

Photonuclear data processing and validation for ENDF/B-VIII.1

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Outline

- Processing photonuclear data with NJOY2016
- Experimental data for validation
- Other validation exercises



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

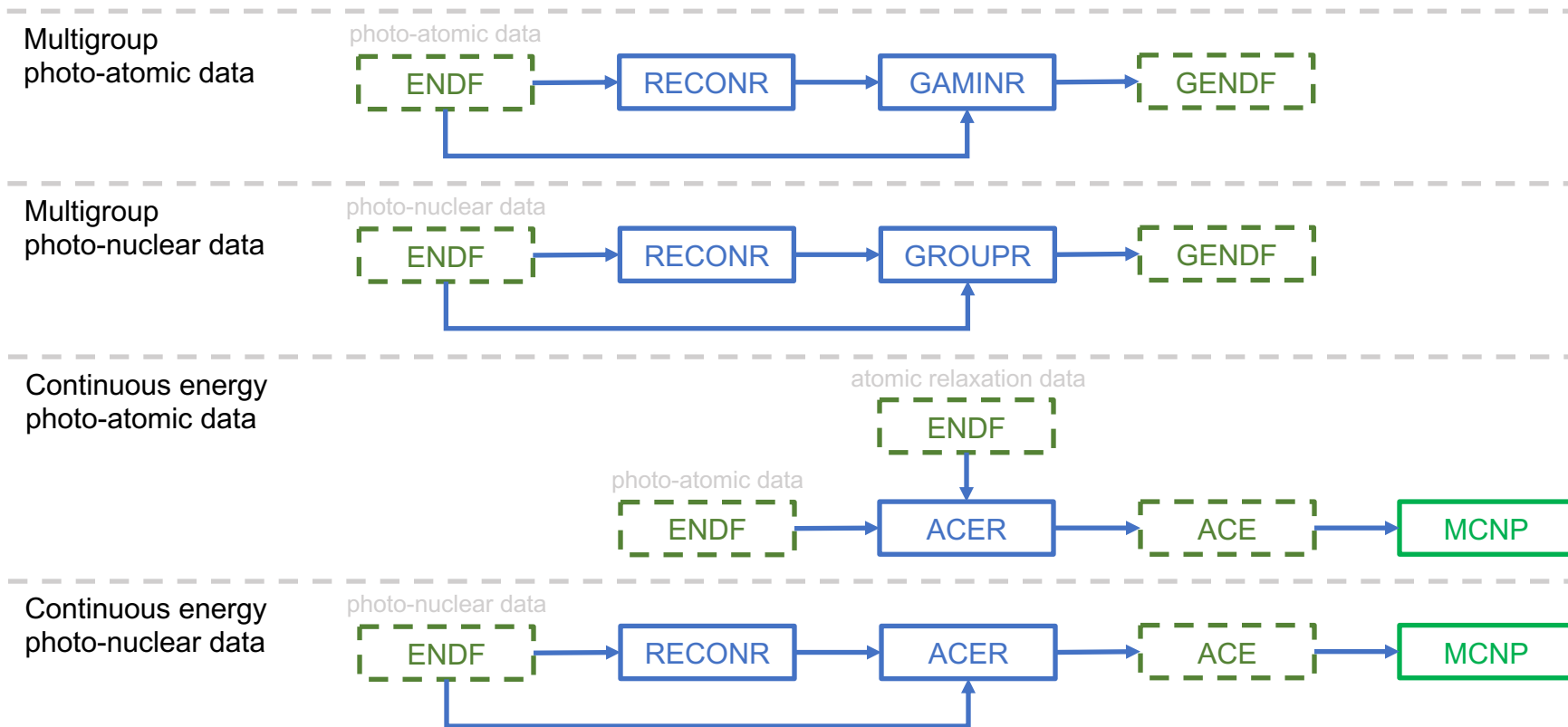


Photo-atomic and photo-nuclear ACE libraries

- 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
 - LA150U released in 2000 and updated in 2001 (for a limited number of nuclides)
 - endf70u was released with MCNPX and contains more nuclides
- 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



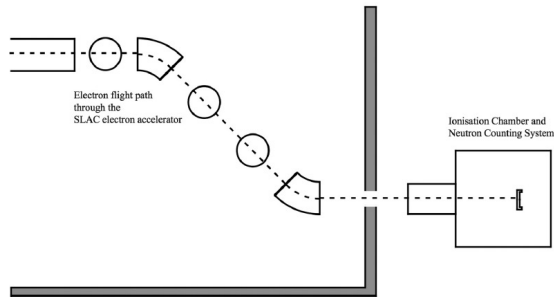
Recent work on photo-nuclear data processing

- 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



Validation against experimental data

- Experimental data and benchmarks for validation
 - Requires demonstratable sensitivity to photo-nuclear interactions
- Barber and George (1959) has been used in the past
 - Neutron yields from targets bombarded by electrons
 - C, Al, Cu, Ta, Pb and U targets
 - Electron beam energies between 15 and 40 MeV
 - 62 measurements were performed



spectrometry could resolve the relative intensities in the heavy-ion decay chains and the relative intensities of the decay chains. The relative intensities of the decay chains were used to determine the relative intensities of the decay chains. The relative intensities of the decay chains were used to determine the relative intensities of the decay chains. The relative intensities of the decay chains were used to determine the relative intensities of the decay chains.

