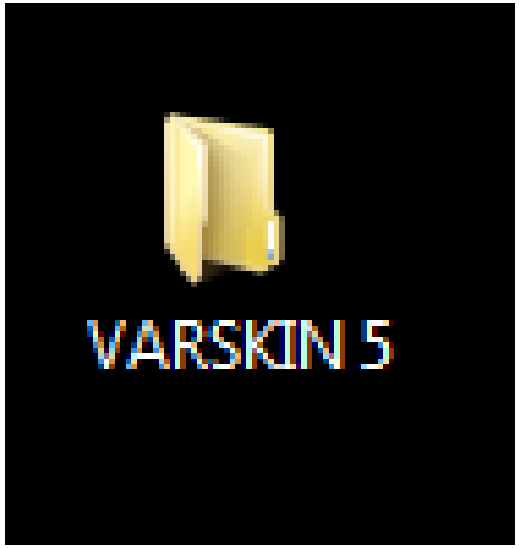
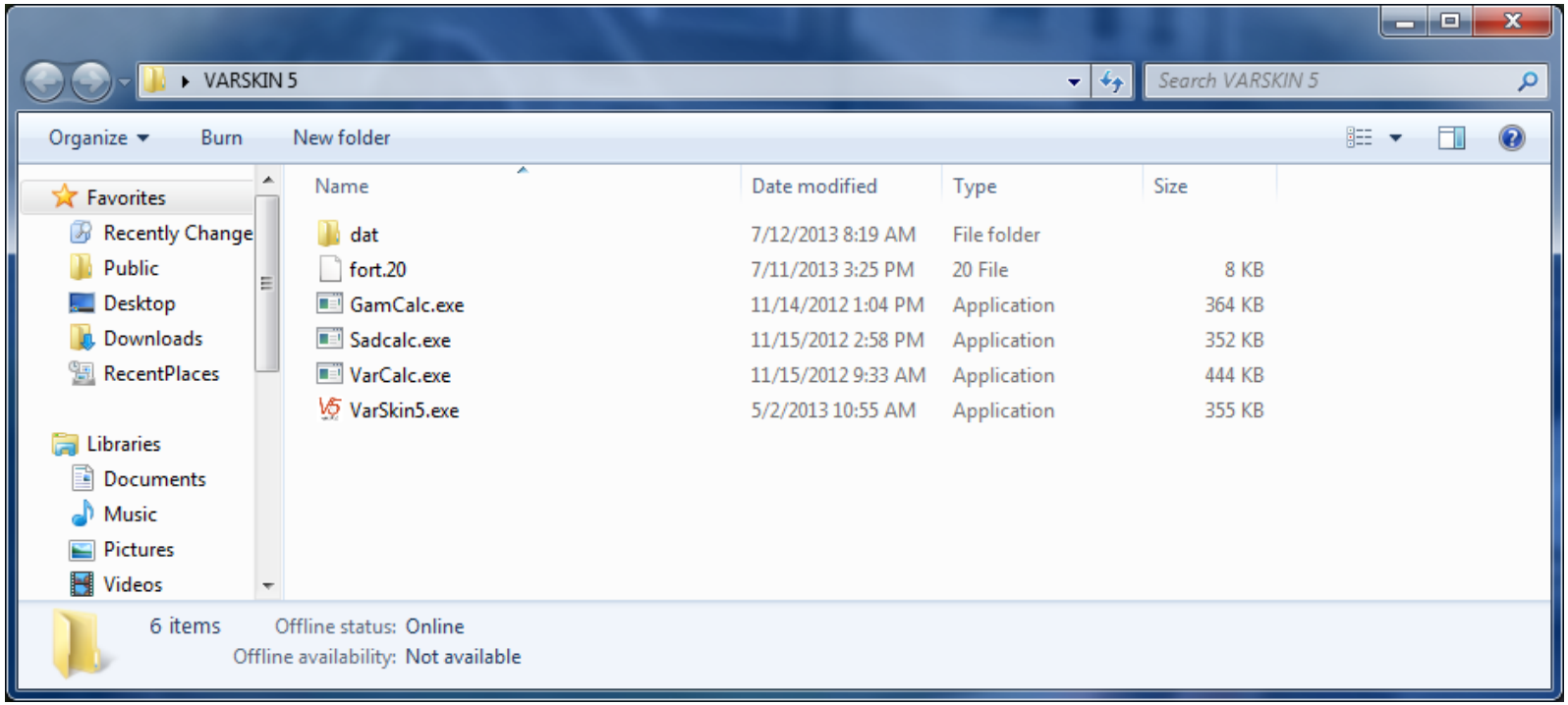
varskin V5

USING THE GUI

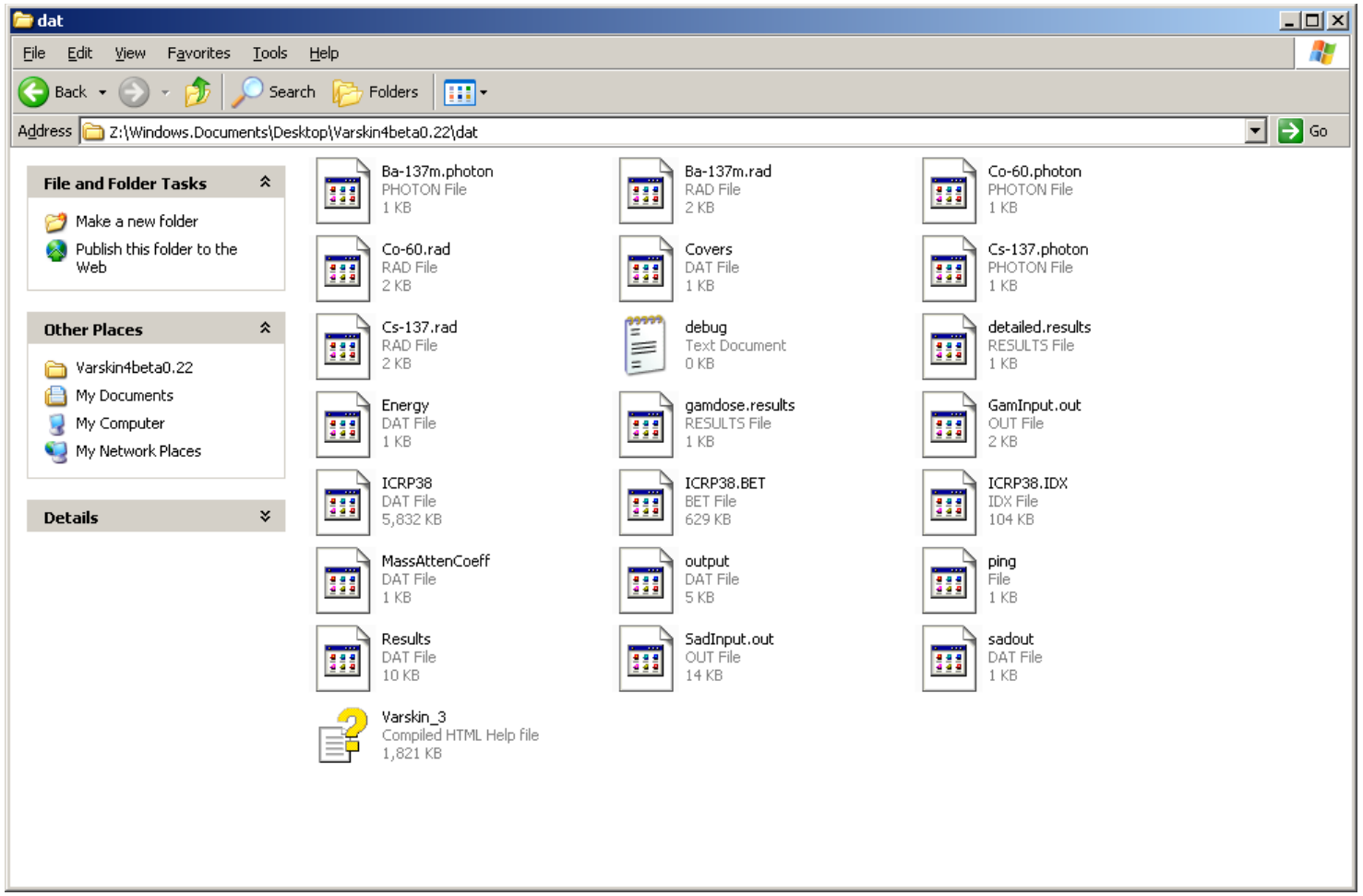
CODING structure

- GUI written in C#
  - controls I/O functions and executables
- Three modules written in FORTRAN
  - SadCalc.exe; VarCalc.exe; GamCalc.exe
- GamCalc.exe file written to execute photon dose model
- No need to “install” the code
  - simply double-click the VARSKIN 5 executable file


VARSKIN 5


VARSKIN 5
Search VARSKIN 5
Organize
Burn
New folder
Favorites
Recently Change
Public
Desktop
Downloads
RecentPlaces
Libraries
Documents
Music
Pictures
Videos
Name
Date modified
Type
Size
dat
7/12/2013 8:19 AM
File folder
fort.20
7/11/2013 3:25 PM
20 File
8 KB
GamCalc.exe
11/14/2012 1:04 PM
Application
364 KB
Sadcalc.exe
11/15/2012 2:58 PM
Application
352 KB
VarCalc.exe
11/15/2012 9:33 AM
Application
444 KB
VarSkin5.exe
5/2/2013 10:55 AM
Application
355 KB
6 items
Offline status: Online
Offline availability: Not available

Dat folder


dat
File Edit View Favorites Tools Help
Back Search Folders
Address Z:\Windows.Documents\Desktop\Varskin4beta0.22\dat
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My Computer
My Network Places
Details
Ba-137m.photon
PHOTON File
1 KB
Ba-137m.rad
RAD File
2 KB
Co-60.photon
PHOTON File
1 KB
Co-60.rad
RAD File
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Covers
DAT File
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Cs-137.photon
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Cs-137.rad
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debug
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0 KB
detailed.results
RESULTS File
1 KB
Energy
DAT File
1 KB
gamdose.results
RESULTS File
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GamInput.out
OUT File
2 KB
ICRP38
DAT File
5,832 KB
ICRP38.BET
BET File
629 KB
ICRP38.IDX
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MassAttenCoeff
DAT File
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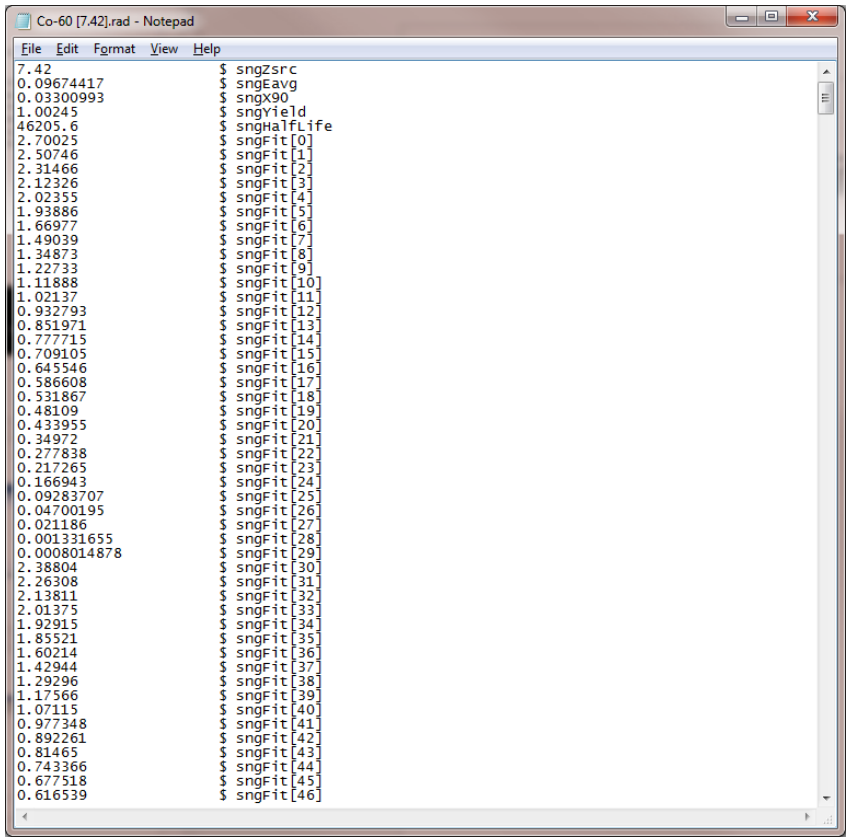
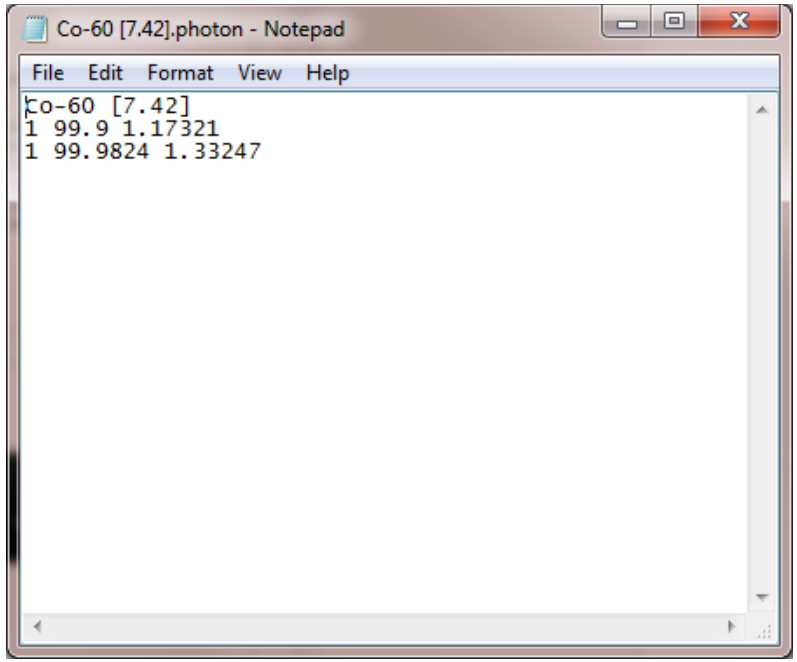
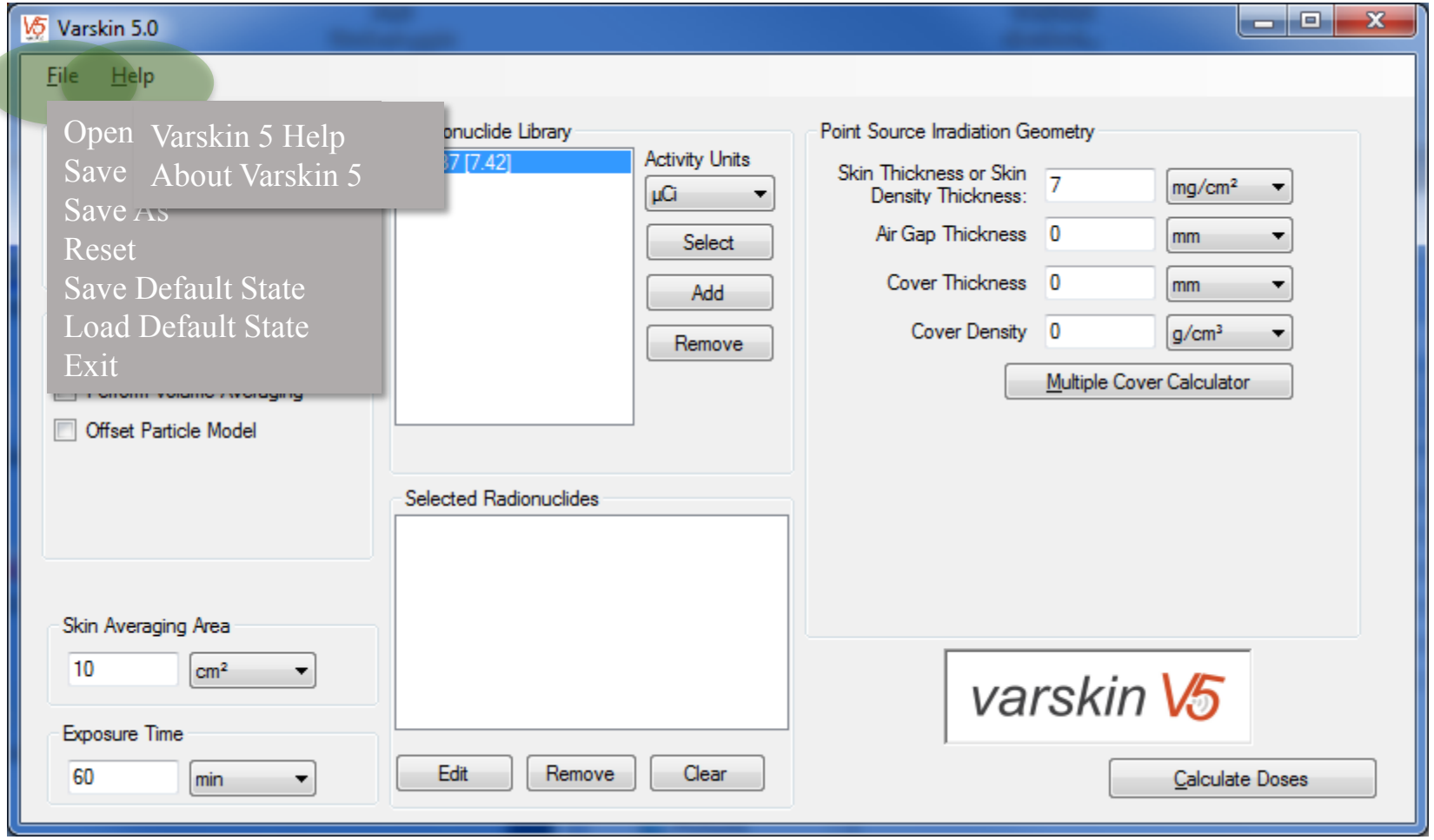
output
DAT File
5 KB
ping
File
1 KB
Results
DAT File
10 KB
SadInput.out
OUT File
14 KB
sadout
DAT File
1 KB
Varskin_3
Compiled HTML Help file
1,821 KB

