2nd order Electrostatic Dipole in LISE++

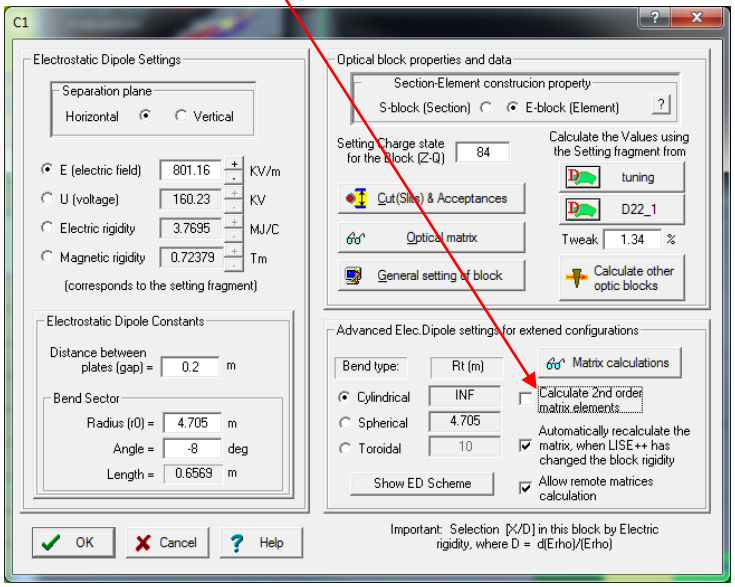
Version 9.10.296
from 06/02/2016

The 2nd order approximation equations in C-format were provided by **Robert Hipple** (Department of Physics and Astronomy, Michigan State University) based on **H.Wolnick**'s work NIM 34 (1965) 213-221

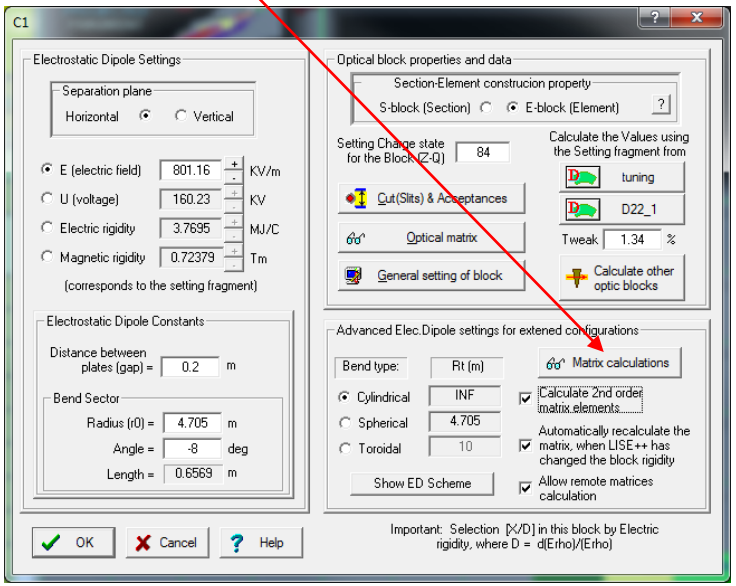
- 2nd order settings for already existed configuration
- Comparison between COSY & LISE calculations for electric dipoles
- Using 2nd order electrostatic dipoles in EMMA @ TRIUMF
- Using 2nd order electrostatic dipoles in SHELS @ FLNR/JINR
- Outlook

2nd order E.D. settings for already existed configuration

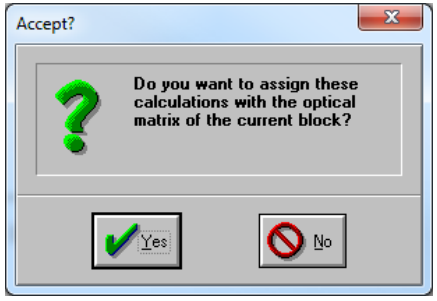
1st step: set “checked” the 2nd order box



