Beam loss monitoring study for SIS100 at FAIR

L.Bozyk, A.Reiter, GSI, Darmstadt, Germany
O.Kester, V.Lavrik*, IAP University of Frankfurt, Frankfurt am Main, Germany

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Abstract

FAIR, the facility for antiproton and ion research, planned as a multi-disciplinary accelerator facility, will extend the existing GSI complex in Darmstadt, Germany. In the FAIR start version, the new synchrotron SIS100 will provide proton and heavy ion beams for a variety of experiments. The GSI synchrotron SIS18 will operate as injector for SIS100. The current study focuses on beam loss measurements for SIS18 and SIS100. The aim of this study is to find quantitative methods to measure beam losses around the machine, mainly SIS100, on an absolute scale. Results of two pilot experiments carried out in the high-energy beam lines and at the SIS18 with Uranium ions in the energy range up to 900 MeV/u is presented. In the first experiment the Uranium beam was totally stopped in a Copper target and the particle shower measured with LHC-type ionization chambers. In the second experiment, the beam was slowly excited in the SIS18 synchrotron to create controlled losses on a scraper. The loss rate was calculated by the ROOT code based on data from DC current transformer and plastic scintillation beam loss monitor. Experimental data are compared against the predictions of FLUKA simulations.

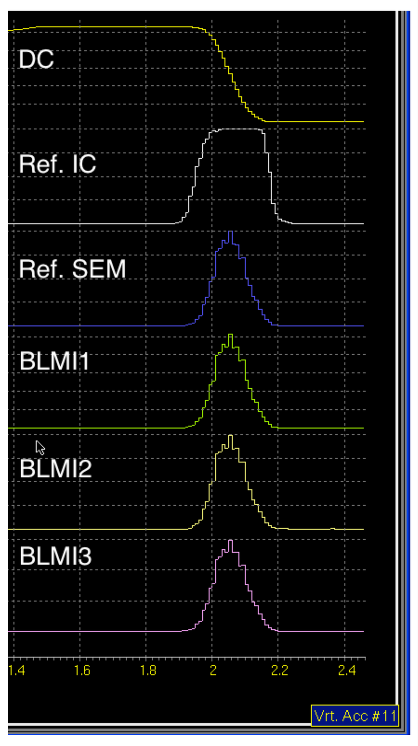
BLMI experiment

1. Test of BLMI, measure the response function in a mixed radiation field
2. Simulation of the response function using FLUKA code
3. Crosscheck: simulations vs. experimental data

Experimental conditions

- High energy beam line at GSI
- Uranium ions at energies: 300, 600, 900 MeV/u - 10^7-$5\cdot10^8$ ions
- Beam loss target: copper cylinder (8 cm diameter, 2.8 cm thick)
- Set of 3 BLMIs and charge to frequency converters
- Data acquisition system: ABLASS

