**Nuclear Data Section**

**International Atomic Energy Agency**

**P.O.Box 100, A-1400 Vienna, Austria**

**Memo CP-D/1046**

**Date:** 3 May 2022

**To:** Distribution

**From:** N. Otsuka

**Subject: LEXFOR “Multiplicity”**

LEXFOR “Multiplicity” starts from the following paragraph:

**Multiplicity**

(See also **Fission Yields, Neutron Yield, Thick- and Thin-Target Yields**)

**Definition**

Yield per event (per one incident particle, per the reaction), except for yield of reaction product (Product yield) and yield from fission (Fission yield).

**REACTION Coding:** MLT in SF6.

***Examples*:**

(…(P,A)…,,MLT,G) γ yield from (p,αγ) reaction

(…(N,G)…,,MLT) γ yield from capture gamma

I propose the following revisions:

**Multiplicity and Product Yield**

(See also **Fission Yields, Neutron Yield, Thick- and Thin-Target Yields**)

**Definition**

Number of particles or nuclei ~~(per one incident particle,~~ per the reaction~~)~~, except for yield ~~of reaction product (Product yield) and yield~~ from fission (Fission yield). The quantity is referred to **multiplicity** when the particle considered is in REACTION SF3 or SF7, and **product yield** when the particle considered is in REACTION SF4.

**REACTION Coding:** ,MLT (for multiplicities) or ,PY (for product yields).

**Units:** a code from Dictionary 25 with the dimension MLT. The unit code PRT/REAC and its derivative for multiplicities and PRD/REAC and its derivative for product yields.

***Examples*:**

(…(P,A)…,,MLT,G) γ yield from a (p,αγ) reaction

(…(N,G)…,,MLT) γ yield from a neutron capture ~~gamma~~

(…(P,X)0-G-0…,,PY) γ yield from a proton induced reaction

…

See LEXFOR **Thick target yields** for the number of particles or nuclei per incident particle.

**Definition**

The current description defines the multiplicity as the “yield per event” but we know the term “yield” is used in various meanings in the literature, and it is better to be more specific.

The current description distinguishes the product yield (PY) from the multiplicity (MLT), but it is more important for compilers to distinguish

(1) the multiplicity (,MLT) and yield (,PY) from

(2) the thick target multiplicity (MLT,,TT) and product yield (PY,,TT).

The first group of the quantities is free from the concept of the target thickness while the second group of the quantities requires the target thickness information (usually assuming a target thicker than the range without a specific number under THICKNESS),

**Units**

The current dictionary does *not* distinguish the unit family of the unit family of the multiplicity/product yield (e.g., PRT/REAC, PRD/REAC) from the thick target multiplicity/product yield (e.g., PRT/INC, PRT/MUCOUL, PRD/INC, PRD/MUCOUL), and it does not allow checking programs to check the right combination between the REACTION SF5-SF8 and unit code.

I propose introduction of new unit families (MLT, MDA, MDE and MAE) for the multiplicity and product yield:

**Dictionary 26 (Unit families)**

MLT products/reaction

MDA products/angle/reaction

MDE products/energy/reaction

MAE products/angle/energy/reaction

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Expansion** | **Family** | **Family (new)** |
| NUC/PART | nuclei per incident projectile | YLD |   |
| P/IN/MEVSR | particl./inc.proj. per Sr per MeV | YAE |   |
| P/MEVMUCSR | particles/(MeV muC sr) | YAEC |   |
| P/RC/MEVSR | particles/reaction/MeV/sr | YAE | MAE |
| PC/DECAY | particles per 100 decays | YLD | ? |
| PC/INC | particles/100 incid.projectiles | YLD |   |
| PC/INC/SR | particles/100 incid.projectiles/sr | YDA |   |
| PC/REAC | particles/100 reactions | YLD | MLT |
| PRD/IN/MEV | products per inc. proj. per MeV | YDE |   |
| PRD/INC | products/incident projectile | YLD |   |
| PRD/INC/SR | products/inc.projectile/steradian | YDA |   |
| PRD/MUAHR | products/micro-Ampere-hour | YLDC |   |
| PRD/MUC/SR | products/micro-Coulomb/sr | YDAC |   |
| PRD/MUCOUL | products/micro-Coulomb | YLDC |   |
| PRD/REAC | products/reaction | YLD | MLT |
| PRT/DECAY | particles per decay | YLD | ? |
| PRT/IN/MEV | particles per inc. proj. per MeV | YDE |   |
| PRT/INC | particles per incident projectile | YLD |   |
| PRT/INC/SR | partcles/inc.projectile/steradian | YDA |   |
| PRT/MAMIN | particles/milli-Ampere-minute | YLDC |   |
| PRT/MUAHR | particles/micro-Ampere-hour | YLDC |   |
| PRT/MUC/SR | particles/micro-Coulomb/steradian | YDAC |   |
| PRT/MUCOUL | particles/micro-Coulomb | YLDC |   |
| PRT/RCT/SR | particles per reaction per sterad | YDA | MDA |
| PRT/REAC | particles/reaction | YLD | MLT |
| PT/RCT/MEV | particles per reaction per MeV | YDE | MDE |

***Example***

|  |  |  |
| --- | --- | --- |
| Quantity | REACTION | Unit |
| 235U(n, γ)236U γ multiplicity | (92-U-235(N,G)92-U-236,,MLT) | PRT/REAC |
| 235U(n,γ+x) γ product yield | (92-U-235(N,X)0-G-0,,PY) | PRD/REAC |
| 235U(n,f) prompt γyield | (92-U-235(N,F)0-G-0,PR,FY | PRD/FIS |

**Distribution:**

a.koning@iaea.org

abhihere@gmail.com

aloks279@gmail.com

daniela.foligno@oecd-nea.org

dbrown@bnl.gov

draj@barc.gov.in

exfor@oecd-nea.org

fukahori.tokio@jaea.go.jp

ganesan555@gmail.com

gezg@ciae.ac.cn

iwamoto.osamu@jaea.go.jp

jmwang@ciae.ac.cn

kaltchenko@kinr.kiev.ua

kimdh@kaeri.re.kr

kimura.atsushi04@jaea.go.jp

l.vrapcenjak@iaea.org

manuel.bossant@oecd-nea.org

masaaki@nucl.sci.hokudai.ac.jp

marina-03-08@yandex.ru

michael.fleming@oecd-nea.org

mmarina@ippe.ru

nicolas.soppera@oecd-nea.org

n.otsuka@iaea.org

nrdc@jcprg.org

odsurenn@gmail.com

ogritzay@ukr.net

ogrudzevich@ippe.ru

otto.schwerer@aon.at

pikulina@expd.vniief.ru

pritychenko@bnl.gov

s.okumura@iaea.org

scyang@kaeri.re.kr

selyankina@expd.vniief.ru

sonzogni@bnl.gov

stakacs@atomki.mta.hu

stanislav.hlavac@savba.sk

sv.dunaeva@gmail.com

tada@nucl.sci.hokudai.ac.jp

taova@expd.vniief.ru

tarkanyi@atomki.hu

v.devi@iaea.org

v.zerkin@iaea.org

vidyathakur@yahoo.co.in

vsemkova@inrne.bas.bg

vvvarlamov@gmail.com

yolee@kaeri.re.kr

zholdybayev@inp.kz