of databases in CMS:
  - Construction databases
    - Holds all information about the sub detector construction up to the start of integration
  - Integration database ← Now called" Equipment Management DB"
    - Holds all information to physically set up the detector and is used for asset tracking
  - Configuration database
    - Holds all information required to bring the detector in any running mode
  - Conditions database
    - Holds all information needed for event reconstruction

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Outlook

- Working group will meet regularly to produce the note, should be finished by September
- “Official” meetings with wider audience to gather required information.
- Work on required clarifications identified in the note (performance tests, implementation issues)
- Report to LCG the CMS requirements on conditions DB

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Conditions/Calibration DB

(David Stickland: LHCC CR, 23-Sep-03)

- Working group created with representative/responsible from
  - Integration DB
  - Configuration DB
  - Conditions/Calibrations DB
  - Reconstruction
  - Start by collecting requirements and document them
- Prototyping
  - Pool is the persistency interface in COBRA:
    - how to use it for conditions data having SQL based back-ends?
  - What are the data access patterns?
  - Sequential event processing vs. selective processing
  - What about the LCG Conditions DB project?
  - integration studies, interface studies, ...
  - Use in distributed environments. How?
- Follow the ongoing work of the HCAL & EMU community
  - bi-weekly meetings; HCAL/EMU doing some prototyping (US)

DPS Sep 03, LHC Review

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Computing & Software Manpower

(David Stickland: LHCC CR, 23-Sep-03)

		CMS Computing and Software Manpower in FTE-years	FTE deficit	FTE actual	FTE need				
			2003	2003	2003	2004	2005	2006	2007
Computing / Software professionals	CCS	Management, Coordination and TDR	3.3	4.3	7.5	7.4	5.3	5.7	5.7
		Computing & Software Infrastructure & Services	2.8	8.1	10.9	11.9	12.1	12.2	12.2
		Architecture, Frameworks and Toolkits	4.6	12.4	16.9	16.2	14.8	17.1	17.1
		Production Processing and Data Management	2.5	7.5	10.0	10.1	10.0	10.5	10.5
		Grid Integration	2.1	8.4	10.5	11.6	12.0	12.0	12.0
		CCS sub-total	15.2	40.6	55.8	57.2	54.2	57.6	57.6
	TriDAS (online farm)	Online Filter Software Framework	1.8	1.8	3.6	4.9	6.5	8.0	8.0
		Online Farm(s)	0.1	0.2	0.3	1.6	2.3	3.8	3.8
		TRIDAS (online farm) sub-total	1.8	2.0	3.8	6.4	8.8	11.8	11.8
		Total CCS + TriDAS (online farm) (computing/SW professionals)	17.0	42.6	59.6	63.6	63.0	69.4	69.4
Physic -ists	PRS	Detector PRS Groups	23	47	70	89	95	93	
		Analysis PRS Groups	17	50	67	80	101	*Incomplete*	
		Total PRS (physicists)	40	97	137	169	196		

DPS Sep 03, LHC Review

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Need help!

DC04: 50M events

(David Stickland: LHCC CR, 23-Sep-03)

- "Tier-0 challenge" (reconstruction)
  - Data catalog
- Data distribution to Tier-1 and Tier-2
  - Data transfer tools interfaced to data catalogs and MSS
- "Calibration challenge"
  - Conditions database (strategy for replication)
- "Analysis challenge" (predefined analysis)
  - At least solid LAN access for files
- *"Analysis challenge" (user analysis) (descope for DC04…)*
  - *Metadata catalog, job preparation and submission tool*

Critical Grid components:

Data catalog, data transfer tool interfaced to MSS (Tier-1 issue)

