

v.11.0.45 03/10/19

The new utility allows to minimize Abrasion-Ablation excitation energy polynomials (up to 2<sup>nd</sup> order) to describe user (experimental) cross-sections

- Introduction to history: Matrix method (v.7.5)
- New “Minimization” method
- Dialog features
  - Save & Read dialog settings
  - Analysis log-file
- Setting the weights
- Examples using EPAX results as input
  - Local lines
  - N of parameters
  - NP (evaporation)
  - Masses

Calculations	<b>Utilities</b>	1D-Plot	2D-Plot	Databases	Help
	LISE++ for Excel (32-bit MS Office)				
	CODES : Charge, Global, PACE4, etc.				▶
	Radioactivity, decays				▶
	<b>Reactions utilities</b>				▶
	Plots : Energy loss, Ranges, Straggling, etc.				▶
	FRIB / NSCL / ISOL rates				▶
	NSCL / Europe / RIKEN primary beam lists				▶
	Set-up utilities				▶
	Range optimizer (Gas cell utility)				
	Gas pressure optimization for gas-filled dipole				
	CATCHER utility (ISOL, Fusion-Residual)				
	Rate & transmission calculation: batch mode				
	Stripper foil lifetime				

Reaction's Characteristics
Angular Straggling & Rutherford scattering probabilities in compound
Differential Cross Sections ; LAB <-> CM converter
Electromagnetic excitation plots
Create an initial file for nucleon pick-up (beta)
<b>User cross-sections analysis using Abrasion-Ablation model</b>

**v.7.5**

Calculation of  $E^*$  vs. sigma matrix

Minimization of  $E^*$  parameters

**v.11.0.45**  
current version

v.7.5 09/2005

[http://lise.nsci.msu.edu/7\\_5/lise++\\_7\\_5.pdf#page=85](http://lise.nsci.msu.edu/7_5/lise++_7_5.pdf#page=85)

User Cross-Section analysis using the Abrasion-Ablation model: MATRIX

This utility can be used if

- "Projectile Fragmentation" reaction mode is selected
- Abrasion-Ablation is the selected cross-section method
- "File" cross section option is set to "on"
- There are more than 2 user cross-sections in memory for this reaction.

Local line to analyze  
Z = 18  
Change

Calculate down to Z = 18

Parameter variations

Parameter	Min Value	Max Value	Number of Points
<E*> - excitation energy per abraded nucleon (MeV)	10	30	11
sigma (standard deviation in MeV)	5	17	23

Universal analysis value

Analysis Value	Local		Global		<input checked="" type="checkbox"/> Correct for the number of data points used
	Chi2	LoD	Chi2	LoD	
weights	1	2	2	4	

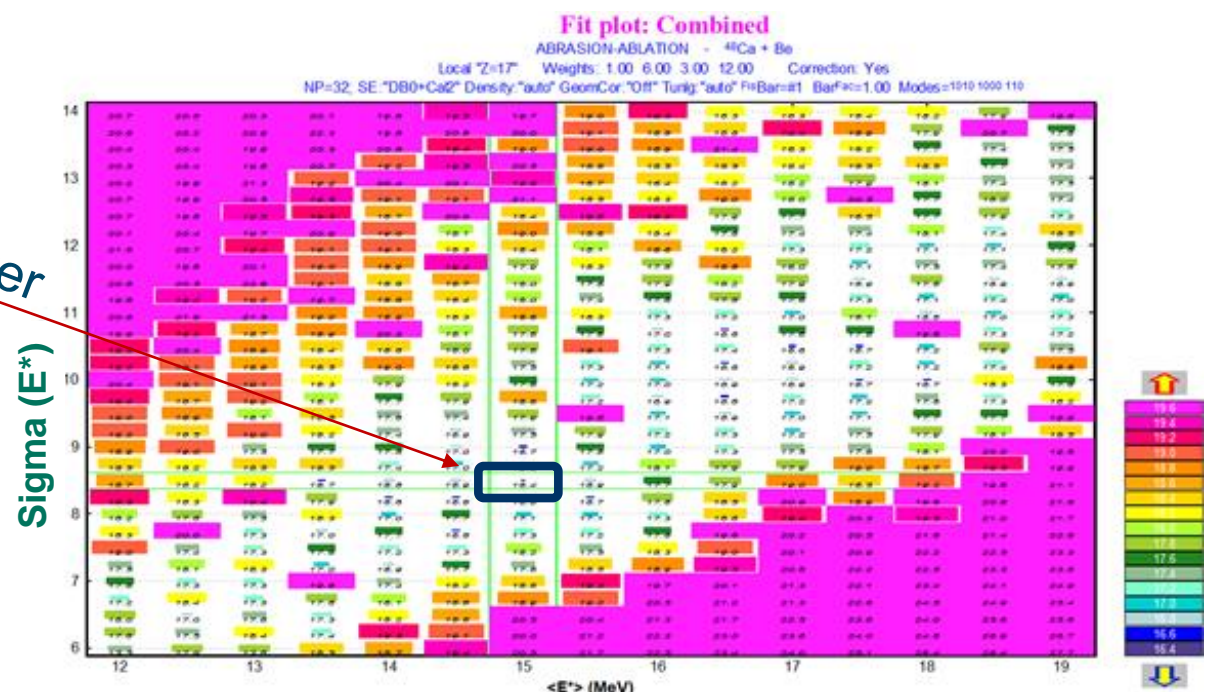
Analysis Log-file: MinimizationCS\_net.fit  
statistics file: MinimizationCS\_min.fit

Make Analysis Cancel Help Make default

Press "Escape" to interrupt analysis

The user defines dimensions of the matrix  $E^*$  vs Sigma

answer



Excitation Energy per Abraded Nucleon (MeV)

The same approach as  
 @ Abrasion-Ablation "MATRIX" dialog  
[http://lise.nycl.msu.edu/7\\_5/lise++\\_7\\_5.pdf#page=85](http://lise.nycl.msu.edu/7_5/lise++_7_5.pdf#page=85)

2 parameters from 6  
 possible will be varied in  
 the current settings

Levmar minimization settings

Options: Maximum number of iterations = 4  
 Use Lower & Upper bounds

LevMar package samples: Choose example = 4 (0-15)  
 Run minimization

Options	Value	Stopping threshold	Default value
tau	1.00e-03	$\mu/\max(J^T J)_i$	1e-03
epsilon 1	1.00e-15	$\ J^T e\ _{inf}$	1e-15
epsilon 2	1.00e-15	$\ Dp\ _2$	1e-15
epsilon 3	1.00e-20	$\ e\ _2$	1e-20
delta	1.00e-06	approximation step *	1e-06

LevMar package info: LEVMAR: Levenberg-Marquardt nonlinear least squares algorithms by M.I.A. Lourakis  
 levmar link

Make default  
 Ok Cancel

\* delta - difference approximation step, used only in the Bounds mode  
 If delta=0, the Jacobian is approximated with central differences which are more accurate (but slower) compared to the forward differences employed by default.

