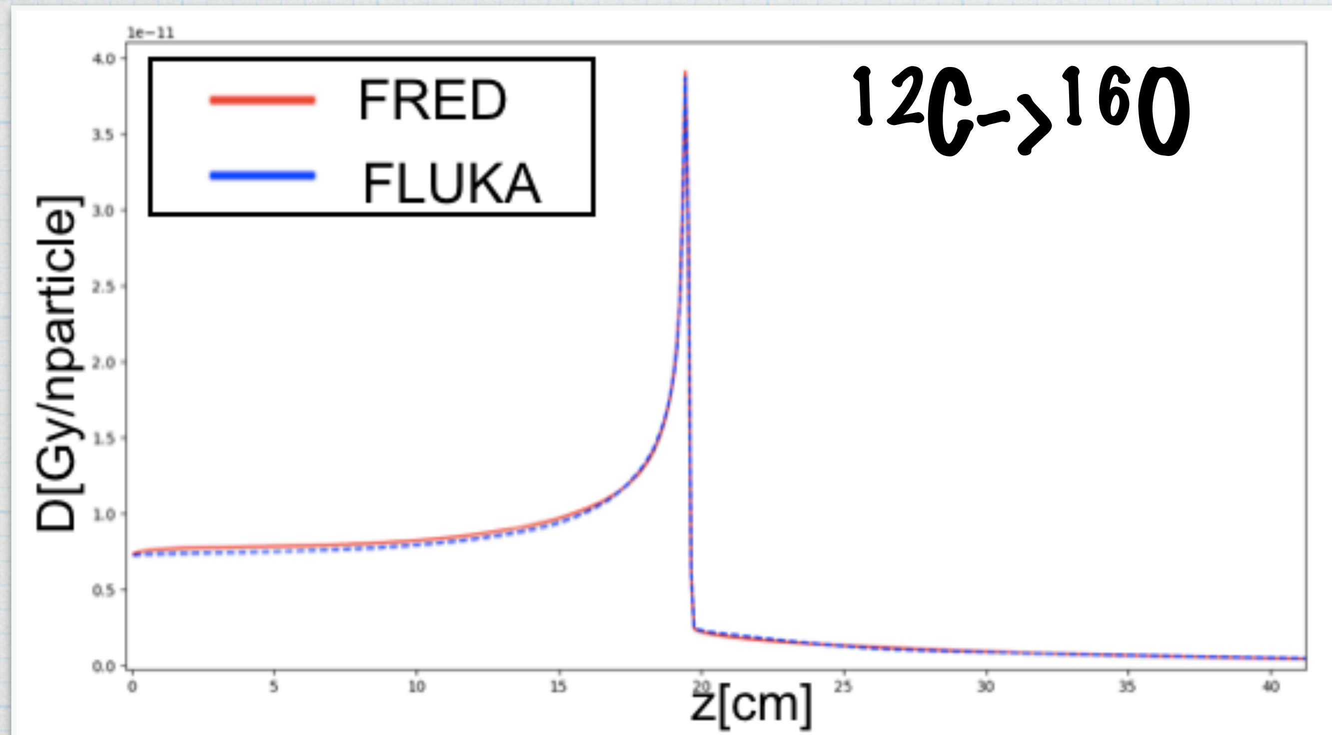
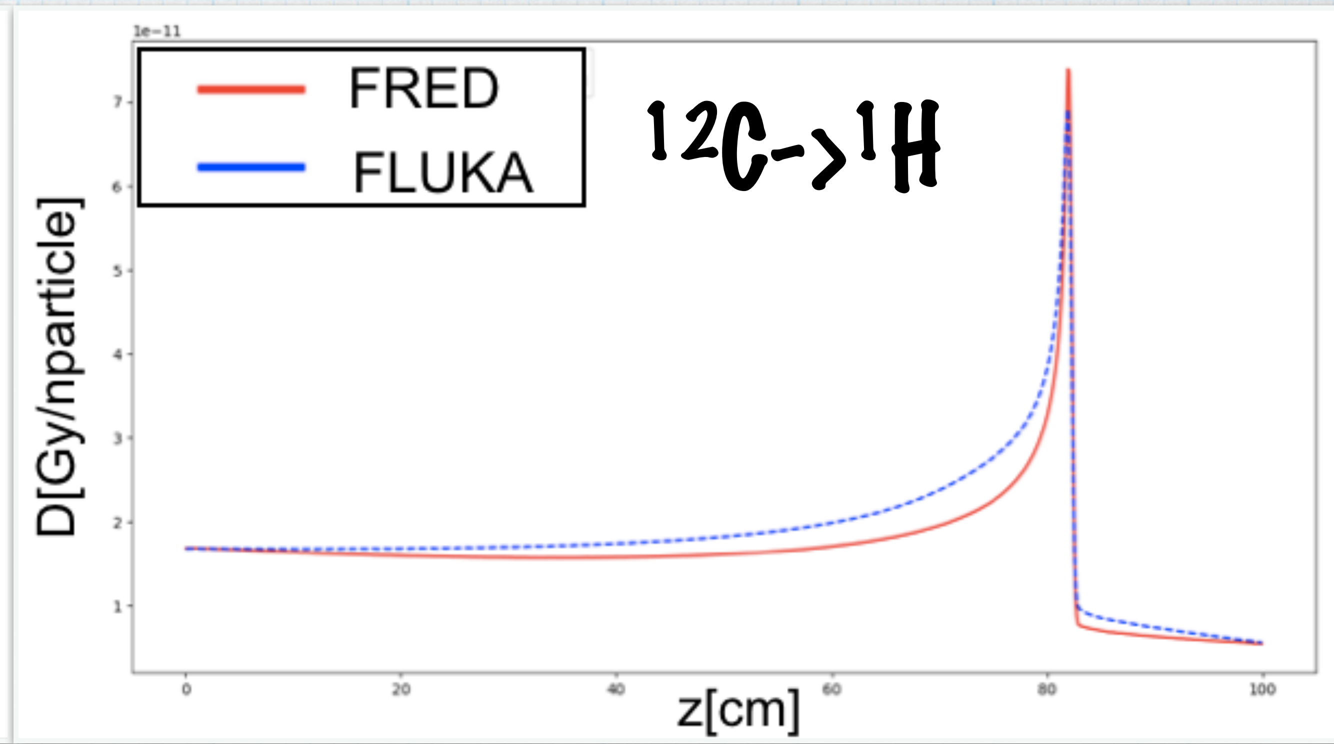
FRED for Carbon Ions: State of Art

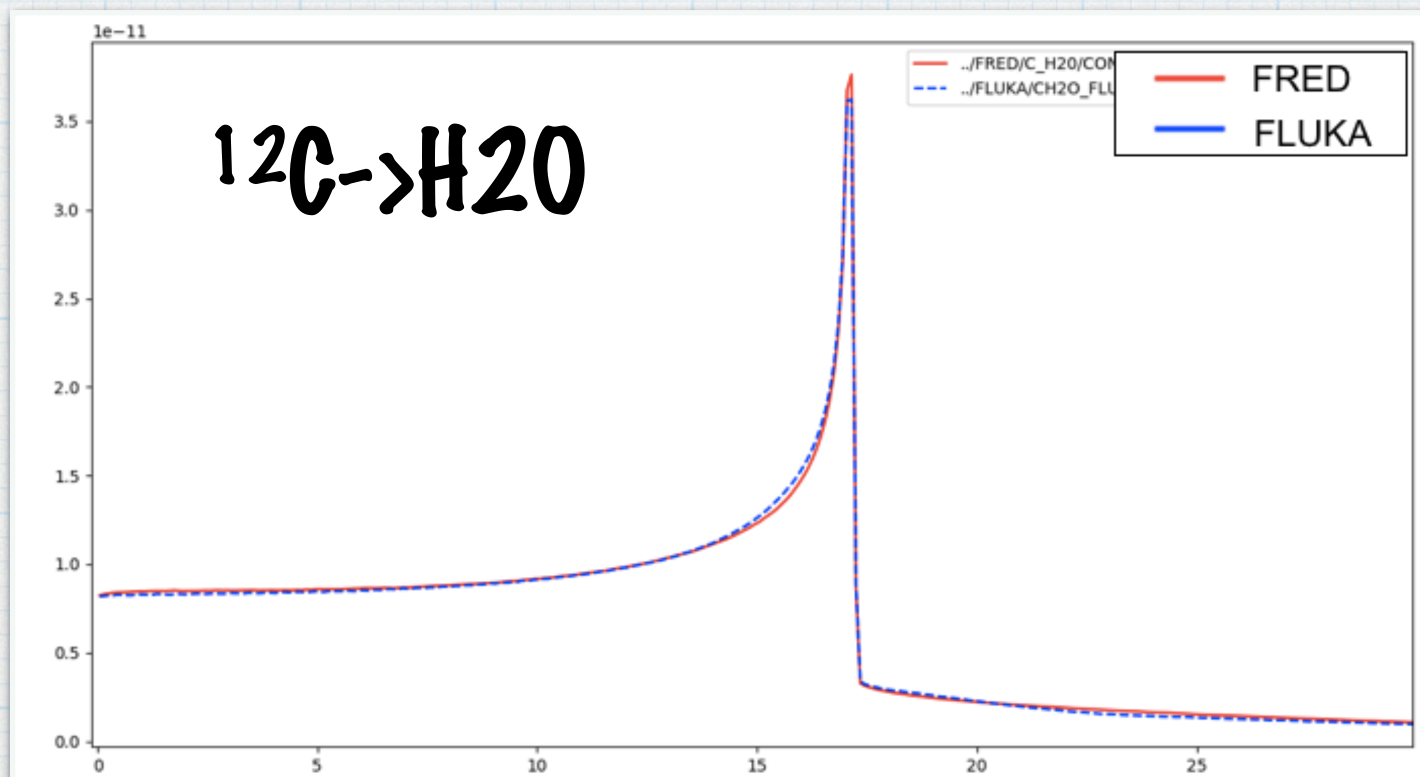
Micol De Simoni

05/11/2020

Where where we?







