THE CONTROL SYSTEM OF SPES TARGET:
CURRENT STATUS AND PERSPECTIVES

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Abstract

The new project of a facility for the Selective Production of Exotic Species (SPES) [1] is starting at LNL. The neutron-rich nuclei will be produced by impinging an UCx target with a 70 MeV, 200 µA proton beam delivered by a commercial cyclotron. The construction of the Target Laboratory, the most innovative and critical part of the entire facility, is at advanced stage and its control system is being developed using EPICS. We present the status of the Target control system and describe the overall architecture foreseen for SPES.

THE SPES TARGET

The Target is based on a novel concept of multi-disk device, optimized from the point of view of dissipated power and release time of produced fragments. Fig. 1 shows the target structure: splitting the target into several disks increases the thermal surface and consequently the power dissipated by thermal radiation, thus simplifying the requirements of cooling system. According to the simulations, the target will be able to sustain a beam power of 8KW; under this condition we expect a production rate of 10^{13} fragments/s, which is adequate for the planned experiments with radioactive beams.
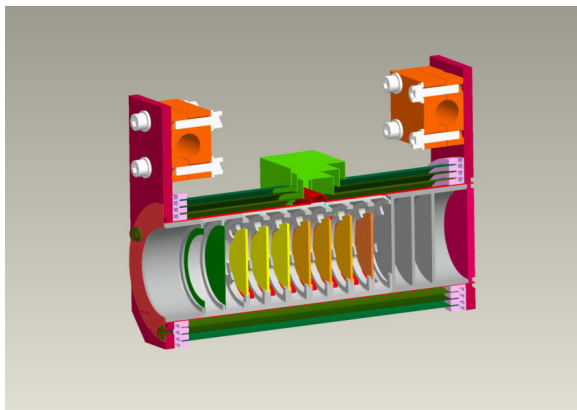

Fig.1 Target multi-disk structure.

The target is integral part of the Ion Source, that is of surface ionization type, with the possibility of including a laser to improve selectively. Being the realization of the target at a still experimental stage, a Target Laboratory has been setup as a test bench facility, to measure the physical characteristics of its components and verify the operation of associated instruments. In this sense, it also constitutes a test bench for SPES Control System, since SPES will replicate the same architecture and use the software tools we are currently using in the control of the Target Laboratory.

THE TARGET CONTROL SYSTEM

The control system includes two main classes of devices: those concerning the beam production, selection and transport and those related to safety. Safety has a crucial role in the control system due to the high radiation levels in the target and ion source area and the design criteria must comply with the specifications foreseen for nuclear installations. PLCs will be widely used in all safety applications since these devices are specifically designed to guarantee a high availability under harsh operating conditions.

EPICS was chosen as general framework to develop SPES controls because it is hardware independent, open-source and well supported by a wide collaboration of scientific Laboratories around the world. As result, all SPES subsystems, including those based on PLCs, will be integrated under a common communication layer based on the high performance Channel Access protocol.

PLC Based Applications

PLCs are currently used in the prototype of Target Laboratory for the control of vacuum pumps and personnel access. (It's worthy to mention that this Laboratory is not intended for tests with UCx targets due to the absence of adequate shielding; therefore the PLC technology and architecture we are using now for preliminary tests is not designed to provide the high security levels required for future operation and may differ from that we'll use in the final control system implementation).

The vacuum system control has been developed using an MBX P340 2020 PLC from Schneider Electric. This system consists of four pumps, 10 valves, six vacuum meters and a touch screen monitor. The touch screen is remotely connected to the CPU through a serial bus based on MODBUS protocol, while the pumps, valves and vacuum meters are locally connected to the PLC I/O modules. The PLC also controls the status of gates in the ion source area and provides interlock signals to the

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power supplies feeding the HV platform on which the target is installed.

PLC integration in the EPICS network will be carried out using the drivers developed in some Laboratories and made available to the user community[2]. This method consists in having a standard Windows PC acting as an IOC server: it accesses the data from the PLC memory and exposes them to the Channel Access.

