PUFI User's manual

PUFI (PENELOPE User-Friendly Interface) is a convenient interface designed to facilitate the preparation of PENELOPE geometry files for application to gamma-ray spectrometry. The software considers typical cases with a cylindrical geometry including detector, volume source and shielding.

Installation

The user must download the file "PUFI-2.0-amd64.msi" and double-click on it to start the installation. By default, the software will be installed in the directory "C:\Program Files\PUFI\", but it is recommended to install it in a different directory (especially for easier updates).

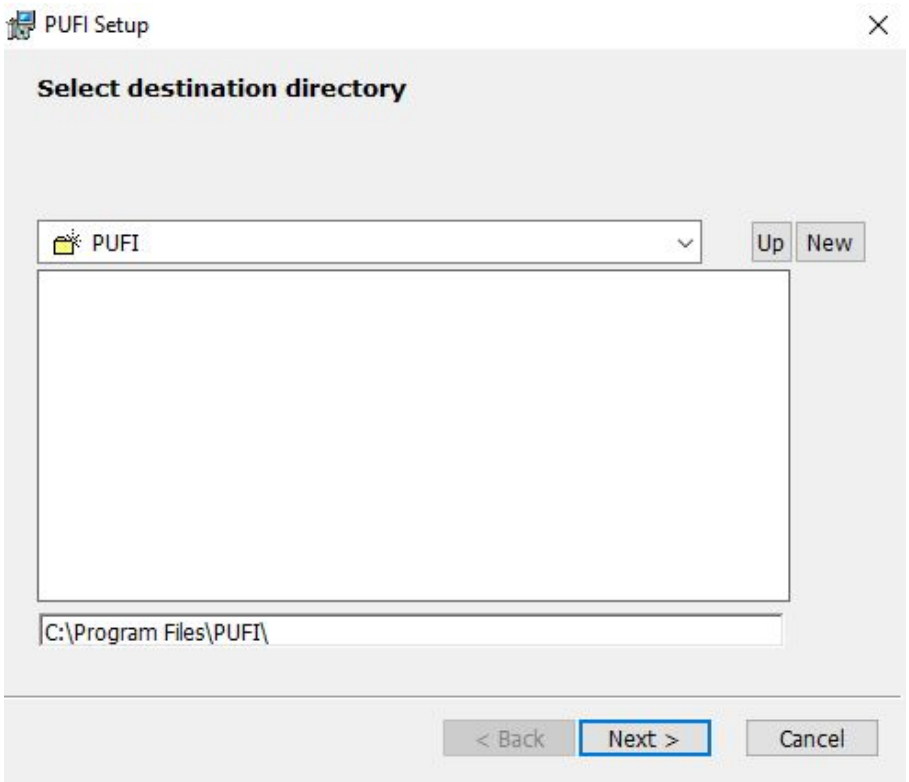


Figure 1: Default choice of the PUFI installation directory

The user can also select another destination (Figure 2) by using the “Up” or “New” buttons:

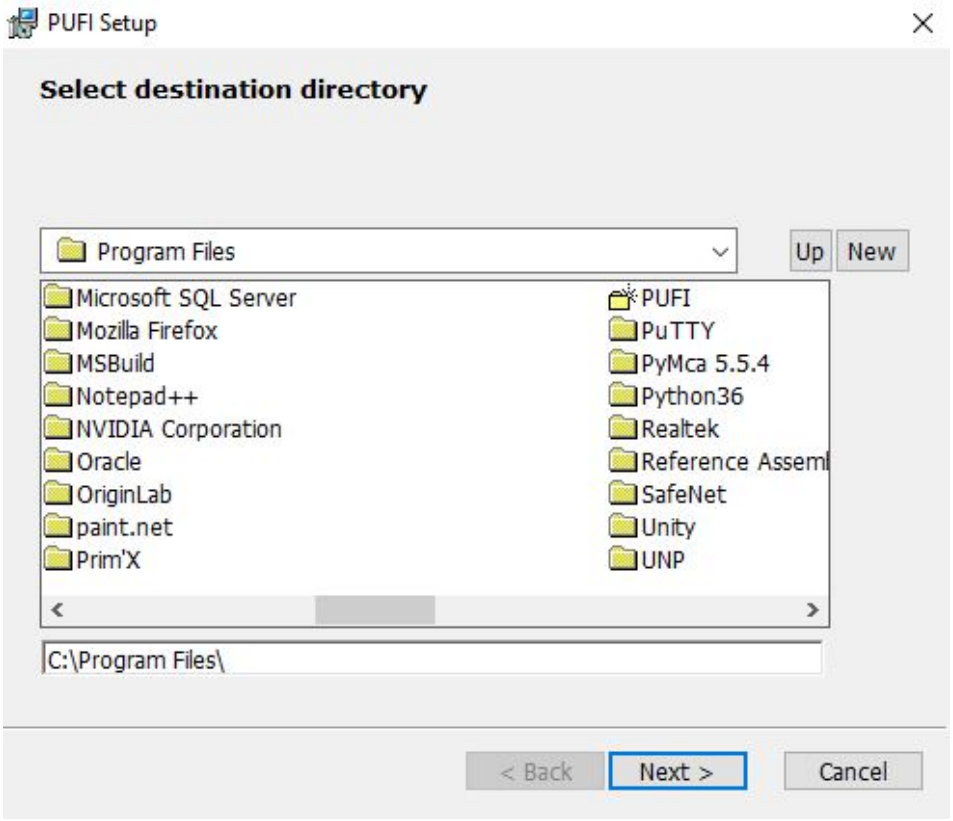


Figure 2: Selecting a directory to install PUFI

Then, the user must click on “Next” to start the installation (Caution, administrator privileges may be required!). Click on “Finish” to complete the process (Figure 3).

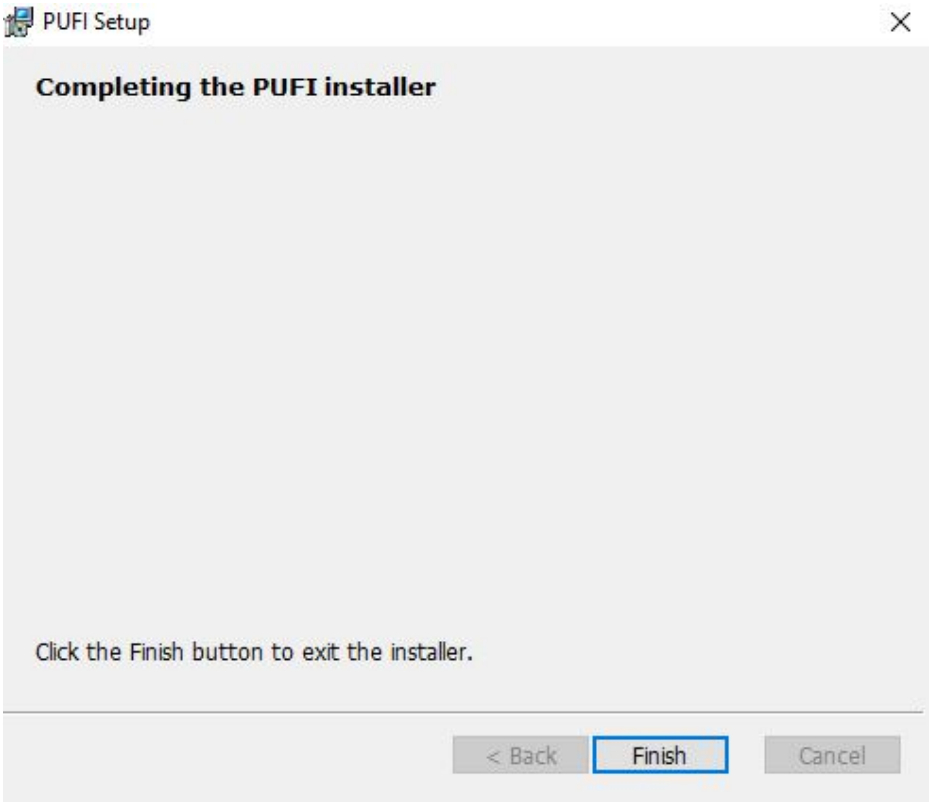


Figure 3: End of the PUFI installation

The installation directory created contains in particular the executable “PUFI.EXE” and the subdirectories “geometry_models” and “projects”.

Using the software

Remark: all dimensions are to be given in millimeters.

The software is launched by clicking on "PUFI.EXE".

Launching the application opens the main window (Figure 4) that gives access to the “File” menu; this one allows either to define a new project (click on “New project”) (the user must then enter a project name) (Figure 5), or to recall (click on “Open project”) an already existing project by selecting it from the list included in the “projects” directory and clicking on “Open” (Figure 6).

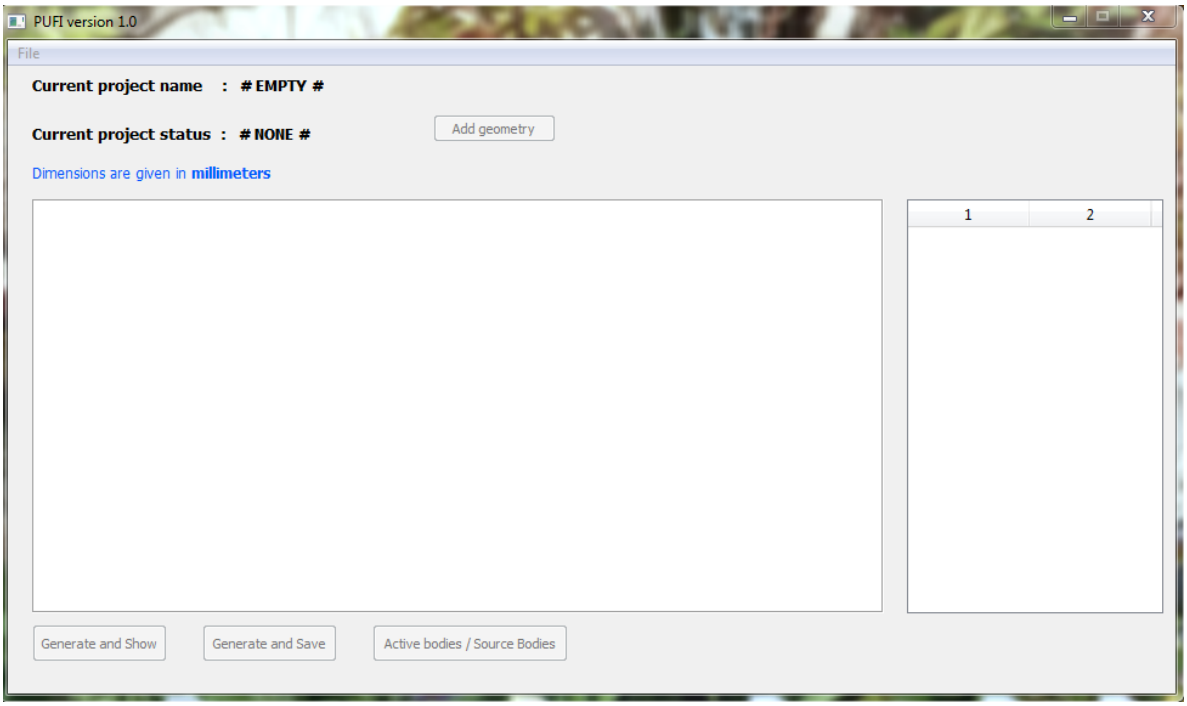


Figure 4: *Main window*

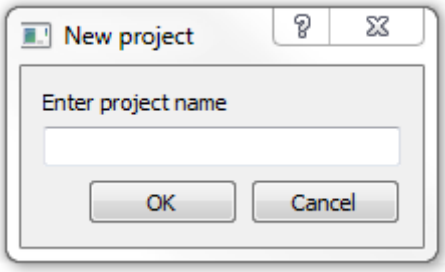


Figure 5: Entering the name of a new project

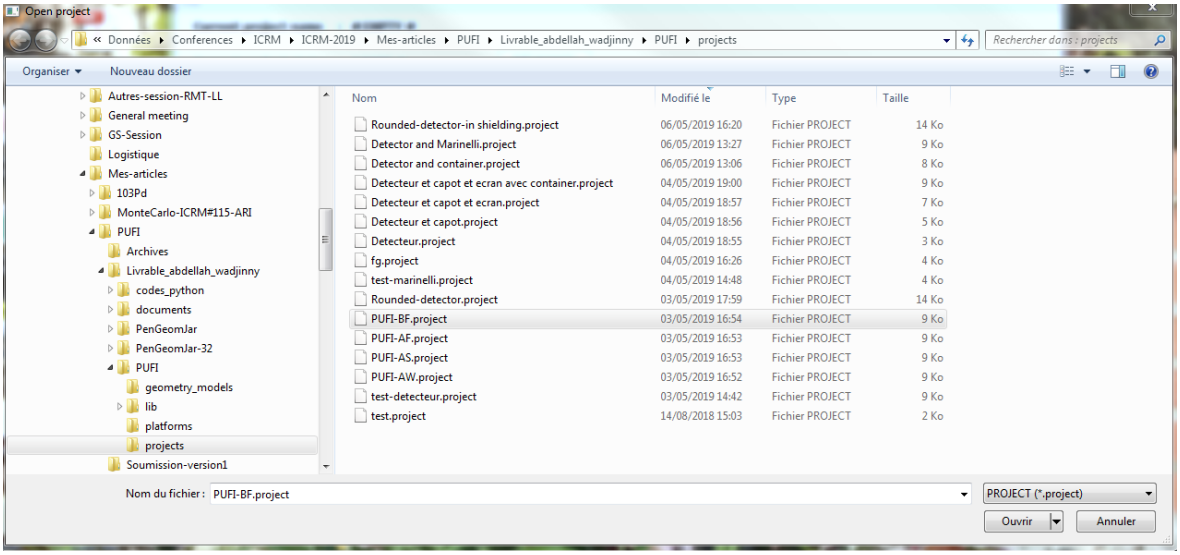


Figure 6: Selecting an existing project

Existing project

When opening an existing project, the elements included in it with their dimensions are displayed in the main window (Figure 7):

