TEN STEPS TO HEAVEN

1. From root to mama matrix
2. Inspecting the alfna raw-matrix
3. Unfold the alfna matrix
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7. D2rho
8. Counting
9. Running root to display output from counting
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An overview (MG1_OsloMeth_MSU2015.pptx)

****

57Fe(p,p')
Cec's experiment March 2 - 12, 2012
Oslo method software version: Oct 23, 2015
****

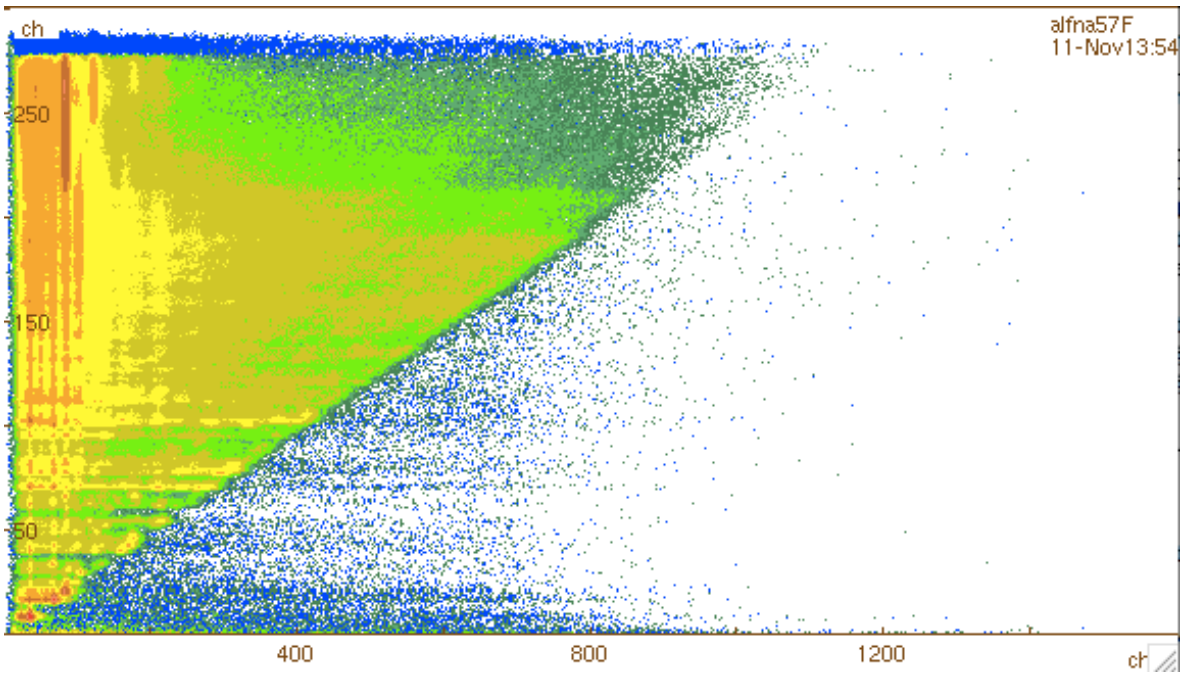
The mama matrix is called alfna57Fe.m (14.8 million counts)

1. From root matrix to mama matrix

```
BE SURE THAT th22mama.C IS IN YOUR DIRECTORY!

magneg@1x-193-157-207-146.uio.no:test>root -l
offline_57Fe_widetimegate.root
root [0]
Attaching file offline_57Fe_widetimegate.root as _file0...
root [1] .ls
TFile**      offline_57Fe_widetimegate.root
 TFile*      offline_57Fe_widetimegate.root
  KEY: TH1I  h_de_n;1 #DeltaE multiplicity
….
  KEY: TH2F  m_alflabr_bg;1   E(LaBr) : E_{x} background
  KEY: TH2F  m_alfna;1    E(NaI) : E_{x}
  KEY: TH2F  m_alfna_bg;1 E(NaI) : E_{x} background
….
  KEY: TH2F  m_siri_e_t_b7;1  t(NaI) : E(Si) detector 7
root [2] .x th22mama.C+ (m_alfna,"alfna57Fe.m")
Info in <TMacOSXSystem::ACLiC>: creating shared library /Users/
magneg/Desktop/test/./th22mama_C.so
matrix is 1600x500; comment='none'
root [3] .q
magneg@1x-193-157-207-146.uio.no:test>
```

2. Inspecting the alfna raw-matrix (MG_TriangelCuts_MSU2015.pptx)

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>mama

 _____________________________________________________
|                                                     |
|              Welcome to M A M A  7.4.1              |
|                                                     |
|   MAtrix MAnipulation, Oslo Cyclotron Laboratory    |
|           Magne Guttormsen, November 2002           |
|                                                     |
|   MAMA handles 2 matrices of dimension 4096x2048    |
|       and 2 singles spectra of length 8192          |
|                                                     |
| Imortant commands:                                  |
|  HE - help            ST - stop MAMA                |
|  RE - read file       WR - write file               |
|  DS - display spec.   CR - curser, activate spec.   |
|  HE NW - news                                       |
|_____________________________________________________|
mama>re
Destination spectrum <1>:
Filename          <TEST>:alfna57Fe.m
 FILE=Disk
 KIND=Matrix
 LABORATORY=Oslo Cyclotron Laboratory (OCL)
 EXPERIMENT=siri2root
 COMMENT=57Fe(p,p')
 TIME=2013-10-30 13:57:42
 CALIBRATION EkeV=6, 0.000000E+00, 1.000000E+01, 0.000000E+00,
0.000000E+00, 4.000000E+01, 0.000000E+00
 PRECISION=16
 DIMENSION=2,0:1599,0: 499
 CHANNEL=(0:1599,0: 499)
..........
mama>ds 2
..
```



Remove left-over of elastic peak

```
mama>ex
 Click two times for proper markers in matrix
mama>cr
Type X or click on green button to exit
x=   81, energy =    810.000 keV
y=    1, energy =     40.000 keV
Number of counts=  0.350000E+02
x=   81, energy =    810.000 keV
y=    0, energy =      0.000 keV
Number of counts=  0.567000E+03
mama>pc
Destination spectrum <1>:

Lower marker on x-axis <    0>:
Higher marker on x-axis< 4095>:

Lower marker on y-axis <    0>:
Higher marker on y-axis< 2047>:3

Type constant < 0.>:
mama>ds 2
..
```

Remove negative counts by filling from neighbours (fn)

```
mama>fn
Destination spectrum <2>:
Source spectrum      <1>:

Dimension along x-axis <1600>:
Dimension along y-axis < 500>:

Lowest and highest counts are (min,max) = (-0.13E+04 0.28E+05)
You may now delete the most negative numbers before filling
```

```
Do you want to delete these negative counts     <n>:y
Counts < Limit will be deleted, Limit = <-0.28E+04>:-50

Write FWHMx (ch) around ch x=  160 <   9.2>:
Write FWHMx (ch) around ch x= 1440 <   3.7>:

Write FWHMy (ch) around ch y=   50 <   1.0>:
Write FWHMy (ch) around ch y=  450 <   1.0>:
 FWHM have been expressed by A + B * SQRT(ch):
Ax= 11.9314  Bx= -0.2168     Ay=  1.0000 By= -0.0000
Probability-matrix around (x,y)=( 160,  50):

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0040.0060.0090.0110.0140.0160.0170.0180.0170.0160.0140.0110.0090.0
060.004

0.0150.0210.0290.0380.0470.0550.0600.0610.0600.0550.0470.0380.0290.0
210.015

0.0040.0060.0090.0110.0140.0160.0170.0180.0170.0160.0140.0110.0090.0
060.004

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

 Probability-matrix around (x,y)=(1440, 450):

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0030.0100.0220.0350.0410.0350.0220.0100.0030.0000.0
000.000

0.0000.0000.0030.0120.0350.0760.1210.1410.1210.0760.0350.0120.0030.0
```

```
000.000

0.0000.0000.0000.0030.0100.0220.0350.0410.0350.0220.0100.0030.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

0.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0000.0
000.000

Probability-matrix OK? (y/n) <y>:
.................................................
Before number of neg. ch. was:  19252, with total counts:   -184369
After  number of neg. ch. is:    5119, with total counts:    -30845
mama>ds
```

Brutally remove negative counts (rn)

```
mama>rn
Destination spectrum <1>:
Source spectrum      <2>:

 With this command you may replace the counts in the
 spectrum/matrix with a given value. The options are:
 Replace counts if they are below a certain value, or,
 if the counts are in-between two values, or if the
 counts exceed a certain value. The defaults are:
 Choose (1), replace-value = 0 and Max = 0 which will
 delete all negative numbers.
 You may also change floating point values -> integers.
 ---------------------------------------------------
       Counts < Max is replaced..... choose: (1)
 Min < Counts < Max is replaced..... choose: (2)
 Min < Counts       is replaced..... choose: (3)
 Replace floating counts by integers..... choose: (4)
 Return to MAMA..................... choose: (5)
 ---------------------------------------------------
 Choose your option                          <1>:

Give new value for the counts to be replaced <  0.00>:
Delete counts with value lower than          <  0.00>:

Number of channels replaced:          5119
Number of counts before:        14880127.0
Number of counts after:         14910972.0
Increase of counts:                30845.0
mama>ds2
```

Make response matrix (rm)

```
mama>rm
Dimension of response-matrix <1600>:
```

```
Cal. coeff. a0 (keV)     <     0.0>:
Cal. coeff. a1 (keV/ch)  <    10.0>:

 List of response functions. The ones marked old, are not
recommended
 (1) NaI_old,    CACTUS 5x5 inch before 2012
 (2) LaBr_2012,  Campaign 4x8 inch LaBr from Milano in CACTUS frame
 (3) NaI_2012,   CACTUS 5x5 inch after 2012
 (4) Seg2,       SuN at MSU 2014, with target inside  (2 cm?),
GEANT4
 (5) Seg3,       SuN at MSU 2014, with target outside (2 cm?),
GEANT4
 (6) Clover_old, Notre Dame 2015, GEANT4
 (7) Clover,     Notre Dame 2015, GEANT4
 (8) Seg23,      SuN at MSU 2015 with target in center, GEANT4
 (9) Gaussian

Choose your response function <3>:

 If you are unfolding/folding a gamma-ray matrix or spectrum,
 you should create response functions with 10 times less FWHM
 than experimentally known. Then FWHM(response) = FWHM(real)/10,
 which is optimal for the unfolding (UN) and folding (FO)
procedures.
 If you just want to view the response matrix with command GR,
 then use a factor = 1. Then FWHM(response) = FWHM(real).

