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First Results of the GERDA Muon Veto

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01.04.2011 / DPG Frühjahrstagung Teilchenphysik

bmb+f - Förderschwerpunkt
Astroteilchenphysik
Großgeräte der physikalischen
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GERDA

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Outline

Hardware status

- The GERDA Experiment
- Calibration system

Muon veto performance

- Simulations
- Muon data

The GERDA Experiment

- **Ger**manium **D**etector **A**rray
- Determination of $T_{1/2}$ of the neutrinoless double beta decay in ^{76}Ge, collaboration with Majorana

Problems:

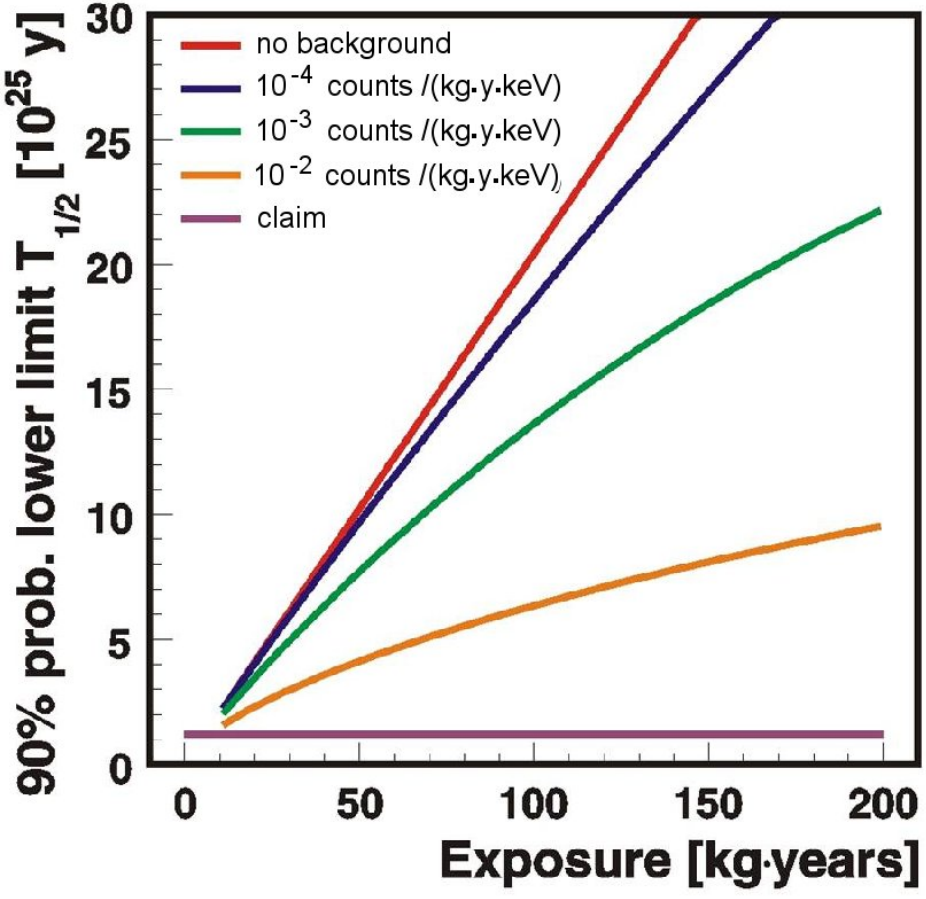
- Low rate of the $0\nu\beta\beta$ decay: $T_{1/2}(^{76}\text{Ge}) \geq 1.2 \times 10^{25}$y [HdM]
- Cosmic muons, “dirty” materials, activation, ambient radioactivity

Solution: background reduction

- Clean environment, Radon tightness, low Z shielding
- LNGS has 1.400 m of overlaying rock, reduction of cosmic muons