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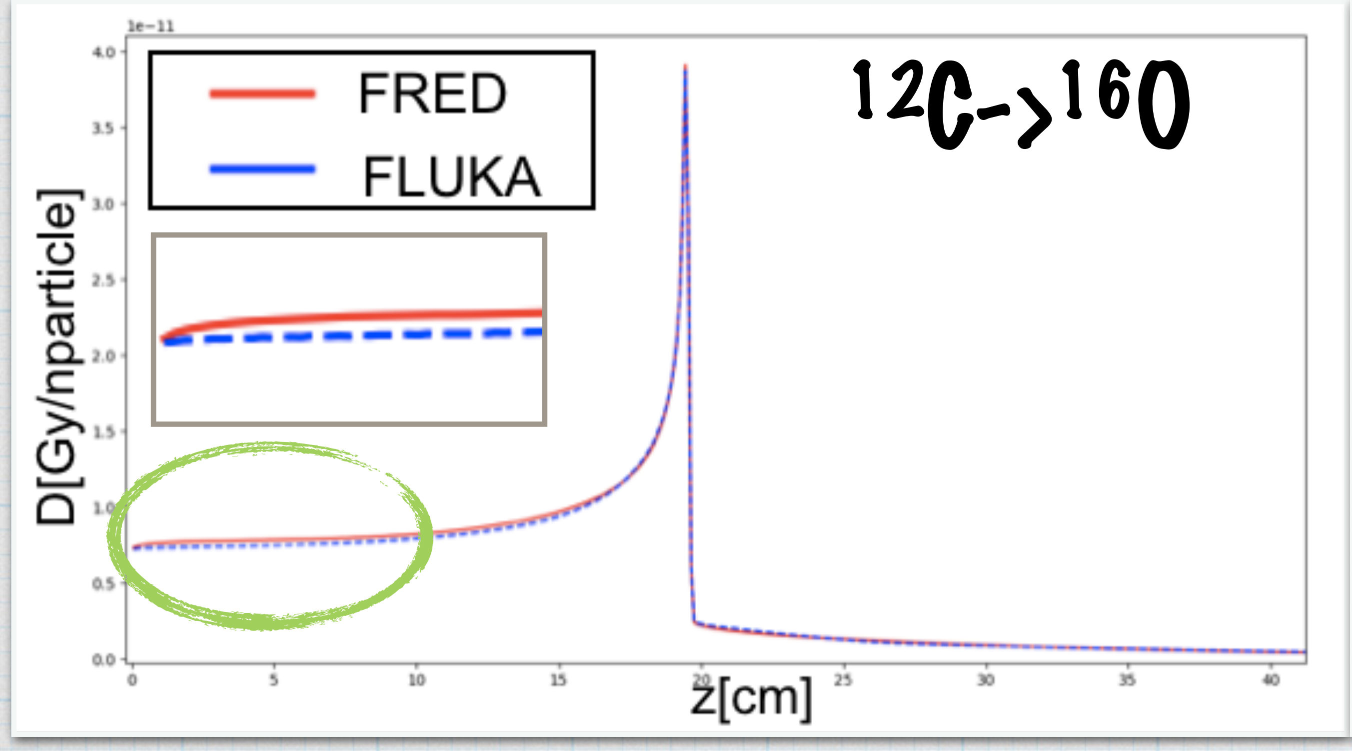
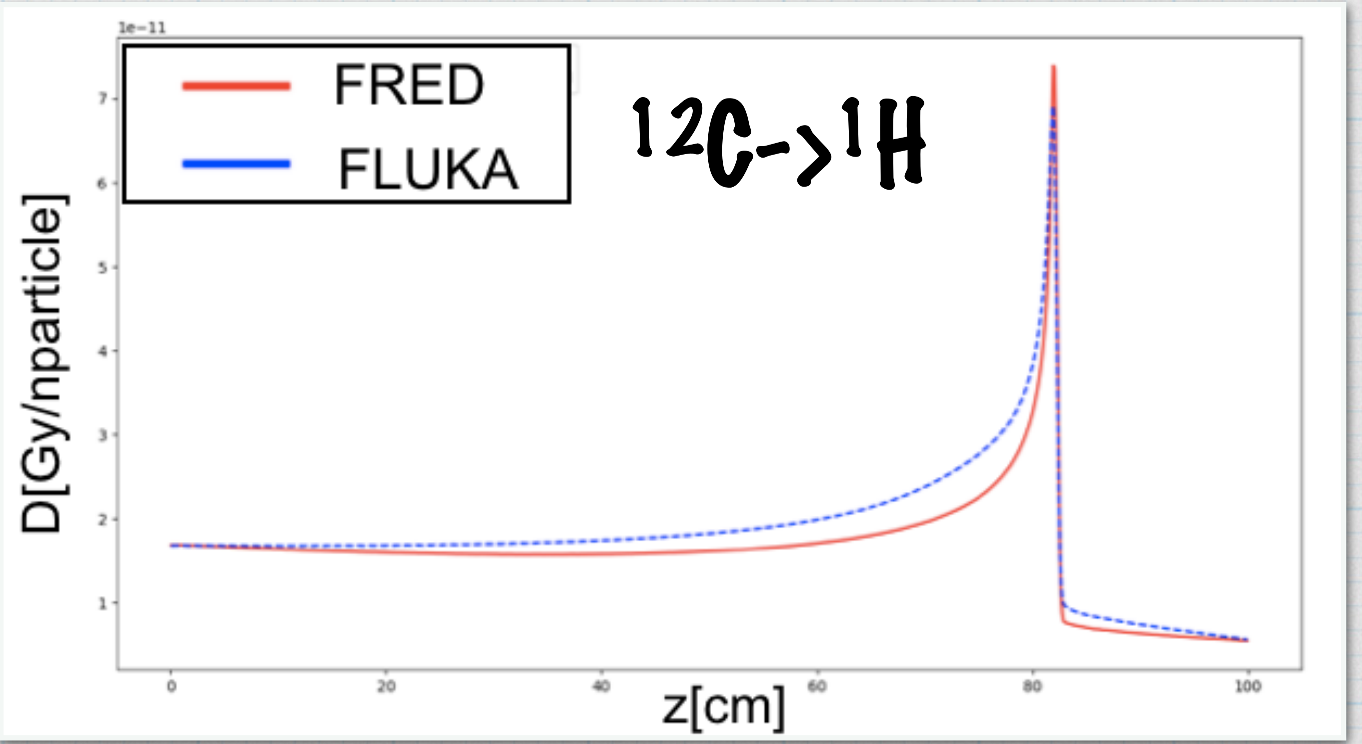
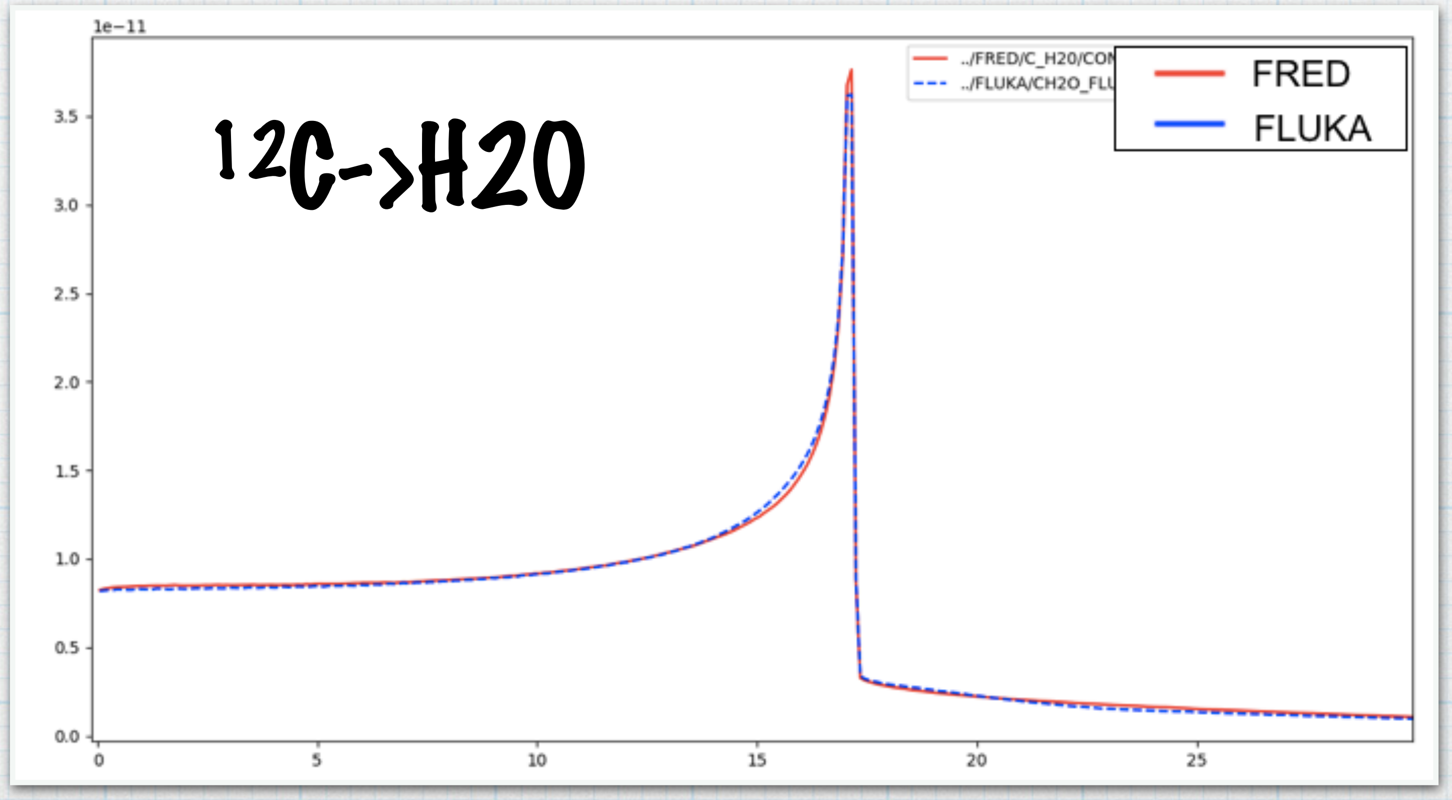
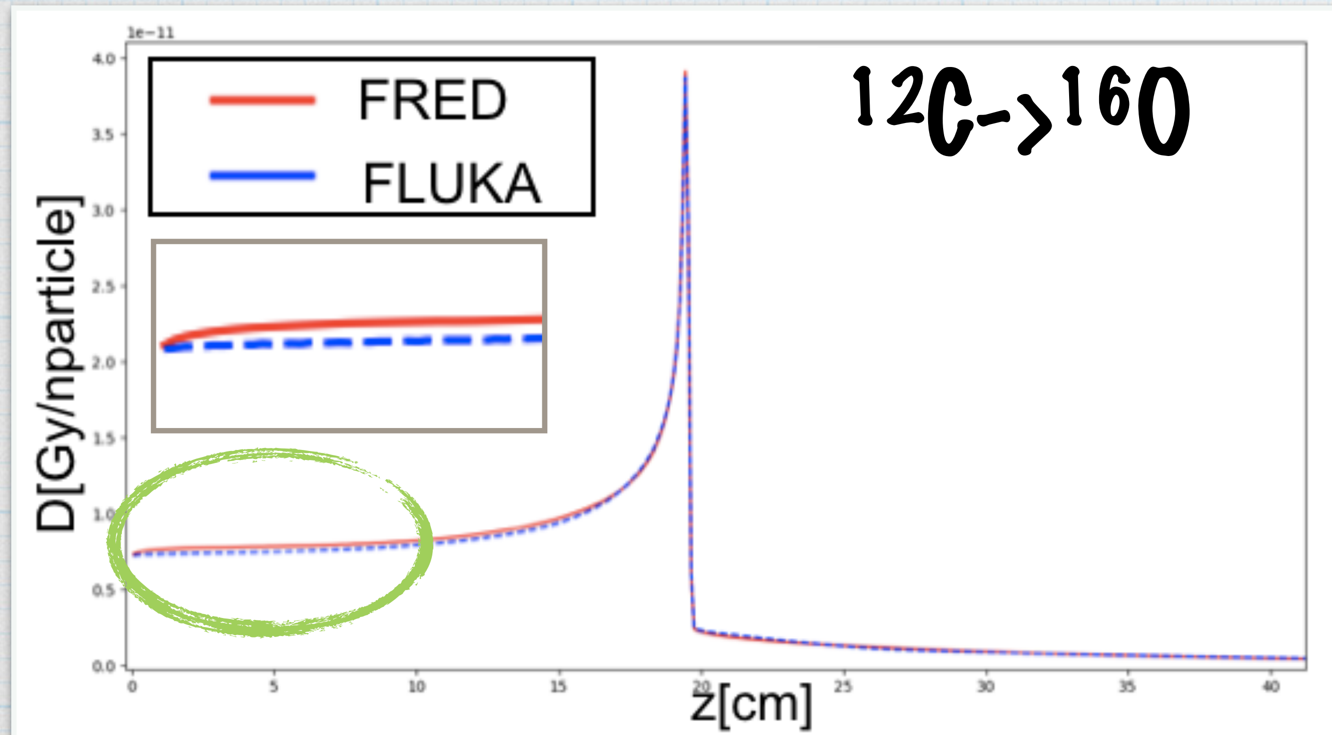
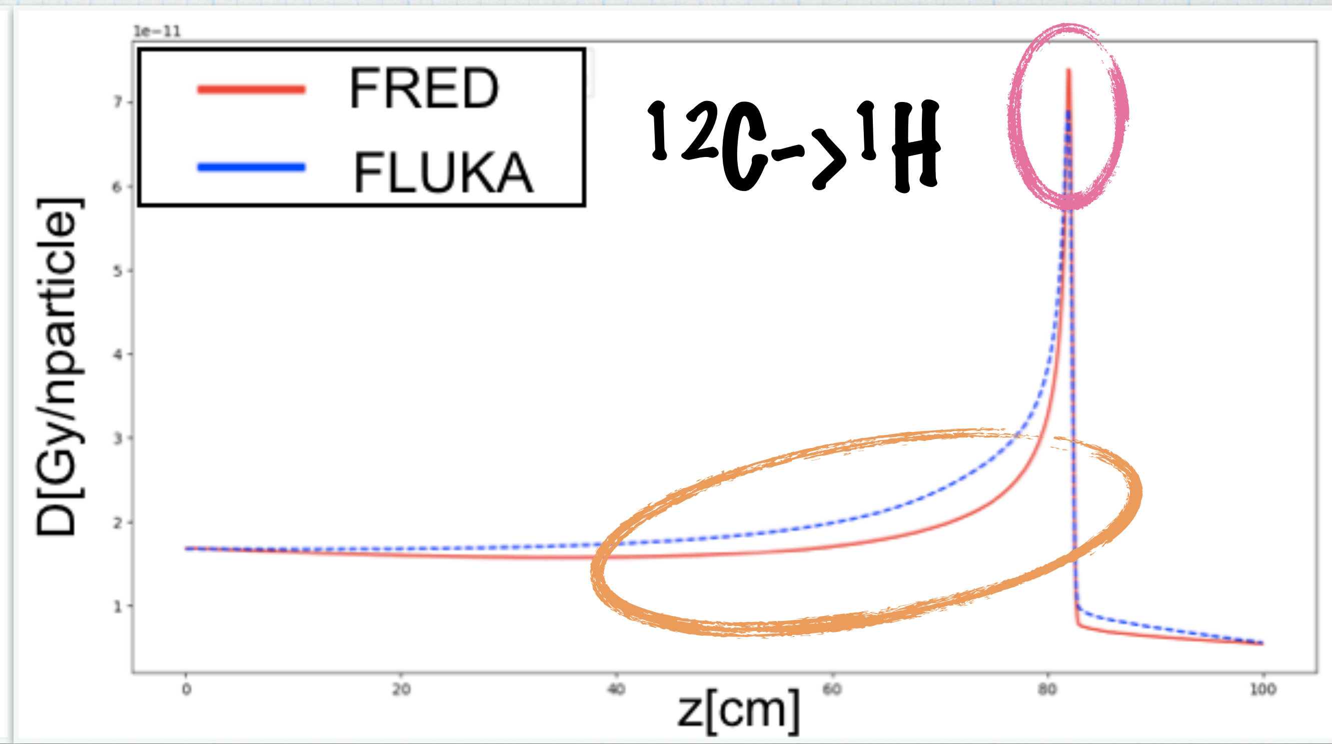


