



# CERN-Greece Industry day

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Industry day, Athens

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**Beams Department Controls Group**  
**CERN, Accelerators and Technology Sector**

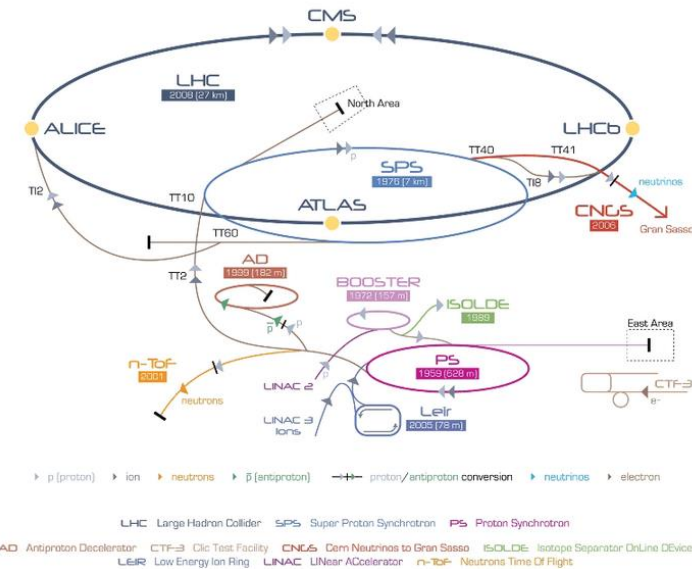


# CERN Beam Department

- **Operation and performance optimization** of the LHC, the injector complex and their transfer lines
- **Designing, building and maintaining** the instruments for **beam observation and measurement** of related parameters for all accelerators and transfer lines
- **Designing, building, and maintaining** of **accelerating and damping systems**
- **Controlling, measuring, monitoring and first line intervention** for all accelerators and transfer lines

- **Range of Activities**

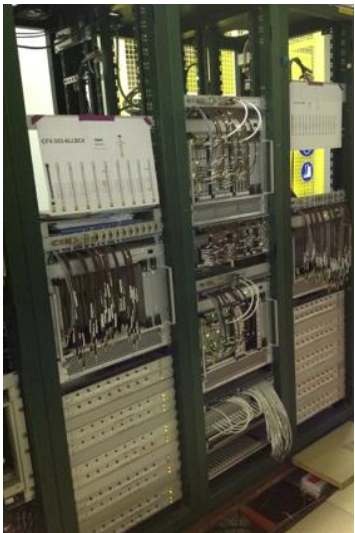
- Accelerator physics, detector technology, custom built electronics, mechanical and vacuum engineering for detector housings, RF beam control and feedback electronics, **controls electronics, software engineering**, dedicated instrumentation, slow control equipment PLC, G64 interface systems, **hardware and embedded software, real-time front-end computers, file and application serves**, cavity servo systems control (tuners, loops), VME - Control and Low Level RF hardware interfaces, high-power RF systems, **font end computers software and equipment drivers, Expert and Control room applications, general machine and beam synchronous timing generation and distribution, signal observation system,....**





# The Beam Controls

- Responsible for the **controls infrastructure** that is deployed over **all the accelerators** of CERN, extending from the **embedded real-time front-end computers** to the **applications software** for operations
- Specification & procurement of the real-time embedded hardware reference platforms of the control System (Industry standard form factors, single board computers and fieldbuses)



- The controls group provides general services
  - front-end software framework
  - general machine and beam synchronous timing generation and distribution
  - signal observation system
  - communication middleware
  - alarms, surveillance and monitoring
  - general logging facilities and data management





# Controls Projects

- Future Front End hardware platform technology
- Investigations regarding future software technologies
- Timing towards the WhiteRabbit technology
- New building for Beams Department management and Controls group



# Controls Initiatives

## Open Hardware Initiative

- Initiated in the CERN Beams Controls group and inspired by Open-Source Software
  - Hardware designs and documentation are publically accessible
  - Knowledge dissemination
  - Improved hardware quality
  - No vendor-lock
  - Re-usage of designs
- Has three main components
  - The Open Hardware Repository
  - The CERN Open Hardware License
  - The CAD tools
- >100 projects in ohwr, 30% of them are coming outside CERN
- >150 developers from 11 institutes and 16 companies all over the world



