# Test stand MC simulation

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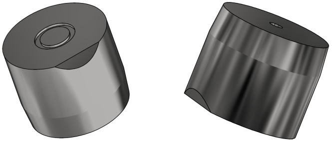
# IC160A detector and FCCD

IC160A detector shows:

- **cut** on the bottom;
- **tapered** shape on the top.



In addition to the fully active volume (FAV), around the surface there are:

- **dead layer** = zero charge collection;
- **transition layer** = partial charge collection.

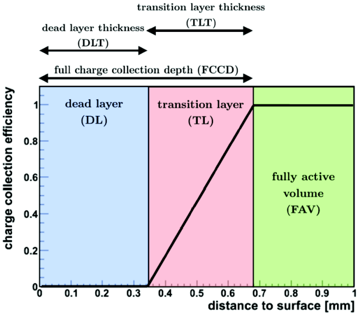



Figura 1: Figure from *B. Lehnert's PhD thesis*

# Database structure for g4simple

https://github.com/legend-exp/legend-g4simple-simulation

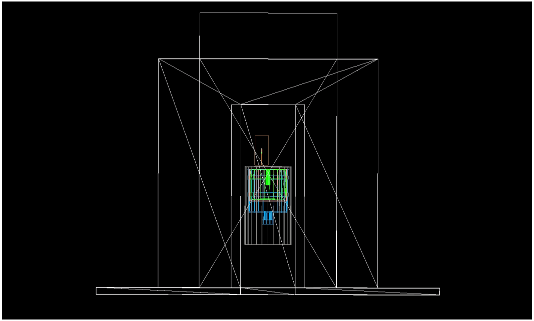
**/lfs/l1/legend/detector_char/enr/hades/simulations/legend-g4simple-simulation**

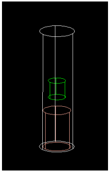
```
|- README
|- IC-legend/
    |- general_geometry/
        |- all "define" xml files and "children" gdml files
    |- IC160A/
        |- Am241/
            |- collimated/
                |- side/
                    |- all raw root file
                    |- geometry/
                        |- link to the required children files and define files
                        |- mother gdml file
                    |-macro/
                        |- all macro files
                        |- qsub file
                        |- run.sh
                        |- log/
                            |- output files
                |- top/
            |- uncollimated/
        |- Th228/
    |- IC160B/
    |- IC162B/
    |- IC166B/
|- IC-gerda/
    |- general_geometry/
    |- IC48A/
    |- IC48B/
    |- IC50A/
    |- IC50B/
    |- IC74A/
```

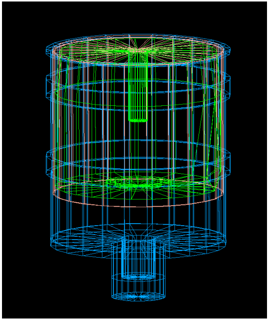
# Example of gdml file

```xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<!DOCTYPE gdml [
<!ENTITY define_detector SYSTEM "define_detector.xml">
]>
<gdml xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://service-spi.web.cern.c
h/service-spi/app/releases/GDML/schema/gdml.xsd">


 <define>
        &define_detector;

        <quantity name="Alcap_z" type="length" value="Alcap_height" unit="mm"/>
        <quantity name="Alcap_radius" type="length" value="Alcap_width/2" unit="mm"/>

        <quantity name="Alcap_cavity_radius" type="length" value="(Alcap_width-2*Alcap_thickness)/2" unit="mm"/>

        <quantity name="start_cavity_z" type="length" value="position_Alcap_cavity_fromTop" unit="mm"/>
        <quantity name="end_cavity_z" type="length" value="(Alcap_height-position_Alcap_cavity_fromBottom)" unit="mm"/>

 </define>

 <materials/>

 <solids>

        <polycone name="Alcap" startphi="0" deltaphi="TWOPI" aunit="rad">
                <zplane rmin="0" rmax="Alcap_radius" z="0" />
                <zplane rmin="0" rmax="Alcap_radius" z="start_cavity_z" />
                <zplane rmin="Alcap_cavity_radius" rmax="Alcap_radius" z="start_cavity_z" />
                <zplane rmin="Alcap_cavity_radius" rmax="Alcap_radius" z="end_cavity_z" />
                <zplane rmin="0" rmax="Alcap_radius" z="end_cavity_z" />
                <zplane rmin="0" rmax="Alcap_radius" z="Alcap_z" />
        </polycone>

 </solids>

 <structure>
        <volume name="AlCap">
                <materialref ref="G4_Al"/>
                <solidref ref="Alcap"/>
        </volume>
 </structure>


 <setup name="Default" version="1.0">
        <world ref="AlCap"/>
 </setup>

</gdml>
```

