

1220 QUANTULUS

Ultra Low Level Liquid Scintillation Spectrometer

DESCRIPTION

The 1220 QUANTULUS™ from PerkinElmer is a dedicated environmental counter with proven unsurpassed performance measuring extremely low concentrations of man-made, cosmogenic and other natural radionuclides. Its superior background reduction means that variable environmental radiation does not affect sample count rates, allowing very long counting times of ultra low activity samples and measurements normally only possible in special underground installations.

The QUANTULUS provides superior alpha/beta discrimination counting, especially for samples containing mixed alpha/beta/gamma radiation (e.g., in the presence of quench and/or high beta activity). It delivers the highest beta and/or alpha liquid scintillation sensitivity and counting performance combined with the lowest possible ^3H backgrounds. This instrument is ideal for applications such as radiocarbon dating, Cerenkov counting, and measurement of fallout radionuclides in food or radionuclides in active or decommissioned nuclear power plants.

STANDARD FEATURES

- **Sample detector assembly** is comprised of two specially selected low noise, low background photomultiplier tubes (PMTs) for sample counting. The assembly also includes light-emitting diodes for the automatic spectrum stabilizer. The sample chamber is fully enclosed inside the guard detector (described below), and the sample and guard detectors are optically isolated from each other.



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- **Automatic Continuous Spectrum Stabilizer** checks the performance of the photomultiplier tubes and pulse amplifiers 62 times/second using green GaP LEDs as reference light sources, and the high voltage is adjusted automatically to keep the signal output constant.
- **Unique anticoincidence guard detector and lead radiation shield** provide active and passive shielding of environmental radiation to stop most gamma radiation and all cosmic radiation. The asymmetric passive **radiation shield** is made of low radioactivity lead that surrounds the detector assembly (maximum thickness: 200 mm on top, 100 mm on the side walls and 150 mm below the counting chamber). The head of the piston is made of copper and is a part of the passive shielding. Active shielding against cosmic particles and environmental gamma radiation is enforced by an **asymmetric guard counter** (length is 350 mm, diameter 160 mm) that is filled with scintillation liquid. The guard's OFHC copper

container offers extra passive attenuation against environmental radiation. The guard is monitored with two 2" PMTs operating in summed coincidence. The guard is optically isolated from and operates in anticoincidence with the sample detector. Its operation is sample independent

- **Additional background reduction devices** include a Pulse Amplitude Comparator (PAC), high bias threshold, RF suppression and static eliminator.
- **Static electricity elimination** is accomplished with an ionizer unit to protect against static electricity created during sample preparation and rack movement on the conveyor lane. The conveyor base and vial holders are metal to minimize static electricity.
- **Electromagnetic interference elimination** is accomplished with an antenna that operates in anticoincidence with the sample detector to reject electromagnetic noise interference from power lines and radiofrequency sources.
- **Random access sample changer and conveyor** loads up to 60 samples in 3 racks (20 each). Samples can be accessed at random or in any pre-programmed order. The sample changer accepts 3 mL to 20 mL vials or other vials sizes (down to 0.3 mL) with adapters. Sample change time is 45 s for the first sample and 20 s for samples in the same rack. Electro-optical sensors control rack and sample position and movements. The vial holders have a unique shutter seal to assure against light leaks.
- **Range of vial types** that can be used with the QUANTULUS include standard 20 mL glass and plastic vials as well as special copper-Teflon vials in 3, 7, 15, and 20 mL sizes. The maximum acceptable sample vial diameter is 28 mm and maximum height 62 mm. Other sizes, such as 0.3 mL Teflon, can be measured using 20 mL vial adapters. The instrument's lift piston can be modified by request for adapters that do not allow axial rotation. The modification does not prevent counting of normal vials.
- **Cooling Unit** uses four Peltier elements to maintain the set temperature of the interior of the instrument and the sample chamber within 12°C from the ambient temperature. The cooling unit fins contain a water inlet to boost cooling. The large amount of lead contained in the instrument is an effective inertia to temperature change. Several hours of power failure

will not cause the instrument's temperature to change significantly.