User Cross-Section analysis using the Abrasion-Ablation model : MINIMIZATION

This utility can be used if:  
 1. "Projectile Fragmentation" reaction mode is selected  
 2. Abrasion-Ablation is the selected cross-section method  
 3. "File" cross section option is set to "on"  
 4. There are more than 2 user cross-sections in memory for this reaction.  
 Make items 1-3

Local line to analyze: Change Z = 18  
 Calculate down to Z = 18

Universal analysis value:  
 Analysis Value: Local Chi2, LoD, Global Chi2, LoD  
 weights: 1, 2, 2, 4  
 Correct for the number of data points used

Save Settings, Load Settings, Evaporation settings, Prefragment excit.energy

Press "Escape" to interrupt analysis

$E^*$ : quadratic polynomial  
 <math>\langle E^\* \rangle</math> - excitation energy per abraded nucleon (MeV)  
 2.03776 + 17.90092 \*  $d_{abr}$  - 0.61537 \*  $d_{abr}^2$   
 Use in Fitting process:  0,  1,  2  
 Use Bounds constraints:  0,  1,  2  
 Lower bound: 0, 10, -2  
 Upper bound: 15, 30, 2

$\sigma(E^*)$ : quadratic polynomial  
 Sigma (standard deviation)  
 0 + 9.68991 \*  $d_{abr}^{1/2}$  + 0 \*  $d_{abr}$   
 Use in Fitting process:  0,  1,  2  
 Use Bounds constraints:  0,  1,  2  
 Lower bound: 0, 4, -2  
 Upper bound: 10, 20, 2

$d_{abr}$  is the number of abraded nucleons

Fitting: N iterations = 4  
 Fit Options, Show initial conditions, Target value = --, N CS points = --, Restore previous values, FIT

Analysis Log-file: Browse, LISE\_net.fit

Make default  
 Ok Cancel Help

Press it to get initial values:

Target value = 1.15e+01  
 N CS points = 11(29)

11 CS points at the local line (Z=18)  
 29 CS points total down to Z=18

Value to minimize

Minimization start

Restore previous values if the minimization process has been canceled

User Cross-Section analysis using the Abrasion-Ablation model : MINIMIZATION

This utility can be used if

1. "Projectile Fragmentation" reaction mode is selected
2. Abrasion-Ablation is the selected cross-section method
3. "File" cross section option is set to "on"
4. There are more than 2 user cross-sections in memory for this reaction.

Local line to analyze

Change Z = 18

Calculate down to Z = 18

Universal analysis value

Analysis Value	Local		Global	
	Chi2	LoD	Chi2	LoD
weights	1	2	2	4

Correct for the number of data points used

Save Settings | Load Settings | Evaporation settings | Prefragment excit.energy

Press "Escape" to interrupt analysis

$E^*$  : quadratic polynomial

	0	1	2
$\langle E^* \rangle$ - excitation energy per abraded nucleon (MeV)	2.03776	17.90092	-0.61537
		* d_abr	* d_abr^2

Use in Fitting process:  0,  1,  2

Use Bounds constraints:  0,  1,  2

Lower bound: 0, 10, -2

Upper bound: 15, 30, 2

$\sigma(E^*)$  : quadratic polynomial

	0	1	2
Sigma (standard deviation)	0	9.68991	0
		* d_abr^(1/2)	* d_abr

Use in Fitting process:  0,  1,  2

Use Bounds constraints:  0,  1,  2

Lower bound: 0, 4, -2

Upper bound: 10, 20, 2

Fitting: N iterations = 4

Fit Options

Show initial conditions

Target value = --

N CS points = --

Restore previous values

FIT

Analysis Log-file: LISE\_net.fit

Make default

Ok | Cancel | Help

Data to Save & Load

Default directory  
"LISE\Results"

Extension "fitset"

```
[E_bound]
Ebound00=0
Ebound01=9.4
Ebound02=-2
Ebound10=15
Ebound11=30.1
Ebound12=2

[weight]
weight0=1.2
weight1=3.5
weight2=1.11
weight3=7.23

[Global]
Divide=1
LastZ=15
state=2
N=20

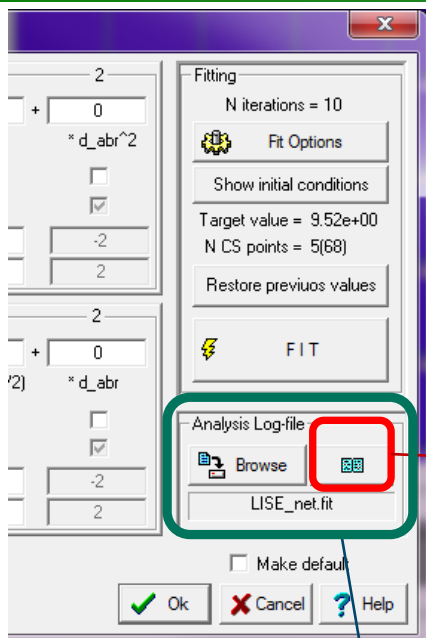
[Levmar]
Niter=4
Bounds=1
Example=4
opt0=1.000e-03
opt1=1.000e-15
opt2=1.000e-15
opt3=1.000e-20
opt4=1.000e-06

[EFitUse]
efu0=1
efu1=1
efu2=0

[EboundUse]
ebu0=1
ebu1=1
ebu2=1

[sigBounduse]
sbu0=0
sbu1=1
sbu2=1

[sigFitUse]
sfu0=1
sfu1=1
sfu2=0
```



The Analysis log-file will be automatically shown after minimization finish.

```

48Ca (140.0 MeV/u) + Be; **** Local line N = 28; Last Z=15
NP=32; SE:"DB0+Ca12" Density:"auto" GeomCor:"off" Tunlg:"auto" $Fis$Bar=#1 Bar$Fac1
No Intrin.Thermalztn; LimitTemp: No

-----
N => Local: init=5, final=5; Total: init=68, final=68
chi2: Initial 8.29326 and Final 8.61022 LISE fit reduced values
Parameters:
1. Energy #a1      LeftBound  Initial      RightBound  Final
+1.0e+01 < +1.4365e+01 < +3.0e+01 | +1.2773e+01
2. Sigma #a1      +4.0e+00 < +8.9502e+00 < +2.0e+01 | +7.5975e+00

-----
Final Excitation Energy Parameters
Energy (a0,a1,a2) : +0.0000e+00 +1.2773e+01 +0.0000e+00
Sigma (a0,a1,a2) : +0.0000e+00 +7.5975e+00 +0.0000e+00

-----
Chi-name      Coef  ChiBoxI  ChiBox  Chi_calc
chi2_local    1.0   1.309   1.804   1.804
LogDif_local  2.0   0.148   0.156   0.313
chi2_total    2.0   2.719   2.640   5.281
LogDif_total  4.0   0.312   0.303   1.213

-----
Levenberg-Marquardt returned 9.0 in 9 iter, reason 2
Termination reason: 2 - stopped by small Dp

Minimization info:
0: 3.293e+01 ||e||_2 at initial p
1: 3.271e+01 ||e||_2
2: 2.632e+03 ||J^T e||_inf
3: 3.234e-29 ||Dp||_2
4: 6.923e-08 mu/max[J^T J]_ii
5: 9 # iterations
6: 2 reason for terminating
7: 765 # function evaluations
8: 9 # Jacobian evaluations
9: 9 # linear systems solved, i.e. # attempts for reducing error

-----
Covariance of the fit :
+1.587924e+01 -9.498596e+00
-9.498596e+00 +5.681911e+00

-----
Options info:
0: 1.000e-03 mu
1: 1.000e-15 epsilon1 ||J^T e||_inf
2: 1.000e-15 epsilon2 ||Dp||_2
3: 1.000e-20 epsilon3 ||e||_2
4: 1.000e-04 delta approx.step
    
```

