Geant4 Space ModuleTest

Desorgher L., Bern University

Overview

- SREM Detector

- General Particle Source module

- Sector Shielding Analysis Tool

- Radioactive Decay Module

- MGA interface

- Low energy extension of electromagnetic process

- SREM detection simulation

- SONTRAC detector and simulation

Standard Radiation Environment Monitor
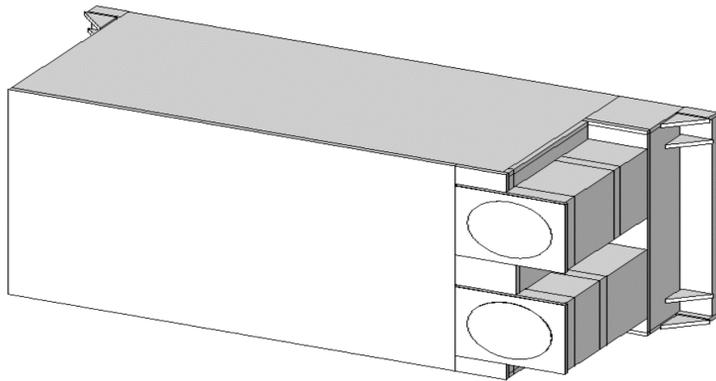
- Radiation monitoring in space
- Energy deposit in three Silicon Detectors
- 15 discriminators
- Protons 8 to 300 MeV
- Electrons .3 to 6 MeV
- Identification of heavy ions
- Geometry transferred from Geant3 to Geant4

# SREM Detector

General Particle Source (GPS) Module

Interactive Geant4 macro commands for the definition of a particle source

```
# Position Definition
/gps/particle proton
/gps/type Plane
/gps/centre 2. 3. -2. cm
/gps/shape Circle
/gps/radius 3. cm

# Angular Distribution Definition
/gps/angtype iso
/gps/minphi 30. deg
/gps/maxphi 130. deg
/gps/mintheta 35. deg
/gps/maxtheta 75. deg

# Spectrum Definition
/gps/energytype User
/gps/histname energy
/gps/histpoint 5 0.
/gps/histpoint 100.   5.
/gps/histpoint 400.   60.
/gps/histpoint 600.   10.
/gps/histpoint 900.   5.
```

General particle source test
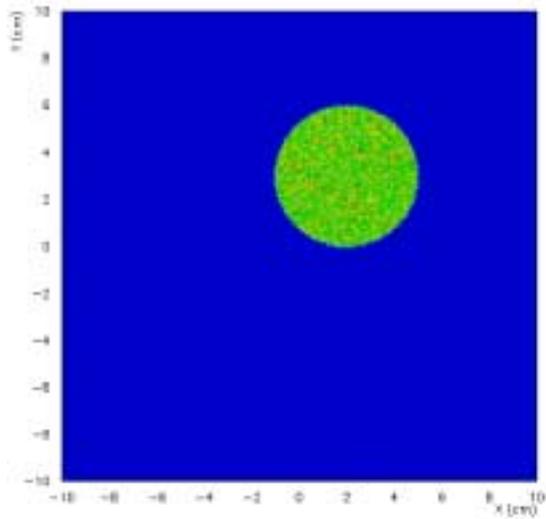
XY positions
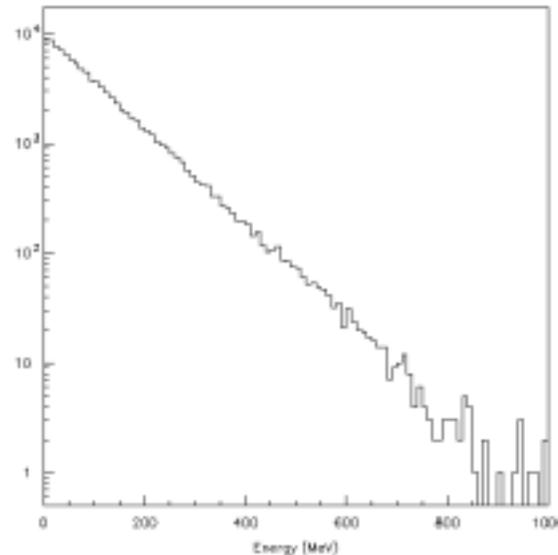
Spectrum
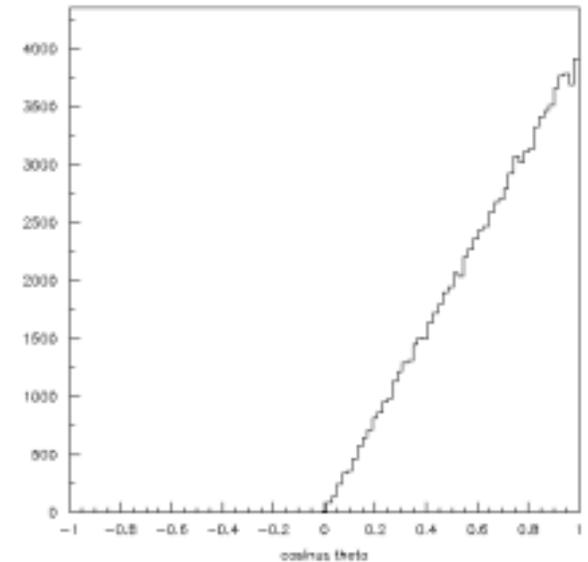
Zenith angle

"Planar Circular source

"Exponential spectrum

"cosinus law

"10^5 particles

# General Particle Source Test

Angular distribution with limits on ϕ and θ
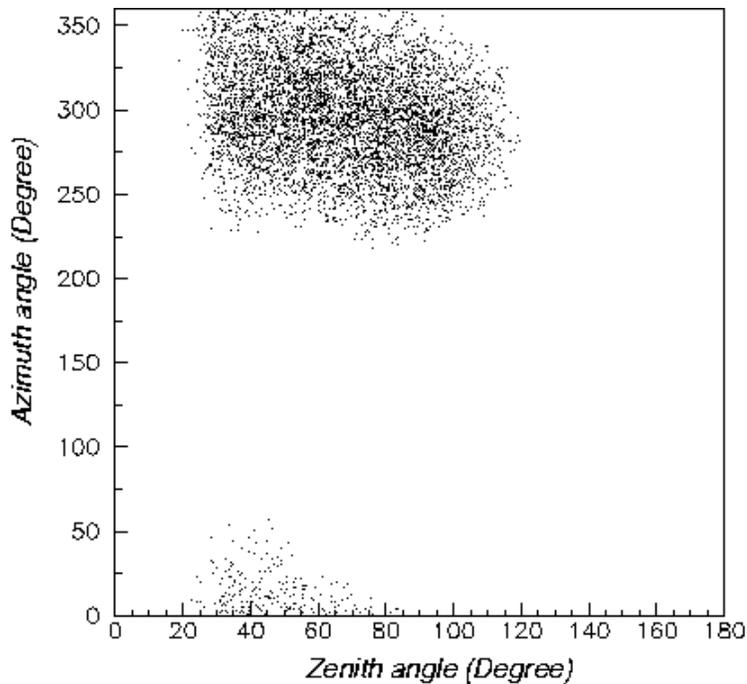
Geant4.3.2

Geant4.4.0

correction
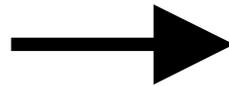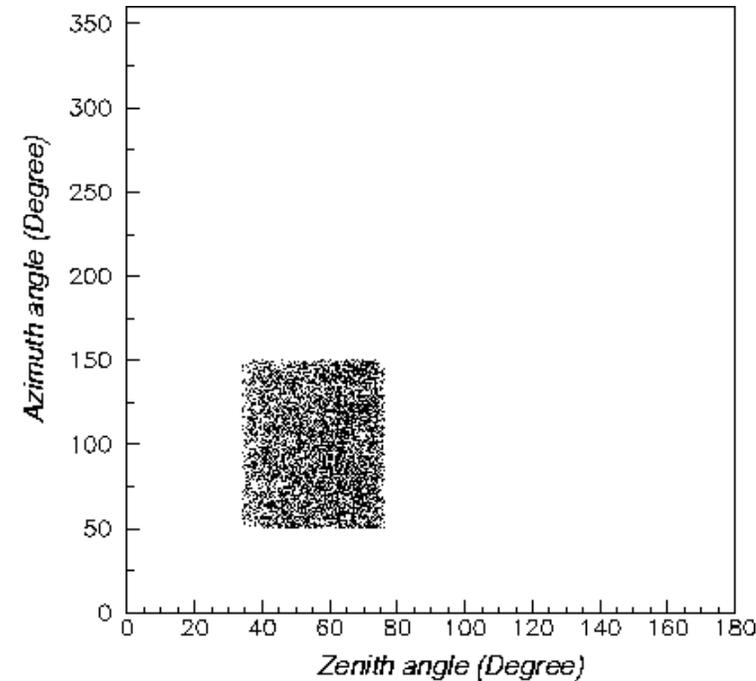
Sector Shielding Analysis Tool SSAT

