CHAPTER IX

CONTROL SYSTEM

9.1 Introduction

SPES is a research complex made of different subsystems whose elements, from the functional point of view, can be grouped into two main categories: the accelerator equipment (including the cyclotron, the target and the re-accelerator instrumentation) and the safety equipment whose function is to provide, in compliance with the government's law, the highest levels of safety for plant operators.

Although safety and accelerator equipment closely interact, they are usually implemented as independent subsystems and, because of different requirements, are managed by dedicated control devices.

The general SPES control system has to integrate into a common framework the control of different subsystems by providing a unique model of graphic user interface and a common set of utilities for data archiving and analysis.

Local control systems (LCS) can have their own supervisor for diagnostic purposes or even for routine operation: in any case, they will make their data available to the higher level supervisor to allow a coherent analysis of all parameters relevant for the overall facility operation.

The key for the integration of SPES Local Control Systems is EPICS (Experimental Physics and Industrial Control Systems). Its open architecture and hardware platform independency provides an effective solution for exchanging data among control devices based on different technologies.

9.2 Safety

9.2.1 Guidelines for the implementation of safety oriented control systems

The study of Safety and Radiation Protection issues foreseen for the SPES project has been carried out with the aim to identify the risks and to implement the safety installations and procedures.

A global Quality and Safety Management System is the reference for the implementation of the safety of the entire SPES project. Aim of this general task is to build a Quality and Safety Management System for SPES (QSMS) complying the international standard ISO 9001:2008 and OHSAS 18001:2007 concerning Quality and Safety respectively. This System will be strictly connected to the already existing ISO 14001:2004 Environmental Management System of LNL.

The goal of QSMS is to define and apply quality and safety standards for each element of the SPES project during the following phases of its life cycle:

- Design;
- Construction;
- Operation;
- Maintenance;
- Disposal.

The basic idea promoting this work is ensuring high quality level in the project realization as the way to obtain a safe facility and considering safety since the design phases. A general risk analysis is performed following the hybrid method following the international standards ISO 12100 / UNI TR 14121-2 and EN/IEC 62061.

Particular care is put in performing risk analysis on some particularly dangerous features of the target area. Many techniques will be applied in order to obtain an integrated result. These are: the Failure Mode and Effect Analysis (FMEA), the HAZard and OPerability analysis (HAZOP) and the Fault Tree Analysis (FT).

The QSMS will be implemented using custom software specifically designed on the SPES project request; with the aim to obtain an everyday-use tool for the machine operation in order to ensure the respect of the safety procedures. To do this a strong integration of the control system among the different sub-systems and the safety procedures is required as well as a user friendly interface.

The safety level of each sub-system, as analyzed inside QSMS, will define the reference for SIL application to components and specific control systems. According to these requirements the control system will be developed following the general rules:

- in case of fault the system is driven to fail-safe mode;
- for most critical elements a safety control is implemented using safety-PLCs in addition to the normal control system for operation;
- if specifically requested a cabled logic is used if a more safe device is not available;
- a log of faults is automatically maintained.

9.2.2 The radiation protection system

Concerning Radiation Protection, Montecarlo simulation with FLUKA code gave the possibility to estimate expected radiation dose rates. This allowed establishing which the most sensible part of the project is and where special care has to be put in order to guarantee a safe operation of the infrastructure.

In particular the following aspects have been evaluated:

- the design of the Cyclotron building (materials to be used, wall thickness, critical parts of the construction);
- the possible problems of the ancillaries plants (air venting system, cooling water system, air outlet of the vacuum system);
- problems connected to materials activation (activated components maintenance, irradiated target handling).

High reliability controls are needed to monitor the radioactivity in the SPES area and to manage the access to the infrastructure.

The radioprotection system has the following main subsystems:

- radiation monitors survey
- control access system
- beam interlocks and alarms

- personnel monitoring

9.3 The Control System Architecture

The SPES control system will be distributed on Ethernet network and will implement the client-server model foreseen by EPICS architecture. While a Local Control System can make use of proprietary network protocols for sharing data within the boundary of LCS itself, the communication with the high supervisor level will be based on EPICS Channel Access specifications.

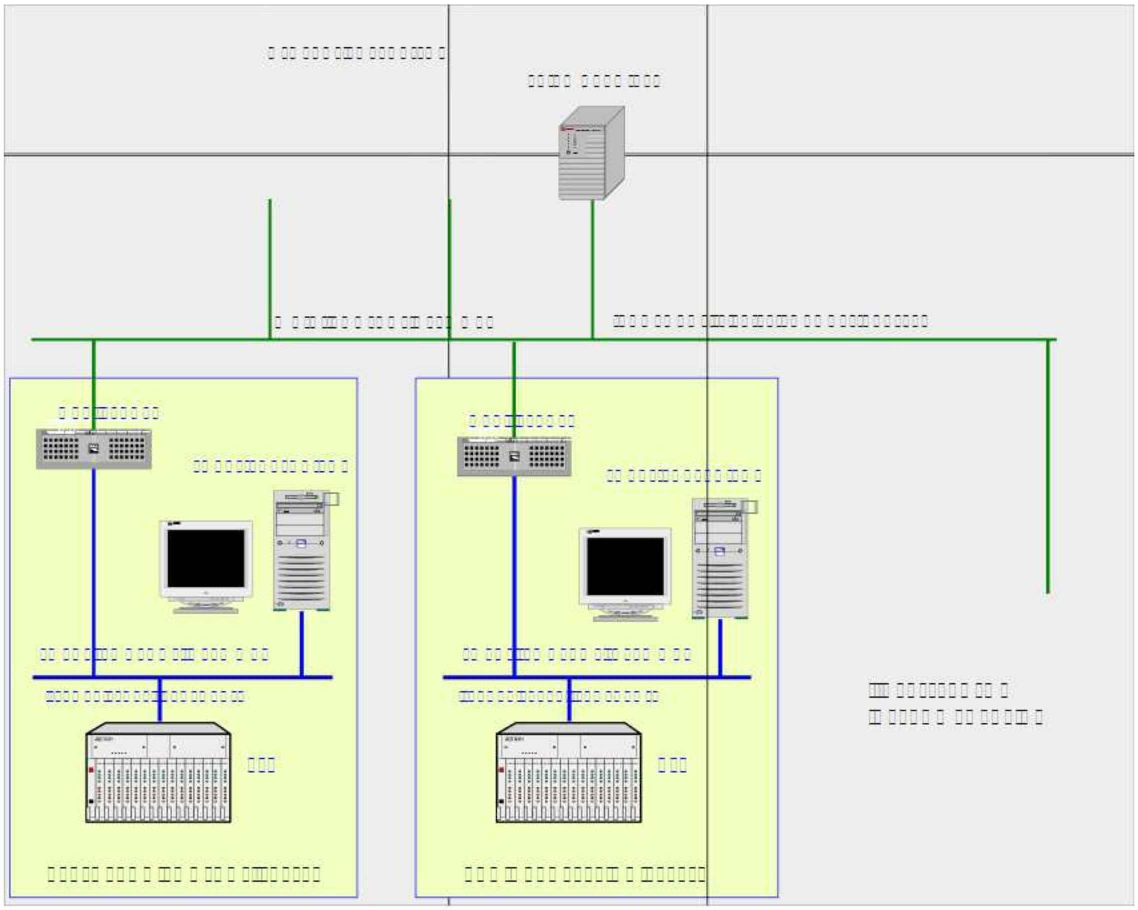
Local Control Systems based on industrial PLCs (which are the case of safety oriented controls), will be connected to dedicated units (Windows PCs) to provide the gateway between the PLC communication protocol and the Channel Access.

