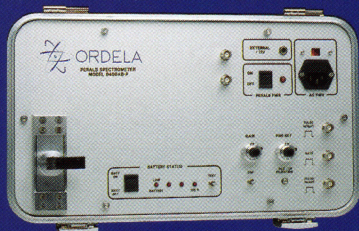


PERALS[®]

SPECTROMETER



Simple and accurate alpha assay.

INSTRUMENTATION

PERALS® Simplifies Environmental Alpha Spectrometry

Dramatically reduce both your sample preparation and counting times. Take advantage of improved sample turnaround times and throughput by using the PERALS® in your laboratory.

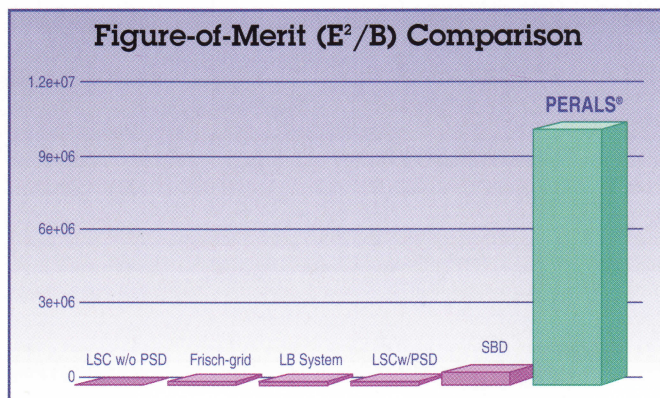
PERALS® will improve the way you do alpha spectrometry in two ways. First, it simplifies your sample preparation. Practical PERALS® application procedures reduce traditional radiochemistry sample preparation times by up to 50% — or more! Save time and reduce the chances for error by using fewer, less complicated steps. Secondly, the nearly 100% counting efficiency and low background of the PERALS® result in the highest figure-of-merit (E^2/B) of any common analytical method. Count faster than ever before and get accurate answers sooner than you thought possible.

The PERALS® (Photon - E_lectron - R_ejecting - A_lpha - L_liquid - S_cintillation) Spectrometer is a proven, unique instrument for **simple, rapid alpha spectrometry**. An unprecedented, **constant 99.7% counting efficiency** and backgrounds as low as **0.001 dpm** from 4 - 7 MeV are just two of the unique features PERALS® offers. Using PERALS® **eliminates** drawbacks such as long, complicated sample preparation procedures, expensive software for peak analysis, recoil contamination, cross-contamination, sample positioning errors, self-absorption and energy degradation in alpha spectrometry. Also, the PERALS® instrument is more accurate than traditional alpha spectrometers; 1 - 2% accuracy vs. 5 - 10%, respectively.

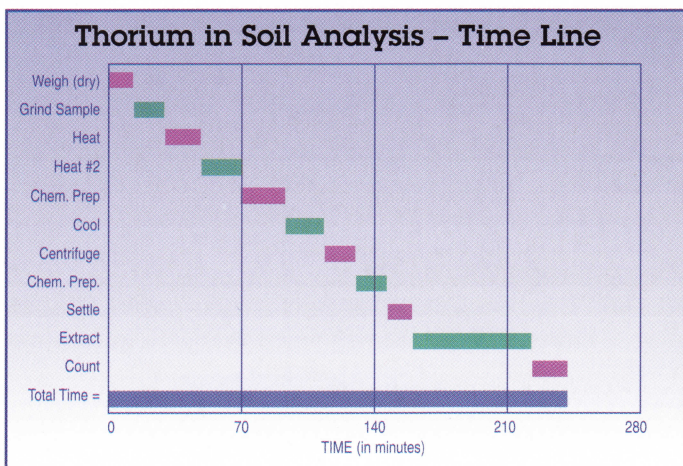
The PERALS® spectrometer is the best analytical weapon in the environmentalist's, health physicist's, and analytical chemist's arsenal. With PERALS® you can now quantify, and usually qualify, alpha-emitting radionuclides from a wide range of sample matrices — soils, water, sludges, smears, and air filter samples — just to name a few.

