

# New Utilities in LISE++ (v.7.8.87 beta)

- \* **Twinsol (solenoid) utility**  
ray trace and matrix solutions
- \* **the Kinematics calculator: Mott scattering and (A\*, A+gamma) mode**
- \* **Wedge-wedge optimization**
- \* **“MOTER” ray trace code for MS Windows**  
(FORTRAN and C++ versions)
- \* **ISOL catcher utility**

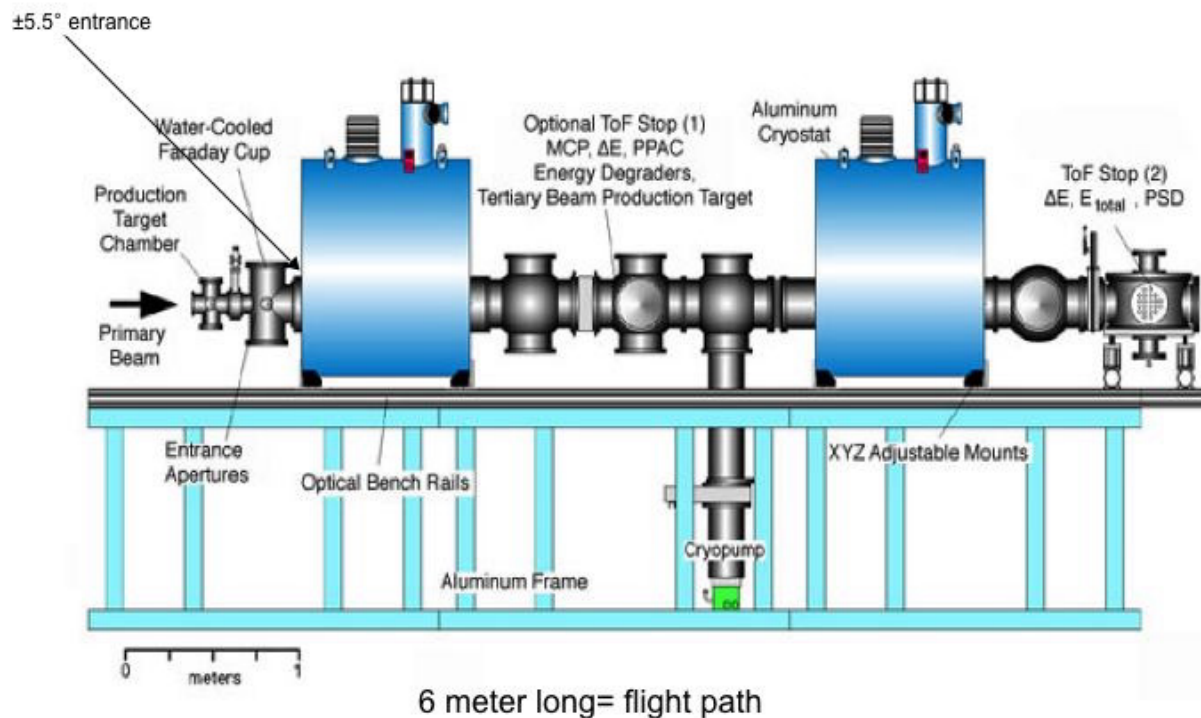
Version 7.8.87 beta from 06/06/06  
available through LISE sites

# I. TwinSol in LISE++

Thanks for the help (ideas, Fortran source, recommendations, etc ) in developing the TwinSol utility in the LISE++ program:

- Dr.G.Chubarian (TAMU)
- Dr.Th.Materna (TAMU)
- Prof. F.Becchetti (UMich)
- Mr. H.Jiang (UMich)
- Dr.V.Shchepunov (ORNL)

## *TwinSOL: RNB production facility*



## Development stages

### 1. *TwinSol utility dialog* (1st stage - DONE)

- a. RayTrace source transformation into C++
- b. TwinSol-solenoid class library development
- c. Relativistic solution for the RayTrace model
- d. TwinSol matrix solution : main part (Transport)
- e. TwinSol matrix solution : soft-edge corrections
- f. TwinSol dialog construction
- g. Solenoid dialog construction
- h. Calculation results plot
- i. Scratch file for multidisplay

### 2. *TwinSol utility dialog* (2nd stage)

- a. Electrode dialog
- b. Midplane absorber dialog
- c. Gas filled solenoid

### 3. TwinSol optimization utilities in the *TwinSol dialog* (3rd stage)

### 4. Research of TwinSol properties using the TwinSol utilities to develop a fragment transmission model through solenoids.

### 5. New blocks: round slits and beam stopper??

### 6. Solenoid block development to be used in LISE++ block frame

- a. Solenoid block optimization in LISE++
- b. Transmission
- c. Solenoid block setting for the fragment of interest
- d. Optimization utility for Solenoid block
- e. LISE transmission plots with Solenoid block



```

class o_solenoid_electrode
{
..
};

//-----
class o_solenoid
{
....
o_solenoid_electrode electrode;
double CalculateOM(Cproj *beam, int Direct, bool
EdgeCorrection, OPTICAL_MATRIX *om, double z);
OPTICAL_MATRIX *OM;
};

//-----
class o_twinsol
{
o_solenoid s1, s2;
...
};

//-----
class G_twinsol : public o_twinsol
{

OPTICAL_MATRIX* CalculateOM(int k);
OPTICAL_MATRIX* CalculateGOM(double z);
....
int RayTrace(distribution **d);

Cproj *Proj;
OPTICAL_MATRIX *GOM;
BEAM *BeamSigma;
BEAM *BeamRay;
};

```

## Fortran Source:

```

GX=V1*DT+.5*AX*DTS
GY=V2*DT+.5*AY*DTS
X=X+GX
Y=Y+GY
Z=DZ*FLOAT(STEP)
T0 = T0 + (SQRT(GX**2+GY**2+DZ**2))/(1.0E-09*V0)
F7=AX*DT
F8=AY*DT
F9=AZ*DT
HF7=.5*F7
HF8=.5*F8
HF9=.5*F9
VX=VX+F7
VY=VY+F8
VZ=VZ+F9

```

## C++ equivalent using the "Vector3" class

```

v3_shift = v3_VelocityWork * deltaT +
           v3_Acceleration * (0.5 * deltaT*deltaT);

v3_position += v3_shift;
v3_position.p3_z = this->Step * double(II);

Vector3 shift_step( v3_shift.x(),
                   v3_shift.y(),
                   this->Step);

TOF += shift_step.r_xyz() / (1.0E-09*V0);

v3_Velocity += v3_Acceleration * deltaT;

```

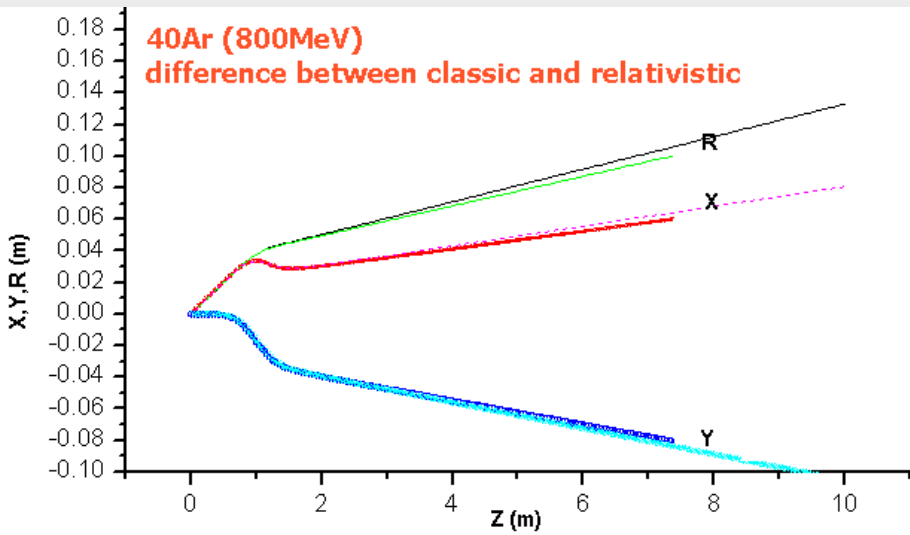
# Relativistic solution for the RayTrace model. Substitution by LISE++ library functions

Substitution expressions like that

$$V0 = 1.389E+07 * \text{SQRT}(E/M)$$

by LISE++ relativistic functions

$$V0 = v_{c\_m\_s} * E\_to\_Beta(\text{energy});$$



```

C*****
C calculate universal nuclear stopping power: SN in MeV/micron *
C*****
      ZABS=ABSORBER
      EPSIL=32.53*M2*E*1000/(N*ABSORBER*(M1+M2)*(N**.23+ZABS**.23))
      IF (EPSIL .GE. 30.) THEN
        SN = LOG(EPSIL)/(2*EPSIL)
      ELSE
        TEMP = (.04321*EPSIL**.21226) + (.19593*EPSIL**.5)
        SN = .5*LOG(1+1.1383*EPSIL)/(EPSIL+TEMP)
      ENDIF
      SN = SN*N*ABSORBER*M1*8.462/((M1+M2)*(N**.23+ZABS**.23))
      SN = SN * ATRHO * .001
      IF (ION .EQ. 1)CALL
      PSTOP(ION,M1,ABSORBER,M2,VELSQR,PCOEF,SE)
      IF (ION .EQ. 2)CALL
      HESTOP(ION,M1,ABSORBER,M2,VELSQR,PCOEF,SE)
      IF (ION .GT. 2)CALL
      HISTOP(ION,M1,ABSORBER,M2,VELSQR,E,VFERMI,
      &
      LFCTR,PCOEF,SE)
      SE = SE * ATRHO * .001
      E = E - SE - SN
      IF (E .LT. .000002) E = .000002
      END DO
      TEMP = E/EO(I)
      TEMP = SQRT(TEMP)
      .....
```

Using LISE++ library the substitution was done:

```

double StoppingPower ( Celement *p,
Compound *cp,
double Energy,
int option);
```

[http://people.web.psi.ch/rohrer\\_u/trantext.htm#Solen](http://people.web.psi.ch/rohrer_u/trantext.htm#Solen)

Urs C. Rohrer, PSI (SIN), CH-5232 Villigen-PSI, Switzerland

## SOLENOID: Type code 19.0

Inside the solenoid, particles possessing a transverse velocity will describe an orbit which is helical in space. In order to study these movements, the beam centroid may be shifted and traced through the solenoid.

For  $B * L > Brho$ , the solenoid has to be divided into a sufficient amount of smaller elements in order to get an accurate image of the particle rays. But the R-matrix used in transport includes the fringe field effects at the entrance and exit of the solenoid. Therefore the slopes (x'/y') computed at the different segments are incorrect. Cubic spline interpolation used for the graphic display of the particle rays or the

envelopes need the correct slopes for a decent picture. Therefore provision has been made to do correct slope computation inside a solenoid by separating it into three regions: a) entrance face, b) homogenous region and c) exit face.

```
19.0 0. B. /ENTR/ ;
19.0 L1 B. /HOM1 / ;
. ( L1 to Ln unequal 0. )
```

```
19.0 Ln B. /HOMn/ ;
19.0 0. B. /EXIT/ ;
```

If the code encounters for the first time a 19. type code with zero length, it takes the R-matrix for the entrance fringe field. For all subsequent 19. type codes with  $Lx \neq 0$  the R-matrix for the homogeneous longitudinal field is taken. If a 19. type code with zero length is encountered for a second time the R-matrix for the exit fringe field is selected. Other data entries between the sequence of 19. type codes are allowed ( e. g. I/O control or RMS addition to beam ), but no checks are made if these entries make sense or not. In order to divide the solenoid into segments of equal length, the automatic segmenting feature of the space charge card may be

used. In first order fitting, the lengths and the magnetic field strengths of the different segments may be adjusted through coupled vary codes.