Zenith
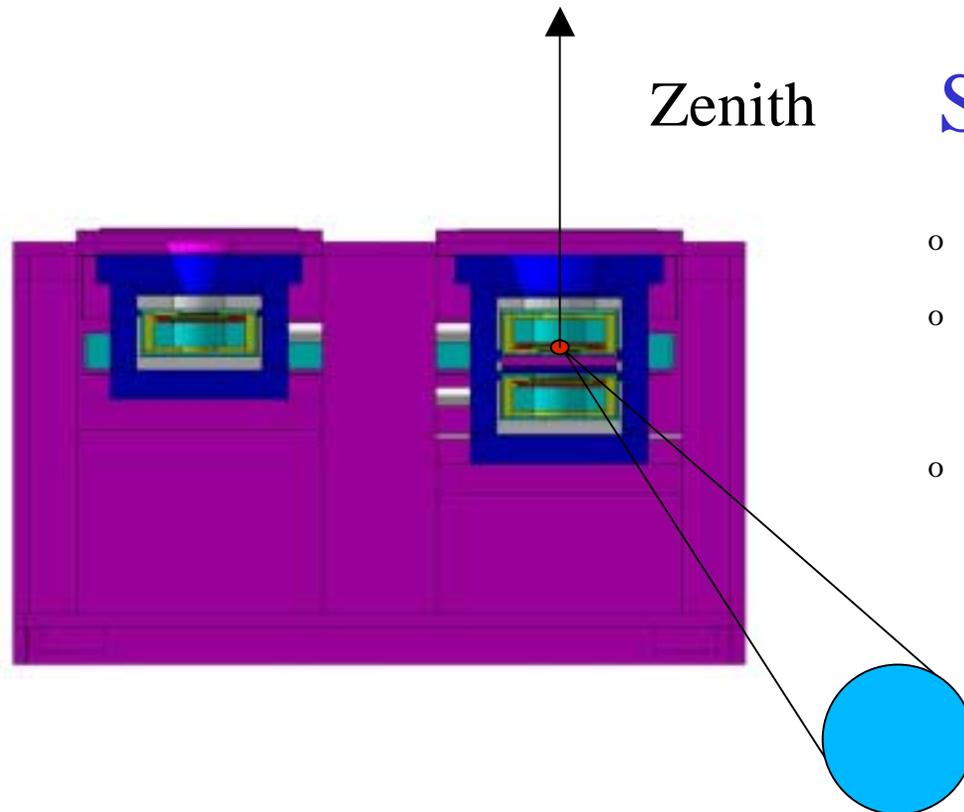
Shielding computation

o From a defined position

o In different direction windows

o For different materials

Aluminium Shielding in SREM
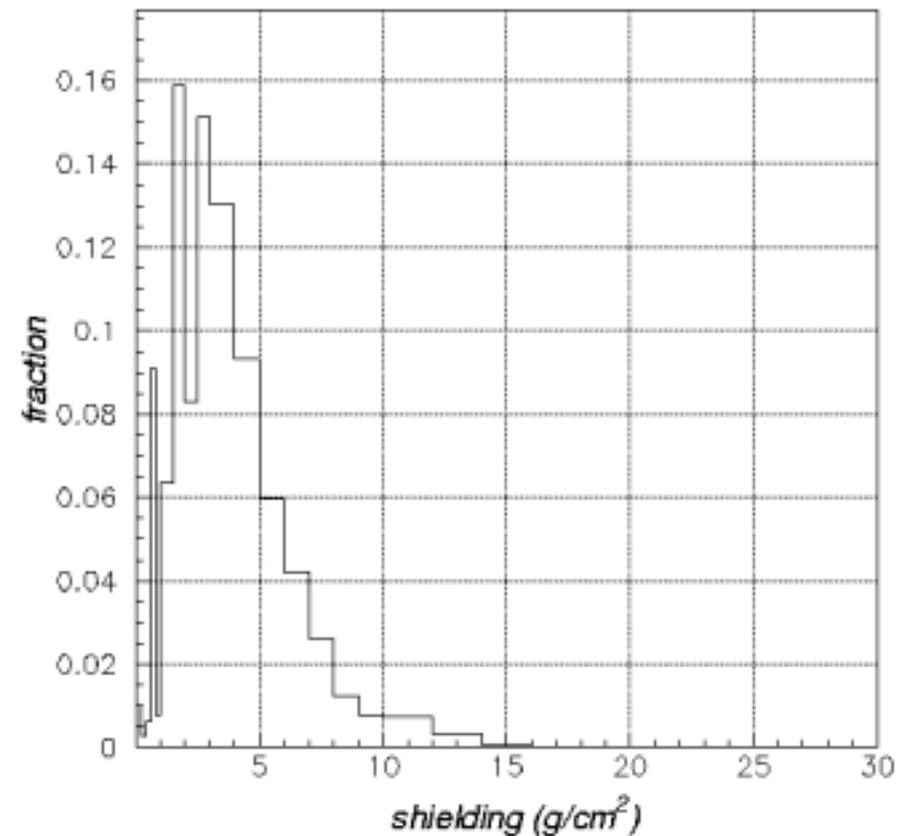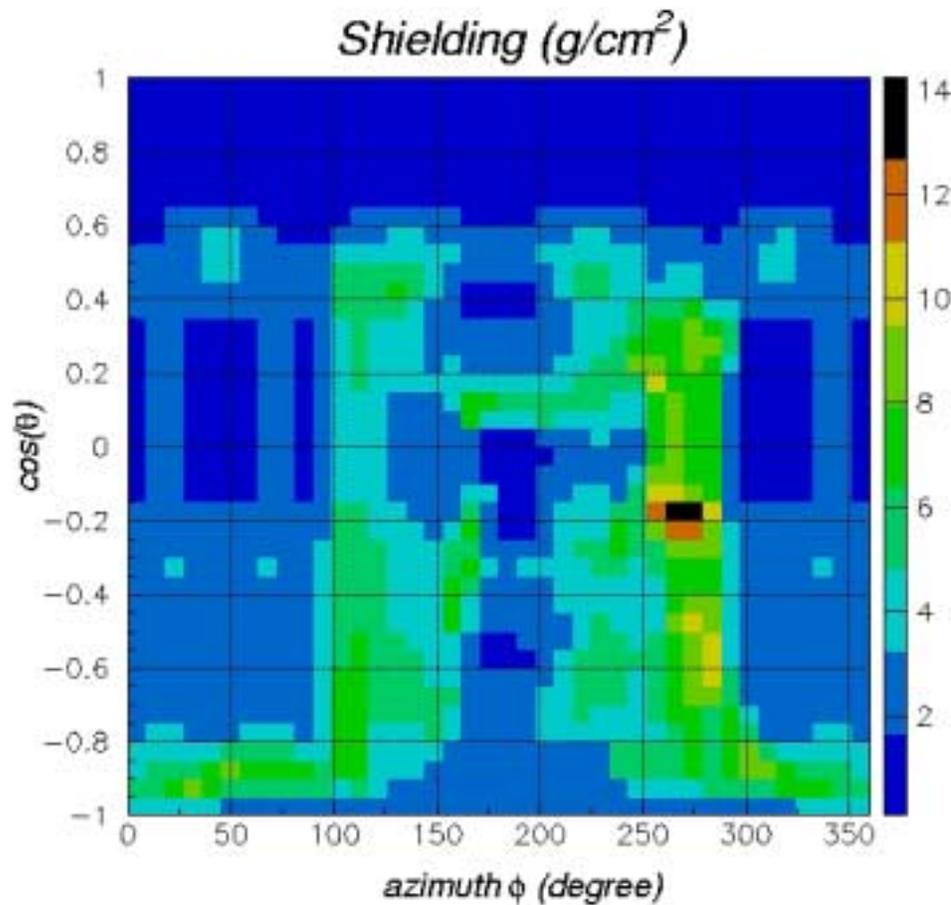
SREM shielding

All materials
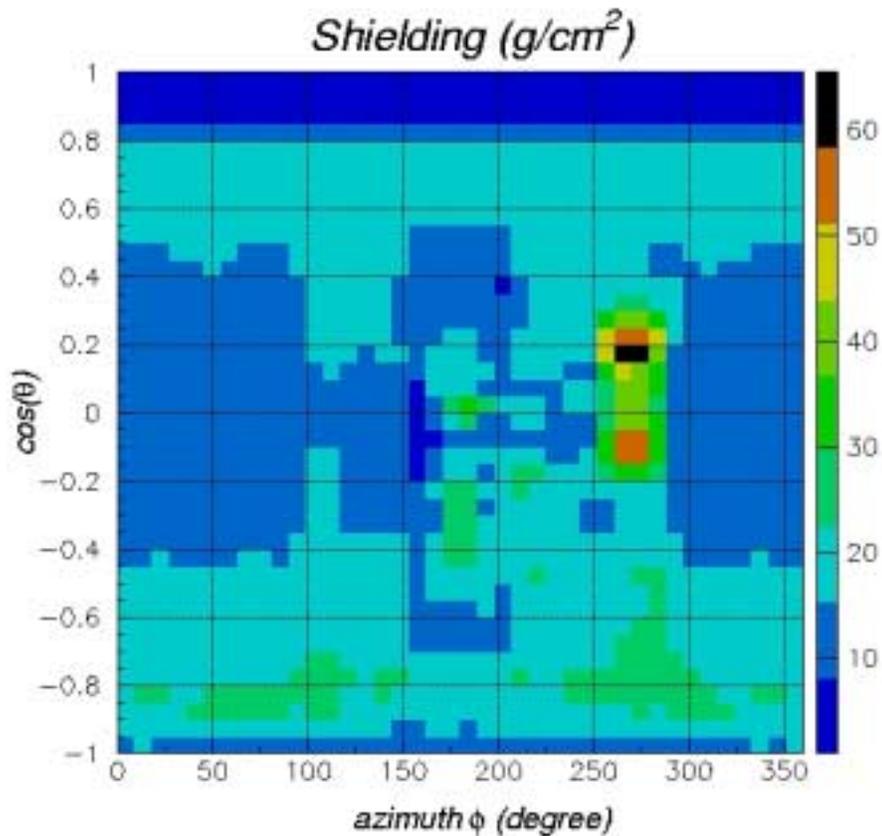
Tantalum
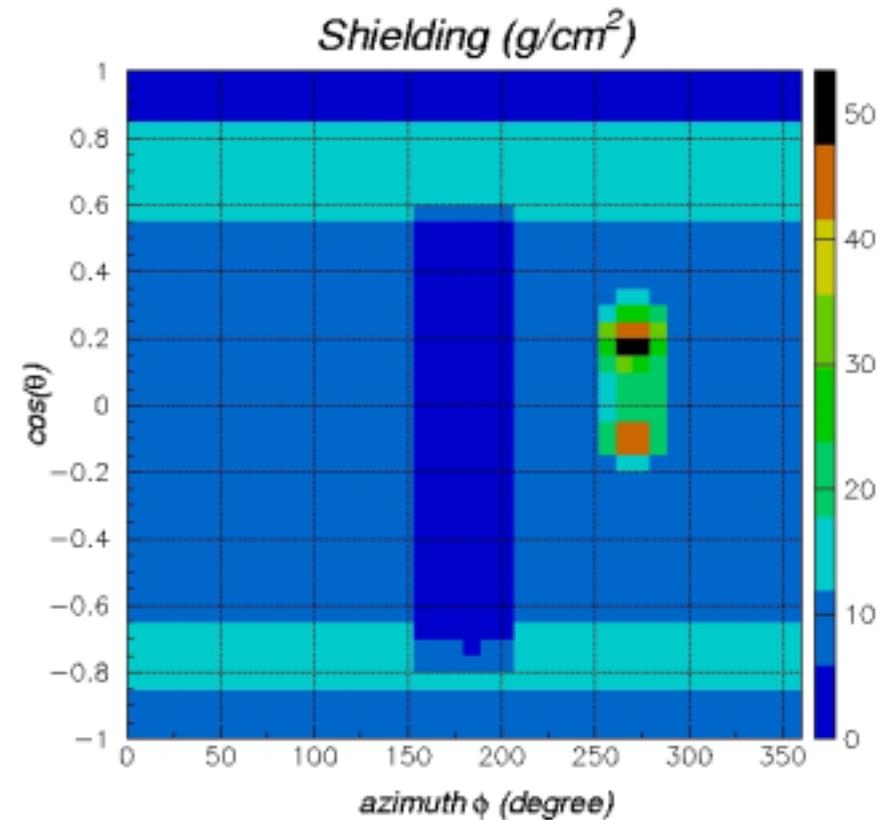
MGA Interface

CAD Tool defines the detector geometry

STEP file

MGA Java Interface
Materials and vizualization attributes definition

MGA file

STEP + MGA files

Geant4 geometrry

MGA Interface

Scan STEP file
Material definition
Vizualisation definition
MGA file

MGA Interface (2)

