TECHNICAL SPECIFICATIONS

bMCA-USB — a compact digital MCA

INTRODUCTION

bMCA is a compact, digital Multi-Channel Analyzer (MCA), which is able to perform Pulse Height Analysis (PHA) of the signal produced by a standard 14-pin standard photomultiplier coupled to a scintillation detector such as NaI(Tl), LaBr$_3$ (Ce), LaCl$_3$(Ce), CeBr$_3$, etc.

The device is useful for obtaining the energy spectrum from the photon radiation detected by the scintillator, and can be easily interfaced to a typical PC or notebook via a standard USB port for further data transfer and analysis.

The bMCA comes with a basic software package that allows you to control the device and to acquire and visualize the energy spectrum. The software incorporates an advanced and easy-to-use "discovery" function that can be used to automatically detect all the bMCAs (USB or Ethernet) in the neighborhood of the PC that are available for connection.

A set of programming libraries are also offered. This makes the incorporation of the bMCA into existing radiation systems or setups very easy. The programming libraries are available for both MS Windows and Linux operating systems.

DESCRIPTION

The bMCA is an advanced, fully digital, compact Multi-Channel Analyzer (MCA). This device is used to process the electronic pulses produced by a photo-multiplier that is coupled to a scintillator detector. Such detectors are commonly used in the detection of gamma-ray radiation due to their high detection efficiency, medium energy resolution, and relatively low price. This kind of MCA is able to produce an energy spectrum from the radiation events detected by the scintillator, storing it in the device's memory for further retrieval and analysis by the PC.

The bMCA implements two modes of data acquisition:

- Pulse Height Analysis (PHA)
- Multi-channel scaling (MCS)

PHA mode is regularly used in nuclear spectrometry and radiometry, while MCS is a very useful feature for following photon detections in specific energy regions in the function of time. MCS acquisition mode is useful for both laboratory and industrial applications that make use of radioactive sources or seek for radioactive materials.

The MCA has built-in advanced PHA data acquisition modes, such as:

- Acquisition on live time
- Acquisition on real time
- Acquisition to a number of counts in a spectrum region (ROI)
- The combination of time (live or real) or counts on ROI,

The bMCA design makes use of the latest advances in digital electronics. The MCA utilizes powerful digital processing techniques and algorithms to separate the useful signals from noise and to maximize performance under high count rate conditions. The acquired spectra under PHA mode is extended for Dead Time. The device has a spectral memory size of up to 4096 channels and can perform MCS in addition to PHA.

The MCA contains a miniaturized high-voltage power supply optimized for low consumption utilization that provides the necessary power for the PMT tube, including those used with large scintillator detectors.

A basic acquisition software package is provided for managing such device operations as setup, control, data acquisition and visualization. A digital oscilloscope function allows monitoring the input and filtered pulses to aid in fine-tuning the MCA parameters. The program also includes a few spectrometry-related functions for processing the spectral data, including calibration, ROI analysis and peak search, to mention a few.

FEATURES

- Fully digital Multi-Channel Analyzer (MCA) built into a compact 14-pin photomultiplier tube socket

- Full Pulse-Height Analysis (PHA) and Multi-Channel Scaling (MCS) modes of data acquisition

- Up to 4096 channels for PHA and MCS acquisition

- Advanced electronic noise reduction algorithms

- Compact MCA with size of H 60 mm x D 55 mm

- USB 2.0 for data communication and device control

- Miniature design combining low-power consumption with low-noise

- Basic spectrum acquisition and device control software included

- Available programming libraries for Windows and Linux Operating System (upon request).

- LED indicators for communication status and device power, HV power and incoming count rate (ICR)
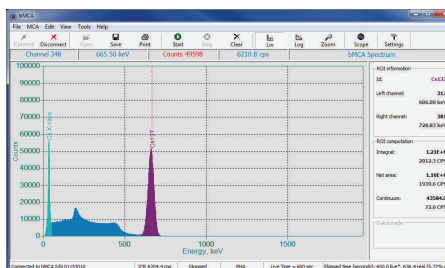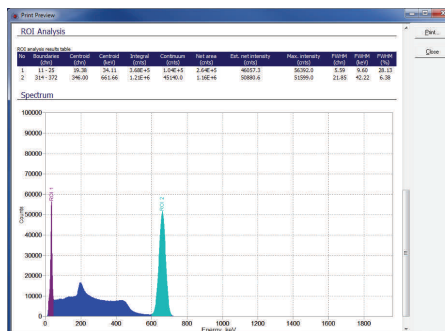
BRIGHTSPEC

is a dynamic engineering company providing novel designs and innovative solutions in the field of nuclear electronics and software development for radiation detection.