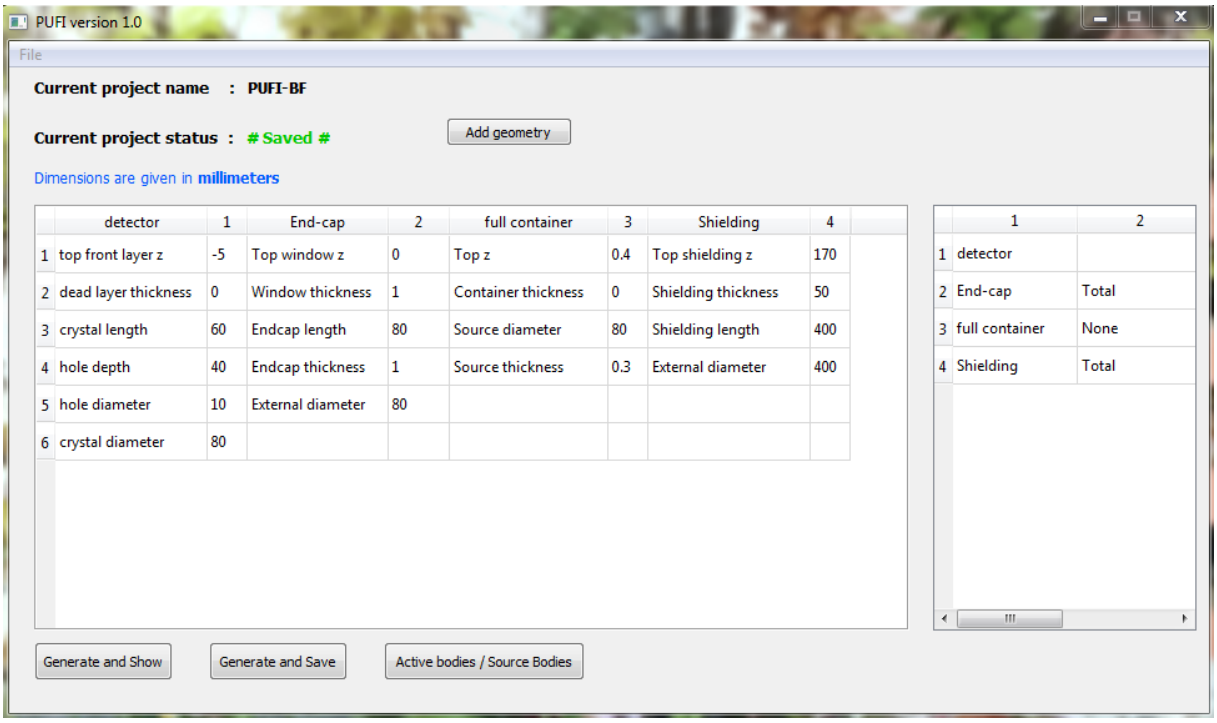


Figure 7: Display of the elements of an existing project

In the example presented in Figure 7, the project includes four elements: the detector and its end-cap, a full container, all installed in a shielding.

Clicking on “Generate and Show” prepares the PENELOPE geometry file and displays it on the screen (Figure 8):

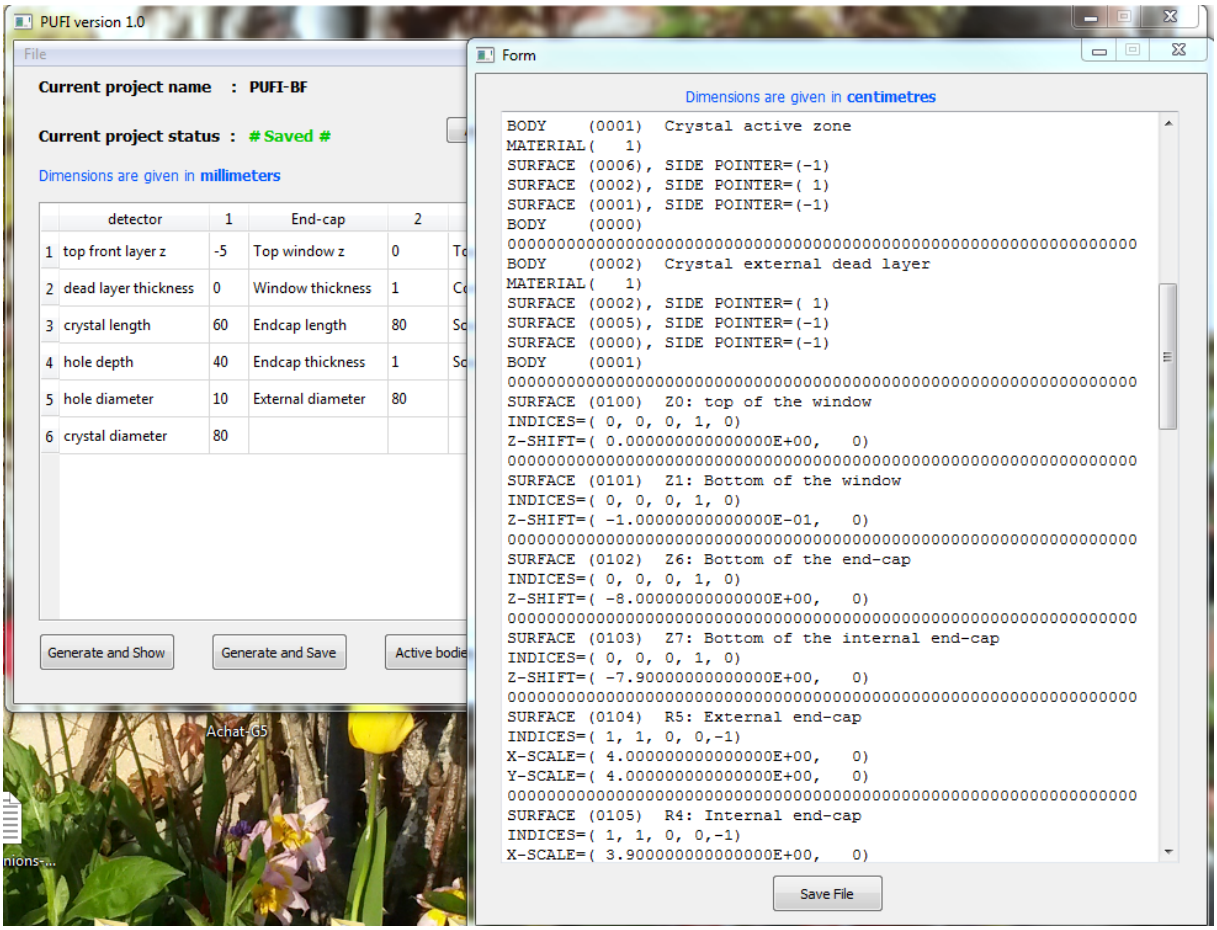


Figure 8: Display of the "geometry" file prepared *by PUFI*

Clicking on “Generate and Save” prepares the PENELOPE geometry file and allows its recording with a name provided by the user, with the extension “.geo”.

The tab “Active bodies / Source Bodies” is not used in the present version.

Note: All dimensions must be entered in millimeters by the user, but the code converts them to centimeters according to the convention of the PENELOPE code.

Build a new project

From a pre-existing project, it is easy to modify the dimensions of the elements and generate a new project.

To prepare a new project *ab initio*, it is necessary to follow different steps:

1st step:

As for any geometry definition for the PENELOPE code, it is recommended to prepare a draft scheme of the experimental arrangement to determine the different elements, materials and relative positions, as shown in Figure 9.
The user must define a reference plane (Z=0) and locate the position of the top of each element with respect to this reference position. A practical reference is the top of the detector window.
In addition, the different materials must be identified and numbered, e.g. 1 = germanium (detector crystal and dead layer), 2 = aluminum (cover), etc.; this numbering is used in the PENELOPE input file to identify the different materials.

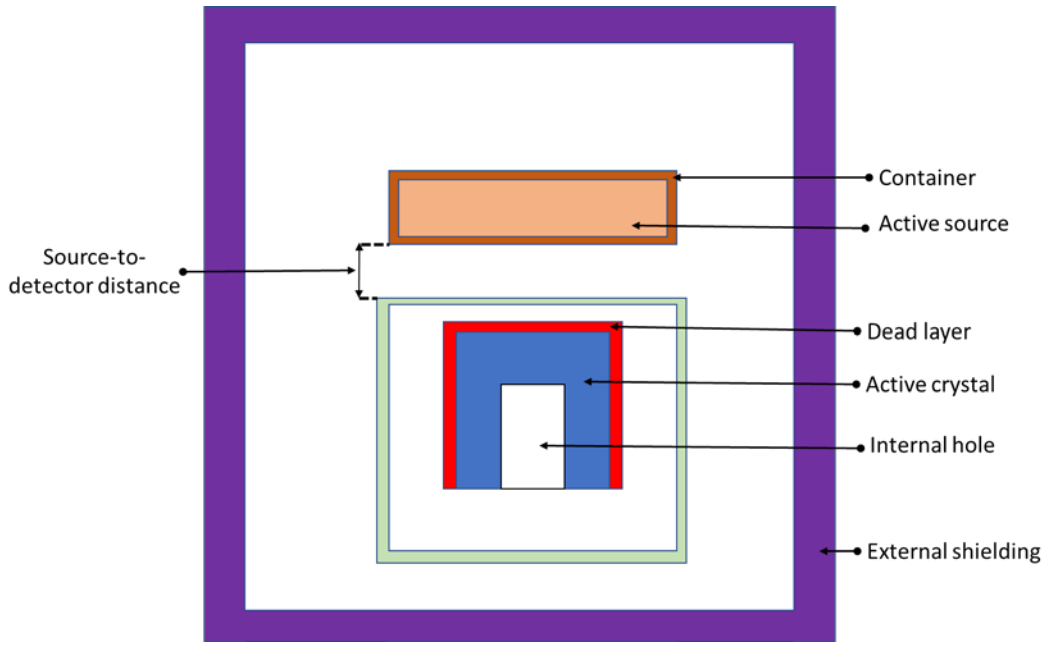


Figure 9: Typical experimental arrangement including a volume source and a detector both installed in a shielding

The project can be prepared by selecting the different elements to create a new geometry. The basic elements, with the display of the dimensions to be entered by the user, are presented in Figures 10 to 16:

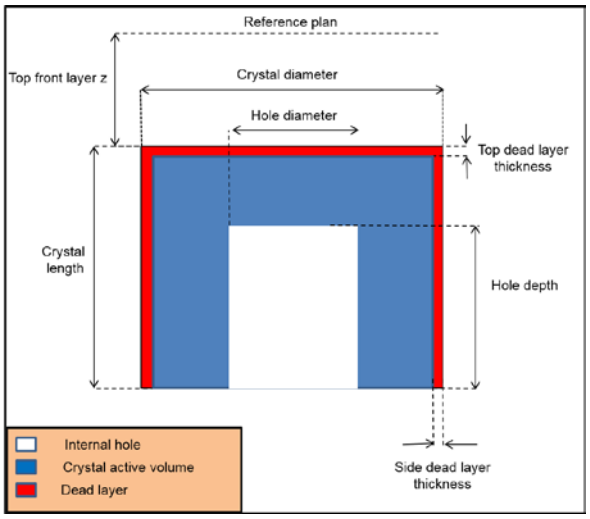


Figure 10: "Detector"

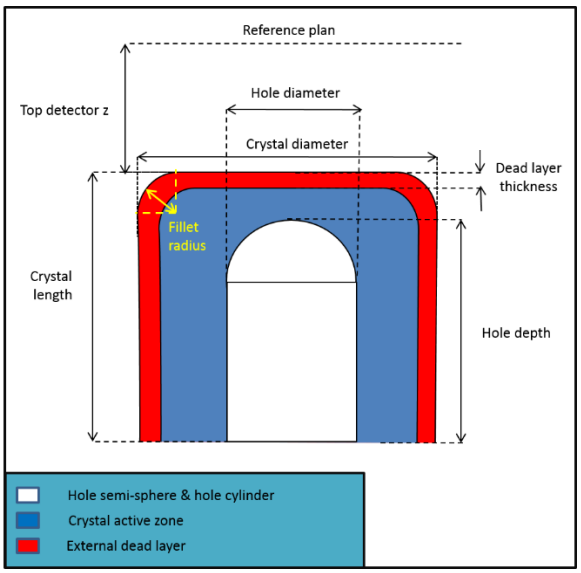


Figure 11: "Rounded detector"

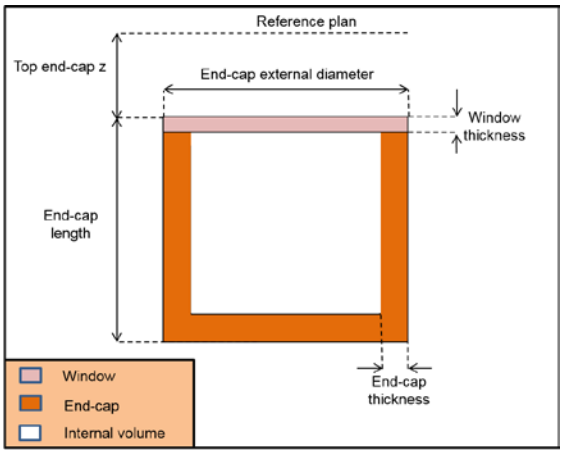


Figure 12: "End cap"