# Visualization of HADES setup







Inside the lead castle:

germanium **detector**

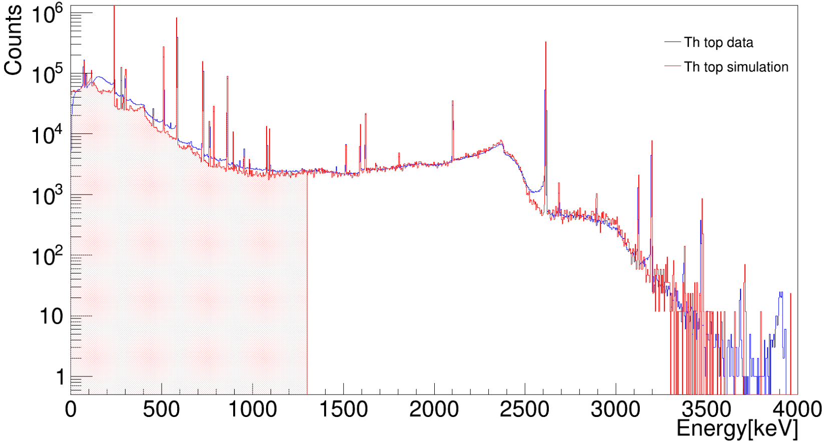
- teflon wrap
- aluminium holder
- aluminium cyrostat

silicon dioxide **source**

- stainless steel capsule
- epoxy window (Th source)
- (Cu collimator)

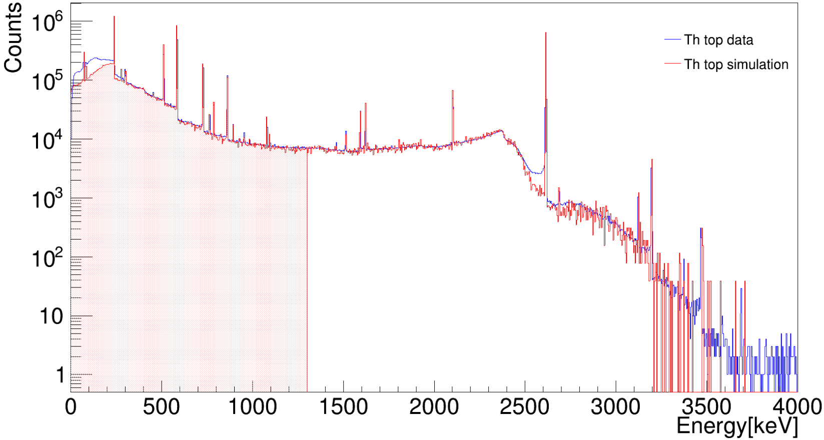
# Energy spectrum - $^{228}$Th top

Uncollimated Thorium at the top - source at 4.2 cm over the cryostat.
Between the source and the detector there is the **cryostat** (Aluminium).



