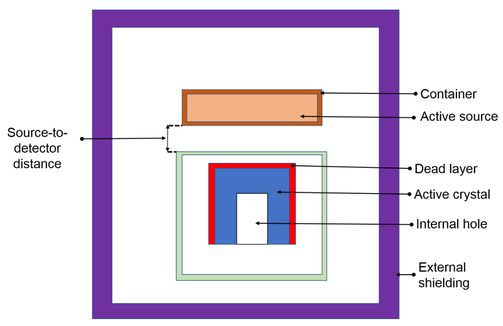
Abdellah WADJINNY, Marie-Christine LÉPY*
CEA, LIST, Laboratoire National Henri Becquerel, F-91191 Gif-sur-Yvette, France.

PUFI: A TOOL TO PREPARE GEOMETRY FILES FOR PENELOPE MONTE CARLO SIMULATION IN GAMMA-RAY SPECTROMETRY

Introduction

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.



The practical use of the Monte Carlo code PENELOPE requires the careful preparation of input geometry files to describe the experimental conditions.

The geometry is defined by a text file, which consists of a sequence of blocks describing the different elements according to a specific format.

First, limiting surfaces must be defined, then different “bodies” are described from the intersection of the pre-defined surfaces.

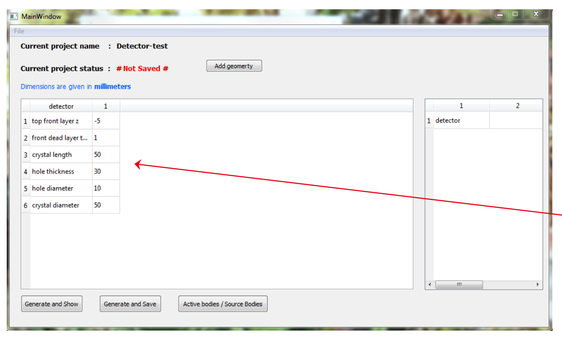
```
      >>>>>>>> Source definition.
SKPAR  2       [Primary particles: 1=electron, 2=photon, 3=positron]
SENERG 2.0E5                                  [Initial energy, in eV]
SPOSIT 0 0 2.1                      [Source position: X0,Y0,Z0 in cm]
SBOX   9.2 9.2 4.2
SBODY  6
SCONE  0 0 180                      [Beam direction: THETA,PHI in deg]

      .
      >>>>>>>> Material data and simulation parameters.
MFNAME Ge.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]
MFNAME Al.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]
MFNAME Water.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]
MFNAME Polyeth.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]
MFNAME Air.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]
MFNAME Pb.mat
MSIMPA 1.0e3 1.0e3 1.0e4 0.1 0.1 1e4 1e3    [EABS(1:3),C1,C2,WCC,WCR]

      .
      >>>>>>>> Geometry definition file.
GEOMFN AW.geo

      .
      >>>>>>>> Energy deposition detectors (up to 25).
ENDETC 5e3 5.5E5 550            [Energy window and number of channels]
EDBODY 2                          [Active body; one line for each body]

      .
      >>>>>>>> Job properties.
NSIMSH 1000000000          [Desired number of showers, max=2**31-1]
TIME   3000                          [Allotted simulation time, in sec]
RSEED  12345 54321                     [Random number generator seeds]
```

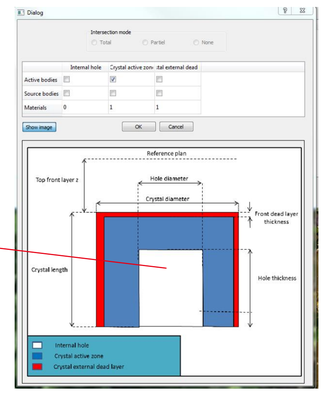
Example of input file to run PENELOPE

Practical use

PUFI is a standalone software written in Python.

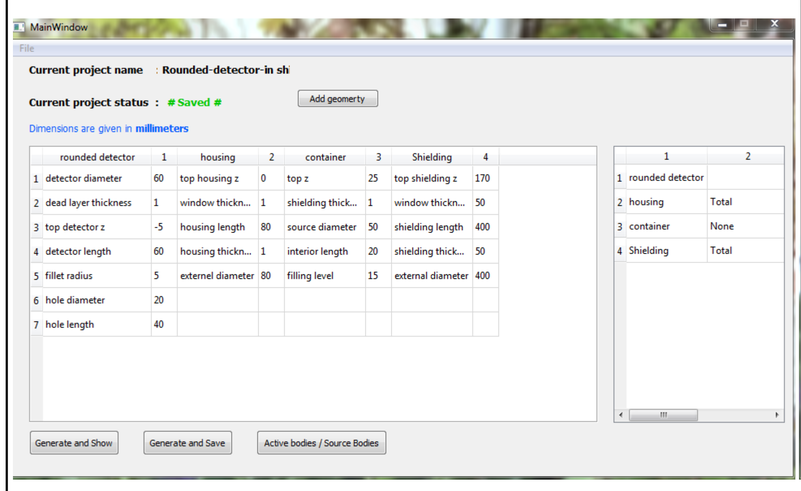
The main window allows a specific "project" (geometrical arrangement) to be prepared by selecting elemental geometries.



