

v.9.10.322
from 07/18/16

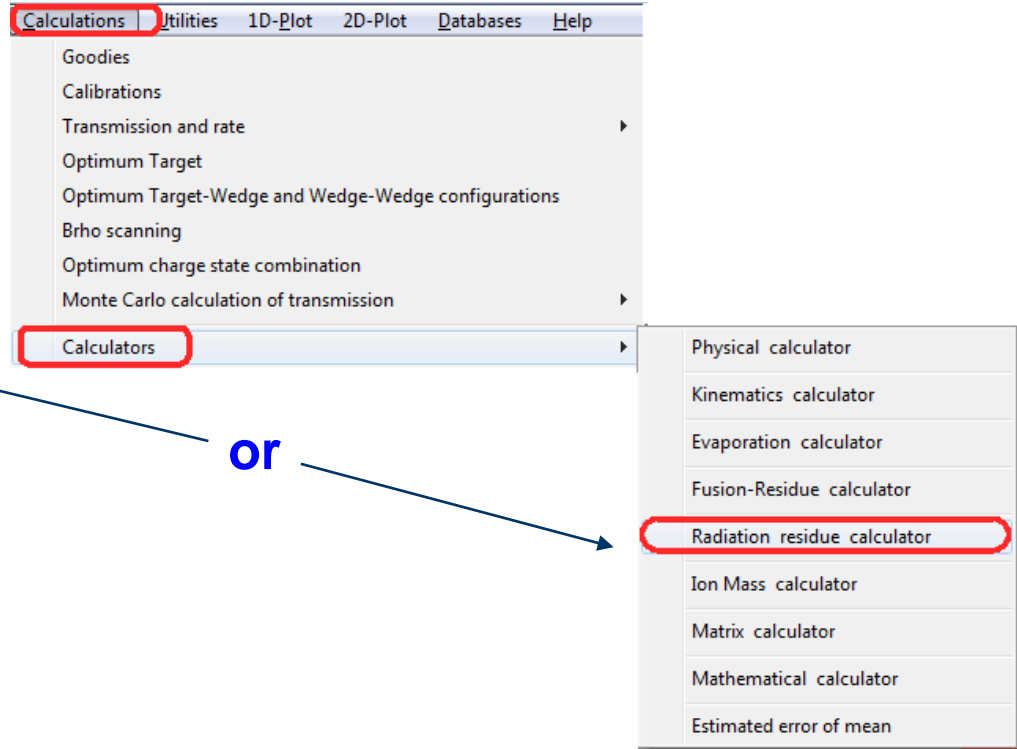
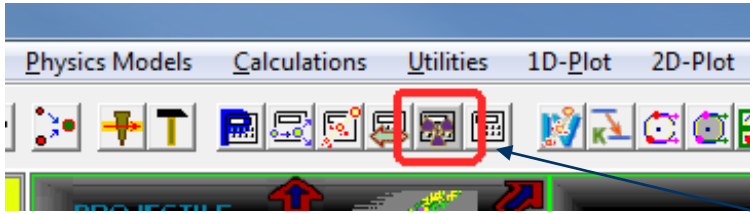
Update
v.9.10.332
from 08/01/16

Update
v.9.10.372
from 11/01/16

- Introduction
- Modes
- Plots
- Options
- Options : $T_{1/2}$ bounds
- ^{238}U fission case calculation
- ^{229}Th case
- “He-jet” case calculation

- ^{44}Ti case
- Isotope Production in Beam dump:
 - * *Fragmentation case;*
 - * *Uranium case*
- “Stiffness” problem
- Using the decay branching ratio database in Radiation Residue calculations
- Final page





or

- About 7300 differential equations
- 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

v.1

Integration model

- ODE (ordinary differential equation solver) ISBN: 0716704617
- RKF45 (Runge-Kutta-Fehlberg ODE solver)

*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

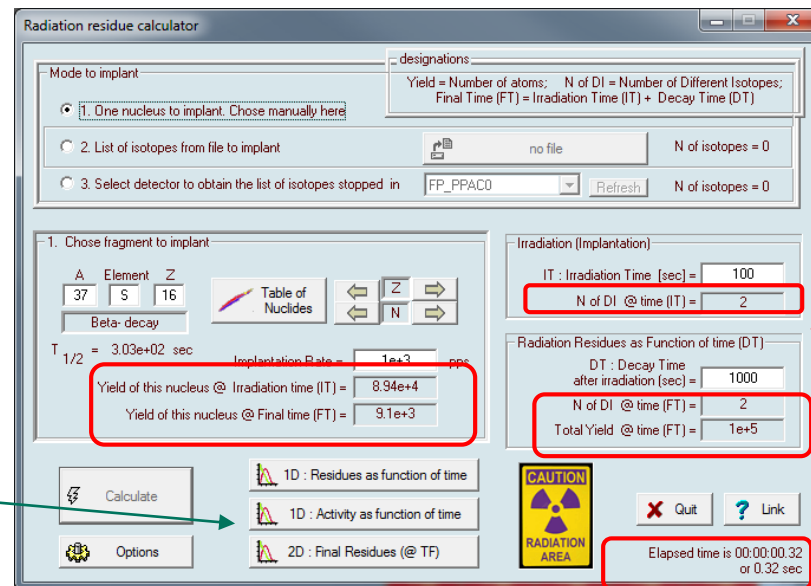
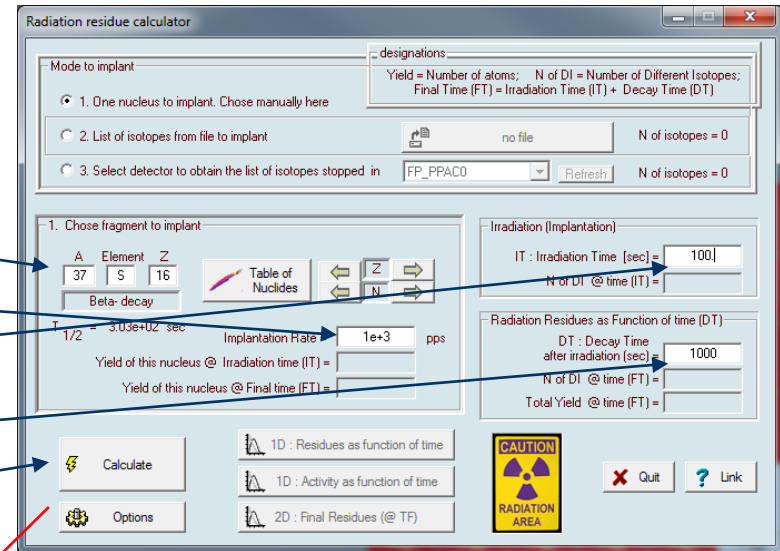
Integration model

- ODE (ordinary differential equation solver) ISBN: 0716704617
- RKF45 (Runge-Kutta-Fehlberg ODE solver)
- Numerical Recipes: ODEINT
- Numerical Recipes: STIFF
- Numerical Recipes: STIFBS

Numerical Recipes in ANSI C++ 2.11

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

- Select nucleus
- Set irradiation rate
- Set irradiation time
- Set Decay time
- Press button “Calculate”



“Plots” buttons became enable

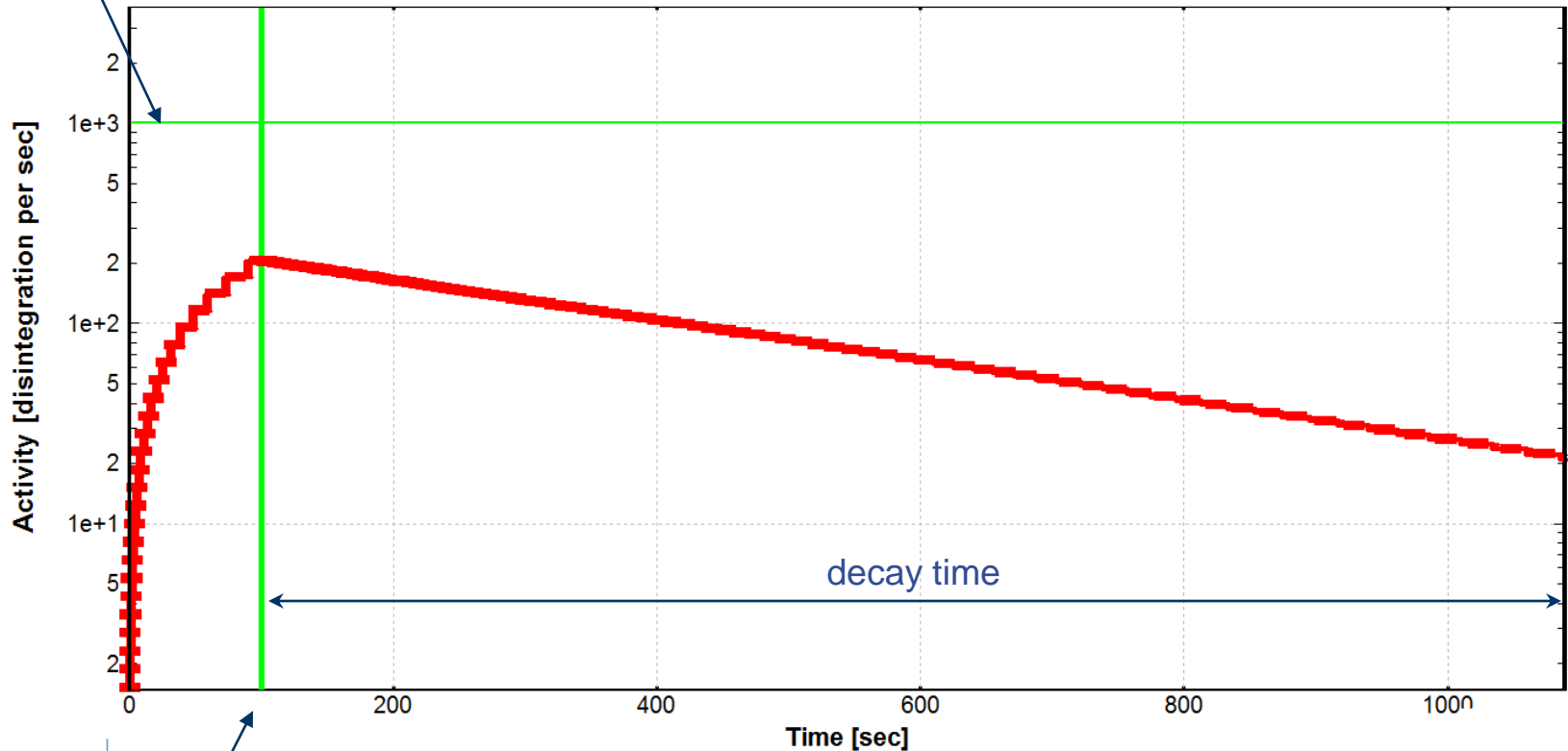
Information about calculation results, and elapsed time