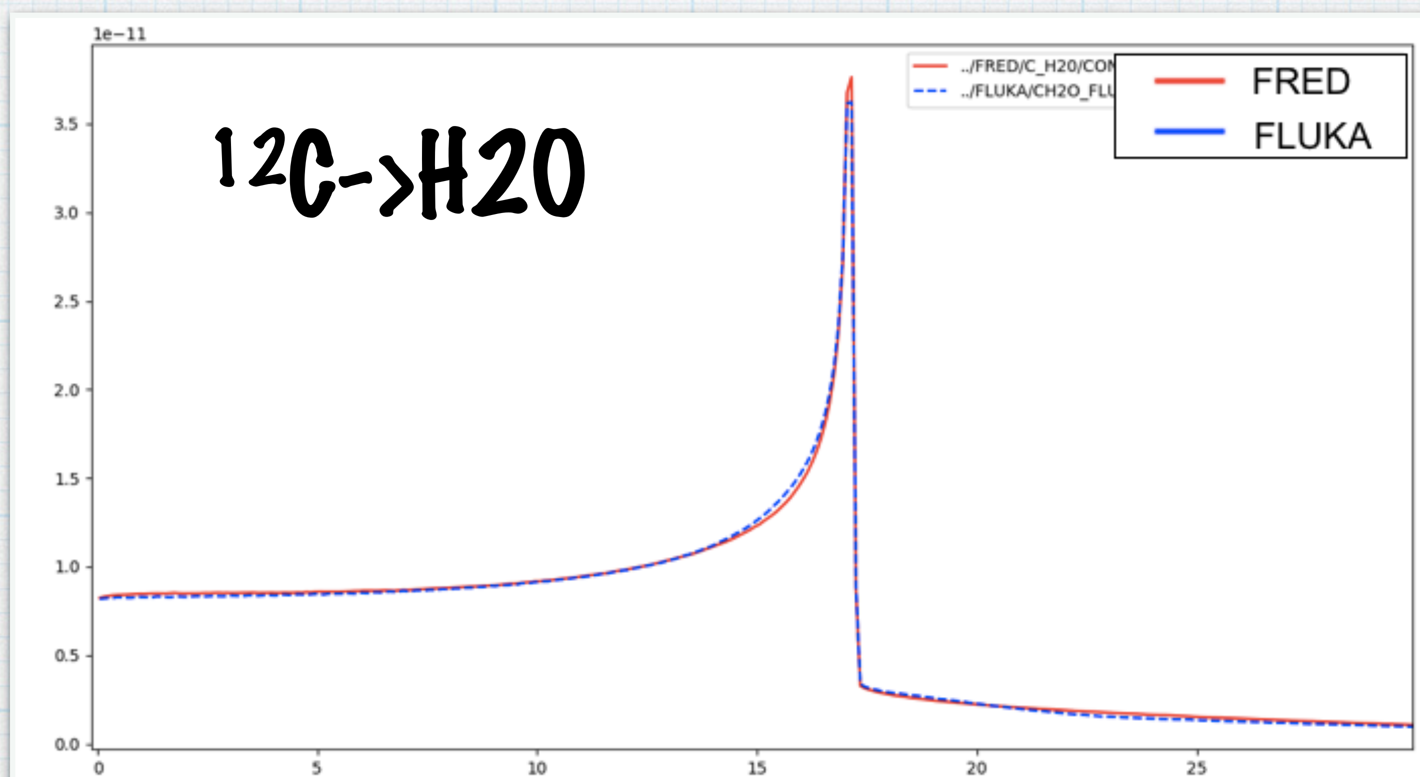




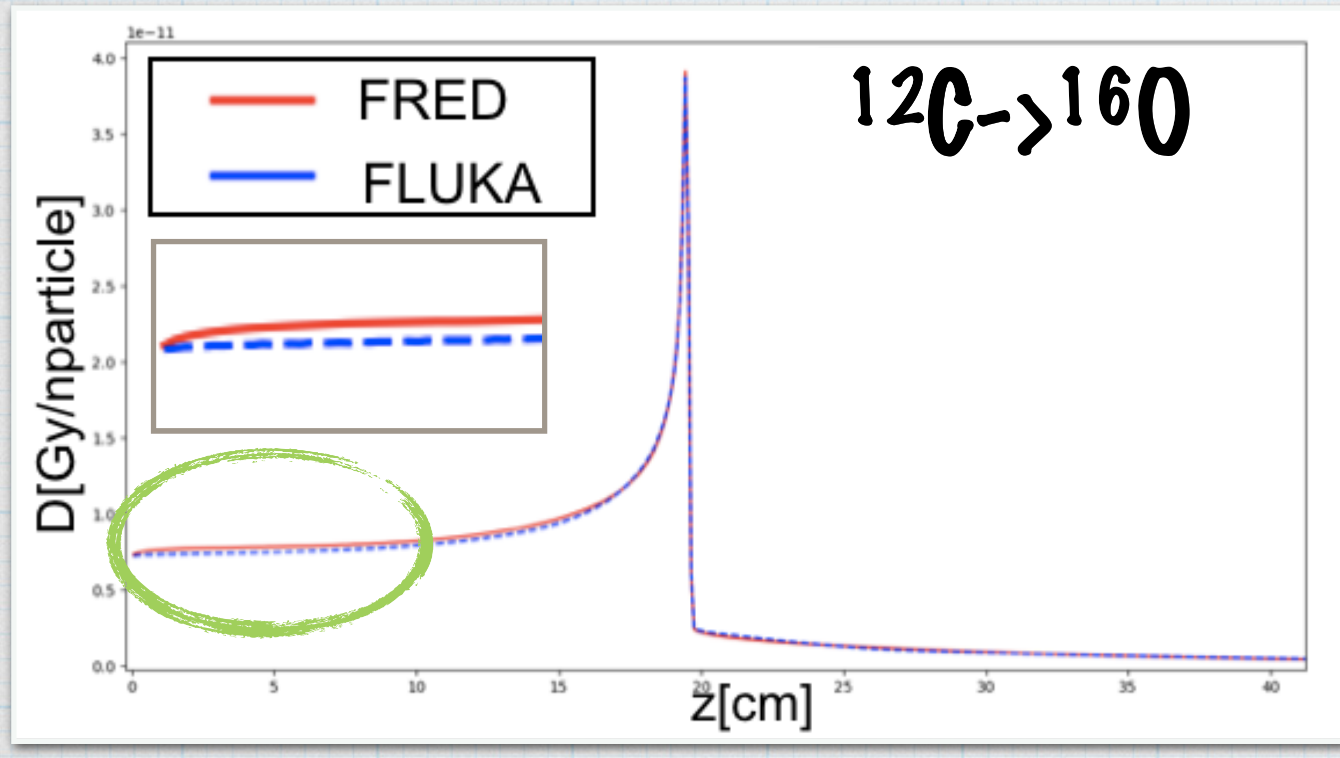
Where where we?

