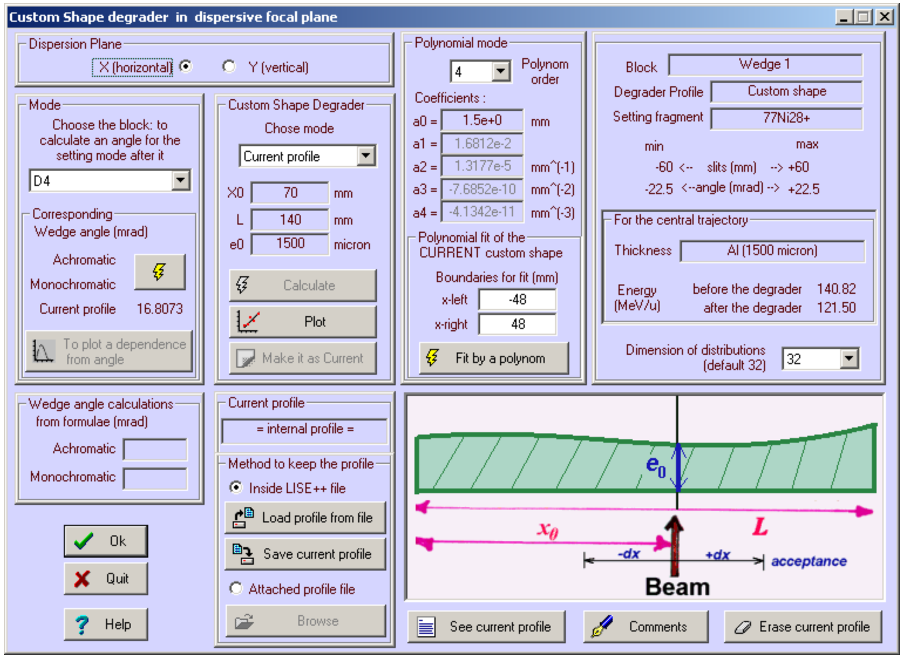
Custom Shape Degrader

The code operates under MS Windows environment and provides a highly user-friendly interface.
It can be freely downloaded from the following internet addresses:
http://www.nscl.msu/edu/lise

version 8.5.28



Contents:

- *Degraders in the dispersive focal plane (wedge, curved profile)*
- *Custom shape degrader*
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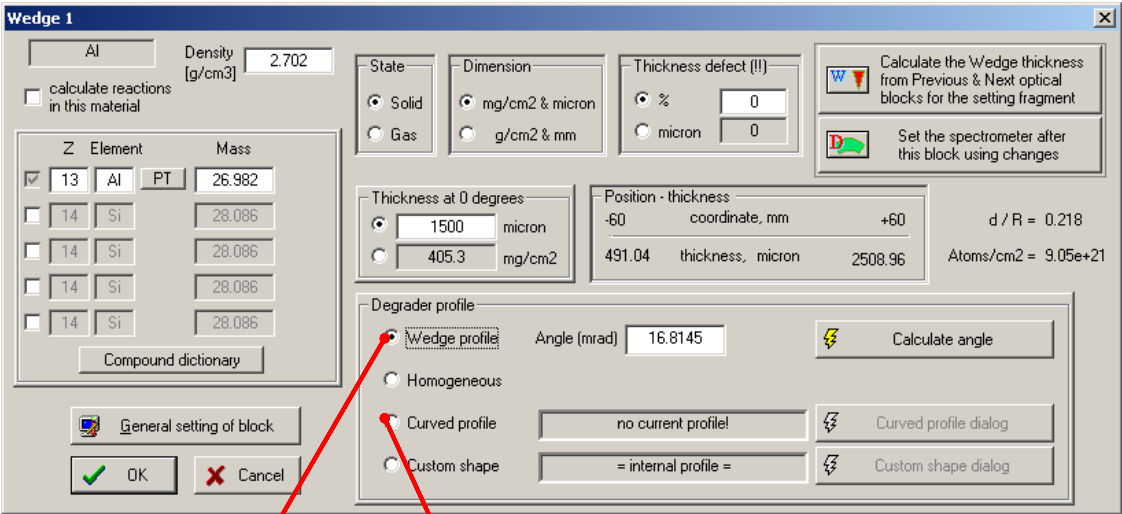
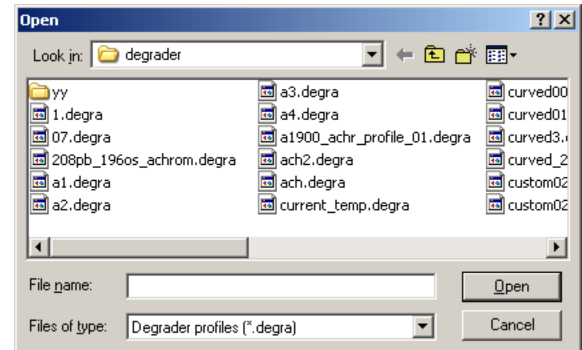
- *Polynomial shape*
- *Algorithm of calculations*
- *Negative thickness*
- *Examples*
- *New other features (version 8.5.9-8.5.28)*

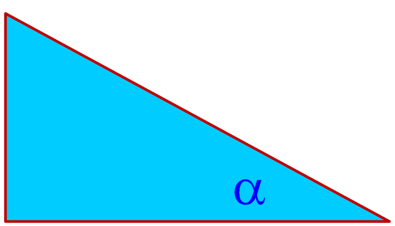
Thanks to
Dr. M.Portillo and Dr. M.Hausmann
(NSCL/MSU)
for fruitful discussions

Degraders in the dispersive focal plane

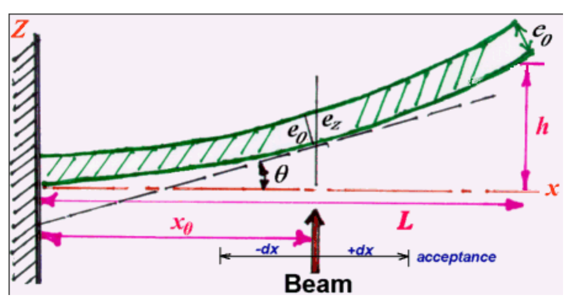


Curved profile shape can saved/loaded to/from files *.degra (default directory "lise\degrader")





LISE++ calculates a curved profile based on the angle of wedge (α)



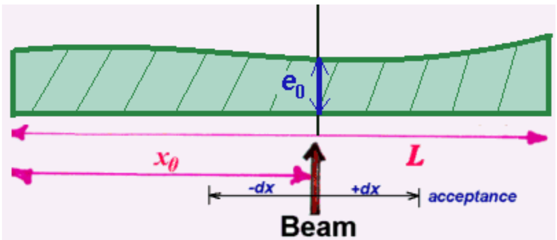
"e0" corresponds to original foil thickness
The wedge dialog shows thickness material at the central axis

Wedge and Curved profile are the first order optic degraders:
*Thickness = a1*x + a0*

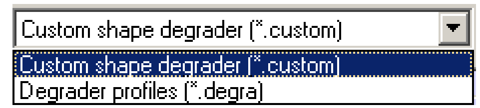
We need higher orders!

Custom Shape Degrader

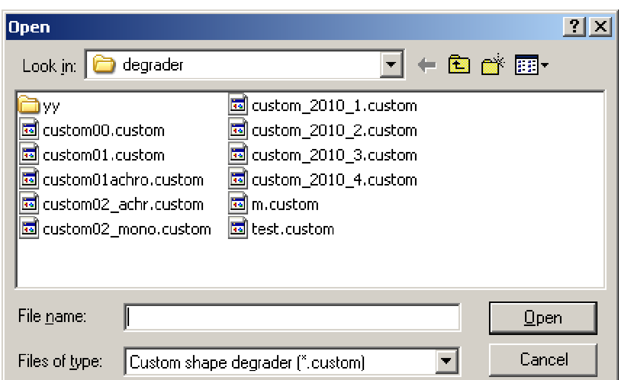
“e0” corresponds to
thickness material at the central axis

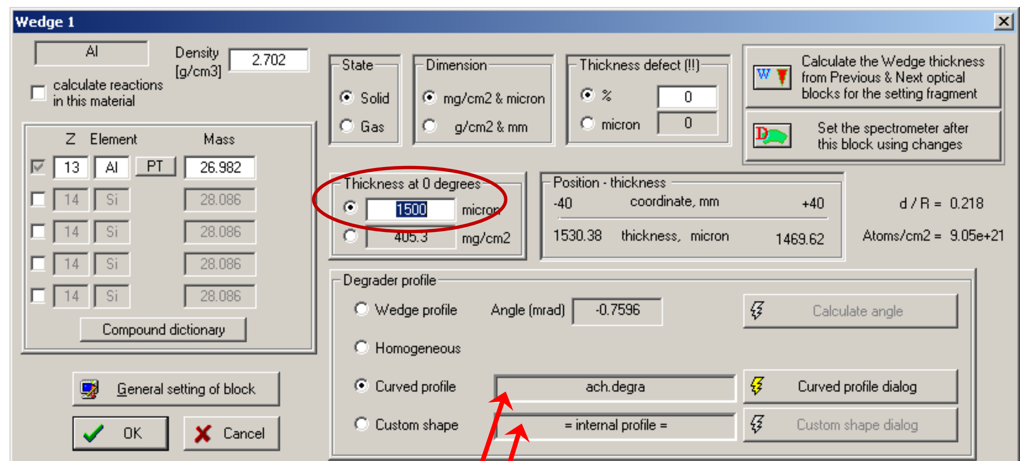


“ *.custom” and “ *.degra” files are compatible



Custom shape can saved/loaded
to/from files *.custom
(default directory “lise\degrader”)

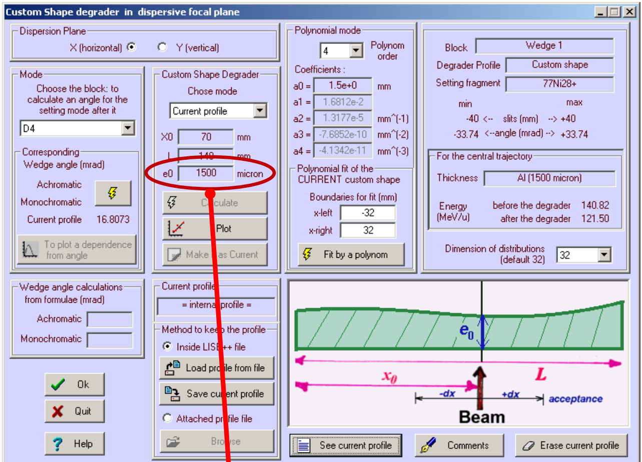




LISE++ is able to operate and keep
independently both shapes
(curved profile & custom shape)

Custom Shape vs. Curved Profile

Custom Shape



c:\user\c\lise_pp_85\degrader\current_temp

; Custom shape* Version 8.5.18 14-01-2010 11:30:40
; Block: "Wedge 1" Settings: 77Ni28+ Energy before I
; Degrader: Al (1500 micron) Dispersion: 12.75 mm/%
; Mode: Polynominal for Block "D4" Wedge angle=16.8104 m:
; NP X0 L E0 (as it was created)
; 32 70.00 140.00 1500.00
; comments here:
;========================= curved degrader ================

; N	X(mm)	Thick(um)	H(mm)	Tan(reduced)
0	-70.0000	386.9950	0.0000	0
1	-65.6250	452.9084	1.3300	0.60799
2	-61.2500	519.2889	4.6172	0.89474
3	-56.8750	585.1580	9.0628	1.1376
4	-52.5000	65[illegible].4951	14.5277	1.3607
5	-48.1250	72[illegible].3086	20.9448	1.5729
6	-43.7500	78[illegible].6084	28.2758	1.7785
7	-39.3750	858.3967	36.4973	1.9799
8	-35.0000	927.6825	45.5940	2.1786
9	-30.6250	997.4772	55.5563	2.3756
10	-26.2500	1067.7563	66.3780	2.5715
11	-21.8750	1138.5272	78.0555	2.7668
12	-17.5000	1209.8066	90.5871	2.9619
13	-13.1250	1281.6067	103.9725	3.1571
14	-8.7500	135[illegible].8883	118.2122	3.3525
15	-4.3750	[illegible]	133.3079	3.5484
16	0.0000	1500.0000	149.2616	3.7448
17	4.3750	[illegible]	166.0760	3.9418
18	8.7500	1648.0846	183.7542	4.1396
19	13.1250	1722.9252	202.2996	4.3383
20	17.5000	1798.2037	221.7159	4.5377
21	21.8750	1874.0524	242.0069	4.7[illegible]
22	26.2500	1950.3417	263.1768	4.9395
23	30.6250	2027.1336	285.2298	5.1418
24	35.0000	2104.4544	308.1701	5.3452
25	39.3750	2182.2556	332.0024	5.5496
26	43.7500	2260.5285	356.7310	5.755
27	48.1250	2339.2650	382.3605	5.9614
28	52.5000	2418.4964	408.8956	6.1689
29	56.8750	2498.2168	436.3409	6.3775
30	61.2500	2578.3824	464.7009	6.5871
31	65.6250	2659.0267	493.9805	6.7978
32	70.0000	2740.1455	524.1841	7.0096

