Wedge "Curiosity"

version 9.0.23

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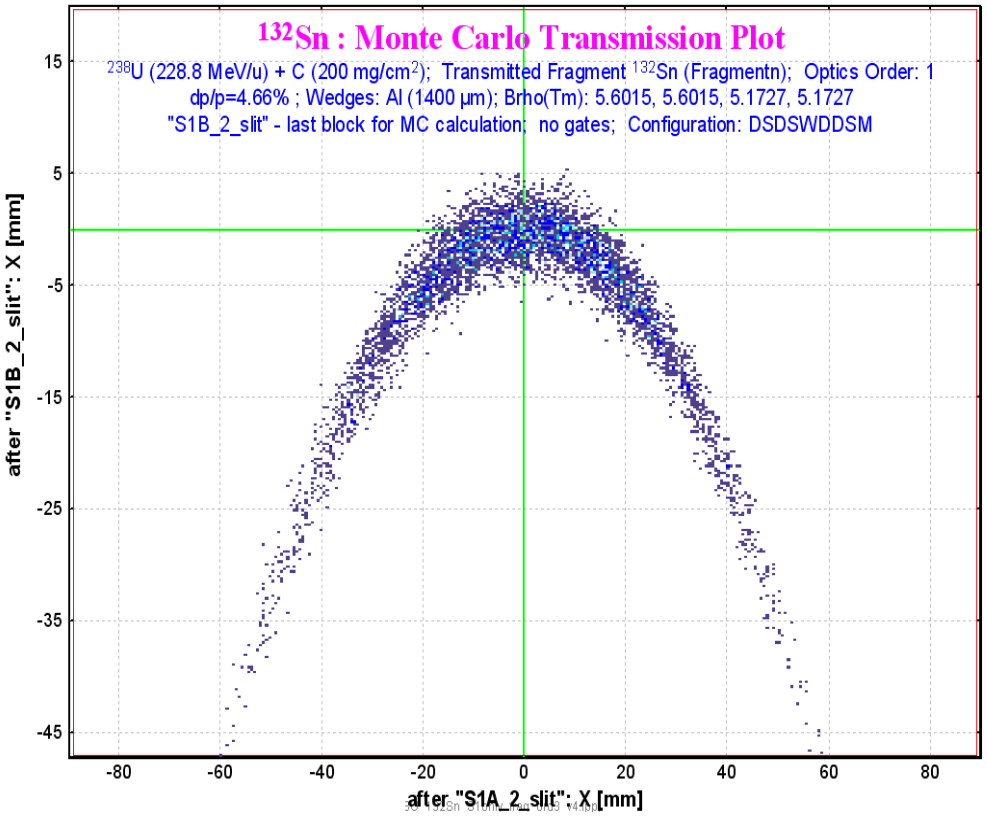

The code operates under MS Windows environment and provides a highly user-friendly interface.
It can be freely downloaded from the following internet addresses:
http://www.nscl.msu/edu/lise

Class "distribution"

PHYSICAL REVIEW E VOLUME 50, NUMBER 5 NOVEMBER 1994

Transport integral: A method to calculate the time evolution of phase-space distributions

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(Received 7 February 1994; revised manuscript received 22 August 1994)

Each integral is now independent and corresponds to a convolution product

$$P_i'(q_i') = \frac{1}{\prod_{k=1}^{n} R_{ik}} \int_2 \cdots \int_{n-1} \bar{P}_1(q_i' - t_2)\bar{P}_2(t_2 - t_3)\cdots \times [\bar{P}_{n-1} \otimes \bar{P}_n](t_{n-1}) \times dt_2 \cdots dt_{n-1} .$$

Finally, the result is given by the convolution product of all $\bar{P}_j$ functions

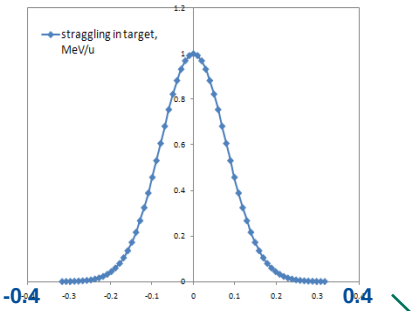
$$P_i'(q_i') = \frac{1}{\prod_{k=1}^{n} R_{ik}} [\bar{P}_1 \otimes \bar{P}_2 \otimes \cdots \otimes \bar{P}_n](q_i') . \quad (10)$$

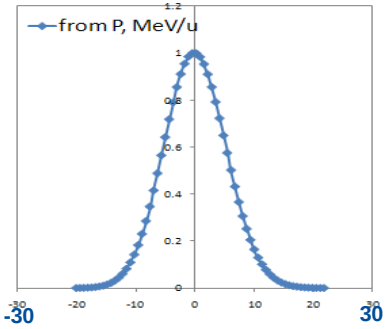
Where P_k is $I_k(x)$ (intensity distribution),
where $x_i = x_0 + i*h$,
h is the step,
$0 \le i \le N$ (distribution dimension)

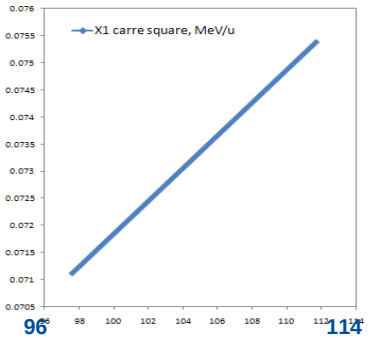
For example the energy distribution after the target:

Input:

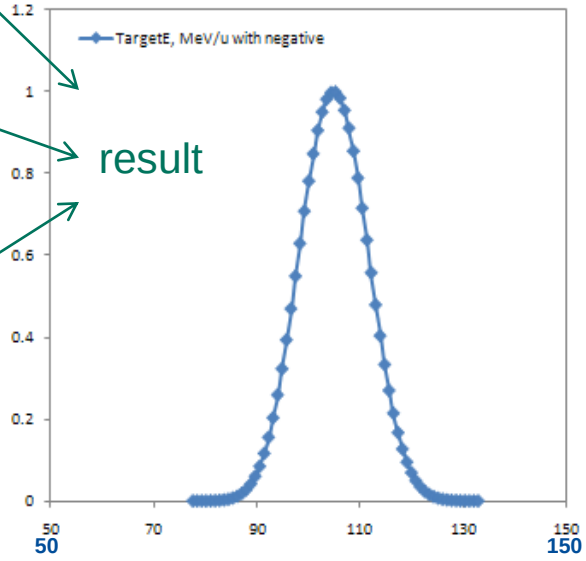
1. Beam emittance,
2. Energy straggling in target
3. Momentum distribution after reaction
4. Energy distribution due to energy loss difference in target between beam and fragment







result



Transformation of distributions

http://groups.nscl.msu.edu/lise/4_5/lise_4_5.htm

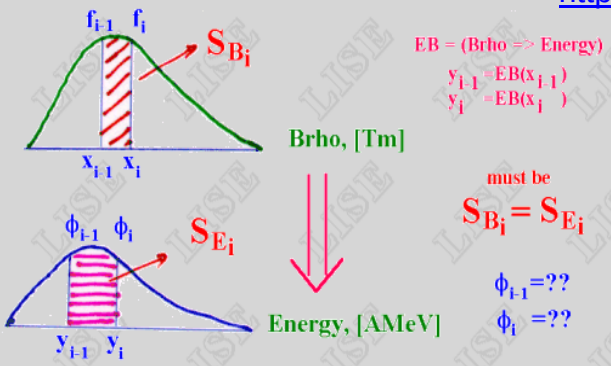


Fig.4. The scheme of conversion of one distribution in another

In a basis of conversion of one distribution in another (the scheme represented in Fig.4) lays saving of squares between every each *i-1* and *i* points. In the last versions the given task was solved rather simple way that had an effect for quality of conversions at such small dimension of distributions (NP=128).

