IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Reflections on a new nuclear data format

Wim Haeck, wim.haeck@irsn.fr

Outline

- Nuclear data needs and applications at IRSN
- Experience with ENDF
- Reflections on a new nuclear data format

IRSN

Public expert body in charge of the scientific assessment of nuclear and radiological risks

This expertise is based on research

- Research: safety, radiation protection and ecosystems
- Contribution to public policy and technical support
- Services to industry and other organisations
  - Dosimetry services, environmental measurements and risk analysis
  - Education and training

Our nuclear data needs

- IRSN is an end user
  - We use basic evaluations to generate our own libraries
  - We use data libraries from the distribution of a calculation code
- Specific needs:
  - Neutron and particle transport calculations
    - Cross sections
    - Energy-angle distributions for secondary particles
  - Depletion calculations
    - Radioactive decay data
    - Reaction product multiplicity (including fission yield data)
    - Heating data
  - Covariance data
  - Auxiliary data: atomic mass data, etc.

Experience with ENDF as an end user

- Advantages:
  - A very modular format
    - A user can combine sections into his own file
  - Stores both basic evaluations and processed data
    - A single format can be used for all aspects of the calculation
- Issues:
  - Fixed format records (legacy of the tape and card)
    - Limited number of significant digits
    - This is especially an issue when using ENDF as a data transfer format
  - No publicly available API
    - Fortran format statements are given
    - Reinvent the wheel over and over again

Need for an API

- Provide an official API in C++, Java, Fortran
  - Common interface between ENDF and the new format
    - Existing ENDF files function as the new format
    - Be careful: backwards compatibility limits the new format's potential
- A new format is nice but it will be a computer that uses it
  - Prefer binary storage over ASCII ⇒ no "file" but a real database ?
  - No need to store redundant total/partial data ⇒ API can sum partials
  - A single unit for each physical quantity ⇒ API can do unit conversion
  - No elemental data if isotopes are given ⇒ API can provide elemental data
- New format can be a common entry point for calculations
  - Interchangeable data libraries
  - No more formatting, only processing to transform data

Basic structure requirements

- A logical structure based on physics
  - Nuclides should be the entry point (avoid elements)
  - Incident particles and radioactive decay data are on the same level
  - Reactions are the second level
    - Flexibility: avoid using identifiers except for particular reactions
  - All data related to the reaction
    - Cross section data, multiplicity, angular and energy distributions
    - Resonance data is only present when it is not added to the cross sections
- We only need to worry about what to put in the new format
  - Internal formatting should not (really) be our concern
  - A cross section is a continuous function of energy

Basic structure requirements

- We need to establish what to store in the format
- General data types
  - Resonance and cross section data
  - Secondary particle angular and energy distributions and multiplicity
  - Thermal scattering data
  - Covariance data
  - Radioactive decay data and decay particle spectra
- General conditions
  - Data should be defined over the entire energy range

Basic structure requirements

- We should ask ourselves some questions
  - Do we store the data as close as possible to reality?
  - Lots of options or limited to the most generic data structures?
    - Analytical laws versus tabulated interpolatable data
    - Less options means less special cases for processing
  - Do we want additional interpolation types?
    - Spline interpolation or higher order polynomial interpolation
  - Do we want flexibility in the data structures?
    - Allow us to store multigroup data or continuous energy data
    - Interesting if we want to store processed application data
  - Do we treat specialised data as a more general data type?
    - Fission yield data is essentially multiplicity data