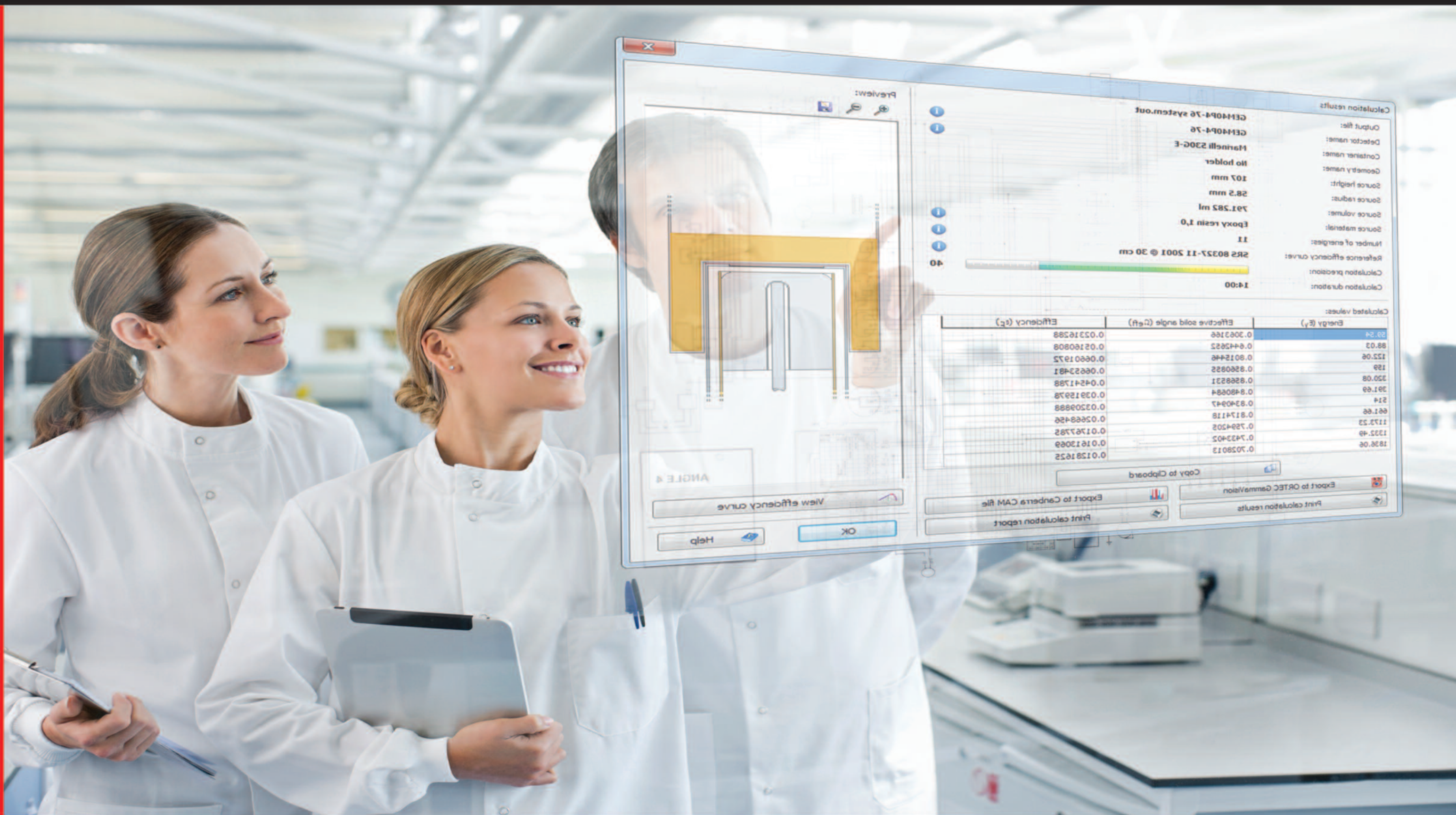
ORTEC®

ANGLE 4

Advanced Gamma Spectroscopy Efficiency Calibration Software

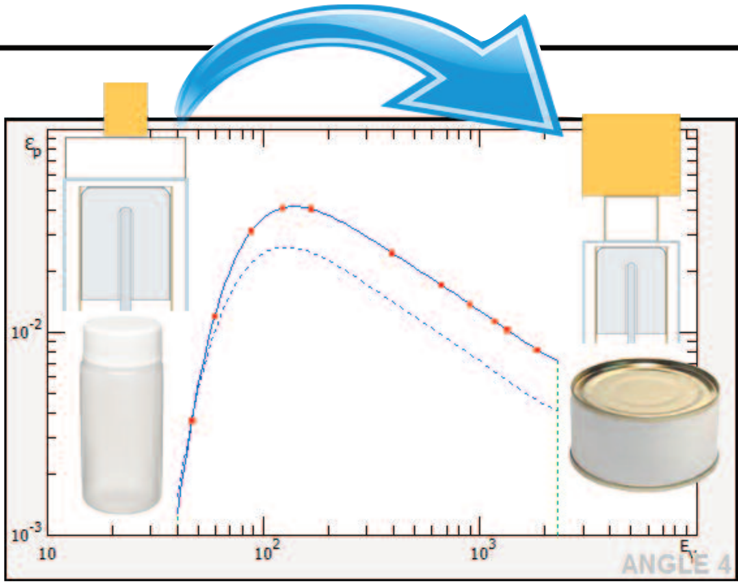


“Compatible, Efficient, and Defendable Calibrations for Gamma Spectroscopy Applications.”

AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY

ANGLE 4

ANGLE is an advanced efficiency calculation application for High Purity Germanium and Sodium Iodide detectors based on the concept of Efficiency Transfer. This method combines the measured efficiency of a known reference configuration and solid angle models to derive the efficiency for different containers, sample materials, and sample positions. This semi-empirical approach is more accurate than pure mathematical models due to large errors than can be imposed by detector characteristics that are not precisely known – such as crystal defects, contact thickness, and dead layers – as these errors cancel out in the reference efficiency measurement. And, since the Reference Efficiency can be determined from any standard source, there is no need for complex and costly factory characterization of the detector.



WHY ANGLE?

Compatibility	• All 32-bit and 64-bit versions of Windows from Windows 95 to Windows 10 • Multiple Language: English, French, Spanish, Russian, Chinese, Japanese – and growing! • High Purity Germanium and Sodium Iodide Detector Types • Modeling for most common laboratory measurement containers
Process Efficiency	• No Factory Detector Characterization Necessary • Import and Export ORTEC and Canberra file formats • Command line scripting and XML Data files for automation and application integration • Rapid modeling using Container, Geometry, and Source Matrix configurations
Defendable Results	• Comprehensive Reporting of Efficiency Calculation Model • Actual and Relative Efficiency Method provides Calibration Standard Traceability • Graphical Display of model • High Accuracy with Extensive Comparison Testing

New Features in ANGLE 4!

New! Modeling for Cylinder and Well Sodium Iodide Detectors in addition to Germanium

New! Multi-Language Support which is easily extended to additional languages

New! Comprehensive and Summary Modeling Reports for validation and record retention

New! Graphical Display of Model and Calculated vs Reference Efficiency curves

New! Geometry Correction Files to maintain traceability and calibration uncertainty in GammaVision analysis

New! Command Line Operation and XML File Format for automation and integration with other applications

New! Import and Export any parameter from Efficiency Calculation Parameter or Results files

New! Discrete Reference Efficiency eliminates the curve fit error at specific energies of interest