TECHNICAL SPECIFICATIONS

PHA acquisition mode

- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Coarse gain with amplification factors of 1, 2, 4 and 8. Fine gain from 1 to 2 in steps of 1/4096
- Upper and Lower Level Discriminator settings given in channels
- PHA acquisition presets on:
    - Live Time
    - Real Time
    - Counts on a ROI
    - A combination of both Time or ROI counts

MCS acquisition mode

- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Dwell time from 0.1 sec to "count-forever"
- Easy to setup from ROIs or nuclide information.

Digital Settings

- Rise Time: from 0.1 to 12 µsec in steps of 0.2 µsec
- Flat Top: from 0.1 to 8.0 µsec in steps of 0.1 µsec
- Threshold: 1 to 255
- Digital Base Line Restorer (BLR)
- Pile-Up Rejector (PUR)

High Voltage Power Supply

- Miniature HV power supply embedded into the MCA assembly
- Voltage: 0 to 1 500 Volts in 4096 steps

Data communication

- USB 2.0, cable included (standardly 3 meters long)

Environmental

- Industrial temperature range: -40 °C to +85 °C.

Physical

- Size: height 60 mm, diameter 55 mm
- Weight: approximately 120 grams
- Connectors: USB type mini B
- Indicators:
    - Red LED for detector high voltage
    - Yellow LED for incoming count rate (ICR)
    - Green color LED for power and communication status

Other

- The device is supplied with a basic software (free download) to control operation, data acquisition and spectrum visualization

Certifications

- The device is CE compliant

CE
CERTIFIED

BRIGHTSPEC

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Technical Compliant Matrix for IAEA RFQ No533524-AM

Introduction

To the IAEA request expressed in the document RFQ No: 533524-AM, BrighSpec NV proposed a solution of few components:

- Cylindrical scintillator detectors of 1.5x1.5 inc CeBr$_3$ crystal with standard PMT.
- Tube-base digital MCA for scintillator detectors with standard PMT 14-pin socket connection.
- A full-featured gamma-ray spectrum analysis and quantification software: bGamma/1. One input hardware connection control. Software fully compatible with MS Windows, Linux and macOS.

With the proposed solution we satisfy most of the technical requirements, exceedingly in few aspects.

For the financial proposal please refer to our "price quotation" document.

Compliant matrix

The following table shows the capabilities of our proposed solutions to the specific technical requirements as per document "Specifications of Equipment.pdf" provided with this RFQ.

Ref No	Specific requirement	Compliant	Our comments or capabilities
Item 1	**1.5" CeBr3 probe** **- 1.5 x 1.5 in. CeBr3(Ce) crystal;** **- In a hermetically sealed aluminum housing;** **- Including a photomultiplier tube;** **- With an internal magnetic/light shield;** **- 14-pin socket;** **- Resolution < 4.3 %;**	YES	Model: 38B38/2M-CEBR-LB-X. CeBr3 scintillator crystal of 38 mm (.5 inch) diameter and 51 mm (1.5 inch) length. Encapsulated into 0.5 mm Al. Incudes 0.63 mm solid magnetic shielding around the PMT. Energy resolutions < 4.3 % on [137]Cs 662 keV Drawing on "Basic proposal".
1.2	Digital MCA Base For use with 10-stage PMTs that fit standard 14-pin sockets; - HVPS and low-noise preamplifier built-in; - USB 2.0 and Ethernet connection, powered either by USB port or Power over Ethernet; - Gain at least x1 – x40; - Detector Voltage in range of at least 0 to 1000 V, Accuracy <3% of full scale; - Base Line Restorer; - Total channels 4096 (internal resolution)	. YES	Compact and fully digital tube base. Model: BrightSpec bMCA-US or bMCA-ETH. Includes low noise PreAmplfier, Amplifier, 50 MHz DSP, MCA and HV BIAS power supply for up to + 1500 Volts Amplification Gain x1-x128. Digital Base Line restorer (BLR) and Pile Up rejector (PUR) **MCA of up-to 4096 channels with 32-bit data depth per channel.**

