Improvements on the ECR ion source remote control and safety systems

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INTRODUCTION

In 2006 new features were added both to the remote control [1],[2] and to the safety system of the LNL ECR ion source. Both the sets of changes were completed by the end of the year aiming to make more safe and simpler the operations of the positive ion source that has to supply reliable and stable beams to the PIAVE injector.

For the ECR remote control system one of the goals was to move the data acquisition system for the beam check (spectra acquisition) from the local scope on the high voltage platform to the remote control computer in the console room. To achieve this specific result, new devices had to be integrated, some analog and digital signals had to be added and a set of completely new software modules had to be installed in the existent control computers.

For the safety system there were two main goals: the first was its complete hardware and software integration in the Tandem-PIAVE-ALPI access control system, the second was to add the safety checks necessary to operate the TWT microwave generator without the lead shields around the plasma chamber, that is only in a strict unmanned condition of the ECR platform, no matter if the platform high voltage generator is active or not. For this last item new hardware and software interlocks had to be added to the existing safety system.

Here a survey of all these improvements is given.

HARDWARE

For the remote control system the following devices were integrated or added:

- the TWT microwaves generator, connected through a RS232 serial link to the local industrial Linux computer installed on the high voltage platform;
- the high precision Heinzinger high voltage generator (0-25KV), used to set the beam extraction potential and connected to the local PC through a RS232 serial link;
- a FUG voltage generator installed at source voltage (11 KV), for a variable bias voltage and controlled by RS232 link with optical converters;
- a logarithmic I/V converter (Danfisyk) to acquire in a large range of values (from 1 nA to 100 µA, see Figure 1) the ECR output beam current collected by the local Faraday Cup which is located before the output pipe, the I/V converter output being an analog voltage signal in the range 0-5 V;
- a digital binary output command to insert and extract the Faraday Cup from the beam line;
- four more analog input channels to monitor different control variables ;
- a step motor controller connected to the local industrial Linux computer through a RS232 serial link for the remote controlled open/close operations on the dosing valves injecting gas in the plasma chamber.

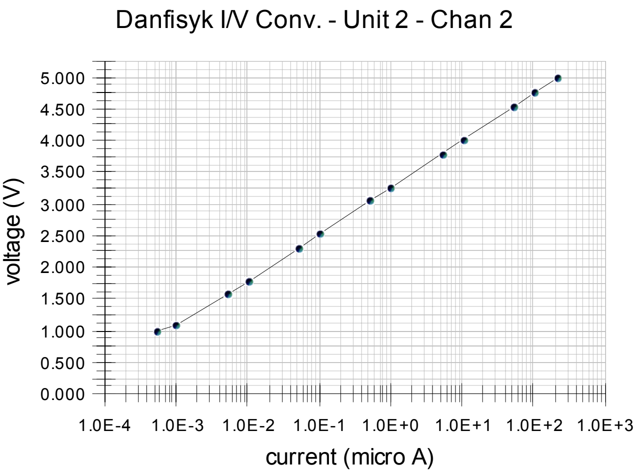

FIG. 1: *Current to Voltage Converter: measured characteristic*

For the safety system new connections of the ECR signals (digital and analog I/O) had to be set towards the local safety PLC inputs for the safe management of the interlock conditions and some more emergency buttons and status switches were also installed.

SOFTWARE

New modules or new capabilities on old modules were necessary for the ECR control system both in the local Linux industrial computer, on the high voltage platform, and in the remote supervisory Linux PC located in the control room.

On the local industrial computer a special module (spectra_server) was installed that jointly manages the bending dipole and two 16-bits adc channels on a local NI acquisition board dedicated to beam spectra acquisition. This last module performs slow current ramps on the bending dipole and acquires voltage signals related to the magnetic field in the dipole (taken from the analog output of the local Group3 teslameter) and to the total current collected by the Faraday Cup through the logarithmic I/V converter, recording related data on local files.

Both on the local and the on remote computers a new graphical user interface module was also added to perform customized beam scanning procedure setups and to start and monitor the data acquisitions. An example of the new graphic module is shown in Figure 2.

