



# Model S573 ISOCS\*™ Calibration Software

## Features

- Eliminates the cost of purchasing, tracking, and disposing of radioactive standards
- No radioactive sources needed for accurate efficiency calibrations
- **New:** Calibrations valid from 10 to 7000 keV
- **New:** 3D visualization speeds geometry creation and error identification
- **New:** Uncertainty Estimator\*\* and Assay Planning tool
- **New:** Advanced Collimator designs include liners and back shielding
- Calibrations valid from detector face out to 500 meters
- Operates with Germanium, NaI and LaBr<sub>3</sub> detectors characterized by Mirion
- Includes 21 geometry templates for common container shapes and sample distributions
- Calibrations accurate at any angle from detector, not just on center line
- Ideal for *In Situ* applications, where large and various sample types are often encountered
- Sample size can be point-like, or up to 500 meters in size
- Includes library of common absorber materials and tools to create new material types
- Custom templates can be provided to meet special application needs
- Multi-Efficiency program allows creation of compound efficiencies for multiple detectors, multiple locations or multiple sources
- Geometry Composer Report summarizing all information defined for a given geometry can be displayed and printed
- Compliant with 2009 NRC Regulatory Guide 1.21

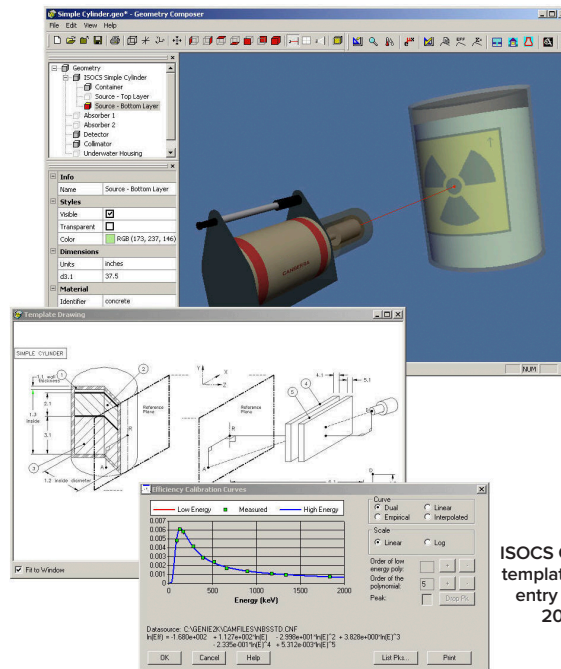


Figure 1  
ISOCS Calibration Software with  
template diagram, used for data  
entry to generate the Genie™  
2000 Efficiency Curve

## Description

The ISOCS (*In Situ* Object Counting System) Calibration Software brings a new level of capabilities to gamma sample assay by eliminating the need for traditional calibration sources during the efficiency calibration process. By combining the detector characterization produced by the MCNP modeling code, mathematical geometry templates, and a few physical sample parameters, the ISOCS Calibration Software gives you the ability to produce accurate qualitative and quantitative gamma assays of most any sample type and size (Figure 1).

In addition to saving money by eliminating the need to purchase, track, and dispose of many calibration sources, ISOCS calibration also saves time in the field. Instead of hours spent in traditional source preparation and long calibration counts, an ISOCS calibration for a new geometry requires only a few seconds of computer calculations. With the ISOCS software you have the flexibility to design your setup, define your geometries, and analyze data in the office; reducing actual time in the field to the system setup and sampling time, no matter how many different geometries you're measuring. And now this capability is available for LaBr<sub>3</sub> and NaI scintillators too.

The secret to this capability is twofold:

1. The energy/efficiency/spatial response profile of the detector has been characterized by Mirion with the well-known MCNP Monte Carlo modeling code.
2. Mathematical templates have been created for most of the sample geometries that will be encountered – planar surfaces, rectangular boxes, barrels, pipes, beakers, etc.

\*US Patent 6228664 B1

\*\*US Patent 8,335,670

# Model S573 ISOCS Calibration Software

To a basic geometry template, add the specifics for a given sample – its size, density, distance from the detector, etc. – and at the click of a button the ISOCS Calibration Software generates a custom efficiency calibration specifically tailored for that detector, sample, and geometry. The remainder of this document will describe how this is done and how the various standard geometry templates are used.

## THE ASSAY AND CALIBRATION PROCESS

To better understand how the ISOCS Calibration Software is used, it's necessary to look at the complete ISOCS sample assay process. In general terms, it's as follows:

1. Using the Data Quality Objective (DQO) process determine your measurement requirements for sensitivity and accuracy. The ISOCS Uncertainty Estimator (IUE) tool can be used in determining your measurement strategy to help achieve your objectives.
2. Count the sample using a detector that has been characterized by Mirion and the Model ISOXSHLD ISOCS Shield and Collimator System, if required.
3. Select the geometry template that best fits the sample type (such as layered pipe, planar surface, rectangular box, cylinder, etc.).
4. Measure the relevant physical sample parameters required by that template (such as size, density, distance to the detector, etc.).
5. Enter these parameters into the ISOCS Calibration Software and generate an efficiency calibration for those conditions in 15 seconds, typically. Examine/modify the shape of the resultant Genie 2000 calibration curve and store it.
6. Use this calibration for the analysis of the spectrum collected during the sample count in Step 2, yielding a qualitative and quantitative assay of the sample.
7. If needed, use the IUE tool again to determine the efficiency calibration error and total propagated uncertainty for your specific geometry setup.

The sample parameters recorded in Step 4 are key elements to the process, for they allow the software to tailor the theoretical response of the detector for a given geometry to the specific sample being assayed. For maximum accuracy and flexibility, each template allows a wide variety of parameters to be specified.

In addition to the parameters mentioned in Step 4, provisions are included for things like container wall thickness, the presence of absorbers between the source and detector, non-homogenous source location within a container (offset from the axis or not), variable sample densities, lined collimators, and off-axis detector placement. In short, most any factor that can impact the assay may be measured and specified. If a parameter is not known the new ISOCS Uncertainty Estimator Tool can be used to determine what, if any, influence that parameter has on the results of the assay. In addition, if more than one parameter is not well known, the IUE tool can be used to vary several values simultaneously to determine the impact on the final result.

## CALIBRATION TEMPLATES INCLUDED WITH ISOCS

The basic geometry templates included with the ISOCS Calibration Software can be seen in the following series of drawings. For each, the various physical parameters that may be varied are shown as numbered call outs.

In addition to these standard templates, custom templates can be defined by Mirion to meet special application needs. For all templates, the presence or absence of a collimator or housing can be specified and accounted for automatically. Composite geometries can also be specified by combining multiple geometries with the Multi-Efficiency utility.

