UPGRADE OF BEAM DIAGNOSTICS SYSTEM OF ALPI-PIAVE ACCELERATOR'S COMPLEX AT LNL

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Abstract

The beam diagnostics system of ALPI-PIAVE accelerators has been recently upgraded by migrating the control software to EPICS[1]. The system is based on 40 modules each one including a Faraday cup and a beam profiler made of a couple of wire grids. The device's insertion is controlled by stepper motors in ALPI and by pneumatic valves in PIAVE. To reduce the upgrade costs the existing VME hardware used for data acquisition has been left unchanged, while the motor controllers only have been replaced by new units developed in house. The control software has been rebuilt from scratch using EPICS tools. The operator interface is based on CSS; a Channel Archiver based on PostgreSQL[2] has been installed to support the analysis of transport setup during tests of new beams. The ALPI-PIAVE control system is also a bench test for the new beam diagnostics under development for the SPES facility, whose installation is foreseen in middle 2015.

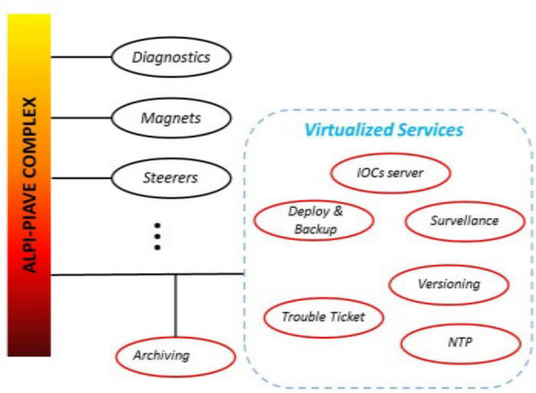

Figure 1: PIAVE-ALPI complex.

INTRODUCTION

Beam diagnostic system is a critical task for managing the accelerator complex, because it is the first stage where scientists and operators understand machine status and behaviour and execute the operations required to provide the desired beam.

Diagnostics system will be a part of the control system architecture under implementation at INFN/LNL Laboratory (Figure 1). One of the greatest improvement coming from the assumption of EPICS as main control system framework is the creation of a distributed environment where every sub-system is integrated and interconnected with others. As consequence, operators and scientists can have an easier and more direct control to the entire apparatus. The upgrade related to the diagnostics system is realized focusing in two aspects: the reuse, as much as possible, of the hardware already installed in ALPI (to contain costs) and the integration into the EPICS environment. First development stage was realized in 2011[3].

DIAGNOSTICS SYSTEM ARCHITECTURE

In principle the ALPI-PIAVE diagnostics environment is composed by 48 diagnostics boxes installed along the apparatus containing, each one, a faraday cup and a couple of grids (horizontal and vertical) where every single grid is made of 40 wires. To avoid white noise inducted by cables, current signals are converted to voltage next to the diagnostics box. After the conversion, grid signals are multiplexed and serialized before the transport to the acquisition system composed by an ADC card installed in VME crates. The multiplexer is driven by a counter whose clock is generated by the ADC itself, to have the signal transmission synchronized with the conversion. At the beginning, the software layer used for this sub-system was based on C programs developed on VxWorks OS for the VME systems and custom java application developed inside the INFN for the Human-Machine Inteface (HMI).

With the focus of renovate and upgrade the control system software, EPICS was chosen as control system framework for the new environment, bringing all the advantages coming from this solution (performances, data distribution, etc.). As consequence, the actual set of programs and tools available to control the ALPI-PIAVE complex has been substituted piece by piece with the new EPICS application.

According to EPICS documentation, VxWorks is supported by EPICS since its origin; therefore VME systems are not completely changed: the VME processor implements an Input/Output Controller (IOC) providing the acquisition of grid signals and faraday cups. Databases loaded in the IOC are not very complex, due to simplify the maintenance, and provide minimal processing on raw data. Signal from beam profilers and faraday cups are acquired by XVME566 board produced by XYCOM: this kind of hardware provides 12 bit resolution and support a conversion rate of 100 KHz in streaming mode. As indicated in Figure 2, a dedicated device driver realized by M. Davidsaver realizes the software interface between the field and the EPICS server host.