← Reaction & Evaporation settings

← Number of Cross-section point (before & after)

← Target value (chi2) (before & after)

← Parameters to vary & (before & after) their bounds

← Final Excitation energy polynomials

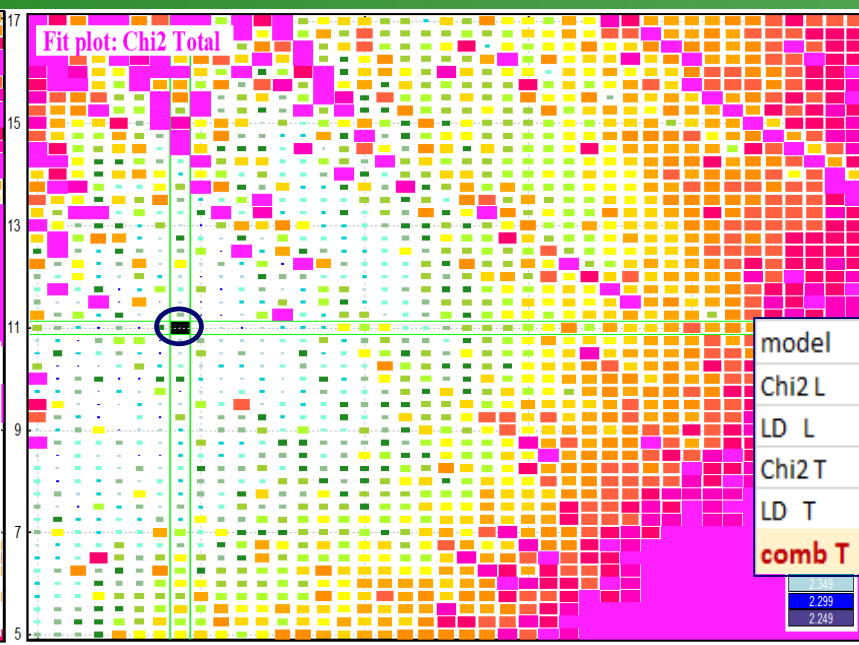
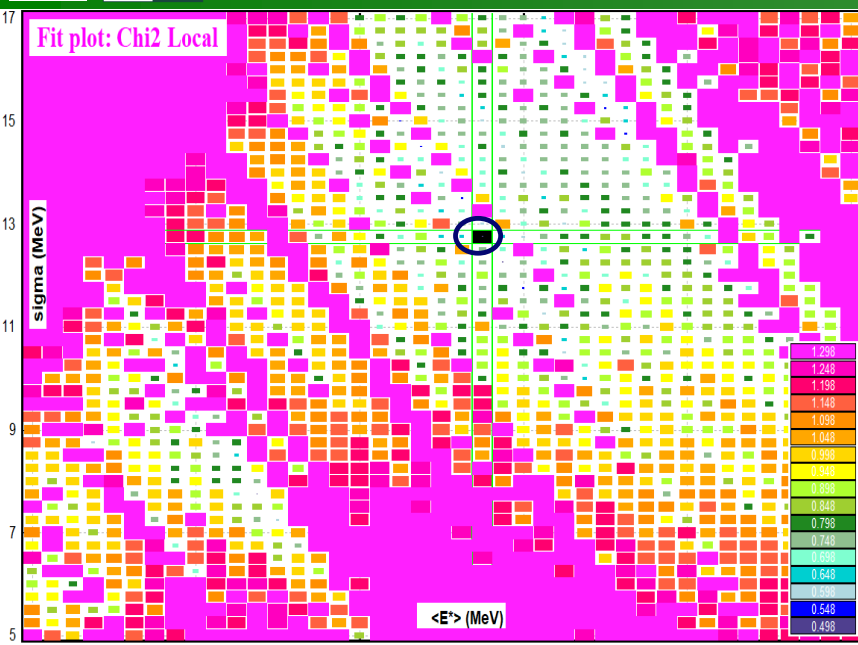
← Target [minimization] value components (before & after)  
 $Chi\_Calc[i] = Coef[i] * ChiBox[i]$   
 $Target\ Value = Sum(Chi\_Calc[i])$

← Levmar Minimization results info

← Covariance matrix

← Levmar Minimization options info

# "MATRIX" method: $^{48}\text{Ca}$ (EPAX2-data) $\rightarrow$ Z=16



$\langle E \rangle$  - excitation energy per abraded nucleon (MeV)    10    30    41

sigma (standard deviation in MeV)    5    17    49

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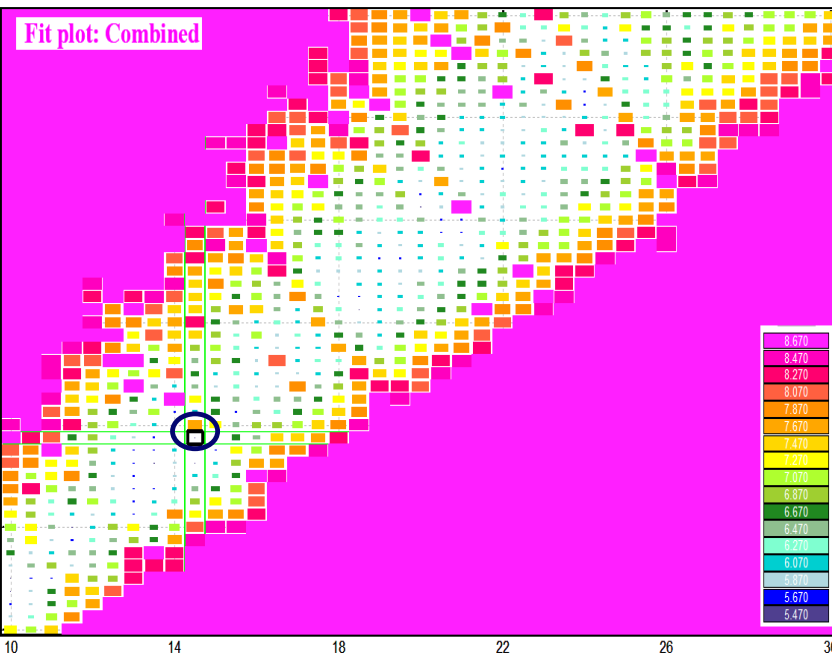
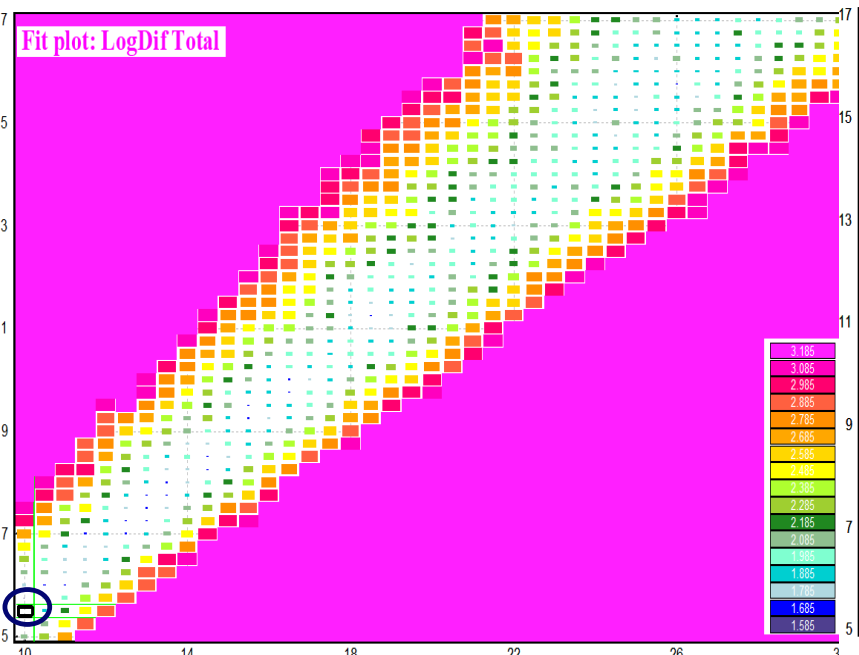
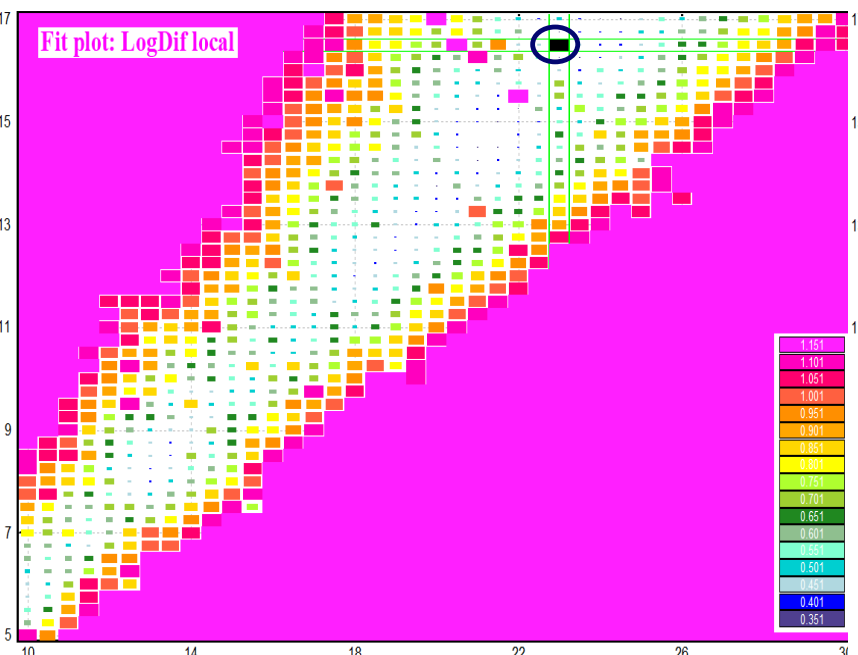
Universal analysis value

