

Version	Date	Problem
8.0.42	27.11.07	Modification of the Angular acceptance subroutine for the fission case
8.0.41	27.11.07	Insignificant modifications in the Reaction Mechanism dialog and the fission potential subroutine
8.0.39	26.11.07	Cutting of X-, Y- & P-distributions due to angular acceptance
8.0.38	25.11.07	Z vs A-2Q, Z vs A-3Q 2D-plots
8.0.37	22.11.07	Correction for pseudo MC plot connected with wedge thickness defect
8.0.36	06.11.07	GeV/c -> MeV/c substitution for Momentum
8.0.35	29.10.07	No Cross sections from file for reactions in stripper Brho-calculation correction for the target+stripper combination The "Charge states" plot modification
8.0.32	05.10.07	Corrections for G.Schiwietz's charge state model
8.0.31	04.10.07	The "GLOBAL" program: changed output format from ".4f" to "9e3" in order to show low-probability cases
8.0.30	01.10.07	SuperFRS (GSI) configuration and example files
8.0.29	20.09.07	Energy deposition in materials for MC
8.0.28	18.09.07	Correction for Moyal straggling in the MC case Correction of Statistics calculation in the contour in the MC case
8.0.26	11.09.07	Corrections for the case of transmission: charge state & secondary reactions
8.0.25	09.09.07	G.Schiwietz's charge state model in LISE.xls
8.0.24	08.09.07	Corrections for charge state calculation in the Monte Carlo mode
8.0.23	28.08.07	Straggling shape: Moyal function for the Landau distribution The "production mechanism" dialog
8.0.22	27.08.07	Several insignificant modifications
8.0.21	26.08.07	New charge state model in the code: "5 - [ < 15AMeV] G.Schiwietz, P.Grande, NIM B175 (2001) 125-131"
8.0.20	17.08.07	MC transmission new parameters: RANGE

Version	Date	Problem
8.0.19	14.08.07	MC transmission new parameters: $R = \text{sign}(X) \sqrt{X^2 + Y^2}$ $A = \text{sign}(X) \text{atan}( \text{Velocity}(XY)  / \text{Velocity}(Z))$
8.0.18	09.08.07	Corrections: Combination of consecutive transmission product calculation for several reactions
8.0.17	04.08.07	Corrections: * Transmission analysis dialog * Analytical transmission: initial emittance * MC transmission for TB and Fission reactions
8.0.16	03.08.07	Elliptical collimator mode is available for slit shape in MC calculations
8.0.15	03.08.07	Possibility to use neutron as conjugate fragment for Two body reactions
8.0.14	03.08.07	Two body kinematics available for MC calculations
8.0.13	02.08.07	New reaction mechanism: Two body reaction
8.0.12	01.08.07	New option to draw new MC calculations in the previous MC calculations plot
8.0.11	01.08.07	Charge state calculations have been implemented in MC calculation of transmission as option
8.0.10	31.07.07	Fission reactions are available for MC calculation of transmission
8.0.9	29.07.07	Total revision of MC calculation of transmission. Corrections for the charge state mode
8.0.8	25.07.07	The "Show prefragments" button in the MC transmission dialog in the fission case to run the Fission information window
8.0.7	22.07.07	The "Fission properties" dialog Entry of St.Dev of Excitation Energy value. Using this value for kinematics in both cases: Distribution and MC methods
8.0.6	19.07.07	Monte Carlo plot* revision * - distribution method of transmission calculation
8.0.5	13.07.07	Revision of fusion-fission and fusion-residual excitation function plot. New option: Excitation function file
8.0.4	10.07.07	Corrections for thick target in the fission case

Version	Date	Complaint	Problem	Recon- struction level (1-5)	Correlation*	Necessity (correction, development) (1-5)
8.2.13	11.02.2008	LISE	Revision of rate normalization for pseudo MC 2D-plots	2	no	2
8.2.12	06.02.2008	LISE	Revision of Contour statistics for Z vs A/Q pseudo MC 2D-plot	1	no	2
8.2.11	05.02.2008	LISE	LISE.xls: new sheet "CalculationReaction"	1	no	2
8.2.10	04.02.2008	LISE	Corrections for the "Z vs. A/Q" pseudo_MC plot : <i>edge effect (TOF zero)</i>	2	no	3
8.2.9	25.01.2008	Oscar Capurro	Revision of Solid angle window in the Kinematics calculator	1	no	2
8.2.8	24.01.2008	Thomas Baumann	Physical Calculator: Correction for the case "beam + zero thickness target" : edge effect + special case	3	yes	5
8.2.7	18.01.2008	Helmut Weick	MC transmission. Corrections for the Brho-value for charge states: <i>bug</i>	3	no	4
8.2.6	17.01.2008	LISE	Correction for the Q <sub>gg</sub> -plot (2D-case)	2	no	2
8.2.5	16.01.2008	LISE	Implementation of the MOTER code to the LISE++ package	1	no	1
8.2.4	15.01.2008	LISE	Potential energy plot for fusion reaction: correction	2	no	3
8.2.3	09.01.2008	Helmut Weick	Fragment production in material (FPiM): angular distributions : <i>bug</i>	4	no	4
8.2.2	09.01.2008	LISE	Monte Carlo Fragment production in material (FPiM): <i>bug</i>	2	no	4
8.2.1	24.12.2007	Leah Broussard	Correction in fission fragment transmission: edge effect	5	yes	5

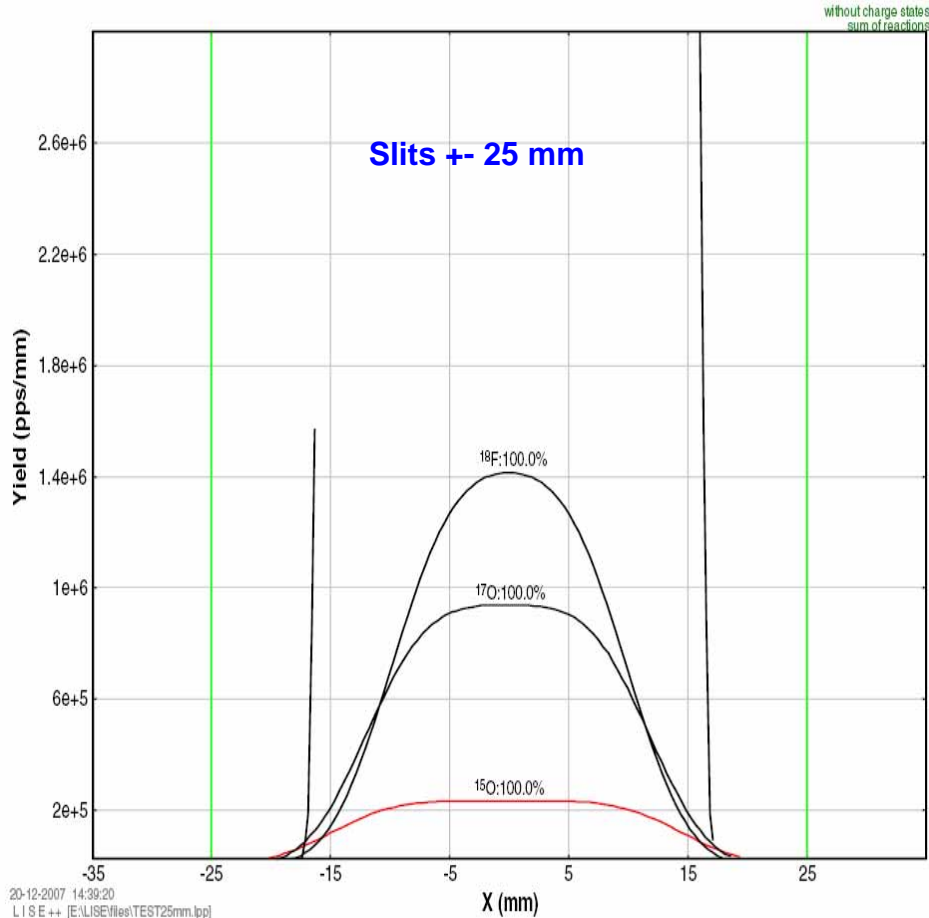
\* correlation with transmission analytical calculations

