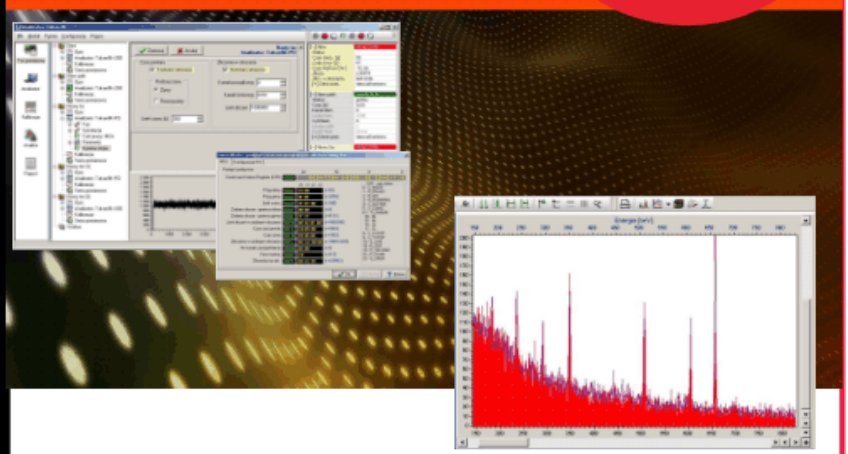
TUKAN 8K

Multichannel analyzer

User's Guide



Version 2.2

National Centre for Nuclear Research
NARODOWE CENTRUM BADAŃ JĄDROWYCH
Świerk, Poland
www.ncbj.gov.pl

Tukan 8k

Multichannel Analyzer & Multichannel Scaler with USB and PCI interface

version 2.2

The multichannel pulse height analyzer (MCA) and multichannel scaler (MCS) is a device for running spectroscopy or timing measurements performed in nuclear laboratories an institutions for radiowctive contamination control.

The Tukan8k analyzer consist of two parts: analyzer hardware and the software.

This manual describes software and hardware installation process, program construction, rules of its operation and methodology of performing particular operation.

Tukan 8k

TUKAN 8k

Printed: 2013-03-20 in NCBJ Swierk, Poland

Hardware

Zbigniew Guzik
Stanislaw Borsuk

Software

Krystyna Traczyk
Michal Plominski
Radoslaw Marcinkowski

Technical support

tel.: (48-22) 718-05-49
(48-22) 718-05-48

e-mail: tukan@ncbj.gov.pl

Production

National Centre for Nuclear Research
Electronics and Detections Systems Division
05-400 Otwock-Swierk, POLAND

Table of Contents

1 Tukan-8k Analyzer 10

1.1 Modification of latest Tukan8k analyzers ... 11

2 General description of program 12

2.1 Program files ... 12

2.2 Program modules ... 13

2.2.1 Hardware module ... 14

2.2.2 Analyzer module ... 15

2.2.3 Calibration module ... 16

2.2.4 Analysis module ... 17

2.2.5 Report module ... 18

2.3 Data files ... 19

2.4 Spectra files formats ... 20

2.5 Start of the program ... 22

2.6 Work with USB Dongle key ... 22

3 Acquisition path 23

3.1 Defining of acquisition path ... 23

3.1.1 Acquisition path name - spectrum name ... 25

3.2 Connecting analyzer ... 25

3.3 Detection and identification of analyzer device ... 28

3.3.1 Hardware registers of the analyzer ... 29

3.3.2 Default values of parameters ... 31

3.4 Mode of running (MCA, MCS) ... 31

3.5 Setting of parameters ... 32

3.6 Measurement description prameters - Sample mass ... 34
3.7 Stop criteria ... 35
3.8 Acquisition path calibration ... 36
3.9 Measurement session ... 38
3.10 Working with several analyzers ... 41
3.10.1 Adding and removing acquisition path ... 41
3.10.2 Select analyzer to control ... 42
3.10.3 Several measurement spectra control ... 44
3.11 Configuration files of acquisition path ... 46

4 Measurement 47

4.1 Acquisition control ... 47
4.2 Acquisition process inspection ... 49
4.3 Setting of stop criteria ... 52
4.4 Common acquisition control ... 54
4.5 Resumation of measurement after program exit ... 55
4.6 Acquisition control during measurement session ... 55
4.7 Measurement spectrum ... 57
4.8 Measurement spectrum periodical backup ... 58

5 Multi-channel scaling (MCS) mode 60

5.1 Analyzer parameters in MCS mode ... 60
5.2 Measurement control in MCS mode ... 63
5.3 Acquisition spectrum MCS ... 65
5.4 Calibration and analysis of MCS type spectra ... 65

6 Working with the spectra 68

6.1 Spectra container ... 68
6.2 Open spectrum ... 71
6.3 Save spectrum ... 72
6.4 List of reference spectra ... 73

6.5 Information about main spectrum ... 74
6.6 Export to ASCII format ... 74
6.7 Import from ASCII format ... 75
6.8 Smoothing spectrum ... 77
6.9 Adding and subtraction spectra ... 77
6.10 Compressing spectrum ... 79
6.11 Printing a spectrum ... 80

7 Plotting a spectrum 81

7.1 Markers ... 82
7.2 Display control ... 83
7.3 Spectrum plot style changing ... 85
7.4 Colors of the plot panel ... 85

8 ROI 87

8.1 ROI controlling commands ... 87
8.2 ROI files ... 89

9 Analysis 91

9.1 Peak analysis 'on-line' ... 91
9.1.1 Peak parameters panel ... 91
9.1.2 Peak parameters calculate ... 94
9.2 Advanced analysis ... 95
9.2.1 Mathematical models of peak analysis ... 96
9.2.2 Selection of fitting function models ... 97
9.2.3 Peak parameters display ... 99
9.3 Automatic peak search ... 101
9.4 Nuclide libraries ... 102
9.5 Peaks identification ... 104
9.6 Activity and concentration calculate ... 106
9.7 Peaks table ... 107

10 Calibration 109

10.1 Calibration operations ... 110

10.1.1 Inserting calibration to spectrum ... 112
10.1.2 Transfer calibration beetw en spectra ... 113
10.1.3 Delete calibration ... 114
10.1.4 Visual control of calibration ... 114
10.2 Inserting of calibration data ... 115
10.2.1 Inserting data from calibration spectrum ... 116
10.2.2 Inserting energy from nuclide library ... 117
10.3 Energy calibration process ... 118
10.4 Peak shape calibration process ... 119
10.5 Efficiency calibration process ... 120
10.5.1 Efficiency of detection calculation ... 121
10.5.2 Calibration standars libraries ... 124
10.6 Calibration curve ... 126

11 Report 128

11.1 Report configuration ... 129
11.1.1 Peaks table configuration ... 131
11.1.2 Spectrum plot configuration ... 132
11.1.3 Configuration file ... 133
11.2 Printing report ... 133
11.3 HTML and Text format of the report ... 134

12 Program configuration 135

12.1 Measurement configuration options ... 136
12.2 Display spectrum options ... 138
12.3 Configuration analysis options ... 139
12.4 Selecting language of program ... 142
12.5 Setting directory of program ... 142

13 Keyboard 144

13.1 Acquisition navigation keys ... 144
13.2 Markers navigation keys ... 144
13.3 Displaying spectrum navigation keys ... 145
13.4 ROI system navigation keys ... 146

14 Appendix A: Library TukanFit.dll 147

15 Appendix B: Instalation of Tukan8k analyzer and program 151

15.1 Hardware requirements ... 151
15.2 Instalation of Tukan8k program ... 152
15.3 Instalation of Tukan-8k-USB box ... 153
15.4 Instalation of Tukan-8k-PCI card ... 154
15.5 Instalation of USB Protection Key ... 155

16 Appendix C: Technical parameters of Tukan_8k_USB Analyzer 156

16.1 I/O Connections and LED Indicators ... 157
16.2 Powering the device ... 157
16.3 MCA - Multichannel Analyzer mode ... 158
16.4 MCS - Multichannel Scaling mode ... 159
16.5 SCA - Single Channel Analyzer ... 161

17 Appendix D: Technical parameters of Tukan_8k_PCI Analyzer 162

17.1 I/O Connections and LED Indicators ... 163
17.2 MCA - Multichannel Analyzer mode ... 163
17.3 MCS - Multichannel Scaling mode ... 165

Index 168

1 Tukan-8k Analyzer

The multi-channel pulse height analyzer (MCA) and multi-channel scaler (MCS) is a device for running spectroscopy or timing measurements performed in nuclear laboratories and institutions of radioactive contamination control.

The TUKAN8k analyzer consists of two parts: analyzer hardware and the software. The program can control unlimited number of analyzers at a time.

The analyzer hardware is available as a device to be connected to the PC via USB interface (Tukan8k-USB 156). But, if needed, it can be produced as a card to be plugged into the host PC into PCI slot (Tukan8k-PCI 162).
Both types of analyzers are controlled by the same program.

Operating mode:
Signal from detector of radiation, respectively amplified and formed in spectroscopy amplifier is carried to a slot placed in front of the analyzer, where is transformed in analog to digital converter. Memory buffer in the device stores spectrum being collected. The Tukan8k software ensures control, "on-line" visualization and analysis of experimental data.

Supported operating systems:
The analyzer can operate in MS Windows 2000 / XP / Vista/ 7 (32 and 64 bit) environment. It is "plug and play" device type.

The program itself can operate with various types of analyzer, including oldest **ISA** version, which was earlier supported by program for MS DOS.
It is also possible to select "undefined" device type what in practice denotes program execution without the analyzer hardware. Then the program works in the "off-line" mode but it requires USB Protection Key 22 connected to the computer.

1.1 Modification of latest Tukan8k analyzers

Modification of latest Tukan8k_USB analyzers are obligatory for the device which **serial number is greate then 237.**

Hardware modifications:

concerns to different functionality and handling of TTL Lemo sockets placed in front panel of the analyzer which are described in Appendix C of User's Guide and are as follows:

Port A (Gate or Even) - no change in comparison to the previous versions

for remaining sockets the same functionality is given for both modes of running

Port B (SCA-OUT) - **Input**: positive TTL pulse 100 ns width generated after detection of input analog pulse which amplitude stays between selected thresholds. It is output of single channel analyzer.

Port C (RUN) - **Input**: starting acquisition by external pulse (rise edge of TTL positive signal)

Port C (RUN) - **Output**: stopping acquisition by external signal (rise edge of TTL positive signal)

Modifications of the program (version 2.2.2):

type and version of an analyzer is recognized by the program – for those analyzers which serial number is **greater then 237** contents of **setting parameters form** is changed (User's Guide chapter 3.5 and 5.1):

- ⇨ in MCA mode of running „TTL Lemo configuration" group of options lacks
- ⇨ in MCS mode of running „TTL Lemo configuration" and "External stop" groups of options lack but options concerned with external triggering are inactive.

The serial number of the analyzer can be viewed in „Spectrum information" box available in „File" menu or „Inform." box available in „Help" menu.

Modifications were performed in respons for users requests.

2 General description of program

The main purpose of the program is to allow the user to perform: acquisition control, collection, visualization and archiving of experimental data, to run spectra analysis and to generate reports containing acquisition results.

The following chapter contains description of the program architecture, rules of data flow between modules of the program and specification of data files structure.

2.1 Program files

The Tukan8k program consists of the following files:

Tukan8k.exe	- the main program
Tukan8k.PLK	- resource file for Polish language version
Tukan8k.ENU	- resource file for English language version
TukanFit.dll	- mathematical library for spectra analysis

During installation procedure the following dynamic-link library files are added to the main directory of the program:

pthreadGC2.dll	- POSIX threads for Windows32 library
mingwm10.dll	- library file for Windows
SiUSBXp.dll	- USBExpress library from 'Silicon Labs Inc.'
FTD2XX.dll	- USB direct access library from 'Future Technology Devices International Ltd.'
borlndmm.dll	from 'CodeGear'

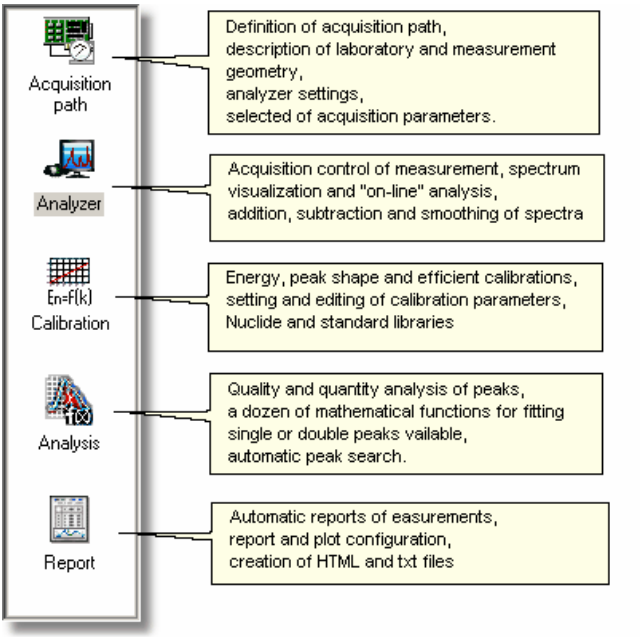
They are necessary for proper program functionality.

During installation process several working directories are establishes for the program and program initial settings are saved the to the Windows Registry.

Language of interface of the program and working directories settings can be changed due to configuration options available in the program.

2.2 Program modules

The program has modular construction – selected purposes are realized by separate program modules.
The whole program is supervised by "manager", which is responsible for proper functionality of each module, data exchange among them, initialization of display parameters etc. One of important elements of the program is the modules selection panel published below, where tasks performed by each module are also presented.



Module selection can be performed by

1. click on an icon representing selected module placed on the module selection panel

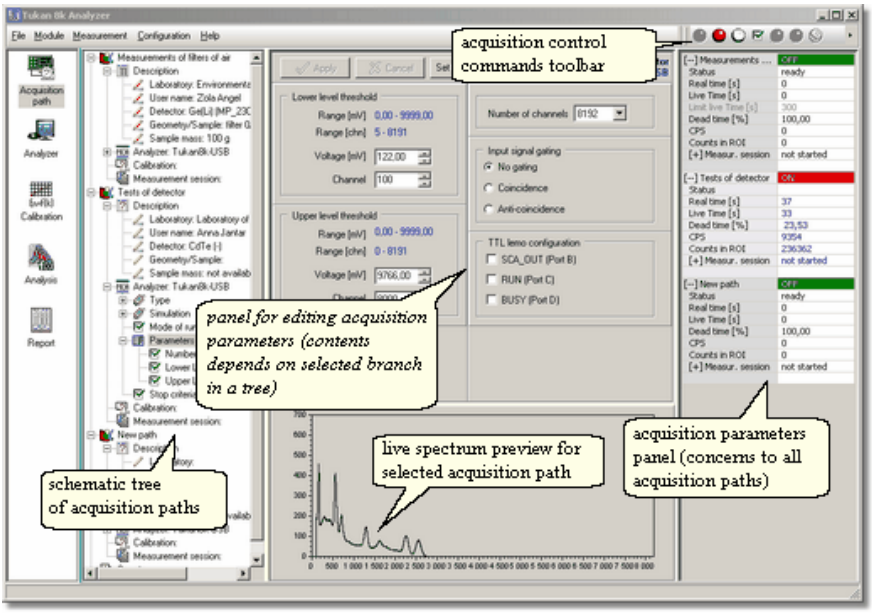
2. menu selection: **Module | Go to...**

General description of functionality of each module is presented in the following chapters:

Hardware module 14
Analyzer module 15
Calibration module 16
Analysis module 17
Report module 18

2.2.1 Hardware module

Purpose:
define an acquisition path, set values of all measurement parameters, full on-line acquisition control.



Functionality:

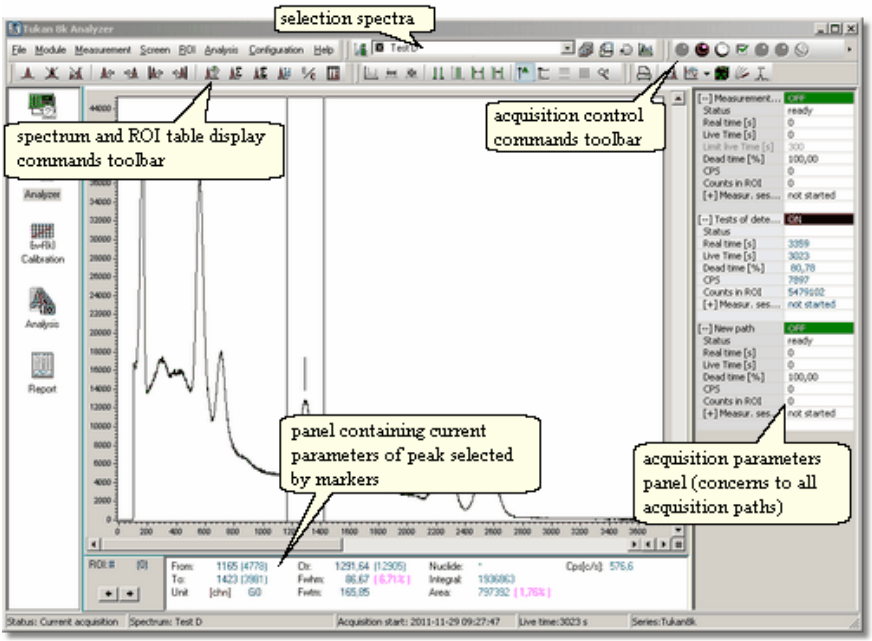
- adding, deleting and ordering acquisition paths,
- filling descriptive options (laboratory, user, geometry, detector),
- filling data concerned to mass of a sample,
- type of analyzer selection,
- analyzer parameters definition,
- mode of running (MCA, MCS) selection,
- calibration control (for selected acquisition path),
- selecting of automatic acquisition stop criteria,
- acquisition control (start, stop, reset),
- on-line monitoring of acquisition (parameters and spectra),
- "live" spectrum preview for selected acquisition path.

see also:

Acquisition path 23

2.2.2 Analyzer module

Purpose:
acquisition control and visualization, initial spectrum analysis, spectra basic manipulation.



Funcionality:

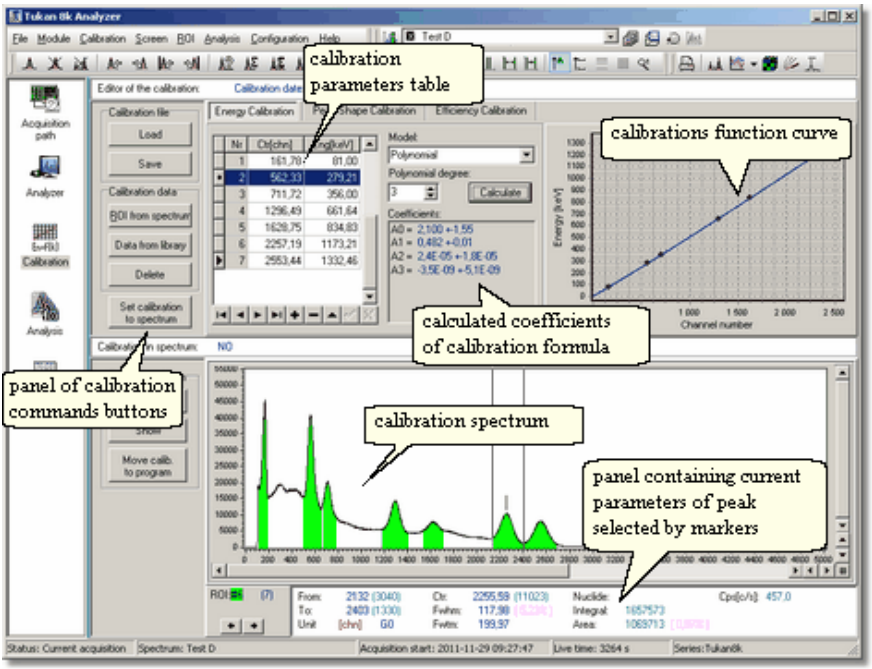
- acquisition control,
- modification of selected acquisition parameters: length of acquisition time, automatic acquisition stop criteria,
- spectra displaying in channel and energy scale,
- visual comparison of current acquisition with spectra loaded from files
- automatic or manual defining of Regions of Interest,
- initial "on-line" spectrum analysis containing calculation of base parameters of a peak
- adding, subtracting, smoothing and compressing spectra,
- automatic peak search,
- nuclide identification,
- saving live spectrum to a file,
- loading spectrum from a file,
- export/import to/from files in ASCII format.

see also:

Measurement 47

2.2.3 Calibration module

Purpose:
energy, peak shape and efficiency calibration run, veryfication of the spectra calibration



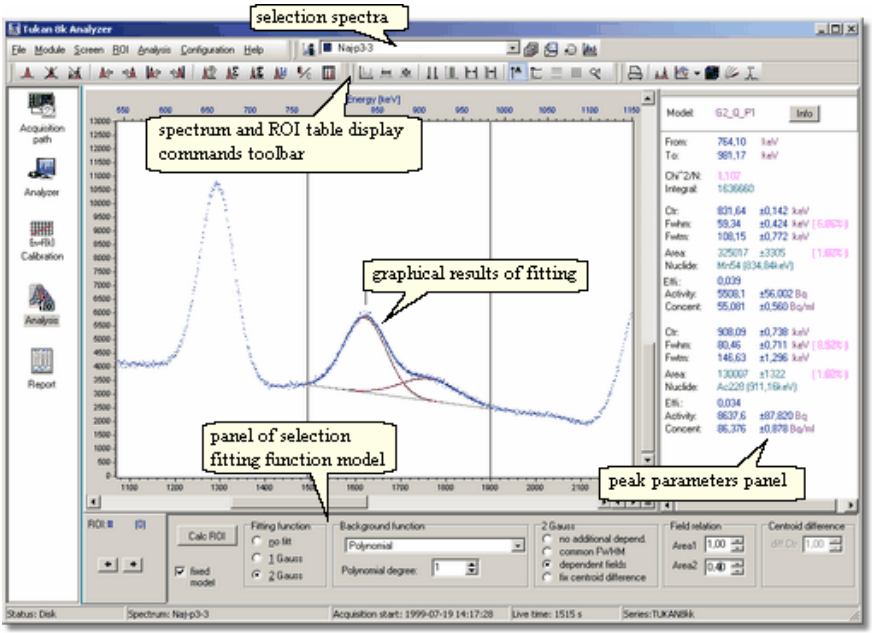
Functionality:

- inserting and edition of calibration data,
- selection of a type of calibration equation (formula),
- energy, peak shape or efficiency calibration execution,
- visualization of the results – formula coefficients and diagram of calibration curve,
- inserting calibration parameters to a spectrum,
- saving/loading spectrum to/from a file,
- automatic peak search,
- nuclide library,
- library of calibration data,
- editor of nuclide library and libary of calibration data.

see also:
Calibration 109

2.2.4 Analysis module

Purpose:
quality and quantity analysis of a spectrum, nuclide identification, peak table creation



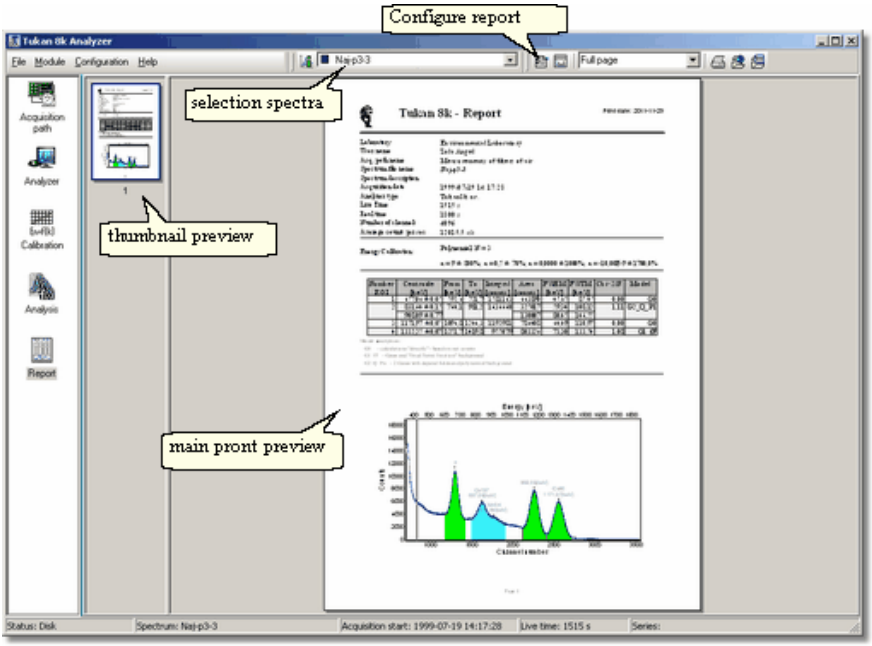
Functionality:

- automatic peak search based on peak shape calibration,
- peak fitting with modified Gauss function,
- double peak separation,
- selection one from dozen fitting functions,
- nuclide identification based on selected nuclide library,
- nuclide library editor,
- efficiency, activity and concentration calculation for selected peak,
- ROI editor,
- peak table editor.

see also:
Analysis 91

2.2.5 Report module

Purpose:
preparation and configuration of reports from acquisition, report printing, saving reports to files



Functionality:

- automatic report creator for selected acquisition spectrum,
- configuration of the report contents: elements selection,
- personalization of peak table structure (contents, placement, units etc.),
- personalization of spectrum diagram,
- possibility to input extra descriptions,
- report printing - selection of printer device and additional printing options,
- saving report as HTML type file,
- saving report as text type file.

see also:

Report 128

2.3 Data files

The measured spectra and various information about them can be saved in the specialized files:

Spectra

MCA spectrum files	**"*.wdm"**,	binary format	(native format of the program)
MCS spectrum files	**"*.wds"**,	binary format	(native format of the program)
spectrum data files	**"*.lst"**	ASCII format	(one column contains counts in channel values only)
spectrum data files	**"*.dat"**	ASCII format	(number of sequential channel and count value are placed in two columns)
spectrum data files	**"*.tab"**,	ASCII format	(table with counts grouped in 10 columns)

Calibration and ROI tables

calibration files – binary format – "***.clb**"
ROI definition files – binary format – "***.roi**"

Reports

report files – HTML format – "***.htm**"
report files – text format – "***.txt**"

Libraries

nuclide library files – text format – "***.tnc**"
calibration standards library files – text format – "***.eff**"

Configurations

hardware setup configuration files – text format – "***.cfh**"
report configuration files – text format – "***.cfr**"

Auxiliary directories

The Tukan program installer creates auxiliary directories **Library** and **Spectra**.
Library files: "***.tnc**" and "***.eff**" are stored in **Library** directory.
Spectrum files, data files and reports are stored in **Spectra** directory.
The other files are stored in program default directory.

see also:

Spectra files formats 20

Setting directory of program 142

2.4 Spectra files formats

File format of .wdm - (binary file of MCA-type spectrum)

Nr of byte	Length in bytes	Data format	Contens
0..3	4	integer	version code
4..5	2	word	number of channels of a spectrum
6..8005 (32768)	4 * 8k	integer	counts (up to 8192 channels * 4 bytes/ chn) *(length depends on number of channels)*
8006	4	longint	check code
	8	double	sample mass
	1	byte	sample mass unit
	n	ASCII (n*byte)	type of analyzer
	n	ASCII (n*byte)	serial number
	n	ASCII (n*byte)	geometry
	n	ASCII (n*byte)	name of spectrum
	n	ASCII (n*byte)	spectrum description
	8	double	date and time of start of acquisition *(format: TDateTime:Year:Month:Day: Hour:Min:Sec)*
	4	integer	acquisition time (in s) – real
	4	integer	acquisition time (in s) - live
	4	integer	indicator if calibration performed and check code
	...		energy, peak shape and efficiency calibration data
	...		list of ROIs

File format of .wds - (binary format of MCS-type spectrum)

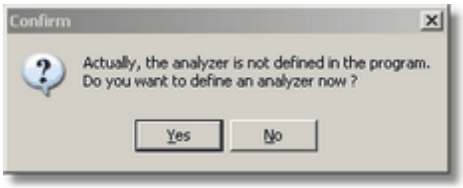
Nr of byte	Length in bytes	Data Format	Contens
0..3	4	integer	version code
4..5	2	word	number of channels of a spectrum
6..8005 (32768)	4 * 8k	integer	counts (up to 8192 channels * 4 bytes/ chn) *(length depends on number of channels)*
8006	4	longint	check code
	8	double	sample mass
	1	byte	sample mass unit
	n	ASCII (n*byte)	type of analyzer
	n	ASCII (n*byte)	serial number
	n	ASCII (n*byte)	geometry
	n	ASCII (n*byte)	name of spectrum
	n	ASCII (n*byte)	spectrum description
	8	double	date and time of start of acquisition *(format: TDateTime:Year:Month:Day: Hour:Min:Sec)*
	4	integer	acquisition time
	4	integer	number of sweeps
	4	integer	lnumber of channels of MCS
	4	integer	DwellTime
	1	byte	units of DwellTime

Formats of spectra text files are described in chapter Export to ASCII format 74

2.5 Start of the program

The Tukan8k program can be started directly from the file **Tukan8k.exe** typically placed by the installation program in directory **c:\ProgramFiles\Tukan8k** or from the icon  also placed by the installation program at the desktop.

When started, the program verifies if any analyzer is connected to PC or if USB Dongle 22 is plugged in.
If none of them is present, the message below will be displayed on a screen and the program will not start.



Similar effect will arise when analyzer is corrupted or USB slot in PC is out of order and device is not detected by the program.

see also:

Connecting analyzer 25
Appendix B: Instalation of Tukan8k analyzer and program 151

2.6 Work with USB Dongle key

The Tukan8k program can be run in PC where instead of the Tukan analyzer, the USB Dongle is connected to.
The USB Dongle is supported by version 1.7 of the program, or higher.

The Tukan8k program activated with the USB Dongle acts as a tool for "off-line" analysis of the spectra. The functionality of the program is the same as with an analyzer connected.

3 Acquisition path

Acquisition path is a set of devices and their settings applied in a measurement process, which form experimental spectrum as a result of their activity. It consists of the following elements: detector, high voltage supplier, spectroscopy amplifier and pulse height analyzer.
In the program concept, acquisition path is a structure uniquely defined by the parameters like: type of analyzer and its settings, detector type, measurement geometry, mass of a sample etc.

The program allows to handle many analyzers at a time on one PC. For better clarity, in a new version of the program (2.0) the new way of data presentation was introduced. The new way is more flexible in comparison with earlier versions in aspect of simultaneous control of many analyzers, like:

- different type of analyzers configuration,
- preset parameters display,
- current parameters display,
- access to data,
- common control of several acquisitions.

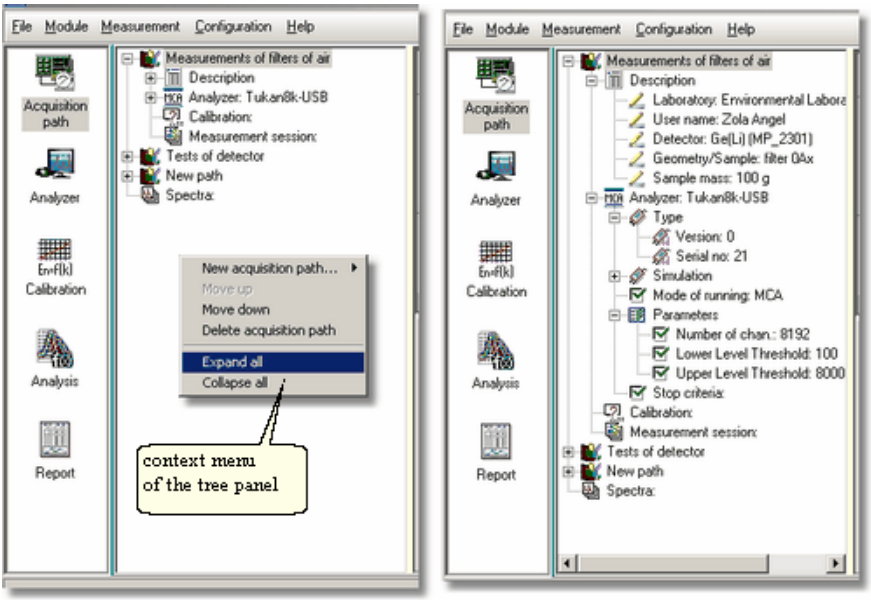
Inspection of current status of acquisition path and changing of its parameters is possible in Hardware module 14 only.
Acquisition control commands are available in 'Hardware' module as well as in Analyzer module 15.

3.1 Defining of acquisition path

Defining of *acquisition path* which means a process of selecting of particular parts from which it consists of, is the very base activity which influence for functionality of the analyzer. Usually it is performed once, because the program saves actual settings for future use.

List of configuration and descriptive parameters are grouped in a tree structure. Extended structure with many branches, which can be freely collapsed or expanded, allow quick access to all data, even then, when many acquisition paths is supported simultaneously by the program.

On figure below a part of "Acquisition path" module screen is shown. Tree diagram is seen in both modes: collapsed and expanded.



Tree structure performs important rule during acquisition path configuration process. All parameters for selected acquisition path are available for a user in dynamically changed forms which are displayed due to context of selected branch of a tree.