Analysis Value	Local	Global		
Chi2	LoD	Chi2	LoD	
weights	1	3	1	6

Correct for the number of data points used

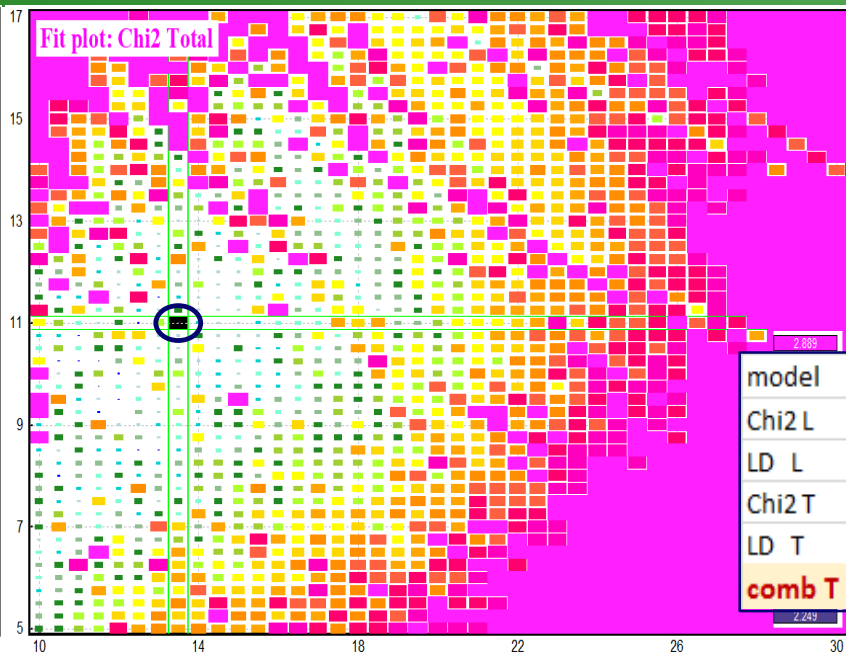
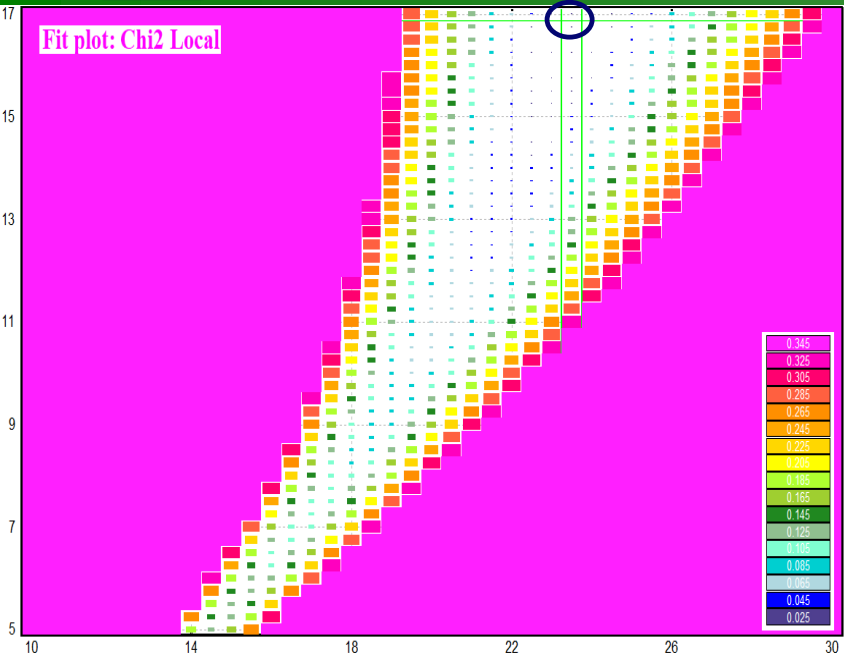
AME2016  
Last Z=13  
 $N_{\text{evap}}=32$

model	minimum	Energy	Sigma	maximum	Abs.Delta	Rel.Delta
Chi2 L	4.98E-01	21	12.75	4.43E+00	3.93E+00	7.89E+00
LD L	3.51E-01	23	16.5	4.20E+00	3.85E+00	1.10E+01
Chi2 T	2.25E+00	13.5	11	4.89E+00	2.64E+00	1.18E+00
LD T	1.59E+00	10	5.5	8.62E+00	7.03E+00	4.44E+00
<b>comb T</b>	<b>5.48E+00</b>	<b>14.5</b>	<b>8.75</b>	<b>1.76E+01</b>	<b>1.22E+01</b>	<b>7.89E+00</b>



