



International Committee for Radionuclide Metrology (ICRM)  
Gamma-Ray Spectrometry Working Group (GSWG)

# GE . SPE . COR

## used in ICRM-GSWG actions

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# GESPECOR

based on the methods developed by: O. Sima, D. Arnold, C. Dovlete

- Self-Attenuation Corrections

- factors useful for computing the detection efficiency for a sample with a given matrix and density on the basis of the efficiency measured with a calibration source of a different matrix and density

The screenshot displays the 'SELF-ATTENUATION COMPUTATIONS' dialog box within the GESPECOR application. The interface is organized into several sections:

- Detector:** Selected: GEM60P4.det; Available: Det\_test\_ISOCART, DT00.DET, GEM60P4.det.
- Geometry:** Selected: Vol88.geo; Available: Vol86.geo, Vol87.geo, Vol88.geo.
- SOURCE MATRIX:** Selected: AL.MAT; Density: 2.7; Available: AIR.MAT, AL.MAT, BE.MAT.
- SHIELD:** Selected: GEMSh.shi; Available: BigSh.shi, GEMSh.shi, ICRM.shi.

The 'CALCULATION:' section is set to 'Single set'. The 'Matrix of calibration source' section shows 'Selected: AIR.MAT' and 'Density: 0.0012'. The 'Energy List File' section shows 'Selected: EN00.ENE' and a list of available files: EN00.ENE, En001.ene, En01.ene.

Buttons at the bottom include 'Start Calculation', 'View Selected Self-Att. Corrections', and 'View Lin. Att. Coeff. for actual sample'. A status bar at the bottom indicates: 'New Calculation: STANDARD, matrix data in the file AL.MAT'.

- Coincidence-Summing Corrections

- procedures applied to obtain the efficiency specific to a given peak of a nuclide with coincidence-summing problems on the basis of the common calibration curve

The screenshot displays the GESPECOR software interface, specifically the 'COINCIDENCE-SUMMING CORRECTIONS AND EFFICIENCY' dialog box. The interface is organized into several sections:

- Detector File:** GEM60P4.det
- Geometry File:** Vol88.geo
- Material File for the Matrix of the Sample:** Dirt.mat
- Density (g/cm<sup>3</sup>):** 1.4
- Shield File:** GEMSh.shi
- Output files:** Selected: P488Dirt.sco; Available: \_17)AIR.dsc, \_17)AIR.eff, \_17)AIR.sco
- Decay Data Files:** Selected: CO1332.ded; Available: BA356.ded, CO1173.ded, CO1332.ded
- Batch Calculations:** Current: BA276.ded; Included: BA276.ded, BA356.ded, CO1173.ded
- CALCULATION:** Single set (selected) and Multiple sets
- DETECTOR:** Selected: GEM60P4.det; Available: Det\_test\_ISOCAR1, DT00.DET, GEM60P4.det
- GEOOMETRY:** Selected: Vol88.geo; Available: Vol86.geo, Vol87.geo, Vol88.geo
- SOURCE MATRIX:** Selected: Dirt.mat; Available: Dirt.mat, Dirt4.mat, Ge.mat; Density: 1.4
- SHIELD:** Selected: GEMSh.shi; Available: BigSh.shi, GEMSh.shi, ICRM.shi

At the bottom, there are three buttons: 'Start Calculation', 'View Selected Output of Computations', and 'View Details of Last Computations'. Below these buttons, it indicates 'Next Calculation: Standard Monte Carlo'.