This horizontal time shows the irradiation rate

Activity

Initial isotope: ^{37}S

Irradiation Time (IT) = $1.00\text{e}+02$ sec; Decay Time (DT) = $1.00\text{e}+03$ sec; Irr.Rate = $1.00\text{e}+03$ pps; Plot All isotopes
N_Implant=100, N_Resid=100, Abs.Error= $1.0\text{e}-11$, Rel.Error= $1.0\text{e}-03$, Threshold= $1.0\text{e}-10$, Model="ODE"



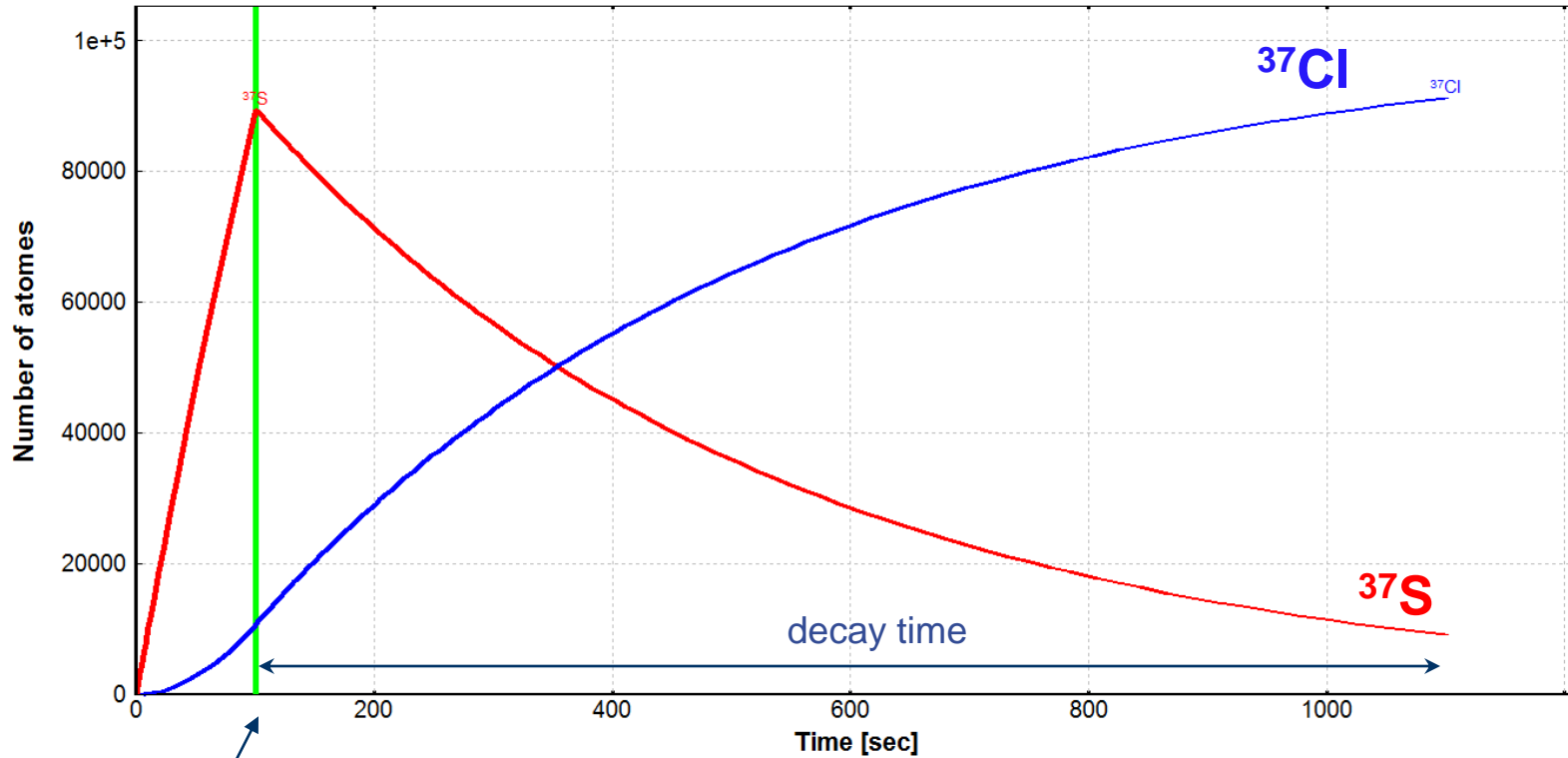
This vertical time shows the irradiation time

decay time

Evolution of Radiation Residue Yield

Initial isotope: ^{37}S

Irradiation Time (IT) = $1.00\text{e}+02$ sec; Decay Time (DT) = $1.00\text{e}+03$ sec; Irr.Rate = $1.00\text{e}+03$ pps; Plot All isotopes
 $N_{\text{Implant}}=100$, $N_{\text{Resid}}=100$, Abs.Error= $1.0\text{e}-11$, Rel.Error= $1.0\text{e}-03$, Threshold= $1.0\text{e}-10$, Model="ODE"



This vertical time shows the irradiation time

Modes : One Selected Nucleus → ³⁷Na example

1. Chose fragment to implant

A	Element	Z
37	na	11

Beta- decay Table of Nuclides

T_{1/2} = 1.74e-03 sec

Implantation speed (RATE) = 1e+3 pps

Yield of this nucleus @ implantation time (TI) = 2.51

Yield of this nucleus @ Final time (TF) = 0

Implantation

Implantation TIME (TI) = 10 sec

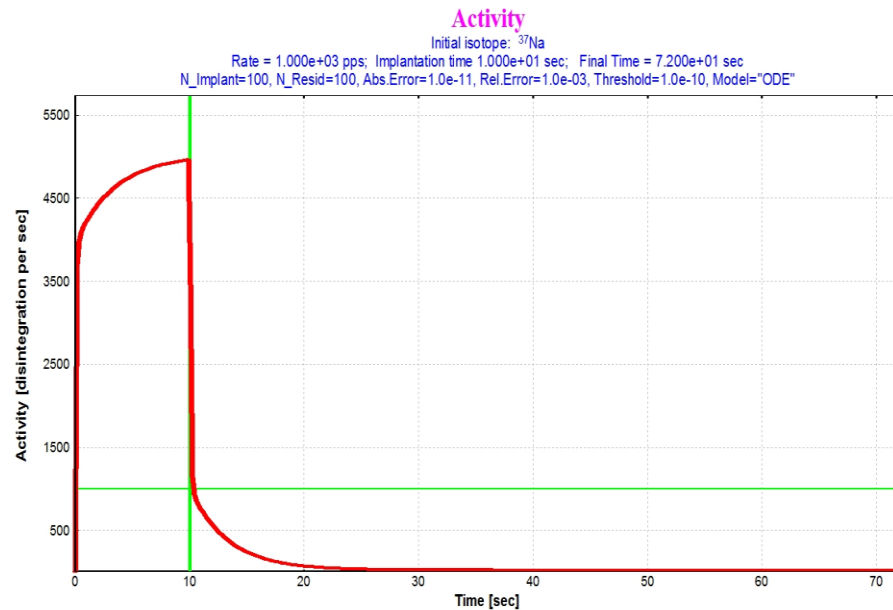
Number of isotopes @ time (TI) = 7

Radiation Residues as Function of time (TF)

Final Time (TF) to calculate residues = 72 sec

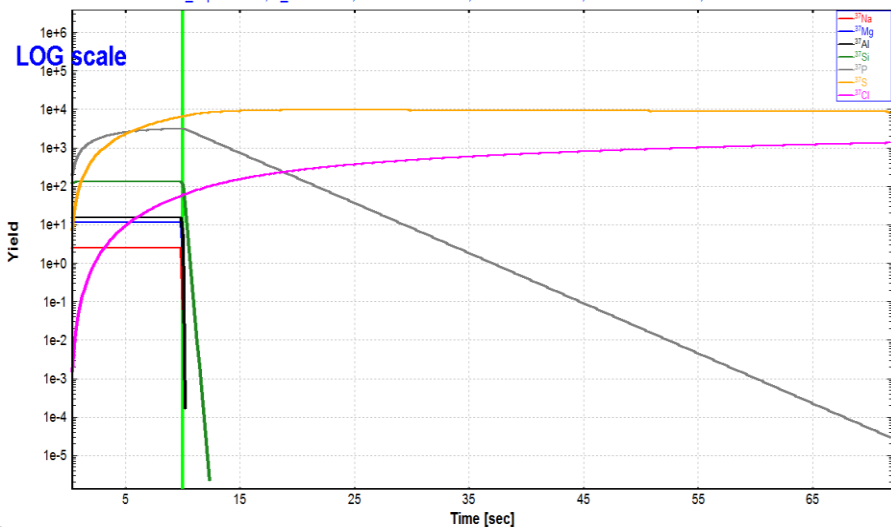
Number of isotopes @ time (TF) = 3

Total Residues Yield @ time (TF) = 1e+4



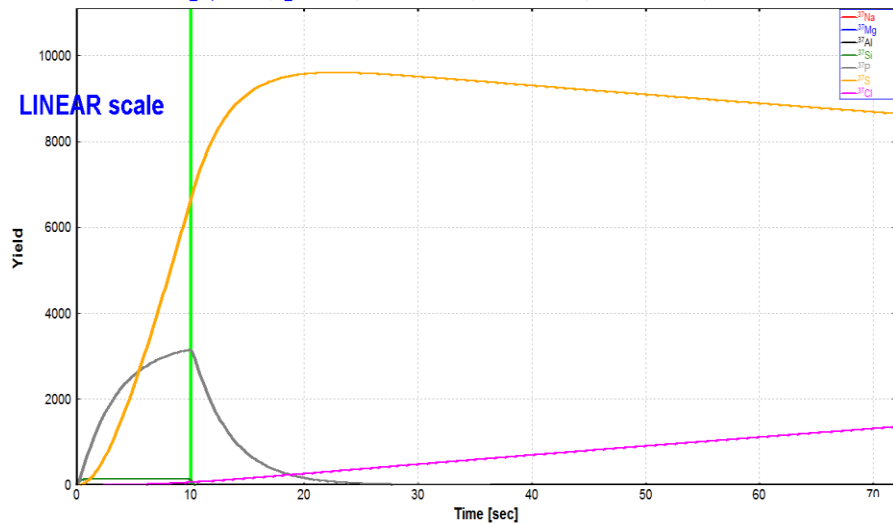
Evolution of Radiation Residue Yield

Initial isotope: ³⁷Na
 Rate = 1.000e+03 pps; Implantation time 1.000e+01 sec; Final Time = 7.200e+01 sec
 N_Implant=100, N_Resid=100, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



