

Status of Low Energy Neutron Transport

Harphool Kumawat
Nuclear Physics Division,
BARC



Outline

- ❑ Status of ENDF Processing
- ❑ ENDF processing tests and Model tests
- ❑ Results
- ❑ Work to do



Endf Processing (offline)

- ◆ Reconstruction of resonance cross-section
- ◆ Linearization of cross-section with tolerance (0.1% or as required but same in all energy range)
- ◆ Doppler broadening at higher temperature
- ◆ Unionization of energy grids
- ◆ Create total ^1H , ^2H , ^3H , ^3He , ^4He production cross-section from various ground and excited states.
- ◆ Create total gas production cross-section from all charge particle production reactions i.e. $(n,p) + (n,2p)$
◆ $+(n,2np),(n,p\alpha)$.



Endf Processing (offline)

- ♦ All **angular distributions** that are given in terms of Legendre polynomials are converted to probability tables with tolerance of 0.5%

$$f(\mu, E) = \frac{2\pi}{\sigma_s(E)} \sigma(\mu, E) = \sum_{l=0}^{NL} \frac{2l+1}{2} a_l(E) P_l(\mu)$$

- ♦ All **angular distributions** that are given in terms of probability tables are converted to **linear probability** tables with tolerance of 0.5%



Endf Processing (offline)

- ♦ All **energy distributions** that are given in terms of 5-6 formulations are converted to **linear probability tables** with tolerance of 0.5%

$$f(E \rightarrow E') = \frac{e^{-E'/a}}{I} \sinh(\sqrt{bE'})$$

I is the normalization constant:

$$I = \frac{1}{2} \sqrt{\frac{\pi a^3 b}{4}} \exp\left(\frac{ab}{4}\right) \left[\operatorname{erf}\left(\sqrt{\frac{E-U}{a}} - \sqrt{\frac{ab}{4}}\right) + \operatorname{erf}\left(\sqrt{\frac{E-U}{a}} + \sqrt{\frac{ab}{4}}\right) \right] - a \exp\left[-\left(\frac{E-U}{a}\right)\right] \sinh \sqrt{b(E-U)}$$

$$f(E \rightarrow E') = \frac{1}{2} [g(E', E_F(L)) + g(E', E_F(H))]$$

$$g(E', E_F) = \frac{1}{3\sqrt{(E_F T_M)}} \left[u_2^{3/2} E_1(u_2) - u_1^{3/2} E_1(u_1) + \gamma\left(\frac{3}{2}, u_2\right) - \gamma\left(\frac{3}{2}, u_1\right) \right]$$

$$u_1 = \left(\sqrt{E'} - \sqrt{E_F}\right)^2 / T_M$$

$$u_2 = \left(\sqrt{E'} + \sqrt{E_F}\right)^2 / T_M$$

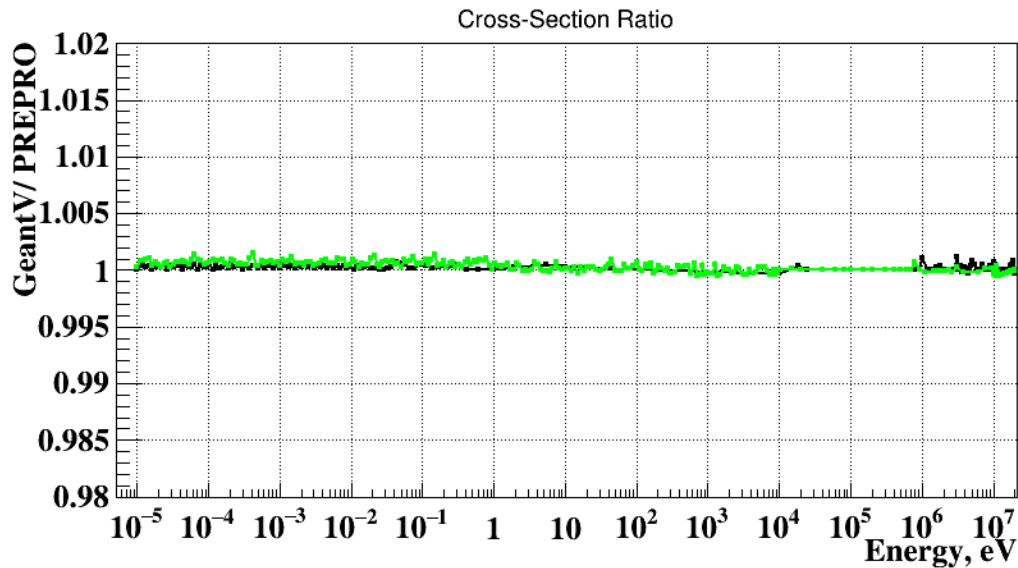
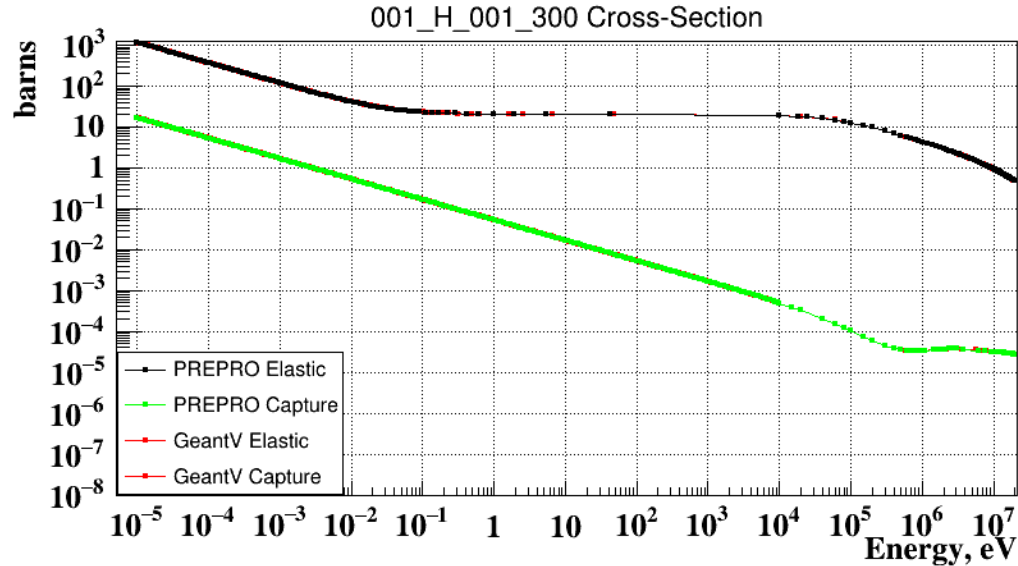


