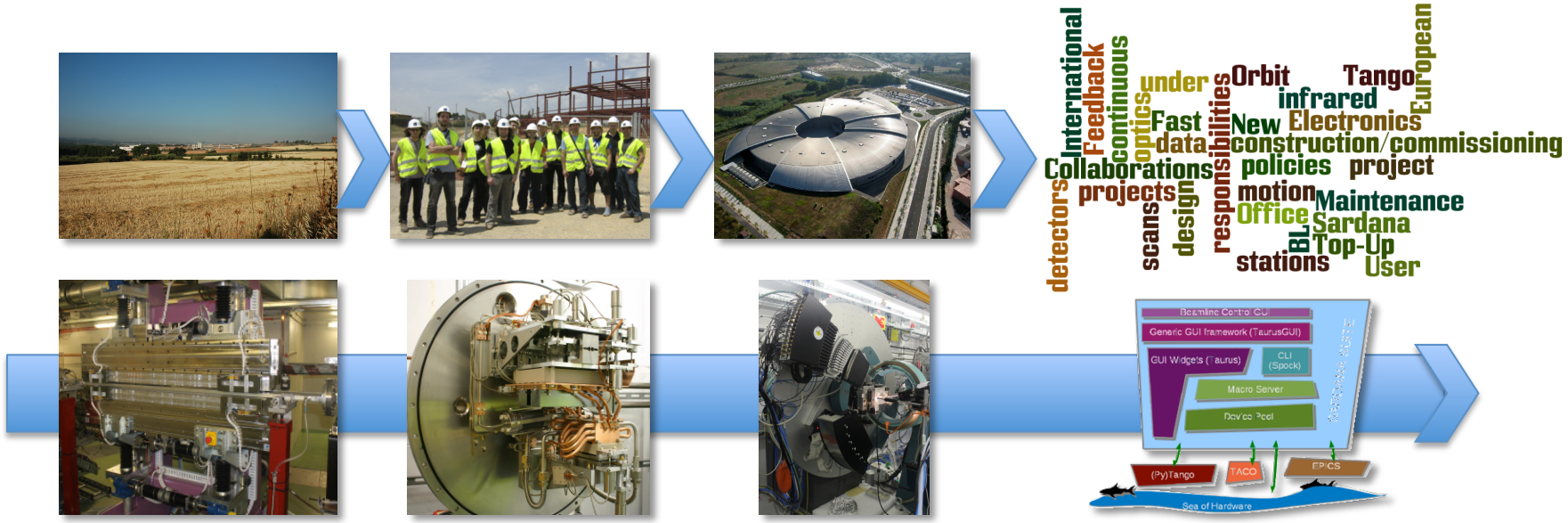


BEAM CONTROL AND DATA ACQUISITION SYSTEMS AT ALBA

D. Fernández on behalf of the Computing and Controls Division. SSRF & ALBA Workshop
Dec, 18th 2013.

7 nationalities

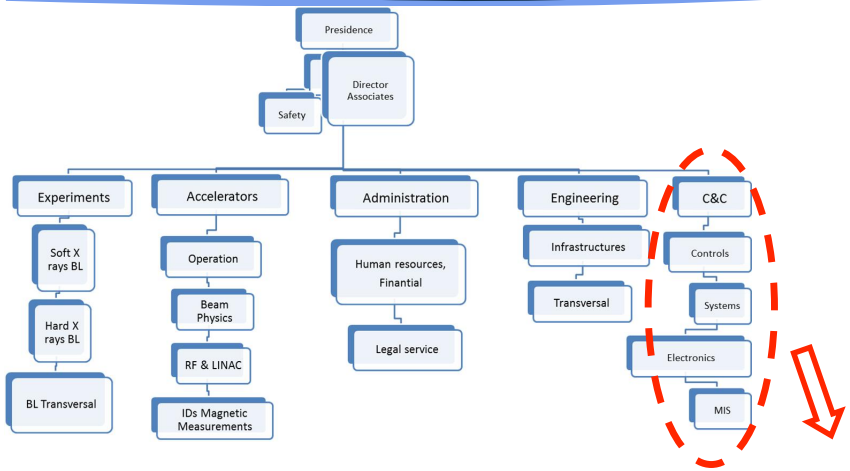
15 **Control** system engineers

7 **Electronics** engineers and 5 technicians

8 IT System administrators and **Networks** engineers

7 Engineers for **Management Information systems**

Computing & Controls Division



Computing and Controls

Electronics

Design. Generic and custom solutions
Installation and infrastr.
Maintenance
Electronics Support
Motion Control
Timing

Controls

Beamline Controls & DAQ
Accelerators Controls
Equipment Protection
Personnel Safety Systems
Synchronization.
Cont. Scans
Timing
Detectors data acquisition
Archivers, Alarms

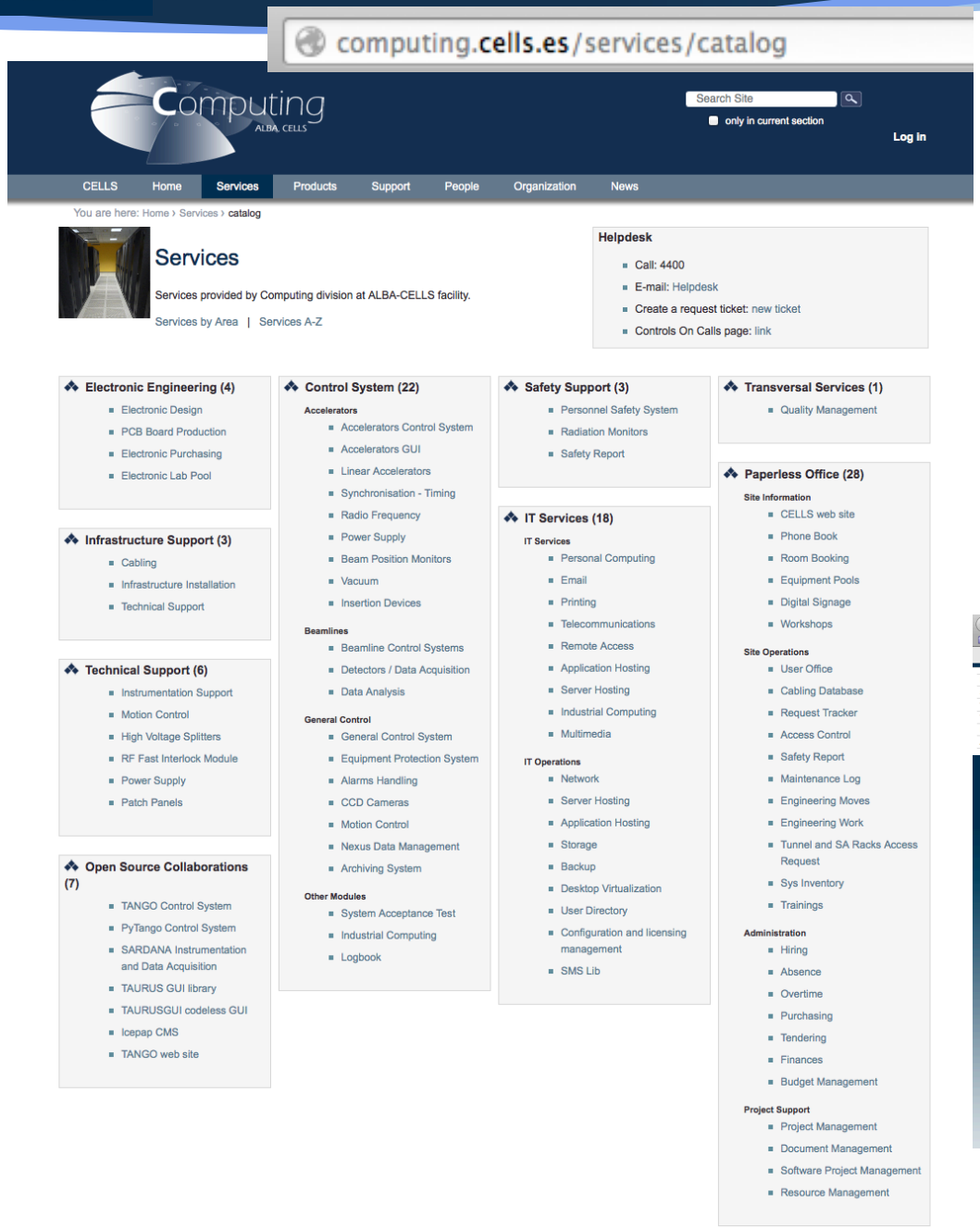
Systems

Networks and Comms
Systems for controls
Personal computers
Multimedia
Central Storage
Virtual Machines
Remote Access,
Security,