Respons functions for unfolding/folding (10.) or viewing (1.)
<10.0>:
Real experimental relative FWHM value at Egam=1.33 MeV (%)<  6.8>:

(In the calculation the response function is obtained
with a FWHM value of (1/10.0)*(the real experimental FWHM)
due to technical reasons in the unfolding procedure)
.....................................................
 Parameters for response function written to resp.dat
```

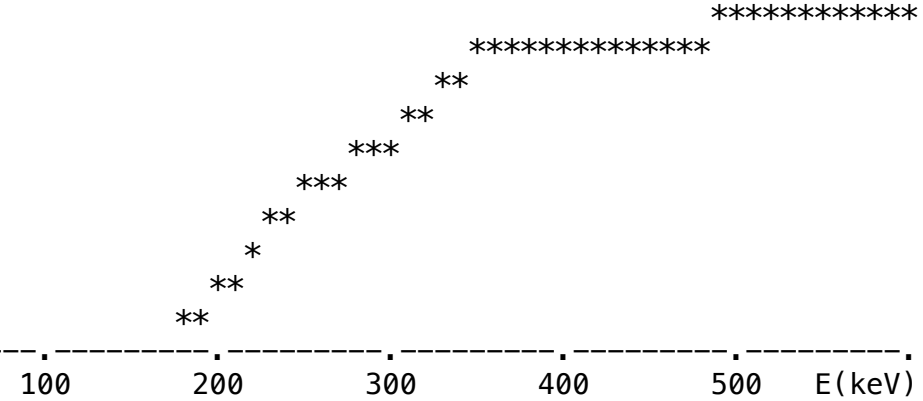
Find the diagonal Ex=Eg

```
mama>cr
Type X or click on green button to exit
x=  104, energy =   1040.000 keV
y=   14, energy =    560.000 keV
Number of counts=  0.000000E+00
x=  788, energy =   7880.000 keV
y=  185, energy =   7400.000 keV
Number of counts=  0.000000E+00
```

3. Unfold the alfna matrix (MG_Unfolding_MSU2015.pptx)

```
mama>un
Destination spectrum <2>:
Source spectrum      <1>:
```

```
New (0) or old (1) unfolding procedure <0>:

Dimension along x-axis <1600>:
Dimension along y-axis < 500>:
 Give upper limits for the unfolding. The boarder is
 given by interpolation between (x1,y1) and (x2,y2)

     (x2,y2) second point
 xxxxxxx
 xxxxxxxxx
 xxxxxxxxxxx
 xx matrix xxx
 xxxxxxxxxxxxxxx
              (x1,y1) first point


First point x1  < 1599>:104
First point y1  <    0>:14
Second point x2 < 1599>:788
Second point y2 <  499>:185
  Give limits for the chisquare-test:
  Opt. 1: Recommended for LaBr- and NaI-spectra. For full-
          energy gammas above 2 MeV, we set lower limit at 500 keV.
           Below, the limit is 1/4 of the full-energy. Remember,
          full-energy is taken from the upper unfolding limit
  Opt. 2: A fixed lower limit for the chi-test is applied
  Opt. 3: Return and set proper upper limits for unfolding


Option (1/2/3)                  <1>:

Include total detector efficiency (y/n) <y>:

 The efficiency at low energy (< 1000 keV) have to be given.
 It depends on various experimental conditions as thresholds
 on ADCs, gamma-absorber (2 mm Cu), timing etc. The program
 always assumes Eff = 0.0 at Egam < 30 keV and Eff = 1.00 at
 Egam > 1000 keV. However, in between these energies you can
 define a new shape of the discrimination.
```



```
Do you want to change the discriminator threshold <n>:n

Number of iterations ( <200 )  <33>:

 The iteration is terminated when the folding of
 the unfolded spectrum equals the raw spectrum. It
 is however recommended to stop before the Chi2 is
 at minimum. Thus, you can put a certain weight on
 the importance not to have too strong fluctuations
 in the final spectrum. We recommend a weight-factor
 of 0.2 (valid range is 0.0 - 0.5)

Weight on fluctuations <0.2>:
 Row:   0  Mode: n  Area:        0(        0)  Chi:   0.00  Fluct:
1.00
 Row:   1  Mode: n  Area:        0(        0)  Chi:   0.00  Fluct:
1.00
 Row:   2  Mode: n  Area:        0(        0)  Chi:   0.00  Fluct:
1.00
 Row:   3  Mode: n  Area:        0(        0)  Chi:   0.00  Fluct:
1.00
 Row:   4  Mode: d  Area:      698(      726)  Chi:   0.00  Fluct:
1.34
 Row:   5  Mode: d  Area:      327(      358)  Chi:   0.00  Fluct:
1.28
 Row:   6  Mode: d  Area:     3008(     3022)  Chi:   0.00  Fluct:
2.34
 Row:   7  Mode: d  Area:    44128(    44132)  Chi:   0.00  Fluct:
18.22
 Row:   8  Mode: r  Area:   150364(   150369)  Chi:   0.00  Fluct:
70.54
 Row:   9  Mode: d  Area:   149663(   149667)  Chi:   0.00  Fluct:
1.44..
..
 Row: 263  Mode: d  Area:    71032(    71450)  Chi:   0.16  Fluct:
7.18
 Row: 264  Mode: d  Area:    69731(    70153)  Chi:   0.15  Fluct:
6.92
 Row: 265  Mode: d  Area:    67453(    67873)  Chi:   0.15  Fluct:
6.77
 Row: 266  Mode: d  Area:    65708(    66135)  Chi:   0.15  Fluct:
7.91
 Row: 267  Mode: d  Area:    62981(    63382)  Chi:   0.12  Fluct:
6.84
 Row: 268  Mode: d  Area:    60410(    60846)  Chi:   0.13  Fluct:
7.49
 Row: 269  Mode: d  Area:    56827(    57253)  Chi:   0.14  Fluct:
7.25
 Row: 270  Mode: d  Area:    55004(    55413)  Chi:   0.11  Fluct:
7.08
 Row: 271  Mode: d  Area:    52369(    52793)  Chi:   0.11  Fluct:
7.36
 Row: 272  Mode: d  Area:    51231(    51642)  Chi:   0.11  Fluct:
7.54
```

```
 Row: 273  Mode: d  Area:    49808(    50224)  Chi:   0.11  Fluct:
6.57
 Row: 274  Mode: d  Area:    46998(    47422)  Chi:   0.09  Fluct:
7.49
 Row: 275  Mode: d  Area:    41562(    41975)  Chi:   0.07  Fluct:
6.38
 Row: 276  Mode: d  Area:    32283(    32723)  Chi:   0.04  Fluct:
5.65
 Row: 277  Mode: d  Area:    18641(    19038)  Chi:   0.02  Fluct:
2.36
 Row: 278  Mode: d  Area:     3754(     4013)  Chi:   0.01  Fluct:
1.50
 Row: 279  Mode: d  Area:        0(        3)  Chi:   0.00  Fluct:
1.01
..
 Row: 499  Mode: n  Area:        0(        0)  Chi:   0.00  Fluct:
1.00
 Calibration is a0=   0.0keV, a1=  10.00keV/ch
```

Fill and remove negative counts (fn, rn)

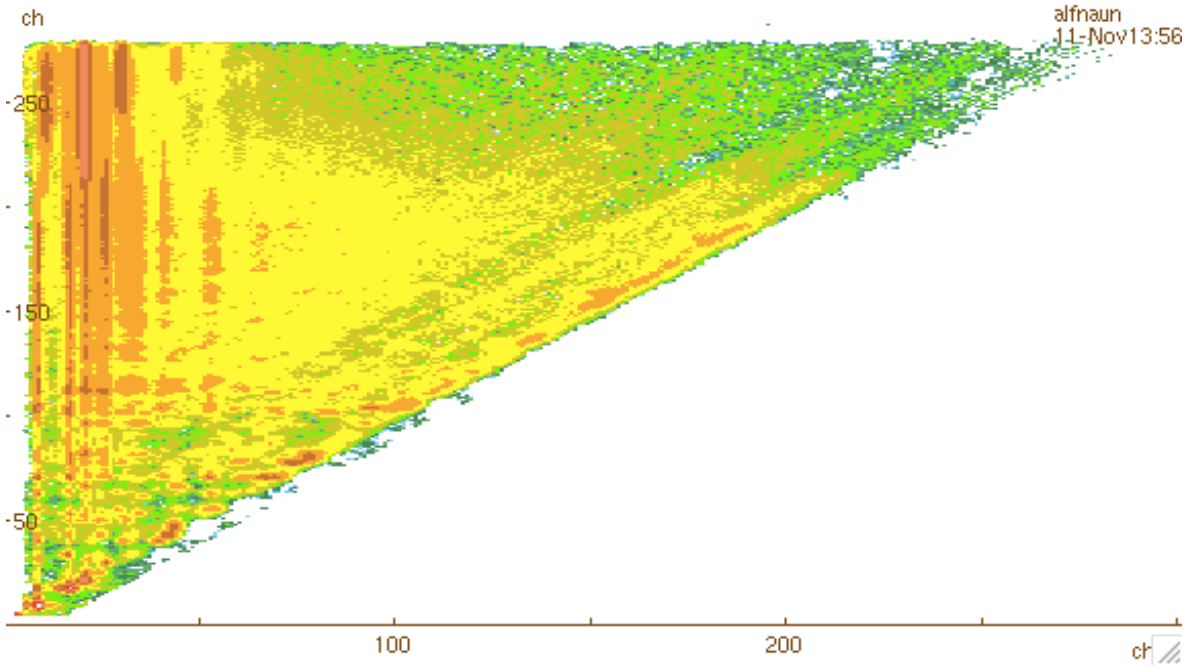
```
..
..
```

Compress matrix (co)