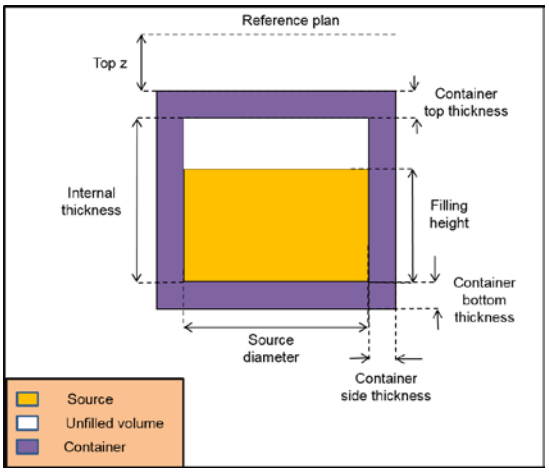


Figure 13: "Container"

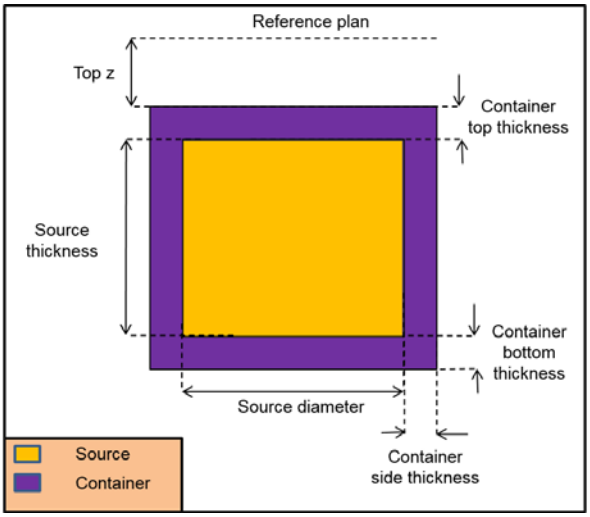


Figure 14: "Full container"

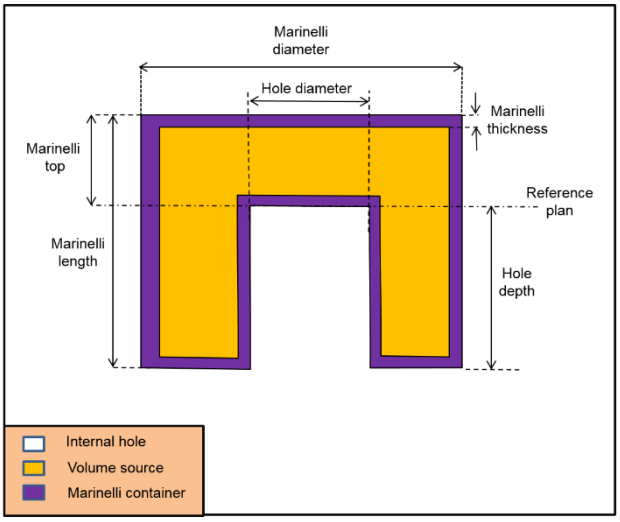


Figure 15: "Marinelli"

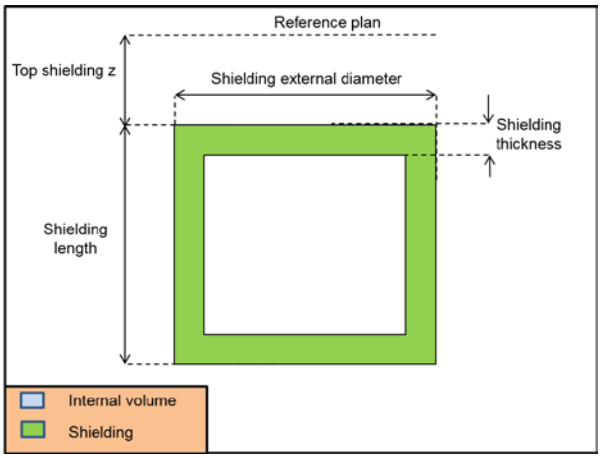


Figure 16: "Shielding"

2nd step:

This step begins with the application's main window (Figure 4) which gives access to the "File" menu and allows you to define a new project (click on "New project"); the user must then enter a project name (Figure 5).

It is then necessary to add the elements by clicking on "Add geometry": this gives access to the "geometry_models" directory which contains the basic elements (see Figures 10 to 16). You must then choose an element and click on "Open". It is important to start with the most internal element and build the geometry by successively adding more external elements (Matryoshka doll).

The dialog window that opens asks the user to specify several information:

1. Define intersection mode: when adding an element, it must be specified if it is an intersection with the previous elements. The intersection can be total ("Total") (shielding around the detector, for example) or partial ("Partial") (Marinelli around the detector, for example) or zero ("None") (container above the detector, for example);
2. Identify the elements that represent the active detector or active source (if applicable) by checking the corresponding box;
3. Identify the material of each element by its number (as defined in step 1).

In this window, the "Show image" button allows you to view the chosen shape and its constituent elements (Figure 17).

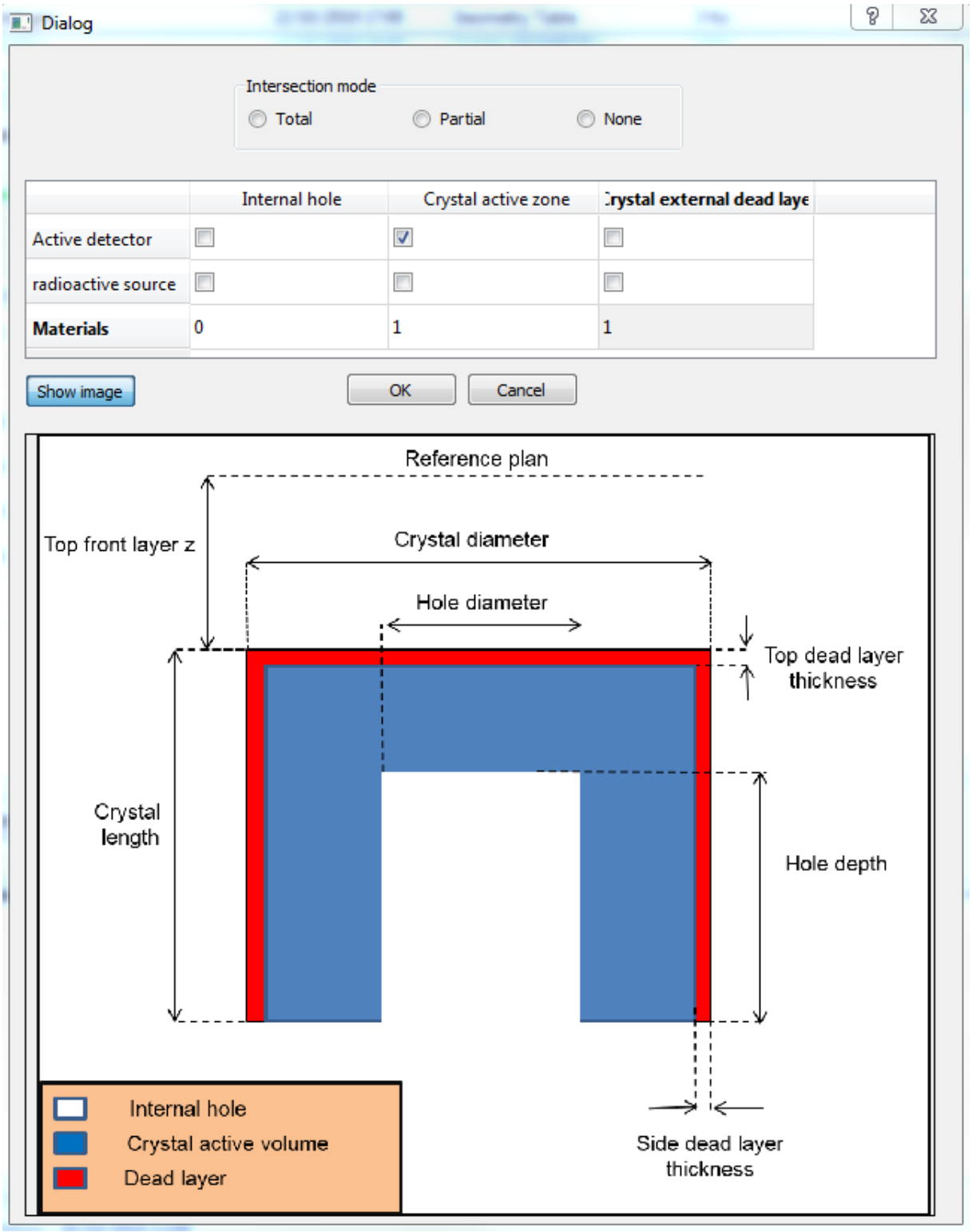


Figure 17: Dialog window used to define an element of the geometry project (here, the detection crystal)

Once this information is entered, it can be validated by clicking on the "OK" button. The program then returns to the main window which will allow you to specify the dimensions characterizing the element (Figure 18):

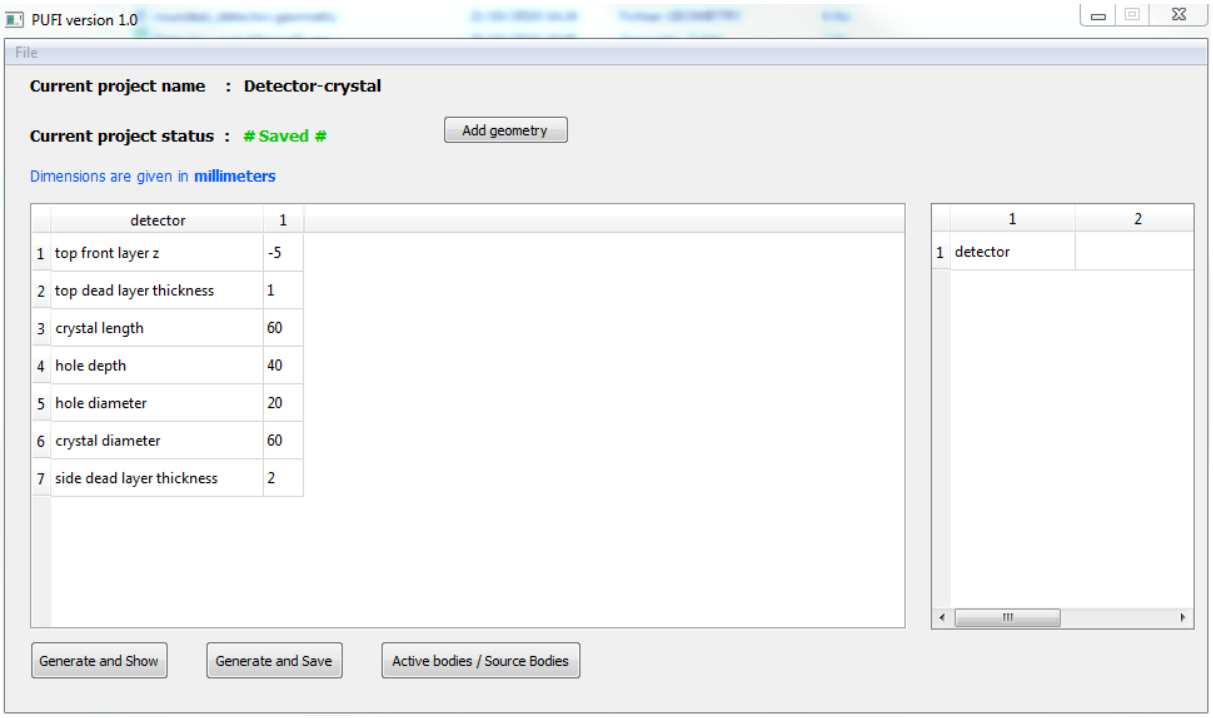


Figure 18: Input of the geometrical parameters characterizing an element (here the detection crystal)

The user can then include other elements using the same procedure. Figure 19 shows the case of the detector end-cap which is in total intersection with the previously defined detection crystal.