PERALS® is easy to use and requires little technician training. Sample preparation procedures are much less involved (and take less time) than electrodeposition! Instrument setup takes only a couple of minutes, thanks to a simple Pulse Shape Discriminator (PSD) control setting.

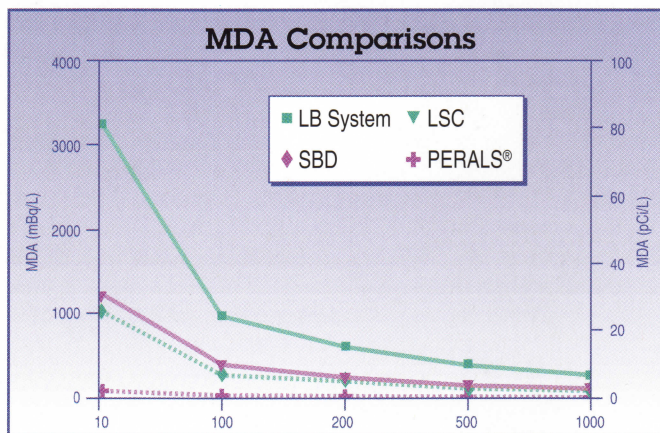
You get the right answers — just in a shorter time! Because you use your own existing multichannel analyzer (MCA) and software, you already know how to use the PERALS®! You do not have to retrain technicians on the most difficult part — the MCA and its software. Also, the PERALS® complements both your gas-flow proportional counter systems and silicon detector alpha spectrometers as it can screen alpha assays for both systems.



PERALS® has the highest Figure-of-Merit (E^2/B) of any other method of alpha counting or spectrometry. Figure-of-Merit is a measure of the relative instrument sensitivity and sample throughput capability. PERALS® can be used to analyze samples or screen specimens for these other instruments, thus increasing laboratory effectiveness.



Thorium in soil is just one application where PERALS® excels. Save time and money by reducing your analysis time to about four (4) hours.



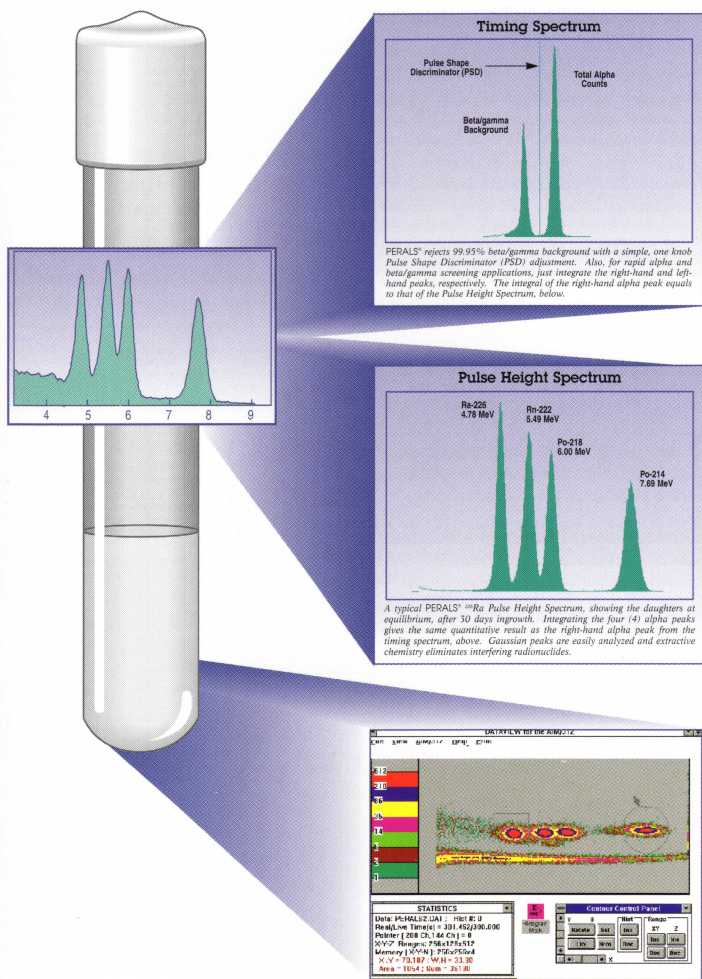
Meet the demand for faster turnaround times and improved throughput capability with PERALS®. PERALS® is better, faster, and cheaper than other methods due to a superior Minimum Detectable Activity (MDA).

