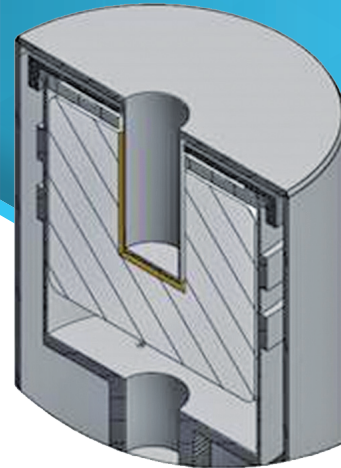




# SAGe™

Small Anode Germanium Well Detector



## FEATURES

- Blind well approaches  $4\pi$  counting geometry yielding high absolute efficiency
- Superior resolution compared to Traditional Well Detectors at both low and high energies
- Larger well diameter (28 mm) available with the same excellent resolution as the standard (16 mm) well sizes
- Thin lithium diffused contact inside well allows spectroscopy from 20 keV up to 10 MeV
- Full LabSOCS™ characterization available, allowing True Coincidence Summing correction
- Equipped with Intelligent Preamplifier
- USB 2.0 Serial Interface

## APPLICATIONS

- Environmental samples
- Radiobioassay
- Geology
- Oceanography

<sup>1</sup>US Patent 9,269,847 B2

## DESCRIPTION

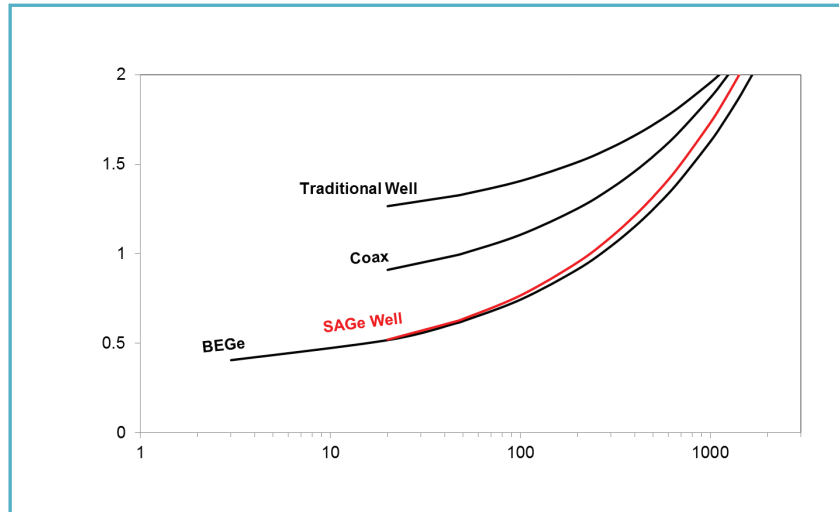
The Mirion SAGe™ Well Detector<sup>1</sup> combines excellent energy resolution at low and high energies with maximum efficiency for small samples. Like Traditional Well Detectors, the SAGe Well is fabricated with a blind hole, leaving at least 20 mm of active detector thickness at the bottom of the well. The counting geometry therefore approaches  $4\pi$ .

The low detector capacitance associated with the small anode technology (similar to what is used on the Mirion BEGe™ detectors) gives the SAGe Well superior low and medium-energy resolution performance compared to Traditional Well or Coaxial Detectors, as well as excellent resolution for higher energy gamma rays.

Furthermore, the detector is manufactured with an aspect ratio of a coaxial detector to allow excellent efficiency performance for standard laboratory geometries such as Marinelli beakers or other large sample containers. The result is a versatile detector that can deliver reductions in count time, through improvements in Minimum Detectable Concentration/Activity (MDC/MDA), for a range of sample sizes and geometries counted inside the well, on the end cap or in Marinelli beakers.

The thin lithium (approximately 50  $\mu\text{m}$ ) diffused contact inside the well, combined with a thin-walled aluminum insert in the detector end cap (0.5 mm on the sides and a 1 mm thick bottom) provide a good low-energy response, allowing spectroscopy down to 20 keV. The contact on the outer surface of the detector is approximately 0.5 mm thick, similar to what is used on SEGe™ Standard Electrode Germanium coaxial detectors. Therefore, the useful energy range for sources outside of the well is limited to 40 keV and up.





