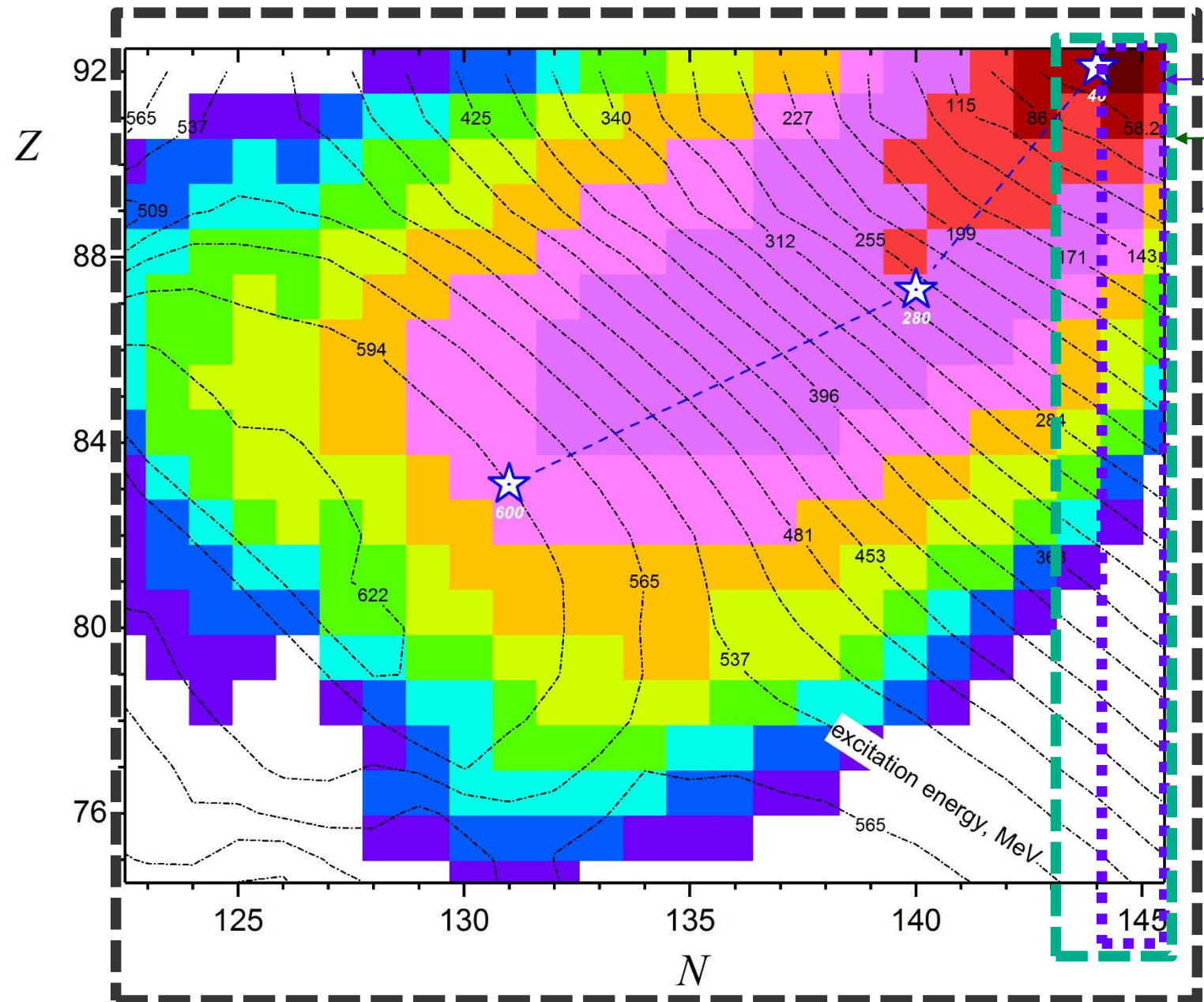


Let's consider 3 different rectangle areas : S, N2, N4

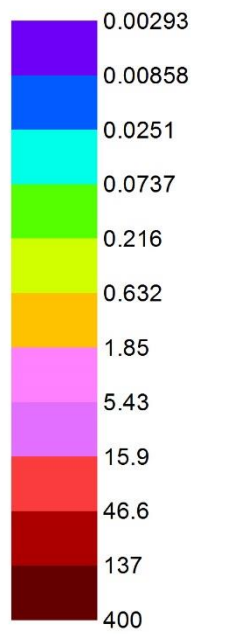
Where  
 S : standard  
 N2 : not more than 2 abraded neutrons  
 N4 : not more than 4 abraded neutrons



N2 settings  
 N4 settings

☆ - 3 excitation energy region nuclei

Fissile nucleus cross sections, mb



S settings

## S settings

## N4 settings

## N2 settings

|  | LOW   | MIDDLE | HIGH  | EM fission |
|--|-------|--------|-------|------------|
| LISE++ hint for the fissile nucleus from excitation energy | 237U  | 233Th  | 223Rn | 238U       |
| Excitation energy (MeV)                                    | 34.3  | 93.7   | 295.6 | 11         |
| Cross section (mb)   | 416.2 | 451.1  | 740.7 | 10.8       |

|       |          |                 |             |             |
|-------|----------|-----------------|-------------|-------------|
| L+M+H | L+M+H+EM | use in code *** | use in code | use in code |
| 1608  | 1618.9   |                 |             |             |