The basic templates and their applications are as follows:

**SIMPLE BOX** – A basic rectangular carton or waste shipping container: a truck filled with scrap iron, or even a small building.

**COMPLEX BOX** – The same as the Simple Box, but with a more complex sample matrix. It includes the ability to distribute the contamination across as many as four layers of material and/or to place an additional concentrated source anywhere in the container. Ideal for use in "What If?" analyses of non-uniform distribution in waste assay containers.

**SIMPLE CYLINDER** – A basic barrel, tank, or drum. In an emergency, it could also be used for a quick whole body contamination count.

**COMPLEX CYLINDER** – The same as the Simple Cylinder, but with a more complex sample matrix. It includes the ability to distribute the contamination across as many as four layers of material and to place an additional concentrated source anywhere in the container. Ideal for use in "What If?" analyses of non-uniformity in barrels and drums.

**WELL OR MARINELLI BEAKER** – Used for well logging applications, or for standard Marinelli beakers.

**PIPE** – A simple pipe, empty or full, including material that has plated out or built up on the inner walls, as shown in Figure 2.

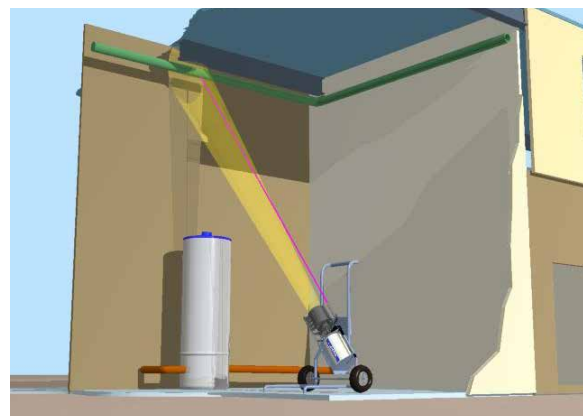


Figure 2  
Using the ISOCS System to assay a pipe

# Model S573 ISOCS Calibration Software

**COMPLEX PIPE** – The same as the pipe but with a more complex sample matrix. This template includes the ability to have multiple layers of concentric build up, with or without radioactive content, multiple solid source layers, and off-center sources.

**TANK PARTIALLY FULL OF FLUID** – A cylinder on its side, viewed from side, below or end with one source layer.

**ROUND TUBE WITH INT/EXT CONTAMINATION** – An open-ended tube on its side, viewed from the side with internal and/or external surface contamination.

**CIRCULAR PLANE** – The end of a barrel or tank, the bottom of a bottle containing a sample, or a filter cartridge. This would also be used for *in situ* measurements of ground. The radioactivity can be distributed in any manner in up to ten layers of sources/absorbers.

**H/I BEAM EXTERNAL CONTAMINATION** – Oriented as an I-beam or an H-beam with contaminated surface(s).

**L ANGLE EXTERNAL CONTAMINATION** – An angle iron at any orientation with contaminated surface(s).

**RECTANGULAR PLANE** – A floor, wall, or ceiling, or soil *in situ*. The template allows for surface contamination as well as up to ten layers of internal contamination behind an absorber such as paint, paneling, or a floor covering.

**ROOM/BOX WITH INTERNAL SURFACE CONTAMINATION** – Detector inside a cube with contaminated surface(s).

**RECTANGULAR TUBE INT/EXT CONTAMINATION** – Useful when modeling ducting with surface contamination distributed on the four internal surfaces and/or four external surfaces.

**U CHANNEL WITH EXTERNAL CONTAMINATION** – Square U-beam at any orientation with contaminated surface(s).

**CONE VIEWED FROM SIDE** – A truncated cone, like a beaker viewed from the side with one source layer.

**EXPONENTIAL CIRCULAR PLANE** – Similar to the Circular Plane, but here the radioactive source can be distributed to first increase in concentration and then decrease in concentration.

Use this for fallout on soil, activation of concrete, analysis of resin beds, etc.

**CONE VIEWED FROM END** – A truncated cone, like a beaker viewed from above or below with two source layers.

**SPHERE** – Internally contaminated spherical objects, like large pipe valves.

**SPECIAL SPHERE** – A multi-layer spherical source located inside a full drum or cylinder.

## USING THE ISOCS CALIBRATION SOFTWARE

To illustrate how these templates and their related sample parameters are used, a typical ISOCS calibration will be described. It will be based upon the Simple Cylinder template, which would be one of the most commonly used to assay material contained in drums.

After installation, the ISOCS calibration software is accessed as a part of the Geometry Composer.

## SELECTING THE TEMPLATE

Once a new file is opened in the Geometry Composer, the ISOCS group of geometry templates can be previewed for selection as shown in Figure 3. Selecting a template, such as the Simple Cylinder, brings up the Detector Selection window as shown in Figure 4. Selecting a detector loads the detector with the body type selected.

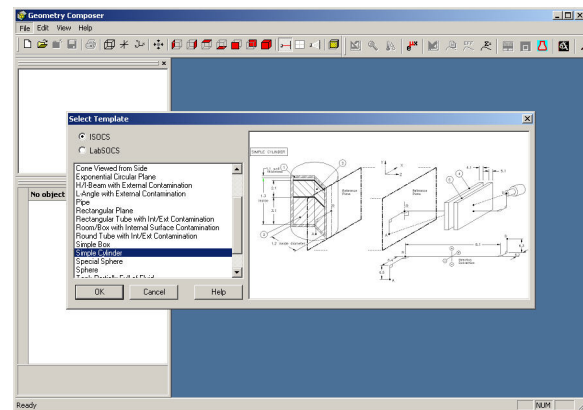


Figure 3  
Selecting a Geometry Template

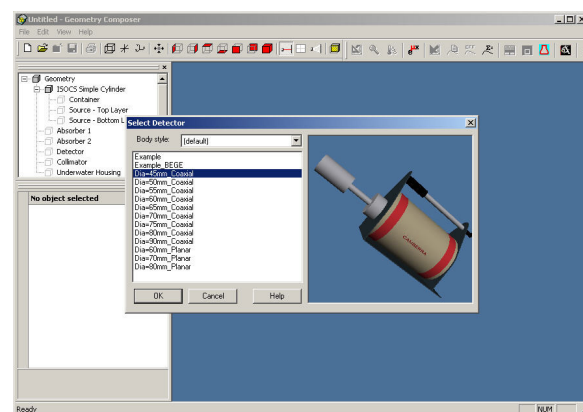
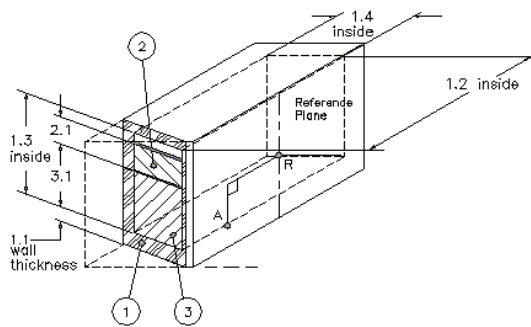