# "MATRIX" method: $^{48}\text{Ca}$ (EPAX2-data) $\rightarrow$ N=28

AME2016  
Last Z=13  
 $N_{\text{evap}}=32$



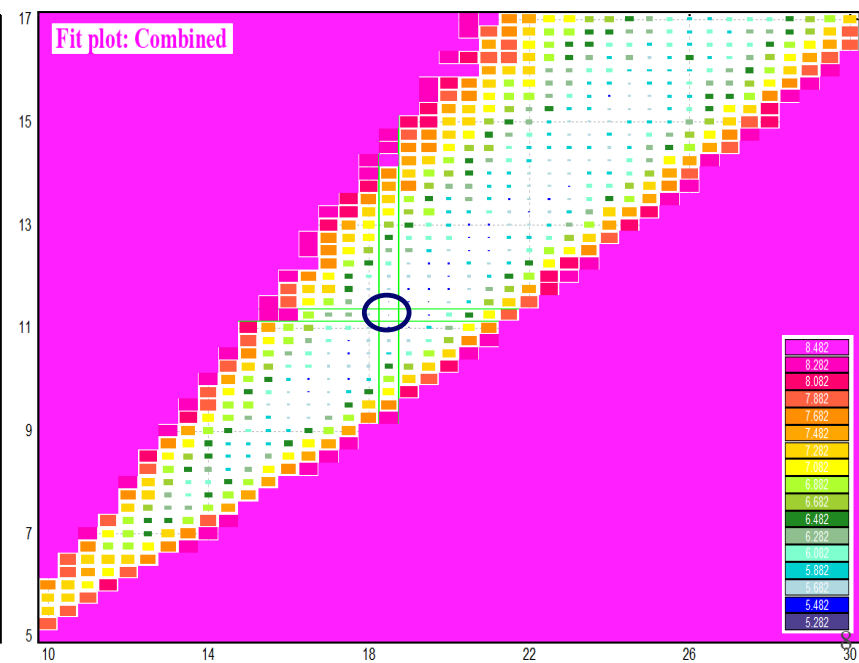
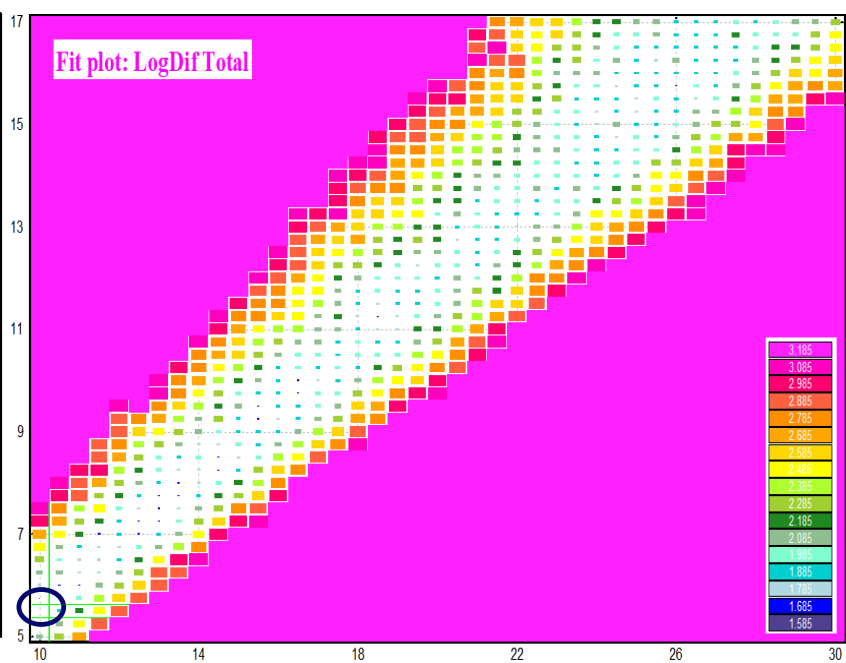
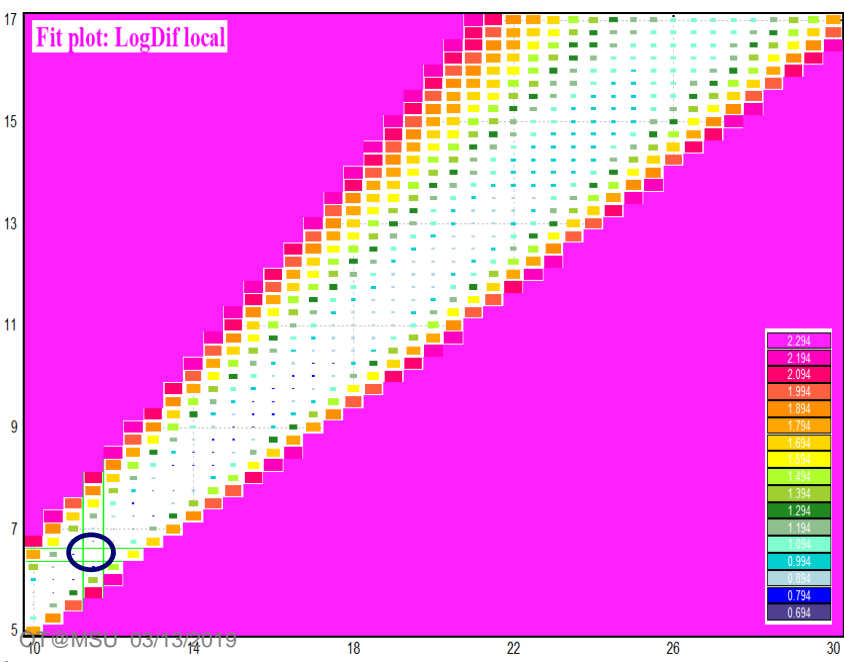
<E> - excitation energy per abraded nucleon (MeV) [ 10 | 30 | 41 ]  
 sigma (standard deviation in MeV) [ 5 | 17 | 49 ]

---

Universal analysis value

Analysis Value	Local	Global	<input checked="" type="checkbox"/> Correct for the number of data points used
	Chi2 LoD	Chi2 LoD	
weights	1 3	1 6	

model	minimum	Energy	Sigma	maximum	Abs.Delta	Rel.Delta
Chi2 L	2.51E-02	23.5	17	2.58E+00	2.56E+00	1.02E+02
LD L	6.94E-01	11.5	6.5	1.60E+01	1.53E+01	2.20E+01
Chi2 T	2.25E+00	13.5	11	4.89E+00	2.64E+00	1.18E+00
LD T	1.59E+00	10	5.5	8.62E+00	7.03E+00	4.44E+00
<b>comb T</b>	<b>5.28E+00</b>	<b>18.5</b>	<b>11.25</b>	2.93E+01	2.40E+01	1.02E+02





## “Matrix” method results

### Local line Z=16

Weight	model	minimum	Energy	Sigma	maximum	Abs.Delta	Rel.Delta
1	Chi2 L	4.98E-01	21	12.75	4.43E+00	3.93E+00	7.89E+00
3	LD L	3.51E-01	23	16.5	4.20E+00	3.85E+00	1.10E+01
1	Chi2 T	2.25E+00	13.5	11	4.89E+00	2.64E+00	1.18E+00
6	LD T	1.59E+00	10	5.5	8.62E+00	7.03E+00	4.44E+00
	<b>comb T</b>	<b>5.48E+00</b>	<b>14.5</b>	<b>8.75</b>	<b>1.76E+01</b>	<b>1.22E+01</b>	<b>7.89E+00</b>

### Local line N=28

Weight	model	minimum	Energy	Sigma	maximum	Abs.Delta	Rel.Delta
1	Chi2 L	2.51E-02	23.5	17	2.58E+00	2.56E+00	1.02E+02
3	LD L	6.94E-01	11.5	6.5	1.60E+01	1.53E+01	2.20E+01
1	Chi2 T	2.25E+00	13.5	11	4.89E+00	2.64E+00	1.18E+00
6	LD T	1.59E+00	10	5.5	8.62E+00	7.03E+00	4.44E+00
	<b>comb T</b>	<b>5.28E+00</b>	<b>18.5</b>	<b>11.25</b>	<b>2.93E+01</b>	<b>2.40E+01</b>	<b>1.02E+02</b>

The “Abs.Delta” column shows the “Maximum”-“Minimum” value, and “Rel.Delta” shows the ratio “Abs.Delta/Maximum”.

