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Abstract : We have developed different beam monitors for the full energy and intensity range of the Ganil beams.

The secondary emission monitors (EMS) are used in the range of 10^8 - 10^{11} pps, while multiwire gas chambers are used for beam intensities in between 10^2 and 10^8 pps. Both monitors provide the width and the gravity center of the beams and are partially interceptive.

The microchannel-plate monitors (GMC) based on the ionisation of the residual gas of the beam transport lines are non-interceptive. They provide the profile or the time structure of the beam (around 10^{-9}sec), and are used in the range of 10^8 - 10^{14} pps .

<u>SECONDARY EMISSION BEAM PROFILE MONITORS (S.E.M)</u> (1), (3)

These monitors are based on the secondary electron emission under the impact of the ion beams on two planes of 47 horizontal and vertical gold plated tungsten wires (see fig 1). The space between two wires (0.5, 1.0, 1.5 mm), depends on the observed beam size. They are used in the 1 to 300 nAe beam intensity range, and for beam energies ranging from a few KeV/u up to 100 MeV/u.

150 such S.E.M. are installed all along the beam transfer lines, between the 3 GANIL cyclotrons and on the experimental areas.

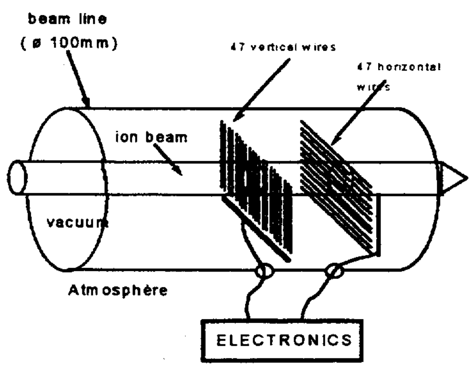


Fig 1

<u>GAS PROFILE MONITORS (G.P.M)</u> (2), (8)

These monitors are adapted from the Charpak multiwire proportional chambers. They are operated with Ar-CO2 gas at atmospheric pressure, enclosed in between two thin foils which isolate them from the beam line vacuum.

The number of such monitors, installed in the GANIL beam lines is about 30. They are used for low intensity or secondary beams tuning, that is from 10^2 to 10^7 ions/sec.

See Fig 3 and 4.

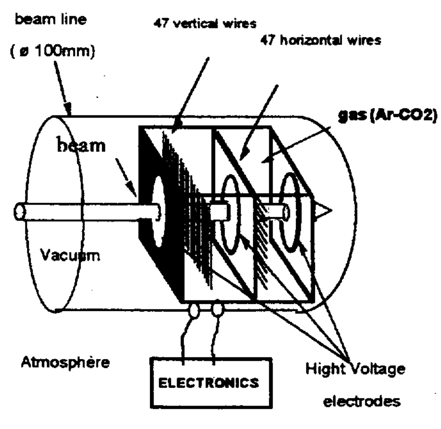
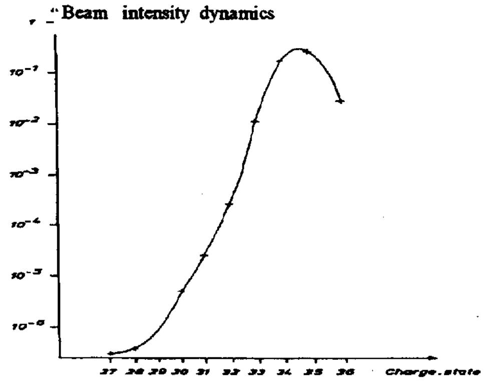
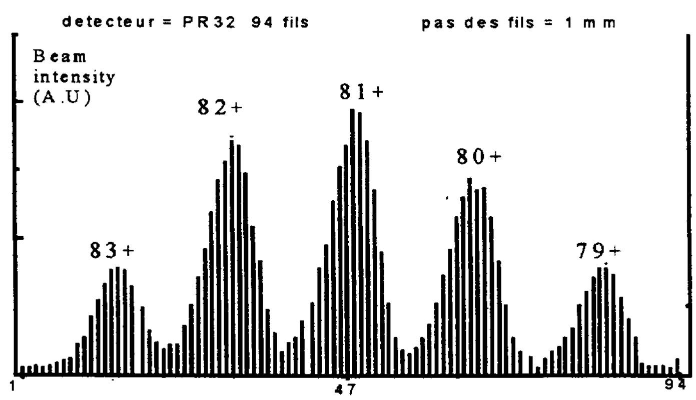


Fig 2



35 MeV/A Kr charge states beam
Fig 3 (from ref 7)



24 Mev/A U58+ charge states beam
Fig 4

Upgrading

Different improvements have been made for the SPIRAL project mainly the reduction of the désorption flux (S.E.M) and the diminution of the entrance window (7 μm of titanium) (G.P.M).