The edge effects were especially appeared in distributions of energy, ranges in matter as they may not be negative. We shall assume that the nucleus with the certain distribution passes through substance and the *i*-point of distribution stops in matter, and following passes. Then function appropriate between *i-1* and *i* pointspoints for preservation of the area should aspires to infinity. Rather complex mechanism of smoothing was applied. But all the same it is ideal to solve this problem it was not possible!

In the last versions the area between points was determined by the next primitive expression:

$$S_i = \frac{(f_{i-1} + f_i)}{2} \cdot |x_i - x_{i-1}|$$

We may use now correct calculation of area is next:

$$S_i = \int_{x_{i-1}}^{x_i} f(x)\,dx \quad ,$$

because we have infinite function f(x) due to introduction of procedure cubic spline.
The condition of equality of the areas in both distributions between in an interval can be presented in the following kind:

$$S_{E_i} = S_{B_i} \quad \Rightarrow \quad \int_{x_{i-1}}^{x_i} f(x)\,dx = \int_{y_{i-1}}^{y_i} \phi(y)\,dy \quad .$$

Doing substitution $y=EB(x)$ it possible to get simple and good solution with application of the first derivative of the function $f(x)$:

$$\phi[y(x)] = f(x) \cdot \left(\frac{dEB}{dx}\right)^{-1} .$$

This derivative can be taken with the help of cubic spline procedure having constructed distribution *x* from *y*. Using further cubic spline procedure for f (*y*) distribution can be proceeded from complicated distribution with a variable step between points to more simple with a constant step accordingly.

Class “distribution2”

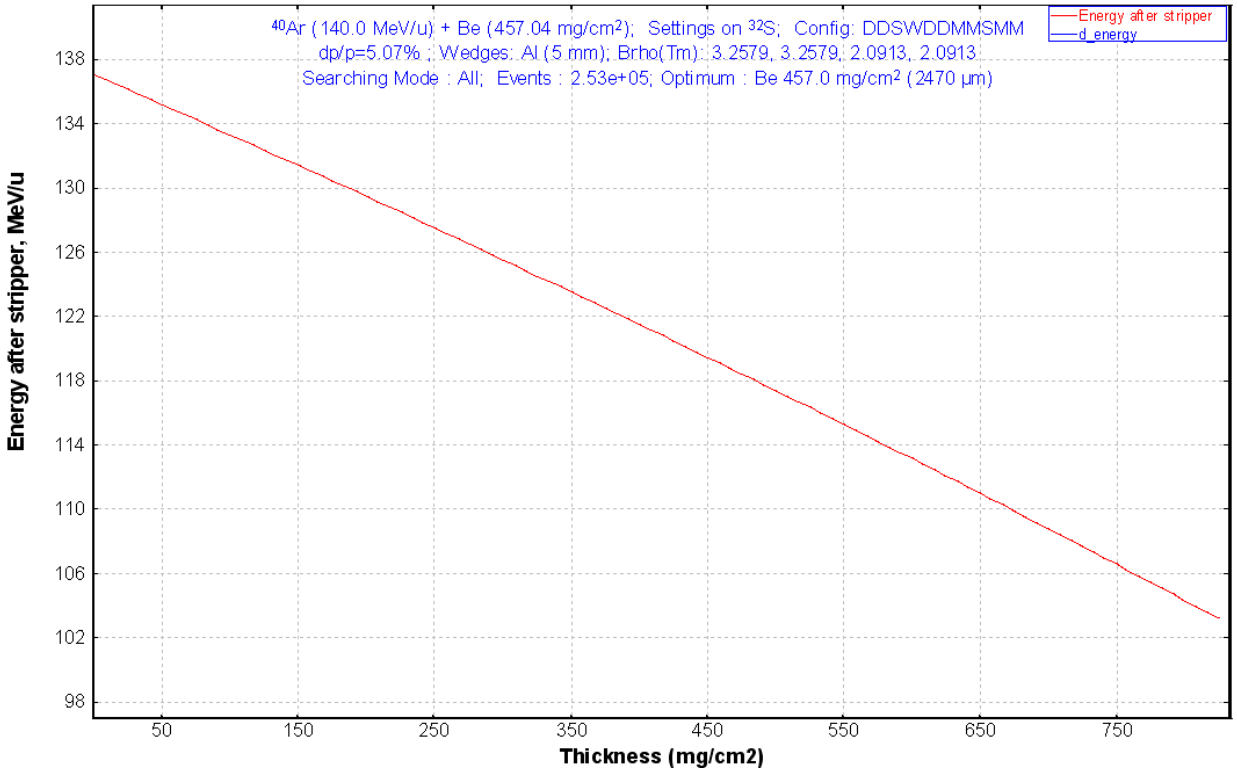
Version 4.

If the “distribution” class has just one array double I[N],

whereas the “distribution2” class
double y[N]
double x[N],

What allows easily create $x=f^{-1}(y)$ from $y=f(x)$

```
//=========================================
class distribution2 : public distribution {

public:

distribution2(double a, double b, int n ,char
*un, char *dim);
distribution2(distribution&);
distribution2(distribution2&);
~distribution2();

void operator = (distribution&);
void operator = (distribution2&);
……
```



