Model S573/S574
ISOCS/LabSOCS

Validation & Verification Manual

V4.0 9231205E

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SYSTEM
CERTIFIED

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1. Introduction

The data in this document was generated with ISOCS/LabSOCS software v4.0. Both ISOCS (model S573) and LabSOCS (model S574) use exactly the same algorithms, and will generate the same results. This document is equally applicable to both products.

The ISOCS calibration method is a convenient tool for calibrating the detector efficiency as a function of energy, for a wide variety of source geometries and activity distributions. The ISOCS method consists of a characterization of the detector, user input of source geometry data, and the ISOCS software, which uses these to produce the efficiency calibration.

Before the software can be used for calibration purposes, the germanium detector in the system must be "ISOCS characterized". This initial characterization is performed by Canberra Industries on each individual detector. First, an MCNP model of the detector is developed. The model is then independently validated using measurements with a NIST traceable source. Given the validated model, the response characteristics of the detector are created to cover any location inside a sphere of radius 500 meters, centered on the detector, and over a photon energy range of 45 keV through 7 MeV.

The ISOCS software is a complex ensemble of computer codes that use elegant mathematical techniques to compute the efficiencies. It contains a series of mathematical models that can simulate a wide variety of common sample shapes (boxes, cylinders, spheres, pipes, stacked boxes, stacked discs, marinelli beakers etc.). These models allow easy input of appropriate parameters necessary for efficiency computation. The ISOCS software divides each source region into a large number of voxels (1024). A point location is defined within each voxel. The point location inside a voxel is determined in a quasi-random fashion. At a given user-specified energy, the detector efficiency is calculated for each voxel. The attenuation due to absorbers within the source and also in the intervening space between the source and the detector is taken into account. If a shield

and/or a collimator is defined in the calculation, the software takes into account the additional attenuation due to those. Finally the efficiencies for all the voxels are summed up at the specified energy. This process is repeated, in a second iteration but this time done with 2048 voxels. ISOCS then checks if the obtained result satisfies a convergence criterion set at twice the user-specified convergence value. ISOCS doubles the number of voxels and performs a third iteration. At the end of the third iteration ISOCS checks whether the obtained results meet the user specified convergence limit. If the two convergence criteria are met in successive iterations then the iterative process is stopped otherwise, it continues with the number of voxels being doubled at each iteration until the convergence criteria are met in successive iterations. This new analysis routine guarantees that the initial convergence result is not spurious. Once this process performed ISOCS moves on to the next energy in the user-specified list. If there are multiple source regions, the process is repeated for each source region.

Given the uniqueness of the mathematical calibration, and given the complexity of the tasks carried out by ISOCS, it is important to test and validate the consistency and accuracy of the software. It is essential to ensure that the software handles the physics correctly for different source shapes and sizes, and for different source-detector geometries. Therefore, two types of test procedures were undertaken, namely, (i) the internal consistency tests, and (ii) the validation tests. The internal consistency tests were designed to prove that the ISOCS software treated the source geometries in a consistent manner. The validation tests were designed to demonstrate the accuracy of the ISOCS efficiency calibrations.

2. Internal Consistency Tests

The general philosophy of these tests was to demonstrate internal consistency of the software by configuring equivalent source geometries using different ISOCS templates, and verifying that the calculated efficiencies were the same. Eight different tests were designed by grouping together similarly shaped objects of same volume. A brief description is given below for each test. The results of these tests are summarized in Table 1 at the end of this section. The input parameters used in each test and the detailed efficiency results of each test are given in Appendix A.

Test 1 : Point sources

A point source geometry is one in which a source is placed far enough away from the detector, so that the source can be considered to be essentially a point. A radioactive source of volume 1 cc, and filled with water, was modeled using each of the 11 ISOCS templates. The source-to-detector distance in each case was 5 meters. Since the source is essentially a point, the efficiencies calculated by ISOCS in all the 11 cases should be very close to each other, if not identical.

Test 2: Marinelli beakers configured using the Beaker Template

In this test, different configurations of Marinelli beakers were configured using the Beaker template and the Marinelli Beaker template, and the results were compared. These tests fell into 4 different categories, in the order of increasing complexity. In Test 2a, the Marinelli beakers had a single wall material, the end and side walls had the same thickness, and there was only a single type of source matrix. In Test 2b, the end and side wall materials were different but the thickness was the same, and there was only a single source matrix. In Test 2c, the end and side wall materials were different, the thickness was different, and a single source matrix was configured. Finally, in Test 2d, the end and side wall materials and thickness were different and two source matrices were used.

Test 3: Different symmetries of boxes

A solid cube of iron of volume 1 cu.m was modeled using various box-like templates such as (i) a simple box, (ii) a complex box, (iii) a complex box with a hot spot filling the entire box, and (iv) a rectangular plane. The ISOCS efficiencies were compared for the four geometries.

Test 4: Different Cylindrical geometries

A solid cylindrical source of iron, of volume 1 cu.m was configured using (i) a simple cylinder, (ii) a complex cylinder (no hot spot), (iii) a pipe with the shell filling the volume, (iv) a pipe with no shell, but with an inner cylinder filling the volume, and (v) a pipe with both a shell and an inner cylinder. The ISOCS efficiencies were calculated for each case, and the results compared.

Test 5: Different Spherical geometries

A solid spherical source of iron was modeled in 5 different ways; (i) a sphere with the source shell filling the entire volume, (ii) a sphere with no shell, and the source volume filled, (iii) a sphere with both a source shell, and a filled source volume, (iv) a complex cylinder with the spherical hot spot filling the entire cylinder, (v) a pre-defined laboratory container configured as a sphere, and filled with iron. The efficiencies were calculated for the five equivalent configurations, and compared.

Test 6: Large Marinelli Beakers

This test is similar to Test 2, in that a Marinelli beaker of zero well diameter is configured in 3 different ways, and the efficiencies are compared amongst themselves, as well as with that of an equivalent circular plane, an exponential circular plane, and a laboratory beaker . In this test, the volume of the source is 1 cu.m.

Test 7: Large sources, massemetric efficiencies

In this test, sources of large dimensions are modeled using different ISOCS templates. As the source dimensions become large, the traditional efficiency continuously decreases.

But the "massemetric efficiency" defined as the "counts detected per gamma ray emitted per gram of sample" approaches a constant value asymptotically. Mathematically, the massemetric efficiency is the product of traditional efficiency and the mass. Test 7 is intended to show that the massemetric efficiencies for large sources of different shapes (a rectangular plane, and a circular plane) approach the same value.

Test 8: Marinelli Beakers, Cylinders and Pipes

In this test, the detector is located off-axis from the source. The source is configured as, (i) a Marinelli beaker of zero well diameter, (ii) a circular plane, (iv) an exponential circular plane, (iv) a simple cylinder, (v) a pipe, (vi) a laboratory beaker. This test involves translating and orienting the detector appropriately in order to achieve the desired source-to-detector geometry.

Test 9: Air Parameters test

This test was performed to verify the effect of the air parameters (temperature, pressure and relative humidity) on ISOCS efficiency. In this test, a single air parameter was varied, while keeping the other two the same. It was verified that the ISOCS efficiencies changed in a manner consistent with the change in the air attenuation.

The air parameter tests revealed the following trends. (a) With the pressure and temperature kept the same, the density of the air+water mixture and the attenuation coefficient at a given energy were hand-calculated for relative humidity values of 0%, 50%, and 100%. As the relative humidity increased, the density of the air+water mixture showed a very small increase (0.003%). The attenuation coefficient of the air+water mixture increased by less than 0.05%. Therefore, the hand calculated photon attenuation values remained practically the same as the relative humidity was increased. The ISOCS efficiency values followed the same trend. (b) The pressure and the relative humidity were kept the same, and the temperature was varied from 0 to 100 degree celsius. The density of air+water mixture decreased progressively as the temperature was increased. The attenuation coefficient remained the same. Based on this, one should expect the

ISOCS efficiencies to increase, with increasing air temperature. The ISOCS efficiencies increased, as expected. (c) The temperature and the relative humidity were kept the same, and the pressure was changed from 380 mm Hg to 1000 mm Hg. The density and attenuation increased. As expected, the ISOCS efficiencies decreased. The ISOCS efficiency results for the air parameter tests are given in Appendix A.

Table 1: Results summary of Internal Consistency Tests

Test #	Test Description	Worse % Difference in Efficiencies (E < 150 keV)	Worse % Difference in Efficiencies (E > 150 keV)
1	Point Sources	0.76	0.50
2	Beaker Symmetries	2.63	1.68
3	Box Symmetries	0.0	0.0
4	Cylinders & pipes	-0.61	-0.11
5	Spheres	-0.47	-0.28
6	Large Marinellis	2.23	3.21
7	Large area sources (massemetric eff.)	0.35	0.32
8	Marinelli beakers & Cylinders (off-axis)	-0.24	-0.27

3. Efficiency Validation Tests

The validation tests are grouped into 3 categories, namely, (1) Field-counting geometry, (2) Laboratory counting geometry, and (3) Collimated geometry. Between them, the 3 categories of tests include 119 different multi-energy sources that are large and small, source-detector distances that are close and far, and both collimated and uncollimated geometries. As many as 6 different detectors were involved in the testing process, so that a representative sample of results can be obtained.

In each of these tests, a reference efficiency calibration was compared to an ISOCS efficiency calibration at the same geometry. The Monte Carlo code MCNP (version 4B), or the measured data from a multi-energy radioactive source was used to generate the reference calibration. The energies of these sources covered the range from low (60-88 keV) to high (1408-1836 keV) energies, with 5-8 points in between. Using MCNP simulation is advantageous in many ways; (i) one can have an exact knowledge of the source geometry, (ii) the precision can be controlled, (iii) there are no interference problems to deal with, and (iv) no radioactive waste is generated. Of the 119 tests that were performed, 34 were MCNP tests and 85 were source tests.

3.1 Field Counting Geometries:

The type of tests included in the field counting geometries were those that involved large sources (> 1 cu.m in volume) and/or large source-to-detector distances (> 1 m). A variety of radioactive source distributions were created inside containers that were shaped like boxes, drums, and pipes. The containers were filled with materials that one would typically encounter in the field, such as soil, dirt, water etc. About half the number tests were MCNP simulations, while the other half were radioactive source measurements.

3.2 Laboratory Counting Geometries

The tests included in the laboratory counting geometries were those that involved small sources located within 1 meter of the detector. Except for one test, which was an MCNP simulation, all the other tests were performed using multi-energy gamma ray standards. The source geometries included point sources, line sources, vials, filter papers, and Marinelli beakers. A set of 5 NIST uranium standards with various certified enrichments of U-235 were also measured and the detector efficiency calibration determined.

In the laboratory geometries, sources are sometimes counted at distances of 10 cm or less from the detector. When a radioactive nuclide emitting multiple gamma rays is counted at such close distances, counts may be lost or gained in the full energy peaks because of cascade summing effects. The extent of these losses or gains will depend upon the total efficiency of the source-to-detector geometry, the peak-to-total ratio of the detector at the given energy, and the decay scheme of the particular nuclide. Examples of nuclides that emit gamma rays in a cascade are Co-60, Y-88, and Eu-152. In the validation tests, appropriate correction factors were applied to the data to account for the cascade summing effects, wherever necessary.

3.3 Collimated Geometries

The tests that were included in this catergory were those in which the collimator had at least a 20% effect on the ISOCS efficiency. In earlier versions of ISOCS (1.2e), it was apparent that the uncertainty in the efficiency calibrations for collimated geometry was larger than that for non-collimated geometries. That does not appear to be the case with ISOCS version 3.0 and 4.0 due to the new collimator algorithms, and the collimated data is presented here to show that.

4. Explanation of the Data Sheets for the Validation tests

Each data sheet contains information and results pertaining to a particular validation test. Given at the top of each sheet are the title of the test, the date the results were entered, and the version of ISOCS that was used (version 3.0 in this report). Following this information, a brief description is provided for the type of test.

The input parameters that were used in the ISOCS calculation are given next. The name of the source template, the name of the ISOCS characterized detector that was used in the test, and the name and input parameters for a shield/collimator if any, are indicated next on the data sheet. A table containing the input parameters for the particular source geometry is included. The layout of this table closely resembles the Source dimensions table in the ISOCS software. Shown below is an example of an input parameter table included in the data sheets.

ISOCS Geometry Parameters
Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578)
Collimator: 50mm-90d CRPN=6
1=0.2 2=5.08 3=2.54 4=7.62 5=10.16 6=5.08 7=15.24 8=5.08 9=3.4 mat=Pb dens=11.35

Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1)Container	0.089	0.775	485.4			Al	2.7	
(2) Top Layer								
(3) Bot Layer	485.4					Epoxy	1.07	1
(4) Absorber 1								
(5) Absorber 2								
(5) Src-Det	97.5	0	1.2	0	1.2			

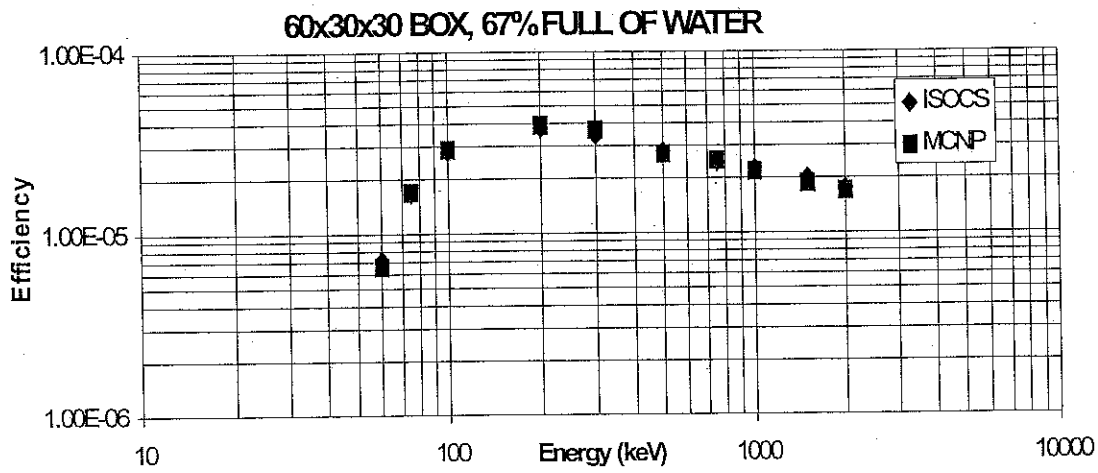
The data sheets also contain information regarding the air parameters used, the desired % convergence of the calculation, and the units of length and density used in the source dimensions table. The composition of the source material is also given. A second table, which compares the ISOCS efficiencies to the True efficiencies, is present in the data sheets. The first column of the comparison table lists the energies at which the efficiencies were obtained. The second column gives the ISOCS efficiencies at the energies listed in column 1. Listed next, are the efficiencies from the reference calibration

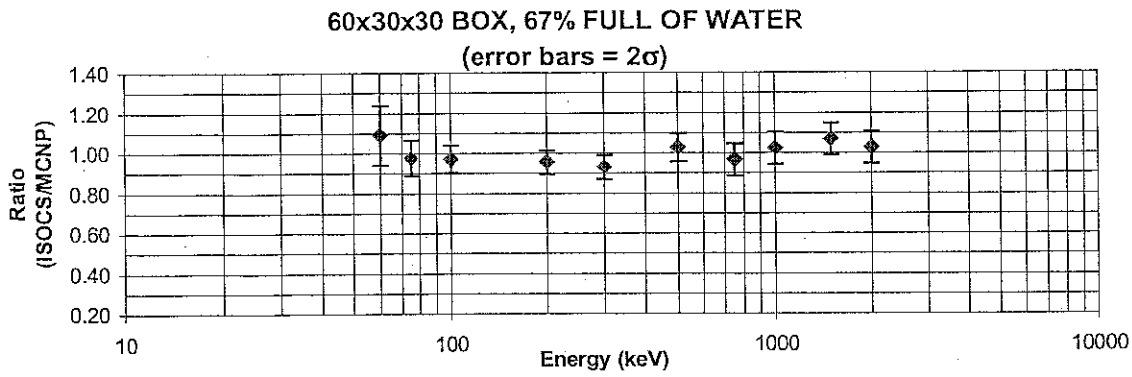
(either MCNP or measurements). The relative uncertainties in the reference efficiencies are given at the 2σ level of confidence. Finally, the ratio of ISOCS efficiency to True efficiency is tabulated at each energy.

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	2σ rel. uncert.	Ratio (ISOCS/MCNP)
60	7.17E-06	6.57E-06	0.15	1.09
75	1.64E-05	1.68E-05	0.09	0.98
100	2.81E-05	2.88E-05	0.07	0.97
200	3.75E-05	3.92E-05	0.06	0.96
300	3.42E-05	3.68E-05	0.06	0.93
500	2.80E-05	2.72E-05	0.07	1.03
750	2.42E-05	2.50E-05	0.08	0.97
1000	2.23E-05	2.18E-05	0.08	1.02
1500	1.99E-05	1.86E-05	0.08	1.07
2000	1.76E-05	1.71E-05	0.08	1.03

Plots are presented in the data sheets showing the efficiencies as a function of energy for both ISOCS and the reference calibration method. The plots are similar to the examples given below.





Finally, an analysis of the data is presented as in the following table.

Dataset	Mean Ratio	Relative Std Dev	ISOCS Std Dev
<150 keV	0.99	0.04	0.04
>150 keV	0.99	0.05	0.04
All	0.99	0.05	0.03

The data set is divided into 3 energy groups, (1) < 150 keV, (2) > 150 keV, and (3) data at all energies pooled. For each energy group, a weighted mean of the ratio of ISOCS to True efficiency is determined. The relative weighted standard deviation of the ratio is also determined for each energy group. The absolute 1σ uncertainties in the True efficiencies were used to weight the mean and the standard deviation. The following relations were used in determining the weighted mean and weighted standard deviation.

$$\mu = \Sigma_i w_i x_i / \Sigma_i w_i \quad (1)$$

$$\text{weighted s.d.} = \text{sqrt}\{[\Sigma_i w_i (x_i - \mu)^2 / \Sigma_i w_i] [N / N\text{-}1]\} \quad (2)$$

x_i represents the ratio of ISOCS to True efficiency, μ is the weighted mean, and N is the number of observations. The weighting factor $w_i = 1/\sigma_i^2$, where σ_i is the absolute uncertainty in the ISOCS/True efficiency ratio at the ith energy.

The uncertainties in the ISOCS/True efficiency ratio come from the calibration source uncertainties, the counting statistics (or the statistical uncertainties in the MCNP simulations), in addition to the uncertainty due to ISOCS itself. Using the relative weighted standard deviation of the ratio, and a weighted average of the relative uncertainty due to the True efficiency, the relative uncertainty due to ISOCS is estimated as follows.

$$[\sigma_{Ratio} / Ratio]^2 = [\sigma_{ISOCS\ eff} / ISOCS\ eff]^2 + [\sigma_{True\ eff} / True\ eff]^2 \quad (3)$$

Or,

$$[\sigma_{ISOCS\ eff} / ISOCS\ eff]^2 = [\sigma_{Ratio} / Ratio]^2 - [\sigma_{True\ eff} / True\ eff]^2 \quad (4)$$

5. Explanation of the Validation Test Summary sheets

A summary sheet containing the results of all the tests performed in each of the 3 counting geometries (Field, Lab, and Collimator) is presented in Appendix B. Column 1 of the summary sheet gives the type of test that was performed. Column 2 indicates the source-detector distance in that particular test. Column 3 of the summary sheet shows the method that was used to generate the reference efficiency calibration (MCNP or standard sources).

Columns 4,5, and 6 contain the results for energies less than 150 keV. Column 4 gives the weighted average ratio of ISOCS/True efficiency, for each test. Column 5 has the weighted relative standard deviation for each test. Column 6 gives the relative standard deviation due to the ISOCS process. Columns 7, 8, and 9 contain the results for energies greater than 150 keV, and columns 10,11, and 12 give the results for all energies pooled together.

In some of the tests, the ISOCS/True efficiency ratio was unusually tightly distributed about the mean and the relative uncertainties in the reference efficiencies exceeded the relative standard deviation of the ratio. Under those circumstances, the ISOCS standard deviation could not be determined. In these cases, the standard deviation of the ratio is taken as a worst case estimate for the ISOCS standard deviation.

Note that, when taken individually, the relative ISOCS standard deviation for each test indicates the random uncertainty introduced by the ISOCS process. But when taken collectively as an average value for a large number of tests, the ISOCS standard deviation becomes a good estimate of the total error, as it also then includes the systematic error in the ISOCS process.

At the bottom of each summary sheet, the ISOCS / True efficiency ratios from all the validation tests in a given energy range, are averaged, weighted by their own standard deviations. The standard deviation of the data set is determined. The standard deviation of the weighted mean is also determined.

The standard deviations of the ISOCS to True efficiency ratios from the various tests are averaged. By comparing the observed standard deviation of the data set of the ratios to the average standard deviation, one can come to a conclusion regarding the shape of the data distribution. If the distribution is a Gaussian, then the observed standard deviation of the data set will be similar to the average standard deviation. If not, it is an indication that perhaps there are other processes adding to the uncertainty of the data set, such as biases, resulting in the non-Gaussian behavior.

Also given in Summary sheets are the chi-squared and reduced chi-squared values calculated for the data in each energy range. The expectation value of the chi-squared is given by,

$$<\chi^2> = \nu = N-1 \qquad (5)$$

where ν is the number of degrees of freedom, and N is the number of observations. The reduced chi-square is defined as,

$$\text{Reduced chi-square} = <\chi^2> / \nu \qquad (6)$$

The reduced chi-squared statistic is an indicator of how closely does the shape of the observed data distribution resemble the assumed Gaussian shape. A value of 1 is expected for a pure Gaussian.

6. Validation test results and discussion

Tables 2,3, and 4 summarize the results for the Field counting geometry, the Laboratory counting geometry, and the Collimated geometry, respectively.

Table 2: Results for Field Counting geometry

Results	Data < 150 keV	Data > 150 keV	All Data pooled
Weighted Average of ISOCS/True efficiency ratio	1.08	0.99	1.00
Uncertainty in wtd. mean	0.25%	0.34%	0.65%
Standard deviation of data	15.7%	7.3%	7.9%
Average standard deviation	11.6%	5.1%	8.1%
Avg. ISOCS standard deviation	**10.5%**	**4.4%**	7.2%
Chi-squared value	466.38	199.27	76.69
No. of degrees of freedom	43	46	46
Reduced chi-squared value	10.85	4.33	1.67

Table 3: Results for Laboratory Counting Geometry

Results	Data < 150 keV	Data > 150 keV	All Data pooled
Weighted Average of ISOCS/True efficiency ratio	1.01	1.05	1.04
Uncertainty in wtd. mean	0.24%	0.23%	0.76%
Standard deviation of data	11.2%	7.0%	7.3%
Average standard deviation	8.2%	4.7%	6.7%
Avg. ISOCS standard deviation	**7.1%**	**4.3%**	5.5%
Chi-squared value	739.13	304.74	75.72
No. of degrees of freedom	42	52	52
Reduced chi-squared value	17.60	5.86	1.46

Table 4: Results for Collimated Geometry

Results	Data < 150 keV	Data > 150 keV	All Data pooled
Weighted Average of ISOCS/True efficiency ratio	0.99	1.00	1.00
Uncertainty in wtd. mean	0.27%	0.46%	0.52%
Standard deviation of data	8.0%	13.0%	13.0%
Average standard deviation	6.0%	5.0%	6.0%
Avg. ISOCS standard deviation	**6.0%**	**4.0%**	5.0%
Chi-squared value	247..92	28.69	19.82
No. of degrees of freedom	18	20	20
Reduced chi-squared value	14.58	1.51	1.04

From the results given in tables 2,3, and 4, it is evident that the ISOCS/True efficiency ratio comes out reasonably close to 1. Using the statistical analysis presented in these tables, one can draw conclusions regarding the shape of the data distribution. If the standard deviation of the ISOCS/True efficiency ratio data comes out close to the average standard deviation of the ratio, then the distribution approaches a Gaussian. If not, perhaps there are biases in some of the individual tests, which make the distribution deviate from a Gaussian shape.

The chi-squared statistic reinforces the conclusion regarding the shape of the distribution. If the data conforms to a Gaussian shape, the chi-squared value will approach the number of degrees of freedom, and the reduced chi-squared value will be close to 1. If this is not the case, it points to the presence of biases in individual tests that contribute to the non-Gaussian behavior.

It is difficult to pinpoint the source(s) of the errors that make the data deviate from a Gaussian behavior. The source of error could be from ISOCS, the detector characterization process, or systematic errors in the measurement, or the systematic errors

in the standard source calibration, or from the MCNP simulation. This data set also covers detectors produced over a 3-year period, and certainly includes some earlier detectors and tests where we were still in the learning phase. However, every effort has been made to eliminate or alleviate the known biases affecting the data, but where this could not be done, the entire data set was included.

The collimator algorithm, similar to the one existing in version 3.0, handles both cylindrical and rectangular collimators. As seen from the results given in Table 4, the ISOCS/True efficiencies are essentially unity. The average standard deviation is much lower than that obtained with the previous collimator algorithm, and is now no different than the standard deviations for field geometry sources.

In addition to the tests included in this validation document, a large series of additional tests were performed to aid in the development and to determine the accuracy limits of the collimator algorithm. A point source geometry was modeled in MCNP as well as in ISOCS, with the detector viewing the source through a collimator. The point source was located on axis initially, and then moved progressively to off-axis locations, until the source was well beyond the penumbra of the collimator opening. The ISOCS/MCNP efficiency ratio was determined at each point source location. In most cases, the ratio was within a few percent of unity. The worst case was for a point source located into the penumbra, just beyond the umbra region, where the ISOCS efficiencies were commonly 10-20% smaller than the MCNP efficiencies. For collimators with small apertures (1 cm), the deviation from MCNP efficiencies was as much as 22%. For point locations inside the umbra and outside the penumbra regions, the ratios were close to unity. It must be remembered that in practical applications, collimated geometries are used to measure point sources on axis or large sources, not point sources off-axis. In the normal case, efficiency contribution from source regions within the field of view of the collimator completely overwhelms the contribution from the source points that are located in the penumbra region of the collimator.

Another source of bias in heavily shielded/collimated geometries is coherent scattering of photons. Coherent scattering is a low probability process in which scattering does not change the energy of the photon; therefore, the scattered photons may still be in the photopeak. Earlier tests using the total photon cross sections gave low ISOCS efficiencies in these cases. The current release of ISOCS now uses total minus coherent cross sections. Now the ISOCS efficiencies are higher than the true value, but a bit closer. It is important to note that this is only a "problem" for sources that are heavily attenuated by an external absorber.

7. Conclusions

7.1 Internal Consistency Tests

The results from the internal consistency tests are summarized in Table 1 in section 2.1. The ISOCS efficiency results in detail are presented in Appendix A for each test. The objective of these tests was to ensure that the ISOCS software handles the template geometries as intended, and calculates efficiencies in a consistent manner. If a given source geometry can be configured using different templates, then ISOCS should give the same efficiency values for the different templates. This was indeed the case in each one of the internal consistency tests.

7.2 Validation Tests

The validation test results reveal that the ISOCS efficiency calibration is fairly accurate for most applications. In all three geometry categories, namely, Field, Laboratory, and Collimated, the average ISOCS to True efficiency ratios were very close to unity. A new collimator algorithm has been devised and tested, and it has significantly improved the ISOCS efficiencies for collimated geometries. Also, a significantly updated detector characterization process has been developed and implemented in the current version of ISOCS and LabSOCS.

The average ISOCS standard deviations in columns 6, 9, and 12 of the Summary sheets are intended to give the user an approximation of the uncertainty in ISOCS efficiency computations. These values presented in the following table are suggested while entering the errors at various energies in the ISOCS software, and for the subsequent propagation in the total error analysis.

Condition	Rel. Std. Dev. (%)
Laboratory Sources	
50 - 100 keV	7.1
100 - 400 keV	5.5
400 - 7000 keV	4.3
Field Sources	
50 - 100 keV	10.5
100 - 400 keV	7.2
400 - 7000 keV	4.4
Collimated geometry	Same as Field

Under certain special conditions, an additional error factor should be added.

Additional error	Special Condition
5-10%	Very small sources (higher error at lower energies)
factor of 1.5	Heavy attenuation (transmission ~ 1E-02) in absorber between the source and the detector
factor of 2	Very heavy attenuation (transmission ~ 1E-04) in absorber between the source and the detector

Appendix A: Internal Consistency Test Results

This section consists of the detailed efficiency results for the internal consistency tests. Also included are the ISOCS input parameters that were used in each test. For each one of the identical geometry tests, the ISOCS efficiencies are tabulated at several energies for each source configuration. An average efficiency is determined at each energy and the deviation from the average is determined for each source configuration.

