Beam Loss And Longitudinal Emittance Growth In SIS

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Abstract

Beam losses of several percent occur regularly in SIS. The onset occurs during the RF capture of the beam. Previous studies have revealed that the losses can come from the RF bucket at the start of acceleration being over filled due to the longitudinal bucket acceptance being too small, or due to the mismatch between the mean energy from the UNILAC and synchronous energy of the SIS [1]. The beam losses as measured by a DC beam transformer however show in addition to the sharp initial drop, for the above reasons, a much slower decay in the beam intensity. The speculated cause comes from the incoherent transverse tune shift of the bunched beam, which forces particles into transverse resonant conditions. The emittance growth is also another important issue for SIS. Past measurements from Schottky-noise pick-ups have shown a factor of 3-5 increase in the emittance depending on the extraction energy; a large factor when compared against expectations from theory. These factors were calculated from the ratio between the normalized relative momentum spread of the DC beam before RF capture and after debunching. In this present work, tomographical techniques have been used to reconstruct the phasespace from a series of bunch profile measurements from a Beam Position Monitor (BPM). Therefore one can find the rate of growth in the emittance from a series of high resolution BPM measurements along the RF ramp. Furthermore the initial phasespace density matrix from these reconstructions has been used to generate the initial population of macroparticles for the ESME longitudinal dynamics Particle-In-Cell code [2], thereby enabling a comparison between the emittance growth of the beam under ideal conditions and that of the experiment. The emittance growth (rms) during the acceleration (~540ms) was approximately 20%, and that during the RF capture was estimated to have an upper limit of about 40%. Later measurements have also been performed from emittance evaluation of the DC beams during the injection and extraction plateaus of the machine cycle. It was found that a blow-up factor of ~270% occurred in the emittance and that this could not be reproduced in the simulation, which yielded a factor of ~50%.

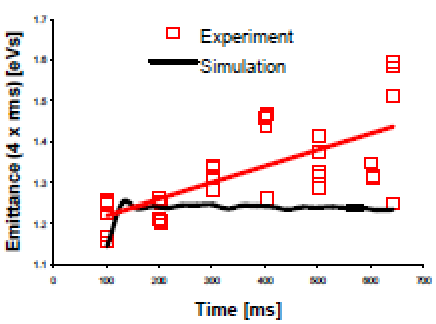

FIGURE 3. Longitudinal emittance growth profile of the fully bunched $^{40}Ar^{10+}$ beam during acceleration.

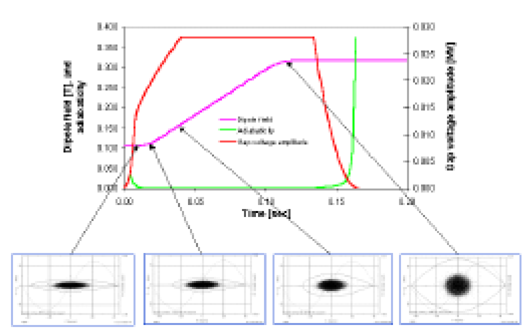

FIGURE 4. Simulated phasespace development of the beam distribution for $^{40}Ar^{18+}$. Injection offset was zero.