

Using Microscopic Tracking for Ionisation Calculations

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RD-51 Collaboration Meeting

Calculation of Ionisation with Garfield

- Energy loss by primary charged particle
- Emission of δ -electron and atomic relaxation
- Transport of δ electron(s)
- Amplification of ionisation

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 - ▶ PAI model (e.g. Heed)
 - ▶ SRIM/TRIM
 - ▶ MIP
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 - ▶ Microscopic tracking
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 - ▶ Townsend coefficient $\alpha(E)$
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Photoabsorption-Ionisation (PAI) Model

Particle: charge ze , speed βc

Medium: complex dielectric function $\varepsilon = \varepsilon' + i\varepsilon''$, density N

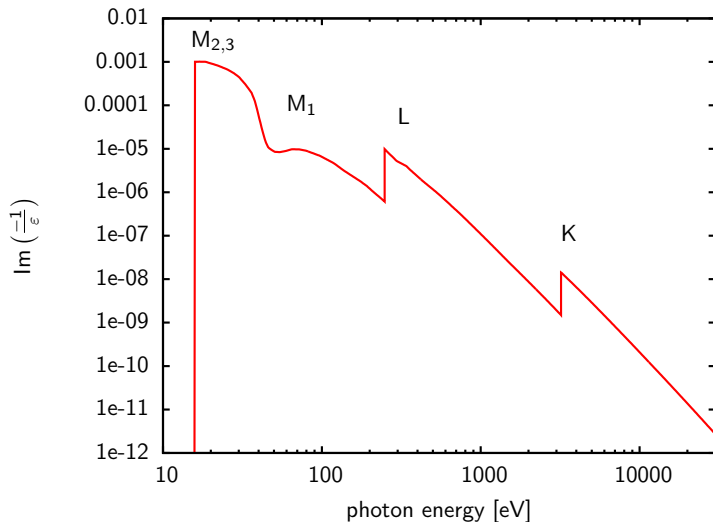
Cross-section for energy transfer E :

$$\begin{aligned} N \frac{d\sigma}{dE} = & \frac{z^2 \alpha}{\beta^2 \pi \hbar c} \operatorname{Im} \left(\frac{-1}{\varepsilon(E)} \right) \ln \frac{2m\beta^2 c^2}{E} \\ & + \frac{z^2 \alpha}{\beta^2 \pi \hbar c} \operatorname{Im} \left(\frac{-1}{\varepsilon(E)} \right) \ln \frac{1}{|1 - \beta^2 \varepsilon(E)|} \\ & + \frac{z^2 \alpha}{\beta^2 \pi \hbar c} \left(\beta^2 - \frac{\varepsilon'(E)}{|\varepsilon(E)|^2} \right) \left(\frac{\pi}{2} - \arctan \frac{1 - \beta^2 \varepsilon'(E)}{\beta^2 \varepsilon''(E)} \right) \\ & + \frac{z^2 \alpha}{\beta^2 \pi \hbar c} \frac{1}{E^2} \int_0^E E' \operatorname{Im} \left(\frac{-1}{\varepsilon(E')} \right) dE' \end{aligned}$$

Heed: $\operatorname{Im} \left(\frac{-1}{\varepsilon} \right) \rightarrow N \hbar c \frac{\sigma_{\gamma}}{E}$

