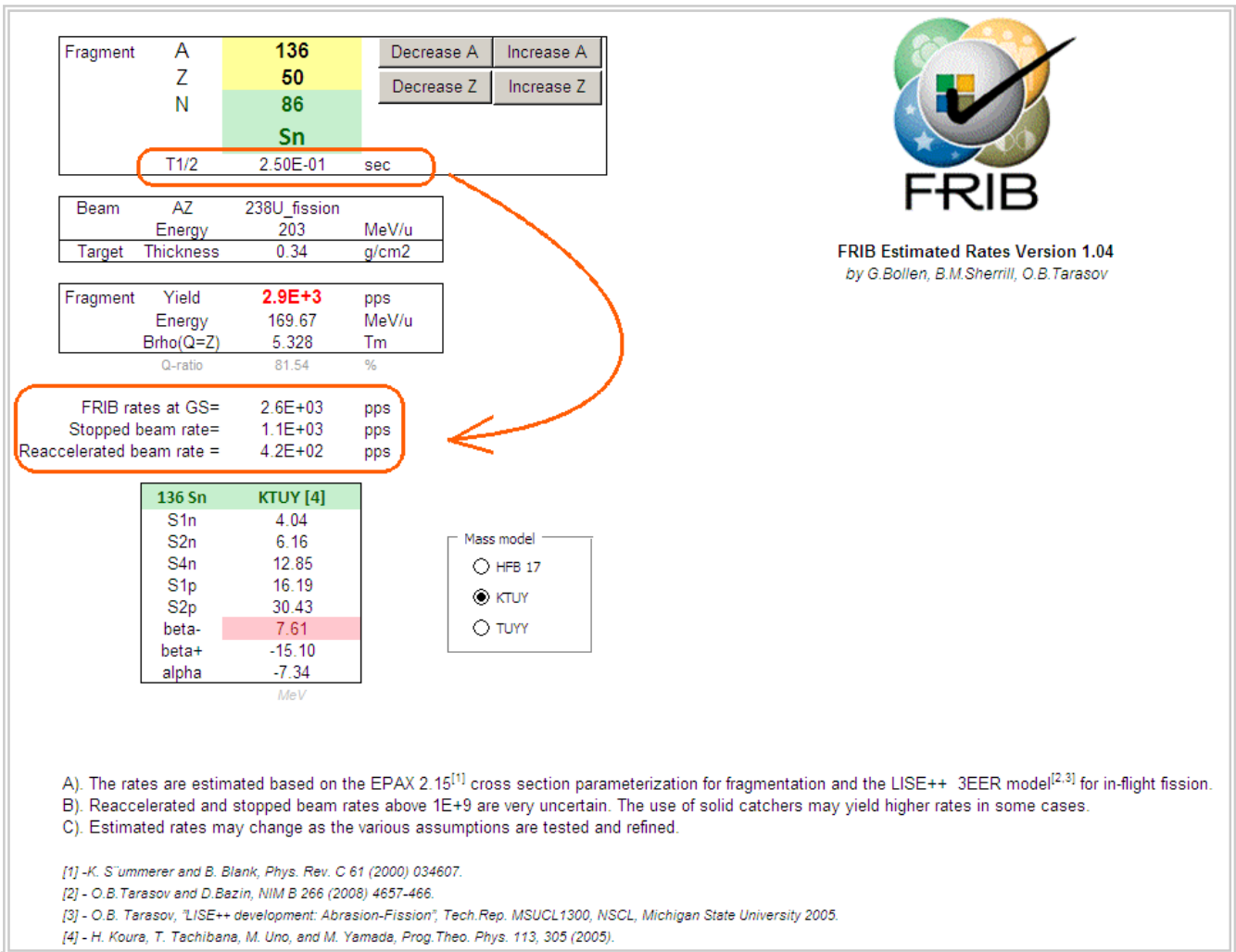
Half-lives: databases, calculation

The code operates under MS Windows environment and provides a highly user-friendly interface.
It can be freely downloaded from the following internet addresses:
http://www.nscl.msu.edu/lise

version 8.3.140

To estimate FRIB potential it is necessary to know half-lives and drip-lines locations

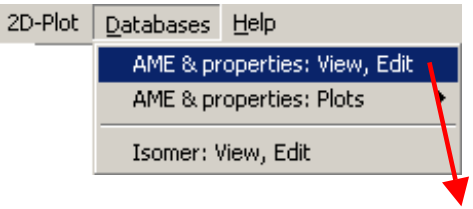
http://groups.nscl.msu.edu/frib/rates/

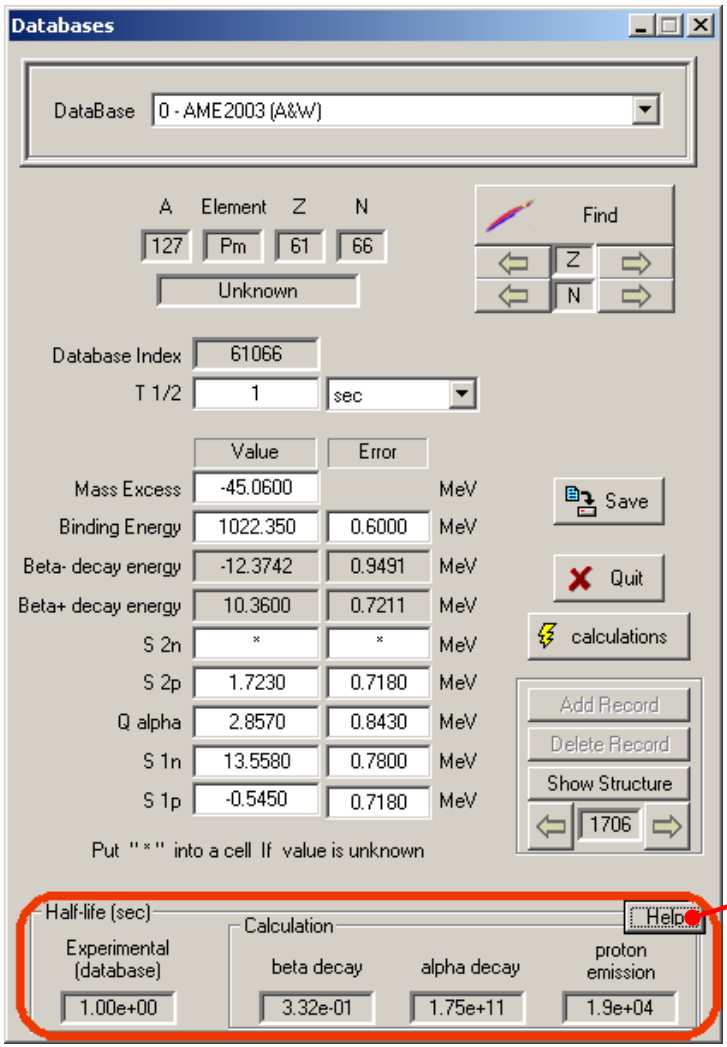


A). The rates are estimated based on the EPAX 2.15[1] cross section parameterization for fragmentation and the LISE++ 3EER model[2,3] for in-flight fission.
B). Reaccelerated and stopped beam rates above 1E+9 are very uncertain. The use of solid catchers may yield higher rates in some cases.
C). Estimated rates may change as the various assumptions are tested and refined.

[1] -K. S¨ummerer and B. Blank, Phys. Rev. C 61 (2000) 034607.
[2] - O.B.Tarasov and D.Bazin, NIM B 266 (2008) 4657-466.
[3] - O.B. Tarasov, "LISE++ development: Abrasion-Fission", Tech.Rep. MSUCL1300, NSCL, Michigan State University 2005.
[4] - H. Koura, T. Tachibana, M. Uno, and M. Yamada, Prog.Theo. Phys. 113, 305 (2005).

Half-live sources





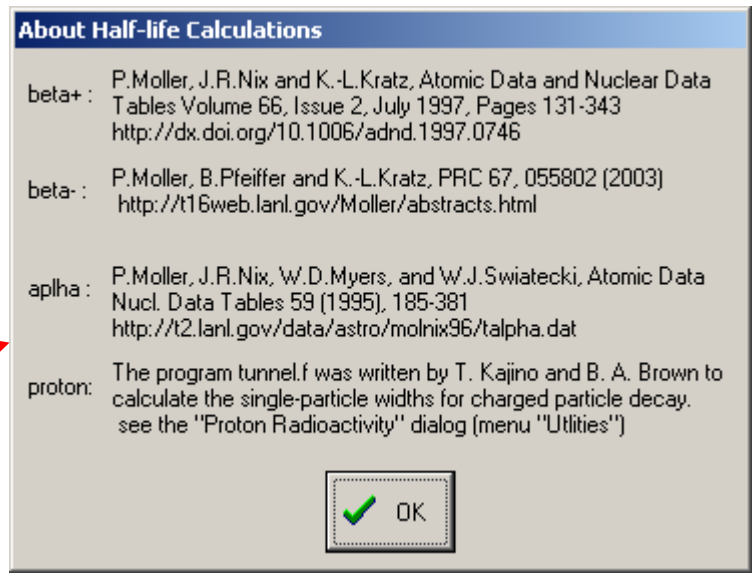
Experimental values: AME2003

Calculations:

Beta- & Beta+ database in LISE^{++} package
"bin\beta_halflives.ltime"

Alpha database in LISE^{++} package
"bin\alpha_halflives.ltime"

Proton emission - calculated in LISE^{++} based on the tools provided by B.A.Brown



Proton decay

Utilities | 1D-Plot | 2D-Plot | Databases | Help

- Spectrometric Calculator by J.Kantele
- The code "CHARGE"
- The code "GLOBAL"
- Units Converter
- BI (search of 2-dimensional peaks)
- Converter of FORTRAN-files to C-files
- PACE4 (fusion-evaporation code)
- PACE4's calculations plot
- MOTER (ray tracing code)
- MOTER's calculations plot
- Reaction's Characteristics
- **Proton radioactivity**
- Radiation length
- Electromagnetic excitation plots
- Create an initial file for nucleon pick-up (beta)
- Plot of Fragment Range in material versus Energy
- Plot of Fragment Stopping Power (dE/dx) in material versus Energy
- Plot of Angular Straggling in material versus Energy
- Plot of Equilibrium Thickness versus Energy
- Range optimizer
- Gas pressure optimization for gas-filled dipole
- Brho Analyzer
- Calculation of Angle on the LISE3 target
- MSP-144 utility
- Twinsol (solenoid) utility
- ISOL catcher utility
- User cross-sections analysis using Abrasion-Ablation model
- Rate & transmission calculation: batch mode
- Stripper foil lifetime

About "Tunnel.f"

The program tunnel.f was written by T. Kajino and B. A. Brown to calculate the single-particle widths for charged particle decay.