The software technology recommended to make PLC data available to Channel Access is the industry-standard OPC, supported by a wide consortium of PLC manufacturers.

Differently from PLC-based subsystems, accelerator instrumentation will be managed by controllers natively implementing the Channel Access interface; these devices can communicate with the high level supervisor with no need of protocol conversion. Figure 9.1 illustrates this concept.

The high level supervisor will be de facto the only supervisor for accelerator instrumentation controllers while it will replicate the control functions on a selected group of process variables managed by PLCs.

This solution not only will provide a user interface with a common "look and feel" for all facility subsystems, but will also provide a common time-stamp for all archived variables, making much easier the correlation of events for alarm management and diagnostic purposes.



9.3.1 The supervisor system.

The supervisor system, installed in the facility control room, will be based on Linux PCs and will provide the graphic user interface (GUI) for all facility subsystems. The GUI will include a set of utilities, available from EPICS distribution, for data analysis, alarm management, data archiving, etc. A more detailed description of such utilities and the general guidelines for the design of graphic interfaces can be found in the chapter 9.3.

9.3.2 The control network.

The SPES control system will be distributed on Ethernet. The network backbone connecting the main console room to the cyclotron and target areas, as well as ALPI and PIAVE vanes, will be based on optic fibers supporting a transfer rate up to 10Gb/s, while fast Ethernet (100 Mb/s) switches will be used locally to connect control devices in the same area.

For security reasons, the SPES control network will be configured as a VPN (Virtual Private Network) and will be accessible from the LNL network through a gateway only.

9.4 The PLC functionalities and requirements

9.4.1 Introduction

PLCs are the most common systems used for industrial controls and are essential part of many control applications at LNL. In order to increase efficiency, to reduce design time, to lower the immediate costs and the long term maintenance costs both in money and human resources, all LNL control projects based on PLCs should select them from the product lines of a limited range of PLC manufacturers. In fact, a single manufacturer's line of PLC products might not satisfy all the needs of the various LNL control projects, but, for the above mentioned reasons, the number of PLC families to be used should be, nevertheless, minimized.

This is feasible as the technical requirements of slow control in the accelerators, technical services and experiments have similar requirements and can be all satisfied by PLCs (in different fields like electricity, water, cryogenics, cooling, ventilation, personnel access and safety systems) if the recommended PLC products are sufficiently general purpose.

Therefore a shared policy, valid for the next 5 to 10 years for the PLCs to be used at LNL, is recommended.

PLCs can be roughly grouped into three categories:

- Large-size, for top level applications requiring fast execution (short instruction cycle times)
- Middle-size, for systems of medium power; offer a large choice of analog and digital input/output modules, are usually connected to a fieldbus on one side and to the equipment on the other side; their speed may be not high, the amount of data exchanged is small
- Small or Micro-size, for direct interface with sensors and actuators, sometimes integrated with the intelligent sensor itself; they have often short reaction times and are the cheap

According to the safety level of the different SPES sub systems, two different applications for PLC’s are envisaged, namely:

- general purpose
- safety

The following subsystems have to be controlled using general purpose PLC control systems:

- Cyclotron
- Vacuum
- Target handling and storage
- Fireproof
- Water cooling
- Compress air supply
- Environmental conditions
- Electrical system conditions

The following subsystems have to be controlled using safety PLC control systems:

- Access and radioprotection
- Venting and vacuum exhaust

The controls of each subsystem have to be implemented on an independent PLC network, exchanging information with the rest of the subsystem on a higher communication level.

At LNL we need products commercially available from manufacturers in a leading market position, able to follow the PLC technology evolution and having a good chance of steadily being on the market in for at least 5-10 years, to assure availability and support of their products for such a period of time.

The main technical items to be considered for the PLC are the general purpose character of PLCs in the selected brands, the available communication protocols (standard TCP/IP and industrial fieldbus), availability of special safety components and software issue.

General Purpose PLCs

The manufacturers should have experience in a large variety of control fields (electricity, water, gas, cryogenics, cooling, ventilation and safety systems), to assure the general purpose character of their products. The product lines should cover different categories of products, ranging from the large-size units down to the small size units and very simple I/O modules.

Safety

Some LNL control systems, controlled by PLCs, have to work as safety systems. Thus, the PLC manufacturers' catalog should include a line of products conforming to European safety standards and give strict instructions for safe installations, configuration and safety certificated programming.

The final whole PLC control system have to satisfy the safety regulations and, in this way, be assigned to a safety performance level defined by the standards EN 62061 (Safety Integrity Level) or EN ISO 13849-1 (Performance Level) according to the risk analysis.

Recommendation

A recommendation is here set limiting the choice of PLCs to be used at LNL in the next 5-10 years to two PLC manufacturers satisfying the required commercial and technical qualification criteria.

In the choice is considered also the use of PLC in projects and items strongly connected to LNL and SPES as IFMIF, ITER, BEST_Cyclotron (the firm delivering the 70MeV cyclotron for the proton driver of SPES)

The recommended brands for future LNL PLC-based slow control solutions are:

- **SIEMENS as primary brand and safety applications**
- **SCHNEIDER for general purpose applications.**

9.4.2 General software and communication requirements

TCP/IP Communication

In order to connect PLCs to the LNL controls data network, it is highly desirable the availability of a standard Ethernet interface: TCP/IP suite of communication protocols, at least by an OPC server. Proprietary protocols are not acceptable, if they are the only available connection protocol.

Standard Fieldbus

It is highly recommended that the PLC manufacturers offer interfaces to at least one of most common industrial fieldbus:

- Modbus
- Can
- Profibus

CAN, is limited in its transmission distance but is suitable for use in experiments and inside buildings while Profibus can transmit over longer distances and may provide solutions for inter-building communication links.

