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Beam-Profile Monitors with Gas Amplification and Current Readout for the Projectile-Fragment Separator

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In order to measure spatial distributions of primary and secondary beams at the Projectile-Fragment Separator (FRS) [1], profile monitors with gas amplification and current readout have been developed. These monitors are called 'current grids' in order to distinguish them from FRS components based on single-event readout such as multi-wire proportional chambre.

Each current grid can be moved into and out of the nominal beam position by means of a compressed-air activated feedthrough (see fig.1). The mechanical layout of the wire planes, the electrodes and the mounting inside the gas chamber is based on experience gained at GANIL [2],[3]. For measuring the horizontal (x) and vertical (y) intensity distribution of a beam, two planes of parallel wires (77 wires/plane, 1mm distance) are used, being mounted between metal-foil cathodes in a gas chamber. There are five such small-area current grids, namely at each of the two target positions the target position, at the intermediate and the final focal points, and in the transfer line to the ESR; furthermore, two large-area current grids are positioned downstream of the first and third dipole, which have 95 wires (2mm distance) in one plane for determining the x distribution only (see fig.2). In fig.3 and fig.4 and in table 1, the most important information on the mechanical layout of the current grids is compiled.

	small-area current grids	large-area current grids
wires:		
planes	X and Y	X
wires/plane	77	95
distance	1mm	2mm
thickness	20μm	20μm
material	gilded tungsten	gilded tungsten
windows:		
number	2	2
thickness	50μm	100μm
size	115mm $\oslash$	194*194mm^2
material	stainless steel	stainless steel
intermediate cathodes:		
number	3	2
thickness	10μm	10μm
material	stainless steel	stainless steel

Table 1: Mechanical parameters of the current grids

The x and y wire planes of each small-area current grid are divided into a central region with single-wire readout, and two side regions, where two wires are combined, so that the 77 wires of one plane are readout into 47 channels. For the large-area current grid, single wires are readout into 95 channels.

By means of four FET multiplexers, up to eight current grids can be connected to two current-measurement units and the related control unit (see fig.5). The current-measurement unit (see fig.6) consists of 48 charge sensitive amplifiers. One amplifier includes in principle two electronic steps, namely a current-to-voltage converter and an integrator. After the integration time t_i the integrator provides a voltage level U_{a1}, which is proportional to the time average of the incoming current, $U_{a1} \sim \frac{1}{t_i} \int_{t_0}^{t_0+t_i} I_{e1}(t)dt$ and stores this level, until the analog multiplexer has read out all of the 48 amplifiers ($t_{store} = 5ms$). The control unit is connected via the SE interface to the VAX computer and allows to select 2*48 channels for simultaneous visualisation, to vary the gain between 2nA/V and 10μA/V, and to select integration times of 0.5ms or 5ms using the software of the SD controll system [4],[5].

Following inital measurements [6], with ^{20}Ne(150 MeV/u), the current grids have meanwhile been further tested with beams of ^{40}Ar(164,200,720 MeV/u), ^{54}Fe(139 MeV/u), ^{197}Au(620 MeV/u), and ^{136}Xe(760 MeV/u). Fig.7 shows as an example the intensity profiles of a 760 MeV/u ^{136}Xe beam on both types of grids using the software of the SD controll system. Typical parameters of the current grids during these measurements were:

gas:	500-800mbar, P10 (90%Ar, 10%CH_4)
voltage on the cathodes:	-100 to -400V
intergration time:	5ms
beam intensities:	8*10^3 - 10^8 ions/bunch
electronic gain:	2 - 100 nA/V

In order to study the gas amplification and to determine the minimum number of detectable ions, systematical parameter investigations as a function of gas composition, gas pressure, and high voltage are planned for various ions and intensities.

References

[1] H. Geissel et al., Projectile-Fragment Separator, A Proposal for the SIS-ESR Experimental Program (1987), unpublished

[2] D. Bazin and Y. Bouveret, Etude et mise au point d'une chambre multifils a ionisation pour la detection de faisceaux secondaires au GANIL, GANIL Report 84.03 (1984), unpublished

[3] R. Anne and Y. Georget, Chambres a circulation de gaz, etalonnage avec le faisceau GANIL, GANIL Report RA.YG. 627.85(1985), unpublished

[4] M. Fradj, Beschreibung Profilgitter-Meßsystem, Internal GSI-Report (1989), unpublished