It is possible to move through the tree by mouse or keyboard. Expanding and collapsing of selected branch is done after mouse click on "+" or "-" field or after pressing <+>, < -> > (arrow) or <->, < <- > (arrow) key. Due to selected branch, corresponding form is displayed in a center of the program screen.

To change any parameter's value, the user has to edit it in a form and accept modifications performed by click of "Apply" button available at a top part of each form. For user comfort, those parameters, which value was changed are distinguished by a different background color (one form can contain many parameters, and many of them can be changed at a time).

Types of forms available in current version of the program:
- acquisition path description: laboratory, detector, geometry, sample mass 34
- analyzer type and mode of running selected 25
- setting of acquisition parameters 32
- analyzer parameters in MCS mode 60
- stop criteria in MCA mode 35
- acquisition path calibration 36

- measurement session configuration 38

3.1.1 Acquisition path name - spectrum name

During creation of a new acquisition path (see Adding and removing acquisition path 41) the program automatically assigns its name as "New path" (or "Nowy tor" if the program is switched to the polish language version).
If another acquisition path with this name already exists, then index part of the name is automatically added, e.g. "New path [1]", "New path [2]" etc. Indexes are added in sequence of their creation and are not related to the place of their existence in the acquisition path tree.

When defining an acquisition path, which is dedicated for specified type of measurements or for dedicated type of apparatus, it is very recommended to change name of an acquisition path for a such one, which describes by its name performed measurements, e.g. "Air filter", "Soil samples", "Detector tests" etc. The new name for acquisition path can be set in a form described in chapter Measurement description prameters 34.

After connecting an analyzer to a new acquisition path, the program allocates in memory "measurement spectrum" object to which the program automatically put data collected in memory buffer of specified analyzer. Name of a spectrum automatically given by the program is identical to a name of acquisition path, so acquisition performed in selected acquisition path is identified by a name of its path. This name can be modified in a form described in chapter Connecting analyzer 25.

In "Acquisition path" module, at the bottom of each form being displayed in a middle part of a screen, a box is displayed, which is dedicated to display actual measurement spectrum.

More information about "live spectrum" and maintenance of all measurement spectra are available in chapter Measurement spectrum 57.

Remark: in the program, many acquisition paths can be defined, but spectra will be shown only in those, where analyzer was defined.

3.2 Connecting analyzer

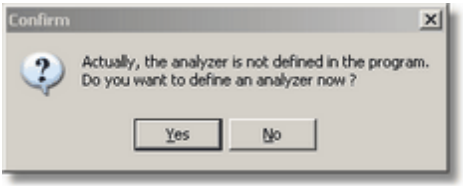
The program allows to control the analyzer, which is:
1. connected to PC,
2. installed in PC (see: Appendix B: Instalation of Tukan8k analyzer 153)

and
3. selected in the tree diagram.

If 1 or 2 condition is not performed, the program will not start and the following message will be displayed: "Neither Tukan analyzer nor USB Authorization Key found." (see: Start of the program 22).

Accessing analyzer when the program starts

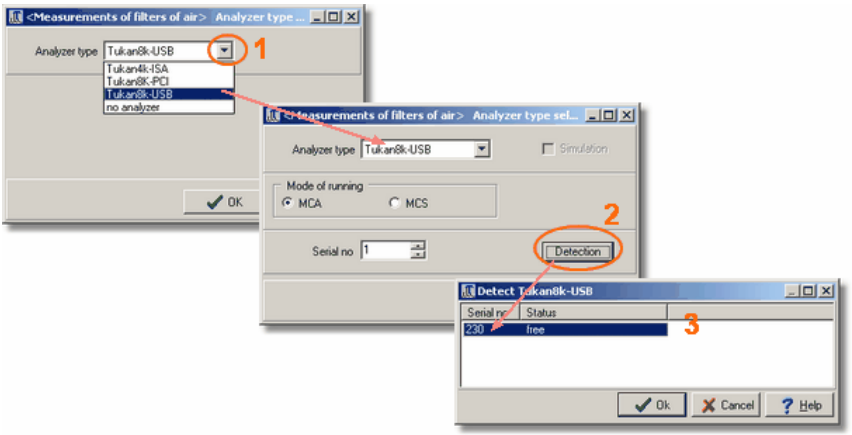
If the analyzer is connected to PC and properly installed, but is not defined in the program, the following message will be displayed when the program starts:



- if on response **"No"** button is selected, then the program starts, all functionality is available for the user except those which concern to acquisition,

- if on response **"Yes"** button is selected, then "Analyzer type selection/ configuration" dialog window appears, in which it is possible to:

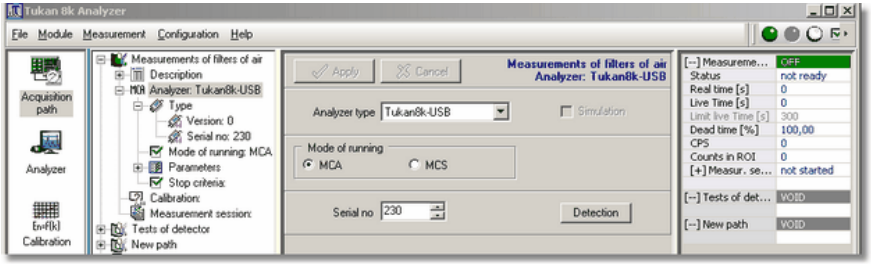
1. expand list of analyzers supported by the program (mouse click on a button with an arrow) and select a proper one. When done, contents of a form is filled by elements suitable for selected type of analyzer,
2. click **Detection** button to display a dialog box containing a list of devices of selected type which are currently connected and recognized by PC,
3. select a proper one from a list and press "**OK**" (attention: even then, when a list contains only one item, it has to be selected) - dialog box disappears and an appropriate serial number will be displayed in the "Serial no" field of dialog box no 2 displayed below.



Insert an analyzer from the tree

Selecting analyzer from the tree diagram takes a course very similar, and runs as follows:

1. select in the tree an "Analyzer" item and click with left mouse button,
2. in a central part of a screen a form shown below will appear,
3. from a list of "Analyzer type" select a proper one and continue process as described before.



Additional remarks about connecting analyzer to the program are placed in next chapter: Detection and identification of analyzer device 28.

3.3 Detection and identification of analyzer device

The Tukan8k-PCI as well as the Tukan8k-USB analyzer can be detected by the program. For both types detect process is performed in the same way. For the Tukan8k-USB analyzer it is described in the chapter Connecting analyzer 25.

Each copy of the **Tukan8k-USB** analyzer contains its serial number, which allows for unique identification.
The program reads that number during detection process and displays it in "Serial no" field ("Acquisition path" module).

The Tukan8k-PCI analyzer is identified by its local address set on the board (number from 0 to 7).

So, the list of devices which appear in "Detection" window is the list of serial numbers of Tukan8k-USB analyzers or list of local addresses of Tukan8k-PCI analyzers.

When after click on "detection" button instead of a list of analyzers the following information is displayed: **"No devices of selected type"** it means that the program does not detect any analyzer of selected type. In such a case it is recommended to verify if an analyzer is properly powered (it is mostly important for Tukan8k-USB powered via USB) and if is properly plugged in.

Information about type of analyzer and its serial number is added to each acquisition spectrum and both are saved to a file (file ".wdm" 20 or ".wds" 20). Thank's to that, each spectrum "knows" in which analyzer was collected.

Serial number of an analyzer is also available in Information about main spectrum 74 dialog box and when opearatin with several acquisition paths 44 allows to identify in additional way, from which acquisition path observed spectrum comes.

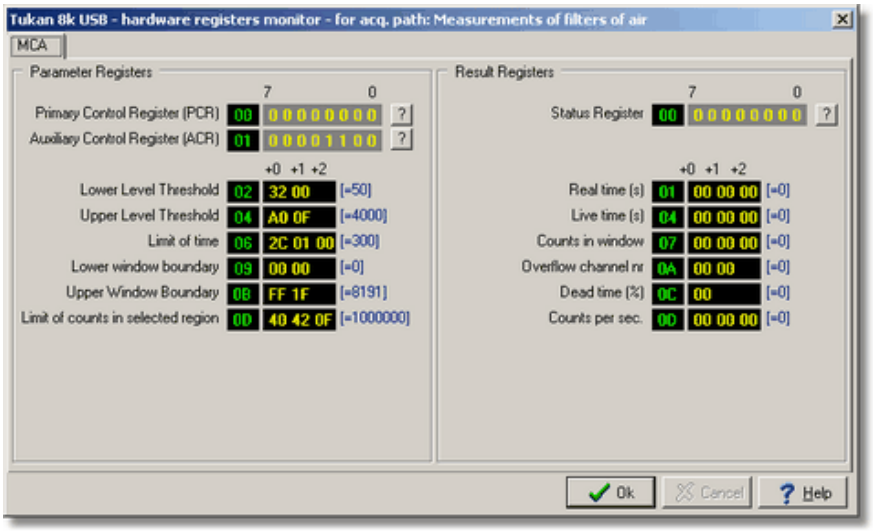
3.3.1 Hardware registers of the analyzer

The program allows to read the hardware registers of an analyzer. The proper command is available in "Acquisition path" module only:

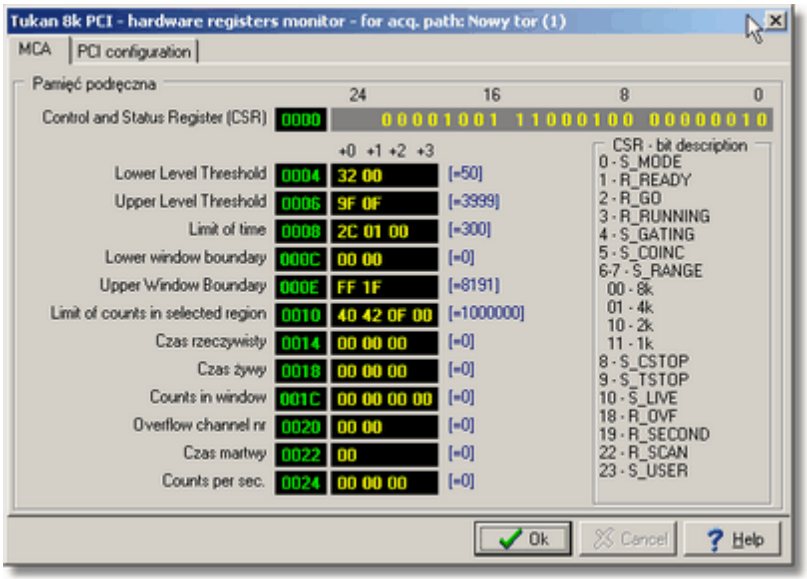
menu: **Measurement | Analyzer internal register...**

Information being presented in windows is read-only, current status of internal registers is shown being refreshed about every 1s.
Appearance of the window may depend on an analyzer type and mode of running.

For the **Tukan8k-USB** analyzer, this window contains hardware register names and addresses with their values. Parameters are split into two groups: Parameter Registers and Result Registers. Meaning of each bit of them is described in a window which can be displayed after click on  button.



In case of the **Tukan8k-PCI** analyzer, this window contains two tabs. The name of the first agrees with the current mode of work. It contains a list of the internal memory cells. Second tab shows the PCI bus communication registers. Meaning of particular bits in a register shown in binary mode is described at the right part of the form.



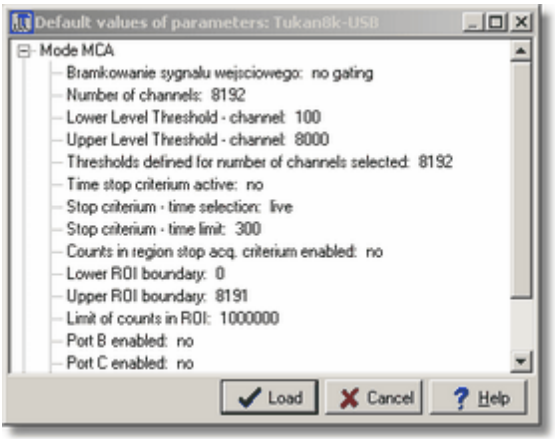
Information shown in the dialog window "Analyzer internal registers" has auxiliary meaning only and is destined for advanced users only.

3.3.2 Default values of parameters

The program allows to load "factory defaults" - default settings for given mode of running (MCA or MCS). It is available in "Acquisition path" module only:

menu: **Measurement | Default settings...**

When the command is selected, window containing a list of parameters accomplished with their default values appears on a screen. Loading displayed values to an analyzer takes place after selecting **"Load"** command.



Meaning of particular parameters is described in the following chapters:

see also:

Appendix C: Technical parameters of Tukan8k-USB Analyzer 156
Setting of parameters 32
Stop criteria 35

3.4 Mode of running (MCA, MCS)

Irrespective of the type of analyzer (USB, PCI), two modes of running are available:

- multi-channel pulse height **MCA** (see Tukan8k-USB MCA mode 158 or Tukan8k-PCI MCA mode 163),

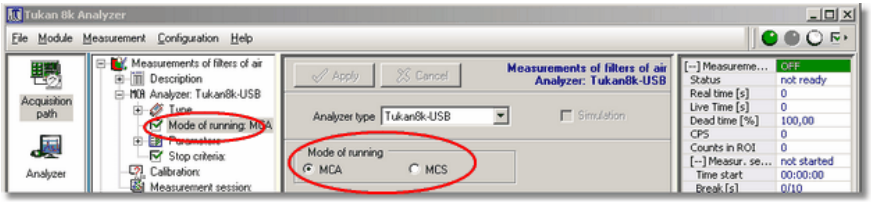
or

- multi-channel scaler **MCS** (see Tukan8k-USB MCS mode 159 or Tukan8k-PCI MCS mode 165).

Mode of running selection:

Changing mode of running can be performed in "ACQUISITION PATH" module only. To do that:

1. select "Mode of running" item in the acquisition path tree (see figure below),
2. in a form displayed in a center of a main form of the program select one of two: MCA or MCS.



Changing mode of running is a very easy task - it is enough to select in "Mode of running" form appropriate radio button:**"MCA"** or **"MCS"**- but keep in mind that it results in many changes in the program, because mode of measurement becomes different. Changes refers to the acquisition path tree view, forms content, parameters of measurement, rules for calibration of acquisition path.

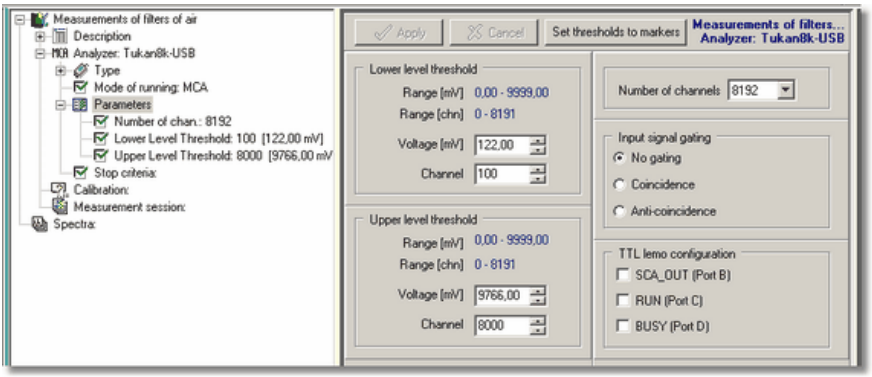
Basic and most frequently applied mode of running is MCA, so in "Acquisition path" and "Measurement" chapters this mode of running is first of all described. Multi-channel scaling (MCS) mode 60 is described in separate chapter of this manual.

3.5 Setting of parameters

Modification or changing parameters of an analyzer can be performed in Hardware module 14 only.

Settings of basic parameters of an analyzer, like lower and upper threshold, are displayed in the acquisition path tree at the "Analyzer/Parameters" branch. When Click on "Parameters" item, the dialog form will appear which contents depends

on the type of analyzer and selected type of running (MCA, MCS).

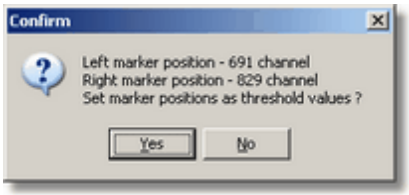


On figure above, form for Tukan8k-USB analyzer running MCA mode is shown. The following parameters can be set there:

Lower and upper level threshold – values of the appropriate threshold may be change by writing their absolute value in millivolt [mV] or by defining particular number of channel from (or to) which a spectrum will be reduced. When changing number of channel, corresponding voltage value will be updated automatically. Minimal and maximal range values are available on the form.

Level thresholds can be also set in the following way:

- select "Analyzer" module and start acquisition,
- when observing spectrum, set position of both markers to a such ones where you expect thresholds to be,
- return to "Acquisition path" module, press **"Set thresholds to markers"** button - the following message will be displayed:



- press "Yes" button - displayed number of channels in the box above will be input as the new values for thresholds.

Number of channels – number of channels of area where spectra are

accumulated (**1024, 2048, 4096 or 8192**) selected from a pull down list.

Input signal gating – selecting mode of gating of analog input signal; then only those signals, which are in coincidence or anti-coincidence with gating signal are being registered. Usually analyzer operates without any external gating (No gating setting).

TTL Lemo configuration – these options are responsible for output signals at TTL connectors. Detailed description of those signals may be found in Appendix C: MCA - Multichannel Analyzer mode 158.

After changing any value, suitable part of a form gains different - yellow color background, what means, that parameter was intended to be changed, but not confirmed yet. Input of changed values to the program occurs after selecting "Apply" button.

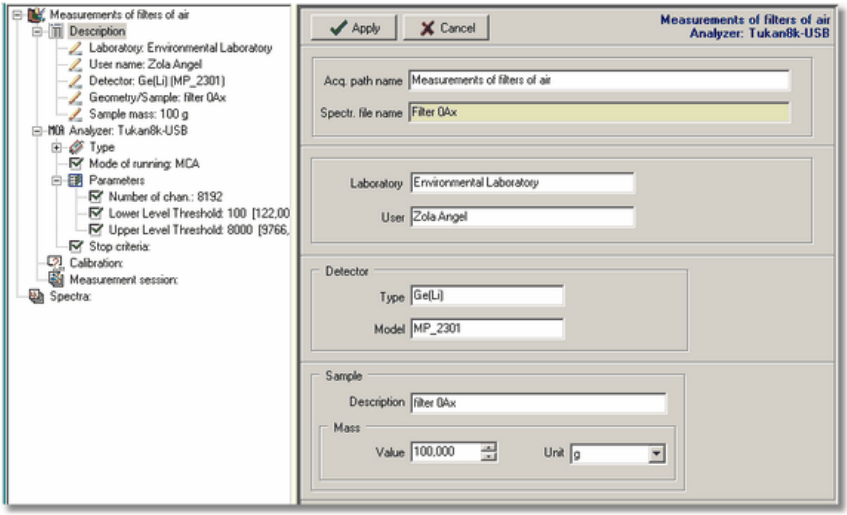
see also:

Appendix C: Technical parameters of Tukan8k-USB Analyzer 156
Default values of parameters 31
Hardware registers of the analyzer 29

3.6 Measurement description prameters - Sample mass

Measurement description parameters include those parameters of acquisition path which describe conditions in which measurement was done and characterize sample being examined. They are placed in acquisition report and (some of them) are stored in a file of spectrum.

Form containing measurement description parameters is available in "Acquisition path" module after selecting "Description" item in the acquisition path tree.



Most of boxes on the form are text edit boxes, in which user can input describing and identifying information.

Sample mass: - numerical value and unit type entered in this place are applied in quantity analysis of examined spectrum to calculate concentration of radiative material in a sample (see Activity and concentration calculate 106).

Value of sample mass input to a spectrum, is also shown in Information about main spectrum 74 box.

3.7 Stop criteria

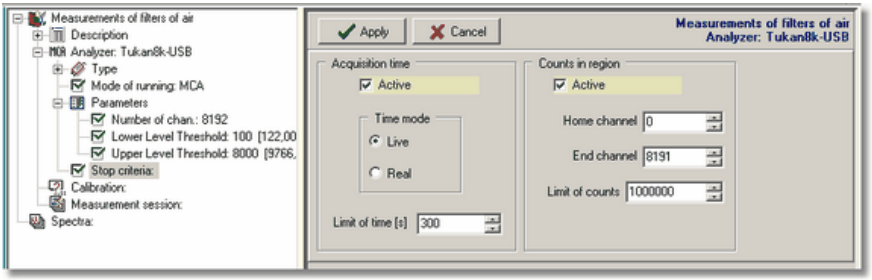
In the Tukan program acquisition can be stopped manually (see: Acquisition control 47) or automatically after reaching selected in "stop criteria" values.

Selected stop acquisition criteria can be set individually for particular measurement (see chapter "Measurement" Setting of stop criteria 52), or for complete acquisition path defining defaults for measurement of samples of the same type.

The program allows to set two independent criteria for automatic acquisition stop:
- time (with possibility of distinguish between two types of time calculation: real or live) and
- total counts, which compares number of counts in defined region with a limit

set by the user.

To set (change) stop criteria, select "Stop criteria" item in the acquisition path tree. The form displayed on a figure below will appear:



In the form, one or both criteria can be set simultaneously:

Acquisition time control:
The program performs control of acquisition time only then when **Active** check box in **Acquisition time** group of options is set.
Only one of two, live or real time flow can be controlled at a time.
Amount of time should be placed in **Limit of time** field given in seconds units (available range is from 1s to 16777215s (2^{24}-1)).

Counts in region control:
When **Active** check box in **Counts in region** group of options is set, it means that the program performs control of number of counts in selected region. Region is defined by two parameters: **Home channel** and **End channel.**
Acquisition is stopped when number of counts in selected region exceeds value set in **Limit of counts** field (available range is from 1 to 2^{32}-1 of counts).

After selecting values, press **"Apply"** button.

see also:
Setting of stop criteria 52
Acquisition process inspection 49

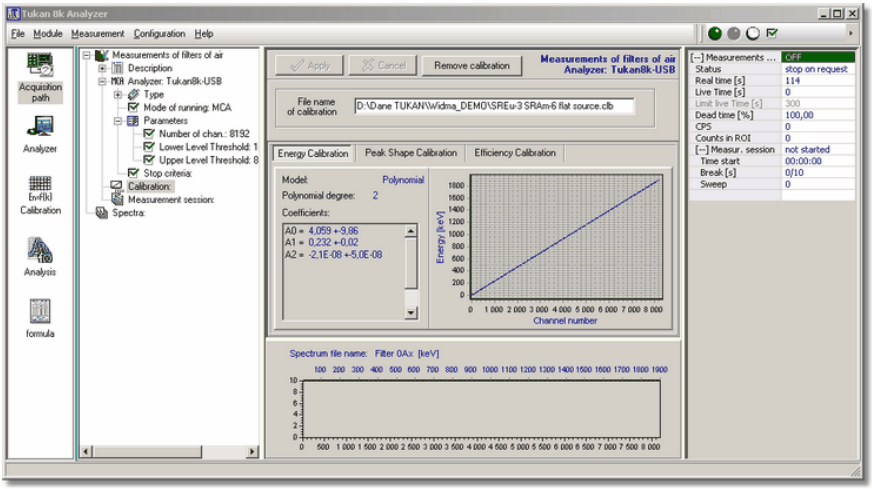
3.8 Acquisition path calibration

Acquisition path is defined for specified type of measurements performed in precise conditions of a job, i.e. analyzer and detector types or specific geometry of measurement.
Energy calibration (as well as timed and efficiency) performed on acquisition

spectrum is provided to acquisition path and in case when no any diametric changes were done (e.g. different level of amplification of input signal) can be automatically added to sequential spectra obtained in acquisition path.

The program does not control changes performed in real acquisition path. User needs to control by itself if calibration of acquisition path is still proper for given conditions.

On figure below is shown the form being displayed after selecting "Calibration" item in the acquisition path tree. The form allows a user to examine calibration parameters, watch calibration curve and to perform **Remove calibration** command from acquisition path.



The following rules are obligatory:

1. calibration introduced to acquisition spectrum becomes current calibration for acquisition path,
2. this calibration is saved when exit the program and is loaded when the program is started again,
3. this calibration is automatically input to each experimental spectrum being collected in given acquisition path.

see also:

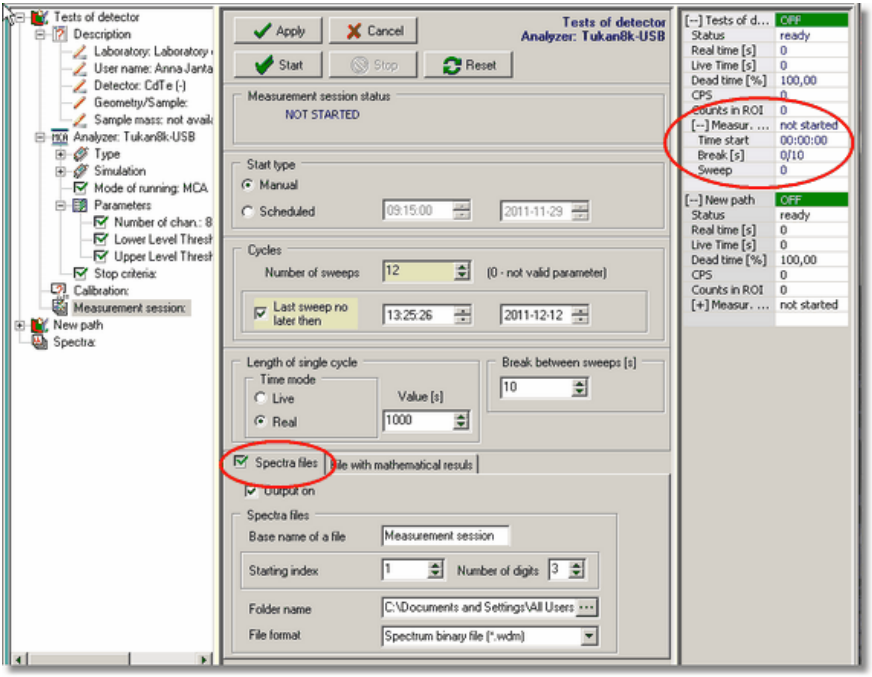
Calibration 109

3.9 Measurement session

Term '**Measurement session**' defines sequence of common measurements performed in the same conditions and at the same analyzer parameter settings. Each cycle consists of the following steps:

- acquisition start
- acquisition stop after defined period
- saving spectrum to a file
- removing spectrum from buffer of an analyzer
- acquisition restart after defined period (break)

On figure below is shown the form being displayed after selecting "Measurement session" item in the acquisition path tree:



The form contains the following information and values:

Measurement session status	status description
Start type	**Manual** - start of measurement session is performed w hen acquisition is started after selecting START of acquisition button

Measurement session status	status description
	Scheduled - start of measurement session is performed automatically at the selected date and time
Cycles	
Number of sweeps	number of sweeps can be set in a range from **0** to **1000**. Value 0 means, that this parameters in omitted, sweeps will be periodically repeated as long as a user stops acquisition manually, selected "last sweep not later then" occurs or number of sweeps exceeds terminal value.
Last sweep no later then	sense of this parameter appears in simultaneous control of time by the program. After reaching selected date and time, start of next sweep will not occur, but currently performed will finish normally
Length of single cycle	time set in this place is automatically moved to acquisition stop criteria 52 of single measurement and this way becomes obligatory for acquisition performed outside of measurement session
Break between sweeps [s]	period between end of last and begin of next acquisition. Permitted range is from **10 s** to **10000 s**.

Current status of measurement session can be observed on the panel at the right side of the screen when operating in ACQUISITION PATH or ANALYZER modules. Date being displayed in that panel are described in chapter Acquisition control during measurement session 55.

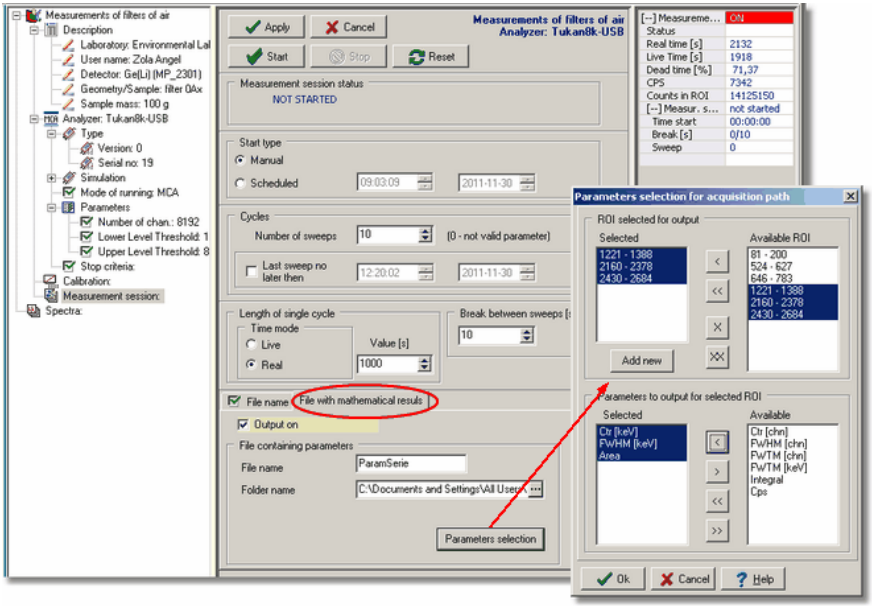
Each measurement from a session can be saved to a file and results of particular measurements can be saved in a text file. Settings for those files are placed at the bottom of the main form and consists of two tabs:
Spectra files i **File with mathematical results**.

Spectra files: - after switching **Output on** option, the program saves automatically spectrum to a file which name consists of **Base name of a file** and sequential number. Files are stored in directory selected in **Folder name**.

Spectra can be saved in binary form (*.wdm) or in one of ASCII form (see Export to ASCII format 74).
Names of spectra saved due to settings shown in the Figure above will be as follows:
D:\DaneTukan\ZywnoscSeria_001.wdm, D:\DaneTukan\ZywnoscSeria_002.wdm, ... etc.

Saving numerical result parameters of acquisition in one text file:

After finish of each acquisition of measurement session it is possible to calculate parameters of selected peaks and save them to a text file.
File with mathematical results: - after switching **Output on** option, the program saves automatically peak parameters to a file with a given name. That file is saved in directory selected in **Folder name**.
For each region to be analyzed, parameters can be defined individually in a dedicated dialog form available after click on **Parameters selection** button (see Figure below).



Generally, in MCS mode 60 of running the measurement sessions are defined in the same manner. Spectra are saved to disk as ".wds" files. Set of available parameters to be calculated for selected regions is different in comparison to MCA mode of work

see also

Acquisition control during measurement session 55

3.10 Working with several analyzers

The program allows to control several analyzers connected to different acquisition paths.

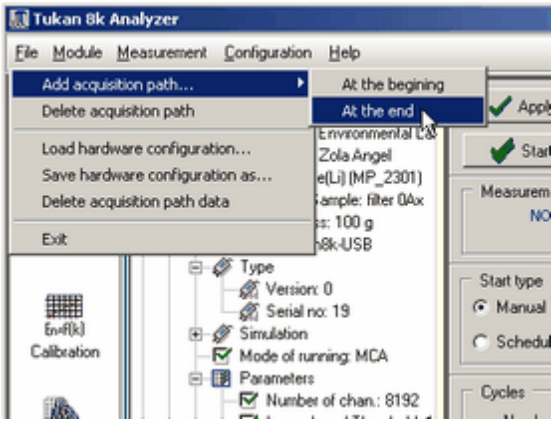
Adding and removing acquisition path 41
Select analyzer to control 42
Several measurement spectra control 44

3.10.1 Adding and removing acquisition path

Controlling by the program a second (or any other) analyzer needs to be preceded by defining additional acquisition path.
This can be done in ACQUISITION PATH module only.

Adding acquisition path

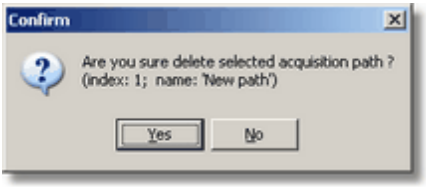
menu: **File | Add acquisition path...**



This command adds "empty" acquisition path and assigns to it a name "New path" followed, if necessary, with a new "not assigned" index in brackets.
Next, it is necessary to assign an analyzer to the newly defined acquisition path and define its other elements in a way described in the chapter: Defining of acquisition path 23

Removing acquisition path

menu: **File | Remove acquisition path...**



Removal of acquisition path is realized irrespective of its contents and status of acquisition.