New! Enhanced User Interface for a more intuitive user experience

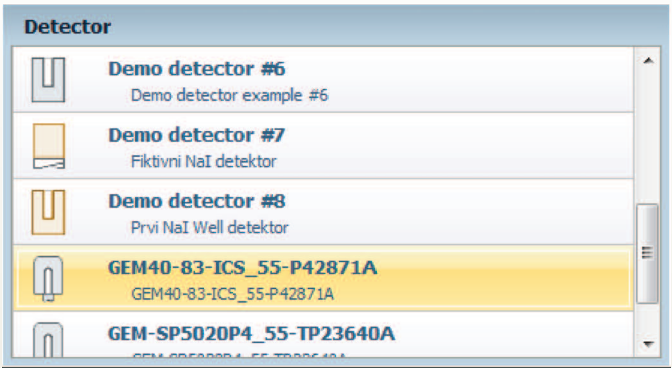
New! Demo Detectors to evaluate and perform training with no registration required

ANGLE 4


ANGLE Overview
Detector, Container, Matrix, and Position Models
Detector
GEM40-83-ICS_55-P42871A
GEM40-83-ICS_55-P42871A
Container
- Example Marinelli
The example of a Marinelli container
1L Marinelli (132G)
1L Marinelli (132G) filled to 105 mm Water
Source
Source height: 105 mm
Source radius: 70.5 mm
Source volume: 1.640 l
Source material: Water
Geometry
1 in Stand-Off
1 inch Stand-off for Small containers
2 in Stand-Off
2 in Stand-Off
Reference Configuration and Measured Efficiency
Detector
Detector name: GEM40-83-ICS_55-P42871A
Container
Container: 20ml Scintillation Vial
Geometry
Geometry: 1 in Stand-Off
Source
Source height: 34.9 mm
Source radius: 13.5 mm
Source material: Water
Calculated Efficiency
Calculation results
Output file: 55-P42871A 20cc Vial 1 in to 1L Marinelli.outx
Detector name: GEM40-83-ICS_55-P42871A
Container name: 1L Marinelli (132G)
Geometry name: No holder
Source height: 95 mm
Source radius: 70.5 mm
Source volume: 1.005 l
Source material: Water
Number of energies: 11
Reference efficiency curve: 55-P42871A 20ml Vial at 1 inch
Calculation precision: 25
Calculation duration: 0:12
Calculated values:
Preview:
Copy to Clipboard
Export to ORTEC GammaVision
Export to Canberra CAM file
Print calculation results
Print calculation report
View efficiency curve
OK
Help
ANGLE 4 Calculation Report
SUMMARY
Output file: 55-P42871A 20cc Vial 1 in to 1L Marinelli.outx
Detector name: GEM40-83-ICS_55-P42871A
Container name: 1L Marinelli (132G)
Geometry name: No holder
Source height: 95 mm
Source radius: 70.5 mm
Source volume: 1.483 l
Source material: Water
Number of energies: 11
Reference efficiency curve: 55-P42871A 20ml Vial at 1 inch
Calculation precision: 25
Calculation duration: 0:12
CALCULATED VALUES
Energy (Eγ) | Effective solid angle (Ωeff) | Efficiency (εp)
46.58 | 0.07859489 | 0.003661535
59.54 | 0.2328852 | 0.01201604
88.03 | 0.5012204 | 0.03166116
122.07 | 0.6333793 | 0.04085006
165.85 | 0.6875661 | 0.04058301
391.69 | 0.6875784 | 0.02462485
661.66 | 0.6659779 | 0.01712960
898.02 | 0.6452383 | 0.01376811
1173.24 | 0.6213754 | 0.01128761
1332.5 | 0.6087096 | 0.01026144
1836.01 | 0.5765179 | 0.008199926

