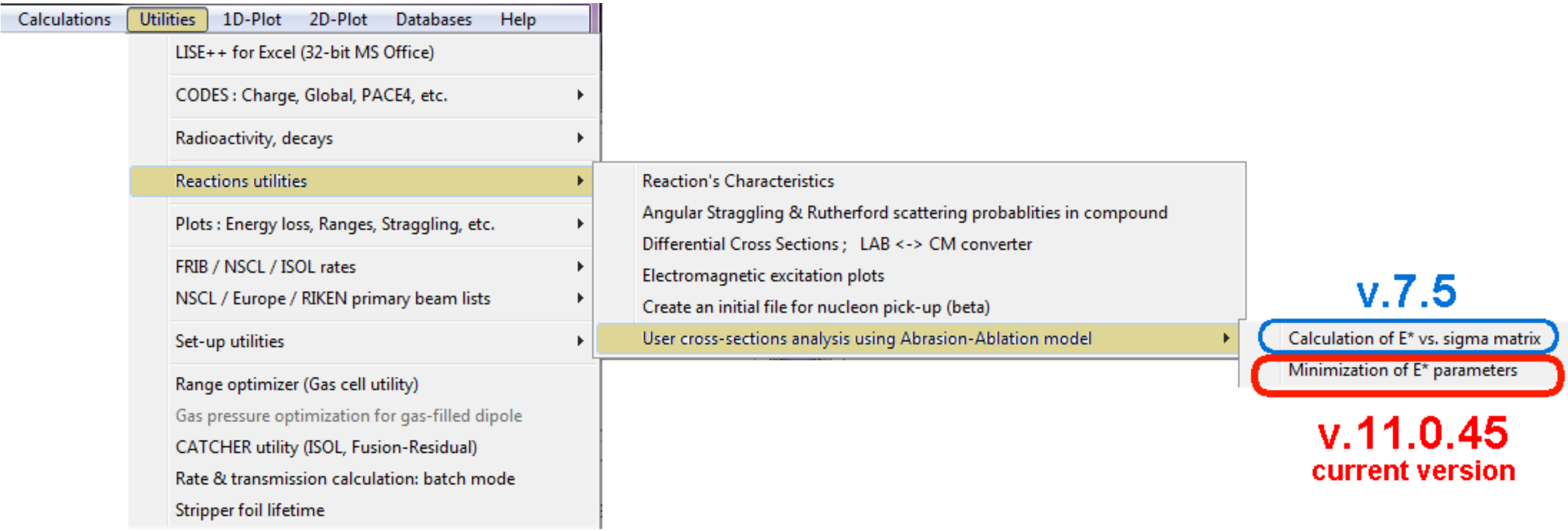
Abrasion-Ablation minimization to describe user cross-sections

v.11.0.45 03/10/19

The new utility allows to minimize Abrasion-Ablation excitation energy polynomials (up to 2nd 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

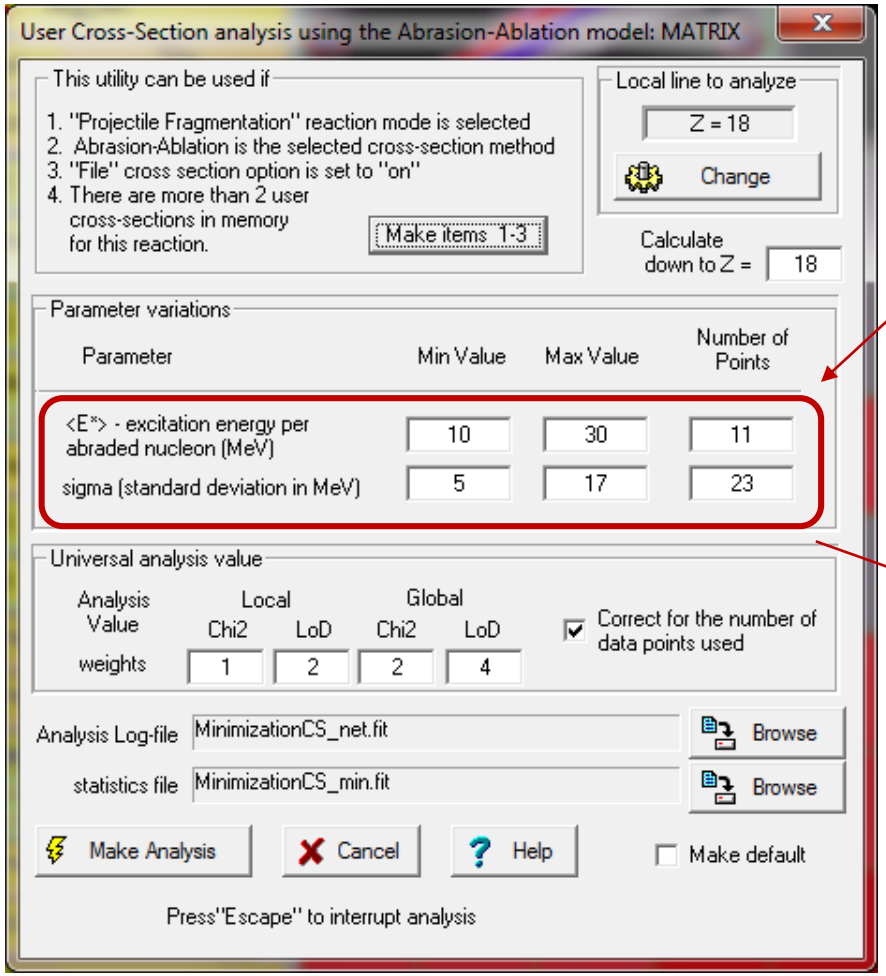
Abrasion-Ablation minimization to describe user cross-sections



