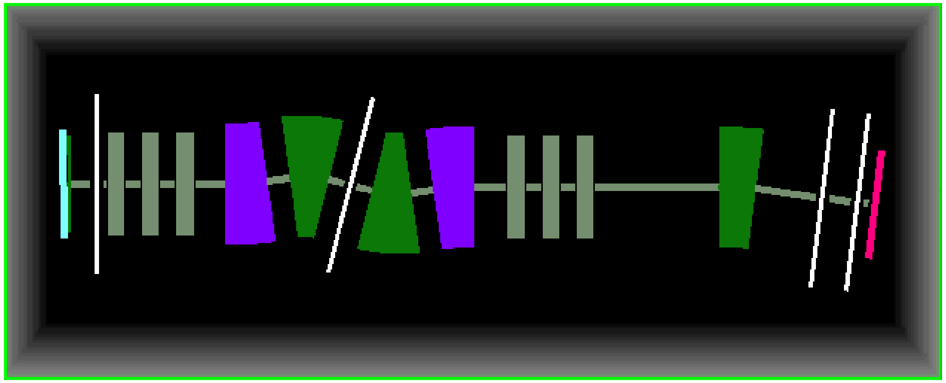
Separator "SHELS" in LISE^{++}

v.9.8.166
from 11/23/14



Separator detail information used to build the LISE^{++} configuration is courtesy by A.G.Popeko

- Introduction
- Effective lengths
  - ✓ Quadrupoles
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- Dispersive elements settings
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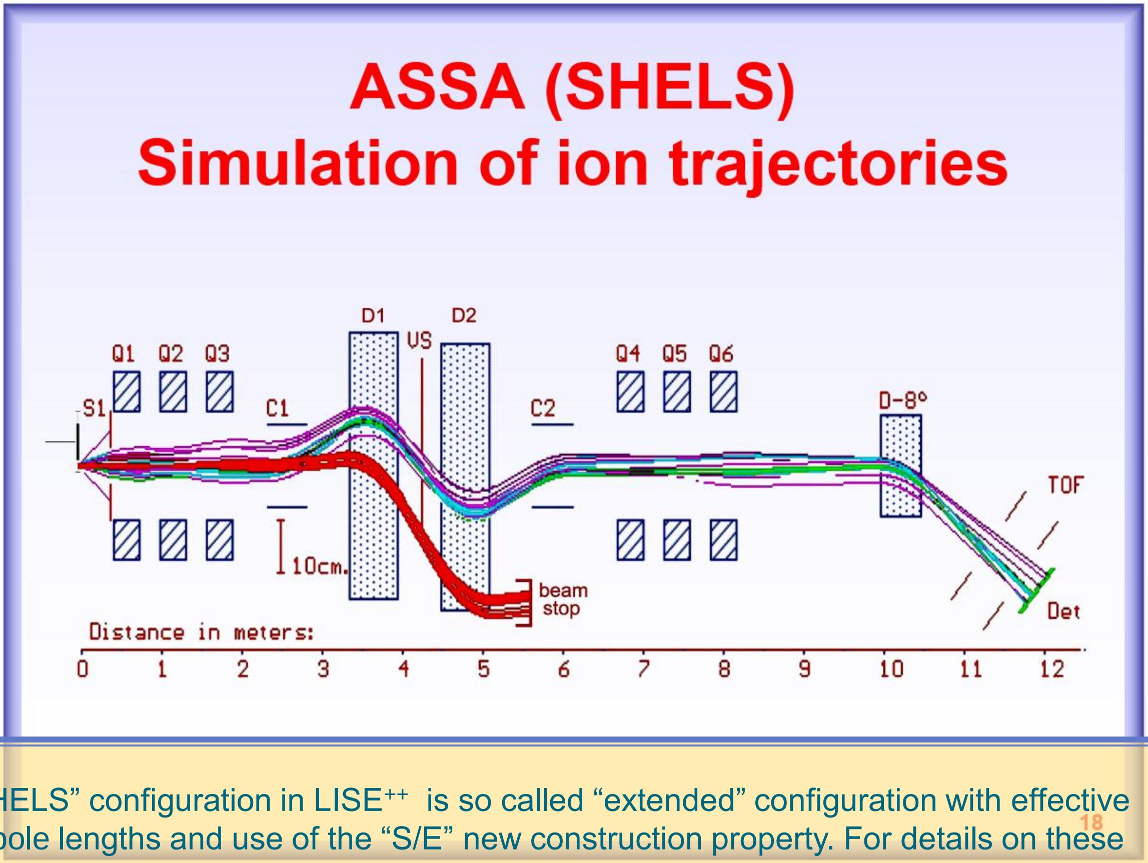
- Angular acceptance
- Beam suppression

"VASSILISSA" electrostatic separator http://flerovlab.jinr.ru/flnr/vassilissa.html

"SHELS" separator http://www-win.gsi.de/tasca14/program/contributions_TASCA14/TASCA14_contribution_Popeko.pdf



The "SHELS" configuration in LISE++ is so called "extended" configuration with effective quadrupole lengths and use of the "S/E" new construction property. For details on these subjectsplease use the next links:

- Configurations http://lise.nscl.msu.edu/9_8/LISE3/Extended%20configurations%20at%20LISE++.pdf
- Effective quad lengths http://lise.nscl.msu.edu/9_8/QuadEffLengths.pdf
- S/E construction property http://lise.nscl.msu.edu/9_8/SE_blocks.pdf

Effective lengths

Original

			"iron"	total	eff.length	delta/2
target				0		
drift	Distance between target and slit 1	DTS1	350	350	350	
slits		Slits1	0	350		
drift	Distance between slit 1 and quadrupole 1	DS1Q1	70	420	35	
Quad1		Quad1	310	730	**380**	35
drift	Distance between irons of quadrupoles I and I+1	DQiQk	270	1000	200	
Quad2		Quad2	310	1310	**380**	35
drift	Distance between irons of quadrupoles I and I+1	DQiQk	270	1580	200	
Quad3		Quad3	310	1890	**380**	35
drift	Distance between quadrupole 3 and C1	DQ3C1	630	2520	516.5	
ElectricDipole	Condensator's 1 plate length	LC1	500	3020	**657**	78.5
drift	Distance between C1 and dipole 1	DC1D1	561	3581	422.9	
Dipole	Length of dipole 1	LD1	500	4081	**619.2**	59.6
drift	Distance between D1 and velocity slit SV	DD1SV	365	4446	305.4	
slits1		slits SV	0	4446		
dirift	Distance between SV and D2	DSVD2	365	4811	305.4	
Dipole	Length of dipole 2	LD2	500	5311	**619.2**	59.6
drift	Distance between dipole 2 and C2	DD2C2	561	5872	422.9	
ElectricDipole	Condensator's 2 plate length	LC2	500	6372	**657**	78.5
drift	Distance between C2 and quadrupole 4	DC2Q4	630	7002	516.5	
Quad4		Quad4	310	7312	**380**	35
drift	Distance between irons of quadrupoles I and I+1	DQiQk	270	7582	200	
Quad5		Quad5	310	7892	**380**	35
drift	Distance between irons of quadrupoles I and I+1	DQiQk	270	8162	200	
Quad6		Quad6	310	8472	**380**	35
drift	Distance between Q6 and S3	DQ6D3	2115	10587	2036	
Dipole		LD3	500	11087	**588**	44
drift		DQ6D3-DS	1058	12145	1014	
slits 3			0	12145		
drift		DS3Det-D:	390	12535	390	
slits 4			0	12535		
drift			110	12645	110	
detectors			TOTAL	12645	12645	

Values used in LISE++

(cells marked white background)

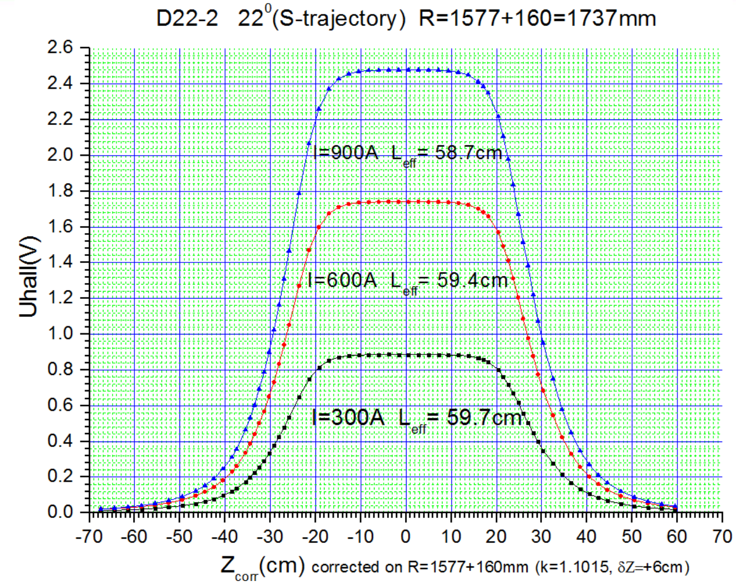
	"iron"	total	eff.length	delta/2	half-app,cm
		0			
DTS1	350	350	350		
Slits1	0	350			
DS1Q1	70	420	35		
Quad1	310	730	**380**	35	
DQiQk	270	1000	200		
Quad2	310	1310	**380**	35	
DQiQk	270	1580	200		
Quad3	310	1890	**380**	35	
DQ3C1	630	2520	516.5		**551.5**
LC1	500	3020	**657**	78.5	
DC1D1	561	3581	422.9		
LD1	500	4081	**619.2**	59.6	
DD1SV	365	4446	305.4		
slits SV	0	4446			
DSVD2	365	4811	305.4		
LD2	500	5311	**619.2**	59.6	
DD2C2	561	5872	422.9		
LC2	500	6372	**657**	78.5	
DC2Q4	630	7002	516.5		**551.5**
Quad4	310	7312	**380**	35	
DQiQk	270	7582	200		
Quad5	310	7892	**380**	35	
DQiQk	270	8162	200		
Quad6	310	8472	**380**	35	
DQ6D3	2115	10587	2036		
LD3	500	11087	**588**	44	
DQ6D3-DS	1058	12145	1014		
	0	12145			
DS3Det-DS	390	12535	390		
	0	12535			
	110	12645	110		
TOTAL	12645	12645	12645		

LISE++ does not support effective dipole lengths, so it has to be set manually

Effective lengths : D22 m-dipoles

Original information

LD1	= 500;	{Length of dipole 1 in mm }
LD1eff	= 650;	{Effective length of dipole 1 in mm }
SDip1	= 0;	{Radial shift of dipole 1 axis in mm}
LD2	= 500;	{Length of dipole 2 in mm }
LD2eff	= 650;	{Effective length of dipole 2 in mm }
SDip2	= 0;	{Radial shift of dipole 2 axis in mm}



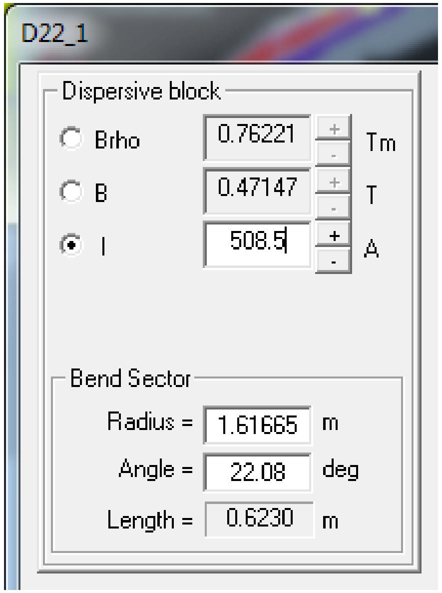
Based on the logbook information

LOGBOOK (14.04.2014)		
Br=	0.77	Tm
ID22-8=	508.5	A
B from calibration		
B=	0.47147	T
Radius frm Brho/B		
radius=	1.63319	mm
Alpha=	22.00	deg
Alpha=	0.3840	Rad
Length=	2R*sin(a/2)	
Length=	623.3	mm

Finally used in LISE++ after Br recalculation

Br recalc=	0.7622	Tm
ID22-8=	508.5	A
B from calibration		
B=	0.47147	T
radius=	1.616646	
Length=	619.2	mm
Alpha=	0.385396	Rad
Alpha=	22.082	Deg
Arc =	0.623049	m

Eff.Length=	2R*sin(a/2)

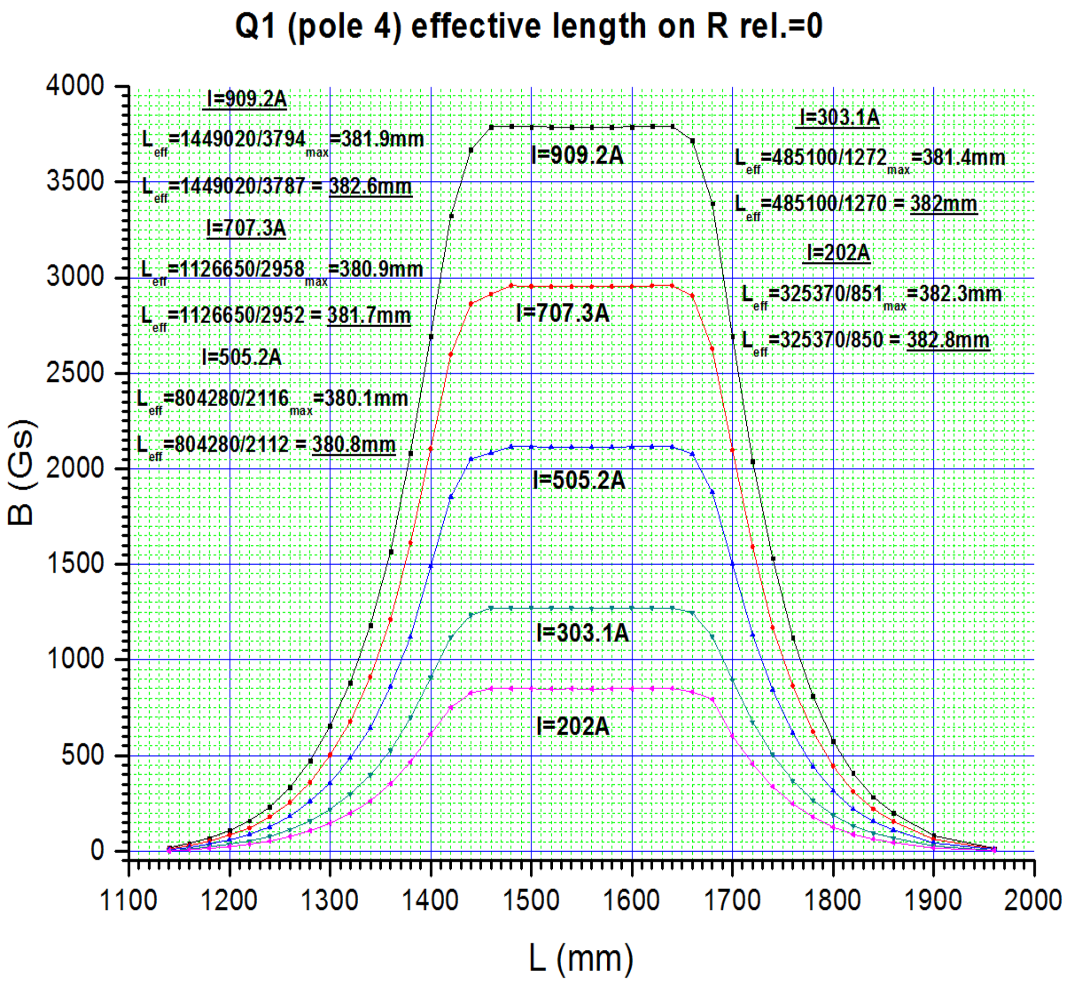


Effective lengths : Quads

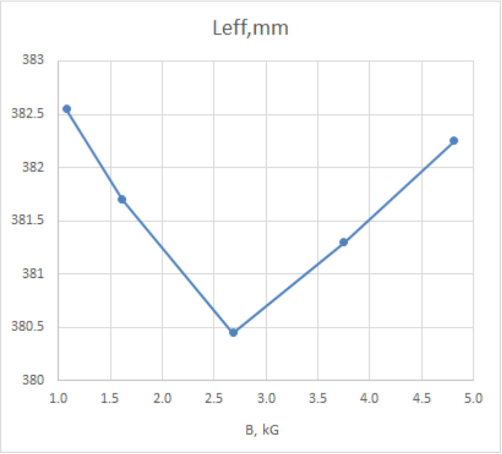
6 identical quads

Used in simulations:

LQ	= 310; {Length of quadrupole iron in mm}
LQeff	= 380; {Effective length of quadrupole in mm}



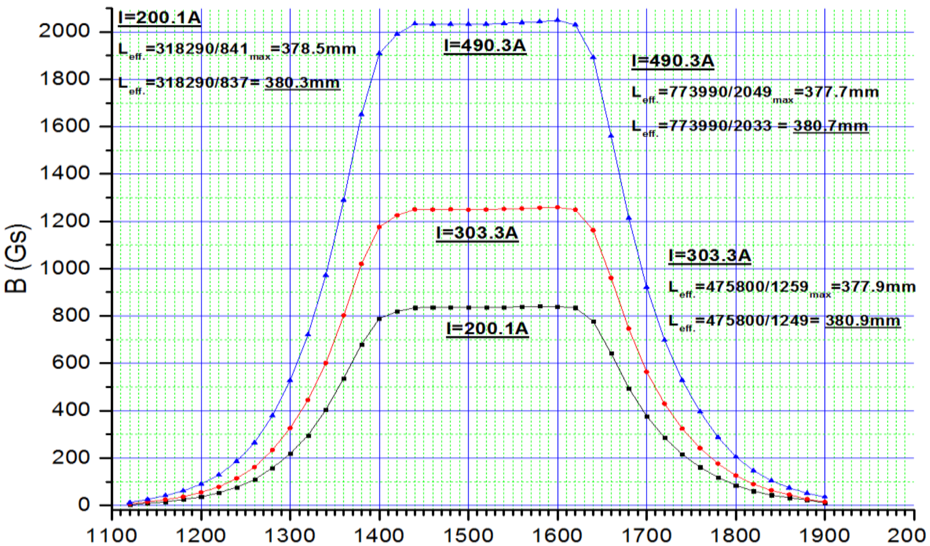
I	B, kG	Leff,mm
202	1.08	382.55
303	1.615	381.7
505	2.68368	380.45
707	3.7504	381.3
909	4.8124	382.25
	average	381.65



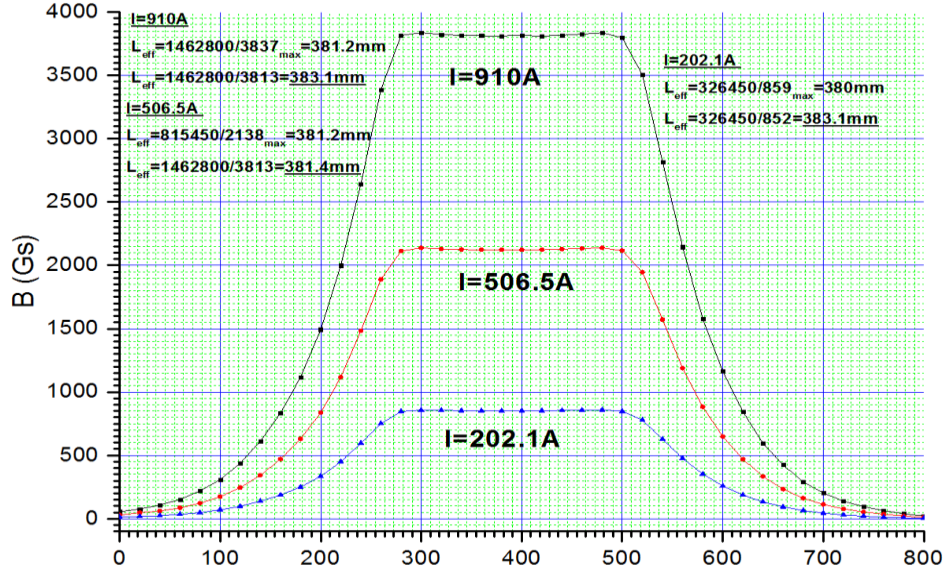
Effective lengths : Quads

Effective Lengths measurement

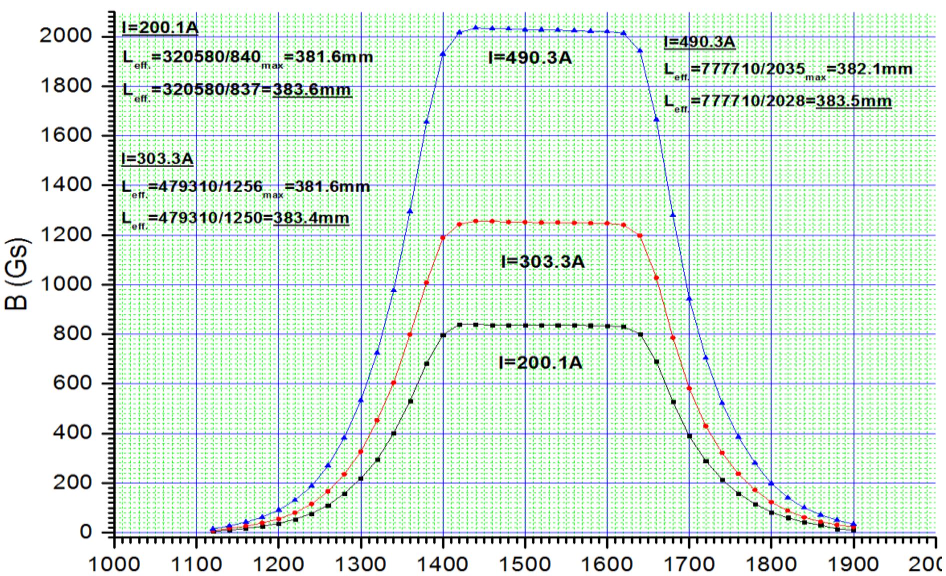
Q6 (pole4) eff. length



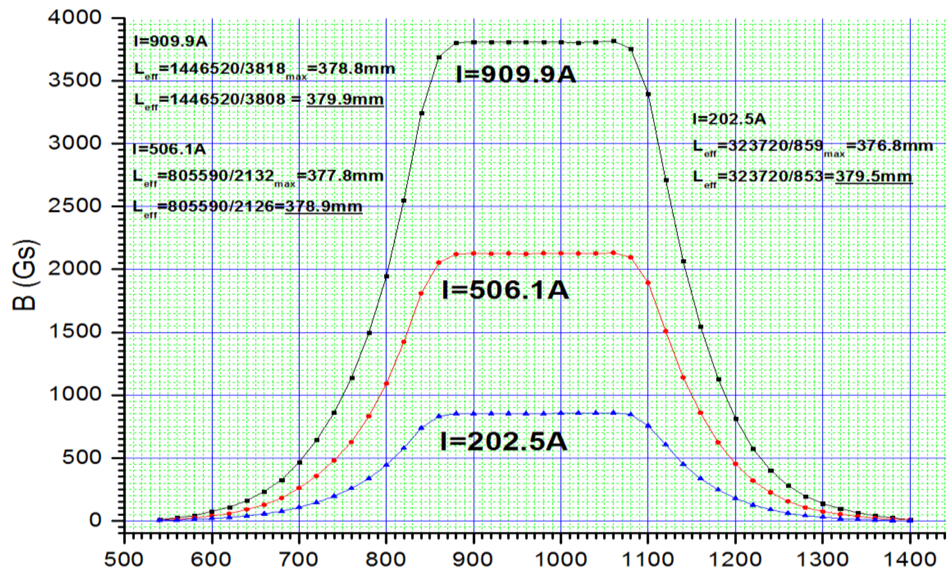
Q3 (pole 3) effective length



Q6(pole3) eff. length



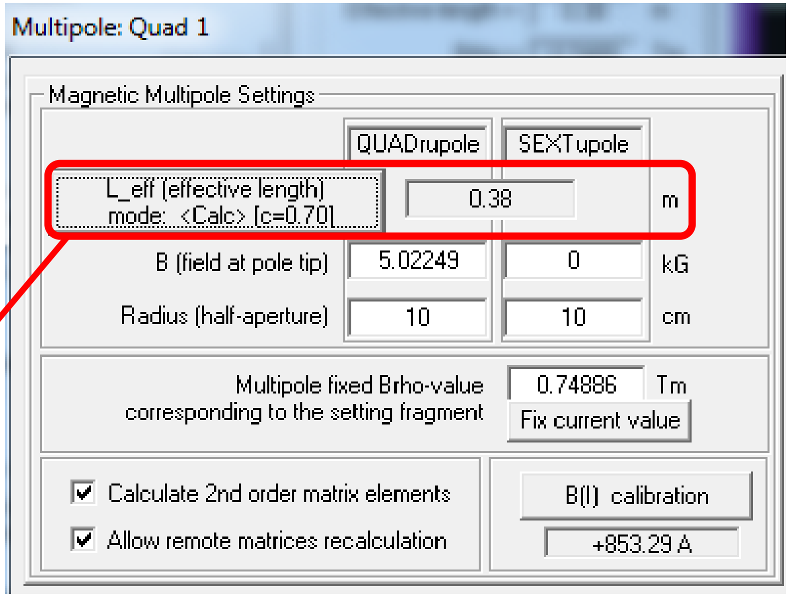
Q2 (pole3) effective length

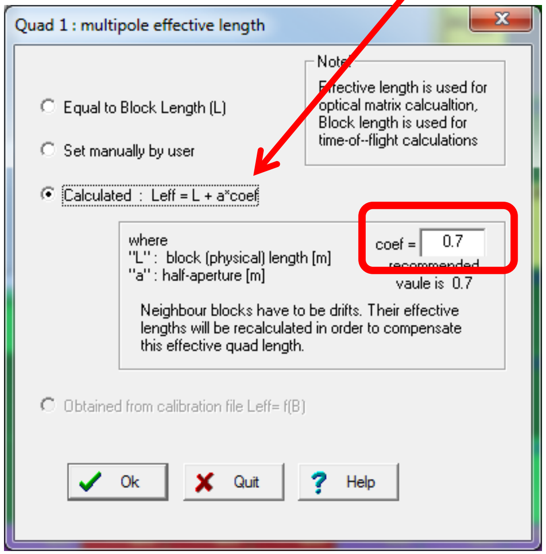


Effective lengths : Quads

	Quad 1-6
a (Half-aperture) [cm]	10
iron length [mm]	310
effective in the code [mm]	380
Leff = L + coef * a	
coef (calculation)=	**0.700**