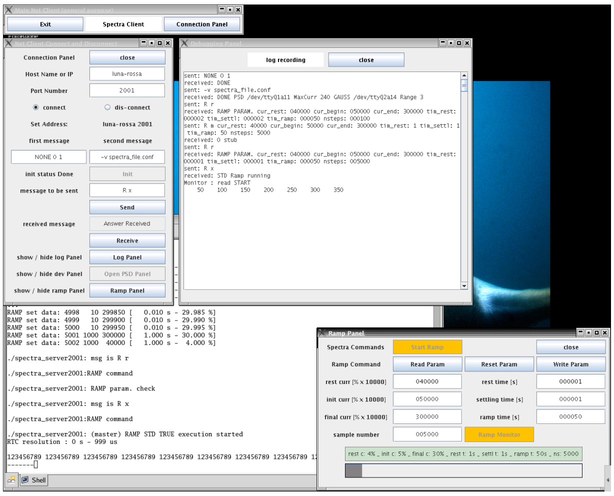

FIG. 2: *Module to take spectra of the beams from the LNL ECR*

A general purpose scientific tool (Grace-5.1.20 [3]) was also configured to plot and check data at the end of each acquisition run; in figure 3 an example is shown of data taken and plotted during the beam preparation of one of the 2006 PAC scheduled experiments.

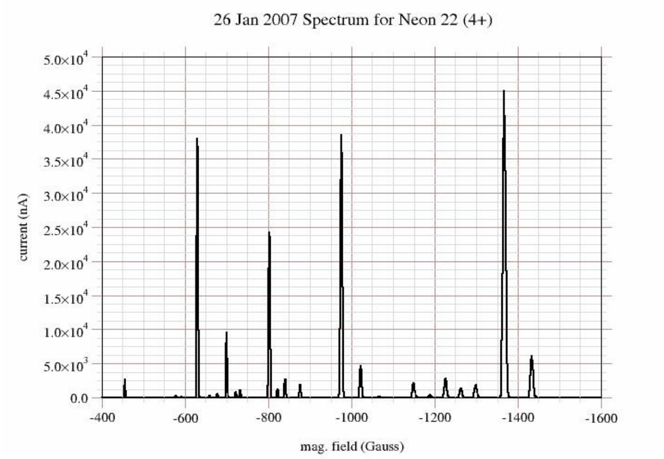

FIG. 3: *Plot of spectrum acquired for the 2006 PAC Ne22 run*

Some new features were also added to the remote control system modules (see Figure 4); among them:

1. a continuous set and monitored ECR variables logging;
2. a strip chart that continuously monitors the 11KV extractor current;
3. a strip chart to monitor the Faraday cup signal (valid when the device is active);
4. a strip chart for the analog signal of dipole magnetic field;
5. configurable tables for slow up and down ramping of the two Danfisyk power supply of the high current ECR solenoids.

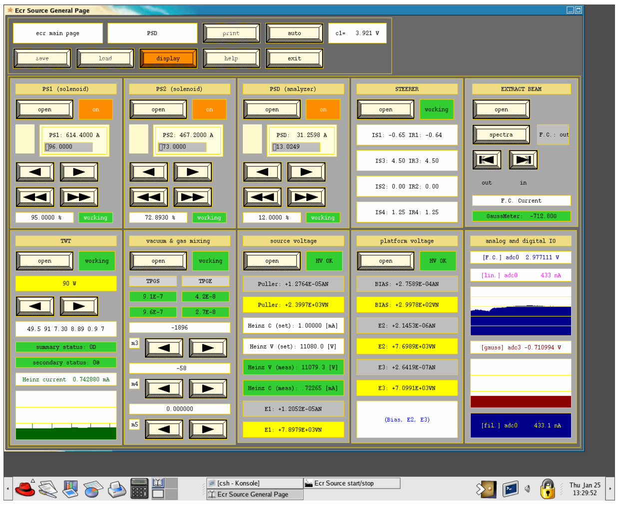

FIG. 4: *ECR Remote Control, main page*

The safety system was also upgraded and new safety conditions were included in the PLC software checks to allow the switching on and a safe working operation of the TWT microwaves power supply and/or of the platform Glasman high voltage generator only while valid safety conditions remain unbroken.

CONCLUSIONS

All the tests on the updated systems were satisfactory and now the operations on the PIAVE injector ECR ion source are safer, simpler and may be completely performed from the remote console in the control room.

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[1] G. Bassato, A. Battistella, S. Canella, LNL - Annual Report 2001, pag. 257
[2] A. Battistella, S. Canella, J. Hu, LNL - Annual Report 2002, pag. 238
[3] http://plasma-gate.weizm ann.ac.il/Grace/