.rad and .photon dat files






Varskin 5.0
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7
mg/cm²
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0
mm
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0
mm
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0
g/cm³
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Hide Back Print Options

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varskin

Acknowledgments

Top

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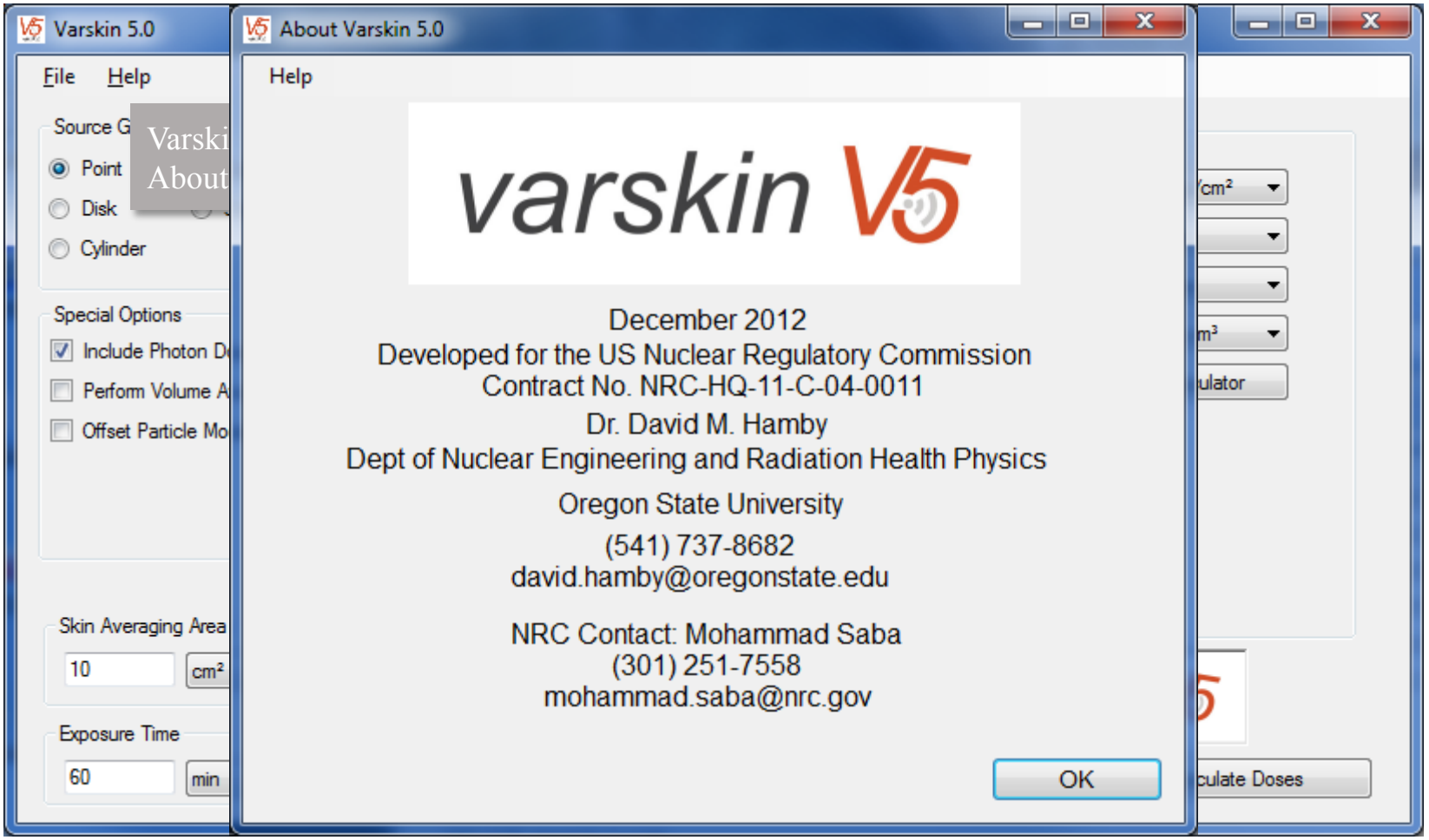
Code Prepared by D.M. Hamby (PI), C.D. Mangini, C.J. Lodwick, T.S. Palmer, S.R. Reese, and K.A. Higley
Help Files Prepared by J.E. Parson
Department of Nuclear Engineering and Radiation Health Physics
Oregon State University
Corvallis, OR 97331-5902

Prepared for U.S. Nuclear Regulatory Commission
M. Saba, NRC Project Manager
Office of Nuclear Regulatory Research
Division of Fuel, Engineering and Radiological Research
Washington, DC 20555-0001


Varskin 5.0
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Point
Disk
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Include Photon D
Perform Volume A
Offset Particle Mo
Skin Averaging Area
10
cm²
Exposure Time
60
min
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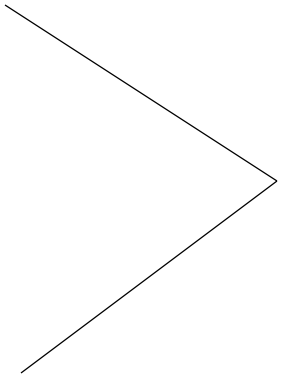
December 2012
Developed for the US Nuclear Regulatory Commission
Contract No. NRC-HQ-11-C-04-0011
Dr. David M. Hamby
Dept of Nuclear Engineering and Radiation Health Physics
Oregon State University
(541) 737-8682
david.hamby@oregonstate.edu
NRC Contact: Mohammad Saba
(301) 251-7558
mohammad.saba@nrc.gov
OK
/cm²
m³
ulator
culate Doses

VARSKIN 4/5 exposure geometries

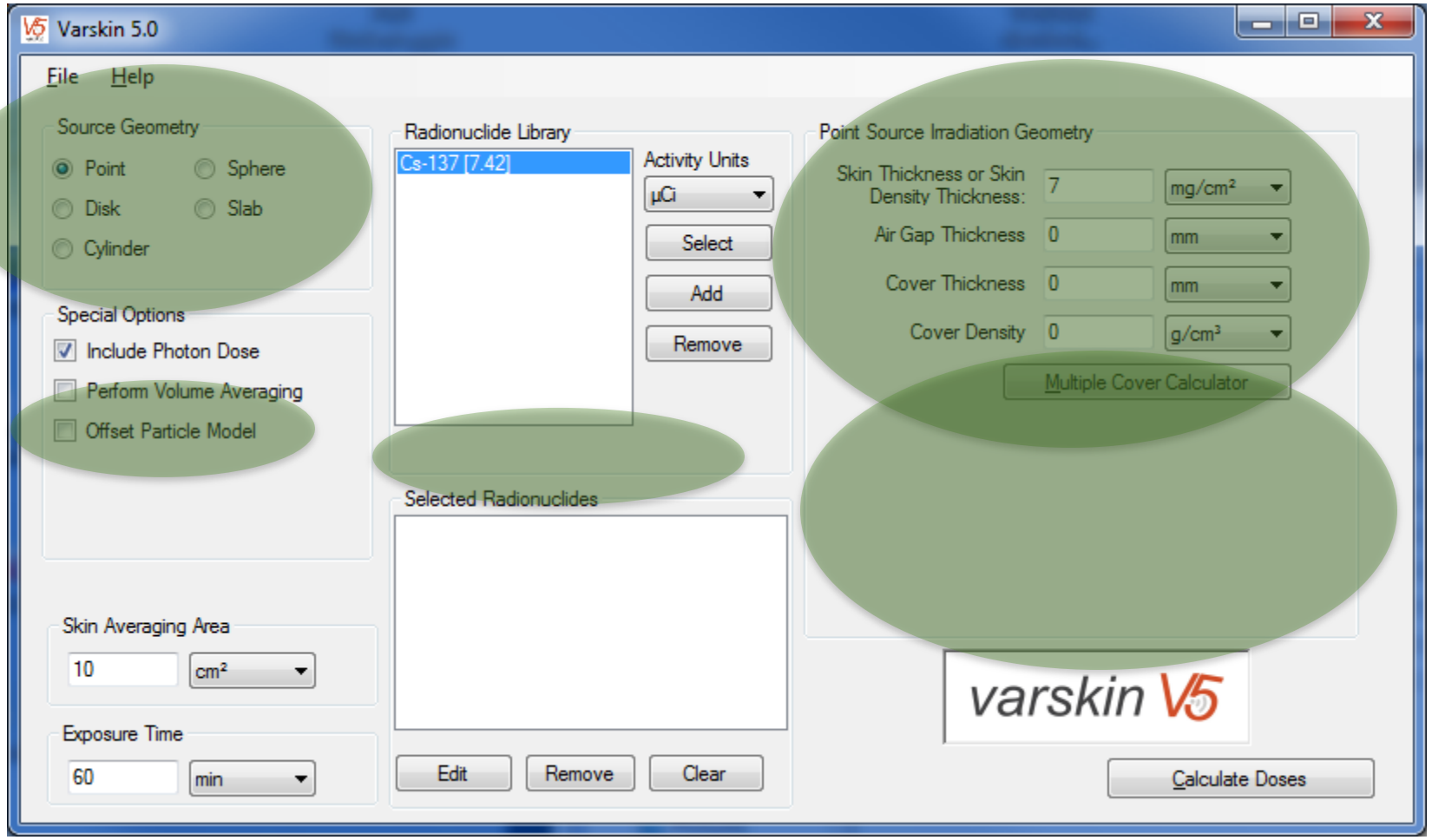
- Source Geometries
  - Point ← Offset Particle Model
  - Disk
  - Cylinder
  - Sphere
  - Slab
  - Syringe ← Geometry eliminated



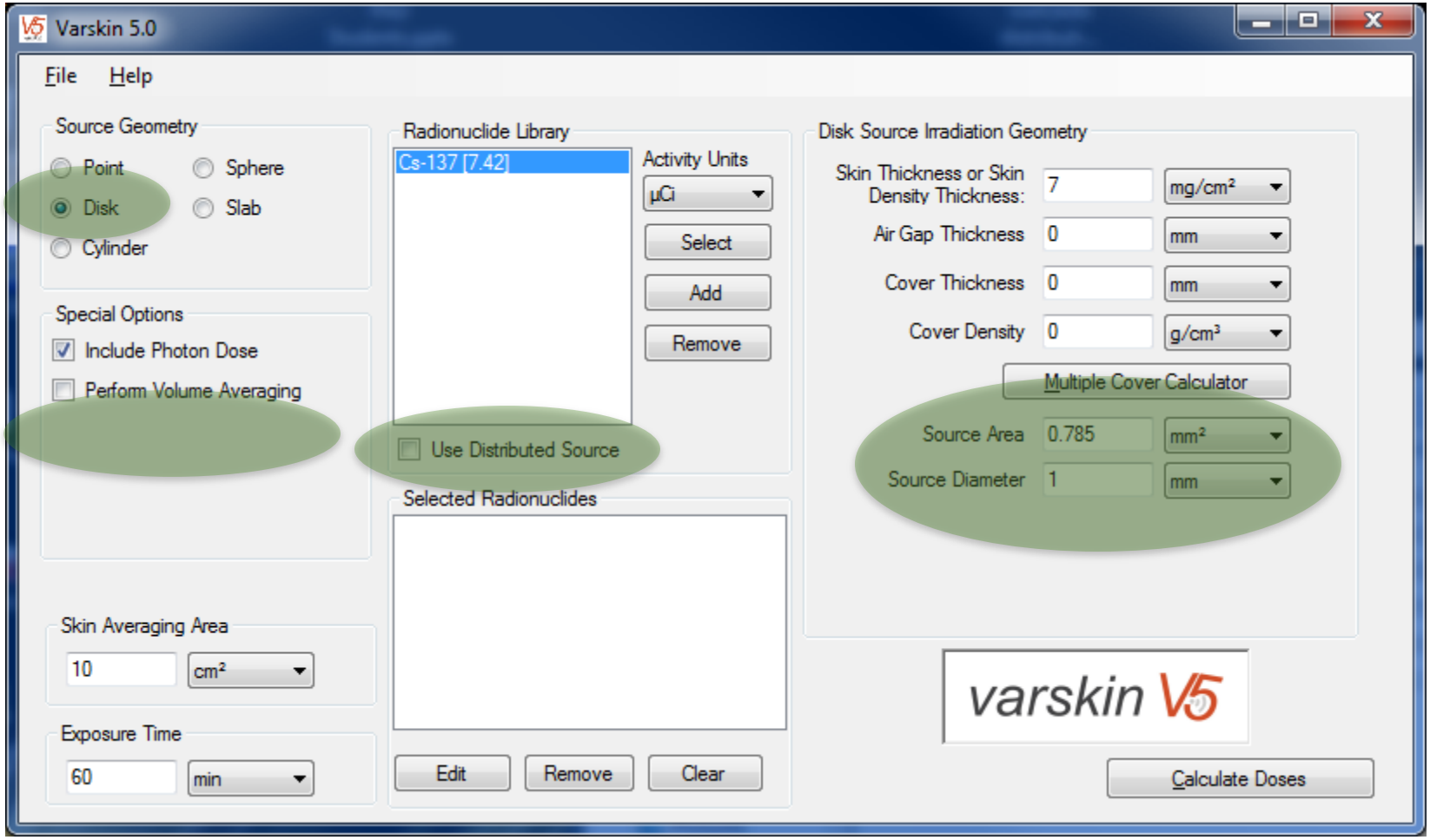
← Distributed Source Option

VARSKIN 4/5 exposure options

- User specifies:
  - Source & Geometry
  - Dose depth
  - Dose averaging area
  - Volume averaging option
  - Air and cover thicknesses
- Multiple cover calculator
- Option to turn off photon dose calculations
- “Reset” feature to re-initialize parameters



