



BEAM CONTROL AND DATA ACQUISITION SYSTEMS AT ALBA

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



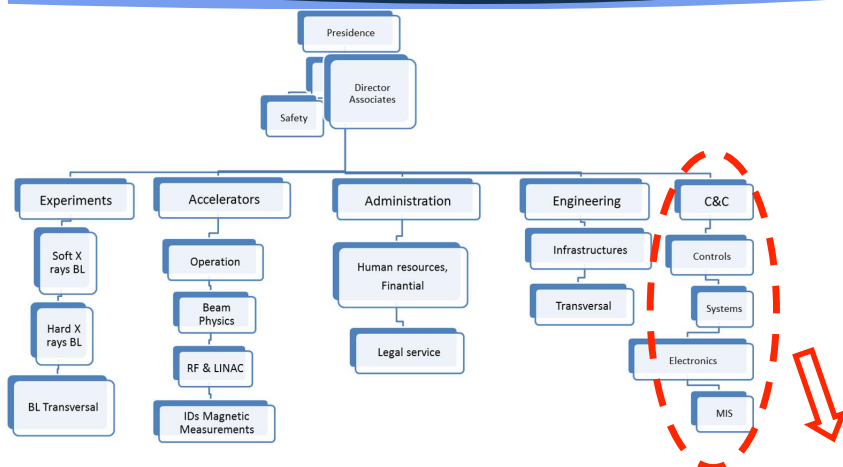
7 nationalities

15 **Control** system engineers

7 **Electronics** engineers and 5 technicians

8 IT System administrators and **Networks** engineers

7 Engineers for **Management Information systems**



Computing 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



Search Site

only in current section

Log in

CELLS Home **Services** Products Support People Organization News

You are here: Home > Services > catalog



Services

Services provided by Computing division at ALBA-CELLS facility.

Services by Area | Services A-Z

Helpdesk

- Call: 4400
- E-mail: Helpdesk
- Create a request ticket: new ticket
- Controls On Calls page: link

Electronic Engineering (4)

- Electronic Design
- PCB Board Production
- Electronic Purchasing
- Electronic Lab Pool

Infrastructure Support (3)

- Cabling
- Infrastructure Installation
- Technical Support

Technical Support (6)

- Instrumentation Support
- Motion Control
- High Voltage Splitters
- RF Fast Interlock Module
- Power Supply
- Patch Panels

Open Source Collaborations (7)

- TANGO Control System
- PyTango Control System
- SARDANA Instrumentation and Data Acquisition
- TAURUS GUI library
- TAURUSGUI codeless GUI
- Icepap CMS
- TANGO web site

Control System (22)

Accelerators

- Accelerators Control System
- Accelerators GUI
- Linear Accelerators
- Synchronisation - Timing
- Radio Frequency
- Power Supply
- Beam Position Monitors
- Vacuum
- Insertion Devices

Beamlines

- Beamline Control Systems
- Detectors / Data Acquisition
- Data Analysis

General Control

- General Control System
- Equipment Protection System
- Alarms Handling
- CCD Cameras
- Motion Control
- Nexus Data Management
- Archiving System

Other Modules

- System Acceptance Test
- Industrial Computing
- Logbook

Safety Support (3)

- Personnel Safety System
- Radiation Monitors
- Safety Report

IT Services (18)

IT Services

- Personal Computing
- Email
- Printing
- Telecommunications
- Remote Access
- Application Hosting
- Server Hosting
- Industrial Computing
- Multimedia

IT Operations

- Network
- Server Hosting
- Application Hosting
- Storage
- Backup
- Desktop Virtualization
- User Directory
- Configuration and licensing management
- SMS Lib

Transversal Services (1)

- Quality Management

Paperless Office (28)

Site Information

- CELLS web site
- Phone Book
- Room Booking
- Equipment Pools
- Digital Signage
- Workshops

Site Operations

- User Office
- Cabling Database
- Request Tracker
- Access Control
- Safety Report
- Maintenance Log
- Engineering Moves
- Engineering Work
- Tunnel and SA Racks Access Request
- Sys Inventory
- Trainings

Administration

- Hiring
- Absence
- Overtime
- Purchasing
- Tendering
- Finances
- Budget Management

Project Support

- Project Management
- Document Management
- Software Project Management
- Resource Management

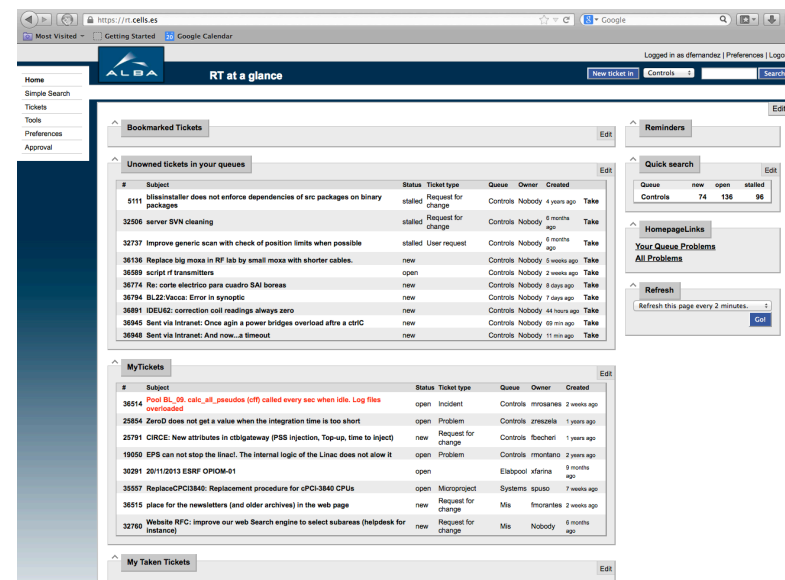
Services:

Service Catalogue at:

<http://computing.cells.es>

Inspired by ITIL best practices

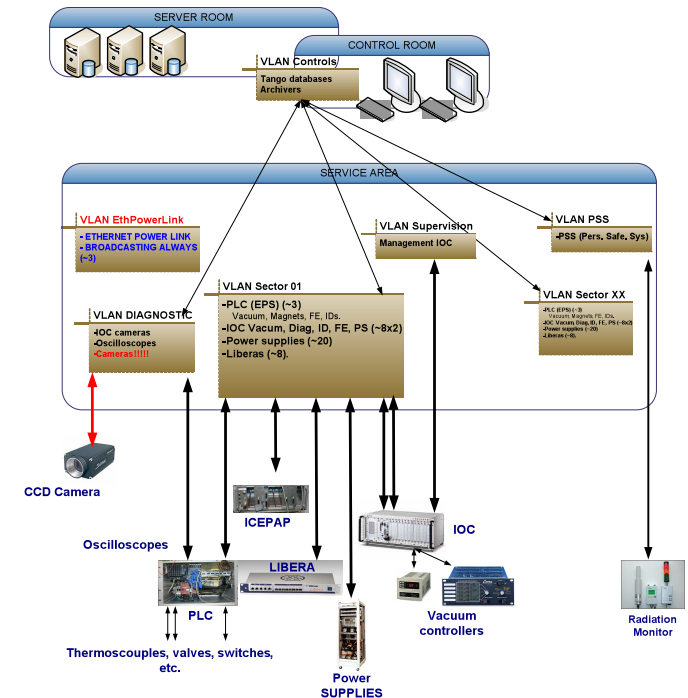
Request tracker as service desk.



