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

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- Degraders in the dispersive focal plane (wedge, curved profile)
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Thanks to Dr. M.Portillo and Dr. M.Hausmann (NSCL/MSU) for fruitful discussions
Degraders in the dispersive focal plane

LISE++ calculates a curved profile based on the angle of wedge ($\alpha$)

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

“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 = $a_1 \times x + a_0$

We need higher orders!
Custom Shape Degrader

“e₀” corresponds to thickness material at the central axis

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

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

LISE++ is able to operate and keep independently both shapes (curved profile & custom shape)
Custom Shape vs. Curved Profile

Custom Shape

Columns are used by LISE++ to calculate shapes

Curved Profile

Tan (reduced) is ....

\[ C(i) = \text{ThickFromX}(i) / \text{min}_e0 \]

\[ \text{Tan\_reduced}(i) = \tan(\acos(C(i))) \]

where min_e0 is the minimum thickness of the degrader

Oleg B. Tarasov. 01/15/10, East Lansing, MI
### Custom Shape vs. Curved Profile in LISE++ file

**ProfileMode** = 2  
PhysProfileDesirable = 2  
Angle = 16.81448 mrad  
Direction = 0  
CalculateForBlock = D4  
ProfileFileName = ach.degra  
ExternalInternal = 0  
ReadInternal = 0  
CustomFileName = NULL  
CustExternalInter = 1  
CustReadInt = 1  

**Profile Mode**

- **Curved profile**: external=0 / internal=1  
  - L = Yes / 0 = No

**Custom Shape**

- external=0 / internal=1  
  - L = Yes / 0 = No

**Polynomial order**

- 4

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**[W1_CustomShape]**

*Custom shape*  
**Version**: 8.5.18  
**Date**: 14-01-2010 11:30 40  
**Block**: "Wedge 1"  
**Settings**: 771128+  
**Energy before block**: 140.82 MeV/u  
**Degradation**: Al (1500 microns)  
**Dispersion**: 12.75 mm/%  
**Mode**: Polynomial for Block 'D4'  
**Wedge angle**: 16 8104 mrad

**NP**

- X0  
- I  
- E0 (as it was created)

**32**

- 70.00  
- 140.00  
- 1500.00

**comments here:**

```
------------------------ curved degrader ------------------------
N X (nm)  Thick (um)  H (nm)  T (reduced)
 0  -70.000  336.9950  0.0000  0  
 1  -65.6250  462.9094  1.3300  0 60799
 2  -61.2500  515.2889  4.5172  0 69474
 3  -56.8750  536.1500  9.0523  1 1376
 4  -52.5000  658.4951  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 9759
 8  -35.0000  927.5825  45.5940  2 1786
 9  -30.6250  997.4722  55.5555  2 3758
10  -26.2500  1067.7653  66.3781  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  148.2516  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  242.0369  4 7362
22  26.2500  1950.3417  263.1760  4 9355
23  30.6250  2027.3366  285.2250  5 1148
24  35.0000  2104.4544  303.1701  5 1542
25  39.3750  2182.5566  322.0224  5 5458
26  43.7500  2260.6588  340.8747  5 9474
27  48.1250  2338.7610  359.7270  5 1349
28  52.5000  2416.8632  378.5793  6 1751
29  56.8750  2494.9654  397.4315  6 1751
30  61.2500  2573.0676  416.2837  6 1751
31  65.6250  2651.1698  435.1359  6 1751
32  70.0000  2729.2720  453.9881  6 1751
```

**Shape inside of LISE++**
Custom Shape Degrader calculation

1. for the central axis \( iX[0]=0 \) at the dispersive 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 \( fE \) cal 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 \( t[1][\text{final}] \) corresponding to \( fX[0] \)

3B. Monochromatic mode: use parabola interpolation with points \( fE[1][0] \), \( fE[1][1] \), \( fE[1][2] \) to find \( t[1][\text{final}] \) corresponding to \( fE[0] \)
Custom Shape Degrader: Achromatic mode
Custom Shape Degrader: Achromatic mode

Block: ld_wedge  Settings: 32S  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

Position @ FP

Degrader thickness

Energy @ FP

Degrade angle

Curved profile

mean value is const

edge effect

Angle is constant, it means 1st order
Edge effect. Wedge shape: Monochromatic mode

\[ \langle E \rangle = 129.7 \text{ MeV/u} \]

\[ \langle E \rangle = 130.7 \text{ MeV/u} \]
Edge effect, Monochromatic mode, Solutions

- Custom shape
- Monochromatic mode
- Original
- 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
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
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”
Algorithm of calculations (part 3):

- **Check polynomial coefficients:** should be $a_0 = e_0$, $a_1 = \text{Wedge angle}$
- **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

It has been done!
Examples: Achromatic mode

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

$^{77}$Ni : Monte Carlo Transmission Plot

$^{89}$Kr (200.0 MeV/u) + Be (1100 mg/cm$^2$); Transmitted Fragment $^{77}$Ni (Fragment), Optics C
dp/p = 3.58% ; Wedges: Al (1500 μm); Brho(Tm): 4.8702, 4.8702, 4.5020, 4.5020

"FP_slits" - last block for MC calculation; no gate; Configuration: DDSWDDSM

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Monochromatic mode

WEDGE

dp/p = 0.0824 %

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Monochromatic mode

Custom shape
dp/p = 0.0423 %

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http://groups.nscl.msu.edu/lise/8_5/custom_shape/wedge_77Ni_mono.lpp
If LISE++ meets negative thickness, then the code supposes zero thickness, and recalculates again.
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