QF simulation

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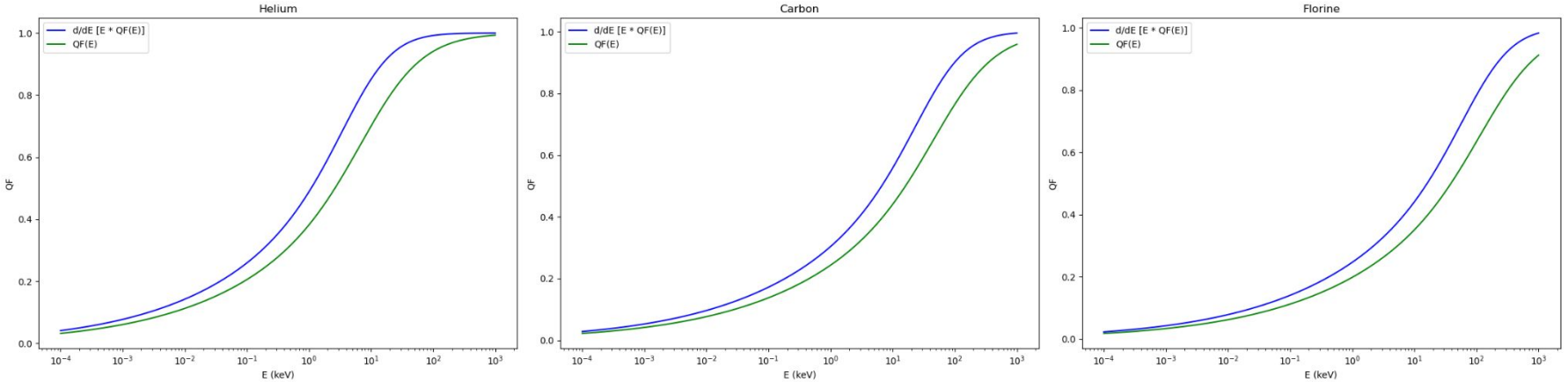
QF simulation

- QF from SRIM implemented in Geant4 using the hits class
- Parameterized with a function (from Flaminia's PhD thesis)

$$QF(E) = \frac{k(E_{ion} + aE_{ion}^{b})}{1 + k(E_{ion} + aE_{ion}^{b})}$$

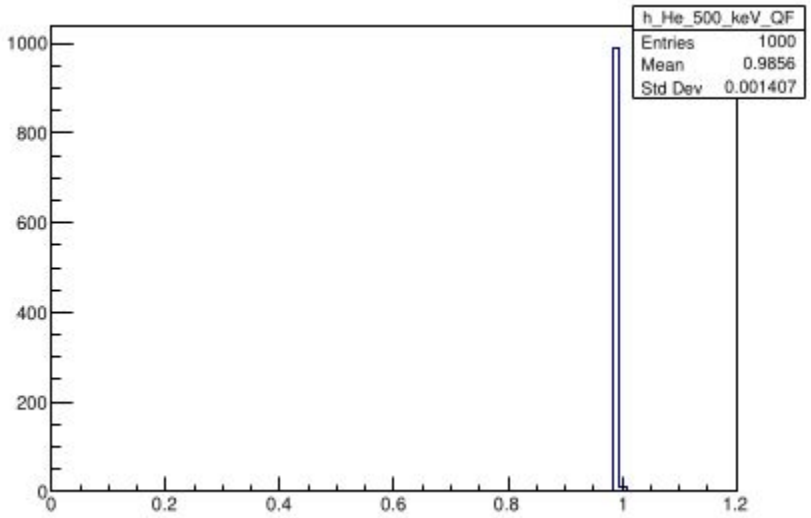
Ion	k	a	b	χ^2/ndf
H	0.65 ± 0.02	1.82 ± 0.08	0.48 ± 0.04	$40.35/20$
He	0.117 ± 0.005	3.9 ± 0.2	0.44 ± 0.03	$20.94/20$
C	0.0195 ± 0.0007	14.7 ± 0.4	0.33 ± 0.1	$36.53/20$
F	0.0083 ± 0.0002	27.4 ± 0.7	0.303 ± 0.008	$16.74/20$

$$F(E) = \frac{d(E \times QF(E))}{dE}$$ → used to calculate hit-by-hit dE_{ion} (corrected with QF)