MGA Test

Vizualisation
**Geantino tracking**

**Not valid for some STEP files**
Otherwise works perfectly
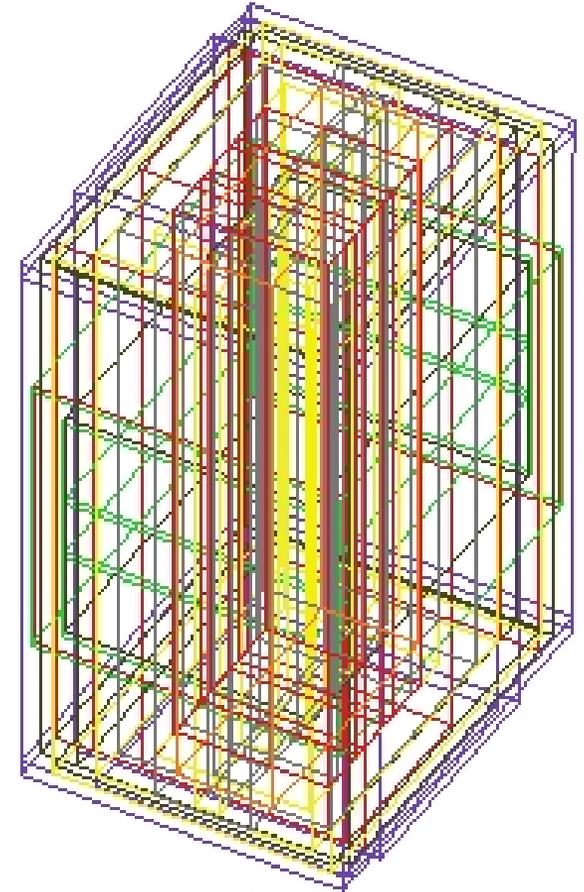
Radioactive Decay Module (RDM)

Geant4 Hadronic physics model for the simulation of radioactive decay

^{8}He Radioactive Source

$$^8\text{He} \rightarrow {}^8\text{Li} + e^- + \bar{\nu}$$
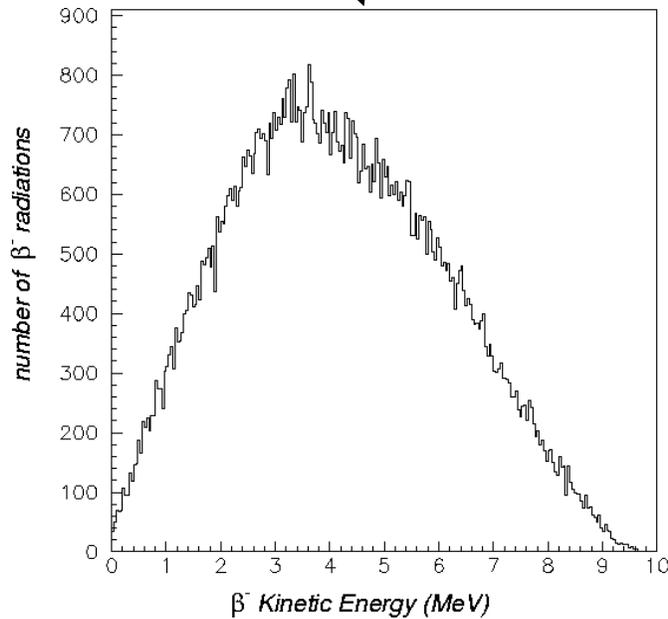
$$T_{1/2}=119 \text{ ms}$$
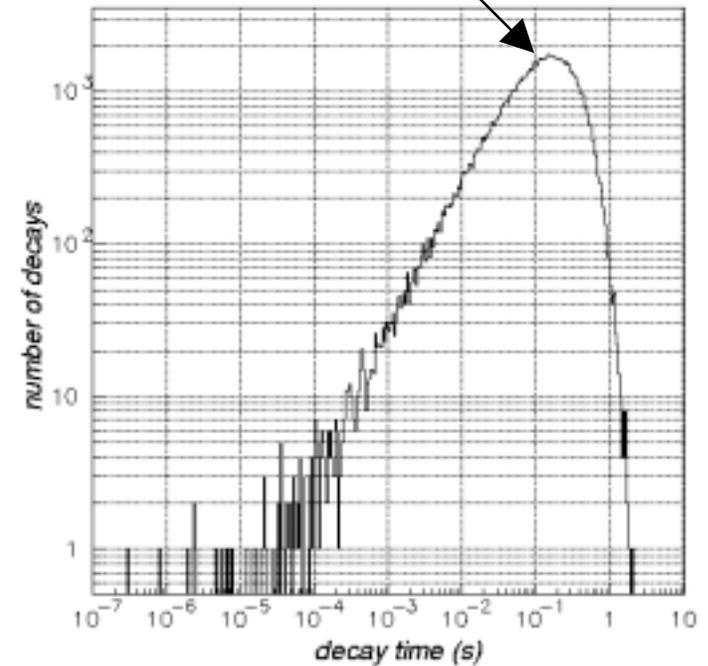
# Spallation Nucleus Production

**10-300 MeV proton beam
on
Aluminium target**

**G4PreCompoundModel
as hadronic
inelastic model**

Spallation nuclei
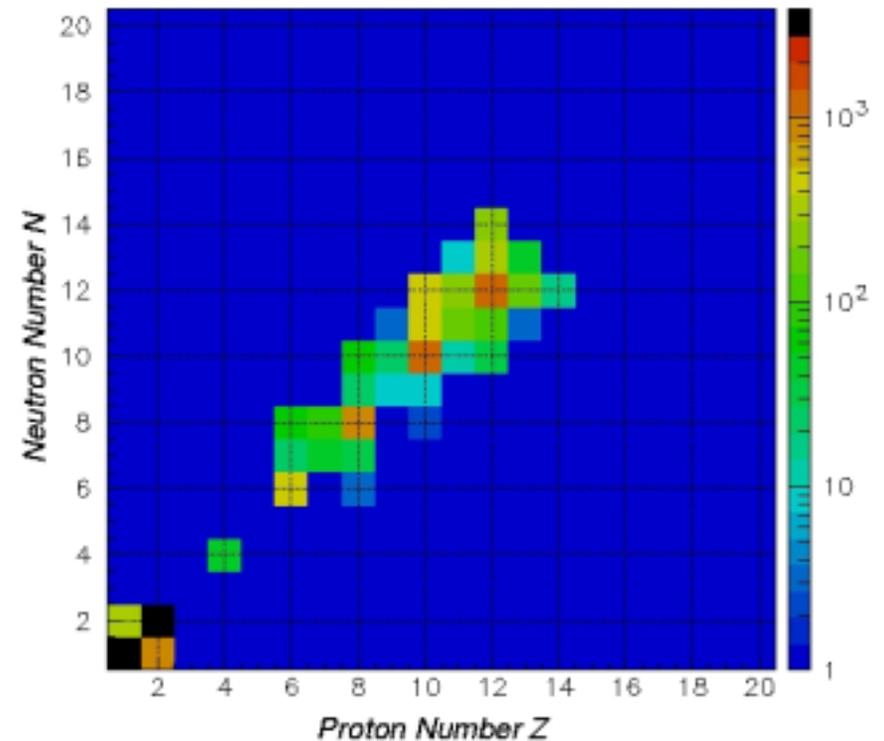
Resulting Radioactivity

Radioactive Nuclei production
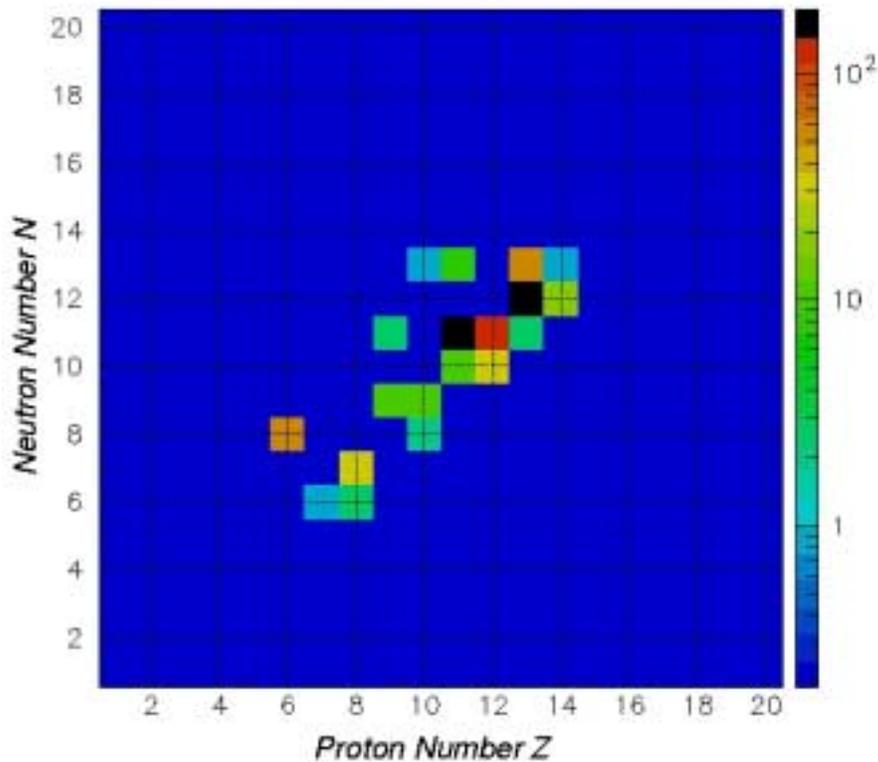
Resulting β^+ decay
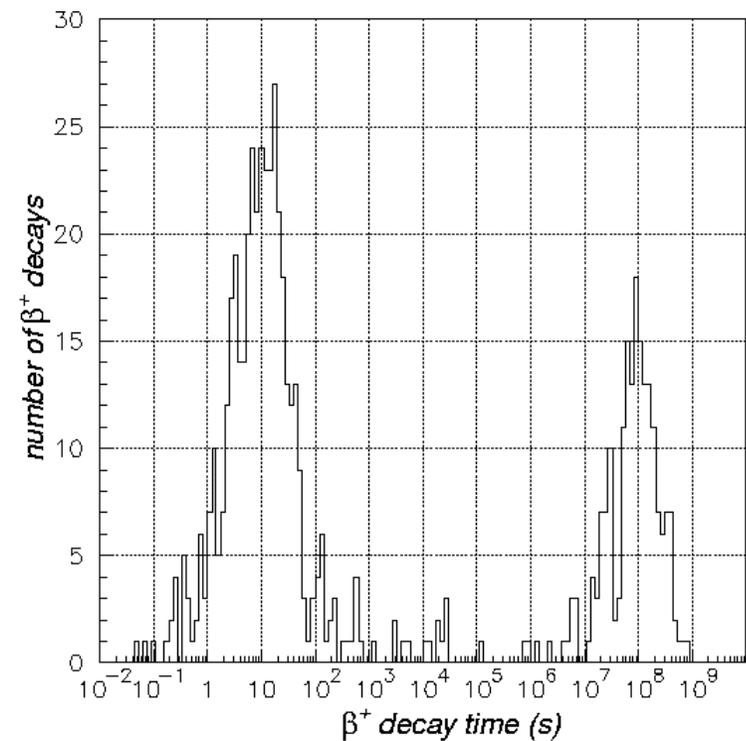
Geant4.3.2 RDM Test

