Radiation Damage in InGaAs Photodiodes

Ana Keating
TOS-QCA

Aims

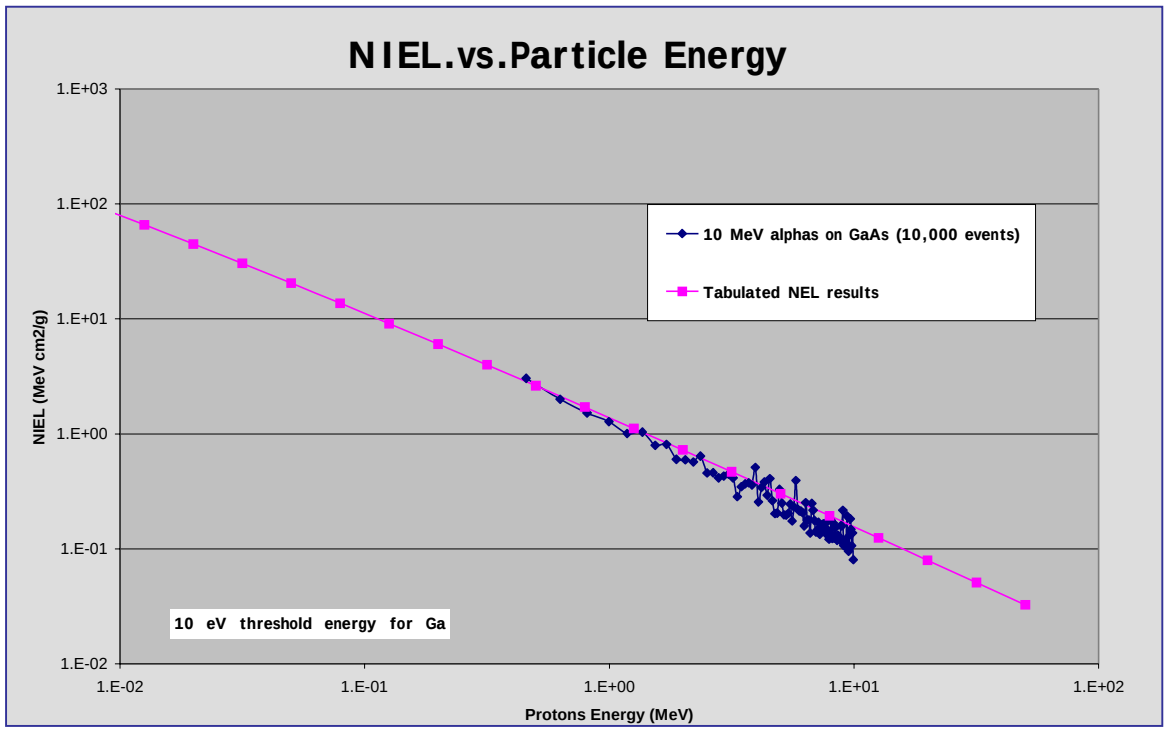
- Verification of InGaAs photodiode proton irradiation results.
- Development of irradiation degradation prediction models for InGaAs photodiodes.

Overview

- Verification by means of Non Ionising Energy Loss
- NIEL in different materials using TRIM
- NIEL in different materials using GEANT4

