**Title**
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**Publication Date**
2016-03-15

# An XML-hierarchical data structure for ENSDF

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March 15, 2016

# 1 Introduction

A data structure based on an eXtensible Markup Language (XML) [1] hierarchy according to experimental nuclear structure data in the Evaluated Nuclear Structure Data File (ENSDF) [2] is presented. A Python-coded translator has been developed to interpret the standard one-card records of the ENSDF datasets, together with their associated quantities defined according to field position, and generate corresponding representative XML output. The quantities belonging to this mixed-record format are described in the ENSDF manual [3]. Of the 16 ENSDF records in total, XML output has been successfully generated for 15 records. An XML-translation for the *Comment Record* is yet to be implemented; this will be considered in a separate phase of the overall translation effort. Continuation records, not yet implemented, will also be treated in a future phase of this work.

Several examples are presented in this document to illustrate the XML schema and methods for handling the various ENSDF data types. However, the proposed nomenclature for the XML elements and attributes need not necessarily be considered as a fixed set of constructs. Indeed, better conventions may be suggested and a consensus can be achieved amongst the various groups of people interested in this project. The main purpose here is to present an initial phase of the translation effort to demonstrate the feasibility of interpreting ENSDF datasets and creating a representative XML-structured hierarchy for data storage.

# 2 The XML tree

A few points regarding various aspects of the data structure:

- **Prolog**: A prolog defines the XML version and character encoding on the first line of the generated output.
- **Root element**: The root element of the XML document in the proposed schema is always `<ensdf2xml>`.
- **Complex elements**: Generally, complex elements (i.e. XML elements with at least one attribute or sub (child) element) are used to describe the tree structure of the XML document in a nested hierarchy in accordance with the interpreted data sequence parsed in the original ENSDF file.
- **Multiple spin assignments**: Frequently, several spin permutations may be reported for a single level in a given Level Record. The structure presented in Fig. 9 illustrates a possible way for representing these data in XML.
- **Extensions to the data structure**: The XML structure is not space-limited and can easily be extended to include additional data elements derived from the ENSDF quantities. For example, `<lifetime>` data may derived from `<halflife>` data in the Parent (Sec. 3.6; Fig. 5) and Level (Sec. 3.9; Figs. 8, 9, and 10) records.
- **Explicit versus Implicit**: Final levels associated with $\gamma$ decays may only be inferred implicitly from the ENSDF Gamma and Level records. However, by indexing the

levels, the final levels associated with the respective $\gamma$ decays can now be added to the XML hierarchy as an additional data element (Sec. 3.14, Figs. 15 and 16).

- **Uncertainties**: All `<uncertainty>` complex elements contain the following two attributes: `value`; `pdf`. Only two probability density functions (pdf) are currently considered: `pdf=''normal''` and `pdf=''asymmetric''`. If `value=''0''` or `value=''None''`, then `pdf=''NA''` is adopted.

- **Asymmetric uncertainties**: Quantities with asymmetric uncertainties are frequently encountered in ENSDF datasets. In these circumstances the following actions are taken:

  (i) upper and lower bounds are reported as independent attributes;

  (ii) the two methods outlined in Ref. [4] describing symmetrization of asymmetric uncertainties are adopted to generate normally-distributed values.

  A representative example of an XML hierarchy for reporting a mixing ratio (belonging to the Gamma Record) with an associated asymmetric uncertainty is shown in Fig. 17.

# 3 The XML-translated standard one-card record formats

In the following subsections the adopted nomenclature for the XML elements and attributes are given for each of the standard one-card record formats used in the ENSDF database. Representative XML-hierarchical data structures are also presented for all quantities associated with each of the standard records. The corresponding 80-character-column formatted ENSDF datasets from which the translated-XML structures have been derived are also presented for comparison.

## 3.1 The Identification Record: <identification/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | <nucleus/> | id |
| 6-9 | | | |
| 10-39 | DSID | <dataset/> | id |
| 40-65 | DSREF | <nsr/> | keynumber |
| 66-74 | PUB | <pubInfo/> | record |
| 75-80 | DATE | <date/> | month, year |

## 3.2 The History Record: <history/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | H | <history/> | |
| 9 | | | |
| 10-80 | History | | |
| | TYP= | <type/> | evaluation |
| | AUT= | <author/> | name |
| | CIT= | <citation/> | value |
| | CUT= | <cutoff/> | value |

```
<?xml version='1.0' encoding='UTF-8'?>
<ensdf2xml>
  <database name="ENSDF"/>
  <identification>
    <nucleus id="133CS"/>
    <dataset id="133BA EC DECAY (10.551 Y)"/>
    <nsr keynumber="1998HW07"/>
    <pubInfo record="11NDS"/>
    <date month="04" year="2011"/>
  </identification>
  <history>
    <type evaluation="full evaluation"/>
    <author name_1="YU. KHAZOV" name_2="A. RODIONOV" name_3="F.G. KONDEV"/>
    <citation value="NDS 112, 855 (2011)"/>
    <cutoff value="=31-Oct-2010"/>
  </history>
-UUU:----F1  ENSDF_133Cs.xml   Top (1,0)      (XML)----------------------------
133CS    133BA EC DECAY (10.551 Y)              1998HW07         11NDS    201104
133CS  H TYP=FUL$AUT=YU. KHAZOV AND A. RODIONOV, F.G. KONDEV$
133CS2 H CIT=NDS 112, 855 (2011)$CUT=31-Oct-2010$
```