These values can be used to define weights. For example: on the basis of equal contribution.

Minimum and maximum values are shown with “weight” factors

## 48Ca – EPAX2 data

### Initial E\* parameters, weight and bound conditions

User Cross-Section analysis using the Abrasion-Ablation model : MINIMIZATION  
 This utility can be used if  
 1. "Projectile Fragmentation" reaction mode is selected  
 2. Abrasion-Ablation is the selected cross-section method  
 3. "File" cross section option is set to "on"  
 4. There are more than 2 user cross-sections in memory for this reaction.

Local line to analyze: **Z = 16**  
 Calculate down to Z = **13**

Universal analysis value  
 Analysis Value: Local (Chi2, LoD) and Global (Chi2, LoD)  
 weights: 1, 3, 1, 6  
 Correct for the number of data points used

E\* : quadratic polynomial 0 1 2  
 <E\*> - excitation energy per abraded nucleon (MeV)  
 0 + 15 + 0  
 \* d\_abr \* d\_abr^2  
 Use in Fitting process:     
 Use Bounds constraints:     
 Lower bound: 0 9 -2  
 Upper bound: 15 30 2

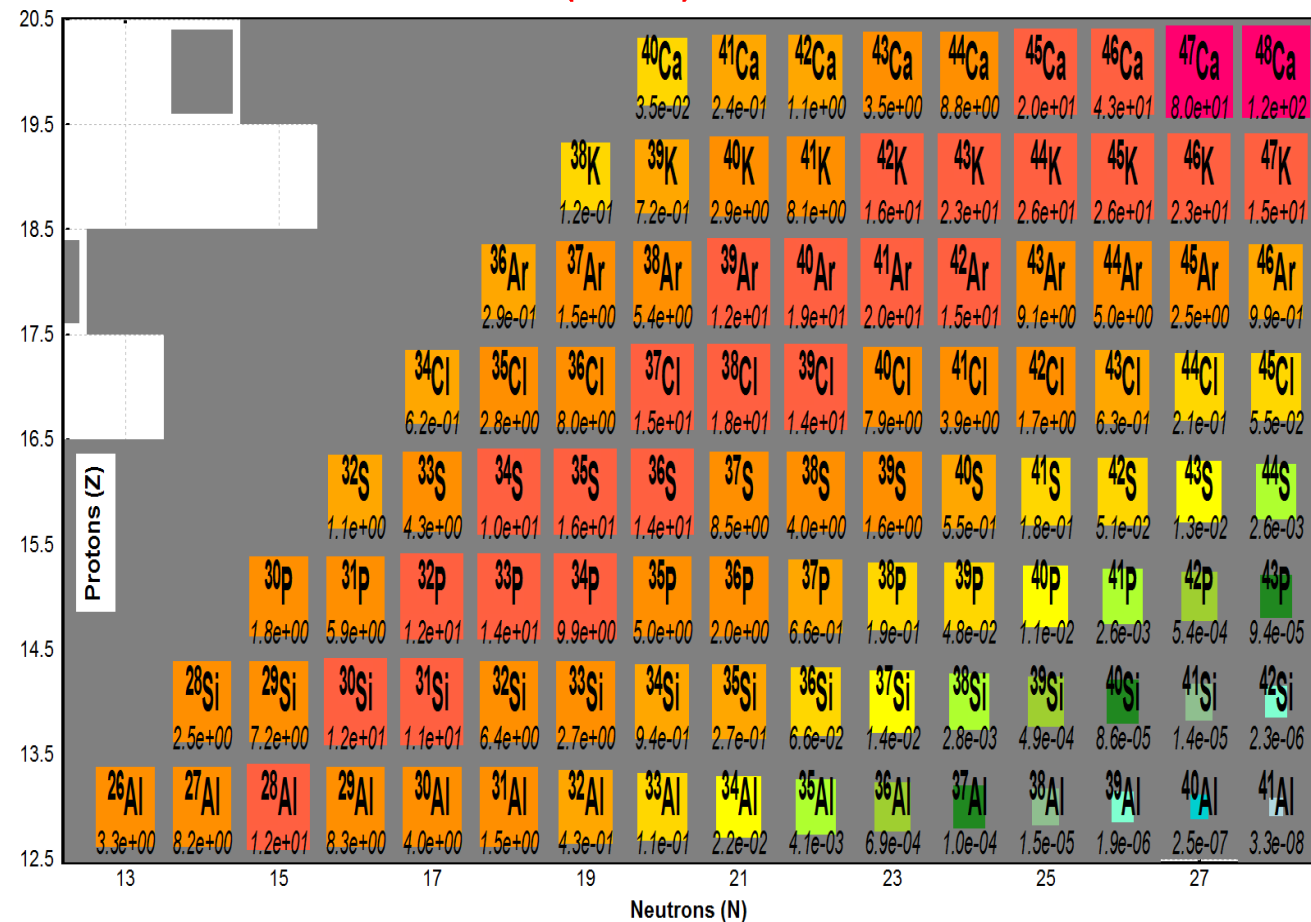
sigma(E\*) : quadratic polynomial 0 1 2  
 Sigma (standard deviation) 0 + 9 + 0  
 \* d\_abr^(1/2) \* d\_abr  
 Use in Fitting process:     
 Use Bounds constraints:     
 Lower bound: 0 4 -2  
 Upper bound: 10 20 2

Fitting  
 N iterations = 200  
 Fit Options  
 Show initial conditions  
 Target value = 7.35e+00  
 N CS points = 13(99)  
 Restore previous values  
**FIT**

Analysis Log-file

Press "Escape" to interrupt analysis  
 d\_abr is the number of abraded nucleons  
 Make default

### User (EPAX2) cross-sections



Do not expect good approximation of EPAX2 data by AA!  
 For example no odd-even effect in EPAXs.

There are just benchmarks for  $N_{evap}$ , Masses, Local line choice, number of modified parameters, Weights and so on.