Evolution of Radiation Residue Yield

Initial isotope: ³⁷Na
 Rate = 1.000e+03 pps; Implantation time 1.000e+01 sec; Final Time = 7.200e+01 sec
 N_Implant=100, N_Resid=100, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



Modes : List of Isotopes to implant from file

Radiation residue calculator

Mode to implant

- 1. One nucleus to implant. Chose manually here
- 2. List of isotopes from file to implant
- 3. Select detector to obtain the list of isotopes stopped in

designations

Yield = Number of atoms; N of DI = Number of Different Isotopes;
Final Time (FT) = Irradiation Time (IT) + Decay Time (DT)

no file N of isotopes = 0

FP_PPAC0 Refresh N of isotopes = 0

Total Irradiation Rate

Rate = 0.000e+00 pps

CAUTION RADIATION AREA

Calculate Options

1D : Residues as function of time
1D : Activity as function of time
2D : Final Residues (@ TF)

List of isotopes from file to implant in material

Open file View file Clear

Save isotopes implanted in selected detector to file

--- absent ---

Rows = OK Cancel

Note

The Implanted Isotope list file is in ASCII format.
Comment string begin with "!" or "!"

The Columns can be separated by a Space, a Comma or a Tabulation. User can put comments after the data.

There are three columns: "Z", "N", "Rate"
where Z is atomic number, N is number of neutrons.
"Rate" is the isotope implantation rate (counts per second)

Open

Look in: files

Name	Date modified	Type
examples	2/1/2016 5:01 PM	Fi
foils	5/21/2015 10:40 AM	Fi
list1.radlist	7/11/2016 1:54 PM	Ru
list2.radlist	7/11/2016 4:03 PM	Ru

File name: list2.radlist

Files of type: List of implanted isotopes (*.radlist)

Open Cancel

List of isotopes from file to implant in material

Open file View file Clear

Save isotopes implanted in selected detector to file

list2.radlist

Rows = 7 OK Cancel

Note

The Implanted Isotope list file is in ASCII format.
Comment string begin with "!" or "!"

The Columns can be separated by a Space, a Comma or a Tabulation. User can put comments after the data.

There are three columns: "Z", "N", "Rate"
where Z is atomic number, N is number of neutrons.
"Rate" is the isotope implantation rate (counts per second)

C:\user\c\vise_pp_910\files\list2.radlist

Z	N	Rate
13	24	100
13	25	100
13	26	100
13	27	100
13	28	100
13	29	100
13	30	100

Options

Isotopes to plot

- ALL (Stable & Radioactive)
- only Radioactive
- only Stable

Radiation residue calculator

Mode to implant

- 1. One nucleus to implant. Chose manually here
- 2. List of isotopes from file to implant
- 3. Select detector to obtain the list of isotopes stopped in

designations: Yield = Number of atoms; N of DI = Number of Different Isotopes; Final Time (FT) = Irradiation Time (IT) + Decay Time (DT)

File: "list2.radlist" N of isotopes = 7

FP_PPACD Refresh N of isotopes = 0

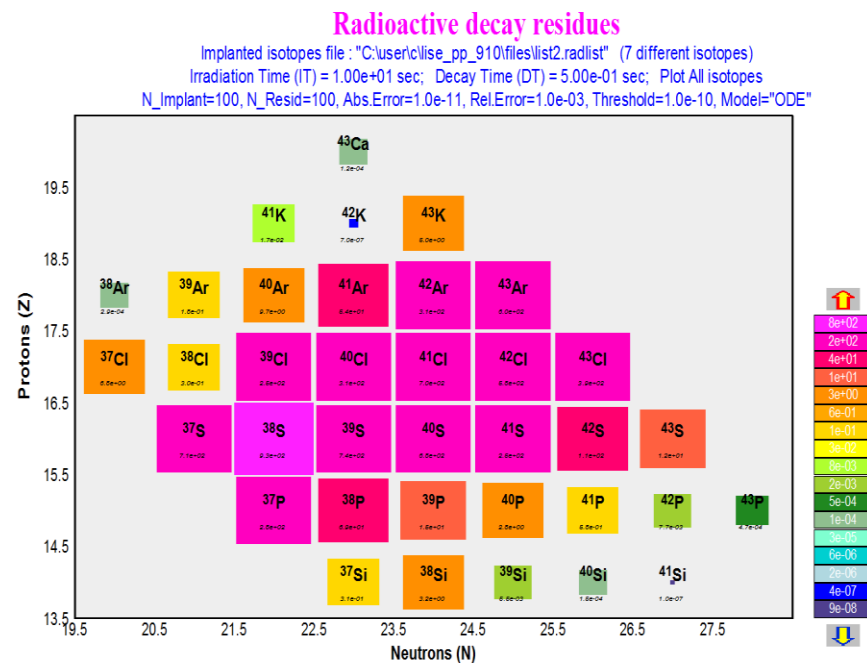
Total Irradiation Rate: Rate = 7.000e+02 pps

Irradiation (Implantation): IT: Irradiation Time [sec] = 10; N of DI @ time (IT) = 45

Radiation Residues as Function of time (DT): DT: Decay Time after irradiation (sec) = 0.5; N of DI @ time (FT) = 36; Total Yield @ time (FT) = 7e+3

Buttons: Calculate, Options, 1D: Residues as function of time, 1D: Activity as function of time, 2D: Final Residues (@ TF), Quit, Link

Elapsed time is 00:00:06.11 or 6.11 sec



Options

Isotopes to plot

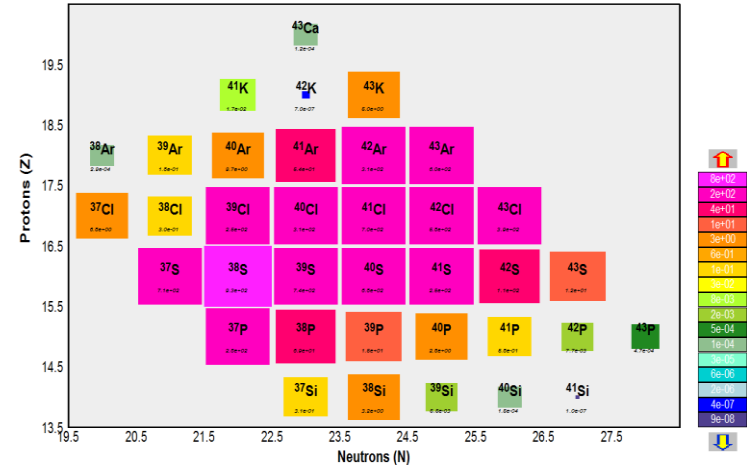
ALL (Stable & Radioactive)

only Radioactive

only Stable

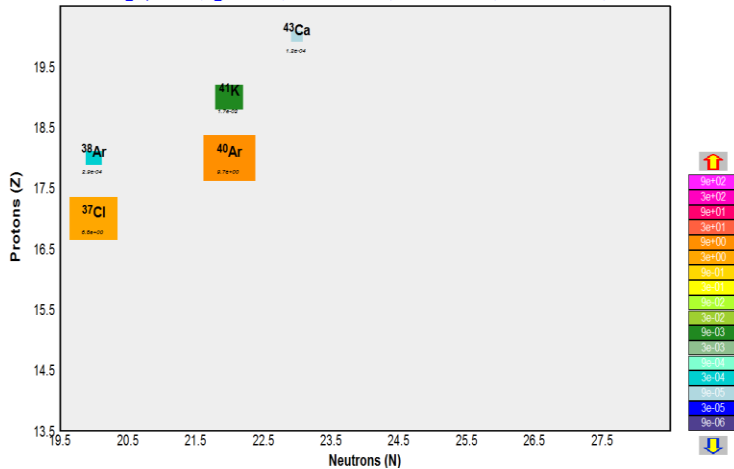
Radioactive decay residues

Implanted isotopes file : "C:\user\lise_pp_910\files\list2.radlist" (7 different isotopes)
 Irradiation Time (IT) = 1.00e+01 sec; Decay Time (DT) = 5.00e-01 sec; Plot All isotopes
 N_Implant=100, N_Resid=100, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



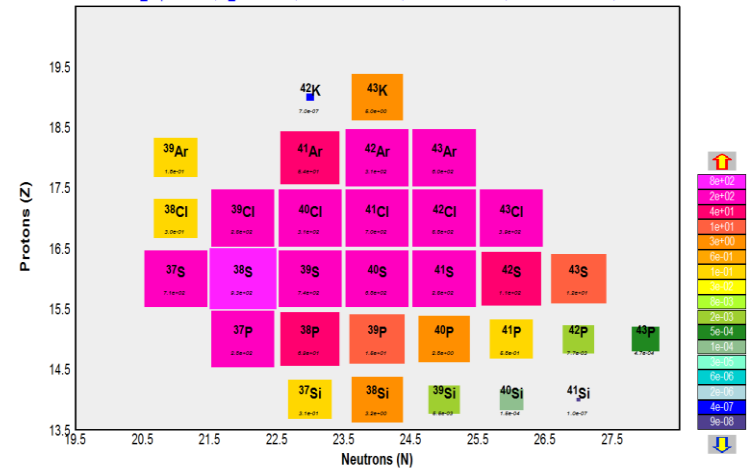
Radioactive decay residues

Implanted isotopes file : "C:\user\lise_pp_910\files\list2.radlist" (7 different isotopes)
 Irradiation Time (IT) = 1.00e+01 sec; Decay Time (DT) = 5.00e-01 sec; Plot only Stable
 N_Implant=100, N_Resid=100, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



