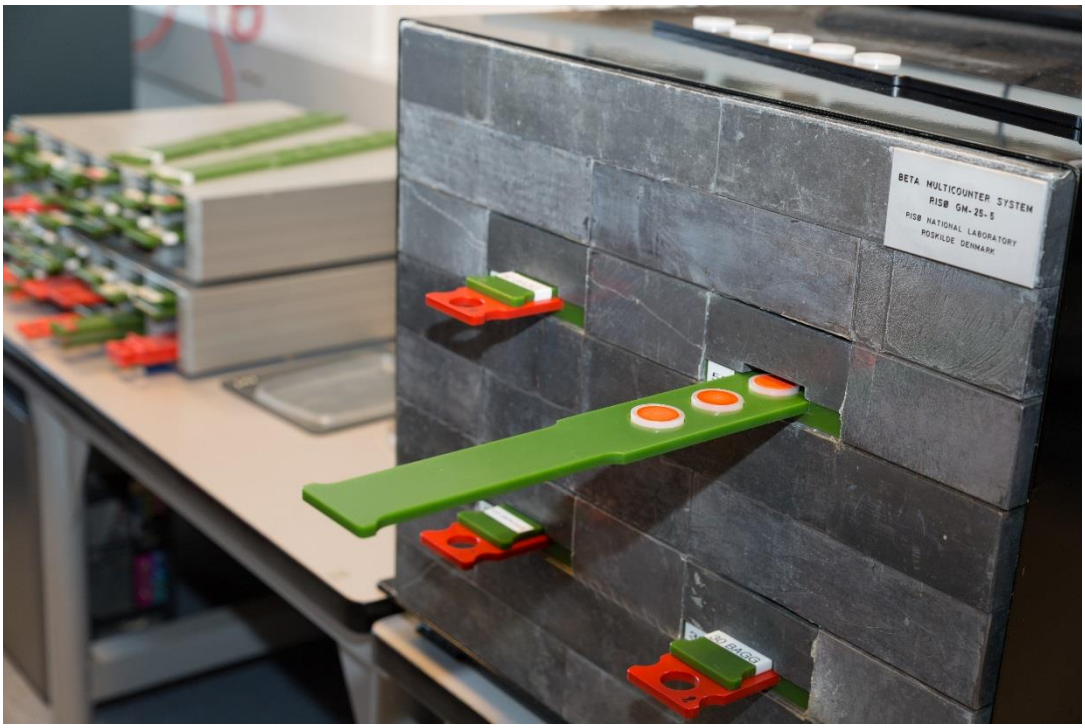
DTU Nutech
Center for Nuclear Technologies

User Manual

Low-level beta GM multicounter system
Model Risø GM-25-5A



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Contents

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1. Specifications

Low-level gas flow beta multicounter system for measurement of 5 samples simultaneously.

Sample size: 25 mm. diameter, 7 mm thick

Counter gas: 99% Argon N48/1% Isobutane N25 (or 99% Argon/1% propane N25)

Sample counter elements: 25 mm diameter with aluminized Mylar window (<1 mg/cm2).

Guard counter: 100 mm x 250 mm x 12 mm.

Background in 100 mm lead shielding: <0.2 CPM (typically <0.15 CPM).

Efficiency:
^{90}Sr/Y (activity prepared on a 25 mm diameter filter paper attached to a 5 mm thick Thallium disc): 49%.
^{36}Cl (activity deposited on a 25 mm. diameter x 5 mm thick plastic disc): 44%.
^{14}C (1 mm. thick acrylic source, 25 mm diameter): 24%.
^{99}Tc (Electro plated on steel disc): 42%

Size:
Mechanical unit: 50 x 100 x 250 mm. (Other dimensions on request) disc./anticoincidence module: 250x250x65 mm.

Power: 115/230 VAC, < 5W (Voltage selector accessible through the bottom plate)

Environmental conditions:
Intended for indoor use only
Operating temperature: 5- 40˚C
Humidity: max 80% up to 31˚C, decreasing linearly to 50% at 40˚C

NOTE:
If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

2. Description

The basic part of the Risø low-level beta multicounter system is a gas-flow unit with dimensions of 50x100x250 mm which incorporates five individual GM sample counter elements and a common guard counter (Fig. 1).

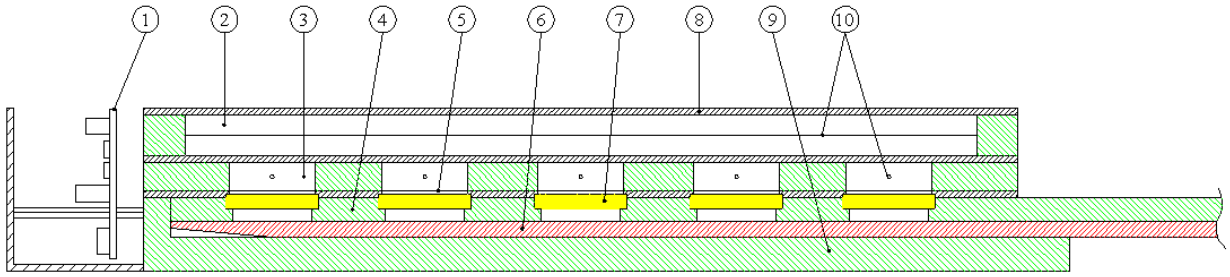


Fig. 1 The five-sample beta GM multicounter, schematically.
(1) Preamp., (2) Guard counter, (3) Sample counter, (4) Sample slide, (5) Mylar window,
(6) Lift slide, (7) Sample, (8) Cu plate Acrylic frame, (9) Acrylic frame, (10) Anodes.