Note: The original default is still available. If no type-code 19. card with zero length is present, then for all solenoid cards the matrix with entrance and exit fringe fields included will be taken.

First-order matrices for the solenoid:

1) Entrance face :

$$R_i = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & K & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ -K & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad 2 * K = B / Brho$$

2) Exit face :

$$R_o = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & -K & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ K & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

3) Homogeneous field:

$$R_h = \begin{pmatrix} 1 & S*C/K & 0 & S*S/K & 0 & 0 \\ 0 & 2*C*C-1 & 0 & 2*S*C & 0 & 0 \\ 0 & -S*S/K & 1 & S*C/K & 0 & 0 \\ 0 & -2*S*C & 0 & 2*C*C-1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$C = \cos(K*L)$$

$$S = \sin(K*L)$$

# TwinSol matrix solution : soft-edge corrections

Alex Bogacz, Workshop on Muon Collider Simulations, Miami Beach, FL December 15, 2004

- Non-zero aperture - correction due to the finite length of the edge :

- It decreases the solenoid total focusing – via the effective length of:

$$L = \frac{1}{B_0} \int_{-\infty}^{\infty} B_z(s) ds$$

- It introduces axially symmetric edge focusing at each solenoid end:

$$\Phi_{\text{edge}} = \frac{1}{2} \left( \int_{-\infty}^{\infty} B_z^2(s) ds - B_0^2 L \right) = -\frac{k^2 a}{8} \quad k = eB_0/pc$$

- axially symmetric quadrupole

- $M_{\text{soft sol}} = M_{\text{edge}} M_{\text{sol}} M_{\text{edge}}$

$$M_{\text{edge}} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -\Phi_{\text{edge}} & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -\Phi_{\text{edge}} & 1 \end{bmatrix}$$

# The TwinSol utility dialog in LISE++

**Twinsol global matrix**

Block matrix						
1. X	-0.9765	-0.6216	-2.5774	-1.6408	0	0
2. T	-0.1001	-0.1923	-0.2643	-0.5075	0	0
3. Y	2.5774	1.6408	-0.9765	-0.6216	0	0
4. F	0.2643	0.5075	-0.1001	-0.1923	0	0
5. L	0	0	0	0	1	0
6. D	0	0	0	0	0	1
	/[mm]	/[mrad]	/[mm]	/[mrad]	/[mm]	/[%]

Det = 0.99985

Beam (sigmas)

35.199	[mm]
10.858	[mrad]
35.199	[mm]
10.858	[mrad]
0	[mm]
0	[%]

Dimension:  mm  cm

Ok

LISE++ [None]

File Settings Options Calculation Utilities ID-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  
Converter of FORTRAN-files to C-files

Reaction's Characteristics  
Radiation length  
Electromagnetic excitation plots

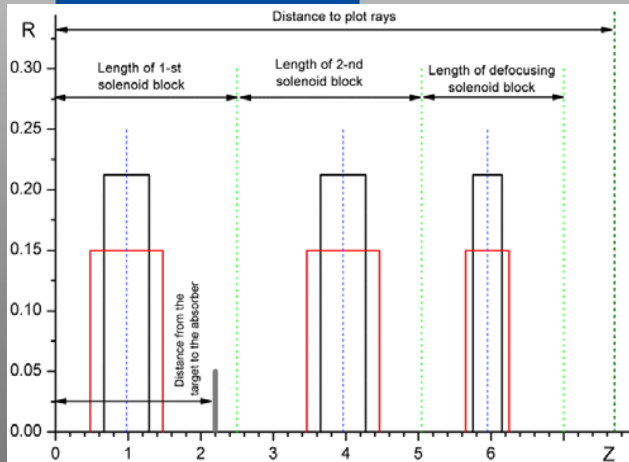
Plot of Fragment Range in material versus Energy  
Plot of Fragment Stopping Power (dE/dx) in material versus Energy  
Plot of Angular Straggling in material versus Energy  
Plot of Equilibrium Thickness versus Energy

Range optimizer  
Gas pressure optimization for gas-filled dipole  
Brho Analyzer  
Calculation of Angle on the LISE3 target  
MSP-144 utility  
**Twinsol (solenoid) utility**  
User cross-sections analysis using Abrasion-Ablation model  
Rate & transmission calculation: batch mode

Projectile:  $40\text{Ar}^{18+}$  140 MeV/u 1 pA  
Fragment:  $32\text{S}^{16+}$

Target: Be 500 micro  
Stripper

D1: Brho 3.4821 Tm  
D2: Brho 3.4821 Tm  
I2\_slits: slits  
I2\_wedge  
D3: Brho 3.4821 Tm  
D4: Brho 3.4821 Tm  
FP\_PPAC0: Al 2 mg/cm  
FP\_slits: slits



**TwinSol**

Twinsol settings

- Use the second solenoid
- Twinsol operation mode:  Antiparallel  Parallel
- Use the defocusing solenoid
- Use the absorber
- Use the "soft-edge" corrections for solenoid matrix calculations

Twinsol optical matrix

Twinsol scheme

Twinsol Length = 5.862 m  
Distance to plot rays = 7.4 m  
Integration Step = 0.002 m

Initial Beam

Projectile

	Beam emittance	Initial ray values	
1. X	1	5	mm
2. T	20	20	mrad
3. Y	1	-5	mm
4. F	20	25	mrad
1&3. R	1.41	7.07	mm
2&4. A	28.28	32.02	mrad

40Ar18+ (10.00 MeV/u)  
P trnsprt 0.3038 GeV/c

1-st solenoid block

1-st solenoid block settings

Optical Matrix for setting fragment

Block Length = 1.954 m  
B = 3.5399 T

2-nd solenoid block

2-nd solenoid block settings

Optical Matrix for setting fragment

Block Length = 1.954 m  
B = 2.4599 T

defocusing solenoid

Settings

Optical Matrix

Length = 1.954 m  
B = 1.8 T

Absorber

Absorber settings

Distance from target to absorber: 2.1 m  
Charge state after absorber (Z0): 0

Files: current file, twinsol\_origin, Save file as, Load file, Save for multidispay

Utility

Plot options: Show:

- Transport: Beam Sigmas
- Transport: Ray Values
- Ray Trace
- Scratch file data

Selected plot: 1.X

Calculate, Plot, Save & Exit, Quit

Beam tracking

2-nd solenoid: x0 1.954 m

"Transport" (matrix solution)

	Beam sigmas	Ray Values	Ray TRACE
1. X	10.71	17.79	19.41
2. T	9.44	-11.63	-7.29
3. Y	10.71	-0.03	-5.28
4. F	9.44	12.66	12.38
1&3. R	15.14	17.79	20.12
2&4. A	13.35	17.2	14.37

Energy (MeV/u) = 10  
Time of flight (ns) = 45.1

Under construction (2nd stage)



# The Solenoid block dialog

**Solenoid**
✕

setting fragment:  Optical matrix for setting fragment

**Magnetic field**

B(0)  T

I  A

Use the electrode ⚙️ Electrode settings

Fill by gas M Gas settings

**Geometry**

1-st half = <input type="text" value="2.2964"/> m	Block Length = <input type="text" value="5.7028"/> m
2-nd half = <input type="text" value="3.4064"/> m	
Coil length = <input type="text" value="0.8128"/> m	Solenoid length = <input type="text" value="1"/> m
Effective radius = <input type="text" value="0.2123"/> m	Bore = <input type="text" value="0.15"/> m

**MA**

MAconstant =  T/A

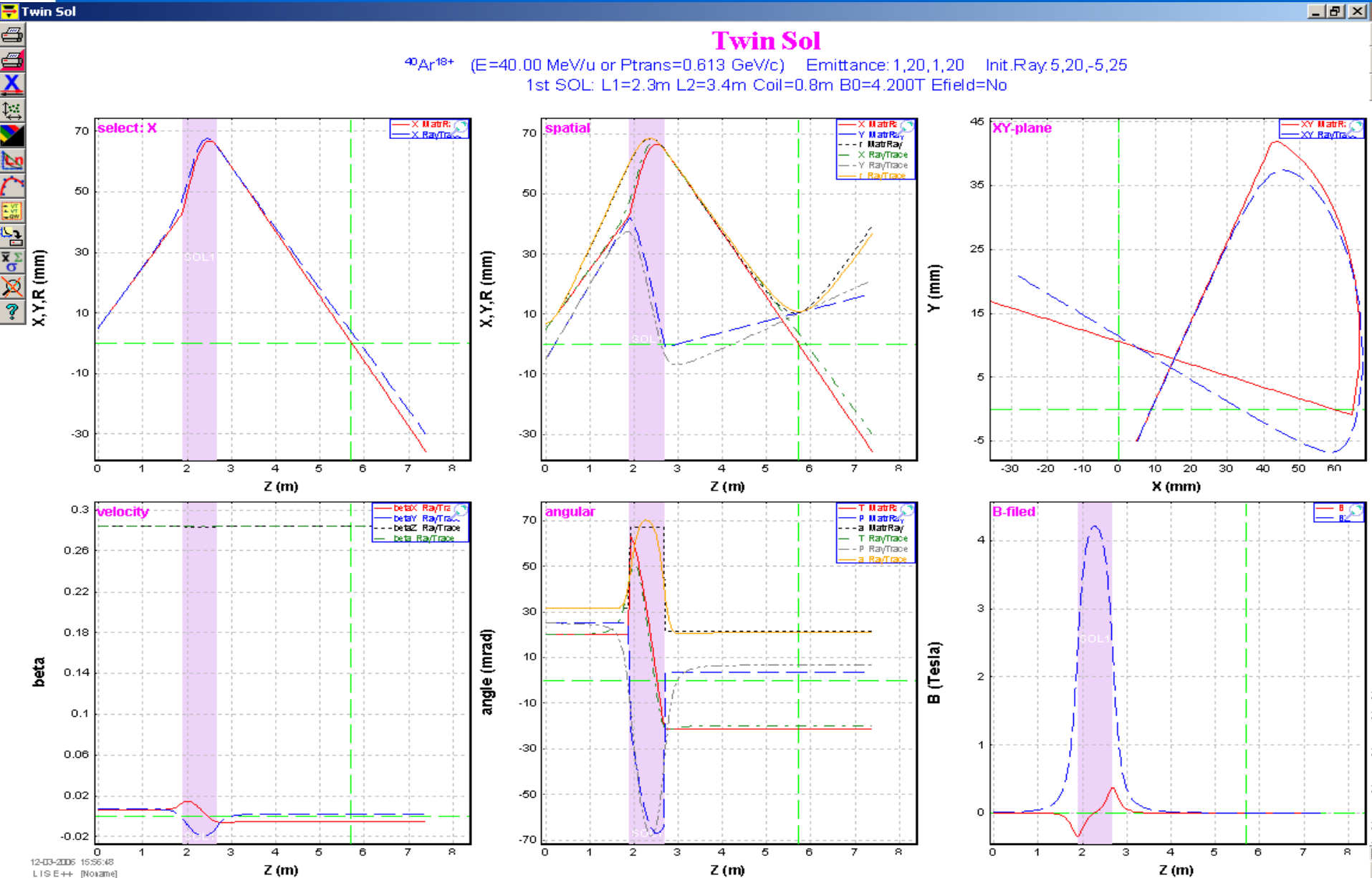
MA = MAconstant \* I      MA =  T

$B(0) = MA * CoilLength / \sqrt{EffRadius * EffRadius + CoilLength * CoilLength / 4}$