For information :
The same coefficient value 0.7 has been obtained in the case of NSCL A1900 quads
http://lise.nscl.msu.edu/9_8/QuadEffLengths.pdf#page=5





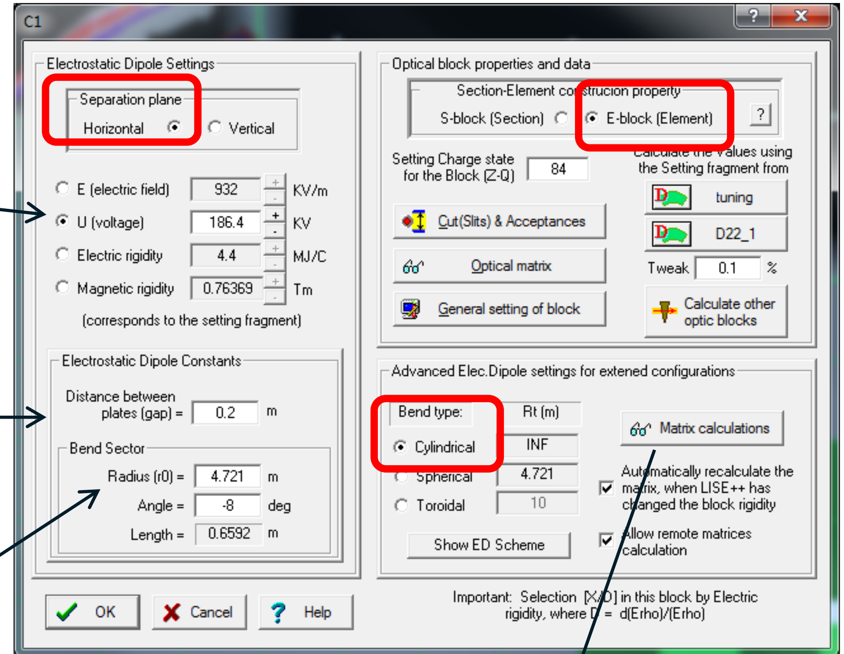
For all six SHELS quads

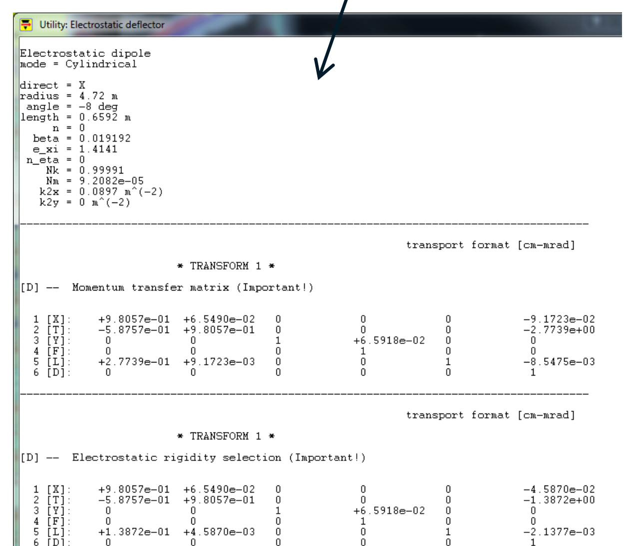
Electrostatic Dipoles C1 & C2 settings

Use double “logbook” voltage value !!

AC1 = 200; {Distance between plates of condensator 1 in mm}

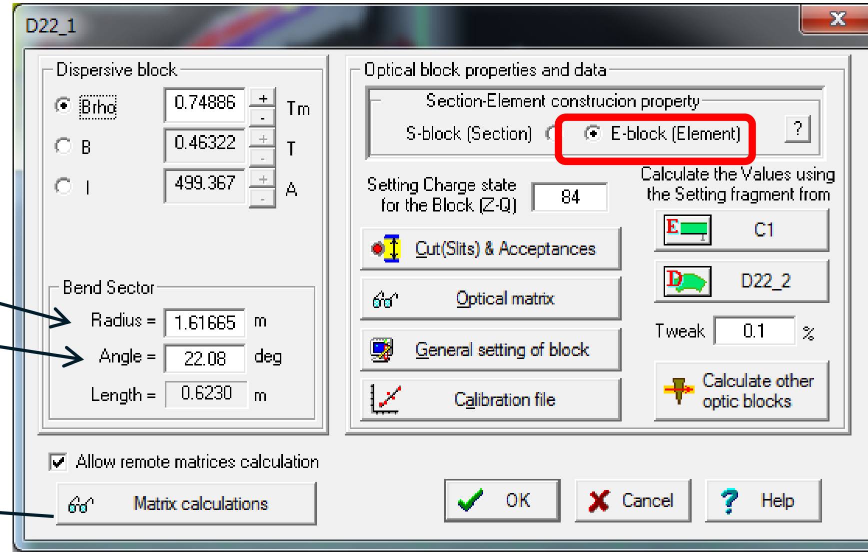
RadiusLC1 = Leff /sin(alpha)		
Alpha=	8.000	deg
Eff.Length=	657	mm
RadiusLC1 =	**4.721**	**m**

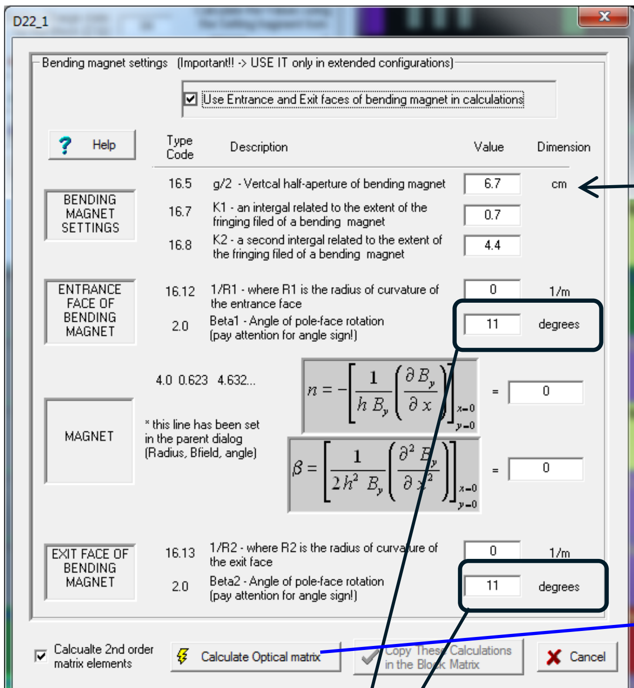




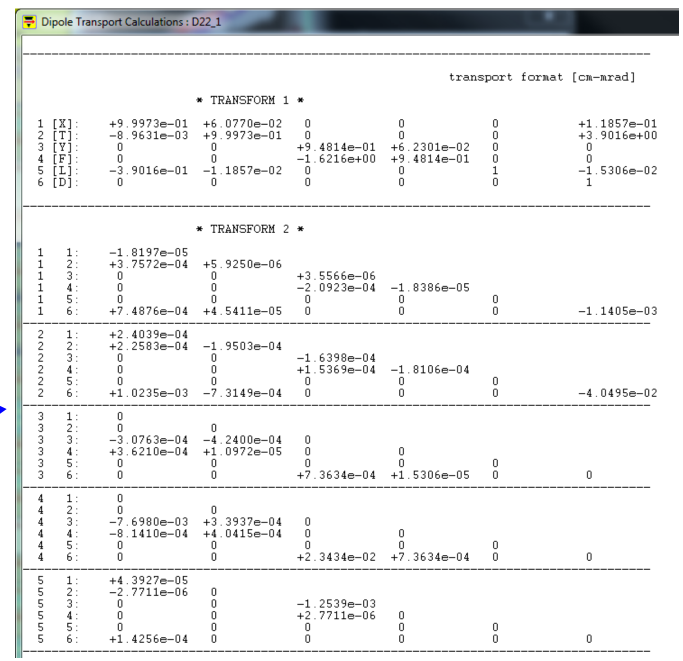
Magnetic Dipoles D22_1 & D22_2 settings

Br recalc=	0.7622	Tm
ID22-8=	508.5	A
B from calibration		
B=	0.47147	T
radius=	1.616646	
Length=	619.2	mm
Alpha=	0.385396	Rad
Alpha=	22.082	Deg
Arc =	0.623049	m





YDlim = 67;
{Halfhight of dipoles gape in mm}

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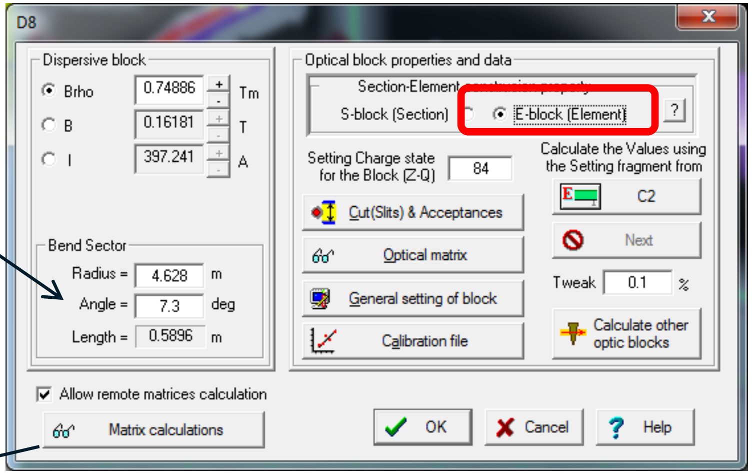
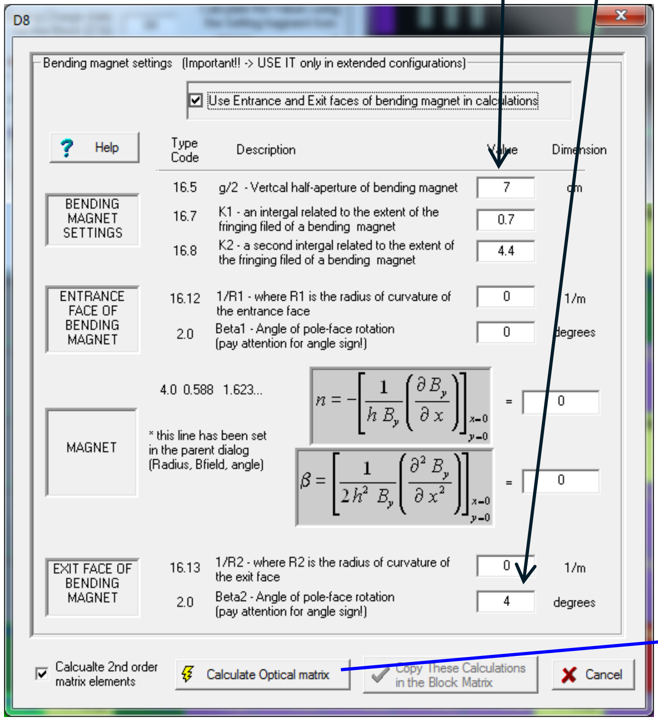
For example, a symmetrically oriented rectangular bending magnet
whose total bend is 10 degrees would be represented by the three entries
2.   5. ;       4.  --- ;   2.   5. ;
```

Magnetic Dipole D8 settings

D3Alfa = 0.1274;	{Bending angle 7.3 of central trajectory in dipole D3 in rad}
LD3 = 500;	{Length of dipole in mm }
LD3eff = 588;	{Effective length of dipole in mm }
D3W05 = 95;	{Half width of dipole 3 in mm}
SD3 = 0;	{Radial shift of dipole axis in mm (245)}
betaD3 = 0.070;	{Rear pole face-rotation angle of dipole D3 (0.07)}
YD3lim = 70;	{Halfhight of dipole camera in mm 70}

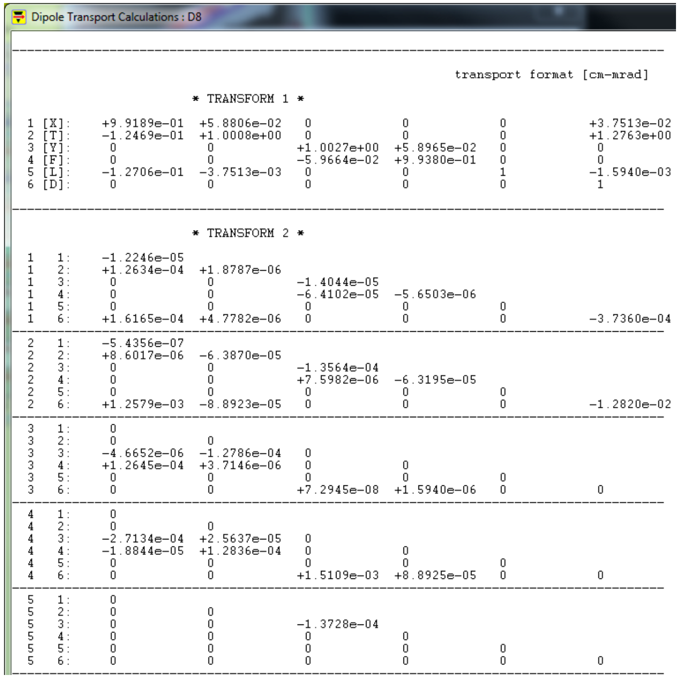
RadiusLD8 = Leff /sin(alpha)		
Alpha=	7.300	deg
Eff.Length=	588	mm
RadiusD8=	**4.628**	**m**
Alpha=	0.1274	rad
RadiusD8=	4627.6	mm
Arc=	0.5896	





$$n = -\left[\frac{1}{h\,B_y}\left(\frac{\partial B_y}{\partial x}\right)\right]_{\substack{x=0\\y=0}} = 0$$

$$\beta = \left[\frac{1}{2h^2\,B_y}\left(\frac{\partial^2 B_y}{\partial x^2}\right)\right]_{\substack{x=0\\y=0}} = 0$$



Dipole Transport Calculations : D8

```
------------------------------------------------------------------------------
                                              transport format [cm-mrad]

                  * TRANSFORM 1 *

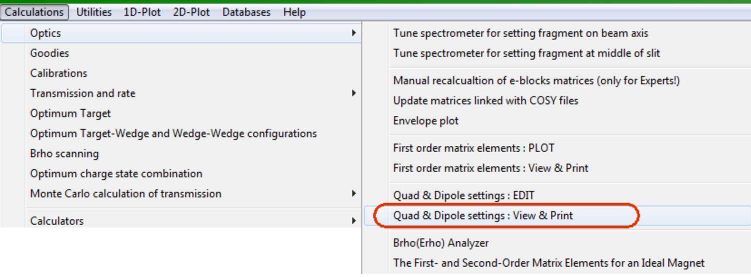
 1 [X]:   +9.9189e-01  +5.8806e-02   0            0            0            +3.7513e-02
 2 [T]:   -1.2469e-01  +1.0008e+00   0            0            0            +1.2763e+00
 3 [Y]:    0            0           +1.0027e+00  +5.8965e-02   0             0
 4 [F]:    0            0           -5.9664e-02  +9.9380e-01   0             0
 5 [L]:   -1.2706e-01  -3.7513e-03   0            0            1            -1.5940e-03
 6 [D]:    0            0            0            0            0             1