EPICS IOCs

Most of instruments installed in the Target Laboratory are controlled by EPICS IOCs. They are either Linux PCs (CentOS distribution) or embedded controllers (microIOCs by CosyLab). We also plan to use VME IOCs based on Vxworks for applications demanding real-time response (i.e. the beam diagnostics system).

The devices currently in operation are the LAMBDA (GENESYS series) high current power supplies used in the target heating system, the ULTRAVOLT HV power supplies driving the electrostatic deflectors used for beam transport and the FUG power supply feeding the HV platform. We give here a brief description of these applications.

The GENESYS power supplies deliver the high current (in excess of 1000 Amps) necessary to bring the target to the optimal temperature for ion's extraction. There are 4 modules connected in parallel, with one acting as group master; the link to the computer is of RS232 type. The IOC is a Linux PC and the device driver is a modified version of that developed at PSI, based on Stream[3] Device support which, in turn, is layered over ASYN[4].

The ULTRAVOLT and FUG power supplies have analog interfaces and are managed through CosyLab MicroOICs. These controllers are embedded PC104 units with a configurable set of I/O cards; they come with Linux Debian preinstalled on the flash disk and a ready-to-use Epics software complete with all the necessary drivers.

The Control Network

The control network is designed to provide an adequate level of security against unauthorized access from the LNL general network. The firewall function is provided by a Linux PC that implements a VPN (Virtual Private Network) with the following additional functions: DHCP server, DNS server, NAT configuration, HTTPS web interface, Web antivirus and intrusion detector. Other key elements of the control network are:

- a node dedicated to run Nagios [5], a software tool that monitors the network services and the status of IOCs and dispatches alarms messages in case of malfunction detection.

- a shared NAS (Network Attached Storage unit based on X-RAID technology) to backup the applications and data of all Linux IOCs and OPI machines in the control network.

- a dual node redundant server (DRDB) to store the OS images of control machines and provide an automatic restoring capability from catastrophic failures.

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- a MEDIAWIKI server to keep a consistent documentation of software development, installations, user guides, etc.

The Operator Interface

As well known, Epics offers many tools to create user graphic interfaces. The traditional tools based on Motif (i.e. EDM) provide a very fast way to test application prototypes but probably they aren't the best solution for the design of a new control system. We tested with appealing results from the point of view graphic rendering (see an example in fig.2) an alternative approach based on LabVIEW. A solution to use LabVIEW as Channel Access client on Windows PCs has been developed at SNS and made available in form of a DLL library that supports the exchange of data with a VI throughout a shared memory block. A different method consists in using "network shared variables" (as defined by LabVIEW terminology); NI committed itself to support this technology and included Epics Client functionality in the LabVIEW 8.6 distribution. More general and modern tools are based on Java; the most known and feature rich is CSS (Control System Studio)[6] originally developed at DESY and now supported by a collaboration of many Laboratories, including Los Alamos, SNS and Argonne National Laboratory. We plan to start testing CSS within the current year
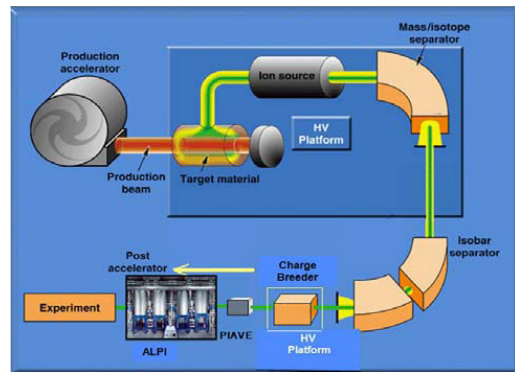

Fig.2 Example of a GUI based on LabVIEW.

The Archiver

To store data collected during tests we are using the well proven EPICS Channel Archiver. At this moment, the PV number doesn't exceed one thousand, but it will increase quickly as soon as we'll add the new beam diagnostics instrumentation.

