

Status of the DEAP-3600 Dark Matter Search Experiment

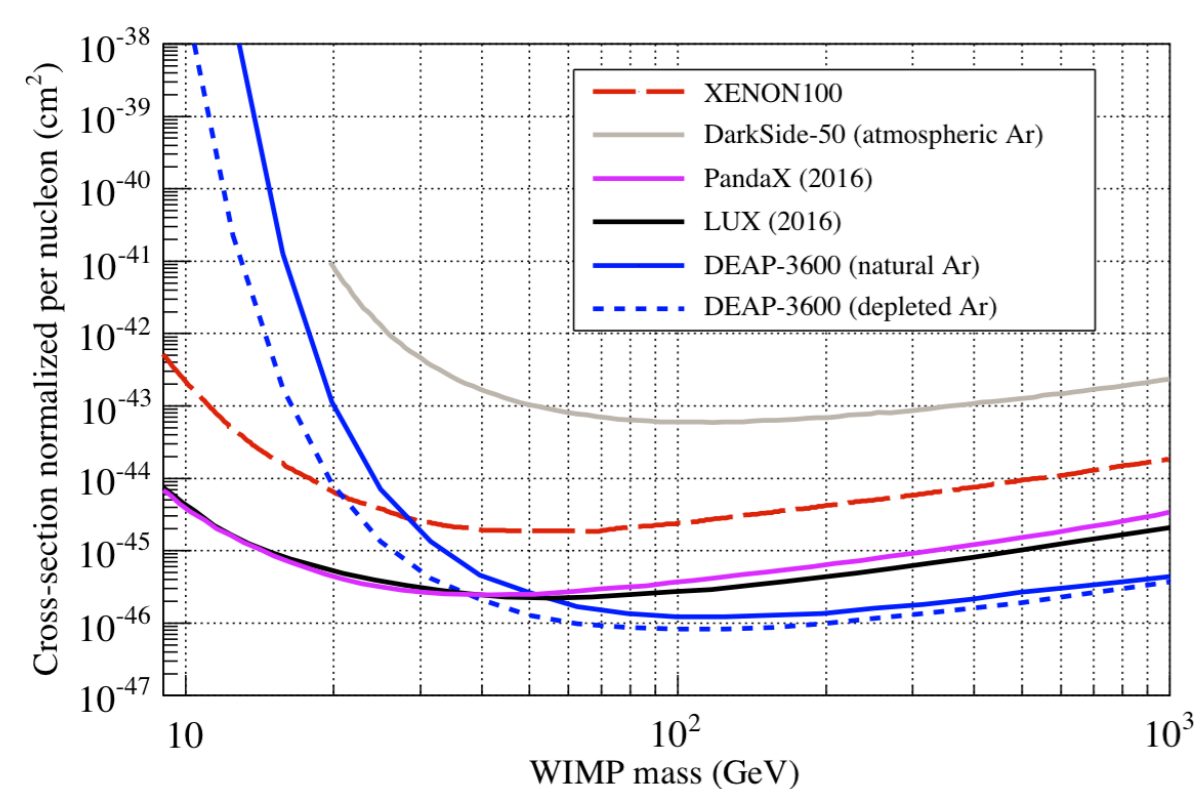
Ben Broerman for the DEAP collaboration
Queen's University

broerman@owl.phy.queensu.ca



Introduction

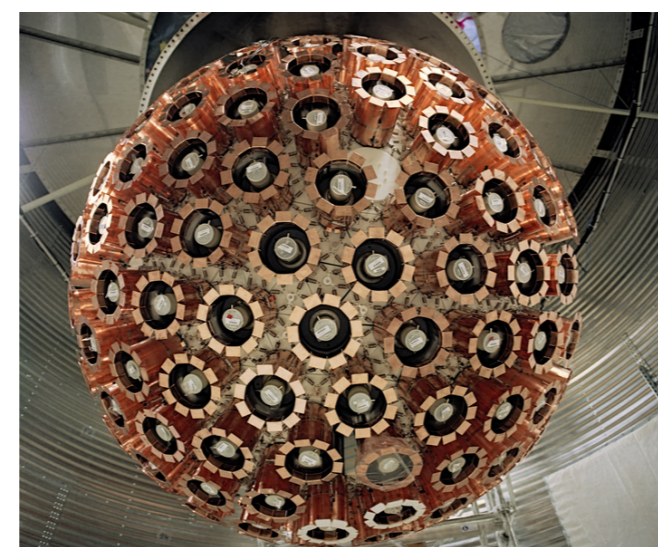
- The Dark matter Experiment using Argon Pulse-shape discrimination (DEAP-3600, Fig. 1) located at SNOLAB in Sudbury, Canada.
- 3.6 tonnes of liquid argon (LAr) in a spherical acrylic vessel 85 cm in radius, coated in wavelength shifter tetraphenyl butadiene (TPB)
- 255 inward-facing 8-inch R5912 photomultiplier tubes (PMTs) coupled through 50 cm light guides (LGs).
- LAr maintained with 2 m neck cooling coil
- Housed in spherical pressure vessel inside 8 m diameter water veto tank.
- PSD and background control allow for a targeted spin-independent sensitivity of 10^{-46} cm^2 for a 100 GeV/ c^2 WIMP mass.



