Beam Loss Monitors

Exercises

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Exercise BLM a:

HERAp is a proton storage ring (920 GeV/c) with 6.3 km circumference.

How many beam particles are lost within a second (N_{Lost}), assuming a proton beam current of I_0= 70 mA and a lifetime of τ = 50 hours?

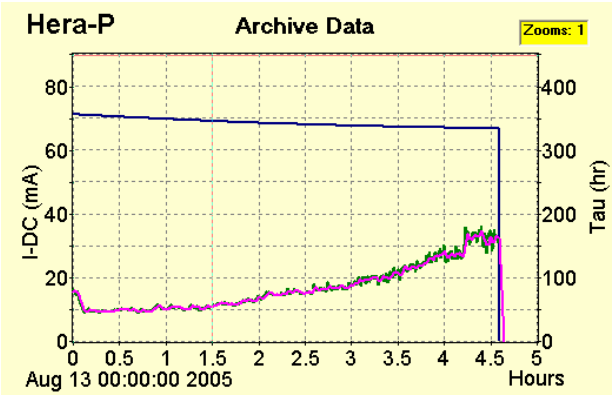

Fig. 1: Beam current [mA] vs time

Solution

Exercise BLM b:

Assuming all protons are lost in a 1 cm^3 block of iron (penetration length L = 1 cm). Calculate the deposit power P [W] in the block (1 J = 6.241 $\cdot 10^{18}$ eV):

Solution:

This number gives a macroscopic feeling of the measurable power due to beam losses during a bad luminosity run in HERAp with worse lifetime. Possible reasons for these losses are: Beam-beam kicks, transversal and longitudinal dispersion, residual gas scattering, halo scraping, instabilities… These losses can be used for beam diagnostics. But note that typically losses might not be concentrated at one location only!

Where to put the BLMs to measure beam losses?

Each BLM at different locations needs its special efficiency-calibration in terms of signal/lost particle. This calibration can be calculated by use of a Monte Carlo Program with the (more or less) exact geometry and materials between the beam and the BLM. For the simulation it might be important to understand the (beam-) dynamics of the losses and the loss mechanism.

Exercise BLM c:

At a certain location of a BLM in HERA (collimator), the efficiency to beam losses is about ε= 0.1 MIP / ($cm^2 \cdot$ lost proton) (at 300 GeV/c) at the BLM location.

Calculate the resulting current I_{ion} of a 1 litre air filled ionization chamber BLM. Assume that 1/10 of the losses above (Exercise BLM a) occur here. About E_{pair} = 22 eV/pair is needed to create an electron / ion pair in air.

Solution:
