ICRM GSWG

Action to facilitate the use of Monte Carlo simulation software

Monte Carlo simulation in Gamma spectrometry

- Can be run on PCs
- Useful for
  - Efficiency calibration (with caution !)
  - Efficiency transfer
  - Coincidence summing corrections (Pennuc)

- Software:
  - Dedicated : GESPECOR, DETEFF, etc.
  - Generalist: PENELOPE, GEANT, MCNP, etc.

Difficulties for generalist codes : input of geometries with specific format

General aim of the action:

To facilitate the use of MC codes for newbies

Simplified geometries (HPGe N or P)

- Include volume samples
- Include external shielding

Prepare input files specific to some MC codes:

- EGS, GEANT4, GESPECOR, MCNP, PENELOPE

Calculate efficiency values to validate the use of the MC codes with the prepared geometries

Make examples available on the ICRM GSWG web page

Next step : more realistic geometries

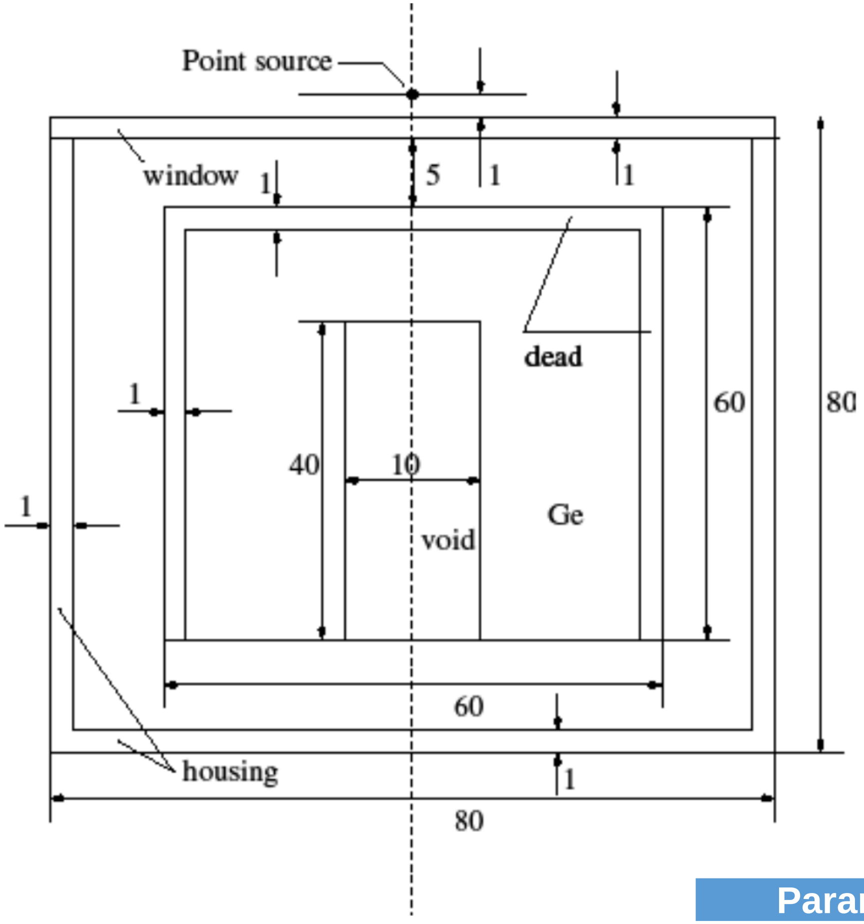
- Test for coincidence summing corrections ?

Test geometries

- (Tim Vidmar examples)

Parameter	Detector A	Detector B
Crystal material	Ge	Ge
Crystal diameter (including the side dead slayer)	60	60
Crystal length (including the top dead layer)	60	60
Dead layer thickness (top and side)	1	0
Hole diameter	10	10
Hole depth	40	40
Window diameter	80	80
Window thickness	1	1
Window material	Al	Al
Crystal-to-window distance	5	5
Housing length	80	80
Housing thickness	1	1
Housing material	Al	Al

Test geometries



Material	Density	Chemical formula
Ge	5.323	Ge
Al	2.70	Al
Water	1.0	H_2O
Dirt	1.4	SiO_2
Cellulose	0.3	$C_6H_{11}O_5$

Parameter	Water	Point	Soil	Filter
Sample diameter	90	-	60	80
Sample thickness	40	-	20	3
Sample material	Water	-	Dirt	Cellulose
Sample-to-window distance	1.0	1.0	1.0	1.0

