

Searching for Dark Matter with the DEAP/CLEAN Detectors

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- Dark matter Experiment using Argon Pulse shape discrimination

- Cryogenic Low Energy Astrophysics with Noble liquids

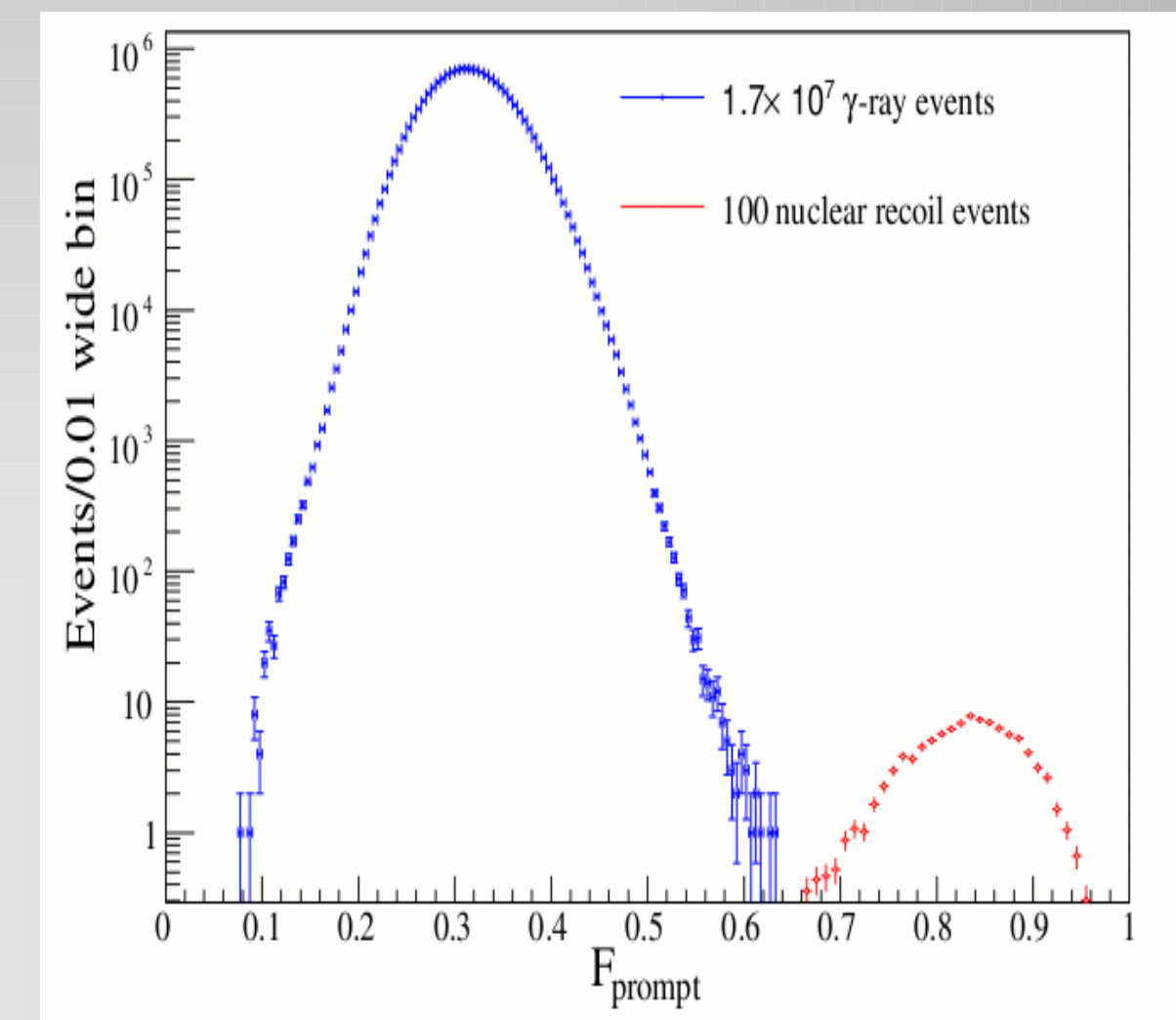
Direct Dark Matter Detection with Pulse Shape Discrimination in Noble Liquids