```
mama>co
Destination spectrum <1>:
Source spectrum      <2>:
 Compression factors must be integer. With a factor
 of e.g. 3, channels 0,1,2,3 goes to 0,0,0,1

Compression along x-axis <  1>:4
Compression along y-axis <  1>:
.....................................................................
New dimension (0: 399,0: 499)
```

Make a partition (pa)

```
mama>ds
mama>pa
Destination spectrum <2>:
Source spectrum      <1>:

Lower marker on x-axis   <    0>:
Higher marker on x-axis  <  399>:300

Lower marker on y-axis   <    0>:
Higher marker on y-axis  <  499>:300
New dimension (0: 300,0: 300)
mama>ds2
```



Write unfolded matrix to disk

```
mama>wr

Spectrum to write            <2>:
Singles spectrum               1
Set of spectra NA-0, NA-1,...  2
2-dimensional spectrum (matrix) 3
Please, choose your type     <3>:

Cal. coeff. a0 (keV) on x-axis     <       15.0>:
Cal. coeff. a1 (keV/ch) on x-axis  <     40.000>:
Cal. coeff. a2 (keV/ch2) on x-axis < 0.0000E+00>:

Cal. coeff. a0 (keV) on y-axis     <        0.0>:
Cal. coeff. a1 (keV/ch) on y-axis  <     40.000>:
Cal. coeff. a2 (keV/ch2) on y-axis < 0.0000E+00>:

Dimension on x-axis (max=4096) < 301>:
Dimension on y-axis (max=2048)  < 301>:
Filename                        <TEST>:alfnaun
```

4. First generation gammas (MG2_OsloMeth_MSU2015.pptx)

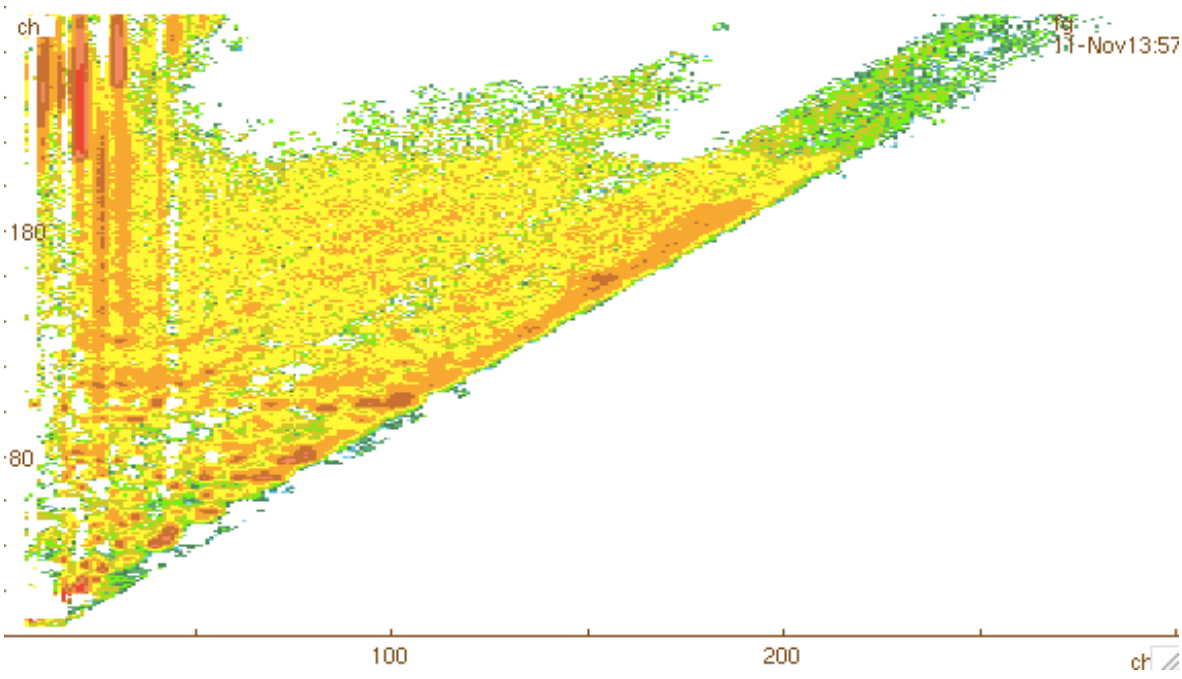
```
mama>fg
 The original gamma-matrix should be stored in
 the source matrix and the extracted 1.gen. matrix
 will appear in the destination spectrum. The last
 weighting functions used can be accessed from the
 response matrix using the command GR

Destination spectrum <1>:
Source spectrum      <2>:
```

```
Calibration for gamma-energies:
Cal. coeff. a0 (keV) on x-axis   <    15.0>:
Cal. coeff. a1 (keV/ch) on x-axis<    40.0>:

Calibration for excitation energies:
Cal. coeff. a0 (keV) on y-axis   <     0.0>:
Cal. coeff. a1 (keV/ch) on y-axis<    40.0>:

Excitation energy of highest gate (keV)  < 12000.0>:11000

Normalization: singles(1) or multiplicity(2)    <2>:
Multiplicity:  statistical(1) or total(2)       <1>:2
Area correction for 1. gen. spectra (y/n)       <y>:
Experimental lower gamma thresholds (keV)  <  200.>:300
Upper threshold for nonstat. gammas (keV)  <  430.>:300
Average entry point in ground band (keV)   <    0.>:

It is recommended to use a sliding upper threshold when the
excitation energy is lower than 1 - 2 MeV. This is performed
by defining a ratio R, giving Thres=Ex*R with a lower and
higher limit of 300. and 300. keV. Use R = 0.2 - 0.3.

Give ratio R           (no sliding = 100.) <  0.30>:

First geneneration spectra extracted for
excitation energies between 11000.-    0. keV
corresponding to y-channels   275 -    0

You may read weighting functions from disk
Weighting by exp. 1. gen. spectra (y/n)         <n>:

Assumes Fermi gas distribution
Level density parameter a (1/MeV)           <16.00>:6
Exponent n for Eg**n                        < 4.20>:

 Multiplicity in each gate:
 ----------------------------------
 Y-ch= 275 Ex= 11000.0 keV < 9.130>:
 Y-ch= 274 Ex= 10960.0 keV < 8.673>:
 Y-ch= 273 Ex= 10920.0 keV < 8.658>:
..
 Y-ch=  85 Ex=  3400.0 keV < 1.931>:
 Y-ch=  84 Ex=  3360.0 keV < 1.968>:
 Y-ch=  83 Ex=  3320.0 keV < 1.927>:
 Y-ch=  82 Ex=  3280.0 keV < 1.903>:
 Y-ch=  81 Ex=  3240.0 keV < 1.834>:
 Y-ch=  80 Ex=  3200.0 keV < 1.630>:
 Y-ch=  79 Ex=  3160.0 keV < 1.512>:
 Y-ch=  78 Ex=  3120.0 keV < 1.538>:
 Y-ch=  77 Ex=  3080.0 keV < 1.527>:
 Y-ch=  76 Ex=  3040.0 keV < 1.517>:
 Y-ch=  75 Ex=  3000.0 keV < 1.823>:
 Y-ch=  74 Ex=  2960.0 keV < 1.936>:
```

```
 Y-ch=  73 Ex=  2920.0 keV < 1.815>:
 Y-ch=  72 Ex=  2880.0 keV < 1.775>:
..
 Y-ch=   5 Ex=   200.0 keV < 0.458>:
 Y-ch=   4 Ex=   160.0 keV < 0.355>:
 Y-ch=   3 Ex=   120.0 keV < 0.000>:
 Y-ch=   2 Ex=    80.0 keV < 0.000>:
 Y-ch=   1 Ex=    40.0 keV < 0.000>:
 Y-ch=   0 Ex=     0.0 keV < 0.000>:

 ---------------------------------- ---------------------------------
.....

Y-ch=   1  Ex=     40.  Area=         0.0  Alpha=   1.00  dA/A(%)=
9999.99
Y-ch=   0  Ex=      0.  Area=         0.0  Alpha=   1.00  dA/A(%)=
9999.99
-----------------------------------------------

Iteration loop = 20, stop(0), activate/modify direct decay(1) or
continue(2)  <2>:0
Last iteration 20 stored in matrix 1
Additional results written to figegaout.dat

mama>ds2
```

Fill and remove negative counts (fn, rn)

```
..
..

mama>ds2
```



Write first-generation matrix to disk

```
mama>wr
```

```
Spectrum to write            <1>:
Singles spectrum               1
Set of spectra NA-0, NA-1,...  2
2-dimensional spectrum (matrix) 3
Please, choose your type     <3>:

Cal. coeff. a0 (keV) on x-axis     <       15.0>:
Cal. coeff. a1 (keV/ch) on x-axis  <     40.000>:
Cal. coeff. a2 (keV/ch2) on x-axis < 0.0000E+00>:

Cal. coeff. a0 (keV) on y-axis     <        0.0>:
Cal. coeff. a1 (keV/ch) on y-axis  <     40.000>:
Cal. coeff. a2 (keV/ch2) on y-axis < 0.0000E+00>:

Dimension on x-axis (max=4096) < 301>:
Dimension on y-axis (max=2048)  < 301>:
Filename                       <TEST>:fg
```

Stop mama (st)

```
mama>st
Are you sure you want to exit? (y/n)y


*************
Try to get away vertical white line in fg
Read in alfnaun
Locate the bad guy
Eliminate the bad guy

mama>ex
 Click two times for proper markers in matrix
mama>cr
Type X or click on green button to exit
x=   42, energy =   1695.000 keV
y=   64, energy =   2560.000 keV
Number of counts=  0.561851E+02
x=   47, energy =   1895.000 keV
y=   68, energy =   2720.000 keV
Number of counts=  0.459987E+02

mama>rd
 Give coordinates for the corners of the rektangel
 that defines the background of the 2-dim peak