Remarks

- removal of acquisition path from the program does not influent on a status of an analyzer, in particular does not stop acquisition
- in case when only one acquisition path is defined, it can not be removed
- restoring previous settings of an acquisition path is possible only by means of utility Configuration files of acquisition patho 46

see also:
Defining of acquisition path 23

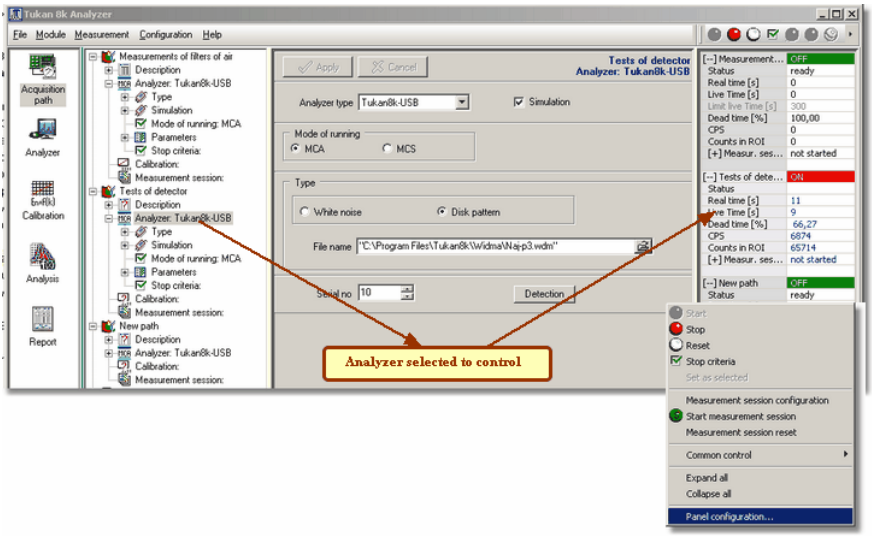
3.10.2 Select analyzer to control

After defining several acquisition paths and several analyzers it could arise a problem with which of them we would like to operate at the moment. Operation with one analyzer means here changing measurement settings and start, stop and reset of acquisition.

Selection of acquisition path can be done in the following ways:

- mouse click on any item of acquisition path in the acquisition path tree, or
- mouse click on any box in acquisition control panel (see: Hardware module 14 and Acquisition process inspection 49), or
- in text context menu of the acquisition control panel (as shown on a figure) - item **"Set as selected"**.

Acquisition path being selected is marked in the acquisition control panel by a background color, which in this case is a little lighter then for other paths.



For selected acquisition path, the following elements of the program are being adjusted:

- contents and status of icons grouped in toolbar of acquisition control,
- contents and status of items of **Measurement menu**,
- contents and status of items in context menu of the **acquisition control panel**.

Context menu as shown in the figure appears after right button mouse click done on the acquisition control panel.
Contents of context menu depends on a place from which was displayed. All items in a context menu are divided into five groups of items. Two upper refer to acquisition path it concerns, the other are common for all acquisition paths.
Contents of acquisition control panel is described in chapter: Acquisition process inspection 49.

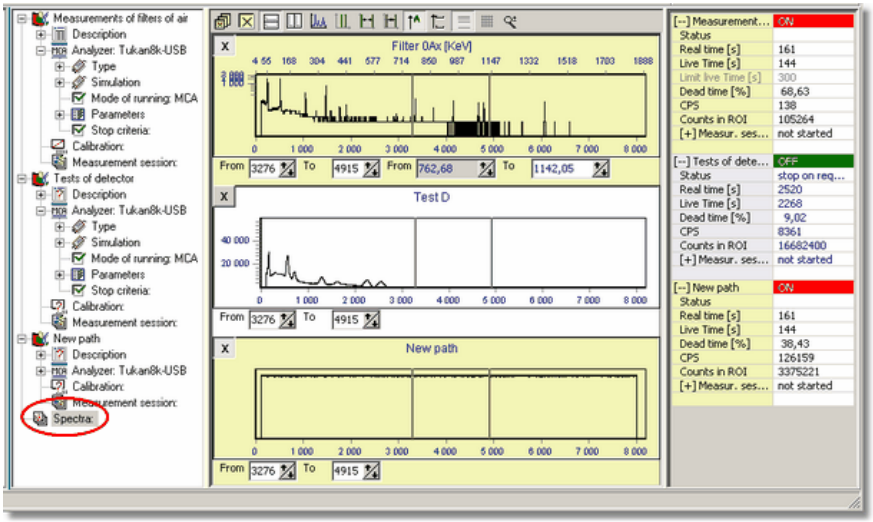
It is possible to control only one selected analyzer or several analyzers at the time. Manner of control are described in chapters: Acquisition control 47 and Common acquisition control 54.

Selection of **acquisition paths for common control** can be performed from Measurement menu or from context menu described above. In both cases **Common control** item should be chosen which contains sub items for adding and removing selected acquisition path and **Show panel** sub item to select and unselect acquisition paths from a list.
Panel shown in figure below allows to make selection easier.

Acquisition paths selected for common control are distinguished by common yellow color of background.

3.10.3 Several measurement spectra control

When operating with several analyzers it is comfortable to have possibility for simultaneous observing all (or selected only) spectra. After selecting **Spectra** item in the acquisition path tree, in a central part of a screen spectra for all analyzers could be seen.



At the top of the screen a toolbar is displayed containing icons allowing to control way of plot of spectra. After moving mouse pointer on each of them, a hint explaining its functionality will appear.

Icon	Hint	Command description
	Select all spectra	selection of all spectra for common control
	Show chosen spectra	selection of a spectrum to be controlled (changing scale and markers position).Selected spectrum is displayed with yellow background
	Horizontal layout	display all spectra in horizontal manner
	Vertical layout	display all spectra in vertical manner
	Show full spectrum	display full spectrum
	Markers at the center of plot panel	setting markers on positions of 1/3 and 2/3 of selected range
	Expand On spectrum between markers	expanding on a part of a spectrum lying between both markers to full diagram space
	Expand Off spectrum between markers	expanding twice number of displayed channels
	Automatic Y scale	switching to automatic Y scale selection adjusting to the highest value of a part of a spectrum being displayed on a screen (increased 20% for the highest value)
	Set Y scale	setting exact values for Y scale in a range "from", "to" (dialog window appears on a screen)
	Set logarithmic scale	switching Y scale type between logarithmic and linear
	Include the grid	switching on/off displaying of coordinate grid
	Spectrum zooming	switching on/off zoom: when zoom is switched on, the cursor has a following view  , the markers do not move and you can arbitrary enlarge selected part of a spectrum: to zoom, drag the pointer with the left mouse button pressed over the part of the spectrum which

Icon	Hint	Command description
		you may to magnify

Commands related to changing marker positions and scale are performed for one or several selected spectra.
Spectrum selected to be controlled is marked by yellow background.
Selection can be performed by pressing icon with "x" on a toolbar or at selected spectrum.

In "**From**" and "**To**" boxes placed below a spectrum, position of markers is displayed in channel and energy scale (if a calibration for a spectrum exists).

3.11 Configuration files of acquisition path

Current configuration of acquisition path can be saved to a file. It can be performed by running "Save hardware configuration as" menu command available in Hardware module 14 only a dialog box appears on a screen:

menu: **File | Save hardware configuration as...**

The box looks very similar to the standard Window "Save as" dialog box giving possibility of selecting path and name for a file. Extra field "Description" allows to introduce additional information describing acquisition path. This information might be useful when loading configuration from a file.

When opened, "Description" and "File name" fields contain text equal to "Acq. path name" parameter.

Files containing parameters of acquisition path have default ".cfh" extension.

Configuration of acquisition path earlier saved to a file can be easily loaded to the program. It can be performed in "Acquisition path" module only in "Save as" dialog box available after selecting the following command:

menu: **File | Load hardware configuration...**

The box looks like the standard Windows "Load" dialog box with additional two fields at the bottom. "Acquisition path name" field contains text entered to a filed of the same name when saved to a file. Second field is dedicated to display parameters of acquisition path saved in a file.

see also:
Defining of acquisition path 23

4 Measurement

All acquisition control and diagnostic commands are available in "Acquisition path" and "Analyzer" modules.

In this chapter, the following can be found:
- acquisition control for one analyzer i.e.. start, stop and reset 47,
- Common acquisition control 54 - applied when operating with several analyzers at a time,
- command for visual acquisition process inspection 49,
- how to perform measurement session 55,
- backup acquisition commands protecting collected data against lost; mechanism of time backup 58; rules for creation, displaying, archiving and analyzing of measurement spectrum 57.

Most of commands relevant to acquisition control is available via icons, menu "Measurement" or by context menu of acquisition parameters panel 49.

4.1 Acquisition control

Commands related to manual or automatic measurement control can be performed in ACQUISITION PATH or ANALYZER module only:
- via icon placed in toolbar,
- from **Measurement** menu,
- from context menu of the control acquisition panel, which displays current status of measurement. Contents of this panel is described in Acquisition process inspection 49,
- from keyboard.

Acquisition control commands:

Icon	Menu: **Measurement**	Key	Command description	Remarks
	**Start**	F2	start of acquisition	1)
	**Stop**	F3	stop of acquisition	2)

	Reset	F4	clear of acquisition data buffer and zero time counters in an analyzer and in the program	
	Stop criteria		display of dialog window for setting of stop criteria 52	

1) Acquisition can not be started if "Status" field on measurement parameters panel 49 contains information: „not ready". In such a case it is necessary to perform Reset command and wait till "ready" text is displayed.
2) Stop acquisition performed by "Stop" command is signalled in that field by message "stop on request"

Notice, that grey color of an icon ( **or** ) means that command linked to it can not be run.
All acquisition control icons stay grey if the program has no analyzer attached (i. e. an analyzer is disconnected).

If the program controls several acquisition path 44 then additional items in menu and additional icons related to common acquisition control 54 appear:

Figures below explain possible configurations of acquisition control toolbar depending on program status or an analyzer state:


only one acquisition path is defined, but no any analyzer is linked to it


only one acquisition path is defined and an analyzer is ready to start acquisition


only one acquisition path is defined and an analyzer is busy (acquisition is performed)


there are several acquisition paths defined, but common acquisition control options are not set

there are several acquisition paths defined and common acquisition control options are set

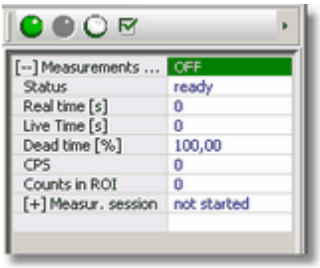
In last figure combo box for setting type of measurement is shown, which is descripbed in chapter "Acquisition path": Setting of parameters 32. This field can be hidden/visible thanks to context menu for toolbar.

Acquisition can also be started and stopped automatically by mechanism of

measurement sessions 38 or by setting of stop criteria 52.

4.2 Acquisition process inspection

The acquisition parameters panel is a frame placed at the right side of a screen in ACQUISITION PATH and ANALYZER modules.
It contains fields describing actual status of acquisition and its parameters; all data are periodically refreshed



The acquisition parameters panel conteining basic items

The acquisition parameters panel conteining extended items

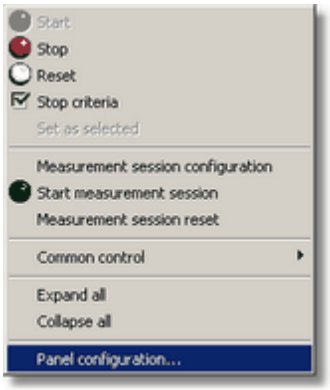
In particular lines of the acquisition parameters panel, the following information can be found:

Parameter name *(left column of panel)*	Parameter status *(right column)*	Description
[--] Path name: here: **Measurements of filters of air**	ON	acquisition is running
	OFF	acquisition is stopped, information displayed in "Status" item describes cause of acquisition stop
	VOID	analyzer is not defined - no any information about status of acquisition is displayed; the acquisition parameters panel contains only one item
	unrecognized	the program can not recognize a type of an analyzer, so no link w ith device is performed

Parameter name *(left column of panel)*	Parameter status *(right column)*	Description
Status		status line item is empty if: acquisition is on and runs normally or analyzer is not defined or not recognized by the program
	ready	analyzer is ready to start acquisition
	stop on request	user stopped acquisition performing STOP command
	live time limit	acquisition was automatically stopped after reaching selected period of live time of measurement defined in automatic stop criteria form
	real time limit	acquisition was automatically stopped after reaching selected period of real time of measurement defined in automatic stop criteria form
	limit of counts	acquisition was automatically stopped after reaching count limit criterion in a region defined in automatic stop criteria form
	channel ovf [ ]	acquisition was automatically stopped because overflow in channel has occurred; number of channel is given in square brackets [] (refers to USB analyzer only). Overload occurs when in any of channels number of counts exceeds 1048575
	not ready	analyzer is not initiated - it is necessary to perform "RESET" command
	unrecognized	acquisition is stopped (OFF status), but reason is not known
Real time [s]	0 ÷ 16777215	duration of the acquisition run (in seconds)
Live time [s]	0 ÷ 16777215	global amount of time (in seconds) when the device is active, i.e. the time when ADC is active or ready

Parameter name *(left column of panel)*	Parameter status *(right column)*	Description
Limit live time [s]		limit of live time set in stop criteria 52 - displayed only then, when automatic stop criterion is set; in such a way, acquisition can be stopped after expiration of selected live time
Limit real time [s]		limit of real time set in stop criteria 52 - displayed only then, when automatic stop criterion is set; in such a way, acquisition can be stopped after expiration of selected real time
Dead time [%]	100,00 ÷ 0,00	proportional ratio of real and live time subtraction to real time
CPS	0 ÷ 100000	(counts per second) number of counts registered by an analyzer in a period of 1 second of real time
Counts in ROI	0 ÷ 2^32 - 1	total counts in region defined in stop acquisition criteria dialog box
Limit of counts		limit of counts in region set in stop criteria 52 - displayed only then, when automatic stop criterion is set; in such a way, acquisition can be stopped after reaching count limit criterion in selected region
Range of ROI		region defined for count limit criterion set in stop criteria 52 - displayed only then, when count limit criterion is active
[+] Measur. session	not started	see: Acquisition control during measurement session 55

Context menu of acquisition parameters panel



Contents of displayed context menu depends on a region of the panel in which mouse pointer is placed at the moment of click of right button. It is mostly important when operating with several acquisition paths, because two upper sections of the context menu refer to one acquisition path only - that one, which is selected by mouse pointer (see Common acquisition control 54).

In the first upper section of the context menu are grouped commands referred to acquisition control described in Acquisition control 47,
in the second commands referred to measurement session described in Acquisition control during measurement session 55

The last two parts contain commands referred to appearance of the panel. **"Panel configuration..."** command provides access to dialog box containing list of all parameters possible to display in the panel. Each of them can be easily visible or hidden.

➨ In the ANALYZER module, if acquisition is not running or it is not necessary to control its parameters, the acquisition parameters panel can be hidden.

Hide acquisition parameters panel:

menu: **Module | Measurement panel**

see also:

Measurement control in MCS mode 63
Acquisition control 47

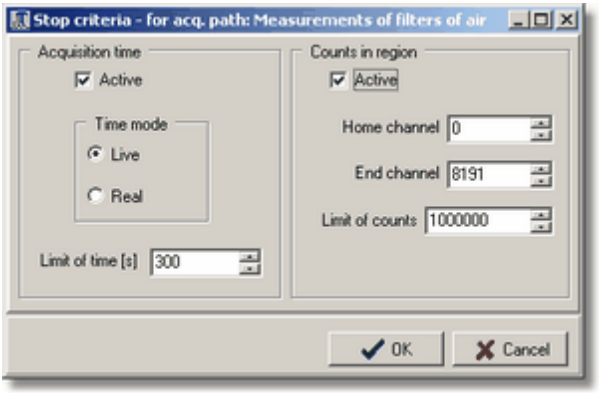
4.3 Setting of stop criteria

Automatic stop criteria 35 are described in Acquisition path 23 chapter. They can be defined for selected acquisition path thanks to mechanism of defining its properties in forms displayed in the program when moving though the acquisition paths tree in ACQUISITION PATH module.

When operating in ANALYZER module it is easier to set those parameters in the dialog window displayed:

by click on the icon , from **Measurement** menu or from context menu of acquisition parametrs panel 49.

When "Stop criteria" command is performed, the dialog window as shown below appears on a screen. Its contents is described in chapter Stop criteria 35
.



Activating acquisition time control:

- in **Stop criteria** dialog box select "Active" check box in "Acquisition time" group of options
- select "Time mode": "Live" or "Real"
- fill "Limit of time [s]"
- press OK button

Activating counts in region control:

- in **Stop criteria** dialog box select "Active" check box in "Counts in region" group of options
- fill "Home channel" and "End channel" - bounds of selected region
- fill "Limit of counts" for selected region
- press OK button

After pressing OK button selected options are set for appropriate acquisition path and are displayed in the acquisition parameters panel.

Remark: both stop criteria can be set simultaneously. Acquisition will be performed till selected time limit occurs or total counts in region is reached.

see also:

Acquisition - stop criteria 35
Acquisition process inspection 49

4.4 Common acquisition control

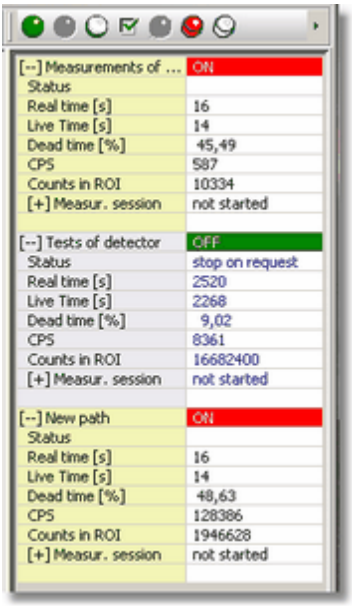
The rules for assigning several analyzers into one program was described in chapter "Acquisition path" (see Several measurement spectra control 44).

If the program controls several analyzers, each of them can be controlled individually but common start, stop and reset is also possible. Selection of acquisition paths for individual or common control is described in chapter Select analyzer to control 42.

Acquisition paths selected for common control are distinguished in the acquisition parameters panel (see Acquisition process inspection 49 by yellow color.

Icon	Menu: **Measurement**	Key	Description	Remarks
	**Common start**		common start of acquisition in selected acquisition paths	
	**Common stop**		common stop of acquisition in selected acquisition paths	
	**Common reset**		common clearing of spectra buffers and reset of time counters for selected acquisition paths	

The rules of actions for described commands are the same as for individual analyzer (see: remarks in the command description table in Acquisition control 47).



Irrespectively of that, if acquisition paths are selected for common control or not, automatic stop criteria need to be set individually for each of them.

The figure near by offers a view of acquisition parameters path for three acquisition paths (analyzers) supported by the program. First and third are selected for common control and in addition first is selected for individual control

4.5 Resumation of measurement after program exit

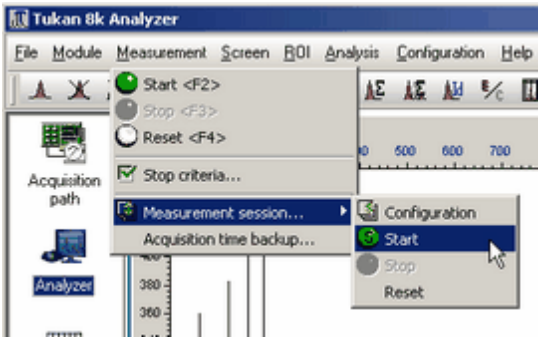
After starting the acquisition, the program can be closed. Exiting the program does not result in acquisition stop – acquisition once started runs autonomous until one circumstance will occur:

- exceeding limit of automatic stop criterion 52 (time flow or counts in region)
- acquisition stop by user
- counts overflow in a channel.

When measurement is on and the program is reopened, actual status of acquisition is detected and if is on, actual parameters of current acquisition are displayed in the acquisition parameters panel.

4.6 Acquisition control during measurement session

Definition of measurement session and way of controlling its parameters is described in chapter "Acquisition path" Measurement session 38.



The dialog box containing parameters of measurement session described in mentioned chapter is also available in ANALYZER module in **Measurement** menu (**"Measurement session" | "Configuration"**) or in context menu of the acquisition parameters panel.

The acquisition parameters panel described in chapter Acquisition process inspection 49 contains in the last bottom part the item: **"[+] Measurement session"**. On figure near by expanded state of this item is shown containing parameters of measurement session.

Parameter r *(left columr*	Parameter *(right colur*	Description
[--] Path nar here: **Meas**	.	. . . . . .
. . .	. . .	. . . (items referring to measurement are described in: Acquisitic
[--] Measu	not started	measurement session is off
	Waiting fo	measurement session is configured and ready to start - w aiting for manual or automatic start at predefined time
	Measurem	measurement sw eep is running
	Break	lasts break betw een sequential sw eeps - remaining period is displayed in a field **Break [s]**
	Interruoted	measurement session w as interrupted by a user - STOP command w as performed
	Finished	measurement session w as finished correctly - all sw eeps w ere performed

Parameter r *(left columr*	Parameter *(right colur*	Description
Time sta	00:00:00	situation w hen measurement session is not started (in brackets exemplary time of start is show n)
		this filed remains empty w hen acquisition is going to be started for the first time ("Waiting for 1 start" condition)
Break [s]	x1/x2	x1 is not zero during breaks betw een sw eeps only - then it displays number of seconds left till end of brake x2 displays length of break in seconds set for measurement session
Sweep	0	number of current sw eep of measurement session

Generally, for MCS mode 60, the measurement sessions are defined in the same manner. Spectra are saved to disk as ".wds" files. Also set of available parameters to be saved in a text result file is different in comparison to MCA mode of work.

4.7 Measurement spectrum

Acquisition spectrum is created automatically by the program for each acquisition path. This is a spectrum which collects data taken directly from a buffer of an analyzer device.
Rules for assigning names to acquisition spectra is described in chapter: Acquisition path > Defining of acquisition path > Acquisition path name - spectrum name 25.
Actual parameters of "live" spectrum: time of beginning, duration, number of channels, CPS, id of analyzer where spectrum is being collected, geometry settings etc. are available in dialog window Information about main spectrum 74. In that dialog, name of acquisition spectrum and additional description can be provided/changed if needed.

Acquisition spectrum, during measurement, is **"live" spectrum** - its contents is refreshed in 1 sec. periods.
Experimental data collection process can be watched in ACQUISITION PATH and ANALYZER modules only – in the rest of modules, acquisition spectrum is treated similarly to all other spectra loaded to the program, i.e. as formed, not changing spectrum.

Calibration of acquisition spectrum becomes at the same time acquisition path calibration 36.
If acquisition path contains calibration and the ROI table, then they are automatically introduced to each spectrum being collected in such an

acquisition path.

For "live" spectra displayed in the ANALYZER module **"on line" analysis** is performed. The program, after every data refresh, calculates current number of counts in channels placed between the markers and performs peak analysis displaying results in the peak parameters panel; it allows a user to observe flow and value of width of peak at half height. Peak parameters are calculated based on Peak analysis 'on-line' 91 method described in "Analysis" chapter.

All spectra being analyzed by the program are grouped in spectra container 68. Acquisition spectra are placed there always at the top - they can not be moved or removed from the spectra container.

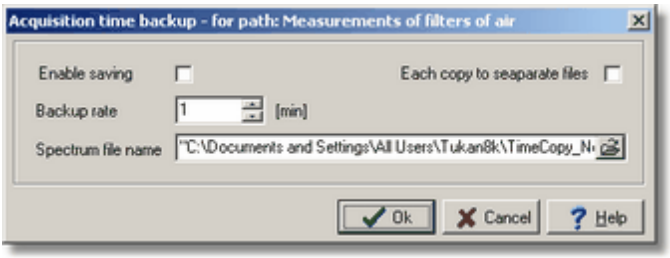
see also:

Working with the spectra 68
Measurement spectrum periodical backup 58

4.8 Measurement spectrum periodical backup

To protect against lost of experimental data (e.g. in case of power failure) the program can automatically, in preset periods, save acquisition spectrum to a file.

Defining options for acquisition time backup:
menu **Configuration | Acquisition time backup**



Enable saving - when checked, it assures, that the program, in preset periods defined in **Backup rate** field, will automatically (i.e. without the user activity) save actually collected spectrum to a file with a name given in **Spectrum file name** field.
The file containing acquisition time backup can be created earlier, but if does not exist the program creates itself. By default, backup file is created in the main folder of the program and is named „**Tuk.wdm**" (or "Tuk.wds" in MCS mode of work) .

Each copy to separate file: - when checked, actual spectrum will be saved to different files at each rate of time. Names of those files consist of base spectrum file name followed by sequential number.
By default, this option is not checked, so acquisition time backup is always saved to the same file which contents is overwritten every time.

➡ Acquisition time backup occurs only then, when acquisition is on.

see also:

Measurement spectrum 57

5 Multi-channel scaling (MCS) mode

Basic mode of running of the analyzer is pulse height analysis mode (MCA). Changing mode of running from MCA to MSC (multi-channel scaling) mode is possible only in ACQUISITION PATH module in a way described in Mode of running (MCA, MCS) 31 chapter.

After switching to MCS mode of running, the following changes are performed automatically in the program:

- list of parameters available in the acquisition path tree,
- contents of the acquisition parameters panel,
- forms for setting parameters displayed in the middle of the screen in the ACQUISITION PATH module,
- format of collected spectra (different set of parameters saved with spectrum),
- calibration is switched to automatic timed calibration,
- algorithms of peak analyze and set of parameters displayed below the spectrum.

Acquisition control and rules for working with experimental spectra are the same as for MCA mode of running.

Notice: mode of running change from MCA to MCS is possible only then, when analyzer assigned to the program was equipped in this facility. This remark is not valid for Tukan8k-USB analyzers which are always equipped in MCS mode of running.

see also:

MCS - Multichannel Scaling mode 165 for Tukan8k-PCI 162 analyzer
MCS - Multichannel Scaling mode 159 for Tukan8k-USB 156 analyzer

5.1 Analyzer parameters in MCS mode

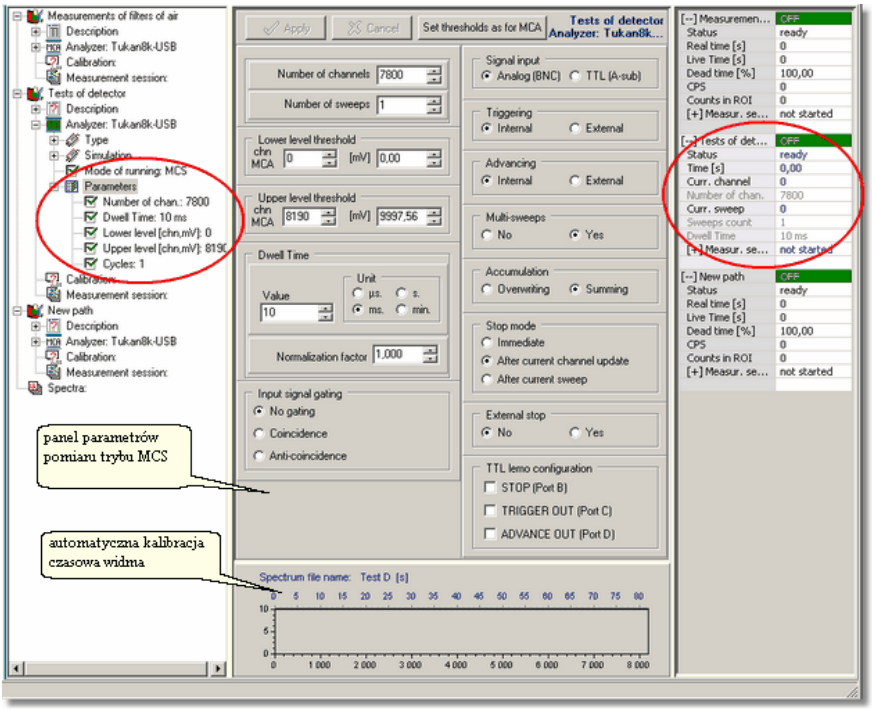
Parameters available to be set in MCS mode of running:

Number of channels – number of channels defining one acquisition cycle – channel nr 0 is always the first and is not related with lower level threshold value.
Range established in this place is marked in the diagram by horizontal line displayed in the same color as markers are.

Number of sweeps – number of sweeps which combine one measurement – set in a range from 1to 1048575 (2^{20}-1).

Lover level threshold, Upper level threshold – set by entering a channel number or voltage value in mV.

Threshold level values can also be set by copying position of markers in MCA mode of running. This command can be performed by clicking **Set thresholds as for MCA** button placed at the bottom of that dialog window.



Dwell Time – duration of processing in one channel – can be set in a range between 2 µs and above 8000 s, a user must select **unit** of time and set **value**.

Normalization factor - number by which "Dwell Time" is multiplied. Normalization factor allows to eliminate possible inaccuracy in measurement of "Dwell Time" by an analyzer, when a user affirms such inaccuracy. Normalization factor can be set above or below value 1, so can correct internal clock in an analyzer when is slow or fast. In most cases, this factor can remain 1.0 which is neutral position.

Signal input – selection of a type of pulse input socket:
Analog (BNC): - analog input
TTL (A-sub) - TTL input

Triggering – selection of a type of acquisition cycle triggering: **internal** (automatic) or **external**

Advancing – selection of a manner of advancing channel: **internal** (automatic) or **external** pulse

Multi **sweeps** – selection of a manner of next cycle activation: **Yes** - automatically or **No** - by external pulse

Accumulation – switching on (**Summing**) and off (**Overwrite**) of accumulation of counts in channels in sequential cycles

Stop mode – selection between three types of rules when acquisition stop is performed:
Immediate,
After current channel update
After current sweep

Input signal gating – selection of gating mode for input signal, i.e. only those signals are registered which appear in coincidence or anti coincidence to gating signal. Most often the analyzer operates in "no gating" mode.

TTL Lemo configuration – enabling these options cause to appear output signals in TTL sockets of the analyzer. Detailed description is available in Appendix C: Tukan8k-USB MCS mode 159.

see also:
Measurement control in MCS mode 63
MCS mode 165 for Tukan8k-PCI 162 analyzer
MCS mode 159 for Tukan8k-USB 156 analyzer

5.2 Measurement control in MCS mode

The acquisition parameters panel is a frame placed at the right side of a screen in ACQUISITION PATH and ANALYZER modules.
It contains fields describing actual status of acquisition and its parameters.

When MCS mode of running is set, the acquisition parameters panel contains the following parameters:

In particular lines of acquisition parameters panel the following information can be found:

Parameter name *(left column of panel)*	Parameter status *(right column)*	Description
[--] Path name: here: **Test of detector**	ON	acquisition is running
	OFF	acquisition is stopped, information displayed in "Status" item describes cause of acquisition stop
	VOID	analyzer is not defined - no any information about status of acquisition is displayed; acquisition parameters panel contains only one item
	unrecognized	the program can not recognize a type of an analyzer, so no link with device is performed
Status		status line item is empty if: acquisition is on and runs normally or analyzer is not defined or not recognized by the program
	ready	analyzer is ready to start acquisition
	completed	acquisition was finished normally
	stop on request	a user stopped acquisition performing STOP command
	not ready	analyzer is not initiated - it is necessary to perform "RESET" command
	unrecognized	acquisition is stopped (OFF status), but cause is not sure
Time [s]	0 ÷ 16777215	total time of acquisition in seconds
Curr. channel		nr of channel currently being processed
Number of chan.	1 ÷ 8192	selected number of channels (for one sweep)
Sweep count	1 ÷ 1048575	selected number of sweeps
Dwell Time	2 µs ÷ 143 min	duration of processing in one channel; value selected by user

Remarks:

1. Acquisition interrupt performed by STOP  command effects to reset of: time counter, current channel pointer and sweep counter.
2. After stop of acquisition performed by STOP command, next start must be preceded by RESET  command, i.e.measurement parameters reset and data buffer clean.

5.3 Acquisition spectrum MCS

Rules for creating MCS acquisition spectrum are the same as for MCA mode of running described in chapter Measurement spectrum 57.

In dialog box Information about main spectrum 74 the following information is available: time of acquisition start, total time of acquisition, selected parameters of measurement, average number of counts for Dwell Time and type of analyzer and its serial number. Similar as for MCA mode of running, in this box name of spectrum can be modified and description can be added.

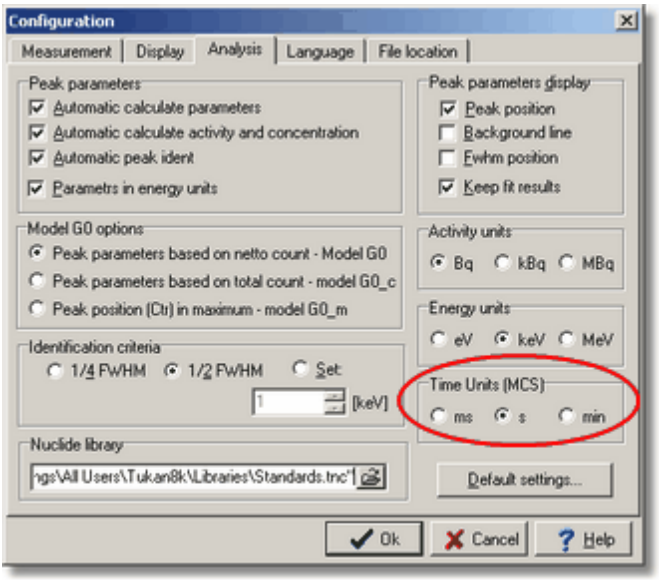
MCS spectrum is saved to files in ".wds" format (see Spectra files formats 20.

In spectra container 68 both types of spectra (MCA or MCS) can be saved. The program adjust automatically set of parameters and units displayed below a diagram regarding type of spectrum.