The bus has to be chosen in order to be compatible with the local supervisor communication protocol as well as with the EPICS Channel Access gateway available devices.

If it is necessary to use another bus outside this list, it must be well explain the reason for this choice and it must be guaranteed that suitable local supervisor and EPICS Channel Access solutions are available.

Standard software

In order to limit investment in software, the PLC programming should be done according to the IEC 1131-3 standard languages. LNL should negotiate, with the selected PLC manufacturers, site license for the development environment, for the target environment and for software maintenance.

OPC Server

All LNL control systems will be interconnected. An OPC (Open Process Control) Server is a software application that acts as an API (Application Programming Interface) or protocol converter and allows connection to a PLC and translation of its internal data into a standard-based OPC format. OPC compliant applications such as a SCADA (Supervisory Control And Data Acquisition system - Epics can act as a SCADA) can connect to the OPC Server and use it to read and write device data. Proven quality OPC servers should be available for the selected manufacturers’ PLC product lines.

9.4.3 Administrative and Commercial Support

In order to support the usage of the recommended PLCs, commercial and administrative support (site agreements) should be set up, for the PLC products from the recommended manufacturers: centralized negotiation and purchasing procedures should be set up for PLC equipment to be purchased both directly by LNL personnel and via industrial contractors. For the development and target software LNL site licenses should be negotiated with the selected PLC manufacturers.

9.4.4 PLC software development guidelines

The PLC software have to be developed using one of the standard programing languages listed on the IEC 61131-3 international standard:

- Ladder diagram (LD)
- Functional block diagram (FBD)
- Structured text (ST)

Basic program structure

For each PLC, the program must be divided into functional sections in order to be clear and easy to read. Each section has to perform the control of as specific part of the control system. It has to have an input, a calculation and an output well defined parts. Clear comments have to be present on all the parts of the program describing its operation.

Variable name convention

The variable names have to be selected in order to clearly show at which part of the control system they belong. The name sections have to give hierarchy information about its position on the system: the first part represents the control subsystem followed by the part within the subsystem and finally the element where it acts. The parts of the name have to be separated by underscore ("_"). For example: VACUM_PUMP01_STAR ACCESS_DOOR05_SWITCH01.

Data exchange with supervisor

The PLC internal memory access has to be set in order to only permit reading and writing operation from the supervisors to the variables that are allowed to been seen or written from the user. All other internal variables have to be protected and cannot be possible to modify them from the outside world.

PLC internal memory distribution and variable allocation

The PLC program has to use two kinds of variables: non allocated variables for internal calculations or process, and allocated variables that allow the system to read and write information to the supervisors.

Each part of the control subsystem has to have a memory block assigned to it for the allocated variables. This memory block has to be divided into: input commands from the supervisor (operation selection), output status information to the supervisor and alarms (status, acknowledge and reset).

A recommend layout is to use 100 memory spaces for each part of the control system from which the first 20 are used for input commands, the next 60 are used for output status and the final 20 are used for alarms. For example: memory 505 could be the power on command for a power supply, 745 could be the threshold status of a vacuum measure and 285 could be a temperature alarm status.

Write-protected software section

Only the memory locations that are used for input command from the supervisor have to be set as write allowed locations. All the rest of the memory has to be configured as read-only memory. Moreover, variables that are not intended to be used as input or output information to the supervisor are advisable to be left as not allocated (to prevent accidental external access).

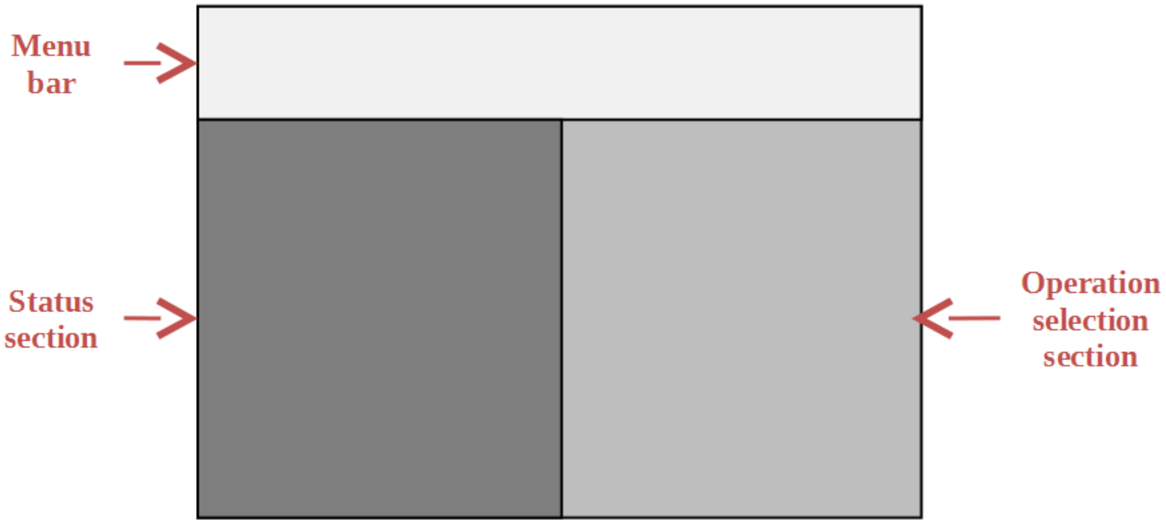
It is also recommend when possible, to specify the allow supervisor devices that have write privilege to each variable.

9.4.5 Local Supervisor development guidelines

It is highly recommend the use of local supervisor on each subsystem. They can be either touchscreen panels or standard PCs using supervisor software. It should present status information to the user and, when possible, it should let the user select some operations to be performed by the control system.

Basic panel structure

Each panel on all supervisor consoles (either touchscreen panels or PCs with supervisor software) should be divided as presented on figure 9.2. At the top of the panel there is a menu bar which allows user to navigate to all different panels present on the supervisor system. In the bottom left there is a status section where the relevant information of the respective subsystem status is present to the user. Finally, on the cases where there is possible for the user to select some operation to be performed by the system, there is a section for it on the bottom right part of the panel; if no operation is allowed to the user then this part of the panel is an extension of the status section.

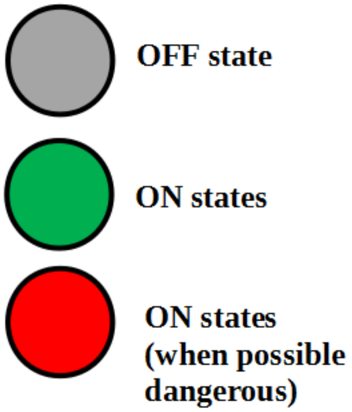


Basic panel structure on the supervisor system.