air gap (5 cm max) is always adjacent to the skin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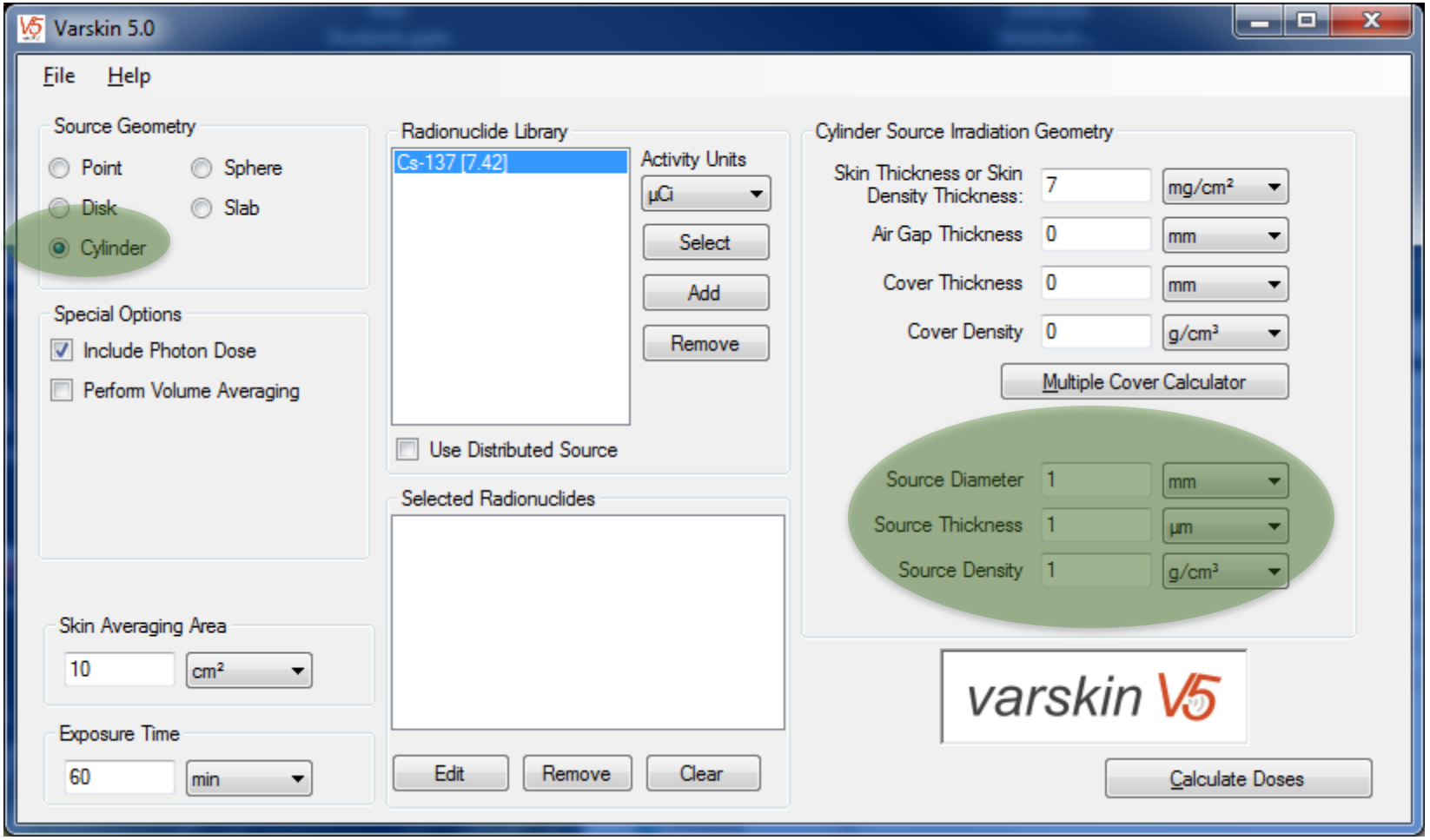
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Activity Units
µCi
Select
Add
Remove
Use Distributed Source
Selected Radionuclides
Edit
Remove
Clear
Disk Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
Source Area
0.785
mm²
Source Diameter
1
mm
varskin V5
Calculate Doses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Air Gap Thickness
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Cover Thickness
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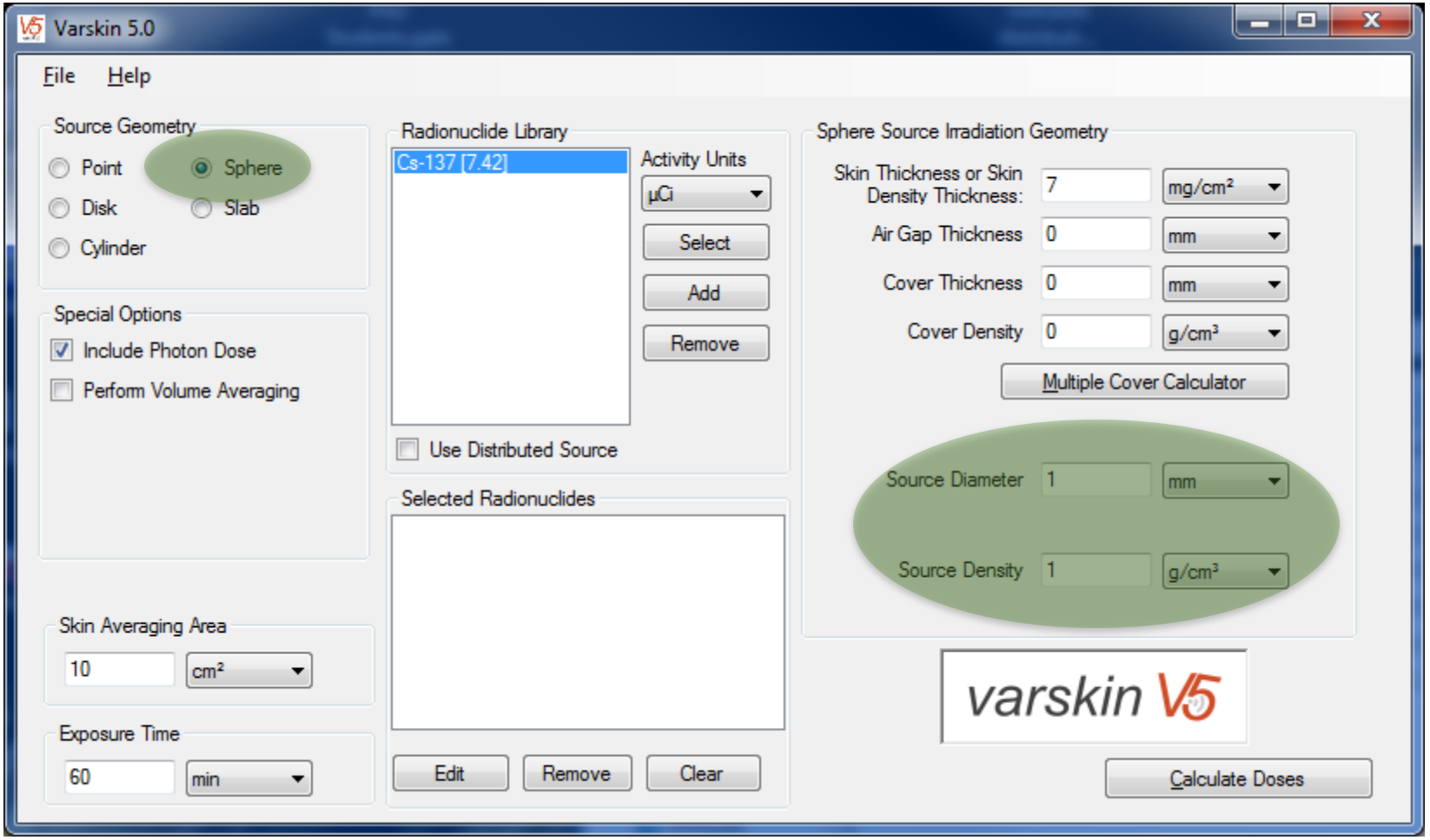
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
Source Diameter
1
mm
Source Thickness
1
µm
Source Density
1
g/cm³
varskin V5
Calculate Doses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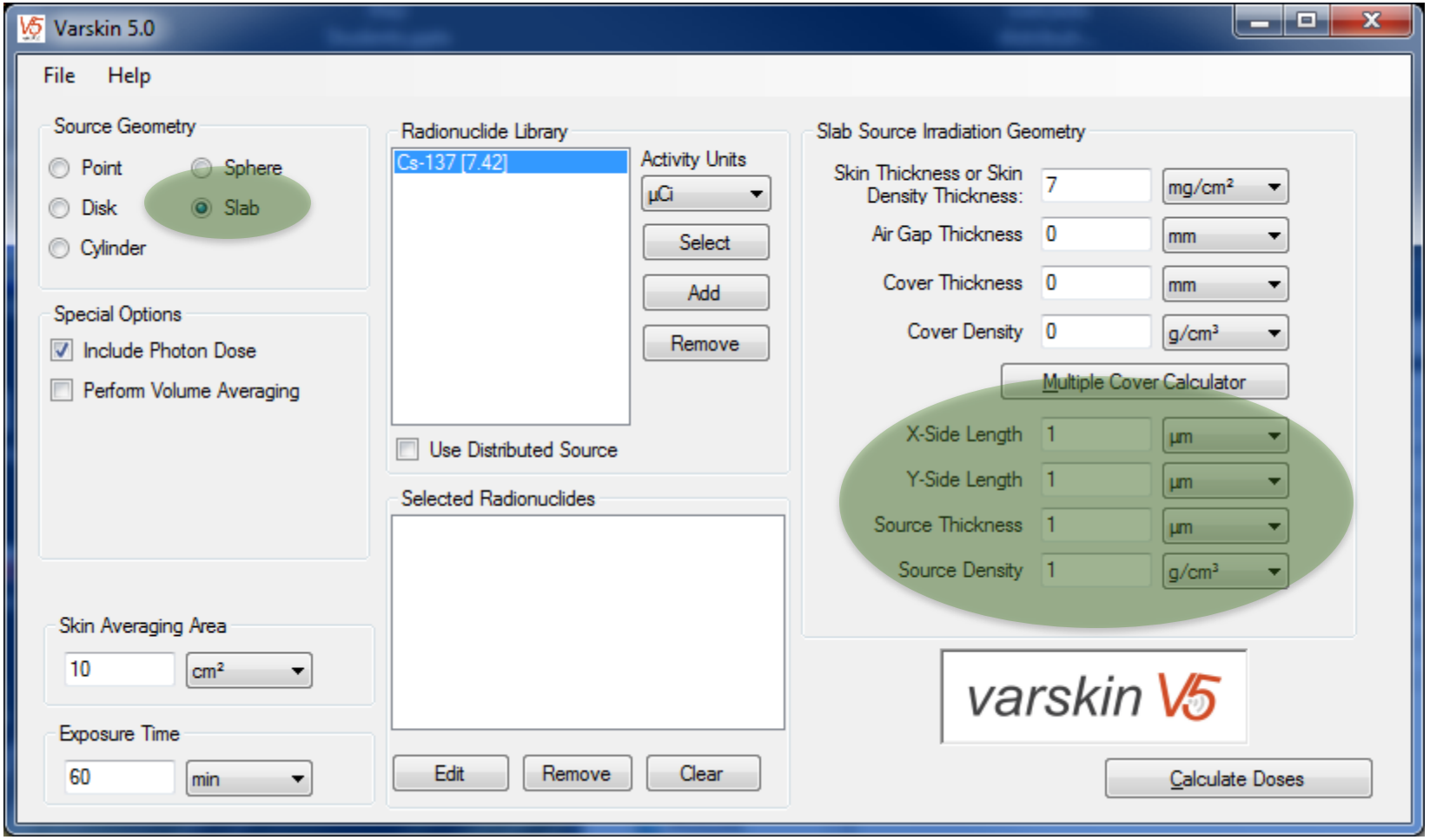
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
Source Diameter
1
mm
Source Density
1
g/cm³
varskin V5
Calculate Doses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60
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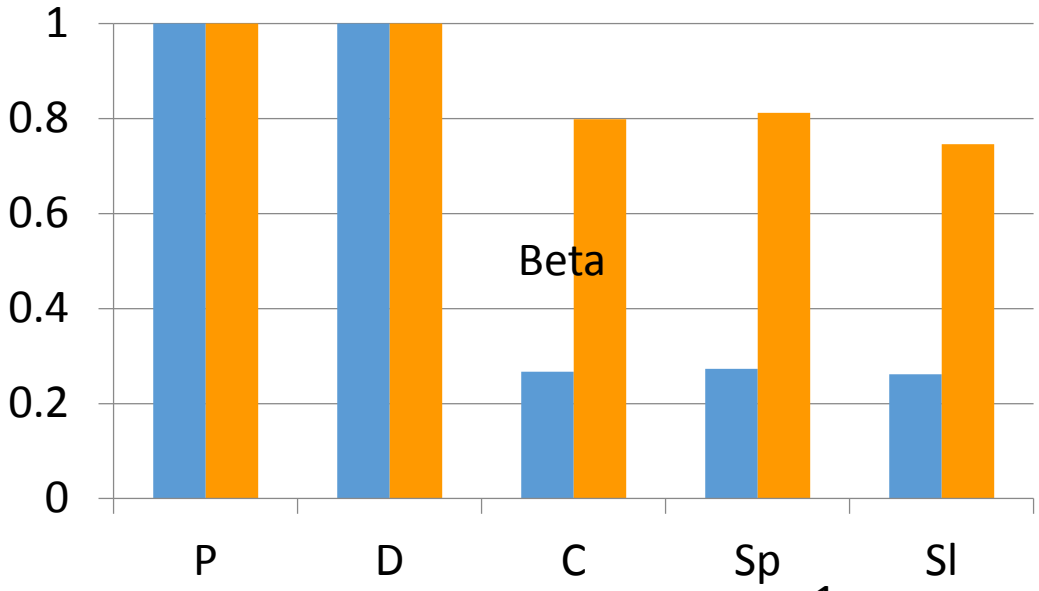
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
X-Side Length
1
µm
Y-Side Length
1
µm
Source Thickness
1
µm
Source Density
1
g/cm³
varskin V5
Calculate Doses

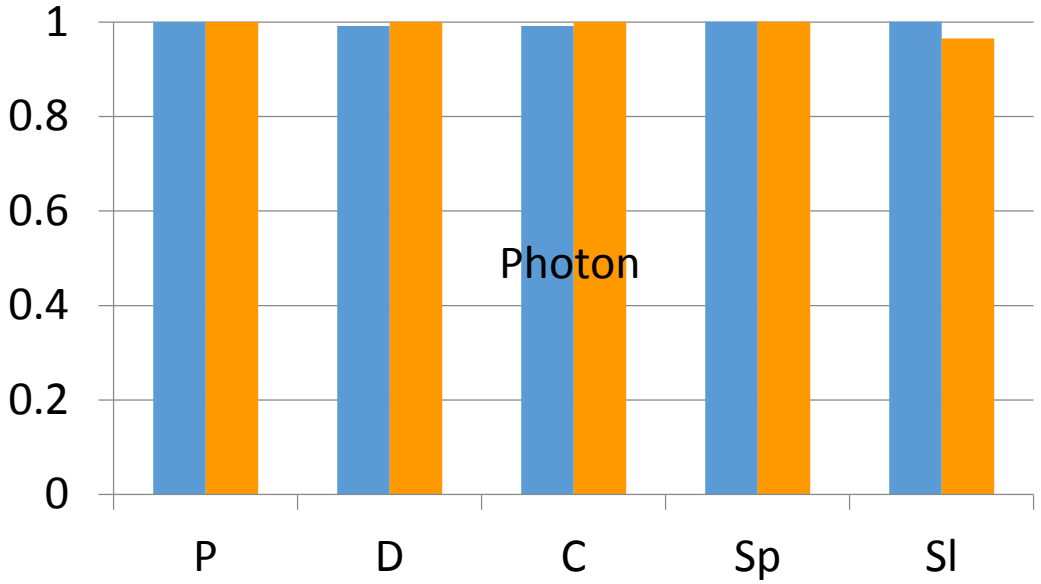
Impact of Source Geometry



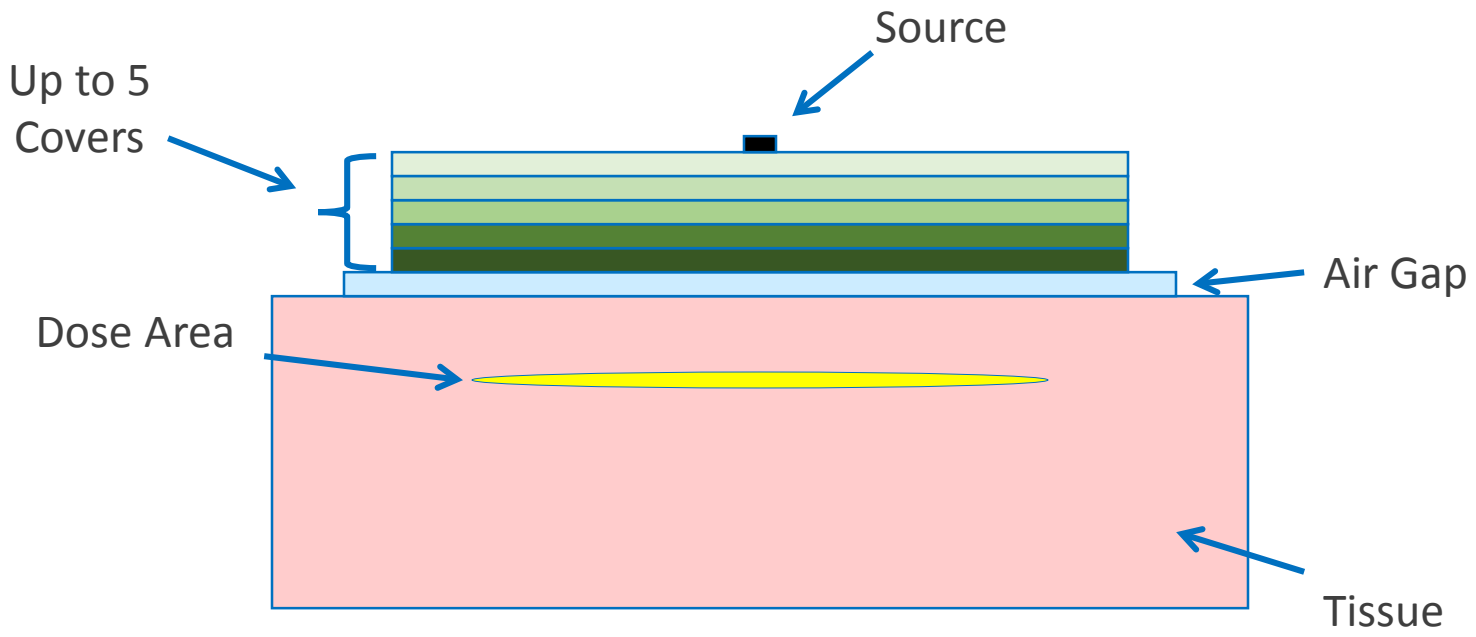
^{60}Co (0.318; 1.25)

