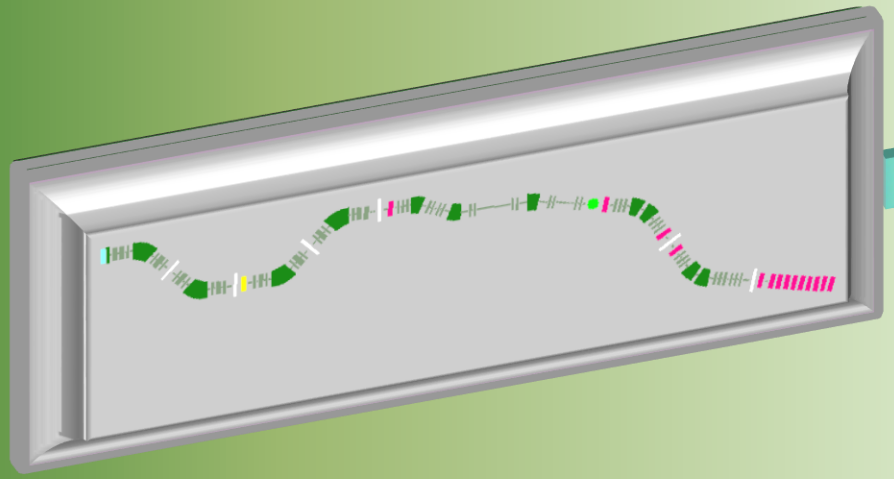
Oleg B. Tarasov
NCSL / MSU, USA

Application of modern methods and reaction models for simulation of rare ion beam production

October 2017

Dubna State University
Dubna State University

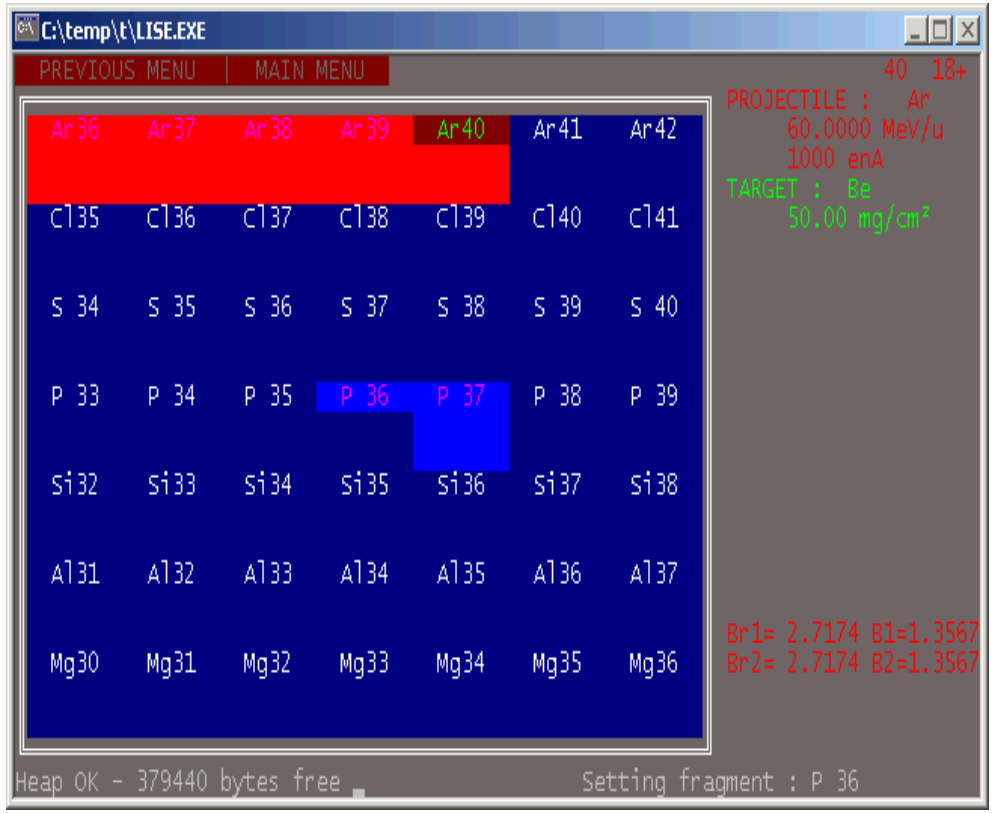


LISE++

LISE++

1. Introduction to production of radioactive ion beams
2. Production Area
3. Separation
4. Identification
5. Production of new isotopes
6. LISE++ : Utilities
7. Radioactive beam physicist task

Already 30 years…



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[..]		<DIR>
[FILES]		<DIR>
[ISOTOP]		<DIR>
[RANGE]		<DIR>
[RESULTS]		<DIR>
EGAVGA	BGI	5,363
LISE	EXE	383,909
LISE	MAN	64,227
READ	ME	3,684

Almost 593 kBytes

GANIL
GRAND ACCELERATEUR NATIONAL D'IONS LOURDS

LISE REFERENCE MANUAL

Version 2.2 - June 8, 1992 ….

LISE is a DOS-based software running on any IBM compatible PC. It runs under DOS 3.1 and following versions, and only needs 640 kbytes of memory. The speed of the program depends greatly on the CPU type, speed and configuration. The use of a co-processor is greatly recommended: the program uses FFT (Fast Fourier Transform) algorithms which contain extensive floating-point operations.The last version has been developed on a 386-SX at 16 MHz with a *co-processor* which provides a *reasonable speed* (about 1 second per transmission calculation).

In 1998 the MS-DOS version with 14 C++ files and less than *10 000* lines of code,

and grew on MS Windows today to 615 files, about *400 000* lines, and size of ~69 MB after Installation.

Already 30 years…

1994-1997
O.T.,
GANIL/Dubna
v.2.3 – 2.9

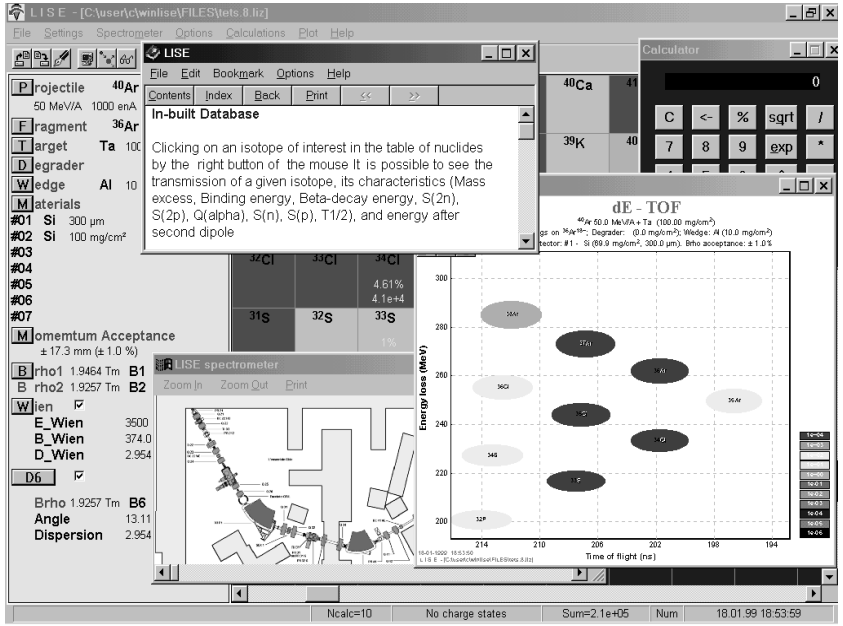
Corrections, Modifications, Development
(compound target, compensating dipole)

1998
O.T.,
GANIL/Dubna
v.3.1

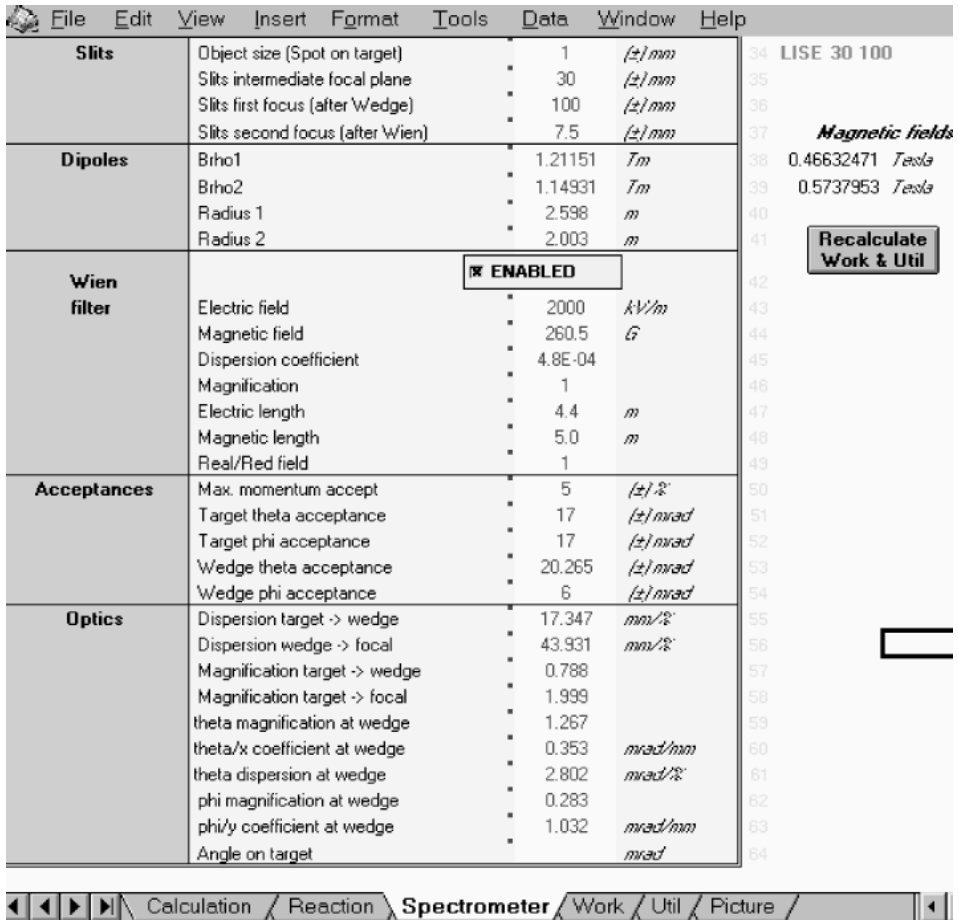
LISE operates under MS Windows

1999-2000
O.T., GANIL
v.3.2-4.9

Active development of the LISE code
stimulated by M.Lewitowicz



LISE for Excel.
It includes even transmission calculations.



Already 30 years…

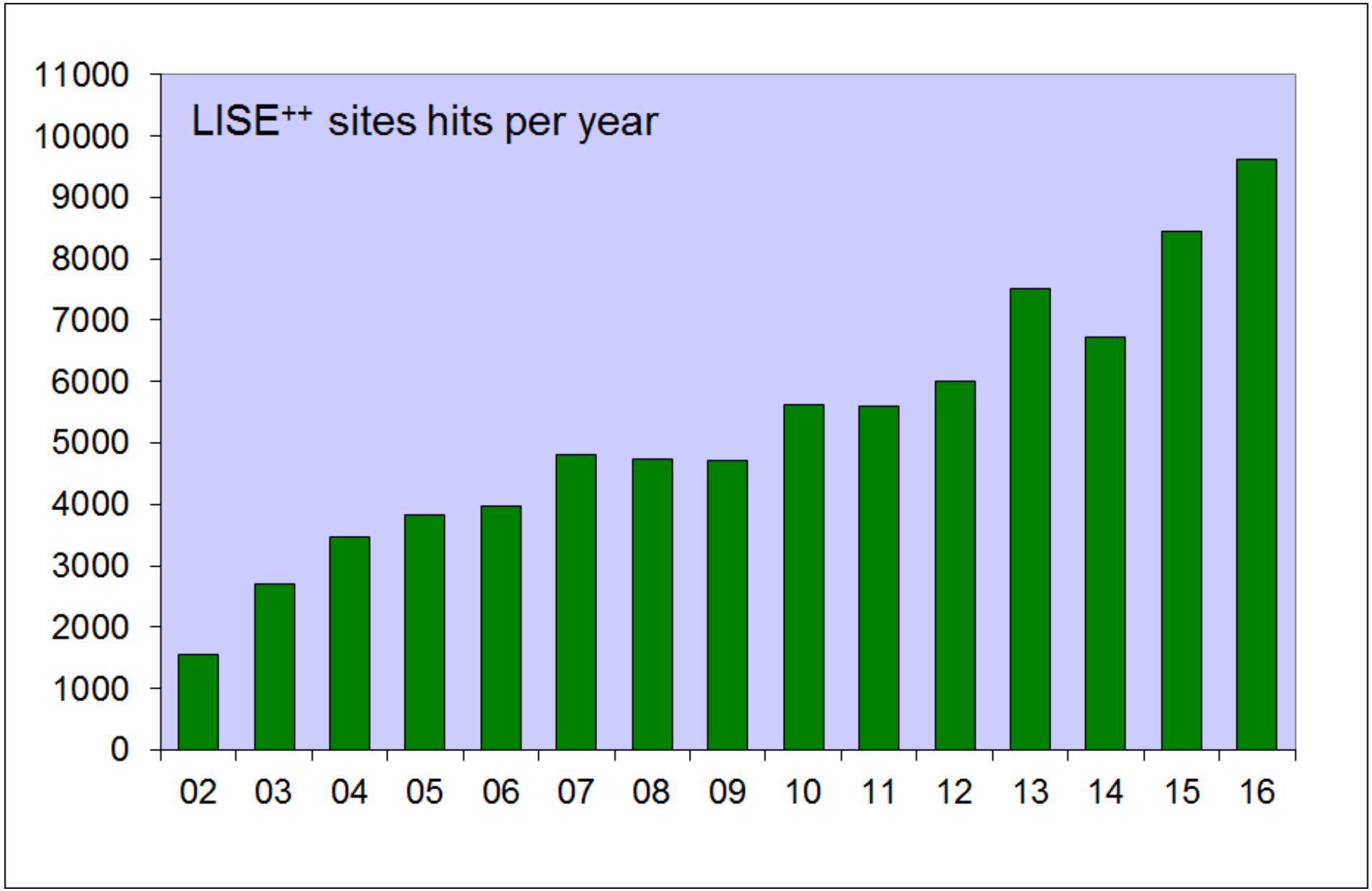
2001 NSCL / MSU v.4.10 –5.12	Active development of the LISE code stimulated by B.Sherrill. Abrasion-Ablation model construction, ATIMA implementation	1) D.Bazin, O.Tarasov, M.Lewitowicz, O.Sorlin, NIM A 482 (2002) 314.
2002 NSCL / MSU v.5.13 –5.15	First references [1,2] since 16 years! Fusion residues transmission [3]. PACE4 implementation.	2) O.Tarasov, D.Bazin, M.Lewitowicz, O.Sorlin, NP A 701 (2002) 661. 3) O.Tarasov and D.Bazin, NIM B 204 (2003) 174.
2003 NSCL / MSU v.6	LISE^{++} [4,5] is the new generation of the LISE code, which allows the creation of a spectrometer through the use of different “blocks”.	4) O.T., Preprint NSCL MSU, MSUCL-1248, 45 pages 5) O.Tarasov and D.Bazin, Nuclear Physics A746 (2004) 411-414
2004 NSCL / MSU v.7.1	Convolution Model of Proj.Frag. momentum distributions [6] Implementation of codes Charge and Global Coulomb Fission [7,8]	6) O.T., Nuclear Physics A734 (2004) 536-540 7) O.T., Preprint NSCL MSU, MSUCL-1299, 2005, 64 pages 8) O.T., EPJ A25 (2005) 751
2005 NSCL / MSU v.7.5	RF separation system, Isomers Abrasion – Fission [9]	9) O.T. Preprint NSCL MSU, MSUCL-1300, 2005, 131 pages
2006 NSCL / MSU v.7.9	Fusion – Fission [10]	10) O.B.Tarasov, and A.C.C.Villari, NIM B 266 (2008) 4670-4673
2007 NSCL / MSU v.8.0	Monte Carlo calculation of fragment transmission, Fragment production in material [11]	11) O.B.Tarasov, and D.Bazin, NIM B 266 (2008) 4657-4664

Already 30 years…

2008 v.8.4	MC : Use of High order optics MOTER code development, new blocks “Solenoid”, “Delay block”, Bunch of new utilities
2010 v.9.1	Working on 64-bit Windows OS, MC : Extended configurations
2012 v.9.3	MC : Optics calculation up to second order inside LISE^{++}, Utilities to develop and modify extended configurations “DF4 distribution” class : Important updates of analytical transmission calculations
03.2013 v.9.5	Physics (^{76}Ge,^{82}Se): EPAX3, Probability for compound nucleus formation, Abrasion-Ablation update, Momentum Distributions, Initial prefragment analysis; Optics: New block "RF-buncher"
11.2013 v.9.7	Physics: User Differential Cross Sections for Two body reactions; MC: new fields, gates optimization, input & output rate files Optics: New blocks “Shift“, “E-quad”, “E-dipole”;
01.2015 v.9.9	Optics: S & E blocks, revision of “Compensating dipole” block, Quadrupole & Sextupole superposition, TRANSPORT code file Import, Active construction of new extended configurations («BigRIPS»,«SHELS»,«MSP144+Q2»,«PRISMA» ,«MARS» …)
2015	Brief report of LISE^{++} status [12] *LISE^{++} porting process started!!* [13,14]
09.2016 v.9.10.345	Physics: Update of Fusion reaction mechanism, Radiation Residue Calculator, ETACHA4, Ionization energy database Optics: Beam Optics Optimization (incl. 2nd order), Reverse configuration technique, active construction of new configurations

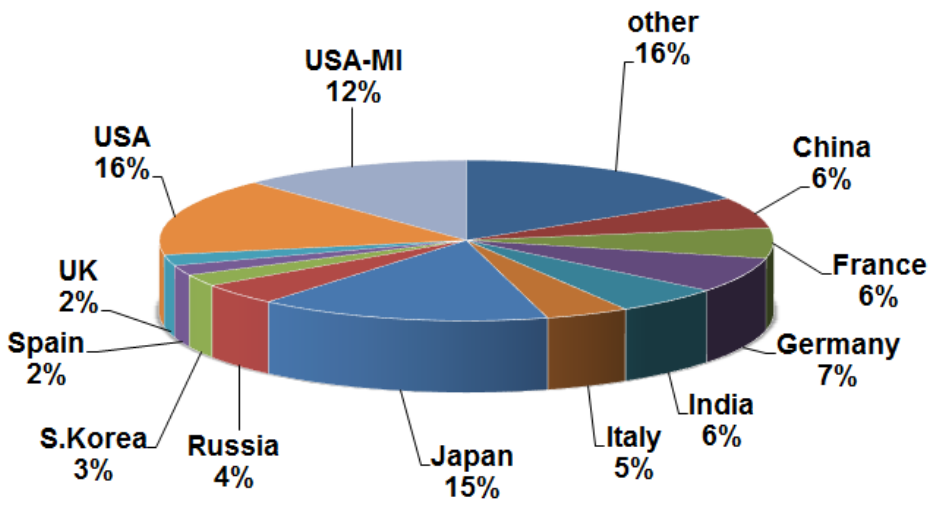
12) O.Tarasov and D.Bazin, NIM B 376 (2016) 185.
13) M.P.Kuchera, O.B.Tarasov, D.Bazin, B.Sherril, K.V.Tarasova, Journal of Physics: 664 (2015) 072029
14) M.P.Kuchera, O.B.Tarasov, D.Bazin, B.Sherril, K.V.Tarasova, NIM B 376 (2016) 168

LISE++ site statistics

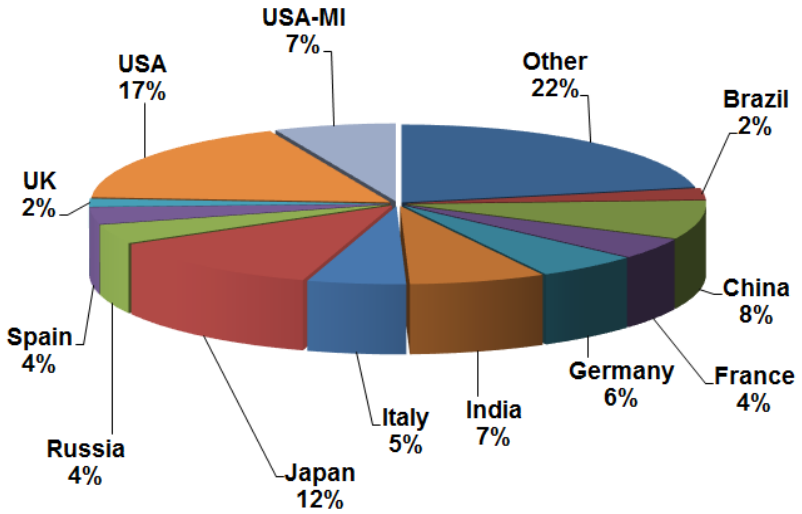


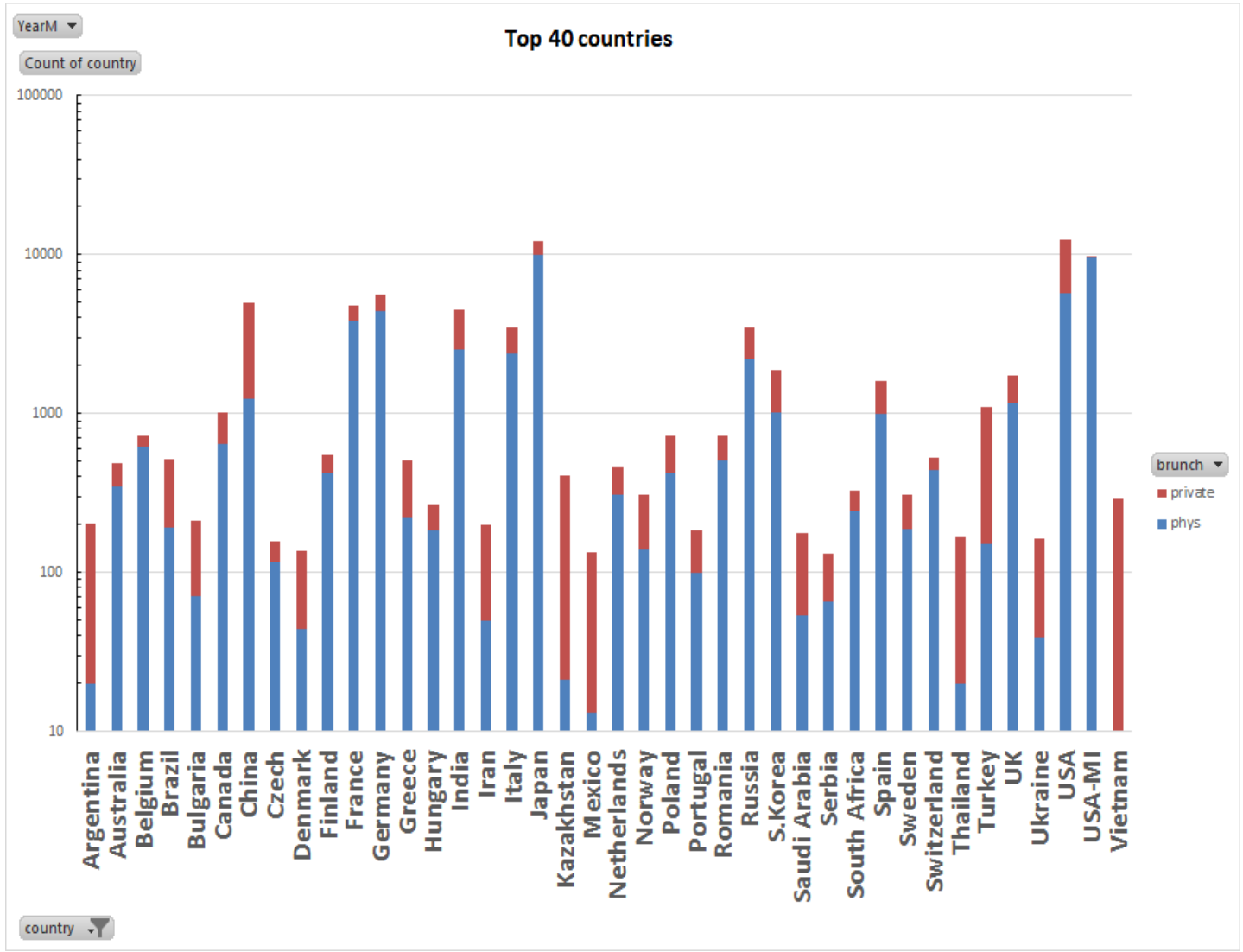
By countries total

The LISE^{++} code geography

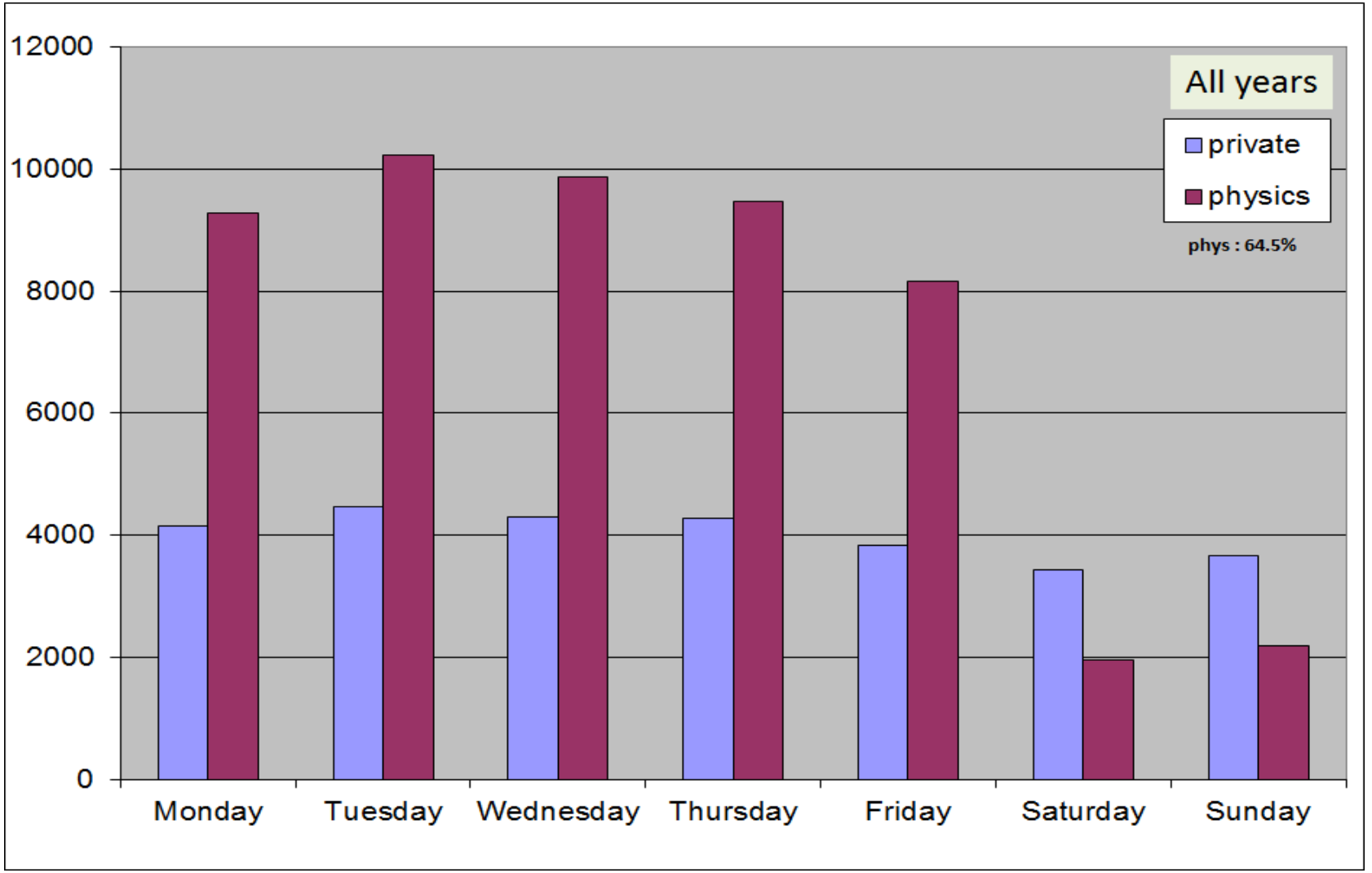


The LISE^{++} code geography (last 2016 year)