Status of ENDF processing

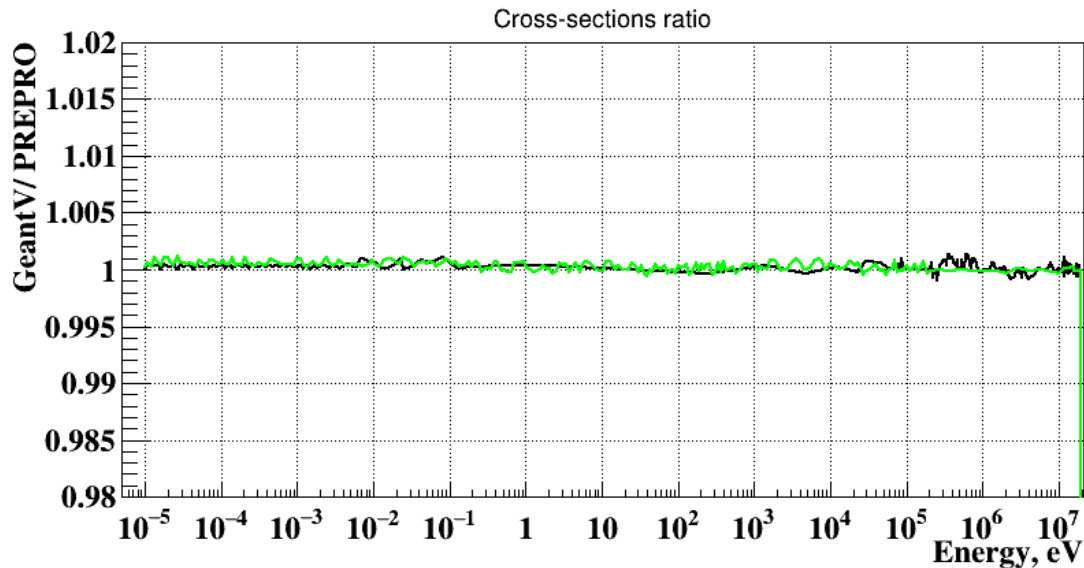
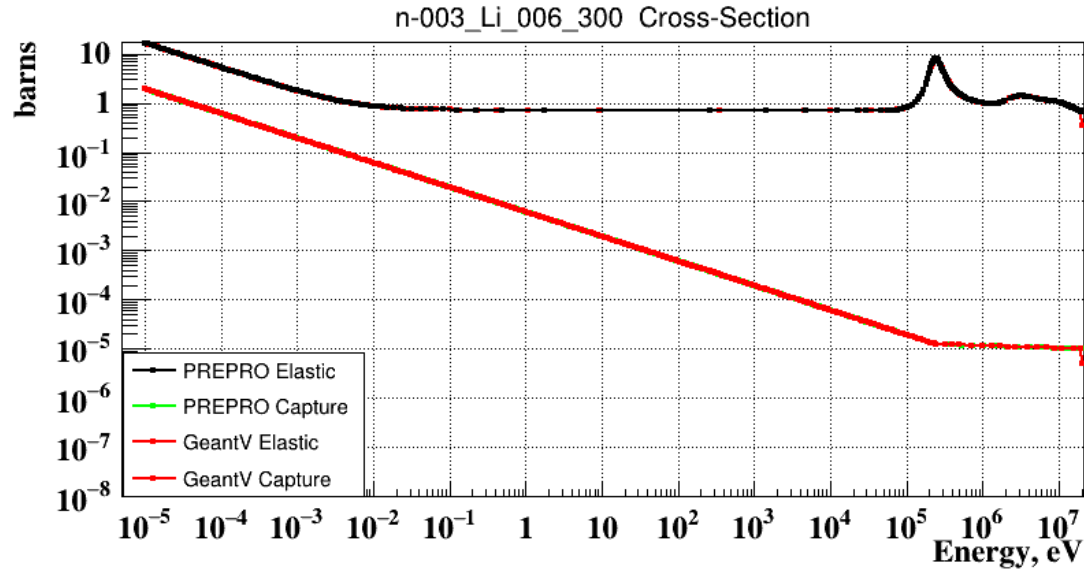
- ♦ All calculation are limited to pre-processing stage which is offline. We just build CDF during initialization of simulation.
- ♦ Preprocessed ENDF/B-VIII.0 (556 isotopes), root files are generated to use in simulation.
- ♦ Processed few JENDL-4.0 JEF-3.2, EAF-2010, ROSFOND-2010 files without any issue but need to check for all isotopes.
- ♦ Photon emission data is processed.
- ♦ 4 processes and models (Elastic, capture, fission and inelastic) are used to couple within hadronic processes.
- ♦ Library processing and retrieving executables are written in nudy, sub-directory EndfToRoot. Data are in written tree for plotting.
- ♦ TestNudy0 is written to physics/tests to test models and integrals



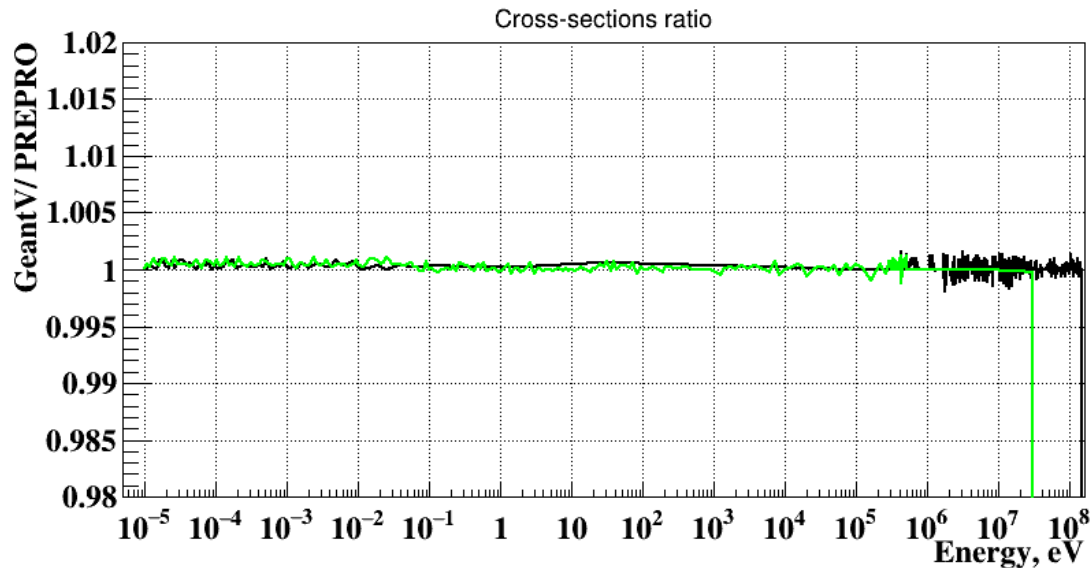
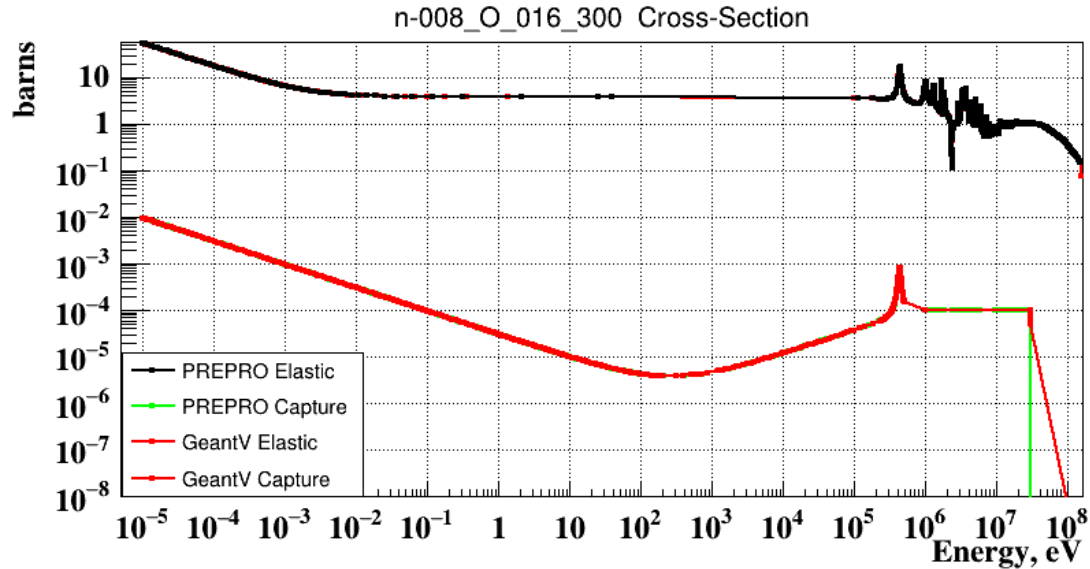
Comparison of cross-section with PREPRO



