First Results of the GERDA Muon Veto

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01.04.2011 / DPG Frühjahrstagung Teilchenphysik
Outline

Hardware status
   The GERDA Experiment
      Calibration system

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   Simulations
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The GERDA Experiment

- **Germanium Detector Array**
- Determination of $T_{1/2}$ of the neutrinoless double beta decay in $^{76}\text{Ge}$, collaboration with Majorana

**Problems:**
- Low rate of the $0\nu\beta\beta$ decay: $T_{1/2}(^{76}\text{Ge}) \geq 1.2 \times 10^{25}\text{y}$ [HdM]
- Cosmic muons, “dirty” materials, activation, ambient radioactivity

**Solution:** background reduction
- Clean environment, Radon tightness, low Z shielding
- LNGS has 1.400 m of overlaying rock, reduction of cosmic muons
The GERDA Experiment: muon veto

- Cosmogenic muons surface: \(200/(s \, m^2)\); LNGS: \(1/(h \, m^2)\)
- Background due to muons: \(10^{-3} \approx 10^{-2}\) cts/(keV kg y)
- Muons limit \(T_{1/2}\) to \(\approx 1.5 \times 10^{26}\) y!!!
- But: muon energy and angular distribution well known
- Muon Cherenkov veto

[Caldwell, Kröninger; PhysRevD.74.092003]
Hardware status

- Ge-strings
-Muon Cherenkov veto
-Water purification & Radon monitor
-Control room
-Cleanroom and lock
-Ge-detectors
-LAr cryostat
-Plastic veto

[Image: MPIK, Heidelberg]
The GERDA Experiment

Hardware status

- Splitter boxes, LED drivers
- Splitter crate
- HV crate
  Supply for PMTs & panels
- Ge−gate
- VME crate
  PC, FADC, DAC
- PMTs, calibration system, VM2000
- Water tank
  Supply for PMTs & panels
- Plastic veto

66 PMTs, 10 FADC, 70 splitters, 6 pulsers, 7 panels
Calibration system

- Five diffuserballs, for homogenous illumination
- Powered by a DAC and driven by VME pulser
- PMT calibrated on single photon peak at 80 FADC channels
- PMT show drift, calibration routine needed
Calibration system

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Monte Carlo studies

- Simulation of placement and coincidence conditions for 66 PMTs
- Simulated events show high PMT multiplicity and a high p.e. count
- Veto efficiency for $\mu_{\text{eDep}}$: $\eta = 99.56 \pm 0.42\%$ (4 FADC in 30 ns) [Knapp,09]
Muon veto performance

PMT multiplicity for different muon classes.
Muon veto performance

PMT multiplicity in comparison to the events integral.
Muon veto performance

- The muon veto is running with the current settings since Nov. 2010
- An abundance of low multiplicity/low p.e. events has to be suppressed by hardware settings (5 FADC in 60 ns)
- Expected $\mu$-rate: 0.03 Hz, actual rate: 0.04 Hz
- Possible causes: Scintillating foil
- Cuts on both integral and multiplicity only offline possible
Comparison with Ge data

- 79 muon hits in recorded data, 78 of which are vetoed
- Cut conditions: >8.5 MeV in one Ge or >4 MeV in several
- Muon rejection efficiency for the germanium of $\epsilon = (97.9^{+1.2}_{-2.0})\%$ [Pandola]
- Data analysis of Ge- and $\mu$ data is currently done separately
- Integration und first joint analysis is ongoing
Comparison with Ge data

Run12. Exposure: 0.587 kg $\times$ year

$\mu$-background in Run12: $\approx 10^{-2}\text{cts/(keV kg y)}$ [Schönert]
Conclusions and Outlook

- The muon veto is running smoothly since last November
- GERDA is taking Ge-data with a muon anticoincidence signal

Outlook

- Remaining plastic panels will be added in the coming months
- Integration of \( \mu \)-date into Ge-framework is ongoing