MIS

Equipment Databases
Financial Applications.
SAP
Users Office Portals
Project Management
Webs. Intranet

Computing & Controls Services



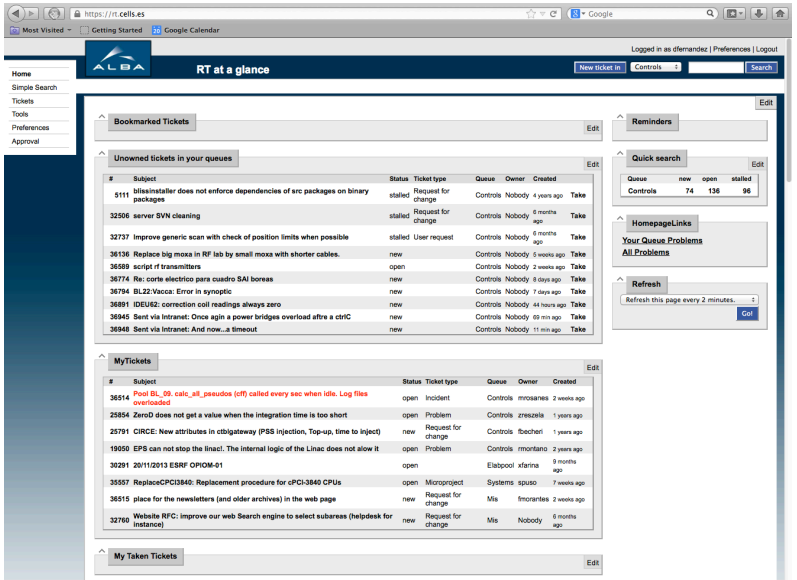
Services:

Service Catalogue at:

http://computing.cells.es

Inspired by ITIL best practices

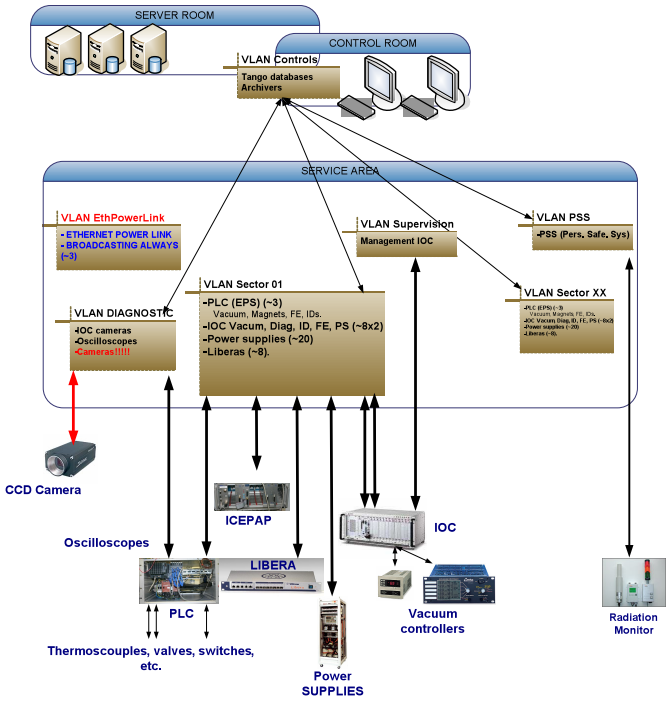
Request tracker as service desk.



- Design premises
  - No Real time
    - Real time needs are achieved with particular hardware, PLCs, Timing…
  - Distributed. Ethernet as a fieldbus

    Due to he architecture of the installation itself.

    VLANS.
  - Tango based
    - Tango collaboration. Products like Sardana and Taurus developed and public domain.
  - cPCI and Industrial PC diskless for the machine.
    - Robustness, Price
  - Linux Suse11.1 and Suse12.1 in most computers, also there are some running Windows.
  - Independent and redundant protection systems.
    - PLCs
  - Hardware developed for particular applications
    - High Voltage Splitter for Vacuum Ion Pumps
    - Fast Interlock modules. For fast interlocks in RF plants
    - Interlock Boards for gathering Libera interlocks and send them around through the timing system and EPS.
    - Patch panels, PSS boards, RF detector interlock boards, etc.
    - Electrometers,
    - …

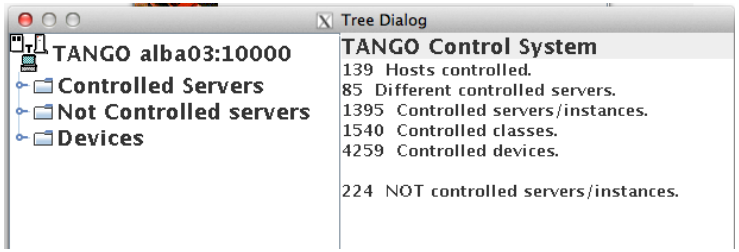


The Control System

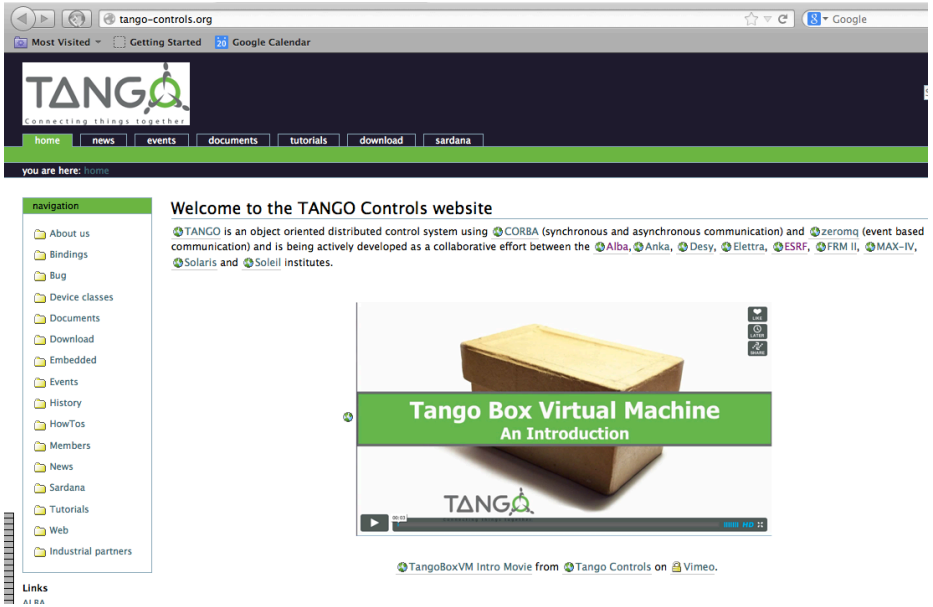
- 3GeV Accelerators Commissioned in 2011
  - Ethernet as a fieldbus. Linux diskless cPCI IOCs B&R PLCs
  - 130 distributed computers, 20 servers and virtual machines in the CPD
  - 7764 variables archived in HDB (Max 12000). 1217 Alarms.
  - Tests of first versions of TOP-UP and FOFB in progress.

