



LISE⁺⁺ Version 9.10.209 from 11/19/2015

11/19/15

⁴⁸Ca(219Mev) + PbS(0.406mg/cm²)

11/24/15

- 1. Dubna's ray table
- 2. How to use a rays table in LISE++
- 3. Results
- 4. Disagreements
 - Beam emittance. What is the real beam emittance?
 - Energy loss ?
 - Distribution after neutron emission
 - Rutherford scattering : is it so important in this case??
- 5. "Today solution" simple solution for distributions
- 6. Comparison of LISE MC, LISE distribution, Dubna distributions
 - Energy
 - Brho
 - Angular



Ray table



X(mm) Y(mm) X'(rad) Y'(rad) E(MeV) q(un e) B\rho(Tm)

1										
	Α	В	С	D	E	F	G	Н	I	
1		-2.63	-2.22	0.0597	0.0267	34.65	21	0.643		
2		2.86	-3.98	-0.1579	0.0524	30.11	17	0.741		
3		1.97	3.26	0.0003	0.0172	40.76	17	0.862		
4		-0.97	3.16	-0.0109	0.0005	38.66	19	0.751		
5		0.56	-4.79	-0.0511	0.0521	26.04	17	0.689		
6		-1.05	4.4	0.1051	-0.005	29.58	18	0.693		
7		-1.51	1.64	0.0005	-0.0475	32.11	20	0.65		
8		4.06	1.98	0.0271	0.0061	34.28	16	0.84		
9		0.54	-0.07	-0.1172	0.1031	28.71	20	0.615		
10		1.69	3.61	0.0531	-0.0024	28.26	20	0.61		
11		2.85	-1.43	0.0228	-0.0196	36.79	13	1.071		
12		-4.49	-0.68	0.0997	-0.0876	34.67	16	0.845		
13		-1.69	0.85	0.0613	0.0782	28.23	21	0.581		

Initial

	Α	В	С	D	E	F	G	Н	Ι	J	К	L	М	
1	! Z	N	q	X,mm	dX	X'mrad	dX'	Y,mm	dY	Y'mrad	dY'	E,MeV/u	dE	
2	102	152	21	-2.63	1	59.7	1	-2.22	1	26.7	1	0.136417	0.002	
3	102	152	17	2.86	1	-157.9	1	-3.98	1	52.4	1	0.118543	0.002	
4	102	152	17	1.97	1	0.3	1	3.26	1	17.2	1	0.160472	0.002	
5	102	152	19	-0.97	1	-10.9	1	3.16	1	0.5	1	0.152205	0.002	
6	102	152	17	0.56	1	-51.1	1	-4.79	1	52.1	1	0.10252	0.002	
7	102	152	18	-1.05	1	105.1	1	4.4	1	-5	1	0.116457	0.002	
8	102	152	20	-1.51	1	0.5	1	1.64	1	-47.5	1	0.126417	0.002	
9	102	152	16	4.06	1	27.1	1	1.98	1	6.1	1	0.134961	0.002	
10	102	152	20	0.54	1	-117.2	1	-0.07	1	103.1	1	0.113031	0.002	
11	102	152	20	1.69	1	53.1	1	3.61	1	-2.4	1	0.11126	0.002	
12	102	152	13	2.85	1	22.8	1	-1.43	1	-19.6	1	0.144843	0.002	