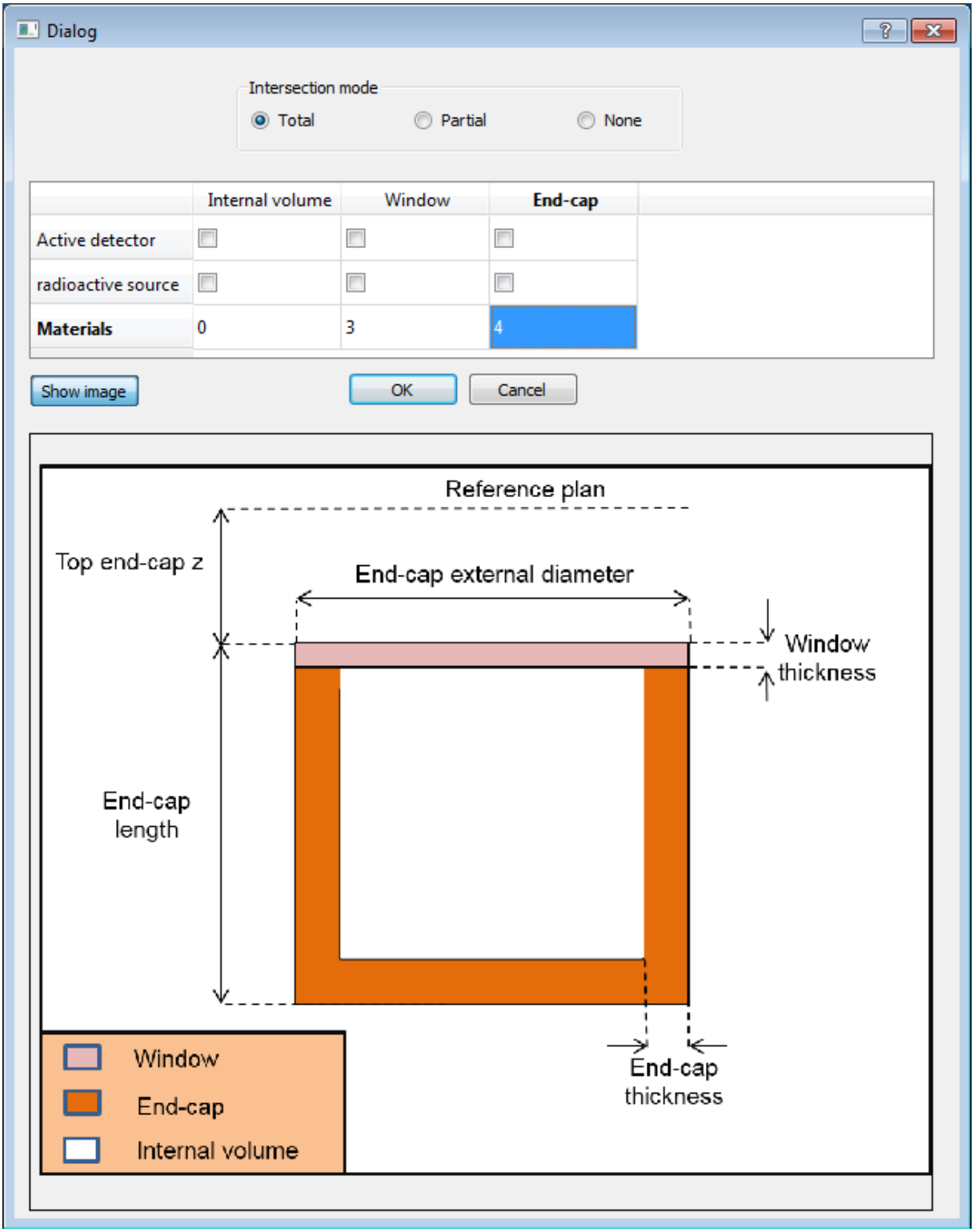
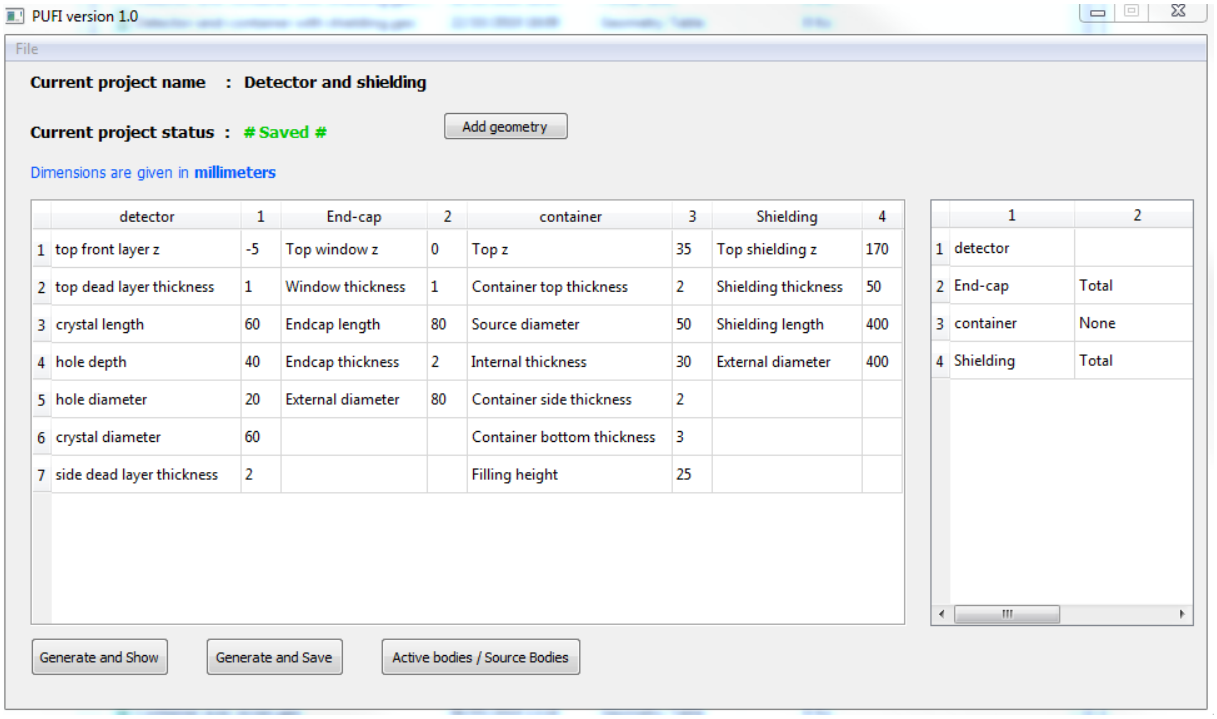


Figure 19: Dialog window determining the detector end-cap with total intersection with the detection crystal

Figure 20 shows an example of a project with four elements: detection crystal, end-cap, container and external shielding.



	detector	1	End-cap	2	container	3	Shielding	4
1	top front layer z	-5	Top window z	0	Top z	35	Top shielding z	170
2	top dead layer thickness	1	Window thickness	1	Container top thickness	2	Shielding thickness	50
3	crystal length	60	Endcap length	80	Source diameter	50	Shielding length	400
4	hole depth	40	Endcap thickness	2	Internal thickness	30	External diameter	400
5	hole diameter	20	External diameter	80	Container side thickness	2		
6	crystal diameter	60			Container bottom thickness	3		
7	side dead layer thickness	2			Filling height	25		

	1	2
1	detector	
2	End-cap	Total
3	container	None
4	Shielding	Total

Figure 20: Project consisting of 4 elements: detection crystal, end-cap, container and external shielding

At any time, the current project can be saved by selecting “File” and then clicking on “Save project” to keep the same name or “Save project as” to give it a different name.

The “Generate and Show” button is used to generate the geometry file and view it (Figure 8):

The “Generate and Save” button allows you to generate the geometry file and save it under a name provided by the user, with extension ".geo".

The "Active bodies / Source Bodies" button is not used in the current version.

Case of a rounded crystal

PUFI can consider crystal with a rounded upper surface: the corresponding element is “Rounded-detector”. The rounding of the crystal entry face can be modeled as the intersection of a torus and a cylinder; the “fillet radius” parameter is the radius of the circle of revolution generating the torus (Figure 21).