			Fast USB or Ethernet (to be chosen) for data communication. Power via USB or PoE (power over Ethernet). PoE injector provided.
1.3	Spectroscopy Software - **For data acquisition, display and analysis of spectroscopy data (identification and activity analyses)** - **Compatible with the MCA base** - **Live and off-line analysis** - **Compatible with Windows 10 (32 and 64-bit)** - **Support for energy and efficiency calibrations**	YES	BrightSpec full-featured spectrum analysis and quantification software, **bGAMMA**. Fully compatible with MS Windows 7, 8 and 10 (32-bits and 64-bits). Linux (including ARM microprocessor) and macOS. Includes many features, such as: real time data acquisition and control of BrightSpec devices (e.g. tube-base bMCAs), import files form ASCI, SPE, CNF (Canberra), CHN (Ortec), .N42; etc. Calibrations: Energy, shape, efficiency, etc. Activities and MDAs calculations using three methods (including ISO11929), etc. See attached specsheets for more technical details
4	**Marking**		
	The System shall have all safety markings in English language.	YES	
5	**Packing and shipping**		
5.1	The System shall be packed in accordance with international standards that are applicable for the shipment of this kind of equipment	YES	EU certified packing
6	**Quality requirements**		
6.1	The System shall be manufactured in accordance with the Supplier's ISO quality assurance system or an equivalent quality assurance system.	YES	The system tests are according to our internal QA\QC guidelines. **A certificate of performance is provided**
6.2	The Contractor shall document the compliance with this quality assurance system.	YES	All components are delivered with performance certificate
Testing			
7	The System, prior to shipment, shall be tested for conformance of the System with manufacturer's performance specifications and the minimum requirements specified herein	YES	Certificate of performance is issued
9	**Deliverable Data Items**		
9.1	The Supplier shall provide two (2) complete sets of operation and servicing manuals and technical drawings in	YES	

	the English language in hard copies and electronic version		
11	**Warranty**		
9.2	The System shall be supplied with a comprehensive warranty, valid for one year from the date of the End-User's receipt of the System	YES	One-year standard warranty is provided. Includes "free" software updates.

Basic proposal

Item 1: 1.5x1.5x3 inch scintillation cylindrical size CeBr$_3$ detector.
Model Model 38B38/2M-CEBR-LB-X. Ttechnical specifications

- Scintillator detector with 38 mm (1.5 inch) diameter and 38 mm length CeBr3 crystal.
- Aluminum housing of <u>0.5 mm thickness</u>
- Standard 10-stages photomultiplier with 14-pin socket output.
- Includes 0.63 mm solid magnetic shielding (mu-shield) around the PMT.
- Warranty energy resolution of < 4.3 % on ^{137}Cs 662 keV peak.

38B38/2M-CEBR(LB)-X

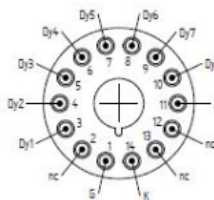**Description:** Low background Cerium Bromide scintillation detector

Drawing	:	VS-0889-230
Scintillation crystal	:	CeBr$_3$
Crystal read out	:	51 mm diameter R6231-100.
Connectors	:	14-pins connector.
Temperature range	:	-20°C to +60°C.

Performance

Energy resolutions	:	< 4.3 FWHM at 662 keV.
High voltage polarity	:	Positive
Typical high voltage	:	+ 700 V.

Φ 58,8
14 pin Base
Epoxy seal
1 max.
Magnetic shield (wall thk's 0,64 mm)
Φ 51 Photomultiplier
Optical interface
138
Epoxy seal
Φ 38 x 38 hgt. CeBr3 (LB) crystal
Reflector
Body of Aluminium (wall thk's 0,5 mm)
28
Φ 42

