Controlled beam loss experiment at SIS18

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The FAIR beam loss monitoring (BLM) system is based on different types of particle detectors. Its main purpose is the minimisation of beam losses around the SIS100 synchrotron and protection of machine components from unnecessary activation. As a part of a BLM feasibility study an experiment with controlled losses on a scraper was performed at SIS18 section.

The aim of this study is the production of beam losses at a well defined position and the measurement of the shower intensity with BLM detectors. In the present setup two plastic scintillators of the existing BLM system were used. They are installed downstream of a scraper at a distance of 2 and 5 meters, respectively. The scraper was positioned close to the beam orbit. Uranium beams of different energies and intensities in the range of 100-900 MeV/u and 10^8-10^9 particles were utilized. The beam was injected into the SIS18 synchrotron, accelerated and then stored for several seconds. During that time the beam was excited and was slowly impinging on the scraper. The resulting count rates in the scintillators were monitored through the ABLASS data acquisition system[1] and further analysed with a ROOT code[2]. Figure 1 shows one BLM signal (blue curve) and the DC current transformer signal DCT (black curve) in arbitrary units. In the flattop region no significant BLM signal is detected. After 2 seconds the exciter was turned on and produced the shown BLM signal. It was carefully checked that no significant losses were produced at other locations around the sychrotron.

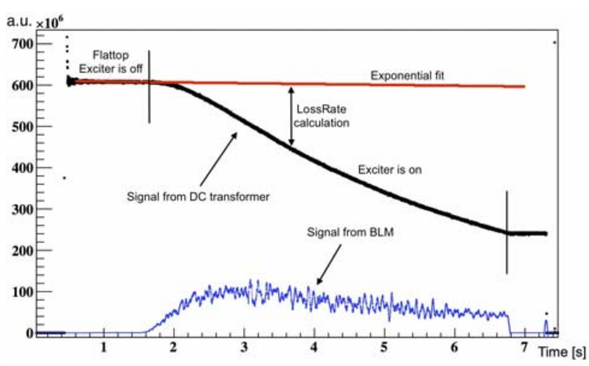

Figure 1: Measured signals of DCT and scintillator in a.u.

During the initial storage when the exciter is switched off only a small fraction of the beam is lost. In order to determine the beam life time (see red curve in figure 1) the beam current can be approximated by an exponential function. When the beam exciter is switched on, one can calculate the number of lost particles on the scraper for each time-bin by taking the difference between the extrapolated life time function and the actual number of particles measured by the DCT.

For each energy, the data were approximated by a linear fit and the ratio between BLM signal and loss rate was retrieved. One can interpret this ratio as a normalised shower intensity. This dependency between the ratio and the beam energy is shown in Figure 2. At low energies it seems to follow parabolic curve. Starting from 300 MeV/u the shower strength of the beam losses follows the expected linear trend which one expects from the results of Monte Carlo simulations. The experiment will be repeated with LHC type ionisation chambers[3] which will be installed during the next short shutdown in order to measure their response function and estimate their signal strength for possible SIS100 beam loss scenarios.

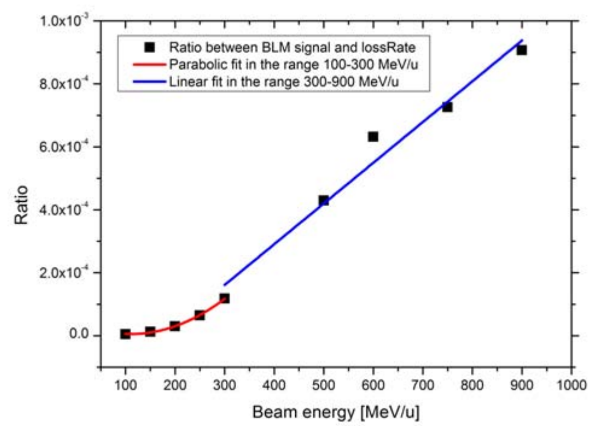

Figure 2: BLM signal to loss rate ratio in dependence on beam energy

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References

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