Class "distribution2" : example

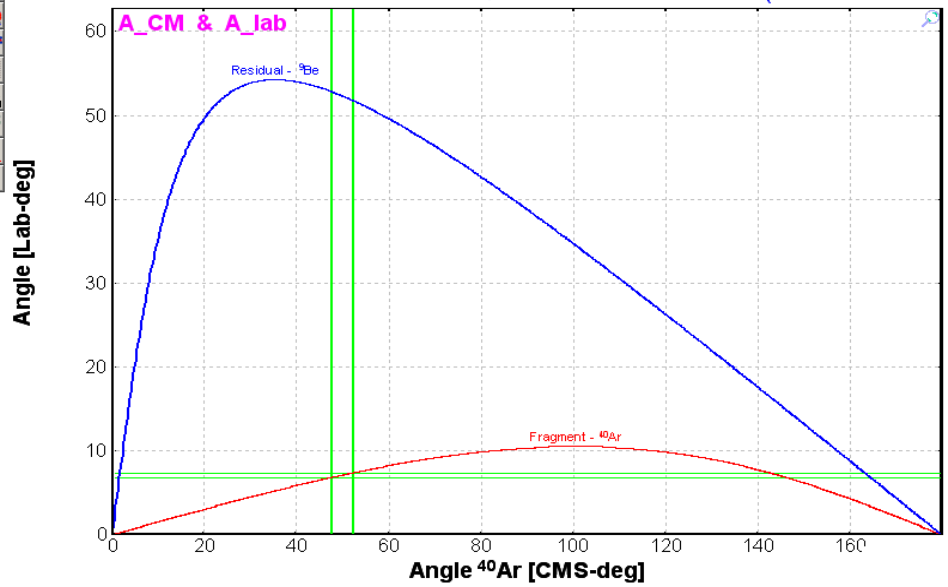
Reaction's Kinematics

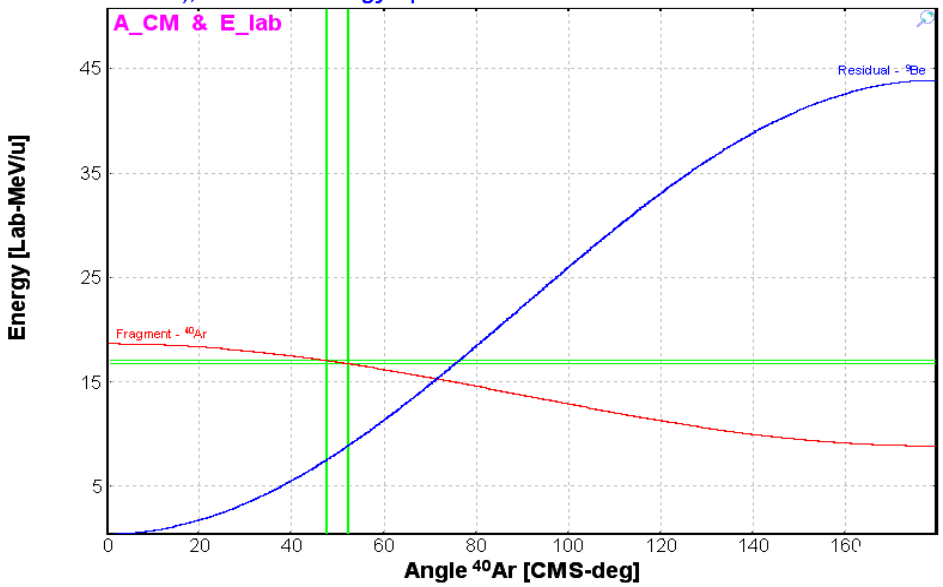
Reaction's Kinematics

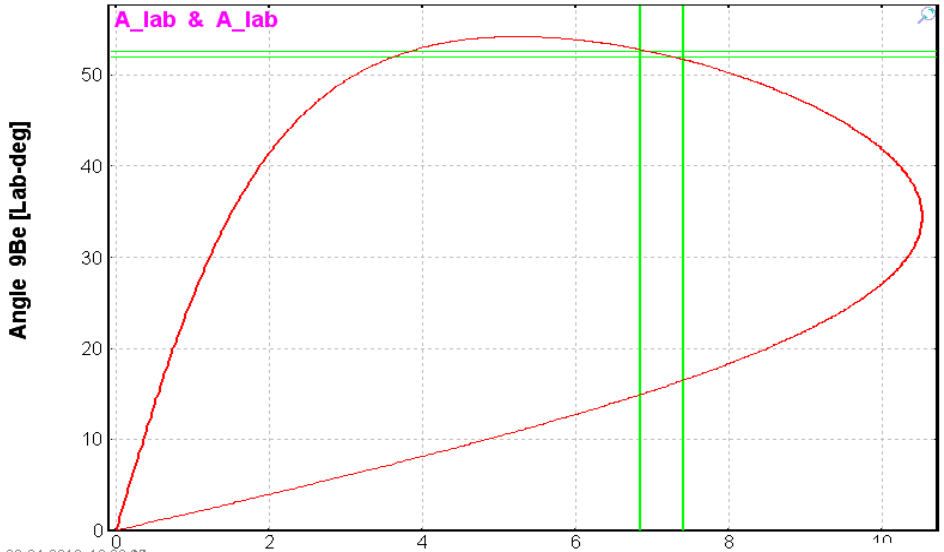
$^{40}Ar + {}^{9}Be \Rightarrow {}^{40}Ar + {}^{9}Be$ $^{9}Be(^{40}Ar,^{40}Ar)\,^{9}Be$; Reaction at the "middle" of the target

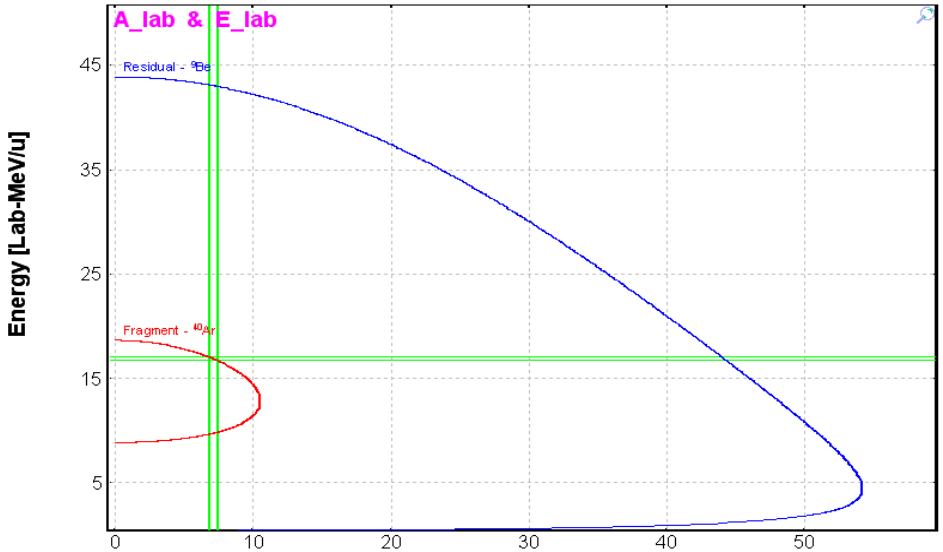
Projectile Energy at the reaction place: 20.00 MeV/u Grazing angle in CMS [$^{40}Ar + {}^{9}Be$] = 4.63 deg

Q reaction : -50.00 MeV (Excitations 0.0+0.0=>50.0+0.0); Plotted Energy option is "after reaction"







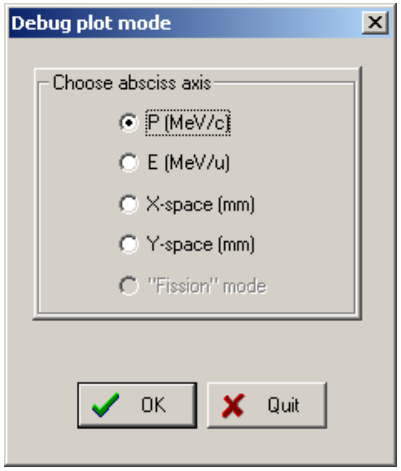


28-04-2010 13:33:02
LISE++ [Noname]

Class "distribution4"

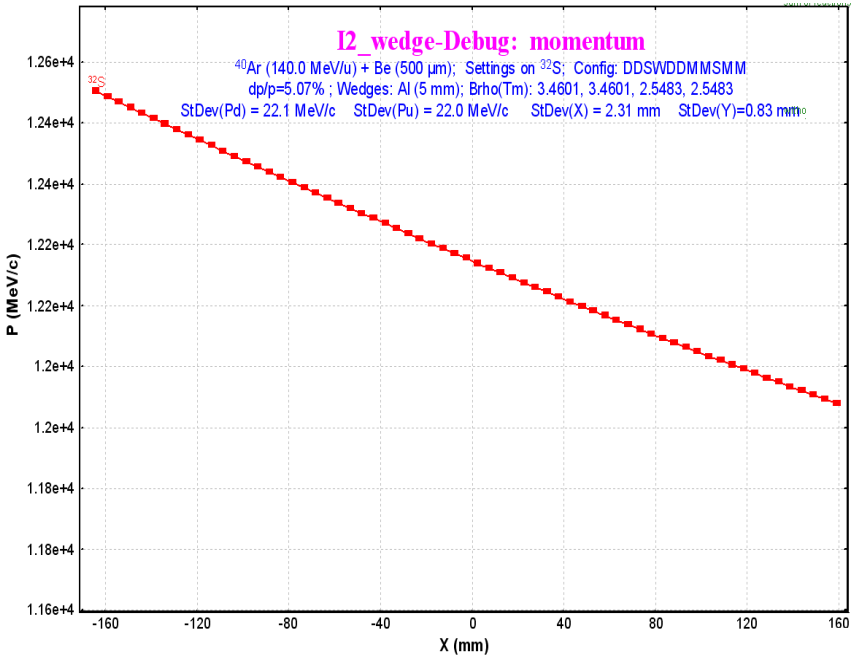
Version 6.