     (x1,y2)-----------(x2,y2)
         |      xxx       |
         |      xxx       |
         |   xxxxxxxxxx   |
         |  xxxxxxxxxxx   |
         |  xxxxxxxxxxx   |
         |   xxxxxxxxxx   |
         |      xxxx      |
     (x1,y1)-----------(x2,y1)
```

```
Give x1 < 100>:42
Give x2 < 120>:47
Give y1 < 200>:64
Give y2 < 230>:68
 We need a region on y-axis where the shape of the gamma-peak can be
determined
 Give lower (L1) and higher (L2) channel on y-axis

     (x1,y2)-----------(x2,y2)
         |      xxx       |
         |      xxx       |
     L2  |   xxxxxxxxxx   |
         |  xxxxxxxxxxxx  |
         |  xxxxxxxxxxxx  |
     L1  |   xxxxxxxxxx   |
         |      xxxx      |
     (x1,y1)-----------(x2,y1)


Give L1 <  65>:
Give L2 <  67>:
mama>ds
mama>ds 2

Run fg again
Call the first generation spectrum fgrd
Now ready for rhosigchi
************
```

5. Rhosigchi

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>rhosigchi
 _____________________________________________
|                                             |
|         R H O S I G C H I  1.5.1            |
|                                             |
|  Program to calculate level density         |
| Rho, and gamma strength function Sig        |
| from first-generation spectra, using        |
|   FgNorm(Ex,Eg)=Rho(Ex-Eg)*Sig(Eg)          |
|                                             |
|      Oslo Cyclotron Laboratory              |
|                                             |
|        Created: 13/08 - 1999                |
|           Andreas Schiller                  |
|  Lisbeth Bergholt, Magne Guttormsen         |
|                                             |
|        Improved: 01/05 - 2003               |
|           Alexander Voinov                  |
|  Magne Guttormsen, Andreas Schiller         |
|        Dubna, Oslo, Livermore               |
```

```
 |  Modified 28 Mar 2014: Ex < 0 MeV      |
 |  Modified 13 Feb 2015: One ch shift,   |
 |  ch ig < 0, cut igmax                  |
 |  Modified 31 Aug 2015: No normalization|
 |________________________________________|
 Please, answer 1 and the name of your input first-
 generation matrix in the two next questions...
Destination spectrum <1>:
Filename          <TEST>:fgrd
 FILE=Disk
 KIND=Spectrum
 LABORATORY=Oslo Cyclotron Laboratory (OCL)
 EXPERIMENT=mama
 COMMENT=C:FN:RN:UN:FN:RN:CO:4-1PA:0-300,0-300|
RE:alfnaunRD:FG:FN:RN:
 TIME=DATE:11-Nov-15 11:32:31[
 CALIBRATION EkeV=6, 0.150000E+02, 0.400000E+02, 0.000000E+00,
0.000000E+00, 0.400000E+02, 0.000000E+00
 PRECISION=16
 DIMENSION=2,0: 300,0: 300
 CHANNEL=(0: 300,0: 300)
......
Lower limit of gamma energy (keV)      < 1800.0>:
Lower limit of excitation energy (keV) < 4560.0>:
Upper limit of excitation energy (keV) < 8520.0>:7646
 Number of data points        1034
 DOF, data points - rho - sig         954
Common calibration is a0=-840.00keV and a1= 120.00keV/ch
Dimension is 102 x  72
excitation energy region is  4560.keV to   7680.keV
rho extracted from  -840.keV to   5880.keV
sig extracted from  1800.keV to  11280.keV
 ____________________________________________________________
        Convergence test using various indicators
Indicator Iteration = 0    10    20    30    40    50
Rho/Rho0 at  U=1200.  1.00  0.96  0.98  0.98  0.97  0.97
Rho/Rho0 at  U=3360.  1.00  1.23  1.21  1.19  1.16  1.16
Rho/Rho0 at  U=5520.  1.00  0.37  0.38  0.41  0.42  0.42
Sig/Sig0 at Eg=3360.  1.00  0.84  0.83  0.82  0.82  0.82
Sig/Sig0 at Eg=5520.  1.00  0.82  0.82  0.81  0.80  0.80
Chi^2 for 1.gen.sp.  24.98  3.11  2.81  2.73  2.70  2.70
 ____________________________________________________________

 ch   Ex(keV)     Rho(1/MeV)  dRho(1/MeV) (UNNORMALIZED)
    0  -840.0     0.000E+00   0.000E+00
    1  -720.0     0.000E+00   0.000E+00
    2  -600.0     0.000E+00   0.000E+00
    3  -480.0     0.000E+00   0.000E+00
    4  -360.0     0.872E-01   0.000E+00
    5  -240.0     0.140E+00   0.202E-01
    6  -120.0     0.109E+01   0.346E-01
    7     0.0     0.240E+01   0.413E-01
    8   120.0     0.237E+01   0.336E-01
    9   240.0     0.162E+01   0.310E-01
```

```
   10   360.0     0.125E+01   0.335E-01
   11   480.0     0.831E+00   0.277E-01
   12   600.0     0.827E+00   0.295E-01
   13   720.0     0.107E+01   0.309E-01
   14   840.0     0.845E+00   0.313E-01
   15   960.0     0.872E+00   0.308E-01
..
   49  5040.0     0.646E+00   0.967E-01
   50  5160.0     0.624E+00   0.885E-01
   51  5280.0     0.521E+00   0.841E-01
   52  5400.0     0.426E+00   0.744E-01
   53  5520.0     0.422E+00   0.889E-01
   54  5640.0     0.464E+00   0.814E-01
   55  5760.0     0.416E+00   0.107E+00
   56  5880.0     0.556E+00   0.191E+00

 ch   Eg(keV)         Sig        dSig (UNNORMALIZED)
   22  1800.0     0.579E+00   0.318E-01
   23  1920.0     0.665E+00   0.327E-01
   24  2040.0     0.638E+00   0.331E-01
   25  2160.0     0.658E+00   0.302E-01
   26  2280.0     0.573E+00   0.302E-01
   27  2400.0     0.463E+00   0.254E-01
..
   60  6360.0     0.555E+00   0.749E-01
   61  6480.0     0.566E+00   0.779E-01
   62  6600.0     0.575E+00   0.794E-01
   63  6720.0     0.574E+00   0.828E-01
   64  6840.0     0.601E+00   0.871E-01
   65  6960.0     0.579E+00   0.924E-01
   66  7080.0     0.707E+00   0.108E+00
   67  7200.0     0.638E+00   0.962E-01
   68  7320.0     0.514E+00   0.804E-01
   69  7440.0     0.482E+00   0.769E-01
   70  7560.0     0.491E+00   0.813E-01
   71  7680.0     0.361E+00   0.734E-01
   72  7800.0     0.000E+00   0.000E+00
   73  7920.0     0.000E+00   0.000E+00
   74  8040.0     0.000E+00   0.000E+00
Observed first generation matrix written to file:     fg.rsg
Estimated first gen. err. matrix written to file:  fgerr.rsg
Theoret. first generation matrix written to file:  fgteo.rsg
Unnormalized Rho and dRho written to array file:  rhopaw.rsg
Unnormalized T and dT     written to array file:  sigpaw.rsg
Unnormalized Rho and dRho written to mama file:    rhosp.rsg
Unnormalized T and dT     written to mama file:    sigsp.rsg
```

6. Robin

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>robin
     ___________________________________________
    |                                           |
    |                 ROBIN 1.7                 |
```

```
    |                                          |
    |  Program to calculate the level density  |
    |         and spin cut-off parameter       |
    |       at Rho(Bn) for a nucleus with      |
    | given proton number Z and mass number A. |
    |       See T. Egidy and Bucurescu:        |
    |                                          |
    |    (E&B2009): PRC 80, 054310 (2009)      |
    |                                          |
    |    (E&B2006): PRC 72, 044311 (2005) and  |
    |               PRC 73, 049901 (E) (2006)  |
    |                                          |
    |        Oslo Cyclotron Laboratory         |
    |             Magne Guttormsen             |
    |            Created: 13 Jun 2005          |
    |           Modified: 14 Sep 2012          |
    |           Modified: 25 Mar 2013          |
    |__________________________________________|

 Reading file /Applications/prog/lib/egidy03/mass.mas03
 Number of nuclei read is        3179  with last (A,Z) =
(         293 ,         118 )
 Reading file /Applications/prog/lib/egidy03/rct2.mas03
 Number of nuclei read is        3179  with last (A,Z) =
(         293 ,         118 )
 Reading file /Applications/prog/lib/egidy03/rct7.mas03
 Number of nuclei read is        3179  with last (A,Z) =
(         293 ,         118 )

 Please, check that the same number of nuclei is read.
 (If not, mismatch of values will give wrong results.)

Give proton number of the nucleus < 26>:
Give mass number of the nucleus   < 57>:

 You should take care to use formulas from the same reference.
 Example: If you use rigid moment of inertia from (E&B2006),
 you should also use temperature T from (E&B2006), as well.
 We recommend to use (E&B2006) (or maybe the old (G&C)) for nuclei
heavier than A > 150,
 and (E&B2009) for lighter nuclei with A < 150.