2nd step: click “Matrix calculations” button



3rd step: Accept calculations



Comparison between COSY & LISE calculations for electric dipoles

"Cylindrical" type; Radius = 1 m; Angle = 20 deg

LISE

Block: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

1 [X]:	+8.8064e-01	+3.3510e-02	0	0	0	+1.1936e-01
2 [T]:	-6.6995e+00	+8.8064e-01	0	0	0	+6.6995e+00
3 [Y]:	0	0	+1.0000e+00	+3.4910e-02	0	0
4 [F]:	0	0	0	+1.0000e+00	0	0
5 [L]:	-6.6995e-01	-1.1940e-02	0	0	+1.0000e+00	-2.8000e-02
6 [D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1 1:	-2.8189e-03					
1 2:	+5.7678e-04	+5.1381e-06				
1 3:	0	0	0			
1 4:	0	0	0	-5.9697e-06		
1 5:	0	0	0	0	0	
1 6:	+5.6350e-03	+9.3310e-05	0	0	0	-1.6237e-03
2 1:	-8.9888e-02					
2 2:	-4.3966e-03	-5.3350e-05				
2 3:	0	0	0			
2 4:	0	0	0	-3.3506e-04		
2 5:	0	0	0	0	0	
2 6:	+1.5725e-01	+4.3938e-03	0	0	0	-1.2329e-01
3 1:	0					
3 2:	0	0				
3 3:	0	0	0			
3 4:	+6.7013e-04	+1.1939e-05	0	0		
3 5:	0	0	0	0	0	
3 6:	0	0	0	+2.8004e-05	0	0
4 1:	0					
4 2:	0	0				
4 3:	0	0	0			
4 4:	-1.1936e-03	+3.3506e-04	0	0		
4 5:	0	0	0	0	0	
4 6:	0	0	0	+1.1936e-03	0	0
5 1:	0					
5 2:	0	0				
5 3:	0	0	0			
5 4:	0	0	0	0		
5 5:	0	0	0	0	0	
5 6:	0	0	0	0	0	0

COSY

: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

X]:	+8.8073e-01	+3.3510e-02	0	0	0	+1.1927e-01
T]:	-6.6943e+00	+8.8073e-01	0	0	0	+6.6943e+00
Y]:	0	0	+1.0000e+00	+3.4910e-02	0	0
F]:	0	0	0	+1.0000e+00	0	0
L]:	-6.6943e-01	-1.1930e-02	0	0	+1.0000e+00	-2.7950e-02
D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1:	-2.8145e-03					
2:	+5.7693e-04	+5.1394e-06				
3:	0	0	0			
4:	0	0	0	-5.9698e-06		
5:	0	0	0	0	0	
6:	+5.6290e-03	+9.3219e-05	0	0	0	-1.6231e-03
1:	-3.0744e-02					
2:	-1.0955e-03	-3.4837e-04				
3:	0	0	0			
4:	0	0	0	-3.3507e-04		
5:	0	0	0	0	0	
6:	+1.9537e-01	+1.0955e-03	0	0	0	-9.7759e-02
1:	0					
2:	0	0				
3:	0	0	0			
4:	+6.7015e-04	+1.1939e-05	0	0		
5:	0	0	0	0	0	
6:	0	0	0	+2.7982e-05	0	0
1:	0					
2:	0	0				
3:	0	0	0			
4:	0	0	0	0		
5:	0	0	0	0	0	
6:	0	0	0	0	0	0
1:	-6.0224e-03					
2:	-3.3386e-04	-2.0081e-05				
3:	0	0	0			
4:	0	0	0	-1.6054e-05		
5:	0	0	0	0	0	
6:	+5.3647e-03	-2.3688e-05	0	0	0	+3.8585e-04

Comparison between COSY & LISE calculations for electric dipoles

"Cylindrical" type; Radius = 4 m; Angle = 20 deg

LISE

Block: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

1	[X]:	+8.8064e-01	+3.3510e-02	0	0	0	+1.1936e-01
2	[T]:	-6.6995e+00	+8.8064e-01	0	0	0	+6.6995e+00
3	[Y]:	0	0	+1.0000e+00	+3.4910e-02	0	0
4	[F]:	0	0	0	+1.0000e+00	0	0
5	[L]:	-6.6995e-01	-1.1940e-02	0	0	+1.0000e+00	-2.8000e-02
6	[D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1	1:	-2.8189e-03					
1	2:	+5.7678e-04	+5.1381e-06				
1	3:	0	0	0			
1	4:	0	0	0	-5.9697e-06		
1	5:	0	0	0	0	0	
1	6:	+5.6350e-03	+9.3310e-05	0	0	0	-1.6237e-03
2	1:	-8.9888e-02					
2	2:	-4.3966e-03	-5.3350e-05				
2	3:	0	0	0			
2	4:	0	0	0	-3.3506e-04		
2	5:	0	0	0	0	0	
2	6:	+1.5725e-01	+4.3938e-03	0	0	0	-1.2329e-01
3	1:	0					
3	2:	0	0				
3	3:	0	0	0			
3	4:	+6.7013e-04	+1.1939e-05	0	0		
3	5:	0	0	0	0	0	
3	6:	0	0	0	+2.8004e-05	0	0
4	1:	0					
4	2:	0	0				
4	3:	0	0	0			
4	4:	-1.1936e-03	+3.3506e-04	0	0		
4	5:	0	0	0	0	0	
4	6:	0	0	0	+1.1936e-03	0	0
5	1:	0					
5	2:	0	0				
5	3:	0	0	0			
5	4:	0	0	0	0		
5	5:	0	0	0	0	0	
5	6:	0	0	0	0	0	0