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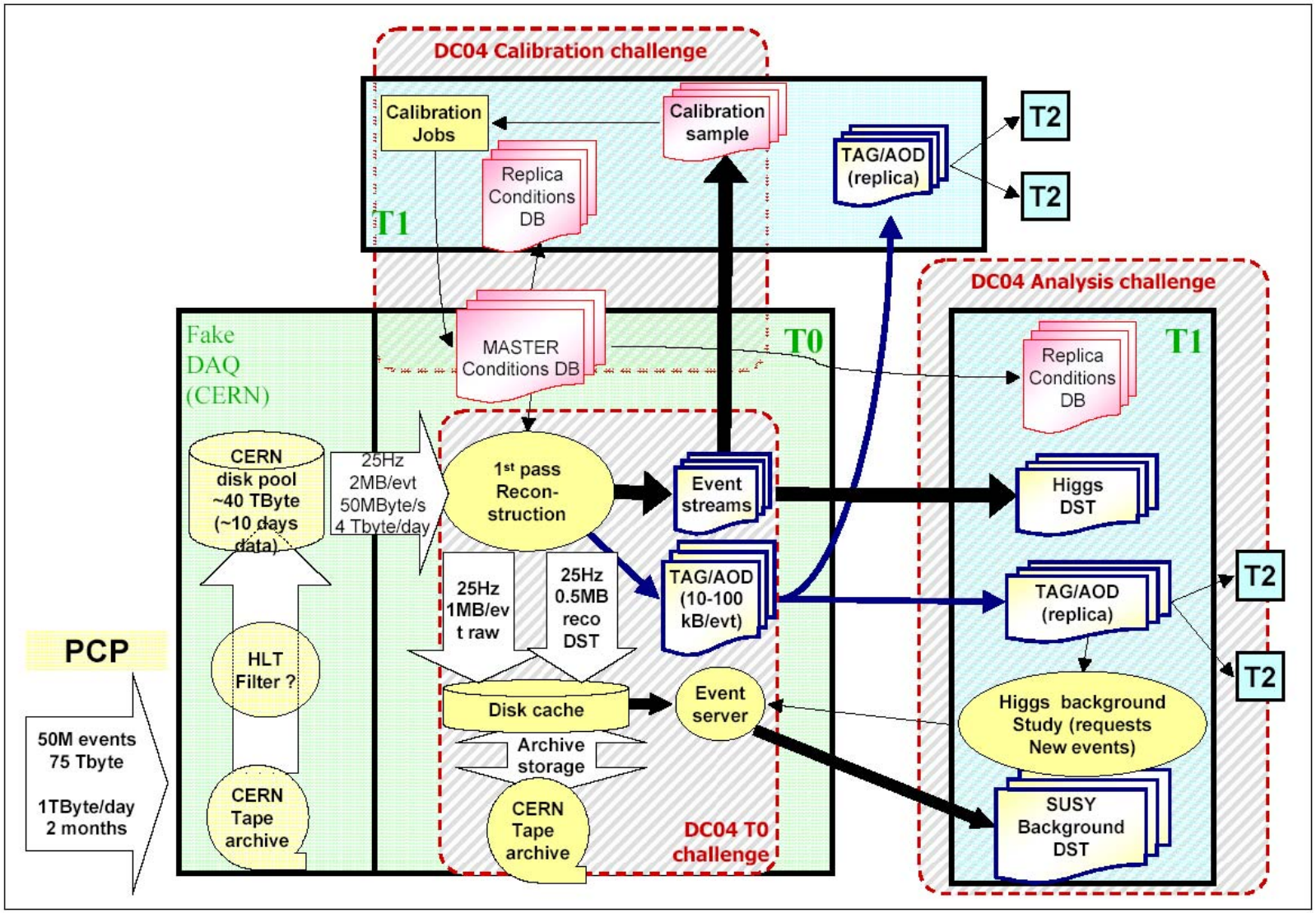
