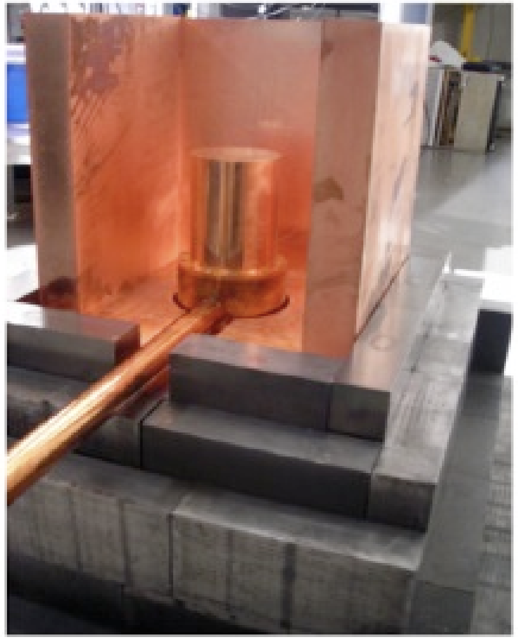

Material Screening Measurement of Xenon100 Detector with GATOR Set-up at LNGS

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Overview

- Introduction
- HPGe Detectors
- The GATOR Detector
- Gator Simulations
- Material Screening
- Future Plans
- Summary

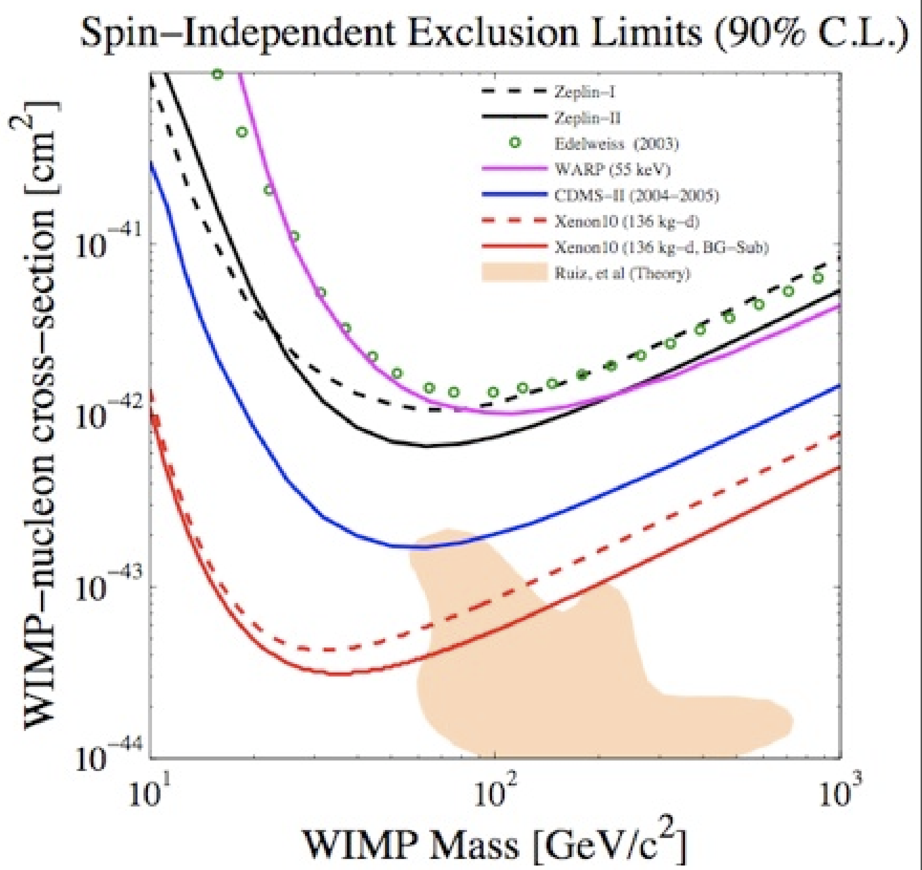
Introduction

- Experimental challenge = Background control

- Dark matter searches => limited by background
  - Cosmic radiation
  - Residual radiation emitted from surrounding materials (U, Th, K, Co contaminations)
  - Passive background suppresion is possible by ;
    - Locating the experiment in a deep underground facility
    - Careful selection of materials