5.4 Calibration and analysis of MCS type spectra

Calibration of MCS spectrum

The program automatically defines time calibration in which time values are calculated directly depending on Dwell Time.
Time scale is displayed on a top border of the spectrum plotting panel. Applied units are selectable in configuration dialog box:

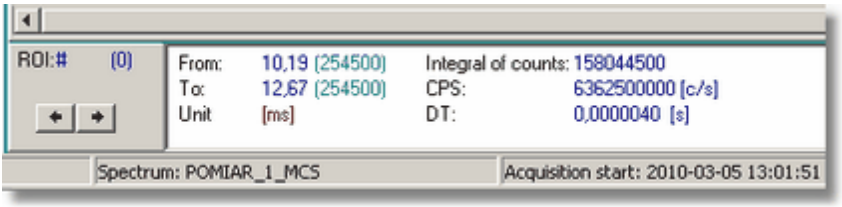


In CALIBRATION module – commands for defining or deleting calibration for MCS-type spectra are disabled. For such kind of a spectrum calibration can not be edited.
Every change of Dwell Time leads to automatic change of time calibration of a spectrum.

Analysis of MCS type spectrum

Changing type of main spectrum between MCA and MCS effects in different set of parameters displayed below a spectrum, i.e. those parameters which are calculated on-line for selected peak. Besides, set of available parameters to be put in the Peak Table and in the report is changed as well.

During "on-line" analysis the program calculates the following parameters for MCS spectra:
integral of counts for part of spectrum bounded by the markers (including channels on which the markers are placed) and
Counts per second (CPS) for the same region.
For information purpose only, value of Dwell Time calculated in seconds is displayed as well.



Bounds of selected region (From, To) are displayed in the same units as applied for time scale of a spectrum. Time units can be switched to counts in channel thanks to the button  placed on a toolbar above a spectrum.
For MCS-type spectra, the user can define Region Of Interest (ROI) and create based on them Peaks table 107.

6 Working with the spectra

The program can display and analyze either spectrum actually acquired or other spectra, loaded from files. Each of them can be copied to memory and stored there until program shut down.
Therefore, the program distinguishes three types of spectra: acquisition, memory and disk:

Acquisition spectrum – spectrum obtained during current measurement process
Memory spectrum – a spectrum being copied to memory
Disk spectrum – a spectrum loaded from a file

Each of above spectra is identified by its name and description.

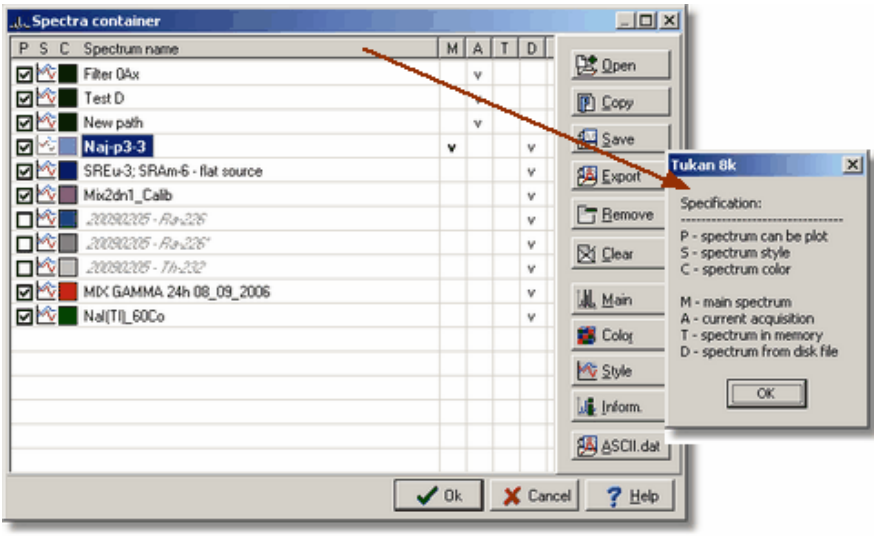
To facilitate manipulation of many spectra, in the program Spectra container 68 is defined, in which the user can store up to 15 spectra of different types. Therefore, the selection of a spectrum to work with (working spectrum) is reduced to pointing at it in a list of spectra stored in spectra container.
The selected spectrum, called *main spectrum*, is distinguished, is displayed and analyzed. Other spectra selected in spectra container can be only displayed in a background of a main spectrum.

6.1 Spectra container

The spectra container holds all spectra, which are available during the work with the program. In addition to the measured spectrum, the container may contain all the spectra (or their copies), which the user wants to display.
The spectra container may hold up to 15 spectra.
If program is shut down and invoked again then all accessible spectra are copied to memory.

Open spectra container dialog box:

icon: 
menu: **File | Spectra container...**



In the dialog window of spectra container there is a table with a list of spectra and a set of buttons to manage the spectra and assign attributes to particular spectrum. The table header contains letter symbols of the attributes:

P	displayed spectrum (it can be plotted) – when a spectrum is not displayed, its name is italicized *)
S	plotting style – the spectrum may be displayed in four styles: line segments, points, bars and filled areas:
C	spectrum color
M	main spectrum, its name is in bold.
A	current acquisition spectrum.
T	temporary spectrum - copy of a spectrum in memory.
D	spectrum from a disk file.

Description of the attributes may be seen by clicking on the table header.

***) „Displayed" and „not displayed" spectra.**
All spectra included in the spectra container can be seen in the list of reference spectra 73, thus visible on a screen, but they do not have to. The reference spectra list contains only those spectra, which have 'display' attribute set. To change "display" status, click the appropriate box on the P column in the table. This allows displaying only theses spectra, which are interesting in a given moment, while all other spectra remain in the container.

Commands available in the spectra container:

Open	Open spectrum 71 from a file
Copy	Copy spectrum to memory *)
Save	Save spectrum 72 to a file
Export	Export to ASCII format 74
Remove	Remove selected (highlighted) spectra
Clear	Erase the spectra container – all spectra, except measurement spectrum and main spectrum, are removed from the container
Main	Assign to a selected (highlighted) spectrum an attribute of a main spectrum – it can be done also by double clicking the spectrum name
Color	Change color 85 of the selected spectrum
Style	Change plot style 85 of the selected spectrum
Inform	Show spectrum information 74 dialog box – spectrum name can be renamed and spectrum description can be changed

*) **Copy** command causes displaying the dialog box Information about main spectrum 74, in which word 'Memory' is automatically added to a name of a spectrum. In this box user can select another name for a spectrum and add description.

memory spectra are hold by the program only during current session - if you want to leave them for a future purpose save them to files before exiting the program.

see also:
List of reference spectra 73

6.2 Open spectrum

Opening a spectrum from a file may be done from menu or from the dialog box of Spectra container 68.

Open spectrum from a file

icon:
menu: **File | Open spectrum....**

If this command is performed from File menu than the opened spectrum is immediately displayed on a screen – it becomes a main spectrum and its name is appended to the list of reference spectra 73.
If a spectrum opening command is performed from **Open** button of the Spectra container dialog box 68 then a given spectrum is only appended to the list of referenced spectra and it is not displayed on a screen.

In both cases, the open dialog window is displayed. It is a lightly modified default box of the Windows system, oriented for files opening. Modification consists of the monitoring sub-window, which allows to plot selected spectrum and watch its parameters such as measurement session name, its creation date, time of acquisition and information about the spectrum type.
All spectra with *.wdm format created by SWAN and TUKAN ver. 1.4 and 2.0 analyzers (these are predecessors of the TUKAN 8K program) can be opened .

Reading a spectrum in text format is possible only by operation Import from ASCII format 75.

Opening a spectrum is possible in ANALYZER, CALIBRATION and ANALYSIS modules.

6.3 Save spectrum

Saving an experimental or any other spectrum placed on the spectra container to a file can be done from menu, from the icon placed on a toolbar or from the dialog box of Spectra container 68

Saving spectrum to a file:

icon: 
menu: **File | Save as...**

Command is performed in default dialog box of the Windows for saving files. Spectra being collected in MCA mode of running are saved with default "**.wdm**" extension, and measured in MCS mode with "**.wds**" extension.

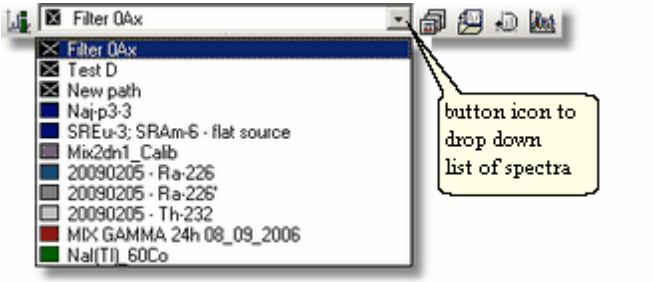
Binary spectra files formats 20
Export to ASCII - files formats 74

Before saving a spectrum, it is recommended to fill in Information 74 dialog box. This will give you a possibility to check status of a saved spectrum, attach a name to it, which is different from a file name, and describe the spectrum.

6.4 List of reference spectra

Each spectrum, either measured or retrieved from a disk file, is inserted into Spectra container 68, accessible via dialog box. On the icon toolbar there is s drop down list of all opened spectra. Initially, this list contains the name of a *main spectrum* accompanied with a small square showing the color of the displayed spectrum. Measurement spectra are signed by 'x' in that square.

List of referenced spectra is a way for quick selection of displayed spectra.



Close to the drop down box containing spectra list, on the same toolbar the following icons are placed:

 display an information 74 window concerning main spectrum

 open dialog box with contents of a spectra container 68

 save spectrum to a file

 run data refresh of measured spectrum (button is active in ANALYZE and CALIBRATION modules only *)

 simultaneous display of all spectra from the list; all spectra other than the main are displayed in background

*) In the ANALYZER module, user can observe live measurement spectra, data are refreshed every 1 sec. After switch to CALIBRATION or ANALYSIS modules measurement spectrum stops to be "live". "Refresh" command allows to update data in the buffer to actual state.

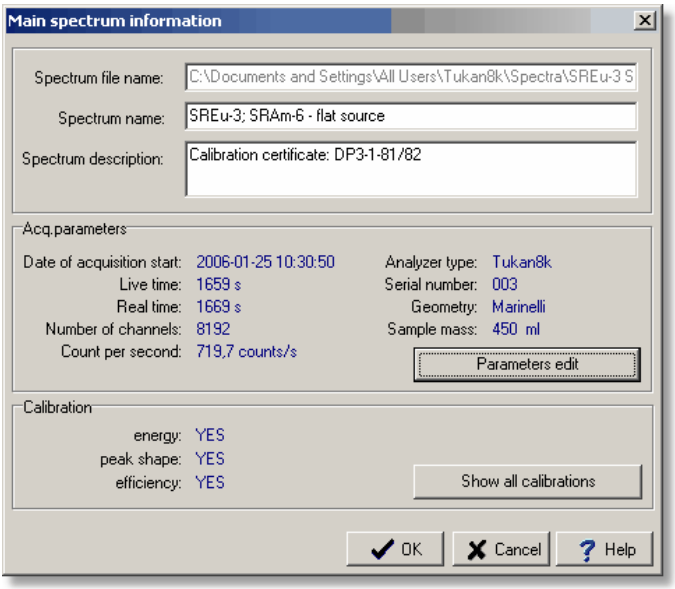
6.5 Information about main spectrum

To show information about main spectrum, select:

icon:

menu: **File | Spectrum Information...**

Spectrum information command performed from the **File** menu or toolbar, opens a dialog box "Main spectrum information". Invoking this command in the spectra container allows to change the information about any spectrum.



In "Main spectrum information" box user can change name of a spectrum and add description. It is recommended to do it before saving spectrum to a file. For spectra being actually measured parameters in the right column (type of analyzer, serial number, geometry and mass sample) are introduced automatically from acquisition path settings and can not be changed here. **Parameters edit** button is active only then, when information refers to a spectrum loaded from a file.

6.6 Export to ASCII format

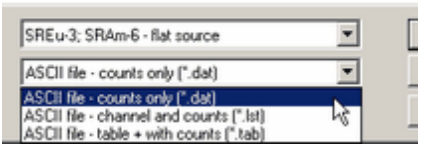
Collected spectra can be saved to files in one of three ASCII forms. **Export ASCII** command is available in the **File** menu (in ANALYZER and

ANALYSIS modules only) or in the spectra container.

Export spectrum in ASCII form:

icon:
menu: **File | Export ASCII...**

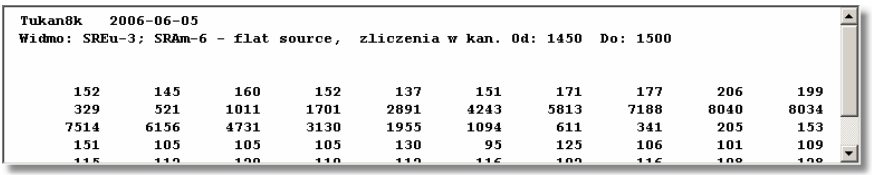
When performed, the following dialog box appears in which a user selects one format:



Format "*.dat": - file contains one column with counts in channels

Format "*.lst": - file begins with header containing name of the Tukan8k program, date of export and a name of a spectrum. Below it two columns of data are placed: one with number of channel and second with number of counts

Format "*.tab": - file begins with header containing name of the Tukan8k program, date of export and a name of a spectrum. Below it counts in channels values are placed in ten columns. In this format the whole spectrum or its part can be saved:



```
Tukan8k   2006-06-05
Widmo: SREu-3; SRAm-6 - flat source,  zliczenia w kan. Od: 1450  Do: 1500

     152      145      160      152      137      151      171      177      206      199
     329      521     1011     1701     2891     4243     5813     7188     8040     8034
    7514     6156     4731     3130     1955     1094      611      341      205      153
     151      105      105      105      130       95      125      106      101      109
```

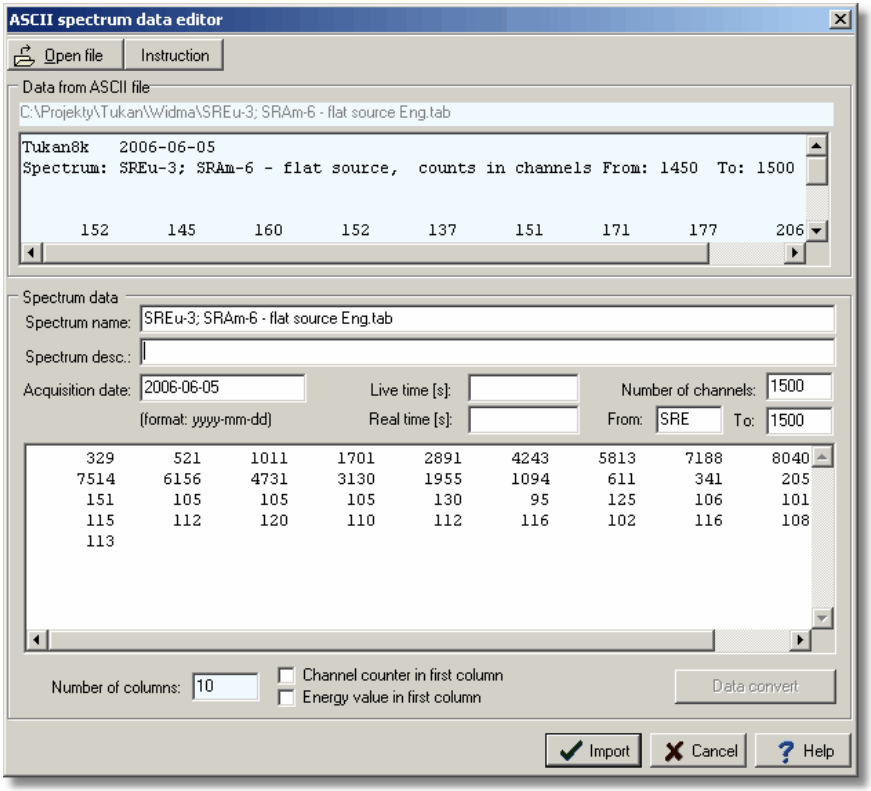
6.7 Import from ASCII format

The program performs function of importing spectra saved to files in ASCII format described in Export to ASCII format 74, i.e."lst", „dat", „tab" and „rpt" (report files) type.

icon:
menu: **File | Import ASCII...**

When performed, the "import spectra" dialog window is displayed containing

textual description of procedure concerned with importing data from ASCII files. As described there, to the program can be imported data from any ASCII file, not necessary saved in the formats described earlier



The „import spectra" dialog window is divided into two parts: upper displaying plain contents of ASCII file from which data is being imported and bottom, containing data as processed by the program. Based on that data, after selecting the „**Import**" key, the program creates a spectrum (in „wdm" format) and places it in the spectra container. When quitting the program, such a spectrum will not be saved. If needed to be saved in „*.wdm" format, user must run appropriate command.

"**Instruction**" button will open detailed instruction how to proceed in case of another file formats.

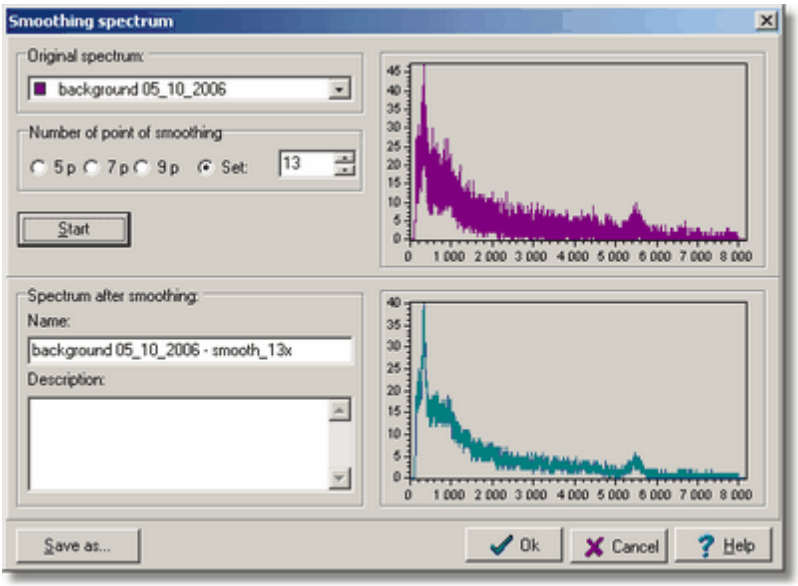
6.8 Smoothing spectrum

Smoothing spectrum operation is accessible in menu Analyze in ANALYZER or ANALYZE modules only.

Smoothing spectrum:

icon:

menu: **Analysis | Smoothing...**



6.9 Adding and subtraction spectra

Addition and subtraction commands are available in the same dialog window. This window is accessible in Analyze menu in ANALYZER or ANALYZE module only.

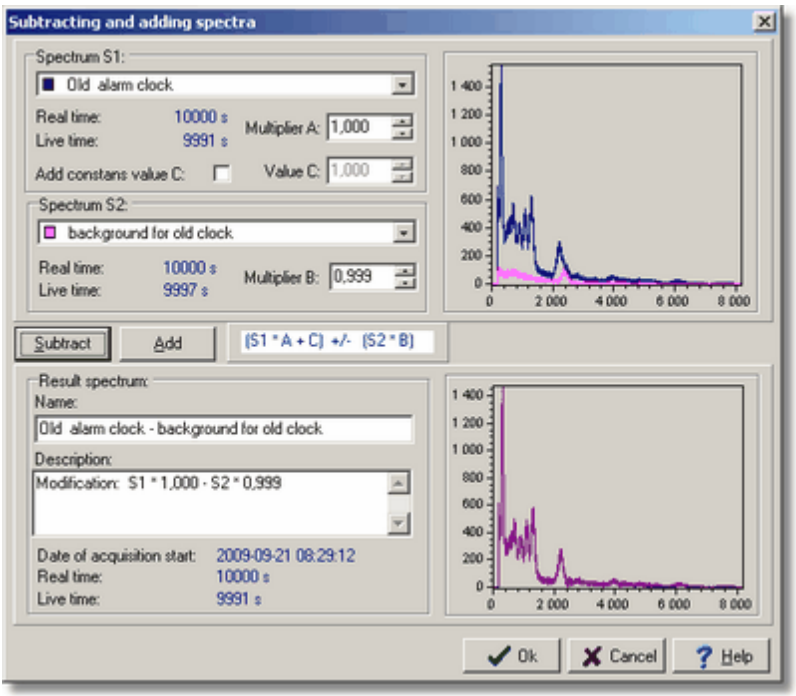
Add and subtract spectra:

icon:

menu: **Add /Subtract spectra...**

Spectra (S1 and S2) for adding or subtraction may come from the Spectra

container 68.
Mathematical rule is done based on the formula: **(S1 * A + C) +/- (S2 * B)** seen in the dialog box.



Subtraction of background spectrum

Normalization multiplier **B** is automatically calculated as a quotient of "live time" value of a spectrum **S1** to a "live time" value of a spectrum **S2**.
So, a background spectrum should be input as **S2** spectrum.

Adding of constant value

Constant value C is applied only then, when "Add constant value C" check box is set.
If **S2** contains no spectrum it will be performed rule of adding constant value to a spectrum **W1**. All operations are processed in float numbers but final results are rounded to integers and negative numbers are zeroed.

Command is performed after press **Add** or **Subtract** button.
After command is performed, the description field of the result spectrum contains algorithm description and performed values of parameters. This field is editable, can be modified by a user.

Result spectrum is stored in memory after pressing **OK** button. Name of result spectrum is automatically created as mix of name of spectra being processed. This name can be changed before saving spectrum or later in information about spectrum 74 dialog box.

6.10 Compressing spectrum

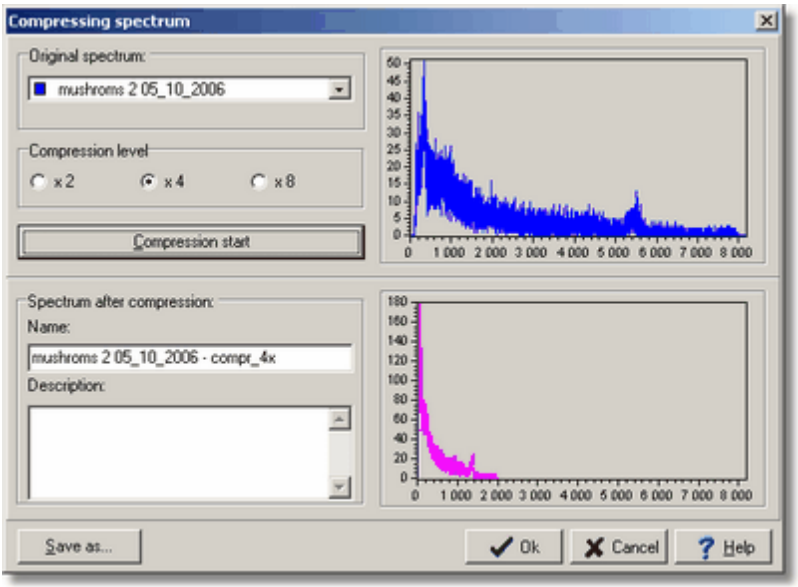
Operation of spectrum compression may be run only in ANALYZER or ANALYZIS modules.

Compressing spectrum:

icon:

menu: **Analysis | Compressing...**

Operation relies on adding of counts in 2, 4 or 8 following channels and storing results in a new spectrum.



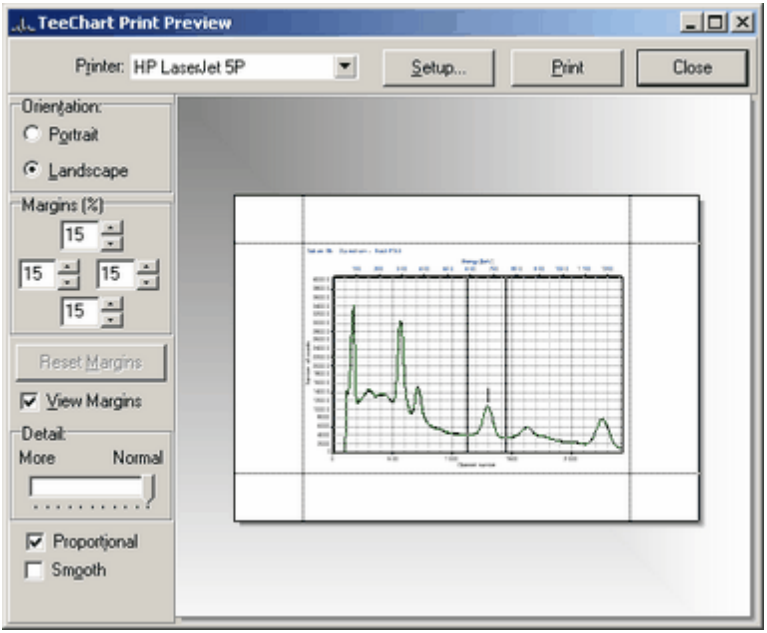
The dialog window shows shape of the result spectrum. It is saved in memory after pressing OK button.

6.11 Printing a spectrum

Each spectrum (or their composition), displayed on a screen can also be printed:

icon: 
menu: **File | Print spectrum...**

This operation opens a dialog window showing a print preview and allowing printer selection and setting printing parameters. The spectrum is printed in the same proportions as seen in the preview (all printing colors are identical if available on the printer).

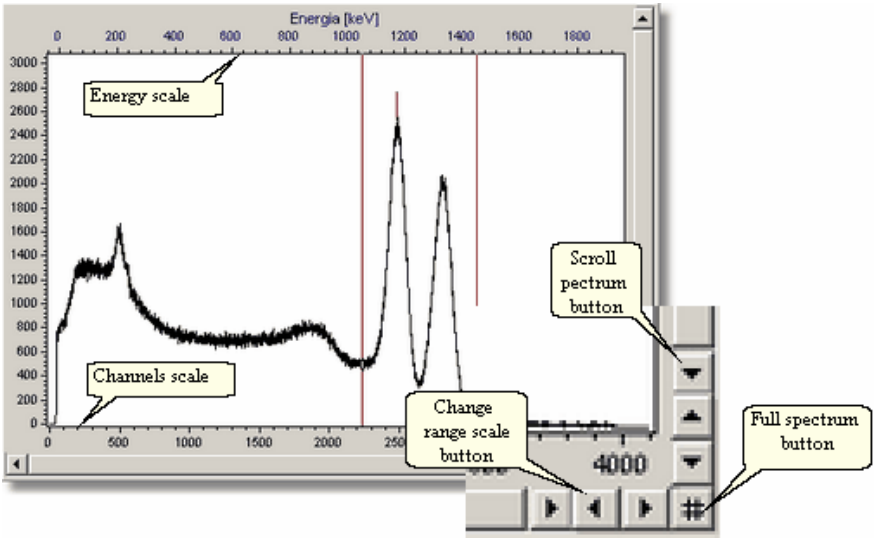


It is recommended, for printing speed reasons, to display a spectrum in the line segment plotting style.

More advanced printing options are available in the REPORTS module.

7 Plotting a spectrum

A spectrum is displayed in the special panel, which has spectra scrolling bars (vertical and horizontal) and buttons for changing of the scaling range. Using keyboard or mouse you can see any fraction of the spectrum enlarged to required level. Both scrolling bars are joined in the bottom right corner of a panel by a # button , which restores the display of the full spectrum.



To change the spectrum scale and its plotting style:

- move the markers controlled by a mouse directly on the displayed spectrum (zoom icon),
- click the appropriate icon on the toolbar:
- choose a command from context menu of the display panel:
- choose a command from the **Screen** menu:
- use the keyboard 145.

Before displaying, the spectrum is analyzed and display scale is automatically adjusted to vertical and horizontal spectrum maxima.
Maximum of **Xscale** is equal to a number of channels in a spectrum (1024, 2048, 4096, 8192, etc). Maximum of **Yscale** is set to 20% over maximal value of a spectrum, minimum is 0 and can not be negative.
At every change of a main spectrum, displayed scale is adjusted automatically to its contents.

Displaying energy scale

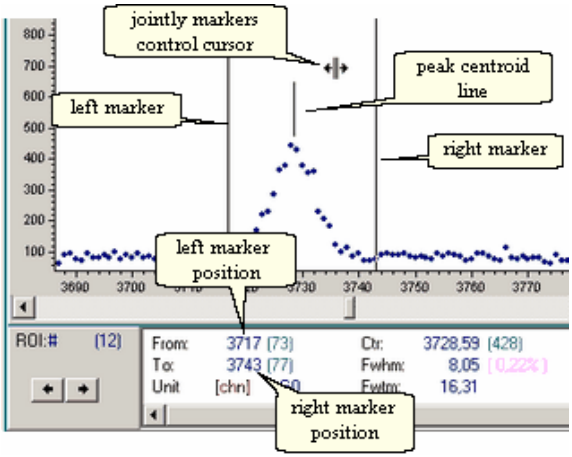
If the spectrum contains energy calibration then in the field of the spectrum plot two horizontal scales are displayed: bottom scale in channels units (black color), upper scale (navy blue color) is displayed in units set in program configuration form (see Configuration analysis options 139).
If a spectrum has no calibration, than upper scale is not displayed.

7.1 Markers

There are two markers implemented (the left – L and the Right – R), which are displayed as the two thin vertical bars and may be moved across a spectrum using either a mouse or a keyboard via Cursor keys 145.
When you position the cursor (via mouse) on the marker then the cursor shape is changed either to  left, or to  right. In this situation, you may move selected marker independently from the other. When cursor is placed between markers, than its shape is changed to  and you move markers jointly.
The cursor shape  means, that zooming has been turned on and markers cannot be moved. To move markers again, turn zoom off.

One marker can be moved either independently from the other or both markers can be moved together with constant distance between them – one marker cannot go past the other and they are always present on the screen. Therefore, setting the marker channel position beyond the screen causes the change the displaying scale.

In ROI window below the spectrum, the position of markers is displayed (in channel or energy) and the number of counts at these marker positions.



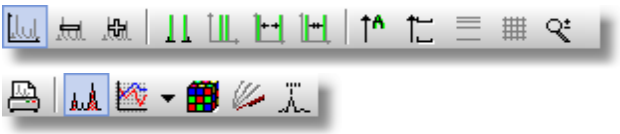
see also:

Markers navigation keys 144

7.2 Display control

Changing of display scale can be performed by buttons and scroll bars of the spectrum display panel (see Plotting a spectrum 81), icons placed on toolbar, cursor keys, main and context menu.

Toolbars dedicated for display control



Icon	Menu: **Screen**	Command description
	Full spectrum	show a full spectrum
	Expand On spectrum	twice expand on a spectrum*)
	Expand Off spectrum	twice expand off selected part of a spectrum
	Set markers	set markers on given positions: a dialog box appears on a screen where user can input required positions and confirm with OK button

Icon	Menu: **Screen**	Command description
	**Markers on centre screen**	set markers on positions equal to 1/3 and 2/3 of a range
	**Expand On spectrum**	expand on a part of a spectrum selected by markers to full size of a screen
	**Expand Off spectrum**	twice expand off number of displayed channels
	**Automatic Y scale**	adjust automatically Y scale to the highest value displayed on a screen additionally enlarged by 20%
	**Set Y scale**	set Y scale in a given range "from" "to": a dialog box appears on a screen where user can input required positions
	**Logarithmic / Line scale**	switch Y scale between logarithmic and linear
	**Grid**	set on or off a grid of coordinates on a screen
	**Mouse zoom**	set on or off a zoom: if a zoom is on, then shape of a cursor is  , both markers do not function, pressing right button of a mouse a user can select any part of a spectrum and enlarge it
	**Print spectrum**	print a spectrum displayed on a screen (see Printing a spectrum 80)
	**Hide ROI**	hide or expose ROIs of a spectrum. That command does not change a structure of ROIs but only hide or expose colorful parts of a spectrum
	**Spectrum style**	see Spectrum plot style changing 85
	**Spectrum panel colors**	see Colors of the plot panel 85
	**Refresh screen**	delete and redraw a spectrum in a spectrum plotting panel - sometimes necessary after closing dialog box displayed earlier on the same area
	**Show peaks position**	display calculated values of centroid of peaks and related to them nuclide

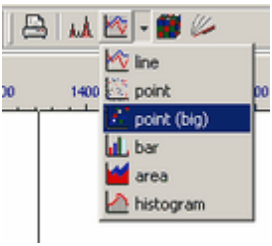
*) Command expands a picture in a way, that preset marker positions (and the area they enclose) are preserved and are always visible on the screen. Each

pressing of the icon causes the number of channels remaining between markers to decrease twice symmetrically on both sides until marker reaches any panel border. In such a case decreasing is continued one-sided (at side of that marker which does not reach end of panel). When moving markers leads to exit any of them outside of a panel, then command does nothing.

7.3 Spectrum plot style changing

Default plotting style is line - spectrum is plotting connecting spectra points. It is the quickest and most recommended type of plot.

Change of *main spectrum* plotting style is performed by  icon placed on a toolbar.
Style of any other spectrum can be changed in spectra container 68.



After selecting "down to triangle" at the right of an icon, menu containing available styles of plotting appears. To change style of plotting click on selected style from a list.