The right side of the interface shows a file browser for 'View File from Directory:' with the following contents:

- C:\
- Program Files (x86)
- Gespecor42
- GESPECOR
- bin

The 'File:' field shows the following files:

- amass.ges
- defa.ini
- ENLOG.GES
- etmtca.out

- Efficiency computation

- procedures applied for direct computation of the full energy peak efficiency and of the total efficiency
- Efficiency evaluation based on the method of efficiency transfer from a reference measurement (detector, geometry, sample matrix, shield) to another measurement

The screenshot shows the GESPECOR software interface. The main window is titled "COINCIDENCE-SUMMING CORRECTIONS AND EFFICIENCY" and has a menu bar with options: TUTORIAL, DETECTOR, GEOMETRY, SHIELD, MATERIAL, ATTENUATION, COINCIDENCE, TRANSFER FACT., EFFICIENCY, OPTIONS, INFO, EXIT. The interface is divided into several sections:

- Input Parameters:**
  - Detector File= GEM60P4.det
  - Geometry File= Vol87.geo
  - Material File for the Matrix of the Sample= Dirt.mat
  - Density (g/cm<sup>3</sup>)= 1.4
  - Shield File= GEMSh.shi
- Energy list files:**
  - Selected: EN00.ENE
  - Available: EN00.ENE, En001.ene, En01.ene
  - Buttons: New, View
- Batch Calculations:**
  - Current: EN00.ENE
  - Included: EN00.ENE
  - Buttons: Add, Rmv., Clear All, Sv. Btch, Btch In
- Output files:**
  - Selected: P487Dirt.eff
  - Available: \_17)AIR.dsc, \_17)AIR.eff, \_17)AIR.sco
  - Buttons: Next Calc.
- Calculation Options:**
  - Single set (selected)
  - Multiple sets
- DETECTOR:**
  - Selected: GEM60P4.det
  - Available: Det\_test\_ISOCART, DT00.DET, GEM60P4.det
- GEOMETRY:**
  - Selected: Vol87.geo
  - Available: Vol86.geo, Vol87.geo, Vol88.geo
- SOURCE MATRIX:**
  - Selected: Dirt.mat
  - Density: 1.4
  - Available: Dirt.mat, Dirt4.mat, Ge.mat
- SHIELD:**
  - Selected: GEMSh.shi
  - Available: BigSh.shi, GEMSh.shi, ICRM.shi
- View File from Directory:**
  - Path: C:\Program Files (x86)\Gespecor42\GESPECOR\bin
  - Files: amass.ges, defa.ini, ENLOG.GES, etmtca.out

At the bottom of the main window, there are three buttons: "Start Calculation", "View Selected Output of Computations", and "View Details of Last Computations". Below these buttons, it says "Next Calculation: Peak Efficiency without summing".

# GESPECOR software used in two ICRM on-going actions

- Action 1: Simple exercise on self-consistency of the methods applied for the evaluation of coincidence summing corrections in the case of volume sources

Coordination: Mr. Octavian Sima

- Action 2: Action to facilitate the use of Monte Carlo simulation software

Coordination: Ms. Marie-Christine Lépy

## Action 1

# Evaluation of the coincidence summing corrections in the case of volume sources

## The detector file

The screenshot displays the HPGe Detector software interface, divided into two main windows: 'DETECTOR FILE' and 'HPGe Detector'.

**DETECTOR FILE Window:**

- Detector type:** HPGe (selected), Well.
- Crystal radius (cm):** 3.000
- Crystal length (cm):** 6.000
- Inner contact:**
  - Radius (cm):** 0.500
  - Length (cm):** 4.000
- Thickness of dead layer (cm):**
  - Active face:** 0.00000
  - Side face:** 0.00000
- Distance from active face to entrance window:** 0.500
- Selected files:** ICRM\_OSima.det, ICRM\_DetA.det, ICRM\_DetB.det, ICRM\_OSima.det, ISOCART.det.
- Detector holder:**
  - Face thickness:** 0.00000
  - Side thickness:** 0.00000
  - Density (g/cm<sup>3</sup>):** 2.70000E+00
  - Material file:** AL.mat
- End cap:**
  - End cap diam. (cm):** 8.00
  - Window thickn. (cm):** 0.10000
  - Density (g/cm<sup>3</sup>):** 2.70000E+00
  - Material file:** AL.mat
- End cap side:**
  - Side thickness (cm):** 0.10000
  - Density (g/cm<sup>3</sup>):** 2.70000E+00
  - Material file:** AL.mat

**HPGe Detector Window:**

Shows a schematic diagram of the detector geometry. It features a central blue rectangular region representing the active volume, surrounded by a green ring representing the dead layer. This is further enclosed by a yellow ring representing the detector holder, and an outer blue square representing the end cap. A vertical dashed line indicates the central axis of the detector.

