

Organic Thin Film Deposition System for DEAP-3600

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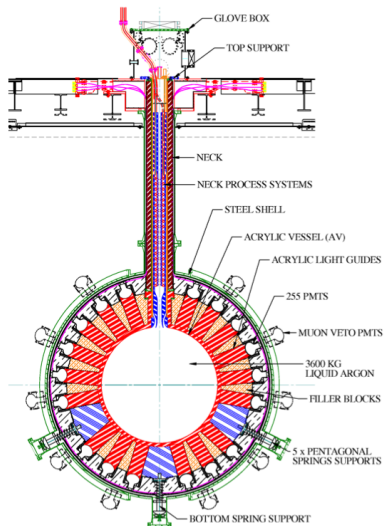
18 June 2014



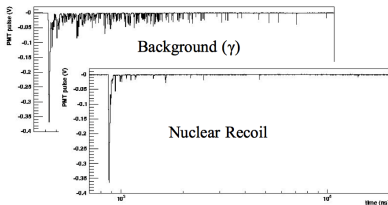
Outline

- DEAP-3600 Dark Matter Experiment
- Wavelength Shifter tetraphenyl butadiene (TPB)
- Deposition System
 - Deposition Source
 - Deployment System
 - Instrumentation
 - Simulation
- Summary and Outlook

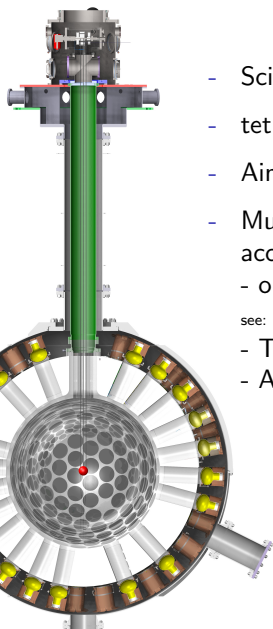
Dark Matter Experiment using Argon Pulse-shape Discrimination



- 3600kg single phase liquid argon (1000kg fiducial)
- Under construction at SNOLAB: 6000 m.w.e.
- Dark matter search with SI sensitivity: 10^{-46} cm² for 100 GeV WIMP
- Pulse-shape discrimination
 - 2 argon dimer states:
 $\tau_1 = 6\text{ns}$, $\tau_3 = 1.6\mu\text{s}$
 - discriminate β/γ vs. n.r.



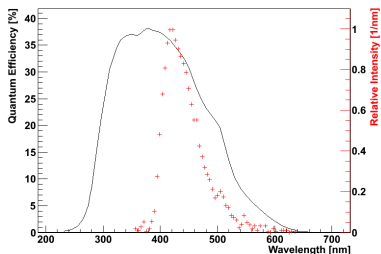
Wavelength Shifting & Deposition Overview



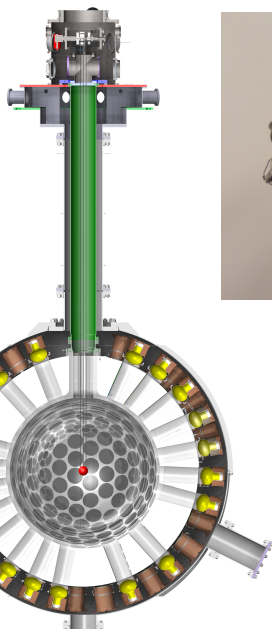
- Scintillation from Ar_2^* or Ar_2^+ dimers produces 128nm γ
- tetraphenyl butadiene (TPB) shifts to peak 430nm
- Aim to deposit $1\mu\text{m}$ TPB coating over AV interior (10m^2).
- Multi-purpose deployment system provides entry into the AV accommodating:
 - optical calibration sources (LED Ball, Laser Ball)
- TPB deposition source
- AV bakeout heating source