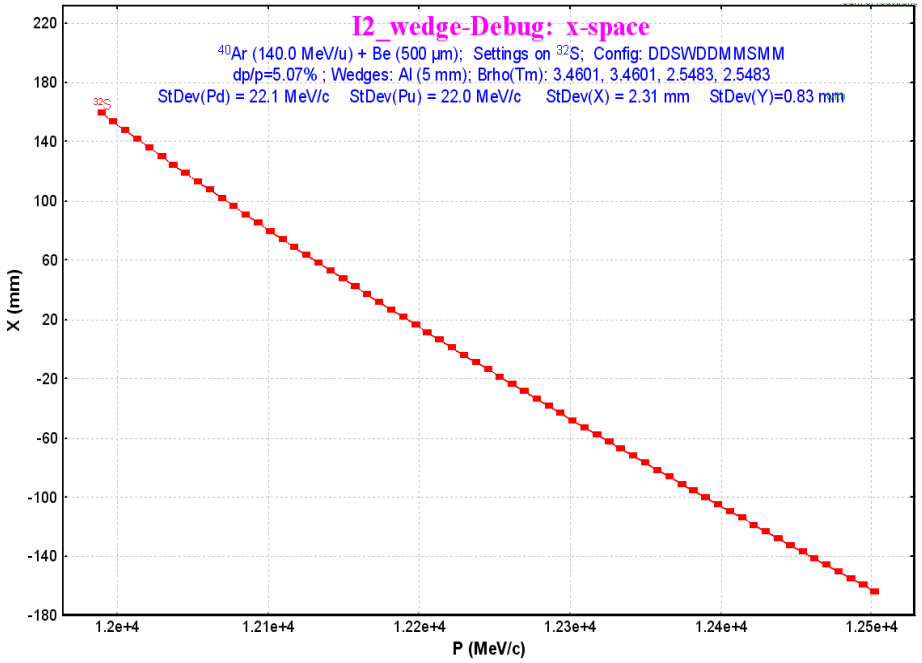
```
class distrFour{

public:
  distrFour(int Ninit=Ndistr4_XY, int mode_init=em_XY);
  distrFour(distrFour&);
 ~distrFour();

  distribution2 **d4;

 void ChangeBase(int BaseNew, bool MakeUniformOpt=false);
……..
```



Can be "Base"

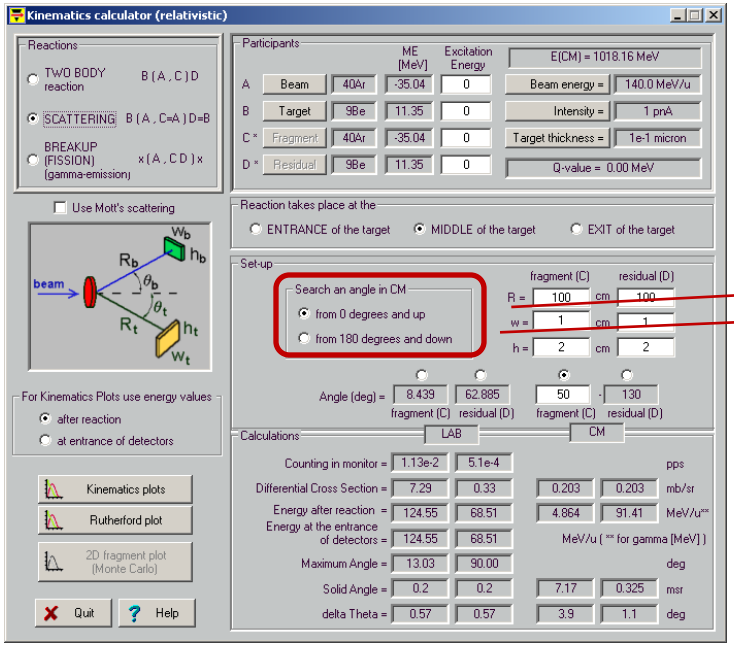
```
enum edistrFour {
    e4I,
    e4P,
    e4E,
    e4X,
    e4Y,
    e4Pd,
    e4Pu,
    e4Ed,
    e4Eu
};
```

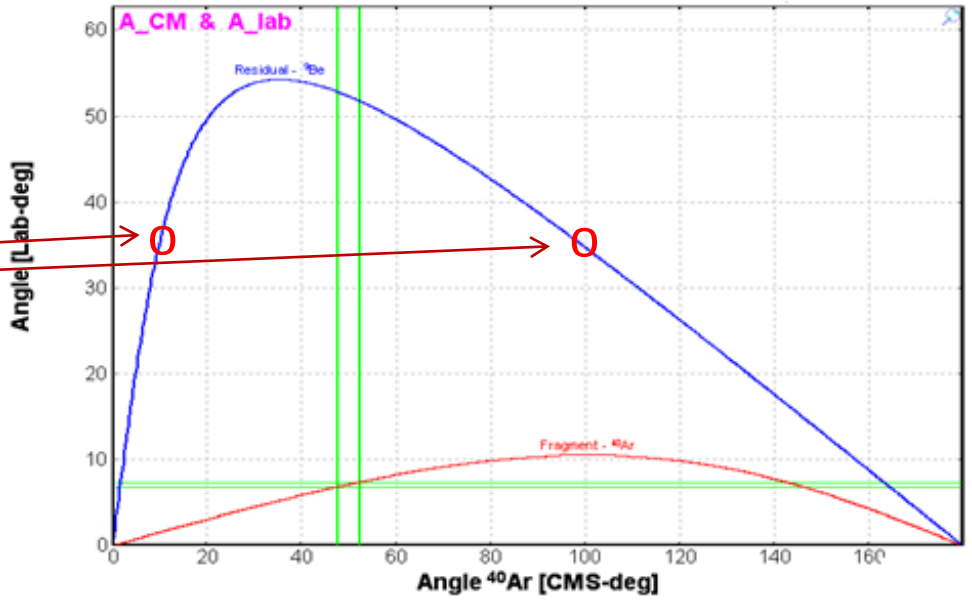




Probably X' and Y' should be included in DistrFour and be used as "Base" to solve MH effect