## Action 1

# Evaluation of the coincidence summing corrections in the case of volume sources

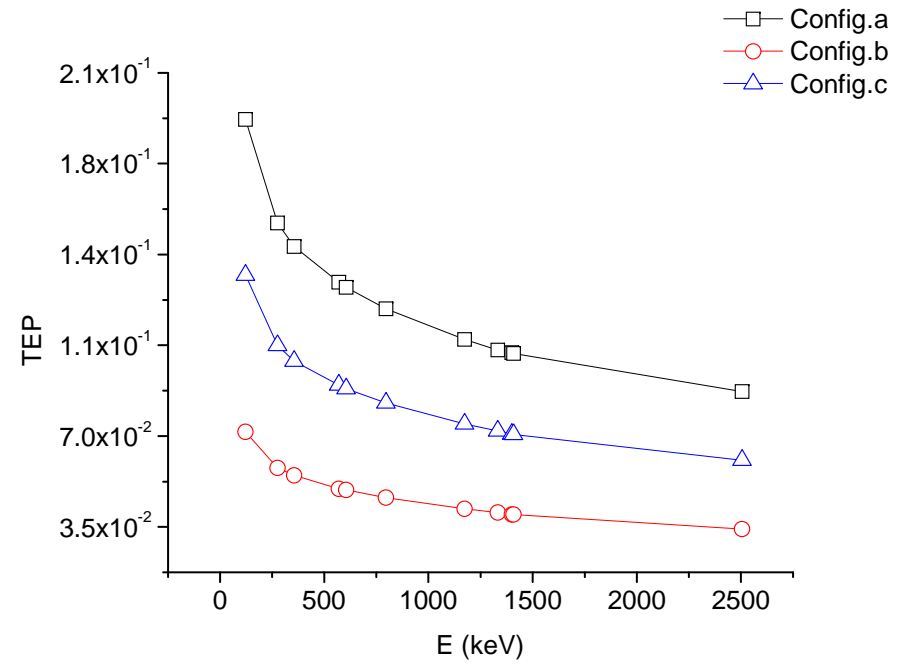
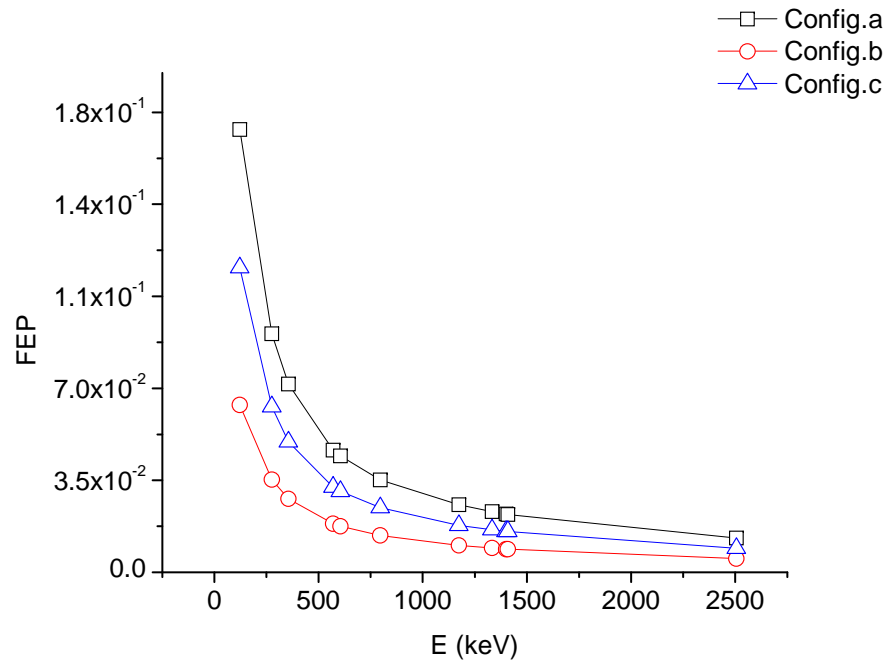
## The geometry file