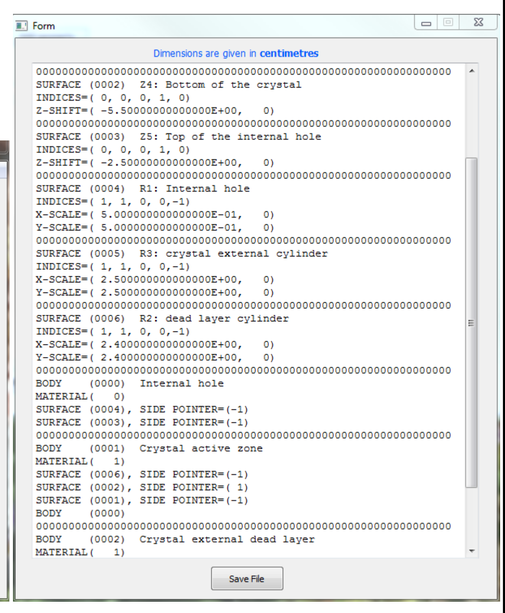


Elemental geometries:
- Cylinder
- Detector
- Rounded detector
- Cylindrical container
- Marinelli container

For each elemental geometry, only a few parameters are required



Example of project prepared with 4 elemental geometries



Example of generated geometry file for PENELOPE

Case of rounded detector

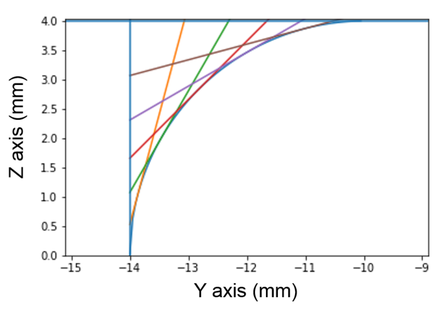
The rounded shape of the crystal upper part should be modeled as the intersection of a torus and a cylinder.

Torus equation: $\left(\sqrt{x^2+y^2}-R^2\right)^2+z^2=r^2$

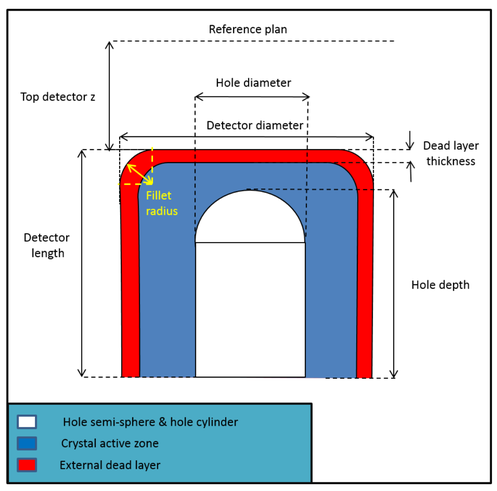
As this equation is not quadratic, it can not be directly modelled by PENELOPE.

PUFI performs an approximation to model the rounding using several cones that can be described by reduced quadrics.

Cone equation: $x^2+y^2-z^2=0$

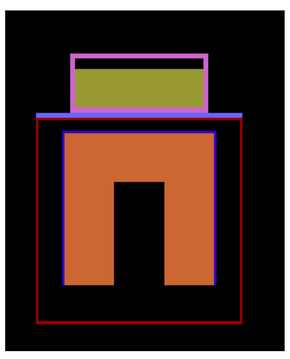


Approximation of a torus using the intersection of five cones and a cylinder (Projection on (y,z) plane)

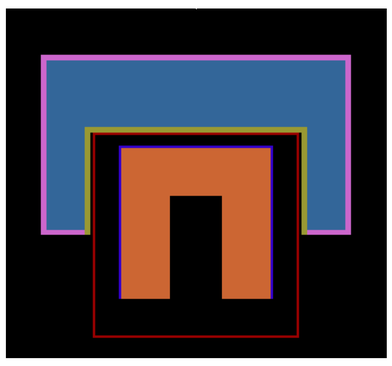


Examples

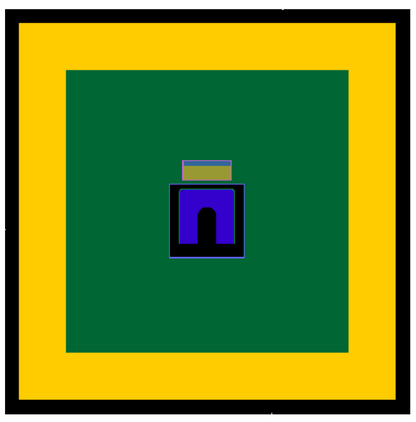
Different projects have been prepared:



Detector and cylindrical container



Detector and Marinelli container



Rounded detector and container in lead shielding

From these prepared geometries, it is very convenient to modify some dimensions directly in the main window to generate new cases.

This can be useful to test the influence of changing the dimensions of the source or the dead layer thickness, etc.

Conclusion and perspectives

PUFI is available on the LNHB website (http://www.lnhb.fr/icrm_gs_wg/icrm_gs_wg_information/), together with geometry example files and the user’s manual.

Some example geometries are taken from the ICRM GSWG Monte Carlo exercise (Lépy *et al.*, ICRM2019), and include two types of detectors and three types of volume sources. The cases of a Marinelli container and a volume source with an absorbing screen are also included.

As part of the increasingly frequent use of Monte Carlo simulation, PUFI brings a simple approach to optimize experimental conditions in gamma-ray spectrometry.

* Corresponding author: marie-christine.lepy@cea.fr

ICRM2019 Conference – 27-31 May 2019 – Salamanca