It uses the Coulomb wavefunction program from [1] to calculate the barrier penetration probability and multiplies this with the Wigner single-particle estimate to obtain the total width and lifetime [2].

1) COULFG - Coulombg and Bessel-Functions and their Dervatives, for Real Arguments, by Steed Method, Computer Physics Communications 27,147 (1982).

2) Diproton Decay of Nuclei on the Proton Drip Line,B. A. Brown, Phys. Rev. C43, R1513 (1991); Phys. Rev. C44, 924 (1991).

OK

Proton Radioactivity

A: 25 Element: S Z: 16 — Doesn't exist!

Table of Nuclides: Z, N

Properties from Database / Mass formula: 1p unbound

Masses from : AME2003 (AW) + LDM#2

	Value [MeV]
S_1p	-2.301
S_2p	-3.242
S_1p + CB	1.425
S_2p + CB	3.374

Code: 0 - tunnel_f; 1 - proton_f; About

R = 1.17 fm

Assume the next momentum for decays

1p - emission: Calculation (spherical case)

2p - emission: L = 0

Width and lifetime

L	1p-emission Width (MeV)	1p-emission T (sec)	2p-emission Width (MeV)	2p-emission T (sec)
0	7.7e-01	5.9e-22	2.3e-02	2.0e-20
1	3.1e-01	1.5e-21	1.2e-02	3.8e-20
2	4.8e-02	9.5e-21	3.4e-03	1.4e-19
3	3.5e-03	1.3e-19	5.5e-04	8.3e-19

Result being used in the code

Use: both 1p and 2p cases

Final result for p-emission: 5.9e-22 T1/2 sec

Shells in a harmonic oscillator

One-particle Proton levels (spherical case)

Configuration = 2 s 1/2 [2/2]

L = 0

Make it default

Ok | Quit

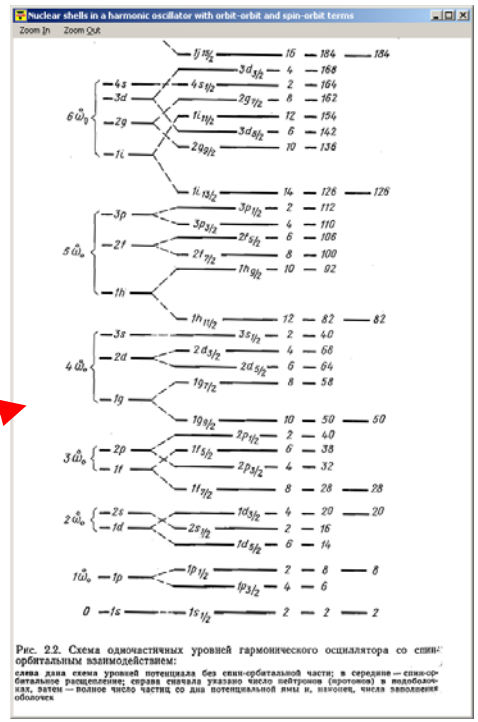
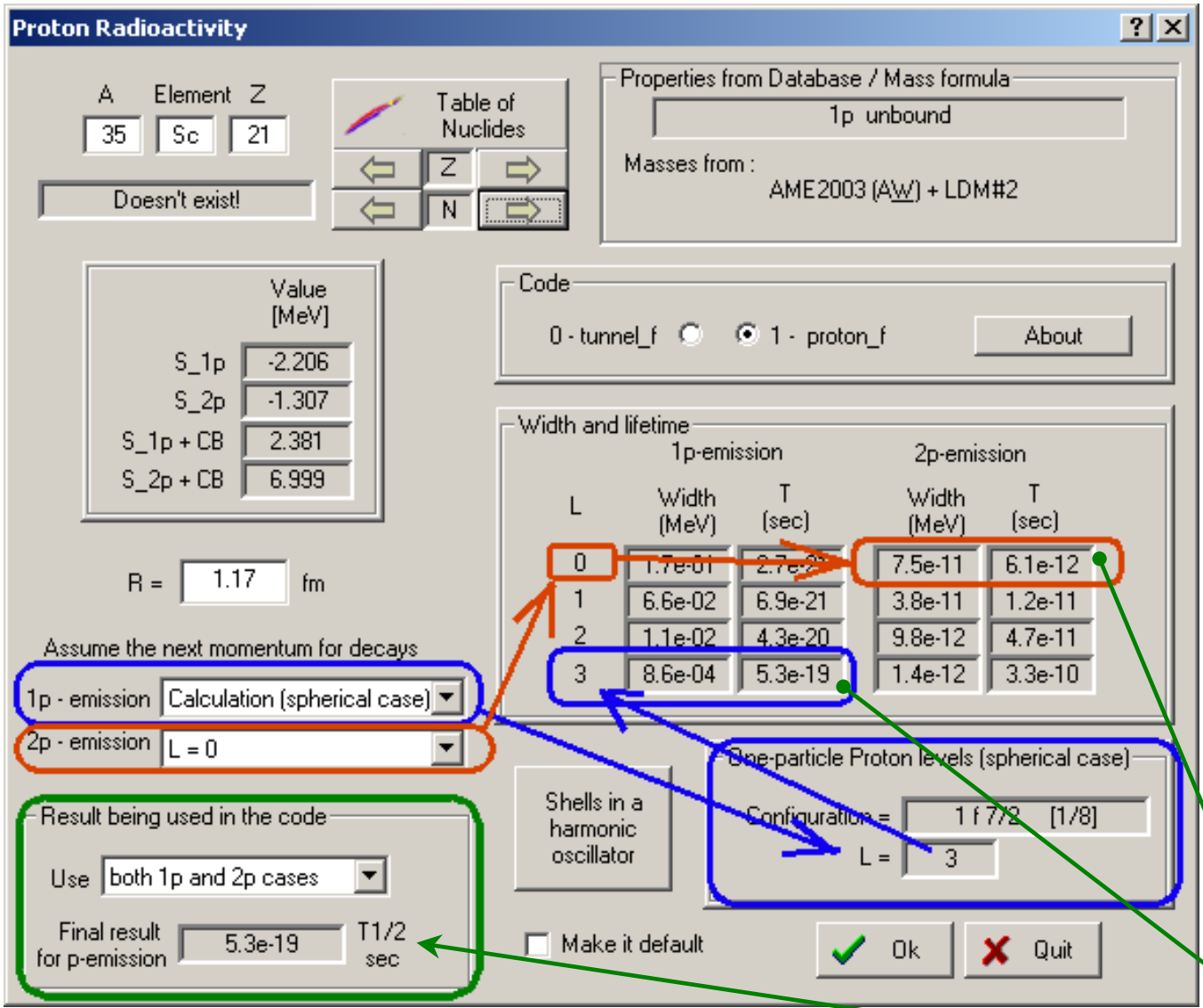


Рис. 22. Схема одночастичных уровней гармонического осциллятора со спин-орбитальным взаимодействием:

слева дана схема уровней потенциала без спин-орбитальной части; в середине — спин-орбитальное расщепление; справа сначала указано число нейтронов (протонов) в подоболочках, затем — полное число частиц со дна потенциальной ямы и, наконец, числа заполнения оболочек

