MaGe: a Monte Carlo framework for the Gerda and Majorana double beta decay experiments

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Abstract. The Gerda [1] and Majorana [2] projects, both searching for the neutrinoless double beta-decay of ^{76}Ge, are developing a joint Monte-Carlo simulation framework called MaGe. Such an approach has many benefits: the workload for the development of general tools is shared between more experts, the code is tested in more detail, and more experimental data is made available for validation.

MaGe is a GEANT4-based simulation package maintained and developed by a joint group of the Gerda [1] and Majorana [2] collaborations. Since both search for $0\nu2\beta$ decay in ^{76}Ge, many common tools, like event generators and physics processes, can be shared; more users test the package, and the simulation is validated with experimental data coming from independent measurements. The object-oriented coding technique makes the MaGe package flexible and versatile, supporting different detector geometries and output schemes (like Root). Geant4 was selected as the underlying Monte-Carlo toolkit because (1) it provides the full simulation chain, from the event generator to the output and visualization, (2) it is now well-established in the Particle Physics community and (3) it includes a wide set of physics models. The default physics list includes specific low-energy electromagnetic models (including atomic effects, like x-ray fluorescence) and general-purpose hadronic processes, describing in particular muon spallation, neutron tracking and isotope production. Simulation of the electric fields and pulse-shape analysis, and models to handle the optical photons, generated by scintillation or Čerenkov effect, are also being developed. The main design principle for a 2β decay application is the reduction of backgrounds. The numerous sources (radioactive chains, cosmic rays, etc) were studied with MaGe for the design of the ^{76}Ge target and electronics, but also for the supporting structures and surrounding materials.

References
[1] Gerda Collaboration Proposal at http://www.mpi-hd.mpg.de/ge76/home.html
[2] Majorana Collaboration 2003 *Preprint* nucl-ex/0311013