CHANNELING STATUS

Solid state support classes

- Rotation from/to lattice
- Potential
- Electric field
- Density
- …
- Useful for other processes (e.g., x-ray diffraction)

Channeling process

- Limited to a few functions
- Ready to be “biased”

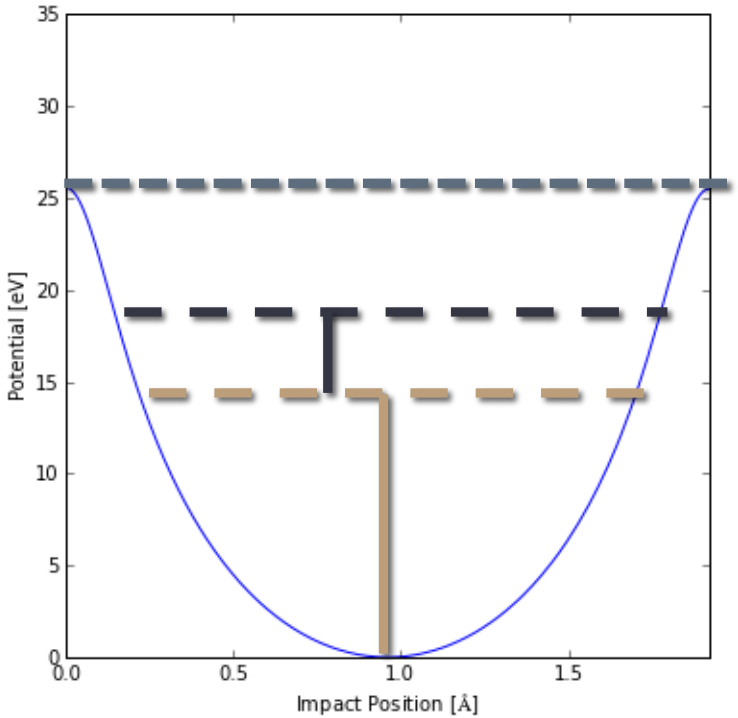
Channeling support class

- Calculation of quantity of interest for channeling
- Analytical function, not used during simulations

