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High Voltage Calibration

of the TANSY-KM5 Neutron Detectors

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Abstract

We have developed a procedure for the high voltage calibration of the TANSY neutron detectors. The procedure is based on the work done during the construction of the spectrometer.

A special CODAS program is written for the measurement of the sensitivity of the neutron detectors as a function of the high voltage. The data are transferred to a PC for the evaluation of the data. We use a Cobalt source during the calibration. With the interactive PC program "HIVOCA" the voltage corresponding to the effective compton edge is found. The voltage settings for the neutron detectors are calculated and stored in a file suitable for input to the progam "PARA", that is used to control the instrument.

A measurement is reported that shows that the reproducibility of the measurement is good.

Contents

1. Introduction

The foil scattered neutrons reaching the neutron detectors in TANSY have energies from approximately .5 to 3 MeV. The high voltage calibration tools are designed to find high voltage settings appropriate for this energy range.

The neutron energy range is defined by the high voltage and the lower and upper discriminator levels. Other factors that have an influence on the range is the preamplifier bias level and the attenuation of the signals. The bias is adjusted to zero prior to the calibration and the attenuation is supposed to be constant as long as no changes are made in the cabling of the instrument.

Appropriate default values for the discriminator levels have been found during the design phase of the instrument. They are adjusted as carefully as possible to the default values. Only the lower level discriminators are used during the calibration.

The Compton edge created by gamma from a Cobalt source is used during the calibration. It is placed as centrally as possible and the high voltage is stepped through a predefined range. The number of counts during a predetermined time is registered for each step. The result is evaluated using the program HIVOCA. The high voltages found are stored and inserted in the parameter file.

The calibration routines are primarily designed for the calibration of the high voltage. However, it is an excellent test of the status of the neutron detectors. Any faults in the optical contact between the scintillator and the photomultiplier or elements in the amplification chain operating improperly will affect the result of the measurement.

2. The method

The method has been carefully investigated during the design phase of TANSY and is reported in the references to this report. Here we give only the main idea of the method. It is based on the amplification equation for the neutron detectors:

$$A = \frac{E}{E_0} \cdot k \cdot V^n$$

A = the amplitude in discriminator units
E = particle (or gamma ray) energy in electron energy units
E_0 = a reference energy, 781 keV for the Cobalt Compton edge[1]
V = the photomultiplier high voltage supply
n = an exponent giving a relation between the photomultiplier voltage and amplification
k = an amplification factor

A complete calibration includes the determination of n and k. Fortunately, the factor n depends on the design of the multiplier only and is almost the same for all the

[1] Co60 gives two lines, one at 1.17 MeV and one at 1.33 MeV. The neutron detectors cannot resolve this. The Compton edge used here is an effective value created by the two lines.

neutron detectors. It has been carefully measured during the construction phase. The mean value for all detectors is 12.78, a value that can be used for a new photomultiplier of the same type. A re-measurement is tedious as it involves several scans of the high voltage.

The factor k depends on the light output from the scintillators, the transfer of light to the photocathode, the sensitivity of the photocathode, the signal amplification, and the setting of the discriminator level. The factor is very different for the different neutron detectors. However, we do not need to know it as long as we do not change any of the above mentioned factors. Therefore, this calibration scheme is only designed for a determination of the high voltage settings.

During the design phase parameters were measured also for the upper discriminator. These values are different as the signal is attenuated between the lower and upper level circuits. However, the upper level values are not as important as the lower ones and therefore it is not necessary to do a re-calibration of these levels

If we apply the equation to the two cases of cobalt and neutrons we get the setting of the high voltage, **V**, to

$$\mathbf{V} = \mathbf{V}_{cobalt} \cdot \left(\frac{\mathbf{E}}{\mathbf{E}_0} \right)^{\frac{1}{n}}$$

where $\mathbf{V}_{cobalt}$ correspond to the inflexion point obtained from the result of a scan of the high voltage. **E** is the energy of the discrimination level. It is presently set to 100 keV corresponding to a neutron energy of about .7 MeV. It is slightly above the design value for the lowest neutron energy.

3. The measurement

Most of the TANSY calibrations are controlled by the PC connected to the Starburst computers. However, the Starburst computers can only control modules in their own CAMAC crate. During this measurement we use the controller for the high voltage units and the latching scalers, both not accessible from the Starburst computers. Therefore, a special CODAS program has been written for this purpose.

The program scans the high voltage in predetermined steps. For each step the number of counts from the neutron detectors is measured during a predetermined time. The result is stored in a file used as an input to the HIVOCA program.

An example of the input to the scan program is given below. The line numbers and comments are not a part of the file. The example gives a total of 21 steps (5+15+1). The maximum number of steps is 32.

```
1     1800        Line 1 to 32 = nominal voltage settings
2     1517
----------------------
----------------------
29    1447
30    1410
31    1391
32    1476
33    -15         The scan starts 15 steps before the nominal voltage.
34    5           It ends 5 steps after the nominal voltage.
```

35	20	The Voltage step is here 20 V.
36	1000	The time for each step is 1000 ms, 1 second

The output file has the following format. Again the comments are not a part of the file.