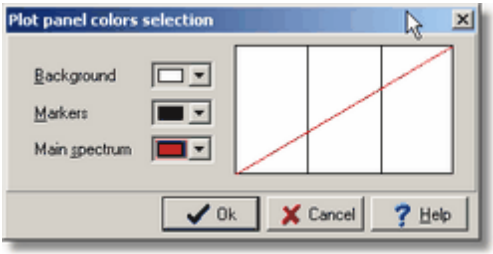
Plotting style of each spectrum may be changed at any time, however this attribute is not retained after program shut down.

7.4 Colors of the plot panel

Set of colors of a spectrum plotting panel consisting **background** color and **marker** color is an independent attribute of each module of the program. Color settings are saved after program shutdown (they are included in the configuration parameters) and are restored when the program is started again. For a **spectrum** is differently, color is its attribute, so the same spectrum is always displayed in the same color in all modules of the program.

Changing colors

icon: 
menu: **Screen | Colors**



In plot panel colors selection dialog box only color for *main spectrum* can be selected - colors for other spectra can be set in spectra container 68. When changing color of background it is important to watch if to none of spectrum placed in the spectra container is given the same color; in this case such a spectrum becomes not visible on a background.

see also:

Display spectrum options 138

8 ROI

A **ROI** (Region Of Interest) is a fragment of a spectrum of special interest, since it contains a peak or group of peaks. It is defined uniquely by two parameters: channel number at the beginning of the region and channel number of the end of the region – both channels are a part of the region.

The **ROI table** is a set o ROIs created for a spectrum. It can be built automatically by executing automatic peak search 101 command or manually using markers and commands described in next chapter.

The ROI table can be **saved** to the same file as a spectrum is, or can be saved in a separate file (see ROI files 89) and then moved to the next measured spectra.

The program uses the idea of "working region of interest". It is a part of a spectrum contained between markers together with the channels, where the markers are set. For such region, the program continually calculates and displays the parameters using "direct" model 94. These parameters are calculated after each change of the marker position or after each change of data. Working region of interest does not belong to the ROI table.

Colors of ROIs
ROIs are shown as color-filled area under a spectrum.
By default, three colors are applied to signify different states of ROI:

- "unanalyzed" ROI - color beige or grey (depends on Windows color scheme)
- "analyzed" ROI containing one peak - color green
- "analyzed" ROI containing doublets (two peaks) - color blue

Colors are user configurable (see Display spectrum options 138).

Parameters of ROI are displayed in Peak parameters panel 91. Parameters of all selected regions are placed in the ROI Table.

8.1 ROI controlling commands

All commands related to ROI can be performed via icons on toolbar, commands available in main menu of the program or commands available in context menu for the spectrum plotting panel.

Toolbar dedicated to perform commands on ROI:

Icon	Menu: **Screen**	Command description	Remarks
	Save ROI	save region selected by markers to the ROI Table (available also from keyboard by Ins key)	1)
	Delete ROI	delete ROI selected by markers (available also from keyboard by Del key)	2)
	Delete all ROI	delete entire ROI table	
	Prev ROI	set markers position on ROI lying to the left of left marker (available also from keyboard by combination of Alt → keys)	
	Next ROI	set markers position on ROI lying to the right of right marker (available also from keyboard by combination of Alt ← keys)	
	Home ROI	set markers position on the first ROI in a spectrum	
	End ROI	set markers position on the last ROI in a spectrum	
	Peak search	run command Automatic peak search 101	
	Calc ROI parameters	calculate parameters of a peak for a ROI surrounded by markers	3)
	Calculate parameters all ROI	calculate parameters for all ROIs in a spectrum	4)
	Nuclide identification	run command Peaks identification 104 for a ROI surrounded by markers	
	Switch ROI param. unit - keV/chn	switch units of peak parameters displayed below the spectrum plotting panel: energy or channel. Appearance of an icon depends on a kind of unit actually selected	5)
	Peak table	show dialog box containing peaks table 107 for actually displayed spectrum	

Remarks:

1) Saved region is highlighted. Each region is automatically numbered. Given to ROI number is visible at left part of a panel of peak parameters 91. Each new ROI is added to the ROI table, such that the whole table is sorted by the first channel number of ROI. ROI can be nested and overlapped; the same ROI cannot be saved in the table twice.
2) There are no special mechanisms for edition of ROIs. If it appears that any ROI is improperly defined, a user should delete it, move markers to proper positions and save region again.
3) ROI newly added to the table by **Save ROI** command is automatically "recalculated", i.e. parameters for a peak contained in a region are calculated (in ANALYZER module it is "direct" method, in ANALYSIS module it is function selected). **Calculate ROI parameters** command allows to calculate those parameters again .
   ROIs saved in acquisition path and those loaded from a file are not "calculated" by default.
4) **Calculate parameters all ROI** command allows to calculate parameters for all regions applying e.g. different fitting function (see Advanced analysis 95).
5) Selection of unit can also be done in Configuration dialog box (see Display spectrum options 138).

Except methods explained above, the program offers mechanism of fast switching of markers for the chosen ROI with buttons in navigation panel (see Peak parameters panel 91) and keyboard (see ROI system navigation keys 146).

8.2 ROI files

ROI files are binary type files. To a file are saved: ROI borders and type of function applied to calculate peak parameters.
The program assigns default extension ".roi" to ROI files and name compatible to a name of a spectrum.
ROI files are saved to working directory 142 of the program.
Commands for loading and saving ROI tables are available in ROI menu only.

Save ROI table to file

icon: 
menu: **ROI | Save to file...**

Sets ROI table from file to a spectrum

icon: 
menu: **ROI | Load from file...**

The operation of inserting data from a ROI file to the ROI table of the program may simplify analysis of the set of measured spectra, if the same ROIs are used for calculations.

9 Analysis

Mathematical analysis is always performed on the *main spectrum* actually being displayed. It consists of: calculation of single peak parameters, manual or automatic peak search and nuclide identification. These commands can be performed in ANALYZER, CALIBRATION and ANALYSIS modules.

In ANALLYZER and CALIBRATION module peak parameters are calculated performing "on-line" method - directly from experimental data, see "Direct" method of peak analysis 91.

In ANALYZE module set of available methods is enlarged by single peak and doublets Gauss fitting operations - see chapter Advanced analysis 95.

Results of spectrum analysis are placed in peaks table 107 which is developed based on the ROI table, what means that every peak needs to exist in ROI structure. The ROI Table can be created manually or automatically thanks to „Peaks search 101" command. This table together with set of data describing measurement is available in REPORT 128 module.

9.1 Peak analysis 'on-line'

„Direct" method of peak analysis, applied mostly in ANALYZER module, is based on calculation of peak parameters directly from experimental data without using any special mathematical functions. Such algorithm is very fast and can be performed on "live" spectrum after every data refresh or every change of markers position.

see also:

Peak parameters panel 91
Peak parameters calculate 94

9.1.1 Peak parameters panel

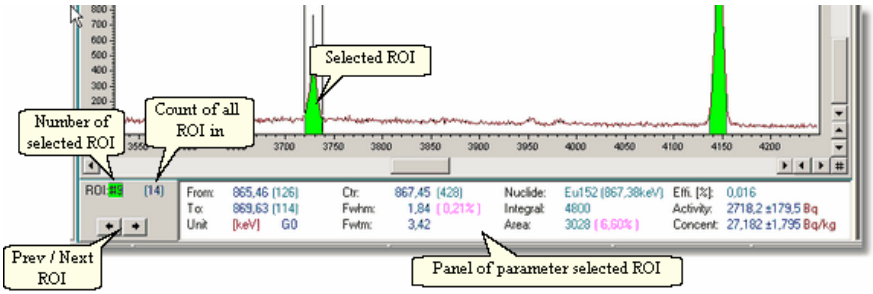
In ANALYZER and CALIBRATION modules parameters of peaks present in ROI are displayed in panel of ROI parameters.

This panel (placed below a spectrum) consists of two parts: navigation and parameters.
Navigation part contains total number of ROIs in a spectrum (in brackets) and

number of a ROI on which markers are currently set. Current number of ROI is preceded by # sign; if the field after this sign is empty, it means that markers are not placed exactly at the borders of ROI. In such a case markers define so-called "working area" 87, that is any part of a spectrum.

If markers are not placed on selected ROI, then panel of parameters contains "live" values calculated "on-line" for working region of interest, but if markers stay exactly on ROI bounds - panel contains parameters calculated earlier, saved in the Peak Table.

Thanks to navigation buttons a user can easily move markers among ROIs.



Parameters available in the ROI Parameters Panel:

Name	Value	Description	Remarks
From:	**xxxxx.xx**	position of a channel defining beginning of region - displayed in energy or channel units*)	1)
	(xxx)	number of counts in channel "From"	
To:	**xxxxx.xx**	position of a channel defining end of region - displayed in energy or channel units*)	1)
	(xxx)	number of counts in channel "To"	
Unit:	[kev] or [chn]	type of unit applied to data displayed in two beginning columns of the panel*)	1)
	G0	symbol of mathematical model applied to calculate peak parameters**)	2)
Ctr:	**xxxxx.xx**	peak centroid - placement of middle part of a peak	
	(xxx)	number of counts in channel placed closest to peak centroid	

Name	Value	Description	Remarks
Fwhm:	**xxxxx.xx**	width a peak at half of maximum	3)
	(0.xx%)	percentage ratio of half peak width to placement of middle part of peak (Fwhm/Ctr * 100%)	
Fwtm:	**xxxxx.xx**	width a peak in 1/10 of maximum	3)
Nuclide:	(xxx)	name of a nuclide identified for ROI - in brackets is given known energy value for that nuclide	
Integral:	**xxxxx.xx**	total counts in all channels belonging to ROI (Net plus background field)	
Area:	**xxxxx.xx**	net total counts in a peak	
	(xx.xx%)	relative error of net field	
Cps[c/s]:	(xx.x)	number of counts per second	

Remarks:

1) Energy (or time for MCS mode of running) units are selected in the program configuration dialog box (see Configuration analysis options 139).
2) List of used symbols of mathematical models applied to calculate peak parameters is described in chapter Mathematical models of peak analysis 96. In ANALYZER module peak parameters are calculated based on "direct" method only (symbols **G0, G0_c** lub **G0_m**).
3) Segment of a line showing peak cut in 1/2 and 1/10 of its maxima can be enabled by selecting proper option in the program configuration dialog box, in Analysis 139 tab.

In ANALYZER module peak parameters are calculated based on "direct" method only. Rule of this method is available in chapter: Peak parameters calculate 94.

If a spectrum being displayed has linked efficiency calibration and in configuration analysis options 139 there is "Automatic calculate activity and concentration" set in, then in peak parameters panel efficiency, activity and concentration (specific activity) are also displayed.

The parameters displayed in this panel correspond to the ones calculated for the current setting of the markers, and are recalculated each time when markers are moved when the option **"Peak parameters - Automatic calculate parameters"** is turned on (see Configuration analysis options 139). If this option is turned off, peak parameters may be calculated by executing command

Calculate ROI; then they are displayed only up to the moment of markers move or to refreshing of *"live" spectrum*.

Calculate ROI parameters

icon: 

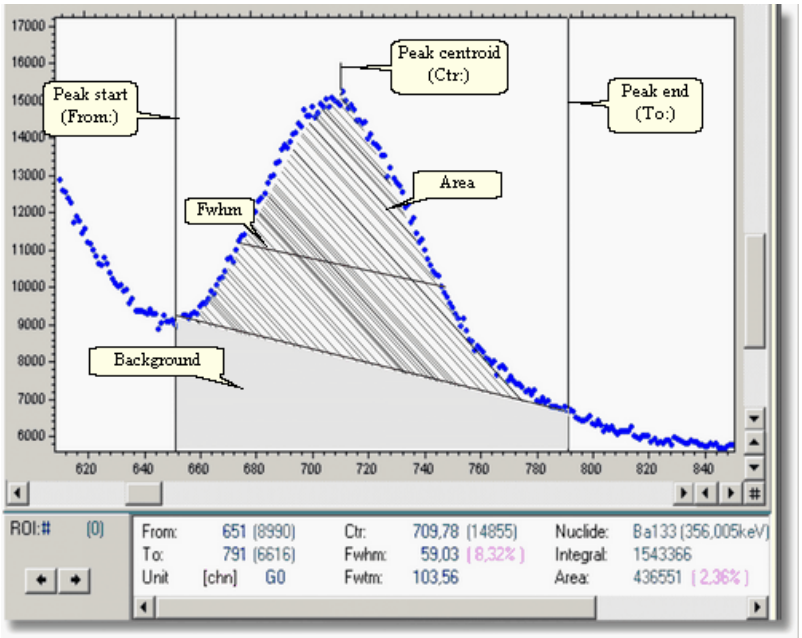
menu: **Analysis | Calculate ROI**

All parameters of a peak are calculated in channels unit, and from such form can be recalculated into energy units. In the program these parameters are displayed in channels or energy units.

9.1.2 Peak parameters calculate

Base model for "direct" on-line calculation of peak parameters is model G0 (see Mathematical models of peak analysis) 96. This model is available in two variants: G0_c and G0_m selected in Configuration analysis options 139.

Model G0 - "direct" (i.e. without fitting function) model of peak parameters calculation. Peak parameters are calculated based on counts in channels belonging to a region set by markers (together with those channels on which markers are placed on).



Peak parameters calculation:

Name	Mode of calculation
Background	set based on line function leaded between interpolated first and last channels of peak. Interpolation is calculated based on three channels lying outside of a region and a channel on which marker is placed.
Integral	calculated by summing counts in all channels laying within peak boundaries
Area	computed as a sum of net counts in a peak: $Area = Integral - \frac{(B_L - B_R)N}{2}$ where BL an average count number in 3 channels laying to the left of a peak, BR an average count number in 3 channels laying to the right of a peak, N is a number of channels inside a peak
Ctr.	peak position (center) calculated using the net counts with a weighted average method
Fwhm	peak half width calculated using net counts. The program calculates with line interpolation method position of two channels laying on a half of peak height on a left and on a right of peak's side – their subtraction defines Fwhm value
Fwtm	peak width calculated for 1/10 of its height calculated with the method similar to Fwhm value

Model G0_c – similar to Go model, the only difference is, that for calculation of **Ctr**., **Fwhm** and **Fwtm** total counts for channels belonging to the region are taken into account.

Model G0_m – **Fwhm** and **Fwtm** parameters are calculated similar as in G0_c model. Placement of **Ctr.** is fixed in a channel with highest number of counts.

9.2 Advanced analysis

Advanced analysis is accessible only in module ANALIZIS. Its includes ie. Gauss function fitting and double peak separation.

see also:

Mathematical models of peak analysis 96
Selection of fitting function models 97
Peak parameters display 99

9.2.1 Mathematical models of peak analysis

Advanced analysis methods are available in ANALYZE module only. Applied functions are available in Appendix A: Library TukanFit.dll 147, containing set of procedures which fit the model's parameters to the experimental data. All fits return parameters of fitting functions with Chi^2 and Chi^2 per degree of freedom errors and calculate peak parameters such as Fwhm, Fwtm, full area under the peak and others.

The implemented version of the library uses thirteen models of peak fitting functions. These models contain data fitting algorithms for a single or double peak Gauss function and different functions for background treatment. Each model is distinguished by its symbol, which is later available in a set of peak parameters.

The following table contains list of all models available in the program.

Symbol of model	Description of model
models available in menu: Configuration / Options / Analysis 139	
G0	"direct" calculation - based on net counts
G0_c	"direct" calculation - based on total counts
G0_m	"direct" calculation - peak position in a maximum counts
models available in ANALYZE module panel (see Selection of fitting function models 97)	
G1_Pn	Gauss function with polynomial background, n - degree of polynomial (n = 1÷3)
G1_F	Gauss function with background defined as Fermi function
G1_fF	Gauss function with background defined as fixed Fermi function
G1_EPn	Gauss function with background "Exponential function with polynomial", n - degree of polynomial (n = 1÷3)
G1_PLPn	Gauss function with background "Power function with polynomial", n - degree of polynomial (n = 1÷3)
G2_Pn	2 Gauss function and polynomial background, n - degree of polynomial (n = 1÷3)
G2_F	2 Gauss function and "Fermi function" background
G2_fF	2 Gauss function and "fixed Fermi function" background
G2_F_Pn	2 Gauss function with common **Fwhm** and polynomial background, n - degree of polynomial (n = 1÷3)

Symbol of model	Description of model
G2_Q_Pn	2 Gauss function with depend fields and polynomial background, n - degree of polynomial (n = 1÷3)
G2_EPn	2 Gauss function and "Exponential function with polynomial" background, n - degree of polynomial (n = 1÷3)
G2_PLPn	2 Gauss function and "Power function with polynomial" background, n - degree of polynomial (n = 1÷3)
G2_D_EPn	2 Gauss function with fixed centroid difference and polynomial background, n - degree of polynomial (n = 1÷3)

see also:

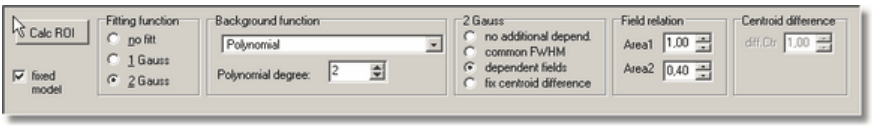
Appendix A: Library TukanFit.dll 147

9.2.2 Selection of fitting function models

In Mathematical models of peak analysis 96 chapter 16 mathematical models for peak analysis is presented.
In ANALYZE module peak parameters panel differs to one available in ANALYZER module. Only left part of this, i.e. ROI navigation part, stays unchanged (see Peak parameters panel 91).
The fitting function selection panel consists of five parts. Selection of mathematical model is reduced to pointing appropriate options. Three exemplary settings are shown below:

Selection of **G1_fF** model

Selection of **G2_F_P3** model



Selection of **G2_Q_P2** model

Model selection:

Fitting function:

- no fit - selection of G0 model, i.e. model without fitting function - after selection, all other options remains unavailable (grayed)
- 1 Gauss - selection of one from five models for fitting single peak
- 2 Gauss - selection of one from eight models for fitting doublet

Background function:

drop down list contains five items:

- ✓ Polynomial
- ✓ Fermi function
- ✓ Fixed Fermi function
- ✓ Exponential function with polynomial
- ✓ Power function with polynomial

Polynomial degree - selected in range from 1 to 3 - available only then, when background function is polynomial

2 Gauss

- no additional depend
- common FWHM - selected with polynomial background only
- dependent fields - only when polynomial background function is selected, then "**Field relation**" becomes active,
- fix centroid difference - applies to polynomial background function only - "**Centroid difference**" becomes active

Centroid difference

distance between centroid of peaks needs to be given in channels

Selection of "2 Gauss" option influence to other fields of the panel. If second, third or fourth option is set, the program automatically selects "Polynomial" item in "Background function" field.

Step by step description of analyse process:

1. set markers on bounds of selected region,
2. in the fitting function selection panel select parameters of function,
3. press **Calc ROI** button,
4. if result is not satisfactory, repeat steps 1 ÷ 3,
5. insert analyzed region to the ROI table.

Description of **fixed model** option (available at the left of the fitting function selection panel)

- when off, the program cancels previous settings of fitting function model and sets model G0 (no background) after every movement of markers
- when on, settings of fitting function model do not change

The result of the fit is displayed as a diagram of fitting function. Calculated parameters of function are displayed in peak parameters panel described in chapter Peak parameters display 99.

9.2.3 Peak parameters display

In ANALYZE module the peak parameters panel is displayed at the right side of a screen.
Fitting results are shown in two forms:

- ✓ graphic - fitting functions are displayed on a screen – Gauss function with a blue line, background with a gray line
- ✓ text - available in the peak parameters panel

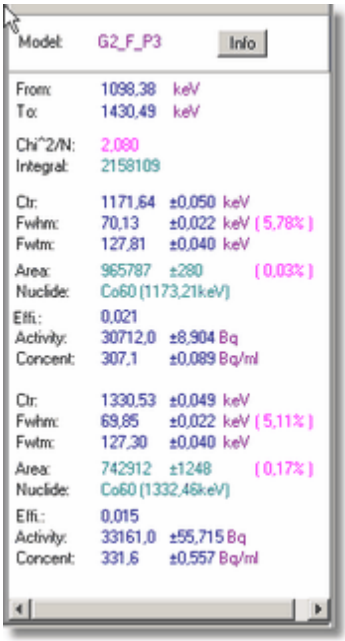
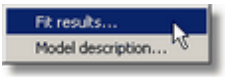


Figure near by shows contents of the peak parameters panel after applying fitting function: 2 Gauss with common Fwhm and background as polynomial of 3 degree.

At the top is seen symbol of applied model, near by is placed "Info" button which allows to display description of mathematical models.

Context menu is available after right mouse button click at any place on the panel:



This way a user can display (and plot) mathematical parameters of fitting function and obtain description of applied model.

If the results are not satisfactory, change the fitting function model or marker setting and press **Calc ROI** button again.

All values are calculated in such units as set in Configuration analysis options 139. By pressing  button, it is possible to obtain values calculated in channels.
Calculated data are saved to the ROI Table in the same units as were displayed, but user can change it in Report configuration options (see Peaks table configuration 131).
Detailed description of all models implemented in the program is available in: Mathematical models of peak analysis 96.

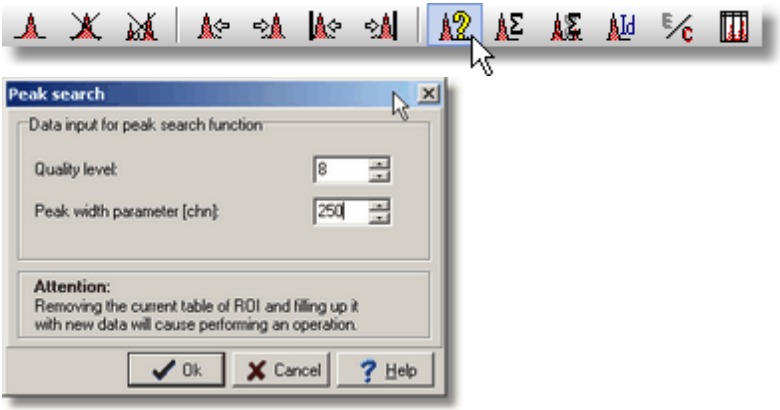
9.3 Automatic peak search

Automatic peak search allows searching for peaks by marking ROI that should contain peaks on a spectrum. It is done using very fast algorithm that is based on rectangular autocorrelation function. If beginning parameters are set correctly, then it yields proper results with spectra obtained by both types of detectors: semiconductor and scintillation.
The input parameters of the algorithm determine the result, which is the number of peaks found in a spectrum and the width of marked ROI.

Peak search

icon: 
menu: **Analysis | Peak search...**

After performed, appears a dialog box in which a user can define conditions and can start search process by click on OK button:



Quality level – determines confidence level of peak search. It can be set in range from 1 to 20; lower value means more sensitive of the method.
Peak width parameter [chn] – sets each peak starting width – the parameter should be close to the mean width of the peaks in the spectrum.

Both above parameters are closely related with a spectrum and are stored with it in the spectra container. The program preserves those values and when command is run again on the same spectrum, they should not be set again.

Automatic peak search command can be started in ANALYZE as well as in ANALYZER and CALIBRATION modules. In both cases process

proceeds a little differently. In ANALYZER and CALIBRATION module as a result of command performance is creation of the ROI table, from which next the program calculates peak parameters applying "direct" method (see Peak parameters calculate 94), run nuclide identification and input results to the peak table.

In ANALYZE module, in the peak search dialog box additional option is available:

Automatic peak fitting – if set, this command marks those ROIs, which contain doublets. Next performs fitting command for all regions applying **G1_fF** model if single peak is found or **G2_fF** model for doublets (see Mathematical models of peak analysis 96). If not set, command is performed in the same way as in ANALYZER and CALIBRATION modules, that is without fitting.

As the result of automatic peak search, found ROIs are displayed in a spectrum, and the peaks table 107 is built in memory. The peak table contains calculated parameters for all ROIs.

9.4 Nuclide libraries

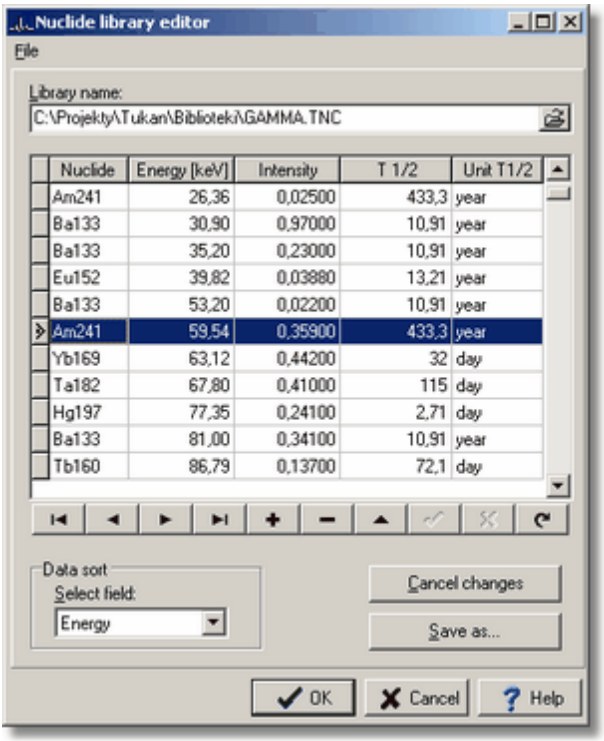
Nuclide libraries available in the program are loaded from files. Files have "tnc" extension. They are placed in directory "Library" established during program installation process.

In Configuration analysis options 139 user may declare name of library automatically read into the memory during each program execution.
Option "Libraries editor..." available in "Analysis" menu shows dialog window in which a user can watch and edit nuclide library or change it on another one.

Preview and library edition:

icon: 

menu: **Analysis | Libraries editor...**



Sorting data

The library dialog window allows to sort data using: names of nuclides, energies, line intensities and half lifetimes.
Sort is run by clicking a header of given column or by choosing a sort criterion in "Data sort" field.

Edition of the library of nuclides

The following commands are available in editor:

- insert item ("**+**" button in navigation toolbar)
- delete item ("**–**" button in navigation toolbar)
- modify selected item

Library file should be saved after any changing - program informs about that in communicate after closing dialog window.
All changes may be canceled using button **Cancel changes**.

Creation of new library of nuclides

Menu of the dialog window contains item **New library**. This command or combination of keys **<Alt+N>** removes all the library data from memory of the

program (clears the data table).
Buttons available in the navigation bar of the data table is useful for filling new data. Using <Tab> key or mouse pointer simplifies movement on the tables fields.
New library should be saved to file with default extension "tnc".
Note: to file are saved only those items which have filled all data fields.

Format of the library file
Library file contains ASCII text. Each item is represented by a new line. Columns are separated by two spaces.

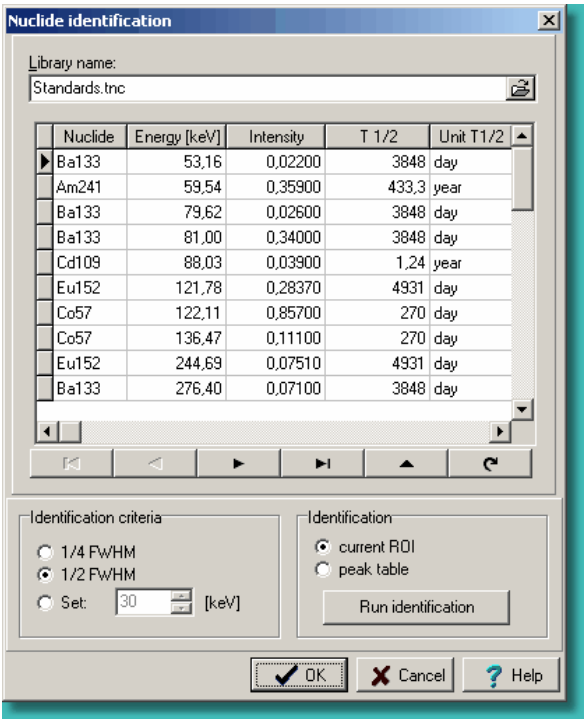
see also:
Peaks identification 104
Peaks table 107

9.5 Peaks identification

Identification of nuclides is done only when two conditions are passed:
1. spectrum has a calibration
2. nuclide library 102 is loaded to memory of the program

Program identifies automatically all peaks each time after recalculating of the peak parameters only then, when
Automatic peak ident is enabled in Configuration analysis options 139. ROI selected between markers is analyzed and all ROIs in the peak table also.
If **Automatic peak ident** is disabled, then identification could be run manually from ROI navigation bar:

or from identification dialog box:
menu: **Analysis | Identification...**



Identification criteria:
The identification procedure searches the library for the nuclide with the closest energy to the peak energy. The program searches the library in the energy range:

E +/- ΔE

where: **E** – peak energy, **ΔE** – width of the energy window

Width of the energy window **ΔE** is defined in the **identification criteria** and is: 1/4 Fwhm or 1/2 Fwhm of the identified peak, or has the value set in the **Set** window

The identification results are displayed in the peak parameters window and saved in the peak table.

see also:

Nuclide libraries 102
Peaks table 107

9.6 Activity and concentration calculate

The program calculates efficiency and activity for ROI region (peak) if:
1. handled spectrum contains efficiency calibration,
2. identified nuclide exists in selected region.

Efficiency for given energy E is calculated based on calibration fitting function applied in Efficiency of detection calculation [121]

$$\varepsilon(E, q_i) = \exp\left(\sum q_i \ln^i(E)\right)$$

Activity is calculated based on formula:

$$A = \frac{N}{\varepsilon(E) \cdot I_\gamma \cdot t_m}$$

where:

e[E]	- efficiency of detection for energy E
N	- number of net counts in peak (net area)
Ig	- line intensify (or quantum efficiency)
tm	- time of measurement (lifetime) in seconds

Concentration (activity for sample mass unit) is calculated only then, when in a spectrum there is defined mass of a sample.

Sample mass value is put automatically into a spectrum if it was defined in the acquisition path (see Measurement description - sample mass [34]). To any disk spectrum, sample mass parameter can be added in Information about main spectrum [74] dialog box.

All parameters mentioned above are automatically calculated only then, when in analysis options [139] option **Automatic calculate activity and concentration** is checked. If this option is not set, those values and all other peak parameters are calculated after performing  **Calculate parameters all ROI** command available in the main toolbar, in the ROI navigation toolbar or in the ROI menu.

see also:

Efficiency calibration process [120]

9.7 Peaks table

The peak table contains parameters of the selected *ROI regions*: left and right marker position limiting ROI, width a peak at half of maximum, integral end the like.
Peak table displayed in ANALYZER, CALIBRATION and ANALYSIS modules is an auxiliary structure - allows to control all ROIs selected in a spectrum. Final peak table treated as documentation of performed measurements is created in REPORT module.

The ROI table may be created manually or automatically by the Peak search 101 command.

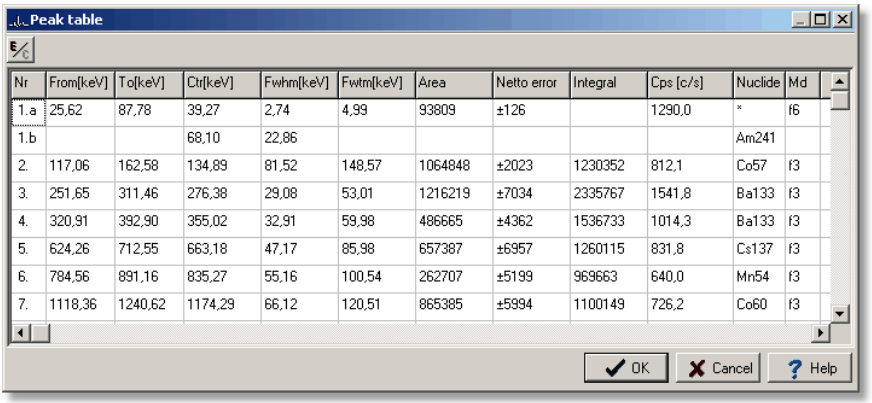
Peak table - show dialog box with peaks table

icon: 

menu: **Analysis | Peak table**

or the ROI toolbar:

The contents of the peak table is related to the main spectrum. It will change with respect to change of the main spectrum.