^{106}Rh (3.54; 0.512)

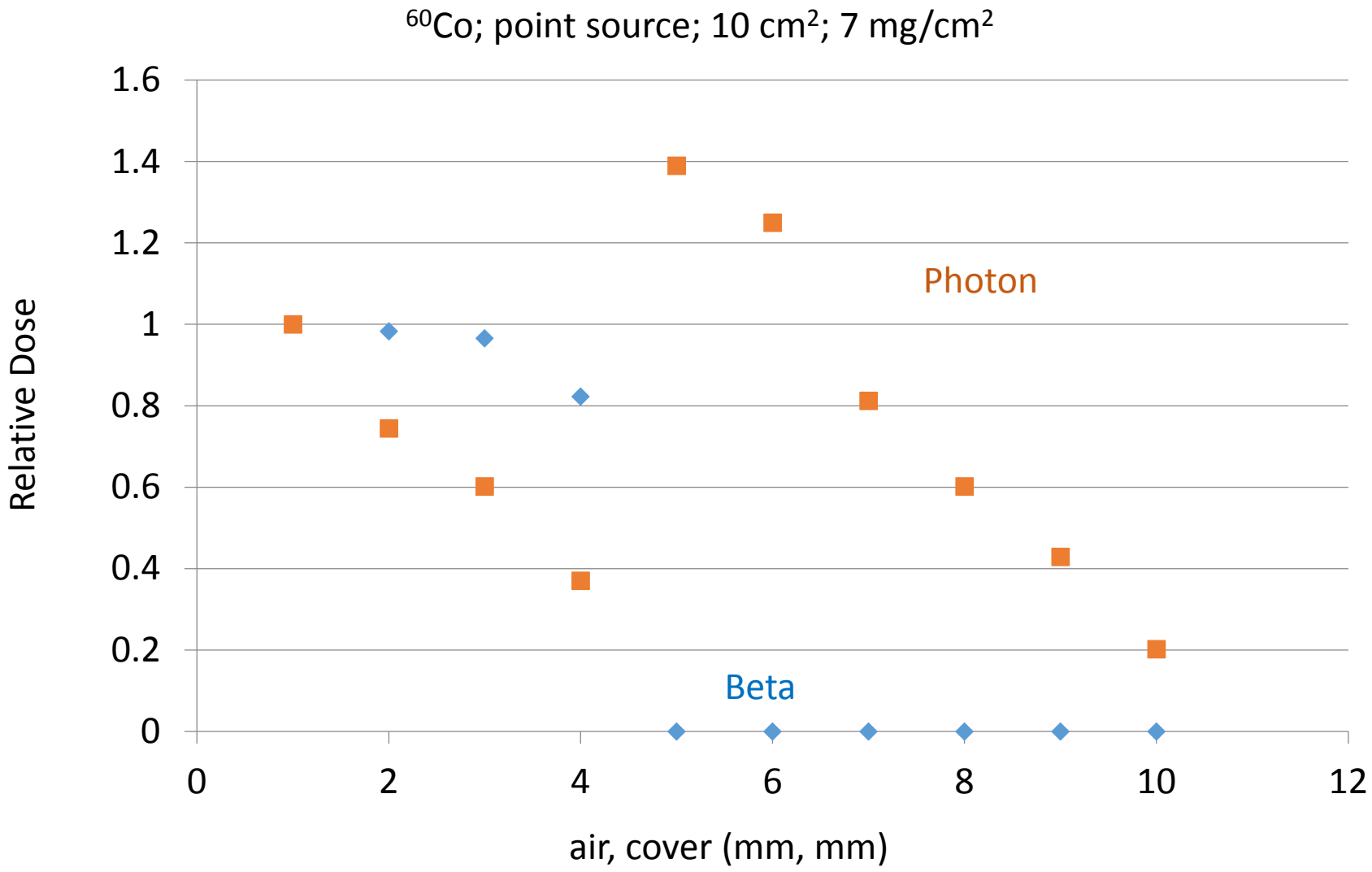
Dose relative to point geometry
1 mm dimensions
10 cm^2 area
Shallow dose

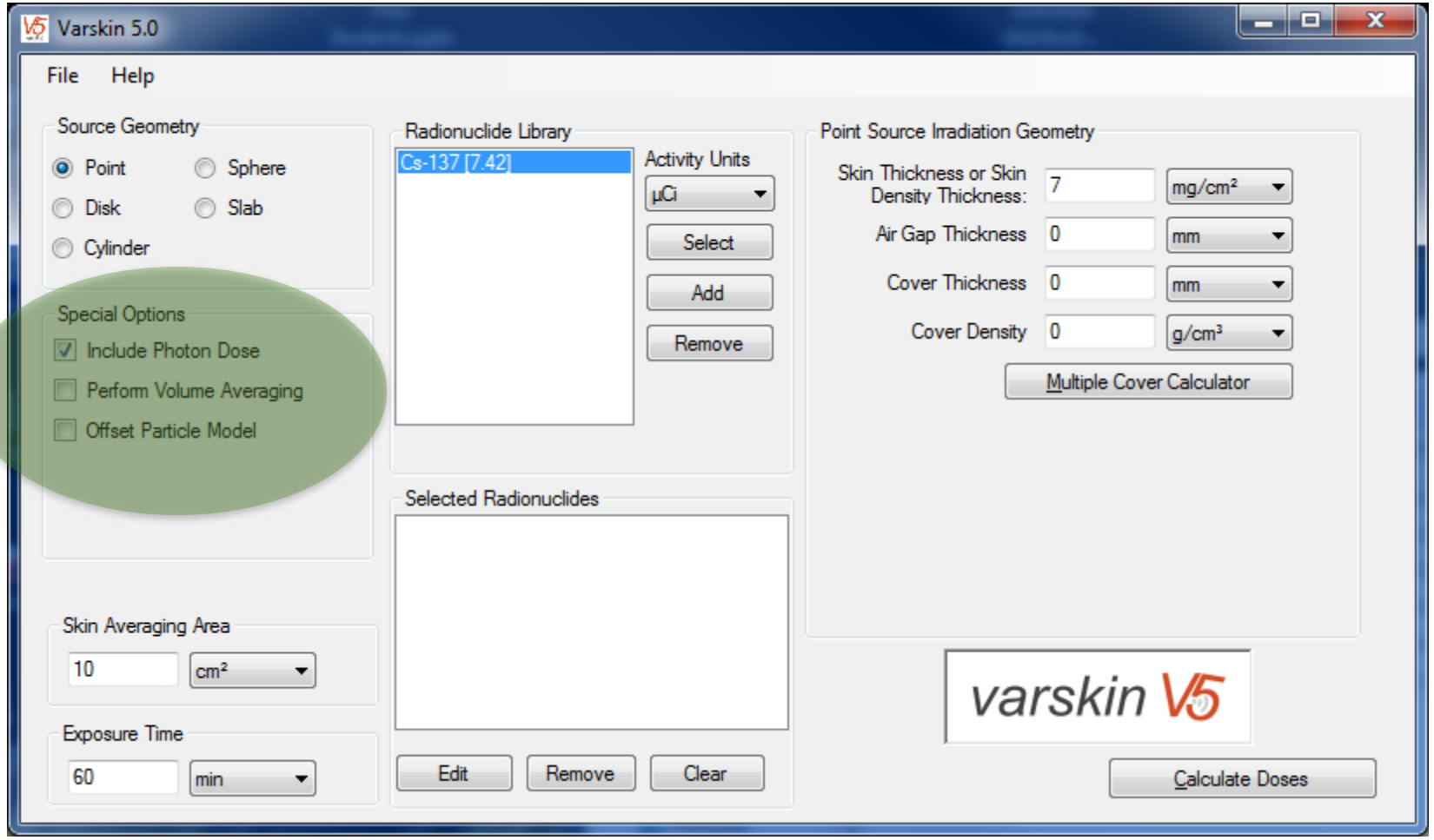


Cover model



Air Gap and Cover

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cm²
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60
min
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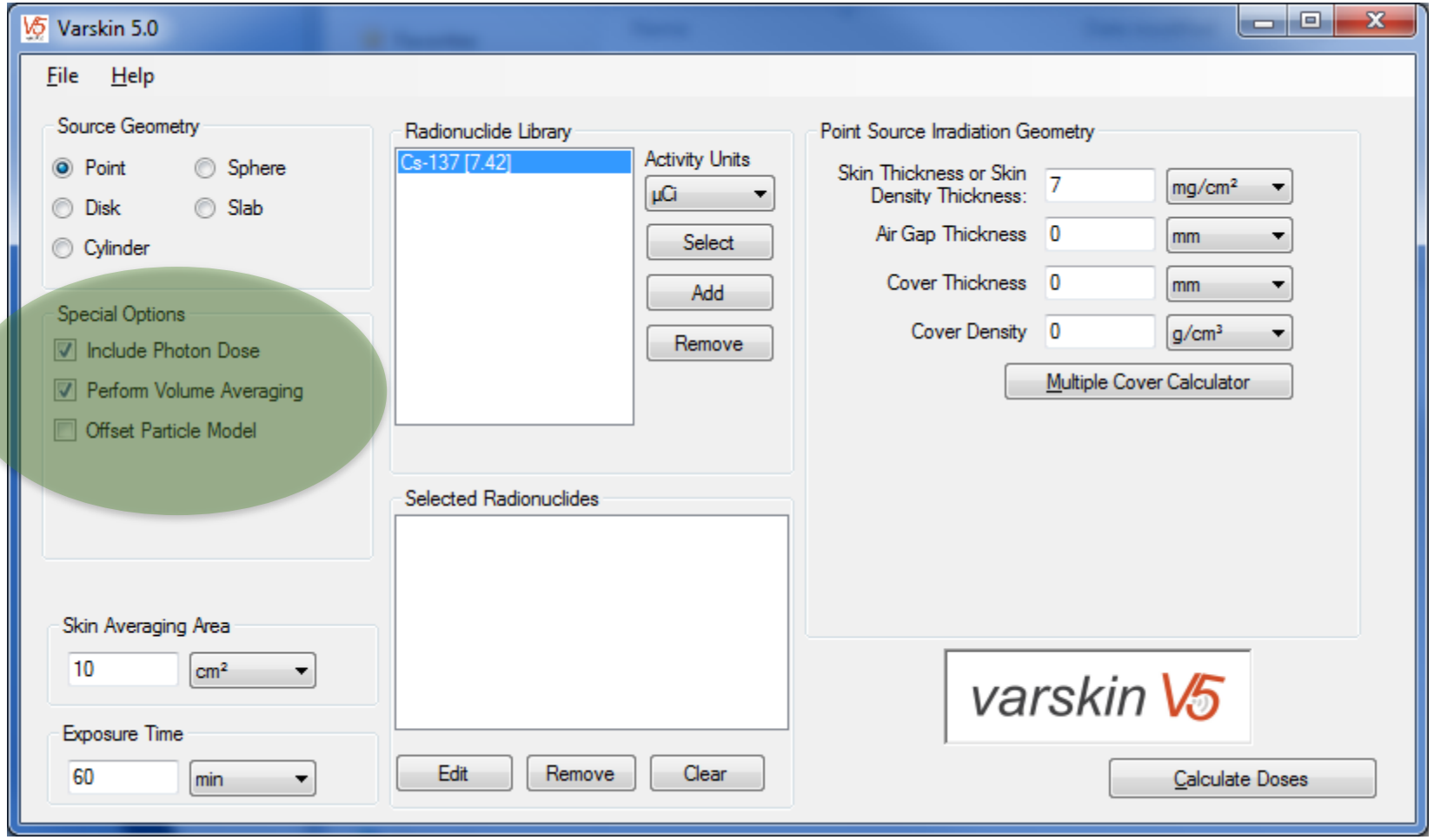
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