Condition for channeling

Straight crystal

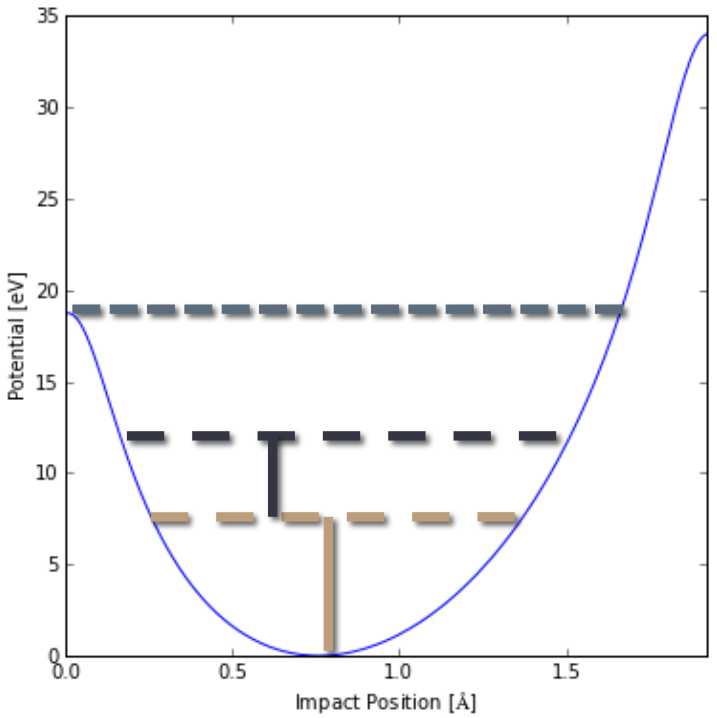
$$E_T < U_{\max}$$



$$E_T' = \frac{p\beta}{2}\theta^2 + U'(x)$$

Bent crystal

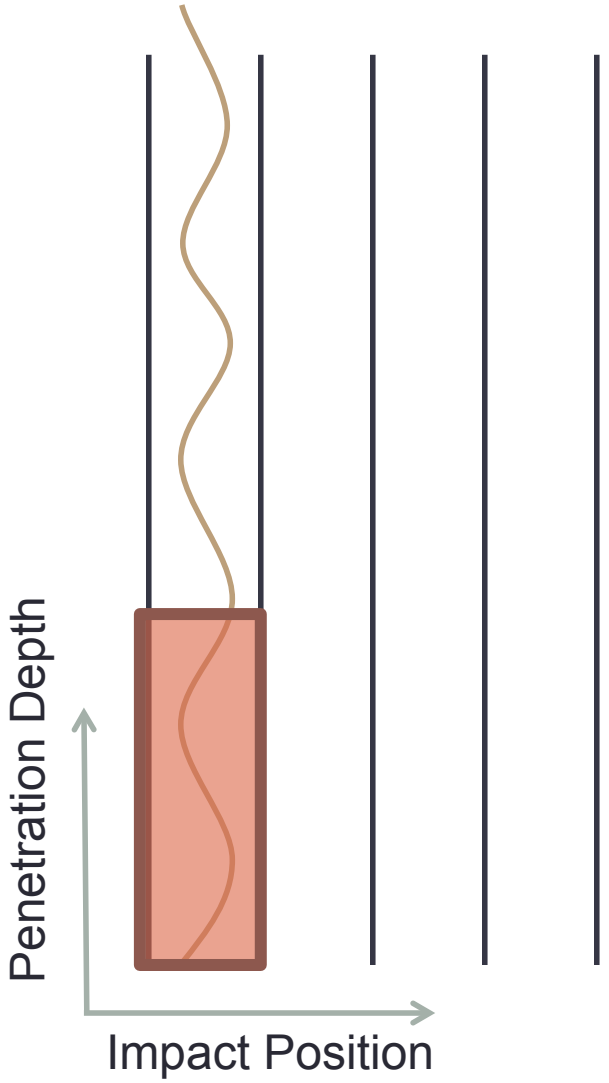
$$E_T' < U'_{\max}$$



$$E_T = \frac{p\beta}{2}\theta^2 + U(x)$$

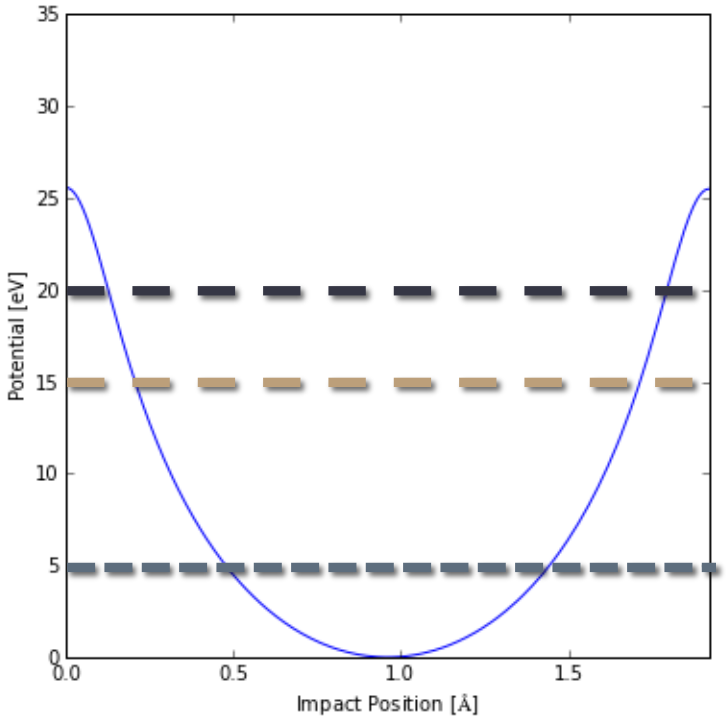
Modified density

- Before the simulation starts, the table of the average density ratio vs. the transverse energy is computed or loaded.
- The path is integrated over one oscillation period.