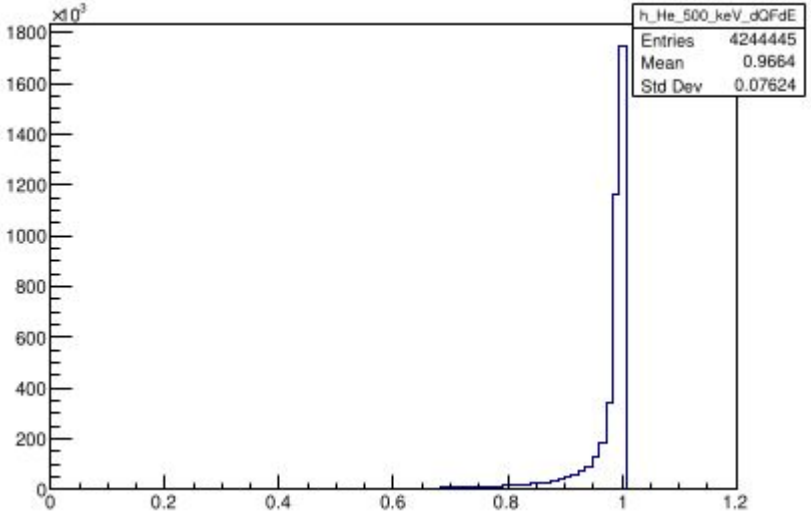


Check QF for He recoils 500 keV

Total QF (E_ion/E_tot)

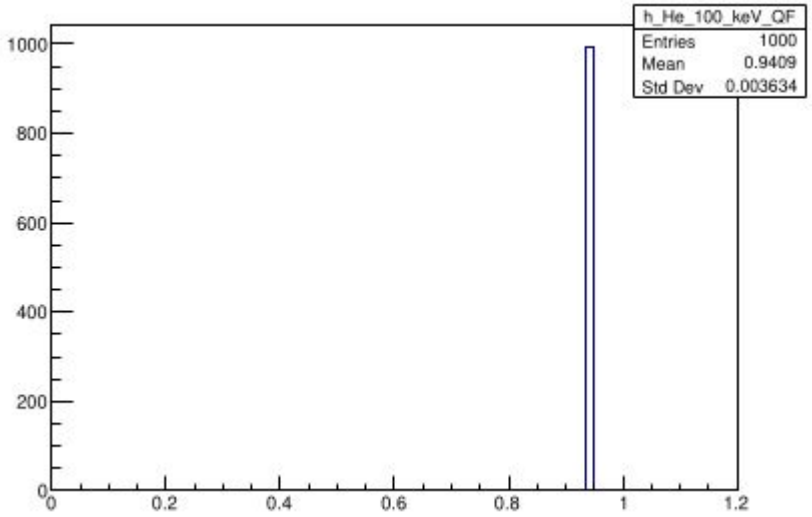


dQFdE (dE_ion/dE_tot)

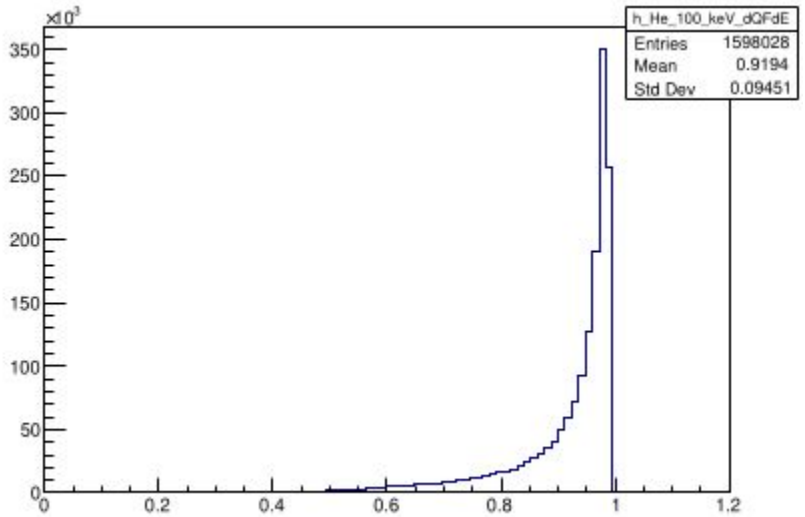


Check QF for He recoils 100 keV

Total QF (E_ion/E_tot)