Run	mass	Line	Last Z	Nevap	para- meters	Energy			Sigma			weights	Target Value	Target Value	itera- tions	chi2-loc	ldif-loc	chi2-tot	ldif-tot
						a0	a1	a2	s0	s1	s2	1-3-1-6	init	final					
1	AME2016	Z=16	13	32	2		14.186			8.655		1-3-1-6	7.354	<b>5.252</b>	13	0.65	0.15	2.51	0.28
2	AME2016	Z=16	13	<b>64</b>	2		8.932			4.003		1-3-1-6		<b>7.072</b>	15	1.03	0.39	2.32	0.42
3	AME2016	Z=16	13	32	<b>3</b>	0.001	14.187			8.654		1-3-1-6	7.354	<b>5.258</b>	13	0.65	0.15	2.51	0.28
4	AME2016	Z=16	13	32	<b>3a</b>		9.020	0.804		7.923		1-3-1-6		<b>5.188</b>	18	0.77	0.16	2.28	0.28
5	AME2016	Z=16	13	32	<b>4</b>	<u>1.215</u>	<u>9.446</u>	<u>1.270</u>		<u>10.147</u>	<a href="#">LISE++ file link</a>	1-3-1-6	7.356	<b>4.780</b>	100	0.48	0.16	2.21	0.28
6	AME2016	Z=16	13	32	<b>4a</b>	1.220	<u>9.176</u>	1.270	<u>3.232</u>	<u>6.309</u>	<u>0.989</u>	1-3-1-6	7.356	<b>4.824</b>	21	0.551	0.154	2.222	0.265
7	AME2016	Z=16	13	32	<b>6</b>	1.170	9.296	1.264	3.160	6.260	0.995	1-3-1-6		<b>4.781</b>	47	0.547	0.149	2.223	0.265
8	<b>UNEDF0</b>	Z=16	13	32	2		15.063			9.012		1-3-1-6		<b>5.597</b>	48	1.02	0.19	2.40	0.27
9	AME2016	<b>N=28</b>	13	32	2		14.456			8.397		1-3-1-6	6.630	<b>5.956</b>	12	0.97	0.27	2.45	0.29
10	AME2016	N=28	13	<b>64</b>	2		13.544			8.404		1-3-1-6	6.940	<b>6.938</b>	32	1.32	0.32	2.31	0.39
11	<b>UNEDF0</b>	N=28	13	32	2		15.798			9.455		1-3-1-6		<b>5.421</b>	6	0.55	0.30	2.26	0.29
12	AME2016	<b>N=28</b>	13	32	<b>4</b>	4.885	12.995	1.515		13.640	<a href="#">LISE++ file link</a>	1-3-1-6	6.669	<b>4.389</b>	50	0.22	0.06	2.36	0.27
13	AME2016	N=28	13	32	4	4.564	13.304	1.071		12.149		<b>1-3-1-10</b>	8.111	<b>5.435</b>	6	0.20	0.08	2.45	0.26

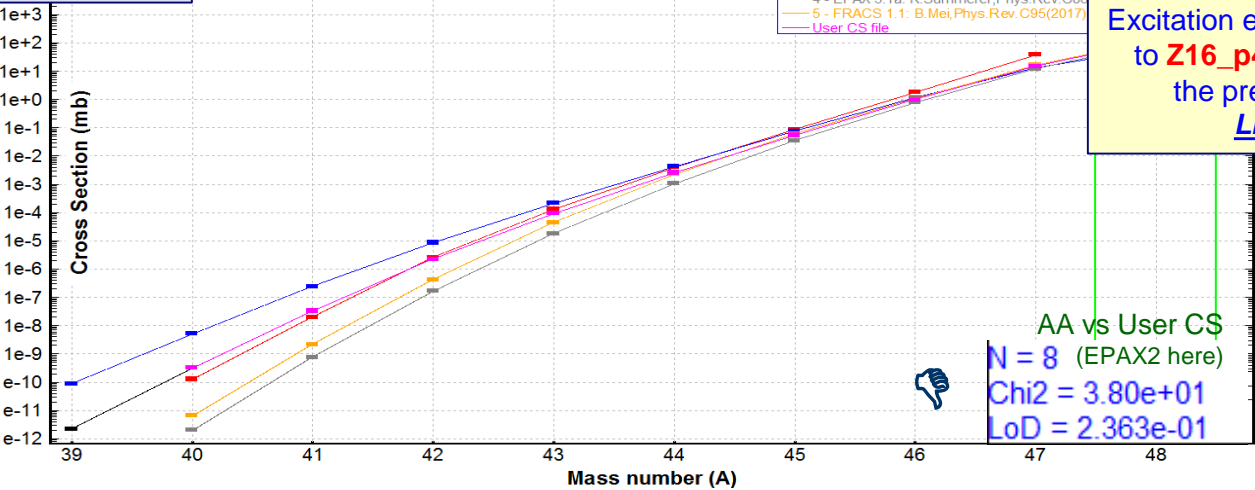
## Cross sections (Projectile Fragmentation)

**N=28**  
line

$^{48}\text{Ca} + \text{Be} \rightarrow \text{N}=28$

Excit.Energy Method:< 2 >; <E\*>:9.4\*dA MeV Sigma:10.15; No Intrin.Thermalztn; LimitTemp: No  
SE:"DB0+Cal2" Density:"auto" GeomCor:"Off" Tunlg:"auto" FisBar=#1 BarF<sup>ac</sup>=1.00 Modes=1010 1000 110

- 0 - Abrasion/Ablation v.6.4
- 1 - EPAX 1.00: K.Summerer et al.,Phys.Rev.C42(1990)2546
- 2 - EPAX 2.15: K.Summerer et al.,Phys.Rev.C61(2000)034607
- 4 - EPAX 3.1a: K.Summerer,Phys.Rev.C86(2012)014601
- 5 - FRACS 1.1: B.Mei,Phys.Rev.C95(2017)
- User CS file



Excitation energy corresponds to **Z16\_p4** settings (row 05) of the previous slide table.  
[LISE++ file link](#)

AA vs User CS  
N = 8 (EPAX2 here)  
Chi2 = 3.80e+01  
LoD = 2.363e-01

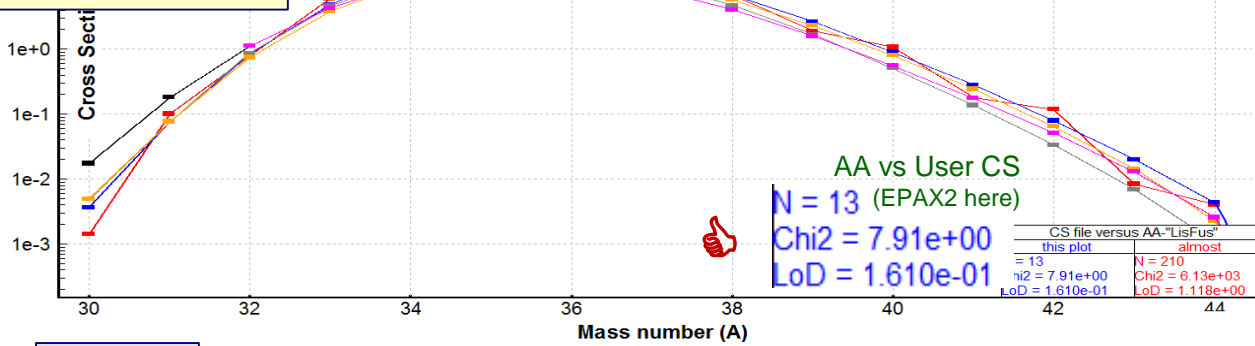
## Cross sections (Projectile Fragmentation)

