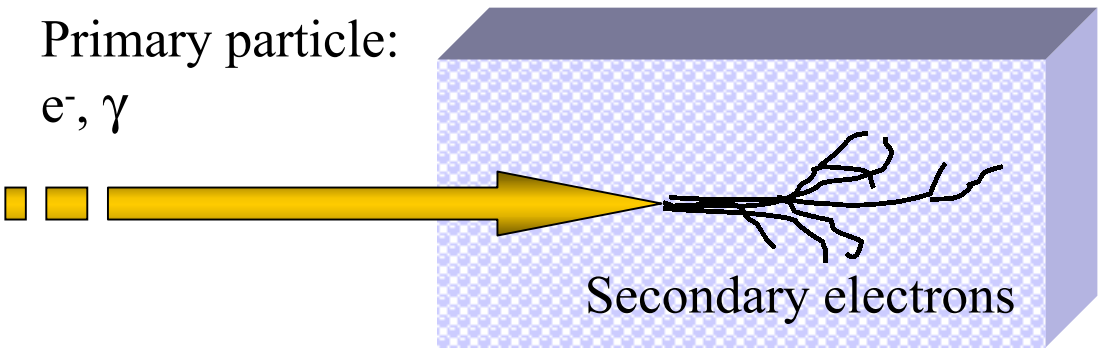
Secondary electron interactions and radiation damage

Gustavo García
CSIC, Madrid

General purpose

Energy deposition models of high energy particles (electrons and photons) at molecular level (nanoscale)



Considered energy range: 10 eV – 100 keV

Available simulation programs

- PENELOPE, EGS4, MCNP, GEANT4

¿Microscopic detail?⇒Appropriate input parameters (energy loss and pathway description)

