The GEp Event Generator

Objective: The GEp Event Generator should generate electrons (and maybe pions) with the energy and angular distribution as expected by the UVa target and beam energies used during the GEp experiment.

The probability for electron with energy E_0 to scatter off nucleus i by interaction j to energy interval $\Delta E'$ and solid angle $\Delta\Omega$ is:

$$P(E_0)=\frac{f_i \rho N_A}{M_{A_i}}\cdot\int_z\int_E\int_{\Delta E'}\int_{\Delta\Omega}\frac{d^3\sigma_{i,j}(E)}{d\Omega\, dE'}\cdot\frac{dn}{dE}(z)\cdot d\Omega\, dE'\, dE\, dz$$

$f_i\rho$ - fractional density of nucleus i. (packing fraction is hidden here).

N_A - Avogadro's number.

M_{A_i} - atomic mass of nucleus i.

$\frac{d^3\sigma_{i,j}(E)}{d\Omega\, dE'}$ - cross section of nucleus i for interaction j.

$\frac{dn}{dE}(z)$ - electron energy distribution at depth z.

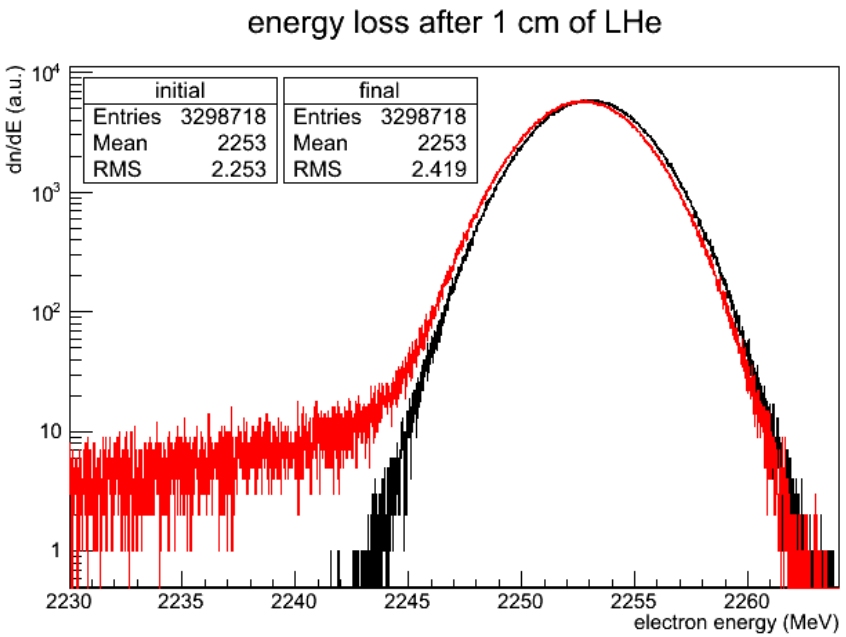
Assuming uniform distribution of the different materials in the target.

energy loss

- Using Geant4 to calculate electron energy distribution as as function of z.
- Calculation done separately => low felxibility.
- Calculating at 0.5,1,1.5,2,2.5 and 3 cm. Using interpulation to get continues z coordinate.
- Don't have experimental data to compare. Comparison with ESTAR is not very good for liquid He, but hard to compare.

