The DarkSide VETO: Neutron and Muon Detector

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The DarkSide Project

Direct detection of dark matter with Argon
in a **background free** environment

Problems:

very **rare** event (< 10events/year/ton)
very **low** energy (< 100keV)

Solutions:

Build detector with:
low detection **threshold**
low internal and external **background**
high background/signal **discrimination power**

Background

Radioactive background (α,β,γ and n) due to materials, natural radioactivity and cosmogenic

Neutrons dangerous background
MIMIC dark matter signals

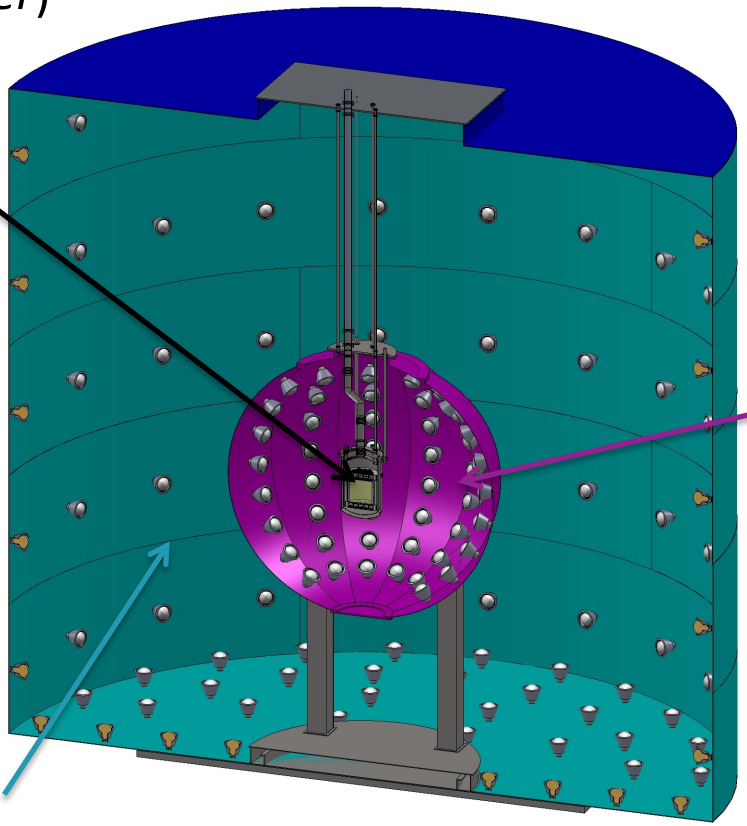
Radiogenic Neutrons:
produced by radioactive decays
of isotopes present
in the detector components

Cosmogenic Neutrons:
produced by cosmic muons
interactions in detector
and surrounding materials

