D-diagrams and Nuclear Data

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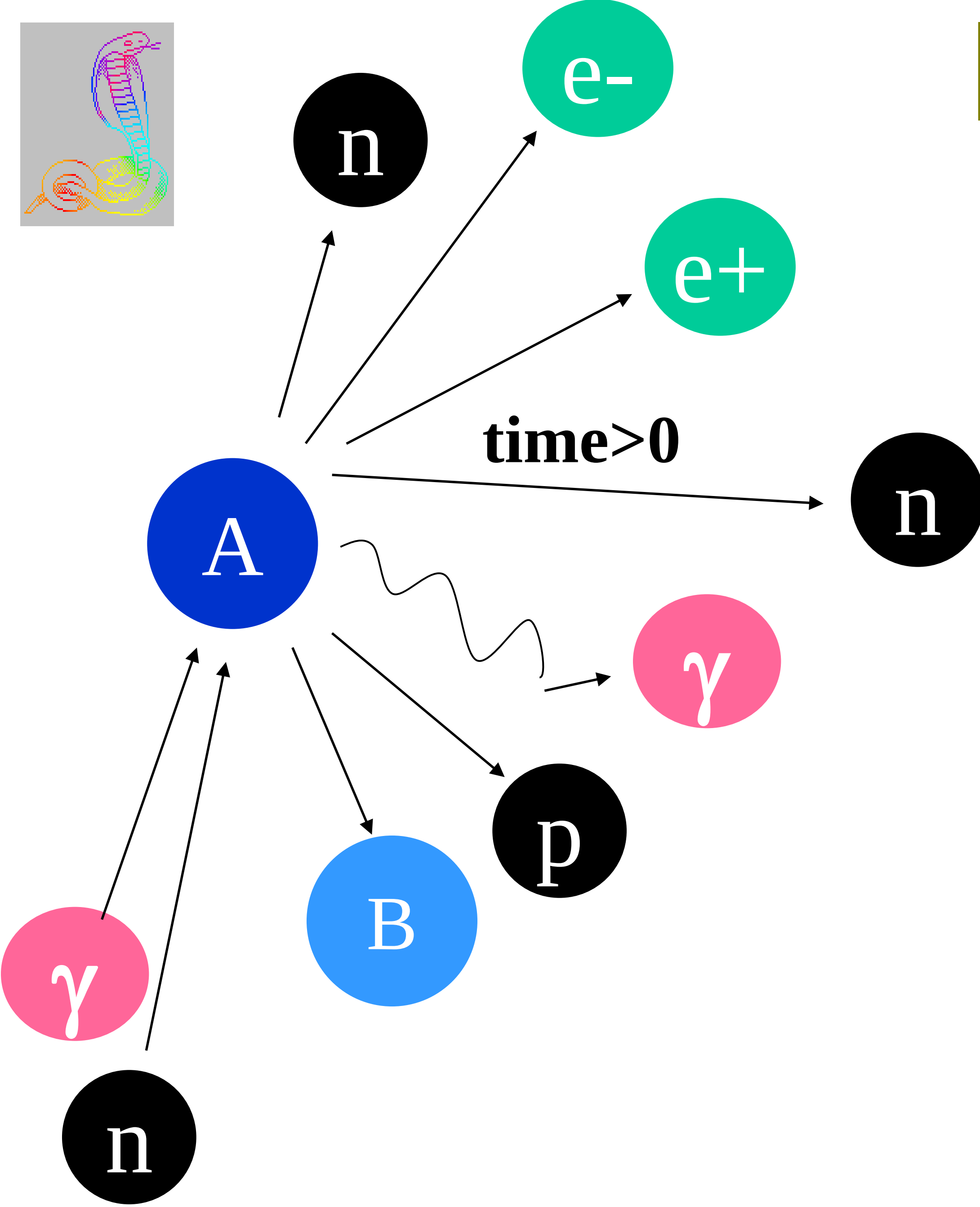
Introduction

30 years ago Vyacheslav Ogibin from VNIITF suggested using D-diagrams for organization and description of spectral nuclear data for Monte-Carlo programs.

D-diagrams use only **4 nonstructural** and **3 structural** elements.