Parameters required by a microscopic model

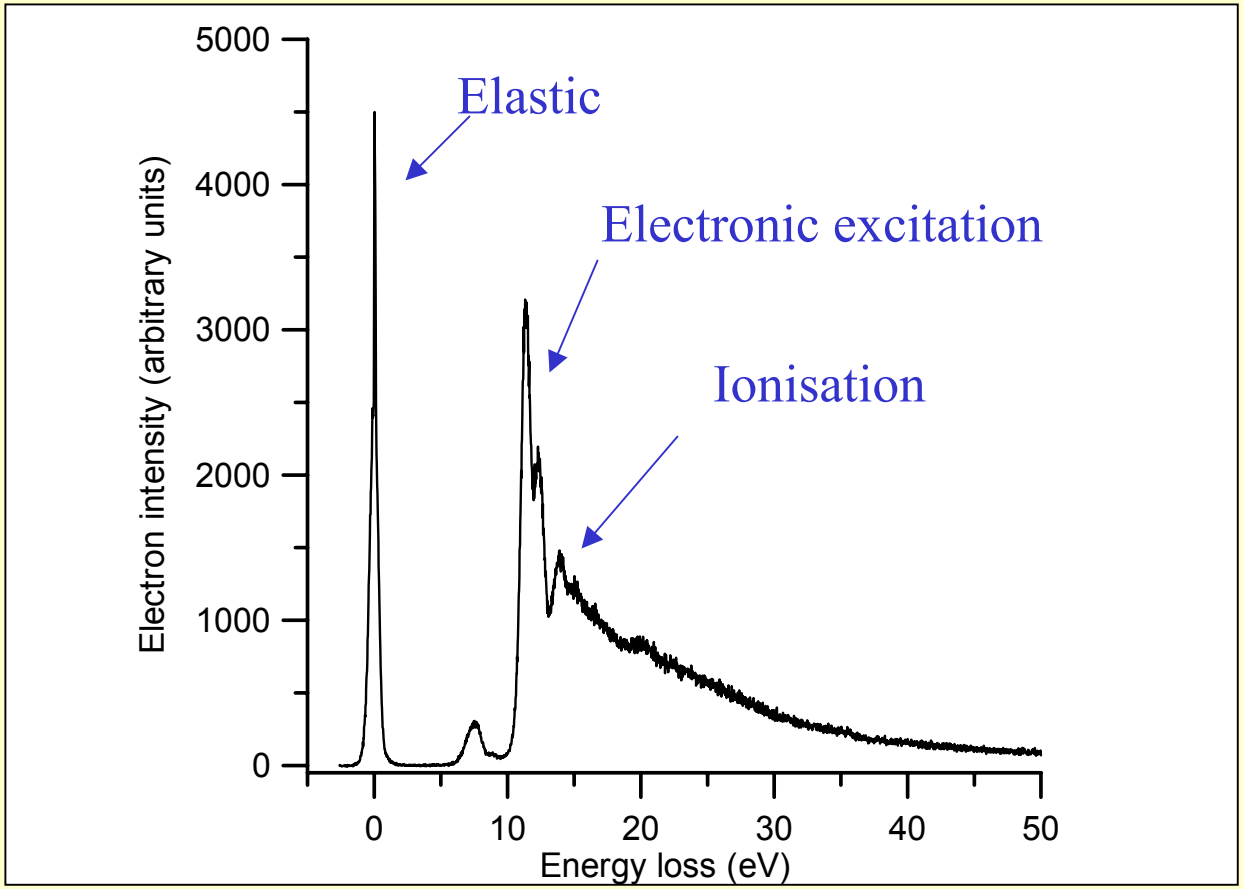
ELECTRONS

- **Process assessment**
  - Total electron scattering cross sections
  - Elastic an inelastic integral cross sections
  - Ionisation cross sections
  - Remaining inelastic channels: Excitation, neutral dissociation
- **Pathway decision**
  - Differential elastic and inelastic electron scattering cross sections
- **Energy deposition in single collisions**
  - Experimental energy loss spectra