DataView - Dual Parameter Software for Windows[®]

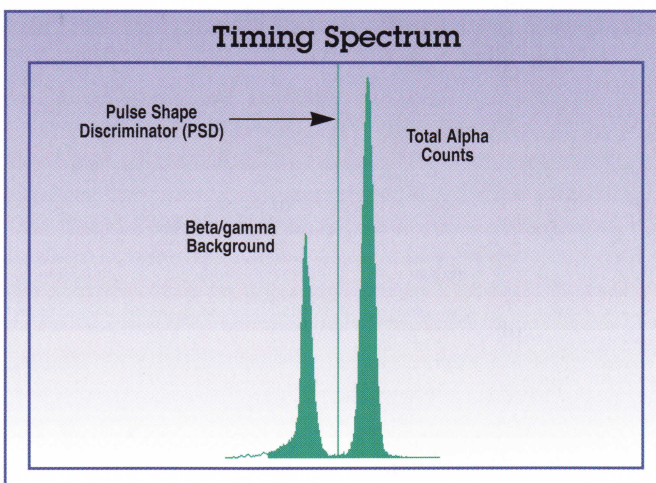
See what you have never seen before!

DataView software allows you to view an alpha, beta, and gamma spectrum like you've never seen before. With DataView, see alpha sample spectra and beta/gamma background – simultaneously! Even see alpha activities that are up to four orders to magnitude (10^4) below the beta/gamma background.

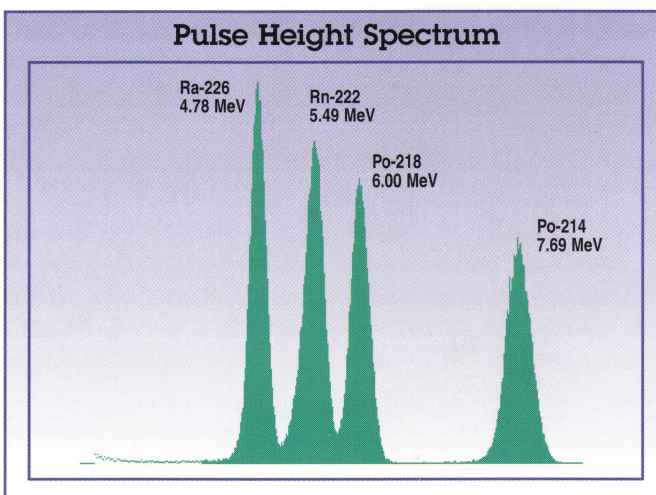
Count extremely low-level environmental samples, as in sediment dating, where every alpha count is important. Or, distinguish plutonium and americium counts that comprise a small fraction of the total counts as in high-level waste samples. In either of these extremes, DataView is for you.



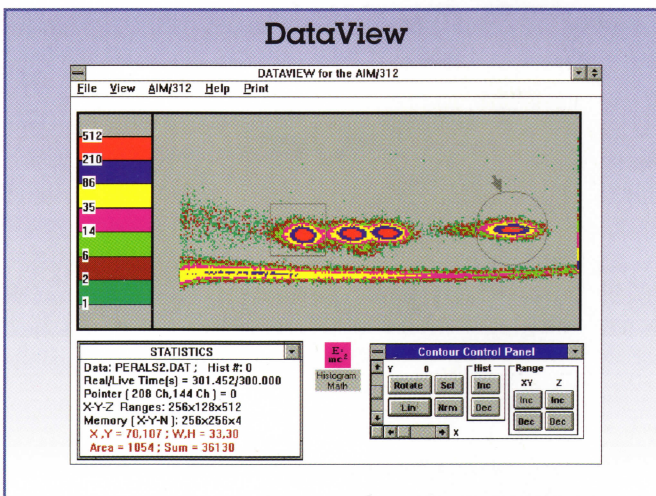
- Assay alphas in the presence of 10^5 to 10^4 beta/ gamma backgrounds
- Multiple regions-of-interest (ROIs)
- Spectrum calibration - both energy and timing
- Eliminates need to set pulse shape discriminator; separation of beta/gamma backgrounds and alphas is automatic
- Complete on-line help and instruction manual
- Works with AIM/312 module and standard IEEE-488 interface