**N= 145 143 137**

Fission barrier < LOW < 60  
 60 < MIDDLE < 180  
 180 < HIGH

Boundary energies for mean values of prefragment excitation energy distributions to split low, middle and high energy regions. Recommendation:  $2.3 * dEx$ , where  $dEx$  is excitation energy per abraded nucleon. Default values are equal to 40 & 180 MeV

coef for Zb = 0.9 0.1 < coef < 0.9; recommendation: 0.75  
 determine low Z (element number) where Abrasion-Ablation stops.  $Z_{stop} = coef * Z_{beam}$

|  | LOW   | MIDDLE | HIGH  | EM fission |
|--|-------|--------|-------|------------|
| LISE++ hint for the fissile nucleus from excitation energy | 237U  | 234Th  | 229Rn | 238U       |
| Excitation energy (MeV)                                    | 34.3  | 81.1   | 221.8 | 11         |
| Cross section (mb)   | 416.2 | 239.8  | 19.9  | 10.8       |

|       |          |                 |             |             |
|-------|----------|-----------------|-------------|-------------|
| L+M+H | L+M+H+EM | use in code *** | use in code | use in code |
| 675.9 | 686.7    |                 |             |             |

**N= 145 144 143**

Fission barrier < LOW < 60  
 60 < MIDDLE < 180  
 180 < HIGH

Boundary energies for mean values of prefragment excitation energy distributions to split low, middle and high energy regions. Recommendation:  $2.3 * dEx$ , where  $dEx$  is excitation energy per abraded nucleon. Default values are equal to 40 & 180 MeV

coef for Zb = 0.9 0.1 < coef <= 1; recommendation: 0.8  
 coef for Nb = 0.98 0.1 < coef <= 1; recommendation: 0.6

**Z\_stop = 83**  
**N\_stop = 143**

determine low Z (element number) where Abrasion-Ablation stops.  $Z_{stop} = coef * Z_{beam}$

|  | LOW   | MIDDLE | HIGH  | EM fission |
|--|-------|--------|-------|------------|
| LISE++ hint for the fissile nucleus from excitation energy | 237U  | 235Th  | 230At | 238U       |
| Excitation energy (MeV)                                    | 34.3  | 81.1   | 192.1 | 11         |
| Cross section (mb)   | 264.1 | 39.7   | 1.1   | 10.8       |

|       |          |                 |             |             |
|-------|----------|-----------------|-------------|-------------|
| L+M+H | L+M+H+EM | use in code *** | use in code | use in code |
| 305   | 315.8    |                 |             |             |

**N= 145 145 145**

Fission barrier < LOW < 60  
 60 < MIDDLE < 180  
 180 < HIGH

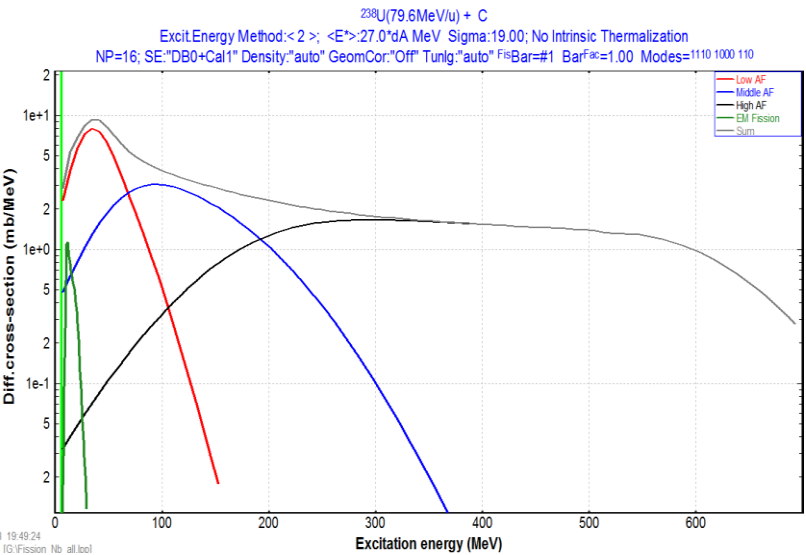
Boundary energies for mean values of prefragment excitation energy distributions to split low, middle and high energy regions. Recommendation:  $2.3 * dEx$ , where  $dEx$  is excitation energy per abraded nucleon. Default values are equal to 40 & 180 MeV

coef for Zb = 0.9 0.1 < coef <= 1; recommendation: 0.8  
 coef for Nb = 0.996 0.1 < coef <= 1; recommendation: 0.6

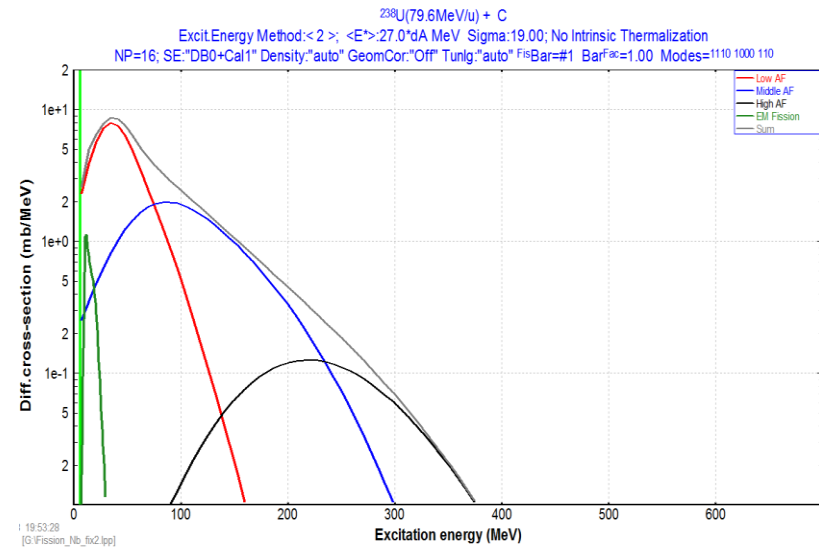
**Z\_stop = 83**  
**N\_stop = 145**

determine low Z (element number) where Abrasion-Ablation stops.  $Z_{stop} = coef * Z_{beam}$