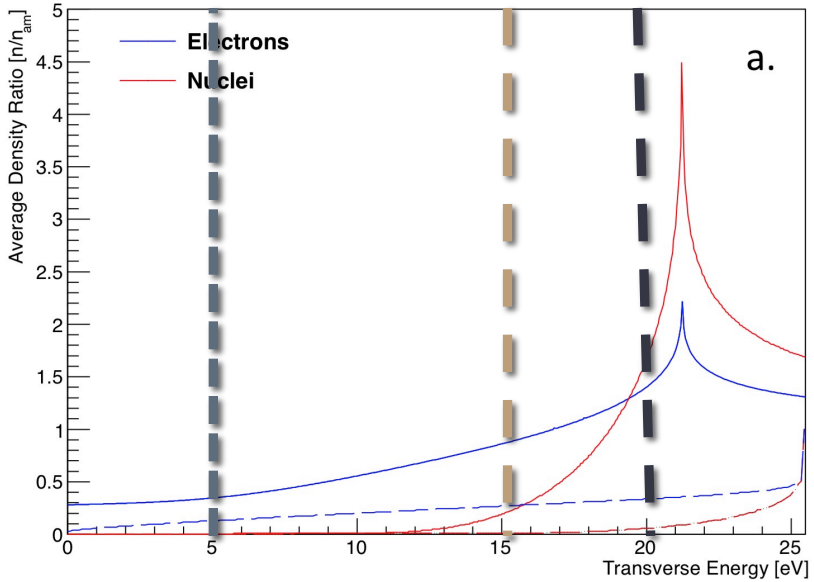


Modified density

Straight crystal



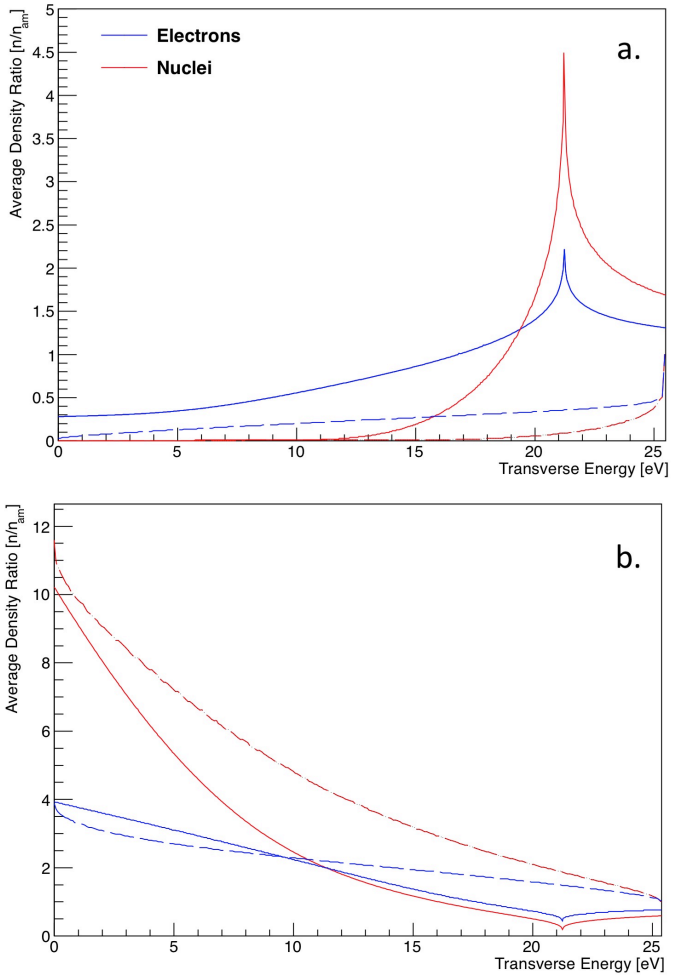
Density Ratio



Depending on the transverse energy of the particle, the density “seen” is different

Modified density

- Nuclei and electron density tables are stored for positive and negative particles.
- This approach can be used for crystal with dimension parallel to the beam much longer than the channeling oscillation period.



Geant4 processes

Discrete processes

- The mean free path of the discrete processes is recomputed at each step using the modified density because it is directly proportional to the density (ρ) of the material.

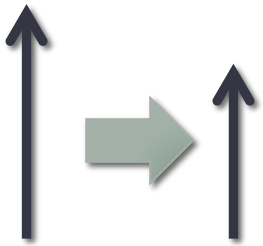
Continuous processes

- Material density (ρ) for the calculation of continuous energy loss (dE/dx) is modified at each step (dx=ρdz) to enable the reduction or the enhancement of the energy loss due to channeling.