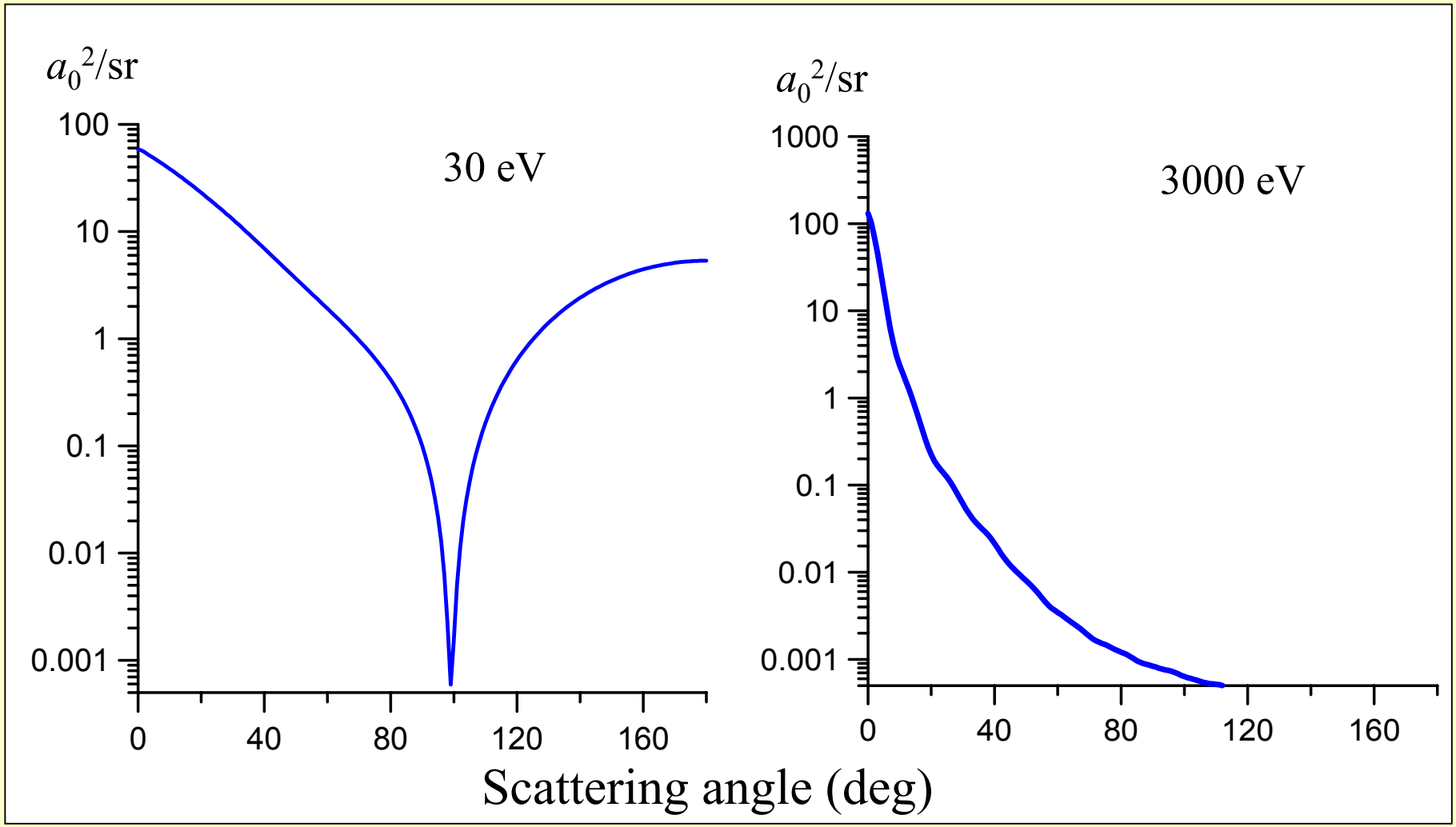
PHOTONS

- Secondary electron generation : Energy and angular distribution

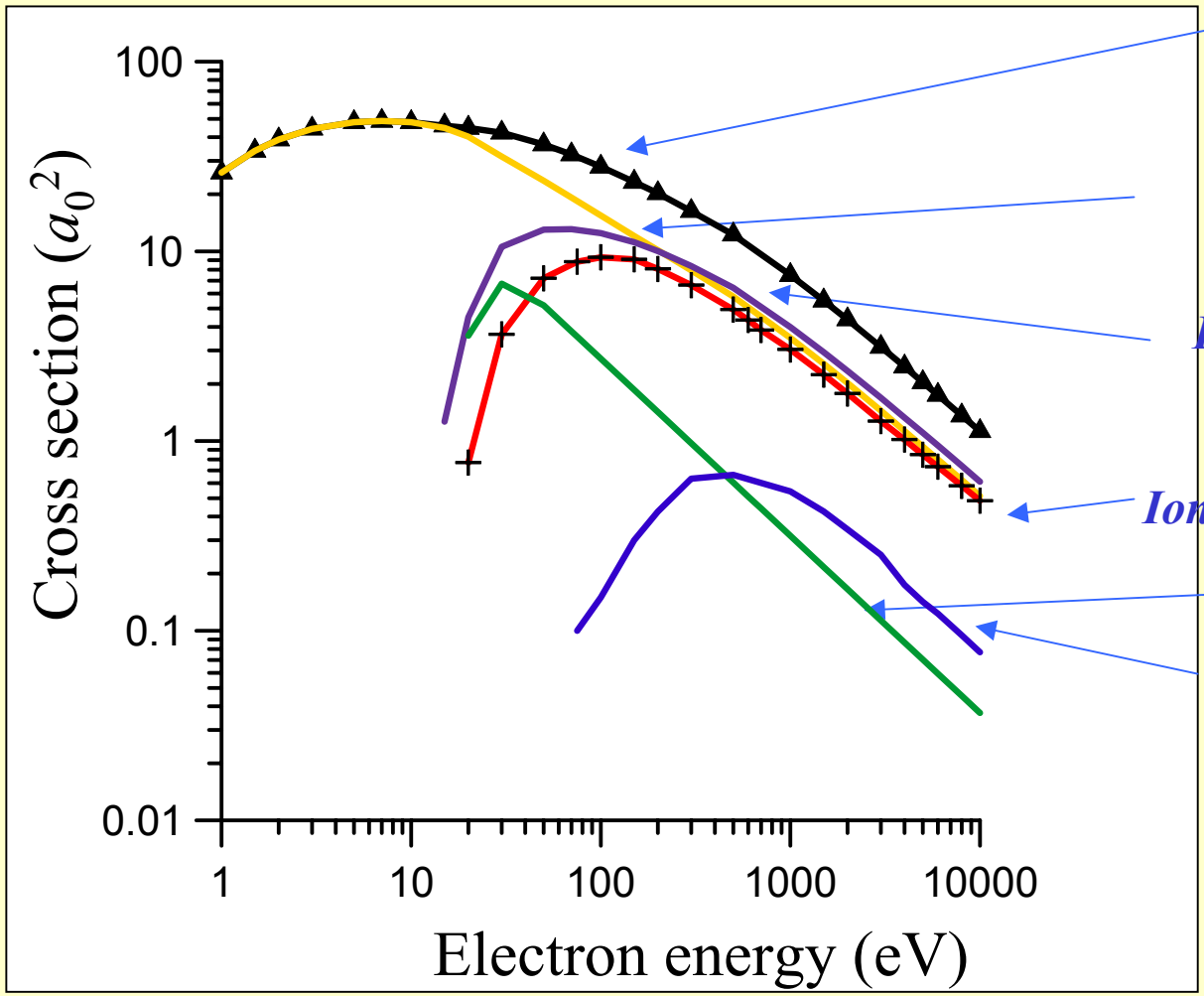
e-Air, energy loss spectrum (2000 eV)