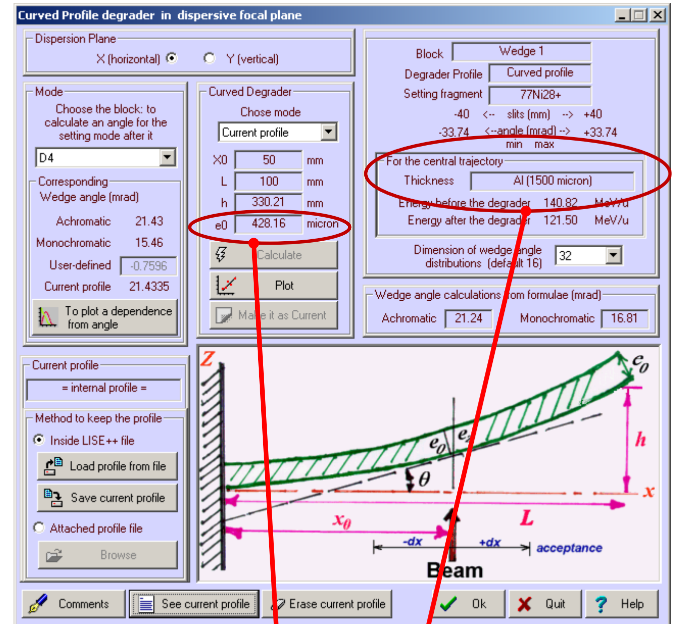
Tan (reduced) is ….

C(i) = ThickFromX(i) / min_e0
Tan_reduced(i) = tan(acos(C(i)))

where min_e0 is the minimum thickness of the degrader

Columns are used by LISE++ to calculate shapes

Curved Profile



c:\user\c\lise_pp_85\degrader\current_temp

; Curved profile* Version 8.5.28 1[illegible]-01-2010 15:45:
; Block: "Wedge 1" Settings: 77Ni28+ Energy bef
; Degrader: Al (1500 micron) Dispersion: 12.75 mm/%
; Mode: Achromatic for Block "D4" Wedge angle=21.433
; NP X0 L h E0 (as it was created
; 32 50.00 100.00 330.21 428.16
; comments here:
;=================== curved degrader ==========

; N	X(mm)	Thick(um)	H(mm)	Tan(reduced)
0	-50.0000	428.1617	0.0000	0
1	-46.8750	[illegible]	0.9[illegible]76	0.58086
2	-43.7500	562.1415	3.1445	0.85074
3	-40.6250	629.1314	6.[illegible]559	1.0766
4	-37.5000	696.1213	9.[illegible]411	1.2819
5	-34.3750	763.1111	14.1494	1.4753
6	-31.2500	830.1010	1[illegible].0498	1.661
7	-28.1250	897.0909	24.5219	1.8412
8	-25.0000	964.0808	30.5510	2.0174
9	-21.8750	1031.0707	[illegible]7.1261	2.1907
10	-18.7500	1098.0606	44.2391	2.3616
11	-15.6250	1165.0505	51.8832	2.5306
12	-12.5000	1232.0404	60.0532	2.6982
13	-9.3750	1299.0303	68.7448	2.8644
14	-6.2500	1366.020[illegible]	77.9543	3.0297
15	-3.1250	1433.0101	87.6788	3.194
16	0.0000	1500.0000	97.9156	3.3576
17	3.1250	[illegible]	108.6627	3.5205
18	6.2500	1633.9798	119.9181	3.6829
19	9.3750	1700.9697	131.6802	3.8448
20	12.5000	1767.9596	143.9475	4.0063
21	15.6250	1834.9495	156.7188	4.1673
22	18.7500	1901.9394	169.9929	4.3281
23	21.8750	1968.9293	183.7688	4.4885
24	25.0000	2035.9192	198.0457	4.6487
25	28.1250	2102.9091	212.8227	4.8086
26	31.2500	2169.8990	228.099[illegible]	4.9683
27	34.3750	2236.8889	243.8743	5.1278
28	37.5000	2303.8787	260.1476	5.2871
29	40.6250	2370.8686	276.9186	5.4463
30	43.7500	2437.8585	294.1866	5.6053
31	46.8750	2504.8484	311.9513	5.7641
32	50.0000	2571.8383	330.2123	5.9229

Custom Shape vs. Curved Profile in LISE++ file

```
[W1_WedgeSettings]
           ProfileMode = 2                                       ; 0-Wedge,1-Homo,2-Curved,3-Custom
    PhysProfileDesirable = 2                                     ; 0-Achrom,1-Monoch,2-user-defined
                 Angle = 16.81448           mrad                 ; wedge slope for the mode (0-Wedge)
             Direction = 0                                       ; x=0, y=1
       CalculateForBlock = D4
         ProfileFileName = ach.degra
        ExternalInternal = 0                                     ; external=0 / internal=1
            ReadInternal = 0                                     ; 1 - Yes / 0 - No
          CustomFileName = NULL
       CustExternalInter = 1                                     ; external=0 / internal=1
           CustReadInter = 1                                     ; 1 - Yes / 0 - No
                  Porder = 4                                     ; polynom order 1-4
                   coef0 = 1.5e+0           mm^(+1)
                   coef1 = 1.6812e-2        mm^(+0)
                   coef2 = 1.3177e-5        mm^(-1)
                   coef3 = -7.6852e-10      mm^(-2)
                   coef4 = -4.1342e-11      mm^(-3)

[W1_CustomShape]
; Custom shape*  Version 8.5.18   14-01-2010   11:30:40
; Block: "Wedge 1"    Settings: 77Ni28+      Energy before block: 140.82 MeV/u
; Degrader: Al (1500 micron)     Dispersion: 12.75 mm/%
; Mode: Polynominal for Block "D4"     Wedge angle=16.8104 mrad
; NP       X0        L        E0 (as it was created)
; 32       70.00     140.00   1500.00
; comments here:
;========================== curved degrader =================================
; N        X(mm)       Thick(um)  H(mm)      Tan(reduced)
0          -70.0000    386.9950   0.0000     0
1          -65.6250    452.9084   1.3300     0.60799
2          -61.2500    519.2889   4.6172     0.89474
3          -56.8750    586.1580   9.0628     1.1376
4          -52.5000    653.4951   14.5277    1.3607
5          -48.1250    721.3086   20.9448    1.5729
6          -43.7500    789.6084   28.2758    1.7785
7          -39.3750    858.3967   36.4973    1.9799
8          -35.0000    927.6825   45.5940    2.1786
9          -30.6250    997.4772   55.5563    2.3756
10         -26.2500    1067.7563  66.3780    2.5715
11         -21.8750    1138.5272  78.0555    2.7668
12         -17.5000    1209.8066  90.5871    2.9619
13         -13.1250    1281.6067  103.9725   3.1571
14         -8.7500     1353.8883  118.2122   3.3525
15         -4.3750     1426.7021  133.3079   3.5484
16         0.0000      1500.0000  149.2616   3.7448
17         4.3750      1573.7799  166.0760   3.9418
18         8.7500      1648.0846  183.7542   4.1396
19         13.1250     1722.9252  202.2996   4.3383
20         17.5000     1798.2037  221.7159   4.5377
21         21.8750     1874.0524  242.0069   4.7382
22         26.2500     1950.3417  263.1768   4.9395
23         30.6250     2027.1336  285.2298   5.1418
24         35.0000     2104.4544  308.1701   5.3452
25         39.3750     2182.2556  332.0024   5.5496
```

Curved profile

Custom Shape

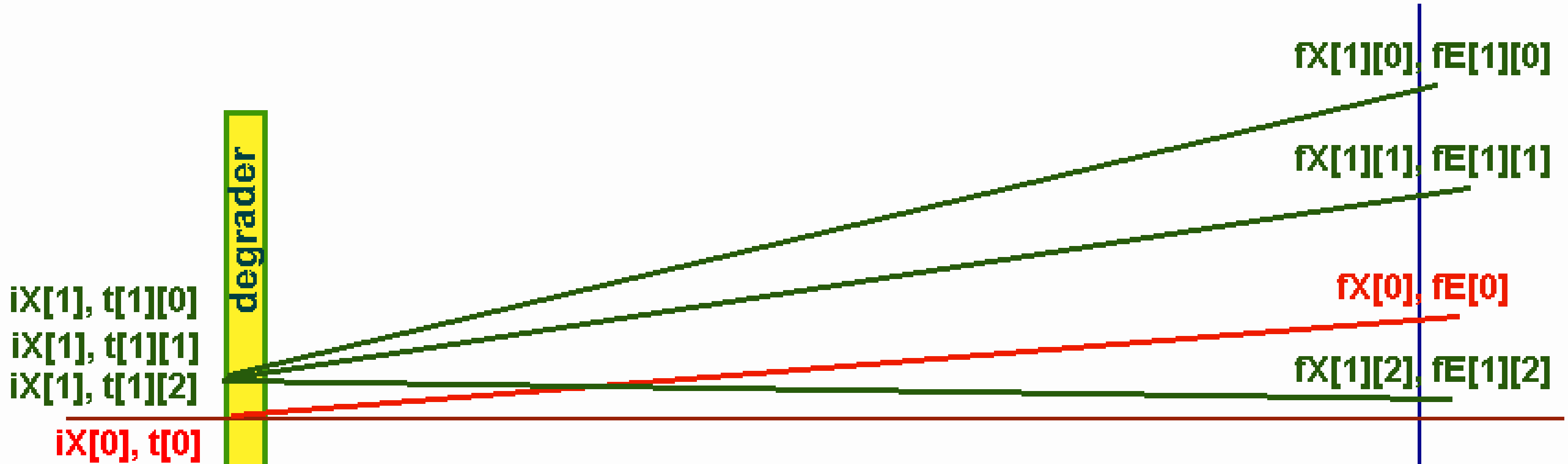
Polynomial settings

Shape inside of LISE++

Custom Shape Degrader calculation

1. for the central axis iX[0]=0 at the dispresive focal plane
 with initial thickness t[0] to obtain fX[0] and fE[0] at the final focal plane