energy loss

liquid helium

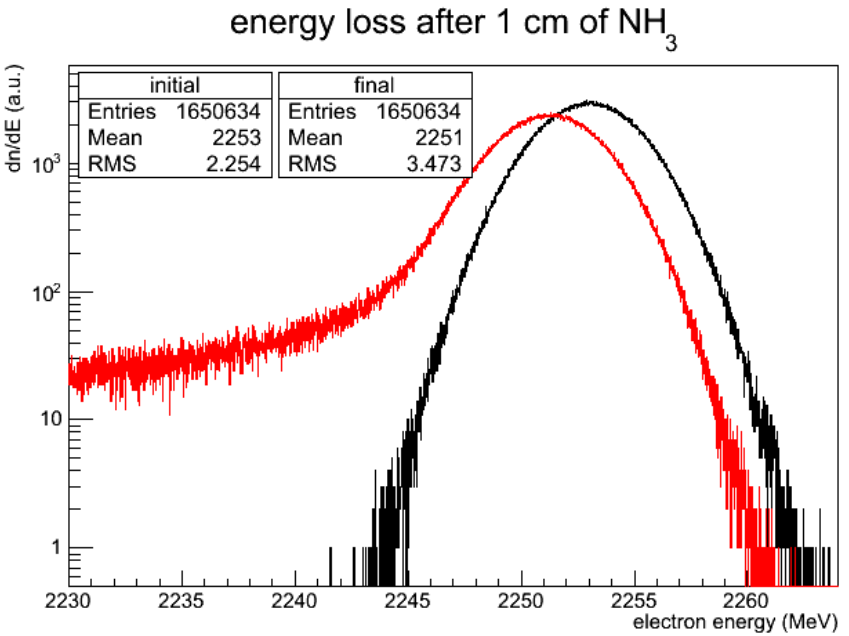


ESTAR

Collisions:2.4 MeV

Radiative: 24 MeV

solid ammonia



ESTAR

Collisions: 2.6 MeV

Radiative: 54 MeV

cross sections

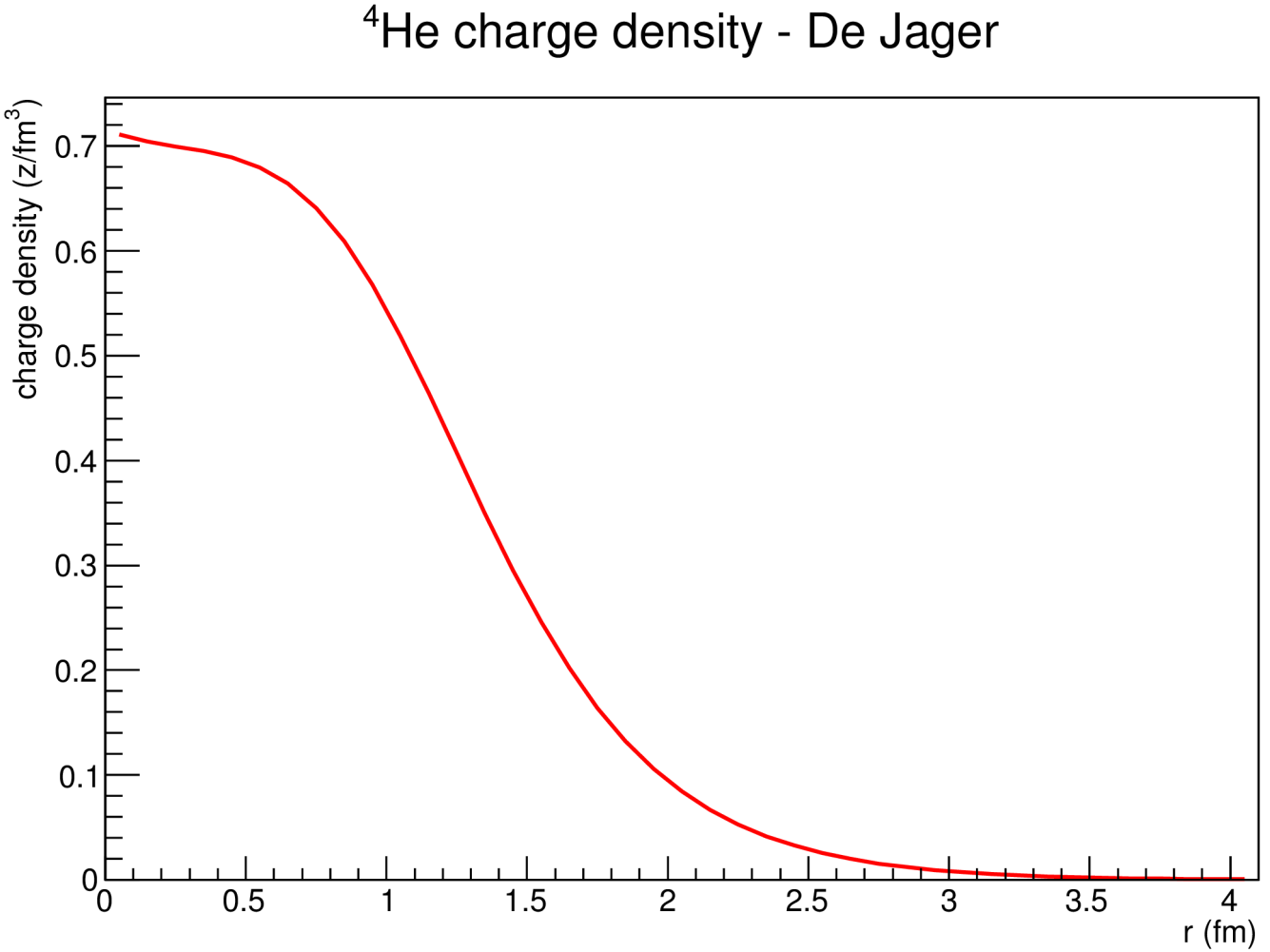
- elastic scattering: using form factors.