ISOCS 4.0 Internal Consistency Tests

Test 1: Templates 1 through 12 are reduced to "point sources" of volume 1 cc

(Filled with Water)

Parameters Used in Efficiency Calculations

Simple Box		*Complex Box*		*Rectangular Plane*		*Simple Cylinder*		*Sphere*	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	1cm	1-d.2	1 cm	1-d.2	1 cm	1-d.2	1.084 cm	1-d.2	1.2408 cm
1-d.3	1 cm	1-d.3	1 cm	1-d.3	1 cm	1-d.3	1.084 cm	2-d.1	0.6204 cm
1-d.4	1 cm	1-d.4	1cm	2-d.1	1 cm	3-d.1	1.084 cm	2-MI	Water
3-d.1	1 cm	5-d.1	1cm	2-MI	Water	3-MI	Water	2-Dens	1g/cc
3-MI	Water	5-MI	Water	2-Dens	1 g/cc	3-Dens	1 g/cc	2-SC	1
3-Dens	1.0 g/cc	5-Dens	1 gm/cc	2-SC	1	3-SC	1	6-d.1	500 cm
3-SC	1	5-SC	1	14-d.1	500 cm	6-d.1	500 cm	Det	Generic60
6-d.1	500 cm	9-d.1	500 cm	Det	Generic60	Det	Generic60	Coll	None
Det	Generic60	Det	Generic60	Coll	None	Coll	None		
Coll	None	Coll	None						

Complex Cylinder		*Circular Plane*		*Pipe*		*Marinelli*			
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1d.1	0 cm	4-d.1	1.084 cm
1-d.2	1.084 cm	1-d.2	1.084 cm	1-d.2	1.084 cm	1d.2	1.082 cm	4-MI	Water
1-d.3	1.084 cm	2-d.1	1.084 cm	1-d.3	0.542 cm	1-d.3	0 cm	4-D	1.0 g/cc
6-d.1	1.084 cm	2-MI	Water	1-d.4	0.542 cm	2-d.1	0 cm	4-SC	1
6-MI	Water	2-Dens	1 g/cc	2-d.1	0.542 cm	3-d.1	0.001	5-d.1	500 cm
6-Dens	1 g/cc	2-SC	1	2-d.2	0.542 cm	3-MI	Water	Det	Generic60
6-SC	1	14-d.1	500 cm	2-d.3	0.542 cm	3-D	1.0 g/cc	Coll	None
9-d.1	500 cm	Det	Generic60	2-MI	Water	3-SC	1		
Det	Generic60	Coll	None	2-Dens	1 g/cc				
Coll	None			2-SC	1				
				6-d.1	500 cm				
				Det	Generic60				
				Coll	None				

Exponent Circ Pln		*Beaker Template*	
Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0
1-d.2	1.084 cm	1-d.2	1.084 cm
5-d.1	1.084 cm	1-d.3	1.084 cm
5-d.2	0 cm	1-d.4	1.084 cm
5-d.3	1E+05 cm	3-d.1	1.084 cm
5-MI	Water	3-MI	Water
5-dens	1 g/cc	3-dens	1 g/cc
5-SC	1	3-SC	1
8-d.1	500 cm	6-d.1	500 cm
Det	Generic60	Det	Generic60
Coll	None		

Air Parameters: Temperature: 20 C Pressure: 760 mm of Hg Humidity: 50%

Convergence: 0.1%

MI = Material Identifier SC = Source Concentration Det = Ge detector Coll = Collimator

ISOCS VERSION 4.0
Test1: Templates 1cc in vol., filled with water, 5 m away
(Point Sources)

Simple Box		Complex Box		Rectangular Plane		Subtotal	Grand total	Average	Relative deviation from the average		
Energy	Efficiency	Energy	Efficiency	Energy	Efficiency			Efficiency	Simp. Box	Comp. Box	Rect. Plane
50	1.965E-06	50	1.965E-06	50	1.965E-06	5.894E-06	2.162E-05	1.966E-06	-0.05%	-0.05%	-0.05%
65	4.243E-06	65	4.243E-06	65	4.243E-06	1.273E-05	4.669E-05	4.245E-06	-0.04%	-0.04%	-0.04%
80	5.787E-06	80	5.787E-06	80	5.787E-06	1.736E-05	6.368E-05	5.789E-06	-0.04%	-0.04%	-0.04%
100	6.803E-06	100	6.803E-06	100	6.803E-06	2.041E-05	7.486E-05	6.805E-06	-0.04%	-0.04%	-0.04%
120	7.221E-06	120	7.221E-06	120	7.221E-06	2.166E-05	7.946E-05	7.224E-06	-0.03%	-0.03%	-0.03%
200	6.913E-06	200	6.913E-06	200	6.913E-06	2.074E-05	7.607E-05	6.915E-06	-0.03%	-0.03%	-0.03%
400	4.708E-06	400	4.708E-06	400	4.708E-06	1.412E-05	5.179E-05	4.708E-06	-0.02%	-0.02%	-0.02%
500	4.108E-06	500	4.108E-06	500	4.108E-06	1.232E-05	4.519E-05	4.109E-06	-0.01%	-0.01%	-0.01%
1000	2.700E-06	1000	2.700E-06	1000	2.700E-06	8.100E-06	2.970E-05	2.700E-06	-0.01%	-0.01%	-0.01%
2000	1.667E-06	2000	1.667E-06	2000	1.667E-06	5.002E-06	1.834E-05	1.667E-06	0.00%	0.00%	0.00%

Simple Cylinder		Complex Cylinder		Pipe		Subtotal	Relative deviation from the average		
Energy	Efficiency	Energy	Efficiency	Energy	Efficiency		Simp Cyl	Comp Cyl	Pipe
50	1.981E-06	50	1.981E-06	50	1.981E-06	5.942E-06	0.76%	0.76%	0.76%
65	4.274E-06	65	4.274E-06	65	4.274E-06	1.282E-05	0.69%	0.69%	0.69%
80	5.826E-06	80	5.826E-06	80	5.826E-06	1.748E-05	0.65%	0.65%	0.65%
100	6.847E-06	100	6.847E-06	100	6.847E-06	2.054E-05	0.61%	0.61%	0.61%
120	7.266E-06	120	7.266E-06	120	7.266E-06	2.180E-05	0.58%	0.58%	0.58%
200	6.950E-06	200	6.950E-06	200	6.950E-06	2.085E-05	0.50%	0.50%	0.50%
400	4.727E-06	400	4.727E-06	400	4.727E-06	1.418E-05	0.39%	0.39%	0.39%
500	4.123E-06	500	4.123E-06	500	4.123E-06	1.237E-05	0.36%	0.36%	0.36%
1000	2.707E-06	1000	2.707E-06	1000	2.707E-06	8.121E-06	0.26%	0.26%	0.26%
2000	1.670E-06	2000	1.670E-06	2000	1.670E-06	5.011E-06	0.18%	0.18%	0.18%

	Circ.Pl.	Exp. CP	Beaker	Marinelli	Sphere		Relative deviation from the average				
Energy	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Subtotal	Circ. Pl.	Exp. CP	Beaker	Marinelli	Sphere
50	1.951E-06	1.951E-06	1.954E-06	1.951E-06	1.979E-06	9.787E-06	-0.73%	-0.73%	-0.60%	-0.73%	0.66%
65	4.217E-06	4.217E-06	4.221E-06	4.217E-06	4.270E-06	2.114E-05	-0.66%	-0.66%	-0.55%	-0.66%	0.60%
80	5.753E-06	5.753E-06	5.759E-06	5.753E-06	5.821E-06	2.884E-05	-0.62%	-0.62%	-0.51%	-0.62%	0.56%
100	6.765E-06	6.765E-06	6.772E-06	6.765E-06	6.841E-06	3.391E-05	-0.59%	-0.59%	-0.49%	-0.59%	0.53%
120	7.183E-06	7.183E-06	7.190E-06	7.183E-06	7.260E-06	3.600E-05	-0.56%	-0.56%	-0.47%	-0.56%	0.50%
200	6.881E-06	6.881E-06	6.887E-06	6.881E-06	6.944E-06	3.448E-05	-0.49%	-0.49%	-0.40%	-0.49%	0.42%
400	4.690E-06	4.690E-06	4.693E-06	4.690E-06	4.724E-06	2.349E-05	-0.38%	-0.38%	-0.31%	-0.38%	0.32%
500	4.094E-06	4.094E-06	4.097E-06	4.094E-06	4.121E-06	2.050E-05	-0.35%	-0.35%	-0.29%	-0.35%	0.29%
1000	2.693E-06	2.693E-06	2.694E-06	2.693E-06	2.705E-06	1.348E-05	-0.25%	-0.25%	-0.21%	-0.25%	0.20%
2000	1.664E-06	1.664E-06	1.665E-06	1.664E-06	1.669E-06	8.327E-06	-0.18%	-0.18%	-0.15%	-0.18%	0.13%

ISOCS 4.0 Internal Consistency Tests

Test 2a: Beaker Template Vs Marinelli Beaker Template

Single wall material; thickness of end and side walls equal; Single source

Parameters used in Efficiency Calculations

Beaker Template (Top Only) Pre-defined container MB1.BKR		**Beaker Template (Top & Bottom)** Pre-defined container MB1.BKR		**Beaker Template (Bottom only)** Pre-defined container MB1.BKR		**Marinelli Beaker**	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
2-d.1	11.7 cm	2-d.1	4.0 cm	2-d.1	0 cm	1-d.1	0.2 cm
2-MI	DIRT2	2-MI	DIRT2	2-MI	N/A	1-d.2	8.0 cm
2-dens	1.6 g/cc	2-dens	1.6 g/cc	2-dens	N/A	1-d.3	7.5 cm
2-SC	1	2-SC	1	2-SC	N/A	1-MI	Polyethy
3-d.1	0 cm	3-d.1	7.7	3-d.1	11.7 cm	1-dens	0.9 g/cc
3-MI	N/A	3-MI	DIRT2	3-MI	DIRT2	2-d.1	0.2 cm
3-dens	N/A	3-dens	1.6 g/cc	3-dens	1.6 g/cc	2-MI	Polyethy
3-SC	N/A	3-SC	1	3-SC	1	2-dens	0.9 g/cc
6-d.1	0 cm	6-d.1	0 cm	6-d.1	0 cm	3-d.1	0.75 cm
DET	42% Coax	DET	42% Coax	DET	42% Coax	3-MI	DIRT2
						3-Dens	1.6 g/cc
						3-SC	1
						4-d.1	4.0 cm
						4-MI	DIRT2
						4-Dens	1.6 g/cc
						4-SC	1
						5-d.1	0 cm
						Det	42% Coax

Air Parameters: Temperature: 20 C Pressure: 0 mm of Hg Humidity: 0%

Convergence: 0.1%

ISOCS 4.0 Internal Consistency Tests

Test 2b: Beaker Template Vs Marinelli Beaker Template

Different wall materials; thickness of end and side walls equal;Single source

Parameters used in Efficiency Calculations

Beaker Template (Top Only)		**Beaker Template (Top & Bottom)**		**Beaker Template (Bottom only)**		**Marinelli Beaker**	
Pre-defined container		**Pre-defined container**		**Pre-defined container**			
MB2.BKR		**MB1.BKR**		**MB1.BKR**			
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
2-d.1	11.7 cm	2-d.1	4.0 cm	2-d.1	0 cm	1-d.1	0.2 cm
2-MI	DIRT2	2-MI	DIRT2	2-MI	N/A	1-d.2	8.0 cm
2-dens	1.6 g/cc	2-dens	1.6 g/cc	2-dens	N/A	1-d.3	7.5 cm
2-SC	1	2-SC	1	2-SC	N/A	1-MI	Polyethy
3-d.1	0 cm	3-d.1	7.7	3-d.1	11.7 cm	1-dens	0.9 g/cc
3-MI	N/A	3-MI	DIRT2	3-MI	DIRT2	2-d.1	0.2 cm
3-dens	N/A	3-dens	1.6 g/cc	3-dens	1.6 g/cc	2-MI	Fe
3-SC	N/A	3-SC	1	3-SC	1	2-dens	7.86 g/cc
6-d.1	0 cm	6-d.1	0 cm	6-d.1	0 cm	3-d.1	0.75 cm
DET	42% Coax	DET	42% Coax	DET	42% Coax	3-MI	DIRT2
						3-Dens	1.6 g/cc
						3-SC	1
						4-d.1	4.0 cm
						4-MI	DIRT2
						4-Dens	1.6 g/cc
						4-SC	1
						5-d.1	0 cm
						Det	42% Coax

Air Parameters: Temperature: 20 C Pressure: 0 mm of Hg Humidity: 0%

Convergence: 0.1%

ISOCS 4.0 Internal Consistency Tests

Test 2c: Beaker Template Vs Marinelli Beaker Template

Different wall materials; Different end & side wall thickness;Single source

Parameters used in Efficiency Calculations

Beaker Template (Top Only)		**Beaker Template (Top & Bottom)**		**Beaker Template (Bottom only)**		**Marinelli Beaker**	
Pre-defined container		**Pre-defined container**		**Pre-defined container**			
MB3.BKR		**MB3.BKR**		**MB3.BKR**			
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
2-d.1	11.7 cm	2-d.1	4.0 cm	2-d.1	0 cm	1-d.1	0.2 cm
2-MI	DIRT2	2-MI	DIRT2	2-MI	N/A	1-d.2	8.0 cm
2-dens	1.6 g/cc	2-dens	1.6 g/cc	2-dens	N/A	1-d.3	7.5 cm
2-SC	1	2-SC	1	2-SC	N/A	1-MI	Polyethy
3-d.1	0 cm	3-d.1	7.7	3-d.1	11.7 cm	1-dens	0.9 g/cc
3-MI	N/A	3-MI	DIRT2	3-MI	DIRT2	2-d.1	0.5 cm
3-dens	N/A	3-dens	1.6 g/cc	3-dens	1.6 g/cc	2-MI	Fe
3-SC	N/A	3-SC	1	3-SC	1	2-dens	7.86 g/cc
6-d.1	0 cm	6-d.1	0 cm	6-d.1	0 cm	3-d.1	0.75 cm
DET	42% Coax	DET	42% Coax	DET	42% Coax	3-MI	DIRT2
						3-Dens	1.6 g/cc
						3-SC	1
						4-d.1	3.7 cm
						4-MI	DIRT2
						4-Dens	1.6 g/cc
						4-SC	1
						5-d.1	0 cm
						Det	42% Coax

Air Parameters: Temperature: 20 C Pressure: 0 mm of Hg Humidity: 0%

Convergence: 0.1%

ISOCS 4.0 Internal Consistency Tests

Test 2d: Beaker Template Vs Marinelli Beaker Template

Different wall materials; Different end & side wall thickness;Two sources

Parameters used in Efficiency Calculations

Beaker Template (Top & Bottom) Pre-defined container MB3.BKR		**Marinelli Beaker**	
Cell	Dimension	Cell	Dimension
2-d.1	3.7 cm	1-d.1	0.2 cm
2-MI	DIRT2	1-d.2	8.0 cm
2-dens	1.6 g/cc	1-d.3	7.5 cm
2-SC	1	1-MI	Polyethy
3-d.1	8.0 cm	1-dens	0.9 g/cc
3-MI	DIRT2	2-d.1	0.5 cm
3-dens	1.6 g/cc	2-MI	Fe
3-SC	1	2-dens	7.86 g/cc
6-d.1	0 cm	3-d.1	0.75 cm
DET	42% Coax	3-MI	Uranium
		3-Dens	19 g/cc
		3-SC	1
		4-d.1	3.7 cm
		4-MI	Water
		4-Dens	1 g/cc
		4-SC	1
		5-d.1	0 cm
		Det	42% Coax

Air Parameters: Temperature: 20 C Pressure: 0 mm of Hg Humidity: 0%

Convergence: 0.1%

ISOCS version 4.0

Test 2: Beaker Template configured as different Marinelli Beakers and compared to **Marinelli Beaker Template**

Test 2a: Single wall material; thickness of side & end walls equal; single source material

Energy (keV)	Efficiency Results: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.	Average	Relative deviation: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.
59.54	1.405E-02	1.408E-02	1.405E-02	1.364E-02	1.396E-02	0.0069	0.0088	0.0069	-0.0225
88.03	3.631E-02	3.637E-02	3.631E-02	3.519E-02	3.605E-02	0.0074	0.0088	0.0074	-0.0236
122.06	4.731E-02	4.737E-02	4.731E-02	4.597E-02	4.699E-02	0.0068	0.0081	0.0068	-0.0217
165.85	4.749E-02	4.755E-02	4.749E-02	4.624E-02	4.719E-02	0.0063	0.0075	0.0063	-0.0202
391.69	2.926E-02	2.928E-02	2.926E-02	2.856E-02	2.909E-02	0.0058	0.0066	0.0058	-0.0182
661.65	2.009E-02	2.010E-02	2.009E-02	1.968E-02	1.999E-02	0.0050	0.0056	0.0050	-0.0156
898.02	1.657E-02	1.658E-02	1.657E-02	1.624E-02	1.649E-02	0.0048	0.0053	0.0048	-0.0150
1173.22	1.387E-02	1.387E-02	1.387E-02	1.361E-02	1.380E-02	0.0046	0.0050	0.0046	-0.0141
1332.49	1.272E-02	1.273E-02	1.272E-02	1.252E-02	1.267E-02	0.0039	0.0043	0.0039	-0.0121

Test 2b: Different side & end wall material; but thickness of walls equal; single source material

Energy (keV)	Efficiency Results: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.	Average	Relative deviation: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.
59.54	8.874E-03	8.868E-03	8.874E-03	8.617E-03	8.808E-03	0.0075	0.0067	0.0075	-0.0217
88.03	2.708E-02	2.709E-02	2.708E-02	2.627E-02	2.688E-02	0.0074	0.0080	0.0074	-0.0227
122.06	3.929E-02	3.936E-02	3.929E-02	3.828E-02	3.905E-02	0.0060	0.0078	0.0060	-0.0198
165.85	4.168E-02	4.176E-02	4.168E-02	4.072E-02	4.146E-02	0.0053	0.0073	0.0053	-0.0179
391.69	2.708E-02	2.712E-02	2.708E-02	2.651E-02	2.695E-02	0.0048	0.0065	0.0048	-0.0162
661.65	1.887E-02	1.890E-02	1.887E-02	1.852E-02	1.879E-02	0.0042	0.0057	0.0042	-0.0142
898.02	1.568E-02	1.570E-02	1.568E-02	1.541E-02	1.562E-02	0.0041	0.0054	0.0041	-0.0135
1173.22	1.321E-02	1.322E-02	1.321E-02	1.299E-02	1.316E-02	0.0039	0.0051	0.0039	-0.0129
1332.49	1.216E-02	1.217E-02	1.216E-02	1.198E-02	1.212E-02	0.0034	0.0045	0.0034	-0.0112

Test 2c: Different materials & different thickness for side & end walls; single source material

Energy (keV)	Efficiency Results: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.	Average	Relative deviation: Beaker Template Top only	Beaker Template Top & bot	Beaker Template Bot. only	MB templ.
59.54	8.596E-03	8.597E-03	8.596E-03	8.307E-03	8.524E-03	0.0084	0.0086	0.0084	-0.0255
88.03	2.322E-02	2.321E-02	2.322E-02	2.241E-02	2.302E-02	0.0089	0.0086	0.0089	-0.0263
122.06	3.356E-02	3.356E-02	3.356E-02	3.264E-02	3.333E-02	0.0068	0.0069	0.0068	-0.0206
165.85	3.641E-02	3.643E-02	3.641E-02	3.560E-02	3.621E-02	0.0055	0.0059	0.0055	-0.0168
391.69	2.447E-02	2.449E-02	2.447E-02	2.406E-02	2.438E-02	0.0041	0.0047	0.0041	-0.0128
661.65	1.730E-02	1.731E-02	1.730E-02	1.702E-02	1.723E-02	0.0039	0.0045	0.0039	-0.0124
898.02	1.448E-02	1.449E-02	1.448E-02	1.426E-02	1.443E-02	0.0038	0.0043	0.0038	-0.0119
1173.22	1.227E-02	1.228E-02	1.227E-02	1.209E-02	1.223E-02	0.0036	0.0041	0.0036	-0.0112
1332.49	1.133E-02	1.134E-02	1.133E-02	1.118E-02	1.130E-02	0.0033	0.0037	0.0033	-0.0103

Test 2d: Different materials & different thickness for side & end walls; Two different source material layers

Energy (keV)	Beaker Efficiency	Marinelli Efficiency	Average	Relative deviation: Beaker	Marinelli
59.54	2.241E-04	2.225E-04	2.233E-04	0.0035	-0.0035
88.03	1.677E-03	1.674E-03	1.675E-03	0.0010	-0.0010
122.06	1.828E-03	1.861E-03	1.845E-03	-0.0090	0.0090
165.85	3.389E-03	3.386E-03	3.388E-03	0.0004	-0.0004
391.69	9.945E-03	9.872E-03	9.908E-03	0.0037	-0.0037
661.65	1.275E-02	1.266E-02	1.270E-02	0.0036	-0.0036
898.02	1.296E-02	1.273E-02	1.284E-02	0.0087	-0.0087
1173.22	1.210E-02	1.189E-02	1.200E-02	0.0088	-0.0088
1332.49	1.153E-02	1.134E-02	1.143E-02	0.0086	-0.0086

ISOCS 4.0 Internal Consistency Tests

Test 3: Different Symmetries of Boxes, 1 cu.m in vol., 3 m away

(Filled with Fe @ 7.86 g/cc)

Parameters used in efficiency calculations

Simple Box		*Complex Box*		*Complex Box (with source detail)*		*Rectangular Plane*	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	100 cm	1-d.2	100 cm	1-d.2	100 cm	1-d.2	100 cm
1-d.3	100 cm	1-d.3	100 cm	1-d.3	100 cm	1-d.3	100 cm
1-d.4	100 cm	1-d.4	100 cm	1-d.4	100 cm	2-d.1	100 cm
3-d.1	100 cm	5-d.1	100 cm	6-d.1	100 cm	2-MI	Fe
3-MI	Fe	5-MI	Fe	6-d.2	100 cm	2-Dens	7.86 g/cc
3-Dens	7.86 g/cc	5-Dens	7.86 g/cc	6-d.3	100 cm	2-SC	1
3-SC	1	5-SC	1	6-d.4	0 cm	14-d.1	300 cm
6-d.1	300 cm	9-d.1	300 cm	6-d.5	0 cm	Det	Generic60
Det	Generic60	Det	Generic60	6-d.6	0 cm	Coll	None
Coll	None	Coll	None	6-MI	Air		
				6-Dens	0.0001 g/cc		
				6-SC	1		
				Det	Generic60		
				Coll	None		

Air Parameters: Temperature: 20 C Pressure: 760 mm of Hg Humidity: 50%

Convergence: 0.1%

ISOCS VERSION 3.0 and 4.0

Test 3: Different Symmetries of Boxes

(1 cu.m in volume, filled with Iron, 300 cm away)

Convergence = 0.1%

Energy	v3.0 Simple box Efficiency	v4.0 Simple box Efficiency	v3.0 Complx box1 Efficiency	v4.0 Complx box1 Efficiency	v3.0 Complx box2 (source conc) Efficiency	v4.0 Complx box2 (source conc) Efficiency	v3.0 Rect. Plane Efficiency	v4.0 Rect. Plane Efficiency	v3.0 Average Efficiency	v4.0 Average Efficiency	ratio v4.0 / v3.0
50	4.326E-09	**4.325E-09**	4.326E-09	**4.325E-09**	4.326E-09	**4.325E-09**	4.326E-09	**4.325E-09**	4.326E-09	**4.325E-09**	*9.996E-01*
65	1.907E-08	**1.905E-08**	1.907E-08	**1.905E-08**	1.907E-08	**1.905E-08**	1.907E-08	**1.905E-08**	1.907E-08	**1.905E-08**	*9.992E-01*
80	4.301E-08	**4.299E-08**	4.301E-08	**4.299E-08**	4.301E-08	**4.299E-08**	4.301E-08	**4.299E-08**	4.301E-08	**4.299E-08**	*9.996E-01*
100	8.092E-08	**8.090E-08**	8.092E-08	**8.090E-08**	8.092E-08	**8.090E-08**	8.092E-08	**8.090E-08**	8.092E-08	**8.090E-08**	*9.998E-01*
120	1.169E-07	**1.167E-07**	1.169E-07	**1.167E-07**	1.169E-07	**1.167E-07**	1.169E-07	**1.167E-07**	1.169E-07	**1.167E-07**	*9.988E-01*
200	1.957E-07	**1.956E-07**	1.957E-07	**1.956E-07**	1.957E-07	**1.956E-07**	1.957E-07	**1.956E-07**	1.957E-07	**1.956E-07**	*9.998E-01*
400	1.935E-07	**1.933E-07**	1.935E-07	**1.933E-07**	1.935E-07	**1.933E-07**	1.935E-07	**1.933E-07**	1.935E-07	**1.933E-07**	*9.994E-01*
500	1.840E-07	**1.839E-07**	1.840E-07	**1.839E-07**	1.840E-07	**1.839E-07**	1.840E-07	**1.839E-07**	1.840E-07	**1.839E-07**	*9.991E-01*
1000	1.632E-07	**1.631E-07**	1.632E-07	**1.631E-07**	1.632E-07	**1.631E-07**	1.632E-07	**1.631E-07**	1.632E-07	**1.631E-07**	*9.997E-01*
2000	1.383E-07	**1.383E-07**	1.383E-07	**1.383E-07**	1.383E-07	**1.383E-07**	1.383E-07	**1.383E-07**	1.383E-07	**1.383E-07**	*9.998E-01*

Relative deviation from average

Energy	v3.0 Simple Box	v4.0 Simple Box	v3.0 Complx box1	v4.0 Complx box1	v3.0 Complx box2	v4.0 Complx box2	v3.0 Rect. Plane	v4.0 Rect. Plane
50	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
65	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
80	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
100	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
120	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
200	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
400	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
500	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
1000	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**
2000	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**	0.00%	**0.00%**

ISOCS 4.0 Internal Consistency Tests					
Test 4: Cylindrical Symmeteries					
(Filled with Fe @ 7.86 g/cc)					
Simple Cylinder		**Complex Cylinder**		**Pipe 3: Source 2 fills**	
		(No Hot Spot)		**volume**	
Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	108.38 cm	1-d.2	108.38 cm	1-d.2	108.38 cm
1-d.3	108.38 cm	1-d.3	108.38 cm	1-d.3	54.19 cm
3-d.1	108.38 cm	6-d.1	108.38 cm	1-d.4	54.19 cm
3-MI	Fe	6-MI	Fe	3-d.1	108.38 cm
3-Dens	7.86 g/cc	6-Dens	7.86 g/cc	3-d.2	54.19 cm
3-SC	1	6-SC	1	3-d.3	54.19 cm
6-d.1	300 cm	9-d.1	300 cm	3-d.4	0 cm
Det	Generic60	Det	Generic60	3-d.5	0 deg
Coll	None	Coll	None	3-MI	Fe
				3-Dens	7.86 g/cc
				3-SC	1
				6-d.1	300 cm
				Det	Generic60
				Coll	None
Pipe 1: Source 1 fills			**Pipe 2: Sources 1 & 2**		
volume			**present**		
Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	3-d.1	54 cm
1-d.2	108.38 cm	1-d.2	108.38 cm	3-d.2	54.19 cm
1-d.3	54.19 cm	1-d.3	54.19 cm	3-d.3	54.19 cm
1-d.4	54.19 cm	1-d.4	54.19 cm	3-d.4	0 cm
2-d.1	54.19 cm	2-d.1	27.19 cm	3-d.5	0 deg
2-d.2	54.19 cm	2-d.2	54.19 cm	3-MI	Fe
2-d.3	54.19 cm	2-d.3	54.19 cm	3-Dens	7.86 g/cc
2-MI	Fe	2-MI	Fe	3-SC	1
2-Dens	7.86 g/cc	2-Dens	7.86 g/cc	6-d.1	300 cm
2-SC	1	2-SC	1	Det	Generic60
6-d.1	300 cm			Coll	None
Det	Generic60				
Coll	None				
Air Parameters: Temperature: 20 C Pressure: 760 mm of Hg Humidity: 50%					
Convergence: 0.1% , 0.001% (for Fe)					

ISOCS VERSION 3.0 and 4.0

Test 4: Different Cylindrical Symmetries

Templates filled with Iron, convergence 0.1%

Simple Cylinder

Energy	v3.0 Efficiency	v4.0 Efficiency
50	4.233E-09	4.229E-09
65	1.865E-08	1.865E-08
80	4.209E-08	4.209E-08
100	7.926E-08	7.913E-08
120	1.145E-07	1.142E-07
200	1.920E-07	1.918E-07
400	1.901E-07	1.897E-07
500	1.811E-07	1.808E-07
1000	1.610E-07	1.608E-07
2000	1.367E-07	1.368E-07

Complex Cylinder (No Hot Spot)

Energy	v3.0 Efficiency	v4.0 Efficiency
50	4.233E-09	4.229E-09
65	1.865E-08	1.865E-08
80	4.209E-08	4.209E-08
100	7.926E-08	7.913E-08
120	1.145E-07	1.142E-07
200	1.920E-07	1.918E-07
400	1.901E-07	1.897E-07
500	1.811E-07	1.808E-07
1000	1.610E-07	1.608E-07
2000	1.367E-07	1.368E-07

Pipe 3: Source 2 fills volume

Energy	v3.0 Efficiency	v4.0 Efficiency
50	4.233E-09	4.229E-09
65	1.865E-08	1.865E-08
80	4.209E-08	4.209E-08
100	7.926E-08	7.913E-08
120	1.145E-07	1.142E-07
200	1.920E-07	1.918E-07
400	1.901E-07	1.897E-07
500	1.811E-07	1.808E-07
1000	1.610E-07	1.608E-07
2000	1.367E-07	1.368E-07

Relative Deviation from Simple cyl

Simp. Cyl v3.0	Simp. Cyl v4.0	Comp cyl v3.0	Comp cyl v4.0	Pipe 3 v3.0	Pipe 3 v4.0
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Pipe 1: Source 1 fills volume

Energy	v3.0 Efficiency	v4.0
50	4.231E-09	4.191E-09
65	1.819E-08	1.851E-08
80	4.184E-08	4.180E-08
100	7.889E-08	7.884E-08
120	1.142E-07	1.140E-07
200	1.903E-07	1.915E-07
400	1.886E-07	1.897E-07
500	1.799E-07	1.808E-07
1000	1.602E-07	1.609E-07
2000	1.362E-07	1.368E-07

Pipe 2: Sources 1 &2 present

Energy	v3.0 Efficiency	v4.0
50	4.230E-09	4.229E-09
65	1.864E-08	1.865E-08
80	4.208E-08	4.209E-08
100	7.925E-08	7.912E-08
120	1.145E-07	1.142E-07
200	1.921E-07	1.918E-07
400	1.902E-07	1.897E-07
500	1.812E-07	1.808E-07
1000	1.605E-07	1.608E-07
2000	1.364E-07	1.368E-07

Pipe 3: Source 2 fills volume

Energy	v3.0 Efficiency	v4.0
50	4.233E-09	4.229E-09
65	1.865E-08	1.865E-08
80	4.209E-08	4.209E-08
100	7.926E-08	7.913E-08
120	1.145E-07	1.142E-07
200	1.920E-07	1.918E-07
400	1.901E-07	1.897E-07
500	1.811E-07	1.808E-07
1000	1.610E-07	1.608E-07
2000	1.367E-07	1.368E-07

Average v3.0	Average v4.0
4.231E-09	4.216E-09
1.849E-08	1.860E-08
4.200E-08	4.199E-08
7.913E-08	7.903E-08
1.144E-07	1.141E-07
1.915E-07	1.917E-07
1.896E-07	1.897E-07
1.807E-07	1.808E-07
1.606E-07	1.609E-07
1.364E-07	1.368E-07

Relative Deviation from Average

Pipe 1 v3.0	Pipe 1 v4.0	Pipe 2 v3.0	Pipe 2 v4.0	Pipe 3 v3.0	Pipe 3 v4.0
-0.01%	-0.61%	-0.02%	0.31%	0.03%	0.30%
-1.65%	-0.48%	0.81%	0.24%	0.84%	0.24%
-0.39%	-0.47%	0.19%	0.23%	0.20%	0.24%
-0.30%	-0.23%	0.15%	0.11%	0.15%	0.12%
-0.19%	-0.11%	0.10%	0.05%	0.09%	0.06%
-0.61%	-0.10%	0.32%	0.05%	0.29%	0.05%
-0.53%	0.00%	0.27%	0.00%	0.25%	0.00%
-0.48%	0.00%	0.25%	0.00%	0.23%	0.00%
-0.23%	0.02%	-0.02%	-0.01%	0.26%	-0.01%
-0.17%	0.04%	-0.01%	-0.02%	0.18%	-0.02%

ISOCS 4.0 Internal Consistency Tests

Test 5: Different Spherical Symmetries
(Filled with Fe @ 7.86 g/cc)

Parameters used in Efficiency Calculations

Spherical hot spot in a complex cylinder		**Sphere w/source shell filling the volume**		**Sphere w/ no source shell, volume filled**		**Sphere: 50% src shell 50% volume**	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	108.38 cm	1-d.2	108.38 cm	1-d.2	108.38 cm	1-d.2	108.38 cm
1-d.3	108.38 cm	2-d.1	54.19 cm	3-MI	Fe	2-d.1	27.095 cm
2-d.1	108.38 cm	2-MI	Fe	3-Dens	7.86 g/cc	2-MI	Fe
2-d.2	54.19 cm	2-Dens	7.86 g/cc	3-SC	1	2-Dens	7.86 g/cc
2-d.3	0 cm	2-SC	1	6-d.1	300 cm	2-SC	1
2-d.4	0 deg	6-d.1	300 cm	Det	Generic60	3-MI	Fe
2-MI	Fe	Det	Generic60	Coll	None	3-Dens	7.86 g/cc
2-Dens	7.86 g/cc	Coll	None			3-SC	1
2-SC	1					6-d.1	300 cm
6-d.1	108.38 cm					Det	Generic60
6-MI	Fe					Coll	None
6-Dens	7.86 g/cc						
6-SC	0						
9-d.1	300 cm						
Det	Generic60						
Coll	None						

Beaker Template	
Pre-defined container	
SP32_2.BKR	
Cell	Dimension
3-d.1	10.838 cm
3-MI	Fe
3-dens	7.86 g/cc
3-SC	1
6-d.1	100 cm
DET	Generic60

Air Parameters: Temperature: 20 C Pressure: 760 mm of Hg Humidity: 50%

Convergence: 0.1% , 0.001% (for Fe)

ISOCS VERSION 3.0 and 4.0

Test 5: Different Spherical Symmeteries
(Templates filled with Iron, 0.1% Convergence)