Recommended (default) values

Proton decay : final result

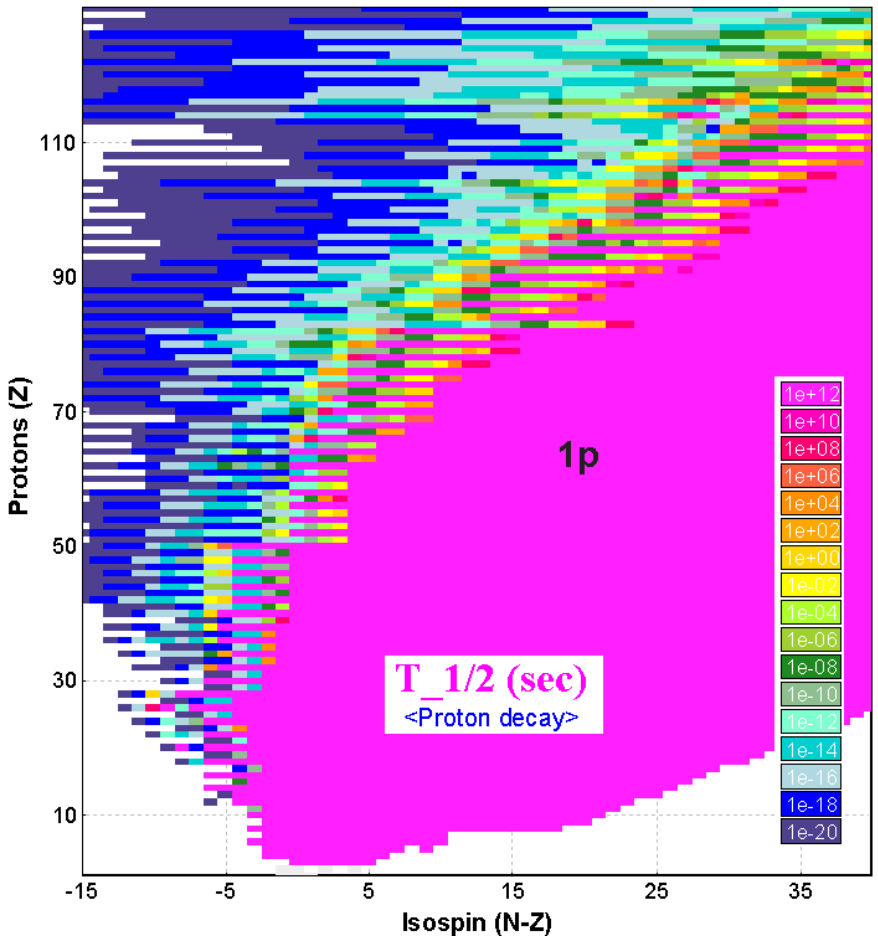


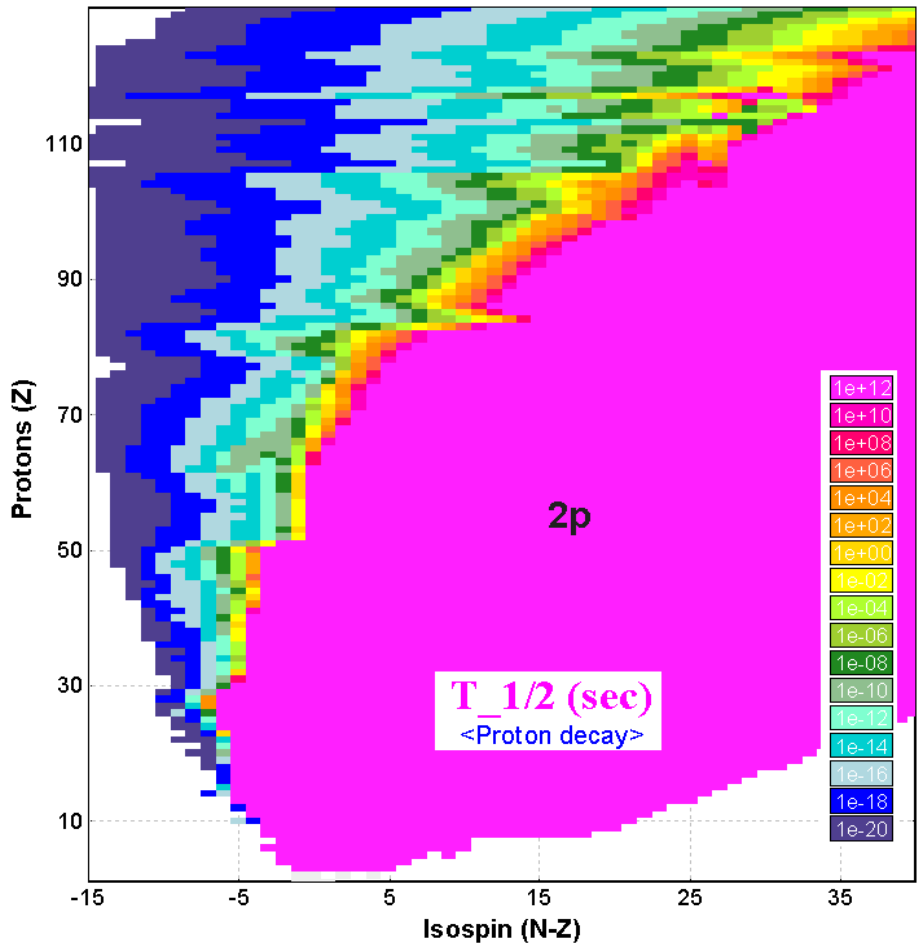
Proton decay : 1p & 2p cases

Masses from :
User's ME file [ktuy] + LDM#2

Use only 1p case

Use only 2p case



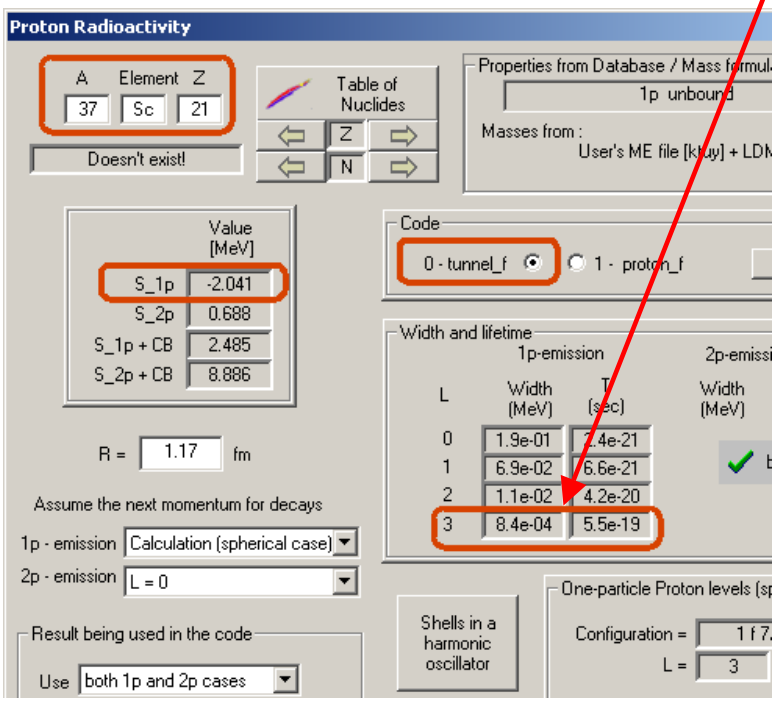


Codes (Courtesy of B.A.Brown)

Both codes have been transported to C++ and implemented in LISE++

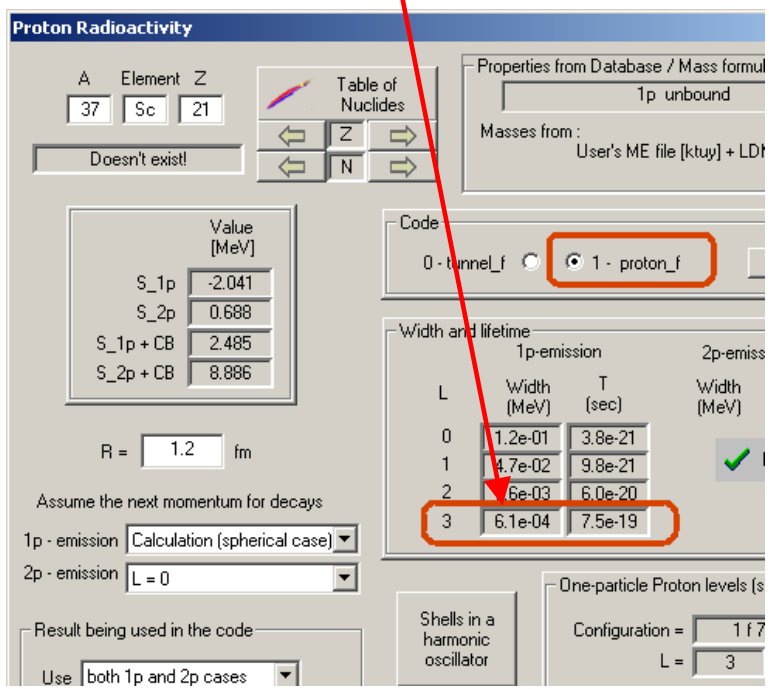
```
(tarasov@beryllium)~/buffer>./alex_v2
 Z1, Z2, A1, A2 --- ?
20 1 36 1
 LMAX --- ?
3
 R(fm),E(MeV)
1.17 2.041
  ETA, R, KR, RM, W =    2.183    5.033    1.558    0.973    2.518
 PENETRABILITY (0,1..)=     3.357E-02     1.270E-02     2.007E-03     1.557E-04
 TOTAL WIDTH   (0,1..)=     1.690E-01     6.395E-02     1.011E-02     7.840E-04
 R(fm),E(MeV)
```

v.8.3.138

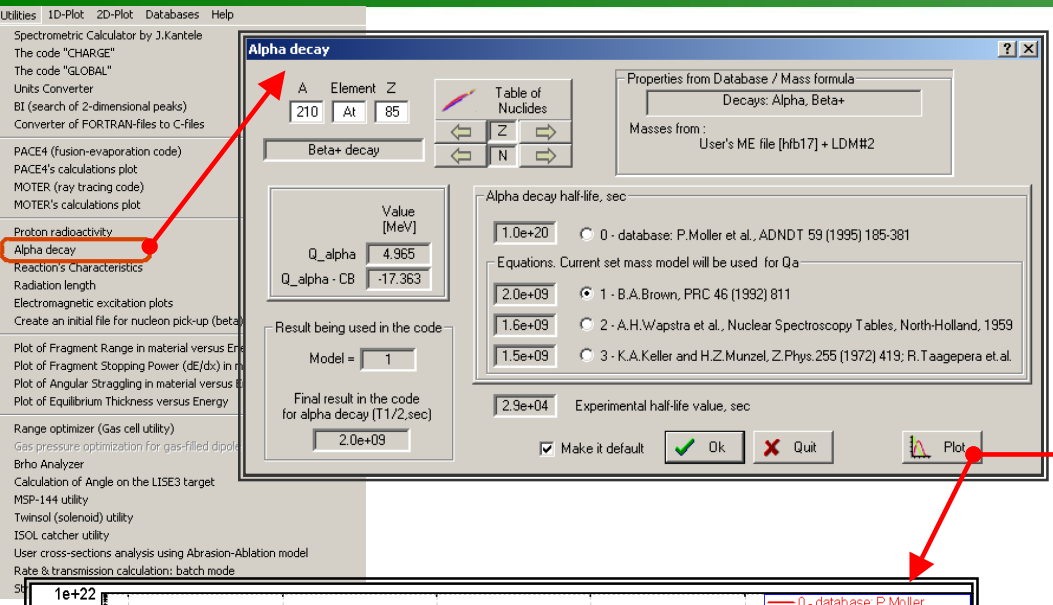



```
(tarasov@beryllium)~/buffer>./p_orig
 ------------------------------------------------------------------------
 Af,Zf (Ai+p = Af), Q value
37.,21.,2.041

ip Af   Zf    Rz    L   - Width -    - Tl/2 -
                        (MeV)        (sec)
1  37.0 21.0  1.200 0   0.1209E+00  0.3782E-20  0.4583E-02  0.9980E-19
2  37.0 21.0  1.200 0   0.6052E-06  0.7557E-15  0.2476E-12  0.1847E-08
1  37.0 21.0  1.200 1   0.4661E-01  0.9813E-20  0.6808E-03  0.6718E-18
2  37.0 21.0  1.200 1   0.3199E-06  0.1430E-14  0.6917E-13  0.6612E-08
1  37.0 21.0  1.200 2   0.7588E-02  0.6028E-19  0.1804E-04  0.2535E-16
2  37.0 21.0  1.200 2   0.9239E-07  0.4951E-14  0.5769E-14  0.7928E-07
1  37.0 21.0  1.200 3   0.6094E-03  0.7506E-18  0.1164E-06  0.3931E-14
2  37.0 21.0  1.200 3   0.1541E-07  0.2968E-13  0.1605E-15  0.2850E-05
1  37.0 21.0  1.200 4   0.2792E-04  0.1638E-16  0.2443E-09  0.1872E-11
2  37.0 21.0  1.200 4   0.1582E-08  0.2891E-12  0.1692E-17  0.2703E-03
1  37.0 21.0  1.200 5   0.8129E-06  0.5626E-15  0.2071E-12  0.2209E-08
2  37.0 21.0  1.200 5   0.1065E-09  0.4296E-11  0.7662E-20  0.5970E-01
 ------------------------------------------------------------------------
```