- **Two dual programmable multichannel analyzers (MCAs)** provide multiple counting parameters and comprehensive spectral analysis capability. This sophisticated device is capable of collecting up to four spectra plus external standard spectrum from the sample simultaneously. The four spectra may all be from samples under different conditions. Storage of full spectral information to the PC hard drive or diskette is possible. Built-in dead time correction compensates for lost counts to high activity samples. The 1024-channel MCAs are controlled by logic commands that allow hundreds of tailored configurations in addition to the default ones. Up to 8 preprogrammable counting windows are allowed.
- **Pulse amplitude comparison (PAC)** is a means to decrease the component of background produced by optical crosstalk in liquid scintillation counting. The user adjustable PAC level can be forced to reduce crosstalk.
- **Pulse Shape Analysis (PSA)** allows simultaneous acquisition and sensitive discrimination of pure alpha and beta spectra from mixed radiation in a sample. An improved PSA circuit combines with the active detector guard for excellent background discrimination to enable measurement of alpha emitters even in the presence of a 100,000 fold excess of beta radiation. Alpha backgrounds are greatly reduced by PSA when compared with total sample background. Use of PSA results in extremely good sensitivity particularly in liquid scintillation counting of alpha particles, not achievable in standard LSA. The pulse shape analyzer is user adjustable to allow optimum separation of alpha particle spectra from other kinds of radiation in environmental samples, such as ^{222}Rn or ^{226}Ra water samples.
- **QUANTULUS software** runs in an external PC on Windows 95, NT4 or XP platforms. The graphical user interface is a menu-driven software program, WinQ (1220-307 WinQ). This program offers an unlimited number of parameter groups or protocols, constrained only by the hard disk size of the computer. It also provides live display of selected spectra on computer screen. In multi-user counting conditions, each user has his own area for protocols. WinQ can control four QUANTULUS instruments simultaneously. Raw data saved on the PC hard disk or a network drive can later

be processed off-line with EASY View spectrum analysis software. 1224-534 EASY View displays up to 6 spectra simultaneously and allows spectral arithmetic, DPM calculations, statistical analyses and radiocarbon age dating.

- **LED instrument display** includes on/off and instrument stability indicators. Any of the four spectra produced by the two MCAs can be displayed on the computer screen using the WinQ screen user interface software to generate commands from the external PC.
- **Date and time clock** provides real time display and printout of time in READY state. Instrument output date and time are synchronized to the external PC date and time.
- **Stand-by power supply** is provided by battery support for a maximum of 50 hours for RAM memory and to provide automatic restart after a power failure. Parameter group data is stored indefinitely in EEPROM memory.
- **Electronic hardware** includes microprocessor controlled counting and data reduction. Memory configuration, ROM 128 k, RAM 642 k and EEPROM 16 k. Logarithmic A/D converter, energy range 1-2000 keV (beta).
- **Highly accurate SQP(E) quench monitor** with ^{152}Eu external standard ensures fast quench evaluation and correction. The high energy, low activity 37 kBq (1 μCi) ^{152}Eu source is in a sealed stainless steel capsule. The source is pneumatically transported to the vicinity of the sample vial for standardization.
- **Sample quality monitor** checks internal quench curve validity for samples when counting in DPM mode.
- **Chemiluminescence monitor** (based on delayed coincidence) is built in for the detection of random coincidences. The random coincidence spectrum is measured in one half of the MCA.
- **Other monitoring facilities** are available for the user to examine any PMT noise or random coincidence signal, and to check guard performance vs. time (by saving coincident (active) and anticoincident (inactive) guard pulses).
- **Printout format** is completely user-selectable using the printout edit function and printout codes.

