MC Simulations for Detector Characterization in LUNA

Background Studies for a BGO Detector

Gran Sasso Summer Institute 2014

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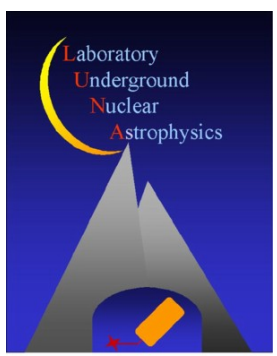
October 3, 2014



Nuclear Astrophysics with LUNA

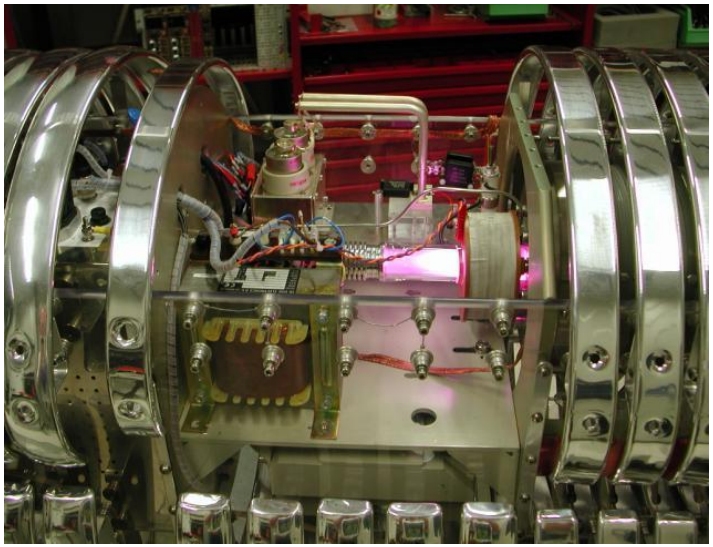
Motivation and Setup

Laboratory for **U**nderground **N**uclear **A**strophysics

Measurement of nuclear cross sections for astrophysical processes

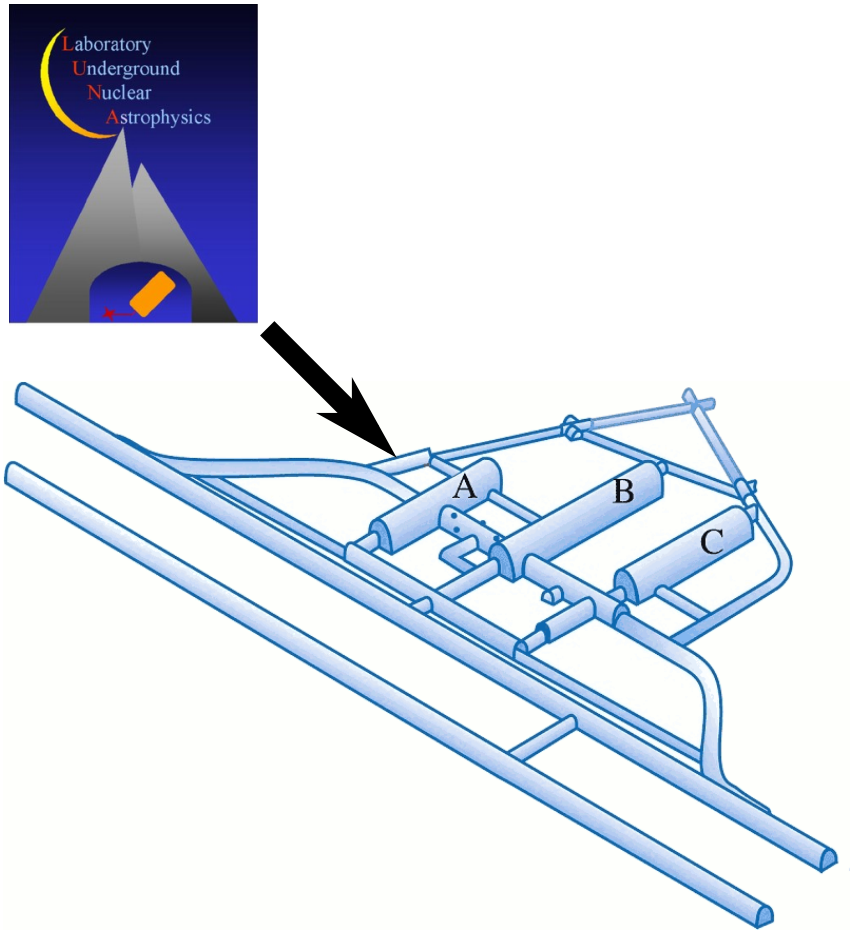
Features

- 400 keV accelerator (p & alpha)
- two beamlines with setups for solid and gaseous targets
- measurements with low event-rates
- different detector types in use