NON-INTERCEPTIVE BEAM PROFILE MONITORS (M.C.P) (4), (5), (6), (7)

All along the beam transfer lines, ions are produced by ionisation, if correctly collected, they provide the spatial distribution, position and size of the beam.

The sensor is an ensemble of two cells, an electrostatic drift space and an amplification signal stage using micro-channel plates, the space between the collecting anode strips is 0.3, 0.5, 1.0 or 1.5 mm, depending on the beam size. This monitor is run in the 1 nAe to qq μAe range.

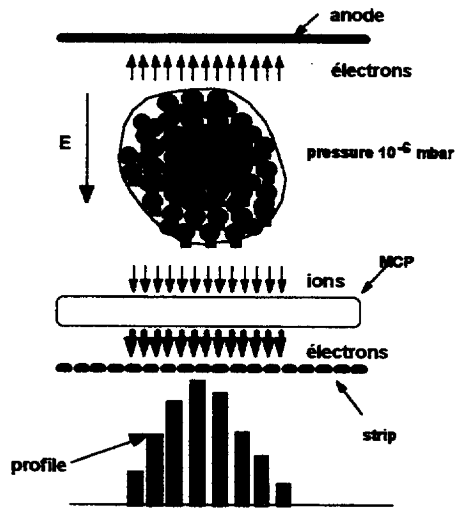


Fig 5 (from ref 6)

Upgrading

These detectors can be adapted to low intensity SPIRAL beams by addition of a thin 45 ° tilted foil providing a large secondary electron emission (≅gain of 10^5).

Similar developments

Detectors using the same principle have been developed in several laboratories. Here is a non-limited list

- -The DESY Proton Accelerators (K.Wittenburg DIPAC 97 3 rd Europeen workshop)
- -The Kerfysisch Versneller Instituut of Groningen (J.M. Schippers NIM A310 (1991) 540-543)
- -The KEK Proton Synchrotron of Japan (T. Kawakubo International Conference on High Energy Accelerators (1989)
- -The FERMILAB of Illinois (W.S.Graves NIM A364 (1995) 13-18)
- -The INFN-LNS of Catane (A.Rovelli DIPAC 97 ,3 rd European workshop)

Associated analog electronics

The analog electronics are identical for all different types of beam profile monitor (SEM, GPM, MCP). The emitted electrons induce a current in each wire or strip, proportional to the beam density. Sequential and adjustable reading of the 47 wires or strips in each plane provides the beam distribution

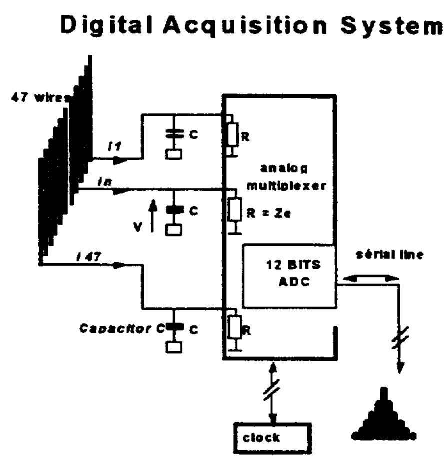


Fig 6 (from ref. 3)

NON-INTERCEPTIVE BEAM TIME MONITORS

The GANIL cyclotrons deliver a pulsed ion beam, the frequency of which is in between 8 and 14 MHz and the bunch width less than 2 nanosecond. The aim of this detector is to provide an on line beam time structure measurement.
The signal is obtained from residual gas ionisation, in the same conditions as previously described for the profile monitor, the localisation strips being replaced by a 50 ohms anode.

Electronics

The collected electrons produce a signal, characteristic of the time structure. After amplification by microchannel-plates, this signal is sent to a constant fraction discriminator (DFC) and finally to a time amplitude converter as start signal, the stop signal being the cyclotron H.F

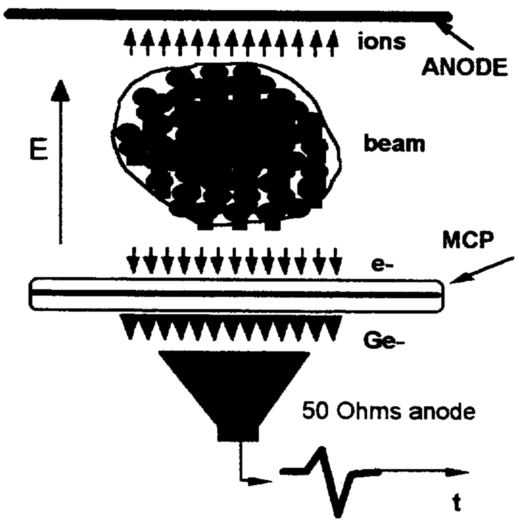


Fig 7 (from ref. 7)