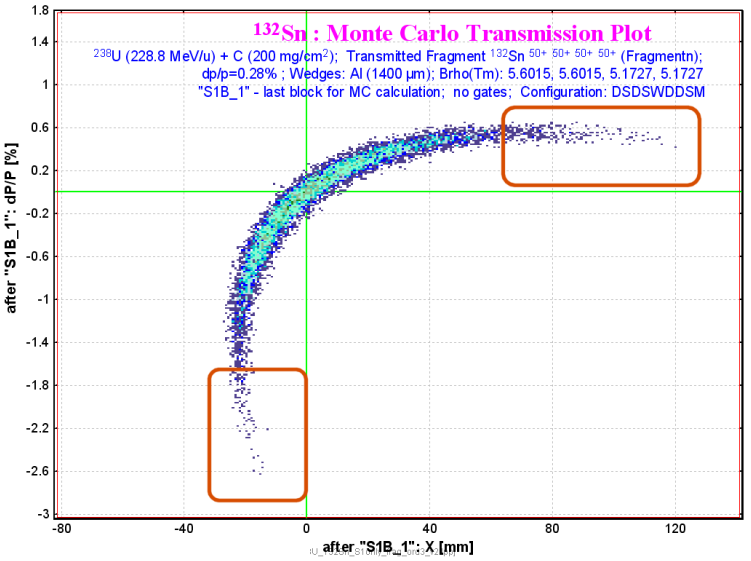
Two solutions for one variable



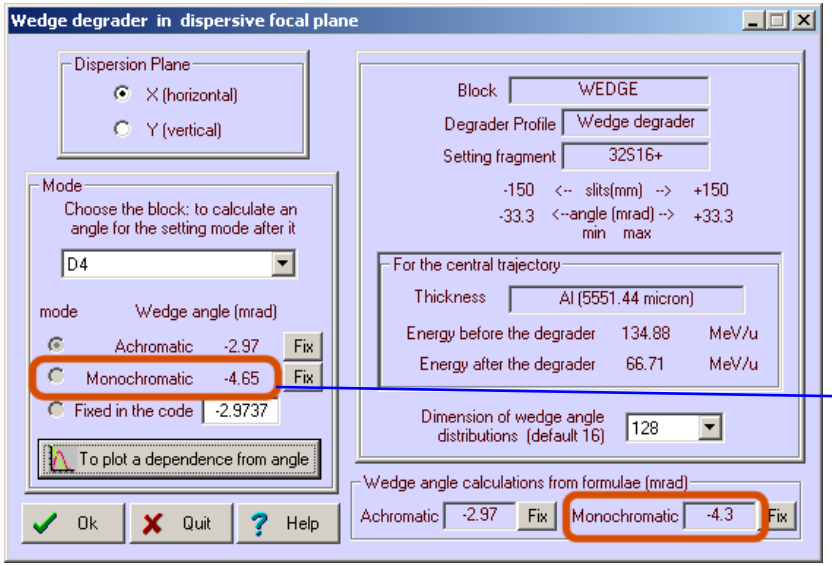


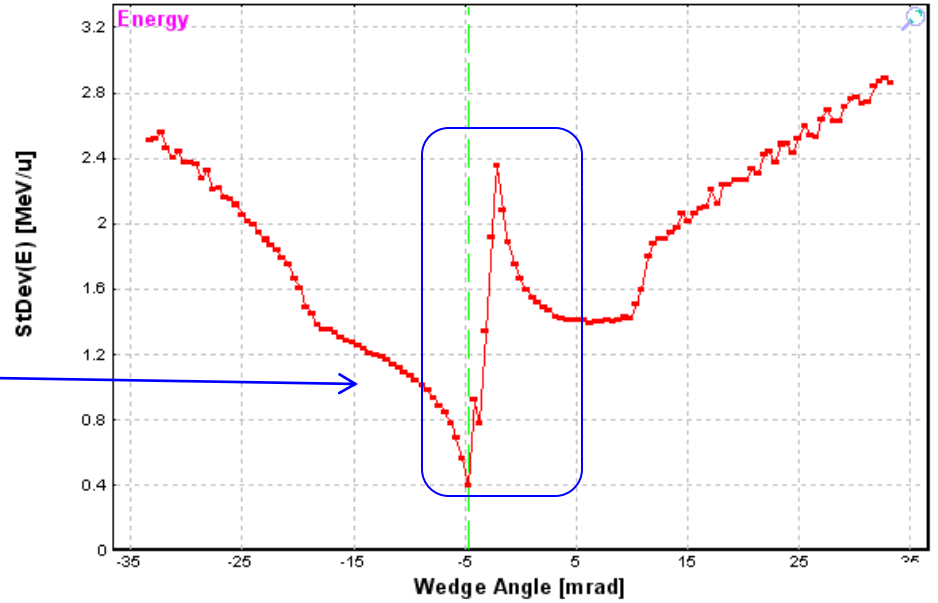
For transmission calculation (material and optical block passing) “distribution2”’s are transformed to simple intensity “distribution”’s for convolution.

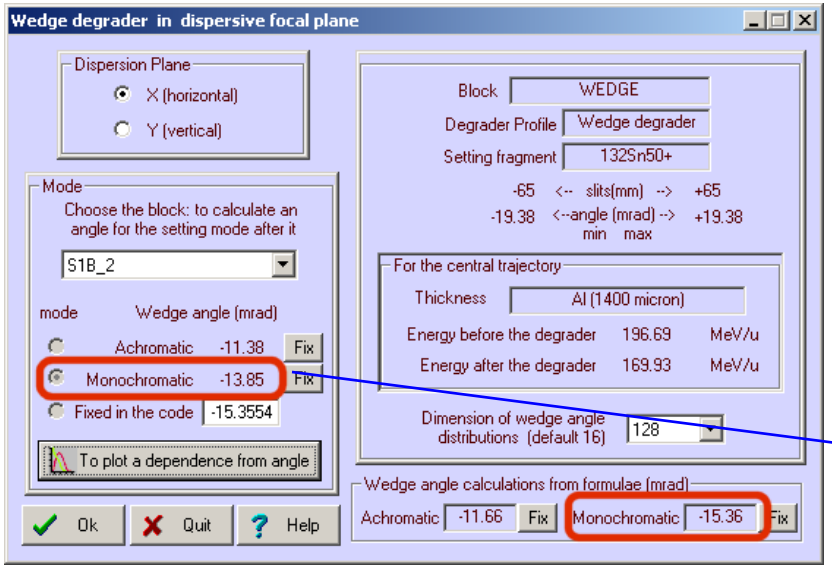
Two solutions for one variable are not acceptable in this case. This situation was used to happen in the case of monochromatic wedge, so called “wedge curiosity.