Nuclear Astrophysics with LUNA

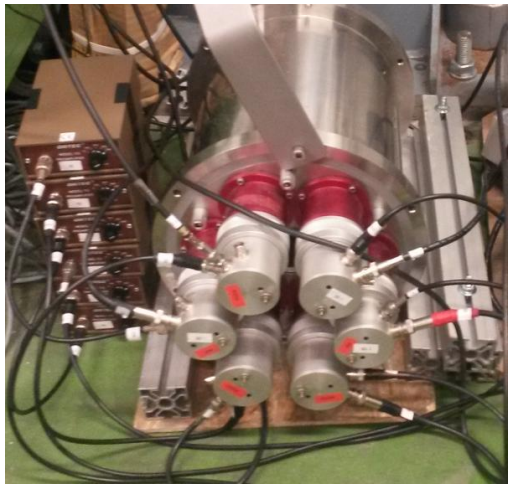
Location & Impressions

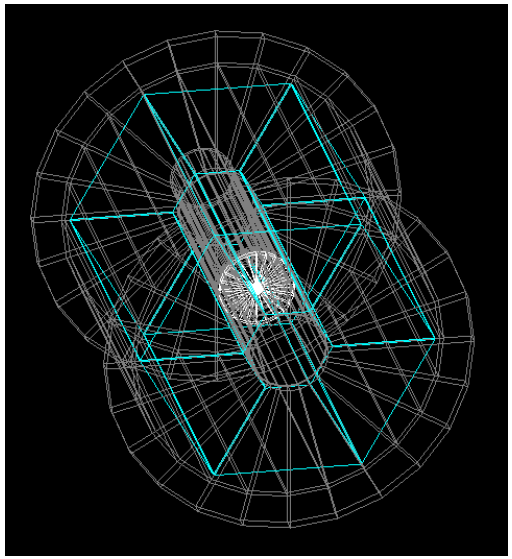


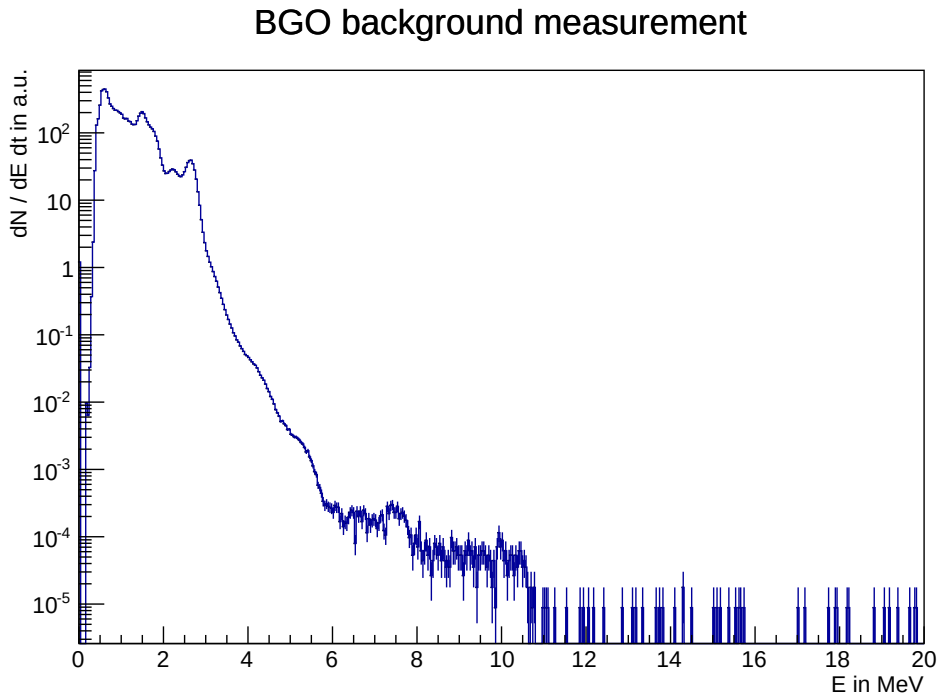
(map: LNGS)

Bismuth Germanate Detector

Background Studies







Aim

Detailed model of measured background spectra (intrinsic + external contributions)

Detector Simulation

Status & Improvements

Existing Simulation

Geant4-based (standard EM physics)

Detector Simulation

Status & Improvements

Existing Simulation

Geant4-based (standard EM physics)

Extension & Modularization

- Geometry

Macro Example

```
/Geometry/add BGODetector
/Geometry/BGODetector/position 0 0 10 cm
/Geometry/BGODetector/rotateX 30 deg
```

