Experiments to reduce Nuclear Data uncertainties

Y. DANON

Professor and Director Gaerttner LINAC Center
Nuclear Engineering Program Director
Department of Mechanical, Aerospace and Nuclear Engineering
Rensselaer Polytechnic Institute, Troy, NY, 12180

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Why do we need experiments?

- Do not fully understand the physics
- Can not theoretically calculate Nuclear Data with sufficient accuracy required by applications
  - Experiments constrain the uncertainty of evaluated data files
  - Test the accuracy of evaluated files and transport codes physics
Types of experiments

- **Differential experiments**, examples:
  - Neutron cross section as a function of neutron energy
  - Neutron capture cascades gamma spectrum
  - Fission fragment yields
  - Quasi-differential experiments

- **Validation experiments**, examples:
  - Criticality experiments (benchmarks)
  - Integral shielding measurements
  - Quasi-differential experiments

All experiments should report experimental covariance data or equivalent.
Differential measurements

- **Types of experiments**
  - Neutron transmission (total cross section)
  - Neutron capture yield (capture cross section)
  - Fission cross section
  - Neutron scattering and angular distribution
  - Other novel experiments

- **Facilities and detectors**
  - Requires accelerators facilities
    - Short pulse to provide high energy-resolution
    - High intensity
  - Variety detector arrays and electronics
    - Detect neutrons, gammas, charge particles
  - Samples
    - Pure isotopes, actinides
    - Radiochemistry and thin uniform films

- **People**
  - Need trained and innovative researchers
Neutron reaction cross section experiments

- **All energy regions** - transmission, capture and fission cross sections
- **Thermal Region** - Thermal scattering and accurate scattering cross section (molecular effects)
- **URR and fast region** - elastic and inelastic scattering
- **URR and fast region** - angular distributions

![Graph](image.png)
One example – resonance region

- Capture measurements on $^{157}$Gd
- Gd is a strong thermal neutron absorber used in many applications
- Part of a series of measurement on several Gd and Dy natural isotopes.
- New resonances were measured and resonance parameters obtained
- New evaluation in progress

Measured using the RPI gamma multiplicity detector