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Erratum: Simulation studies of the beam cooling process in presence of heating effects in the Extra Low ENergy Antiproton ring (ELENA)

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ABSTRACT: The Extra Low ENergy Antiproton ring (ELENA) is a small synchrotron equipped with an electron cooler, which is currently being constructed at CERN to further decelerate antiprotons from the Antiproton Decelerator (AD) from 5.3 MeV to energies as low as 100 keV. At such low energies it is very important to carefully take contributions from electron cooling and beam heating mechanisms (e.g. on the residual gas and intrabeam scattering) into account. Detailed investigations into the ion kinetics under consideration of effects from electron cooling and heating sources have been carried out, and the equilibrium phase space dimensions of the beam have been computed, based on numerical simulations using the code BETACOOl. The goal is to provide a consistent explanation of the different physical effects acting on the beam in ELENA.

After reviewing the calculations, table 4 has been corrected, and here we show the correct values of the emittance growth due to rest gas scattering calculated using eq. (5.1). It is also necessary to clearly specify that these calculations have been performed assuming a rest gas consisting of N₂ molecules with density (at room temperature) of $n = 9.6 \times 10^{10} \text{ m}^{-3}$. Furthermore, the corresponding slopes of the analytical line in figures 4 and 5 have also been corrected consistently. This correction does not affect the subsequent discussion and the conclusions are still valid.

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Table 4. Emittance growth rate results for ELENA due to rest gas scattering with vacuum pressure 3×10^{-12} Torr and assuming 100% N_2 residual gas.

Model	$d\epsilon_{\text{rms}}/dt$ [$\mu\text{m/s}$] (at $p = 35 \text{ MeV}/c$)	$d\epsilon_{\text{rms}}/dt$ [$\mu\text{m/s}$] (at $p = 13.7 \text{ MeV}/c$)
BETACOOOL	0.015	0.21
Analytical formula, eq. (5.1)	0.011	0.18

Figure 4. Horizontal (left) and vertical (right) emittance evolution due to rest gas scattering for an ELENA antiproton beam of $p = 35 \text{ MeV}/c$. The blue line represents the average curve over 10 realisations simulated with BETACOOOL. The red line is the analytical estimate. No cooling is applied.

Figure 5. Horizontal (left) and vertical (right) emittance evolution due to rest gas scattering for an ELENA antiproton beam of $p = 13.7 \text{ MeV}/c$. The blue line represents the average curve over 10 realisations simulated with BETACOOOL. The red line is the analytical estimate. No cooling is applied.