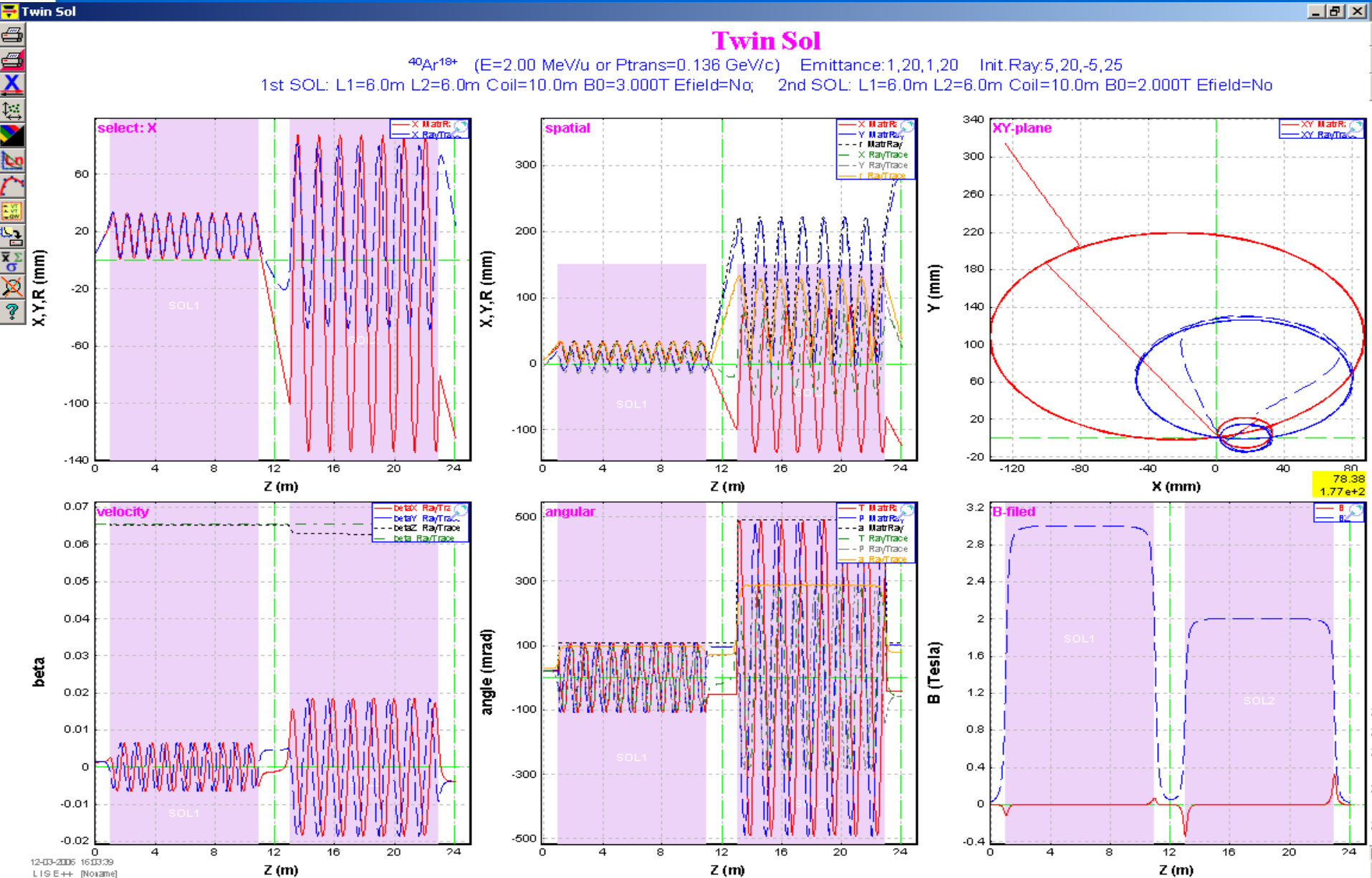
Ok

Quit

# Calculation results plot: 1 solenoid, $L*B(0)/Br < 1$



# Calculation results plot: 2 solenoids, $L \cdot B(0)/Br \gg 1$



# II. The Kinematics calculator: Mott scattering (1)

Thanks for the ideas to

Dr. A. Villari (GANIL)

Quantum-mechanical scattering. Mott's approaches have been realized in LISE++ to:

a. **Relativistic case:**  $\xi(\vartheta)d\omega = \xi_0(\vartheta)[1 - \beta^2 \cdot \sin^2(\vartheta/2) + \dots]d\omega$ , where  $\xi_0(\vartheta)$  is the classical differential cross section.

b. **Identical particles:**  $d\sigma(\theta) = \left(\frac{q_i q_j}{4 \cdot E}\right)^2 \left[ \frac{1}{\sin^4(\theta/2)} + \frac{\delta_{ij}}{\cos^4(\theta/2)} + \delta_{ij} \frac{(-1)^{2S}}{(2S+1) \cos^2(\theta/2) \sin^2(\theta/2)} \cos[\eta \log \tan^2(\theta/2)] \right] d\omega$

**Kinematics calculator (relativistic)**

Reactions:

- TWO BODY reaction B(A, C)D
- SCATTERING B(A, C=A)D=B
- BREAKUP
- FISSION x(A, C,D)x (gamma-emission)

Participants:

	Spin	ME [MeV]	Excitation Energy	E[CM] = 434.23 MeV
A * Beam	208Pb	-21.75	0	Beam energy = 4.2 MeV/u
B Target	208Pb	-21.75	0	Intensity = 1 pA
C * Fragment	208Pb	-21.75	0	Target thickness = 0.1 micron
D * Residual	208Pb	-21.75	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):

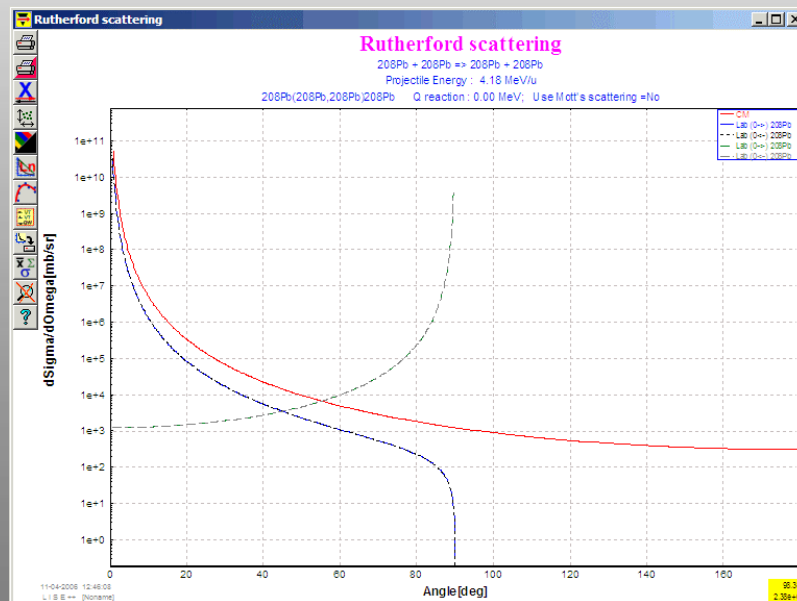
R = 100 cm 100  
w = 1 cm 1  
h = 2 cm 2

Angle (deg) = 24.975 64.975 50 130  
fragment (C) residual (D) fragment (C) residual (D)

Calculations:

	LAB	CM	
Counting in monitor	1.48e+1	6.9e+0	pps
Differential Cross Section	4.64e+04	2.16e+04	1.28e+04 1.28e+04 mb/sr
Energy after reaction*	3.43	0.75	1.04 1.04 MeV/u**
Energy before detectors	3.42	0.73	MeV/u**
Maximum Angle	90.00	90.00	deg
Solid Angle	0.16	0.16	0.57 0.27 msr
delta Theta	0.57	0.57	1.1 1.1 deg

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



Coulomb scattering  $^{208}\text{Pb}$  (873MeV)+ $^{208}\text{Pb}$  (classical case)

# The Kinematics calculator: Mott scattering (2)

VOLUME 71, NUMBER 16

PHYSICAL REVIEW LETTERS

18 OCTOBER 1993

## Search for Color van der Waals Force in $^{208}\text{Pb}+^{208}\text{Pb}$ Mott Scattering

A. C. C. Villari,<sup>2</sup> W. Mittig,<sup>1</sup> A. Lépine-Szily,<sup>1,2</sup> R. Lichtenthäler Filho,<sup>2</sup> G. Auger,<sup>1</sup> L. Bianchi,<sup>1</sup> R. Beunard,<sup>1</sup> J. M. Casandjian,<sup>2</sup> J. L. Ciffre,<sup>1</sup> A. Cunsolo,<sup>3</sup> A. Foti,<sup>3</sup> L. Gaudard,<sup>1</sup> C. L. Lima,<sup>2</sup> E. Plagnol,<sup>1</sup> Y. Schutz,<sup>1</sup> R. H. Siemssen,<sup>1,4</sup> and J. P. Wieleczko<sup>1</sup>

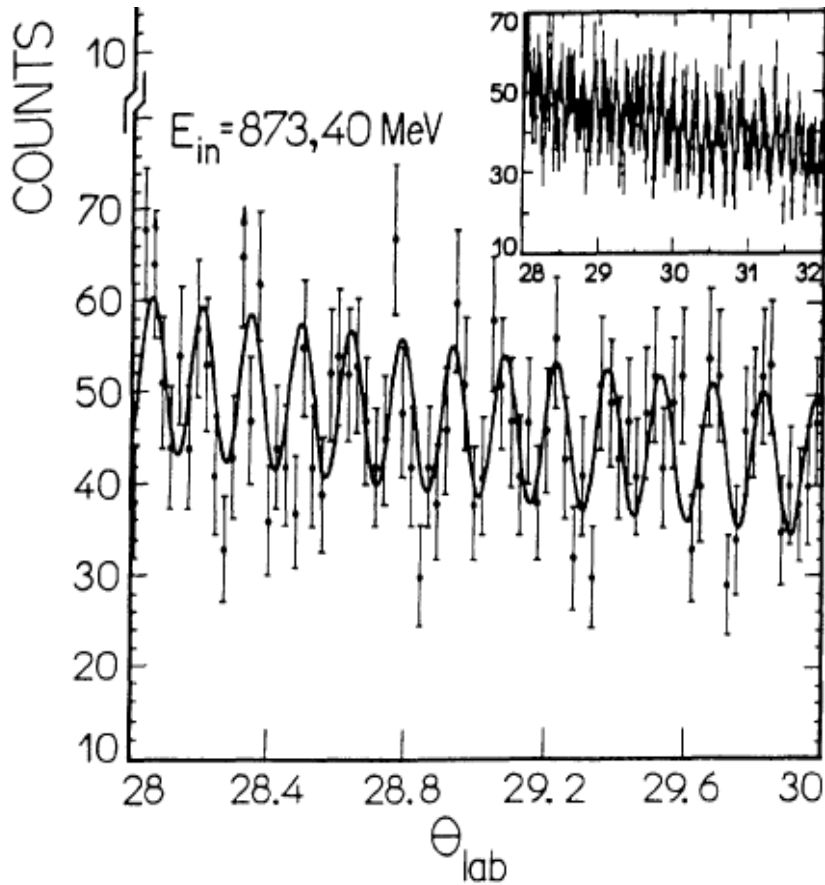
<sup>1</sup>Grand Accélérateur National d'Ions Lourds, Boîte Postale 5027, 14021 Caen Cedex, France

<sup>2</sup>Instituto de Física, Departamento de Física Nuclear, Universidade de São Paulo, Caixa Postal 20516, 01498, São Paulo, São Paulo, Brazil