Introduction

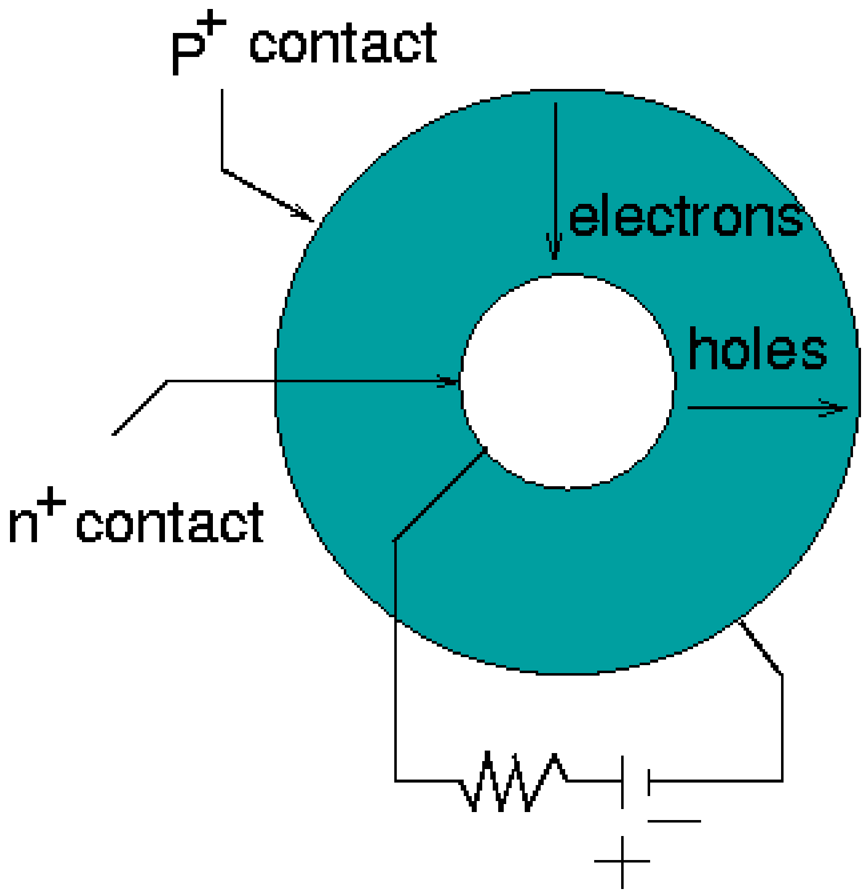
- First phase (Xenon10) = Proof of principle
- a 15 kg xenon dual phase time projection chamber (XeTPC)
- simultaneous measurement of scintillation and ionization in pure LXe
- Best limit in the spin independent WIMP-nucleon interaction (8.8×10^{-44} cm^2)



- Second Phase (Xenon100)
- Sensitivity increasment = Suppression of background + increase detector mass
- Increase of detector mass (100 kg Liquid Xenon)
- Careful selection of experimental materials => Material screening with a high purity Ge detector

