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## version 9.1

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The code operates under MS Windows environment and provides a highly user-friendly interface. It can be freely downloaded from the following internet addresses:

http://www.nscl.msu/edu/lise



# Four gates instead one





File Format

Number o

Header (s

Field sepa







Rays generator	×
Setting Fragment	File Format
40Ar18+18+ Projectile Fragmentation	Number of fields = 10 110
	Header (settings, field names) 🔽
- Gate	Field separator tab
< A [mrad] > after Stripper	Field Parameter
	1 🗙 [cm]
Fields to Plot	2 🗙 (Theta) [mrad]
X-axis X [mm]	3 Y [cm]
Y-axis dP/P [%]	4 [Y'(Phi) [mrad]
	5 dP/P [%]
after BLOCK Image4(104)	6 Mass (amu)
Description (Provide	7 Energy Loss (MeV) 💌
Output Ray file	8 Cross Section (mb)
MC_LISE.lay	9 🛛 Q (ion charge) 🔍
	10 Mass (amu) 💌
🖸 Run	Number of Rays = 100 110 000
🗶 Quit	🥅 Make Default

The user can chose X & Y axes to plot rays generated to file X [cm] X'(Theta) [mrad] Y[cm] Y'(Phi) [mrad] dP/P [%] R [cm] A [mrad] Energy [MeV/u] TKE [MeV] Momentum [GeV/c] Brho [T\*m] Length from Target [m] Time from Target [ns] Z (atomic number) Q (ion charge) Mass (amu) Cross Section (mb) Energy Loss (MeV) 0 (empty)

New parameters can be written to file: Energy loss Cross sections









## Envelope mode



hat isotope transmission to calculate?	-X-coordinate		Y-coordinate		- Gate 1	
One fragment of interest. Chose manually here	After BLOC	К	After BLOC	Ж		Settings
Group of Isotopes alreadu calculated	Image4(104)	-	Image4(104)	7		WV TIMES
by the Distribution method (Ncalc = (	n	_			"NC	IT'' [-30, 30]
		mm .	• X	mm .	< A fmr	adl > after Stripper
ose fragment of interest		mrad	OX'(I)	mrad	( ) ( ) ( )	al > area orappor
-		mm	OY	mm		
A Element Z Table of	C Y'(P)	mrad	O Y' (P)	mrad	Gate 2	
40 Ar 18 Nuclides	C dP/P	%	C dP/P	%		🚯 Settings
		mm	C B [f[X,Y]]	mm	1916	
Stable 🦾 🛚 📥	C A LBX 'Y11	mrad	O A LIX'Y'I	mrad		11 [-20, 20]
	1				< ×'(Th	eta) [mrad] > after
Charge states	C Energy	MeV/u	C Energy	MeV/u		Stripper
18+ D1 💌 Set	C TKE	MeV	C TKE	MeV	- Gato 2	
	C Momentum	MeV/c	C Momentum	MeV/c	Gale 5	ATTA Cottingo
Reaction mechanism	C Brho	T*m	C Brho	T*m		Seconds
Projectile Fragmentation	C Velocity	cm/ns	C Velocity	cm/ns	"'NC	IT'' [-25, 25]
	C Energy Loss	MeV	C Energy Loss	MeV		n. (. or )
	1 C Paras		C Bange	mm	< Y (Phi) [r	nradj> after Stripper
🚜 📑 MC transmission options	Envelope	m	C Envelope	m		
	<ul> <li>Energy</li> </ul>	Meyznim		MeV/mm	Gate 4	
	Deposition	/particle	Deposition	/particle		
177	1 C. Time of flight	ns	C. Time of flight	ne		
dd in the '\$ "Distribution" calculation	C Length	m	C Length	m	"AND	)'' [-100, 100]
revious ML lot window	Congar		Congar		< B [m	ml.>after Stripper
	Strippor	will der Sta	art> Ctrippor			1.1 (Control of the second
	Joupper		and a loubber			
Monte Carlo calculation	dE_Si	🚽 < Sti	op → dE_Si	<b>V</b>		
Quit 20-plot					E   E	IVELOPE

This mode is more effective for "expanded" configurations, where not dispersive blocks joining dipole, quadrupoles and drifts.

#### In the Envelope mode you can see the red sign in right bottom corner.

Two options only for the Envelope mode are accessible through the MC options dialog

Trajectory is drawn based on a third order polynomial using two input X<sub>i</sub>,X'<sub>i</sub> and two output X<sub>o</sub>, X'<sub>o</sub> coordinates