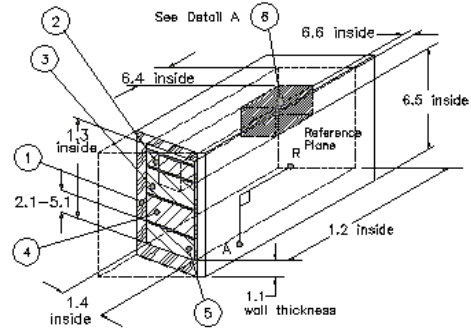
Figure 4  
Detector Selection Window

# Model S573 ISOCS Calibration Software

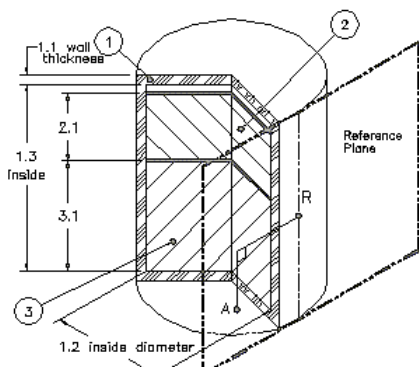
## THE BASIC ISOCS CALIBRATION TEMPLATES



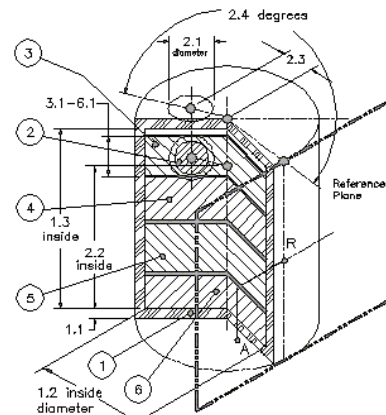
Simple Box



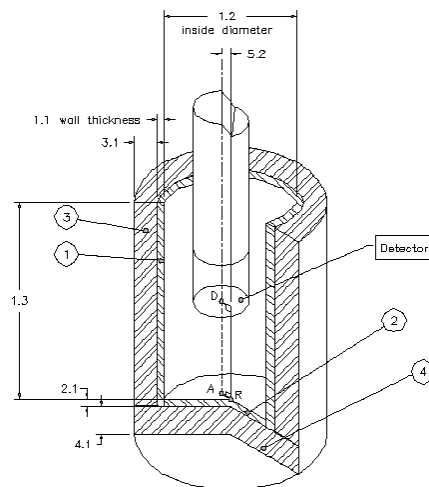
Complex Box



Simple Cylinder

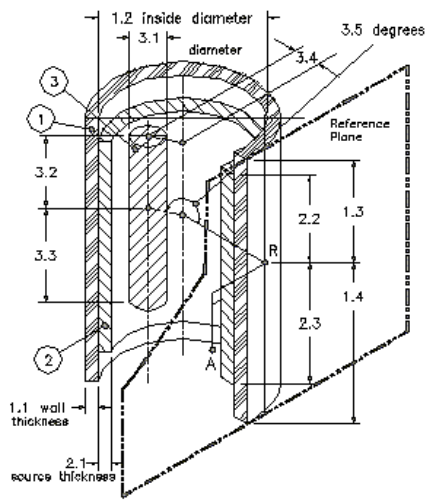


Complex Cylinder

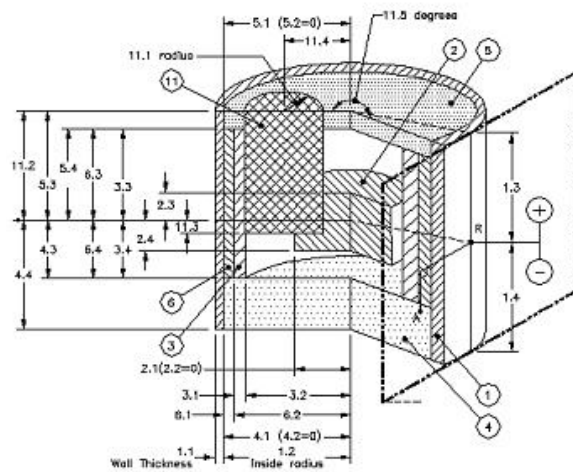


Well or Marinelli Beaker

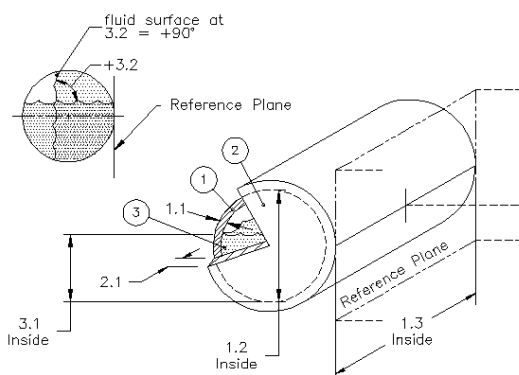
# Model S573 ISOCS Calibration Software



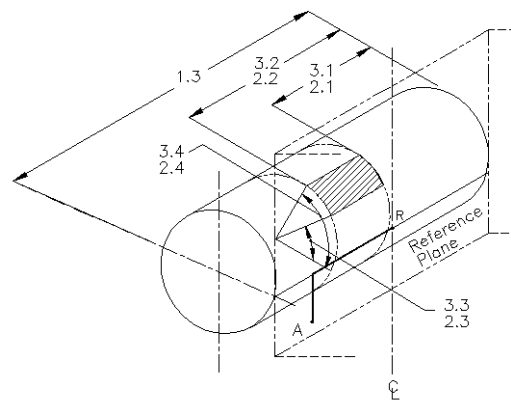
Pipe



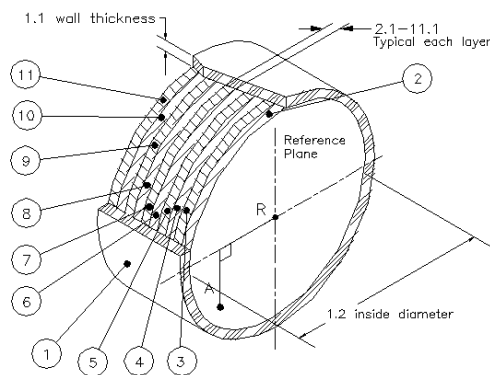
Complex Pipe



Tank Partially Full of Fluid



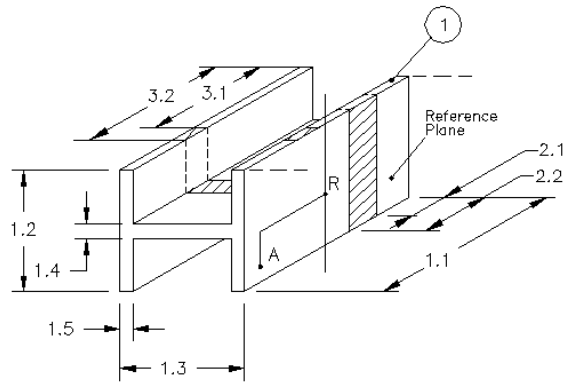
Round Tube with Int/Ext Contamination