Energy	Spherical hot Spot filling cylinder v3.0 Efficiency	v4.0 Efficiency	Energy	Sphere, w/source shell filling the volume v3.0 Efficiency	v4.0 Efficiency	Energy	Sphere w/ no shell, source volume filled v3.0 Efficiency	v4.0 Efficiency	Energy	Sphere w/ 50% shell, 50% source volume v3.0 Efficiency	v4.0 Efficiency	Energy	Beaker Template v3.0 Efficiency	v4.0 Efficiency
50	5.457E-07	5.444E-07	50	5.457E-07	5.442E-07	50	5.457E-07	5.442E-07	50	5.457E-07	5.478E-07	50	5.448E-07	5.470E-07
65	2.37E-06	2.375E-06	65	2.371E-06	2.374E-06	65	2.371E-06	2.374E-06	65	2.370E-06	2.377E-06	65	2.369E-06	2.373E-06
80	5.291E-06	5.314E-06	80	5.281E-06	5.312E-06	80	5.281E-06	5.312E-06	80	5.299E-06	5.313E-06	80	5.299E-06	5.304E-06
100	9.769E-06	9.803E-06	100	9.745E-06	9.800E-06	100	9.745E-06	9.800E-06	100	9.778E-06	9.807E-06	100	9.779E-06	9.780E-06
120	1.398E-05	1.402E-05	120	1.396E-05	1.401E-05	120	1.396E-05	1.401E-05	120	1.398E-05	1.402E-05	120	1.399E-05	1.399E-05
200	2.282E-05	2.284E-05	200	2.279E-05	2.284E-05	200	2.279E-05	2.284E-05	200	2.280E-05	2.285E-05	200	2.283E-05	2.282E-05
400	2.165E-05	2.166E-05	400	2.163E-05	2.166E-05	400	2.163E-05	2.166E-05	400	2.163E-05	2.167E-05	400	2.16E-05	2.163E-05
500	2.046E-05	2.047E-05	500	2.044E-05	2.047E-05	500	2.044E-05	2.047E-05	500	2.045E-05	2.048E-05	500	2.042E-05	2.045E-05
1000	1.759E-05	1.758E-05	1000	1.758E-05	1.758E-05	1000	1.758E-05	1.758E-05	1000	1.758E-05	1.763E-05	1000	1.757E-05	1.756E-05
2000	1.382E-05	1.383E-05	2000	1.381E-05	1.383E-05	2000	1.381E-05	1.383E-05	2000	1.382E-05	1.384E-05	2000	1.381E-05	1.380E-05

Energy	Ave. Eff. v3.0	Ave. Eff. v4.0	Relative deviation: Sphere in Comp cyl v3.0	Sphere in Comp cyl v4.0	Shell filling the volume v3.0	Shell filling the volume v4.0	No Shell v3.0	No Shell v4.0	Shell 50% Vol. 50% v3.0	Shell 50% Vol. 50% v4.0	Beaker v3.0	Beaker v4.0
50	5.454E-07	5.452E-07	0.05%	-0.15%	0.06%	-0.18%	0.06%	-0.18%	-0.06%	-0.47%	0.11%	-0.33%
65	2.370E-06	2.374E-06	0.00%	0.04%	0.04%	0.01%	0.04%	0.01%	0.01%	-0.12%	0.04%	0.04%
80	5.290E-06	5.310E-06	0.01%	0.07%	-0.17%	0.04%	-0.17%	0.04%	-0.16%	-0.05%	-0.16%	0.11%
100	9.764E-06	9.794E-06	0.05%	0.09%	-0.20%	0.06%	-0.20%	0.06%	-0.14%	-0.14%	-0.15%	0.14%
120	1.397E-05	1.401E-05	0.03%	0.06%	-0.12%	0.04%	-0.12%	0.04%	-0.08%	-0.13%	-0.10%	0.10%
200	2.281E-05	2.283E-05	0.05%	0.04%	-0.11%	0.02%	-0.11%	0.02%	0.06%	-0.10%	-0.07%	0.06%
400	2.163E-05	2.165E-05	0.11%	0.05%	0.00%	0.03%	0.00%	0.03%	-0.04%	-0.09%	0.11%	0.08%
500	2.044E-05	2.046E-05	0.10%	0.04%	0.00%	0.03%	0.00%	0.03%	-0.03%	-0.08%	0.10%	0.07%
1000	1.758E-05	1.758E-05	0.05%	0.04%	-0.01%	0.03%	-0.01%	0.03%	-0.01%	-0.28%	0.03%	0.07%
2000	1.382E-05	1.382E-05	0.03%	0.08%	-0.01%	0.07%	-0.01%	0.07%	-0.01%	-0.19%	0.02%	0.16%

ISOCS 4.0 Internal Consistency Tests

Test 6: Different Configurations of Marinelli

(1 cu.m in vol., filled with Water)

Parameters used in Efficiency Calculations

Bottom ~100%		**Top 50%, Bot 50%**		**Bottom ~ 0%**		**Circular Plane**	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	108 cm	1-d.2	0 cm	1-d.2	0 cm	1-d.2	108.38 cm
1-d.3	0 cm	1-d.3	54.19 cm	1-d.3	108.28 cm	2-d.1	108.38 cm
2-d.1	0 cm	2-d.1	0 cm	2-d.1	0 cm	2-MI	Water
3-d.1	0.19 cm	3-d.1	54.19 cm	3-d.1	54.19 cm	2-Dens	1 g/cc
3-MI	Water	3-MI	Water	3-MI	Water	2-SC	1
3-Dens	1 g/cc	3-Dens	1 g/cc	3-Dens	1 g/cc	14-d.1	300 cm
3-SC	1	3-SC	1	3-SC	1	Det	Generic60
4-d.1	108.38	4-d.1	54.19 cm	4-d.1	0.1 cm	Coll	None
4-MI	Water	4-MI	Water	4-MI	Water		
4-Dens	1 g/cc	4-Dens	1 g/cc	4-Dens	1		
4-SC	1	4-SC	1	4-SC	1 g/cc		
5-d.1	300 cm	5-d.1	354.19 cm	5-d.1	408.28 cm		
Det	Generic60	Det	Generic60	Det	Generic60		
Coll	None	Coll	None	Coll	None		

Exponential Circ. Pln		**Beaker Template**		**Beaker Template**	
				Pre-defined container	
				TEST6_6.BKR	
Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	3-d.1	108 cm
1-d.2	108.38 cm	1-d.2	108 cm	3-MI	Water
5-d.1	108.38 cm	1-d.3	108 cm	3-dens	1 g/cc
5-d.2	0 cm	1-d.4	108 cm	3-SC	1
5-d.3	1E+06 cm	3-d.1	108 cm	6-d.1	300 cm
5-MI	Water	3-MI	Water	DET	Generic60
5-dens	1 g/cc	3-dens	1 g/cc		
5-SC	1	3-SC	1		
8-d.1	300 cm	6-d.1	300 cm		
DET	Geneic60	DET	Generic60		

Air Parameters: Temperature: 20 C Pressure: 0 mm of Hg Humidity: 0%

Convergence: 0.1%

ISOCS VERSION 3.0 and 4.0

Test 6: Different configurations of Marinelli geometry and Circular Planes
(1 cu.m in volume, filled with water, 300 cm away)

	Marinelli 1 Bottom ~ 100%		Marinelli 2 Top 50%, Bot 50%		Marinelli 3 Bottom ~0%		Beaker 1 From UIM Screen		Beaker 2 From Beaker File		Exponential Circ. Pl		Circular Plane	
	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0
Energy	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
50	2.685E-07	2.715E-07	2.683E-07	2.708E-07	2.683E-07	2.712E-07	2.686E-07	2.748E-07	2.685E-07	2.747E-07	2.685E-07	2.696E-07	2.701E-07	2.715E-07
65	6.347E-07	6.411E-07	6.341E-07	6.396E-07	6.342E-07	6.405E-07	6.349E-07	6.483E-07	6.347E-07	6.481E-07	6.345E-07	6.368E-07	6.381E-07	6.412E-07
80	9.113E-07	9.199E-07	9.103E-07	9.178E-07	9.104E-07	9.191E-07	9.115E-07	9.298E-07	9.113E-07	9.296E-07	9.108E-07	9.147E-07	9.158E-07	9.201E-07
100	1.139E-06	1.150E-06	1.138E-06	1.147E-06	1.138E-06	1.149E-06	1.140E-06	1.161E-06	1.139E-06	1.161E-06	1.139E-06	1.143E-06	1.145E-06	1.150E-06
120	1.262E-06	1.273E-06	1.261E-06	1.270E-06	1.261E-06	1.272E-06	1.262E-06	1.285E-06	1.262E-06	1.285E-06	1.261E-06	1.266E-06	1.268E-06	1.273E-06
200	1.373E-06	1.383E-06	1.371E-06	1.380E-06	1.371E-06	1.382E-06	1.373E-06	1.395E-06	1.373E-06	1.395E-06	1.371E-06	1.376E-06	1.378E-06	1.383E-06
400	1.162E-06	1.170E-06	1.160E-06	1.167E-06	1.161E-06	1.168E-06	1.162E-06	1.187E-06	1.162E-06	1.187E-06	1.160E-06	1.164E-06	1.165E-06	1.170E-06
500	1.091E-06	1.098E-06	1.089E-06	1.095E-06	1.090E-06	1.097E-06	1.091E-06	1.126E-06	1.091E-06	1.126E-06	1.089E-06	1.092E-06	1.094E-06	1.098E-06
1000	9.332E-07	9.382E-07	9.314E-07	9.357E-07	9.324E-07	9.373E-07	9.334E-07	9.577E-07	9.332E-07	9.576E-07	9.317E-07	9.338E-07	9.350E-07	9.383E-07
2000	7.877E-07	7.916E-07	7.861E-07	7.891E-07	7.870E-07	7.909E-07	7.878E-07	8.035E-07	7.877E-07	8.034E-07	7.859E-07	7.879E-07	7.887E-07	7.917E-07

	Average Efficiency	
Energy	v3.0	v4.0
50	**2.687E-07**	**2.720E-07**
65	**6.351E-07**	**6.422E-07**
80	**9.118E-07**	**9.216E-07**
100	**1.140E-06**	**1.152E-06**
120	**1.263E-06**	**1.275E-06**
200	**1.373E-06**	**1.385E-06**
400	**1.162E-06**	**1.173E-06**
500	**1.091E-06**	**1.104E-06**
1000	**9.331E-07**	**9.426E-07**
2000	**7.875E-07**	**7.940E-07**

Relative devn from the average

	Marinl 1		Marinl. 2		Marinl. 3		Beaker1		Beaker2		Exp. CP		Circ. Pl.	
	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0	v3.0	v4.0
	-0.064%	-0.199%	-0.145%	-0.437%	-0.158%	0.932%	-0.035%	2.255%	-0.064%	2.225%	-0.060%	0.319%	0.526%	1.057%
	-0.060%	-0.176%	-0.158%	-0.414%	-0.153%	0.845%	-0.036%	2.071%	-0.060%	2.047%	-0.095%	0.262%	0.466%	0.963%
	-0.052%	-0.176%	-0.158%	-0.412%	-0.146%	0.801%	-0.031%	1.972%	-0.052%	1.951%	-0.109%	0.318%	0.439%	0.917%
	-0.043%	-0.160%	-0.160%	-0.397%	-0.136%	0.765%	-0.028%	1.876%	-0.043%	1.860%	-0.124%	0.293%	0.409%	0.875%
	-0.037%	-0.149%	-0.159%	-0.382%	-0.131%	0.737%	-0.025%	1.801%	-0.037%	1.787%	-0.134%	0.273%	0.389%	0.845%
	-0.024%	-0.115%	-0.165%	-0.352%	-0.118%	0.652%	-0.011%	1.588%	-0.024%	1.574%	-0.112%	0.210%	0.342%	0.759%
	-0.006%	-0.318%	-0.168%	-0.555%	-0.099%	0.546%	0.005%	2.182%	-0.006%	2.171%	-0.158%	0.137%	0.275%	0.651%
	-0.001%	-0.616%	-0.172%	-0.857%	-0.094%	0.516%	0.011%	3.211%	-0.001%	3.198%	-0.170%	0.116%	0.257%	0.622%
	0.013%	-0.475%	-0.179%	-0.740%	-0.080%	0.450%	0.027%	2.640%	0.013%	2.626%	-0.155%	0.069%	0.205%	0.557%
	0.026%	-0.303%	-0.179%	-0.616%	-0.066%	0.428%	0.037%	2.027%	0.026%	2.017%	-0.197%	0.054%	0.155%	0.531%

ISOCS 4.0 Internal Consistency Tests

Test 7: Infinitely large sources, filled with water, at 1 meter

Parameters used in Massemetric Efficiency Calculations

Simple Box		*Complex Box*		*Rectangular Plane*		*Circular Plane*	
Cell	Dimension	Cell	Dimension	Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm	1-d.1	0 cm
1-d.2	7500 cm	1-d.2	7500 cm	1-d.2	7500 cm	1-d.2	7500 cm
1-d.3	7500 cm	1-d.3	7500 cm	1-d.3	7500 cm	2-d.1	100 cm
1-d.4	100 cm	1-d.4	100 cm	2-d.1	100 cm	2-MI	Water
3-d.1	7500 cm	5-d.1	7500 cm	2-MI	Water	2-Dens	1 g/cc
3-MI	Water	5-MI	Water	2-Dens	1.0 g/cc	2-SC	1
3-Dens	1.0 g/cc	5-Dens	1.0 g/cc	2-SC	1	14-d.1	100 cm
3-SC	1	5-SC	1	14-d.1	100 cm	Det	42% Coax
6-d.1	100 cm	9-d.1	100 cm	Det	42% Coax	Coll	None
Det	42% Coax	Det	42% Coax	Coll	None		
Coll	None	Coll	None				

Exponential Circ. Pln		**Beaker Template**	
Cell	Dimension	Cell	Dimension
1-d.1	0 cm	1-d.1	0 cm
1-d.2	7500 cm	1-d.2	7500 cm
5-d.1	100 cm	1-d.3	7500 cm
5-d.2	0 cm	1-d.4	100 cm
5-d.3	1E+06 cm	3-d.1	100 cm
5-MI	Water	3-MI	Water
5-dens	1 g/cc	3-dens	1 g/cc
8-d.1	100 cm	6-d.1	100 cm
DET	42% Coax	DET	42% Coax

Air Parameters: Temperature: 20 C Pressure: 760 mm of Hg Humidity: 50%

Convergence: 0.01% , 0.001%

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Test 7: Infinitely large sources of water, 1 m away from the detector

(Convergence = 0.1 %)

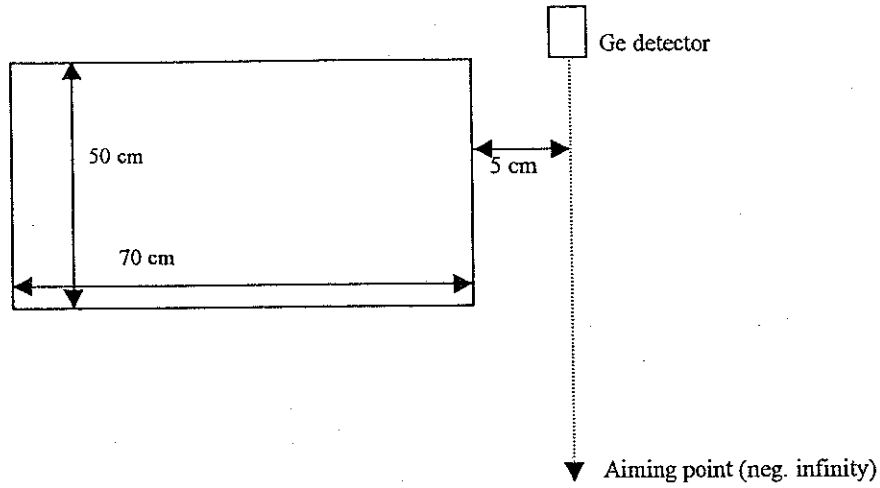
Energy	Simple Box 75m,75m,1m Effy.*mass v3.0	Effy.*mass v4.0	Compl. Box 75m,75m,1m Effy.*mass v3.0	v4.0	Rect. Plane 75m,75m,1m Effy.*mass v3.0	v4.0	Circ. Plane d=75m, t=1m Effy.*mass v3.0	v4.0	Exp. CP d=75m, t=1m Effy.*mass v3.0	v4.0	Beaker d=75m, t=1m Effy.*mass v3.0	v4.0
50	8.101E+00	7.975E+00	8.101E+00	7.975E+00	8.101E+00	7.975E+00	7.997E+00	7.967E+00	7.998E+00	7.997E+00	7.874E+00	7.968E+00
65	2.632E+01	2.613E+01	2.632E+01	2.613E+01	2.632E+01	2.613E+01	2.621E+01	2.614E+01	2.621E+01	2.622E+01	2.589E+01	2.614E+01
80	4.355E+01	4.336E+01	4.355E+01	4.336E+01	4.355E+01	4.336E+01	4.349E+01	4.338E+01	4.349E+01	4.351E+01	4.301E+01	4.338E+01
100	5.951E+01	5.937E+01	5.951E+01	5.937E+01	5.951E+01	5.937E+01	5.954E+01	5.934E+01	5.954E+01	5.961E+01	5.894E+01	5.934E+01
120	6.832E+01	6.821E+01	6.832E+01	6.821E+01	6.832E+01	6.821E+01	6.840E+01	6.817E+01	6.840E+01	6.849E+01	6.776E+01	6.818E+01
200	7.372E+01	7.359E+01	7.372E+01	7.359E+01	7.372E+01	7.359E+01	7.380E+01	7.354E+01	7.380E+01	7.385E+01	7.316E+01	7.354E+01
400	5.983E+01	5.971E+01	5.983E+01	5.971E+01	5.983E+01	5.971E+01	5.990E+01	5.969E+01	5.990E+01	5.990E+01	5.944E+01	5.969E+01
500	5.535E+01	5.524E+01	5.535E+01	5.524E+01	5.535E+01	5.524E+01	5.539E+01	5.521E+01	5.540E+01	5.539E+01	5.500E+01	5.521E+01
1000	4.524E+01	4.515E+01	4.524E+01	4.515E+01	4.524E+01	4.515E+01	4.523E+01	4.510E+01	4.523E+01	4.523E+01	4.497E+01	4.510E+01
2000	4.005E+01	4.004E+01	4.005E+01	4.004E+01	4.005E+01	4.004E+01	4.005E+01	3.996E+01	4.006E+01	4.005E+01	3.987E+01	3.996E+01

Relative deviation from the average

Energy	Average Effy.*mass v3.0	Average Effy.*mass v4.0	Simple Box v3.0	Simple Box v4.0	Compl. Box v3.0	Compl. Box v4.0	Rect. Plane v3.0	Rect. Plane v4.0	Circ. Plane v3.0	Circ. Plane v4.0	Exp. CP v3.0	Exp. CP v4.0	Beaker v3.0	Beaker v4.0
50	8.029E+00	7.976E+00	0.90%	-0.02%	0.90%	-0.02%	0.90%	-0.02%	-0.39%	-0.11%	-0.39%	0.27%	-1.92%	-0.10%
65	2.621E+01	2.615E+01	0.42%	-0.07%	0.42%	-0.07%	0.42%	-0.07%	-0.01%	-0.04%	-0.01%	0.28%	-1.24%	-0.03%
80	4.344E+01	4.339E+01	0.26%	-0.07%	0.26%	-0.07%	0.26%	-0.07%	0.11%	-0.04%	0.12%	0.27%	-1.00%	-0.03%
100	5.943E+01	5.940E+01	0.15%	-0.05%	0.15%	-0.05%	0.15%	-0.05%	0.19%	-0.10%	0.19%	0.36%	-0.82%	-0.10%
120	6.826E+01	6.825E+01	0.10%	-0.05%	0.10%	-0.05%	0.10%	-0.05%	0.21%	-0.11%	0.22%	0.35%	-0.73%	-0.10%
200	7.365E+01	7.362E+01	0.09%	-0.04%	0.09%	-0.04%	0.09%	-0.04%	0.20%	-0.11%	0.20%	0.32%	-0.67%	-0.10%
400	5.979E+01	5.973E+01	0.07%	-0.04%	0.07%	-0.04%	0.07%	-0.04%	0.18%	-0.08%	0.19%	0.28%	-0.58%	-0.08%
500	5.531E+01	5.525E+01	0.08%	-0.03%	0.08%	-0.03%	0.08%	-0.03%	0.16%	-0.08%	0.16%	0.25%	-0.56%	-0.08%
1000	4.519E+01	4.515E+01	0.11%	0.00%	0.11%	0.00%	0.11%	0.00%	0.08%	-0.10%	0.09%	0.19%	-0.49%	-0.09%
2000	4.002E+01	4.001E+01	0.07%	0.06%	0.07%	0.06%	0.07%	0.06%	0.08%	-0.14%	0.09%	0.10%	-0.37%	-0.14%

Test 8: Symmetry tests for Off-axis Marinelli beakers and Cylinders

For Marinellis, Circular Plane and Beaker sources, detector translated by 40 cm;
For cylindrical sources, detector translated by 25 cm, and rotated to aim at -(infinity)



ISOCS/LabSOCS Efficiencies

Energy (keV)	Marinelli (Bottom)	Marinelli (Top)	Circ. Pl.	Exp. CP	Pipe (Src 1)	Pipe (Src 2)	Simp.Cyl.	Beaker (UIM)	Beaker (*.BKR)	Energy (keV)	Average
59.5	3.614E-05	3.613E-05	3.614E-05	3.617E-05	3.617E-05	3.617E-05	3.618E-05	3.618E-05	3.615E-05	59.5	**3.616E-05**
88	9.276E-05	9.274E-05	9.276E-05	9.277E-05	9.277E-05	9.277E-05	9.254E-05	9.254E-05	9.281E-05	88	**9.272E-05**
122.1	1.251E-04	1.250E-04	1.251E-04	1.251E-04	1.251E-04	1.251E-04	1.247E-04	1.247E-04	1.251E-04	122.1	**1.250E-04**
165.9	1.333E-04	1.333E-04	1.333E-04	1.333E-04	1.333E-04	1.333E-04	1.328E-04	1.328E-04	1.334E-04	165.9	**1.332E-04**
391.7	1.028E-04	1.028E-04	1.028E-04	1.028E-04	1.028E-04	1.028E-04	1.026E-04	1.026E-04	1.029E-04	391.7	**1.028E-04**
661.7	8.248E-05	8.248E-05	8.248E-05	8.262E-05	8.262E-05	8.262E-05	8.236E-05	8.236E-05	8.238E-05	661.7	**8.249E-05**
898	7.607E-05	7.607E-05	7.607E-05	7.622E-05	7.622E-05	7.622E-05	7.602E-05	7.602E-05	7.598E-05	898	**7.610E-05**
1173	6.951E-05	6.943E-05	6.951E-05	6.953E-05	6.953E-05	6.953E-05	6.943E-05	6.952E-05	6.943E-05	1173	**6.949E-05**
1332	6.714E-05	6.697E-05	6.714E-05	6.708E-05	6.708E-05	6.708E-05	6.697E-05	6.714E-05	6.707E-05	1332	**6.708E-05**

Relative deviation from the average

Energy (keV)	Marinelli (Bottom)	Marinelli (Top)	Circ. Pl.	Exp. CP	Pipe (Src 1)	Pipe (Src 2)	Simp.Cyl.	Beaker (UIM)	Beaker (*.BKR)
59.5	-0.06%	-0.08%	-0.06%	0.03%	0.03%	0.03%	0.07%	0.07%	-0.03%
88	0.04%	0.03%	0.04%	0.06%	0.06%	0.06%	-0.19%	-0.19%	0.10%
122.1	0.05%	0.04%	0.05%	0.08%	0.08%	0.08%	-0.24%	-0.24%	0.11%
165.9	0.05%	0.04%	0.05%	0.09%	0.09%	0.09%	-0.27%	-0.27%	0.12%
391.7	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	-0.21%	-0.21%	0.12%
661.7	-0.01%	-0.01%	-0.01%	0.16%	0.16%	0.16%	-0.16%	-0.16%	-0.13%
898	-0.04%	-0.03%	-0.04%	0.16%	0.16%	0.16%	-0.11%	-0.11%	-0.15%
1173	0.02%	-0.09%	0.02%	0.06%	0.06%	0.06%	-0.08%	0.04%	-0.08%
1332	0.09%	-0.15%	0.09%	0.01%	0.01%	0.01%	-0.15%	0.10%	-0.01%

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Test 9: Verifying the effect of air parameters on ISOCS calculations

The source is a 1 cu.cm box of water at a distance of 10 meters from the detector.

Detector: Generic 60% No Collimator

Case (1): Temp=20 c Pressure=760 mm of Hg RH is variable

Energy (keV)	Efficiency (RH=0%)	Efficiency (RH=50%)	Efficiency (RH=100%)
	0	50	100
50	5.342E-07	5.346E-07	5.351E-07
60	9.790E-07	9.797E-07	9.805E-07
80	1.549E-06	1.551E-06	1.552E-06
100	1.819E-06	1.820E-06	1.821E-06
150	1.955E-06	1.956E-06	1.957E-06
200	1.828E-06	1.829E-06	1.830E-06
400	1.231E-06	1.231E-06	1.232E-06
500	1.072E-06	1.073E-06	1.073E-06
600	9.542E-07	9.545E-07	9.549E-07
800	8.074E-07	8.077E-07	8.079E-07
1022	6.872E-07	6.874E-07	6.876E-07
1500	5.407E-07	5.408E-07	5.409E-07
2000	4.292E-07	4.293E-07	4.294E-07

Case (3): Temp=20 c Pressure is variable RH=50%

Energy (keV)	Efficiency (P=380 mm)	Efficiency (P=760 mm)	Efficiency (P=1000)
50	5.980E-07	5.346E-07	4.981E-07
60	1.087E-06	9.797E-07	9.174E-07
80	1.706E-06	1.551E-06	1.460E-06
100	1.992E-06	1.820E-06	1.719E-06
150	2.121E-06	1.956E-06	1.859E-06
200	1.969E-06	1.829E-06	1.745E-06
400	1.305E-06	1.231E-06	1.187E-06
500	1.131E-06	1.073E-06	1.038E-06
600	1.002E-06	9.545E-07	9.255E-07
800	8.431E-07	8.077E-07	7.860E-07
1022	7.142E-07	6.874E-07	6.710E-07
1500	5.581E-07	5.408E-07	5.302E-07
2000	4.411E-07	4.293E-07	4.221E-07

Case (2): Temp. is variable P=760 mm of Hg RH=50%

Energy (keV)	Efficiency (T=0 c)	Efficiency (T=20 c)	Efficiency (T=100 c)
50	5.256E-07	5.346E-07	5.759E-07
60	9.644E-07	9.797E-07	1.050E-06
80	1.528E-06	1.551E-06	1.652E-06
100	1.795E-06	1.820E-06	1.933E-06
150	1.932E-06	1.956E-06	2.064E-06
200	1.808E-06	1.829E-06	1.921E-06
400	1.221E-06	1.231E-06	1.280E-06
500	1.064E-06	1.073E-06	1.111E-06
600	9.475E-07	9.545E-07	9.860E-07
800	8.024E-07	8.077E-07	8.310E-07
1022	6.835E-07	6.874E-07	7.051E-07
1500	5.383E-07	5.408E-07	5.522E-07
2000	4.276E-07	4.293E-07	4.371E-07

Case (1): As RH increases, the peak efficiencies show a very slight increasing trend.

Case (2): As the temp. increases, the density of air+water decreases and so does photon attenuation. As a result, the peak efficiencies increase.

Case(3): Increasing the barometric pressure while maintaining the RH and temperature, increases the air+water mixture density, thus resulting in larger photon attenuations. The peak efficiencies decrease.

Appendix B: Summary Sheets for the Validation Tests

This section contains the result summary of the validation tests, for each of the three counting geometries, namely, Field, Laboratory and Collimated geometries. In each Summary Sheet, ISOCS over true efficiency ratios from all the validation tests performed in that geometry are given, along with their uncertainty values. The data is presented in the Summary Sheets in the Three energy groups; data < 150 keV, data > 150 keV and data at all energies pooled. The Summary Sheets also contain the result of the statistical analysis performed on the data. The standard deviation of the data, the average standard deviation of the ratio, the average ISOCS standard deviation and the chi-squared values are presented in each energy group.