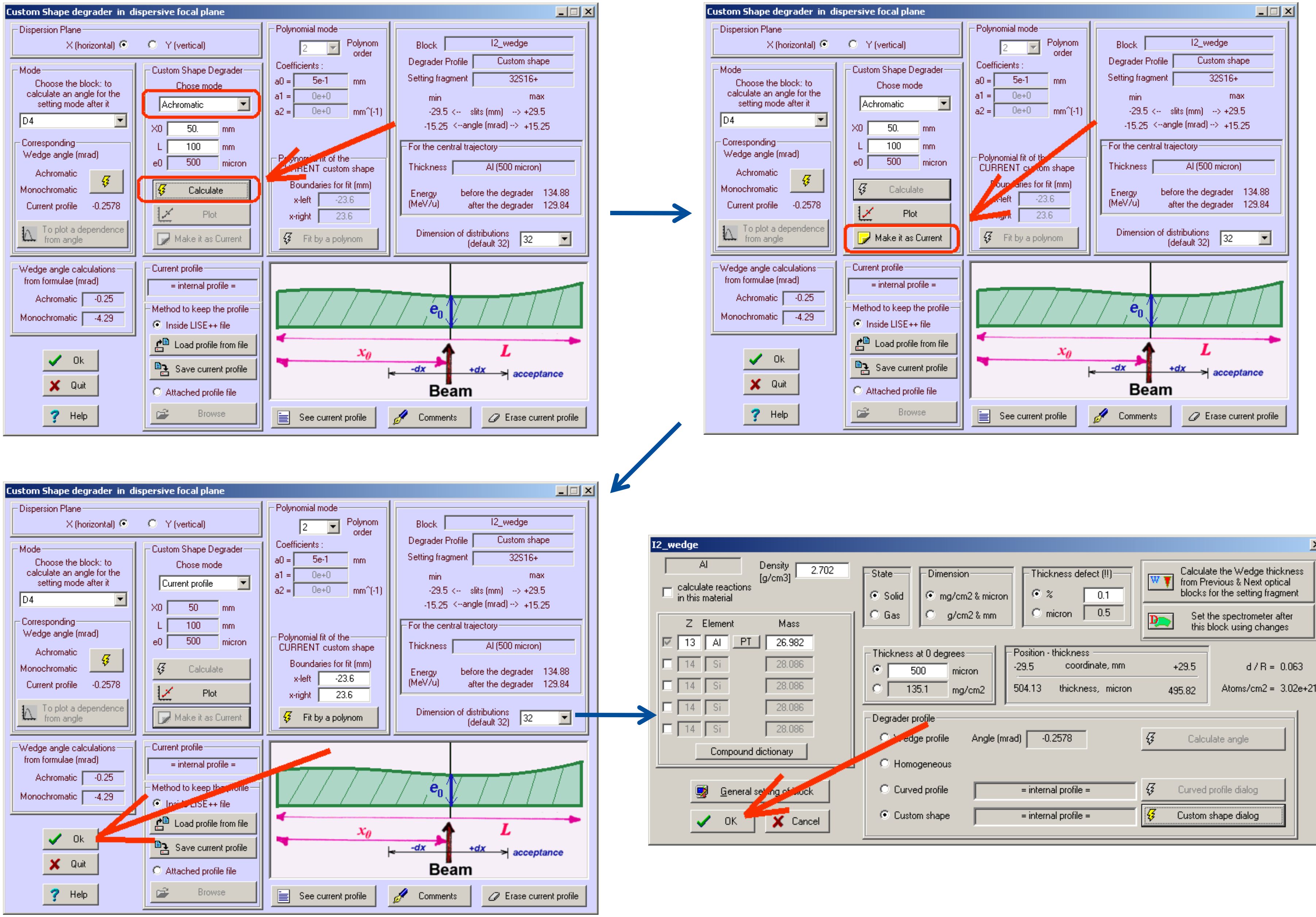
2. For iX[1]=iX[0] + h (h is step) at the DFP for 3 different thicknesses
t[1][0] = t[0], t[1] = t[0] + A*h, t[2] = t[0] + A*h calculate fX and fEcal plane,
where A is wedge angle corresponding to initial conditions



3A. Achromatic mode: use parabola interpolation with points
fX[1][0], fX[1][1], fX[1][2] to find t[1][final] corresponding to fX[0]

3B. Monocromatic mode: use parabola interpolation with points
fE[1][0], fE[1][1], fE[1][2] to find t[1][final] corresponding to fE[0]

Custom Shape Degrader : Achromatic mode



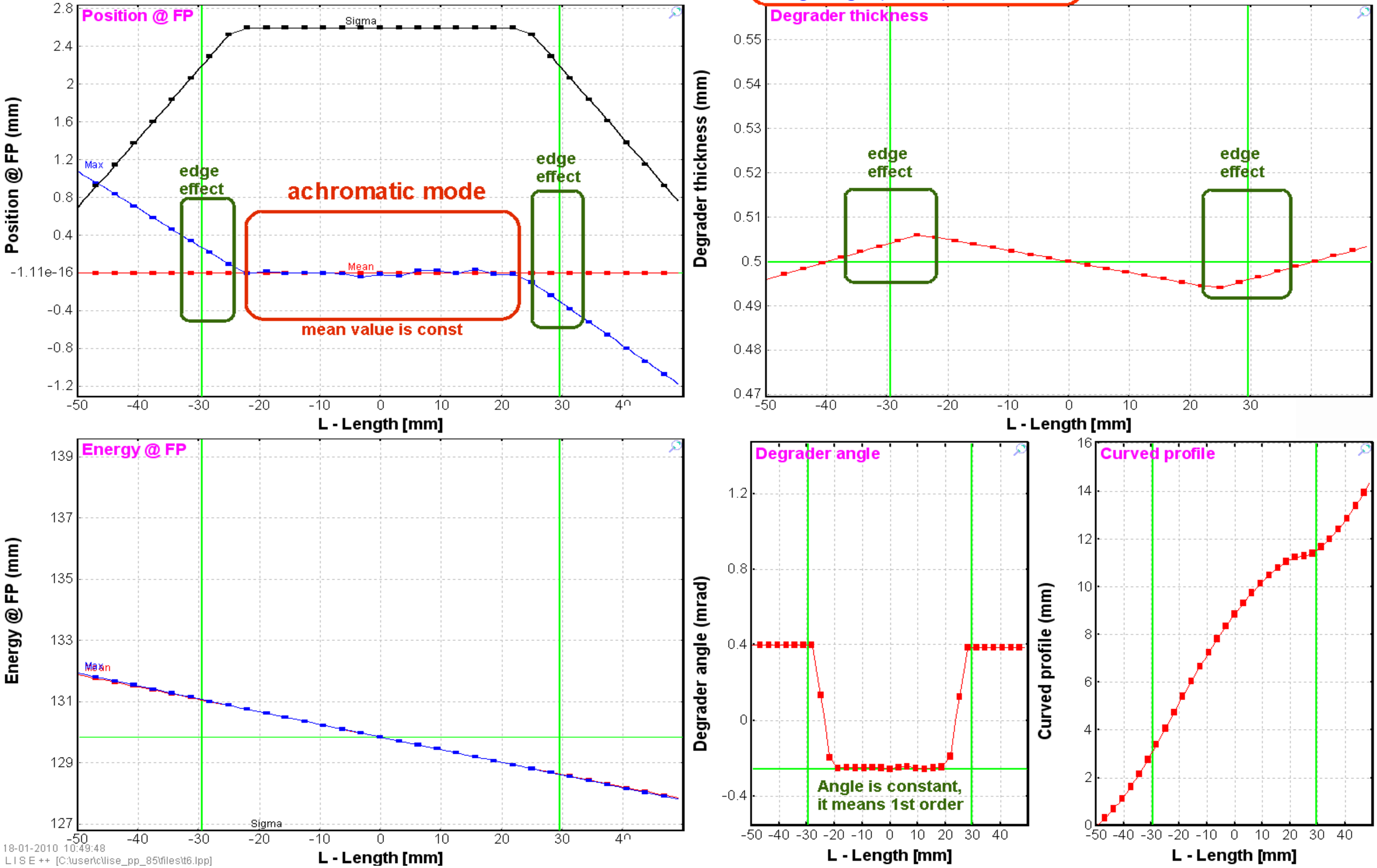
Custom Shape Degrader : Achromatic mode

Custom Shape Degrader

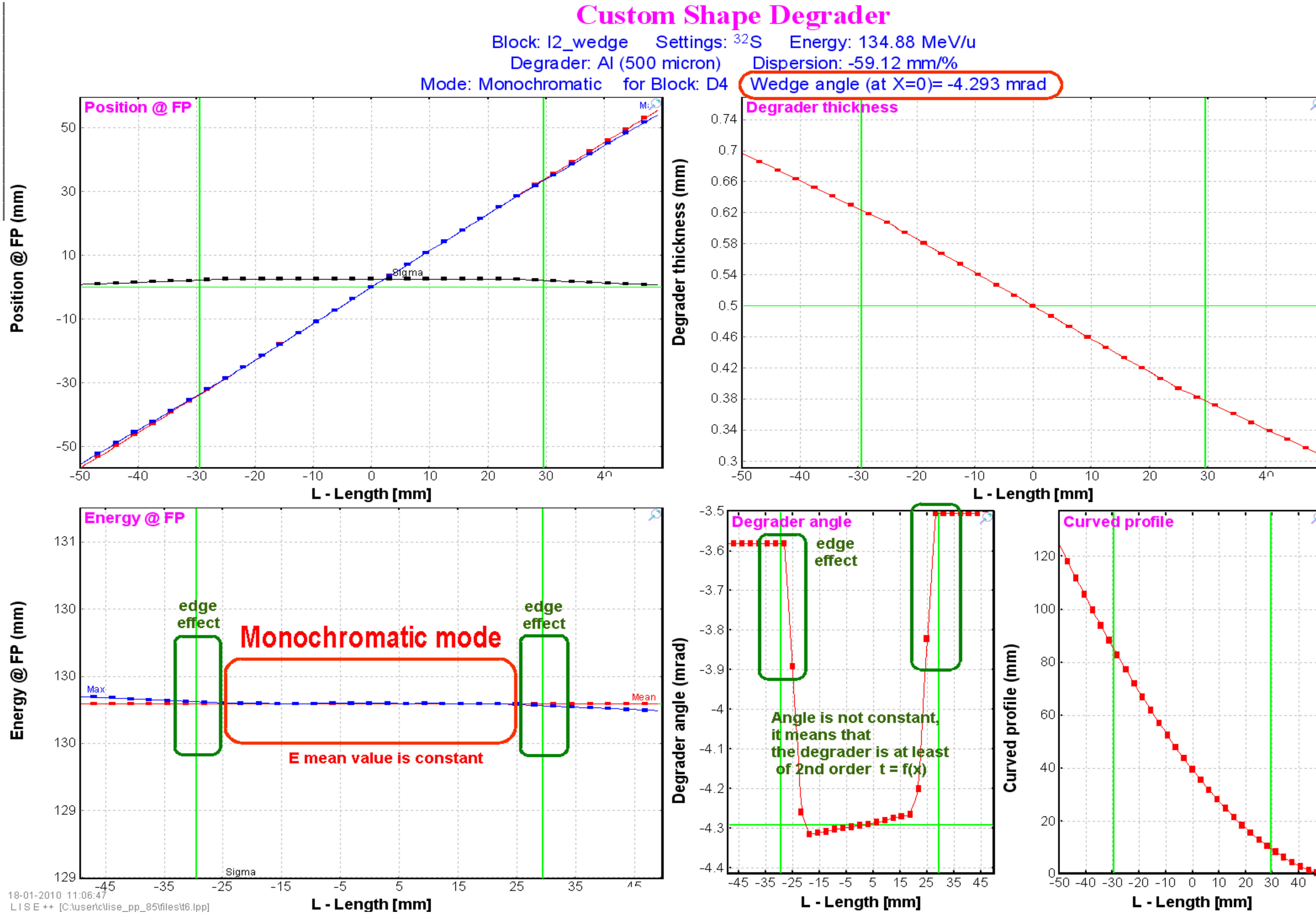
Block: I2_wedge Settings: ^{32}S Energy: 134.88 MeV/u

Degrader: Al (500 micron) Dispersion: -59.12 mm/%

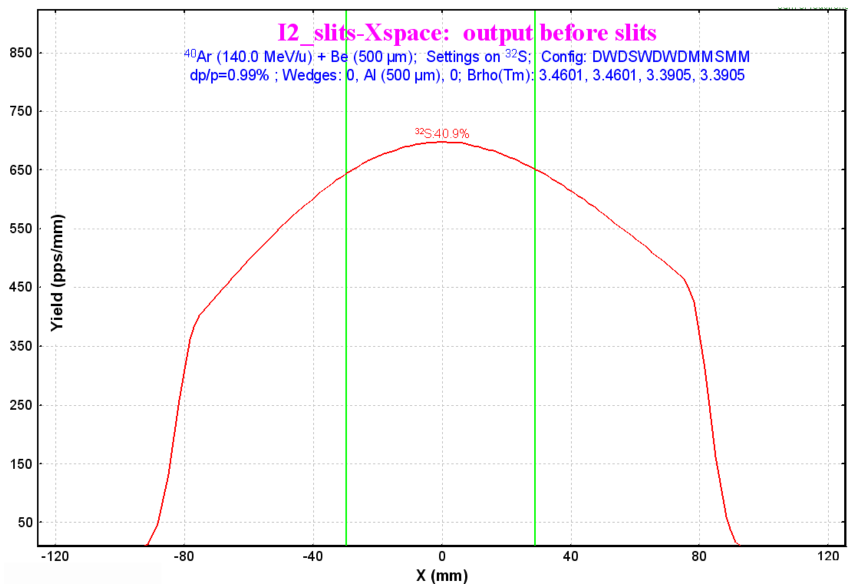
Mode: Achromatic for Block: D4 Wedge angle (at X=0)= -0.258 mrad

