Brief introduction to MaGe

- History
- MaGe frame
- Some features in geometry/physics
- Summary

Xiang Liu for the MaGe MC group
Shanghai Jiaotong University
Sino-German GDT Collaboration Symposium

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(very much personally biased)

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MAGE - a GEANT4-based Monte Carlo Application Framework for Low-background Germanium Experiments

Yuen-Dat Chan[1], Melissa Boswell[2], Jason A. Detwiler[1,3], Padraic Finnerty[4], Reyco Henning[4], Victor M. Gehman[2,3] Rob A. Johnson[3], David V. Jordan[5], Kareem Kazkaz[3,6], Markus Knapp[7], Kevin Kröninger[8,9], Daniel Lenz[8], Jing Liu[8], Xiang Liu[8], Sean MacMullin[4], Michael G. Marino[3], Akbar Mokhtarani[1], Luciano Pandola[10], Alexis G. Schubert[3], Jens Schubert[8], Claudia Tomei[10,11], Oleksandr Volynets[8]

IEEE Trans. Nucl. Sci. 58:1211-1220,2011 (arXiv:1011.3827)

The Beginning of MaGe

In 2004, GERDA needed common MC package urgently.

- Background simulation.

- Pulse shape.
- DAQ/Offline analysis.

	Material	Geometry	Event generator	Physics process	Output
Default	definition of normal materials and their components	whole Gerda setup, including crystal , cryogenics, supporting and shielding.	Geant4 particle generations with most radioactive isotopes and their decay chain	Geant4 simulation of particles interacting in detector and shielding materials	Root ntuples with energy deposit information
LNGS	default	default	interface for 0ν- and 2ν- 2β decays from Decay0 package $\star$	default	generalize to other analysis tools than ROOT $\star$
Background Munich	materials for supporting structure	provide default Gerda setup $\star$	default	default	provide trajectories and points $\star$
Test-facility Munich	default	own geometry	default	default	own output
Neutron Tübingen	default	default	provide neutron flux	study neutron interaction	default
^{39}Ar Heidelberg	special liquid argon if necessary	liquid Ar cryogenic structure	default	optical photon tracking	default
GeMPI-II Heidelberg	new material definition if necessary	own geometry	default	default	own output
To be defined	default	default	default	mirror charge and pulse shape simulation	energy deposit as function of time

The Beginning of MaGe

MaGe Evaluation Report

Contact: Xiang Liu, Luciano Pandola

Version 0.5

November 25, 2004

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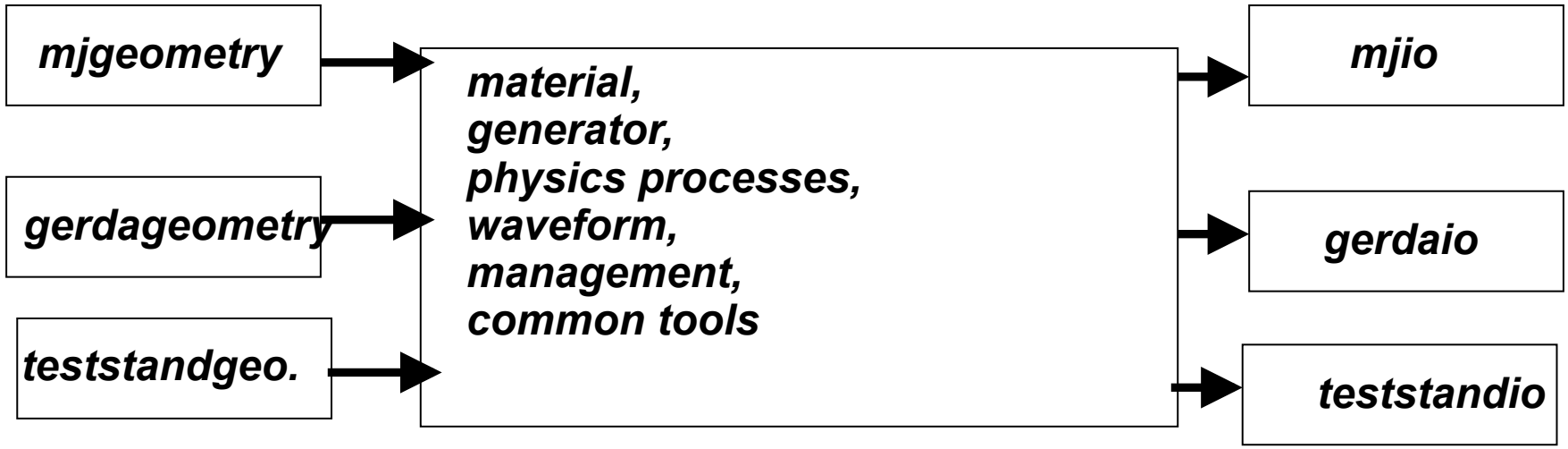
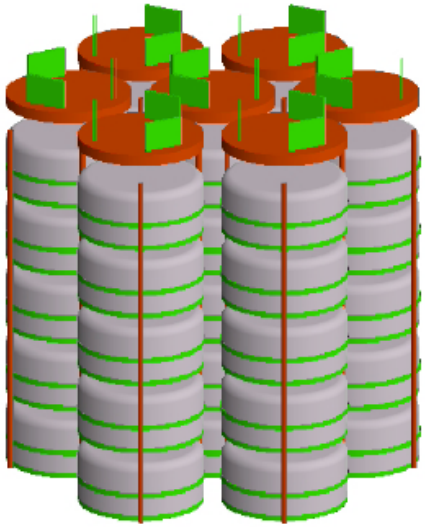
MaGe Frame

