



**Geant4 simulations for Emission  
Tomography on low-activity radioactive  
waste drums with Compton detectors**

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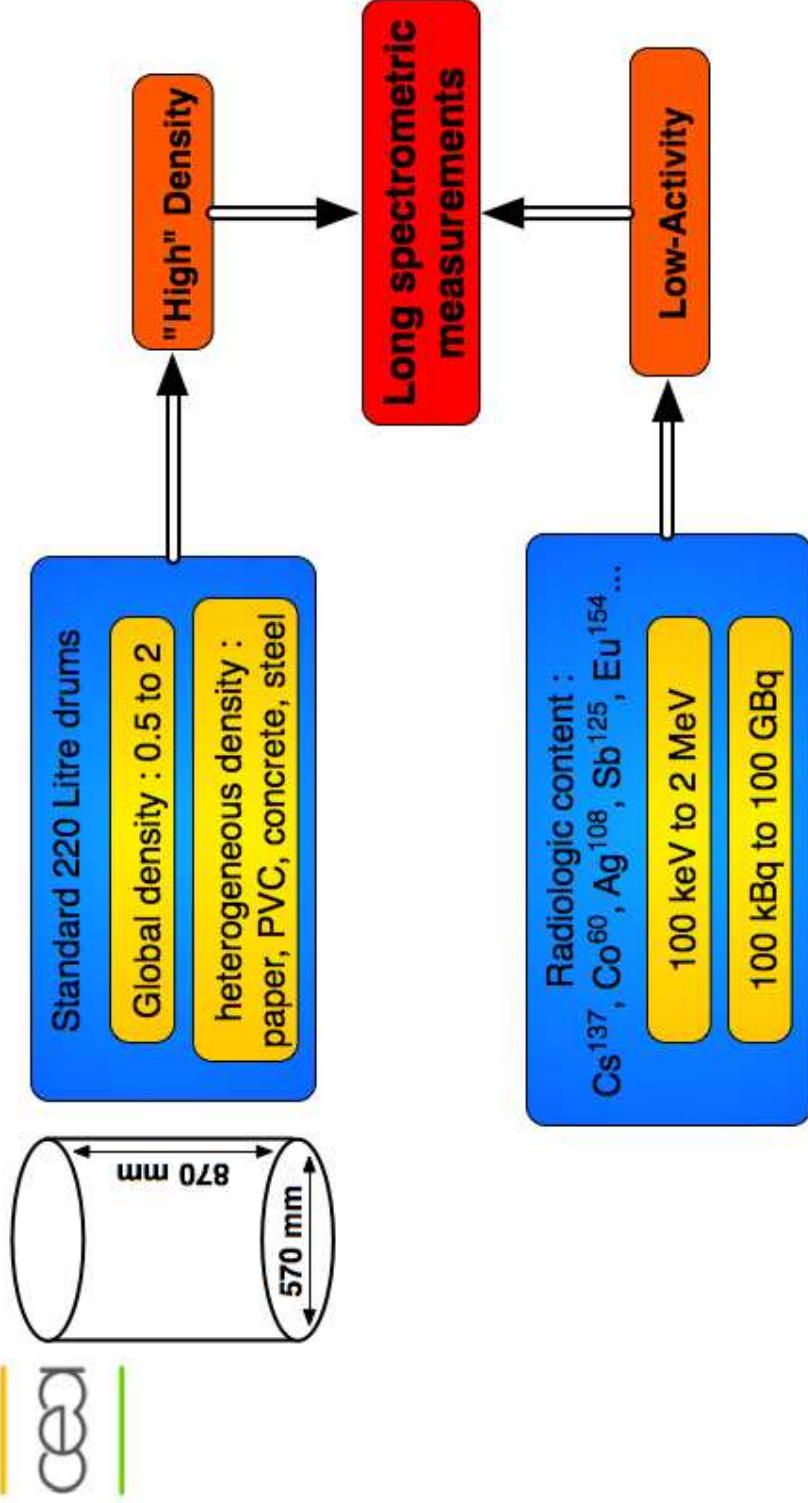
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Nuclear Measurements Laboratory

DEN/DTN/SMTM/LMN, CEA Cadarache, France

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## Low-Activity Radioactive Waste Assay