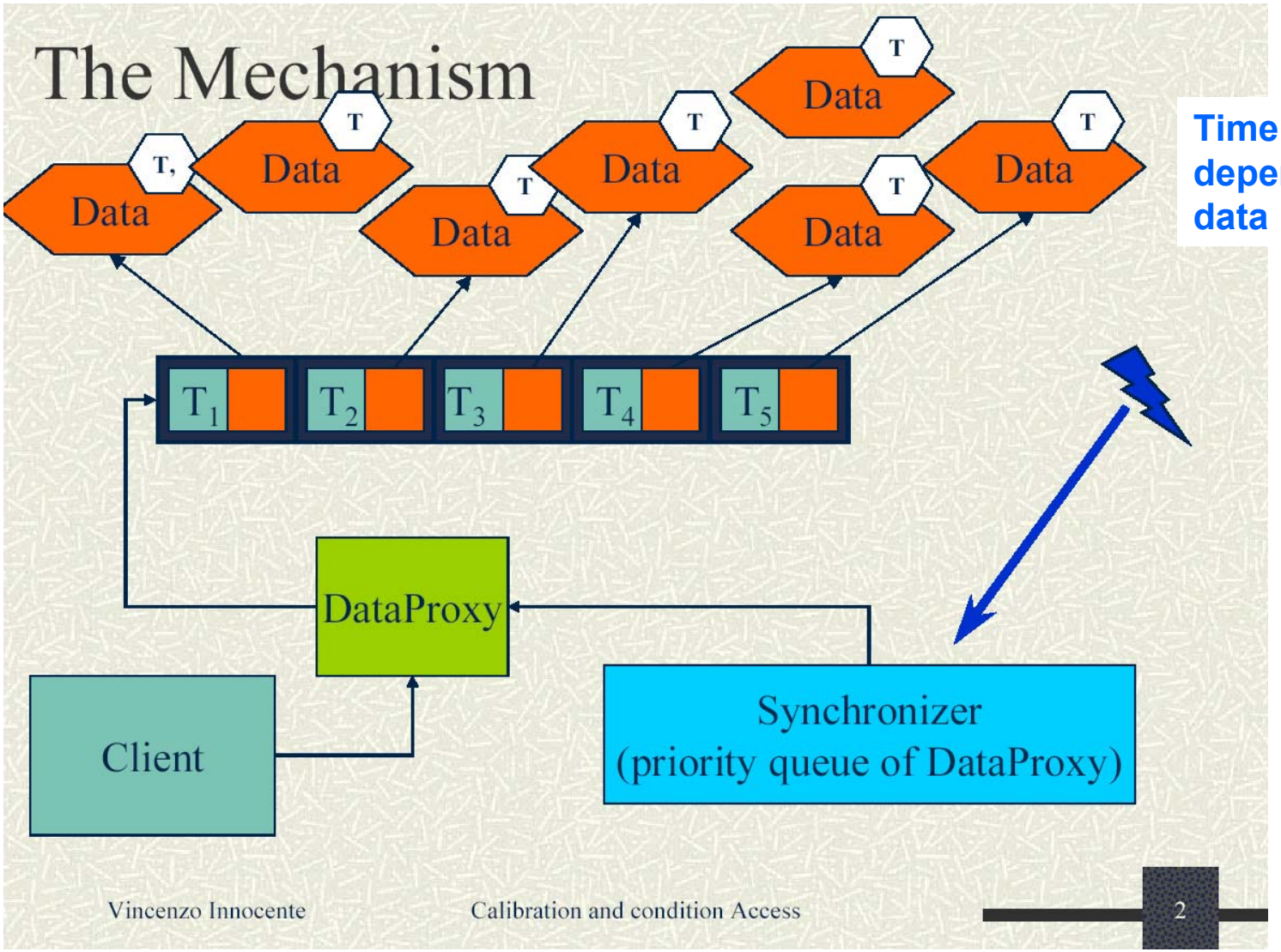
DC04: Calibration Challenge