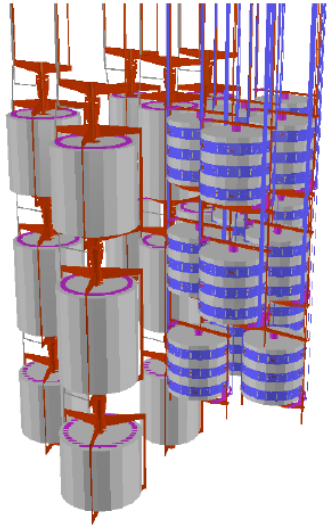


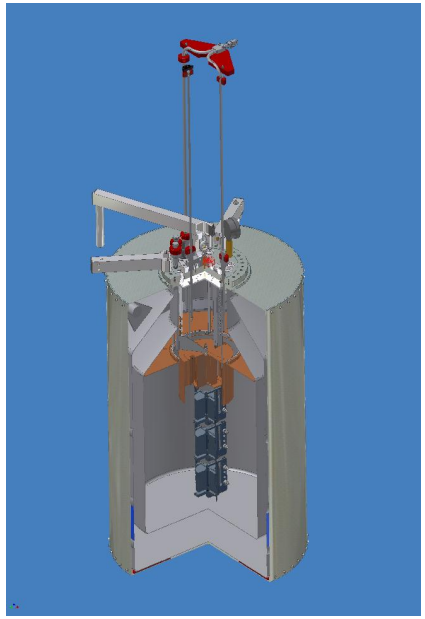
- Common MC framework.
  - same package for all users.
  - flexible in specific simulations,
  - avoid redundant coding.

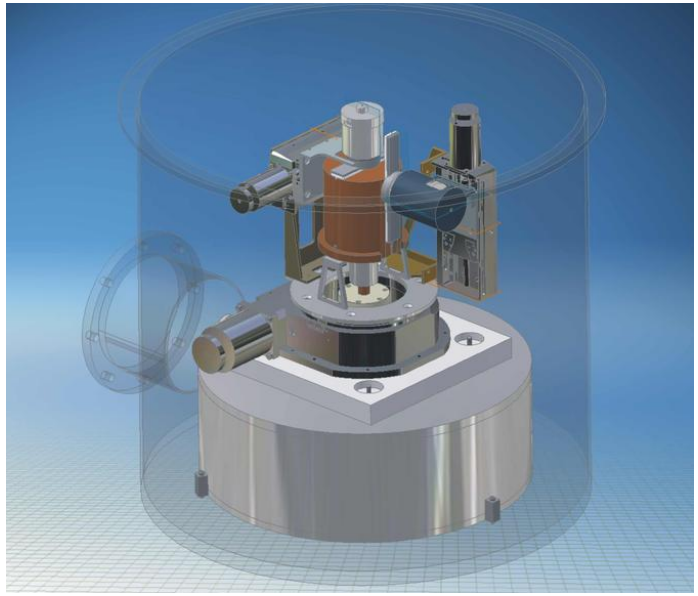
- knowledge sharing
  - physics optimization and validation.