Figure 1: Identification and History records. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panel: representative XML translation.

```
<?xml version='1.0' encoding='UTF-8'?>
<ensdf2xml>
  <database name="ENSDF"/>
  <identification>
    <nucleus id="236U"/>
    <dataset id="240PU A DECAY"/>
    <nsr keynumber_1="1981HE16" keynumber_2="1986LOZT"/>
    <pubInfo record="06NDS"/>
    <date month="10" year="2006"/>
  </identification>
  <history>
    <type evaluation="full evaluation"/>
    <author name_1="E. BROWNE" name_2="J. K. TULI"/>
    <citation value="NDS 107, 2649 (2006)"/>
    <cutoff value="=1-Oct-2005"/>
  </history>
-UUU:----F1  ENSDF_236U.xml   Top (1,0)      (XML)----------------------------
236U     240PU A DECAY                  1981HE16,1986LOZT         06NDS    200610
236U   H TYP=FUL$AUT=E. BROWNE, J. K. TULI$CIT=NDS 107, 2649 (2006)$
236U 2 H CUT=1-Oct-2005$
```

Figure 2: Identification and History records. Lower panel: ENSDF-formatted dataset for $^{236}$U; upper panel: representative XML translation.

### 3.3 The Q-value Record: <qvalue/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | Q | <qvalue/> | |
| 9 | | | |
| 10-19 | $Q^-$ | <totalBetaDecayEnergyGS/> | value, unit, mode, Z |
| 20-21 | $DQ^-$ | <uncertainty/> | value, pdf |
| 22-29 | SN | <neutronSeparationEnergy/> | value, unit |
| 30-31 | DSN | <uncertainty/> | value, pdf |
| 32-39 | SP | <protonSeparationEnergy/> | value, unit |
| 40-41 | DSP | <uncertainty/> | value, pdf |
| 42-49 | QA | <totalAlphaDecayEnergyGS/> | value, unit |
| 50-55 | DQA | <uncertainty/> | value, pdf |
| 56-80 | QREF | <qref/> | keynumber |

```
<qvalue>
  <nucleus id="26SI"/>
  <totalBetaDecayEnergyGS value="-18110" unit="keV">
    <uncertainty value="18110" pdf="normal"/>
  </totalBetaDecayEnergyGS>
  <neutronSeparationEnergy value="19040" unit="keV">
    <uncertainty value="10" pdf="normal"/>
  </neutronSeparationEnergy>
  <protonSeparationEnergy value="5513.8" unit="keV">
    <uncertainty value="0.5" pdf="normal"/>
  </protonSeparationEnergy>
  <totalAlphaDecayEnergyGS value="-9166.0" unit="keV">
    <uncertainty value="0.3" pdf="normal"/>
  </totalAlphaDecayEnergyGS>
  <qref keynumber="2012WA38"/>
</qvalue>
--- ENSDF_ADPT26SI.xml    1% (9,0)      (XML)------------------------------
26SI  Q  -18110   SY 19040  10 5513.8  5 -9166.0   3  2012WA38
```

Figure 3: Q-value record. Lower panel: ENSDF-formatted dataset for $^{26}$Si Adopted Levels; upper panel: representative XML translation.

## 3.4 The Cross-Reference Record: <xrefs/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | <nucid/> | id |
| 6 | | | |
| 7 | | | |
| 8 | X | <xref/> | index |
| 9 | DSSYM | <dssym/> | id |
| 10-39 | DSID | <dsid/> | id |


Figure 4: Cross-Reference records. Lower panel: ENSDF-formatted dataset for $^{26}$Si Adopted Levels; upper panel: representative XML translation. The left-hand side shows the first three cross-referenced data sets; the right-hand side shows the final three.

## 3.5 The Comment Record

Comments are not currently being considered for translation. This issue will be addressed in the future.