The image displays three screenshots of the GEOMETRY FILE software interface, showing different source configurations. Each window has a yellow background and a blue title bar. The first window shows the 'Sample geometry type' set to 'Cylinder' and 'Marinelli'. The 'Sample radius (cm)' is 2.000 and 'Sample height (cm)' is 2.500. The 'Container walls thickness=' is 0.000. The 'Material file' is 'AIR.mat' and the 'Density (g/cm<sup>3</sup>)=' is 1.20000E-03. The 'Selected:' file is 'ICRM\_S1.geo'. The 'Available files:' list includes ICRM\_S1.geo, ICRM\_S2.geo, ICRM\_S3.geo, insitu4B.geo, LMR\_Filter.geo, LMR\_Pct-ICRM.geo, LMR\_Soil.geo, and LMR\_Water.geo. The 'View' button is visible. The second window shows the 'Sample radius (cm)' as 2.000 and 'Sample height (cm)' as 2.500. The 'Selected:' file is 'ICRM\_S2.geo'. The 'Available files:' list is the same. The 'View' button is visible. The third window shows the 'Sample radius (cm)' as 2.000 and 'Sample height (cm)' as 5.000. The 'Selected:' file is 'ICRM\_S3.geo'. The 'Available files:' list is the same. The 'View' button is visible. A fourth window, titled 'HPGe Detector- Cylindric Source', shows a 3D schematic of the detector geometry. It features a central green cylinder (source) inside a blue rectangular container, with a dashed vertical line representing the detector's axis.

Each configuration is placed in air and there are no other materials in the vicinity of the detector and sources.

# Action 1

## Full and total energy peak efficiency



Uncertainties  $< 0.6\%$ ,  $k=1$



## Action 1

# Coincidence-summing correction factor

FC is a measure of the coincidence-summing effects

Nuclide	E (keV)	Config.a		Config.b		Config.c	
		FC	UNC(FC)	FC	UNC(FC)	FC	UNC(FC)
Co-60	1173.23	8.87E-01	2.30E-01	9.58E-01	2.00E-01	9.06E-01	2.20E-01
Co-60	1332.49	8.81E-01	2.30E-01	9.56E-01	3.30E-01	9.02E-01	3.30E-01
<b>Co-60</b>	<b>2505.75</b>	<b>5.20E-02</b>	<b>2.80E-01</b>	<b>1.92E-02</b>	<b>6.50E-01</b>	<b>4.19E-02</b>	<b>4.10E-01</b>
Cs-134	569.33	7.48E-01	1.80E-01	9.02E-01	2.20E-01	7.91E-01	3.10E-01
Cs-134	604.72	8.38E-01	2.70E-01	9.40E-01	1.70E-01	8.66E-01	2.20E-01
Cs-134	795.86	8.36E-01	1.20E-01	9.39E-01	3.30E-01	8.66E-01	3.10E-01
<b>Cs-134</b>	<b>1400.59</b>	<b>6.62E-02</b>	<b>2.10E-01</b>	<b>2.55E-02</b>	<b>2.80E-01</b>	<b>5.40E-02</b>	<b>3.40E-01</b>
Ba-133	276.4	6.31E-01	1.30E-01	8.48E-01	1.80E-01	6.93E-01	1.80E-01
Ba-133	356.01	7.54E-01	2.20E-01	9.04E-01	2.70E-01	7.97E-01	2.20E-01
Eu-152	121.78	7.21E-01	6.00E-02	8.90E-01	9.20E-02	7.67E-01	1.30E-01
Eu-152	1408.01	7.15E-01	2.50E-01	8.92E-01	3.80E-01	7.66E-01	2.00E-01

For normal peaks FC it is

- equal to 1 if the effects are absent,
- <1 if the coincidence losses from the peak are prevailing,
- >1 if coincidence summing up in the peak is the dominating factor.