Version	Date	Complaint	Problem
8.2.19	22.02.2008	Brad Sherrill	Correction for the "FPiM & Charge states" combination Thick wedge with charge state option gave a wrong answer with charge state distribution. Crucial bug. Corrected
8.2.18	16.02.2008	LISE	FPiM modifications
8.2.17		LISE	The About dialog has been changed
8.2.16		LISE	Correction: crash for the table of nuclides - unknown isotopes
8.2.15		Marc Hausmann	Secondary reactions: negative thickness value for Optimum target
8.2.14		LISE	No Dubna's server

## Problem: No $^{19}\text{F}$ for two-body reaction in the case of cut by slits

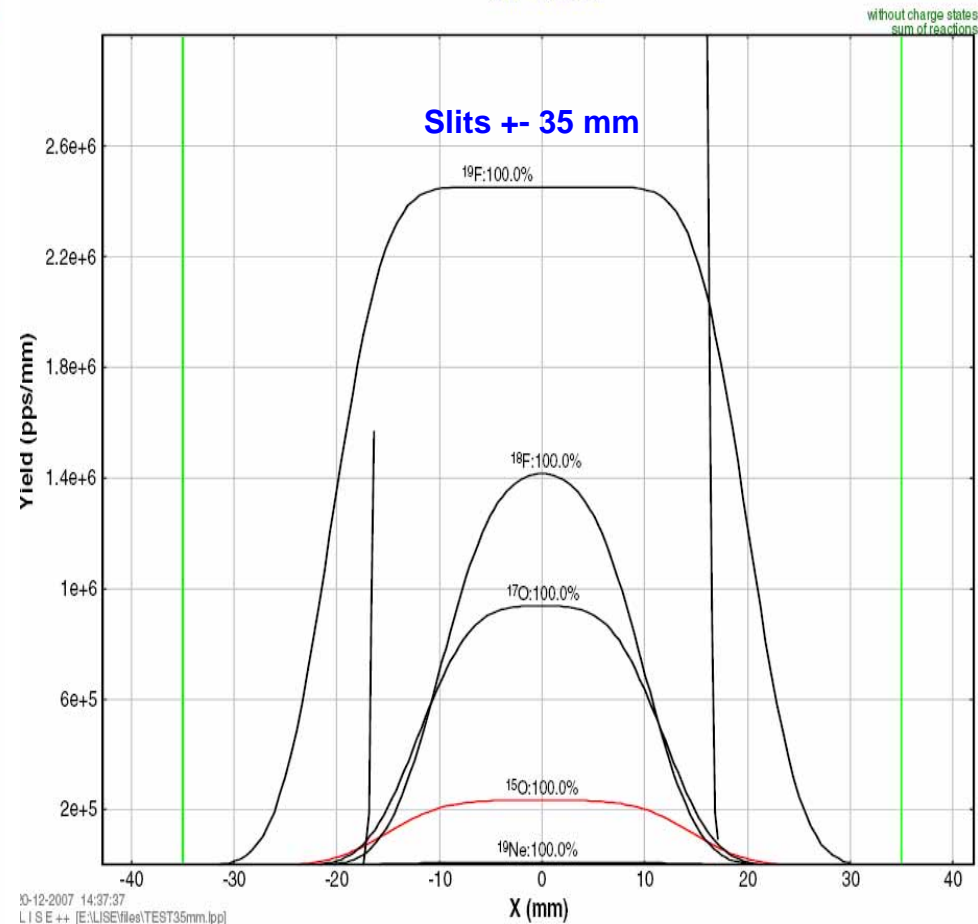
### Defining aperture-Xspace: output before slits

$^{19}\text{F}$  (10.0 MeV/u) + H<sub>2</sub> (100000  $\mu\text{m}$ ), Co<sub>42</sub>Cr<sub>20</sub>Ni<sub>13</sub>Fe<sub>19</sub>W (5  $\mu\text{m}$ ); Settings on  $^{15}\text{O}$ ; Config: SSM  
dp/p=100.00%



### Defining aperture-Xspace: output before slits

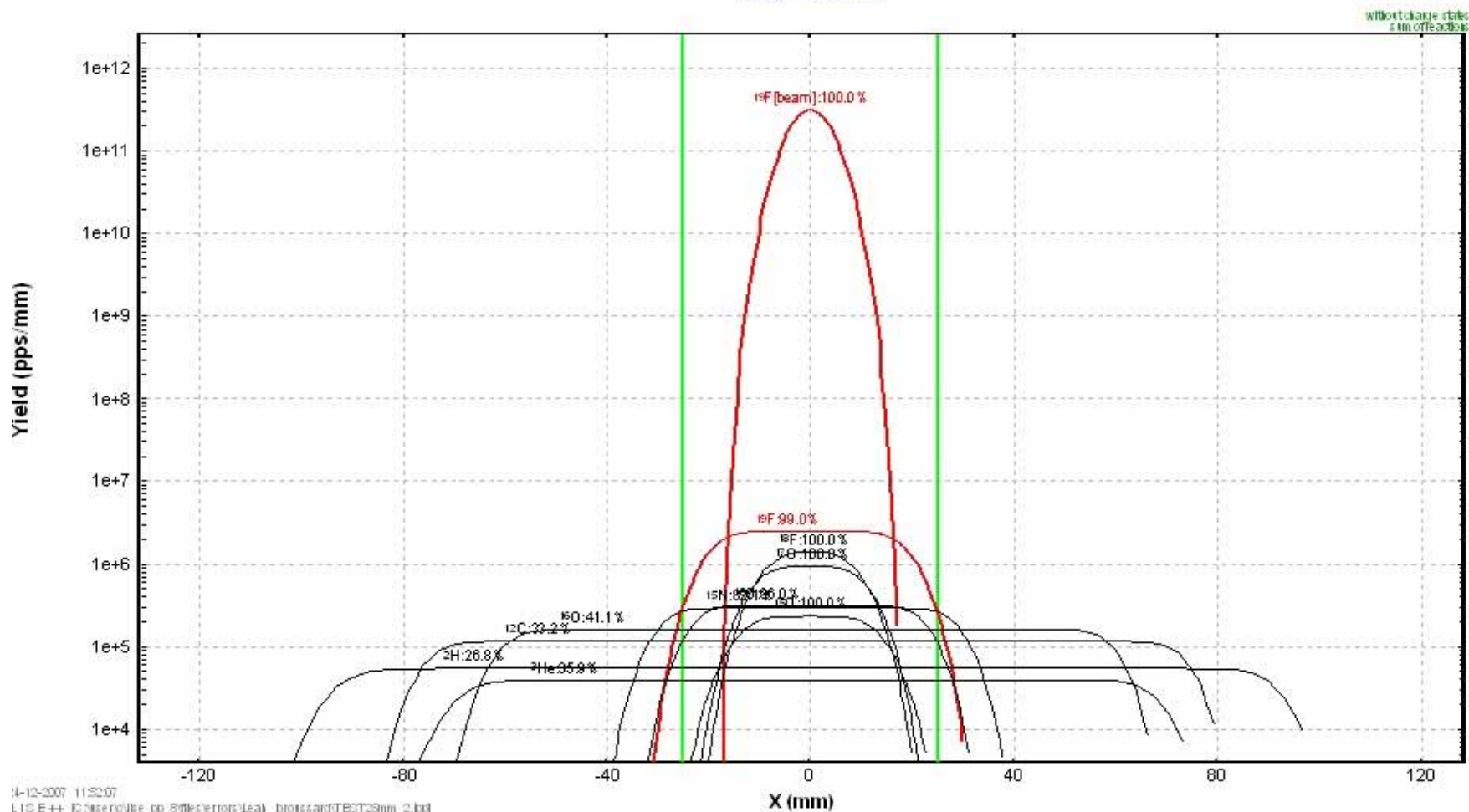
$^{19}\text{F}$  (10.0 MeV/u) + H<sub>2</sub> (100000  $\mu\text{m}$ ), Co<sub>42</sub>Cr<sub>20</sub>Ni<sub>13</sub>Fe<sub>19</sub>W (5  $\mu\text{m}$ ); Settings on  $^{15}\text{O}$ ; Config: SSM  
dp/p=100.00%