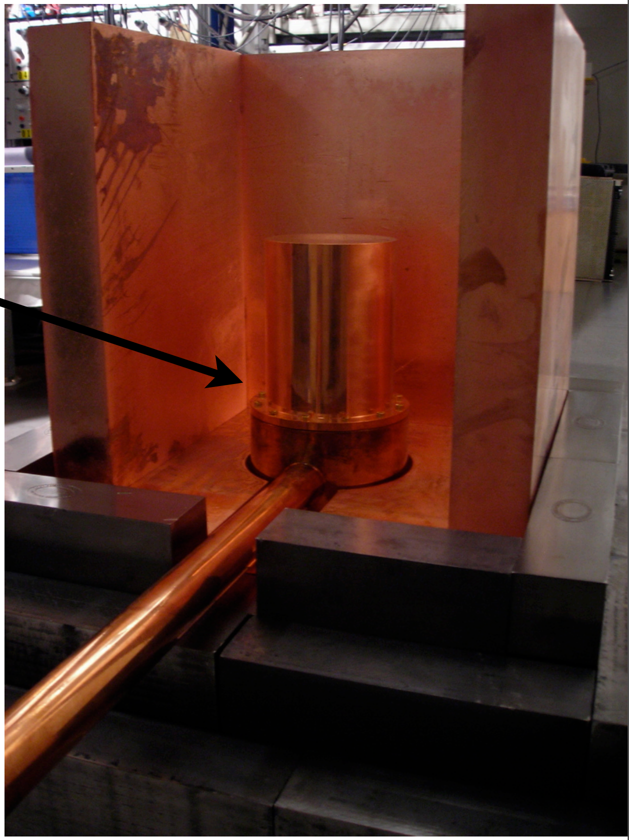
HPGe Spectrometers

- Small bandgap between valence and conduction bands
- Incoming gamma ray excites electrons to conduction band creating electron-hole pairs
- Cool via liquid N2 to reduce leak current



The GATOR DETECTOR

- **HPGe detector produced by Canberra**
- 2.2 kg HPGe crystal
  - coaxial crystal: 82 mm diameter, 81.5 mm height.
- Ultra Low Background Cu housing
- Able to measure all energies of interest for our background studies (0-3000 keV)



Physical Characteristics

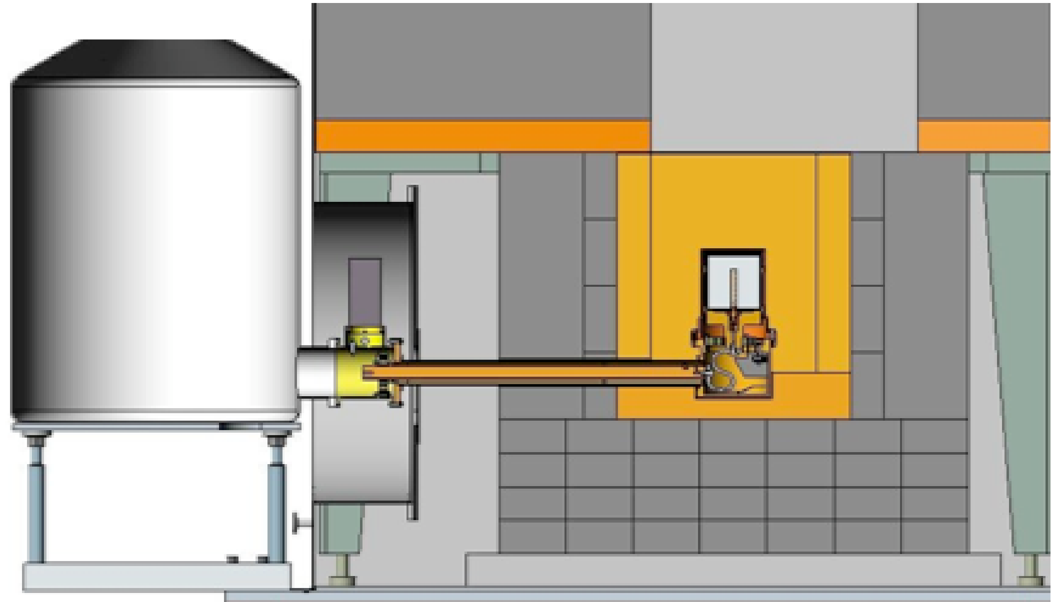
Source (isotope)	^{57}Co	^{60}Co
Energy (keV)	122	1332
FWHM (keV)	1.09	2.06
FWTM (keV)		4.04
Peak/Compton		76.0 : 1
Rel. Efficiency		100.5 %