Optimized Access to Calibration Data
from ORCA (offline reconstruction program)



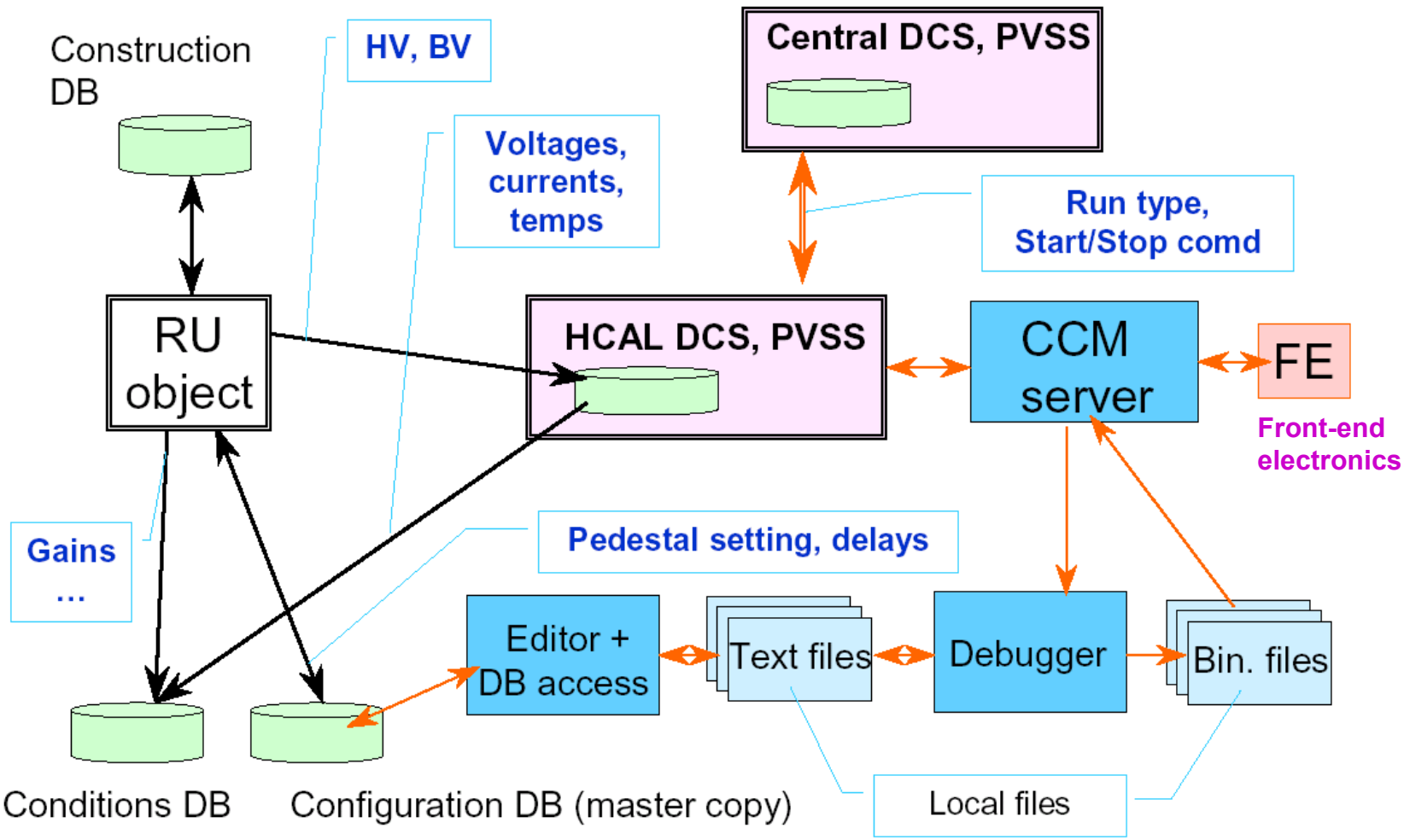
Time dependent data

Components for Conditions/Calibration DB Acess

Components

- **Data**
  - Stored in whatever technology
  - Indexed with whatever metadata
- **Time-Series**
  - The real condition objects
  - Strict time ordered collection of **Data:**
    - Associate to each **Data** its expiration time
- **DataProxy**
  - export to the **Client** the current "value" of **Data**
  - Both **DataProxy** and **Client** implement lazy-update logic
- **Synchronizer**
  - Keeps **DataProxies** young
    - Use a priority-queue keyed with the expiration time of the current value
    - Or reacts to external notification for real-time applications
  - Observe a Time-stamped event
    - Critical to its efficiency that events are served time-ordered

Databases: a View from HCAL DCS



S.Sergueev, DCS WG meeting, Sept 17, .2003, CMS week

Next Step

Current Situation:

No infrastructure / framework / clear guideline on DB in CMS.
Unclear situation of conditions DB in LCG.

Our next step:

Coordinate ourselves (HCAL/EMU/PIXEL)
Look for global/common solution for hardware/online/offline.

Two strategies:

Bottom-up: expand our current prototype.
from calibration domain to hardware/online
from HCAL to EMU & PIXEL (vise versa)

Top-down: define DB system architecture and interfaces, and build infrastructure, and then implement detector specific part.

HELP needed:

A technical coordinator for the HCAL/EMU/PIXEL DB project.
DB data modeling / OO experts for top-down approach.
DB experts for consulting for bottom-up approach.

Plan

- **Phase-1: 2003 (3 months)**
  - Design Version 1 DB for slice test/DC04.
  - Explore a possible role of the FNAL CD in the CMS wide DB project.
  - Define a detailed development plan.
- **Phase-2: 2004**
  - Implement Version 1 and evaluate.
  - Design of Version 2.
- **Phase-3: 2005-2006**
  - Implement V2 and further improvement.

Manpower (as of today)

HCAL	S.Kunori (coordinator) J.Cranshaw, J.Damgov [FNAL] S.Sergueev (DCS) [CERN] + A.Oulianov, V.Ladygin [Moscow] students/CS [Iowa, Texas tech, …]
EMU	R.Clare (coordinator) V.Sytnik(DCS), I.Vorobiev(Construction) [CERN]
PIXEL	U.Joshi [FNAL]
CAS (US-CMS)	R.Clare (L2 manager) M.Case [UC Davis]

Other parties:

CMS	CCS, DAQ, Integration
LCG	
CERN-IT	

Request to CD

For the HCAL/EMU/PIXEL DB development.

A technical coordinator for the HCAL/EMU/PIXEL DB team.

We will find a deputy from the detector groups to help the coordinator.

Top-down DB (software) system design.

Including evaluation of new technologies/standards and implementation.

Consulting for developers from three detector groups for their bottom-up approach.

For the CMS wide DB develoment.

Exploring a possibility of taking a leading role in CMS wide DB development.