Color convention

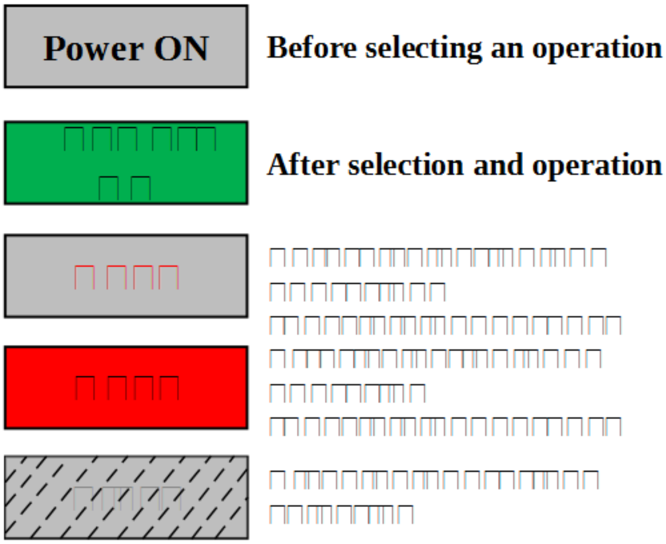
The background of the panels has to be selected in order to allow a clear visualization of the elements on the panel. Dark blue is suggested.

For binary status representation it has to be used LED type elements which have to be GREY when the state if the variable is OFF and GREEN when the status of the variable is ON. If the ON status represent a possible dangerous status (alarm, ON state of a high voltage power supply, an abnormal status of an element, etc.) RED color has to be used instead of GREEN.



Binary status representation elements.

For operation selection elements, it has to be used push buttons elements. The button has to be of color GREY when in the OFF state. Once the respective operation is selected it has to change its color to GREEN. If the selected operation represents a possible dangerous status (power ON a high voltage power supply, open an element, etc.) RED color has to be used instead of GREEN for the selected status and also the description text on the button has to be RED before the operation selection. When the operation selection is disabled it has to be evident to the user.



Operation selection elements.

User privilege management

The supervisor system has to provide a user identification mechanism by login. Two or more user privilege level could be implemented depending on the subsystem. The supervisor system will present to the user only the status and operation that he is allowed seeing and/or writing depending on his privilege.

All the information about user login time, name, location, operation performed, etc. have to be logged by the system.

Alarm handling

The supervisor system has to present one or more panels for the presentation of alarm status to the user. Furthermore, when the alarm type requires it, it can be present as a float element on other panels in order that its presence is clear to the user. For the alarms that need to be acknowledged or resettled, there have to be presented appropriate buttons for it.

All the information about alarms status, type, durations, acknowledgments, etc. have to be logged by the system.

9.5 The control of accelerator equipment

9.5.1 General criteria for hardware selection.

As general rule, all control devices - except those based on PLCs - should be natively implemented as EPICS compliant controllers (IOCs). The practical realization will depend on requirements of a specific application in terms of number of I/O channels, interface type, response speed, etc.

General guidelines for hardware selection can be summarized as follows:

- in control applications dedicated to a single instrument or a group of devices localized in a small area, usage of embedded controllers is highly recommended. These devices will have a network connection and no mechanical disk. Flash memories in SD or MMC cards or similar types of solid state storage will be used as booting devices. Such controllers should operate under a small-footprint operating system, tailored to provide the essential services to support the IOC functionality. The embedded controllers should be fan-less: because of this, low power consumption should be privileged over the computational performance in processor choice.

- in applications involving a high number of I/O channels, VME computers should be used for IOC implementation. Usage of CPU modules based on PowerPC processor is recommended because of their architecture optimized for Ethernet communication and their exceptional performance/power ratio. The crates should be VME64x compliant to allow an easy installation of expansion cards and adapters on the rear backplane. The VME power supplies must be pluggable units to facilitate maintenance. Also the cooling fans will be housed in pluggable modules, their operation must be monitored and information on their status must be available remotely.

- VME computers should also be the natural platform for controls where a fast, deterministic response to some event is a strict requirement. In this case, the fast response is achieved when the CPU operates under a true real time OS. Vxworks is recommended for such kind of applications.

9.5.2 EPICS software: architecture and tools

A common software platform definition is the preliminary and essential step in control system development, since it provides the necessary references to software designers and hardware integrators. As minimal target, the key points that need to be fixed are:

- the IOCcore (Epics Base) software release for all IOC implementations
- operating systems suitable for IOC hosting, together with the OS releases: a list of compatible versions must be explicitly indicated to assure consistency in software validation tests
- selection of Epics Extensions available for Client-side applications. This category includes tools for graphics development, alarm management, data archiving, etc.

Device Support modules: a huge number of drivers is available from user community. Although the quality of such modules is in general good, they should be carefully tested and a list of validated drivers should be created.

According to the above considerations, some basic decisions were taken and can be summarized as follows:

- Epics Base release: R3.14.11
- Operating systems for IOC implementation:
- Linux Debian for embedded controllers
- Vxworks 6.8 on PowerPC targets for real time applications
- Linux CentOS for generic instrumentation using asynchronous serial interfaces
- Epics Extension for Client applications:
- CSS (SNS version) for GUI development and the
- Alarm manager configured as CSS plug-in

- Channel Archiver working in conjunction with MySQL on Linux server
- Device support for integration of PLCs into the Epics control network: OPC server (decision still pending, tests are in progress with Siemens Simatic Net OPC)

A complete list of device support can be found in [1]:

9.5.3 EPICS software development guidelines

To improve the software development and maintenance of the control system it is necessary to follow guidelines as reported in [2].

The SPES EPICS Software Platform configures important rules to be followed for development in the EPICS environment.

It covers developments of:

- EPICS applications for VxWorks IOC
- EPICS applications for Linux IOC
- EPICS stand-alone applications for Linux
- EPICS CSS panels

These rules must be followed carefully to guarantee the software maintenance. They are based on SPES Target Laboratory experience of developing for EPICS, and the standardization used at CEA-Saclay in the IRFU/SIS/LDISC by Yves Lussignol, Jean Francois Gournay. They will ease the integration of the sub-systems software on the final SPES site.

The SPES Software Platform and the □□□□□□□ development tree are the basic EPICS components already available for developers.

The package □□□□□□□ is an EPICS Top Directory specifically designed for the control system of the SPES. It must be used for development area on developers' systems as well as for installation directory on the control system servers.