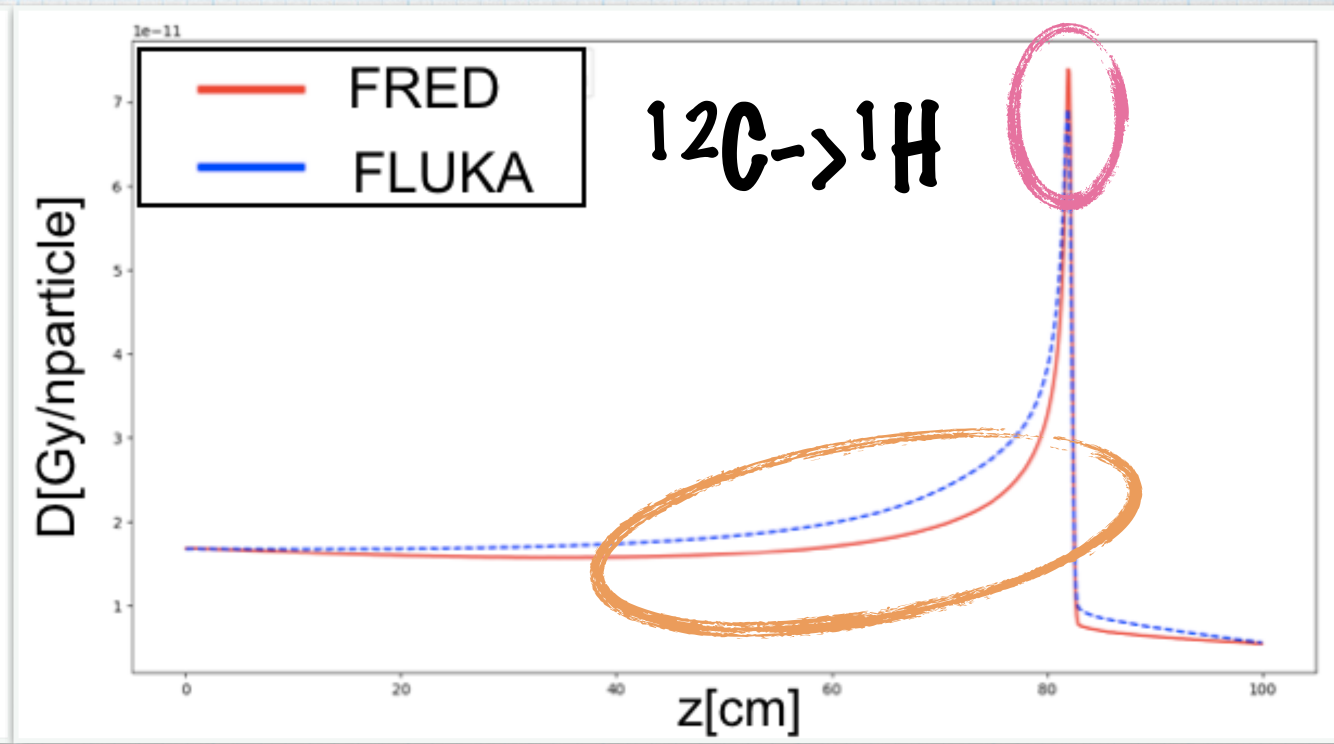


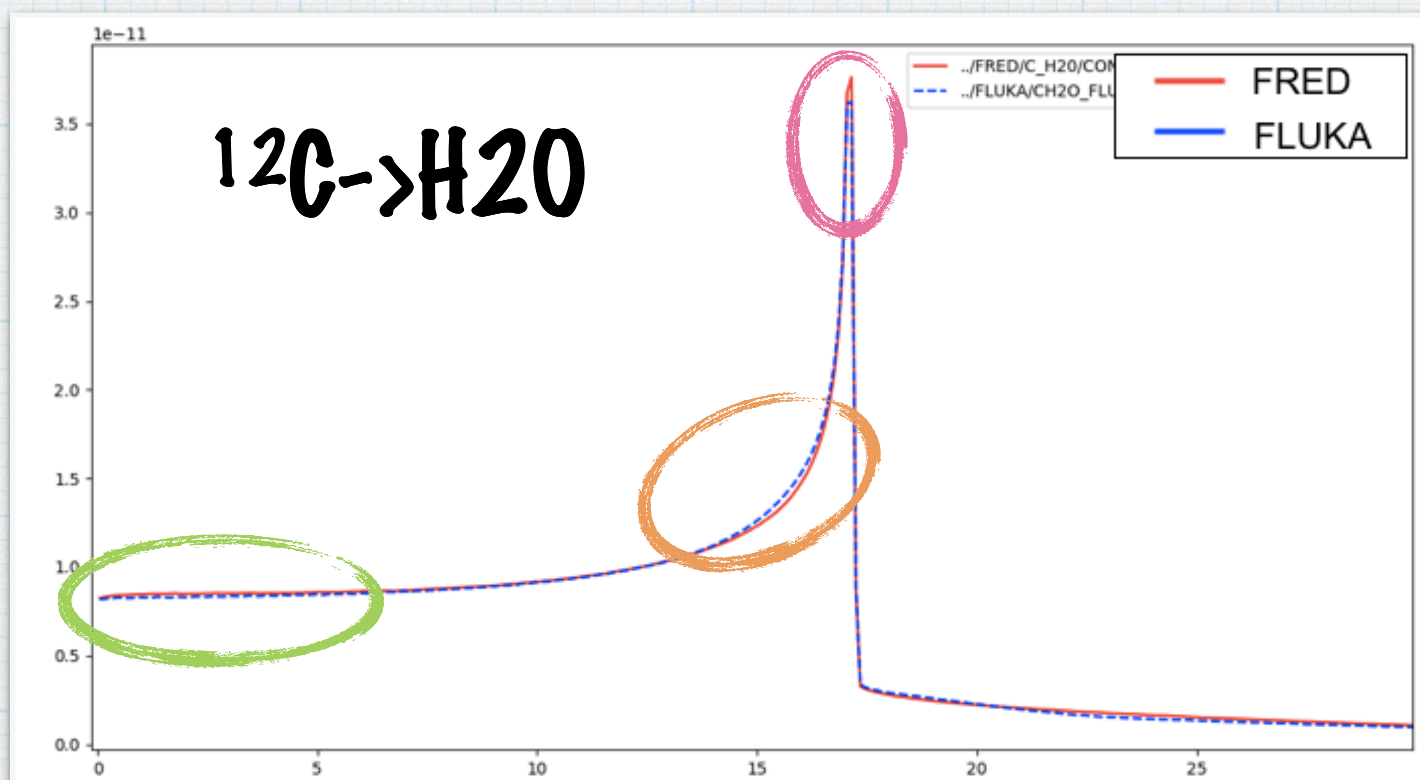




Where where we?







Ganil

	σ (barns) Targets				
Fragments	H	C	O	Al	Ti
^{1}H	$4.1(0.6).10^{-1}$	1.7(0.1)	2.1(0.2)	3.0(0.2)	4.4(0.3)
^{2}H	$7.3(1.5).10^{-2}$	$7.9(0.4).10^{-1}$	$9.3(0.8).10^{-1}$	1.3(0.1)	1.9(0.1)
^{3}H	$1.6(0.3).10^{-2}$	$3.2(0.2).10^{-1}$	$3.6(0.4).10^{-1}$	$5.2(0.3).10^{-1}$	$7.7(0.4).10^{-1}$
^{3}He	$4.1(0.4).10^{-2}$	$3.3(0.6).10^{-1}$	$4.0(0.5).10^{-1}$	$5.1(0.8).10^{-1}$	$6.7(1.0).10^{-1}$
^{4}He	$2.0(0.8).10^{-1}$	1.2(0.3)	1.2(0.4)	1.7(0.1)	2.0(0.2)
^{6}He	$1.0(0.1).10^{-2}$	$4.9(1.2).10^{-2}$	$5.7(2.2).10^{-2}$	$7.0(1.4).10^{-2}$	$8.7(1.5).10^{-2}$
^{6}Li	$1.2(0.6).10^{-2}$	$6.8(1.1).10^{-2}$	$7.4(1.5).10^{-2}$	$9.4(1.3).10^{-2}$	$1.2(0.2).10^{-1}$
^{7}Li	$8.0(1.8).10^{-3}$	$6.1(1.0).10^{-2}$	$6.6(1.4).10^{-2}$	$8.6(1.3).10^{-2}$	$1.1(0.1).10^{-1}$
^{7}Be	$1.6(0.3).10^{-2}$	$5.0(0.8).10^{-2}$	$5.5(1.0).10^{-2}$	$6.7(1.0).10^{-2}$	$7.6(1.1).10^{-2}$
^{9}Be	-	$1.8(0.7).10^{-2}$	$1.9(0.4).10^{-2}$	$2.3(0.5).10^{-2}$	$3.0(0.5).10^{-2}$
^{10}Be	-	$9.3(2.0).10^{-3}$	$1.0(0.3).10^{-2}$	$1.2(0.3).10^{-2}$	$1.5(0.3).10^{-2}$
^{8}B	-	$6.1(1.8).10^{-3}$	$6.9(2.7).10^{-3}$	$7.8(2.1).10^{-3}$	$8.5(6.3).10^{-3}$
^{10}B	-	$4.7(1.5).10^{-2}$	$5.0(3.3).10^{-2}$	$5.3(1.6).10^{-2}$	$6.2(1.8).10^{-2}$
^{11}B	-	$6.0(2.4).10^{-2}$	$6.3(6.2).10^{-2}$	$6.8(3.9).10^{-2}$	$7.1(2.4).10^{-2}$
^{10}C	-	$8.2(3.0).10^{-3}$	$8.5(5.4).10^{-3}$	$9.3(3.3).10^{-3}$	$1.1(0.4).10^{-2}$
^{11}C	-	$5.3(2.2).10^{-2}$	$5.5(3.7).10^{-2}$	$5.5(2.1).10^{-2}$	$5.8(3.5).10^{-2}$
^{12}C	-	$7.6(4.4).10^{-2}$	$8.1(5.0).10^{-2}$	$8.0(3.9).10^{-2}$	$7.6(3.3).10^{-2}$

TABLE V: Production cross sections per isotope and for each elemental target.

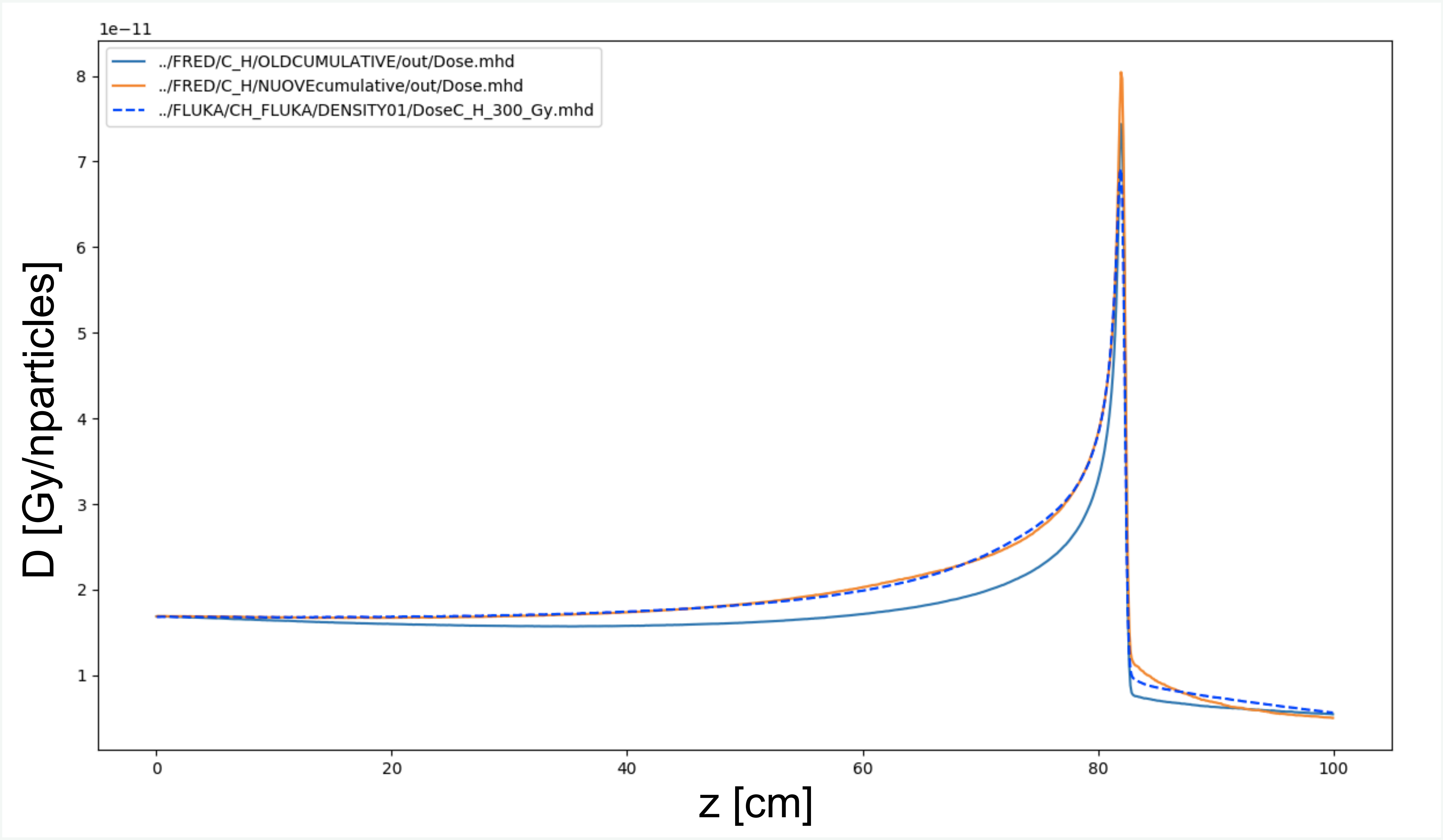
Regarding the hydrogen target, it is not possible to integrate the distributions for fragments heavier than 7Be. Indeed, in such cases, the gaussian width become too small to be fitted with our experimental measurements.