SECTION A-A
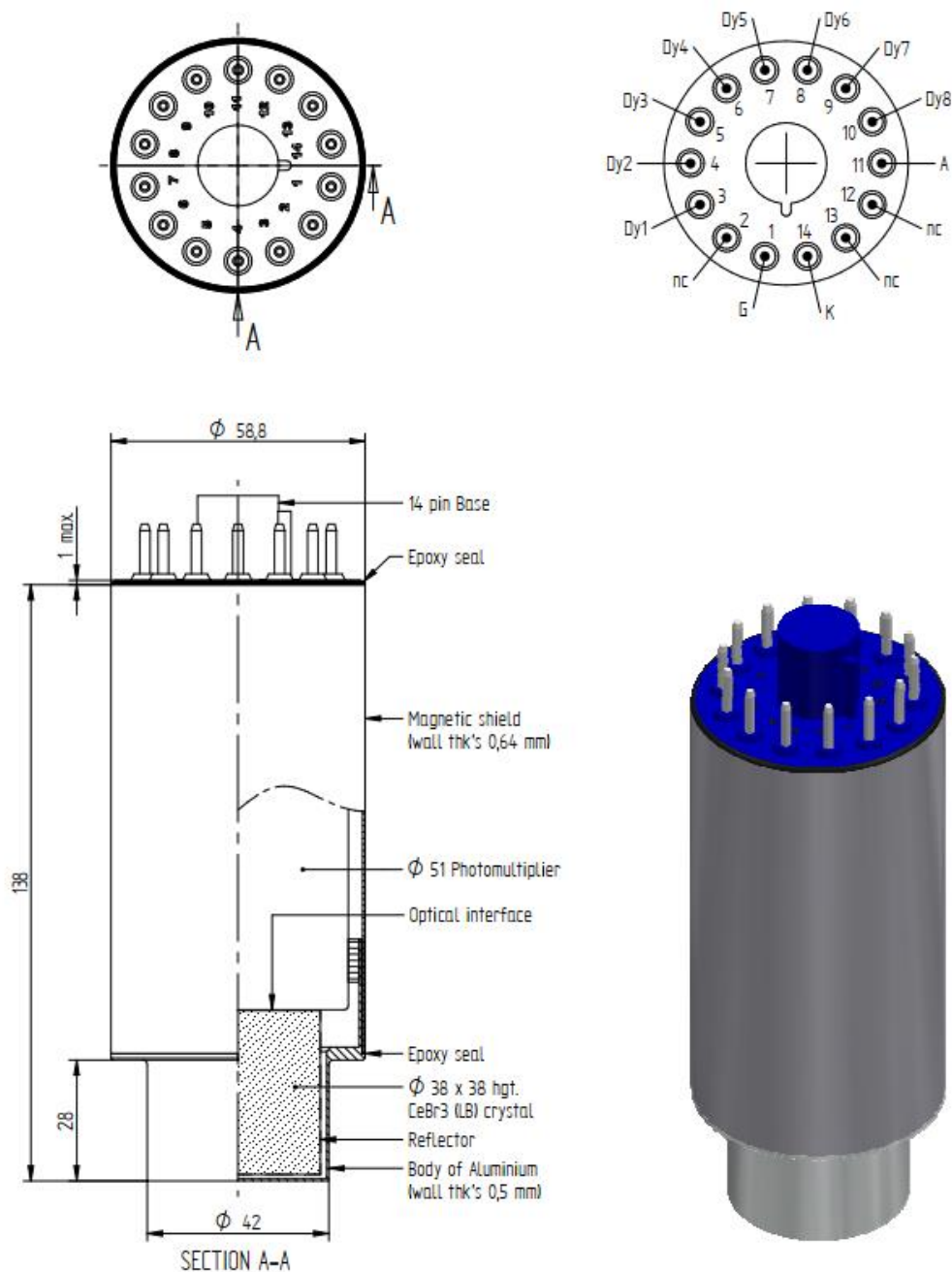
Item2: Some features of bMCA tube base

- Compact sizes
- Acquisition modes:
  - Standard PHA
  - MCS
- Diversity of data acquisition presets
  - Acquisition preset on time (Live or Real)
  - Acquisition reset on Counts on spectrum ROI
  - Acquisition Preset on external signal (start/stop)
  - Any combination of all 3 above !!!
  - Acquire-for-ever mode.
- MCA with up-to 4K with 32-bit channel depth

- 50 Mhz DSP and 25 MSamp/sec flash ADC of 12-bit resolution.
- 40 MHz micro-controller
- Include High Voltage BIAS supply. Up to + 1 500 Volts
- Fast data transfer. In the case of Ethernet interface less than 72 msec data transmission speed for 4K spectrum
- Full programming support via SDK