Detector Simulation

Status & Improvements

Existing Simulation

Geant4-based (standard EM physics)

Extension & Modularization

- Geometry
- Particle & position generators

Macro Example

```
/PrimaryGenerator/setPositionGenerator Fill
/PrimaryGenerator/setLogicalVolume BGODetector_crystal
```

Detector Simulation

Status & Improvements

Existing Simulation

Geant4-based (standard EM physics)

Extension & Modularization

- Geometry
- Particle & position generators

Employing Geant4.10

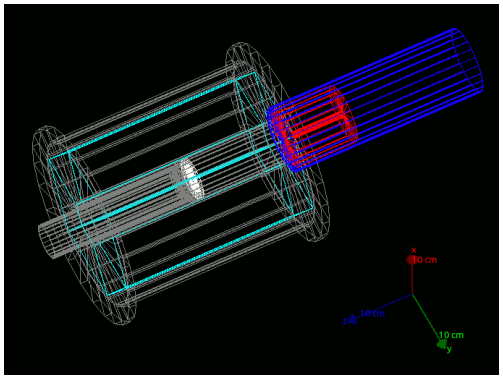
- Parallelization of simulation
- ! Access to certain parts of data structure remains mutually exclusive (parts of ROOT not thread-safe)

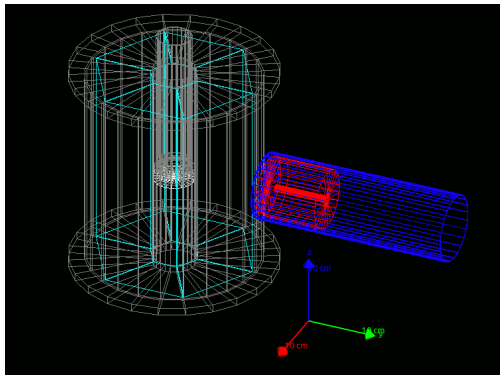
Macro Example

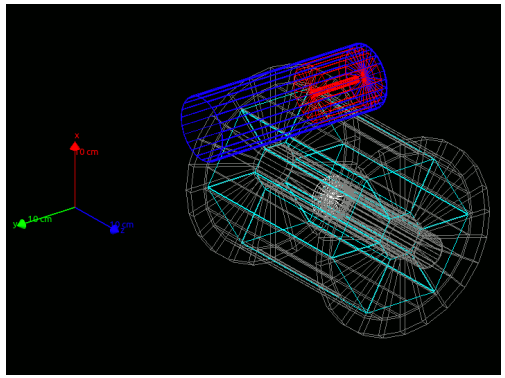
```
/run/numberOfThreads 16
```

Simulation of BGO + Ge Setup