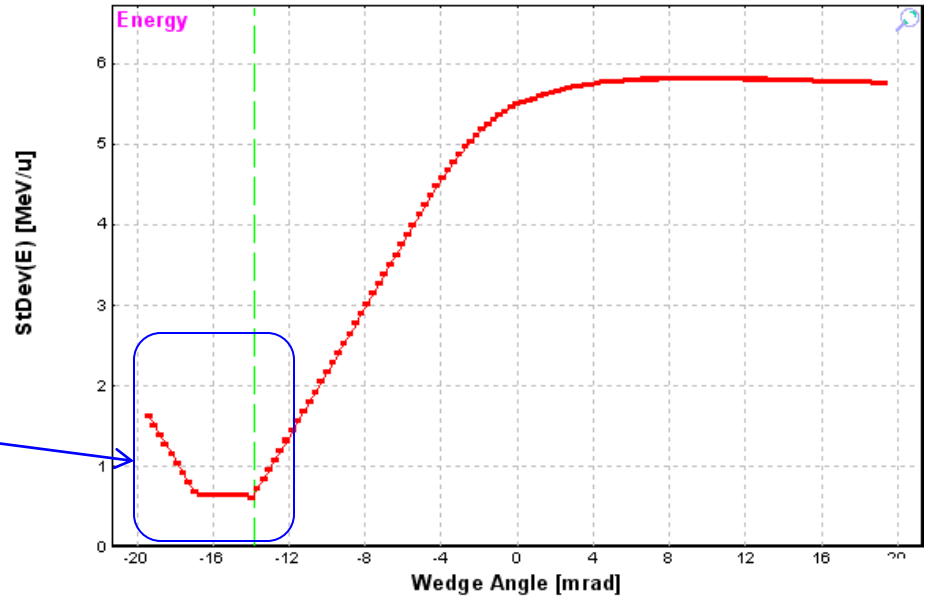


“Wedge curiosity” v.8.5



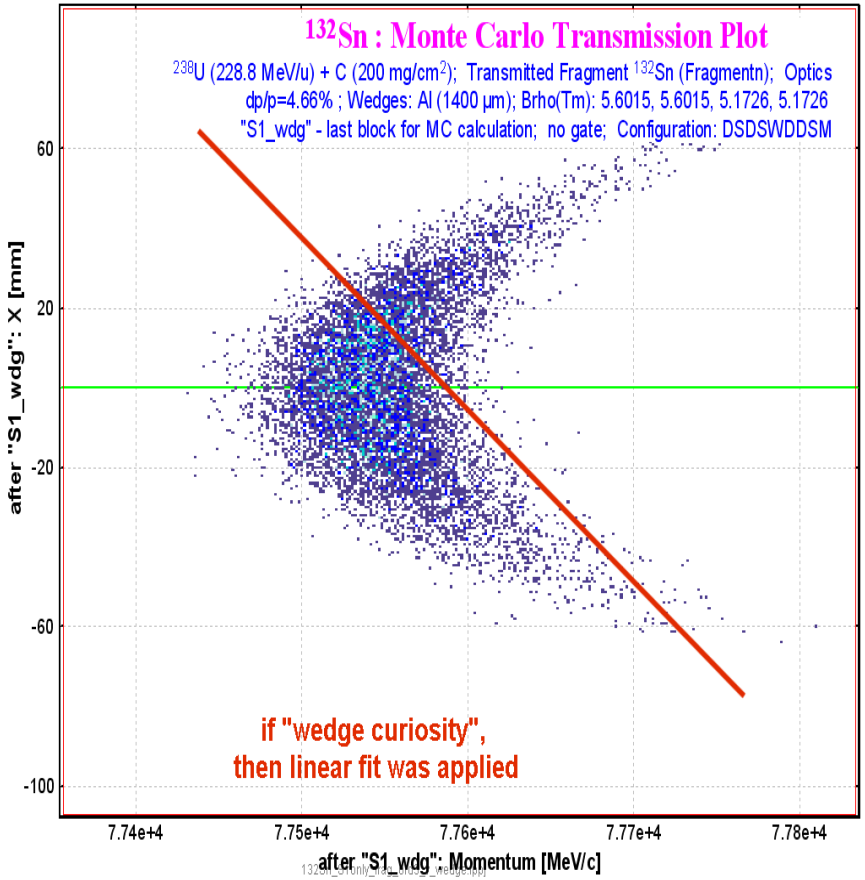


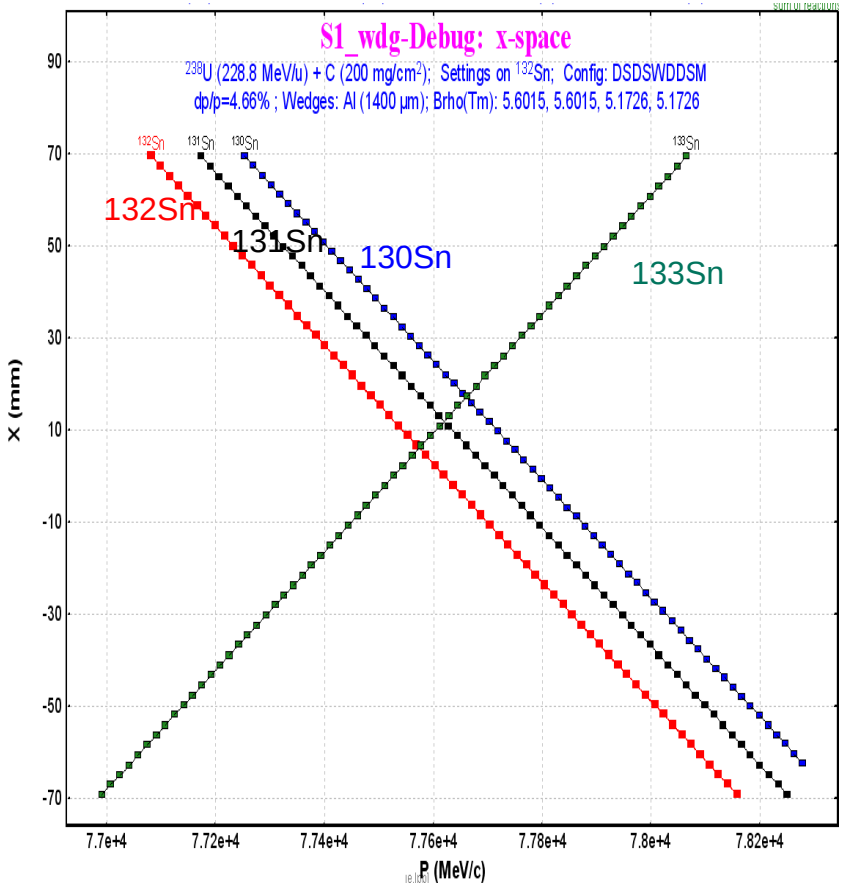




"Wedge curiosity" *solution* v.8.5

The worse case is zero transmission for the setting fragment ☹





“Wedge curiosity” solution v.9.1

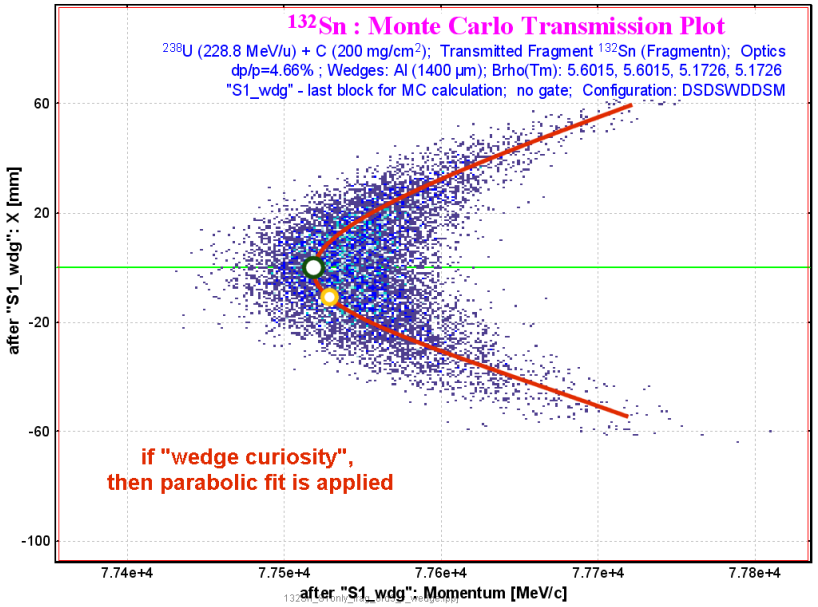
In DistFour distributions the “base” has been changed