D-diagrams were very convenient to create complex codes by many people of different qualifications.

The experience showed that it was the good choice as D-diagram are still successfully used.



Reaction Data

Cross Section - $\sigma(E_o)$

Energy reaction - Q

Particle type - n, γ, p, e^-, …

Yield - ν, n_γ , n_p, n_{e-}, …

Energy out particle - E

Cos(θ) - μ

Time - t

Total Data

$\sigma_{tot}(E_o)$ -

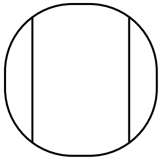
< Eя > - KERMA

$\sigma^*(\nu-1)$ - production

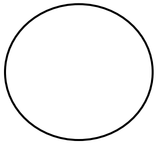
…

The non-structured types

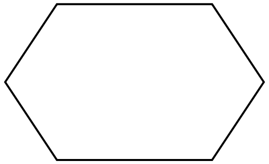
Integer



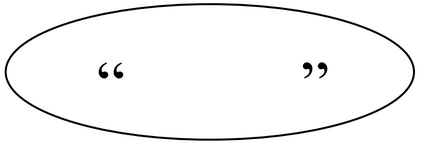
Real



Alphanumeric word

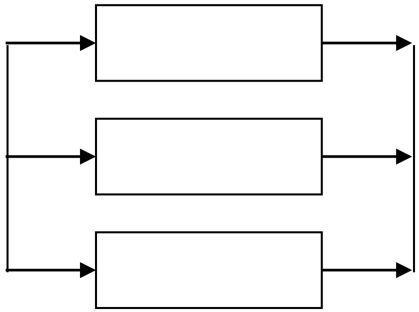


Alphanumeric string (cart)



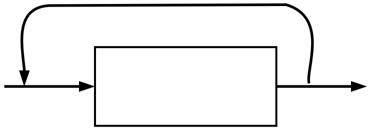
The structured types

Choice (Branch)



Direct Product

Sequence



Using D-diagrams

- In documentation for the format description of text and binary libraries
- For visually description of date structure and their representation
- Using the following additional symbols: J (Jump), N (Number), O (Omit) and Pac (Packing) show the data representation on cards (for example: Hollerith with 80 position of ASCII).
- Using the following additional symbol for binary data: У (Address) show the data representation in an array I and R (IR-equivalent).