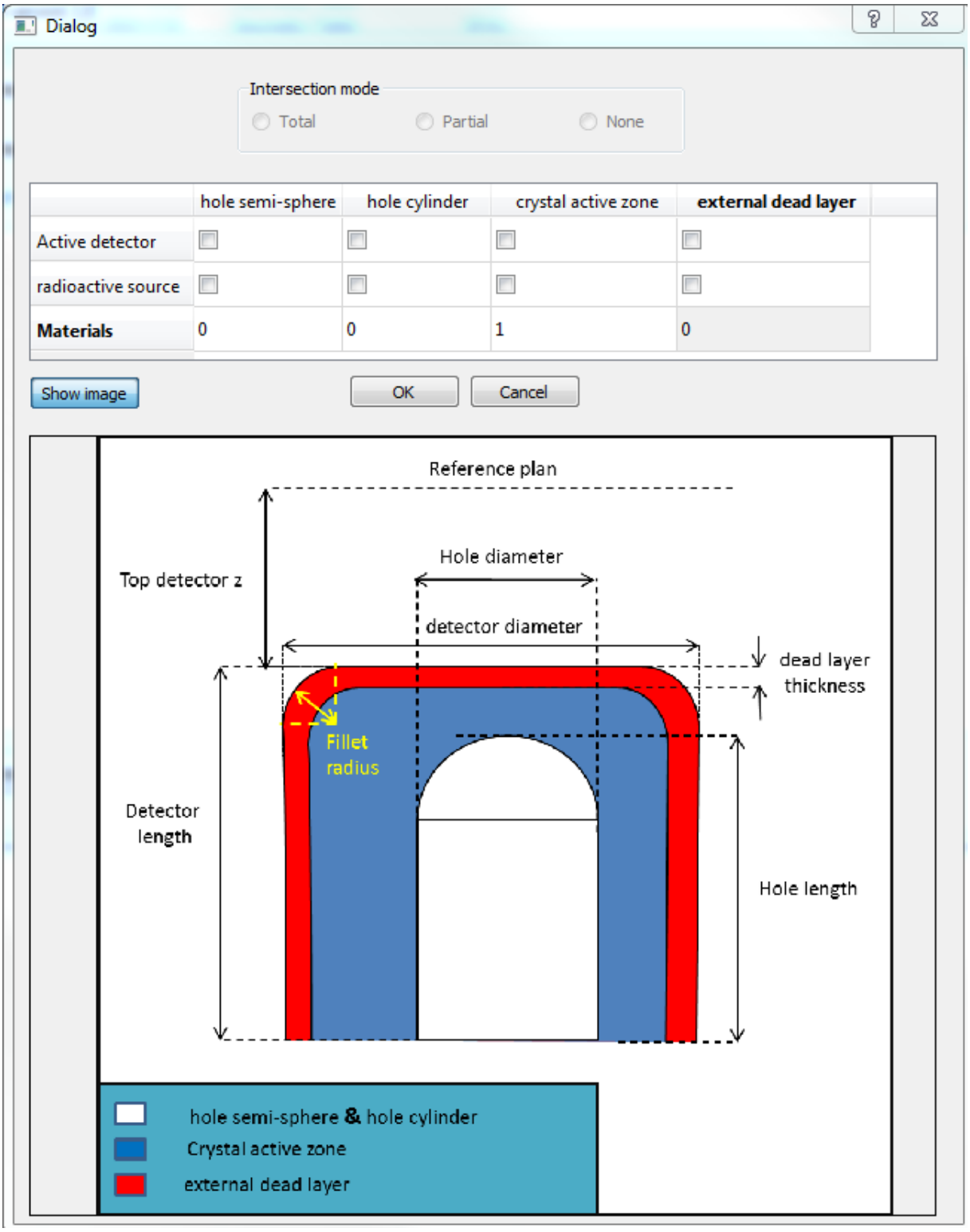


Figure 21: Case of a rounded crystal

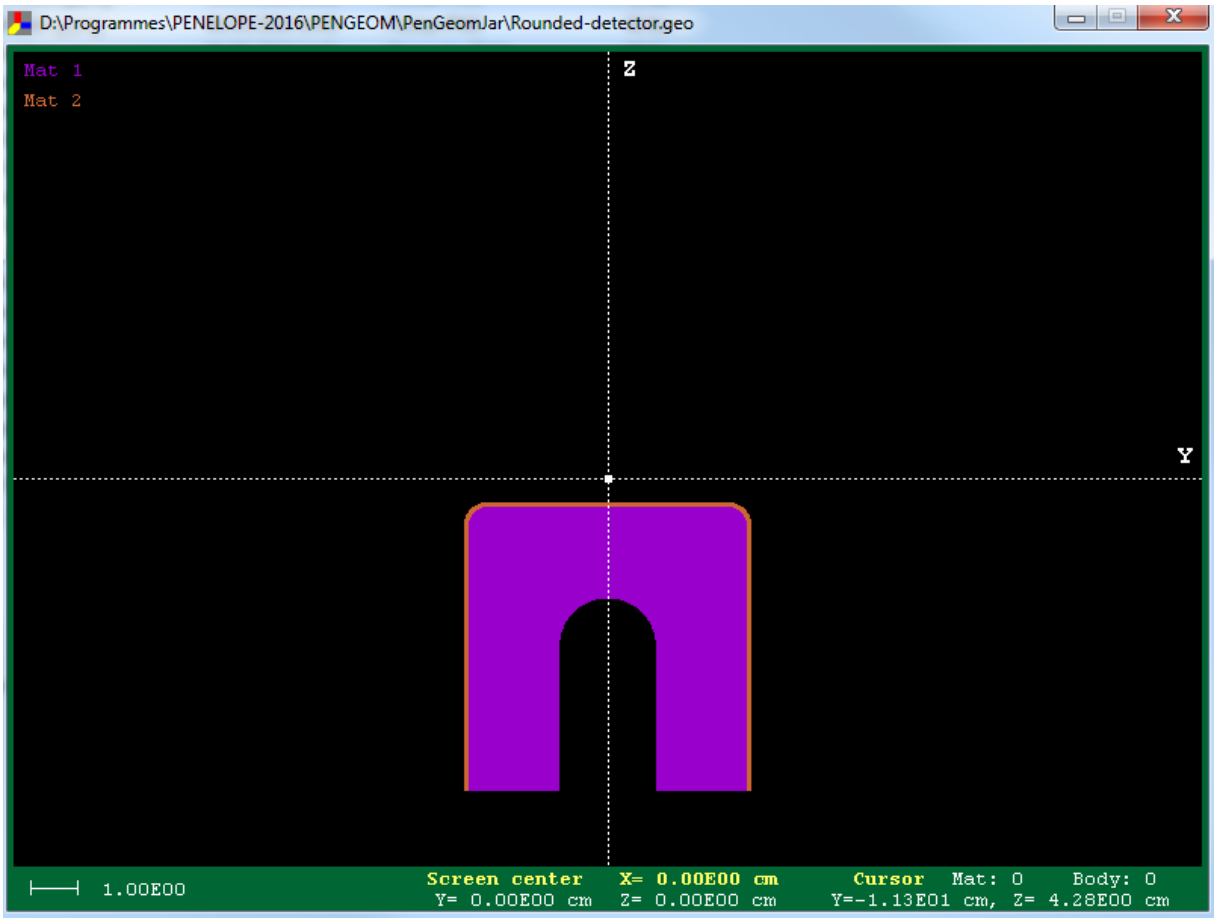


Figure 22: Visualization of the "Rounded-detector" geometry for PENELOPE

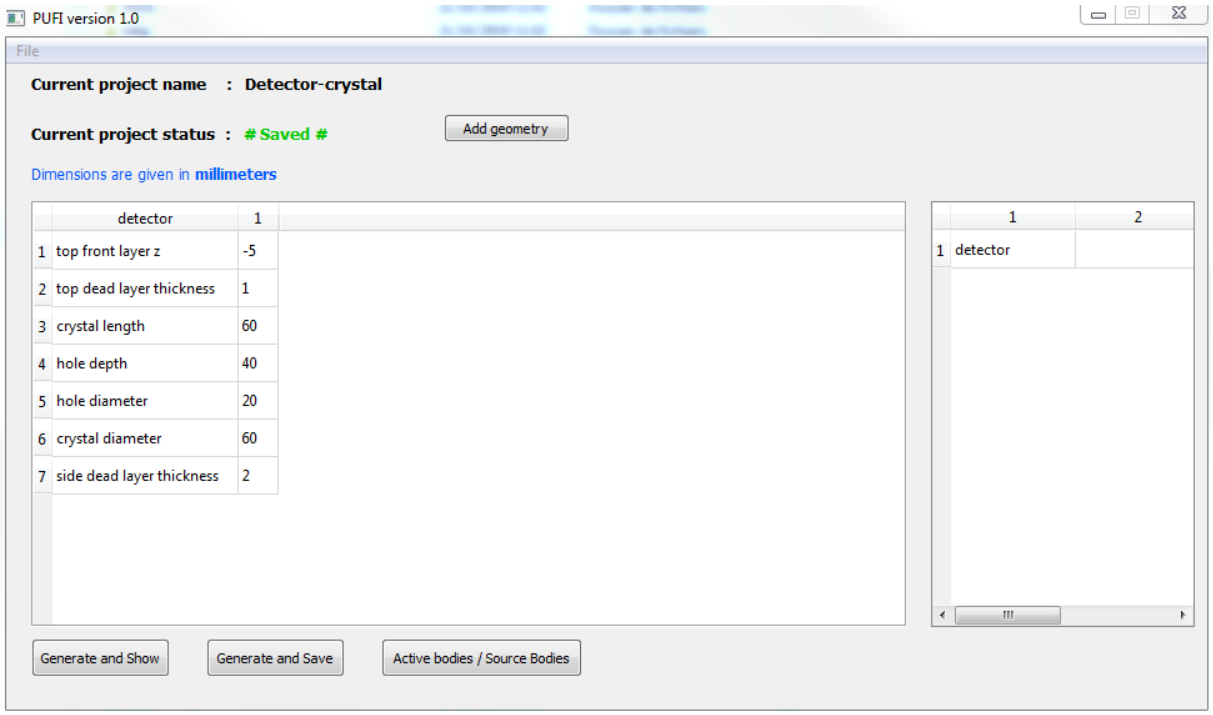
Use in PENELOPE

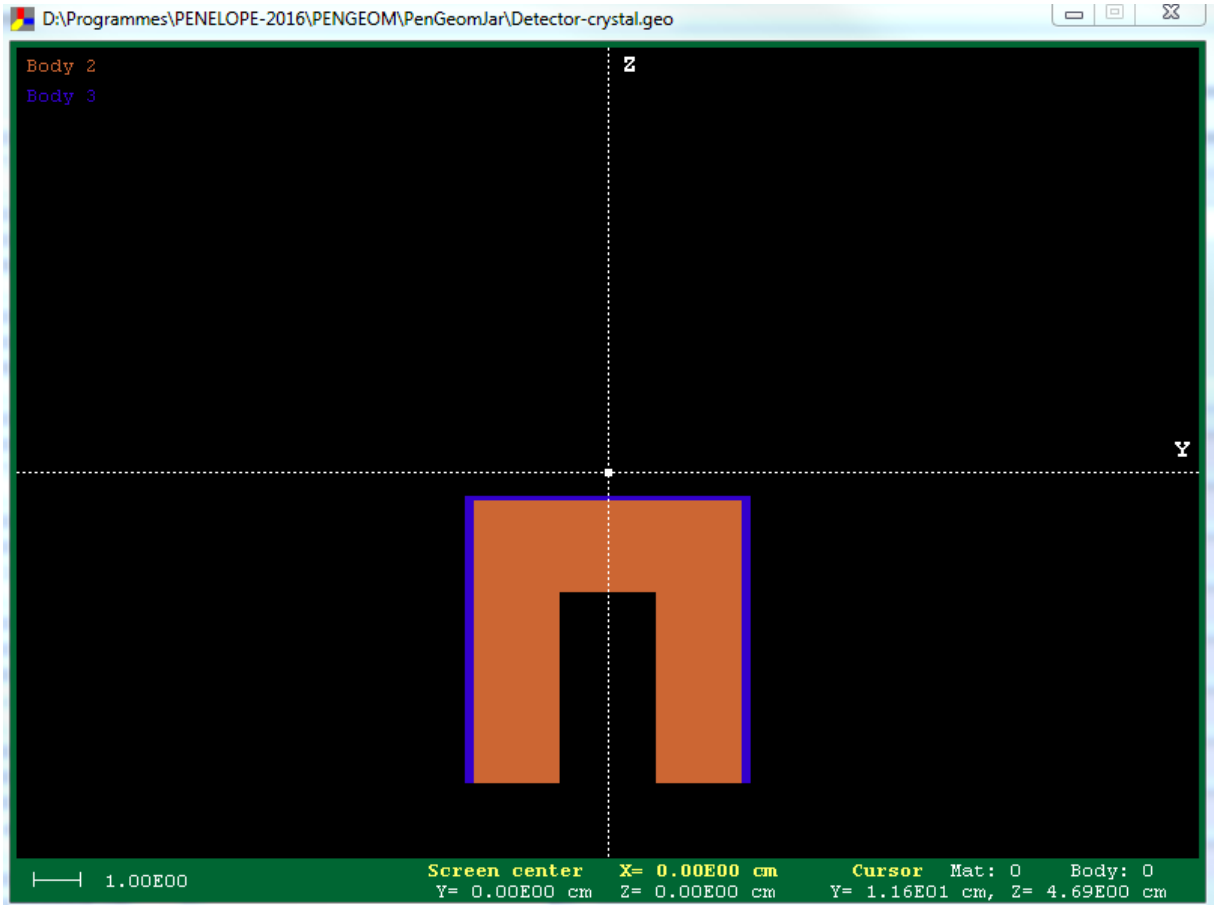
PUFI generates a geometry file that can be used directly in the input file for PENELOPE. However, it is necessary to check that it corresponds to the geometric conditions desired by the user. To do this, use the "PenGeom.Jar" tool provided with version 2016 of PENELOPE, which allows you to renumber the different elements in a sequential order, using the "Relabel" option, and visualize the defined geometry, as shown in Figure 22.

"Projects": prepared models

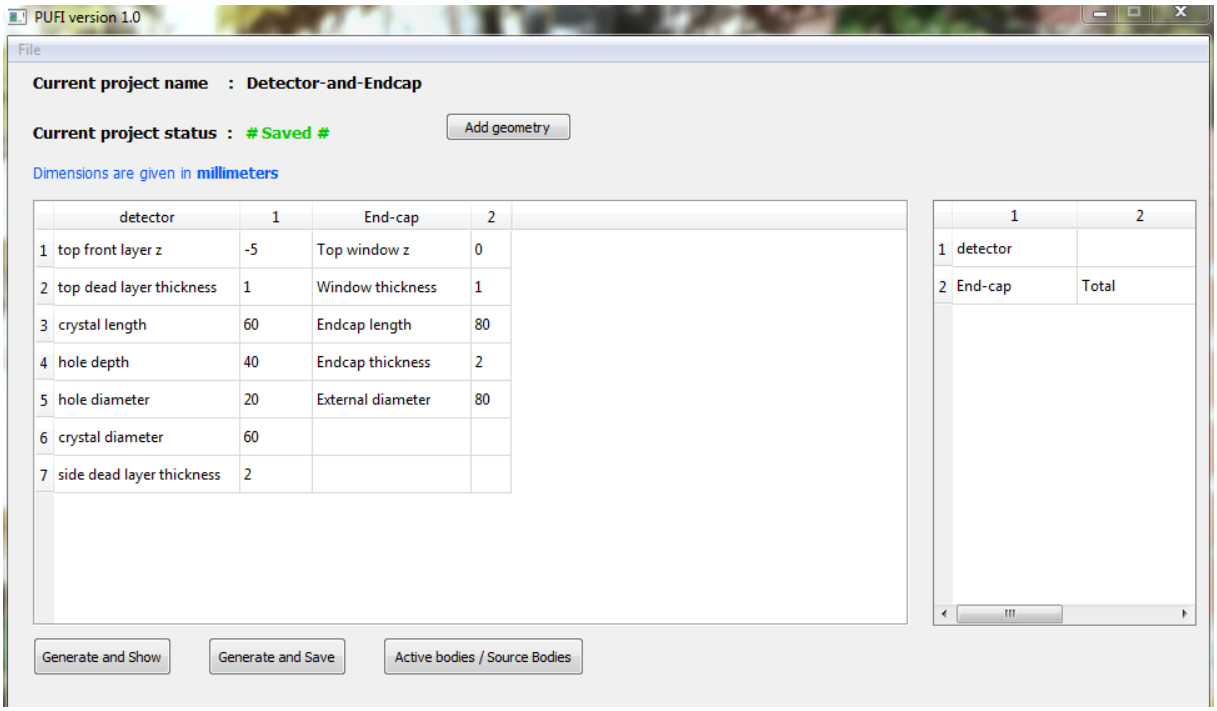
Different projects corresponding to standard geometries have been predefined and can be recalled by the user who can then modify the geometric parameters to create new projects.
The dialog windows and the resulting geometry visualization, with the "Pengeom.Jar" tool of PENELOPE, of the geometry files generated by PUFI are presented below:

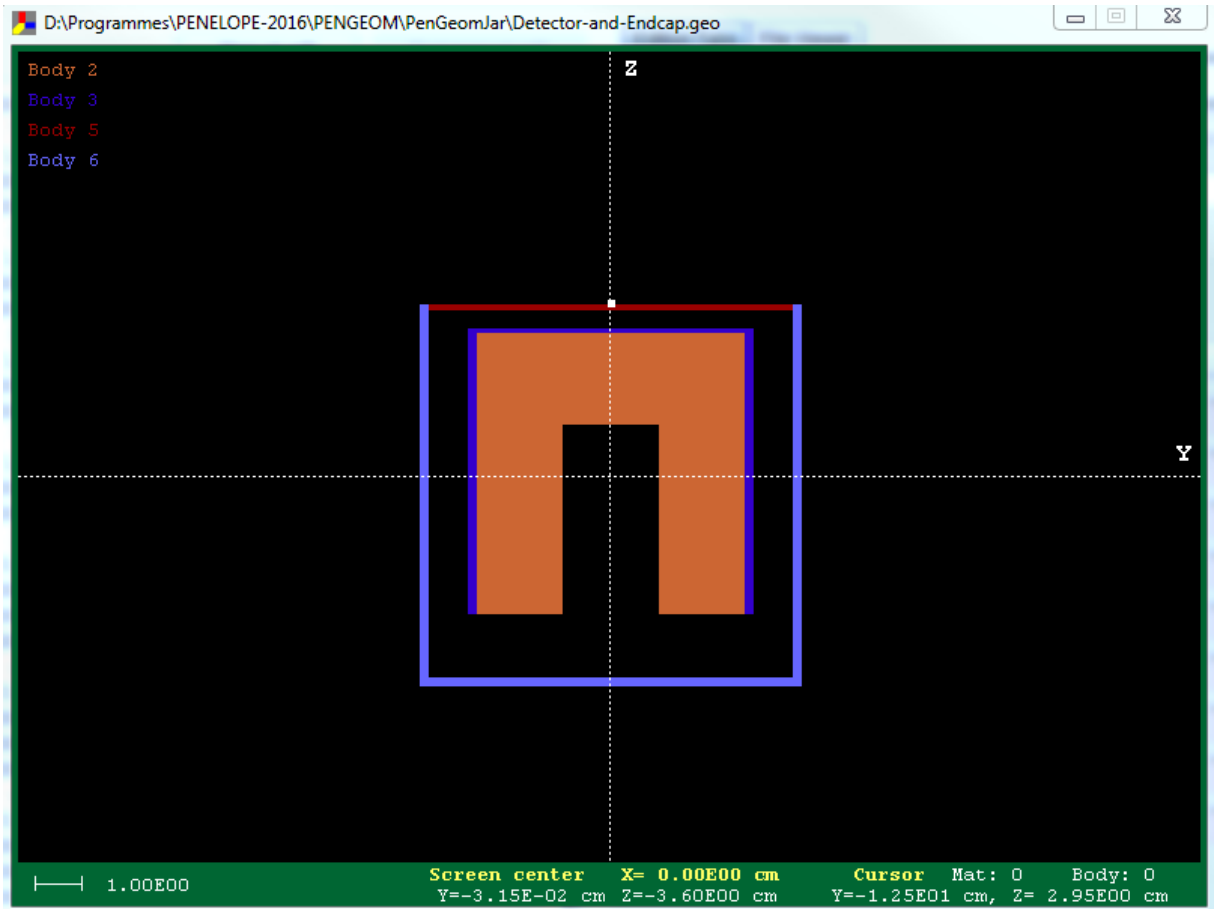
Detector-crystal:



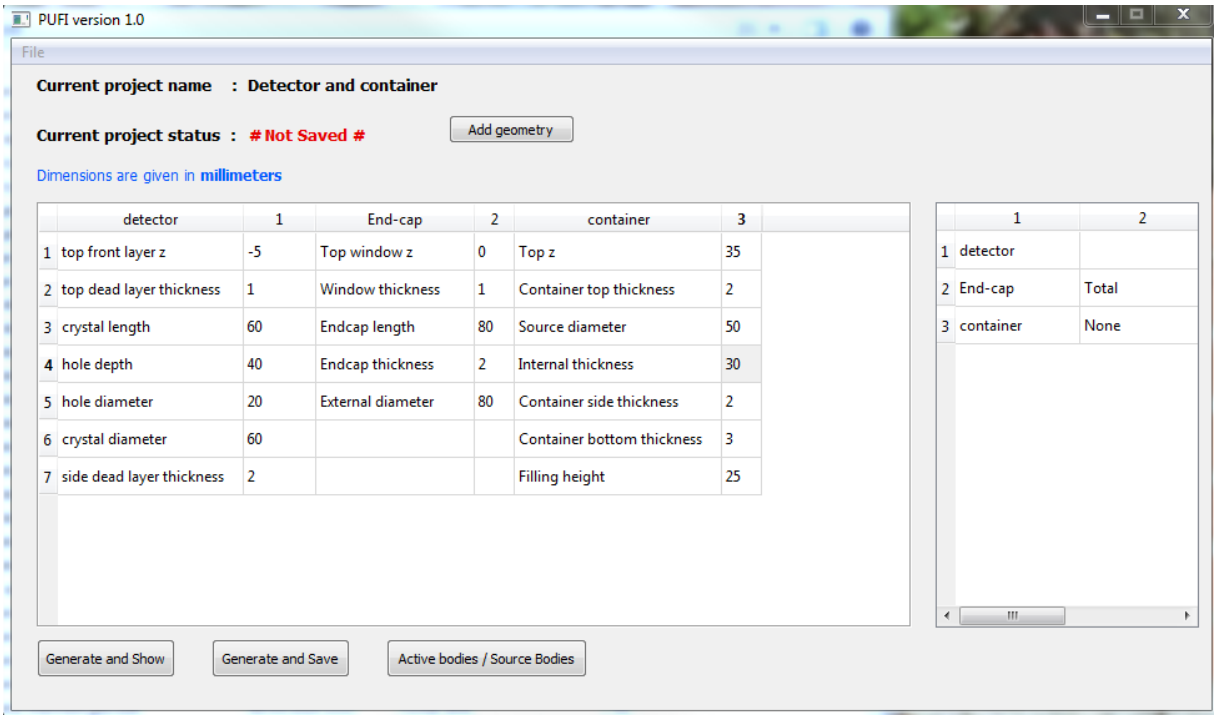


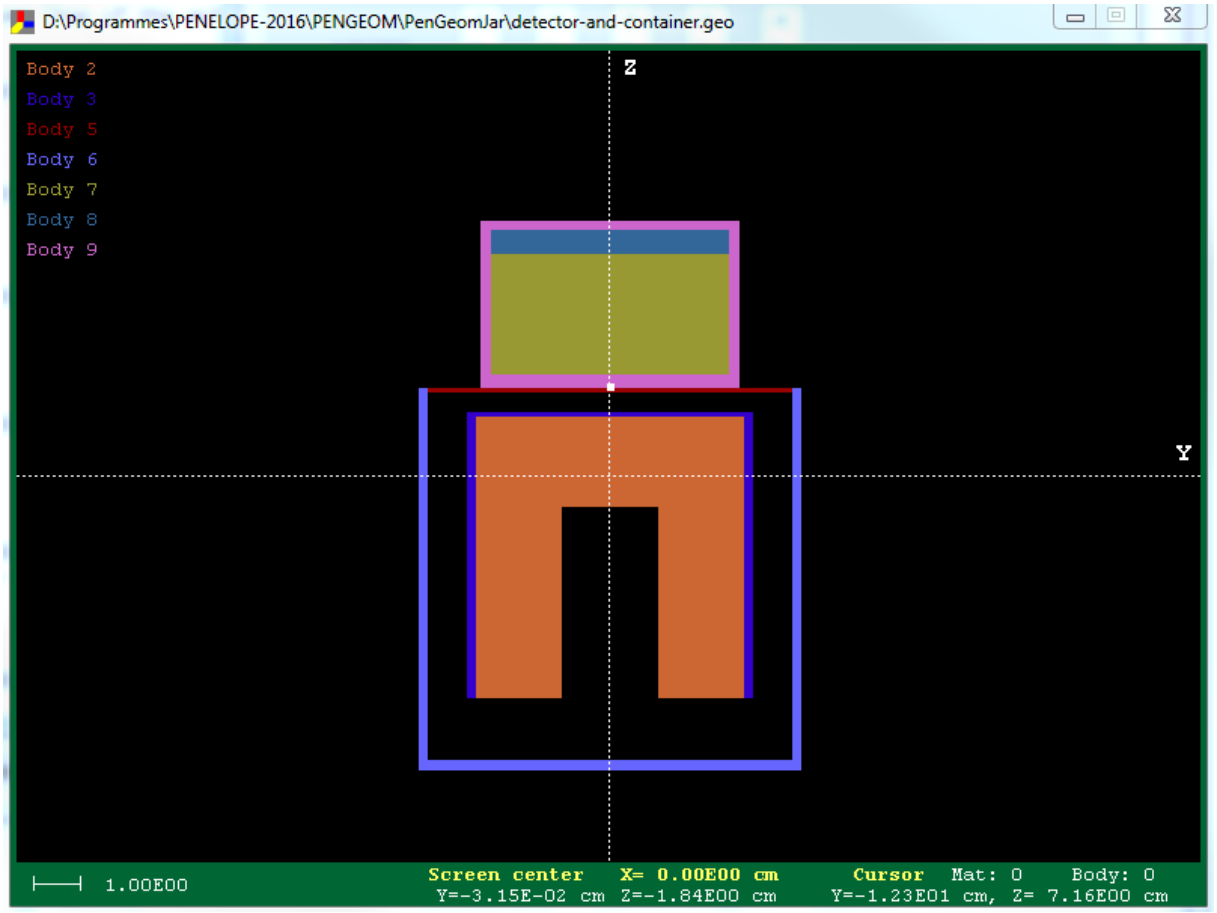
Detector and endcap:



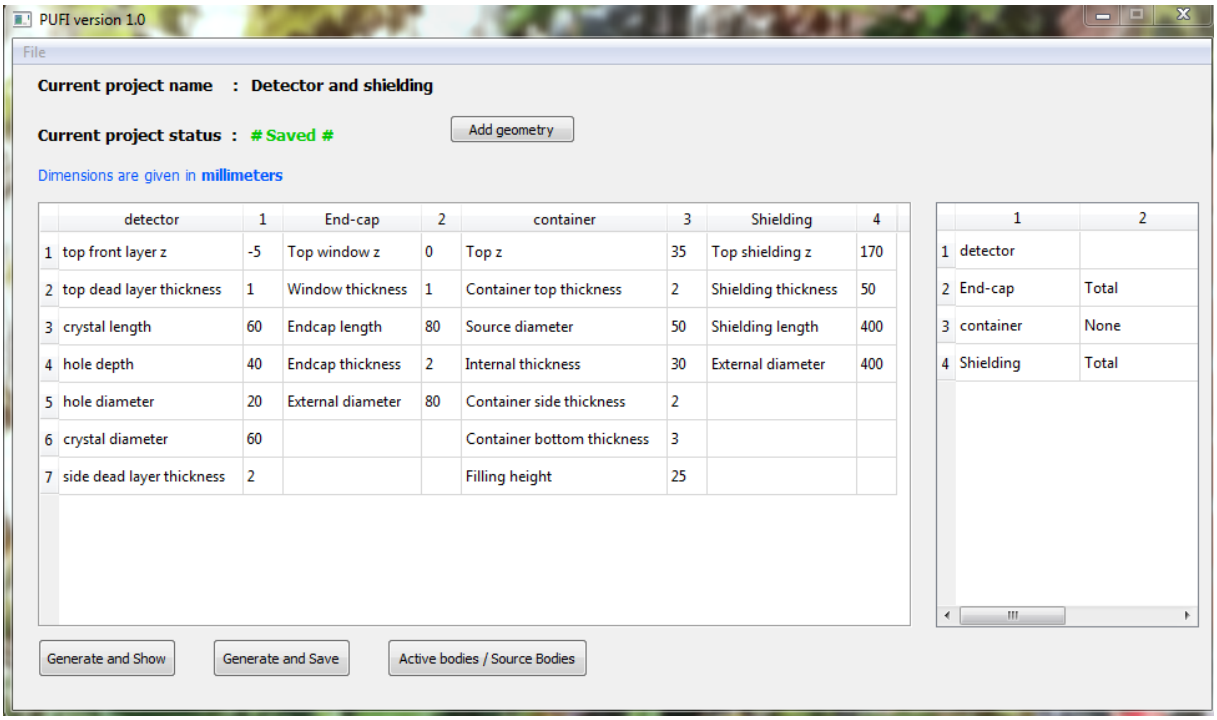


Detector and container:



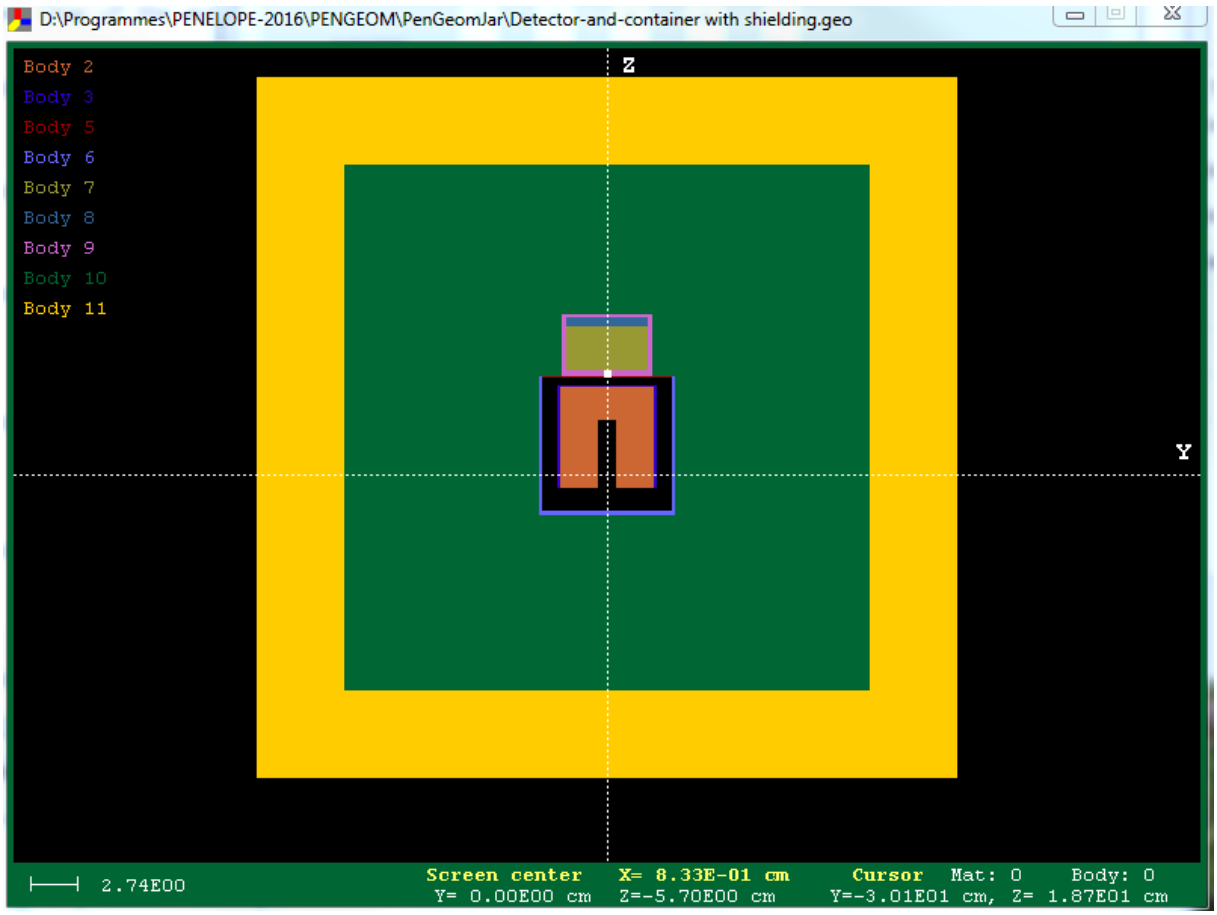


Detector and container with shielding:

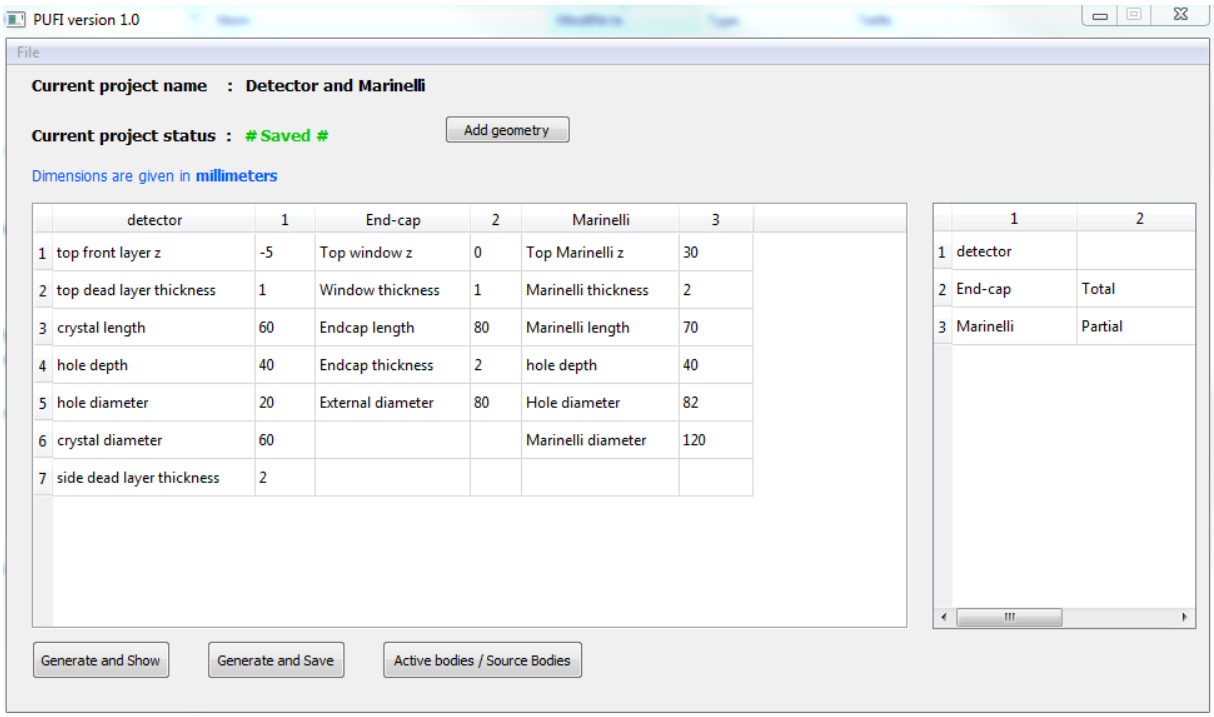


	detector	1	End-cap	2	container	3	Shielding	4
1	top front layer z	-5	Top window z	0	Top z	35	Top shielding z	170
2	top dead layer thickness	1	Window thickness	1	Container top thickness	2	Shielding thickness	50
3	crystal length	60	Endcap length	80	Source diameter	50	Shielding length	400
4	hole depth	40	Endcap thickness	2	Internal thickness	30	External diameter	400
5	hole diameter	20	External diameter	80	Container side thickness	2		
6	crystal diameter	60			Container bottom thickness	3		
7	side dead layer thickness	2			Filling height	25		

	1	2
1	detector	
2	End-cap	Total
3	container	None
4	Shielding	Total



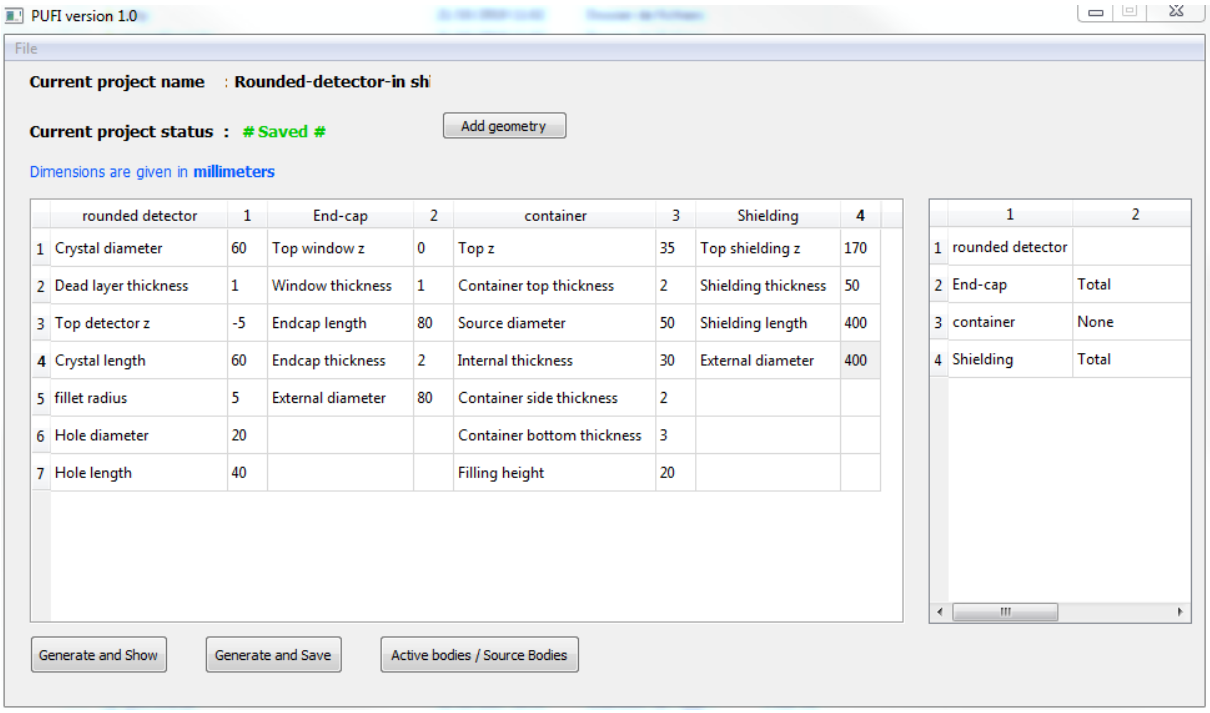
Detector and Marinelli:



	detector	1	End-cap	2	Marinelli	3
1	top front layer z	-5	Top window z	0	Top Marinelli z	30
2	top dead layer thickness	1	Window thickness	1	Marinelli thickness	2
3	crystal length	60	Endcap length	80	Marinelli length	70
4	hole depth	40	Endcap thickness	2	hole depth	40
5	hole diameter	20	External diameter	80	Hole diameter	82
6	crystal diameter	60			Marinelli diameter	120
7	side dead layer thickness	2				

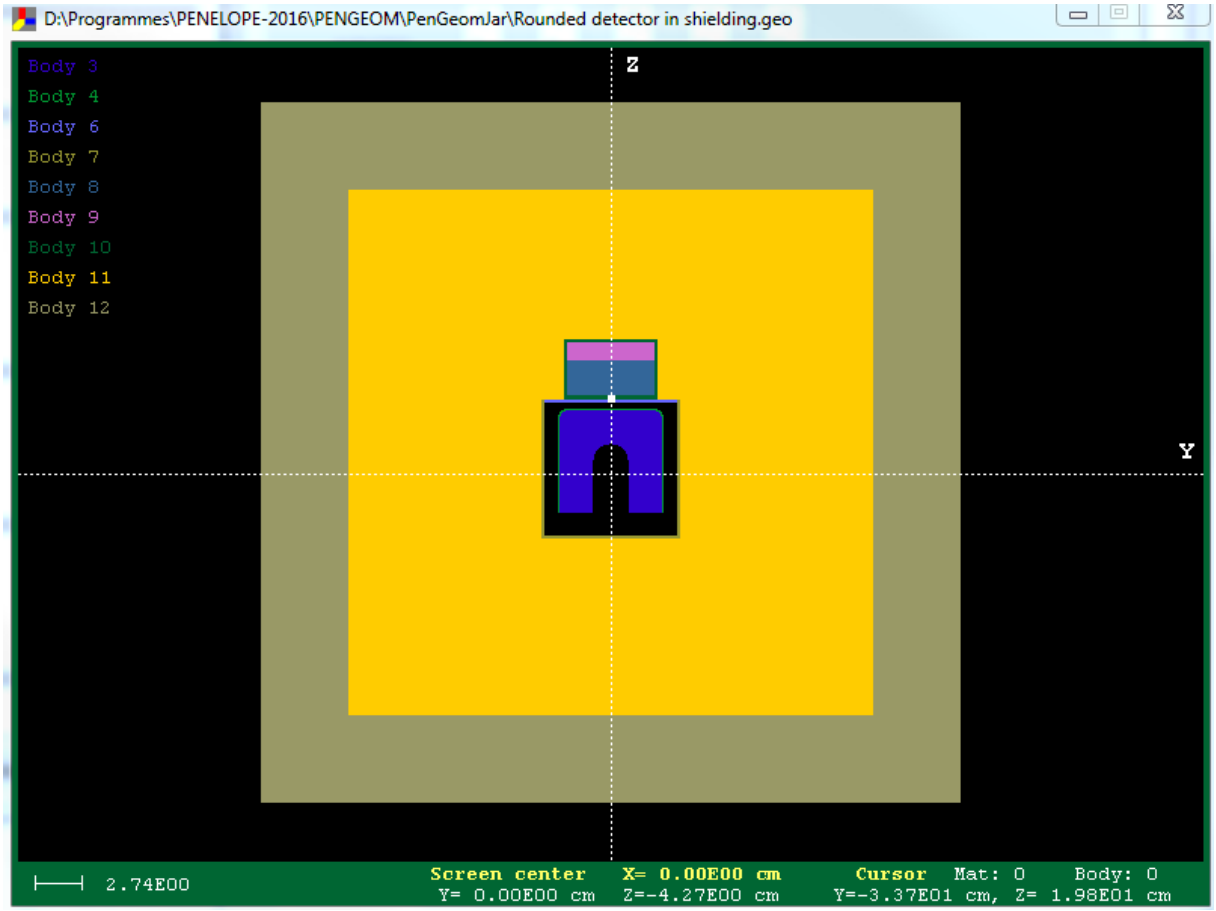
	1	2
1	detector	
2	End-cap	Total
3	Marinelli	Partial

Rounded detector in shielding:



	rounded detector	1	End-cap	2	container	3	Shielding	4
1	Crystal diameter	60	Top window z	0	Top z	35	Top shielding z	170
2	Dead layer thickness	1	Window thickness	1	Container top thickness	2	Shielding thickness	50
3	Top detector z	-5	Endcap length	80	Source diameter	50	Shielding length	400
4	Crystal length	60	Endcap thickness	2	Internal thickness	30	External diameter	400
5	fillet radius	5	External diameter	80	Container side thickness	2		
6	Hole diameter	20			Container bottom thickness	3		
7	Hole length	40			Filling height	20		

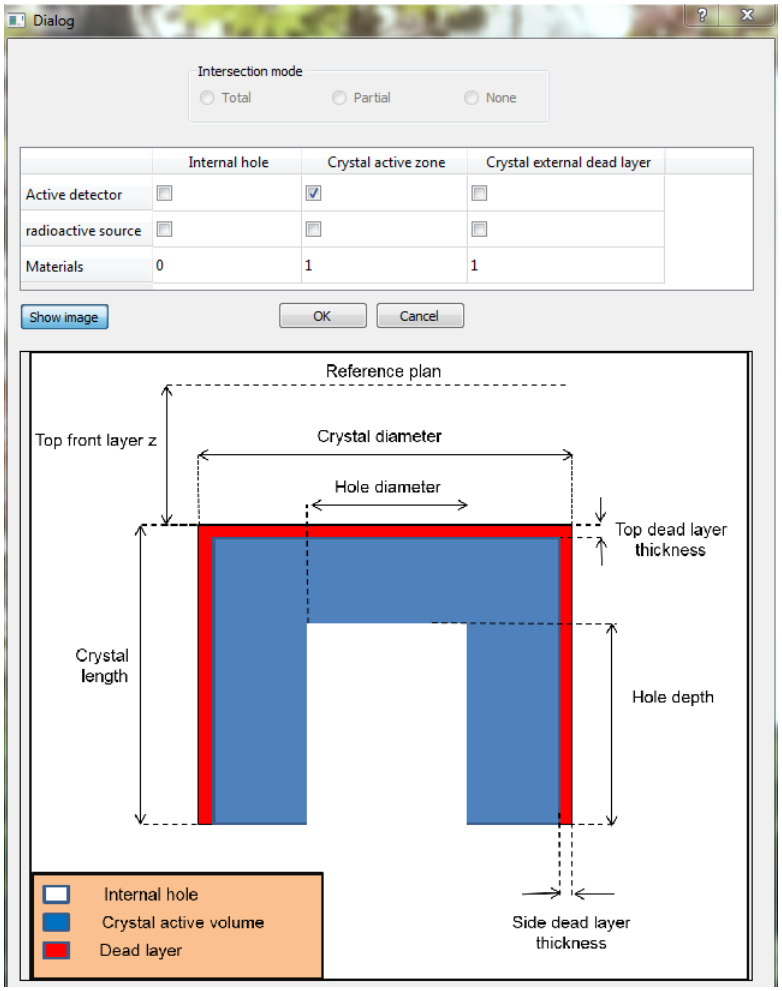
	1	2
1	rounded detector	
2	End-cap	Total
3	container	None
4	Shielding	Total



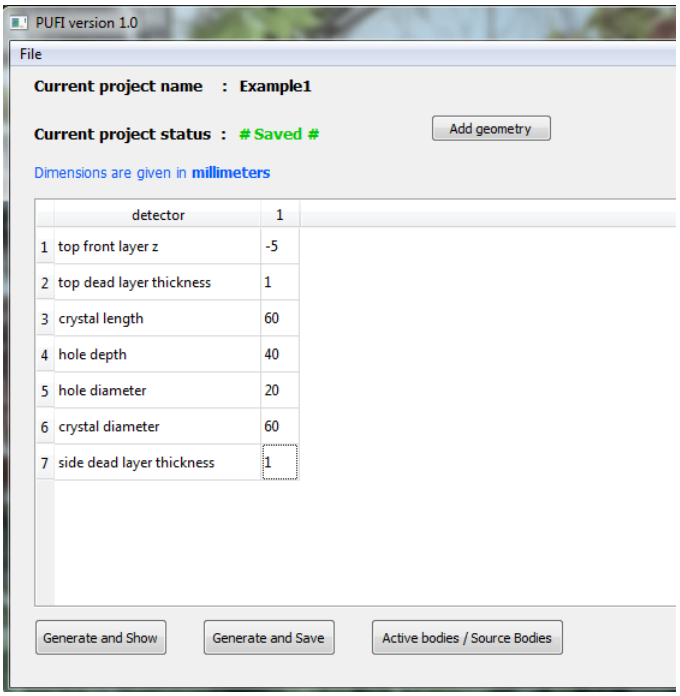
Annex: example

This annex presents successive steps to define a new project with a detection crystal and its end-cap (beryllium window and aluminum cap), a plastic container with radioactive material (liquid), all included in a lead shielding.