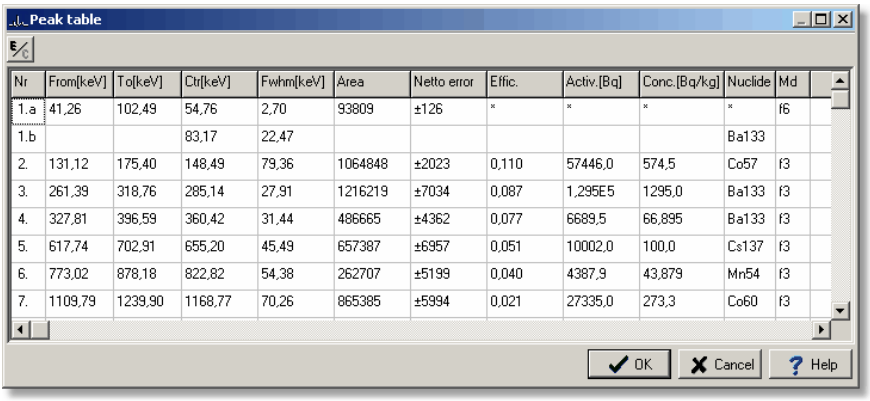


Nr	From[keV]	To[keV]	Ctr[keV]	Fwhm[keV]	Fwtm[keV]	Area	Netto error	Integral	Cps [c/s]	Nuclide	Md
1.a	25,62	87,78	39,27	2,74	4,99	93809	±126		1290,0	*	f6
1.b			68,10	22,86						Am241	
2.	117,06	162,58	134,89	81,52	148,57	1064848	±2023	1230352	812,1	Co57	f3
3.	251,65	311,46	276,38	29,08	53,01	1216219	±7034	2335767	1541,8	Ba133	f3
4.	320,91	392,90	355,02	32,91	59,98	486665	±4362	1536733	1014,3	Ba133	f3
5.	624,26	712,55	663,18	47,17	85,98	657387	±6957	1260115	831,8	Cs137	f3
6.	784,56	891,16	835,27	55,16	100,54	262707	±5199	969663	640,0	Mn54	f3
7.	1118,36	1240,62	1174,29	66,12	120,51	865385	±5994	1100149	726,2	Co60	f3

First item in the table shown on figure refers to doublet included in ROI nr 1.
Contents of the table can be displayed in channels or energy units selected in Configuration analysis options 139.

If analyzed spectrum contains efficiency calibration then set of parameters in the

peak table changes as follows:



Edition of peak table

This program version does not allow direct edition of peak table, because it is a direct copy of the ROI table; you can delete and add new ROI directly on the spectrum.

see also

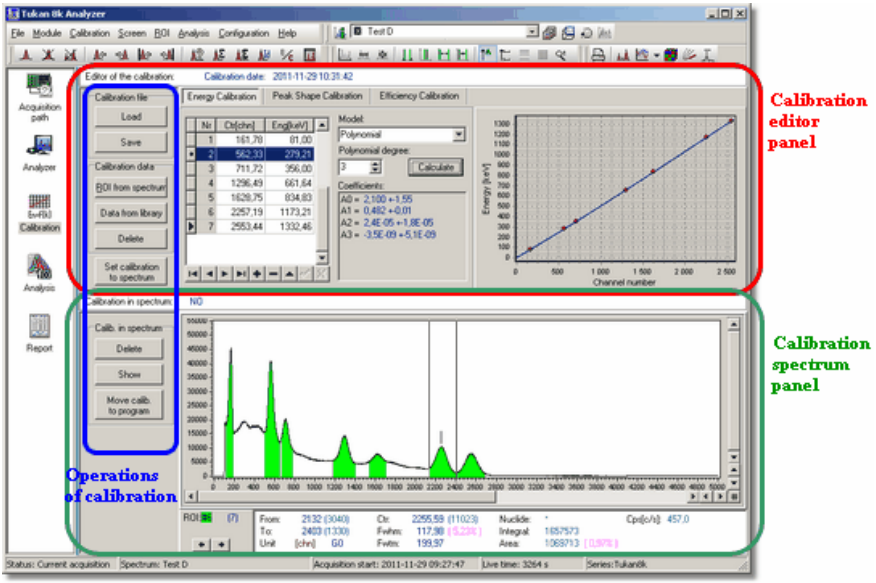
ROI controlling commands 87

10 Calibration

All commands concerning the calibration are grouped in Calibration module 16. In ANALYZER and ANALYSIS modules visual control of calibration 114 is available for the main spectrum .

The program can realize three types of calibration: energetic, peak shape and efficiency:
Energy calibration is necessary process for nuclide identification in examined sample. It relays on assigning energy value to each channel.
Peak shape calibration describes function defining dependents of width a peak at half of maximum to energy. It is applied in automatic peak search algorithms.
Efficiency calibration is necessary for procedures of calculation quantitative parameters of examined sample, i.e. activity and concentration.

CALIBRATION module main screen is divided into two parts: calibration editor panel and calibration spectrum panel:



The **calibration editor** panel contains calibration parameters and set of related commands. The panel consists of three tabs sheets, one for each of calibration types.

Tab selection means changing of set of displayed information respectively for energy, peak shape and efficiency calibration. Changes refers to: data table contents, type of calibration equations and coefficient of calibration function diagram.

Spectrum displayed in the bottom panel may, but has not to be calibration spectrum.

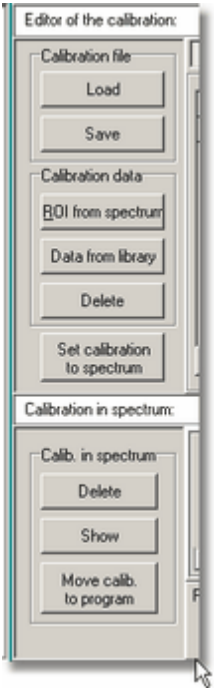
Calibration available in editor and calibration within a spectrum loaded to the bottom panel are independent, i.e. can be the same but not have to. White field separating both panels contains description informing if calibration in a spectrum is CONSISTENT or NOT CONSISTENT with calibration available in editor.

Such program philosophy causes, that in CALIBRATION module is possible to:

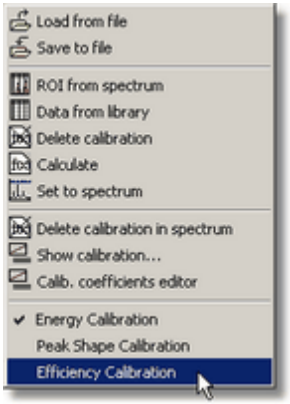
- insert calibration from editor to a spectrum displayed in the bottom panel
- insert calibration from editor to any number of spectra sequentially loaded to the bottom panel
- transfer calibration beetwen spectra 113,
- insert calibration from calibration files to spectra.

10.1 Calibration operations

Commands related to calibration process are available in CALIBRATION module or from menu **Calibration**:



Calibrations operation panel



Menu **Calibration**

In calibrations operation panel there are distinguished two groups of commands: related to calibration editor and related to a spectrum:

Calibration file group**:**

Load	load calibration from calibration file (file with "**.clb**" extension) to calibration editor: includes data table contents, type and degree of equation, coefficients of equation together with error factor and calibration curve data
Save	save calibration to calibration file; name of a file is user selectable (default name is the same as for a spectrum displayed in the bottom panel).

Calibration data group**:**

ROI from spectrum	get ROI parameters (Ctr and Fwhm) from a spectrum displayed in the bottom panel to data table of calibration editor

Data from library	open dialog box to display selected nuclide library - there a user can move energy values from nuclide library to data table of calibration editor
Delete	delete all data and results in calibration editor
Set calibration to spectrum	insert calibration available in calibration edit panel to a spectrum displayed in the bottom panel. Command can be run repeatedly for different spectra.

Calibration in spectrum group**:**

Delete	delete calibration in a spectrum displayed in the bottom panel - actual spectrum status becomes NO CALIBRATION
Show	show full calibration of a spectrum displayed in the bottom panel in separate dialog window. This is useful to compare calibration available in calibration editor with calibration set in a spectrum.
Move calib. to program	copy calibration data, like: type and degree of equation, coefficients of equation from spectrum to calibration editor. It is useful for copying calibration to another spectrum.

10.1.1 Inserting calibration to spectrum

Insert calibration command refers to loading description of calibration equation, i.e. type of function and coefficients to a spectrum.
Calibration should be available in calibration editor and a spectrum to which calibration is inserting should be displayed in the bottom panel.

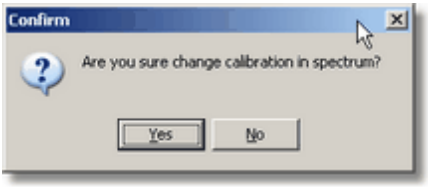
Inserting calibration to spectrum:

menu: **Calibration | Set to spectrum**
operation panel **Set calibration to spectrum**

After executing this command, at the upper axis of the spectrum diagram additional energy scale is displayed (in blue) and peak parameters displayed below a spectrum are recalculated to be given in energy units.
Command can be executed repeatedly for many spectra by loading them from

the spectra container to the calibration spectrum panel.

Change calibration in spectrum
If a spectrum already contains calibration, after execution of **Set calibration to spectrum** the following question is displayed:



For every spectrum placed in the spectra container calibration can be set many times. Permanent including occurs then, when calibration parameters with counts in channels is saved to a file.

Before changing, it is possible to verify existing calibration in a spectrum. To do that, it is necessary to run **Show** command to display a dialog box of visual control of calibration 114.

10.1.2 Transfer calibration beetwen spectra

In some cases (ie. series of measurement) is needed to transfer calibration from one spectrum to another. This operation can be done in the following way:

- read a spectrum containing calibration to the spectra container 68 and then read this calibration to the spectrum panel in Calibration module 16,,
- press the button **Move calib. to program** placed in the calibration operation panel - calibration from a spectrum will be transferred to the calibration editor panel
- read the target spectrum to the spectrum panel,
- run operation Set calibration to spectrum 112

see also:
Calibration operations 110

10.1.3 Delete calibration

Calibration can be removed from a spectrum in CALIBRATION module only and only then, when a spectrum is displayed in the calibration spectrum panel.

Delete calibration in spectrum

icon: 
menu: **Calibration | Delete calibration in spectrum**
operation panel ("Calibration in spectrum" group): **Delete**

Calibration can be also removed from a spectrum by inserting empty calibration. To do that, it is necessary to perform **Delete** command (available in a panel related to calibration editor) and then perform **Set calibration to spectrum** command.

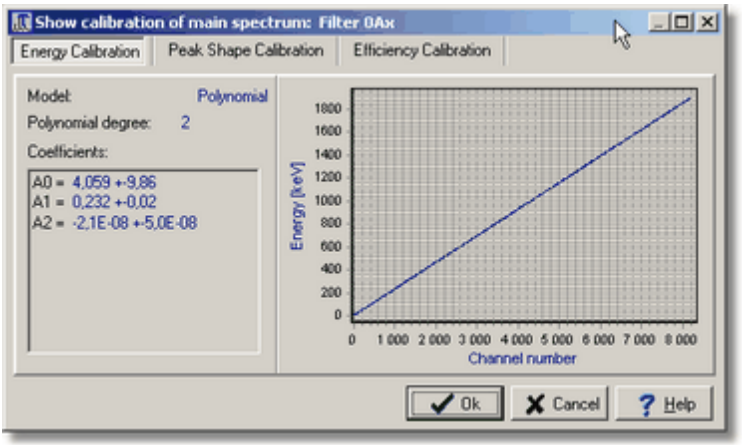
Delete calibration command is preceded by "Are you sure that you want to delete calibration in the spectrum?" message which at the same time is a notice and allows to cancel performed command. This message is displayed a dialog box. Calibration is removed after **"Yes"** response to this question.

Remark: **Delete** command available in "Calibration data" block of commands removes data in calibration editor only, but do not remove calibration from a spectrum.

see also:
Inserting calibration to spectrum 112

10.1.4 Visual control of calibration

The dialog window with calibration preview is showed below. It shows coefficients of the calibration equations and function plots for three types of calibration.



This window is presented after executing operation **Spectrum calibration show,** which can be find in ANALYZER and ANALYSIS modules, in menu Analyse. Calibrations presented in this window always concern to the main spectrum.

Show spectrum calibration in ANALYZER and ANALYSIS module

icon:
menu: **Analysis | Show calibration...**

Show spectrum calibration in CALIBRATION module

icon:
menu: **Calibration | Show calibration**
operation panel: **Show**

see also:
Calibration 109

10.2 Inserting of calibration data

To calibration editor, calibration data can be insert in the following way:
- manually,
- from calibration spectrum (moving placement of peaks) and from nuclide library,
- from calibration file.

Coefficients and parameters of calibration equations can be also input from any spectrum containing calibration.

Table of the calibration data is common for three types of calibration:

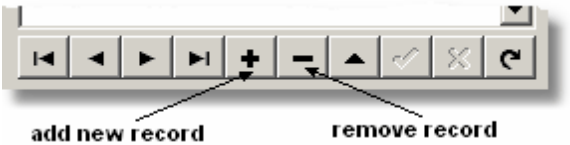
	Nr	Ctr[chn]	Eng [keV]	Fwhm[chn]	Netto	Effic.[%]
	1	561,50	356,00	53,54	1115525,7	0,009
	2	709,13	383,85	57,12	417553,5	0,017
	3	1292,58	661,64	84,94	617055,8	0,0089
	4	2255,16	1173,21	119,47	768072,1	0,0041
▶	5	2552,03	1332,46	128,46	703131,3	0,0037

1 2 3 4 5

data form column 1 and 2 are related to the energy calibration,
data form column 1 and 3 are related to the peak shape calibration,
data form column 2 and 5 are related to the efficiency calibration.

The above table is never showed in program as a whole - only parts related to selected calibration type exist.

Data can be edited directly in a table fields. New position are added after pressing "+" button on the bottom navigation panel. Navigation on the table fields can be done using "Tab" key or mouse pointer.



Order of filed date is free. After pressing **Calculate** button (see Energy calibration process 118) the program checks and sorts data with respect to the values in the first column.

10.2.1 Inserting data from calibration spectrum

To automate process of calibration data input, you have to use the ROI table and a nuclide library, which contains descriptions of those nuclides, which are present in a standard of calibration. The rule of operation is following:

- Make a measurement of the calibration spectrum,
- Choosing calibration lines and define them as ROI regions 87. It could be done manually or automatically (ie. in the module ANALYZIS run Automatic peak search 101 with fitting peaks),
- Switch to Calibration module 16 and make a calibration spectrum with

ROIs visible in the spectrum panel,

- Run operation **ROI from spectrum**:

  icon: 
  menu: **Calibration | ROI from spectr.**
  calibration operations panel 110: **ROI from spectr.**

This operation automatically fills data table 115 using the following parameters from ROIs: positions of centroid to column 1, FWHM values to column 3 and net areas to column 4.

- Column 2 will be filled after operation **Data from library** (see Inserting energy from nuclide library 117)
- Values in column 5 will be filled after **Calc. efficiency** operation (see Efficiency of detection calculation 121)

see also:

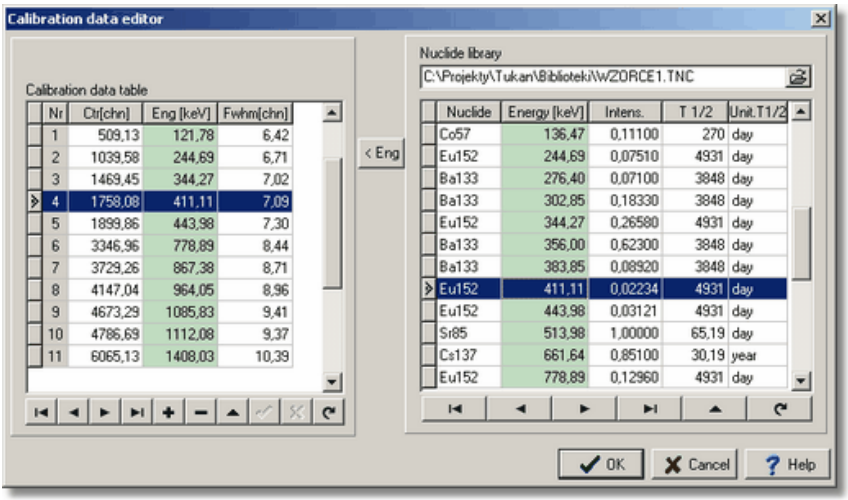
Energy calibration process 118
Peak shape calibration process 119
Efficiency calibration process 120

10.2.2 Inserting energy from nuclide library

The program allows to move energy values related to calibration peaks from nuclide library to calibration data table.
Set of calibration operations 110 contains one button, which adjust its function due to type of calibration actually selected on the calibration editor panel 109.
For energy and peak shape calibration it is **Data from library**, for efficiency calibration it is **Calc. efficiency**.

After execution of **Data from library** command dialog box appears as

presented below. The left table contains calibration data. The right table contains data taken from the nuclide library. User can select another nuclide library with button.



To move energy value, first select with the mouse or keyboard an appropriate row in the table of calibration data (left one), then in the library table select the correct row containing data for selected nuclide. Pressing the **Eng** button, copies the value of energy for selected nuclide to the calibration data table. Command should be performed separately for each item (row) of the table.

see also:

Energy calibration process 118

10.3 Energy calibration process

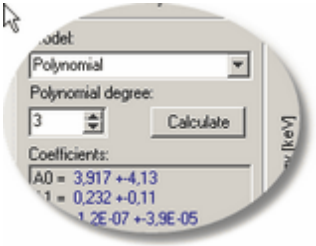
Energy calibration is calculated using data pairs: peak position - energy. If these data points are placed into the table automatically, the program calculates their errors and takes them into account while calculating the calibration curve.

Fitting of energy values to the peaks position is done using polynomial function:

$$y(x, A_i) = \sum A_i x^i$$

where: y – energy value in [keV], x – channel number, Ai – i-th coefficient of equation, i – equation degree, (i = 1,2,3)

After inserting of calibration data 115: peak position - energy, process of energy calibration relies on calculation of coefficients of calibration equation. Polynomial degree number should be defined in editor panel (see figure below).

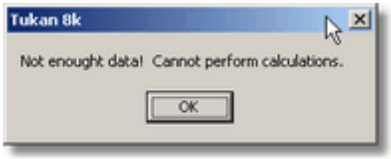


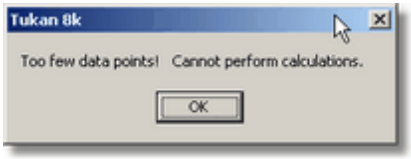
Calculate calibration equation coefficients

menu: **Calibration | Calculate**

context menu of calibration panel: **Calculate**

After invoking **Calculate** command, the program verifies whether the table of calibration data is complete and whether the number of rows in the table is enough to fit the polynomial of required degree – if it is not then the message is displayed on screen:





or

After performing calculations, the equation coefficients values are displayed on a screen with errors and calibration curve.
In case when a curve does not fit calibration data properly, then operation may be repeated with different polynomial degree.

After finish of calibration process, operation Inserting calibration to spectrum 112 should be performed.

10.4 Peak shape calibration process

Peak shape calibration is calculated using data pairs: peak position – Fwhm. If automatic peak search command was executed before, then table of data is filled automatically by data pairs: peak position - peak half width. The command is executed in the same way as in a case of energy calibration with only one

difference, that you have a choice between two types of calibration equations:

polynomial:

$$y(x;a_i) = \sum a_i x^i$$

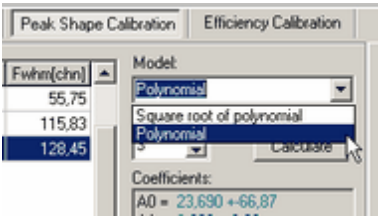
square root of polynomial:

$$y(x;a_i) = \sqrt{\sum a_i x^i}$$

where for both types, equation degree can be set in a range from zero to three.

There are two ways of invoking process of peak shape calibration:
- from calibration panel: - mouse click on tab **Peak shape calibration**
- from menu **Calibration | Peak shape calibration**

To perform calibration, do the following:
- fill data table - input data pairs: peak position (Ctr) - width a peak at half of maximum (Fwhm) for that peak. Both data should be given in channel units. When entering data from ROI selected on a spectrum, this table is filled automatically.
- choose **model** (type of calibration equation) between "Polynomial" or "Square root of polynomial").



- select **Polynomial degree** (0, 1, 2 or 3)
- calculate coefficients of equation by pressing **Calculate** button
- calculated coefficients of equation are displayed on a screen together with error factors and preview of Calibration curve 126.

10.5 Efficiency calibration process

Efficiency calibration is calculated using data pairs: energy – efficiency. Correct efficiency calibration requires sure identification of the energetic lines in the calibration spectrum and calculating detector affectivity for each line. Detector efficiency is a ratio of counts under the line peak to gamma-ray photons with corresponding energy emitted from a source. This quantity strongly depends on

energy and measurement geometry.

Calibration fitting function in this case is an exponent of polynomial of logarithm:

$$y(x;q_i) = \exp\left(\sum q_i \ln^i(x)\right)$$

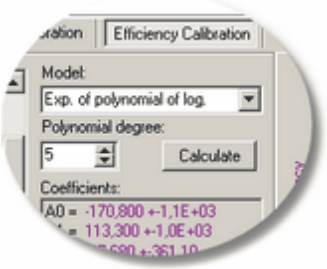
where: y – efficiency, x - energy value in [keV], qi – i-th coefficient of equation, i – polynomial degree (can be chosen from 0 to 6).

Efficiency of detection is calculated based on parameters of calibration peaks and data coming from libraries of standards or input directly from keyboard.

To invoke process of peak shape calibration:
1. mouse click on tab **Efficiency calibration** in calibration panel,
2. select in menu: **Calibration | Efficiency calibration**

Calibration data table can be obtained by:
Inserting data from calibration spectrum 116 and Efficiency of detection calculation 121

Efficiency calibration should be performed in the same way as energy calibration 118 selecting appropriate degree of calibration equation (from 1 to 6).



After performing calculations, the equation coefficients values are displayed on a screen with errors and calibration curve 126 is drawn.
In case, when a curve does not fit calibration data properly, then operation may be repeated with different polynomial degree.

After finish of calibration process, operation Inserting calibration to spectrum 112 should be performed.

10.5.1 Efficiency of detection calculation

Efficiency of detection defined as quotient of number of pulses calculated for photo peak to number of gamma ray quantum of certain energy related to photo peak emitted by radiation source. This value strongly depends on energy of

gamma ray and on geometry of measurement.
Determination of the efficiency requires: data coming from calibration source measurement with correct peak recognition and data coming from certificate of the source given by the producer of the source.

$$\varepsilon[E] = \frac{N}{Ad \cdot I_\gamma \cdot t_m}$$

- $\varepsilon[E]$ - efficiency of detection for energy E
- **N** - number of net counts in peak (net area)
- **Iγ** - intensify (or quantum efficiency)
- **tm** - time of measurement (lifetime) in seconds
- **Ad** - nuclide activity given by formula:

where:

$$Ad = Ao \cdot e^{-\ln 2 \frac{(T_d - T_0)}{T_{1/2}}}$$

- **Ao** - activity of the standard according to the certificate (in Bq)
- **Td** - date and time of the measurement with additional lifetime of measurement (in seconds)
- **T0** - date and time coming from the certificate (in seconds)
- **T1/2** - nuclide half-lifetime in seconds

Calculation of efficiency of detection for particular energy lines of calibration spectrum is necessary for calculation of efficiency calibration 120.

Efficiency of detection calculation:

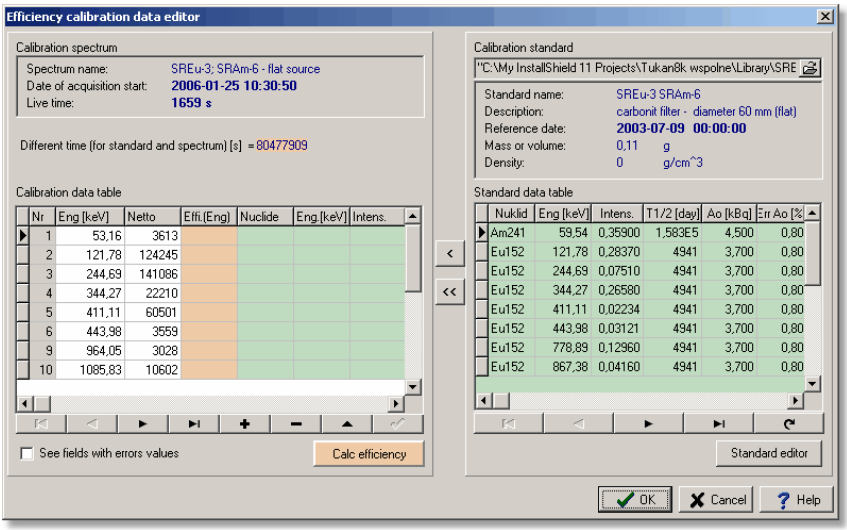
menu **Calibration | Calc. efficiency**
calibration operations panel: **Calc. efficiency**

Operation "**Calc. efficiency**" is an element of the main menu and the calibration operation panel, but only when "**Efficiency calibration**" tab is selected (for other tabs, the same button has linked different meaning).

Running this operation causes showing a dialog window. Program will automatically fill the following fields in this window:

- data of the calibration spectrum: name, date and time, lifetime,
- data according to the calibration peaks: photo peak energy and net area,

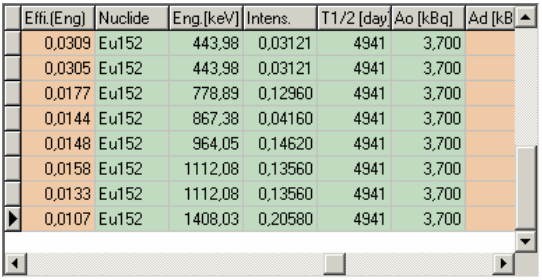
- certificate data (if has been loaded to the memory earlier)



If there is no standards library loaded in memory, it can be read from a file by pressing button  , or by pressing button **Standards Editor** and then fill data from certificate (see Standards editor 124).

Filling calibration data table

A set of date is required for making efficiency calibration for energy line. They are read from a nuclide table and standard certificate (see Efficiency of detection 121). Columns containing this data are seen in the table. Horizontal scroll bar may be needed to reach all of them:



Effi.(Eng)	Nuclide	Eng.[keV]	Intens.	T1/2 [day	Ao [kBq]	Ad [kB
0,0309	Eu152	443,98	0,03121	4941	3,700	
0,0305	Eu152	443,98	0,03121	4941	3,700	
0,0177	Eu152	778,89	0,12960	4941	3,700	
0,0144	Eu152	867,38	0,04160	4941	3,700	
0,0148	Eu152	964,05	0,14620	4941	3,700	
0,0158	Eu152	1112,08	0,13560	4941	3,700	
0,0133	Eu152	1112,08	0,13560	4941	3,700	
0,0107	Eu152	1408,03	0,20580	4941	3,700	

Data can be copied from the right to the left table by selecting given rows in each of them and pressing button < lying between tables.
If values of energy in the left table are correct and agree with the right one, then

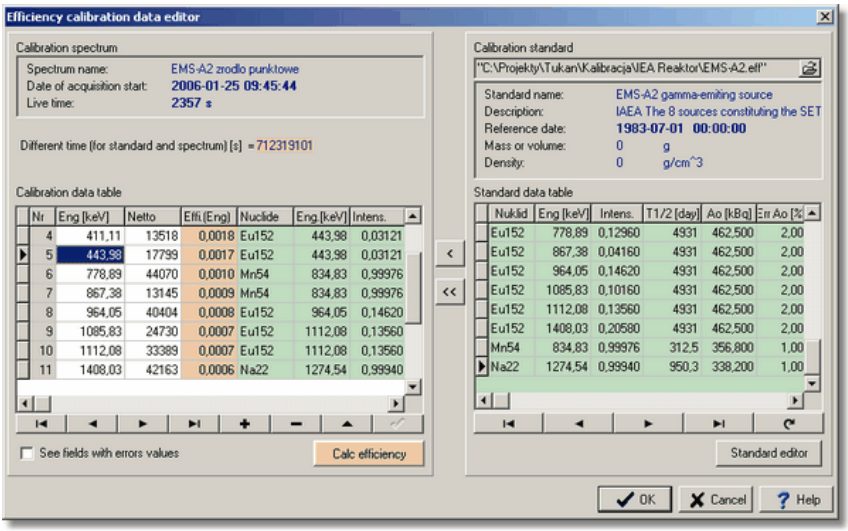
pressing button << will copy all data.

Calculating efficiency

Except data from the tables, it is needed a time since the standard measurement (from certificate) to the moment of given measurement of the calibration source. This time is calculated automatically by the program.

Calculation if the efficiency must be done separately for each energetic line.

Select the row in the table and press button Calc efficiency.
First of all the program calculates activity Ad for given energy and then efficiency. Both values are stored in the orange columns of the table.



After calculating efficiency for all nuclides, OK button should be pressed. It turns focus back to the Calibration module.
Calculated calibrating points will be seen on the plot. It helps for additional control of all process.

see also:

Efficiency calibration process 120

10.5.2 Calibration standars libraries

The library of the calibration standards is useful during calculating efficiency of the detector for given energy lines of the source. The library data are filled based on the certificate of the standard. Calibration sources usually have a

standard contents of the nuclides. Having a package covering a standard sources causes, that in a future, only little update is required during calibration. Access to the library editor is possible only form Calibration module.

Preview and edition of calibration standards

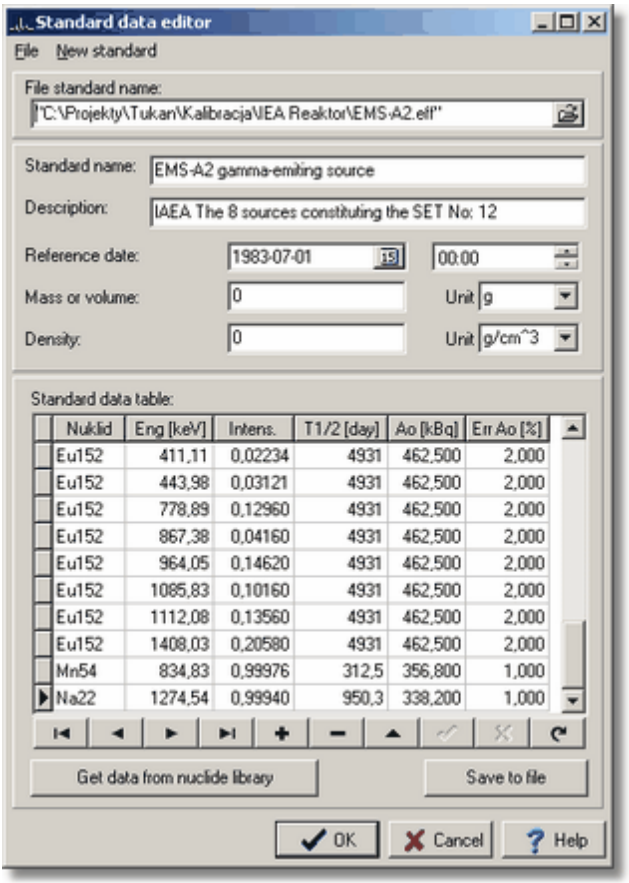
icon: 
menu: **Analysis | Standards editor**

Selection command **Standards editor** opens the dialog window. In this window is possible to:

- create new library and fill it with date from standard certyficate
- view and/or edit of existing library
- load library from disk

Creating new library

User should fill data fields in the "Standard data editor" window, corresponding to the standard parameters and save as a new file. If (some) fields were filled before then **New standard** option should be execute. This will remove all data from memory.
For simplicity, user may use **Get data from nuclide library** (available at the bottom of the dialog window) and fill only field with activity of the standard lines. Set of parameters of library of standard except data necessary to calculate efficiency contains also name and description of library allowing this way better identification of library.



see also:

Efficiency of detection calculation 121

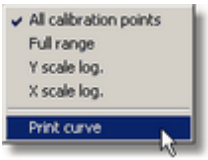
10.6 Calibration curve

Calibration results are displayed on a screen as the coefficients of calibration equation and calibration curve diagram.
Calibration nodes taken from the calibration data table are displayed on a diagram. Either diagram axis coordinates automatically adjust to the calibration curve or, in case if there is no curve, to calibration nodes.

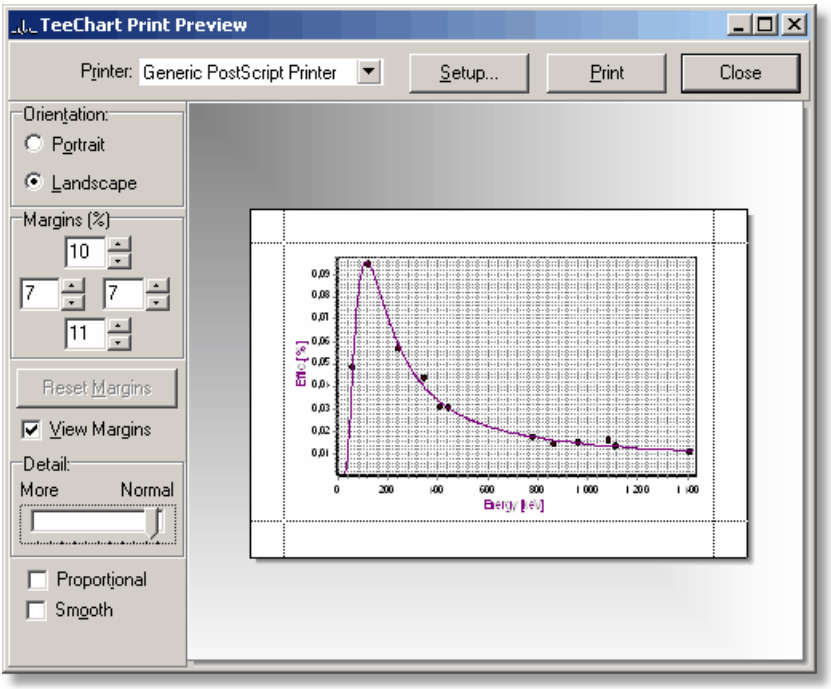
There is a splitting bar between calibration and spectrum panel to change the heights of both panels. You can zoom any part of calibration spectra. To do this,

drag the mouse over the part to zoom. Right clicking of the mouse allows dragging the calibration plot freely horizontally and vertically.

