



Endeca Information Discovery for the Monitoring & Control of the LHC

Manuel Martín Márquez





Largest machine in the world
27km, 6000+ superconducting magnets

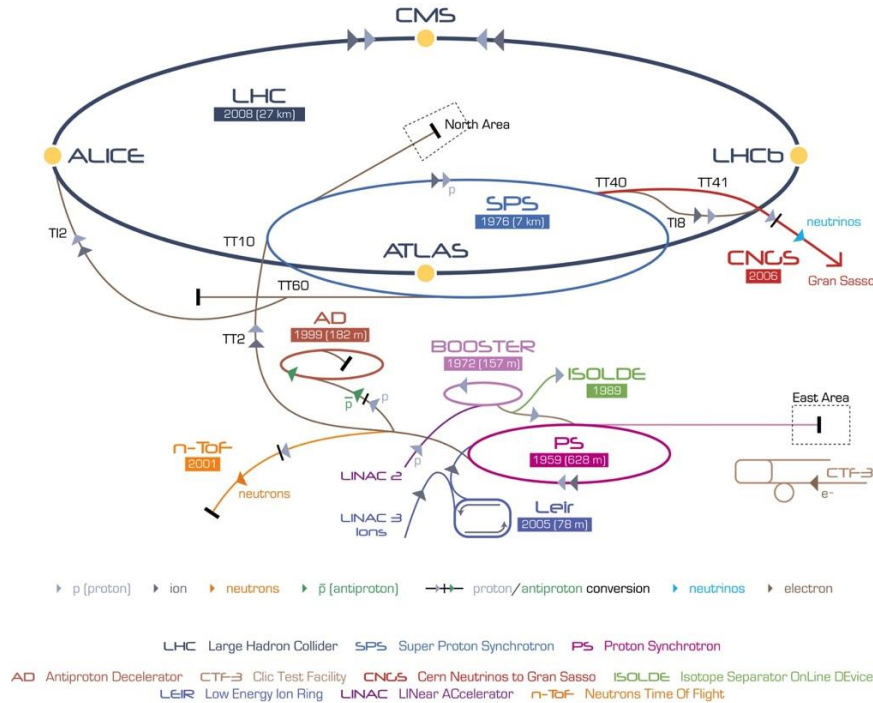
Fastest racetrack on Earth
Protons circulate 11245 times/s (99.9999991% the speed of light)

Emptiest place in the solar system
High vacuum inside the magnets

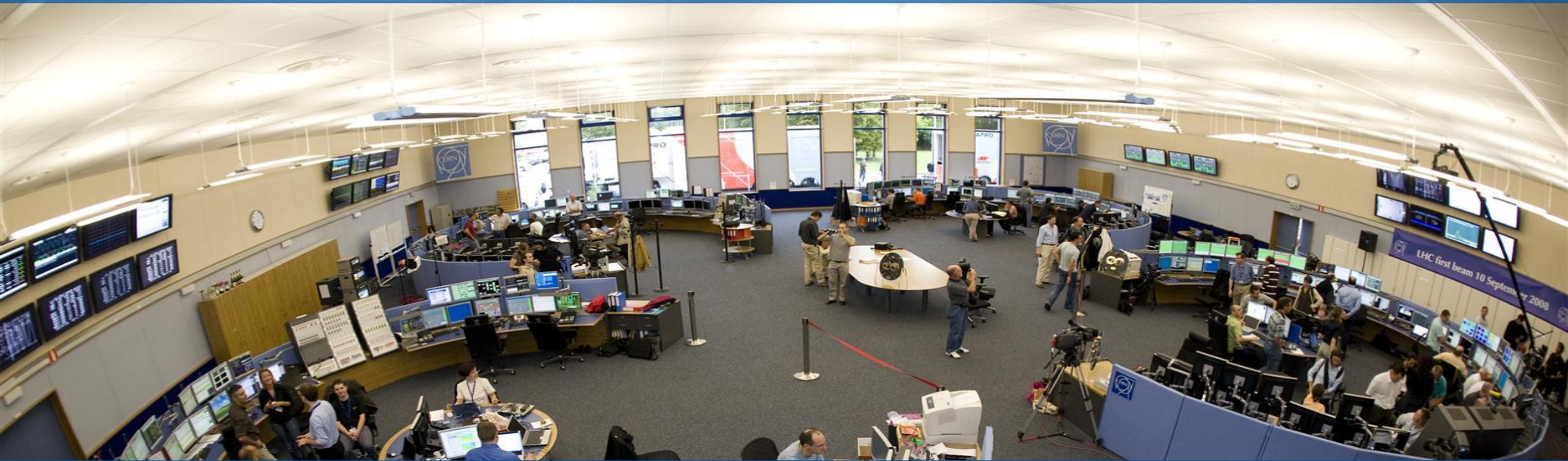
Hottest spot in the galaxy
During Lead ion collisions create temperatures 100 000x hotter than the heart of the sun;