10 radioactive decay chains
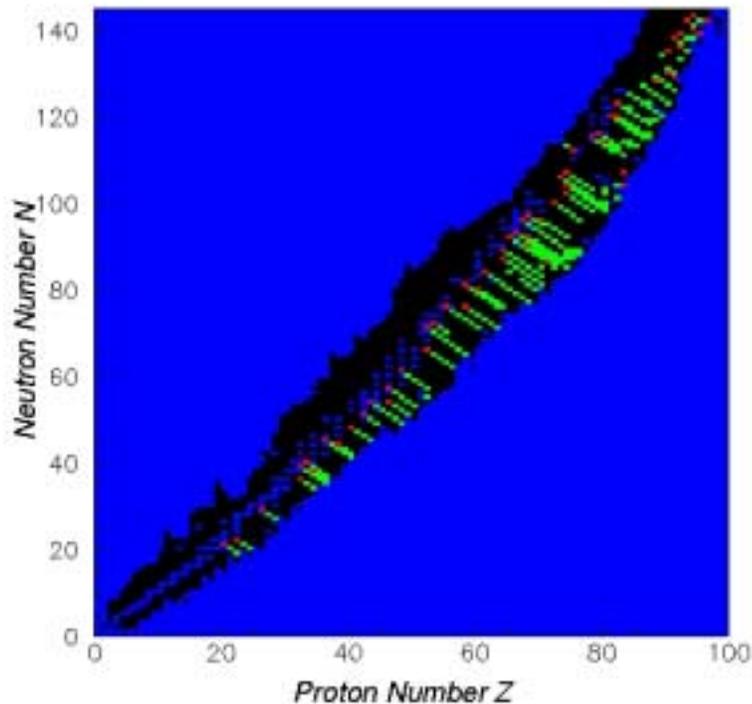
Computing time (s)

Unsuccesfull simulation for
- **Full radioactive chain**
- **Single decay**
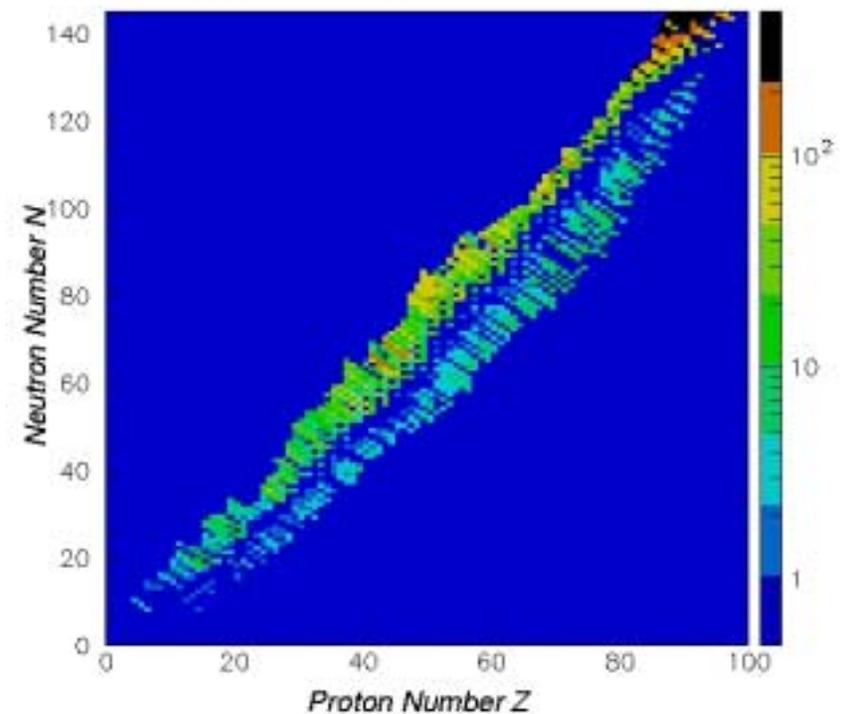
Geant4.4.0 RDM Test

10 radioactive decay chains
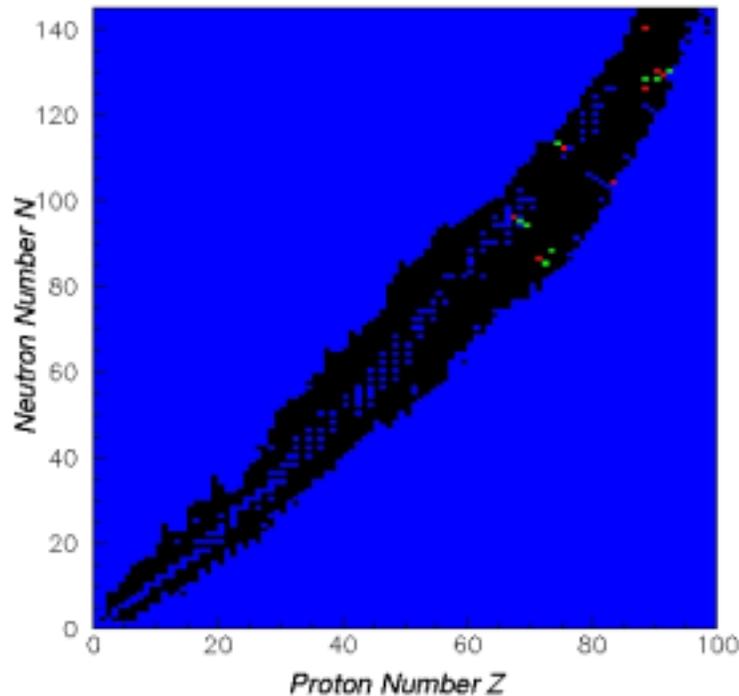
Computing time (s)

Unsuccesfull simulation for
- **Full radioactive chain**
- **Single decay**
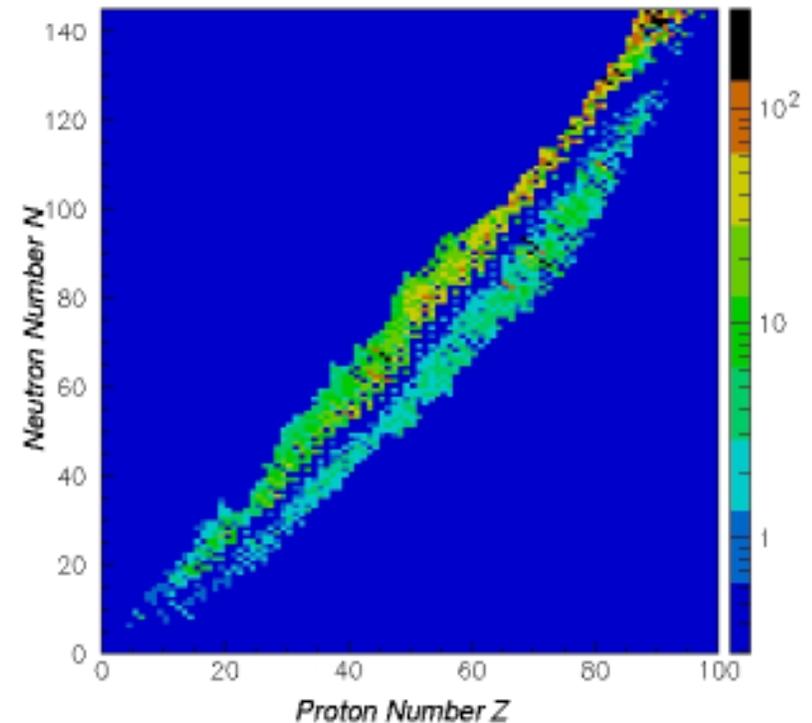
Low Energy EM Model
100 keV electrons on 20 µm Al
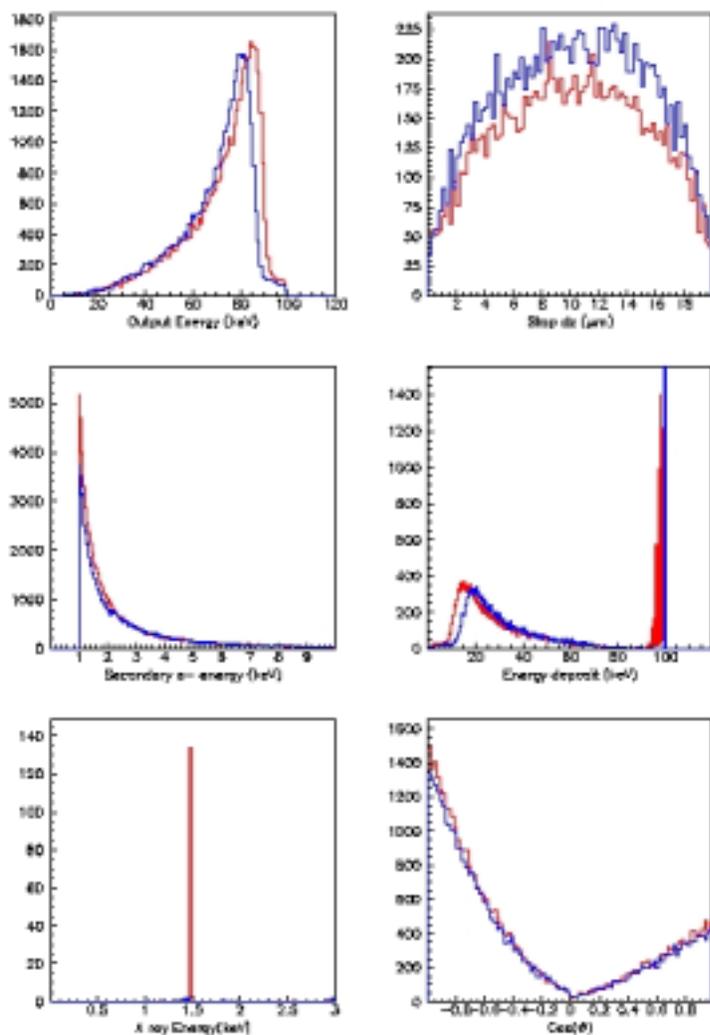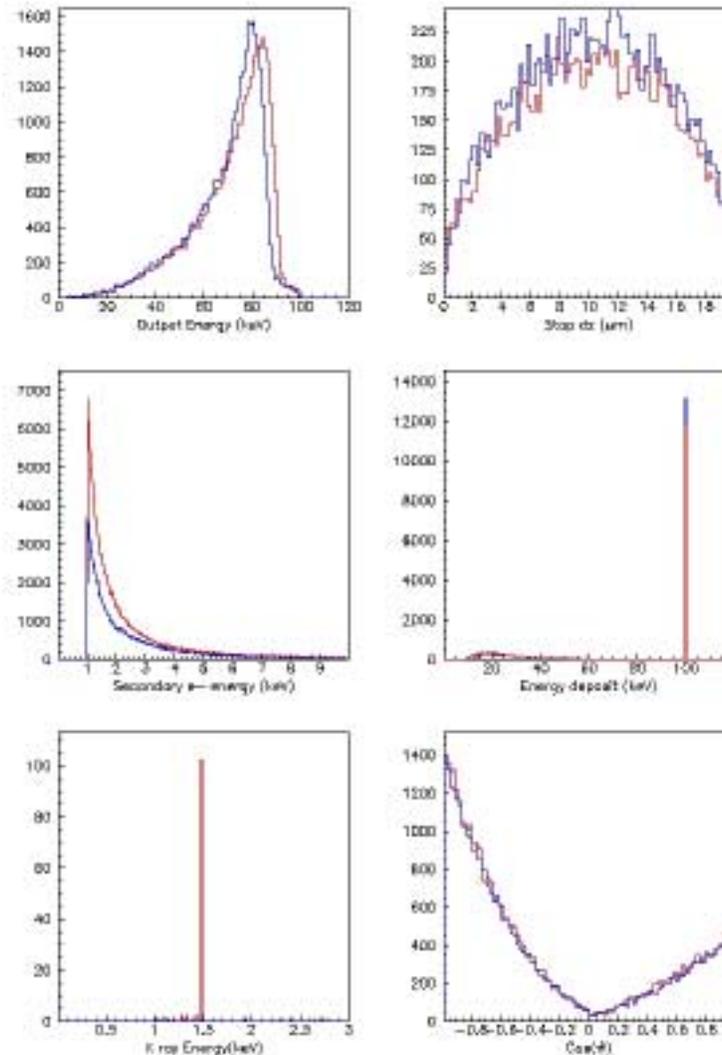
SREM : G4 vs G3
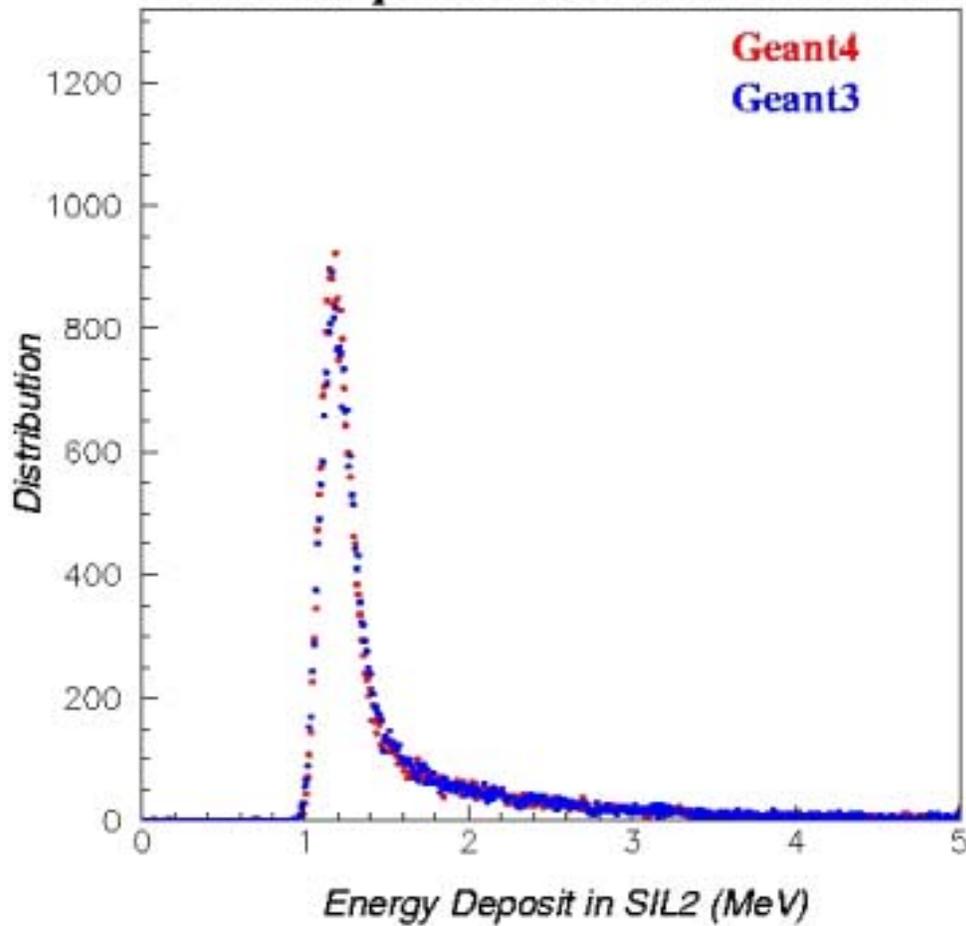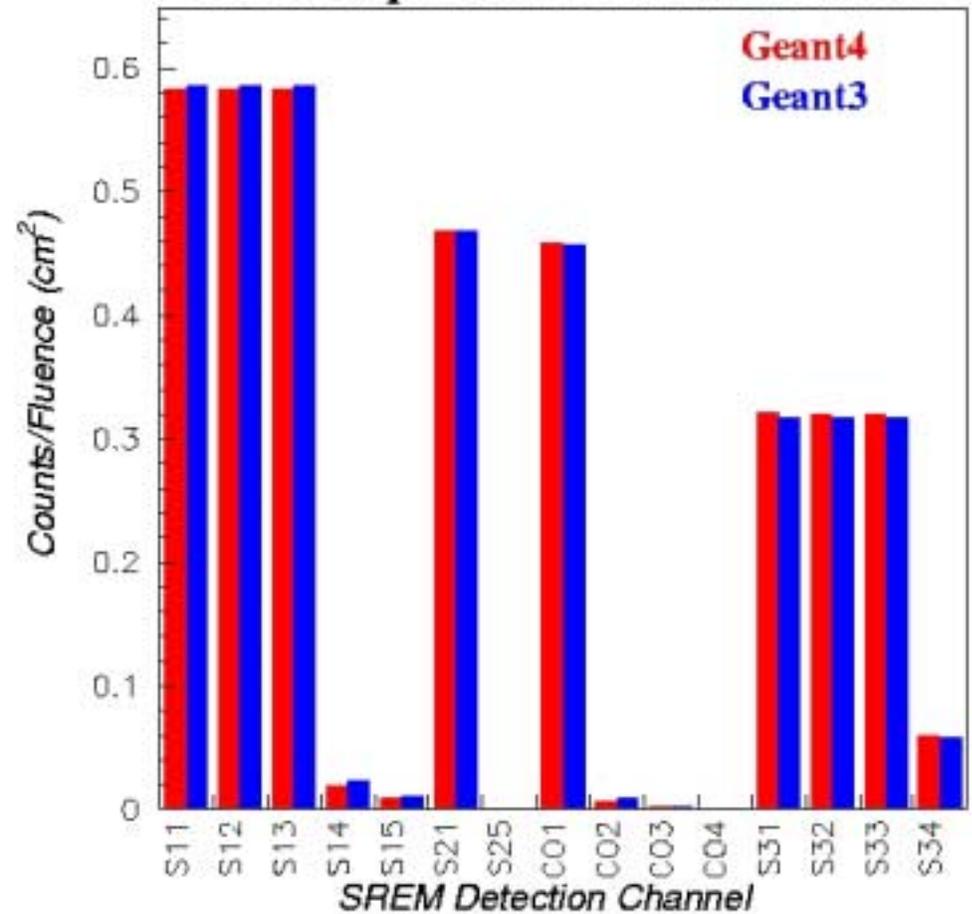
SREM Proton Detection