Radioactive decay residues

Implanted isotopes file : "C:\user\lise_pp_910\files\list2.radlist" (7 different isotopes)
 Irradiation Time (IT) = 1.00e+01 sec; Decay Time (DT) = 5.00e-01 sec; Plot only Radioactive
 N_Implant=100, N_Resid=100, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



File: http://lise.nsci.msu.edu/9_10/radiation/test_radiation.lpp

S	FP_slits	slits
	-25	+25
	-25	+25
M	FP_PIN	Si
		£13 µm crin
M	FP_Stack0	Si
		£00 µm crin
M	FP_Stack1	Si
		£00 µm crin
M	FP_Stack2	Si
		£00 µm crin
A	FaradayCup 1	enable

189Ta	190Ta	191Ta	192Ta	193Ta	194Ta	195Ta
	1.97e-3 0.695%	6.89e-4 7.715%	2.87e-4 20.474%	7.38e-5 21.477%	1.11e-5 11.529%	
188Hf	189Hf	190Hf	191Hf	192Hf	193Hf	194Hf
187Lu	188Lu	189Lu	190Lu	191Lu	192Lu	193Lu

Radiation residue calculator

Mode to implant

1. One nucleus to implant. Chose manually here

2. List of isotopes from file to implant

3. Select detector to obtain the list of isotopes stopped in

designations

Yield = Number of atoms; N of DI = Number of Different Isotopes;
Final Time (FT) = Irradiation Time (IT) + Decay Time (DT)

no file N of isotopes = 0

FP_Stack1 Refresh N of isotopes = 5

Total Irradiation Rate

Rate = 1.435e-06 pps

Irradiation (Implantation)

IT : Irradiation Time [sec] = 10

N of DI @ time (IT) =

Radiation Residues as Function of time (DT)

DT : Decay Time after irradiation (sec) = 100

N of DI @ time (FT) =

Total Yield @ time (FT) =



Calculate Options

1D : Residues as function of time

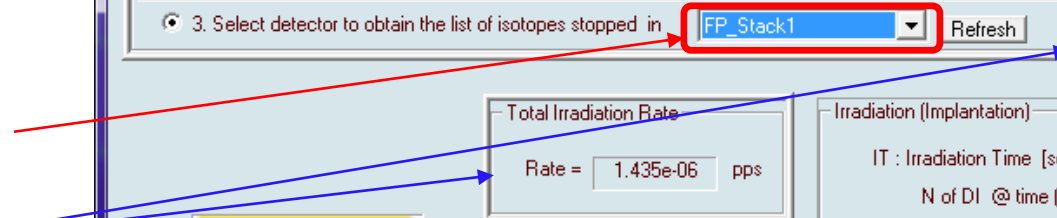
1D : Activity as function of time

2D : Final Residues (@ TF)

Quit Link

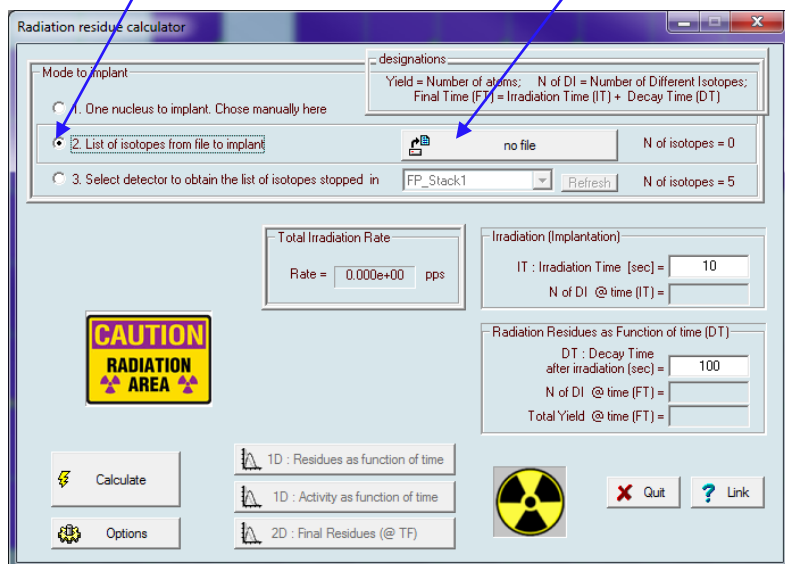
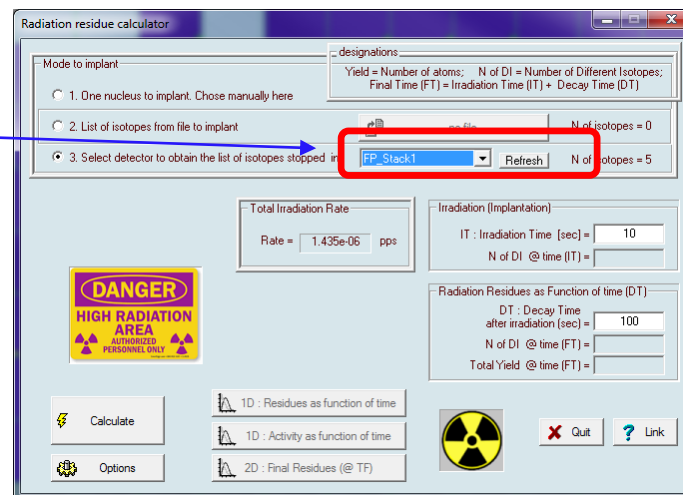
Select detector where some isotopes stopped



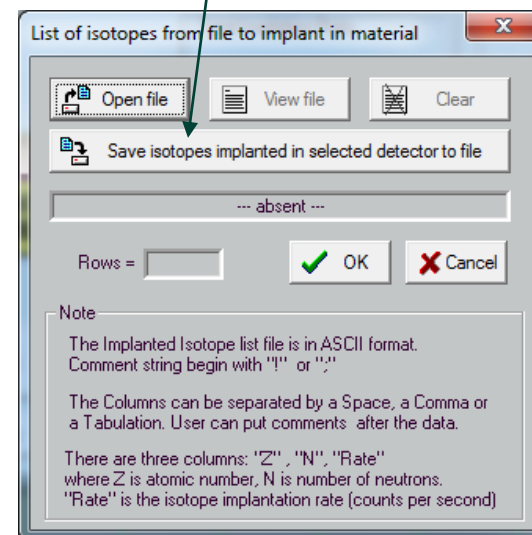
Modes : List of Isotopes from DETECTOR → save to file

1. Select detector where some isotopes stopped

2. Chose the mode “List of isotope to implant” and then click the “File” button



3. Save isotopes to file



default

Radiation residue calculator settings

Integration model

ODE (ordinary differential equation solver) ISBN: 0716704617

RKF45 (Runge-Kutta-Fehlberg ODE solver)

Numerical Recipes: ODEINT

Numerical Recipes: STIFF

Numerical Recipes: STIFBS

Option	Value	Description	Default value
N_Implant	100	number of points : Irradiation	100
N_Decay	100	number of points : DECAY	100
AbsError	1.000e-11	absolute error tolerance	1e-11
RelError	1.000e-03	relative error tolerance	1e-03
Y_thrshld	1.000e-10	Minimum yield value	1e-10

At each step for first two models, the code requires
 $\text{abs}(\text{local error}) \leq \text{abs}(\text{Y}) * \text{RelErr} + \text{AbsErr}$

Isotopes to plot

ALL (Stable & Radioactive)

only Radioactive

only Stable

2D-plot

Z vs. N

Z vs. N-Z

Z vs. N-ZZ

Half-life boundaries (sec)

T1/2_min = 1.0e-09 "unbound" below this value

T1/2_max = 1.0e+20 "stable" above this value

1e-19 < Tmin < Tmax < 1e+20

"Isotope conservation law"
 (apply primary irradiation rates of eliminated nuclei to their daughters)

Number of non-dimensional distributions: 20

Make default

For HUGE decay time (years)

Try to keep "AbsError" value (used in ODE) smaller than Y_thrshld (minimum yield value used in LISE++ Radiation class)

Radiation residue calculator settings

Integration model

ODE (ordinary differential equation solver) ISBN: 0716704617

RKF45 (Runge-Kutta-Fehlberg ODE solver)

Numerical Recipes: ODEINT

Numerical Recipes: STIFF

Numerical Recipes: STIFBS

Option	Value	Description	Default value
N_Implant	100	number of points : Irradiation	100
N_Decay	1000	number of points : DECAY	100
AbsError	1.000e-5	absolute error tolerance	1e-11
RelError	1.000e-03	relative error tolerance	1e-03
Y_thrshld	1.000e-4	Minimum yield value	1e-10

At each step for first two models, the code requires
 $\text{abs}(\text{local error}) \leq \text{abs}(\text{Y}) * \text{RelErr} + \text{AbsErr}$

Isotopes to plot

ALL (Stable & Radioactive)

only Radioactive

only Stable

2D-plot

Z vs. N

Z vs. N-Z

Z vs. N-ZZ

Half-life boundaries (sec)

T1/2_min = 1 "unbound" below this value

T1/2_max = 1.0e+20 "stable" above this value

1e-19 < Tmin < Tmax < 1e+20

"Isotope conservation law"
 (apply primary irradiation rates of eliminated nuclei to their daughters)

Number of non-dimensional distributions: 100

Make default

http://lise.nsci.msu.edu/9_10/radiation/RadResCalc_v2a.pdf

Radiation Residues Calculator : $T_{1/2}$ bounds

- New $T_{1/2}$ boundaries options
- ^{221}U irradiation case
- ^{238}U @ FRIB Beam Dump & $T_{1/2}$ boundaries options

Version 2 : http://lise.nsl.msu.edu/9_10/radiation/RadiationResidue_U2.pdf

Version 1 : http://lise.nsl.msu.edu/9_10/radiation/RadiationResidue_U1.pdf

Radioactive decay residues

Implanted isotopes file : "G:\238U_CoulombFission.radlist" (490 different isotopes)

