* Abstract
* Introduction:
  + HPGes/MCNP/Optimization Codes
  + Previous Work
  + The Problem:
  + Experimental Data
* Procedure:
  + Creating the Model
  + Creating the Code
* Results
  + Efficiency curves
  + Optimal Parameters
  + Adjoint Flux?
* Conclusions

|  |  |  |  |
| --- | --- | --- | --- |
| **Gamma-Ray Energy [keV]** | **Nuclide** | **Activity [µCi]** | **Gammas per Second** |
| 60 | Am-241 | 0.02941 | 391.7 |
| 88 | Cd-109 | 0.2707 | 363.6 |
| 122 | Co-157 | 0.01019 | 322.7 |
| 159 | Te-123 | 0.01403 | 436.1 |
| 320 | Cr-51 | 0.3389 | 1236 |
| 392 | Sn-113 | 0.05109 | 1227 |
| 514 | Sr-85 | 0.06171 | 2247 |
| 662 | Cs-137 | 0.04325 | 1362 |
| 898 | Y-88 | 0.09633 | 3347 |
| 1173 | Co-60 | 0.05101 | 1885 |
| 1333 | Co-60 | 0.05101 | 1887 |
| 1836 | Y-88 | 0.09622 | 3539 |

* Energies were kept constant with manufacturer provided documentation
* Source Uncertainty for each energy was 3.1%

|  |  |  |
| --- | --- | --- |
| **Material** | **Density [g/cm3]** | **Component(s)** |
| Mylar | 1.38 | IR Window |
| Brass | 8.41 | Metal Clasps |
| Aluminum | 2.7 | Detector Housing and Casing |
| Germanium | 5.32 | Ge Crystal |
| Lithium | 0.534 | Outer Deadlayer |
| Boron | 2.73 | Inner Deadlayer |
| Copper | 8.96 | Shield Lining |
| Tin | 7.31 | Shield Lining |
| Kapton Film | 1.42 | IR Window |
| Air | 0.001224 | Shielding Chamber |
| Lead | 11.34 | Shielding |
| Acrylic Glass | 1.19 | Source Encapsulation |
| Vacuum | --- | Coaxial Space |

\* All materials from LANLs ACE Data Tables, or PNNLs Compendium of Material Composition Data for Radiation Transport Modeling

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Initial Value** | **Lower Bound** | **Upper Bound** |
| Outer Top Deadlayer [cm] | 0.13 | 0.013 | 0.73899333 |
| Outer Sides Deadlayer [cm] | 0.13 | 0.03 | 0.23 |
| Ge Crystal Length [cm] | 8.32 | 7.474993997 | 9.165002 |
| Kapton Window [cm] | 0.01016 | 0.00516 | 0.11016 |
| Inner Top Coaxial Deadlayer [cm] | 3.00E-05 | 5.67E-06 | 0.00013 |
| Inner Sides Coaxial Deadlayer [cm] | 3.00E-05 | 1.00E-05 | 1.00E-04 |
| Top Al Casing Thickness [cm] | 0.15 | 0.05 | 0.25 |
| Sides Al Casing Thickness [cm] | 0.15 | 0.05 | 0.25 |
| Ge Crystal Density [g/cm] | 5.32 | 5.29 | 5.32 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Initial Value** | **Position** | | | | |
| **1** | **2** | **3** | **4** | **5** |
| Outer Top Deadlayer [cm] | 0.13 |  |  |  |  |  |
| Outer Sides Deadlayer [cm] | 0.13 |  |  |  |  |  |
| Ge Crystal Length [cm] | 8.32 |  |  |  |  |  |
| Kapton Window [cm] | 0.01016 |  |  |  |  |  |
| Inner Top Coaxial Deadlayer [cm] | 0.00003 |  |  |  |  |  |
| Inner Sides Coaxial Deadlayer [cm] | 0.00003 |  |  |  |  |  |
| Top Al Casing Thickness [cm] | 0.15 |  |  |  |  |  |
| Sides Al Casing Thickness [cm] | 0.15 |  |  |  |  |  |
| Ge Crystal Density [g/cm] | 5.32 |  |  |  |  |  |

[1]

[2]

[3]

[4]

[5]

[6]

[7]

http://www.iaea.org/inis/collection/NCLCollectionStore/\_Public/42/107/42107607.pdf

