

- Specifically designed to meet the demanding requirements of isotopic ratio software codes used in Safeguards and NDA.
- Excellent resolution is maintained over a wide range of count rates, enhancing measurement flexibility
- Available in a full range of crystal diameters
- Extensive range of cryostats with multi-orientation dewar options for applications requiring portability
- Compatible with all existing Safeguards multichannel analyzers

The precise measurement of isotopic ratios required in Safeguards and non-destructive assay (NDA) applications places a severe demand on the techniques of gamma-ray and x-ray spectroscopy. Figure 1 demonstrates the complexity of the 90–130 keV region of a typical Pu spectrum. (The choice of energy region(s) for analysis depends specifically on the sample type and origin and the material matrix.)

National laboratory software codes<sup>1</sup> written to obtain highly accurate isotopic ratios, must deal with these spectra to analyze low-energy and/or high-energy regions in which groups of peaks are located close together. Each code requires exceptional system resolution and stability in order to achieve accurate unfolding of these regions.

Recent safeguards development trends have led to a growing requirement of isotopic ratio determinations involving higher energy gamma-rays. Such needs spring from the need to measure attenuated samples, such as those found in waste assay and in certain homeland security applications. Software codes such as PC/FRAM and MGAHI<sup>2</sup> can now determine Pu isotopic ratios from the higher energy regions of the spectrum. As a consequence, it is desirable to produce HPGe detectors that offer improved higher energy performance, while maintaining the excellent resolution characteristics required in such applications.

The ORTEC Safeguards series include both coaxial and planar geometry detectors, specifically designed to meet the demands of the applications software used for isotopic ratio determination, have been developed to strike an optimum balance between low-energy resolution and high-energy efficiency.

SGD series detectors are compatible with ALL conventional MCA types, although optimum performance will be obtained when used with the ORTEC Digital Signal Processing Spectrometers.

All SGD detectors feature the following:

- Choice of fixed, portable, and custom cryostats, including the latest MOD multi-orientation dewar option.
- Robust aluminum end-cap
- Streamline preamplifier assembly
- LN<sub>2</sub>-Free option

The latest low-power resistive feedback preamplifier with "no ring" output, suitable for use with all existing types of MCA systems. Power consumption less than 25 mA at ±12 and ±24 V.

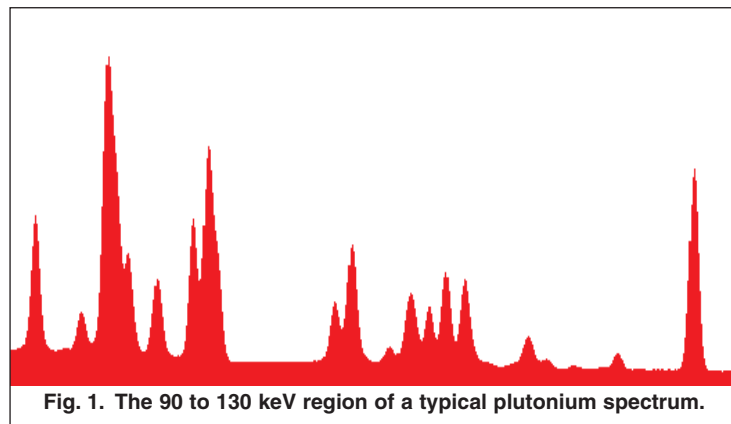


Fig. 1. The 90 to 130 keV region of a typical plutonium spectrum.

# High-Performance Germanium Detectors for Safeguards and Non-Destructive Assay

## Application Considerations

### SGD Planar

For safeguards accountancy measurements involving the verification of declared materials values, the sample is usually presented in a pure form in a purpose-designed thin-walled container. This occurs with routine safeguards inspection programs, when a portable system is employed.

### SGD GEM

For samples in thick walled containers, or when significant matrix attenuation is present, it may be necessary to use a higher energy region of the spectrum to perform the analysis. In these cases, the SGD-GEM detectors, which are coaxial or semi-coaxial, have been developed to strike an optimum balance between low-energy resolution and high-energy efficiency.

The SGD-GEM-5050P4 is the "traditional" coaxial detector for use with PC/FRAM<sup>3</sup> in a wide variety of cases, including the measurement of UF6 cylinders.