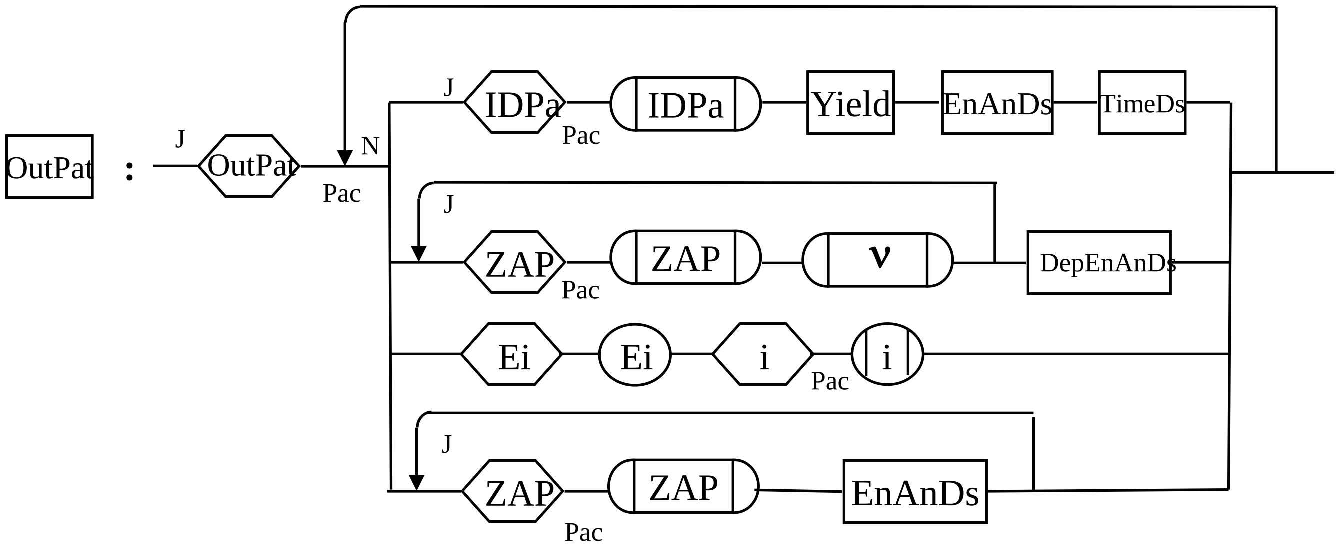
Data representation on ASCII cards

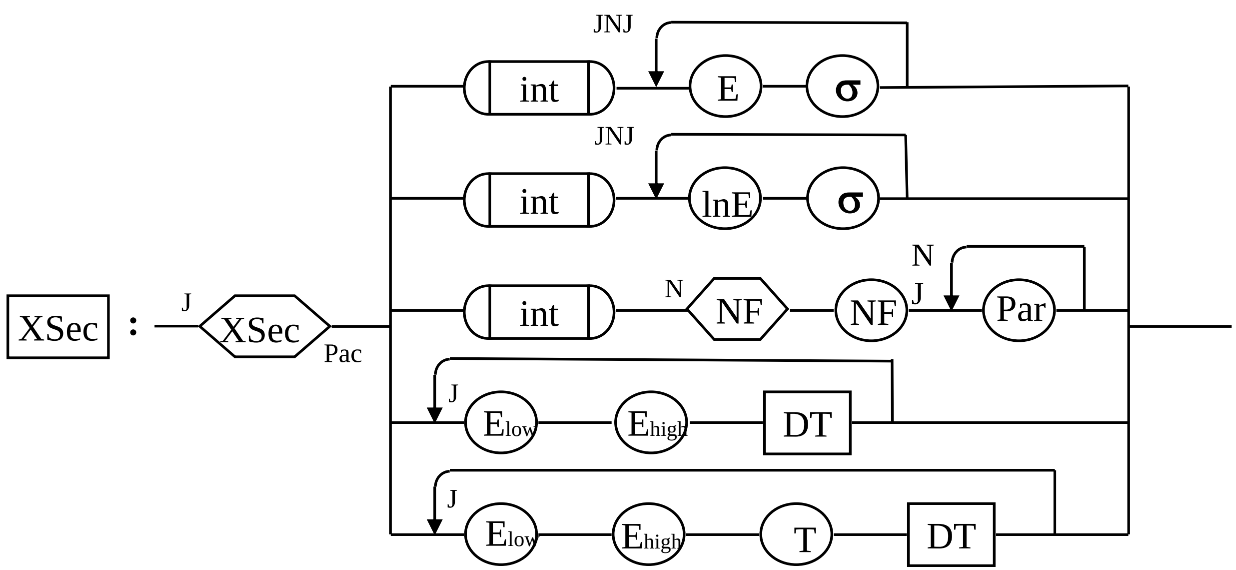
Additional symbols

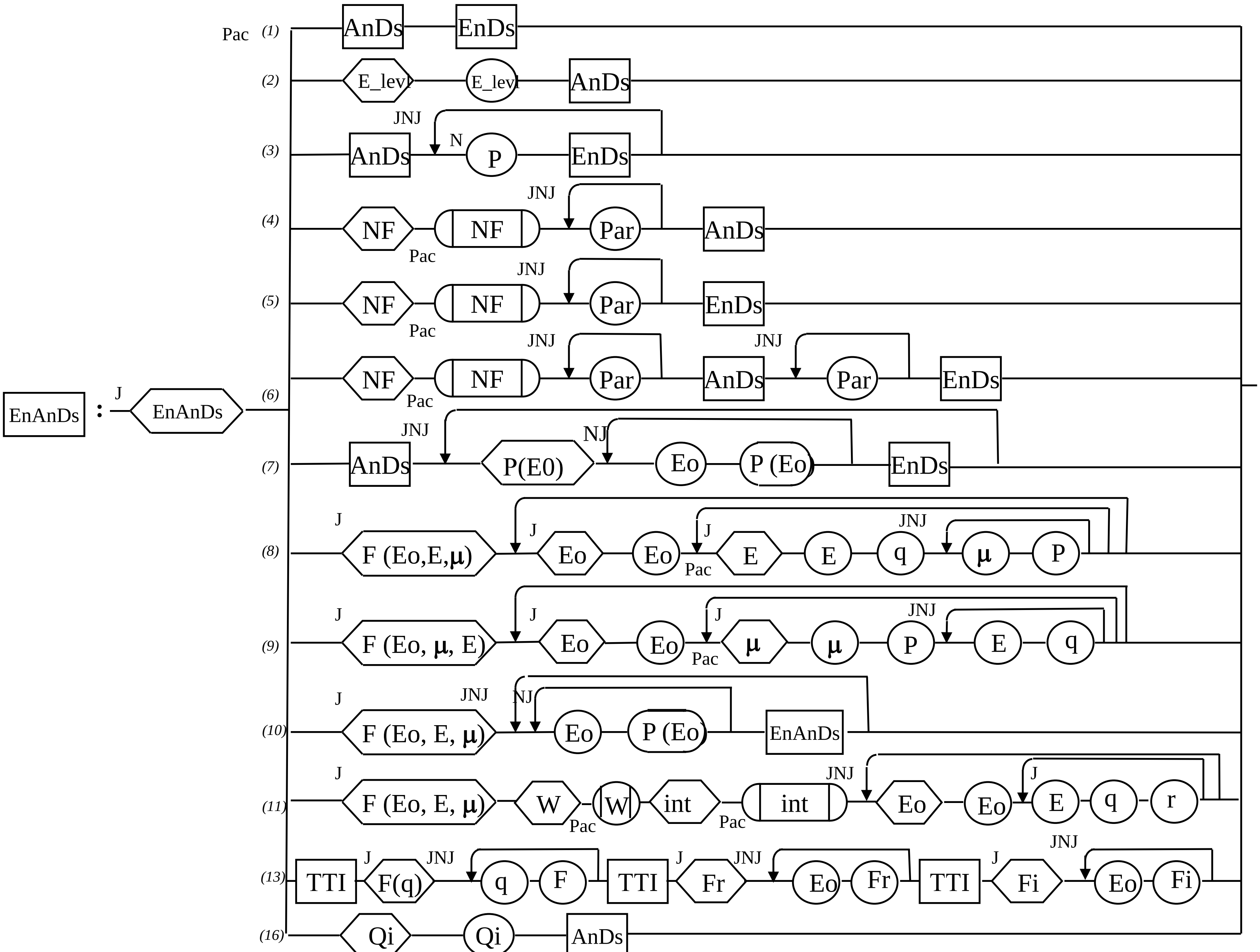
- **N - Number** of repetitions or the branch **Number**
- **J - Jump** on the following card or a line where values of the D-diagram will be placed.
- **O** – **Omitting** the current value of data**.**
- **P – Packing** two values on one field which consists of 12 positions each of which consists of six positions.

Some combinations:

- **NJ –** transmition to a new line after the number repetition placemen.
- **JNJ** – After jumping place N and jump to a new line.

