STATUS OF THE ALBA CONTROL SYSTEM

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ABSTRACT

Alba is the new light source in Spain. It is situated in the Barcelona area and co-financed by the Spanish and Catalan governments. This 3 GeV third generation light source is planned to deliver the first x-rays beam to the users in 2010. This paper describes the progress in the design of the control system for the machine and beamlines. Solutions for interfacing devices, networking, interlocks, diagnostics etc. are being studied and prototyped as it is presented here.

INTRODUCTION

CELLS is a consortium co-financed by two public administrations with a total budget reaching 187 M€ [1]. The completion of the building project and the beginning of civil engineering works are scheduled for November 2005 and the commissioning is scheduled for 2009. Concerning equipment, the LINAC contract is already awarded and calls for tender for Cavity Combiners, RF cavities, quadrupole and sextupole magnets for the storage ring are already published.

Accelerators

The initial financial budget gave us a rough number of the circumference. The final lattice makes a storage ring 268 meters long, with 16 cells. Seventeen straight sections are available for insertion devices. Four straight sections are 8 meters long (one of which is used for injection) twelve are 4.3 meters long and there are eight short sections of 2.6 meters (of which 6 have the RF cavities). The target energy is 3 GeV, reaching (with "in-vacuum" undulators) photon energies of 20 KeV. Horizontal emittance equal to 4.3 nm-rad, current 400 mA, and lifetime greater than ten hours, are the other key parameters of the storage ring. Six RF cavities are foreseen, consuming a total power of 960 KW with a total voltage of 3.6 MV.

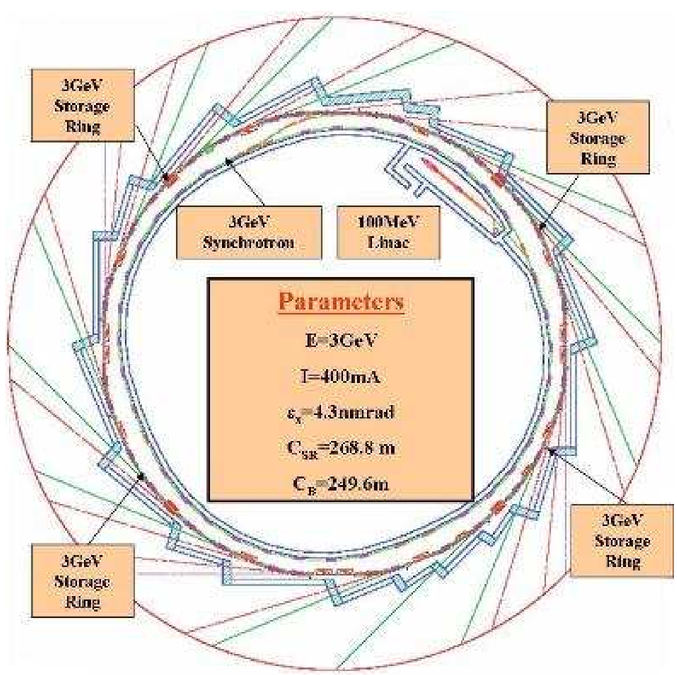

Figure 1: Alba machine overview [5]

Experiments

The number of Beamlines has been increased from five in the original plan to seven. The names of the beamlines are [2]:

1. Soft X-ray BL for polarisation dependent spectroscopies and microscopies (Magnetism, Mat. Sci.).
2. BL for electron and soft X-ray emission spectroscopies (¨dirty or real surface¨ Surface Science).
3. BL for high resolution powder diffraction with micro-focus option (Materials Science.).
4. High brilliance XAS (Chemistry, Biology, Materials science).
5. Non-crystalline diffraction with micro-focus option (Biology and Materials science.).
6. Crystallography of very large macromolecules (Biology).
7. X-ray microscopy BL (Biology).

SOFTWARE DEVELOPMENT

The main goal from the software (and hardware) point of view is to use standard tools and be as homogeneous as possible in order to ease development training and troubleshooting. Beamlines and Accelerators will have the same software structure and will use the same applications wherever it is possible, for example vacuum control.