  H - Arrington Phys. Rev. C 69, 022201 (2004)
  He & N – charge and magnetization densities from De Jager, At. Data Nucl. Data Tab. 14 (1974).

$$FF(q) = \int_0^\infty \rho \frac{\sin(qx)}{qx} x^2 \, dx$$

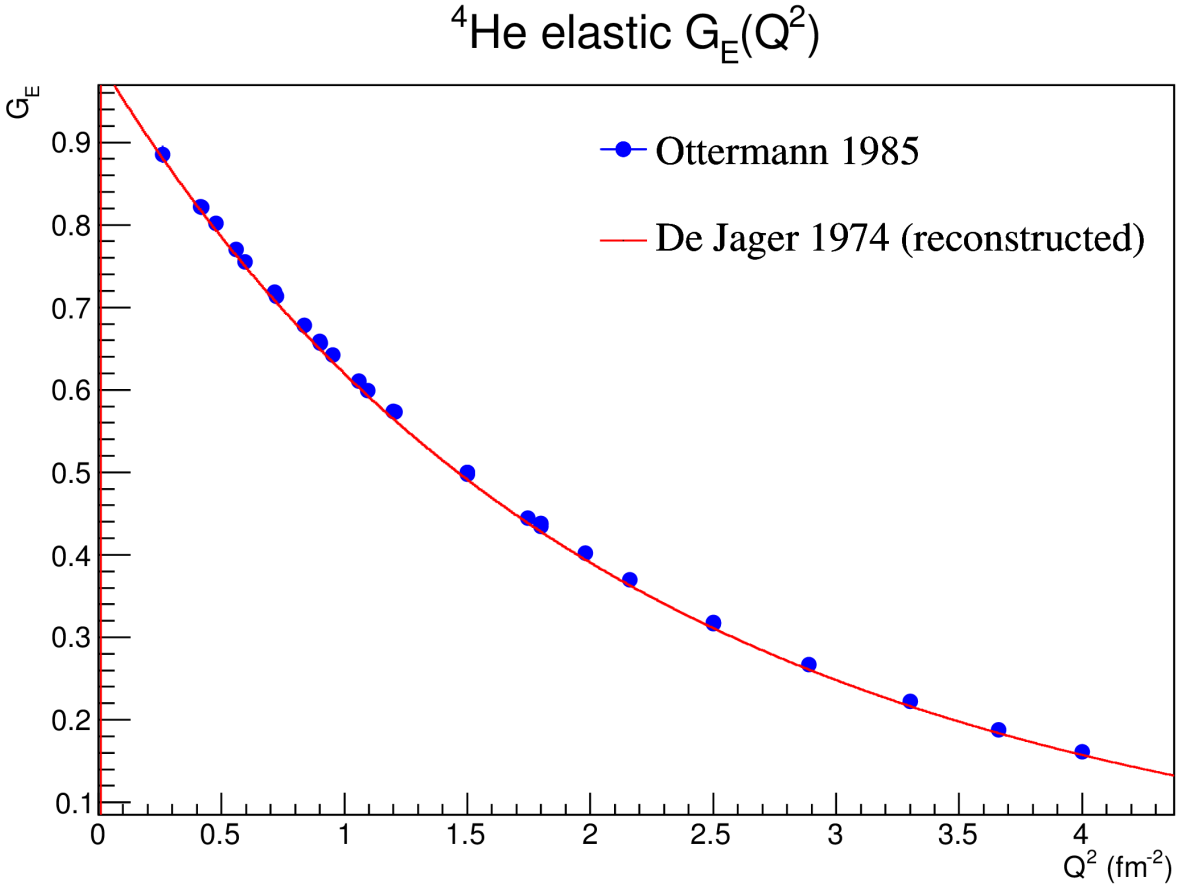
- non-elastic: using QFS.