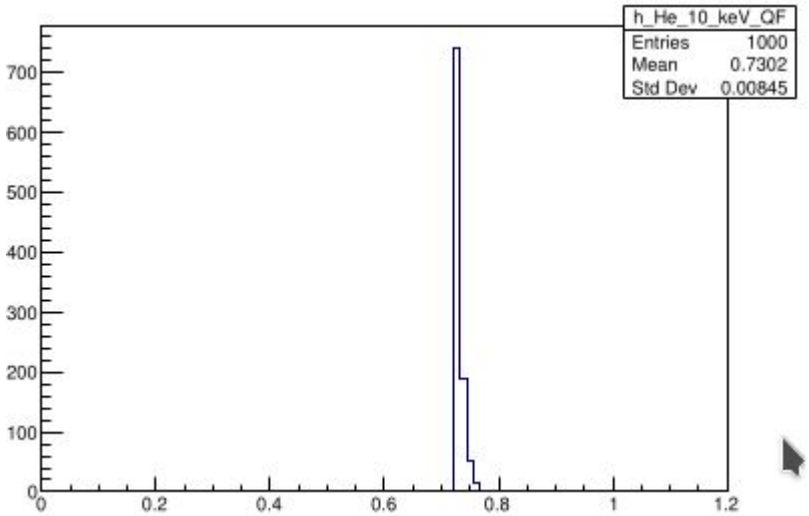


dQFdE (dE_ion/dE_tot)

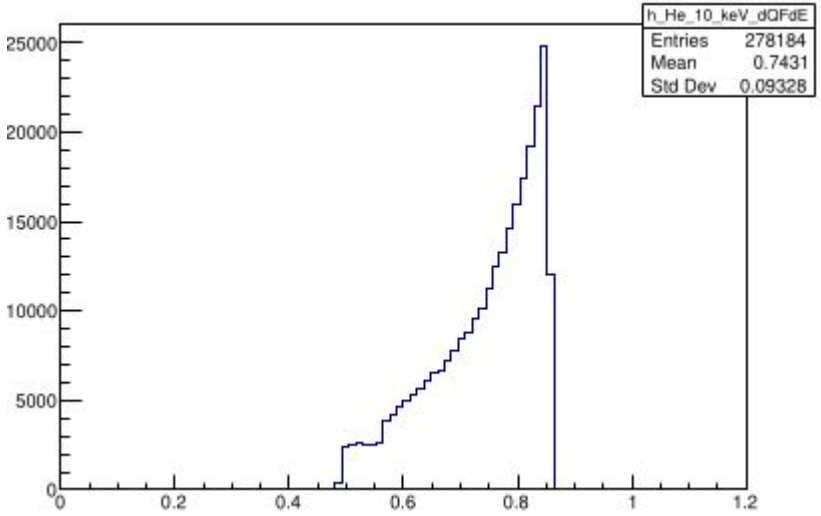


Check QF for He recoils 10 keV

Total QF (E_ion/E_tot)

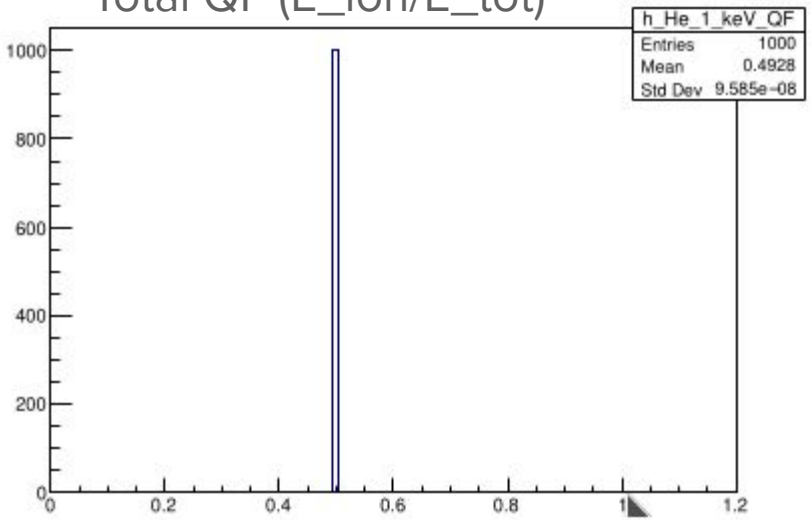


dQFdE (dE_ion/dE_tot)