## Correction

### Defining aperture-Xspace: output before slits

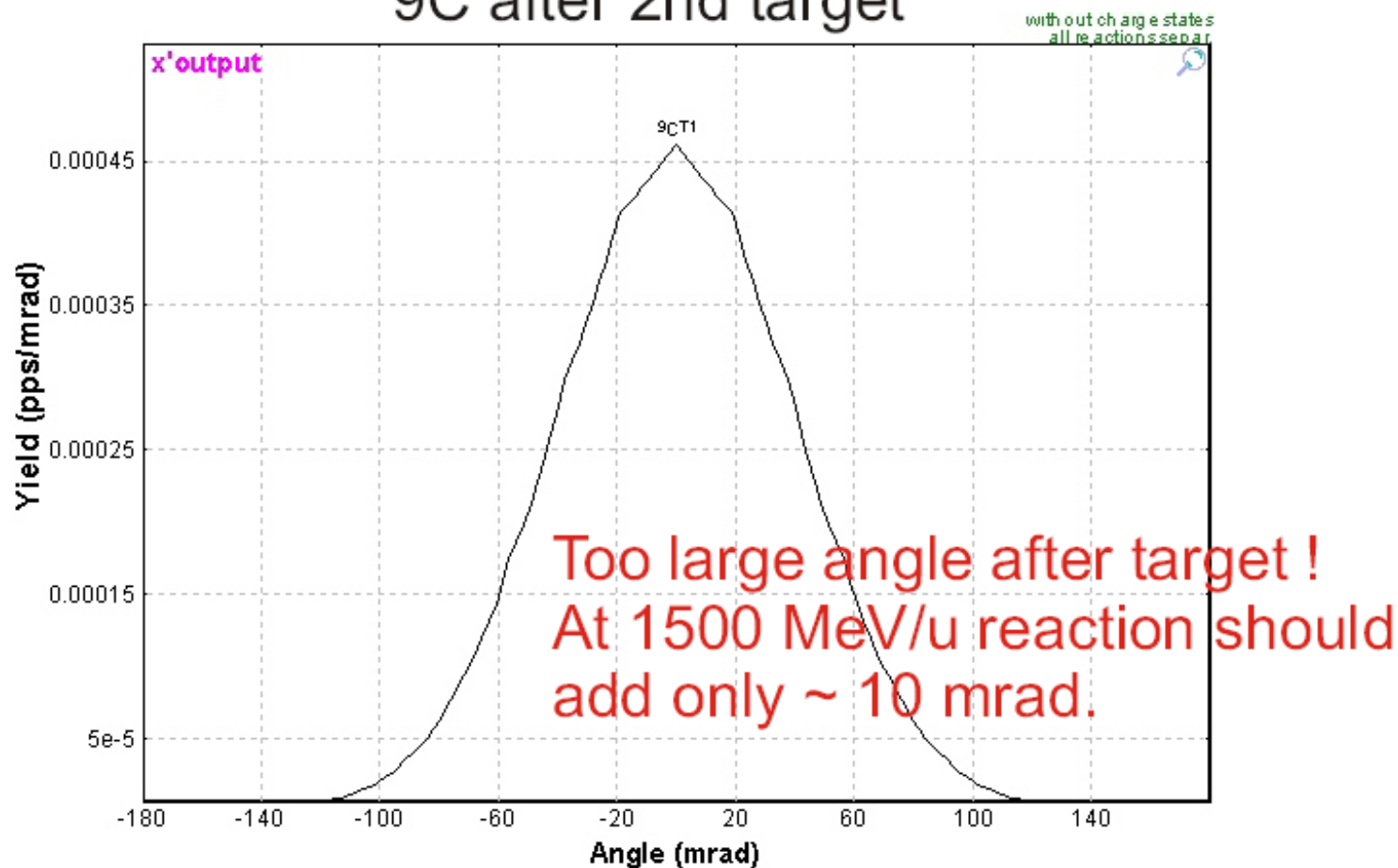
<sup>19</sup>F (10.0 MeV/u) + H<sub>2</sub> (100000 μm), Co42Cr20Ni13Fe19W (5 μm); Settings on <sup>19</sup>F; Config: SSM  
dp/p=100.0%



4-12-2007 11:52:07  
L:\E++\Data\series\ksp-pp\files\errors\Leak\_broadband\FE3T23mm\_2.tsp