- 7 Beamlines commissioned in 2012.
  - Independent control system for each Beamline with acknowledged communication channels with the Machine. Databases, archivers, alarms…
  - Electrometers, ADCs, VTF Counters, pseudocounters and pseudomotors…
  - 2D, CCD and Pixel detectors: Pilatus, Mythen, ImXPAD1400 read through LIMA

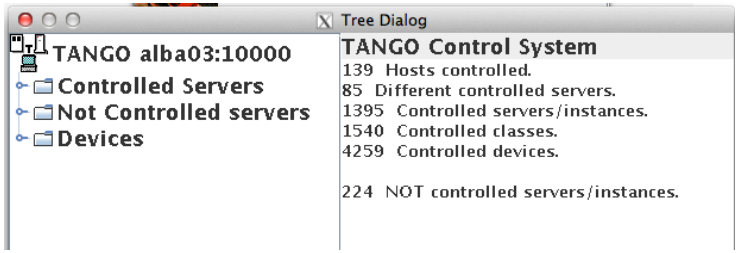
…preparing for time resolved experiments…



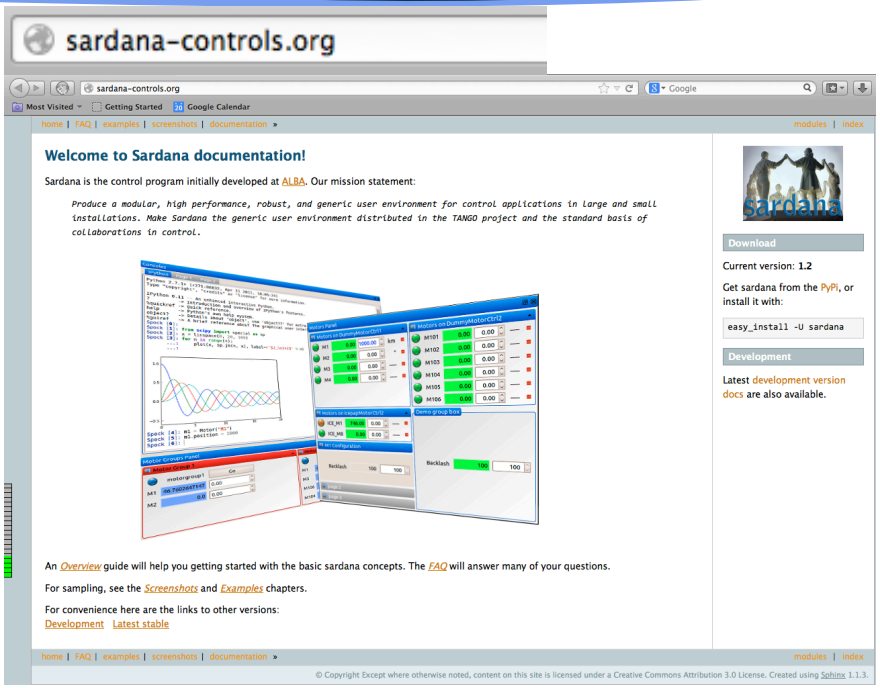
The control system. TANGO

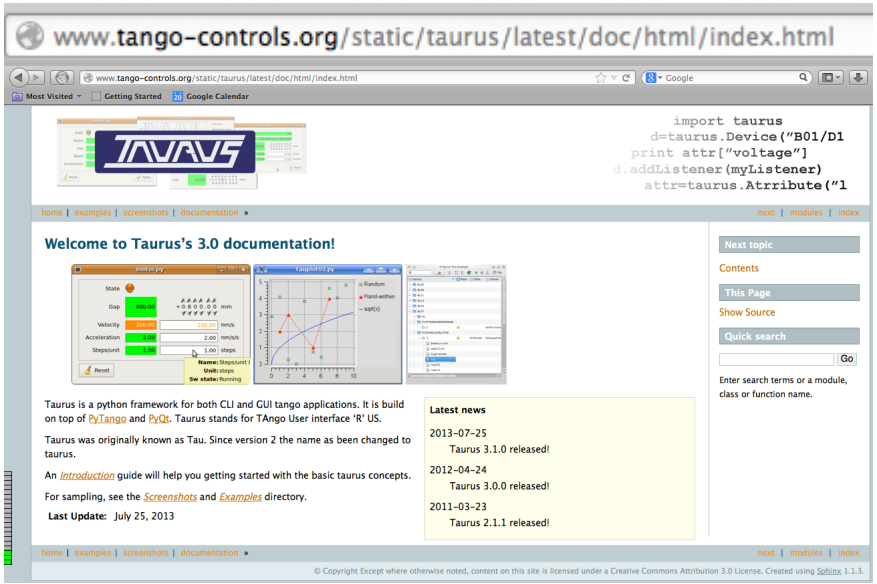


- TANGO: Active collaboration between 9 scientific institutions in Europe. Users all around the world
- Communication layer based on CORBA and ZMQ and implementing C++, Java and Python as programming languages.
- Management and self-diagnostic tools
- Code generators
- The communications layer for the control system of the Accelerators and all Beamlines



Control system. The scientific SCADA. Sardana





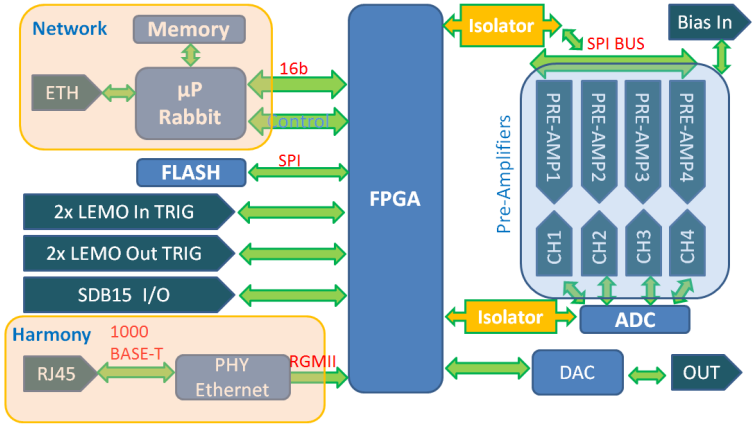
- Scientific SCADA. Macro execution and edition environment. Access to the hardware. Graphical and Command Line interfaces.
- Created at Alba. Today adopted at DESY, in Germany, MaxIV in Sweden and Solaris in Poland.
- Many others, mainly in the Tango collaboration using components such as TAURUS (Graphical layer built in Python and Qt).

Accelerators Controls and Beamlines Controls

TANGO
Connecting things together

TANGO	SARDANA
Communication layer. Client-Server	SCADA (Supervision, Control And DA)
Generic services. Control system control	Powerful sequencer (Macro executor). SCAN
Naming services. Control system infrastructure	Integrated Human interfaces GUI and CLI
Tools for building your control system	Tools for configuring and using your control system
International collaboration	International collaboration