**Z=16**  
line

$^{48}\text{Ca} + \text{Be} \rightarrow \text{Z}=16$

Excit.Energy Method:< 2 >; <E\*>:9.4\*dA MeV Sigma:10.15; No Intrin.Thermalztn; LimitTemp: No  
SE:"DB0+Cal2" Density:"auto" GeomCor:"Off" Tunlg:"auto" FisBar=#1 BarF<sup>ac</sup>=1.00 Modes=1010 1000 110

- 0 - Abrasion/Ablation v.6.4
- 1 - EPAX 1.00: K.Summerer et al.,Phys.Rev.C42(1990)2546
- 2 - EPAX 2.15: K.Summerer et al.,Phys.Rev.C61(2000)034607
- 4 - EPAX 3.1a: K.Summerer,Phys.Rev.C86(2012)014601
- 5 - FRACS 1.1: B.Mei,Phys.Rev.C95(2017)034608 [E=300MeV/u]
- User CS file



AA vs User CS  
N = 13 (EPAX2 here)  
Chi2 = 7.91e+00  
LoD = 1.610e-01

CS file versus AA-"LisFus"	
this plot	almost
N = 13	N = 210
chi2 = 7.91e+00	Chi2 = 6.13e+03
LoD = 1.610e-01	LoD = 1.118e+00

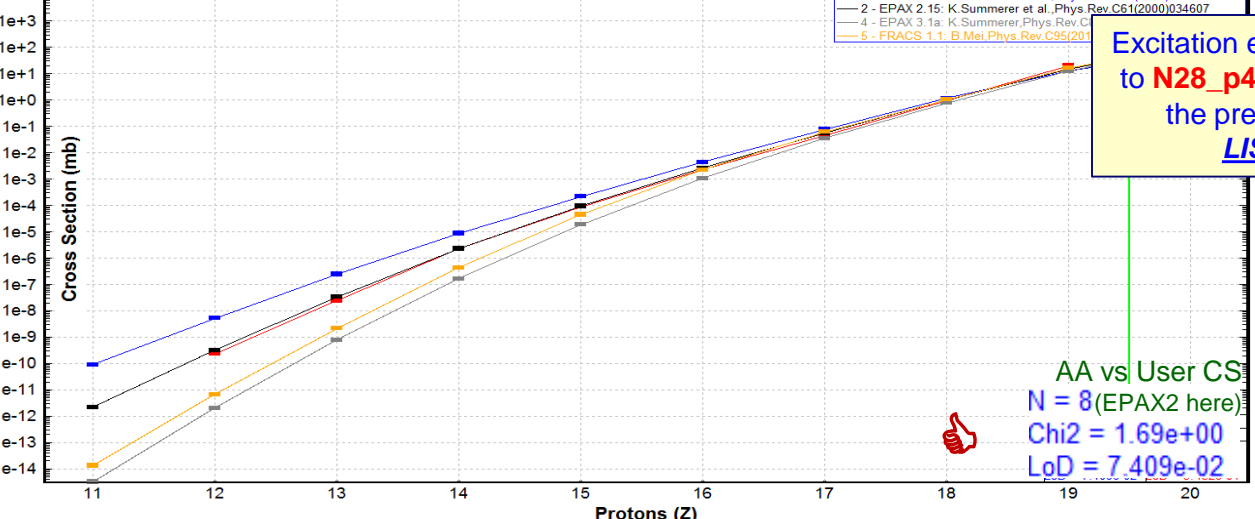
## Cross sections (Projectile Fragmentation)

**N=28**  
line

$^{48}\text{Ca} + \text{Be} \rightarrow \text{N}=28$

Excit.Energy Method:< 2 >; <E\*>:13.0\*dA MeV Sigma:13.64; No Intrin.Thermalztn; LimitTemp: No  
NP=32; SE:"DB0+Cal2" Density:"auto" GeomCor:"Off" Tunlg:"auto" FisBar=#1 BarF<sup>ac</sup>=1.00 Modes=1010 1000 110

- 0 - Abrasion/Ablation v.6.4
- 1 - EPAX 1.00: K.Summerer et al.,Phys.Rev.C42(1990)2546
- 2 - EPAX 2.15: K.Summerer et al.,Phys.Rev.C61(2000)034607
- 4 - EPAX 3.1a: K.Summerer,Phys.Rev.C86(2012)014601
- 5 - FRACS 1.1: B.Mei,Phys.Rev.C95(2017)
- User CS file



Excitation energy corresponds to **N28\_p4** settings (row 12) of the previous slide table.  
[LISE++ file link](#)

AA vs User CS  
N = 8 (EPAX2 here)  
Chi2 = 1.69e+00  
LoD = 7.409e-02

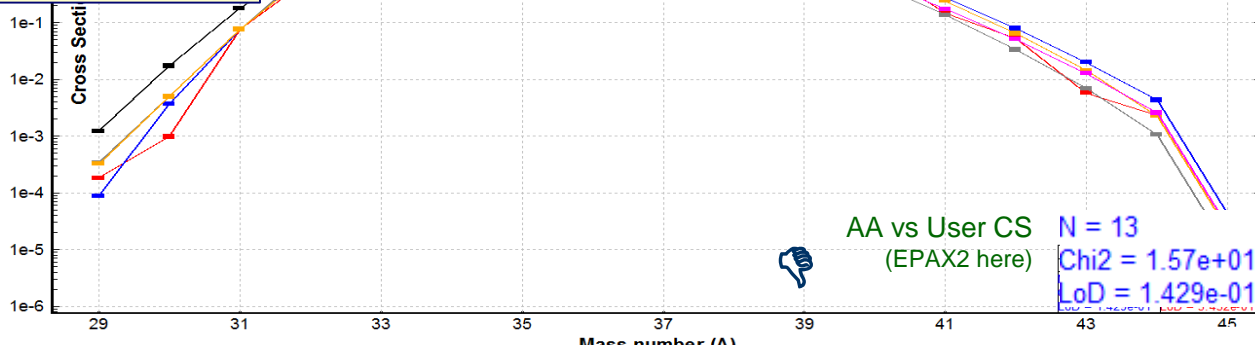
## Cross sections (Projectile Fragmentation)

**Z=16**  
line

$^{48}\text{Ca} + \text{Be} \rightarrow \text{Z}=16$

Excit.Energy Method:< 2 >; <E\*>:13.0\*dA MeV Sigma:13.64; No Intrin.Thermalztn; LimitTemp: No  
P=32; SE:"DB0+Cal2" Density:"auto" GeomCor:"Off" Tunlg:"auto" FisBar=#1 BarF<sup>ac</sup>=1.00 Modes=1010 1000 110

- 0 - Abrasion/Ablation v.6.4
- 1 - EPAX 1.00: K.Summerer et al.,Phys.Rev.C42(1990)2546
- 2 - EPAX 2.15: K.Summerer et al.,Phys.Rev.C61(2000)034607
- 4 - EPAX 3.1a: K.Summerer,Phys.Rev.C86(2012)014601
- 5 - FRACS 1.1: B.Mei,Phys.Rev.C95(2017)034608 [E=300MeV/u]
- User CS file



AA vs User CS  
(EPAX2 here)

N = 13  
Chi2 = 1.57e+01  
LoD = 1.429e-01

Applying the new utility to analyze the recent experimental data obtained with  $^{132}\text{Sn}$ ,  $^{70}\text{Zn}$  and  $^{48}\text{Ca}$  beams using different mass tables.