The GATOR Detector

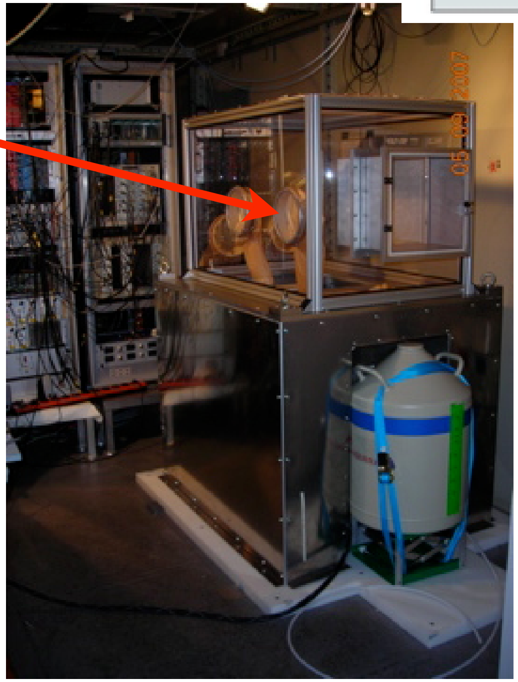
√ N2 Atmosphere

√ Located @ LNGS

√ Started taking data on december 2007



Glove box on top for sample

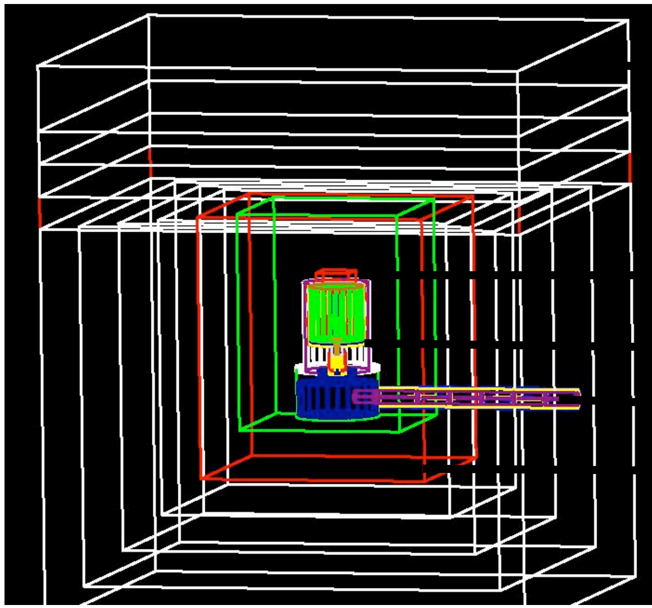


Detector in the shield

Sample

Gator Simulations

- Simulations done with Geant4 by CERN
- All major components simulated



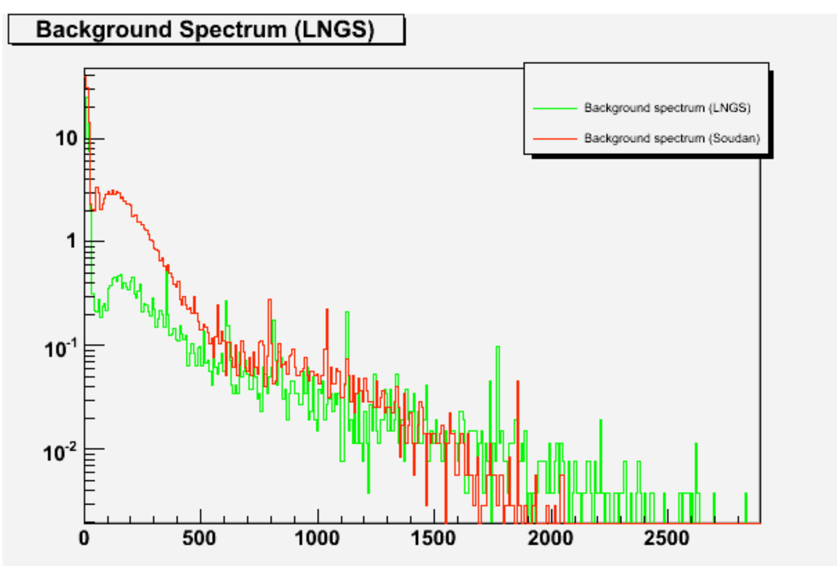
Lead layers

Cirlex PMT Bases (on top of the copper end cap)