cross sections



De Jager *et al.*, At. Data Nucl. Data Tab. 14 (1974).

comparison with experimental data elastic scattering

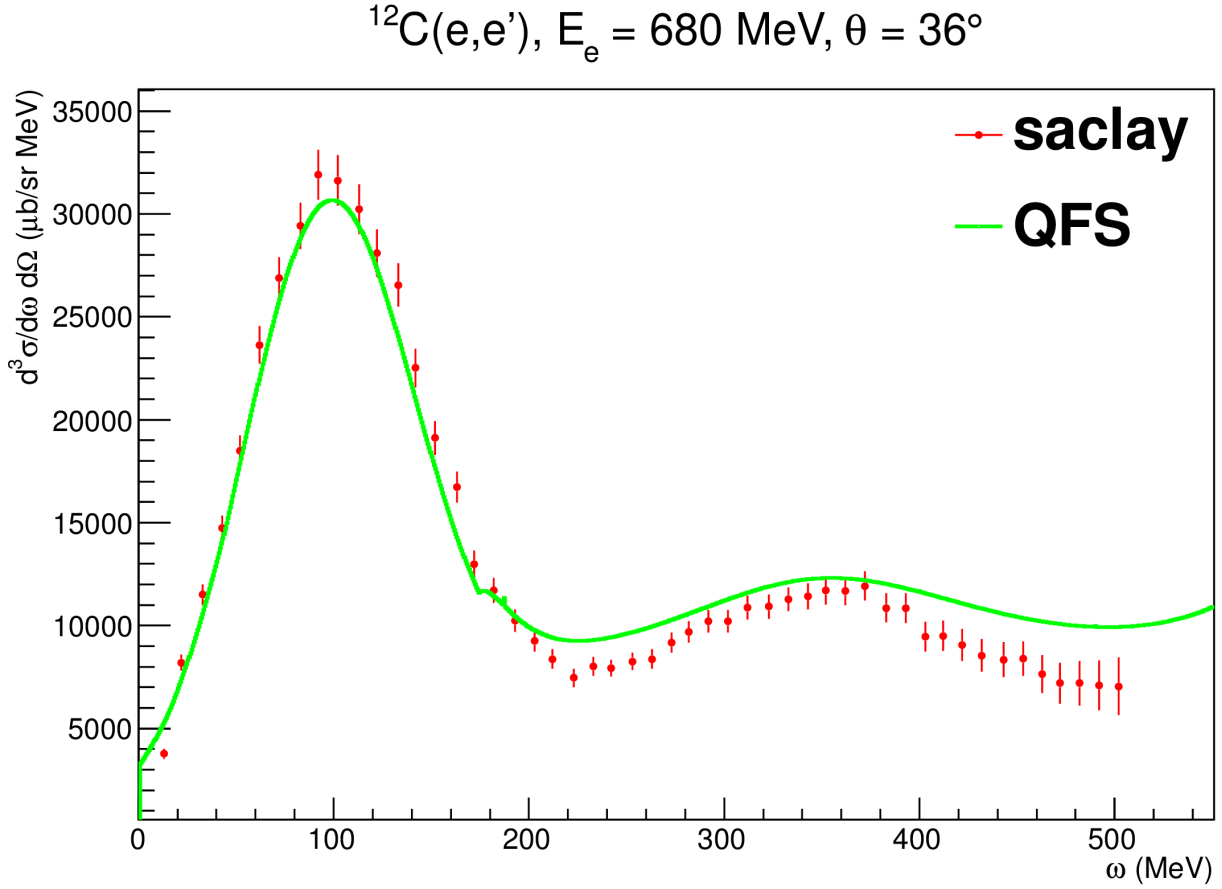


De Jager *et al.*, At. Data Nucl. Data Tab. 14 (1974).