[5] V. Schaa, Kurzbeschreibung SD-Anwahlprogramm, Internal GSI-Report (1990), unpublished

[6] R. Anne et al., Development of Beam-Profile Monitors with Gas Amplification and Current Readout for the SIS Projectile-Fragment Separator, GSI Scientific Report (1990) p.257

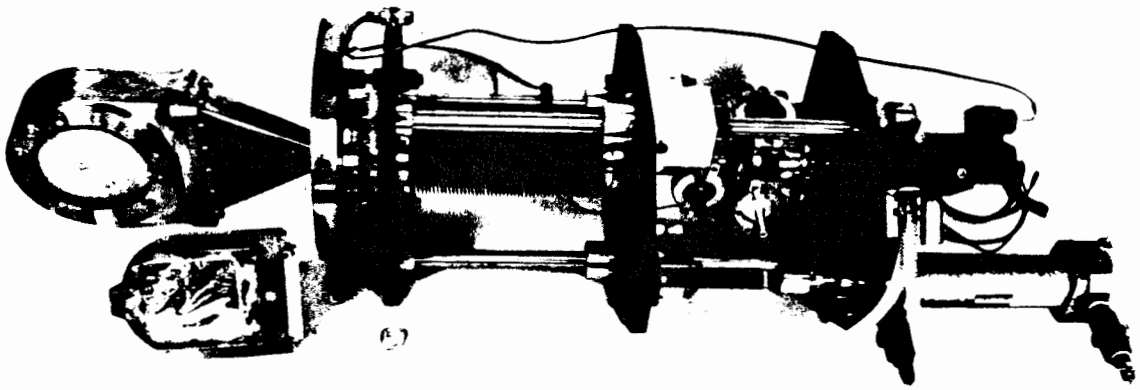

Figure 1: Mounting of a small-area current grid on a compressed-air activated feedthrough