We suggest a few people from CD visit CERN in very near future (November or December) to explore the possibility, and also to collect information needed for the top-down design work and consulting.

→The FNAL CD has a lot of experience with the CDF/D0 DB. We hope that CD will help CMS in database development in major way as a part of the base program support at Fermilab.

Additional Slides

Questions

How much can we reuse DB software components (or whole system) from CDF and/or Dzero?

How much can we share with ongoing DB development effort at Fermilab?

Construction DBs

- Sub detector specific
- Sub detector responsibility
- Already existing for most sub detectors.
- Have to be available for the lifetime of CMS
- Data: construction info, initial calibration data, work flow info, etc.
- Data will partially be copied into the 3 other DBs.

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Integration DB
(Equipment Management DB)

- Common for all CMS
- Set up by CMS integration, data entered and maintained by sub detectors
- Partially existing
- Data: detector and electronics parts, cables, racks, crates, location history of all items, etc…
- User interface existing (rack wizard) to enter required information.

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Configuration DB

- Sub detector specific parts on front end electronics configuration, combined DAQ, Trigger and DCS info.
- Set up by corresponding groups
- Very few parts existing
- Data: see above
- Interface to online software framework XDAQ existing
- First prototype of interface to DCS existing

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Conditions DB

- First interface definition by Pere Mato
- Implementations of this interface for Objectivity, mySQL and ORACLE existing
- Tools provided by LCG?
- Data: all parameters describing the run conditions needed for offline reconstruction.
- Could be used for error tracking in the online system

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HCAL: Conditions Database

All information needed for event reconstruction (HLT/Offiline)

HB, HE, HO : scintillator/brass sampling calorimeter
scint. - HPD – QIE (ADC) – HTR (Trig Primitive/pipeline) – L1/DAQ
HF : quartz fiber/iron calorimeter
fibers - PMT – QIE (ADC) – HTR (Trig Primitive/pipeline) – L1/DAQ

Readout channels ~ 10k
Stable detector – no need to update constants frequently, hopefully.
HF gain will decrease due to radiation damage (slow time constant).

Constants – from ADC counts to GeV

1) Channel response (scint-HPD-QIE)	1	* 10k (ch)
2) QIE calibration (ADC-to-Charge(fC))	128 (bin)	* 10k (ch)
3) Charge-to-GeV (HB,HE,HO,HF)	1	* 4
4) Pedestal	4 (capid)	* 10k (ch)

+) Channel# – (eta,phi,depth) map

Constants – required for JetMET, e.g.
1) average EC, HC response (used by energy flow algorithm)
2) …

HCAL: Configuration DB

All information required to bring the detector in any running mode.

Run modes:

1) beam, 2) pedestal 3) source calib 4) laser calib 5) LED calib

Constants (on detector)

HPD/PMT	- HV	1/(HPD or PMT)
CCM	- clock phase	1/(ch)
CalibModule	- mode+	
RBX	- LV	

Constants (in counting room)

HTR	- pedestal	1/(ch)
	- LUT(ADC-to-GEV)	1LUT/(ch)
	- threshold	1/(ch)
TTC	- timing	

HACL: Equipment Management DB

All information to physically set up the detector and is used for asset tracking

Detector components: (on detector)

- 1) Absorber
- 2a) Megatile
- 2b) Quartz fiber bundle (HF)
- 3) Optical cable
- 4) RBX(readout box)
- 4.1) RM{ODU, HPD(PMT), QIE}
- 4.2) CCM
- 4.3) Calibration Module
- 5) Cable
- +) shielding, support (HF)

Detector components: (in counting room)

- 1) Crate
- 1.1) HTR
- 1.2) TTC

Channel map (eta,phi,depth)→megatile→optical cable→RM{ODU,HPD,QIE}→HTR(ch)}

HCAL: Construction/Hardware DB

C-DB: all information about the sub detector construction up to the start of integration.

H-DB: all information required for cross checking calibration constants and for detector simulation.

Detector components: (on detector)

1) Absorber	- dimension, source tube location (HF)
2a) Megatile/fibers	- dimension, fiber length, att.length, source scan
2b) Quartz fiber bundle (HF)	- type
3) Optical cable	- length
4) RBX(readout box)	-
4.1) RM{ODU, HPD(PMT), QIE}	- HPD(PMT) gain, QIE(ADC→fC, timing), map
4.2) CCM	-
4.3) Calibration Module	-
5) data cable	-
+) shielding, support (HF)	

Detector components: (in counting room)

1) Crate
1.1) HTR
1.2) TTC

Calibration Data

Most of these are in
simple ASCII files
Excel files
Autocad
mySQL