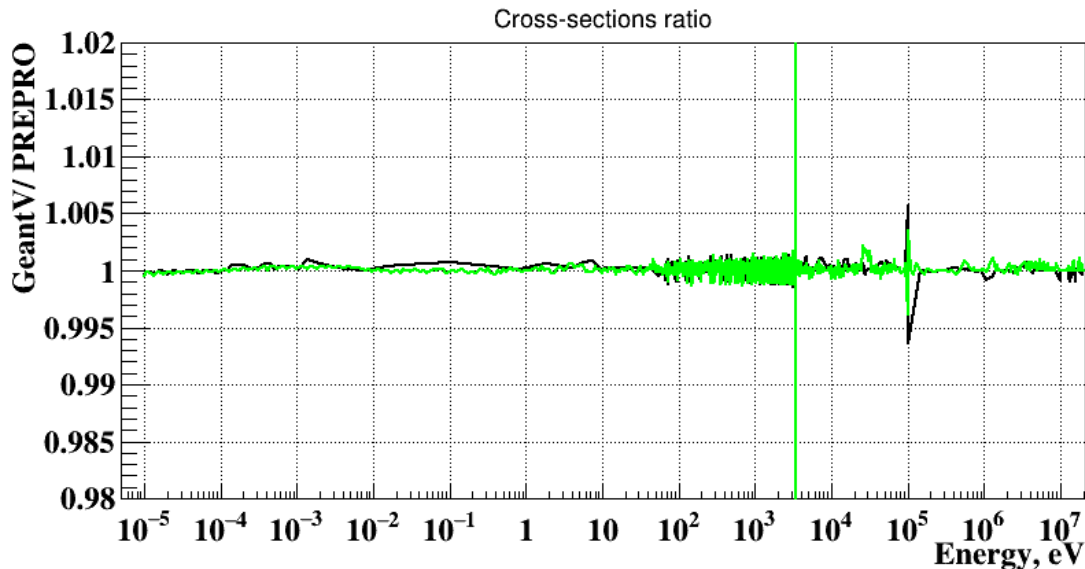
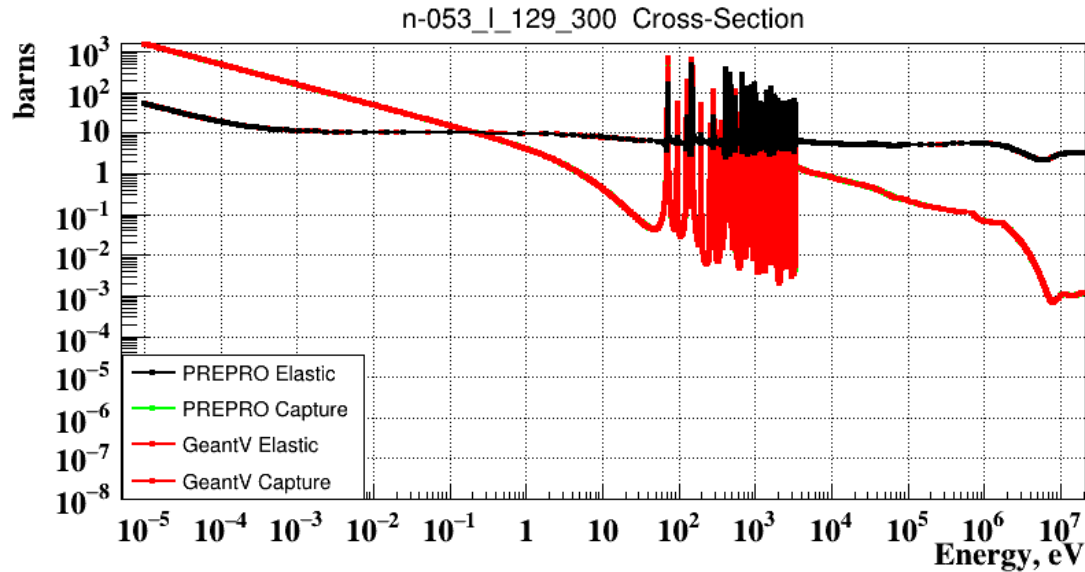
Comparison of cross-section with PREPRO



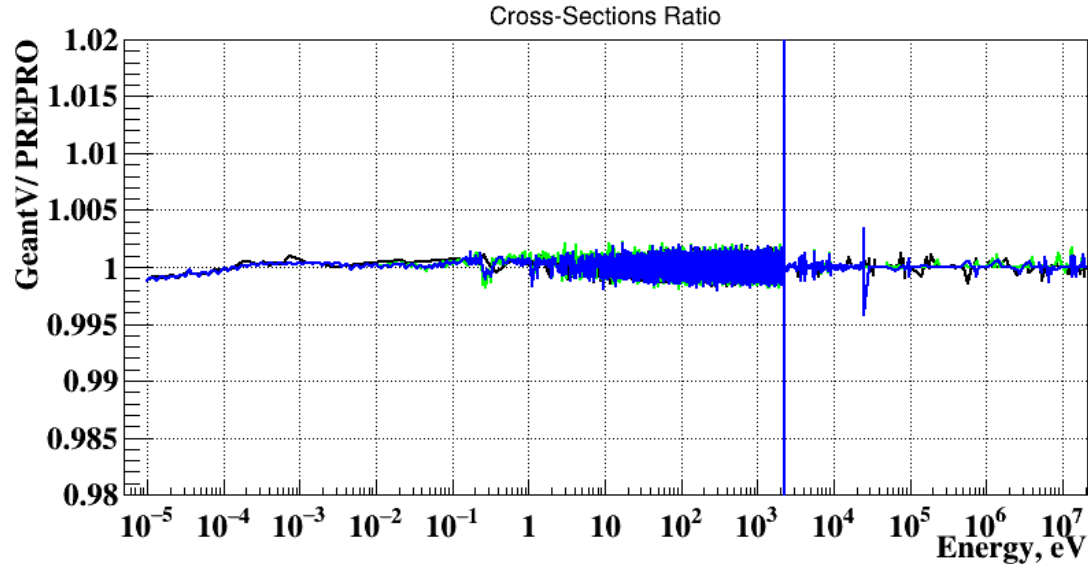
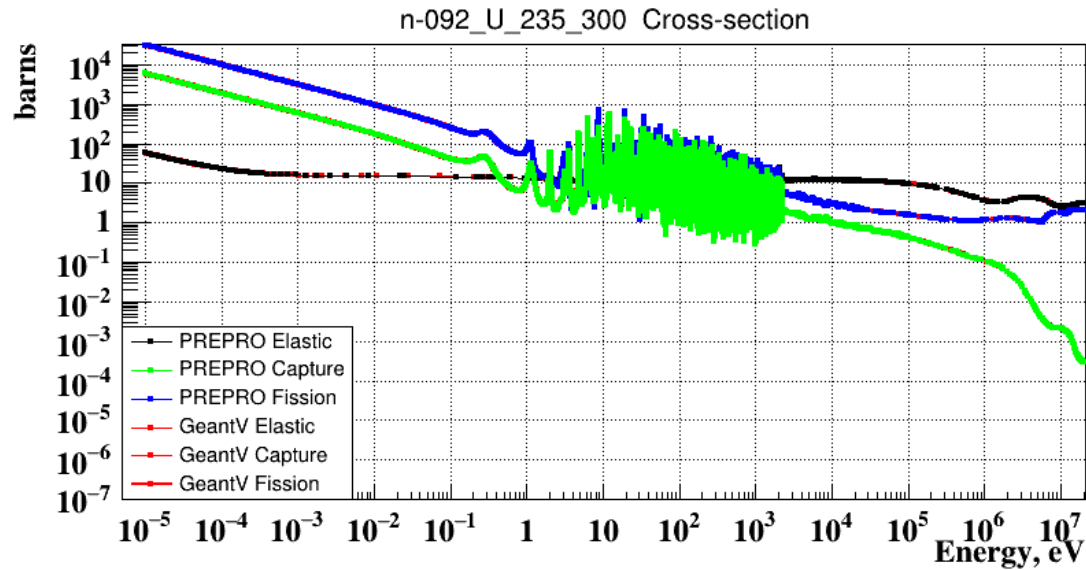
Comparison of cross-section with PREPRO