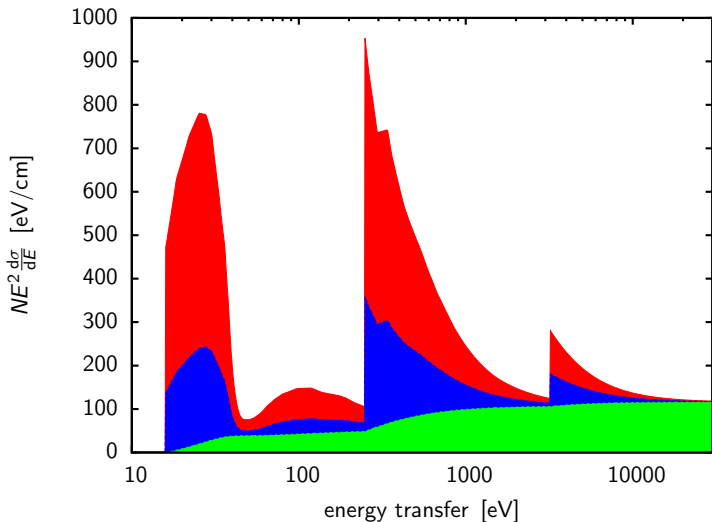
Photoabsorption-Ionisation (PAI) Model

- Argon



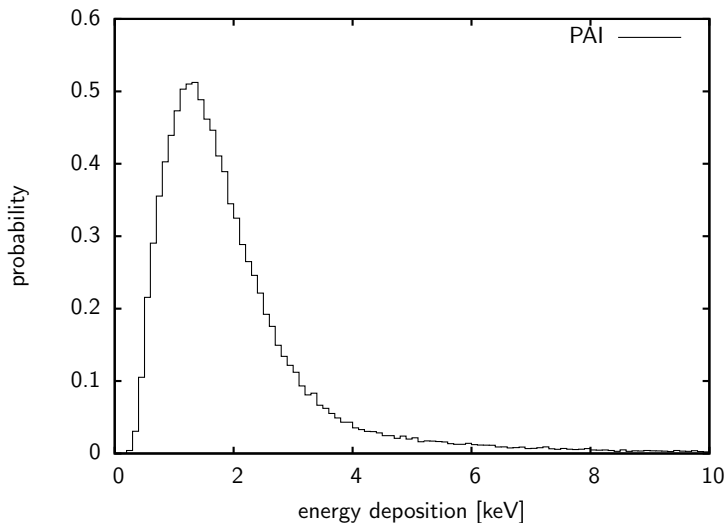
Photoabsorption-Ionisation (PAI) Model

- Argon, 2 GeV/c π



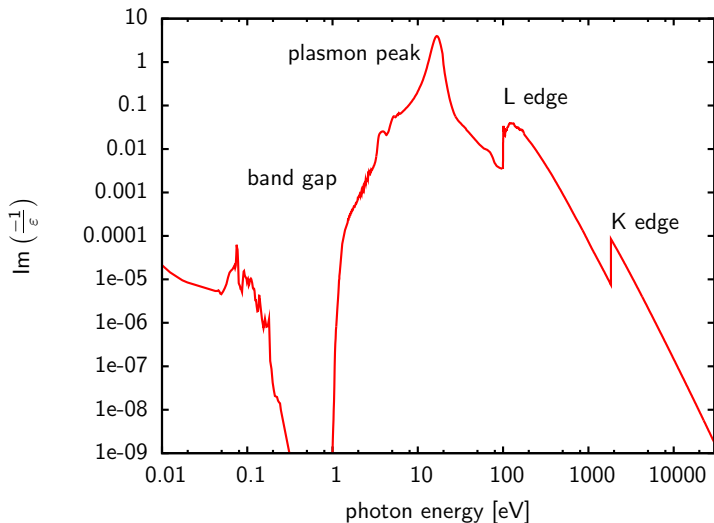
Photoabsorption-Ionisation (PAI) Model

- Argon 1cm, 2 GeV/c π



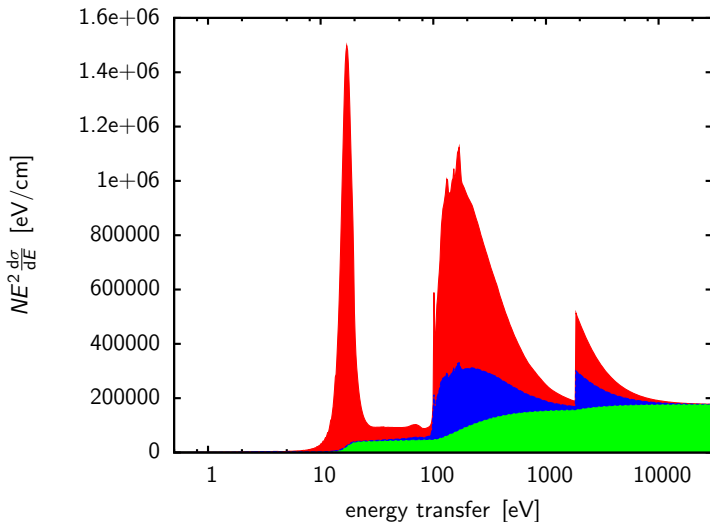
Photoabsorption-Ionisation (PAI) Model

- Silicon



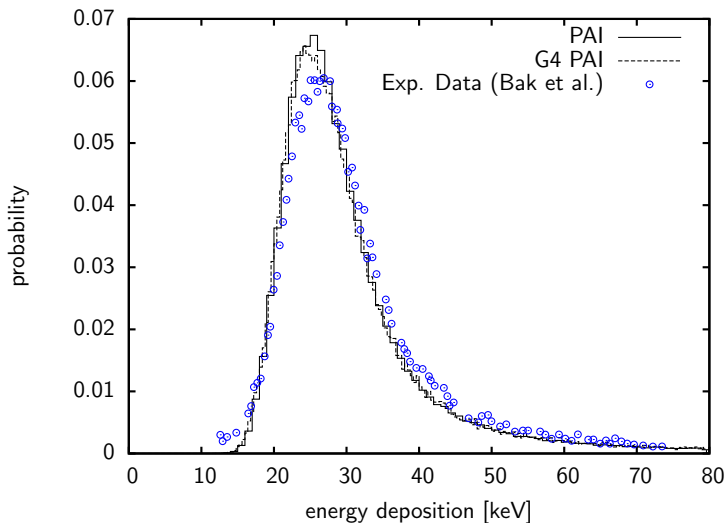
Photoabsorption-Ionisation (PAI) Model

- Silicon, 2 GeV/c π



Photoabsorption-Ionisation (PAI) Model

- Silicon 100 μm , 2 GeV/c π