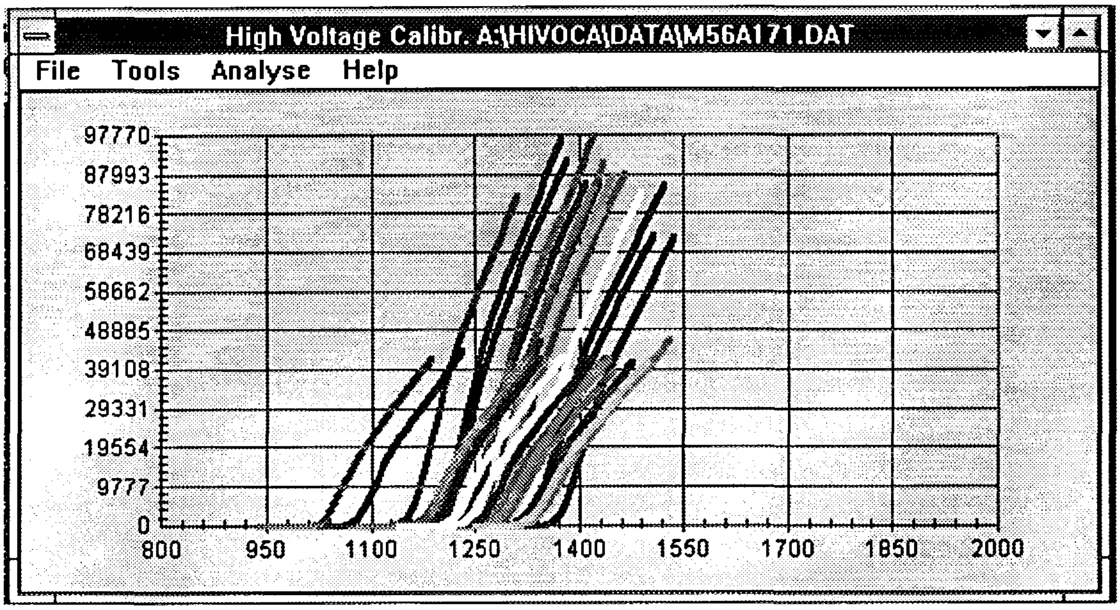
```
32                    ; 32 voltage steps are used
 1257 12              ;Voltage and counts, detector 0 in branch A
 1265 14              ;A total of 32 values for this detector
 1273 15
 1281 16
 1289 17
 1297 18
 1305 25
 1313 73
 1321 318
 1329 1105
 1337 2837
 1345 5804
 1353 9809
 1361 14461
 1369 19312
 1377 23950
 1385 28197
 1393 32006
 1401 -29961
 1409 -26631
 1417 -23571
 1425 -20549
 1433 -17552
 1441 -14649
 1449 -12013
 1457 -9217
 1465 -6606
 1473 -3657
 1481 -921
 1489 1713
 1497 4373
 1505 6878
 1185 13      Next detector. The Branch B Detectors follow after Branch A.
 1193 14
---------------------- and so on for all the 32 neutron detectors
```

Note that the number of counts change from positive to negative and then back to positive. It comes from the fact that only 16 bits are used by the scalers. The input routine in the analyse program HIVOCA takes care of this problem as long as the difference between the counts in two consecutive steps is less than 32767.

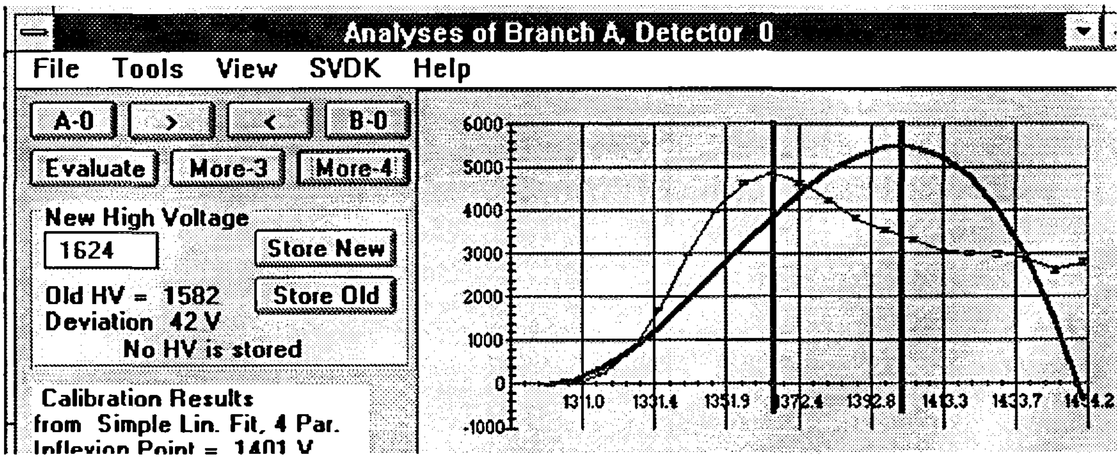
Prescalers are used to enhance the dynamic range of the scalers. The count-down factor of the prescalers is not a part of the file but must be remembered and manually given to the analysis program.

4. The evaluation using the program HIVOCA

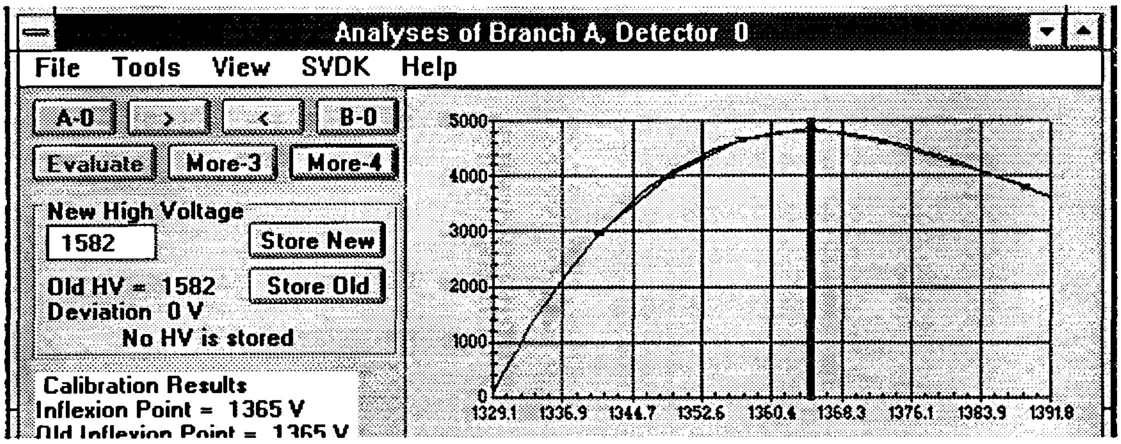
The data read into the program are first presented in a graph giving an overview over all detectors.