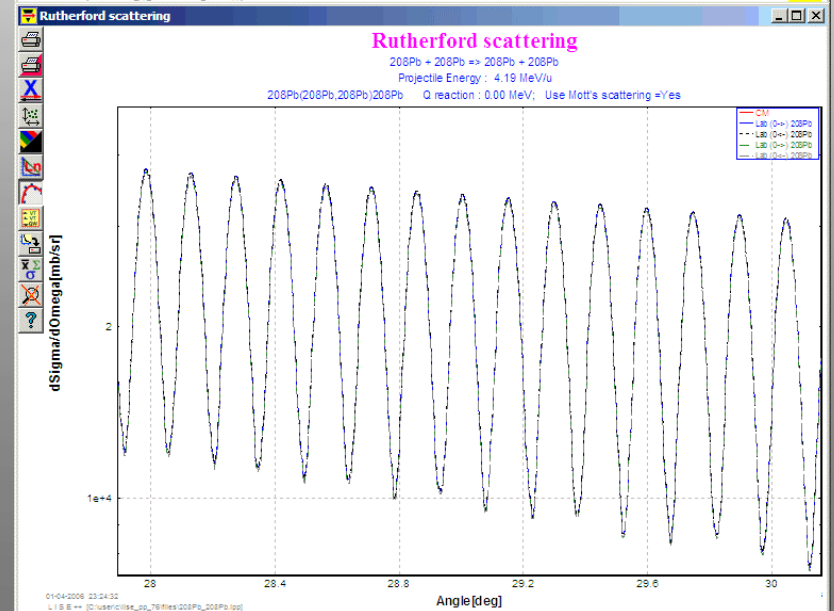
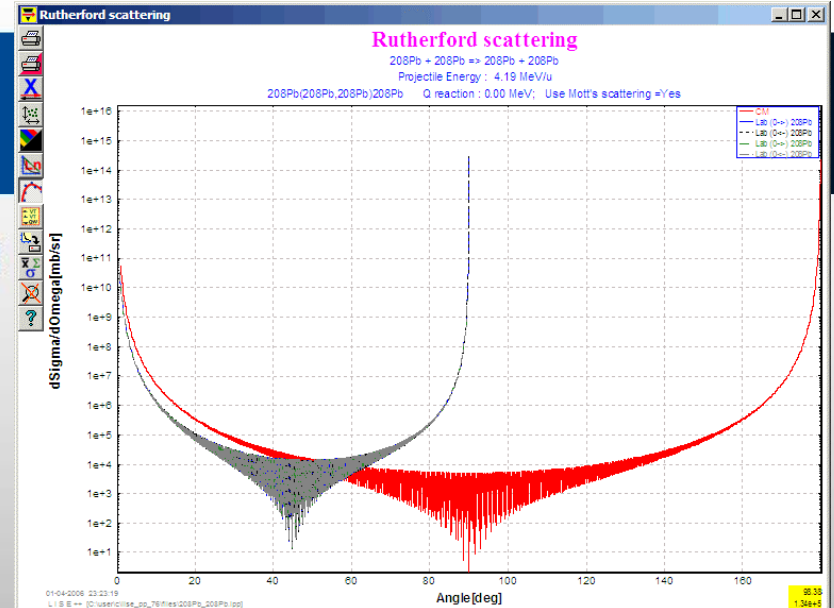
<sup>3</sup>Dipartimento di Fisica and Istituto Nazionale di Fisica Nucleare-Sezione di Catania, 95129 Catania, Italy

<sup>4</sup>Kernfysisch Versneller Instituut, 9747 AA Groningen, The Netherlands

(Received 15 April 1992)



Experiment: Mott scattering of identical particles  
 $^{208}\text{Pb}$  (873MeV)+ $^{208}\text{Pb}$ .



LISE++ calculation: Mott scattering of identical particles  
 $^{208}\text{Pb}$  (873MeV)+ $^{208}\text{Pb}$ .

# The Kinematics calculator: ( $A^*$ , $A+\text{gamma}$ )

Thanks for the idea to Dr. V. Goldberg (TAMU)

**Kinematics calculator (relativistic)**

**Reactions**

- TWO BODY reaction B (A, C) D
- SCATTERING B (A, C=A) D=B
- BREAKUP (FISSION) x (A, C, D) x (gamma-emission)**

**Participants**

	ME [MeV]	Excitation Energy
A Beam 40Ar	-35.04	<b>5</b>
B Target 9Be		
<b>C* Fragment 40Ar</b>	<b>-35.04</b>	<b>2</b>
D* Residual gamma	energy=	3

Beam energy = 140.0 MeV/u  
Intensity = 1 pA  
Target thickness = 0.1 micron  
Q-value = 0.00 MeV

**1-st step**

It is supposed, that the reaction takes place in middle of a target

**2-nd step**

Search an angle in CM

- from 0 degrees and up
- from 180 degrees and down

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

Angle (deg) = 0.008, 60.384, 90, 90

**3-rd step**

Calculations

	LAB	CM	pps
Counting in monitor =	1.62e-1	2.04e-1	
Differential Cross Section =	3.05e+13	132	100 mb/rad
Energy after reaction* =	139.99	3.451	3e-06 MeV/u**
Energy before detectors =	139.99	<b>3.451</b>	MeV/u**
Maximum Angle =	0.01	180.00	deg
Solid Angle =	0.16	0	0.21 msr
delta Theta =	0.57	0.66	deg

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

**1-st step** click here to get the kinematics plot

**2-nd step** gamma-ray value

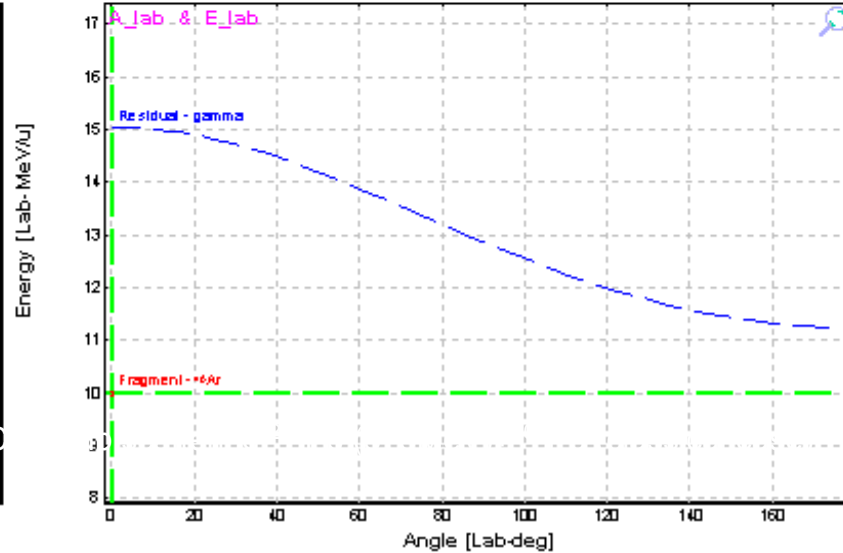
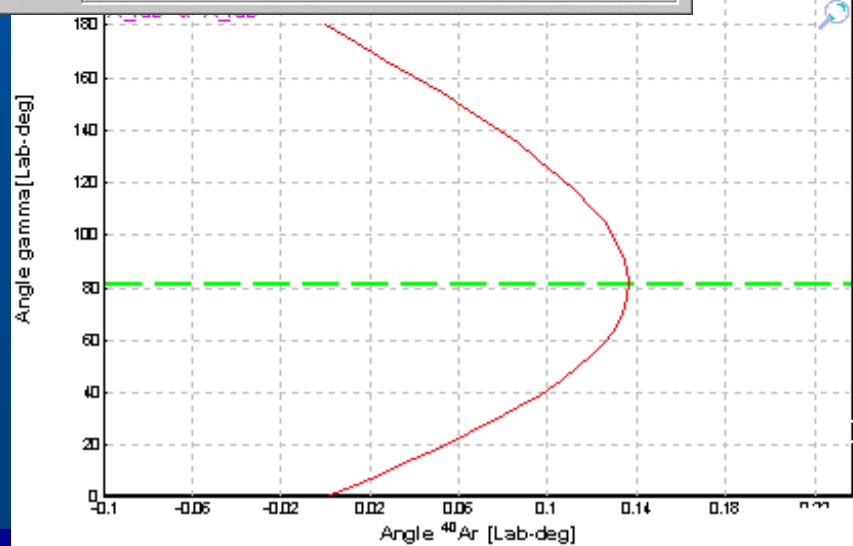
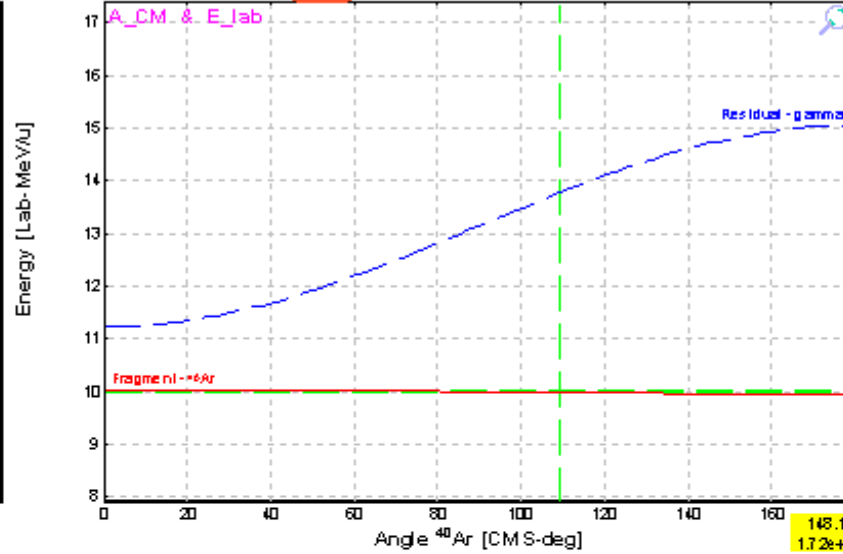
**3-rd step** gamma-ray energy value in LAB

**Reaction's Kinematics**

$^{40}\text{Ar} \Rightarrow ^{40}\text{Ar} + \text{gamma}$  x ( $^{40}\text{Ar}, ^{40}\text{Ar} + \text{gamma}$ ) x

Projectile Energy **10.00 MeV/u**

Q reaction: 0.00 MeV (Excitations 15.0 => 2.0 + 13.0) - gamma ray value



# III. Wedge-Wedge optimization

## Wedge shape degrader in the Target-Wedge optimization utility

Before it was assumed that only curved profile degraders can be used for optimization. Now you can assign the wedge operation mode (Fig.1) in order to use in the Target-Wedge optimization dialog (Fig.2). Wedge angle of a wedge shape degrader will be recalculated according to chosen mode during optimization calculation.