- Separate electron recoil events from nuclear recoils based on time distribution of scintillation light (Pulse Shape Discrimination)
- Single phase experiments do not need to worry about problems with drifting charges over large distances such as incomplete charge collection and pileup of pulses due to long drift time

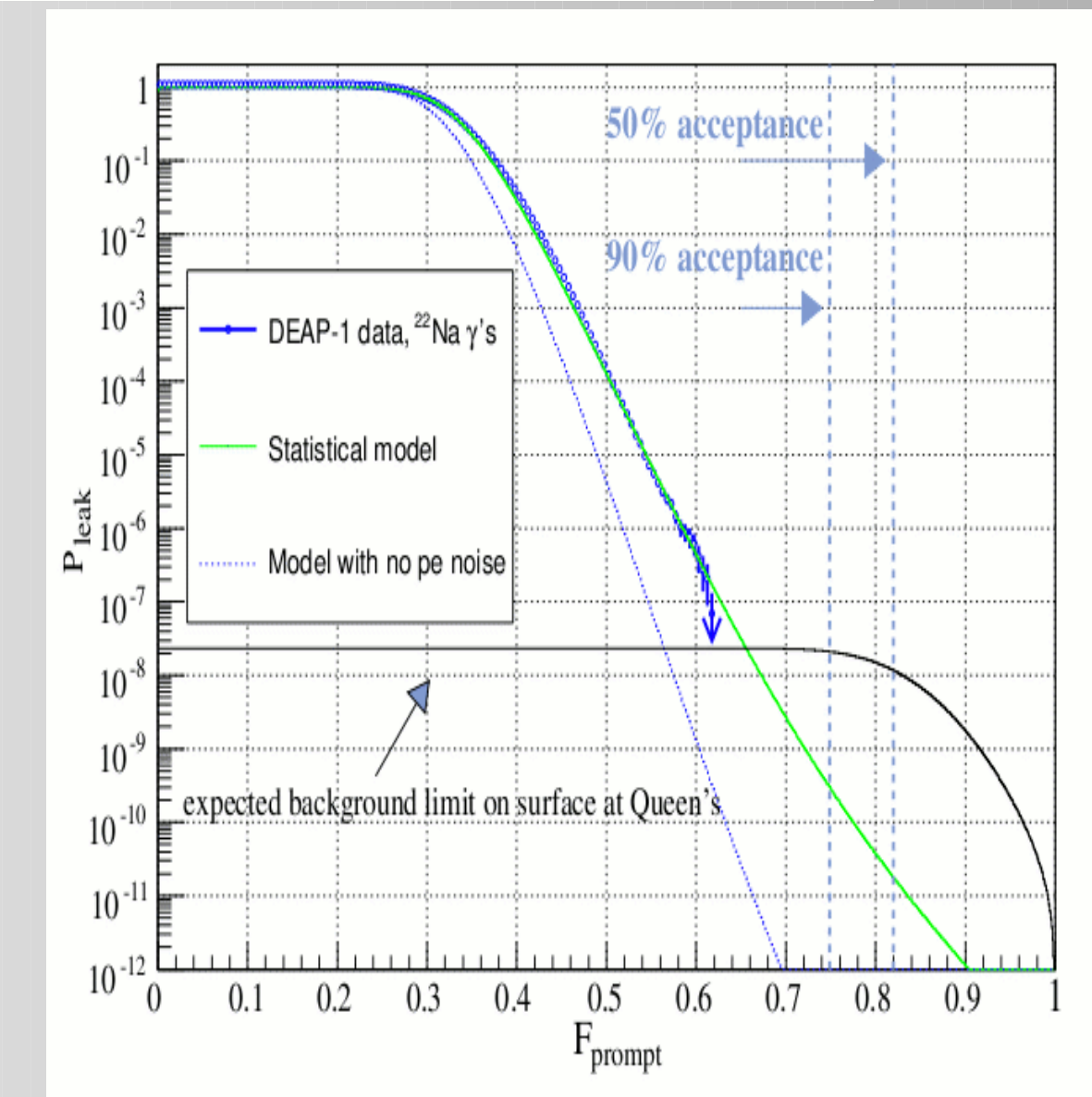
Easily scalable to large detectors

PSD: Prompt Fraction DEAP-1