Context menu of calibration curve panel:



Operation "**Print curve**" opens a dialog window showing a print preview and allowing printer selection and setting printing parameters. The curve is printed in the same shape as in the preview (all printing colors are identical if available in the printer).



11 Report

Report of measurement may be printed after switching to REPORT module. This module consists of two parts:

- **print preview** panel representing page of paper and
- **thumbnail preview** panel with miniatures of all pages of the report.

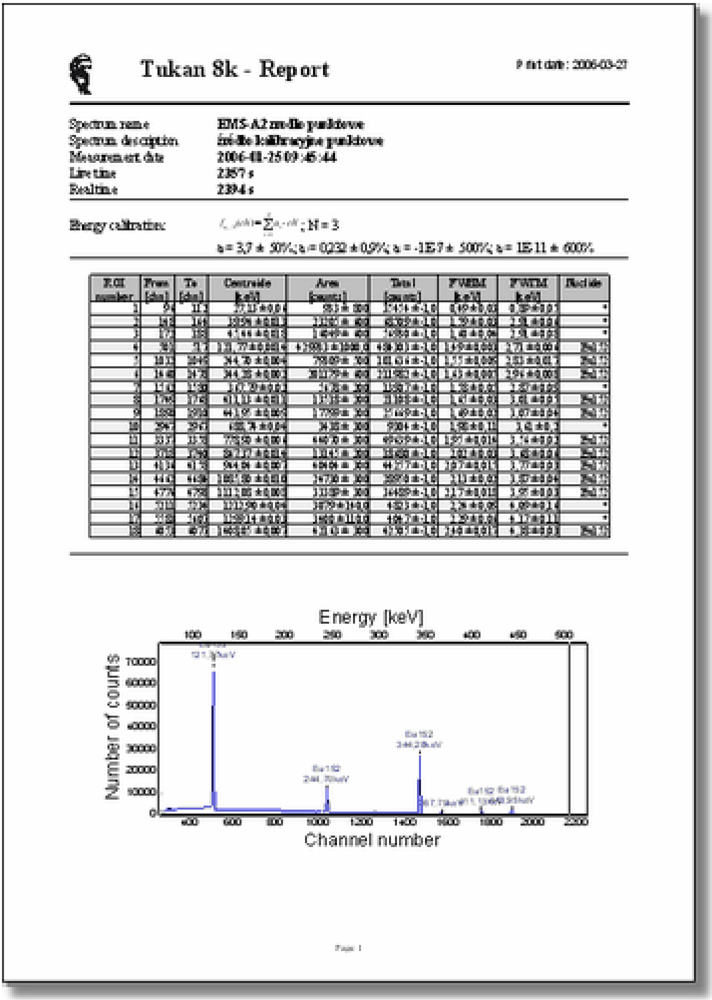
Thumbnail preview helps with navigation on multi pages report.

Report contains header with information about spectrum and measurement, calibrations information, table of peaks and figure of the spectrum.

Report content may be easily changed, each part of report is fully configurable (see next subsections). Report module allows to print generated reports by windows print dialog. User may scale the **print preview** by changing **Zoom** drop down menu.

see also:

Report configuration 129
Printing report 133
HTML and Text format of the report 134



Tukan 8k - Report

Print date: 2006-03-27

Spectrum name	EMS-A2 zrodlo punktowe
Spectrum description	źródło kalibracyjne punktowe
Measurement date	2006-01-25 09:45:44
Live time	2357 s
Real time	2394 s

Energy calibration: [illegible]; N = 3

[illegible]

ROI number	From [chn]	To [chn]	Centroid [keV]	Area [counts]	Total [counts]	FWHM [keV]	FWTM [keV]	Nuclide
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Page 1

11.1 Report configuration

There are two ways to configure content of the report:

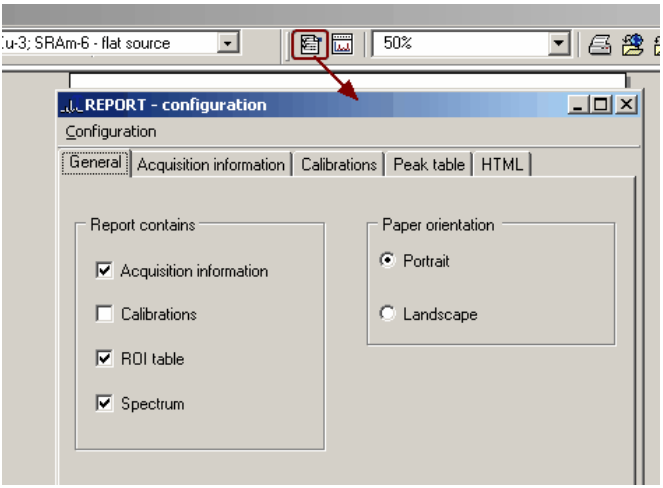
- click on button **Configure report**
- from menu: **Configuration | Configure report…**

The **Report configuration** window contains 4 tabs sheets:

- General
- Acquisition information

- Calibrations
- Peak table

Each tab corresponds to the section of the report presented in the main panel and allows to configure the section:



General tab gives possibility to plug-in and plug-off parts to the report by setting on or off to options related to particular parameters.
In this tab it is also possible to set orientation of the paper (only A4 paper size is supported now) and decide if spectrum plot should be included.

Acquisition information tab allows to add to report some descriptive information, like name of a spectrum file, identification of a person who performed measurement, name of acquisition path etc.

Calibration tab allows to configure information about calibration of a spectrum - only if a spectrum contains it.

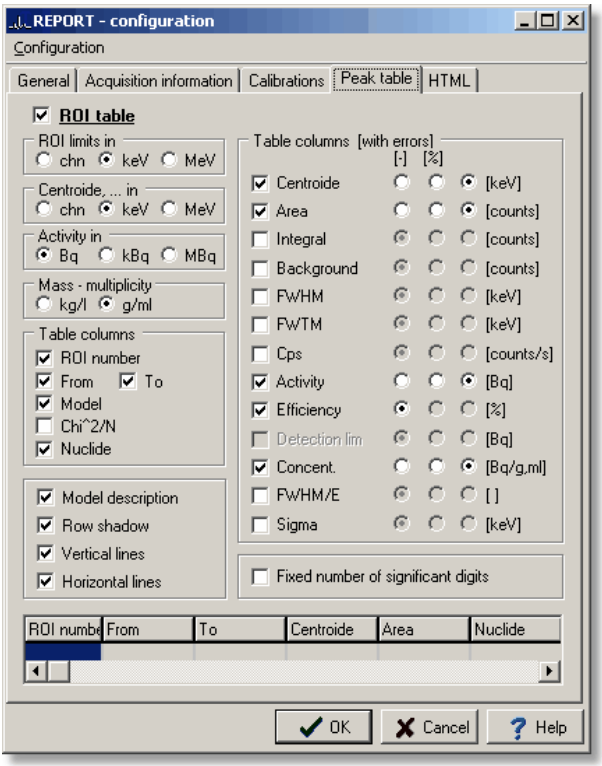
The most extended tab is **Peak table**, which has been described in section: Peaks table configuration 131.

Clicking **OK** button (common for all tabs of Report configuration dialog box) closes window, stores all setting and generates new report regarding new settings.
At every moment it is possible to save actual settings of report to configuration file 133.

Report module allows also to configure contents of diagram of a spectrum - see: Spectrum plot configuration 132.

11.1.1 Peaks table configuration

The window Report configuration 129 contains the tab **Peak table**.
Peak table gives possibility to mange the contents of the ROI/peak table, recapitulating information about all ROIs in a spectrum. Particular visual controls allow to select units in which parameters will be plot in columns. User may choose which column will be displayed and if error factors should be added to report.



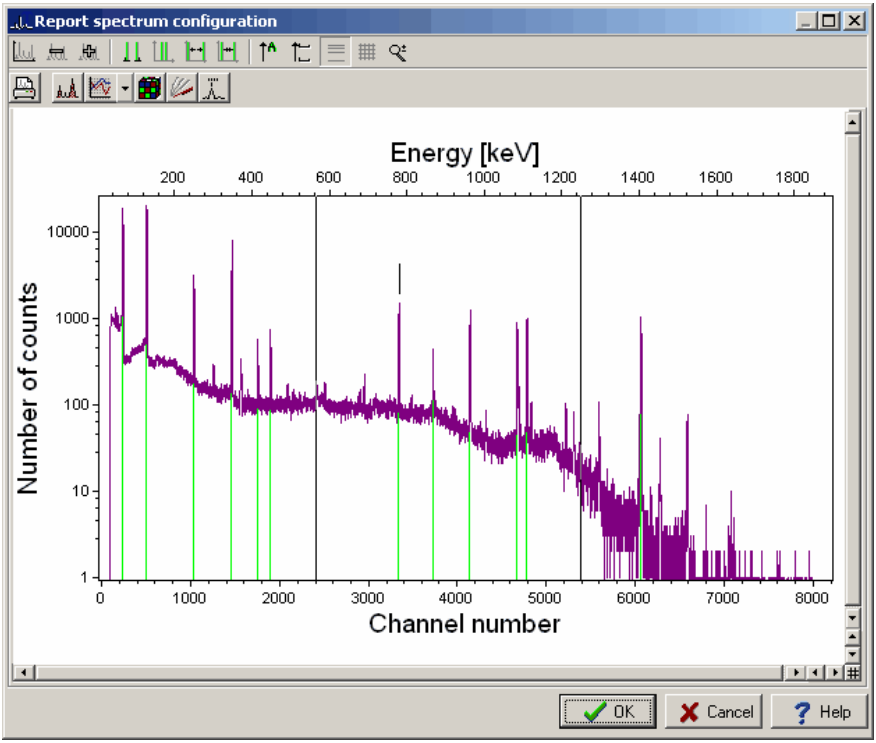
Bottom part of **Peak table** tab allows to select sequence of columns in a table - applying "drag and drop" mechanism, a user can easily move columns to any place in a table.

All report settings can be saved to configuration file 133 of report.

11.1.2 Spectrum plot configuration

Report module makes possible configuration of the contents of the figure with spectrum, which is add
to the report.
Configuration window is run from:

icon:
menu: **Configuration | Configuration spectrum...**



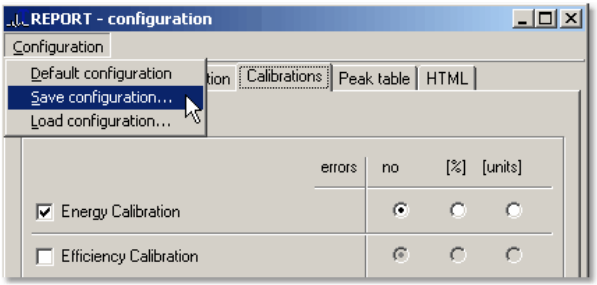
Report spectrum configuration dialog window makes possible to set many properties of plotted spectrum. These settings are similar to other settings in the Tukan 8k program: spectrum size, colors, add grid, add peak description etc. (see Plotting a spectrum 81).
Changed size of Report spectrum configuration window influence on proportions of a spectrum displayed in a main window of Report module and in

print copy.

11.1.3 Configuration file

Settings of the report configuration may be saved in configuration file.
It could be done only from menu of the configuration window:

menu of the configuration window: **Configuration | Save configuration…**



Configuration file may be loaded by:
Configuration | Load configuration...

Additionally, the program contains built-in standard configuration settings, loaded by:
Configuration | Default configuration

Configuration data are saved in files with extension ***.cfg**. These files are saved in working directory by default, but may be saved anywhere else.

11.2 Printing report

Report printing process can be started from the icon of the toolbar of Report module or from "File" menu of this module.

Print report:

icon:
menu: **File | Print report**

Remark: Changing orientation in Windows **Print…** dialog does not effect –

program forces configured in **Report** module orientation.

11.3 HTML and Text format of the report

The measurement report may be saved as HTML file or as a plain text - in both cases saved contents is similar to its preview on a screen.
Report saving may be done using icon available in Report module or **File** menu:

Save report in HTML form:

icon: 
menu: **File | Save as HTML...**
or:
menu: **File | Save as HTML file and show in browser**

HTML report looks similar to print preview in the program. Graphical elements (mathematical formulas and spectrum figure) are saved as JPEG files (Tukan8k version 1.6 or higher).
Second option, **Save as HTML and show in web browser**, opens automatically default browser with displayed just saved report.

Save report in text form:

icon: 
menu: **File | Save as text file...**
or:
menu: **File | Save as text and open in editor...**

Report is saved as non-formatted (plain) text in a file with extension **.txt** and does not contain graphical elements.
Second option: **Save as text file and show in editor** saves file and opens it in default editor (e.g. Notepad). Contents of the report is editable.

12 Program configuration

Program configuration contains: general style of modules view, the spectra display view and default parameters for mathematical analysis and peak identification.

Windows Registry usage

For the storage of the chosen parameters and screen appearance setup, Windows Registry is used.
In Windows Registry the following parameters are stored:

- number of defined acquisition paths,
- parameters of each acquisition path, like: name, description, identification of an analyzer, mode of running, acquisition settings and other,
- general status of the program, dimensions, colors etc.
- program configuration options, like display and analyzes options, language of the interface of the program, etc.
- the spectra container contents.

➨ Process of loading/saving parameters from/to Windows Registry is performed automatically during switching to other modules or at shutdown of the program.

Menu Configuration - available options

Menu of each module except REPORT contains **Configuration** item with only one sub item: **Options...** When performed, dialog window appears on a screen, which contains five tab sheets:

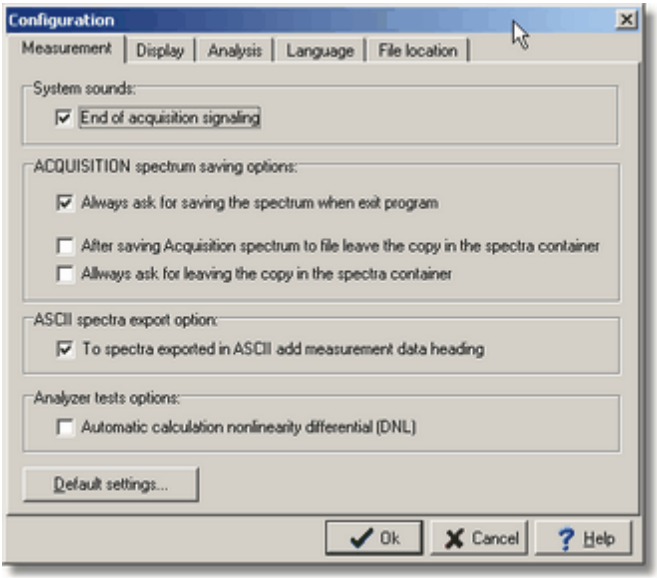
- Measurement
- Display
- Analysis
- Language
- File location

Options available in each of them are discussed precisely in next chapters.

12.1 Measurement configuration options

Measurement configuration options can be preset in 'Measurement' tab sheet of 'Configuration' dialog box activated via the main menu of the program:

menu **Configuration | Options... | Measurement**



System sounds:
End of acquisition signaling: - by default, this option is not checked

ACQUISITION spectrum saving option:
Always ask for saving the spectrum when exit program: - by default, this option is checked

By default, next two options are not checked.

ASCII spectra export options:
Counts in channels saved to text files (see Export to ASCII format 74) are by default preceded by header containing name of a spectrum, measurement description and date. Setting this option off causes, that to text files only counts in channels are saved.

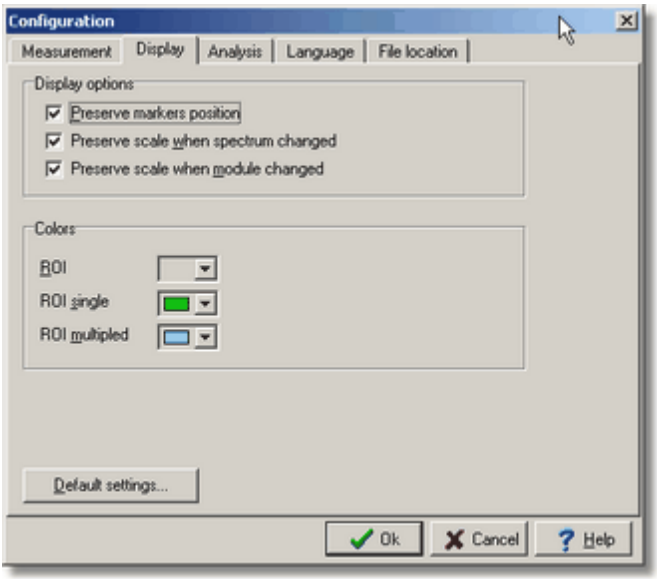
Analyzer tests options:

Switching this option on causes, that in the peak parameter panel placed below a spectrum (in ANALYZER module only) additional line appears, in which DNL value is displayed. DNL means differential non linearity of a spectrum calculated "on-line" for a part of it surrounded by markers and given in percentage value.

12.2 Display spectrum options

Spectrum display options can be controlled and modified from the menu:

menu **Configuration | Options... | Display**



Selectable options:

Parameters of displayed spectra:

✓ **Preserve markers position**

- If this option is set then last markers position is preserved after change of displayed *main spectrum* or after switching to another module.
- If this option is not set then after each change of the main spectrum or each change of a module, the markers are displayed in the default position, i.e. the left on the channel laying at 1/3 and the right on the channel laying at 3/4 of the channel range width.

✓ **Preserve scale when spectrum changed**

- If this option is set then the horizontal and vertical scaling is retained upon changing the displayed spectra.
- If this option is not set then, after each change of the displayed spectrum the new one is shown in full scale.

✓ **Preserve scale when modules changed**
- if this option is set then horizontal and vertical scaling is retained upon program module change, i.e. moving from ANALYZER to ANALYZE module, spectrum is displayed in the same scale.

Colors:

Colors in which ROI regions 87 are displayed are obligatory for all modules of the program and do not depend on which color spectra are plotted.
In the program there are three default colors used to distinguish states of ROIs:

- ROI "not calculated" – color beige or gray (depends on scheme of colors in Windows)
- ROI "calculated" containing single peak – color green
- ROI "calculated" containing doublet – color blue

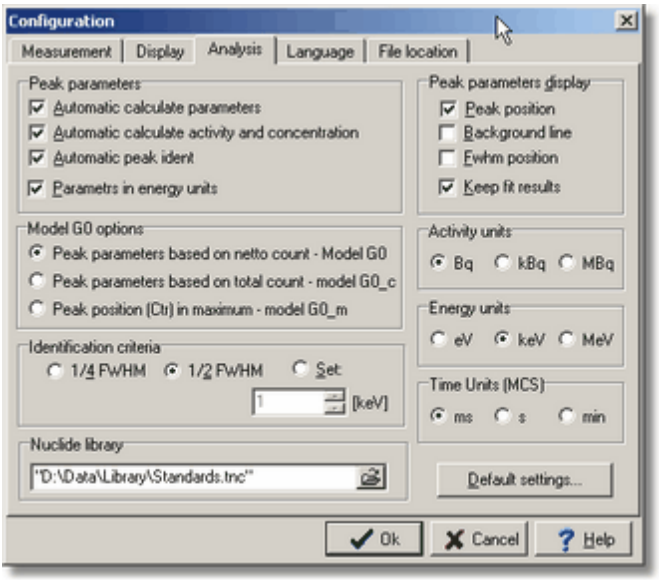
Clicking on buttons with arrows it is possible to select different color from palette of 16 colors.

see also:
Colors of the plot panel 85

12.3 Configuration analysis options

Analysis configuration options can be preset in 'Analysis' tab sheet of 'Configuration' dialog box activated via the main menu of the program:

menu: **Configuration | Options... | Analysis**



The Configuration of analysis dialog window consists of the following groups of options:

Peak parameters:

- ✓ **Automatic calculate parameters** – switches on/off automatic calculation of peak parameters lying between the markers, performed after every change of marker placement or spectrum refresh.
- ✓ **Automatic calculate activity and concentration** – if option is on, a spectrum contains efficiency calibration and in region surrounded by markers exists peak, which is identified, then the program together with calculation of peak parameters calculates activity and concentration.
- ✓ **Automatic peak ident** – switches on/off mode of automatic peaks identification performed after every recalculation of peak parameters. The necessary condition for this is nuclides library 102 to be loaded from selected file.
- ✓ **Parameters in energy units** – if set, then the program always displays peak parameters in energy units (if a spectrum is calibrated) when the main spectrum is changed.

Way of calculation of peak parameters by "direct" model 91:

- ✓ **Peak parameters based on net count – Model G0** – peak parameters are calculated based on net counts in channels as it is described in "Analyze"

chapter - Peak analysis 'on-line' 91

- ✓ **Peak parameters based on total count – Model G0c** – peak parameters are calculated based on real counts in channels (without background subtraction), peak position (Ctr) is calculated as weighted average of counts in channels
- ✓ **Peak position (Ctr) in maximum – Model G0_m** – peak parameters are calculated based on real counts in channels (without background subtraction), peak position (Ctr) is placed in a channel containing the highest number of counts

In the peak parameters panel (below panel of a spectrum view) and in the peak table, mathematical model based on which calculation was performed is always visible.

Identification criteria:
Selection of width of energy window necessary for automatic peak identification procedure (see Peaks identification 104).

Nuclide library:
File with default nuclide library for identification procedure (see Nuclide libraries 102).

Peak parameters display:
The program allows to observe "on-line" analysis of peak (position, background cut function, Fwhm) at every movement of markers or every spectrum refresh. It is possible only then, when peak parameters are calculated by "direct" method (models G0, G0_c, G0_m) (see Peak parameters calculate 94).

- ✓ **Peak position** - if selected, then vertical line of constant dimension (depending on „panel of a spectrum view" size) is displayed which points to that channel which is placed closest to peak centroide (parameter „Ctr") calculated by the program. If "Ctr" for peak between markers can not be calculated, then line is not drawn.
- ✓ **Background line** - displaying background cut function line for region surrounded by markers. Integral above this line is net total for peak.
- ✓ **Fwhm position** - displaying Fwhm line, i.e. line connecting point in left edge with point in right edge, both placed in a half of peaks height.
- ✓ **Keep fit results** - the fitted curves are shown between markers immediately after calculation. If this option is not set, it is displayed up to the changing position of markers. Selection of this option causes, that curve will be showed until next "Calculate" command will be run.

Units:
Units selected in this place are obligatory for all program modules and for

all analyzed spectra.
Selected unit for energy is applied in peak parameters introduction and for energy scale description display.
The same rule is valid for units of time for MCS spectra.

In **Reports**, however, units can be set independently to mentioned above (see Peaks table configuration 131).

12.4 Selecting language of program

The program can operate in either **English** or **Polish**.
Switching between languages:

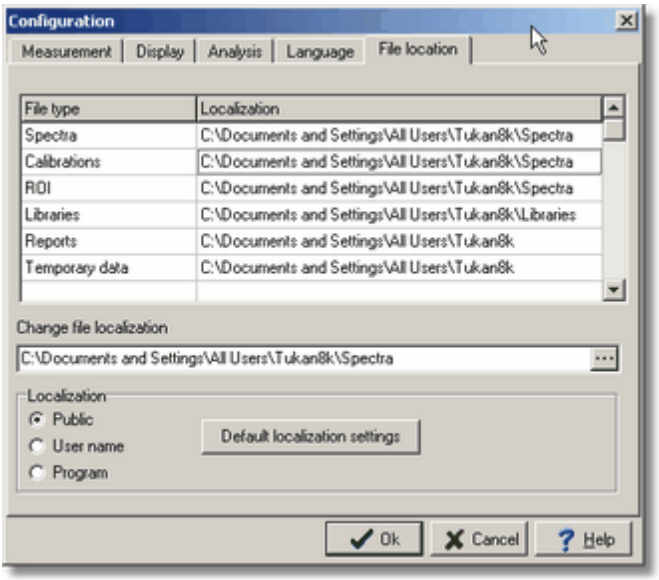
menu: **Configuration | Options... | Language**

Program will be closed after selecting the new language. One should execute it again.
The program starts in the language which was used at the program exit.
Once changed, a new language setting is effective in all layers of the program: on a screen, in messages, in data tables.

Attention If program is dedicated to service one language only, then panel **Language** is empty.

12.5 Setting directory of program

During program installation process, working directories are created on disk.
Placement of these directories depends on selected option during installation: for all users or "for me" only.
In "File location" tab sheet of Configuration dialog window, user can change default directories placement.
Irrespective to group settings (selected in group of options "Localization") each directory can be defined independently.



After closing "Configuration" dialog window by "OK" button, selected directories become default for the program.

13 Keyboard

Acquisition navigation keys 144
Markers navigation keys 144
Displaying spectrum navigation keys 145
ROI system navigation keys 146

13.1 Acquisition navigation keys

Acquisition start

Acquisition stop

Acquisition reset

Common acquisition start

Common acquisition stop

Common acquisition reset

13.2 Markers navigation keys

select control to left marker

select control to right marker


move marker one channel to the left


move marker one channel to the right

select control to both (coupled) markers - next press selects control to one marker
(the middle key of numeric pad)


move coupled markers right


move coupled markers left


push markers aside


bring markers closer


increase twice the number of channels displayed between markers


decrease twice the number of channels displayed between markers


expand a spectrum between markers to the whole width of the panel


display spectrum in a full scale

13.3 Displaying spectrum navigation keys


decrease horizontal scale


increase horizontal scale


decrease vertical scalej


increase vertical scale


move spectrum to the right


move spectrum to the left


move spectrum up


move spectrum down


expand twice a spectrum selected between markers


squeeze twice a spectrum selected between markers


expand a spectrum between markers to the whole width of the panel

display spectrum in full scale

13.4 ROI system navigation keys

insert area selected by markers to the ROI table

delete ROI area selected by markers

move markers on next ROI to the right

move markers on next ROI to the left

14 Appendix A: Library TukanFit.dll

In the Tukan program, all principal mathematical algorithms are included in independent DLL (Dynamic Linked Library) library: TukanFit.dll.

Library consists of three main modules, containing:

- Gauss fitting functions (non linear models),
- Polynomial fitting functions and their variants (linear models),
- Automatic search for gamma lines.

Module of fitting non linear functions

Rules applied In the module rely on well known methods of minimization: Marquardta, BFGS and simplex in minimum chi-square method. Allows to fit to experimental data free combinations of single or double Gauss functions with the following background functions:

- Polynomial: $\sum a_i x^i$,
- Fermi function: $A + \sum \frac{\delta_i}{1 + \exp(\lambda_i (x - x_i))}$,
- Fermi function with width parameter related to width of a line:

$$A + \sum \frac{\delta_i}{1 + \exp(\lambda_i (x - x_i))} \quad \lambda_i = \frac{4}{\sigma_i \sqrt{2\pi}},$$

- Exponent function with polynomial: $\exp(\alpha(x - x_e)) + \sum a_i x^i$,
- Exponential function with polynomial: $A \cdot (x - x_p)^\beta + \sum a_i x^i$.

In all above mathematical formulas *x* is independent variable, other symbols respond to fitted parameters, σ_i is width of Gauss function.

In case of fitting double Gauss lines it is available a set of special variants of above functions:

- with constant ratio of fields of spectrum lines,
- with common width of both spectrum lines.

Module of fitting linear functions

In case of calibration fittings (energy, efficiency or peak width calibration) those mathematical methods are applied, which reduce problem of least square method to solving system of linear equations. It is possible, because in every model an equation was managed to be transformed to a linear type of its parameters.

The module contains the following functions:

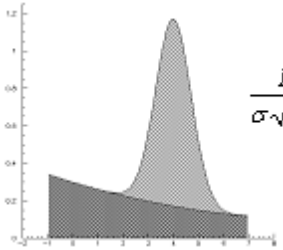
- Polynomial: $y(x;a_i) = \sum a_i x^i$,
- Exponent function of polynomial of logarithms: $y(x;q_i) = \exp\left(\sum q_i \ln^i(x)\right)$,
- Square root of polynomial: $y(x;a_i) = \sqrt{\sum a_i x^i}$.

Module of automatic search of gamma lines (Peak Search)

Separate module is a set of procedures for automatic search of lines in a spectrum. They use mechanism of auto correlation function. Based on many tests and trials it was introduced rectangular process of negative, positive and again negative value. Such a choice gave very efficient and simple algorithm which does not perform many time-consuming multiplication calculations.
Algorithm was adjusted by mechanism which takes into account width of a peak, what essentially corrected its good results.

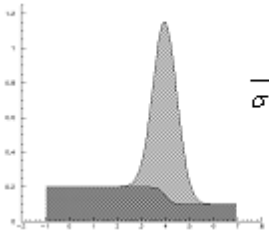
Mathematical description of certain models:

Model G1_Pn – „Gauss and polynomial" - single peak fitting by Gauss function with polynomial background. Depending on a degree of polynomial, model is described by a symbol: **G1_P1**, **G1_P2** or **G1_P3**



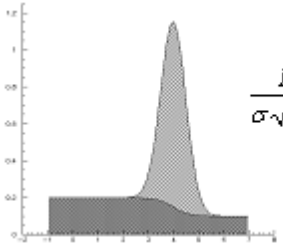
$$\frac{P}{\sigma\sqrt{2\pi}}\exp\left(0.5\cdot(x-x_0)^2/\sigma^2\right)+\sum a_i x^i$$

Model G1_F – „Gauss and Fermi" – single peak fitting by Gauss function with background defined as Fermi function



$$\frac{P}{\sigma\sqrt{2\pi}}\exp\left(0.5\cdot(x-x_0)^2/\sigma^2\right)+A+\sum\frac{\delta_i}{1+\exp\left(\lambda_i(x-x_i)\right)}$$

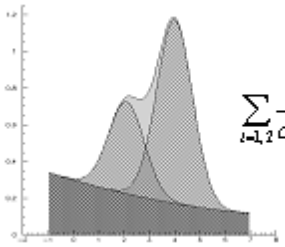
Model G1_fF – „Gauss and fixed Fermi" – single peak fitting by Gauss function with background defined as fixed Fermi function



$$\frac{P}{\sigma\sqrt{2\pi}}\exp\left(0.5\cdot(x-x_0)^2/\sigma^2\right)+A+\sum\frac{\delta_i}{1+\exp\left(\lambda_i(x-x_i)\right)}$$

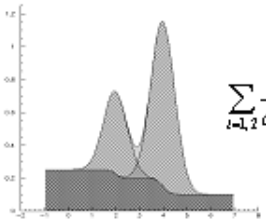
$$\lambda_i=\frac{4}{\sigma_i\sqrt{2\pi}}$$

Model G2_Pn – „2 Gausses and polynomial" – peak fitting by „double Gauss" function with polynomial background. Depending on selected polynomial degree, model is described by a symbol: **G2_P1**, **G2_P2** or **G2_P3**



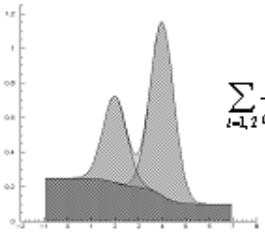
$$\sum_{i=1,2} \frac{P_i}{\sigma_i \sqrt{2\pi}} \exp\left(0.5 \cdot (x - x_i)^2 / \sigma_i^2\right) + \sum a_i x^i$$

Model G2_F – „2 Gausses and Fermi" – peak fitting by „double Gauss" function with Fermi function as a background



$$\sum_{i=1,2} \frac{P_i}{\sigma_i \sqrt{2\pi}} \exp\left(0.5 \cdot (x - x_i)^2 / \sigma_i^2\right) + A + \sum \frac{\delta_i}{1 + \exp(\lambda_i (x - x_i))}$$

Model G2_fF – „2 Gausses and fixed Fermi" – peak fitting by „double Gauss" function with background defined as fixed Fermi function



$$\sum_{i=1,2} \frac{P_i}{\sigma_i \sqrt{2\pi}} \exp\left(0.5 \cdot (x - x_i)^2 / \sigma_i^2\right) + A + \sum \frac{\delta_i}{1 + \exp(\lambda_i (x - x_i))}$$

$$\lambda_i = \frac{4}{\sigma_i \sqrt{2\pi}}$$

Where, in all above formulas:

x_0, x_i = 1, 2	centroid of the Gauss functions,
σ, σ_i = 1, 2	widths of the Gauss functions (FWHM = 2,355 s),
P, P_i = 1, 2	fields of the Gauss functions,
a_i	parameters of the background polynomial,
A	offset,
δ_i	steps highs in the Fermi function,
λ_i	speed of the Fermi function increasing.

15 Appendix B: Instalation of Tukan8k analyzer and program

Installation process consists of two steps:
1. the Tukan8k program setup,
2. installation of drivers of an analyzer and/or USB protection key.
Sequence of them is optionally because each of them is performed independently.

After installation of the program and drivers, during the first program run 22 it is necessary to define a type of an analyzer supported by the program.

- For proper installation, administrative privileges are necessary.

Hardware requirements 151
Instalation of Tukan8k program 152
Instalation of Tukan-8k-PCI card 154
Instalation of Tukan-8k-USB box 153
Instalation of USB Protection Key 155

15.1 Hardware requirements

There are no special requirements for proper functionality of the Tukan 8k program. The program functions correctly on any present PC. The minimal recommended free space of a hard disk is 40MB.