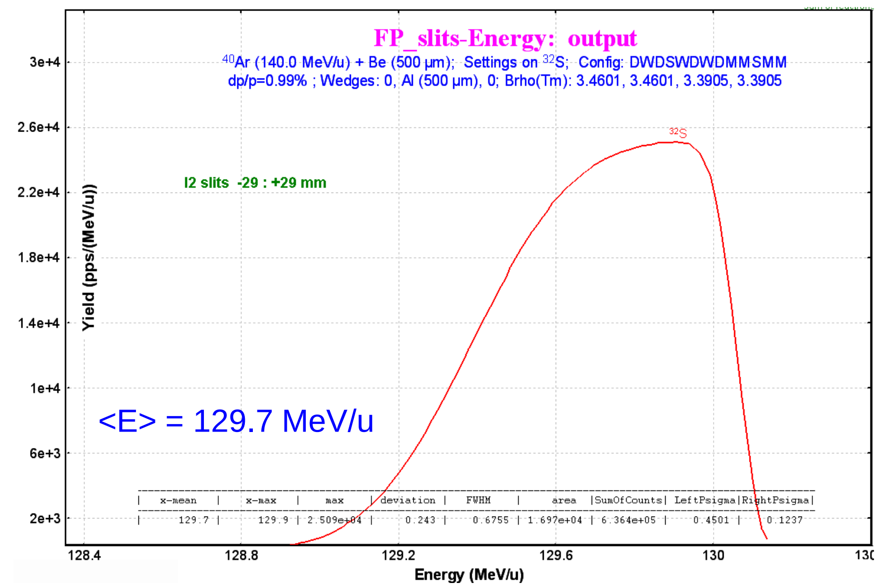


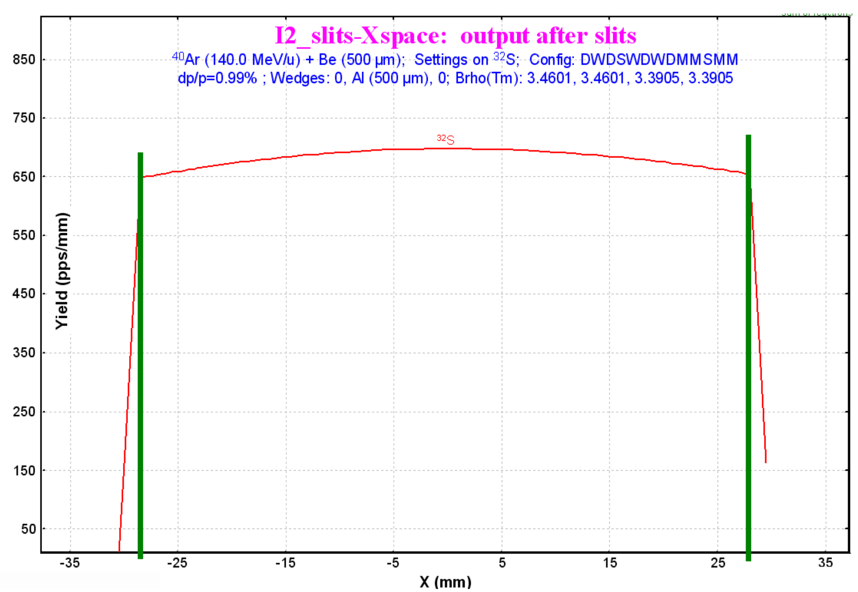
Custom Shape Degrader : Monochromatic mode