RESULTS SUMMARY OF ISOCS VALIDATION TESTING			ISOCS Version 4.0: Ratio of ISOCS Efficiency to True Efficiency								
Field Counting Geometry Tests											
			|-------- Data < 150 keV ---------|			|------- Data > 150 keV ----------|		|---------- All ----------|		
TYPE OF TEST	s-d dist	Method	avg ratio	ratio sd	ISCOS sd	avg ratio	ratio sd	ISCOS sd	avg ratio	ratio sd	ISCOS sd
200 LITER DRUM OF WATER AT 1 METER	100 cm	MCNP	1.03	0.108	0.069	0.98	0.063	0.022	0.99	0.071	0.030
200 LITER DRUM, 50% FULL, HOT SPOT	100 cm	MCNP	0.88	0.163	0.039	0.99	0.031	0.031	0.98	0.075	0.057
60x30x30 BOX, 67% FULL OF WATER	100 cm	MCNP	0.99	0.051	0.025	1.00	0.055	0.042	1.00	0.053	0.037
300 LITER BOX OF WATER	100 cm	MCNP	1.03	0.103	0.106	1.00	0.083	0.083	1.00	0.084	0.084
1 CUBIC METER BOX OF WATER AT 30 METERS	3000 cm	MCNP	1.06	0.035	0.035	0.96	0.020	0.020	1.00	0.058	0.042
1 CUBIC METER BOX OF WATER AT 1 METER	100 cm	MCNP	1.06	0.018	0.017	1.00	0.017	0.016	1.03	0.031	0.031
1 CUBIC METER BOX OF AIR AT 1 METER	100 cm	MCNP	0.99	0.034	0.016	0.99	0.012	0.012	0.99	0.022	0.023
1 CUBIC METER BOX OF AIR AT 30 METERS	3000 cm	MCNP	1.01	0.007	0.007	0.97	0.016	0.016	0.99	0.027	0.027
1 CUBIC METER BOX OF WATER AT 1 M, 90 DEG	100 cm	MCNP	0.88	0.127	0.007	0.99	0.020	0.016	0.93	0.098	0.027
1 CUBIC METER BOX OF AIR AT 1 M, 90 DEG	100 cm	MCNP	0.80	0.149	0.146	0.96	0.031	0.007	0.87	0.142	0.138
4 CUBIC METER BOX OF DIRT AT 1M, DENS=0.3, W/COLLIMATOR	100 cm	MCNP	0.97	0.003	0.005	1.00	0.018	0.018	0.99	0.022	0.022
4 CUBIC METER BOX OF DIRT AT 1M, DENS=0.7, W/COLLIMATOR	100 cm	MCNP	0.96	0.013	0.012	1.00	0.024	0.024	0.98	0.025	0.025
2.5 CUBIC METER BOX OF DIRT AT 1M, DENS=1.3, W/COLLIMATOR	100 cm	MCNP	0.98	0.048	0.050	0.97	0.044	0.010	0.97	0.043	0.043
60x30x30 BOX OF WATER, HOT SPOT	100 cm	MCNP	1.11	0.074	0.073	0.99	0.015	0.011	1.01	0.054	0.053
4 M3 BOX OF DIRT AT 1M, POINT SOURCE, DENS=0.3, W/COLLIMATOR	100 cm	MCNP	1.34	0.070	0.070	1.02	0.028	0.028	1.02	0.027	0.027
4 M3 BOX OF DIRT AT 1M, POINT SOURCE, DENS=0.7, W/COLLIMATOR	100 cm	MCNP	1.81	0.071	0.071	1.00	0.028	0.028	1.00	0.030	0.030
200 LITER DRUM OF WATER AT 1 M, END-ON	100 cm	MCNP	1.01	0.055	0.055	0.98	0.076	0.065	0.98	0.073	0.057
HOLLOW SPHERICAL SHELL OF WATER AT 1 METER	95 cm	MCNP	1.06	0.022	0.018	1.00	0.009	0.009	1.01	0.027	0.024
PIPE FULL OF WATER, CONTAMINATION PLATED INSIDE WALL	50 cm	MCNP	1.00	0.017	0.011	0.99	0.018	0.011	0.99	0.017	0.010
IN-SITU DIRT W/DETECTOR AT 1 M (Lee Booth)	100 cm	MCNP-EML	1.15	0.085	0.084	0.97	0.031	0.030	0.98	0.056	0.053
GENITRON RADIUM CALIBRATION PAD, 25mm-90d COLLIMATOR	49.2cm	Measured				0.93	0.142	0.126	0.93	0.142	0.126
GENITRON THORIUM CALIBRATION PAD, 25mm-90d COLLIMATOR	50.2 cm	Measured				0.94	0.117	0.094	0.94	0.117	0.094
GENITRON K40 CALIBRATION PAD, 25mm-90d COLLIMATOR	49.2 cm	Measured				0.98	0.073		0.98	0.073	
LINE SOURCE (6 X 80CM) 4.8M LONG, AT 1 METER	97.5 cm	Measured	1.35	0.286	0.283	1.12	0.021	0.021	1.16	0.132	0.125
LINE SOURCES INSIDE A FOAM CALIBRATION DRUM	100 cm	Measured	1.00	0.111	0.108	1.02	0.031	0.018	1.02	0.061	0.056
LINE SOURCES INSIDE A SOFT CALIBRATION DRUM	100 cm	Measured	0.93	0.079	0.063	0.96	0.043	0.038	0.96	0.044	0.037
LINE SOURCES INSIDE A PART. BOARD CALIBRATION DRUM	100 cm	Measured	0.89	0.082	0.061	0.91	0.052	0.044	0.91	0.052	0.041
LINE SOURCES INSIDE A SAND CALIBRATION DRUM	100 cm	Measured	0.75	0.001	0.003	0.88	0.055	0.046	0.87	0.068	0.059
LINE SOURCES ON THE INNER WALL OF AN EMPTY DRUM (PIPE)	100 cm	Measured	0.98	0.267	0.267	0.94	0.040	0.036	0.95	0.096	0.094
80 CM LINE SOURCE AT 0 DEGREES, AND 10 CM	10 cm	Measured	1.14	0.232	0.228	1.02	0.031	0.031	1.05	0.107	0.097
80 CM LINE SOURCE AT 0 DEGREES, AND 100 CM	100 cm	Measured	1.13	0.180	0.174	1.06	0.077	0.060	1.08	0.100	0.088
80 CM LINE SOURCE AT 0 DEGREES, AND 300 CM	300 cm	Measured	1.08	0.197	0.184	0.79	0.242	0.234	0.83	0.252	0.244
80 CM LINE SOURCE AT 45 DEGREES, AND 10 CM	10 cm	Measured	1.19	0.291	0.287	1.01	0.018	0.018	1.05	0.133	0.125
80 CM LINE SOURCE AT 45 DEGREES, AND 100 CM	100 cm	Measured	1.12	0.238	0.233	1.02	0.054	0.033	1.04	0.107	0.099
80 CM LINE SOURCE AT 45 DEGREES, AND 300 CM	300 cm	Measured	1.07	0.226	0.208	0.83	0.255	0.245	0.85	0.257	0.246
80 CM LINE SOURCE AT 90 DEGREES, AND 10 CM	10 cm	Measured	1.15	0.244	0.240	0.99	0.031	0.031	1.02	0.119	0.110
80 CM LINE SOURCE AT 90 DEGREES, AND 100 CM	100 cm	Measured	1.20	0.259	0.254	1.04	0.044	0.043	1.07	0.126	0.117
80 CM LINE SOURCE AT 90 DEGREES, AND 300 CM	300 cm	Measured	1.13	0.269	0.250	0.83	0.208	0.196	0.86	0.228	0.216
3' x 3' PLANE SOURCE AT 0 DEGREES AND 10CM	10 cm	Measured	1.08	0.092	0.090	0.96	0.034	0.025	0.99	0.072	0.069
3' x 3' PLANE SOURCE AT 0 DEGREES AND 100CM	100 cm	Measured	1.08	0.071	0.068	1.05	0.017	0.018	1.06	0.038	0.029
3' x 3' PLANE SOURCE AT 0 DEGREES AND 300CM	300 cm	Measured	1.06	0.050	0.043	1.03	0.036	0.039	1.04	0.039	0.037
3' x 3' PLANE SOURCE AT 45 DEGREES AND 10CM	10 cm	Measured	1.21	0.101	0.099	1.13	0.018	0.017	1.15	0.054	0.050

SUMMARY

3' x 3' PLANE SOURCE AT 45 DEGREES AND 100CM	100 cm	Measured	1.16	0.139	0.137	1.05	0.017	0.016	1.08	0.079	0.075
3' x 3' PLANE SOURCE AT 45 DEGREES AND 300CM	300 cm	Measured	1.15	0.160	0.150	1.03	0.049	0.047	1.06	0.094	0.073
3' x 3' PLANE SOURCE AT 90 DEGREES AND 10CM	10 cm	Measured	1.29	0.087	0.068	1.21	0.013	0.013	1.23	0.047	0.046
3' x 3' PLANE SOURCE AT 90 DEGREES AND 100CM	100 cm	Measured	1.14	0.089	0.087	1.07	0.013	0.014	1.09	0.052	0.046
3' x 3' PLANE SOURCE AT 90 DEGREES AND 300CM	300 cm	Measured	1.15	0.099	0.097	1.05	0.039	0.020	1.09	0.071	0.065
		Average	**1.08**	**0.116**	**0.105**	**0.99**	**0.051**	**0.044**	**1.00**	**0.081**	**0.072**
	Relative Std. Dev.		**0.157**			**0.073**			**0.079**		
	Weighted average		**0.98**			**1.02**			**1.00**		
	Rel.unc.in wt. avg		**0.0025**			**0.0034**			**0.0065**		
		Chi-square	**466.38**			**199.27**			**76.69**		
	no. of degrees of freedom		**43**			**46**			**46**		
	reduced Chi-square		**10.85**			**4.33**			**1.67**		

RESULTS SUMMARY OF ISOCS VALIDATION TESTS			ISOCS Version 4.0: Ratio of ISOCS efficiency to true efficiency								
			Data < 150 keV			Data > 150 keV			All		
Laboratory Source Tests	s-d dist.	Method	avg. ratio	ratio sd	ISOCS sd	avg. ratio	ratio sd	ISOCS sd	avg. ratio	ratio sd	ISOCS sd
20ML VIAL, AT 0CM AND PERPENDICULAR TO DET AXIS	0 cm	Measured	1.08	0.015	0.015	1.11	0.028	0.028	1.11	0.027	0.027
20ML VIAL, AT 5CM AND PERPENDICULAR TO DET AXIS	5 cm	Measured	0.98	0.010	0.011	1.07	0.003	0.003	1.04	0.058	0.031
20ML VIAL, AT 10CM AND PERPENDICULAR TO DET AXIS.	10 cm	Measured	0.99	0.037	0.037	1.05	0.030	0.031	1.04	0.037	0.037
20ML VIAL, AT 20CM AND PERPENDICULAR TO DET AXIS.	20 cm	Measured	1.03	0.009	0.009	1.05	0.036	0.036	1.05	0.034	0.034
20ML VIAL END-ON, AT 0CM FROM THE DETECTOR	0 cm	Measured	1.06	0.005	0.005	1.15	0.024	0.024	1.13	0.042	0.042
20ML VIAL END-ON, AT 5CM FROM THE DETECTOR	5 cm	Measured	1.03	0.064	0.044	1.11	0.037	0.037	1.10	0.051	0.019
20ML VIAL END-ON, AT 10CM FROM THE DETECTOR	10 cm	Measured	1.00	0.025	0.025	1.05	0.045	0.045	1.04	0.047	0.047
125ML BOTTLE, AT 0CM AND PERPENDICULAR TO DET AXIS	0 cm	Measured	1.02	0.093	0.076	1.12	0.052	0.051	1.08	0.075	0.047
125ML BOTTLE , AT 5CM AND PERPENDICULAR TO DET AXIS	5 cm	Measured	0.96	0.115	0.100	1.07	0.043	0.040	1.03	0.084	0.059
125ML BOTTLE, AT 10CM AND PERPENDICULAR TO DET AXIS	10 cm	Measured	1.01	0.055	0.055	1.08	0.037	0.037	1.06	0.054	0.055
125ML BOTTLE, AT 25CM AND PERPENDICULAR TO DET AXIS	25 cm	Measured	0.77	0.175	0.155	0.86	0.048	0.048	0.84	0.092	0.067
125ML BOTTLE END-ON, AT 0CM FROM THE DETECTOR	0 cm	Measured	1.01	0.093	0.076	1.11	0.080	0.049	1.08	0.091	0.068
125ML BOTTLE END-ON, AT 5CM FROM THE DETECTOR	5 cm	Measured	1.00	0.110	0.091	1.13	0.059	0.059	1.09	0.087	0.058
125ML BOTTLE END-ON, AT 10CM FROM THE DETECTOR	10 cm	Measured	0.99	0.175	0.154	1.06	0.042	0.042	1.04	0.090	0.060
125ML BOTTLE END-ON, AT 25CM FROM THE DETECTOR	25 cm	Measured	1.00	0.080	0.079	1.00	0.067	0.029	1.00	0.065	0.065
FILTER PAPER IN PETRI DISH, 0CM FROM THE DETECTOR	0 cm	Measured	1.15	0.153	0.146	1.11	0.052	0.052	1.12	0.073	0.049
FILTER PAPER IN PETRI DISH, 5CM FROM THE DETECTOR	5 cm	Measured	1.10	0.118	0.106	1.18	0.065	0.026	1.16	0.076	0.052
FILTER PAPER IN PETRI DISH, 25CM FROM THE DETECTOR	25 cm	Measured	1.00	0.253	0.243	1.03	0.057	0.057	1.02	0.104	0.080
URANIUM STANDARD NBS-031 80CM AWAY	80 cm	Measured				1.07	0.048	0.043	1.07	0.048	0.043
URANIUM STANDARD NBS-031 30CM AWAY	30 cm	Measured				1.11	0.058	0.056	1.11	0.058	0.056
URANIUM STANDARD NBS-071 80CM AWAY	80 cm	Measured				1.04	0.083	0.080	1.04	0.083	0.080
URANIUM STANDARD NBS-071 30CM AWAY	30 cm	Measured				1.06	0.080	0.079	1.06	0.080	0.079
URANIUM STANDARD NBS-194 80CM AWAY	80 cm	Measured				0.99	0.070	0.067	0.99	0.070	0.067
URANIUM STANDARD NBS-194 30CM AWAY	30 cm	Measured				1.00	0.077	0.076	1.00	0.077	0.076
URANIUM STANDARD NBS-295 80CM AWAY	80 cm	Measured				0.98	0.056	0.055	0.98	0.056	0.055
URANIUM STANDARD NBS-295 30CM AWAY	30 cm	Measured				0.98	0.064	0.064	0.98	0.064	0.064
URANIUM STANDARD NBS-446 80CM AWAY	80 cm	Measured				0.96	0.061	0.060	0.96	0.061	0.060
URANIUM STANDARD NBS-446 30CM AWAY	30 cm	Measured				0.99	0.048	0.048	0.99	0.048	0.048
1 LITER MARINELLI BEAKER (1 g/cc)		MCNP	0.85	0.081	0.081	0.98	0.014	0.013	0.93	0.078	0.078
1 LITER MARINELLI BEAKER (1.15 g/cc) ON A 42% DETECTOR		Measured	1.03	0.110	0.098	1.00	0.030	0.030	1.01	0.057	0.028
1 LITER MARINELLI BEAKER (1.6 g/cc) ON A 42% DETECTOR		Measured	1.07	0.074	0.052	1.03	0.039	0.039	1.04	0.049	0.049
400 ML M.BEAKER (1.15 g/cc) ON A 42% DETECTOR		Measured	1.11	0.084	0.066	1.09	0.028	0.028	1.09	0.046	0.045
400 ML M.BEAKER (1.6 g/cc) ON A 42% DETECTOR		Measured	1.15	0.091	0.075	1.10	0.028	0.028	1.11	0.053	0.005
1 LITER MARINELLI BEAKER (1.15 g/cc) ON A 20% DETECTOR		Measured	0.82	0.053	0.023	0.95	0.044	0.043	0.91	0.078	0.064
1 LITER MARINELLI BEAKER (1.6 g/cc) ON A 20% DETECTOR		Measured	0.86	0.074	0.056	0.98	0.046	0.013	0.94	0.075	0.060
400 ML M.BEAKER (1.15 g/cc) ON A 20% DETECTOR		Measured	0.86	0.079	0.017	0.99	0.032	0.032	0.95	0.081	0.068
400 ML M.BEAKER (1.6 g/cc) ON A 20% DETECTOR		Measured	0.94	0.057	0.008	1.01	0.040	0.040	1.01	0.063	0.045
1 LITER MARINELLI BEAKER (1.15 g/cc) ON A 60% DETECTOR		Measured	0.86	0.040	0.039	0.93	0.034	0.034	0.91	0.050	0.012
1 LITER MARINELLI BEAKER (1.6 g/cc) ON A 60% DETECTOR		Measured	0.87	0.061	0.035	0.95	0.044	0.044	0.93	0.062	0.040
400 ML M.BEAKER (1.15 g/cc) ON A 60% DETECTOR		Measured	0.91	0.062	0.038	1.00	0.028	0.029	0.98	0.058	0.034
400 ML M.BEAKER (1.6 g/cc) ON A 60% DETECTOR		Measured	0.93	0.058	0.058	1.05	0.020	0.023	1.04	0.042	0.042

Summary

POINT SOURCE AT 0 DEGREES AND 10CM	10 cm	Measured	1.15	0.070	0.062	1.10	0.015	0.015	1.12	0.042	0.022
POINT SOURCE AT 0 DEGREES AND 100CM	100 cm	Measured	1.09	0.102	0.091	1.01	0.129	0.119	1.04	0.116	0.106
POINT SOURCE AT 45 DEGREES AND 10CM	10 cm	Measured	1.29	0.272	0.269	1.15	0.016	0.016	1.20	0.141	0.136
POINT SOURCE AT 45 DEGREES AND 100CM	100 cm	Measured	1.18	0.137	0.129	0.97	0.103	0.093	1.03	0.139	0.131
POINT SOURCE AT 90 DEGREES AND 10CM	10 cm	Measured	1.25	0.152	0.148	1.32	0.032	0.031	1.29	0.081	0.073
POINT SOURCE AT 90 DEGREES AND 100CM	100 cm	Measured	1.20	0.196	0.190	1.02	0.096	0.085	1.06	0.142	0.135
20ML VIAL ON SHELF 0 OF TVA DETECTOR 1765	0.565 cm	Measured	1.00	0.037	0.022	1.06	0.049	0.030	1.04	0.051	0.030
20ML VIAL ON SHELF 1 OF TVA DETECTOR 1765	3.017 cm	Measured	0.95	0.025	0.022	1.03	0.047	0.030	1.00	0.055	0.040
20ML VIAL ON SHELF 2 OF TVA DETECTOR 1765	9.684 cm	Measured	0.98	0.005	0.022	1.02	0.062	0.044	1.01	0.056	0.035
GA-MA RG-25 VIAL ON SHELF 1 OF TVA DETECTOR 1765	3.017 cm	Measured	0.97	0.018	0.022	1.04	0.034	0.034	1.02	0.042	0.042
1 LITER MARINELLI BEAKER (1.15 g/cc) TVA DETECTOR 1765		Measured	1.04	0.005	0.005	1.10	0.015	0.015	1.08	0.029	0.029
4 LITER MARINELLI BEAKER (1.15 g/cc) TVA DETECTOR 1765		Measured	0.98	0.016	0.016	1.05	0.026	0.026	1.02	0.042	0.042
		Average	**1.01**	**0.082**	**0.071**	**1.05**	**0.047**	**0.043**	**1.04**	**0.067**	**0.055**
	Relative Std Dev		**0.112**			**0.070**			**0.073**		
	Weighted Average		**1.02**			**1.06**			**1.04**		
	Rel.unc.in wtd. avg.		**0.00237**			**0.0023**			**0.0076**		
		Chi-square	**739.13**			**304.74**			**75.72**		
	no. of degrees of freedom		**42**			**52**			**52**		
	reduced Chi-square		**17.60**			**5.86**			**1.46**		

RESULTS SUMMARY OF ISOCS VALIDATION TESTING			Ratio of ISOCS version 4.0 efficiencies to true efficiencies								
Collimator Geometry tests											
		|---------- < 150 keV ----------			|--------- > 150 keV ---------- |			|---------- All ----------		
	Method	avg. ratio	ratio sd	ISOCS sd	avg. ratio	ratio sd	ISOCS sd	avg. ratio	ratio sd	ISOCS sd
20M LINE SOURCE, 50mm-180d CYLINDRICAL COLLIMATOR	MCNP	1.00	0.01	0.00	0.99	0.02	0.02	0.99	0.02	0.02
20M LINE SOURCE, 50mm-90d CYLINDRICAL COLLIMATOR	MCNP	1.02	0.03	0.00	0.99	0.02	0.02	1.00	0.01	0.01
20M LINE SOURCE, 50mm-30D CYLINDRICAL COLLIMATOR	MCNP	0.92	0.06	0.05	0.93	0.03	0.02	0.93	0.03	0.02
20M X 20M PLANE SOURCE, 50mm-180d CYLND. COLLIMATOR	MCNP	1.00	0.01	0.01	1.00	0.03	0.03	1.00	0.02	0.02
20M X 20M PLANE SOURCE, 50mm-90D CYLND. COLLIMATOR	MCNP	1.01	0.04	0.03	0.98	0.03	0.02	0.99	0.03	0.02
2M X 2M PLANE SOURCE, 50mm-30D CYLND. COLLIMATOR	MCNP	0.91	0.02	0.02	0.94	0.04	0.04	0.93	0.04	0.04
20M LINE SOURCE, 50mm-180D RECT. COLLIMATOR	MCNP	1.02	0.01	0.01	1.01	0.01	0.01	1.01	0.01	0.01
20M LINE SOURCE, 50mm-90D RECT. COLLIMATOR	MCNP	1.03	0.02	0.02	0.99	0.015	0.015	1.01	0.02	0.02
2M LINE SOURCE, 50mm-30D RECT. COLLIMATOR	MCNP	0.92	0.05	0.05	0.95	0.04	0.04	0.94	0.05	0.05
20M X 20M PLANE SOURCE, 50mm-180d RECT. COLLIMATOR	MCNP	1.01	0.02	0.01	1.01	0.01	0.01	1.01	0.01	0.01
20M X 20M PLANE SOURCE, 50mm-90d RECT. COLLIMATOR	MCNP	1.06	0.04	0.04	1.00	0.04	0.03	1.02	0.04	0.04
2M X 2M PLANE SOURCE, 50mm-30d RECT. COLLIMATOR	MCNP	0.95	0.00	0.01	1.06	0.04	0.04	1.03	0.06	0.06
4 CU.M BOX OF DIRT AT 1M, DENS=0.3, 180d COLLIMATOR	MCNP	0.97	0.00		1.00	0.02	0.01	1.00	0.02	0.02
4 CU.M BOX OF DIRT AT 1M, DENS=0.7, 180d COLLIMATOR	MCNP	0.96	0.01	0.02	0.99	0.02	0.02	0.99	0.03	0.02
2.5 CU.M BOX OF DIRT AT 1M, DENS=1.3, 180d COLLIMATOR	MCNP	0.98	0.06	0.02	0.97	0.04	0.04	0.97	0.04	0.04
LINE SOURCE MEASUREMENTS, 50mm-180d COLLIMATOR	Measured	1.22	0.27	0.26	1.04	0.02	0.02	1.07	0.12	0.11
LINE SOURCE MEASUREMENTS, 50mm-90d COLLIMATOR	Measured	1.02	0.28	0.27	0.99	0.03	0.03	1.00	0.11	0.10
LINE SOURCE MEASUREMENTS, 50mm-30d COLLIMATOR	Measured	0.85	0.21	0.20	0.80	0.11	0.09	0.81	0.12	0.11
ENVIRONMENTAL MEASUREMENTS, 50mm-180d COLLIMATOR	Measured				1.18	0.15	0.12	1.18	0.15	0.12
ENVIRONMENTAL MEASUREMENTS, 50mm-90d COLLIMATOR	Measured				1.14	0.20	0.18	1.14	0.20	0.18
* ENVIRONMENTAL MEASUREMENTS, 50mm-30d COLLIMATOR	Measured				0.51	0.61	0.59	0.51	0.61	0.59
*(* not included in averages; rejected as an outlier; see data sheet)*										
Average		0.99	0.06	0.06	1.00	0.05	0.04	1.00	0.06	0.05
Std. Dev.		0.08			0.13			0.13		
Weighted Average		0.98			1.00			1.00		
Uncertainty in wtd. avg.		0.0027			0.0046			0.0052		
Chi-squared	247.92				28.69			19.82		
No. of degrees of freedom	18				20			20		
Reduced Chi-squared	14.58				1.51			1.04		

Appendix C: Data Sheets for Field Counting Geometry Validation Test

The data sheets for the validation tests performed in Field counting geometry are presented in this section. Each data sheet contains information about a given validation test. The input parameters used in the ISOCS calibration are given. The efficiencies for both the ISOCS method and the reference (true) method are given as a function of energy. The weighted average of the ISOCS over true efficiency ratio is given for each test, along with a weighted standard deviation and an ISOCS standard deviation. Plots of efficiency versus energy and ISOCS over true efficiency ratio versus energy are included in each data sheet.

200 LITER DRUM OF WATER AT 1 METER
Date: October 10, 2000 ISOCS Version: v4.0

This is a standard 55 gallon waste drum, 90% full of water.
It is 1 meter from the detector on axis. The source data
comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE CYLINDER
Detector: 60% (S/N 3222)
Collimator: NONE

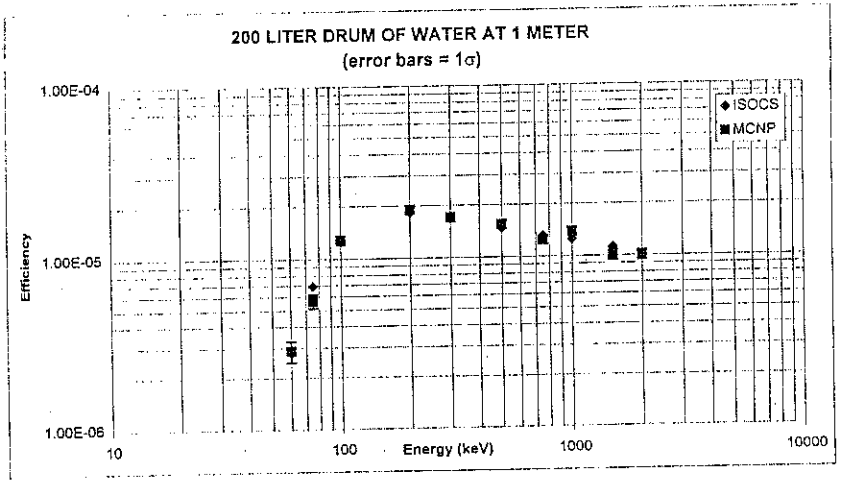
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.1	58.8	82.4			Fe	7.86	
(2) Src - Top	0							
(3) Src - Bottom	74.16					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

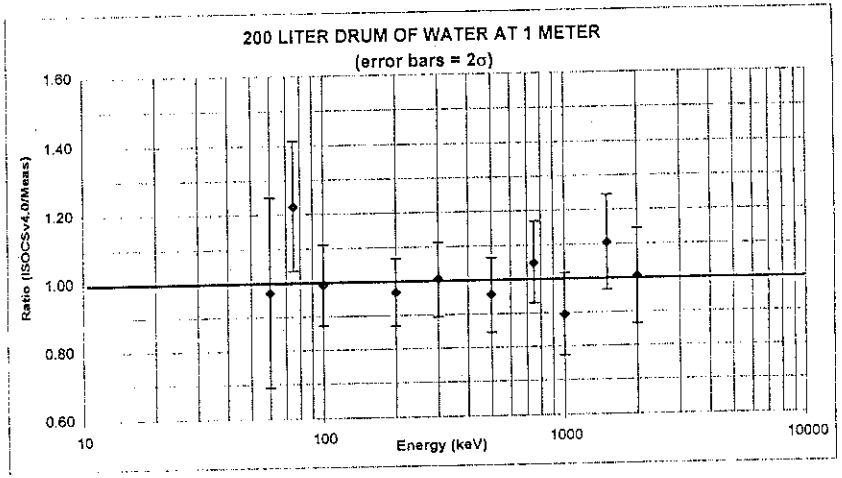
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
60	2.80E-06	2.88E-06	4.03E-07	2.80E-01	0.97
75	6.94E-06	5.67E-06	5.39E-07	1.90E-01	1.22
100	1.27E-05	1.28E-05	7.70E-07	1.20E-01	0.99
200	1.85E-05	1.91E-05	9.56E-07	1.00E-01	0.97
300	1.72E-05	1.71E-05	9.43E-07	1.10E-01	1.00
500	1.48E-05	1.55E-05	8.53E-07	1.10E-01	0.96
750	1.32E-05	1.25E-05	7.52E-07	1.20E-01	1.05
1000	1.25E-05	1.40E-05	8.39E-07	1.20E-01	0.90
1500	1.12E-05	1.01E-05	7.07E-07	1.40E-01	1.11
2000	1.01E-05	1.01E-05	7.05E-07	1.40E-01	1.01

Dataset	Mean Ratio	Relative Std Dev	ISOCS Std Dev
<150 keV	1.03	0.11	0.07
>150 keV	0.98	0.06	0.02
All	0.99	0.07	0.03





200 LITER DRUM, 50% FULL, HOT SPOT
Date: October 10, 2000 ISOCS Version: v4.0

This is a standard 55 gallon waste drum, 50% full of water. It has a 5 cm diam water sphere 20 cm from axis at 70 degrees, and 25 cm from bottom. Drum is 1 meter from the detector on axis. The source data comes from MCNP.

ISOCS Geometry Parameters
Template: COMPLEX CYLINDER
Detector: 60% (S/N 3222)
Collimator: NONE

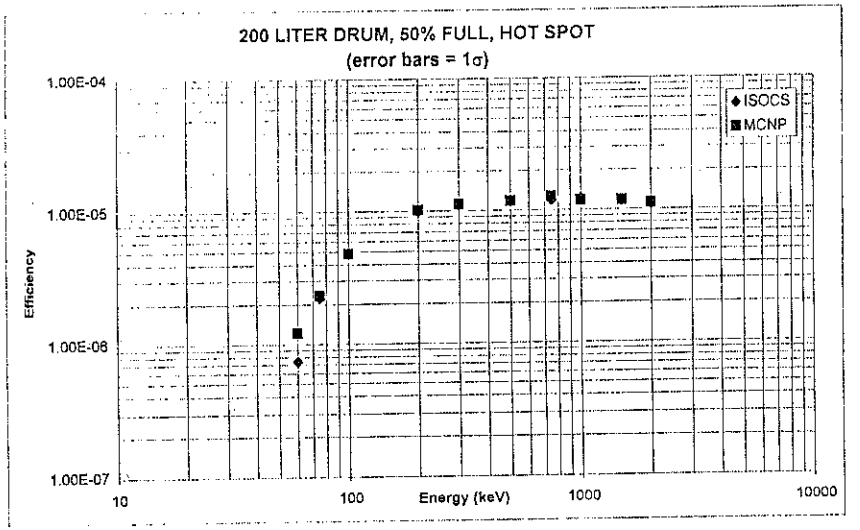
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.1	58.8	82.4			Fe	7.86	
(2) Sph Source	5	25	20	70		Water	1	1
(3) Src - Top	41.2					Water	1	0
(4) Src - Lr 2								
(5) Src - Lr 3								
(6) Src - Bottom								
(7) Absorber 1								
(8) Absorber 2								
(9) Src-Det	100	0	0	0	0			

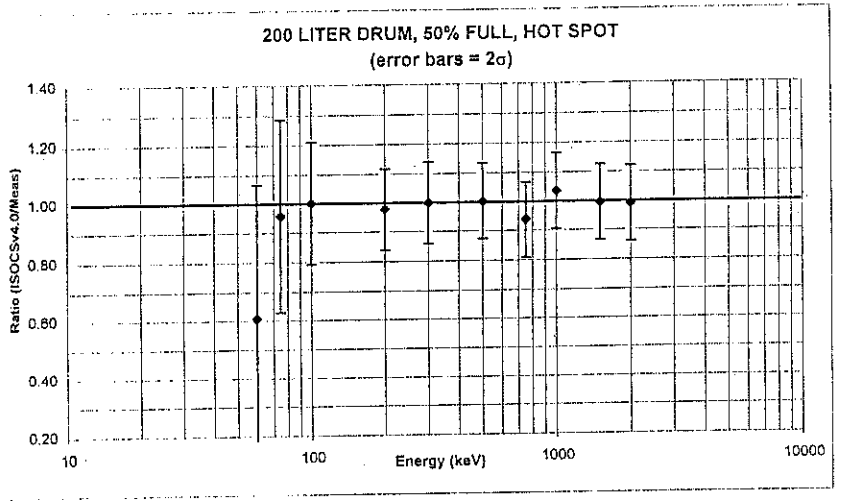
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	7.41E-07	1.22E-06	2.81E-07	4.60E-01	0.61
75	2.24E-06	2.34E-06	3.86E-07	3.30E-01	0.96
100	4.86E-06	4.85E-06	5.09E-07	2.10E-01	1.00
200	9.98E-06	1.02E-05	7.14E-07	1.40E-01	0.98
300	1.12E-05	1.12E-05	7.84E-07	1.40E-01	1.00
500	1.18E-05	1.18E-05	7.67E-07	1.30E-01	1.00
750	1.19E-05	1.27E-05	8.26E-07	1.30E-01	0.94
1000	1.22E-05	1.18E-05	7.67E-07	1.30E-01	1.04
1500	1.18E-05	1.18E-05	7.67E-07	1.30E-01	1.00
2000	1.11E-05	1.12E-05	7.26E-07	1.30E-01	0.99

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.88	0.16	0.04
>150 keV	0.99	0.03	0.03
All	0.98	0.07	0.06





60x30x30 BOX, 67% FULL OF WATER
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 60cm x 30cm x 30cm with 1 mm iron walls. It is 2/3 full of active water.
The front face of the box is 1 m from the detector. The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

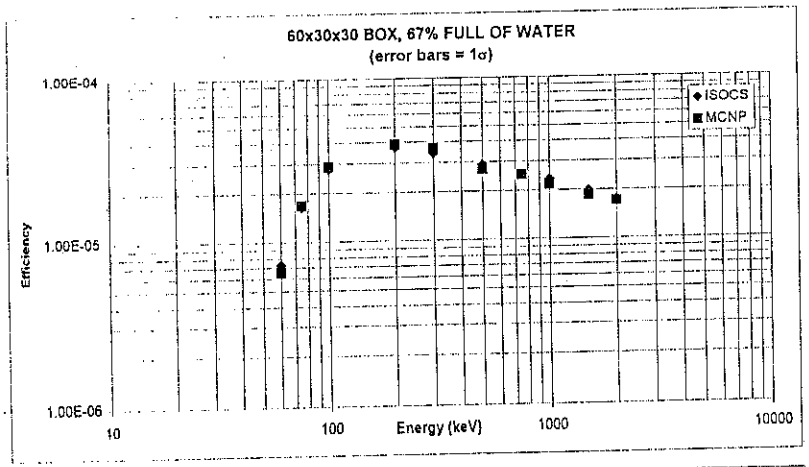
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.1	59.8	29.8	29.8		Fe	7.86	
(2) Src - Top								
(3) Src - Bottom	19.87					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

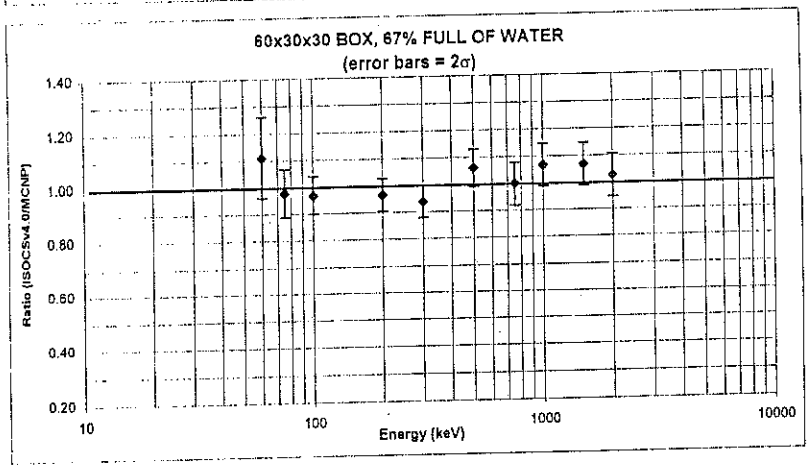
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	7.31E-06	6.57E-06	4.92E-07	1.50E-01	1.11
75	1.65E-05	1.68E-05	7.57E-07	9.00E-02	0.98
100	2.80E-05	2.88E-05	1.01E-06	7.00E-02	0.97
200	3.79E-05	3.92E-05	1.17E-06	6.00E-02	0.97
300	3.45E-05	3.68E-05	1.10E-06	6.00E-02	0.94
500	2.89E-05	2.72E-05	9.52E-07	7.00E-02	1.06
750	2.50E-05	2.50E-05	1.00E-06	8.00E-02	1.00
1000	2.32E-05	2.18E-05	8.70E-07	8.00E-02	1.07
1500	1.99E-05	1.86E-05	7.45E-07	8.00E-02	1.07
2000	1.75E-05	1.71E-05	6.82E-07	8.00E-02	1.03

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.99	0.05	0.02
>150 keV	1.00	0.06	0.04
All	1.00	0.05	0.04





300 LITER BOX OF WATER

Date: October 10, 2000 ISOCS Version: v4.0

This is a 300 l box (59.8cm x 58.8cm x 82.4cm) with 1 mm iron walls. It is 90% full of active water. The front face of the box is 1 m from the detector. The source data comes from MCNP.