Status

- 19 people using 4 generalist codes and 1 dedicated software.
- Direct exchanges between participants on the input files for each code strongly encouraged.
- 8 geometries/input files

- FEP and TE calculations for E=50, 100, 200, 500, 1000 keV

Name	Detector	Source
AP	A	Point
AW	A	Water
AS	A	Soil
AF	A	Filter
BP	B	Point
BW	B	Water
BS	B	Soil
BF	B	Filter

Information from Iason K. Mitsios
M.Eng., PhD Student
Nuclear Engineering Department
National Technical University of Athens

I performed the simulations for the AF and BF geometry files, for the energy of 50 keV, using the correct Cellulose formula ($C_6H_{10}O_5$), and the results compared to the results

we reported are:

$C_6H_{11}O_5$ (reported)				$C_6H_{10}O_5$			
AF - 50 keV		BF - 50 keV		AF - 50 keV		BF - 50 keV	
FEP	UNC(FEP)	FEP	UNC(FEP)	FEP	UNC(FEP)	FEP	UNC(FEP)
0.0127	0.16%	0.1777	0.07%	0.0126	0.11%	0.1779	0.03%

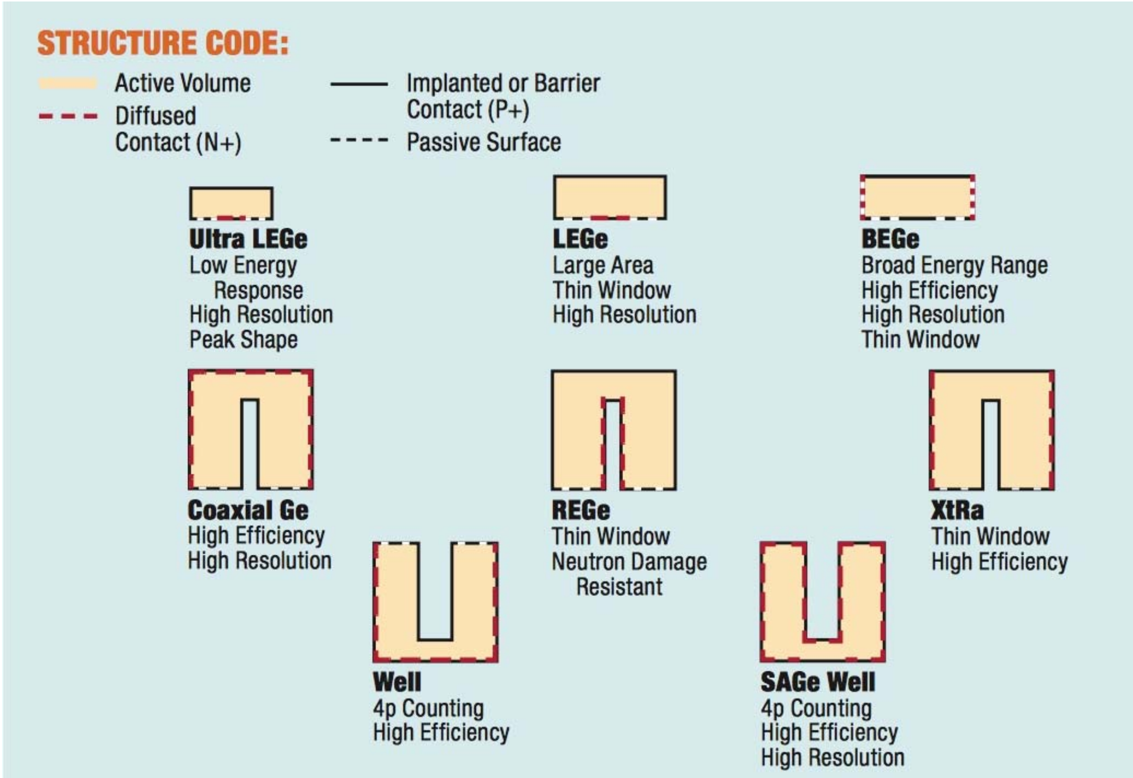
Example PENELOPE

1. Define surfaces
2. Define « bodys » as the intersection of pre-defined surfaces
3. Specific format

```
SURFACE (  89)  Plane Z=-34.45 bas cellule Cu (interieur) ****
INDICES=( 0, 0, 0, 1, 1)
Z-SCALE=( 3.445000000000000E+01,   0)
0000000000000000000000000000000000000000000000000000000000000000
SURFACE (  90)  Plans avant-arrere interieur cellule Cu    X= 24   ****
INDICES=( 1, 0, 0, 0,-1)
X-SCALE=( 2.400000000000000E+01,   0)
0000000000000000000000000000000000000000000000000000000000000000
SURFACE (  91)  Plans cotes interieur cellule Cu    Y= 24  ****
INDICES=( 0, 1, 0, 0,-1)
Y-SCALE=( 2.400000000000000E+01,   0)
0000000000000000000000000000000000000000000000000000000000000000
C
BODY    (   1)  Canne Cuivre (haut)
MATERIAL(   4)
SURFACE (  32), SIDE POINTER=(-1)
SURFACE (  33), SIDE POINTER=(-1)
SURFACE (  34), SIDE POINTER=(+1)
```