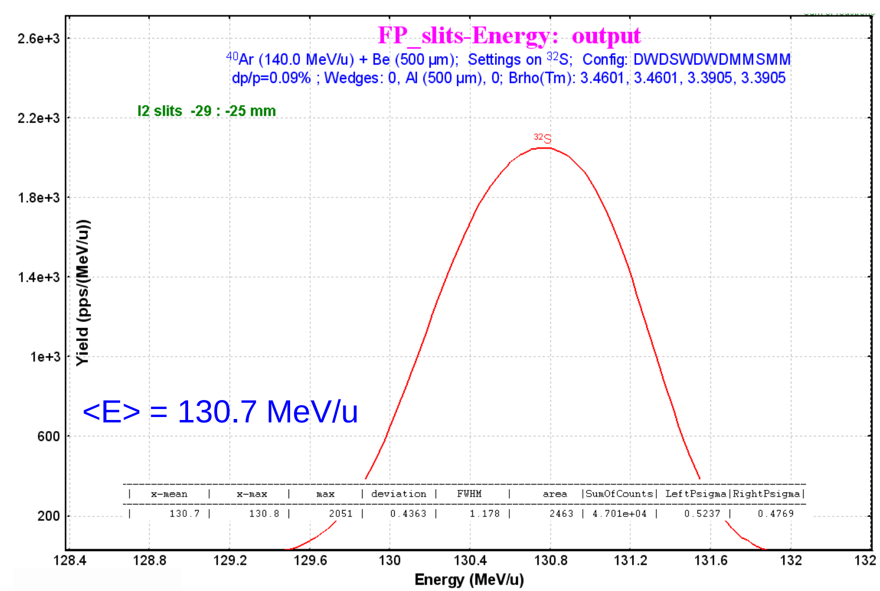


Edge effect. Wedge shape : Monochromatic mode

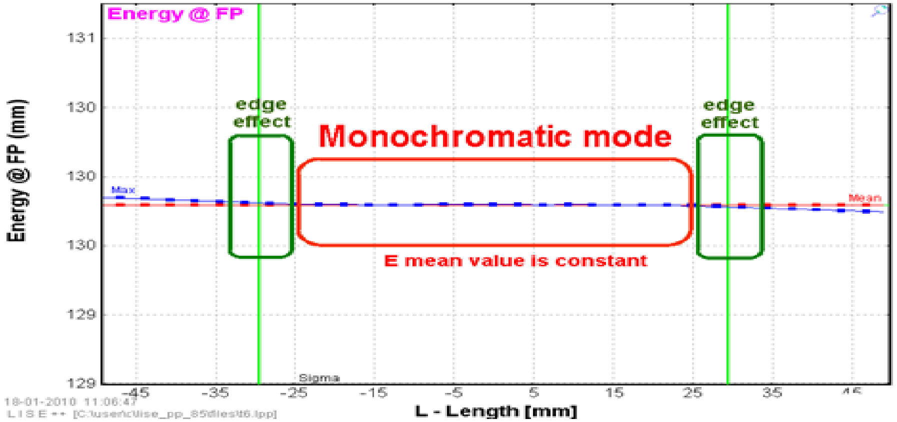


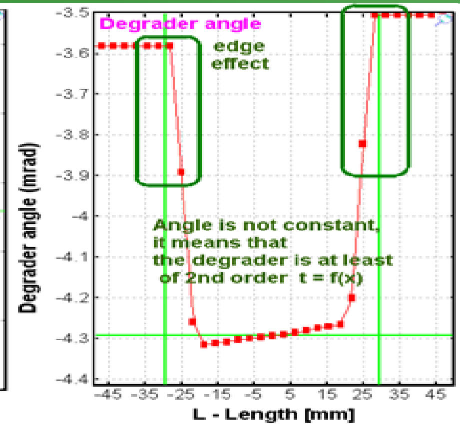






Edge effect. Monochromatic mode. Solutions

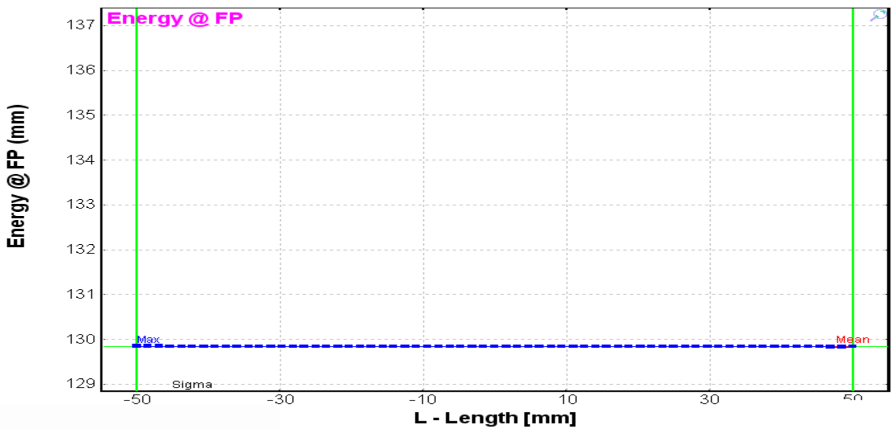


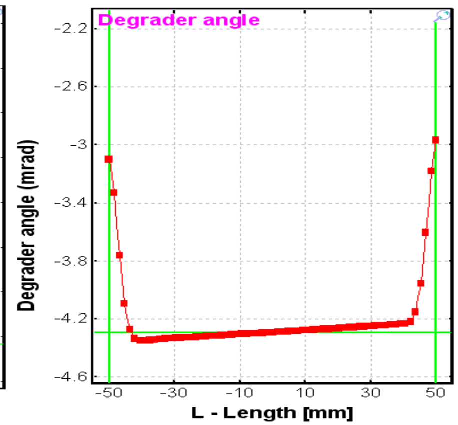


Custom shape

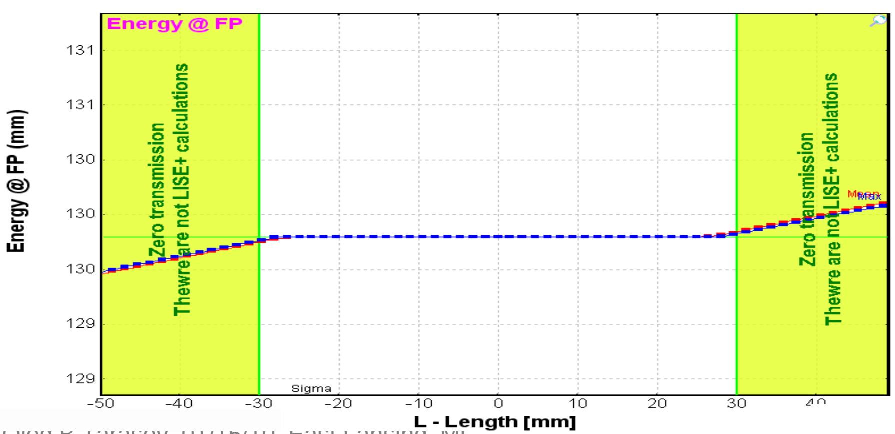
Monochromatic mode

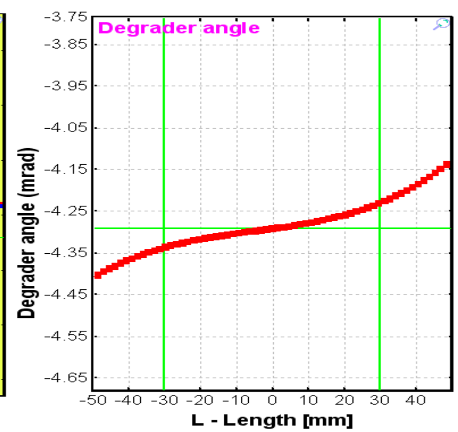
Original





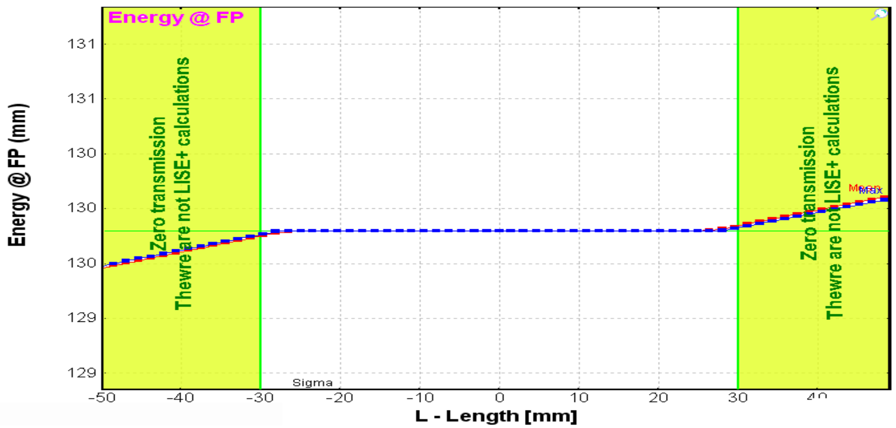
Monochromatic mode
+
Large slits

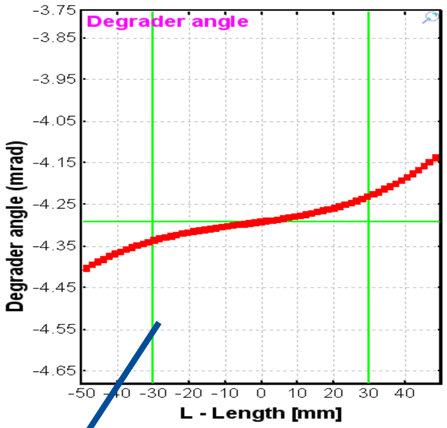




Monochromatic mode
+
Polynomial fit
+
Polynomial mode

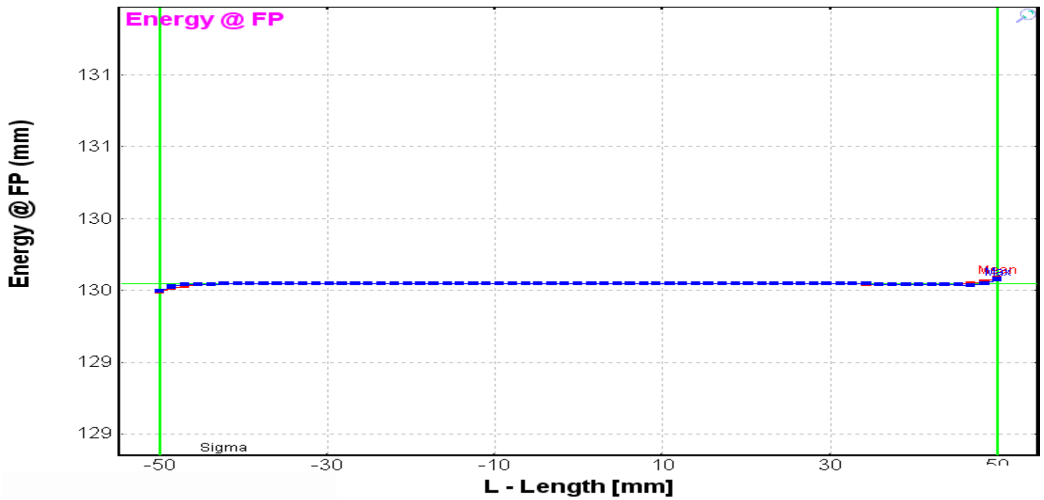
Edge effect. Monochromatic mode. Solutions



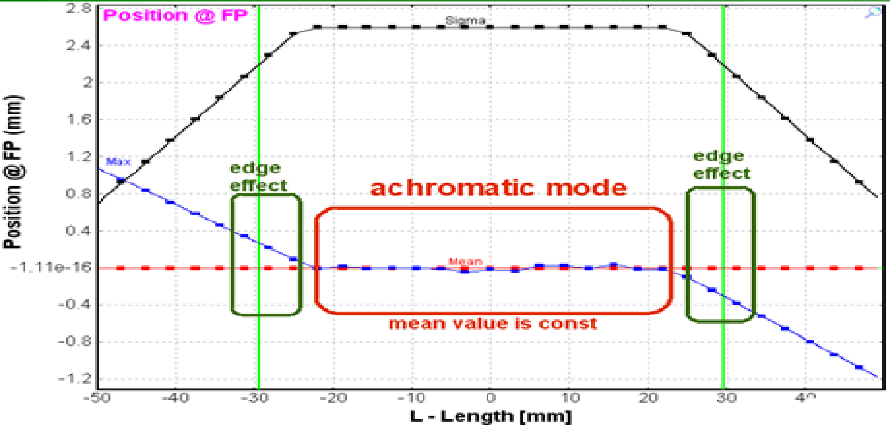


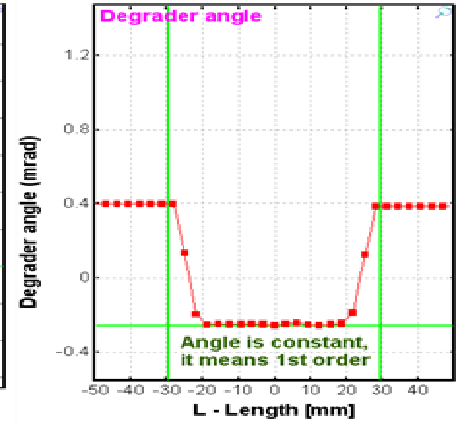
Monochromatic mode
+
Polynomial fit
+
Polynomial mode