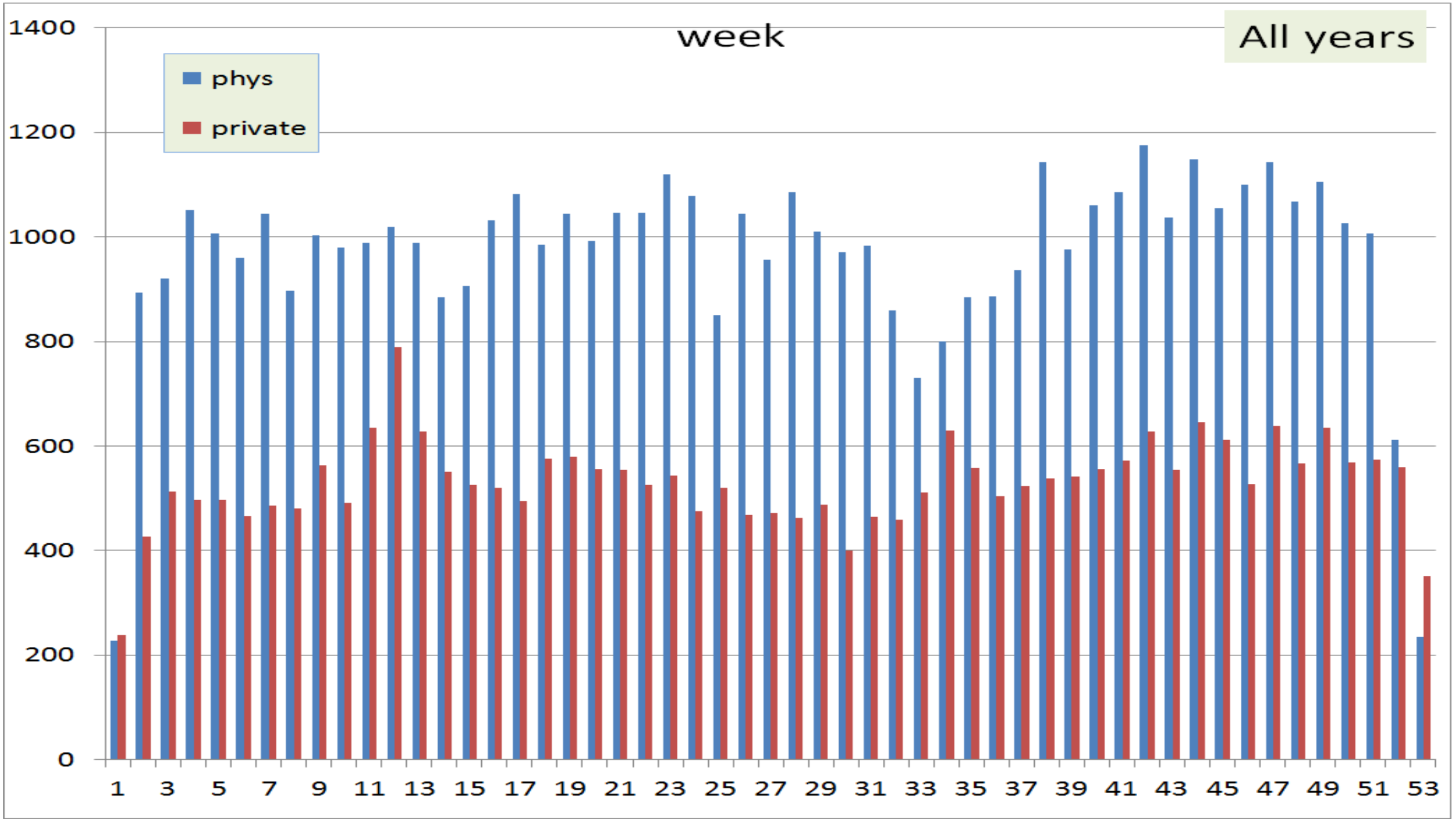




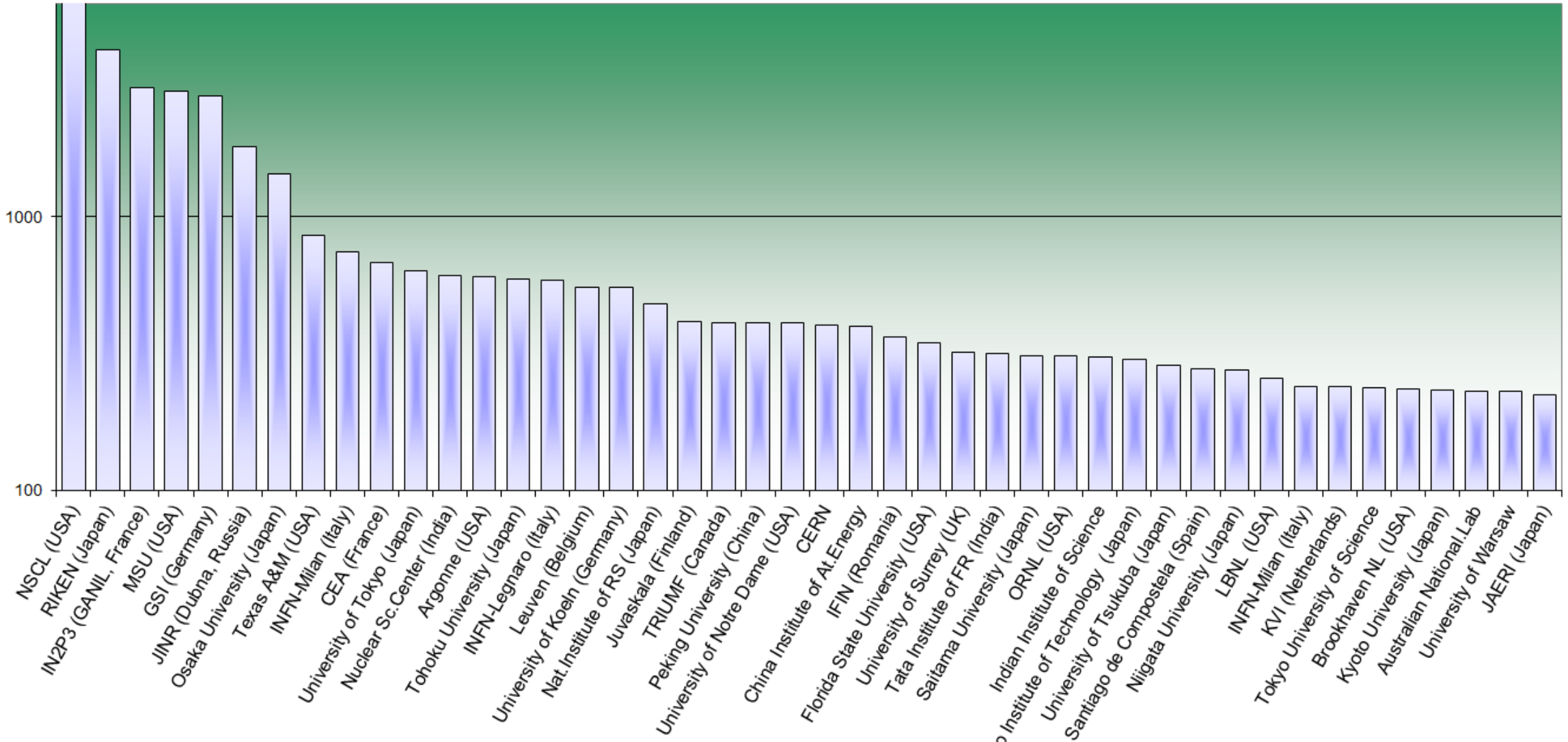
Weekday


12000
10000
8000
6000
4000
2000
0
All years
private
physics
phys : 64.5%
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

Week


week
All years
phys
private
1400
1200
1000
800
600
400
200
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53

Laboratories (absolute values) : 2016



6. LISE++ : Utilities

http://lise.nscl.msu.edu/util.html

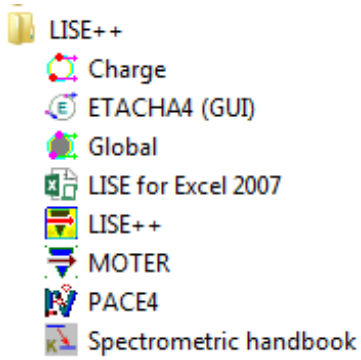
6. LISE^{++} : Utilities

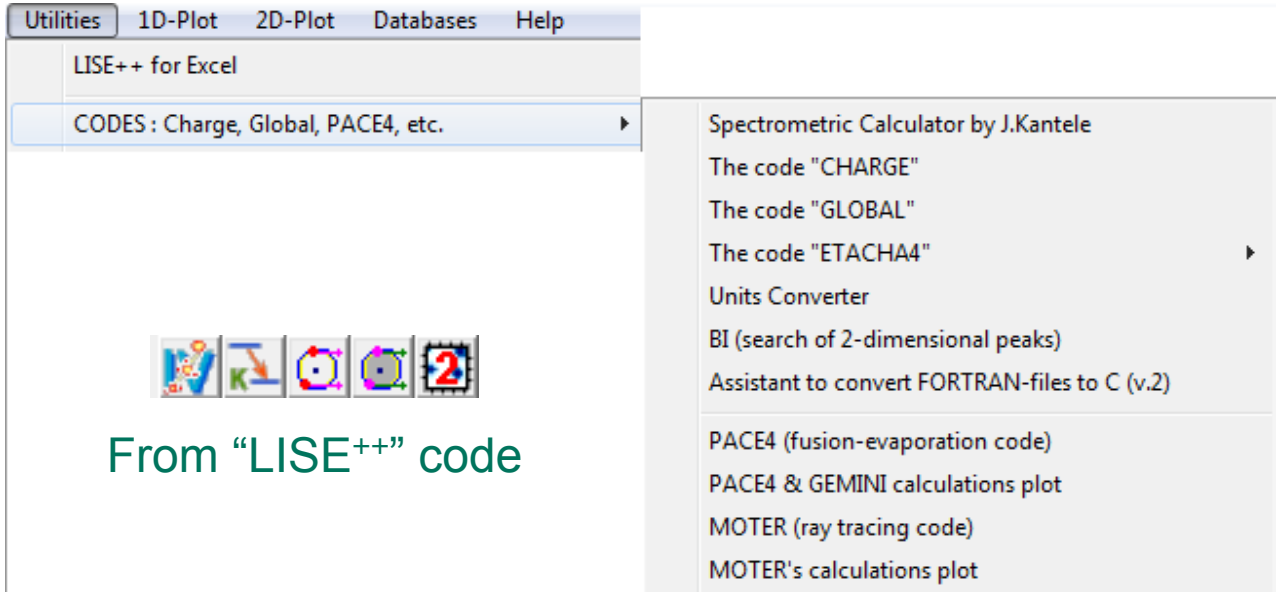
- **Implemented codes**
  PACE4, Global, Charge, Moter, ETACHA, Gemini++ …
- **General purpose utilities**
  LISE for Excel, Nuclide Database plots…
- **Built-in Calculators**
  Physical, Kinematic, Evaporation, Radiation Residues…
- **Specific block utilities**
  Twinsol, Brho-Erho analyzer, ISOL-catcher …
- **Production mechanism utilities**
  Radioactivity utilities, Lab-CM Dif.CS converter …
- **Optimizers**
  Target thickness, Target-Wedge optimizer,
  RF-buncher, RF-kicker…

Implemented and updated codes

- PACE4 – evaporation MC code for Windows
- The spectrometric handbook of J.Kantele
- Units converter
- Code “Global” (charge state distributions)
- Code “Charge” (charge state distributions)
- “MOTER” ray-tracing code with optimization capabilities
- ETACHA
- GEMINI++ (Qt-version)

From “LISE++” folder

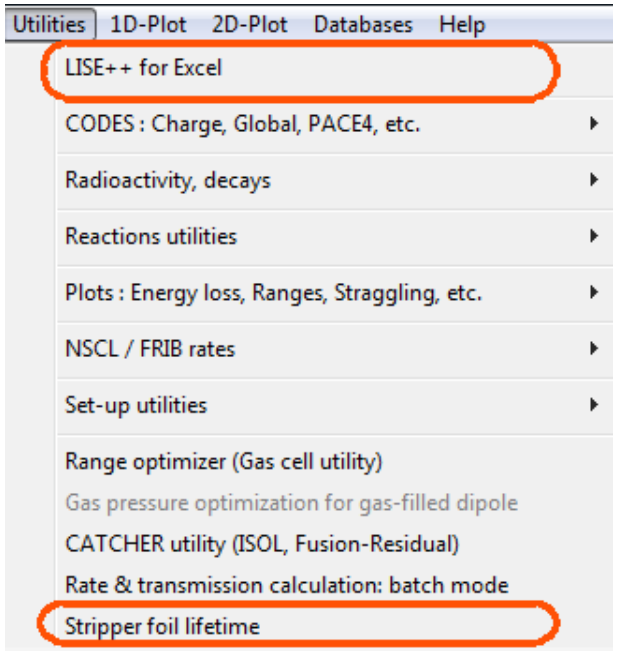


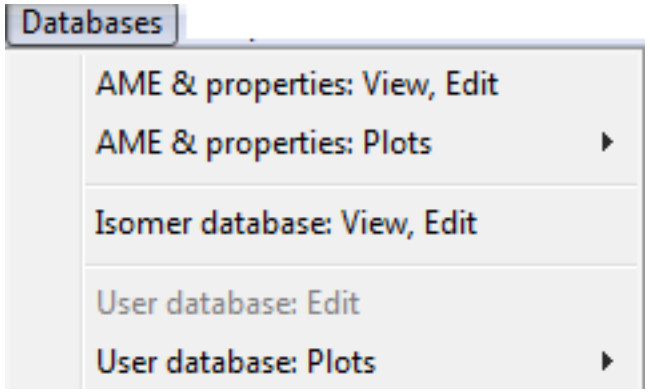


From “LISE++” code

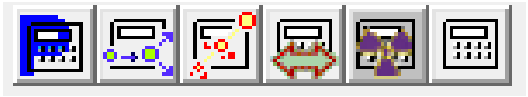
General purpose Utilities

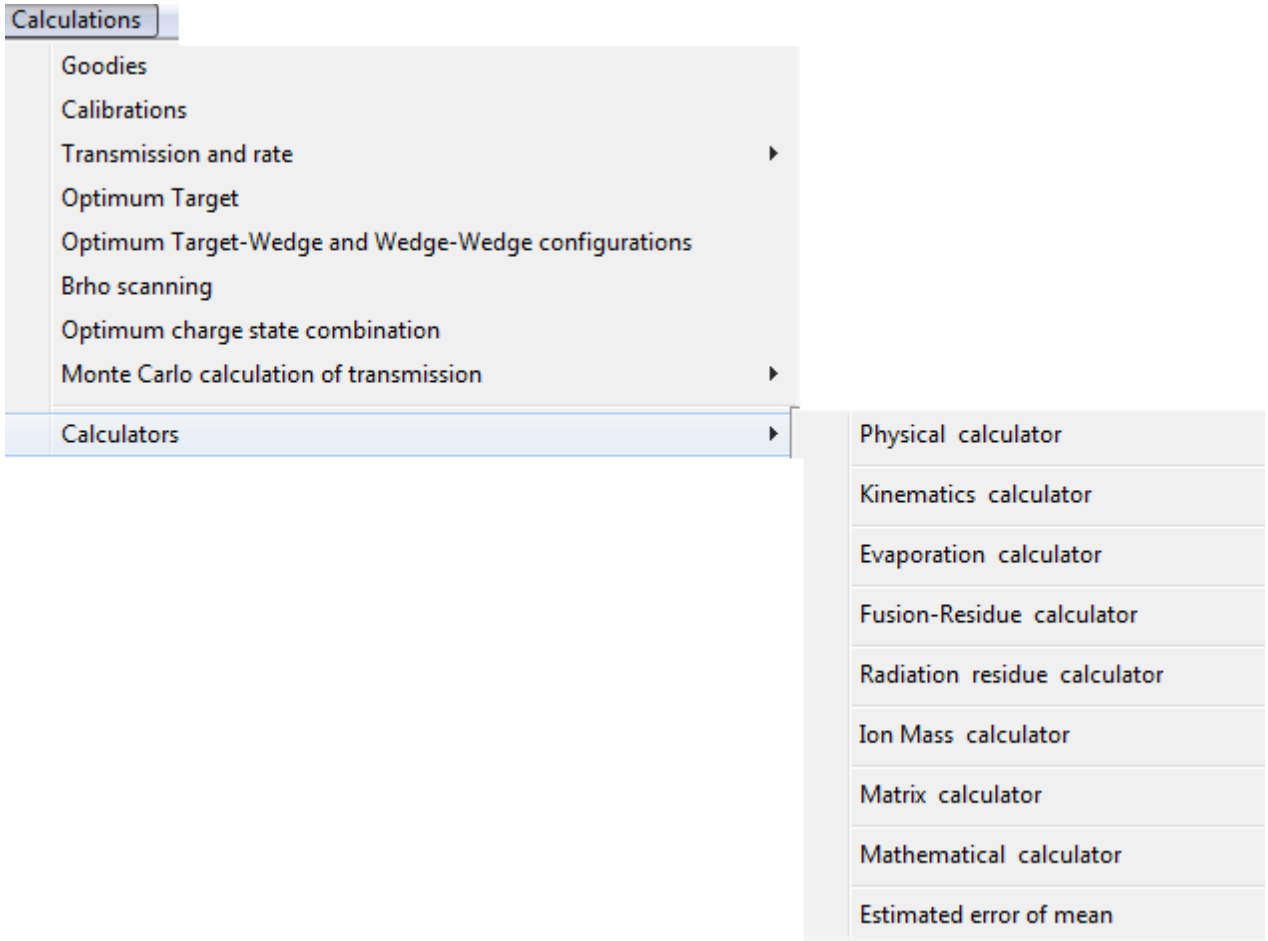
- LISE^{++} for Excel
- Nuclide and Isomeric states Databases utilities
- Stripping foil lifetime
- Automatic search of two-dimensional peaks in experimental spectra





Built-in Calculators

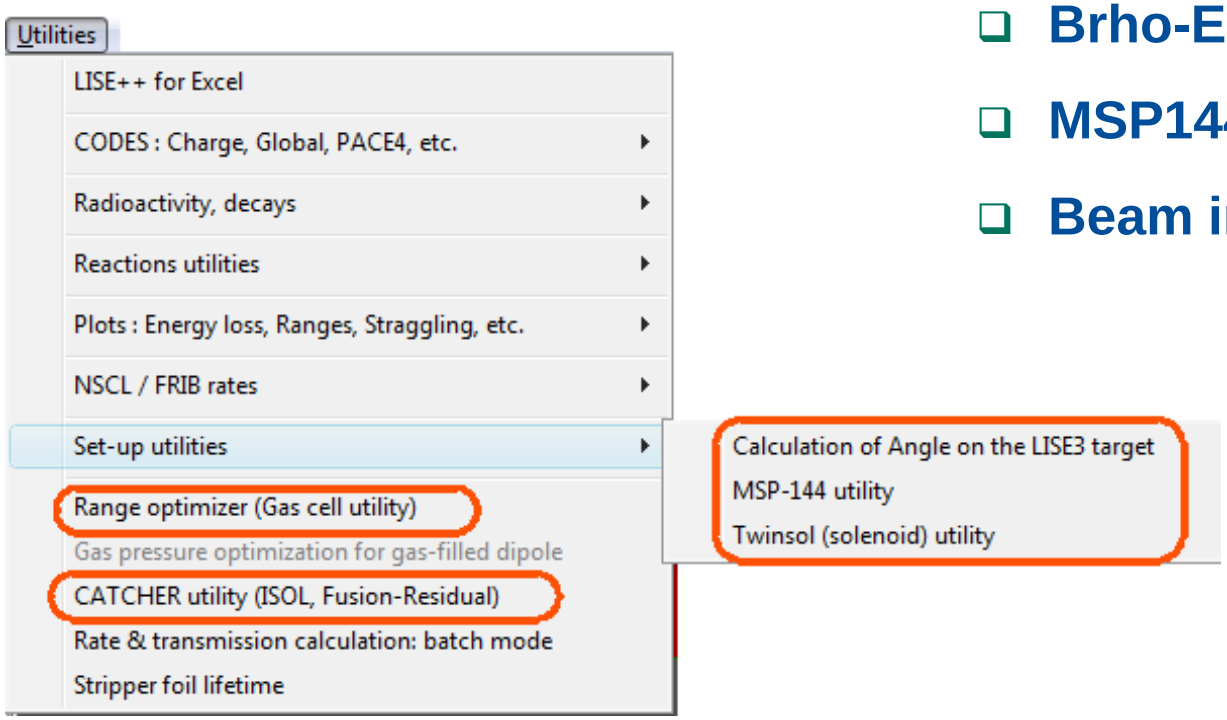




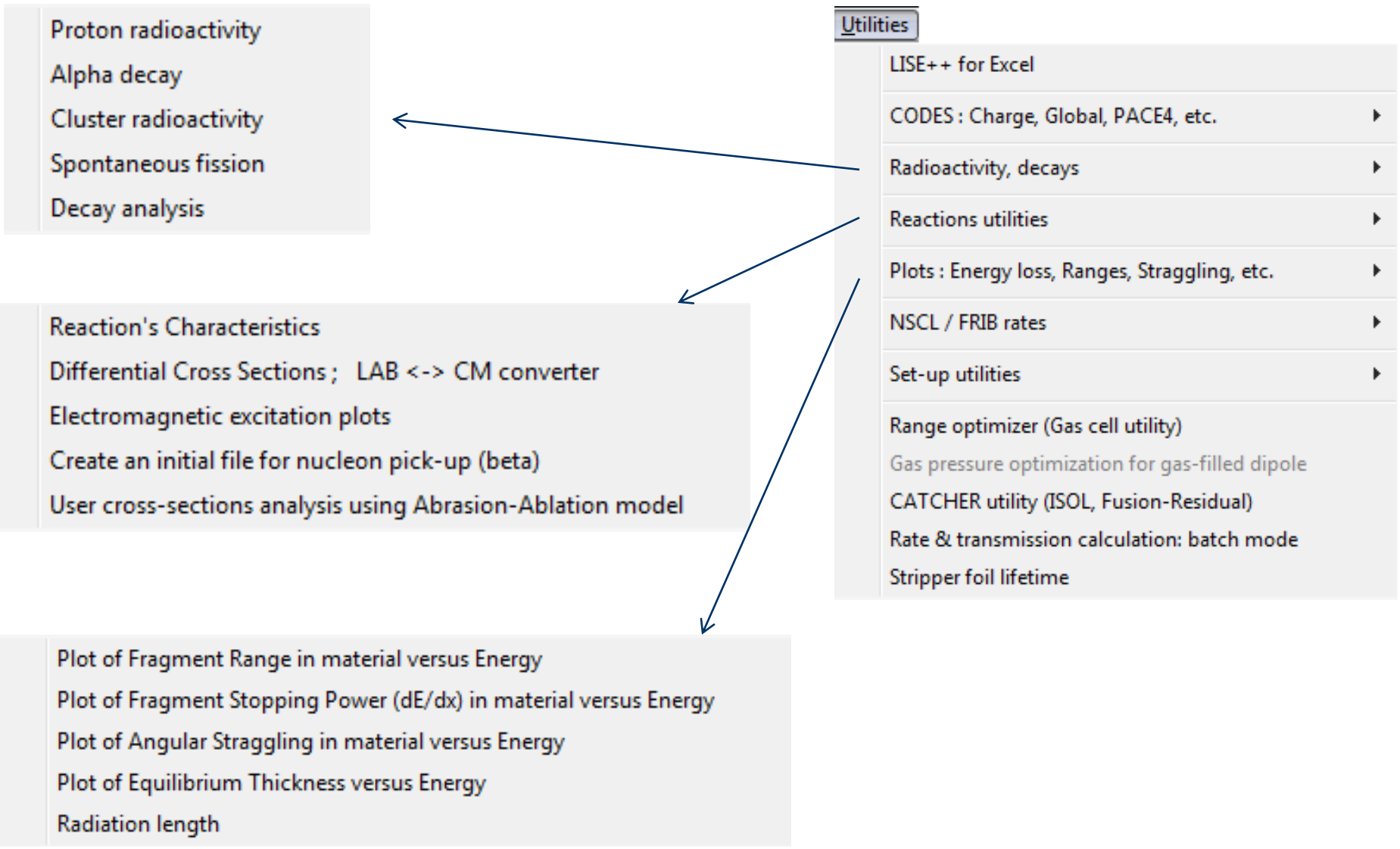
- Physical Calculator
- Relativistic Reaction Kinematics Calculator
- Evaporation calculator
- Fusion-Residue calculator
- Radiation Residue Calculator
- Ion Mass calculator
- Mathematical calculator
- Matrix calculator

