# Geant4 Ion Physics Introduction

CERN Geant4 Training Course
## 15-19 February 2010

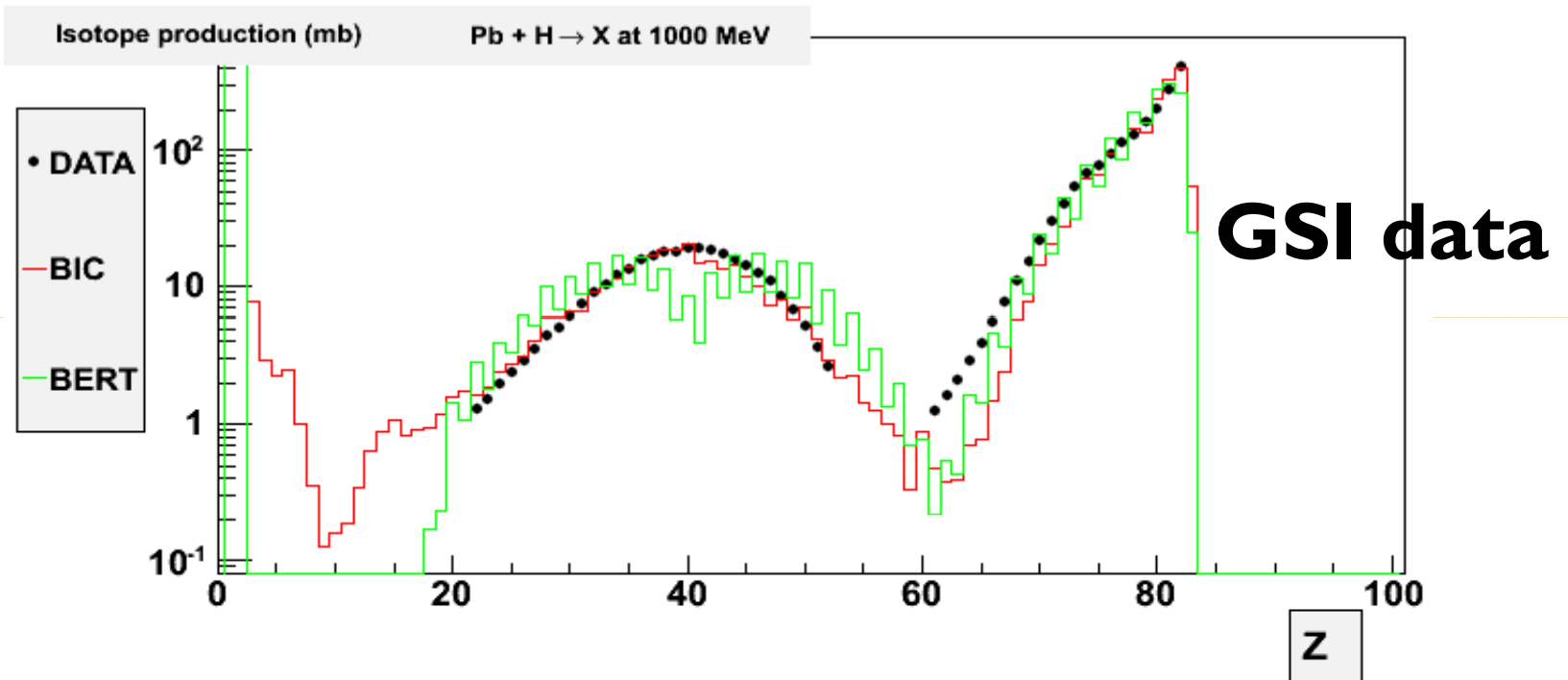*V.Ivanchenko, CERN, Geneva, Switzerland*

Geant4 Ion Physics Applications

- In HEP describing detector response for high energy hadronic shower
- Carbon ion therapy the frontier in medicine
- Space radiation environment simulation and single event effects
- Technology and material science

