CODE BENCHMARKING STUDIES WITH THE ESR INTERNAL TARGET

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Nuclear physics and fundamental interaction studies in collisions of rare isotope or antiproton beams with dense targets play a central role in the NESR and HESR storage rings of the future FAIR facility [1]. For instance, high luminosities are expected in experiments with a hydrogen pellet target in the HESR. Therefore, it is important not only to understand but also to predict the influence of a dense target on the stored beam and to investigate the interplay between phase space cooling, intrabeam scattering (IBS) and target effects. Some experiments with gas targets in light ion storage rings were carried out earlier [2]. Measurements of equilibrium horizontal emittance ε_x and momentum spread $\Delta p/p$ were performed before at the ESR [3].

The new experiments were carried out with a stored coasting beam of bare lead ions (Pb^{82+}) with an intensity of about 10^8 particles and a kinetic energy of 400 MeV/u. The ESR electron cooler was used to reduce the phase space density of the injected beam, to provide a high quality, dense stored beam and to compensate heating by the target. Four target gases (N_2, Ar, Kr, Xe) were used in the gas-jet, with densities in the range $2.5-8\times10^{12}$ atoms/cm^2 (gas-jet diameter ≈ 5 mm).

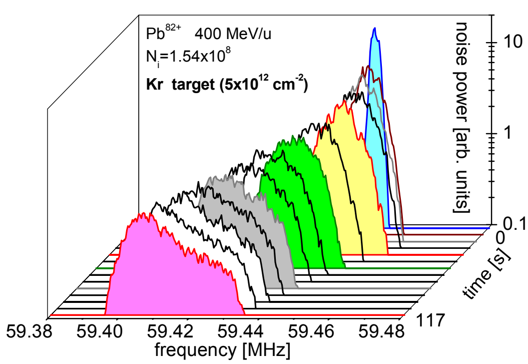

Figure 1: Schottky spectra recorded every 9 s during the blow-up measurement with the electron cooler off. Target is on for $t \geq 30$ s.

The study was focused on two main procedures. For both procedures, the corresponding measurements without target were performed, thus allowing to identify and evaluate target effects. First, in the blow-up measurements the energy loss and the phase space growth of the beam due to the target have been measured as a function of time within a time interval of 2 min. Initially, the beam was cooled down to equilibrium state. At t=0 the electron cooler was switched off. Then, after about 30 seconds delay to allow for the relaxation of the beam phase space due to IBS, the Kr gas-jet target was switched on. The evolution within approximately 120 s of the longitudinal Schottky noise power spectrum for the 30th harmonic of the revolution frequency was recorded. A typical measurement is shown in Fig. 1 with a time step of 9 s. After the target was switched on ($t \geq 30$ s), the position of the peak shifted to lower frequencies i.e. to lower energy due to energy loss and the width of the distribution increased due to energy straggling.

In another series of measurements at a fixed ion beam intensity of 1.58×10^8 particles, the beam parameters at the equilibrium between electron cooling, IBS and the target effects were measured for various electron currents in the cooler in the range 10 − 800 mA. These data in comparison with BETACOOL [4] simulations are shown in Fig.2. The non-magnetised model (NM) and Parkhomchuk model were used for the evaluation of cooling effects. The NM is in better agreement with experiment because it reproduces the measured dependence of emittance and momentum spread on electron current for the case without target and predicts the equilibrium states when the target is on [5].

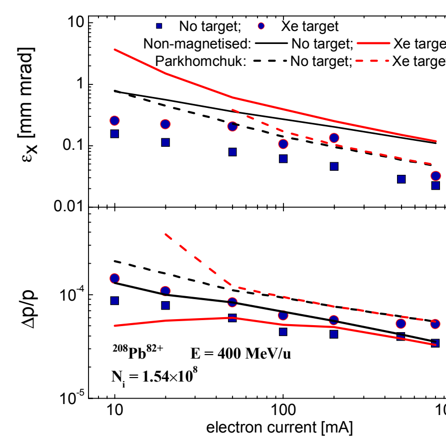

Figure 2: Equilibrium horizontal emittance and momentum spread (r.m.s. values) versus electron current of the cooler for Xe target (2.5×10^{12} atoms/cm^2).

REFERENCES

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