Geometries in MaGe









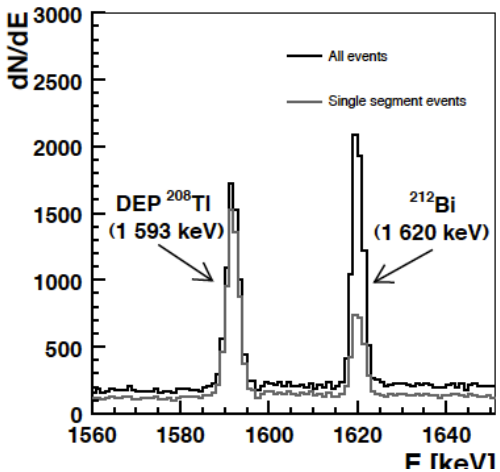
Physics optimization

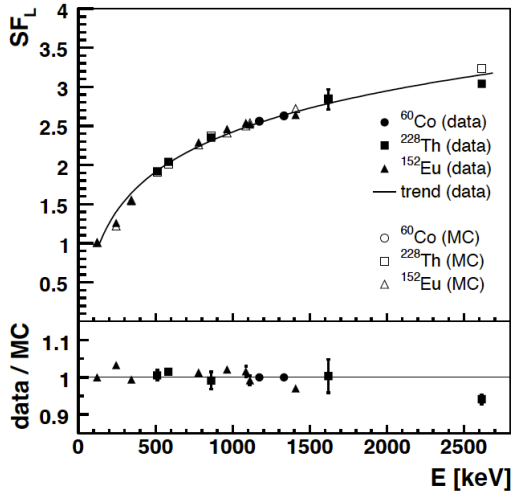
- Based on Geant4 for low-background experiment.
- Low energy EM models.
- Flags implemented for different hadronic models.

	$0\nu\beta\beta$(bb)	dark-matter(dk)	Cosmic Ray	Default
γ	0.1	0.005	30 (50)	0.01 (30)
e^- e^+	0.1	0.0005	0.04 (10.0)	0.01 (0.04)
p α	0.1	0.1	5	0.1

Table 1.1: Range cuts as defined within MaGe in unit of mm. Values in the brackets are for range cuts within the insensitive volumes. If no brackets are shown, then the cuts within the insensitive volumes are the same as those in the sensitive volumes.

Physics validation





NIM A583 (2007) 332

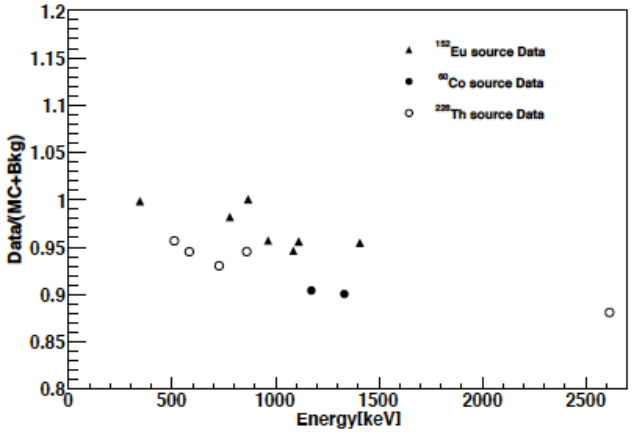


Fig. 5. Difference between number of events in characteristic photon peaks from ^{60}Co, ^{152}Eu and ^{228}Th sources plus background and a simple MAGE simulation. The maximal deviation was found to be approx. 12%.