The guard counter reduces the cosmic-ray background by using anticoincidence technique. Each sample counter element is provided with an aluminized Mylar window of density < 1 mg/cm2 and diameter 25 mm. The counters are gas-flow types designed for 99 % Ar/1 % isobutane or 99 % Ar/1% propane counter gas. A sample slide allows five samples to be inserted into the multicounter and be measured simultaneously. A lift mechanism minimizes the sample-to-window distance to obtain optimal efficiency. The multicounter is normally placed inside a lead shielding of 100 mm thickness to reduce the ambient background radiation.

Another part is an electronic system for treatment of the signals produced by the beta particles in the GM multicounter. A block diagram of the electronic circuit is shown in Fig. 2. Preamplifiers placed on the gas flow counter unit produce signals from the individual counter elements that are fed to the discriminator/anticoincidence module (see Fig. 3) which also incorporates an automatically controlled high-voltage supply. The anticoincidence circuits eliminate the background counts produced in the sample counters by cosmic radiation. The counts are acquired by a built-in microprocessor and transferred to a connected PC via a USB interface.
A pulse-height analysing system is provided to automatically control that the high voltage is maintained at a proper value, i.e. well within the GM voltage plateau. The analyser system continuously compensates for varying gas flow and atmospheric pressure.

The software controls start/stop, re-cycle, preset time and pulse height analysing functions. The results of repeated measurements continuously appear on the computer screen by using different programs and data files can be stored for further calculations and analyses.

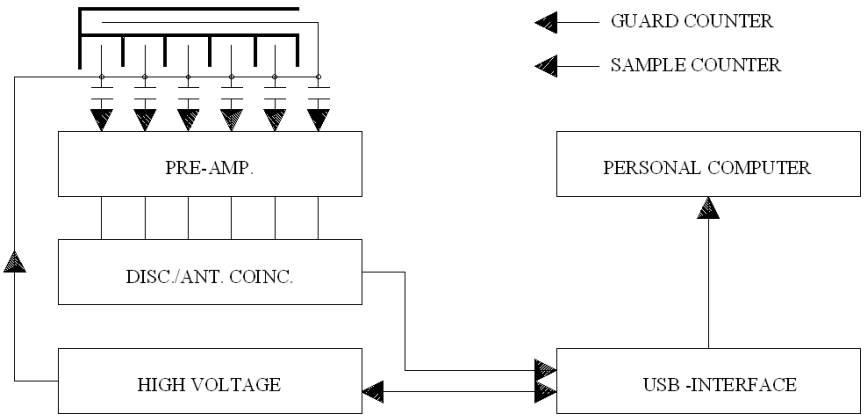


Fig 2. Block diagram of the electronics for the five sample multicounter.

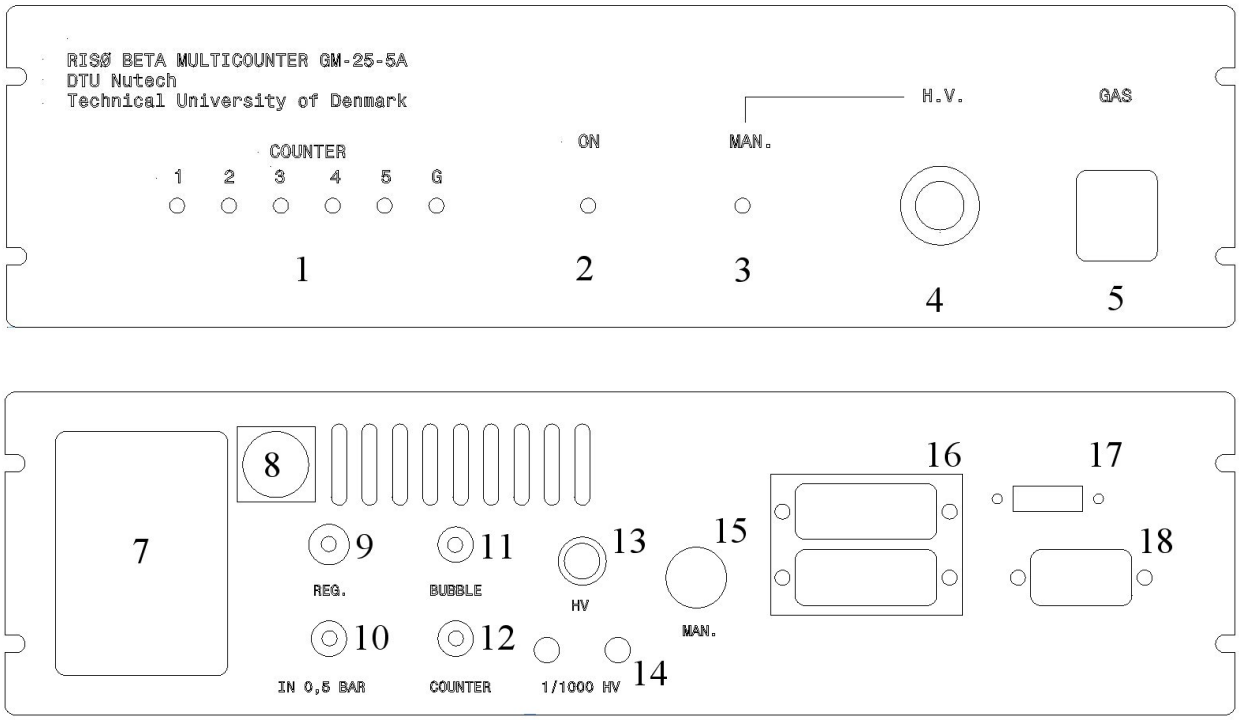


Fig. 3. Discriminator/anticoincidence module.