ISOCS Geometry Parameters

Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

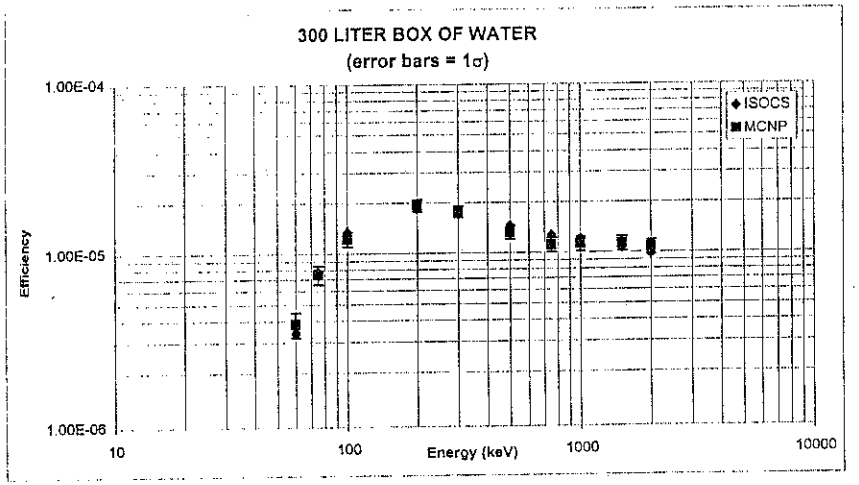
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.1	59.8	82.4	58.8		Fe	7.86	
(2) Src - Top								
(3) Src - Bottom	74.16					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

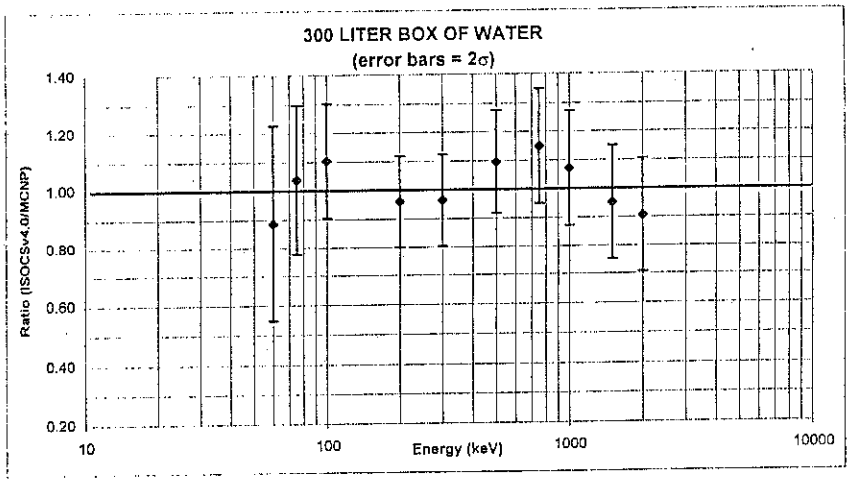
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	3.41E-06	3.85E-06	6.55E-07	3.40E-01	0.89
75	7.82E-06	7.54E-06	9.80E-07	2.60E-01	1.04
100	1.35E-05	1.22E-05	1.22E-06	2.00E-01	1.10
200	1.86E-05	1.94E-05	1.55E-06	1.60E-01	0.96
300	1.71E-05	1.77E-05	1.42E-06	1.60E-01	0.96
500	1.45E-05	1.33E-05	1.19E-06	1.80E-01	1.10
750	1.28E-05	1.11E-05	1.11E-06	2.00E-01	1.15
1000	1.21E-05	1.13E-05	1.13E-06	2.00E-01	1.07
1500	1.08E-05	1.13E-05	1.13E-06	2.00E-01	0.95
2000	9.77E-06	1.08E-05	1.08E-06	2.00E-01	0.91

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.03	0.10	0.11
>150 keV	1.00	0.08	0.08
All	1.00	0.08	0.08





1 CUBIC METER BOX OF WATER AT 30 METERS
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active water.
The front face of the box is 30 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

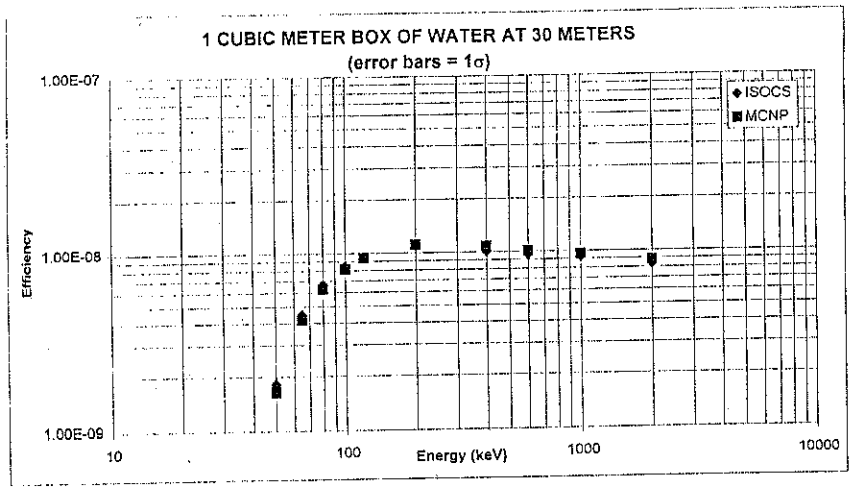
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top								
(3) Src - Bottom	100					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	3000	0	0	0	0			

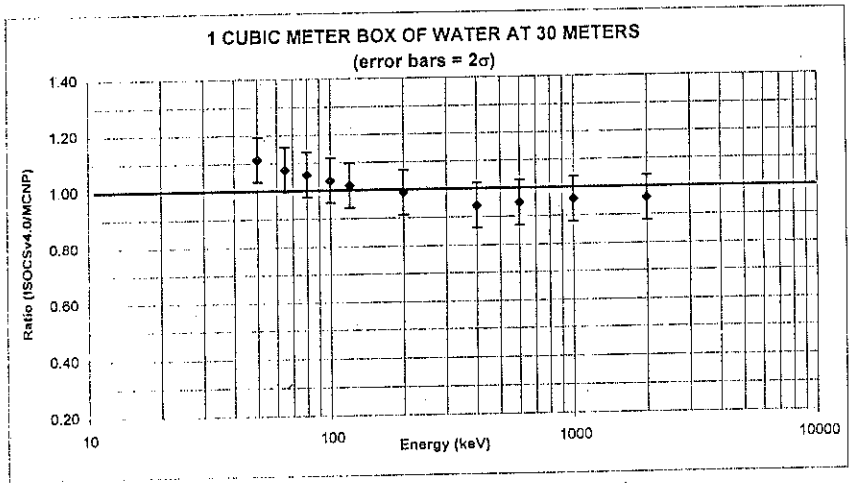
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	1.82E-09	1.63E-09	6.53E-11	8.00E-02	1.11
65	4.50E-09	4.18E-09	1.67E-10	8.00E-02	1.08
80	6.65E-09	6.28E-09	2.51E-10	8.00E-02	1.06
100	8.43E-09	8.13E-09	3.25E-10	8.00E-02	1.04
120	9.54E-09	9.37E-09	3.75E-10	8.00E-02	1.02
200	1.10E-08	1.11E-08	4.45E-10	8.00E-02	0.99
400	1.01E-08	1.08E-08	4.31E-10	8.00E-02	0.94
600	9.61E-09	1.01E-08	4.05E-10	8.00E-02	0.95
1000	9.26E-09	9.65E-09	3.86E-10	8.00E-02	0.96
2000	8.46E-09	8.80E-09	3.52E-10	8.00E-02	0.96

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.06	0.03	0.03
>150 keV	0.96	0.02	0.02
All	1.00	0.06	0.04





1 CUBIC METER BOX OF WATER AT 1 METER
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active water.
The front face of the box is 1 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

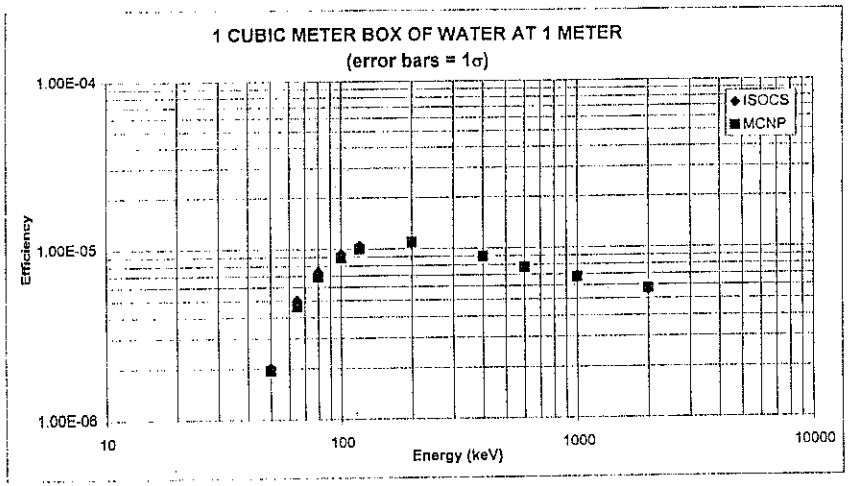
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top								
(3) Src - Bottom	100					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

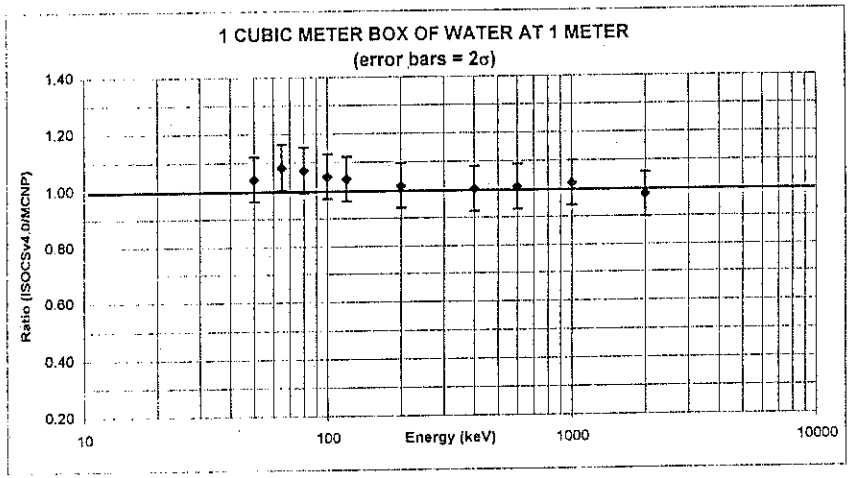
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	2.03E-06	1.95E-06	7.79E-08	8.00E-02	1.04
65	5.04E-06	4.66E-06	1.86E-07	8.00E-02	1.08
80	7.42E-06	6.92E-06	2.77E-07	8.00E-02	1.07
100	9.37E-06	8.93E-06	3.57E-07	8.00E-02	1.05
120	1.05E-05	1.01E-05	4.03E-07	8.00E-02	1.04
200	1.11E-05	1.09E-05	4.37E-07	8.00E-02	1.02
400	8.99E-06	8.96E-06	3.58E-07	8.00E-02	1.00
600	7.78E-06	7.72E-06	3.09E-07	8.00E-02	1.01
1000	6.91E-06	6.77E-06	2.71E-07	8.00E-02	1.02
2000	5.62E-06	5.74E-06	2.30E-07	8.00E-02	0.98

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.06	0.02	0.02
>150 keV	1.00	0.02	0.02
All	1.03	0.03	0.03





1 CUBIC METER BOX OF AIR AT 1 METER
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active air.
The front face of the box is 1 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

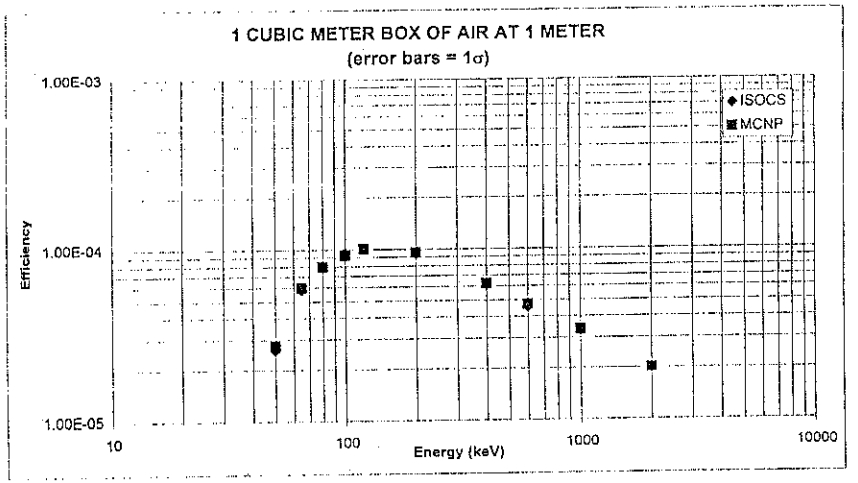
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top								
(3) Src - Bottom	100					Air	0.00129	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

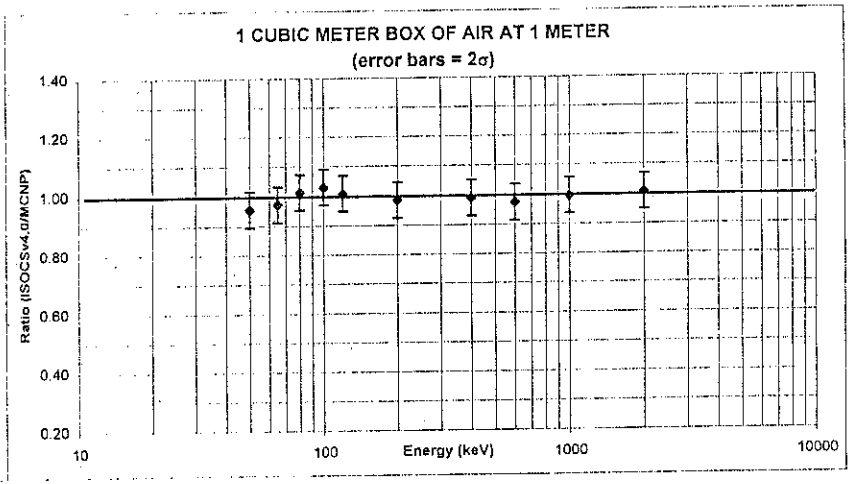
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	2.63E-05	2.76E-05	8.27E-07	6.00E-02	0.95
65	5.84E-05	6.01E-05	1.80E-06	6.00E-02	0.97
80	8.04E-05	7.94E-05	2.38E-06	6.00E-02	1.01
100	9.56E-05	9.30E-05	2.79E-06	6.00E-02	1.03
120	1.02E-04	1.01E-04	3.03E-06	6.00E-02	1.01
200	9.45E-05	9.59E-05	2.88E-06	6.00E-02	0.98
400	6.17E-05	6.23E-05	1.87E-06	6.00E-02	0.99
600	4.60E-05	4.72E-05	1.41E-06	6.00E-02	0.97
1000	3.34E-05	3.35E-05	1.01E-06	6.00E-02	1.00
2000	2.03E-05	2.02E-05	6.05E-07	6.00E-02	1.01

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.99	0.03	0.02
>150 keV	0.99	0.01	0.01
All	0.99	0.02	0.02





1 CUBIC METER BOX OF AIR AT 30 METERS
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active air.
The front face of the box is 30 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

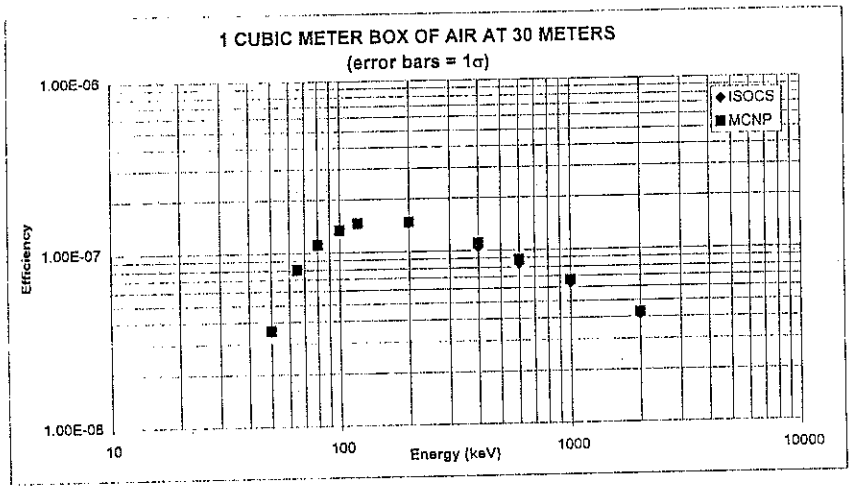
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top						Air	0.00129	1
(3) Src - Bottom	100							
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	3000	0	0	0	0			

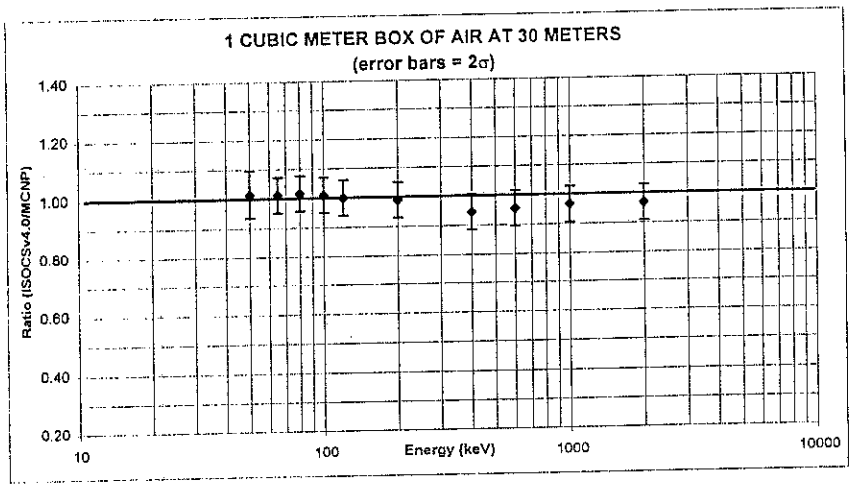
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	3.61E-08	3.55E-08	1.42E-09	8.00E-02	1.02
65	8.11E-08	8.01E-08	2.40E-09	6.00E-02	1.01
80	1.13E-07	1.11E-07	3.33E-09	6.00E-02	1.02
100	1.35E-07	1.34E-07	4.02E-09	6.00E-02	1.01
120	1.46E-07	1.46E-07	4.38E-09	6.00E-02	1.00
200	1.46E-07	1.47E-07	4.41E-09	6.00E-02	0.99
400	1.05E-07	1.11E-07	3.32E-09	6.00E-02	0.95
600	8.42E-08	8.80E-08	2.64E-09	6.00E-02	0.96
1000	6.43E-08	6.65E-08	1.99E-09	6.00E-02	0.97
2000	4.15E-08	4.28E-08	1.28E-09	6.00E-02	0.97

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.01	0.01	0.01
>150 keV	0.97	0.02	0.02
All	0.99	0.03	0.03





1 CUBIC METER BOX OF WATER AT 1 M, 90 DEG
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active water, 90 degrees from the detector axis.
The front face of the box is 1 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

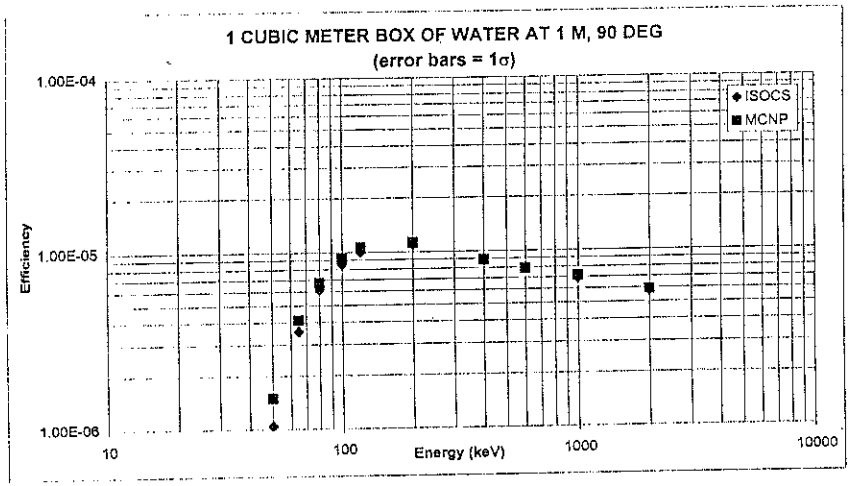
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top								
(3) Src - Bottom	100					Water	1	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	10000			

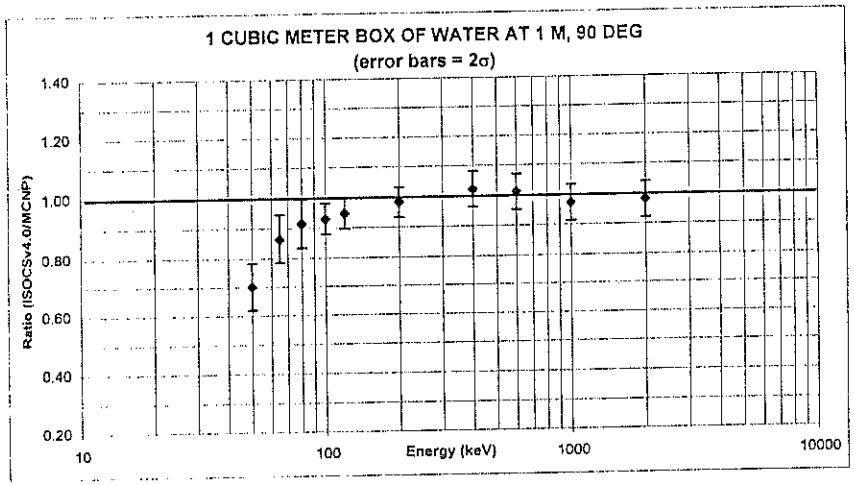
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	1.05E-06	1.49E-06	5.97E-08	8.00E-02	0.70
65	3.57E-06	4.13E-06	1.65E-07	8.00E-02	0.86
80	6.15E-06	6.72E-06	2.69E-07	8.00E-02	0.92
100	8.60E-06	9.25E-06	2.31E-07	5.00E-02	0.93
120	1.00E-05	1.06E-05	2.65E-07	5.00E-02	0.95
200	1.10E-05	1.12E-05	2.81E-07	5.00E-02	0.98
400	9.10E-06	8.90E-06	2.67E-07	6.00E-02	1.02
600	7.97E-06	7.88E-06	2.36E-07	6.00E-02	1.01
1000	6.93E-06	7.13E-06	2.14E-07	6.00E-02	0.97
2000	5.77E-06	5.89E-06	1.77E-07	6.00E-02	0.98

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.88	0.13	0.01
>150 keV	0.99	0.02	0.02
All	0.93	0.10	0.03





1 CUBIC METER BOX OF AIR AT 1 M, 90 DEG
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 1m x 1m x 1m full of active air, 90 degrees from the detector axis.
The front face of the box is 1 m from the detector.
The source data comes from MCNP.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: 60% (S/N 3222)
Collimator: NONE

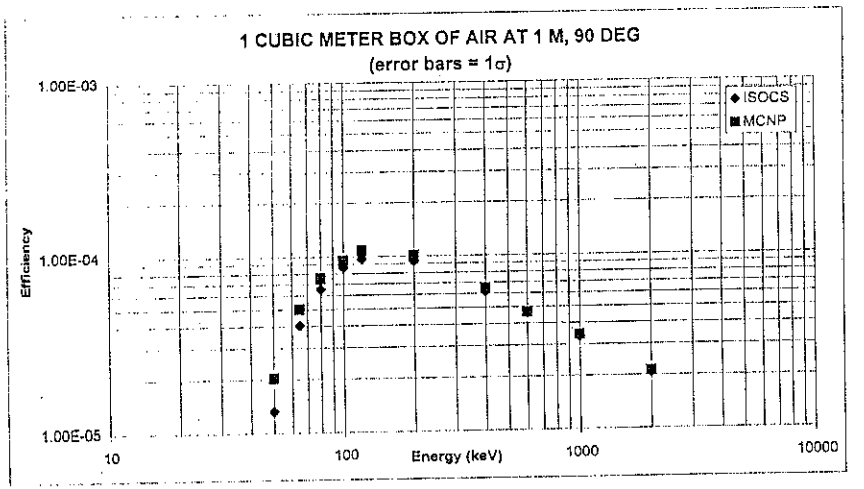
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container		100	100	100				
(2) Src - Top								
(3) Src - Bottom	100					Air	0.00129	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	10000			

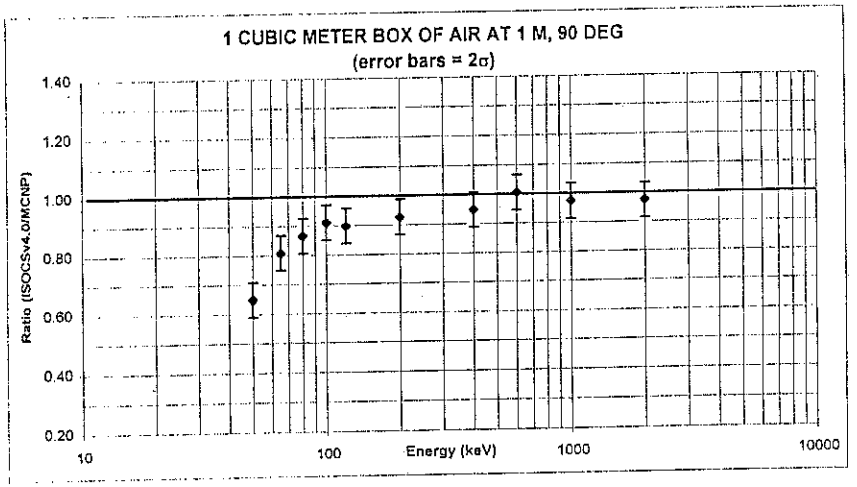
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
50	1.32E-05	2.04E-05	6.11E-07	6.00E-02	0.65
65	4.05E-05	5.01E-05	1.50E-06	6.00E-02	0.81
80	6.56E-05	7.56E-05	2.27E-06	6.00E-02	0.87
100	8.67E-05	9.51E-05	2.85E-06	6.00E-02	0.91
120	9.69E-05	1.08E-04	3.23E-06	6.00E-02	0.90
200	9.31E-05	1.00E-04	3.01E-06	6.00E-02	0.93
400	6.19E-05	6.52E-05	1.96E-06	6.00E-02	0.95
600	4.69E-05	4.66E-05	1.40E-06	6.00E-02	1.01
1000	3.33E-05	3.42E-05	1.03E-06	6.00E-02	0.97
2000	2.08E-05	2.13E-05	6.39E-07	6.00E-02	0.97

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.80	0.15	0.15
>150 keV	0.96	0.03	0.01
All	0.87	0.14	0.14





4 CUBIC METER BOX OF DIRT AT 1M, DENS=0.3, W/COLLIMATOR
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 224 x 137 x 137cm full of dirt. The container was 0.16cm of Iron.
The front face of the box is 1 m from the detector. The detector points at the center of the box.
The source data comes from MCNP [lb_geom7.eff], as was used on the Mound project for Special Services Division.
The dirt composition is O60_Si12_C9_Ca8_H5_Al4_Mg2 . Density is 0.3 g/cc.
The detector was a 40% from SSD, and had a collimator 8.9cm ID, 2.54 thick, and 0.708 extension past endcap.

ISOCS Geometry Parameters
Template: SIMPLE BOX
Detector: LBooth
Collimator: Special, CRPN=8
1=0.708, 2=3=4=0, 5=6.99, 6=2.54, 7=16.5, 8=9=0, material=Pb, density=11.36

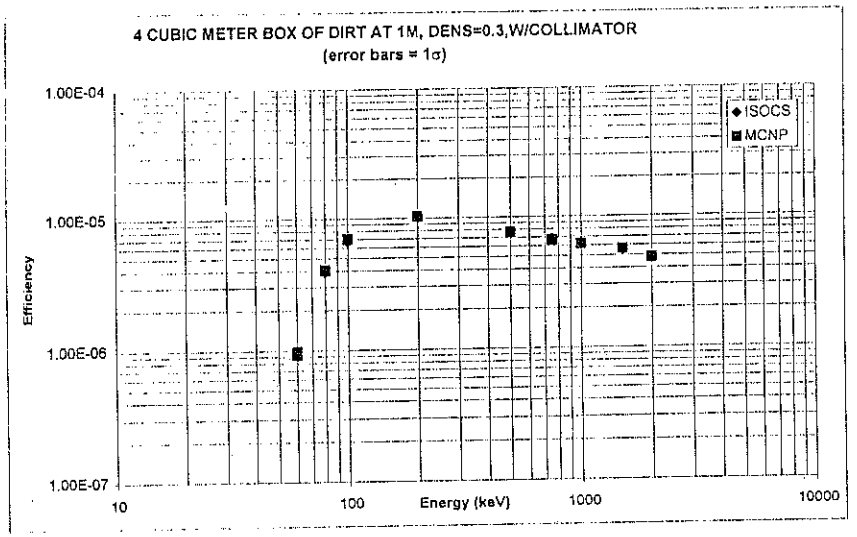
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.16	224	137	136.84		FE	7.86	
(2) Src - Top								
(3) Src - Bottom	137					Moundirt	0.3	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

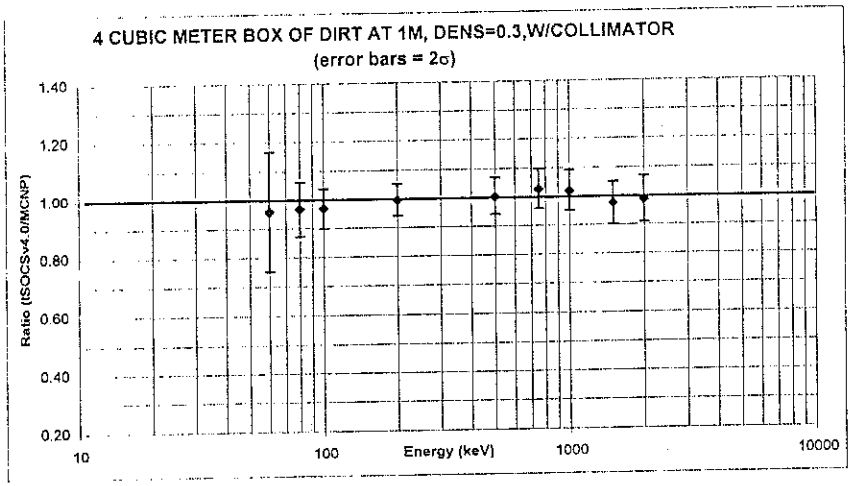
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	9.24E-07	9.63E-07	1.01E-07	2.09E-01	0.96
80	3.92E-06	4.05E-06	1.92E-07	9.48E-02	0.97
100	6.75E-06	6.97E-06	2.45E-07	7.04E-02	0.97
200	1.02E-05	1.03E-05	2.90E-07	5.64E-02	1.00
500	7.71E-06	7.68E-06	2.50E-07	6.50E-02	1.00
750	6.82E-06	6.63E-06	2.30E-07	6.94E-02	1.03
1000	6.29E-06	6.16E-06	2.20E-07	7.14E-02	1.02
1500	5.50E-06	5.63E-06	2.10E-07	7.46E-02	0.98
2000	4.77E-06	4.83E-06	1.94E-07	8.04E-02	0.99

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.97	0.00	0.00
>150 keV	1.00	0.02	0.02
All	0.99	0.02	0.02





4 CUBIC METER BOX OF DIRT AT 1M, DENS=0.7, W/COLLIMATOR

Date: October 10, 2000 ISOCS Version: v4.0

This is a box 224 x 137 x 137cm full of dirt. The container was 0.16cm of Iron.
The front face of the box is 1 m from the detector. The detector points at the center of the box.
The source data comes from MCNP [lb_geom8.eff], as was used on the Mound project for Special Services Division.
The source data comes from MCNP [lb_geom8.eff], as was used on the Mound project for Special Services Division.
The dirt composition is O60_Si12_C9_Ca8_H5_Al4_Mg2 . Density is 0.7g/cc.
The detector was a 40% from SSD, and had a collimator 8.9cm ID, 2.54 thick, and 0.708 extension past endcap.