Specific block utilities

- Catcher utility
- Solenoid (Twinsol)
- Range optimization (Gas Cell utility)
- Curved & Custom degraders calculation
- Brho-Erho analyzer
- MSP144 (FLNR) utility
- Beam inclination on target (GANIL)

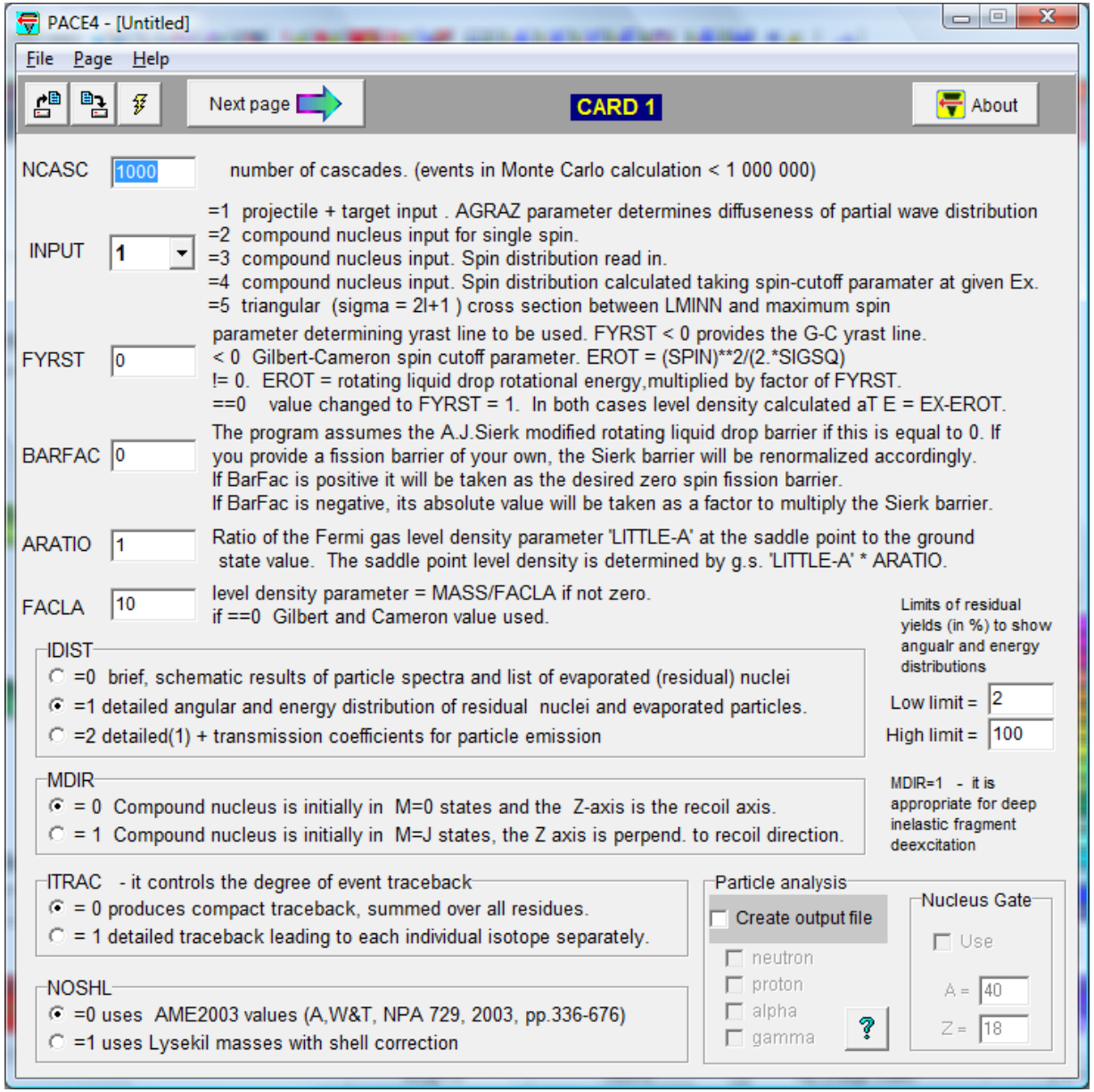


Production mechanism utilities



PACE IV (evaporation cascade)

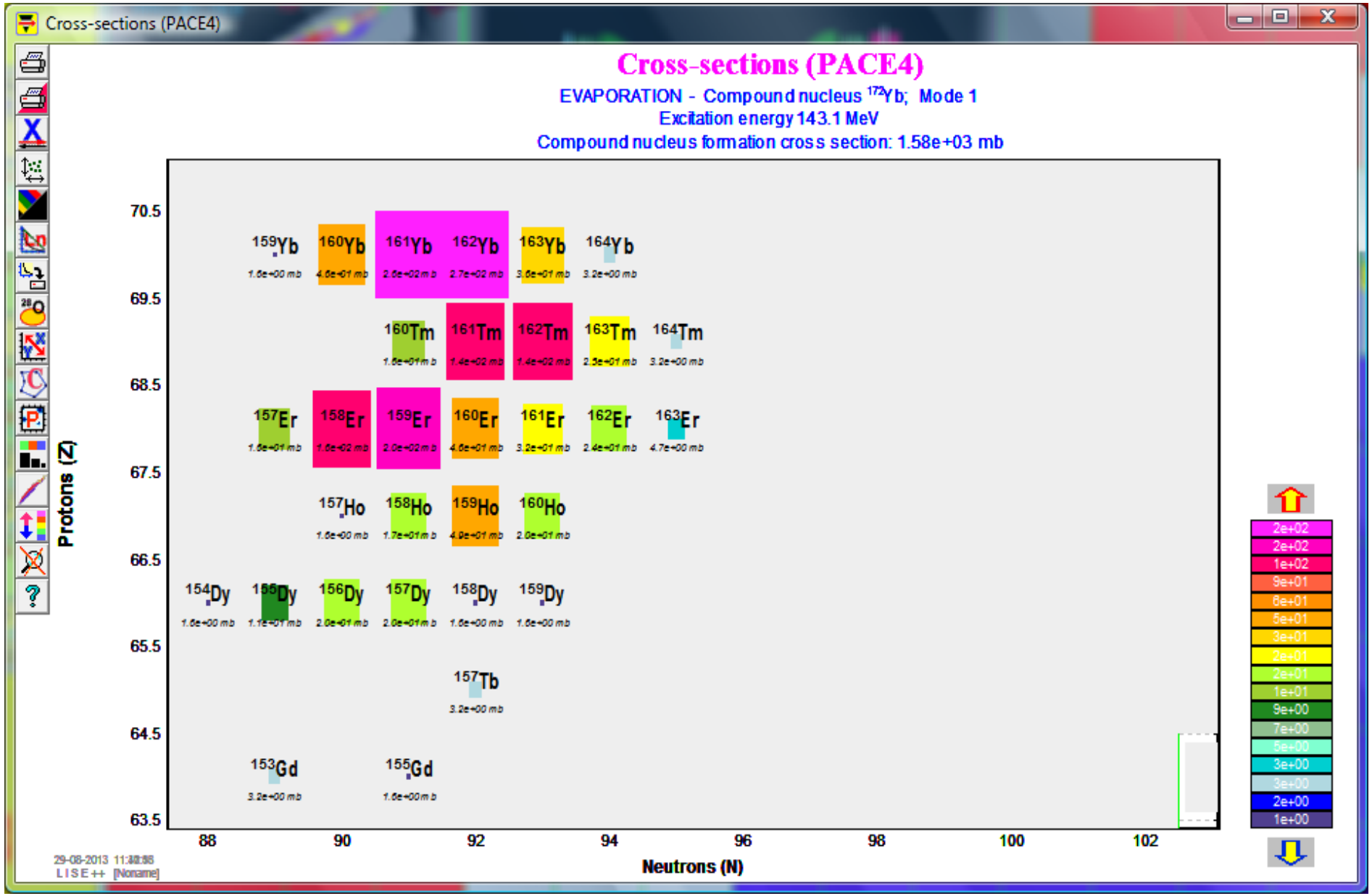
http://lise.nscl.msu.edu/pace4.html



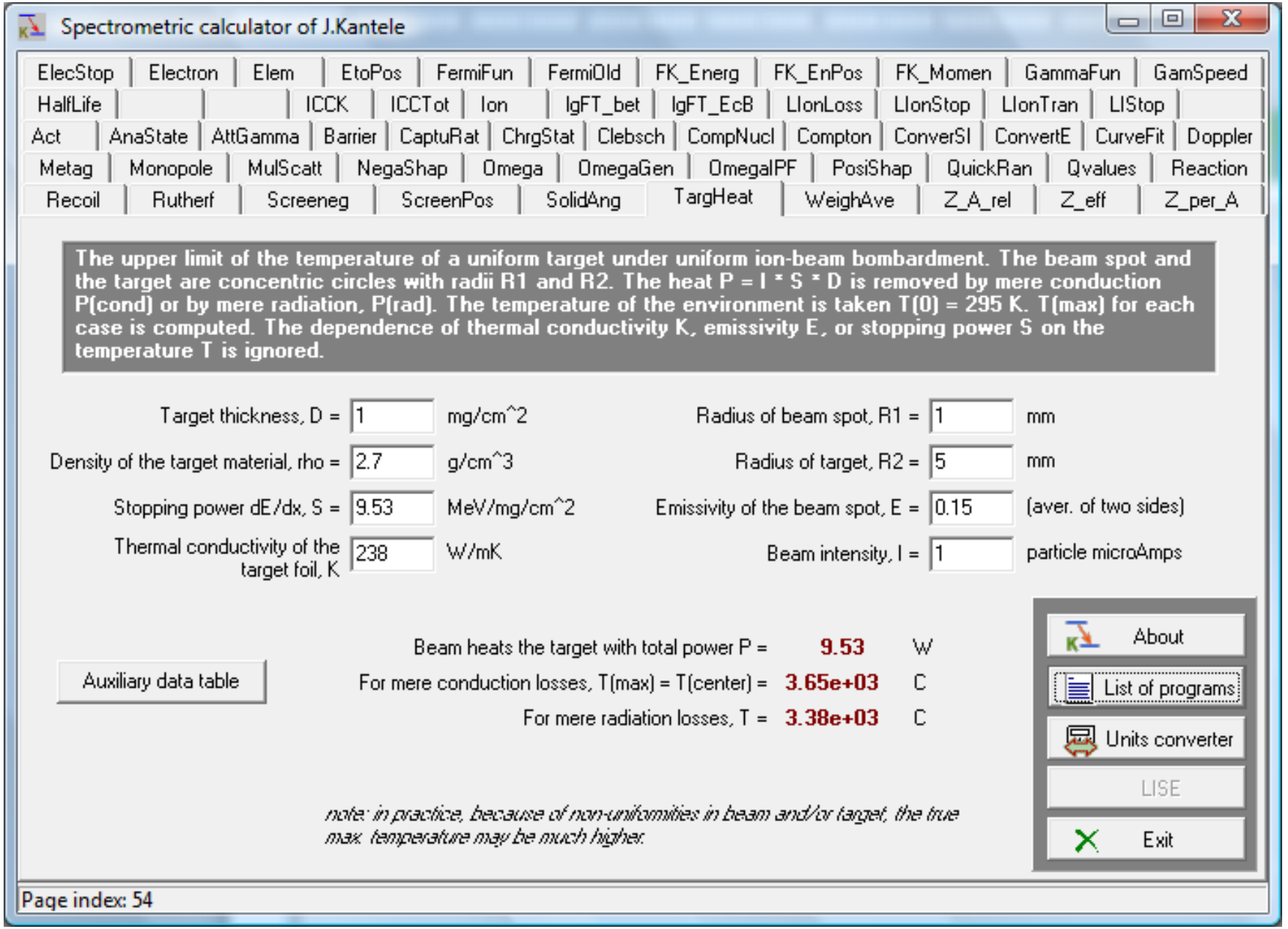
Updates:

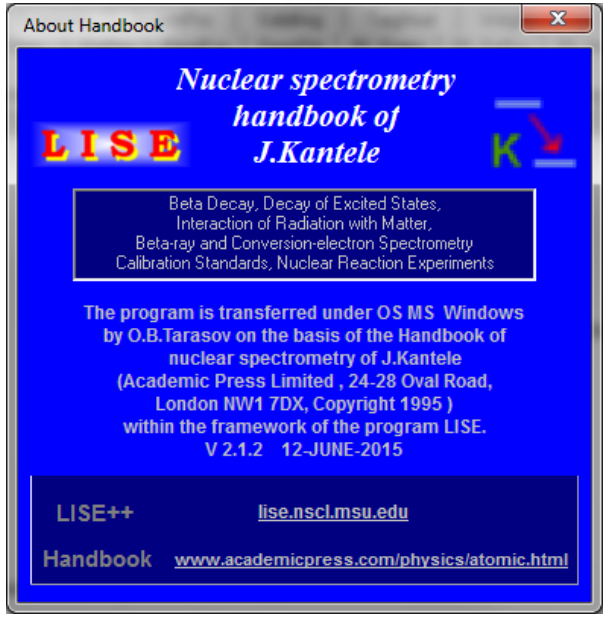
- Masses from the AME2012 database
- Quantum-mechanical transmission probability for one-dimensional barrier
- Batch mode
- Detailed decay analysis options
- Possibility to plot

PACE IV

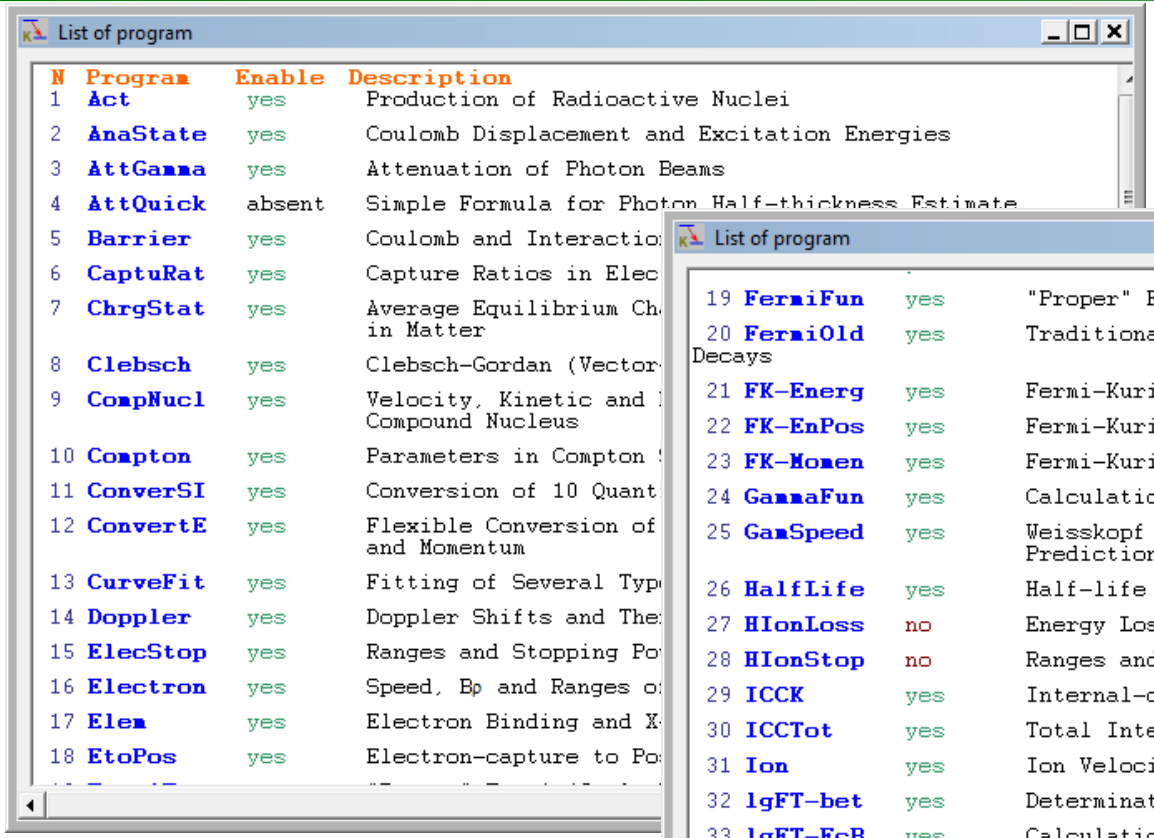

Cross-sections (PACE4)
Cross-sections (PACE4)
EVAPORATION - Compound nucleus 172Yb; Mode 1
Excitation energy 143.1 MeV
Compound nucleus formation cross section: 1.58e+03 mb
Protons (Z)
Neutrons (N)
70.5
69.5
68.5
67.5
66.5
65.5
64.5
63.5
88
90
92
94
96
98
100
102
159Yb 160Yb 161Yb 162Yb 163Yb 164Yb
160Tm 161Tm 162Tm 163Tm 164Tm
157Er 158Er 159Er 160Er 161Er 162Er 163Er
157Ho 158Ho 159Ho 160Ho
154Dy 155Dy 156Dy 157Dy 158Dy 159Dy
157Tb
153Gd 155Gd
2e+02
2e+02
1e+02
9e+01
6e+01
5e+01
3e+01
2e+01
2e+01
1e+01
9e+00
7e+00
5e+00
3e+00
3e+00
2e+00
1e+00
LISE++ [Noname]