## White Rabbit Network

- The White Rabbit network is the biggest Open Hardware project
  - Is an extension of standard Ethernet that provides deterministic data delivery and node synchronisation better than 1 ns
- It is a collaboration of several institutes and companies
- The **Real-time distribution of B field value** in the Injector complex
- The BI and RF equipment used for the LHC **Instability Studies project**
- 1<sup>st</sup> deployment for the **ELENA timing** in 2015

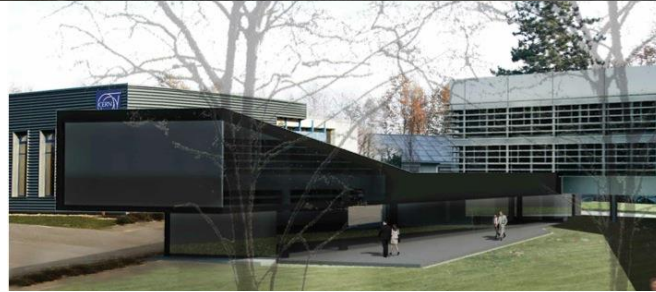




# New Building

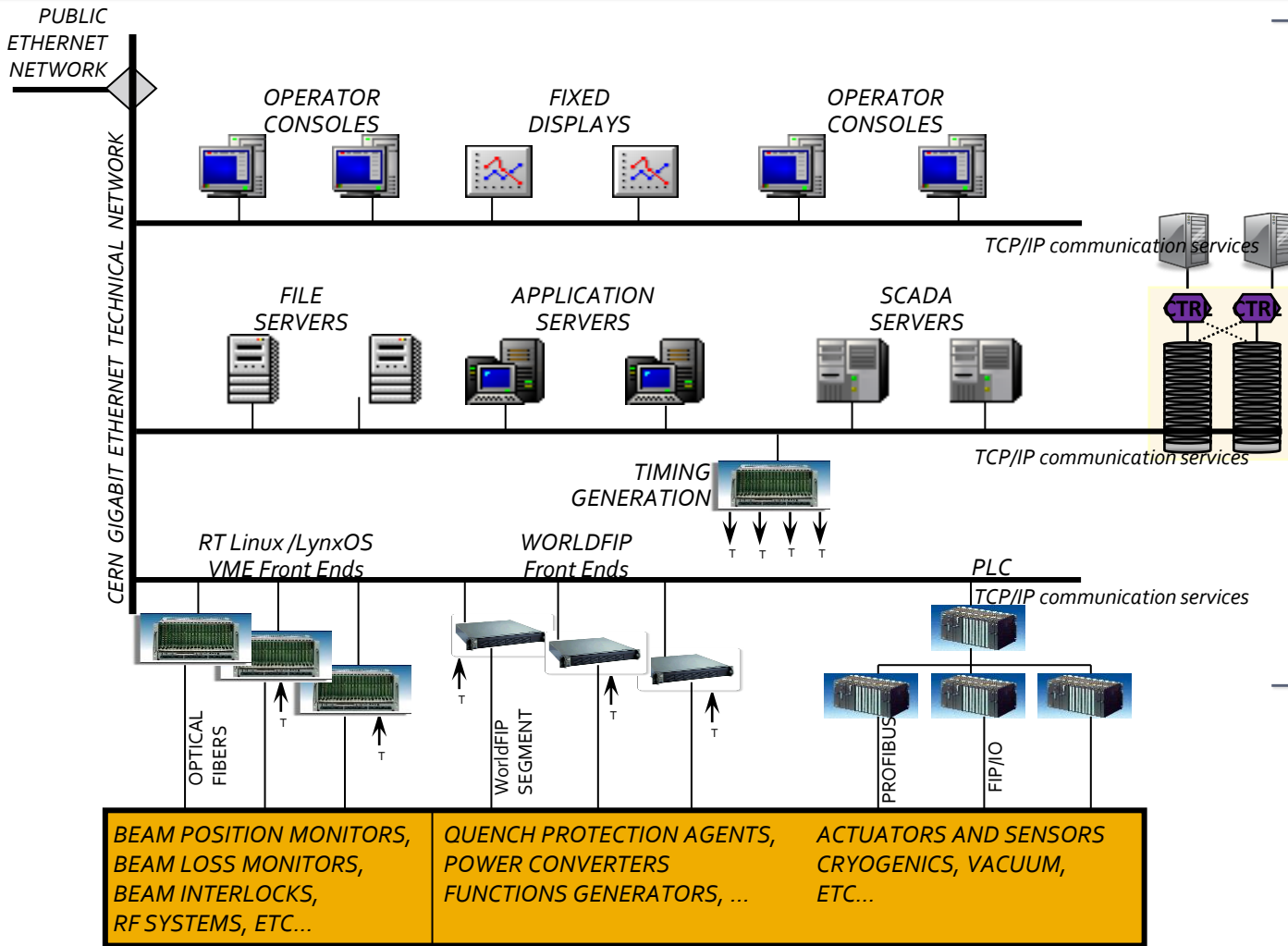
- CERN is currently building a new 3'900 m<sup>2</sup> building close to the CERN Control Center that will provide
  - 80 offices hosting the 100 members of the BE/CO group
  - 4 offices hosting the BE head management
  - A 110 seats auditorium
  - A public cafeteria
- Main construction is done, expected delivery of the building end August 2014
- CERN is now contacting firms to provide the office and laboratory furniture