Irradiation Time (IT) = 1.00e+00 sec; Decay Time (DT) = 3.15e+07 sec; Plot All isotopes

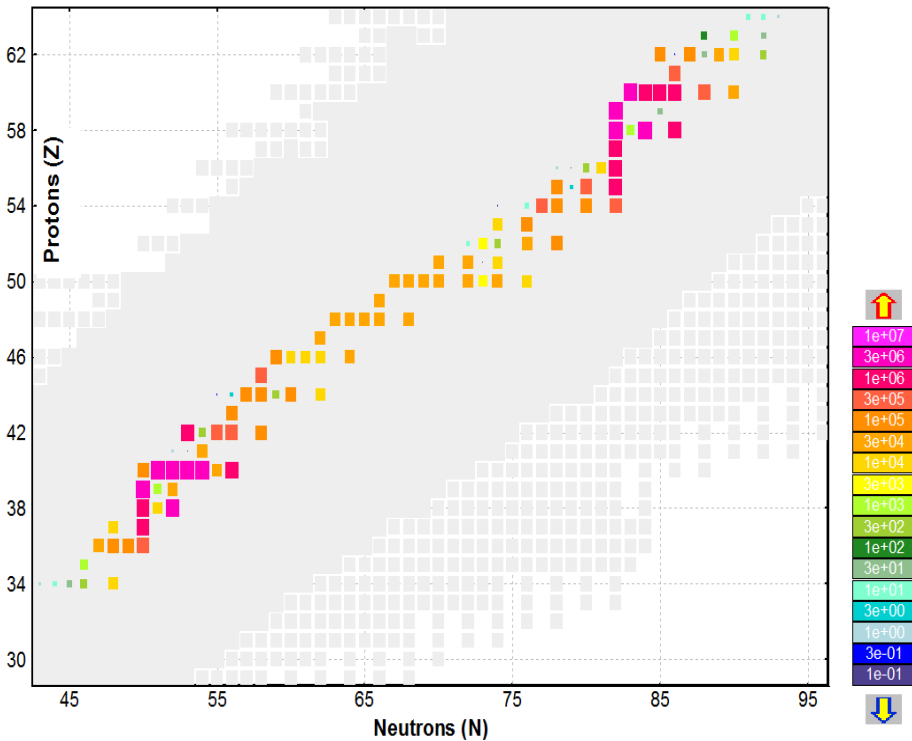
N_Implant=100, N_Resid=1000, Abs.Error=1.0e-05, Rel.Error=1.0e-03, Threshold=1.0e-04, Model="RKf4"

Activity

Implanted isotopes file : "G:\BeamDump\238U_CoulombFission.radlist" (490 different isotopes)

Irradiation Time (IT) = 1.00e+00 sec; Decay Time (DT) = 1.00e+12 sec; Plot only Radioactive

Model="ODE", N_Implant=100, N_Resid=10000, Abs.Err=1.0e-05, Rel.Err=1.0e-04, Threshold=1.0e-06, T_{1/2}^{bounds} = 1.0e-01, 1.0e



Version 2 :

http://lise.nslc.msu.edu/9_10/radiation/RadiationResidue_229Th_v2.pdf

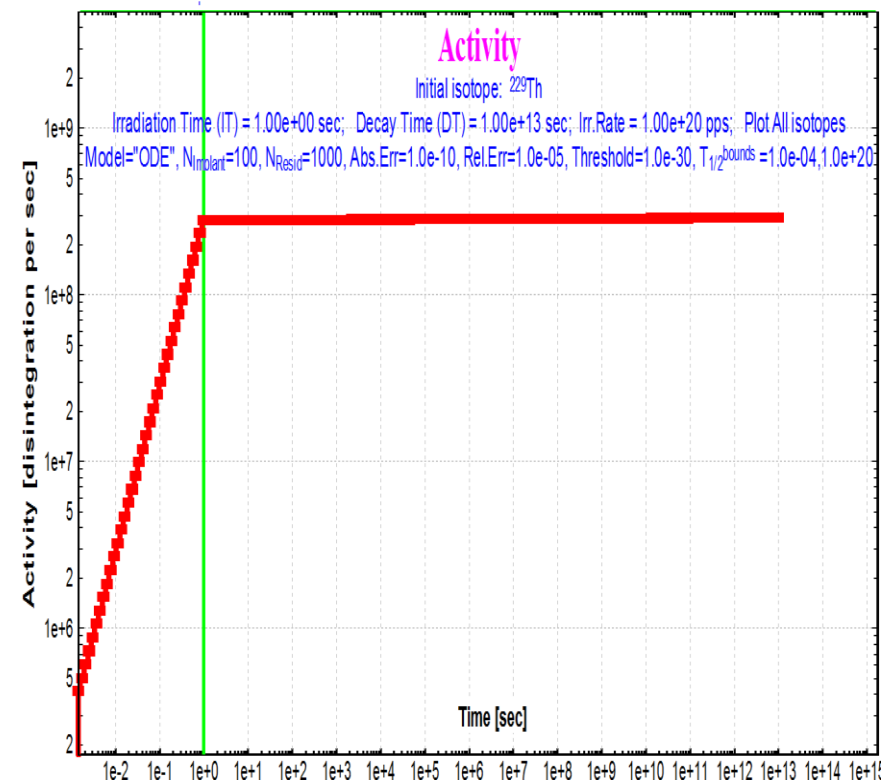
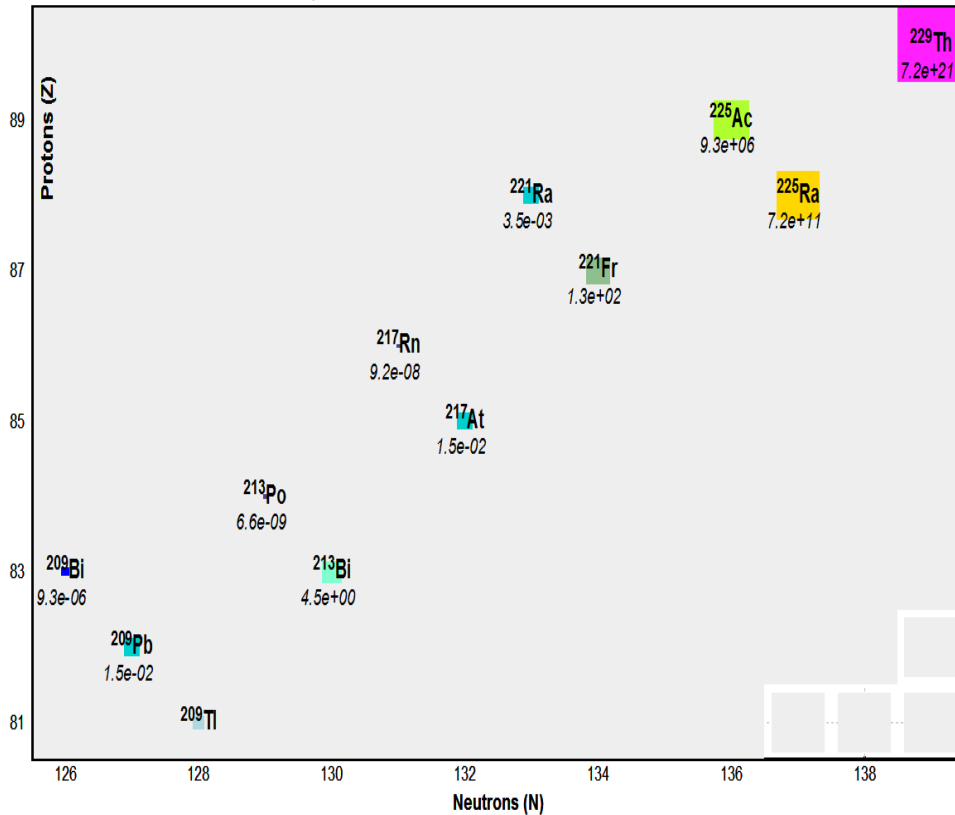
Version 1 :

http://lise.nslc.msu.edu/9_10/radiation/RadiationResidue_229Th_v1.pdf

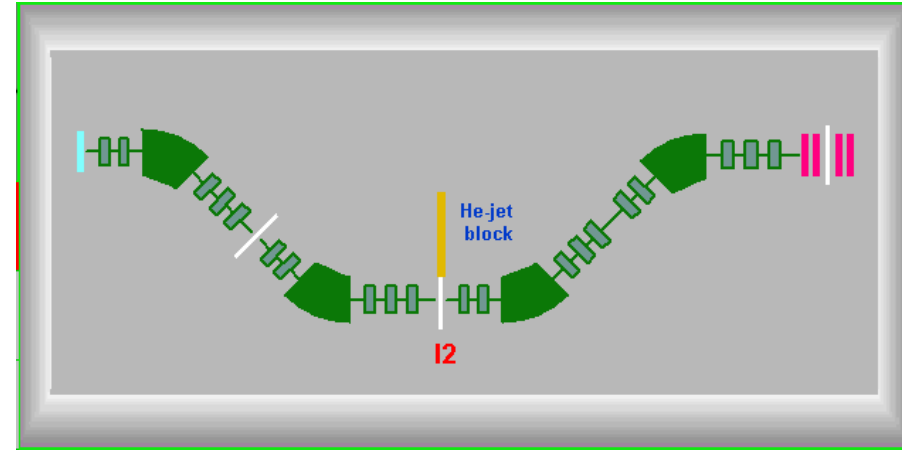
Radioactive decay residues

Initial isotope: ²²⁹Th

Irradiation Time (IT) = 1.00e+02 sec; Decay Time (DT) = 1.00e-07 sec; Irr.Rate = 1.00e+20 pps; Plot All isotopes
 Model="ODE", N_{implant}=10, N_{Resid}=100, Abs.Err=1.0e-10, Rel.Err=1.0e-05, Threshold=1.0e-40, T_{1/2}^{bounds}=1.0e-20,1.0e+20