CONCLUSIONS

The work carried out for the control of the SPES Target prototype has been an important test bench to verify the validity of the software architecture proposed for the entire facility. A few issues still remain open: a very important one is the realization of a comprehensive documentation of EPICS databases loaded in all IOCs.

To this purpose, one of next steps will be the installation of IRMIS[7]: this work is planned by spring 2010.
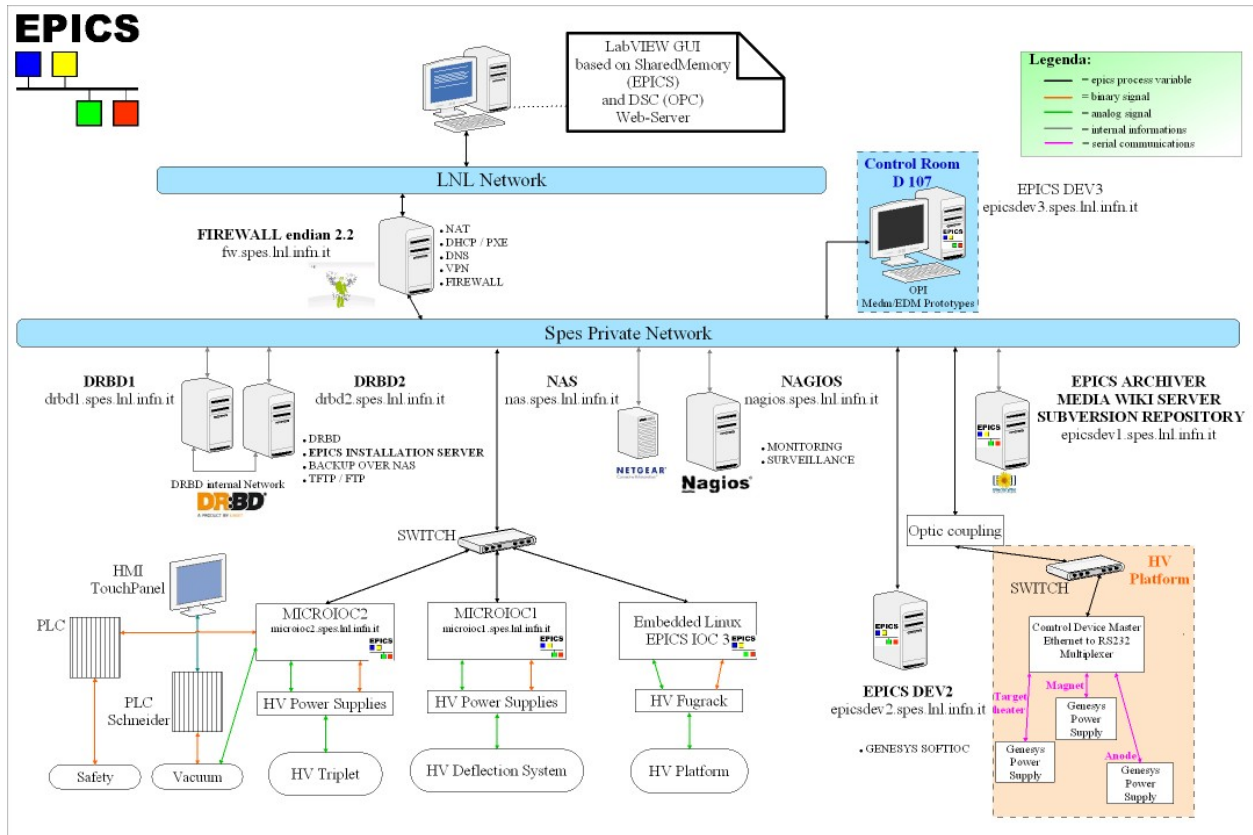

Figure 2: Layout of Target Laboratory control network.

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[2] http://epics.web.psi.ch/software/s7plc/.

[3] http://epics.web.psi.ch/software/streamdevice/.

[4] http://www.aps.anl.gov/epics/modules/soft/asyn/.

[5] http://www.lnl.infn.it/~epics/NAL.html.

[6] http://css.desy.de/content/index_eng.html.

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