## Problem:

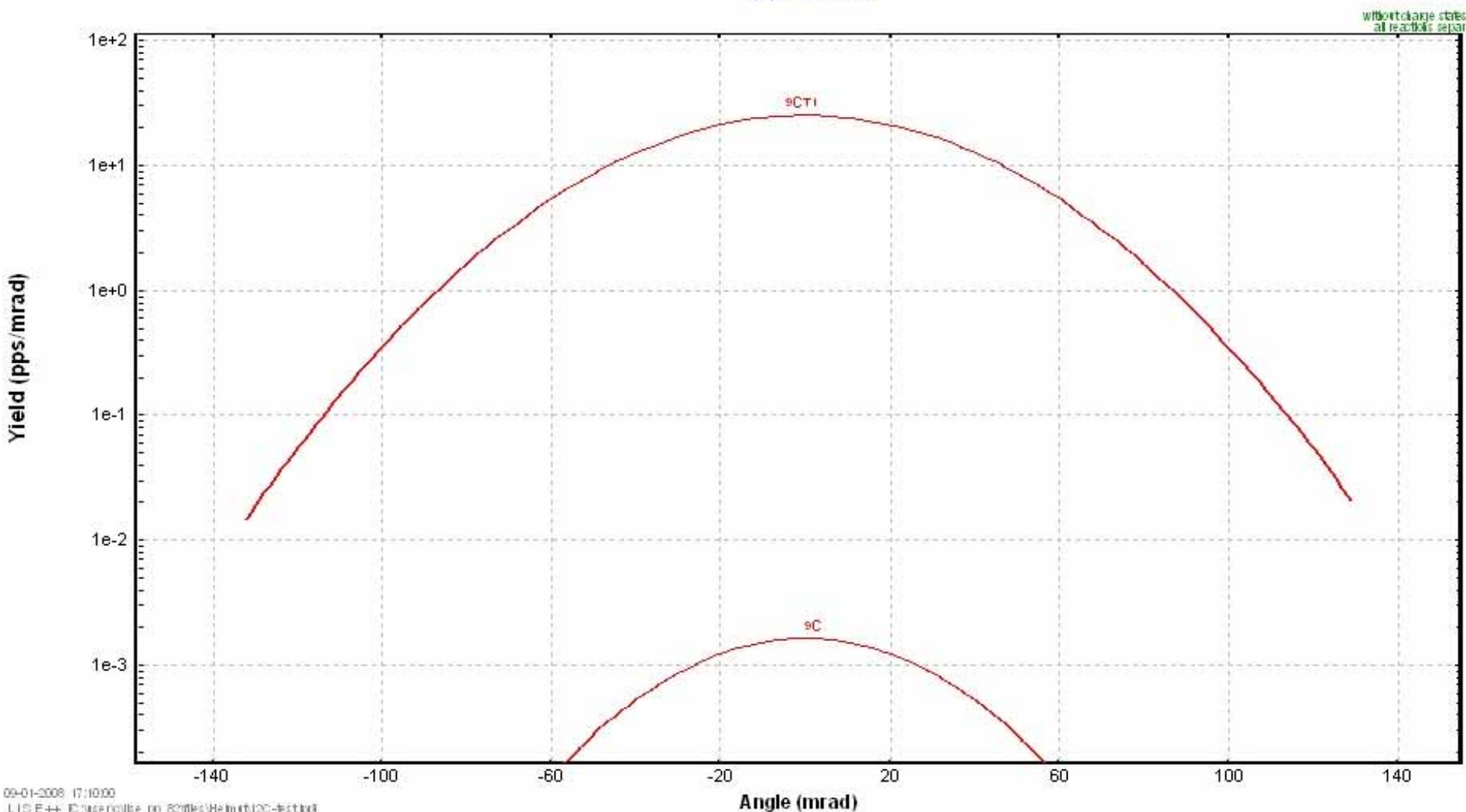
## 9C after 2nd target



## Correction

### Material 1-Angle: x'output

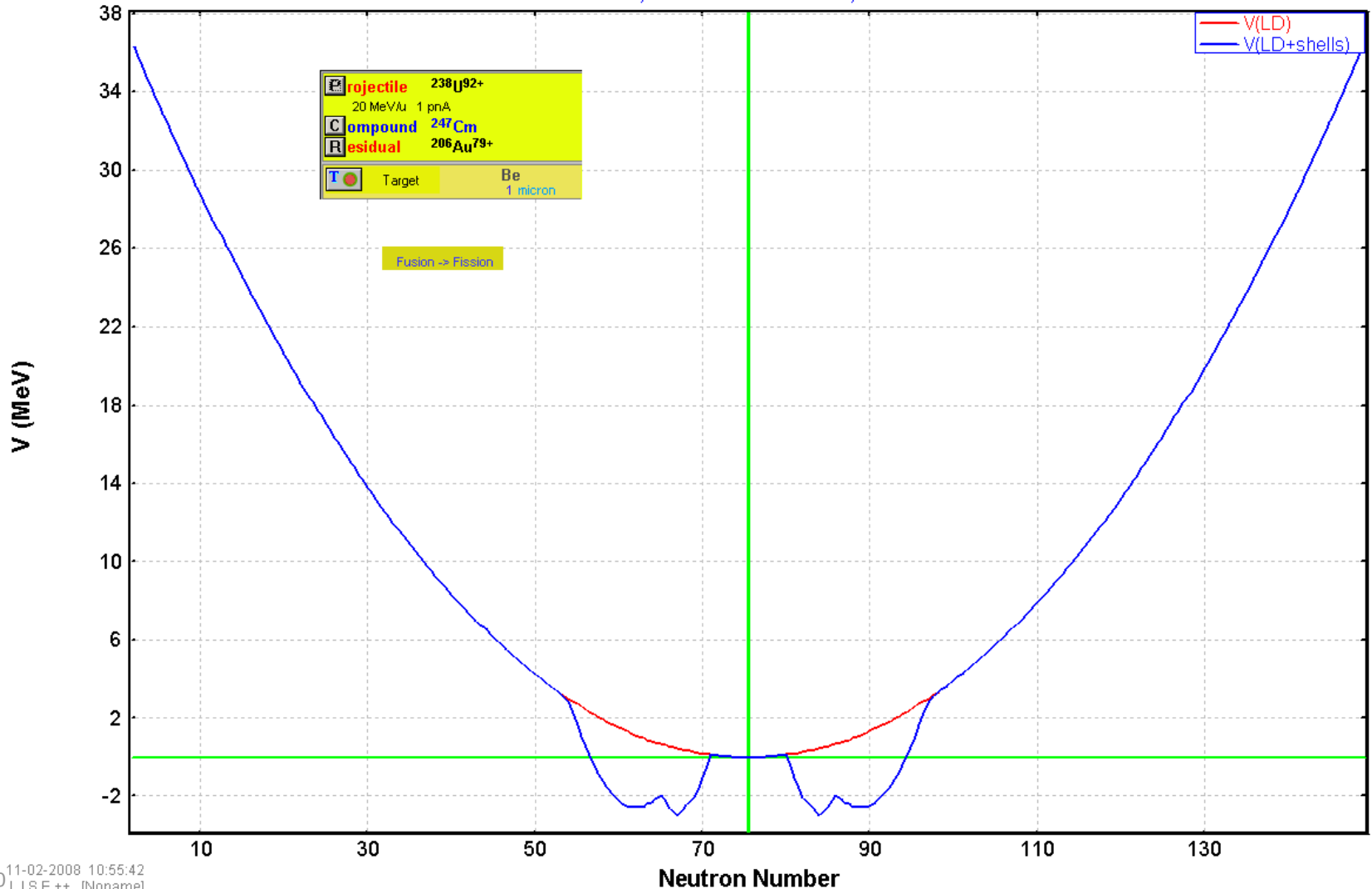
$^{12}\text{C}$  (400.0 MeV/u) + Be ( $1\text{e-}1$  mg/cm $^2$ ); Settings on  $^9\text{C}$ ; Config: MS  
dp/p=100.00 %



Problem: was only for Abrasion-Fission and Coulomb Fission reactions

Potential energy at fission barrier for  $^{247}\text{Cm}$

shell ~1: N = 83; dU = -2.65 MeV; 2C = 0.70 MeV  
 shell ~2: N = 90; dU = -3.80 MeV; 2C = 0.15 MeV