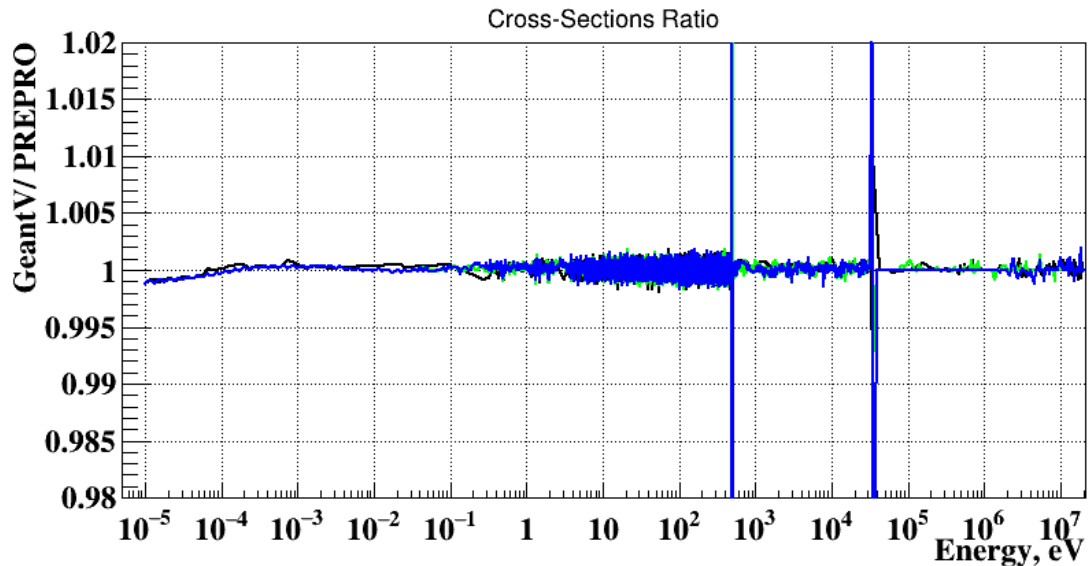
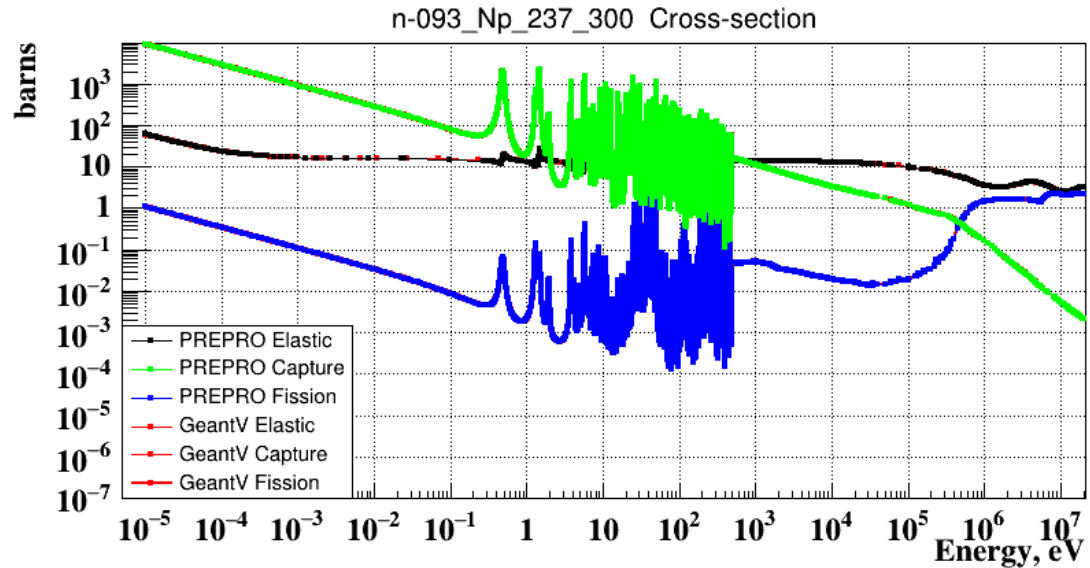
Comparison of cross-section with PREPRO



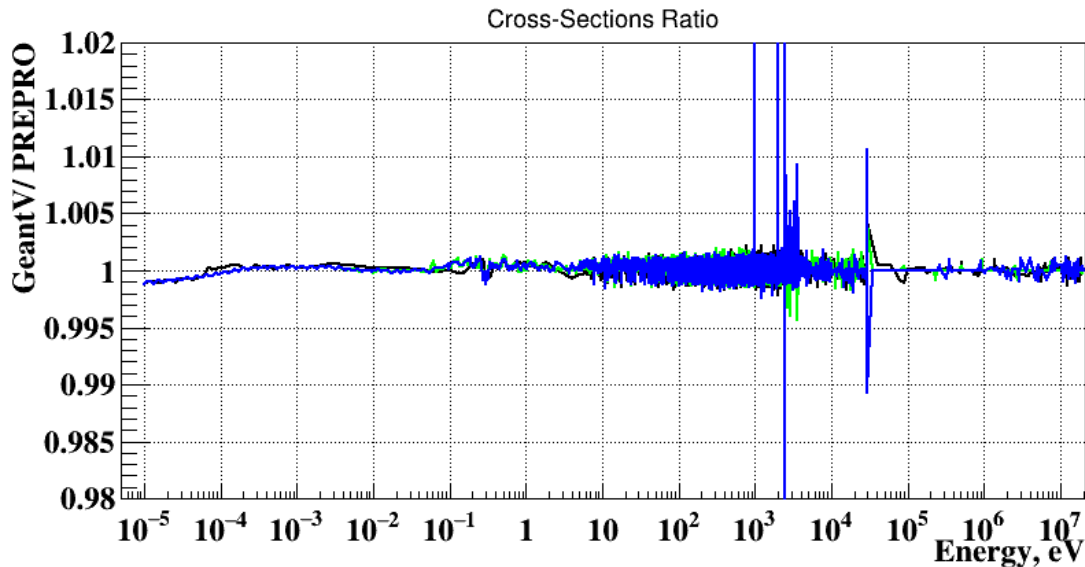
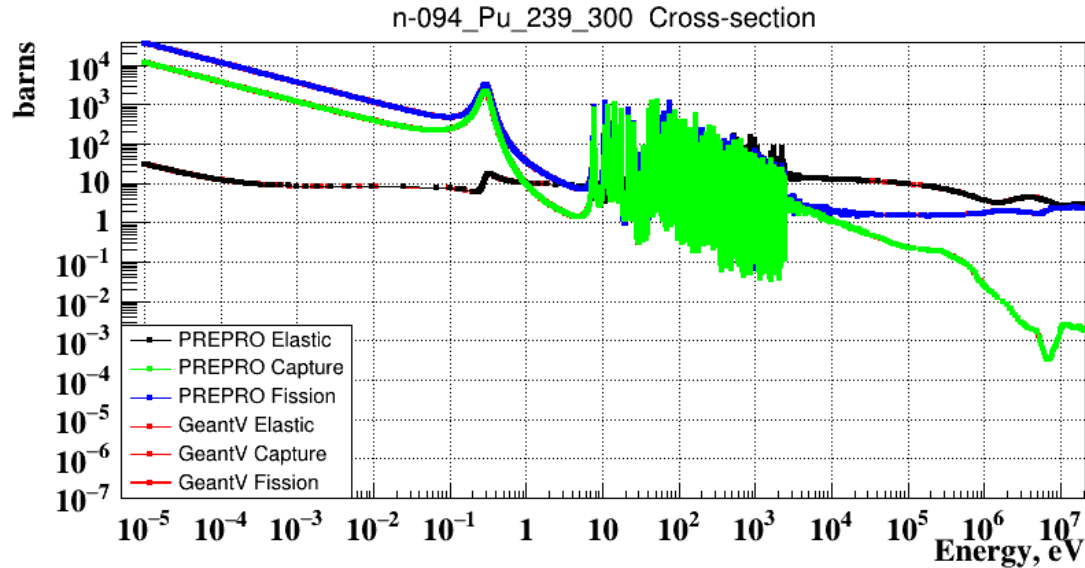
Comparison of cross-section with PREPRO



