SHELS: ^{48}Ca(219Mev) + PbS(0.406mg/cm^2) → $^{254}No^{19+}$

LISE++ Version 9.10.209
from 11/19/2015

Version 3
From 11/23/15
(the update starts from page 24)

Attached files:

11/19/15

SHELSeff.lpp : previous SHELS.lpp file modified for effective lengths and new drifts according to SHELS_parameters.doc and new last drifts information. The Tof start detector has been included. Constraints were not optimized

SHELSeff_sym.lpp : SHELSeff.lpp with a Faraday cup 38.1cm after Q6, to make symmetrical system.

SHELSeff_sym_part0.lpp : SHELSeff_sym.lpp with a Faraday cup after the tuning dipole to get ^{254}No fragment distribution parameters after the target in order to use them in the optics optimization

SHELSeff_sym_part1.lpp : SHELSeff_sym.lpp with a Faraday cup after the CV slits to optimize Quad fields on new constraints

11/20/15

SHELSeff_sym_part2.lpp : SHELSeff_sym_part1.lpp without a Faraday cup after the CV slits to optimize Quad fields on with the 2nd half

SHELSeff_sym_part2_E.lpp : as SHELSeff_sym_part2.lpp with large energy emittance (optimization beam sigma vector)

SHELSeff_sym_part3_7.lpp : as SHELSeff_sym2_part2.lpp with modified Q6-FP drift to be equal to 4.18 m

11/23/15

SHELSeff_All_v1.lpp : configuration with D8-part using SHELSeff_sym_part3_7.lpp quad fields

SHELSeff_All_v3.lpp : attempt to optimize SHELSeff_All_v1.lpp for smaller horizontal final spot and higher transmission

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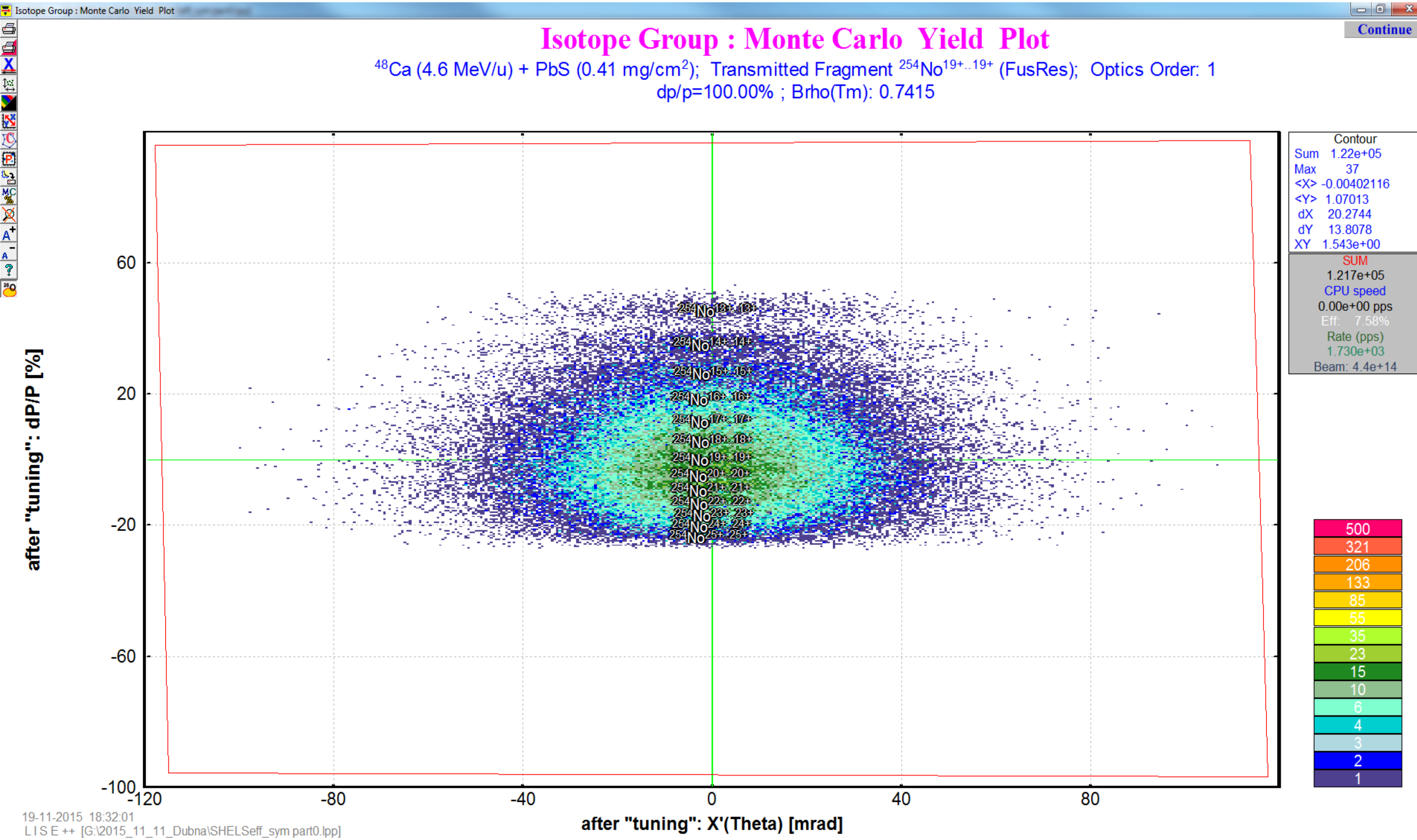
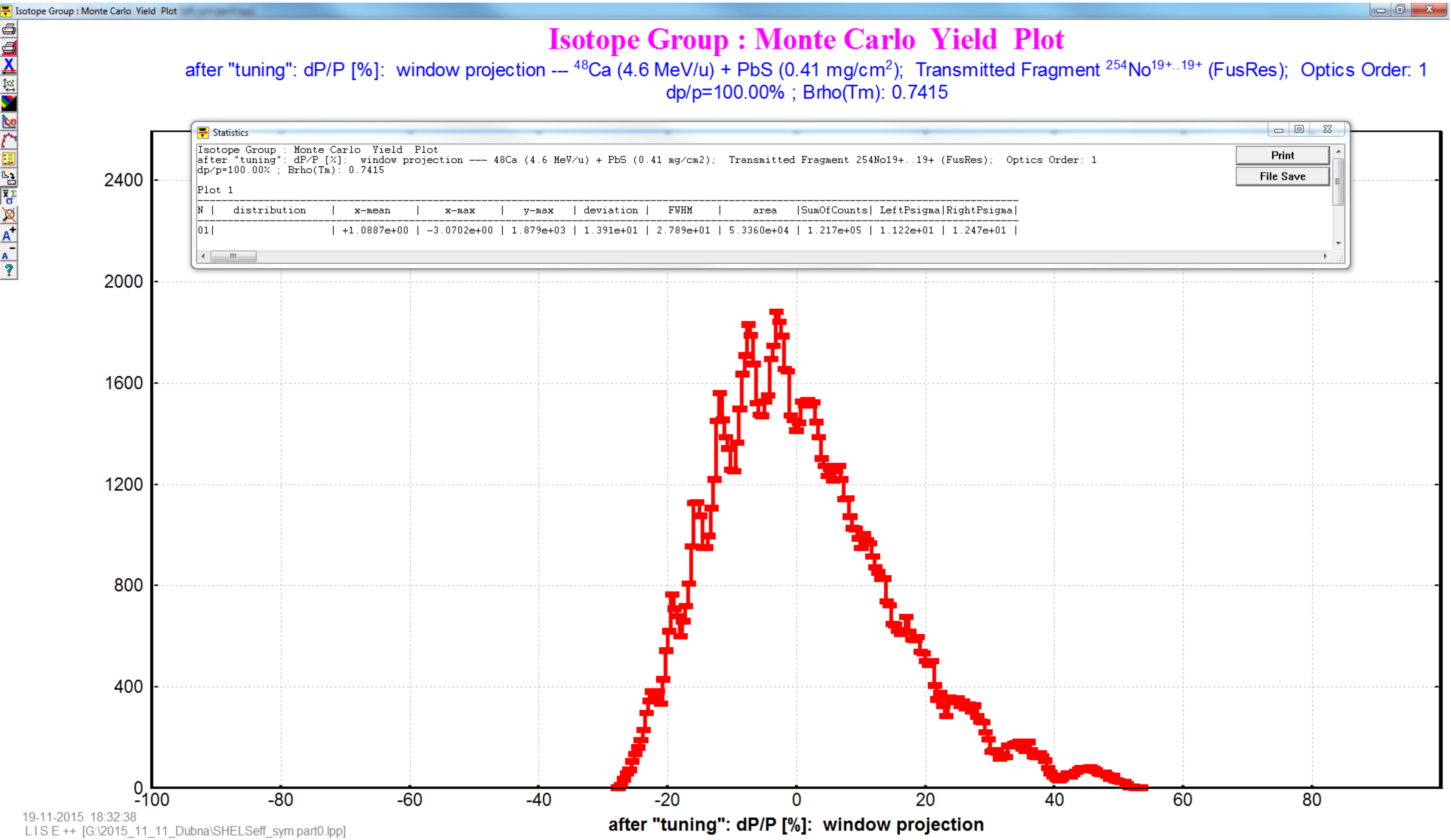
X' vs. dP/P



SHELSeff_sym_part0.lpp : ^{254}No fragment distribution parameters

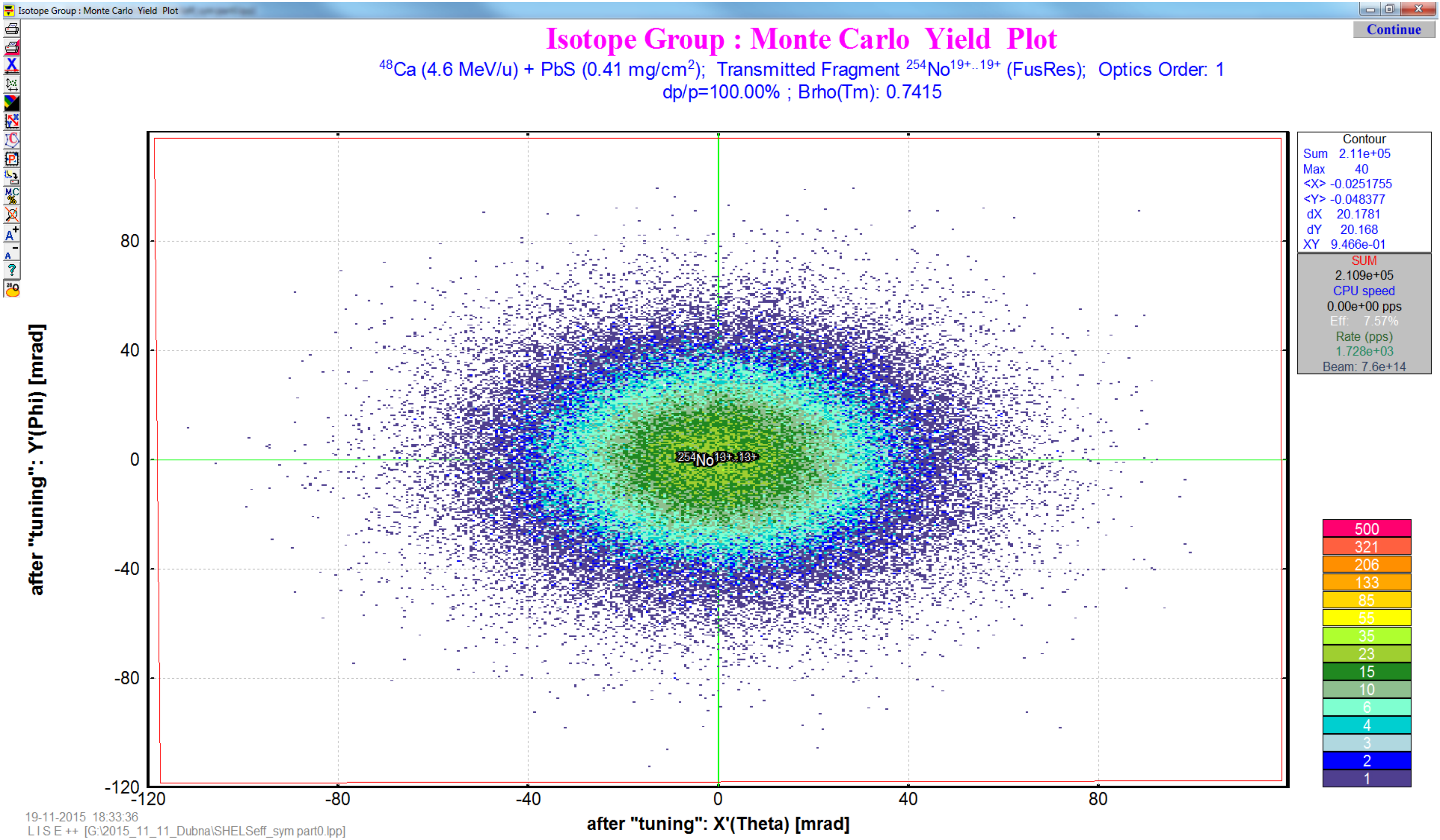
dP/P (vertical projection of the previous plot)