User cross-section analysis using Abrasion-Ablation model : MATRIX method

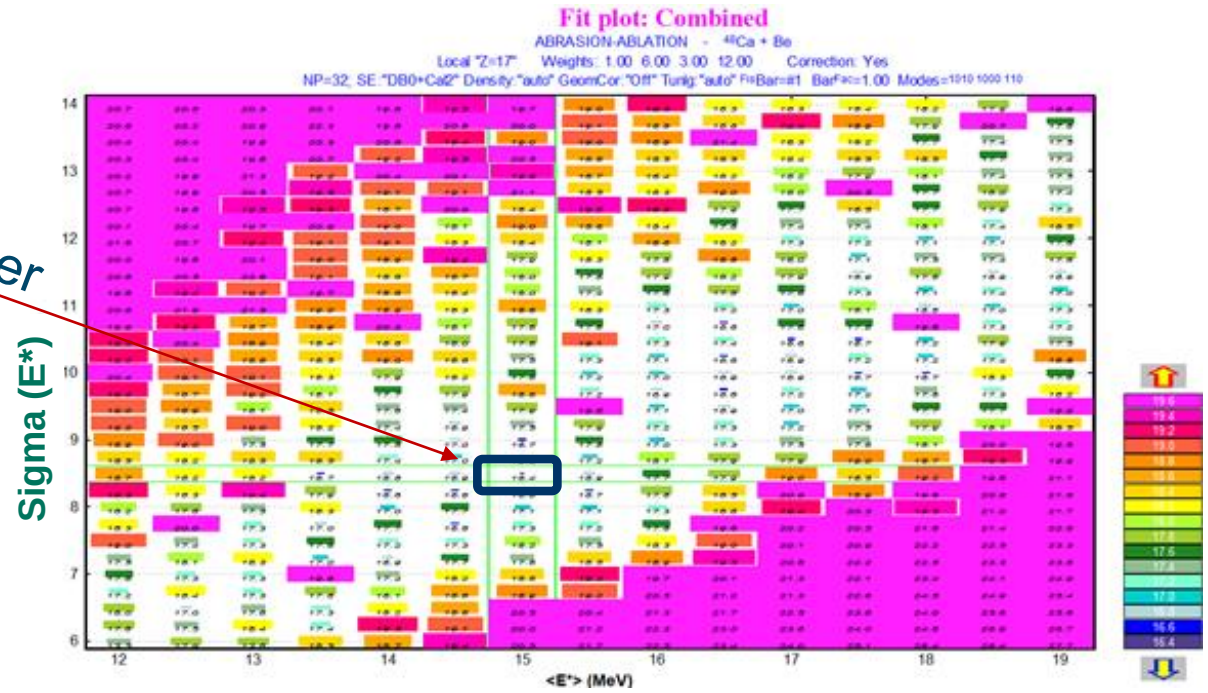
v.7.5 09/2005

http://lise.nscl.msu.edu/7_5/lise++_7_5.pdf#page=85



The user defines dimensions of the matrix E* vs Sigma

answer

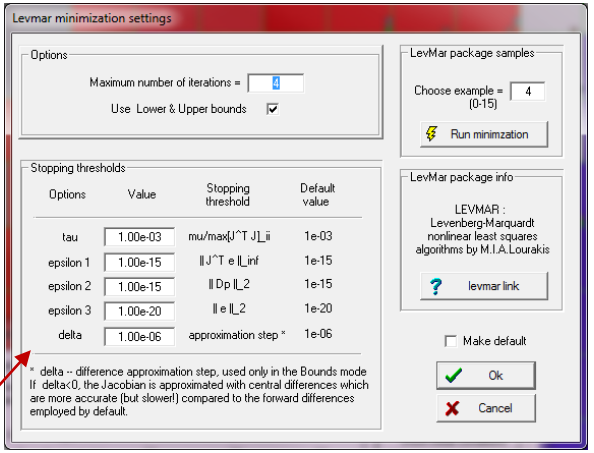


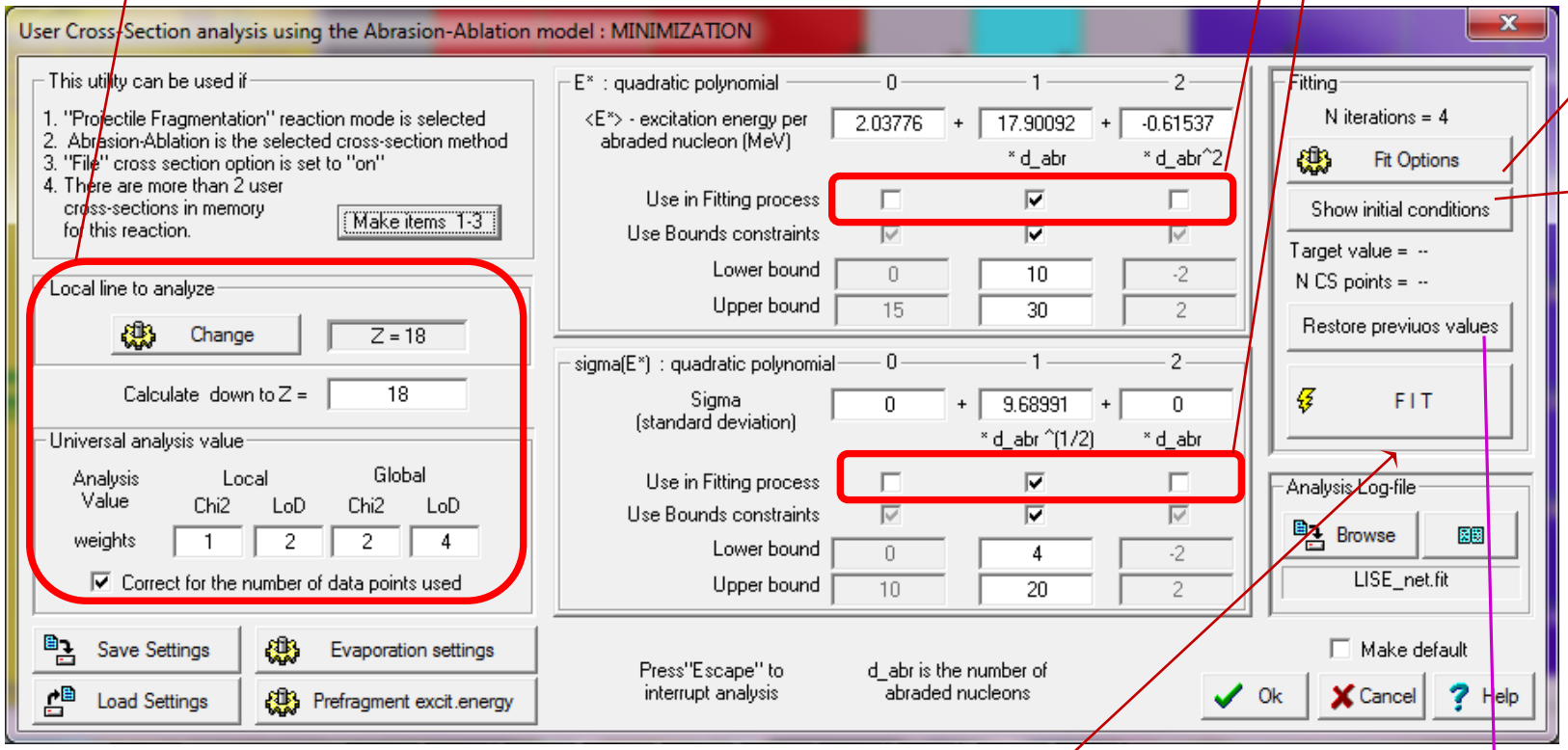
Excitation Energy per Abraded Nucleon (MeV)

Abrasion-Ablation minimization dialog

The same approach as
@ Abrasion-Ablation “MATRIX” dialog
http://lise.nscl.msu.edu/7_5/lise++_7_5.pdf#page=85

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





Press it to get initial values:

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

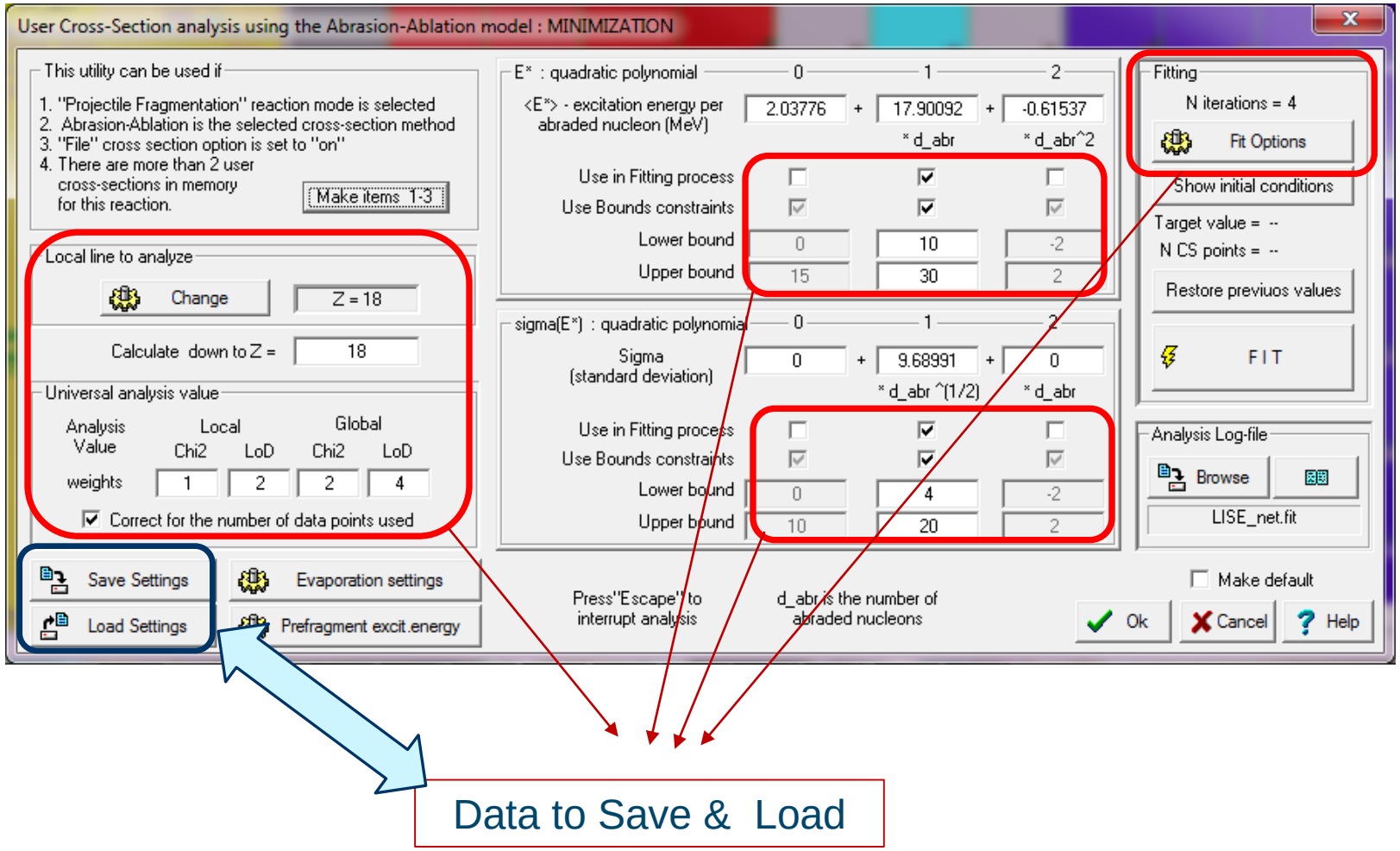
11 CS points at the local line (Z=18)
29 CS points total down to Z=18

Minimization start

Restore previous values if the minimization process has been canceled

Value to minimize

Save & Read dialog settings



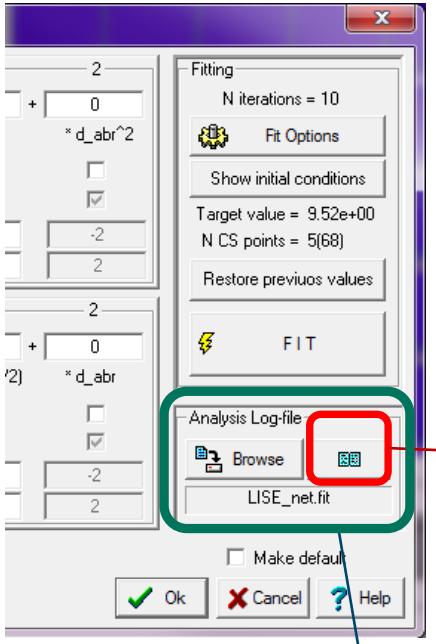
Data to Save & Load

Default directory "LISE\Results"

Extension "fitset"