PERALS[®] rejects 99.95% beta/gamma background with a simple, one knob Pulse Shape Discriminator (PSD) adjustment. Also, for rapid alpha and beta/gamma screening applications, just integrate the right-hand and left-hand peaks, respectively. The integral of the right-hand alpha peak equals to that of the Pulse Height Spectrum, below.



A typical PERALS[®] ²²⁶Ra Pulse Height Spectrum, showing the daughters at equilibrium, after 30 days ingrowth. Integrating the four (4) alpha peaks gives the same quantitative result as the right-hand alpha peak from the timing spectrum, above. Gaussian peaks are easily analyzed and extractive chemistry eliminates interfering radionuclides.



DataView lets you see more of your ²²⁶Ra spectrum! This is the view of the ²²⁶Ra spectrum, above, you see with DataView.

A Very Short Course in Solvent Extraction Chemistry...

Basic principles of solvent extraction have been known since the early 1800s when uranyl nitrate was reported to be soluble in diethyl ether. The technique was not widely used before the 1940s, however. Solvent extraction methods were rapidly developed to meet the needs of the Nuclear Age, namely, the separation of uranium and plutonium. These elements were separated by phase-transfer from an aqueous solution to an immiscible organic extractant solution, generally called the "extractant." The extractants can be thought of as elemental-selective "sponges" that are capable of separating metals from aqueous (i.e. water-based) solutions. When extractive solutions are contacted with aqueous solutions of the proper pH and ionic compositions, they selectively, and normally quantitatively, transfer the radionuclide of interest from the aqueous phase to the organic (extractive solvent) phase. Combining these extractive solvents with scintillators enables you to with-

draw 1 mL of this solution containing the radionuclide of interest and count it in the PERALS[®] spectrometer.

Choose from a complete line of extractive scintillators that enables the radiochemist to selectively remove radionuclides from a solution and differentiate them from both interferences and other nuclides. Element-specific extractive scintillators eliminate spectral overlap and greatly simplify nuclide identification. In alpha screening applications, simple regions of interest (ROIs) may be set, and counts observed in these regions correspond to the nuclides of interest. A wide selection of application notes has been developed for analysis of specific nuclides in many sample matrices. They are FREE for the asking. In addition, users of the PERALS[®] method continually provide suggestions, additional research, papers, and application notes that benefit everyone.

Reference: McDowell, W. J. and McDowell, B. L., *Liquid Scintillation Alpha Spectrometry*, CRC Press, Boca Raton, FL, 1994.

Applications of ETRAC[®] Extractive Scintillators

The following table summarizes the extractive scintillator required to concentrate and analyze the radionuclide of interest. Find the element, e.g. plutonium, that you want to quantify in the middle column. The required extractive scintillator and the conditions for extraction are listed in the other two columns.

Reagent to be used	Radionuclides of Interest	Aqueous-Phase Conditions
ALPHAEX_α [®]	Uranium (VI) and (IV), Thorium, Protactinium Hafnium, Zirconium, Plutonium (IV)	Aqueous anion non-complexing for cation to be extracted; pH 1 - 3
	All above + Actinides (III), Lanthanides (III) and Iron (III)	Non-complexing anion; pH 2 - 4
URAEX_α [®]	Selective for Uranium	0.1 - 1.0 M SO ₄ ; pH 0.5 - 1.0
THOREX_α [®]	Thorium, Uranium, Bismuth (III), Zirconium, Hafnium Scandium, Iron (III), Yttrium, Plutonium, Europium, Indium	0.1 - 1.0 M SO ₄ ; pH 0.5 - 1.0
POLEX_α [®]	Selective for Polonium	7.5 M H ₃ PO ₄ PLUS 0.001 M HCL
RADAEX_α [®]	Selective for Radium	0.3 to 0.4 M NaNO ₃ ; pH 10 - 12
RADONS_α [®]	Selective for Radon	Any aqueous solution; pH 5 - 7
STRONEX_α [®]	Selective for Strontium	1 to 3 M NaNO ₃ ; pH 10 - 12
NONEX_α [®]	None; for diluting extractive scintillators if a reduction in the extractive power is needed or for the dilution of a sample if the count rate is too high.	Non-extractant. Contains all other components of the extractive scintillators.