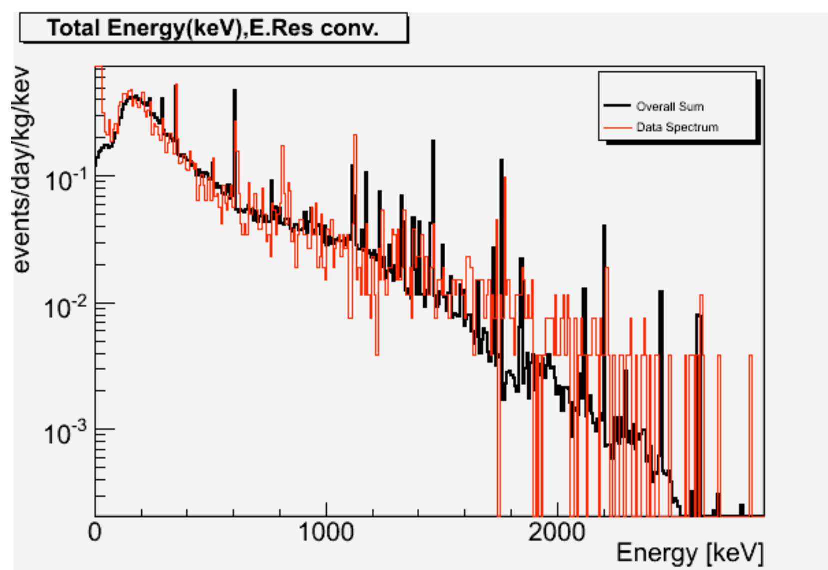
HPGe Crystal

Cold finger for cooling

Inner most ultra low background copper layer

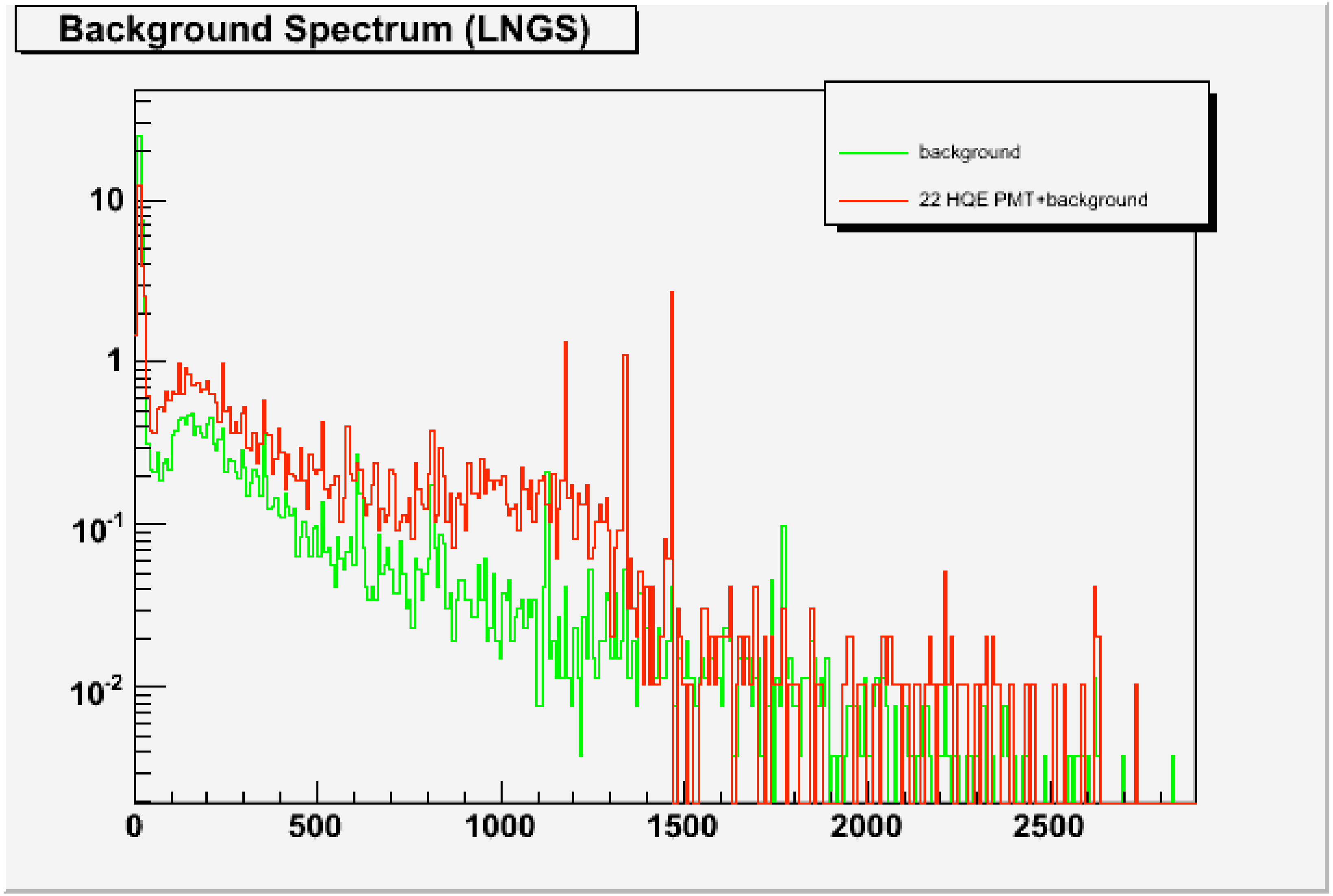


LNGS background spectrum vs SOLO facility in Soudan