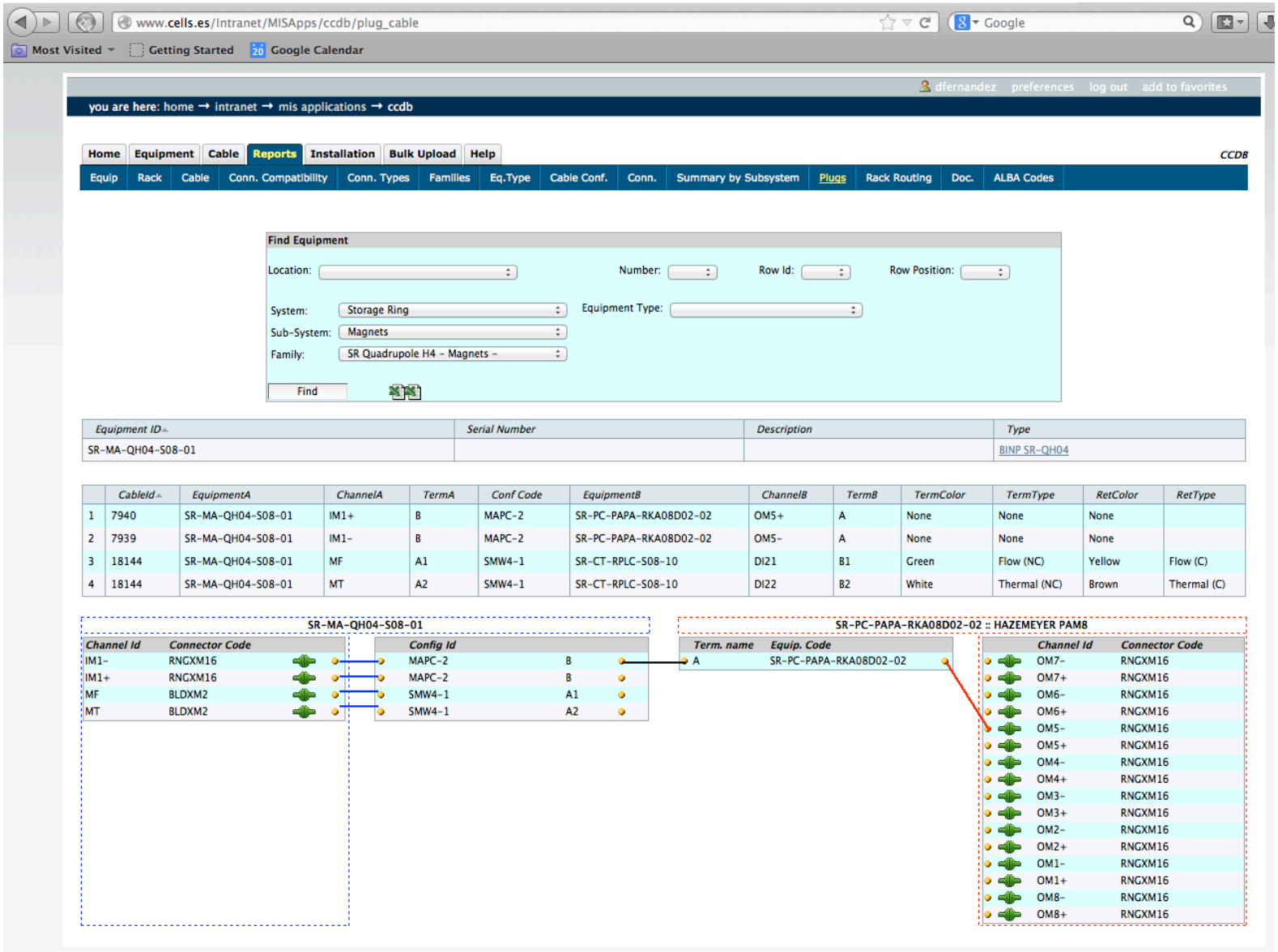
Electronics infrastructures



- Electronics Infrastructures
- Installation and support of electronics components. More than 6000 equipments and 19000 cables
- Design of electronics devices for data acquisition and diagnostics (Electrometers, Fast Interlock modules, High Voltage Splitters…)
- Maintenance. Every rack, equipment, cable and connection inventoried in a up-to-date database

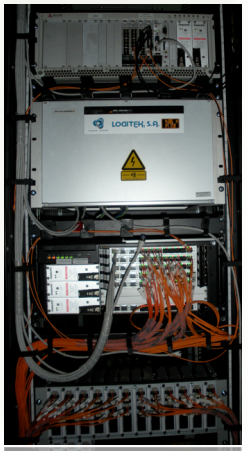
372 Racks
6726 *Equipments*
18980 *Total Cables*
5806 *Internal Cables*
747 *Equipment types*
386 *Cable configurations*
14700 *Routed cables*
41 *Installed by Thales*
Current total length: 169051.32 *m.*
Length average: 11.32 *m.*

The Cabling and Equipments database

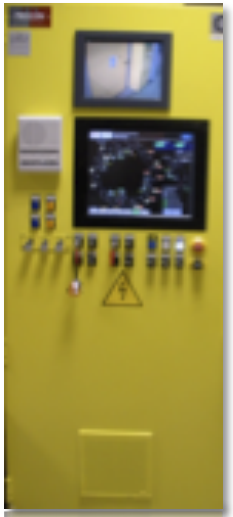


PLC based independent protection systems

- Equipment Protection System
  - >7000 Signals
  - Real time (in the sense of deterministic). Ethernet PowerLink
  - Distributed. Periphery inside the shielding areas. (Making cabling easier)
  - Cost effective
  - Communication through Modbus TCP



- Personnel Safety Systems
  - Safety devices (Safety PLC avoiding hardwiring)
  - SIL3 in the norm 61508
  - Distributed but electronics outside the bunkers
  - Independent installation. Independent hardware and Software. Private SafetyBus



TIMING

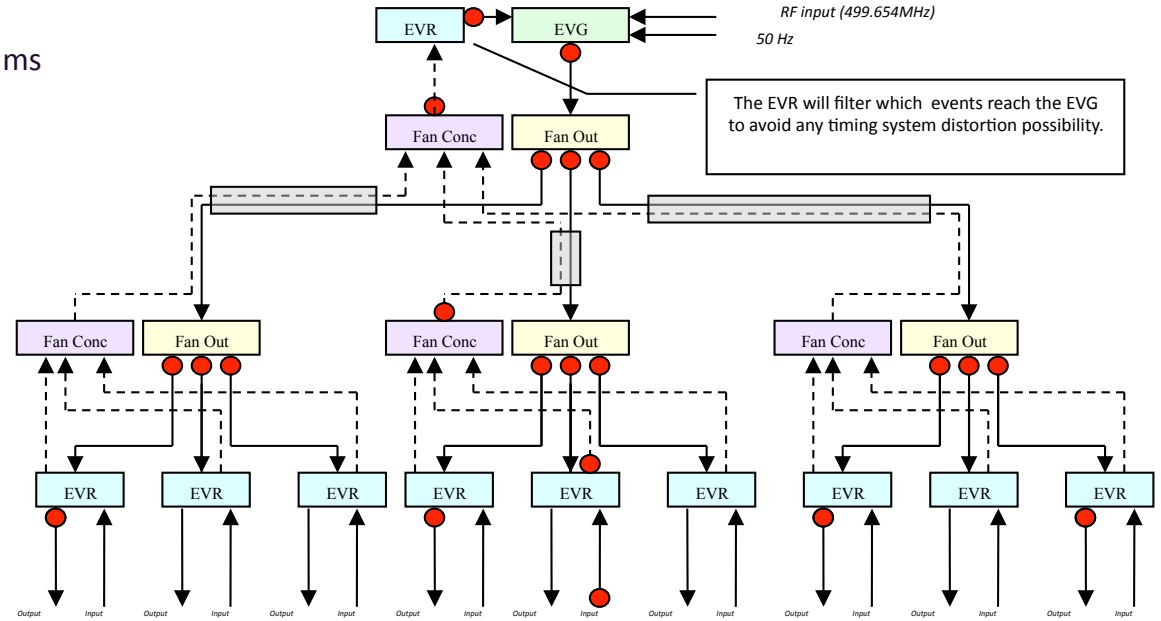
- Based on MicroResearch Finland.
  - Modified to serve as
    - the well known synchronization system
    - AND, a fast interlock system

- This is a Fast Interlock system (µsec range) redundant to the PLC (msec range)

MACHINE PROTECTION SYSTEMS (redundancy)

PLC network (EPS). Ethernet Powerlink (EPL). <20 ms

- Timing system (MRF bidirectional). < 5us
  - RF fast interlock module.
  - BPM electronics. Liberas. Beam orbit thresholds
- Redundancy: PLCs and Timing system.



time = 240 ns x 4 stages + 5 ns/m x 500m ~ 3.5 us

(4 stages – 1 EVR + 3 Fan In + 1 EVG)

Few examples of electronics Projects…

Accelerators

High Voltage Splitter

- 7kV distribution to Vacuum ion pumps with logarithmic nA-mA reading
- > 80 units working during 4 years

Storage Ring & Booster Power Supplies

- From 4W to 650kW.
- From DC to 1KHz bandwidth.
- > 450 different power supplies.

Fast Orbit Feedback electronics

- Based in Virtex-6 FPGA.
- 10KHz feedback loop implementation in BPM data reading.

RF Fast Interlocks management (FIM)

- 220ns response time based in FPGA design.

Beamlines

Alba Electrometer

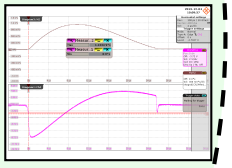
- pA-mA high current precision reading.
- High precision sample by sample processing to optimize experiment results.
- >40 units working during 2 years.