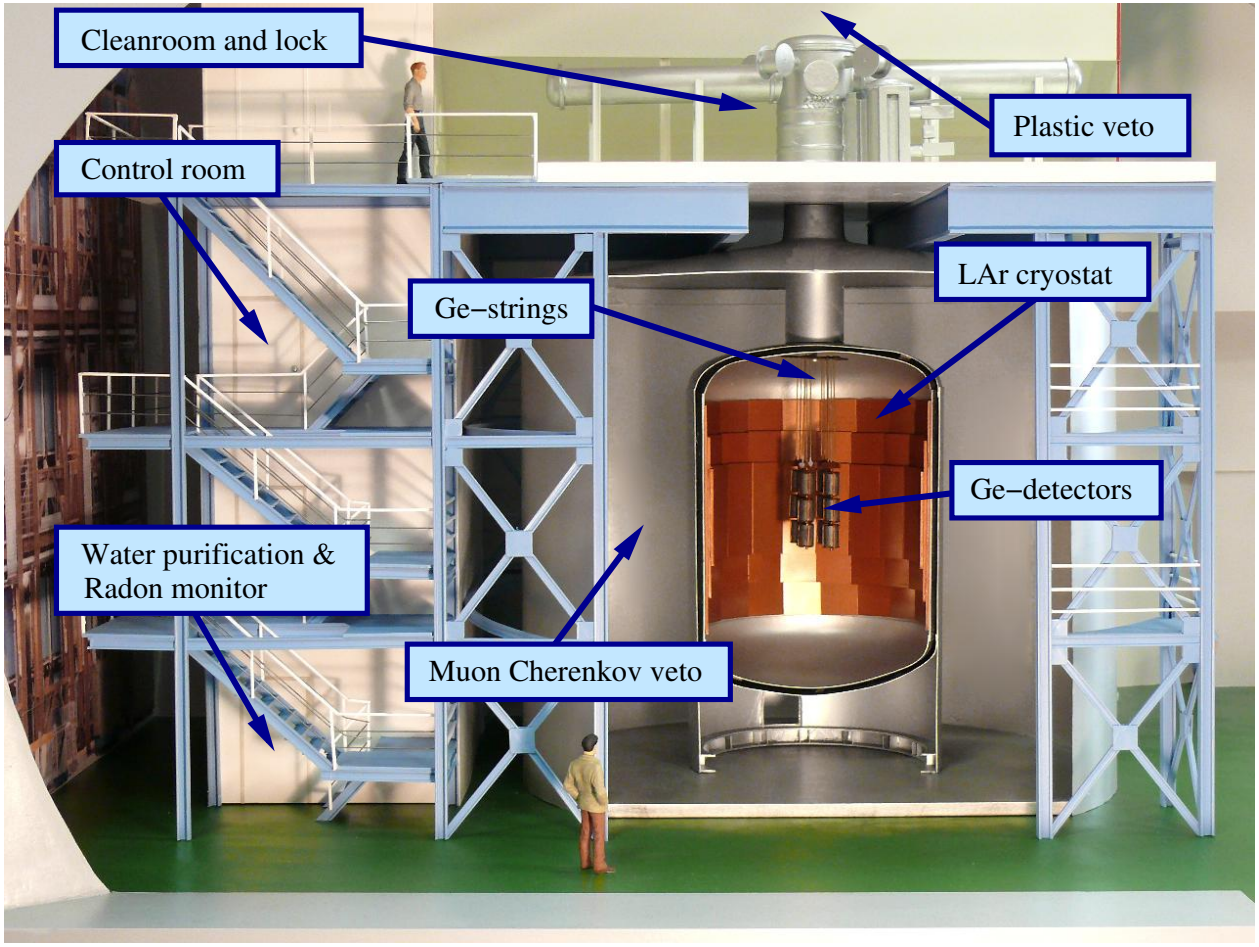
The GERDA Experiment: muon veto

- Cosmogenic muons surface: 200/(s m^2); LNGS: 1/(h m^2)
- Background due to muons: $10^{-3} - 10^{-2}$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