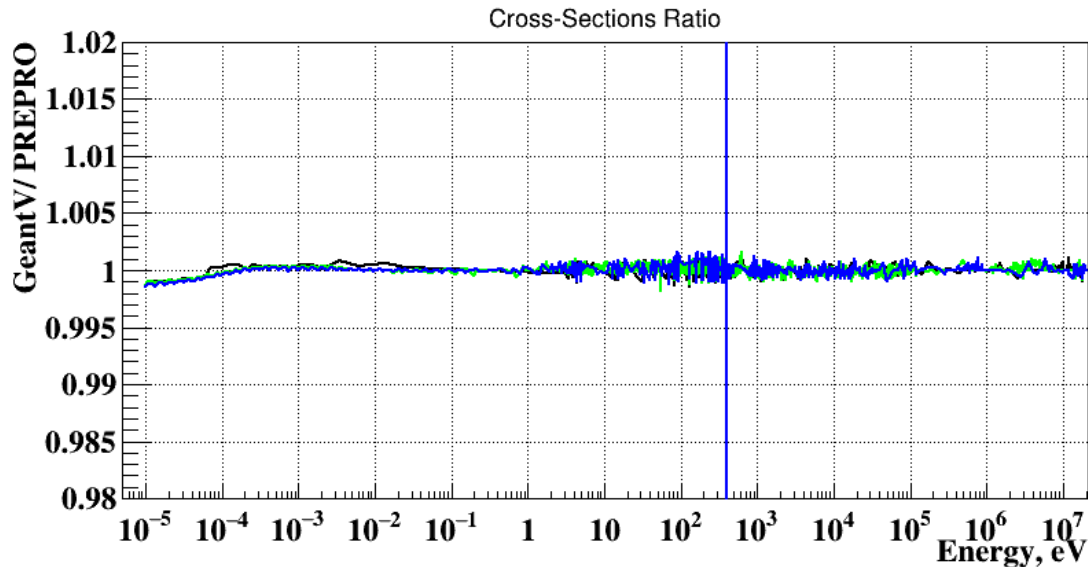
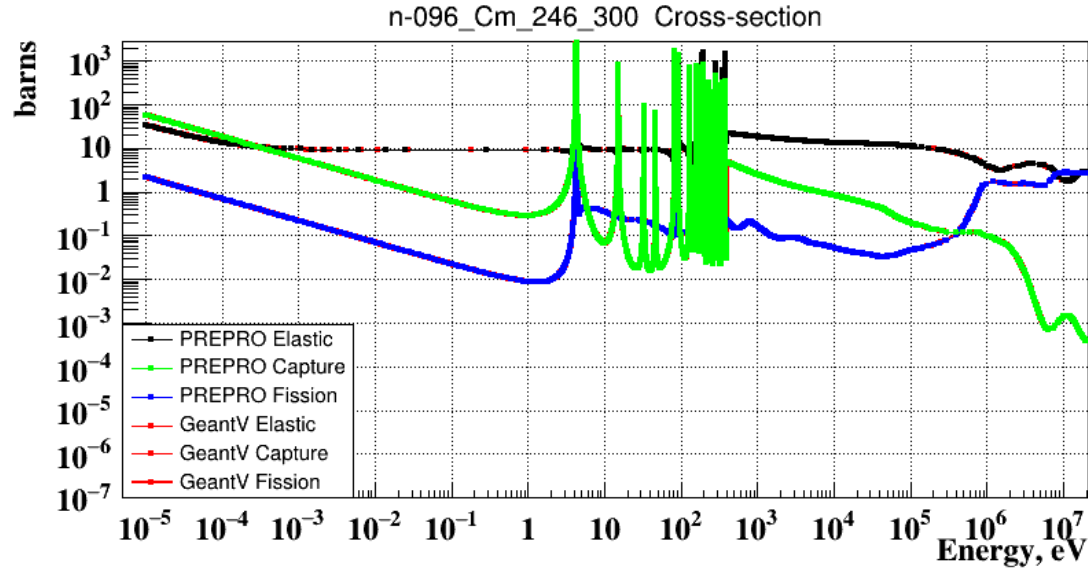
Comparison of cross-section with PREPRO