## Beta-version

Utilities 1D-Plot 2D-Plot Databases Help

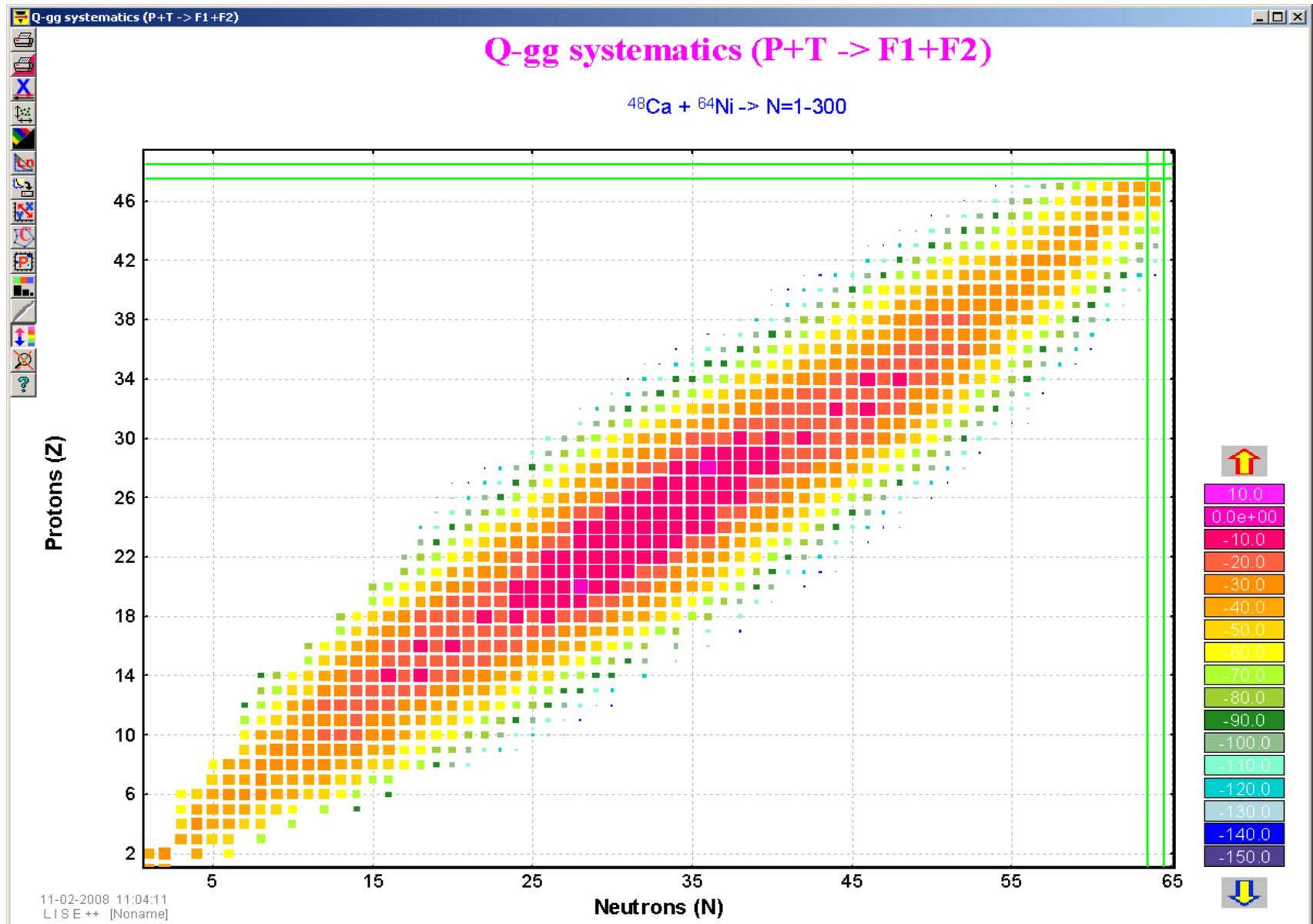
- Spectrometric Calculator by J.Kantele
- The code "CHARGE"
- The code "GLOBAL"
- Units Converter
- BI (search of 2-dimensional peaks)
- PACE4 (fusion-evaporation code)
- Plot PACE4's calculations
- MOTER (ray tracing code)**
- Plot MOTER's calculations

**MOTER** Project Help

Optimization Demand Magnet1 Magnet2 Elements Results

Line	Variables	Value	Type	Default	Comments				
11	JRKSTMS	3	I	3	Variables for integration routines				
	JHAMMING	5	I	1	3,1 normally used (see moter manual)				
12	IBMTYPE	1	I	1	Normally 1=0 for tgt in place (ctrl.beamType)				
	NSIGMA	1	I	1	Number of phase space variables				
	ISIGMA(1-6)	1	1	1	1	0	1	=1 for each phase space variable to generate random rays. eg, for all 5 normal variables with IBMTYPE=1 this card is: 1 5 1 1 1 1 0 1	
13	Half width	SIG	RSIGMA1	RSIGMA2	RSIGMA3	RSIGMA4	RSIGMA5	RSIGMA6	
	X	0.4	1	0	0	0	0	0	
	Theta	17.5	0	1	0	0	0	0	
	Y	0.4	0	0	1	0	0	0	
	Phi	5	0	0	0	1	0	0	
	L	0	0	0	0	0	1	0	
	Delta	4	0	0	0	0	0	1	
	<b>14abc</b> Cards 14 A,B,C cards are used if IBMTYPE=0								
14	KRAY	5	I	0	Number of fixed rays to be defined by the user always use at least 1 (0 ray)				
	KOUT	1	I	1	Must be 1 to print rays, =0 no print				
15	FRAC	1	R	0					
16	Rays Dialog								
17	Xoffset	0	R	0					
	ThetaOffset	0	R	0					
	Yoffset	0	R	0					
	PhiOffset	0	R	0					
18	J	-1	I	set =-1					
					19	IRANCM	0	this card not in file	
						RANCM	1	this card not in file	

