SOFTWARE TRENDS FOR BOTH THE GANIL & SPIRAL CONTROL

L. DAVID, E. LECORCHE AND THE CONTROL GROUP

Grand Accélérateur National d'Ions Lourds

BP 5027 14076 CAEN CEDEX 5 FRANCE

The Ganil facility has been running with a new control system since 1993. Many improvements have been done since that time to bring new capabilities to the system. So, in February 1996, when the Spiral control system was designed, it was mainly considered as an extension of the Ganil control system.
This paper briefly recalls the basic architecture of the whole control system and the main choices upon which it relies. Then it presents the new software trends, to show how the Spiral control system has been integrated alongside the existing one.
The last part describe the new developments and the most significant functionalities it brings as seen from the operator point of view, with some emphasis about the application programs for beam tuning.
Indeed, these new programs have to be provided both for the Spiral tuning with exotic ions beams and for the coupling of the Spiral and older Ganil facilities.

1. Control Environnement

The addition of Spiral was made without changing the main basis of the GANIL control system, to be able to command all the pieces of equipment in the same way.
These hardware devices have been upgraded and new software components have been added to improve the facilities of the whole system.

1.1 Computers and network

The renewal of the control room, now common, has allowed us to install three more operator stations, so there are fifteen operator workstations for the beam tuning :
3 for the main control, 2 for the ion sources, 3 for tests, 2 in the technical areas, 2 for the Spiral control and 3 for the experiment rooms control.
Two alarm screens have also been installed, with another one to survey the slow variations of the ion beam intensity or phase.
This extent of the cluster needed a best fiability, got with a new raid array set of disks.
This storage subsystem is made of 24 disks, each one 2 or 4 Gbytes, used in raid shadow and connected to the alpha servers by Fast Wide SCSI 20 Mbytes/s links.
The Alpha servers have been upgraded with new 400 Mhz CPU chips and with Fast Ethernet 100 Mbits/s network controllers.
These connections are centralized into a network crate with a 1.2 Gbytes/s backplane bus using bandwith switching.
The slots inside are now switches but no more hubs, so the links between the main crate in the control room and the remote crates in the electronic rooms are optic fiber 100 Mbits/s.
There is a remote switch reserved for Spiral, two for the main cyclotrons and beam lines and one for the injectors.
For the Spiral control, 6 VME crates are connected to the switch with a private UTP 10 Mbits/s link for each one, but the other crates are still connected with coaxial wire.

1.2 Software specifications

To help the software programs development and to present the same graphical user interface for the operators while tuning the Ganil or Spiral beam, the programs have been modified so they can control both the existing separated sectors cyclotrons and the new Spiral magnets and diagnostics.
However, they detect if the calling workstation is dedicated to Spiral or not, and they allow beam tuning only on the corresponding devices.
These Spiral devices have been added in the same database as the older ones, but with new device drivers like the new Jbus motor controllers.
The Spiral installation added 600 new devices, all controlled by VME crates, so the total number of devices is around 3000, but there is never both Ganil and Spiral devices controlled by the same VME crate.
The beam parameters database has been seriously modified to be used both by Ganil and Spiral and a new release of Ingres has offered more SQL functions (SQL92).

2. Object Programming

2.1 Objects classes

For the Spiral control, the new object method used for the "set parameters" program has been extended to all the programs, allowing us to be ready in time for the first tests.
The old programs use a different procedure for each type of device : power supplies, motors, propellers, diagnostics, NMR probes and so on.
Each procedure translates the operational name of the device, connects the program to the VME crate, and reads or writes values in the device.
With the object classes, we can now define the same entities as the ones used by the beam tuning : dipoles, steerers, emittance slits, radial probes, ...
So the dipole object recognize the set command, like a power supply, but also the cycle command and the NMR

measurement to know his magnetic field, all commands that are not available on a mere power supply.

In the same way, the radial probe object recognize the « set to ejection » command to look at the ejection area inside the cyclotrons, although the motor cannot because it is also used for the emittance slits in the beam lines.

These objets can all archive in database or store in memory their own values when the operators want to save the beam parameters.