Final for LISE++

SHELS particles v2.inrays file is attached to the e-mail





lise.nscl.msu.edu/9_6/9_6_23.pdf#page=10

What isotope transmission to calculate?X-coordinateAfter BLOCKAfter BLOCK After BLOCKAfter BLOCK After BLOC	K Gate 1	Input ions rays from file emitted from target
C Une magnent of interest. Choice manually rise D1 ▼ 45 Y D1 C Group of isotopes already calculated by the Distribution method (Noalc = 0) © × mm C × C List of isotopes from file by index isotifs to pass from file c list of isotopes from file c list of isotopes from file c list of isotopes from file c v mm C × mm C × C × (T) c list of isotopes from file c v mm - no file c v - no file c v C × (T)	as mm mvad mad	no gole Open file View file E Clear
Chose fragment of interest C dP/P % © dP/P Chose fragment of interest C Radial [f(X;Y)] mm C Radial [f(X;Y)] A Element Z C Angle [f(X;Y)] mmad C Angle [f(X)] 100 Sn 50 Beta+ decay C Momentum MeV/u C TKE MeV/u C Energy C TKE MeV/u C TKE C Brho T*m C Brho	% Gate 2 Y] mm Г y']] mrad MeV/u MeV/c Tm	no gate
Charge states C Velocity cm/hs C Velocity 50+ D1 Image C Energy Loss MeV C Energy Loss Reaction mechanism Image C Energy Loss MeV C Energy Loss Projectile Fragmentation Image C Energy MeV/mm C Energy Image Image C Energy MeV/mm C Energy Image Image C Time of flicit ns C Time of flicit	cm/ns MeV mm m MeV/mm /particle t ns	Note The Isotope list file is in ASCII format. Comment string begin with "!" or "," The Columtion User can be separated by a Space, a Comma or a Tabulation. User can put comments also at the end of data line
Add in the previous MC plot window 16 "Distribution" calculation MC calculation to file 12 wedge MC calculation to file C lon parameters (M.Z.q) Add in the previous MC plot window Monte Carlo calculation Monte Carlo calculation A-2q	m v ses (MZ,q. umber) v	no gate At least 13 columns should be in the specified order. Three first columns: "Z", "N", "q", where Z is atomic number, N is number of neutrons, q is ionic charge The next ten are X, dX, X', dX', Y, dY'Y,dY', E, dE. "d" means StDev. Set 0 if you do not want to use it. XY in mm, X'Y" in mrad, E in MeV/u Two addional columns can be used for time (t dt) in ns





SHELSeff_All_v1_NewSet.lpp

The File is attached to the e-mail

Transmission 54.5%





Results with the ray table



➡ Ions rays after target : MC Yield Plot - Envelope (all) SHELSeff_All_v1_NewSet.lpp Ions rays after target : MC Yield Plot - Envelope (all) Continue The File is attached to the e-mail Input rays file: "SHELS particles v2"; Number of rays: 25001; Optics Order: 1 dp/p=61.05%; Brho(Tm): 0.7401, 0.7401, 0.7401, 0.7401 AnaAccept: Off: Bounds: ON: Contou 160 Sum 2.01e+06 Max 3824 <X> 5.99894 5.5096 3.67567 30.5847 3.132e+00 dУ 120 7.040e+03 CPU speed 0 pps 80 where Rate (pps) Beam: 4.4e+1 transmission 40 X [mm] lost? -40 -80 -120 10 12 24-11-2015 19:35:54 LISE++ [G:\2015_11_24_Dubna\SHELSeff_All_v1_NewSet.lpp Length [m] F Ions rays after target : MC Yield Plot - Envelope (all) Ions rays after target : MC Yield Plot - Envelope (all) Length [m]: window projection --- Input rays file: "SHELS particles v2"; Number of rays: 25001; Optics Order: 1 7200 6800 6400 6000 5600 5200 4800 4400 4000 3600 3200

Length [m]: window projection



Length [m]: window projection





- Beam emittance. What is the real beam emittance?
- Energy loss ? (very different <E> and FWHM)
- Distribution after neutron emission (angular distribution shape, width) ?
- Rutherford scattering : is it so important in this case??





It has been used in LISE⁺⁺ files

Emitta	nce [# B (sig	1] Beam CARD ma, semi-ax half-width]	1D - shape is, (Distribution) method)		2l mo
1. X	mm	1	Gaussian	-	Γ
2. T	mrad	10	Gaussian	-	Γ
3. Y	mm	1	Gaussian	-	Γ
4. P	mrad	10	Gaussian	-	Γ
5. L	mm	0	Gaussian	•	Γ
6. D	%	0.1	Gaussian	-	Γ

Dubna's ray table



It is the ellipse by 5x5 mm!!



$$E_{beam} = 4.505484 \text{ MeV/u}$$



Library and a state of the second state of the

1.3 and 0.9 MeV

Reaction @ beginning of target

- 1. ²⁵⁶No* Compound energy 40.6 MeV or 0.158569 MeV/u. Excitation energy 21.6 MeV
- 2. Evaporation of two neutrons (more probable are 1.3 and 1.5 MeV)

Components		Shape	kinematics.xisx
Evaporation	σ(E) = 2.9e-3 (7.2e-3) MeV/u	Gaussian	is attached.
	or 1.82% σ(Ax) = 8.1 mrad (FWHM 21.5)	Gaussian	More probable consecutive emission of two neutrons with