COSY

: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

X]:	+8.8073e-01	+3.3510e-02	0	0	0	+1.1927e-01
T]:	-6.6943e+00	+8.8073e-01	0	0	0	+6.6943e+00
Y]:	0	0	+1.0000e+00	+3.4910e-02	0	0
F]:	0	0	0	+1.0000e+00	0	0
L]:	-6.6943e-01	-1.1930e-02	0	0	+1.0000e+00	-2.7950e-02
D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1:	-2.8145e-03					
2:	+5.7693e-04	+5.1394e-06				
3:	0	0	0			
4:	0	0	0	-5.9698e-06		
5:	0	0	0	0	0	
6:	+5.6290e-03	+9.3219e-05	0	0	0	-1.6231e-03
1:	-3.0744e-02					
2:	-1.0955e-03	-3.4837e-04				
3:	0	0	0			
4:	0	0	0	-3.3507e-04		
5:	0	0	0	0	0	
6:	+1.9537e-01	+1.0955e-03	0	0	0	-9.7759e-02
1:	0					
2:	0	0				
3:	0	0	0			
4:	+6.7015e-04	+1.1939e-05	0	0		
5:	0	0	0	0	0	
6:	0	0	0	+2.7982e-05	0	0
1:	0					
2:	0	0				
3:	0	0	0			
4:	0	0	0	0		
5:	0	0	0	0	0	
6:	0	0	0	0	0	0
1:	-6.0224e-03					
2:	-3.3386e-04	-2.0081e-05				
3:	0	0	0			
4:	0	0	0	-1.6054e-05		
5:	0	0	0	0	0	
6:	+5.3647e-03	-2.3688e-05	0	0	0	+3.8585e-04

Comparison between COSY & LISE calculations for electric dipoles

"Spherical" type; Radius = 4 m; Angle = 45 deg

LISE

Block: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

1	[X]:	+7.0717e-01	+2.8285e-01	0	0	0	+2.3429e+00
2	[T]:	-1.7674e+00	+7.0717e-01	0	0	0	+1.4141e+01
3	[Y]:	0	0	+7.0711e-01	+2.8284e-01	0	0
4	[F]:	0	0	-1.7678e+00	+7.0711e-01	0	0
5	[L]:	-1.4141e+00	-2.3429e-01	0	0	+1.0000e+00	-1.2524e+00
6	[D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1	1:	-1.2502e-03					
1	2:	+1.0000e-03	+8.2843e-05				
1	3:	0	0	+2.5889e-04			
1	4:	0	0	+2.0711e-04	-1.0000e-04		
1	5:	0	0	0	0	0	
1	6:	+1.9997e-02	+3.3133e-03	0	0	0	-2.1418e-02
2	1:	-5.0031e-02					
2	2:	-7.0730e-03	-8.2863e-04				
2	3:	0	0	+9.1533e-04			
2	4:	0	0	+1.7678e-03	-5.0001e-04		
2	5:	0	0	0	0	0	
2	6:	+1.9990e-01	+5.6557e-02	0	0	0	-1.9997e-01
3	1:	0					
3	2:	0	0				
3	3:	-5.1780e-04	-2.0711e-04	0			
3	4:	+1.2071e-03	+2.0000e-04	0	0		
3	5:	0	0	0	0	0	
3	6:	0	0	+4.1417e-03	+1.6567e-03	0	0
4	1:	0					
4	2:	0	0				
4	3:	+2.0708e-02	-8.2846e-03	0			
4	4:	-4.9995e-03	+2.0001e-03	0	0		
4	5:	0	0	0	0	0	
4	6:	0	0	+2.4997e-02	+9.9990e-03	0	0
5	1:	0					
5	2:	0	0				
5	3:	0	0	0			
5	4:	0	0	0			
5	5:	0	0	0			
5	6:	0	0	0			

COSY

ck: "ElecDipole" Matrices: "LOCAL"

transport format [cm-mrad]