1. LED indicators for sample counters 1-5, and the guard counter.
2. Main power (LED).
3. HV. man. (LED) ON
4. HV. man. regulator 500-1500 V (5-15 on potentiometer)
5. Bubble chamber (3/4 full with PEG 400 oil)
6. Bubble chamber top
7. Main power, ON/OFF switch
8. Main fuse (230V: M125mA/ 115V: M250mA).
9. Gas flow regulator
10. Gas input (0.2 bar from main gas regulator)
11. Bubble chamber (from guard counter)
12. Gas output to GM multi counter unit
13. HV output to GM multi counter unit
14. Test output HV 0.5-1.5 V
15. HV.man. switch (on/off)
16. Jumper lead.
17. USB connector to personal computer.
18. Signal input from counter

3. Installation and initial start-up procedure

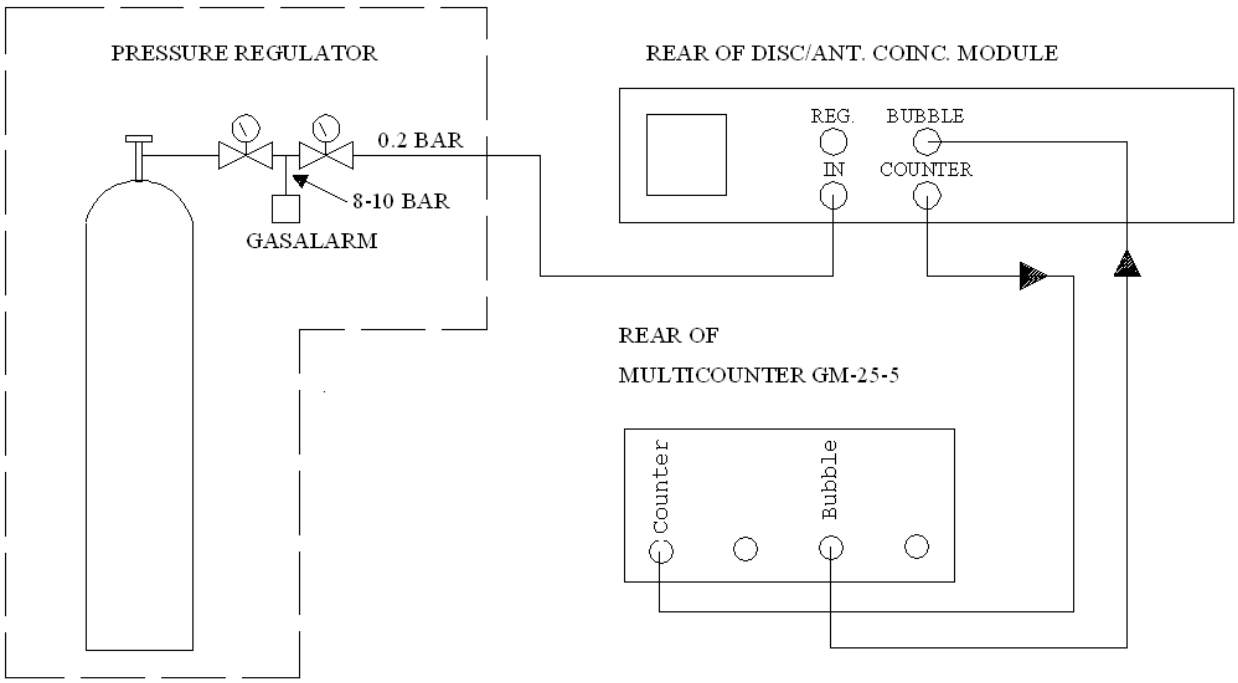


Fig. 4. Flow diagram of the counter gas connections to the multicounter GM-25-5. The pressure from the cylinder is reduced to 0.2 bar and the gas flow is adjusted with the flow regulator (reg.) to approx. 100-120 bubbles per min. (NB! Counters bought before 1. august 2010 have a different type of bubble chamber that should be set to 50-60 bubbles / min.). Note that the gas is led through the guard counter first and then through the sample counters.
Gas cylinder, optional gas alarm and pressure regulator are not supplied by Risø.

1) Read the User Manual carefully.

2) Fill PEG 400 oil (Polyethylenglycol) (enclosed) into the bubble chamber with a syringe, approximately 3/4. Access to the bubble chamber is made by removing the yellow plate with inscription "CAUTION This side up" situated on top of the disc/ant. coinc. module. Be sure that the gas flow valve on the rear of the disc/ant. coinc. module(Fig. 3.) is closed (fully clockwise).

3) Optionally connect the gas-alarm unit between the two regulators where the pressure is 8-10 bar as shown in Fig. 4. If the gas alarm indicates low pressure, then close the gas cylinder and change to a new full one as soon as possible.

4) Adjust the pressure regulator on the gas cylinder to an output pressure of 0.2 Bar and close the main high pressure valve on cylinder.

5) Connect the black rubber gas tubes according to the diagram in Fig. 4.
NB! The soft gas tubes should be as short as possible.

6) At this stage DO NOT connect the counter unit to the computer.

7) Place the counter unit into the lead shielding and be sure that the sample slide can move smoothly and that cables and gas tubes are placed properly.

8) Open the main valve on the gas cylinder.

9) Slowly open the gas flow valve on the back of the disc./anticoincidence module until a fast but uniform bubble rate is observed in the bubble chamber. Leave the counter in this flushing condition for some hours to remove air from the counter.

10) After flushing, reduce the gas flow control valve to a flow rate of about 120 bubbles per minute and leave the counter for 6 hours. (NB! Counters bought before 1. august 2010 have a different type of bubble chamber that should be set to 50-60 bubbles / min.)

11) Switch on the disc./anticoincidence module.

13) Switch to manual mode by activating the "HV.man." switch on the rear of the disc./anticoincidence module (Fig. 3) ("HV.man." LED on the front plate is on).

14) Place one ^{99}Tc test source in position 5, the most distant hole while holding the green sample slide and push it into the GM multicounter. Lift the source by inserting the red lift slide under the green sample slide.

15) Slowly increase the high voltage by turning the high voltage potentiometer clockwise. Observe the counter LED controls on the front of the disc./anticoincidence module. Increase the voltage until the green counter 5 LED is flashing.

The high voltage should now be about 1100-1400 V.