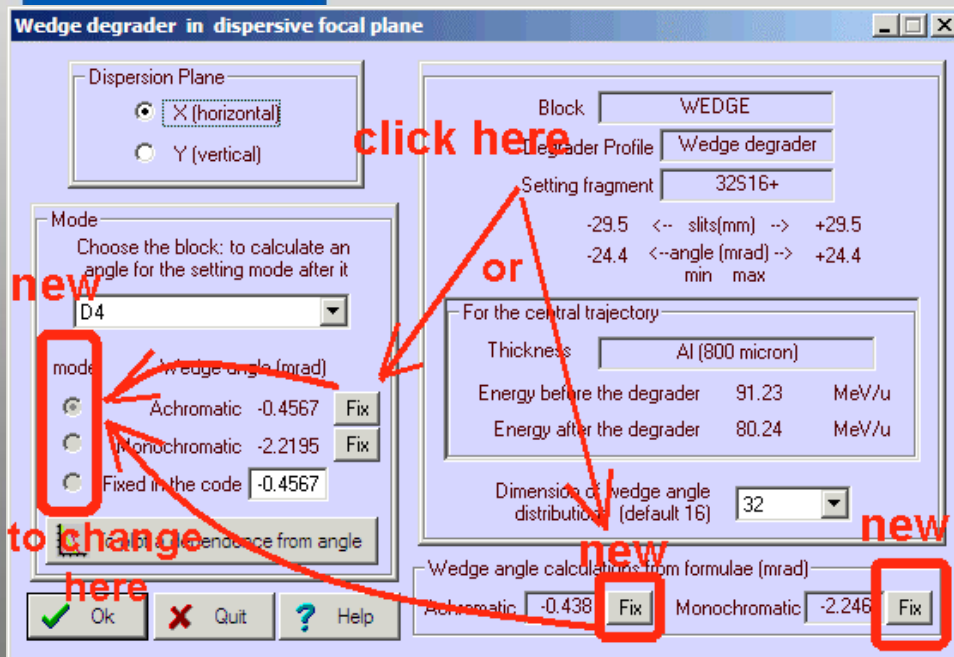


Fig.1

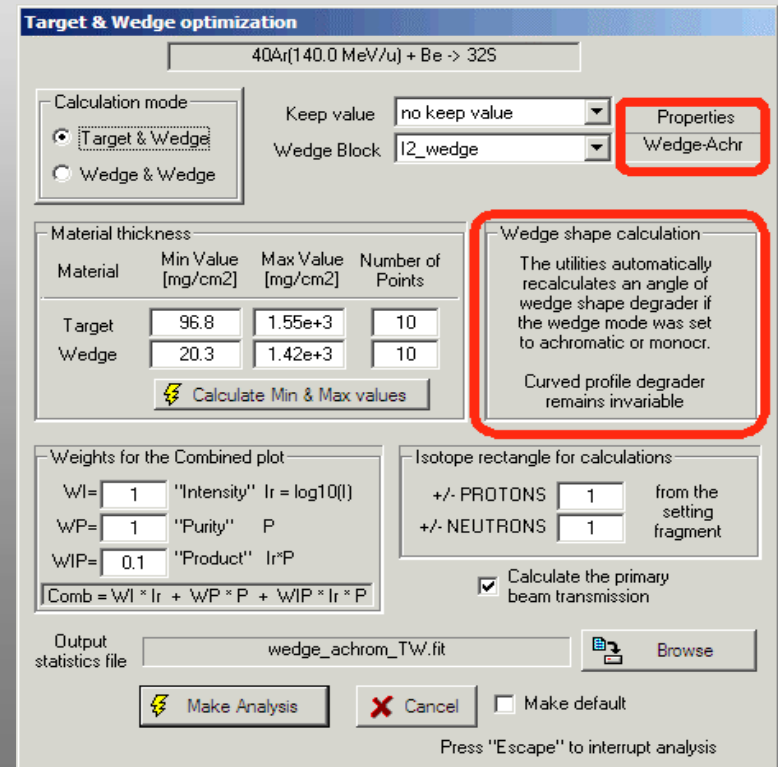


Fig.2

# III. Wedge-Wedge optimization (2)

Wedge-Wedge optimization mode in the Target-Wedge optimization utility

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

- Tune spectrometer for setting fragment on beam axis
- Tune spectrometer for setting fragment at middle of slit
- Goodies
- Calibrations
- Transmission and rate
- Optimum Target
- Optimum Target-Wedge and Wedge-Wedge configurations**
- Brho scanning
- Optimum charge state combination

---

- Physical Calculator
- Kinematics Calculator
- Mathematical Calculator
- Evaporation Calculator
- Fusion-Residue Calculator
- Matrix Calculator

**The wedge angle of wedge-shape degrader is taken from the formula (not from scan)**

**Target & Wedge optimization**

40Ar(140.0 MeV/u) + Be -> 32S

Calculation mode:  Target & Wedge  **Wedge & Wedge**

Keep value: no keep value

Wedge Block 1: I2\_wedge (Wedge-Achr)

Wedge block 2: I2a\_wedge (Wedge-Achr)

Material	Min Value [mg/cm2]	Max Value [mg/cm2]	Number of Points
Wedge1	10	1.11e+3	11
Wedge2	10	1.1e+3	11

Wedge shape calculation: The utilities automatically recalculates an angle of wedge shape degrader if the wedge mode was set to achromatic or monocr. Curved profile degrader remains invariable.

Weights for the Combined plot: WI= 2 "Intensity" Ir = log10(I); WP= 1 "Purity" P; WIP= 0.1 "Product" Ir\*P

Isotope rectangle for calculations: +/- PROTONS 2 from the setting fragment; +/- NEUTRONS 2

Output statistics file: double A1900\_TW.fit

Buttons: Make Analysis, Cancel, Make default

Footer: Sum=0, No charge states, DG=0.00mm/% NP=32

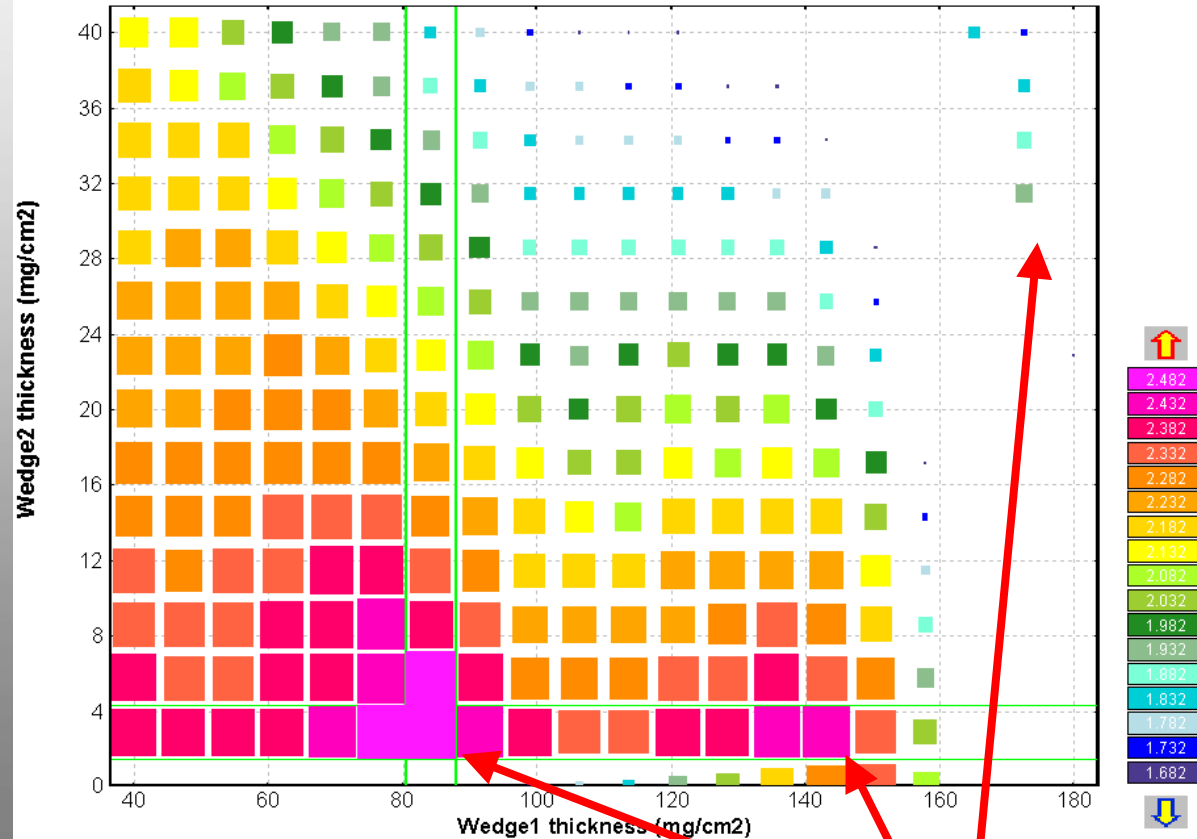


# III. Wedge-Wedge optimization (3)

## Wedge-Wedge optimization + optimum charge state combination

### Wedge1 & Wedge2 plot: Combined

T & W optimization:  $^{208}\text{Pb}$  (85.0 MeV/u) + Be  $\rightarrow$   $^{202}\text{Os}$  optimization Config: DDSWDDSDDSWDDMSMMM  
 NoIT=20; NoIW=15; dP=4; dN=4; Weights: 1.00 2.00 1.00  
 dp/p=3.38% SecReact: "off" Wedge: I2\_wedge



But this optimization now can be used with two wedges only for charge states analysis, and it is not so effective without secondary reactions in wedge.

The next important step in LISE development: secondary reactions in wedge!!!

Different charge state combinations

## IV. "MOTER" ray trace code for MS Windows (FORTRAN and C++ versions)

Prof.B.Sherrill  
Prof.D.Morrissey

Transformation to C++  
S.Lobastov (Dubna)

© 1991 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyright component of this work in other works must be obtained from the IEEE.

### Using MOTER To Design PILAC\*

H. S. Butler, Z. Li<sup>†</sup> and H. A. Thiessen  
Los Alamos National Laboratory  
P. O. Box 16663, Mail Stop H847  
Los Alamos, New Mexico 87545

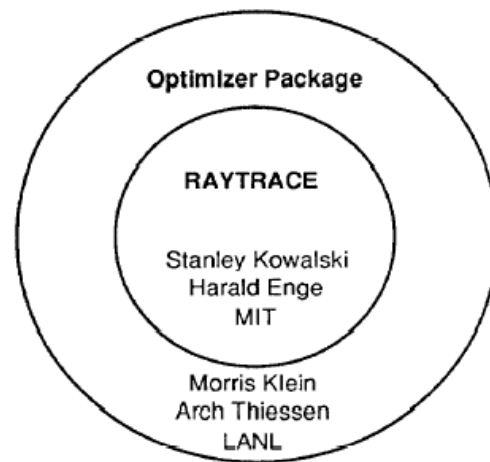


Figure 1. Structure of MOTER -- an optimizer package built around the RAYTRACE kernel.