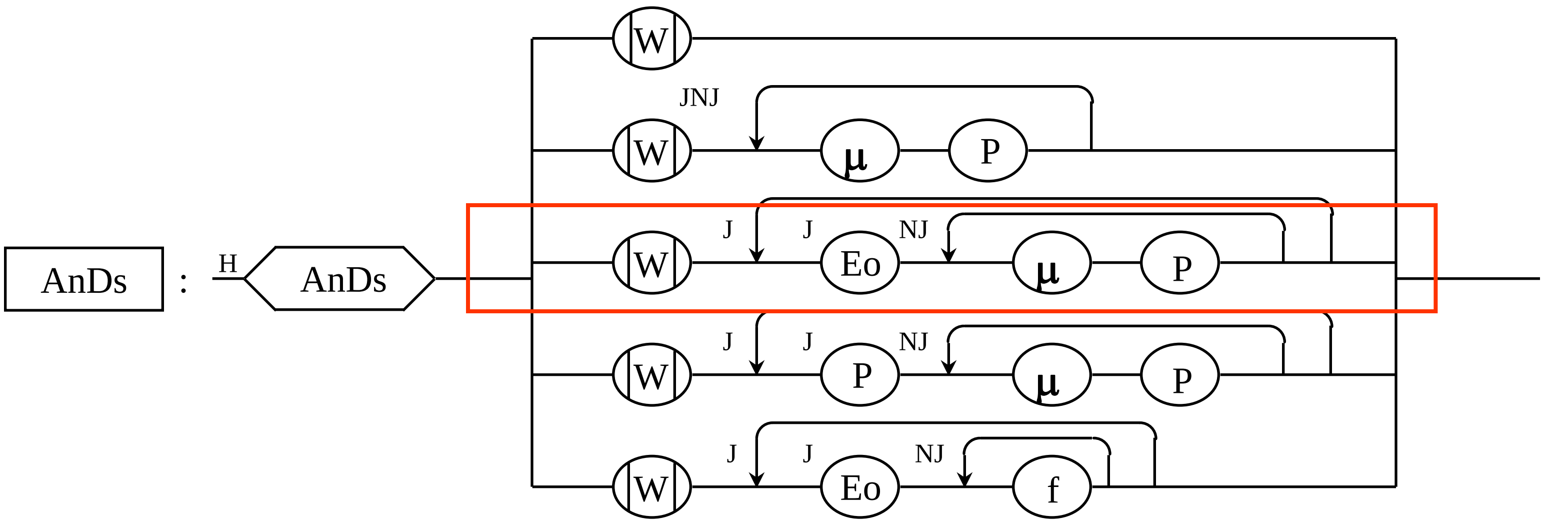

OutPat
:
J
OutPat
Pac
N
J
IDPa
Pac
IDPa
Yield
EnAnDs
TimeDs
J
ZAP
Pac
ZAP
ν
DepEnAnDs
Ei
Ei
i
Pac
i
J
ZAP
Pac
ZAP
EnAnDs


XSec
:
J
XSec
Pac
JNJ
int
E
σ
JNJ
int
lnE
σ
int
N
NF
NF
N
J
Par
J
Elow
Ehigh
DT
J
Elow
Ehigh
T
DT