The screenshot shows the 'RT at a glance' web application. It features a sidebar with navigation links like Home, Simple Search, Tickets, Tools, Preferences, and Approval. The main content area displays 'Bookmarked Tickets' and 'Unowned tickets in your queues'. A table lists tickets with columns for #, Subject, Status, Ticket type, Queue, Owner, and Created. Tickets include details like '5111 libanalyzer does not enforce dependencies of src packages on binary' and '32506 server SVN cleaning'. On the right, there are sections for 'Reminders', 'Quick search', 'HomepageLinks', and 'Your Queue Problems All Problems'. At the bottom, there's a 'My Tickets' section and a 'My Taken Tickets' section.

• Design premises

- No Real time
 - Real time needs are achieved with particular hardware, PLCs, Timing...
- Distributed. Ethernet as a fieldbus
Due to the 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,
 - ...



- 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.

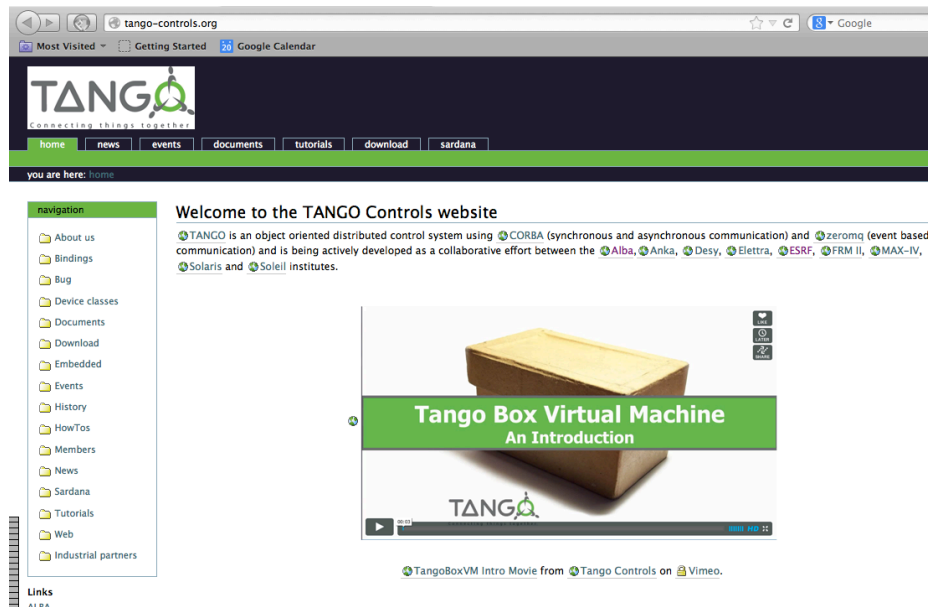
- Independent control system for each Beamline with acknowledged communication channels with the Machine. Databases, archivers, alarms...
- Electrometers, ADCs, VTF Counters, pseudocounters and pseudomotors...
- 2D, CCD and Pixel detectors: Pilatus, Mythen, ImXPAD1400 read through LIMA



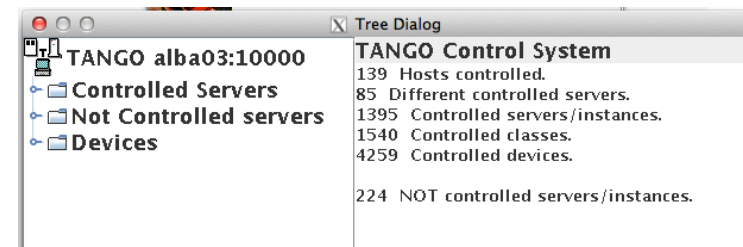
...preparing for time resolved experiments...

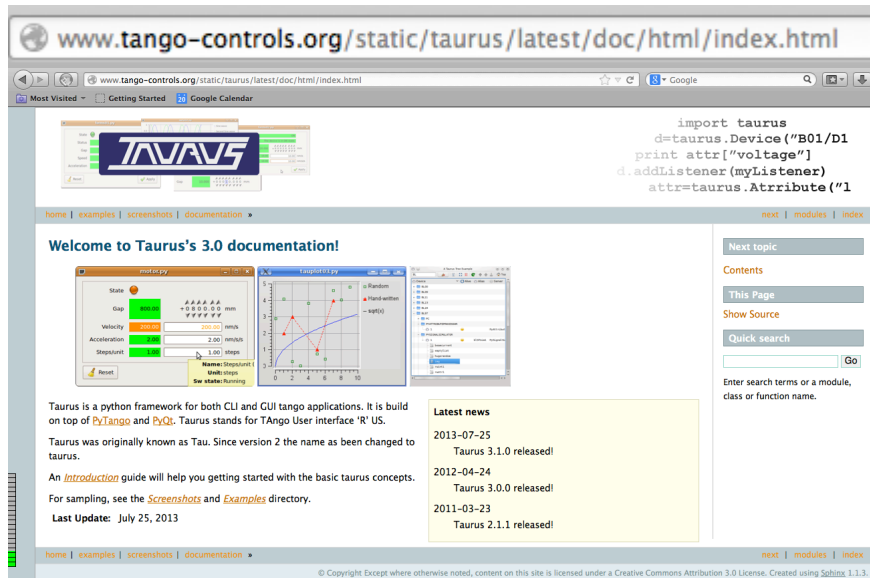
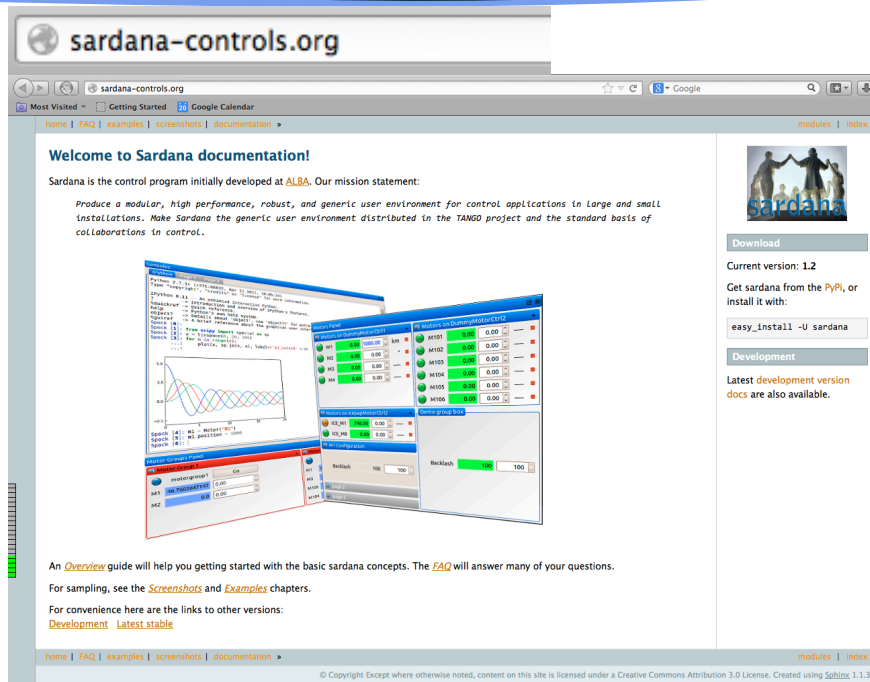
	372 Racks 6726 Equipments 18980 Total Cables 5806 Internal Cables 747 Equipment types 386 Cable configurations 14700 Routed cables 41 Installed by Thales Current total length: 169051.32 m. Length average: 11.32 m.
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Tree Dialog TANGO alba03:10000 Controlled Servers Not Controlled servers Devices	TANGO Control System 139 Hosts controlled. 85 Different controlled servers. 1395 Controlled servers/instances. 1540 Controlled classes. 4259 Controlled devices. 224 NOT controlled servers/instances.
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- **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**