Comparison of cross-section with PREPRO

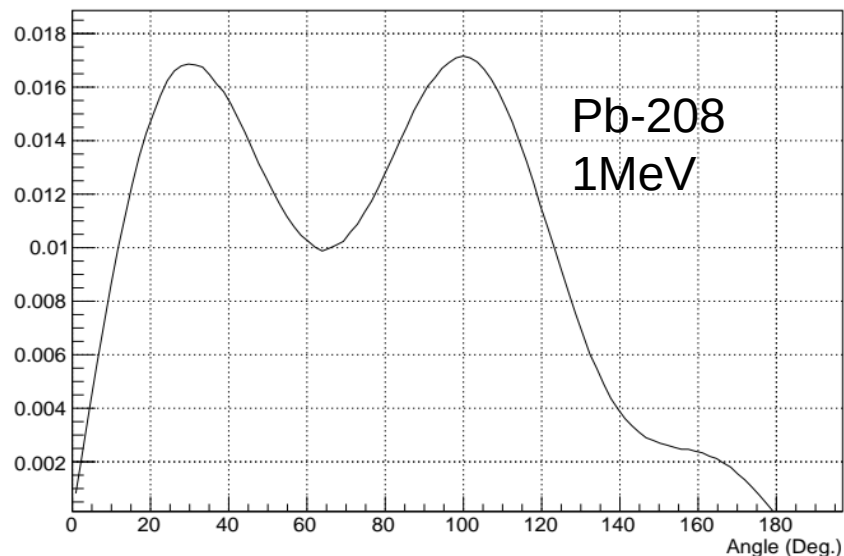


Comparison of cross-section with PREPRO

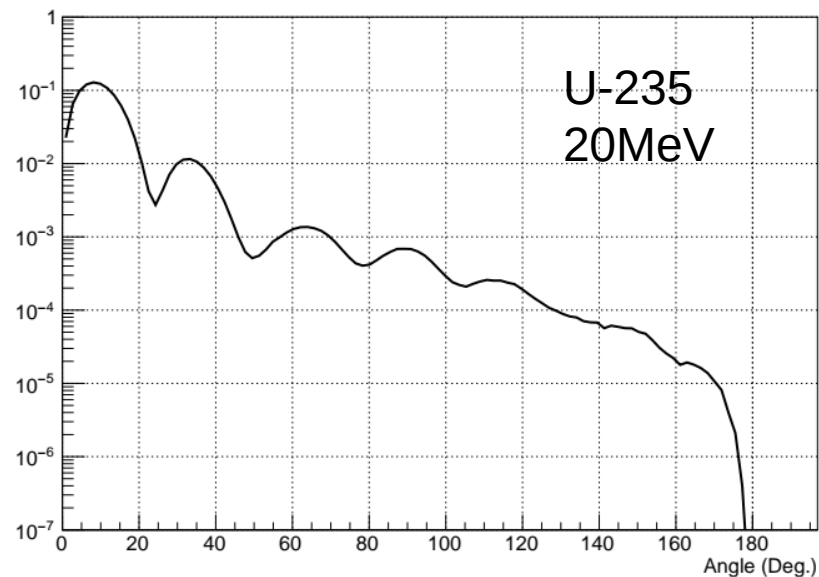


Elastic Angular Distributions

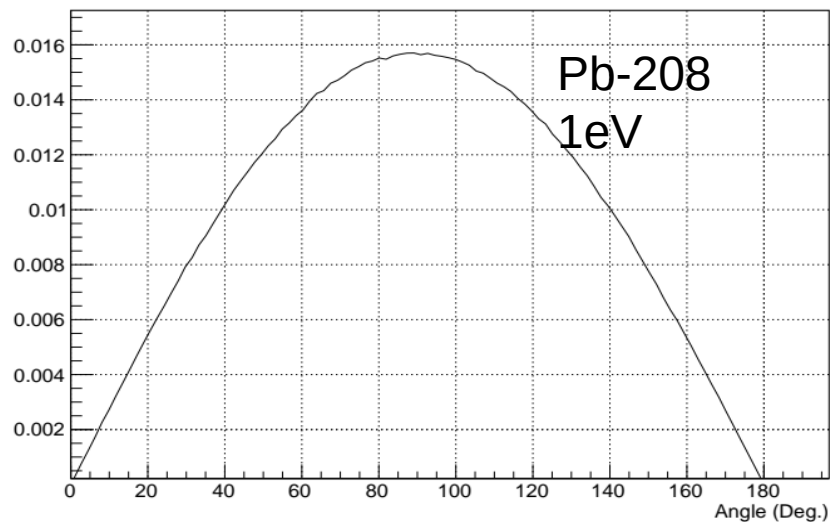
Angular Distribution



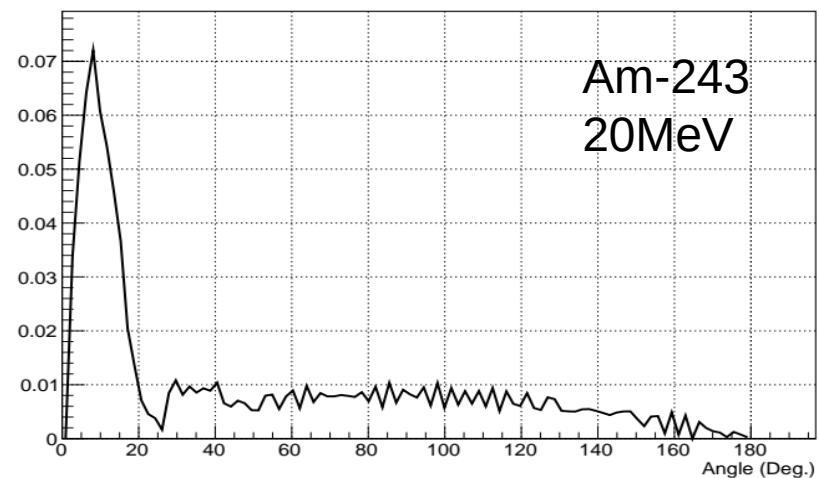
Angular Distribution



Angular Distribution

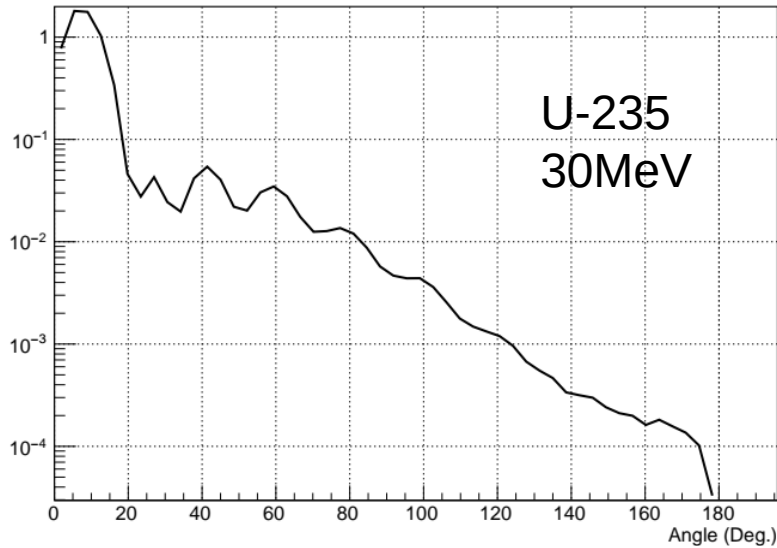


Angular Distribution

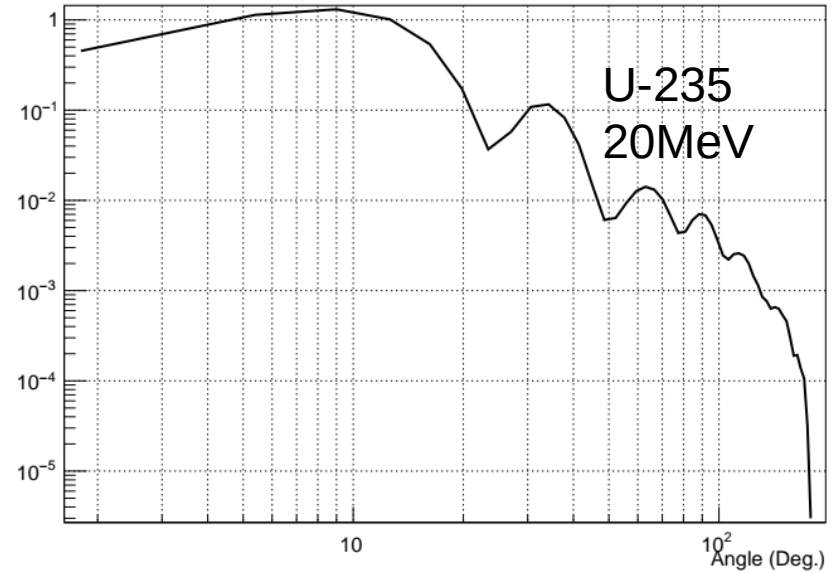


Fission Neutron Angular Distributions

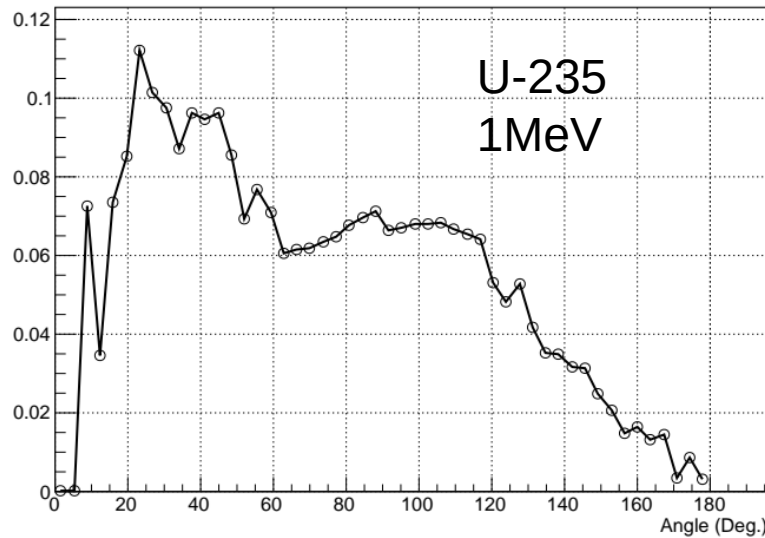