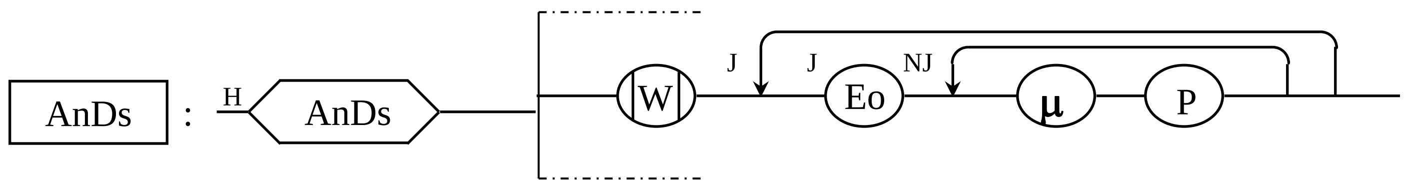


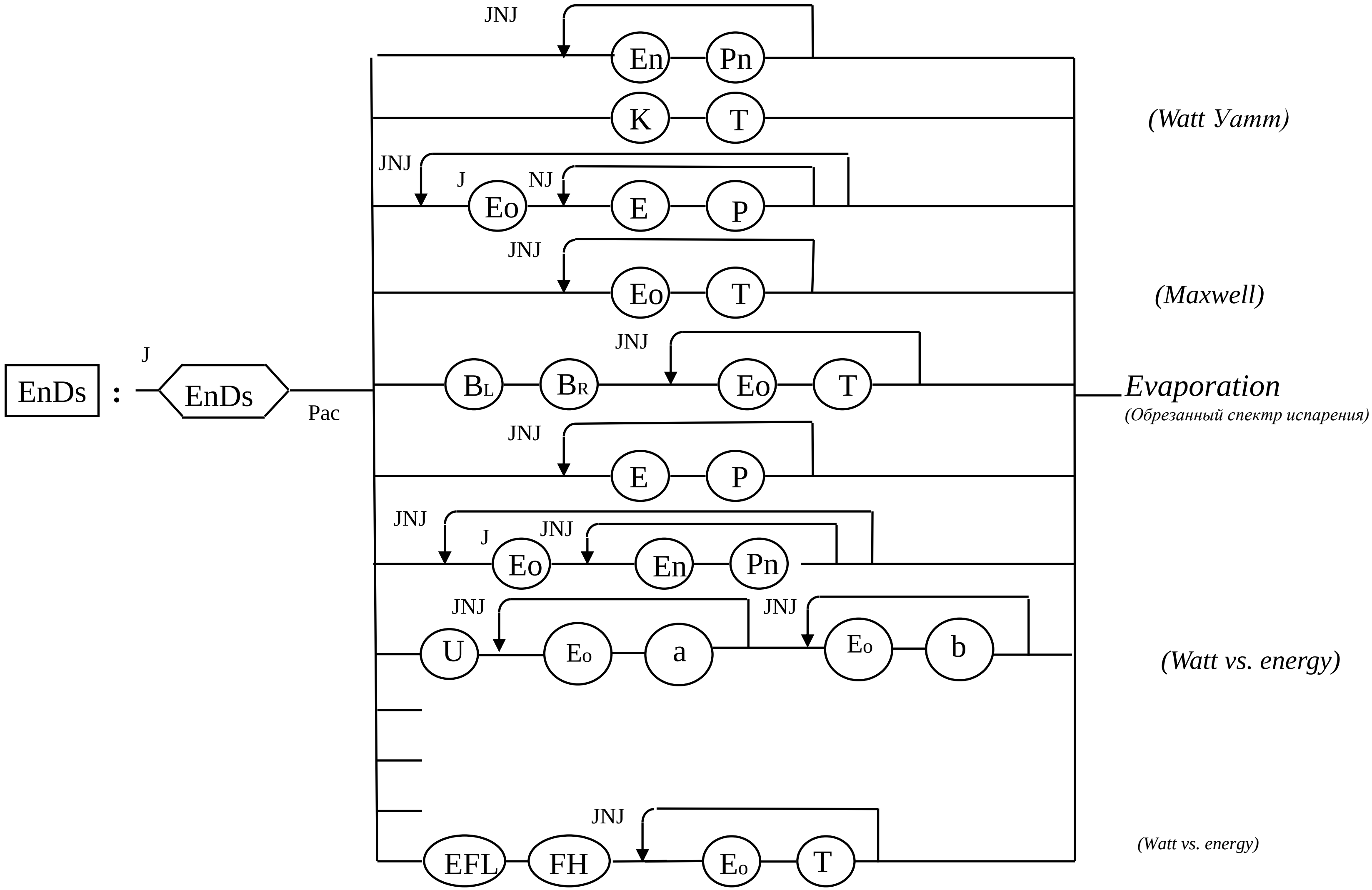
EnAnDs
:
J
EnAnDs
Pac
(1)
AnDs
EnDs
(2)
E_levl
E_levl
AnDs
(3)
JNJ
N
AnDs
P
EnDs
(4)
JNJ
NF
NF
Par
AnDs
Pac
(5)
JNJ
NF
NF
Par
EnDs
Pac
(6)
JNJ
JNJ
NF
NF
Par
AnDs
Par
EnDs
Pac
(7)
JNJ
NJ
AnDs
P(E0)
Eo
P (Eo)
EnDs
(8)
J
J
J
JNJ
F (Eo,E,μ)
Eo
Eo
Pac
E
E
q
μ
P
(9)
J
J
J
JNJ
F (Eo, μ, E)
Eo
Eo
Pac
μ
μ
P
E
q
(10)
J
JNJ
NJ
F (Eo, E, μ)
Eo
P (Eo)
EnAnDs
(11)
J
JNJ
J
F (Eo, E, μ)
W
W
Pac
int
int
Pac
Eo
Eo
E
q
r
(13)
J
JNJ
J
JNJ
J
JNJ
TTI
F(q)
q
F
TTI
Fr
Eo
Fr
TTI
Fi
Eo
Fi
(16)
Qi
Qi
AnDs