------------------------------------------------------------------------------

                  * TRANSFORM 2 *

 1   1:   -1.2246e-05
 1   2:   +1.2634e-04  +1.8787e-06
 1   3:    0            0           -1.4044e-05
 1   4:    0            0           -6.4102e-05  -5.6503e-06
 1   5:    0            0            0            0            0
 1   6:   +1.6165e-04  +4.7782e-06   0            0            0            -3.7360e-04
------------------------------------------------------------------------------
 2   1:   -5.4356e-07
 2   2:   +8.6017e-06  -6.3870e-05
 2   3:    0            0           -1.3564e-04
 2   4:    0            0           +7.5982e-06  -6.3195e-05
 2   5:    0            0            0            0            0
 2   6:   +1.2579e-03  -8.8923e-05   0            0            0            -1.2820e-02
------------------------------------------------------------------------------
 3   1:    0
 3   2:    0            0
 3   3:   -4.6652e-06  -1.2786e-04   0
 3   4:   +1.2645e-04  +3.7146e-06   0            0
 3   5:    0            0            0            0            0
 3   6:    0            0           +7.2945e-08  +1.5940e-06   0             0
------------------------------------------------------------------------------
 4   1:    0
 4   2:    0            0
 4   3:   -2.7134e-04  +2.5637e-05   0
 4   4:   -1.8844e-05  +1.2836e-04   0            0
 4   5:    0            0            0            0            0
 4   6:    0            0           +1.5109e-03  +8.8925e-05   0             0
------------------------------------------------------------------------------
 5   1:    0
 5   2:    0            0
 5   3:    0            0           -1.3728e-04
 5   4:    0            0            0            0
 5   5:    0            0            0            0            0
 5   6:    0            0            0            0            0             0
------------------------------------------------------------------------------
```

Apertures & Slits



Note: Slits 4 are temporary not used due to large transmission cut of fragment of interest.
It should be discussed!

Quads & Dipoles settings

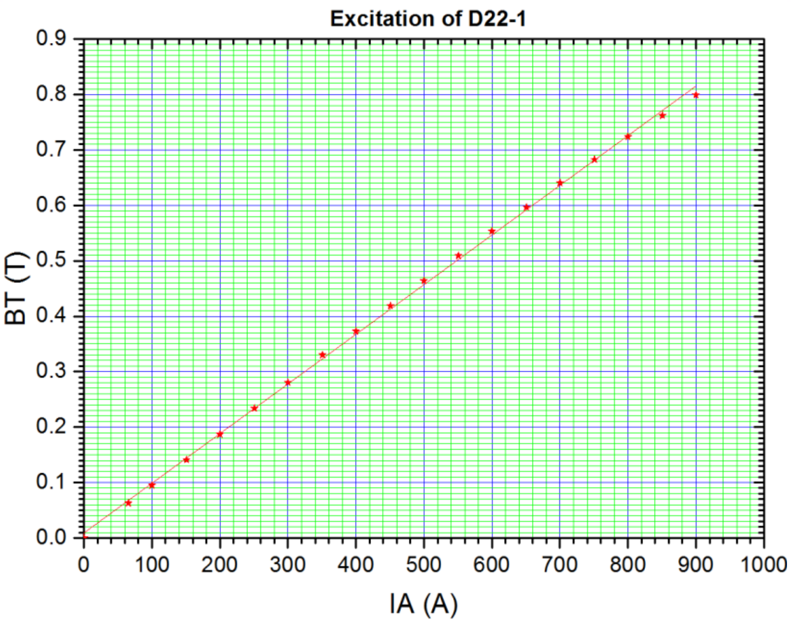
slits | aperture

! FILE: C:_Popeko\SHELS.lpp

1 N or	2 Block name	3 Kind of Block	4 Start (m)	5 Length (m)	6 DriftMode Angle(°)*	7 B0(kG)	8 Br-corrsp Br-dip*	9 Rapp(cm) R(m)*	10 L_eff(m) Len(m)*	11 2nd order	12 Calc Mode	13 AngAcc mode	14 Slits shape	15 Xmin slit	16 Xmax slit	17 Ymin slit	18 Ymax slit	19 Appert shape	20 Xmin limit	21 Xmax limit	22 Ymin limit	23 Ymax limit
1.	tuning	Dipole	0.000	0.000	+0.0 *	+2.496	0.7489*	3.00*	0.00*	-		HV	rectn					ellps				
2.	DTS1	Drift	0.000	0.350	standard							---	rectn					ellps	-90	+90	-90	+90
3.	slits 1	Drift	0.350	0.000	SLITS							---	ellps	-35	+35	-35	+35	ellps	-90	+90	-90	+90
4.	DS1Q1	Drift	0.350	0.070	standard							---	rectn					ellps	-90	+90	-90	+90
5.	Quad 1	Drift	0.420	0.310	multipole	+5.022	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
6.	dqiqk	Drift	0.730	0.270	standard							---	rectn					ellps	-90	+90	-90	+90
7.	Quad 2	Drift	1.000	0.310	multipole	-4.581	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
8.	dqiqk	Drift	1.310	0.270	standard							---	rectn					ellps	-90	+90	-90	+90
9.	Quad 3	Drift	1.580	0.310	multipole	+2.239	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
10.	dq3c1	Drift	1.890	0.551	standard							---	rectn					ellps	-90	+90	-90	+90
11.	C1	ElecDip	2.442	0.659	-8.0 *	179.2kV	0.7489*	4.72*	0.66*	-		---	rectn					rectn	-100	+100	-175	+175
12.	dc1d1	Drift	3.101	0.423	standard							---	rectn					rectn	-100	+100	-175	+175
13.	D22_1	Dipole	3.524	0.623	+22.1 *	+2.496	0.7489*	1.62*	0.62*	yes		---	rectn					rectn	-215	+215	-67	+67
14.	dd1sv	Drift	4.147	0.305	standard							---	rectn					ellps	-215	+215	-67	+67
15.	slits SV	Drift	4.452	0.000	SLITS							---	rectn	-100	+100	-67	+67	rectn				
16.	dsvd2	Drift	4.452	0.305	standard							---	rectn					rectn	-215	+215	-67	+67
17.	D22_2	Dipole	4.757	0.623	-22.1 *	+2.496	0.7489*	1.62*	0.62*	yes		---	rectn					rectn	-215	+215	-67	+67
18.	dd2c2	Drift	5.380	0.423	standard							---	rectn					rectn	-216	+216	-67	+67
19.	C2	ElecDip	5.803	0.659	+8.0 *	179.2kV	0.7489*	4.72*	0.66*	-		---	rectn					rectn	-100	+100	-175	+175
20.	dc2q4	Drift	6.463	0.551	standard							---	rectn					ellps	-90	+90	-90	+90
21.	Quad 4	Drift	7.014	0.310	multipole	+0.699	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
22.	dqiqk	Drift	7.324	0.270	standard							---	rectn					ellps	-90	+90	-90	+90
23.	Quad 5	Drift	7.594	0.310	multipole	-3.300	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
24.	dqiqk	Drift	7.904	0.270	standard							---	rectn					ellps	-90	+90	-90	+90
25.	Quad 6	Drift	8.174	0.310	multipole	+2.358	0.7489	10.00	0.38	yes	1	---	rectn					ellps	-90	+90	-90	+90