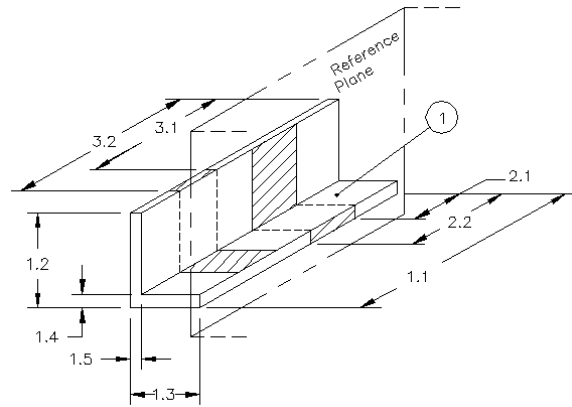
Circular Plane

NOTE: Custom templates are also available. Consult the factory for details.

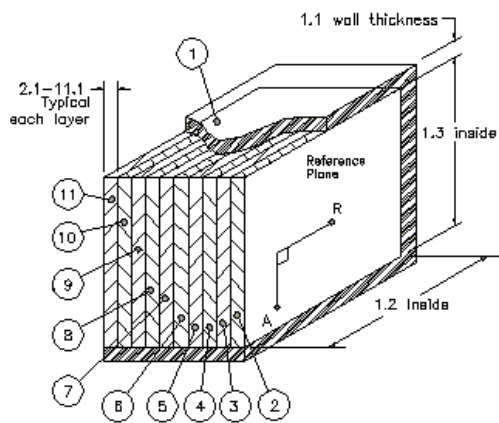
# Model S573 ISOCS Calibration Software



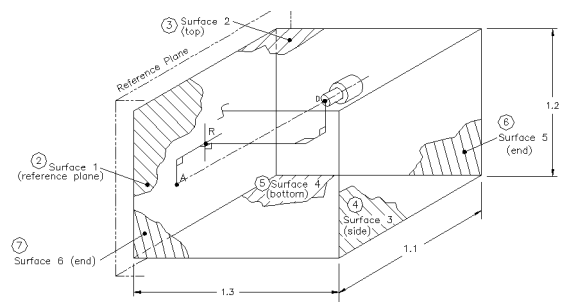
H/I Beam with External Contamination



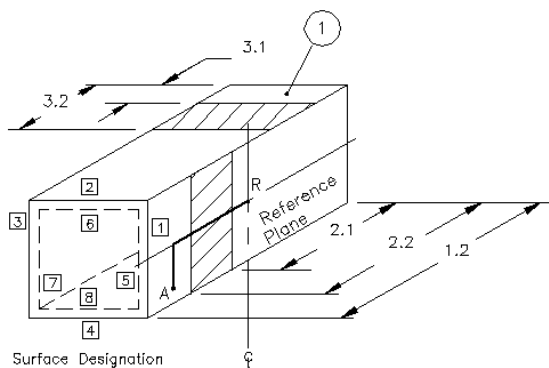
L Angle with External Contamination



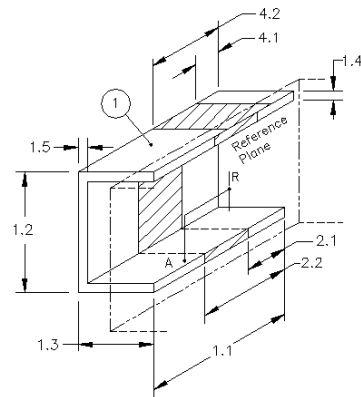
Rectangular Plane



Room/Box with Internal Surface Contamination



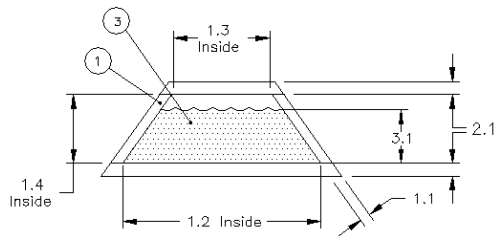
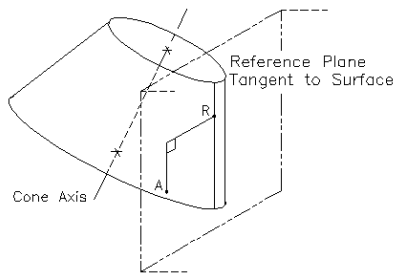
Rectangular Tube with Int/Ext Contamination



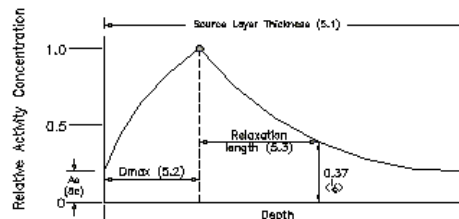
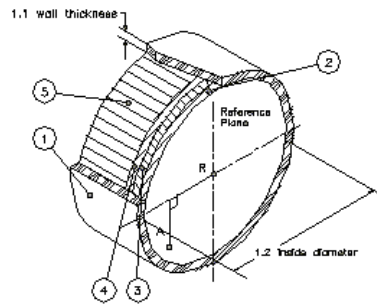
U Channel with External Contamination