NIEL for GaAs

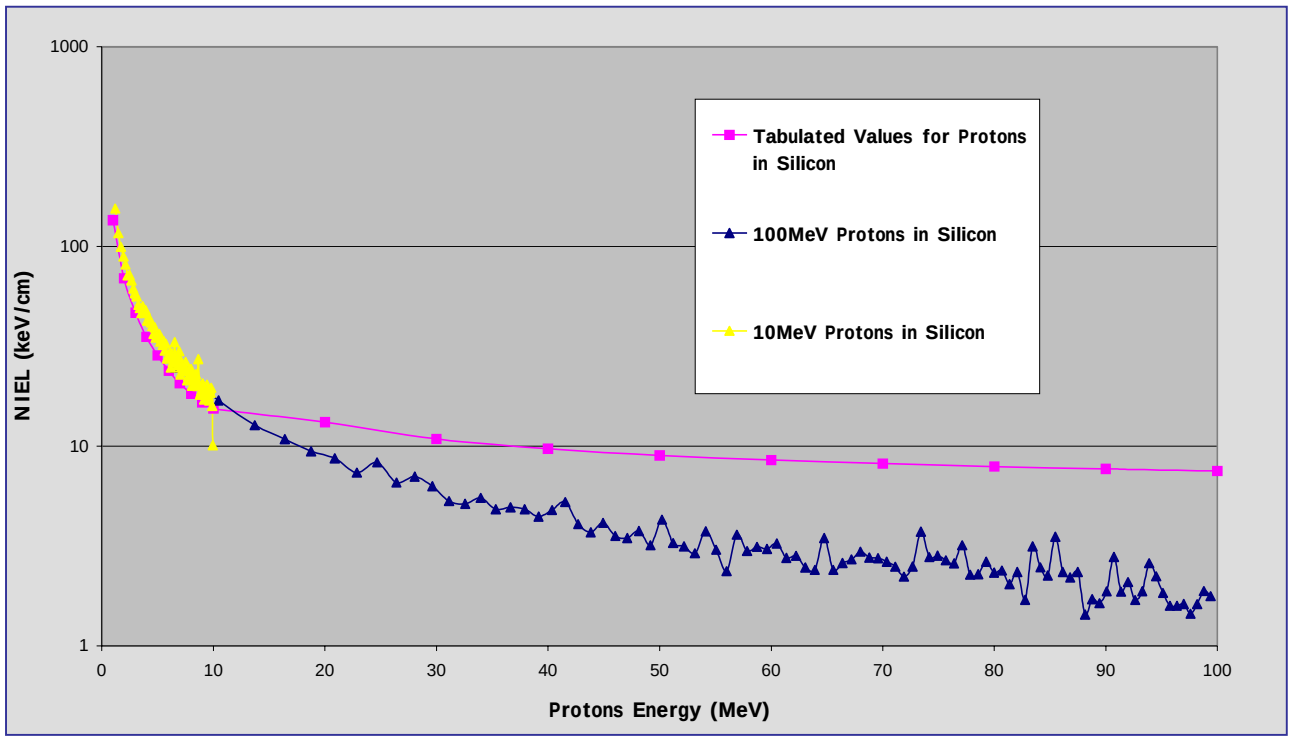
- Method suggested by Messenger et all in “Nonionizing Energy Loss for Heavy Ions”



- SRIM method is compatible with tabulated values in literature.

NIEL for Silicon

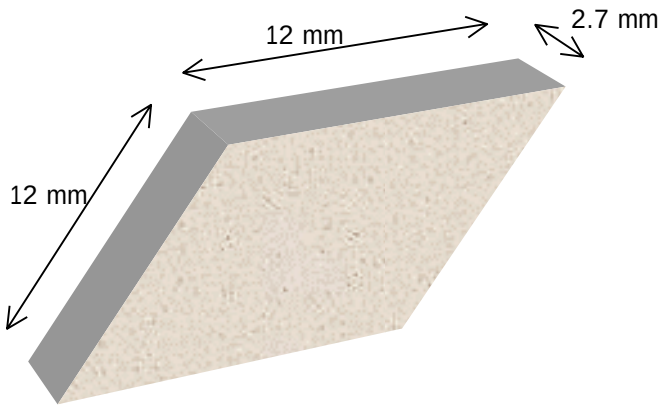
- NIEL as a function of the incident particle energy derived by SRIM data:



- Good agreement at low energies
- Tabulated data gives higher values of NIEL for energies above 10MeV.
  (SRIM limitation to Coulomb and non-relativistic interactions).