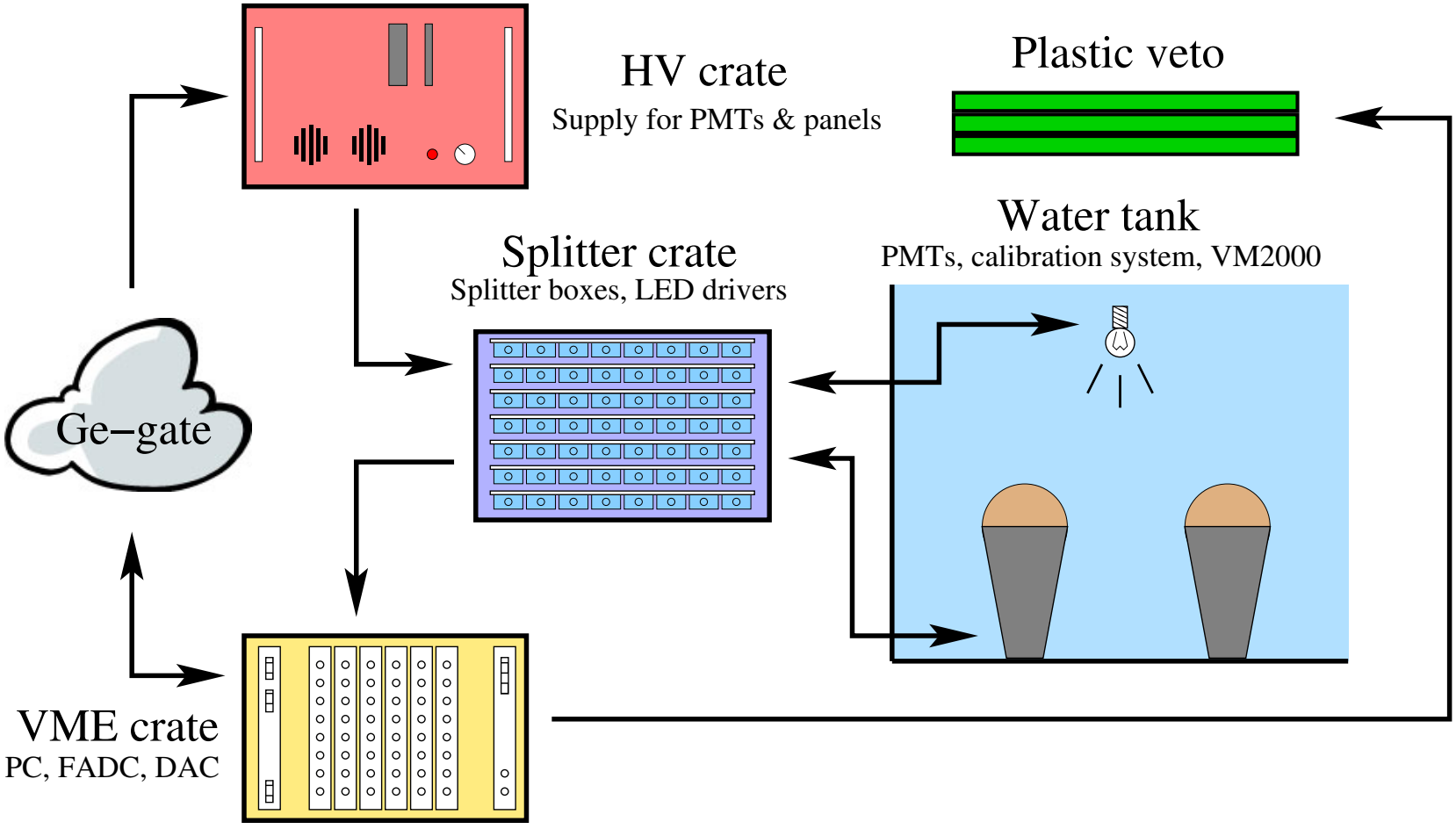


[Caldwell,Kröninger;PhysRevD.74.092003]