Alpha decay


Utilities 1D-Plot 2D-Plot Databases Help
Spectrometric Calculator by J.Kantele
The code "CHARGE"
The code "GLOBAL"
Units Converter
BI (search of 2-dimensional peaks)
Converter of FORTRAN-files to C-files
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Plot of Angular Straggling in material versus t
Plot of Equilibrium Thickness versus Energy
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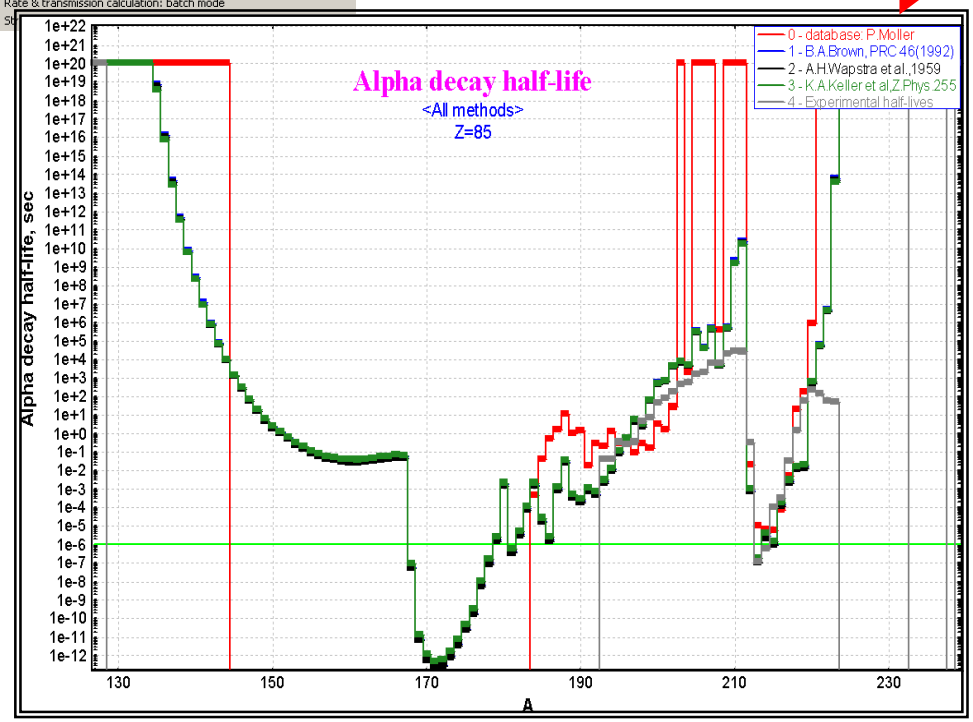
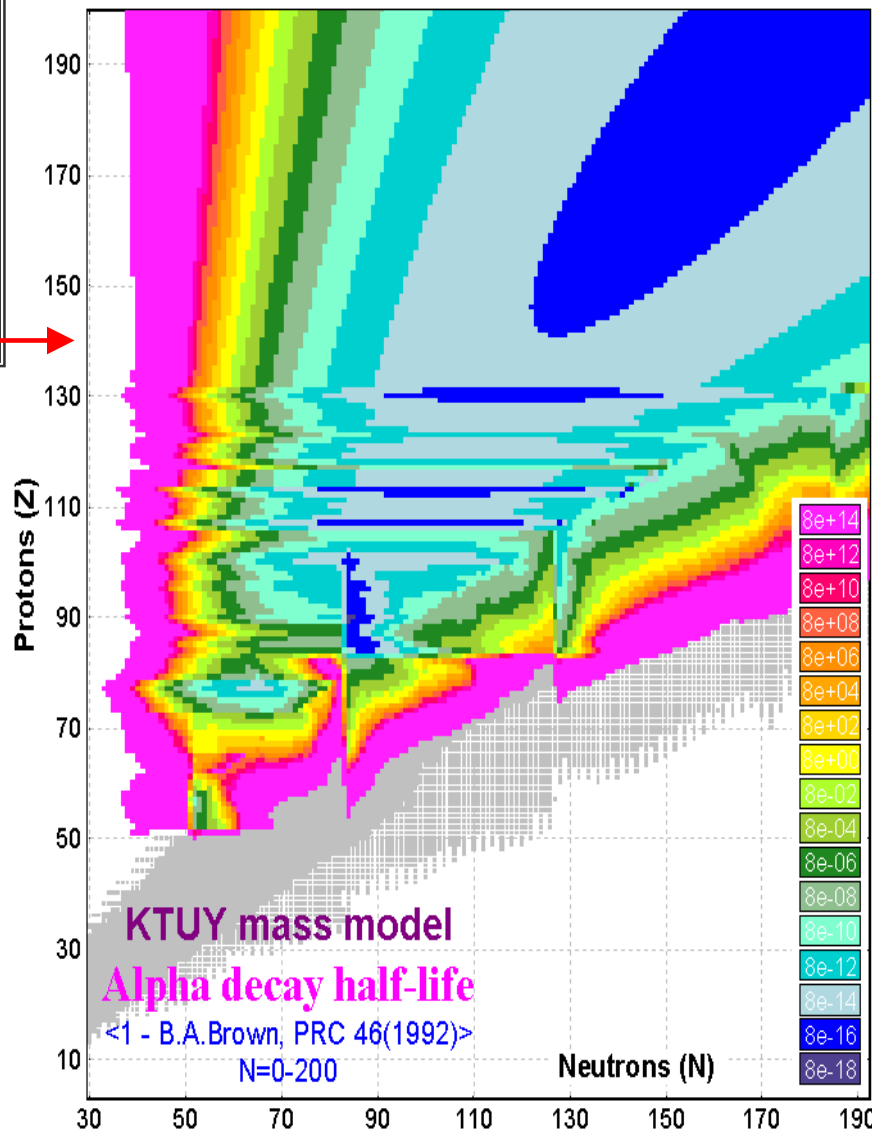
Gas pressure optimization for gas-filled dipole
Brho Analyzer
Calculation of Angle on the LISE3 target
MSP-144 utility
Twinsol (solenoid) utility
ISOL catcher utility
User cross-sections analysis using Abrasion-Ablation model
Rate & transmission calculation: batch mode
Alpha decay
A Element Z
210 At 85
Beta+ decay
Table of Nuclides
Z
N
Properties from Database / Mass formula
Decays: Alpha, Beta+
Masses from :
User's ME file [hfb17] + LDM#2
Value [MeV]
Q_alpha 4.965
Q_alpha - CB -17.363
Result being used in the code
Model = 1
Final result in the code for alpha decay (T1/2,sec)
2.0e+09
Alpha decay half-life, sec
1.0e+20 0 - database: P.Moller et al., ADNDT 59 (1995) 185-381
Equations. Current set mass model will be used for Qa
2.0e+09 1 - B.A.Brown, PRC 46 (1992) 811
1.6e+09 2 - A.H.Wapstra et al., Nuclear Spectroscopy Tables, North-Holland, 1959
1.5e+09 3 - K.A.Keller and H.Z.Munzel, Z.Phys.255 (1972) 419; R.Taagepera et.al.
2.9e+04 Experimental half-life value, sec
Make it default
Ok
Quit
Plot

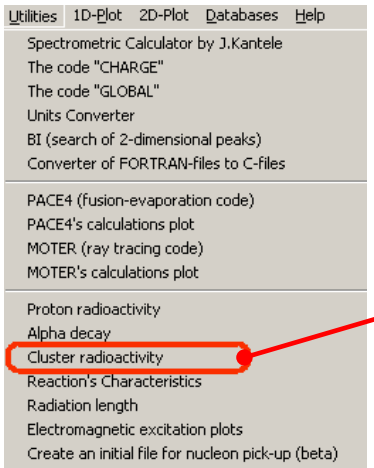

Alpha decay half-life
<All methods>
Z=85
0 - database: P.Moller
1 - B.A.Brown, PRC 46(1992)
2 - A.H.Wapstra et al.,1959
3 - K.A.Keller et al,Z.Phys.255
4 - Experimental half-lives
Alpha decay half-life, sec
A

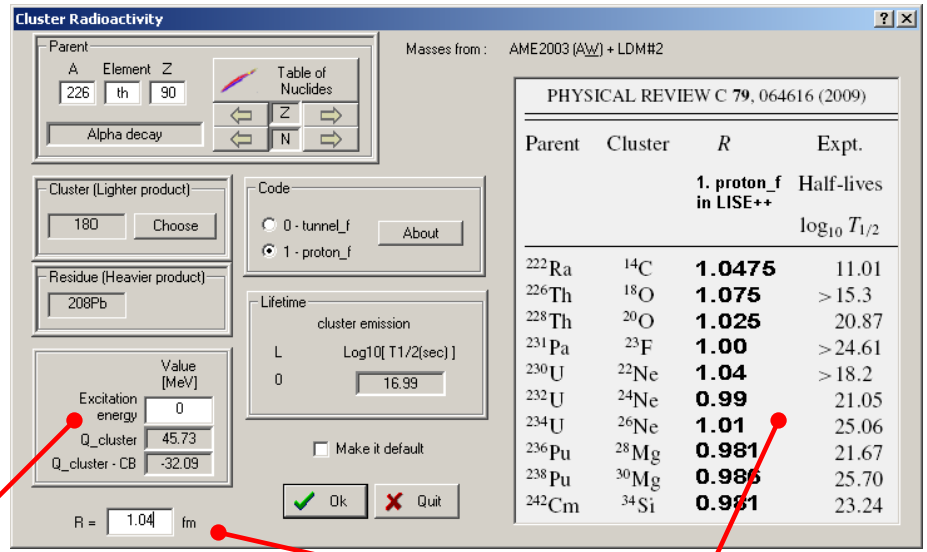

KTUY mass model
Alpha decay half-life
<1 - B.A.Brown, PRC 46(1992)>
N=0-200
Protons (Z)
Neutrons (N)

