Unfolding of measurements with the Neutron Generator from Purdue, May/June 2016:

NE213 Det 19, HV = 1867 V
PH-ADC, 4k => rebined to 2k spectrum by software to improve statistics in channels and get around 5 keVee/Chn as energy scale.

Gamma calibration:

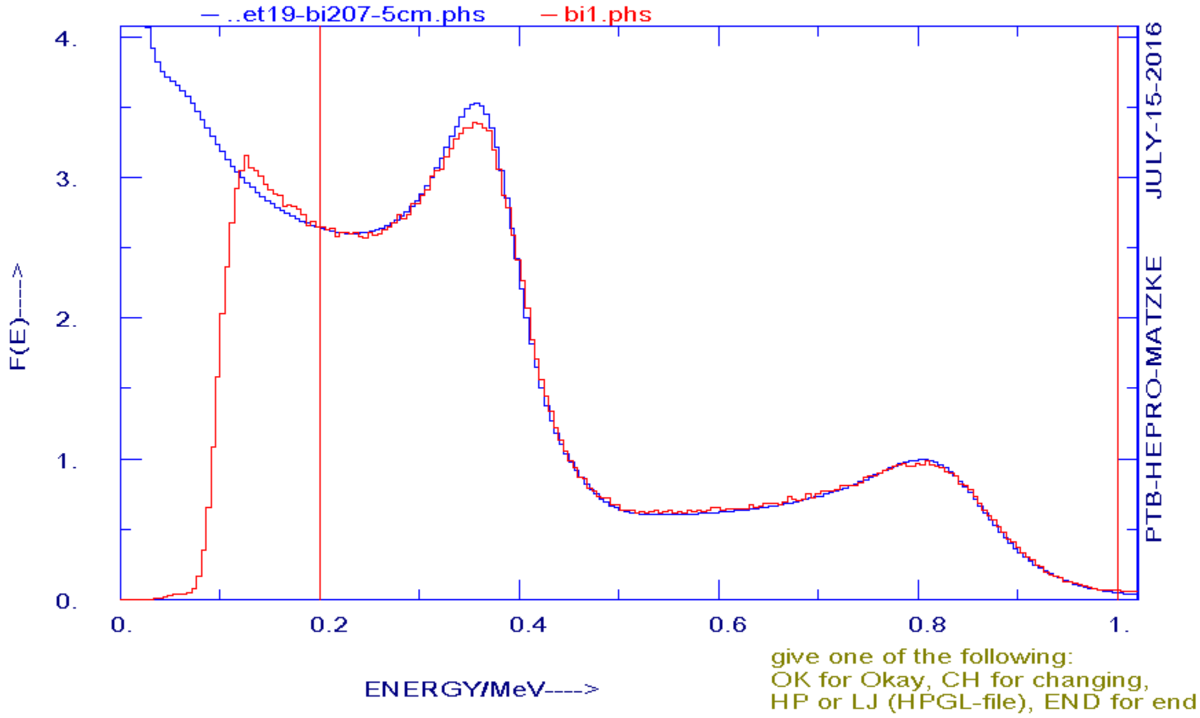
2016_MAY_31_2_5MeV_NE213FG_8.MPA, LT = 224 s