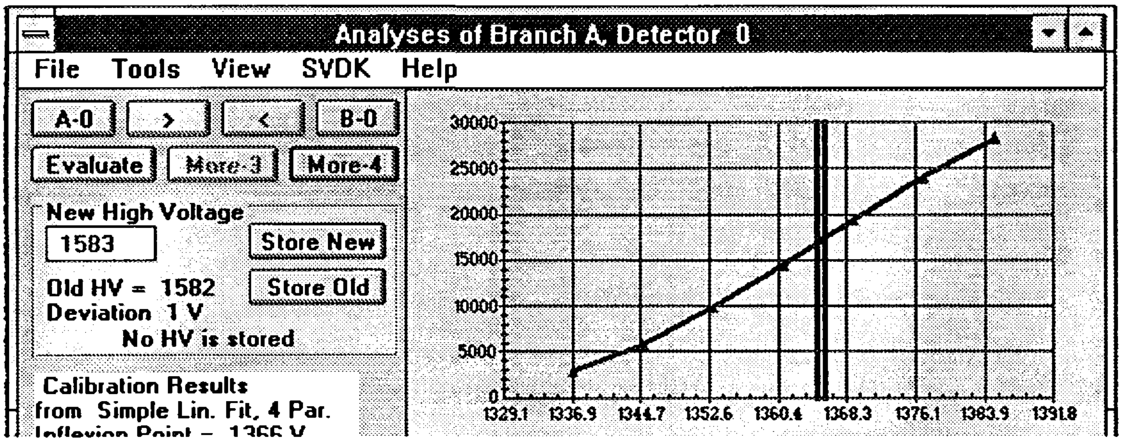
Several options are now available to investigate the data. Here we will only describe the recommended option. The menu item "Analyse Single Detector" activates the evaluation part of the program. The detectors are investigated one by one normally starting with detector 0 in Branch A. Start by a zoom to a relevant part of the data. View the differentiated data. Then you see a window as the following one.



The left (blue) vertical line shows the old cobalt value. The new one is indicated by the right (red) one. The evaluation is shown as the curve with the maximum at the right vertical line. To get a good fit you must zoom to a better range. Trial and error gives the following result.



In this case the old and the new values coincide. One of them are stored by a click on either of the store buttons. Sometimes it is valuable to go back to the original distribution. In this case it gives a deviation of 1 Volt. It is up to the user to decide upon which value is to be used.



A text window gives some information to help the user. On entering the evaluation part of the program the user is prompted for an .HVP file. Some of the data in this file are reproduced in the text window. The file also contains the old high voltages. It is a text file that may be edited by "write" or "notepad".

The results of the calculations are stored in files (.PAA, .PAB) that can be read by the parameter program. Note that a reading of these files will only affect the high voltage values.

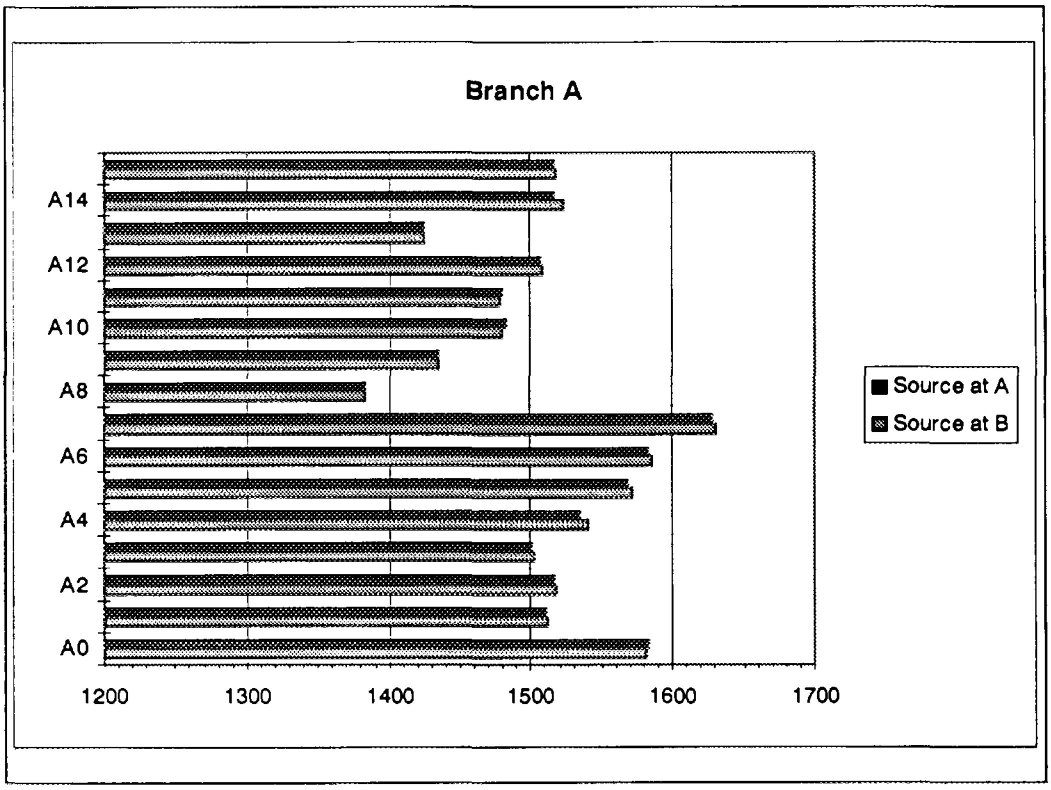
More information about the different program options is given in the help file.

5. Results of a calibration

Two overnight measurements were done in October 1996. The Cobalt source was placed on the vacuum vessel flange close to the foil. In the first measurement it was placed at the B branch side and in the second at the A branch side of the neutron detectors. The results are presented in the two following pages.