bMCA-USB Tube base MCA		
bMCA-ETH Tube base MCA		

Technical drawings for bMCA-USB
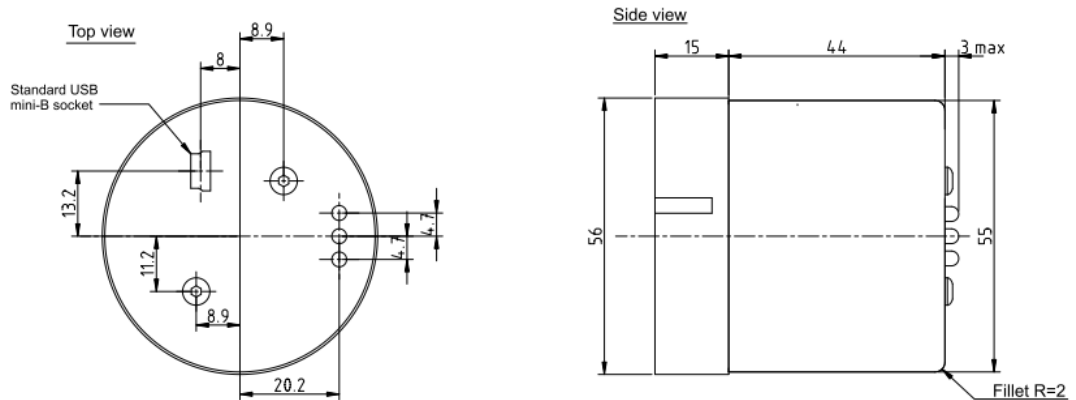
Technical drawings for bMCA-ETH
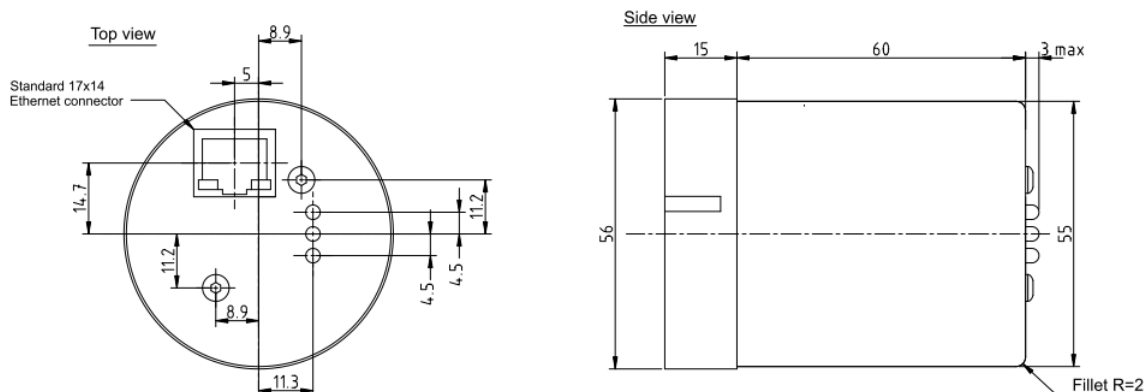
Item3: Outstanding features of bGAMMA software

- <mark>Multi-platform: the software and all its components are fully compatible with MS Windows (7, 8 and 10) x86 32-bit and 64-bit processors; Linux (x86 and ARM processors) and macOS.</mark>

- Multi-document on a modern and visually powerful graphical user interface

- Fully control ad setup of ANY BrightSpec spectroscopy devices.

- Multiple peak search algorithms: more than seven methods

- Multiple-peak fitting algorithms, <mark>INCLUDING Bayesian peak fitting</mark>, which does not depend on peak shape calibration as other standard peak fitting algorithm do.

- <mark>All spectrum analysis results are given with their fully propagated uncertainties, which also includes co-variance treatment</mark>

- Provision of 3 methods for MDA calculations<mark>, including ISO-11929 (comprising revision 2010, as well)</mark>

- Intuitive efficiency calibration with 2 polynomials and user-selectable cross-point

- Multi-efficiency curve calculation included into standard package

- Extensive, full and embedded nuclide radiation library, with instant search capabilities

- Import of files formatted from
    - ORTEC binary files (*.chn)
    - IAEA text (*.SPE).
    - Canberra binary files (*.cnf) with <mark>no need of VDM to be installed on the PC</mark>
    - N42.42 xml-based files (including latest 2012 revision)
    - Simple ASCII files (.txt)
    - Comma-delimited data files (*.csv)
    - etc

- Color reports with tables and plots.
    - User-defined report contents possible

- Modules for QA\QC, Procedures, File batch analysis, User management Control, etc.; are available as additions to the standard distribution.

Among many others, see attached full technical specifications

For more technical details of each proposed component see attached Product Technical Specifications

OPTIONAL Items

Optional available packages

Procedures

Allows automatic and fast spectrum analysis guided by pre-defined analysis steps, including spectrum data acquisition. Below is an example of the "Procedures" editor, where the different "steps" for the spectrum analysis are defined.