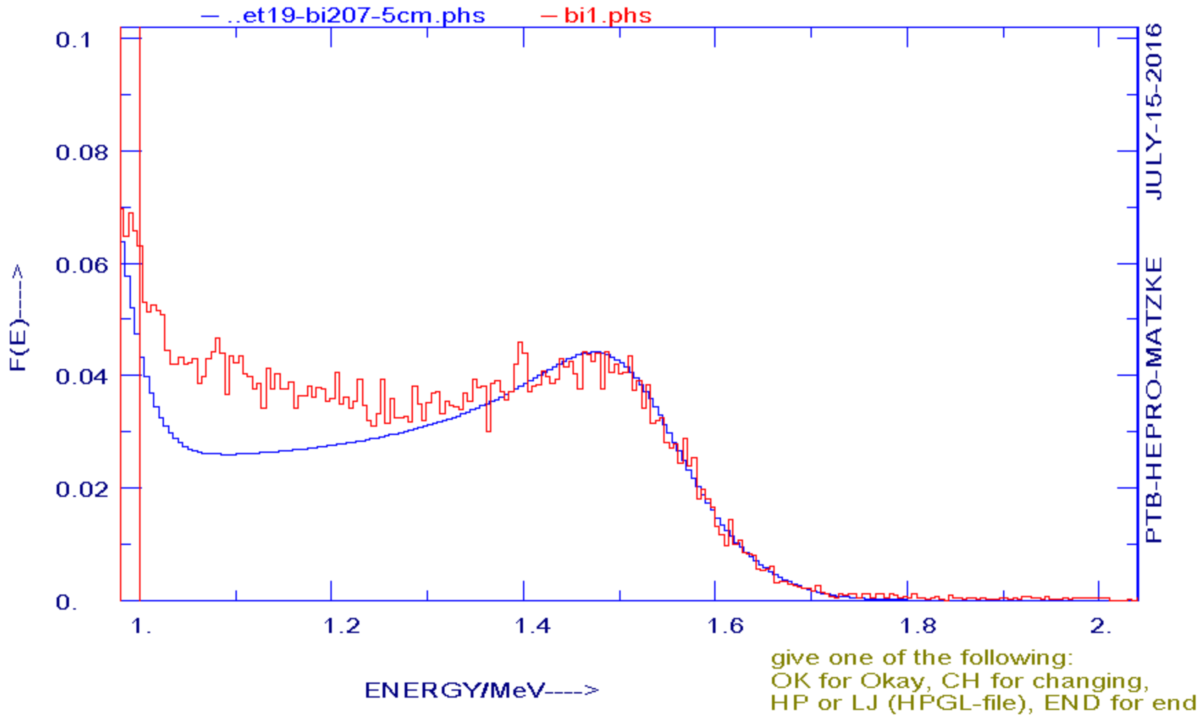
Parameters for E_cal and offset adjusted:

3.000	*XI0, channel No. related to energy zero*
4.775e-3	*EKA, channel width in MeV*

Comparison with calculated PHS: *det19-bi207-5cm.phs*

0.0252	*a parameter*
0.0931	*b parameter*
0.0060	*c parameter*


— ..et19-bi207-5cm.phs
— bi1.phs
4.
3.
2.
1.
0.
F(E)---->
0.
0.2
0.4
0.6
0.8
1.
ENERGY/MeV---->
JULY-15-2016
PTB-HEPRO-MATZKE
give one of the following:
OK for Okay, CH for changing,
HP or LJ (HPGL-file), END for end


— ..et19-bi207-5cm.phs
— bi1.phs
0.1
0.08
0.06
0.04
0.02
0.
F(E)---->
1.
1.2
1.4
1.6
1.8
2.
ENERGY/MeV---->
JULY-15-2016
PTB-HEPRO-MATZKE
give one of the following:
OK for Okay, CH for changing,
HP or LJ (HPGL-file), END for end