 You may choose between 4 spin cut-off formulas:
 1 The rigid moment of inertia formula (RMI)(E&B2006)
 2 The Gilbert and Cameron formula (G&C) Can. J. Phys 43(1965) 1446
 3 The constant temperature (CT) formula (E&B2009) and NPA 481
(1988) 189
 4 The Fermi gas formula with appropriate cut-off parameter
(E&B2009)
 Type 1 for RMI: sig**2=0.0146*(A**(5/3))*T for FG (E&B2006)
 Type 2 for G&C: sig**2=0.0888*(A**(2/3))*a*T for FG
 Type 3 for E&B: sig**2=(0.98*(A**(0.29)))**2 for CT
 Type 4 for E&B: sig**2=0.391*A**0.675*(E-0.5*Pa_prime)**0.312 for
FG
```

```
Choose RMI(FG) (1), G&C(FG) (2), E&B(CT) (3) or E&B(FG) (4)  <4>:

 You may choose another a and/or E1 than proposed by E&B:
Level density parameter a    <  6.296>:
Total backshift parameter E1 < -0.276>:

Shell values            : S=     -1.294 MeV,   dS/dA= -0.083 MeV
Pairing energies        : P_n=    1.487 MeV,   P_p=    1.268 MeV,
P_d=  -0.211 MeV, Pa_prime=   0.211 MeV
Binding energies        : B_n=    7.646 MeV,   B_p=   10.559 MeV
Fermi gas parameters    : a=      6.296 1/MeV, E1=    -0.276 MeV
Spin cut-off parameters : sig_n=  3.354        sig_p=  3.529
Level densities         : rho_n= 0.11366E+04 1/MeV, rho_p= 0.80035E
+04 1/MeV
Calculate rho and sigma at Ex (MeV)  <  7.646>:
For Ex =  7.646 MeV     : rho  = 0.11366E+04 1/MeV, sig =  3.354
Write file with spin distribution for spin cut-off sig = <  3.834>:

File spindis.rbn written with <I> = 4.33, Pmax @ I = 3.5 and sum_P
=0.994
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>
```

7. D2rho

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>d2rho

 _____________________________________________________________________
|                                                                     |
|                          D2RHO 1.1.3                                |
|                                                                     |
|   Program to calculate level density from level spacing D    |
|  at Bn, Bp or Ex. The resonance capture levels are formed by |
|           neutron or proton s (l=0) or p-waves (l=1)         |
|            (based on neutron.f by Andreas Schiller)          |
|                                                                     |
|  Input files: (input.d2r)          Output files: input.d2r   |
|                                                                     |
| E-mail  : magne.guttormsen@fys.uio.no                               |
| Created : 15 Dec 2006                                               |
| Modified: 17 Mar 2007                                               |
| Modified: 05 Nov 2012                                               |
|_____________________________________________________________________|

 The spin cut-off parameter sigma can be found in two ways (A) or
(B).
 For the uncertainty, use about 10 percent of sigma

 (A) The easiest and recommended way:
 Run the ROBIN program and find sigma (use option 4)

 (B) Very old, but values are a sort of standards:
 Take Tables I or II (pages 1448-1450) from the article:
 A. Gilbert, A.G.W. Cameron, Can. Jour. Phys. 43(1965)1446
```

```
 Note: Take the row on the left side with target nucleus A-1
 in the neutron capture. This is one less mass number
 than the nucleus (A) that you investigate. If the nucleus
 is not listed there, find another reference...

s- (l=0) or p- (l=1) wave neutron/proton capture
<0>:
Target spin in (n,g) or (p,g) reaction (for the A-1 nucleus)     <
0.0>:
Neutron or proton resonance spacing parameter D (eV)        <
25400.00>:
Standard deviation for resonance spacing parameter dD (eV)  <
1700.00>:2200
Spin cut-off parameter sigma                                <
3.35>:
Standard deviation of spin cut-off parameter sigma          <
0.33>:

Spin populated in nucleus A:  1/2. Parity = parity of gs of nucleus
A-1
Level density is rho = 9.260E+02 +/- 1.917E+02 1/MeV
(This level density is the total density defined as
twice the level density obtained for one parity, where we
asssume equal number of positive and negative parity states.
If you know D's for l=0 and l=1, the total level density is
rho(total) = 0.5*rho(l=0) + 0.5*rho(l=1))
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>
```

8. Counting

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>counting

 _____________________________________________________________________
|                                                                     |
|                    C O U N T I N G   1.7.2                          |
|                                                                     |
|Program to normalize experimental nuclear level density (NLD)       |
|  to NLD from known low energy levels and NLD extracted from         |
|     resonances spacing data at Bn. Thus, the A and alpha            |
|     parameters are determined for NLD. The slope of the             |
|   transmision coefficient T(Eg) is normalized according to          |
|                    the alpha parameter.                             |
|                                                                     |
|  Input files:  counting.dat    Output files: rhopaw.cnt             |
|                rhosp.rsg                     rhotmopaw.cnt         |
|                sigsp.rsg                     sigpaw.cnt            |
|                rhopaw.rsg                    input.cnt             |
|                sigpaw.rsg                    spincut.cnt           |
|               (input.cnt)                    fermigas.cnt          |
|                                              efit.f                |
|                                              counting.cpp          |
|                                              spincut.cpp           |
|                                              sigext.cpp            |
```

```
 |                                                                |
 |  Fermi gas or constant temperatur parameteres are calculated |
 |      from Egidy and Bucurescu: PRC 80, 054310 (2009)          |
 | E-mail  : magne.guttormsen@fys.uio.no                         |
 | Created : 11 Aug 2006                                         |
 | Modified: 17 Jun 2009                                         |
 | Modified: 16 Nov 2014 Ex < 0 MeV, CT output, CT with sig_FG   |
 | Modified: 10 Feb 2015 dimRhox, dimSigx                        |
 | Modified: 01 Jun 2015 allow modifying ExL and ExH of sigext   |
 | Modified: 28 Aug 2015 ? replaced by " for root scripts        |
 | and deleting kumac output files                               |
 |_______________________________________________________________|

Reading calibration and dimensions from: rhosp.rsg
rhosp.rsg has dimension (0 : 71, 0 : 1) and calibration (a0, a1) =
(-840.000000, 120.000000)
Reading calibration and dimensions from: sigsp.rsg
sigsp.rsg has dimension (0 : 101, 0 : 1) and calibration (a0, a1) =
(-840.000000, 120.000000)

Reading data and errors of experimental nuclear level density:
rhopaw.rsg
 No   Ex(keV)      Rho(1/MeV)     dRho(1/MeV)
  0   -840.00       0.000e+00       0.000e+00
  1   -720.00       0.000e+00       0.000e+00
  2   -600.00       0.000e+00       0.000e+00
  3   -480.00       0.000e+00       0.000e+00
  4   -360.00       8.724e-02       0.000e+00
  5   -240.00       1.395e-01       2.021e-02
  6   -120.00       1.095e+00       3.465e-02
  7      0.00       2.397e+00       4.130e-02
  8    120.00       2.367e+00       3.359e-02
  9    240.00       1.622e+00       3.103e-02
 10    360.00       1.253e+00       3.346e-02
 11    480.00       8.307e-01       2.768e-02
 12    600.00       8.271e-01       2.955e-02
 13    720.00       1.070e+00       3.092e-02
 14    840.00       8.452e-01       3.132e-02
 15    960.00       8.722e-01       3.078e-02
..
 50   5160.00       6.243e-01       8.853e-02
 51   5280.00       5.212e-01       8.407e-02
 52   5400.00       4.260e-01       7.442e-02
 53   5520.00       4.215e-01       8.890e-02
 54   5640.00       4.638e-01       8.144e-02
 55   5760.00       4.160e-01       1.068e-01
 56   5880.00       5.559e-01       1.914e-01
 57   6000.00       0.000e+00       0.000e+00
 58   6120.00       0.000e+00       0.000e+00
 59   6240.00       0.000e+00       0.000e+00
 60   6360.00       0.000e+00       0.000e+00
 61   6480.00       0.000e+00       0.000e+00
 62   6600.00       0.000e+00       0.000e+00
 63   6720.00       0.000e+00       0.000e+00
```

```
 64   6840.00       0.000e+00       0.000e+00
 65   6960.00       0.000e+00       0.000e+00
 66   7080.00       0.000e+00       0.000e+00
 67   7200.00       0.000e+00       0.000e+00
 68   7320.00       0.000e+00       0.000e+00
 69   7440.00       0.000e+00       0.000e+00
 70   7560.00       0.000e+00       0.000e+00
 71   7680.00       0.000e+00       0.000e+00

Reading data and errors of experimental transmision coefficient:
sigpaw.rsg
 No   Eg(keV)         Trans           dTrans
  0   -840.00       0.000e+00       0.000e+00
  1   -720.00       0.000e+00       0.000e+00
  2   -600.00       0.000e+00       0.000e+00
  3   -480.00       0.000e+00       0.000e+00
  4   -360.00       0.000e+00       0.000e+00
  5   -240.00       0.000e+00       0.000e+00
  6   -120.00       0.000e+00       0.000e+00
  7      0.00       0.000e+00       0.000e+00
  8    120.00       0.000e+00       0.000e+00
  9    240.00       0.000e+00       0.000e+00
 10    360.00       0.000e+00       0.000e+00
 11    480.00       0.000e+00       0.000e+00
 12    600.00       0.000e+00       0.000e+00
 13    720.00       0.000e+00       0.000e+00
 14    840.00       0.000e+00       0.000e+00
 15    960.00       0.000e+00       0.000e+00
 16   1080.00       0.000e+00       0.000e+00
..
 53   5520.00       4.177e-01       4.659e-02
 54   5640.00       4.324e-01       5.105e-02
 55   5760.00       4.896e-01       6.229e-02
 56   5880.00       5.903e-01       7.386e-02
 57   6000.00       6.964e-01       8.869e-02
 58   6120.00       8.064e-01       1.063e-01
 59   6240.00       6.981e-01       9.723e-02
 60   6360.00       5.550e-01       7.494e-02
 61   6480.00       5.664e-01       7.787e-02
 62   6600.00       5.747e-01       7.944e-02
 63   6720.00       5.737e-01       8.279e-02
 64   6840.00       6.010e-01       8.715e-02
 65   6960.00       5.793e-01       9.241e-02
 66   7080.00       7.074e-01       1.080e-01
 67   7200.00       6.382e-01       9.621e-02
 68   7320.00       5.143e-01       8.040e-02
 69   7440.00       4.819e-01       7.694e-02
 70   7560.00       4.915e-01       8.133e-02
 71   7680.00       3.610e-01       7.342e-02
..
100  11160.00       0.000e+00       0.000e+00
101  11280.00       0.000e+00       0.000e+00