## 3.6 The Parent Record: <parent/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | <nucid/> | id |
| 6 | | | |
| 7 | | | |
| 8 | P | <parent/> | id, A |
| 9 | | | |
| 10-19 | E | <energy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-39 | J | <spin/> | string, value, unit |
| | | <parity/> | value |
| 40-49 | T | <halflife/> | value, unit |
| | | <lifetime/> | value, unit |
| 50-55 | DT | <uncertainty/> | value, pdf |
| | | <uncertainty/> | value, pdf |
| 56-64 | | | |
| 65-74 | QP | <Q-value/> | value, unit, transition |
| 75-76 | DQP | <uncertainty/> | value, pdf |
| 77-80 | ION | <atomicIonizationState/> | value |

```
  <parent id="Ba133" A="133">
    <level>
      <energy value="0.0" unit="keV">
        <uncertainty value="0.0" pdf="NA"/>
      </energy>
      <spin string="1/2" value="0.5" unit="hbar"/>
      <parity value="+"/>
      <halflife value="10.551" unit="y">
        <uncertainty value="0.011" pdf="normal"/>
      </halflife>
      <lifetime value="15.222" unit="y">
        <uncertainty value="0.016" pdf="normal"/>
      </lifetime>
      <Q-value value="517.5" unit="keV" transition="G.S. to G.S.">
        <uncertainty value="1.0" pdf="normal"/>
      </Q-value>
      <atomicIonizationState value=""/>
    </level>
    <daughter id="Cs133" A="133"/>
  </parent>
---  ENSDF_133Cs.xml    4% (42,11)    (XML)-----------------------------------
133BA  P 0.0         1/2+              10.551 Y  11             517.5     10
133CS  N 0.6205    19          1.0       1.0
133CS cN NR$from I|g(356|g)=0.6205 {I19} (1983Ch11). Other: 0.627 {I7} from
133CS2cN |S(I(|g+ce))=100 to g.s., assuming that there is no direct |e decay
133CS3cN feeding to the 7/2{++} g.s. of {+133}Cs
133CS PN                                                                  5
133CS  L 0.0         7/2+              STABLE
```

Figure 5: Parent record. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panel: representative XML translation. The dataset corresponds to $^{133}$Ba $\epsilon$ decay.

## 3.7 The Normalization Record: <normalization/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | N | <normalization/> | |
| 9 | | | |
| 10-19 | NR | <NR/> | value, definition |
| 20-21 | DNR | <uncertainty/> | value, pdf |
| 22-29 | NT | <NT/> | value, definition |
| 30-31 | DNT | <uncertainty/> | value, pdf |
| 32-39 | BR | <BR/> | value, definition |
| 40-41 | DBR | <uncertainty/> | value, pdf |
| 42-49 | NB | <NB/> | value, definition |
| 50-55 | DNB | <uncertainty/> | value, pdf |
| 56-62 | NP | <NB/> | value, definition |
| 63-64 | DNP | <uncertainty/> | value, pdf |
| 65-80 | | | |

```
  <normalization>
    <NR value="0.98960" definition="photon intensity multiplier">
      <uncertainty value="0.00030" pdf="normal"/>
    </NR>
    <NT value="0.00000" definition="transition intensity multiplier">
      <uncertainty value="0.00000" pdf="NA"/>
    </NT>
    <BR value="1.00000" definition="branching ratio multiplier">
      <uncertainty value="0.00000" pdf="NA"/>
    </BR>
    <NB value="1.00000" definition="beta (or EC) intensity multiplier">
      <uncertainty value="0.00000" pdf="NA"/>
    </NB>
    <NP value="0.00000" definition="delayed-particle intensity multiplier">
      <uncertainty value="0.00000" pdf="NA"/>
    </NP>
  </normalization>
```

```
---  ENSDF_210Pb.xml    4% (36,11)    (XML)-----------------------------------
210PB  N 0.9896    3           1.0       1.0
210PB PN                                                                    3
210PB cN NR        deduced by evaluator from decay scheme and
210PB2cN I(|g+ce)(799|g)=100%. Measured I|g(799|g)/|b{+-}=1.03 {I10}, 4|p|b|g
210PBxcN coin (1964We06).
```

Figure 6: Normalization record. Lower panel: ENSDF-formatted dataset for $^{210}$Pb; upper panel: representative XML translation. The dataset corresponds to $^{210}$Tl $\beta^-$ decay.

## 3.8 The Production Normalization Record: <productionNormalization/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | P | | |
| 8 | N | | |
| 9 | | | |
| 10-19 | NR×BR | <NRBR/> | value, definition |
| 20-21 | UNC | <uncertainty/> | value, pdf |
| 22-29 | NT×BR | <NTBR/> | value, definition |
| 30-31 | UNC | <uncertainty/> | value, pdf |
| 42-49 | NB×BR | <NBBR/> | value, definition |
| 50-55 | UNC | <uncertainty/> | value, pdf |
| 56-62 | NP | <NP/> | value, definition |
| 63-64 | UNC | <uncertainty/> | value, pdf |
| 77 | COM | <intensity/> | cflag |
| | | <comment/> | text |
| 78 | OPT | <intensity/> | option |
| | | <display/> | quantity |

```
  <productionNormalization>
    <NRBR value="0.98960" definition="NR * BR">
      <uncertainty value="0.00030" pdf="normal"/>
    </NRBR>
    <NTBR value="0.00000" definition="NT * BR">
      <uncertainty value="0.00000" pdf="NA"/>
    </NTBR>
    <NBBR value="1.00000" definition="NB * BR">
      <uncertainty value="0.00000" pdf="NA"/>
    </NBBR>
    <NP value="None" definition="delayed-particle intensity multiplier">
      <uncertainty value="0.00000" pdf="NA"/>
    </NP>
    <intensity cflag=" " option="3">
      <display quantity="TI*NT*BR or RI*BR*NR*(1 + alpha)"/>
      <comment text="I(g + ce) per 100 parent decays"/>
    </intensity>
  </productionNormalization>
```

```
---  ENSDF_210Pb.xml    6% (52,0)     (XML)-----------------------------------
210TL  P 0.0         (5+)              1.30 M    3              5482      12
210PB  N 0.9896    3           1.0       1.0
210PB PN                                                                  3
```

Figure 7: Normalization record. Lower panel: ENSDF-formatted dataset for $^{210}$Pb; upper panel: representative XML translation. The dataset corresponds to $^{210}$Tl $\beta^-$ decay.