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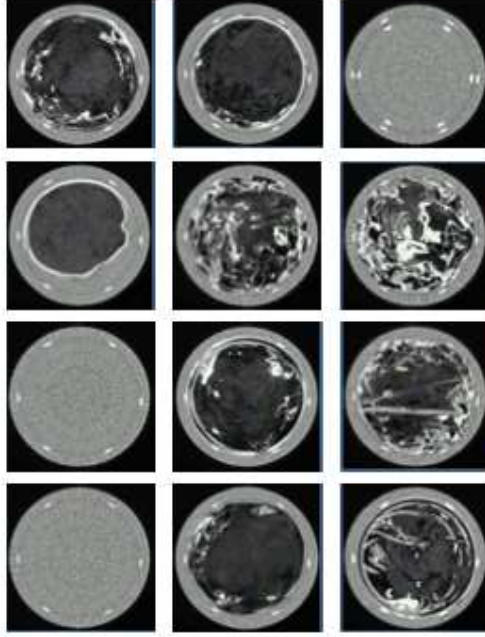
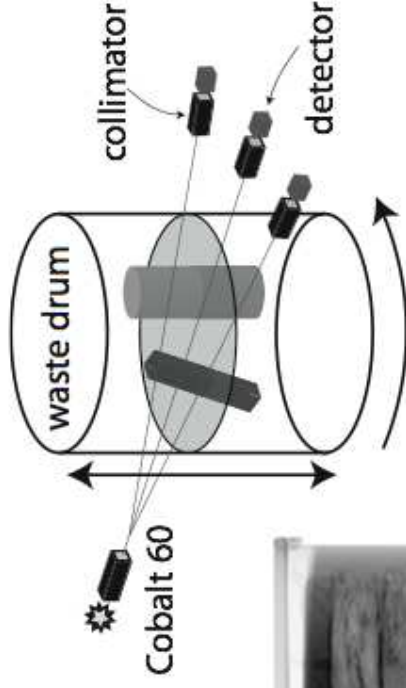
# Current TCT system



**Co<sup>60</sup> > 1173 & 1332 eV**

**Spatial Resolution < 4 mm**

**Error on attenuation : 3 to 10 %**

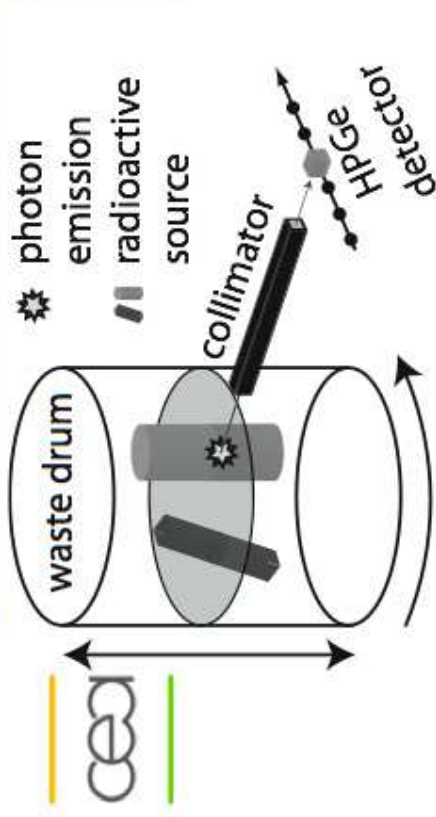


**Tomography**



**Radiography**

## Current ECT system



**Collimator**  
30 x 30 x 385 mm

**Spatial Resolution : 30 to 50 mm**

- slice by slice tomography
- Poor statistic

**Error on activity : 10 to 50 %**

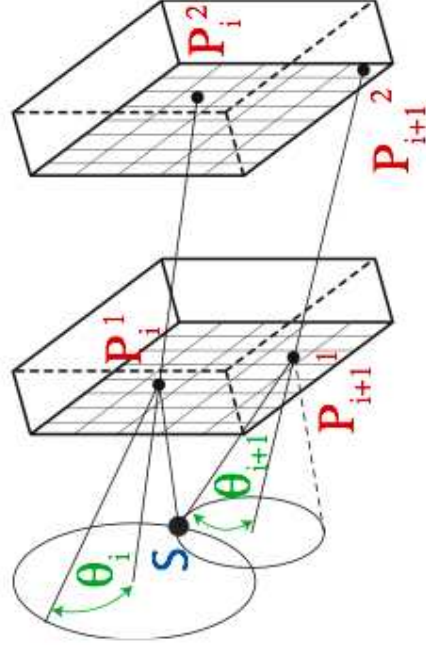
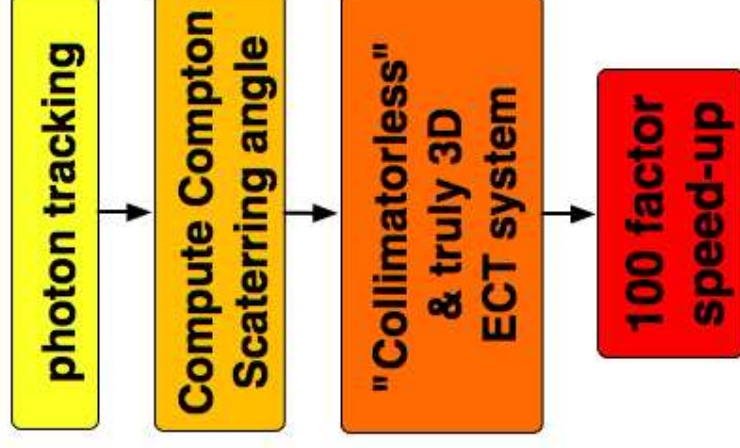
- 400 to 1000 Measurements
  - 3 to 10 minutes each
- 2D Acquisition Time > day**