F_{prompt} is the ratio of light in a prompt time window around the start of the pulse (-50ns to 150ns) to the total light (up to 9 μsec)



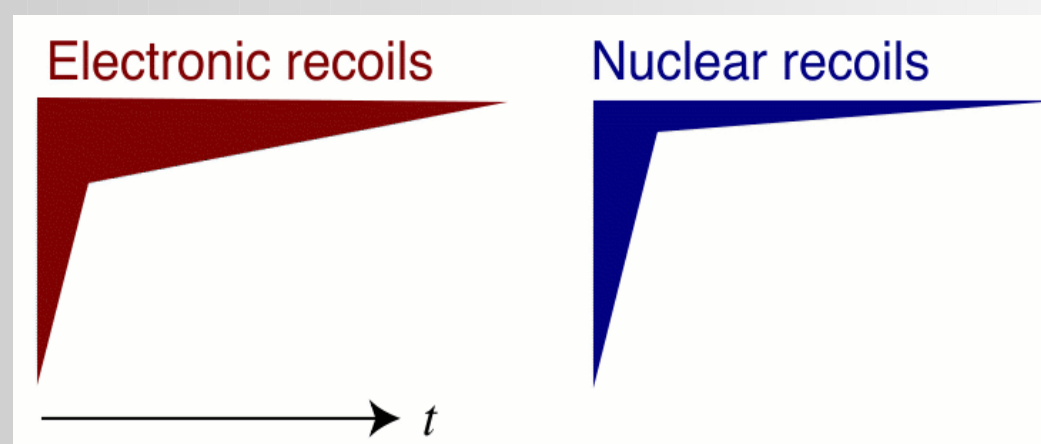
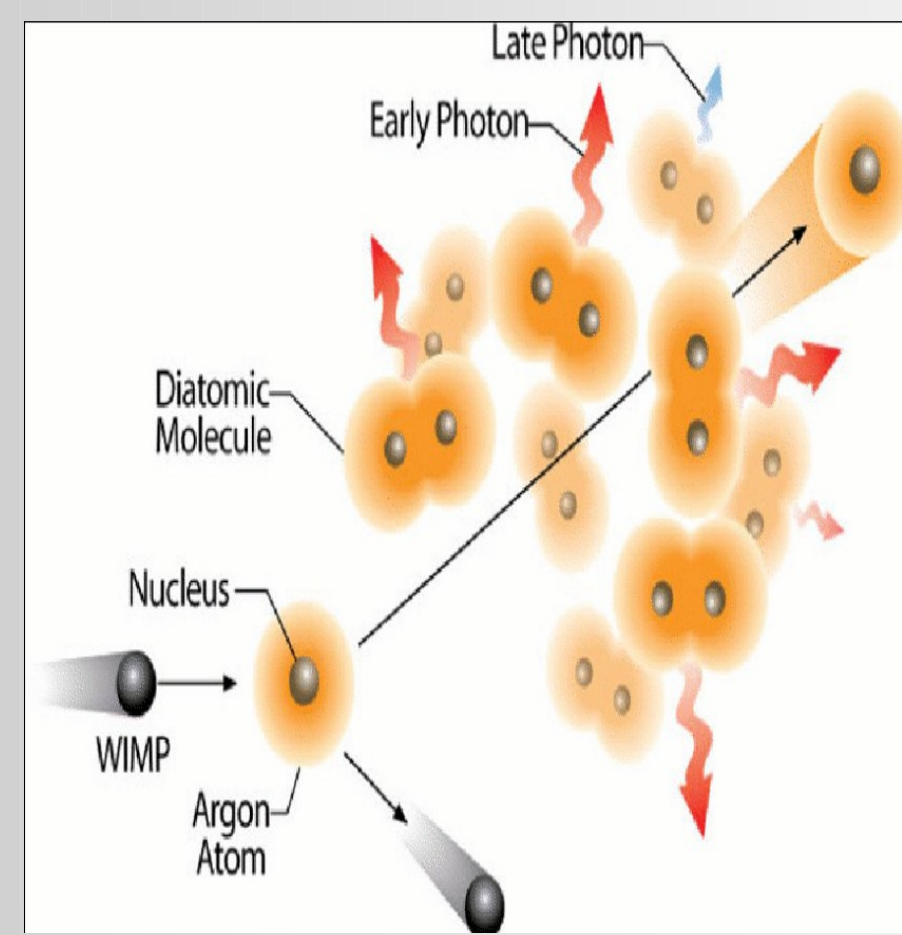
- Boulay et al. Background discrimination as a function of F_{prompt} cut arXiv:0904.2930
- Pleak: leakage probability
- 6×10^{-8} γ events misreconstruct in nuclear recoil F_{prompt} window