The SGD-GEM-5030P4 has a semi-planar geometry and can be used as a more practical substitute for "telescope" detectors which have traditionally been used with the codes TRIFID and MGA in so-called "two-detector" mode. Recent improvements in crystal and preamplifier technologies have made it possible to gather both high- and low-energy spectra SIMULTANEOUSLY with a single SGD-GEM-5030P4 detector.

The SGD-GEM-6560P4 has been produced specifically to provide a large-area detector, which meets the resolution requirements of the FRAM code, and has good high-energy efficiency and a large detection area.

<sup>1</sup>Specifically these codes are: FRAM from Los Alamos National Laboratory; MGA from Lawrence Livermore National Laboratory and TRIFID from Rocky Flats Plant.

<sup>2</sup>MGAHI is now included in the MGA-B32 suite of software available from ORTEC.

<sup>3</sup>See for example LA-UR-98-2007 Los Alamos reprint "Test and Evaluation of FRAM Isotopic Analysis Code for Euratom Applications", T.E. Sampson et al. Paper presented at the 1999 INMM, Phoenix, AZ.

# High-Performance Germanium Detectors for Safeguards and Non-Destructive Assay

## Ordering Information

The cryostat should be specified at time of order, e.g.:

SGD-GEM-5050P4

CFG-PG4-1.2

Specifies the SGD-GEM-5050P4 in PopTop capsule and a 1.2L Gamma Gage cryostat/dewar.

The Multi-Orientation Dewar (MOD), is available with all SGD series detectors. Specify "DWR-MOD4-3" or "DWR-MOD4-7" for 3 or 7 liter versions respectively. Each comes with a funnel for horizontal filling.

## SGD Planar Safeguards Detector

Supplied in "classic" PopTop capsule. These capsules are compatible with P4 cryostats. Cryostat and Dewar not included. For non-PopTop remove the "P" from the model number. If dimensional considerations are critical, contact factory.

Model No.	Active Diameter (mm)	Thickness (mm)	Warranted Resolution (eV)		Warranted FW.1M/FWHM @ ≤50 kcps	Warranted FW.02M/FWHM @ ≤50 kcps
			@ 1 kcps	@ 122 keV @ 50 kcps (1 μs)		
SGD-16510P	16	15	510	590	1.87	2.50

### Options

SMART-1-N SMART-1 detector option for negative bias detector. To order, add SMART-1-N as a separate line item.

**NOTE:** SGD Planar Detectors are available with internal shielding, contact the factory for details.

## SGD GEM Safeguards Detector

The SGD GEM p-type coaxial detectors are optimized for current and emerging needs in safeguards and non-destructive assay. The 5050 was developed as an optimum detector for use with PC/FRAM. The 6560 was developed for use in Tomographic Waste assay systems for fissile waste measurements. In general, coaxial detectors offer better high energy response than thinner planar detectors, a fact which makes them ideal for measurement of shielded sources.

Cryostat and Dewar not included. For non-PopTop remove the "P4" from the model number.

Model No.	Active Diameter (mm)	Minimum Thickness (mm)	Nominal Relative Efficiency	Energy	Warranted Resolution (keV)			Warranted FW.1M/FWHM @ <1 kcps (6 μs)	Warranted FW.02M/FWHM @ <1 kcps (6 μs)
					@ 1 kcps (6 μs)	@ 1 kcps (2 μs)	@ 30 kcps (2 μs)		
SGD-GEM-3615P4	36	15	3	122 keV	575 eV	600 eV	630 eV	1.9	2.6
				1.33 MeV	1.65 keV	1.75 keV	2.00 keV		
SGD-GEM-5030P4	50	30	15	122 keV	625 eV	675 eV	725 eV	1.9	2.6
				1.33 MeV	1.70 keV	1.85 keV	2.05 keV		
SGD-GEM-5050P4	50	50	25	122 keV	750 eV	870 eV	880 eV	1.9	2.6
				1.33 MeV	1.75 keV	1.95 keV	2.10 keV		
SGD-GEM-6560P4	65	60	50	122 keV	800 eV	925 eV	950 eV	1.9	2.6
				1.33 MeV	1.80 keV	2.05 keV	2.15 keV		

### Options

SMART-1-P SMART-1 detector option for positive bias detector. To order, add SMART-1-P as a separate line item.

All measurements are made using state-of-the-art amplification.