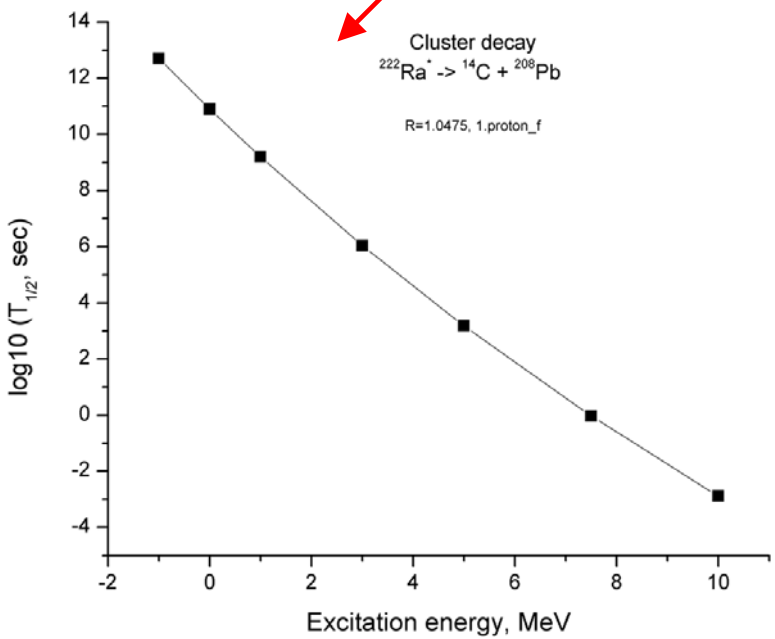
Cluster decay

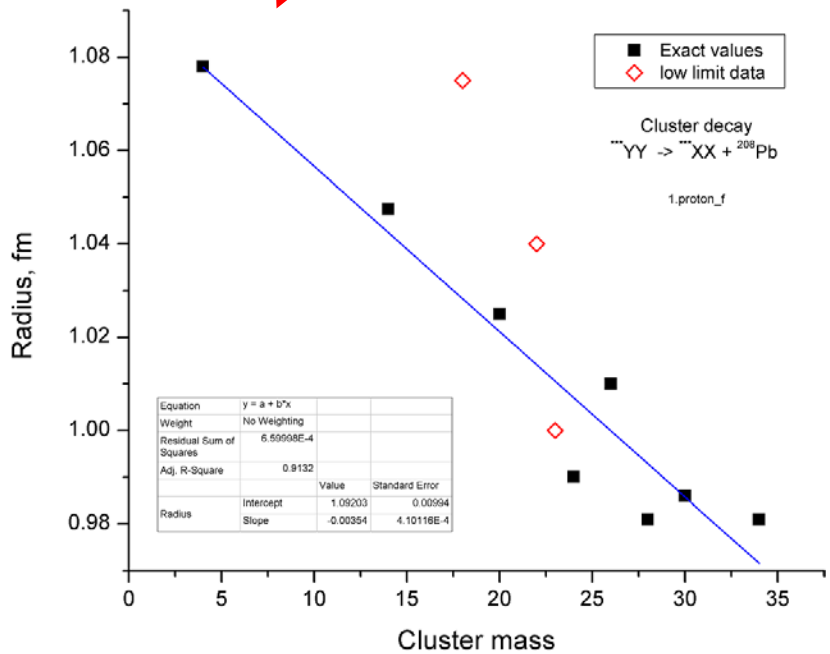
version 8.3.148

B.A.Brown's demand

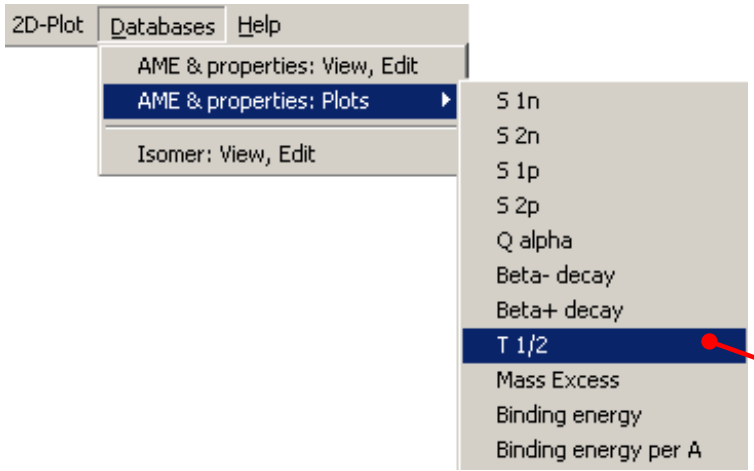


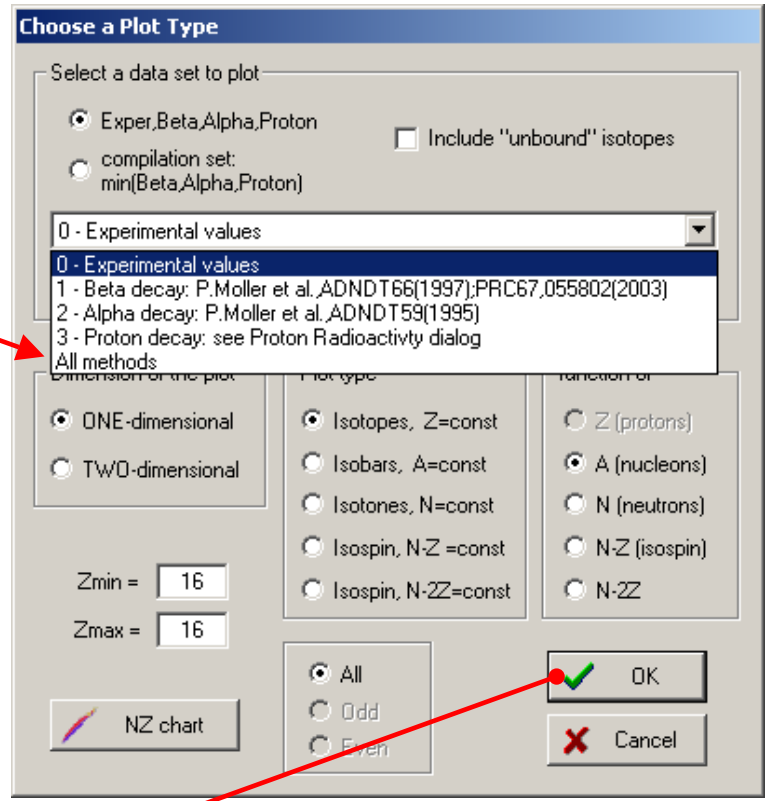


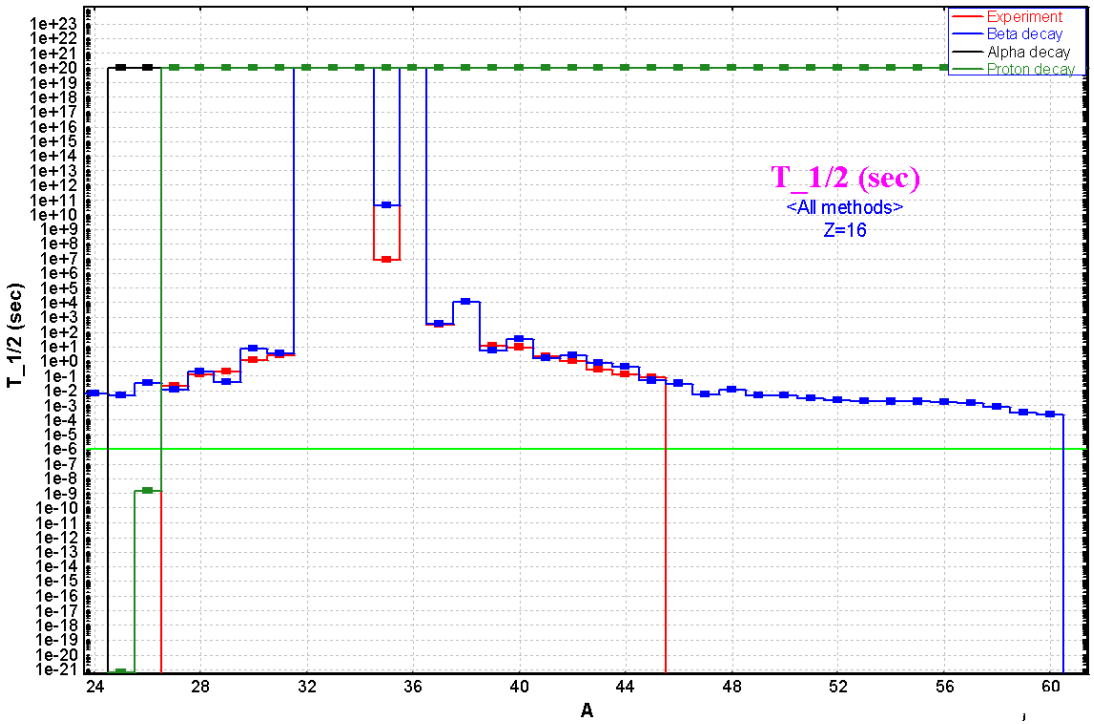




Half-lives plots





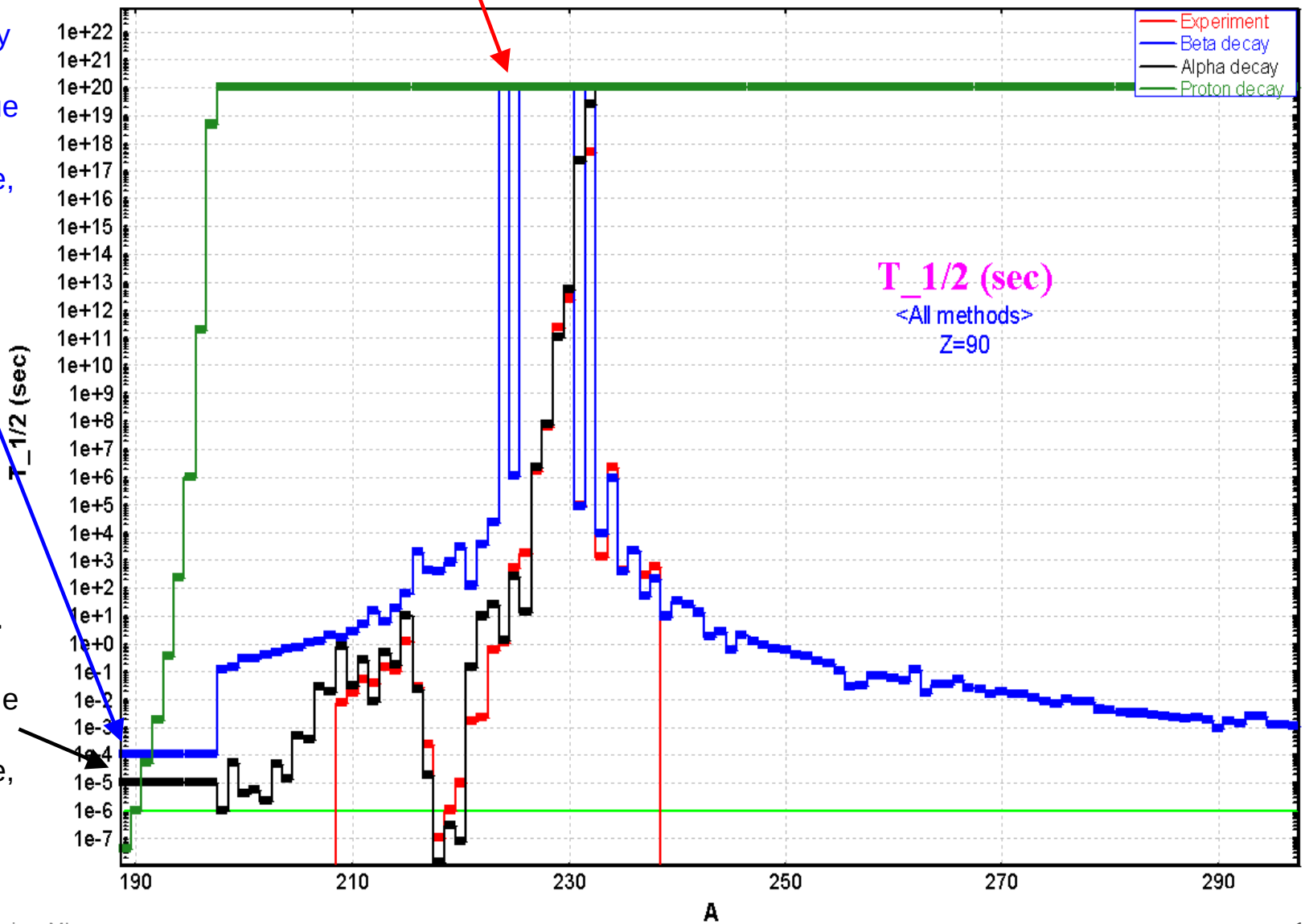


Half-lives plots : suggestions