Pulse Shape Discrimination

Time dependence of scintillation is significantly different for heavy ionizers (alphas, recoiling nuclei) compared to light ionizers, betas (Kubota et al. 1977)

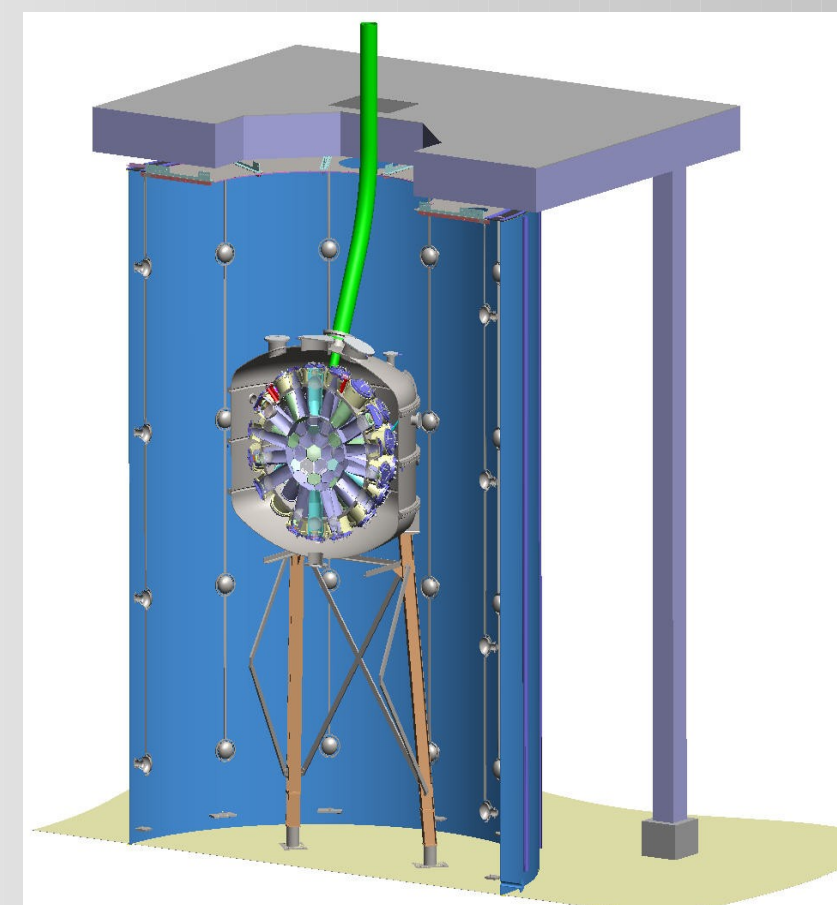
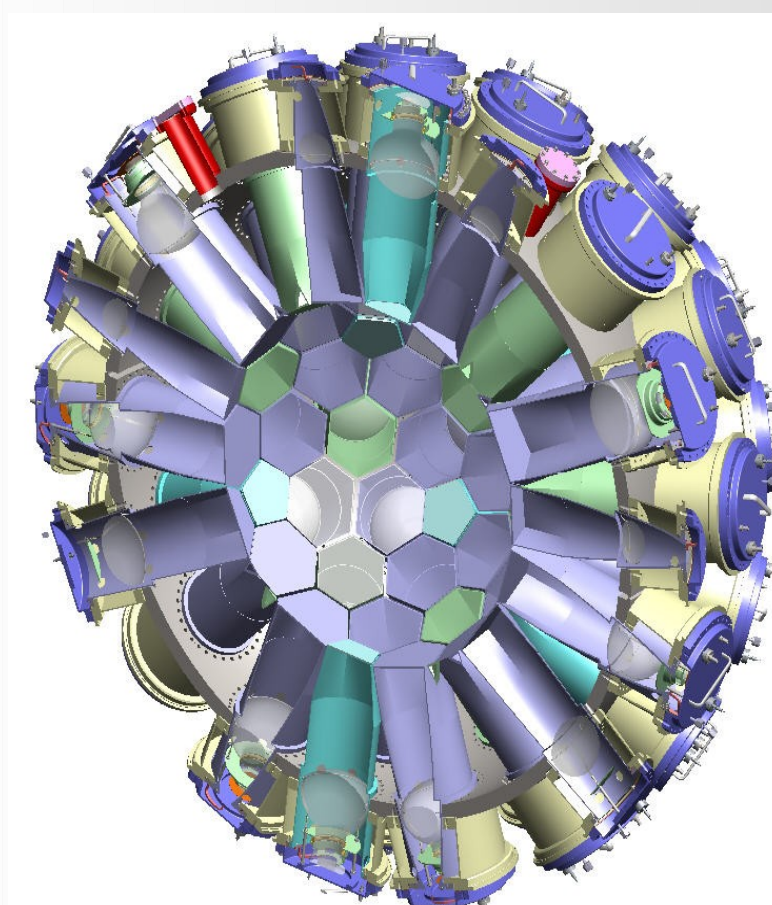
- Scintillation in noble gases produced by decay of excimers in either singlet or triplet excited states
- Triplet state gives slow scintillation component
- Triplet scintillation is suppressed for nuclear recoils



Schematic of difference in pulse shapes between electric recoils and nuclear recoils

miniCLEAN

- 500kg LAr target
- 92 PMTs
- Outer vacuum vessel built
- 2yr run planned for SNOLAB