Hardware status



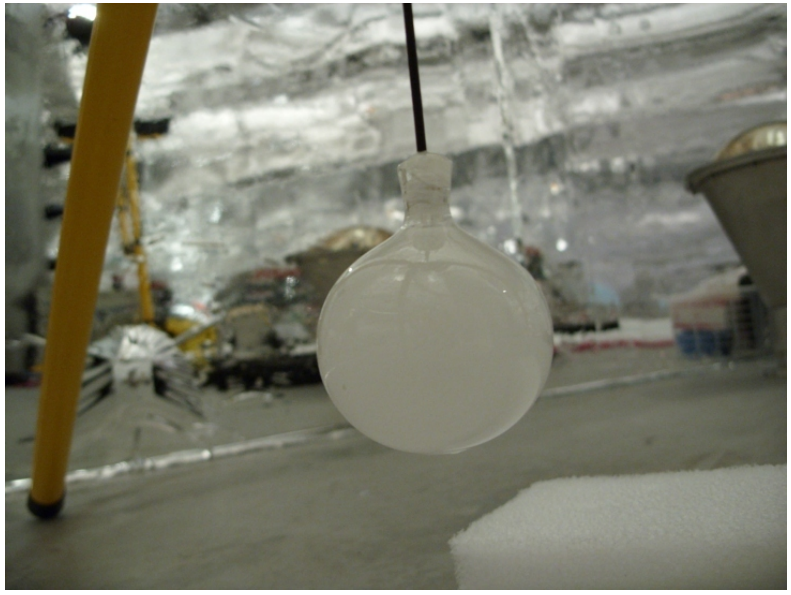
[Image: MPIK, Heidelberg]



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

Calibration system

- Five diffuserballs, for homogenenous 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