Press the "HV.man." switch once on the rear of disc./anticoincidence module ("HV.man." LED switches off). The HV supply is now in automatic mode and is awaiting control signals from the GM-25-5 software.

NB! The described manual procedure is only needed for an initial start up of the system. Exchange of gas cylinder can be made without any readjustments.

NB! Be careful not to empty the gas cylinder completely which may cause a slight under-pressure that can result in oil to be sucked back into the counter unit. A reservoir chamber is placed in connection with the bubble chamber as an emergency arrangement (see Fig. 5.). Access to the bubble chamber and reservoir is made by removing the plastic frames on the front and back of the disc./anti-coincidence module and lifting of the top cover. Oil sucked into the reservoir can be removed by a syringe.

4. The GM-25-5 software version for Windows

The instructions for the window version of the RISØ GM-25-5 software assume that you are familiar with the Microsoft Windows terminology and procedures and that you have installed Windows on your computer.

If you have not set up Windows on your computer, or if you are not familiar with the use of Windows, please read your Windows documentation.

Hardware and software requirements

You will need the following (or better) computer configuration to use the Risø GM-25-5 beta counter for Windows:

Computer: Windows PC with USB connector.
Memory: Minimum of 1 GB RAM.
Monitor: 1024 by 768 pixels screen resolution or better.

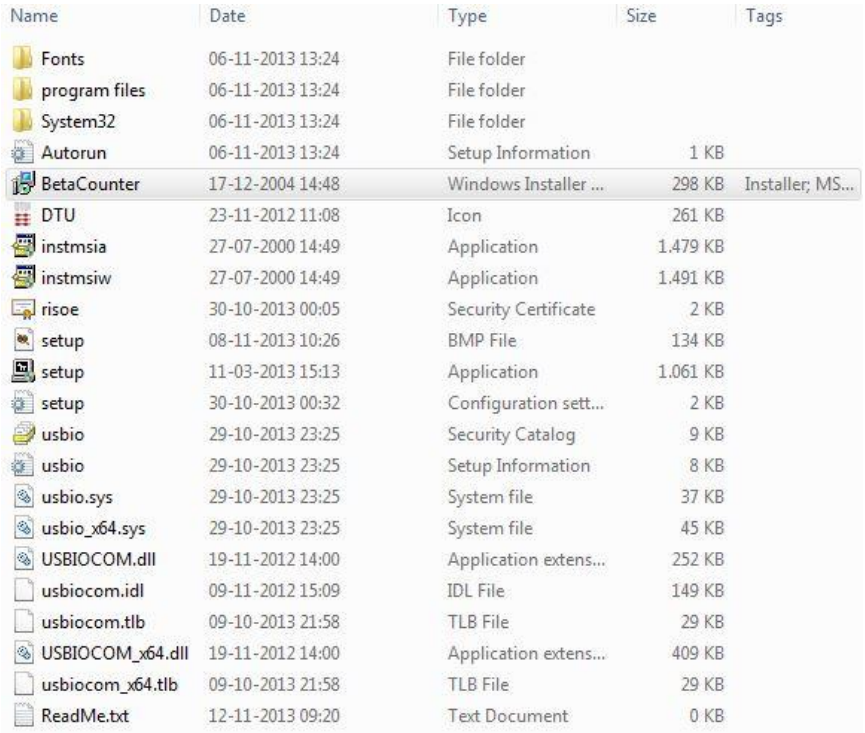
You will need one of the following operating systems to run the Risø GM-25-5 beta counter software:

- Windows 7
- Windows 8
- Windows 10

5. Installation of the Risø Beta Counter Software.

Software installation.

NB! Do not connect the Beta Counter yet.



Name	Date	Type	Size	Tags
Fonts	06-11-2013 13:24	File folder		
program files	06-11-2013 13:24	File folder		
System32	06-11-2013 13:24	File folder		
Autorun	06-11-2013 13:24	Setup Information	1 KB	
BetaCounter	17-12-2004 14:48	Windows Installer ...	298 KB	Installer; MS...
DTU	23-11-2012 11:08	Icon	261 KB	
instmsia	27-07-2000 14:49	Application	1.479 KB	
instmsiw	27-07-2000 14:49	Application	1.491 KB	
risoe	30-10-2013 00:05	Security Certificate	2 KB	
setup	08-11-2013 10:26	BMP File	134 KB	
setup	11-03-2013 15:13	Application	1.061 KB	
setup	30-10-2013 00:32	Configuration sett...	2 KB	
usbio	29-10-2013 23:25	Security Catalog	9 KB	
usbio	29-10-2013 23:25	Setup Information	8 KB	
usbio.sys	29-10-2013 23:25	System file	37 KB	
usbio_x64.sys	29-10-2013 23:25	System file	45 KB	
USBIOCOM.dll	19-11-2012 14:00	Application extens...	252 KB	
usbiocom.idl	09-11-2012 15:09	IDL File	149 KB	
usbiocom.tlb	09-10-2013 21:58	TLB File	29 KB	
USBIOCOM_x64.dll	19-11-2012 14:00	Application extens...	409 KB	
usbiocom_x64.tlb	09-10-2013 21:58	TLB File	29 KB	
ReadMe.txt	12-11-2013 09:20	Text Document	0 KB	

First run "BetaCounter" to install the Beta Counter software.

Win XP:

Install to default folder, continue and finish the installation.