Modules must be created with the EPICS command □□□□□□□□□□□□□□□□and the template type **spes** designed for the SPES software. Support Application and IOC Application templates are provided by the package □□□□□□□□□□□□□□□installed with the EPICS Support.

Developers must keep the following rules when creating a module:

1 Make sure with the project manager that the module name is not already used.

2 The name of every file which must be installed in the top sub-directories has to begin with the module name. This rule concerns all the files going into src, db and gui directories.

The package □□□□□□□□□□□□□□□contains the Support Application and IOC Application templates for the SPES software. These templates are designed to work with the EPICS command □□□□□□□□□□□□□□□. The Top Directory package □□□□□□□□□contains the necessary □□□□□□□□□□□□□□path that allows □□□□□□□□□□□□□□□□to find these templates.

These templates aim to provide standard containers to develop SPES IOC software. To be effective, all the IOC applications for the Control System of SPES should be based on these templates.

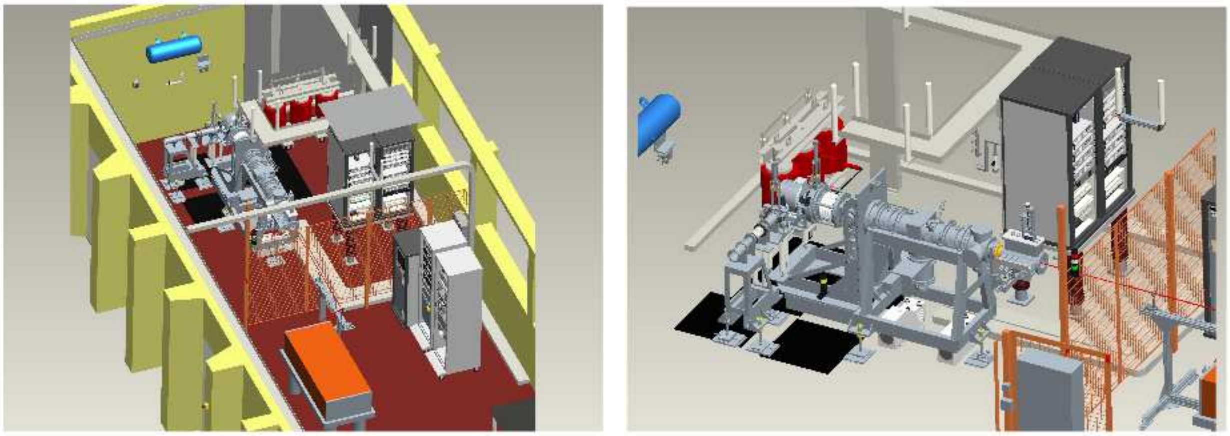
Additional and extensive rules are available in ref [2] covering the Graphical User Interfaces development with panel and color rules.

9.6 Safety control system for the SPES Off-Line FrontEnd Laboratory at LNL

A safety control system for the off-line laboratory of SPES was developed and installed to allow the operation of the laboratory and as a prototype for a (cabled) safety application.

It has been designed using self-controlled safety modules and applying redundancy for achieving a PL e/Cat. 4 (EN/ISO 13849-1) and a SIL3 (EN/IEC 62061) safety level. The safety modules used are from the Schneider Preventa XPS Safety Relay family.

The laboratory hosts the front-end equipped with target, ion source (both surface or plasma ionization and laser activated), beam transfer, HV platform, wien filter, laser and associated electronics, diagnostics and data acquisition. It is divided into two areas: controlled and open divided by a metallic net with access door. A drawing of the laboratory is in figure 9.5.



[illegible] *off-line front-end laboratory (wien filter is missed, it follows the beam line inside the controlled area)*

The system controls the following sub-systems:

1. high voltage power supply
2. target complex heating system
3. target chamber handling system
4. LASER system

Each sub-system is powered using a series of contactors. A safety module monitors one safety condition and then controls a series of two contactors accordingly. When the safety condition is on the safe state, the safety modules close both contactors powering the system; if the safety condition is not on the safe state, the safety module opens both contactors switching off the sub-system.

On each system could be more than one safety condition to be monitored, in this case a safety module and a couple of contactors are used for each condition. The safety conditions for each system are:

1. High voltage power supply
    a. Access doors status
    b. Emergency push buttons

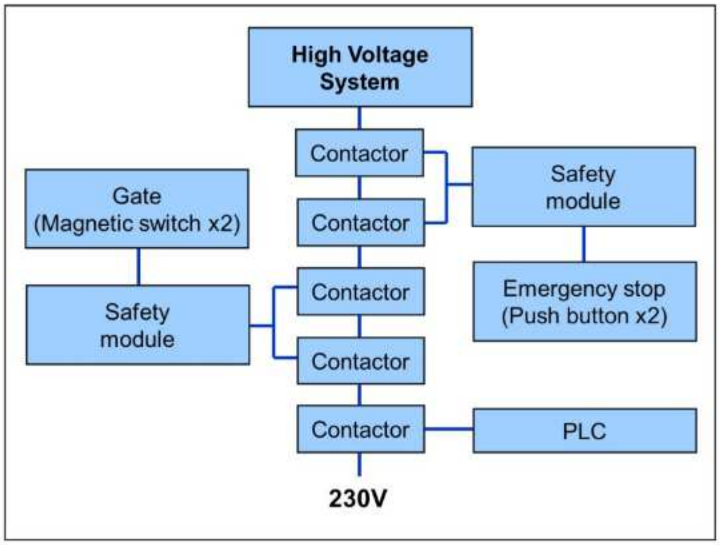
2. Target complex heating system
    a. Emergency push buttons

3. Target chamber handling system
    a. Emergency push buttons
    b. Personal near the movement elements (detected using safety mats)
    c. Two hand controller

