Los Alamos NATIONAL LABORATORY

Processing photo-nuclear and photo-atomic data in NJOY

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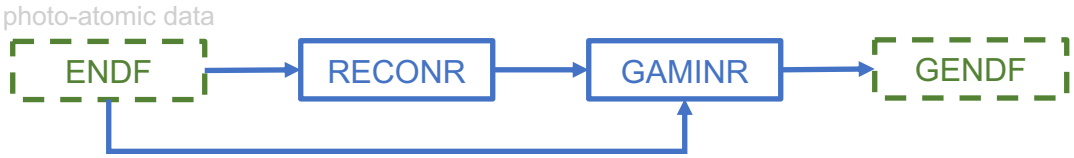
Table of Contents

Photo-atomic and photo-nuclear data in ENDF

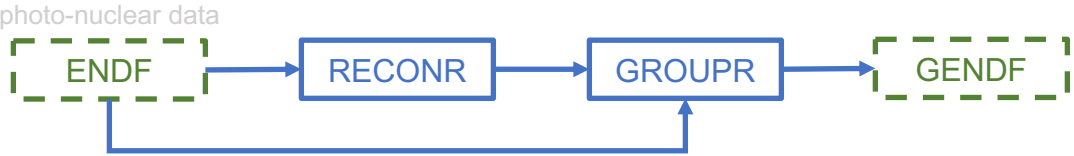
- Photo-atomic and photo-nuclear data have their own distinct sub-library
  - Photo-atomic data is given for elements (photons interact with the electron cloud)
  - Photo-nuclear data is given for nuclides (photons interact with the nucleus)
- ENDF files use distinctly different formats for these sub-libraries
  - Photo-atomic sub-library (NSUB=3)
    - MF23 for smooth cross sections
    - MF27 for coherent scattering form factors and incoherent scattering functions
    - MF26 for secondary particle distributions
  - Photo-nuclear sub-library (NSUB=0)
    - Essentially the same as incident neutron and incident charged particle sub-libraries
    - MF3 for cross section data
    - MF4-MF6 for secondary particle distribution data
    - MF31-MF40 for covariance data

Processing modules in NJOY2016

Multigroup photo-atomic data



Multigroup photo-nuclear data



Continuous energy photo-atomic data

Continuous energy photo-nuclear data

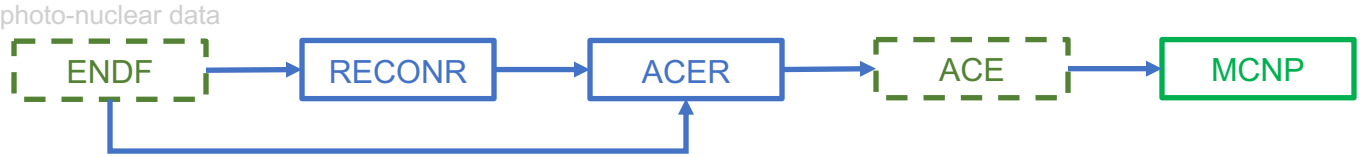


Photo-atomic and photo-nuclear ACE libraries

- Official ACE libraries for MCNP: https://nucleardata.lanl.gov
- Photo-atomic libraries
  - Multiple photo-atomic libraries have been released since 1982
  - Most recent version: MCPLIB63 and MCPLIB84 released in 2012
- Photo-nuclear libraries
  - Only one official library available: LA150U released in 2000 and updated in 2001
  - For a limited number of nuclides only (H2, C12, W184, Pb, etc.)

- Our long term goal: a new photo-nuclear ACE library based on ENDF/B-VIII.1
  - Work on improving processing (NJOY2016.64 and 2016.66)
  - Work on adding the photo-nuclear format to the ACE format specifications
  - Work on verification and validation for such a new library

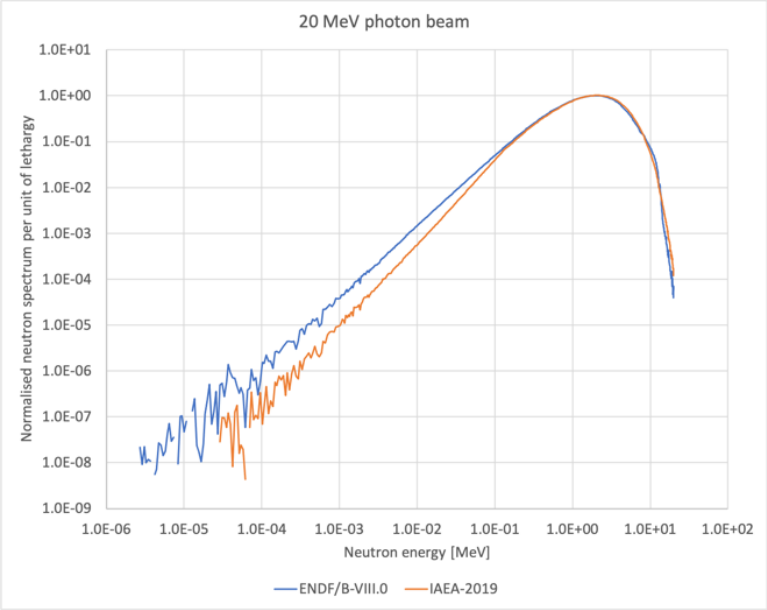
Recent work on photo-nuclear data processing

- Traditional photo-nuclear data
  - Secondary photon distributions traditionally given using the LAW=1 LANG=1 format
  - Traditionally using a single Legendre coefficient (i.e. isotropic distribution)
  - This assumption was hardcoded in NJOY2016's ACER module
- And then the IAEA-2019 library was released (August 2020)
  - Secondary distributions are using anisotropic Legendre expansion

- A major update for photo-nuclear data processing: NJOY2016.66
  - Secondary photon distributions now translated into ACE LAW=61
  - Properly handle photo-fission neutron multiplicity data when MF6/MT18 is used
- Please note: only MCNP6.3 is capable of using the photonuclear ACE files produced by NJOY2016.66

Recent work on photo-nuclear data validation

- We need experimental data and benchmarks for validation
  - It requires demonstratable sensitivity to photo-nuclear interactions
- We are looking into data comparison for now
  - For example: compare ENDF/B-VIII.0 and the IAEA-2019 library
  - Tallying particle spectra outside a disk bombarded mono-energetic photon or electron beam
- We could use your input and help on this topic



Conclusions and questions

- Photo-atomic data processing is an established activity at LANL
  - Multiple libraries have been released over the last 40 years
  - Verification and validation has been limited though

- Photo-nuclear data processing is being actively worked on
  - We want to release a new photo-nuclear ACE data library based on ENDF/B-VIII.1
  - We have been updating NJOY2016 towards this goal

- We need to work on photo-atomic and photo-nuclear data validation
  - Comparing data libraries on simplified problems
  - Identify validation benchmarks and experimental data
  - If you work on this, we want to collaborate with you