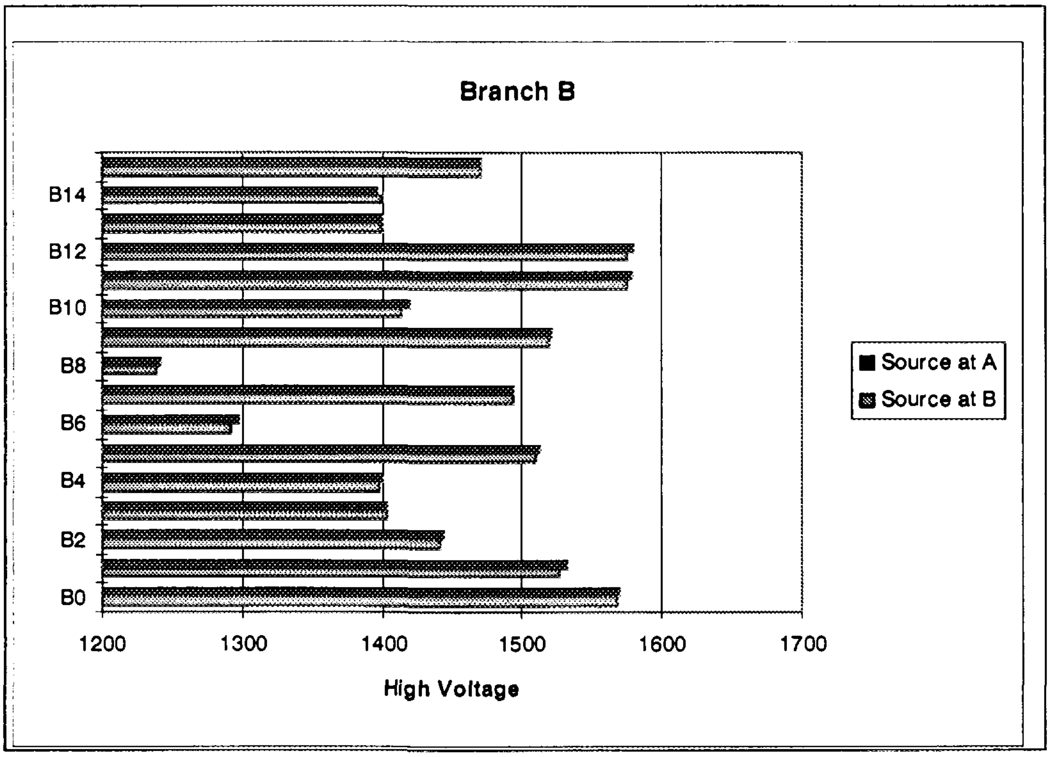
The result for the A-branch neutron detectors.

Detector	Source at B	Source at A	Difference	Eq. Amp. Error, %
A0	1582	1583	-1	-0.8
A1	1512	1511	1	0.8
A2	1518	1517	1	0.8
A3	1502	1501	1	0.9
A4	1540	1535	5	4.1
A5	1572	1569	3	2.4
A6	1586	1583	3	2.4
A7	1631	1628	3	2.4
A8	1384	1383	1	0.9
A9	1435	1435	0	0.0
A10	1480	1483	-3	-2.6
A11	1478	1479	-1	-0.9
A12	1508	1507	1	0.8
A13	1425	1424	1	0.9
A14	1524	1517	7	5.9
A15	1518	1516	2	1.7
		Mean value	1.5	1.24



The result for the B-branch neutron detectors.

Detector	Source at B	Source at A	Difference	Eq. Amp. Error, %
B0	1568	1569	-1	-0.8
B1	1526	1532	-6	-5.0
B2	1440	1443	-3	-2.7
B3	1403	1404	-1	-0.9
B4	1398	1400	-2	-1.8
B5	1510	1513	-3	-2.5
B6	1292	1297	-5	-4.9
B7	1493	1494	-1	-0.9
B8	1239	1241	-2	-2.1
B9	1519	1521	-2	-1.7
B10	1414	1419	-5	-4.5
B11	1575	1578	-3	-2.4
B12	1576	1580	-4	-3.2
B13	1399	1399	0	0.0
B14	1399	1396	3	2.7
B15	1471	1471	0	0.0
		Mean value	-2.1875	-1.92

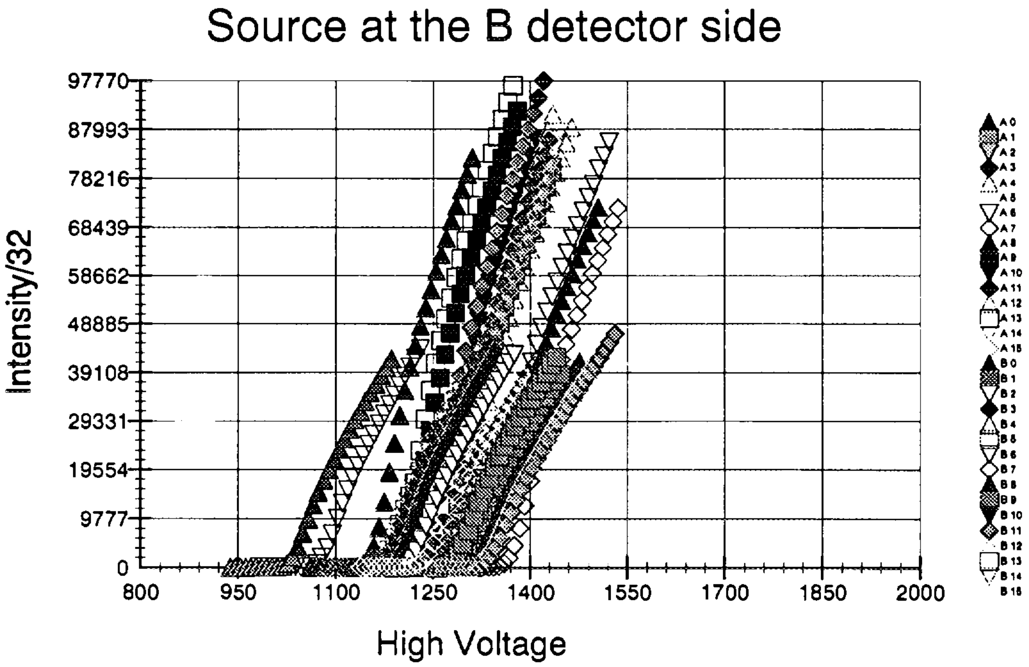


The differences between the two measurements are small, the mean difference is about 2 Volt and the maximum difference is 7 Volt. Any of the measurements can be used. The figure below shows however that the number of counts is about 2.5 times higher for the detectors closest to the source. Therefore we will use these values as the result of the calibration.