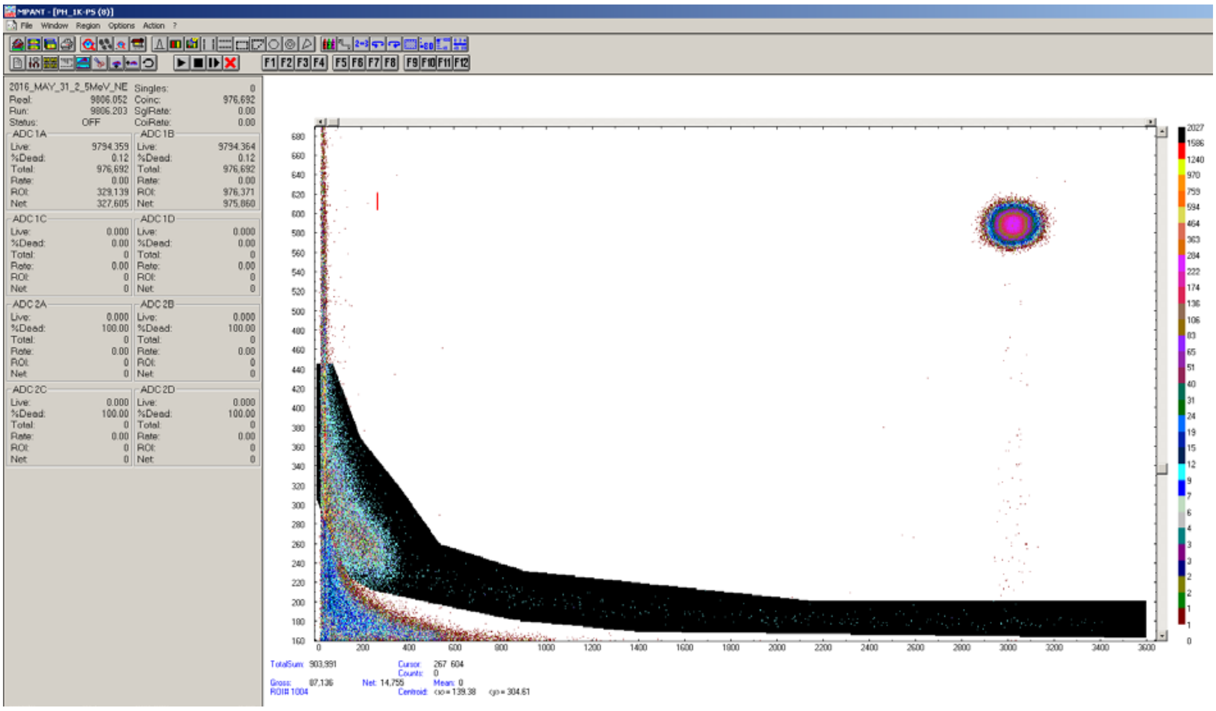
Data used:

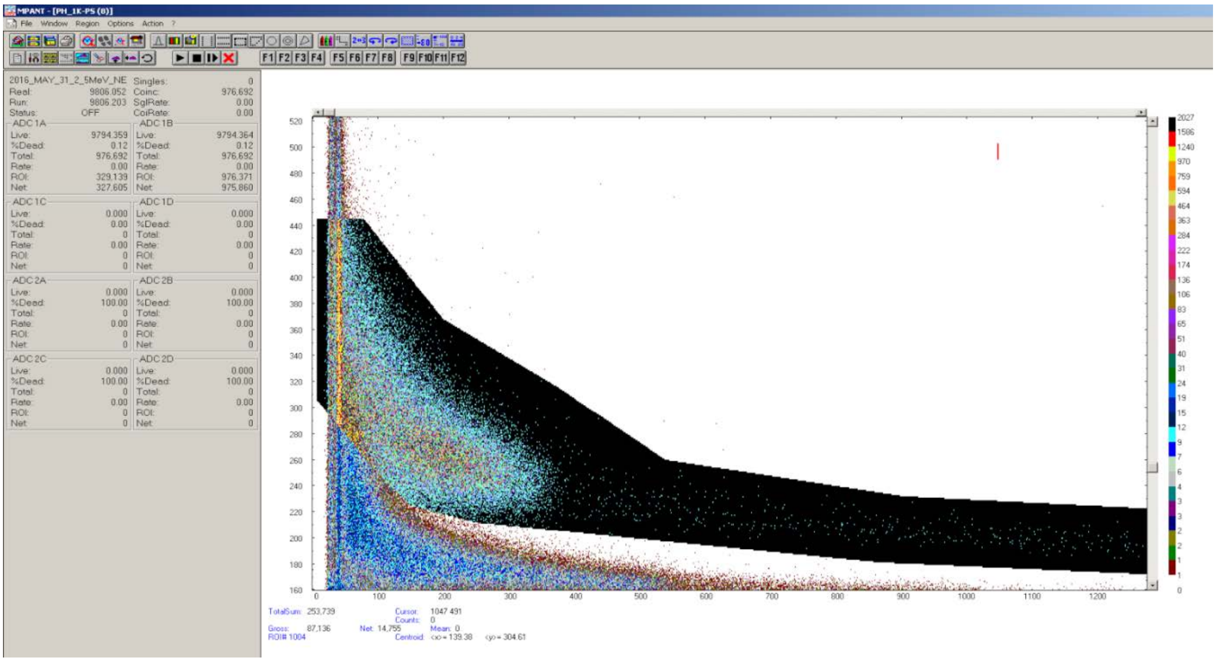
50 kV, 2.5 mA, 796 mm, 0 deg,

Measurements with running NG

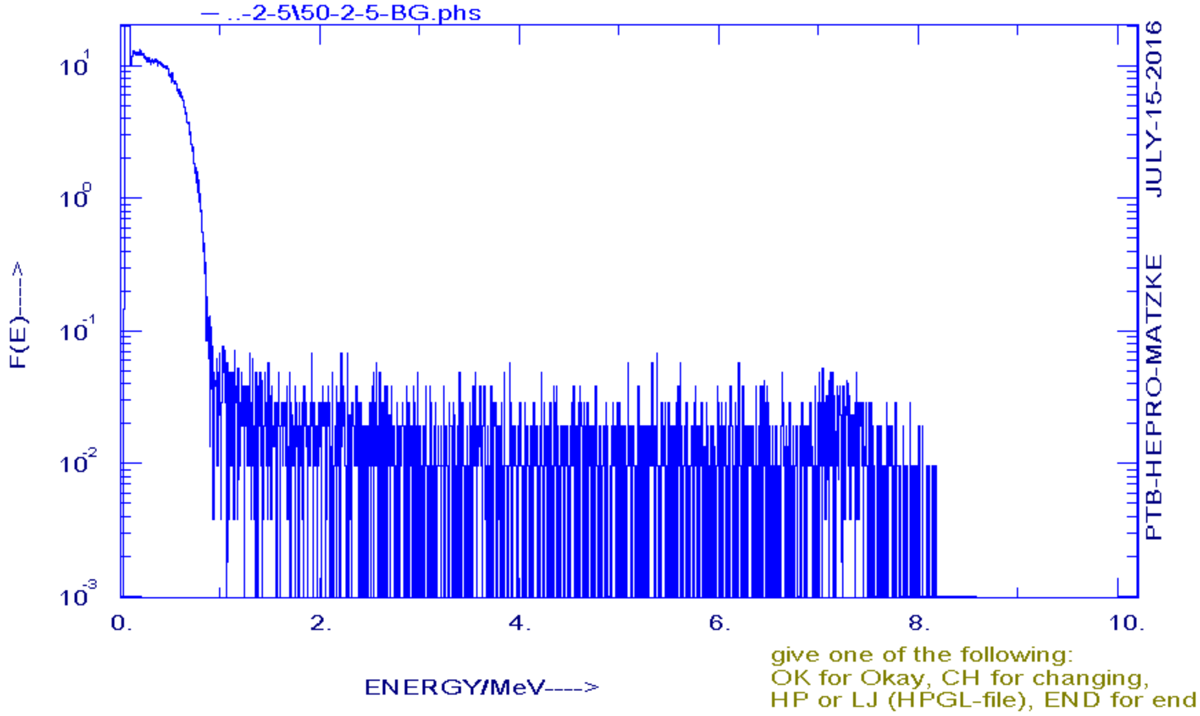
2016_MAY_31_2_5MeV_NE213FG_7.MPA LT = 9794 s
2016_JUNE_01_2_5MeV_NE213FG_01.MPA LT = 11935 s
both spectra added

BG subtracted:
2016_MAY_31_2_5MeV_NE213FG7_12.MPA LT = 35964 s





Pulse height spectrum for 50 kV, 2.5 mA, background subtracted



Input parameters for Gravel

50-2-5-bg.phs	*file with data*
n100cm25nl50.rsp	*file with response functions (RF)*
gv	*name of output file*
flat_fin.flu	*file with default spectrum (DS)*
0.35,1.0	*lowest, highest MC E bin edges (MeV)*
1.55,3.2	*lowest, highest RF E bin edges (MeV)*
0.8	*chi-square factor*
50000,10000	*Maximum number of iter. in L-BFGS-B*
3,1	*3 = use RF bin structure, 1 = dF/dE*
1	*1 = use a scale factor for the DS*
0	*0 = use MAXED scale factor*

Output from Gravel

Chi-squared P.D.F. Using the Default Spectrum = 209.4753364
Final Chi-squared P.D.F. = 1.2843119
NOTE: Chi-squared Per Degree of Freedom was set to: 0.800

Iteration	*Chi-squared*
0	*2.094753E+02*
5	*2.306427E+02*
10000	*1.287630E+00*
20000	*1.281577E+00*
30000	*1.282373E+00*
40000	*1.283641E+00*
50000	*1.284312E+00*