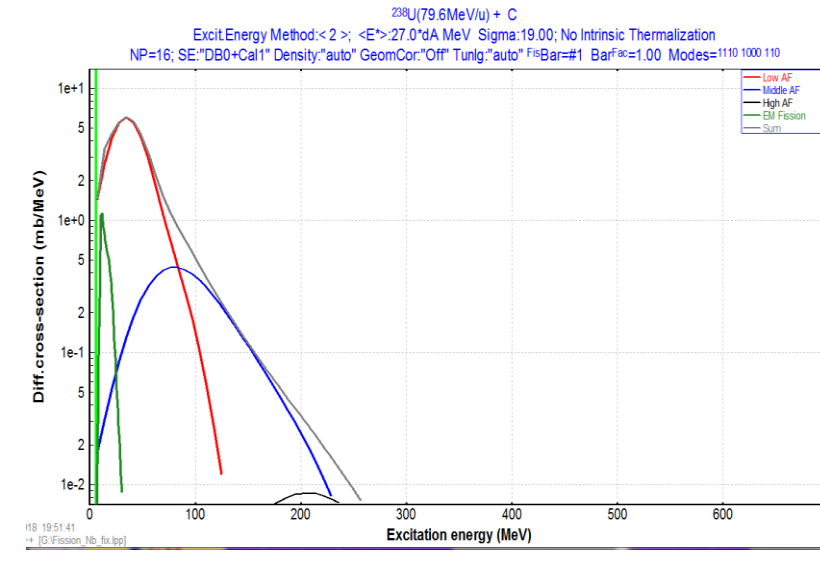
### Fission excitation functions



### Fission excitation functions



### Fission excitation functions



**Abrasion-Fission** X

238U (79.6 MeV/u) + C

---

**Energy region definitions**

|  |                                     |                                     |                                     |
|--|-------------------------------------|-------------------------------------|-------------------------------------|
| Excitation energy region                                 | LOW                                 | MIDDLE                              | HIGH                                |
| Choose a primary reaction                                | <input type="radio"/>               | <input checked="" type="radio"/>    | <input type="radio"/>               |
| Perform transmission calculations for this energy region | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Choose FISSILE nucleus                                   | 223Rn                               | 229Rn                               | 230At                               |
| Excitation energy (MeV)                                  | 295.6                               | 221.8                               | 192.1                               |
| Cross section (mb)                                       | 740.7                               | 19.9                                | 1.1                                 |

Restore previous settings      Cross sections sum (mb) 761.7

Load Fission, Evaporation, Excit. Energy Region settings from file

Fission properties       Calculate Fissile nuclei velocity based on the Projectile Fragmentation model (DJM)

Evaporation settings

Prefragment excit. energy

OK    Cancel    Help     Make default

LISE++ Abrasion-Ablation calculations to estimate excitation energy regions

1. Calculate.    2. Use "All" hints in code.    3. Plot

Calculate \*      no calculations were found

Plot      use "ALL" hints in code

|  | LOW            | MIDDLE      | HIGH        | EM fission |
|--|----------------|-------------|-------------|------------|
| LISE++ hint for the fissile nucleus from excitation energy |                |             |             |            |
| Excitation energy (MeV)                                    |                |             |             |            |
| Cross section (mb)   |                |             |             |            |
|  | use in code ** | use in code | use in code |            |

Fission barrier < LOW < 60      Boundary energies for mean values of prefragment excitation energy distributions to split low, middle and high energy regions. Recommendation:  $2.3 * dEx$ , where  $dEx$  is excitation energy per abraded nucleon. Default values are equal to 40 & 180 MeV

60 < MIDDLE < 180

180 < HIGH

|               |     |                                      |             |
|---------------|-----|--------------------------------------|-------------|
| coef for Zb = | 0.8 | 0.1 < coef <= 1; recommendation: 0.8 | Z_stop = 74 |
| coef for Nb = | 0.5 | 0.1 < coef <= 1; recommendation: 0.6 | N_stop = 73 |

determine low Z (element number) where Abrasion-Ablation stops.  $Z_{stop} = coef * Z_{beam}$