The voltage differences can be transformed to equivalent amplitude differences. From our main equation we get

$$\frac{\Delta A}{A} = n \cdot \frac{\Delta V}{V}$$

From the tables we find a maximum deviation of 6 % and a mean value of less than 2 %. This is in agreement with the accuracy of the discriminator level settings.



6. The HIVOCA help file

A help file is provided for the HIVOCA program. We reproduce some parts of it here as an introduction for the user of the program.

6.1. Contents

Welcome to the TANSY[2] high voltage calibration program for the neutron detectors.

Contents:

6.2. Introduction

The calibration is based on a method developed at the Department of Reactor Physics, Chalmers University of Technology. It has been documented in reports as referred to in the reference section of this help file.

A Cobalt source is placed centrally in the TANSY instrument. The high voltages of the neutron detectors are stepped and the number of pulses at each step is recorded.

The pulses recorded as a function of the high voltage, have an inflexion point indicating the energy of the Cobalt-60 Compton edge.

[2] TANSY is a neutron spectrometer for D-T neutrons at JET.

The purpose of the calibration is to determine the inflexion point and relate it to the corresponding neutron energy. The result of the calibration is the high voltage values to be used by the neutron detectors.

6.3. The Calibration Method

The energy of the scattered neutrons in TANSY ranges from about 0.5 to 3 MeV. The corresponding electron energies are 100 and 1400 keV, respectively. The sensitive energy interval of the neutron detectors is defined by the voltage of the photomultiplier supply and the lower and upper levels of the discriminators.

6.4. The Measurement

A Cobalt source is placed as centrally as possible in the spectrometer. The voltages are scanned and the number of counts for each detector is recorded.

The cables from the upper discriminators of the coincidence modules should be disconnected and the count-down factor should be set to an appropriate value. Only 15 bits[3] are used for positive numbers in the scalers.

The Calibration measurement is controlled by a CODAS program written by Donald Wilson. The input file contains information about nominal voltages, number of steps before and after the nominal voltages, the step voltage, and the measurement time. An example of an input file is given in the Files topic.

The resulting file contains the number of detectors[4] in the first line. It is followed by the voltages and counts recorded for all detectors. See the Files topic for more details. The result is copied by FTP to the .DAT file[5] in the PC and is used as input to this program.

6.5. The Evaluation

Start the program by clicking on the Icon.
Choose an input file from the alternatives presented in the file input dialogue.

The count distributions for all detectors are displayed. Use the display for a first look at the result.

Click Analyse Single Detector in the Analyse menu.

You are prompted for a choice of the Count Down factors. These are not included in the files but must be noticed and remembered manually.

In the "Single Detector Analysis" form you are able to navigate through the results for all the detectors. Several options are available for the determination of the inflexion point. You can display

[3] Max 32767 counts

[4] We use 32 detectors in TANSY, numbered from 0 to 31.

[5] We use Mymdd#.DAT, year, month(hex), day, and experiment #.

the integral curves or the differentiated curve. You can use zooming for selecting the points included in the analysis. You may use 3-parameter or 4-parameter analyse to get the inflexion point.

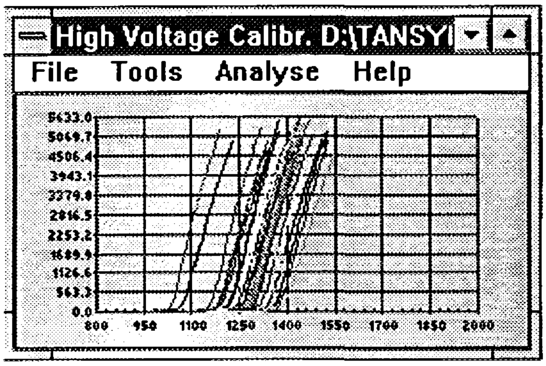
The result is presented in the "New High Voltage" frame. A text box contains additional information.

Use the "Store" buttons to store either the old or the new high voltage.

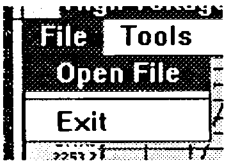
After the evaluation of all the detectors the result is saved, appended to file, which can be read by the parameter program, PARA. Save is only permitted after an analysis of all the detectors.

6.6. The Main Form

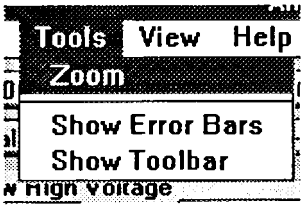
The main form is the entrance to the program. It gives an overview of all the detectors.



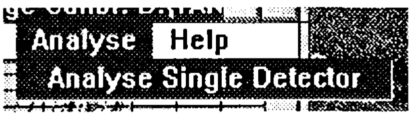
6.6.1. The Main Form Menu



With File you open a new project or exit the program.



Tools gives you options for manipulating the graphic. You can enlarge the display using Zoom. The "toolbar" gives you access to the graph library options. However, only some of the options are relevant. Only the data are loaded.



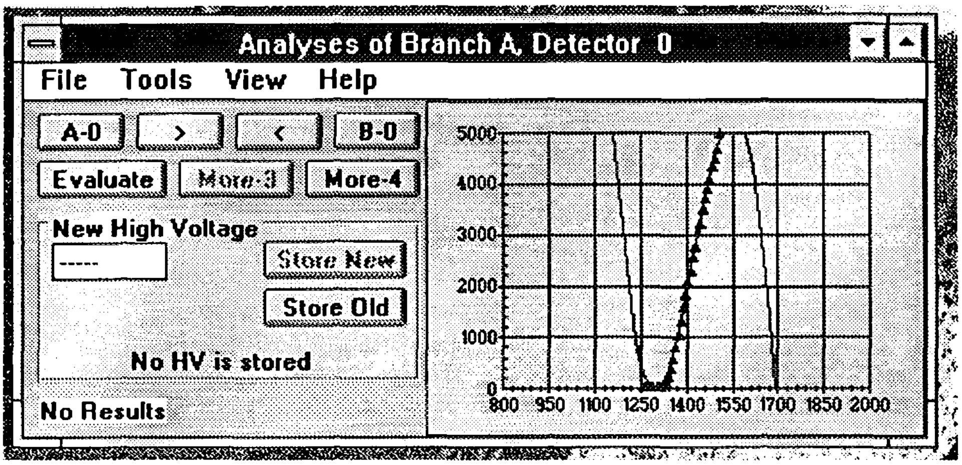
Analyse brings you to the analyse part of the program. The detectors are analysed one by one using several tools available in that program.