C. R. Ottermann *et al.* Nucl. Phys. A 436 (1985)

Hard to find data for ^{14}N!

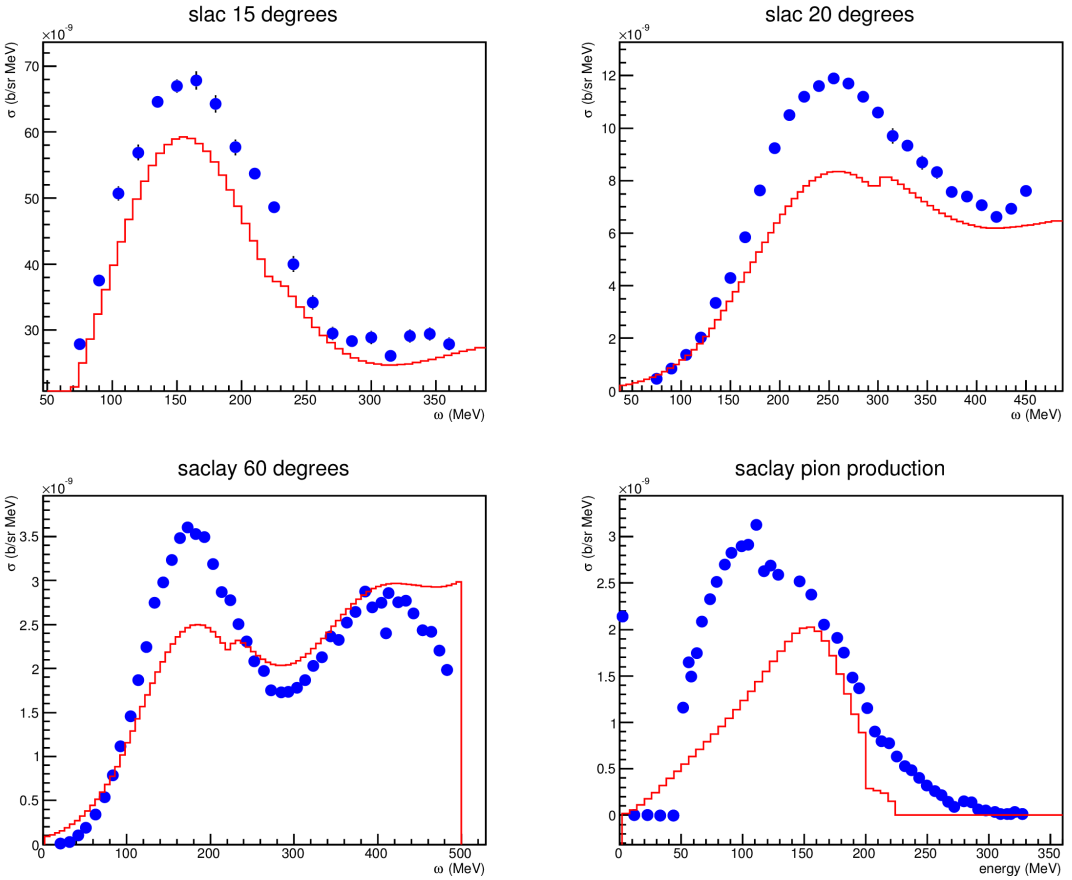
comparison with experimental data non-elastic scattering



P Barreau *et al.*, Nucl. Phys. A 402 (1983)

Hard to find data for ^{14}N!

comparison with experimental data non-elastic scattering



Slac - D B Day *et al.*, Phys. Rev. C 48 (1993)
Saclay - P Barreau *et al.*, Nucl. Phys. A 402 (1983)

Have to make sure that I'm using QFS correctly

next steps

- Convince myself that I can use QFS to get acceptable results. Depends whether g2p will need this tool.
- Search for experimental ^{14}N elastic and non-elastic CS data for validation. (Maybe Vince can help?)
- Implement GEp event generator into HRSMC PrimaryGeneratorAction.
- Make the simulation run in reasonable time. This might be a trade-off with flexibility. Also Depends whether g2p will need this tool.
- Compare HRSMC results to experimental focal plane variables.
- Use simulation to tune packing fraction, if possible, and compare to independent packing fraction analysis, if exists.
- Use simulations to extract dilution.