## 3.9 The Level Record: <level/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | L | <level/> | id, index |
| 9 | | | |
| 10-19 | E | <energy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-39 | J | <spin/> | string, value, unit |
| | | <altSpin_i/> | value, unit |
| | | <parity/> | value |
| 40-49 | T | <halflife/> | value, unit |
| | | <lifetime/> | value, unit |
| 50-55 | DT | <uncertainty/> | value, pdf |
| | | <uncertainty/> | value, pdf |
| 56-64 | L | <angularMomentumTransfer/> | value, wave |
| 65-74 | S | <spectroscopicFactor/> | value |
| 75-76 | DS | <uncertainty/> | value, pdf |
| 77 | C | <commentFlag/> | record |
| 78-79 | MS | <metaStableIsomer/> | record, classification |
| 80 | Q | <assignment/> | record |

```
      </level>
      <level id="Na26_e5" index="5">
        <energy value="1807.6" unit="keV">
          <uncertainty value="0.6" pdf="normal"/>
        </energy>
        <spin string="3" value="3.0" unit="hbar"/>
        <parity value="+"/>
        <halflife value="None" unit="None">
          <uncertainty value="None" pdf="NA"/>
        </halflife>
        <lifetime value="None" unit="None">
          <uncertainty value="None" pdf="NA"/>
        </lifetime>
        <angularMomentumTransfer value="2" wave="d"/>
        <spectroscopicFactor value="0.216">
          <uncertainty value="0.000" pdf="NA"/>
        </spectroscopicFactor>
        <commentFlag record="None"/>
        <metastableIsomer record="None" classification="None"/>
        <assignment record="firm"/>
        <decay mode="gamma">
          <gammaEnergy value="1402" unit="keV">
            <uncertainty value="0" pdf="NA"/>
          </gammaEnergy>
---  ENSDF_26Na.xml   25% (305,16)   (XML)----------------------------------
 26NA  L 1807.6     6  3+                                  2       0.216
 26NA  G  1402        6.6    14
```

Figure 8: Level record. Lower panel: ENSDF-formatted dataset for $^{26}$Na; upper panel: representative XML translation. The dataset corresponds to $^{2}$H($^{25}$Na,$^{26}$Na$\gamma$). Note that the $\gamma$-decay mode is a child element of the level element (see Sec. 3.14).

```
    </level>
    <level id="Na26_e17" index="17">
      <energy value="5012.8" unit="keV">
        <uncertainty value="1.2" pdf="normal"/>
      </energy>
      <spin string="(3,4)" unit="hbar">
        <altSpin_0 value="3" unit="hbar"/>
        <altSpin_1 value="4" unit="hbar"/>
      </spin>
      <parity value="-"/>
      <halflife value="None" unit="None">
        <uncertainty value="None" pdf="NA"/>
      </halflife>
      <lifetime value="None" unit="None">
        <uncertainty value="None" pdf="NA"/>
      </lifetime>
      <angularMomentumTransfer value="None" wave="None"/>
      <spectroscopicFactor value="None">
        <uncertainty value="None" pdf="NA"/>
      </spectroscopicFactor>
      <commentFlag record="None"/>
      <metastableIsomer record="None" classification="None"/>
      <assignment record="firm"/>
      <decay mode="gamma">
--  ENSDF_26Na.xml   96% (1170,0)   (XML)-------------------------------------
26NA  L 5012.8    12  (3-,4-)
26NA  G  3205        100
```

Figure 9: Level record. Lower panel: ENSDF-formatted dataset for $^{26}$Na; upper panel: representative XML translation. The dataset corresponds to $^{2}$H($^{25}$Na,$^{26}$Na$\gamma$). This example illustrates a method for handling multiple $J^{\pi}$ permutations for a given level.

```
      </level>
      <level id="U236_e1" index="1">
        <energy value="45.244" unit="keV">
          <uncertainty value="0.002" pdf="normal"/>
        </energy>
        <spin string="2" value="2.0" unit="hbar"/>
        <parity value="+"/>
        <halflife value="0.234" unit="ns">
          <uncertainty value="0.006" pdf="normal"/>
        </halflife>
        <lifetime value="0.338" unit="ns">
          <uncertainty value="0.009" pdf="normal"/>
        </lifetime>
        <angularMomentumTransfer value="None" wave="None"/>
        <spectroscopicFactor value="None">
          <uncertainty value="None" pdf="NA"/>
        </spectroscopicFactor>
        <commentFlag record="None"/>
        <metastableIsomer record="None" classification="None"/>
        <assignment record="firm"/>
        <decay mode="alpha">
          <alphaEnergy value="5123.68" unit="keV">
            <uncertainty value="0.23" pdf="normal"/>
          </alphaEnergy>
---  ENSDF_236U.xml   13% (105,16)   (XML)----------------------------------
236U   L 45.244    2  2+                0.234 NS  6
236U  cL T          from 1960Be25, 1970ToZZ
236U   A 5123.68    23 27.1    1  1.40
```

