



Surface Backgrounds in DEAP-3600

Summer Research Presentation

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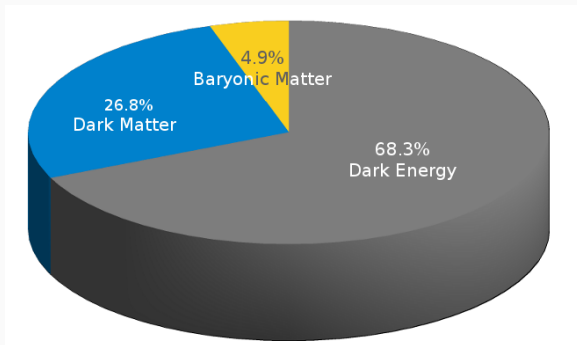
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Dark Matter and Detection

Dark Matter

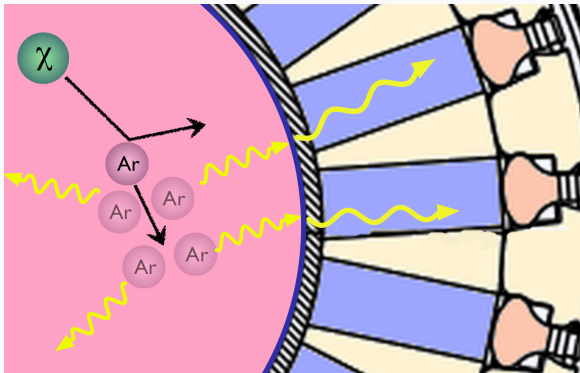
"Dark" Matter is matter that does not interact with the Electromagnetic field.



It composes a significant portion of the energy density of the universe, yet we know very little about it.

WIMP's

Enter WIMP's; A proposed solution to the Dark Matter problem.
(Weakly Interacting Massive Particles)



DEAP-3600 (Dark Matter Experiment using Argon Pulse-shape discrimination)



Types of Signals

Two main types of events:

- Electron Recoils
- Nuclear Recoils

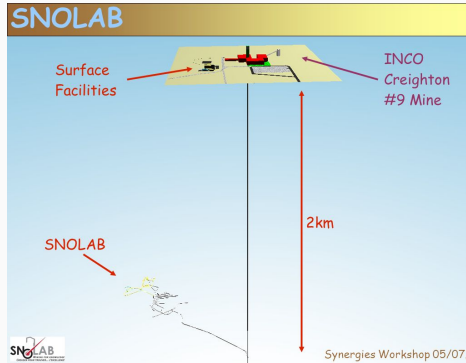
These events have characteristic signals, which we can discriminate against using our metric.

$$F_{prompt} = \frac{\sum \text{Early Light}}{\sum \text{Total Light}} \quad (1)$$

Background on Backgrounds

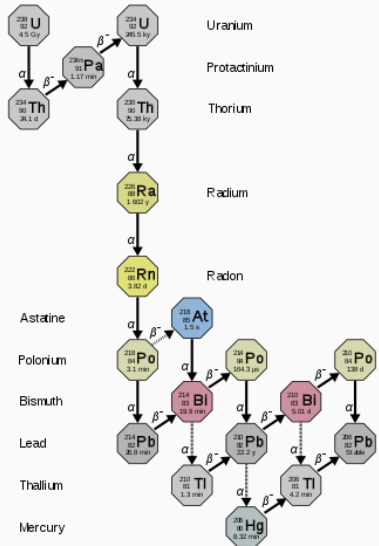
The Avoidable

- SNOLab is 2km underground, shielding the majority of background particles.
- The detector was also made with ultra radio-pure substances and is surrounded by a Water Veto Tank.



The Inevitable

- Radon 222 is a daughter of Uranium, and is also a gas, making it difficult to remove.
- Everything that is exposed to air has some Radon 222 content



Understanding Signals

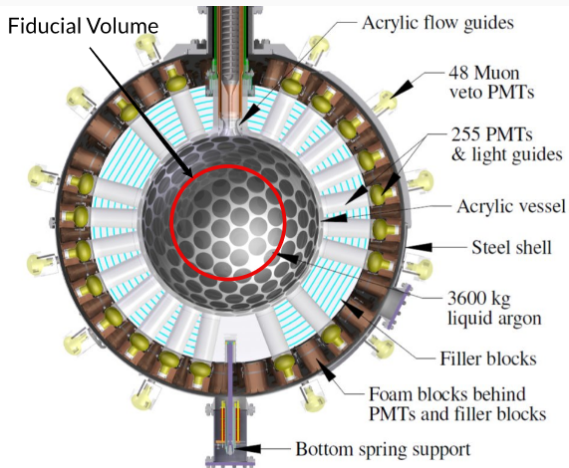
Position Reconstruction

Position Reconstruction is the process of taking the information the detector (Charge and Timing) and reconstructing where we think that event occurred.

This is important because, one powerful technique to remove backgrounds is to perform a "Fiducialization" of the Argon target mass, and only consider events inside the fiducial volume.