deviation	FWHM
1.391e+01	2.789e+01



SHELSeff_sym_part0.lpp : ^{254}No fragment distribution parameters

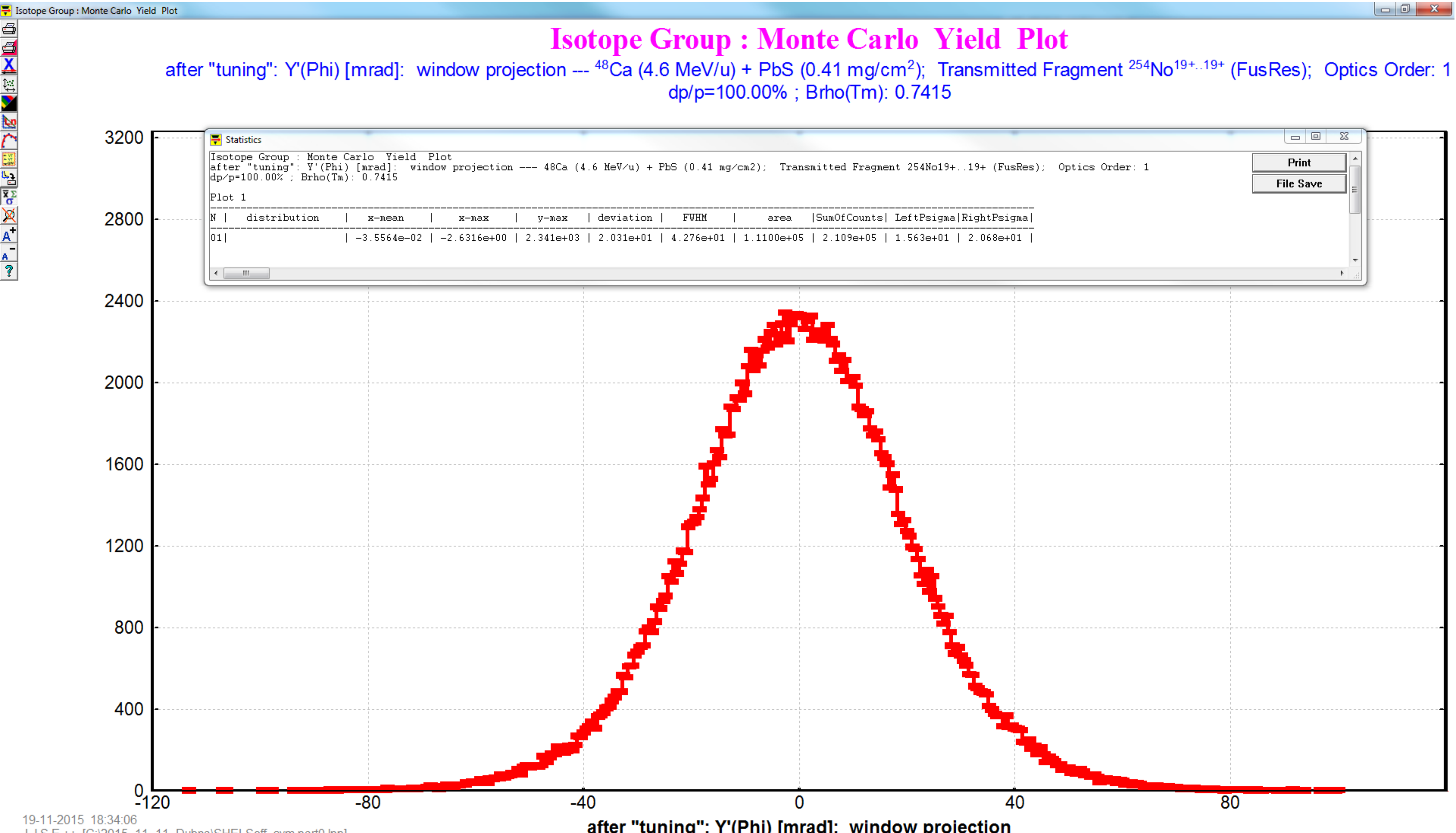
X’ vs. Y’



SHELSeff_sym_part0.lpp : ^{254}No fragment distribution parameters

Y' (vertical projection of the previous plot)

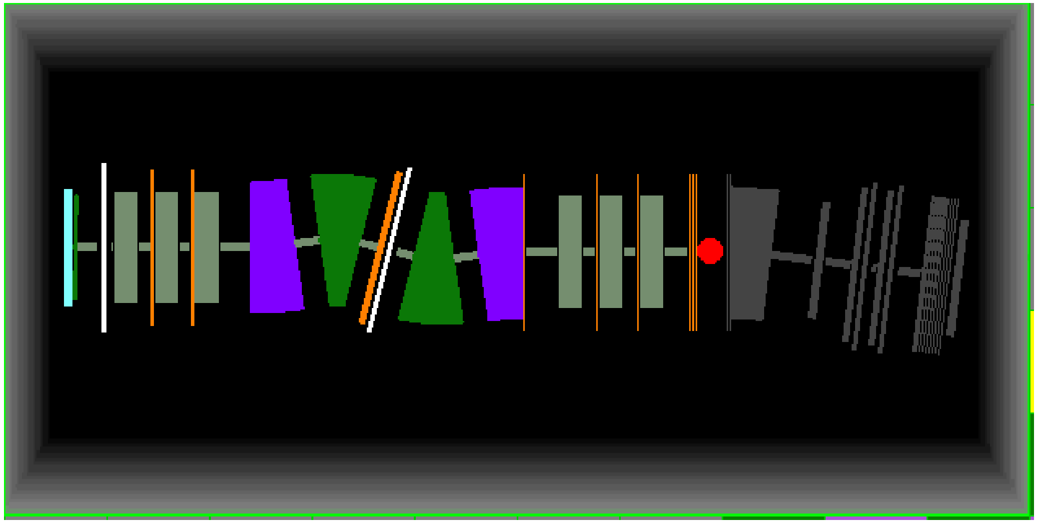
deviation	FWHM
2.031e+01	4.276e+01



Main purpose of the optimization is to provide highest transmission of ^{254}Nb ions.

Principal purpose of this file to find solution for known optical constraints of the symmetrical configuration as

- Dispersive plane (Y/P)=0 (point to point), (T/T)=0 (point to parallel)
- Focal plane X/D=0, X/T=0, Y/P=0 - achromatic with both focuses



SHELSeff_sym_part1.lpp

Main purpose of the optimization is to provide highest transmission of ^{254}Nb ions.

thus, main restriction for the dispersive point (SV-slits) is Y-size due to M-dipole gaps,
Which does agree with constraints of the symmetrical configuration for the Dispersive plane
(Y/P)=0 (point to point), (T/T)=0 (point to parallel)

Preliminary solution:

Q	<Quad>	Quad 1	0.381	0.3800	+4.5800
d	drift	d_q12	0.761	0.2000	
F	Fit	Q2a sR	0.961	0.0000	
Q	<Quad>	Quad 2	0.961	0.3800	-4.5918
d	drift	d_q23	1.341	0.2000	
F	Fit	Q3a sR	1.541	0.0000	
Q	<Quad>	Quad 3	1.541	0.3800	+1.9502

For the next conditions:
Quad to vary and constraints:

1st quad was not modified

Blocks with parameters to vary

#01-q	Position@010:	Quad 2
#02-q	Position@013:	Quad 3

Active Constraint blocks

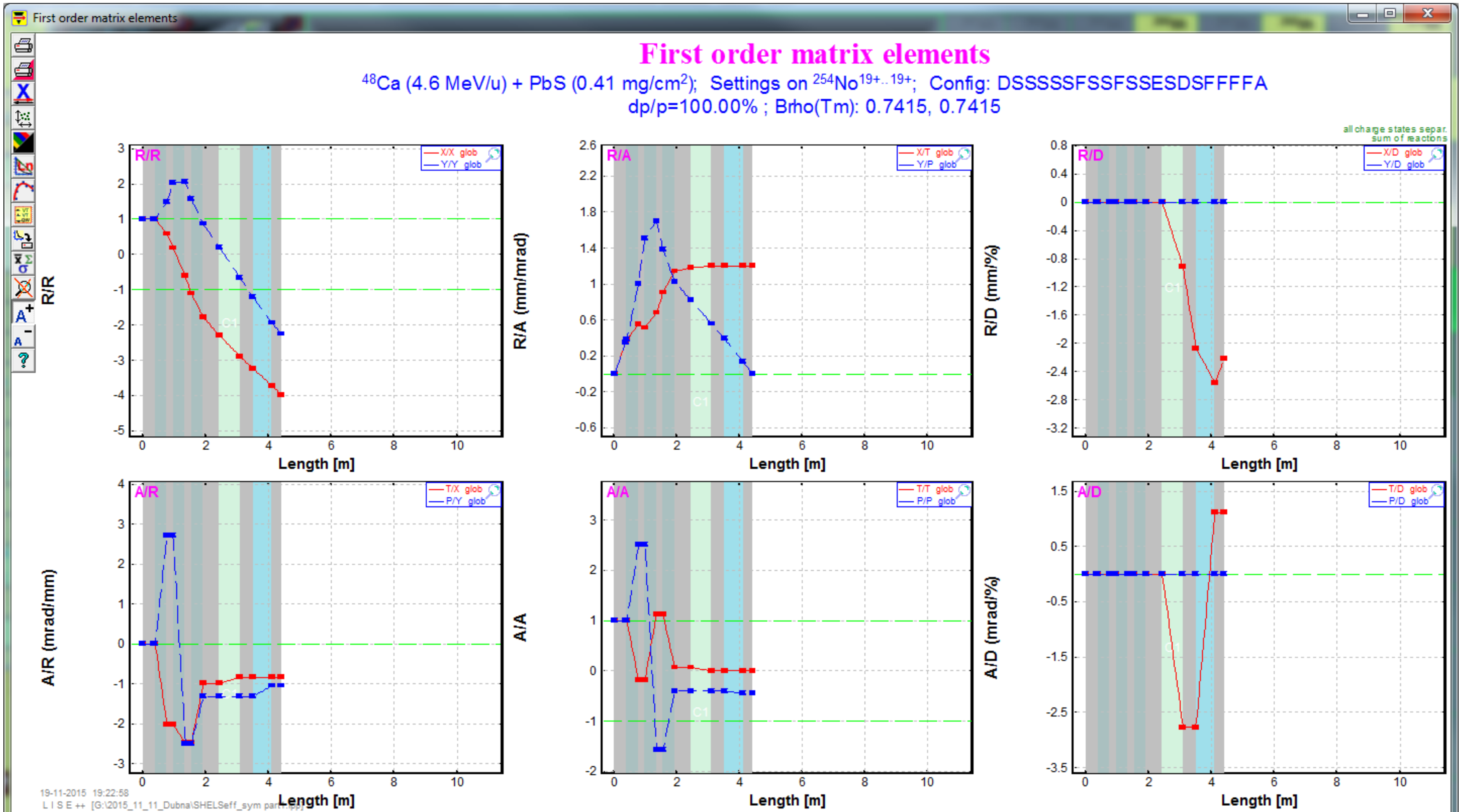
#01	@009:	s R < 80	Q2a sR
#02	@012:	s R < 80	Q3a sR
#03	@019:	s X < 200	sv sX
#04	@020:	R34 = 0	sv Yfoc
#05	@022:	R22 = 0	sv TT

See result on the next page

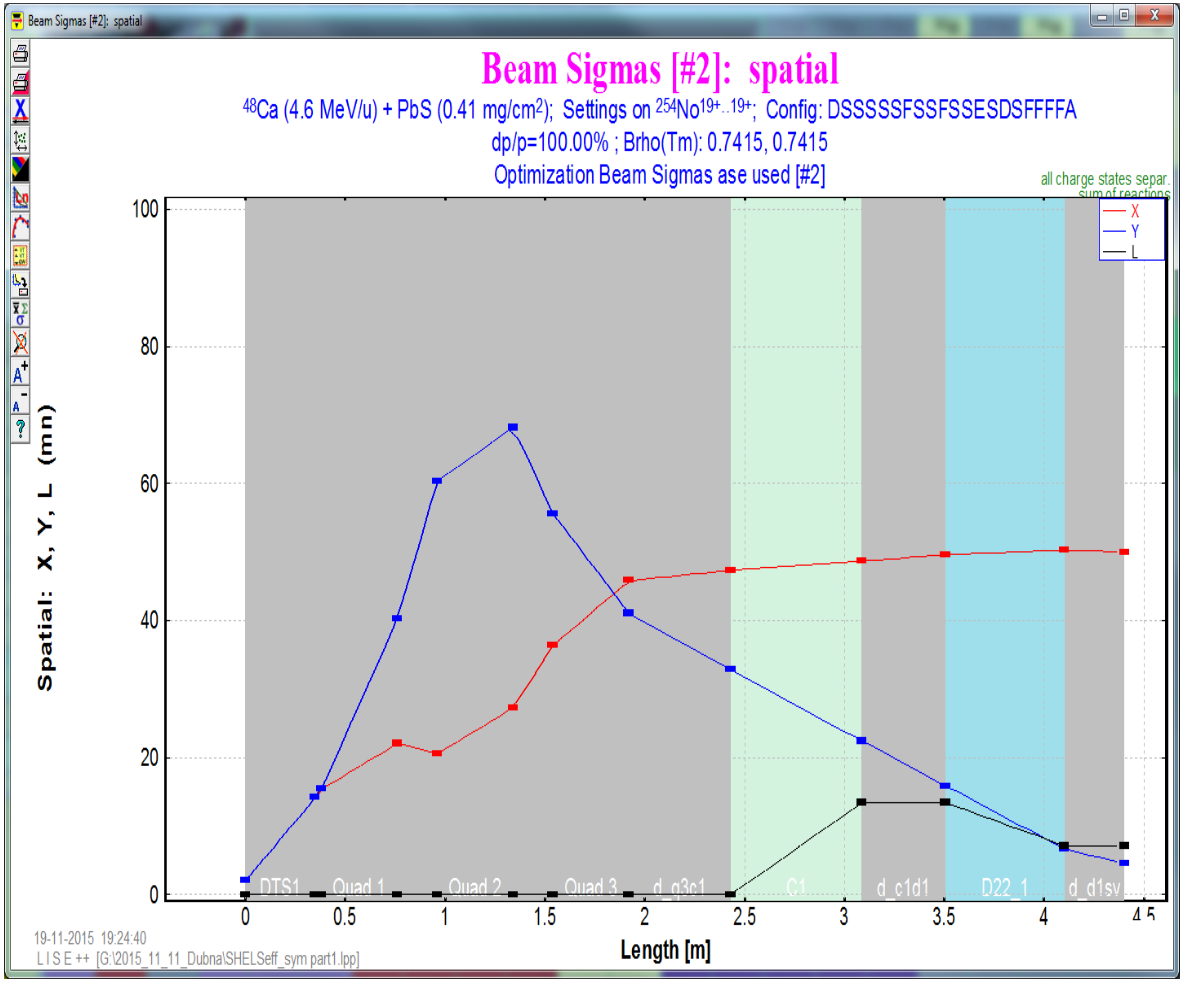
SHELSeff_sym_part1.lpp : 1st results

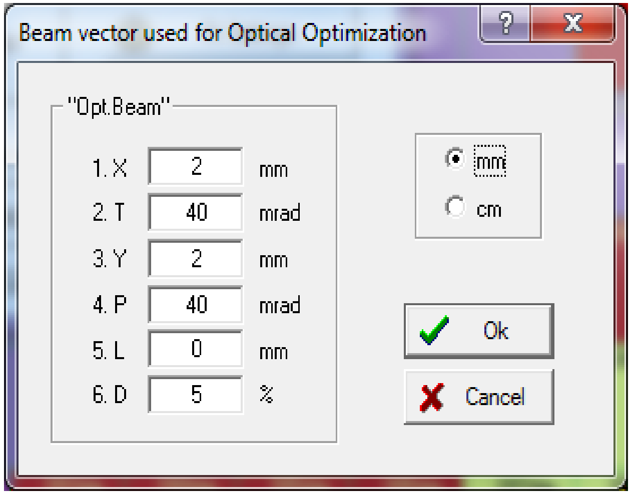
```
Initial   +1.2153e-09  LISE fit reduced values

Parameters:              LeftBound      Initial       RightBound   |
#01-q:  Quad 2           -1.0e+01  <  -4.592e+00  <   +0.0e+00     |
#02-q:  Quad 3           +0.0e+00  <  +1.950e+00  <   +1.0e+01     |
-----------------------------------------------------------------------------
Constraint values:     Initial        Final       Precision   (Init-Des)/P|    Desired
#01:  Q2a sR          +6.376e+01                  1.0e+00        0        |   <  80
#02:  Q3a sR          +6.638e+01                  1.0e+00        0        |   <  80
#03:  sv sX           +4.995e+01                  1.0e+00        0        |   <  200
#04:  sv Yfoc         +1.347e-15                  1.0e-01        0        |   =  0
#05:  sv TT           -2.376e-16                  1.0e-02        0        |   =  0
```

```
==> "sv TT" : last fitting block global optical matrix and sigma vector

                                                  Format [mm-mrad]
===================== G L O B A L ====  matrix ==================  | Beam(sigma) |
   -3.978e+00  +1.201e+00   0            0            0  -2.223e+00 |   5.00e+01 |
   -8.326e-01  -2.376e-16   0            0            0  +1.114e+00 |   5.81e+00 |
    0           0          -2.254e+00   +1.347e-15    0   0         |   4.51e+00 |
    0           0          -1.045e+00   -4.437e-01    0   0         |   1.79e+01 |
   +6.280e-01  -1.338e-01   0            0          1.0  +8.894e-01 |   7.07e+00 |
    0           0           0            0            0  +1.000e+00 |   5.00e+00 |
```