* TRANSFORM 1 *

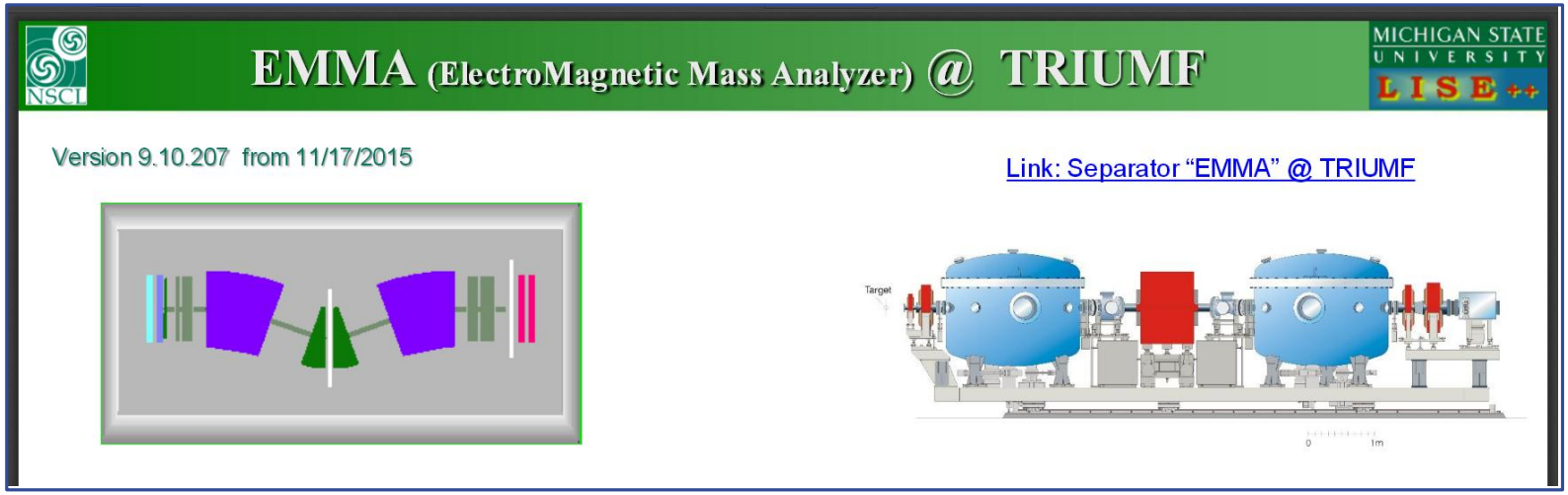
[X]:	+7.0717e-01	+2.8285e-01	0	0	0	+2.3429e+00
[T]:	-1.7674e+00	+7.0717e-01	0	0	0	+1.4141e+01
[Y]:	0	0	+7.0711e-01	+2.8284e-01	0	0
[F]:	0	0	-1.7678e+00	+7.0711e-01	0	0
[L]:	-1.4141e+00	-2.3429e-01	0	0	+1.0000e+00	-1.2524e+00
[D]:	0	0	0	0	0	+1.0000e+00

* TRANSFORM 2 *

1:	-1.2498e-03					
2:	+1.0001e-03	+8.2851e-05				
3:	0	0	+2.5896e-04			
4:	0	0	+2.0712e-04	-1.0000e-04		
5:	0	0	0	0	0	
6:	+1.9998e-02	+3.3133e-03	0	0	0	-2.1421e-02
1:	0					
2:	0	-7.0712e-04				
3:	0	0	+9.1571e-04			
4:	0	0	+1.7679e-03	-5.0000e-04		
5:	0	0	0	0	0	
6:	+7.0698e-02	-1.1922e-06	0	0	0	-2.1212e-01
1:	0					
2:	0	0				
3:	-5.1766e-04	-2.0709e-04	0			
4:	+1.2071e-03	+2.0001e-04	0	0		
5:	0	0	0	0	0	
6:	0	0	+4.1417e-03	+1.6567e-03	0	0
1:	0					
2:	0	0				
3:	+4.4203e-03	+7.3237e-04	0			
4:	-7.3210e-04	+3.0634e-08	0	0		
5:	0	0	0	0	0	
6:	0	0	+3.5352e-02	+5.8574e-03	0	0
1:	-1.8747e-03					
2:	-1.4999e-03	-2.6567e-04				
3:	0	0	-1.1426e-03			
4:	0	0	-8.5730e-05	-1.0000e-04		
5:	0	0	0	0	0	
6:	+1.7175e-03	-2.0584e-03	0	0	0	+1.2124e-02

Using 2nd order electrostatic dipoles in EMMA @ TRIUMF

http://lise.nscl.msu.edu/9_10/EMMA.pdf



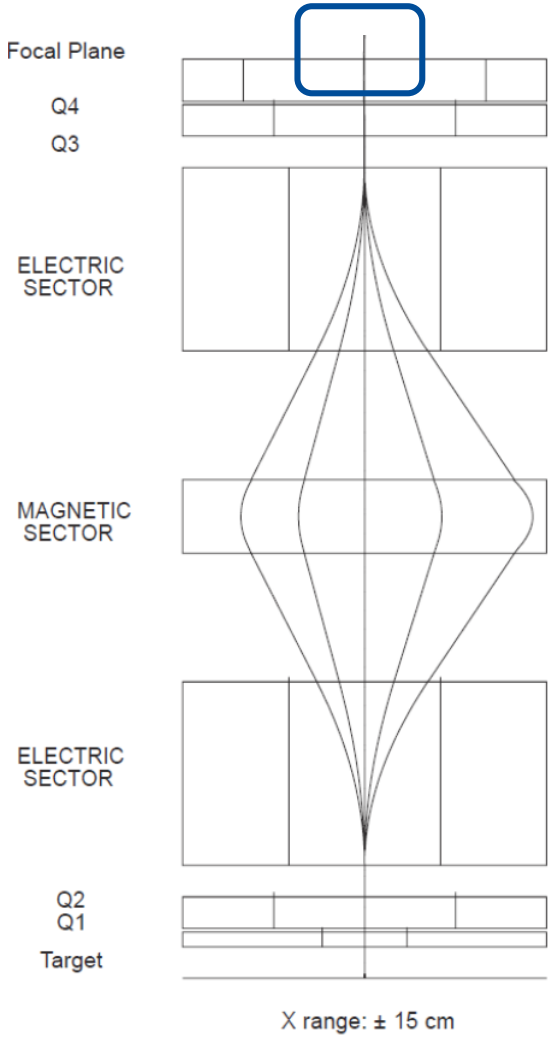
The new version with 2nd order electrostatic dipoles :