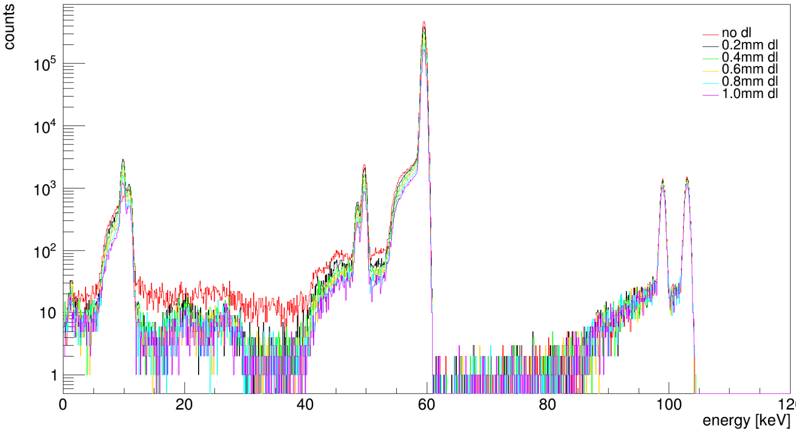
# Energy spectrum - $^{228}$Th side

Collimated Thorium at the side - Copper collimator.
Between the source and the detector there are **cryostat** (Aluminium), wrap (Teflon) and **holder** (Aluminium).



# Energy spectrum - $^{241}$Am Top - dead layer

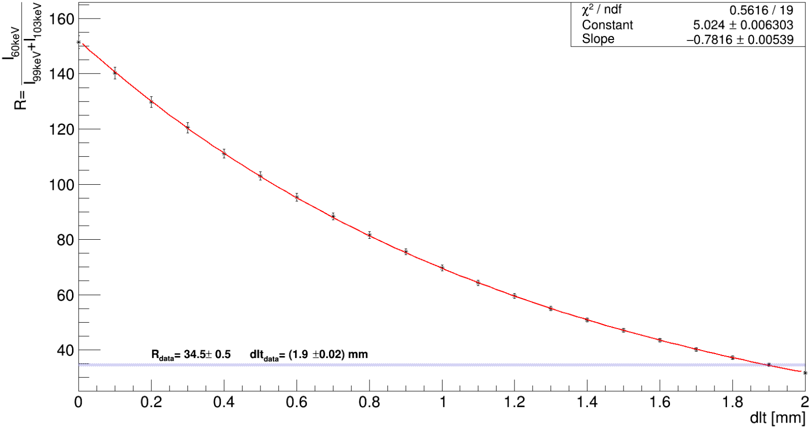
Collimated americium at the top - source at 2.9 cm over the cryostat - Copper collimator.
The source is not centered on the cavity of the detector.
In the plot every energy spectrum is from simulation.



# $^{241}$Am Top - peak ratios vs dead layer

The peak ratio $R = \frac{I_{60keV}}{I_{99keV}+I_{103keV}}$ is shown as a function of dead layer thickness (dlt).

The computed dead layer for data is not equal to what expected ($\sim 1.0$ mm).



# What's next?

The geometries of the setup for Inverted Coaxial detectors are ready for g4simple.

**g4simple** gave several unsolved problems with simulation and analysis:

- discrepancies between simulation and data at low energies in $^{228}$Th Top energy spectra;
- in $^{241}$Am analysis the computed dlt for data is higher than the expected value.

What's next?

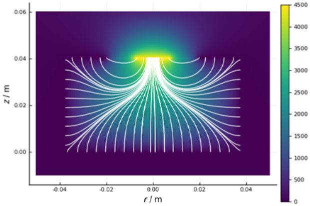
- simulation in **MaGe**;
- complete $^{241}$Am analysis for dead layer;
- $^{133}$Ba analysis for dead layer.

# Simulation software SSD

Solid State Detectors

Contribution from **Lukas Hauertmann**

MAX-PLANCK-INSTITUT FÜR PHYSIK




- Arbitrary (segmented) detector geometry (CSG – Geant4 like) including surroundings, like holding structures, cryostats or even multiple detectors (LEGEND detector strings)
- 2D & 3D: Cylindrical or Cartesian Coordinates
- Fast: Multi-threaded and SIMD-accelerated
- Arbitrary impurity density profiles, depletion handling
- Capacitance calculation
- Arbitrary charge drift models including temperature and impurity density dependency, defaults provided (e.g. ADL/Bruyneel)
- Arbitrary surface charges and surface drift modulation
- Modular and Open Source: GitHub (PR's are welcome)
- Automatic package testing including comparison to analytical solutions
- Geant4-Simple interface, support SigGen config files

Work in Progress:

- GPU support
- Geometry import from STL-Files
- Further performance improvements
- Extend documentation and examples

julia

https://github.com/JuliaPhysics/SolidStateDetectors.jl