see: DEAP-3600 Optical Calibration Systems poster

TPB Re-emission and PMT Efficiency

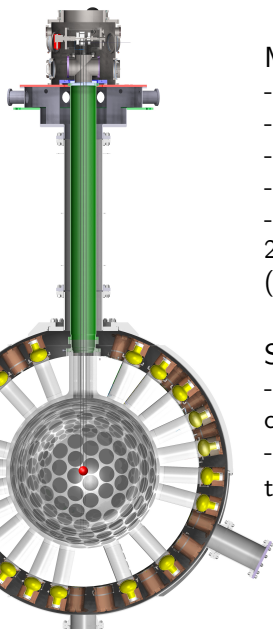


Deposition Source



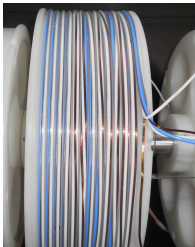
- 11cm dia. spherical source
- Exterior SS sheathed Nichrome wire
- Inner copper crucible holds TPB
- Instrumented w/ temperature sensors
- Aluminum prototype source tested
- SS source in manufacturing
 - controlled radiopurity

Cable and Stage



Main Cable Bundle

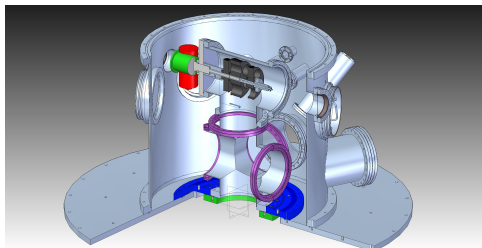
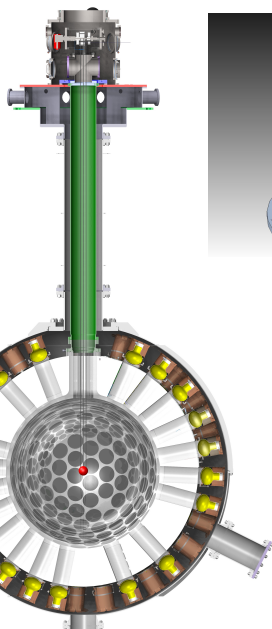
- 1 SS structural member
 - 2 power cables
 - 1 coax (LED triggering)
 - 2 4-wire thermocouple cable
 - Encased in 1' sections of teflon tubing
- 2 additional coax cables offer stability and affix to stage (IR probe/ deposition monitor connections)



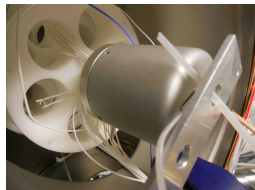
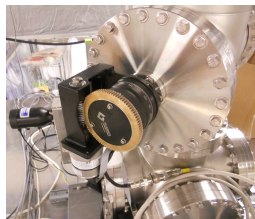
Stage

- Deployed to base of neck to prevent extraneous TPB coating
- Mounting for deposition monitor, IR probe, support lines, target for laser distance gauge

Deployment System

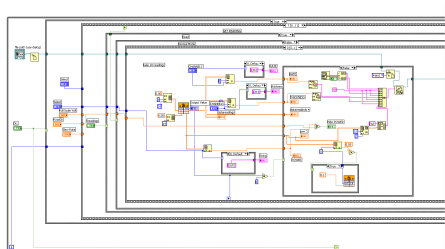


- McLennan Sim-Step Motor
- Main deployment bobbin, 2 tuned secondary bobbins.
- Coax slip ring: LED triggering and position monitor
- 14 wire fixed slip ring: control, heater, RTD sensors
- Laser Distance gauge

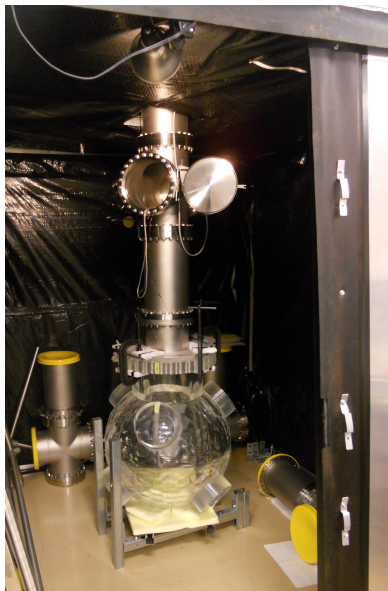


Sensors and Control

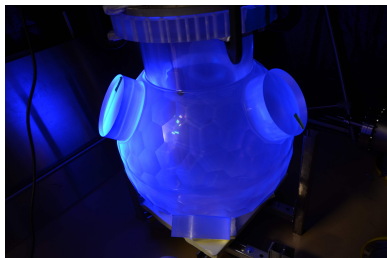
- Direct Thickness Measurement: quartz deposition monitor
- Source temperature control: 2 RTDs
- Acrylic surface temperature: IR probe
- Motor control through McTerminal
- Power/temperature/position logging in LabView