http://lise.nscl.msu.edu/9_10/ED/EMMA_2016.lpp

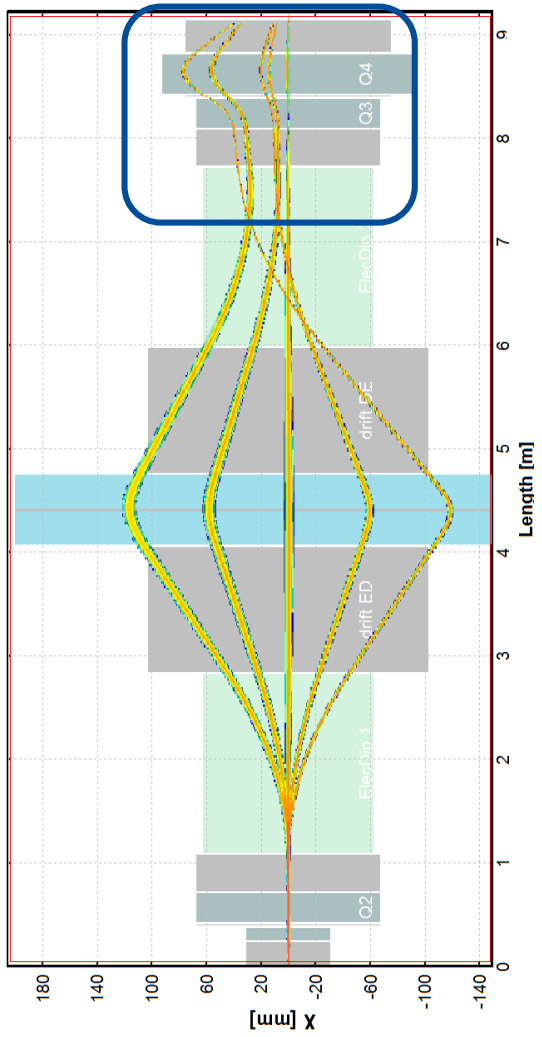
Or in the LISE++ package "files\examples\TRIUMF\EMMA_2016.lpp"