Angular Distribution



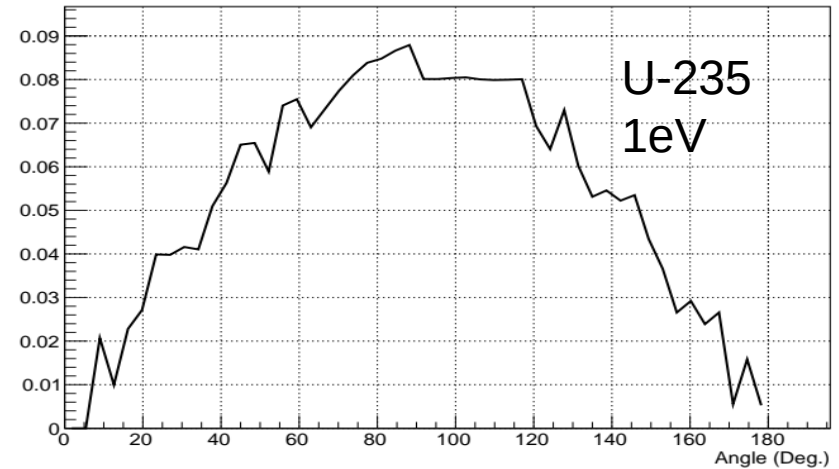
Angular Distribution



Angular Distribution

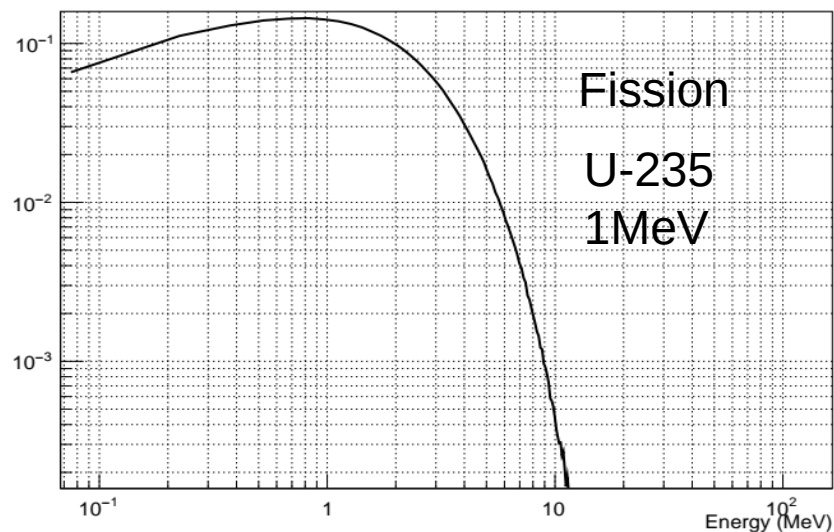


Angular Distribution

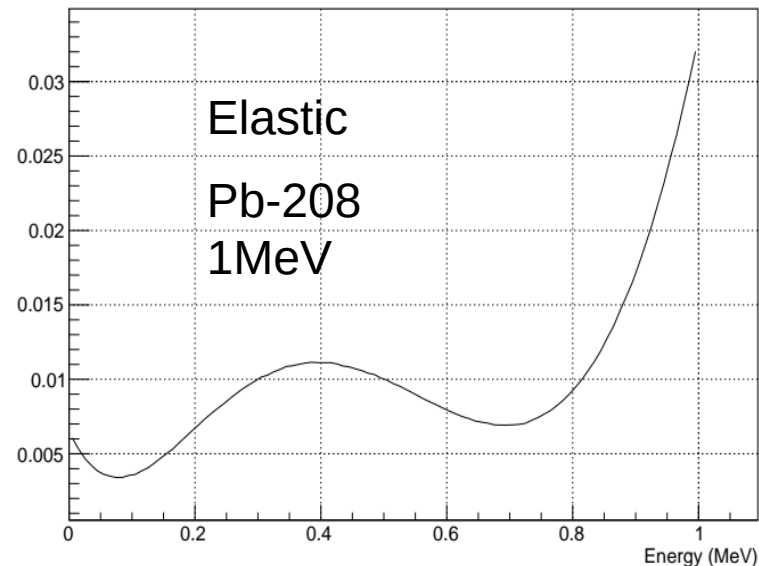


Energy Distributions

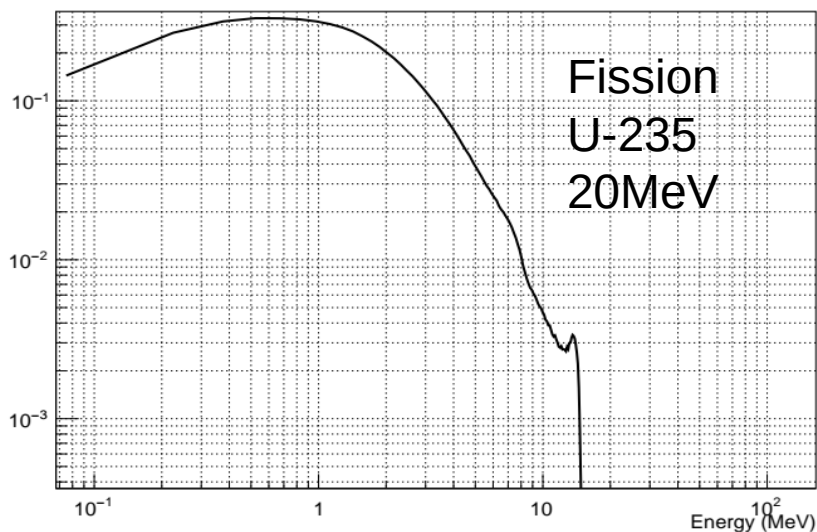
Energy Distribution



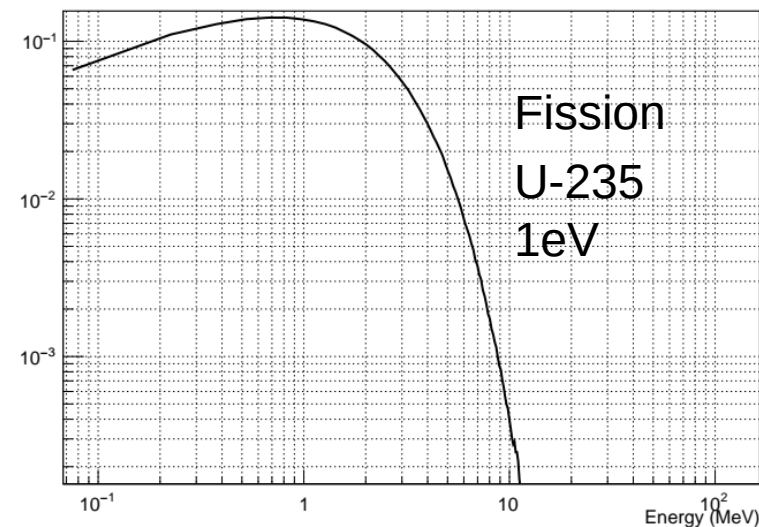
Energy Distribution



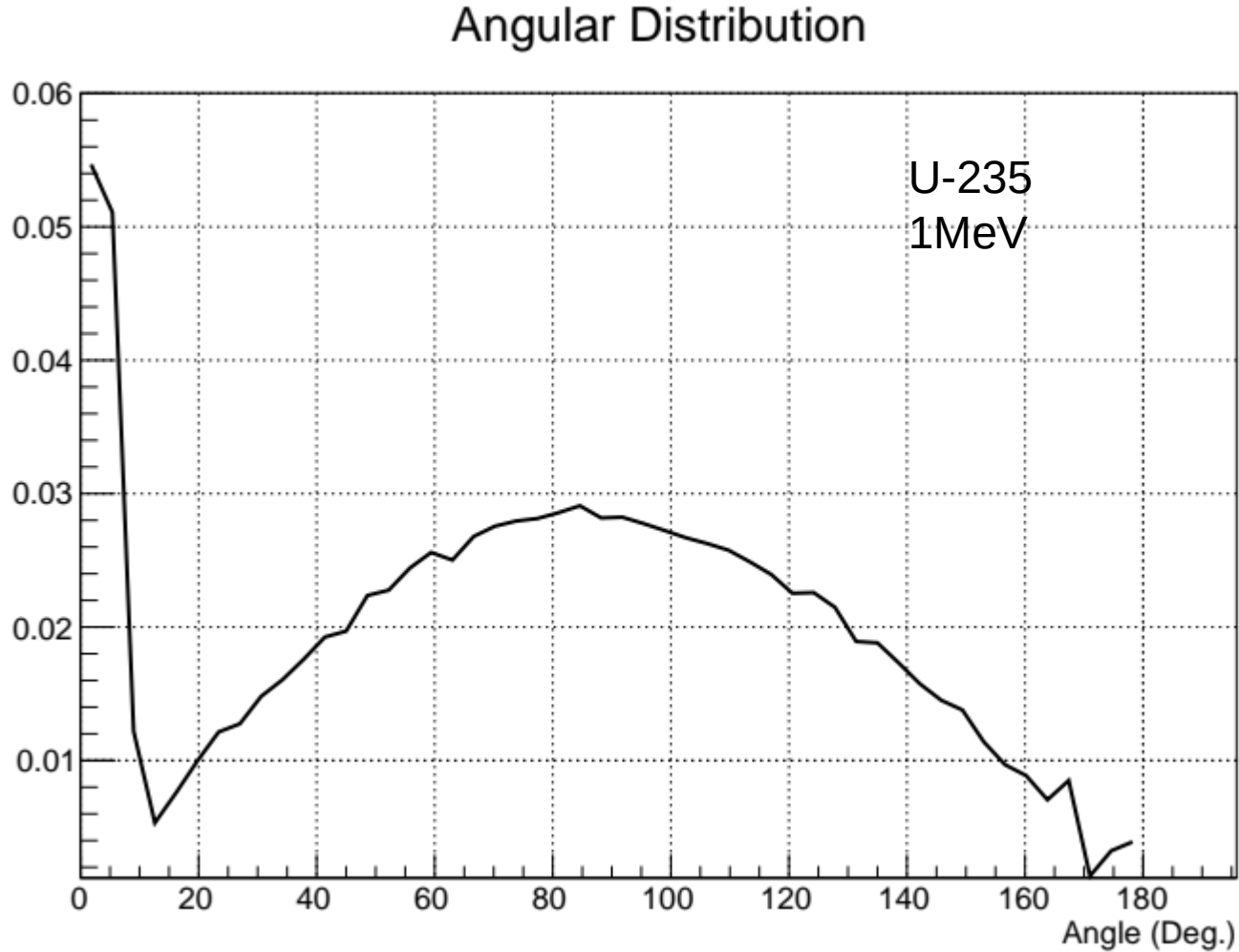
Energy Distribution



Energy Distribution

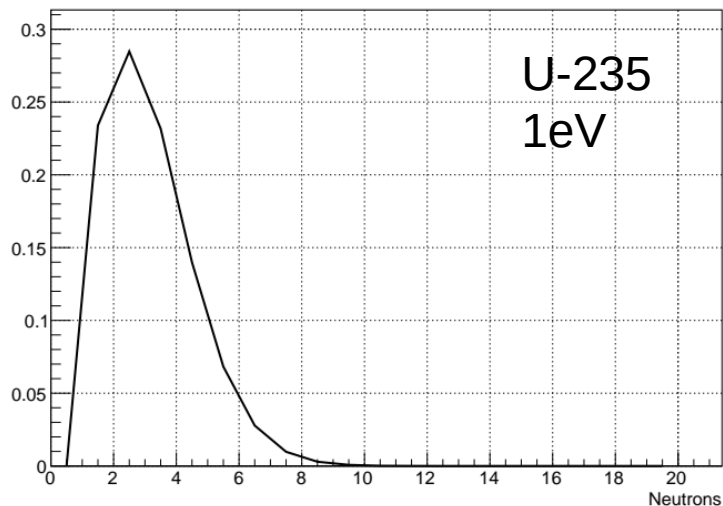


Inelastic Angular Distributions

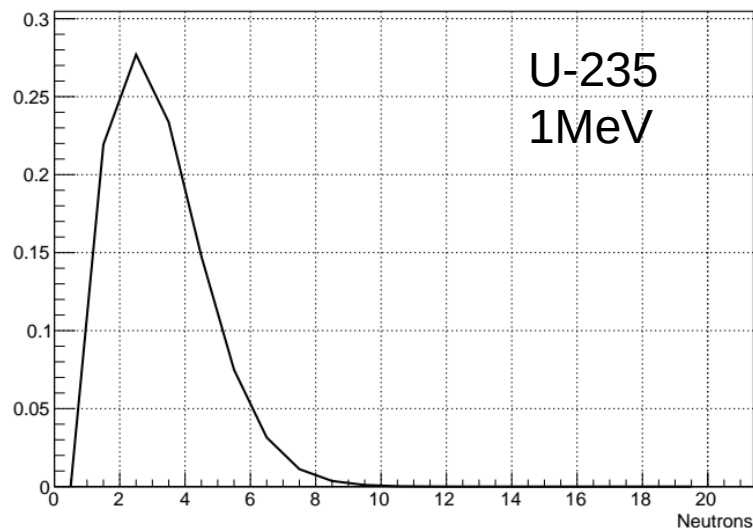