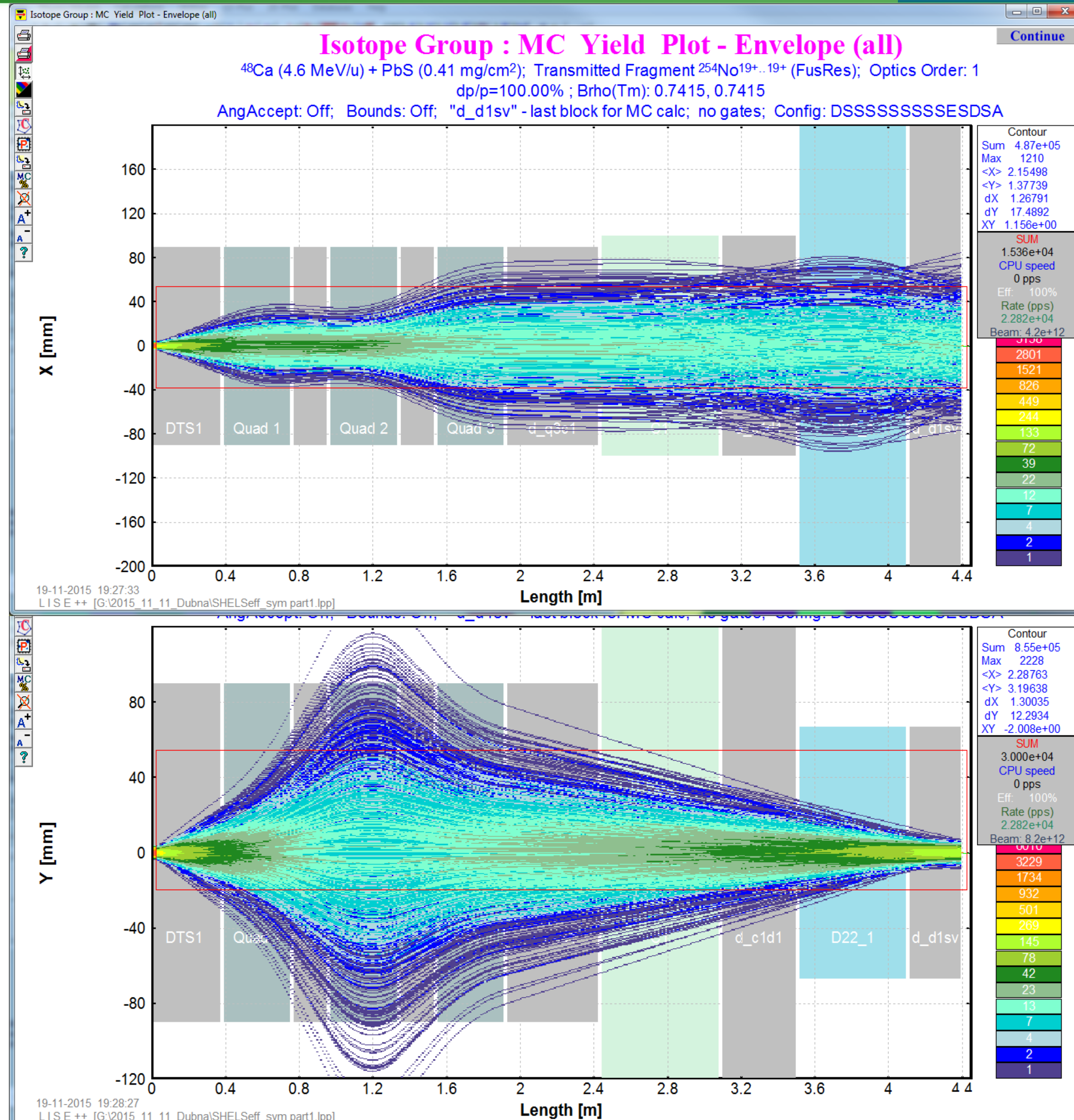
Beam sigma plot for the current beam sigma vector





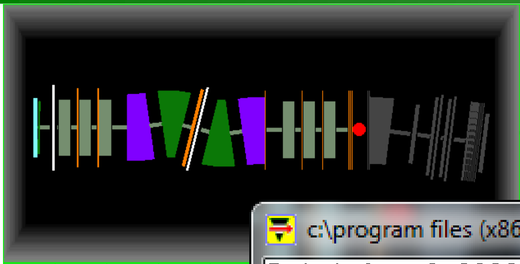
SHELSeff_sym_part1.lpp : 1st results

1st part envelopes for all produced ^{254}Nb ions



Transmission 98.94%

SHELSeff_sym_part2.lpp : 1st results



c:\program files (x86)\lise\results\SHELSeff_sym part2.fit_init

Initial +0.000367858 LISE fit reduced values

Parameters:	LeftBound		Initial		RightBound
#01-q: Quad 1	+0.0e+00	<	+4.834e+00	<	+1.0e+01
#02-q: Quad 2	-1.0e+01	<	-4.601e+00	<	+0.0e+00
#03-q: Quad 3	+0.0e+00	<	+1.889e+00	<	+1.0e+01
#04-q: Quad 4	-3.0e+00	<	+1.881e+00	<	+3.0e+00
#05-q: Quad 5	-1.0e+01	<	-4.593e+00	<	+0.0e+00
#06-q: Quad 6	+0.0e+00	<	+4.845e+00	<	+1.0e+01

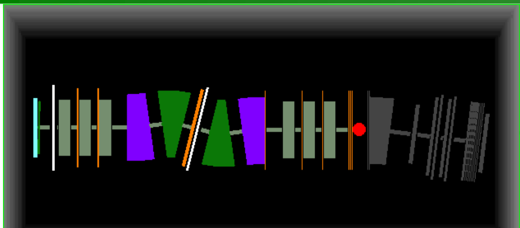
Constraint values:	Initial	Final	Precision	(Init-Des)/P		Desired
#01: Q2a sR	+6.475e+01		1.0e+00	0	<	80
#02: Q3a sR	+6.614e+01		1.0e+00	0	<	80
#03: sv sX	+4.678e+01		1.0e+00	0	<	200
#04: sv Yfoc	+4.373e-06		1.0e-01	+4.373e-05	=	0
#05: sv TT	-1.572e-06		1.0e-02	+1.572e-04	=	0
#06: C2 sX	+5.364e+01		1.0e+00	0	<	80
#07: Q5a sR	+7.778e+01		1.0e-01	+1.083e-03	<	80
#08: Q6a sR	+5.004e+01		1.0e-01	0	<	80
#09: sym X-focus	-3.525e-06		1.0e-03	+3.525e-03	=	0
#10: sym Y-focus	-1.004e-06		1.0e-02	+1.004e-04	=	0
#11: sym X-disp	+7.056e-06		1.0e-02	+7.056e-04	=	0

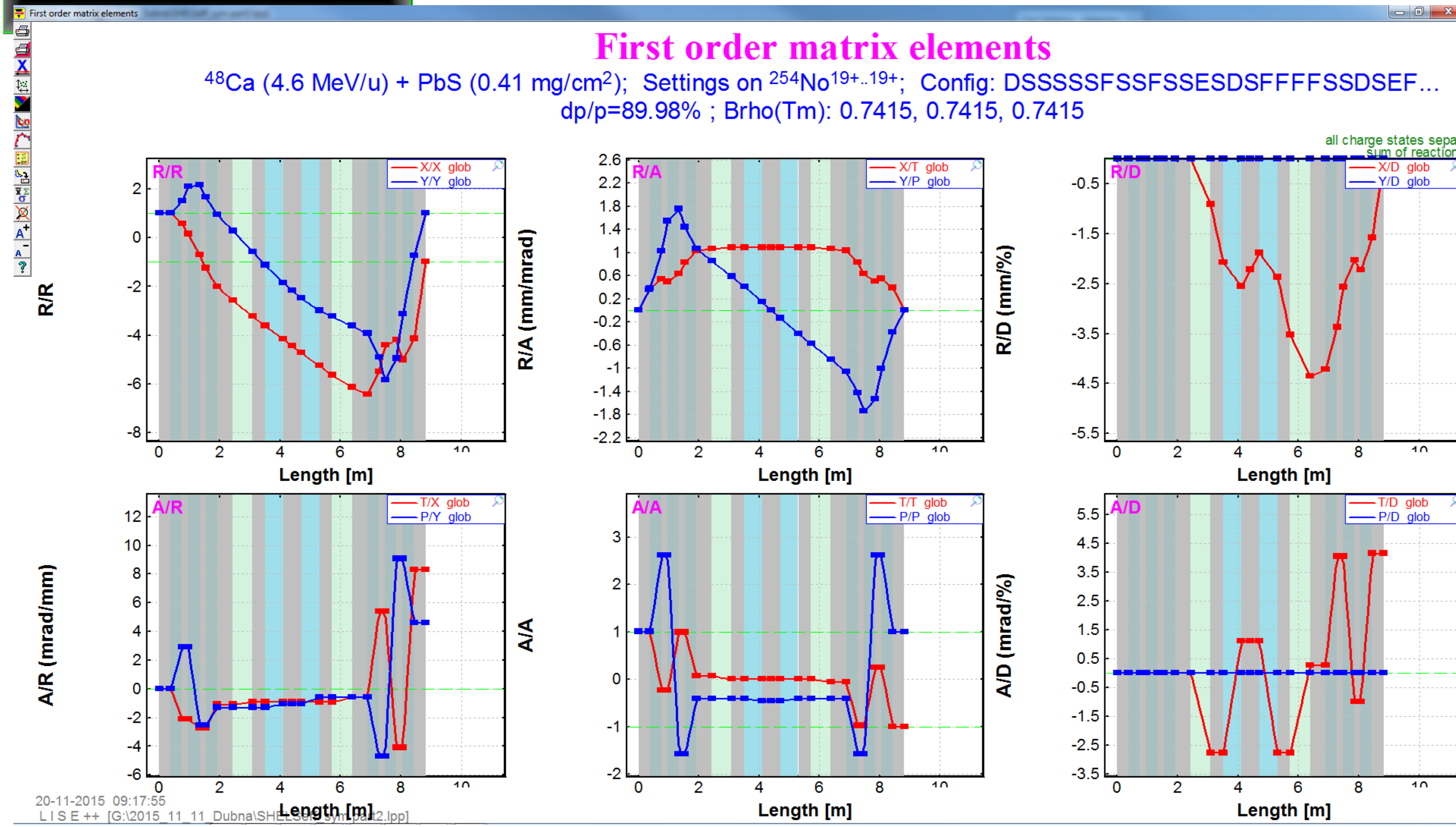
==> "sym X-disp" : last fitting block global optical matrix and sigma vector

Format [mm-mrad]

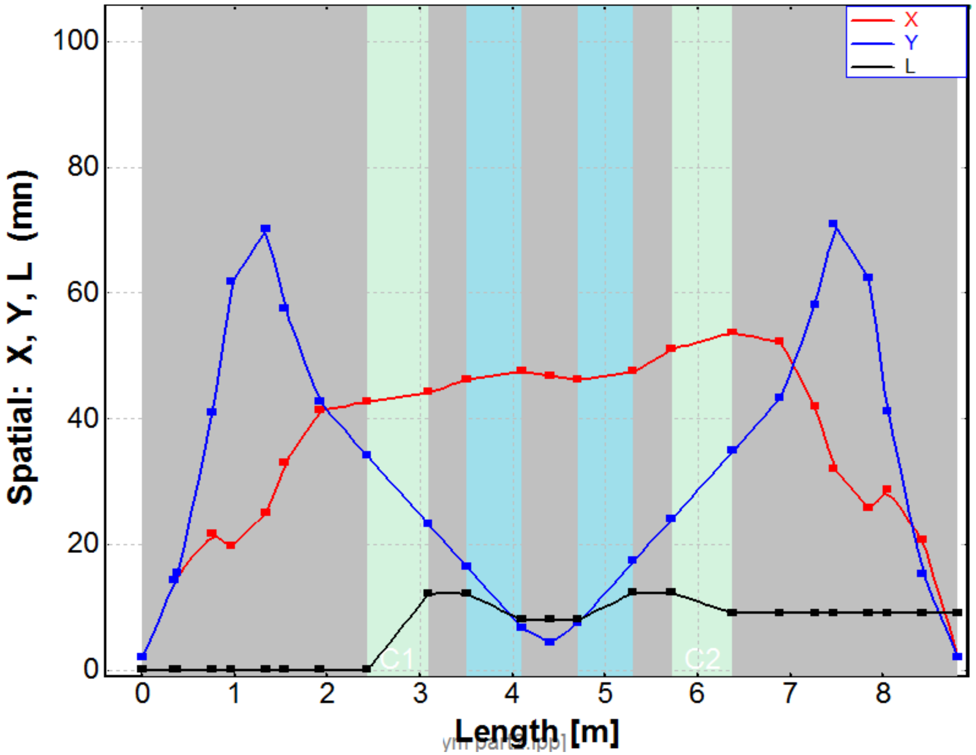
GLOBAL matrix						Beam(sigma)
-9.915e-01	-3.525e-06	0	0	0	+7.056e-06	1.98e+00
+8.294e+00	-1.003e+00	0	0	0	+4.150e+00	5.24e+01
0	0	+1.003e+00	-1.004e-06	0	0	2.01e+00
0	0	+4.577e+00	+9.971e-01	0	0	4.09e+01
+4.115e-01	+6.462e-07	0	0	1.0	+1.284e+00	9.02e+00
0	0	0	0	0	+1.000e+00	7.00e+00