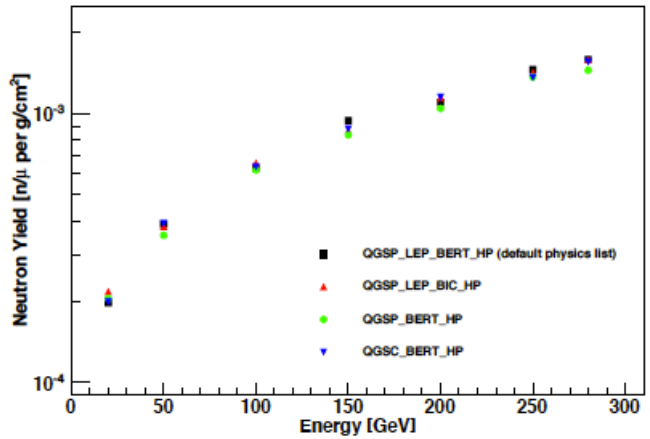
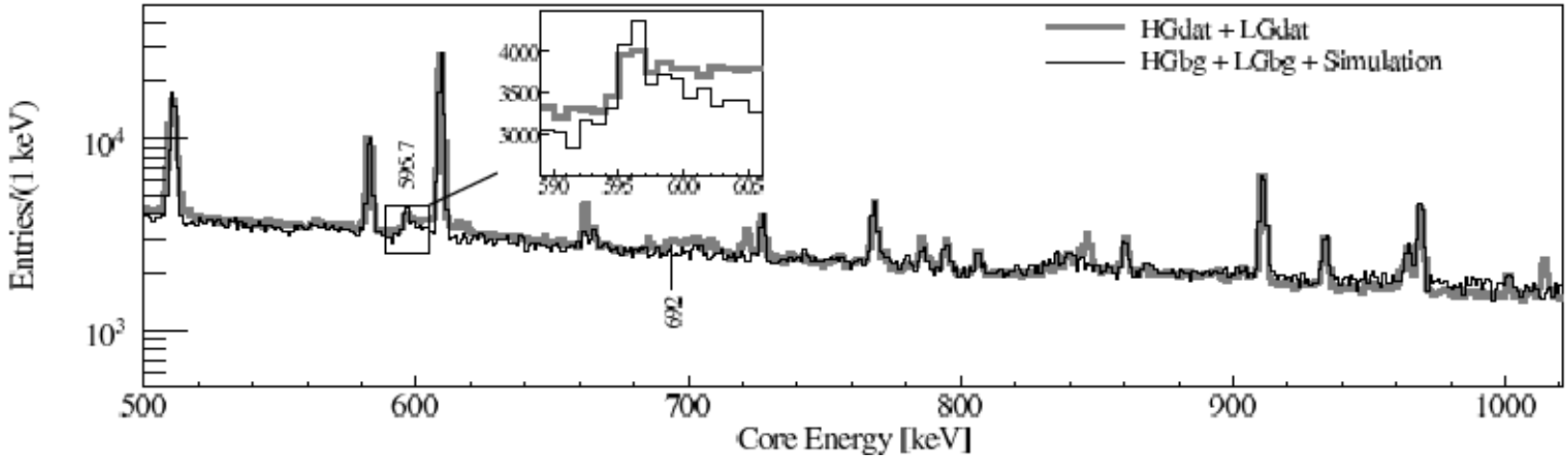
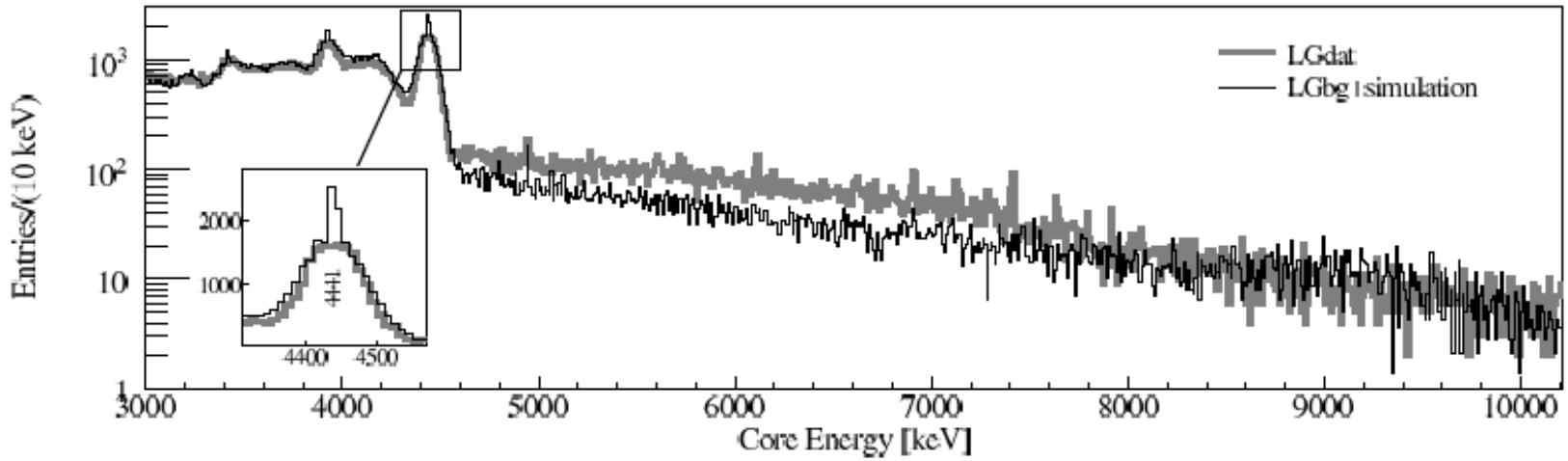


Fig. 4. Neutron yield from muon-induced showers in metallic germanium. MAGE has been run with the version 9.0 of GEANT4.

Identified Geant4 bugs

Neutron interactions as seen by a segmented germanium detector
Eur. Phys. J. A36: 139-149, 2008





Summary

- MaGe used intensively by Majorana/GERDA
  - Radioactive background simulation
  - Pusle shape simulation
  - Offline analysis tools and detector database

- Team work in coding/optimizing/validating
  - geometry
  - physics processes
  - event generator
  - general io

Try it!

Support materials

User and developer's Documents

https://github.com/mppmu/MaGe

http://mjwiki.npl.washington.edu/bin/view/MaGe/WebHome