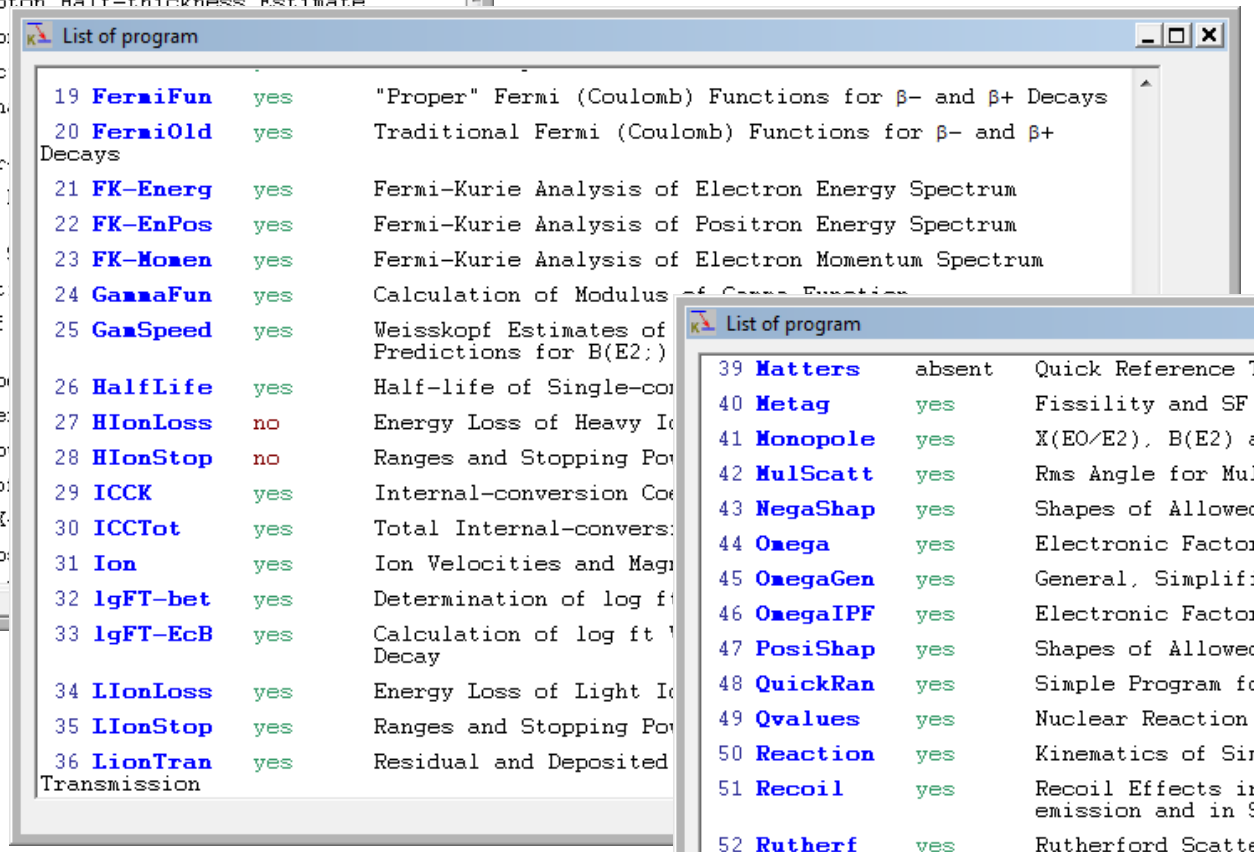
The spectrometric handbook of J.Kantele

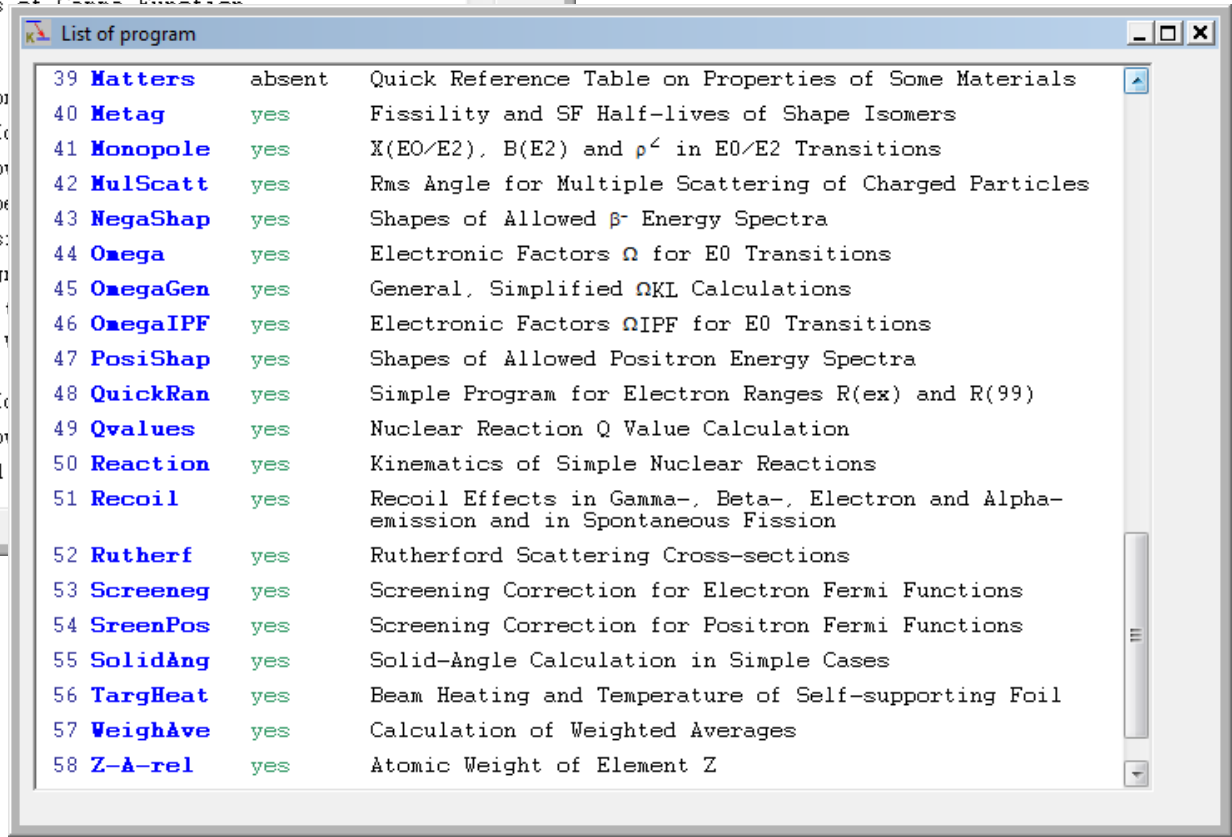




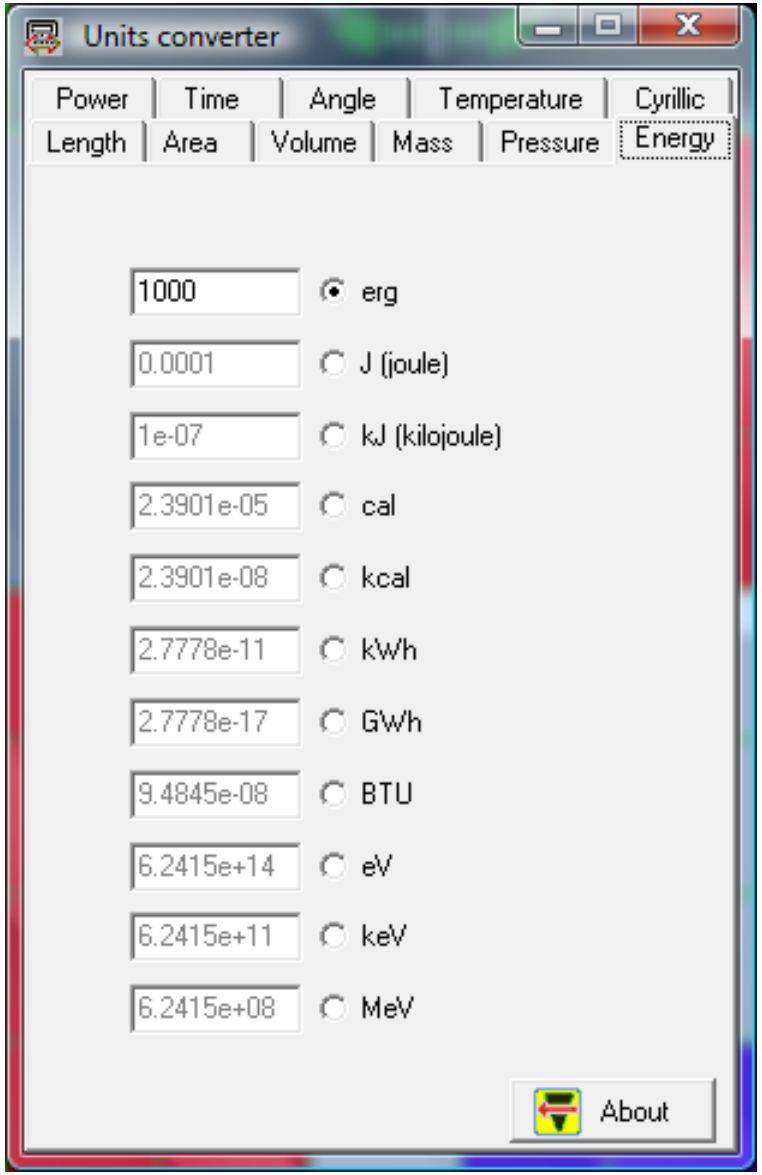
The spectrometric handbook of J.Kantele

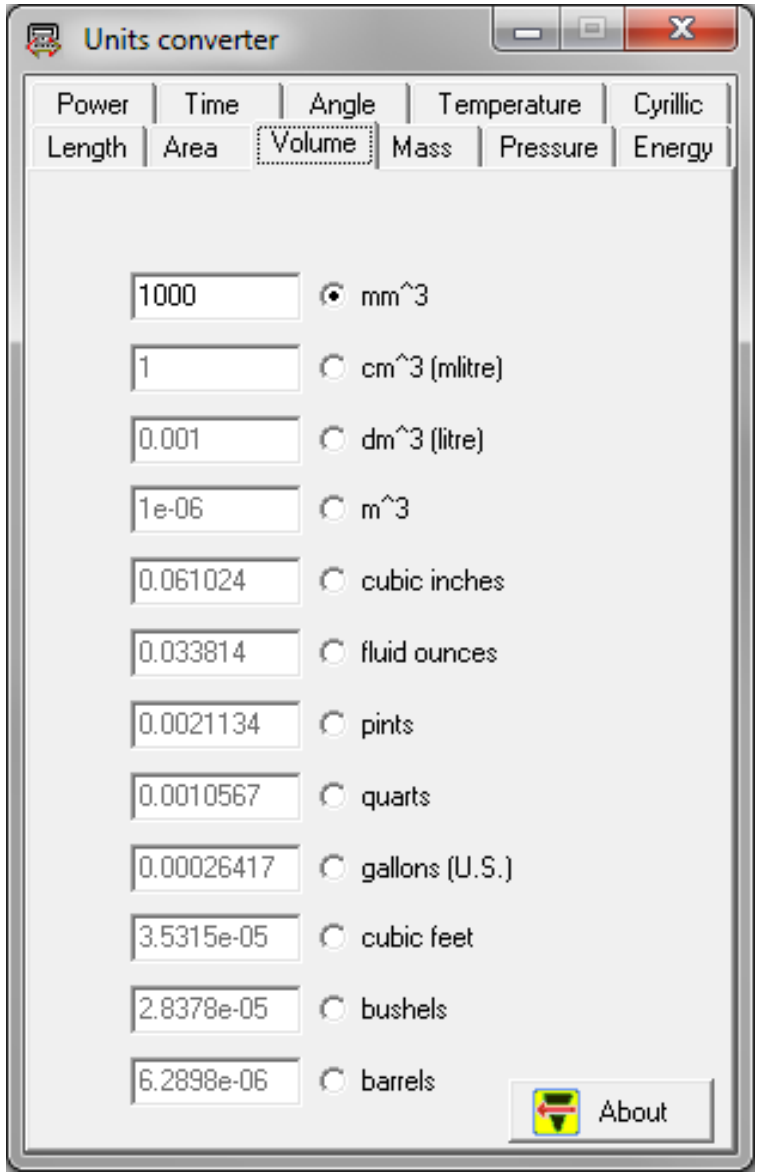


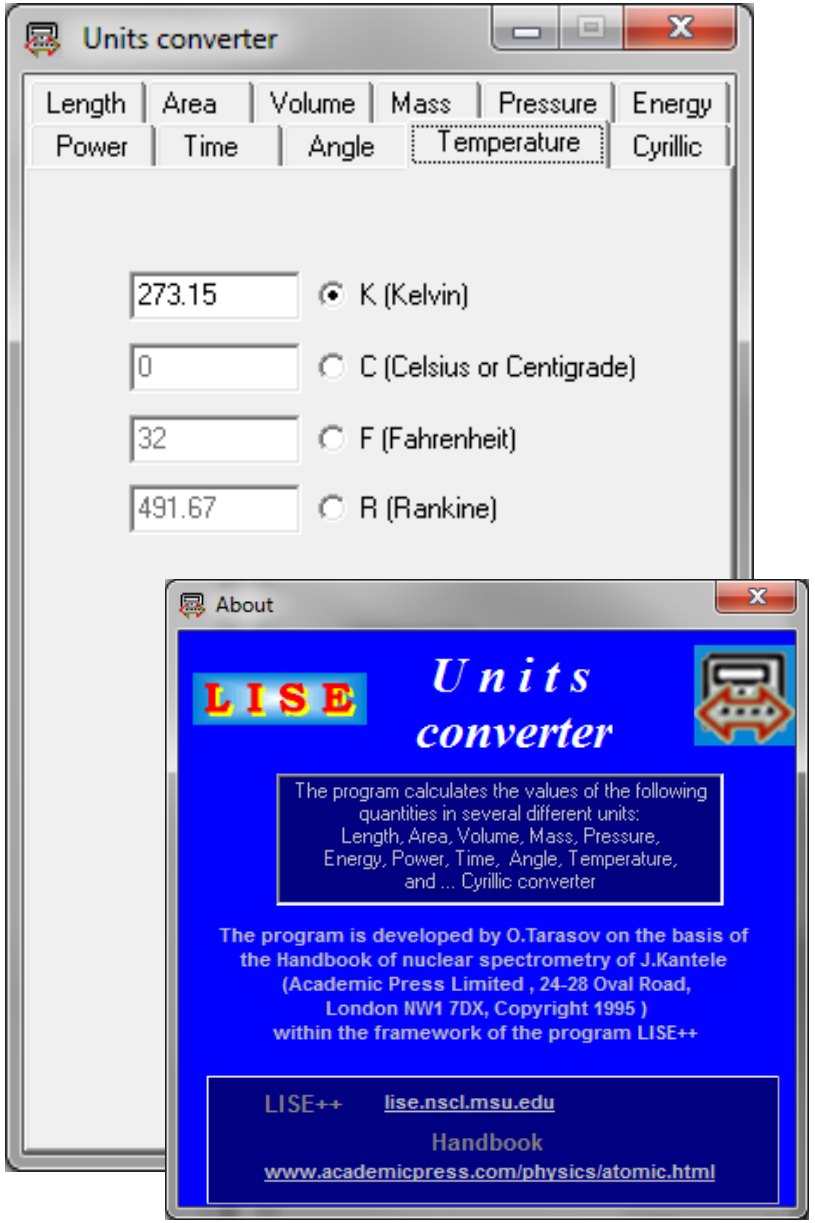




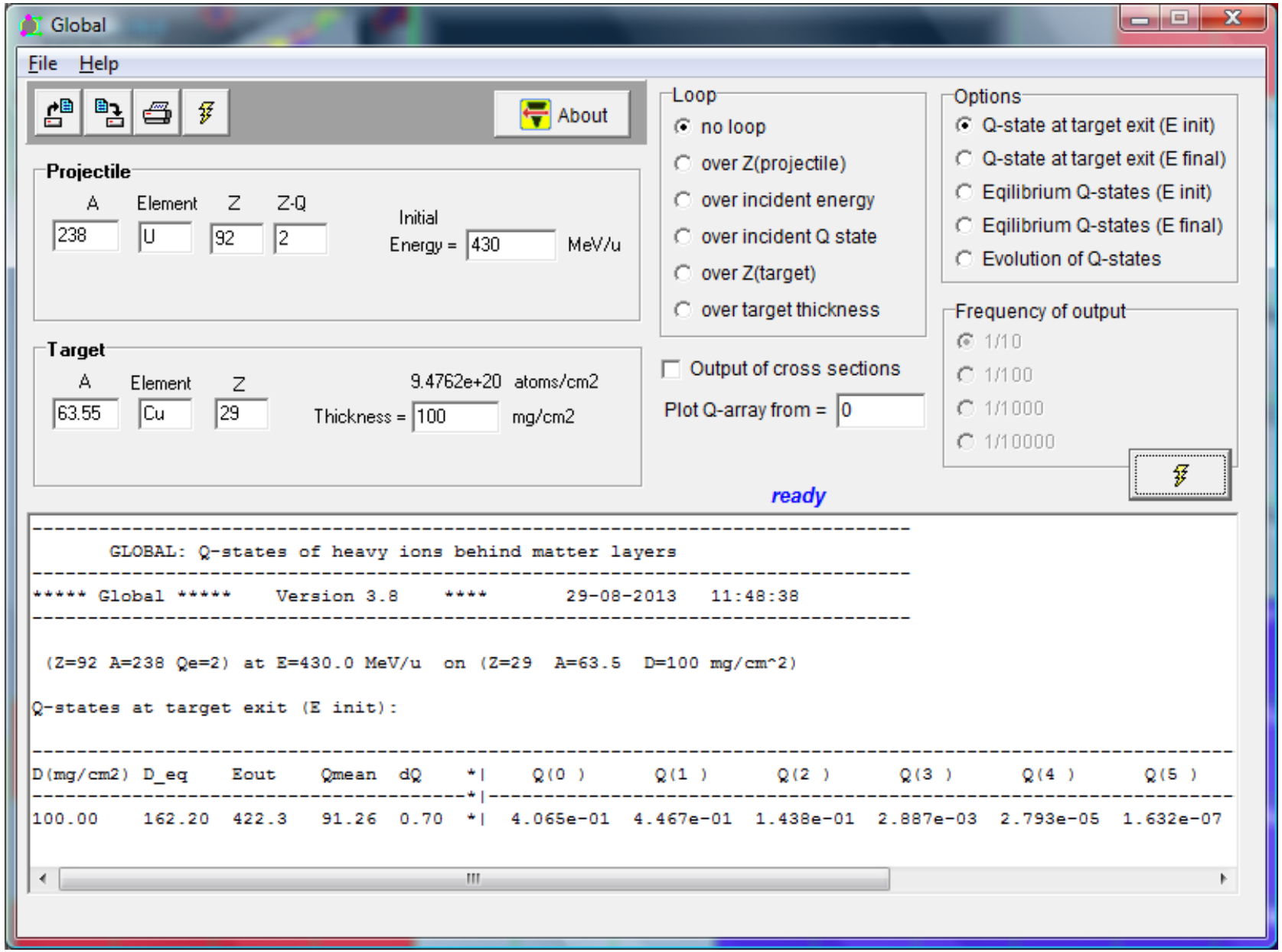
Units converter

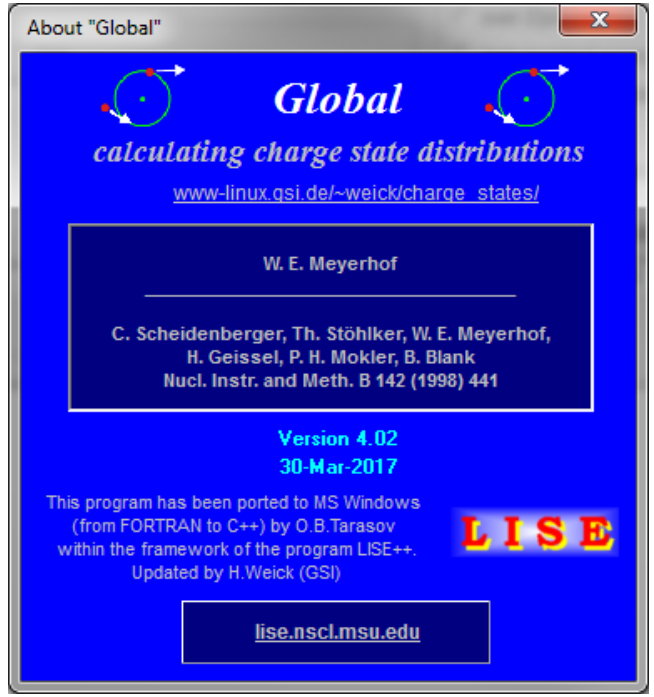




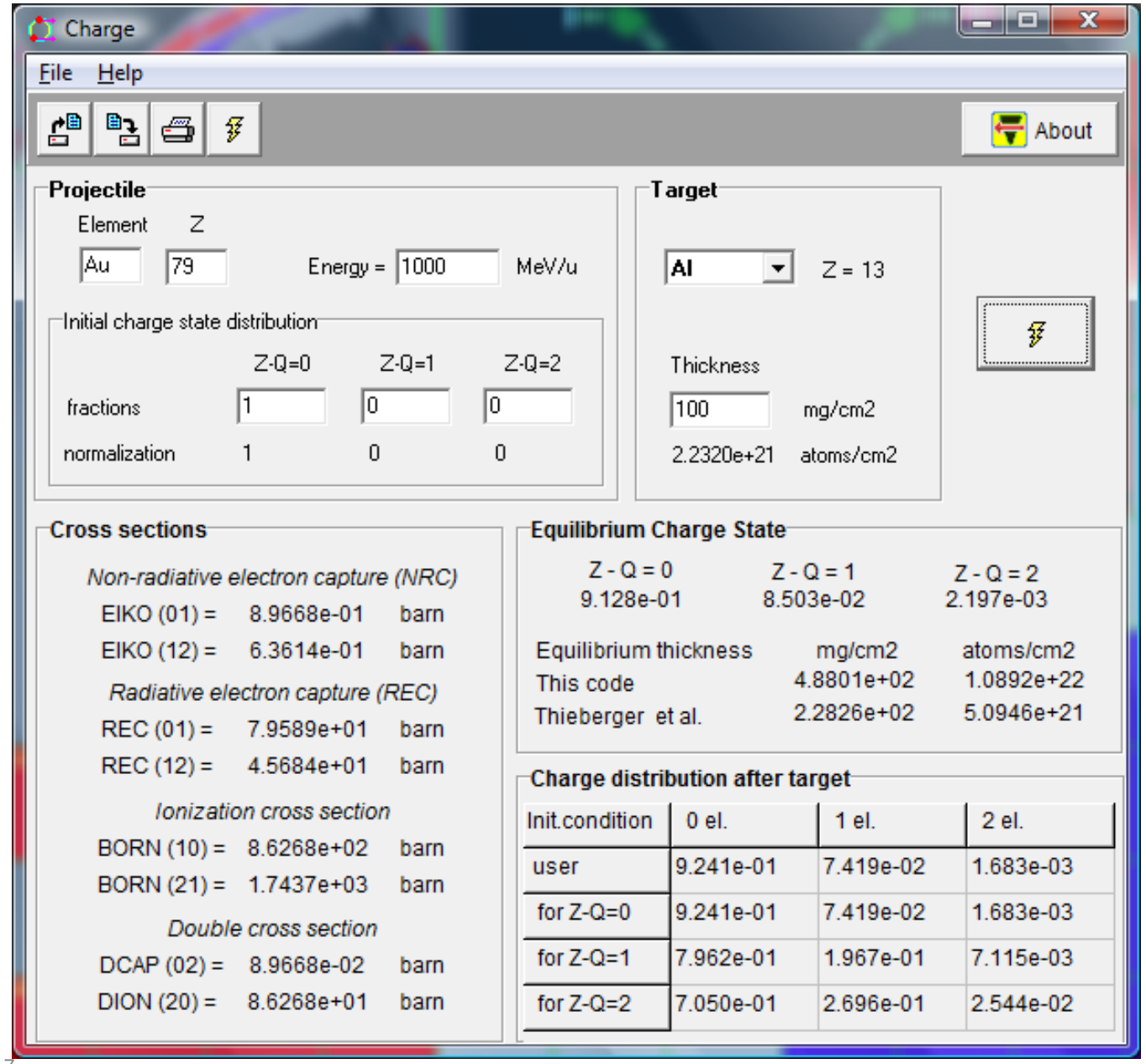


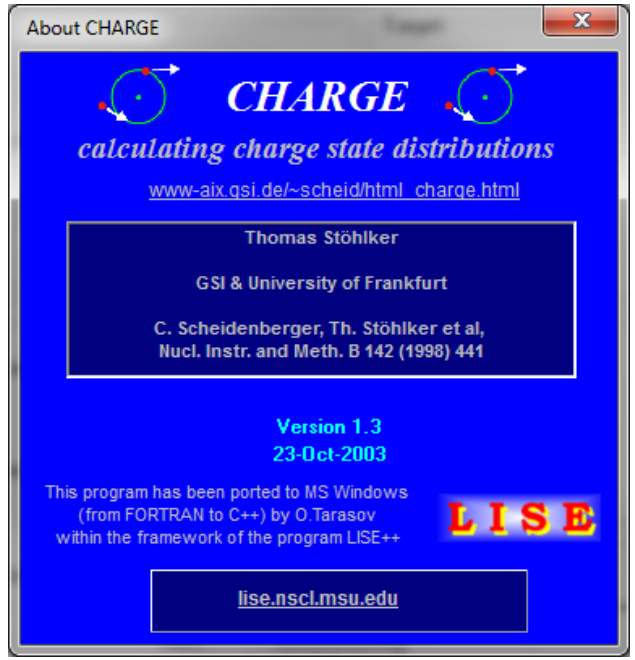
Code “Global” (charge state evolution)





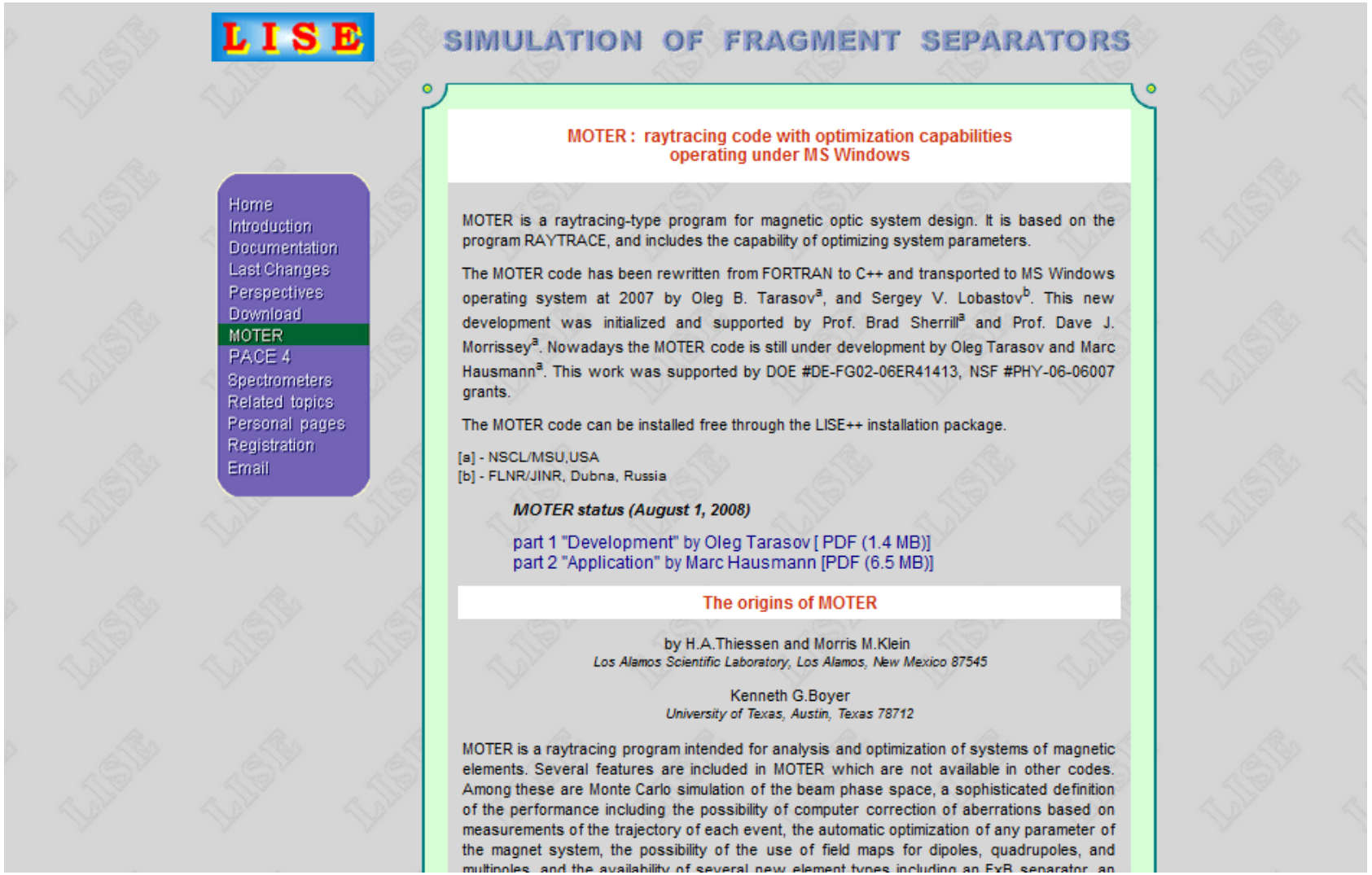
Code “Charge” (charge state evolution)





MOTER

http://lise.nscl.msu.edu/moter.html



LISE

SIMULATION OF FRAGMENT SEPARATORS

- Home
- Introduction
- Documentation
- Last Changes
- Perspectives
- Download
- MOTER
- PACE 4
- Spectrometers
- Related topics
- Personal pages
- Registration
- Email

MOTER : raytracing code with optimization capabilities operating under MS Windows

MOTER is a raytracing-type program for magnetic optic system design. It is based on the program RAYTRACE, and includes the capability of optimizing system parameters.

The MOTER code has been rewritten from FORTRAN to C++ and transported to MS Windows operating system at 2007 by Oleg B. Tarasov[a], and Sergey V. Lobastov[b]. This new development was initialized and supported by Prof. Brad Sherrill[a] and Prof. Dave J. Morrissey[a]. Nowadays the MOTER code is still under development by Oleg Tarasov and Marc Hausmann[a]. This work was supported by DOE #DE-FG02-06ER41413, NSF #PHY-06-06007 grants.

The MOTER code can be installed free through the LISE++ installation package.

[a] - NSCL/MSU,USA
[b] - FLNR/JINR, Dubna, Russia

MOTER status (August 1, 2008)

part 1 "Development" by Oleg Tarasov [PDF (1.4 MB)]
part 2 "Application" by Marc Hausmann [PDF (6.5 MB)]

The origins of MOTER

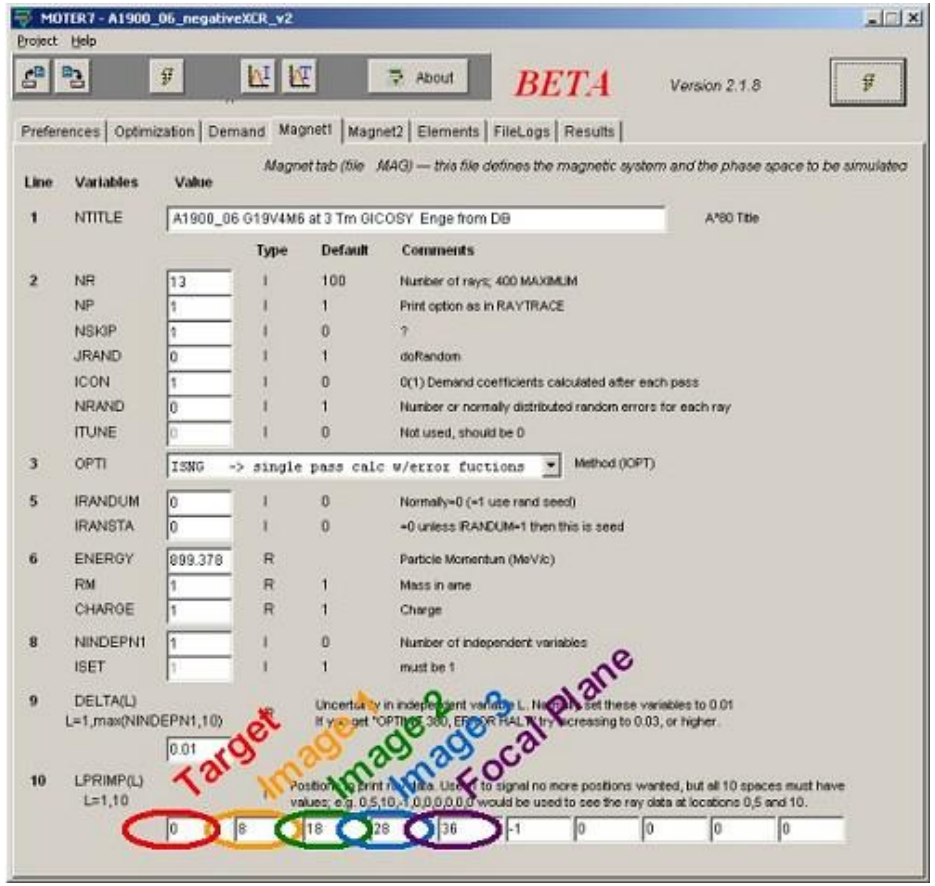
by H.A.Thiessen and Morris M.Klein
Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545

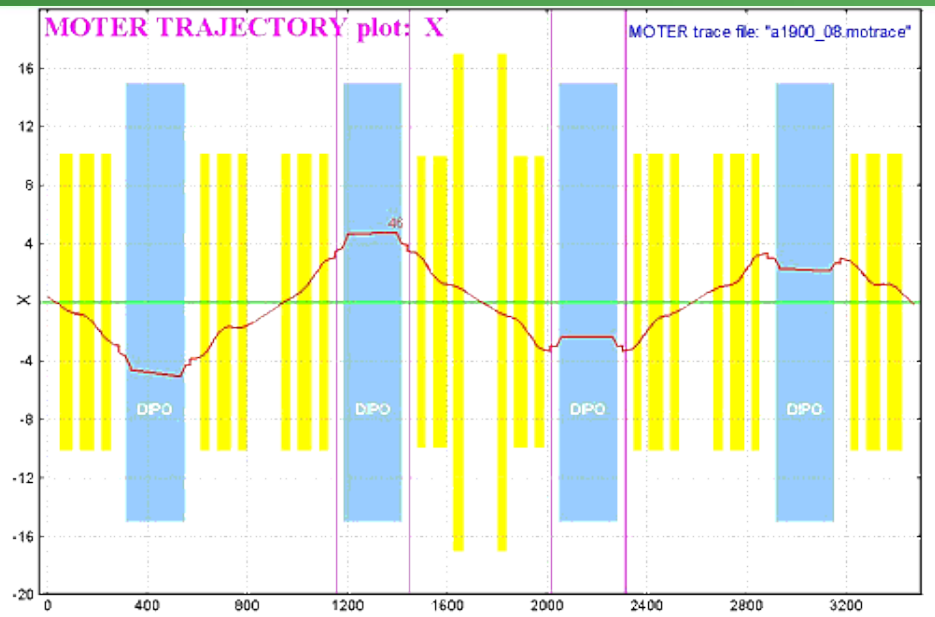
Kenneth G.Boyer
University of Texas, Austin, Texas 78712

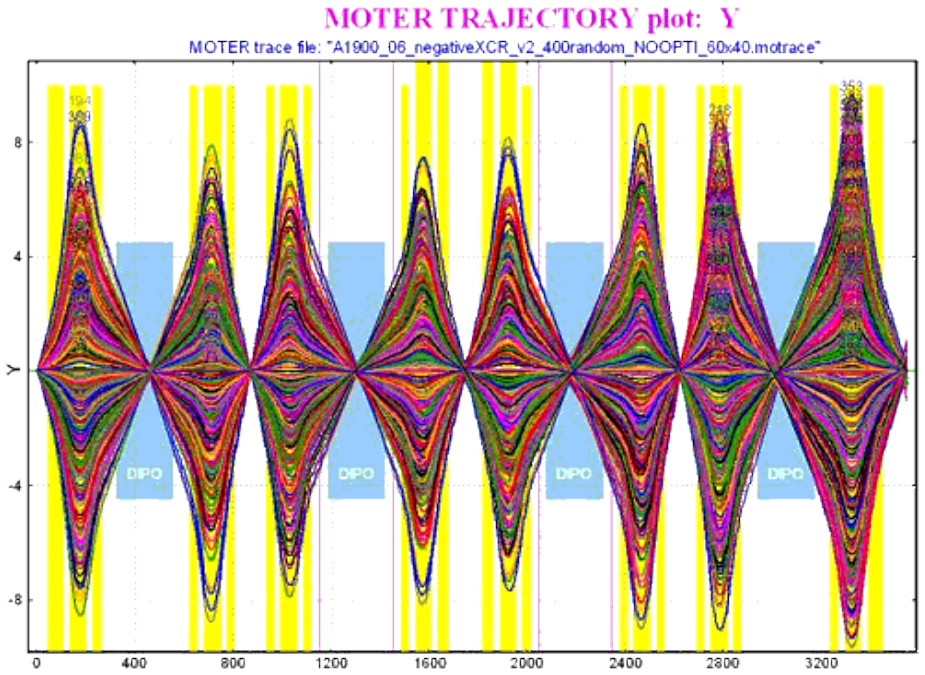
MOTER is a raytracing program intended for analysis and optimization of systems of magnetic elements. Several features are included in MOTER which are not available in other codes. Among these are Monte Carlo simulation of the beam phase space, a sophisticated definition of the performance including the possibility of computer correction of aberrations based on measurements of the trajectory of each event, the automatic optimization of any parameter of the magnet system, the possibility of the use of field maps for dipoles, quadrupoles, and multipoles, and the availability of several new element types including an ExB separator, an

The Development has been frozen. If do you wish… ?