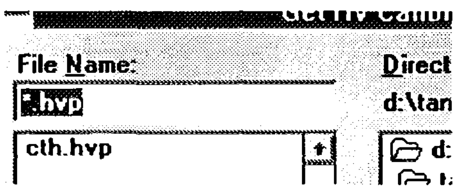
6.7. The Analysis Form

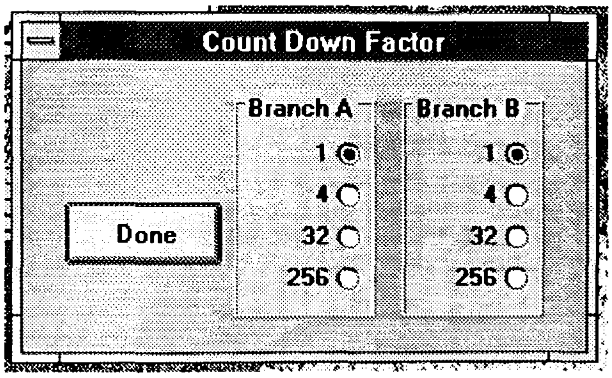
The form is started from the main menu, "Analyse Single Detector"
Before entering the form you are prompted for the reference file[6], .HVP, and the Count Down Factor[7] used at the measurement.

The .HVP-file is a background file containing the reference voltages, old voltages, and information about the system, i.e., the discriminator settings.

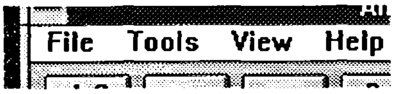
The "Count Down Factor" is the one used at the measurement. A value in the .HVP file is presented as a first value. However, as this is a standard file, the Count Down Factor should be documented in some other way.



6


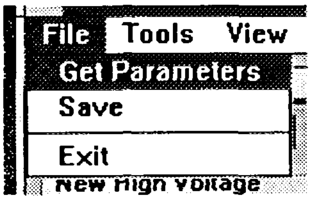
7


6.7.1. The Analyses Form Menu



The Analyses Form Menu enables you to save the result, get new data, manipulate the graph, and differentiate the distribution.

6.7.1.1.The File Menu



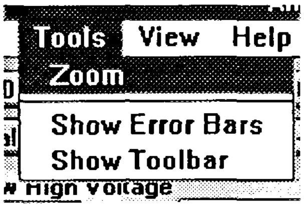
"Get Parameters" gives you access to a new .HVP file. You are prompted for an update of theCount Down Factor.

"Exit" is an exit to the main form in which you may load a new experiment.

"Save" saves the result of the calibration, the high voltage values. The values are appended to files of type.PAA and .PAB, formatted for the use of the parameter program PARA.

Save is only permitted when all detectors are calibrated. If not, the missing ones are listed in a message box.

6.7.1.2.The Tools Menu



Zooming.

1) Click on zoom in the menu.

2) Click on the left low corner of the zooming region. A rectangle is shown as soon as you move the mouse

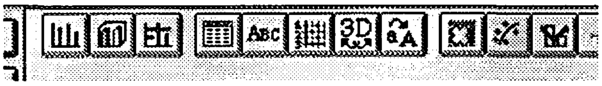
3) Expand the rectangle to the right high corner and click again

A first evaluation is done. The evaluated inflexion point is shown as a red line in the diagram, the old one is marked by a blue colour. The resulting curve is shown in red.

The zooming can be repeated to a smaller region. "Reset Zoom" resets the zooming to a full display.

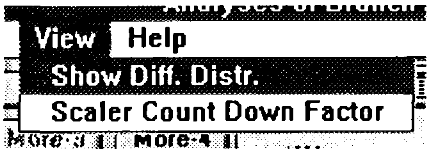
Show Error Bars
Error bars are shown and may be taken away by clicking "Hide Error Bar".

<u>Show Toolbar</u>



The toolbar is supplied for the experienced user of the Graph Library. Only some options are relevant. However, it enables possibilities to edit, print, save, or copy the graph. Click "Hide toolbar" to get rid of it.

6.7.1.3.The View menu



<u>Show Diff. Distr.</u>
An alternative method to find the inflexion point is to differentiate the measured data and search for the maximum value. The Diff. Distribution is defined as the difference between consecutive points in the distribution.

Show Distribution reloads the original values.

<u>Scaler Count Down Factors</u>
The least-square evaluations "More 3" and "More 4" take the variances of the input data into account. These variances depend on the pre-scaling defined by the count-down factors. Here is a possibility to check and correct them.

6.7.1.4.The SVDK Menu

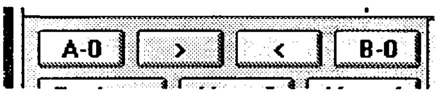
The evaluation options given in the SVDK menu use the routine SVDFIT translated to visual basic from the FORTRAN routine described in Numerical Recipes. Normally it is not needed but it may be used for a further analyse of the data.

Tolerance
A low value of the tolerance level removes higher order terms in the polynomial expansion.

SVDK More-3 corresponds to the More-3 button
SVDK More-4 corresponds to the More-4 button

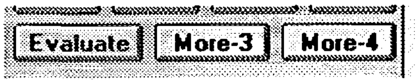
Test creates data points from the last evaluated power series. The standard deviations of the data points are the square root of the data values. Return to the original data points by clicking the "Set Test Off" item of the menu.

