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Latest developments for the Geant4 PIXE

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Geant4 PIXE

Introduction

new set of proton, α and C-12 ionisation cross sections

based on the state of the art recommendations documented in
(Cohen, D.D., 2015)(1985,86 and 89)

Particle-Induced X-ray Emission (PIXE)

Introduction

- **Incident** ions
- **ionise** some atoms
- **removing** one or more electrons from the shells.
- vacancy is **filled** by an electron
- **emission** of X-rays or Auger electrons and Coster-Kronig transitions

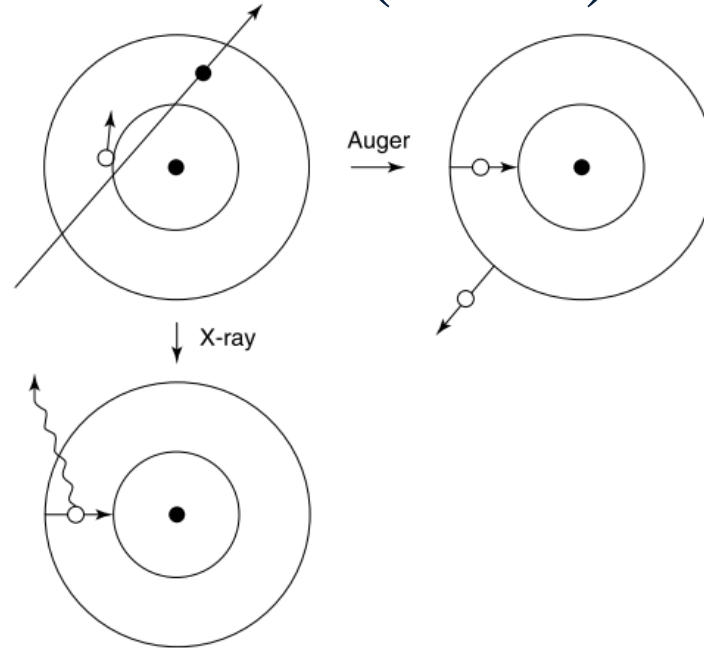


Figure 1 Diagram of an inner-shell ionization induced by proton bombardment, followed by Auger electron or X-ray emission (alternative to each other). (Reproduced from Ref. 1. © John Wiley & Sons, Ltd, 1995.)

(Mandò and Przybyłowicz 2009)

PIXE in Geant4

Geant4 Atomic Relaxation Package

In Geant4, two stages:

1. The **creation of a vacancy** in a shell (or subshell).
2. Then the **relaxation** cascade is triggered
 - EADL libraries



PIXE in Geant4

a brief History

1. The first implementation of PIXE Geant4 was based on the **Gryzinski** theoretical model.
(Abdelouahed, Incerti et al. 2009)
2. **Mantero** et al. 2005: new PIXE cross sections in Geant4 limited to the **K-shell ionisation by incident protons**.
3. **Abdelouahed** provided two models (2009):
 - Theoretical: based on the ECPSSR theory for K-shell ionisation, both for incident protons and alpha particles.
 - Semi-empirical: based upon expressions proposed by Paul et al. and Orlic et al. calculations.
4. 2011, 2013, Taborda et al. ionisation cross sections of K, L and **M** using ECPSSR
(Abdelouahed, Incerti et al. 2009)

PIXE in Geant4

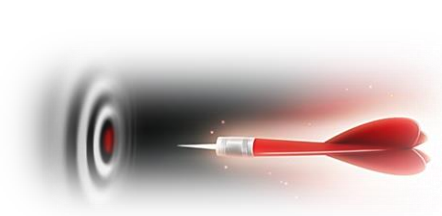
Ionisation cross sections models in Geant4

Currently three PIXE cross sections data sets in Geant4:

1. **Empirical**, K and L shell ionisation cross
2. **Analytical**, based on the ECPSSR theory for the description of K and L shells ionisation for incident protons and α particles.
3. **ECPSSR Form Factor**, based on a polynomial approximation of the ionisation cross sections of K, L and a selection of M shells calculated by Taborda et al

(Incerti, Barberet et al. 2015)

Aim of this project



- Provide a unique, accurate, self-consistent and robust recommended approach to the user community
- Validate against experimental measurements
- Revise the EADL library based on ANSTO experience in PIXE technique
- develop state of the art software tools based on G4-PIXE to support the μ -PIXE analysis at ANSTO