	σ (barns) Targets				
Fragments	H	C	O	Al	Ti
^{1}H	$4.1(0.6).10^{-1}$	1.7(0.1)	2.1(0.2)	3.0(0.2)	4.4(0.3)
^{2}H	$7.3(1.5).10^{-2}$	$7.9(0.4).10^{-1}$	$9.3(0.8).10^{-1}$	1.3(0.1)	1.9(0.1)
^{3}H	$1.6(0.3).10^{-2}$	$3.2(0.2).10^{-1}$	$3.6(0.4).10^{-1}$	$5.2(0.3).10^{-1}$	$7.7(0.4).10^{-1}$
^{3}He	$4.1(0.4).10^{-2}$	$3.3(0.6).10^{-1}$	$4.0(0.5).10^{-1}$	$5.1(0.8).10^{-1}$	$6.7(1.0).10^{-1}$
^{4}He	$2.0(0.8).10^{-1}$	1.2(0.3)	1.2(0.4)	1.7(0.1)	2.0(0.2)
^{6}He	$1.0(0.1).10^{-2}$	$4.9(1.2).10^{-2}$	$5.7(2.2).10^{-2}$	$7.0(1.4).10^{-2}$	$8.7(1.5).10^{-2}$
^{6}Li	$1.2(0.6).10^{-2}$	$6.8(1.1).10^{-2}$	$7.4(1.5).10^{-2}$	$9.4(1.3).10^{-2}$	$1.2(0.2).10^{-1}$
^{10}Be	-	$9.3(2.0).10^{-3}$	$1.0(0.3).10^{-2}$	$1.2(0.3).10^{-2}$	$1.5(0.3).10^{-2}$
^{8}B	-	$6.1(1.8).10^{-3}$	$6.9(2.7).10^{-3}$	$7.8(2.1).10^{-3}$	$8.5(6.3).10^{-3}$
^{10}B	-	$4.7(1.5).10^{-2}$	$5.0(3.3).10^{-2}$	$5.3(1.6).10^{-2}$	$6.2(1.8).10^{-2}$
^{11}B	-	$6.0(2.4).10^{-2}$	$6.3(6.2).10^{-2}$	$6.8(3.9).10^{-2}$	$7.1(2.4).10^{-2}$
^{10}C	-	$8.2(3.0).10^{-3}$	$8.5(5.4).10^{-3}$	$9.3(3.3).10^{-3}$	$1.1(0.4).10^{-2}$
^{11}C	-	$5.3(2.2).10^{-2}$	$5.5(3.7).10^{-2}$	$5.5(2.1).10^{-2}$	$5.8(3.5).10^{-2}$
^{12}C	-	$7.6(4.4).10^{-2}$	$8.1(5.0).10^{-2}$	$8.0(3.9).10^{-2}$	$7.6(3.3).10^{-2}$

I tried to use directly FLUKA cumulative

TABLE V: Production cross sections per isotope and for each elemental target.

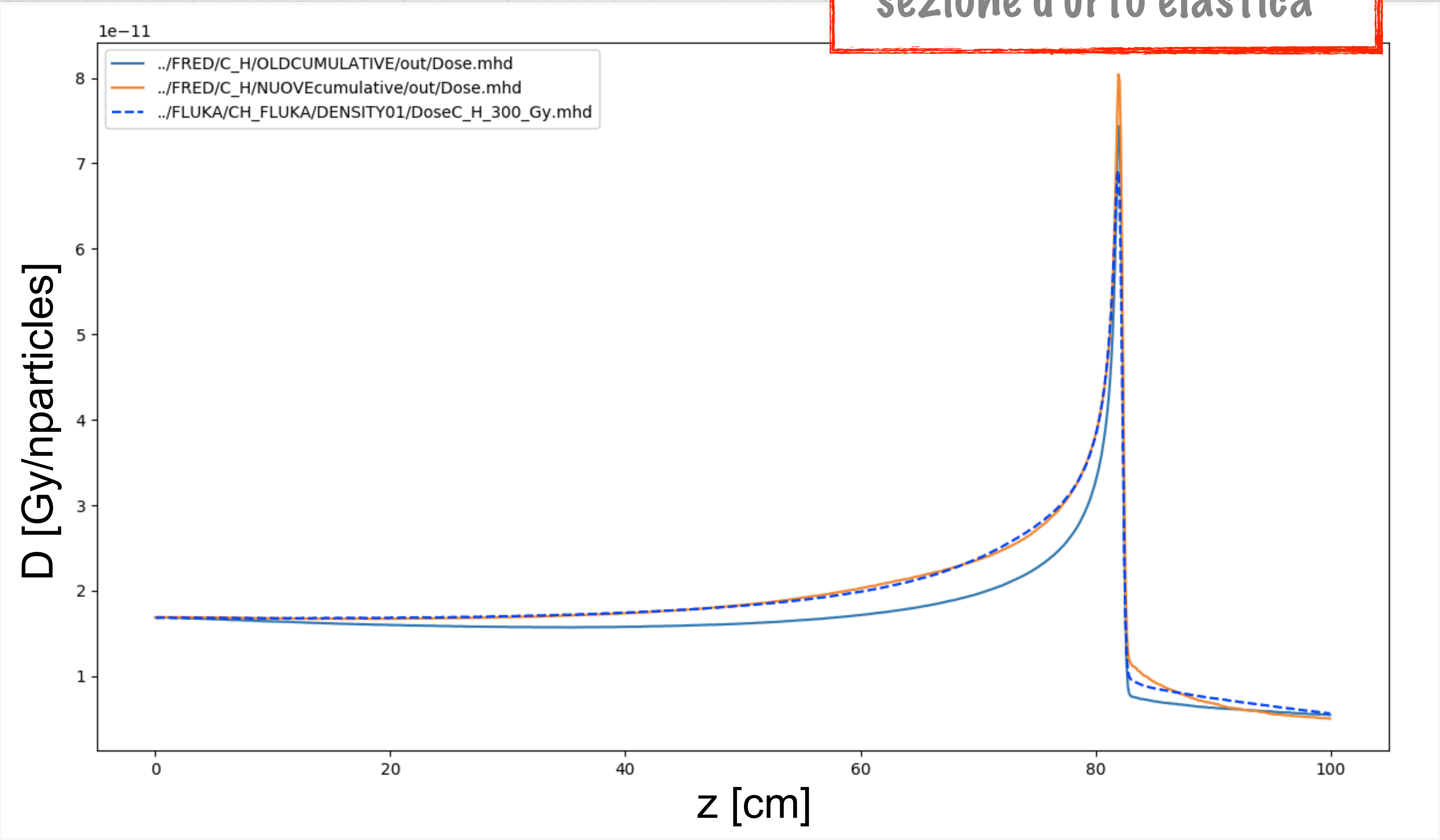
12C->H



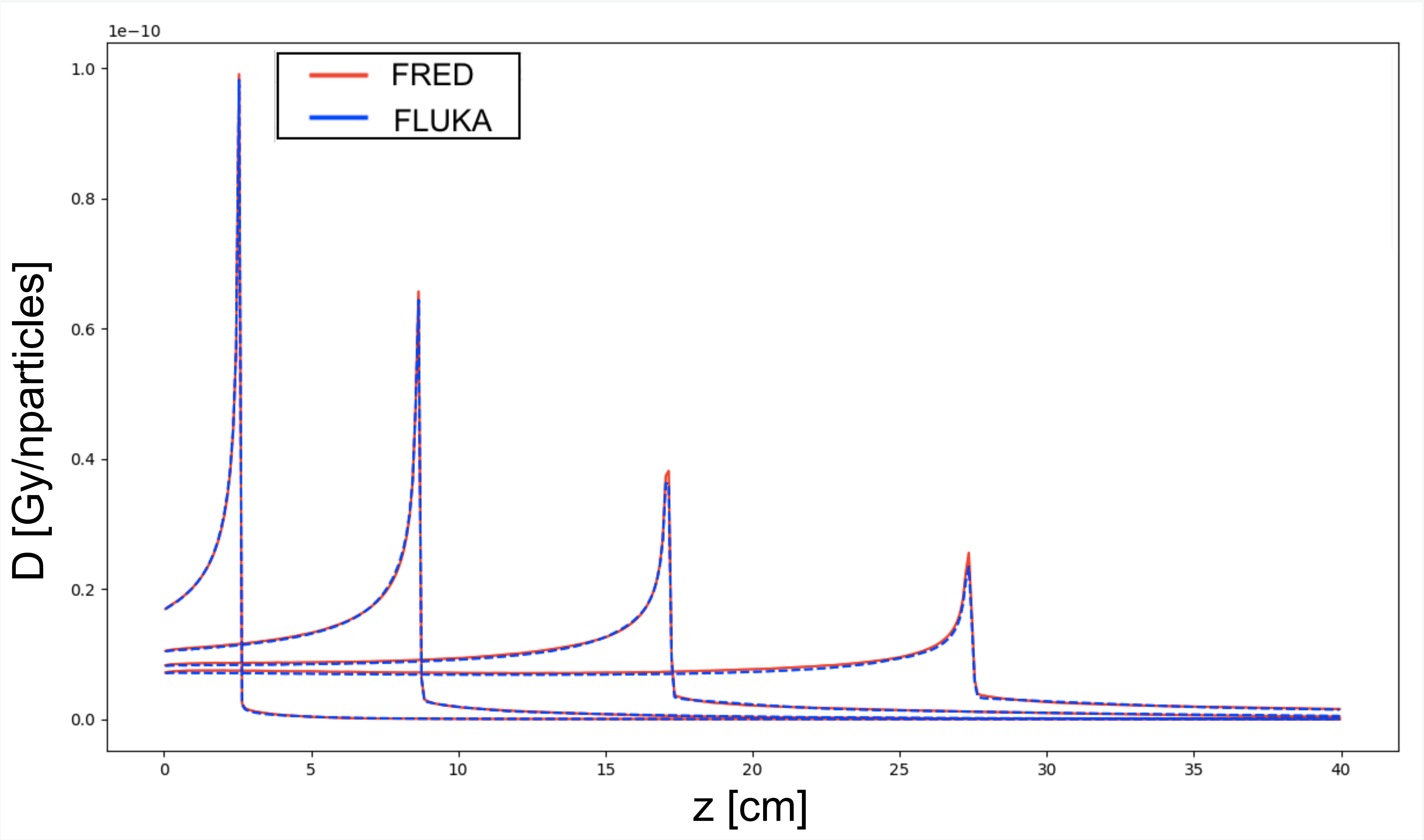
1e−11
../FRED/C_H/OLDCUMULATIVE/out/Dose.mhd
../FRED/C_H/NUOVEcumulative/out/Dose.mhd
../FLUKA/CH_FLUKA/DENSITY01/DoseC_H_300_Gy.mhd
D [Gy/nparticles]
1
2
3
4
5
6
7
8
0
20
40
60
80
100
z [cm]