PHYSICAL REVIEW C

VOLUME 47, NUMBER 2

FEBRUARY 1993

### Reconstructive correction of aberrations in nuclear particle spectrographs

M. Berz, K. Joh,\* J. A. Nolen,\* B. M. Sherrill, and A. F. Zeller

*Department of Physics and Astronomy and National Superconducting Cyclotron Laboratory,  
Michigan State University, East Lansing, Michigan 48824*

(Received 24 August 1992)

data file assignment is the next:	FORTRAN	C++
	fort.12	K8ts.mag
	fort.14	K8ts.dem
	fort.19	For019.dat
	fort.6	K8ts.out
	fort.8	K8ts.opt

### Next Steps

1. C++ classes and source optimization, search for Bugs
2. Substitution by functions from LISE++ library (for example energy loss, straggling)
3. Documentation, Manual
4. Shell construction
5. Graphical output of calculation results

Data and executable files are in the directory  
**moter\_root = \\ projects \ proj4 \ temp \ Tarasov \ Moter**

C++ version	moter_root \ CCMoter
executable file	moter_root \ CCMoter\Moter.exe
data files in the directory	moter_root \ CCMoter\data

FORTRAN version	moter_root \ Fmoter
executable file	moter_root \ Fmoter \ Debug \ FMoter.exe
data files in the directory	moter_root \ Fmoter \ debug

Thanks for the  
collaboration :

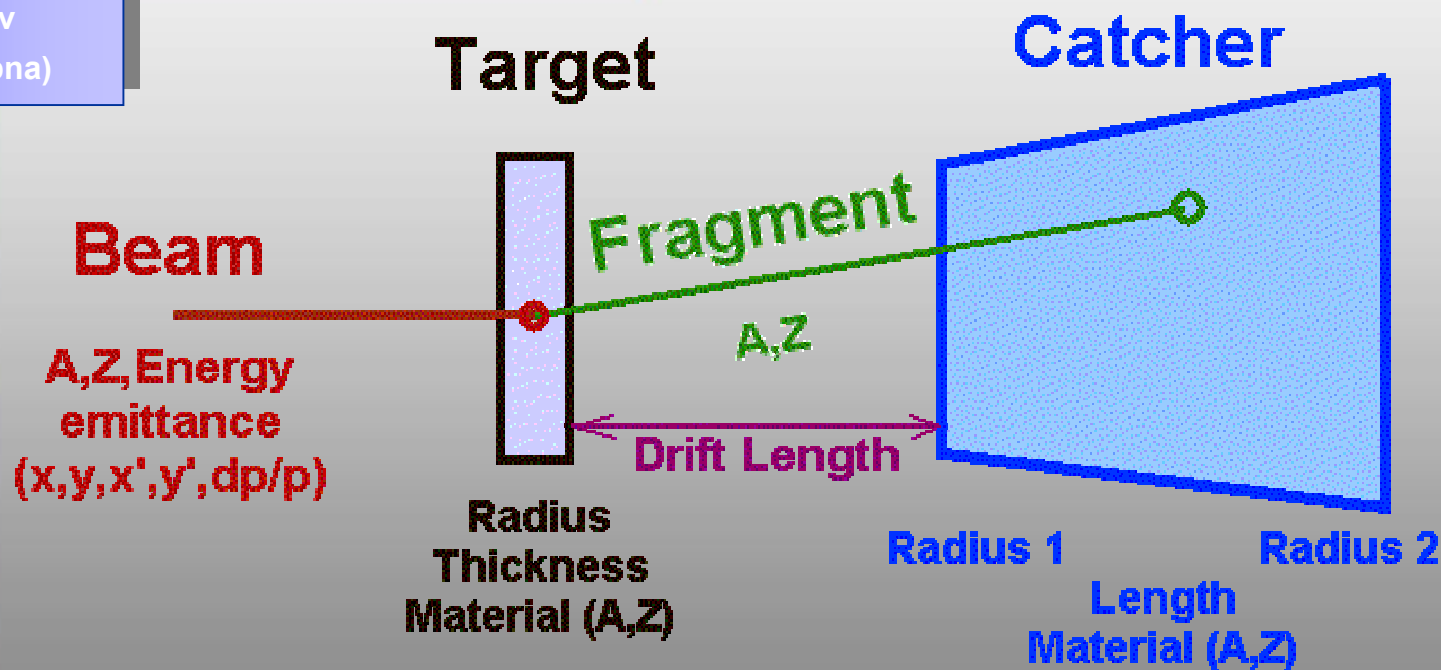
Prof. Yu. Peninozhkevich

Dr. G. Gulbekian

Mr. S. Mitrofanov

(FLNR, JINR, Dubna)

## V. ISOL catcher in LISE++



Aim: define catch efficiency of projectile fragmentation products for different geometrical and material configurations.

Monte Carlo solution

# Access to the ISOL catcher utility

# ISOL catcher dialog

LISE++ [C:\user\c\lise\_pp\_76\files\Dubna\11\_b\_6he.lpp]

File Settings Options Calculations 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  
Converter of FORTRAN-files to C-files

Reaction's Characteristics  
Radiation length  
Electromagnetic excitation plots

Plot of Fragment Range in material versus Energy  
Plot of Fragment Stopping Power (dE/dx) in material versus Energy  
Plot of Angular Stragglng 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

ISOL catcher

Target Catcher

Beam A,Z,Energy emittance (x,y,x',y',dp/p)

Fragment A,Z

Drift Length

Radius Thickness Material (A,Z)

Radius 1 Length Material (A,Z)

Radius 2

Files: current file, 30pimrad, Save file as, Load file

Mode: Reaction place, Fragment stopping place, Projectile stopping place

Options: Z & R(X,Y), Z & Y, Z & R(X,Y,Z), X & Y

Target: Be (2 mm), Radius = 5 mm

Catcher: C (10 mm), Radius 1 = 5 mm, Radius 2 = 7 mm

Set-up: Projectile 11B (35.00 MeV/u; 1pA), Fragment 6He

Distance from source to target = 10 mm  
Distance from target to catcher = 5 mm

Calculate, Save & Exit, Quit

**ISOL files**  
Last saved file is loaded at the beginning  
Default directory "LISE/files"  
Extension "\*.isol"

Save As

Save in: files

03034, GANIL, save2.isol, sav  
DaveMorrissey, matrices, save3.isol, sav  
DissiaptionEE, RF\_kicker, save4.isol, scr  
Dubna, 30pimrad.isol, save5.isol, zer  
errors, 60pimrad.isol, save6.isol  
examples, catcher\_origin.isol, save8.isol

File name: 30pimrad.isol Save  
Save as type: IsolCatcher files (\*.isol) Cancel

ISOL catcher calculations are performed for the "Projectile fragmentation" reaction mechanism set to the EPAX2 cross section mode.

Other options (Energy Loss mode, Velocity and momentum distribution width) are taken from LISE current settings.

It is recommended to load a LISE file with your settings before to use LISE ISOL catcher utility.

Do not use the Convolution model: it takes a lot of time for Monte Carlo calculations.

# The primary beam dialog

**Beam** [?] [X]

A	Element	q+
11	B	5
	5	
	Z	

Stable

Table of Nuclides

← Z →  
← N →

Ok  
Cancel

**Beam energy**

Energy	<input checked="" type="radio"/>	35	MeV/u
TKE	<input type="radio"/>	385.33	MeV
Brho	<input type="radio"/>	1.893	Tm
P	<input type="radio"/>	2.838	GeV/c
U	<input type="radio"/>	7.71e+4	KV

**Beam intensity**

<input type="radio"/>	5	enA
<input checked="" type="radio"/>	1	pnA
<input type="radio"/>	6.25e+9	pps
<input type="radio"/>	0.000385	KW

Energy Loss in the target box [KW]