Reading excitation energies of known levels: counting.dat
```

```
Binning 178 known levels:
 No   Ex(keV)   NoLev   RhoLeV(1/MeV)
  0   -840.00       0       0.000e+00
  1   -720.00       0       0.000e+00
  2   -600.00       0       0.000e+00
  3   -480.00       0       0.000e+00
  4   -360.00       0       0.000e+00
  5   -240.00       0       0.000e+00
  6   -120.00       0       0.000e+00
  7      0.00       2       1.667e+01
  8    120.00       1       8.333e+00
  9    240.00       0       0.000e+00
 10    360.00       1       8.333e+00
 11    480.00       0       0.000e+00
 12    600.00       0       0.000e+00
 13    720.00       1       8.333e+00
 14    840.00       0       0.000e+00
 15    960.00       1       8.333e+00
 16   1080.00       1       8.333e+00
..
 60   6360.00       5       4.167e+01
 61   6480.00       3       2.500e+01
 62   6600.00       4       3.333e+01
 63   6720.00       3       2.500e+01
 64   6840.00       0       0.000e+00
 65   6960.00       0       0.000e+00
 66   7080.00       0       0.000e+00
 67   7200.00       0       0.000e+00
 68   7320.00       0       0.000e+00
 69   7440.00       0       0.000e+00
 70   7560.00       0       0.000e+00
 71   7680.00       1       8.333e+00
 72   7800.00       0       0.000e+00
Mass number A             < 57>:
Neutron or proton binding energy (Bn or Bp) (MeV)  < 7.646>:


Choose constant temperature CT (1) or Fermi gas FG (2) formula <1>:


You should take care to use formulas from the same reference.
Example: If you use rigid moment of inertia from (E&B2006),
you should also use temperature T from (E&B2006), as well.
We recommend to use (E&B2006) (or maybe the old (G&C)) for nuclei
heavier than A > 150,
and (E&B2009) for lighter nuclei with A < 150.

If you have chosen the CT formula, we recommend to use FG spin cut-
off formula since
the CT spin cut-off formula is a constant, which is rather
unphysical. In the following,
option (1) might be the most appropriate for the CT-model (instead
of (3)).
```

```
You may choose between 4 spin cut-off formulas:
1 The rigid moment of inertia formula (RMI) (E&B2006)
2 The Gilbert and Cameron formula (G&C) Can. J. Phys 43(1965) 1446
3 The constant temperature (CT) formula (E&B2009) and NPA 481 (1988)
189
4 The Fermi gas formula with appropriate cut-off parameter (E&B2009)
Type 1 for RMI: sig**2=0.0146*(A**(5/3))*T for FG+CT (E&B2006)
Type 2 for G&C: sig**2=0.0888*(A**(2/3))*a*T for FG+CT
Type 3 for E&B: sig**2=(0.98*(A**(0.29)))**2 for CT
Type 4 for E&B: sig**2=0.391*A**0.675*(E-0.5*Pa_prime)**0.312 for FG
+CT


Choose RMI(FG+CT) (1), G&C(FG+CT) (2), E&B(CT) (3) or E&B(FG+CT) (4)
<4>:

Be sure to use the correct Rho(Bn or Bp) according
to type 1, 2, 3 or 4. Run the d2rho program to find Rho
or use the systematic value found by running Robin
Level density at Bn or Bp (1/MeV)                <     926>:
Uncertainty of level density at Bn or Bp (1/MeV) <     192>:

You need to run the program Robin to get the Fermi-gas parameters a
and E1:
Level density parameters a (1/MeV) <  6.296>:
Fermi-gas shift parameter E1 (MeV) < -0.276>:

You need to run the program Robin to get the constant temperature
parameters T:
Temperature parameter T (MeV) <  1.400>:

The level density goes through Rho(Bn), thus determining the
const. temp. shift parameter to be E0 =  -2.388 MeV