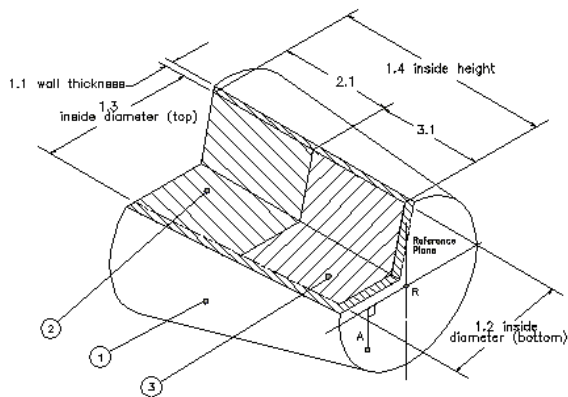
# Model S573 ISOCS Calibration Software



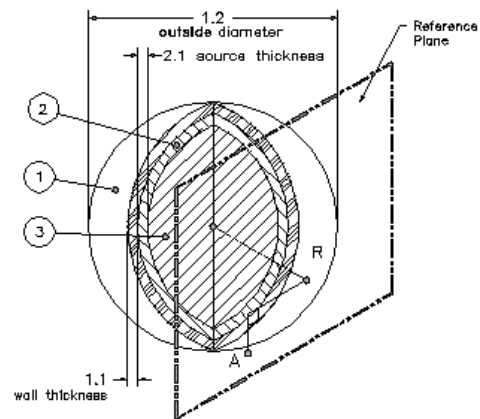
Cone Viewed from Side



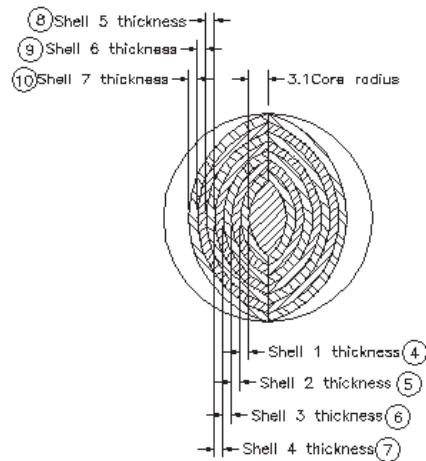
Exponential Circular Plane



Cone Viewed from End



Sphere



Special Sphere

# Model S573 ISOCS Calibration Software

## 3D VISUAL DISPLAY

The Geometry Composer main screen, shown in Figure 5, displays the selected template and detector, to scale, in 3-dimensional virtual space. The graphical interface displays all the components of the geometry such as the detector, container, collimator, etc. and lists them in an object tree for easy selection and modification. When a component is selected its properties are displayed in a property pane for easy editing. An Edit Menu is also provided to facilitate editing dimensions, adding collimators and housings, changing detector selection, and editing materials and environmental conditions. The powerful interface uses finger tip controls, including context menus, to achieve many functions such as 360 degree rotation of the object, translation of the entire field of view, zooming in and out with the mouse wheel and/or keyboard, tip of the day, various views such as wire frame, cross section, and transparency for viewing internal items, etc. All these features and the inherent nature of a 3D view make the modeling process and verification much easier and less time consuming.

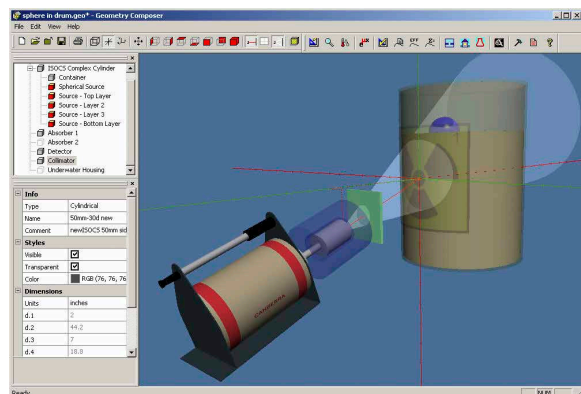


Figure 5  
The Geometry Template Window

## DIMENSION ENTRY

The Dimension Editor, shown in Figure 6, facilitates entry of dimensions for the container absorbers and detector to container distances, selection of units, and definition of materials, material density, and source concentration. Note that the window title always identifies the currently selected template, and the contents of the window are always tailored to that template. Entry of dimensions is aided by referencing a detailed drawing of the template geometry, labeled with dimension indices and an Apply button that renders the changes in the 3D view. Figure 7 shows the drawing for the simple cylinder, accessed via the View Drawing button. Dimensions can also be edited and rendered real-time via the properties pane on the main composer window (bottom-left pane in Figure 5).

No.	Description	d.1	d.2	d.3	d.4	d.5	Material	Density	Rel. Conc.
1	Container	0.53	30.2	42			ststeel	7.86	
2	Source - Top Layer	0						0	0.00
3	Source - Bottom Layer	37.5					concrete	2.35	1.00
4	Absorber 1	0						0	
5	Absorber 2	0						0	
6	Source - Detector	42.9	0	0	0	0			

Figure 6  
The Template Reference Diagram

To simplify the operation of the software, only a few of the parameters are mandatory; the others are needed only if you wish to have them used in the calculations. For example, the size of the sample is mandatory, but things like the size and type of any absorbers that may be located between the detector and the sample are only required when you wish to have them taken into account during the calibration process.

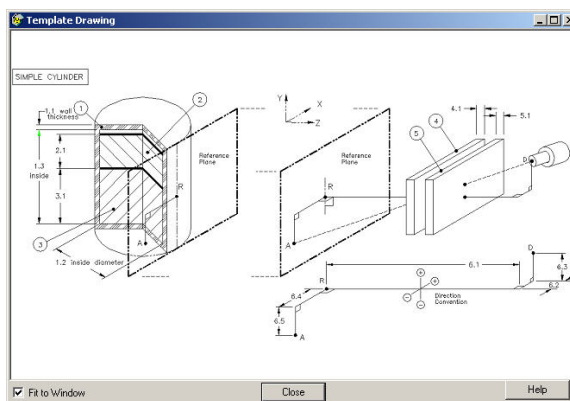


Figure 7  
The Mu-Library Window

During the entry of source parameters, the materials must be specified; a list of available materials is displayed in a drop down list for easy selection. Selection of the material also loads the default density, which can be edited if necessary. The software performs absorption corrections for each of the object elements.

## MATERIAL LIBRARY

An extensive library of available materials can be used to specify geometry component materials. The powerful Mu-Library editor, shown in Figure 8, can be used to create the chemistry composition of any custom materials and now has the extended range of 10 keV to 7000 keV. The library stores the cross-sections of all the chemical elements. Any material can be defined by atom fraction (chemical formula) or mass fraction. Composition information for the 44 predefined materials is available by double clicking on the material of interest.