LHC 27 km

CERN Accelerator Complex



CERN Control Centre



CERN Accelerator Complex is unique installation
Therefore, we have to face unique challenges

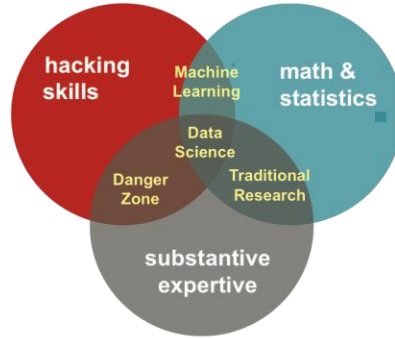
Control and Operations

Million of sensors, large number of control devices, front-end equipment, etc.
Many critical systems: Cryogenics, Vacuums, Machine Protection, etc.

Data Analytics Challenges

- **Control and Monitoring Systems**
 - Proactive
 - Predictive
 - Intelligent
- **Optimize our systems is mandatory**
 - Reducing and predicting faults and corrective interventions
 - Increase the availability and operations efficiency
- **Profit from our data investment**
 - Extracting knowledge.
 - **Information Discovery**





ORACLE
DATABASE

MySQL

cassandra

mongoDB

hadoop

timber
The LHC Logging System

LHC Logging Service

PVSS II

Control System Health

Network Monitoring for WLCG

ATLAS & CMS Control System



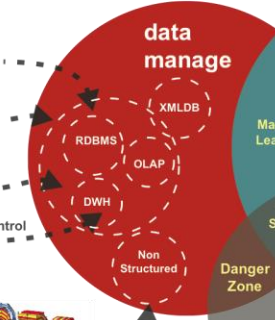
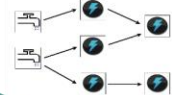
CASTOR
CERN Advanced Storage Manager

CASTOR Predictive Analytics

ORACLE

EsperTech

ORACLE
COMPLEX EVENT PROCESSING



Danger Zone

Data Science

Traditional Research

Advance Visualization

Information Discovery

Advance Analytics

Event Processing

Streaming Analysis

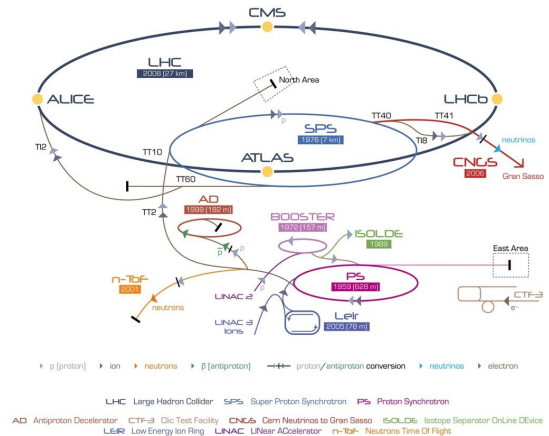
Machine Learning

Discovery & Knowledge

ORACLE
ENDECA
ORACLE
BUSINESS INTELLIGENCE

Endeca Information Discovery

- Information Discovery for improving the Accelerator Complex Operations
- Electronic Logbook
- Log of events