**Emittance**

1. X	1	mm
2. T	30	mrاد
3. Y	1	mm
4. F	30	mrاد
5. L	0	mm
6. D	1	%

mm  
 cm

**Angle: beam - spectrometer**

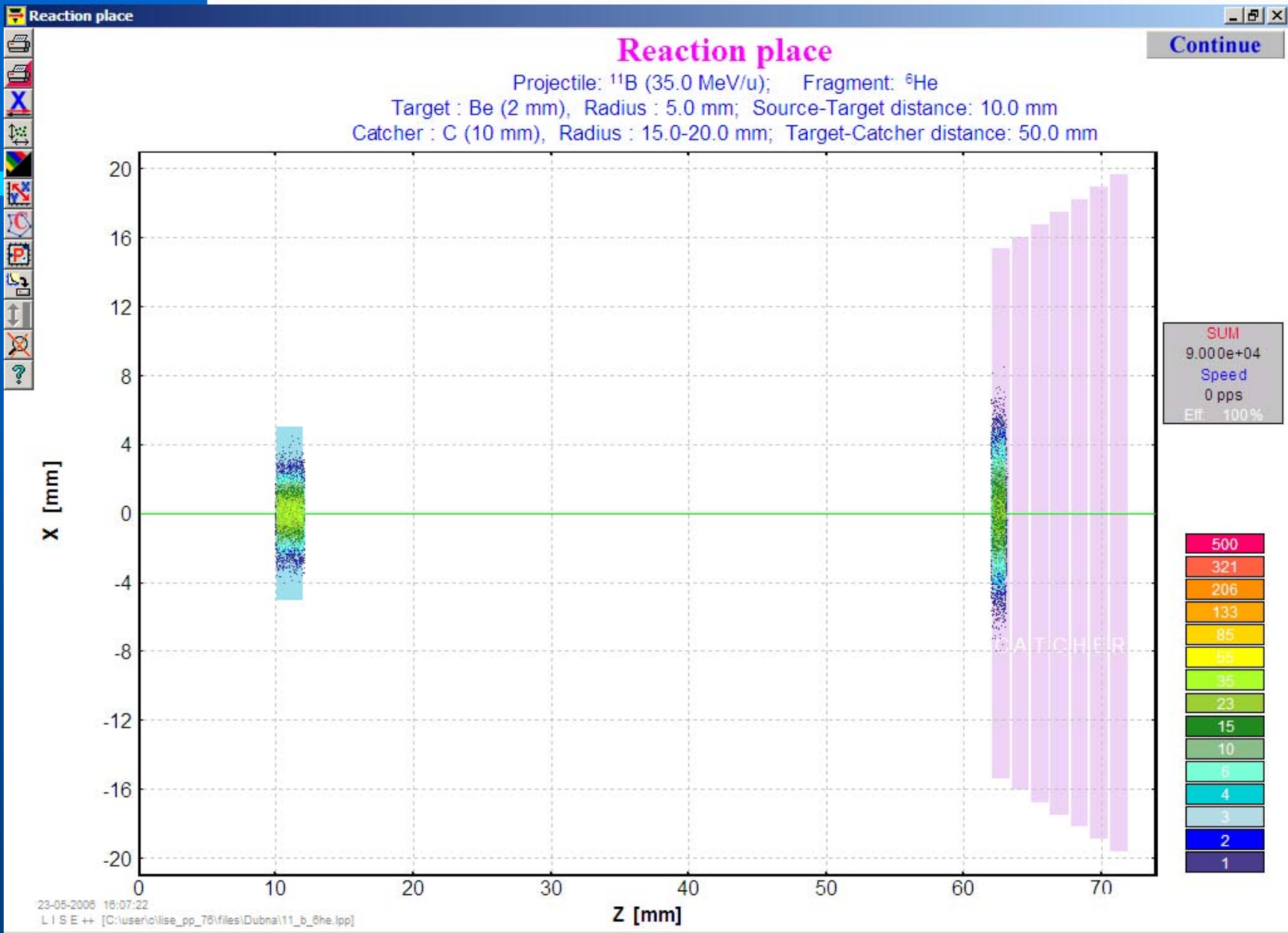
x'	y'	unit
		mrاد
0	0	degrees

RF frequency 20 MHz

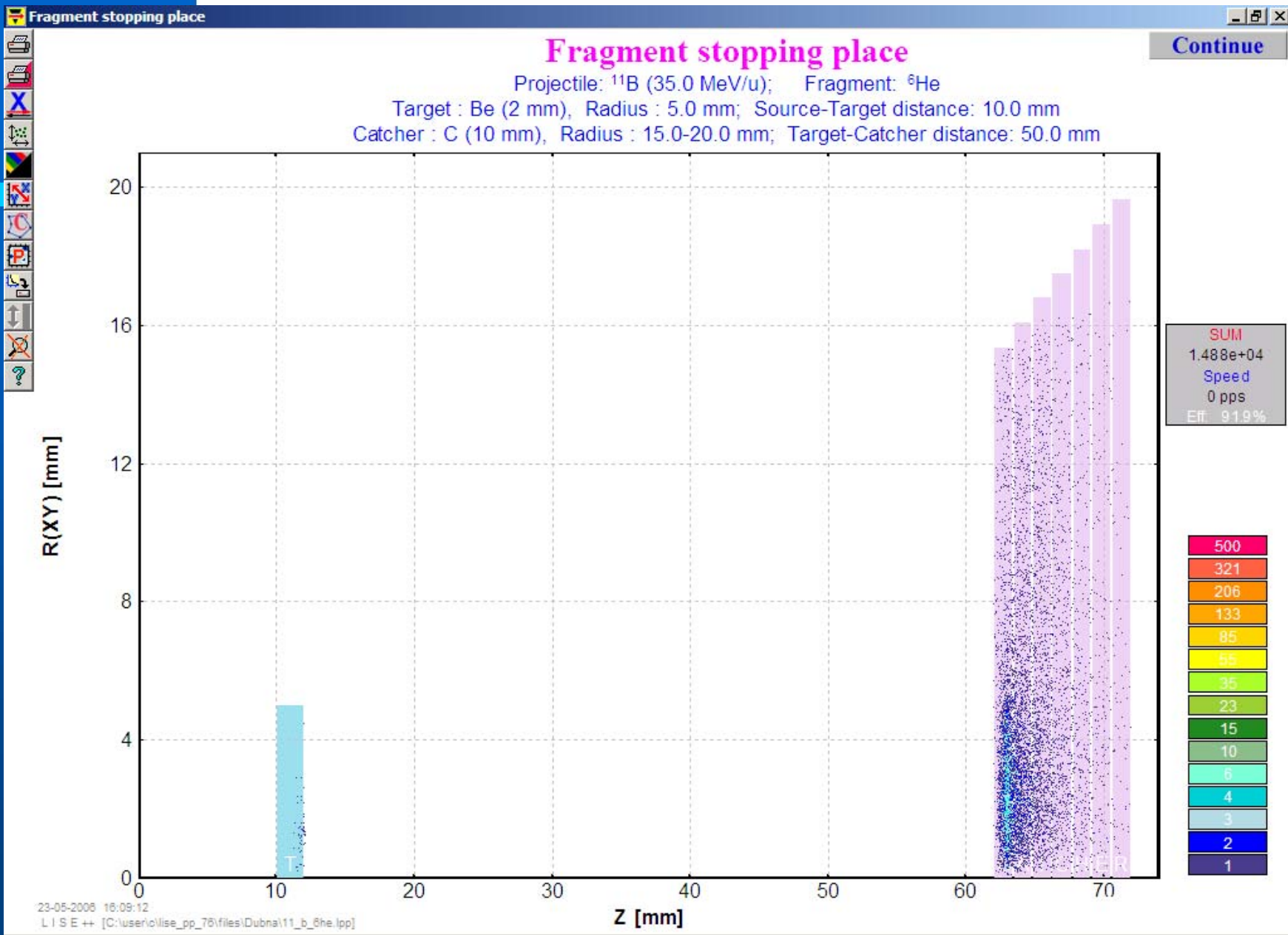
First simulation step is determination of initial coordinates ( $x$ ,  $x'$ ,  $y$ ,  $y'$ ,  $E$ ) using the beam emittance