Energy resolution (FWHM) as a function of energy for different detector types

## MODELS AND SPECIFICATIONS

SAGe Well is available in five different models which are identifiable by their active volume (see table below). There are four models with a 16 mm diameter well and one model with a larger, 28 mm, diameter well. All models have a usable well depth of 40 mm. A particular advantage of the small anode geometry is that the resolution performance is independent of the detector size or well diameter.

Model	Min. Active volume (cc)	Well diameter (mm)	Well depth (mm)	1332 keV FWHM (keV)*	122 keV FWHM (keV)*	Endcap diam. (inch)
GSW120	120	16	40	2.2	0.75	3.25
GSW200	200	16	40	2.2	0.75	3.5
GSW300	300	16	40	2.2	0.75	4.25
GSW425	425	16	40	2.2	0.75	4.5
GSW275L	275	28	40	2.2	0.75	4.25

\*These specifications are in accordance with IEEE Std 325-1996. Resolution performance is tested and guaranteed using Mirion digital MCA's. Because of the specific settings required to optimize detector performance, SAGe Well Detectors are recommended to be used with digital signal processing (DSP) rather than analog (Gaussian) shaping amplifiers.

SAGE Well Detectors come in a fixed size and the aspect ratios (diameter/length) of each model are specifically chosen to have approximately an equal thickness of active germanium material on the sides and bottom of the well. This optimizes the absolute detection efficiency for measuring samples inside the well. As shown in the figure below the benefits of a larger active volume become more and more significant for increasing gamma ray energies. Although the outer dimensions of the GSW275L and GSW300 models are similar, the absolute efficiency of the GSW275L is lower because more active germanium material is removed to manufacture the large well. However, the 28 mm well can fit three times more sample material than the 16 mm version. So the massimetric efficiency (sample mass \* efficiency) is actually higher, resulting in lower detection limits and faster counting times for applications where these larger sample volumes are available. All SAGE Well Detector models are equipped with an iPA™ Intelligent Preamplifier AC-coupled resistive feedback preamplifier. The iPA Intelligent Preamplifier included with this style of HPGe detector has an improved, low power analog front stage providing excellent resolution and count rate performance. An integrated digital back-end makes use of the detector sensors to continuously monitor and store all relevant parameters and status information. This data, which may be trended over time, allows the user to take preventative measures if a key parameter starts to shift and ultimately improves equipment availability and productivity. It also enables setup and tuning of the preamplifier through digital controls rather than potentiometers. The preamplifier status information, on board log file and digital controls are accessible through a USB 2.0 serial connection and software application which is provided with the iPA unit. See the “Intelligent Preamplifier” specification sheet for more details.

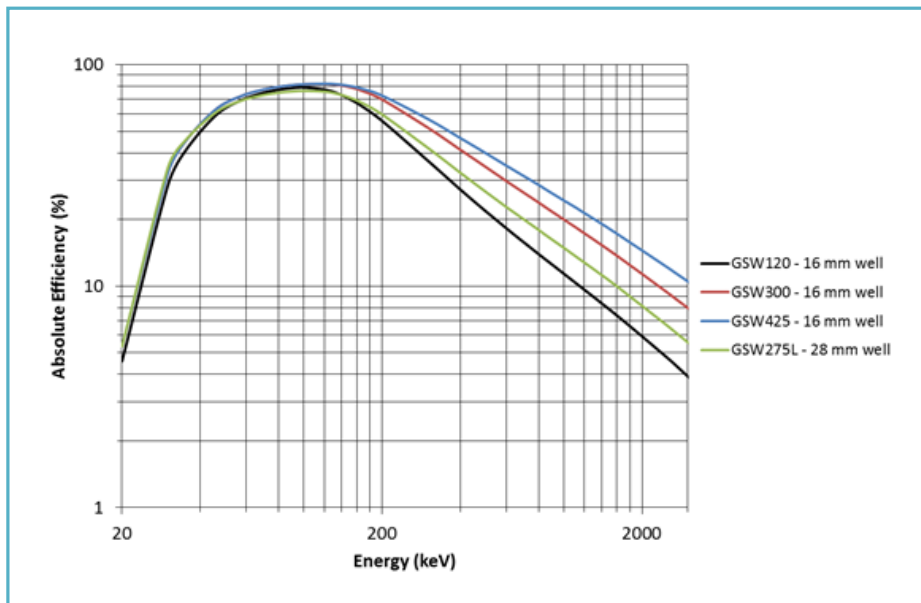
**ADVANTAGES OF WELL DETECTORS**

The advantages of well type detectors are based on the near 4π counting geometry for a source placed inside the well. This geometry assures a **high counting efficiency** as the full energy peak efficiency may be written as:

$$\epsilon = \eta \cdot \epsilon_i$$

Where η represents the geometrical efficiency given by  $\eta = \theta / 4\pi$ . θ is the solid angle under which the detector “sees” the source and ε<sub>i</sub> is the intrinsic efficiency. For a well type detector, η ~1 as θ approaches 4π. The absolute efficiency is thus mainly governed by the intrinsic efficiency.