^{12}C->H

Devo ancora aggiungere la sezione d'urto elastica

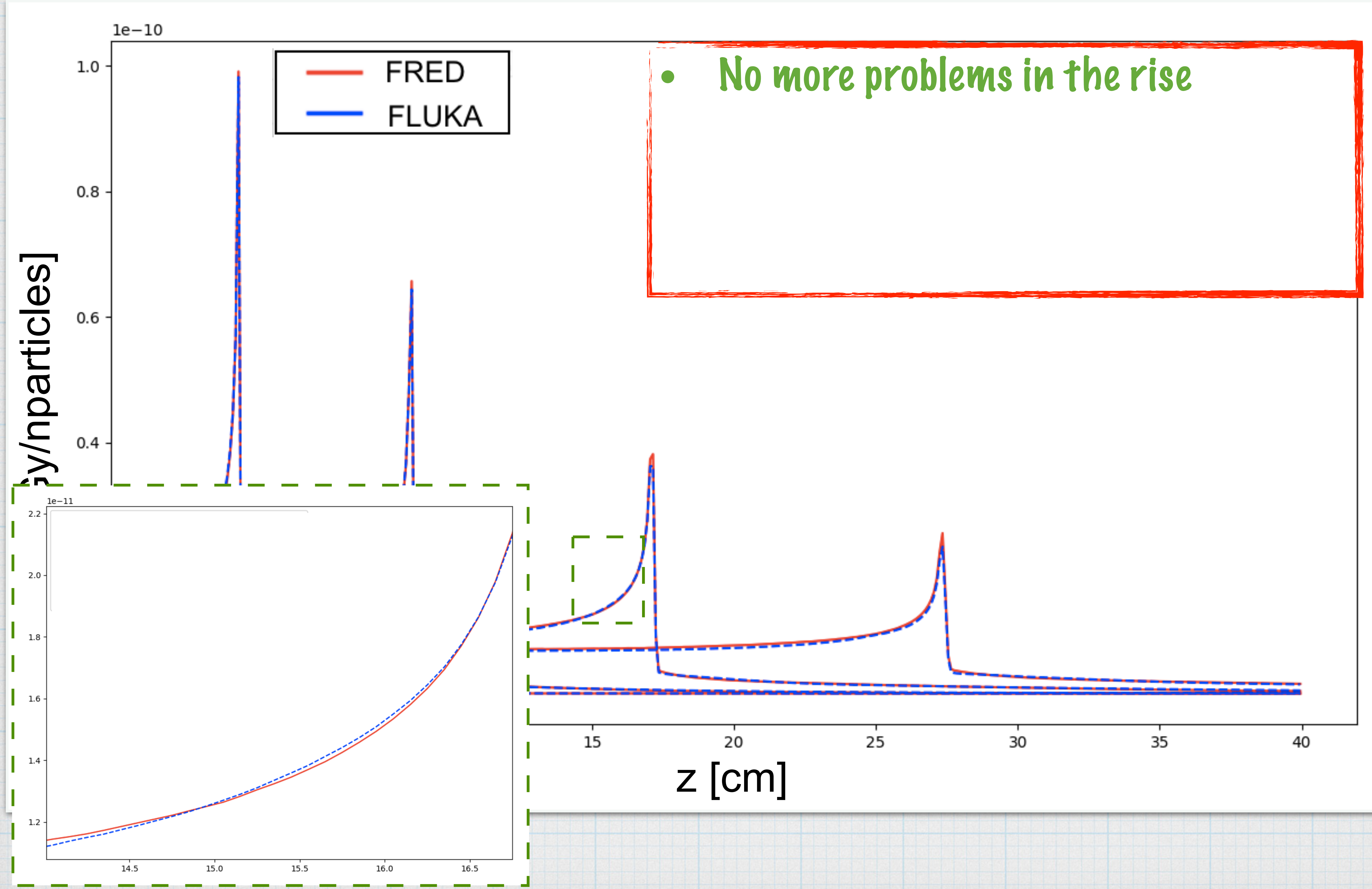


^{12}C->H2O



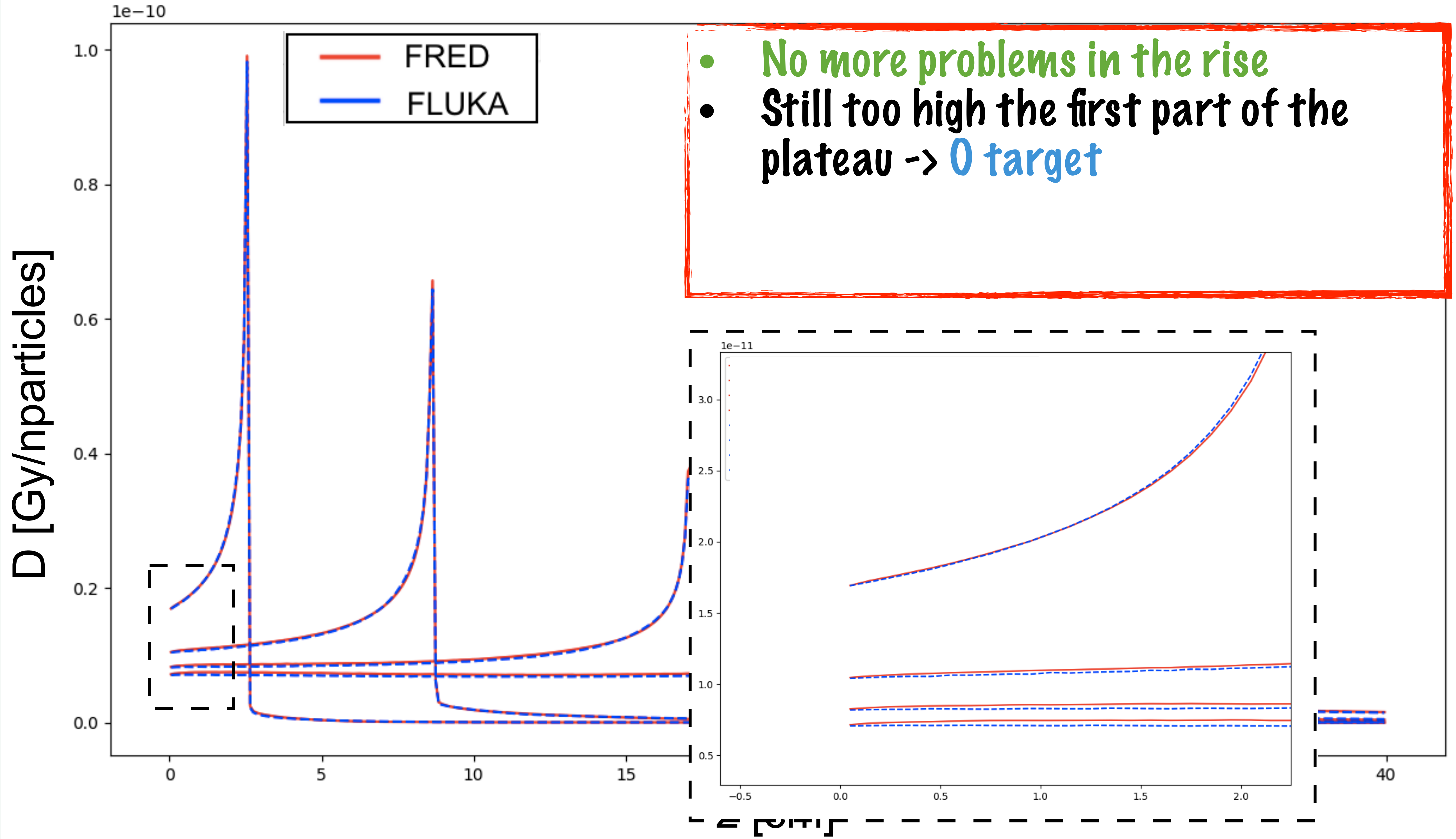
1e−10
1.0
0.8
0.6
0.4
0.2
0.0
D [Gy/nparticles]
FRED
FLUKA
0
5
10
15
20
25
30
35
40
z [cm]