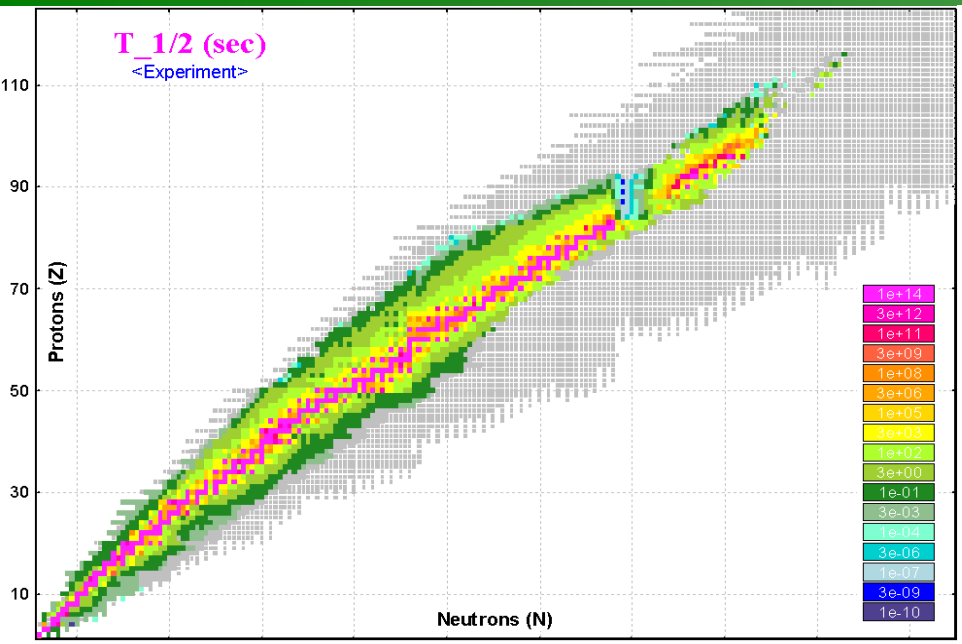
If T1/2 >1e20 sec , or isotope is stable then the code plots 1e20

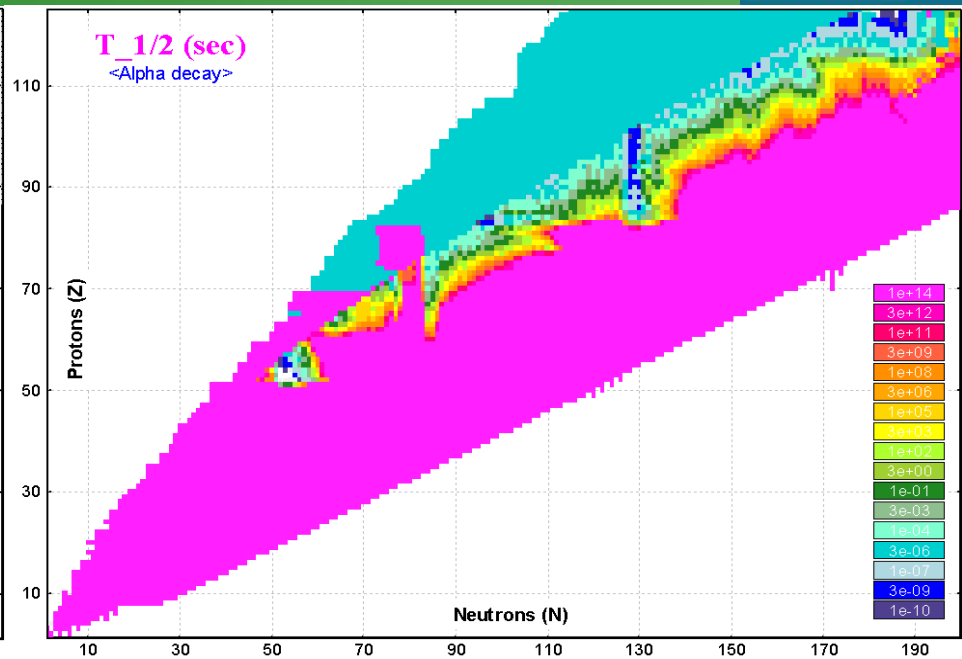
If beta-decay energy > 0, but T1/2 value is absent in the database, then value 1e-4 sec is used

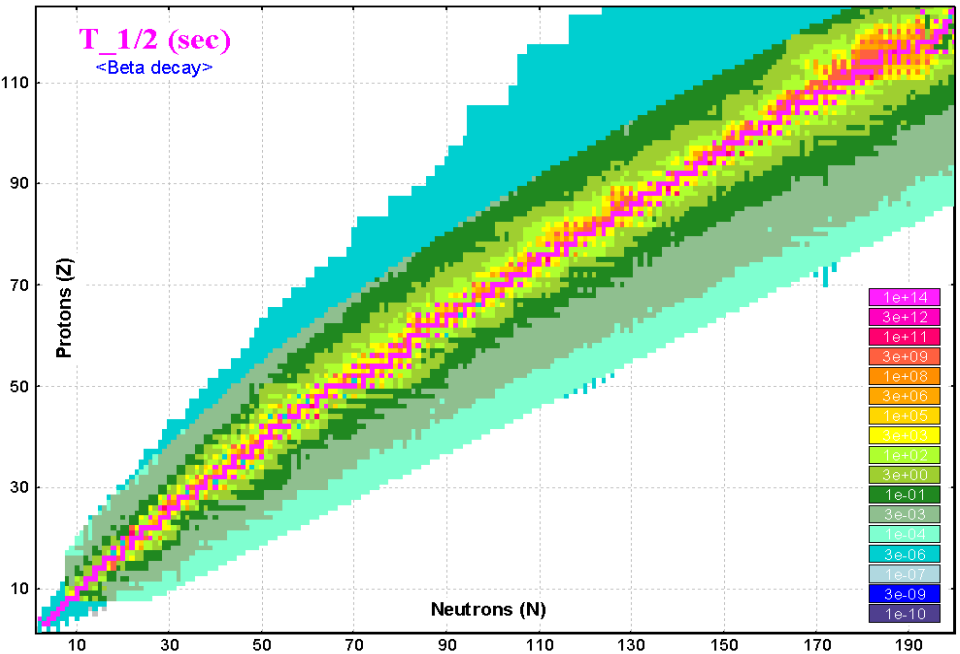
If Q-alpha > 6MeV, but T1/2 value is absent in the database, then value 1e-5 sec is used