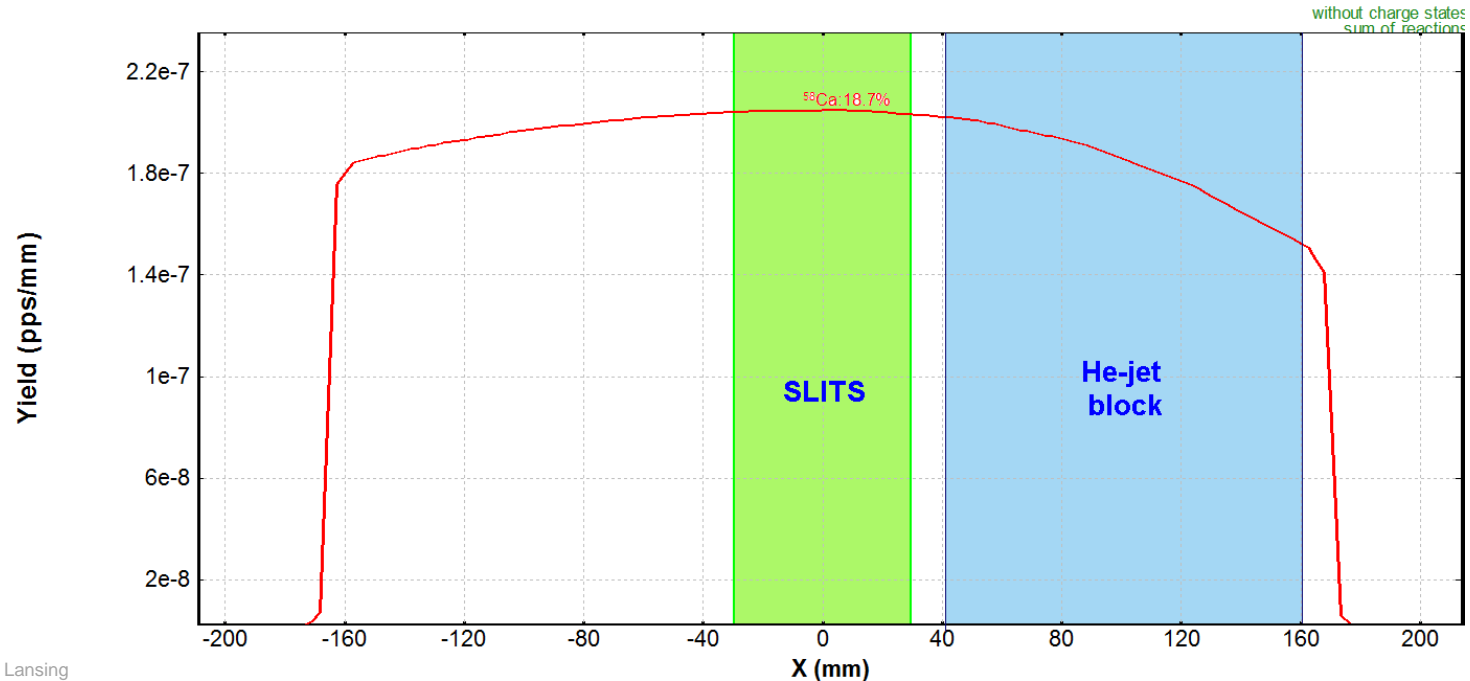
Assume the production ^{58}Ca from using the ^{82}Se beam with the A1900 fragment separator, and the He-jet block located at 40-160 mm (I2 position)



File: http://lise.nslc.msu.edu/9_10/radiation/82Se_58Ca.lpp

I2_slits-Xspace: output before slits

^{82}Se (140 MeV/u) + Be (500 mg/cm²); Settings on ^{58}Ca ; Config: DSDSWDDMMSMM
 dp/p=1.00% ; Wedges: 0; Brho(Tm): 4.4920, 4.4920, 4.4920, 4.4920



Steps to create the “He-jet” configuration from previous case:

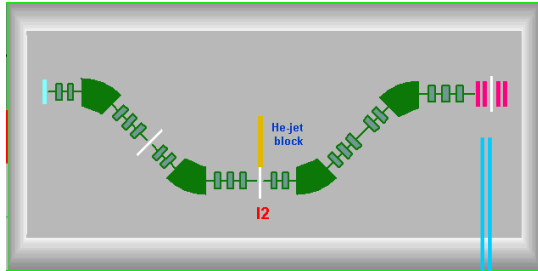
1. Set Width of I2 slits equal to the He-jet block width (+/- 60 mm)
2. Behind the I2 slits insert a thick material enough to stop all products
3. After this material set the Faraday cup
4. Insert the shift block dX=100 mm in front of the I2 slits, assuming the central axis is passing through the center of He-jet block

File: http://lise.nsci.msu.edu/9_10/radiation/82Se_58Ca_He-jet.lpp

P	Projectile	82 Se ³⁴⁺
		140 MeV/u 100 pA
F	Fragment	58 Ca ²⁰⁺
T	Target	⁹ Be 500 mg/cm ²
St	Stripper	
D	D1	Brho 4.4920 Tm
S	I1_slits	slits -100 B +100
D	D2	Brho 4.4920 Tm
H	Shift 1	d X = +100.0 mm
S	I2_slits	slits -ε0 B +ε0
M	He-jet block	Fe 10 mm
A	FaradayCup 1	<input checked="" type="checkbox"/> enable

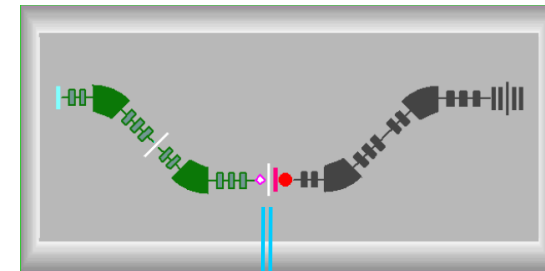
47Ti	48Ti	49Ti	50Ti	51Ti	52Ti	53Ti	54Ti	55Ti	56Ti
------	------	------	------	------	------	------	------	------	------

82Se 58Ca.lpp

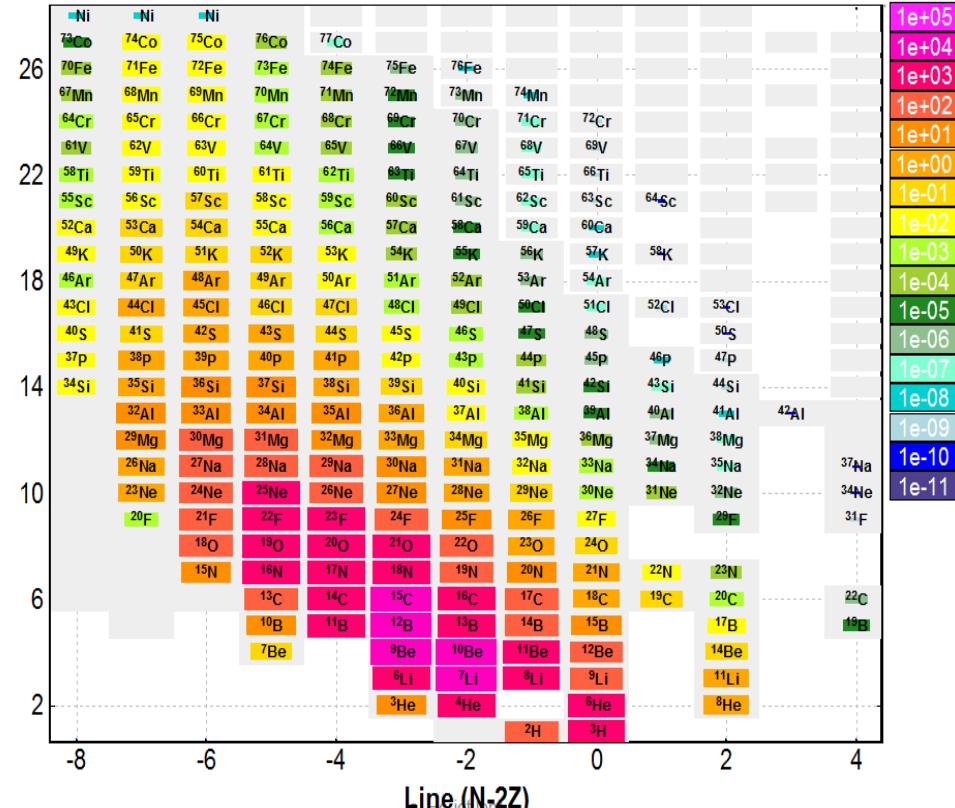
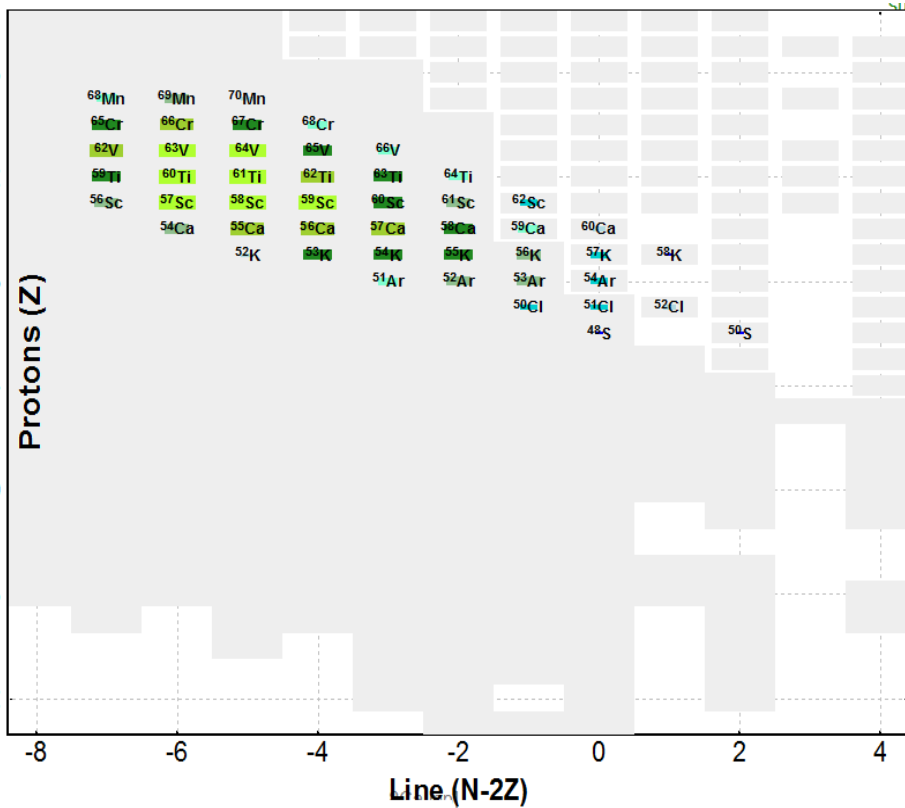