Use in calculations :	lations C through 3rd order Highest Or in this	rder for the Isotope group case only
only 1-st order	C through 4th order configural	tion 🔽 X-sections independent
C through 2nd order	C through 5th order	(all cross sections equal)
Straggling in material	Detector resolution	
🔽 Angular	Use energy and time resolution of detectors for TOF, Energy	^ No resolution will be taken into accoun if the selected block is optical or wedge
🔽 Energy	loss, and TKE values	^ Only energy resolution of first detector
🗖 Lateral **	Use spatial resolution of detectors for X and Y values	after the selected block will be taken into account for TKE value
Take into account t	hickness defect of materials	only for ENVELOPE mode
<ul> <li>Take into account t</li> <li>Take into account I</li> </ul>	hickness defect of materials osses due to reactions in materials	only for ENVELOPE mode Show trajectories of all fragments (including unselected by fragment-separator)
<ul> <li>Take into account t</li> <li>Take into account I</li> <li>Include charge state in the total transmis</li> </ul>	hickness defect of materials osses due to reactions in materials e calculations sion ‴	only for ENVELOPE mode Show trajectories of all fragments [Including unselected by fragment-separator] Use physical limits (aperture) inside a block to calculate fragment
<ul> <li>Take into account t</li> <li>Take into account I</li> <li>Take into account I</li> <li>Include charge state in the total transmis</li> <li>Assume the reaction take</li> </ul>	hickness defect of materials osses due to reactions in materials e calculations sion <sup>mat</sup> es place at the middle of target	only for ENVELOPE mode Show trajectories of all fragments (Including unselected by fragment separator) Use physical limits (aperture) inside a block to calculate fragment transmission
Take into account t     Take into account t     Take into account I     Include charge stat     in the total transmis     Assume the reaction tak     for Angular distributi	hickness defect of materials osses due to reactions in materials e calculations sion ** es place at the middle of target ons * these two distributions are correlated for fusion	only for ENVELOPE mode Show trajectories of all fragments (including unselected by itragment separator) Use physical limits (aperture) inside a block to calculate fragment transmission For block apertures LISE++ uses the site limits accessible from the place Cut & Accestence dialog
Take into account t     Take into account t     Take into account I     Include charge state     in the total transmis Assume the reaction tak     for Angular distributi     for Momentum distril	hickness defect of materials osses due to reactions in materials e calculations sion ** es place at the middle of target ons * these two distributions are correlated for fusion butions and fission reactions	only for ENVELOPE mode Show trajectories of all fragments (including unselected by ifragment separator) Use physical limits (aperture) inside a block to calculate fragment transmission For block apertures LISE++ uses the slit limits accessible from the Block Cut & Acceptance dialog



## **Option "Show all trajectories" : ON**





It is possible to see the particle is out of the device

Very good tools for this option is using "projection on X-axis! See the next slide



## **Option "Show all trajectories": ON. Projection**





You can see how transmission is changed from block to block, where are main lost and so on

🖶 Monte Carlo transmission statistics by blocks

#### 40Ar : MC Transmission Plot - Envelope (all

40År (84.3 MeV/u) + Be (1e-4 µm); Transmitted Fragment 40J dp/p=5.07%; Brho(Tm): 3.0000, 3.0000, 3.0000 "Image4(104)" - last block for MC calculation; no gates; Number of passed ions 0

Global Transmission	23.12%
Target	100.0%
dr L1A (016)	100.0%
QL1TA-017	80.11%
Slits	80.11%
dr L1AB	86.65%
Slits	86.65%
QL1TB-019	80.44%
Slits	80.44%
dr L1BC	94.26%
Slits	94.26%
QL1TC-021	91.14%
Slits	91.14%
dr L1C	96.70%
Slits	96.70%
D1	98.39%
Slits	98.39%
dr R1A (026)	93.16%
Slits	93.16%
QR1TA-031	99.74%
Slits	99.74%
dr R1AB	99.78%
Slits	99.78%
QR1TB-033	95.39%
Slits	95.39%
dr R1BC	96.84%
Slits	96.84%
QR1TC-035	93.89%
Slits	93.89%
dr R1C	98.30%
Slits	98.30%

MC transmission statistics block by block is also available in the Envelope mode



## **Option "Show all trajectories" : OFF**

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Vertical plane

Use in Calculations

dispersion [mrad/%]

🥒 ок

🗶 Cancel

y '-momentum[%] (accept./disp.)

7 Help

Even if the slit is not used in transmission calculations, its LIMIT will be used with this option turned ON.



Vertical

conjointly

C separately

0

x-momentum[%]

(slit/dispersion)

total 100

Horizontal plane dispersion (mm/%) ✓ Use in Calculations

Show in schematics

dispersion (mm/%)

=

0

y-momentum[%]

(slit/dispersion)

total 100

Vertical plane



# **Use physical limits (aperture) option. Examples**



#### Use limits: No

Use limits: Yes





## **Envelope examples**







OT. 04/30/10, East Lansing, MI



### Examples of A1900 different envelope calculations (X)





Initial Phase space: 60 mrad (x), 40 mrad (y), 2.5 % (dp/p)

Standard A1900 configuration LISE++ distribution : 23% LISE++ MC (1<sup>st</sup> order): 22% LISE++ MC (5<sup>th</sup> order): 12%

Expanded A1900 configuration LISE++ distribution : 11% LISE++ MC (1<sup>st</sup> order): 23%





#### Examples of A1900 different envelope calculations (Y)





#### Initial Phase space: 60 mrad (x), 40 mrad (y), 2.5 % (dp/p)







Version	Date	Subject
9.0.40	24.04.10	The setting fragment (including reaction, charge states) is initially in the MC dialog
8.5.50	28.02.10	Optimization for speed: timer interruption, division coefficient to redraw
8.5.47	18.02.10	Modifications of ToF calculations in MC mode
8.5.46	16.02.10	Corrections for Q-state calculations in MC mode
8.5.44	09.02.10	Corrections for MC high order calculations
8.5.38	02.02.10	Monte Carlo transmission: Isotope group calculation -> secondary target

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