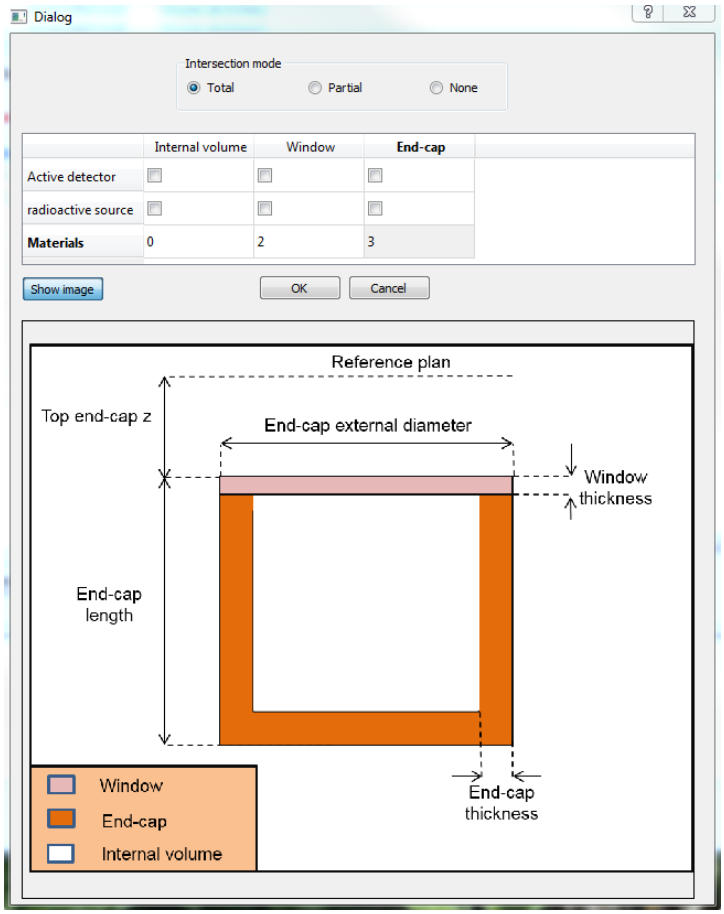
1. Detector: the active body (detector) is the crystal active zone; material numbered 1 (Ge) is defined for both the active crystal and the dead layer. The internal hole is filled with material 0 (vacuum).



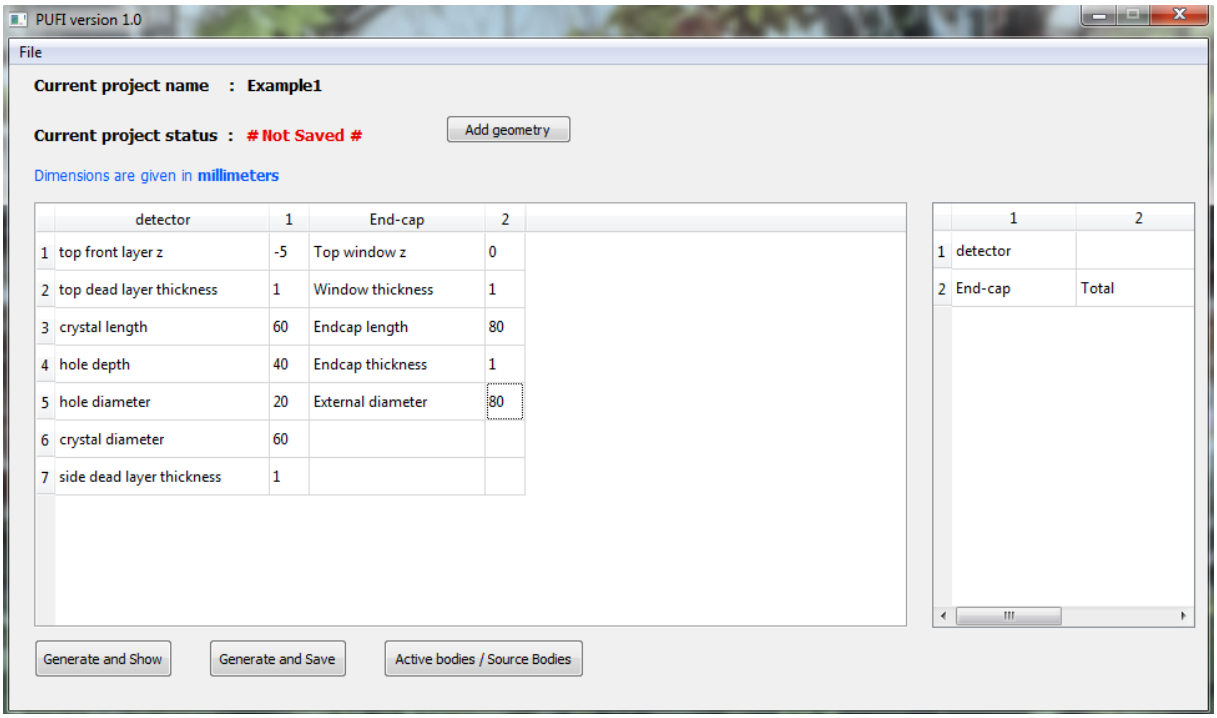
The reference plan is chosen at the top of the end-cap (detector window) and the crystal is situated 5 mm below it. The dimensions inputs are:



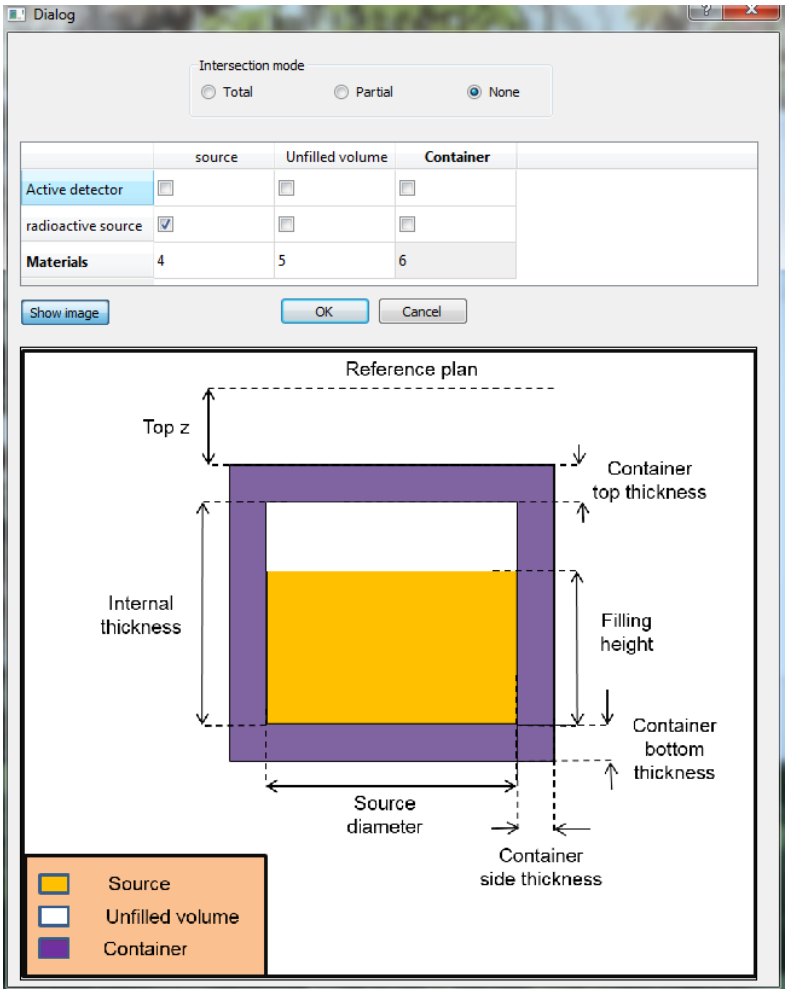
2. Detector end-cap: there is total intersection with the 1st element (the crystal is inside the cap). The internal housing is filled with material 0 (vacuum) and material 2 (Be) is defined for the window and material 3 (Al) is defined for the cylindrical cap.

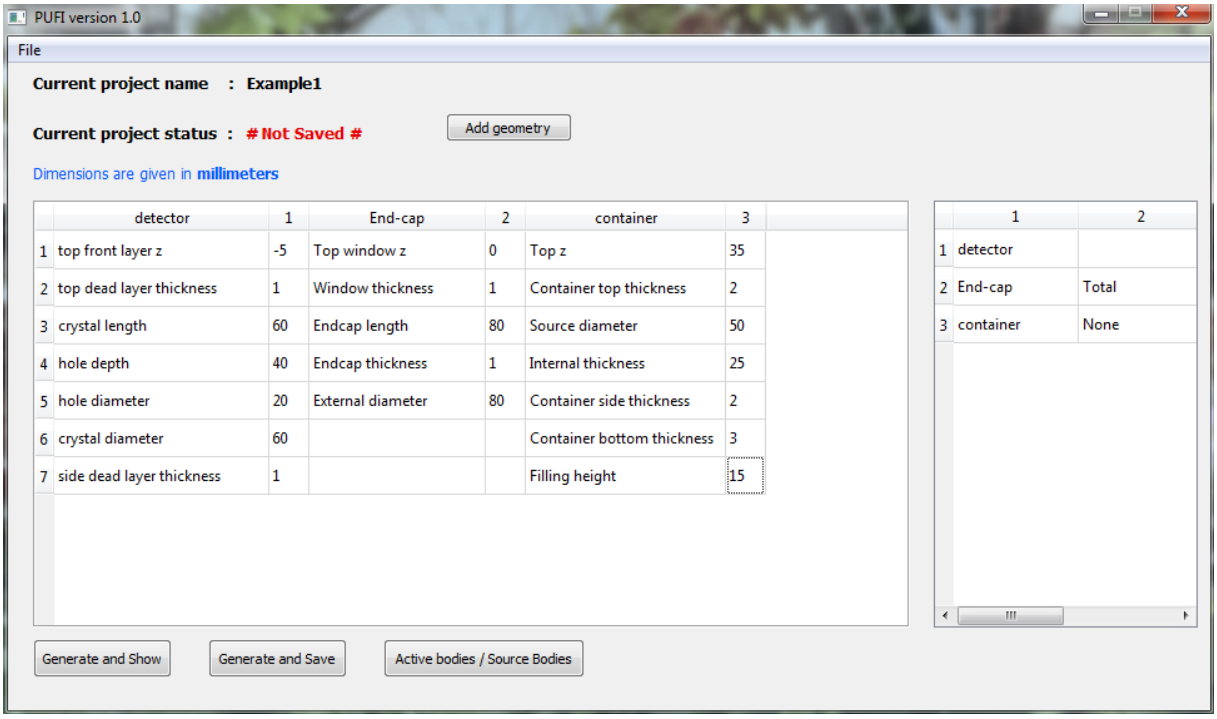


The external dimensions of the end-cap are 80 mm (length and diameter); the Be window thickness is 1 mm and the cylindrical end-cap is 1-mm thick:



3. Container: There is no intersection with the previous elements (the container is above the end cap). The radioactive source is the liquid and materials are numbered 4 (active material of the source, e.g. water), 5 (air on the upper part of the container) and 6 (container material, e.g. plastic).


Dialog
Intersection mode
Total
Partial
None
source
Unfilled volume
Container
Active detector
radioactive source
Materials
4
5
6
Show image
OK
Cancel
Reference plan
Top z
Container top thickness
Internal thickness
Filling height
Container bottom thickness
Source diameter
Container side thickness
Source
Unfilled volume
Container


PUFI version 1.0
File
Current project name : Example1
Current project status : # Not Saved #
Add geometry
Dimensions are given in millimeters
detector 1 End-cap 2 container 3
1 top front layer z -5 Top window z 0 Top z 35
2 top dead layer thickness 1 Window thickness 1 Container top thickness 2
3 crystal length 60 Endcap length 80 Source diameter 50
4 hole depth 40 Endcap thickness 1 Internal thickness 25
5 hole diameter 20 External diameter 80 Container side thickness 2
6 crystal diameter 60 Container bottom thickness 3
7 side dead layer thickness 1 Filling height 15
1 2
1 detector
2 End-cap Total
3 container None
Generate and Show
Generate and Save
Active bodies / Source Bodies

4. External shielding: As for the detector end-cap, there is full intersection with the previous elements (these are inside the external shielding). The internal housing is filled with air (already numbered 5) and the material 7 (e.g. Pb) is defined for the shielding.