 No   Ex(keV)   RhoLeV(1/MeV)
  0   -840.00       0.000e+00
  1   -720.00       0.000e+00
  2   -600.00       0.000e+00
  3   -480.00       0.000e+00
  4   -360.00       0.000e+00
  5   -240.00       0.000e+00
  6   -120.00       0.000e+00
------------------------------
  7      0.00       1.667e+01
  8    120.00       8.333e+00
  9    240.00       0.000e+00
 10    360.00       8.333e+00
 11    480.00       0.000e+00
 12    600.00       0.000e+00
 13    720.00       8.333e+00
 14    840.00       0.000e+00
 15    960.00       8.333e+00
 16   1080.00       8.333e+00
 17   1200.00       8.333e+00
```

18	1320.00	1.667e+01
19	1440.00	0.000e+00
20	1560.00	0.000e+00
21	1680.00	1.667e+01
22	1800.00	0.000e+00
23	1920.00	8.333e+00

Lower fit limit L1 for known levels < 7>:
Higher fit limit L2 for known levels < 23>:

No	Ex(keV)	Rho(1/MeV)	dRho(1/MeV)
43	4320.00	6.471e-01	7.619e-02
44	4440.00	6.520e-01	7.966e-02
45	4560.00	7.863e-01	8.981e-02
46	4680.00	8.089e-01	1.027e-01
47	4800.00	7.229e-01	8.839e-02
48	4920.00	6.490e-01	9.078e-02
49	5040.00	6.464e-01	9.675e-02
50	5160.00	6.243e-01	8.853e-02
51	5280.00	5.212e-01	8.407e-02
52	5400.00	4.260e-01	7.442e-02
53	5520.00	4.215e-01	8.890e-02
54	5640.00	4.638e-01	8.144e-02
55	5760.00	4.160e-01	1.068e-01
56	5880.00	5.559e-01	1.914e-01
57	6000.00	0.000e+00	0.000e+00
58	6120.00	0.000e+00	0.000e+00
59	6240.00	0.000e+00	0.000e+00
60	6360.00	0.000e+00	0.000e+00
61	6480.00	0.000e+00	0.000e+00
62	6600.00	0.000e+00	0.000e+00
63	6720.00	0.000e+00	0.000e+00

Lower fit limit H1 for Rho around Bn or Bp < 51>:52
Higher fit limit H2 for Rho around Bn or Bp < 55>:56

No	Eg(keV)	Trans	dTrans
0	-840.00	0.000e+00	0.000e+00
1	-720.00	0.000e+00	0.000e+00
2	-600.00	0.000e+00	0.000e+00
3	-480.00	0.000e+00	0.000e+00
4	-360.00	0.000e+00	0.000e+00
5	-240.00	0.000e+00	0.000e+00
6	-120.00	0.000e+00	0.000e+00
7	0.00	0.000e+00	0.000e+00

8	120.00	0.000e+00	0.000e+00
9	240.00	0.000e+00	0.000e+00
10	360.00	0.000e+00	0.000e+00
11	480.00	0.000e+00	0.000e+00
12	600.00	0.000e+00	0.000e+00
13	720.00	0.000e+00	0.000e+00
14	840.00	0.000e+00	0.000e+00
15	960.00	0.000e+00	0.000e+00
16	1080.00	0.000e+00	0.000e+00
17	1200.00	0.000e+00	0.000e+00
18	1320.00	0.000e+00	0.000e+00
19	1440.00	0.000e+00	0.000e+00
20	1560.00	0.000e+00	0.000e+00
21	1680.00	0.000e+00	0.000e+00
22	1800.00	5.791e-01	3.179e-02
23	1920.00	6.645e-01	3.271e-02
24	2040.00	6.381e-01	3.310e-02
25	2160.00	6.575e-01	3.023e-02
26	2280.00	5.726e-01	3.017e-02
27	2400.00	4.633e-01	2.538e-02
28	2520.00	5.916e-01	2.871e-02
29	2640.00	4.451e-01	2.469e-02
30	2760.00	2.955e-01	2.589e-02
31	2880.00	4.050e-01	2.984e-02
32	3000.00	4.995e-01	3.150e-02
33	3120.00	4.369e-01	2.962e-02
34	3240.00	5.022e-01	3.440e-02
35	3360.00	5.202e-01	3.377e-02
36	3480.00	5.196e-01	3.299e-02
37	3600.00	5.794e-01	3.673e-02

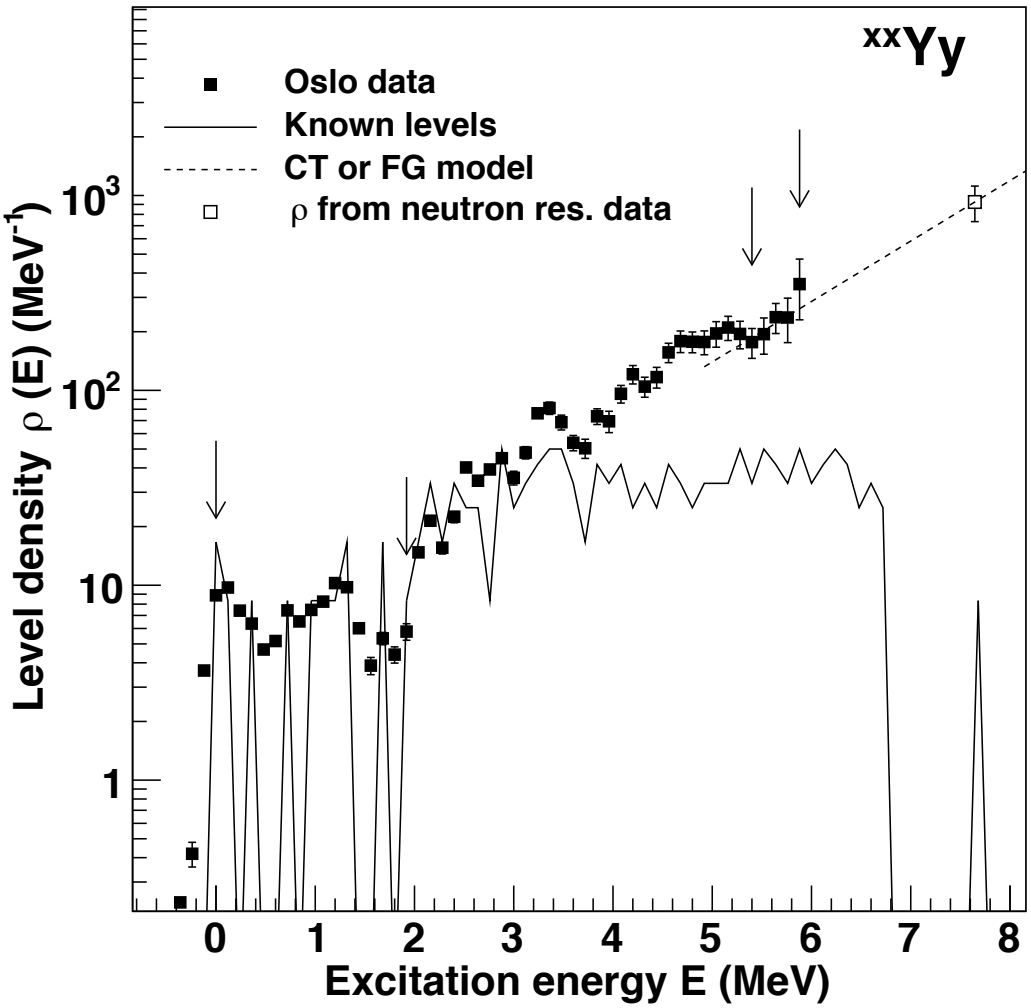
Lower fit limit L1 for low energy region of T(Eg) < 22>:
Higher fit limit L2 for low energy region of T(Eg) < 29>:

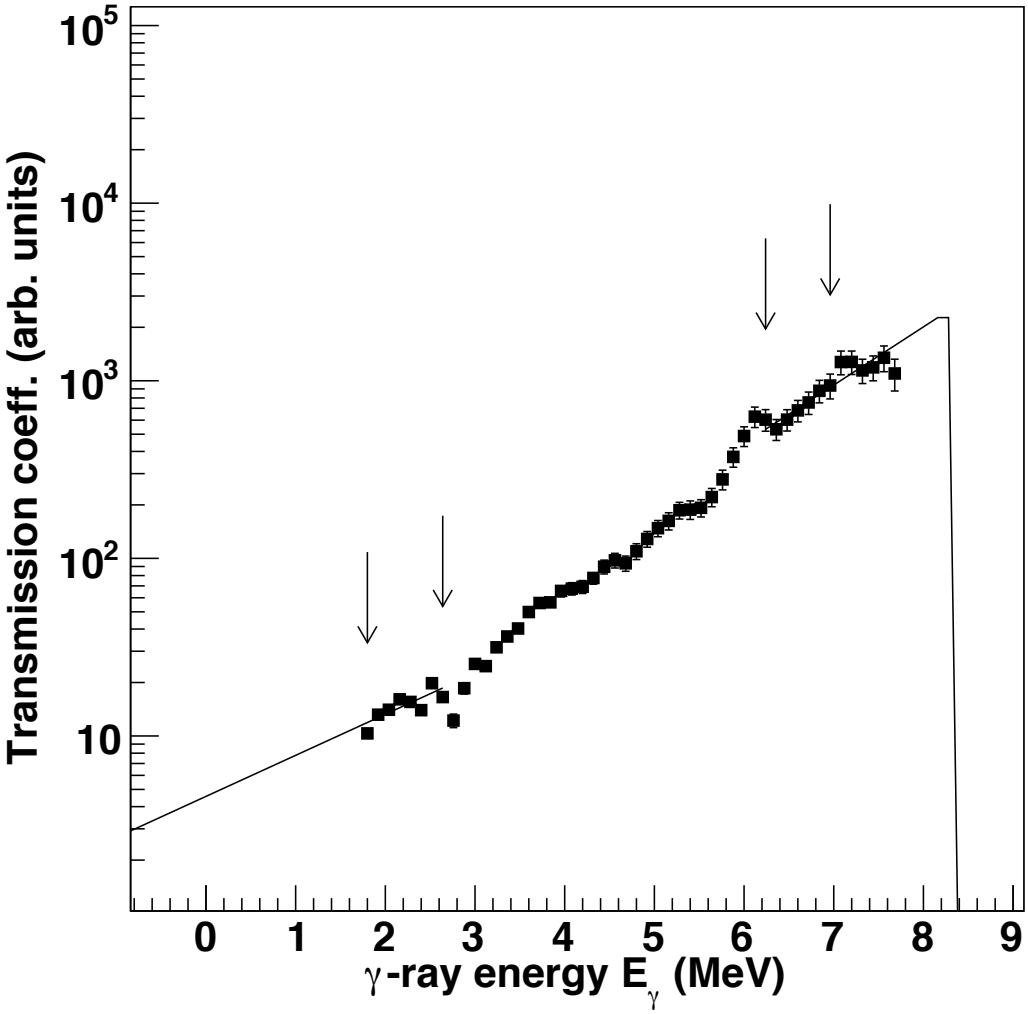
No	Eg(keV)	Trans	dTrans
51	5280.00	4.993e-01	5.378e-02
52	5400.00	4.532e-01	5.407e-02
53	5520.00	4.177e-01	4.659e-02
54	5640.00	4.324e-01	5.105e-02
55	5760.00	4.896e-01	6.229e-02
56	5880.00	5.903e-01	7.386e-02
57	6000.00	6.964e-01	8.869e-02
58	6120.00	8.064e-01	1.063e-01
59	6240.00	6.981e-01	9.723e-02
60	6360.00	5.550e-01	7.494e-02
61	6480.00	5.664e-01	7.787e-02
62	6600.00	5.747e-01	7.944e-02
63	6720.00	5.737e-01	8.279e-02
64	6840.00	6.010e-01	8.715e-02
65	6960.00	5.793e-01	9.241e-02
66	7080.00	7.074e-01	1.080e-01

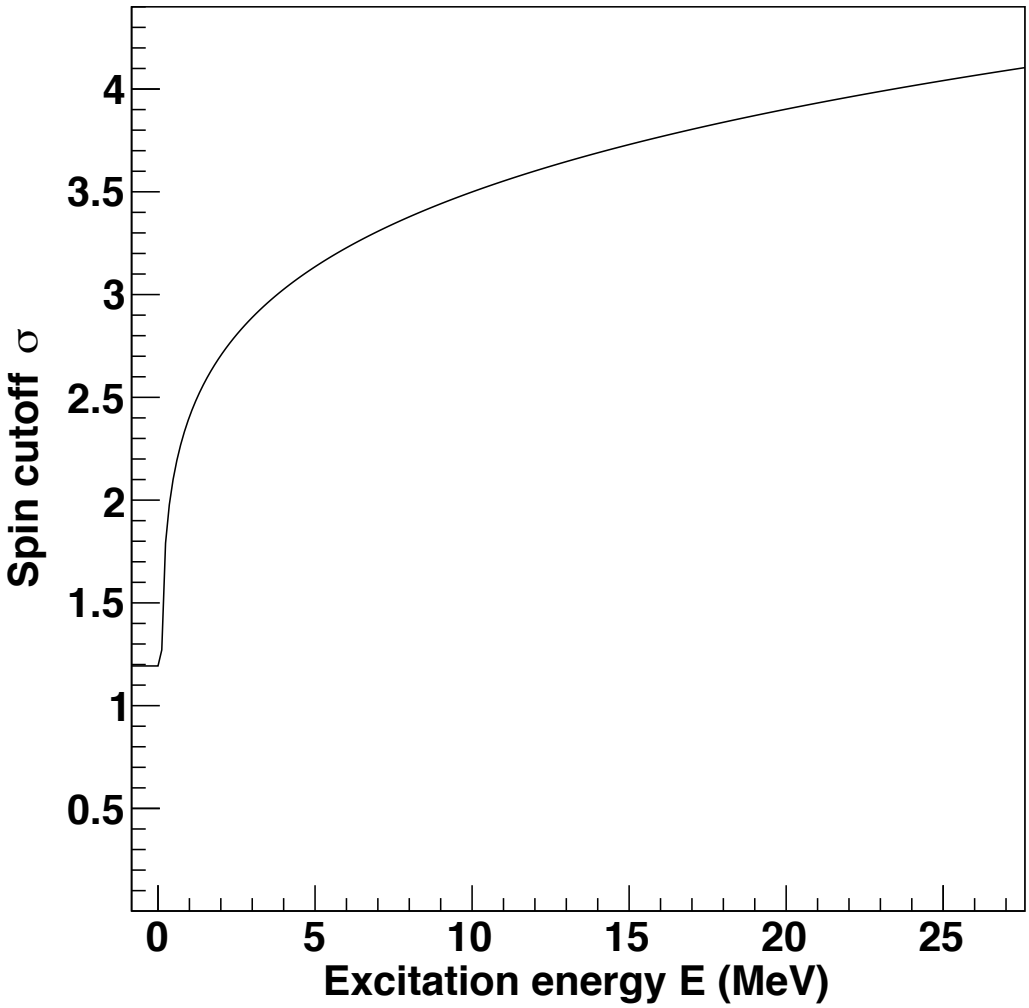
```
 67   7200.00       6.382e-01       9.621e-02
 68   7320.00       5.143e-01       8.040e-02
 69   7440.00       4.819e-01       7.694e-02
 70   7560.00       4.915e-01       8.133e-02
 71   7680.00       3.610e-01       7.342e-02
 72   7800.00       0.000e+00       0.000e+00
Lower fit limit H1 for high energy region of T(Eg)  < 59>:
Higher fit limit H2 for high energy region of T(Eg) < 65>:

Fermi-gas level density has been multiplied with eta =  1.000
in order to match Rho(Bn or Bp) =    926.0 (1/MeV)

Spin cut-off parameter used at Bn or Bp =  3.354

First estimate of normalization parameters: A =  2.6332 and alpha =
0.9335
Improved Chi2 for lower part:  39.08 -> 28.97 with count correction
= 1.328
Improved Chi2 for higher part:  3.43 ->  0.24 with count correction
= 1.005
Final estimate of normalization parameters: A =  3.7027 and alpha =
0.8740