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

[Sig_bound]
Sbound00=0
Sbound01=4
Sbound02=-2
Sbound10=10
Sbound11=20
Sbound12=2

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

[EBoundUse]
ebu0=1
ebu1=1
ebu2=1

[SigFitUse]
sfu0=1
sfu1=1
sfu2=0

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

[Weights]
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
```

Analysis log-file



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+Cal2" Density:"auto" GeomCor:"Off" Tunlg:"auto" $Fis$Bar=#1  Bar$Fac$
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:         LeftBound      Initial       RightBound |  Final
1. Energy #a1       +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      aprrox.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]*

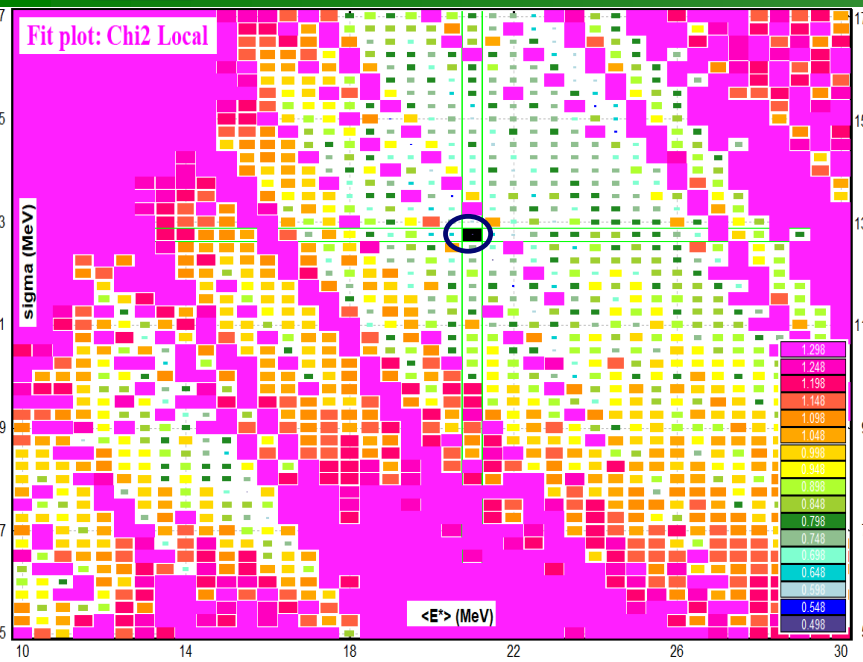
Target Value = Sum(Chi_Calc[i])

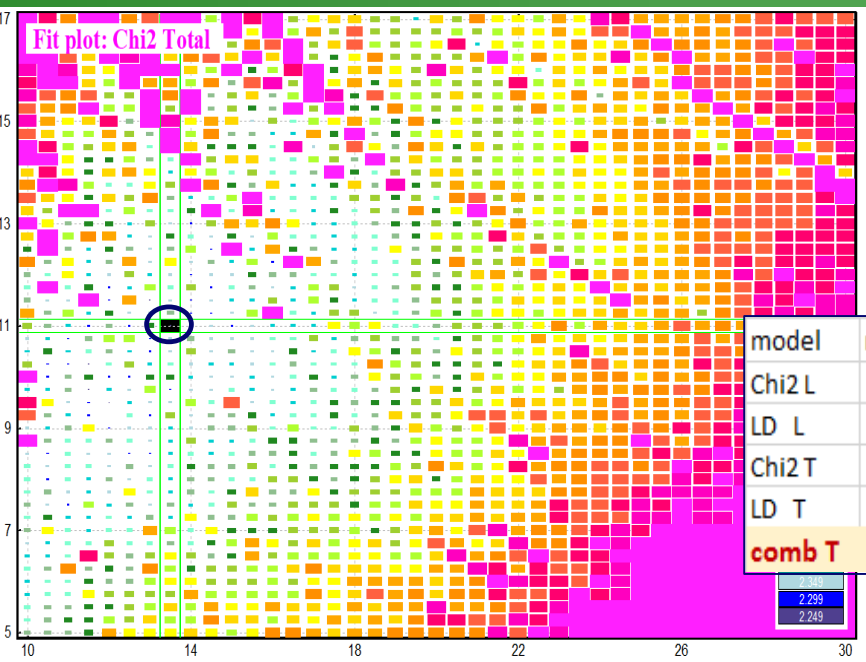
Levmar Minimization results info

Covariance matrix

Levmar Minimization options info

“MATRIX” method: ^{48}Ca (EPAX2-data) → Z=16





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

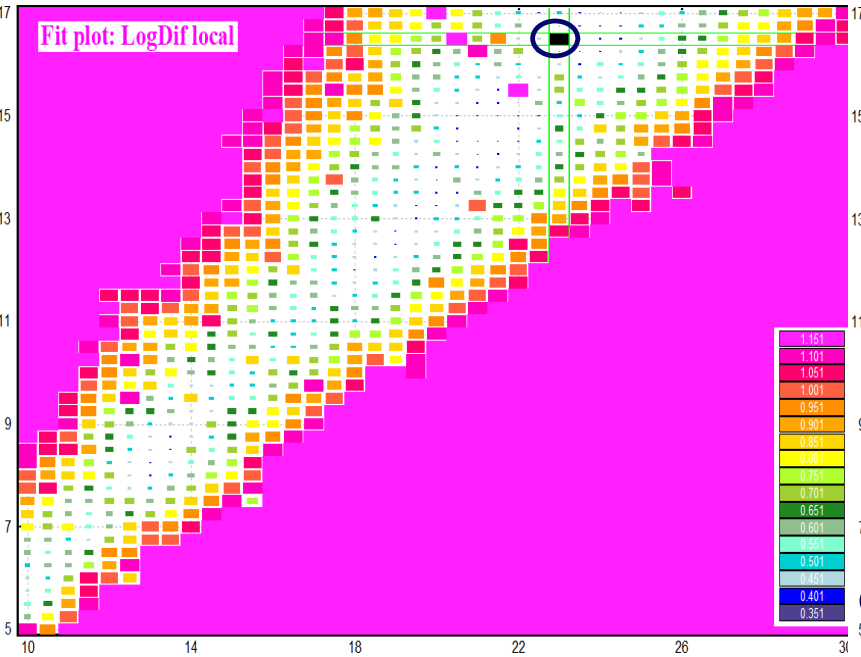
Universal analysis value

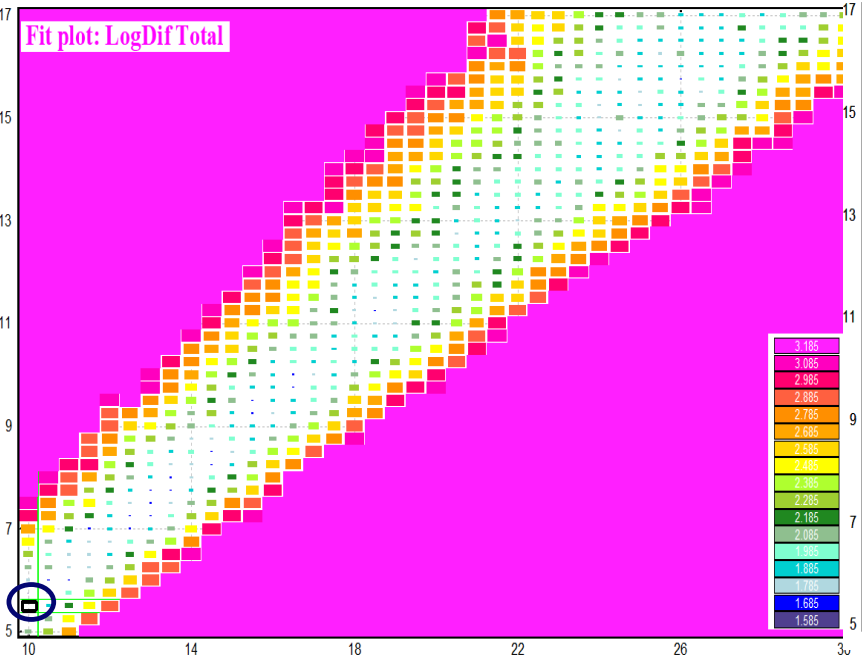
Analysis Value	Local Chi2	Local LoD	Global Chi2	Global LoD
weights	1	3	1	6

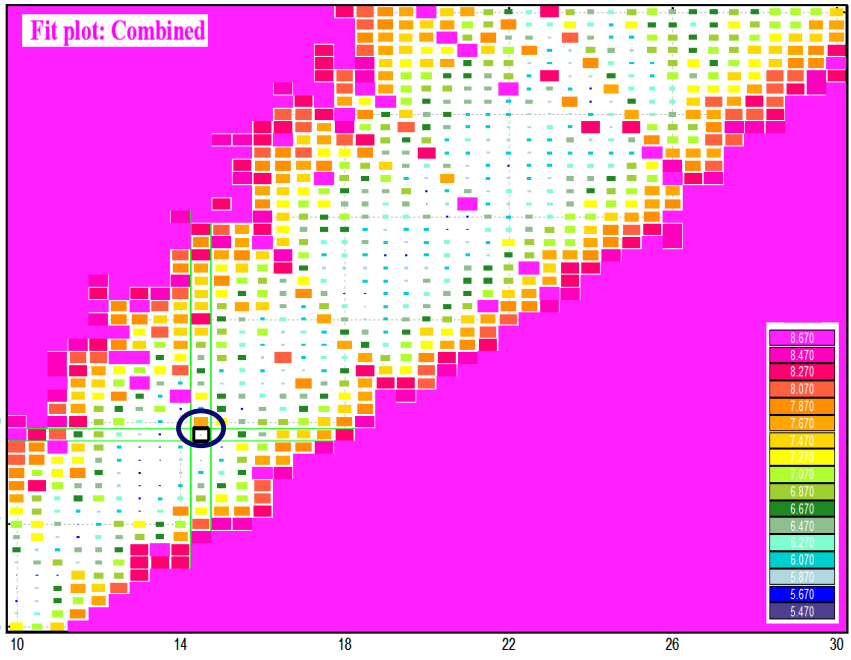
Correct for the number of data points used

AME2016
Last Z=13
N_{evap}=32

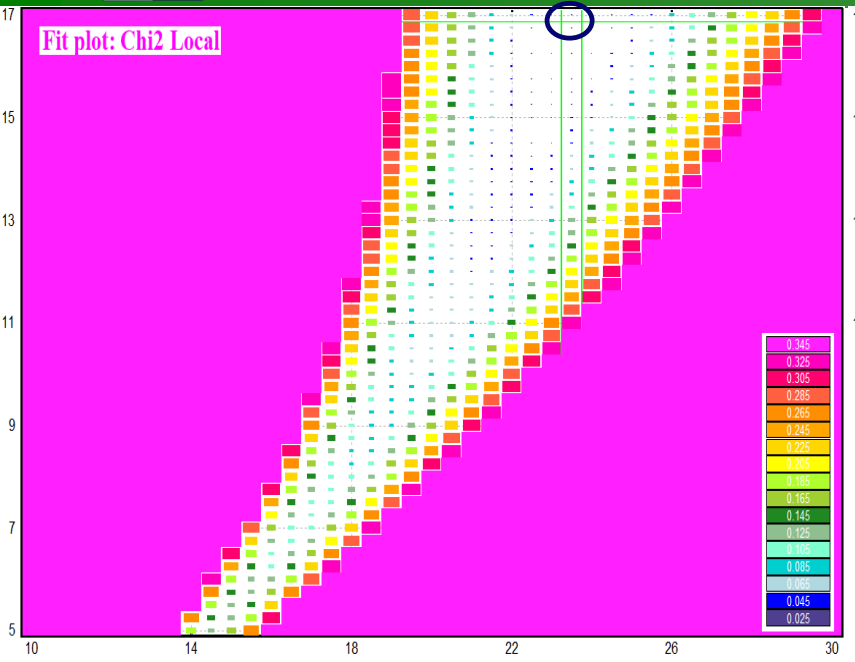