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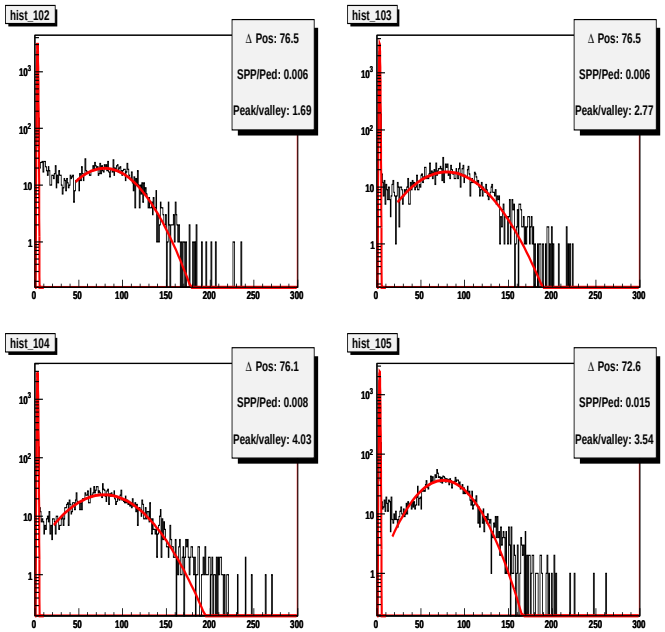
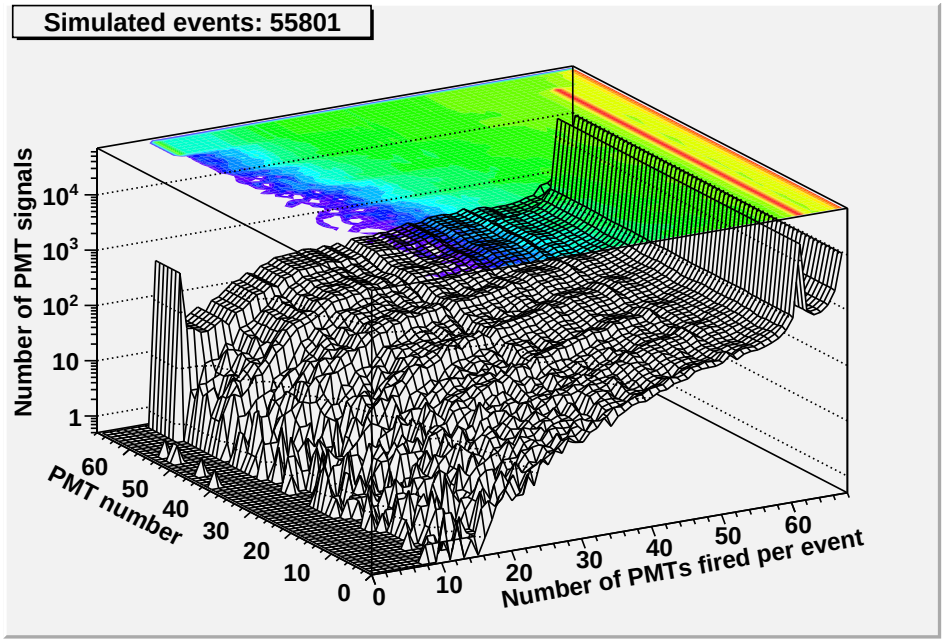
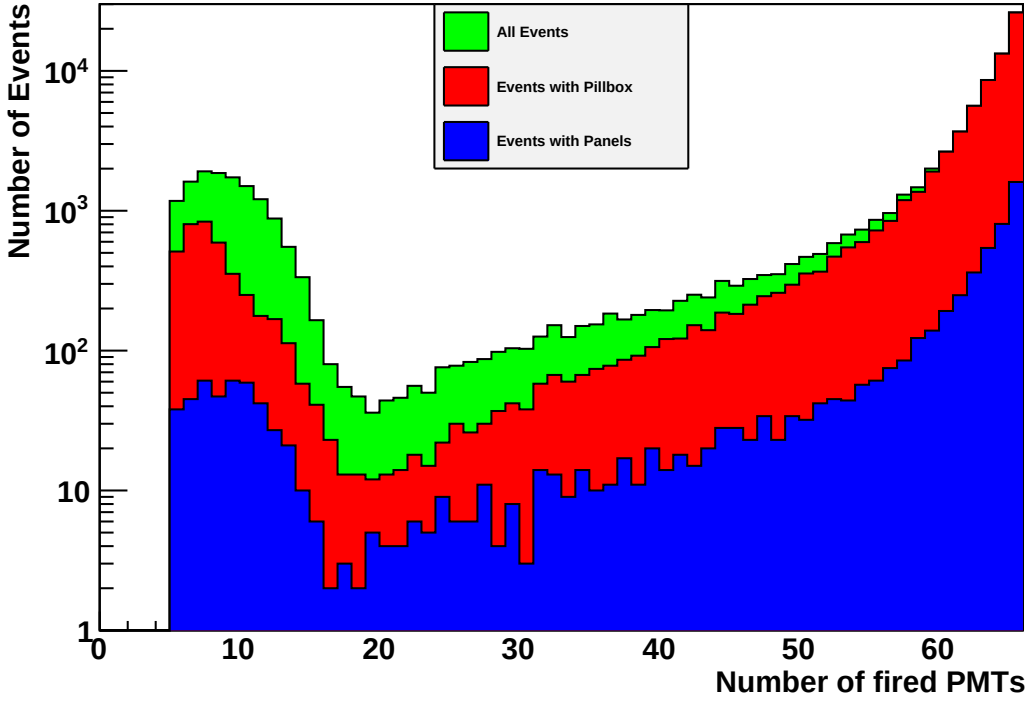