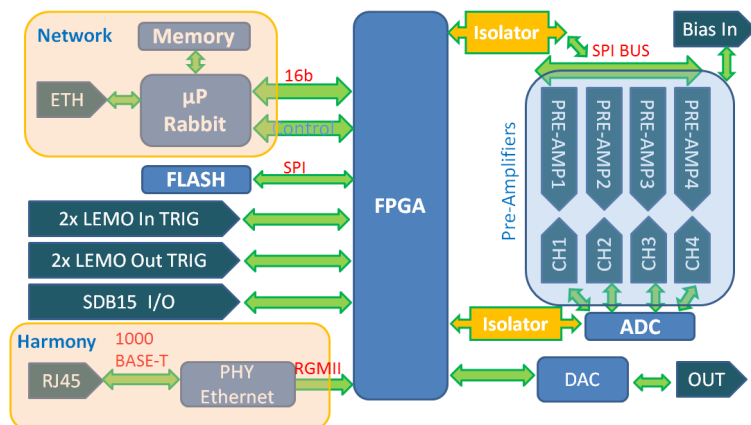


- Scientific SCADA. Macro execution and edition environment. Access to the hardware. Graphical and Command Line interfaces.
- Created at Alba. Today adopted at DESY, in Germany, MaxIV in Sweden and Solaris in Poland.
- Many others, mainly in the Tango collaboration using components such as TAURUS (Graphical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





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
- 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.

www.cells.es/Intranet/MISApps/ccdb/plug_cable

Most Visited Getting Started 20 Google Calendar

dfernandez preferences log out add to favorites

you are here: home → intranet → mis applications → ccdb

Home Equipment Cable **Reports** Installation Bulk Upload Help

Equip Rack Cable Conn. Compatibility Conn. Types Familles Eq.Type Cable Conf. Conn. Summary by Subsystem **Plugs** Rack Routing Doc. ALBA Codes


Find Equipment

Location: Number: Row Id: Row Position:

System: Equipment Type:

Sub-System:

Family:

Find 

Equipment ID	Serial Number	Description	Type
SR-MA-QH04-S08-01			BINP SR-QH04

CableId	EquipmentA	ChannelA	TermA	Conf Code	EquipmentB	ChannelB	TermB	TermColor	TermType	RetColor	RetType
1 7940	SR-MA-QH04-S08-01	IM1+	B	MAPC-2	SR-PC-PAPA-RKA08D02-02	OM5+	A	None	None	None	
2 7939	SR-MA-QH04-S08-01	IM1-	B	MAPC-2	SR-PC-PAPA-RKA08D02-02	OM5-	A	None	None	None	
3 18144	SR-MA-QH04-S08-01	MF	A1	SMW4-1	SR-CT-RPLC-S08-10	DI21	B1	Green	Flow (NC)	Yellow	Flow (C)
4 18144	SR-MA-QH04-S08-01	MT	A2	SMW4-1	SR-CT-RPLC-S08-10	DI22	B2	White	Thermal (NC)	Brown	Thermal (C)

SR-MA-QH04-S08-01

Channel Id	Connector Code	Config Id	Term
IM1-	RNGXM16	MAPC-2	B
IM1+	RNGXM16	MAPC-2	B
MF	BLDXM2	SMW4-1	A1
MT	BLDXM2	SMW4-1	A2

SR-PC-PAPA-RKA08D02-02 :: HAZEMEYER PAM8

Term. name	Equip. Code	Channel Id	Connector Code
A	SR-PC-PAPA-RKA08D02-02	OM7-	RNGXM16
		OM7+	RNGXM16
		OM6-	RNGXM16
		OM6+	RNGXM16
		OM5-	RNGXM16
		OM5+	RNGXM16
		OM4-	RNGXM16
		OM4+	RNGXM16
		OM3-	RNGXM16
		OM3+	RNGXM16
		OM2-	RNGXM16
		OM2+	RNGXM16
		OM1-	RNGXM16
		OM1+	RNGXM16
		OM8-	RNGXM16
		OM8+	RNGXM16

- 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

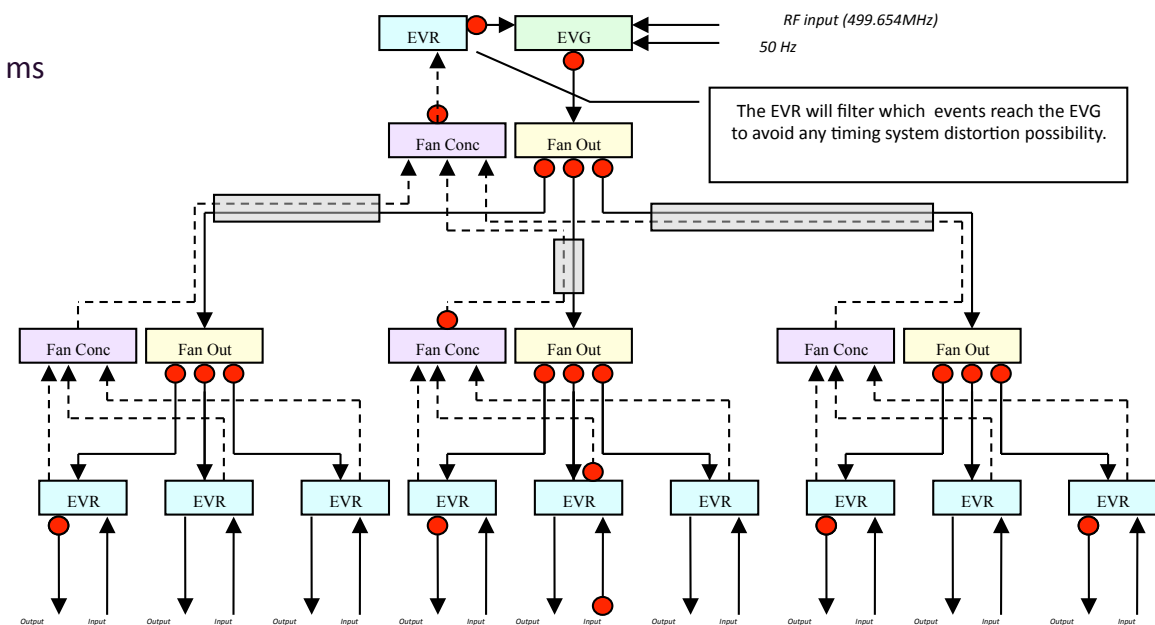
- Based on MicroResearch Finland.
 - Modified to serve as
 - the well known synchronization system
 - AND, a fast interlock system
- This is a Fast Interlock system (μsec range)
redundant to the PLC (msec range)