## Action 1

### The coincidence-summing effects

- depend on the probability with which other radiations are emitted simultaneously with the gamma radiation for which the effects are computed.

❖ **Example!** The sum peak of  $^{134}\text{Cs}$  at 1400 keV is due to the simultaneous detection in the peak of the 604 keV and 796 keV photons, that are emitted together with the probability of 0.8547 per photon

### KORDATEN.ALL

- library included in GESPECOR and contain 225 nuclides encountered most frequently in gamma-ray spectrometry

## Action 2

Action to facilitate the use of Monte Carlo simulation software

The detector file

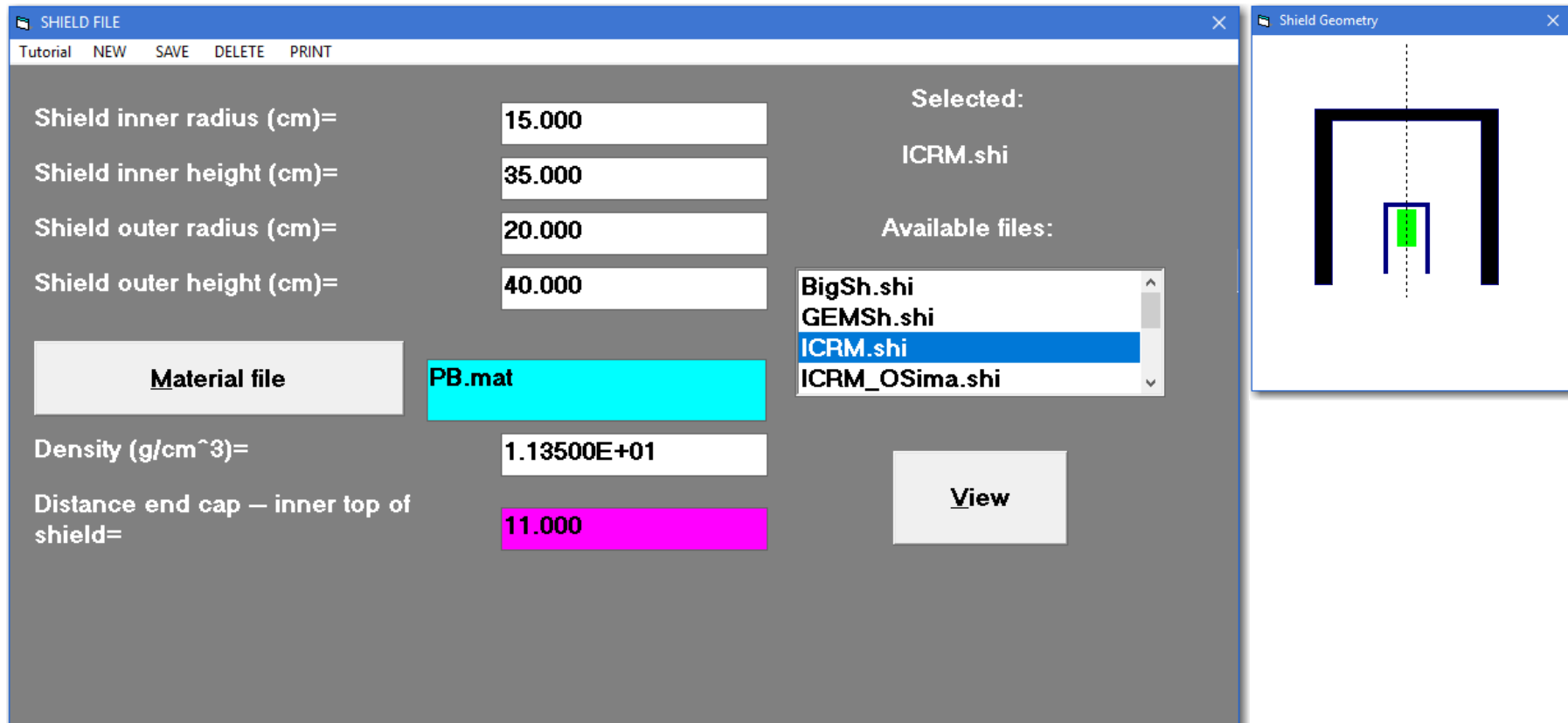
The image displays the DETECTOR FILE software interface, which is used for configuring Monte Carlo simulation software. The interface is divided into several sections:

- Detector Selection:** A dropdown menu shows "ICRM\_DetA.det" and "ICRM\_DetB.det" as available files. The "Selected:" field shows "ICRM\_DetA.det".
- Detector Parameters:** A form with various input fields for detector specifications. The "Detector" type is set to "HPGe" and "Well".
- Crystal Dimensions:** Fields for "Crystal radius (cm)" (2.900) and "Crystal length (cm)" (5.900).
- Inner Contact:** Fields for "Radius (cm)" (0.500) and "Length (cm)" (4.000).
- Thickness of dead layer (cm):** Fields for "Active face=" (0.10000) and "Side face=" (0.10000).
- Distance from active face to entrance window:** Field set to 0.500.
- End cap:** Fields for "End cap diam. (cm)=" (8.00), "Window thickn.(cm)=" (0.10000), and "Density (g/cm<sup>3</sup>)=" (2.70000E+00).
- End cap side:** Fields for "Side thickness (cm)=" (0.10000) and "Density (g/cm<sup>3</sup>)=" (2.70000E+00).
- Material file:** A dropdown menu showing "AL.mat" as the selected material.
- HPGe Detector Schematic:** A 3D schematic diagram of an HPGe detector, showing a central active region (green) surrounded by a dead layer (yellow) and an end cap (blue).

## Action 2

Action to facilitate the use of Monte Carlo simulation software

The shield file



## Action 2

# Action to facilitate the use of Monte Carlo simulation software

### The geometry file

Parameter	Geom1	Geom2	Geom3	Geom4
	Water	Point	Soil	Filter
Sample diameter (mm)	90	-	60	80
Sample thickness (mm)	40	-	20	3
Sample material	Water	-	Dirt	Cellulose
Sample-to-window distance (mm)	1.0	1.0	1.0	1.0