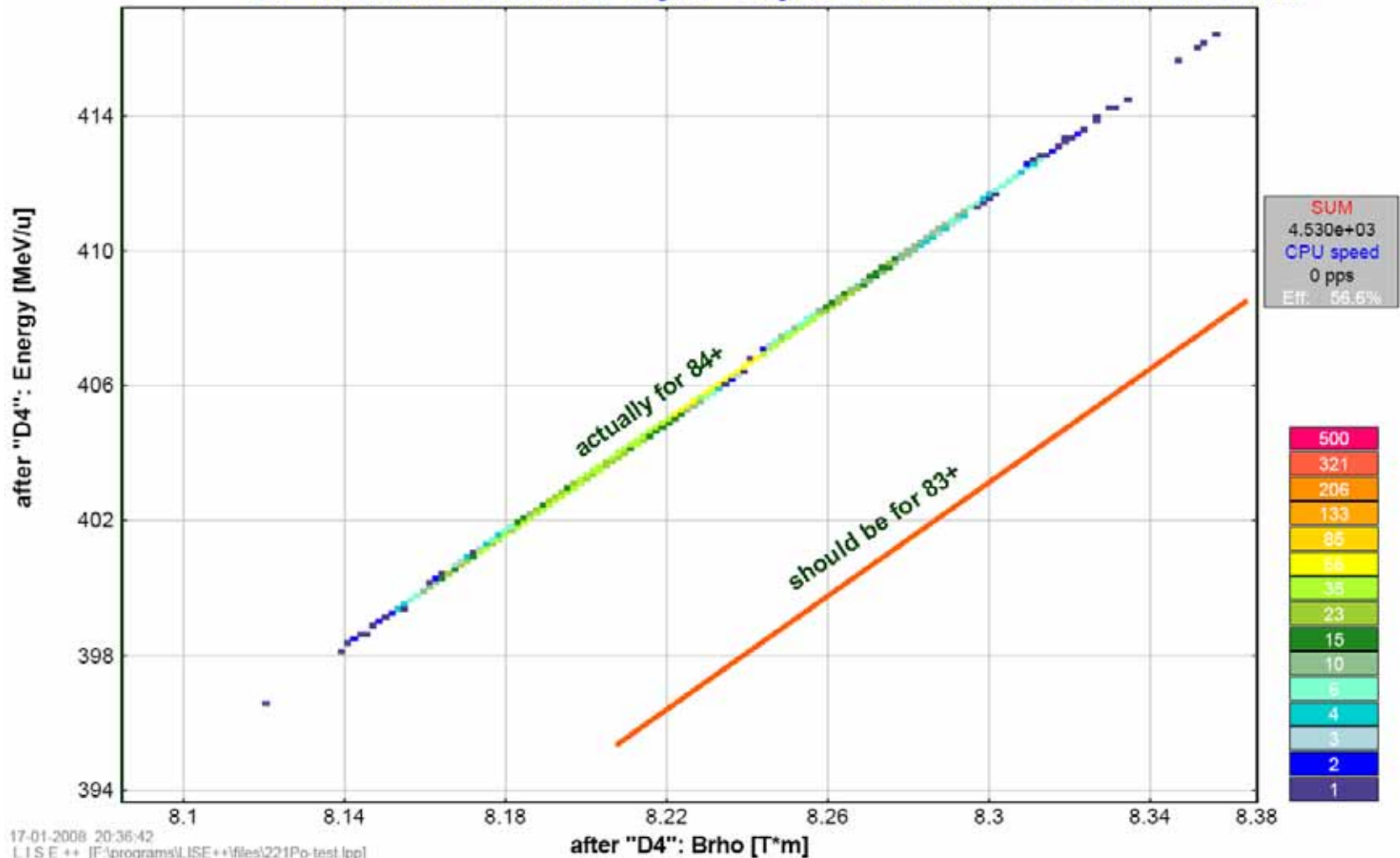
1D-plot: Ok, and crash for 2D-plot



**Q=Z was used instead current Q to recalculate  $B\rho$  from Energy for plots**

## $^{216}\text{Po}$ : Monte Carlo Transmission Plot

$^{238}\text{U}$  (1000.0 MeV/u) + Be (4000 mg/cm<sup>2</sup>); Transmitted Fragment  $^{216}\text{Po}_{83+}$  (Fragmentn)  
 dp/p=3.09% ; Wedges: 0, Al (4500 mg/cm<sup>2</sup>), Al (2000 mg/cm<sup>2</sup>); Brho(Tm): 12.0508, 12.0508, 8.4332, 8.4332  
 "D4" - last block for MC calculation; no gate; Configuration: DSWDMMMWSMDSMMMMMMMSMMWMM



## In the case of the primary beam with zero-thickness target

**P** Projectile  $40\text{Ar}^{18+}$  **1**  
140 MeV/u, 1 ppA

**F** Fragment  $40\text{Ar}^{18+}$  =beam=

**T** Target **2**

**Str** Stripper C  
10 micron

**D** D1 **3A** Brho 3.9196 Tm

**D** D2 Brho 3.9196 Tm

**S** I2\_slits slits  
-29.5 H +29.5

**W** I2\_wedge

**D** D3 Brho 3.9196 Tm

**D** D4 Brho 3.9196 Tm

**M** FP\_PPAC0 Al 2 mg/cm2

**S** FP\_slits slits  
-25 H +25

**M** FP\_PIN Si 470 micron

**M** FP\_PPAC1 Al 2 mg/cm2

**M** FP\_SCI C9H10 100 mm

**Physical calculator**

**1** A Element Z Q  
40 Ar 18 18  
Stable

Energy  5.1768 MeV/u    Energy  5.17194 AMeV

Brho  0.728277 Tm **3B**    TKE  206.877 MeV

Erho  22.9541 MJ/C    Velocity  3.14755 cm/ns

P  3929.98 MeV/c    Beta  0.1049908

p\_trnspt  0.218332 GeV/c    Gamma  1.005558

After  Stripper

Block	Z \ Thickness	MeV/u	MeV	MeV	<Q>
<b>M</b> FP_PIN	Si 470 micron	0	0	206.88	0.00
<b>M</b> FP_PP...	Al 2 mg/cm2	0	0	0	
<b>M</b> FP_SCI	C9H10 100 mm	0	0	0	

after/into Si 470 micron

Energy Remain  0 MeV/u

Energy Loss 206.88 MeV

Energy Strag.(sigma) 0.0027146 MeV/u

Angular Strag.(sigma) 10.506 mrad (plane)

Lateral spread (sigma) 0.15922 microns

Brho (for Q=Z) 0 Tm

Equilibrium values for material "Si"

Charge State <Q> 15.9

dQ (sigma) 0.92

Thickness \*\*\*\* mg/cm2

Range and Energy Loss to Si

Range dRange (sigma)

12.7298 0.028432 mg/cm2

54.6343 0.12202 micron

Energy Remain. 0.000 MeV/u

Material thickness 12.73 mg/cm2  
for energy rest 54.634 micron

Calculation method of

Energy Losses 2    Energy straggling 1

Charge States 3    Angular straggling 1

Solid angle should be 0.2msr instead 0.16 msr shown in the dialog (Area=1x2 cm, distance 100 cm).  
 An elliptical acceptance  $\pi \times H/2 \times W/2 = 0.16$  was shown in the dialog instead rectangle  $H \times W = 0.2$ .  
 The LISE code used the rectangle acceptance value for calculations in the Kinematics calculator.  
 LISE++ calculations were correct for counting in monitor.

Participants

		ME [MeV]	Excitation Energy	E(CM) = 1018.16 MeV	
A	Beam	40Ar	-35.04	0	Beam energy = 140.0 MeV/u
B	Target	9Be	11.35	0	Intensity = 1 pA
C *	Fragment	40Ar	-35.04	0	Target thickness = 1e-1 micron
D *	Residual	9Be	11.35	0	Q-value = 0.00 MeV

Set-up

Search an angle in CM

from 0 degrees and up  
 from 180 degrees and down

fragment (C) residual (D)

R = 100 cm 100  
 w = 1 cm 1  
 h = 2 cm 2

**OLD**

Angle (deg) = 8.439 62.885 50 130  
 fragment (C) residual (D) fragment (C) residual (D)

Calculations

Counting in monitor =	1.13e-2	5.1e-4	pps
Differential Cross Section =	7.29	0.33	0.203 0.203 mb/sr
Energy after reaction* =	124.55	68.51	4.86 91.41 MeV/u***
Energy before detectors =	124.55	68.51	MeV/u***
Maximum Angle =	13.03	90.00	deg
<b>Solid Angle =</b>	<b>0.16</b>	0.16	5.6 0.26 msr
delta Theta =	0.57	0.57	3.9 1.1 deg

\* - the reaction takes place at the middle of target; \*\*\* - [MeV] for gamma

Participants

		ME [MeV]	Excitation Energy	E(CM) = 1018.16 MeV	
A	Beam	40Ar	-35.04	0	Beam energy = 140.0 MeV/u
B	Target	9Be	11.35	0	Intensity = 1 pA
C *	Fragment	40Ar	-35.04	0	Target thickness = 1e-1 micron
D *	Residual	9Be	11.35	0	Q-value = 0.00 MeV

Set-up

Search an angle in CM

from 0 degrees and up  
 from 180 degrees and down

fragment (C) residual (D)

R = 100 cm 100  
 w = 1 cm 1  
 h = 2 cm 2

**NEW**

Angle (deg) = 8.439 62.885 50 130  
 fragment (C) residual (D) fragment (C) residual (D)