Using 2nd order electrostatic dipoles in EMMA @ TRIUMF

NIM A544 (2005) 565

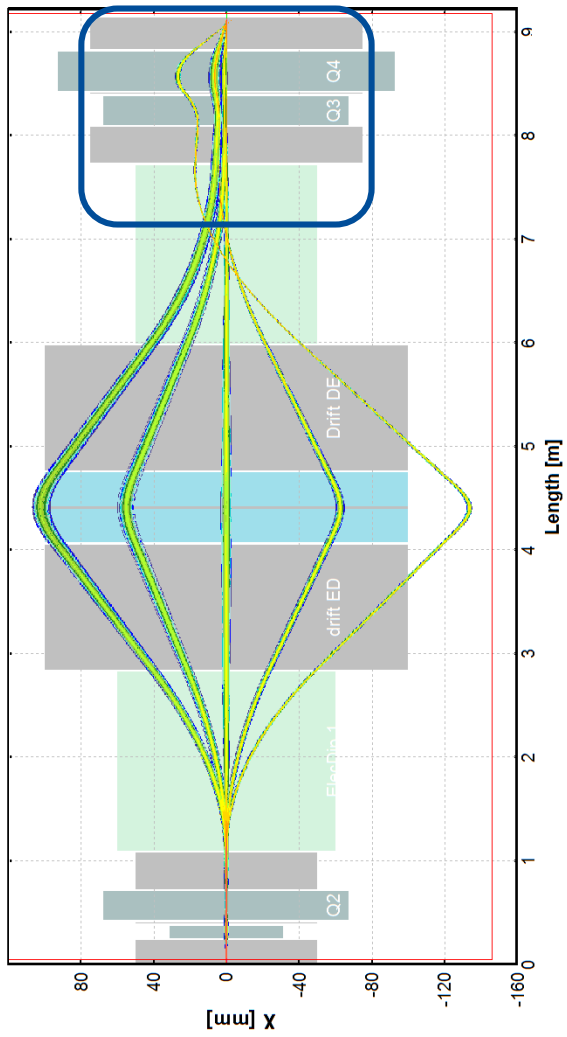


LISE++ v.9.10.207



2nd order

LISE++ v.9.10.296