Define « standard » HPGe detectors

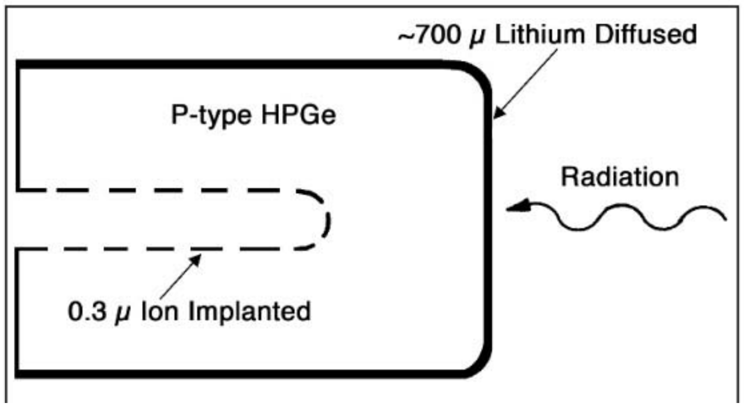
Coaxial – P and N types, Planar, BEGe, well-type



Some typical detectors:

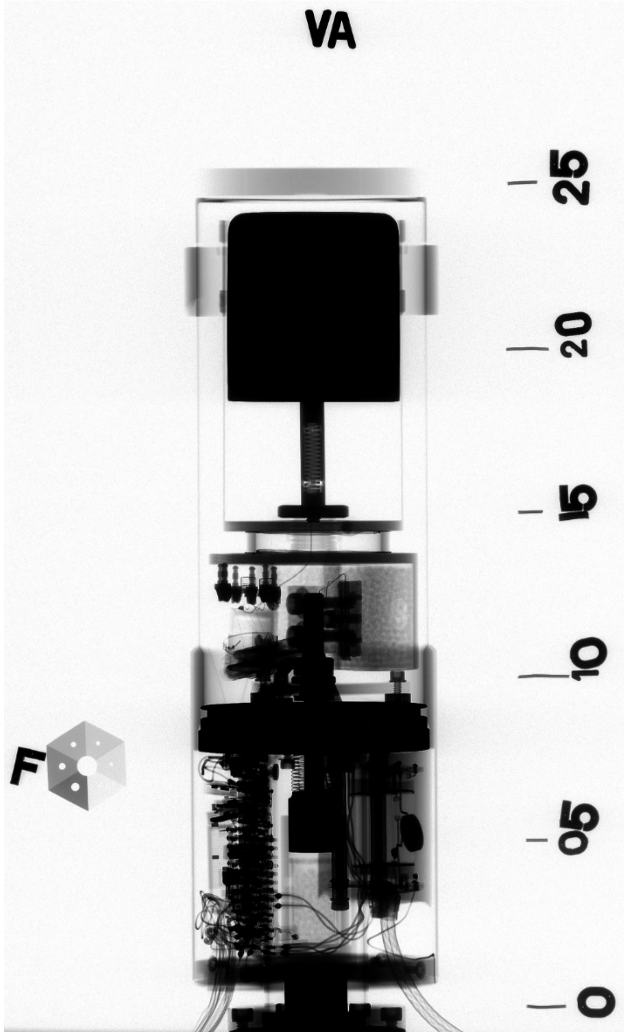
1st approximation: cylinders….

More realistic:
Rounding should be included



If a radiograph is available:

More information and details on the crystal position, hole dimensions, structure of the
crystal holder, etc.



Possible steps:

1. Interest of participants: what kind of detectors and samples geometries, MC codes, etc.
2. Enquiry and tests on freely available 3D/CAD codes
3. Selection of detector geometries
4. Design of one simple detector using the selected CAD code
5. Prepare exportation tools for MC codes
6. Use MC codes with these models to compute:
    - Full-energy peak and total efficiencies for point source
    - Coincidence summing for some typical radionuclides

7. Repeat steps 4 and 6 for more complex models

Specific working meeting in the frame of a GSWG meeting on mid-2018 ?