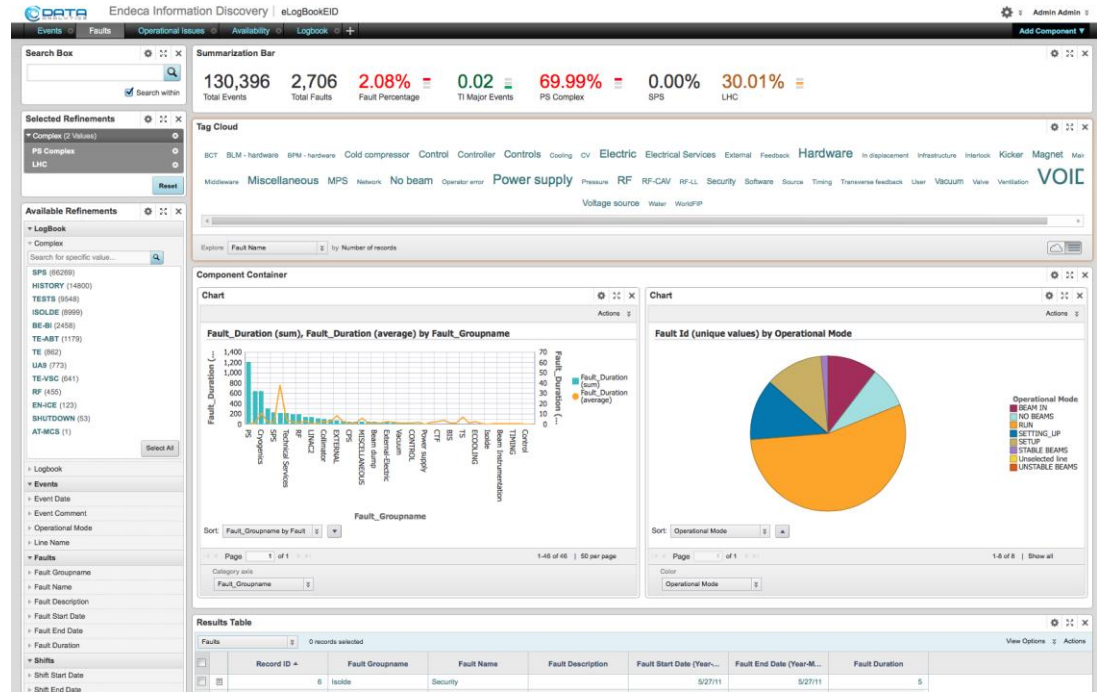


4	23:42	SUP	Global Post Mortem Event Event Timestamp: 10/06/12 23:42:39.163 Fill Number: 2718 Accelerator / beam mode: PROTON PHYSICS / STABLE BEAMS Energy: 4000080 [MeV] Intensity B1/B2: 15509 / 14217 [e ¹⁰ charges] Event Category / Classification: PROGRAMMED_DUMP / MULTIPLE_SYSTEM_DUMP First BIC input Triggered: First USR_PERMIT change: Ch 1-Programable Dump b1: A T -> F on CIB.CCR.LHC.B1
5	23:42	SUP	Global Post Mortem Event Confirmation Dump Classification: Programmed Dump Operator / Comment: papotti / End of physics fill, clean dump.
6	23:42	SUP	BEAM MODE > BEAM DUMP LHC RUN CTRL: BEAM MODE changed to BEAM DUMP
7	23:42	SUP	BEAM MODE > BEAM DUMP LHC RUN CTRL: BEAM MODE changed to BEAM DUMP
8	23:42	SUP	ELOGBOOK: STARTING B1 MKISS
9	23:43	SUP	ELOGBOOK: STARTING B2 MKISS
10	23:44	SUP	LHC SEQ: beam dump handshake closed; LHC=STANBY, EXP=VETO
11	23:44	SUP	LHC SEQ: MCS checks finished
12	23:45	SUP	LHC SEQ: SMP pre-operational checks finished
13	23:45	SUP	LHC SEQ: BIS pre-operational checks finished
14	23:48	SUP	BEAM MODE > RAMP DOWN LHC RUN CTRL: BEAM MODE changed to RAMP DOWN
15	23:48	SUP	LHC SEQ: BPMLHC calibration finished. Overall result: SUCCESS Chosen bunch spacing: (B1 & B2) BUNCH_50NSEC (manually chosen) (For more details see BI-LHC ELogBook)

Endeca Information Discovery

- Electronic Logbook
- Information Discovery

DEMO





www.cern.ch