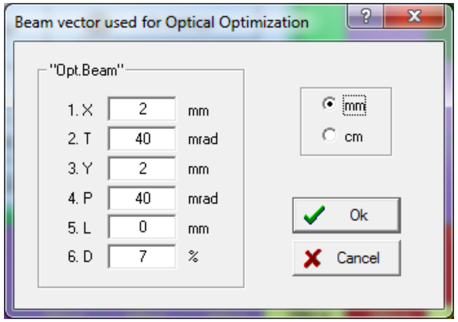
SHELSeff_sym_part2.lpp : 1st results





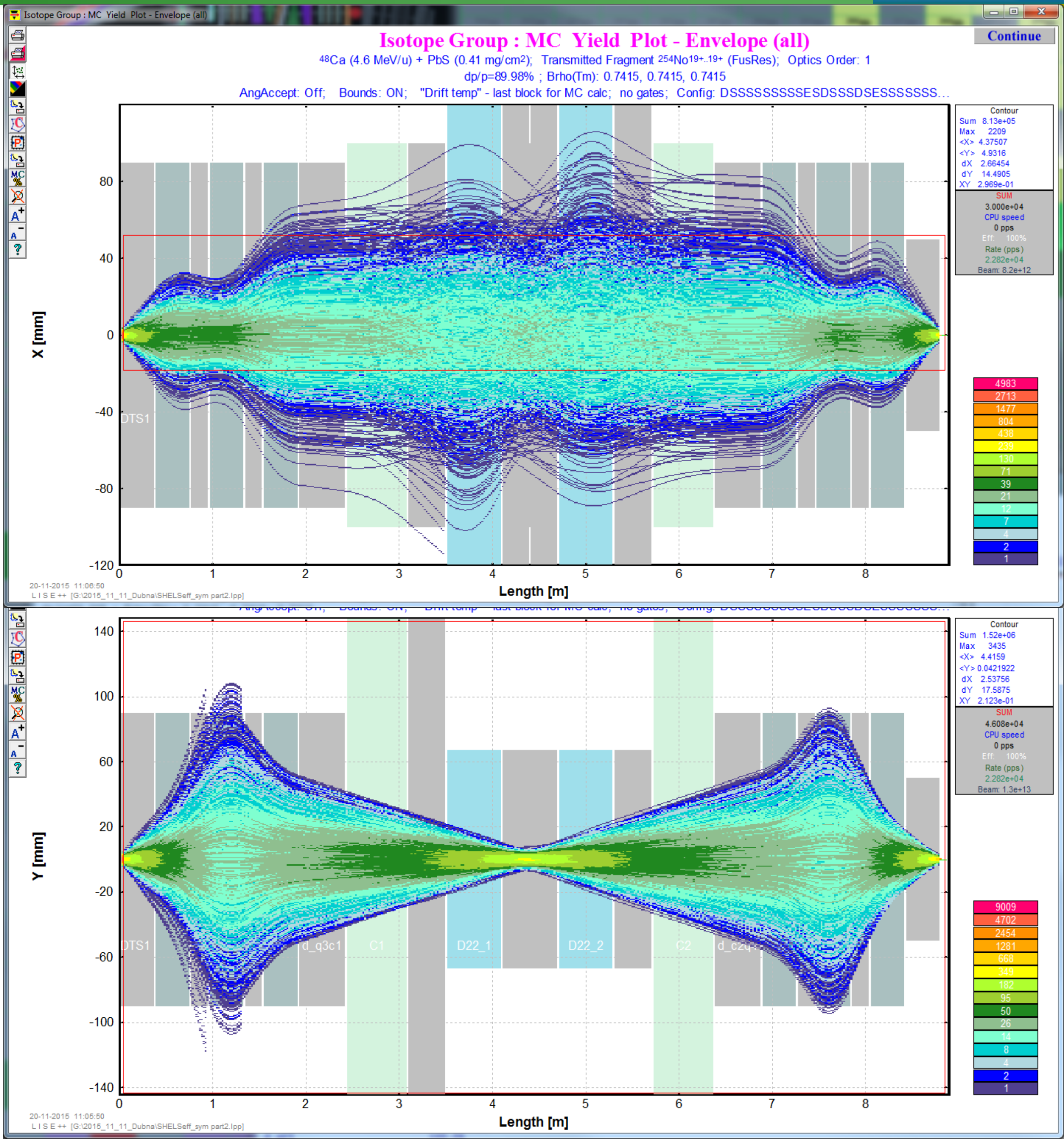
Beam sigma plot for the current beam sigma vector





SHELSeff_sym_part2.lpp : 1st results

1st and 2nd parts envelopes for all produced ^{254}Nb ions



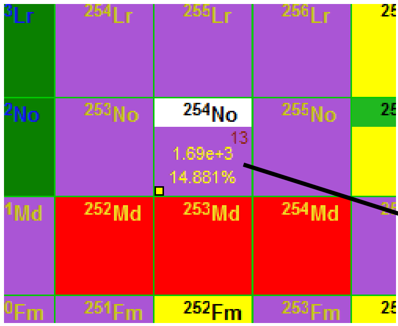
Transmission:

Monte Carlo 97.5%

Analytical 96.3%

How to get overall transmission?

Analytical



statistics: 254No

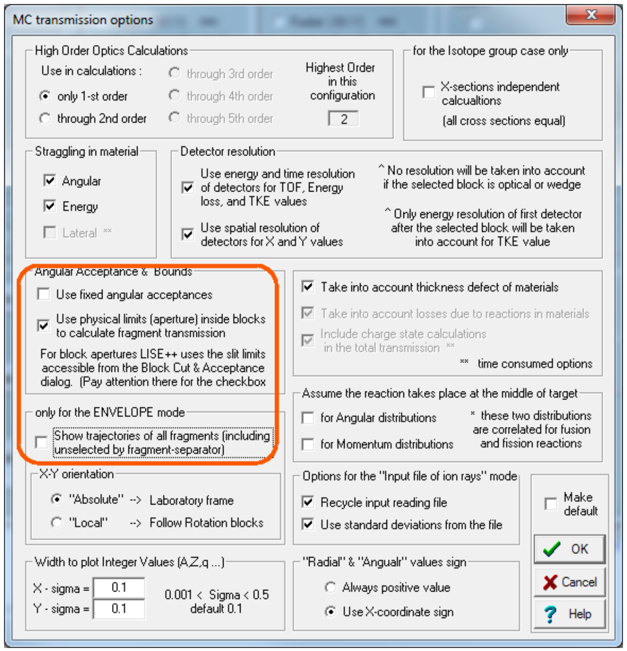
254No Alpha and Beta+ decay (Z=102, N=152) Nobelium

All reactions total isotope rate 1.69e+3 pps
and Overall isotope transmission 96.302 %

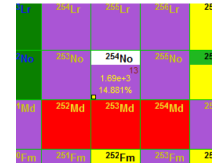
Q1(tuning)		25	24	23	22	21
Q2(C1)		25	24	23	22	21
Q3(D22_1)		25	24	23	22	21
Q4(D22_2)		25	24	23	22	21
Q5(C2)		25	24	23	22	21
Q6(D8)		25	24	23	22	21
Reaction		FusRes	FusRes	FusRes	FusRes	FusR
Ion Production Rate	(pps)	2.09e+1	4.58e+1	8.69e+1	1.43e+2	2.02
Total ion transmission	(%)	1.188	2.608	4.95	8.122	11.5
Total: this reaction	(pps)	1.69e+3	1.69e+3	1.69e+3	1.69e+3	1.69
X-Section in target	(mb)	1.38e-1	1.38e-1	1.38e-1	1.38e-1	1.38
Target	(%)	1.22	2.67	5.08	8.33	11.8
Unreacted in material	(%)	100	100	100	100	100
Q (Charge) ratio	(%)	1.22	2.67	5.08	8.33	11.8
Unstopped in material	(%)	100	100	100	100	100
tuning	(%)	97.53	97.53	97.53	97.53	97.5
X angular transmission	(%)	100	100	100	100	100
Y angular transmission	(%)	97.53	97.53	97.53	97.53	97.5
DTS1	(%)	100	100	100	100	100
slits 1	(%)	100	100	100	100	100
X space transmission	(%)	100	100	100	100	100
Y space transmission	(%)	100	100	100	100	100
DS1Q1	(%)	100	100	100	100	100

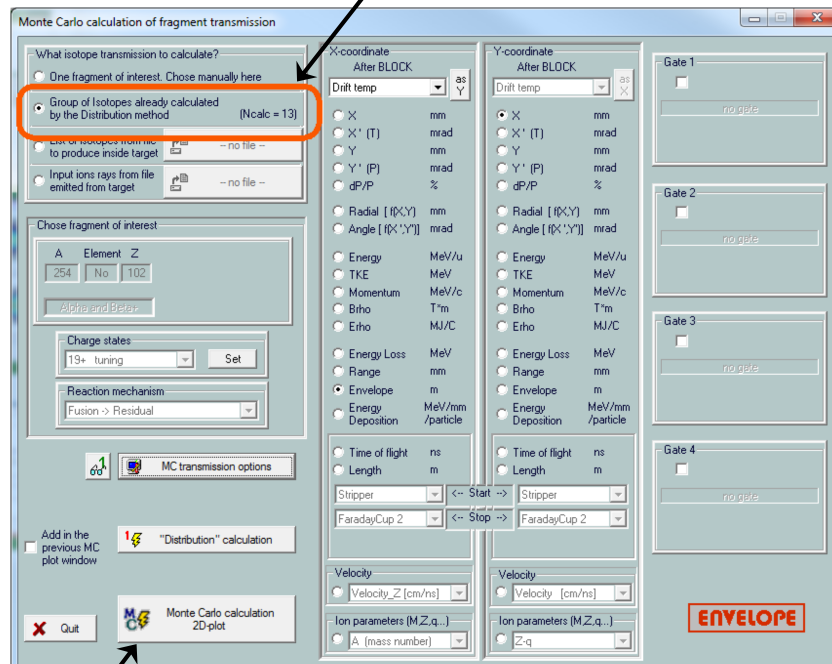
Monte Carlo

Step 1



Step 2

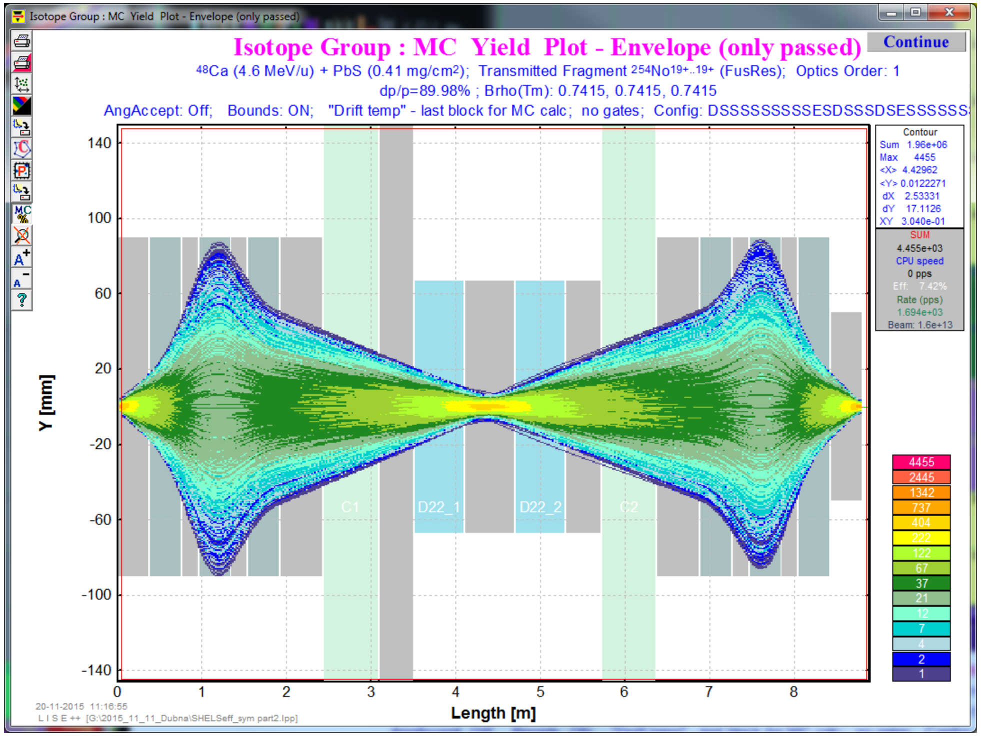




Step 3

How to get overall transmission?

Monte Carlo



Step 4

Monte Carlo transmission statistics by blocks

Isotope Group : MC Yield Plot - Envelope (only passed)

48Ca (4.6 MeV/u) + PbS (0.41 mg/cm2); Transmitted Fragment
dp/p=89.98% ; Brho(Tm): 0.7415, 0.7415, 0.7415
AngAccept: Off; Bounds: ON; "Drift temp" - last block f

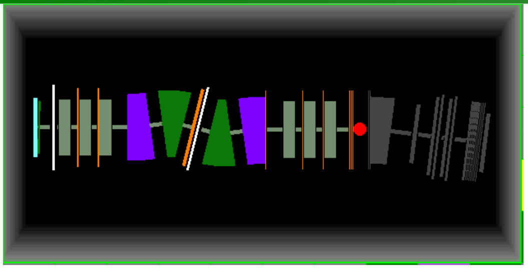
#	Ion	N of Passed	N of Initial	Transmission		Z
All		4464	60123	7.43%		
0	254No	0	4668	0%	(+/-0.02%)	102
1	254No	0	4662	0%	(+/-0.02%)	102
2	254No	0	4488	0%	(+/-0.02%)	102
3	254No	0	4604	0%	(+/-0.02%)	102
4	254No	0	4593	0%	(+/-0.02%)	102
5	254No	0	4623	0%	(+/-0.02%)	102
6	254No	0	4692	0%	(+/-0.02%)	102
7	254No	0	4601	0%	(+/-0.02%)	102
8	254No	0	4668	0%	(+/-0.02%)	102
9	254No	0	4537	0%	(+/-0.02%)	102
10	254No	0	4583	0%	(+/-0.02%)	102
11	254No	0	4607	0%	(+/-0.02%)	102
12	254No	0	4674	0%	(+/-0.02%)	102

Target	7.62%
Q-state	7.62%
tuning	100.0%
DTS1	100.0%
slits 1	99.98%
Slits	99.98%
DS1Q1	100.0%