ISOCS Geometry Parameters

Template: SIMPLE BOX
Detector: LBooth
Collimator: Special, CRPN=8
1=0.708, 2=3=4=0, 5=6.99, 6=2.54, 7=16.5, 8=9=0, material=Pb, density=11.36

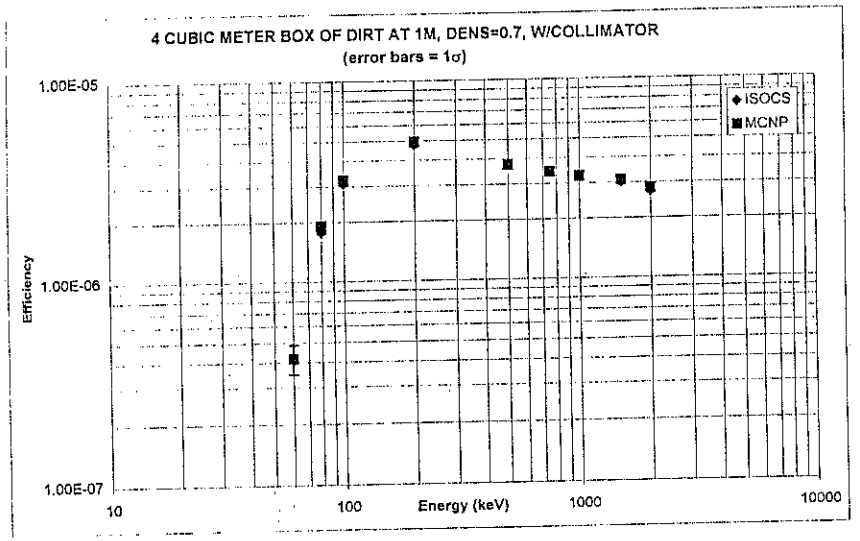
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.16	224	137	136.84		FE	7.86	
(2) Src - Top								
(3) Src - Bottom	137					Moundirt	0.7	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

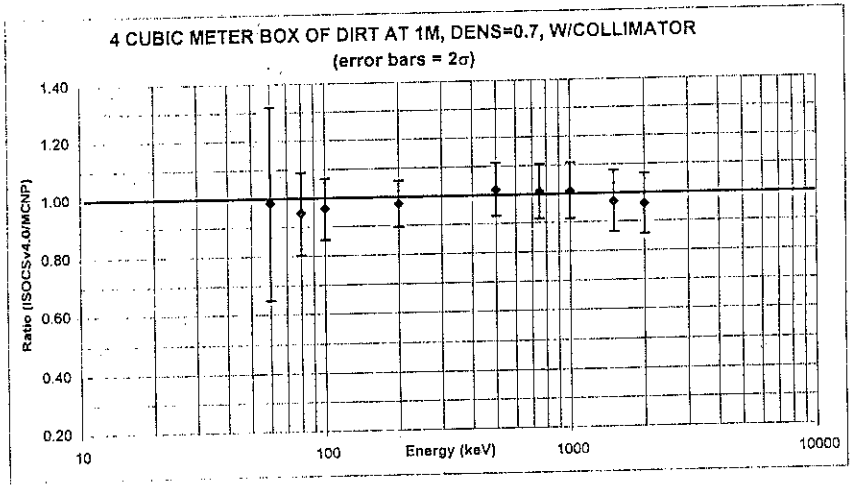
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	4.11E-07	4.17E-07	6.97E-08	3.34E-01	0.98
80	1.78E-06	1.88E-06	1.35E-07	1.43E-01	0.95
100	3.11E-06	3.23E-06	1.71E-07	1.06E-01	0.96
200	4.83E-06	4.95E-06	2.02E-07	8.18E-02	0.98
500	3.81E-06	3.74E-06	1.75E-07	9.36E-02	1.02
750	3.47E-06	3.44E-06	1.65E-07	9.58E-02	1.01
1000	3.29E-06	3.26E-06	1.60E-07	9.82E-02	1.01
1500	3.02E-06	3.10E-06	1.68E-07	1.08E-01	0.97
2000	2.72E-06	2.82E-06	1.48E-07	1.05E-01	0.96

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.96	0.01	0.01
>150 keV	1.00	0.02	0.02
All	0.98	0.03	0.03





2.5 CUBIC METER BOX OF DIRT AT 1M, DENS=1.3, W/COLLIMATOR

Date: October 10, 2000 ISOCS Version: v4.0

This is a box 175 x 137 x 99cm full of dirt. The container was 0.16cm of Iron.
The front face of the box is 1 m from the detector. The detector points at the center of the box.
The source data comes from MCNP [lb_geom8.eff], as was used on the Mound project for Special Services Division.
The dirt composition is O60_Si12_C9_Ca8_H5_Al4_Mg2 .
The detector was a 40% from SSD, and had a collimator 8.9cm ID, 2.54 thick, and 0.708 extension past endcap.

ISOCS Geometry Parameters

Template: SIMPLE BOX
Detector: LBooth
Collimator: Special, CRPN=8
1=0.708, 2=3=4=0, 5=6.99, 6=2.54, 7=16.5, 8=9=0, material=Pb, density=11.36

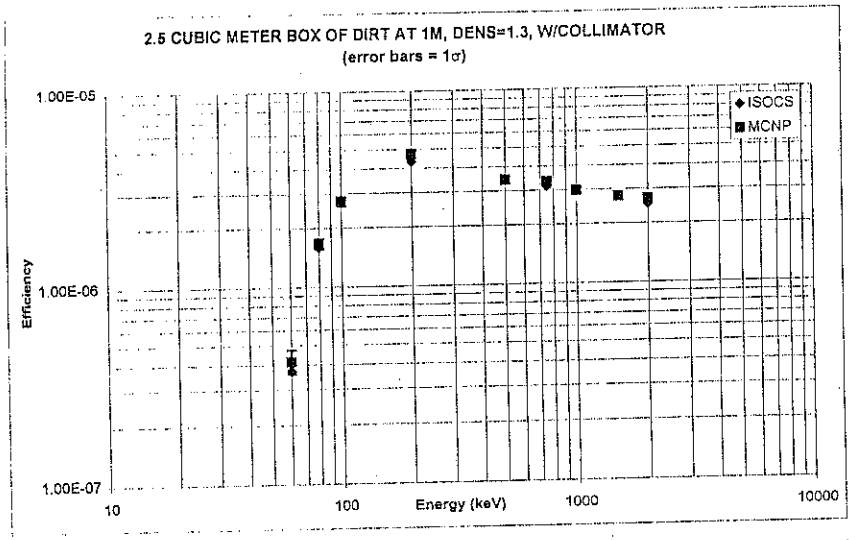
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.16	175	137	99		FE	7.86	
(2) Src - Top								
(3) Src - Bottom	137					Moundirt	1.3	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

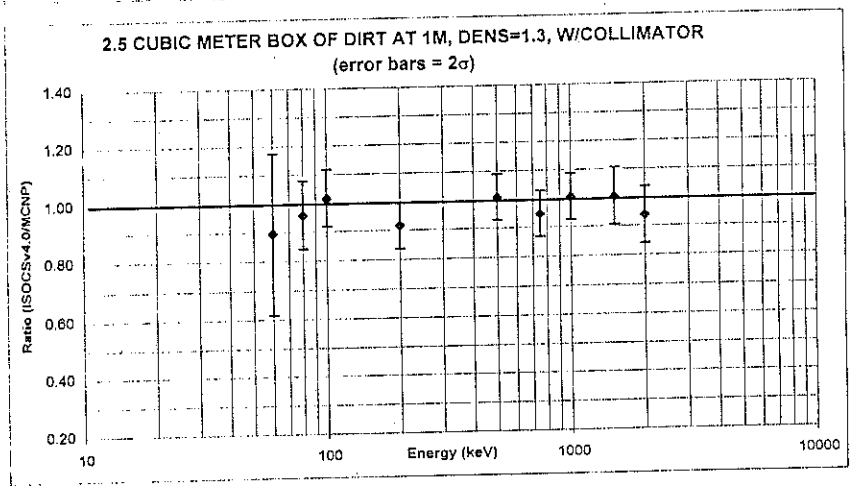
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	3.73E-07	4.16E-07	5.83E-08	2.80E-01	0.90
80	1.60E-06	1.67E-06	1.00E-07	1.20E-01	0.96
100	2.78E-06	2.73E-06	1.37E-07	1.00E-01	1.02
200	4.34E-06	4.74E-06	1.90E-07	8.00E-02	0.92
500	3.46E-06	3.42E-06	1.37E-07	8.00E-02	1.01
750	3.17E-06	3.33E-06	1.33E-07	8.00E-02	0.95
1000	3.02E-06	2.99E-06	1.20E-07	8.00E-02	1.01
1500	2.78E-06	2.76E-06	1.38E-07	1.00E-01	1.01
2000	2.52E-06	2.68E-06	1.34E-07	1.00E-01	0.94

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	0.98	0.05	0.05
>150 keV	0.97	0.04	0.01
All	0.97	0.04	0.04





60x30x30 BOX OF WATER, HOT SPOT
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 60cm x 30cm x 30cm with 1 mm iron walls. It is 100% full of inactive water with a 1cc cube of active water in the center of the box. The front face of the box is 1 m from the detector. The source data comes from MCNP.

ISOCS Geometry Parameters
Template: COMPLEX BOX
Detector: 60% (S/N 3222)
Collimator: NONE

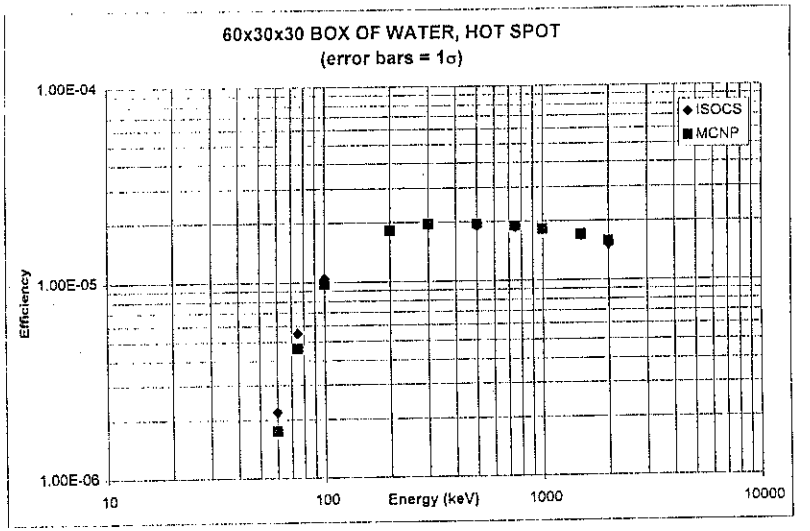
Item	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Conc.
(1) Container	0.1	59.8	29.8	29.8			Fe	7.86	
(2) Src - Top									
(3) Src - Lr 2									
(4) Src - Lr 3									
(5) Src - Bottom	29.8						Water	1	0
(6) Src - Conc.	1	1	1	29.4	14.4	14.4	Water	1	1
(7) Absorber 1									
(8) Absorber 2									
(9) Src-Det	100	0	0	0	0				

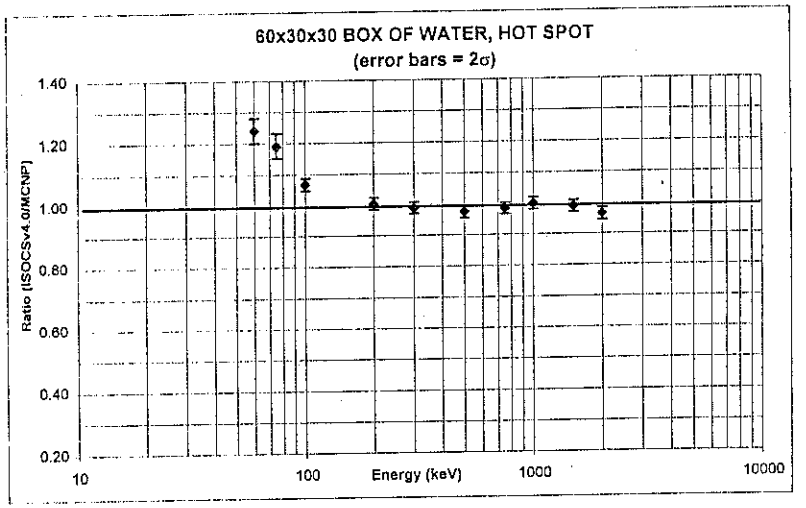
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	**2.18E-06**	1.76E-06	3.52E-08	4.00E-02	1.24
75	**5.51E-06**	4.62E-06	9.25E-08	4.00E-02	1.19
100	**1.04E-05**	9.77E-06	9.77E-08	2.00E-02	1.07
200	**1.82E-05**	1.82E-05	1.82E-07	2.00E-02	1.00
300	**1.93E-05**	1.95E-05	1.95E-07	2.00E-02	0.99
500	**1.90E-05**	1.95E-05	1.95E-07	2.00E-02	0.98
750	**1.87E-05**	1.90E-05	1.90E-07	2.00E-02	0.99
1000	**1.82E-05**	1.82E-05	1.82E-07	2.00E-02	1.00
1500	**1.69E-05**	1.70E-05	1.70E-07	2.00E-02	0.99
2000	**1.52E-05**	1.57E-05	1.57E-07	2.00E-02	0.97

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	**1.11**	**0.07**	**0.07**
>150 keV	**0.99**	**0.01**	**0.01**
All	**1.01**	**0.05**	**0.05**





4 M3 BOX OF DIRT AT 1M, POINT SOURCE, DENS=0.3, W/COLLIMATOR

Date: October 10, 2000 ISOCS Version: v4.0

This is a box 224 x 137 x 137cm full of dirt. The container was 0.16cm of Iron. The source was a point in the center.
The front face of the box is 1 m from the detector. The detector points at the center of the box.
The source data comes from MCNP [lb_geom1.eff], as was used on the Mound project for Special Services Division.
The dirt is composition is O60_Si12_C9_Ca8_H5_Al4_Mg2 . Density is 0.3g/cc.
The detector was a 40% from SSD, and had a collimator 8.9cm ID, 2.54 thick, and 0.708 extension past endcap.

ISOCS Geometry Parameters

Template: COMPLEX BOX
Detector: LBooth
Collimator: Special, CRPN=8
1=0.708, 2=3=4=0, 5=6.99, 6=2.54, 7=16.5, 8=9=0, material=Pb, density=11.36

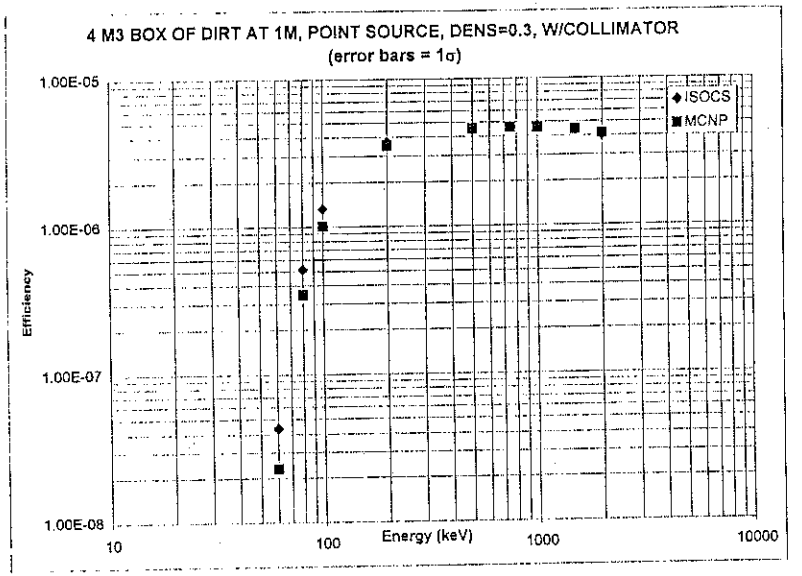
Item	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Conc.
(1) Container	0.16	224	137	136.84			FE	7.86	
(2) Src - Top							Moundirt	0.3	0
(5) Src - Bottom	137						Moundirt	0.3	1
(6) Src - Detail	0.1	0.1	0.1	112	68	68			
(7) Absorber 1									
(8) Absorber 2									
(9) Src-Det	100	0	0	0	0				

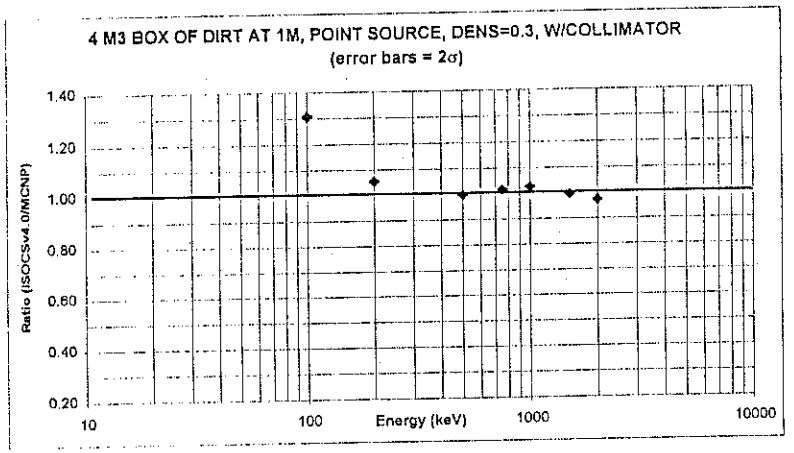
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	4.41E-08	2.32E-08	8.03E-10	6.92E-02	1.90
80	5.22E-07	3.48E-07	1.60E-09	9.20E-03	1.50
100	1.33E-06	1.02E-06	2.54E-09	5.00E-03	1.31
200	3.73E-06	3.53E-06	4.59E-09	2.60E-03	1.05
500	4.53E-06	4.55E-06	5.01E-09	2.20E-03	1.00
750	4.70E-06	4.63E-06	5.09E-09	2.20E-03	1.02
1000	4.74E-06	4.63E-06	5.09E-09	2.20E-03	1.03
1500	4.44E-06	4.46E-06	4.91E-09	2.20E-03	0.99
2000	4.05E-06	4.17E-06	5.00E-09	2.40E-03	0.97

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	ISOCS Std Dev
<150 keV	1.34	0.07	0.07
>150 keV	1.02	0.03	0.03
All	1.02	0.03	0.03





4 M3 BOX OF DIRT AT 1M, POINT SOURCE, DENS=0.7, W/COLLIMATOR
Date: October 10, 2000 ISOCS Version: v4.0

This is a box 224 x 137 x 137cm full of dirt. The container was 0.16cm of Iron. The source was a point in the center.
The front face of the box is 1 m from the detector. The detector points at the center of the box.
The source data comes from MCNP [lb_geom2.eff], as was used on the Mound project for Special Services Division.
The dirt composition is O60_Si12_C9_Ca8_H5_Al4_Mg2 . Density is 0.7g/cc.
The detector was a 40% from SSD, and had a collimator 8.9cm ID, 2.54 thick, and 0.708 extension past endcap.

ISOCS Geometry Parameters
Template: COMPLEX BOX
Detector: LBooth
Collimator: Special, CRPN=8
1=0.708, 2=3=4=0, 5=6.99, 6=2.54, 7=16.5, 8=9=0, material=Pb, density=11.36

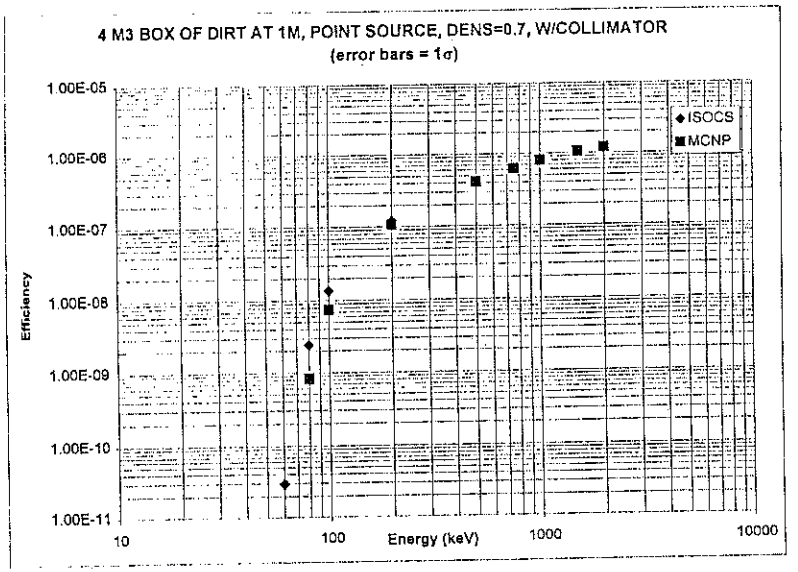
Item	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Conc.
(1) Container	0.16	224	137	137			FE	7.86	
(2) Src - Top							Moundirt	0.7	0
(5) Src - Bottom	137								
(6) Src - Detail	0.1	0.1	0.1	112	68	68	Moundirt	0.7	1
(7) Absorber 1									
(8) Absorber 2									
(9) Src-Det	100	0	0	0	0				

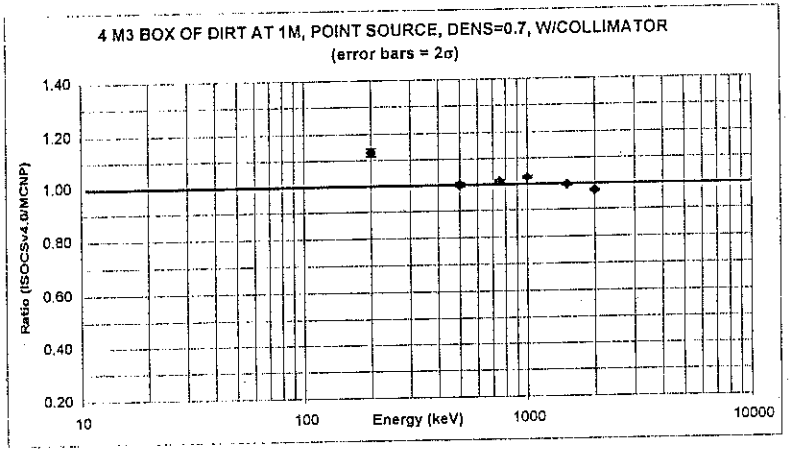
Air: Temp: 20 C Rel. Hum.: 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	**2.95E-11**				
80	**2.43E-09**	8.35E-10		7.00E-01	2.91
100	**1.35E-08**	7.48E-09		9.39E-02	1.81
200	**1.23E-07**	1.09E-07		1.56E-02	1.13
500	**4.16E-07**	4.16E-07		7.60E-03	1.00
750	**6.35E-07**	6.29E-07		6.20E-03	1.01
1000	**8.27E-07**	8.06E-07		5.40E-03	1.03
1500	**1.07E-06**	1.07E-06		4.60E-03	1.00
2000	**1.19E-06**	1.22E-06		4.40E-03	0.97

Dataset	Wt.Mean Ratio	Wtd. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.81	0.07	0.07
>150 keV	1.00	0.03	0.03
All	1.00	0.03	0.03





200 LITER DRUM OF WATER AT 1 M, END-ON
Date: July 20, 1999 ISOCS Version: 3.0

This is a standard 55 gallon waste drum, 100% full of water, viewed end-on.
It is 1 meter from the detector on axis. The source data
comes from MCNP.

ISOCS Geometry Parameters
Template: CIRCULAR PLANE
Detector: 60% (S/N 3222)
Collimator: NONE

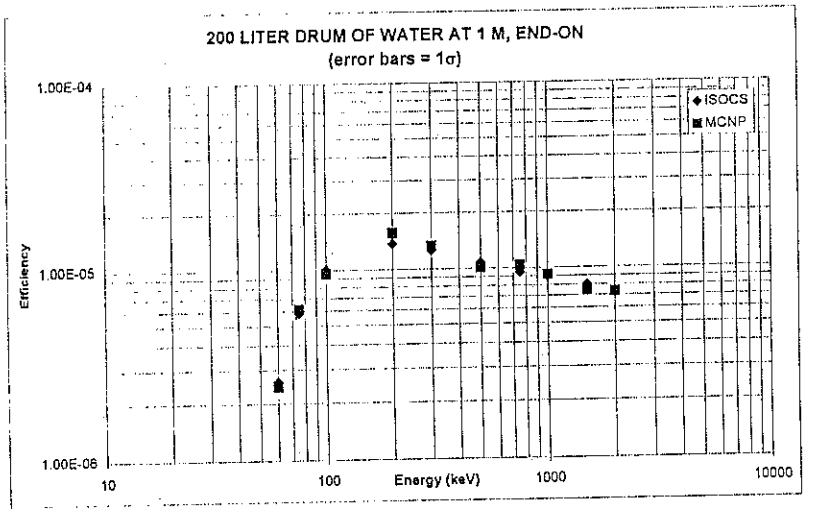
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Side Wall	0.1	58.8				Fe	7.86	
(2) Src - Lr 1	0.1					Fe	7.86	0
(3) Src - Lr 2	82.4					Water	1	1
(4...10) Source Layers 3...9 are all empty								
(11) Src - Lr 10	0.1					Fe	7.86	0
(12) Absorber 1								
(13) Absorber 2								
(14) Src-Det	100	0	0	0	0			

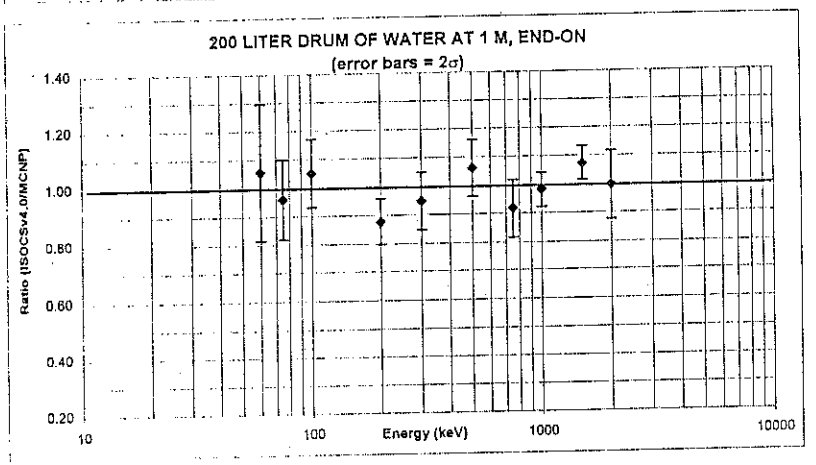
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	2.61E-06	2.47E-06	2.96E-07	2.40E-01	1.06
75	5.90E-06	6.14E-06	4.30E-07	1.40E-01	0.96
100	1.01E-05	9.59E-06	5.75E-07	1.20E-01	1.05
200	1.38E-05	1.57E-05	6.27E-07	8.00E-02	0.88
300	1.26E-05	1.33E-05	6.66E-07	1.00E-01	0.95
500	1.08E-05	1.01E-05	5.07E-07	1.00E-01	1.06
750	9.50E-06	1.03E-05	5.17E-07	1.00E-01	0.92
1000	9.04E-06	9.20E-06	2.76E-07	6.00E-02	0.98
1500	8.05E-06	7.49E-06	2.25E-07	6.00E-02	1.07
2000	7.33E-06	7.35E-06	4.41E-07	1.20E-01	1.00

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.01	0.05	0.05
>150 keV	0.98	0.08	0.06
All	0.98	0.07	0.06





HOLLOW SPHERICAL SHELL OF WATER AT 1 METER

Date: October 10, 2000 ISOCS Version: v4.0

This is a spherical shell of Fe with OD of 20 cm. Inside the Fe shell is a 9 mm thick active layer of water. The remainder of the spherical volume is inactive air. The source data comes from MCNP. NOTE: The source is actually 95 cm from the detector.