The DarkSide detector @ LNGS

The DarkSide detector

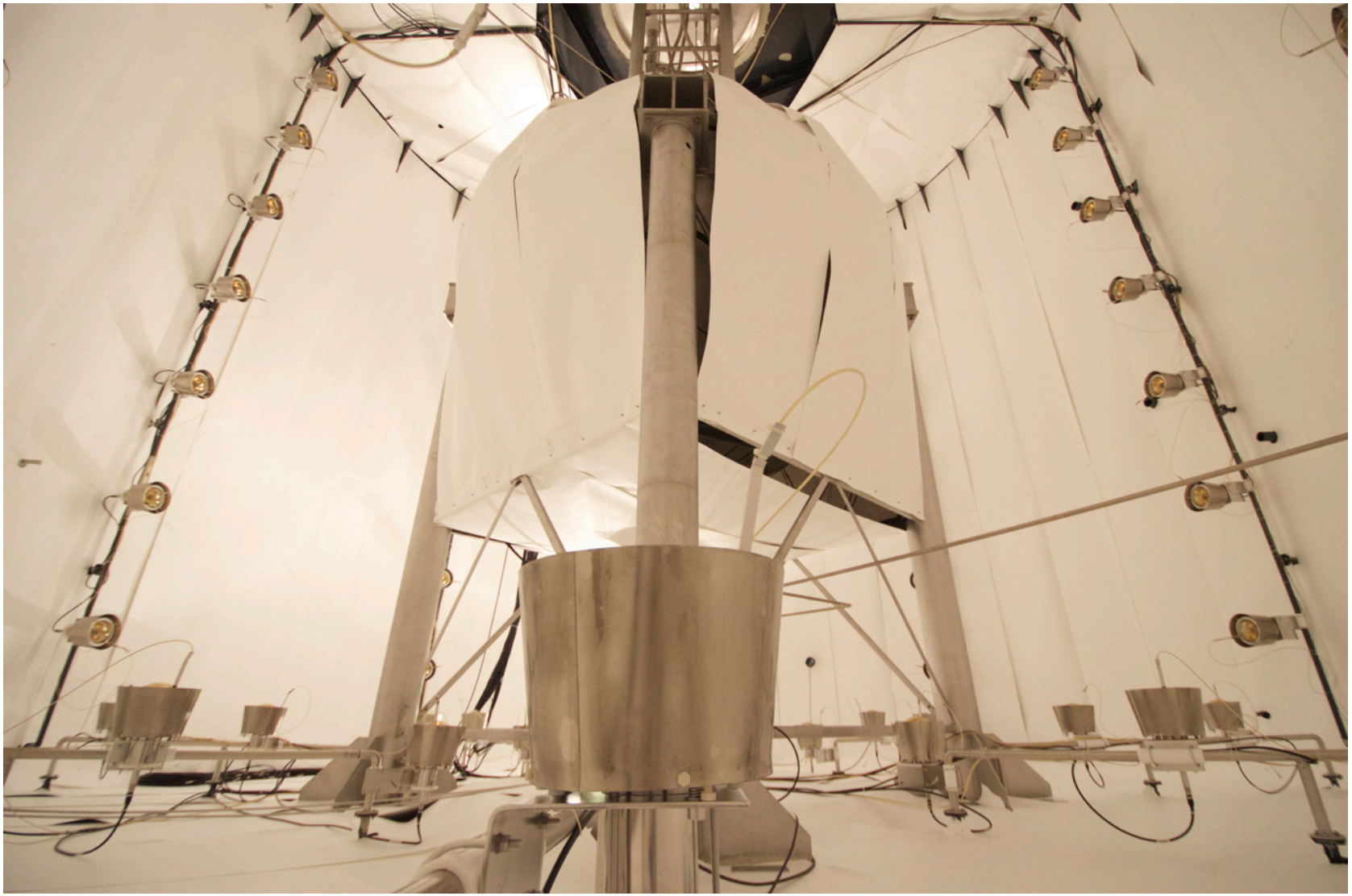
Inner Detector:
2-phase LAr TPC
(*Time Projection Chamber*)



Veto and neutron shielding:
NV (*Neutron Veto*)
Stainless Steel Sphere
(diameter: 4m)

Veto and muon shielding:
MV (*Muon Veto*)
cylindrical tank
(high: 10m, width: 11m)

Muon Veto



Muon Veto

Cherenkov detector made of 1000 ton of ultrapure water
seen by 80 8'' PMTs on the wall and floor

Borexino CTF (*Counting Test Facility*) water tank
covered by TYVEK (high reflectivity material)

Active VETO for cosmogenic muons
passive shielding for natural/external radioactivity (γ and n)

Neutron Veto

Neutron Veto

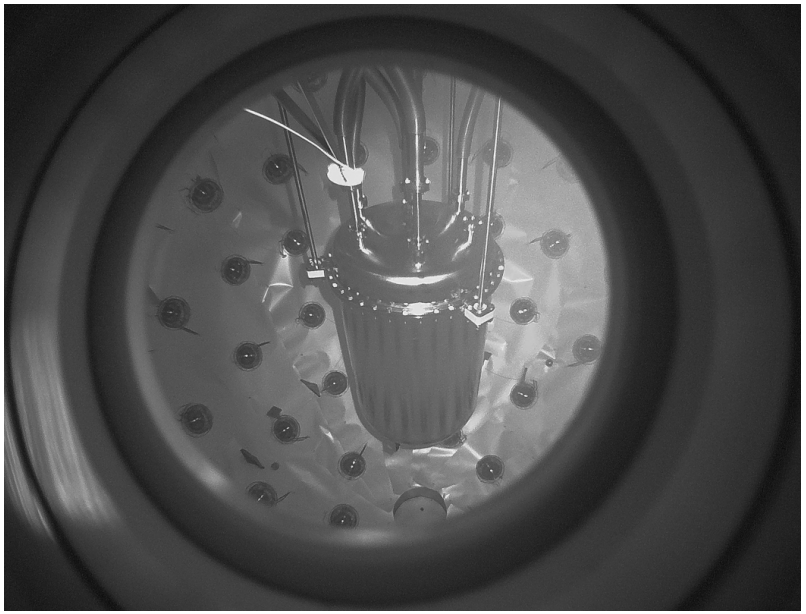
Liquid scintillator detector doped with **boron**: 30 ton
mixture 1:1 of PC (*PseudoCumene*) + PPO and TMB (*Tri-Methyl Borate*)
seen by 110 8'' PMTs with high Q.E. low intrinsic radioactivity