Software development teams

Alba is divided into five divisions: Experiments, Accelerators, Engineering, Computing and Administration. The computing division, headed by J.Klora, has four sections: “Systems administration”, “Management Information System”, “Electronics” and “Controls Software”. The last two are particularly concerned with the control system. The “Controls section” (headed by D. Fernández-Carreiras) will be composed by about sixteen people and is divided in two groups “Machine” headed by D. Beltran, and “Experiments”, headed by R. Butzbach.

Tango

On the software side ALBA has adopted Tango as the toolkit for the control system development. Tango [6] is based on CORBA and was born at the ESRF. Later Soleil, Elettra and now Alba have joined the Tango collaboration. Tango supports C++ and Java for the server layer and offers many applications available already "off the shelf". Several different physical components for data networks, timing, fieldbuses, motors, data acquisition, and diagnostics will co-habit and be distributed around the machine.

At Alba, the first project in development using Tango is an upgrade/migration from a previous system to Tango [7]. The system controls the magnet measurement bench and it drives the data acquisition, archives data, manages the interlocks etc.

Source control

CVS[4] will be used as a mechanism to maintain versions and releases of the different software developments and to facilitate migration from development to production.

MACHINE CONTROL SYSTEM

At this stage of the project, the controls section is collecting user requirements from all the groups in the accelerators division. Equipment protection, vacuum controls, diagnostics, are in the requirement analysis phase or being prototyped.

Machine protection

The interlock system design is in an early stage. Interfaces with the data logger, personnel safety system etc. are still to be defined. The system will be divided in two subsystems. “Beam permit”, and “Beam Dump”. Beam permit is the signal needed for injection which will be given by vacuum, RF, magnets, and all the equipment concerned and will be managed by PLCs. A Beam-dump signal will be also generated by the PLCs, with its delay time, often bigger than 10 ms. (cycle time + network delay time). The first estimates of the number of beam-permit interlocks are being collected from the different groups of the Accelerators division. Hardwired interlocks are needed in some cases, for example between gauges and vacuum gate valves.

Vacuum

The storage ring is divided into 16 cells, half unit cells and half matching cells. A unit cell has seven ion pump controllers, two TSP (Titanium sublimation pumps) controllers, 1 gauge controller and between twenty to thirty thermocouples read by a PLC. A matching cell has five ion pump controllers, two TSP, one gauge controller, and also 20-30 thermocouples and 2 valves. The control system will be divided in two parts. One corresponds to the equipment protection interlocks, and the other is the supervisory control itself which has two levels.

Diagnostics

Most part of the diagnostic elements will be located in section two of the storage ring, except Beam position Monitors (BPM), which will be distributed along the ring. Among the diagnostic equipment the storage ring has at least one Fast Current Transformer (FCT), one fluorescence screen, four scrappers, one Tune monitor, and two fast feedback kickers.

Timing

Two different behaviours are possible. The first and most traditional is to use the standard pulse + delay-line system. The alternative is to use the system which has been implemented at the Swiss Light Source (SLS), consisting of digital processing (by FPGA’s) and fast fiber-optics transmissions between them.

Power supplies

One single power supply will be shared by all 32 dipoles. Each of the 120 quadrupoles is driven by a individual power supply making a total of 120 distributed in the ring. Finally, the sextupoles are connected by families. There are nine power supplies in total, situated together in the same section. The correctors have not been specified yet, but they should be driven in the range of 5-10 KHz.

Hardware Layout

At this moment the general layout is being designed at the same time a first draft for the general cabling is being produced. The different parts of the control system are being identified following the information available from the groups concerned.

It will be a distributed control spread into sixteen technical areas, one for each section, each of them having a network node.

Fiber optics interconnections between BPM controllers for the different orbit corrections are foreseen. Also some interlocks are hardwired and an independent network for the fieldbuses is needed as well. Therefore in this first draft of the layout, the Machine will use at least three physical networks for the control system.