MOTER

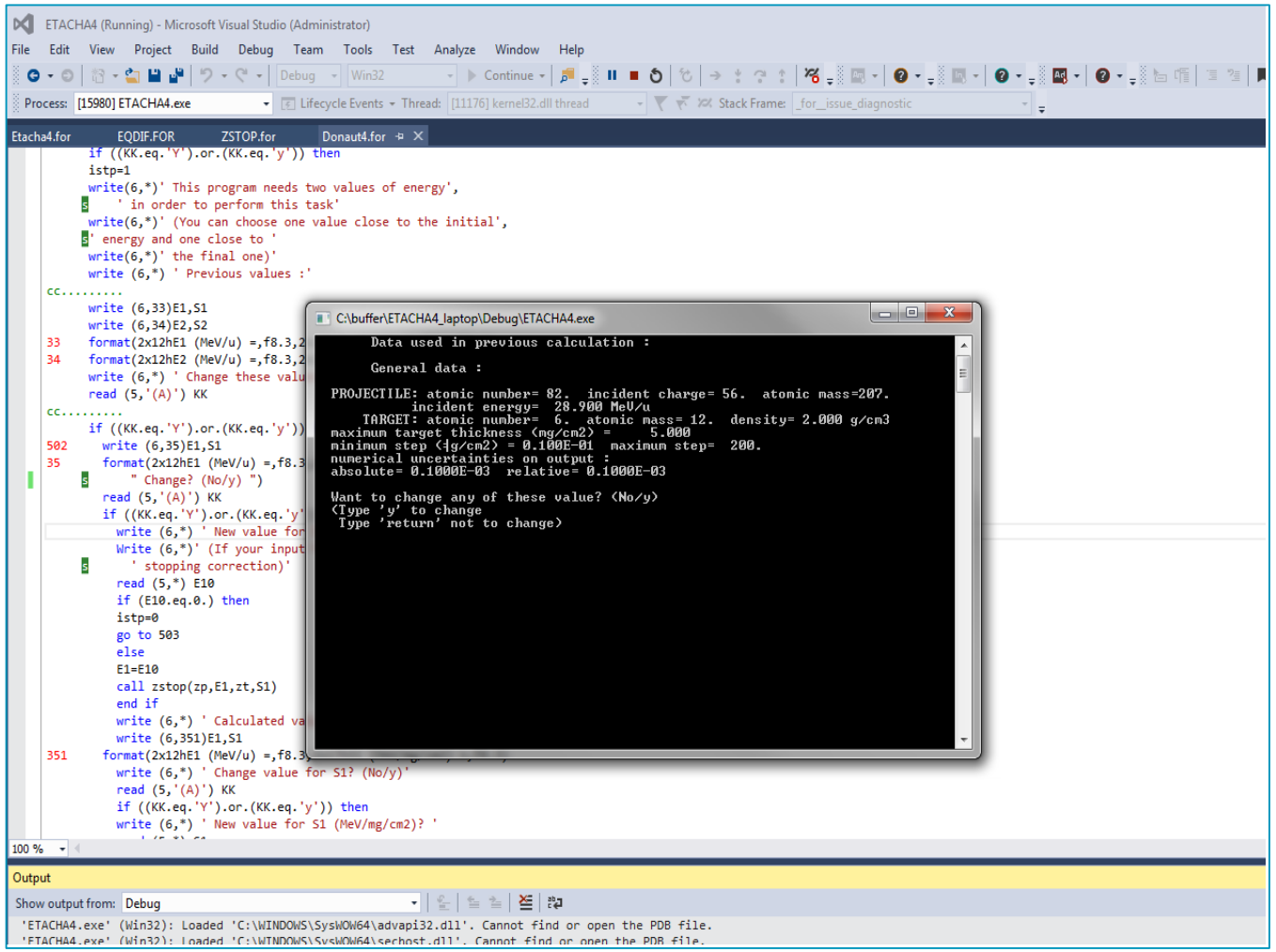

MOTER7 - A1900_06_negativeXCR_v2
Project Help
About
BETA
Version 2.1.8
Preferences Optimization Demand Magnet1 Magnet2 Elements FileLogs Results
Magnet tab (file MAG) — this file defines the magnetic system and the phase space to be simulated
Line Variables Value
1 NTITLE A1900_06 G19V4M6 at 3 Tm GICOSY Enge from DB
A*80 Title
Type Default Comments
2 NR 13 I 100 Number of rays; 400 MAXIMUM
NP 1 I 1 Print option as in RAYTRACE
NSKIP 1 I 0 ?
JRAND 0 I 1 doRandom
ICON 1 I 0 0(1) Demand coefficients calculated after each pass
NRAND 0 I 1 Number or normally distributed random errors for each ray
ITUNE 0 I 0 Not used, should be 0
3 OPTI ISNG -> single pass calc w/error fuctions
Method (IOPT)
5 IRANDUM 0 I 0 Normally=0 (=1 use rand seed)
IRANSTA 0 I 0 =0 unless IRANDUM=1 then this is seed
6 ENERGY 899.378 R Particle Momentum (MeV/c)
RM 1 R 1 Mass in amu
CHARGE 1 R 1 Charge
8 NINDEPN1 1 I 0 Number of independent variables
ISET 1 I 1 must be 1
9 DELTA(L) L=1,max(NINDEPN1,10)
0.01
10 LPRIMP(L) L=1,10
0 8 18 28 36 -1 0 0 0 0
Target
Image 1
Image 2
Image 3
Focal Plane


MOTER TRAJECTORY plot: X
MOTER trace file: "a1900_08.motrace"
DIPO
DIPO
DIPO
DIPO
X

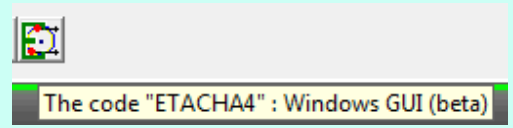

MOTER TRAJECTORY plot: Y
MOTER trace file: "A1900_06_negativeXCR_v2_400random_NOOPTI_60x40.motrace"
DIPO
DIPO
DIPO
DIPO
Y

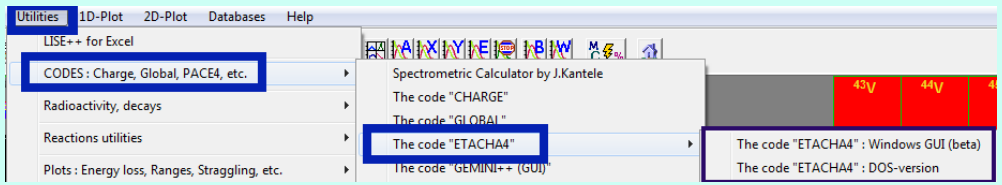
ETACHA4 (charge state evolution)

1. The current ETACHA version is “DOS-window” (“terminal” window) application
2. To compile the current version you need MS Visual Studio (project) and Intel Parallel Studio XE2016 (FORTRAN)
3. Long-long manual data entry
4. The user should manually entry final energy at the exit of material

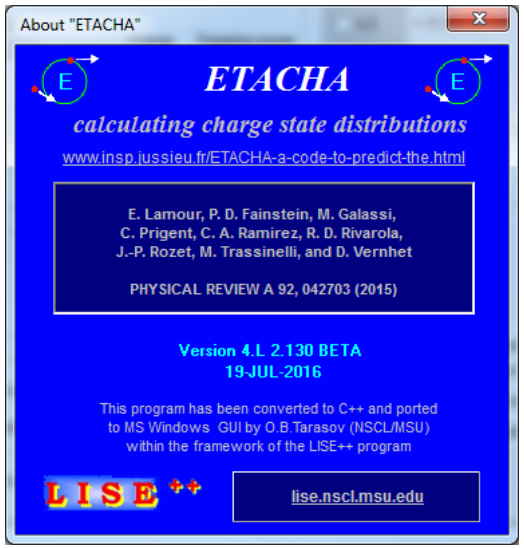


ETACHA GUI in LISE++ package

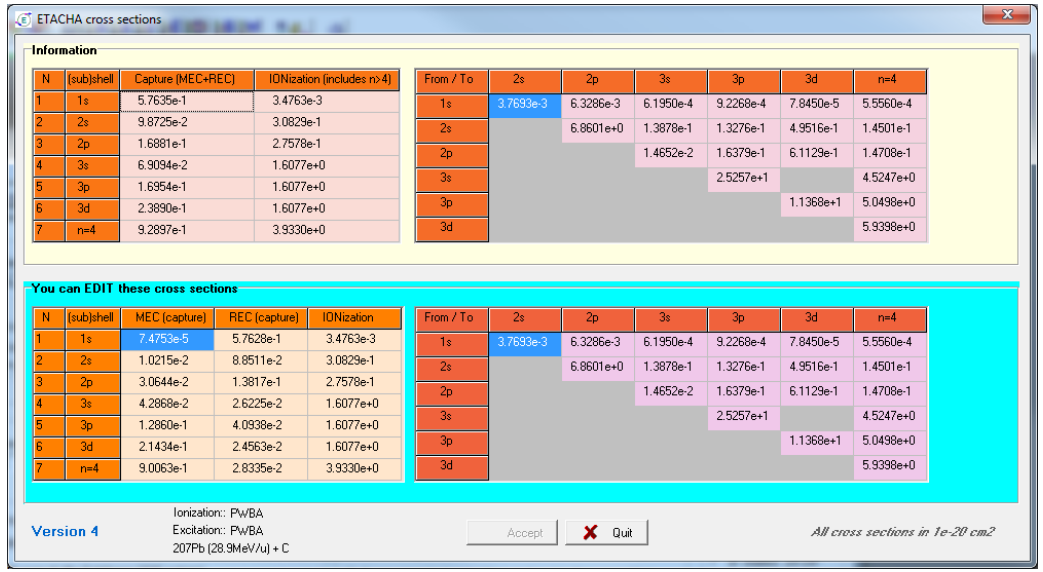




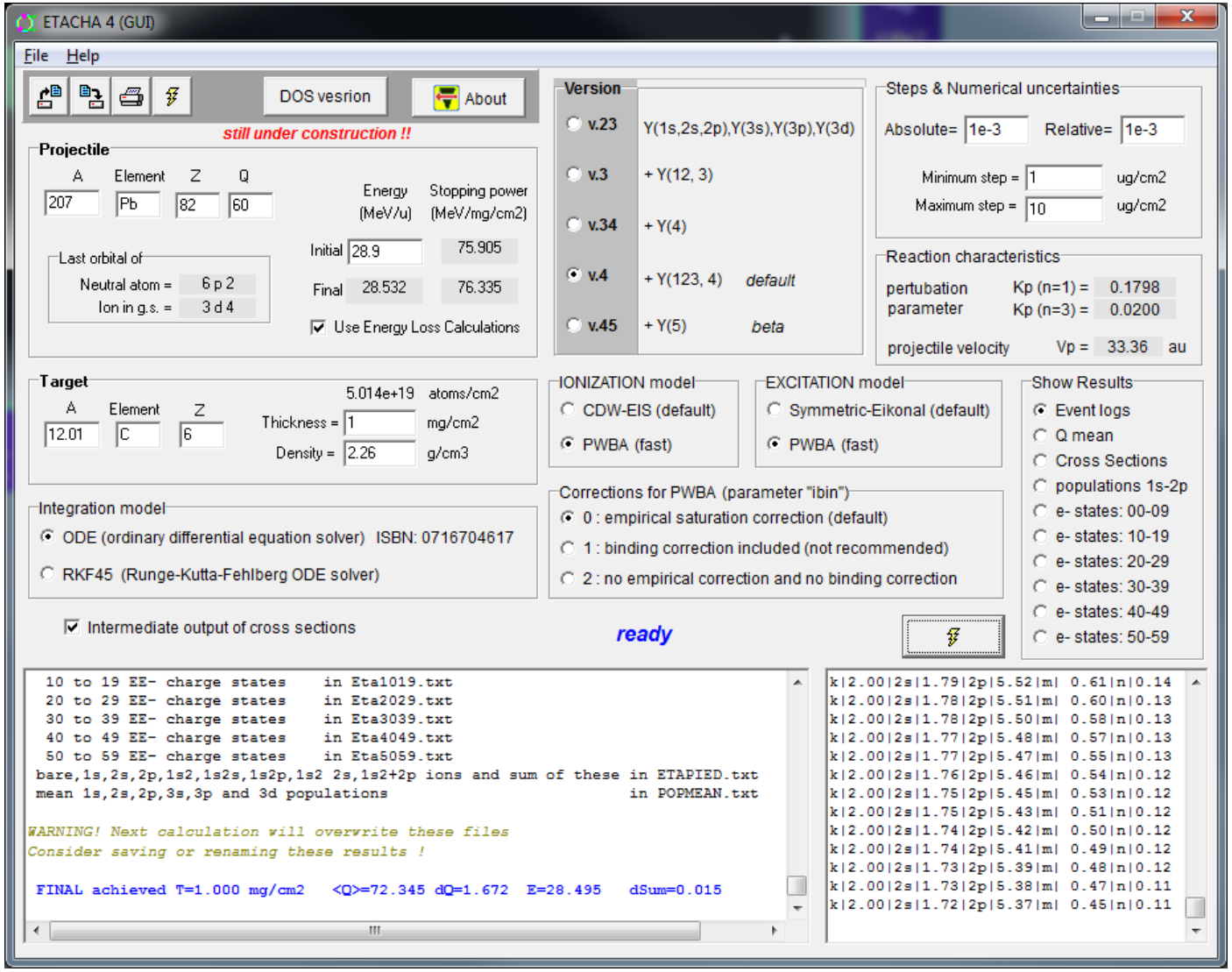
ETACHA4 (charge state evolution)



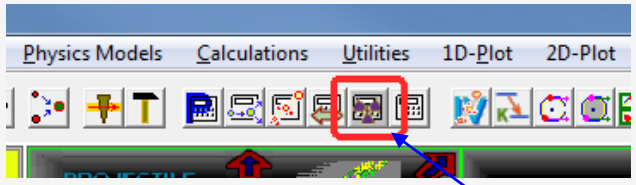
Intermediate output window of cross sections

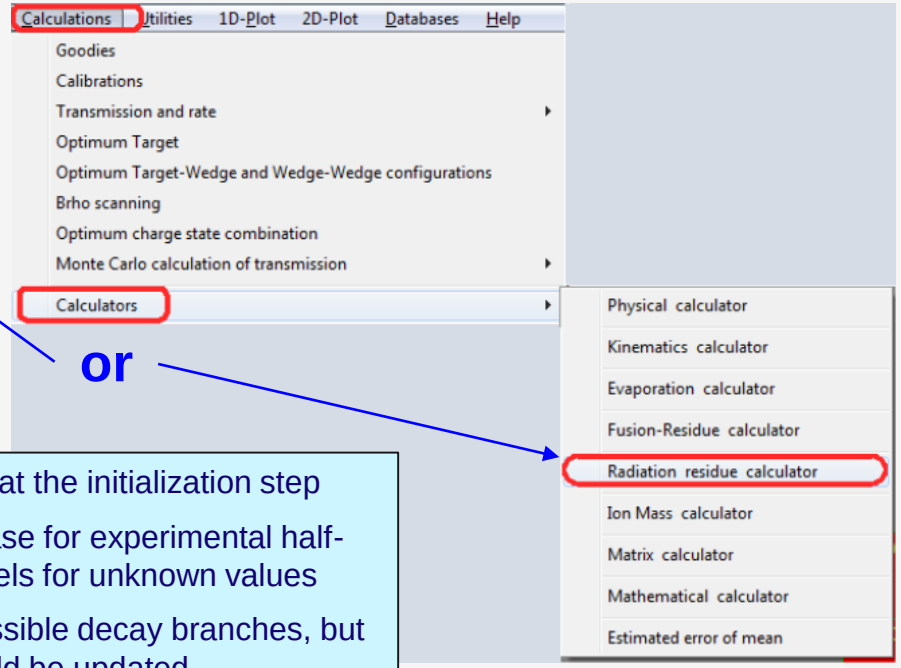


Main window



Radiation Residue Calculator



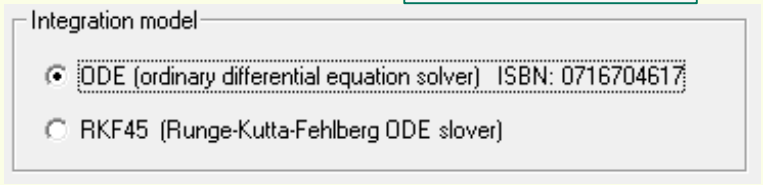


or

- About 7300 differential equations at the initialization step
- LISE^{++} uses the AME2012 database for experimental half-lives and internal calculation models for unknown values
- LISE^{++} takes into account two possible decay branches, but the Decay Branch database should be updated

"integrators"

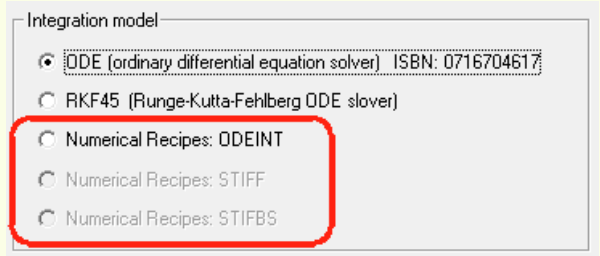
v.1



Lawrence Shampine, Marilyn Gordon,
Computer Solution of Ordinary Differential Equations:
The Initial Value Problem,
Freeman, 1975, ISBN: 0716704617, LC: QA372.S416.

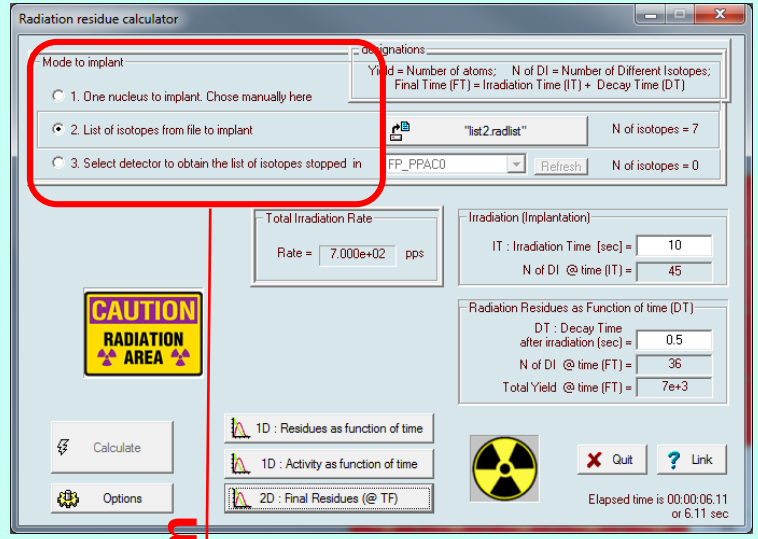
C++ version by John Burkardt

v.2

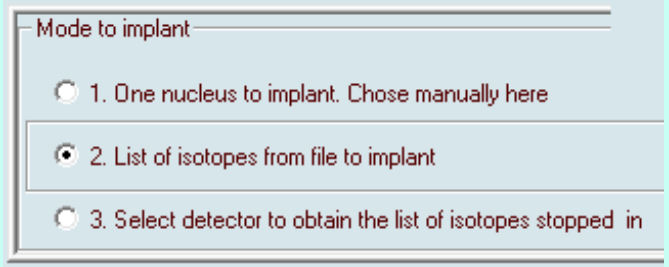


Numerical Recipes in ANSI C++ 2.11

NUMERICAL RECIPES SOFTWARE
P.O. Box 243, Cambridge, MA 02238 (USA)

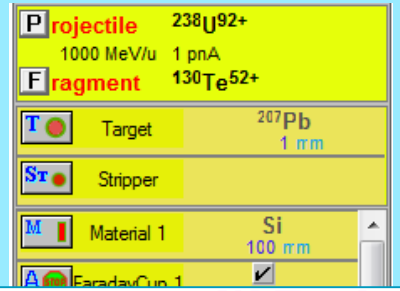


zoom



Radiation Residue Calculator : ^{238}U low excitation fission

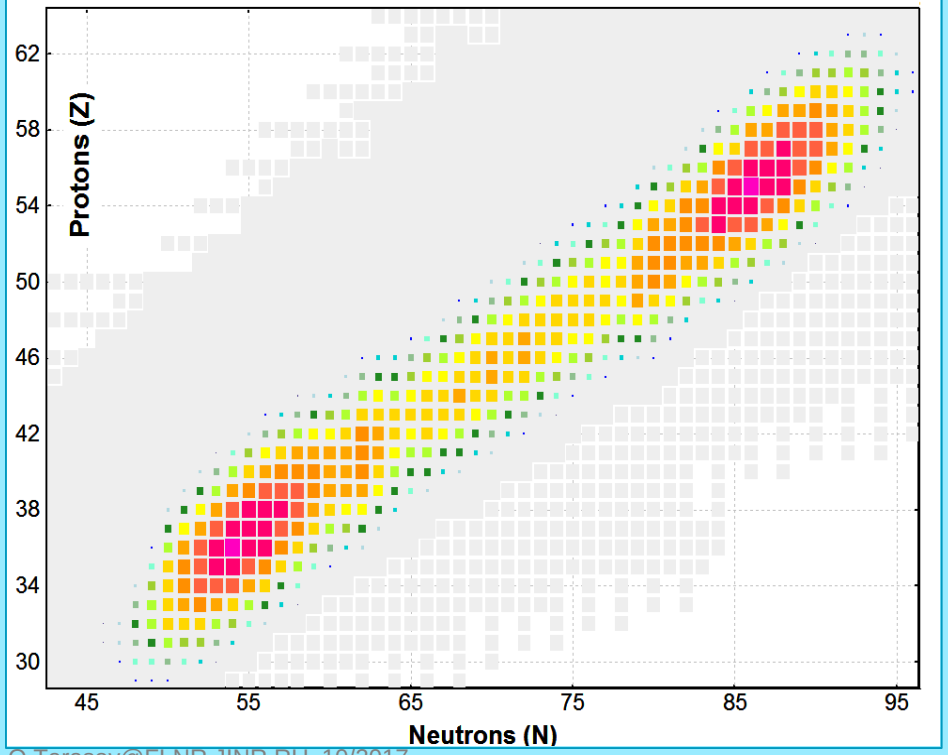
This file has been produced by LISE^{++} with next settings and Coulomb Fission mechanism



Implanted isotopes
(number of different isotopes is 490)

[3] Total: All reactions (pps)

^{238}U (1000 MeV/u) + Pb (1 mm); Settings on ^{130}Te; Config: MA
dp/p=100.00%
N=0-200

