GERDA

Progress report to the LNGS scientific committee

(Short Write-up)

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This GERDA report summarizes the progress achieved during the last six months. This *Short Write-up* is linked at

`http://www.mpi-hd.mpg.de/GERDA/reportsLNGS/gerda-lngs-sc-nov09-shwup.pdf`.

Experimental and technical details are given in the *Appendix* which is linked at

`http://www.mpi-hd.mpg.de/GERDA/reportsLNGS/gerda-lngs-sc-nov09-appdx.pdf`.

Previous reports are available at `http://www.mpi-hd.mpg.de/GERDA/reportsLNGS`.

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The construction and integration of the GERDA experiment has been resumed immediately after the re-opening of the LNGS in early May to external users. The main parts of the GERDA underground installation including the clean room on top of the tank, the cryogenic infrastructures, the muon veto system and the general infrastructure have been completed and the commissioning of GERDA has started with the cooling of the cryostat. The Phase I signal chain integration test in Hall di Montaggio was successfully completed.

The most relevant issues are summarized in this *short write-up*. Further details can be found in the *appendix*.

Cryostat cooling started on November 2: The cryostat installation was completed during the last six months. This includes the installation of the external thermal shields, the vacuum infrastructure, the mounting of the pipes for argon and nitrogen from the storage tanks to the cryostat, the connections to the LNGS ventilation duct, the mounting of all safety devices including the argon gas–water heat exchanger and its connection to the LNGS cooling water system, cabling of all sensors and valves, and the installation of the PLC including the communication to the LNGS safety network. The readiness of GERDA and of LNGS for cooling the cryostat and for liquid argon filling were reviewed by the LNGS director, SPP, technical division and external experts in two consecutive meetings on October 7 and on October 27. GERDA received green light to start the cryostat cooling on November 2.

Cherenkov muon veto mounted: The muon veto mounting was resumed in May and completed in August. The inner surface of the water tank and the outer surface of the cryostat have been covered with a reflecting mirror foil. All photomultipler (PMT) have been installed, the cables routed to the electronic area, the PMTs tested, and the light calibration sources mounted.

Signal chain integration test completed: The glove box and commissioning lock were mounted on a platform in the Hall di Montaggio in order to test a Phase I detector string together with the PZ0 charge sensitive amplifier, the signal chain, the Phase I DAQ and the mechanics of the commissioning lock system. A cryostat with an active cooling system was mounted below the platform to simulate the GERDA cryostat. Detector and string handling procedures were defined and tested. An energy resolution of 2.9 keV (FWHM) at 1.3 MeV (10 μs shaping) was achieved for two detectors mounted in a string. The induced amplitudes in neighboring channels (cross talk) is about 1% of the parent amplitude. The integration test was completed successfully in November. Interface issues and technical problems could be identified such that the necessary modifications are being implemented to ensure a smooth start-up of GERDA underground in Hall A.

Calibration system for commissioning lock optimized: A (20.2 ± 0.4) kBq ^{228}Th gamma source using a gold substrate to reduce neutron production through (α, n) reactions has been produced, encapsulated and characterized. Wipe test where carried out to verify the tightness of the source. The measured neutron rate of the source is (0.017 ± 0.003)/sec which is well within the specifications. Two additional customized sources will be prepared before February 2010.

Purity of front-end electronics meets Phase I specifications: The capacitors which were responsible for the high ^{226}Ra background have been identified and replaced by low-background tantalum capacitors. The measured activity for the three channel PCB is 0.7 mBq for ^{226}Ra and and < 0.4 mBq for ^{228}Th. With 30 cm distance to the detectors, the PCB meets the specifications for the Phase I background requirements.

Low-background test stand LArGe filled: The low-background test stand with liquid argon scintillation read out has been installed in the Gerda underground detector laboratory (GDL) during the summer and the cryogenic commissioning has been completed recently. The PMT calibration and the study of detector response is currently ongoing.

R&D for Phase II detectors ongoing: For the production test of thick-window p-type BEGe detectors, 34 kg of depleted germanium oxide from ECP were reduced to germanium bars and zone refined at PPM. 21.5 kg germanium with 6N purity of this material was delivered to Canberra, Oak Ridge. So far, three crystals have been pulled with net impurity concentrations matching the requirements for BEGe detector production. Thick-window BEGe detectors will be available early 2010 for characterization and mass yield estimation. The successful crystal pulling at Oak Ridge, together with the high-purity float-zone crystals from IKZ showed that the germanium raw material and the purification at PPM are meeting the purity goals required for HP-Ge detector production. The contracts with PPM for the reduction and purification of 37.5 kg of enriched germanium material are now under preparation and the operations at PPM will start within the next months. During crystal pulling tests at IKZ it was realized that the source of the As impurity was the Czochralski puller itself. The Czochralski puller has been dismounted and all surfaces electro-polished. Crystal pulling tests should restart still this year.

Monte Carlo simulations of BEGe detector response: Detailed field and charge velocity calculations have been performed for BEGe detectors. Energy, position and time of the individual energy deposits are first simulated with the MaGe Monte Carlo package and then fed as inputs to a dedicated code in order to produce realistic electric pulses. The simulations were validated with experimental data. The computation of the electron and hole trajectories inside the BEGe detector gave an important insight on the origin of the peculiar shapes of the BEGe detector signals and on their time dependence on the interaction position. Moreover, the calculation of the pulse shapes allowed the investigation of the pulse shape discrimination capabilities of this detector between single-site events (SSE) and multi-site events (MSE) and possibly the tuning of the analysis algorithms.

In the light of the future data taking, the development of a general "New Energy Spectrum Toolkit" (NEST) was started. NEST is meant to draw, scale, and stack simulated energy spectra (e.g. from MaGe) in order to assemble a realistic energy spectrum as measured in the early phase of the Gerda experiment. The final goal is to fit simulated energy spectra to a measured energy spectrum and to extract parameters, e.g. the radioactive contamination of a certain part used inside the GERDA experiment.

Radon emanation measurements and material screening: The radon emanation of the cryostat was measured again after the installation of the connecting pipes, sensors and shroud. The value of 55 ± 4 mBq is about a factor of two higher than before and there is evidence that the emanation is higher in the neck of the cryostat. A detailed analysis of the individual emanation contributions is impracticable. With the two active cooling circuits there should be little mixing of the argon in the cryostat with the argon in the neck, since the latter will be tuned to a higher temperature. Therefore, radon from the neck (or from the connecting pipes) is not expected to get close to the diodes.

The electrostatic radon monitor was shipped to the Gran Sasso underground laboratory in August and successfully installed in September. Within the next months, it will be connected to the exhaust line of the GERDA cryostat to measure the radon content in gaseous Ar. Most gamma spectroscopy measurements during the last months were dedicated to the selection of high-purity components for the front-end electronics.

Schedule update: The commissioning of the GERDA experiment started on November 2 with the cooling of the cryostat. Provided that the cooling and filling is carried out according to the planning, the liquid argon filling will be completed by the end of November. Final commissioning of the active cooling system will be carried out during December. A verification of the water discharge rate from the water tank is required prior to the filling of the water tank. It has been agreed with the LNGS director to perform the water drainage test as soon as possible.

With the completion of the detector and signal integration test in the Hall di Montaggio, the glove box will be moved into the clean room on top of the cryostat during the last week of November. The single-string commissioning lock is currently being modified and scheduled for installation in Hall A in February. Subsequently, non-enriched detectors will be deployed in the cryostat as the final step of the commissioning phase.