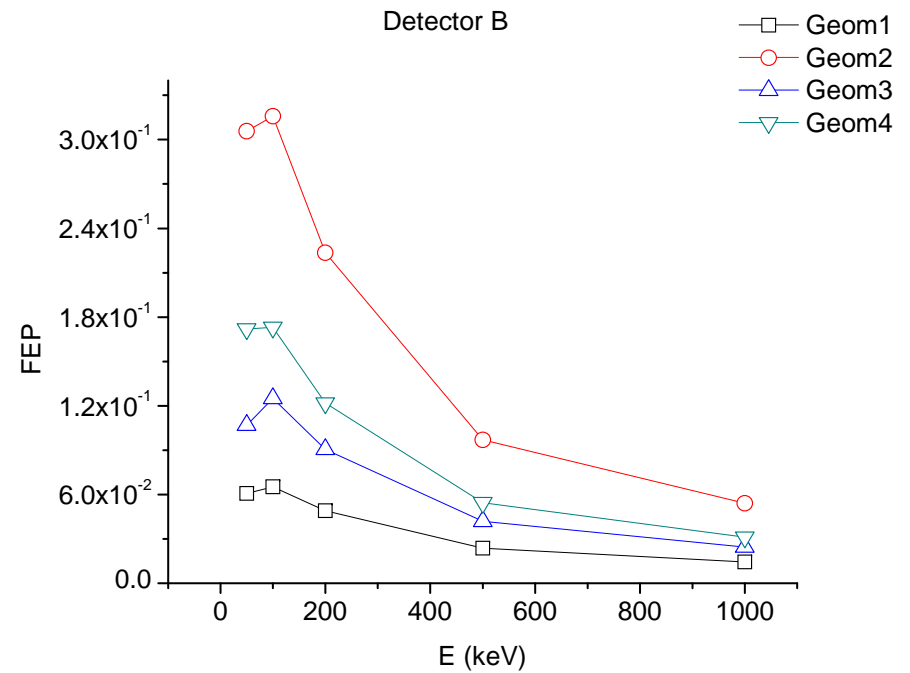
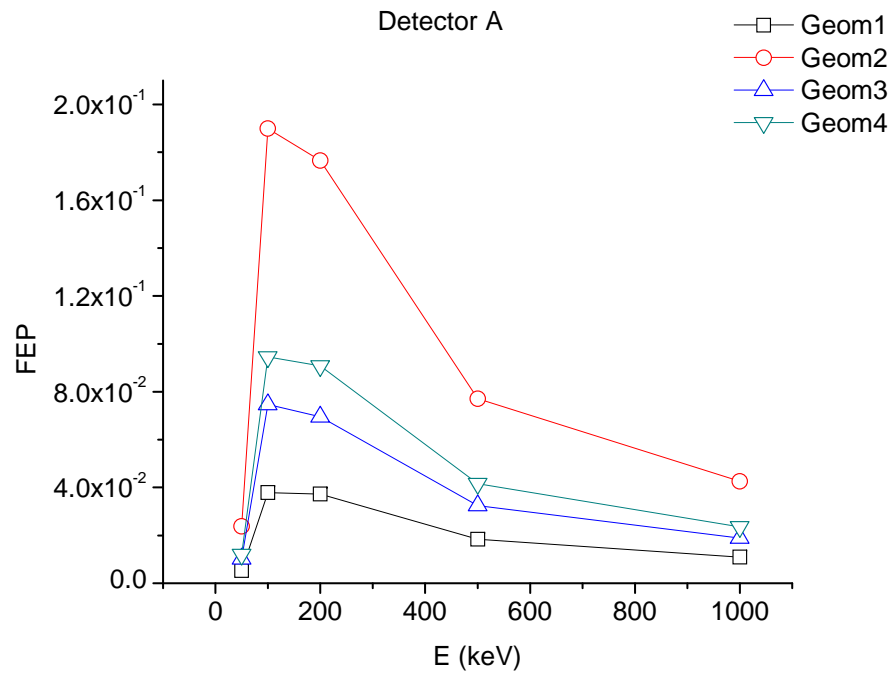
### Sample materials

Material	Density (g/cm <sup>3</sup> )	Chemical formula
Ge	5.323	Ge
Al	2.70	Al
Water	1.0	H <sub>2</sub> O
Dirt	1.4	SiO <sub>2</sub>
Cellulose	0.3	C <sub>6</sub> H <sub>11</sub> O <sub>5</sub>