Angle Distribution Data



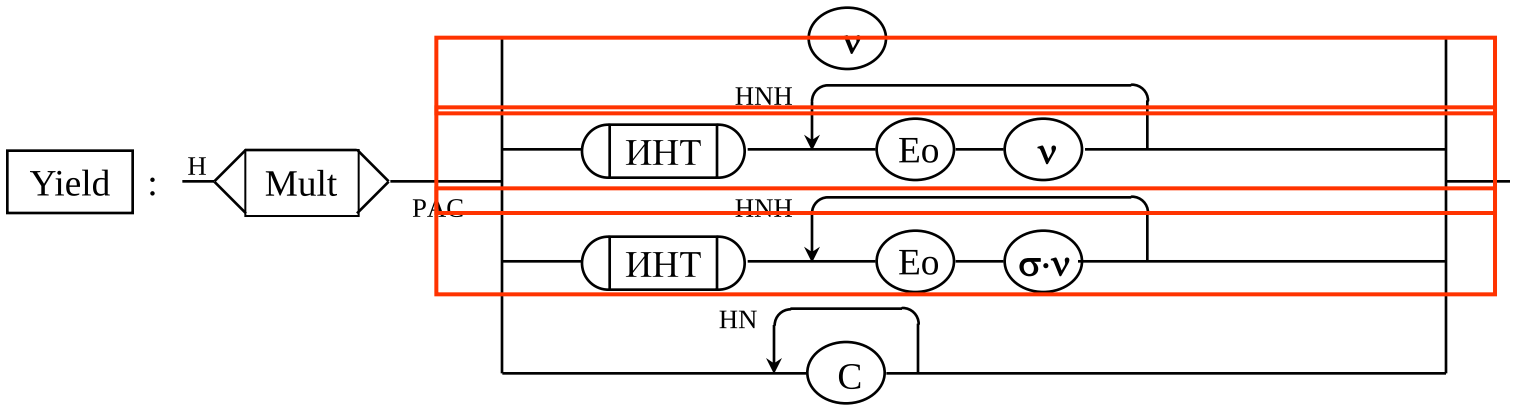
AnDs	3	1				13000 65
	3					13000 66
8.50000+05		2				13000 67
-1.00000+00	5.00000-01	1.00000+00	5.00000-01			13000 68
8.00000+06		2				13000 69
-1.00000+00	5.00000-01	1.00000+00	5.00000-01			13000 70
1.50000+07		3				13000 71
-1.00000+00	2.00000-01	0.00000+00	3.60000-01	1.00000+00	1.08000+00	13000 72





EnDs
:
J
EnDs
Pac
JNJ
En
Pn
K
T
(Watt Уamm)
JNJ
J
Eo
NJ
E
P
JNJ
Eo
T
(Maxwell)
JNJ
BL
BR
Eo
T
Evaporation
(Обрезанный спектр испарения)
JNJ
E
P
JNJ
J
Eo
JNJ
En
Pn
JNJ
U
Eo
a
JNJ
Eo
b
(Watt vs. energy)
JNJ
EFL
FH
Eo
T
(Watt vs. energy)

Particle Production Multiplicity



INT is the interpolation scheme identification number used in the range

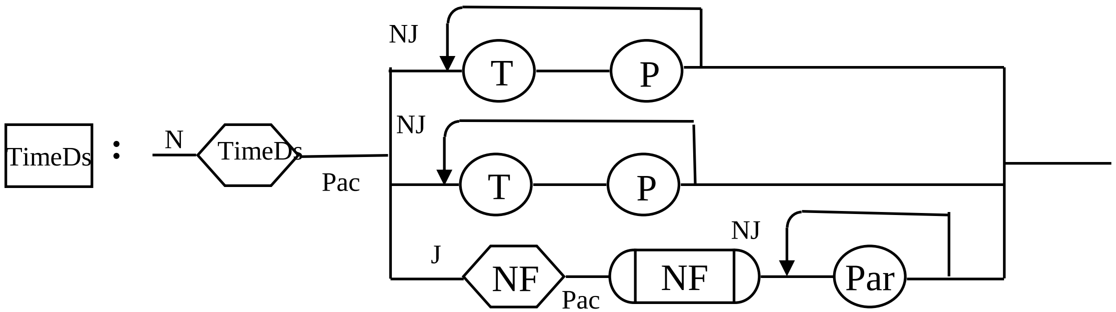
= 1 y is constant in x (constant, histogram)
= 2 y is linear in x (linear-linear)
= 3 y is linear in ln(x) (linear-log)
= 4 ln(y) is linear in x (log-linear)
= 5 ln(y) is linear in ln(x) (log-log)
= 7 equal(y) is linear in x (equal-linear)