^{12}C->H2O



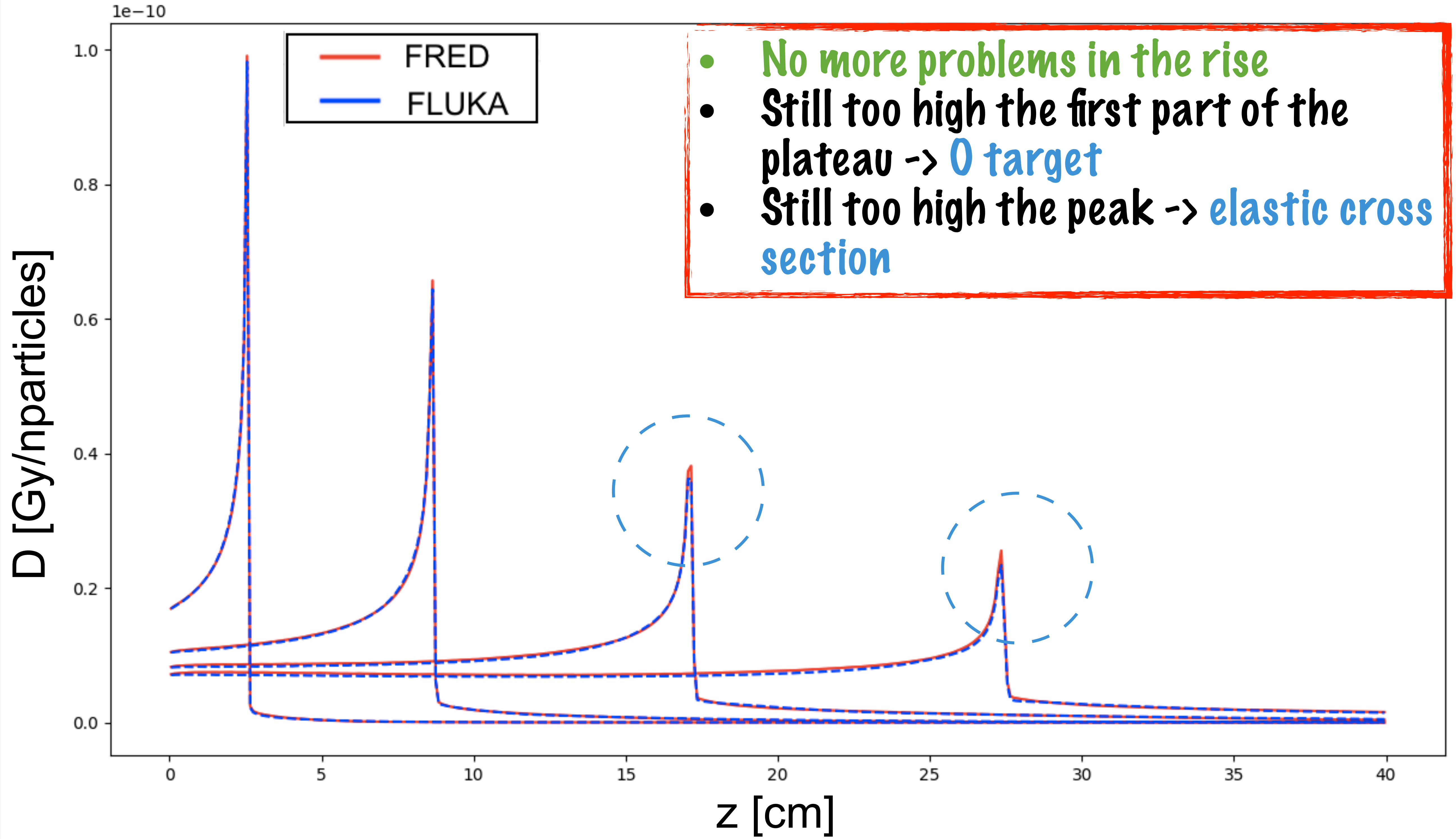
- No more problems in the rise

^{12}C->H20



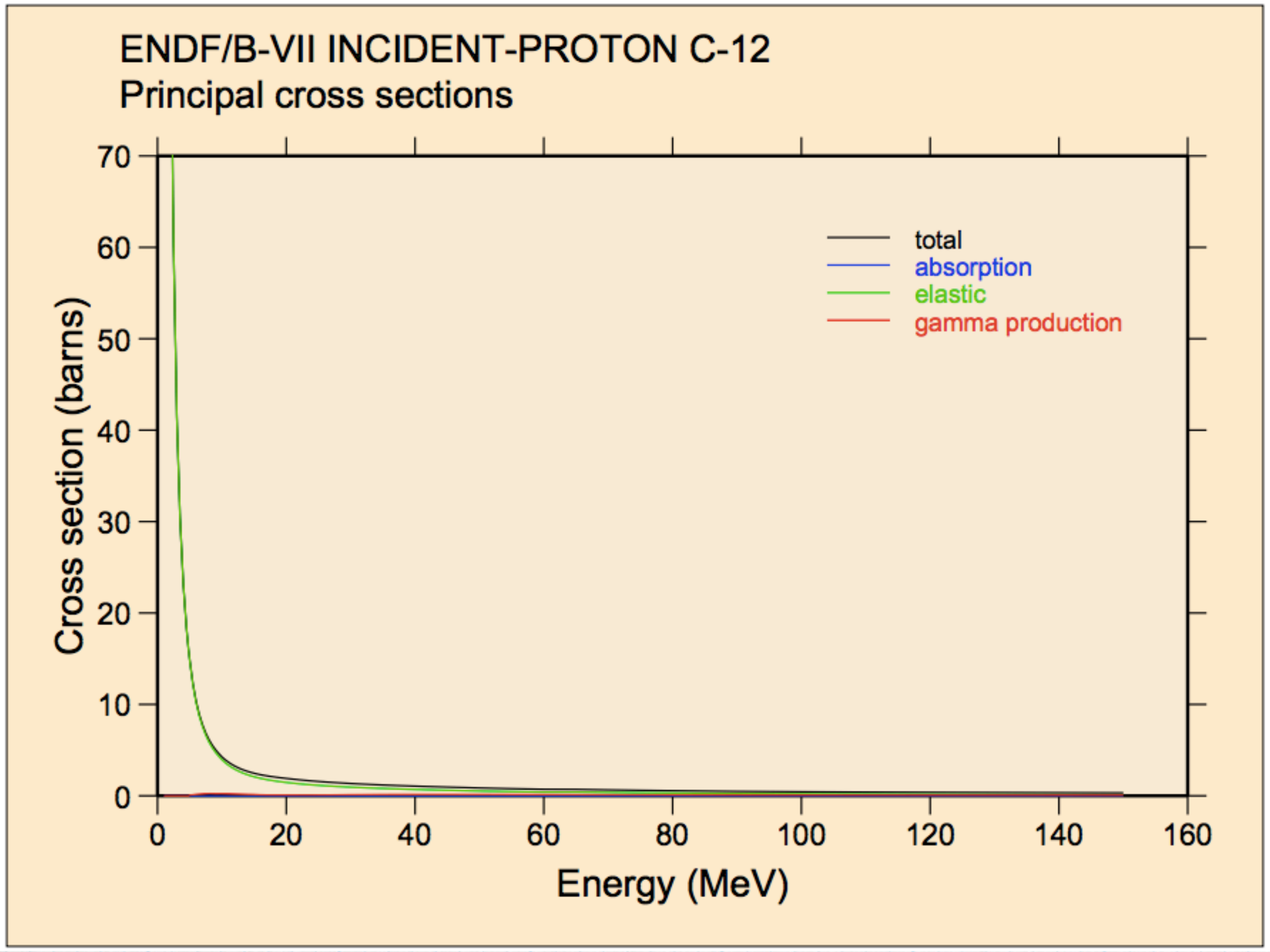
- No more problems in the rise
- Still too high the first part of the plateau -> 0 target

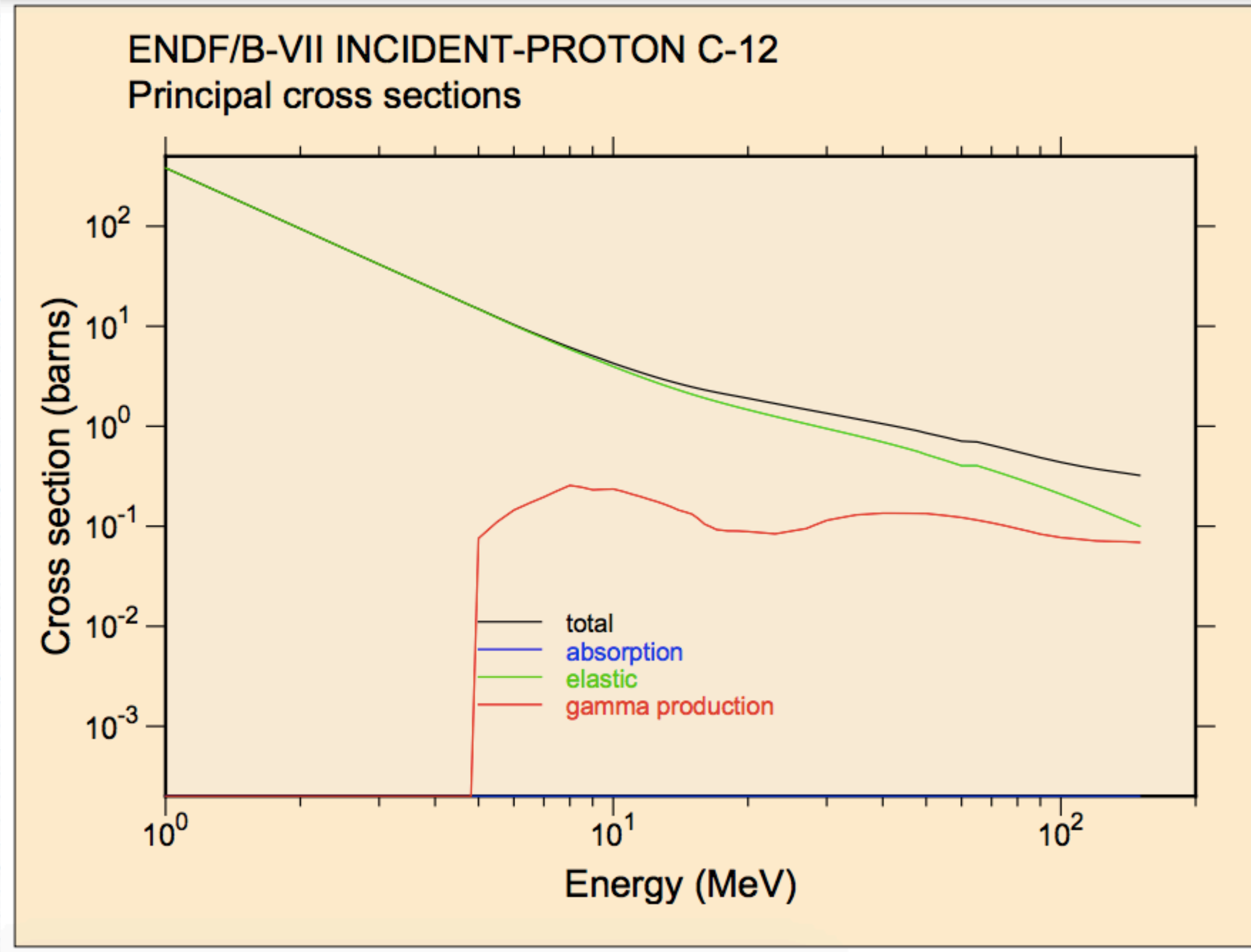
^{12}C->H2O

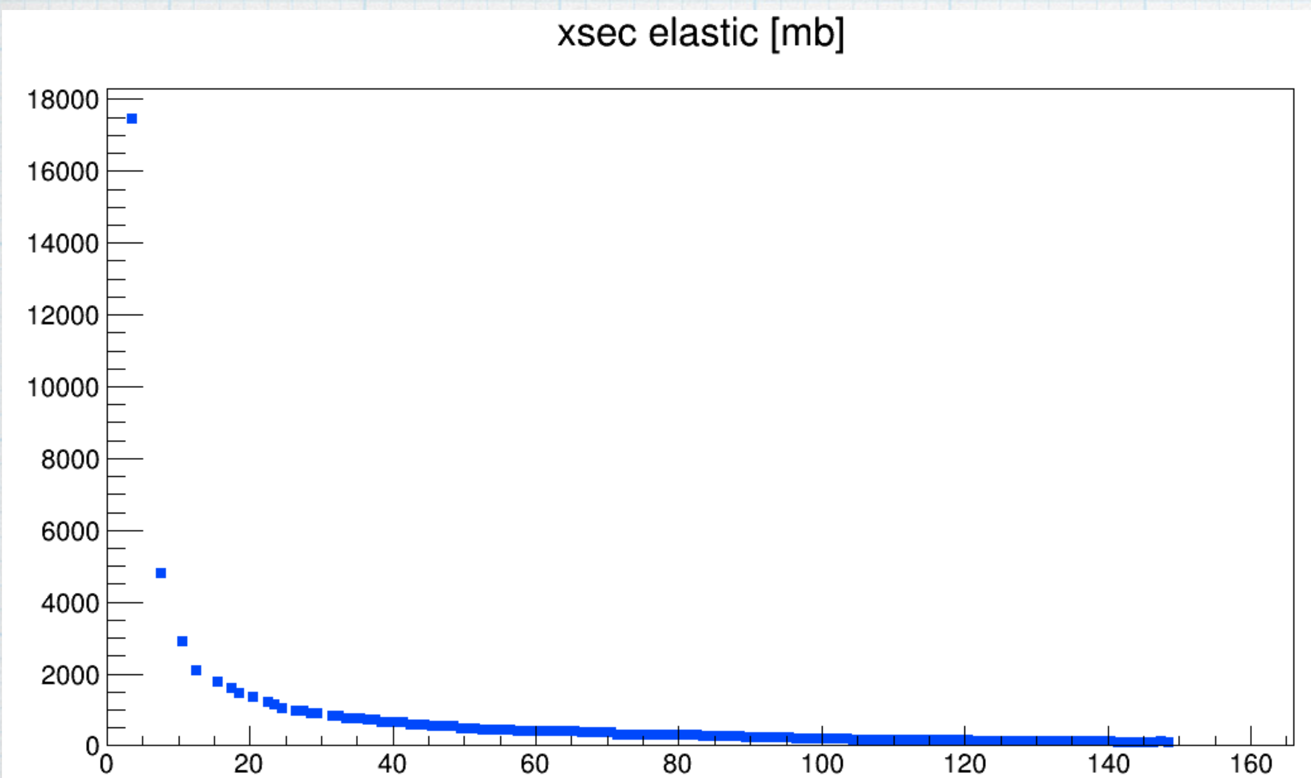


- No more problems in the rise
- Still too high the first part of the plateau -> O target
- Still too high the peak -> elastic cross section

