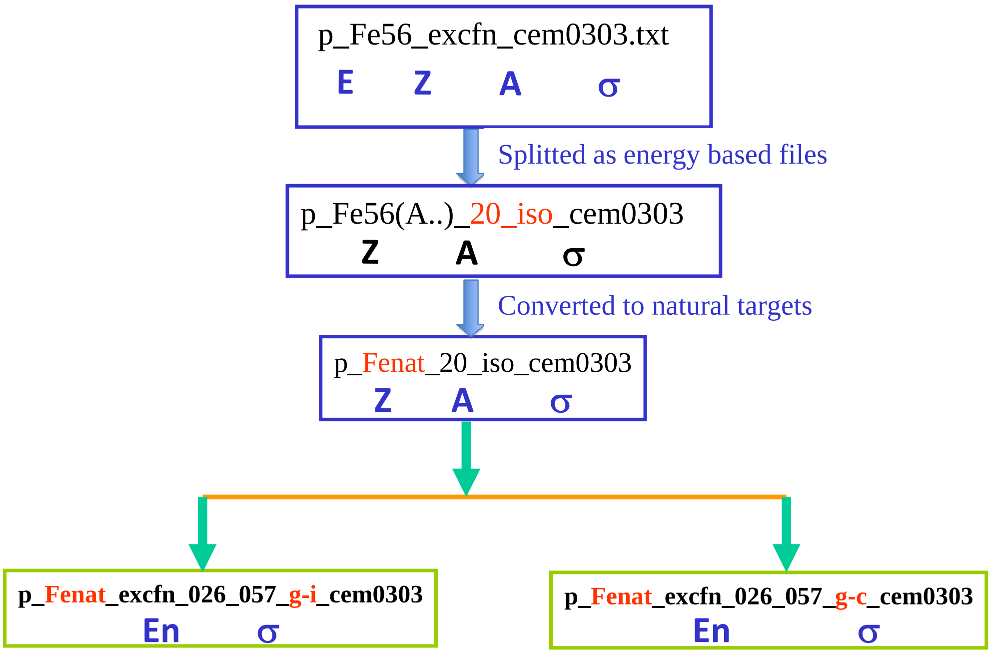
- **Excitation Function**
- **Independent and Cumulative cross-sections**
- **Production of Cumulative cross sections from the independent ones**



The measured nuclide production cross section can be either independent or cumulative. If the nuclide is produced only by the high-energy reaction, it is considered as independent. If the nuclide measured has been produced via high-energy interaction and decay of precursors, then it is considered as cumulative and production cross-section of the precursors has to be taken into account.

Participants were asked to give only the direct or independent production cross-sections for all nuclides to avoid a more complex analysis of the results due to different ways used to cumulate the cross sections.

Assuming only one hypothesis, which is that the half-life of the Mother is short compared to that one of the Daughter, the cumulative cross section is given by:

$$\sigma_{D,cum} = \sigma_{D,ind} + \sigma_M \frac{\lambda_M}{\lambda_M + \lambda_D},$$

where

- $\sigma_{D,cum}$ is the cumulative cross-section of the Daughter,
- $\sigma_{D,ind}$ is the independent cross-section of the Daughter,
- σ_M is the cross-section of the Mother (which can take into account grand-mother, etc.), and
- $\lambda_{M(D)}$ is half-life of the Mother (Daughter).

To perform cumulative calculations a code has been built which uses the above equation and doing the possible iterations (mother, grand mothers, etc.). This code needs a library, which contains the chains of precursors for all nuclides with necessary information that are branching ratio and half-life. According to the meaning of "the half-life of the Mother is short compared to that one of the Daughter", some chains of precursors can change. Then, several libraries can be built (using a code dedicated to this) with different λ_M / λ_D values.