Figure 10: Level record. Lower panel: ENSDF-formatted dataset for $^{236}$U; upper panel: representative XML translation. The dataset corresponds to $^{240}$Pu $\alpha$ decay. Note that the $\alpha$-decay mode is a child element of the level element (see Sec. 3.12). This example also highlights the feasibility of adding new data (elements and associated attribiutes) to the nested hierarchy: the lifetime data (not in ENSDF) are derived from the halflife.

## 3.10 The Beta ($\beta^-$) Record:
`<decay mode=‘‘betaMinus’’/>`

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | B | `<decay/>` | `mode` |
| 9 | | | |
| 10-19 | E | `<betaEnergy/>` | `value, unit` |
| 20-21 | DE | `<uncertainty/>` | `value, pdf` |
| 22-29 | IB | `<betaIntensity/>` | `value` |
| 30-31 | DIB | `<uncertainty/>` | `value, pdf` |
| 42-49 | LOGFT | `<logft/>` | `value` |
| 50-55 | DFT | `<uncertainty/>` | `value, pdf` |
| 56-76 | | | |
| 77 | C | `<commentFlag/>` | `record` |
| 78-79 | UN | `<forbiddeness/>` | `record, classification` |
| 80 | Q | `<assignment/>` | `record` |

```
      <level id="Pb210_e4" index="4">
        <energy value="1275" unit="keV">
          <uncertainty value="38" pdf="normal"/>
        </energy>
        <spin string="8" value="8.0" unit="hbar"/>
        <parity value="+"/>
        <halflife value="None" unit="None">
---  ENSDF_210Pb.xml   29% (242,0)    (XML)-------------------------------------
        <metastableIsomer record="None" classification="None"/>
        <assignment record="firm"/>
        <decay mode="betaMinus">
          <betaEnergy value="None" unit="keV">
            <uncertainty value="None" pdf="NA"/>
          </betaEnergy>
          <betaIntensity value="30">
            <uncertainty value="6" pdf="normal"/>
          </betaIntensity>
          <logft value="10.3">
            <uncertainty value="0.1" pdf="normal"/>
          </logft>
          <commentFlag record="A"/>
          <forbiddenness record="2U" classification="second-forbidden unique"/>
          <assignment record="firm"/>
        </decay>
---  ENSDF_210Pb.xml   31% (275,80)   (XML)-------------------------------------
210PB  L      1275 388+
210PB  B            30      6             10.3  1                          A2U
```

Figure 11: Beta ($\beta^-$) record. Lower panel: ENSDF-formatted dataset for $^{210}$Pb; upper panels: representative XML translation. The dataset corresponds to $^{210}$Tl $\beta^-$ decay. The $\beta^-$-decay mode is a child element of the level element.

### 3.11 The EC (or EC + $\beta^+$) Record: <decay mode=‘‘ECandBetaPlus’’/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | E | <decay/> | mode |
| 9 | | | |
| 10-19 | E | <ecEnergy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-29 | IB | <betaPlusIntensity/> | value |
| 30-31 | DIB | <uncertainty/> | value, pdf |
| 32-39 | IE | <ecIntensity/> | value |
| 40-41 | DIE | <uncertainty/> | value, pdf |
| 42-49 | LOGFT | <logft/> | value |
| 50-55 | DFT | <uncertainty/> | value, pdf |
| 65-74 | TI | <ecBetaTotalIntensity/> | value |
| 75-76 | DTI | <uncertainty/> | value, pdf |
| 77 | C | <commentFlag/> | record |
| 78-79 | UN | <forbiddeness/> | record, classification |
| 80 | Q | <assignment/> | record |

```
      <level id="Cs133_e3" index="3">
        <energy value="383.8491" unit="keV">
          <uncertainty value="0.0008" pdf="normal"/>
        </energy>
---  ENSDF_133Cs.xml   50% (258,80)   (XML)-----------------------------------
        <decay mode="ECandBetaPlus">
          <ecEnergy value="None" unit="keV">
            <uncertainty value="None" pdf="NA"/>
          </ecEnergy>
          <betaPlusIntensity value="None">
            <uncertainty value="None" pdf="NA"/>
          </betaPlusIntensity>
          <ecIntensity value="14.5">
            <uncertainty value="0.4" pdf="normal"/>
          </ecIntensity>
          <logft value="8.020">
            <uncertainty value="0.015" pdf="normal"/>
          </logft>
          <ecBetaTotalIntensity value="None">
            <uncertainty value="None" pdf="NA"/>
          </ecBetaTotalIntensity>
          <commentFlag record="None"/>
          <forbiddenness record="None" classification="None"/>
          <assignment record="firm"/>
        </decay>
---  ENSDF_133Cs.xml   54% (293,80)   (XML)-----------------------------------
133CS  L 383.8491   83/2+              44 PS     11
133CS cL T$weighted average of 46 ps {I13} (1967He09) and 40 ps {I20} (1970Va34)
133CS  E                          14.5  4   8.020 15
```