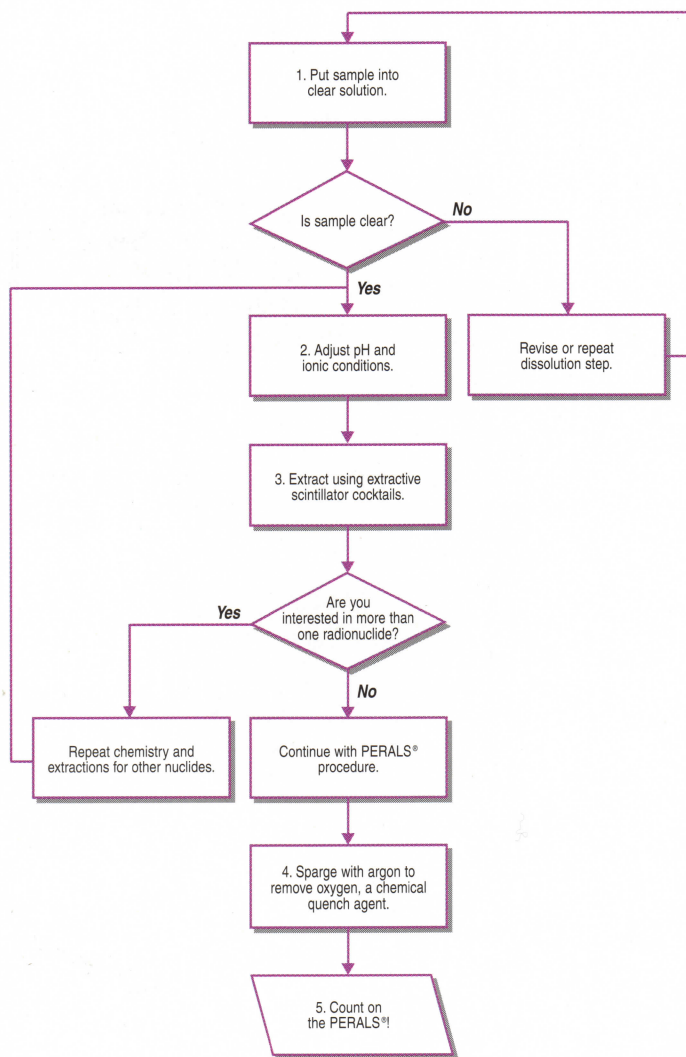
Element is considered extractable if the distribution coefficient, $D = [M]_{\text{org}}/[M]_{\text{aq}}$ is > 100 . Distribution coefficients of > 1000 are usual. Quantitative recovery of the nuclide depends both on D_M and on the volume ratio, $V_{\text{org}}/V_{\text{aq}}$.

If you look for Alphas, count on the PERALS[®]!

PERALS® Simplifies Environmental Alpha Spectrometry

Rapid sample preparation chemistry is another advantage of the PERALS® system. The solvent extraction technology allows sample preparation that once took days to be accomplished in minutes!

PERALS® Chemistry consists of just five basic steps:



PERALS® chemistry for alpha spectrometry is much simpler than traditional radiochemistry and has fewer steps. Technicians with little experience and training can work with the simple PERALS® system, thus freeing senior workers for lab troubleshooting and more difficult procedures. Dramatically reduce your turnaround times! Throughput may similarly improve. Prepare samples in batches and quickly analyze them with near 100% counting efficiency, which dramatically reduces sample counting time!