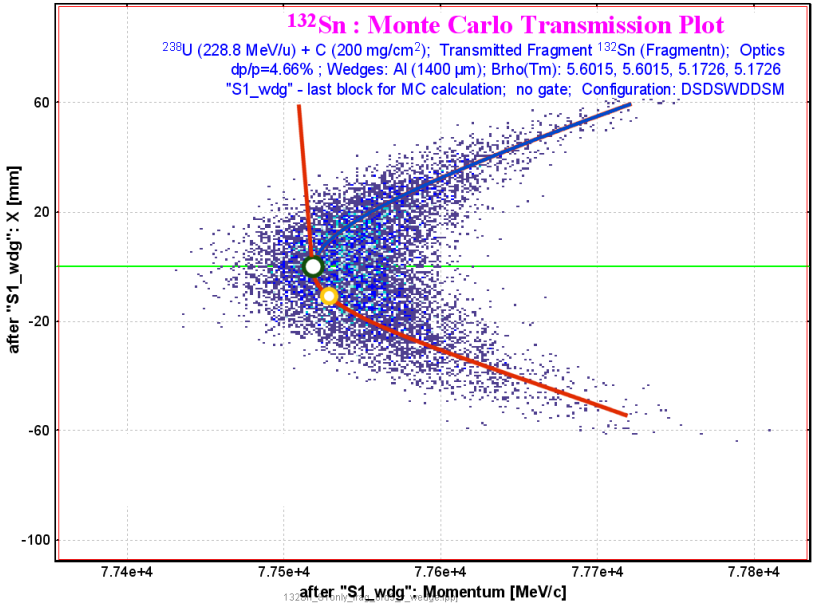
Passing Materials from P to X(Y)
Passing Optical blocks from X(Y) to P

Steps

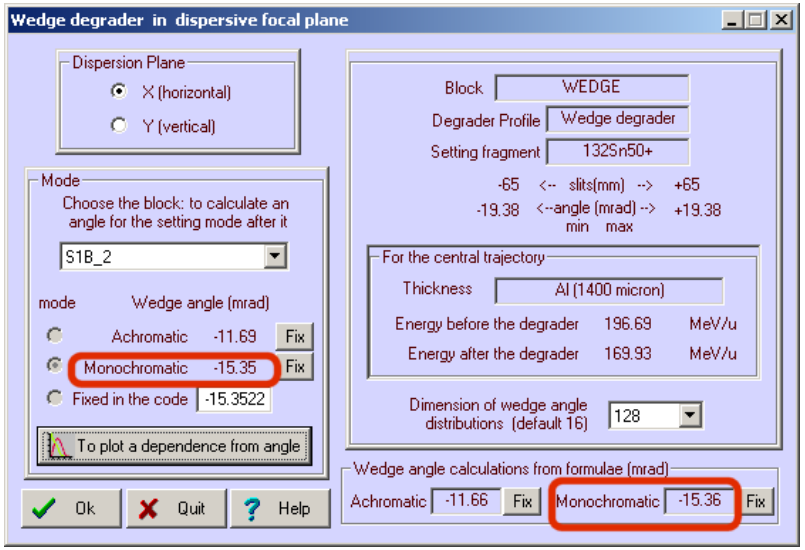
1. Parabolic fit
2. Search a turning point
3. Search more intense point
4. Combining this parabola with line.

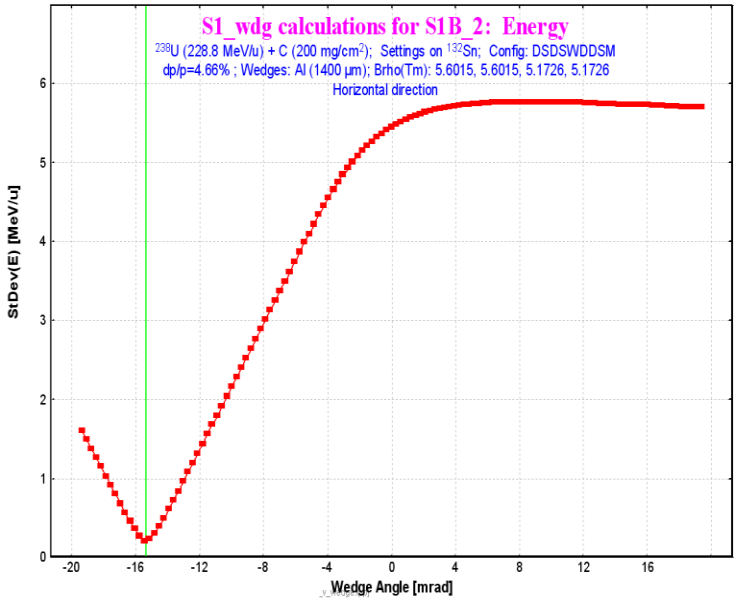
More Intense point should have
the same X and P values after these operations