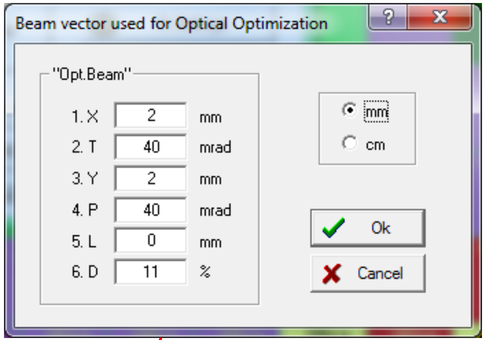
Step 5

7.43% / 7.62% * 100% = **97.5%**

SHELSeff_sym_part2_E.lpp : 1st results

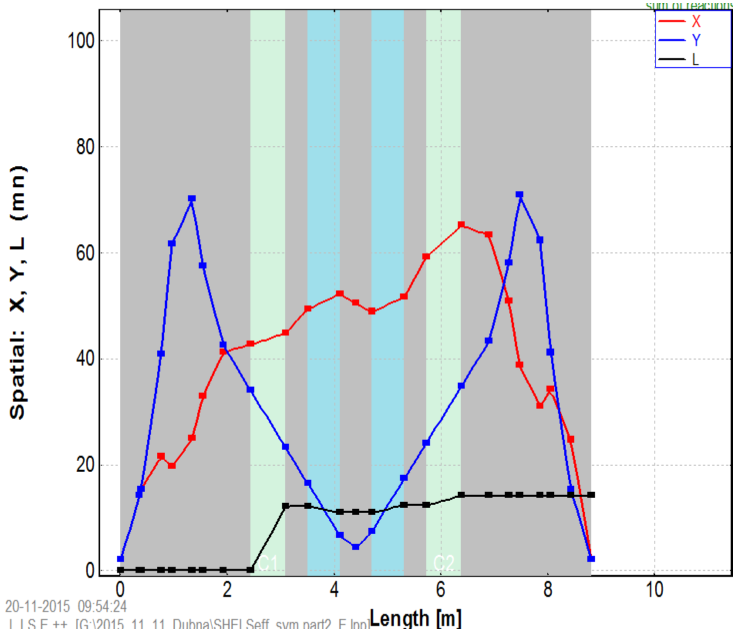


Larger emittance

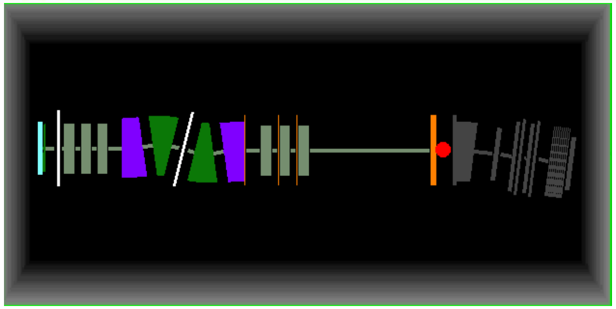


c:\program files (x86)\lise\results\SHELSeff_sym part2_E.fit_init

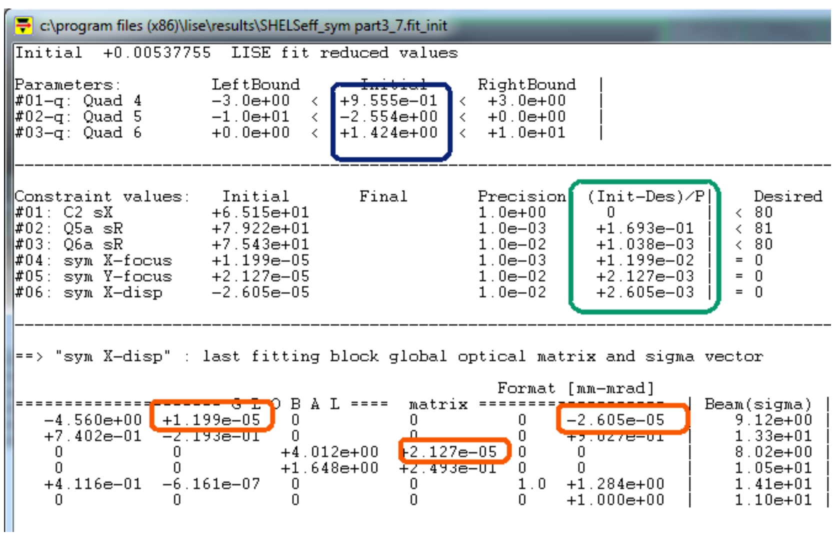
```
Initial  +0.0253866  LISE fit reduced values

Parameters:          LeftBound      Initial      RightBound  |
#01-q: Quad 1        +0.0e+00  <  +4.834e+00  <  +1.0e+01   |
#02-q: Quad 2        -1.0e+01  <  -4.601e+00  <  +0.0e+00   |
#03-q: Quad 3        +0.0e+00  <  +1.889e+00  <  +1.0e+01   |
#04-q: Quad 4        -3.0e+00  <  +1.881e+00  <  +3.0e+00   |
#05-q: Quad 5        -1.0e+01  <  -4.593e+00  <  +0.0e+00   |
#06-q: Quad 6        +0.0e+00  <  +4.845e+00  <  +1.0e+01   |

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

Constraint values:    Initial       Final     Precision  (Init-Des)/P    Desired
#01: Q2a sR          +6.475e+01               1.0e+00       0           < 80
#02: Q3a sR          +6.614e+01               1.0e+00       0           < 80
#03: sv sX           +5.043e+01               1.0e+00       0           < 200
#04: sv Yfoc         +6.865e-14               1.0e-01       0           = 0
#05: sv TT           +1.114e-07               1.0e-02    +1.114e-05     = 0
#06: C2 sX           +6.515e+01               1.0e+00       0           < 80
#07: Q5a sR          +8.078e+01               1.0e-03    +8.028e-01     < 81
#08: Q6a sR          +5.351e+01               1.0e-02       0           < 80
#09: sym X-focus     -1.040e-09               1.0e-03    +1.040e-06     = 0
#10: sym Y-focus     -3.457e-15               1.0e-02       0           = 0
#11: sym X-disp      -2.526e-08               1.0e-02    +2.526e-06     = 0

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

==> "sym X-disp" : last fitting block global optical matrix and sigma vector

                                       Format [mm-mrad]
==================== G L O B A L ==== matrix ===================  | Beam(sigma) |
  -9.918e-01  -1.040e-09   0          0          0    -2.526e-08  |  1.98e+00   |
  +8.296e+00  -1.008e+00   0          0          0    +4.150e+00  |  6.31e+01   |
   0           0          +1.003e+00 -3.032e-13  0     0          |  2.01e+00   |
   0           0          +4.577e+00 +9.972e-01  0     0          |  4.09e+01   |
  +4.116e-01  -1.020e-07   0          0          1.0  +1.284e+00  |  1.41e+01   |
   0           0           0          0          0    +1.000e+00  |  1.10e+01   |
```



SHELSeff_sym_part3_7.lpp : moving away the focal plain

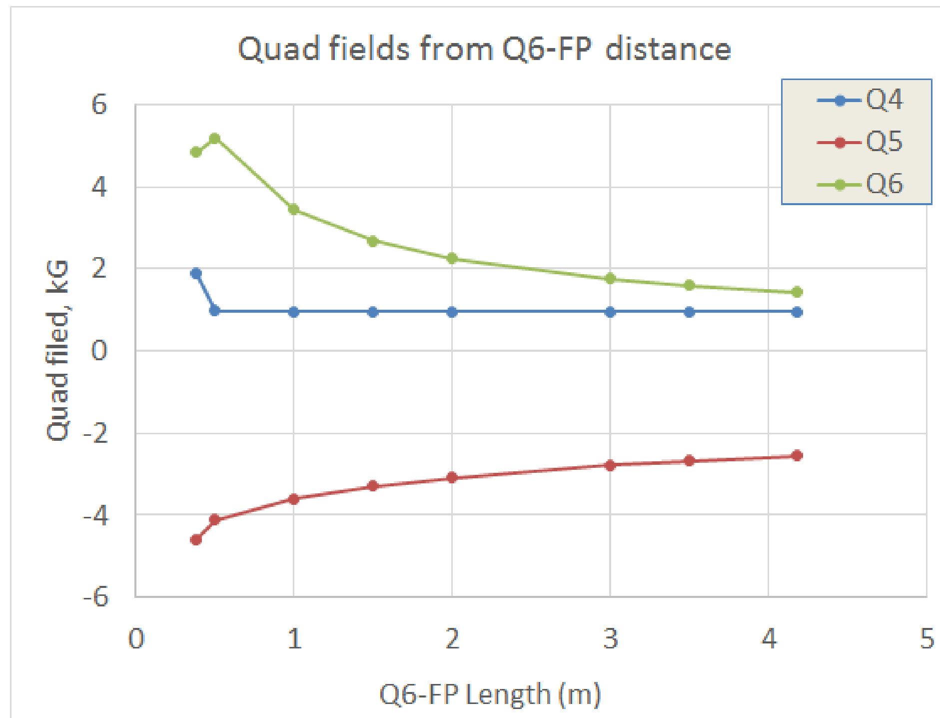


1. First three quads are frozen!
2. L=4.18 m corresponds to the real SHEL configuration
   (assuming D8 as drift)

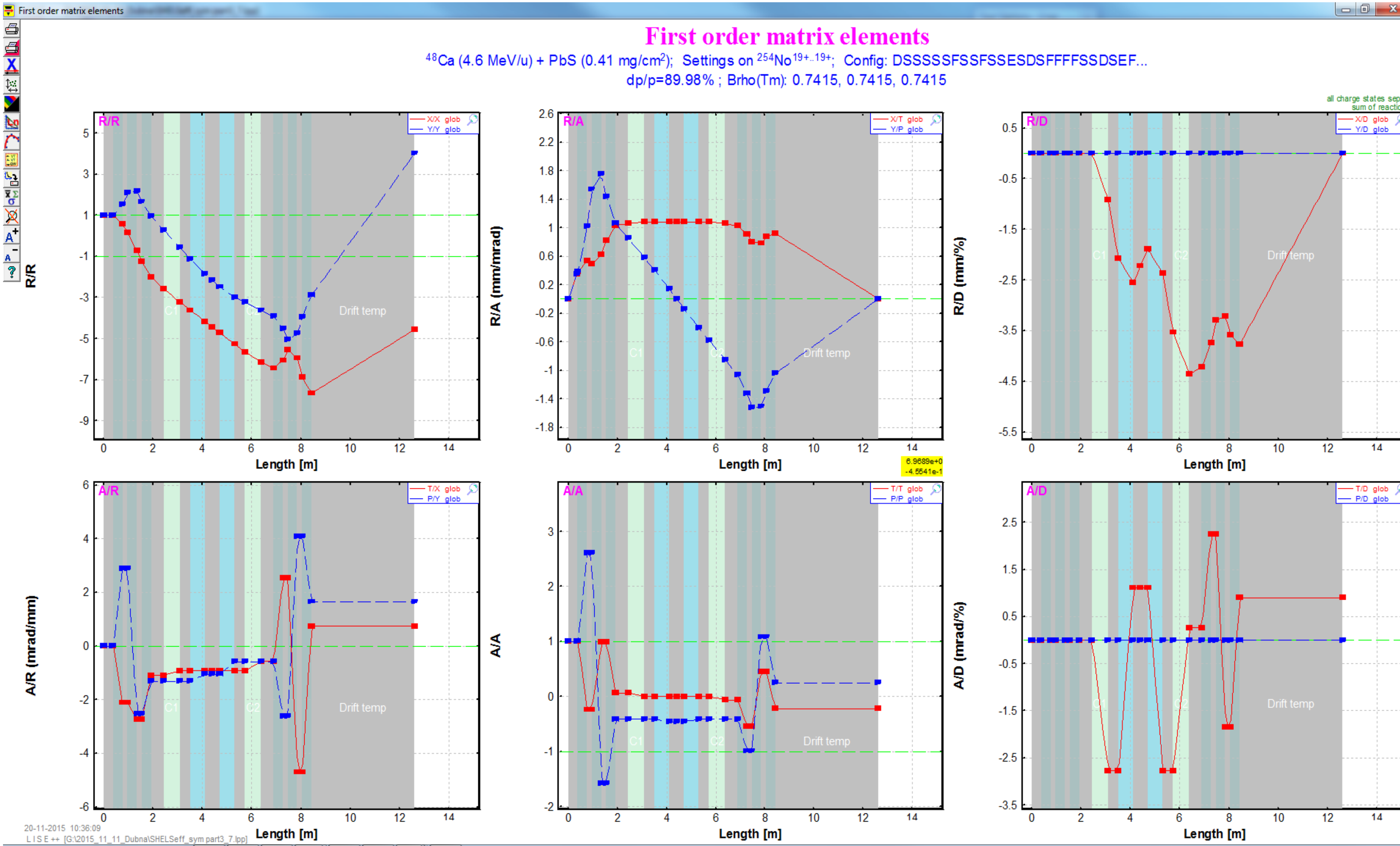


```
c:\program files (x86)\lise\results\SHELSeff_sym part3_7.fit_init
Initial  +0.00537755  LISE fit reduced values

Parameters:          LeftBound      Initial      RightBound  |
#01-q:  Quad 4       -3.0e+00  <  +9.555e-01  <  +3.0e+00    |
#02-q:  Quad 5       -1.0e+01  <  -2.554e+00  <  +0.0e+00    |
#03-q:  Quad 6       +0.0e+00  <  +1.424e+00  <  +1.0e+01    |
------------------------------------------------------------------------------------

Constraint values:    Initial        Final       Precision  (Init-Des)/P|    Desired
#01: C2 sX           +6.515e+01                  1.0e+00      0         |  < 80
#02: Q5a sR          +7.922e+01                  1.0e-03    +1.693e-01  |  < 81
#03: Q6a sR          +7.543e+01                  1.0e-02    +1.038e-03  |  < 80
#04: sym X-focus     +1.199e-05                  1.0e-03    +1.199e-02  |  = 0
#05: sym Y-focus     +2.127e-05                  1.0e-02    +2.127e-03  |  = 0
#06: sym X-disp      -2.605e-05                  1.0e-02    +2.605e-03  |  = 0
------------------------------------------------------------------------------------

==> "sym X-disp" : last fitting block global optical matrix and sigma vector

                                          Format [mm-mrad]
======================== G L O B A L ====  matrix ====================| Beam(sigma) |
  -4.560e+00  +1.199e-05  0           0           0    -2.605e-05     |   9.12e+00  |
  +7.402e-01  -2.193e-01  0           0           0    +9.027e-01     |   1.33e+01  |
  0           0           +4.012e+00  +2.127e-05  0    0              |   8.02e+00  |
  0           0           +1.648e+00  +2.493e-01  0    0              |   1.05e+01  |
  +4.116e-01  -6.161e-07  0           0           1.0  +1.284e+00     |   1.41e+01  |
  0           0           0           0           0    +1.000e+00     |   1.10e+01  |
```

L	Q4	Q5	Q6
0.381	1.8807	-4.5932	4.8447
0.5	0.9816	-4.1051	5.1918
1	0.9575	-3.6066	3.4325
1.5	0.9559	-3.3021	2.6875
2	0.9557	-3.0862	2.2587
3	0.9556	-2.7889	1.7617
3.5	0.9554	-2.6789	1.5986
4.18	0.9555	-2.5542	1.4239