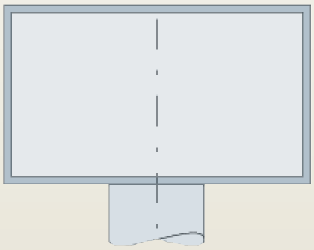
Detector Model

The Detector Model defines the physical construction of the detector. The input parameters are dependent on the detector type which may be Germanium or Sodium Iodide in Coaxial, Planar, or Well configurations. A graphic display of each model helps validate the appropriate detector type in the configuration process. Some parameters, such as the Inactive material thickness and the Contact thickness, are usually not precisely known for each detector so nominal values are typically used. These minor deviations are typically inconsequential with the Efficiency Transfer calculation method implemented in ANGLE because the minor error in transmission cancels out in the Reference and Target solid angle models. This is one of the significant advantages of Efficiency Transfer over modeling alone. And, if the detector response is affected by changes to any of these parameters, then a new Reference calibration can be generated with standard sources in the lab instead of having to return the detector to the factory for an expensive and time consuming characterization.

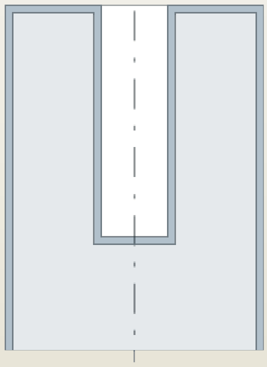


Detector Types:

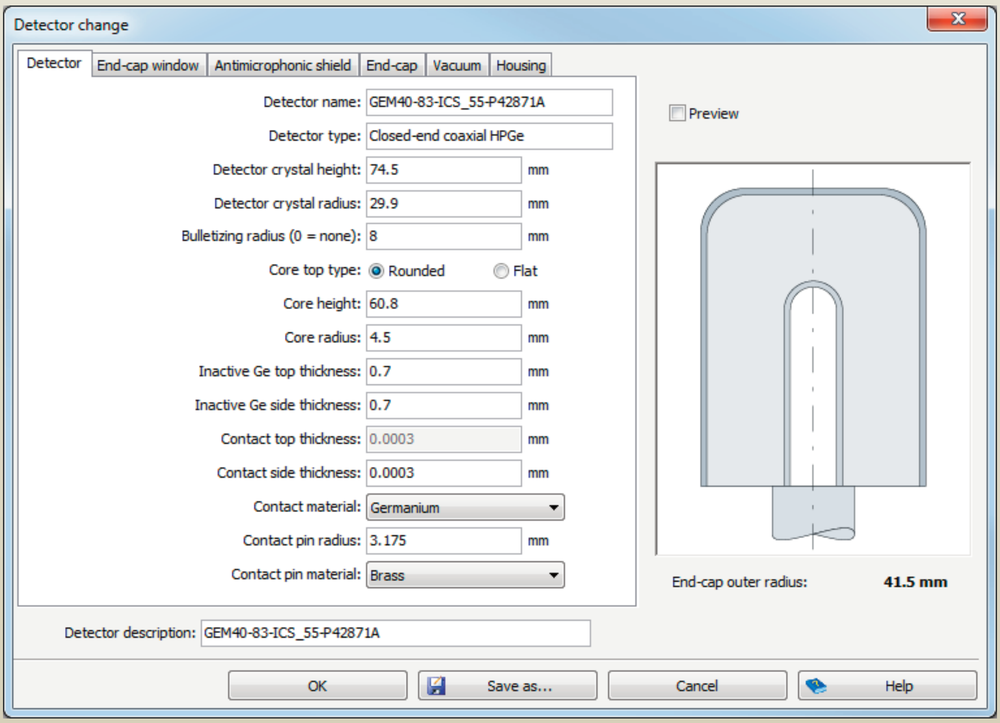
- γ HPGe: Closed or open end coaxial, Planar, and Well
- γ Ge(Li): Closed or open end coaxial
- γ NaI: Cylinder and Well

