The calibration system of the GERDA Muon Veto Cherenkov Detector

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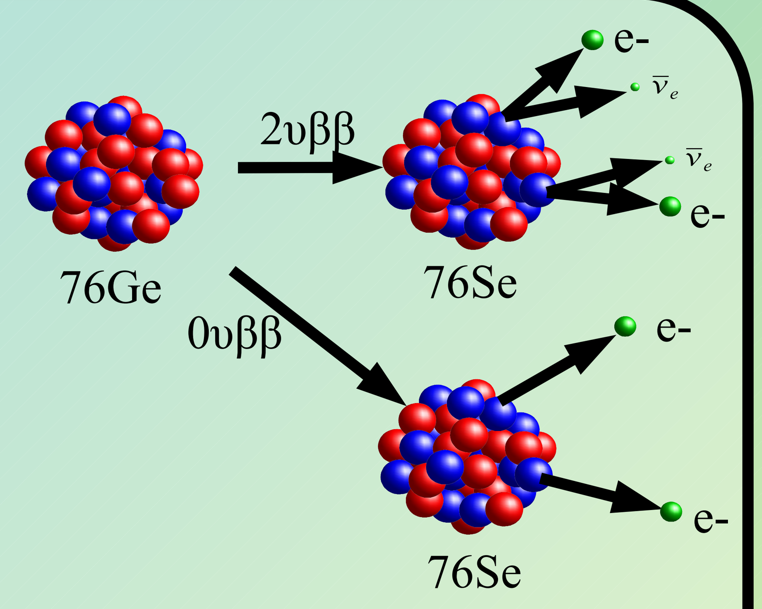
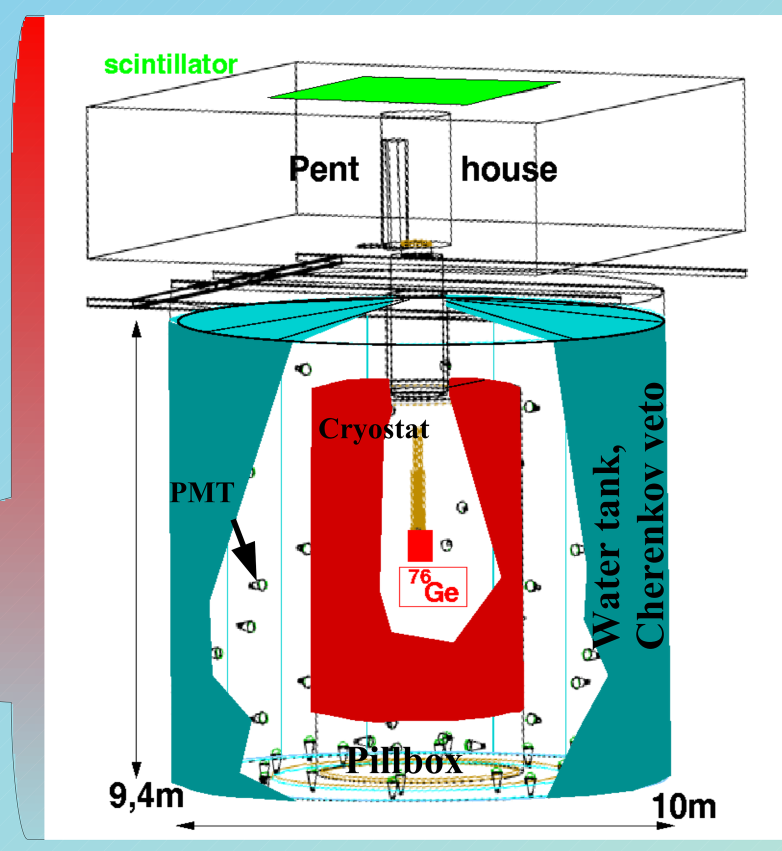
The **GER**manium **D**etector **A**rray **GERDA** is an experiment searching for the neutrinoless double beta decay (**0υββ**) of ^{76}Ge. This very rare, weakly interacting process is predicted to occur if the neutrino exhibits a mass and is a Majorana particle, i.e. the neutrino is its own antiparticle.



