

Technical note 1: EPICS2017 (EPDL)

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Introduction

EPICS2017 [1] is the Electron Photon Interaction Cross Section library that provides the atomic data needed to perform Electron and Photon transport calculations. Atomic data are provided for elements $Z = 1$ to 100, over the energy range 10 eV to 100 GeV. EPICS2017 include four separate databases:

- 1) EEDL: the Evaluated Electron Data Library, describes the interaction of electrons with matter
- 2) EPDL [2]: the Evaluated Photon Data Library, describes the interaction of photons with matter
- 3) EADL: the Evaluated Atomic Data Library, describes the emission of electrons and photons following an ionizing event, caused by either electron or photon interaction on atoms

These data files are prepared by Dr Dermott E. Cullen, National Nuclear Data Center, BNL, alumnus, Nuclear Data Section, IAEA, Vienna, alumnus, University of California, LLNL, retired, 1466 Hudson Way, Livermore, CA 94550.

In this technical note, we explain explicitly the format of EPDL2017.

1. Original data files of EPICS2017

We can download the databases on the web site of IAEA as indicated in Fig. 1:

<https://www-nds.iaea.org/epics/>

Whole Libraries (ALL Elements: Z=1 to 100, in one file)	
ENDF Format	ENDL Format (ALL updated July 2018)
EADL (updated Apr. 2018)	EADL
EEDL	EEDL
EPDL	EPDL
Individual Elements (EACH Element: Z=1 to 100, in a separate file)	
ENDF Format	ENDL Format (ALL updated July 2018)
EADL (updated Apr. 2018)	EADL
EEDL	EEDL
EPDL	EPDL

Fig. 1. Download page of IAEA website.

2. Description of EPDL2017.ALL

2.1. Physical quantities

The data file *EPDL2017.ALL* (Evaluated Photon Data Library) [3] contains complete information for particle transport for $Z = 1-100$ and specific data as follows:

1) Coherent scattering

- a) integrated cross section,
- b) form factor,
- c) real and imaginary anomalous scattering factors,
- d) average energy of the scattered photon,

2) Incoherent scattering

- a) integrated cross section,
- b) scattering function,
- c) average energy of the scattered photon and recoil electron.

3a) Total photoelectric reaction

- a) integrated cross section,
- b) average energy to the residual atom, i.e., local deposition,
- c) average energy of the secondary photons and electrons.

3b) Photoelectric reaction, by subshell

- a) integrated cross section,
- b) average energy to the residual atom, i.e., local deposition,
- c) average energy of the secondary photons and electrons.

4) Pair production reaction

- a) integrated cross section,
- b) average energy of the secondary electron and positron.

5) Triplet production reaction

- a) integrated cross section,
- b) average energy of the secondary electron and positron.

2.2. Units

Energy is in **MeV**.

Cross section is in **barns**.

2.3. Format

EPDL2017.ALL contains a series of tables in **ASCII format**. Each table starts with **two header lines** that contain the parameters related to the data that follow (Fig. 2). The two header lines are followed by a series of two-column **physical data lines**, one data point per line. Each table is terminated by an end of table line which is blank except for a 1 placed in column 72 (column 72 is blank on all other lines in the table). Fig. 2 presents an example of two complete tables contained in *EPDL2017.ALL*.

2.3.2. Information in the second header line

Fig. 4 illustrates the information contained in the second header line. As an example, we extracted the second header line from the first table presented in Fig. 2.

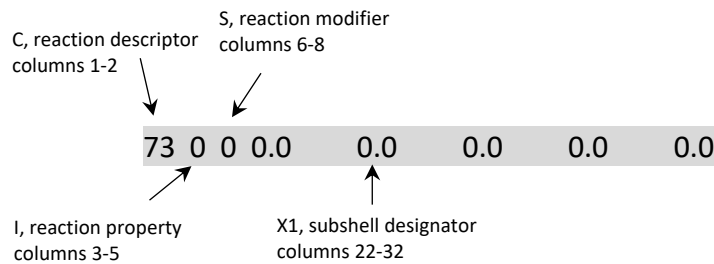


Fig. 4. Information in the second line of a character table

Additional information:

- for reaction descriptor (it is equivalent to the notion “physical process” used in Geant4)
 - C = 71, coherent scattering
 - C = 72, incoherent scattering
 - C = 73, photoelectric effect
 - C = 74, pair production
 - C = 75, triplet production
 - C = 93, whole atom parameters
- for reaction property
 - I = 0, the table contains data about the integrated cross section
 - I = 10, the table contains data about the average energy of secondary/outgoing particle, Y_0
 - I = 11, table contains data about the average energy to the residual atom
 - I = 941, table contains data about the form factor
 - I = 942, table contains data about the scattering function
 - I = 943, table contains data about the imaginary anomalous scattering factor
 - I = 944, table contains data about the real anomalous scattering factor
- for reaction modifier
 - S = 0, no X1 field data required
 - S = 91, X1 field data required
- for X1, value depends upon the value of S
 - S = 0, X1 = 0
 - S = 91, X1 = subshell designator

2.3.3. Physical data lines

After the two header lines, are given the two-column physical data lines, **with 10 significant digits**. The physical quantities tabulated in these data lines depend on the value of the reaction property number I, which is indicated in the second header line (Fig. 4).

For example, in Fig. 4, $I = 0$. That means the physical data is about the integrated cross section. Therefore, the first column is the energy (**MeV**) of incident gamma, and the second is the corresponding cross section (**barn**).

References

- [1] Cullen DE. EPICS2017: April 2019 Status Report. NA; 2019.
 [2] Cullen DE. A survey of photon cross section data for use in EPICS2017. IAEA-NDS-225, rev. 1; 2018.

[3] Perkins S, Cullen D. ENDL type formats for the LLNL evaluated atomic data library, EADL, for the evaluated electron data library, EEDL, and for the evaluated photon data library, EPDL. International Atomic Energy Agency; 1994.