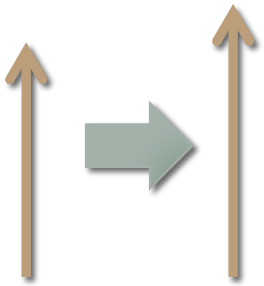
Modified density

Geant4 Mean Free Path Modification

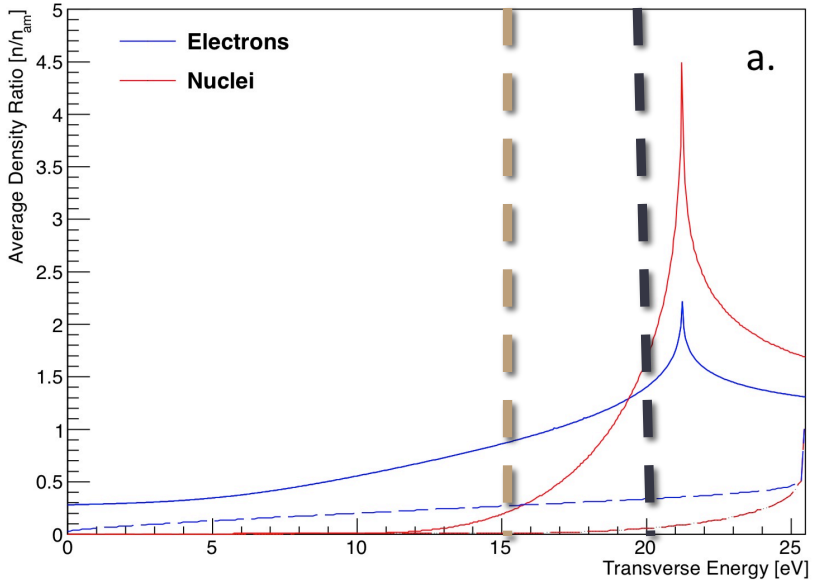
(@20 eV) Density Ratio = 1.5



(@15 eV) Density Ratio = 0.8



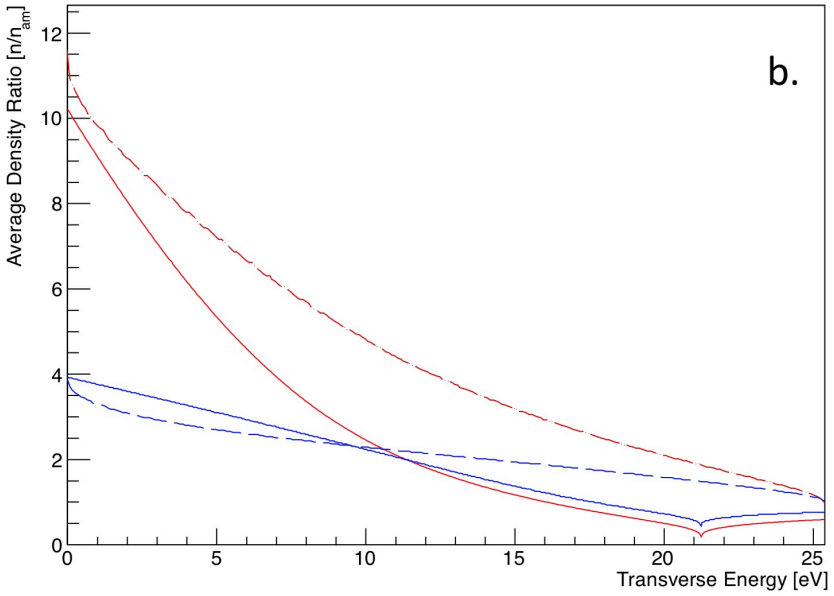
Density Ratio



Depending on the transverse energy of the particle, the density “seen” is different

Modified density

- For negative particles the ratio is always higher than unity. Thus, the particles interact more frequently with nuclei and electrons in a crystal under coherent effects than in an amorphous media with the same average atomic density.



CHANNELING BIASING REQUIREMENTS

On/Off:

- Each process which modify position (e.g., Multiple Scattering processes) **disabled inside the crytal**.
- Processes to substitute Multiple Scattering (e.g., Single Scattering?) **enabled only inside crystal**.

Cross section:

- PostStep/AlongStep processes:
  - Biased Cross-Section changes linearly with density ratio in the crystal.
- AtRest processes: no changes
- Applicable to charged particles only
- Two different density ratio (nuclei,electrons) for processes
  - manual map for all G4 processes?

AuxiliaryTrackInfo

- Position/Momentum in the crystal reference frame
- Density ratio for nuclei and electrons