The same polynomial
for large slits



Edge effect. Achromatic mode. Solutions

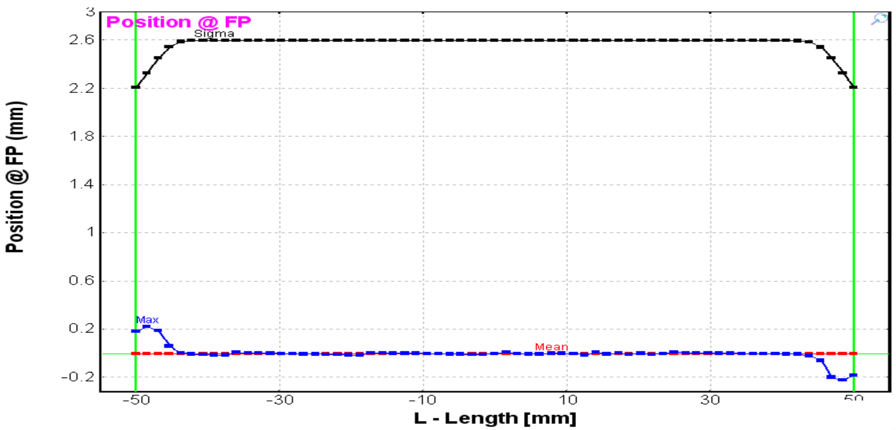


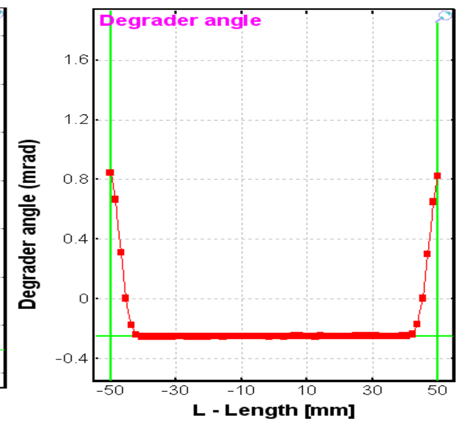


Custom shape

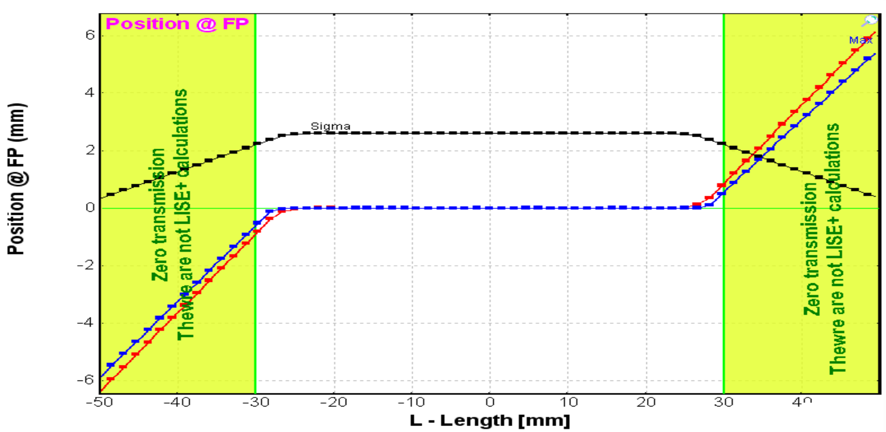
Achromatic mode

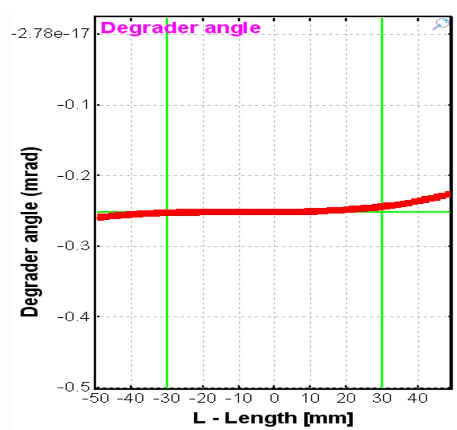
Original





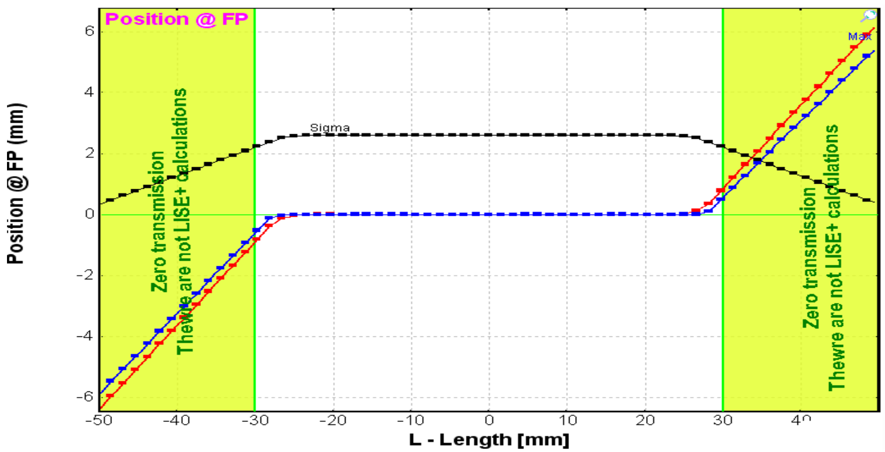
Achromatic mode
+
Large slits

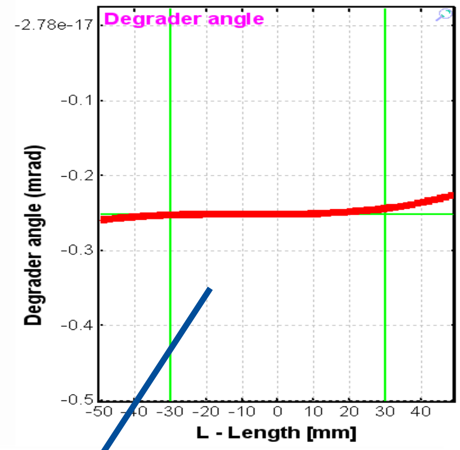




Achromatic mode
+
Polynomial fit
+
Polynomial mode

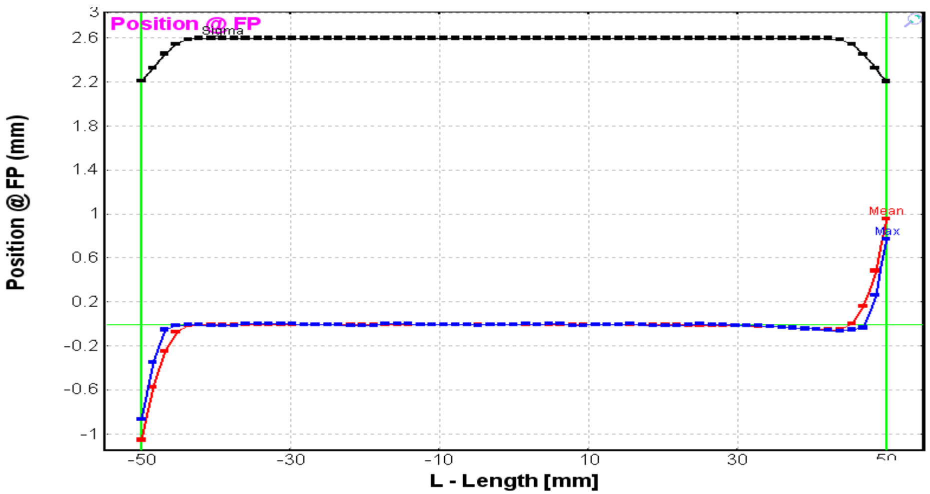
Edge effect. Achromatic mode. Solutions





Achromatic mode
+
Polynomial fit
+
Polynomial mode

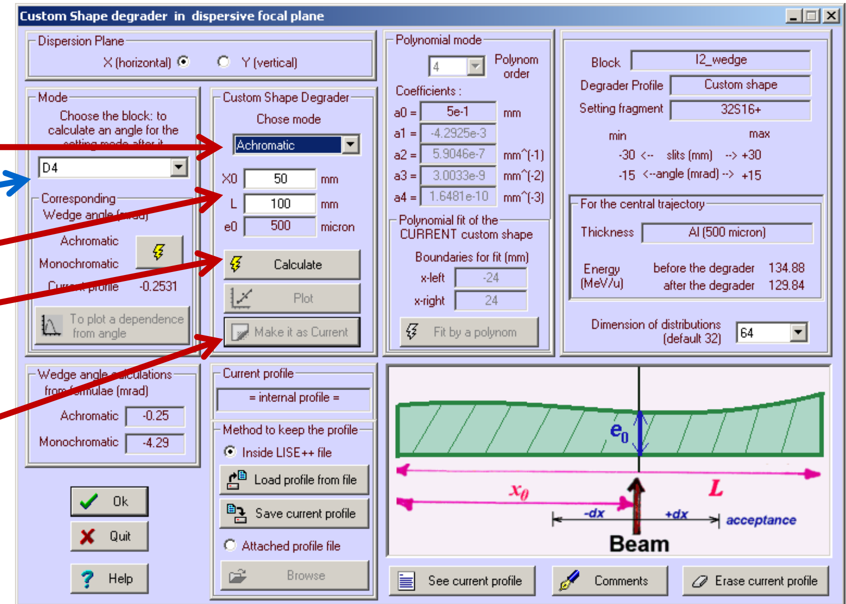
The same polynomial
for large slits

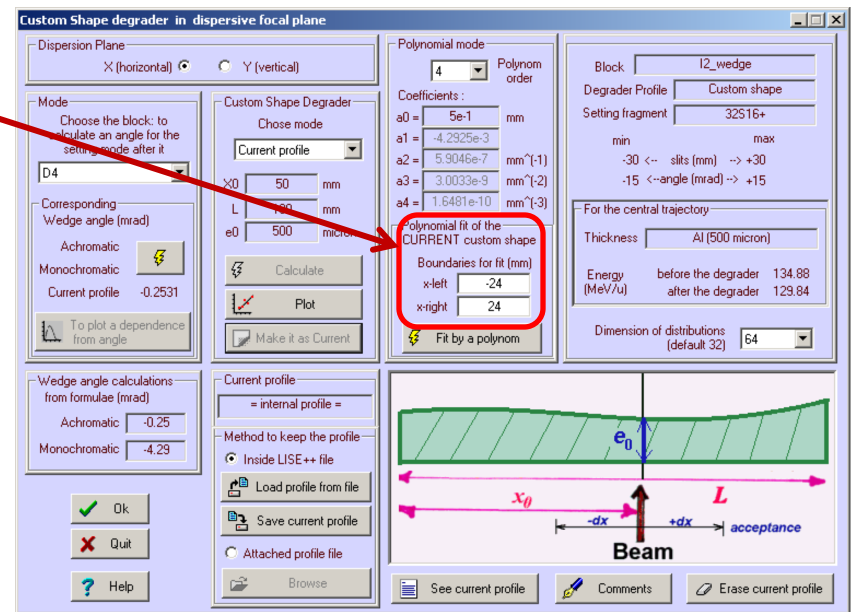


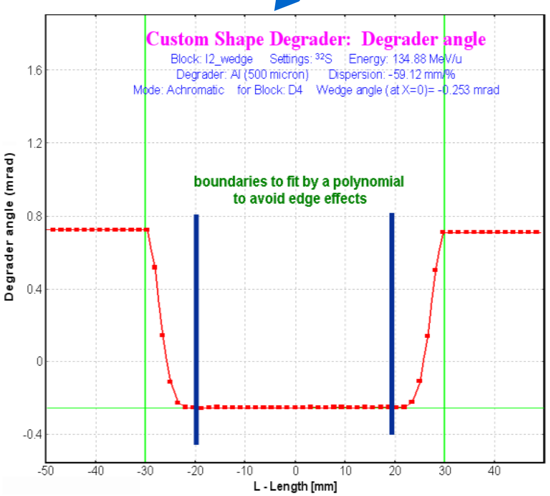
Polynomial mode. Algorithm (part 1)

Algorithm of calculations (part 1) :

- *Chose a calculation mode (achromatic or monochromatic)*
- *Set shape parameters (Block, X0,L,)*
- *Calculate (button "Calculate")*
- *Make the calculated custom shape as CURRENT (button "Make it as Current")*
- *Set the boundaries of fit (pay attention to avoid edge effect zones)*







LISE++ proposes automatically the next boundaries

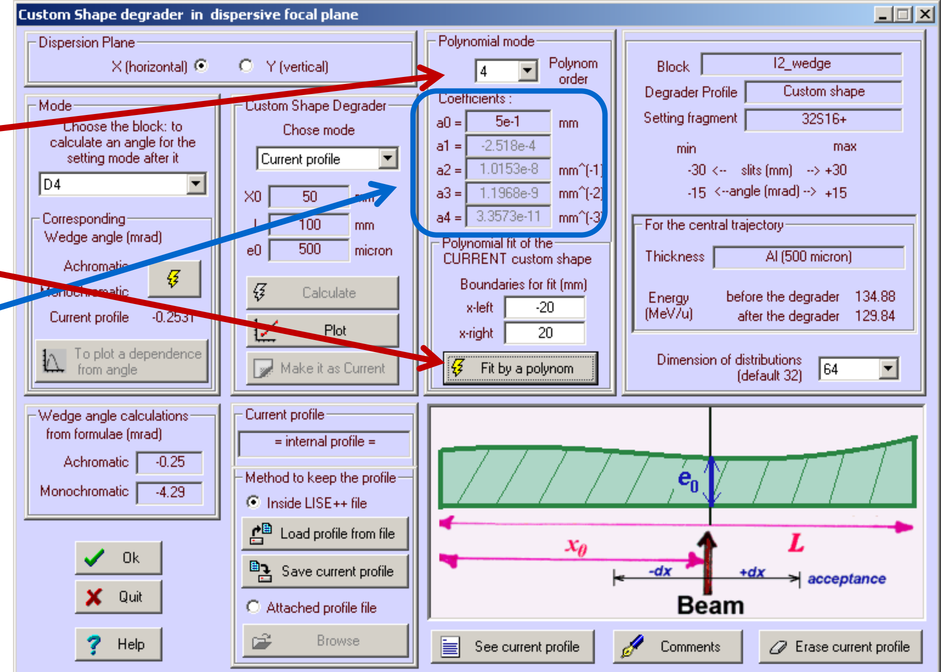
Left B = Left Slit + D
Right B = Right Slit - D

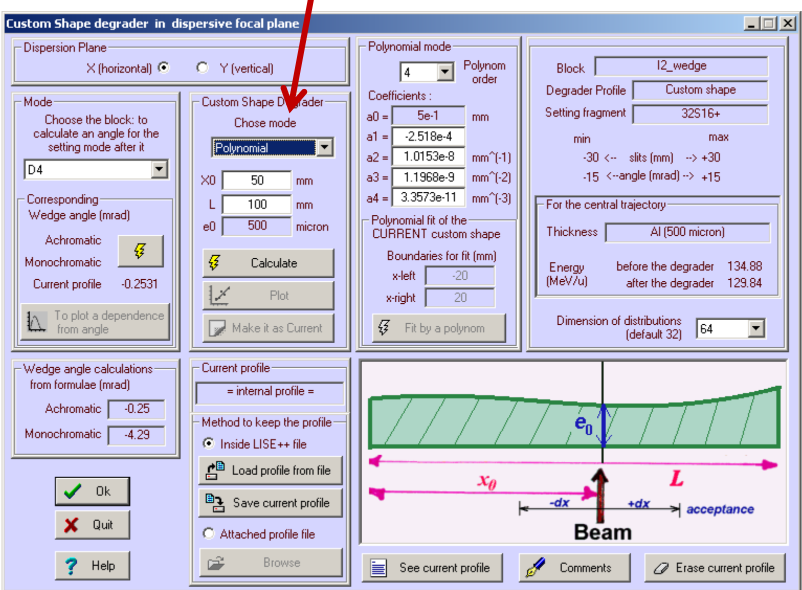
where D is
*0.1 * Slit Width*

Polynomial mode. Algorithm (part 2)

Algorithm of calculations (part 2) :

- *Select a polynomial order*
- *Now you are ready to fit (click button “Fit by a polynomial”).*
  Polynomial coefficients will be shown in the dialog, and Fit results in a new window
- *Chose mode “Polynomial”*





Polynomial description of already calculated custom shape

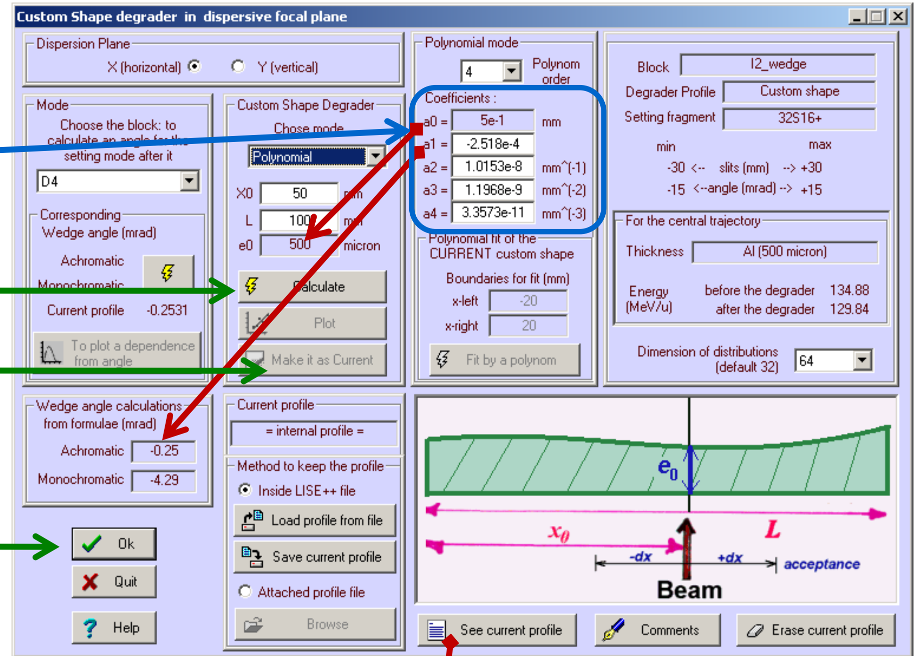
```
Polynom order : 4
Boundaries (mm):  Left=-20.0;   Right=20.0
Overcrossing with the distribution of the previous calculated custom shape
I_start=20;   I_stop=44;   N_points=25
rms=4.37e-04;   rmsAbs=2.18e-06
coef0 =  4.999977e-01  [mm^(+1)]
coef1 = -2.517990e-04  [mm^(+0)]
coef2 =  1.015298e-08  [mm^(-1)]
coef3 =  1.196804e-09  [mm^(-2)]
coef4 =  3.357319e-11  [mm^(-3)]
```

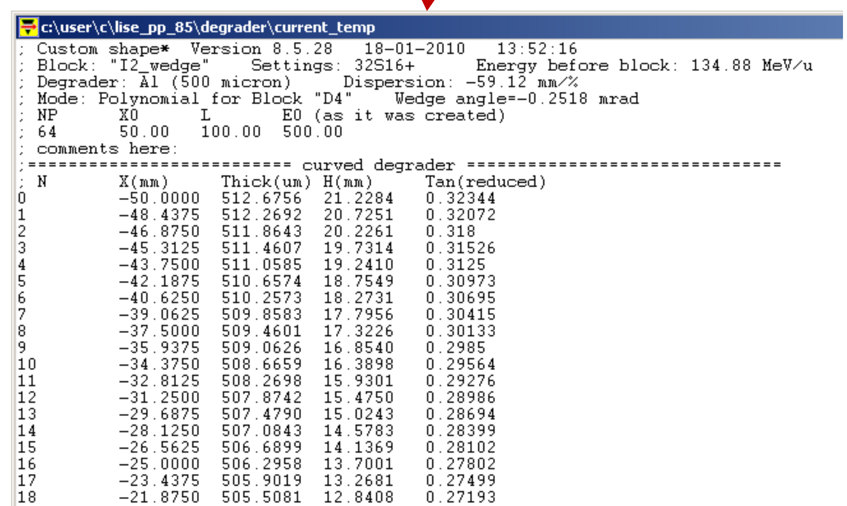
N	X (mm)	Y-old(mm)	Y-new(mm)	dY (mm)
1	-18.75	5.04722e-01	5.04719e-01	2.72959e-06
2	-17.19	5.04322e-01	5.04325e-01	-3.83127e-06
3	-15.62	5.03933e-01	5.03932e-01	5.07657e-07
4	-14.06	5.03539e-01	5.03539e-01	3.41943e-07
5	-12.50	5.03144e-01	5.03145e-01	-9.28739e-07
6	-10.94	5.02752e-01	5.02752e-01	-1.60210e-07
7	-9.38	5.02358e-01	5.02359e-01	-2.13138e-08
8	-7.81	5.01966e-01	5.01965e-01	7.01285e-07
9	-6.25	5.01572e-01	5.01572e-01	2.31877e-07
10	-4.69	5.01178e-01	5.01178e-01	1.74910e-07
11	-3.12	5.00787e-01	5.00785e-01	2.16882e-06
12	-1.56	5.00392e-01	5.00391e-01	5.06919e-07
13	0.00	5.00000e-01	4.99998e-01	2.26756e-06
14	1.56	4.99601e-01	4.99604e-01	-3.55041e-06
15	3.12	4.99208e-01	4.99211e-01	-2.90365e-06
16	4.69	4.98821e-01	4.98818e-01	3.12862e-06
17	6.25	4.98422e-01	4.98425e-01	-3.01431e-06
18	7.81	4.98031e-01	4.98032e-01	-1.21216e-06
19	9.38	4.97638e-01	4.97639e-01	-1.17244e-06
20	10.94	4.97251e-01	4.97247e-01	4.07335e-06
21	12.50	4.96854e-01	4.96855e-01	-6.75712e-07
22	14.06	4.96467e-01	4.96463e-01	3.81049e-06
23	15.62	4.96071e-01	4.96072e-01	-1.50255e-06
24	17.19	4.95679e-01	4.95682e-01	-2.67992e-06
25	18.75	4.95293e-01	4.95292e-01	1.00968e-06