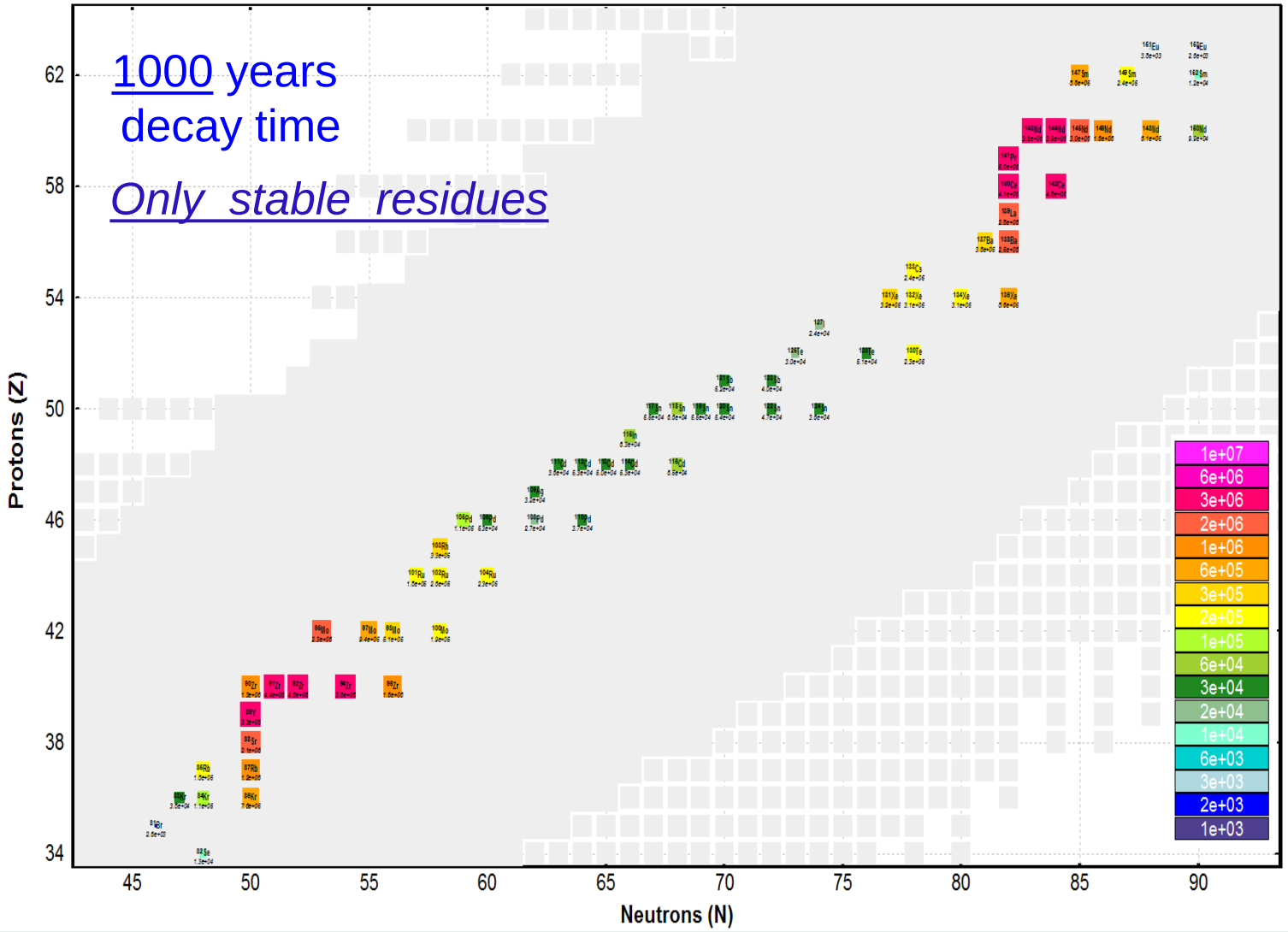


Radioactive decay residues

Implanted isotopes file : "G:\238U_CoulombFission.radlist" (490 isotopes)
Irradiation Time (IT) = 1.000e+00 sec; Decay Time (DT) = 3.150e+10 sec
N_Implant=100, N_Resid=1000, Abs.Error=1.0e-06, Rel.Error=1.0e-03, Threshold=1.0e-05, Model="RKF45"

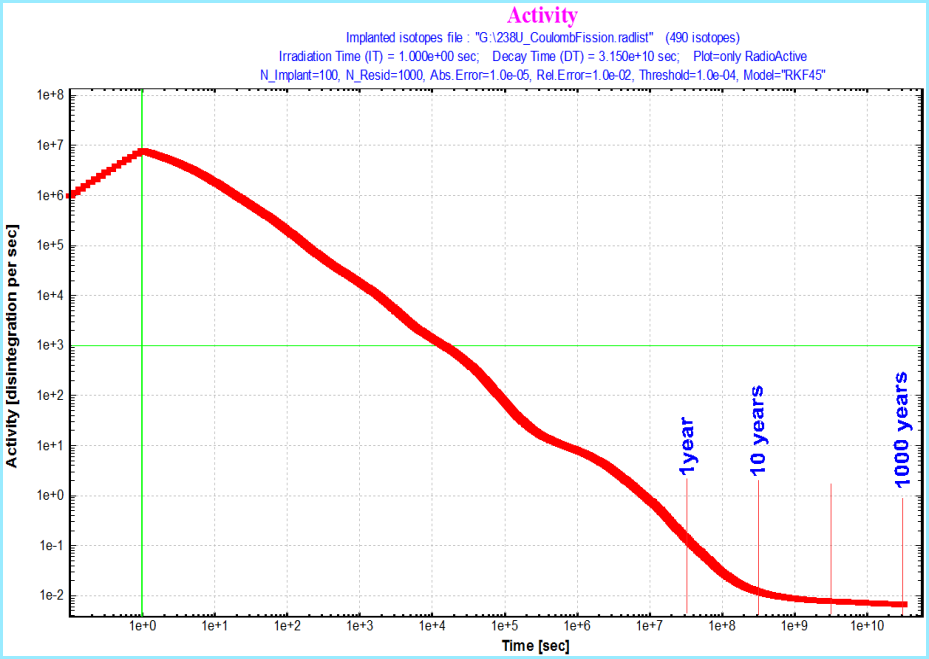
1000 years decay time

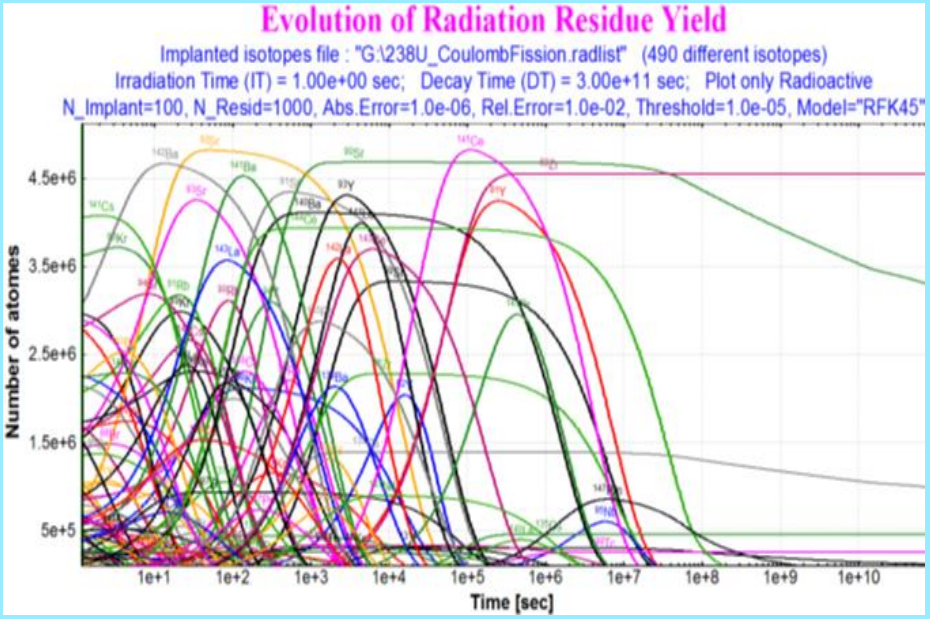
Only stable residues



O.Tarasov@FLNR.JINR.RU 10/2017

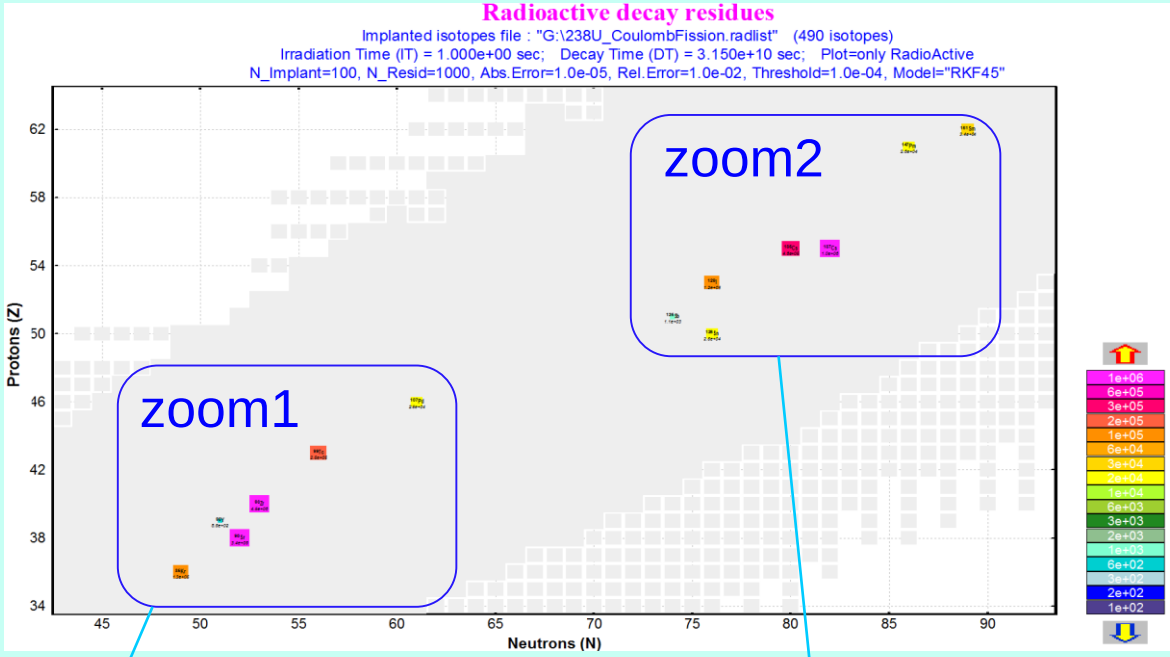
Radiation Residue Calculator : ^{238}U low excitation fission

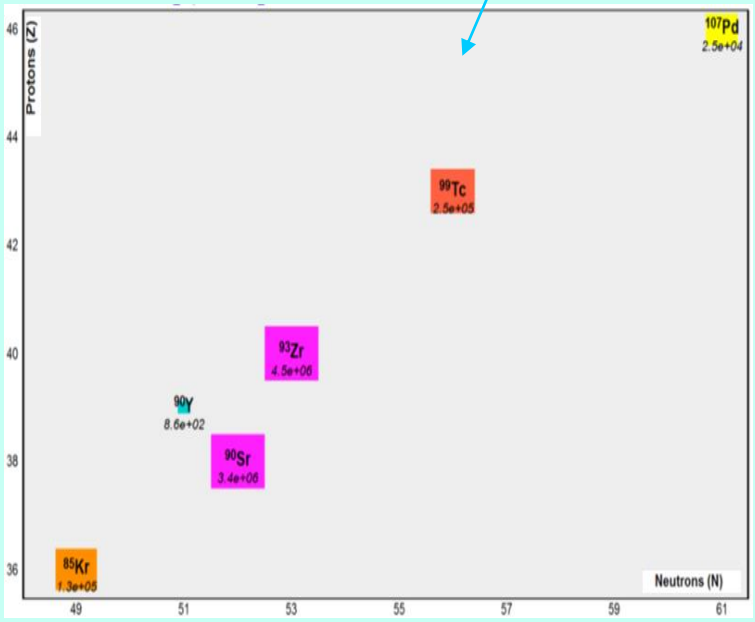


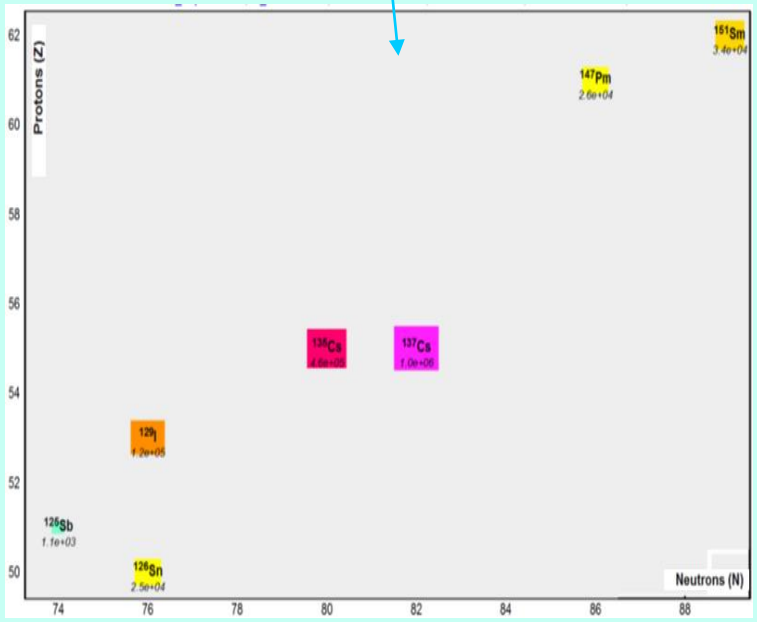


1000 years decay time

Only Radioactive residues

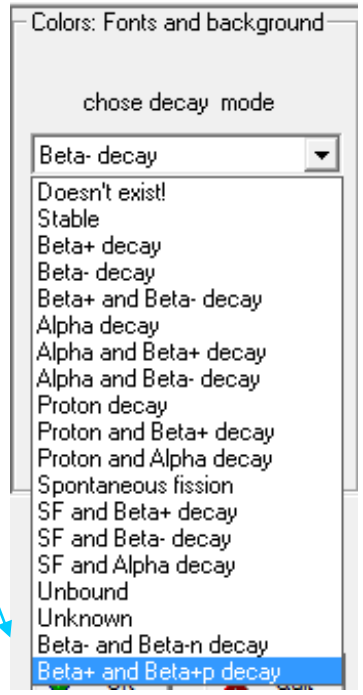


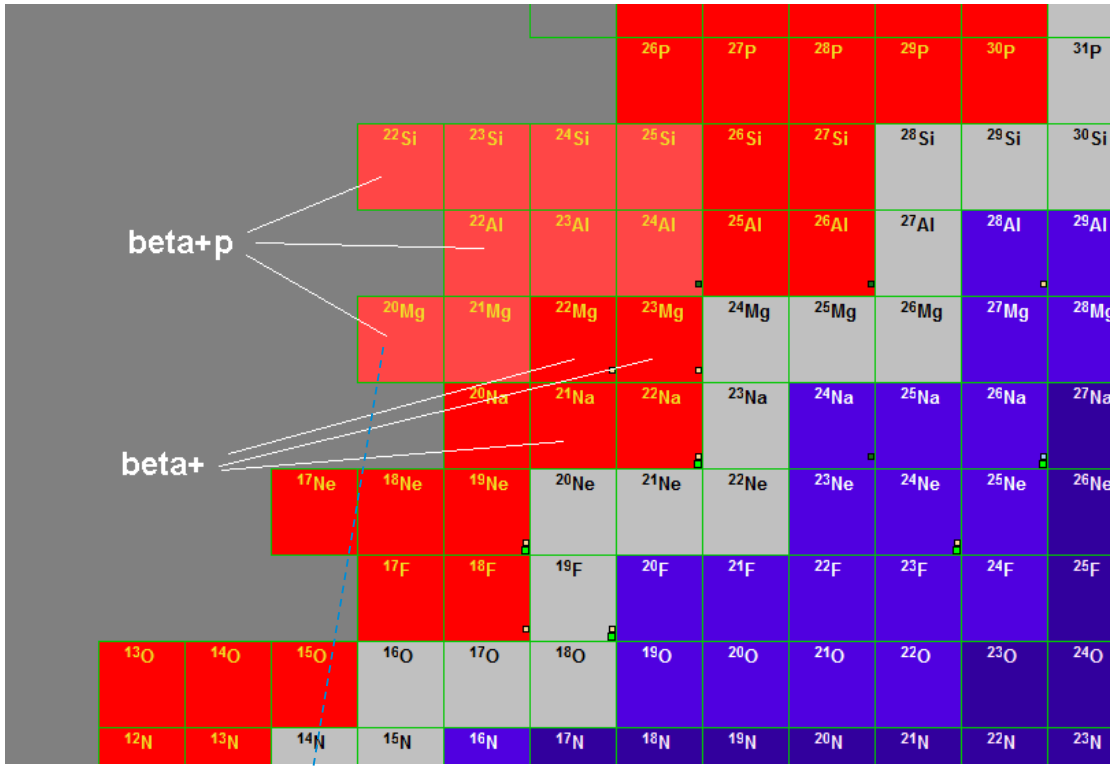


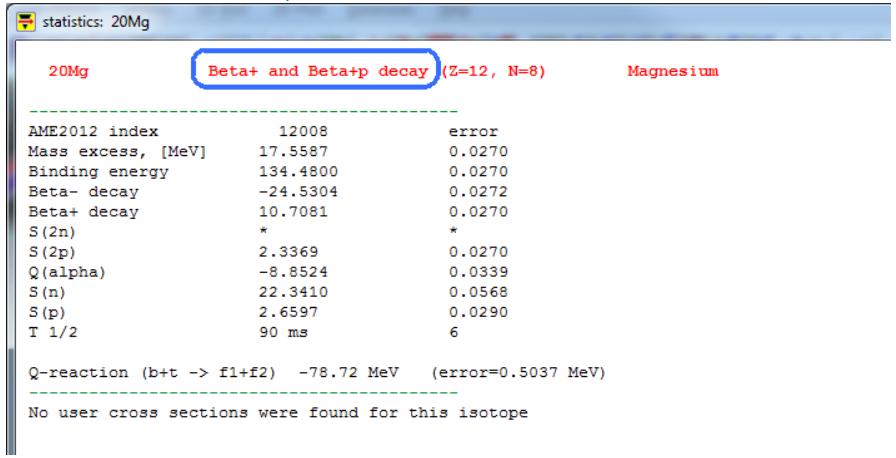


Decay Branching Ratio Database

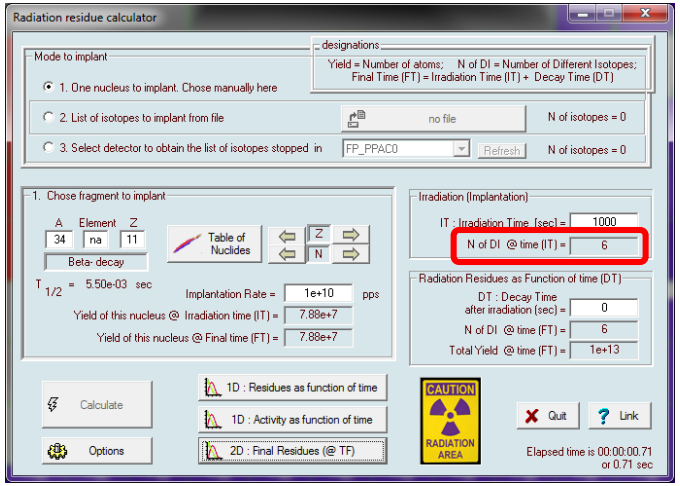
1. **Beta-Delayed Neutron Emission is new decay mode in LISE^{++}**
2. **Beta-Delayed Proton Emission is new decay mode in LISE^{++}**
3. **Decay branching ratio database**
4. **Editor of Decay branching ratio database**
5. **Using the Decay branching ratio database in Radiation Residue calculations**







v.9.10.331. No Decay Branch Database

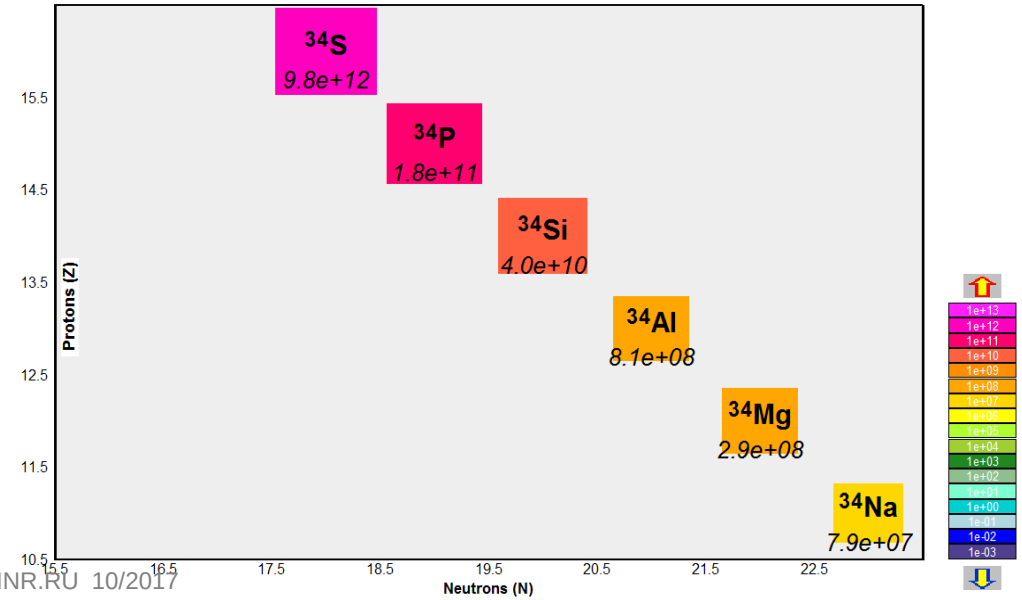


Radioactive decay residues

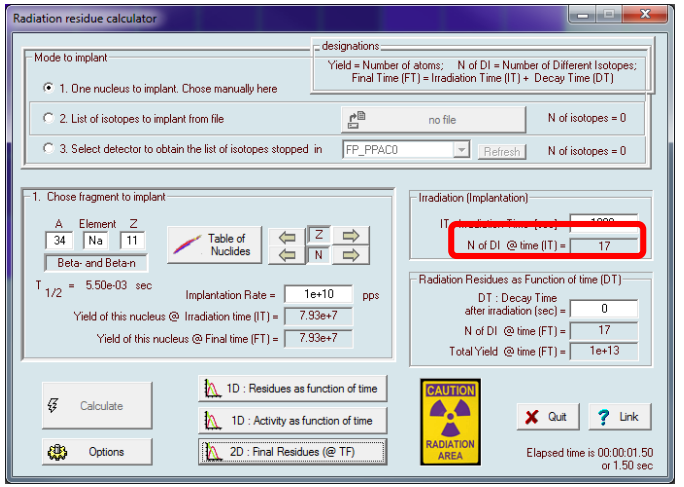
Initial isotope: ^{34}Na

Irradiation Time (IT) = 1.00e+03 sec; Decay Time (DT) = 1.00e-06 sec; Irr.Rate = 1.00e+10 pps; Plot All isotopes

N_Implant=100, N_Resid=1000, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



v.9.10.341. With Decay Branch Database

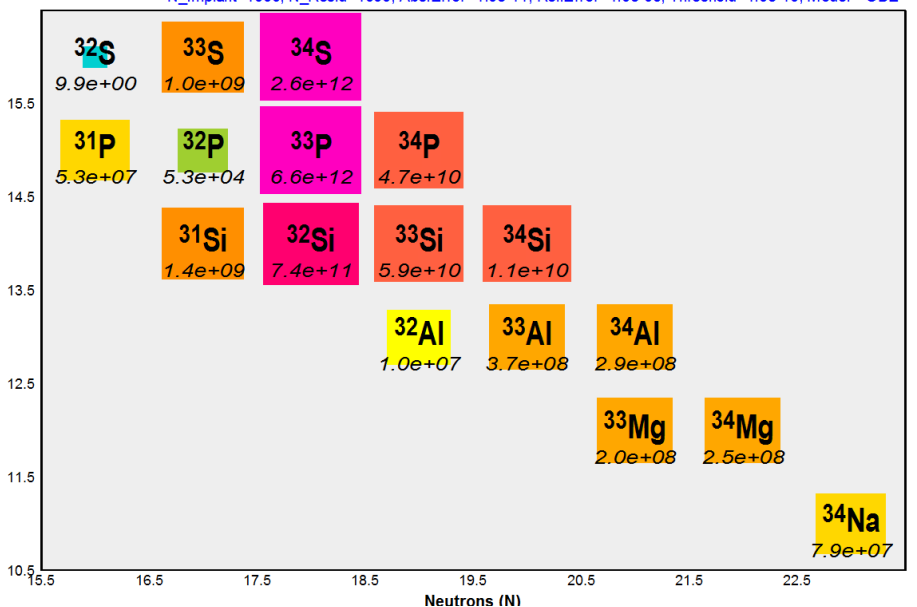


Radioactive decay residues

Initial isotope: ^{34}Na

Irradiation Time (IT) = 1.00e+03 sec; Decay Time (DT) = 1.00e-06 sec; Irr.Rate = 1.00e+10 pps; Plot All isotop

N_Implant=1000, N_Resid=1000, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"