Special Options

- Include Photon Dose (on)
  - choice is likely to be removed with next version
- Perform Volume Averaging (off)
  - errors possible with large values
- Offset Particle Model (off)
  - available only for point source geometry and only for photon dosimetry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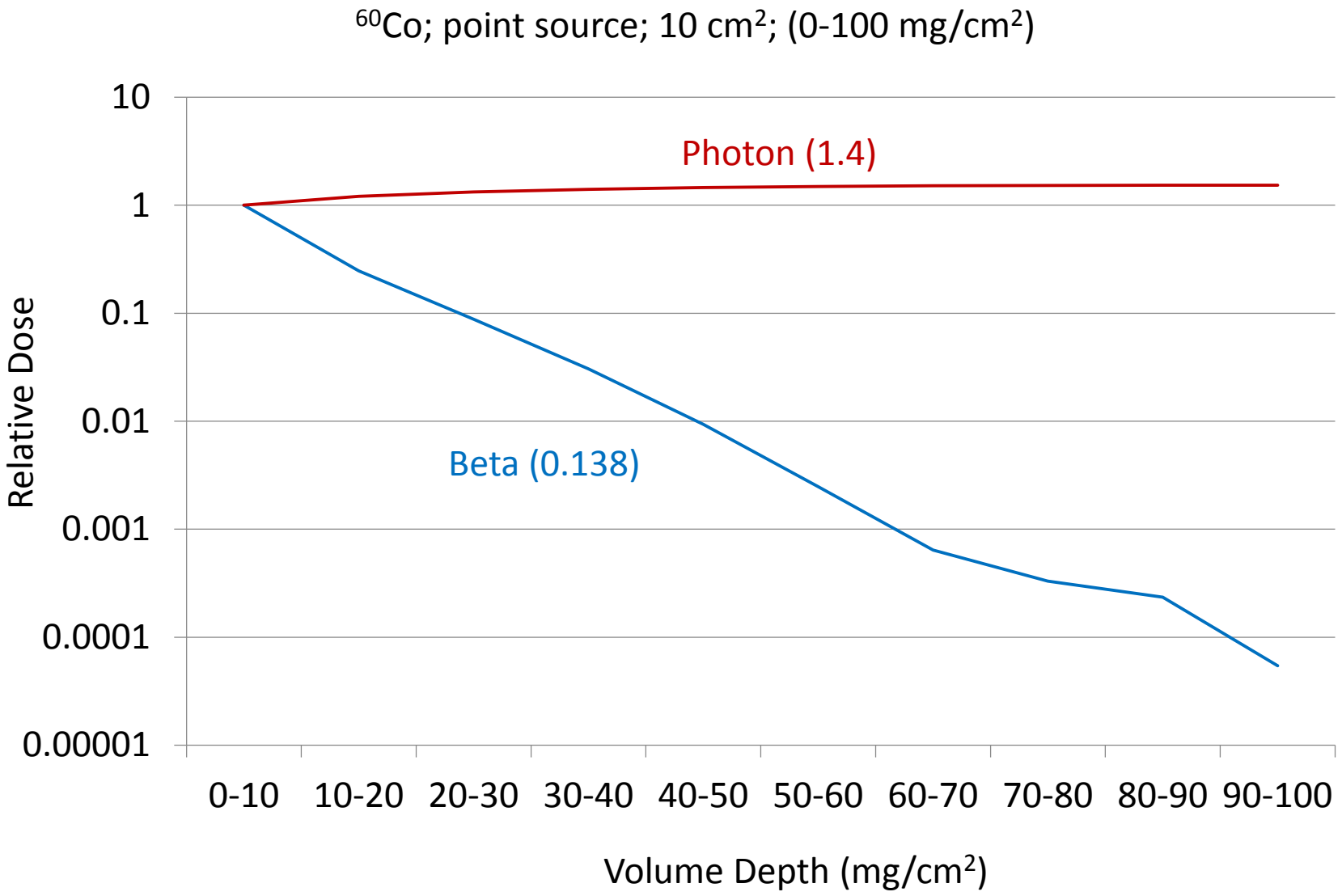
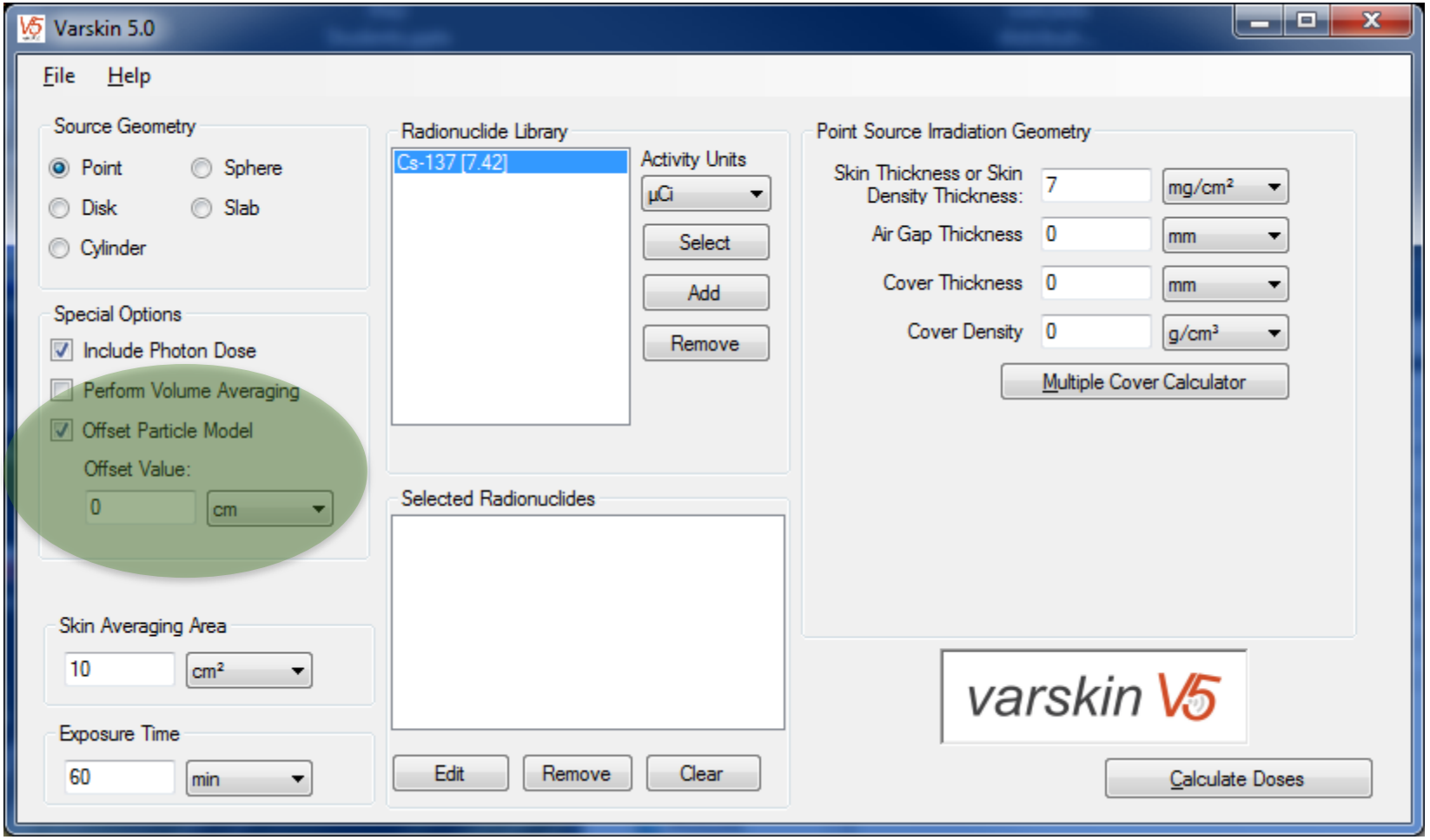
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

Volume Averaging

- Averaging cell is a cylinder defined laterally by the skin averaging area, with a user-specified top and bottom
- As defaults, the “top” of the cell is assumed to be the skin surface (0 mg/cm^2) and the “bottom” is assumed to be equal to the range of the maximum energy electron for the chosen radionuclide (not to exceed 1500 mg/cm^2)

Volume Averaging

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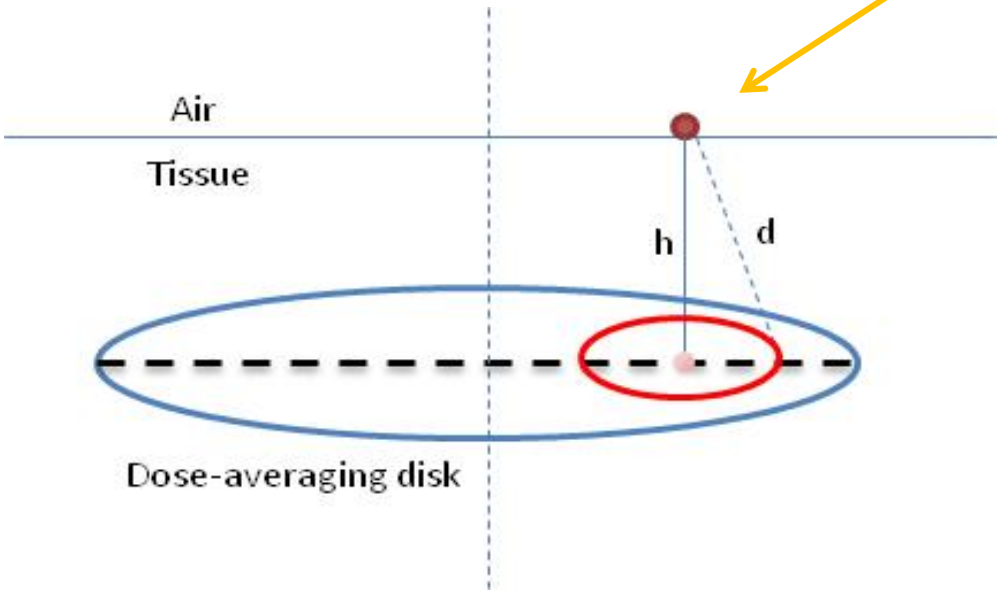
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

Offset Particle Model

- For point source, photon dosimetry
- To estimate the greatest dose to a single averaging area beneath multiple sources
- Used when two (or more) hot particles are in proximity to each other (when separation is less than the diameter of the averaging area)
- On selection, user must enter the Offset Value (0 cm)

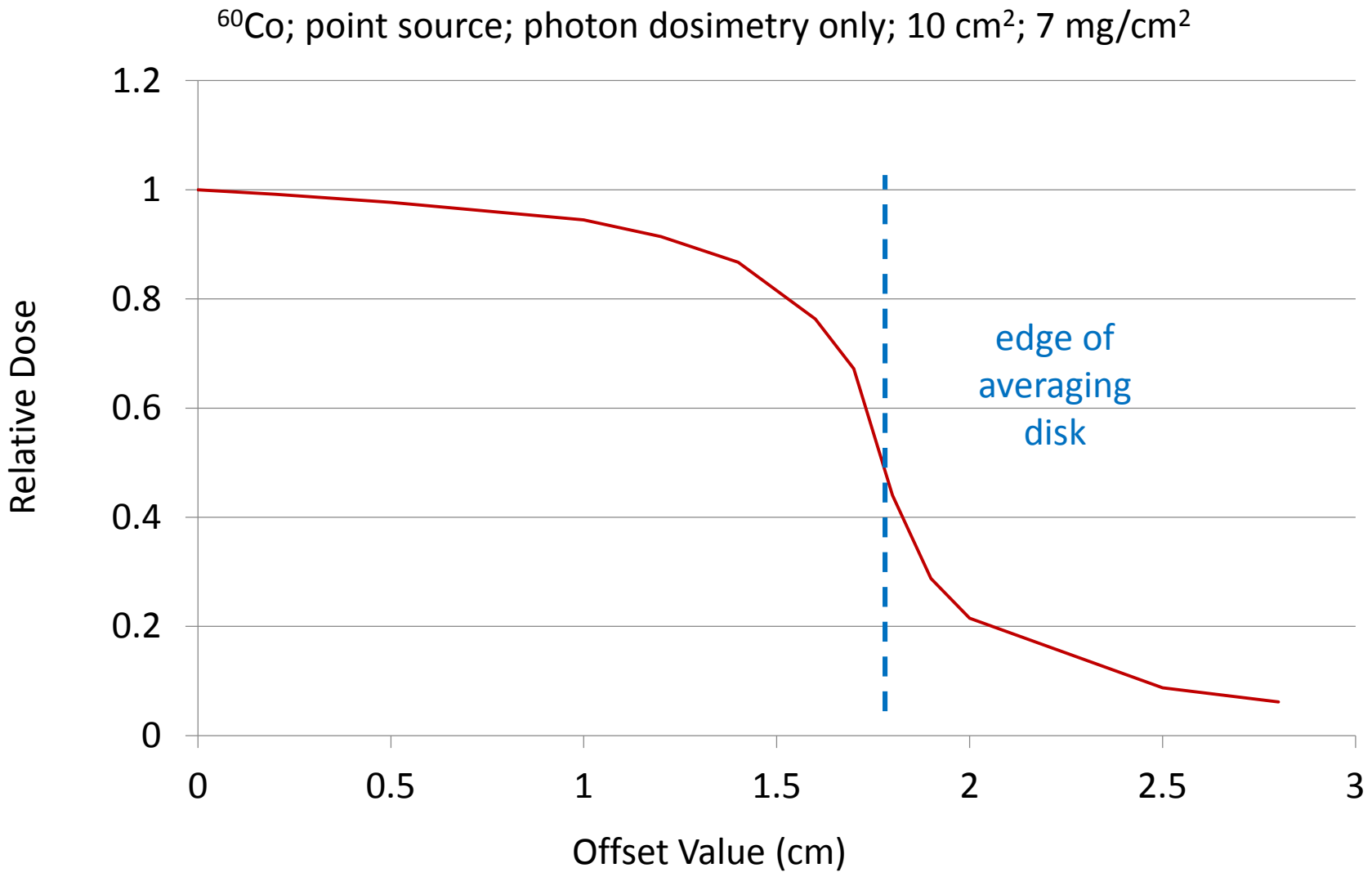
Offset-particle model

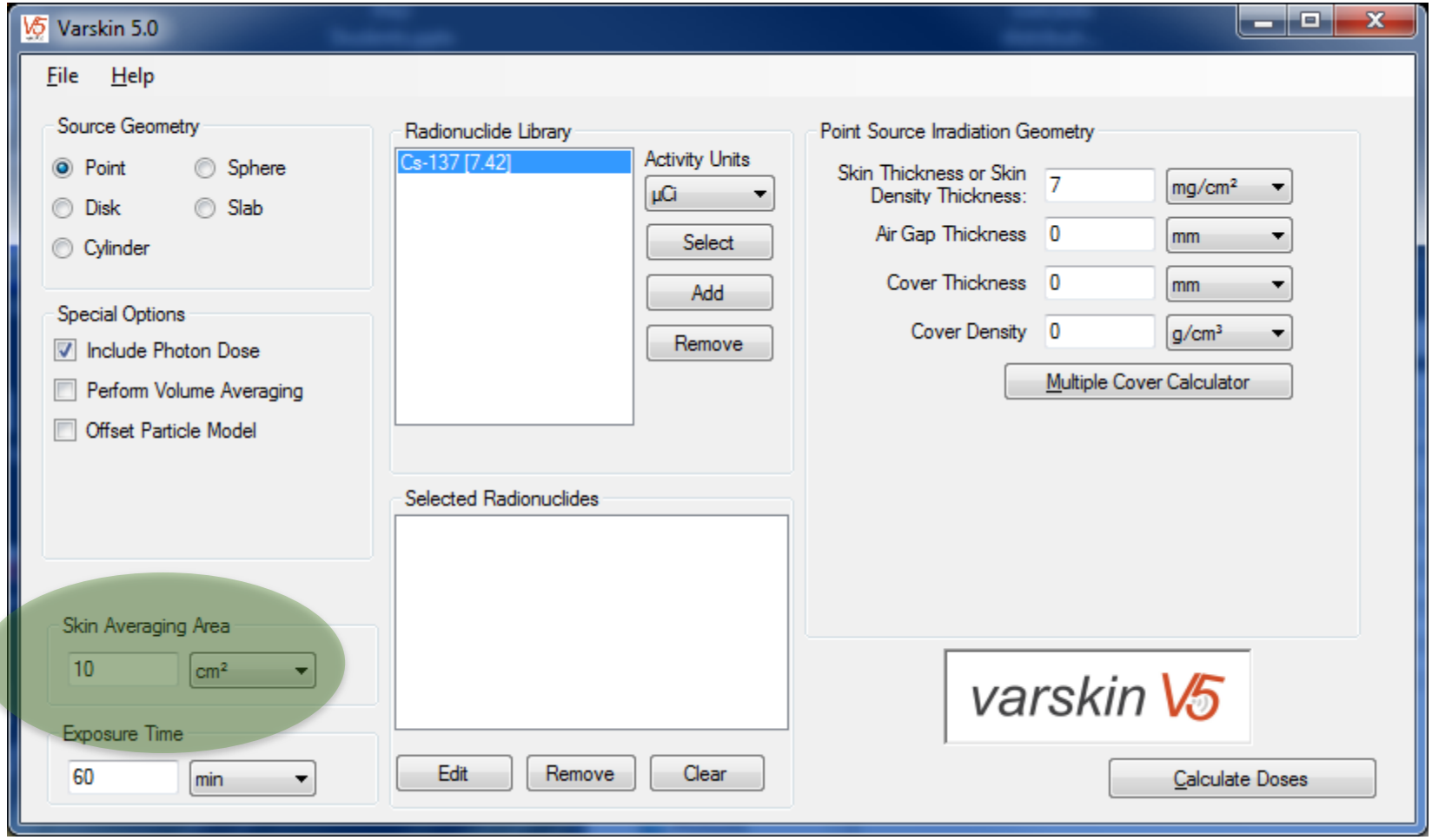


Source is not on axis of dose-averaging disk

This feature allows for the calculation of photon dose from multiple hot particles to a single dose-averaging disk