The LNGS is located below the Gran Sasso mountain region, about 150 km east of Rome. It is covered with an average of 1400 meters of rock, that provide about 3800 m.w.e. shielding.

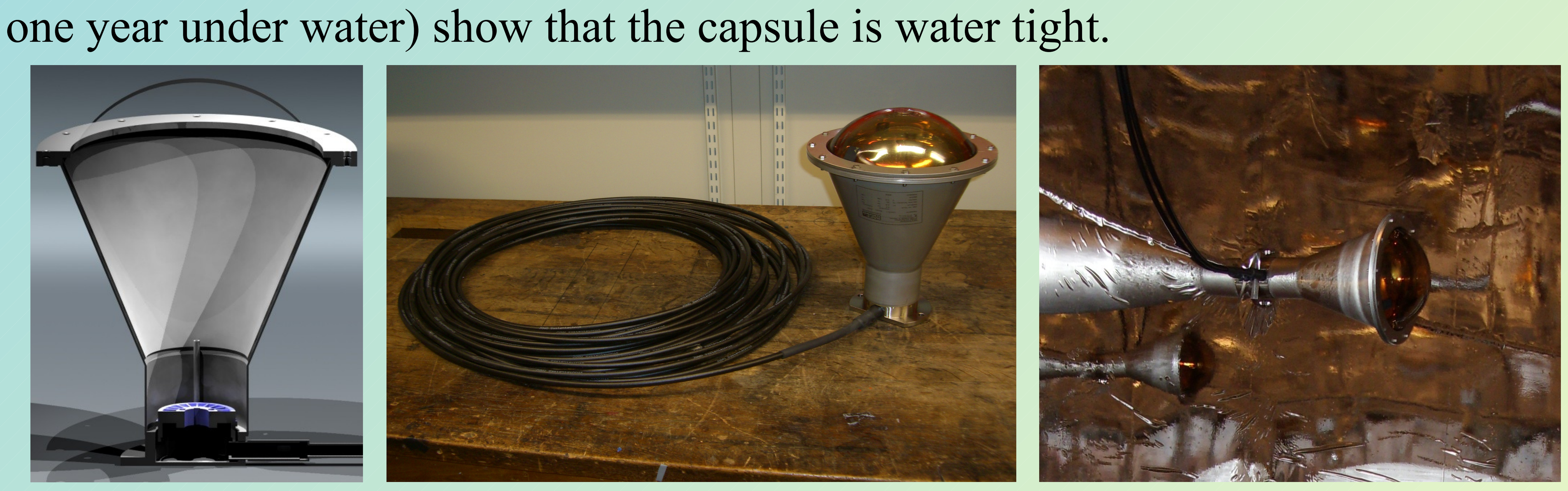


GERDA-geometry, with final PMT distribution, used for the Monte-Carlo-simulations, implemented in the MaGe framework.

Although the 2υββ decay has been found in several nuclei, there is at this moment no proof for 0υββ decay. Only a part of the Heidelberg-Moscow Collaboration claims to have observed 0υββ. Their best limit for the halflife is $T_{1/2} > 1.2 \cdot 10^{25}$ y. To achieve this limit, any background event must be identified. Therefore, the experiment is well shielded inside the Gran Sasso mountain, also a muon veto is needed. The 1st phase of GERDA will measure with existing enriched germanium detectors from the Heidelberg-Moscow and IGEX experiments. With these 15 kg, GERDA will be able to test the claim due to reduced background within one year.
Commissioning of the experiment starts in fall 2009.

The **muon veto** will consist of three independent detector systems. A layer of plastic scintillators above the penthouse will detect muons coming straight through the neck of the cryostat, while the water tank will be equipped with 4 times 10 PMTs on the wall and 20 more on the bottom [1].
It will act as an active **Cherenkov veto**. Six more PMTs just below the cryostat will complete the GERDA muon veto.