e-N_2 Elastic differential cross sections



e-Air integral cross sections



Total **(Experimental: ±3%)**

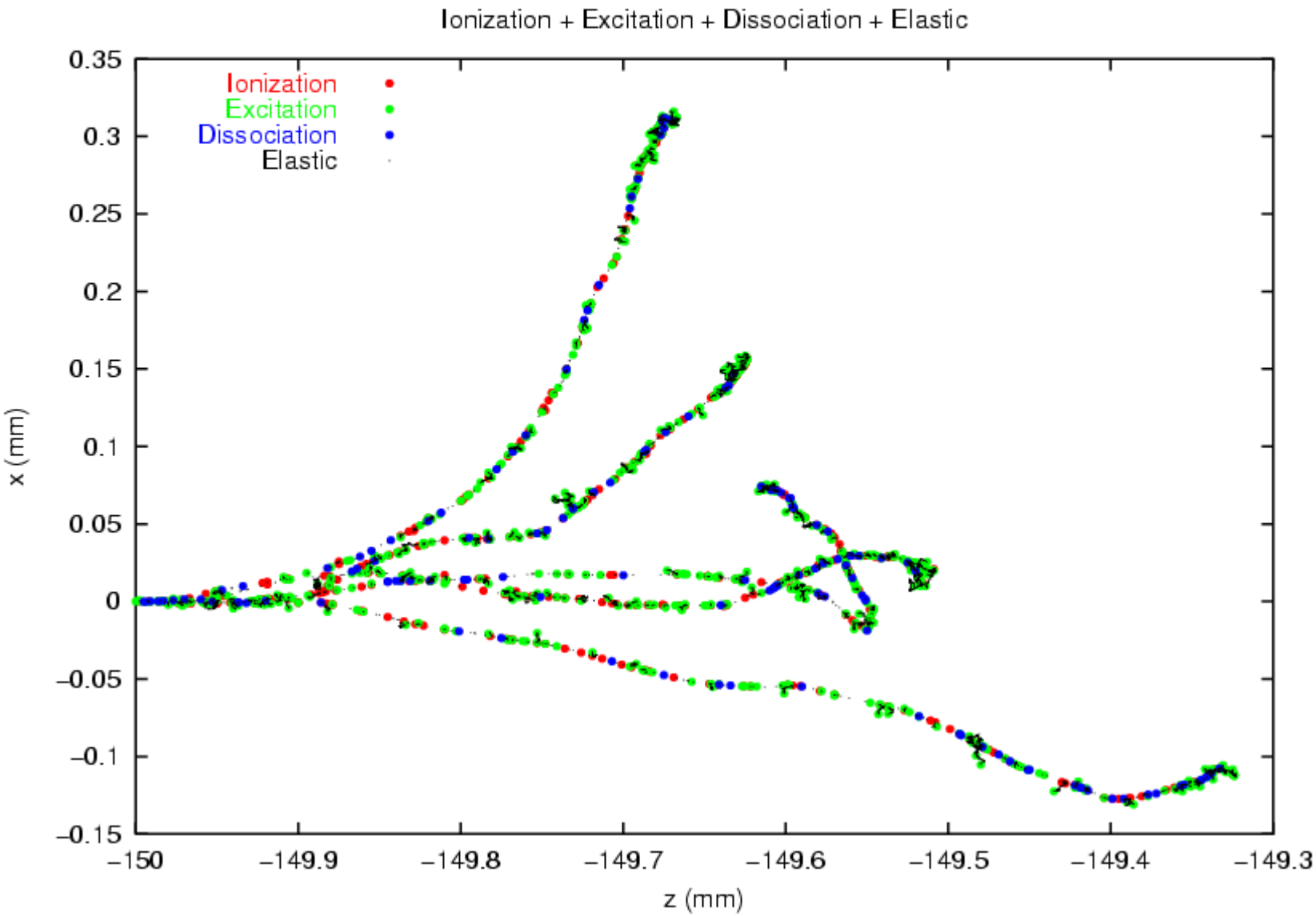
Elastic **(Calculation: ±10%)**

Inelastic **(Subtraction: ±12%)**

Ionisation **(Experimental: ±7 %)**

Excitation,
neutral dissociation **(±20%)**

Energy deposition of 5 keV electrons in air (1 atm)



Energy deposition of 5 keV electrons in air (1 atm)