MACHINE PROTECTION SYSTEMS (redundancy)

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

- Timing system (MRF bidirectional). $<5\mu\text{s}$
 - RF fast interlock module.
 - BPM electronics. Liberas. Beam orbit thresholds
- Redundancy: PLCs and Timing system.



$$\text{time} = 240 \text{ ns} \times 4 \text{ stages} + 5 \text{ ns/m} \times 500\text{m} \sim 3.5 \mu\text{s}$$

(4 stages – 1 EVR + 3 Fan In + 1 EVG)

Accelerators

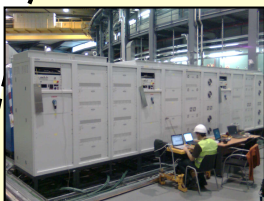
High Voltage Splitter

- 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.



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...)

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.



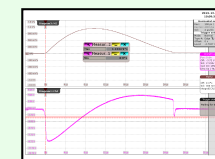
Icepap Motor controller

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



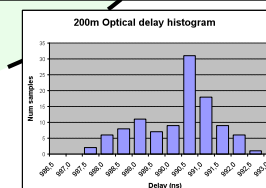
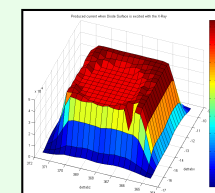
High magnetic pulse generation in BL09

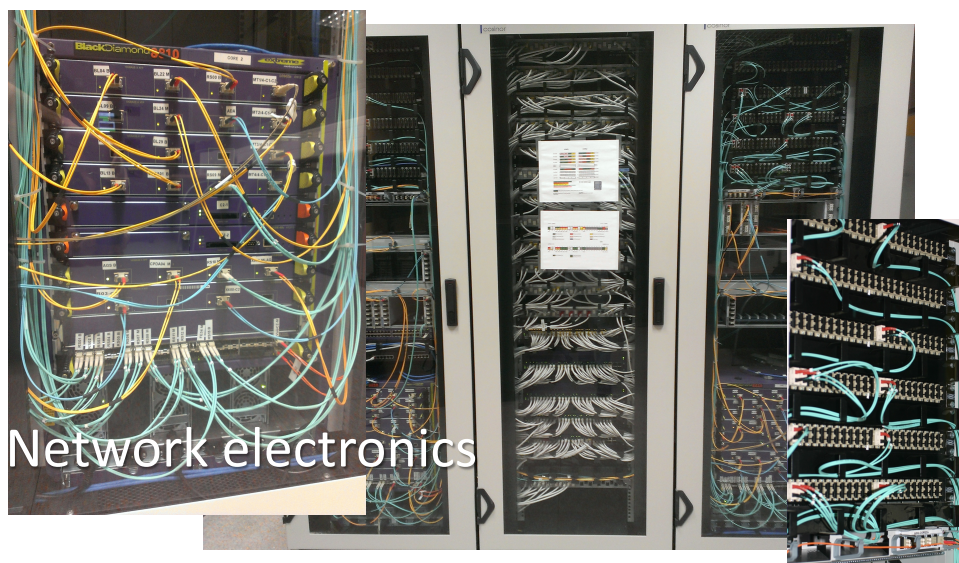
- >1,5T achieved with 2kA pulsed current in 1μs.



Transmissive Photodiode manufacturing

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





- **Network and communications**

- 2 cores 800 Gbps each. 124 switches
 - 2400+ equipments
 - 65 WiFi access points
 - 500Mbps to outside internet
 - 5 firewalls

- **Data Center**

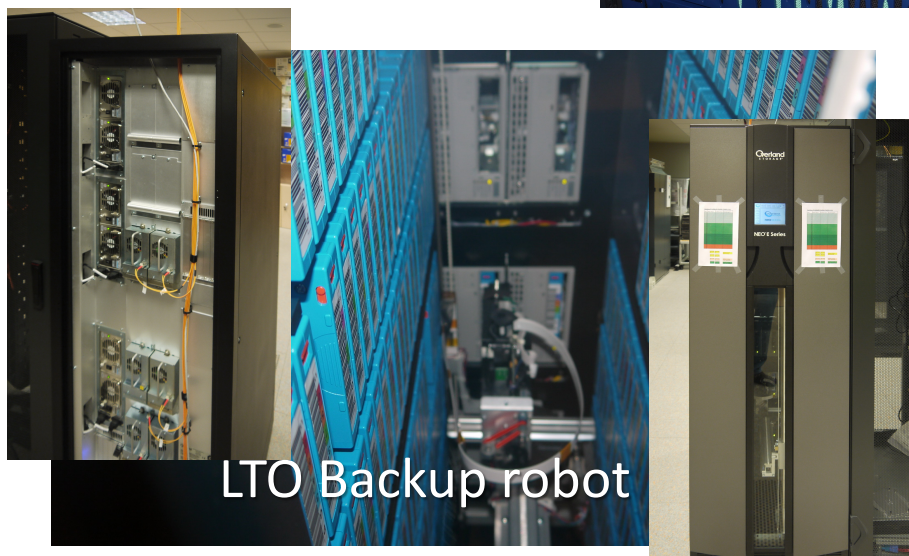
- 46 racks, 100% availability in critical servers.
 - Most services Virtualized