Fit of simulated background to the real measurement

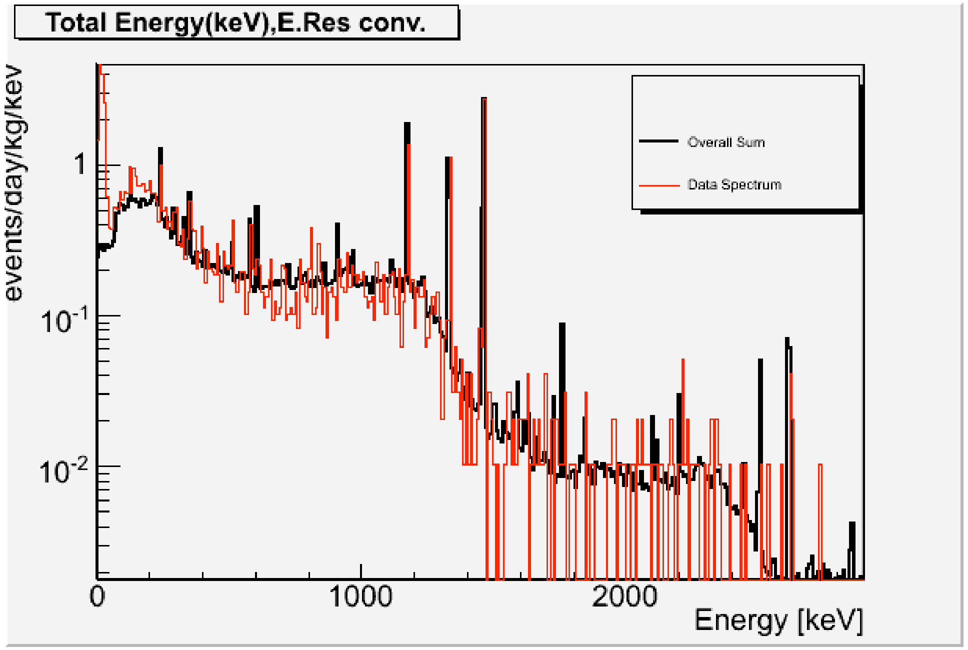
Material Screening



22 High QE PMT SPECTRUM

- Activity = Counts per second / Efficiency / Sample Mass (Bq / kg)

