

Lessons from GNDS and SG38

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Generalised Nuclear Database Structure (GNDS)

- GNDS was developed over several years by the WPEC SG-38 collaboration
 - supports storing evaluated and processed nuclear reaction data, and some types of nuclear structure data
 - No provision for experimental data
- GNDS v1.9 specifications are available at <https://read.oecd.org/10.1787/94d5e451-en>
- v2.0 of GNDS specifications currently under development

SG38 tasks were broken into two broad categories

- 1) Define *requirements* for the new format:
 - what types of data must be supported?
 - how do we expect users to interact with GNDS?
 - can we outline a design philosophy to help guide writing of specifications?
- 2) Define *specifications*:
 - describe and provide examples of all possible GNDS data types

These were useful categories, but had much more overlap than we initially expected. Both tasks evolved throughout SG38

Some GNDS decisions were easier than expected

- General agreement that data should be stored as a nested hierarchy
 - Compatible with standard tools like XML, JSON, HDF
 - Easy to navigate and search
 - Extensible

- Top-level organization was stable from early in the process
 - reaction
 - cross section
 - output channel
 - Q value
 - product 1
 - multiplicity
 - distribution
 - product 2
 - ...

Other choices were more contentious

- Designing flexible low-level data containers required many iterations of effort, discussion, *argument*. Partly due to requirements:
 - Must support 1D – 3D functions,
 - various interpolation rules including special 2D / 3D interpolation methods,
 - discontinuities, multiple interpolation regions
- Tricks used in early GNDS versions to save space were later eliminated in favor of consistency. For example,

<product id="n" ... multiplicity="2">

became

<product id="n" ...>

<multiplicity>

<constant1d label="eval" value="2" ...>

- Wrap like elements, e.g. all <product> nodes inside <products>

Early design decision: unify *evaluated* and *processed* data into the same hierarchy



