GERDA

Progress report to the LNGS scientific committee

(Short Write-up)

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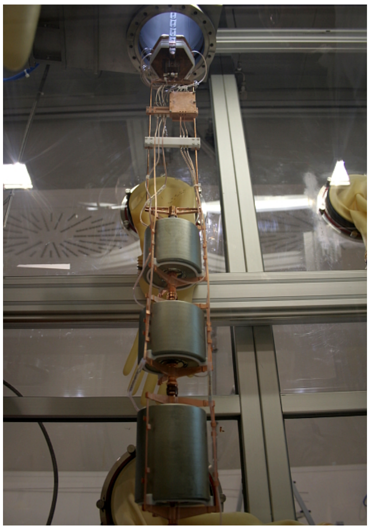
This GERDA report summarizes the progress achieved during the last six months. This *Short Write-up* is linked at:

`http://www.mpi-hd.mpg.de/GERDA/reportsLNGS/gerda-lngs-sc-oct10-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-oct10-appdx.pdf`.

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



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H. Aghaei [m], M. Agostini [f], M. Allardt [c], A.M. Bakalyarov [l], M. Balata [a], I. Barabanov [j], M. Barnabe-Heider [f], L. Baudis [r], C. Bauer [f], N. Becerici-Schmid [m], E. Bellotti [g,h], S. Belogurov [k,j], S.T. Belyaev [l], A. Bettini [n,o], L. Bezrukov [j], T. Bruch [r], V. Brudanin [d], R. Brugnera [n,o], D. Budjas [f], A. Caldwell [m], C. Cattadori [g,h], F. Cossavella [m], E.V. Demidova [k], A. Denisiv [j], S. Dinter [m], A. Di Vacri [a], A. Domula [c], V. Egorov [d], F. Faulstich [m], A. Ferella [r], K. Freund [q], F. Froborg [r], N. Frodyma [b], A. Gangapshev [j], A. Garfagnini [n,o], S. Gazzana [f,a], R. Gonzalea de Orduna [e], P. Grabmayr [q], K.N. Gusev [l,d], V. Gutentsov [j], W. Hampel [f], M. Heisel [f], S. Hemmer [m], G. Heusser [f], W. Hofmann [f], M. Hult [e], L.V. Inzhechik [j], J. Janicsko [m], J. Jochum [q], M. Junker [a], S. Kionanovsky [j], I.V. Kirpichnikov [k], A. Klimenko [d,j], K-T. Knoepfle [f], O. Kochetov [d], V.N. Kornoukhov [k,j], V. Kusminov [j], M. Laubenstein [a], V.I. Lebedev [l], B. Lehnert [c], D. Lenz [m], S. Lindemann [f], M. Lindner [f], I. Lippi [o], X. Liu [p], A. Lubashevskiy [f], B. Lubsandorzhiev [j], B. Majorovits [m], G. Meierhofer [q], I. Nemchenok [d], C. O'Shaugnessy [m], L. Pandola [a], K. Pelczar [b], G. Pivato [o], F. Potenza [a], A. Pullia [i], S. Riboldi [i], F. Ritter [q], C. Rossi Alvarez [o], C. Sada [o], J. Schreiner [f], B. Schwingenheuer [f], S. Schönert [f], M. Shirchenko [l,d], H. Simgen [f], A. Smolnikov [d,j], L. Stanco [o], F. Stelzer [m], M. Tarka [r], A.V. Tikhomirov [l], C.A. Ur [o], A.A. Vasenko [k], A. Vauth [m], O. Volynets [m], M. Weber [f], M. Wojcik [b], E. Yanovich [j], P. Zavarise [a], S.V. Zhukov [l], D. Zinatulina [d], F. Zocca [i], K. Zuber [c], G. Zuzel [b],

[a]) INFN Laboratori Nazionali del Gran Sasso, LNGS, Assergi, Italy
[b]) Institute of Physics, Jagellonian University, Cracow, Poland
[c]) Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Dresden, Germany
[d]) Joint Institute for Nuclear Research, Dubna, Russia
[e]) Institute for Reference Materials and Measurements, Geel, Belgium
[f]) Max Planck Institut für Kernphysik, Heidelberg, Germany
[g]) Dipartimento di Fisica, Università Milano Bicocca, Milano, Italy
[h]) INFN Milano Bicocca, Milano, Italy
[i]) Dipartimento di Fisica, Università degli Studi di Milano e INFN Milano, Milano, Italy
[j]) Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia
[k]) Institute for Theoretical and Experimental Physics, Moscow, Russia
[l]) Russian Research Center Kurchatov Institute, Moscow, Russia
[m]) Max-Planck-Institut für Physik, München, Germany
[n]) Dipartimento di Fisica dell'Università di Padova, Padova, Italy
[o]) INFN Padova, Padova, Italy
[p]) Shanghai Jiaotong University, Shanghai, China
[q]) Physikalisches Institut, Eberhard Karls Universit"at Tübingen, Tübingen, Germany
[r]) Physik Institut der Universität Zürich, Zürich, Switzerland

Spokesperson: S. Schönert
(*Stefan.Schoenert@mpi-hd.mpg.de*)
Deputy Spokesperson: C. Cattadori
(*Carla.Cattadori@lngs.infn.it*)
Technical Coordinator: K.T. Knoepfle
(*Karl-Tasso.Knoepfle@mpi-hd.mpg.de*)
URL: `http://www.mpi-hd.mpg.de/GERDA/`

Major progress has been achieved since the last meeting. Following first deployment and operational tests with a detector mock-up and a single non-enriched bare diode during May, the first string of three non-enriched low-background detectors was deployed successfully in the GERDA cryostat on June 2.