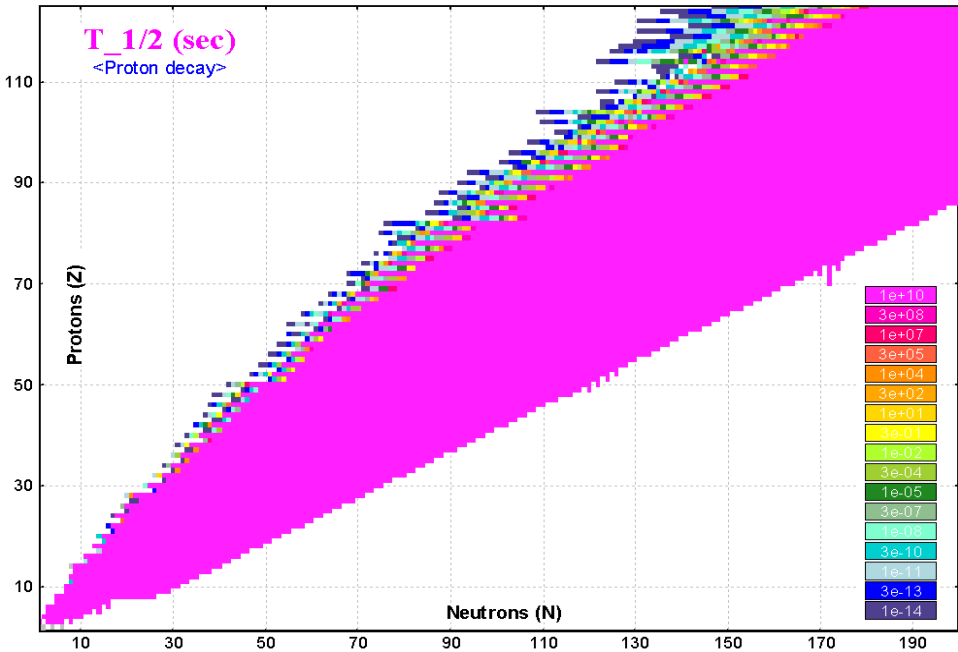


2D half-lives plots : decays

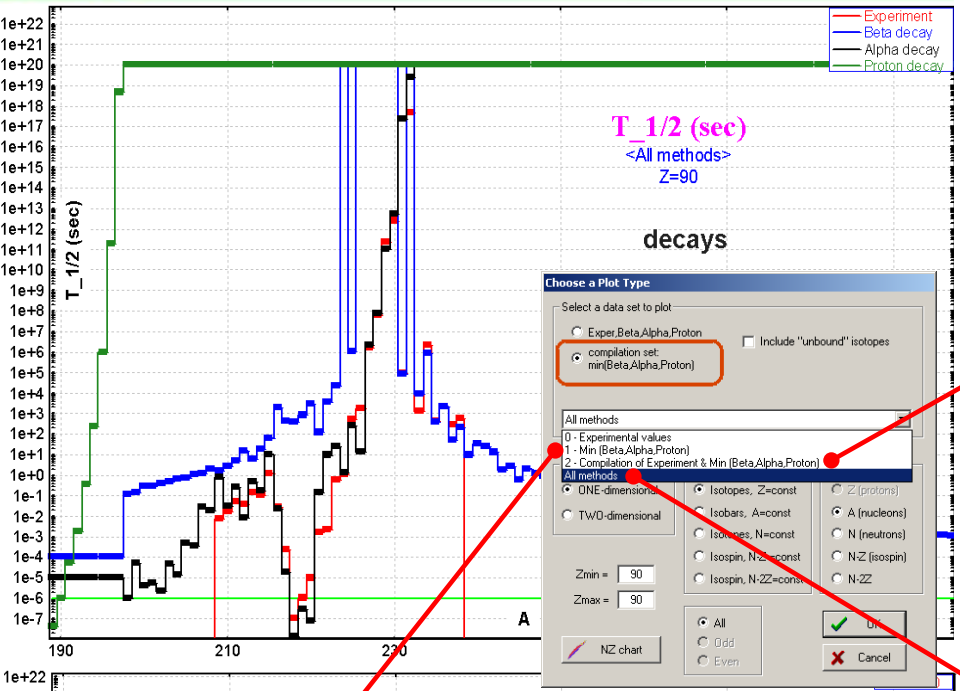


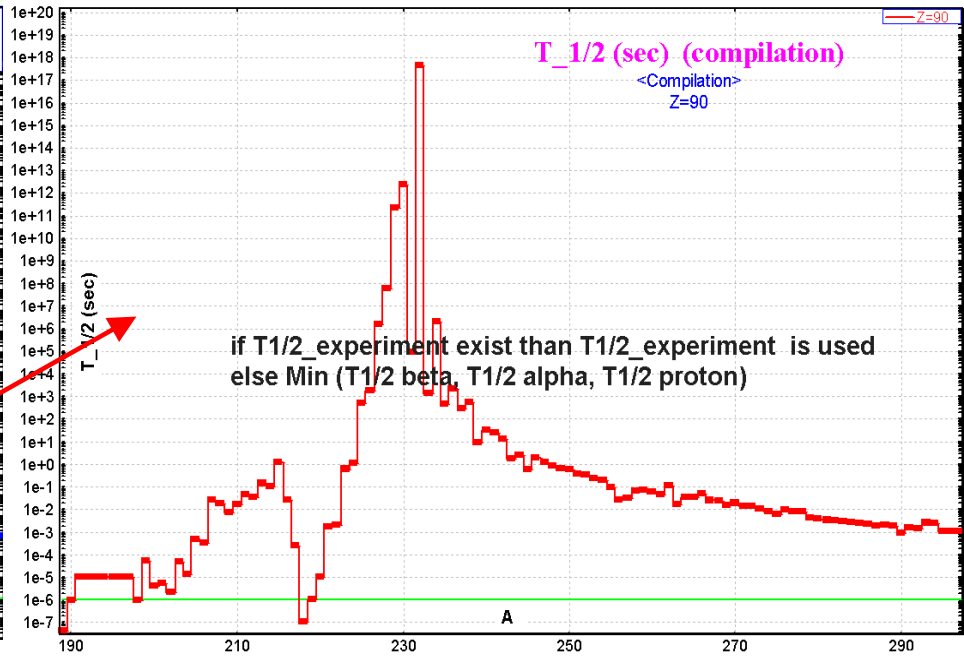


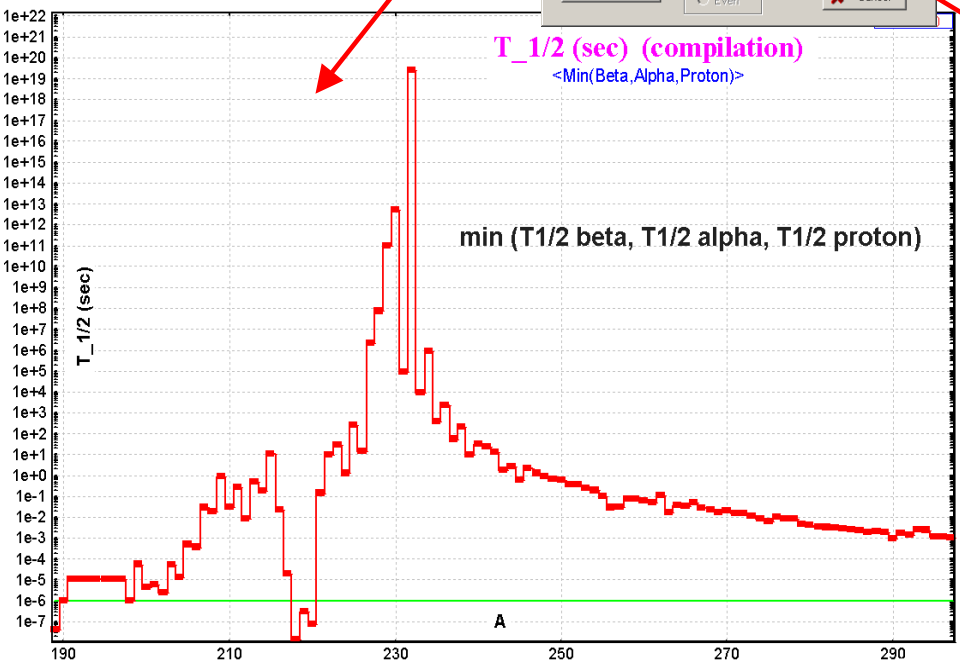


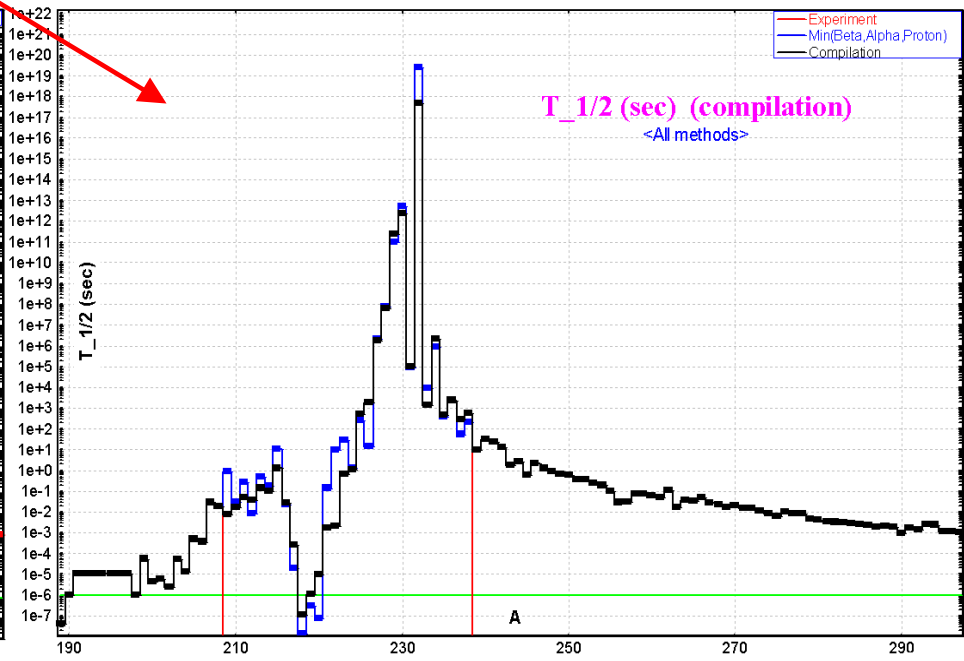


Half-life compilation

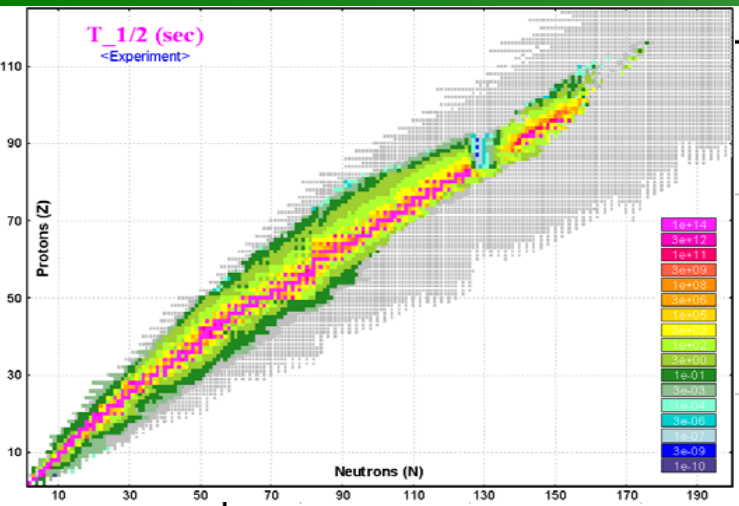








2D half-life compilation

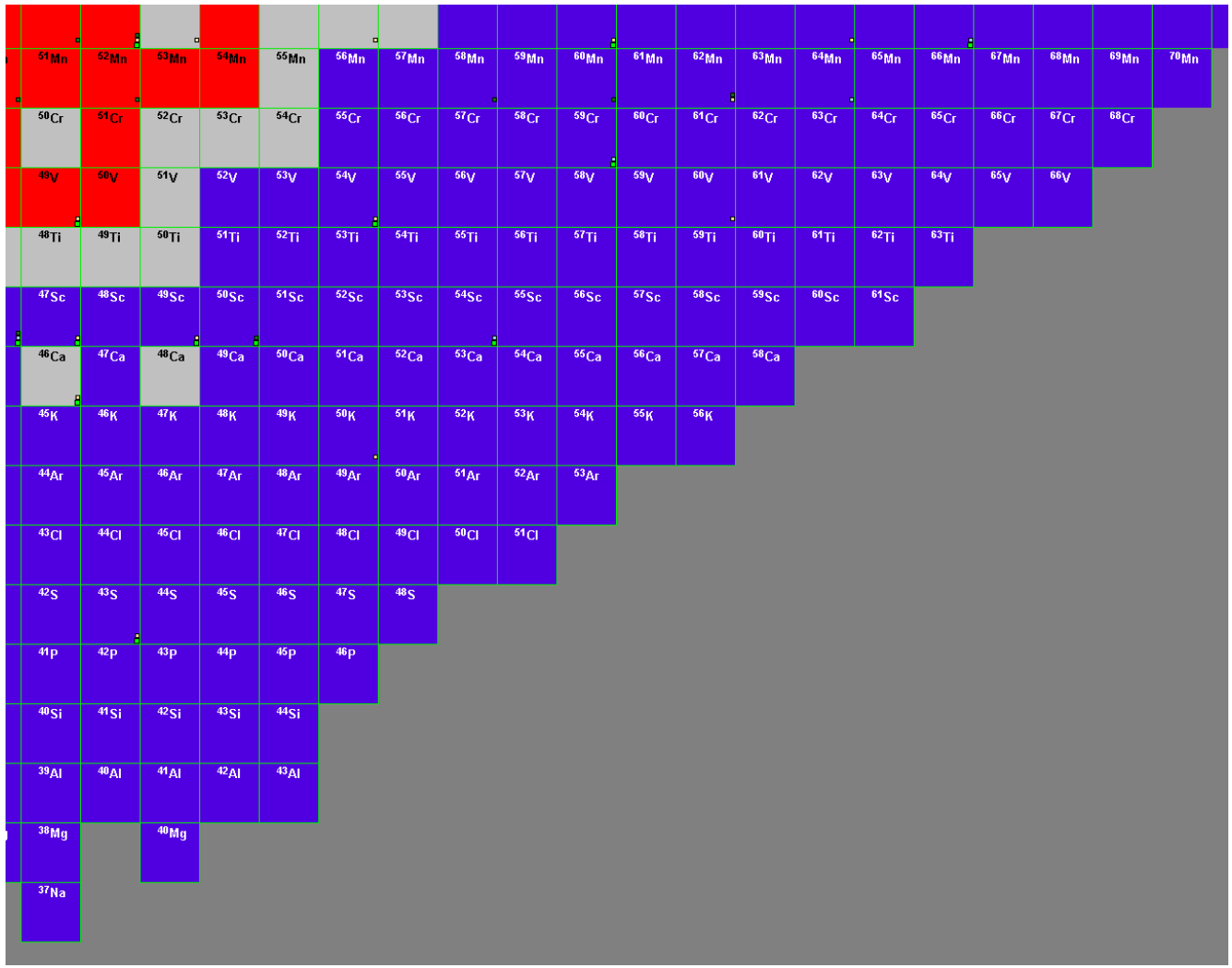


Total revision of decay modes and half-lives

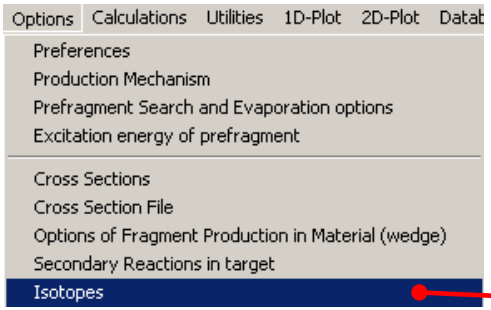
version 8.3.135

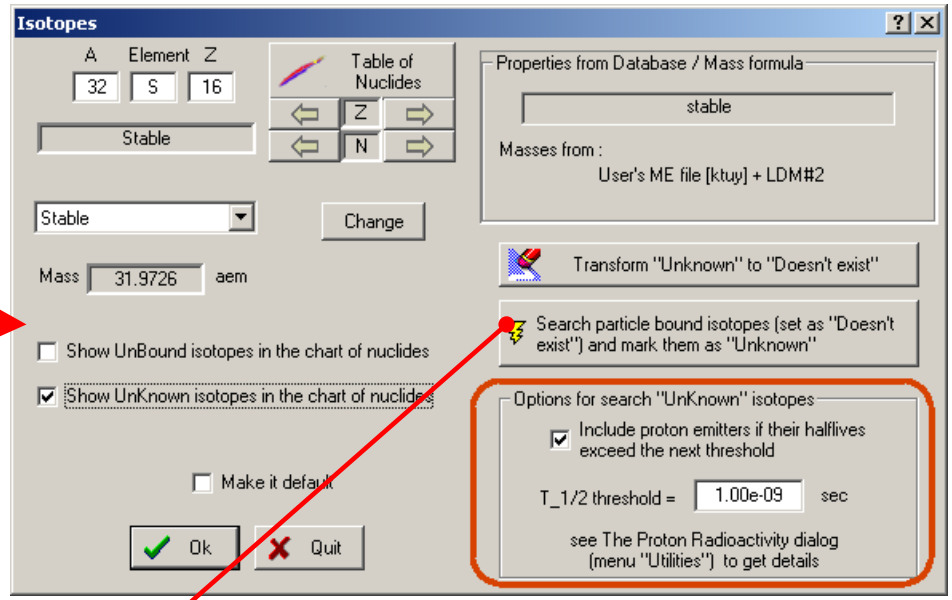