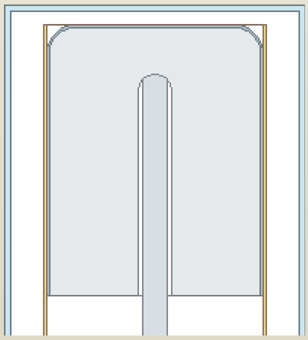


NaI Cylinder



NaI Well





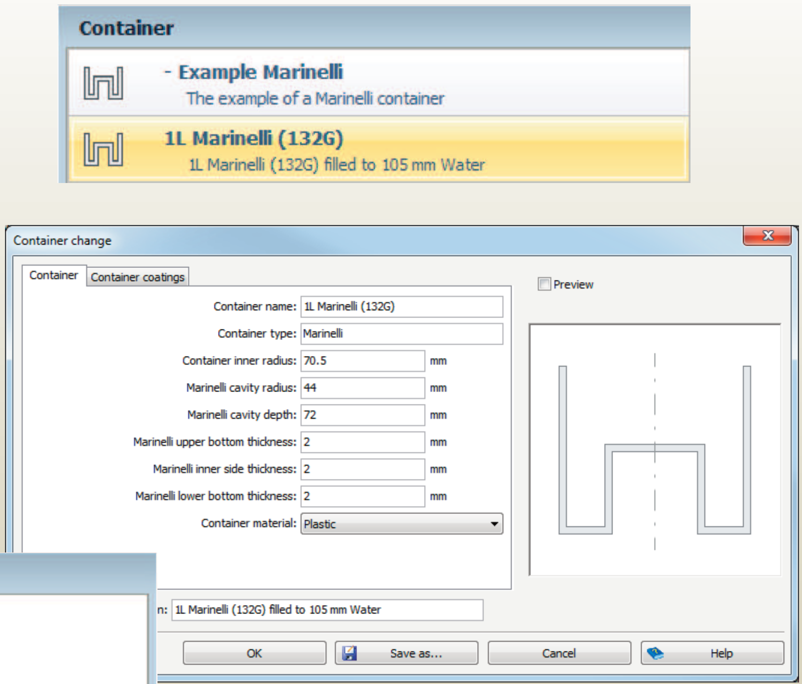
HPGe Closed End Coaxial

Container and Source Model

Containers define the physical holders of source or sample material, and Sources define the actual material within the container. Containers and Sources are defined independently in ANGLE to simplify the process of establishing different combinations of material and volume in each container. Common materials are pre-defined for Containers and Sources, and additional materials can easily be added based on user-defined compounds or mixtures.

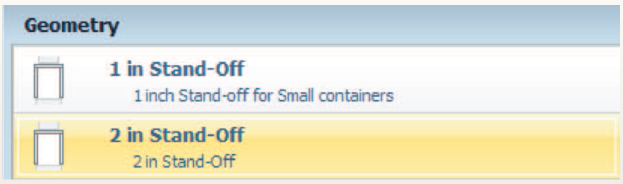
Container Types:

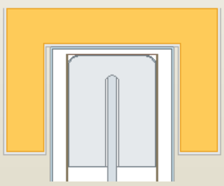
- γ Marinelli
- γ Cylinder to define Point Source, Filter Paper, Disk, Charcoal Cartridge, and Bottles



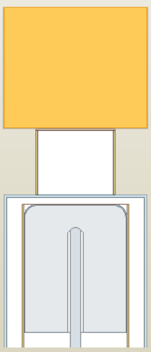
Geometry Model

The Geometry defines the relative position of the Container to the Detector including any sample holders that may be used and up to five additional absorbing layers between the detector and the container. Common materials for sample holders and absorbers and pre-defined, and additional materials are easily added by the user.