The primary beam intensity is always equal to 1 pnA

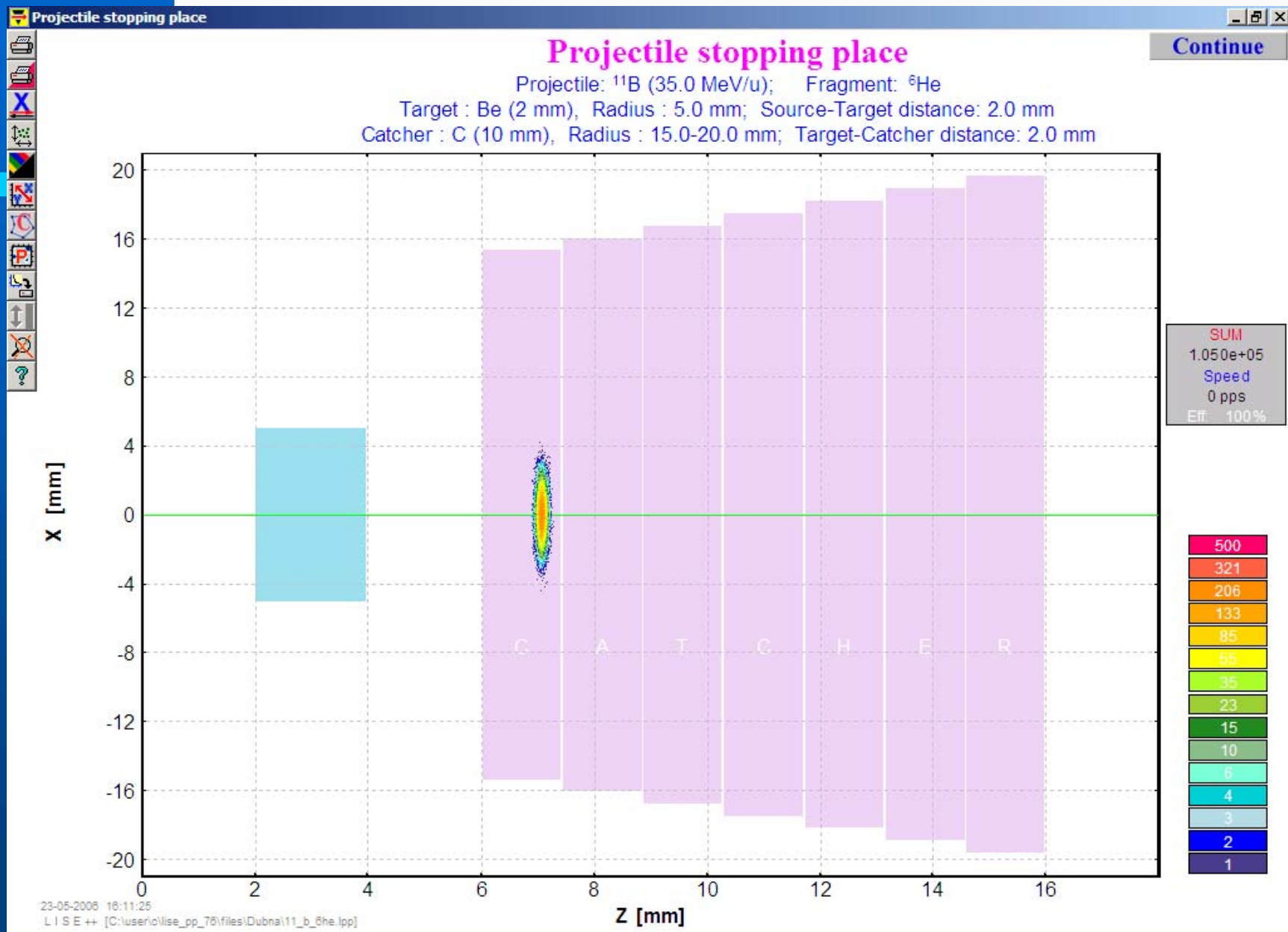
## Reaction place



# Fragment stopping place

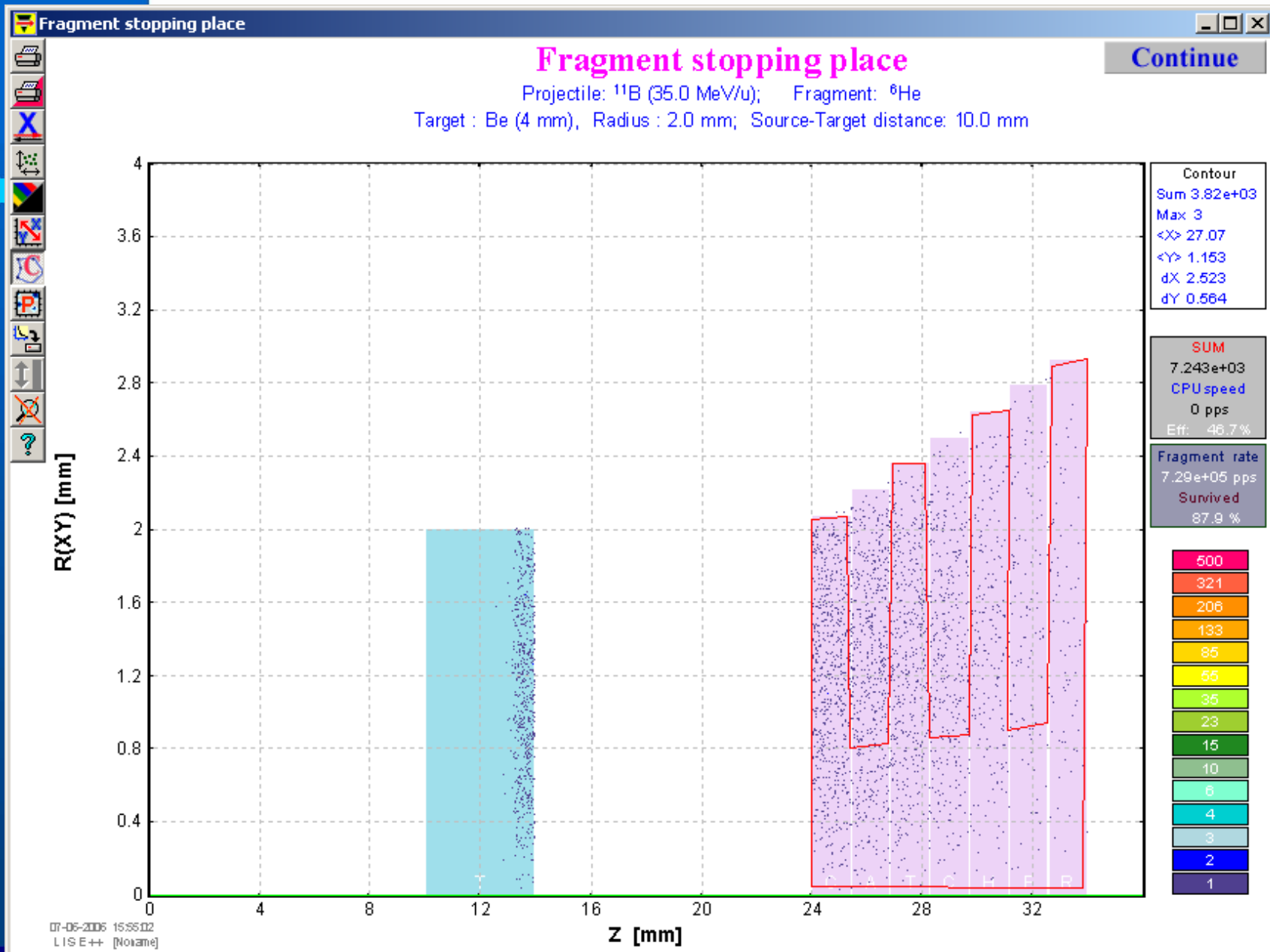


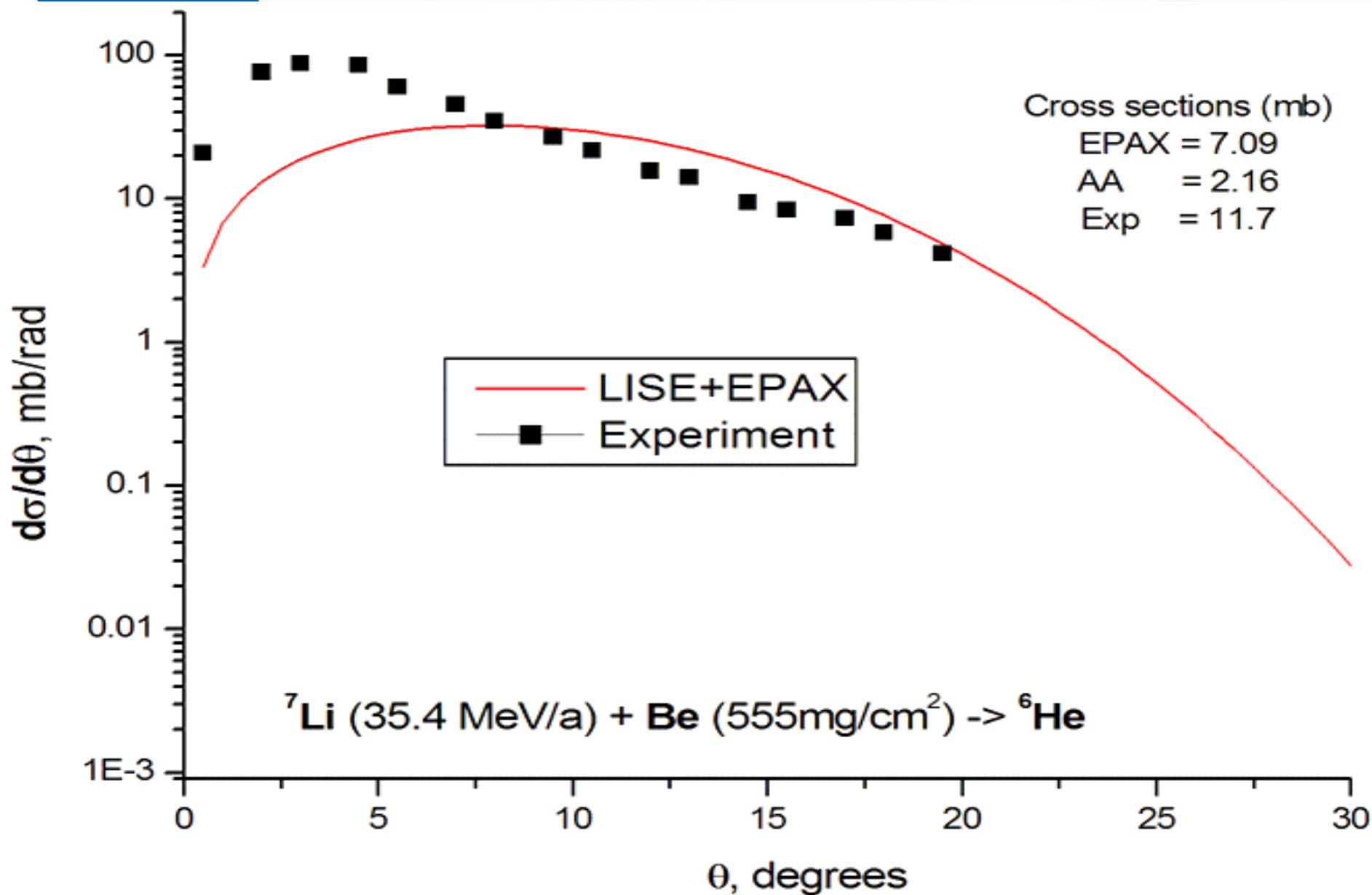
# Projectile stopping place

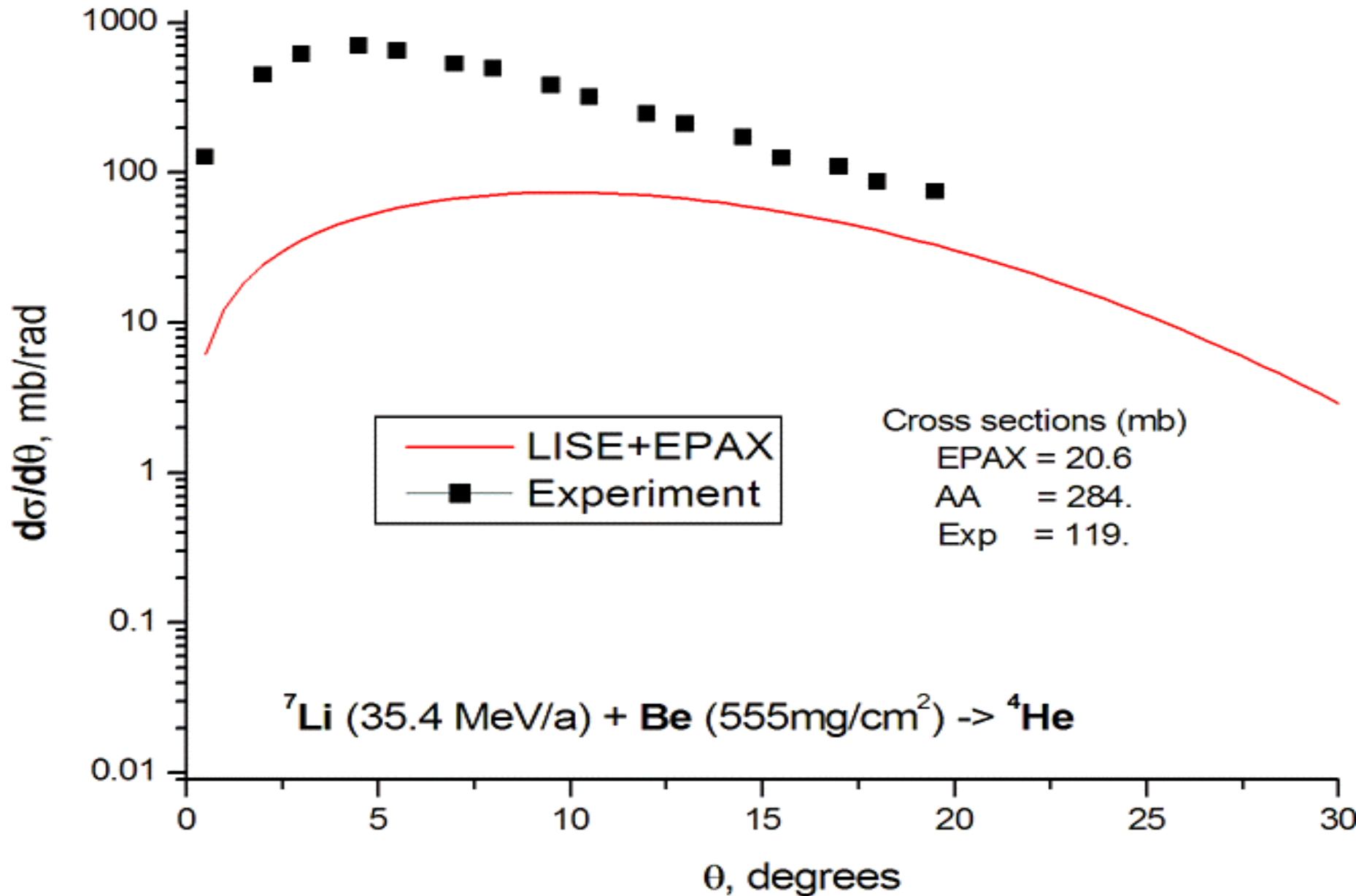




# Fragment stopping place + contours



${}^7\text{Li}$  (35MeV/u) + Be  $\Rightarrow$   ${}^6\text{He}$  (A.Rodin et al. Acculina, Dubna)


${}^7\text{Li}$  (35MeV/u) + Be  $\Rightarrow$   ${}^4\text{He}$  (A.Rodin et al. Acculina, Dubna)


# ISOL Catcher development

## Next steps

- *Rate analysis*
- *Intensity loss due to reactions*
- **Cross sections:  $E_{min}=V_c$**
- **Cross section: user file**
- **Re-direction: modification**
- **Angular straggling**
- **Angle: beam-target**
- **Intensity variation**
- **Calculation speed optimization**
- **Secondary reactions**
- **Other reactions?**  
(for example: fission => SPIRAL2)

## New modes

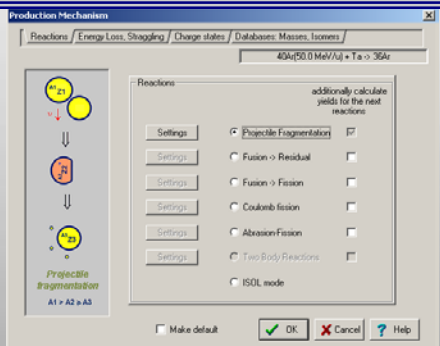
- **Energy loss plot**

## After catcher

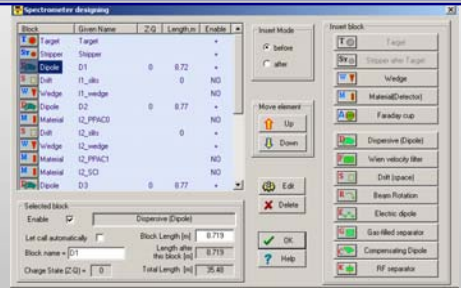
- **Angular distribution plot**
- **Momentum, velocity and energy distributions**
- **Simulate dipole cuttings**  
(angular and momentum acceptances)

# New code: LISE++ ⊗ MOTER = LISE\_RAY??

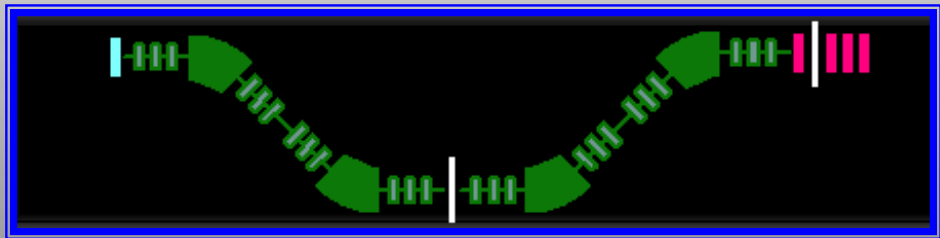
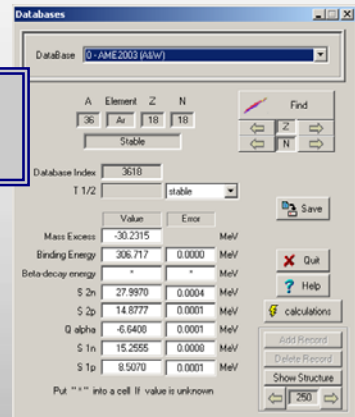
**LISE physics:**  
Production mechanisms,  
energy loss etc



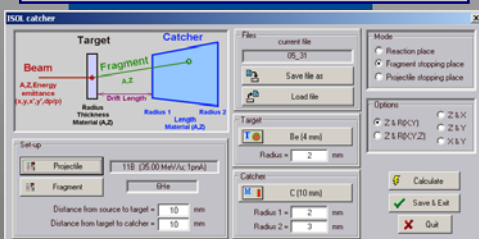
A la "LISE" shell to  
construct a spectrometer



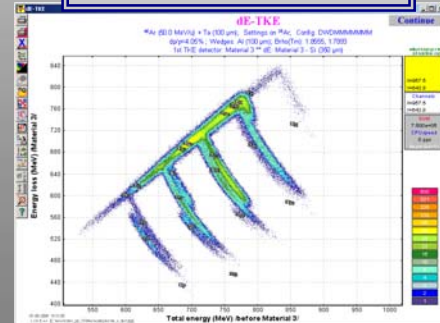
**LISE  
databases**



**LISE ISOL catcher**



**LISE graphics**



**MOTER:  
optics and  
optimization**

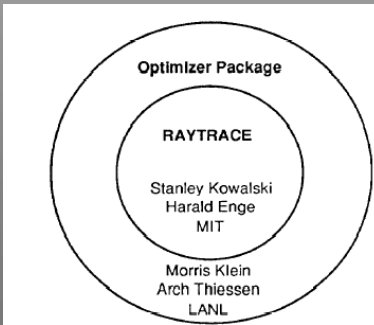


Figure 1. Structure of MOTER -- an optimizer package built around the RAYTRACE kernel.

LISE\_RAY file can be adapted by  
LISE++, but in other side?