Based on AME2003 experimental half-lives have been updated.

Decay modes have been revised for the table of nuclides, As well as for Observed / Non-observed case

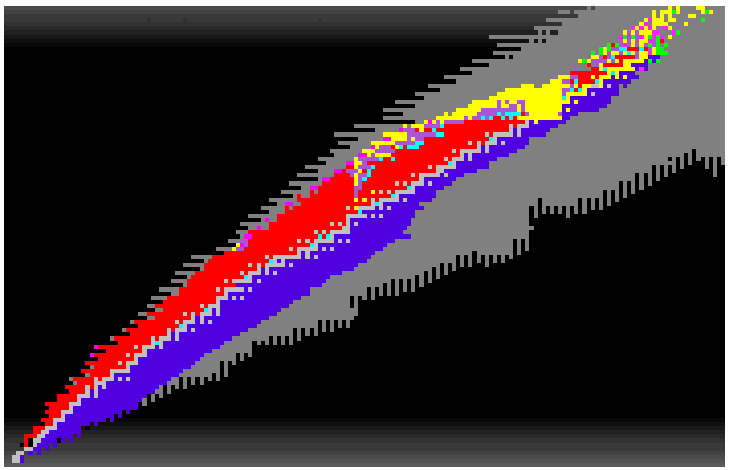


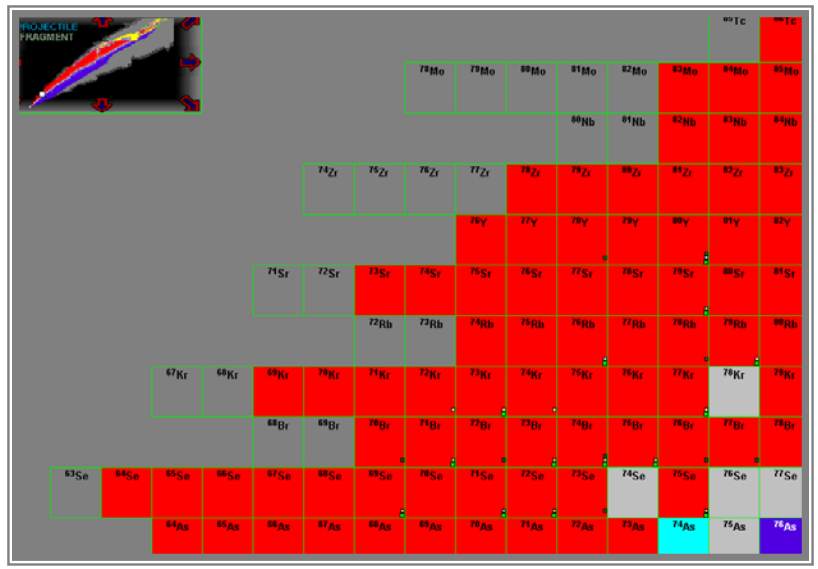
“Isotopes” dialog. New option: Proton emitters search



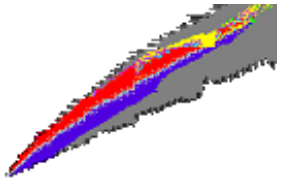


Unknown isotopes in the Table of nuclides for version 8.3.138 have been generated with the KTUY mass model including proton emitters (threshold > 1ns)





Acknowledgement



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