Icepap Motor controller

- In collaboration with ESRF (Maxlab IV recently joined also).
- Around 700 motor axes

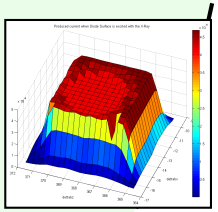
High magnetic pulse generation in BL09

- >1,5T achieved with 2kA pulsed current in 1µs.



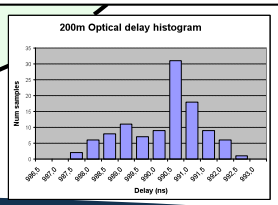
Transmissive Photodiode manufacturing

- First project in detectors field.
- 10µm width.
- Project done in collaboration with CNM



Timing System

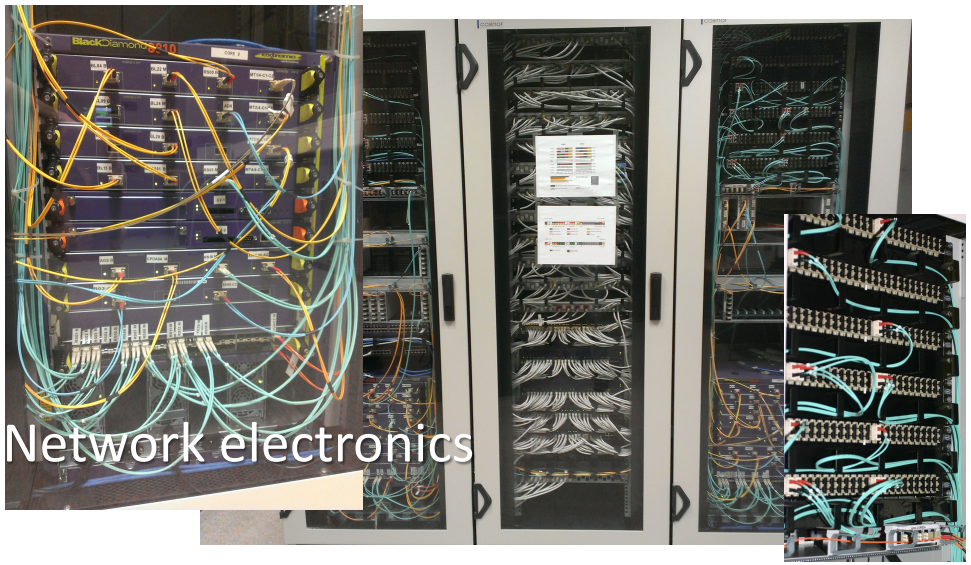
- More than 400 synchronization points in the machine.
- Maximum 10ps delay adjustment
- Bidirectional events for Fast Interlocks (< 5µs reaction time)



Industrial IO controller hardware

- > 300 equipments (cPCI, NIM, PLCs...)

IT infrastructure

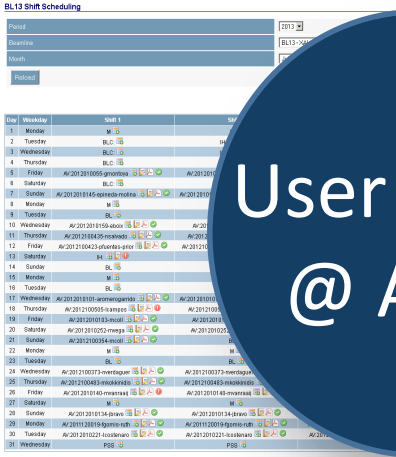


- **Network** and communications
  - 2 cores 800 Gbps each. 124 switches
  - 2400+ equipments
  - 65 WiFi access points
  - 500Mbps to outside internet
  - 5 firewalls
- **Data Center**
  - 46 racks, 100% availability in critical servers.
  - Most services Virtualized
- **Printing**
  - 40+ printers and 2 plotters
- **Multimedia**
  - 8 meeting rooms capable of videoconferences
  - 15 screens distributed around the installation
  - 20 IP cameras
  - 100 Wifi telephones

IT infrastructure

- **More than 30 servers and 70 application servers**
- **eMail**
  Antispam & antivirus, 268 mail accounts, 130 mailing lists, webmail
- **File servers**
  256TB disks (RAID 5), high availability. 2 NAS heads.
- High performance computing 6 servers cluster , 192 CPU, 384GB RAM memory, 333 Gflops per node.
- **Backup**
  Robot managing 500 tapes (600TB), 8 drives
- **User support** and authentication
  OpenLDAP & Samba
- **Licence** management and application support

Management Information Systems



User portal @ ALBA

1538 registered users

697 Proposals for experiments

383 accepted proposals by the **review panel**

267 programmed experiments

892 visitor scientists managed on-line

Computing operations management

Access Control

Service desk, incidents and requests

Configuration management databases, cables racks, connectors and equipments

Project management tools

Document management

Resource management

Management Information Systems

Communications

17 WEB sites for CELLS, cllaborations, workshops
Distribution of **Digital Signaling**
Phone directories

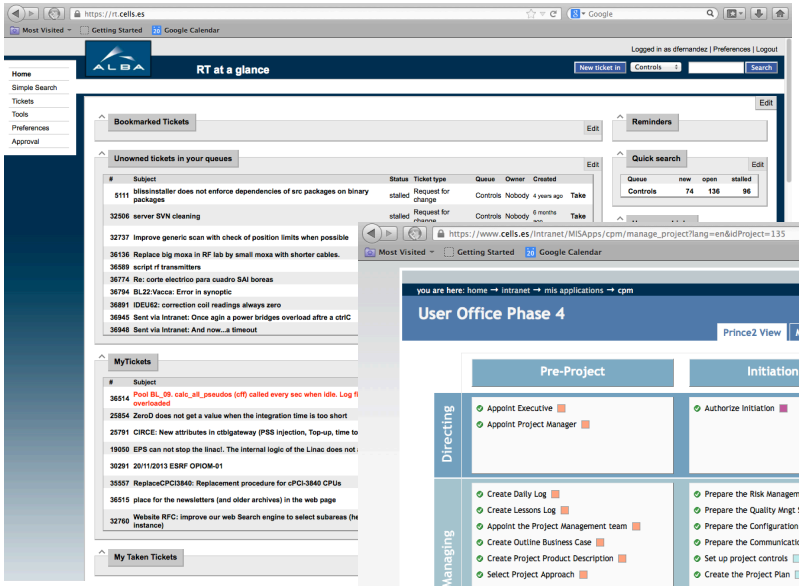
Administration HHRR

Employment portal on the web
Physical and Logical **Access Control** Management
Absences and overtime electronic Management