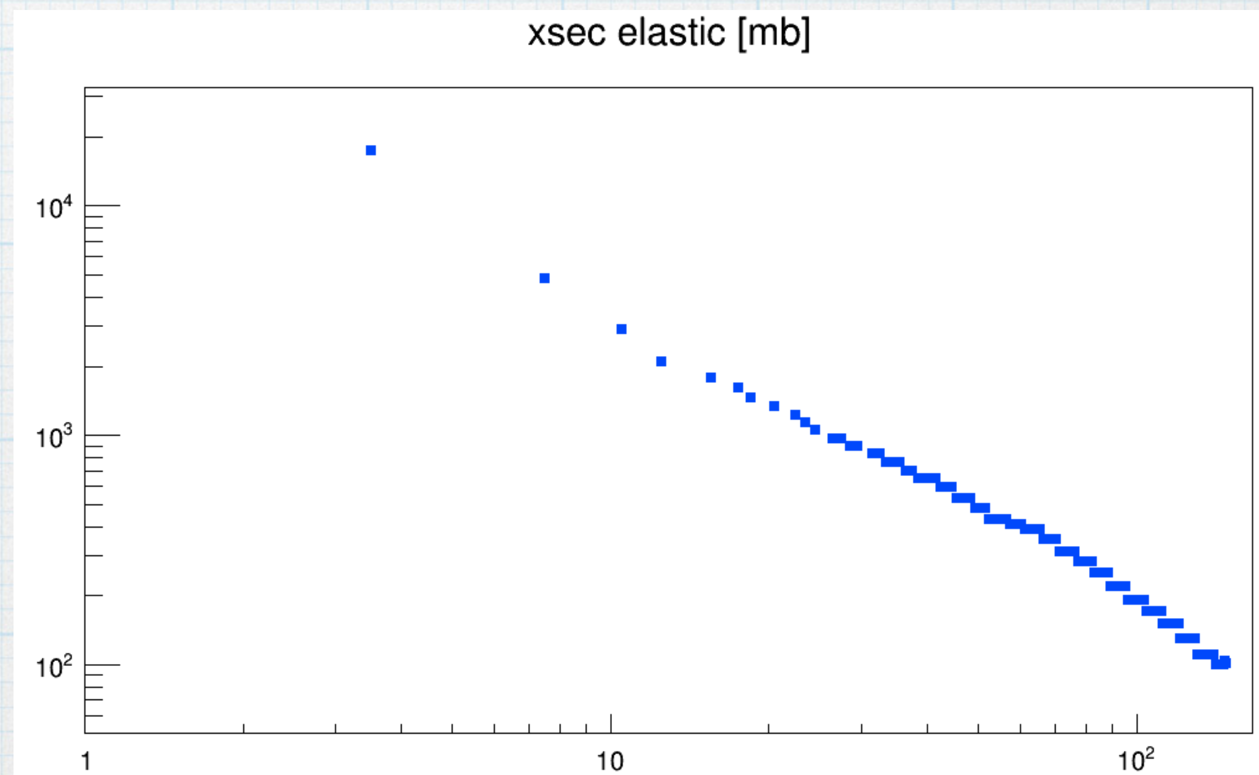
Adding an elastic cross section to correct the peak



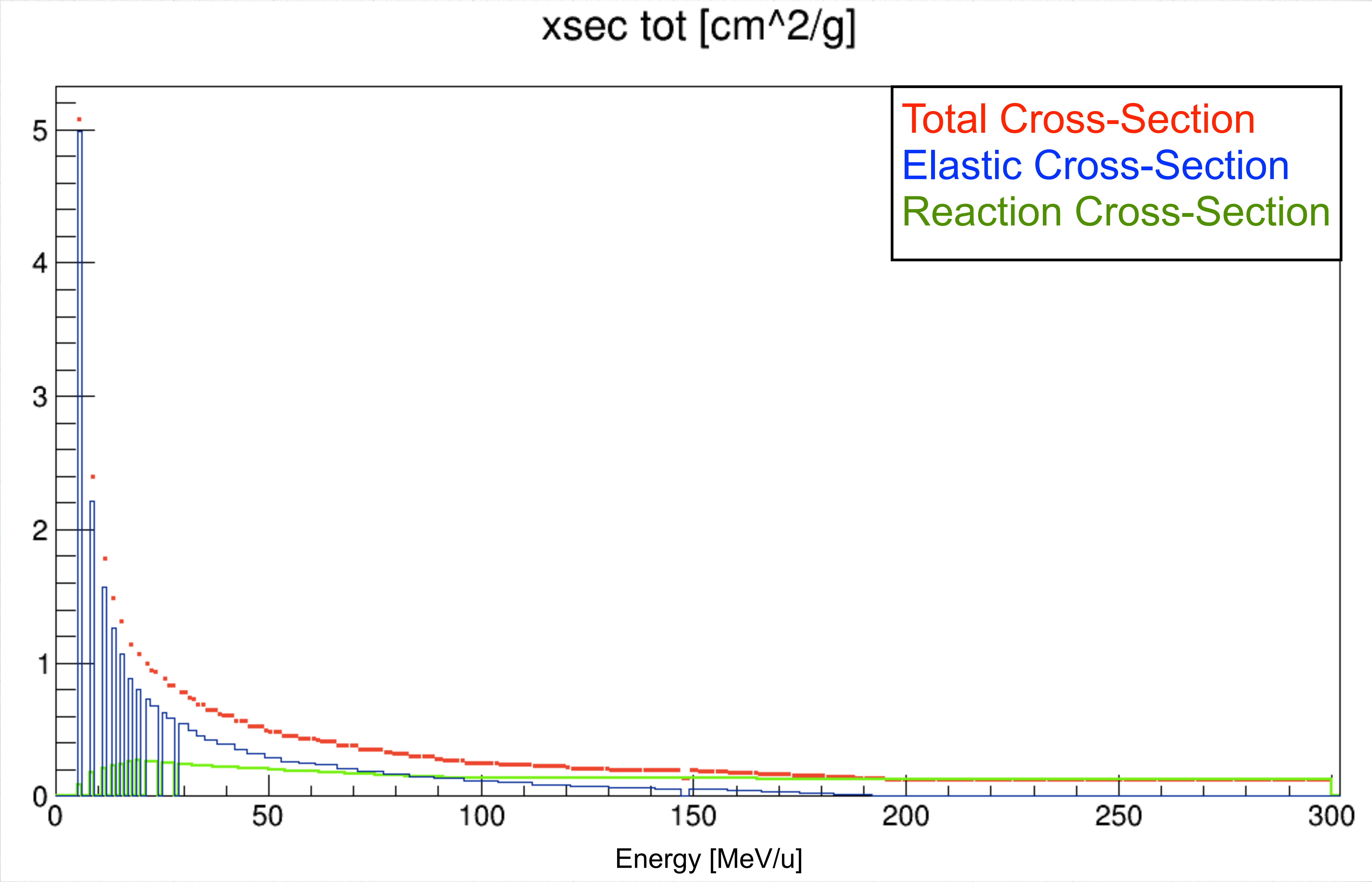




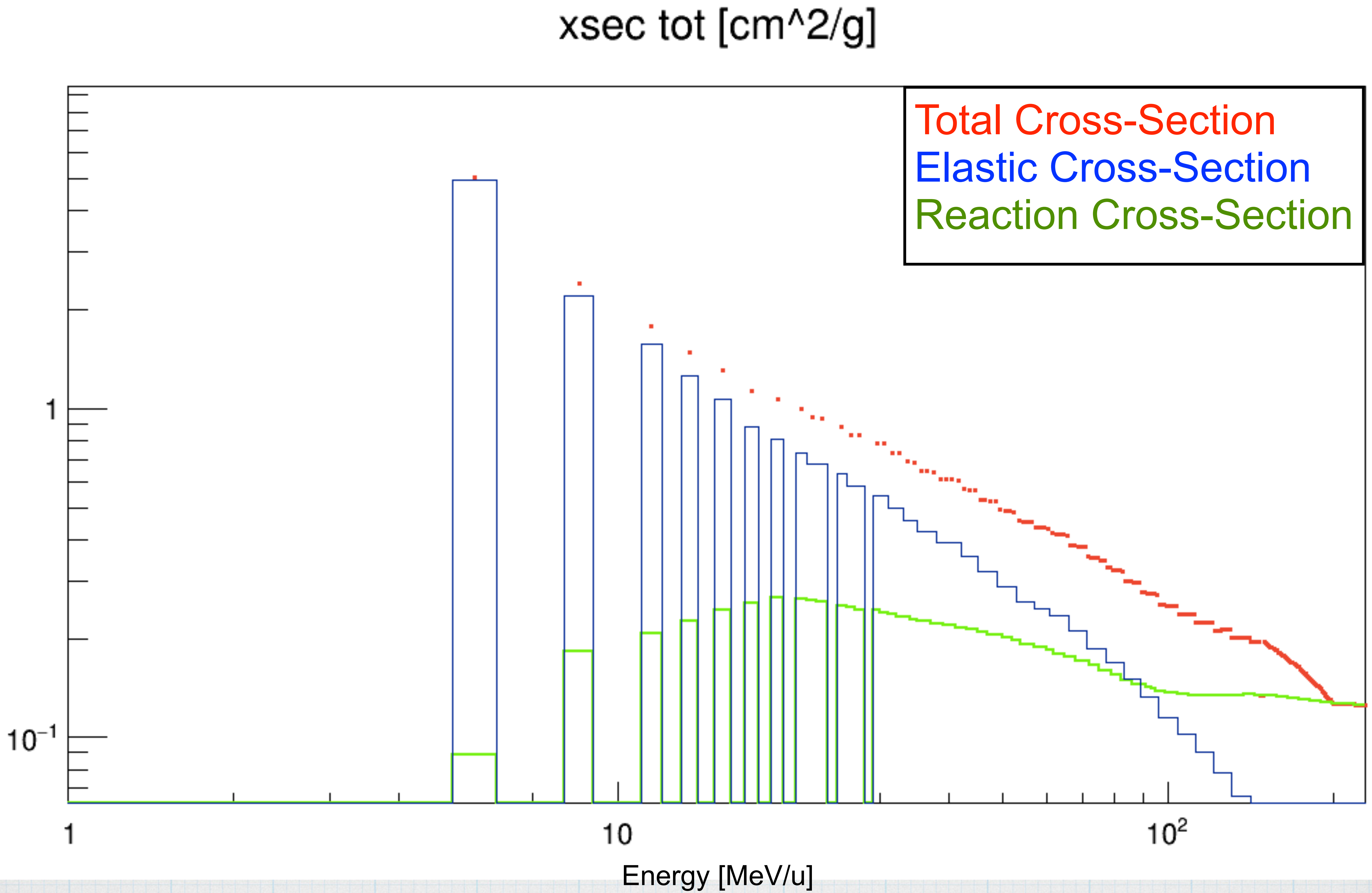
Energy [MeV/u]



Energy [MeV/u]



xsec tot [cm^2/g]
Total Cross-Section
Elastic Cross-Section
Reaction Cross-Section
0
1
2
3
4
5
0
50
100
150
200
250
300
Energy [MeV/u]


xsec tot [cm^2/g]
Total Cross-Section
Elastic Cross-Section
Reaction Cross-Section
1
10^{-1}
1
10
10^2
Energy [MeV/u]

Next steps

* Adding in FRED the angle of scattering due to the elastic cross-section

* Trying to use new cumulative which gave in output the cumulative of FLUKA (Vincenzo)

* Observe the new agreement with Haettner, Ganil and Marafini/Mattei experiments