26.	dq6d3	Drift	8.484	2.115	standard							---	rectn					ellps	-90	+90	-90	+90
27.	D8	Dipole	10.599	0.590	+7.3 *	+2.496	0.7489*	4.63*	0.59*	yes		---	rectn					ellps	-95	+95	-70	+70
28.	drift	Drift	11.189	1.058	standard							---	rectn					ellps	-95	+95	-70	+70
29.	slits 3	Drift	12.247	0.000	SLITS							---	rectn	-40	+40	-40	+40	rectn				
30.	drift	Drift	12.247	0.390	standard							---	rectn					rectn				
31.	slits 4	Drift	12.637	0.000	SLITS							---	rectn					ellps	-40	+40	-40	+40
32.	drift	Drift	12.637	0.110	standard							---	rectn					rectn				

! symbol "*" after values denotes, that these values belongs to Dipole settings, where column names are found in the second row of titles, and also marked by "*"
! Column 08: "Br-corrsp" - quadrupole(sextupole) field is scaled to this Brho-value; "Br-dip*" - dipole magnetic rigidity [T*m]
! Column 09: "Rapp(cm)" - radius(half-aperture) of quadrupole(sextupole) in cm; "R(m)-dip*" - dipole raidus [m]
! Column 10: "L_eff(m)" - effective length of quadrupole(sextupole) in m, wich is used for Optical matrix calcualtiuons; "Len(m)*" - dipole length at ther central axis [m]
! Column 12: "Calc mode" - only for quadrupole(sextupole); 0 - no actions; 1 - recalculate automatically B(field), keep matrix;
! 2 - recalculate automatically the matrix, keep B(field)
!
! Column 13: "AngAcc mode" - "H(V)" : horizontal(vertical) angular acceptance will be applied for this block
! Columns 15-18,20-23: slits and aperture(limit) sizes in [mm]. If slit or aperture(limit) does not have action, then its size value is absent

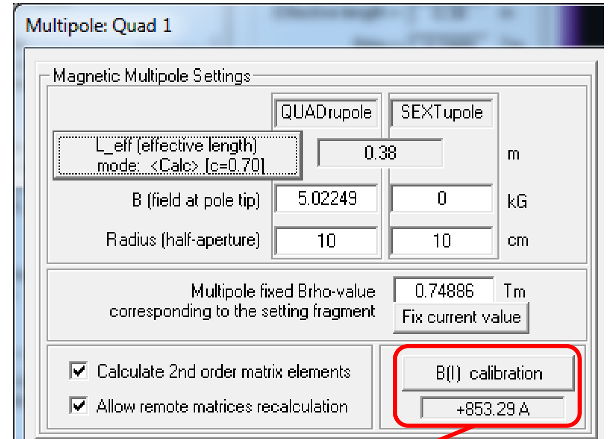
Calibrations

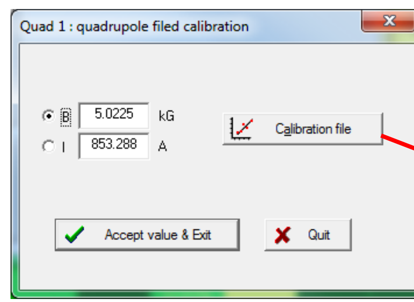


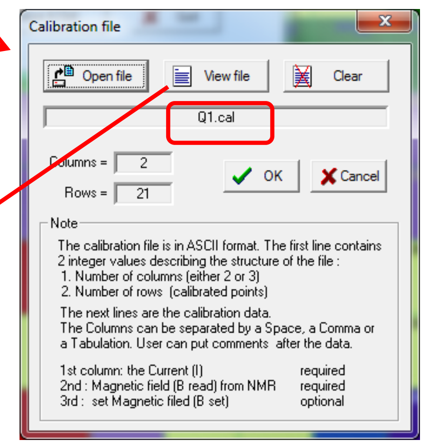
Calibration data of all 6 quad, m-dipoles D22-1, D22-2 and D8 have been transported to LISE++ calibrated files and linked to the SHELS configuration to be used in the corresponding dialogs.

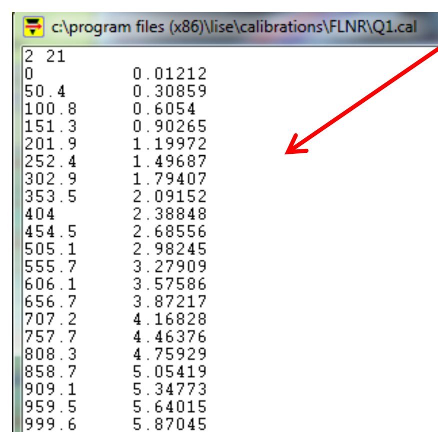
Calibration files are located in the directory "calibrations\FLNR".

Q6	cal	151	11/21/2014
Q5	cal	232	11/21/2014
Q4	cal	166	11/21/2014
Q3	cal	314	11/21/2014
Q2	cal	329	11/21/2014
Q1	cal	315	11/21/2014
D8	cal	576	11/03/2014
D22_1	cal	277	11/03/2014
D22_2	cal	257	11/03/2014







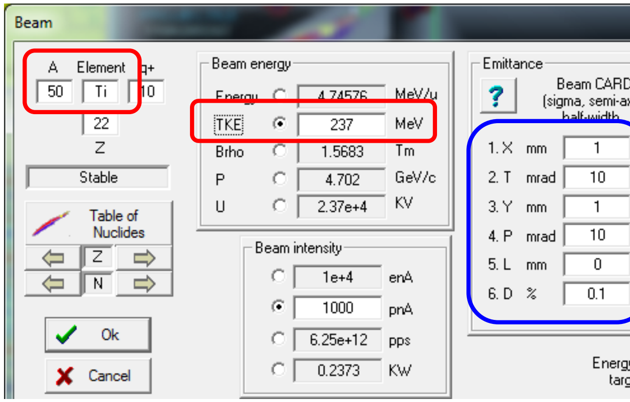


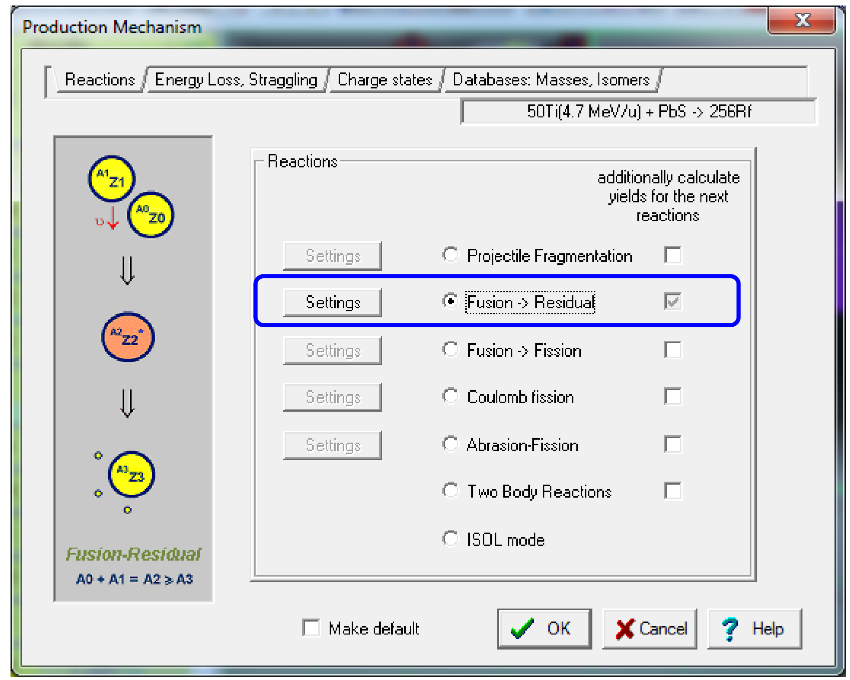
c:\program files (x86)\lise\calibrations\FLNR\Q1.cal

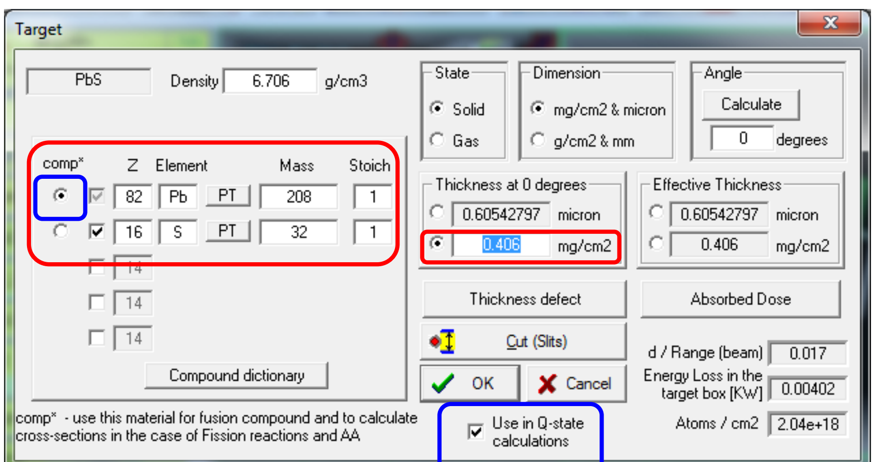
```
2 21
0       0.01212
50.4    0.30859
100.8   0.6054
151.3   0.90265
201.9   1.19972
252.4   1.49687
302.9   1.79407
353.5   2.09152
404     2.38848
454.5   2.68556
505.1   2.98245
555.7   3.27909
606.1   3.57586
656.7   3.87217
707.2   4.16828
757.7   4.46376
808.3   4.75929
858.7   5.05419
909.1   5.34773
959.5   5.64015
999.6   5.87045
```

^{208}Pb(^{50}Ti,2n)^{256}Rf experiment used to create configuration (logbook 14.04.2014)

Energy = 237 MeV
Target ^{208}PbS (0.35mg Pb)







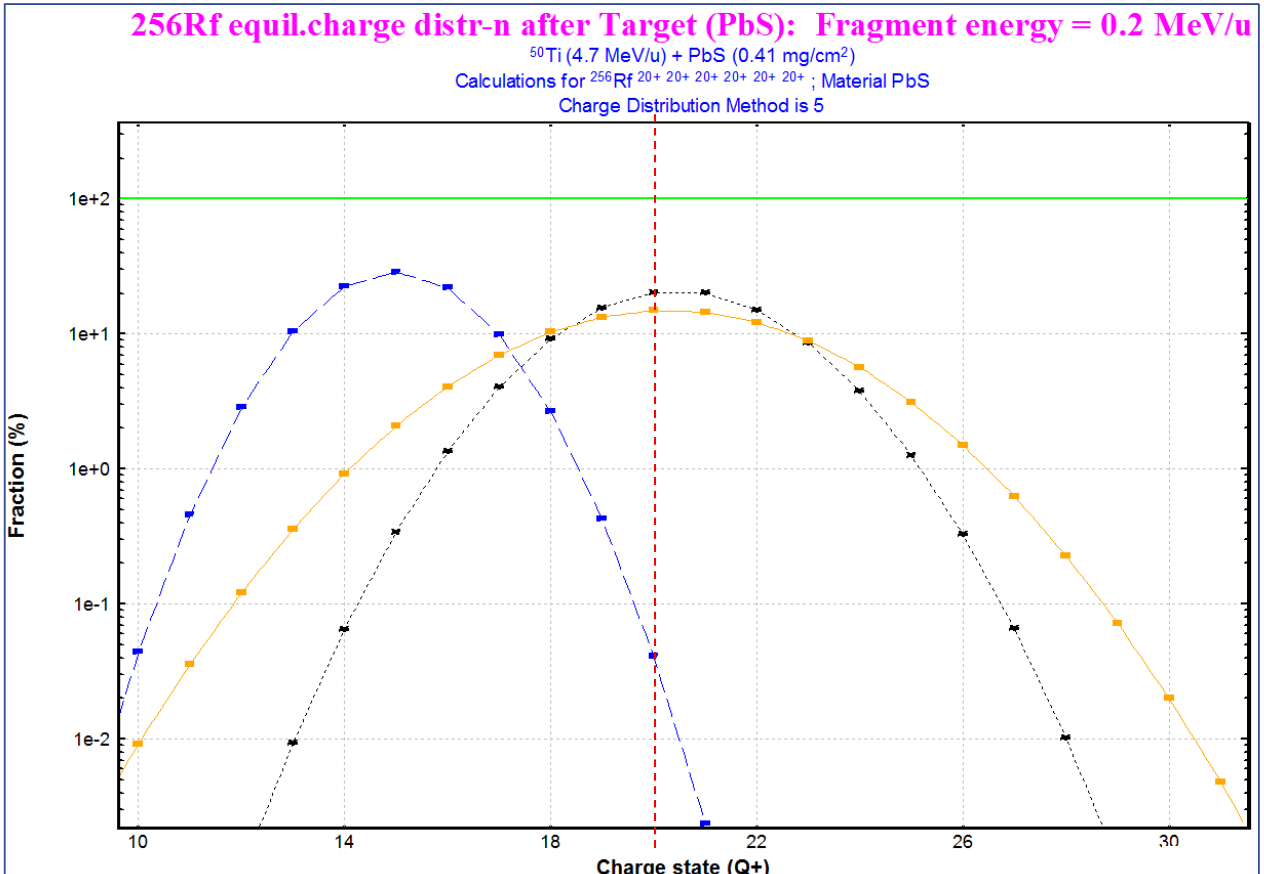
Reaction choice: Charge state model

5 - [< 15AMeV] G.Schiwietz, P.Grande, NIM B175-177 (2001) 125-131

Schiwietz's model has been chosen for this reaction with setting charge state 20+

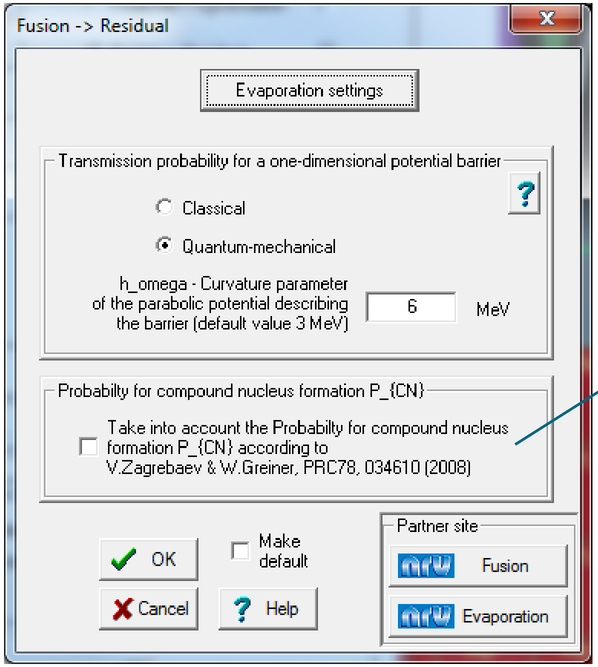
According to the logbook
<q> = 19.5, sig(q) = 2.44

Question: The Sulfur component has been taken into account ?



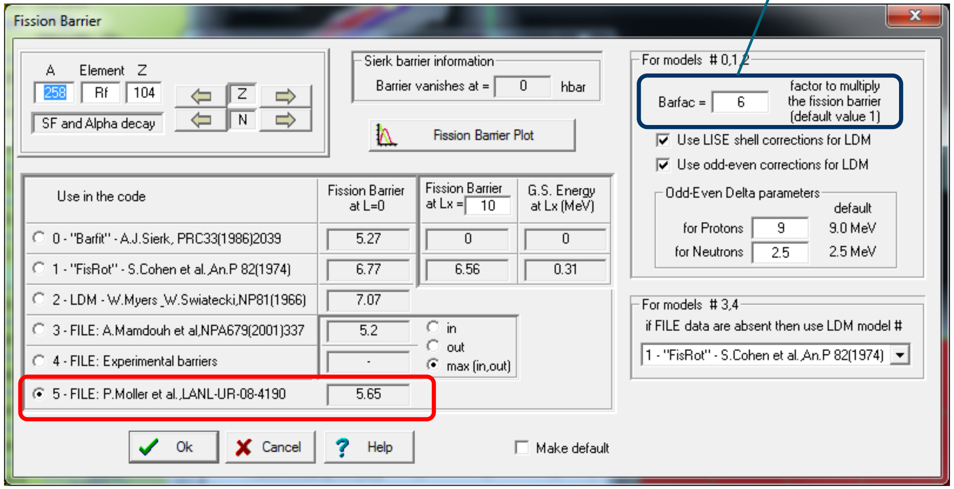
N	distribution	x-mean	x-max	y-max	deviation	FWHM
01	0-Winger	+4.4900e+01	+4.5000e+01	1.689e+01	2.372e+00	5.576e+00
02	1-Leon	+1.4979e+01	+1.5000e+01	2.882e+01	1.401e+00	3.292e+00
03	2-Shima	+2.0463e+01	+2.0000e+01	2.031e+01	1.923e+00	4.601e+00
04	3-GLOBAL+W	+4.4900e+01	+4.5000e+01	1.689e+01	2.372e+00	5.576e+00
05	4-GLOBAL+L	+1.4979e+01	+1.5000e+01	2.882e+01	1.401e+00	3.292e+00
06	5-Schiwietz	+2.0292e+01	+2.0000e+01	1.491e+01	2.672e+00	6.307e+00

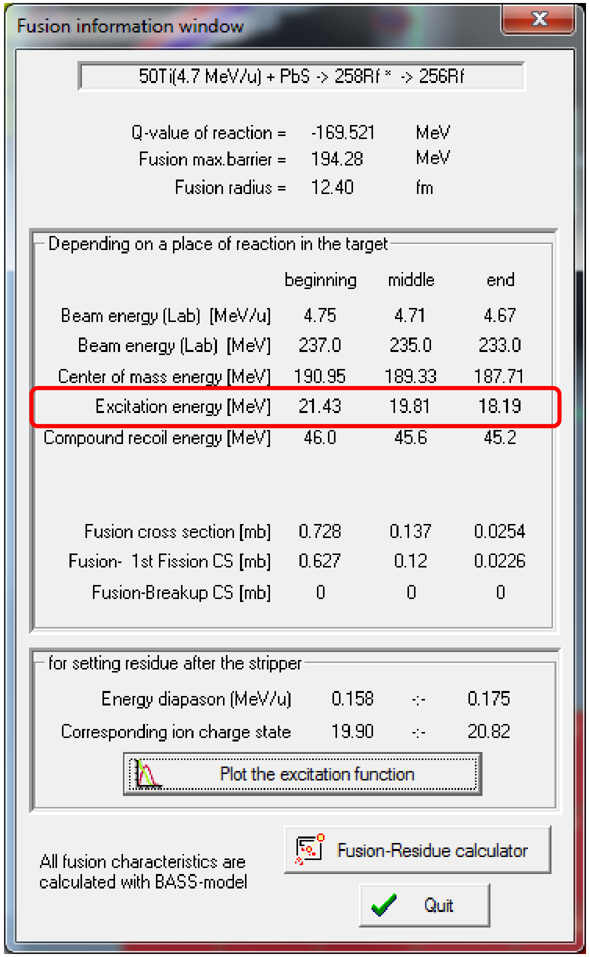
Reaction choice: Fusion residual (SHE region)



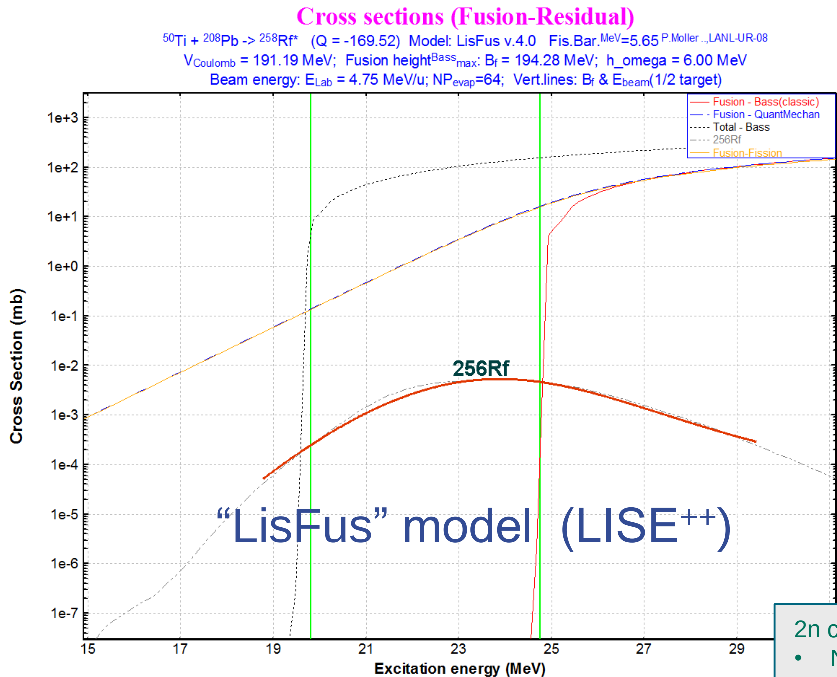
Temporarily turned off

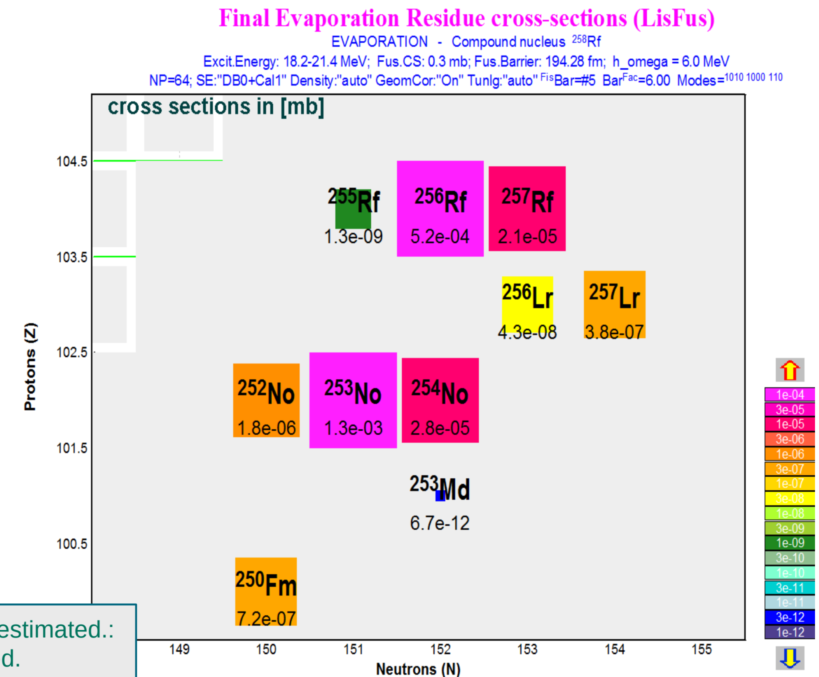
For nuclei in this region, which are absent in data file





Reaction choice: Fusion residual (SHE region)





2n channel is overestimated.:

- No P_{CN} used.
- Play with Kramers coefs for fission.
- Fission barriers

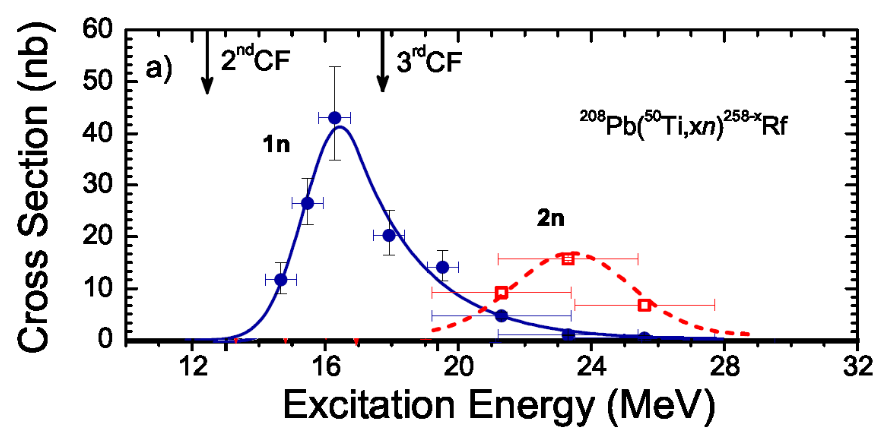
The influence of projectile neutron number in the ^{208}Pb(^{48}Ti, *n*)^{255}Rf and ^{208}Pb(^{50}Ti, *n*)^{257}Rf reactions

I. Dragojević[1,2], K.E. Gregorich[2], Ch. E. Düllmann[1,2,3], M.A. Garcia[1,2], J.M. Gates[1,2], S.L. Nelson[1,2], L. Stavsetra[2], R. Sudowe[2,*], and H. Nitsche[1,2]

[1] *Department of Chemistry, University of California, Berkeley, California 94720, U.S.A.*

[2] *Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, U.S.A.*

[3] *Abteilung Kernchemie, Gesellschaft für Schwerionenforschung mbH, 64291 Darmstadt, Germany*