2nd order

Using 2nd order electrostatic dipoles in EMMA @ TRIUMF

NIM A544 (2005) 565

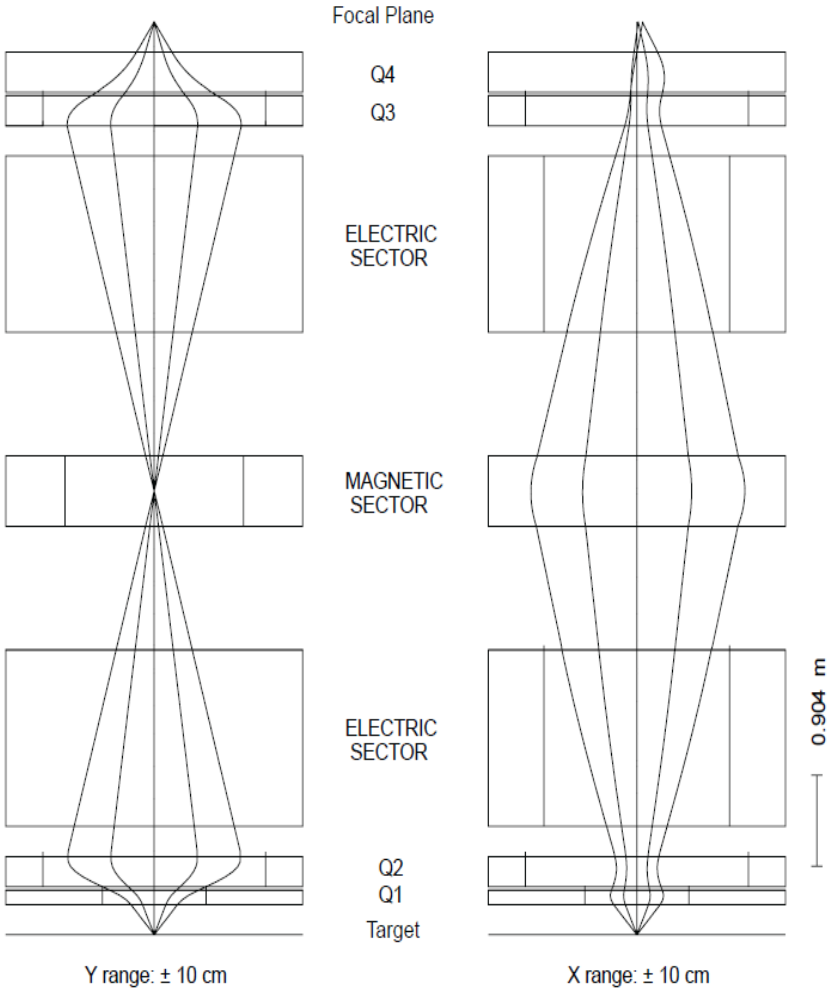
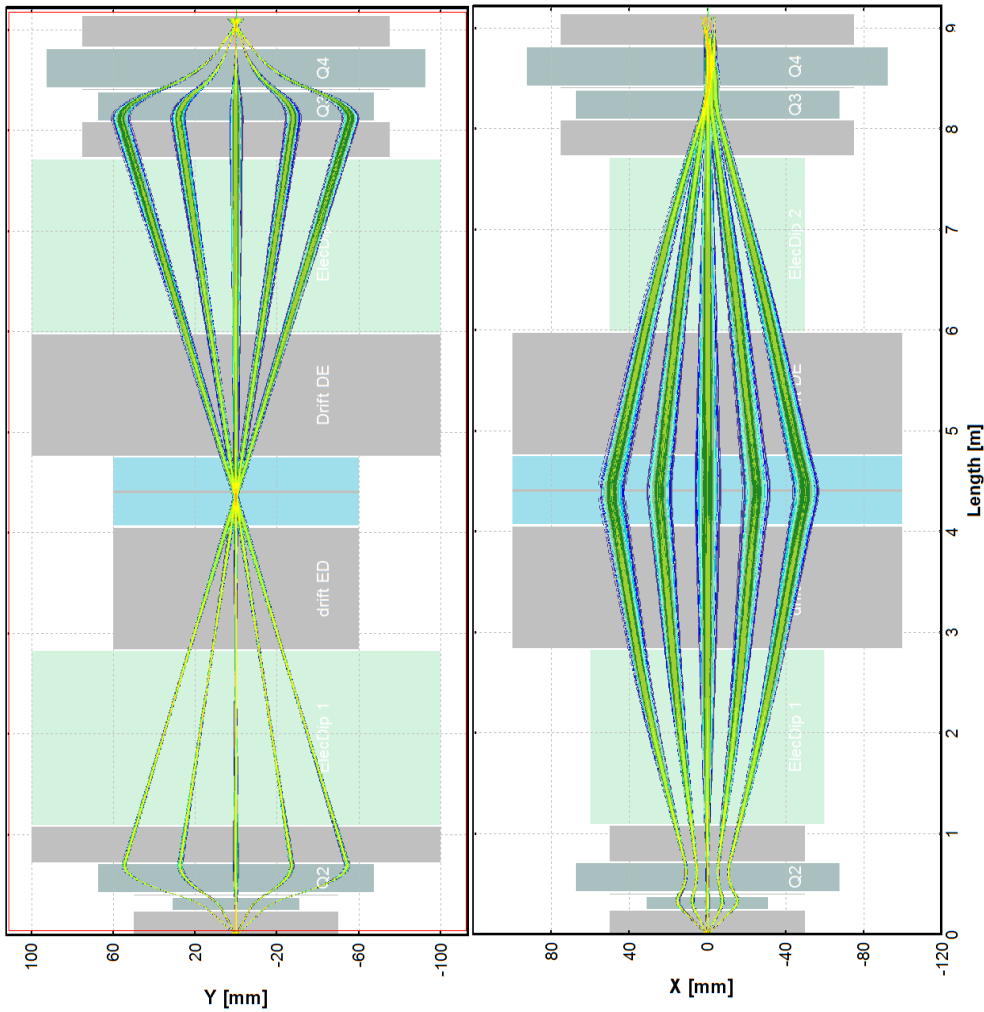