**Correction of the  
photon attenuation  
with TCT data**

## Faisability study of Compton detectors based ECT systems

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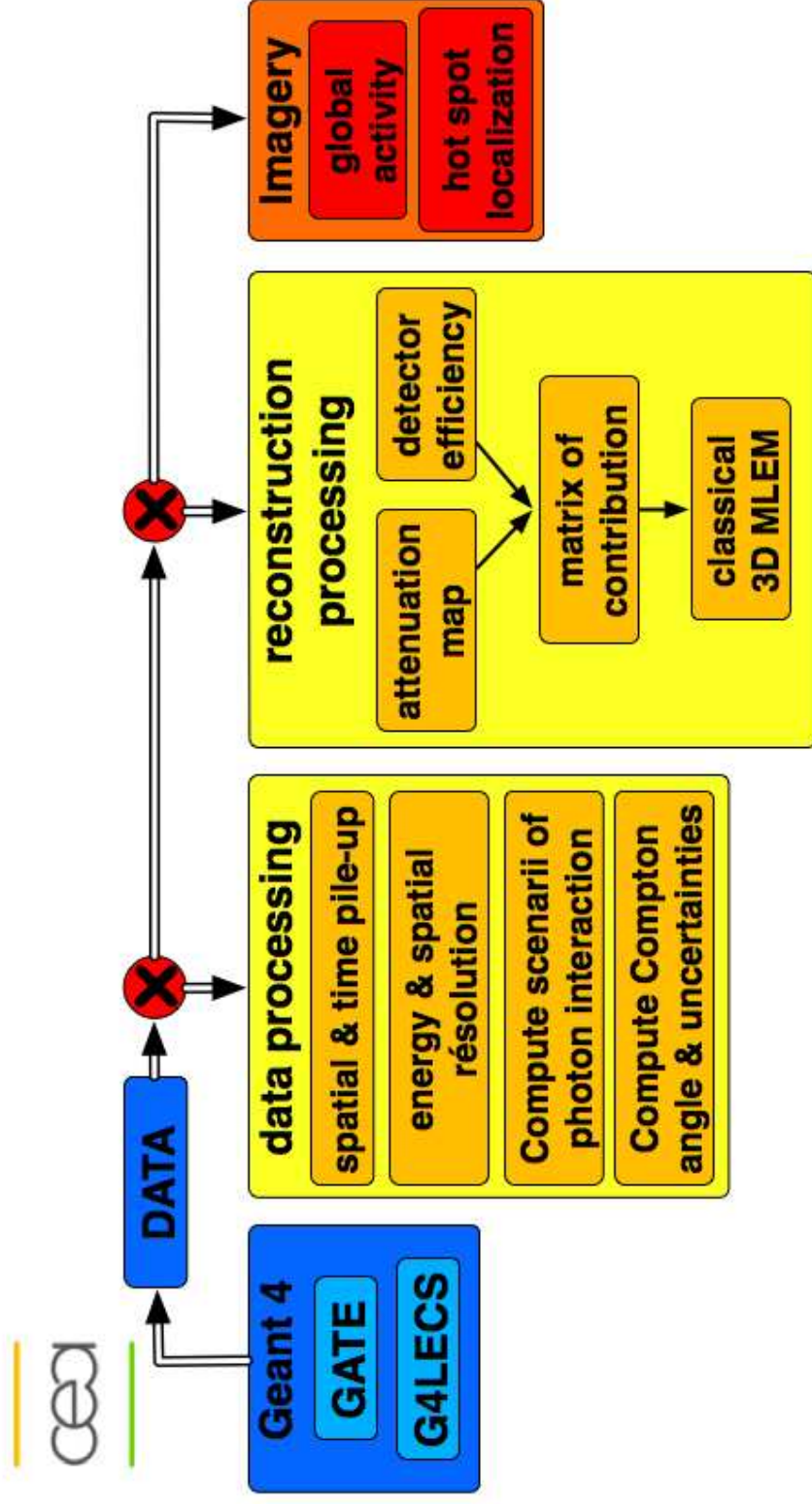
$$P_i^j \leftarrow (E_i^j, X_i^j, Y_i^j, Z_i^j)$$