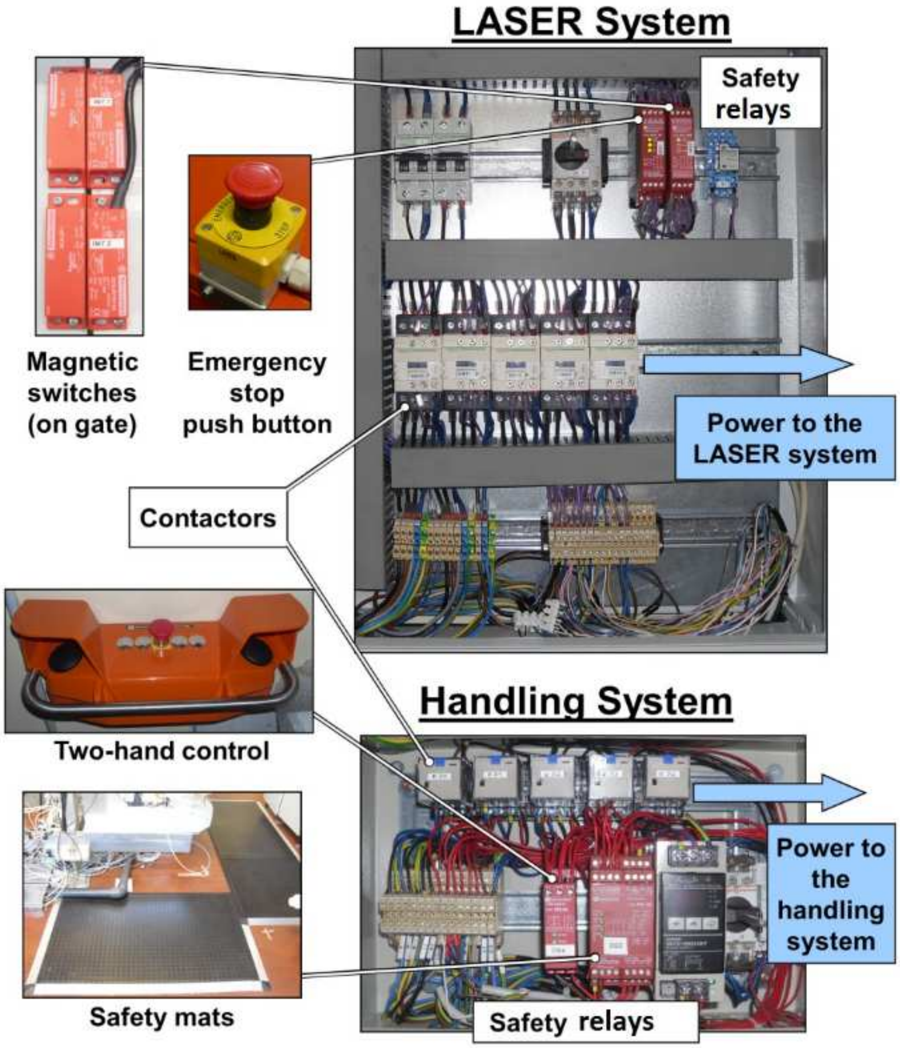
4. LASER system
    a. Access doors status
    b. Emergency push button2

Additionally to the safety functions, an extra contactor was added to each system controlled by a conventional PLC. This allows the user to effectively power on the system when all the safety conditions are reached.

Figure 9.6 shows as an example the safety control system for the high voltage power supply, while figure 9.7 shows a picture of the control system for the LASER and target chamber handling systems.



[illegible]: *High voltage power supply safety control system scheme.*



[illegible] *Safety control systems for the LASER and target chamber handling systems.*

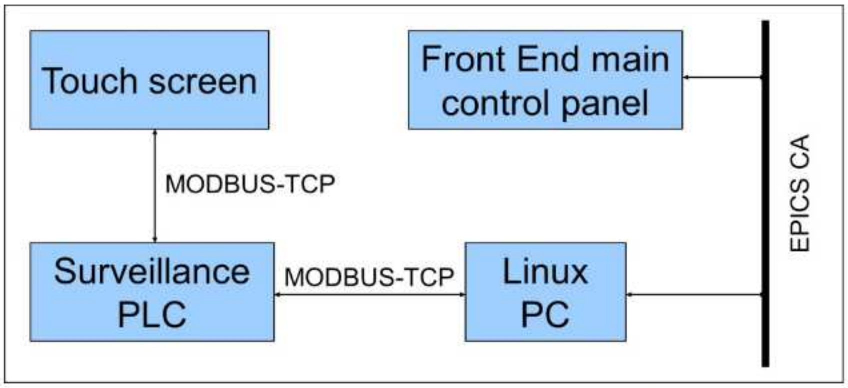
The laboratory control system is finally equipped with a surveillance system carried out by a conventional PLC (Schneider Modicon M340) (figure 9.8). The scheme is shown in Figure 9.9.

Nevertheless a conventional PLC is used, the system is classified as a “safety system” as the PLC operates as supervisor only and the safety functions are embedded into the safety relays.

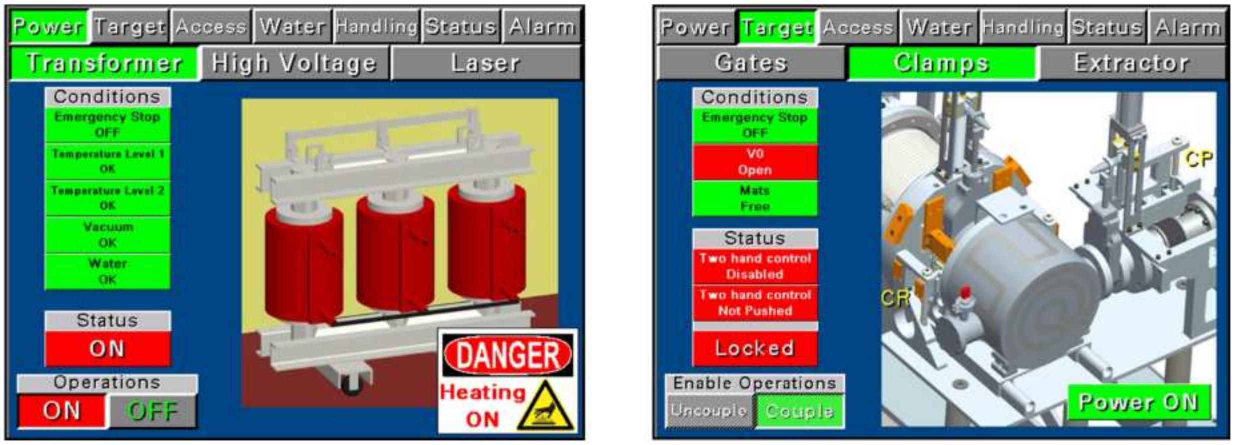
Locally, the user is able to control and see the status of the system using a touch screen interface (Schneider Magelis XBTGT533) (figure 9.10). On the other hand, sn EPICS IOC (Input Output Controller) implementing a home-made MODBUS-TCP driver was developed in order to interconnect the system to the Front End control system (based on EPICS). This permits to present the status of the system on the Front End main control panel (figure 9.11).

The IOC was implemented on a Linux PC using two Ethernet interfaces: one is used for the PLC communication (MODBUS-TCP) and the other one is used for the EPICS communication (Channel Access). On the other hand, the MODBUS-TCP driver was developed using the “StreamDevice” device support for EPICS.