Offset Particle

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Air Gap Thickness
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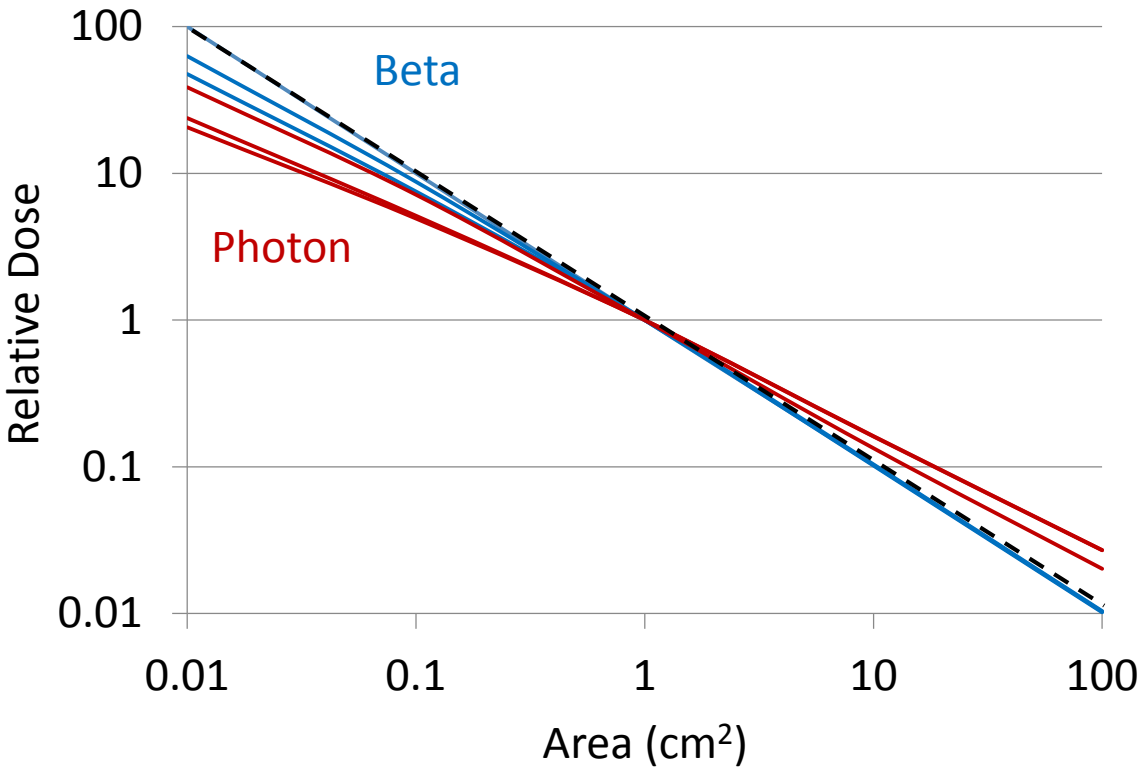
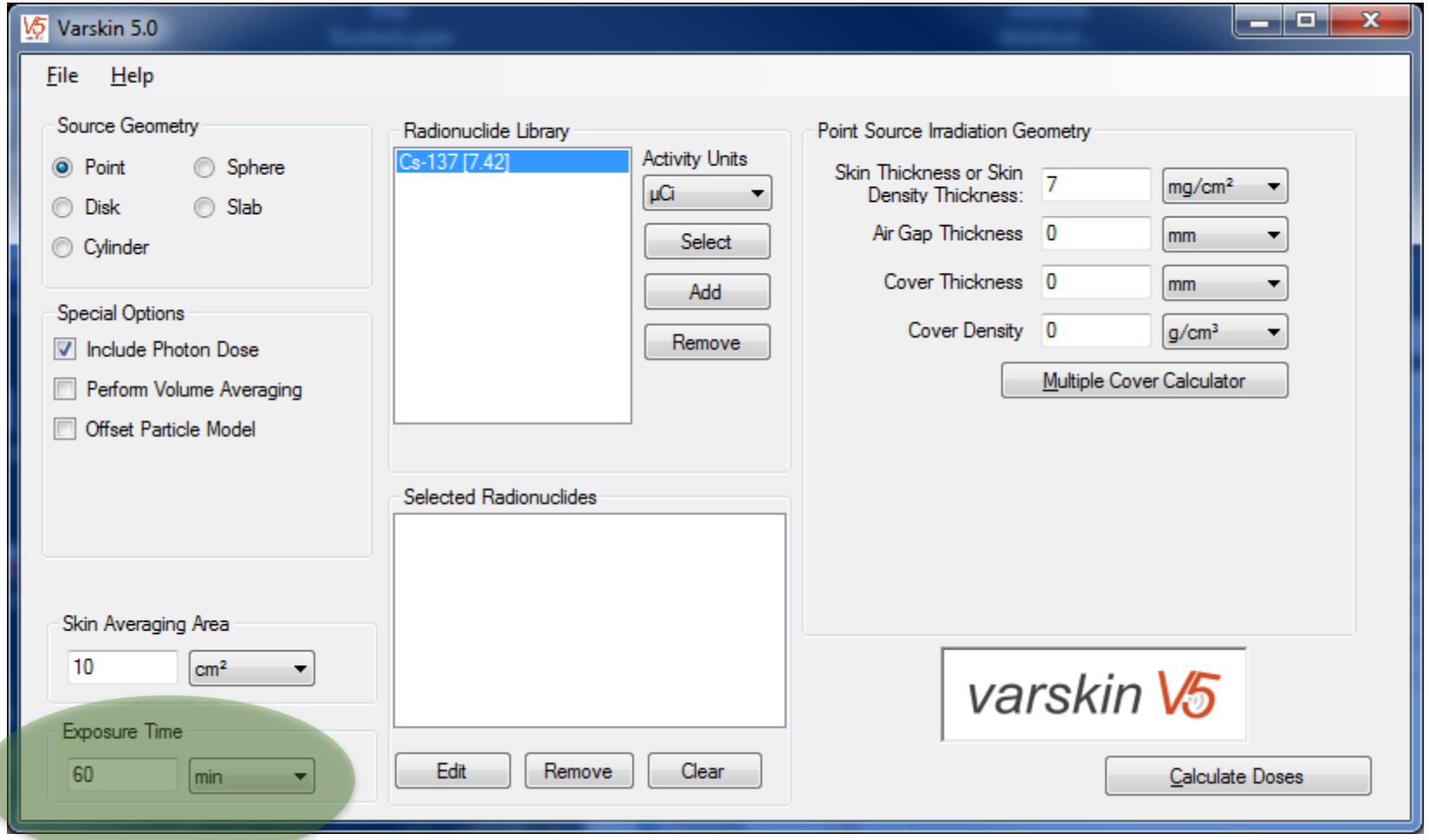
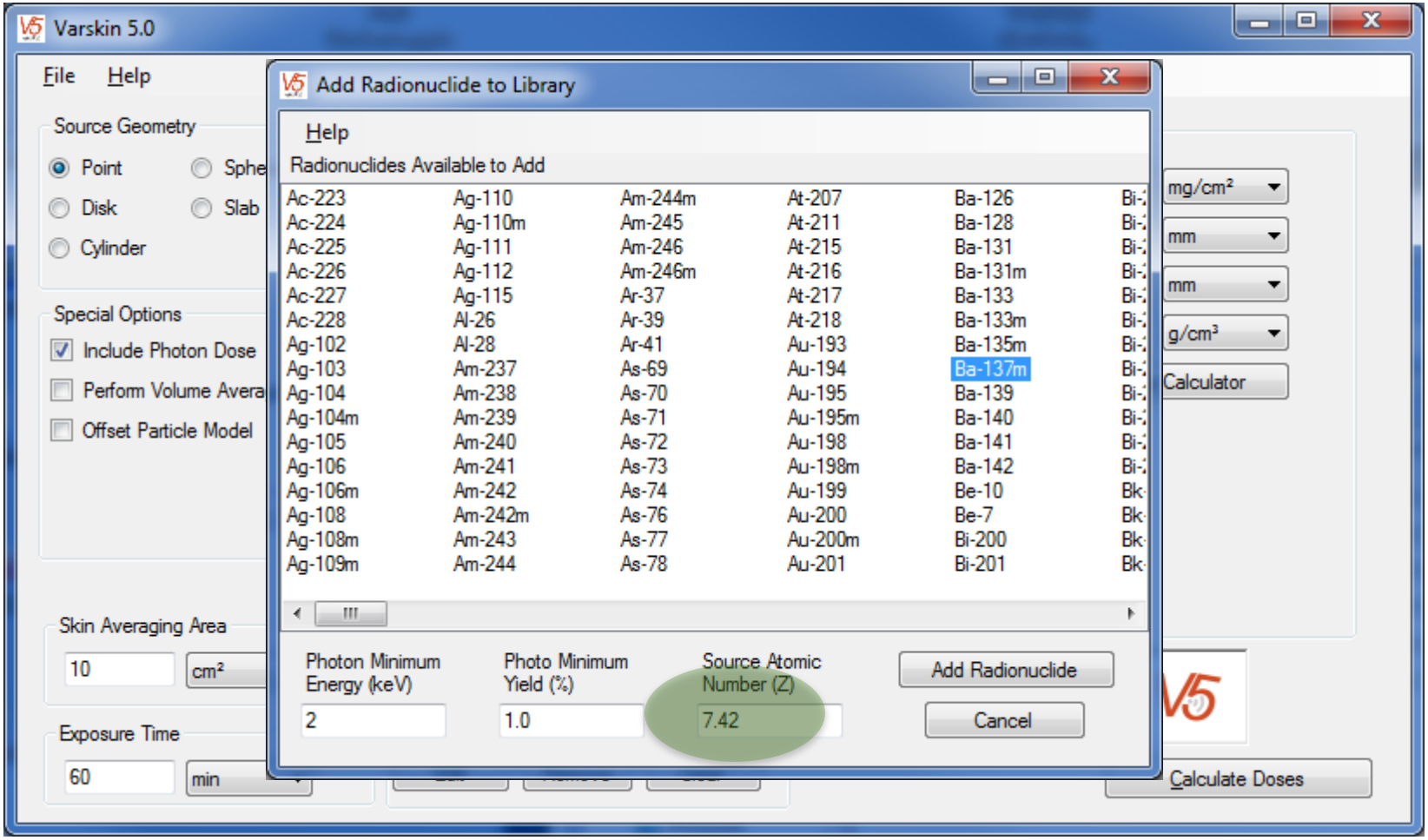
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

Skin Averaging Area

- Averaging area mandated by 10 CFR 20.1201
- Entry limited to between 0.01 and 100 cm^2
- 10 cm^2
- Examples:
  - ^{60}Co
  - ^{65}Ni
  - ^{106}Rh



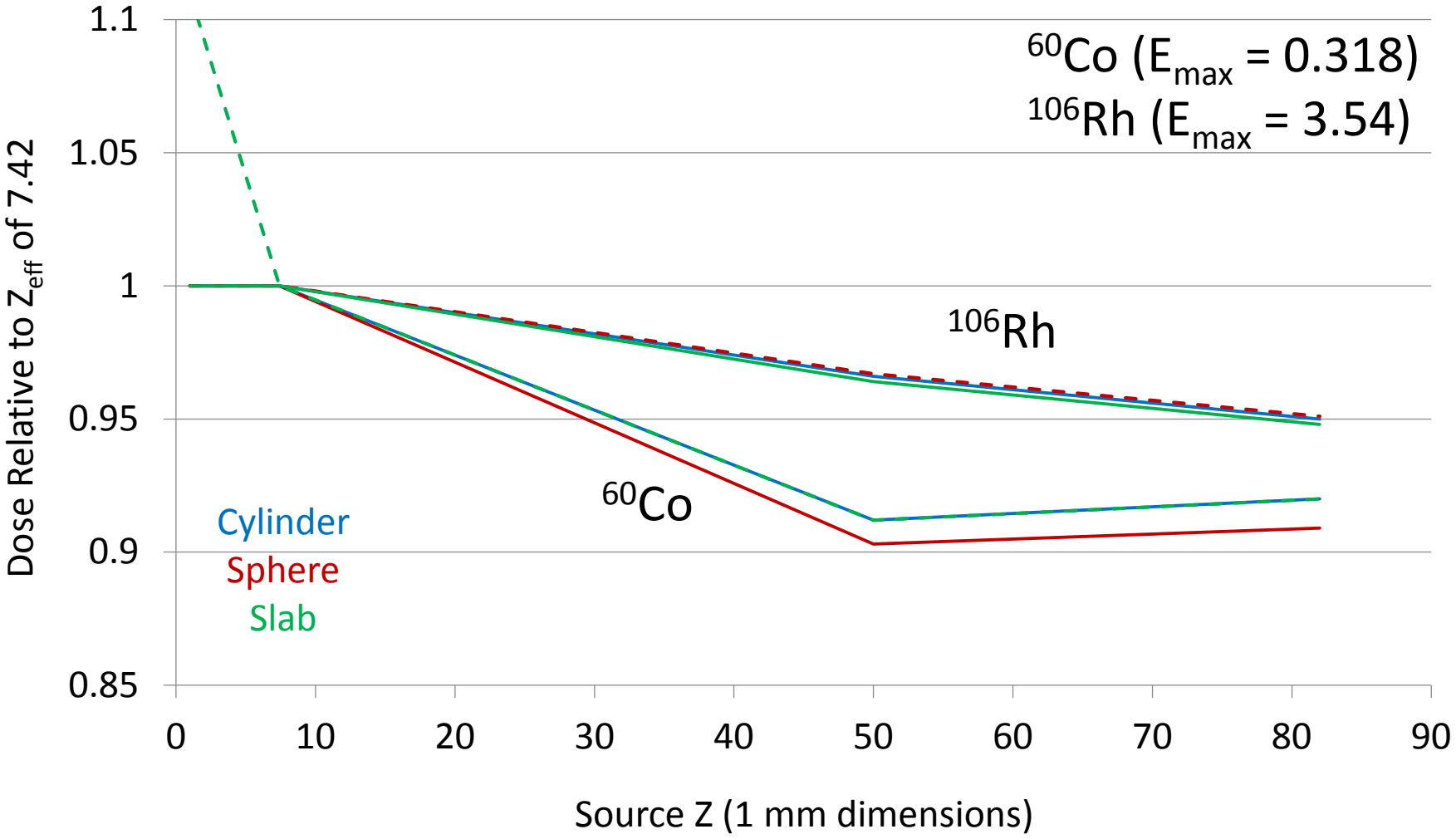

Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Activity Units
µCi
Select
Add
Remove
Selected Radionuclides
Edit
Remove
Clear
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

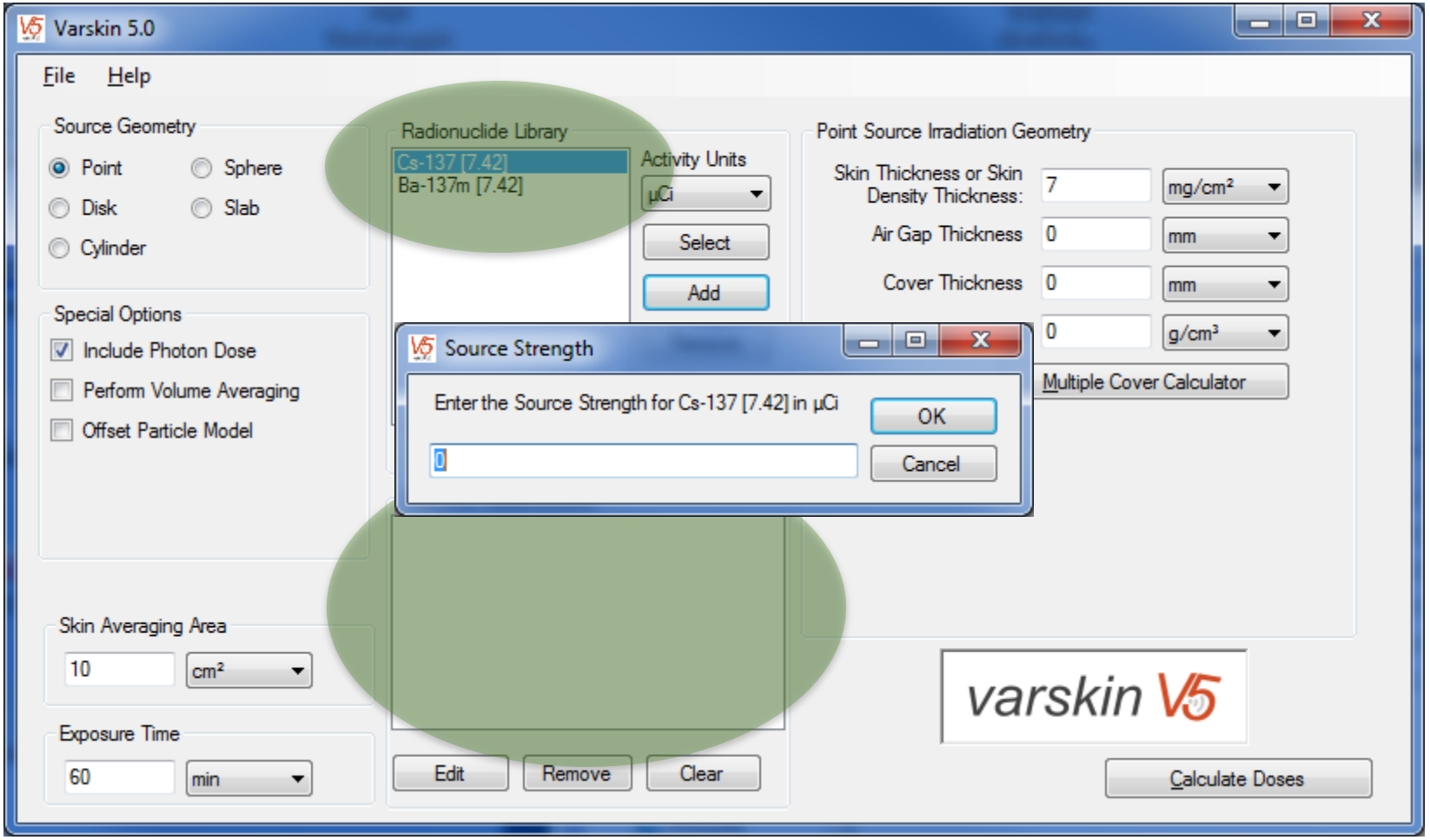

Varskin 5.0
File
Help
Source Geometry
Point
Sphe
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Avera
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
mg/cm²
mm
mm
g/cm³
Calculator
Calculate Doses
Add Radionuclide to Library
Help
Radionuclides Available to Add
Ac-223 Ac-224 Ac-225 Ac-226 Ac-227 Ac-228 Ag-102 Ag-103 Ag-104 Ag-104m Ag-105 Ag-106 Ag-106m Ag-108 Ag-108m Ag-109m
Ag-110 Ag-110m Ag-111 Ag-112 Ag-115 Al-26 Al-28 Am-237 Am-238 Am-239 Am-240 Am-241 Am-242 Am-242m Am-243 Am-244
Am-244m Am-245 Am-246 Am-246m Ar-37 Ar-39 Ar-41 As-69 As-70 As-71 As-72 As-73 As-74 As-76 As-77 As-78
At-207 At-211 At-215 At-216 At-217 At-218 Au-193 Au-194 Au-195 Au-195m Au-198 Au-198m Au-199 Au-200 Au-200m Au-201
Ba-126 Ba-128 Ba-131 Ba-131m Ba-133 Ba-133m Ba-135m Ba-137m Ba-139 Ba-140 Ba-141 Ba-142 Be-10 Be-7 Bi-200 Bi-201
Photon Minimum Energy (keV)
2
Photo Minimum Yield (%)
1.0
Source Atomic Number (Z)
7.42
Add Radionuclide
Cancel