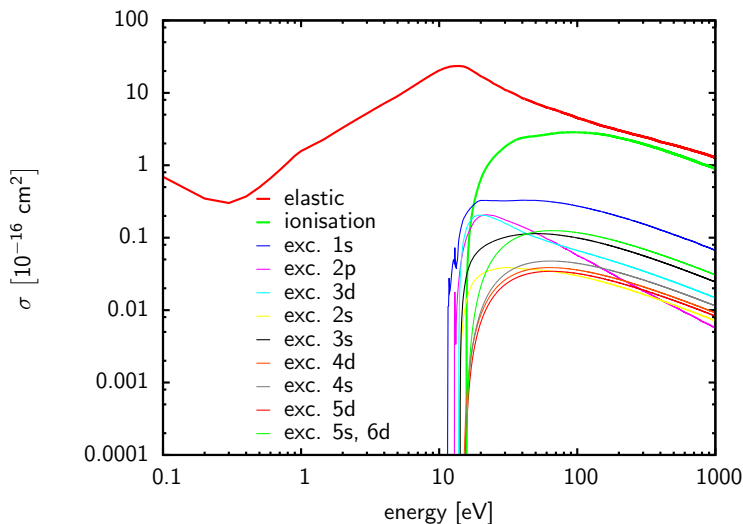


Microscopic Tracking

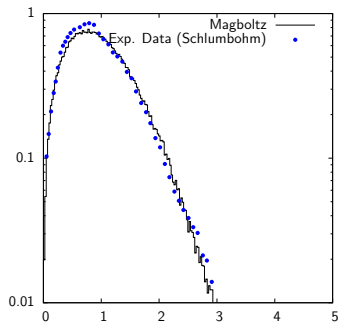
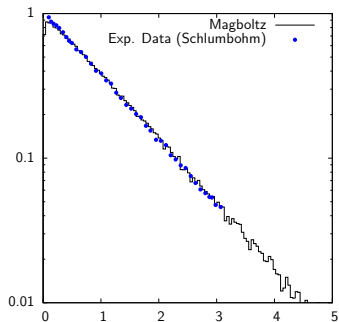
- MC transport of electrons using cross-sections from Magboltz database
- Based on Monte algorithm from Magboltz/MIP
- C++ version interfaced to Magboltz 8 available

Microscopic Tracking

- Magboltz 8.6: cross-sections for electrons in Ar

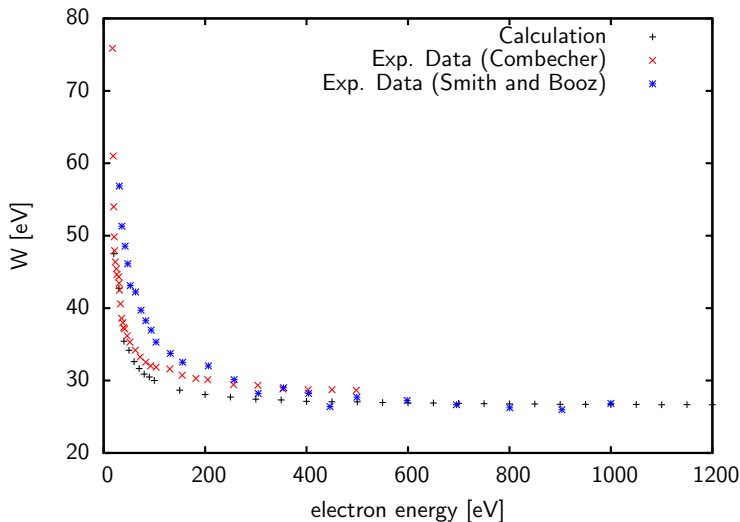


Microscopic Tracking



Microscopic Tracking

- Argon: W value for electrons



Microscopic Tracking

- First test: Cluster size distribution for Ar, $\beta\gamma = 4$