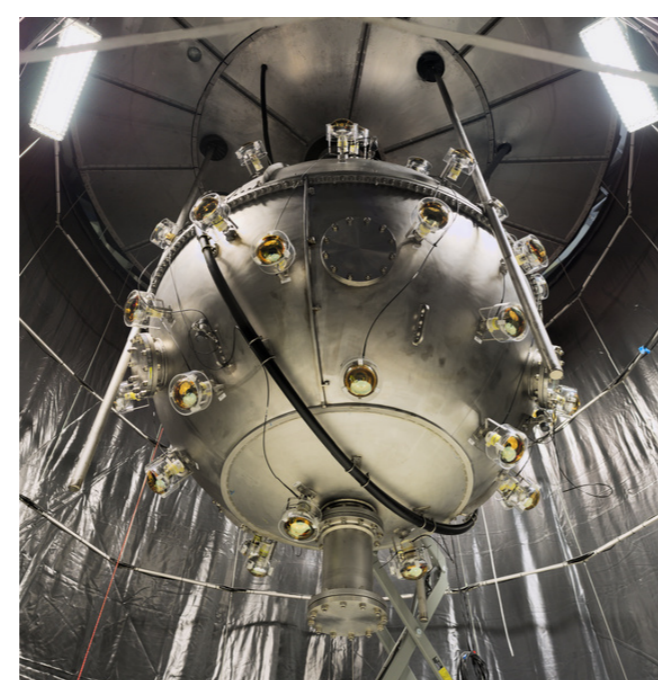
DEAP-3600 projected spin independent sensitivity for a background-free 3 tonne-year exposure along with experimental Limits from DarkSide-50 (2015), Xenon-100 (2012), PandaX (2016), and LUX (2016).