Figure 12: EC (or EC + $\beta^-$) record. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panels: representative XML translation. The dataset corresponds to $^{133}$Ba $\epsilon$ decay. The $\epsilon$- (or $\epsilon + \beta^+$) decay mode is a child element of the level element.

## 3.12 The Alpha Record:
<decay mode=‘‘alpha’’/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | A | <decay/> | mode |
| 9 | | | |
| 10-19 | E | <alphaEnergy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-29 | IA | <alphaIntensity/> | value |
| 30-31 | DIA | <uncertainty/> | value, pdf |
| 32-39 | HF | <hindranceFactor/> | value |
| 40-41 | DHF | <uncertainty/> | value, pdf |
| 42-76 | | | |
| 77 | C | <commentFlag/> | record |
| 78-79 | | | |
| 80 | Q | <assignment/> | record |

```
  <isotope id="U236" A="236">
    <levels>
      <level id="U236_e0" index="0">
        <energy value="0" unit="keV">
          <uncertainty value="0" pdf="NA"/>
        </energy>
        <spin string="0" value="0.0" unit="hbar"/>
        <parity value="+"/>
---  ENSDF_236U.xml    8% (71,29)    (XML)-------------------------------------
        <assignment record="firm"/>
        <decay mode="alpha">
          <alphaEnergy value="5168.17" unit="keV">
            <uncertainty value="0.15" pdf="normal"/>
          </alphaEnergy>
          <alphaIntensity value="72.8">
            <uncertainty value="0.1" pdf="normal"/>
          </alphaIntensity>
          <hindranceFactor value="1.00">
            <uncertainty value="0.00" pdf="NA"/>
          </hindranceFactor>
          <commentFlag record="A"/>
          <assignment record="firm"/>
        </decay>
      </level>
---  ENSDF_236U.xml   11% (106,80)   (XML)-------------------------------------
236U   L 0            0+
236U   A 5168.17   15 72.8   1  1.00                                        A
```

Figure 13: Alpha record. Lower panel: ENSDF-formatted dataset for $^{236}$U; upper panel: representative XML translation. The dataset corresponds to $^{240}$Pu $\alpha$ decay. The $\alpha$-decay mode is a child element of the level element. The nested hierarchy of the child elements belonging to the isotope parent element is also illustrated in this example.

### 3.13 The (Delayed-) Particle Record: <decay mode=''delayedParticle''/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6 | | | |
| 7 | | | |
| 8 | D | <decay/> | mode, id, particle |
| 9 | Particle | | |
| 10-19 | E | <*particle*Energy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-29 | IP | <*particle*Intensity/> | value |
| 30-31 | DIP | <uncertainty/> | value, pdf |
| 32-39 | EI | <intermediateNuclide/> | id, A, Z |
| | | <level/> | energy, unit |
| 40-49 | T | <width/> | value, unit |
| 50-55 | DT | <uncertainty/> | value, pdf |
| 56-64 | L | <angularMomentumTransfer/> | value, wave, particle |
| 65-76 | | | |
| 77 | C | <commentFlag/> | record |
| 78 | COIN | <coincidence/> | record, classification |
| 79 | | | |
| 80 | Q | <assignment/> | record, classification |

```
   <levels>
     <level id="Si26_e0" index="0">
       <energy value="1797.3" unit="keV">
--  ENSDF_26Si.xml   59% (68,0)     (XML)-------------------------------------
       <assignment record="firm"/>
       <decay mode="delayedParticle" id="P" particle="proton">
         <protonEnergy value="10560" unit="keV">
           <uncertainty value="400" pdf="normal"/>
         </protonEnergy>
         <protonIntensity value="39" unit="percent of total proton emissions">
           <uncertainty value="14" pdf="normal"/>
         </protonIntensity>
         <intermediateNuclide id="P" A="27" Z="15">
           <level energy="12002" unit="keV"/>
         </intermediateNuclide>
         <width value="None" unit="keV">
           <uncertainty value="None" pdf="NA"/>
         </width>
         <angularMomentumTransfer value="None" wave="None" particle="proton"/>
         <commentFlag record="None"/>
         <coincidence record="None" classification="None"/>
         <assignment record="None" classification="firm"/>
       </decay>
     </level>
   </levels>
--  ENSDF_26Si.xml   76% (107,80)   (XML)-------------------------------------
26SI  L  1797.3    1 2+
26SI  DP 10.56E+3 40 39     14 12002
```

Figure 14: Delayed-Particle record. Lower panel: ENSDF-formatted dataset for $^{26}$Si; upper panel: representative XML translation. The dataset corresponds to $^{27}$S $\beta^-$-delayed proton decay. The delayed-particle decay mode is a child element of the level element.