The DEAP/CLEAN Program

microCLEAN: 4kg LAr or LNe with 2PMTs at Yale



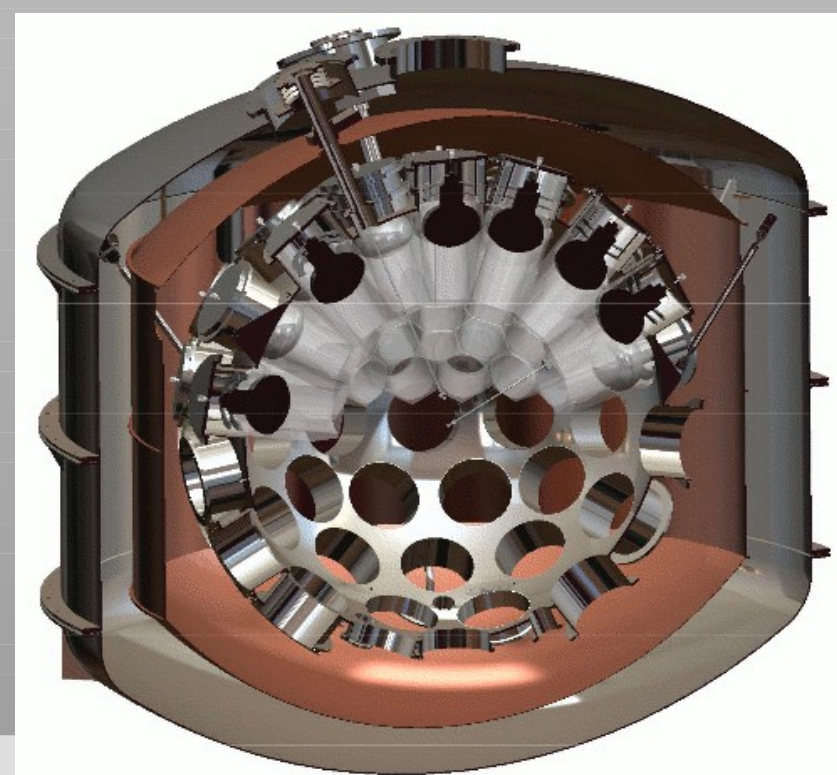
Currently running

DEAP-1: 7kg LAr with 2PMTs now in SNOLAB



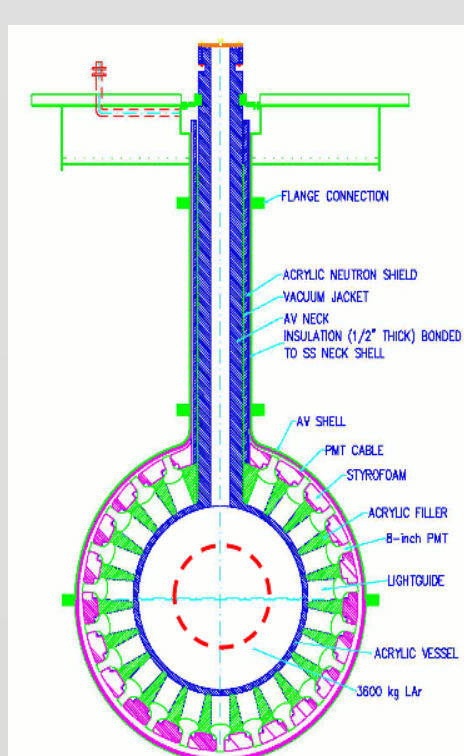
Increasing sensitivity

miniCLEAN: 500 kg LAr and LNe, 92 PMTs, 42.3 cm radius, $\sigma \sim 2 \times 10^{-45} \text{ cm}^2$