Acrylic vessel, after bonding of the LGs

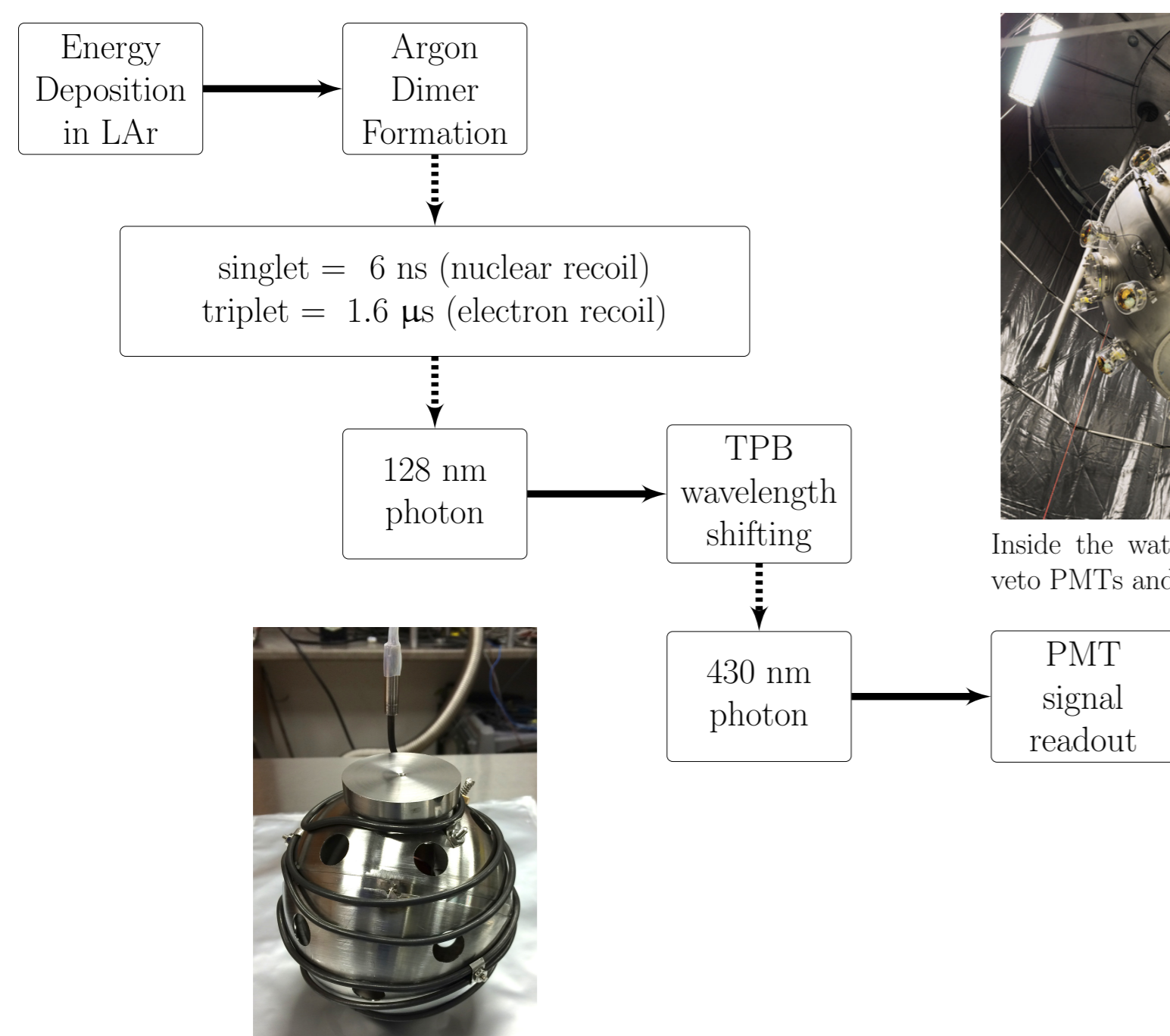


DEAP-3600 after installation of PMTs



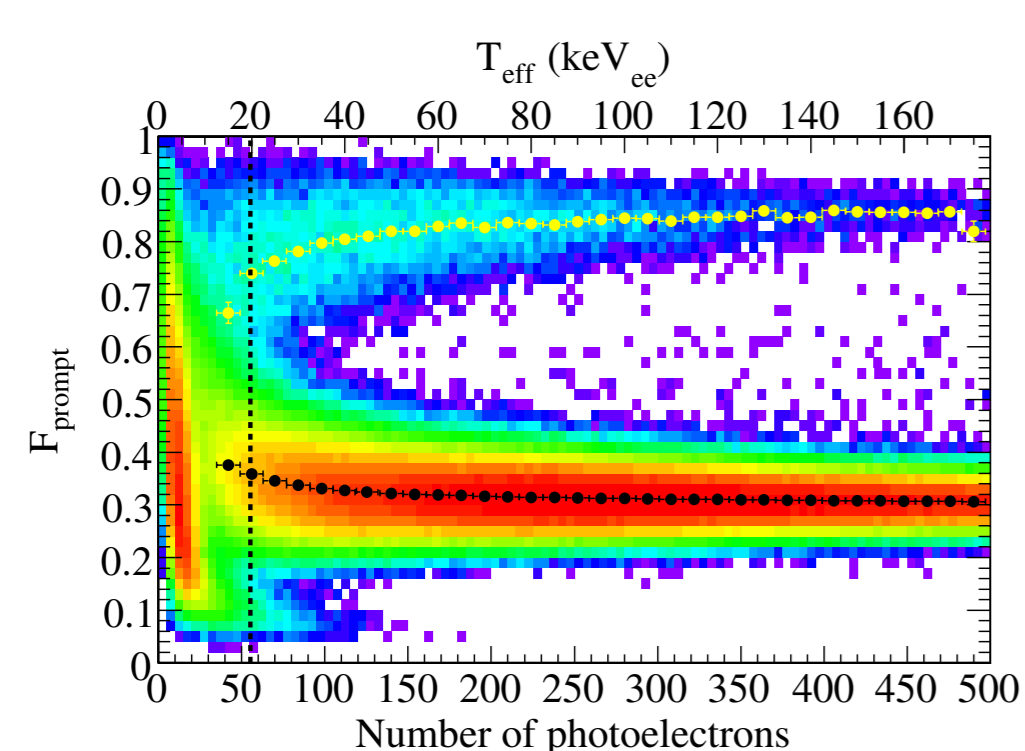
Inside the water tank, steel shell closed, veto PMTs and calibration tubes installed.