- **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



- **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

BL13 Shift Scheduling

Filter
 Shifts
 Shifts
 Shifts

Day	Weekday	Shift	Start	End	Shift
1	Monday	BL13	08:00	16:00	BL13
2	Tuesday	BL13	08:00	16:00	BL13
3	Wednesday	BL13	08:00	16:00	BL13
4	Thursday	BL13	08:00	16:00	BL13
5	Friday	BL13	08:00	16:00	BL13
6	Saturday	BL13	08:00	16:00	BL13
7	Sunday	BL13	08:00	16:00	BL13
8	Monday	BL13	08:00	16:00	BL13
9	Tuesday	BL13	08:00	16:00	BL13
10	Wednesday	BL13	08:00	16:00	BL13
11	Thursday	BL13	08:00	16:00	BL13
12	Friday	BL13	08:00	16:00	BL13
13	Saturday	BL13	08:00	16:00	BL13
14	Sunday	BL13	08:00	16:00	BL13
15	Monday	BL13	08:00	16:00	BL13
16	Tuesday	BL13	08:00	16:00	BL13
17	Wednesday	BL13	08:00	16:00	BL13
18	Thursday	BL13	08:00	16:00	BL13
19	Friday	BL13	08:00	16:00	BL13
20	Saturday	BL13	08:00	16:00	BL13
21	Sunday	BL13	08:00	16:00	BL13
22	Monday	BL13	08:00	16:00	BL13
23	Tuesday	BL13	08:00	16:00	BL13
24	Wednesday	BL13	08:00	16:00	BL13
25	Thursday	BL13	08:00	16:00	BL13
26	Friday	BL13	08:00	16:00	BL13
27	Saturday	BL13	08:00	16:00	BL13
28	Sunday	BL13	08:00	16:00	BL13
29	Monday	BL13	08:00	16:00	BL13
30	Tuesday	BL13	08:00	16:00	BL13
31	Wednesday	BL13	08:00	16:00	BL13

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

Access Control

Service desk, incidents and requests

Configuration management databases, cables

racks, connectors and equipments

Project management tools

Document management

Resource management

Computing
operations
management

Communications



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

Administration HHRR

Choose the type and the day of your absence (for the first day and the last day if several days).
You can have a look on the different **absences types** [here](#).

Type:
From:
To:
Comment (optional):
Ask:

If you want to **delete** some of your absences or **view** all your absences, click on the corresponding button.

CHECK YOUR ABSENCE(S)

View absences of someone:
Choose a name:

☐ Holders or special absences ☐ Work absences

Calendar view for November 2013 and December 2013.

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

Request Tracker

The screenshot shows the Request Tracker interface. The main area displays a list of tickets with columns for Subject, Status, Ticket type, Queue, Owner, and Created. The sidebar on the left contains navigation links: Home, Simple Search, Tickets, Tools, Preferences, and Approval. The top bar includes the ALBA logo and the text 'RT at a glance'.

The screenshot shows the User Office Phase 4 interface. The main area displays a grid of tasks organized into three columns: Pre-Project, Initiation Stage, and Call 2014 proposal changes. The sidebar on the left contains navigation links: Home, Simple Search, Tickets, Tools, Preferences, and Approval. The top bar includes the ALBA logo and the text 'RT at a glance'.

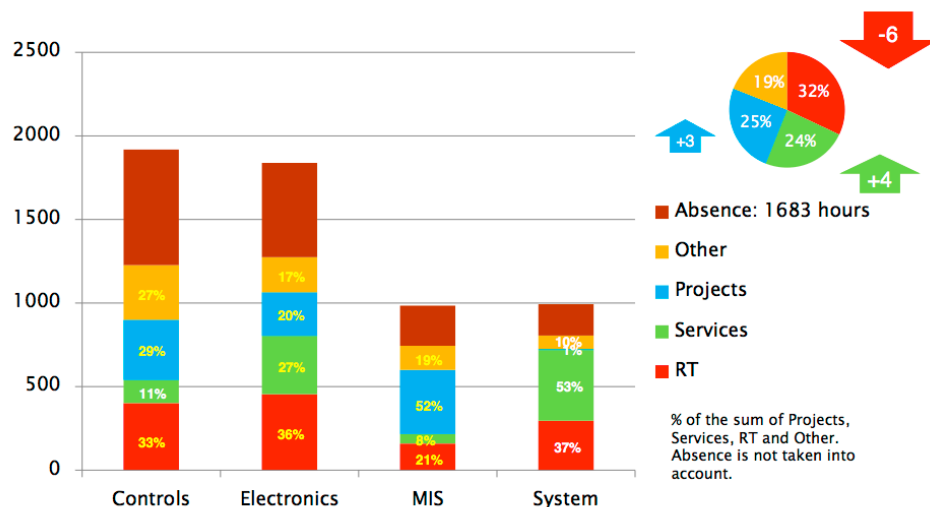
Project Management tool

The screenshot shows the Time DB (Week 46 / 2013: nov 11-nov 17) interface. The main area displays a table of time spent on various services and projects. The table has columns for Service, Unit, and Time. The sidebar on the right contains navigation links: Home, Simple Search, Tickets, Tools, Preferences, and Approval. The top bar includes the ALBA logo and the text 'RT at a glance'.

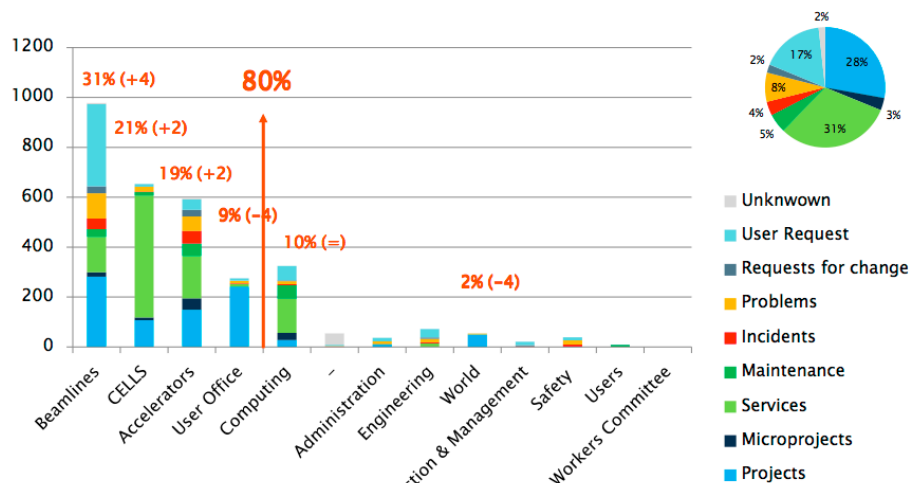
Service	Unit	Time
Data Analysis	CELLS	0:0'
Detectors DAQ-Control	Experiments	2:0'
Detectors DAQ-Control	BL13 XALOC	0:0'
Detectors DAQ-Control	BL11 NCD	0:0'
Detectors DAQ-Control	BL24 CIRCE	0:0'
Detectors DAQ-Control	Accelerators	0:0'
Detectors DAQ-Control	BL22 XAS	0:0'
Device Servers -others-	BL09 MISTRAL	0:0'
Device Servers -others-	Accelerators	0:0'