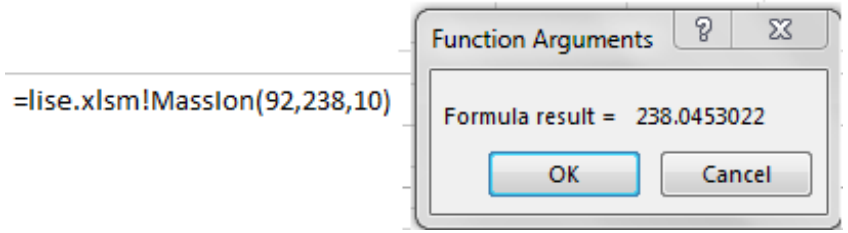


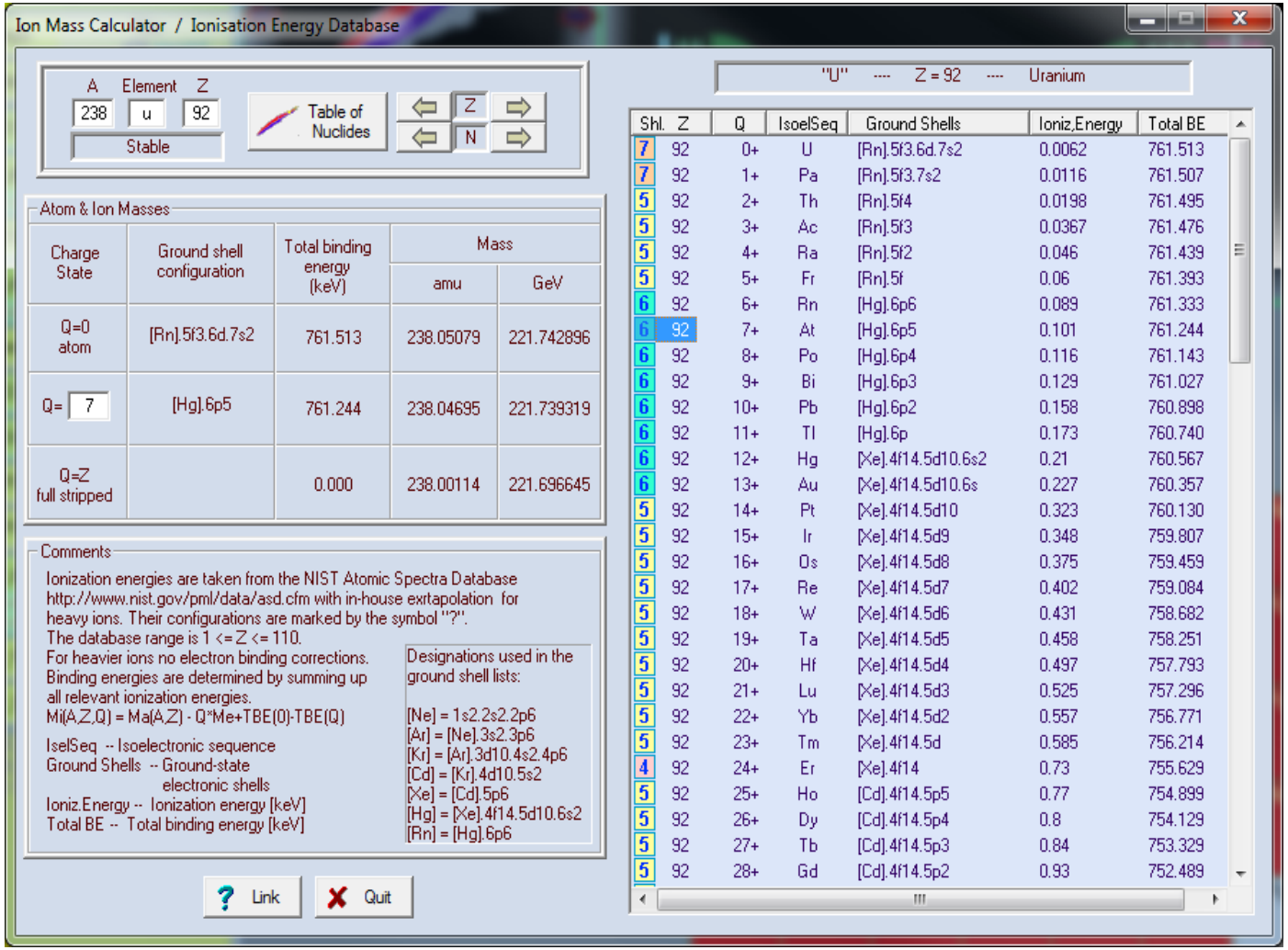
Ionization energy database & Ion mass calculator

$^{238}U^{92+}$ ion mass

- v.9.8.114 atomic mass was used 238.0508 amu
- v.9.8.117 correction for e- masses 238.0003 amu
- v.9.10.131 correction for e- binding energies 238.0011 amu

LISE for Excel new function



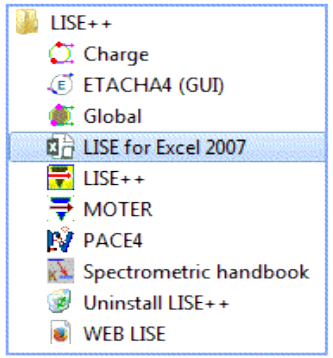


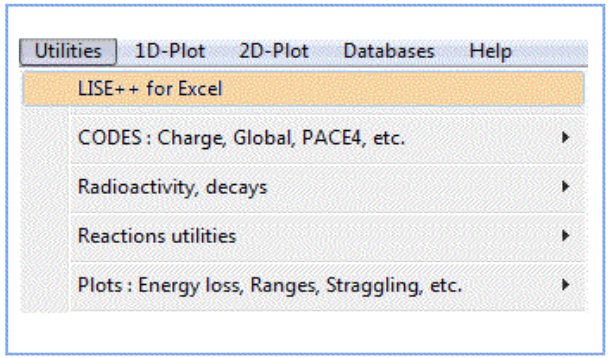
LISE++ for Excel

The opportunity of using the LISE++ computing package by other programs has appeared with implementation of dynamical libraries (LISE_atima.dll, LISE_Global.dll, LISE_loss.dll, and others) in the package. Some subroutines were moved from the LISE.exe main module to separate libraries (*.DLL), and can be executed from these libraries by other programs.

The modules of calculation of energy losses in matter, range in materials, straggling of range and energy losses, and also empirical parameterizations of cross sections (EPAX 2.15, EPAX 3.01) are available to be used for calculations in MS Excel through the LISE_xls.dll library. It is necessary to notice, that such opportunity exists only for the versions of the program LISE++ installed in a standard way, instead of taken from the "open version" directory. The libraries are placed by the installer to the directory "windows/system" ("windows/system32").

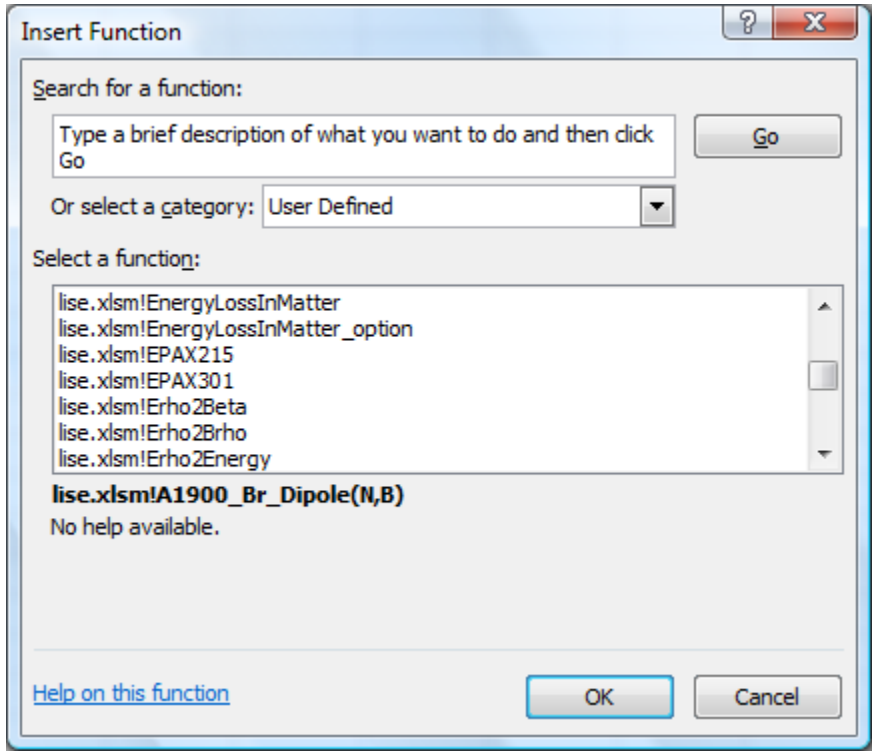
The LISE.XLSM is located in the LISE++ root directory, and its icon is available from the LISE++ folder (see Fig.1, left panel). Alternatively it is possible to run LISE.xlsm from the LISE++ code menu (see Fig.1, right panel).

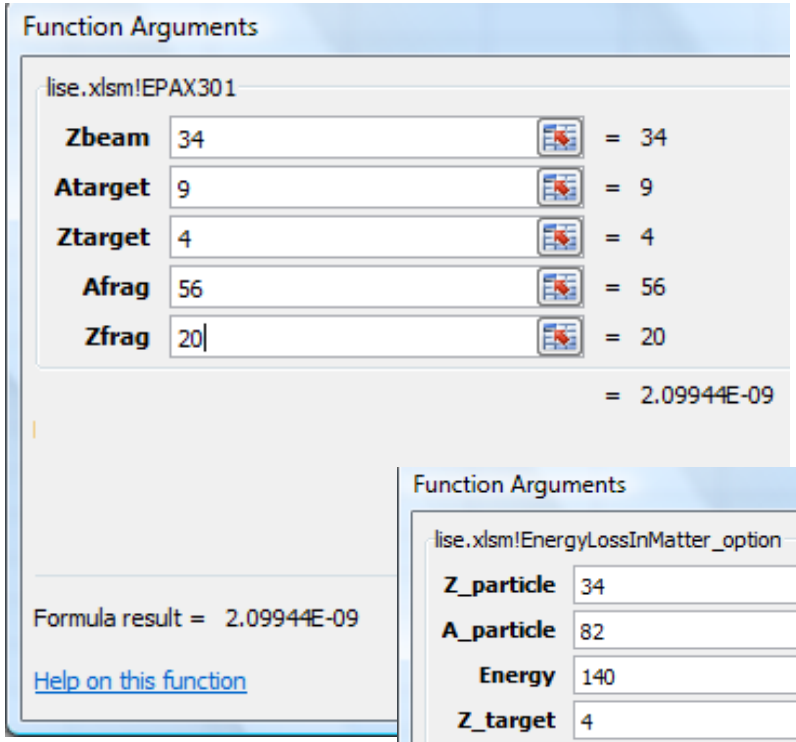


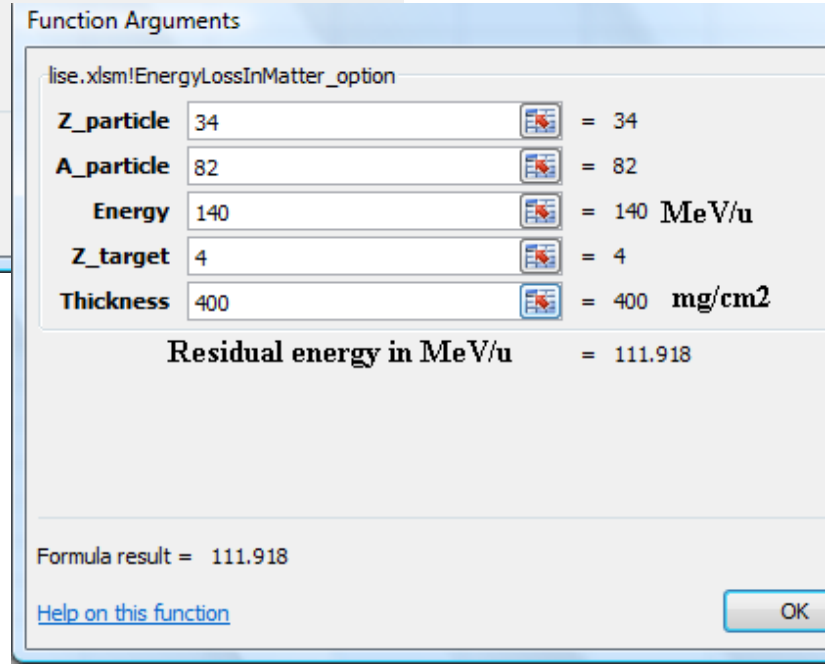


Energy loss calculation method	Charge State calculation methods	Energy Straggling calculation methods	names		
0 - Hubert	0 - Winger	0 - Anne	Zparticle=	92	
1 - Ziegler	1 - Leon	1 - ATIMA	Aparticle=	238	
2 - ATIMA	2 - Shima		Ztarget=	4	
	3 - Global+Winger		Atarget=	9	
	4 - Global+Leon		Energy=	100	MeV/u
	5 - Schiwietz (solid)		Thickness=	5	mg/cm2
			ZmQ=	1	
current state = 2	current state = 3	current state = 1	you may change		
Energy After Matter with option	**Residual energy in MeV/u**	Zparticle, Aparticle Energy [MeV/u], Ztarget Thickness [mg/cm2],option	**99.05**	MeV/u	
Range In Matter	**Range in mg/cm2**	Zparticle, Aparticle Energy [MeV/u] Ztarget	**337.57**	mg/cm2	
Range In Matter with option	**Range in mg/cm2**	Zparticle, Aparticle Energy [MeV/u] Ztarget, option	**369.62**	mg/cm2	
StragglingEnergy	**energy straggling in material [MeV/u]**	Zparticle, Aparticle Energy [MeV/u] Ztarget, Thickness [mg/cm2]	**0.009**	MeV/u	
StragglingRange	**range straggling in material [mg/cm2]**	Zparticle, Aparticle Energy [MeV/u] Ztarget	**0.279**	mg/cm2	
Stopping power	**Hubert - option=0**	Zparticle, Aparticle Energy [MeV/u] Ztarget	**44.95945**	MeV/(mg/cm2)	

LISE++ for Excel

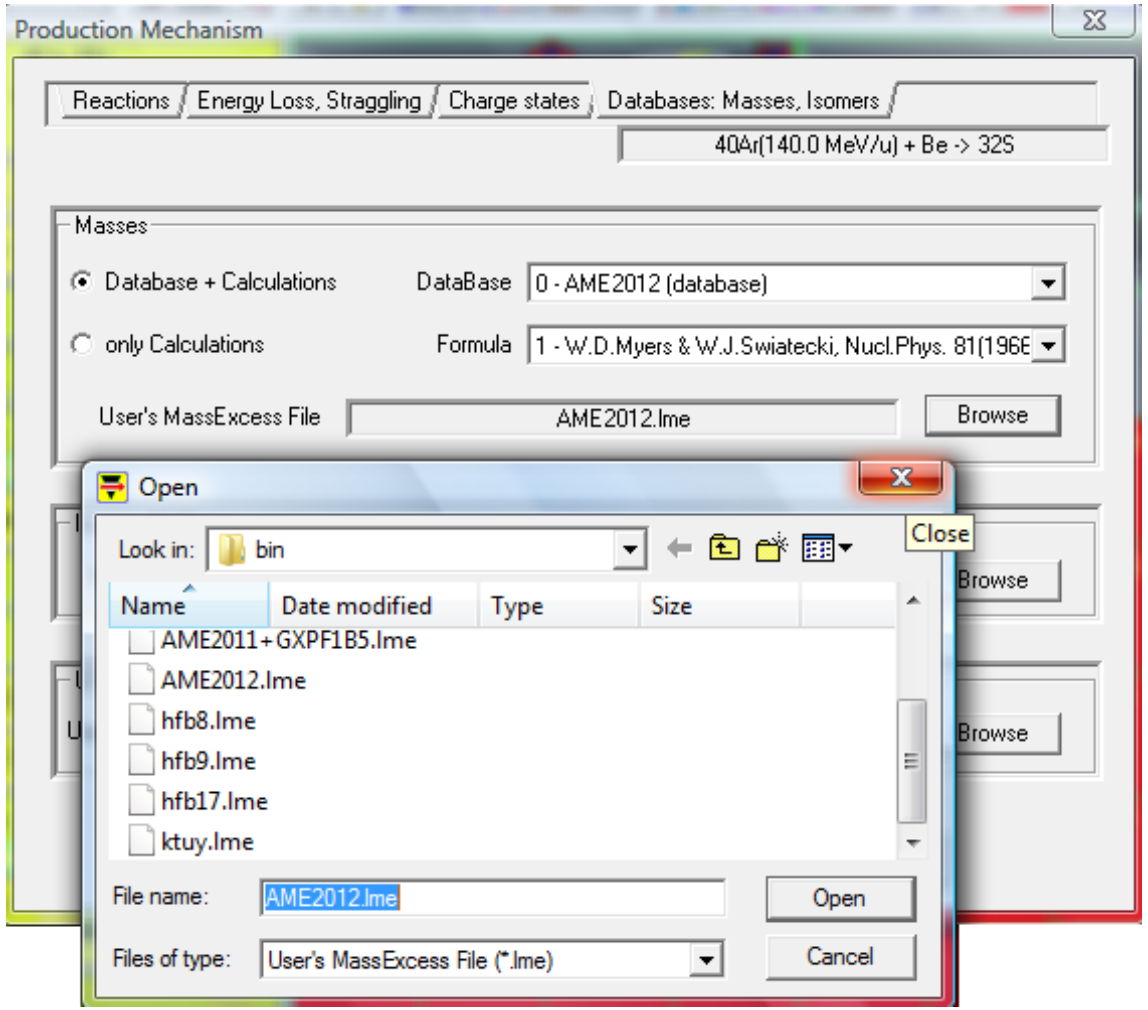


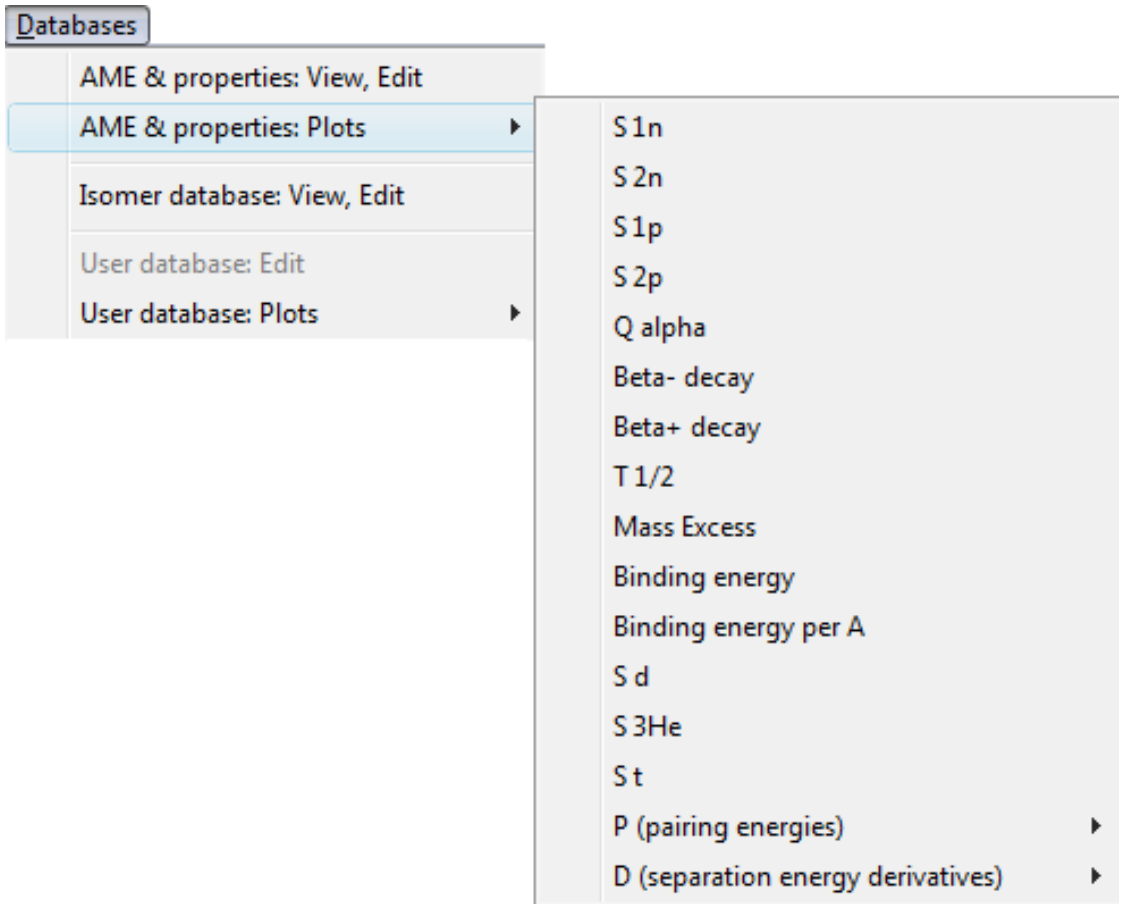




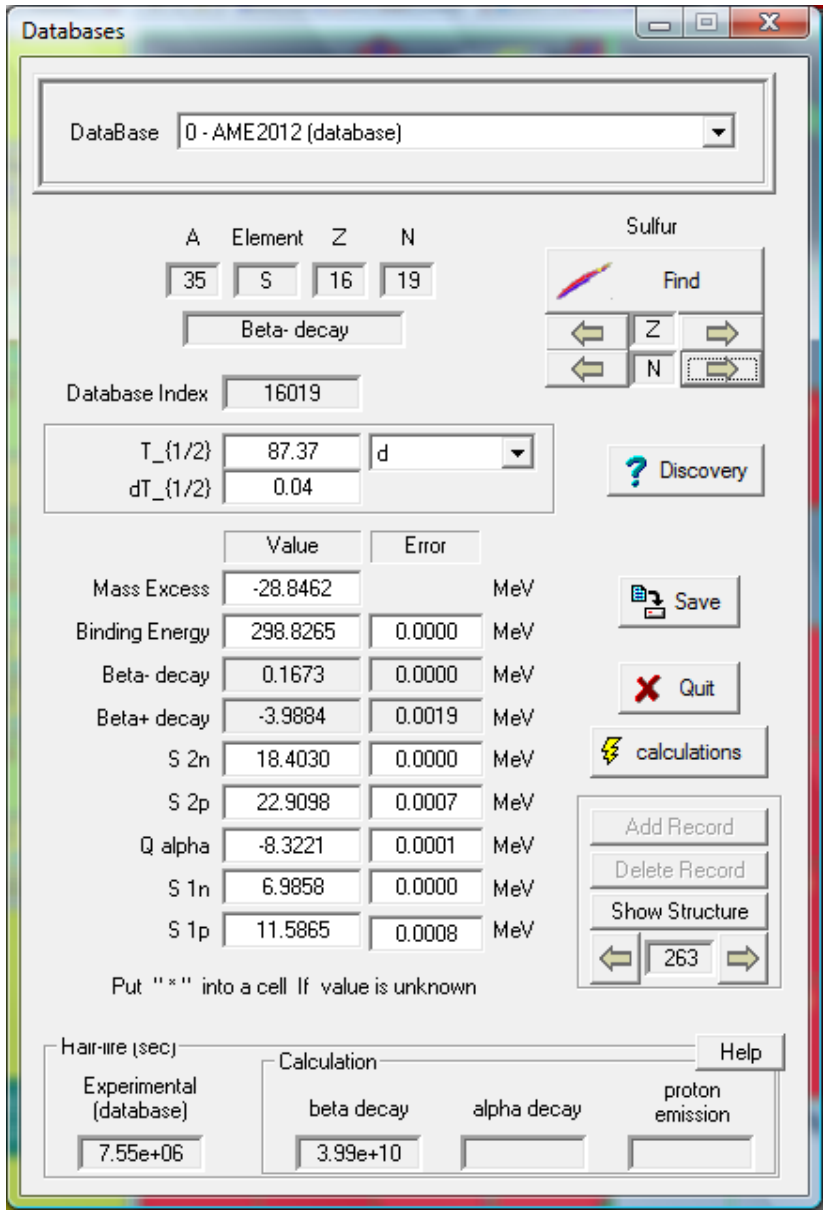
1	**A1900_Br_Dipole** (N of dipole,B_field)
2	**A1900_R_Dipole** (N of dipole,B_field)
3	**Beta2Brho** (beta, Mass, Q)
4	**Beta2Energy** (beta)
5	**Beta2Gamma** (beta)
6	**Brho2Beta** (Brho, mass, Q)
7	**Brho2Energy** (Brho, Mass, q)
8	**Brho2Momentum** (Brho, q)
9	**BrhoEnergy2Q** (Brho, Energy, Mass)
10	**Charge_dQ** (Energy, Z_particle, Z_target, Option)
11	**Charge_Qmean** (Energy, Z_particle, Z_target, Option)
12	**ChargeState** (Energy, Z_particle, Z_target, Z-q)
13	**ChargeState_option** (Energy, Z_particle, Z_target, Z-q, Option)
14	**Energy2Beta** (Energy)
15	**Energy2Brho** (Energy, Mass, Q)
16	**Energy2Gamma** (Energy)
17	**Energy2Momentum** (Energy, Mass)
18	**EnergyLossInMatter** (Z_particle, A_particle, Energy, Z_target , Thickness (mg/cm2))
19	**EnergyLossInMatter_option** (Z_particle, A_particle, Energy, Z_target , Thick (mg/cm2), Option)
20	**EPAX215** (Abeam, Zbeam, Atarget, Ztarget, Afrag, Zfrag)
21	**EPAX301** (Abeam, Zbeam, Atarget, Ztarget, Afrag, Zfrag)
22	**Erho2Beta** (Erho, Mass,Q)
23	**Erho2Brho** (Erho, Mass,Q)
24	**Erho2Energy** (Erho, Mass,Q)
25	**Find_Line** (x1, y1, x2, y2, X)
26	**Find_Parabola** (x1, y1, x2, y2, x3, y3, X)
27	**Gamma2Beta** (gamma)
28	**Gamma2Energy** (gamma)
29	**GlobalCode** ([Z-q]_out, Ab, Zb, [Z-q]_in, Energy, At, Zt, Thick (mg/cm2), Option, Fast)
30	**Interpolate2** (X_array, Y_array, X)
31	**Interpolate3** (X_array, Y_array, X)
32	**Mass** (Z)
33	**MassIon** (Z, A, q)
34	**MassIsotope** (Z, A)
35	**MatricesMult** (Matrix1, Matrix2, Row, Column)
36	**Matrix2OrderVectorMult**(Matrix, Vector)
37	**MatrixElement** (Matrix, Row, Column)
38	**MatrixVectorMult** (Matrix, Vector, Row)
39	**MatrixVectorSumSquare** (Matrix, Vector, Row)
40	**Mg2Mkm** (ThickMg, Z)
41	**Mkm2Mg** (ThickMkm, Z)
42	**Momentum2Brho** (Momentum, Q)
43	**Momentum2Energy** (Momentum, Mass)
44	**MyGauss** (X, X_mean, Sigma)
45	**MyGaussAsym** (X, X_peak, Sigma, Asymmetry)
46	**NumberEvents** (A_target, CS (mb), Flux , TargetThickness (mg/cm2))
47	**RangeInMatter** (Zparticle, Aparticle, Energy, Ztarget)
48	**RangeInMatter_optiuon** (Zparticle, Aparticle, Energy, Ztarget, Range_option)
49	**S_Accident** (Average, Sigma)
50	**S_AreaXY** (X_array, Y_array)
51	**S_AreaXYwithError** (X_array, Y_array, Yerror_array, Ref [0-Area/1-dArea])
52	**S_AssymXY** (Xmean(XY), Sigma(XY), X_array, Y_array)
53	**S_AverageXwithError** (X_array, Xerror_array, Ref [0-Area/1-dArea])
54	**S_AverageXY** (X_array, Y_array)
55	**S_AverageXY_Error** (X_array, Y_array)
56	**S_AverageXY_Error_instr** (X_array, Y_array, Error_array)
57	**S_chi_sq** (Experimental value, Calculated value)
58	**S_chi_sq_sum** (Experimental array, Calculated array)
59	**S_rounded_rectangle** (X, left Boundary, Right Boundary, Sigma)
60	**S_SigmaXY** (XmeanXY, X_array, Y_array)
61	**S_SigmaXY_error** (X_array, Y_array)
62	**S_SigmaXY_Error_instr** (X_array, Y_array, E_array)
63	**SchiwietzGas** (Energy, Z_particle, Z_target, Z-q)
64	**Show_Element** (Z_element)
65	**Show_Z** (Name of element)
66	**ShowOption** (Option)
67	**StoppingPower** (Z_particle, A_particle, Energy, Z_target, Option)
68	**StragglingEnergy** (Z_particle, A_particle, Energy, Z_target, Thickness)
69	**StragglingRange** (Z_particle, A_particle, Energy, Z_target)