ISOCS Geometry Parameters

Template: SPHERE
Detector: 60% (S/N 3222)
Collimator: NONE

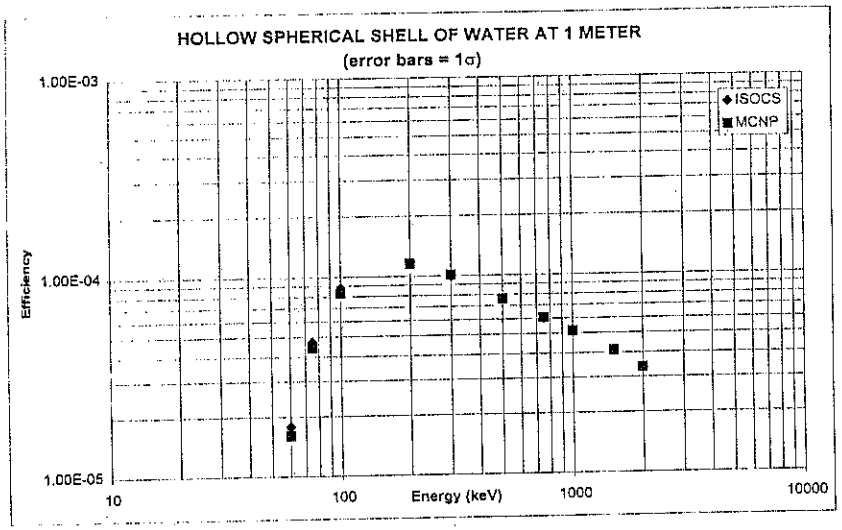
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Shell	0.1	20				Fe	7.86	
(2) Src - Shell	0.9					Water	1	1
(3) Src - Volume						Air	0.0012	0
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	95	0	0	0	0			

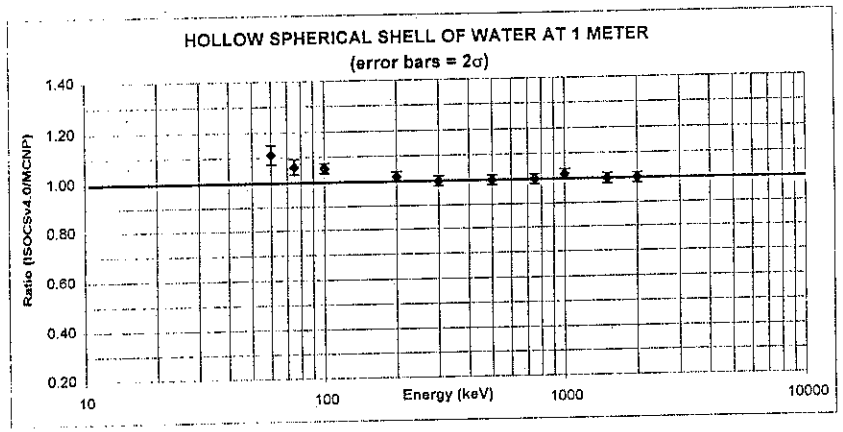
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	1.80E-05	1.62E-05	3.24E-07	4.00E-02	1.11
75	4.72E-05	4.45E-05	6.68E-07	3.00E-02	1.06
100	8.79E-05	8.34E-05	8.34E-07	2.00E-02	1.05
200	1.18E-04	1.16E-04	1.16E-06	2.00E-02	1.02
300	1.01E-04	1.01E-04	1.01E-06	2.00E-02	1.00
500	7.60E-05	7.62E-05	7.62E-07	2.00E-02	1.00
750	6.07E-05	6.08E-05	6.08E-07	2.00E-02	1.00
1000	5.25E-05	5.16E-05	5.16E-07	2.00E-02	1.02
1500	4.11E-05	4.12E-05	4.12E-07	2.00E-02	1.00
2000	3.37E-05	3.37E-05	3.37E-07	2.00E-02	1.00

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.06	0.02	0.02
>150 keV	1.00	0.01	0.01
All	1.01	0.03	0.02





PIPE FULL OF WATER, CONTAMINATION PLATED INSIDE WALL
Date: October 10, 2000 ISOCS Version: v4.0

This is an Al pipe, 20 cm OD, 1 m long, 5 mm wall thickness. The outer 4 mm of the wall is inactive. The inner 1 mm of the wall is active. The volume inside the wall is full of inactive water. The detector is perpendicular to the pipe and aimed at the center of the pipe. The source data is from MCNP.

ISOCS Geometry Parameters
Template: PIPE
Detector: 60% (S/N 3222)
Collimator: NONE

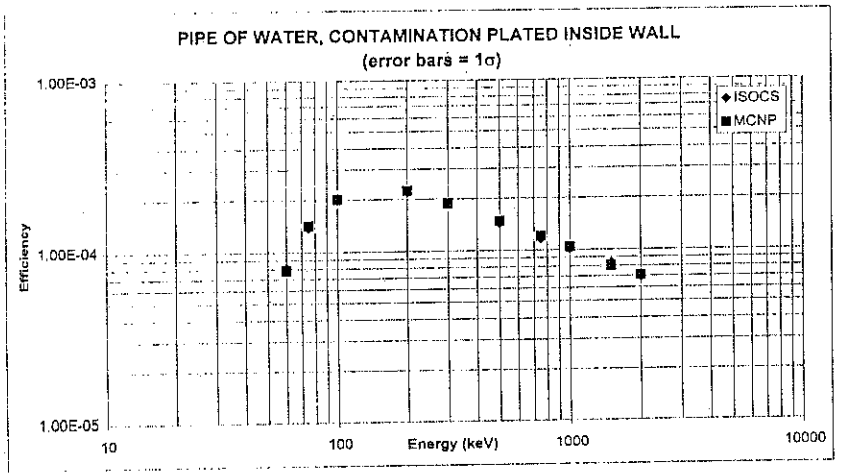
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Pipe	0.4	19.2	50	50		Al	2.7	
(2) Src 1	0.1	50	50			Al	2.7	1
(3) Src 2	19	50	50	0	0	Water	1	0
(4) Absorber 1								
(5) Absorber 2								
(5) Src-Det	50	0	0	0	0			

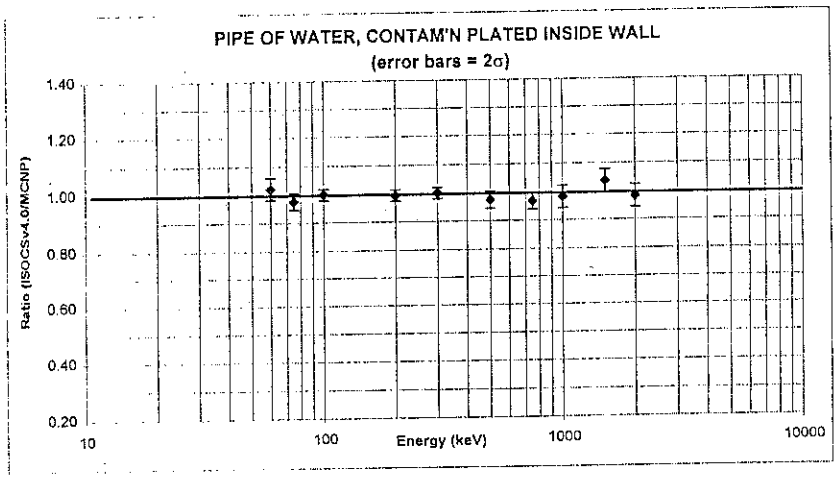
Air: Temp: 0 C Rel. Hum.: 0% Bar. Press.: 0 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MCNP efficiency	MCNP 1 σ unc	MCNP 2σ rel. unc	Ratio (ISOCS/Meas)
60	8.07E-05	7.91E-05	1.58E-06	4.00E-02	1.02
75	1.39E-04	1.43E-04	2.14E-06	3.00E-02	0.98
100	2.02E-04	2.02E-04	2.02E-06	2.00E-02	1.00
200	2.24E-04	2.26E-04	2.26E-06	2.00E-02	0.99
300	1.89E-04	1.89E-04	1.89E-06	2.00E-02	1.00
500	1.44E-04	1.48E-04	2.22E-06	3.00E-02	0.97
750	1.17E-04	1.21E-04	1.81E-06	3.00E-02	0.97
1000	1.03E-04	1.04E-04	2.09E-06	4.00E-02	0.98
1500	8.34E-05	8.04E-05	1.61E-06	4.00E-02	1.04
2000	6.98E-05	7.09E-05	1.42E-06	4.00E-02	0.98

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.00	0.02	0.01
>150 keV	0.99	0.02	0.01
All	0.99	0.02	0.01





IN-SITU DIRT W/DETECTOR AT 1 M (Lee Booth)
Date: October 10, 2000 ISOCS Version: v4.0

This is the standard InSitu dirt measurement. The detector is 1 m from the surface of a semi-infinite field of dirt having a uniform distribution of activity. The data comes from Lee Booth's Insitu calibration. The massemetric efficiency (product of mass and efficiency) is determined.

ISOCS Geometry Parameters
Template: CIRCULAR PLANE
Detector: Lee Booth's
Collimator: NONE

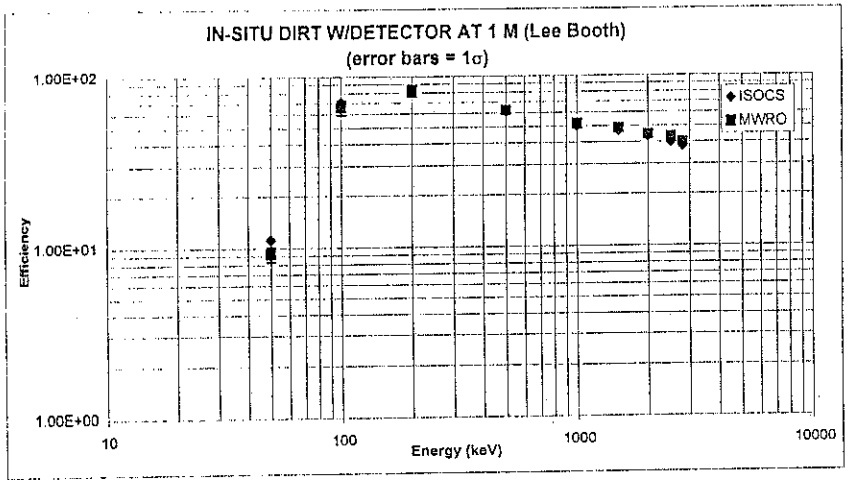
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Side Wall	0	7500						
(2) Src - Lr 1	50					Dirt2	1.6	1
(3...11) Source Layers 2...10 are all empty								
(12) Absorber 1								
(13) Absorber 2								
(14) Src-Det	100	0	0	0	0			

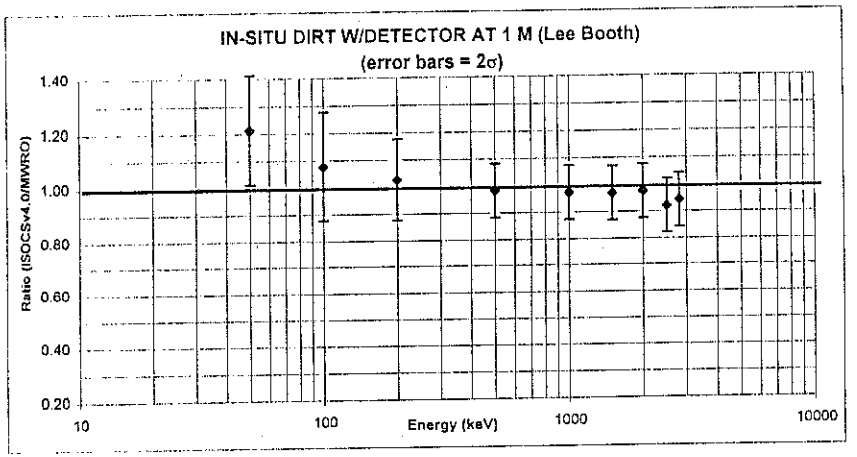
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

Comparison Results

Energy (keV)	ISOCS efficiency	MWRO efficiency	MWRO 1 σ unc	MWRO 2σ rel. unc	Ratio (ISOCS/Meas)
50	1.12E+01	9.24E+00	9.24E-01	2.00E-01	1.21
100	7.12E+01	6.60E+01	6.60E+00	2.00E-01	1.08
200	8.44E+01	8.22E+01	6.17E+00	1.50E-01	1.03
500	6.16E+01	6.27E+01	3.14E+00	1.00E-01	0.98
1000	5.05E+01	5.18E+01	2.59E+00	1.00E-01	0.97
1500	4.72E+01	4.87E+01	2.44E+00	1.00E-01	0.97
2000	4.36E+01	4.47E+01	2.24E+00	1.00E-01	0.98
2500	3.99E+01	4.33E+01	2.17E+00	1.00E-01	0.92
2800	3.79E+01	4.01E+01	2.01E+00	1.00E-01	0.95

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.14	0.08	0.08
>150 keV	0.96	0.03	0.03
All	0.97	0.05	0.05





GENITRON RADIUM CALIBRATION PAD, 25mm-90d COLLIMATOR
Date: October 10, 2000 ISOCS Version: v4.0

The activity of Ra-226+daughters from the Genitron Calibration Pad was measured using an ISOCS characterized detector. The measured activity is compared with the certified activity of the calibration source.

ISOCS Geometry Parameters
Template: CIRCULAR PLANE
Detector: Siemens
Collimator: 25mm-90d CRPN=6

Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Side Wall	0	72						
(2) Src - Lr 1	32					Beton1	2.3	1
(3...10) Source Layers 2...9 are all empty								
(11) Src - Lr 10								
(12) Absorber 1								
(13) Absorber 2								
(14) Src-Det	49.2	4	0	4	0			

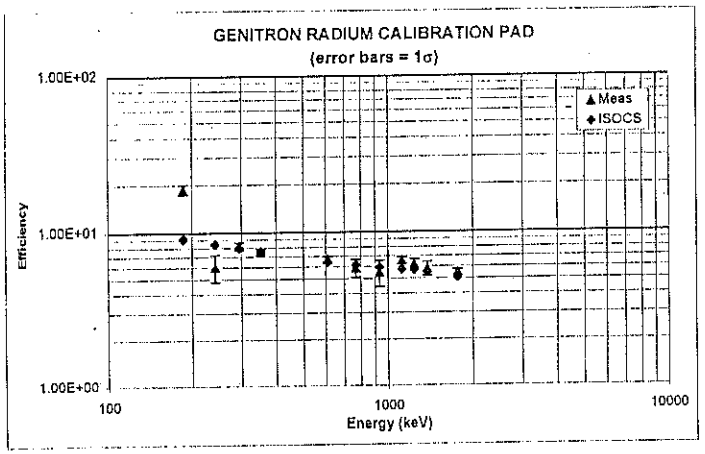
Air: Temp: 20 C Rel. Hum.: 5.0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

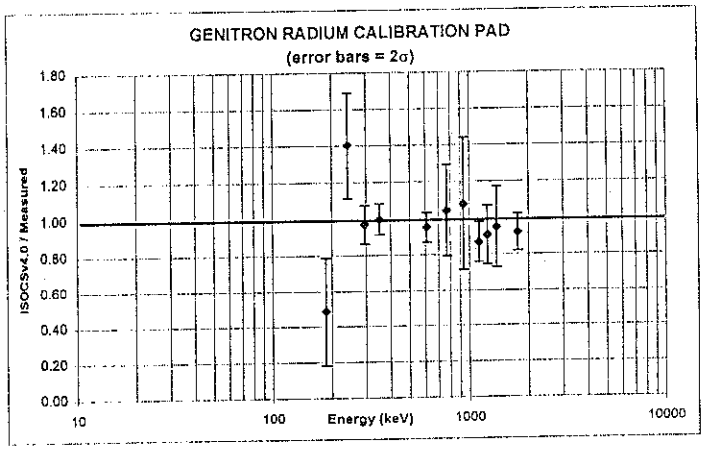
	Ra pad	Blank pad
Counting time (sec)	1000	1000

Comparison Results Efficiency in units of count/gamma/gram

Energy (keV)	Intensity	Certified act. (Ra)	Certified act. (BL.)	Meas. pk area (Ra)	Meas. pk area (BL.)	Measured efficiency	2σ rel. unc (meas)	1 σ unc	ISOCS efficiency	ISOCS/meas
186	3.15	1001	12	5.86E+02	0.00E+00	1.88E+01	0.304	1.39E+00	9.16E+00	0.487
241.98	7.15	1001	12	4.57E+02	3.05E+01	6.03E+00	0.287	1.22E+00	8.47E+00	1.405
295.22	18.4	1001	12	1.50E+03	0.00E+00	8.24E+00	0.105	4.19E-01	8.01E+00	0.971
351.99	35.5	1001	12	2.74E+03	6.42E+01	7.62E+00	0.085	3.24E-01	7.62E+00	0.999
609.31	44.1	1001	12	3.01E+03	6.85E+01	6.74E+00	0.081	2.60E-01	6.43E+00	0.953
768.36	4.68	1001	12	2.73E+02	0.00E+00	5.90E+00	0.251	7.72E-01	6.15E+00	1.043
934.06	3.03	1001	12	1.65E+02	0.00E+00	5.51E+00	0.362	1.08E+00	5.94E+00	1.079
1120.29	14.4	1001	12	9.64E+02	2.45E+01	6.60E+00	0.109	3.11E-01	5.73E+00	0.869
1238.11	5.67	1001	12	3.50E+02	0.00E+00	6.24E+00	0.162	4.59E-01	5.68E+00	0.909
1377.67	3.85	1001	12	2.22E+02	0.00E+00	5.83E+00	0.220	6.12E-01	5.55E+00	0.952
1764.49	15.2	1001	12	8.49E+02	2.42E+01	5.49E+00	0.102	2.57E-01	5.07E+00	0.924

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
All	0.923	0.142	0.126





GENITRON THORIUM CALIBRATION PAD, 25mm-90d COLLIMATOR
Date: October 10, 2000 ISOCS Version: v4.0

The activity of Th-232+daughters from the Genitron Calibration Pad was measured using an ISOCS characterized detector. The measured activity is compared with the certified activity of the calibration source.

ISOCS Geometry Parameters
Template: CIRCULAR PLANE
Detector: Siemens
Collimator: 25mm-90d CRPN=6

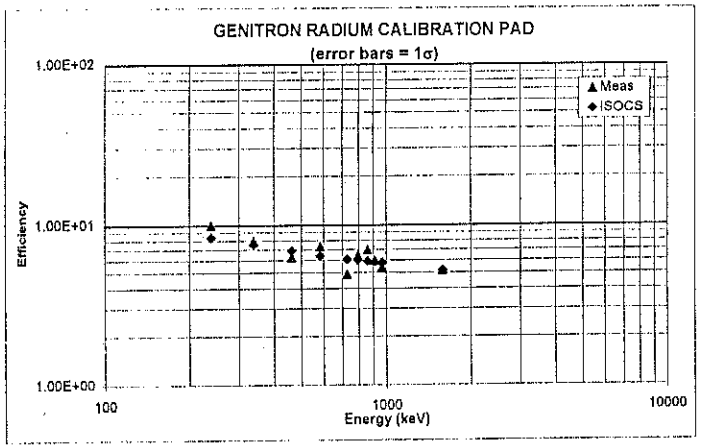
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Side Wall	0	72						
(2) Src - Lr 1	32					Beton1	2.3	1
(3...10) Source Layers 2...9 are all empty								
(11) Src - Lr 10								
(12) Absorber 1								
(13) Absorber 2								
(14) Src-Det	50.2	0	0	0	0			

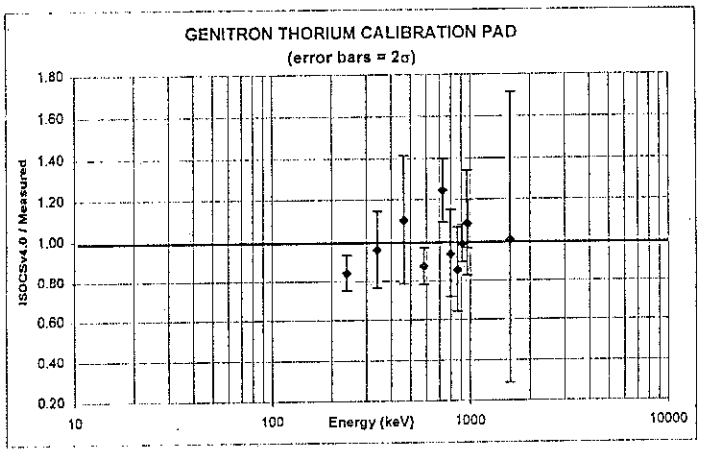
Air: Temp:2 0 C Rel. Hum.:5 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

	Ra pad	Blank pad
Counting time (sec)	1000	1000

Comparison Results **Efficiency in units of count/gamma/gram**

Energy (keV)	Intensity	Certified act. (Ra)	Certified act. (BL.)	Meas. pk area (Ra)	Meas. pk area (BL.)	Measured efficiency	2σ rel. unc (meas)	1 σ unc	ISOCS efficiency	ISOCS/meas
238.63	41.4	961	19	4.02E+03	1.18E+02	1.00E+01	0.089	3.75E-01	8.40E+00	0.840
338.32	11.7	961	19	8.77E+02	0.00E+00	7.96E+00	0.190	7.20E-01	7.59E+00	0.954
463.01	4.52	961	19	2.68E+02	0.00E+00	6.29E+00	0.313	1.08E+00	6.93E+00	1.100
583.19	29.7	961	19	2.11E+03	5.34E+01	7.35E+00	0.091	2.93E-01	6.41E+00	0.872
727.18	11.3	961	19	5.23E+02	0.00E+00	4.91E+00	0.155	4.74E-01	6.11E+00	1.244
794.95	4.71	961	19	2.87E+02	0.00E+00	6.47E+00	0.218	6.56E-01	6.03E+00	0.932
860.47	4.14	961	19	2.72E+02	0.00E+00	6.97E+00	0.210	6.26E-01	5.95E+00	0.854
911.07	28.2	961	19	1.65E+03	6.24E+01	5.98E+00	0.092	2.70E-01	5.89E+00	0.985
964.77	5.31	961	19	2.68E+02	0.00E+00	5.36E+00	0.258	7.49E-01	5.81E+00	1.084
968.97	17	961	19	9.08E+02	4.72E+01	5.38E+00	0.118	3.43E-01	5.80E+00	1.080
1587.9	3.61	961	19	1.76E+02	0.00E+00	5.18E+00	0.714	1.85E+00	5.19E+00	1.002
								Wt.Mean	Wt. Rel.	ISOCS
							Dataset	Ratio	Std Dev	Std Dev
							All	0.932	0.117	0.094





GENITRON K40 CALIBRATION PAD, 25mm-90d COLLIMATOR
Date: October 10, 2000 ISOCS Version: v4.0

The activity of K-40 from the Genitron Calibration Pad
was measured using an ISOCS characterized detector. The measured
activity is compared with the certified activity of the calibration source.

ISOCS Geometry Parameters
Template: CIRCULAR PLANE
Detector: Siemens
Collimator: 25mm-90d CRPN=6

Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Side Wall	0	72						
(2) Src - Lr 1	32					Beton2	2.1	1
(3...10) Source Layers 2...9 are all empty								
(11) Src - Lr 10								
(12) Absorber 1								
(13) Absorber 2								
(14) Src-Det	49.2	3	0	3	0			

Air: Temp:2 0 C Rel. Hum.:5 0% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc

	Ra pad	Blank pad
Counting time (sec)	1000	1000

Comparison Results **Efficiency In units of count/gamma/gram**

Energy (keV)	Intensity	Certified act. (Ra)	Certified act. (BL.)	Meas. pk area (Ra)	Meas. pk area (BL.)	Measured efficiency	2σ rel. unc (meas)	1 σ unc	ISOCS efficiency	ISOCS/meas
1460.8	10.64	2026	137	1.54E+03	4.17E+02	5.59E+00	0.151	4.11E-01	**5.45E+00**	**0.976**

LINE SOURCE (6 X 80CM) 4.8M LONG, AT 1 METER
Date: October 10, 2000 ISOCS Version: v4.0

Six standard line sources, each 81.3 cm in length and 0.953 cm in diameter were taped end-to-end to form a single long source. The radioactivity in the standard sources is distributed in an epoxy matrix of density 1.07 g/cc.

ISOCS Geometry Parameters
Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578) New characterization
Collimator: NONE

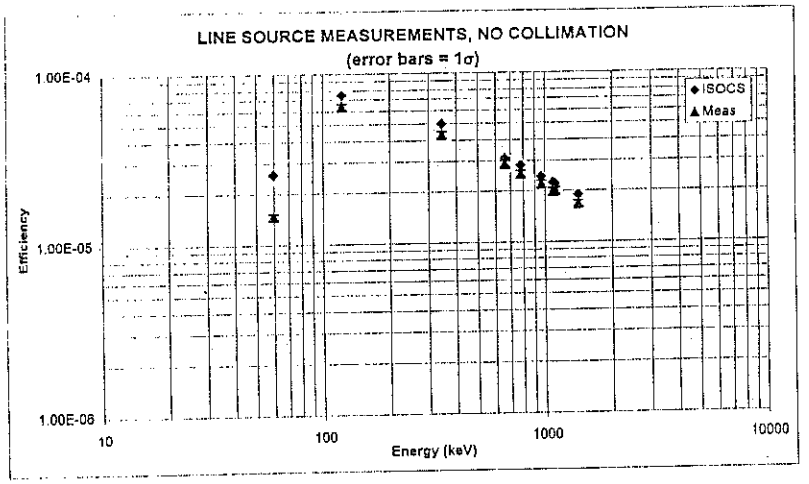
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1)Container	0.089	0.775	485.4			Al	2.7	
(2) Top Layer								
(3) Bot Layer	485.4					Epoxy	1.07	1
(4) Absorber 1								
(5) Absorber 2								
(5) Src-Det	97.5	0	1.2	0	1.2			

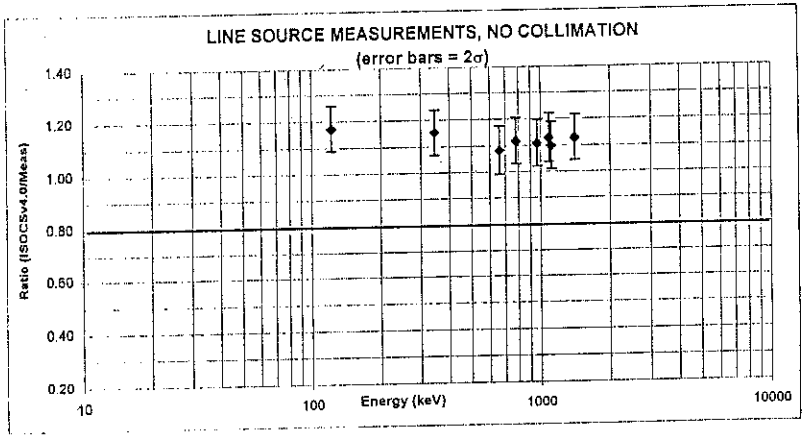
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 0.1%
Units: Length: cm Density: g/cc
Source material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	2.60E-05	1.47E-05	6.26E-07	8.52E-02	1.77
121.78	7.51E-05	6.40E-05	2.72E-06	8.50E-02	1.17
344.29	5.02E-05	4.35E-05	1.85E-06	8.51E-02	1.15
661.66	3.14E-05	2.90E-05	1.33E-06	9.17E-02	1.08
778.92	2.83E-05	2.53E-05	1.12E-06	8.85E-02	1.12
964.11	2.44E-05	2.20E-05	9.75E-07	8.86E-02	1.11
1085.89	2.25E-05	1.99E-05	9.09E-07	9.14E-02	1.13
1112.08	2.21E-05	2.01E-05	8.93E-07	8.89E-02	1.10
1408	1.90E-05	1.68E-05	7.27E-07	8.65E-02	1.13

Dataset	Wt.Mean Ratio	Wt. Rel. Std Dev	ISOCS Std Dev
<150 keV	1.35	0.29	0.28
>150 keV	1.12	0.02	0.02
All	1.16	0.13	0.12





LINE SOURCES INSIDE A FOAM CALIBRATION DRUM

Date: October 10, 2000 ISOCS Version: v4.0

Each line source consist of an Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls. The activity is uniformly distributed in an epoxy matrix. The line sources are in tubes 2,3,4,5,6 and 9. The drum is rotating and the detector is centered along the length of the sources.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578), New Characterization
Collimator: NONE

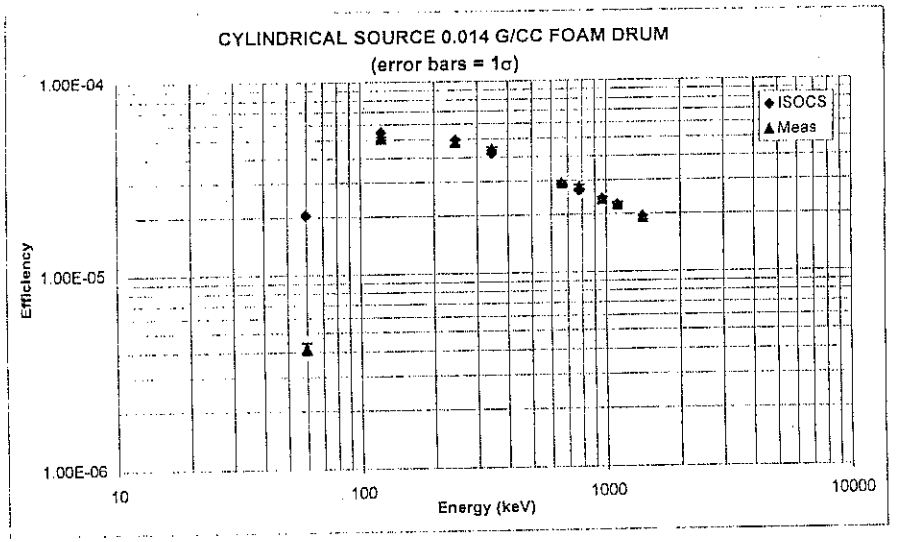
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.936	55.128	86.4			NewMat	2.45	
(2) Src. Top Lay.								
(3) Src. Bot Lay.	81.3					Rubber	0.014	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	-2.55	0	-2.55			

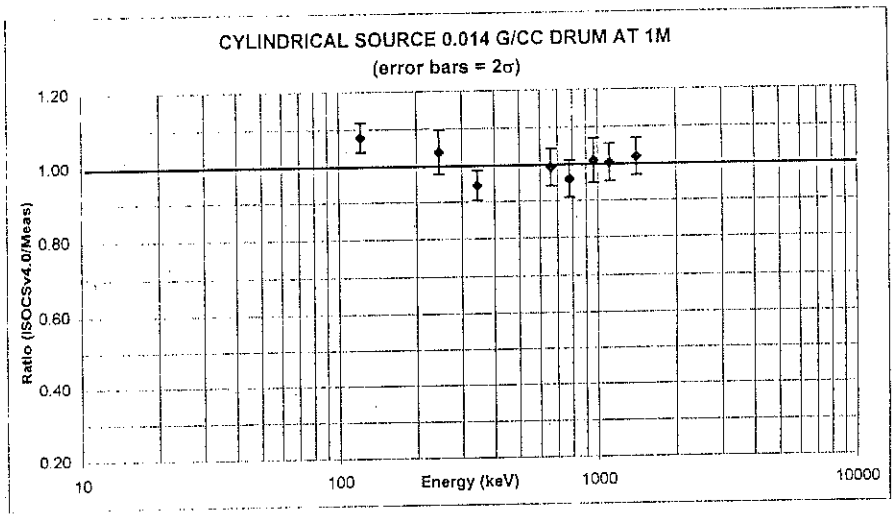
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: .3%
Units: Length: cm Density: g/cc
Container wall Material: Fe + PVC +Al + Epoxy
Source Material: C10_H16_S2

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	2.06E-05	4.20E-06	2.94E-07	1.40E-01	4.90
121.78	5.48E-05	5.08E-05	1.02E-06	4.00E-02	1.08
244.69	4.99E-05	4.81E-05	1.44E-06	6.00E-02	1.04
344.27	4.20E-05	4.44E-05	8.88E-07	4.00E-02	0.95
661.65	2.91E-05	2.93E-05	7.33E-07	5.00E-02	0.99
778.89	2.67E-05	2.78E-05	6.95E-07	5.00E-02	0.96
964.01	2.41E-05	2.39E-05	7.17E-07	6.00E-02	1.01
1112.02	2.25E-05	2.24E-05	5.60E-07	5.00E-02	1.00
1407.95	1.94E-05	1.91E-05	4.78E-07	5.00E-02	1.02

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	1.09	0.31	0.31
>150keV	0.99	0.03	0.02
All	1.00	0.15	0.15





LINE SOURCES INSIDE A SOFT CALIBRATION DRUM

Date: October 10, 2000 ISOCS Version: v4.0

Each line source consist of an Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls. The activity is uniformly distributed in an epoxy matrix. The line sources are in tubes 2,3,4,5,6 and 9. The drum is rotating and the detector is centered along the length of the sources.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578), New Characterization
Collimator: NONE