Monte Carlo studies

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

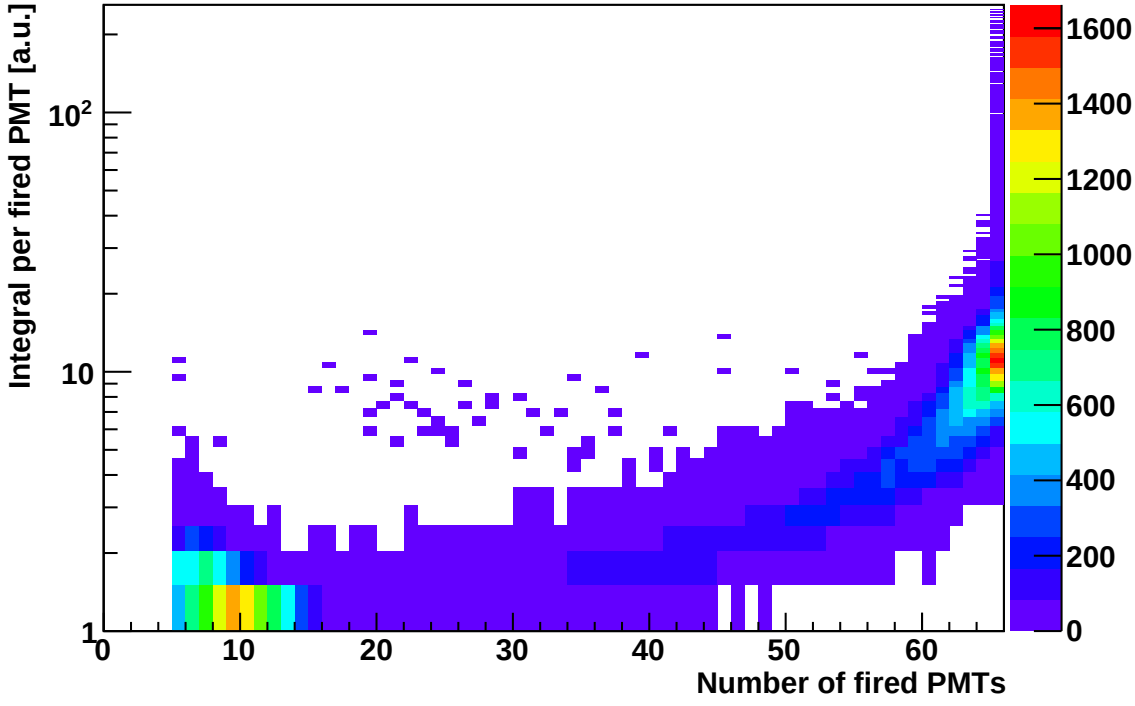


Muon veto performance



PMT multiplicity for different muon classes.

Muon veto performance



PMT multiplicity in comparison to the events integral.