COUNTING CONDITIONS

- Quasisimultaneous or Ultra Low Background Counting Mode offers the full control of two MCAs by logic Boolean commands. There are hundreds of combinations to control measurement in special counting mode. Default counting modes and parameters include:
 - ^3H (low energy beta), ^{14}C (high energy beta & Cerenkov) and alpha/beta MCA modes.
 - Coincidence sample counting with guard counter active, i.e. low background counting (sample in anticoincidence with the guard).
 - Coincidence sample counting with guard counter inactive (can be used for high activity samples).
 - Luminescence counting in noncoincident mode with or without guard.
 - Chemiluminescence (random coincidence) recording in ^3H counting mode.
 - 24 sample input lines/parameter group. Each line may contain one position or a range of positions (maximum 1-60).
 - Sample(s) ID: maximum 16 characters — notes field available for extra information.
 - Preset counting time per cycle/repeat: 1 s to 277 hrs.
 - Count limit/cycle: 1-9.9E99 counts or no limit for a given window.
 - Cumulative limit: 1-9.9E99 counts or no limit for a given window.
 - Repeats for a sample: 1-99.
 - Cycles for a sample: 1-999.
 - External standard: yes/no (SQP(E)), counting time selectable 1 s – 2 hrs.
 - External standard on each sample cycle or every Nth cycle: N=1-99.
 - Preset windows: 1-8.
 - Printout selection and definition for 2 printers.
 - Spectrum save selection: maximum 4 spectra plus external standard.
 - Spectrum resolution on save: 16, 32, 64, 128, 256, 512, 1024 (1024 required in Windows software).
 - Guard, PAC, PSA rejected sample pulses can be saved.

- Coincidence bias can be selected on high or low through the software program. High bias gives improved performance in low background ^{14}C counting in glass vials.

Physical Data

Dimensions:

Width: 101 cm (39.8 in.)

Height: 156 cm (61.4 in.)

Depth: 92 cm (36.2 in.)

QUANTULUS stands on four feet, each 28 cm² (11 sq. in.), 90 cm (35.4 in.) apart.

Weight:

Approximately 1000 kg (2204 lb.)

Input/Output Connections:

Serial ASCII interfaces RS-232C.

Two I/O terminals: terminal 1 for data input/output to a video display/printer; terminal 2 for data input/output to an external PC.

Electrical Requirements:

Main voltage selectable 100, 115, 120, 220, 240 V, $\pm 10\%$, 50/60 Hz.

Power Consumption:

200 VA; cooling unit consumes approximately 200 VA, voltage rating as above.

Environmental:

Operating temperature $+15$ to $+35$ °C.

Operating relative humidity maximum 75%.

Air conditioning of the counting laboratory with stabilized temperature is recommended in conditions where temperature rises above 30 °C and/or humidity is above 75%.

ACCESSORIES

- An external PC and printer are always needed for Windows software operation. (See specifications in the Order Guide.)
- AAAJA-0002 Uninterruptible Power Supply. (See specifications in the Order Guide.)
- See the Equipment, Chemicals & Supplies section in the PerkinElmer catalog.

TYPICAL PERFORMANCE DATA

Counting performance:

	Efficiency	Background	Best verified E^2V^2/B
^3H	Unquenched ^3H $\geq 65\%$. Typical water sample efficiency up to 27%.	0.4 – 1.2 CPM, down to 0.5 Bq/L in 500 min counting, 8:12 H_2O : cocktail, typically.	116,000 in water samples.
^{14}C	Unquenched ^{14}C $\geq 95\%$. Radiocarbon dating with PAC on = 73%.	< 0.3 CPM, 7 mL vial. Max age up to 65,000 years.	565,000 in 5 mL benzene samples, silica vials.
Alpha	Typically > 95%,	< 0.1 CPM in plastic vials.	> 5,000,000

Stability:

Count variation less than 0.2%/24 hours (not including random statistics).

Safety, Radiated Emissions and Immunity:

The 1220 QUANTULUS has been tested for safety, radiated emissions and immunity according to the standards IEC1010-1, EN 50082-1, EN 50081-1, EN 61000-3-2 and EN 61000-3-3, which are based on directives 89/336/EEC and 72/23/EEC. Manufacturing is certified to ISO 9001.

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