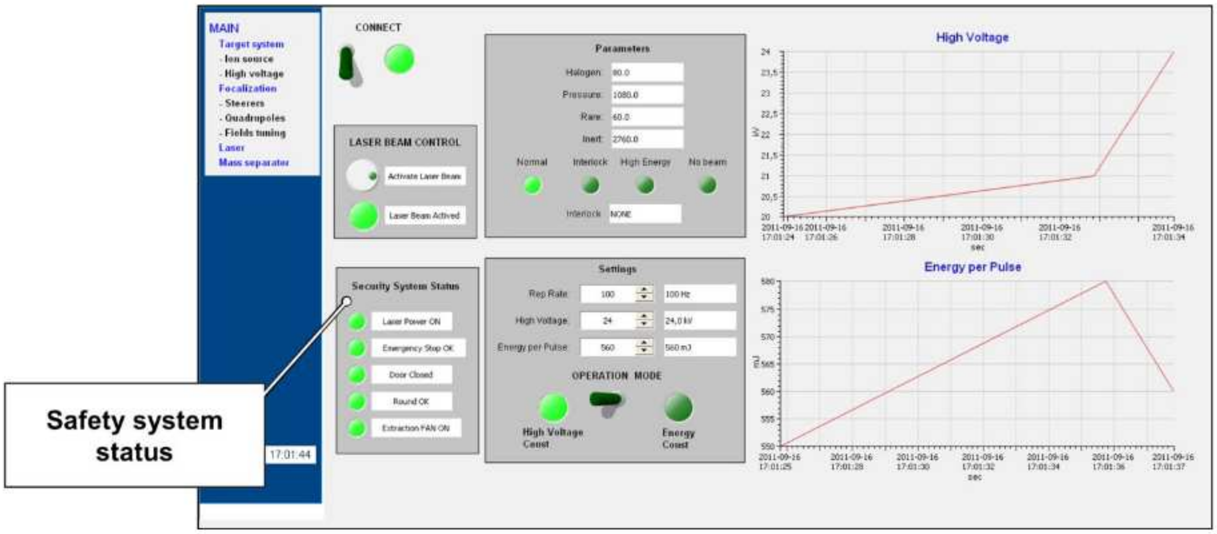
[illegible] Conventional PLC used to power on and off the systems and to monitor the status of the safety control system.



[illegible]: Scheme of the safety control surveillance system.



: Local surveillance panel on the touch screen device.



Halogen: 80.0
Pressure: 1080.0
Rare: 60.0
Inert: 2760.0
Interlock: NONE

Rep Rate: 100 — 100 Hz
High Voltage: 24 — 24,0 kV
Energy per Pulse: 560 — 560 mJ

Safety system status

: Remote surveillance screen on the Front End main control panel.

9.7 New EPICS controls under implementation at ALPI accelerator

9.7.1 RF System.

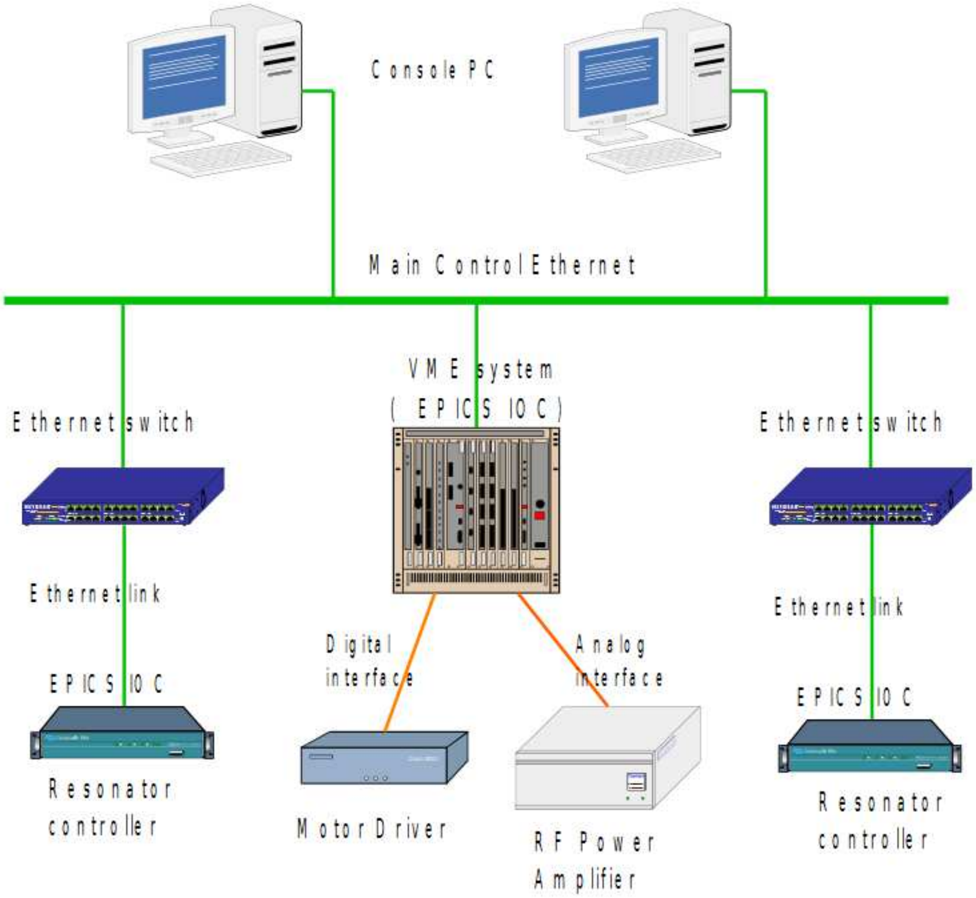
The RF system now in operation in ALPI and PIAVE is based on analog resonator controllers equipped with serial interface. The controllers are connected to VME systems that support the communication with the higher level software (operator interface) and provide the control of power amplifiers and other ancillary equipment (motor drivers, etc.).

The upgrade of RF system is intended to achieve two important goals:

1. have a better precision and thermal stability in cavity locking

2. migrate the control software towards an open architecture (EPICS) that will allow sharing data across different subsystems.