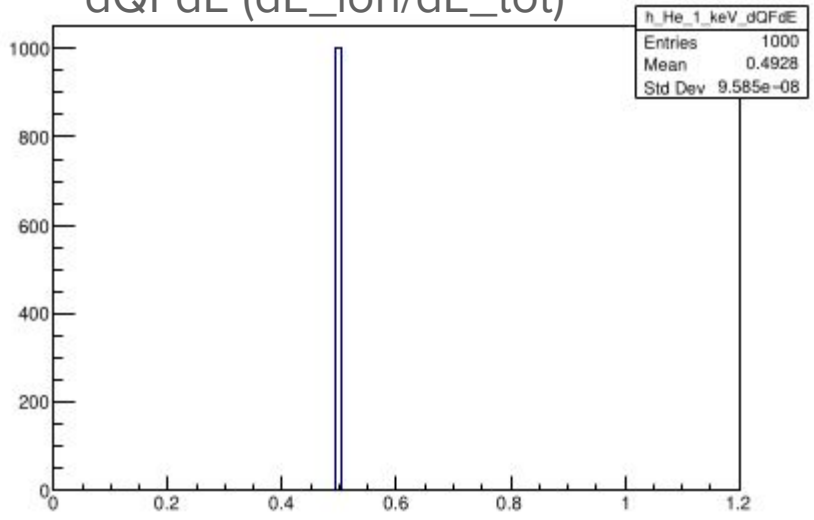


Check QF for He recoils 1 keV

Total QF (E_ion/E_tot)



dQFdE (dE_ion/dE_tot)



Ions with E=1 keV lose their energy in a single step

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**********************************************************************************************************
* G4Track Information:   Particle = alpha,   Track ID = 1,   Parent ID = 0
**********************************************************************************************************

Step#    X(mm)     Y(mm)     Z(mm) KinE(MeV)  dE(MeV) StepLeng TrackLeng  NextVolume ProcName
    0     -195      -112     -10.8     0.001        0        0         0   CYGNO_gas initStep
    1     -195      -112     -10.9         0    0.001   0.0553    0.0553   CYGNO_gas ionIoni
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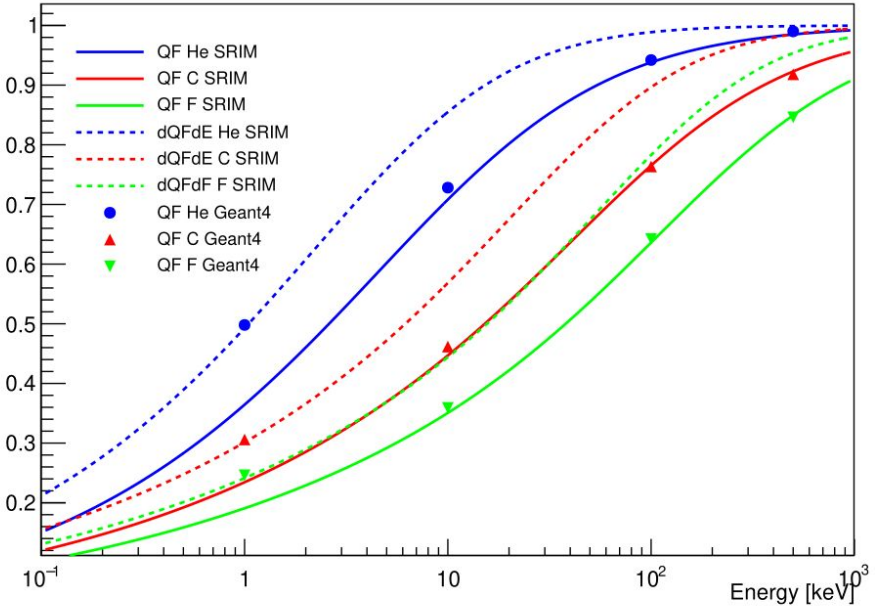
Closure test

The QF returned by Geant is correct for energies > 10 keV, while at 1 keV the total QF is equal to the derivative dQFdE because Geant4 tracks of 1 keV ions have only one step.



To do: force geant to do finer steps or find a workaround to apply the correct QF at ~few keV