In construction

DEAP3600: ~3600 kg LAr, 266PMTs $\sigma \sim 10^{-46} \text{ cm}^2$

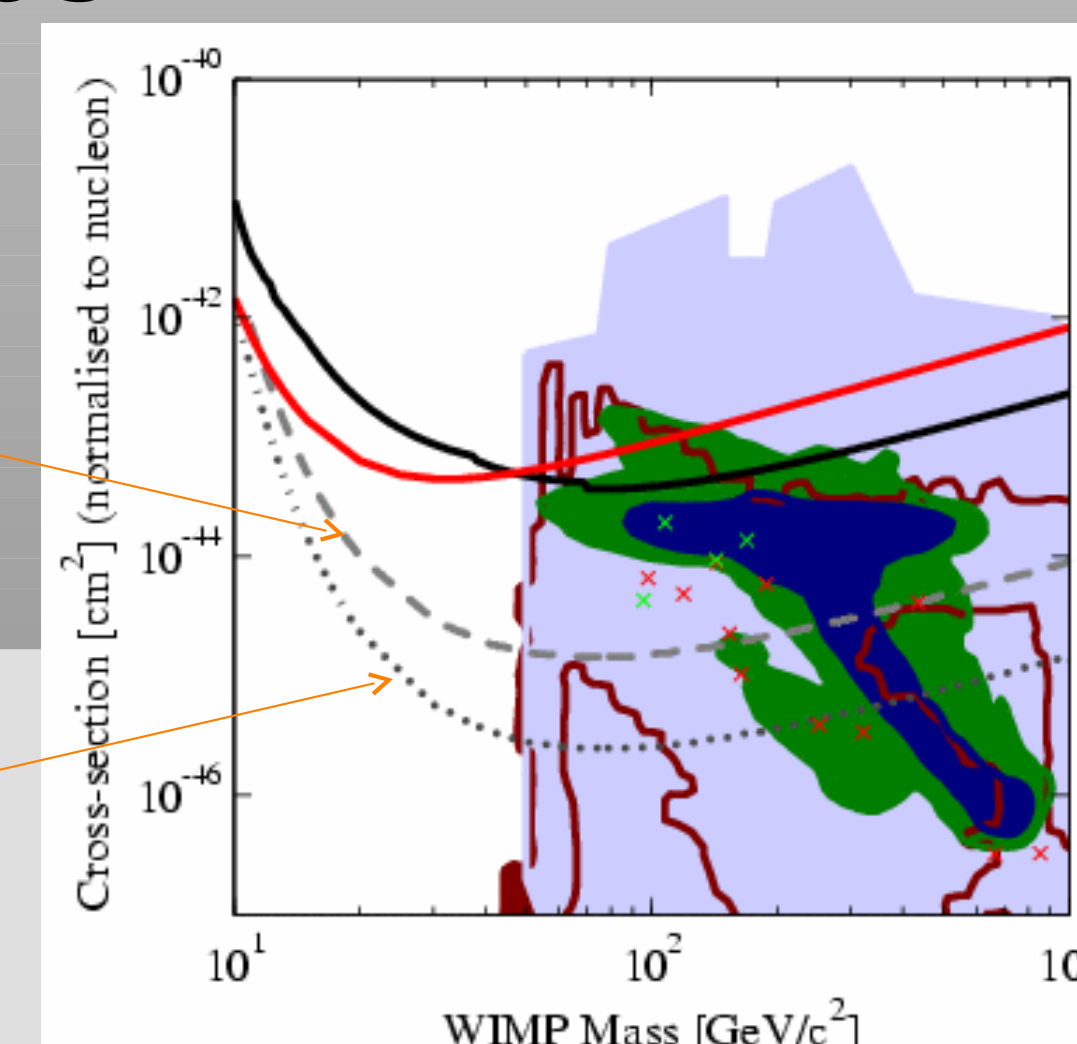


Cube Hall at SNOLAB



Expected Sensitivities

- miniCLEAN expected sensitivity $\sim 10^{-45} \text{ cm}^2$ after 2yrs, starting late 2011
- DEAP3600 expected sensitivity $\sim 10^{-46} \text{ cm}^2$ expected underground at SNOLAB late 2012



Legend for the graph:
 - - - DATA listed top to bottom on plot
 - - - XENON10 2007 (Net 136 kg-d)
 - - - CDMS: Soudan 2004-2009 Ge
 - - - Linear Collider Cosmology Benchmarks (preliminary)
 - - - DEAP CLEAN 150kg FV [proj]
 - - - DEAP CLEAN 1000kg FV [proj]
 - - - Trotta et al 2008, CMSSM Bayesian: 68% contour
 - - - Trota et al 2008, CMSSM Bayesian: 95% contour
 - - - Ellis et al Theory region post-LEP benchmark points
 - - - Baltz and Gondolo 2003
 - - - Baltz and Gondolo 2004, Marlow Chain Monte Carlos