Time Management tool

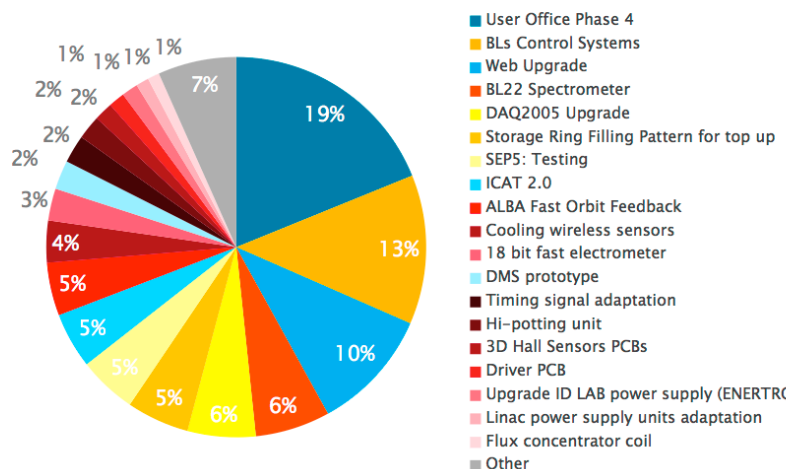
Computing Overview - 5733 hours



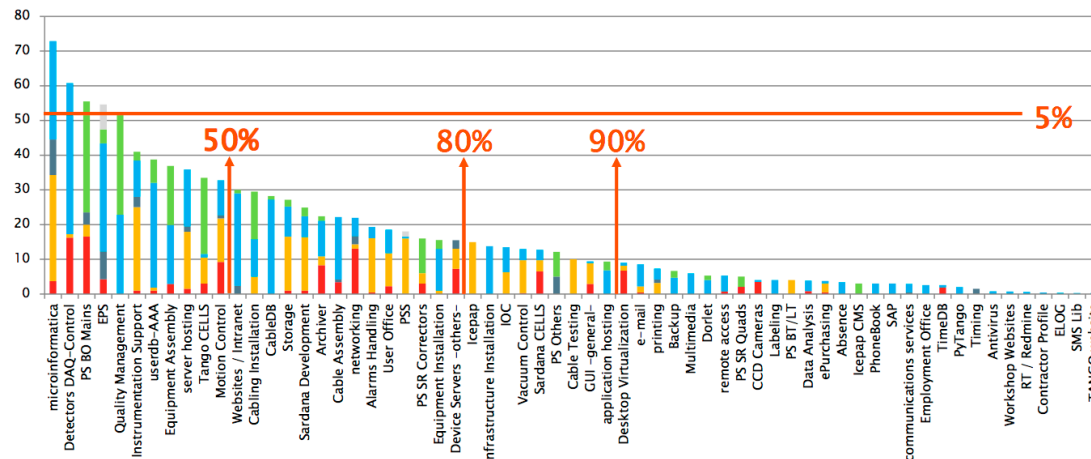
Hours Spent per Customer: 3109 hours



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

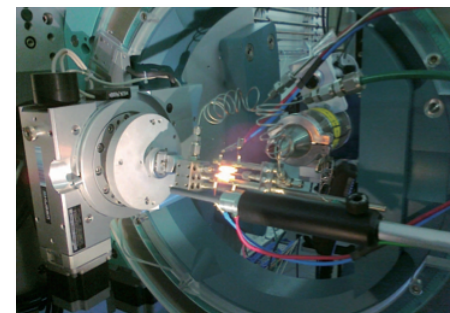


Helpdesk: Time Worked (hours)





The control system
of an Accelerator
and a Beamline



ACCELERATOR

Large.
Vacuum, **EPS**, PSS, **Diagnostics**, Tango,
Sardana

Archiver, Alarms, Power supplies, BPM,
RF...

Graphical User interfaces for various
procedures

Timing

Provide Insertion devices

BEAMLINE

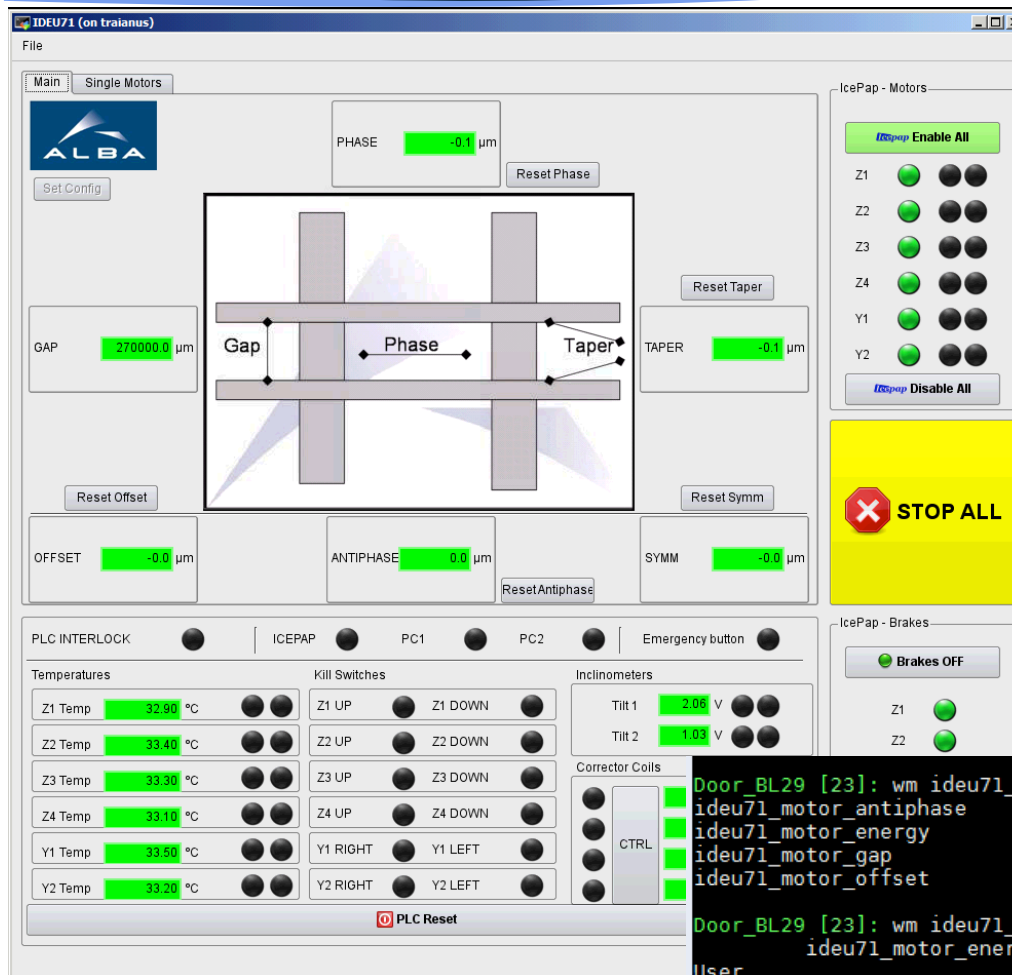
Smaller
Vacuum, EPS, PSS, Diagnostics, Tango,
Sardana