model	minimum	Energy	Sigma	maximum	*Abs.Delta*	Rel.Delta
Chi2 L	4.98E-01	21	12.75	4.43E+00	*3.93E+00*	7.89E+00
LD L	3.51E-01	23	16.5	4.20E+00	*3.85E+00*	1.10E+01
Chi2 T	2.25E+00	13.5	11	4.89E+00	*2.64E+00*	1.18E+00
LD T	1.59E+00	10	5.5	8.62E+00	*7.03E+00*	4.44E+00
comb T	**5.48E+00**	**14.5**	**8.75**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

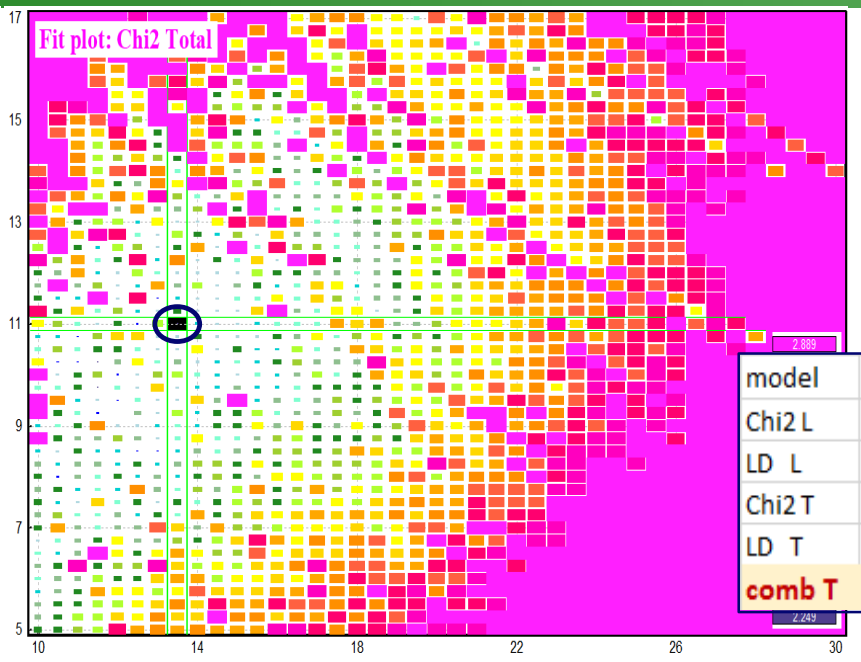


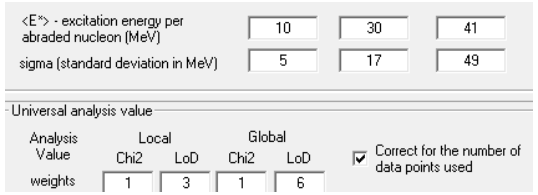




“MATRIX” method: ^{48}Ca (EPAX2-data)→ N=28

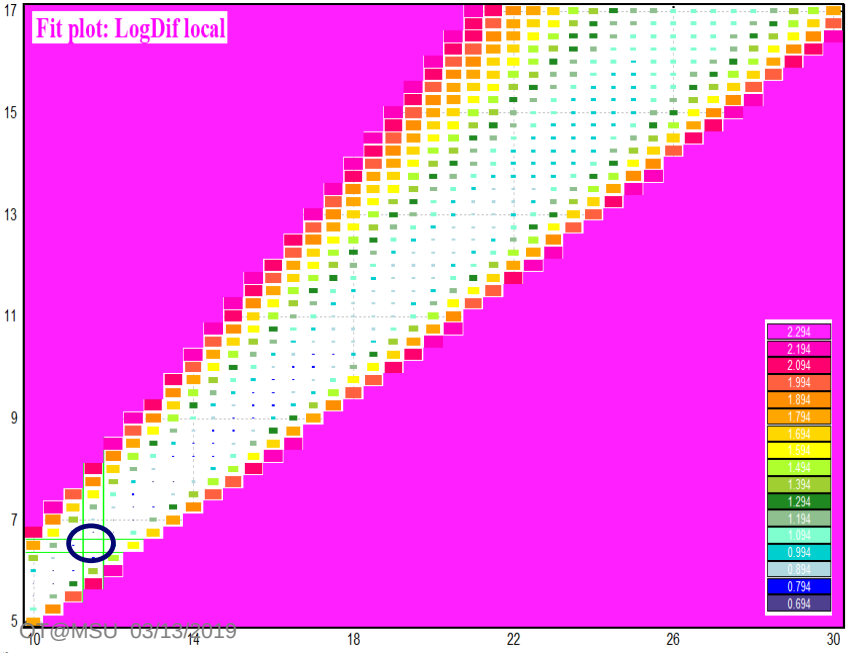


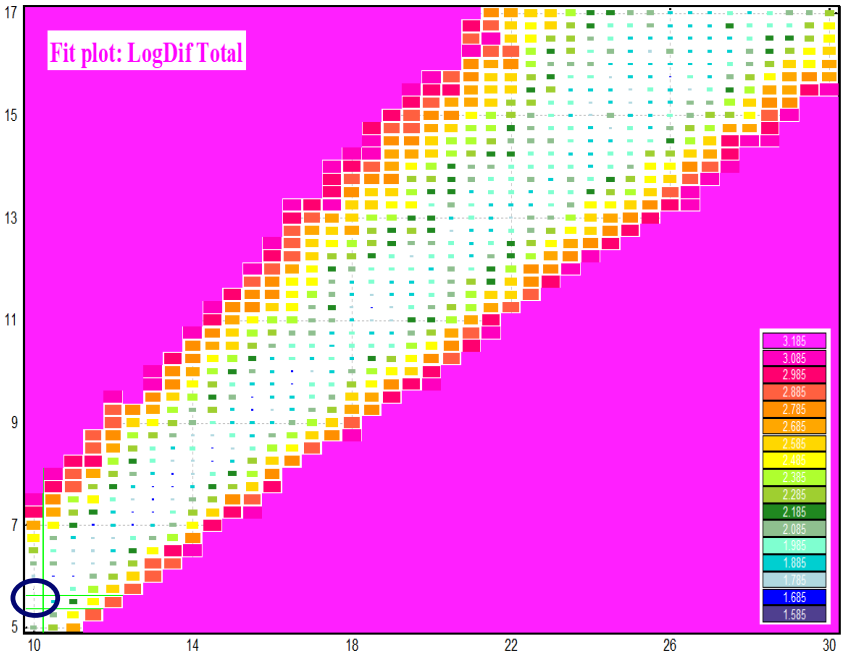


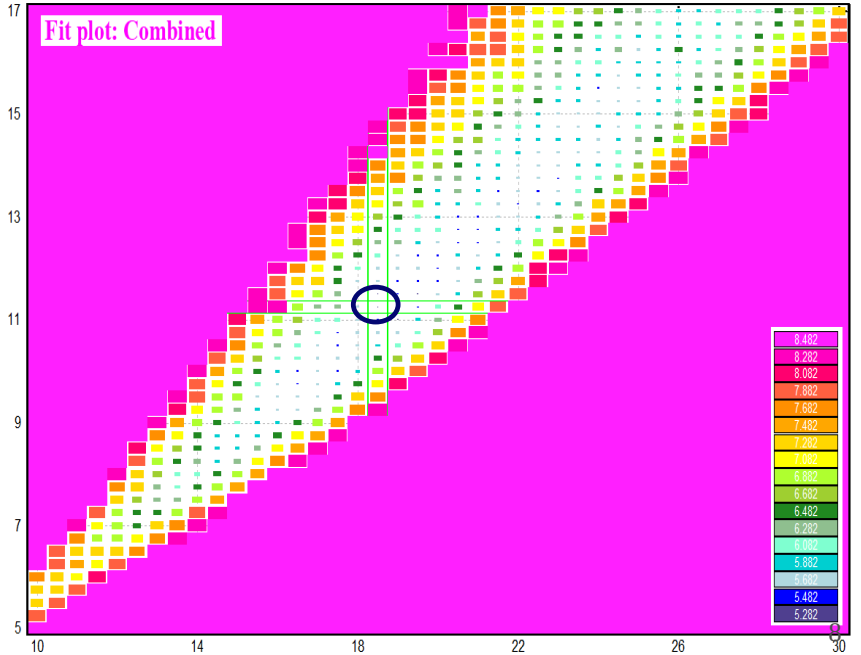


AME2016
Last Z=13
N_{evap}=32

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
comb T	5.28E+00	18.5	11.25	2.93E+01	*2.40E+01*	1.02E+02