# Model S573 ISOCS Calibration Software

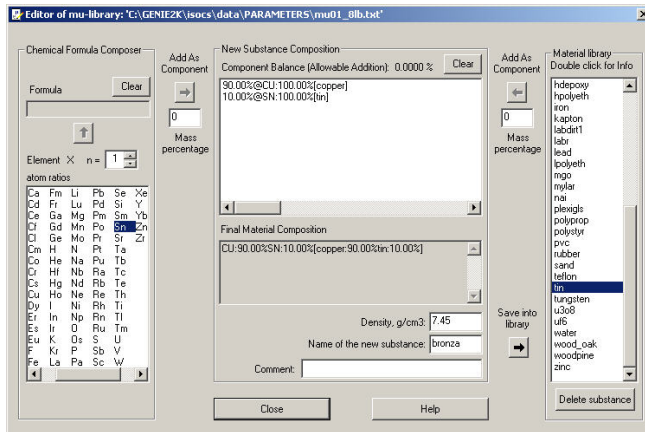


Figure 8  
The Mu-Library Window

energy gamma and X-rays) and back shielding. As an example, in Figure 10 you see the Sieve-Slit collimator drawing that would typically be used in a high count rate application. The drawing shows the backshield and internal liners of one of the slits.

Basic Collimator creation is facilitated by a detailed drawing, shown in Figure 11, labeled with dimension indices and a 3D preview window, seen in Figure 9, immediately displaying any changes made.

The Edit Housing window has similar types of specifications and interfaces. This editor allows you to totally enclose the detector in a housing and in addition to defining dimensions, density, etc., it gives the option of defining the external material as water, useful for underwater applications.

## COLLIMATOR AND HOUSING ENTRY

The Housing and Collimator Editors can be selected to specify structures around the detector. A detector collimator can be selected from a library of predefined collimators or a custom collimator can be created and viewed with the editor, shown in Figure 9, by indicating dimensions and materials. The software comes with two basic collimator templates and five advanced templates that allow design of complex collimators that can optionally include internal liners (for suppression of low

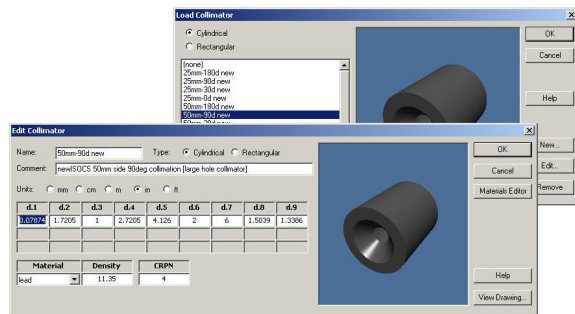


Figure 9  
The Edit Collimator Window

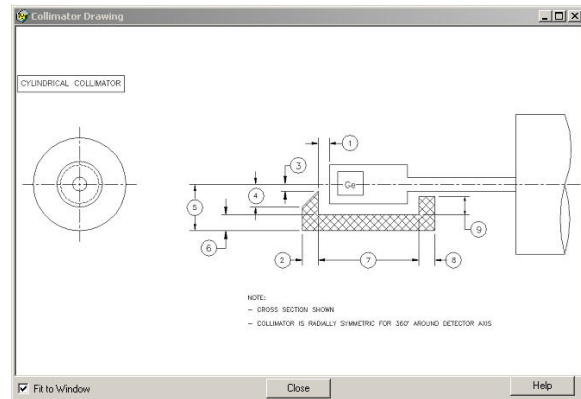


Figure 11  
The Geometry Composer Report

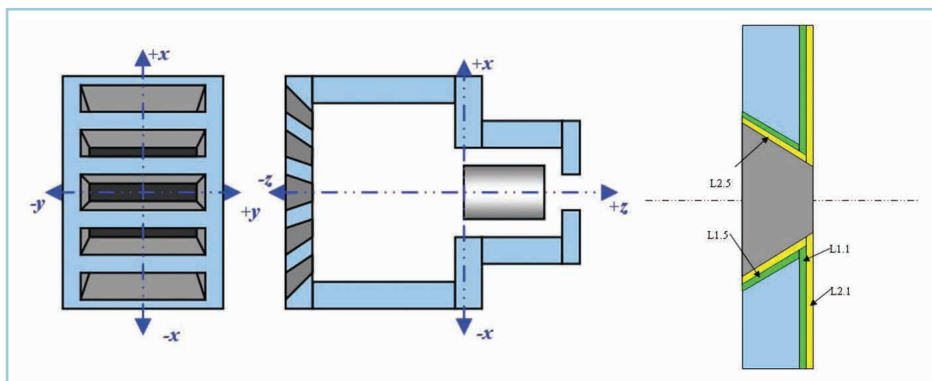


Figure 10  
Sieve-Slit collimator drawing

# Model S573 ISOCS Calibration Software

## THE RESULTS

After entering the parameters, a preliminary check of the geometry validity is done before generating the calibration and report. Toolbar and Menu selections allow modifications for all aspects of the geometry and report, including environmental conditions affecting air quality. When satisfied, a geometry report is run, shown in Figure 12, and the Efficiency function is generated. The efficiency file can then be used for sample assay in exactly the same manner as those produced by traditional “calibrated source” calibrations.

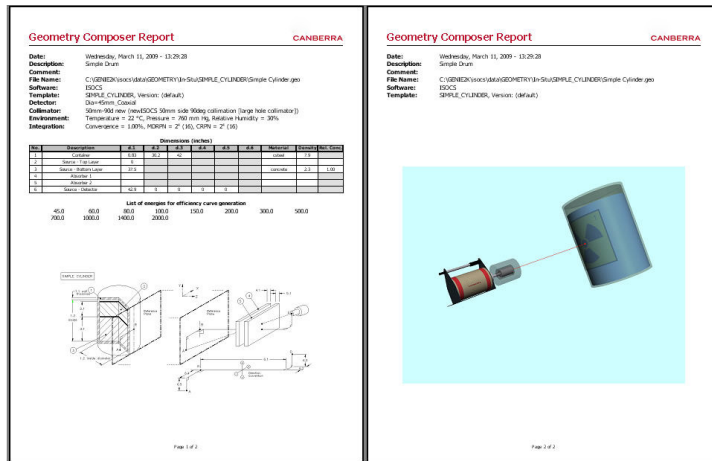


Figure 12  
Geometry Composer Report

## USING THE ISOCS UNCERTAINTY ESTIMATOR (IUE) TO DETERMINE THE ERROR LIMITS OF AN ASSAY AND REDUCE YOUR TMU

Another major benefit of the ISOCS software is the ability to easily determine the error limits of the calibration and the Total Propagated Uncertainty in the results of an *in situ* assay. Typically the uncertainty in the efficiency calibration is the largest contributor to the total uncertainty in the measurement. The deviation between the as-calibrated geometry and the as-measured geometry contribute to the total uncertainty. The Uncertainty Estimator is a unique and powerful new tool that can be used in several different modes to evaluate these variations between the calibration and the measurement conditions and to improve the quality of the gamma spectroscopy uncertainty estimate. The IUE makes it now easier than ever to determine the uncertainty and provides documentation on how it was generated; all input parameters are stored in a file, and in a printed report for the project record.

