COMPUTING METHODS FOR PHYSICS
16 NOVEMBER 2021

You must submit your exam by following the instructions at http://www.roma1.infn.it/people/rahatlou/cmp/

Bethe-Bloch Energy Loss

Provide a class **`Particle`** characterised by

- mass (in GeV)
- charge (in units of e)
- Three momentum

with proper data members, constructor, and accessor functions. Implement the following 3 member functions (with proper arguments if needed and proper return type): **`beta()`**, **`gamma()`**, **`betagamma()`**.

Provide a class **`Material`** characterised by

- Density ρ (in g/cm^3)
- Atomic mass A
- charge Z (in units of e)
- mean ionisation energy <I> (in eV)

with proper data members, constructor, and accessor functions. Implement the member function **`dEdx(…)`**, using a **`Particle`** object as argument, to compute the mean energy loss by a particle:

- for kinetic energy above 50 MeV use the Bethe-Bloch formula for the energy loss
- for kinetic energy below 50 MeV, assume an energy loss proportional to the particle momentum squared p^2

Provide a test application **`app.cc`** using these classes, to compute the mean energy loss $\langle dE/dx \rangle$ for a proton and an α particle of momentum p = 10 MeV, as a function of the penetration depth x (in cm) in silicon.

Plot the mean energy loss $\langle dE/dx \rangle$ as a function of x for both particles. Use red for the proton and blue for the α particle and provide a legend.

Evaluation will be based on: correct C++ syntax, proper return type and arguments of functions, data members and interface of classes, unnecessary void functions, correct mathematical operations, correct physics calculation and units.

Useful data:

	densita` [g/cm^3]	<I> [eV]	E_c [MeV]	Lungh. Radiazione X_0 [cm]	Lungh. Interazione X_I [cm]	Z	A	δ
Si	2.33	173	40	9.37	46.52	14	28	0