STATUS OF THE ALBA CONTROL SYSTEM

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Abstract

Alba [1] is a synchrotron light source located 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. Hardware and Software solutions are presented. Ethernet, PCI and Linux are extensively used. Servers are mostly written Python and C++, whereas clients are most Python and Java. Solutions for interfacing devices, networking, interlocks, diagnostics are presented.

Figure 1: View of the progress of the works. Picture taken on the 1st of September 2007.

INTRODUCTION

The construction of ALBA, the 3 GeV Synchrotron Light Source near Barcelona (Spain) is proceeding according to schedule. Although the building will be finished on June 2008, the preparation and installation of the components for the Linac is foreseen in November 2007. The 100 MeV Linac is manufactured by Thales Communication as a turnkey system. The 3GeV booster and the storage ring are installed in the same tunnel.

The architecture of the control system is distributed. Boot servers and Tango [2] databases and archivers run on boxes in the computing room. Tango servers run in IOCs (Input Output Controllers) which are linux boxes, most of them diskless. Compact PCI crates are installed in all those devices where a timing event receiver is needed. The remaining ones are Industrial PCs. Beamlines have industrial PCs with disk.

SUBSYSTEMS

Linac

The 100 MeV Linac is manufactured by Thales Communication as a turnkey system. Nevertheless the control system is based on PLCs with 2 interfaces based on a common library. One of the interfaces is for local control, intended to be used for commissioning. It is delivered with the system, and the other one connects to the ALBA control system allowing the use of common tools for archiving, save and restore, and inter-communications.

RF

The storage ring has six radio frequency plants with a power of 160 kW (two transmitters of 80 kW each) The booster has another plant of 80 kW. Pulses in the electron gun are chopped at 499.654 Mhz. A transmitter including a high voltage power supply (HVPS) and a Inductive Output Tube (IOT) have been already installed in the Radiofrequency lab. The control system for the transmitter is based on Siemens Programmable Logic Controllers (PLCs) and delivered by Thomsom. The interlock system follows the same philosophy as the general Equipment Protection System (EPS) and uses B&R PLCs with CPUs installed in cabinets outside the tunnel and distributed I/O modules inside the tunnel. Both are interconnected through an X20 bus. Graphical interfaces are written in Python [3] and Qt4 [4]

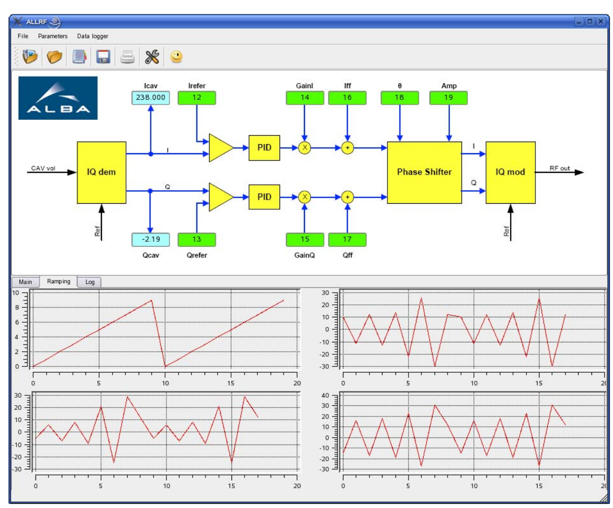

Figure 2: Graphical user interface of the for the low level analogue regulation of the RF. It is written in Python and Qt4.

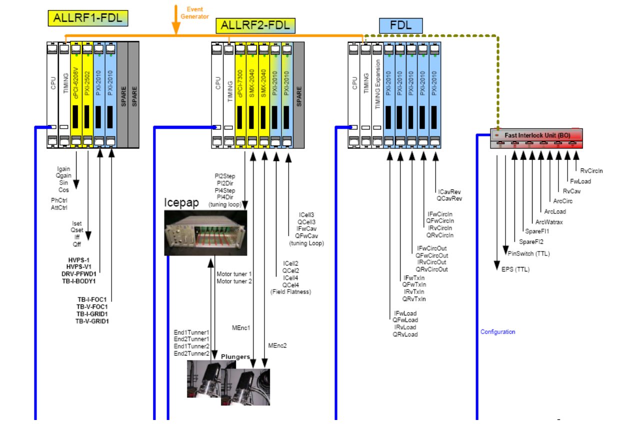

Figure 3: Block diagram of the control of the and data acquisition built on top of the low level RF regulation.