Ion Production in Hadronic Collisions

p

nucleus

Cascade

Pre-equilibrium

Evaporation
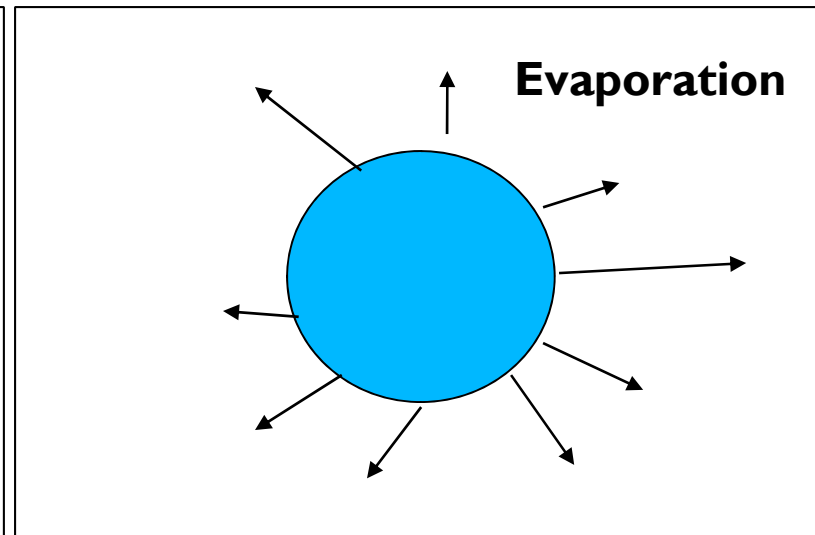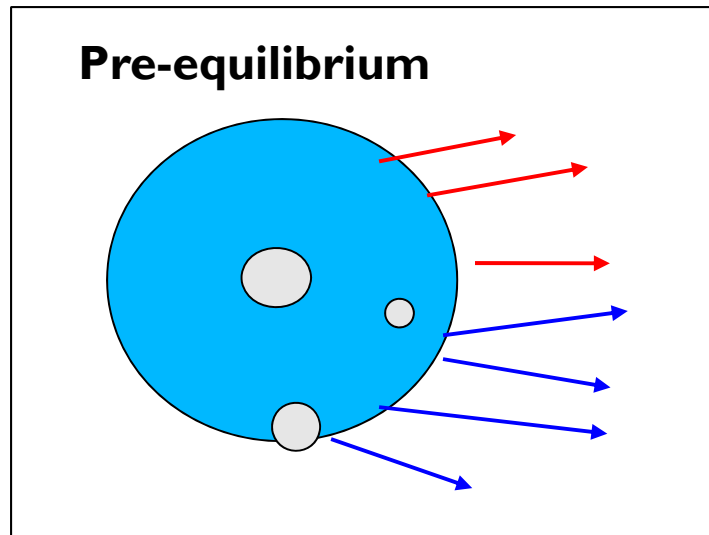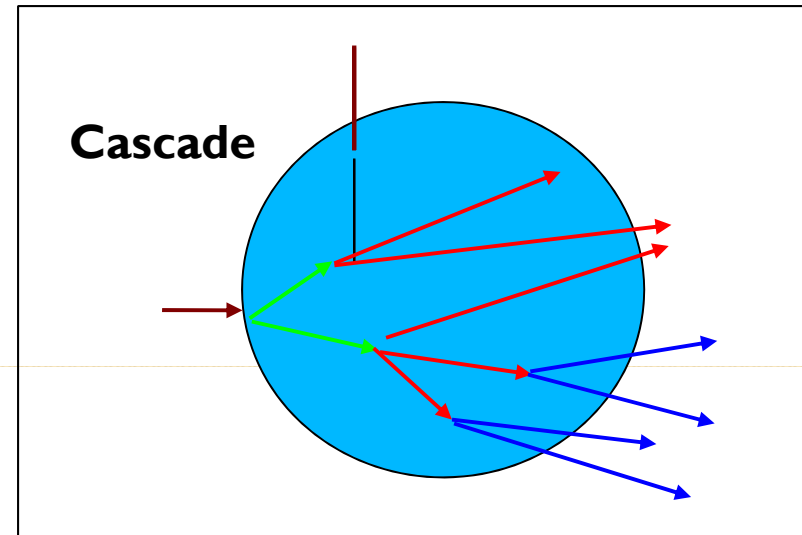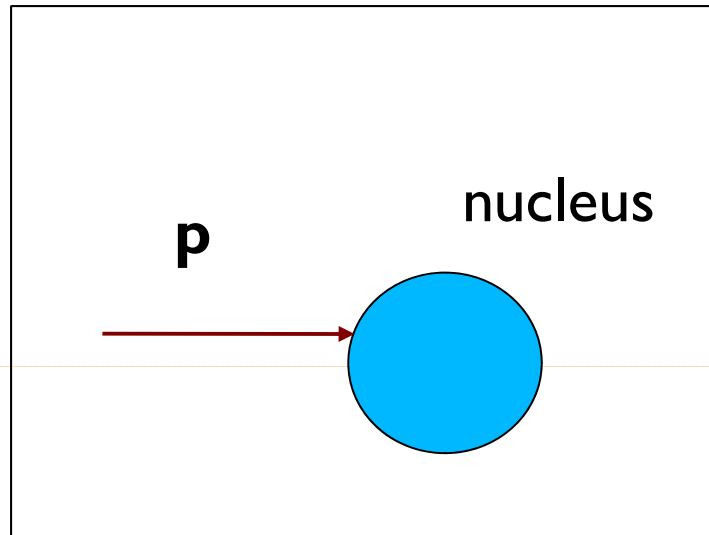
Isotope Production in Proton-Lead Collision g4 9.3