Simulation

Calibration Measurements

" PIF proton beam @ 300 MeV
" Different degraders
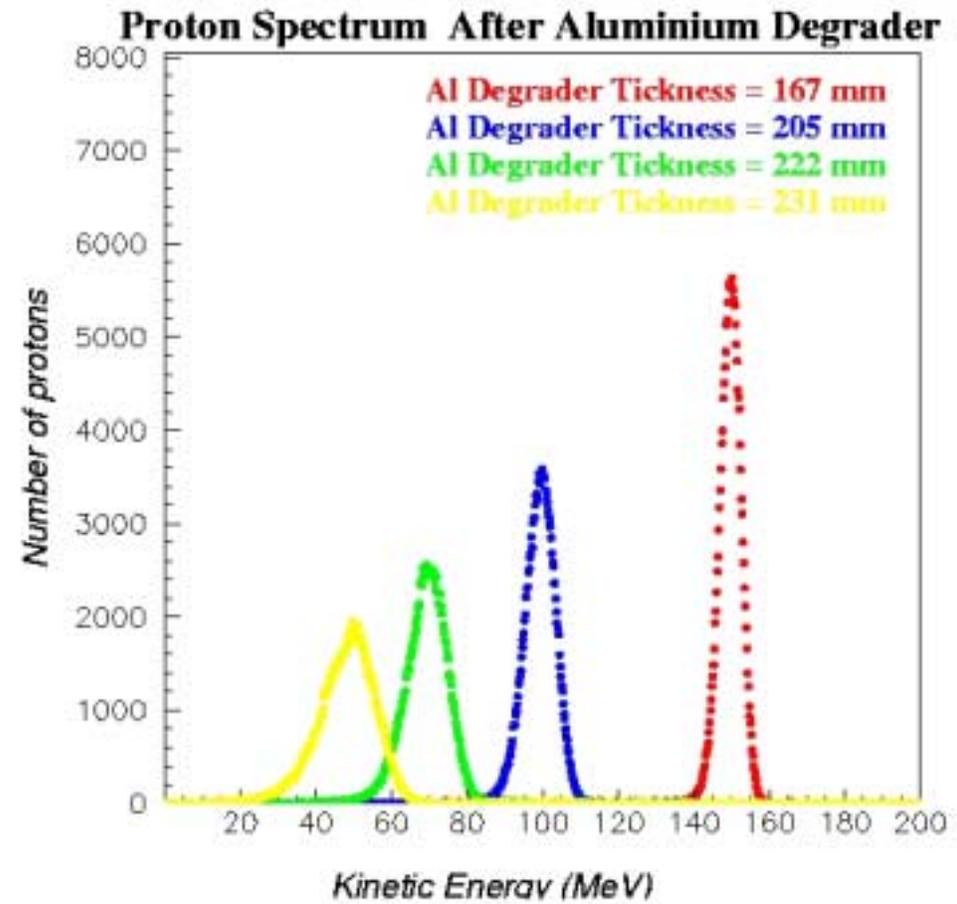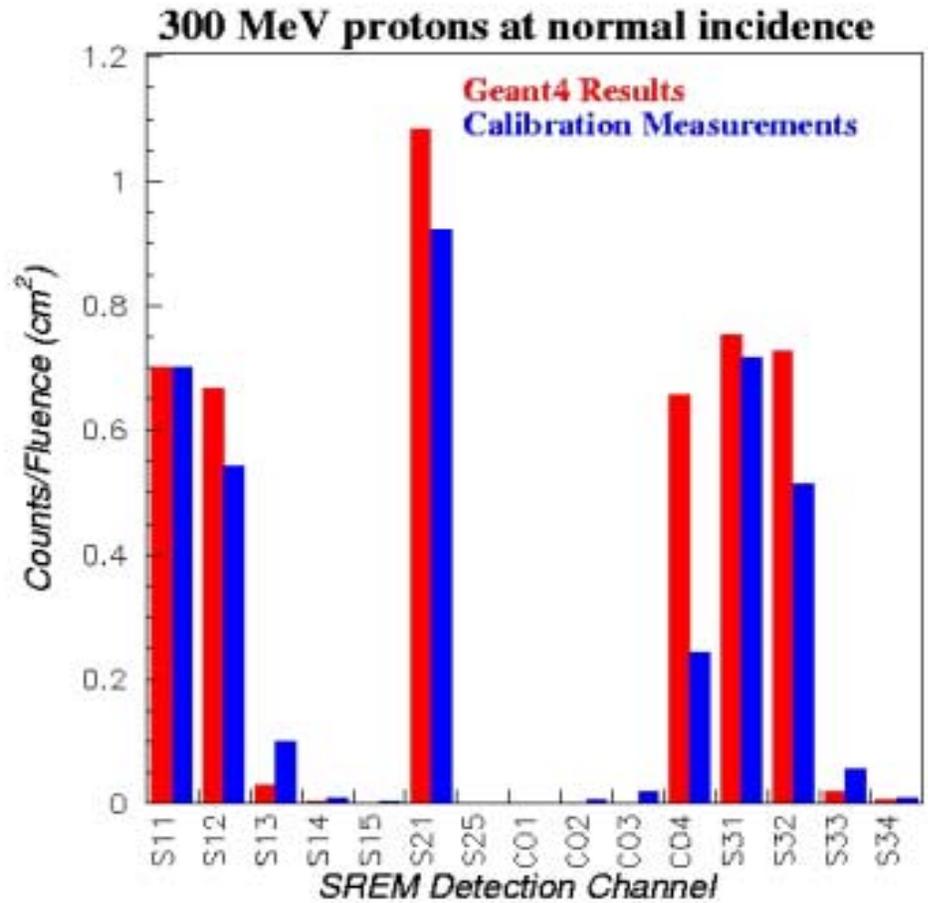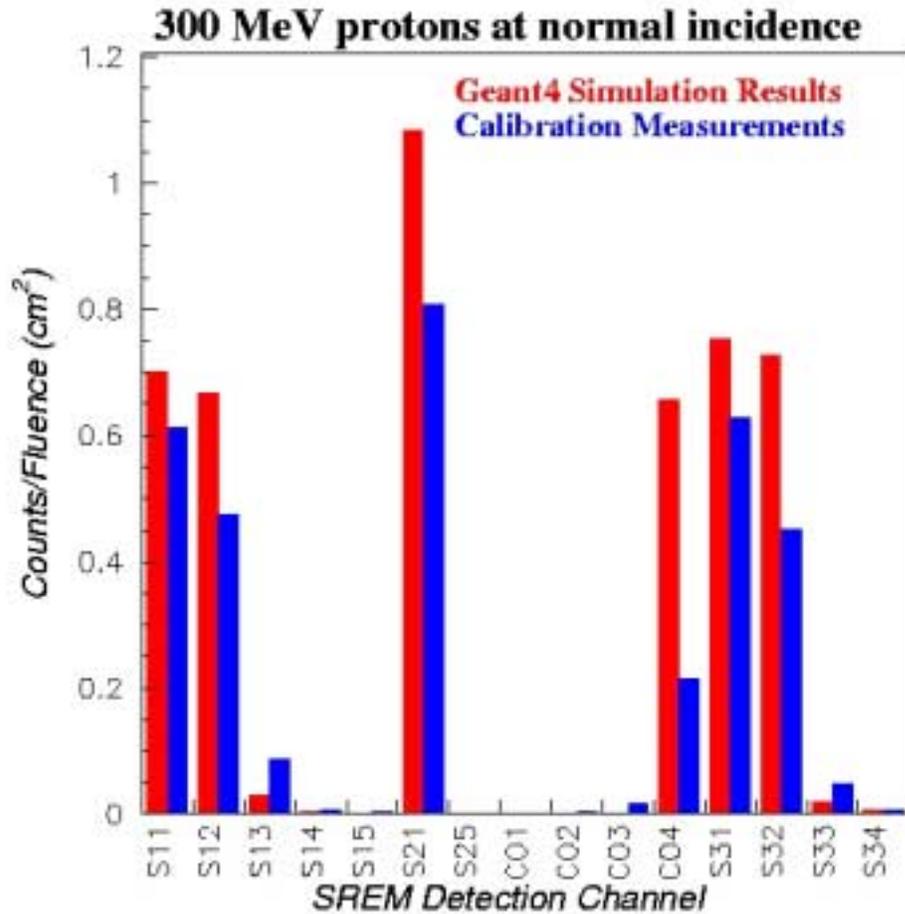
Proton Spectrum After Aluminium Degrader