Configurations

http://lise.nscl.msu.edu/9_8/SHELS/

Index of /9_8/SHELS

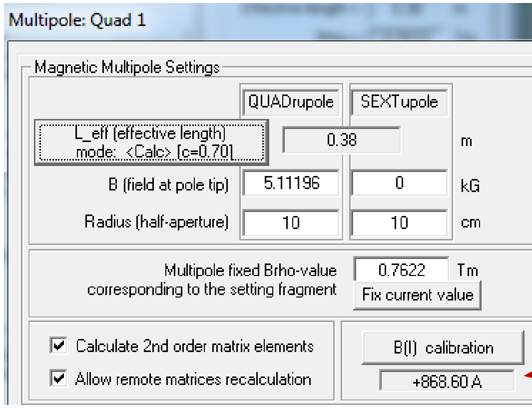
Name	Last modified	Size	Description
Parent Directory		-	
SHELS.lcn	23-Nov-2014 17:08	153K	
SHELS.lpp	23-Nov-2014 17:08	182K	
SHELS.xlsx	23-Nov-2014 19:15	49K	
SHELSinLISE.pdf	23-Nov-2014 19:14	3.6M	
SHELS_v9.lpp	21-Nov-2014 18:18	173K	
SHELS_v9_brho.lpp	21-Nov-2014 18:21	173K	
SHELS_v9_brho_quad5.lpp	23-Nov-2014 17:08	182K	
SHELS_v9_brho_quad5_acceptance.lpp	21-Nov-2014 18:17	173K	

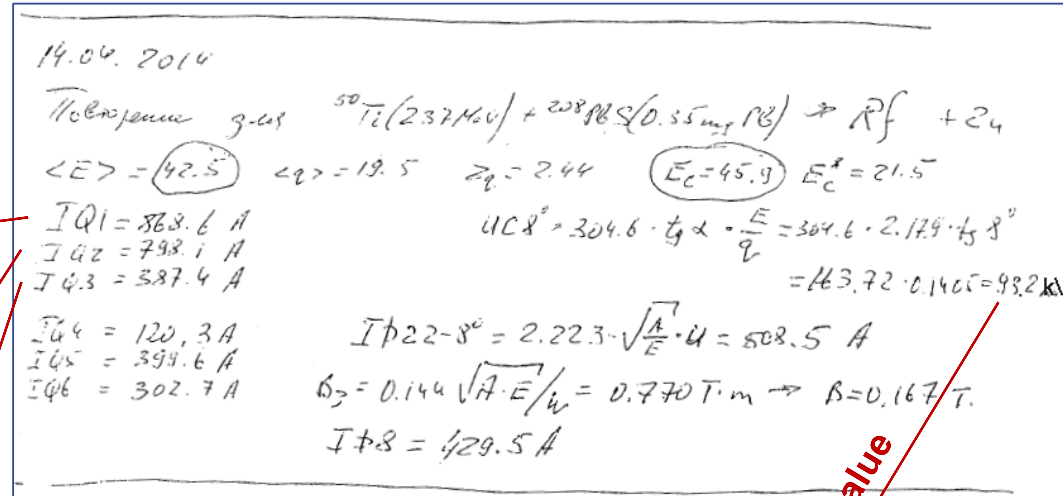
The LISE^{++} package already contains the SHELS configuration and calibration files. Please use v.9.8.166

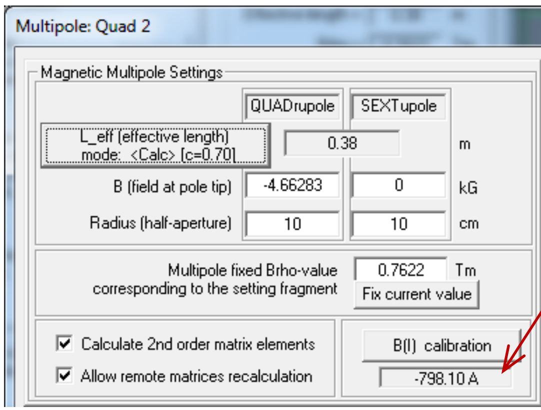
- ✓ Experimental (logbook) settings — SHELS_v9.lpp
- ✓ Brho values by LISE++ — SHELS_v9_brho.lpp
- ✓ Q5 field value modification — SHELS_v9_brho_quad5.lpp
- ✓ Obtaining angular acceptance — SHELS_v9_brho_quad5_acceptance.lpp
- ✓ Final version for the LISE++ package — SHELS.lpp SHELS.lcn

Configurations : Experimental (logbook) settings

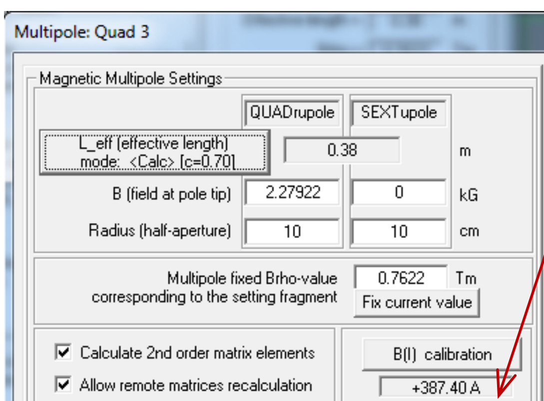
SHELS v9.lpp

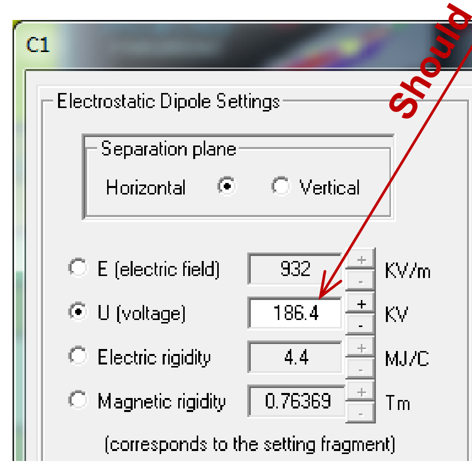






Should be double value

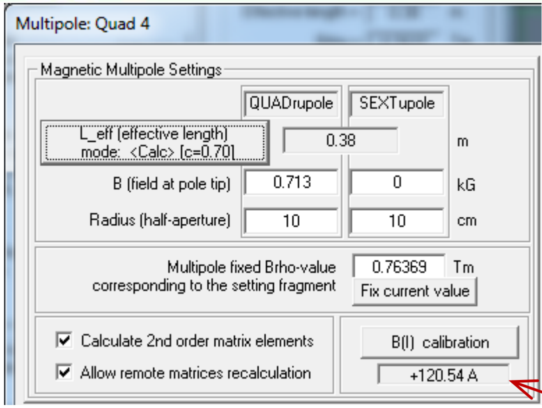


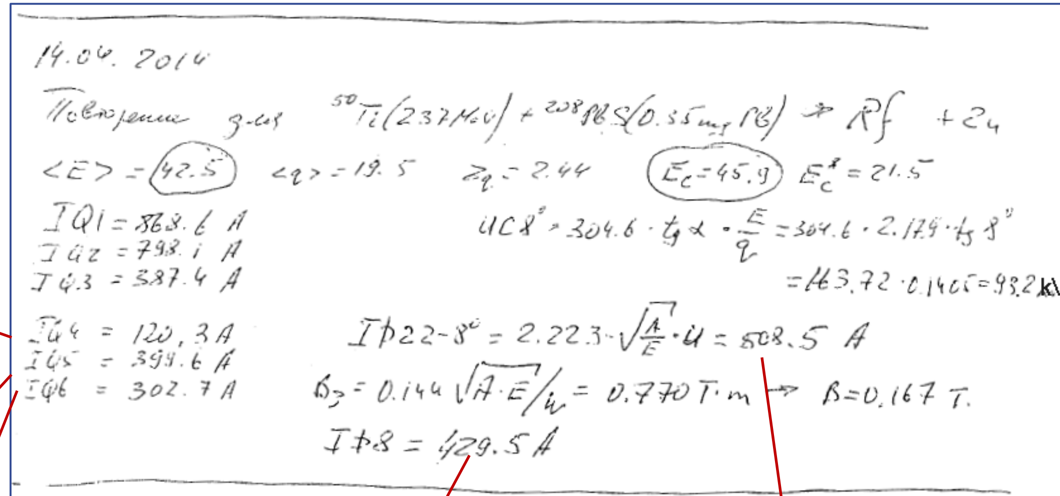


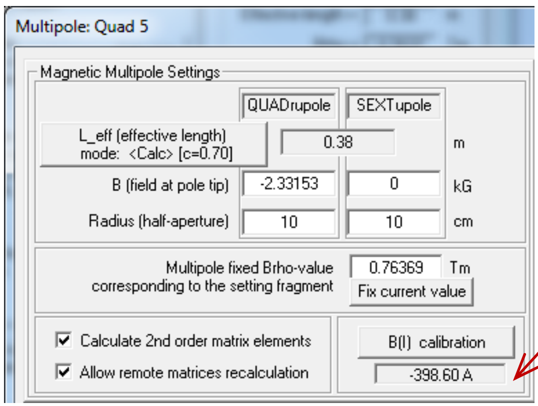
U_C1 = U_C2

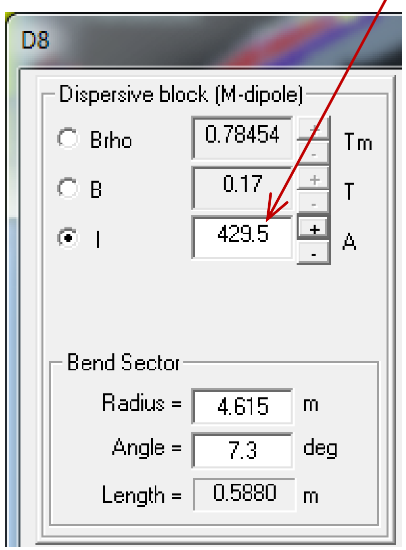
Configurations : Experimental (logbook) settings

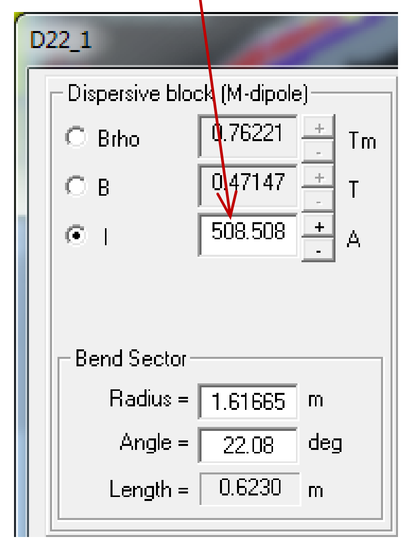
SHELS v9.lpp

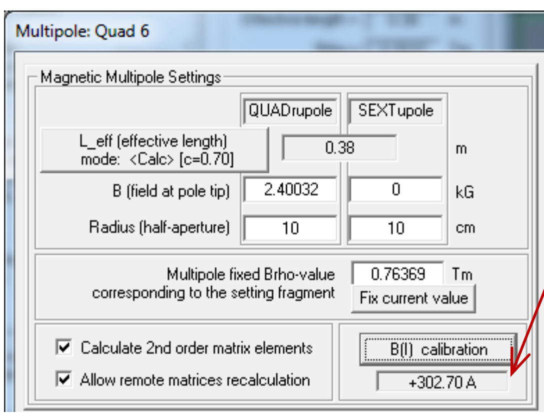












Br_D22_1 = Br_D22_2

Configurations : Experimental (logbook) settings

SHELS v9.lpp

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

- Optics
- Goodies
- Calibrations
- Transmission and rate
- Optimum Target
- Optimum Target-Wedge and Wedge-Wedge configurations
- Brho scanning
- Optimum charge state combination
- Monte Carlo calculation of transmission
- Calculators

- Tune spectrometer for setting fragment on beam axis
- Tune spectrometer for setting fragment at middle of slit
- Manual recalcualtion of e-blocks matrices (only for Experts!)
- Update matrices linked with COSY files
- Envelope plot
- First order matrix elements : PLOT
- First order matrix elements : View & Print
- Quad & Dipole settings : EDIT
- Quad & Dipole settings : View & Print
- Brho(Erho) Analyzer
- The First- and Second-Order Matrix Elements for an Ideal Magnet

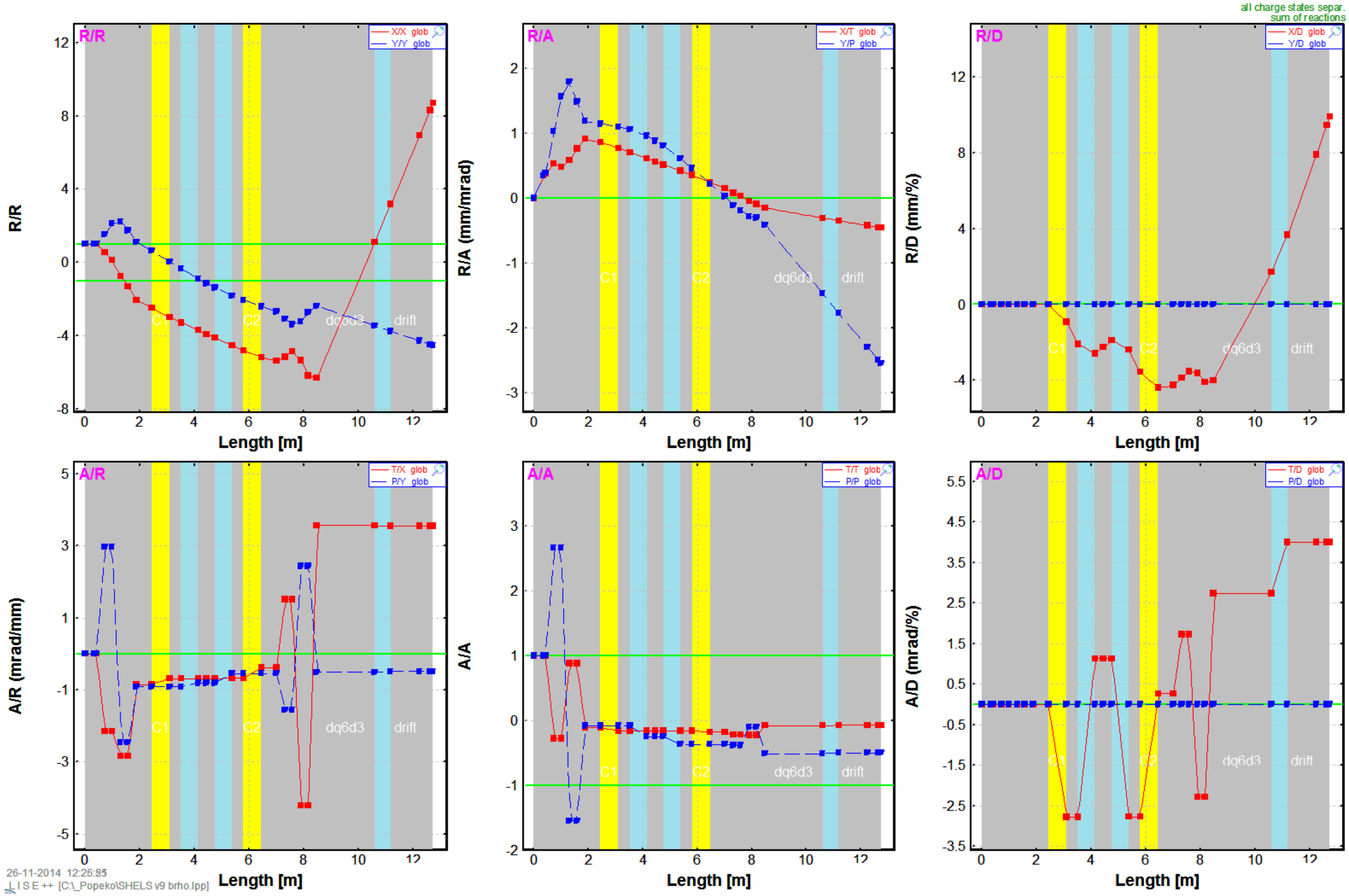
The sectors with different rigidities

Quadrupoles and dipoles fast editting

Block	Given Name	Start(m)	Length(m)	B0(kG)	Br(Tm)cor/*real	DriftM/*Angle	Rapp(cm)/*R(...	Leff(m)/*Ldip(m)	2 nd order	CalcMatr/*Z-Q	AngAcc,Apps,Slits	COSY_link	SE
Drift	dqiqk	0.730	0.2700			standard		c_0.2000			-- HV --	-	e
Drift	Quad 2	1.000	0.3100	-4.6628	0.7637	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
Drift	dqiqk	1.310	0.2700			standard		c_0.2000			-- HV --	-	e
Drift	Quad 3	1.580	0.3100	+2.2792	0.7637	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
Drift	dq3c1	1.890	0.5515			standard		c_0.5165			-- HV --	-	e
ElecDip	C1	2.442	0.6592	186.4kV	0.7637	* -8.0	* 4.7210	* 0.6592	-	* 84	-- HV --	-	E
Drift	dc1d1	3.101	0.4229			standard					-- HV --	-	e
Dipole	D22_1	3.524	0.6230	+4.7147	* 0.7622	* +22.1	* 1.6166	* 0.6230	yes	* 84	-- HV --	-	E
Drift	dd1sv	4.147	0.3054			standard					-- HV --	-	e
Drift	slits SV	4.452	0.0000			SLITS					-- -- HV	-	e
Drift	dsvd2	4.452	0.3054			standard					-- HV --	-	e
Dipole	D22_2	4.757	0.6230	-4.7147	* 0.7622	* -22.1	* 1.6166	* 0.6230	yes	* 84	-- HV --	-	E
Drift	dd2c2	5.380	0.4229			standard					-- HV --	-	e
ElecDip	C2	5.803	0.6592	186.4kV	0.7637	* +8.0	* 4.7210	* 0.6592	-	* 84	-- HV --	-	E
Drift	dc2q4	6.463	0.5515			standard		c_0.5165			-- HV --	-	e
Drift	Quad 4	7.014	0.3100	+0.7130	0.7637	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
Drift	dqiqk	7.324	0.2700			standard		c_0.2000			-- HV --	-	e
Drift	Quad 5	7.594	0.3100	-2.3315	0.7637	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
Drift	dqiqk	7.904	0.2700			standard		c_0.2000			-- HV --	-	e
Drift	Quad 6	8.174	0.3100	+2.4003	0.7637	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
Drift	dq6d3	8.484	2.1150			standard		c_2.0800			-- HV --	-	e
Dipole	D8	10.599	0.5880	+1.7000	* 0.7845	* +7.3	* 4.6150	* 0.5880	yes	* 84	-- HV --	-	E
Drift	drift	11.187	1.0580			standard					-- HV --	-	e

First order matrix elements

^{50}Ti (4.7 MeV/u) + PbS (0.41 mg/cm^2); Settings on ^{256}Rf$^{20+..20+}$; Config: DSSSSSSSSSESDSSSDSESSSSSSS...
dp/p=10.14% ; Brho(Tm): 0.7637, 0.7622, 0.7622, 0.7845



Configurations : Experimental (logbook) settings

Overall transmission 45.1%

statistics: 256Rf

Analytical solution

256Rf Spontaneous fission (Z=104, N=152) Rutherfordium

All reactions total isotope rate 1.55e+0 pps
and Overall isotope transmission 45.789 %

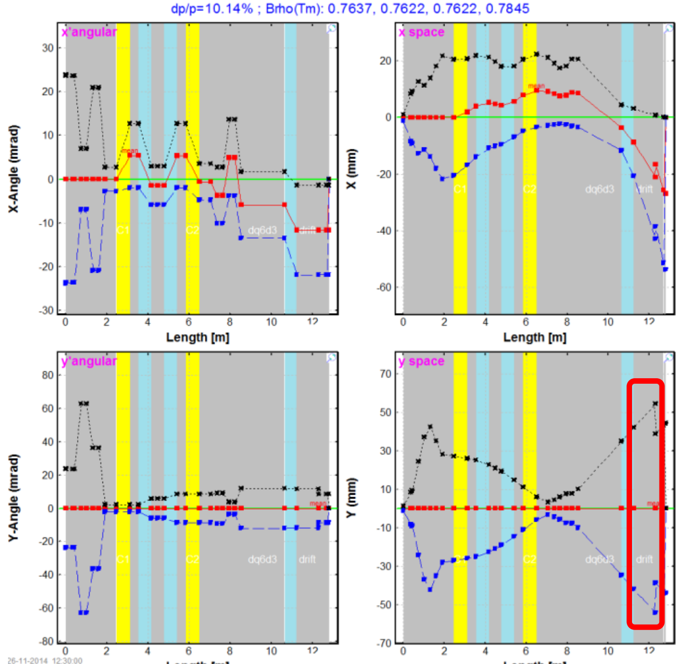