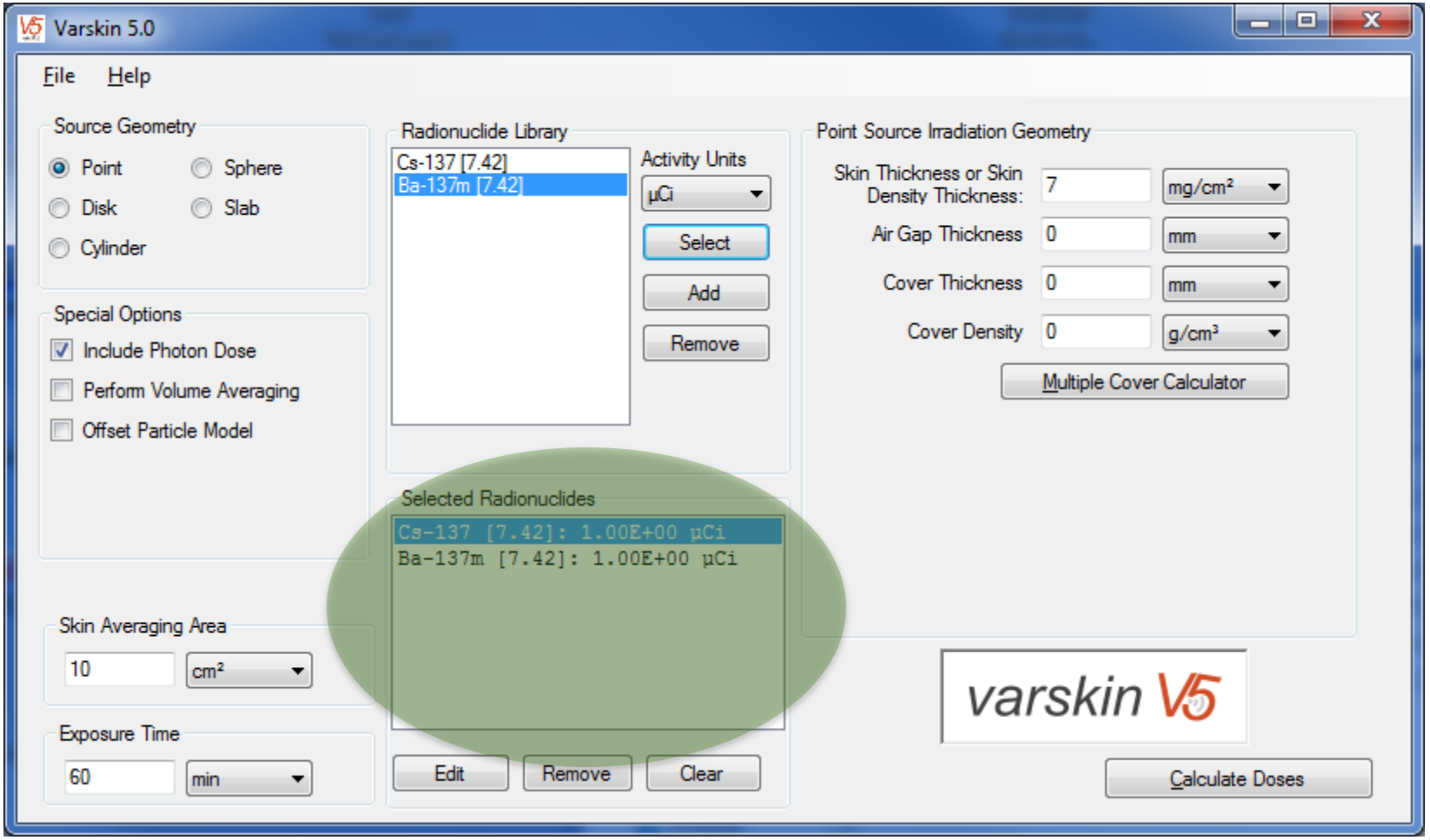
Radionuclide Library

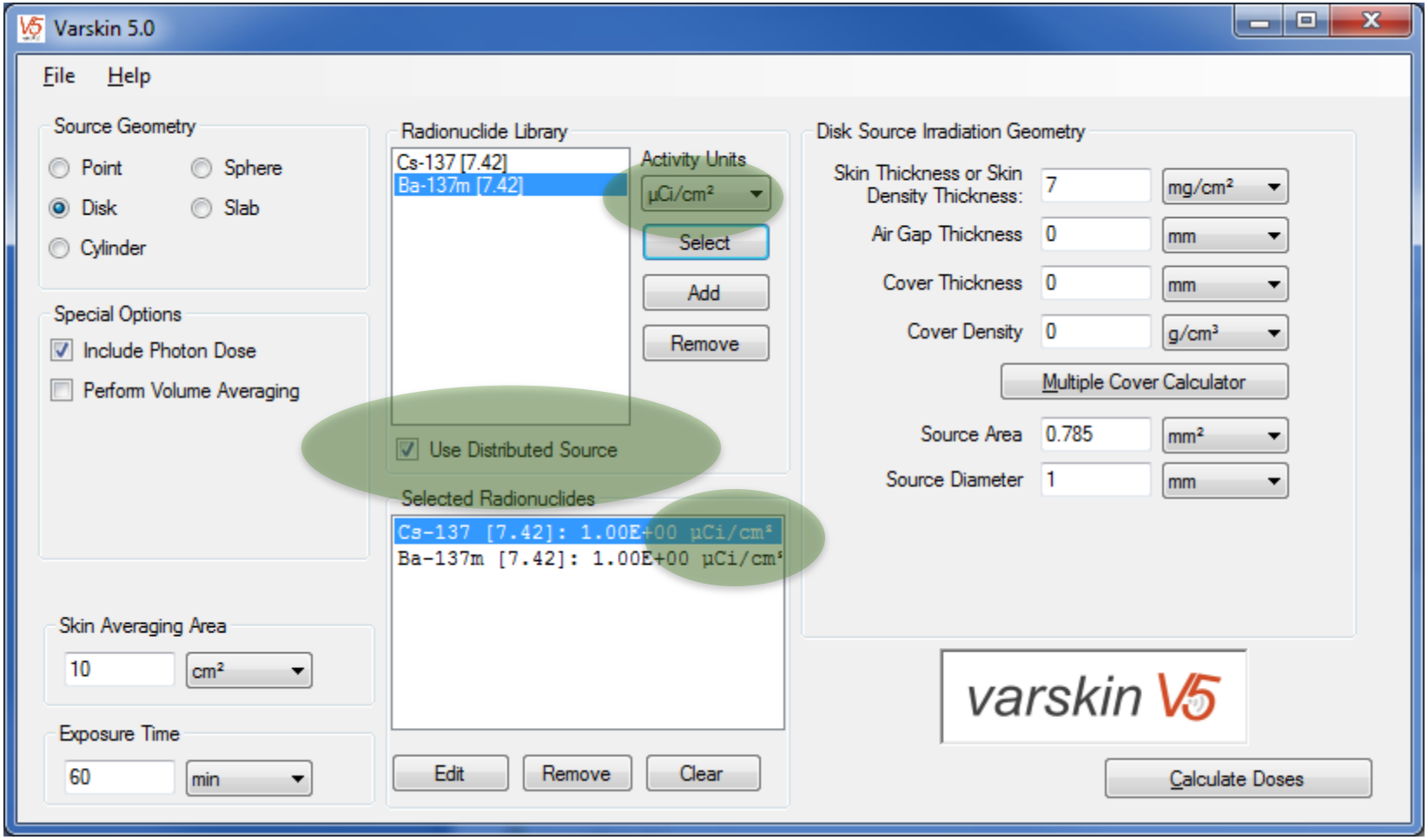
- Current database taken from ICRP 38
- Contains > 800 radionuclides
- Parent/daughter relationships NOT incorporated
- Emissions include:
  - photons (gamma; X-ray; annihilation)
  - electrons (beta; positron; conversion; Auger)
- Source atomic number (Z) affects electron energy loss prior to skin entry

Volumetric Beta Dose vs Source Z



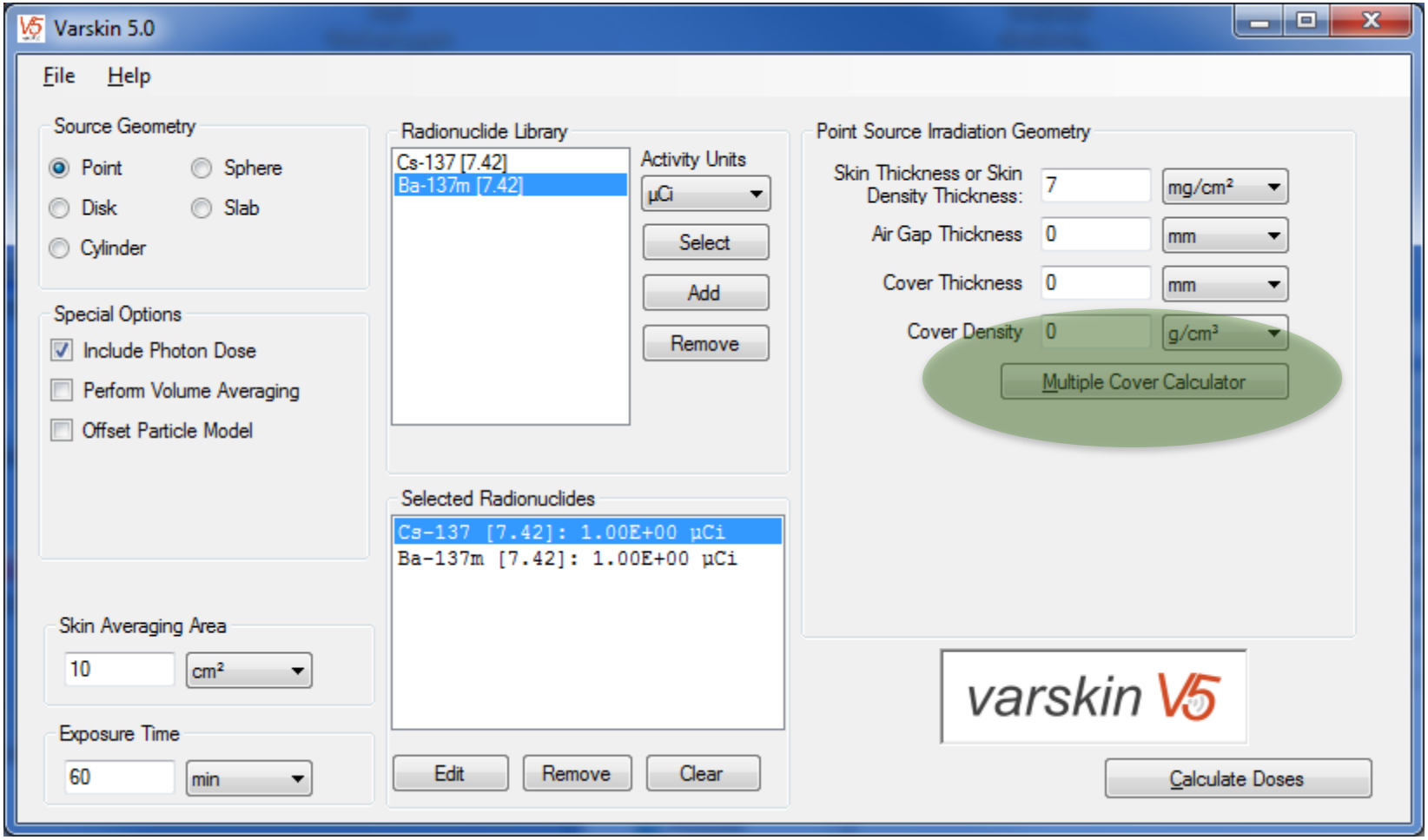

Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Ba-137m [7.42]
Activity Units
µCi
Select
Add
Edit
Remove
Clear
Source Strength
Enter the Source Strength for Cs-137 [7.42] in µCi
OK
Cancel
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses


Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Ba-137m [7.42]
Activity Units
µCi
Select
Add
Remove
Selected Radionuclides
Cs-137 [7.42]: 1.00E+00 µCi
Ba-137m [7.42]: 1.00E+00 µCi
Edit
Remove
Clear
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses


Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Ba-137m [7.42]
Activity Units
µCi/cm²
Select
Add
Remove
Use Distributed Source
Selected Radionuclides
Cs-137 [7.42]: 1.00E+00 µCi/cm²
Ba-137m [7.42]: 1.00E+00 µCi/cm²
Edit
Remove
Clear
Disk Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
Source Area
0.785
mm²
Source Diameter
1
mm
varskin V5
Calculate Doses

Distributed Source

- For all geometries except point
- The selected radionuclide is always distributed throughout the source area or volume
- This option simply gives the user the ability to enter the volumetric equivalent of activity, as opposed to total activity
- On selection:
  - source units change from activity to activty per unit area ($\mu Ci/cm^2$) or volume ($\mu Ci/cm^3$)
  - user must remove and re-select radionuclide(s)

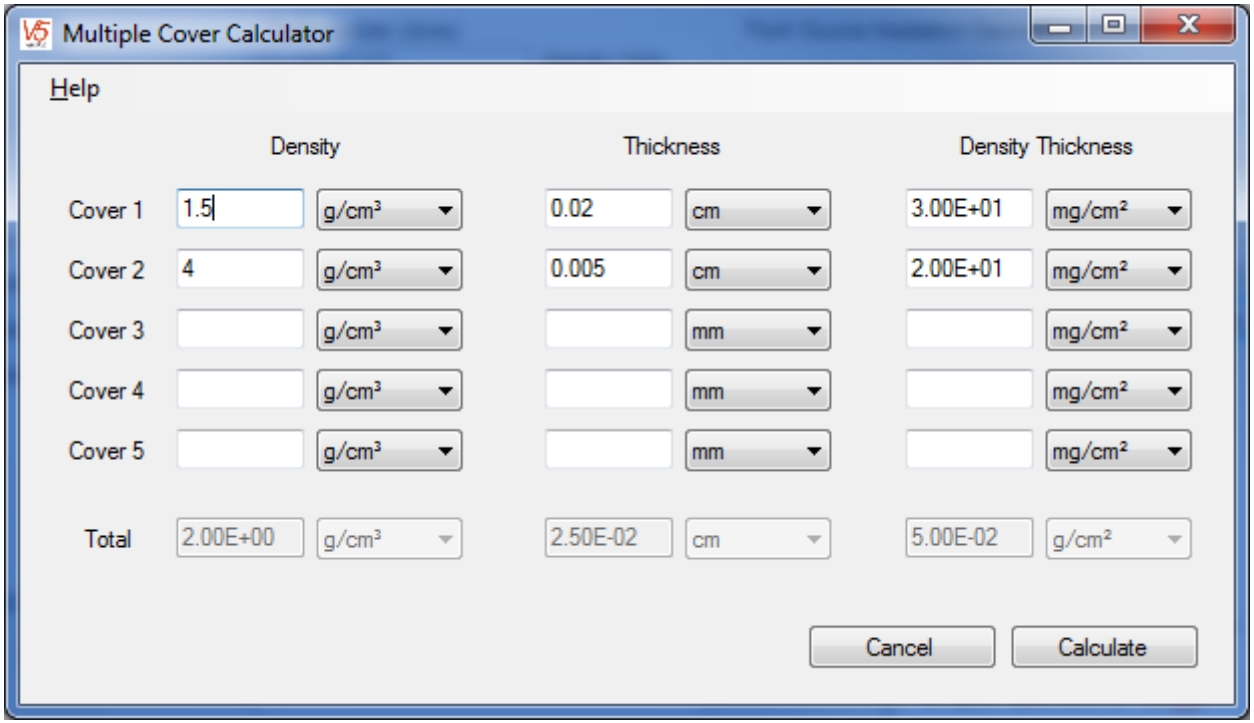

Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Ba-137m [7.42]
Activity Units
µCi
Select
Add
Remove
Selected Radionuclides
Cs-137 [7.42]: 1.00E+00 µCi
Ba-137m [7.42]: 1.00E+00 µCi
Edit
Remove
Clear
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0
mm
Cover Density
0
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