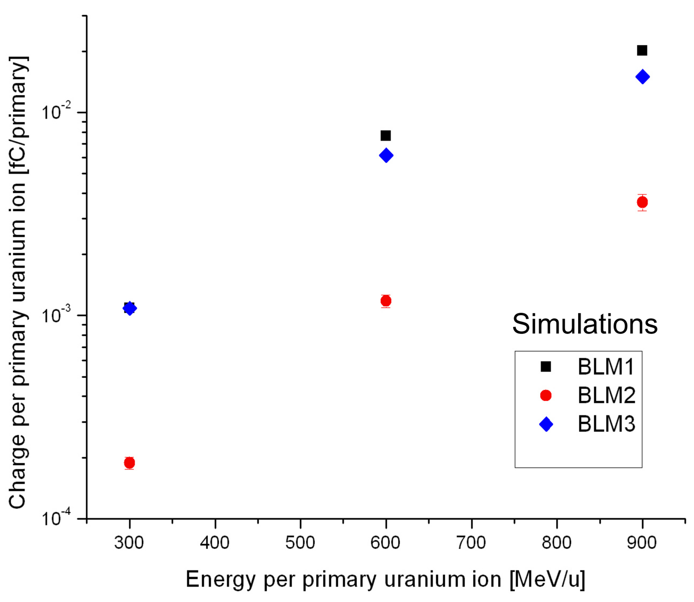


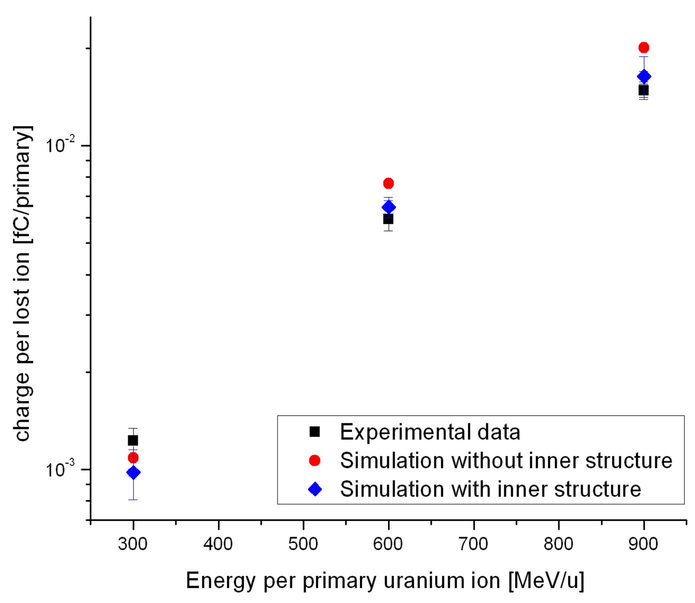


Simulation approach

- Calculation of energy deposition (ED) by shower particles within the effective volume of BLMI
- Converting ED to charge by dividing ED by mean ionization potential of nitrogen

Results





Contribution to the total response function from different particles

	All	p	π+	π-	n	e+	e-	μ+	μ-	γ
Percentage	100	78.1	0.39	1.4	4.4	1.3	4.1	0.2	0.12	0.7

Simulations to experimental data ratio

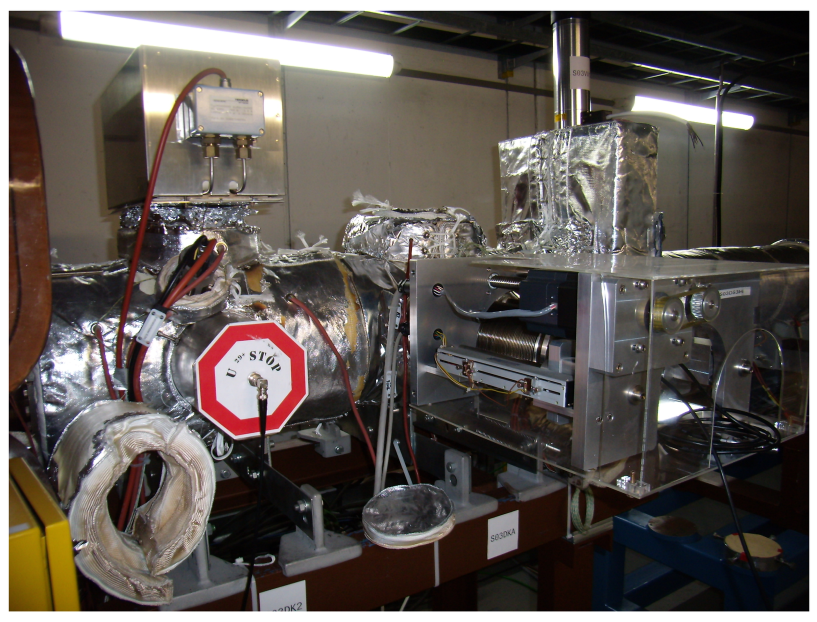
	BLMI1	BLMI2	BLMI3
300 MeV/u	0.8	1.02	1.8
600 MeV/u	0.8	0.7	2.0
900 MeV/u	0.6	0.7	0.9