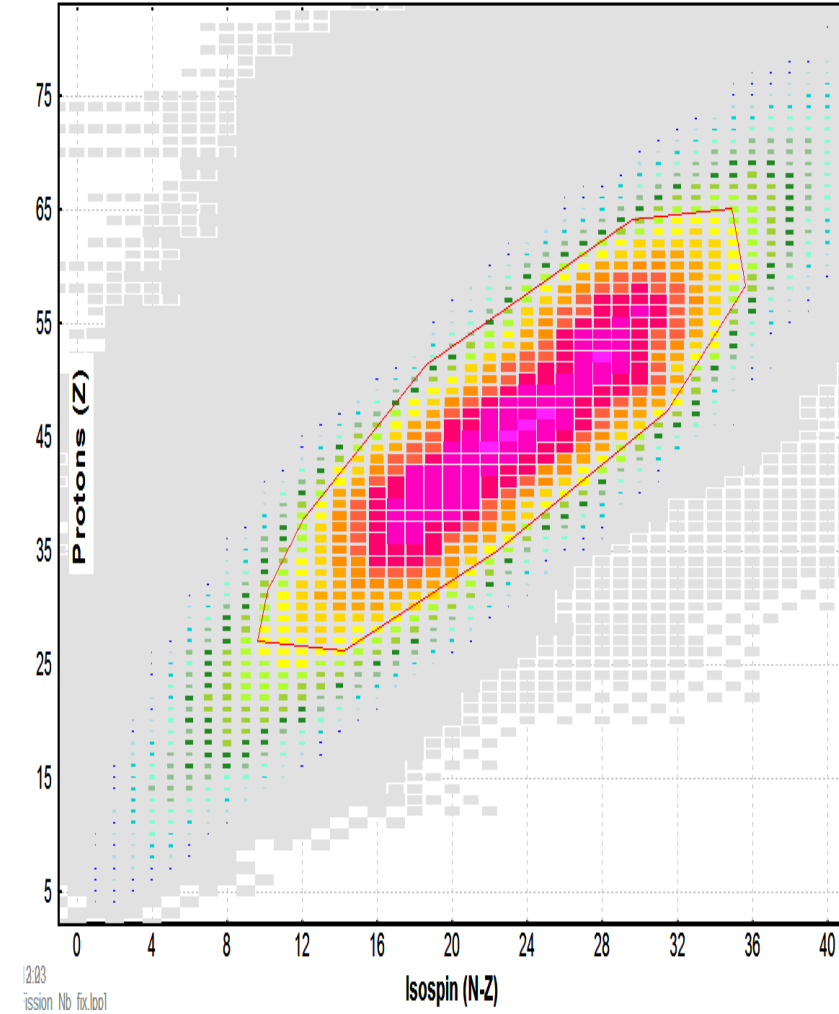
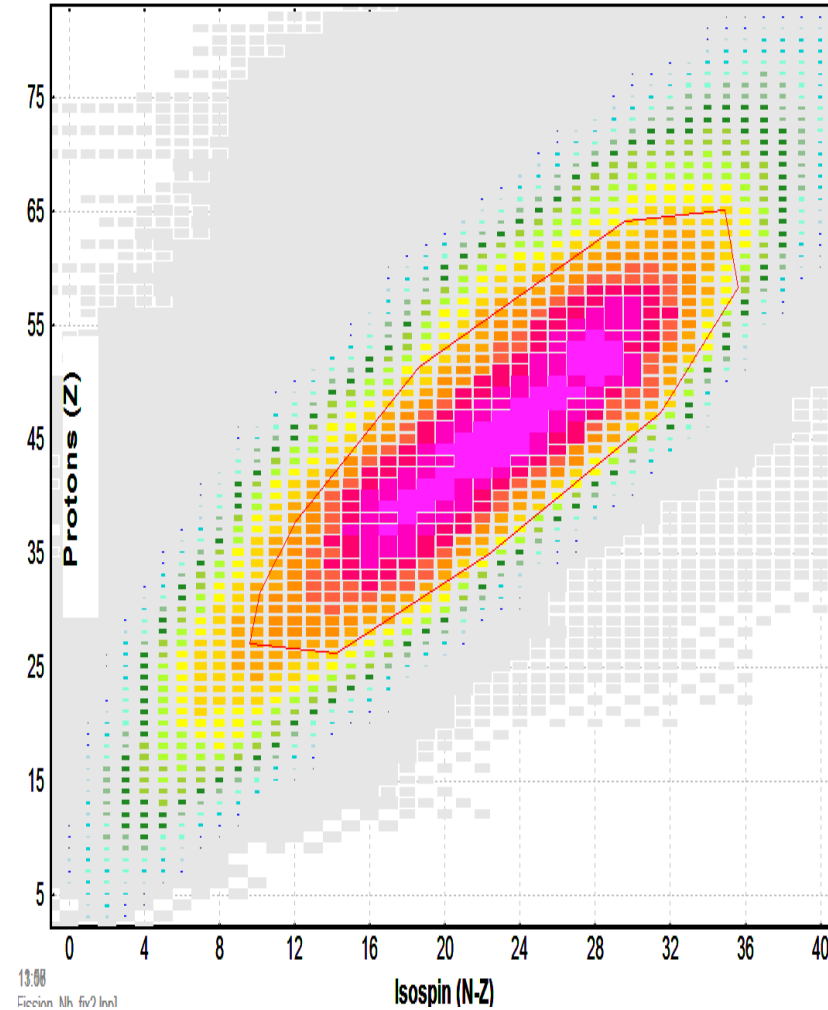
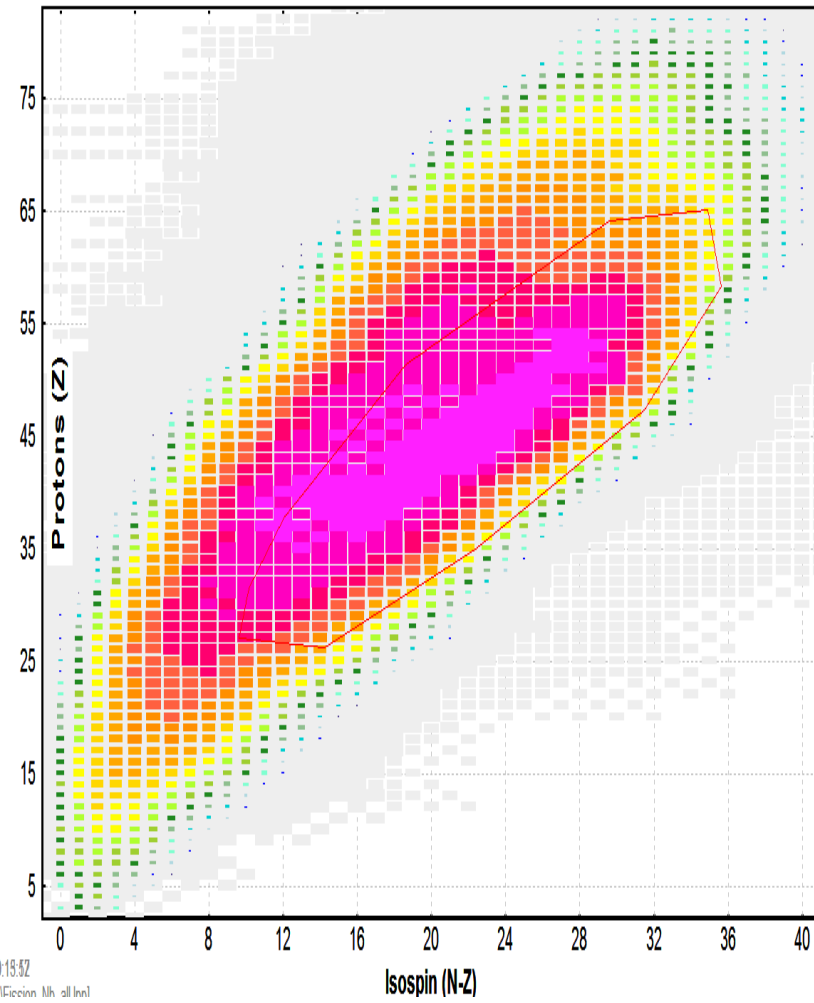
\* - takes about 0.5 - 1 minute      \*\* - Low-excitation Abrasion-Fission and EM fission results will be used together