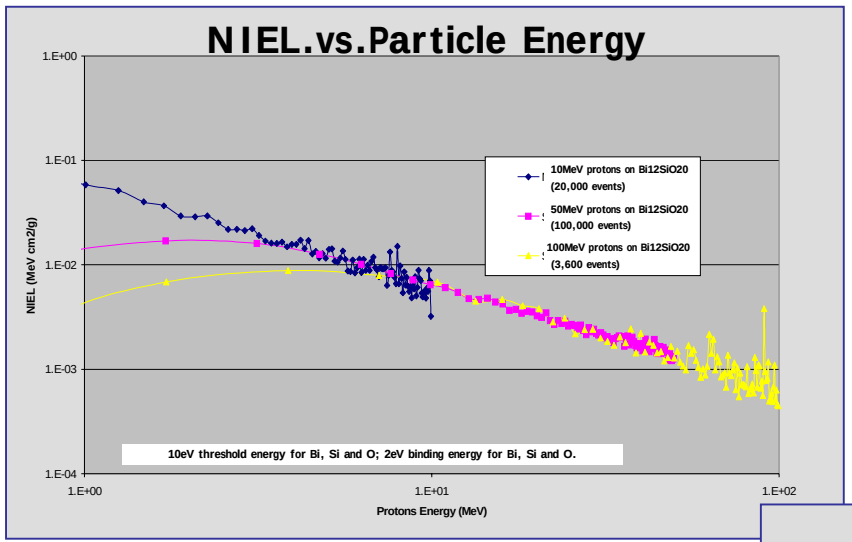
$Bi_{12}SiO_{20}$ - hologram in ISS

- Bismuth Silicon Oxide: Bi= 12; Si= 1; O = 20.
- The base for the hologram : recorded on the complete thickness, with a section of about 3 x 3 mm^2.



- **European Fluid Science Laboratory** (FSL)

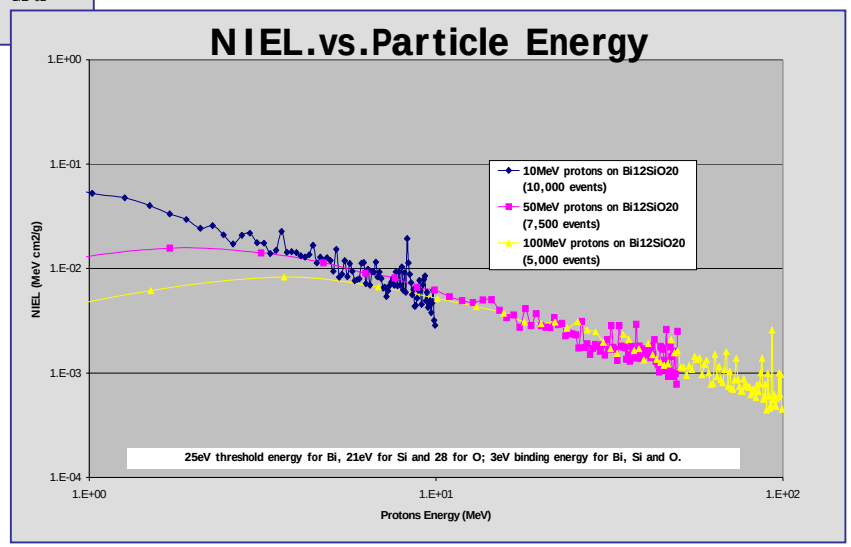
NIEL for Bi_{12} SiO_{20}



⇦ **Threshold energy** for atomic displacement used for Bi, Si and O atoms was **10eV**, **binding energy** was **2eV**.

⇩ **Threshold energy** used for Bi was **25eV**, for Si was **21eV** and for O was **28eV**. **Binding energy** used was **3eV**.

✶ Threshold values within this energy range do **not** significantly influence the NIEL calculations for $Bi_{12}SiO_{20}$.



GEANT 4

- Geometry is defined
- Elastic & Inelastic process are constructed for Protons, Neutrons, Deuteron, Triton & Alpha particles.
- Secondary Neutrons, Deuterons & Tritons with sufficient energy create displacement damage.

Conclusions

- SRIM calculations have been performed as an exercise to enable a better understanding of NIEL in different materials.
- GEANT4 is being used to compute NIEL because it enables the implementation of inelastic interaction.
- Next Step is to use the experience gained in GEANT4 to verify the results obtained for InGaAs photodiodes.