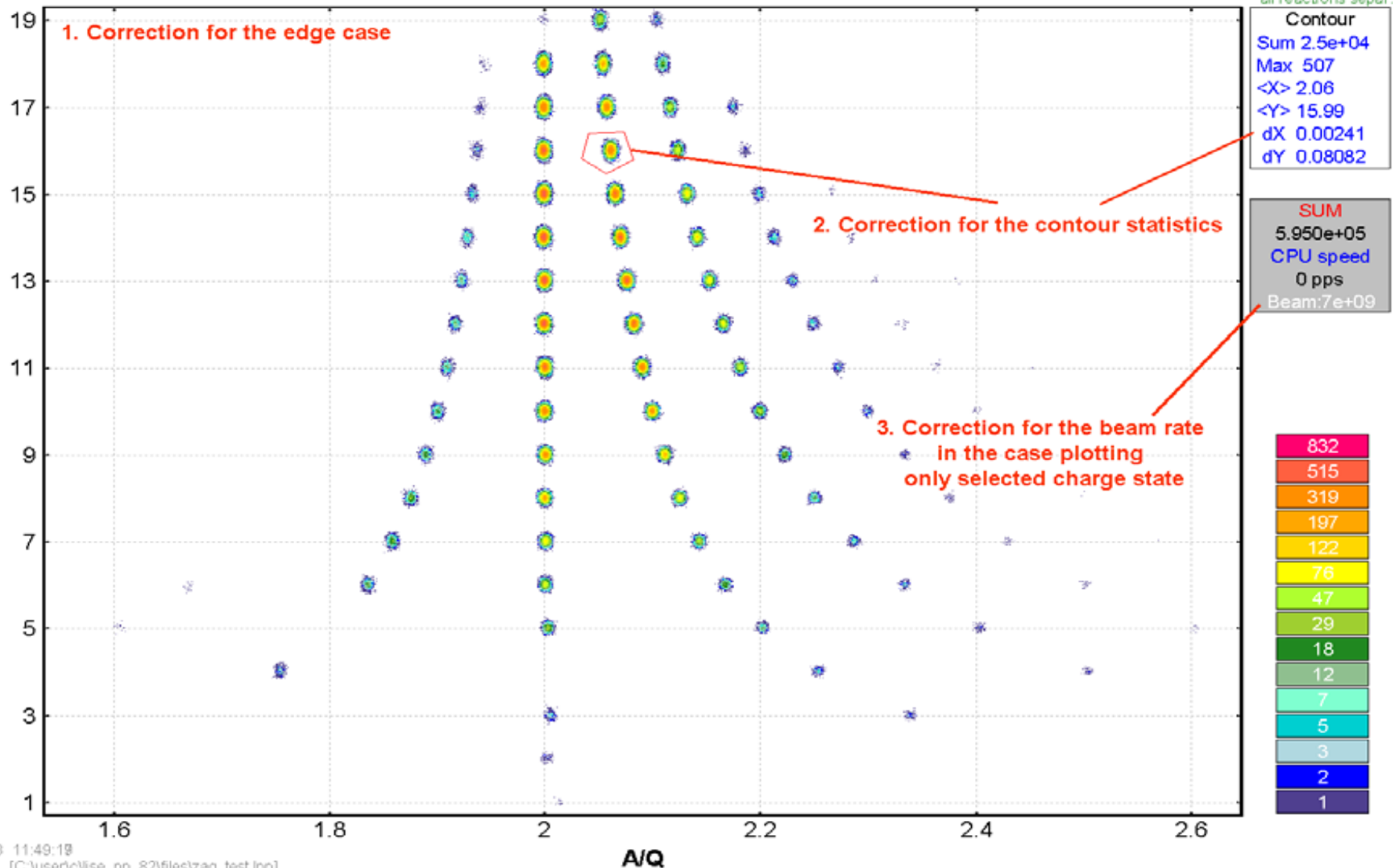
Calculations

Counting in monitor =	1.13e-2	5.1e-4	pps
Differential Cross Section =	7.29	0.33	0.203 0.203 mb/sr
Energy after reaction* =	124.55	68.51	4.86 91.41 MeV/u***
Energy before detectors =	124.55	68.51	MeV/u***
Maximum Angle =	13.03	90.00	deg
<b>Solid Angle =</b>	<b>0.2</b>	0.2	7.17 0.325 msr
delta Theta =	0.57	0.57	3.9 1.1 deg

\* - the reaction takes place at the middle of target; \*\*\* - [MeV] for gamma

## Z-A/Q

$^{40}\text{Ar}$  (140.0 MeV/u) + Be (500  $\mu\text{m}$ ); Settings on  $^{32}\text{S}$  16+ 16+ 16+ 16+; Config: DDSWDDMMSMM  
 dp/p=1.00%; Wedges: 0; Brho(Tm): 3.4571, 3.4571, 3.4571, 3.4571  
 constructed from TOF and dE1 measurements \*\*