That's it! Finish procedures in 30 minutes that once took a whole day! Soil samples that once took two weeks in the lab can yield spectra in as little as four hours!

Extractive Scintillators

Extractive scintillators make your sample preparation simple and fast. Each of the following contain an extractive solvent to selectively extract elemental radionuclides of interest, an energy transfer agent, and a scintillation fluor — everything you need!

Extractive scintillators are aqueous-immiscible organic solutions that quantitatively and selectively phase-transfer radionuclides from an aqueous sample into the organic scintillator. Mixing the two phases results in a dispersion of one phase in the other. Since they contain colorless, high-vacuum distilled compounds, they eliminate many of the problems normally associated with alpha spectrometry via liquid scintillation — namely variable quenching and high and variable background. Extractive scintillators are often elementally selective and aid in identification of the unknown nuclide.

ALPHAEX_α®

Used for extraction and analysis of all alpha-emitting nuclides, with the exception of radium isotopes. Contains an alkyl phosphoric acid, an energy transfer agent, and scintillator fluor.

POLEX_α®

Polonium isotopes are quickly and easily extracted with this extractive scintillator. Contains an alkyl phosphine oxide, an energy transfer agent, and scintillator fluor.

RADAEX_α®

Radium isotopes may be extracted and analyzed with this extractive scintillator. ²²⁶Ra may be immediately analyzed after extraction, without waiting long periods for ingrowth. Contains a synergistic mixture of a high-molecular-weight neo-carboxylic acid, dicyclohexano-21-crown-7 crown ether, an energy transfer agent, and scintillator fluor.

RADONS_α®

Contains a scintillator and energy transfer agent specifically tailored for measuring radon in water.

THOREX_α®

Primarily used for both uranium and thorium alpha-emitting radionuclides but may also be used for plutonium and americium analysis. If a separate uranium and thorium analysis is desired, sequentially use URAEX_α® and then THOREX_α®. Contains a high-molecular-weight primary amine, an energy transfer agent, and scintillator fluor.

URAEX_α®

For extraction and analysis of all uranium isotopes. Contains a high-molecular-weight tertiary amine, an energy transfer agent, and scintillator fluor.

SPECIFICATIONS

NIM Module PERALS® MODEL 8100AB

Inputs:

Bin Power: Rear panel NIM Bin connector; ± 12 V @ 450 mA, ± 24 V @ 240 mA.

Input: Rear panel SHV connector; accepts +500 V @ 1 mA input current to provide power to the photomultiplier tube (PMT). (Note: Not required if internal high voltage option is installed.)

Outputs:

Pulse Height: Front panel BNC connector; provides unipolar, positive pulses, 0 to 10 V amplitude; linear with alpha energy (6 MeV alpha energy = 6 V output at GAIN = 1); 1.5 μ s dwell time, 100 Ω output impedance; <300 keV (FWHM) resolution at 6 MeV alpha energy; output internally gated by Pulse Shape Discriminator (PSD) setting.

Gate: Front panel BNC connector; provides unipolar, positive pulses, 3.5 V amplitude; 3 μ s dwell time, 100 Ω output impedance; time coincident with all Pulse Height outputs having amplitudes between the PSD and Pile-up set points.

Pulse Shape: Front panel BNC connector; provides unipolar, positive pulses, 0 to 10 V amplitude (approximately 0.5 V/ns); 1.5 μ s dwell time, 100 Ω output impedance; 10 ns (FWHM) resolution. For samples having beta/gamma and alpha activity, the multichannel analyzer display of the pulse shape spectrum shows two peaks separated by approximately 35 ns.

Disable: Rear panel BNC connector; provides short to ground to disable bias and prevent damage to PMT when sample chamber is opened. (Note: Not required if internal high voltage option is installed.)

Controls:

Gain: Front panel, 10-turn potentiometer; 0.4 X - 1.4 X range. Allows calibrating the energy scale from 2.4 V to 8.4 V for 6 MeV alpha energy.

PSD Set: Front panel, 10-turn potentiometer; 0 to 10 V range. Sets the lower level discriminator of the Pulse Shape output pulses to eliminate beta/gamma background.

