WP 2004-20
(CP-D/414, CP-E/047, CP-D/400, CP-A/154)

Nuclear Data Section
International Atomic Energy Agency
P.O.Box 100, A-1400 Vienna, Austria

Memo CP-D/414

Date: 19 September 2004
To: Distribution
From: O. Schwerer

Subject: Probability for emission of N particles, EM/NUM,PY and quantity code SIG/DN

Reference: CP-E/047, CP-A/154, CP-D/400, e-mail of V. McLane of 9 September

There are two issues:

1) I agree to drop the quantity `DN` because it can be replaced by the branch code `NUM`.

2) I agree with CP-E/047 that there is an inconsistency with the units currently used for probabilities for emission of a number of particles (quantities `EM/NUM,PY` and `PR/NUM,NU`). Dimension YLD (for SF6=PY) and FY (for SF6=NU) are suitable for **multiplicities** but not for the **probability of emission of a certain number of particles**.

Artificial example:

No.of emitted X-particles	Probability (%)	No.of produced particles
1	20	20
2	15	30
3	12	36
4	45	180
5	8	40
SUM	**100**	**306**

The **average number** of emitted X-particles is 3.06 per reaction, or 306 per 100 reactions. This is to be compiled with dimension YLD or FY. Units are e.g. particles per reaction or particles per 100 fissions.

However, the **probability of emission of 3 particles** in one reaction is 12%.
To compile this number (12.), no units of dimension FY or YLD are suitable. This is not *"12 particles per 100 reactions"* or similar; it is "the probability for emitting 3 particles is 12 %", or "in 12 out of 100 reactions, precisely 3 particles (but not more) are emitted".
Since we allow units PER-CENT only for errors, I propose to use NO-DIM for such data because other, newly-invented units may perhaps add to the confusion.

In entry O1086, as mentioned in CP-E/047, units PC/REAC are used. The abbreviation PC/REAC was originally deduced from "Percent per Reaction" but the definition was then modified to mean "particles per 100 reactions". For multiplicities this makes no difference but for the probabilities as given here it is wrong.

For discussion at the NRDC meeting.

E-mail from V. McLane of 9 September:

It appears that we can drop the quantity DN and replace it with the NUM branch code. Is there any disagreement?

Data sets O0837, O0848, O0953, and O0954 will have to be corrected.

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Memo CP-E/047

Date : July 16, 2004
To : Distribution
From : OTSUKA Naohiko
Subject : Probability for emission of N particles, EM/NUM,PY
Reference : CP-A/154, CP-D/400

The authors of O1086 (B. Mukherjee *et al*.) give the probability to find *n* proton production events in proton production events (Table II and III of the reference). I agree to introduce new code for "Probability for emission of N particles). However proposed dimension (`FY`) is not suitable. This quantity is now compiled with `PC/REAC` (= particles in 100 reactions). Can we use this unit for the present measurement? I have similar question for the dimension of `PR/NUM,NU` for which dimension `FY` is now assigned.

We must distinguish the case of "probability for emission of N particles" from the case of " probability for production of fission fragment (*Z*,*A*)". For the latter case, % is often used in figures, and we code this probability with "`PC/FIS` = particles (or product) per 100 fissions", because always 200 fission fragments are produced in 100 fission events. In the present case (O1086), however, we cannot translate % to "`PC/REAC`=particle in 100 reactions" for the tables.

Additional questions:

1) Now `26-FE-56(P,X)1-H-1,EM/NUM,PY` is used for O1086.002. Another possibility is `26-FE-56(P,X)NPART,EM/NUM,PY,P`. Which one is preference in our practice?
2) How do we distinguish the usage of "`,SIG/DN`" formalism from "`NUM,SIG`" formalism? It looks that "`NUM,SIG`" can always replaces "`,SIG/DN`". The first one might have wider applicability.

Concerning O1086 again, we can see the following description in this paper:

"Overall, each measured spectrum is characterized by an exponential line (not shown in the Figures), starting with *a huge contribution at multiplicity one, mainly attributed to the elastic contribution for forward angle*, while completely non-elastic contribution for backward angle."

Therefore `EM` in SF5 in the proposed code is questionable (especially for SALAD detector set at forward angle).

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Memo CP-D/400

Date: 3 June 2004
To: Distribution
From: O. Schwerer

Subject: **Proposed code for "Probability for emission of N particles"**

Reference: **Memo CP-A/154**

In this memo the dictionary 36 code

EM/NUM,PY (unit dimension YLD) is proposed for the probability for emission of N particles.

In the corresponding draft entry O1086 the REACTION is

(25-FE-56(P,X)1-H-1,EM/NUM,PY)

with the number of protons given under the heading PART-OUT and the DATA units PC/REAC.

I have the following comments:

1) Though we don't have such quantities yet (with the exception of the special case of fission neutrons), it is a consistent possibility to code such data as product yields. However this is probably not the only way of doing it, therefore I want feedback from other centers. I personally have no objection against this way of coding except the following question:

2) EM in SF5 for "emission" is reserved for the special case where the product particle is identical with the projectile and elastic scattering is explicitly excluded. Is this really meant here? (From a quick check of the preprint by Mukherjee et al. I could not tell.) If this is the case, then the words "excluding elastic scattering" must be added to the expansion in dictionary 36. If not, EM must not be given in SF5 and the code would be just **NUM,PY**. (If necessary the authors should be asked whether elastic scattering was actually excluded.)

MEMO CP-A/154

14-May-2004

To: **Distribution**
From: **F.E. Chukreev**
Subject**: addition for Dictionary 36**

Please add the following code to Dictionary 36 (Quantities):

EM/NUM,PY YLD (Probability for emission of N particles)

Quantity	Unit	Reference
EM/NUM,PY	**PC/REAC**	(W,MUKHERJEE,200404) Submitted to EPJ/A

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