Fission Neutron Multiplicity

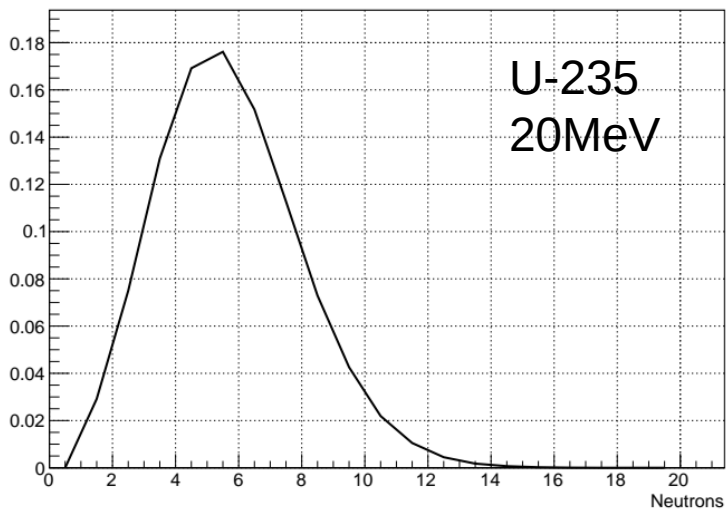
Fission neutrons



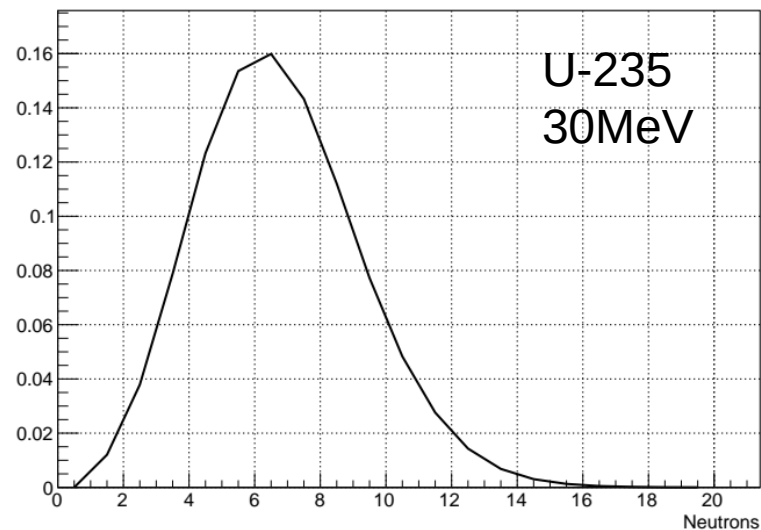
Fission neutrons



Fission neutrons



Fission neutrons



Work to Do

- ◆ Process the library for charge particles using same tools
- ◆ Create similar test as in Geant4 and test performance
- ◆ Process co-variance data and add error bar to simulated data along with statistical error.
- ◆ Generate root independent version and implement in Geant4



धन्यवाद

Thank you for your attention!