## “WHAT IF...?” ERRORS

This classification covers questions such as “What if the container walls are thicker than we think?”, “What if the container level is not as high as we think?”, and “What if the material matrix is different than we assumed?” It is these not-well-known (NWK) parameters that contribute to the uncertainty in the calibration efficiency. By varying these parameters between a maximum and minimum we can bound the problem.

To test the impact of these types of assumptions on the results, the IUE is used in its Uncertainty Analysis mode. To answer these questions in the past we used to have to generate a model and reanalyze the spectrum for each not-well-known parameter we varied. Now the IUE does this for you, for one parameter or more, by simultaneously and randomly varying all of the NWK input values within limits defined by the user, and then propagating that uncertainty with the spectroscopic analysis results into the final results for the sample.

In a matter of a few seconds (for typical geometries) you’ll see exactly what impact the new assumptions have on the assay.

In a similar manner, the IUE can estimate the uncertainty contribution from each individual input allowing you to identify which parameters have the largest contribution to the overall uncertainty. This is an especially useful diagnostic tool you can use in determining where to concentrate your effort towards reducing the total measurement uncertainty.

## NON-HOMOGENEITY ERRORS

This class of error is essentially the same as a sampling error in a traditional “take some random samples and send them to a lab for analysis” method of doing waste assay. That is, if the activity in a container is not homogeneously distributed, how do you know that the assay of your samples (or the results a single ISOCS measurement) truly represent the contents of the container?

For the “sample and analyze” scenario, the only way to find out is to take a very large number of samples, and analyze the distribution.

Even then, the sampling results may not be correct for very non-uniform cases. If the sampling processes happened to completely miss a “hot spot”, there is no evidence of the error, nor any measure of the bounds of the error. With *in situ* Gamma Spectroscopy, none of the sample is missed, but some of it may have a different efficiency.

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With the Uncertainty Estimator in the Non-Uniform Sample Concentration mode multiple counting of the sample is no longer necessary to answer these questions. Now samples can be modeled varying the number of hot spots and the size of the hot spots. In addition to computing the efficiency uncertainty from non-uniformity, the software also simulates the sampling uncertainty from extracting a sample or series of samples from the non-uniformly distributed radioactivity. Now, quickly and easily, you determine the impact on Total Propagated Uncertainty from sample non-homogeneity, and can compare the differences between the *in situ* measurement uncertainty and the sampling uncertainty.

The Uncertainty Estimator Tool comes with complete documentation including tutorials describing in detail how to analyze in each of the various modes.

## TYPICAL RESULTS

Extensive testing and validation has been done on both the MCNP Detector Characterization and the ISOCS/LabSOCS Calibration algorithms. The full MCNP method has been shown to be accurate to within 5% typically. ISOCS results have been compared to the results of 119 geometries from both MCNP models and directly measured radioactive calibration source configurations. In general, ISOCS software is accurate to within 4–5% for energies greater than 400 keV and 7–11% at 1 standard deviation for energies between 50 and 400 keV. ISOCS calibration is estimated to be accurate within 20% for energies less than 50 keV. The full validation report showing the results of each of 119 test geometries is included with delivered software, and is available upon request to Mirion. A few of the comparisons are shown in Figure 13.

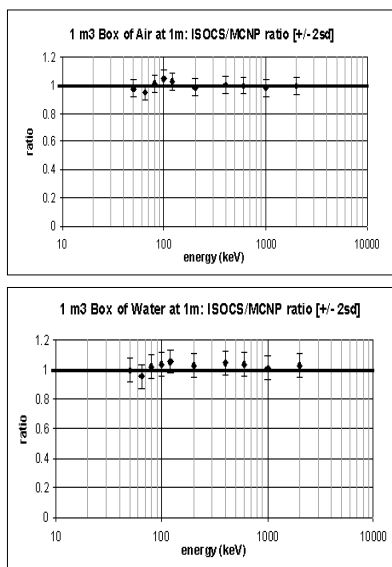


Figure 13  
Extensive testing has shown that ISOCS and traditional calibrations typically agree within a few percent

In addition to this generic validation document, Mirion offers Model ISOXVRFY. With the purchase of this product, the customer's Ge detector is used with the ISOCS calibration process to analyze a series of typical laboratory radioactive standards using the characterization file specific

to this detector. A report of this process, demonstrating the accuracy of ISOCS software from 60 to 1836 keV for these sources, is provided to the customer.

## ADDITIONAL INFORMATION

Additional information on ISOCS, its hardware and software components, and its applications may be found in the following publications, all of which are available from Mirion:

### SPECIFICATION SHEETS AND MANUALS

- ISOXSHLD – ISOCS Shield System.
- 1300 – InSpector™ 2000 Portable Spectroscopy Workstation.
- S500/S502/S504 – Genie™ 2000 Basic Spectroscopy Software.
- S501 – Genie 2000 Gamma Analysis Software (Includes Geometry Composer and Beaker Editor).
- S573 – ISOCS Calibration Software Technical Reference Manual.
- S573/S574 – ISOCS/LabSOCS Validation and Verification Manual, Part ICN 9231205e.

### APPLICATION NOTE

*In Situ Gamma Spectroscopy with ISOCS, an In Situ Object Counting System*, Canberra Industries.

### PUBLICATIONS

- *Comparability of ISOCS Instrument in Radionuclide Characterization at Brookhaven National Laboratory*, Kalb, P., Luckett, L., Miller, K., Milian, L. BNL-52607-01/04-Rev, 2008.
- *Optimum Method to Determine Radioactivity in Large Tracts of Land – In-situ Gamma Spectroscopy or Sampling Followed by Laboratory Measurement*, Bronson, F., 2008.
- *Optimum Method to Determine Gamma Activity in 200 Liter Drums – In-toto Measurement or Extracting a Sample*, Bronson, F., 2008.
- *Optimum Method to Determine Gamma Activity in Large Boxes of Radioactive Material – In-toto Measurement vs. Sample Extraction 9246*, Bronson, F., Morris, K., 2008.
- *Emergency Response Efficiency Calibrations for Portable Gamma Spectroscopy Instruments*, Bronson, F., Bosko, A., 2008.
- *Applications of In Situ Gamma Spectroscopy in D&D\_ER'*, Bronson, F., Canberra Industries, Spectrum 2000 Conference on Nuclear and Hazardous Waste Management, American Nuclear Society, 2000.
- *Probabilistic Uncertainty Estimator for Gamma-Spectroscopy Measurements*, Bronson, F., Geurkov, G., Young, B., Atrashkevich, V., Journal of Radioanalytical and Nuclear Chemistry, Vol. 276, No. 3, 2008.
- *The Use of In-Situ Germanium Gamma Spectroscopy to Find, Identify, Localize, and Quantify Hidden Radioactivity*, Bronson, F., Canberra Industries, Waste Management Conference 2001.
- *Radioactivity Measurements at Regulatory Release Levels*, NEA No. 6186, Nuclear Energy Agency; Organization for Economic Co-operation and Development.
- *Measurement Uncertainty from In Situ Gamma Spectroscopy of Nonhomogeneous Containers and from Laboratory Assay*, Bronson, F., Atrashkevich, V., Waste Management Conference, 2007.
- *ISOCS, A Laboratory Quality GE Gamma Spectroscopy System that you can Take to the Source for Immediate High Quality Results*, Bronson, Frazier, CHP, Rapid Radioactivity Measurements in Emergency and Routine Situations Conference, '97.