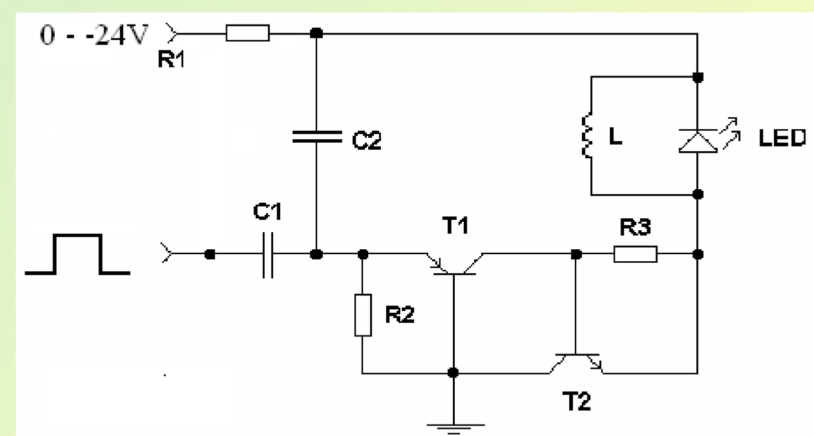
The PMTs are encapsulated in housings of stainless steel with a PET window at the front. To protect the PMTs against the water, the contacts of the voltage divider are protected with polyurethane and silicone. Long-time tests (more than one year under water) show that the capsule is water tight.



Left: Sketch of the GERDA Photomultiplier capsule
Middle: Finished capsule with 32 m cable (RG 213 U)
Right: Mounted capsule on the wall of the water tank

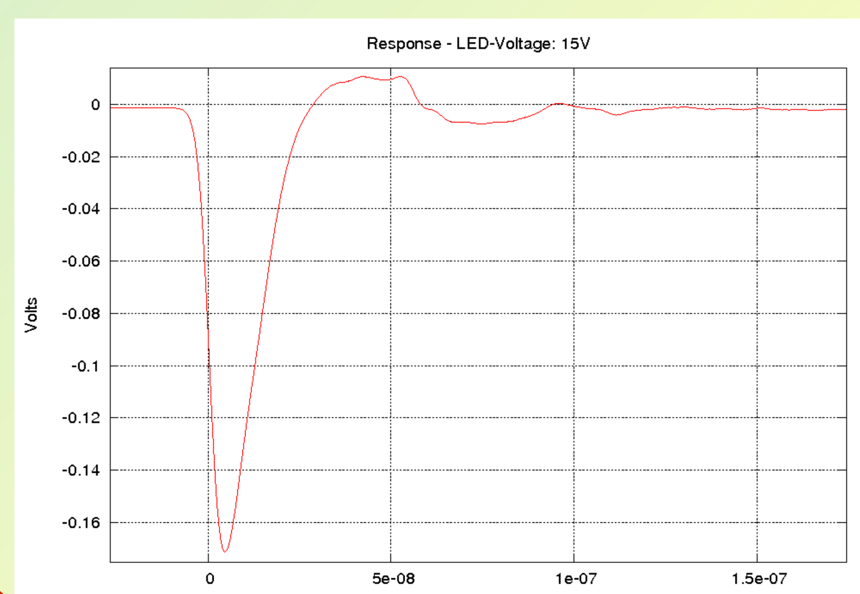
For **calibration and monitoring**, two systems will be implemented.