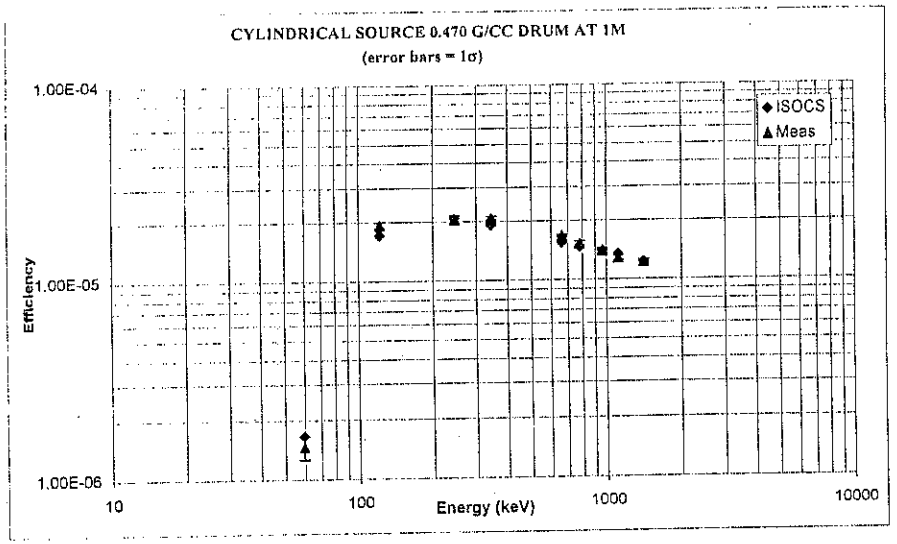
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.936	55.128	86.4			NewMat	2.49	
(2) Src. Top Lay.								
(3) Src. Bot Lay.	81.3					Cellulose	0.43	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	-2.55	0	-2.55			

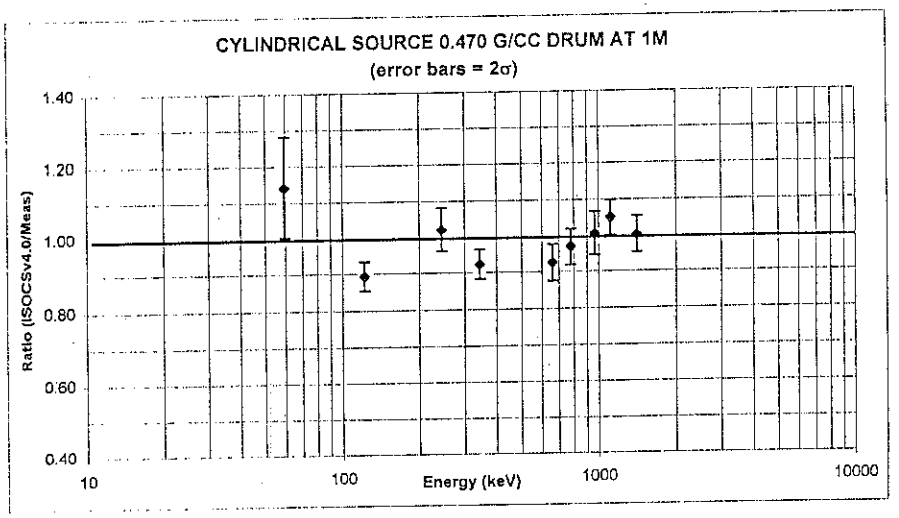
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: .3%
Units: Length: cm Density: g/cc
Container wall Material: Fe + PVC + Al + Epoxy
Source Material: H10_C6_O5

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	1.67E-06	1.46E-06	2.04E-07	2.80E-01	1.14
121.78	1.73E-05	1.93E-05	6.76E-07	7.00E-02	0.89
244.69	2.09E-05	2.05E-05	1.03E-06	1.00E-01	1.02
344.27	1.92E-05	2.08E-05	5.20E-07	5.00E-02	0.92
661.65	1.56E-05	1.68E-05	1.68E-07	2.00E-02	0.93
778.89	1.48E-05	1.53E-05	4.59E-07	6.00E-02	0.97
964.01	1.41E-05	1.40E-05	4.20E-07	6.00E-02	1.01
1112.02	1.35E-05	1.29E-05	3.87E-07	6.00E-02	1.05
1407.95	1.23E-05	1.23E-05	3.08E-07	5.00E-02	1.00

Dataset	Wt. Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	0.90	0.07	0.06
>150keV	0.95	0.04	0.04
All	0.95	0.04	0.04





LINE SOURCES INSIDE A PART. BOARD CALIBRATION DRUM

Date: October 10, 2000 ISOCS Version: v4.0

Each line source consist of an Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls. The activity is uniformly distributed in an epoxy matrix. The line sources are in tubes 2,3,4,5,6 and 9. The drum is rotating and the detector is centered along the length of the sources.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578), New Characterization
Collimator: NONE

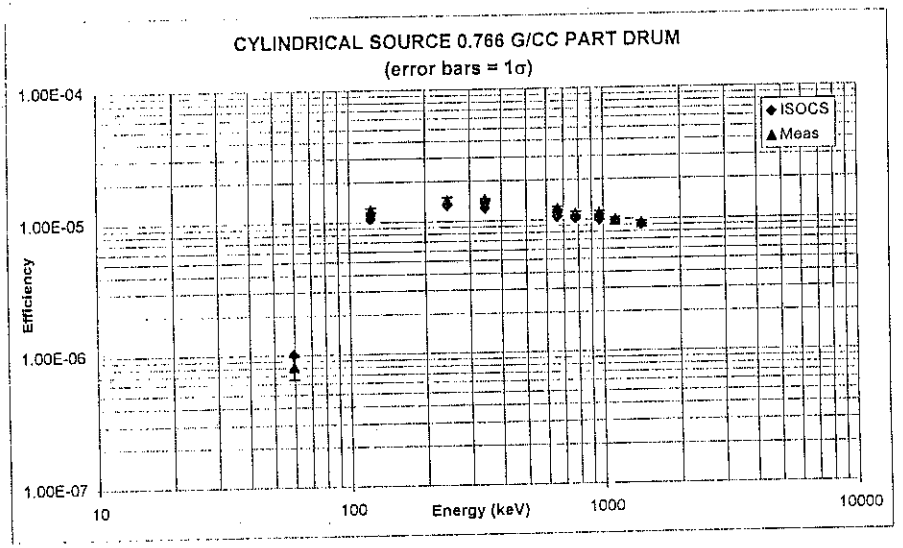
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.936	55.128	86.4			NewMat	2.45	
(2) Src. Top Lay.								
(3) Src. Bot Lay.	81.3					Cellulose	0.766	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	-2.55	0	-2.55			

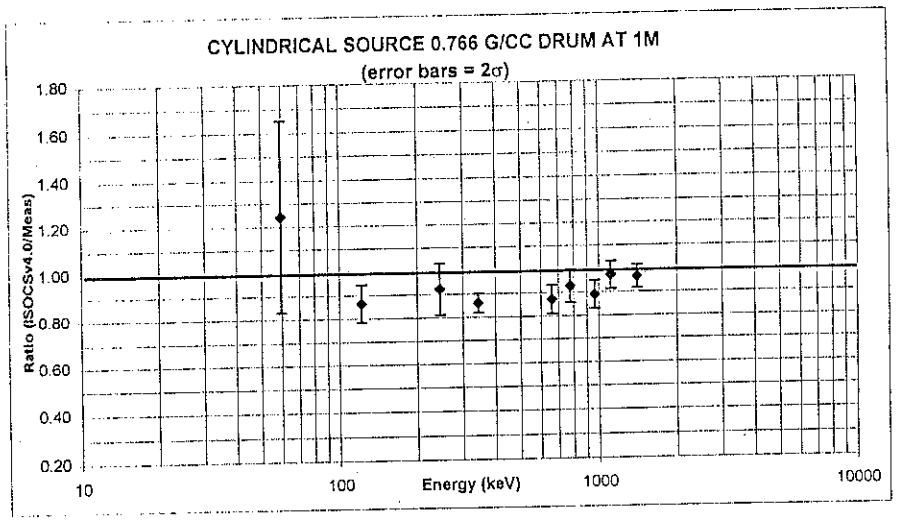
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: .3%
Units: Length: cm Density: g/cc
Container wall Material: Fe + PVC + Al + Epoxy
Source Material: H10_C6_O5

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	1.02E-06	8.17E-07	1.67E-07	4.10E-01	1.24
121.78	1.06E-05	1.23E-05	4.92E-07	8.00E-02	0.87
244.69	1.33E-05	1.44E-05	7.92E-07	1.10E-01	0.92
344.27	1.25E-05	1.45E-05	2.90E-07	4.00E-02	0.86
661.65	1.06E-05	1.22E-05	3.66E-07	6.00E-02	0.87
778.89	1.03E-05	1.11E-05	3.89E-07	7.00E-02	0.93
964.01	9.98E-06	1.12E-05	3.36E-07	6.00E-02	0.89
1112.02	9.73E-06	1.00E-05	3.00E-07	6.00E-02	0.97
1407.95	9.09E-06	9.41E-06	2.35E-07	5.00E-02	0.97

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	0.87	0.08	0.06
>150keV	0.90	0.05	0.05
All	0.90	0.05	0.04





LINE SOURCES INSIDE A SAND CALIBRATION DRUM

Date: October 10, 2000 ISOCS Version: v4.0

Each line source consist of an Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls. The activity is uniformly distributed in an epoxy matrix. The line sources are in tubes 2,3,4,5,6 and 9. The drum is rotating and the detector is centered along the length of the sources.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578)
Collimator: NONE

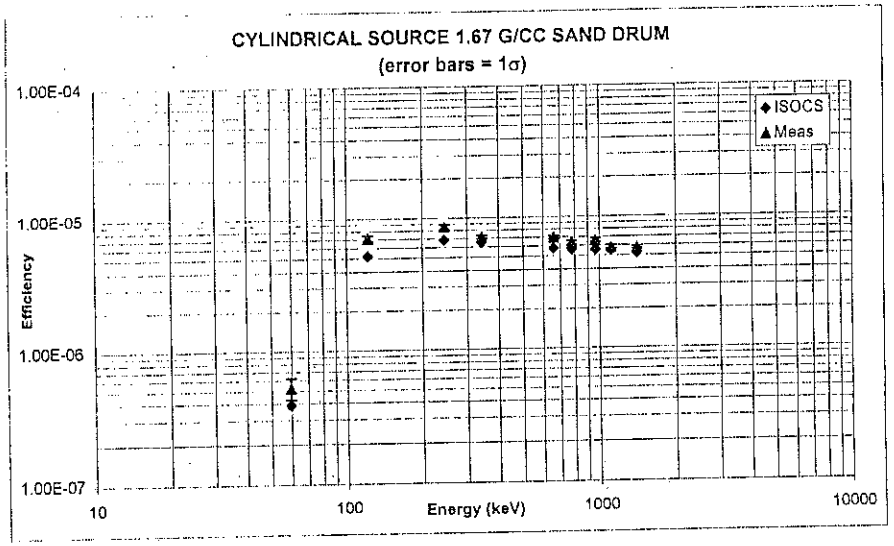
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.936	55.128	86.4			NewMat	2.45	
(2) Src. Top Lay.								
(3) Src. Bot Lay.	81.3					Sand	1.67	1
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	-2.55	0	-2.55			

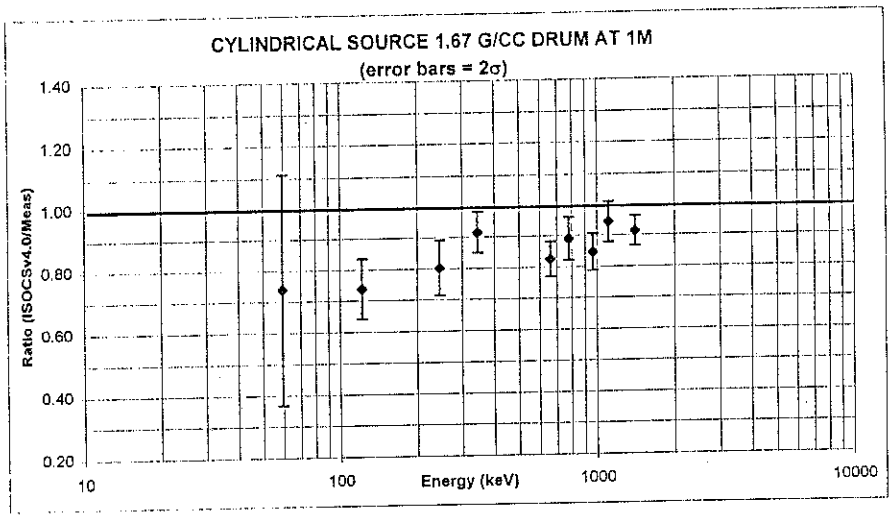
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: .3%
Units: Length: cm Density: g/cc
Container wall Material: Fe + PVC + Al + Epoxy
Source Material: Si_O2

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	3.89E-07	5.26E-07	9.79E-08	3.72E-01	0.74
121.78	5.25E-06	7.10E-06	3.40E-07	9.58E-02	0.74
244.69	6.86E-06	8.54E-06	3.78E-07	8.85E-02	0.80
344.27	6.52E-06	7.13E-06	2.34E-07	6.56E-02	0.92
661.65	5.76E-06	6.98E-06	1.98E-07	5.67E-02	0.83
778.89	5.65E-06	6.34E-06	2.19E-07	6.91E-02	0.89
964.01	5.57E-06	6.58E-06	1.96E-07	5.96E-02	0.85
1112.02	5.51E-06	5.84E-06	1.93E-07	6.61E-02	0.94
1407.95	5.28E-06	5.78E-06	1.36E-07	4.71E-02	0.91

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	0.74	0.00	0.00
>150keV	0.88	0.06	0.05
All	0.87	0.07	0.06





LINE SOURCES ON THE INNER WALL OF AN EMPTY DRUM (PIPE)

Date: October 10, 2000 ISOCS Version: v4.0

Each source consist of one Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls.
The activity is uniformly distributed in an epoxy matrix. The line sources are against the drum inside wall.
The drum is rotating and the detector is centered along the length of the line source.

ISOCS Geometry Parameters

Template: PIPE
Detector: 42% (S/N 3578), New Characterization
Collimator: NONE

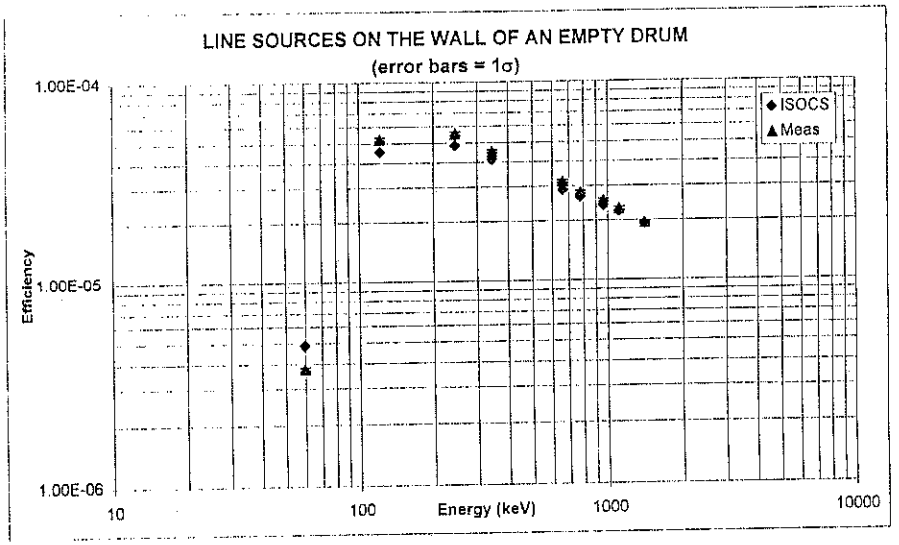
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Pipe	0.142	57	44.6	41.8		Csteel	8	
(2)Source 1	0.775	40.6	40.6			Epoxy	1.15	1
(3)Source 2								
(4) Absorber 1	0.089					Al	2.7	
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

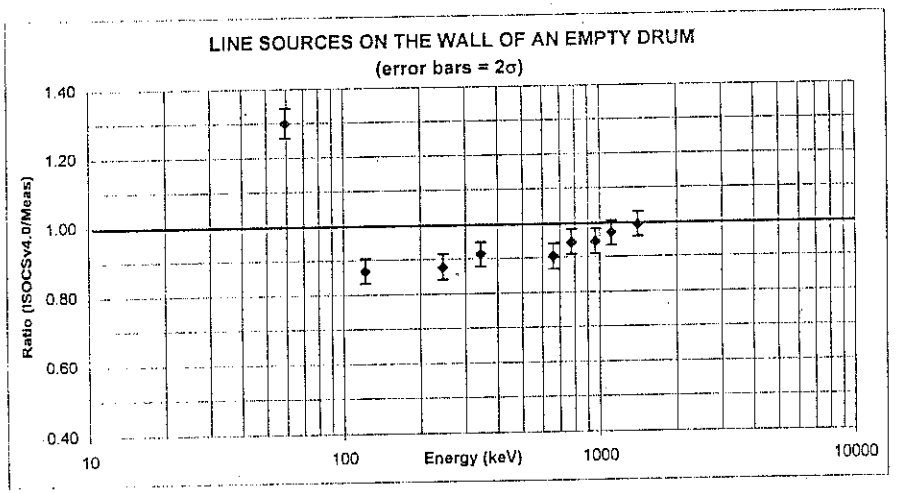
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: .3%
Units: Length: cm Density: g/cc
Source Material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	1 σ unc	2σ rel. unc	Ratio (ISOCS/Meas)
59.54	4.89E-06	3.76E-06	8.14E-08	4.33E-02	1.30
121.78	4.55E-05	5.24E-05	9.25E-07	3.53E-02	0.87
244.69	4.86E-05	5.54E-05	1.00E-06	3.61E-02	0.88
344.27	4.14E-05	4.53E-05	7.94E-07	3.51E-02	0.91
661.65	2.88E-05	3.18E-05	5.95E-07	3.74E-02	0.91
778.89	2.64E-05	2.80E-05	5.03E-07	3.59E-02	0.94
964.01	2.39E-05	2.53E-05	4.52E-07	3.57E-02	0.95
1112.02	2.23E-05	2.30E-05	4.11E-07	3.57E-02	0.97
1407.95	1.94E-05	1.95E-05	3.46E-07	3.55E-02	0.99

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	0.97	0.27	0.26
>150keV	0.93	0.04	0.04
All	0.94	0.10	0.09





80 CM LINE SOURCE AT 0 DEGREES, AND 10 CM
Date: October 10, 2000 ISOCS Version: v4.0

The source consist of one Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls.
The activity is uniformly distributed in an epoxy matrix.
The rod is positioned vertically upright. The detector is centered along the length of the rod.

ISOCS Geometry Parameters
Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578) New characterization
Collimator: NONE

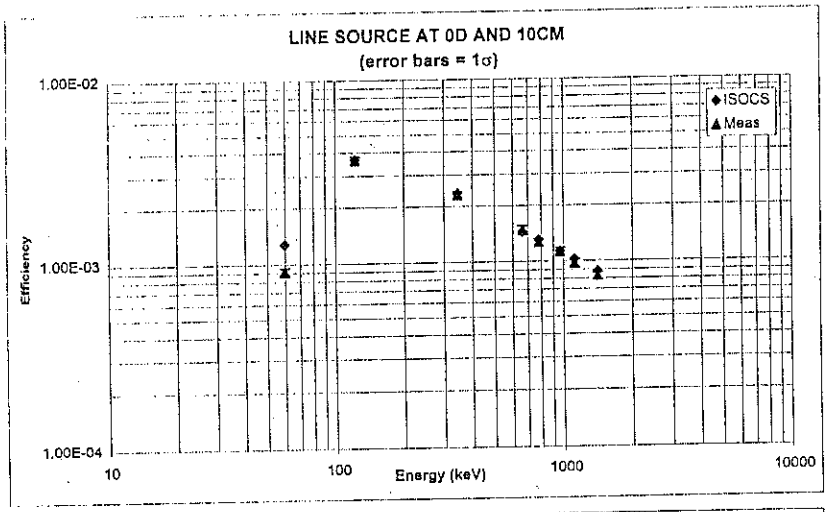
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.089	0.775	80.9			Al	2.7	
(2) Src. Top Lay.	80.9					Epoxy	1.07	1
(3) Src. Bot. Lay								
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	10	0	0	0	0			

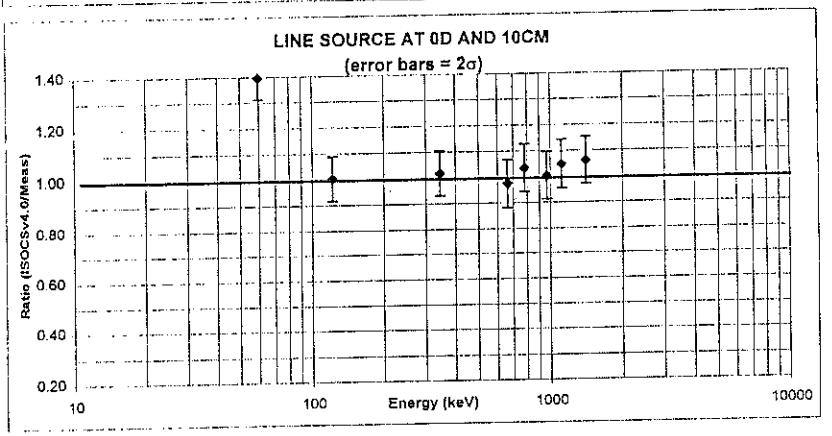
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 1%
Units: Length: cm Density: g/cc
Source Material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	**1.28E-03**	9.15E-04	3.89E-05	8.50E-02	1.40
121.78	**3.66E-03**	3.65E-03	1.56E-04	8.55E-02	1.00
344.28	**2.37E-03**	2.33E-03	1.00E-04	8.58E-02	1.02
661.66	**1.45E-03**	1.49E-03	6.95E-05	9.33E-02	0.98
778.9	**1.31E-03**	1.27E-03	5.88E-05	9.26E-02	1.04
964.13	**1.14E-03**	1.13E-03	5.15E-05	9.12E-02	1.01
1112.12	**1.03E-03**	9.80E-04	4.59E-05	9.37E-02	1.05
1408.01	**8.83E-04**	8.31E-04	3.71E-05	8.93E-02	1.06

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	1.14	0.23	0.23
>150keV	1.02	0.03	0.03
All	1.05	0.11	0.10





80 CM LINE SOURCE AT 0 DEGREES, AND 100 CM

Date: October 10, 2000 ISOCS Version: v4.0

The source consist of one Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls.
The activity is uniformly distributed in an epoxy matrix.
The rod is positioned vertically upright. The detector is centered along the length of the rod.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578) New characterization
Collimator: NONE

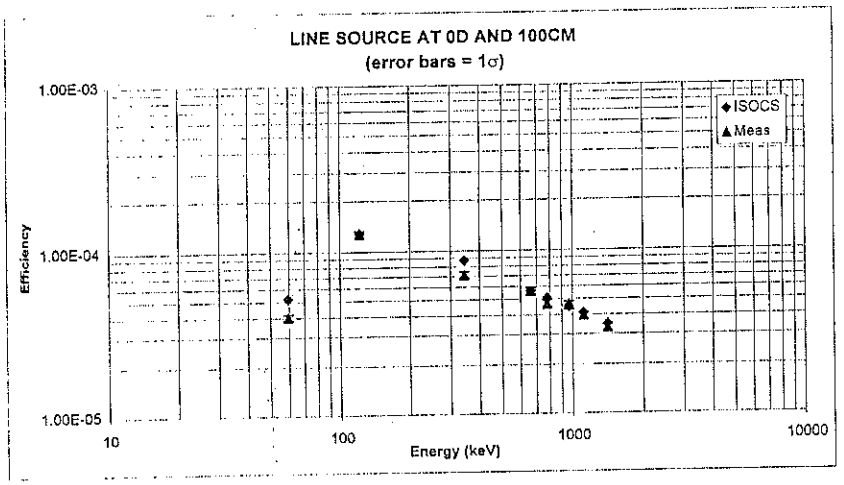
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.089	0.775	80.9			Al	2.7	
(2) Src. Top Lay.	80.9					Epoxy	1.07	1
(3) Src. Bot. Lay								
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	100	0	0	0	0			

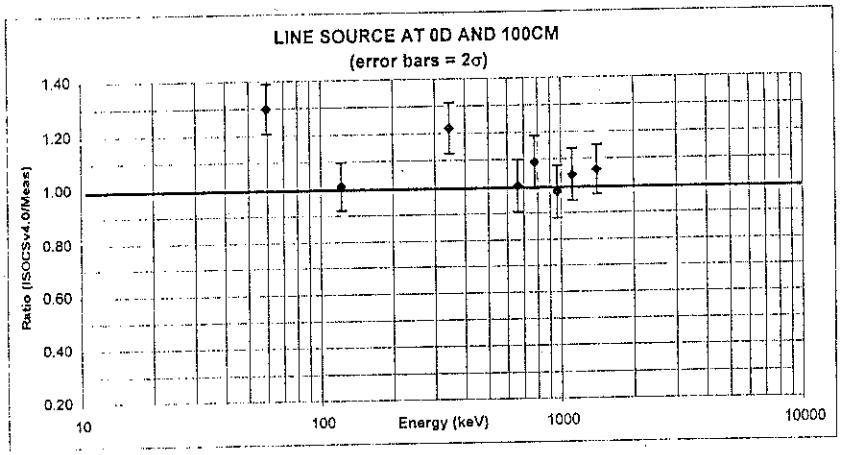
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 1%
Units: Length: cm Density: g/cc
Source Material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	5.22E-05	4.02E-05	1.83E-06	9.10E-02	1.30
121.78	1.28E-04	1.27E-04	5.67E-06	8.93E-02	1.01
344.28	8.75E-05	7.17E-05	3.37E-06	9.40E-02	1.22
661.66	5.64E-05	5.62E-05	2.72E-06	9.68E-02	1.00
778.9	5.10E-05	4.68E-05	2.32E-06	9.91E-02	1.09
964.13	4.51E-05	4.61E-05	2.25E-06	9.76E-02	0.98
1112.12	4.14E-05	3.98E-05	1.95E-06	9.80E-02	1.04
1408.01	3.52E-05	3.32E-05	1.53E-06	9.22E-02	1.06

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	1.12	0.18	0.17
>150keV	1.06	0.08	0.06
All	1.07	0.10	0.09





80 CM LINE SOURCE AT 0 DEGREES, AND 300 CM

Date: October 10, 2000 ISOCS Version: v4.0

The source consist of one Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls.
The activity is uniformly distributed in an epoxy matrix.
The rod is positioned vertically upright. The detector is centered along the length of the rod.

ISOCS Geometry Parameters

Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578) New characterization
Collimator: NONE

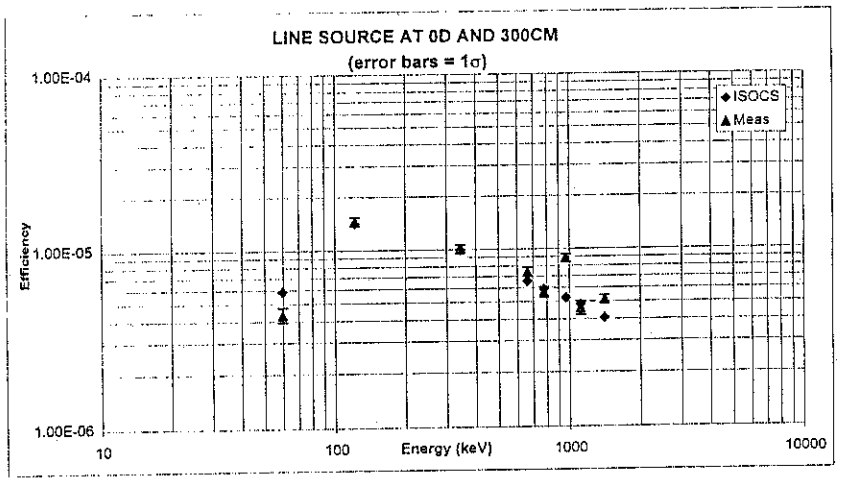
Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.089	0.775	80.9			Al	2.7	
(2) Src. Top Lay.	80.9					Epoxy	1.07	1
(3) Src. Bot. Lay								
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	300	0	0	0	0			

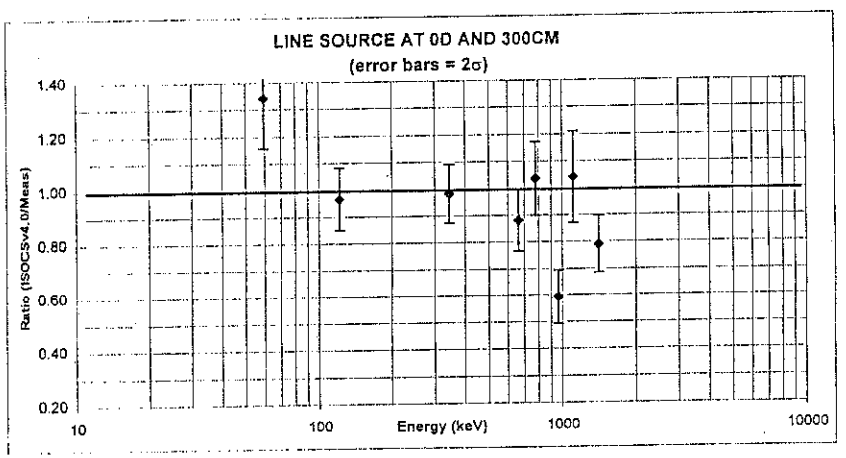
Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 1%
Units: Length: cm Density: g/cc
Source Material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	Measured 1 σ unc	Measured 2σ rel. unc	Ratio (ISOCS/Meas)
59.54	5.87E-06	4.37E-06	4.06E-07	1.86E-01	1.34
121.78	1.41E-05	1.46E-05	8.41E-07	1.15E-01	0.97
344.28	9.93E-06	1.01E-05	5.45E-07	1.08E-01	0.98
661.66	6.56E-06	7.44E-06	4.23E-07	1.14E-01	0.88
778.9	5.93E-06	5.71E-06	3.93E-07	1.38E-01	1.04
964.13	5.26E-06	8.87E-06	4.47E-07	1.01E-01	0.59
1112.12	4.85E-06	4.65E-06	3.95E-07	1.70E-01	1.04
1408.01	4.08E-06	5.16E-06	2.75E-07	1.07E-01	0.79

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	1.03	0.19	0.18
>150keV	0.78	0.24	0.23
All	0.81	0.25	0.24





80 CM LINE SOURCE AT 45 DEGREES, AND 10 CM
Date: October 10, 2000 ISOCS Version: v4.0

The source consist of one Aluminum tube 813mm long by 9.53mm OD and 0.89mm thick walls.
The activity is uniformly distributed in an epoxy matrix.
The rod is positioned vertically upright. The detector is centered along the length of the rod.

ISOCS Geometry Parameters
Template: SIMPLE CYLINDER
Detector: 42% (S/N 3578) New characterization
Collimator: NONE

Item	d.1	d.2	d.3	d.4	d.5	Material	Density	Conc.
(1) Container	0.089	0.775	80.9			Al	2.7	
(2) Src. Top Lay.	80.9					Epoxy	1.07	1
(3) Src. Bot. Lay								
(4) Absorber 1								
(5) Absorber 2								
(6) Src-Det	10	0	0	10	0			

Air: Temp: 20 C Rel. Hum.: 50% Bar. Press.: 760 mm Hg
Convergence: 1%
Units: Length: cm Density: g/cc
Source Material: 72.1%C+21.9%O+6%H

Comparison Results

Energy (keV)	ISOCS efficiency	Measured efficiency	1 σ unc	2σ rel. unc	Ratio (ISOCS/Meas)
59.54	1.16E-03	7.40E-04	3.29E-05	8.89E-02	1.57
121.78	3.88E-03	3.76E-03	1.61E-04	8.56E-02	1.03
344.28	2.55E-03	2.50E-03	1.08E-04	8.64E-02	1.02
661.66	1.57E-03	1.60E-03	7.49E-05	9.36E-02	0.98
778.9	1.41E-03	1.37E-03	6.34E-05	9.26E-02	1.03
964.13	1.21E-03	1.20E-03	5.47E-05	9.12E-02	1.01
1112.12	1.09E-03	1.06E-03	4.93E-05	9.30E-02	1.03
1408.01	9.39E-04	9.24E-04	4.12E-05	8.92E-02	1.02

Dataset	Wt.Mean Ratio	Wt. Rel. Std. Dev.	Isocs Std. Dev.
<150keV	1.19	0.29	0.29
>150keV	1.01	0.02	0.02
All	1.05	0.13	0.12