The user can specify the fissile nuclei region in the new version

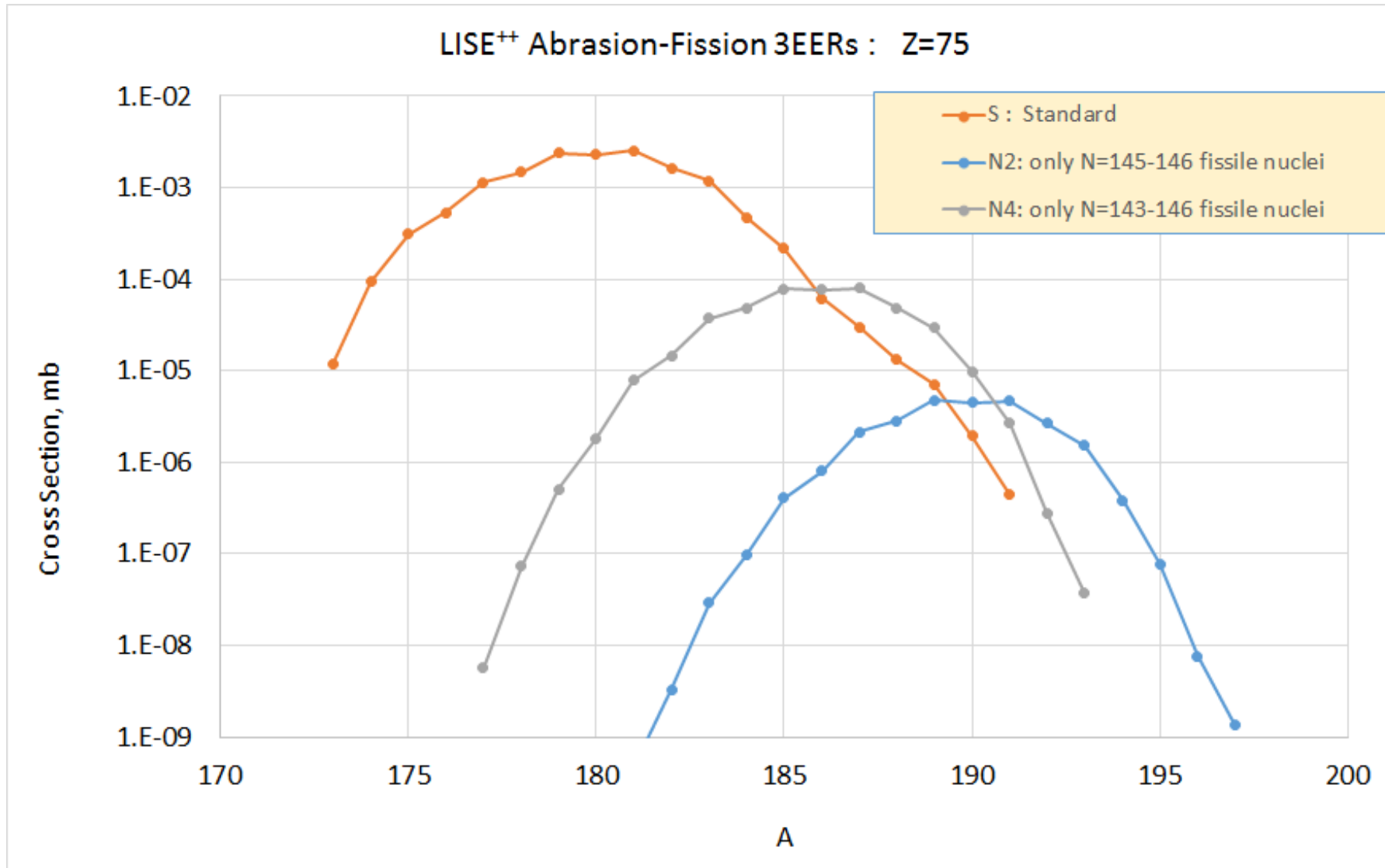
## S settings

## N4 settings

## N2 settings



The same are X & Y axis, color scales, contour positions in all plots



|          | 190Re (Z=75) |          |          |
|----------|--------------|----------|----------|
|          | Regions      |          |          |
| settings | low          | middle   | high     |
| N2       | 0            | 1.76E-07 | 4.34E-06 |
| N4       | 0            | 9.62E-07 | 8.90E-06 |
| S        | 0            | 1.94E-06 |          |

High regions are responsible for <sup>190</sup>Re production



## N1 settings

|  | LOW      | MIDDLE         | HIGH        | EM fission  |
|--|----------|----------------|-------------|-------------|
| LISE++ hint for the fissile nucleus from excitation energy | 237Pa    | 236Th          | 38Si        | 238U        |
| Excitation energy (MeV)                                    | 39.6     | 70.3           | 192.1       | 11          |
| Cross section (mb)   | 25.8     | 8.7            | 0.2         | 10.8        |
| L+M+H  | L+M+H+EM | use in code ** | use in code | use in code |
| 34.7   | 45.5     | <b>N= 146</b>  | <b>146</b>  |             |

Fission barrier < LOW < 60  
 60 < MIDDLE < 180  
 180 < HIGH

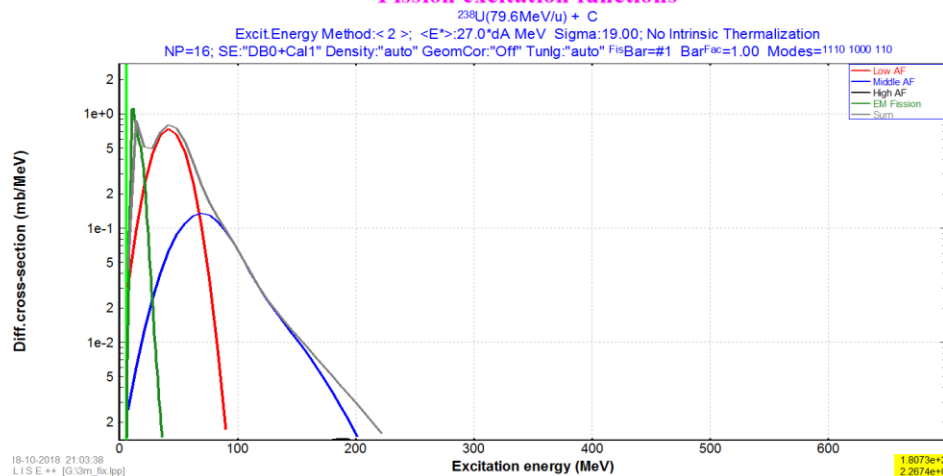
Boundary energies for mean values of prefragment excitation energy distributions to split low, middle and high energy regions. Recommendation:  $2.3 * dEx$ , where  $dEx$  is excitation energy per abraded nucleon. Default values are equal to 40 & 180 MeV

coef for Zb = 0.9    0.1 < coef <= 1; recommendation: 0.8  
 coef for Nb = 0.999    0.1 < coef <= 1; recommendation: 0.6

determine low Z (element number) where Abrasion-Ablation stops.  $Z_{stop} = coef * Z_{beam}$