Geometries and Preliminary Results







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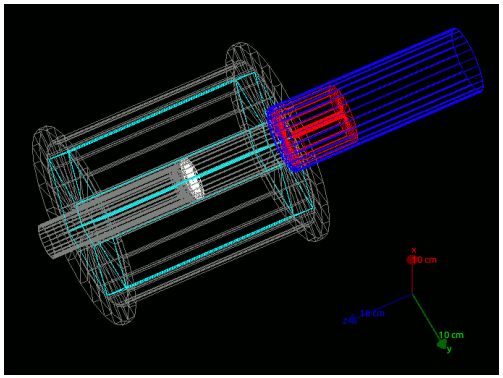
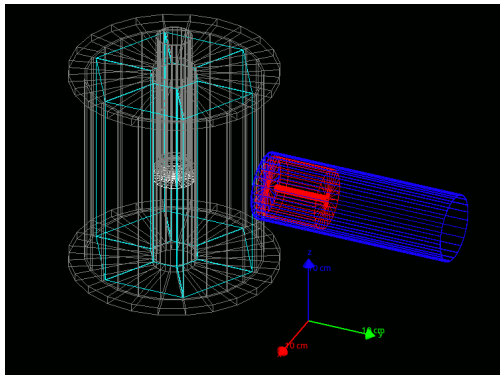
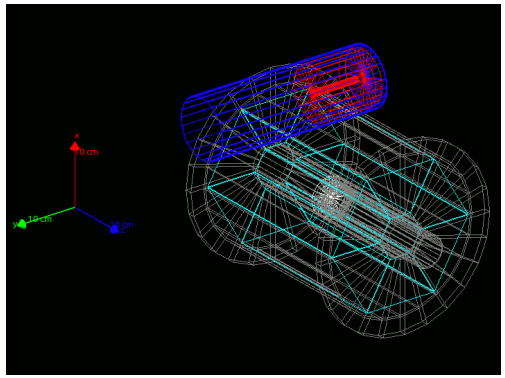
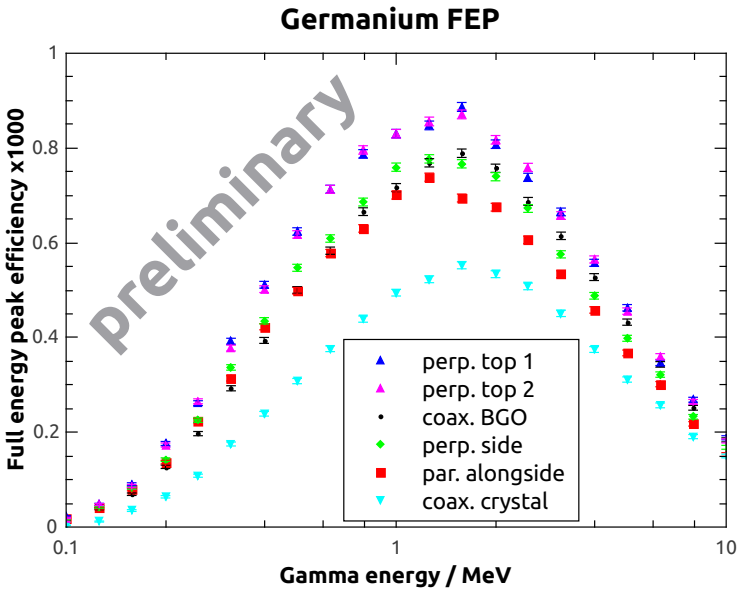
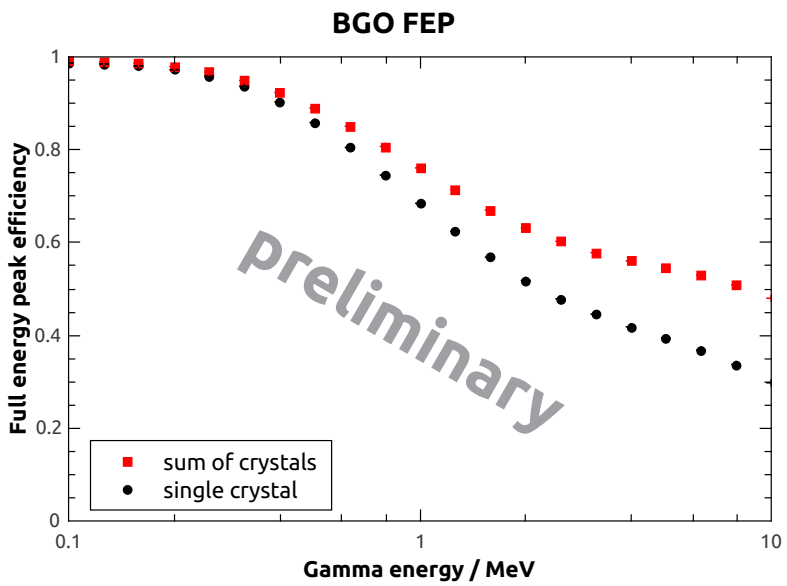
Geometries and Preliminary Results











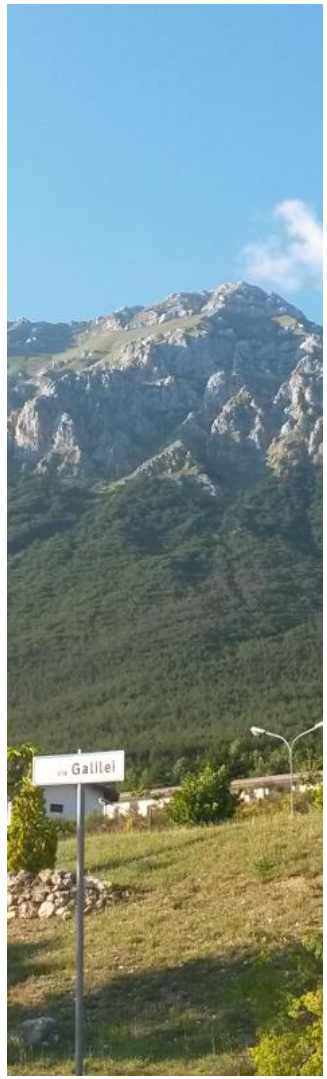
Conclusions

Summary

- Detector background model crucial for analysis of low count rate experiments with LUNA
- Existing LUNA detector simulation extended and applied to test scenario

Outlook

- Background measurements for BGO ongoing
- Next steps to be discussed with help of simulations
- Modeling of BG spectra with simulation of different contributions



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Thank you!