Win 7 and 8:

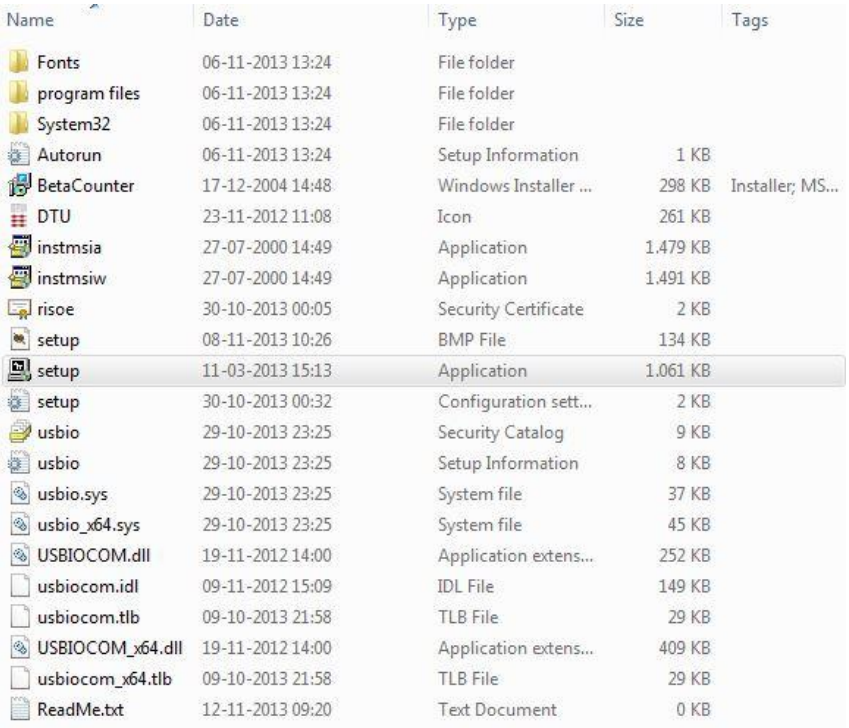
For Windows 7/8 it is now customary to keep program data files in a separate program data file directory. On these systems you are advised to install the program in another directory than the installation program proposes.

When a destination folder is requested, press “Change”.

Change folder name to e.g. “C:\Beta Counter” and press ok.

Continue and finish the installation.

Driver installation.



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Fonts	06-11-2013 13:24	File folder		
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risoe	30-10-2013 00:05	Security Certificate	2 KB	
setup	08-11-2013 10:26	BMP File	134 KB	
setup	11-03-2013 15:13	Application	1.061 KB	
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usbiocom_x64.tlb	09-10-2013 21:58	TLB File	29 KB	
ReadMe.txt	12-11-2013 09:20	Text Document	0 KB	

Run "Setup" to install the driver, and use default destination folder.

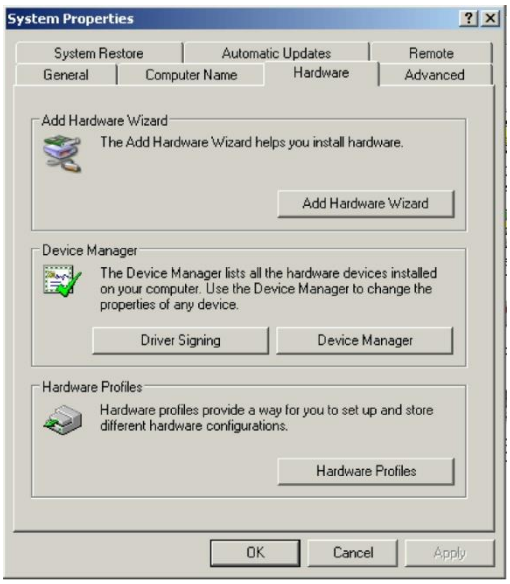
When requested, connect the Beta Counter, and wait for Windows to install the device.

Finish installation and start the Beta Counter software.

Regarding the use of multiple USB interfaces.

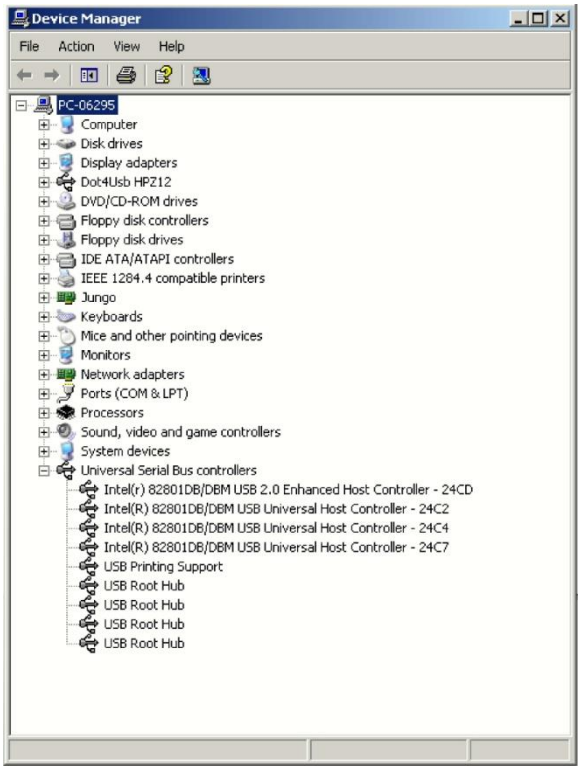
The software supplied with the USB multi counter interface is capable of running up to six interfaces off the same computer. However in order to meet the high specifications of the counter module, it is recommended that each counter be driven directly by one of the computer's USB Host Controller and not a via an internal or external USB hub.
To verify the number of counters that can be run on a PC:

1) Access the "System Properties" menu found in "Control Panel"



2) Select "Hardware" and then the "Device Manager" option.