Al Degrader Tickness = 167 mm
Al Degrader Tickness = 205 mm
Al Degrader Tickness = 222 mm
Al Degrader Tickness = 231 mm

Number of protons

8000
7000
6000
5000
4000
3000
2000
1000
0

20   40   60   80   100   120   140   160   180   200

Kinetic Enerav (MeV)

# SREM proton detection

SREM Proton Detection

SREM Proton Detection

# SREM Proton Detection

300 MeV protons at 30° incidence

Geant4 Simulation Results
Measurements Scaled to G4 S11
Measurements

300 MeV protons at 60° incidence

Geant4 Simulation Results
Measurements Scaled to G4 S11
Measurements
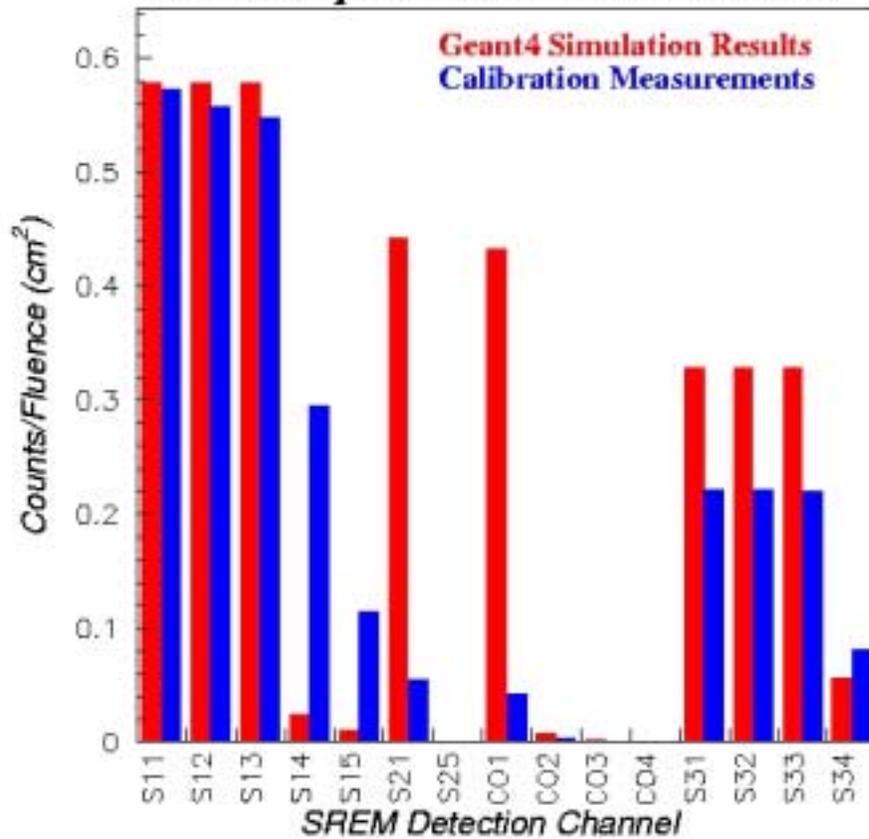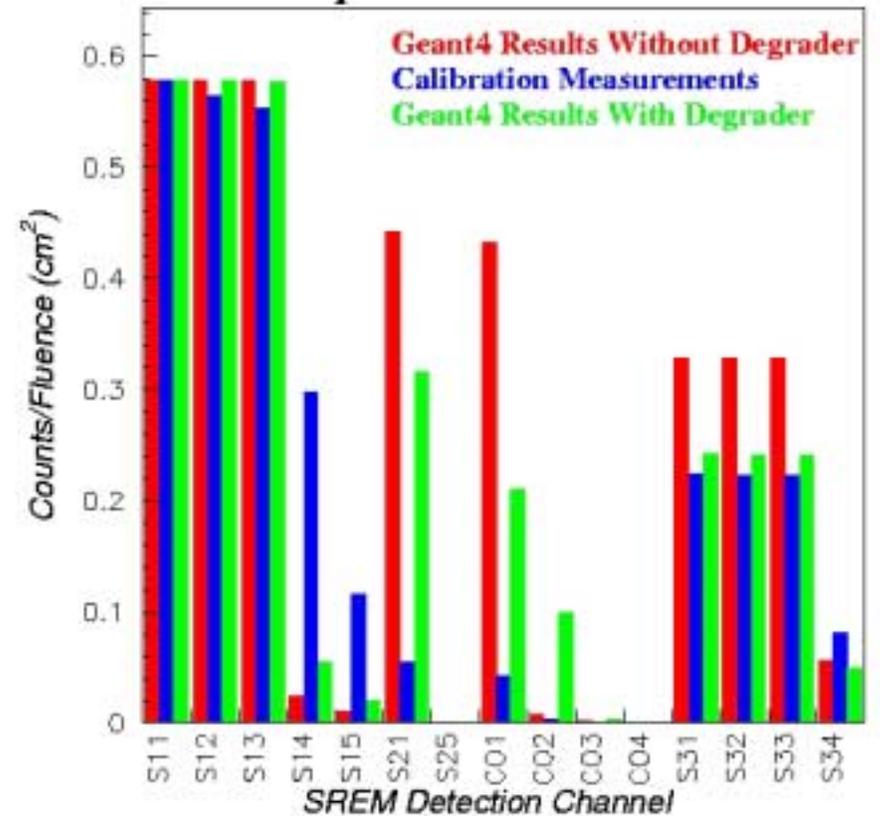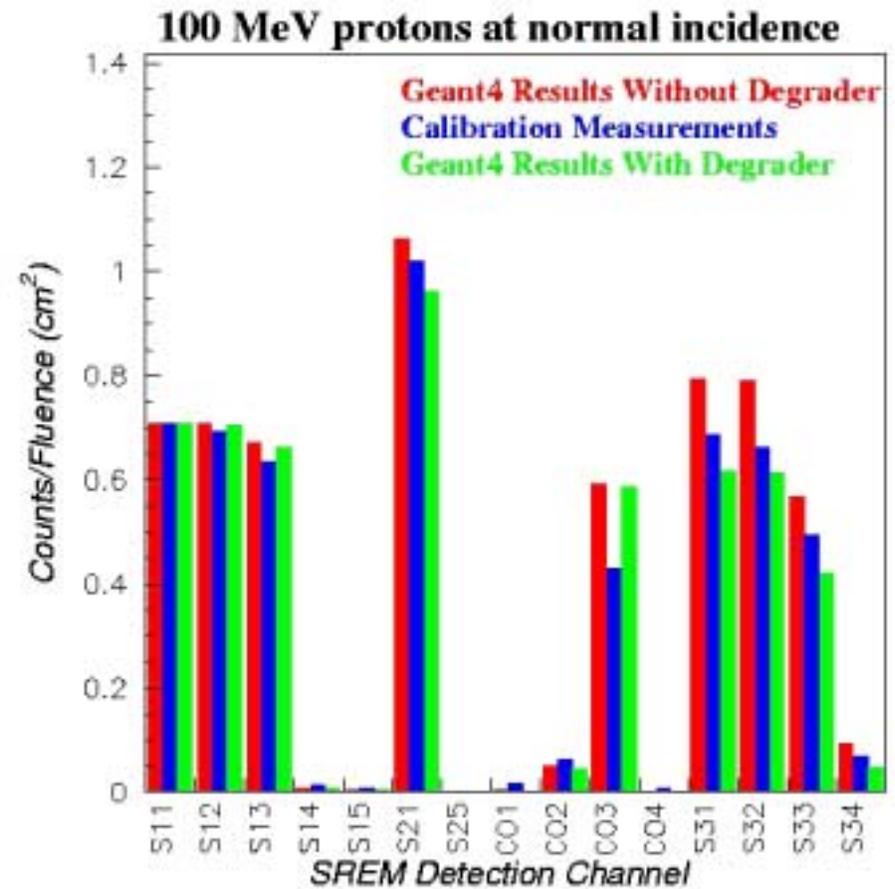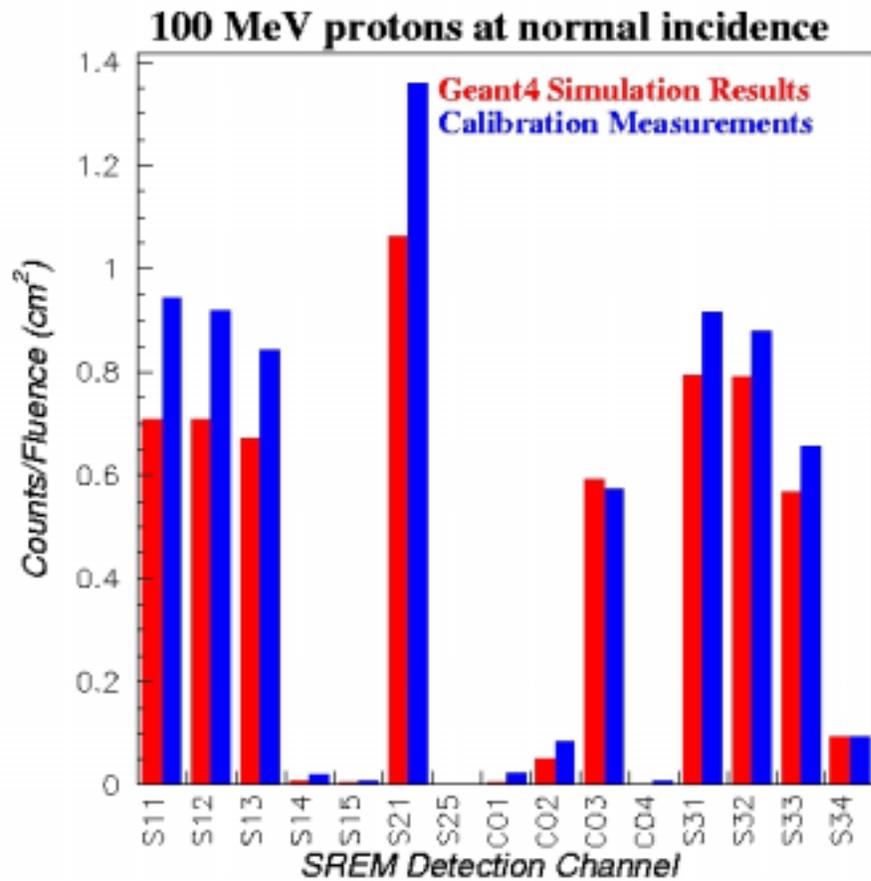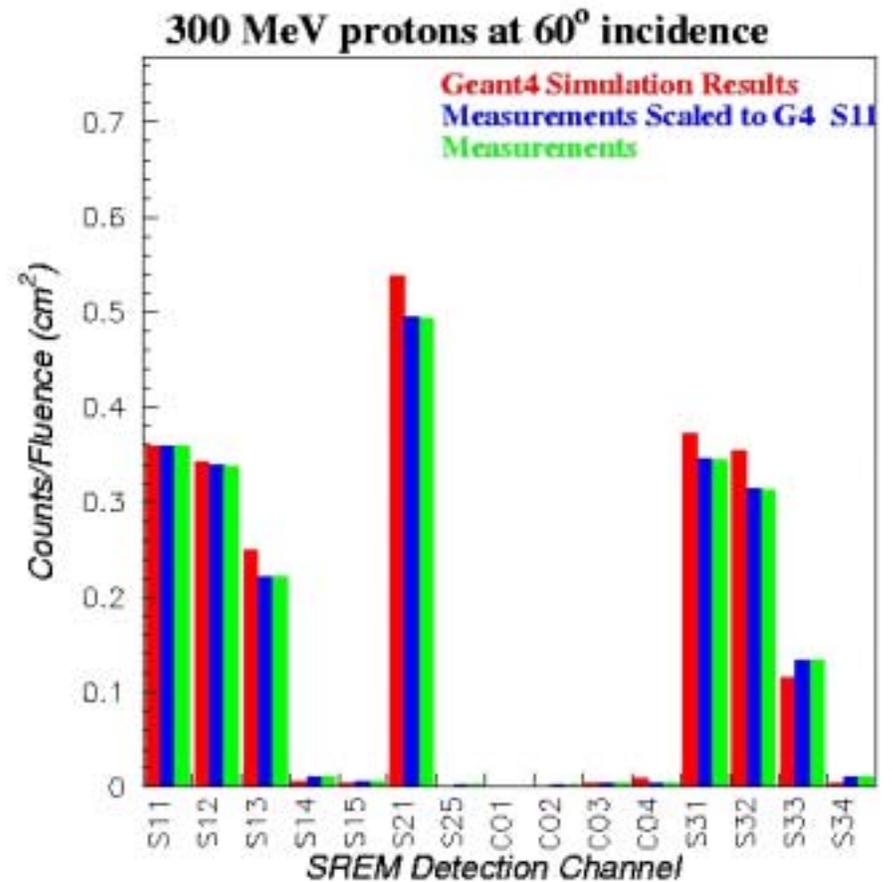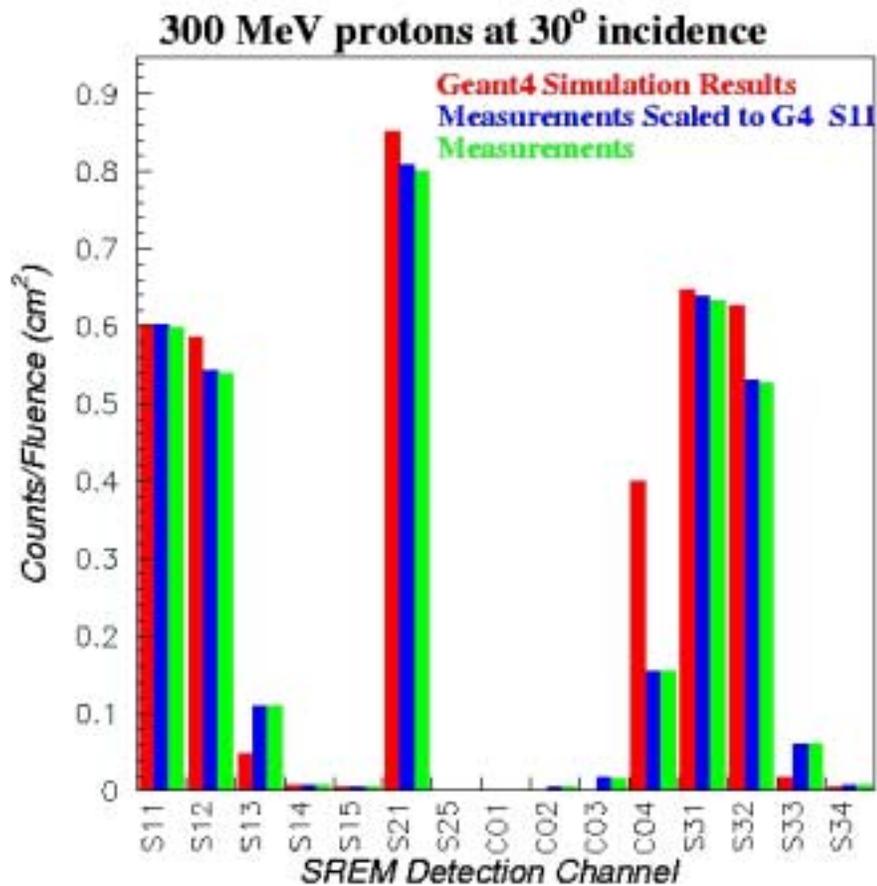
SREM Proton Detection
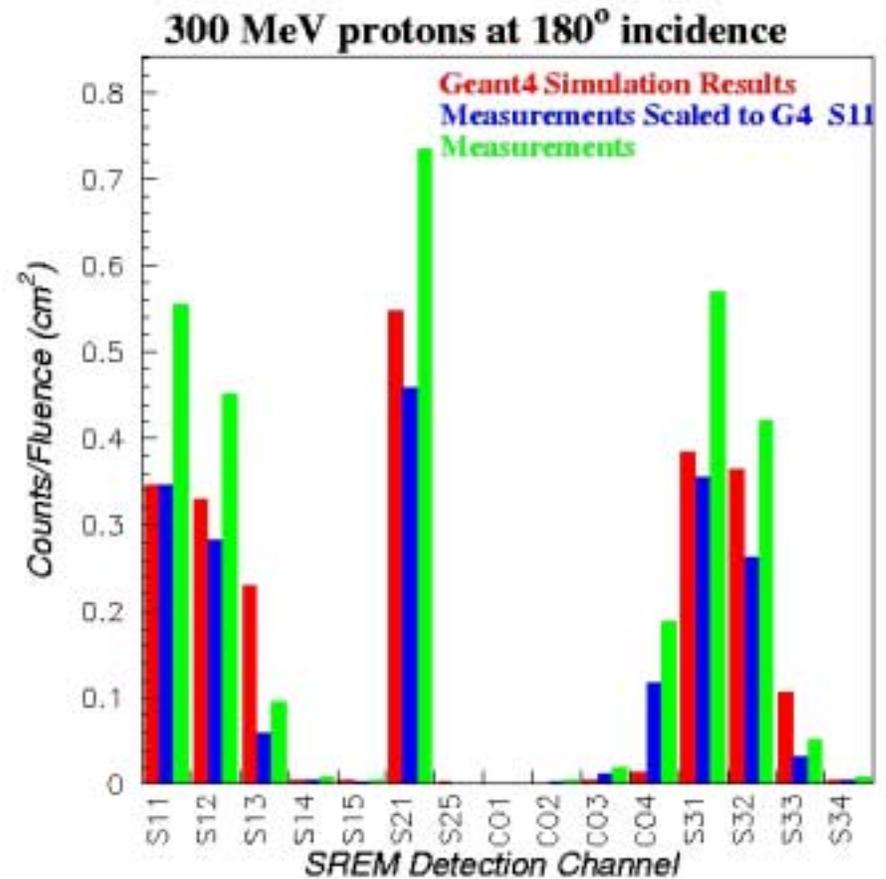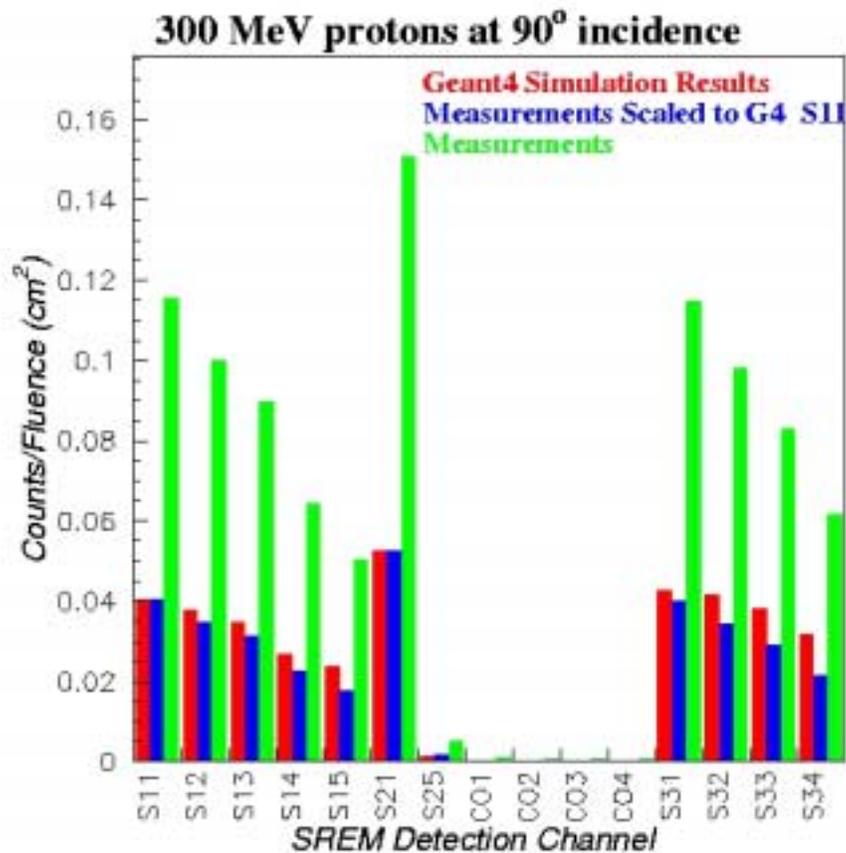
SREM Electron Detection

