Identification system for SPIRAL

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IDENTIFICATION SYSTEM FOR SPIRAL

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An identification station, to measure the on line production rate of the radioactive ions out of the target and source of SPIRAL (on Line System for Producing Accelerated Radioactive Ions) project, is being installed in the injection line of the CIME (Cyclotron for Medium Energy) cyclotron. The production rate is deduced via the radioactive decay of the nucleus in detecting a characteristic γ-ray and, if necessary, verifying the half-life associated. The goal is to enable a non-specialist to use the station as a regular diagnostic tool. A detailed description of the device is presented, including the associated detectors and the software.

1 Introduction

The SPIRAL project [1] at GANIL is a Radioactive Ion Beam (R.I.B) facility which will provide the production and acceleration of the nuclei in the energy range of 1.7A to 25A MeV. In order to identify unambiguously the radioactive element produced in the production cave [2] before its acceleration, an identification station is being installed in the injection line the cyclotron. The schematic view of the low energy beam line is shown in figure 1.

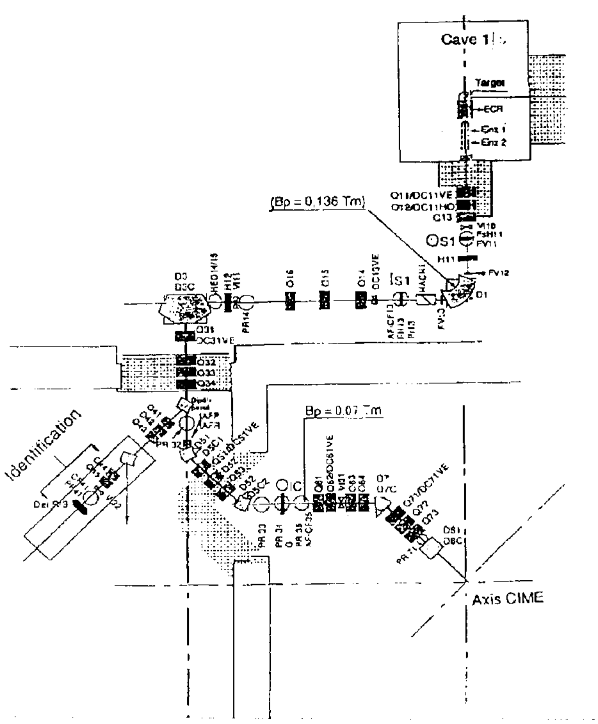

Figure 1 : schematic view of low energy beam line.

The identification system identifies the radioactive nuclei produced and provides their productions rate. The user gives his own choice nucleus to have the information of its production rate and those of its parent and pollutants . These informations are particularly important for the cyclotron downstream regulation [3] prior to the acceleration.
The identification method is based on the measurement of the radioactive properties : either direct method or through controlling the half-life of the nucleus. A faraday cup placed just upstream the system can count for the overall current, including stable nuclei. The minimum detectable current in this case is of the order of several Pico Amperes.

2 General description:

The beam is deviated either to the identification line or to CIME cyclotron (« dipole pulse » in figure 1). The upstream fast chopper (« HACH1 » in figure 1) allows to stop the beam far of the detection. These two systems allow to generate the time structure necessary for different types radioactivity measurements. The modes used are:

- SPIRAL source regulation : the beam is switched to the low energy detection permanently by the deviator. The radioactivity will be detected:

  a) either by collecting simultaneously the ions on the tape (direct mode for the nuclei);

  b) or after stopping the ions in the tape and stopping the beam with the chopper (chopper mode) for the nuclei which the half-life needs to be checked.
- control of beam: the beam will be switched alternately to CIME cyclotron (90% of the time for example) and to the low energy detection (10% of the time) by the deviator , the radioactivity will be detected:
- by collecting simultaneously the ions on the tape (direct mode),

Table 1 : Summary of different detection modes

Detection mode	Radiation	Remark	Example	Half-life
Germanium direct	γ	characteristic of ion	^{11}Be ^{18}Ne	13.8s 1.67s
Germanium chopper	γ	ambiguous case	^{29}P ^{29}Al	4.1s 6.6mn
Germanium deviator	γ	long half-life	^{7}Be	53d
High Plastic	β^-	no γ radiation , short half-life	^{6}He	0.806s
Low Plastic	β^-	no γ radiation , long half-life	^{32}P	14d
Silicon	proton	no γ radiation	^{31}Ar	0.015s
Ger-Ger	γ	coincidence	^{76}Kr	14.82h
Plastic-Ger	γ and β	coincidence	^{43}Ar	5.4mn

a) after stopping the ions in the tape during the beam is switched to CIME cyclotron (deviator mode),
c) the beam chopped during the time it is deviated to the low energy detection.

The summary of the different detection modes is shown on the table 1 [5], [6].

The system is controlled through :

- JBUS connection,
- processor
- the power modules,

These elements are linked to the station through the GANIL network [4].

3 Command and control of the detection equipment:

The system is constituted by the following devices (figure 2):

- the first chamber which allows the introduction of the profiler and supporting of the turbomolecular pump,
- the second chamber, containing the retractable faraday cup, the tape and an airlock for the introduction of a sample,
- the tape and its winder. the displacement of tape is controlled by the workstation,
- the scintillator detectors for β- measurement,
- the silicon detector for proton measurement.