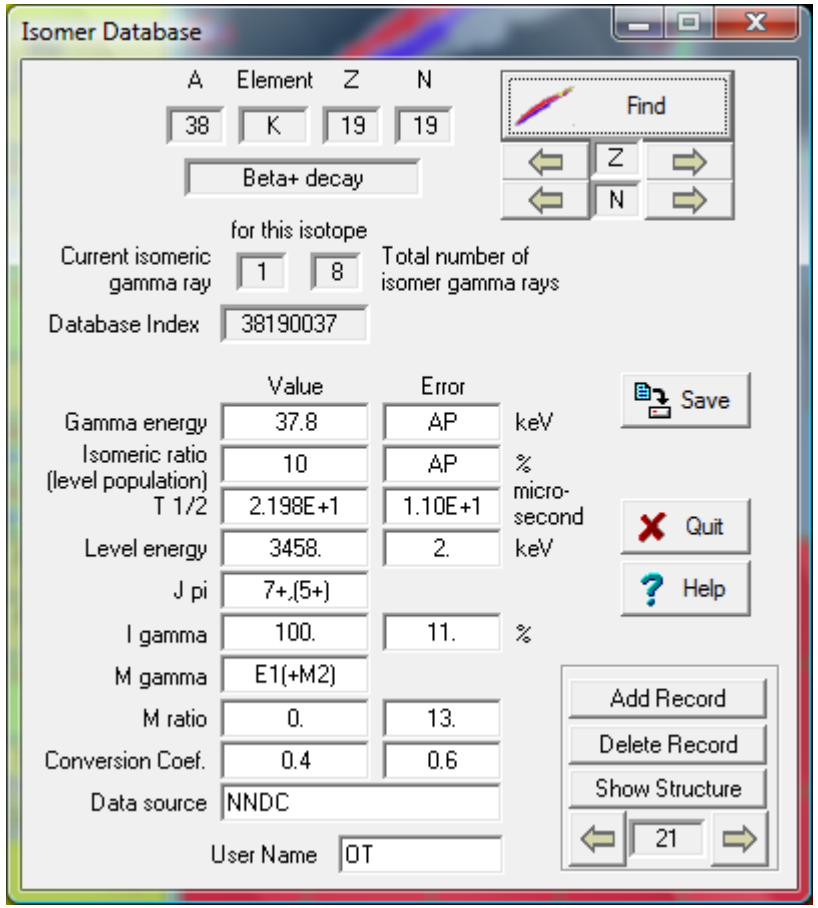
Nuclide and Isomeric states Databases utilities



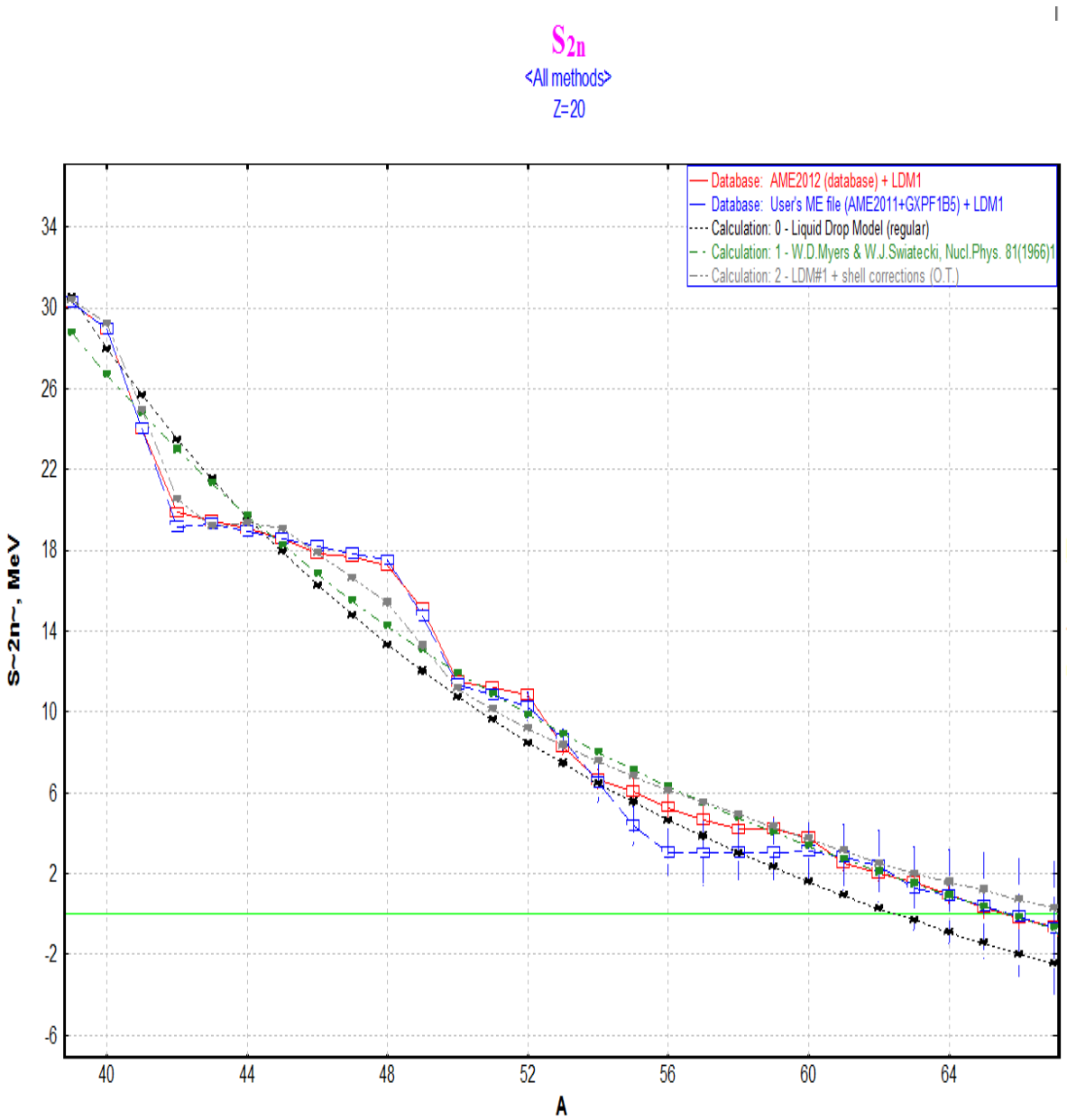


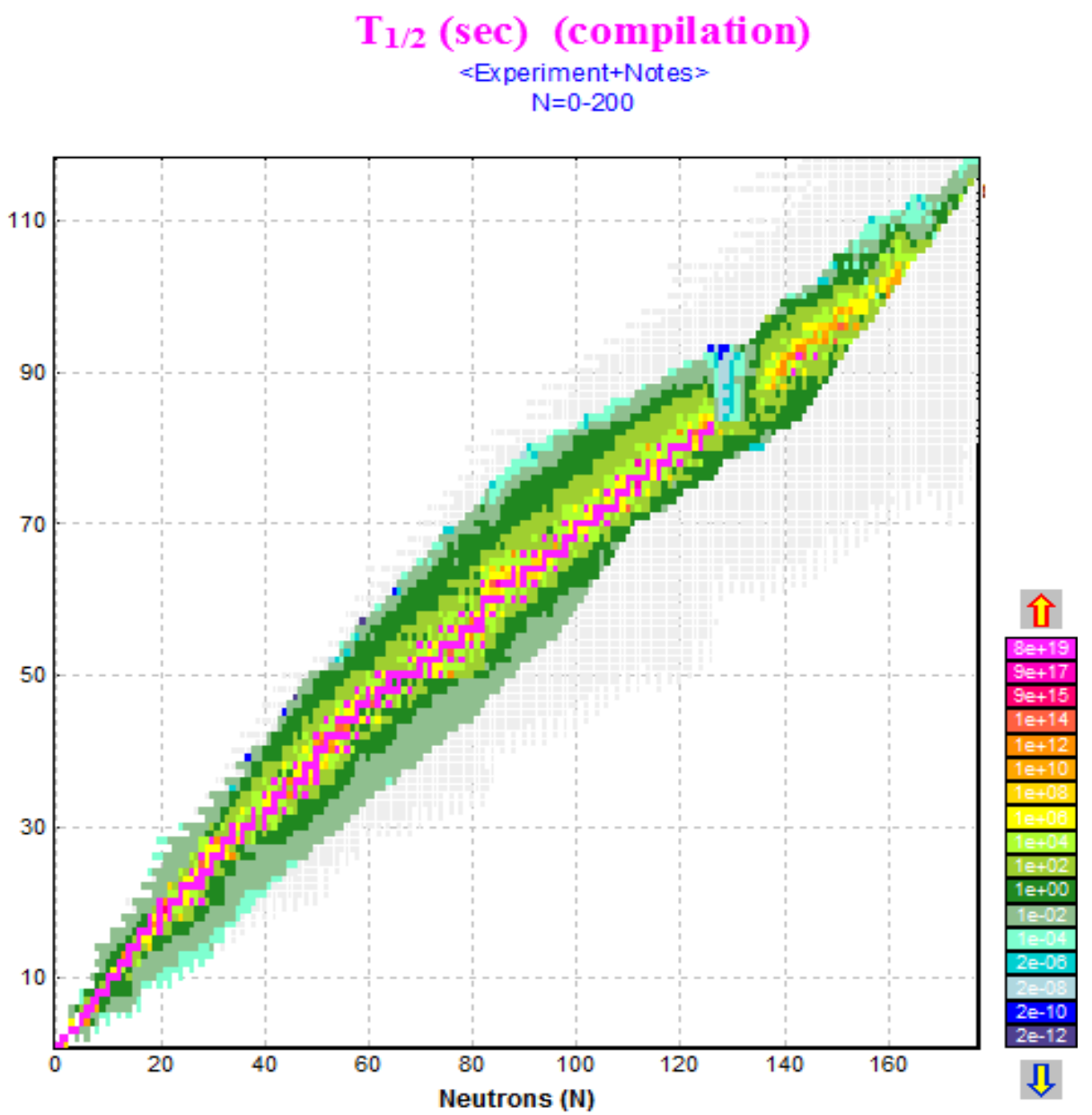
Nuclide and Isomeric states Databases utilities





Nuclide and Isomeric states Databases utilities



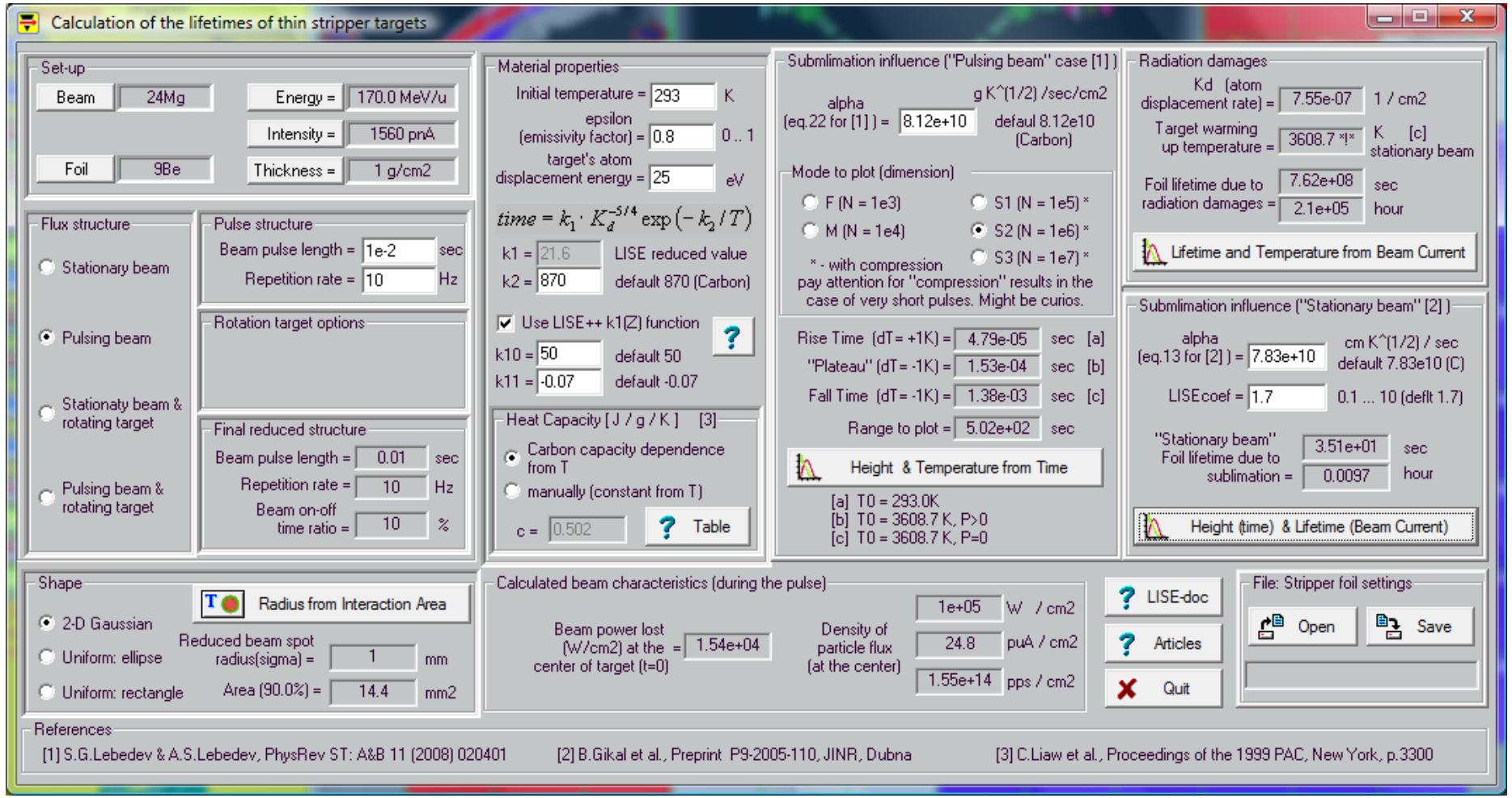


Stripper foil time

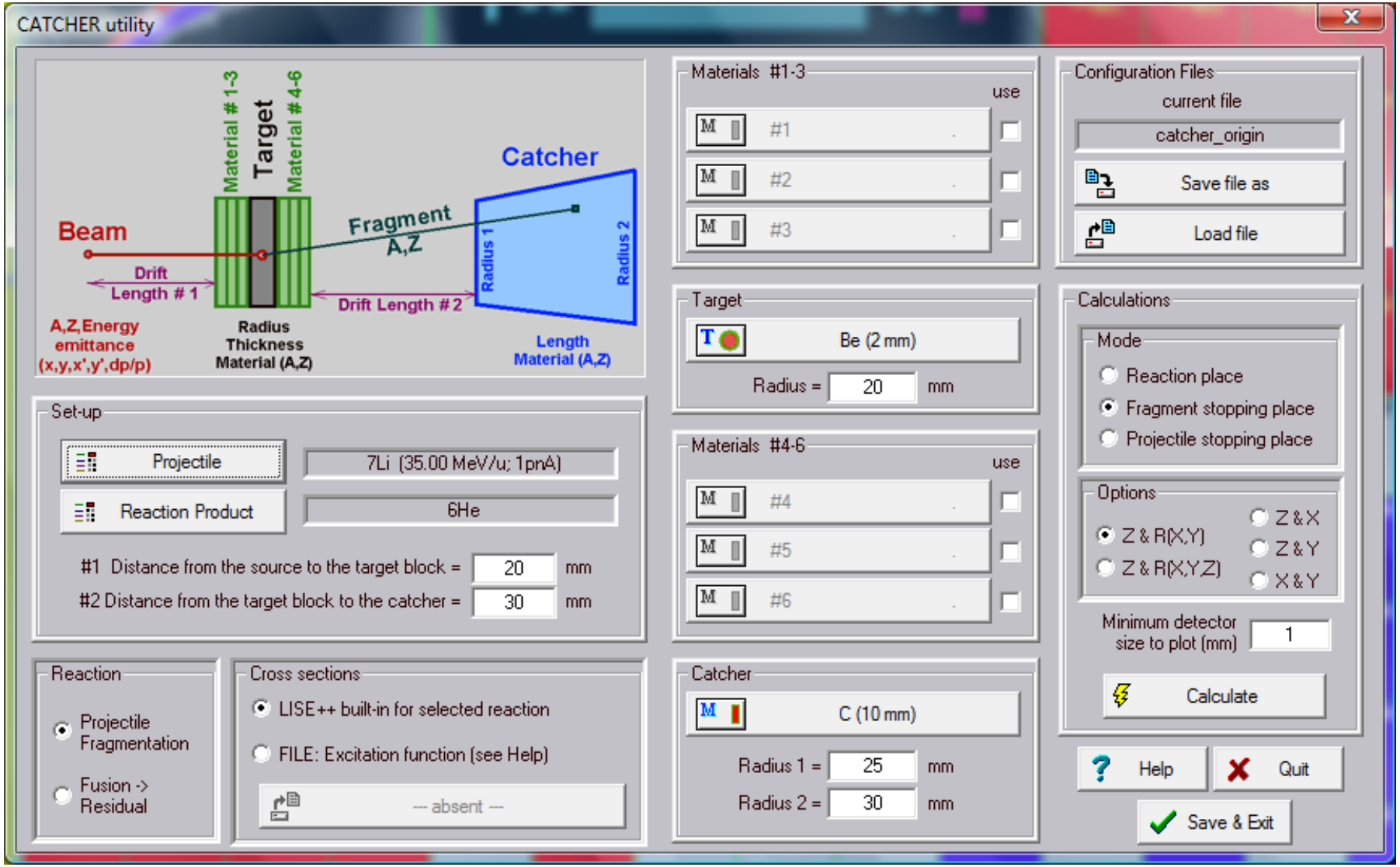
http://lise.nscl.msu.edu/doc/foil/part1_foil_lifetime_v_8_3_6.pdf

http://lise.nscl.msu.edu/doc/foil/part2_foil_lifetime_v_8_3_13.pdf

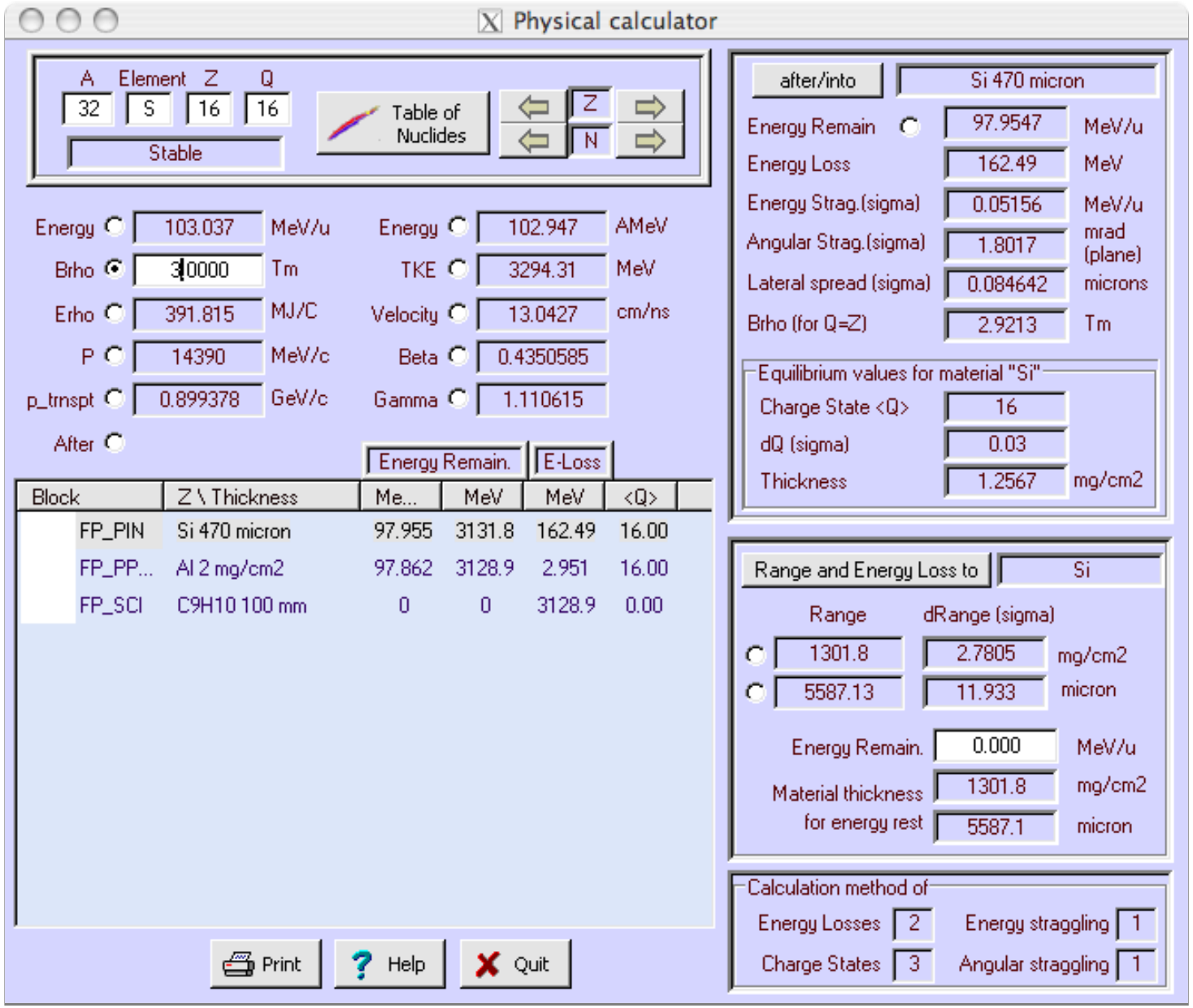
http://lise.nscl.msu.edu/doc/foil/part3_foil_lifetime_v_9_2_38.pdf



ISOL catcher utility



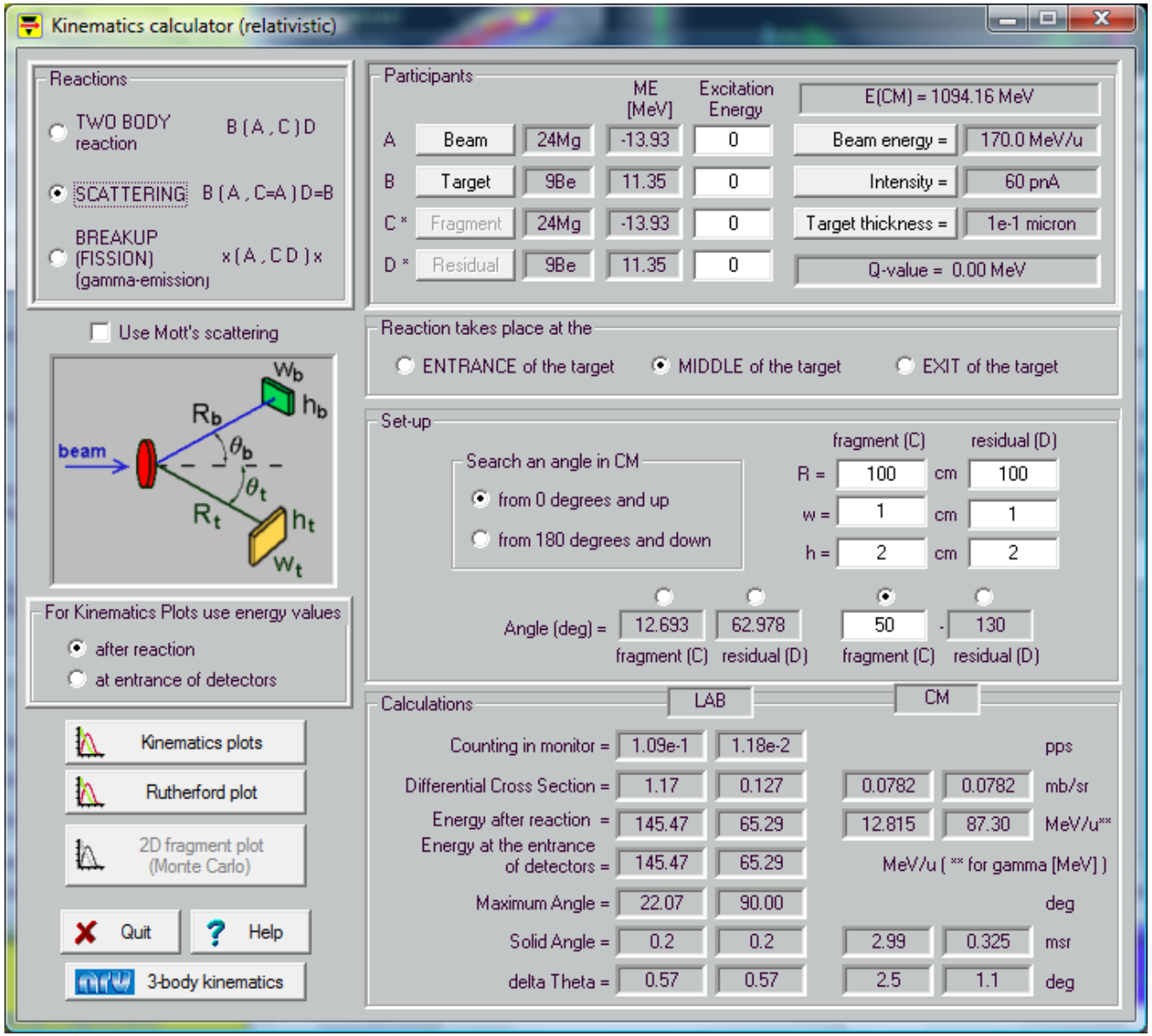
Physical calculator



- Convert energy, momentum, magnetic rigidity seamlessly
- Calculate energy loss, range, angular and energy straggling
- “Backwards” modes to find energy of particles based on their energy loss or range

Relativistic Kinematic Calculator

- Calculate two-body, elastic scattering or breakup kinematics
- Results in laboratory and center of mass systems
- Kinematics results can be exported to file



Evaporation calculator