not included  
in GESPECOR

## Action 2

# Full energy peak efficiency



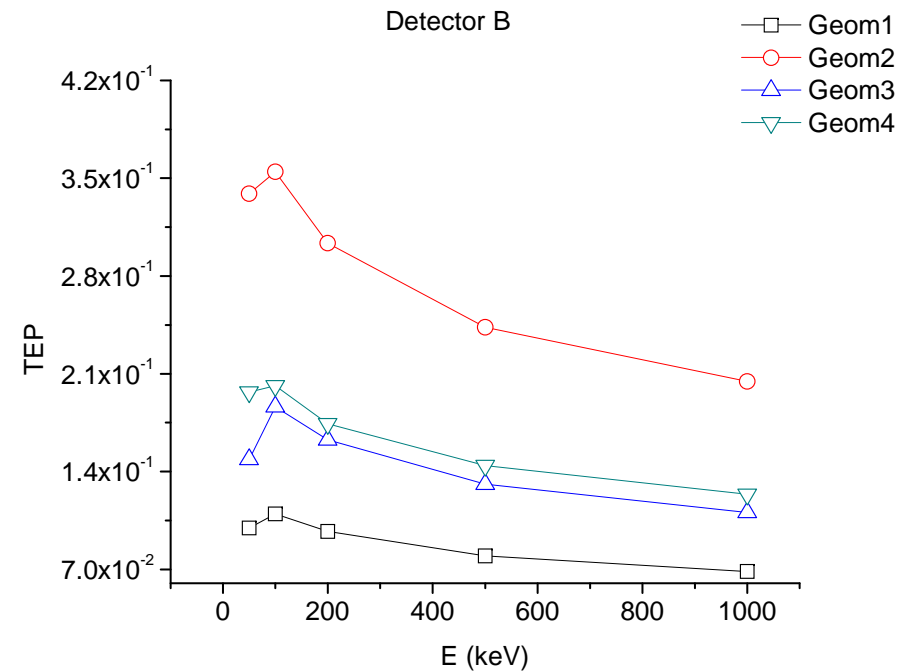
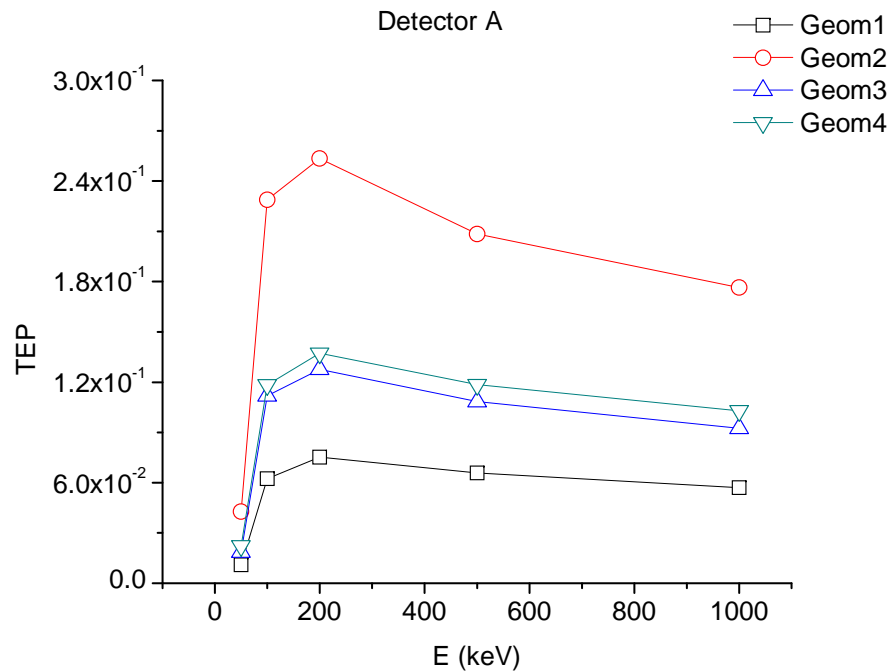
Uncertainties

<0.30%, k=1, for Detector A (<0.28% for A. Luca)

<0.29%, k=1, for Detector B (<0.31% for A. Luca)

## Action 2

# Total energy peak efficiency



Uncertainties

<0.76%, k=1, for Detector A (<0.72% for A. Luca)

<0.40%, k=1, for Detector B (<0.33% for A. Luca)

## An important comment (Action 2):

- Both participants used GESPECOR, version 4.2, with software files from 2007 (A. Luca) and 2014 (D. Gurau), respectively; very high relative differences (up to 65 %) were obtained between the two sets of results for the total energy peak efficiency, at 50 keV, for all the four types of samples and especially for the detector A.
- When A. Luca installed the new files (beginning of May 2018), kindly provided by prof. Octavian Sima, and re-run the simulations, then the two sets of results were in good agreement (within  $k=3$ ).
- **SO, BE CAREFUL WHICH FILES YOU USE WITH YOUR SOFTWARE !**





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**Thank you for your attention!**

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