Signal Detection

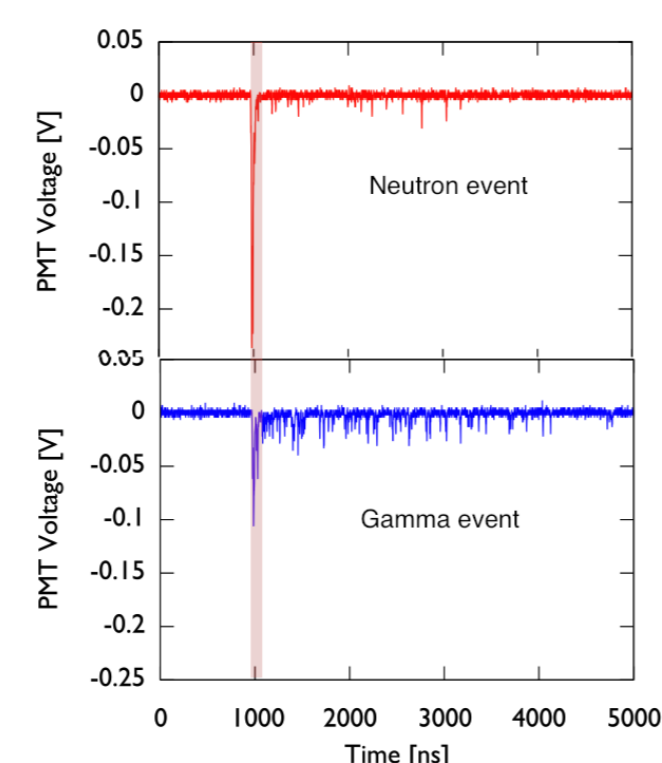


Evaporation source for the TPB wavelength shifter. A 3 µm thick coating was applied through vacuum deposition.

Pulse Shape Discrimination (PSD)



DEAP-1 calibration data with AmBe (top band, n) and ²²Na (lower band, γ). Singlet/triplet lifetime differences lead to the two recoil bands.



Nuclear and electromagnetic recoil PMT traces, prompt region (1st 150 ns) shaded.