Rate 0.02 pps

82Se 58Ca He-jet.lpp



Rate 1.6e5 pps



1. Calculate all products with new 82Se_58Ca_He-jet.lpp file
2. Call the Radiation Residue Calculator
3. Set the Irradiation and Detector times (for example 1 & 10 hours)
4. Chose “He-jet block” as detector
5. Click the “Calculation” button

Option	Value	Description	Default value
N_Implant	500	number of points : Irradiation	100
N_Decay	500	number of points : DECAY	100
AbsError	1.000e-15	absolute error tolerance	1e-11
RelError	1.000e-04	relative error tolerance	1e-03
Y_thrshld	1.000e-14	Minimum yield value	1e-10

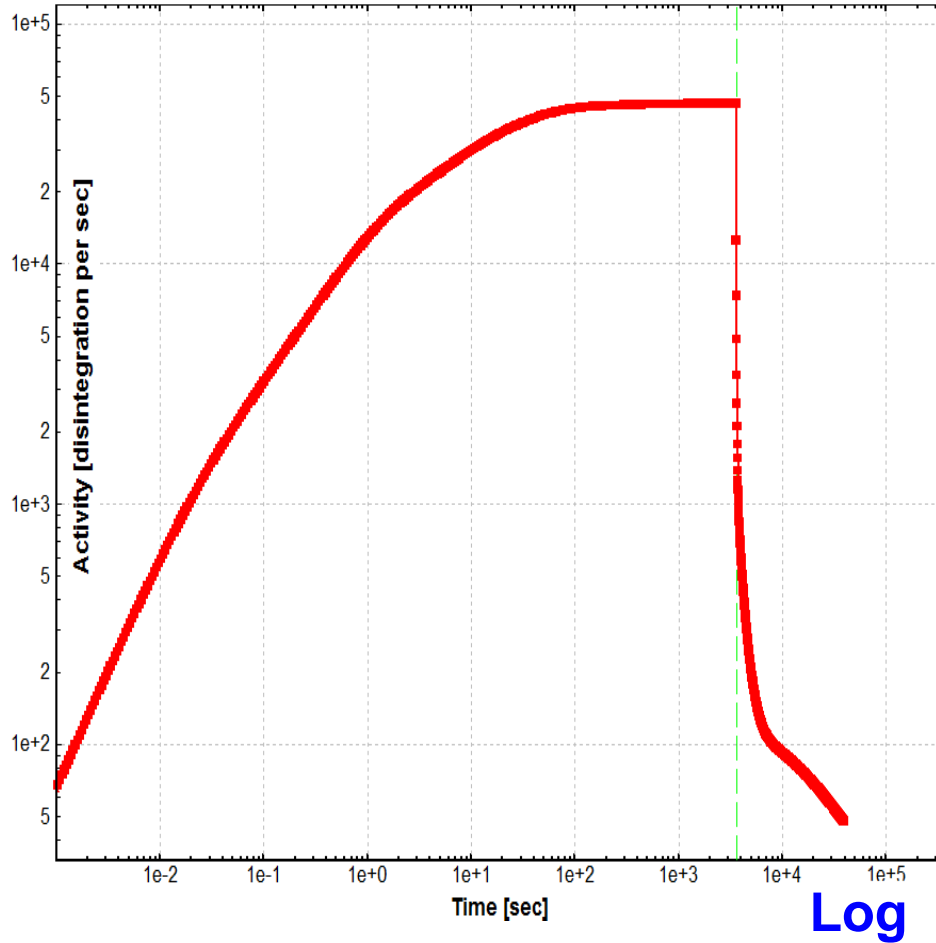
Maximum number of iterations (50000) has been reached for N_implantation=100 for two last implantation steps

Activity

Implantation detector : "He-jet block" (161 different isotopes)

Irradiation Time (IT) = 3.60e+03 sec; Decay Time (DT) = 3.60e+04 sec; Plot All isotopes

N_Implant=500, N_Resid=500, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Mode="ODE"

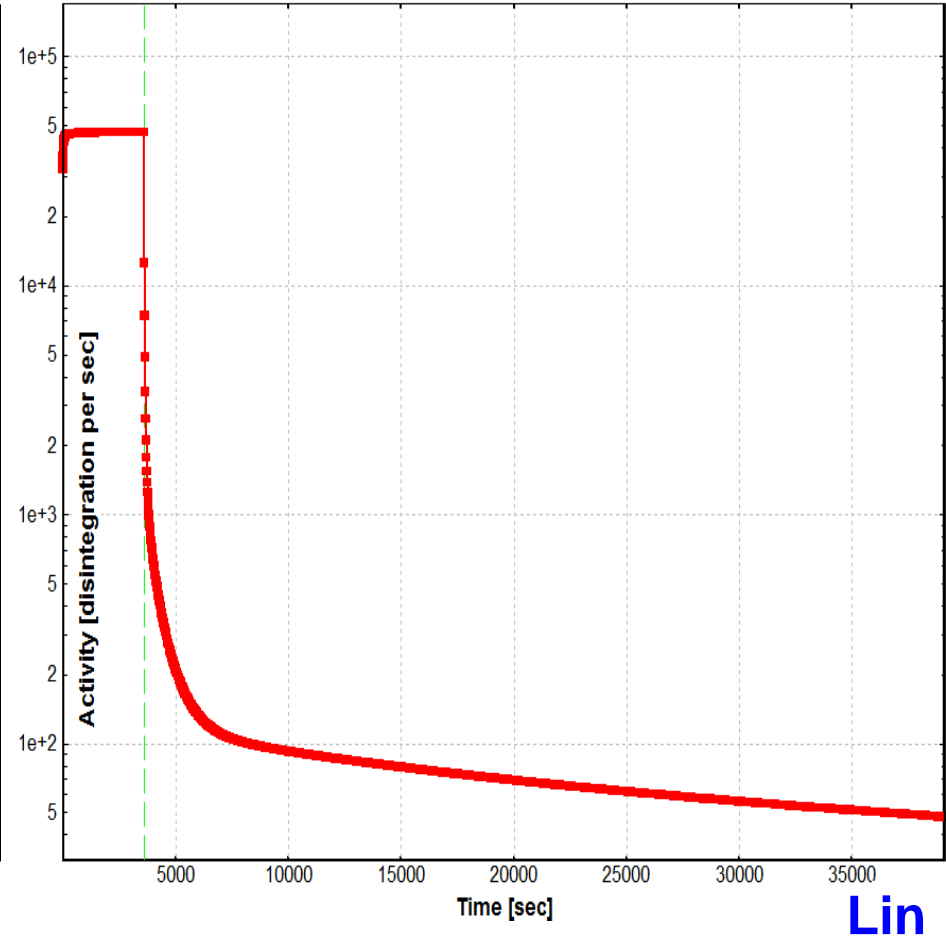


Activity

Implantation detector : "He-jet block" (161 different isotopes)

Irradiation Time (IT) = 3.60e+03 sec; Decay Time (DT) = 3.60e+04 sec; Plot All isotopes

N_Implant=500, N_Resid=500, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Mode="ODE"



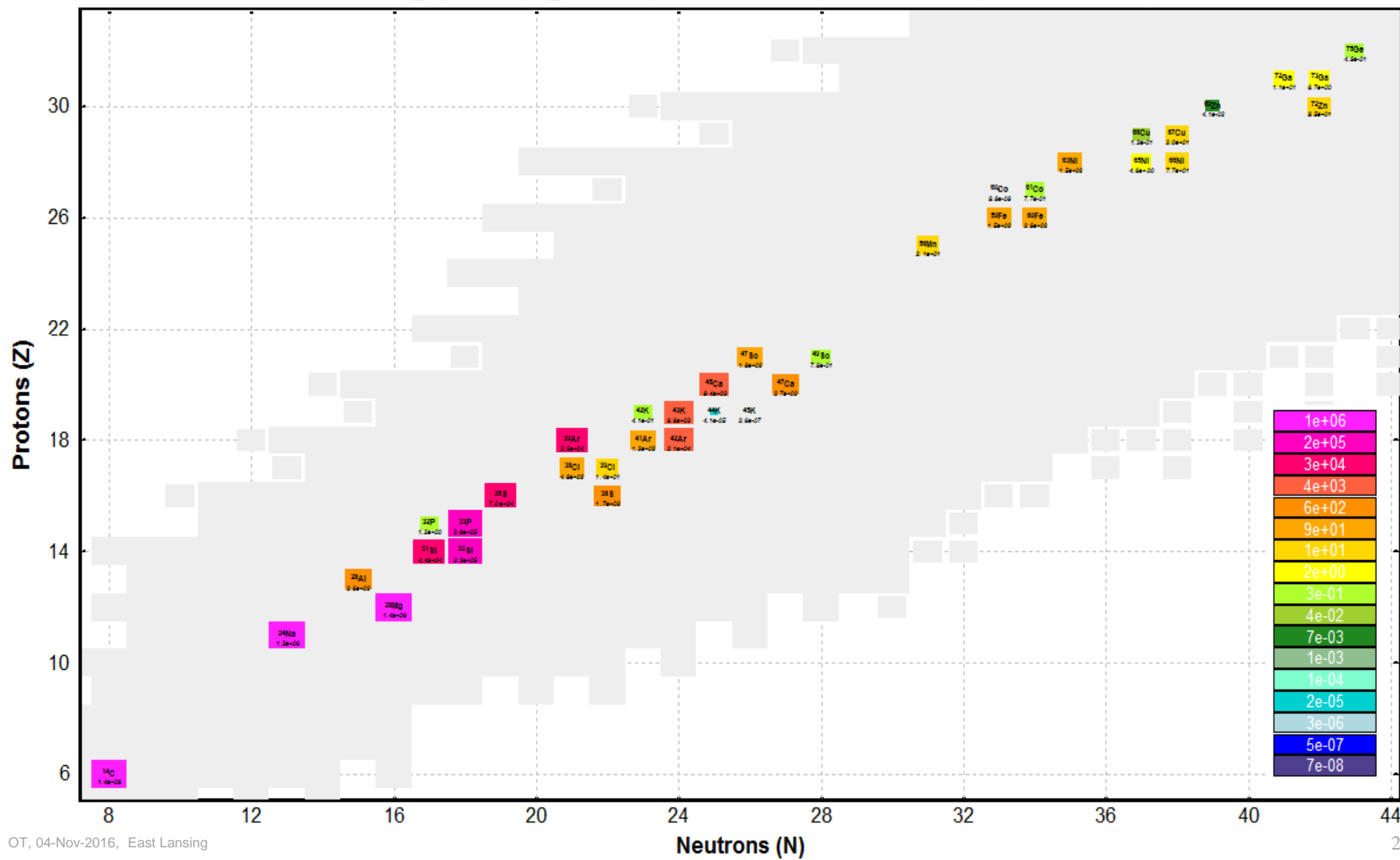
Only radioactive residues

Radioactive decay residues

Implantation detector : "He-jet block" (161 different isotopes)