6.7.2. The Navigation Command Buttons



Select the detector number using the buttons.
The actual detector is shown as the form caption.
A-0 or B-0 displays the first detector in the A-branch and the B-branch.

6.7.3. The Evaluation Tools

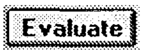


Three types of evaluation are available. All of them use power series. They may be applied to the direct data as well as the differentiated data with one exception.

Evaluate is the evaluation offered by the graphic library.
More-3 and More-4 is power series with 3 and 4 parameters, respectively.

The text changes to red for the actual evaluation.

6.7.3.1. The Evaluate Command Button

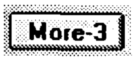


The mean-square evaluation offered by the graphic library uses the data with no weights included. No correlation matrix is returned.

The evaluation uses four parameters for the direct data and three parameters for the differentiated data. No statistical data are reported.

This evaluation is automatically done when a new detector is selected.

6.7.3.2.The More-3 Command Button



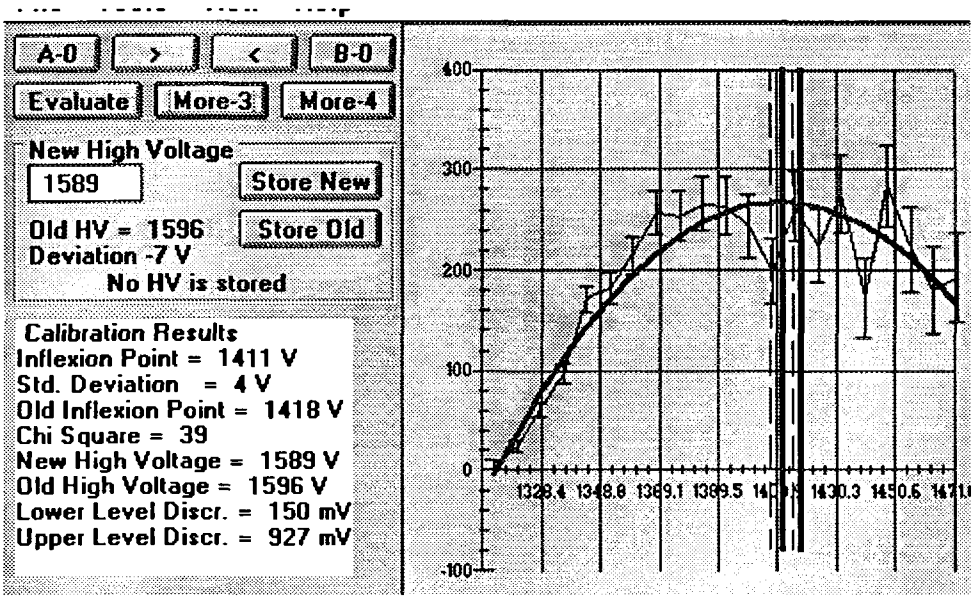
More-3 is a three parameter power series evaluation using the least-mean-square method.
It is enabled for the differentiated distribution only.
The standard deviation is reported on the graph as dotted lines but only if the limits are inside the graph range. Small standard deviation is covered by the red line indicating the inflexion point. The full covariance matrix is taken into account.

6.7.3.3.The More-4 Command Button

More-4 is a four parameter power series evaluation using the least-mean-square method.
The standard deviation is reported on the graph as dotted lines but only if the limits are inside the graph range. Small standard deviations are covered by the red line indicating the inflexion point. The full covariance matrix is taken into account.

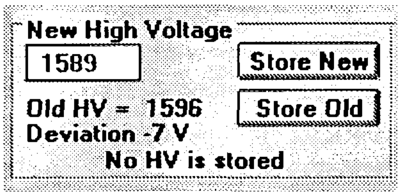
A four-parameter evaluation on differentiated data gives high standard deviations unless the data are of a very good quality. Very high standard deviations are reported as "Error". However, the estimated high voltage may still be valuable.

6.8. The Result of the Analyses

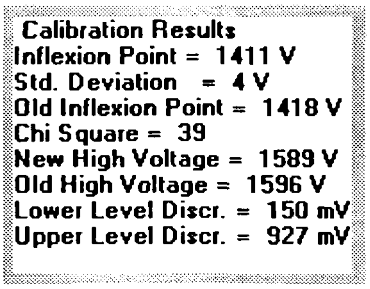


The result of the analyses is presented in three ways.

The graph has a blue line for the old inflection point and a red line supported by two dashed red lines for the evaluated inflexion point and its standard deviation.



The result frame gives the evaluated new high voltage and the old one as a comparison. Either of these can be stored and saved at the time all the detectors are analysed. You may go back to the detector at any time and redo the evaluation and save the new result. There is a notice in the frame indicating the type of result stored.



The text box gives additional information from the HVP file and the evaluation.

6.9. The Files

Input Files

.DAT	output from the HV scan program created by Donald Wilson. Input to this program.
.HVP	A file containing the old voltage data and some system information.
.PAA	The resulting high voltage settings for branch A are appended to this file
.PAB	The resulting high voltage settings for branch B are appended to this file

All files are text files and can be edited by ,e.g. Notepad.

6.9.1. The Input File for the HV Scan

The input to the Donald Wilson scan program: The line numbers and comment are not a part of the file. The example gives a total of 21 steps (5+15+1). The maximum number of steps is 32.

1	1800	Line 1 to 32 = nominal voltage settings
2	1517	

29	1447	
30	1410	
31	1391	
32	1476	
33	-15	The scan starts 15 steps before the nominal voltage.
34	5	It ends 5 steps after the nominal voltage.
35	20	The Voltage step is here 20 V.
36	1000	The time for each step is 1000 ms, 1 second

6.9.2. The HV Scan results (.DAT)

The resulting file named .DAT in the PC. Only the first part is reproduced here. The data are taken from a measurement using the input data shown in the preceding page.

