



# PSMC-01™

## Plutonium Scrap Multiplicity Counter



### APPLICATIONS

- Waste and Safeguards measurements for plutonium contents

### KEY FEATURES

- High efficiency: >50% for  $^{240}\text{Pu}$  spontaneous fission neutrons
- Die-away time: 50  $\mu\text{s}$
- Uniform axial response profile
- Sample Cavity 19.7 x 41 cm (7.8 x 16.1 in.) (Dia. x Height)
- Custom pre-amplifier electronics for fast-processing and low-noise
- Operated using Mirion JSR-14™ and JSR-15™ shift registers
- Includes internal de-randomizing board
- Available with NDA 2000™ software
- Higher efficiency versions available (greater than 60%)

### KEY BENEFITS

- Provides high accuracies for plutonium product, waste, or scrap materials
- Fully integrated system requires minimal setup and training
- Applicable to a wide range of sample types

### DESCRIPTION

The PSMC Plutonium Scrap Multiplicity Counter<sup>1,2</sup> is a high efficiency neutron coincidence counter designed for measuring the multiplicity of the neutron emission from both spontaneous fission and induced-fission reaction in plutonium and uranium. The PSMC counter was originally developed by Los Alamos National Laboratory to measure impure plutonium and mixed-oxide (MOX) scrap materials for safeguards and inventory control applications. Intended for the measurement of items up to 10 liters in volume, the counter is designed to provide improved measurement precision through the use of multiple rings of  $^3\text{He}$  proportional tubes.

#### NEUTRON DETECTION

The counter provides a neutron detection efficiency of >50% for  $^{240}\text{Pu}$  spontaneous fission neutron emitted within the center of the assay cavity. The high neutron efficiency makes the PSMC unit an ideal counter for the assay of plutonium product, waste or scrap material. For clean or slightly impure product materials, measurement precisions of less than 1% are readily achievable in multiplicity mode over the mass range of 1 g to several kilograms of plutonium oxide and MOX.

#### SYSTEM CONFIGURATION

The PSMC system configuration requires minimal setup time consisting only of the neutron counter, multiplicity shift register and personal computer loaded with operating software. The fully computer controlled shift register provides both neutron coincidence and multiplicity capability that is selectable. This provides the user with analysis capability for a broad range of material configurations including: Pu pellets, powder, solutions, Mixed Oxides, MOX fuel pellets, Pu fuel assemblies, HEU and LEU in metals, oxides, powders, fuel pellets and rods, as well as uranium hexafluoride ( $\text{UF}_6$ ) samples.

# PSMC-01 Plutonium Scrap Multiplicity Counter

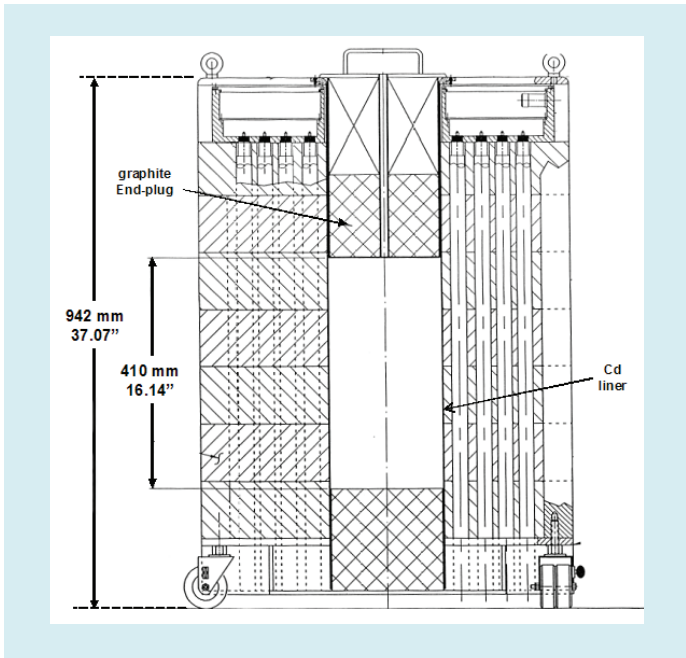


Figure 2.  
Sketch of the PSMC tube arrangement.

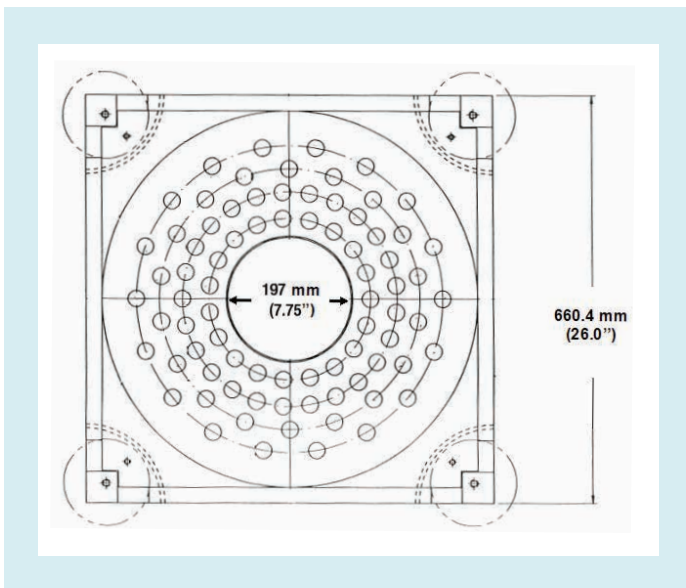


Figure 3.  
Relative Placement of the four concentric rings of  $^3\text{He}$  tubes about the assay cavity. The diameter shown is the outer diameter (with liners). The inner diameter of the assay cavity is 197 mm.