Vacuum

Main vacuum electronics are Varian Dual Ion Pump controllers and MKS gauge controllers . They are interfaced by RS232/RS485. An industrial PC per sector (16 in total is in charge of the vacuum control. This includes serial connections, Tango servers for the different controllers, and connections with the different PLCs. PLCs manage interlocks of the different devices, as well as temperature readouts. They follow the Alba standard distributed architecture, having a CPU installed in a cabinet in the service area and distributed I/O modules installed inside the tunnel on cable trays. Figure 4 shows a plc to be installed in a rack in the service area. Contactor blocks are behind the electronics in three levels. Boxes to be installed in the tunnel are shielded with 1.5 mm of lead.

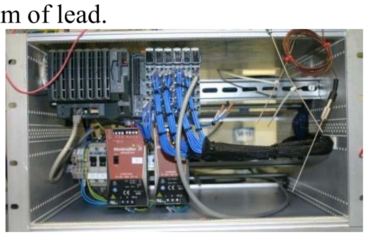

Figure 4: B&R PLC for vacuum interlocks installed in a rack in the Service Area.

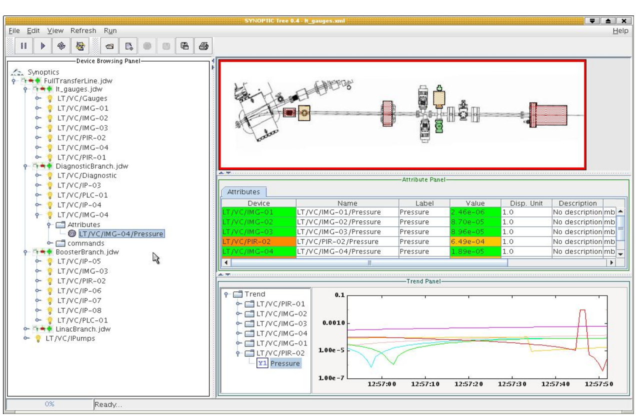

Figure 5:Graphical interface of the vacuum control of the Linac to booster transfer line.

Graphical interfaces, synoptics and archiving system are written in Java and use Tango standard tools. Figure 5 shows a graphical interface for the diagnostics line of the linac. This interface is fully customizable. On the right the different devices are shown in a tree. A synoptic is shown on the top, some variables (arbitrary chosen in the center) and a trend chart in the botton.

Power Converters

All power converters have an Ethernet interface complemented with an external trigger input. Corrector magnets of the storage ring will have a fast link for the fast orbit feedback [6]. They are interlocked with the corresponding magnet flow-switches and thermo-switches by the EPS, and each of them having the corresponding Tango server (implementing the power supply interface) for slow control and data acquisition.

Timing system

Timing system provides the synchronism signals to diagnostics devices, beamlines, and the injection mechanism. It is based on events where an Event Generator (EVG) produces the event stream that is communicated to multiple Event Receivers (EVR). Transmission to all event receivers is multiplexed with fan-out modules and carried out by optic fibers of the same length. This system follows the same philosophy as SLS, Diamond, Soleil and few other institutes and has been manufactured by Microresearch Finland.

Diagnostics and beam dynamics

The storage ring includes 88 Libera BPM electronics [5] and 88 correctors in each plane for orbit correction. Corrector magnets are integrated in the sextupoles as extra coils. Data from the Liberas is being distributed among the liberas up to the Compact PCI crate using the protocol developed at Diamond. This data transmission meant to be used for the fast orbit correction uses a dedicated fiber optics link. A tango server for every Libera box runs in the Compact PCI crate and is accessible from the control system for the slow orbit correction, displays, archiving etc.. This so called slow control goes over the normal Ethernet link.

30 CCD cameras for fluorescence screens are also read by Ethernet, using the E-Giga protocol whereas other signals like BCM are read by analogue input cards in the CPCI crates. Oscilloscopes are used for Fast Current Transformers, Faraday cups, among others. Beam Lost Monitors are read through RS485.