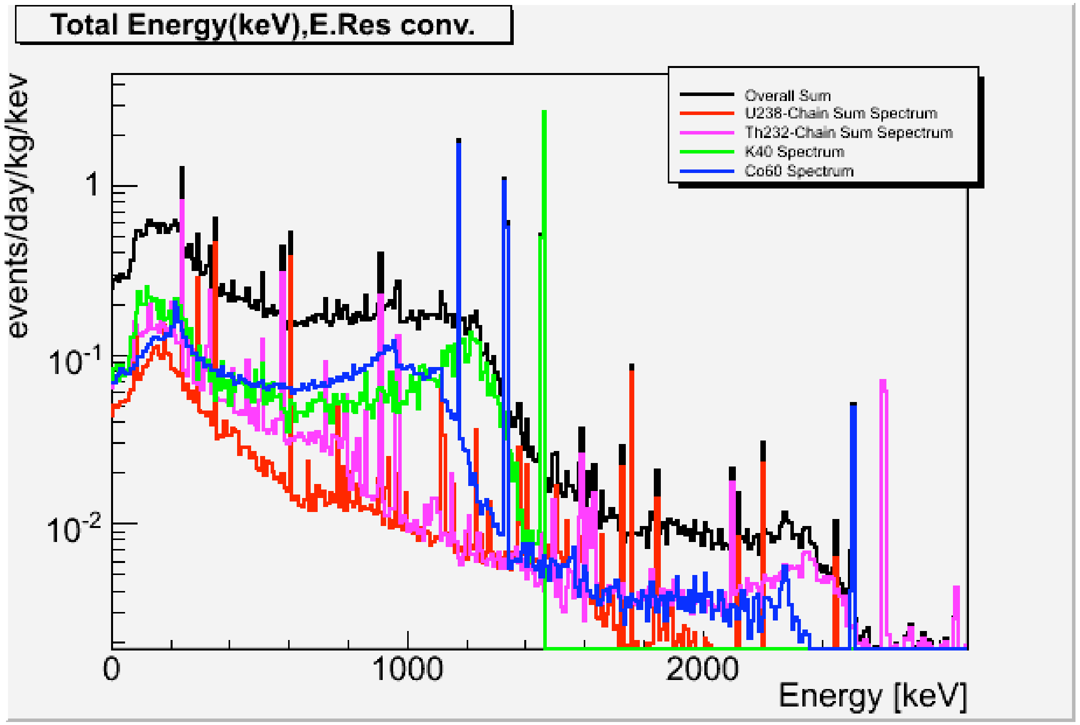
Material Screening



22 HQE PMT

U238 | Th232 |K40 | Co60

0.64 | 0.18 | 12 | 0.60
(mBq / PMT)



- Activity = Events Simulated * Detector Mass * Bin Width * Scale / Sample Mass (events / kg / day)

Material Screening

PMTs

Sample	Detector	238U (mBq/PMT)	232Th (mBq/PMT)	60Co (mBq/PMT)	40K (mBq/PMT)
23 HQE PMEs	GeMPI2	0.16 ± 0.05	0.46 ± 0.16	0.73 ± 0.07	14 ± 2
39 PMTs	GeMPI2	0.12 ± 0.01	0.11 ± 0.01	1.5 ± 0.1	6.9 ± 0.7
48 PMTs	GeMPI2	0.11 ± 0.01	0.12 ± 0.01	0.56 +/- 0.04	7.7 +/- 0.8
22 HQE PMTs	Gator	< 0.64	0.18 ± 0.06	0.60 ± 0.1	12 ± 2

Other materials

Sample	Detector	238U (mBq/kg)	232Th (mBq/kg)	60Co (mBq/kg)	40K (mBq/kg)
Cirlex PMT Bases	Gator	60 ±10	36 ± 9	<3.6	<66
Poly (UZH)	Gator	< 2.22	< 1.81	0.60	< 4.66
Poly from Shield	Gator	< 3.54	< 2.69	< 0.77	< 5.88
2.5 mm SS Nitronit	GeMPI2	< 2.7	< 1.5	1.3 ± 0.1	< 12
25 mm SS Nitronit	LNGS Fac.	< 1.3	2.9 ± 0.7	1.4 ± 0.3	< 7.1

Future Work

- Future Screening
  - Screening of all different detector components
- Future simulations
  - Simulate background for all different detector components
  - Compare to latest data
    - Allows for improvements to future XENON design
- Installation of a slow control system
    - Allows to monitor different detector parameters and keep the detector under control

Summary

- Gator detector screens samples for XENON-100 and improvements to the system will make these measurements more accurate.

- Geant4 simulations and comparison with data helps to better our understanding of XENON-100 backgrounds and provide information needed for future upgrades.