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# Simulation process



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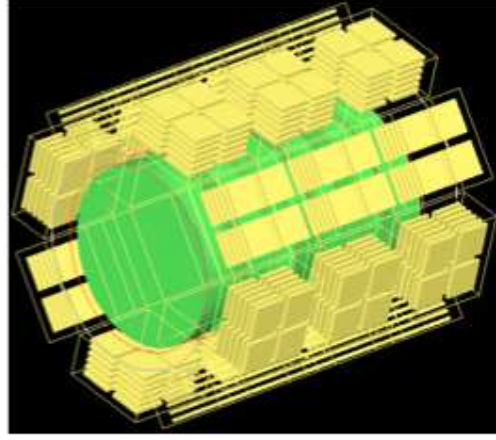
## A sample of Reconstruction



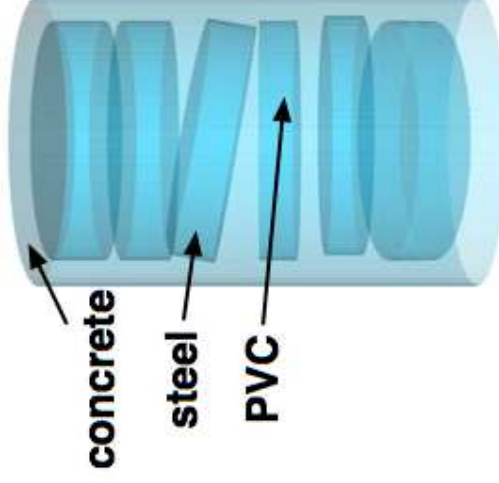
low  $\text{Cs}^{137}$  activity : 4 MBq

full 3D acquisition time : 30 minutes

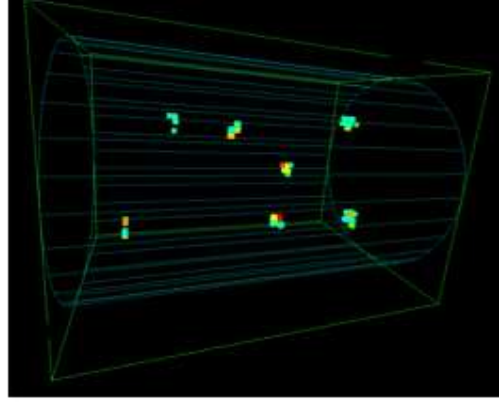
43.000 photons used for MLEM reconstruction