Isotope production (mb)   **Pb + H → X at 1000 MeV**

- DATA
- BIC
- BERT

GSI data

Z

- All kind of ions can be produced in one collision
- Part are stable, part radioactive
- Large amount of light ions $Z <= 2$

Geant4 Approach for Ions

- Light ions:
  - G4Deuteron
  - G4Triton
  - G4He3
  - G4Alpha
- Generic ion:
  - G4GenericIon - only one particle
  - Not a real particle (charge +1, mass = Mp)
  - Serving for any kind of ion with Z>2
- G4ParticleGun

/gun/particle ion
/gun/ion 6 12 3   # C12 with 3 electrons at electronic shells

EM Physics Lists for Ions (g4 9.3)

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```
If (particleName == "alpha" || particleName == "He3" ) {
    pmanager->AddProcess(new G4hMultipleScattering, -1,1,1);
    pmanager->AddProcess(new G4ionIonisation,      -1,2,2);
} else If(particleName == "GenericIon") {
    pmanager->AddProcess(new G4hMultipleScattering, -1,1,1);
    pmanager->AddProcess(new G4ionIonisation,      -1,2,2);
}
```

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- Only light ions and G4GenericIon is included in the Physics Lists
- Any ion dynamically created in run time will peak up physics processes of G4GenericIon
- Energy loss and cross sections are obtained using scaling relation and G4GenericIon quantities

EM Processes and Models for Ions

Status for g4 9.3

Process	Models	Application
G4ionIonisation	G4BetheBlochModel G4BraggIonModel G4ParameterisedLossModel	default > 2 MeV/n default < 2 MeV/n ICRU'73 < 1 GeV/n
G4hMultipleScattering	G4UrbanMscModel90 G4WentzelVIModel	default should be used with G4CoulombScattering
G4CoulombScattering	G4CoulombScatteringModel	
G4ScreenedNuclearRecoil		< 100 MeV/n
G4hLowEnergyIonisation		PIXE, obsolete ionisation

Hadronic physics of ions will follow