1	21		The number of steps in the scan.
2	1500	1788	Detector 1, A-0, voltage and counts for each step.
3	1520	1922	
4	1540	2101	

19	1840	2561	
20	1860	2520	
21	1880	2438	
22	1900	2320	
23	1217	78	Detector 2, A-1
24	1237	94	
25	1257	97	

6.9.3. The System Data File (.HVP)

Some parameters are collected here and reproduced in the Analyses Text Box during the analyses of the data.

```
;SETTINGS for energy-calibrated NEUTRON DETECTORS.
; Syntax: ; in first position = comment line
;          Three letters in the first positions = parameter name
;          a / in position 4 after the name = parameters on 2 lines
;          The parameters are capital letters or figures separated by
;          anything else.
;
; Input data: Low Upper Level Neutron Energy in keV
ELL 100.0
EUL 1400.0
;
; Calibration parameters: Co-60 Energy in keV
ECO = 781.0
; Neutron detector parameters: VERSION 1 of 09-MAY-90
; Constant C Lower Level A side
ALC/   -95.59770 – -92.98448 – -92.67700 – -94.71216 -94.02595– -94.15124 – -95.71883 – -95.37336
       -89.64796 – -94.05767 – -92.60953 – -93.63454 – -94.35622 – -95.02723 – -96.64515 – -90.92054
; Constant N Lower Level A side
ALN/   13.9199– – 13.6593– – 13.6140– – 13.9067– – 13.7617– – 13.7548– – 13.9254–  13.8737
       13.3720– – 13.8962– – 13.6415– – 13.7802– – 13.8519– – 14.0444– – 14.1437–  13.3984
; Constant C Upper Level A side
AUC/   -95.93807-97.03045-94.83014-96.51661-94.33855-93.86630-93.99732-97.10278
       -92.16994-92.76257-92.78299-94.57716-97.09632-95.59081-98.74255-92.85490
; Constant N Upper Level A side
AUN/   13.8552– – 14.1008– – 13.7963– – 14.0441– 13.6972– – 13.6082– – 13.5837– – 14.0017
       13.6088– – 13.6038– – 13.5531– – 13.7974– 14.1143– – 14.0087– – 14.3156– – 13.5530
; Constant C Lower Level B side
BLC/   -94.32612– -94.69771– -95.20302– -91.35313– -93.16808– -93.91614– -85.90939– -92.92239
       -85.10455– -96.38091– -93.43744– -101.54265– -94.26544– -93.53030– -92.13696– -92.13000
; Constant N Lower Level B side
BLN/   13.7845– – 13.8778– – 14.0554– – 13.5781– 13.8366– – 13.7961– – 12.9904– – 13.6960
       12.9348– – 14.1114– – 13.8595– – 14.6917– 13.9245– – 13.8722– – 13.7060– – 13.5939
; Constant C Upper Level B side
BUC/   -97.53858– -96.95764– -93.84972– -94.32944– -94.18201– -96.26985– -85.23893– -92.48105
       -80.74310– -97.91914– -91.37764– -106.64184– -94.83786– -93.36443– -93.20802– -94.02959
; Constant N Upper Level B side
BUN/   14.1077– – 14.0739– – 13.7565– – 13.8779– 13.8629– – 14.0069– – 12.7811– – 13.5235
       12.2098– – 14.2092– – 13.4656– – 15.2696– 13.8927– – 13.7377– – 13.7402– – 13.7413
;
; SETTINGS FOR NEUTRON DETECTORS -
; The following values may be positive or negative.
; They will in both cases be used as positive numbers in the program.
; Note that the names are not the same as in files .PAA and .PAB
; However, the structure is the same, values can be copied from .PAA or .PAB
; ==============================
; Lower Level Discriminators Branch A
ALL/   150.   150.   150.   150.   150.   150.   150.   150.
       150.   150.   150.   150.   150.   150.   150.   150.
;Upper Level Discriminators Branch A
AUL/   927.   932.   927.   945.   957.   949.   943.   959.
       935.   913.   925.   928.   926.   922.   909.   940.
; High Voltages Branch A
AHV/   1596.  1517.  1520.  1508.  1550.  1570.  1605.  1610.
       1384.  1447.  1490.  1492.  1513.  1436.  1529.  1500.
; Lower Level Discriminators Branch B
BLL/   150.   150.   150.   150.   150.   150.   150.   150.
       150.   150.   150.   150.   150.   150.   150.   150.
; Upper Level Discriminators Branch B
```

```
BUL/    911.    923.    923.    941.    922.    934.    918.    927.
        939.    924.    947.    918.    940.    935.    922.    921.
; High Voltages Branch B
BHV/    1565.   1530.   1445.   1406.   1400.   1510.   1283.   1481.
        1244.   1527.   1410.   1624.   1447.   1410.   1391.   1476.
; Count Down
CDO     1       1
; End of Data
```

6.9.4. The Result Files (.PAA, .PAB)

```
;Parameters # 19, Branch AA at August-29-1995--12-56
;
; Syntax: ; in first position = comment line
;           Three letters in the first positions = parameter name
;           a / in position 4 after the name = parameters on 2 lines
;           The parameters are capital letters or figures separated by
;           anything else.
;         The spare parameters use the syntax SPRindex value explanation
; Branch AA or BB, ASCII.
BRN     AA
; Option of data, date or some other identification, Unsigned integer
OPT     19
; Number of memories in the system, 1, 2, or 3
MSY     3
        ----------------------
        ---------------------
; ------------------------------------------------
; High Voltage Settings from D:\TANSYEVA\HIVOCA\DATA\CTH.HVP
; or from High Voltage Calibr. D:\TANSYEVA\HIVOCA\DATA\M563081.DAT
; at April-17-1996--09-46
; Values in V
NDB/    -1596   -1517   -1520   -1508   -1550   -1570   -1605   -1610
        -1384   -1447   -1490   -1492   -1513   -1436   -1529   -1500
; ------------------------------------------------
```

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William H. Press et al, Numerical Recipes, Cambridge University Press, 1986.

Filename:	RF119.DOC
Directory:	D:\TANSYEVA\HIVOCA\DOCUMENT
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Title:	CTH-RF-119
Subject:	
Author:	Gudmar Grosshög
Keywords:	
Comments:	
Creation Date:	96-11-08 09.43
Revision Number:	8
Last Saved On:	96-11-22 15.56
Last Saved By:	Gudmar Grosshög
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