Defining method weights

"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
	comb T	**5.48E+00**	**14.5**	**8.75**	1.76E+01	*1.22E+01*	7.89E+00

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
	comb T	**5.28E+00**	**18.5**	**11.25**	2.93E+01	*2.40E+01*	1.02E+02

Minimum and maximum values are shown with "weight" factors

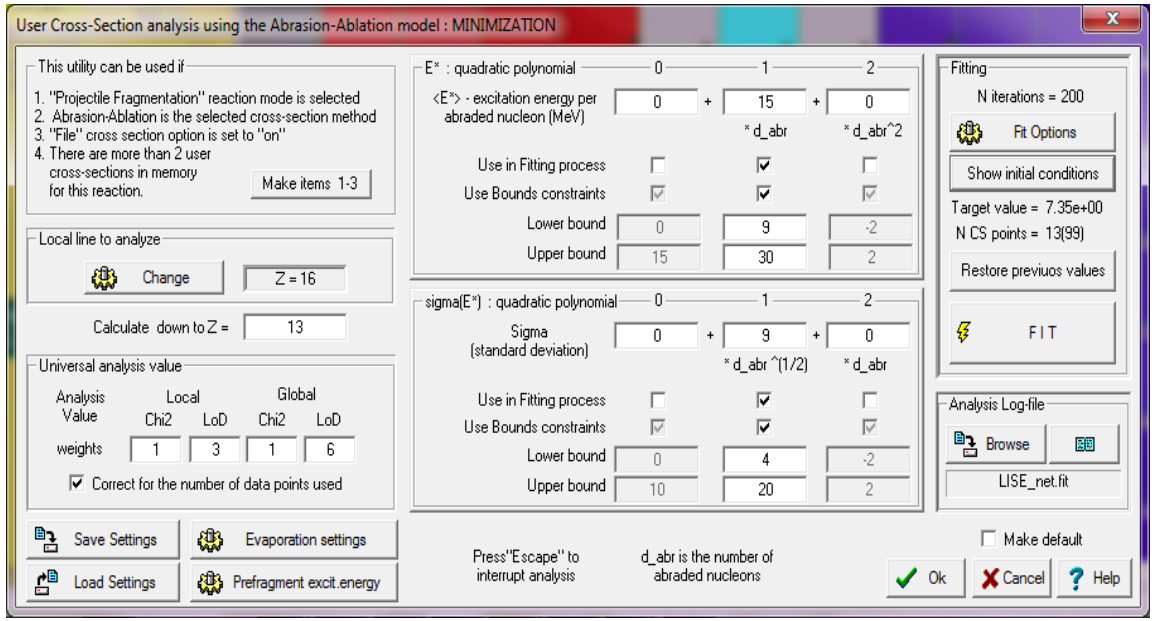
The "Abs.Delta" column shows the "Maximum"-"Minimum" value, and "Rel.Delta" shows the ratio "Abs.Delta/Maximum".

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

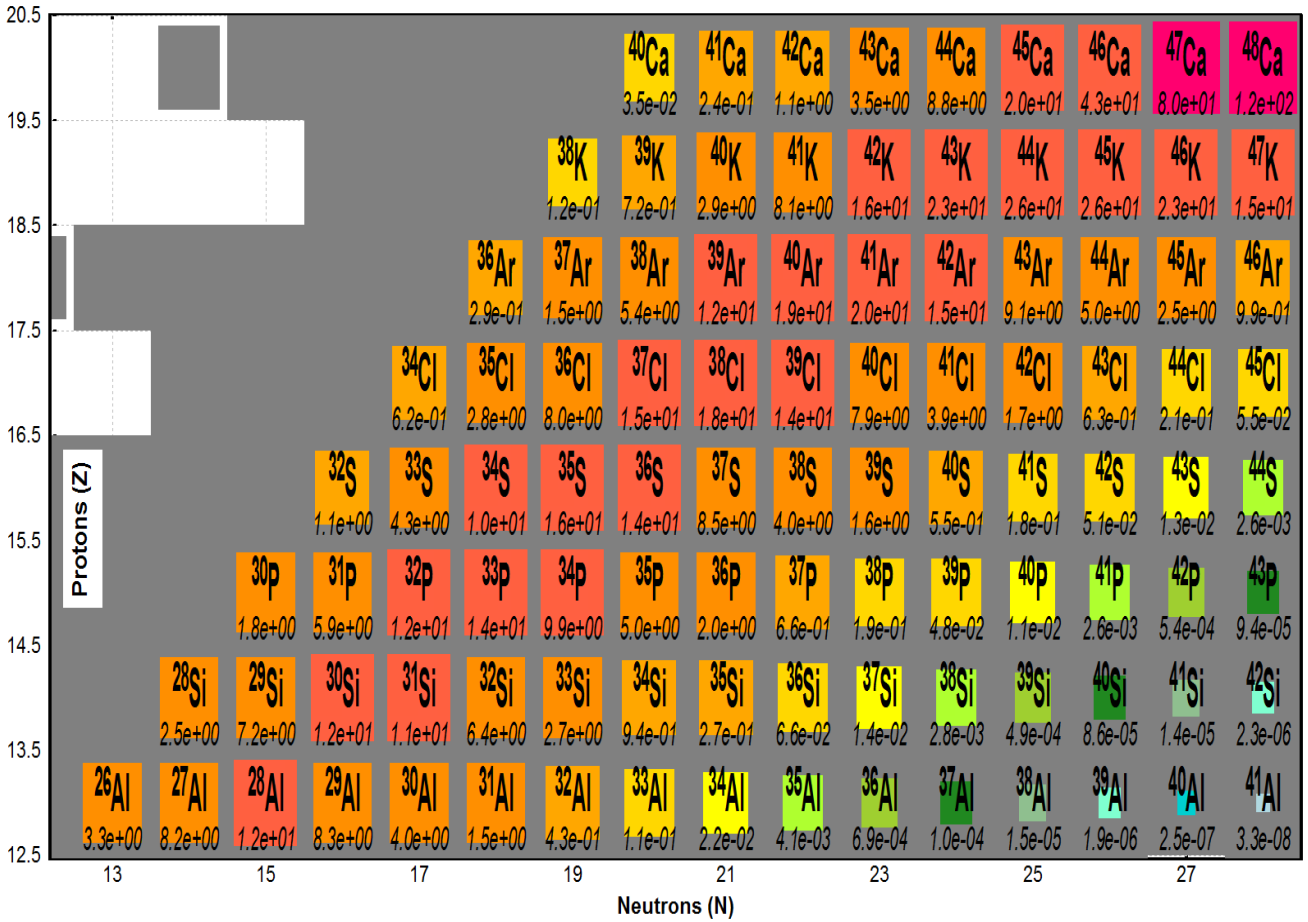
“Minimization” method : input data

^{48}Ca – EPAX2 data

Initial E* parameters, weight and bound conditions