The details of data taking and the first assessment of the signal spectra are summarized in the GERDA Scientific and Technical Report GSTR-10-004, which is available to the LNGS SC. The most relevant issues are summarized in this *short write-up*. Further details can be found in the *appendix*.

First technical run with non-enriched detectors: The GERDA data taking with three ^{nat}Ge diodes started 2 June. No lines from uranium, thorium and their progenies are visible within the acquired statistics of 1.3 kg years. This provides stringent limits on the achieved radio purities which meet our requirements. However, there is one prominent and unexpected feature in the energy spectrum: a line at 1525 keV with a count rate of about 1 count/(kg$\cdot$d). The signal originates from ^{42}K, the progeny of ^{42}Ar. There are also events with energies above 1525 keV ranging into the energy region of interest of $Q_{\beta\beta}$. At least a large fraction of these events are created by beta and beta/gamma events from the ^{42}K beta decay. The measured counting rate in the line is more than one order of magnitude higher than when adopting the 90% upper limit of ^{42}Ar/^{40}Ar $< 4.3 \times 10^{-21}$ given by the DBA experiment assuming a homogeneous distribution in the liquid argon. We observed that the counting rate of the ^{42}Ar (^{42}K) signal depends on the electric fields in the liquid argon in the vicinity of the germanium detectors. The results indicate that the ^{42}K is positively charged after its production and that it drifts within the electrical field which can lead to signal enhancement effects. In the ongoing experimental campaign, we are investigating the impact of particular bias schemes on the counting rate of the ^{42}Ar (^{42}K) signal varying the voltages of the diodes, of the detector holder, of the enclosing cylindrical copper electrode (mini-shroud), and of the radon shroud. Experimental studies are simultaneously ongoing in the GERDA cryostat and in the LArGe facility. The experimental work is complemented by extensive Monte Carlo simulations and by modeling of the electrical field and of the ion drift. Though the current rate is higher than expected, we are confident, that an optimization of the electronic field configuration in the vicinity of the germanium diodes will allow us to further reduce the ^{42}Ar (^{42}K) rate. The details of the measurements are summarized in the GERDA Scientific and Technical Report GSTR-10-004.

Phase II detectors: Since the last scientific committee meeting, a milestone was reached and a very important decision was made: The collaboration has decided to pursue the BEGe detector technology for Phase II, and the purification of the ^{enr}Ge for Phase II was completed successfully with very high yield of 6N material.

Background suppression studies with a BEGe detector in LArGe: The 80 mm diameter BEGe (s/n: b 09001) with 878 g mass, previously operated in the GDL liquid argon test stand, has been deployed in the LArGe test stand. The energy resolution of the detector inside LArGe, coupled to a (non-low background) CC2 front-end board was 2.0 keV (FWHM) at 1.33 MeV and 1.6 keV (FWHM) with the pulser. A survival probability of $(1.6 \pm 0.7) \times 10^{-4}$ (ie. background suppression factor of 0.6×10^4) at $Q_{\beta\beta}$ was achieved for a close by ^{228}Th gamma source using simultaneously the liquid argon scintillation and the pulse shape information of the BEGe detector.

Stable operation of cryostat: The operation of the cryostat is very stable since it was filled in December 2009. The vacuum pressure is stable at 3×10^{-8} mbar, the active cooling with liquid nitrogen is working such that no argon was refilled since January 2010, the pressure regulation keeps the absolute pressure at 1.2 bar with a variation of less than 50 mbar and the monitoring and PLC control is running continuously.

Front-end electronics radioactive budget further reduced: The number of SMD capacitors could be further reduced in the new CC2 front-end electronic circuit. The measured activities for a 3-channel PCB mounted with all its components are now 170 μBq and 290 μBq for the ^{232}Th and ^{238}U progenies.

Data analysis infrastructures improved: In addition to the upgrade, testing and debugging of the MGDO (Majorana-GERDA Data Object) software library, a new dedicated C++ software package called Gelatio (GErda LAyouT for Input/Output) has been initiated and intensively developed in the past months. The main aim of Gelatio is to provide general and flexible Gerda-dedicated tools for the handling and analysis of data, starting from data files in MGDO format.

Calibration source lowering system: At the end of September, the stainless steel band holding the source and its Ta holder has suffered a rupture during a calibration procedure. This led to the holder and source being lost at the bottom of the cryostat. The cause of this rupture is under investigation but it is likely related to the operation of the motor, namely to the fact that the handling of the source parking position and the motor torque protection had not been implemented. At the time of writing we are building a new source holder and we will be starting to design and test a new source lowering system. With 3 m of liquid argon between source and detectors, a ^{228}Th source activity of 30 kBq and a measured neutron flux of 1.3×10^{-3} n/(s $\cdot$ kBq), we obtain a background rate of $< 2 \cdot 10^{-3}$ cnt/(kg $\cdot$ y $\cdot$ keV) and $5 \cdot 10^{-5}$ cnt/(kg $\cdot$ y $\cdot$ keV) from gammas and neutrons, respectively, which is acceptable for Gerda Phase I.

New task group for data management formed: A new task group has been created to organize the data management and data quality control. Many pieces of hardware and software have been created or established already by the experts. However, the coordination and control should ensure the most complete measurement and documentation of parameters for an efficient analysis. The handling of slow control and calibration is included in this work; data security is an essential issue. The on-line monitoring of the data, e.g., will set immediate alarms in case of unforeseen changes of any parameter. The data stream is being worked out and the interrelation between the hardware on the acquisition side and the storage side are detailed, as well as the interconnection between data and simulation.