Polynomial mode. Algorithm (part 3)

Algorithm of calculations (part 3) :

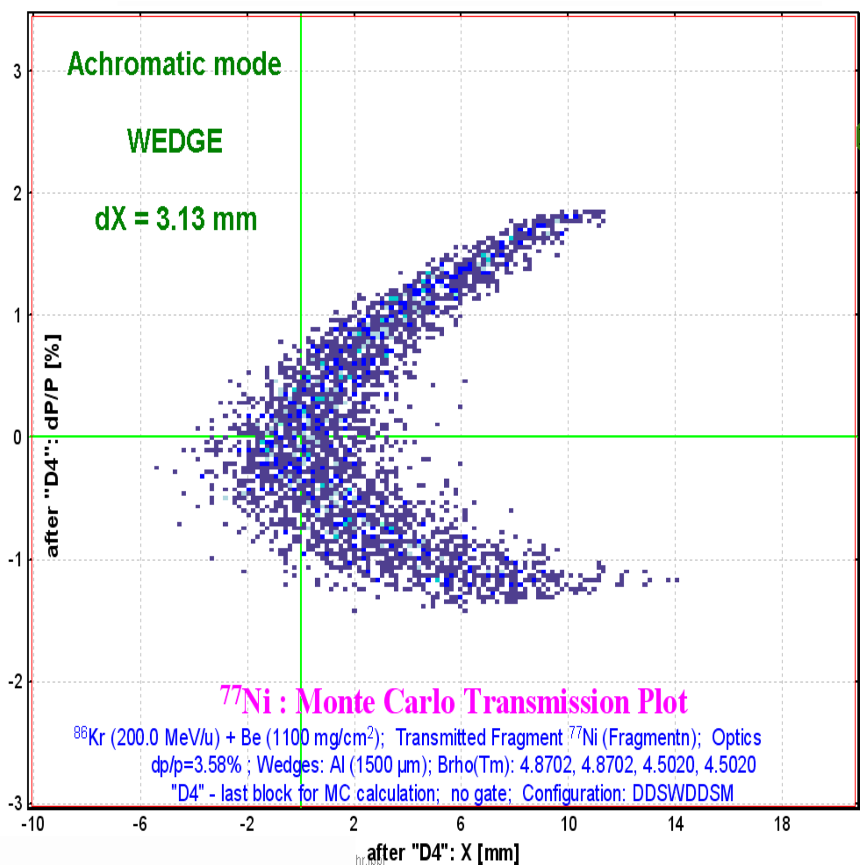
- *Check polynomial coefficients:* should be a0 = e0, a1 = Wedge angle
- *Calculate (button "Calculate")*
- *Make the calculated custom shape as CURRENT (button "Make it as Current")*
- *Click the button "Ok" to save this current shape in the Wedge block*
- *Click the button "Ok" in the Wedge dialog to save this current Wedge block in LISE++ Set-up configuration*

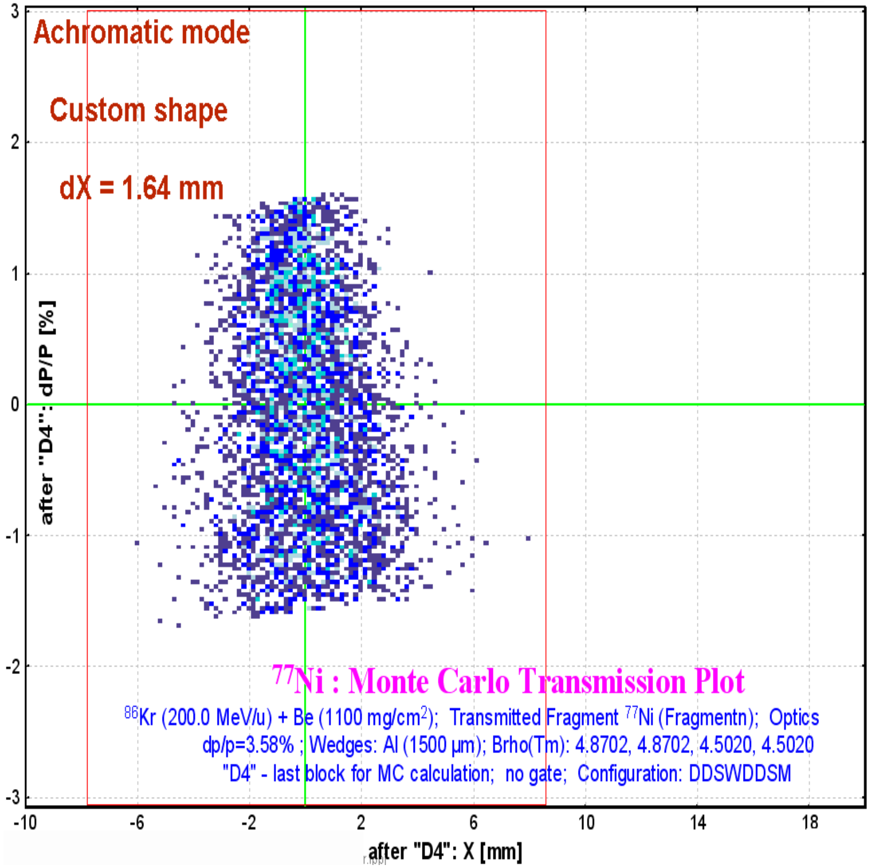



c:\user\c\lise_pp_85\degrader\current_temp

```
; Custom shape*  Version 8.5.28   18-01-2010   13:52:16
; Block: "I2_wedge"    Settings: 32S16+      Energy before block: 134.88 MeV/u
; Degrader: Al (500 micron)     Dispersion: -59.12 mm/%
; Mode: Polynomial for Block "D4"     Wedge angle=-0.2518 mrad
; NP      X0       L        E0 (as it was created)
; 64      50.00    100.00   500.00
; comments here:
;========================= curved degrader ==============================
; N         X(mm)      Thick(um) H(mm)      Tan(reduced)
0          -50.0000   512.6756  21.2284    0.32344
1          -48.4375   512.2692  20.7251    0.32072
2          -46.8750   511.8643  20.2261    0.318
3          -45.3125   511.4607  19.7314    0.31526
4          -43.7500   511.0585  19.2410    0.3125
5          -42.1875   510.6574  18.7549    0.30973
6          -40.6250   510.2573  18.2731    0.30695
7          -39.0625   509.8583  17.7956    0.30415
8          -37.5000   509.4601  17.3226    0.30133
9          -35.9375   509.0626  16.8540    0.2985
10         -34.3750   508.6659  16.3898    0.29564
11         -32.8125   508.2698  15.9301    0.29276
12         -31.2500   507.8742  15.4750    0.28986
13         -29.6875   507.4790  15.0243    0.28694
14         -28.1250   507.0843  14.5783    0.28399
15         -26.5625   506.6899  14.1369    0.28102
16         -25.0000   506.2958  13.7001    0.27802
17         -23.4375   505.9019  13.2681    0.27499
18         -21.8750   505.5081  12.8408    0.27193
```