2.2 The graphical Editor

While developing beam tuning programs, the graphical interfaces become more and more consuming in time, and it was mandatory to use a commercial tool for them. So the same graphical interface is available for the same class of devices in different programs, instead of writing it again each time. And when one interface changes, this change is immediately transmitted to all the users programs without any more action.

In fact, the Builder Xcessory editor is used to create the static part of the graphical interfaces (size, colors and position) and the "callback" procedures that are called by a click on a widget.

The animation side is made by the program itself, depending on the operators' actions and the results from acquisitions.

2.3 Graphical Objects

For each object class, a graphical panel has been created and associated to the software procedures.

So when an object is called, the corresponding panel is created and displayed on the screen, and the enable actions (the object properties) can be realized and displayed on this graphical panel. For example, when a probe is called, its position will be automatically displayed on its panel and also transmitted to the calling program.

Several graphical objects are now available:

The probes
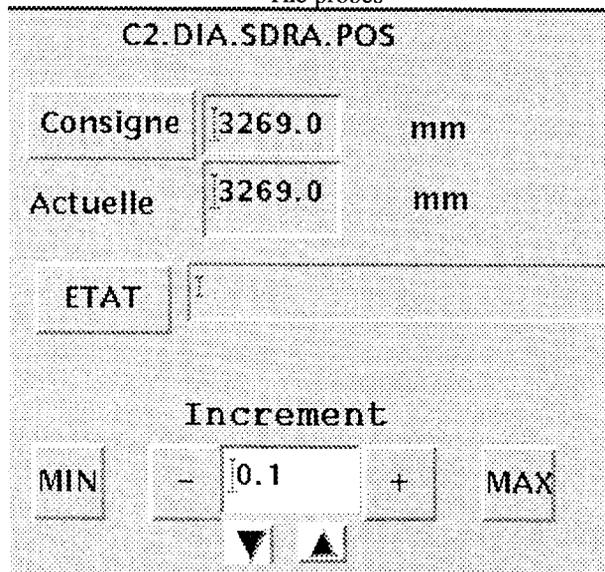
The magnets
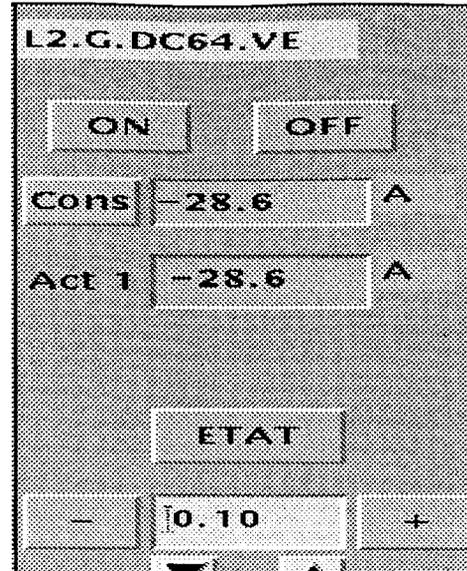
The power supply can be set on or off with two push buttons. The keyboard value is sent to the power supply, and the real read value is displayed into a text field just underneath.

The push buttons (+) (-) can increase or decrease the current, and the increment value is managed by the two arrows.

The profile monitors
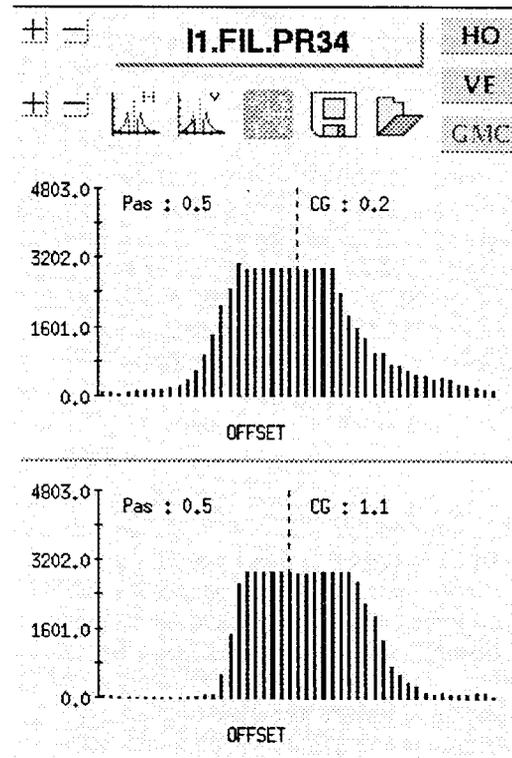
The horizontal and vertical profile monitor are displayed and their scale can be changed with the (+) or (-) push buttons. The shape can be frozen at any time, to be compared with the real time variations, and the HO or VE button displays the numeric values such as the center of gravity, the width ...