Motion Control. Mechanics

Macro execution. SCANS and Continuous
Scans. Maximum Flexibility

Detectors

Use Insertion devices



← 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_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

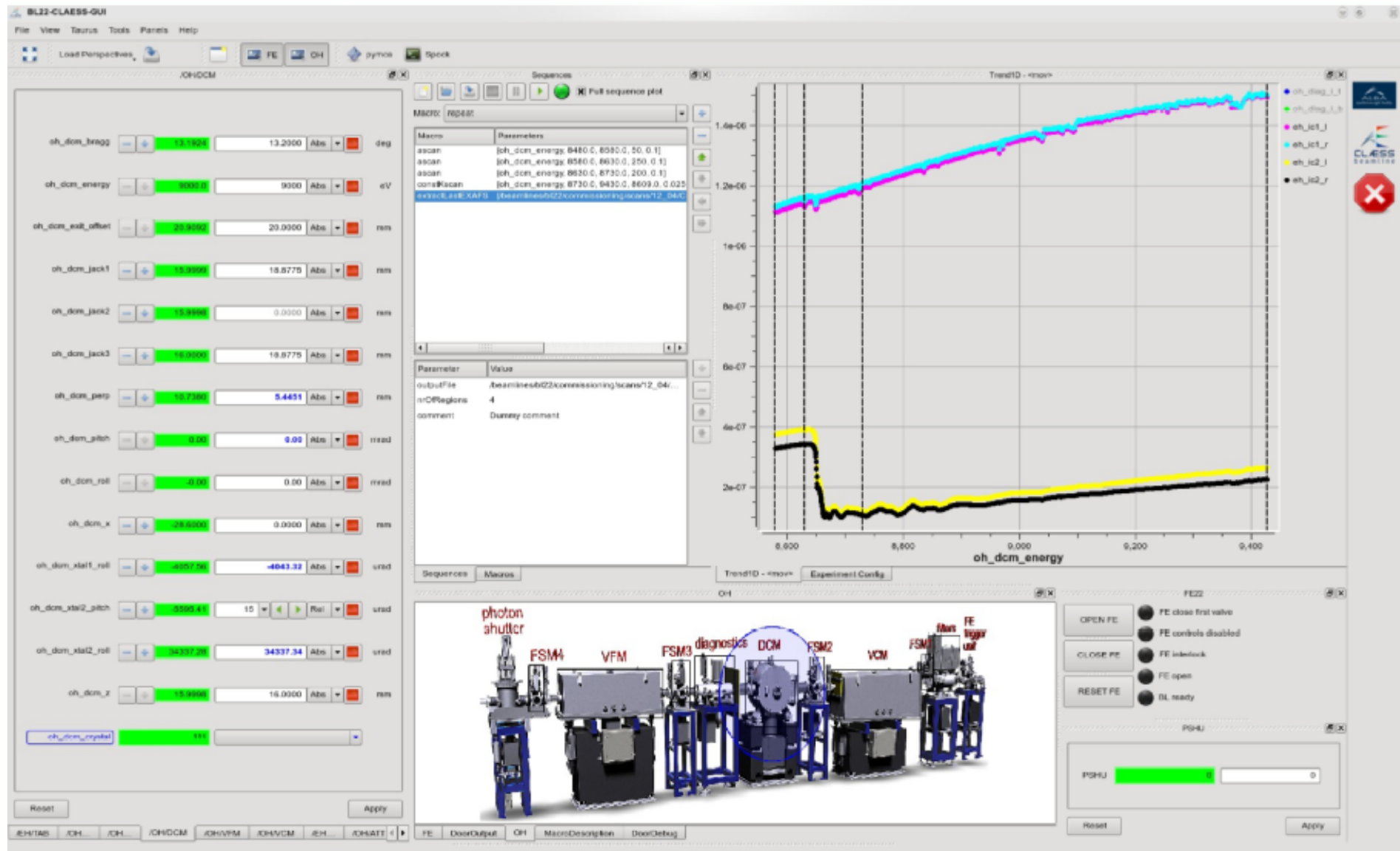
Door_BL29 [23]: wm ideu71_motor_energy ideu71_motor_gap ideu71_motor_offset ideu71_motor_phase ideu71_motor_energy ideu71_motor_gap ideu71_motor_offset ideu71_motor_phase

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 -0.0499999999984 -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

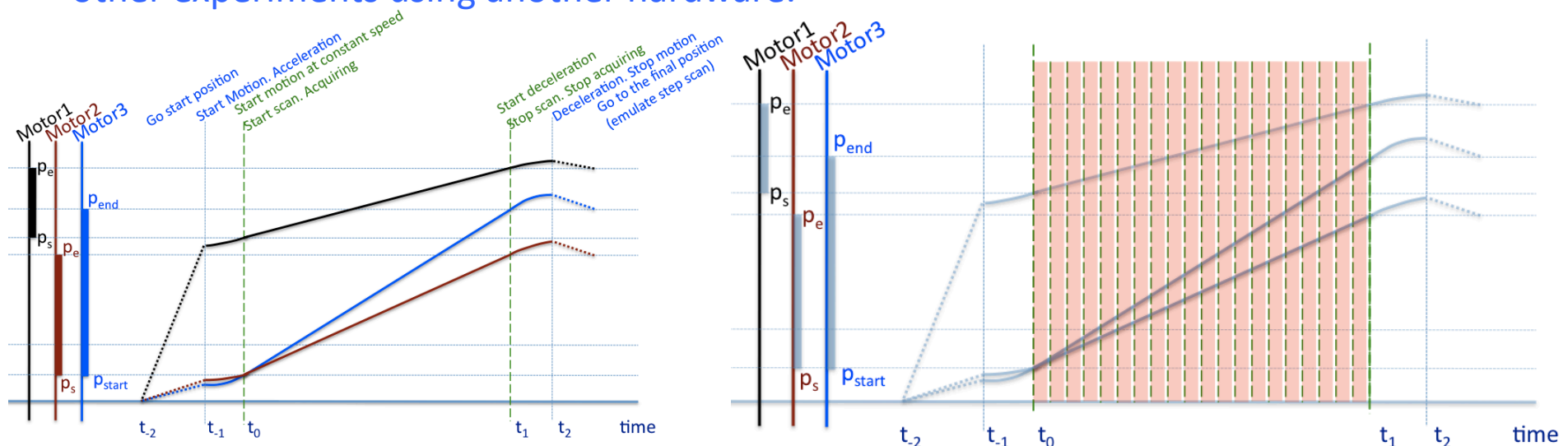


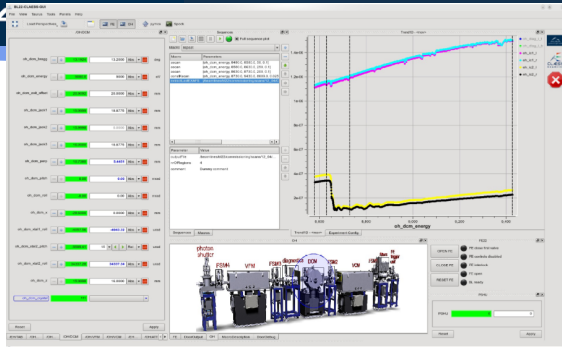
- Running in most Beamlines synchrotrons
- Overcome the “slow” issue of step scans

Need dedicated hardware with dedicated cabling for a particular purpose.