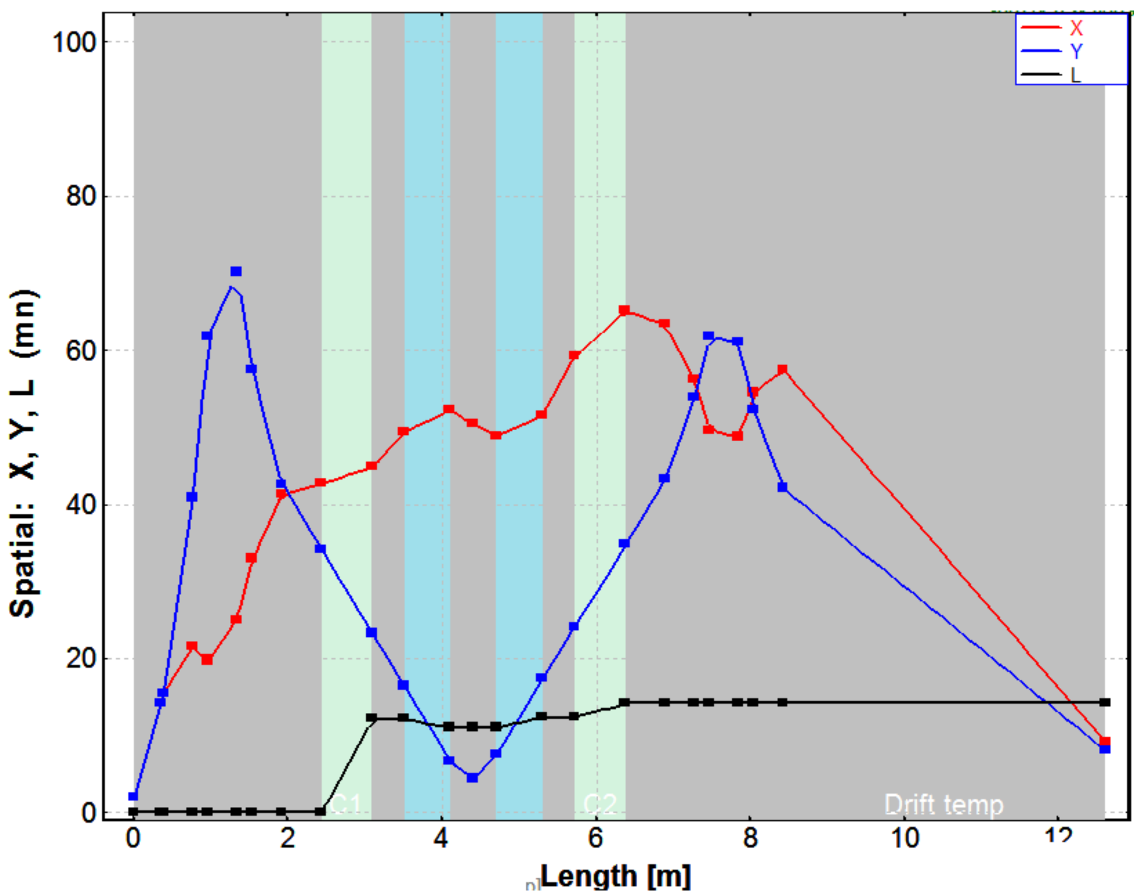


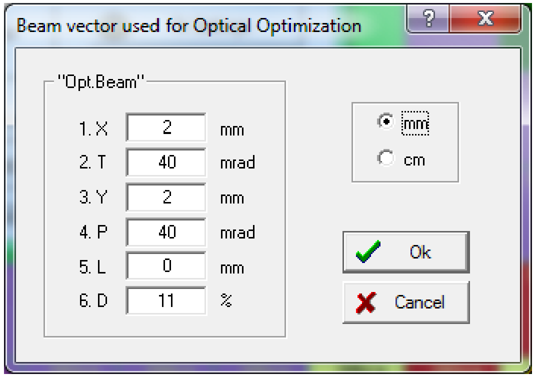
SHELSeff_sym_part3_7.lpp : moving away the focal plain



SHELSeff_sym_part3_7.lpp : moving away the focal plain

Beam sigma plot for the current beam sigma vector



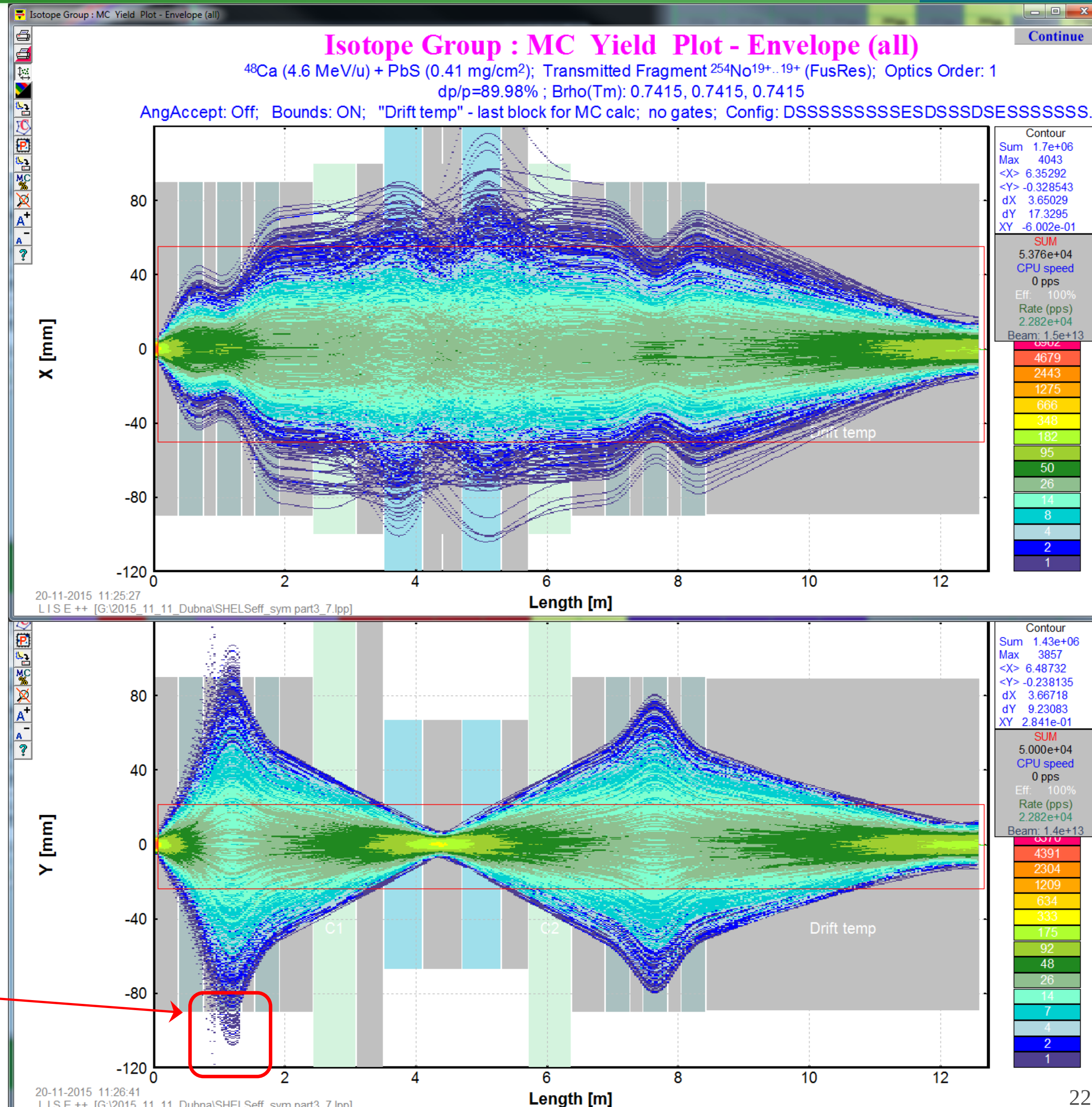


SHELSeff_sym_part3_7.lpp : moving away the focal plain

All parts envelopes for all produced ^{254}Nb ions

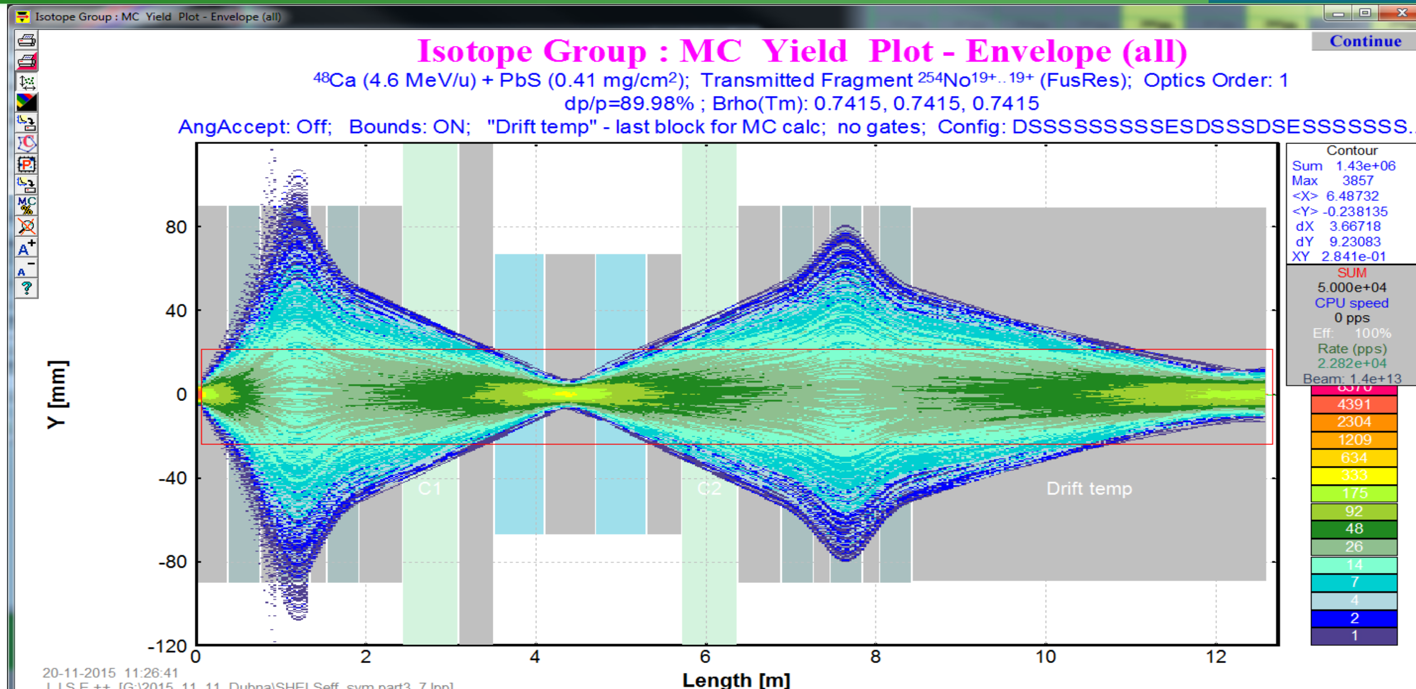
MC Transmission 96.74%

Lost

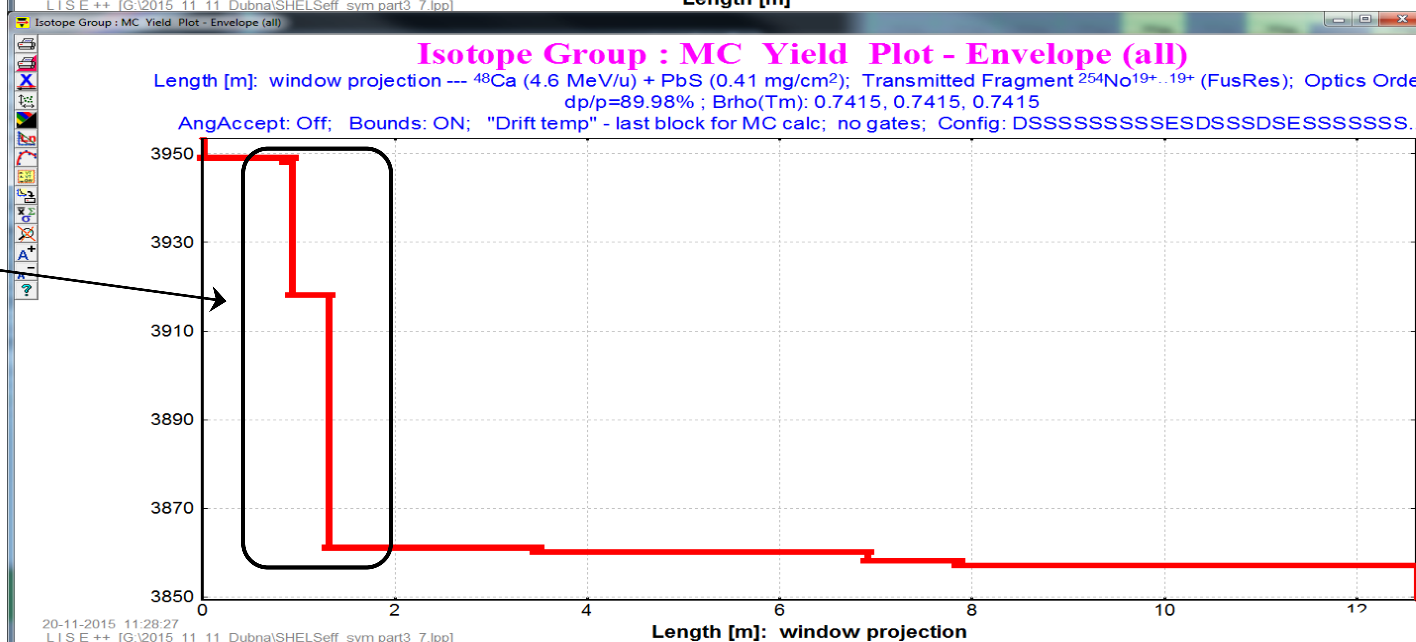


SHELSeff_sym_part3_7.lpp : where we are losing?