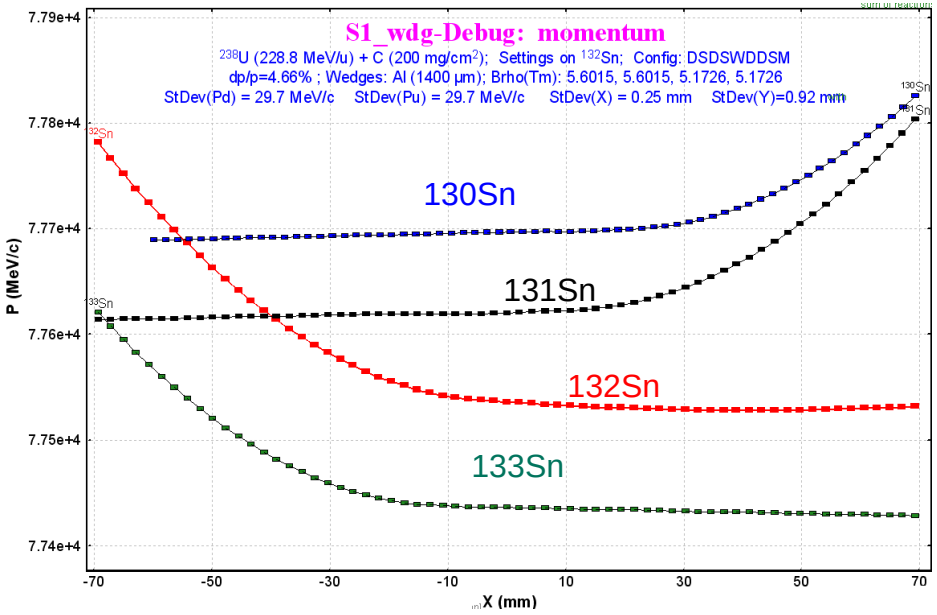




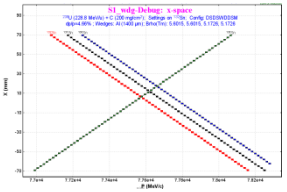
“Wedge curiosity” solution v.9.1



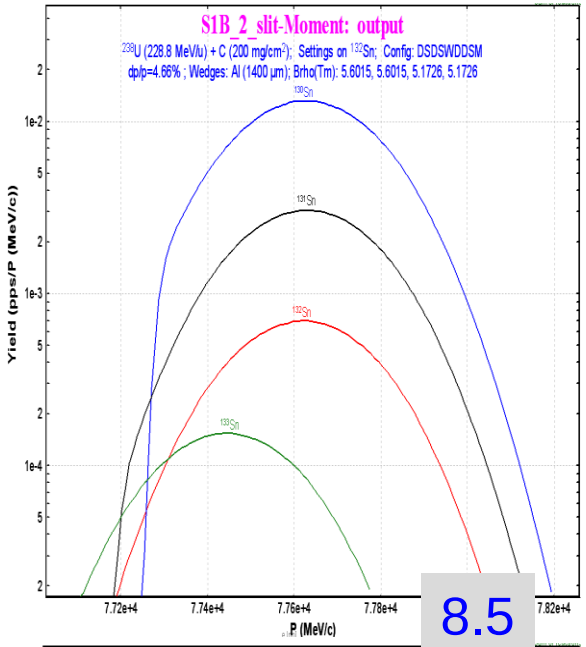




8.5



Comparison (X & P)



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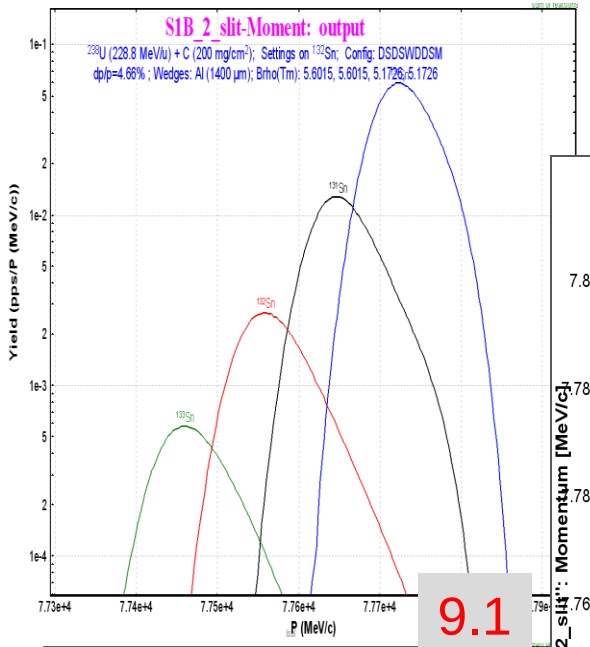
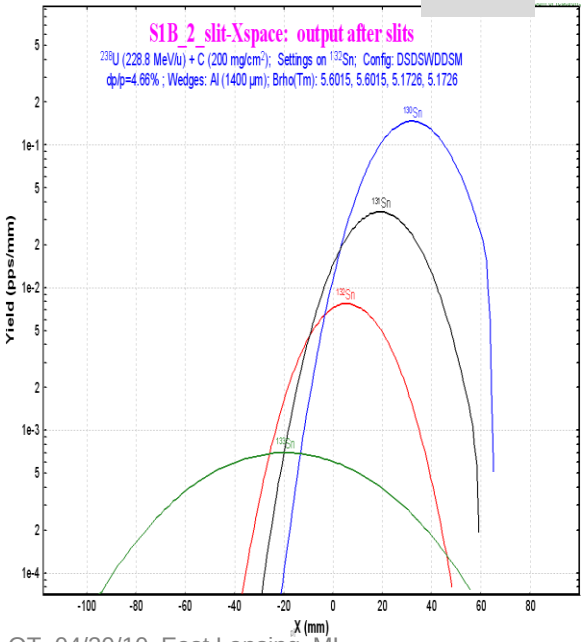
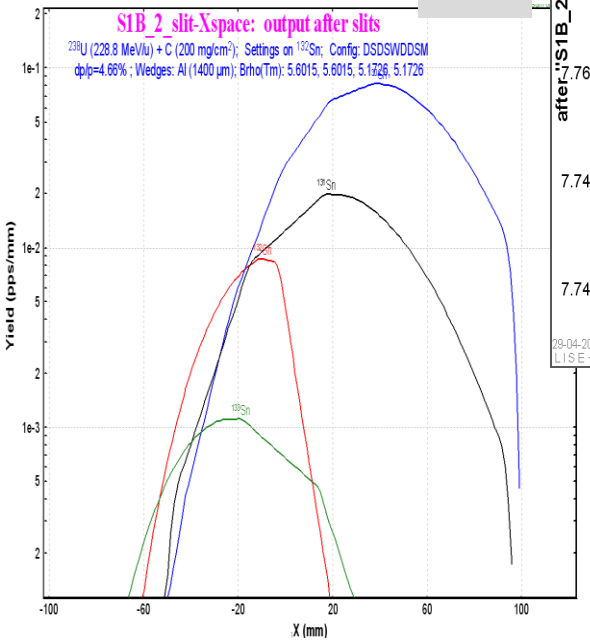
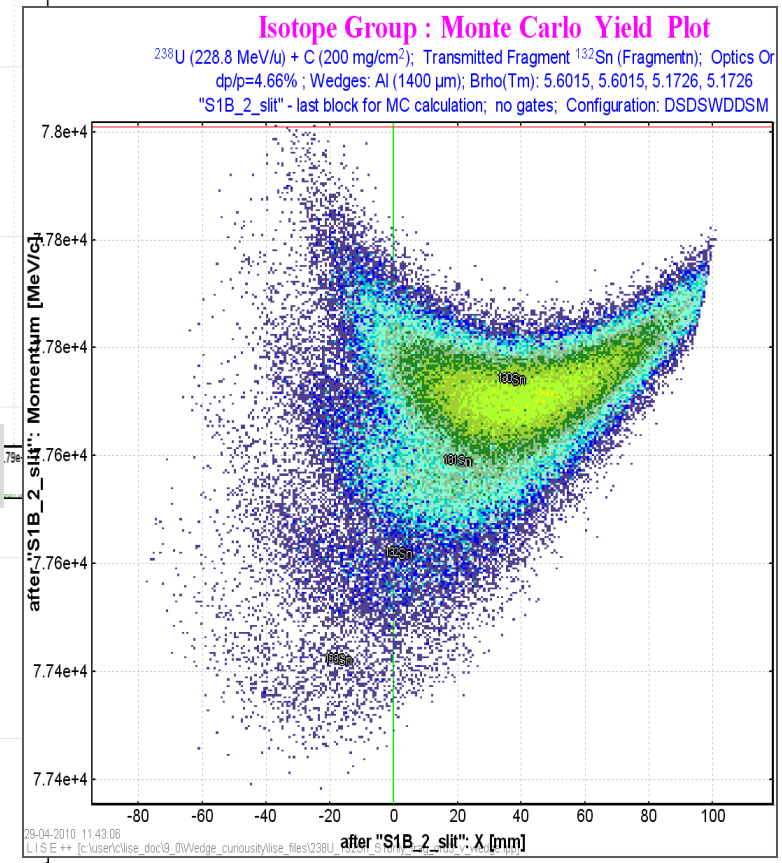


9.1







Comparison (X & ToF)