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Memorandum

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To: LEM group
cc:

Beam deflection of the low-energy μ^+ beam in the AEW magnet ("Bpar")

A simple estimate is given for the deflection of the keV μ^+ beam in the AEW experimental magnet before impinging on the sample of the LEM setup at PSI. For 12 kV – 15 kV extraction at the moderator target the deflection angle of the muons is about 10° at an applied field of 10 mT.

The deflection angle ϕ_B of a charged particle with momentum p in a magnetic field B with effective length l_{eff} can be approximated by [1]

$$\phi_B \simeq \frac{e \cdot l_{eff} \cdot B}{p} = \eta_B \cdot \frac{B}{p}. \quad (1)$$

The effective length of the AEW magnet up to the center of the AEW field is $l_{eff} \approx 8$ cm, which yields $\eta_B \simeq 2.7$ mrad(MeV/c)/G. For 12 and 15 kV extraction at the moderator, the respective energies E after the start detector (TD) are 11.1 keV and 14.3 keV. It follows for the momentum $p = \sqrt{2mE}$ with m the muon mass

$$\begin{aligned} p(15\mathrm{kV}) &= 1.74\ \mathrm{MeV/c} \\ p(12\mathrm{kV}) &= 1.53\ \mathrm{MeV/c}. \end{aligned}$$

This gives deflection angles ϕ_B in an applied field of 100 G of

$$\begin{aligned} \phi_B(15\mathrm{kV}, 100\mathrm{G}) &\simeq 155\ \mathrm{mrad} = 8.9^\circ \\ \phi_B(12\mathrm{kV}, 100\mathrm{G}) &\simeq 176\ \mathrm{mrad} = 10.1^\circ. \end{aligned}$$

The deflection Δx at the sample position is then given by

$$\begin{aligned} \Delta x &= r \cdot (1 - \cos\phi_B),\ r = \frac{l_{eff}}{\phi_B}, \\ \Delta x(15\mathrm{kV}, 100\mathrm{G}) &\simeq 0.6\ \mathrm{cm}, \\ \Delta x(12\mathrm{kV}, 100\mathrm{G}) &\simeq 0.7\ \mathrm{cm}, \end{aligned}$$

where the deceleration/acceleration in the electric field of the last focusing element RA has been ignored for simplicity.

[1] see, for example, T. Prokscha, *The new μE4 separator*, PSI (2007), available under http://www.psi.ch/smus/BeamlineMuE4EN/mue4_separator.pdf