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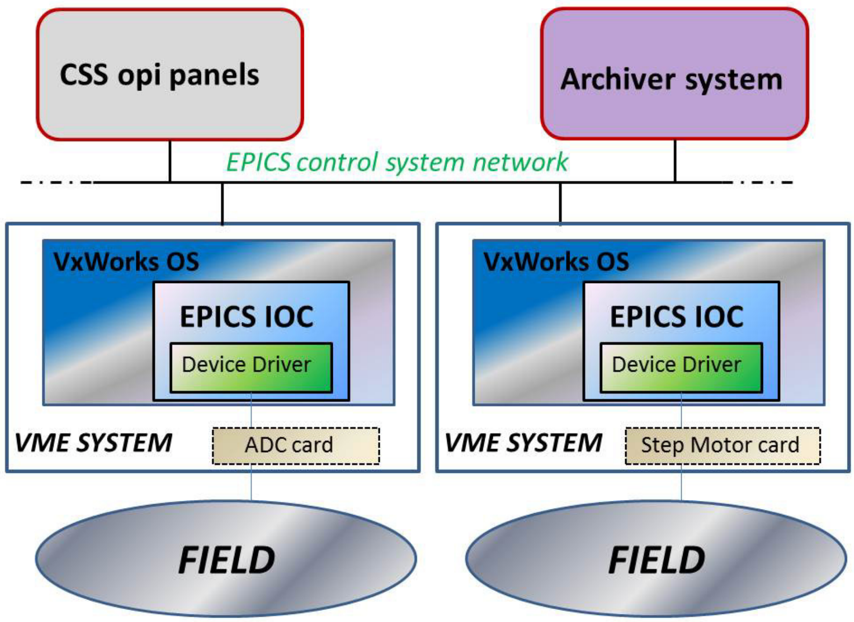

Figure 2: Software schema adopted for VME systems.

The steppers motor controllers for collimator position are VME cards built inside the LNL, together with the associated power drivers: every single controller is able to manage up to 8 motors. The crate controller is an Emerson MVME3100 based on the PowerPC8540 equipped with 256MB RAM. Also this host runs under VxWorks OS which provides an EPICS IOC properly configured to manage the devices connected and provide a set of basic functions:

- acquisition of collimator position from linear encoders
- control of step motors used to synchronize the collimator motion with the grid signal acquisition

Due to realize this functionality, a dedicated Device Driver has been developed by D. Chabot to control motor position and provide feedbacks.

The entire diagnostics system results composed by 1600 record, counting both records managing raw and elaborated data. For more details see Table 1.

Table 1: Records Implemented for Diagnostics System

Sub-sytem	Number of PVs
Grids and FC	1300
Step motors	300

HUMAN MACHINE INTERFACE AND ARCHIVE SERVICES

Different tools and applications are available in the EPICS environment to create dedicated control panels for managing the facility and the Linac apparatus, and every one provides particular features. Following the line defined for the SPES Project, Control System Studio (CSS) was chosen as common layer to realize human machine interfaces, in order to have an integrated environment where the user (scientist or operator) can use different tools (such as control panel, archiver viewer and alarm handler) in the same application.

As consequence, a dedicated set of control panels are developed in CSS inheriting as starting point the layout used until now by final users. The whole HMI for the ALPI diagnostics system is composed by a main panel representing the map of the linear accelerator (Figure 3) and a template where user can read information from a particular diagnostic box:

- in the main panel only the general information about diagnostic boxes are shown, such as grid and faraday cups' status and commands, due to simplify the reading
- selecting the interested diagnostic boxes from a dedicated table, it is possible to open the template window where all the information related to the desired devices is shown.