File batch analysis

File Batch Analysis is an extension of bGamma spectrum analysis software for performing spectrum analysis on a large number of files containing previously collected gamma-ray spectrum. Their analysis is done with minimum operator's intervention.
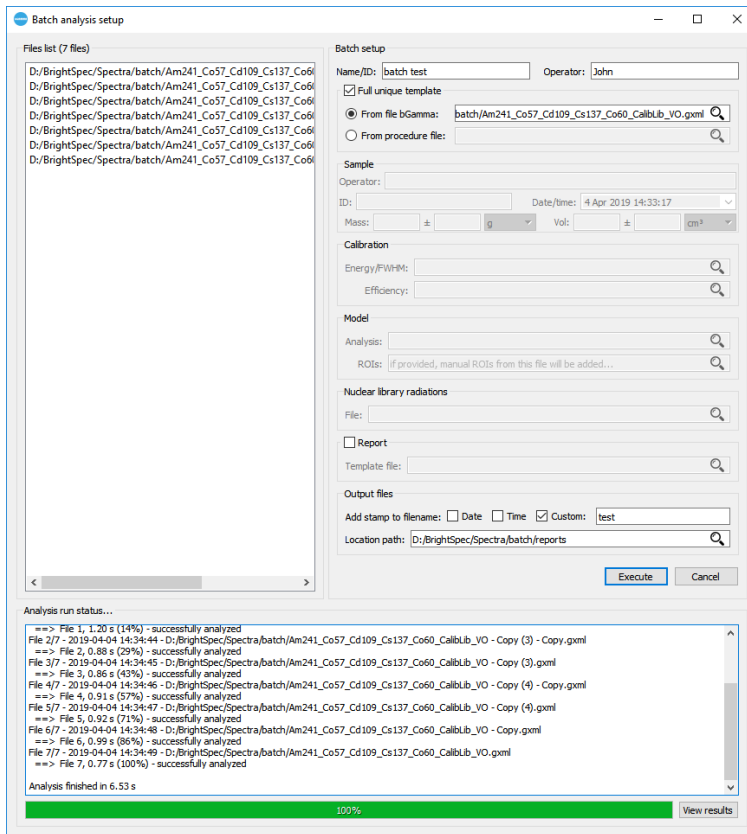
Files browser

Files Browser is a valuable addition for reviewing data files, extracting their contents and making statistical analysis of results or any other parameter (e.g. parameters or settings related to data acquisition).

The Files browser is an enhanced add-in into bGamma that would extract data from ANY bGamma (*.gxml) formatted file, and hence its name of "Files browser".
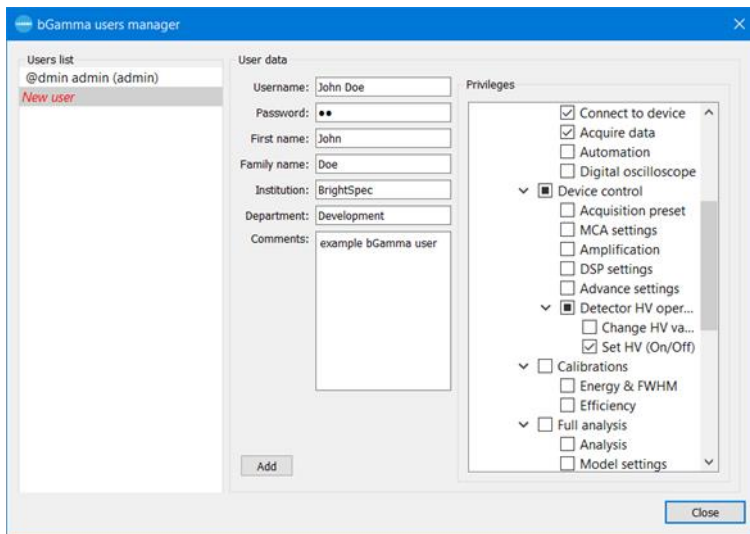
Above here, is a screen shot of the file browser operational dialog.
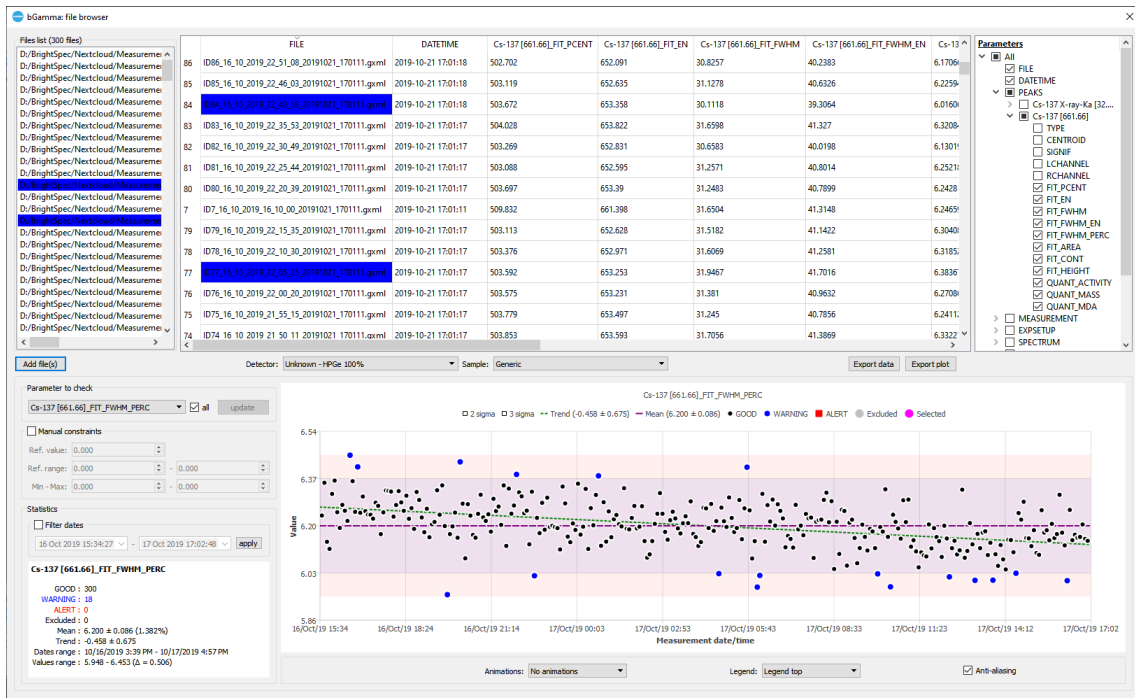
bGamma-User's management