Q1 (tuning)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q2 (C1)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q3 (D22_1)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q4 (D22_2)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q5 (C2)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q6 (D8)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Reaction		FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes
Ion Production Rate	(pps)	5.9e-4	3.23e-3	1.31e-2	3.92e-2	8.92e-2	1.6e-1	2.29e-1	[illegible]	[illegible]	2.09e-1	1.43e-1	8.31e-2	4.15e-2	1.78e-2
Total ion transmission	(%)	0.017	0.095	0.385	1.154	2.629	4.7	6.743	7.89	7.621	6.155	4.204	2.449	1.222	0.525
Total: this reaction	(pps)	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0	1.55e+0
X-Section in target	(mb)	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4
Target	(%)	0.629	1.51	3.14	5.68	8.94	12.22	14.49	14.9	13.31	10.32	6.95	4.07	2.08	0.922
X space transmission	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Y space transmission	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Unreacted in material	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Q (Charge) ratio	(%)	0.629	1.51	3.14	5.68	8.94	12.22	14.49	14.9	13.31	10.32	6.95	4.07	2.08	0.922
Unstopped in material	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100

7.9%

Analytical solution

Envelope for ^{256}Rf FusRes 20+ 20+ 20+ 20+ 20+ 20+

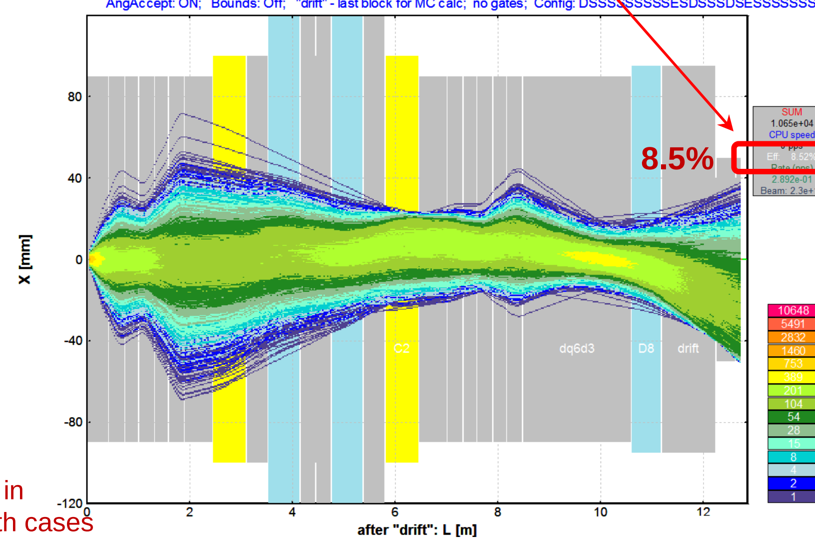
^{50}Ti (4.7 MeV/u) + PbS (0.41 mg/cm²); Settings on ^{256}Rf$^{20+,20+}$
dp/p=10.14% ; Brho(Tm): 0.7637, 0.7622, 0.7622, 0.7845



MC solution

^{256}Rf : MC Transmission Plot - Envelope (only passed)

^{50}Ti (4.7 MeV/u) + PbS (0.41 mg/cm²); Transmitted Fragment ^{256}Rf$^{20+,20+}$ (FusRes); Optics Order: 1
dp/p=10.14% ; Brho(Tm): 0.7637, 0.7622, 0.7622, 0.7845
AngAccept: ON; Bounds: Off; "drift" - last block for MC calc; no gates; Config: DSSSSSSSSESDSSSDSESSSSSSS...



About 50% lost in the slits 3 in both cases

slits 4 were not used

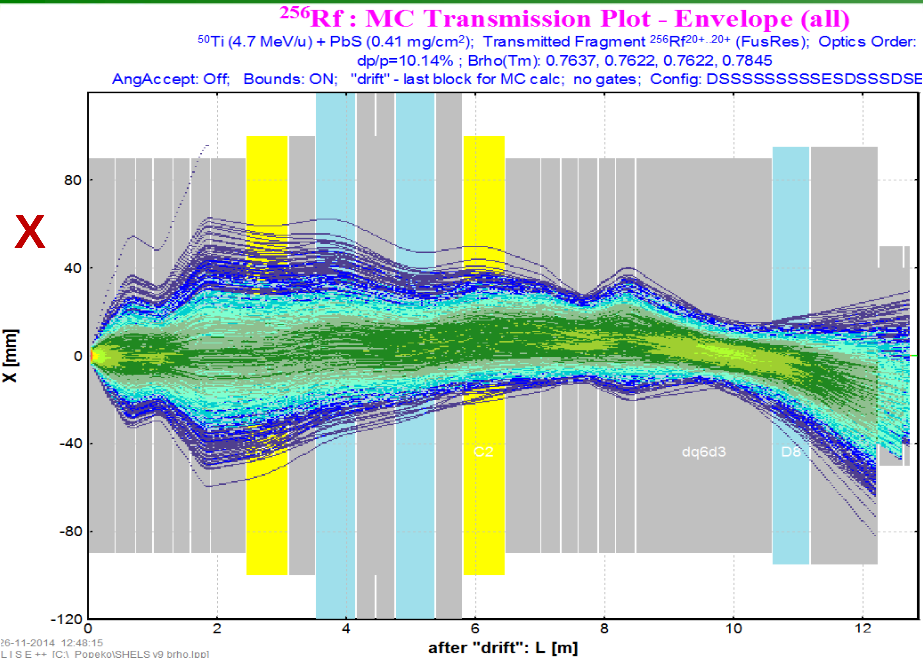
Angular Acceptance & Bounds
- [x] Use fixed angular acceptances
- [ ] Use physical limits (aperture) inside blocks to calculate fragment transmission

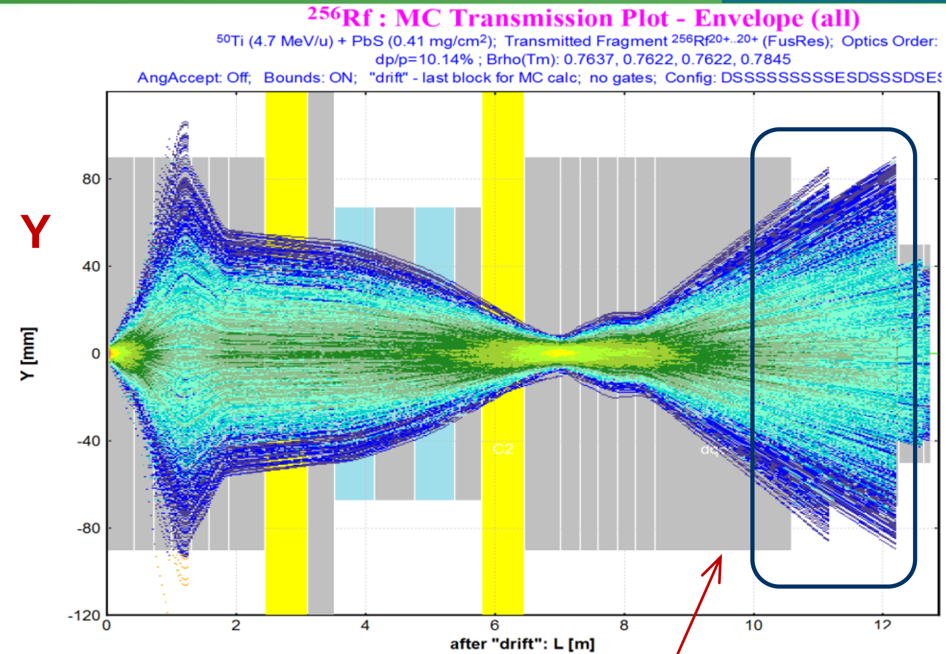
For block apertures LISE++ uses the slit limits accessible from the Block Cut & Acceptance dialog. (Pay attention there for the checkbox

- [x] Take into account thickness defect of materials
- [x] Take into account losses due to reactions in materials
- [x] Include charge state calculations in the total transmission **

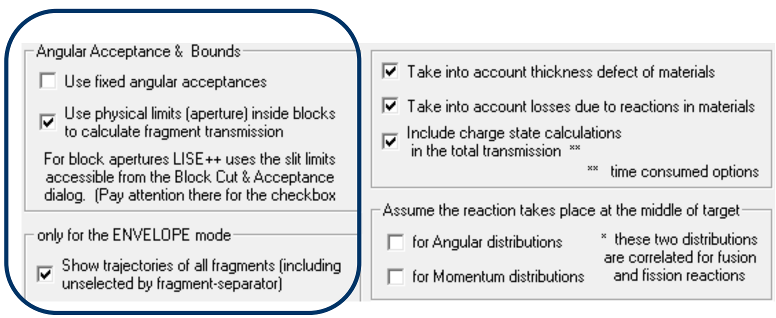
** time consumed options

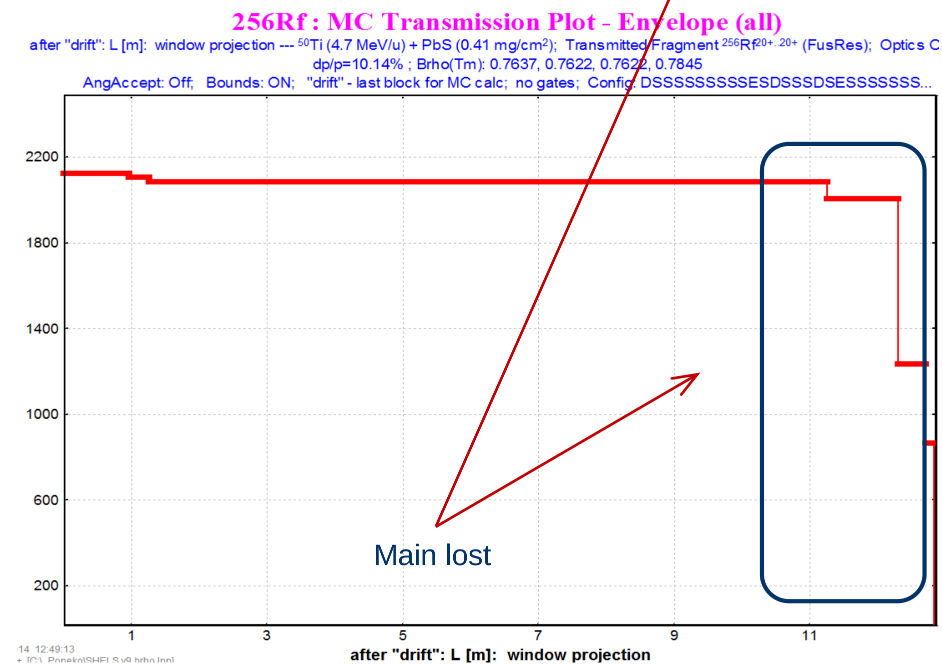
Configurations : Experimental (logbook) settings





MC solution





Configurations : Brho values by LISE++

All disperse optical blocks were set to Brho = 0.7489 Tm
calculated by LISE++ to be optimal for $^{256}Rf^{20+}$

SHELS v9 brho.lpp

Quadrupoles and dipoles fast editting

Block	Given Name	Start(m)	Length(m)	B0(kG)	Br(Tm)cor/*real	DriftM/*Angle	Rapp(cm)/*R(...	Leff(m)/*Ldip(m)	2 nd order	CalcMatr/*Z-Q	AngAcc,Apps,Slits	COSY_link	SE
Q Drift	Quad 1	0.420	0.3100	+5.0127	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dqiqk	0.730	0.2700			standard		c_0.2000			-- HV --	-	e
Q Drift	Quad 2	1.000	0.3100	-4.5723	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dqiqk	1.310	0.2700			standard		c_0.2000			-- HV --	-	e
Q Drift	Quad 3	1.580	0.3100	+2.2350	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dq3c1	1.890	0.5515			standard		c_0.5165			-- HV --	-	e
E ElecDip	C1	2.442	0.6592	179.2kV	0.7489	* -8.0	* 4.7210	* 0.6592	-	* 84	-- HV --	-	E
S Drift	dc1d1	3.101	0.4229			standard					-- HV --	-	e
D Dipole	D22_1	3.524	0.6230	+4.6322	* 0.7489	* +22.1	* 1.6166	* 0.6230	yes	* 84	-- HV --	-	E
S Drift	dd1sv	4.147	0.3054			standard					-- HV --	-	e
S Drift	slits SV	4.452	0.0000			SLITS					-- -- HV	-	e
S Drift	dsvd2	4.452	0.3054			standard					-- HV --	-	e
D Dipole	D22_2	4.757	0.6230	-4.6322	* 0.7489	* -22.1	* 1.6166	* 0.6230	yes	* 84	-- HV --	-	E
S Drift	dd2c2	5.380	0.4229			standard					-- HV --	-	e
E ElecDip	C2	5.803	0.6592	179.2kV	0.7489	* +8.0	* 4.7210	* 0.6592	-	* 84	-- HV --	-	E
S Drift	dc2q4	6.463	0.5515			standard		c_0.5165			-- HV --	-	e
Q Drift	Quad 4	7.014	0.3100	+0.6992	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dqiqk	7.324	0.2700			standard		c_0.2000			-- HV --	-	e
Q Drift	Quad 5	7.594	0.3100	-2.2863	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dqiqk	7.904	0.2700			standard		c_0.2000			-- HV --	-	e
Q Drift	Quad 6	8.174	0.3100	+2.3537	0.7489	QUAD	10.0000	c_0.3800	yes	1	-- HV --	-	e
S Drift	dq6d3	8.484	2.1150			standard		c_2.0800			-- HV --	-	e
D Dipole	D8	10.599	0.5880	+1.6227	* 0.7489	* +7.3	* 4.6150	* 0.5880	yes	* 84	-- HV --	-	E

Configurations : Brho values by LISE++