3) A list of the different devices on that PC will then be shown:



4) Clicking on the "Universal Serial Bus Controllers" will display a list of the available USB connections

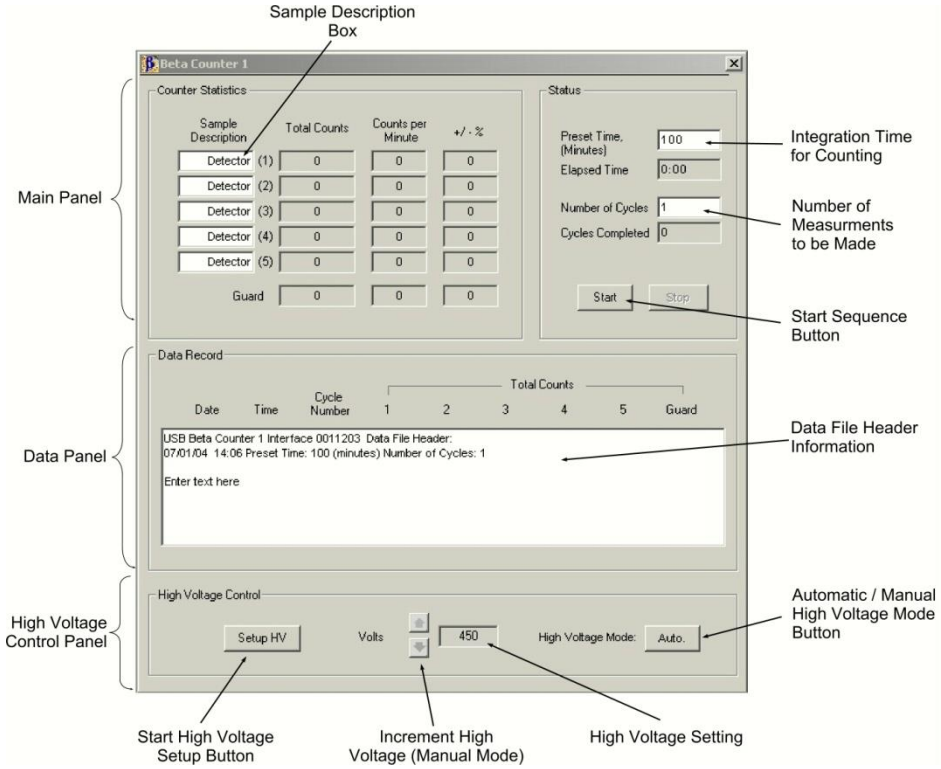
In the case shown above, there are 4 "Host controllers". Each of these host controllers has two associated USB connections, (the second being the "USB Root Hub" shown above). These are usually found as a paired connector on the computer. Either one of these may be used to run a USB interface, however using both the Host and Hub connections is not recommended as this is likely to lead to stalling of the USB interface, resulting in loss of connection to the counter and no further counts being recorded.

The Beta Multicounter Window

When the Beta Counter Software has been started the Beta Multicounter Window appears in full-screen size. If a Beta Counter unit is connected the serial number will automatically be displayed and the interface will start when the "OK" button is pressed. Otherwise, a counter should be plugged in and, going to the "Counter Select" menu, the "Rescan for Counters" option should be selected. (This will again look for any connected counter units.)

The Beta Counter Interface Window

Once started the interface window will appear:



The majority of the interface is self-explanatory. The preset time and number of counting cycles can be typed into the corresponding white boxes. Similarly, the sample descriptions can also be changed. These are then appended to the information in the Data Record section, which will be added as a header to the Data File if saved (which can also be added to by entering text where prompted in the window).

High Voltage Mode & Setup:

The "High Voltage Mode" is set by pressing the button located in the High voltage Control area of the window. This will switch between a manual mode (in which the voltage can be incremented by pressing the up and down arrows in this panel,) and an automatic mode. The automatic mode uses a pulse-height analyzing system to automatically ensure that the high voltage is maintained at a proper value, i.e. well within the GM voltage plateau.

In order to function correctly the high voltage must first be set onto the plateau. This is done in the following way:

1. Ensure that the "HV. man." LED located at the front of the Disc./anticoincidence module is switched off. If not, then press the "H.V. man" switch located at the rear of the Disc./anticoincidence module. (The High Voltage Control panel on the software interface will be disabled if this is not done.)
2. Place the ^{99}Tc test source in position 5, (the most distant hole) while holding the green sample slide and push it into the GM multi counter.

3. Press the “Setup HV” button on the software panel.
4. When the test source is in position press the “OK” button when prompted. (The high voltage will now gradually increase, until the plateau has been reached.
5. A message will appear when the setup has been completed.

Once completed, these settings are then written to a log file for that particular counter unit and will be recalled when running the counter normally. Under normal running conditions this file will be updated at regular intervals to keep track of the high voltage.

Running the Counter:

Once the high voltage has been setup, the counter is ready for use:

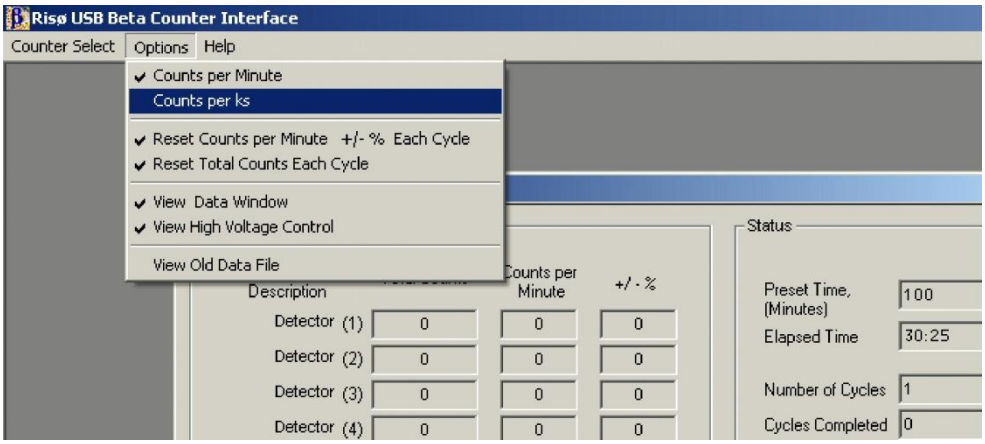
1. Enter the desired cycle time and number of cycles, sample description and any file header information in the corresponding boxes in the main window.
2. Press the “Start” Button.
3. You will then be asked if you would like to save the data to a file.
4. By selecting “Yes” a dialogue box will open to set the file name. (If that file already exists you will be given the option of either overwriting or appending to that file.) Overwriting will write over the existing file. (Appending, will write the data and file header to the bottom of the existing file.)
5. The counter system will now start, (disabling the editable text boxes.)
6. Pressing the “Stop” Button will temporarily pause the counting procedure, which can be restarted with the “Continue” Button.
7. After each cycle the data will be displayed in the “Data Record” section of the screen and recorded to file (if selected.)
8. Pressing the “Auto.” Button in the high voltage control panel will switch off the automatic high voltage system and allow manual adjustment using the arrow buttons located next to the high voltage display.
9. The current status of the counter system displayed at the top of the window:

10. When the sequence has finished the status at the top of the window will read “Counting Completed.”

11. Pressing the “Reset” Button will reset the counter and returns the window to the initial start up conditions.

N.B. If an error should occur and the counter no longer seems to be responding, the counter window should be closed. The USB connection to the counter unit, should then be unplugged and re-plugged, before rescanning for counters.

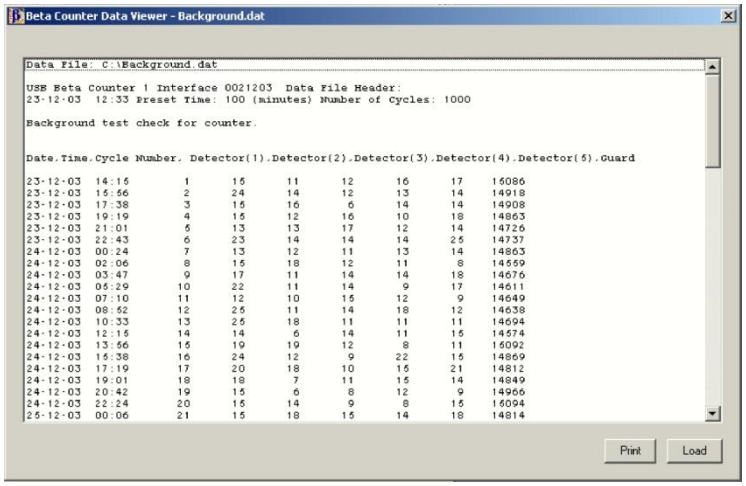
The "Options" Menu:



This menu allows several options to be set:

- The time units can be changed from minutes to kilo seconds.
- The counter system can be made to reset or keep the number of counts per minute and the standard deviation (SD) for each cycle.
- The counter system can be made to reset or keep the total number of counts per minute for each cycle.
- The "Data" and "High Voltage" control panels can also be hidden.

There is also a possibility to view old data files. Selecting this option will open a prompt for a file name. The file will then be opened and displayed in a new window:



Pressing the "Load" Button allows a new file to be loaded.
Pressing the "Print" Button allows the current formatted data file to be sent to the default printer.

6. Sample preparation

Samples for beta counting are prepared on the enclosed nylon disc/rings which are according to the

Health and Safety Laboratory Procedure Manual. HASL - 300 USAEC.

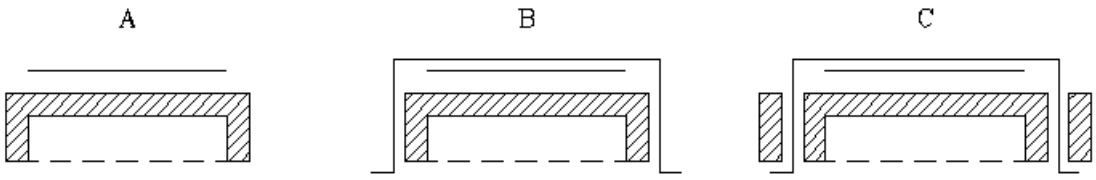
The nylon sample disc/ring consists of:

1. Nylon ring
2. Nylon disc

3. (Steel discs are provided for further reduction of the background and for reflection to improve counter efficiency (^{90}Sr)).

How to prepare a sample:

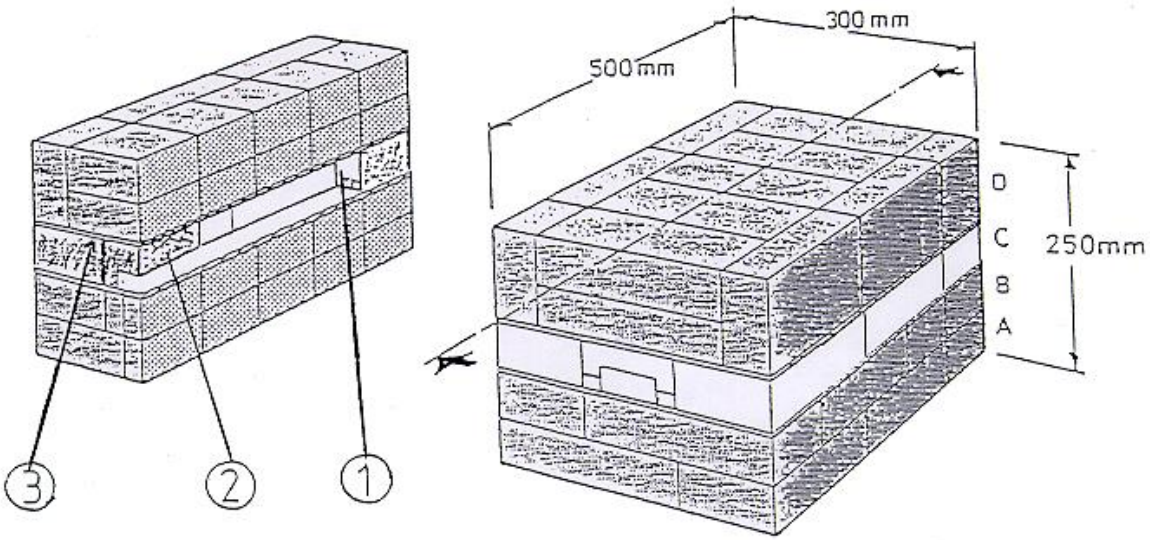
1. Arrange a flat sample on the nylon disc (A)
2. Cover the sample with Mylar foil (B) (1 mg/cm2)
3. Press the ring around the disc to fix the Mylar foil and cut the Mylar foil overhang with a pair of scissors (C)