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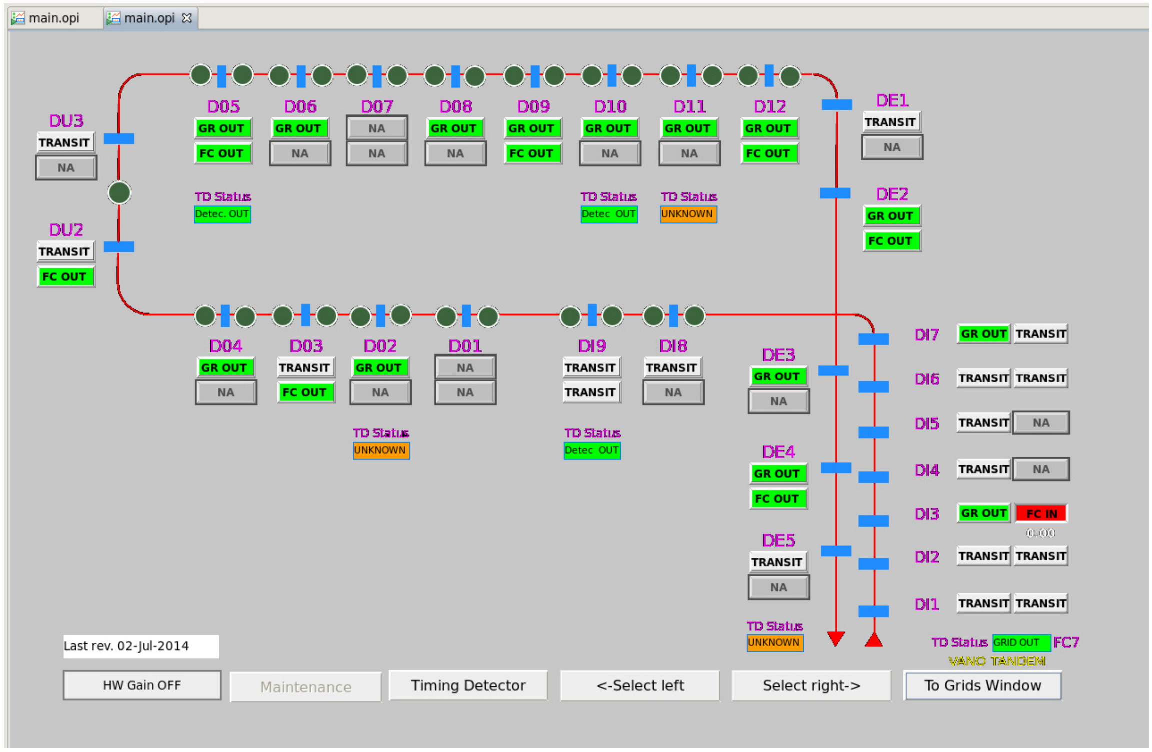

Figure 3: Main panel for ALPI Diagnostics system based on EPICS CSS framework.

The diagnostics system, as the first part of the apparatus involved in the control system upgrade was used as test bench for EPICS archiver service. Preliminary basic operation related to data storing and retrieving are performed between this sub-system and the archiver machine in order to verify the correct communication in both sides and define the common standard configuration which will be used for all the other sub-systems. The data acquisition performed now is used to estimate the hardware requirements (disk space, etc.) needed by the archiver service in production. In these tests both raw and elaborated data are stored, due to understand the best sampling configuration for archiver acquisition with different type of data.

For the ALPI diagnostics system, archiving all the information provided by this system requires about 70 GB/day; obviously this is the worst case and optimization is required, but this information can be used as upper bound for design data archiving for the diagnostics.

CONCLUSION

The diagnostics system for ALPI-PIAVE complex is migrated to the new EPICS control system framework in according to the guidelines defined in the SPES Project. The software migration to EPICS resulted in a significant increase of flexibility and performance of overall system.

All the diagnostics boxes provide EPICS IOC and the interconnection to the field through dedicate Driver Support developed in collaboration with BNL, while a dedicated HMI is developed in CSS. The functionality is full tested and the system is ready for production. Minimal minor configurations will be required in order to

optimize services related to the control system, such as Archiver system.

ACKNOWLEDGMENTS

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This works leveraged of years of experience on EPICS use from good engineers of other laboratories around the world: great acknowledgments to them.

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