Irradiation Time (IT) = 3.60e+03 sec; Decay Time (DT) = 3.60e+04 sec; Plot only Radioactive

N_Implant=500, N_Resid=500, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



Only radioactive residues

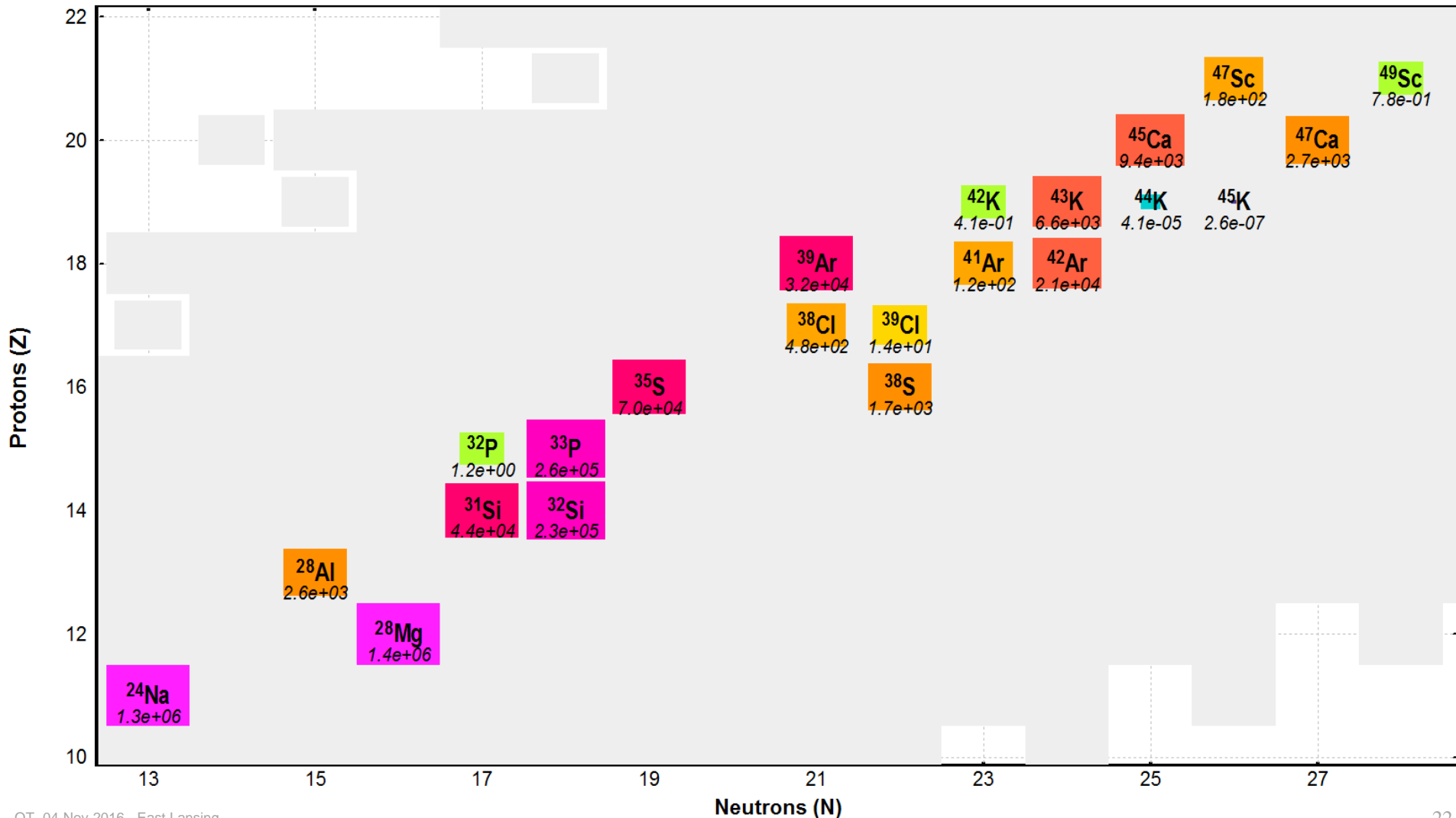
Radioactive decay residues

ZOOM

Implantation detector : "He-jet block" (161 different isotopes)

Irradiation Time (IT) = 3.60e+03 sec; Decay Time (DT) = 3.60e+04 sec; Plot only Radioactive

N_Implant=500, N_Resid=500, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"



http://lise.nsci.msu.edu/9_10/radiation/RadiationResidue_44Ti.pdf

Radiation Residue Calculator : ^{44}Ti

v.9.10.341
from 08/05/16

http://lise.nsci.msu.edu/9_10/radiation/44Ti%20from%2058Ni.lpp

Table 1. Priority isotopes for harvesting at FRIB. These isotopes were identified at the Working Group meeting in Santa Fe, NM September 30 – October 1, 2010.

Isotope	Half-life	Application
^{32}Si	160 y	Tracer; geology and botany
^{44}Ti	50 y	Medicine, astrophysics, nuclear structure
^{48}V	16 d	Stockpile Stewardship
^{67}Cu	2.6 d	Medicine
^{85}Kr	10.0 d	Astrophysics, stockpile stewardship
Eu^+		Stockpile Stewardship
^{211}Rn	14.6 h	Medicine
^{225}Ra	14.9d	Medicine, Electric Dipole Moment
^{225}Ac	10.0 d	Medicine

OT, 08-Aug-2016, East Lansing

http://lise.nsl.msu.edu/9_10/radiation/RadiationResidueStiff.pdf

In mathematics, a stiff equation is a differential equation for which certain numerical methods for solving the equation are numerically unstable, unless the step size is taken to be extremely small. It has proven difficult to formulate a precise definition of stiffness, but the main idea is that the equation includes some terms that can lead to rapid variation in the solution.

The screenshot shows the 'Radiation residue calculator' software interface. Key elements include:

- Mode to implant:** Three radio buttons: '1. One nucleus to implant. Chose manually here' (selected), '2. List of isotopes to implant from file', and '3. Select detector to obtain the list of isotopes stopped in'.
- designations:** A text box containing the formula: Yield = Number of atoms; N of DI = Number of Different Isotopes; Final Time (FT) = Irradiation Time (IT) + Decay Time (DT).
- File selection:** A 'no file' button and a dropdown menu showing 'FP_PPACO' with a 'Refresh' button. 'N of isotopes = 0' is displayed on the right.
- Fragment selection:** A section titled '-1. Chose fragment to implant' with input fields for Atomic Number (A: 221), Element (u), and Atomic Number (Z: 92). It includes a 'Table of Nuclides' button and navigation arrows for Z and N.
- Calculation parameters:**
 - Half-life (T_{1/2}): 1.30e-06 sec
 - Implantation Rate: 1e+10 pps
 - Yield of this nucleus @ Irradiation time (IT): 1.88e+4
 - Yield of this nucleus @ Final time (FT): 1.88e+4
- Stiffness settings (highlighted in red boxes):**
 - 'Irradiation (Implantation) Stiffness starts @ 6 step'
 - 'Radiation Residues Stiffness starts @ 1 step'
- Output parameters:**
 - IT : Irradiation Time [sec] = 10
 - N of DI @ time (IT) = 15
 - after irradiation (sec) = 10
 - N of DI @ time (FT) = 14
 - Total Yield @ time (FT) = 1.13e+9
- Buttons and Options:** 'Calculate', 'Options', '1D : Residues as function of time', '1D : Activity as function of time', '2D : Final Residues (@ TF)', 'View Results (Text)', 'Quit', and 'Link'.
- Warning:** A yellow 'CAUTION RADIATION AREA' sign.
- Elapsed time:** 00:00:04.74 or 4.74 sec.

http://lise.nsci.msu.edu/work/BeamDump/BeamDump_v1.pdf

Isotope Production in the FRIB Beam Dump : projectile fragmentation case

- Manual "step-by-step" table with initial beam & target settings
- Production settings
- Energy, Intensity, Thickness
- Radiation residues calculator
- Equivalent material and thickness
- Next steps

<http://lise.nsci.msu.edu/work/BeamDump/BeamDumpUranium.pdf>

Isotope Production in the FRIB Beam Dump : ^{238}U case

- How to get isotope yields in the beam dump with the Uranium beam?
- Production settings : why a Li-target was used?
- Radiation residues calculator : $T_{1/2}$ boundaries against the “stiffness” problem
- Link to the “Isotope Production in the FRIB Beam Dump : projectile fragmentation case” presentation

http://lise.nsci.msu.edu/9_10/Branching.pdf#page=7

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-08 sec; Irr.Rate = 1.00e+10 pps; Plot All isotop
N_Implant=100, N_Resid=1000, Abs.Error=1.0e-11, Rel.Error=1.0e-03, Threshold=1.0e-10, Model="ODE"

Using the Decay branching ratio database in Radiation Residue calculations

β- n case

MICHIGAN STATE UNIVERSITY
LISE++

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-08 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"

- Thanks to Prof. D.J.Morrisey and B.Sherrill for discussions
 - The Decay Branch database should be updated
 - Calculations should be optimized for the stiff problem