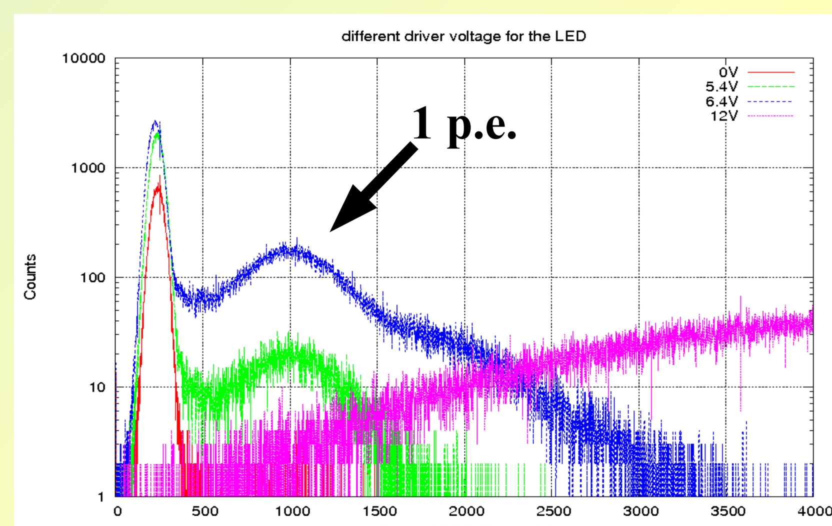
The first system uses a single fast ultra bright blue LED. An electronic driver for the source is a modified version of a driver first proposed by J. Kapustinsky et al. [2] (Figure on the right). The light output of this source is adjustable in the range of 0 – 109 photons per pulse in the range of 3-10 ns. Thus, the response of the PMTs is easily monitored. The light pulses are fed to each individual PMT via optical fibres (PMMA, core diameter: 1mm).



T1 – BFT92; T2 – BRF92;
R1 – 100kΩ; R2 – 2.2kΩ; R3 – 10kΩ;
C1 – 47pF; C2 – 100pF; L – 100nH

Sketch of the electronics for the LED.

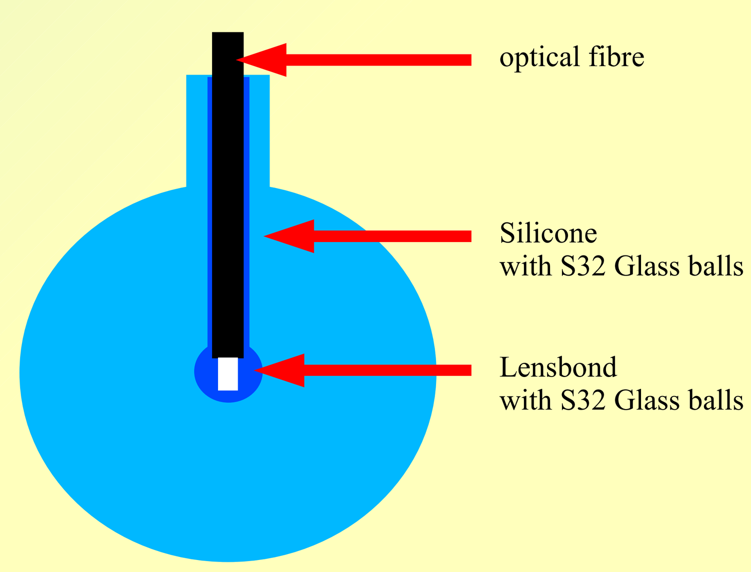




Light output of the system 1 for different supply voltages of the LED.

References:
1: M. Knapp, "The Gerda Muon Veto Cherenkov Detector", NIM-A
2: J.S. Kapustinsky et al., "A fast timing light pulser for scintillation detectors", NIM-A 241 (1985), p. 612
3: B.K. Lubsandorzhiev et al., "Powerful nanosecond light sources based on LEDs for astroparticle physics experiments"

The **second system** will use **diffuser balls** in the tank to illuminate it for geometry dependent calibration. Four of them will be located in the water tank, while one will be located in the volume under the cryostat. These balls are glass bulbs (diameter ~ 50mm) filled with silicone (Wacker SilGel 612 A&B) mixed with S32 5 microns glass bubbles (3M).
The light source itself consists of a high power blue LED and a special electronic driver based on three consecutively switched avalanche transistors [3]. It provides 10^{12} photons per pulse and is not adjustable. The width of the light pulse is 10ns.
The use of these diffuser balls will provide not only geometric dependent responses of the PMTs, but also a timing information due to the different distance of the PMTs to the diffuser ball.



Sketch and Picture of one diffuser ball

The PMTs on the wall are mounted. The others for the bottom have been prepared and are inside the water tank. After the final work on the cryostat, they will be fixed in their final position. The fibres are already connected to the capsules. The diffuser balls will come last. A first test will be made when the water tank is filled.