name	definition		formula	Sf	24O-2H	24O-2H	24O-2H	48Ca-9Be	48Ca-9Be	4He-22Ne	4He-22Ne
<b>Ap</b>					<b>24</b>	<b>24</b>	<b>24</b>	<b>48</b>	<b>48</b>	<b>4</b>	<b>4</b>
<b>Zp</b>					<b>8</b>	<b>8</b>	<b>8</b>	<b>20</b>	<b>20</b>	<b>2</b>	<b>2</b>
Name_p					<b>O</b>	<b>O</b>	<b>O</b>	<b>Ca</b>	<b>Ca</b>	<b>He</b>	<b>He</b>
Mp	Mass			com	24.02	24.02	24.02	47.95	47.95	4.00	4.00
dEp	MassExcess			MeV	19.070	19.070	19.070	-44.214	-44.214	2.425	2.425
Ap3	Ap*(1/3)				2.88	2.88	2.88	3.63	3.63	1.59	1.59
Rp	equivalent sharp radius(calc)	Wilcke	$1.28*Ap3-0.76-0.8*Ap3$	fm	3.21	3.21	3.21	4.11	4.11	1.78	1.78
Rp1	equivalent sharp radius(calc)	Hodgson	$(1.13-0.0002*Ap)*Ap3$	fm	3.27	3.27	3.27	4.14	4.14	1.80	1.80
Cp	matter half-density radius(calc)	Wilcke	$Rp*(1-(1/Rp)^2)$	fm	2.90	2.90	2.90	3.87	3.87	1.21	1.21
Cp1	matter half-density radius(calc)	Hodgson	$Rp1*(1-(1/Rp1)^2)$	fm	2.97	2.97	2.97	3.90	3.90	1.24	1.24
Cp2	matter half-density radius(calc)		$1.18*Ap3-0.48$	fm	2.92	2.92	2.92	3.81	3.81	1.39	1.39
Rpcharge	charge radius	Hodgson	$1.12*Ap3+2.009*Ap3-1513*Ap$	fm	3.86	3.86	3.86	4.59	4.59	2.67	2.67
<b>At</b>					<b>2</b>	<b>2</b>	<b>2</b>	<b>9</b>	<b>9</b>	<b>22</b>	<b>22</b>
<b>Zt</b>					<b>1</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>10</b>	<b>10</b>
Name_t					<b>H</b>	<b>H</b>	<b>H</b>	<b>Be</b>	<b>Be</b>	<b>Ne</b>	<b>Ne</b>
Mt	Mass			com	2.01	2.01	2.01	9.01	9.01	21.99	21.99
dEt	MassExcess			MeV	13.14	13.14	13.14	11.35	11.35	-8.02	-8.02
At3	At*(1/3)				1.26	1.26	1.26	2.08	2.08	2.80	2.80
Rt	equivalent sharp radius(calc)	Wilcke	$1.28*At3-0.76-0.8*At3$	fm	1.49	1.49	1.49	2.29	2.29	3.11	3.11
Rt1	equivalent sharp radius(calc)	Hodgson	$(1.13-0.0002*At)*At3$	fm	1.42	1.42	1.42	2.35	2.35	3.18	3.18
Ct	matter half-density radius(calc)	Wilcke	$Rt*(1-(1/Rt)^2)$	fm	0.82	0.82	0.82	1.85	1.85	2.79	2.79
Ct1	matter half-density radius(calc)	Hodgson	$Rt1*(1-(1/Rt1)^2)$	fm	0.72	0.72	0.72	1.93	1.93	2.86	2.86
Ct2	matter half-density radius(calc)		$1.18*At3-0.48$	fm	1.01	1.01	1.01	1.97	1.97	2.83	2.83
Rtcharge	charge radius	Hodgson	$1.12*At3+2.009*At3-1513*At$	fm	2.25	2.25	2.25	3.13	3.13	3.79	3.79
<b>Ac</b>					<b>26</b>	<b>26</b>	<b>26</b>	<b>57</b>	<b>57</b>	<b>26</b>	<b>26</b>
<b>Zc</b>					<b>9</b>	<b>9</b>	<b>9</b>	<b>24</b>	<b>24</b>	<b>12</b>	<b>12</b>
Name_t					<b>F</b>	<b>F</b>	<b>F</b>	<b>Cr</b>	<b>Cr</b>	<b>Mg</b>	<b>Mg</b>
Mo	Mass			com	26.02	26.02	26.02	56.94	56.94	25.98	25.98
dEc	MassExcess			MeV	18.27	18.27	18.27	-52.52	-52.52	-16.22	-16.22
Q	ground state Q-value for fusion			MeV	13.94	13.94	13.94	19.66	19.66	10.62	10.62
m	reduced mass number				1.85	1.85	1.85	7.58	7.58	3.38	3.38
Ac3	Ac*(1/3)				2.96	2.96	2.96	3.85	3.85	2.96	2.96
AtAp3	At*(1/3)*Ap*(1/3)				4.14	4.14	4.14	5.71	5.71	4.39	4.39
RtRp	sum Rt and Rp			fm	4.70	4.70	4.70	6.40	6.40	4.89	4.89
Rint	interaction radius	Wilcke	$Ct+Cp+4.49*(Ct+Cp)/6.35$	fm	7.62	7.62	7.62	9.31	9.31	7.86	7.86
Rn1	interaction radius	Hodgson	$1.68*AtAp$	fm	6.96	6.96	6.96	9.60	9.60	7.37	7.37
Rn2	interaction radius	Hodgson	$Cp1+Ct1+3.2$	fm	6.89	6.89	6.89	9.03	9.03	7.30	7.30
Rbarrier	fusion barrier radius for s-wav.	Wilcke	$Rint-0.3117*(Zp*Zt)^*(0.2122)$	fm	7.13	7.13	7.13	8.52	8.52	7.27	7.27
Rc	coulomb radius from "LNP"	LNP	$0.5+1.36*AtAp3$	fm	6.14	6.14	6.14	8.27	8.27	6.47	6.47
Rc			$Rint/(At*(1/3)+Ap*(1/3))$	fm	1.84	1.84	1.84	1.63	1.63	1.79	1.79
<C>	reduced half-density radius		$Ct*Cp/(Ct+Cp)$	fm	0.64	0.64	0.64	1.25	1.25	0.85	0.85
VC	BSS Coulomb pot. at r=Rint		$1.438*Zp*Zt/Rint$	MeV	1.51	1.51	1.51	12.36	12.36	3.66	3.66
VC_Rc	BSS Coulomb pot. at r=Rc		$1.438*Zp*Zt/Rc$	MeV	1.87	1.87	1.87	13.91	13.91	4.45	4.45
VC_Rbar	total conserv. potential at Rbar		$1.438*Zp*Zt/Rbar$	MeV	1.61	1.61	1.61	13.51	13.51	3.95	3.95
Xf	Saddle point (fissility parameter)		$Z^2*2/A/50.13(1-7.826(N-Z)^2/A^2)$		0.05	0.05	0.05	0.19	0.19	0.11	0.11
TKE	fission TKE for simmet. fission		$0.1071*Zc^2/Ac3+22.3$	MeV	25.23	25.23	25.23	38.33	38.33	27.51	27.51
Elab				MeV	120.1	240.2	480.4	959.1	1438.6	20.0	40.0
Elab / Mp	Energy per nucleon		Elab / Ap	MeV/u	<b>5.00</b>	<b>10.00</b>	<b>20.00</b>	<b>20.00</b>	<b>30.00</b>	<b>5.00</b>	<b>10.00</b>
Eom	Energy SCM		Mt*Elab/(Mt+Mp)	MeV	9.3	18.6	37.2	151.7	227.6	16.9	33.9
Eom+Q	Excitation Energy		Eom+Q	MeV	23.2	32.5	51.1	171.4	247.2	27.5	44.5
ETA	coulomb parameter	Wilcke	$Zp*Zt*e^2/hv$		0.6	0.4	0.3	2.8	2.3	1.4	1.0
k	asym. wave number in the CMS	Wilcke	$(2*m*mu_nuclon*Eom/h^2)^*(1/2)$	1 / fm	0.9	1.3	1.8	7.4	9.1	1.7	2.3
a	parameter	Wilcke-Hod	$Zt*Zp*e^2/(mv^2) --- ETA/k$		0.6	0.3	0.2	0.4	0.3	0.9	0.4
QP-CM	quarterpoint angle in the CMS	Wilcke	$2*asin(ETA/(k*Rint-ETA))$	deg	10.2	4.9	2.4	4.9	3.2	13.9	6.6
Qgr	grazing angle in the CMS(LNF)	LNF	$2*ATAN(ETA / Lmas)$	deg	10.2	4.9	2.4	4.9	3.2	13.9	6.6
Qcr	critical angle		$2*asin(a/(Rint-a))$	deg	10.2	4.9	2.4	4.9	3.2	13.9	6.6
LorticalF	crit.ang.momentum for fusion		$k*RtRp*(1-2a/RtRp)*0.5-0.5$	MeV	3	5	8	44	55	6	10
Lmax	graz.ang.momentum by QP-CM	Wilcke	$ETA*a*oat(QP-CM/2)$	MeV	6	9	14	66	82	12	17
SGMAR	reaction CS derived from Lmax		$(pi/k^2)*(Lmax+1/2)^2$	mb	1777	1858	1881	2538	2605	1657	1833
SGcr	critical CS		$(pi/k^2)*(Lcr+0.5)^2$	mb	510	602	647	1134	1185	489	620
SGMgr1	grazing CS		$(pi/Rc^2)*(1-VC_Rc/Eom)$	mb	944	1064	1123	1952	2018	970	1142
SGMgr2	grazing CS		$(pi/Rint^2)*(1-VC_Rc/Eom)$	mb	1527	1675	1749	2500	2574	1523	1733
Dgr	dist.of.ol.appr. in the graz.angle		$a*(1+ooscc((QP-CM/2))$	fm	4.1	4.0	3.9	4.8	4.8	4.4	4.2
Dgr/AtAp3	ratio Dgr to AtAp3		Dgr/AtAp3	fm	1.0	1.0	0.9	0.8	0.8	1.0	0.9
WaveLength			$197/sqrt(2*Ap*931*Elab)$	fm	0.09	0.06	0.04	0.02	0.02	0.51	0.36
AngDir1			$2*asin(pi)*WaveLength/Rt$	degrees	10.30	7.28	5.15	1.67	1.37	29.85	20.99
AngDir2			$2*asin(pi)*WaveLength/Rt$	degrees	20.69	14.59	10.30	3.35	2.73	62.01	42.72
bgr	impact parameter for graz.		$a*cos(1/2*Qgr)$	fm	0.6	0.3	0.2	0.4	0.3	0.8	0.4