# References

|  |  |
| --- | --- |
| [1] | R. M. Keyser, "Resolution and Sensitivity as a Function of Energy and incident Geometry for Germanium Detectors," *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* vol. 213, pp. 236-240, 2004. |
| [2] | R. G. Helmer, R. G. Hardy, V. E. Iacob, M. Sanchez-Vega, R. G. Neilson and J. Nelson, "The use of Monte Carlo Calculations in the Determination of a Ge Detector Efficiency Curve," *Nuclear Instruments and Methods in Physics Research A,* vol. 511, pp. 360-381, 2002. |
| [3] | W. F. R. R. K. M. D. O. S. C. A. C. A. X. d. S. Guilherme J. de S. Corrêa, "COMPUTATIONAL MODELING OF A HIGH PURITY GERMANIUM," in *International Nuclear Atlantic Conference*, Belo Horizonte,MG, Brazil, 2011. |
| [4] | G. F. Knoll, Radiation Detection and Measurement, Hoboken, NJ: John Wiley & Sons, Inc., 2010. |
| [5] | D. K. P. S. J. G. M. Jeremy Lloyd Conlin, "Listing of Available ACE Data Tables," Los Alamos National Laboratory, Los Alamos National Laboratory, 2013. |
| [6] | C. G. R. P. R. R. R. W. I. RJ McConn Jr, "Compendium of Material Composition Data for Radiation Transport Modeling," Pacific North Western National Laboratory, Pacific North Western National Laboratory, 2011. |
| [7] | R. E. F. J. K. Shultis, "An MCNP Primer," Department of Mechanical and Nuclear Engineering, Manhattan, KS, 2011. |

|  |  |
| --- | --- |
| [1] | R. M. Keyser, "Resolution and Sensitivity as a Function of Energy and incident Geometry for Germanium Detectors," *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* vol. 213, pp. 236-240, 2004. |
| [2] | R. G. Helmer, R. G. Hardy, V. E. Iacob, M. Sanchez-Vega, R. G. Neilson and J. Nelson, "The use of Monte Carlo Calculations in the Determination of a Ge Detector Efficiency Curve," *Nuclear Instruments and Methods in Physics Research A,* vol. 511, pp. 360-381, 2002. |
| [3] | W. F. R. R. K. M. D. O. S. C. A. C. A. X. d. S. Guilherme J. de S. Corrêa, "COMPUTATIONAL MODELING OF A HIGH PURITY GERMANIUM," in *International Nuclear Atlantic Conference*, Belo Horizonte,MG, Brazil, 2011. |
| [4] | G. F. Knoll, Radiation Detection and Measurement, Hoboken, NJ: John Wiley & Sons, Inc., 2010. |
| [5] | D. K. P. S. J. G. M. Jeremy Lloyd Conlin, "Listing of Available ACE Data Tables," Los Alamos National Laboratory, Los Alamos National Laboratory, 2013. |
| [6] | C. G. R. P. R. R. R. W. I. RJ McConn Jr, "Compendium of Material Composition Data for Radiation Transport Modeling," Pacific North Western National Laboratory, Pacific North Western National Laboratory, 2011. |
| [7] | R. E. F. J. K. Shultis, "An MCNP Primer," Department of Mechanical and Nuclear Engineering, Manhattan, KS, 2011. |

[1] R. M. Keyser, "Resolution and Sensitivity as a Function of Energy and incident Geometry for Germanium Detectors," Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, vol. 213, pp. 236-240, 2004.

[2] R. G. Helmer, R. G. Hardy, V. E. Iacob, M. Sanchez-Vega, R. G. Neilson and J. Nelson, "The use of Monte Carlo Calculations in the Determination of a Ge Detector Efficiency Curve," Nuclear Instruments and Methods in Physics Research A, vol. 511, pp. 360-381, 2002.

[3] W. F. R. R. K. M. D. O. S. C. A. C. A. X. d. S. Guilherme J. de S. Corrêa, "COMPUTATIONAL MODELING OF A HIGH PURITY GERMANIUM," in International Nuclear Atlantic Conference, Belo Horizonte,MG, Brazil, 2011.

[4] G. F. Knoll, Radiation Detection and Measurement, Hoboken, NJ: John Wiley & Sons, Inc., 2010.

[5] D. K. P. S. J. G. M. Jeremy Lloyd Conlin, "Listing of Available ACE Data Tables," Los Alamos National Laboratory, Los Alamos National Laboratory, 2013.

[6] C. G. R. P. R. R. R. W. I. RJ McConn Jr, "Compendium of Material Composition Data for Radiation Transport Modeling," Pacific North Western National Laboratory, Pacific North Western National Laboratory, 2011.

[7] R. E. F. J. K. Shultis, "An MCNP Primer," Department of Mechanical and Nuclear Engineering, Manhattan, KS, 2011.