3. Beam Tuning Programs

3.1 Source Analysis

This program changes the magnetic field in the first dipole of the injection line, or the high voltage of the ion source.

A beam intensity measure is performed during this time, either on a profiler or on a faraday cup, and a spectrum of all the ions created is displayed.

The program can highlight the position of a special ion, with its mass and charge, so we can be able to know if this kind of ion is present in the ion source.

3.2 Transverse Matching [1]

This program realizes the automatic matching, by sections, of the transport beam lines. The three profile monitors and the four quadrupoles of each section are displayed, and a second window indicates the appropriate beam size ratio. The matching algorithm can be launched and the calculated values of the quadrupoles are displayed. The operator can set the values in the power supplies or store them to try a new calculation with different parameters. The characteristics of all the matching sections are stored in the database and dynamically modified, according to the optic which is used.

3.3 Emittance

This program sets to calculated values the six motors of each emittance slits along the beam lines. The algorithm parameters can be changed to compare the emittance set with another one.

3.4 Beam centering

This program realizes the automatic centering in the beam transport lines . The center of gravity of each profile monitor is measured [2], the tranfer matrix calculated and then the corrections are sent to the dipoles and steerers.

3.5 Cycling

This program sets to parameters values the power supplies of the dipoles, and all the trim coils of the cyclotrons, taking care of the $\Delta I / \Delta t$ and the steps to get rid of the hysteresis problems. While the current is increased in a power supply, a graph $I=f(t)$ is displayed inside a secondary window.

3.6 Isochronism

This program measures the variations of the beam phase in the cyclotron then calculates the magnetic field modifications and the corresponding differences of current intensity that must be set in the trim coils to get an isochrone field. It can also use the NMR probes inside the cyclotrons to measure directly the magnetic field, without beam.

The isochronism graph and the power supplies values can be stored to be compared later to another measure.

The polynome degree in the algorithm can be modified to get different possibilities and bad measures may be rejected. The relations between the current in the trim coils and the magnetic field, the $B=f(r)$ array and the characteristics of the phase probes are archived in the database.

3.7 Injection beam losses [3]

This program reads the injection or ejection diagnostics inside the cyclotrons and displays the beam losses for each of them on four bar-graphs. The commands of the two injection steerers, the two motors of the electrostatic deflector and the four injection magnetic devices are available to make adjustments. For each power supply, the same graphical object is used.

3.8 Turns separation

This program allows the operators to choose which cyclotron and which probe they want to use (radial probe or ejection probe), then sends a message to the VME crate to start an acquisition and waits for the results. When the acquisition is finished, it displays the graph $I=f(r)$ with one maximum value for each beam turn.

Several graphs can be stored for comparison and the tuning is made by changing the phase or voltage of the HF cavity.

Both for the Spiral cyclotron Cime and for the separated sectors cyclotrons, the old Camac commands of the motors for the probes have been replaced by VME cards with a Jbus link, using a new driver.

3.9 High frequency

This program allows the operators to choose what cavity they want to manage : cyclotrons, injectors or bunchers It controls the phase and the voltage of the HF cavity, and also the frequency if necessary.

If somebody needs to come in the cyclotron rooms, the high voltage is decreased to 50 Kv and the beam is stopped.

4. Evolution

As both the Ganil and Spiral control system were based on the same architecture, they will jointly evolve in the future.

The weakness is mainly coming from the old Camac crates which need to be replaced by VME crates.

This work is under way and now there is almost the same number of each kind, around twenty-five.

The second milestone is to move, for the real-time VME crates, from the VAXELN operating system to VXWORKS.

5. References

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