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Memo CP-C/334

DATE: January 20, 2004
TO: Distribution
FROM: V. McLane, S. Tacács
SUBJECT: Memo CP-C/334 (Thick and Thin Target Yields))

Attached is the final draft of the new LEXFOR entry on thick target yields.

This requires the following dictionary updates.

Dictionary 34 (Modifiers), please add:

PHY physical yield

Dictionary 36 (Quantities), please add:

, TTY , , PHY	Physical thick or thin target yield	TTT
, TTY / PY	Product yield as a function of beam current	PYT
, TTY / MLT	Outgoing particle multiplicity as a function of beam current	PYT

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Thick- and Thin-Target Yields

Thick-target yields: yield of an outgoing particle (or radiation) measured on a target whose thickness is such that the incident beam is either:

- 1) completely stopped within the target,
- 2) significantly degraded in energy,
- 3) degraded in energy to below the threshold for producing the measured product.

Thin-target yields: yield of an outgoing particle (or radiation) measured on a target whose thickness is such that the incident beam is less significantly degraded in energy. The incident energy range must be given in the data table under the filed headings EN-MIN and EN-MAX.

The data are sensitive to target thickness and beam profile. The energy loss is a function of the stopping power (S) of the target material.

The thick target yield is given by

$$Y_{thick} \approx \int_{E_2}^{E_0} \sigma(E') \left[\frac{dE}{dX}(E') \right]^{-1} dE'$$

$$S = dE / dX$$

where E_0 is the incident particle energy,
 E_2 is the final energy of the incident particle; either 0 if the beam is stopped in the target, or equal to the energy of the particle exiting the target,
 E' is the energy at a given depth in the target,
 X is the target thickness in g cm^{-2} .

Types of data compiled:

- 1) Saturated thick/thin-target yield: target yield measured after a long irradiation time (*i.e.*, longer than 3 half-lives of the product activity) and usually given as decay rate per unit of incident beam current.

REACTION Coding: TTY in SF6

Units: a code from Dictionary 25 with dimension TTY (decay rate per unit of beam current), *e.g.*, MCI /MUA.

- 2) Production¹ thick/thin-target yield: (unsaturated) target yield measured after an irradiation time that is short compared to the product half-life and given as decay rate per unit of incident beam current * time.

REACTION Coding: TTY , , DT

Units: a code from Dictionary 25 with dimension TTT (decay rate per unit of beam current * time), *e.g.*, MCI /MUAHR or DPS /MUAHR.

¹ Do not confuse with product yields.

Thick-Target yields

- 3) Physical thick/thin-target yield: target yield measured after an irradiation time that is short compared to the product half-life, is given as decay rate per unit of incident beam current * time, and has been corrected for decays during irradiation.

REACTION Coding: TTY , , PHY

Units: a code from Dictionary 25 with dimension TTT (decay rate per unit of beam current * time), *e.g.*, MCI /MUAHR or DPS /MUAHR.

4) Other representations of thick target yields

- a) Thick Target Product Yields: thick target yield of a reaction product, where:

- the value is given in units of number of nuclei per incident projectile.

REACTION Coding: PY in SF 6, TT in SF8.

Units: a code from Dictionary 25 with dimension YLD, *e.g.*, PRD/INC

- the value is given in units of number of nuclei as a function of incident beam current.

REACTION Coding: TTY/PY in SF 6.

Units: a code from Dictionary 25 with dimension PYT, *e.g.*, PRD/MUAHR

- b) Thick Target Yield Multiplicities: yield of an outgoing particle (or radiation), where:

- the value is given as the number of particles per incident projectile.

REACTION Coding: MLT in SF 6, TT in SF8.

Units: a code from Dictionary 25 with dimension YLD, *e.g.*, PRT/INC

- the value is given as the number of particles as a function of incident beam current.

REACTION Coding: TTY/MLT in SF 6.

Units: a code from Dictionary 25 with dimension PYT, *e.g.*, PRT/MUAHR

- c) Thick Target Gamma-Ray Yields: spectrum of gammas, where the value is given as the number of particles per incident projectile as a function of gamma energy.

REACTION Coding: SPC in SF 6, TT in SF8.

Units: a code from Dictionary 25 with dimension YLD, *e.g.*, PRT/INC

Unit definitions

Saturated thick target yields are most often measured as observed decay rate per unit of beam current. Unsaturated thick target yields are most often measured as observed decay rate per unit of beam current per unit time.

Measures of beam current

Ampere: SI fundamental unit of current.

Coulomb: SI fundamental unit of charge; 1 C = 1 Ampere of current for 1 second.

Measures of decay rate

Becquerels SI fundamental unit of radioactivity; 1 Bq = 1 decay/second.

Curies²: unit of radioactivity; 1 Ci = 3.7x10¹⁰ decays/second.

$$1 \text{ Bq} = 2.7 \times 10^{-11} \text{ Ci}$$

² The Curie has been replaced in usage by the Becquerel.