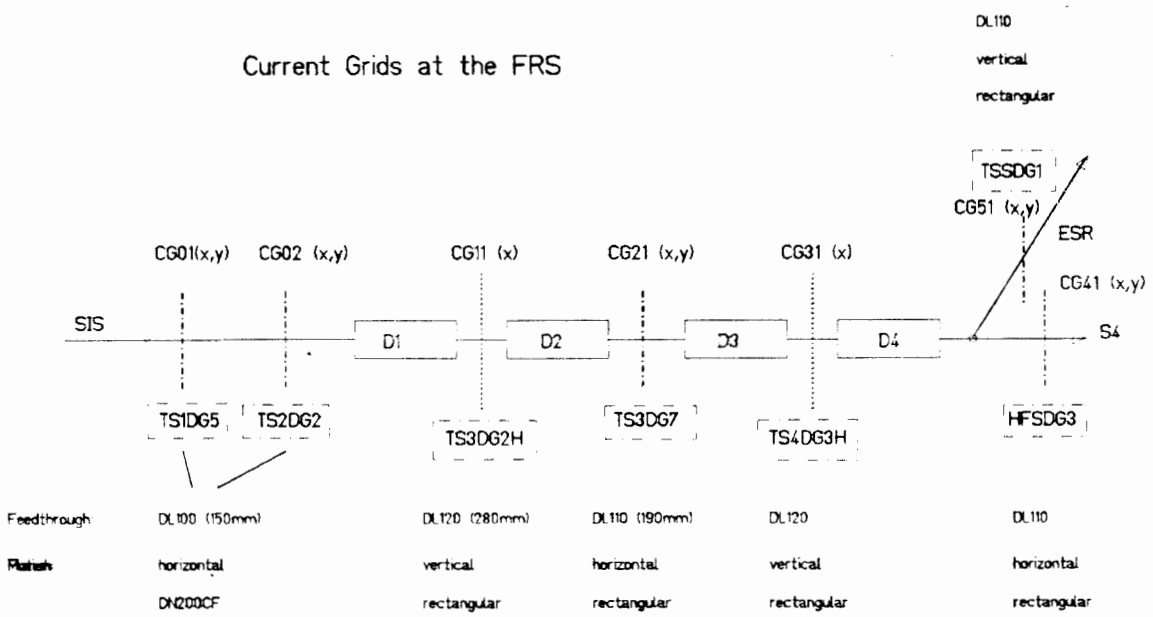

Figure 2: Positions of the current grids at the FRS

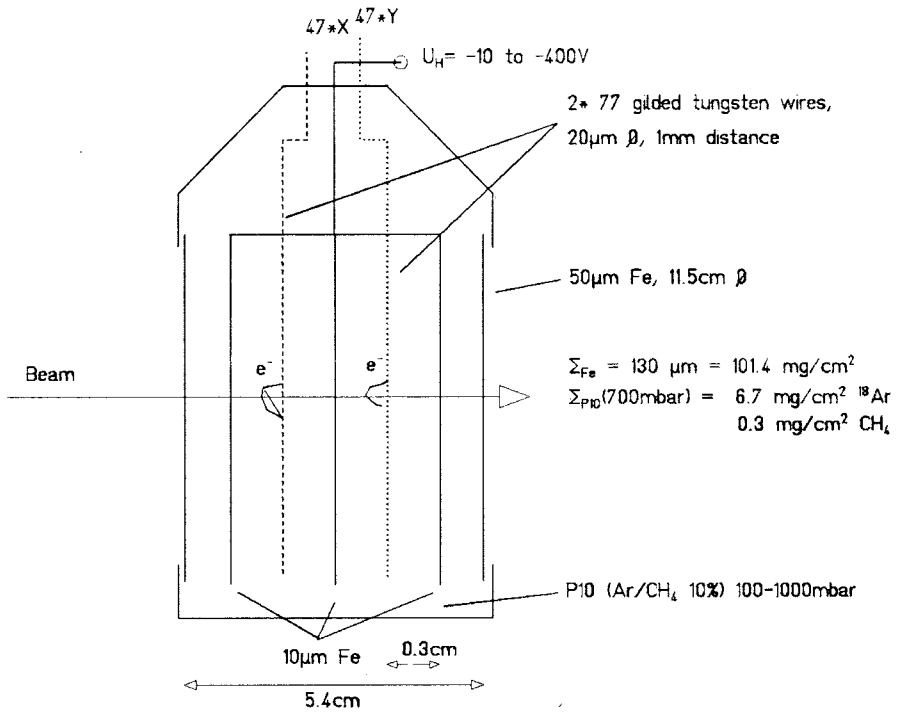

Figure 3: Sketch of the small-area current grid

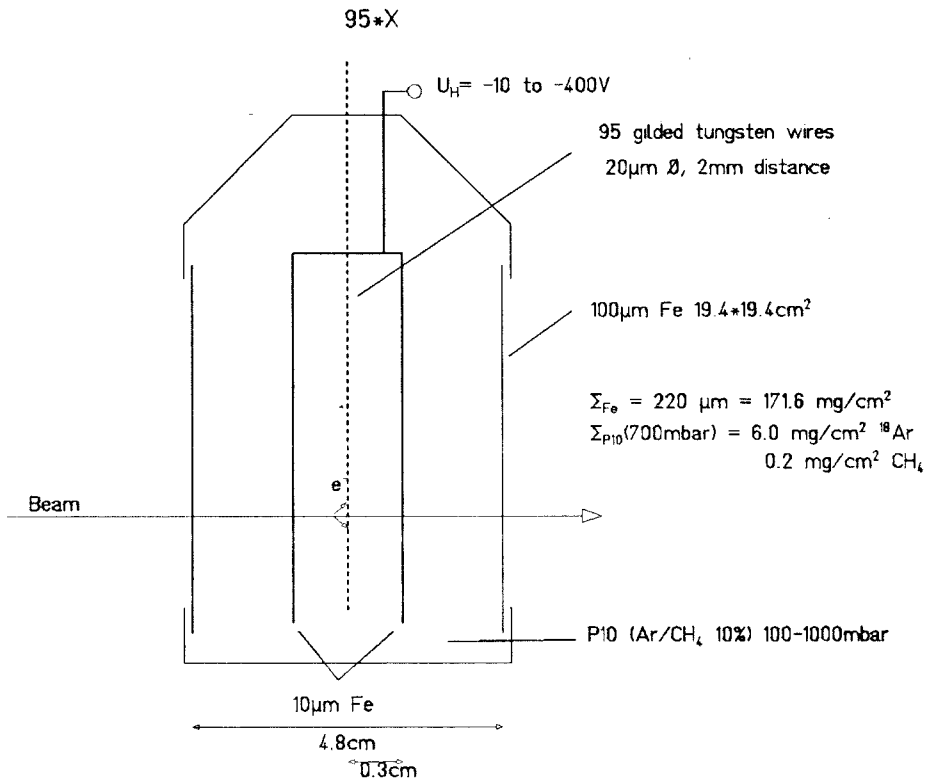

Figure 4: Sketch of the large-area current grid