## 3.14 The Gamma Record: <decay mode=''gamma''/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-5 | NUCID | | |
| 6-7 | | | |
| 8 | G | <decay/> | mode |
| 9 | | | |
| 10-19 | E | <gammaEnergy/> | value, unit |
| 20-21 | DE | <uncertainty/> | value, pdf |
| 22-29 | RI | <branchingRatio/> | value |
| 30-31 | DRI | <uncertainty/> | value, pdf |
| 32-41 | M | <multipolarity/> | value |
| 42-49 | MR | <mixingRatio/> | value, sign |
| 50-55 | DMR | <uncertainty/> | value, pdf |
| 56-62 | CC | <totalICC/> | value |
| 63-64 | DCC | <uncertainty/> | value, pdf |
| 65-74 | TI | <relativeTotalIntensity/> | value, method |
| 75-76 | DTI | <uncertainty/> | value, pdf |
| 77 | C | <commentFlag/> | record, classification |
| 78 | COIN | <coincidence/> | record, classification |
| 80 | Q | <assignment/> | record, classification |
| | | <finalLevel/> | |
| | | <flevel/> | id, index |
| | | <fenergy/> | value, unit |

```
      <decay mode="gamma">
        <gammaEnergy value="223.2368" unit="keV">
          <uncertainty value="0.0013" pdf="normal"/>
        </gammaEnergy>
        <branchingRatio value="0.730">
          <uncertainty value="0.005" pdf="normal"/>
        </branchingRatio>
        <multipolarity value="M1+E2"/>
        <mixingRatio value="0.114" sign="-">
          <uncertainty value="0.014" pdf="normal"/>
        </mixingRatio>
        <totalICC value="0.0975">
          <uncertainty value="0.0000" pdf="NA"/>
        </totalICC>
        <relativeTotalIntensity value="0.801175" method="calculatedUsingRIandCC">
          <uncertainty value="0.0054875" pdf="normal"/>
        </relativeTotalIntensity>
        <commentFlag record="None" classification="None"/>
        <coincidence record="None" classification="None"/>
        <assignment record="None" classification="firm"/>
        <finalLevel>
          <flevel id="Cs133_2" index="2"/>
          <fenergy value="160.6121" unit="keV"/>
        </finalLevel>
      </decay>
---  ENSDF_133Cs.xml   58% (294,84)   (XML)----------------------------------------
133CS  G 223.2368  13 0.730   5M1+E2     -0.114  14    0.0975
```

Figure 15: Gamma record. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panel: representative XML translation. The dataset corresponds to $^{133}$Ba $\epsilon$ decay. The gamma-decay mode is a child element of the level element. A new final-level element is explicitly defined in the hierarchy cf. implicit in the current ENSDF dataset.

```
      <level id="Cs133_e2" index="2">
        <energy value="160.6121" unit="keV">
          <uncertainty value="0.0009" pdf="normal"/>
        </energy>
---   ENSDF_133Cs.xml   31% (168,84)   (XML)-----------------------------------
      <level id="Cs133_e3" index="3">
        <energy value="383.8491" unit="keV">
          <uncertainty value="0.0008" pdf="normal"/>
        </energy>
---   ENSDF_133Cs.xml   49% (258,84)   (XML)-----------------------------------
        <decay mode="gamma">
          <gammaEnergy value="223.2368" unit="keV">
            <uncertainty value="0.0013" pdf="normal"/>
          </gammaEnergy>
          <branchingRatio value="0.730">
            <uncertainty value="0.005" pdf="normal"/>
          </branchingRatio>
          <multipolarity value="M1+E2"/>
          <mixingRatio value="0.114" sign="-">
            <uncertainty value="0.014" pdf="normal"/>
---   ENSDF_133Cs.xml   58% (303,84)   (XML)-----------------------------------
          <finalLevel>
            <flevel id="Cs133_2" index="2"/>
            <fenergy value="160.6121" unit="keV"/>
          </finalLevel>
---   ENSDF_133Cs.xml   63% (317,84)   (XML)-----------------------------------
133CS  G 223.2368  13 0.730   5M1+E2     -0.114  14    0.0975
```