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.

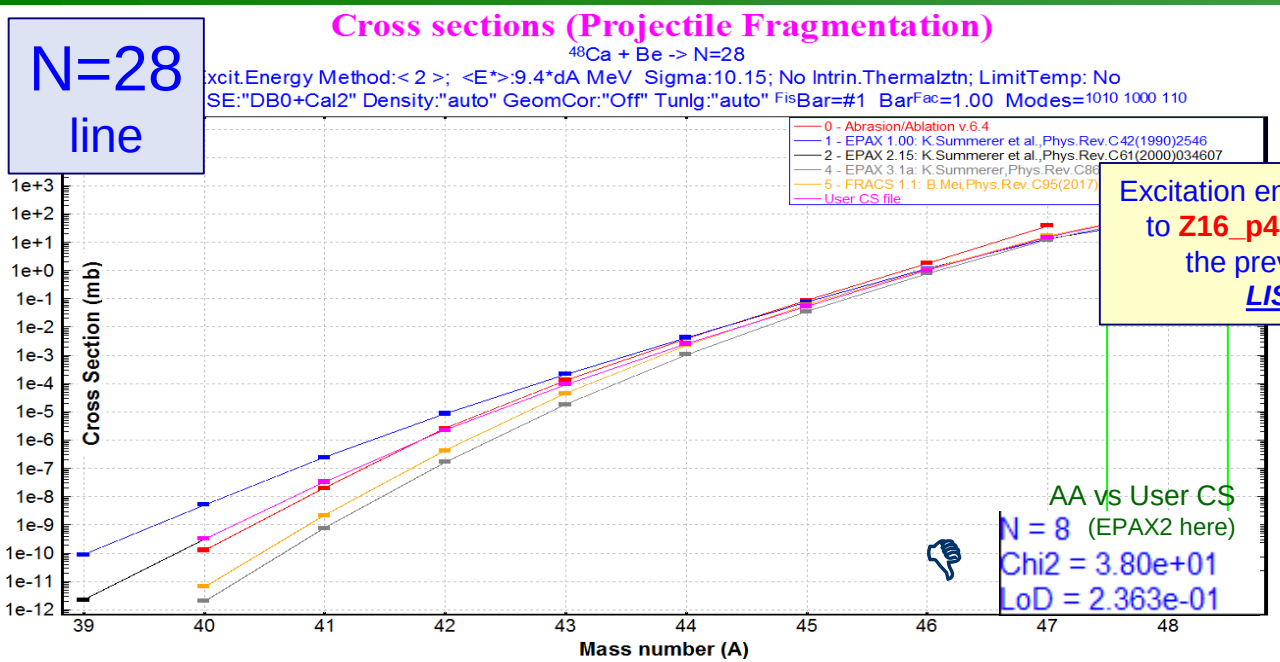
"Minimization" method : Results

^{48}Ca – EPAX2 data

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

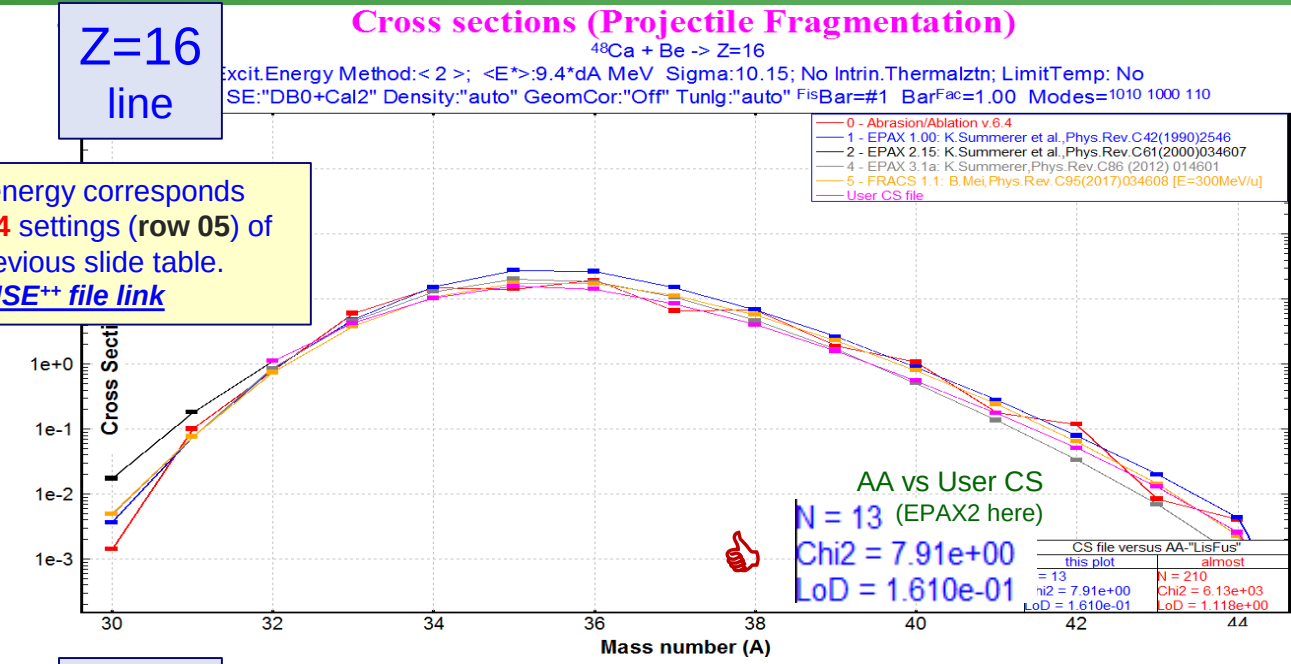
“Minimization” method results : AA vs. User CS

N=28 line

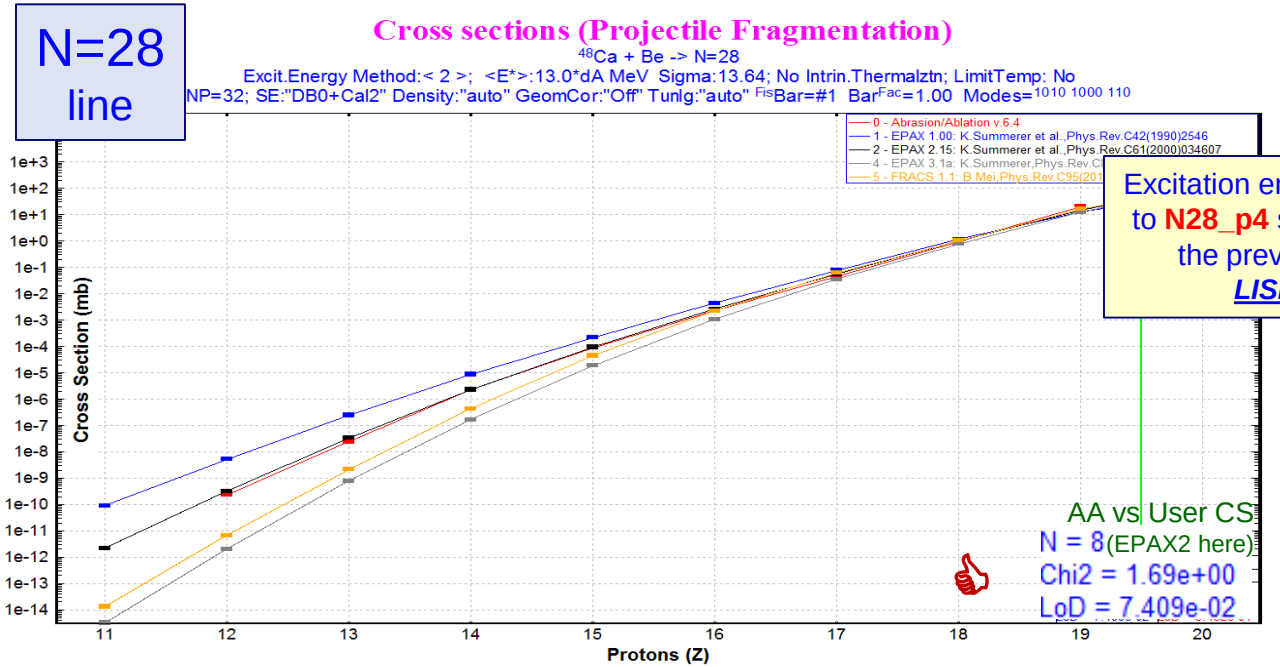


Excitation energy corresponds to **Z16_p4** settings (**row 05**) of the previous slide table.
LISE++ file link

Z=16 line

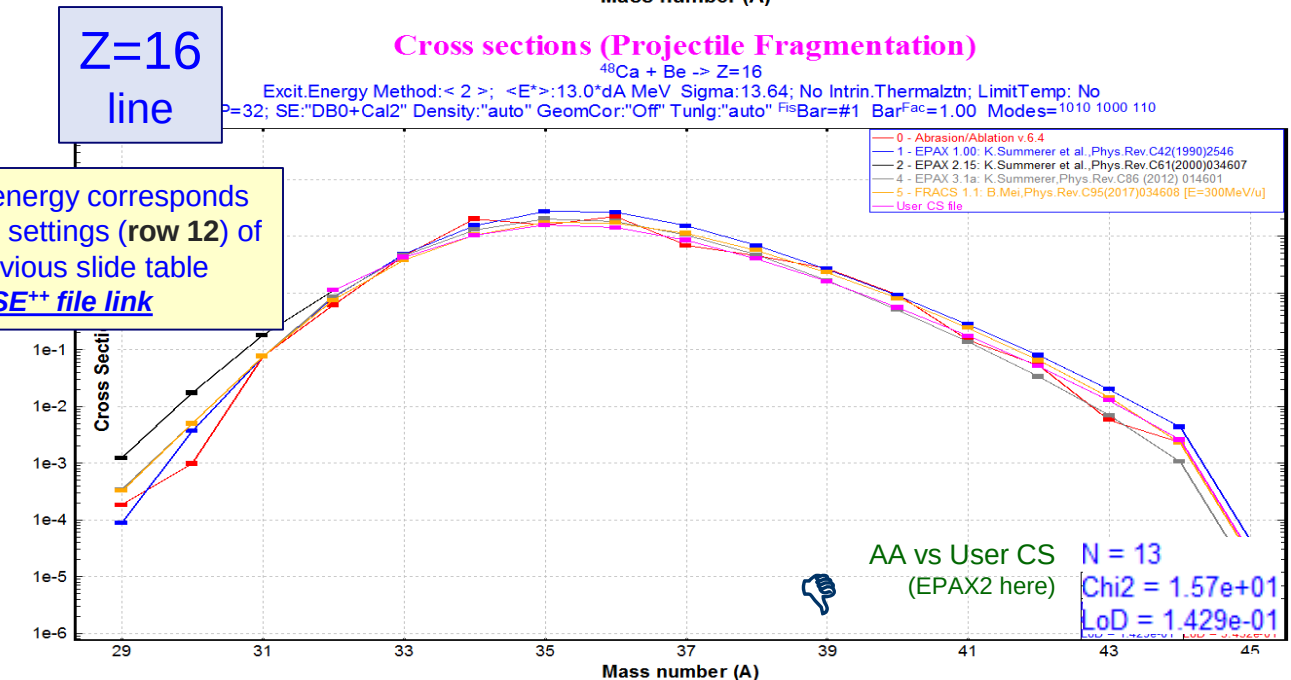


N=28 line



Excitation energy corresponds to **N28_p4** settings (**row 12**) of the previous slide table
LISE++ file link

Z=16 line



Next steps

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