Overall transmission 54.3%

statistics: 256Rf

SHELS v9 brho.lpp

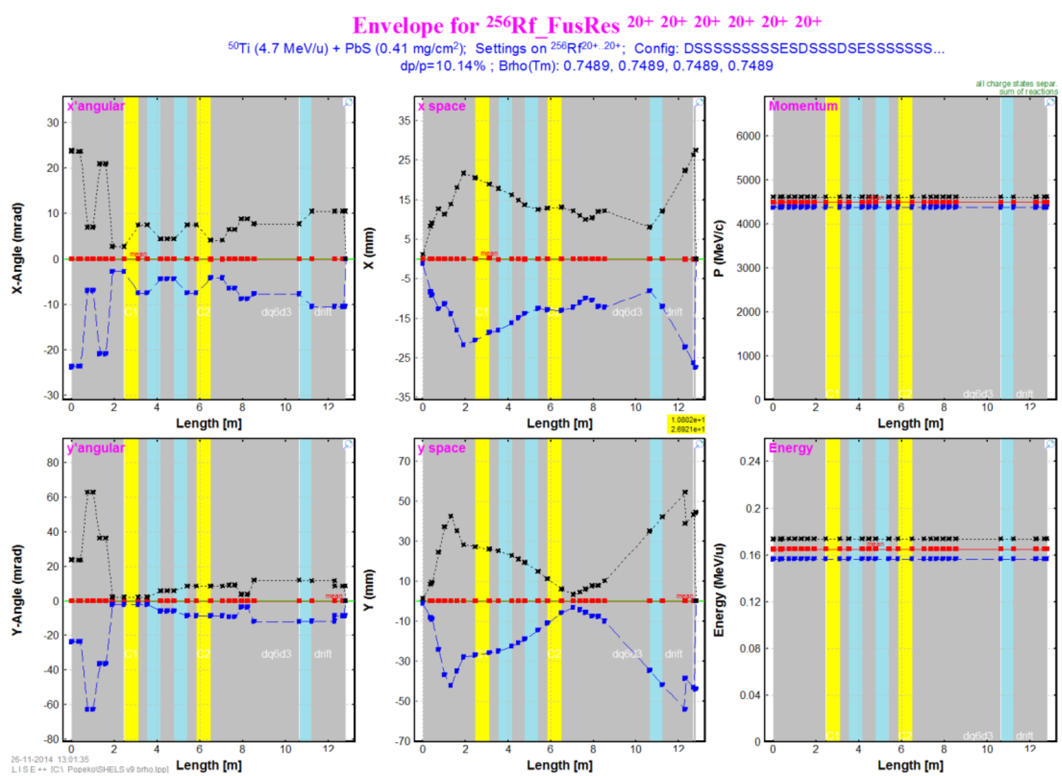
256Rf   Spontaneous fission (Z=104, N=152)   Rutherfordium

All reactions total isotope rate 1.84e+0 pps
and Overall isotope transmission 54.294 %

Q1(tuning)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q2(C1)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q3(D22_1)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q4(D22_2)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q5(C2)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q6(D8)		27	26	25	24	23	22	21	20	19	18	17	16	15	14
Reaction		FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes
Ion Production Rate	(pps)	4.18e-3	1.47e-2	4.06e-2	8.94e-2	1.61e-1	2.38e-1	2.94e-1	3.06e-1	2.7e-1	2e-1	1.24e-1	6.41e-2	2.8e-2	1.05e-2
Total ion transmission	(%)	0.123	0.434	1.195	2.634	4.728	7.006	8.661	9.02	7.94	5.883	3.646	1.89	0.825	0.308
Total: this reaction	(pps)	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0	1.84e+0
X-Section in target	(mb)	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4
Target	(%)	0.631	1.51	3.14	5.69	8.95	12.23	14.49	14.9	13.3	10.31	6.94	4.06	2.07	0.919
X space transmission	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Y space transmission	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Unreacted in material	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Q (Charge) ratio	(%)	0.631	1.51	3.14	5.69	8.95	12.23	14.49	14.9	13.3	10.31	6.94	4.06	2.07	0.919
Unstopped in material	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
tuning	(%)	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96
X angular transmission	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Y angular transmission	(%)	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96
DTS1	(%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100

9.0%

Analytical solution



Still large lost in the slits3

Transmission through the slits 3 about 62%
for the setting ion (vertical cut)

slits 4 were not used

It's necessary to make vertical focusing at the end.
See matrix elements on page 21

Configurations : Q5 field value modification

Q5, B(kG)	Overal Transmisson
-2.2863	54.30%
-3	68.40%
-3.1	70.20%
-3.2	72.01%
-3.3	73.83%
-3.4	75.39%
-3.5	76.92%
-3.6	78.09%
-3.7	79.22%
-3.8	80.03%
-3.9	80.57%
-4	80.70%
-4.1	80.82%
-4.2	80.61%

SHELS v9 brho_quad5.lpp

Let's use Q5 B-field equal to -4kG (-685A)

Analytical solution

statistics: 256Rf

256Rf Spontaneous fission (Z=104, N=152) Rutherfordium

All reactions total isotope rate [illegible]
and Overall isotope transmission 80.697 %

Q1(tuning)	27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q2(C1)	27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q3(D22_1)	27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q4(D22_2)	27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q5(C2)	27	26	25	24	23	22	21	20	19	18	17	16	15	14
Q6(D8)	27	26	25	24	23	22	21	20	[illegible]	18	17	16	15	14
Reaction	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes	FusRes
Ion Production Rate (pps)	6.3e-3	2.45e-2	7.14e-2	1.57e-1	2.67e-1	3.73e-1	4.44e-1	4.56e-1	4.07e-1	3.11e-1	1.78e-1	4.28e-2	1.54e-3	1.41e-6
Total ion transmission (%)	0.185	0.722	2.104	4.613	7.87	10.99	13.067	13.441	11.992	9.173	5.233	1.262	0.045	4.16e-5
Total: this reaction (pps)	2.74e+0	2.74e+0	2.74e+0	2.74e+0	2.74e+0	2.74e+0	2.74e+0	[illegible]	2.74e+0	2.74e+0	2.74e+0	2.74e+0	2.74e+0	2.74e+0
X-Section in target (mb)	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4	2.67e-4
Target (%)	0.631	1.51	3.14	5.69	8.95	12.23	14.49	14.9	13.3	10.31	6.94	4.06	2.07	0.919
X space transmission (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Y space transmission (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Unreacted in material (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Q (Charge) ratio (%)	0.631	1.51	3.14	5.69	8.95	12.23	14.49	14.9	13.3	10.31	6.94	4.06	2.07	0.919
Unstopped in material (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
tuning (%)	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96
X angular transmission (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Y angular transmission (%)	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96	97.96

13.4%

Overall transmission 80.7%

The Quad field minimization utility is expected to be developed in LISE++ in 2015!!

Transmission through the slits 3 about 92% for the setting ion (vertical cut)

slits 4 were not used

Configurations : Q5 field value modification

MICHIGAN STATE UNIVERSITY

LISE++

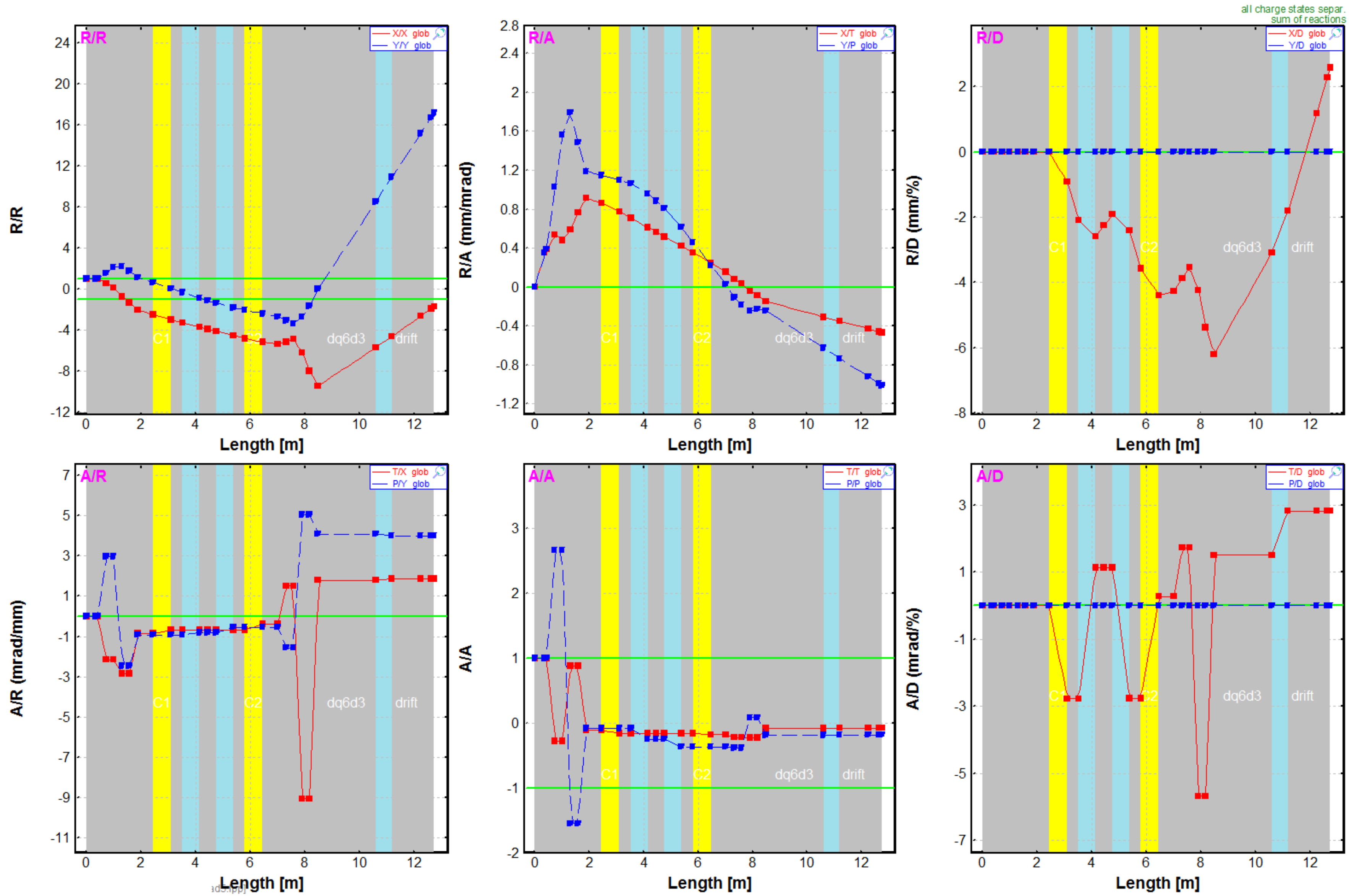
NSCL

First order matrix elements

SHELS_v9_brho_quad5.lpp

^{50}Ti (4.7 MeV/u) + PbS (0.41 mg/cm^2); Settings on ^{256}Rf$^{20+..20+}$; Config: DSSSSSSSSESDSSSDSESSSSSSS...

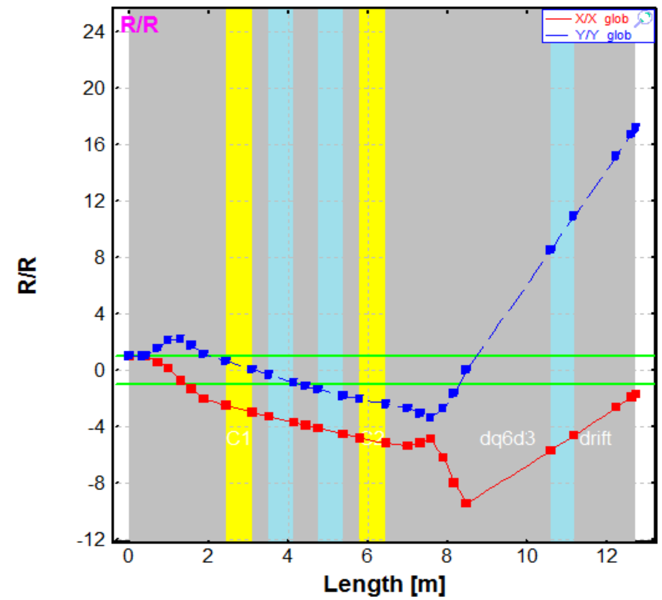