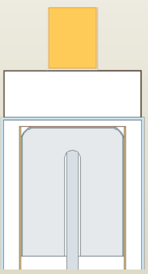




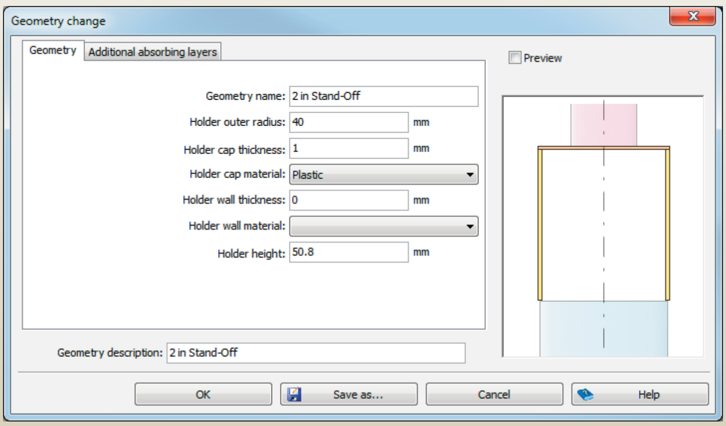
Marinelli Beaker on end cap



Large Bottle on narrow stand-off



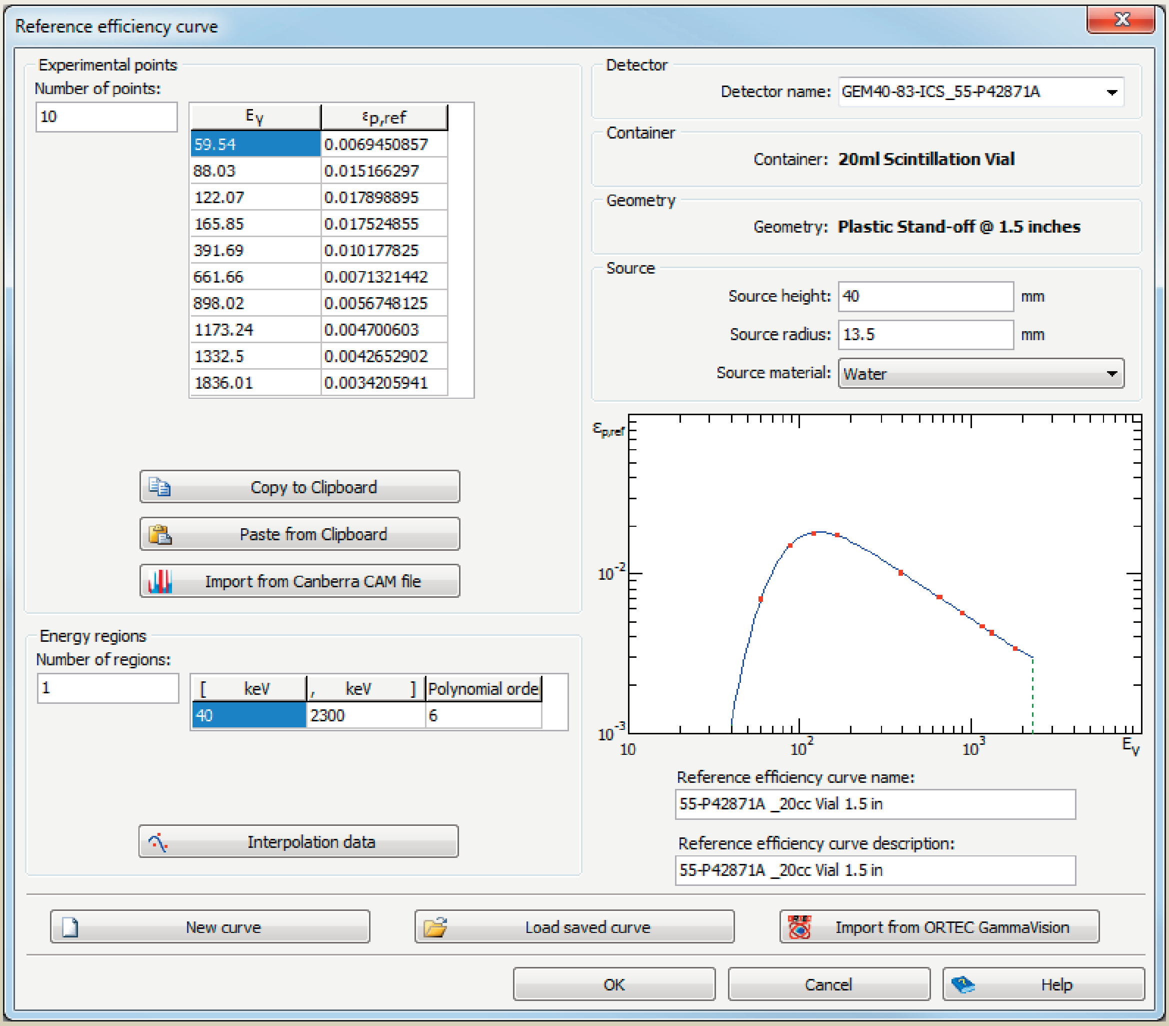
Small Bottle on wide stand-off



Reference Efficiency Calibration

ANGLE eliminates complex, expensive, and time consuming detector characterization because the Reference Calibration can be determined by direct measurement of a known source within the lab. Optimally, the Reference Calibration is determined using a source/geometry that is similar to the one being modeled in order to minimize uncertainty in the modeled efficiency; however, any source/geometry can be used as the reference when modeling any other source/geometry with good results when all of the detector and source/geometry configuration parameters are well known.

The Reference Energy/Efficiency pairs can be manually entered into ANGLE, or imported from either ORTEC's GammaVision Efficiency Tables or Canberra's CAM files. A calibration curve is then generated using up to a 6-order logarithmic polynomial function over each of up to ten different energy regions to optimize the calibration fit. Alternatively, the reference Energy/Efficiency pairs can exclude the fit function in order to calculate the modeled efficiency for only the input energy points without any uncertainty imposed by using a fit function. The choice to use a fit function or discrete energy/efficiency pairs is largely determined by how the extrapolated efficiency calibration will be used. In many cases, the extensive calibration fit algorithms in ANGLE can achieve a much more precise calibration fit than is possible with other spectroscopy applications.