The multiplicity shift register, software, and personal computer are supplied separately.

## NON-DESTRUCTIVE ASSAY – NDA 2000 SOFTWARE

Mirion's NDA 2000 software is a multipurpose application software package intended to operate all Mirion waste and safeguards assay systems. The software supports several neutron coincidence and multiplicity analysis modes. Such as: Multiplicity Analyses supported:

- Known efficiency.
- Known alpha.
- Known multiplication.
- Curium/californium discrimination.
- Cosmic ray rejection.
- Truncated histogram analysis.

Requires:

- S529 – NDA 2000 Software.
- S500 – Genie™ 2000 Basic Multi-Input.
- S505 – Quality Assurance Software.

The NDA 2000 software and supporting Genie 2000 software are supplied separately.

## SPECIFICATIONS

### COUNTER ASSEMBLY

- The counter assembly consists of a cylindrical high-density polyethylene (HDPE) moderator with embedded  $^3\text{He}$  proportional tubes threaded into an aluminum junction box.
- The junction box houses the electronics including twenty pre-amplifier/amplifier/discriminator boards and a de-randomizer board.
- Each pre-amplifier processes the combined signals from several tubes grouped together in a detector "bank".
- Outputs from each detector bank or pre-amplifier are then all combined through a de-randomizer board to reduce losses due to deadtime.
- The assay cavity is lined with a 0.8 mm (0.030 in.) cadmium liner.
- Lockable casters for movement of the system.

### CAVITY DIMENSIONS

- Inner Diameter – 197 mm (7.75 in.).
- Cavity Height – 410 mm (16.14 in.).

### OUTER DIMENSIONS

- Footprint – 661 x 661 mm (26.0 x 26.0 in.).
- Height (to top of handle) – 992 mm (39.0 in.).
- Height (to top of body) – 942 mm (37.1 in.).
- Approximate Weight – 325 kg (715 lb).

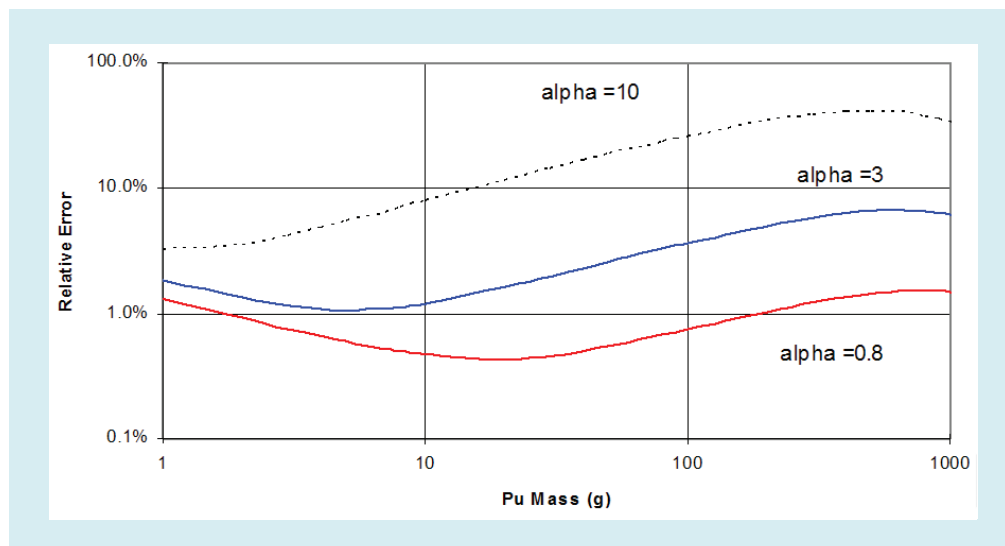


Figure 4.  
Estimated precision of the PSMC-01 counter as a function of plutonium mass for several values of alpha typical of MOX and MOX scrap materials. Precision estimates based on 3600 data acquisition.

## NEUTRON DETECTION

- Eighty  $^3\text{He}$  proportional tubes.
- Twenty JAB-01 model Pre-amplifier/Amplifier/SCAs.
- One derandomizer board.
- Active Length – 711 mm (28.0 in.).
- Outer diameter – 25.4 mm (1.0 in.).
- $^3\text{He}$  partial Pressure – 400 kPa (4 atm).

## PERFORMANCE

- Detection Efficiency – >50% for  $^{240}\text{Pu}$  spontaneous fission neutrons in cavity center.
- HV Bias Setting – 1680 V.
- Gate Width Setting – 64  $\mu\text{s}$ .
- Pre-Delay Setting – 4.5  $\mu\text{s}$ .
- Die-Away Time – 50  $\mu\text{s}$ .
- Sensitivity –  $\sim 170$  reals/s/g  $^{240}\text{Pu}_{\text{eff}}$ .

## INPUTS

- +5 V LVPS (BNC connector), 2.5 A. Supplied by an external 5 V dc power supply provided with the system.
- HVPS bias supply (SHV connector). (Supplied by Shift Register with a typical operating plateau voltage of +1680 V.)

## OUTPUTS

- TTL pulse (BNC connector).
- One output for each of three rings.
- Summed from all detector banks.

## REFERENCES

1. H.O. Menlove, et. al., “Plutonium Scrap Multiplicity Counter Operation Manual”, Los Alamos National Laboratory Report LA-12479-M, January 1993.
2. D. Davidson and R. McElroy, “Comparison of Neutron Coincidence and Multiplicity Counting Techniques for Safeguards”, Proceedings of the 16th Annual Meeting of INMM Japan Chapter, December 7-8, 1995, Tokyo, page 163.



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