Evaluated
data

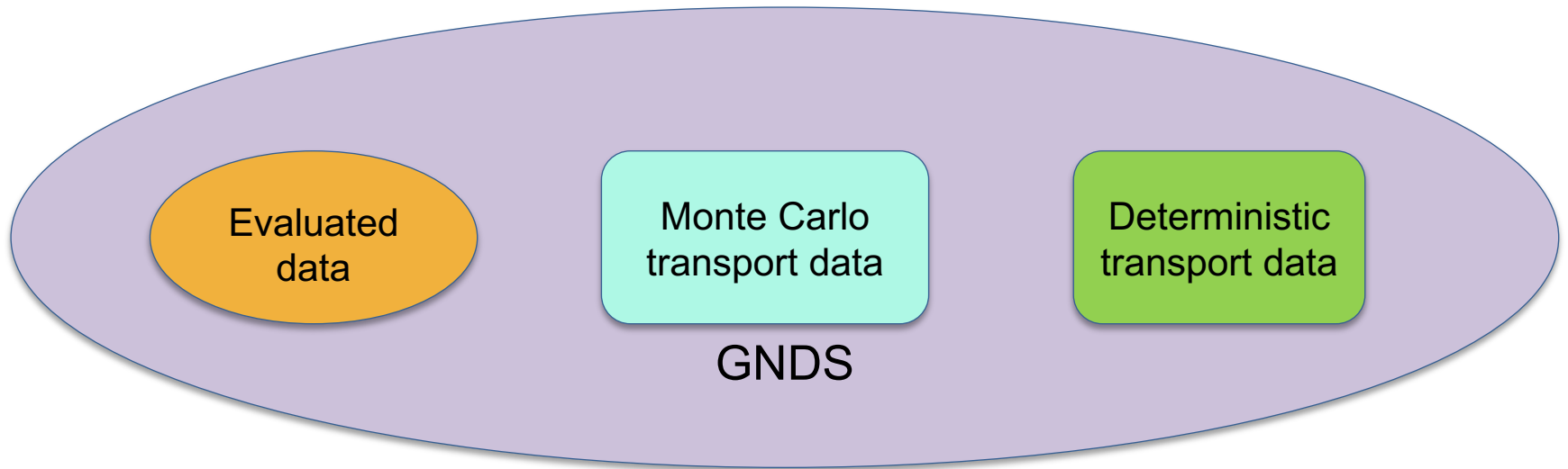


Monte Carlo
transport data

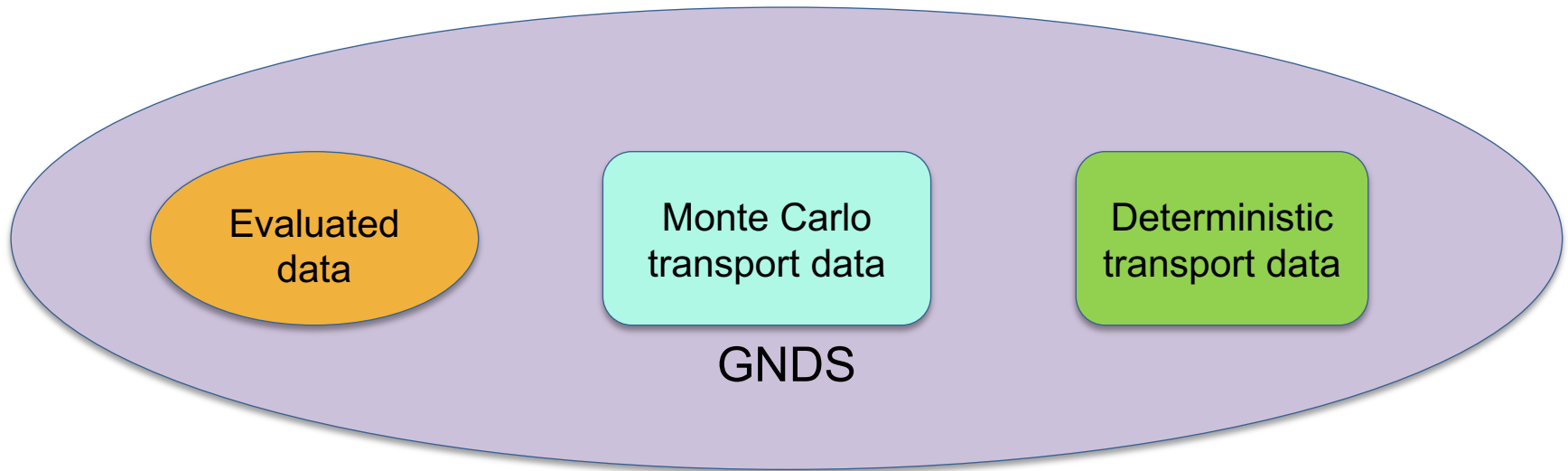


Deterministic
transport data

Early design decision: unify *evaluated* and *processed* data into the same hierarchy



Early design decision: unify *evaluated* and *processed* data into the same hierarchy



- Similar concept may be useful to the 3-layer library outlined in SG50
 - Allow layers 2 and 3 (objective and subjective corrections) as optional additions to the original tabulated data rather than as separate files

GNDS data containers may be useful to SG50

- `<table>` node, e.g. storing resonance parameters in GNDS

```
<table rows="39" columns="4">
  <columnHeaders>
    <column index="0" name="energy" unit="eV"/>
    <column index="1" name="Ca41 + photon width" unit="eV"/>
    <column index="2" name="n + Ca40 width" unit="eV"/>
    <column index="3" name="He4 + Ar37 width" unit="eV"/></columnHeaders>
  <data>
    <!-- energy | Ca41 + photon | n + Ca40 | He4 + Ar37 -->
    <!--          |          width |          width |          width -->
      -458668.7      1.000091      980.9761      2.199782e-3
      -239421.4      1.000309      704.1383      1.219849e-3
      -192985.9      1.000388      507.6764      1.163776e-3
      ...
```

- Supports arbitrary number of columns
- Data may be space delimited, or each cell may be wrapped in `<tr></tr>` to store strings, empty cells, etc.

GND data containers might be useful to SG50

- `<XYs1d>` functional container
 - Linear interpolation by default, but
 - also supports histogram-style interpolation which would be more appropriate for experimental results
 - Supports uncertainties / covariances
 - Covariance specifications may need to be expanded to handle experimental needs

```
<XYs1d label="eval" interpolation="flat">
  <axes>
    <axis index="1" label="energy_in" unit="eV"/>
    <axis index="0" label="crossSection" unit="b"/></axes>
  <values>
    1.28262e+05 0.0 1.3e+05 6.15264e-02 ... 5.5e+07 7.56553e-03 6.0e+07 6.81747e-03</values>
  <uncertainty>
    <covariance href="..."></uncertainty></XYs1d></crossSection>
```

Final thoughts

- What helped SG38 move forward?
 - Allowing requirements and specifications to evolve together
 - Where possible bringing real examples of candidate GNDS files to discussion
 - Bringing multiple parties into the discussion
 - E.g. evaluators + processing code maintainers + data users