One of the Methods used for this is Monte Carlo(MC) which is a software technique used for modeling physical and known physical effects.

Fiducial Volume



A Work in Three Parts*

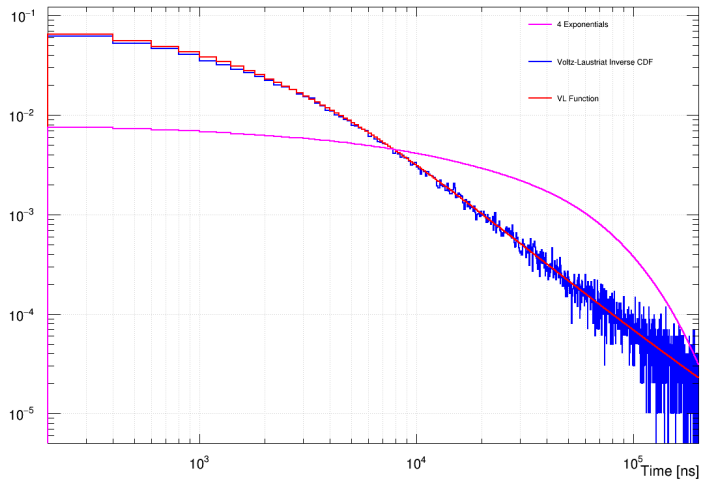
TPB Florescence

Tetra-phenyl-butadiene(TPB) is the wavelength shifter used in DEAP to convert 128nm VUV light to 400nm visible blue light, to which Acrylic is transparent. TPB has a short and a long component of its lifetime.

Taking updated Literature values from a recent publication on TPB florescence lifetime, we found a significant difference between the current implementation and updated values.

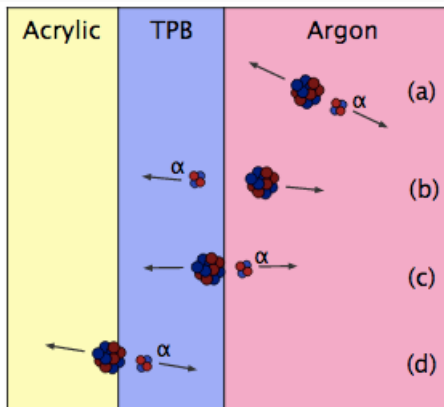
To optimize the implementation of this process we developed an inverse CDF sampling method.

V-L and 4 Exps for 128nm Photons

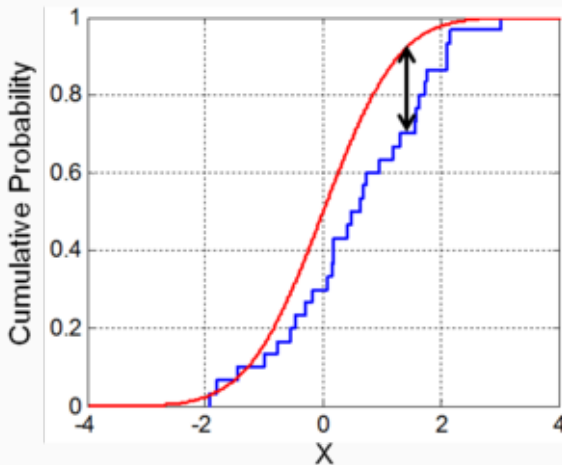


TPB Surface Event Hypothesis

- One of our position reconstruction methods has a goodness of fit check (GOF), This check assumes an event occurring in the bulk of the detector.
- In this work we extend this to include a surface event hypothesis.



Our GOF test is called a Kolmogorov–Smirnov(KS) Test, It is described as the distance between two cumulative distributions as shown below.

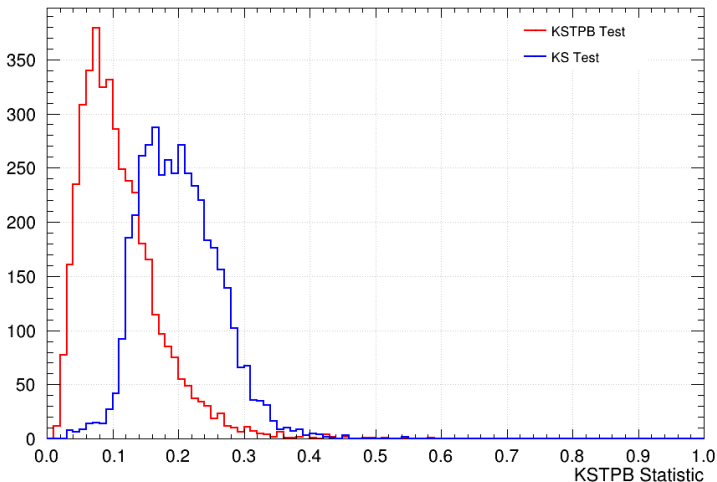


Where the Black arrow represents the magnitude of the maximum difference between distributions.