# Overall architecture: 3 floors





# Controls Hardware Infrastructure



- **Client Tier**
  - Interactive Consoles
  - Fixed Displays
  - ~100 consoles running Linux SLC6 or W7
- **Server Tier**
  - Application servers
  - Database Servers where the setting and configuration of all devices exist
  - File Servers
  - Central Timing
  - 300 blade servers, ~4000 CPU cores, 72 Tbytes of NFS disk space
- **Resource Tier**
  - VME crates, PC GW & PLC dealing with high performance acquisitions and real-time processing
  - FeldBuses for local connection ( Mil1553, WorldFIP, Profibus)





# Front Ends

## Crates Types

PICMG 1.3 INTEL CORE2 DUO RACKABLE PC 2U  
PICMG 1.3 INTEL CORE2 DUO RACKABLE PC 4U  
VME 64x WIENER CRATE (with remote reset and terminal server)  
VME 32 CRATE (WES)  
cPCI WIENER CRATE (with remote reset and terminal server)  
VXI HP  
VMEBus 64x - 9U, 17 Slots , ELMA  
VMEBus 64x - 3U, 6 Slots , ELMA  
VMEBus 64x - 1U, 2 Slots , ELMA  
VMEBus VXS - 9U, 21 Slots , ELMA  
cPCI - 9U, 17 Slots , ELMA  
cPCI - 3U, 6 Slots, ELMA

## CPUs for VME and cPCI

VME CES RIO3 8064 DD (5 rows)  
VME CES RIO3 8064 RD (3 rows)  
VME CES RIO2  
cPCI CONCURRENT TECHNOLOGY INTEL  
VME MEN A20 - Intel Core2Duo

## Timing Receiver Cards

CTR-I RECEIVER (PCI)  
CTR-P RECEIVER (PMC)  
CTR-V RECEIVER (VME)  
TG8 (VME)

## Operating System

LynxOS 4.0  
LINUX SLCx



# The Control System in numbers

## Modular distributed system

### ■ Front-End Layer (C/C++)

- 85'000 devices controlled by 2000 different machines
- 600 different device types
- Developed by 100 people from 16 different groups

### ■ LHC Timing System

- 2 source nodes (active + hot spare)
- ~1000 timing receivers serving ~8000 clients

It performs **mission-critical tasks**

### ■ Business/Presentation Layer (Java)

- 400 different GUIs and 150 server applications
- Up to 600 processes on 400 machines
- Developed by ~100 people from 10 different groups

### ■ Archived Long Term Data

- ~ 1000 clients
- ~ 4 billion records / day
- ~ 5 million extraction requests / day
- ~ 1 TB / week stored
- ~ 170 TB stored now

**Big developer community**