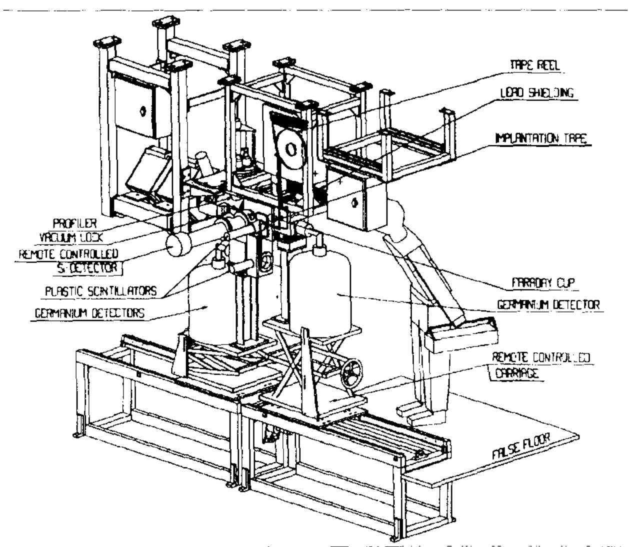

Figure 2 : schematic view of mechanical system

4 Electronic and acquisition:

The electronic used is essentially formed by the linear and fast amplifiers, discriminators, power supplies. The used analog-digital converters have a dynamic of 10V on 16384 channels. The programming trigger module will allow to use many different trigger actions without disconnecting the cabling. The scaler modules are read by the acquisition system allowing to calculate the flow of the nuclei on line, before automatic display.

The system will be synchronized through the programming clock module which the principal functions are:

- to provide the information time for each decay,
- to manage the time of the deviator, chopper, and the synchronism between these equipments,
- to provide an waiting time in order to delay acquisition of the activity if the counting rate is too large. To provide the timing for the winding of the tape.

The data acquisition is based in the GANIL acquisition and treatment [4]. The principle of this acquisition is:

- real time data acquisition,
- control and storage data,
- visualization of results.

The data acquisition is realized through the standard VME front-end which accepts the data coding (figure 3). The control, storage and visualization of data are being realized on an ALPHA workstation with Open-VMS. The visualization of the spectra is performed using the X-Windows/MOTIF environment. In the course of data acquisition, the recovered parameters allow to calculate automatically the flow of the interest nuclei, its parent and their pollutants.

The flow is refreshed automatically each interval of time selected by the user. The treatment of the time spectrum allows to determine the half-life of the interest nucleus.

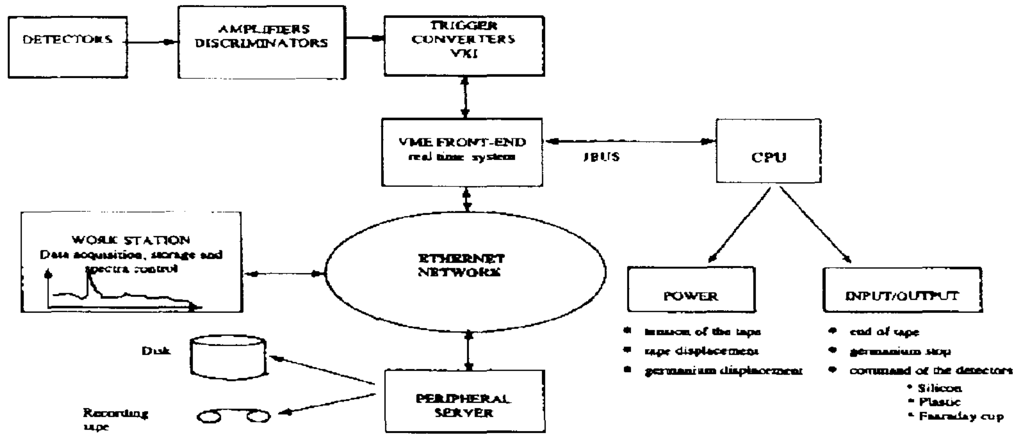

Figure 3 : Block scheme of data acquisition and command & control system

5 Production and detection mode:

Depending on the decay mode of a nucleus, the detection mode corresponding is used. The list of different configurations is shown in the table 1.
The theoretical production (simulated flow) of the interest nuclei, its parent and their pollutants will be calculated from the primary beam parameters: target, incident energy, intensity of primary beam [7]. This simulated flow will be compared with the production calculated on line, which is refreshed periodically, depending on the user choice.

6 Visualization and results:

Two windows of control and visualization of different parameters of acquisition (dead time, control rate , flow...) and detection equipment (position of tape, distance of germanium detector - tape, ...) are being realized. This allows to have the time evolution of all different parameters.
The different actions and parameters of the experience will be written in a file, which will be displayed permanently on the control window.

7 Conclusion:

The identification workstation allows to diagnose the beam in the low energy line of the SPIRAL project and determine its intensity. Independant tests of the different parts of the system will be shortly finished. The preliminary off line test will be performed in winter of 98. The functioning of the workstation with radioactive beams is expected to the beginning of 99.

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