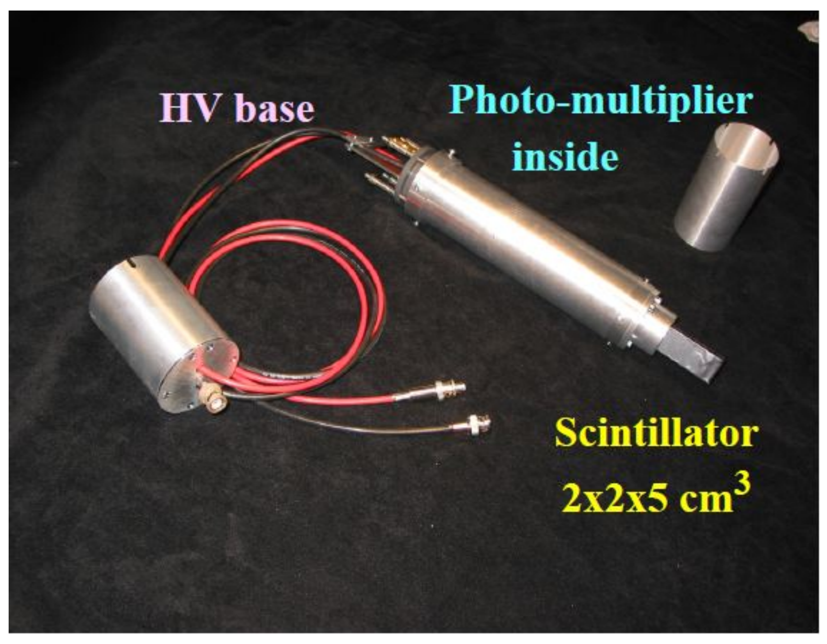
Experiment at SIS18

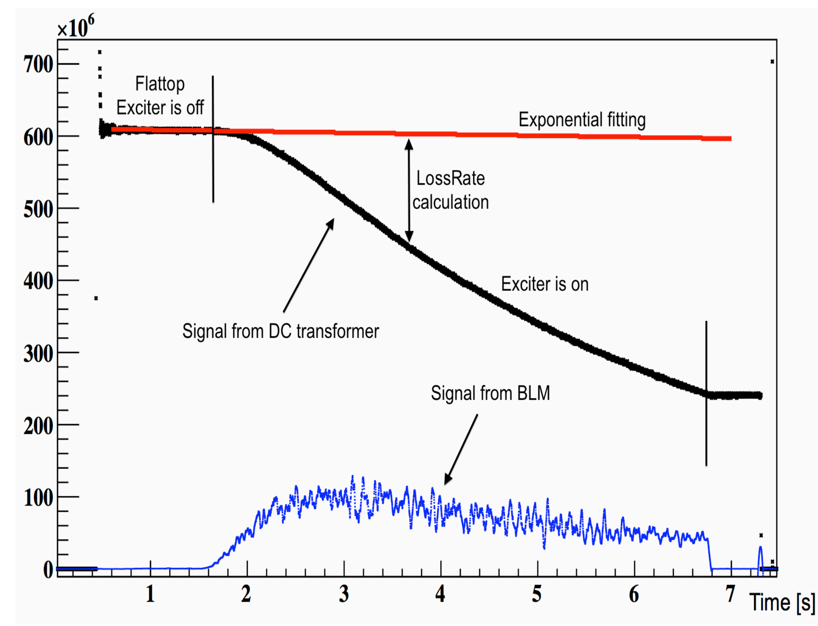
Measure the relative beam losses along SIS18 synchrotron at known position

Experimental conditions

- Losses on scraper at SIS18 synchrotron section
- Uranium beam at energies: 100-900 MeV/u - 10^8- 10^9 ions
- Scintillation based BLM 2 m downstream the scraper
- Data acquisition system: ABLASS
- Data analysis: ROOT macros