Efficiently tagging of neutron background
via neutron capture on ^{10}B (σ ~$10^{-21}cm^2$):
$\gamma + \alpha(1.47MeV)$ (BR 96%) or $\alpha(1.01MeV)$ (BR 4%)
released α corresponding to a signal of ~40÷60keV_{ee}

Active neutron **VETO**
anti-coincidence detector
***in situ* measurement** of neutron background

Current Status

Successfully filling of the two detectors



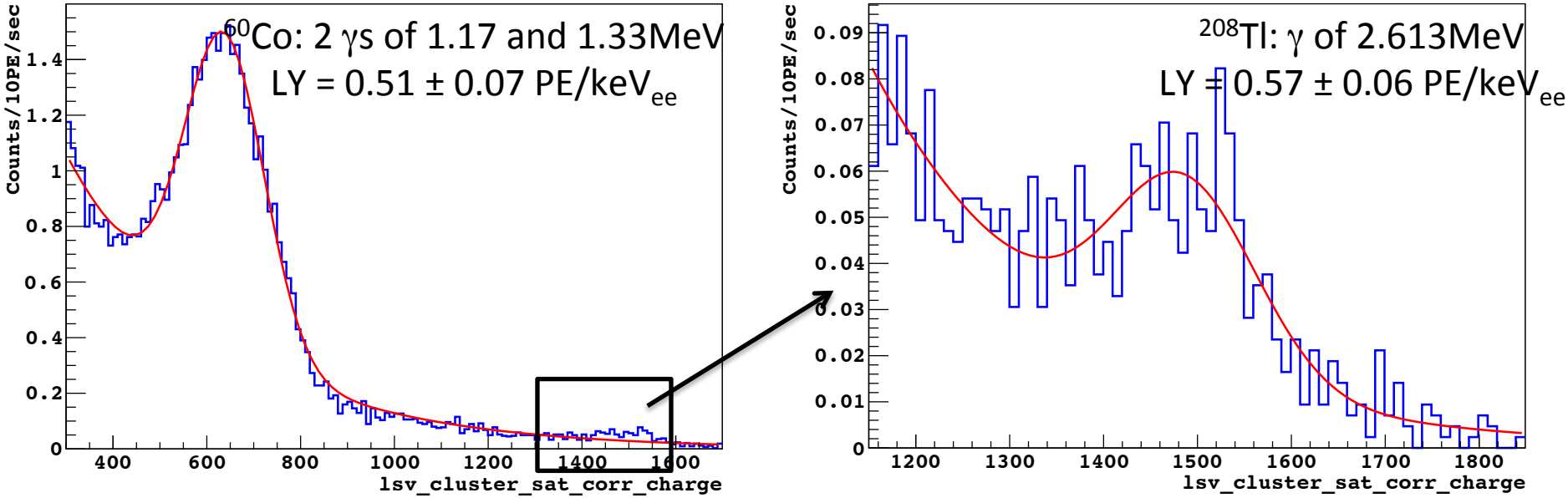
Since **October 2013** data taking TPC+VETO

Current Status

Neutron Veto: light yield (LY) ~0.5PE/keV$_{ee}$

measured by ^{60}Co, confirmed by ^{208}Tl and ^{14}C

satisfactory for background suppression requirements



Current Status

Problem:

Neutron Veto: high rate

background studies show high rate due to high contamination of ^{14}C present in the TMB

Solutions:

Already identified a new batch of TMB with low ^{14}C content

on going **tests** for **removal** and **replacement** of the old TMB

study on actual quantity of TMB needed to meet VETO requirements

Summary and Conclusions

Since **October 2013** DarkSide is **taking data**

✓ **Muon Veto:**
fully functional

✓ **Neutron Veto:**
LY ~0.5PE/keV$_{ee}$ **satisfactory** for neutron rejection:
released α produces signal 40÷60keV$_{ee}$ -> ~30PE easy to detect

❑ **Neutron Veto:**
High rate: **identified** source on ^{14}C
on going tests for **removal** and **replacement** of old TMB