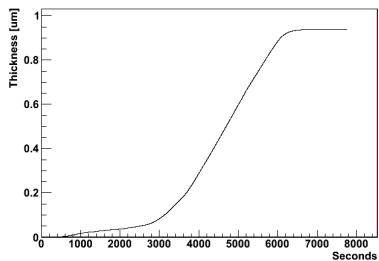
20" Test Vessel



B. Broerman Queen's



TPB Thickness

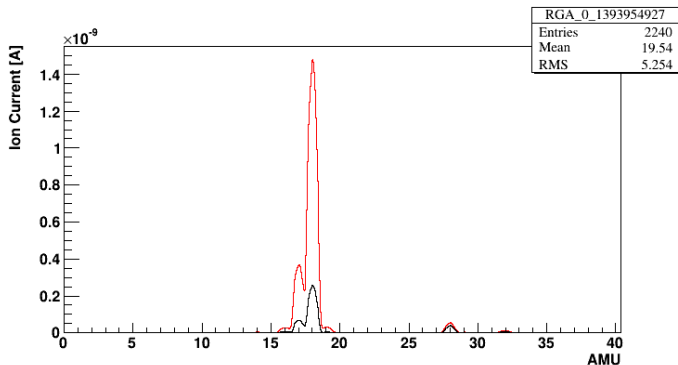


CAP 2014

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AV Bakeout

- During resurfacing, AV is rinsed with water.
- Perform vacuum bake out of AV, heating inner acrylic surface to 60°C.
- Monitor outgassing w/ Cirrus RGA.

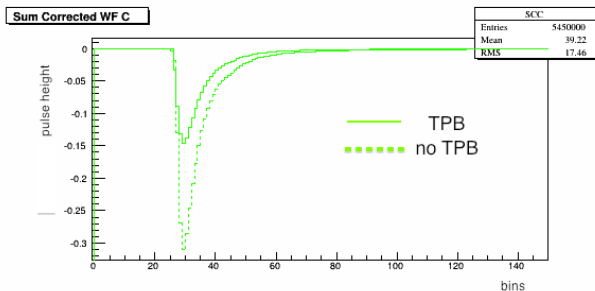


RGA spectrum from bakeout of 20" test vessel

Thickness Monitoring

- Deposition monitor provides single sample point of TPB thickness
 - expect uniform distribution, but attempt to map uniformity
- Install LED's on evaporation source
- Flash during TPB deposition
- Monitor light attenuation vs. thickness.

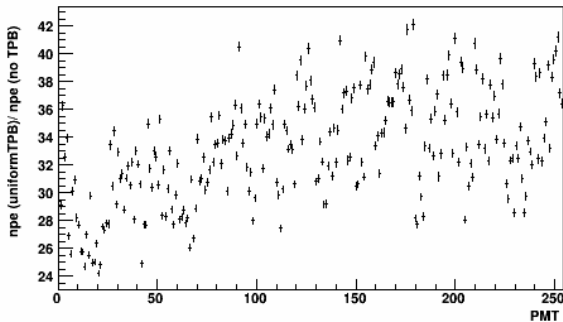
- Intensity highly dependent on LED orientation.



Simulation

- Require TPB thickness non-uniformity to be less than 15%.
- Simulation of uniform and non-uniform (top hemisphere thicker) geometries.

Expected number photoelectrons per pmt for uniform TPB coating vs. no TPB coating:



Summary and Outlook

- Wavelength shifting required to view scintillation in argon
- Deposit $1\mu\text{m}$ tetraphenyl butadiene over inner AV surface.
- Current deposition source tested on small scale.
- Deployment system tested.
- Continued exercising of full system/ test TPB deposition.
- Deposition late July/August.



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