In case of Tukan8k_PCI analyzer it is obligatory presence of spare PCI slot compatible to 2.2 version of specification for that type of bus and such a computer mechanical construction, which allows to plug in the analyzer.

In case of Tukan8k_USB analyzer, a spare USB slot of type A is needed.

In case of applying USB Protection Key, a spare USB slot of type A is needed only.

Operating system:
TheTukan8k_PCI analyzer is supported by Windows 2000 (SP 4) or Windows XP (SP 2 or higher) operating system only.

The Tukan8k_USB analyzer is supported by Windows 2000/XP/Vista Business (32 bit and 64 bit versions)/7 Professional (32 bit and 64 bit versions).

15.2 Instalation of Tukan8k program

To install the program, place the "Tukan installation disk" in CD and run "**Setup.exe**"

- For proper installation, administrative privileges are necessary for a user actually logged in. In case of lack such privileges, appropriate message is displayed (depending on the version of Windows) and installation process is canceled.

Installation processes typically for Windows operating system. Installation program recognizes localized version of Windows. In case when it is Polish version, the program interfaces with a user in Polish. If it is other version, the program switches itself to English.

ATTENTION:

- If the Tukan program version 2 or higher was already installed, then after running the installation program, a user will find a message informing, that installation can not be continued: previous version of the program should be uninstalled first.
- The Tukan program can be installed in any place. If the Tukan program version 1.9 or lower is already installed, then a user can leave it in its typical placement (which is c:\Program Files\Tukan8k) and install version 2.2 of the program in different localization. The installation program informs a user about such a chance in dedicated message.

Installation process is simple, intuitive and is self-explaining at each step.

On a figure above available program versions are seen:

The difference between **standard** and **extended** version relies on types of supported analyzers only. ALL FUNCTIONS RELATED TO MEASUREMENT CONTROL AND ANALYSIS OF RESULTS ARE IDENTICAL IN BOTH VERSIONS. **Standard** version of the program is intended for users who apply Tukan8k_USB analyzer. Extended version allows additional support of previous versions of the analyzer (if not really necessary, it is recommended to install standard version of the program).

Depending on an option selected earlier, defining if the program should be

installed for all users or for one user only, the following directories are created:

C:\Documents and Settings\All Users\Application data\Tukan8k\
C:\Documents and Settings\All Users\Application data\Tukan8k\Libraries\
C:\Documents and Settings\All Users\Application data\Tukan8k\Doc\
C:\Documents and Settings\All Users\Application data\Tukan8k\Spectra\

or

C:\Documents and Settings\user\Application data\Tukan8k\
C:\Documents and Settings\user\Application data\Tukan8k\Libraries\
C:\Documents and Settings\user\Application data\Tukan8k\Doc\
C:\Documents and Settings\user\Application data\Tukan8k\Spectra\

During installation process to those directories are copied exemplary files of libraries and spectra as well as documentation of the Tukan8k program.

15.3 Instalation of Tukan-8k-USB box

For proper functionality of the analyzer it is necessary to install "D2XX" drivers developed by "Future Technology Devices International Ltd." The driver version should be 2.8.14 or higher. The drivers are available in the Installation disk in **"Drivers\FTDI"** directory.
Administrative privileges are necessary for a user performing installation.

After the first connection of the Tukan8k_USB analyzer to PC (via USB A-B type cable delivered together with the analyzer) Windows informs about recognition of a new device and takes up an attempt to search for a driver. Irrespective of Windows version, typical process of driver installations takes place similarly. First, a user is asked to allow Windows to search Internet. It is recommended not to allow. Next a user is asked to point to place where the system could find the driver. At this place the user should point to "Drivers\FTDI" directory available in the Installation disk.

Successful installation is signalized by adequate Windows message. At the same time, LED in the analyzer lights in green.
The latest versions of "D2XX" driver are available fee of charge at the address: "http://www.ftdichip.com/FTDrivers.htm". It is recommended to apply the driver delivered in the Installation Disk, because the Tukan8k program is examined to cooperate with that version of the driver. Newer driver should be applied only then, when are concrete circumstances (usually these are Windows upgrades).

see:

Start of the program 22
Connecting analyzer 25

15.4 Instalation of Tukan-8k-PCI card

For proper functionality of the analyzer it is necessary to install "WinDriver" v. 6.0.2 - Windows drivers developed and distributed by "Jungo Ltd.".
It is recommended to install the drivers before plugging in the analyzer to PCI slot. You are reminded that delivered drivers support MS Windows 2000 SP4 and Windows XP only.

Administrative privileges are necessary for a user performing installation.

Supporting of the Tukan8k_PCI analyzer in PC where newer version of Windows (Vista or 7) is installed, is not possible.

To install the driver, run as follows:
- insert the Installation disk in CD device
- open Windows console application (Start/Run/cmd)
- in the console select CD device in which the Installation Disk is placed (e.g. "d:" if CD device is seen in a system as "d" device
- run "cd" command to make "Jungo" directory current directory (e.g. "d: >cd \Drivers\Jungo")
- run the following sequence: "D:\Drivers\Jungo\wdreg16 -inf D: \Drivers\Jungo\windrvr6.inf install"
- run the following sequence: "D:\Drivers\Jungo\wdreg16 -inf D: \Drivers\Jungo\Tukan8kPCI.inf install"

Please note, that it is extremely important to use full paths in commands above (like "D:\Drivers\Jungo\Tukan8kPCI.inf ").

After proper installation of the drivers, the analyzer can be plugged in. After power on the PC, the drivers should be reached by automatically by Windows. In case when the system asks a user during device installation procedure about any file connected with the device, indicate "Drivers\Jungo" directory available in the Installation Disk.
Successful installation is signalized by adequate Windows message. At the same time, LED in the analyzer lights in green.

see:

Start of the program 22
Connecting analyzer 25

15.5 Instalation of USB Protection Key

The USB Protection Key allows to run the Tukan8k program version 1.7.0 or higher in a PC to which the analyzer is not connected (plugged in). Older versions of the program do not support the Key.

For proper functionality of the Key "USB Express" driver version 3.5.1(or higher) developed and distributed by "Silicon Labs Corporate" is needed. Administrative privileges are necessary for a user performing installation.

After the first connection of the Key, Windows informs about recognition of a new device and takes up an attempt to search for a driver. Irrespective of Windows version, typical process of driver installations takes place similarly.
First, a user is asked to allow Windows to search Internet. It is recommended not to allow. Next a user is asked to point to place where the system could find the driver. At this place the user should point to **"Drivers\SyliconLabs"** directory available in the Installation Disk.
The latest versions of "USB Express" drivers are available fee of charge at the address: "http://www.silabs.com/products/mcu/Pages/USBXpress.aspx ". It is recommended to apply the driver delivered in the Installation Disk, because the Tukan8k program is examined to cooperate with that version of the driver. Newer driver should be applied only then, when are concrete circumstances (usually these are Windows upgrades).

Successful installation is signalized by adequate Windows message. At the same time, LED in the Key lights.

16 Appendix C: Technical parameters of Tukan_8k_USB Analyzer

The Tukan8k-USB box can operate in two modes: as multi-channel pulse height analyzer (MCA) and as multi-channel scaler (MCS). Additionally there is also possible to operate the device as the Single Channel Analyzer (SCA).

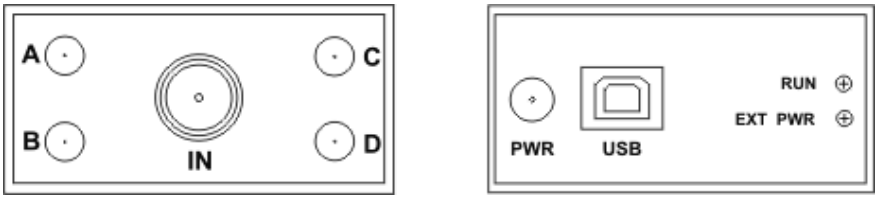
The device is controlled by host computer via USB. After disconnecting USB, the device continues data acquisition and collects experimental data, which remain available after reconnecting the device to the host. When operating autonomously, the device needs to be supplied by external power supplier.

Specification:

I/O Connections and LED Indicators 157
Powering the device 157
MCA - Multichannel Analyzer mode 158
MCS - Multichannel Scaling mode 159

16.1 I/O Connections and LED Indicators

The left part of the figure below shows front panel of the device, while right part shows back panel with USB socket, power connector and two bicolor LEDs.



Front panel contains analog BNC input connector and four TTL I/O LEMO connectors (Ports A, B, C and D). Designation of the TTL connectors depends on the operational mode of the device and established settings.

Back panel contains USB socket, power connector and two LEDs.
The power connector is discussed in next chapter. The USB socket should be adequate to the B-type receptacle.

Upper diode LED indicates different modes of operation or failure of the device:
During typical measurement process, when powered via USB connector:
green color blinking - acquisition is running,
green color lighting - acquisition was not started or has finished or paused.
separate red color short blink - external power adapter was plugged in

Bottom diode LED indicates external power status:
blank -no external power is applied (device is powered via USB connector),
red color lighting - external voltage is outside given range,
green color lighting - device is powered correctly, the voltage is between +5.5V and +10V.

16.2 Powering the device

The device can be powered either from the USB port or from external DC power source. The USB bus power supply is a primary power source, however an external power supply prevails – it is ultimately used when applied.
The external power supply, which may be either a DC wall adaptor or a battery, should be used when device is connected to bus powered USB hub or when it is autonomously operating without PC or LAPTOP connected.

The DC external voltage is applied by means of EIAJ RC-5320 Class IV socket/ plug connectors. Note, that internal pin is used for positive voltage. The requirements for external DC voltage are:

- minimal voltage: 5.5V
- maximal voltage: 9V
- minimal current load: 200 mA.

16.3 MCA - Multichannel Analyzer mode

Principle of operation is as follows: input analog signal (pulse) is stretched, converted to digital value proportional to its height and normalized to a number of channels and maximum pulse height value, which is 10V; such a value defines the address of a unique channel in histogram memory, which is incremented by one.

Parameters

ADC Successive approximation type (16 bits) with sliding scale averaging.
Max resolution 8k; 8192 channels, software selectable as 8192, 4096, 2048 and 1024 blocks.
Dead time per event < 5 µs (including memory transferi).
Integral non linearity <= ±0.05% over the top 99% dynamic range.
Differential non linearity < ±1% over the top 99% dynamic range.
Gain instability <= ±1% ppm / ^{O}C.

Histogram memory 8k channels (volatile): 2^{24} - 1 counts per each channel (almost 17 millions counts).

Presets

Real time or **Live time:** data acquisition real or live time preset in multiples of exact one-second intervals; selectable automatic stop on real or live time exhaustion; maximal preset time = 16777215 (2^{24} -1) s, i.e. about 200 days.
Region of interest Integral count inside or outside established preset window, selectable automatic stop on up to 2^{32} integral counts.

Data overflow - Terminate acquisition when any channel exceeds 2^{24}–1.
Analog Lower Level Discriminator (LLD) and Upper Level Discriminator (ULD) Computer controlled independent thresholds. Signal processing occurs when amplitude of input pulse is contained in given range between thresholds (value of low threshold must be lower then value of upper threshold); both thresholds are set with 12 bit accuracy.

Data available on-line

- total real time

- total live time
- counts in region of interest (independent of time stop criteria)
- dead time for second (in percent, accuracy 3.906 ms)
- number of counts per second

Inputs and Outputs

ANALOG INPUT Accepts positive unipolar or bipolar semigaussian type pulses of shaping time constants >= 100 ns. DC Coupled. The dynamic range is 10mV to +10 V. BNC connector.
Port A (GATE) Active HIGH TTL compatible logic gate. Computer controlled Gating/Nongating and Coincidence/Anti-coincidence mode. Active state of this signal (HIGH for coincidence and LOW for anticoincidence) must occur prior to and extend 200 ns beyond the peak of analog pulse. LEMO connector.
Port B (SCA-OUT) – Output; 100 ns wide positive pulse generated when the gate justified Single Channel Analyzer detects a pulse inside the voltage window with peak detection provided.
Port C (RUNING) – Output; positive level indicating when acquisition is running.
Port D (BUSY) – Output; positive pulse indicating when analog circuitry is busy (Analog Input is above the ***ZLD*** or conversion is in progress).

16.4 MCS - Multichannel Scaling mode

The device hardware and software provides medium speed Multi-Channel Scaling (MCS). The MCS acquisition mode is used for applications requiring a measurement of intensity vs. time and includes interface logic to TTL pulses coming from some measuring instrument. The maximum counting frequency is 8 MHz and is synchronized with the 20 MHz reference clock.

The Multi-Channel Scaler records the counting rate of events as a function of time. When a scan is started, the MCS begins by counting input events in the first time slot (channel 0) in the digital memory. At the end of a preset period of time, called "dwell time", the MCS advances to the next channel in the memory and continues the counting. The dwell and advance processes are repeated until the MCS has scanned through the preset number of channels. A single scan through all selected channels is called a sweep, which may be repeated selected number of times. In multi-sweep mode the accumulated data may be either replaced by the new sweep or they may be summed channel by channel. Starting a sweep, as well as advancing from one channel to the next, may be triggered internally or externally.

Events given on analog input can also be registered by the device. The ADC BNC input signal is then processed by the Single Channel Analyzer (SCA). This mode of operation allows event counting up to a frequency of 1 MHz

Characteristic

- Maximum counting rate – 8 MHz
- Minimal pulse pair resolution – 60 ns
- Minimal dwell time (step) – 2 µs
- Dwell Time – up to 2^{24} steps optionally multiplied up to 256
- Sweep Length – up to 8192 channels with automatic or externally triggered sweep repetition
- Acquisition modes – summing or replacing
- No dead time between channels and sweeps
- Possibility to use Single Channel Analyzer as an counting input (SCA formed from MCA with threshold presetting).

Presets

- Sweep length (number of channels)
- Dwell time
- Sweep count
- Input signal type
- Triggering mode
- Advancing mode
- Accumulation type
- Stop acquisition mode
- Low and high thresholds (available for analog input only)
- Gating mode (available for analog input only)

Data available on-line

- total acquisition time
- number of actually processed channel
- number of actual sweep

Inputs and outputs

Analog input - As in MCA mode when used for events counting. Alternatively it can be use for Single Channel Analyzer mode working in parallel in MCS mode.
Port A (EVENT or GATE) –Input. If Digital input is selected this line serves as a Counting input. If Analog input is selected this line serves as a Gating pulse as described in MCA mode.
Port B (STOP or SWEEP) – Input or Output; if internal triggering is enabled than rising edge on this line causes to stops acquisition after the current sweep. If external triggering is enabled this line serves as a **SWEEP** output being HIGH when current sweep is in progress.
Port C (TRIGGER In or Out) – Input or Output; if external triggering is selected, than rising edge of this line starts each new sweep. If internal triggering is selected this 100 ns positive output pulse informs external circuitry when each new sweep was started.

Port D (ADVANCE In or Out) – Input or Output; If external advancing is selected then rising edge of this line causes to step to the next channel. If internal advancing is selected this 100 ns positive output pulse informs external circuitry when each new dwell step was started.

Note: All digital ports have 1 kΩ input impedance, are DC coupled and have positive polarity.

see also:

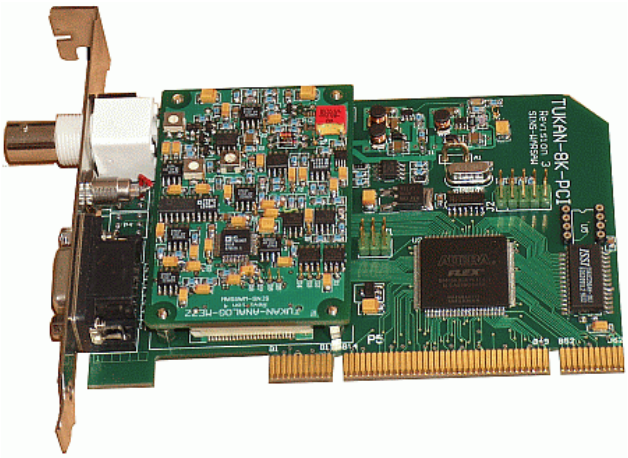
Multi-channel scaling (MCS) mode 60

16.5 SCA - Single Channel Analyzer

In single channel analyzer mode of running, output **B** generates impulse (TTL, positive) as a response on each analog input signal, which amplitude is located in a given, extreme close threshold's levels range. Such an amplitude range defined by the Lower Level Discriminator (**LLD**) and the Upper Level Discriminator (**ULD**) is usually described as *measurement channel*. Number of impulses registered in output **B** in a such range of amplitude is equal to number of input signals performing the following condition: $V_{LLD} < V < V_{ULD}$.

17 Appendix D: Technical parameters of Tukan_8k_PCI Analyzer

The Tukan8k-PCI card is produced in two versions: basic - operating as multi-channel pulse height analyzer running in a pulse height analysis (MCA) mode and enhanced version where the card can additionally operate in multi-channel scaling (MCS) mode. In the next release of the device both operational modes (MCA and MCS) will be available as a basic set.



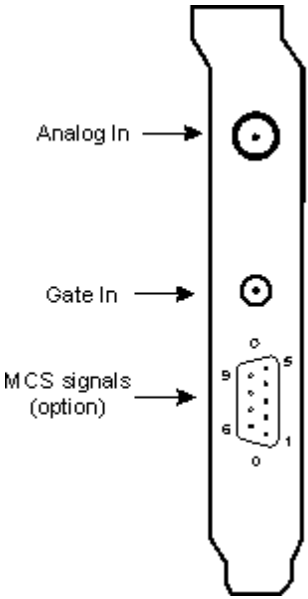
Device interfaces PC via PCI bus. Interface type: universal; powering +5V and +3.3V; 32-bit (target) with 33MHz clock, compatible to Specification of PCI Local Bus version 2.2.
"**Plug and play**" supported. 64KB of memory projected via BAR 0 into 32-bit memory space.

Specification:

I/O Connections and LED Indicators 163
MCA - Multichannel Analyzer mode 163
MCS - Multichannel Scaling mode 165

17.1 I/O Connections and LED Indicators

The interface of the analyzer is located on mounting bracket and is shown on figure below. It consists of three types of connectors: BNC type, Lemo and Canon 9-pin. Rules of particular connectors depend on mode of running (MCA or MCS) of the analyzer and are described in chapters describing both modes.



Pin nr	Signal
1	GND
2	TRIGGER
3	STOP
4	ACQUIRE
5	SCA OUT
6	EVENT
7	ADVANCE
8	-
9	NEXT

The analyzer is equipped with additional two LEDs mounted directly to the board. One should light permanently indicating that the device is properly initialized and is ready to use. The second LED, when blinking, indicates that acquisition is running.

17.2 MCA - Multichannel Analyzer mode

MCA – base mode of running for the analyzer card.

Principle of operation can be discussed as follows: input analog signal (pulse) is converted to digital value proportional to its height and normalized to a number of channels and maximum pulse height value, which is 10V; such a value defines the address of a unique channel in histogram memory, which is

incremented by one.

Parameters

ADC Successive approximation type (16 bits) with sliding scale averaging.
Max resolution 8k; 8192 channels, software selectable as **8192**, **4096**, **2048** and **1024**.
Dead time per event <5 µs (including memory transfer).
Integral non linearity <=±0.05% over the top 99% dynamic range.
Differential non linearity <±1% over the top 99% dynamic range.
Gain instability <= ±1% ppm/ ^{O}C.
Histogram memory 8k channels (volatile): 2^{24} - 1counts per each channel (almost 17 millions counts).

Presets

Data acquisition **real time** or **live time** preset in multiples of exact one-second intervals; selectable automatic stop on real or live time exhaustion; maximal preset time = 16777215 (2^{24} -1) s, i.e. about 200 days. Integral live time measurement accuracy: circa 250 ns.
Region of interest Integral count inside or outside established preset window, selectable automatic stop on up to 2^{32} integral counts.
Data overflow - terminate acquisition when any channel exceeds 2^{24} -1.
Control - ADC fully controlled by host PC via PCI bus.
Analog Lower Level Discriminator (LLD) - lower threshold selectable programmatically in range from 0 mV up to 50% of full range with step 1.22 mV.
Analog Upper Level Discriminator (ULD) - upper threshold selectable programmatically in range from 0 mV up to 50% of full range with step 1.22 mV.

Data available on-line

- total real time
- total live time
- counts in region of interest (independent of time stop criteria)
- dead time for second (in percent, accuracy 3.906 ms)
- number of counts per second

Inputs

Analog input Accepts positive unipolar or bipolar semigaussian type pulses of shaping time constants >= 100 ns. DC Coupled. The dynamic range is 10mV to +10 V. BNC connector.
Gate Active HIGH TTL compatible logic gate. Computer controlled Gating/Non gating and Coincidence/Anti-coincidence mode

17.3 MCS - Multichannel Scaling mode

The device hardware and software provides optional medium speed Multi-Channel Scaling (MCS). The MCS acquisition mode is used for applications requiring a measurement of intensity vs. time and includes interface logic to TTL pulses coming from some measuring instrument. The maximum counting frequency is 12.5 MHz and is synchronized with the 33 MHz PCI clock.

Event counting can also be performed on signals coming directly from a detector/amplifier by using the ADC BNC input. The ADC BNC input signal is then processed by the Single Channel Analyzer (SCA). This mode of operation allows event counting up to a frequency of 1 MHz. The computer controlled SCA window makes signal filtering easy.

The Multi-Channel Scaler records the counting rate of events as a function of time. When a scan is started, the MCS begins by counting input events in the first time slot (channel 0) in the digital memory. At the end of a preset period of time, called "dwell time", the MCS advances to the next channel in the memory and continues the counting. The dwell and advance processes are repeated until the MCS has scanned through the preset number of channels. A single scan through all selected channels is called a sweep, which may be repeated selected number of times. In multi-sweep mode the accumulated data may be either replaced by the new sweep or they may be summed channel by channel. Starting a sweep, as well as advancing from one channel to the next, may be triggered internally or externally.

Communication in Multi-Channel Scaling mode occurs via D socket placed on front panel of the device. Communication protocol is precisely described in **Technical Reference Tukan8k-PCI** available in installation disk.

Characteristic

- Maximum counting rate – 12.5 MHz
- Dwell Time – up to 2^{24} steps (one step = 1.9 µs)
- Sweep Length – up to 8192 channels with automatic or externally triggered sweep repetition
- Acquisition modes – summing or replacing
- No dead time between channels and sweeps
- Possibility to use Single Channel Analyzer as an counting input (SCA formed from MCA with threshold presetting)

Presets

- Sweep length (number of channels)
- Low and high thresholds

- Dwell time
- Sweep count
- Input signal gating mode
- Input signal type
- Triggering mode
- Advancing mode
- Accumulation type
- Stop mode

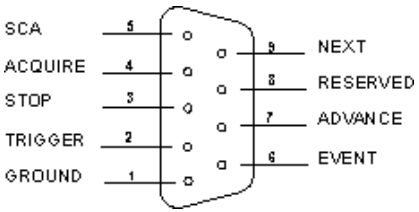
Data available on-line

- total acquisition time
- number of actually processed channel
- number of actual sweep

Inputs and outputs

Analog input – Accepts positive unipolar or bipolar semigaussian type pulses with shaping time constants >= 100 ns as well as amplified detector pulses without shaping. DC Coupled. The dynamic range is 10mV to +10 V (Zin = 1 kOhm). Overload protection over +12.5V and below -0.5V. BNC connector. Also used as SCA input.
Gating input – Accepts TTL positive (+2.5V) level. Computer controlled Gating/ Non-gating and Coincidence/Anti coincidence mode. Active state of this signal (asserted for coincidence and unasserted for anti coincidence) must occur prior to and extend 200 ns beyond the peak of the analog pulse. LEMO connector. Also used for EVENT pulse gating in MCS mode – in the latter case it must cover the entire pulse.

D-connector (9 pin) (for MCS mode only)



- **EVENT** – TTL input (1 kOhm input impedance, DC coupled, positive polarity); Input signal to be counted by MCS. Minimum width 40 ns, minimal gap between two successive pulses 40 ns.
- **TRIGGER** – TTL input (1 kOhm input impedance, DC coupled, positive polarity); Input signal, starts a new sweep, provided External Triggering has been set. Minimum width 40 ns.
- **ADVANCE** – TTL input (1 kOhm input impedance, DC coupled, positive

polarity); Input signal causes the acquisition to step to the next channel, provided External Dwell has been selected. Minimum width 40 ns.

- **STOP** – TTL input (1 kOhm input impedance, DC coupled, positive polarity); Input signal causes the acquisition to terminate at the end of the current sweep. Minimum width 40 ns.
- **ACQUIRE** – TTL output (>2.5V); 100 ns wide output pulse generated when the MCS data acquisition is invoked.
- **NEXT** – this positive TTL (>2.5V) output pulse generation depends on selected advancing method:
  - auto-advancing – 100 ns wide output pulse generated when the MCS advances from one channel to the next,
  - external advancing – a positive pulse level asserted when current sweep is processed and de-asserted after current sweep completion.
- **SCA** – TTL output (>2.5V); 100 ns wide output pulse generated when the non gated SCA detects a pulse inside the voltage window with peak detection provided.
- **RESERVED** – reserved for user added feature.

Index

*

*.wdm 20
*.wds 20

A

Acquisition control
  Common acquisition control 54
  Reset 47
  Start/Stop 47
  Toolbar of acquisition control 47
Acquisition parameters
  Acquisition path name 49
  Counts control 49
  CPS control 49
  Dead time 49
  Live time 49
  Real time 49
  Status 49
Acquisition path 23
  Adding acquisition path 41
  Calibration 36
  Configuration files 46
  Connecting analyzer 25
  Description prameters 34
  Detection and identification of analyzer device 28
  Measurement session 38
  Mode of running (MCA, MCS) 31
  Path name 25
  Removing acquisition path 41
  Structure 23
Activity and concentration calculate 106
Activity calculated formula 106
Adding acquisition path 41
Adding spectra 77
Advanced analysis 95
Analysis 91
  Mathematical models of peak analysis 96
  Peak parameters display 99
  Peak search 101
  Peaks table 107
  Selection of fitting function models 97
Analyzer
  Basic parameters 32
  Default values of parameters 31
  Hardware registers 29
Analyzer parameters
  Input signal gating 32
  Lower level threshold 32
  Number of channels 32
  TTL Lemo configuration 32
  Upper level threshold 32
Analyzer parameters in MCS mode
  Dwell Time 60
  Mesurement cycles 60
  Number of channels 60
  Number of sweeps 60
  Signal input socket 60
  TTL Lemo configuration 60
Analyzer Tukan-8k 10
ASCII format of spectrum 74
Automatic peak search 101
Automatic stop criteria of acquisition 52
Auxiliary directories 19

C

Calibration 109
  Calibration curve 126
  Calibration operations 110
  Delete calibration 114
  Efficiency calibration 120
  Energy calibration 118
  Inserting calibration 112
  Inserting energy from nuclide library 117
  Inserting of calibration data 115
  Inserting of calibration data from spectrum 116
  Peak shape calibration 119
  Transfer calibration beetwen spectra 113
  Visual control of calibration 114
Calibration curve 126
Calibration standars libraries 124
Change calibration in spectrum 112
Change from MCA to MCS mode 60
Coincidence 32

Colors of the spectrum, background and markers 85
Compressing spectrum 79
Concentration 106
Configuration files of acquisition path 46
CPS 91

D

Defining of acquisition path 23
Delete calibration 114
Detection of analyzer device 28
Dwell Time
  Normalization factor 60

E

Efficiency calculated formula 106
Efficiency calibration process 120
  Calibration standars libraries 121, 124
  Efficiency of detection calculation 121
Efficiency of detection 121
Energy calibration process 118
Export to ASCII format 74
  ASCII spectra export options 136

F

Fitting function models
  2 Gauss 97
  Background function 97
  Centroid difference 97
  Field relation 97
  Fitting function 97
  Model selection 97
Formats of spectra files 20
Fwhm 91
Fwtm 91

H

Hardware requirements 151

I

Identification of analyzer device 28
Import from ASCII format 75
Information about main spectrum 74
Inserting calibration to spectrum 112
Instalation of Tukan8k analyzer and program 151
Instalation of Tukan8k program 152
Instalation of Tukan-8k-PCI card 154
Instalation of Tukan-8k-USB box 153
Instalation of USB Protection Key 155

K

Keyboard 144
  Acquisition navigation keys 144
  Displaying spectrum navigation keys 145
  Markers navigation keys 144
  ROI system navigation keys 146

L

Laboratory - information 34
Language of program 142
List of reference spectra 73
Load spectrum from file 71
Lower and upper level threshold 32

M

Markers 82
Mathematical library TukanFit.dll
  Mathematical description of fitting models 147
Mathematical models description 96
MCA mode - Tukan-8k-PCI 163
MCA mode - Tukan-8k-USB 158
MCS mode 60
  Analysis of MCS spectrum 65
  Calibration of MCS type spectra 65
  MCS spectrum, 65
  Measurement control 63
  ROI parameters for MCS spectrum 65
MCS mode - Tukan-8k-PCI 165
MCS mode - Tukan-8k-USB 159
MCS type spectra 65
Measurement 47
  Acquisition control 47
  Acquisition process inspection 49
  Acquisition time control: 35
  Automatic stop criteria 52

Measurement 47
Counts in region control 35
Measuremet duration 49
Resumation of measurement after program exit 55
Stop criteria 35
Measurement control in MCS mode 63
Measurement geometry 34
Measurement session
Acquisition control during measurement session 55
Cycles of session 38
Spectra files 38
Text file with mathematical results 38
Measurement spectrum 57
Measurement spectrum periodical backup 58
Model G0, G0_c, G0_m 94
Multi-channel scaling (MCS) mode 60

N

Nuclide libraries
Creation of new library 102
Edition 102
Format 102
Library files 102
Sorting data 102
Number of channels - change 32

P

Peak analysis 'on-line' 91
Peak parameters
Area 91
CPS 91
From - To number channel 91
Fwhm 91
Fwtm 91
Integral 91
Units 91
Peak parameters "on-line" calculate 94
Peak shape calibration process 119
Peaks identification
Identification criteria 104
Peaks table 107
Plotting a spectrum
Automatic scale 83
Colors 83, 85
Displaying energy scale 81
Expand On/Off spectrum 83
Grid 83
Hide or expose ROIs of a spectrum 83
Logarithmic / Line scale 83
Markers 82
Spectrum plot style changing 85
Zoom 83
Printing a spectrum 80
Printing report 133
Program configuration
Analysis options 139
Automatic calculate parameters 139
Display spectrum options 138
Measurement configuration options 136
Menu Configuration 135
Peak parameters display 139
Preserve markers position 138
Preserve scale 138
ROI regions colors 138
Selecting language of program 142
Setting directory of program 142
Units of peaks parameters 139
Windows Registry usage 135
Program modules 13
Analysis module 17
Analyzer module 15
Calibration module 16
Hardware module 14
Report module 18
Program Tukan8k 12
Data files 19
Program files 12
Start of the program 22
Work with USB Dongle key 22

R

Removing acquisition path 41
Report 129
Configuration file 133
Format HTML 134
Peaks table configuration 131
Printing 133

Report 129
Report files 134
Spectrum plot configuration 132
Structure 128
Text format 134
Report configuration 129
Reset of acquisition 47
Resumation of measurement after program exit 55
ROI
Calculate parameters 87
Delete 87
Edition 87
Load from file 89
Nawigation keys 87
ROI files 89
Save 87
Save to file 89
Switch units 87
ROI - Region Of Interest 87
ROI controlling commands 87
ROI files 89

S

Sample mass 34
Save spectrum 72
SCA mode - Tukan-8k-USB 161
Select analyzer to control 42
Several analyzer
Common control 42
Select analyzer to control 42
Spectra common control 44
Several analyzers in the program 41
Several measurement spectra control 44
Single Channel Analyzer 161
Smoothing spectrum 77
Sounds - End of acquisition signaling 136
Spectra
Acquisition spectrum 68
Adding spectra 77
Compressing spectrum 79
Disk spectrum 68
Export to ASCII format 74
Import from ASCII format 75
Information about spectrum 74
List of reference spectra 73
Main spectrum 68
Memory spectrum 68
Open spectrum 71
Printing a spectrum 80
Save spectrum to file 72
Smoothing 77
Spectra container 68
Spectra files formats 20
Subtraction spectra 77
Spectra colors change 85
Spectra container 68
Spectrum name 25
Spectrum plot style changing 85
Start of acquisition 47
Start of the program 22
Stop of acquisition 47
Subtraction spectra 77

T

Technical parameters of Tukan_8k_PCI Analyzer 162
Technical parameters of Tukan_8k_USB Analyzer 156
Time backup of measurement 58
Tukan_8k_PCI Analyzer 162
I/O Connections and LED Indicators 163
MCA mode 163
MCS mode 165
Tukan_8k_USB Analyzer 156
I/O Connections and LED Indicators 157
MCA mode 158
MCS mode 159
Powering the device 157
SCA mode 161
TukanFit.dll 147

U

USB Dongle 22

V

Visual control of calibration in spectrum 114

W

Working directories 142
Working with several analyzers 41
Working with the spectra 68