ν is independent of E0 and has constant value;

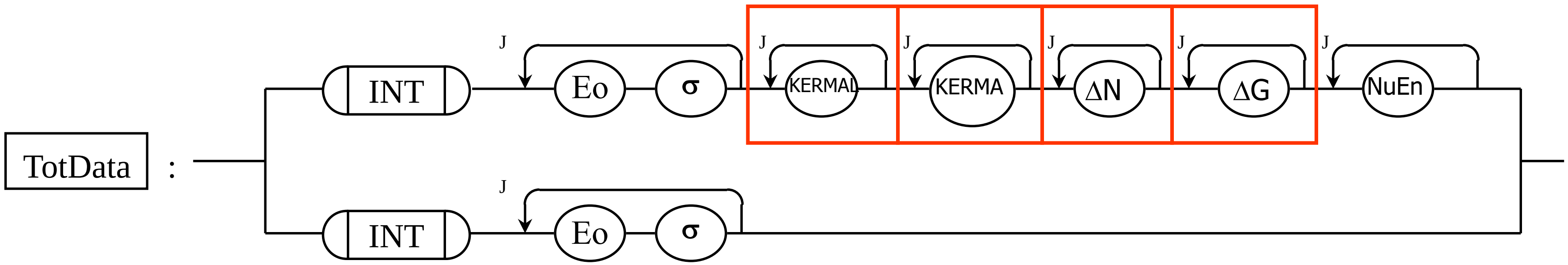
number of ν(E0) particles is tabulated with low of interpolation, as a rule, ИНТ=2;

σν - gamma production is set depending on energy E0

Time Distribution Data



Integral characteristic



$$KERMAL(E_0) = \sum_{\substack{i=1 \\ i\neq fiss}}^{N} \frac{\sigma_i(E_0)}{\sigma_{tot}(E_0)} \left[E_0 + Q_i - \sum_k (\nu_i^{(k)}(E_0)\cdot \bar{E}_i^{(k)}(E_0)) \right] + \frac{\sigma_{fiss}(E_0)}{\sigma_{tot}(E_0)} (Q_{fiss} + \sum_m \nu_{fiss,\gamma}^{(m)} \cdot \bar{E}_{fiss,\gamma}^{(m)}(E_0))$$

$$KERMA(E_0) = \sum_{\substack{i=1 \\ i\neq fiss}}^{N} \frac{\sigma_i(E_0)}{\sigma_{tot}(E_0)} \left[E_0 + Q_i - \sum_k (\nu_i^{(k)}(E_0)\cdot \bar{E}_i^{(k)}) - \sum_m (\nu_{i,\gamma}^{(m)}(E_0)\cdot \bar{E}_{i,\gamma}^{(m)}) \right] +$$

$$+ Q_{fiss} \frac{\sigma_{fiss}(E_0)}{\sigma_{tot}(E_0)} - \sum_m (\nu_{Non,\gamma}^{(m)}(E_0)\cdot \bar{E}_{Non,\gamma}^{(m)}) \frac{\sigma_{Non}(E_0)}{\sigma_{tot}(E_0)}$$

$$\mathbf{\Delta N(E_0) = \sum_{i}^{\text{ЧПР}} \sum_{k} \left(\nu_n^i(E_0) - 1\right) \frac{\sigma_i(E_0)}{\sigma_{tot}(E_0)}}$$

$$\Delta G(E_0) = \sum_{i}^{N} \sum_{m} \nu_\gamma^i \frac{\sigma_i(E_0)}{\sigma_{tot}(E_0)} + \sum_m \nu_{Non,\gamma}^{(m)}(E_0) \frac{\sigma_{Non}(E_0)}{\sigma_{tot}(E_0)}$$