The proposed solution also contains User's management control enhancement.

This option enriches the operations of bGamma software in terms of multi-user capabilities and operational trailing.

It allows you to establish or define different users for bGamma; each user with its individual operational privileges and functional access in the program. Additionally, the software keeps trailing history of each individual user and the exact operations performed. The software operational trailing, or Logbook, can be reviewed, and data reported or exported into files.

Below is a screen shot of the user's manager editor where users can be managed, and their specific operational privileges assigned.

The QA\QC expansion, included into bGamma software package proposal, is a program extension specifically designed to track and review the performance of your gamma-ray spectrometer through bGamma software.

Using these modules, the quality of the spectrum analysis and its spectrometer can be monitored over time, through out certain number of parameters such as energy resolution, peak centroids, activities of reference material or calibration sources, etc.

The package provides statistical analysis of the data as well as comprehensive visual feedback.

Using this software part, QA-QC performance checks can be a priory scheduled and assigned to a particular user.

bGammEff: Full Monte-Carlo-based efficiency calculation software with incorporated 3D editor and setup modelling

•   Suitable for counting Marinelli beakers, other containers (plastic steel bottles) with different volumes (25ml to 1000ml), filters

We propose a mathematical efficiency calculation software bGammEff.

bGammaEff is a software package incorporated into bGamma software that can calculate the photon efficiency calibration curves from a given experimental setup or sample.

For input of the different objects and dimensions of the measurement setup bGammEff incorporates a novel and sophisticated 3D Editor. Using this 3D editor, the user can enter "eventually" any object and/or geometry in the setup and therefore take it into account for the corresponding calculations.

bGammEff, in different with other existing similar software packages, is based on FULL MONTECARLO CALCULATION and therefore is not limited to a certain object, type of detector, sample or proposed template. It can model ABSOLUTELY ANYTHING.

Below we underline the advantages of bGammaEff in comparison to similar software in the market:

- Full Monte Carlo calculation
- Unlimited objects, forms, and setup. Not limited to pre-defined "templates".
- Real-time update and display of objects'dimensions.
- Different colors for each "material" in the setup
- View of sampling points
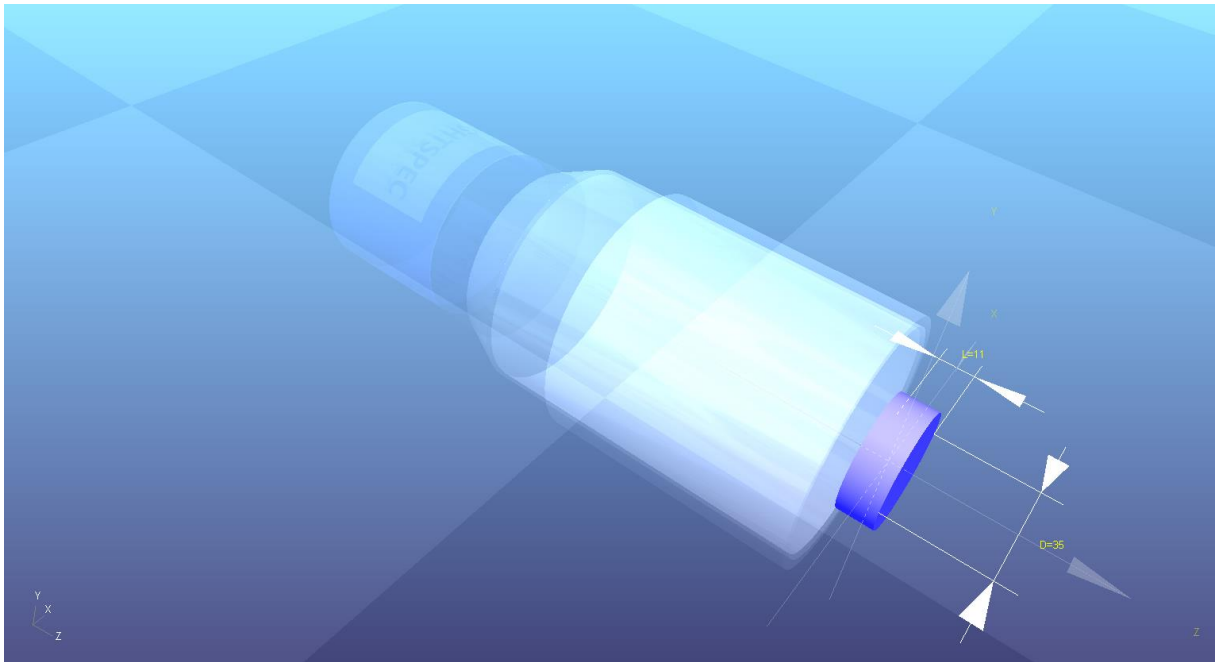- Raytracing and display of successful photo-events
- Visual floor indication

Hereafter; are a few screen shots of bGammEff.

A 3x3 NaI(tl) simple geometry
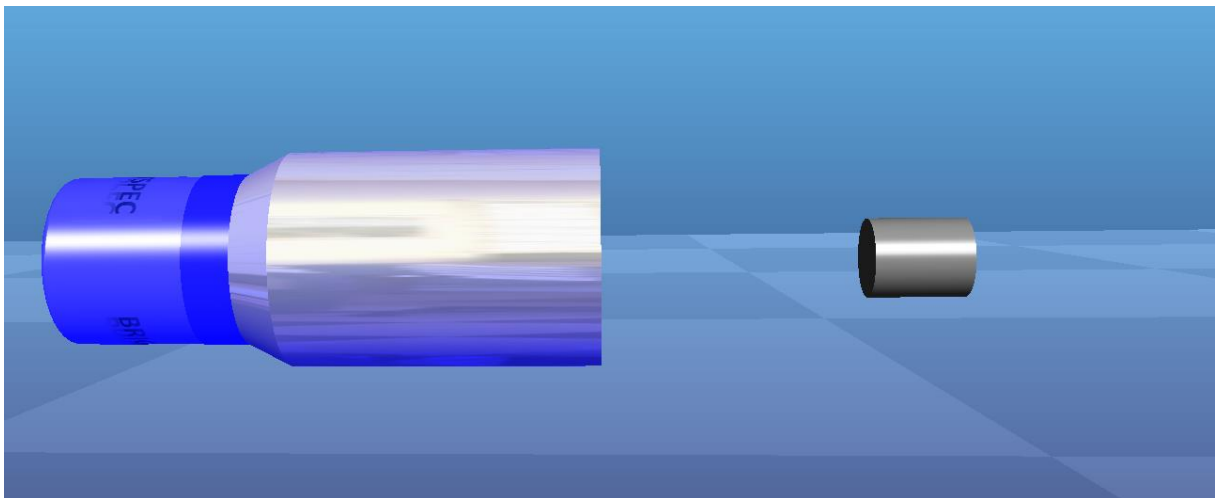
A 3x3 inc NaI(Tl) with a rod and showing sample object dimensions

(Optional) Stand for Detector+MCA+sample.

Diagram of "Detector+MCA+sample" plastic stand, adapted for specific scintillator crystal dimensions and specifications.