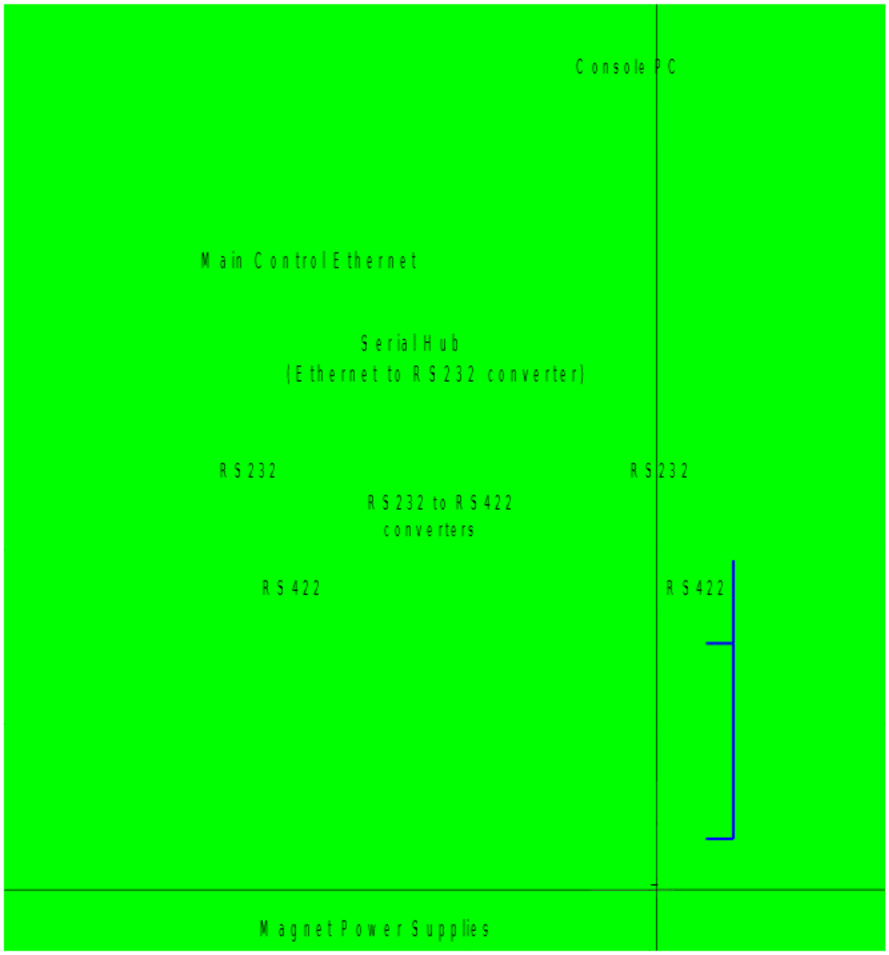
The key of this enhancement will be the realization of a new Resonator Controller based on a fully digital design. The module will be embedded in a single board with a high performance FPGA and will have a local processor to provide Ethernet connectivity. The controller will include all features necessary to implement an EPICS IOC (Input Output Controller). After the necessary software remake, the VME systems will continue to provide, as EPICS IOCs, the control of power amplifiers and motors.



[illegible] *Planned layout of RF Control system*

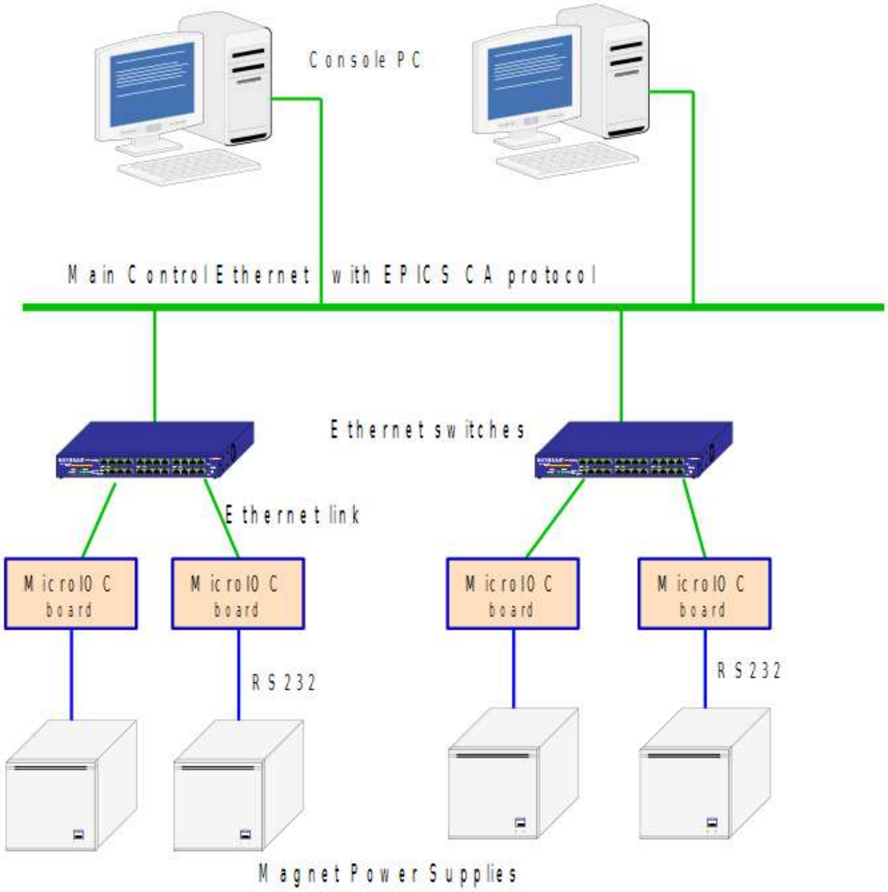
9.7.2 Magnet control system.

The magnet control system is currently based on a single PC that manages a set of almost 100 power supplies equipped with serial interface and configured in small groups of RS-422 segments. The data access is accomplished by a number of Ethernet-to-Serial hubs dispatching commands and data sequentially, with the capability of focusing the control on one power supply at once (see Fig. 9.13A).



Current layout of magnet control system.

Our plan of control migration to EPICS requires a deep change in the software architecture and hardware solutions. We foresee using a low cost microprocessor board for each power supply (or for a limited group of supplies) that will provide the capability of running the EPICS IOC software together with the Ethernet-to-RS232 interface translation. This approach will make the magnet control accessible to a non-restricted number of console PCs and their data available to the EPICS high level utilities (i.e. the Archiver). The availability of controller boards based on ARM processor makes this solution viable at a low cost. The Fig. 9.13B shows the new scheme of magnet control system.



Planned configuration of magnet control system.

9.7.3 Beam Diagnostics

Basic beam diagnostic with beam profile reading by grids has been upgraded starting from the standard ALPI beam diagnostic and implemented with a control system interfaced to EPICS. The new electronics was tested at the SPES off-line laboratory and installed in the PIAVE accelerator accomplishing the migration to EPICS. The new software makes use of existing hardware with minimal changes only. The same scheme will be replicated for ALPI and put in operation within summer 2013.

References

[1] reference....
[2] reference....