$$F_{\text{prompt}} = \frac{\text{PromptPE}}{\text{TotalPE}}$$

Detector Schematic

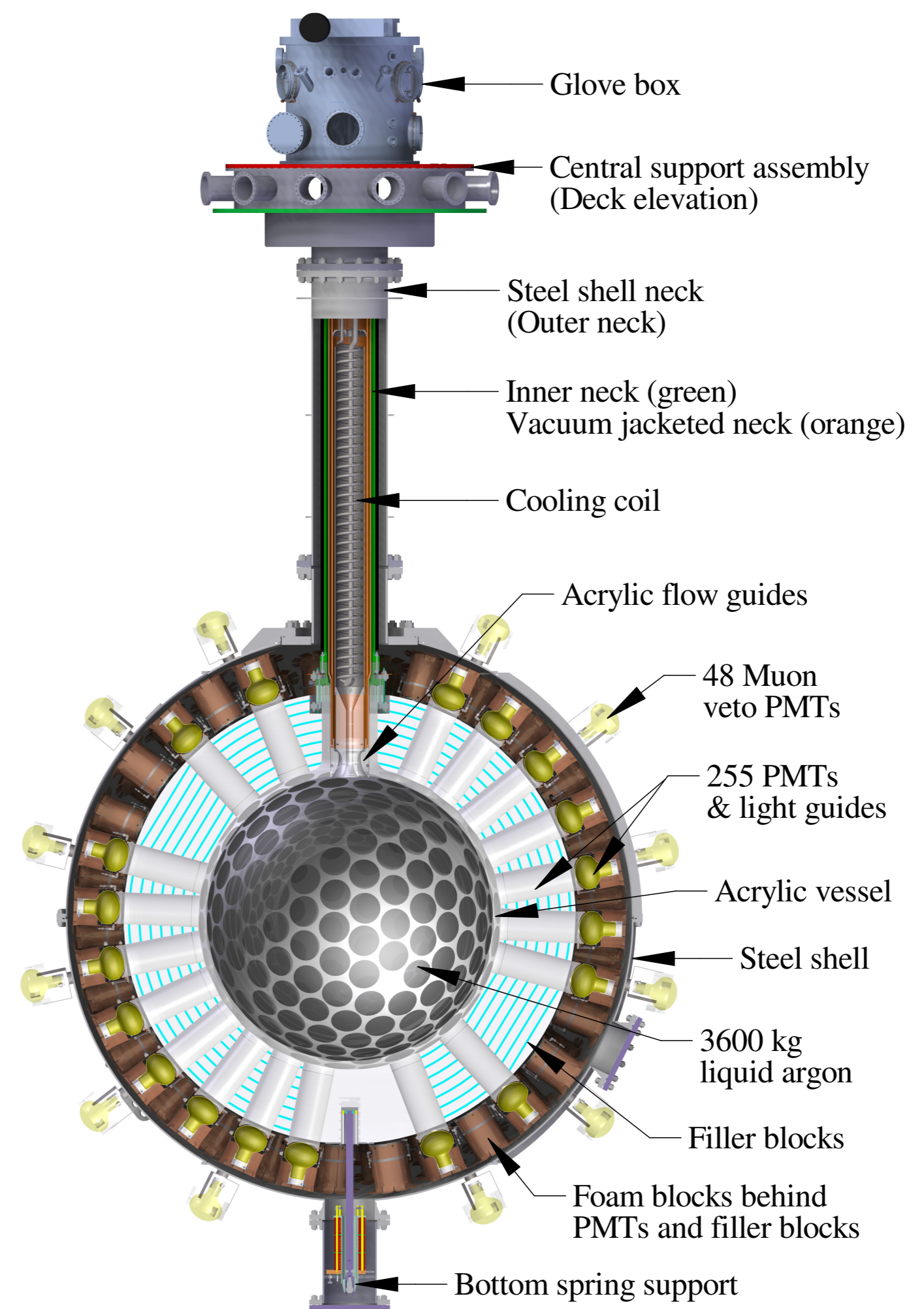
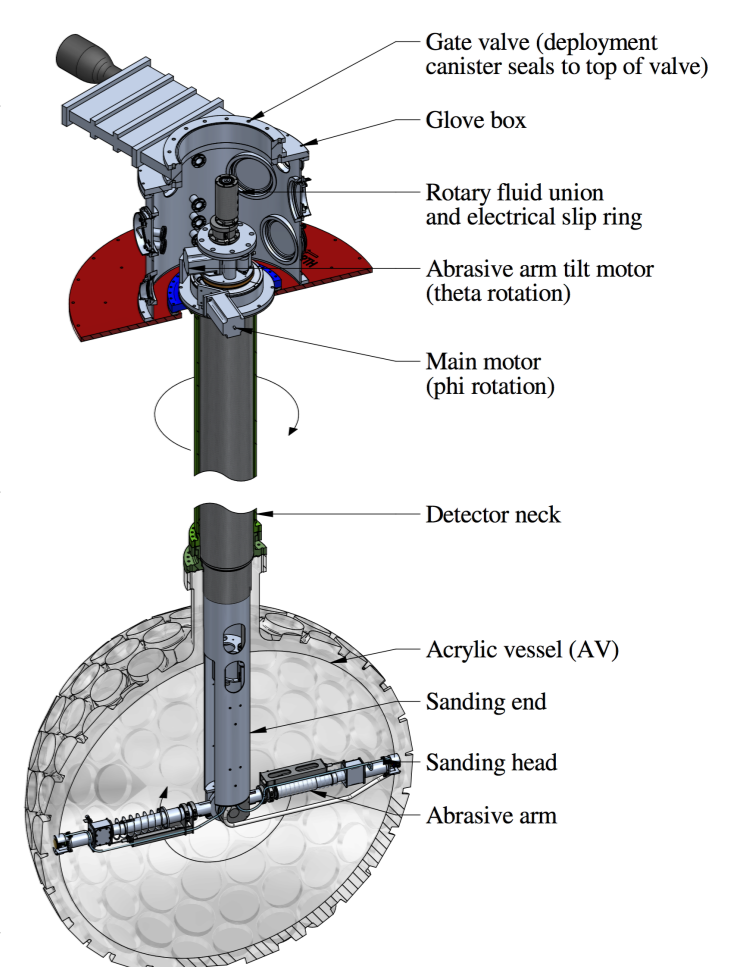


Figure 1: Schematic of the DEAP-3600 detector. The inner surface of the AV is coated in TPB (not shown).