Final Chi2 from Gravel used as input for Maxed

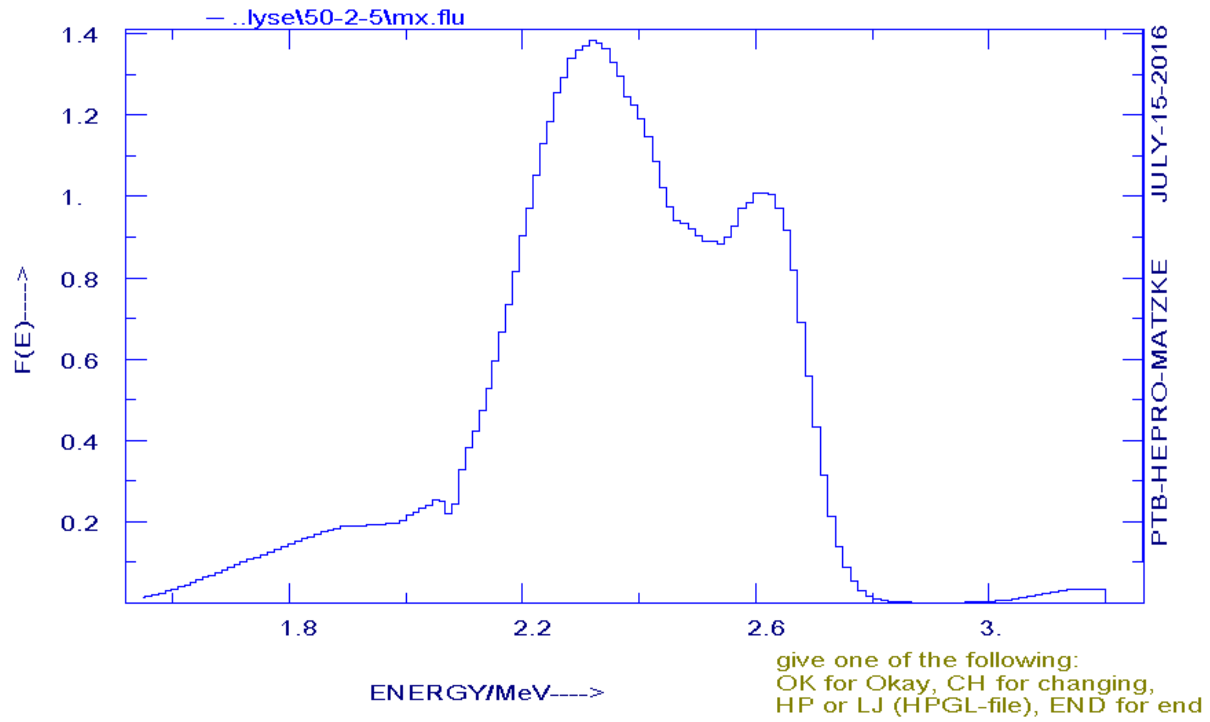
50-2-5-bg.phs	*file with data*
n100cm25nl50.rsp	*file with response functions (RF)*
mx	*name of output file*
flat_fin.flu	*file with default spectrum (DS)*
0.35,1.0	*lowest, highest MC E bin edges (MeV)*
1.55,3.2	*lowest, highest RF E bin edges (MeV)*
1.30	*chi-square factor*
200000	*Maximum number of iter. in L-BFGS-B*
3,1	*3 = use RF bin structure, 1 = dF/dE*
1	*1 = use a scale factor for the DS*
1	*0 = use MAXED scale factor*
0.0025	

The pulse height scale energy range was limited from 350 keVee to 1.0 MeVee. In the pulse height spectrum, the contribution from 14 MeV is clearly visible, but the number of counts is not sufficient to perform unfold a “free unfolding”. As start spectrum for the unfolding, a flat spectrum was used. This default spectrum was scaled manually with a factor which is a factor 100 smaller than the intrinsically determined scaling factor:

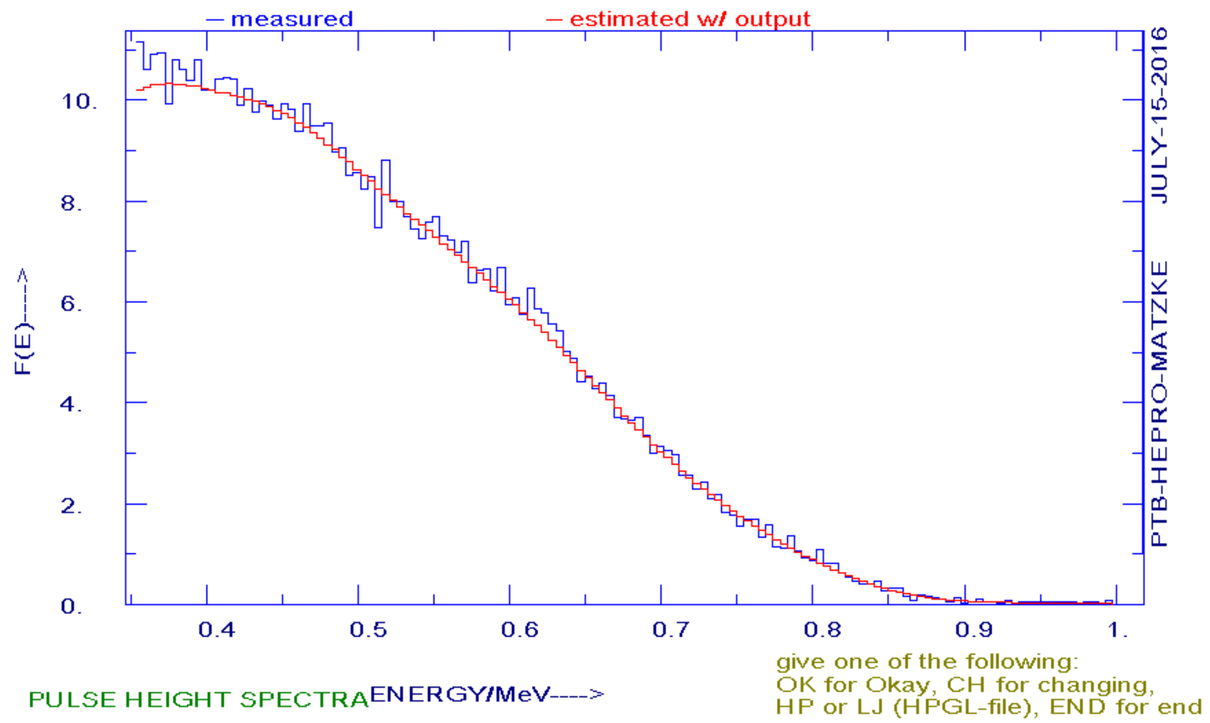
Scaling Factor/Default Spectrum for best fit = 2.5610E-01
Scaling Factor/Default Spectrum used = 2.5000E-03

With such a procedure, the result of the unfolding is forced to drop on the high energy side of the 2.5 MeV peak. The remaining structure at about 3 MeV neutron energy is an artifact from misinterpreted 14 MeV neutrons resulting in events with energies higher than about 1 MeVee.

Output from maxed using calculated response matrix:



Result of folding the output spectrum with the response matrix.



Analysis of results:

From the output spectrum (mx.flu) the calculated fluence rate at the detector position is the following:

Phi (2 MeV < E < 2.9 MeV) = 0.62851 1/ (s cm^2)

The contribution from 14 MeV neutrons can be calculated from the counts in the pulse height spectrum (50-2-5-BG.phs) in the range from 2 MeV to 10 MeV and the response of the scintillation detector.

Number of Counts (2 MeV < PH < 10 MeV) = 0.0735 1/s

The response of the scintillation detector for 14 MeV for the pulse height range > 2 MeVee is:

R(E_n = 14 MeV, PH > 2 MeVee) = 2.0668 cm^2

From these numbers, the fluence rate of 14 MeV can be calculated:

Phi (14 MeV) = $Counts_{14MeV}$ / $R_{14\ MeV}$ = 0.03556 1/ (s cm^2)

The ratio of neutrons with energies of 14 MeV and 2.5 MeV is therefore:

Ratio (14 MeV / 2.5 MeV) = (0.03556 / 0.62851) = 0.056 (= 5.6 %)