For applications where small, low-activity samples must be measured, this high counting efficiency results into lower detection limits or shorter counting times to achieve a given detection limit. Also, Well Detectors have the advantage that sample positioning is easy and not very critical. Sample vials can easily be placed inside the well. The effect on the absolute efficiency of moving the sample inside the well is about an order of magnitude less than positioning a source inaccurately above a coaxial detector. In making the choice for a well-type detector for a certain application, the above advantages have to be weighed against some potential disadvantages. The Well geometry only accommodates a small sample volume. If more sample material is available another measurement geometry using a coaxial or planar detector may yield a lower MDA per gram of sample. Secondly, due to the higher capacitance of the detector and the consequently higher electronic noise, the resolution performance of Well type detectors is worse than coaxial detectors, particularly at low energies. And thirdly, because the sample is very close to the detector and completely surrounded by it, a Well detector is more prone to summing effects, especially when isotopes with many coincident gamma’s are measured.



Absolute efficiency as function of energy for a point source located at the bottom of the well

## IMPROVEMENTS REALIZED WITH SAGE WELL

The SAGE Well Detector has been specifically developed to address the drawbacks associated with Traditional Well Detectors described in the previous section.

- SAGE Well offers excellent energy resolution at both the low and the high end of the spectrum. This excellent resolution performance is guaranteed on both LN2 and electrically cooled cryostats.
- As the resolution performance is independent of the detector size (active volume) and the diameter of the well, a SAGE Well model with a 28 mm diameter well is now available with the same excellent energy resolution.
- The aspect ratio of SAGE Well Detectors is similar to coaxial detectors, making them perfectly suited for measuring samples in Marinelli beakers or other larger containers.
- The compatibility of ISOCS™/LabSOCS characterization with SAGE Well provides an excellent solution to correct for True Coincidence Summing.

**These improvements lead to the following application benefits:**

- The step-change in energy resolution performance over Traditional Well Detectors (for example around a factor of 3 improvement at 50 keV) means that detection limits are significantly improved leading to large reductions in counting times.
- The drastic improvement in energy resolution coupled with the larger well diameter accepting more sample, means that the SAGE Well Detector becomes the best choice for a broader range of applications.
- In addition to measuring samples inside the well, the geometry of the SAGE Well detector is such that it is compatible with Marinelli beakers and large sample containers. And as the energy resolution performance is superior to standard coaxial detectors (particularly in the low-energy region), significantly reduced counting times can be achieved when comparing with coaxial detectors of a comparable size

## Available Options

SAGE Well Detectors are used to measure small samples, often with very low activity, sometimes leading to very long counting times. This type of detector can therefore significantly benefit from adding the ULB™ Ultra-Low Background option. In this option Mirion uses a cryostat construction and select materials to reduce the background radiation on the detector, resulting in a shorter counting time to achieve a required detection limit. See the ULB section under 'Cryostats and cryostat options' for more details.

SAGE Well Detectors are compatible with the full range of LN2 Dewars and electric coolers (Cryo-Pulse® 5 Plus and Cryo-Cycle™ II cryostats).

ISOCS/LabSOCS characterization is available for SAGE Well Detectors. As this option requires factory measurements on each individual detector, this option is best ordered together with a new detector.

## Maintenance and Operation

In addition to the normal care and maintenance for a HPGe detector (which is described in detail in the Mirion "Germanium Detector User Manual"), it is important to note that SAGE Well Detectors are best always kept cooled to LN2 temperature in order to preserve the low energy sensitivity inside the well.

Performance specifications of the SAGE Well Detector models are guaranteed under the following environmental conditions:

- 10-30 °C ambient temperature.
- Up to 50% relative humidity (non-condensing).
- Meets the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