File fermigas.cnt (0:72) written to disk, (a0,a1)=( -840.00,
120.000)
File rhotmopaw.cnt (0:833) written to disk, (a0,a1)=( -840.00,
120.000)
File rhopaw.cnt (0:145) written to disk, (a0,a1)=( -840.00, 120.000)
File sigpaw.cnt (0:145) written to disk, (a0,a1)=( -840.00, 120.000)

 Transmission function sigext = exp(a*Eg + b) is fitted to the
 lower data points with result: Chi2 = 4.726155 a = 0.532308 b =
1.519070
 Change a and b parameters? (0 = no, 1 = yes) <0>:

 Transmission function sigext = exp(a*Eg + b) is fitted to the
 upper data points with result: Chi2 = 0.264424 a = 0.754477 b =
1.570187
 Change a and b parameters? (0 = no, 1 = yes) <0>:

File sigpawext.cnt (0:75) written to disk, (a0,a1)=( -840.00,
120.000)
File extendLH.cnt (0:75) (0:75) written to disk, (a0,a1)=( -840.00,
120.000)
File rholev.cnt (0:72) written to disk, (a0,a1)=( -840.00, 120.000)
File spincut.cnt (0:216) written to disk, (a0,a1)=( -840.00,
120.000)
File counting.cpp written to disk. Run root to plot normalized NLD.
File spincut.cpp written to disk. Run root to plot the spincut.
File sigext.cpp written to disk. Run root to plot sigextpaw.cnt.
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>
```

9. Running root to display output from counting

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>root -l
counting.cpp
root [0]
Processing counting.cpp...
Info in <TCanvas::Print>: pdf file counting.pdf has been created
Info in <TCanvas::Print>: eps file counting.eps has been created
Info in <TCanvas::Print>: ps file counting.ps has been created
root [1] .x sigext.cpp
Warning in <TCanvas::Constructor>: Deleting canvas with same name:
c1
Info in <TCanvas::Print>: pdf file sigext.pdf has been created
Info in <TCanvas::Print>: eps file sigext.eps has been created
Info in <TCanvas::Print>: ps file sigext.ps has been created
```




Transmission coeff. (arb. units)
10^5
10^4
10^3
10^2
10
0
1
2
3
4
5
6
7
8
9
γ-ray energy E_γ (MeV)



10. Normalization (MG_Ripl3D0Gg_MSU2015.rtf)

```
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>normalization

 ____________________________________________________________________
|                                                                    |
|                N O R M A L I Z A T I O N  1.5.2                    |
|                                                                    |
|  Program to normalize the gamma-ray strength function f(Eg)        |
|         to the total average radiation width Gamma                 |
|                      measured at Bn or Bp                          |
|         (based on normalization.f by Andreas Schiller)             |
|                                                                    |
|  Input files: rhotmopaw.cnt    Output files: input.nrm             |
|               sigextpaw.cnt                  strength.nrm          |
|               spincut.cnt                    trans.nrm             |
|               sigpaw.cnt                     transext.nrm          |
```

```
 |               (input.nrm)                      strength.cpp    |
 |                                                                |
 | E-mail  : magne.guttormsen@fys.uio.no                          |
 | Created : 14 Nov 2006                                          |
 | Modified: 26 Mar 2014                                          |
 | Modified: 28 Aug 2015 replace ? and deleting kumac files       |
 |________________________________________________________________|

Reading calibration and dimensions from: rhosp.rsg
Dimension (0 : 71, 0 : 1) and calibration (a0, a1) = ( -840.00,
120.000)
s- (l=0) or p- (l=1) wave neutron/proton capture              <0>:
Neutron or proton binding energy (Bn or Bp) (MeV)         < 7.646>:
Target spin in (n,g) or (p,g) reaction (for the A-1 nucleus). Use
values 0.0, 1.0,... for even and 0.5, 1.5,... for odd spins < 0.0>:
Neutron resonance spacing parameter D (eV)                <25400.0>:
Average total radiative resonance width G (meV)           < 920.0>:

Reading data of experimental nuclear level density: rhotmopaw.cnt
Reading data of experimental transmision coefficient: sigextpaw.cnt
Reading data and errors of experimental transmision coefficient:
sigpaw.cnt
Reading spincutoff parameters: spincut.cnt

 No Ex(keV) Rho(1/MeV)  2*Spincut**2  Eg(keV)    Sigext      Sigpaw
dSigpaw
  0  -840.0  0.000e+00     2.85       -840.0    2.921e+00    0.000e
+00 ( 0.000e+00)
  1  -720.0  0.000e+00     2.85       -720.0    3.114e+00    0.000e
+00 ( 0.000e+00)
  2  -600.0  0.000e+00     2.85       -600.0    3.319e+00    0.000e
+00 ( 0.000e+00)
  3  -480.0  0.000e+00     2.85       -480.0    3.538e+00    0.000e
+00 ( 0.000e+00)
  4  -360.0  2.358e-01     2.85       -360.0    3.771e+00    0.000e
+00 ( 0.000e+00)
  5  -240.0  4.188e-01     2.85       -240.0    4.020e+00    0.000e
+00 ( 0.000e+00)
  6  -120.0  3.650e+00     2.85       -120.0    4.285e+00    0.000e
+00 ( 0.000e+00)
  7     0.0  8.874e+00     2.85          0.0    4.568e+00    0.000e
+00 ( 0.000e+00)
  8   120.0  9.733e+00     3.23        120.0    4.869e+00    0.000e
+00 ( 0.000e+00)
  9   240.0  7.407e+00     6.41        240.0    5.190e+00    0.000e
+00 ( 0.000e+00)
 10   360.0  6.355e+00     7.82        360.0    5.533e+00    0.000e
+00 ( 0.000e+00)
 11   480.0  4.679e+00     8.82        480.0    5.898e+00    0.000e
+00 ( 0.000e+00)
 12   600.0  5.174e+00     9.62        600.0    6.287e+00    0.000e
+00 ( 0.000e+00)
 13   720.0  7.430e+00    10.29        720.0    6.702e+00    0.000e
+00 ( 0.000e+00)
```

```
 14   840.0  6.521e+00    10.88        840.0    7.144e+00    0.000e
+00 ( 0.000e+00)
 15   960.0  7.473e+00    11.41        960.0    7.615e+00    0.000e
+00 ( 0.000e+00)
 16  1080.0  8.239e+00    11.88       1080.0    8.117e+00    0.000e
+00 ( 0.000e+00)
 17  1200.0  1.026e+01    12.32       1200.0    8.652e+00    0.000e
+00 ( 0.000e+00)
 18  1320.0  9.767e+00    12.73       1320.0    9.223e+00    0.000e
+00 ( 0.000e+00)
 19  1440.0  6.016e+00    13.11       1440.0    9.832e+00    0.000e
+00 ( 0.000e+00)
 20  1560.0  3.868e+00    13.47       1560.0    1.048e+01    0.000e
+00 ( 0.000e+00)
 21  1680.0  5.337e+00    13.80       1680.0    1.117e+01    0.000e
+00 ( 0.000e+00)
 22  1800.0  4.406e+00    14.12       1800.0    1.191e+01    1.034e
+01 ( 5.676e-01)
 23  1920.0  5.783e+00    14.43       1920.0    1.318e+01    1.318e
+01 ( 6.485e-01)
 24  2040.0  1.475e+01    14.72       2040.0    1.405e+01    1.405e
+01 ( 7.289e-01)
 25  2160.0  2.143e+01    15.00       2160.0    1.608e+01    1.608e
+01 ( 7.392e-01)
 26  2280.0  1.558e+01    15.27       2280.0    1.555e+01    1.555e
+01 ( 8.193e-01)
 27  2400.0  2.249e+01    15.52       2400.0    1.397e+01    1.397e
+01 ( 7.655e-01)
 28  2520.0  4.022e+01    15.77       2520.0    1.982e+01    1.982e
+01 ( 9.616e-01)
..
 60  6360.0  3.696e+02    21.22       6360.0    5.331e+02    5.331e
+02 ( 7.198e+01)
 61  6480.0  4.026e+02    21.35       6480.0    6.042e+02    6.042e
+02 ( 8.306e+01)
 62  6600.0  4.387e+02    21.48       6600.0    6.809e+02    6.809e
+02 ( 9.412e+01)
 63  6720.0  4.779e+02    21.60       6720.0    7.548e+02    7.548e
+02 ( 1.089e+02)
 64  6840.0  5.207e+02    21.72       6840.0    8.781e+02    8.781e
+02 ( 1.273e+02)
 65  6960.0  5.673e+02    21.84       6960.0    9.172e+02    9.401e
+02 ( 1.499e+02)
 66  7080.0  6.181e+02    21.96       7080.0    1.004e+03    1.275e
+03 ( 1.947e+02)
 67  7200.0  6.734e+02    22.08       7200.0    1.099e+03    1.277e
+03 ( 1.925e+02)
 68  7320.0  7.336e+02    22.19       7320.0    1.203e+03    1.143e
+03 ( 1.787e+02)
 69  7440.0  7.993e+02    22.31       7440.0    1.318e+03    1.189e
+03 ( 1.899e+02)
 70  7560.0  8.708e+02    22.42       7560.0    1.442e+03    1.347e
+03 ( 2.229e+02)
 71  7680.0  9.488e+02    22.53       7680.0    1.579e+03    1.099e
```

```
+03 ( 2.235e+02)

Normalization integral =  6.6062280e+06
Normalization factor =    1.8238934e+08
File strength.nrm (0:145) written to disk, (a0,a1)=( -840.00,
120.000)
File trans.nrm (0:145) written to disk, (a0,a1)=( -840.00, 120.000)
File transext.nrm (0:71) written to disk, (a0,a1)=( -840.00,
120.000)
File strength.cpp written to disk. Run root to plot strength.nrm

magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>root -l
strength.cpp
root [0]
Processing strength.cpp...
Info in <TCanvas::Print>: pdf file strength.pdf has been created
Info in <TCanvas::Print>: eps file strength.eps has been created
Info in <TCanvas::Print>: ps file strength.ps has been created
root [3] .q
magneg@1x-193-157-207-146.uio.no:Fe57_to_MSUworkshop>
```