Fig. 4. Calculated spatial focus of EMMA, showing rays corresponding to a single mass emitted from the target with angles of 0, ±1.5°, and ±3° in the vertical and horizontal directions. The dominant geometric aberration in the dispersive direction, proportional to the square of the horizontal angle, is evident in the horizontal extent of the final focus.

LISE++ v.9.10.296



2nd order **2nd order**

Using 2nd order electrostatic dipoles in EMMA @ TRIUMF

NIM A544 (2005) 565

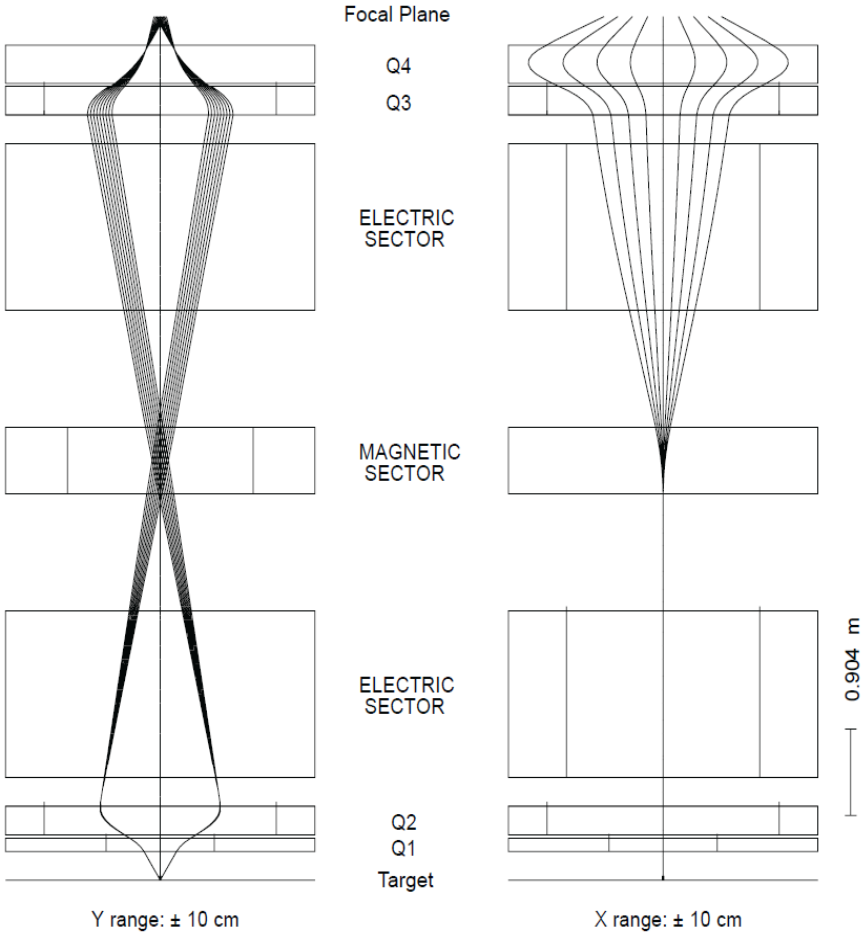
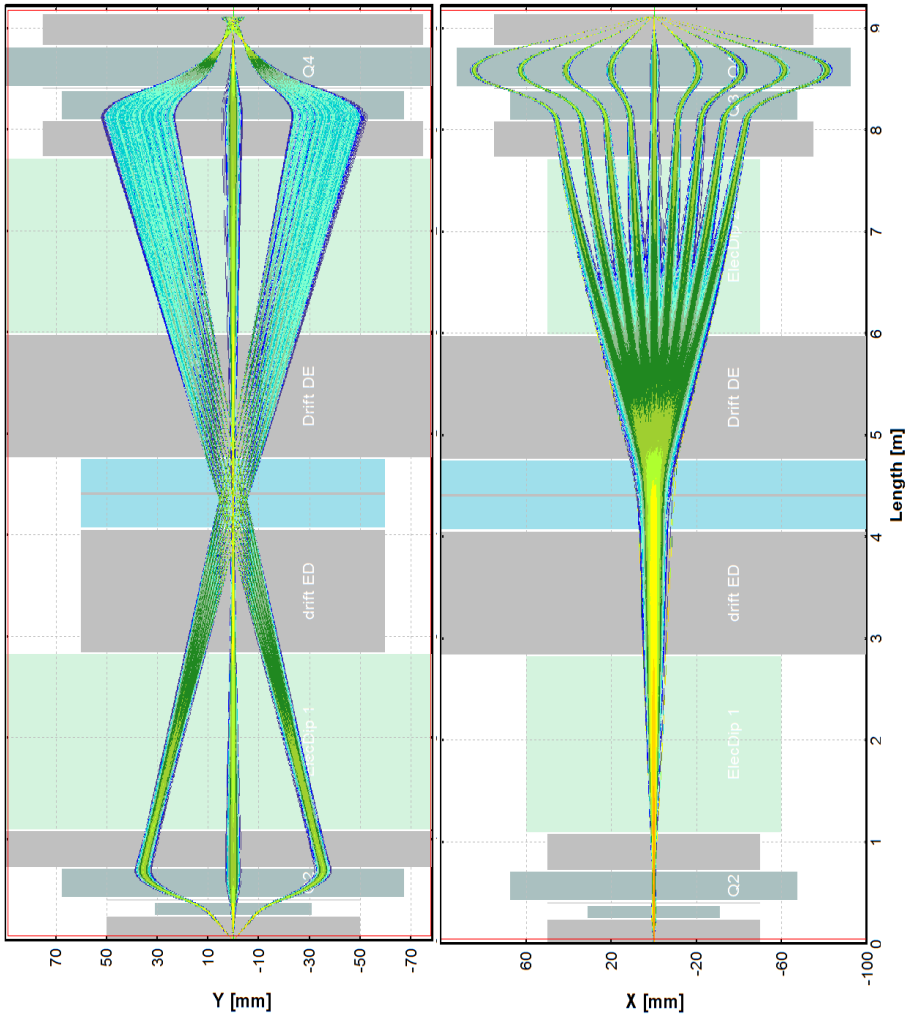


Fig. 2. Calculated mass focus of EMMA, showing rays corresponding to 9 adjacent masses emitted from the target with vertical angles of −2°, 0°, and 2°. At the focal plane, the 9 masses are seen to be dispersed horizontally and focussed vertically. Angular focussing in the horizontal direction is shown in Fig. 4.

LISE++ v.9.10.296



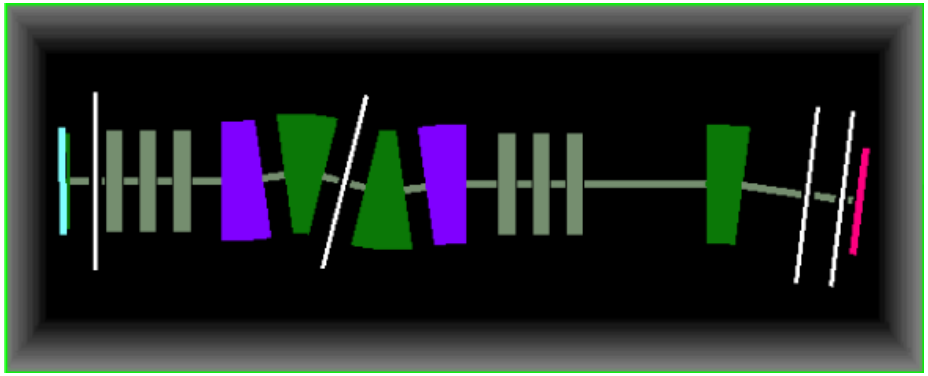
2nd order **2nd order**

with σ(X)=0.02mm & σ(Y')=1mrad

Using 2nd order electrostatic dipoles in SHELS @ FLNR/JINR

v.9.8.166
from 11/23/14

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



Outlook

To find out why the difference between H.Wolnik (used in LISE^{++}) and COSY calculations for θ/** & φ/** elements