All parts envelopes for all produced ^{254}Nb ions

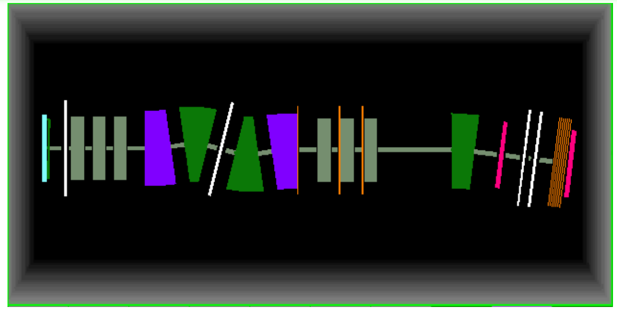


Lost



SHELSeff_All_v1.lpp

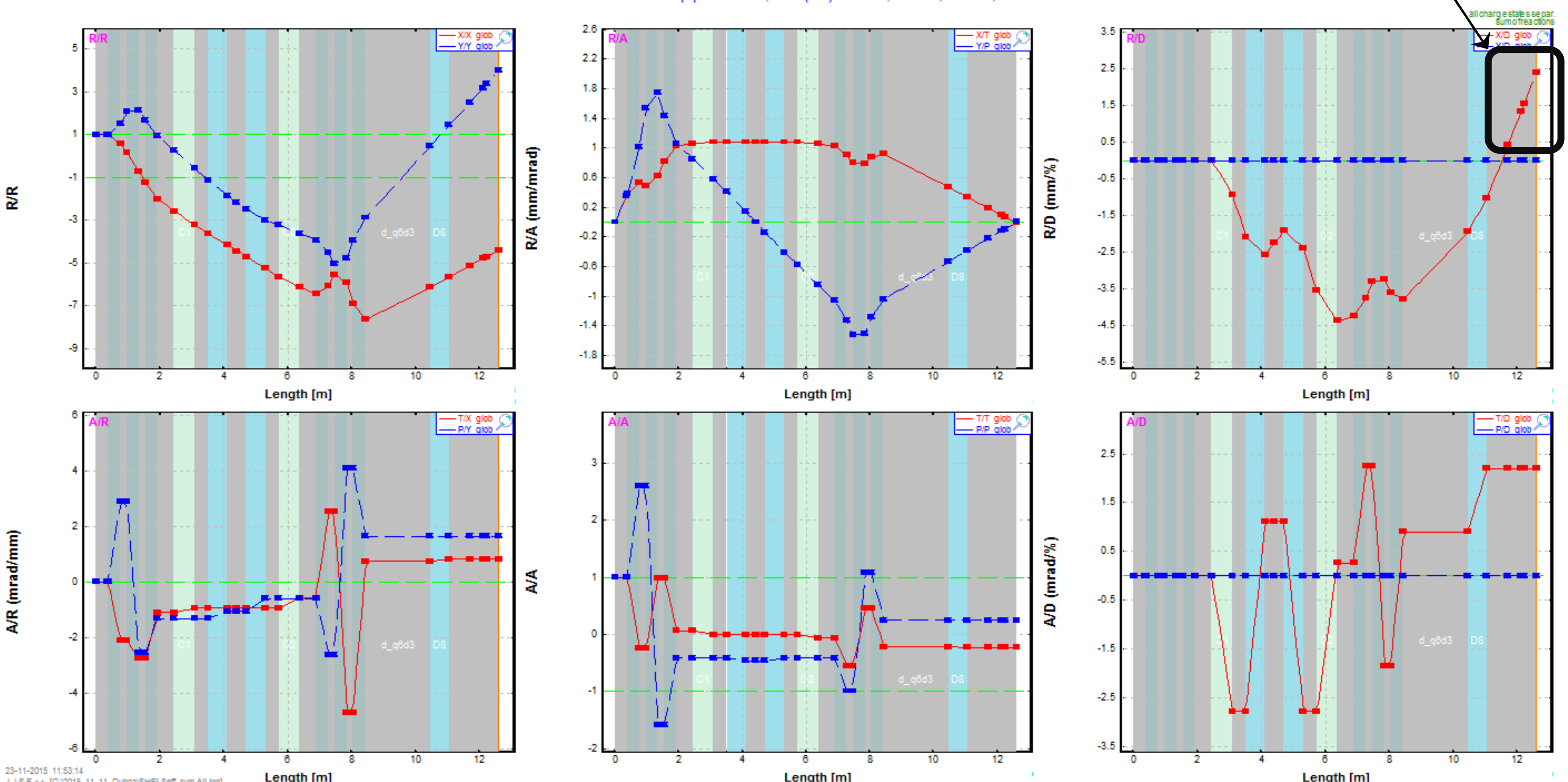
Using SHELSeff_sym_part3_7.lpp quad fields

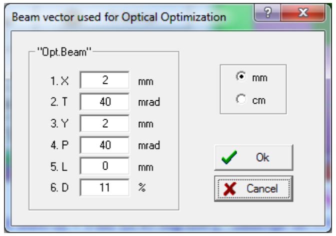


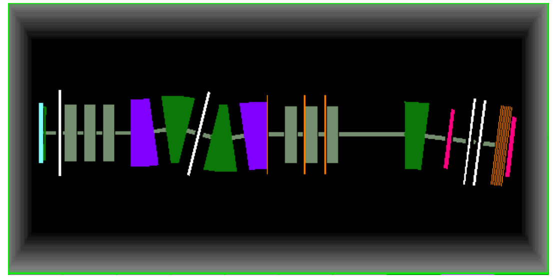
The Dispersion probably should be decreased!

First order matrix elements

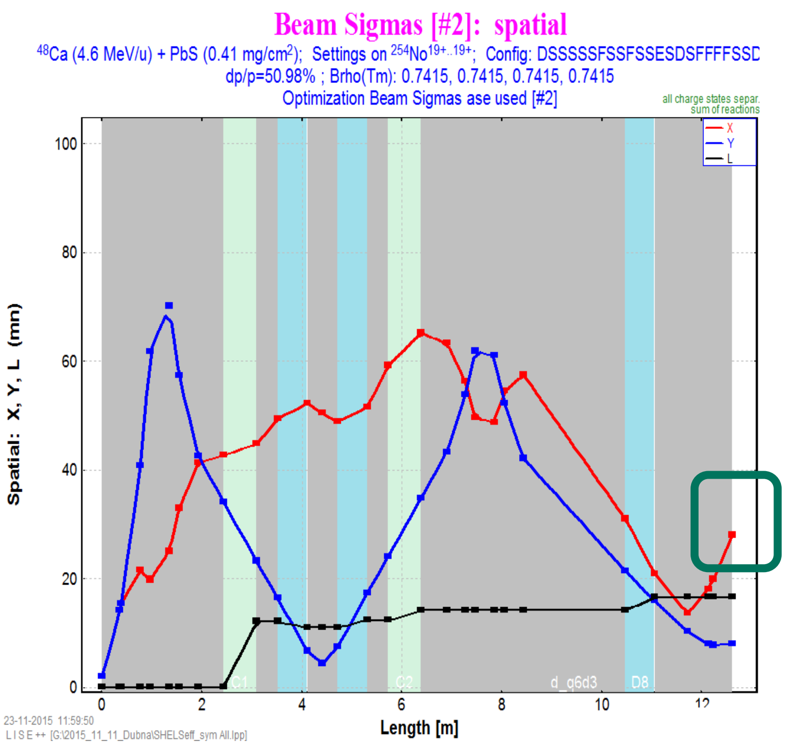
^{48}Ca (4.6 MeV/u) + PbS (0.41 mg/cm^2); Settings on ^{254}No$^{19+..19+}$; Config: DSSSSSFSSFSSESDSFFFFSSDSEF...
dp/p=50.98% ; Brho(Tm): 0.7415, 0.7415, 0.7415, 0.7415

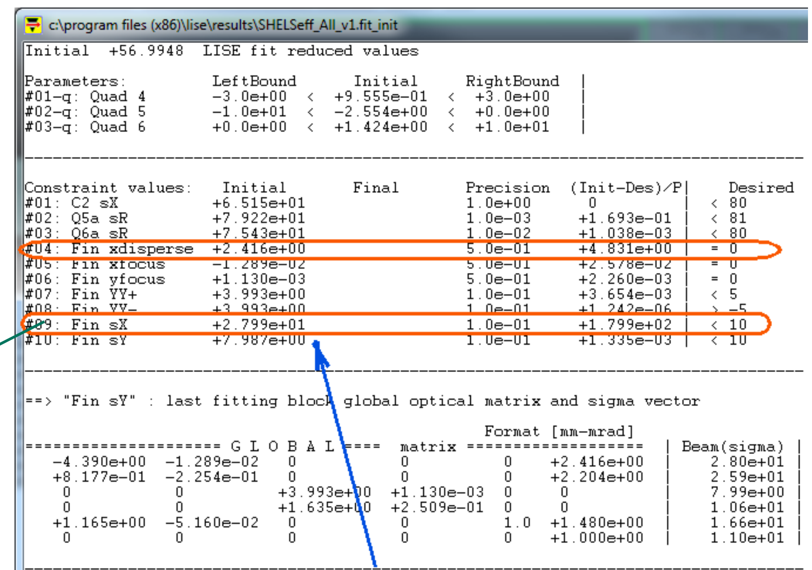






Using
SHELSeff_sym_part3_7.lpp
quad fields





c:\program files (x86)\lise\results\SHELSeff_All_v1.fit_init

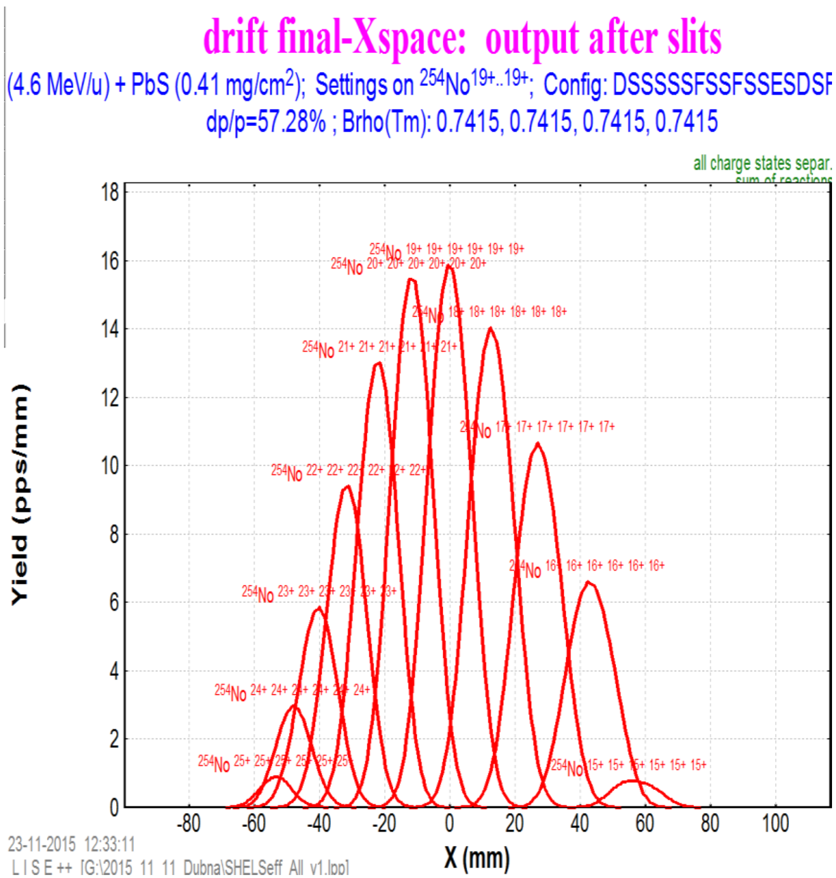
```
Initial  +56.9948  LISE fit reduced values

Parameters:          LeftBound      Initial        RightBound  |
#01-q: Quad 4        -3.0e+00  <  +9.555e-01  <   +3.0e+00     |
#02-q: Quad 5        -1.0e+01  <  -2.554e+00  <   +0.0e+00     |
#03-q: Quad 6        +0.0e+00  <  +1.424e+00  <   +1.0e+01     |

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

Constraint values:   Initial        Final        Precision  (Init-Des)/P|    Desired
#01: C2 sX           +6.515e+01                  1.0e+00     0          |  < 80
#02: Q5a sR          +7.922e+01                  1.0e-03    +1.693e-01  |  < 81
#03: Q6a sR          +7.543e+01                  1.0e-02    +1.038e-03  |  < 80
#04: Fin xdisperse   +2.416e+00                  5.0e-01    +4.831e+00  |  = 0
#05: Fin xfocus      -1.289e-02                  5.0e-01    +2.578e-02  |  = 0
#06: Fin yfocus      +1.130e-03                  5.0e-01    +2.260e-03  |  = 0
#07: Fin YY+         +3.993e+00                  1.0e-01    +3.654e-03  |  < 5
#08: Fin YY-         +3.993e+00                  1.0e-01    +1.242e-06  |  > -5
#09: Fin sX          +2.799e+01                  1.0e-01    +1.799e+02  |  < 10
#10: Fin sY          +7.987e+00                  1.0e-01    +1.335e-03  |  < 10

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

==> "Fin sY" : last fitting block global optical matrix and sigma vector

                                             Format [mm-mrad]
====================== G L O B A L ====  matrix ====================  | Beam(sigma) |
   -4.390e+00  -1.289e-02   0           0            0    +2.416e+00  |   2.80e+01 |
   +8.177e-01  -2.254e-01   0           0            0    +2.204e+00  |   2.59e+01 |
    0           0          +3.993e+00  +1.130e-03    0     0          |   7.99e+00 |
    0           0          +1.635e+00  +2.509e-01    0     0          |   1.06e+01 |
   +1.165e+00  -5.160e-02   0           0           1.0   +1.480e+00  |   1.66e+01 |
    0           0           0           0            0    +1.000e+00  |   1.10e+01 |

------------------------------------------------------------------------------------
```

not so good
due to large dispersion

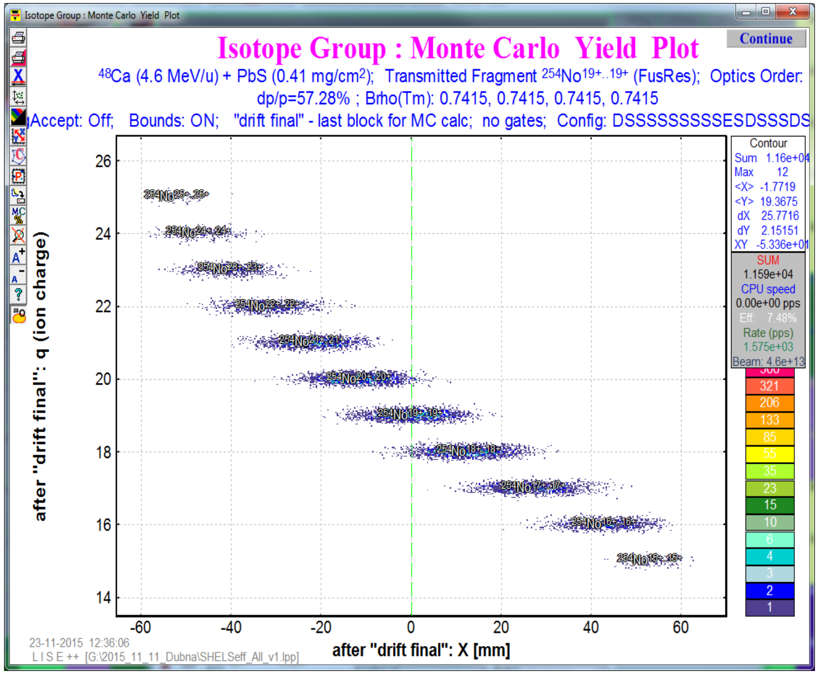
SHELSeff_All_v1.lpp

With the D8 dipole implementation we created large charge dispersion! (**x/dQ** ~ 10mm/unit)