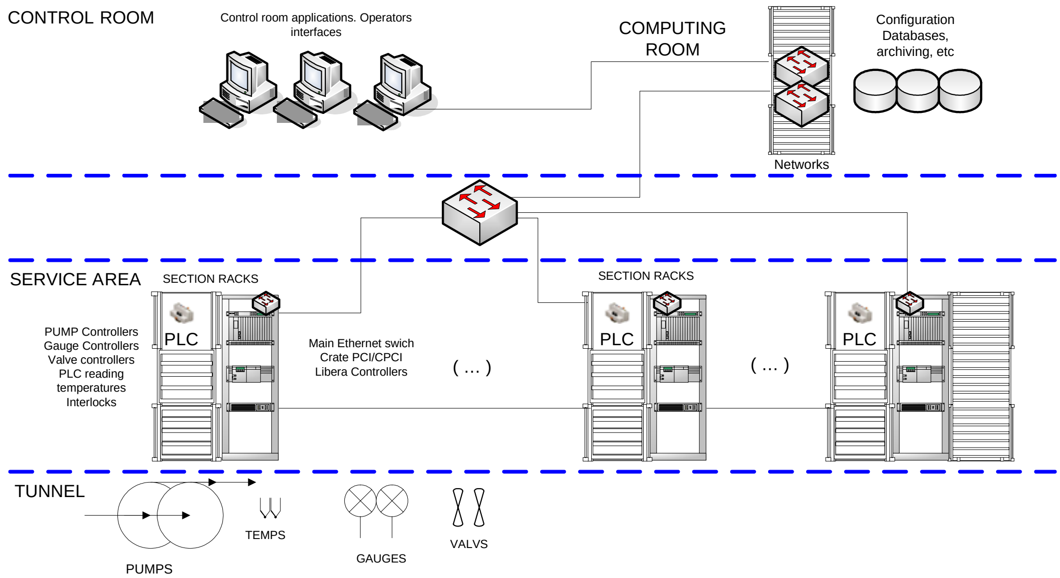

Figure 2: Accelerators controls layout

CONTROL SYSTEM FOR THE BEAMLINES.

The control system for the beamlines will follow the same philosophy as the machine from the software point of view. Some parts, for instance vacuum controls and interlocks, will incorporate also the same equipment. Nevertheless, beamlines have many particularities not common or not existing in the machine. For example, stepper motors. Whereas in the machine there is a small number, this is one of the crucial elements of the beamlines, where there is a large number of moving parts which will increase with time, even after the commissioning and during the operation. Synchronization is the workhorse of many user experiments.

Motor controllers

A market overview is currently being carried out in order to identify the latest state-of-the-art technology as well as possible suppliers of motion control technology. As we estimate to have about 500 motors on the beamlines in the initial phase in 2010 and about 2000 motors in the final stage, particular emphasis is placed on electromagnetic compatibility issues. Additionally, the controllers and drivers should be able to handle a broad range of motors, reducing the number of different kinds of controllers and drivers to an absolute minimum. Moreover, the controllers should offer advanced signal handling for sophisticated experiment control. Here, the willingness of the supplier to co-operate is another important issue.

Detectors

General purpose data acquisition systems for detectors like counter cards and frame grabbers, will be proposed in collaboration with the electronics and experiments division representatives. Nevertheless, detectors are continuously evolving, and a synchrotron will certainly need the latest developments. Consequently development in data acquisition systems is a continuous project. New detectors will continuously become available and new software interfaces will be written for each particular equipment, keeping them as much reusable as possible.