Neutron Yields from Targets Bombarded by Electrons*
M. C. Barber and W. D. George
Los Alamos National Laboratory, Los Alamos, New Mexico 87545
(Received July 10, 2008)

The total neutron yields from heavy-ion bombardment of targets were measured as a function of electron beam energy and target material. The neutron yields were measured as a function of electron beam energy and target material. The neutron yields were measured as a function of electron beam energy and target material. The neutron yields were measured as a function of electron beam energy and target material.

INTRODUCTION
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Photonuclear Benchmarks of C, Al, Cu, Ta, Pb, and U from the ENDF/B-VII Cross-Section Library ENDF70 Using MCNPX

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Abstract—In radiation transport simulations, photonuclear processes still represent a rather new feature and are not as well established as neutron, electron, or other photon processes. This could present a challenge for the photonuclear yield in C, Al, Cu, Ta, Pb, and U targets using the most current photonuclear cross-section library ENDF70 and the transport code MCNPX. The authors present a description of C, Al, Cu, Ta, Pb, and U targets using the most current photonuclear cross-section library ENDF70 and the transport code MCNPX. The authors present a description of C, Al, Cu, Ta, Pb, and U targets using the most current photonuclear cross-section library ENDF70 and the transport code MCNPX.

Keywords—Photonuclear benchmark; Monte Carlo; MCNPX.

Note—Some figures may be in color only in the electronic version.

1. INTRODUCTION

Photonuclear physics has long been neglected in the ENDF/B-VII library.^{1,2} The results of the entire program, including those from ENDF/B-VII, were used to produce the ENDF/B-VII library in 2003 (Ref. 1). The ENDF/B-VII library was used to produce the ENDF/B-VII library in 2003 (Ref. 1). The ENDF/B-VII library was used to produce the ENDF/B-VII library in 2003 (Ref. 1). The ENDF/B-VII library was used to produce the ENDF/B-VII library in 2003 (Ref. 1).

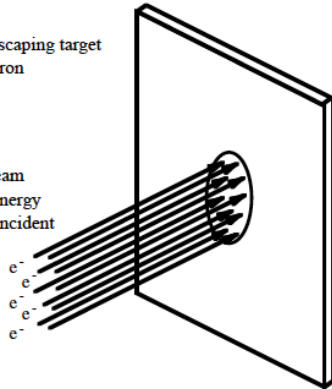
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Validation against experimental data

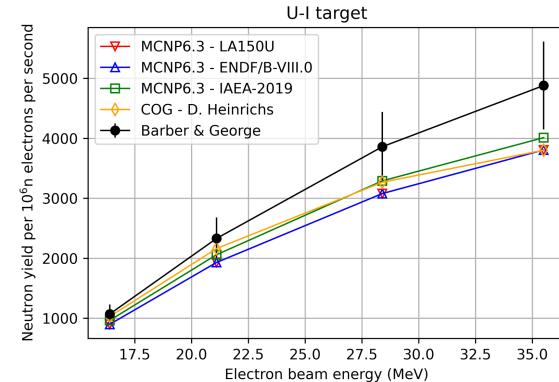
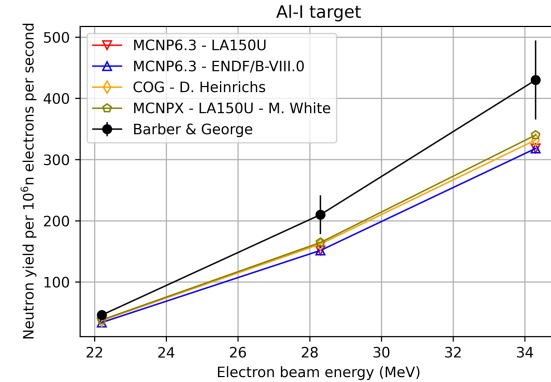
- Preliminary MCNP 6.3 simulation results
 - Electron, photon and neutron transport
 - Using LA150U, ENDF/B-VIII.0 and IAEA-2019 photonuclear data

Yield tallied as
neutron current escaping target
per incident electron

1/2" Diameter Beam
Monoenergetic Energy
Perpendicularly Incident



4 1/2" Square Target
Various Thickness'



Other validation exercises

- The Barber and George measurements are a good star, but we would like to have more
- Another option is data comparison
 - Compare the impact of using the ENDF/B-VIII.0 versus the IAEA-2019 library through “probing”
 - Tallying particle spectra outside a disk bombarded mono-energetic photon or electron beam
- For example:
 - Pu239 disk in a 14 and 20 MeV photon beam