Figure 16: Gamma record. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panels: representative XML translation. The dataset corresponds to $^{133}$Ba $\epsilon$ decay. This example demonstrates the advantage of indexing levels to find final levels associated with the $\gamma$ decay of the initial level.

```
      </decay>
      <decay mode="gamma">
        <gammaEnergy value="53.1622" unit="keV">
          <uncertainty value="0.0006" pdf="normal"/>
        </gammaEnergy>
        <branchingRatio value="3.45">
          <uncertainty value="0.05" pdf="normal"/>
        </branchingRatio>
        <multipolarity value="M1+E2"/>
        <mixingRatio value="0.08" sign="None">
          <uncertainty upperBound="+0.02" lowerBound="-0.03" pdf="asymmetric">
            <symmetrizationMethods>
              <method1 value="0.075000">
                <uncertainty value="0.025000" pdf="normal"/>
              </method1>
              <method2 value="0.072021">
                <uncertainty value="0.025226" pdf="normal"/>
              </method2>
            </symmetrizationMethods>
          </uncertainty>
        </mixingRatio>
---  ENSDF_133Cs.xml   82% (408,16)   (XML)-------------------------------------
133CS  L 437.0113   91/2+              150 PS    LE
133CS cL T$from 1964Va25, 1970Va34
133CS  E                          85.4   5  6.627 18
133CSS E CK=0.671 5$CL=0.251 4$CM+=0.0777 11
133CS cE           |eK(exp)=0.65 {I3} (1992Sa28)
133CS cE           |eL(exp)/|eK(exp)=0.371 {I7} (1967Sc10)
133CS  G 53.1622   6 3.45     5M1+E2     0.08    +2-3  5.66   10
```

Figure 17: Gamma record. Lower panel: ENSDF-formatted dataset for $^{133}$Cs; upper panel: representative XML translation. The dataset corresponds to $^{133}$Ba $\epsilon$ decay. This example illustrates methods for representing asymmetric uncertainties; in this case, for the mixing ratio $\delta_\gamma = 0.08\,(^{+2}_{-3})$.

## 3.15 The Reference Record: <references/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-3 | MASS | <mass/> | A |
| 4-7 | | | |
| 8 | R | <reference/> | index |
| 9 | | | |
| 10-17 | KEYNUM | <keynumber/> | id |
| 18-80 | REFERENCE | <ref/> | id |

## 3.16 The End Record: <end/>

| Field | Name | XML Element | XML Attributes |
|---|---|---|---|
| 1-80 | | <end/> | |

```
<references>
  <reference index="0">
    <mass A="26"/>
    <keynumber id="1931MU02"/>
    <ref id="JOUR ZEPYA 72 793"/>
  </reference>
  <reference index="1">
    <mass A="26"/>
    <keynumber id="1958NU41"/>
    <ref id="JOUR NUPHA 8 139"/>
  </reference>
  <reference index="2">
    <mass A="26"/>
    <keynumber id="1960RO06"/>
    <ref id="JOUR PHRVA 120 1321"/>
  </reference>
  <reference index="3">
    <mass A="26"/>
    <keynumber id="1961HI11"/>
    <ref id="Proc.Phys.Soc.(London) 78, 473 (1961)"/>
  </reference>
```

```
---  ENSDF_A26.xml    1% (12,0)     (XML)----------------------------------------
26       REFERENCES
26     R 1931MU02 JOUR ZEPYA 72 793
26     R 1958NU41 JOUR NUPHA 8 139
26     R 1960RO06 JOUR PHRVA 120 1321
26     R 1961HI11 Proc.Phys.Soc.(London) 78, 473 (1961)
```

Figure 18: Reference record. Lower panel: ENSDF-formatted dataset for $A = 26$; upper panel: representative XML translation. The first four references from the Adopted Dataset for $A = 26$ are presented.

```
    <reference index="362">
      <mass A="26"/>
      <keynumber id="2015KO08"/>
      <ref id="JOUR PRVCA 91 034323"/>
    </reference>
    <reference index="363">
      <mass A="26"/>
      <keynumber id="2015SC16"/>
      <ref id="JOUR PRVCA 92 031302"/>
    </reference>
    <reference index="364">
      <mass A="26"/>
      <keynumber id="2015SR03"/>
      <ref id="JOUR PRVCA 91 054611"/>
    </reference>
    <reference index="365">
      <mass A="26"/>
      <keynumber id="2015SI01"/>
      <ref id="JOUR PRVCA 91 014311"/>
    </reference>
  </references>
  <end/>
</ensdf2xml>
---  ENSDF_A26.xml   Bot (1847,80)  (XML)---------------------------------------
 26    R 2015KO08 JOUR PRVCA 91 034323
 26    R 2015SC16 JOUR PRVCA 92 031302
 26    R 2015SR03 JOUR PRVCA 91 054611
 26    R 2015SI01 JOUR PRVCA 91 014311

---  REFS_A26.ENS   Bot (368,79)   (Fundamental)--------------------------------
```

Figure 19: End record. Lower panel: ENSDF-formatted dataset for $A = 26$; upper panel: representative XML translation. The final four references from the Adopted Dataset for $A = 26$ are presented. The last line of the ENSDF-formatted file indicates the marker is in position number 79 which corresponds to column number 80 in the emacs editor (C-style counting). The XML translation represents the end record as a simple element.

# Acknowledgments

This work was performed under the auspices of the University of California, supported by the Director, Office of Science, Office of Basic Energy Sciences, of the U. S. Department of Energy at Lawrence Berkeley National Laboratory under Contract DE-AC02-05CH11231.

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