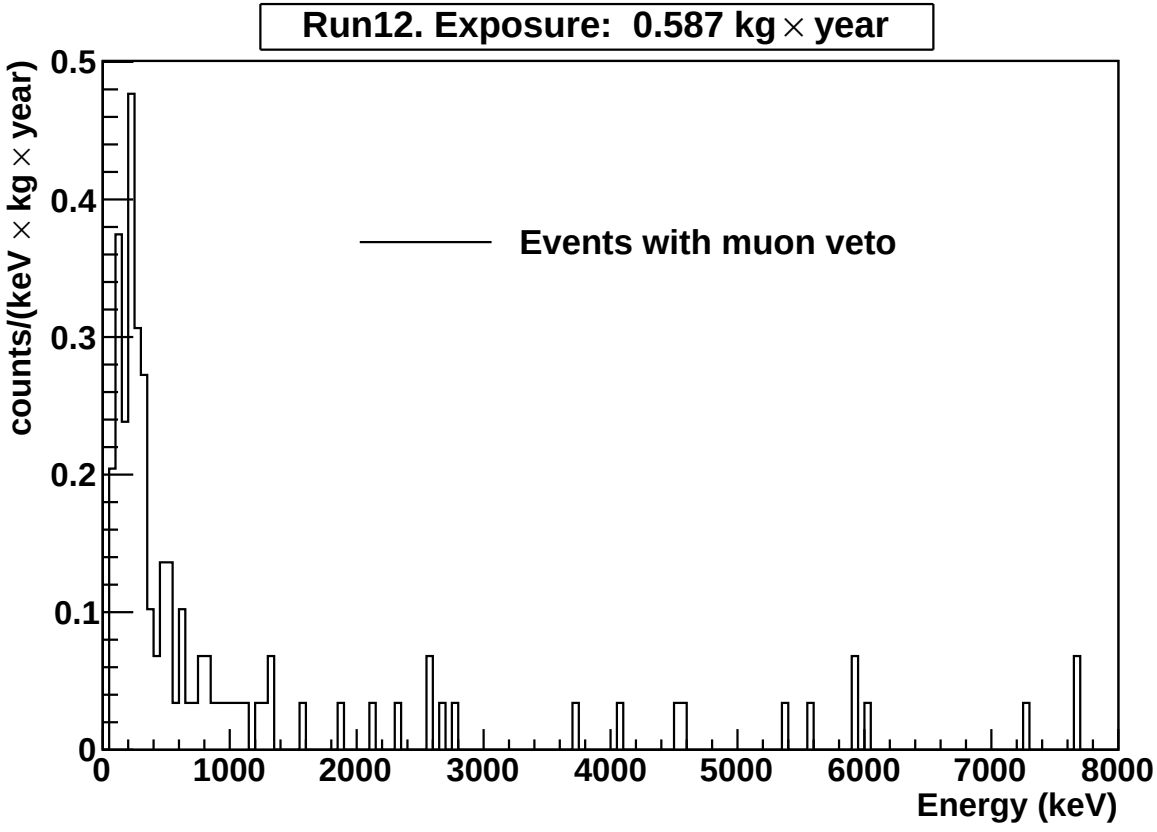
Muon veto performance

- 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 μ-rate: 0.03 Hz, actual rate: 0.04 Hz
- Possible causes: Scintillating foil
- Cuts on both integral and multiplicity only offline possible

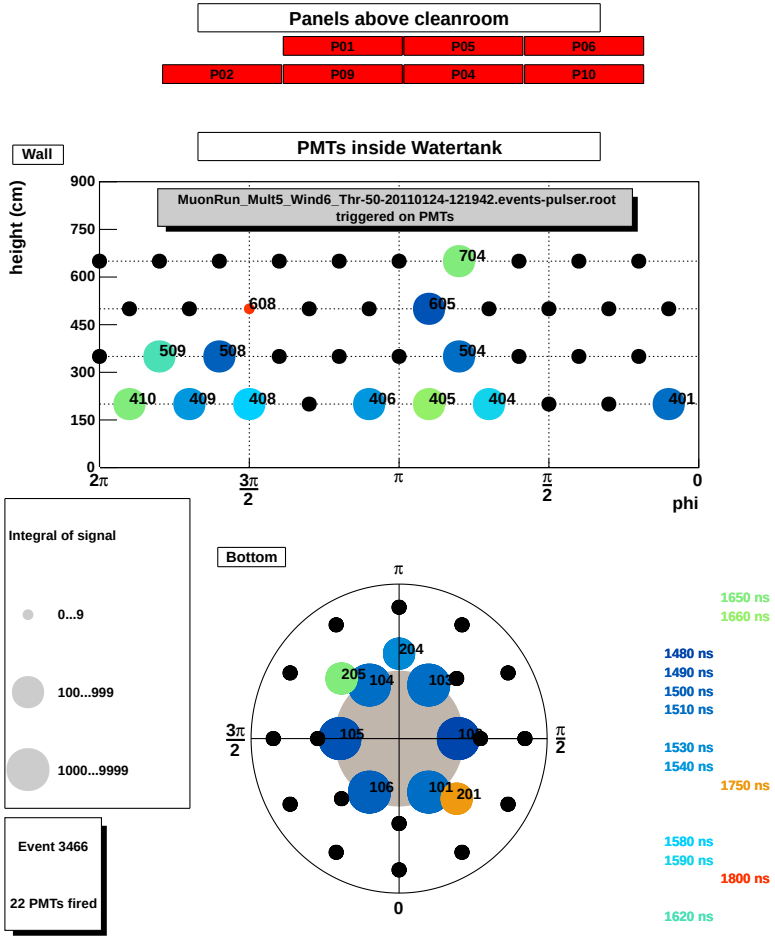
Comparison with Ge data

- 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 μ data is currently done seperately
- Integration und first joint analysis is ongoing

Comparison with Ge data



μ-background in Run12: $\approx 10^{-2}$cts/(kev kg y) [Schönert]



Coincident μ-Ge event

Conclusions and Outlook

- The muon veto is running smoothely 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 μ-date into Ge-framework is ongoing