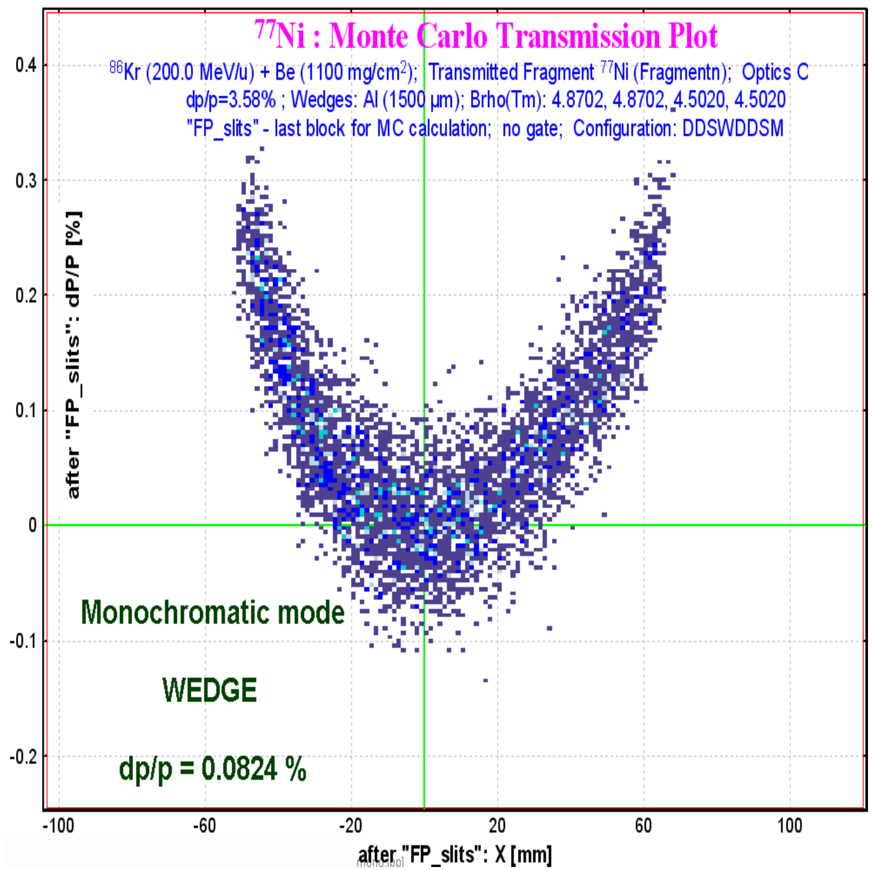
Examples: Achromatic mode

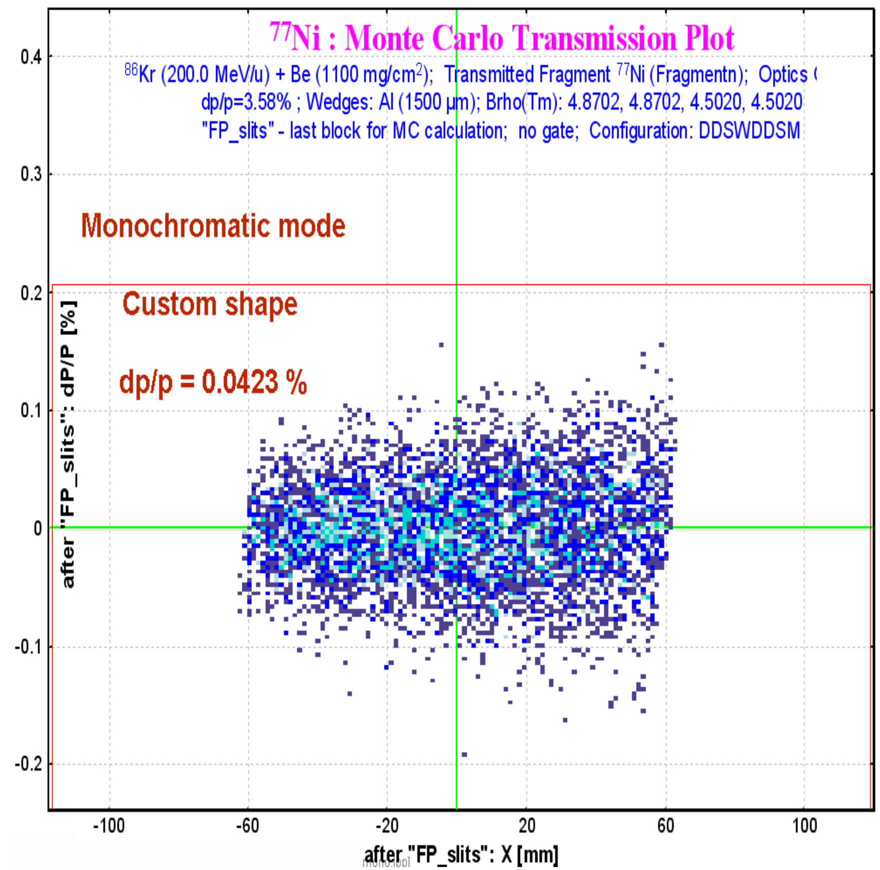




http://groups.nscl.msu.edu/lise/8_5/custom_shape/wedge_77Ni_achr.lpp

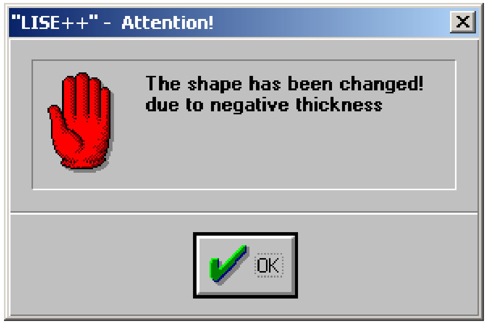
Examples: Monochromatic mode



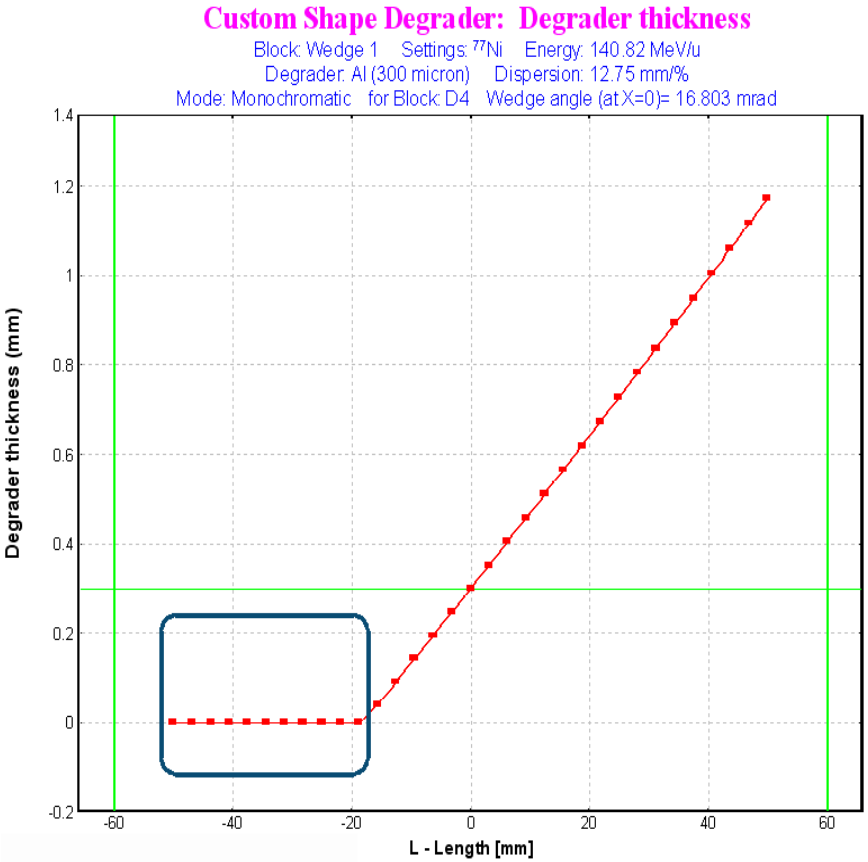


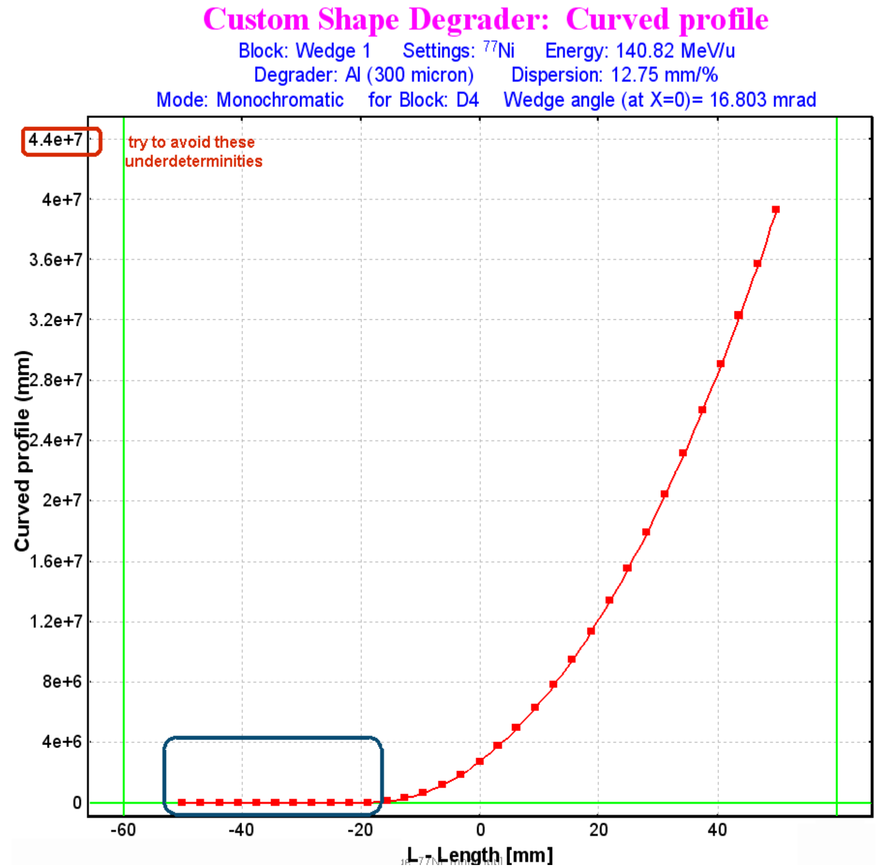
http://groups.nscl.msu.edu/lise/8_5/custom_shape/wedge_77Ni_mono.lpp

Negative thickness

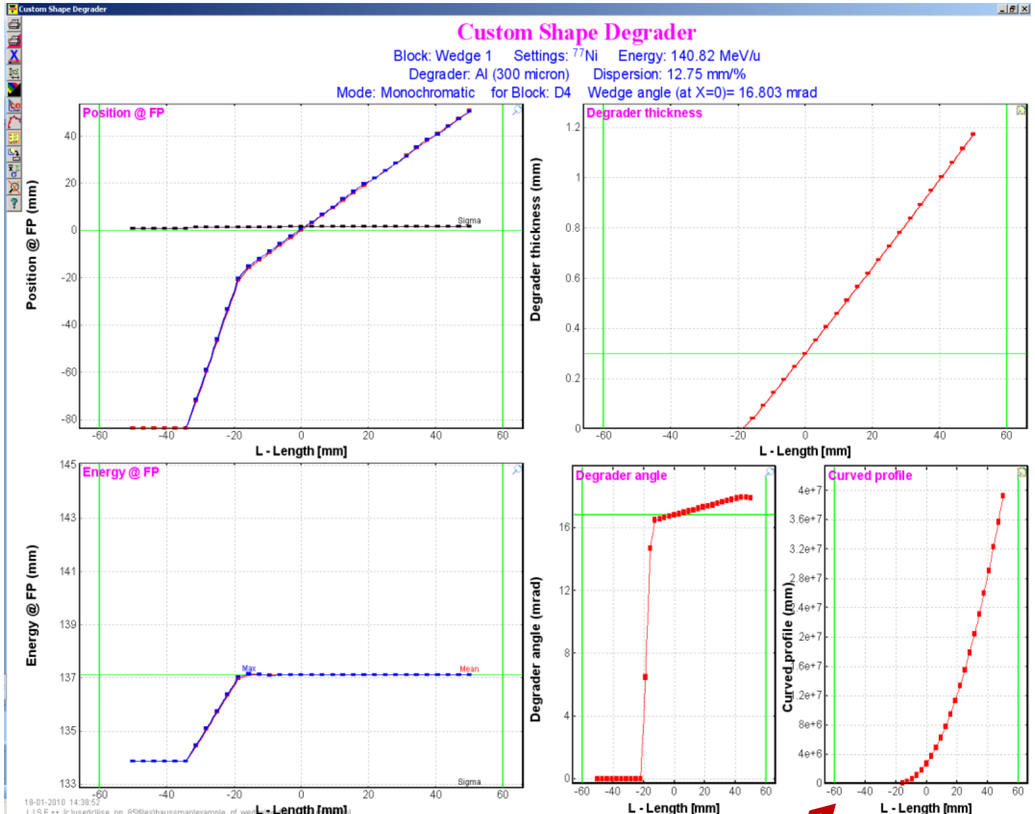


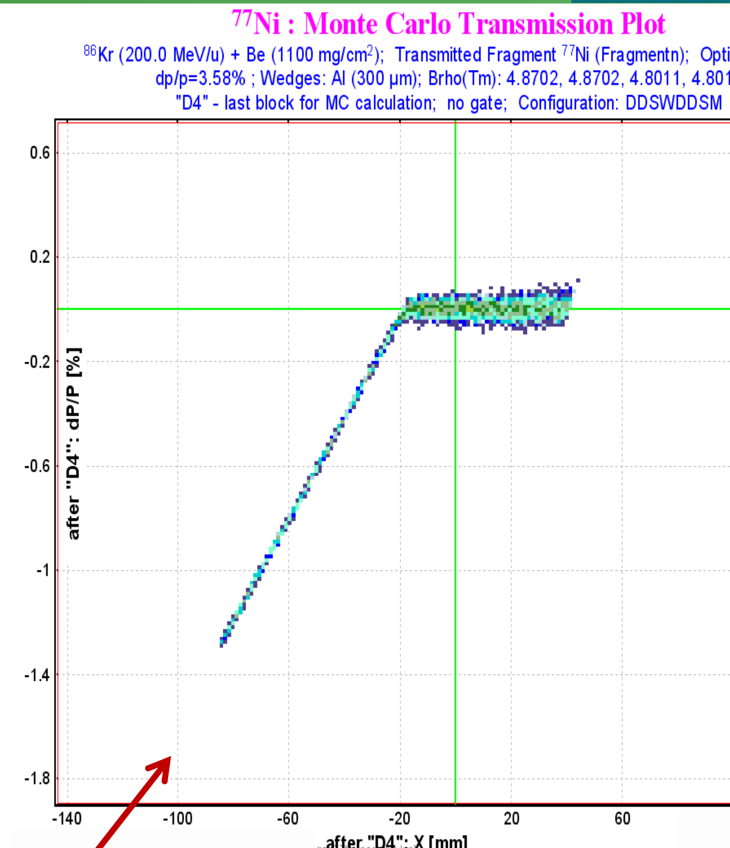
If LISE++ meets negative thickness, then the code supposes zero thickness, and recalculates again





Negative thickness





LISE++ keeps this profile
with zero thickness for some places,
and work then by a regular way

http://groups.nscl.msu.edu/lise/8_5/custom_shape/wedge_77Ni_negative.lpp

New other features (version 8.5.1-8.5.28)

- Plotting errors : option "turn off“
- Plotting data : "NO LINE" option through the Method drawing dialog
- Plotting Legend or caption : option "turn off"
- Database plot: option "decay mode“
- "BI" code: corrections for 1-dimensional file
- Solenoid block in the "Setup" dialog: modifications
- Brho scanning utility: modifications for fission case
- Several modifications including the correction of E=f(B,v) function for Wien-filter
- Option : Y-title turn on 180 degrees for screen (Mac's case)
- Erasing space in COSY log-files for high order optics. Magnification optic coefficients should be not equal to zero. LISE++ checks and corrects.
- Modification for Abrasion-Fission reaction if User Cross section & Secondary reactions options set
- Changes to get new option and configuration files for users without admin privileges
- Correction in Monte Carlo transmission calculations for Length
- Version 8.5.8 - New version of ISOL catcher includes fusion-residual, user excitation files, materials in front and behind the target