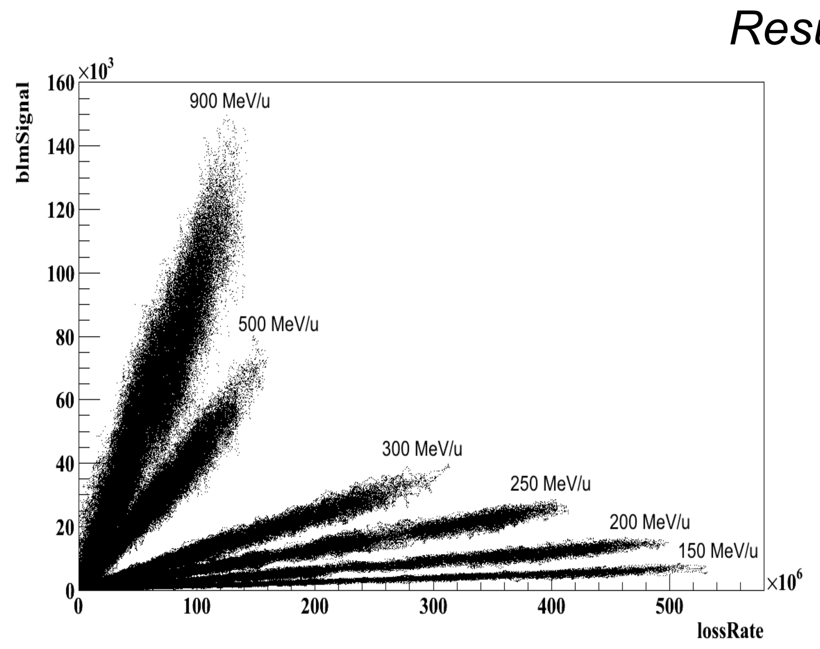


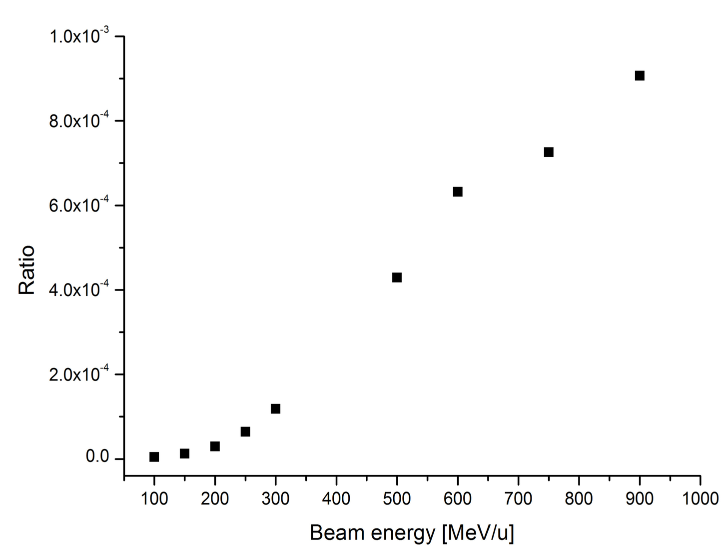


Loss rate calculation

- Exciter is on
- Measuring the beam intensity by DC transformer
- Fitting the total amount of particles by exponential function
- Taking the difference between the extrapolated life time function and the actual number of particles measured by DC transformer

Results





Conclusions

Two experiments on beam losses were performed at GSI. During the experimental testing of LHC-type BLMI several aims were reached:

- Response function in mixed radiation field was obtained. Based on retrieved data one can say that response function depends linearly on beam energy in half-logarithmic scale.
- Simulations were compared with experimental data. Chosen simulation concept was proven. However more experimental data with different species of beam are needed.

The experiment with controlled losses at SIS18 was performed and led to the following conclusions:

- The information concerning the relative losses along SIS18 synchrotron was obtained.
- Using the ROOT code the loss rate against BLM signal was calculated based on experimental data from DC transformer and the signal from scintillation beam loss monitor. The ratio between loss rate and BLM signal was calculated. One can see that the ratio depends linearly on energy at given position.
- It's concluded to repeat the same experiment using LHC-type BLMI in order to crosscheck the data and performance each type of the BLM.

The future work will concentrate on scaling the results, obtained during these experiments, to SIS100 environment and trying to implement the quantitative approach in measuring beam losses along the SIS100 synchrotron.

E-mail: v.lavrik@gsi.de