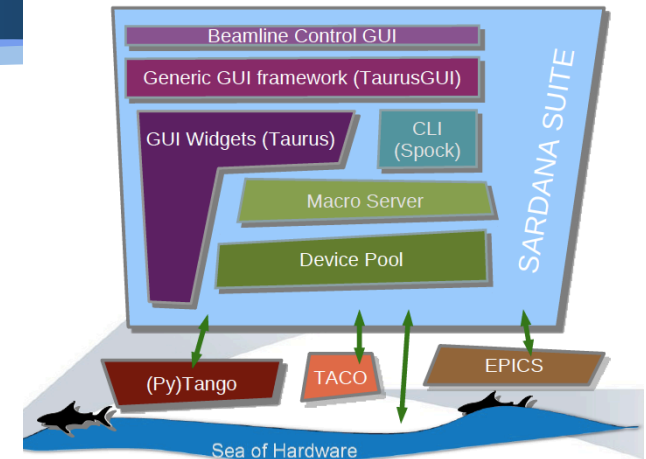
- : Solve the problem for a particular type of experiment.
- : Adapted to the purpose.
- : Fast, optimized.

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

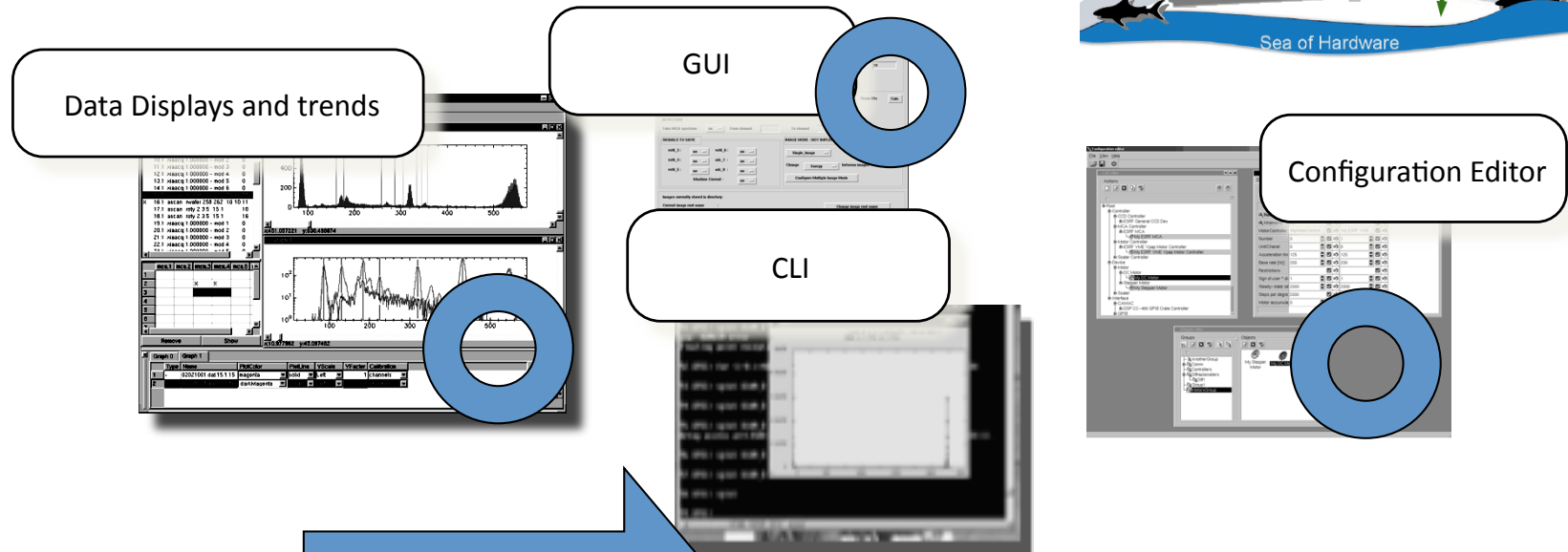




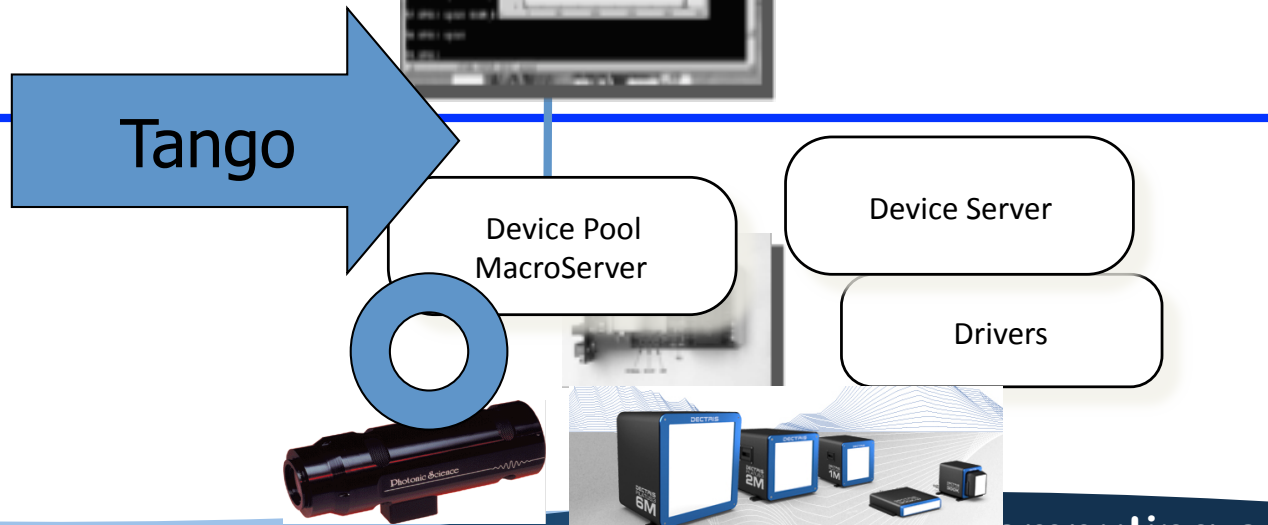
Distributed. Basic Architecture



Client



Server



gràcies
谢谢

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