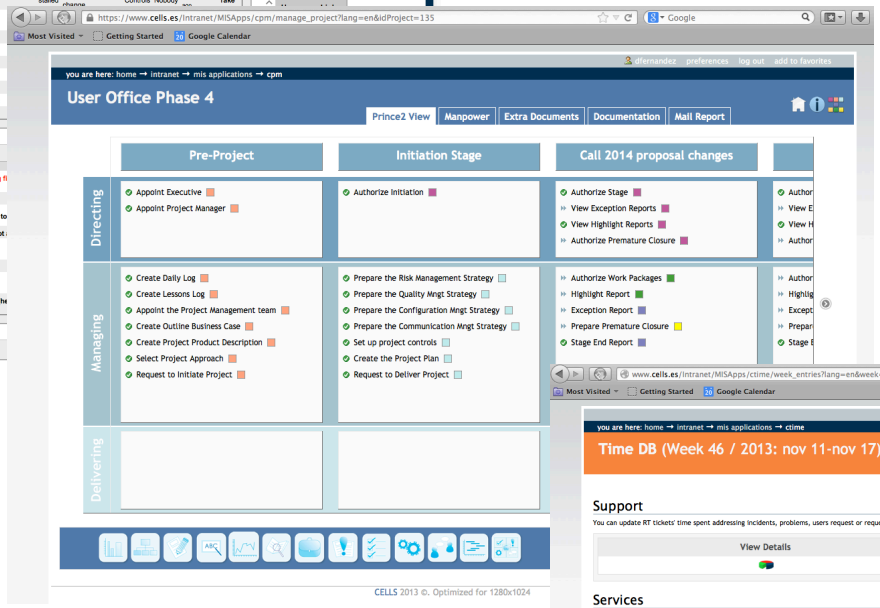
Administration

Budget app. management
SAP and financial software
Purchases´ Management

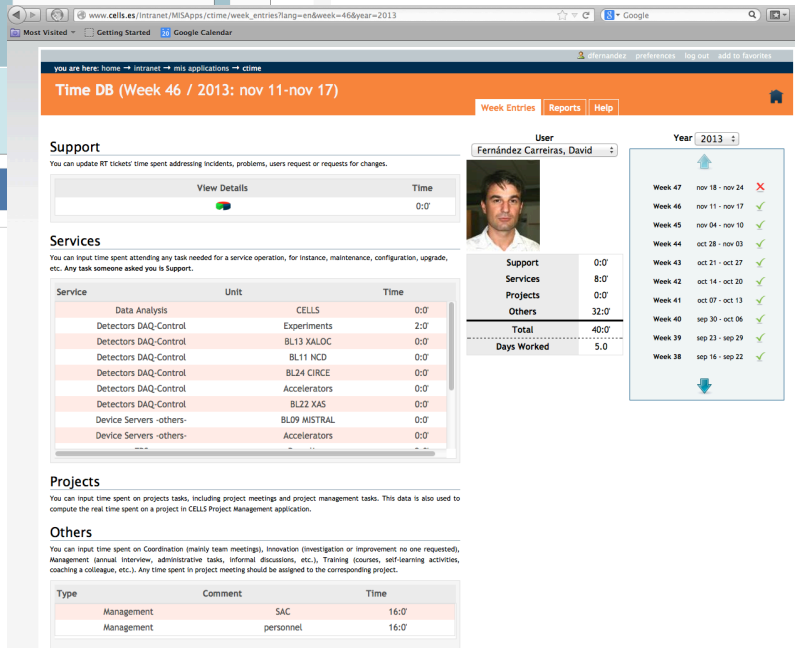
Management of resources



Request Tracker



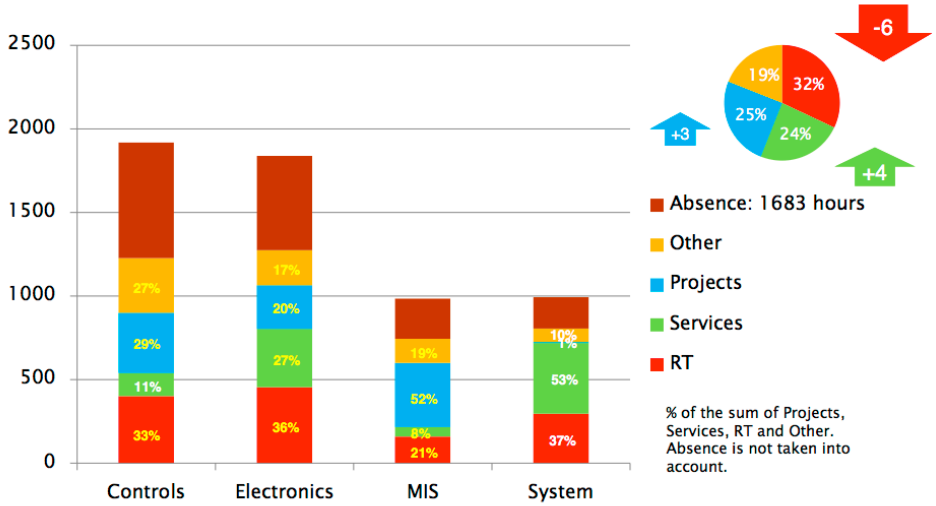
Project Management tool



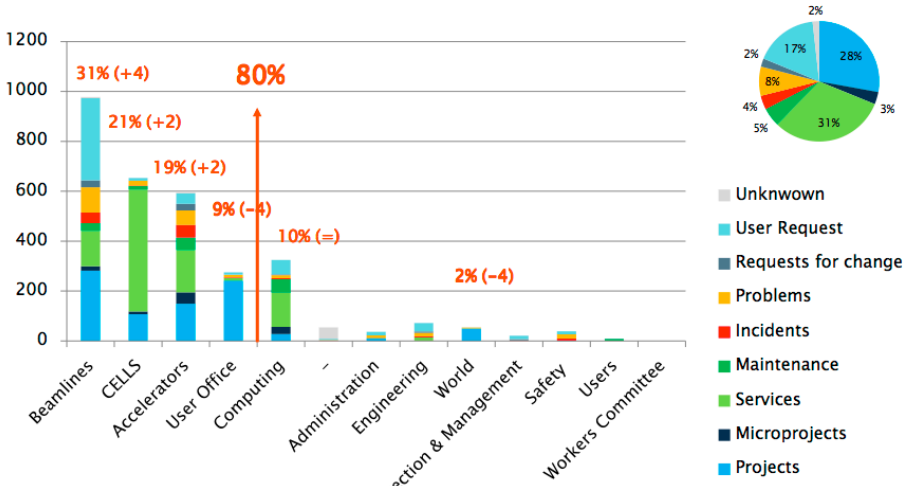
Time Management tool

Time allocated. COM. Sept, 2013

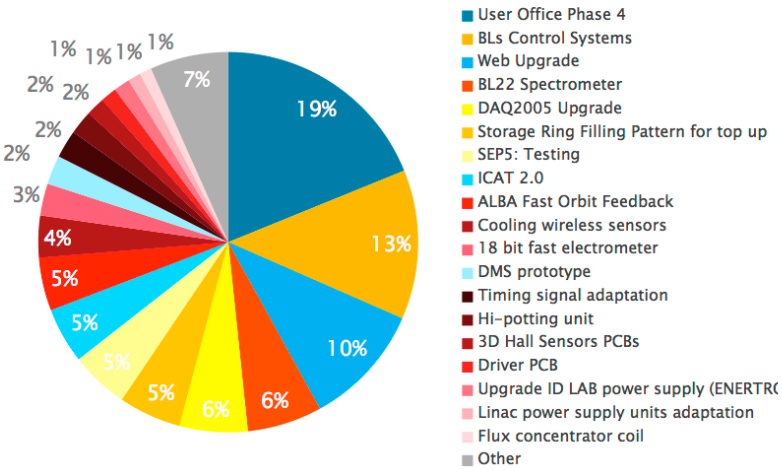
Computing Overview – 5733 hours



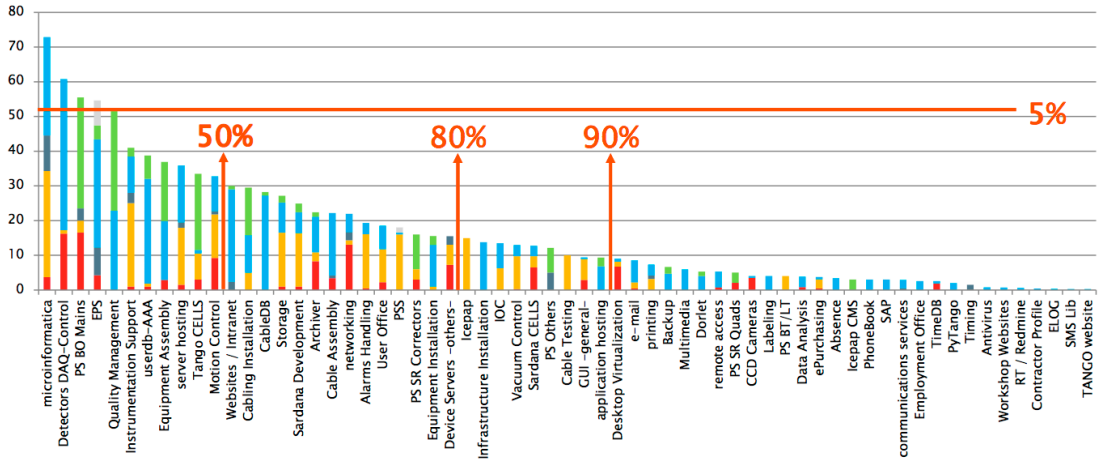
Hours Spent per Customer: 3109 hours



Projects Hours: 1011 hours, 25% (+3)