# Model S573 ISOCS Calibration Software

- *Near-Real-Time Characterization of BNL Stockpiled Soils – Another ASTD Success Story*, Bowerman, S., Adams, J., Kalb, P., and Lockwood, A., Brookhaven National Laboratory, Waste Management Conference, 2003.
- *Rapid Gamma Screening of Shipments of Analytical Samples To Meet DOT Regulations*, Wojtaszek, P., Remington, D., Canberra Industries, Ideker-Mulligan, V., Kaiser Analytical Management Services, Inc., Waste Management Conference 2006.
- *ISOCS for Free Release Deactivation and Decommissioning Focus Area*, DOE Innovative Technology Summary Report, OST Reference 2098, 2001.
- *Use of In Situ Gamma Spectroscopy to Support Decontamination and Decommissioning Activities*, Bronson, F., Booth, L., Groff, D., and Umbaugh, L., ANS Topical Symposium on Decommissioning, Decontamination and Reutilization of Commercial and Government Facilities, 1999.
- *The Use of In Situ Gamma Spectroscopy to Save Time, Dose, and Money in Operating Nuclear Facilities*, Bronson, F., Canberra Industries, Health Physics Society Midyear Topical Meeting, 2001.
- *Technical Considerations for Using in situ Gamma Spectroscopy in Conducting Final Status Surveys*, Dehmel, J.C., Schneider, S., Operational Health Physics, Supplement to Health Physics Journal, Vol 84, 2003.
- *LabSOCS vs. Source-Based Gamma-Ray Detector Efficiency Comparisons for Nuclear Power Plant Geometries*, Stewart, J., Groff, D., Canberra Industries, 2002.
- *Characterization of Decommissioned UF<sub>6</sub> Cylinders Using Gamma Spectroscopy and ISOCS Mathematical Calibrations*, Meyer, K., Canberra Industries, 35th Midyear Topical Meeting on Decommissioning and Environmental Restoration Health Physics Society, 2002.
- *Utilization of Risk-Based Methodology and Non-Destructive Assay Technologies to Characterize and Disposition Legacy Low Level Radioactive Waste*, Wolf, J., LLNL, Waste Management Conference, '05.
- *Results of a Field Study – Sampling with ISOCS and SAM 935 at the Savannah River Site*, Witt, J., Bechtel Savannah River Incorporated, REMEDIATION, 2006.
- *Nondestructive Assay Test Report on the Canberra Portable Assay System*, Jassen, W., Flour-Hanford, HNF-28354 Revision 0 EDC#: HNF-EDC-05-28355.
- *Validation of In Situ Object Counting System (ISOCS) Mathematical Efficiency Calibration Software*, Venkataraman, R., Bronson, F., Atraskevich, V., Young, B. M., Field, M., Ninth Symposium on Radiation Measurements and Applications, 1998.
- ISOXCALU – Re-characterization of a previously characterized detector.
- ISXCLF5K – Characterization for a Falcon 5000® unit.
- ISXCLNA2 – Characterization for 2X2 NaI Detectors.
- ISXCLNA3 – Characterization for 3X3 NaI Detectors.
- ISXCLNS2 – Characterization for the IPROS-2 2x2 NaI Stabilized Probe.
- ISXCLLA1 – Characterization for LaBr<sub>3</sub> 1.5x1.5.

The same characterization works for both ISOCS and LabSOCS™ software.

NOTE: a QA Calibration Check Source (ISOXSRC) comes with each characterization. This source is measured at the factory with the newly characterized detector as a baseline QC measurement and is recommended for use in the customers QC program.

## SHIELD

Mirion Model ISOXSHLD ISOCS Shield, or equivalent, if applicable.

## TRIPOD

Mirion Model INSITPOD lightweight tripod or Model 7413F heavy duty tripod.

## SPECTROSCOPY SYSTEM

Any Mirion PC-based MCA system running the following software as a minimum:

- S500 – Genie 2000 Basic Spectroscopy Software, V3.2.
- S501 – Genie 2000 Gamma Analysis Software, V3.2.
- S505 – Genie 2000 Quality Assurance Software, V1.3.
- S573 – ISOCS Calibration Software, V4.2.

The PC should be a Pentium 2.0 GHz or better. For fast computations of large or highly attenuating geometries, a high-end PC is recommended.

## RECOMMENDED OPTIONS

- S506 – Genie 2000 Interactive Peak Fit.
- ISOXVRFY – Verification Counts with Laboratory Standards.
- ISOXSRC – 2324 QA Calibration Check Source.
- S574 – LabSOCS Calibration Software.

Model ISOXVRFY Verification Counts with Laboratory Standards is strongly recommended to provide proof of the validity of specific system results. When this model is ordered, the detector's characterization and ISOCS/LabSOCS software is used to create a series of efficiency calibrations. Then, four different laboratory reference calibration standards are counted in seven different positions and analyzed as "unknowns" using these efficiency calibrations. A report is generated comparing the reported activity to the known activity. The sample types are two liter Marinelli beaker, 20 cc liquid scintillation vial, 50 mm filter paper, and 350 cc cylindrical container. These are all counted close to the endcap, and (except for the Marinelli beaker) at 10 cm from the endcap.

## SYSTEM REQUIREMENTS

To use the ISOCS Calibration Software, the following minimum system configuration is required:

### DETECTOR

Any Germanium, 2x2 NaI, 3x3 NaI, 1.5x1.5 LaBr<sub>3</sub> detector, characterized by Mirion. For each detector, order one of the following:

- ISOXCAL – Characterization for a new Mirion detector.
- ISOXCAL1 – Characterization a previously ordered Mirion detector.
- ISOXCAL2 – Characterization a non-Mirion detector.