^{90}Sr radioactive source
on top of D1 and D2



Simulated β⁻ spectrum of ^{90}Sr
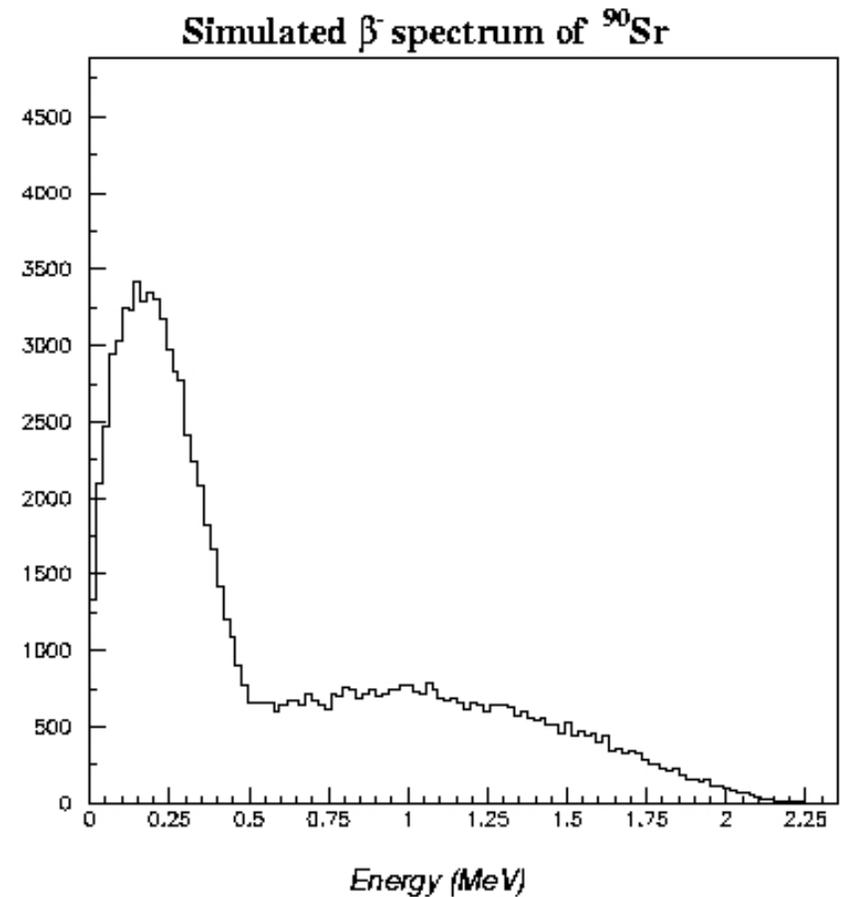
SREM Electron Detection
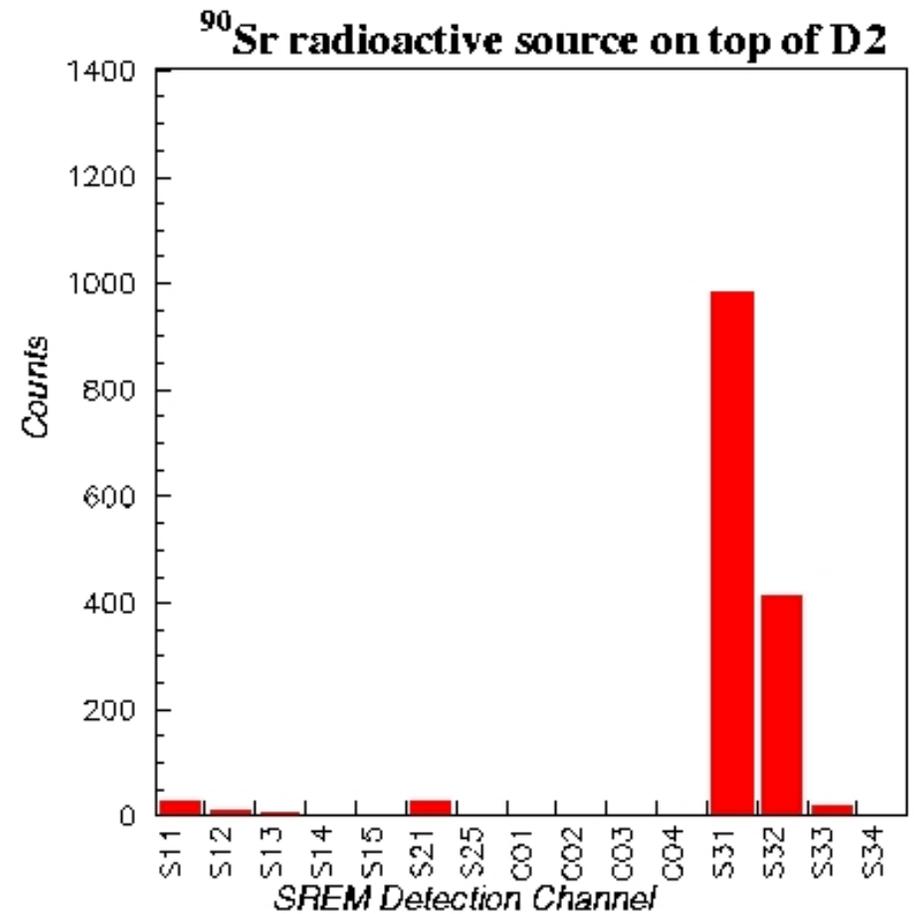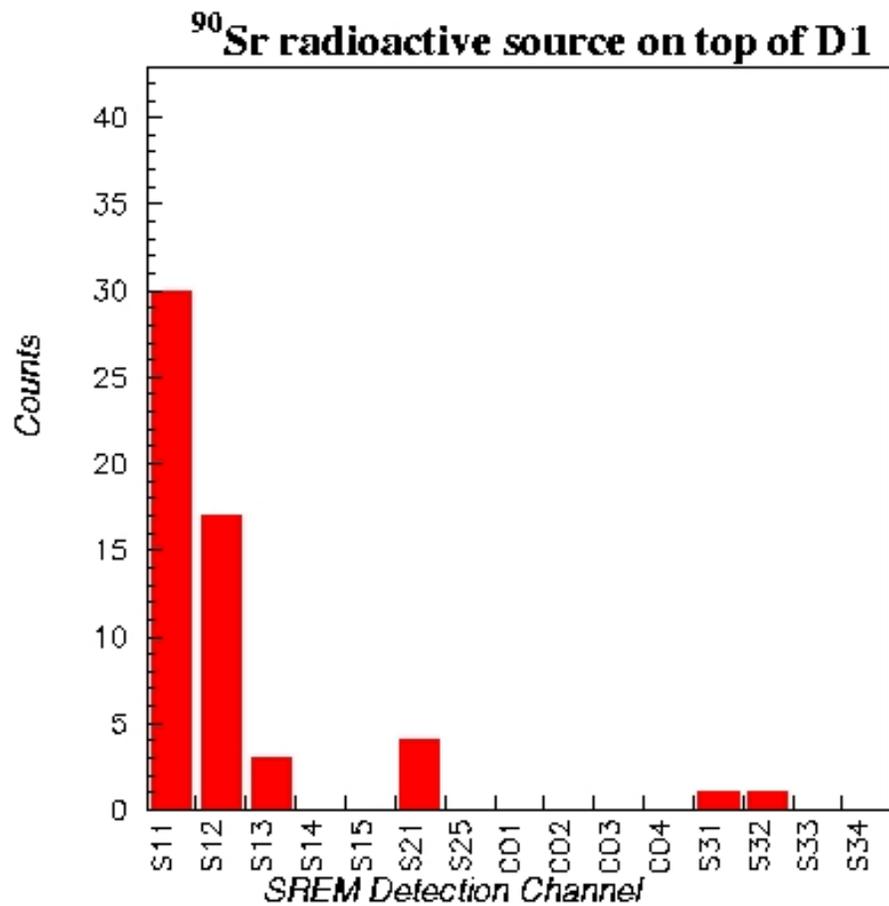
Solar Neutron Tracking Telescope (SONTRAC)

Neutron detection in 30-250 MeV energy range

Scintillating fiber block

Detection mechanism

single np scattering
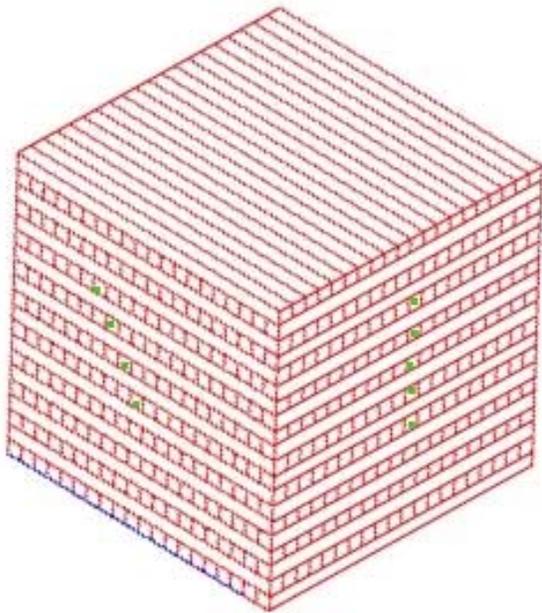
double np scattering
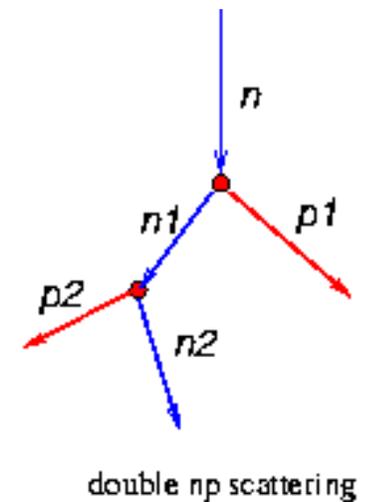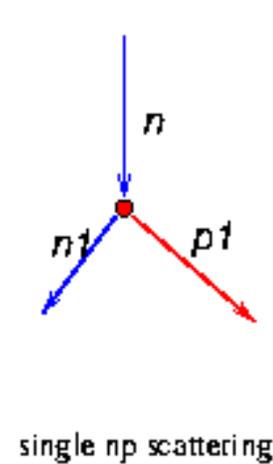
SONTRAC Simulation
5.10^5 normal incident neutrons

Single np elastic scattering mode

50 MeV
100 MeV

Neutron Kinetic Energy (MeV)

Double np elastic scattering mode

50 MeV
100 MeV

Neutron Kinetic Energy (MeV)