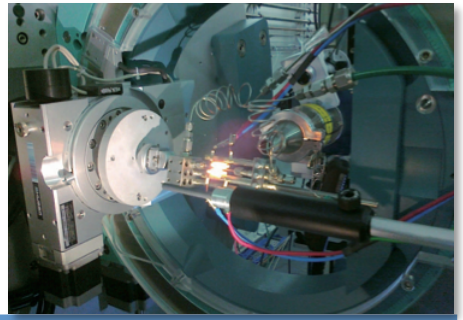


Helpdesk: Time Worked (hours)



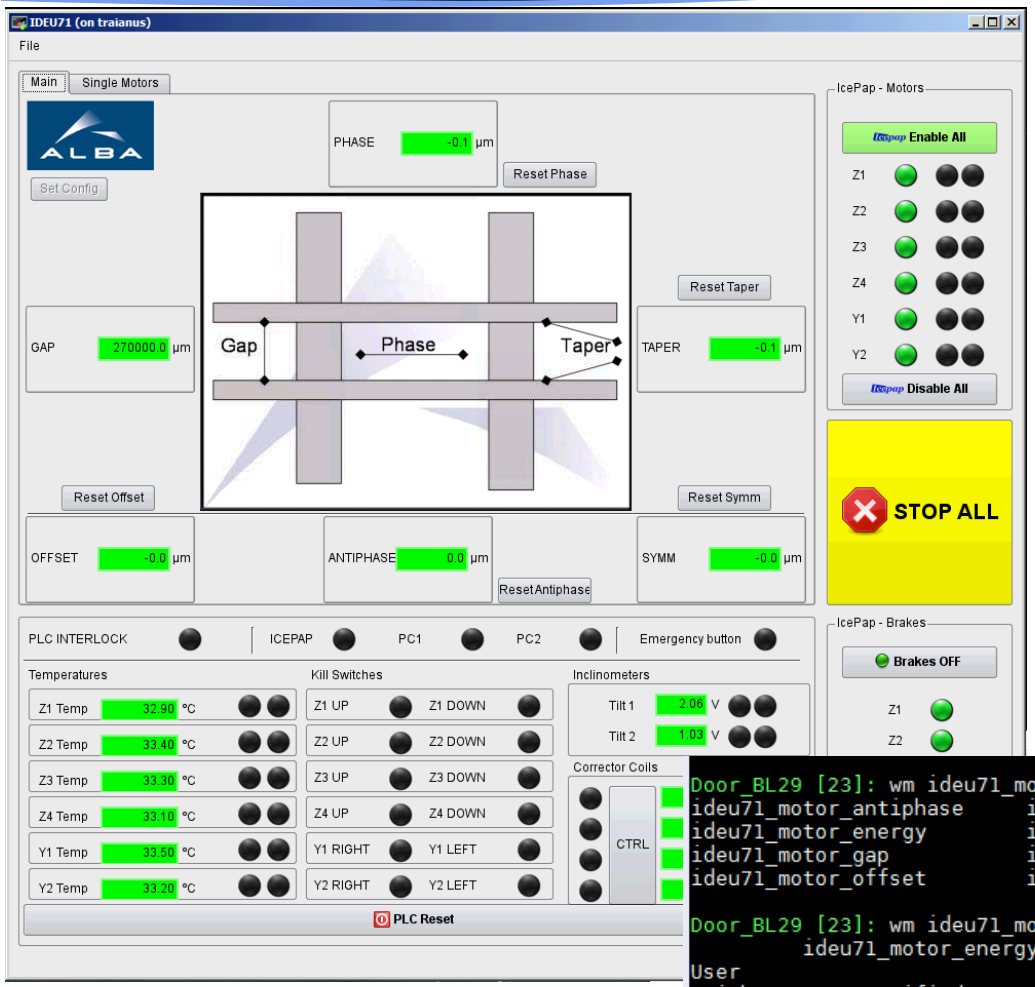
Accelerators Controls and Beamlines Controls

The control system
of an Accelerator
and a Beamline



ACCELERATOR	BEAMLINE
Large. Vacuum, **EPS**, PSS, **Diagnostics**, Tango, Sardana	Smaller Vacuum, EPS, PSS, Diagnostics, Tango, Sardana
Archiver, Alarms, Power supplies, BPM, RF…	**Motion Control. Mechanics**
Graphical User interfaces for various procedures	**Macro execution**. **SCANS** and Continuous Scans. Maximum Flexibility
Timing	**Detectors**
Provide Insertion devices	Use Insertion devices

Accelerators Controls and Beamlines Controls



An insertion device view from Accelerators

An insertion device view from the beamlines

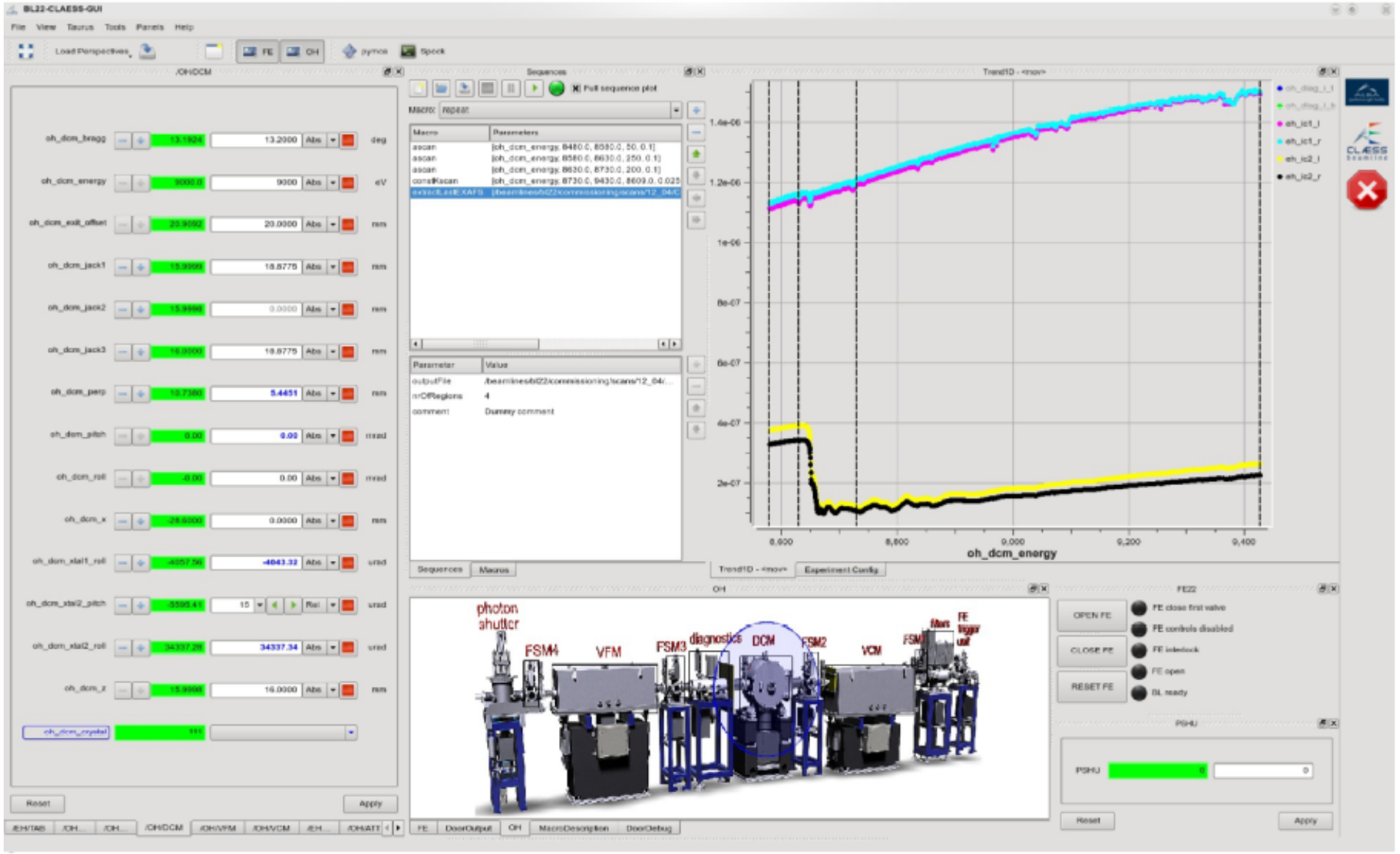
```
Door_BL29 [23]: wm ideu71_motor_energy ideu71_motor_gap ideu71_motor_offset ideu71_mo
ideu71_motor_antiphase     ideu71_motor_phase         ideu71_motor_y1            ideu71_motor_z3
ideu71_motor_energy        ideu71_motor_polarization  ideu71_motor_y2            ideu71_motor_z4
ideu71_motor_gap           ideu71_motor_symmetry      ideu71_motor_z1
ideu71_motor_offset        ideu71_motor_taper         ideu71_motor_z2

Door_BL29 [23]: wm ideu71_motor_energy ideu71_motor_gap ideu71_motor_offset ideu71_motor_phase
         ideu71_motor_energy ideu71_motor_gap ideu71_motor_offset ideu71_motor_phase
User
 High    Not specified   273001.0      100.0    35680.0
 Current 1177.68889345   270000.0 -0.0249999999942 -0.0999999999913
 Low     Not specified    15499.0     -100.0   -35680.0
Dial
 High    Not specified   273001.0      100.0    35680.0
 Current 1177.68889345   270000.0 -0.0499999999884 -0.0999999999913
 Low     Not specified    15499.0     -100.0   -35680.0

Door_BL29 [24]:
```

```
Door_BL29 [25]: energy_scanct 690 770 4000 0.1
```