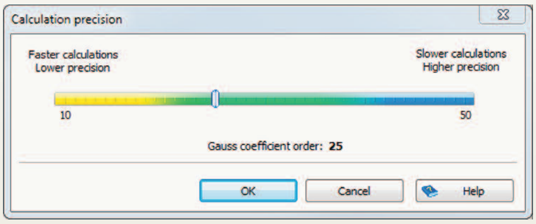


Calculated Efficiency

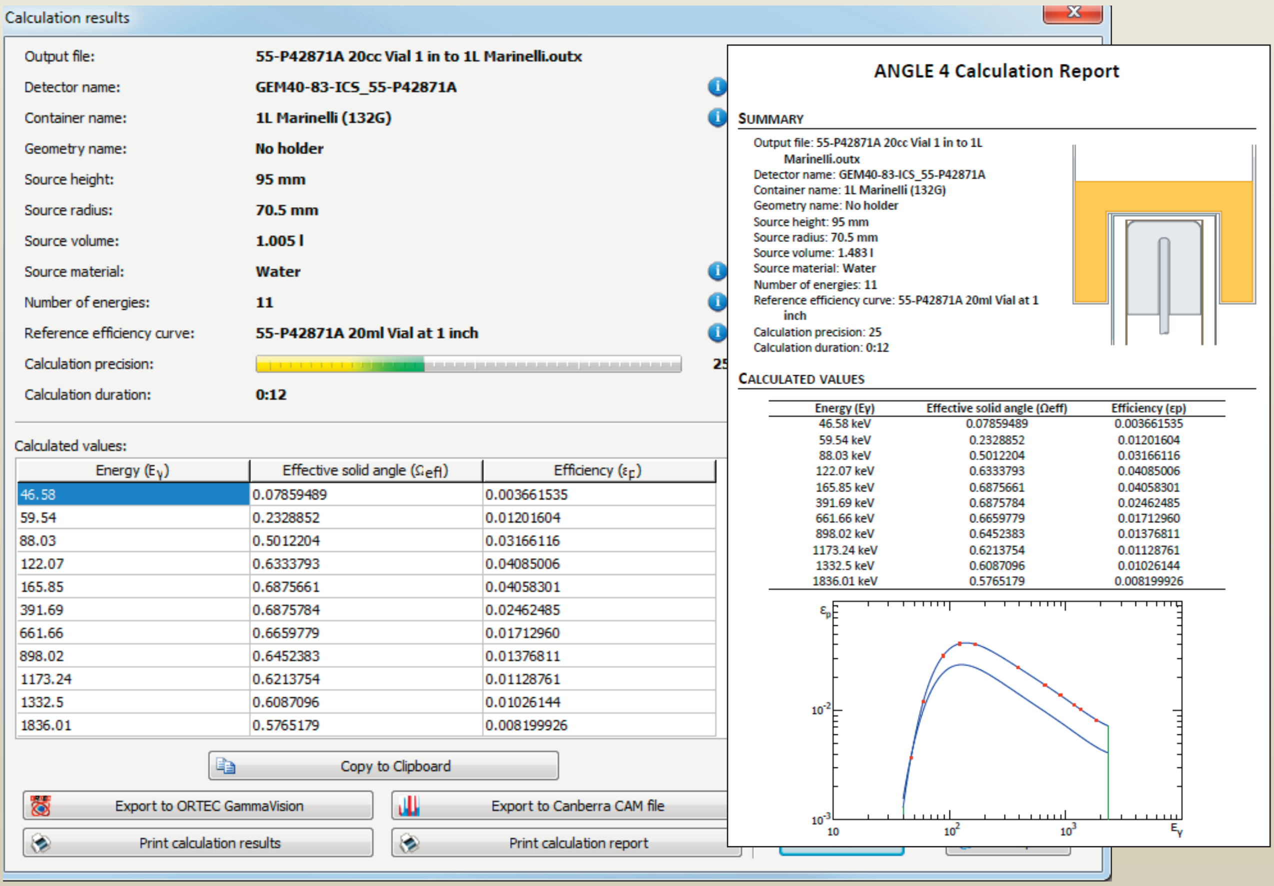
ANGLE uses an Efficiency Transfer method, which is a semi-empirical approach comprised of experimental evidence (i.e. measured efficiency of a known reference source) and mathematical comparison of effective solid angle modeling for the reference and target configurations. The precision of the effective solid angle models is based on the number of integration segments over the source volume and detector surface visible to the source, and is easily adjustable to optimize calibration accuracy versus calculation time.

$$\varepsilon_p = \varepsilon_{p,ref} \frac{\overline{\Omega}}{\overline{\Omega}_{ref}}$$

The derived efficiency data can be comprised of the same energy points used in the reference calibration or user-defined energy points derived by ANGLE's robust fitting algorithms. These Energy/Efficiency pairs can then be used to generate efficiency calibrations in standard gamma spectroscopy applications. A Geometry correction file can also be generated for use in ORTEC's GammaVision application so that the final analysis results retain traceability to the Reference calibration while applying the necessary efficiency corrections to the derived geometry configuration.



Detailed and Summary reports of the reference and derived efficiency calibrations and their associated configurations are also available for verification and record retention.



Energy (E_γ)	Effective solid angle (Ω_{eff})	Efficiency (ε_p)
46.58	0.07859489	0.003661535
59.54	0.2328852	0.01201604
88.03	0.5012204	0.03166116
122.07	0.6333793	0.04085006
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1173.24	0.6213754	0.01128761
1332.5	0.6087096	0.01026144
1836.01	0.5765179	0.008199926

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Ordering Information

Model	Description
ANGLE-BW	Advanced Gamma Spectroscopy Efficiency Calibration Software
ANGLE-UW	Update from ANGLE-B32 (Version 2 or 3) to ANGLE-BW (Version 4)
ANGLE-GW	Additional Hard Copy Documentation for ANGLE

References

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