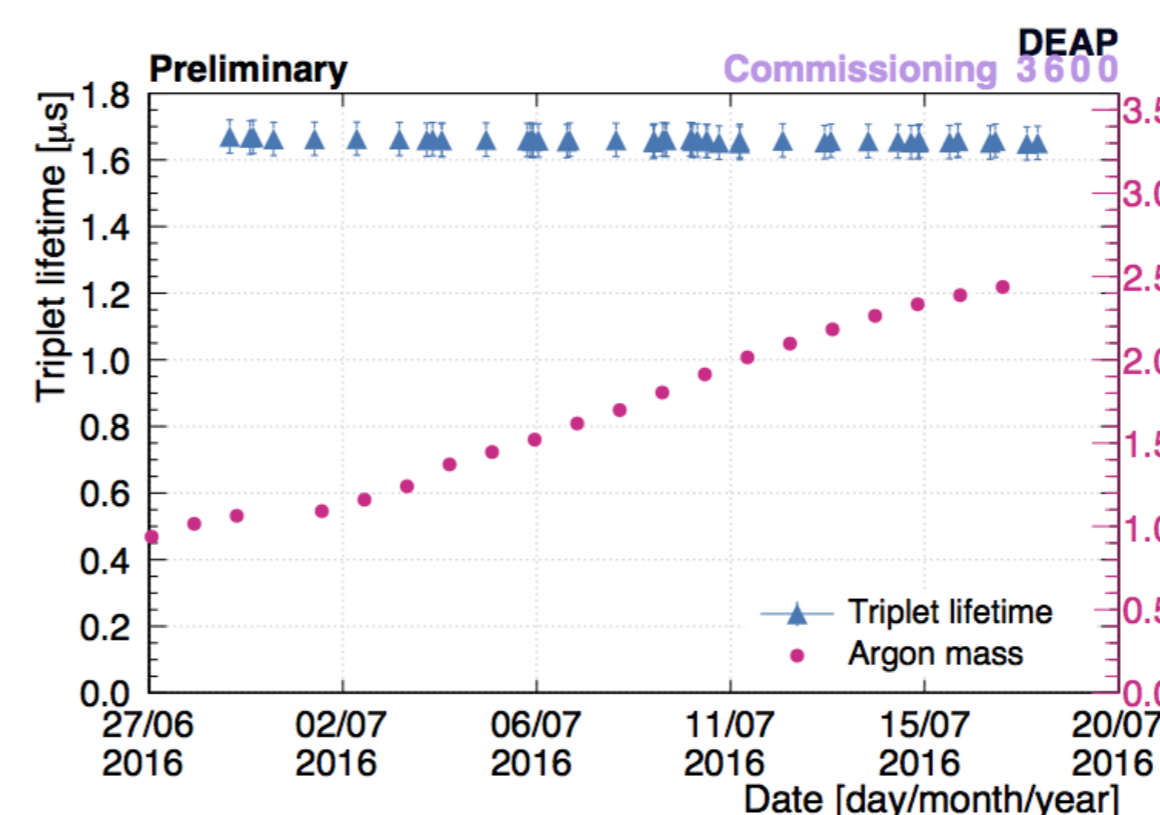
Sources of Background and Control

	Control	Target
Surface α's	radiopure acrylic and TPB, resurfacing, fiducialization	< 0.2 µBq/m ²
Neutrons	50 cm LGs, HDPE filler blocks, and material selection to reduce ¹³ C(α, n)	< 2 pBq/kg
Rn in Ar	Cold charcoal trap, low emanation components	< 1.4 nBq/kg
³⁹ Ar	PSD	< 2 pBq/kg
3 tonne-year exposure in ROI		< 0.6 events



Schematic of the Resurfacer used to sand the inner acrylic surface. 0.5 mm of acrylic was removed to reduce Rn progeny on the inner surface. After resurfacing, the clean acrylic was kept under vacuum or boil-off N₂.

Current Status: Liquid Fill



- Mass in detector and triplet lifetime (left) indicate stability and a clean fill
- Current mass: **2800 kg**
- Taking DM physics data soon