Main Graphical User Interface (TaurusGUI) in BL22



- **Running in most Beamlines synchrotrons**
  - **Overcome the "slow" issue of step scans**

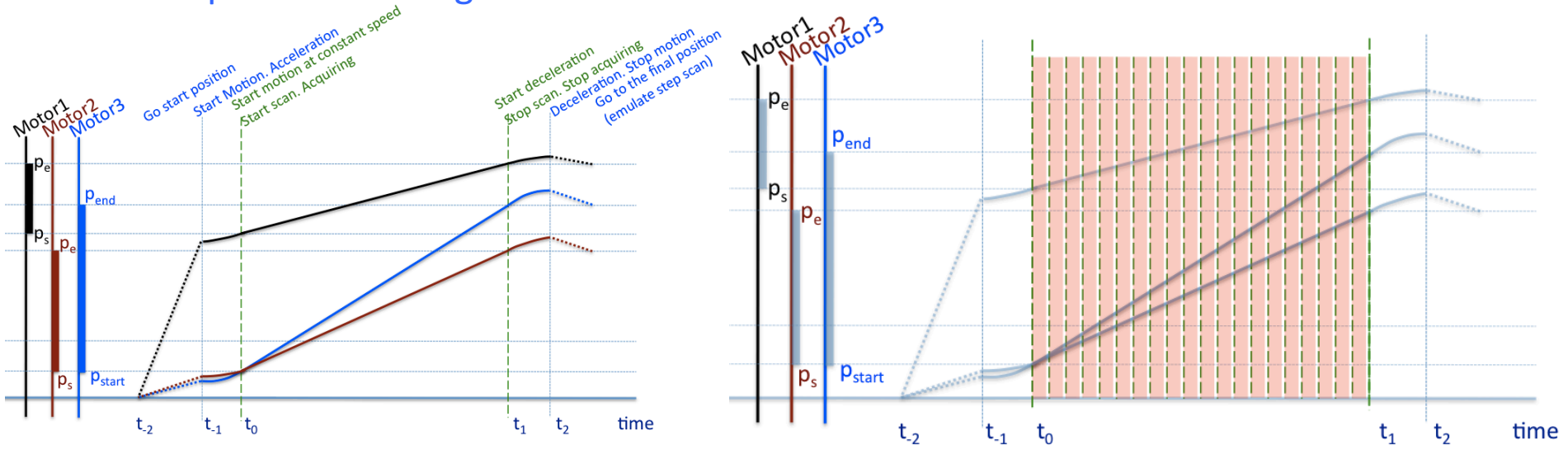
Need dedicated hardware with dedicated cabling for a particular purpose.

: Solve the problem for a particular type of experiment.

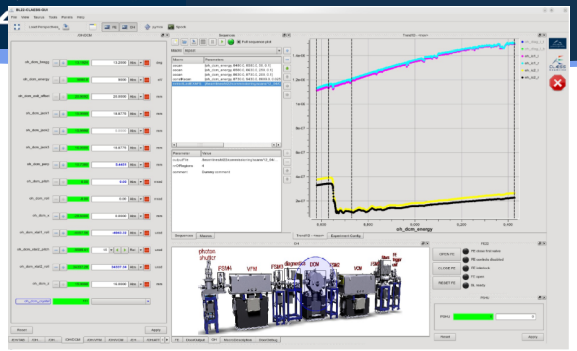
: Adapted to the purpose.

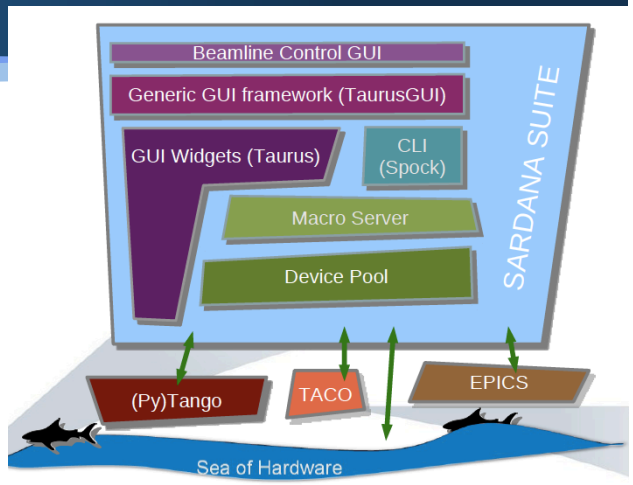
: Fast, optimized.

They do not solve all problems, being necessary to reprogram the Beamline for other experiments using another hardware.



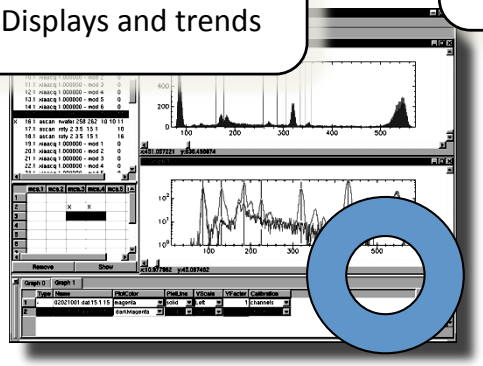
Distributed. Basic Architecture





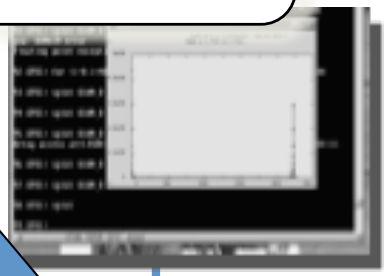
Client

Data Displays and trends

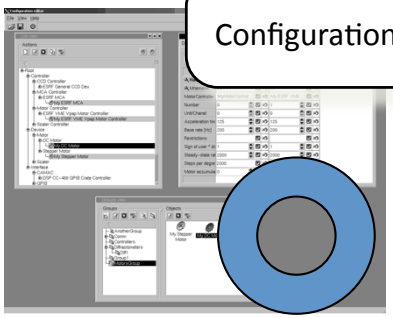


GUI

CLI



Configuration Editor



Tango

Server

Device Pool
MacroServer

Device Server

Drivers

gràcies
谢谢

Next Talk: Going into details of the control system of the beamlines: Guifré Cuní.