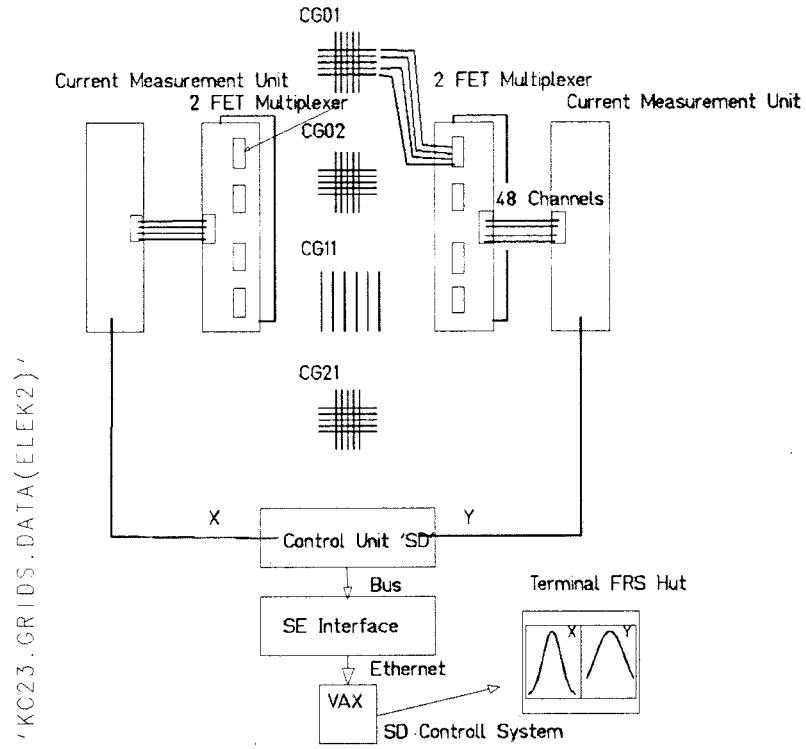

Figure 5: Principle of the readout-elektronics for the current grids

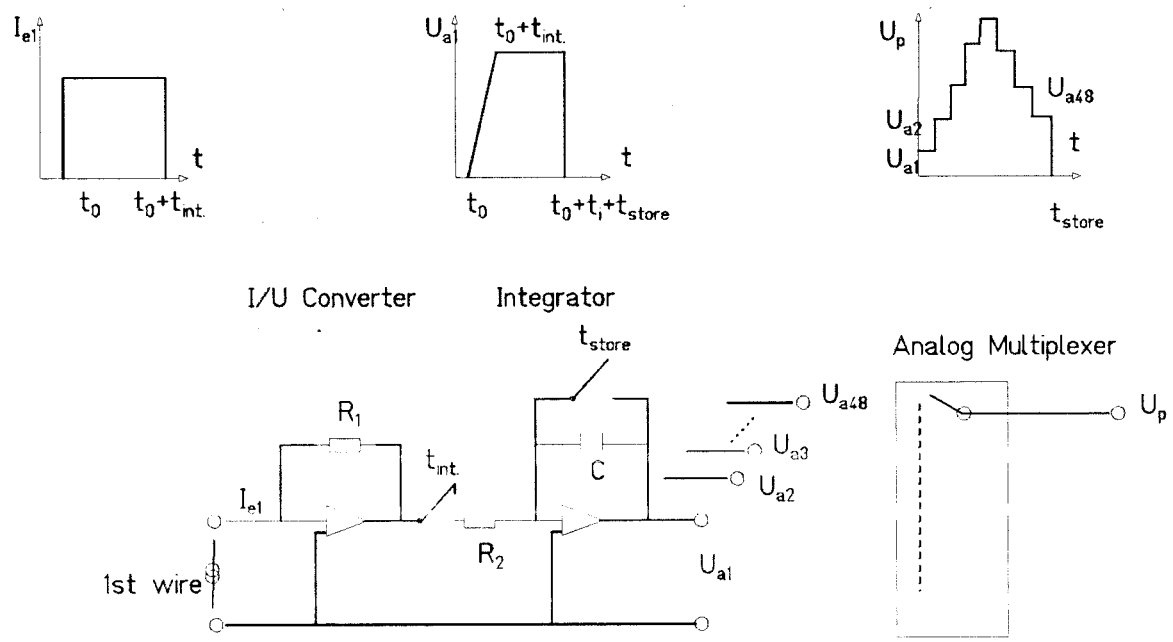

Figure 6: Principle of the current-measurement unit

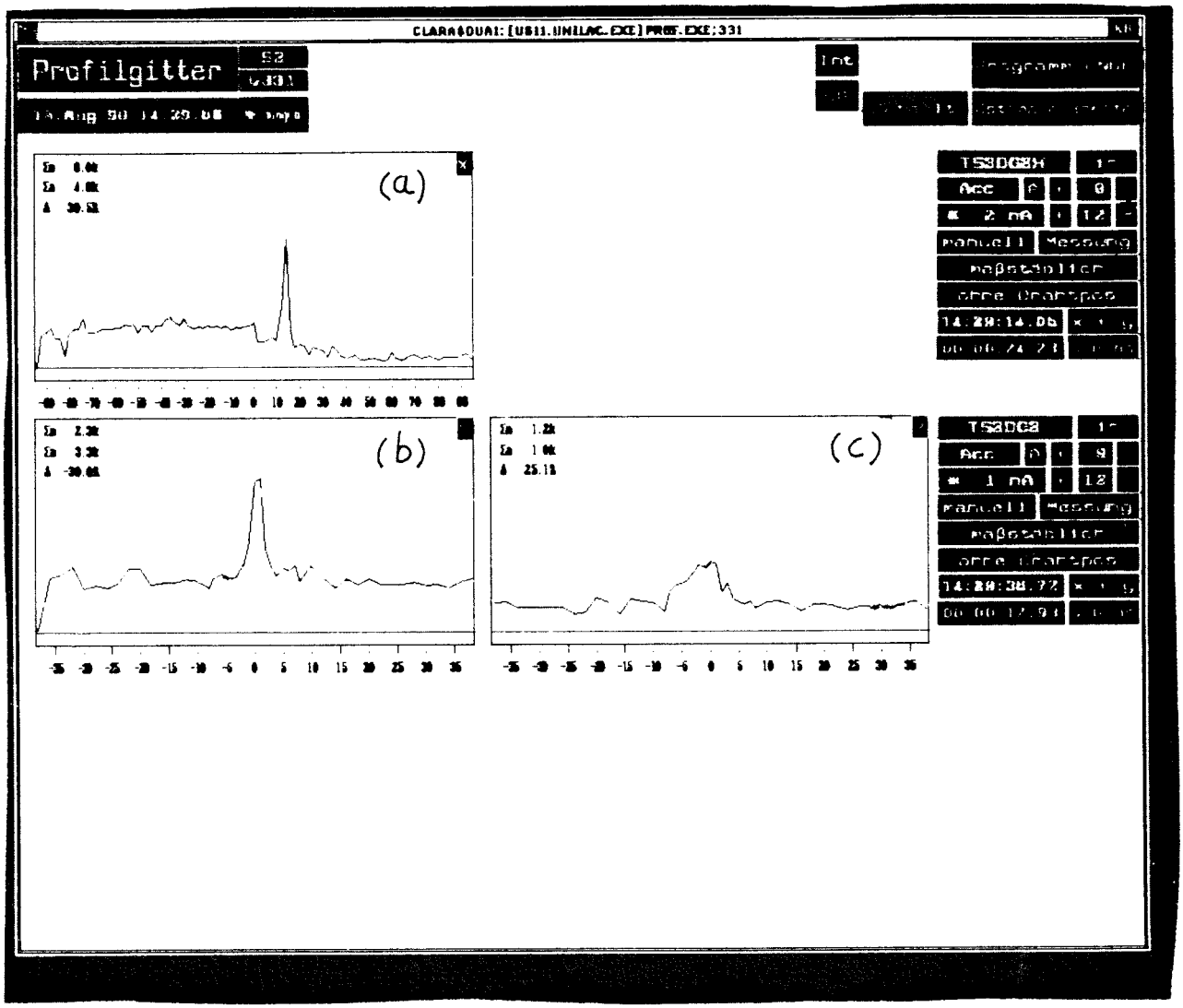

Figure 7: Intensity profiles of a 760 MeV/u ^{136}Xe beam from SIS. Shown are the vertical distribution measured with the current grids TS3DG2H (a), and the horizontal (b) and vertical (c) distributions measured with the current grid TS2DG2. The bunch width of the slowly extracted beam was approximately 600 ms, and the electronic integration time was 5 ms.