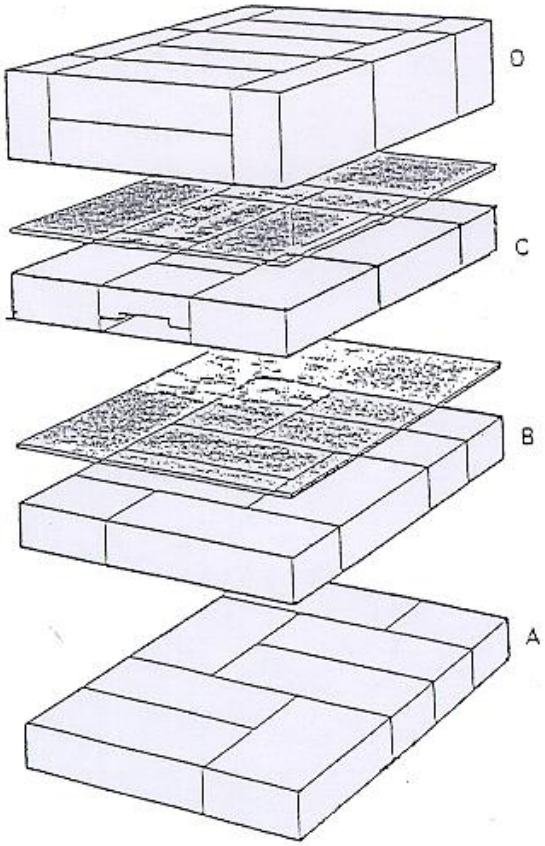


CAUTION!

The total sample height must not exceed 7 mm. as the counter windows may be damaged.

7. Lead shielding





SUGGESTED LEAD SHIELDING FOR BETA MULTICOUNTER MODEL RISØ GM25 – 5A.

1&2. Two special lead bricks.
Delivered by DTU.

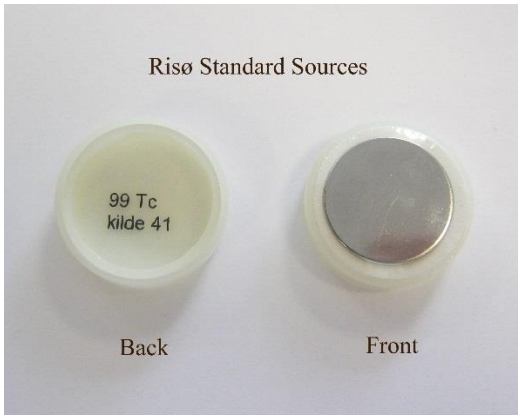
3. Two (1.5 mm.) steel plates.
Delivered by DTU

TOTAL NUMBER OF LEAD BRICKS:
Full size - (200 x 100 x 50 mm.) - 32 pcs.
Half size- (100 x 100 x 50 mm.) - 6 pcs.
Total weight of lead bricks: 385 Kg.

Please see page 20 for safety advice on using lead.

8. Risø ^{99}Tc test sources

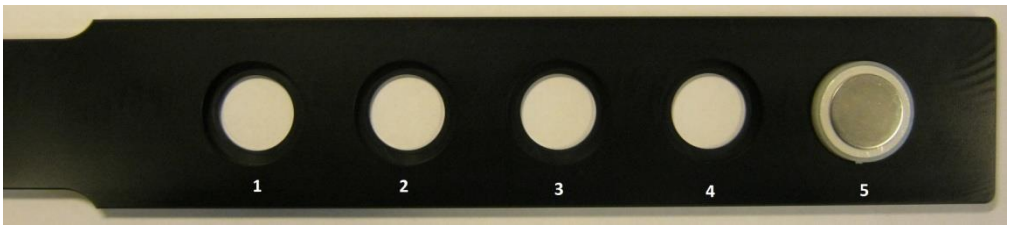
The Risø Beta Counter GM25-5A is shipped with a set of five ^{99}Tc test sources.
The sources are used when running the automated HV setup.



^{99}Tc test sources

How to set up the High Voltage automatically.

Start the Risø Beta Counter Software, and press "Setup HV".
The program will then ask you to insert a sample in position no. 5.
Place one ^{99}Tc test source in position 5, insert the black sample slide
and push it into the Beta Counter.



Sample Slide.

Lift the source by inserting the red lift slide under the black sample slide,

Lift Slide.

and press "Ok" to start the setup. Wait for the program to finish.

9. Appendix

Safety advice for the use of lead shielding for the GM-25-5A Risø Beta Multicounter.

Lead is a widely used and highly effective means of shielding radiation. However, metallic lead itself can be toxic if ingested or inhaled. Studies have shown that lead particles are readily removed from the surface of uncoated lead and can be a source of occupational exposure. Lead particles may be transferred to hands or clothing, or accumulate as dust on floors and other laboratory surfaces. Under heavy handling, it may even become airborne. The following guidelines can help reduce your exposure to this material when handling or working with lead shielding.

1. **Cover the lead shielding with plastic foil to prevent lead contamination**

You can use plastic foil (like the SMP foil from TENEKA - http://www.teneka.co/ or similar) for this purpose. You can either wrap each lead brick in plastic before assembling the lead shielding,

or assemble the shielding according to the instructions supplied by DTU Nutech, and then wrap the entire lead shielding in plastic foil.

2. **ALWAYS** wear gloves when handling metallic lead.