Display: Front panel, two-position, momentary contact switch; allows superposition of the PSD lower level discriminator setting and the Pile-up upper level discriminator setting on the Pulse Shape output spectrum.

Pile-up: Front panel, multi-turn trimpot, 0 to 10 V range. Sets upper level discriminator for rejection of pulses with longer decay times than alpha particles of interest.

LLD: Rear-panel, multi-turn trimpot, factory set lower-level discriminator for the Pulse Height output spectrum.

EXP: Rear-panel, multi-turn trimpot, factory set gain for the Pulse Shape output spectrum.

Shift: Rear-panel, multi-turn trimpot, factory set offset for the Pulse Shape output spectrum.

Options:

-HV Internal high voltage module for PERALS®. Provides correct amplitude and polarity power for PMT. Also includes automatic high voltage disable to protect PMT when sample cover is opened and the following:

Indicator: Red LED illuminates to indicate application of bias to the photomultiplier tube (PMT).

Shipping information:

Weight: (Shipping) 5 kg (Net) 2.5 kg

Dimensions: 3 NIM wide module; 10.2 cm wide, 22.1 cm high, and 24.6 cm long

Portable PERALS® MODEL 8400AB-P

Inputs:

AC PWR: Standard 3-prong NEMA-type connector accepts 110/115 V or 200/230 V, 50/60 Hz input power.

External + 12 V: Switchcraft® type 712-A male jack accepts + 12 V input power from external source, battery, or cigarette lighter.

Outputs:

Pulse Height: Front panel BNC connector; provides unipolar, positive pulses, 0 to 10 V amplitude; linear with alpha energy (6 MeV alpha energy = 6 V output at GAIN = 1); 1.5 μ s dwell time, 100 Ω output impedance; <300 keV (FWHM) resolution at 6 MeV alpha energy; output internally gated by Pulse Shape Discriminator (PSD) setting.

Gate: Front panel BNC connector; provides unipolar, positive pulses, 3.5 V amplitude; 3 μ s dwell time, 100 Ω output impedance; time coincident with all Pulse Height outputs having amplitudes between the PSD and Pile-up set points.

Pulse Shape: Front panel BNC connector; provides unipolar, positive pulses, 0 to 10 V amplitude (approximately 0.5 V/ns); 1.5 μ s dwell time, 100 Ω output impedance; 10 ns (FWHM) resolution. For samples having beta/gamma and alpha activity, the multichannel analyzer display of the pulse shape spectrum shows two peaks separated by approximately 35 ns.

Controls:

PERALS PWR: Rocker switch controls power to unit from ac, +12 V external source, or internal rechargeable battery.

Gain: Front panel, 10-turn potentiometer; 0.4 X - 1.4 X range. Allows calibrating the energy scale from 2.4 V to 8.4 V for 6 MeV alpha energy.

PSD Set: Front panel, 10-turn potentiometer; 0 to 10 V range. Sets the lower level discriminator of the Pulse Shape output pulses to eliminate beta/gamma background.

Display: Front panel, two-position, momentary contact switch; allows superposition of the PSD lower level discriminator setting and the Pile-up upper level discriminator setting on the Pulse Shape output spectrum.

Pile-up Rejection: Front panel, multi-turn trimpot, 0 to 10 V range. Sets upper level discriminator for rejection of pulses with longer decay times than alpha particles of interest.

Indicators:

PERALS PWR: Red LED; illuminates to indicate application of bias to the photomultiplier tube (PMT).

Options:

-B Internal battery and charger; allows completely independent, stand-alone operation of PERALS®. Includes integral ac charger and the following:

Test: Two position momentary contact switch allows testing of the charge status of internal battery.

Batt On/Batt Off: Two position rocker switch allows selection of internal battery to power unit.

Low Battery: Red LED illuminates if battery has less than 20% charge remaining.

Battery Status: Series of four red LEDs; illuminate to indicate battery charge condition when TEST toggle switch is activated.

Shipping information

Weight: (Shipping) 7.5 kg (Net) 5 kg

Dimensions: 24 cm wide, 22 cm high, and 37 cm long

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