Horizontal distribution of ^{254}No ions in the final point



“Distribution” method

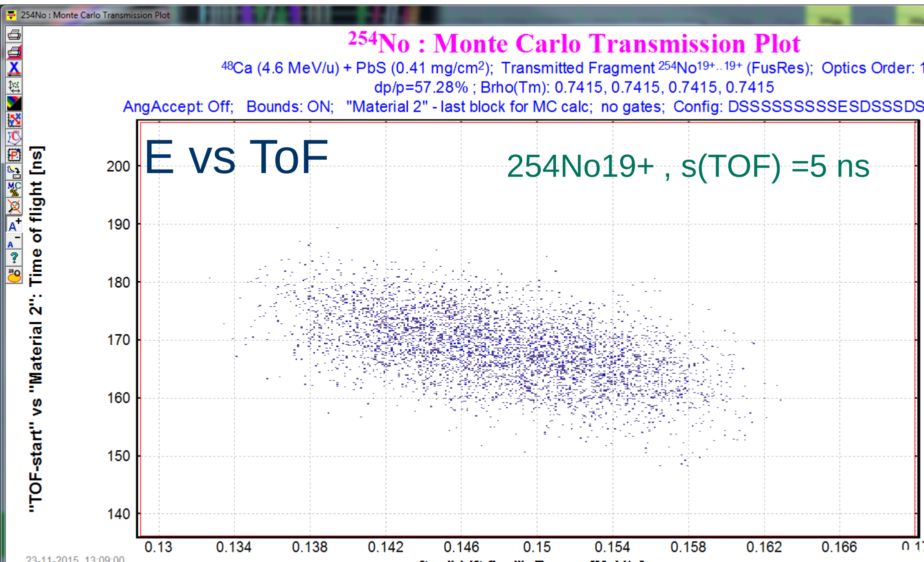


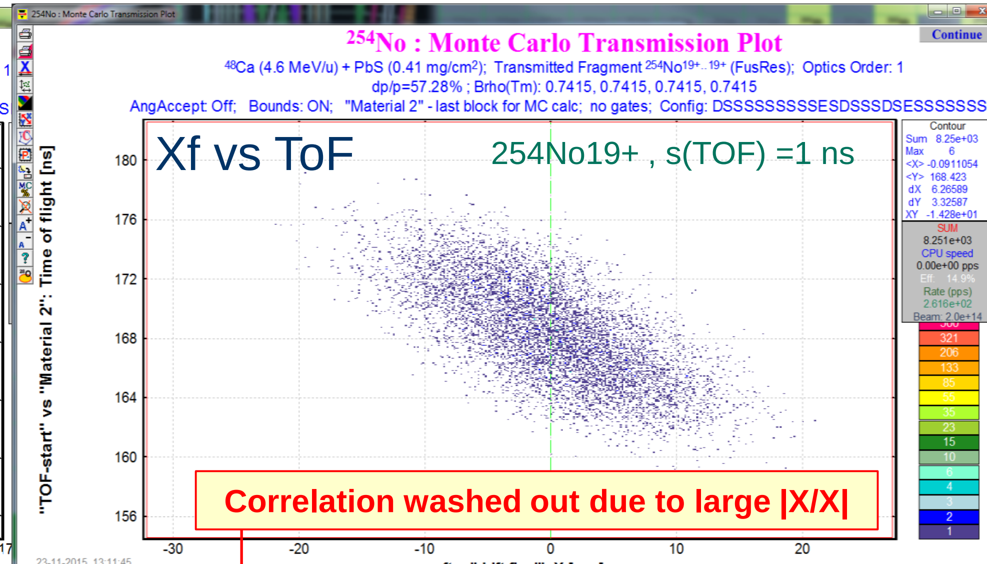
Monte Carlo method

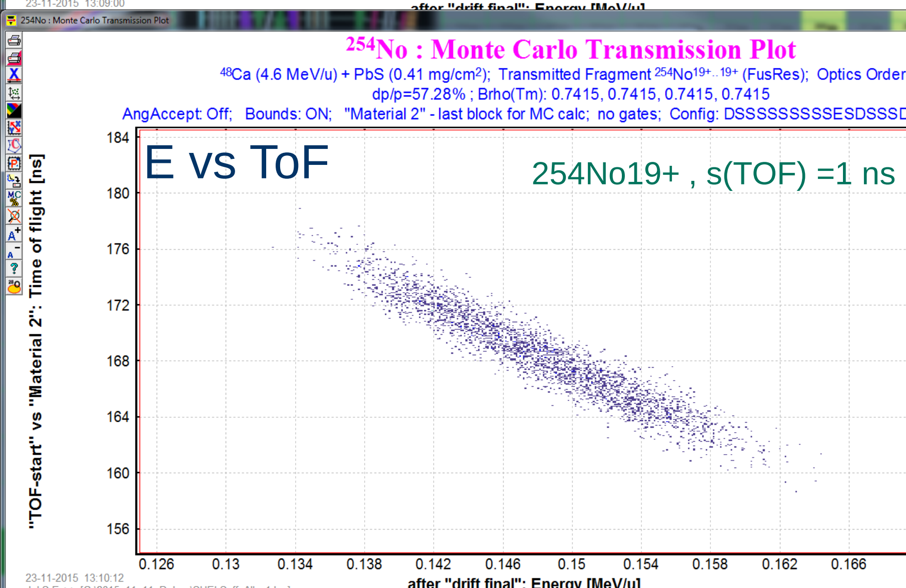
SHELSeff_All_v1.lpp : ToF vs X_{final}

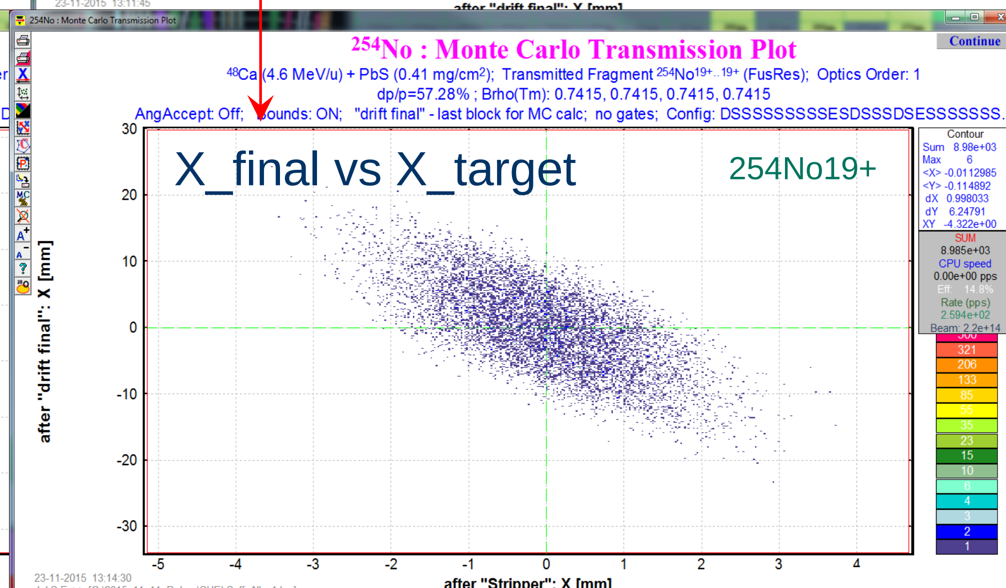
So, the final dispersion is not equal to 0, then what is about X–ToF correlation?

ToF resolution ~ 0.5 us??
Assume for simulations a little bit better



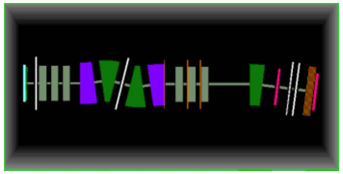




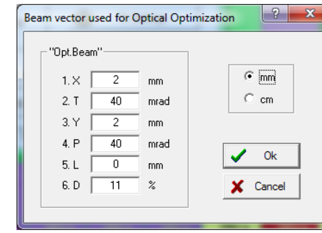


MICHIGAN STATE UNIVERSITY LISE++

attempt to optimize SHELSeff_All_v1.lpp for smaller horizontal final spot and higher transmission



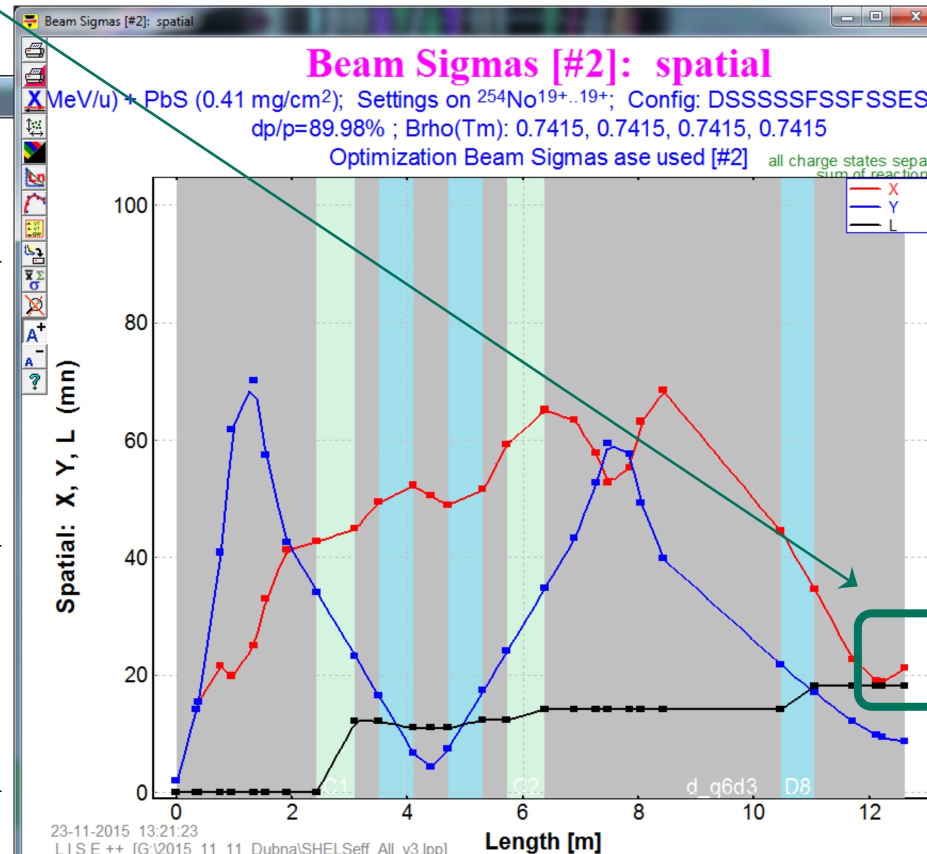
Smaller X-spot
and X-dispersion



Larger |X/X| and
worse focus

c:\program files (x86)\lise\results\SHELSeff_All_v3.fit_init

```
Initial  +4.53649  LISE fit reduced values

Parameters:          LeftBound       Initial      RightBound  |
#01-q:  Quad 4       -3.0e+00   <   +6.938e-01  <  +3.0e+00   |
#02-q:  Quad 5       -1.0e+01   <   -2.413e+00  <  +0.0e+00   |
#03-q:  Quad 6       +0.0e+00   <   +1.474e+00  <  +1.0e+01   |

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

Constraint values:    Initial        Final       Precision   (Init-Des)/P|   Desired
#01: C2 sX            +6.515e+01                  1.0e+00        0        |  < 80
#02: Q5a sR           +7.935e+01                  1.0e-03    +1.922e-01   |  < 81
#03: Q6a sR           +8.000e+01                  1.0e-02    +1.011e-01   |  < 80
#04: Fin xdisperse    +1.327e+00                  5.0e-01    +2.655e+00   |  = 0
#05: Fin xfocus       +2.515e-01                  5.0e-01    +5.031e-01   |  = 0
#06: Fin yfocus       -7.634e-02                  1.0e+00    +7.634e-02   |  = 0
#07: Fin YY+          +4.016e+00                  1.0e+00    +3.739e-04   |  < 5
#08: Fin YY-          +4.016e+00                  1.0e+00    +1.214e-07   |  > -5
#10: Fin sX           +2.117e+01                  1.0e-01    +1.172e+01   |  < 20

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

==> "Fin sY" : last fitting block global optical matrix and sigma vector

                                              Format [mm-mrad]
==================== G L O B A L ==== matrix ===================  | Beam(sigma) |
  -5.784e+00  +2.515e-01   0          0           0   +1.327e+00   |   2.12e+01  |
  +7.548e-01  -2.057e-01   0          0           0   +2.123e+00   |   2.48e+01  |
   0           0          +4.016e+00  -7.634e-02  0    0           |   8.59e+00  |
   0           0          +1.585e+00  +2.189e-01  0    0           |   9.31e+00  |
  +1.328e+00  -8.070e-02   0          0          1.0  +1.600e+00   |   1.81e+01  |
   0           0           0          0           0   +1.000e+00   |   1.10e+01  |
-------------------------------------------------------------------------------
```



Conclusion

1. It has been shown that with the symmetric configuration QQQ+EDDE+QQQ it's possible to obtain good separator optical properties, as focuses in both directions, momentum and charge zero dispersions, as well high 97% transmission of all produced ^{254}No ions (1st order optics). This configuration is used to be easy to tune.

2. The neutron flow made to implement a special dispersive block to move charge particles from central axis of the symmetric separator. The D8 magnet creates large charge dispersion (x/dQ ~ 10 mm/unit), that decreases overall ^{254}No ion transmission.

3. First attempts of the QQQ+EDDE+QQQ+D configuration optimization could not make zero momentum dispersion and avoid charge dispersion. These attempts made large horizontal magnification and worse focusing, even the spot has became a little bit smaller. Transmission is about ~90%.

4. It has been shown that Analytical calculations ("Distribution" method) fairly agree to Monte Carlo transmission calculations.

Outlooks

1. It is necessary to note the significance* of electric dipole 2nd optics contribution, which was not applied for this analysis, and should be used in future.

2. The charge dispersion value should be calculated in LISE++, and further be used in optimization process for constraints.

3. Consider (discuss) a possibility to implement a new additional disperse block at the end of separator to compensate dispersion.

4. Work more under the SHELSeff_All_v1.lpp configuration optimization to get better optical properties and higher transmission.

* lise.nscl.msu.edu/9_10/EMMA.pdf#page=18