PSS

The personnel safety system ensures that nobody gets irradiated during operation. This comprises access control to bunkers, intrusion and malfunction detection as well as radiation level monitoring. The system is based on Safety PLCs from Pilz, following the golden rule of redundancy and diversity. All inputs and outputs like door switches, radiation monitors, emergency stops, shutter limit switches, have redundant cabling, actuators and contacts.

The PSS interlocks every RF transmitter (out of 13) in two different ways as well as both klystrons of the Linac and the electron gun. It has been designed to be SIL3 compliant.

Beamlines

A project for writing a generic tool for beamline control has been started at Alba, and now the European Synchrotron Radiation Facility (ESRF) is collaborating in the development. This “device pool” provides a common way of acquiring data, moving motors, scanning and in general interfacing any device. It is based on Tango, written in C++ and Python. This is very appropriate for beamline controls, diffractometers, detectors, motors, counters, etc. but also for some applications in the accelerator controls. For example, scanning scrappers or power supplies like in the case of the measurement of emittances, etc. Figure 6 shows one configuration panel of the device pool.

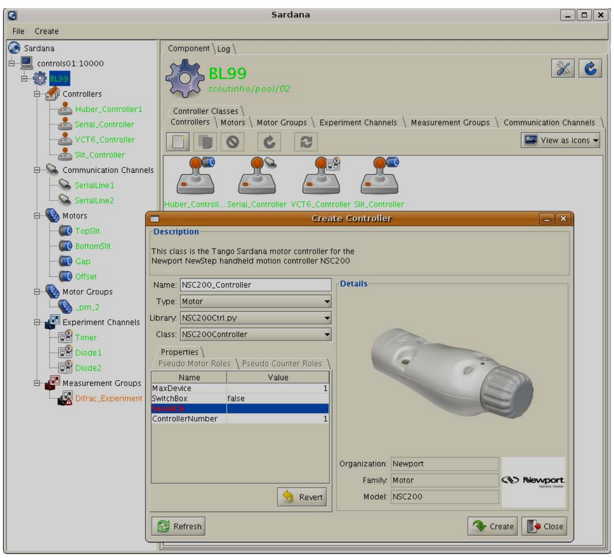

Figure 6: Configuration tool of the “device pool”

Motion control

Alba uses Icepap as the standard motor controller. The Icepap electronics is a development of the ESRF. It is presented in crates of 8 power drives and a controller which can be a master or a slave. It is fully configurable by software and accessed by Ethernet or serial lines. The configuration and test tool is an application written at Alba using python and Qt4. Icepaps are used at the beamlines as well as in the insertion devices, scrappers, and RF cavity plungers.

SOFTWARE

Computers in the server room, operator consoles, and IOCs use Suse10.2 linux distribution as the current standard. Python 2.5 and Qt4 are also being adopted. Applications are packaged using Red hat Package Manager (RPM), and deployed using blissinstaller and blissbuilder [8]. Those are a couple of tools for building and later installing packages, and keeping track of the versions of the packages and where they have been installed.

ARCHITECTURE

Ethernet is widely used by the control electronics. Power supplies, Liberas, CCD cameras, Oscilloscopes, and of course IOCs are connected by Ethernet. Most IOCs get a dynamic address by Dynamic Host Configuration Protocol (DHCP). Few VLANS (Virtual Local Area Networks) are defined. The main control, EPS, liberas, power supplies and diagnostics are separated into different VLANS as most communications are between devices of the same group.
The Tango database and databases for archivers (mysql) reside in linux boxes in the computing room whereas fast data loggers for RF and eventually vacuum will store data online.

CONCLUSION

Major choices like Ethernet as field bus, PCI and cPCI, Liberas, Icepaps, Linux and Tango have been taken. Prototypes have already been implemented mostly for the RF lab which needs an RF control, EPS, Vacuum control, Archivers, Save/Restore, and even a PSS. Choices up to now demonstrated to fulfil all the needs and expectations. However, Large scale systems need still to be tested, in particular for the archiver and tango databases.

AKNOWLEDGEMENTS

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