dp/p=67.77% ; Brho(Tm): 0.7489, 0.7489, 0.7489, 0.7489

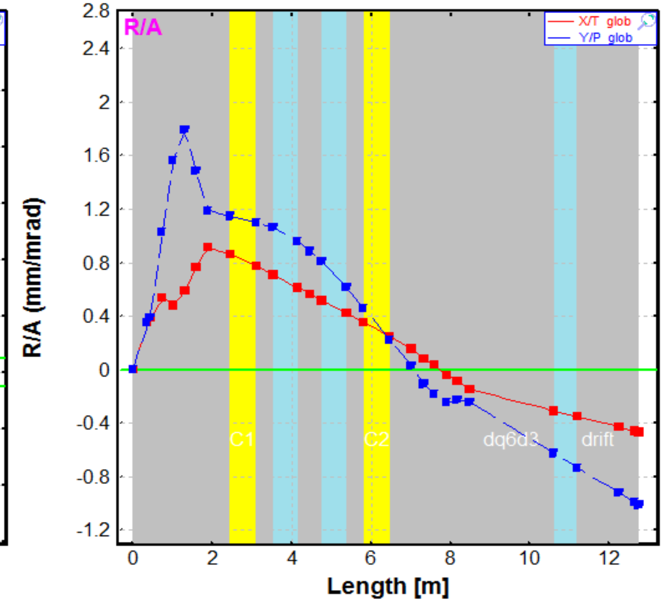


Configurations : Q5 field value modification

[SHELS v9 brho_quad5.lpp]

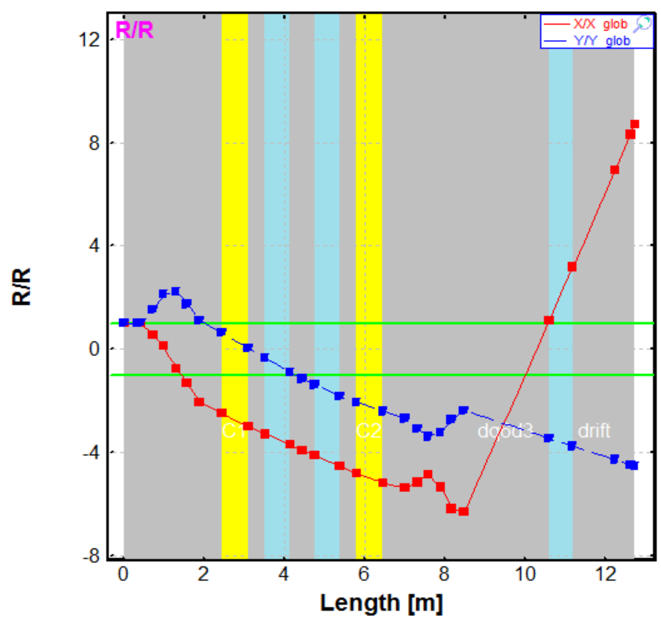
Settings with Brho and Q5 field modifications

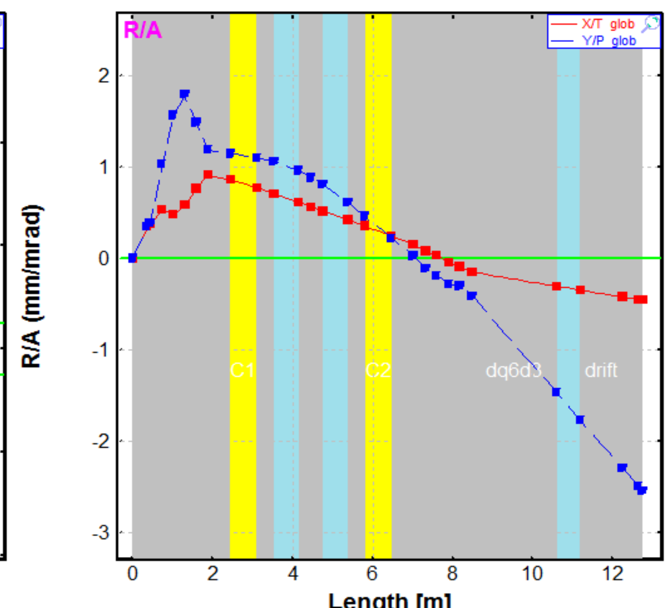




[SHELS v9.lpp]

Experimental (logbook) settings





Configurations : Q5 field value modification

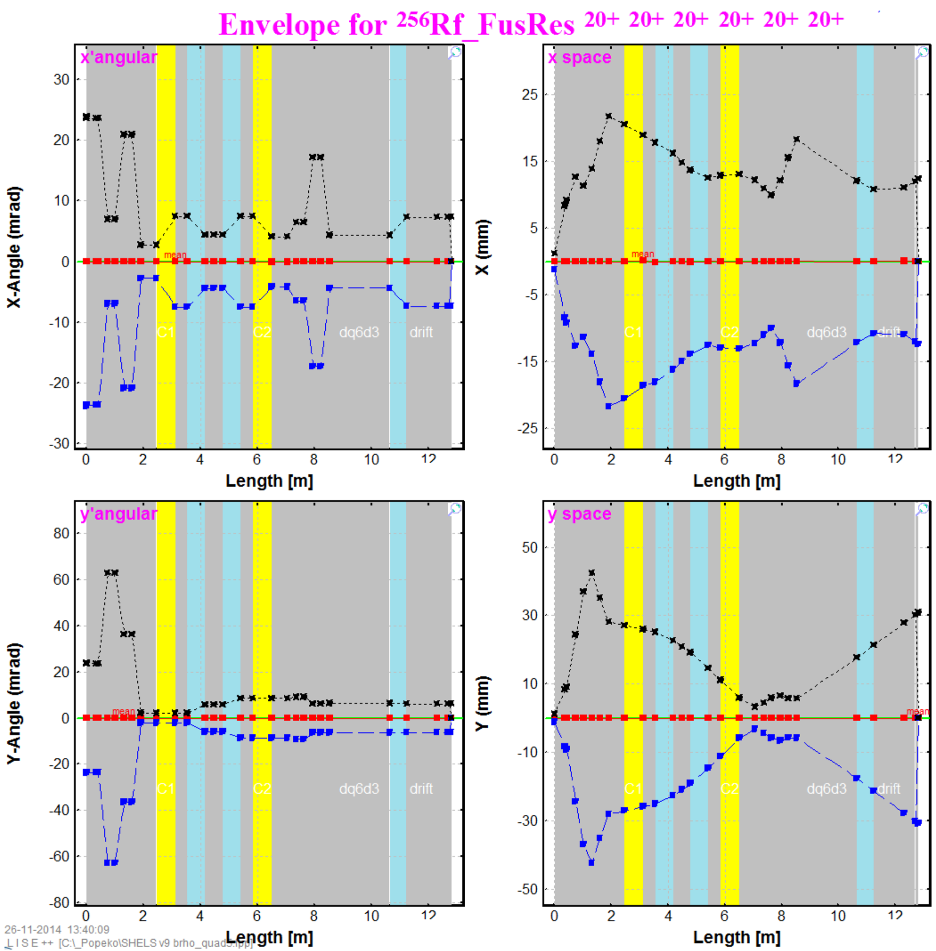
Analytical solution

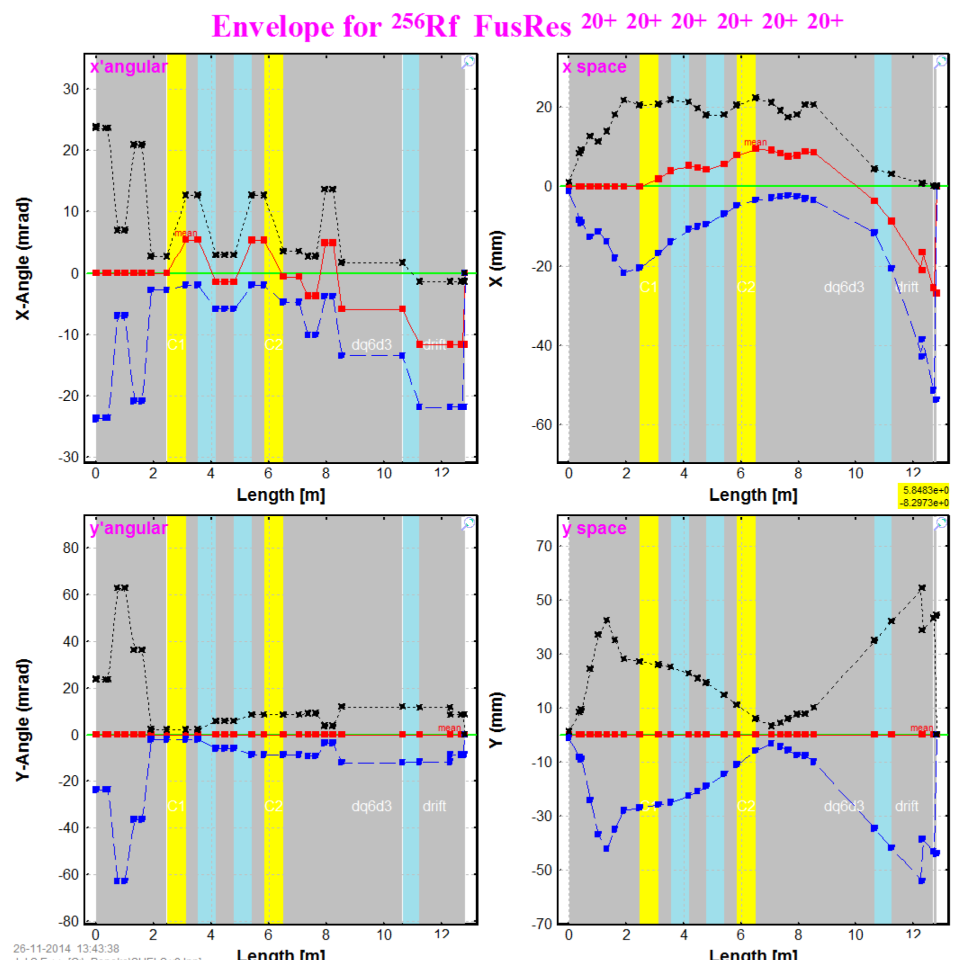
SHELS v9 brho_quad5.lpp

Settings with Brho and Q5 field modifications

SHELS v9.lpp

Experimental (logbook) settings





Configurations : Q5 field value modification

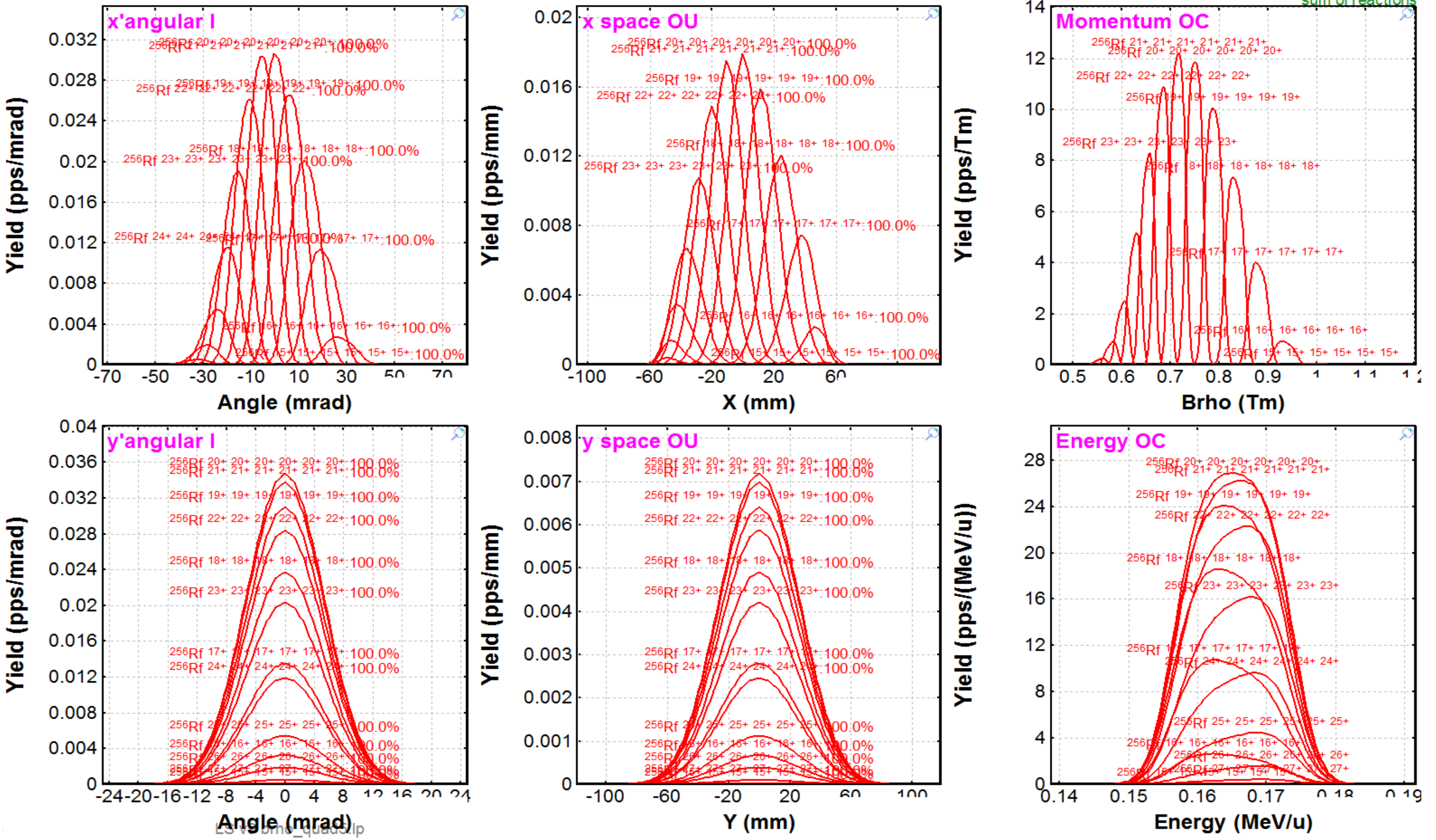
Analytical solution

SHELS v9 brho_quad5.lpp

slits 4

^{50}Ti (4.7 MeV/u) + PbS (0.41 mg/cm^2); Settings on ^{256}Rf$^{20+..20+}$;
dp/p=67.77% ; Brho(Tm): 0.7489, 0.7489, 0.7489, 0.7489

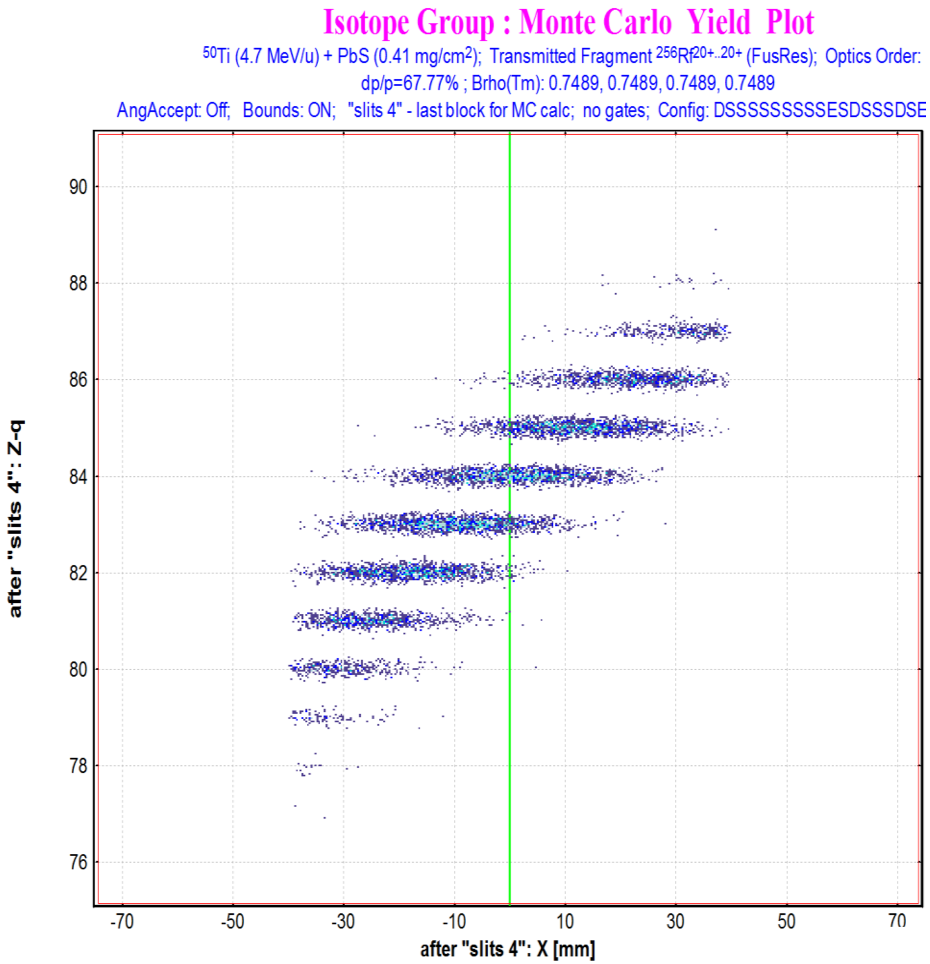
all charge states separ.
sum of reactions

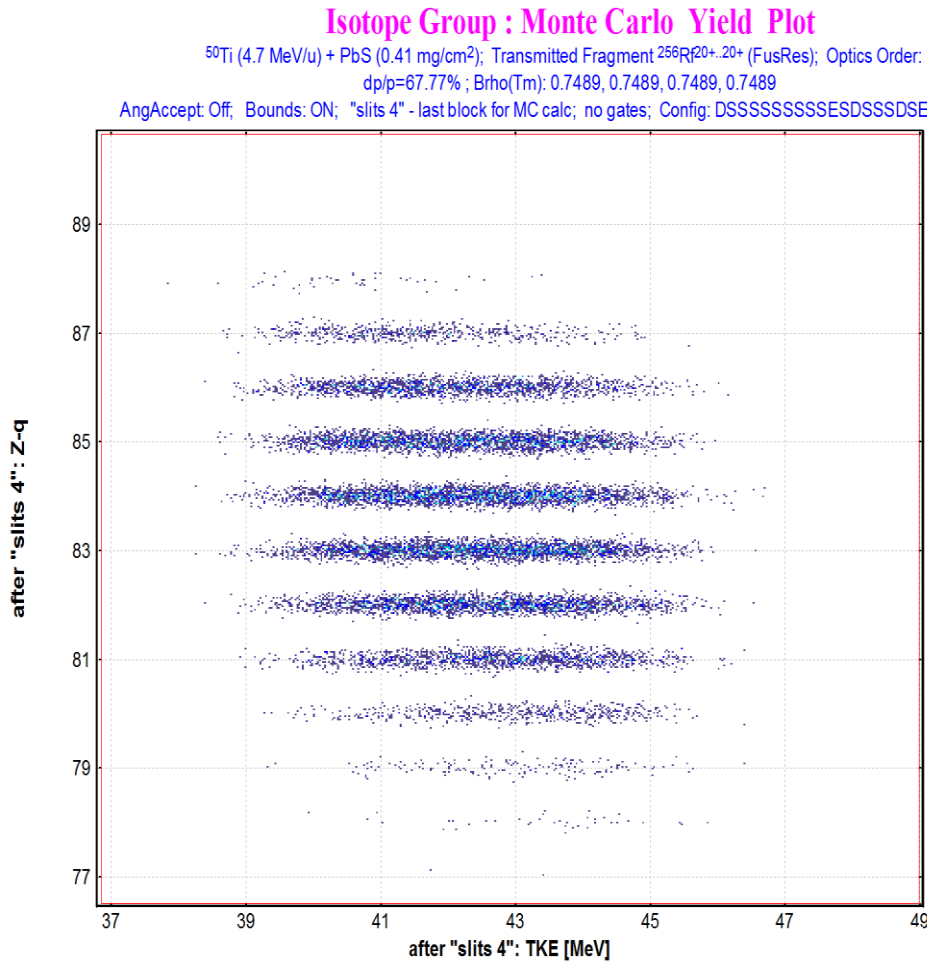


MC solution

SHELS v9 brho_quad5.lpp

^{256}Rf charge states at the Slits 4 position



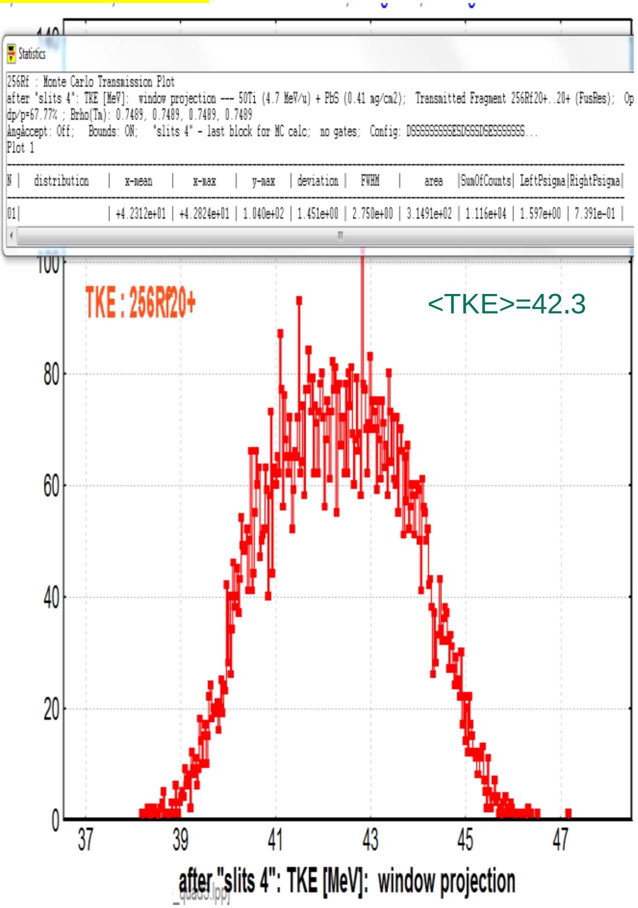


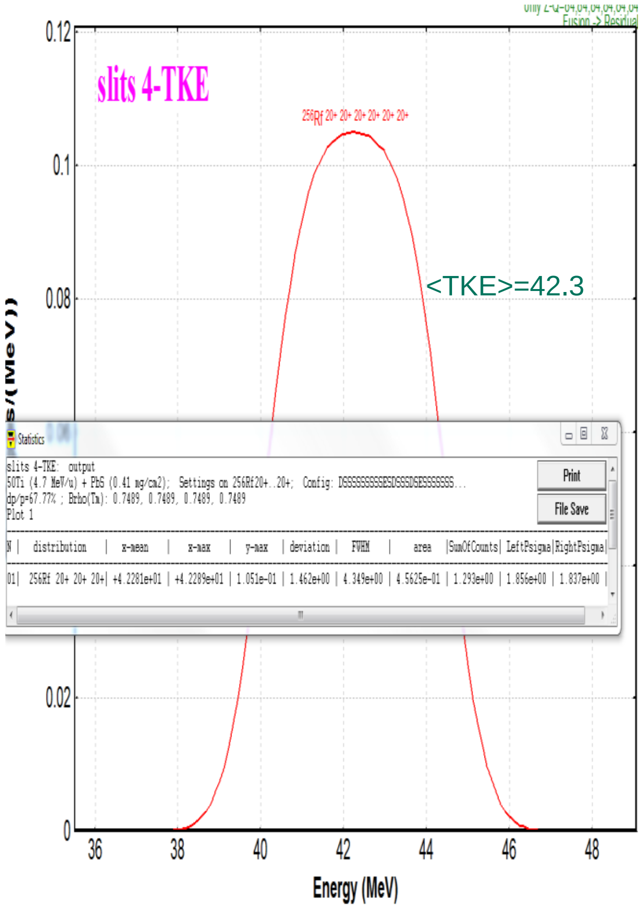
Configurations : Q5 field value modification

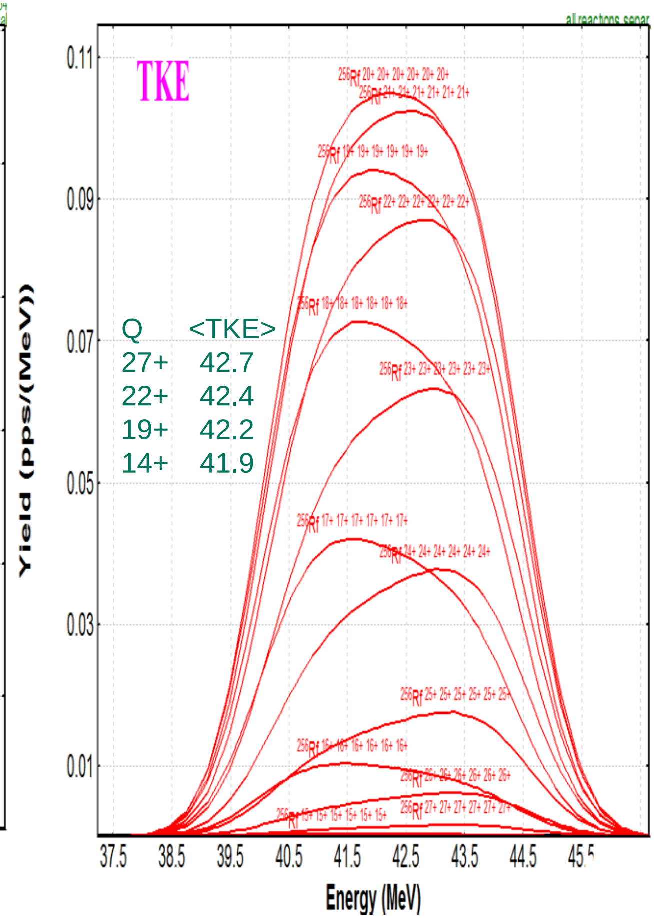
MC solution

Analytical solution

SHELS v9 brho_quad5.lpp







Statistics

drift-TKE: output
50Ti (4.7 MeV/u) + PbS (0.41 mg/cm2); Settings on 256Rf20+..20+; Config: DSSSSSSSSESDSSSDSESSSSSS
dp/p=67.77% ; Brho(Tm): 0.7489, 0.7489, 0.7489, 0.7489
Plot 1

N	distribution	x-mean	x-max	y-max	deviation	FWHM	area
01	256Rf 20+ 20+ 20+	+4.2281e+01	+4.2289e+01	1.051e-01	1.461e+00	4.348e+00	4.5625e-01
02	256Rf 27+ 27+ 27+	+4.2737e+01	+4.3348e+01	1.613e-03	1.435e+00	3.970e+00	6.2951e-03
03	256Rf 26+ 26+ 26+	+4.2673e+01	+4.3348e+01	6.157e-03	1.442e+00	4.056e+00	2.4524e-02
04	256Rf 25+ 25+ 25+	+4.2607e+01	+4.3348e+01	1.753e-02	1.447e+00	4.144e+00	7.1427e-02
05	256Rf 24+ 24+ 24+	+4.2542e+01	+4.2995e+01	3.775e-02	1.452e+00	4.207e+00	1.5657e-01
06	256Rf 23+ 23+ 23+	+4.2477e+01	+4.2995e+01	6.341e-02	1.456e+00	4.258e+00	2.6714e-01
07	256Rf 22+ 22+ 22+	+4.2411e+01	+4.2642e+01	8.702e-02	1.459e+00	4.308e+00	3.7304e-01
08	256Rf 21+ 21+ 21+	+4.2346e+01	+4.2642e+01	1.026e-01	1.461e+00	4.337e+00	4.4357e-01
09	256Rf 19+ 19+ 19+	+4.2217e+01	+4.1936e+01	9.418e-02	1.462e+00	4.337e+00	4.0706e-01
10	256Rf 18+ 18+ 18+	+4.2154e+01	+4.1584e+01	7.267e-02	1.461e+00	4.312e+00	3.1139e-01
11	256Rf 17+ 17+ 17+	+4.2092e+01	+4.1584e+01	4.209e-02	1.459e+00	4.271e+00	1.7763e-01
12	256Rf 16+ 16+ 16+	+4.2031e+01	+4.1584e+01	1.029e-02	1.456e+00	4.230e+00	4.2844e-02
13	256Rf 15+ 15+ 15+	+4.1971e+01	+4.1231e+01	3.746e-04	1.453e+00	4.179e+00	1.5357e-03
14	256Rf 14+ 14+ 14+	+4.1913e+01	+4.1231e+01	3.509e-07	1.449e+00	4.106e+00	1.4114e-06

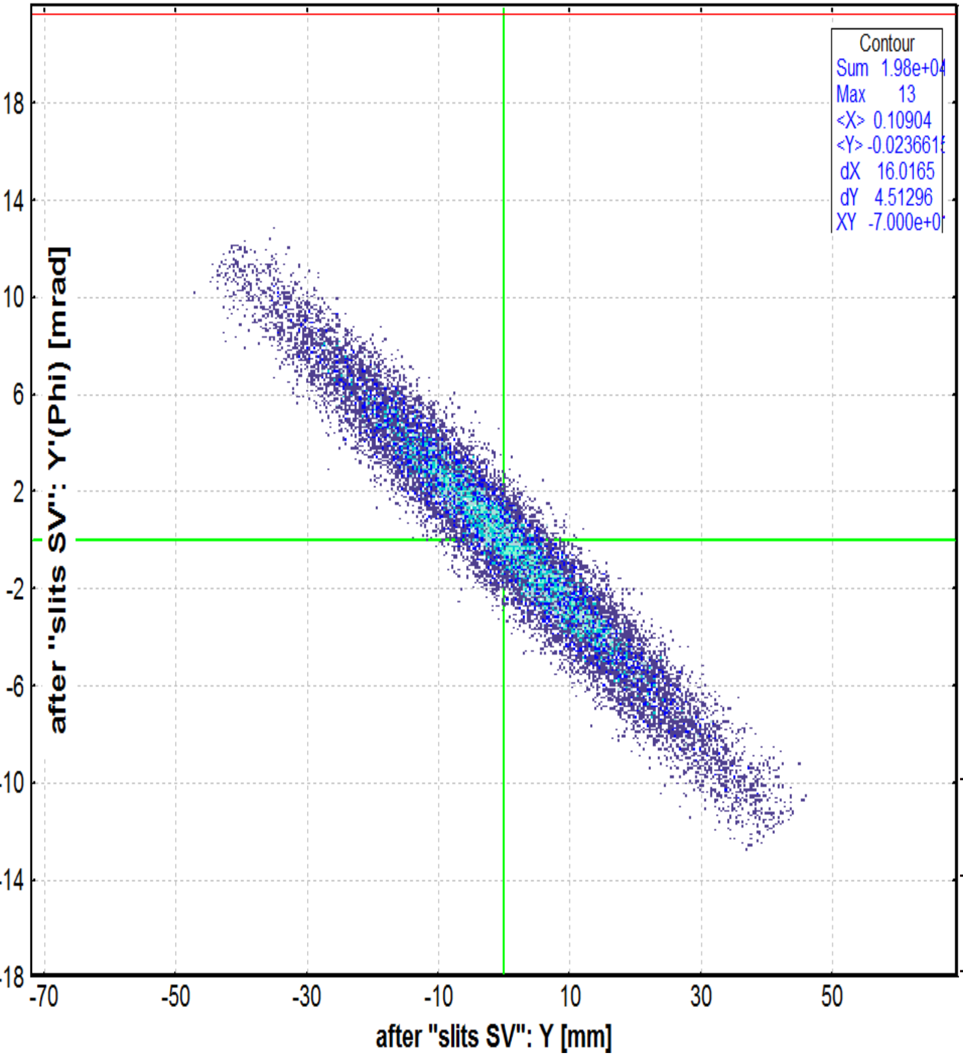
MC solution

SHELS v9 brho_quad5.lpp

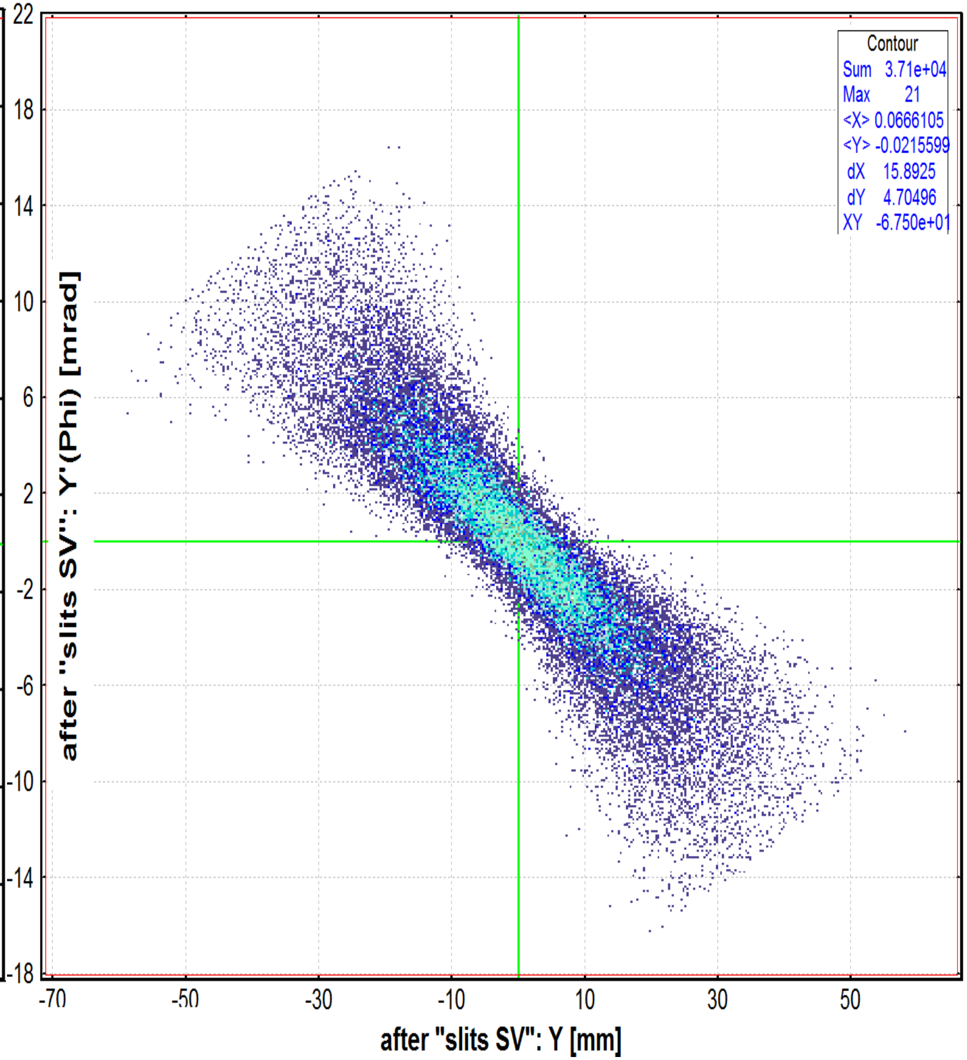
Y' vs Y @ the SV slits

$^{256}Rf^{20+}$

1st order optics

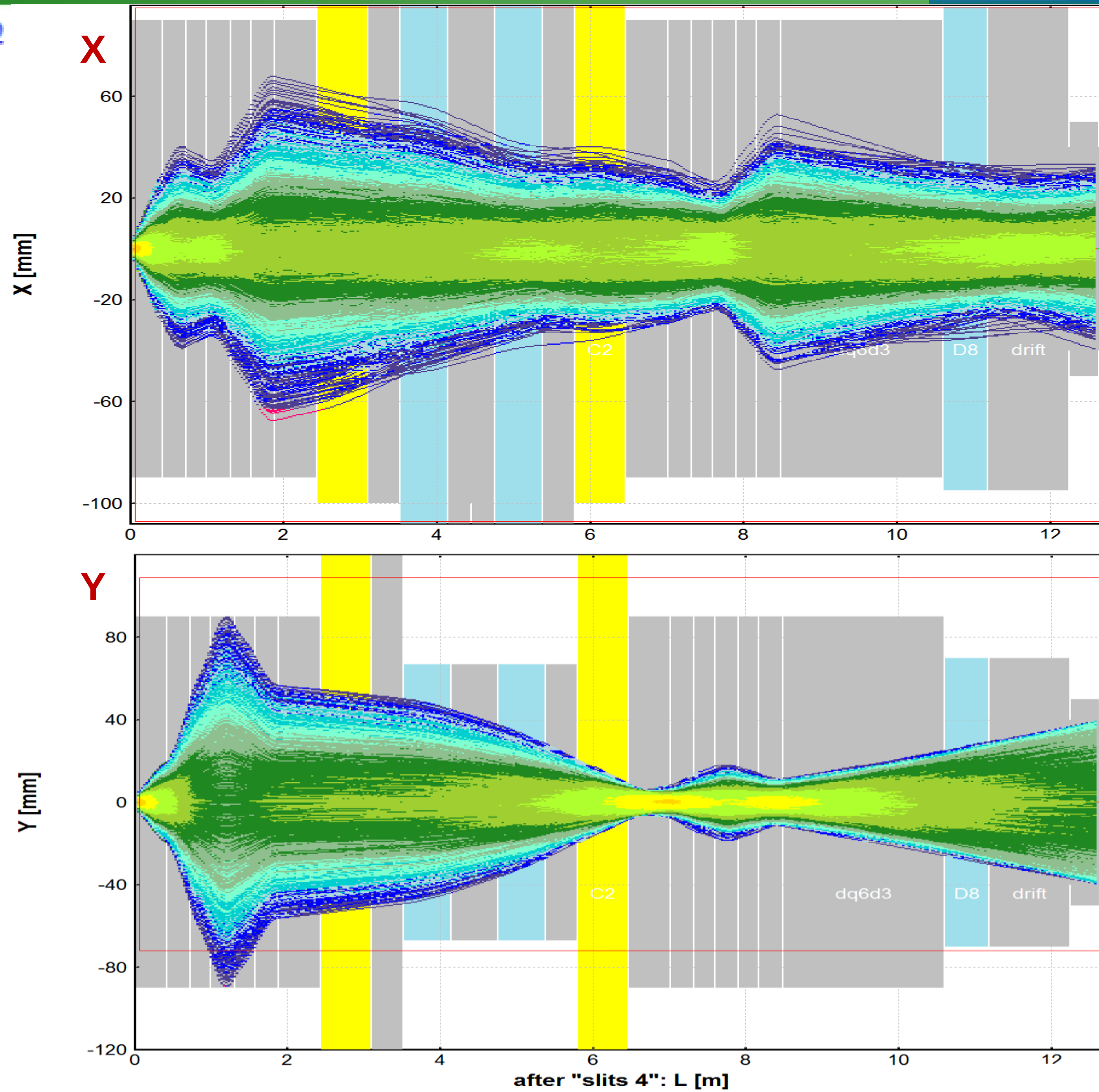


2nd order optics



Configurations : Q5 field value modification

MC solution SHELS v9 brho_quad5.lpp



X & Y envelopes of $^{256}Rf^{20+}$

$^{256}Rf^{20+}$ transmission

(without charge state coefficient)

86.6%

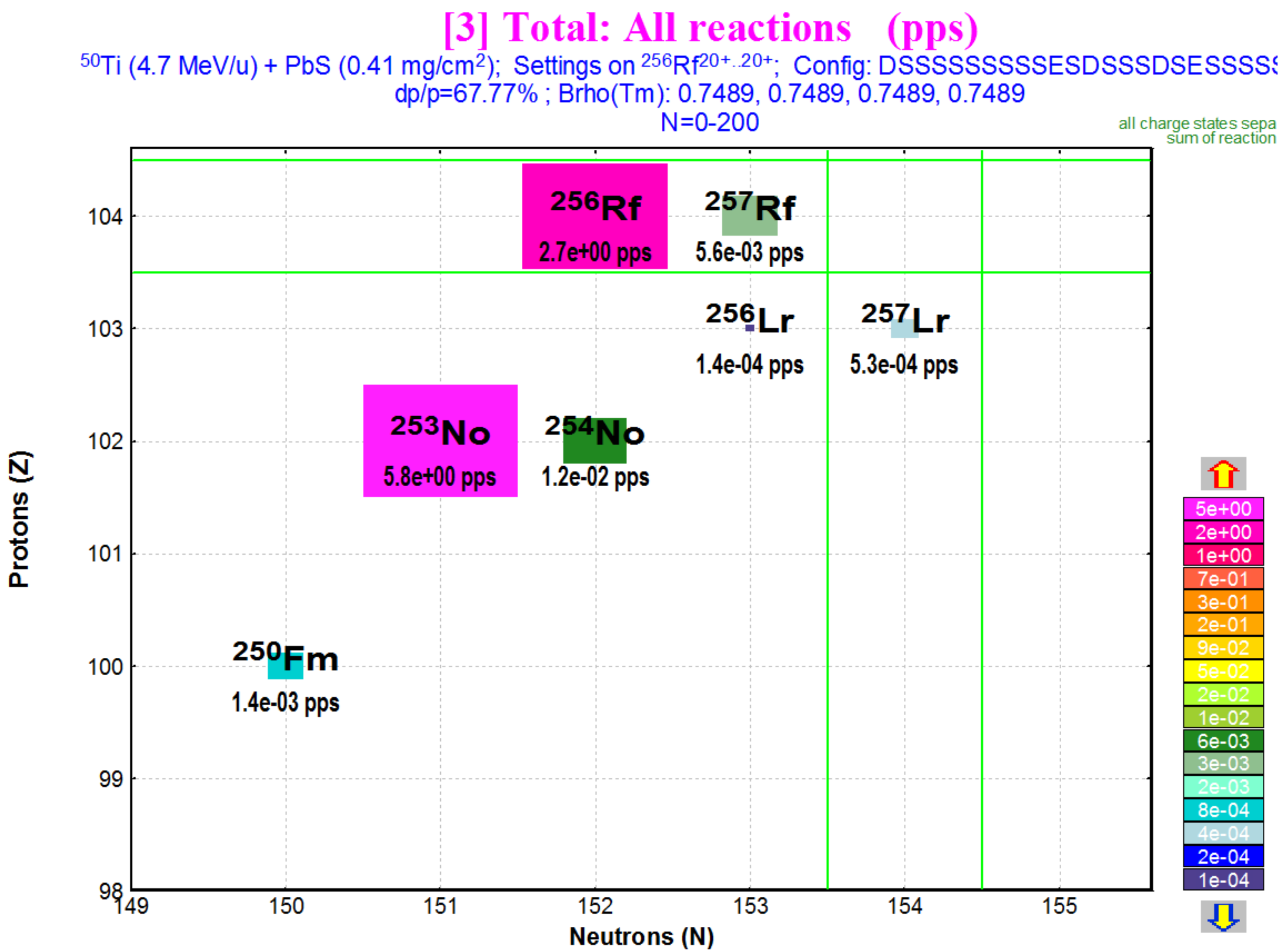
No slits 4 in use

Configurations : Q5 field value modification

Analytical solution

Fusion-Residues products

SHELS v9 brho_quad5.lpp



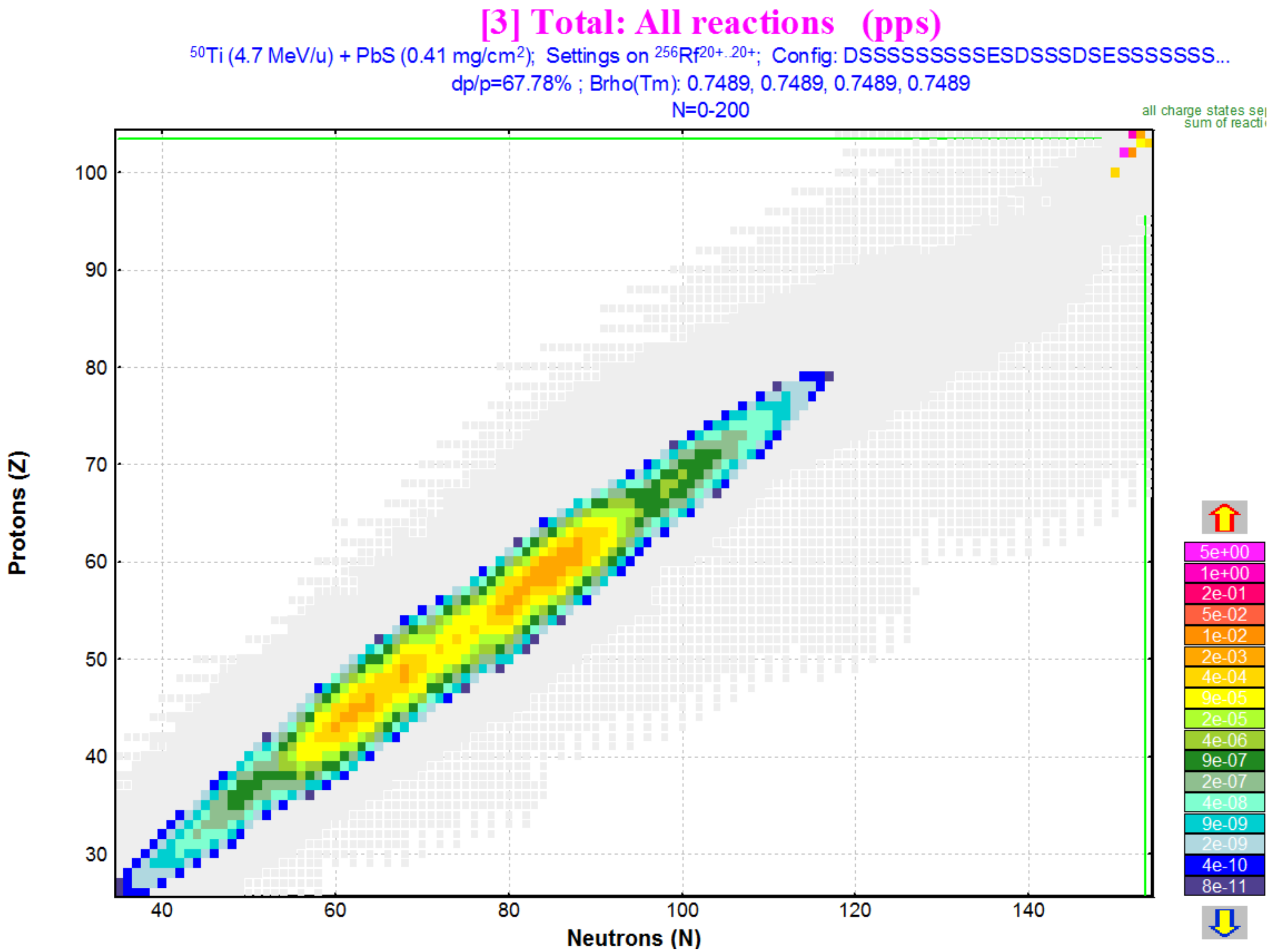
Total rate is 8.5 pps / 1 puA

Configurations : Q5 field value modification

Analytical solution

Fusion-Residues +
Fusion-Fission products

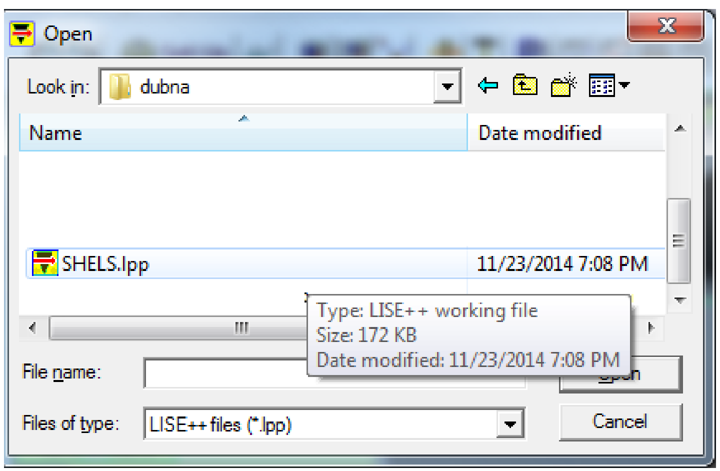
File (link) :
SHELS_v9_brho_quad5_fission.lpp

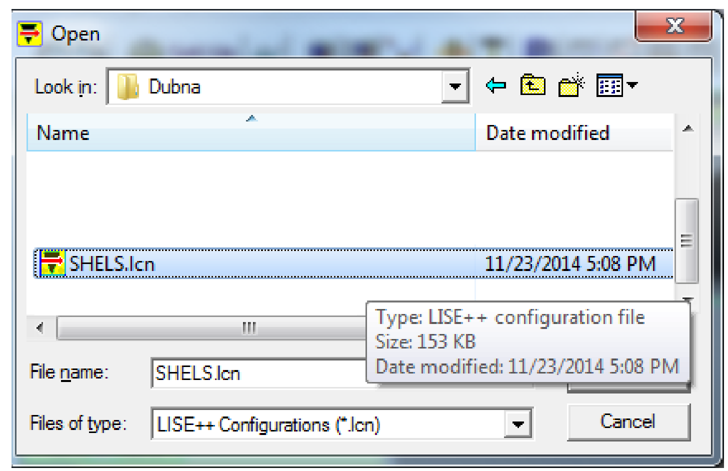


Total rate is
8.7 pps / 1 puA

Configurations : Final version for the LISE^{++} package

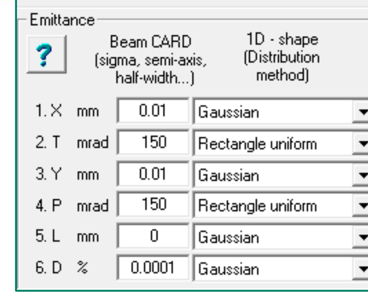
SHELS.lpp SHELS.lcn are based on SHELS v9 brho quad5.lpp

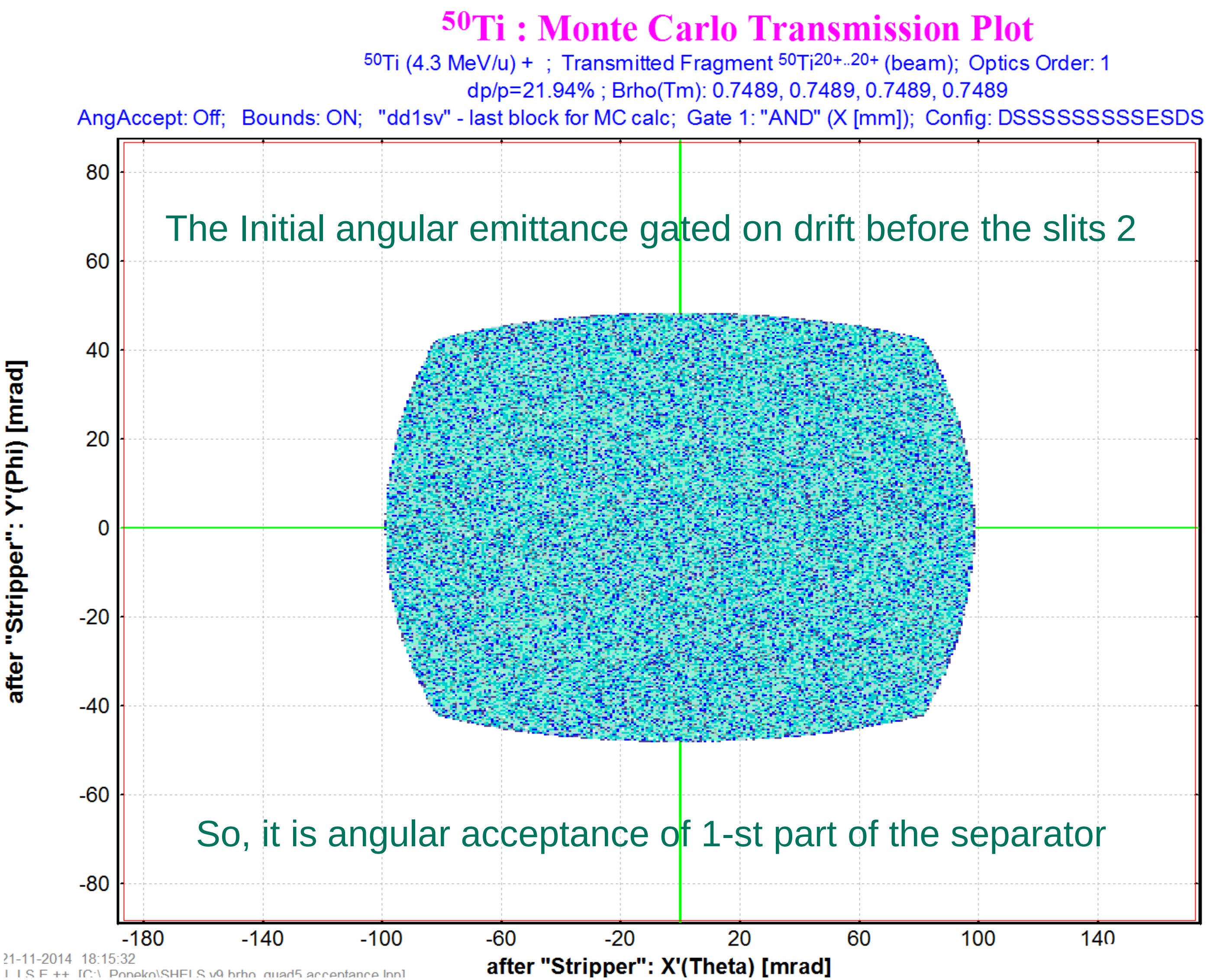




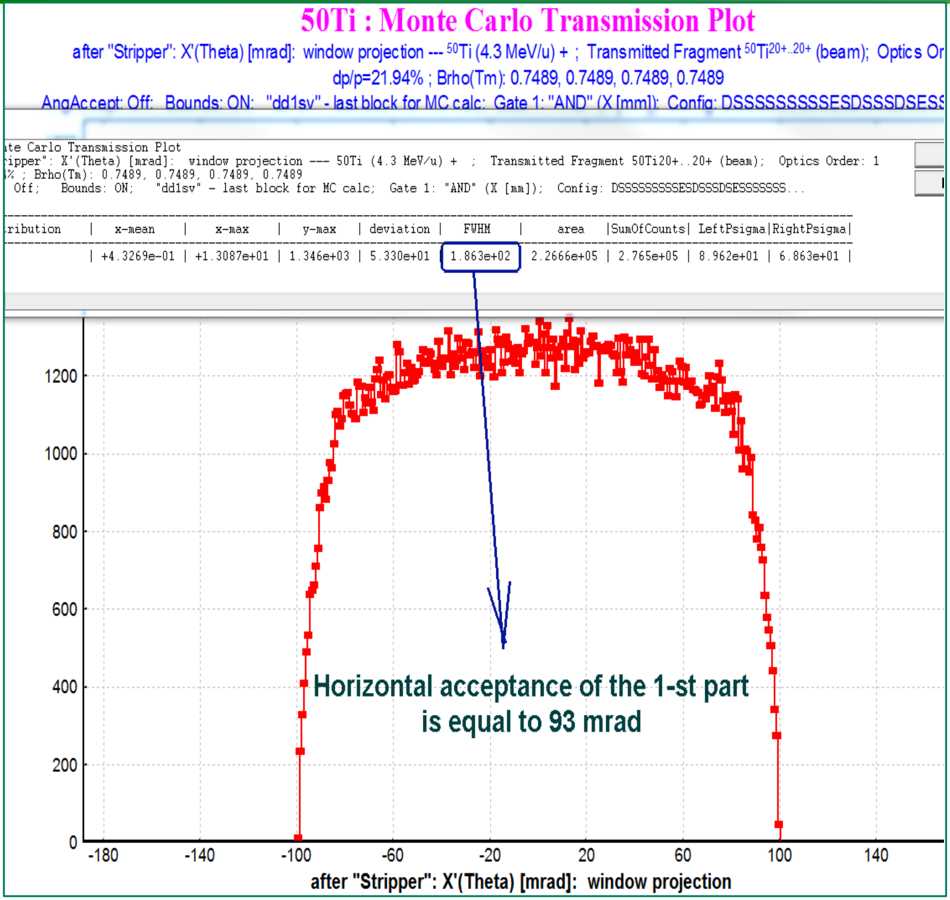
Angular Acceptance

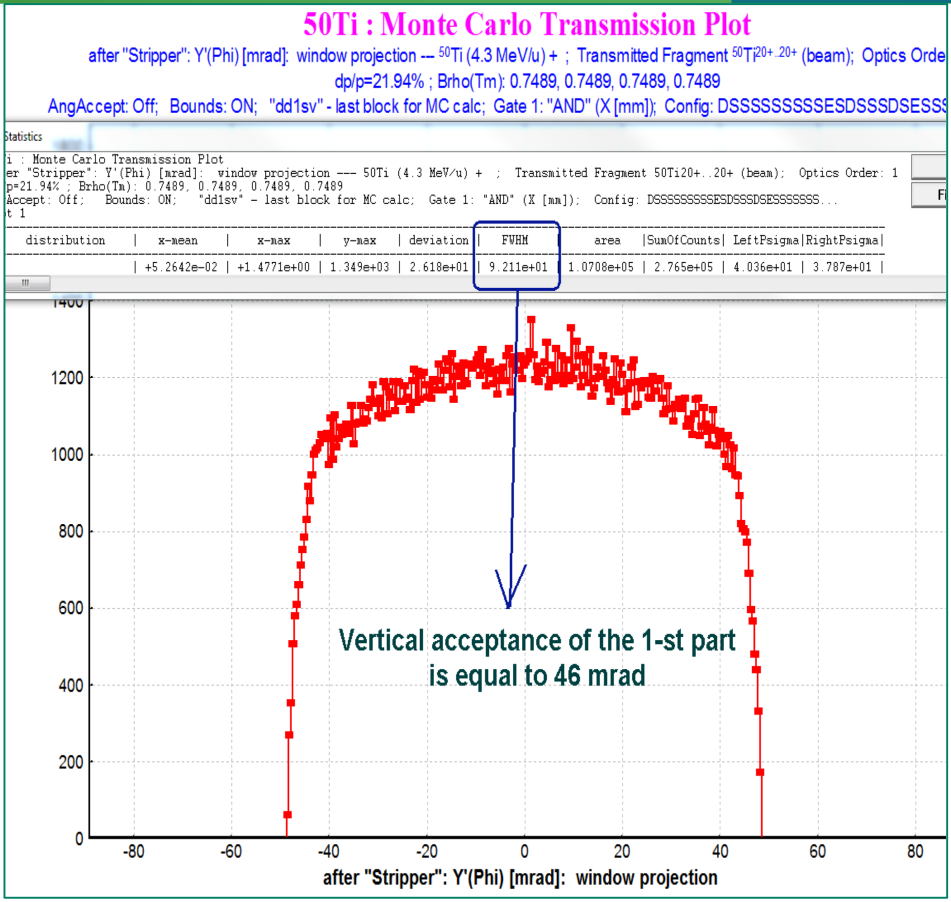
File: SHELS v9 brho_quad5 acceptance.lpp





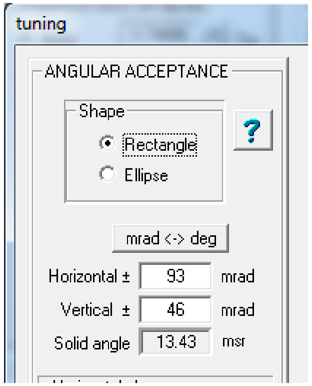
Angular Acceptance of the 1s-t half of separator



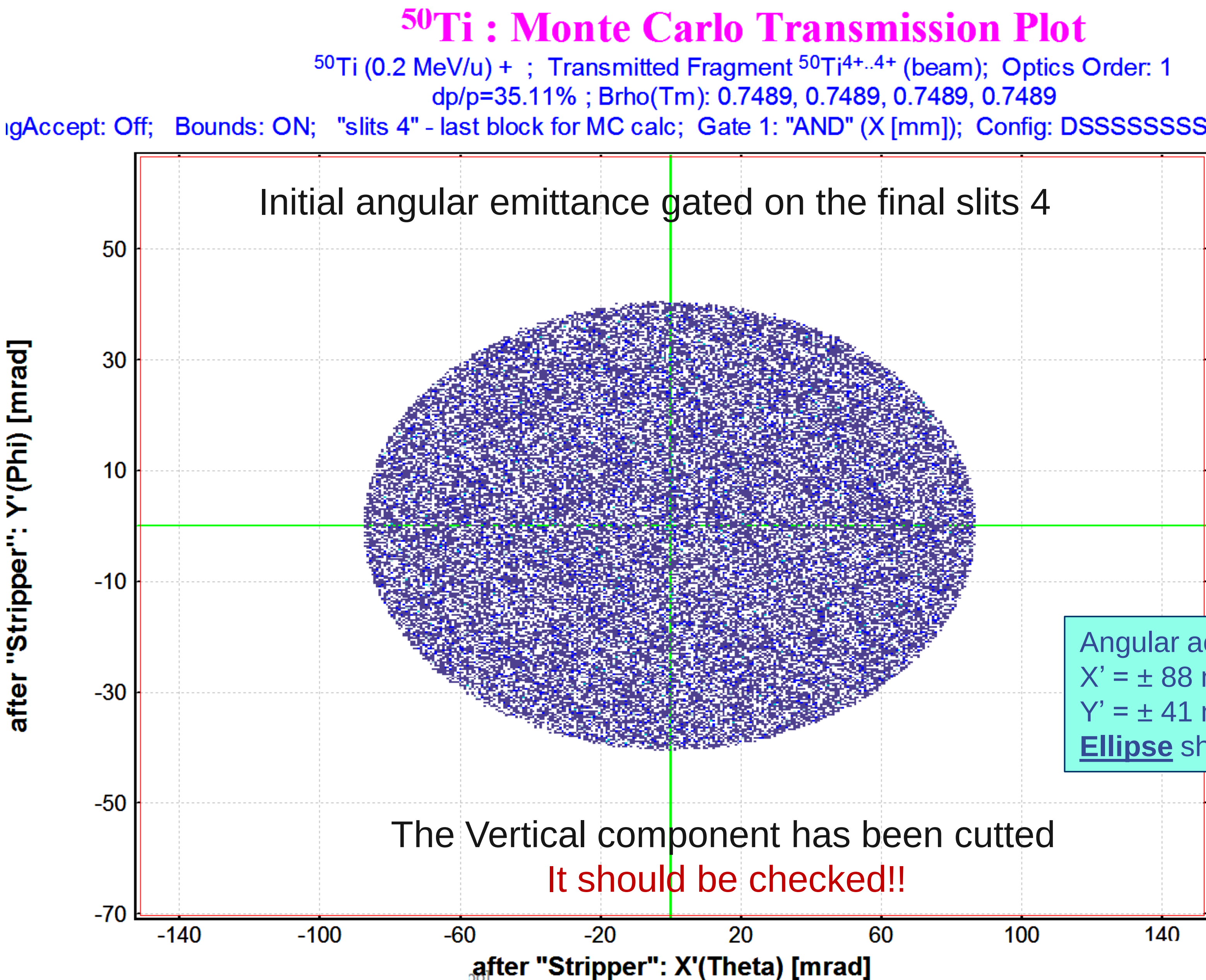


Angular acceptance X' = ± 93 mrad, Y' = ± 46 mrad (**Rectangle** shape) has been applied to the "Tuning" dipole.

It's important for Analytical transmission calculations ("Distribution" method).
The Angular acceptance option can be turned off in the Monte Carlo case.

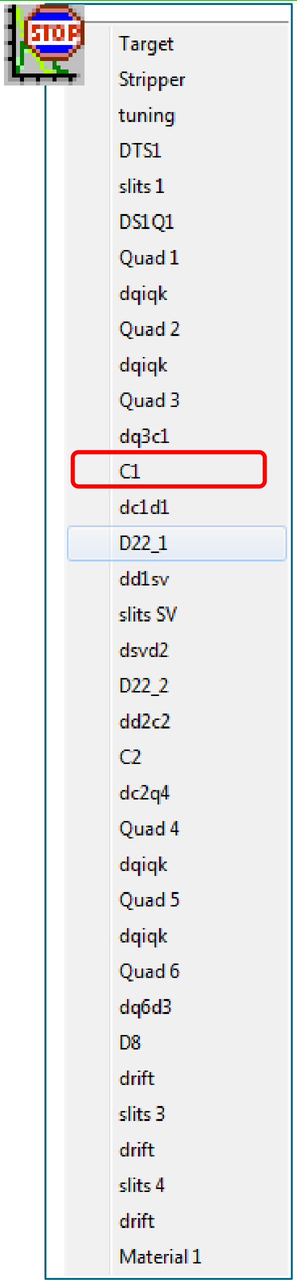


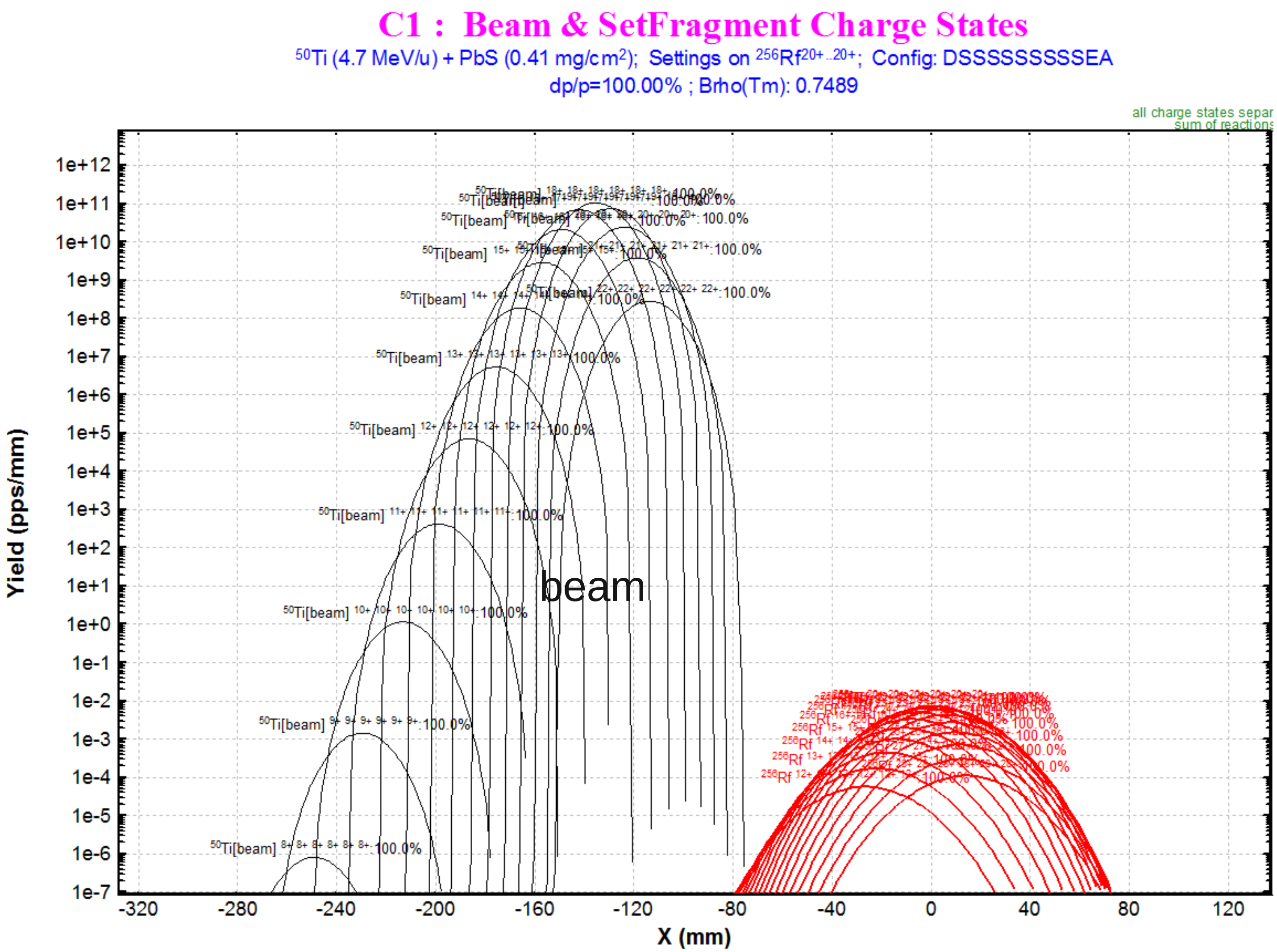
Angular Acceptance of the entire separator



Angular acceptance
X' = ± 88 mrad,
Y' = ± 41 mrad
Ellipse shape

Beam suppression : after C1





Beam suppression : after D22_1