3. ²⁵⁴No passing the target

Components		Shape
Energy remain	E = 0.141755 MeV/u	
Straggling	σ(E) = 1.6452e-4 MeV/u (0.116%)	Gaussian
	$\sigma(Ax) = 17.058 \text{ mrad}$	Gaussian



"Today simple"

Reaction @ end of target

- 1. ⁴⁸Ca passing the target
 - Components Energy remain Straggling

- $\begin{array}{l} {\sf E} = 4.44186 \; {\sf MeV/u} \\ {\sigma}({\sf E}) = 1.4\text{e-3 MeV/u} \; \; (0.03\%) \\ {\sigma}({\sf Ax}) = 3.25 \; {\sf mrad} \end{array}$
- Shape
- Gaussian Gaussian

- 2. ²⁵⁶No* Compound energy 40.0 MeV or 0.156226 MeV/u. Excitation energy 19.15 MeV
- 3. Evaporation of two neutrons (assume as in the previous case)



Energy distribution



⁴⁸ Ca(216Mev) + PbS(0.35mg/cm ²)	E = 4.505484 MeV/u	"Today simple"		
Components	Energy Shape			
1. Beam emittance or	$\pm 0.2\%$ Gaussian $\sigma(E) = 2.98e-4$ MeV/u (for final energy)	gy)		
2. Energy rectangle due to energy $E1 = 0.141755$ MeV/u	loss difference			
E2 = 0.156226 MeV/u	<e>=0.1489905 MeV/u FWHM = 0.014471 MeV/u (rectangle)</e>			
3. Straggling $\sigma(E) = \operatorname{sqrt}(\sigma_{\text{beam}}^2 + \sigma_{\text{resid}}^2)/2 = 0.06\%$				
4. Evaporation	σ(E) = 1.82%			
5. Target non-uniformity (3% thick	ness) Gaussian			
Components 1. Gaussian	Energy $\sigma(E) = 1.83\%$ (or 2.72e-3 M	∕leV/u)		
2. Rectangle	<e>=0.1489905 MeV/u FWHM = 0.014471 MeV/u (rectangle)</e>			



Energy distribution



⁴⁸Ca(216Mev) + PbS(0.35mg/cm²)

1. X	mm	1	Gaussian 💌
2. T	mrad	0	Gaussian 💌
3. Y	mm	1	Gaussian 💌
4. P	mrad	0	Gaussian 💌
5. L	mm	0	Gaussian 💌
6. D	%	0.1	Gaussian 💌

LISE⁺⁺ analytical





LISE⁺⁺ Monte Carlo







Dubna





LISE⁺⁺ analytical









OT, 11/24/15, East Lansing













	in MeV/u					
	<e></e>	sig.E	FWHM E			
Dubna	0.1343	1.42E-02	4.03E-02			
LISE MC	0.14755	5.03E-03	1.44E-02			
LISE analytical	0.14752	5.85E-03	1.63E-02			
"today simple"	0.14899	~ 0.006-0.007	~0.015			

	in T*m				
	<brho></brho>	sig.Brho	FWHM Brho		
Dubna	0.7197	1.04E-01	2.04E-01		
LISE MC	0.7502	1.03E-01			
LISE analytical	0.7459	9.67E-01	2.20E-01		



⁴⁸ Ca(216Mev) + PbS(0.35mg/cm ²)	E = 4.505484 Me	E = 4.505484 MeV/u		
Components	Energy	Shape		
Components	Energy	onape		
1. Beam emittance	$\sigma(Ax) = 10 mrad$	Gaussian		
2. Evaporation	$\sigma(Ax) = 8.8 \text{ mrad}$	Gaussian		
3. Straggling	$\sigma(A) = \operatorname{sqrt}(\sigma_{\operatorname{beam}}^2 +$	$\sigma_{\rm resid}^2$)		
	= 17.3 mrad	Gaussian		
Final	$\sigma(Ax) = 21.8 \text{ mrad}$	Gaussian		



Without angular emittance





LISE⁺⁺ Monte Carlo







Dubna







	in mrad				
		sig.Ax	FWHM Ax		
Dubna		5.06E+01	5.55E+01		
LISE MC *		1.64E+01	3.22E+01		
LISE analytical *		1.66E+01	3.94E+01		
"today simple"	gaussian	2.18E+01	5.14E+01		
* without beam angualr emittance					