Pilot study of beam position and profile monitoring for the pBar target

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At secondary target installations like the FAIR antiproton target, monitoring of the beam-target-overlap is a crucial task for the beam instrumentation. For antiproton production an intense 29 GeV proton beam pulse is extracted within 50 ns from the SIS100 synchrotron. The primary beam is focussed after a 3 m drift section in air on a 3 mm Nickel target rod. Because the target station is surrounded by a 1 m iron shielding, the spot size must be derived from detectors in the short drift section. To this purpose the performance of two detectors operating in air has been studied with 300 MeV/u Nickel beams and fast extraction.

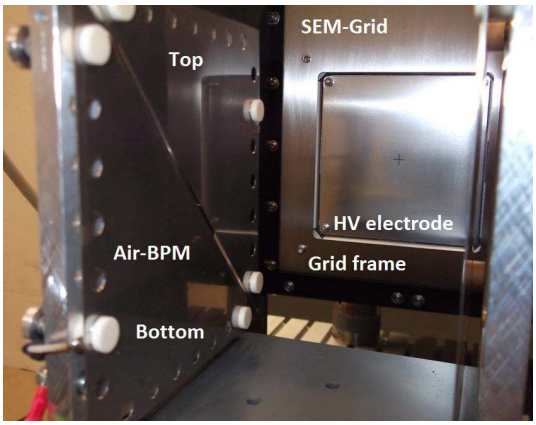

Figure 1: Air-BPM (front) with two electrodes (Bottom and Top) shown on the left; SEM-Grid (at back) with HV electrodes that cover the arrays of Tungsten wires.

Experiment Setup and Results

Two radiation-hard detectors were installed at the end of the HTP beam line next to the dump (see Figure 1):

- ”Air-BPM”: This detector consists of two diagonally-cut 135 mm electrodes, separated by a ground guard, and was placed 50 mm from the beam axis. A vertical motor drive typically moved the device in 1 mm steps.
- SEM-Grid: This detector is an existing GSI design mounted on an external pneumatic drive 20 cm in front of the beam dump. No high voltage was applied.

Both detectors were connected via pulse-stretchers to charge-to-frequency converter POLAND units [1] and read out via FESA, the new FAIR standard for acquisition systems. For each spill offset-corrected data were stored for further analysis. The Air-BPM signals were fed to the POLAND units via 80 m long coaxial cables to emulate the situation in the target hall where 150 m are required.

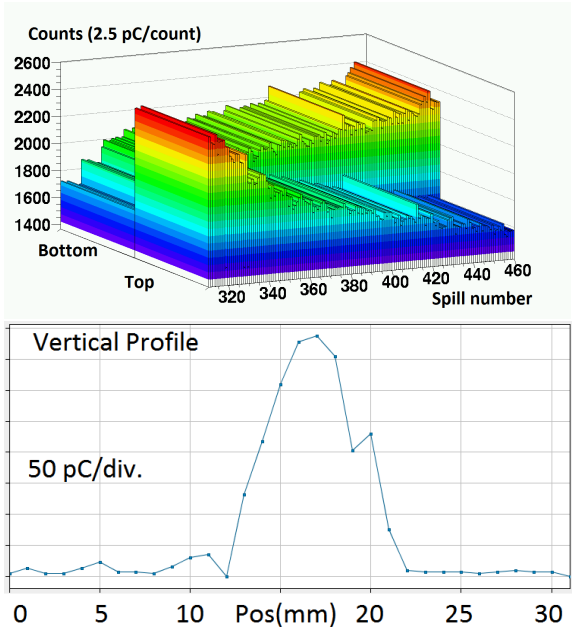

Figure 2: Scan of Air-BPM for 1x10^9 Ni ions (A) and vertical SEM-Grid profile for 2.5x10^9 Ni ions (B).

In Figure 2 detector signals of Air-BPM (A) and SEM-Grid (B) are presented. The Air-BPM was scanned through the beam in 1 mm steps. For each of the 15 positions ten spills were analysed and the normalised ratio ’difference-over-sum’ Δ/Σ calculated. The measured gradient of Δ/Σ=(1.42$\pm$0.02)%/mm is in good agreement with the theoretical value based on the electrode geometry.
The vertical profile shows a smooth distribution with a kink at 19 mm, which might be due to imperfections in the offset subtraction. The full profile width of 10 mm fairly agrees with the data of Cromox screen and SEM-Grid in the upstream diagnostic chamber. The calculated charge integral is only 20% lower than the prediction of Sternglas [2]. Similar ratios have been observed in ref. [3] and by the authors for other data sets of SEM-Grids installed in vacuum. However, the present data are yet too sparce to conclude that the secondary electron yield does not suffer significantly from operation in air. Further data need to back up the present encouraging results.

References

[1] S. Löchner et al., GSI Scientific Report 2013, Darmstadt.
[2] E. J. Sternglas, Phys. Rev. 108 (1957) 1.
[3] C. Nociforo et al., ”Profile Monitors for the Super-FRS”, This Scientific Report.

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