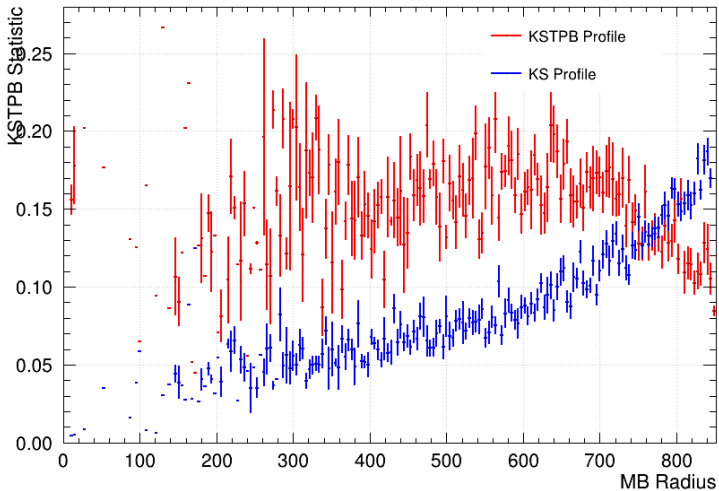
Results

Below we see some results from this implementation.

KSTPB Test

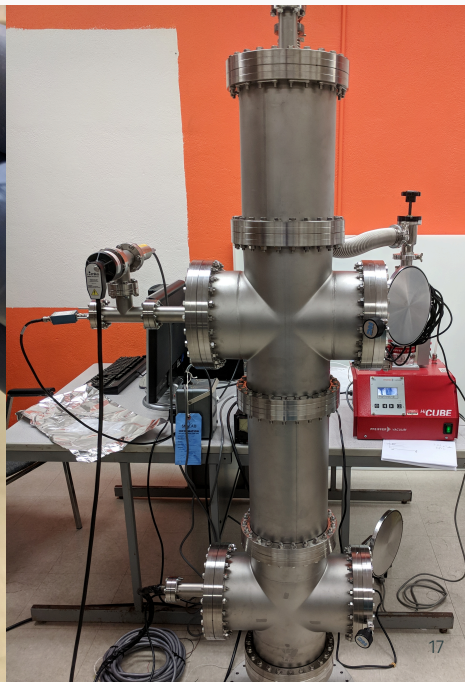
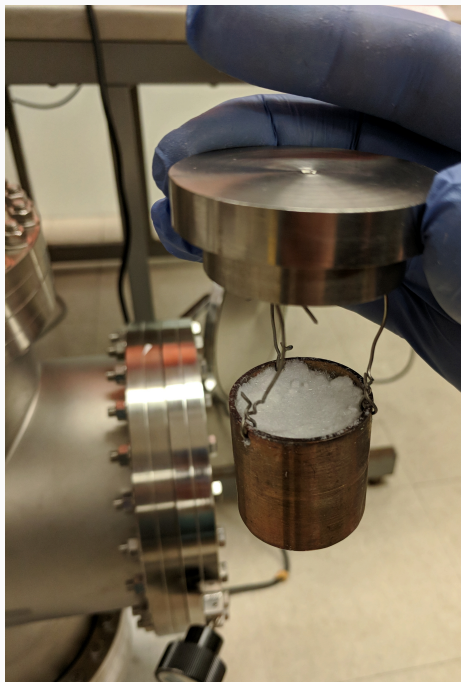


KSTPB Profile



To see if there was a possibility of TPB being present on the neck in DEAP-3600, we mimicked the deposition settings with a shield similar to that used in the original deposition.

This is an important example of trying to get a better understanding of what's going on in the detector.





Conclusion

We covered quite a lot about the experiment and what kind of signals can impact the ability to discern our results, including the effects of optics, understanding of surface events and how they differ from bulk events, and worked with some hardware problems.

I Will be continuing some of this work in the following year, working with Professor Boulay and Marcin Kuzniak on my Fourth year project. As well as working with the DEAP-1 setup.

Learning Outcomes

- Learned a lot of C++ and ROOT Programming
- Importance and impact of analytic techniques
- Got our hands dirty with some Hardware
- Gained a more detailed statistics testing understanding
- Experience of working collaboratively with many people on a common project.

Questions?

Po210 Event Search + Any Additional Figures

1 <http://inspirehep.net/record/1261376/plots>

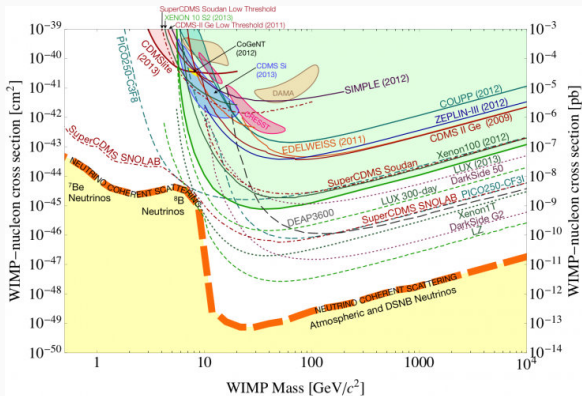


Figure 2: WIMP Cross section including DEAP projection