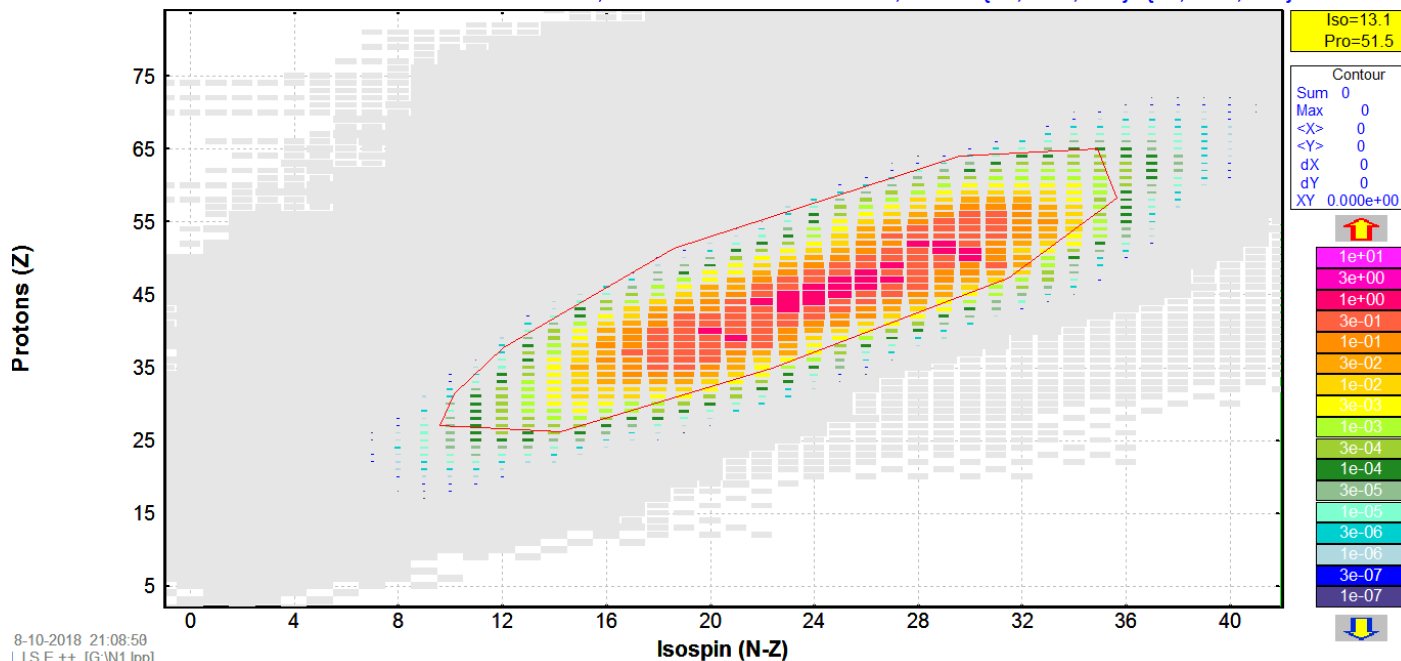
Z\_stop = 83  
 N\_stop = 146

### Fission excitation functions



### Cross sections (Abrasion-Fission (Low+Middle+High))

--- Final CS ---  $^{238}\text{U}$  (79.56 MeV/u) + C (33.5 mg/cm<sup>2</sup>) -> N-Z=-20-200 Abrasion-Fission (Low+Middle+High)  
 $^{237}\text{Pa}^*$  Ex=31MeV CS=36.6mb ---  $^{236}\text{Th}^*$  Ex=70MeV CS=8.7mb ---  
 Fission => Odd-Even corr.: Yes; Post-scission emission: Yes; Shells: {83,-2.65,0.70}&{90,-3.80,0.15}



The same are X & Y axis, color scales, contour positions as in previous all plots

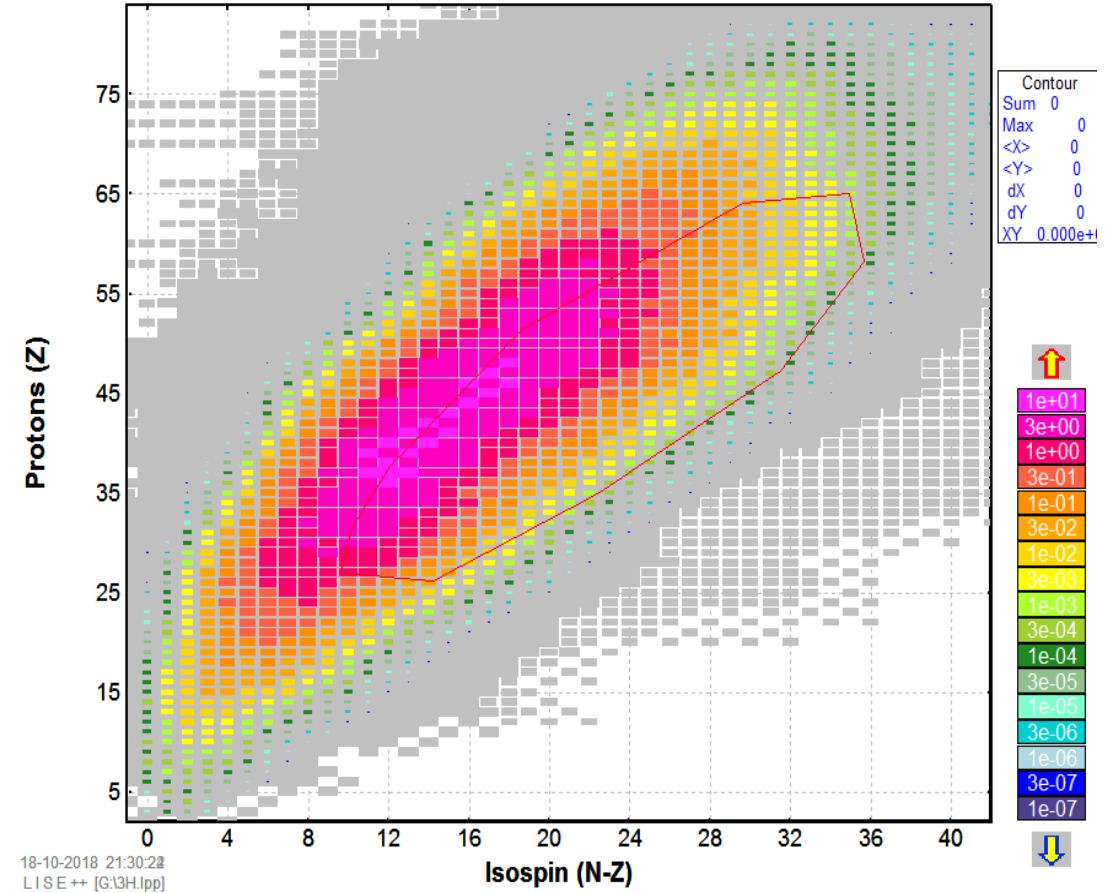
## "3H" settings

Taking only High EERs from the **S,N2,N4** settings to construct the new "3H" configuration