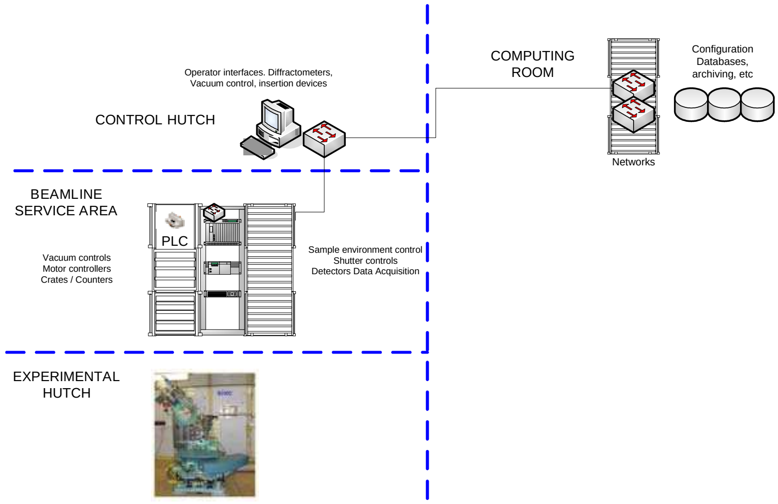

Figure 3: Beamline controls layout

Scripting

One of the software tools related to the beamline data acquisition and control system is a macro interpreter. The basics of the data acquisition of a X-ray beamline is the SCAN. A basic scan is a stepped movement combined with data acquisition (DAQ). Detectors used in a beamline from the point of view of DAQ, range from counters to 1 dimensional (MCA) or 2 dimensional detectors, like CCDs.

Scans can be generalized to many detectors and many motors at the same time. Then, experiments are composed of several scans, punctual acquisitions, realignment, recalibrations etc. The fact that each experiment is unique makes having an easy way to produce sequences to drive experiments crucial. Such a tool could have several user interfaces, like a graphical "copy-paste" of components to produce sequences, or a procedural scripting language providing abstraction of hardware. One example of this is SPEC, widely used at the ESRF, and many other institutes [3]. Some features like events, are not available, and some others like the macro language interpreter could be improved. Thus, the implementation of these new aspects together with a better communication with Tango is considered as an important issue.

GENERAL EQUIPMENT

General equipments will be chosen where possible to be common for beamlines and accelerators, in order to make both development and maintenance easier. Major choices like crates, PLC's and motor controllers will be tested in house, to make the final decision institute-wide before calling for tenders.

IOC

The Input Output Controllers (IOC) will be PCI/CPCI running Linux, although other operating systems like Windows for particular applications can be easily managed by Tango and are not excluded. Two different PCI crates are being tested at the moment in two prototypes: "the magnet test bench" and the "low level electronics for RF".

PLC

Three different PLCs are being tested. Criteria used are performance of CPUs, input/output cards, communications, programming and diagnostic tools and of course prices. The main philosophy is to install the same manufacturer everywhere in the institute in order to simplify learning development environments, licenses, interconnection with other equipment etc. Though two types of PLCs can be used for different purposes (low-end for temperature readout, for instance, and high end for RF control).

Figure 4: One of the PLC prototype for evaluation

NEAR FUTURE MILESTONES

The milestones for the near future have been defined a few months ago, and for the moment everything is under schedule. Fieldbuses and PLCs are being tested. Some crates are also being installed in some prototypes, and the motor controllers have been exhaustively evaluated in the market and some prototyping will be performed soon. The project for Python servers and scripting facilities has been recently started and is already giving nice results.

ID	Task Name	Start	Finish	Duration
1	Choice of fieldbuses, PLCs, motor controllers	5/25/2005	12/30/2005	158d
2	Choice of Crates, CPUs, counters.	1/3/2006	6/30/2006	129d
3	Prototyping. AI/AO DIO cards.	5/25/2005	12/30/2005	158d
4	Prototyping Moving/ counting	1/2/2006	12/29/2006	260d
5	High level applications. GUIs, archiving…	6/1/2006	12/29/2006	152d
6	Python servers (sequencers etc.)	11/1/2005	6/7/2007	418d
7				

Figure 5: Near future milestones in the controls section

CONCLUSIONS

The elements of the control system are being identified. The main structure is defined as well as the software architecture based on Tango. Nevertheless many important issues are still to be decided i.e. PLC types, or a generic IOC crate keeping the philosophy of using the same equipment for the machine and for the experiments. At this moment the main occupation of the people from controls is the acquisition of user requirements and prototyping.

REFERENCES

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[4] http://www.cvshome.org

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[7] D. Beltran et Al. "A tango based control system for a 3D measurement bench for magnets". These proceedings.