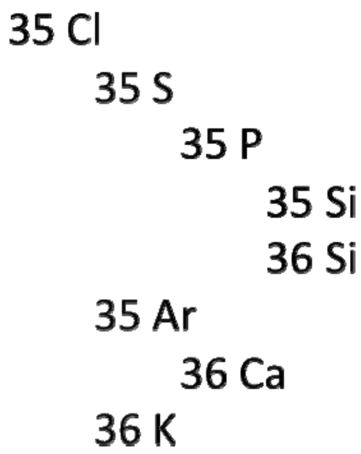
Information to create the library comes from the DCHAIN-SP library (JAERI-Data/Code 99-008) and below an extract of the paragraph concerning "Decay Data Library".

The decay data library for the DCHAIN-SP code contains half-life of nuclide, Q-value of a decay averaged with branching ratio [...], decay mode and so on. These data of primary nuclides have been taken from the evaluated nuclear data file EAF-3.1. The data in the FENDL/D-2 have been also employed for the radioactive nuclides excluded from EAF-3.1. For the other nuclides excluded from both data files, the decay data have been supplementally evaluated from the data in ENSDF, Table of Isotopes 8th edition and Chart of the Nuclides 1996.

[...]. [The] present decay data library contains the data of the 3139 kinds of nuclides with the atomic number range of $1 \leq Z \leq 100$ which covers 261 kinds of stable nuclides.
Eighteen decay modes are taken into account in the DCHAIN-SP library:

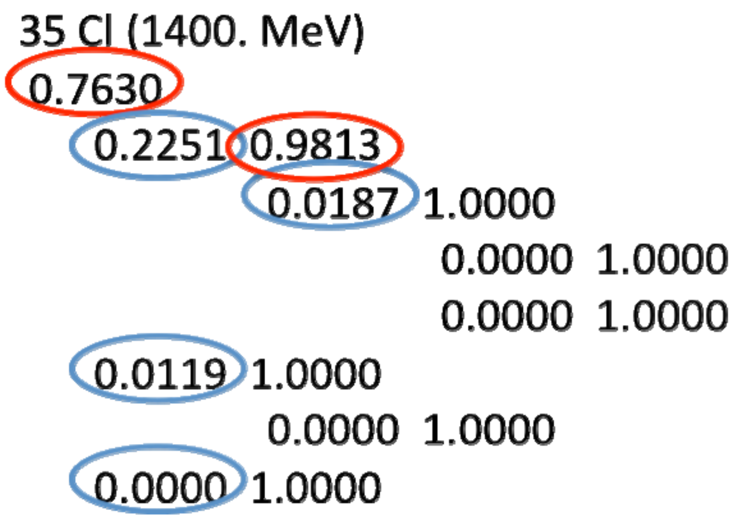
γ	Gamma decay
β^-	Beta decay
e.c., (β^+)	Positron decay
IT	Isomeric transition
α	Alpha decay
n	Neutron emission
SF	Spontaneous fission
p	Proton emission
β^-, β^-	Beta decay followed by beta decay
β^-,α	Beta decay followed by alpha emission
β^-,n	Beta decay followed by neutron emission
β^-,2n	Beta decay followed by two neutron emission
β^-,3n	Beta decay followed by three neutron emission
β^-,nα	Beta decay followed by neutron and alpha emission
β^+,α	Positron decay followed by alpha emission
β^+,p	Positron decay followed by proton emission
β^+,2p	Positron decay followed by two proton emission
2p	Two proton emission

We give below an example, the chain obtained for ^{35}Cl with $\lambda_M / \lambda_D = 10$.



^{35}Cl has 3 mothers (^{35}S, ^{35}Ar and ^{36}K). ^{35}S has 1 mother (^{35}P), which has 2 mothers (^{35}Si and ^{36}Si). Finally ^{35}Ar has 1 mother (^{36}Ca)

In addition to the cumulative cross-section values, the code provides the different contribution. Below the case of ^{35}Cl produced via p(1.4 GeV)+^{54}Fe



For each line (except the first one), the number on the left is the decay contribution to the daughter and the number on the right the direct production contribution (in red the direct production and in blue the decay production).

From this example, 76.3% of the ^{35}Cl come from direct production and 23.7% from decays (22.51 from ^{35}S, 1.19 from ^{35}Ar and nothing from ^{36}K). Moreover, ^{35}S is produced directly by reaction (98.13%), but also by decay of ^{35}P (1.87%).