**GATE view**

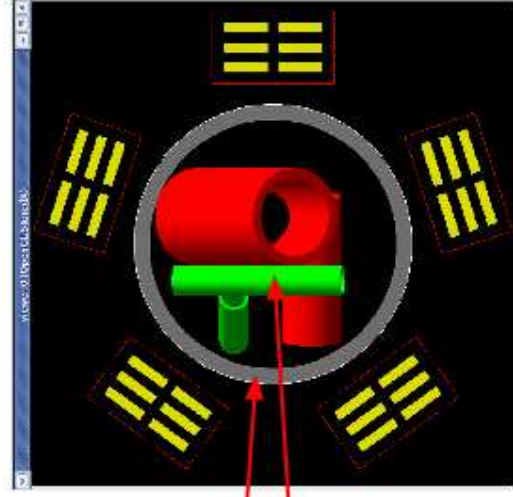


**MAYAVI view**

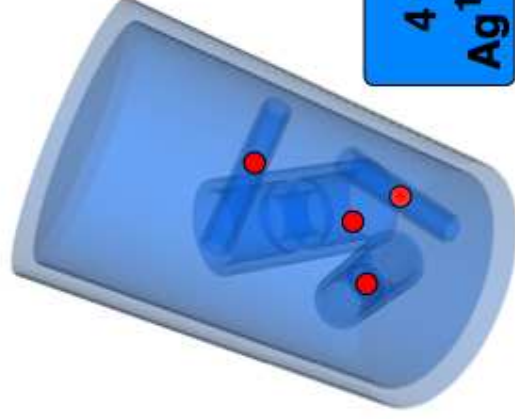


**Reconstruction view**

## Importance of the G4LECS package 1/3



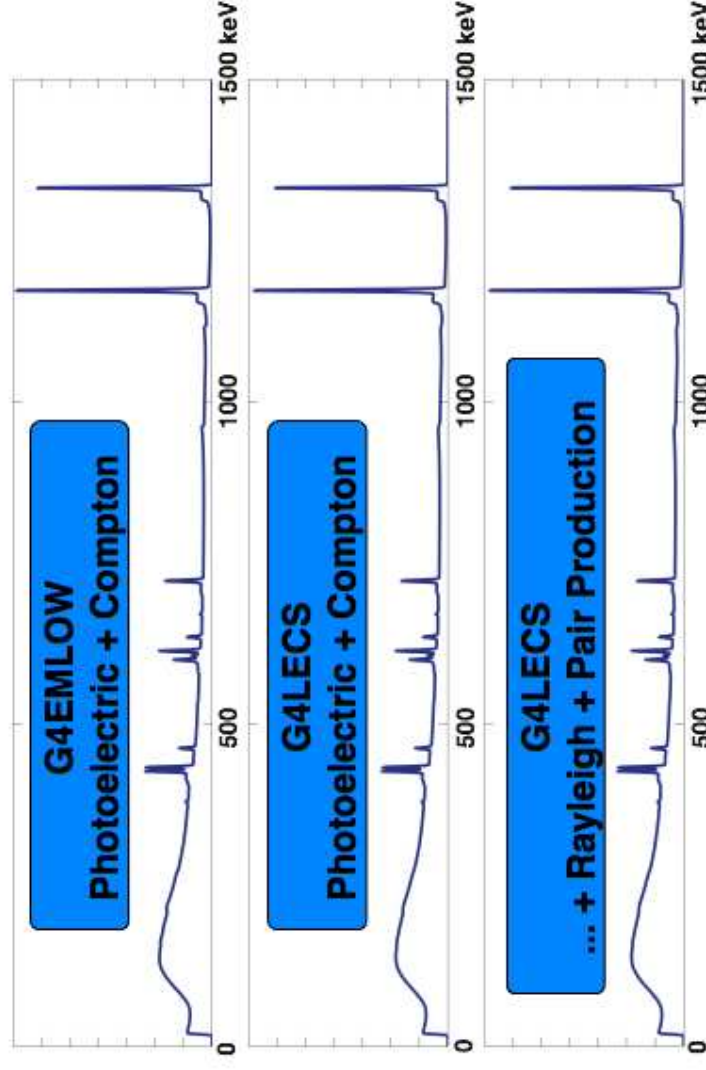
concrete  
steel



4 sources with  
 $\text{Ag}^{108}$ ,  $\text{Co}^{60}$ ,  $\text{Sb}^{125}$



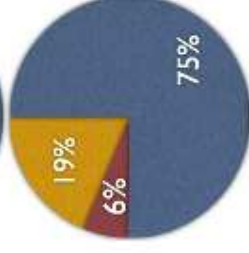
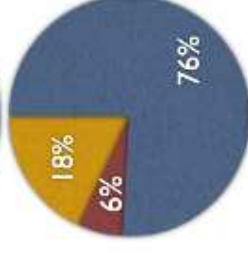
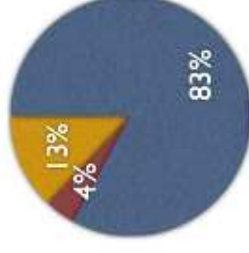
## Importance of the G4LECS package 2/3



global gamma spectra seems to be identical ...

## Importance of the G4LECS package 3/3

Estimation of Compton Scattering angle $Co^{60}$ @ 1173 keV	GOOD 	BAD 	REJECTED 
Good case	279465	10636	37645
Compton in the drum	2345	199	2267
Escape from the detector	371	187	2793
Compton & Escape	17	78	1086
Good case	251807	16861	54 877
Compton in the drum	2223	211	2395
Escape from the detector	296	202	2712
Compton & Escape	15	61	1103
Good case	250926	17303	57073
Compton in the drum	2144	258	2421
Escape from the detector	314	180	2734
Compton & Escape	27	72	303



GAEMLOW

GALECS

GALECS \*

## Why Geant4 & GATE ?

Easy geometry description

Easy Photon tracking

Accurate description of the  
Compton scattering via G4LECS

**Thank you  
for your attention**

**Any Question ?**