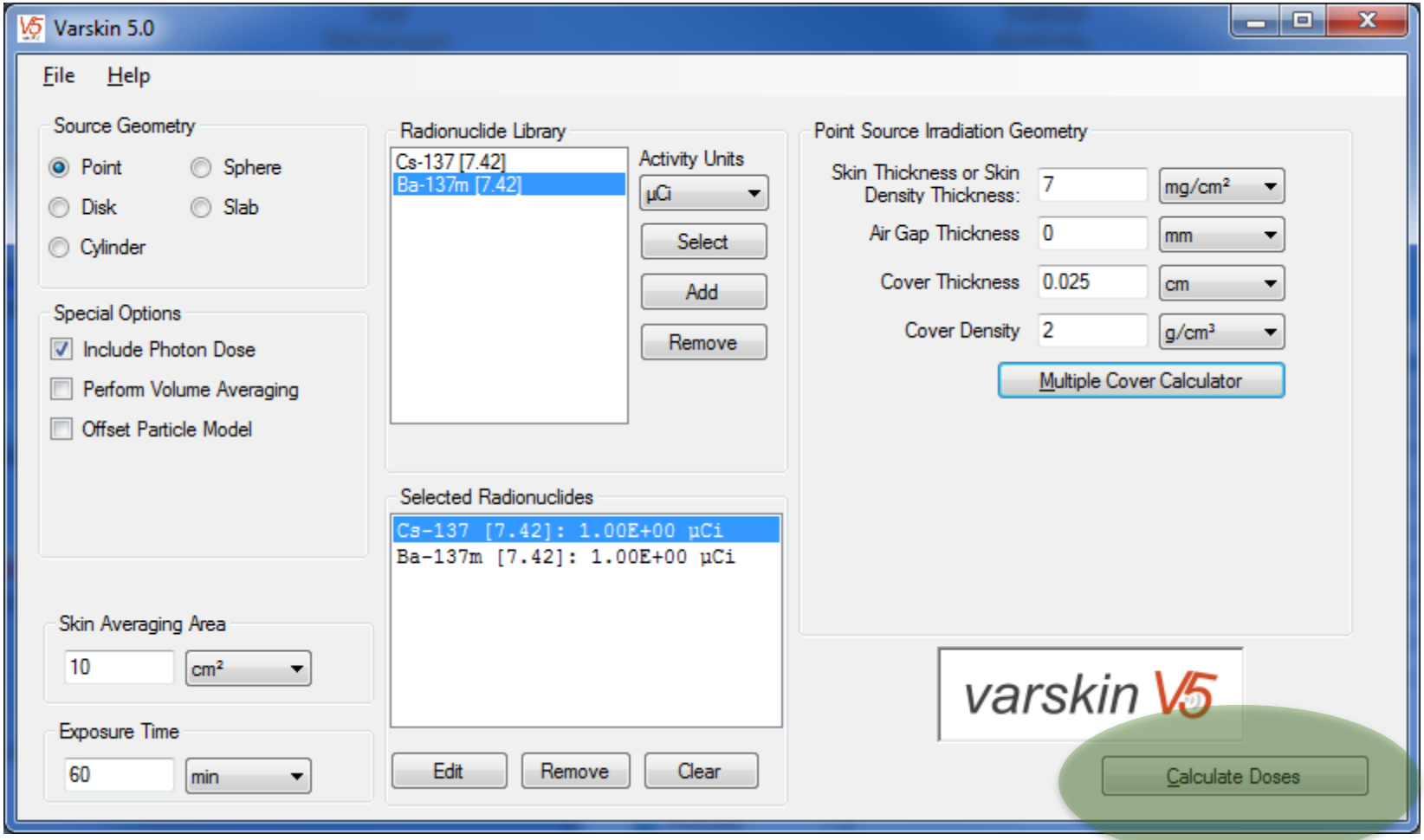
Multiple Cover Calculator

- For each cover material, user enters <u>two</u> of:
  - density (g/cm^3)
  - thickness (mm)
  - density thickness (mg/cm^2)

- Then, total thickness and effective density are used as inputs describing the total cover:

$$\rho_{eff}\left(\frac{g}{cm^3}\right) = \frac{\sum \rho x \left(\frac{g}{cm^2}\right)}{\sum x\,(cm)}$$


Multiple Cover Calculator
Help
Density
Thickness
Density Thickness
Cover 1
1.5
g/cm³
0.02
cm
3.00E+01
mg/cm²
Cover 2
4
g/cm³
0.005
cm
2.00E+01
mg/cm²
Cover 3
g/cm³
mm
mg/cm²
Cover 4
g/cm³
mm
mg/cm²
Cover 5
g/cm³
mm
mg/cm²
Total
2.00E+00
g/cm³
2.50E-02
cm
5.00E-02
g/cm²
Cancel
Calculate


Varskin 5.0
File
Help
Source Geometry
Point
Sphere
Disk
Slab
Cylinder
Special Options
Include Photon Dose
Perform Volume Averaging
Offset Particle Model
Skin Averaging Area
10
cm²
Exposure Time
60
min
Radionuclide Library
Cs-137 [7.42]
Ba-137m [7.42]
Activity Units
µCi
Select
Add
Remove
Selected Radionuclides
Cs-137 [7.42]: 1.00E+00 µCi
Ba-137m [7.42]: 1.00E+00 µCi
Edit
Remove
Clear
Point Source Irradiation Geometry
Skin Thickness or Skin Density Thickness:
7
mg/cm²
Air Gap Thickness
0
mm
Cover Thickness
0.025
cm
Cover Density
2
g/cm³
Multiple Cover Calculator
varskin V5
Calculate Doses

VARSKIN Output

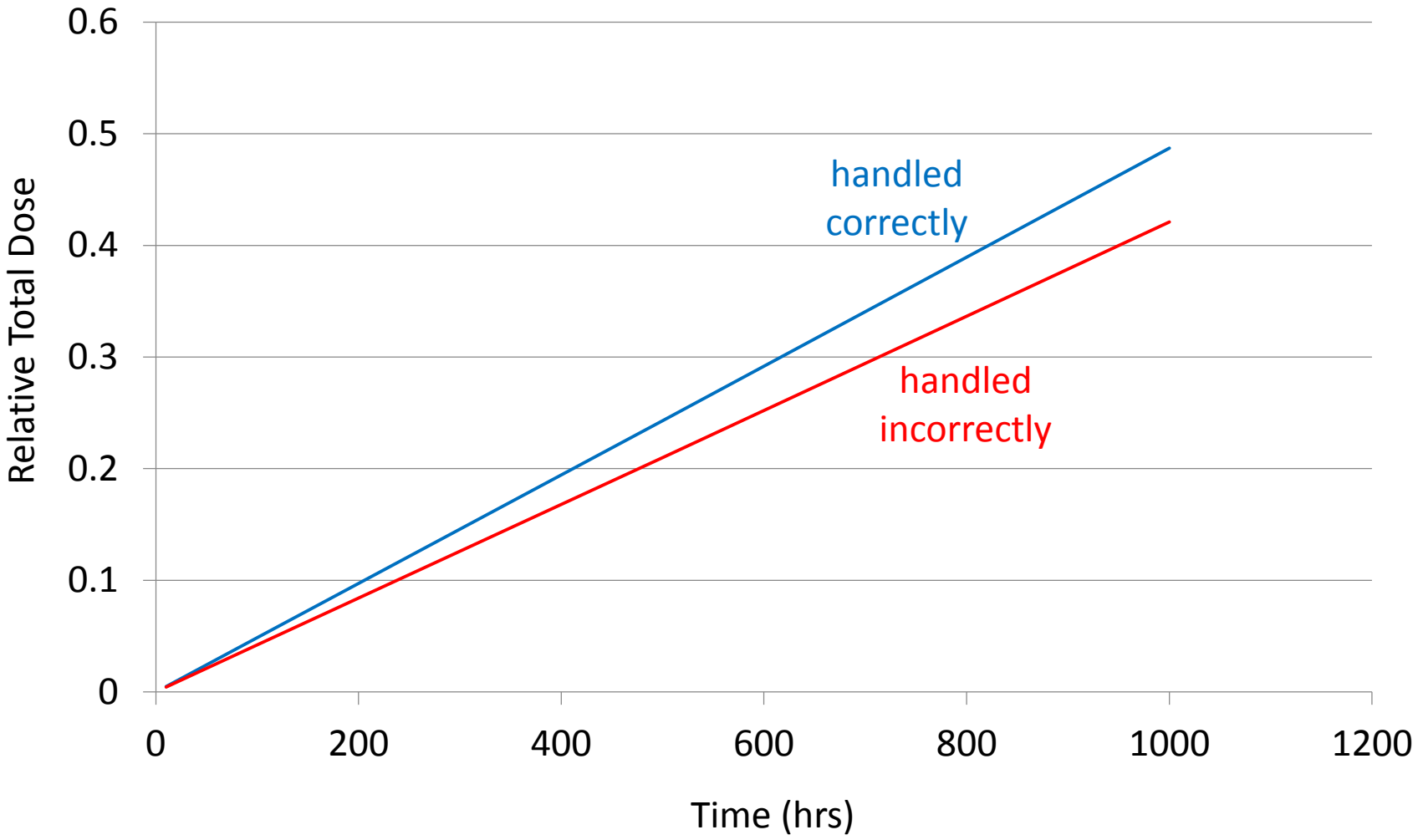
- English or SI units
- For each radionuclide (and total), the following doses are provided:
  - Beta, Photon & Total:
    - initial dose rate
    - dose (no decay)
    - decay-corrected dose
- Date/time
- Geometry summary
- Print option (to html file)

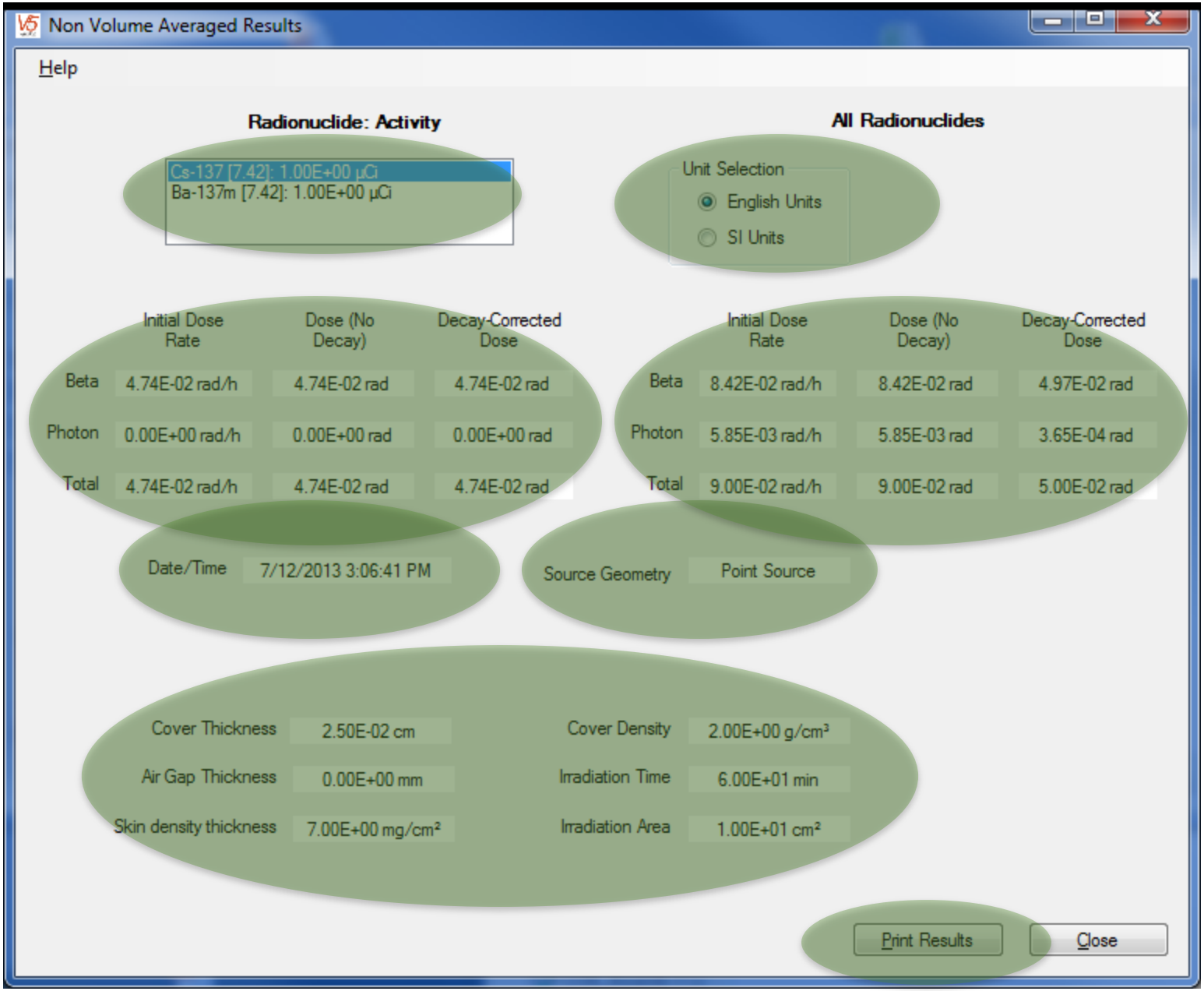
$$D = \dot{D}(0) \cdot t$$

$$D_{dc} = \int_0^t \dot{D}(t)dt = \dot{D}(0) \int_0^t e^{-\lambda t} dt$$

Decay-Corrected Dose

^{137}Cs and ^{137m}Ba; point source; 10 cm^2; 7 mg/cm^2




Non Volume Averaged Results
Help
Radionuclide: Activity
Cs-137 [7.42]: 1.00E+00 µCi
Ba-137m [7.42]: 1.00E+00 µCi
All Radionuclides
Unit Selection
English Units
SI Units
Initial Dose Rate
Dose (No Decay)
Decay-Corrected Dose
Beta 4.74E-02 rad/h 4.74E-02 rad 4.74E-02 rad
Photon 0.00E+00 rad/h 0.00E+00 rad 0.00E+00 rad
Total 4.74E-02 rad/h 4.74E-02 rad 4.74E-02 rad
Initial Dose Rate
Dose (No Decay)
Decay-Corrected Dose
Beta 8.42E-02 rad/h 8.42E-02 rad 4.97E-02 rad
Photon 5.85E-03 rad/h 5.85E-03 rad 3.65E-04 rad
Total 9.00E-02 rad/h 9.00E-02 rad 5.00E-02 rad
Date/Time 7/12/2013 3:06:41 PM
Source Geometry Point Source
Cover Thickness 2.50E-02 cm
Air Gap Thickness 0.00E+00 mm
Skin density thickness 7.00E+00 mg/cm²
Cover Density 2.00E+00 g/cm³
Irradiation Time 6.00E+01 min
Irradiation Area 1.00E+01 cm²
Print Results
Close