S-h    N4-h    N2-h

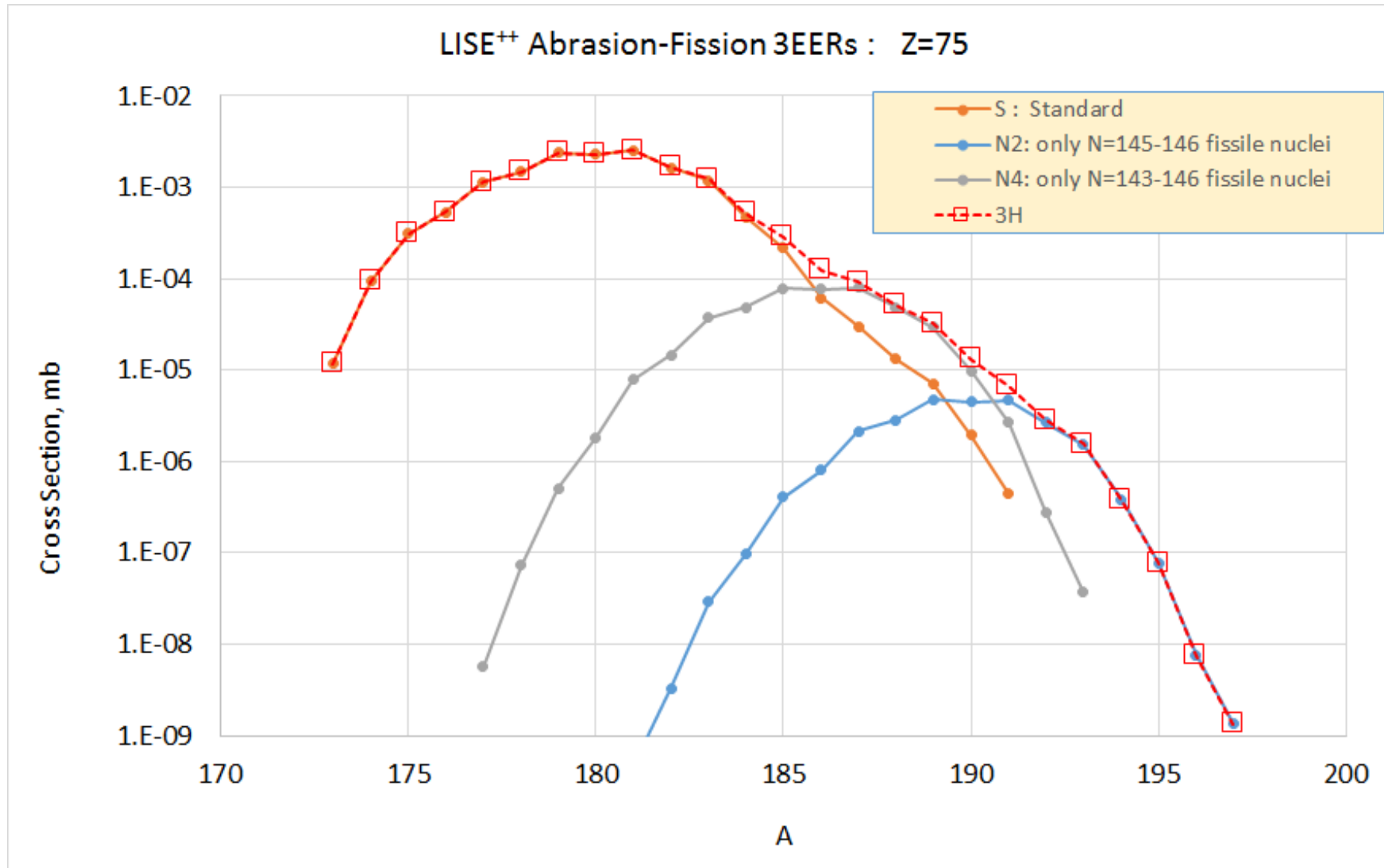
| Energy region definitions                                |                                     |                                     |                                     |
|--|-------------------------------------|-------------------------------------|-------------------------------------|
| Excitation energy region                                 | LOW                                 | MIDDLE                              | HIGH                                |
| Choose a primary reaction                                | <input type="radio"/>               | <input checked="" type="radio"/>    | <input type="radio"/>               |
| Perform transmission calculations for this energy region | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Choose FISSILE nucleus                                   | 223Rn                               | 229Rn                               | 230At                               |
| Excitation energy (MeV)                                  | 295.6                               | 221.8                               | 192.1                               |
| Cross section (mb)                                       | 740.7                               | 19.9                                | 1.1                                 |
| Restore previous settings                                | Cross sections sum (mb)             |                                     | 761.7                               |

N=    137    143    145



The same are X & Y axis, color scales, contour positions as in previous all plots

# “3H” settings for Z=75



High excitation energy regions are responsible for Z=75 isotopes production!



“3H” settings