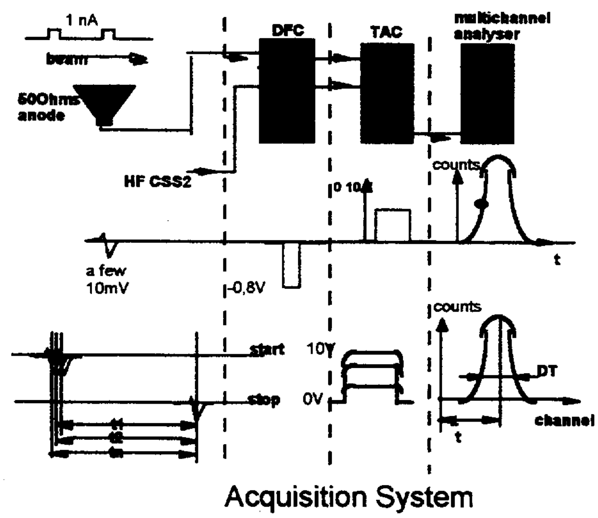


Fig 8

Recent measurements (control of the bunch width of an extracted cyclotron beam over a 8 days experiment)

We have measured continuously over two weeks the beam bunch width of a Xe 129 beam and registered its variations, the mean value was found around 500ps. These results are reported on a graph (see fig 9). (The observed variations take into account the tuning corrections of the beam).

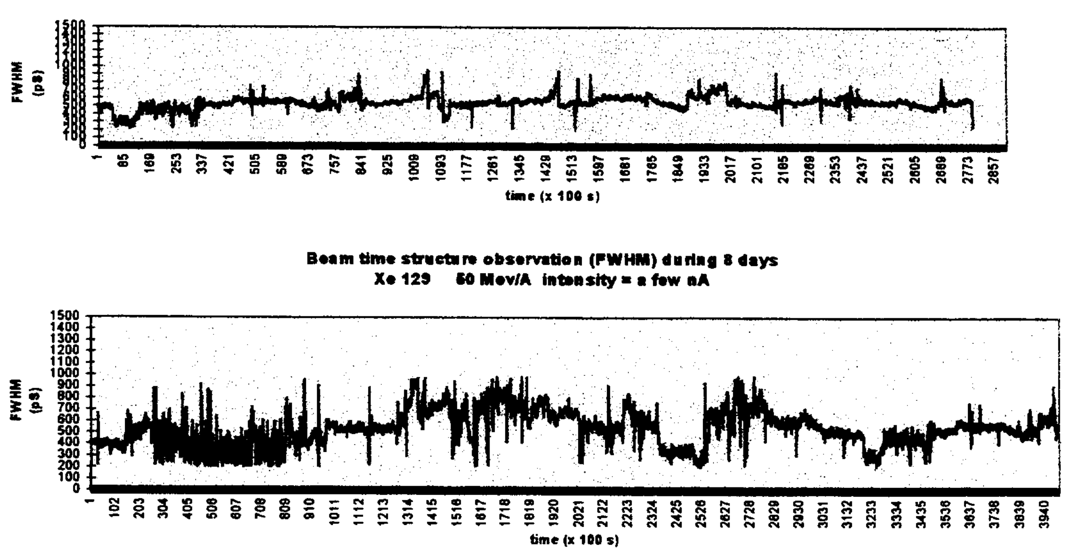
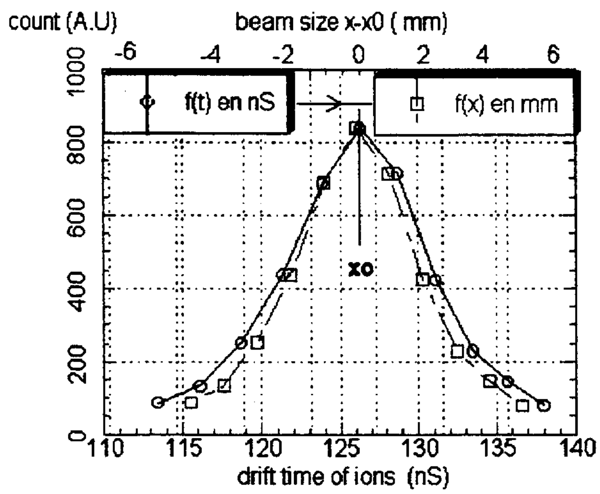


Fig 9

Upgrading

Gas profile monitors have titanium windows, the thickness of which is at least 7 µm .Very low energy SPIRAL beams could be stopped in these windows. So, we are thinking to and testing, the use of a non-interceptive beam time structure monitor as a beam profile monitor. (the time of flight distribution of the ions is converted into their spatial distribution)



Simulation of the conversion of the time of flight distribution into the corresponding spatial distribution (beam size = 10 mm)

Fig 10

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