DEAP-3600

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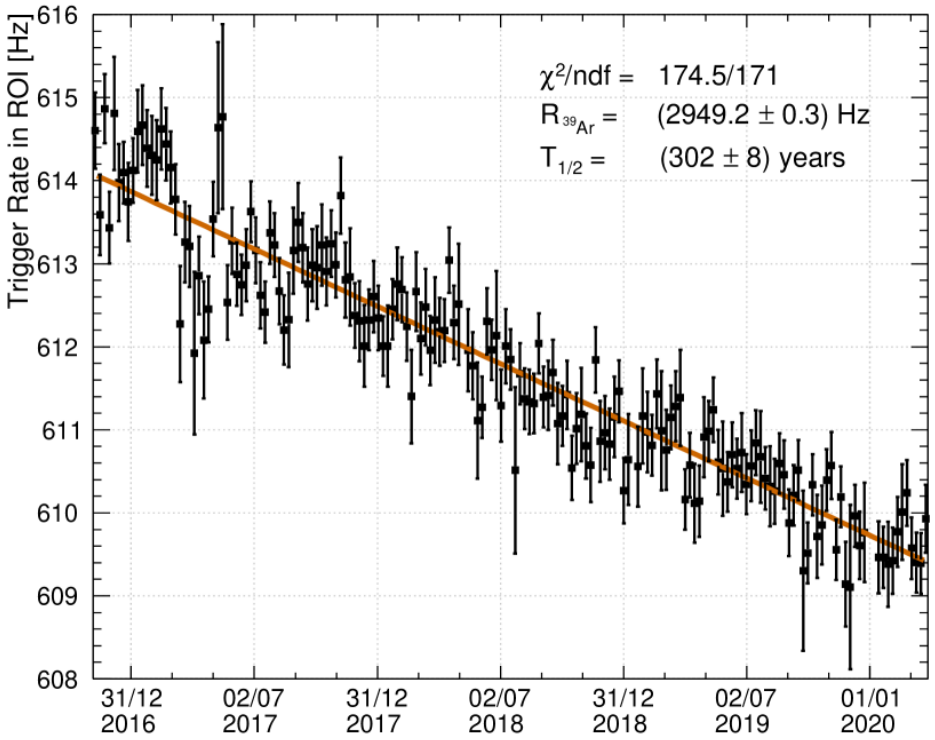
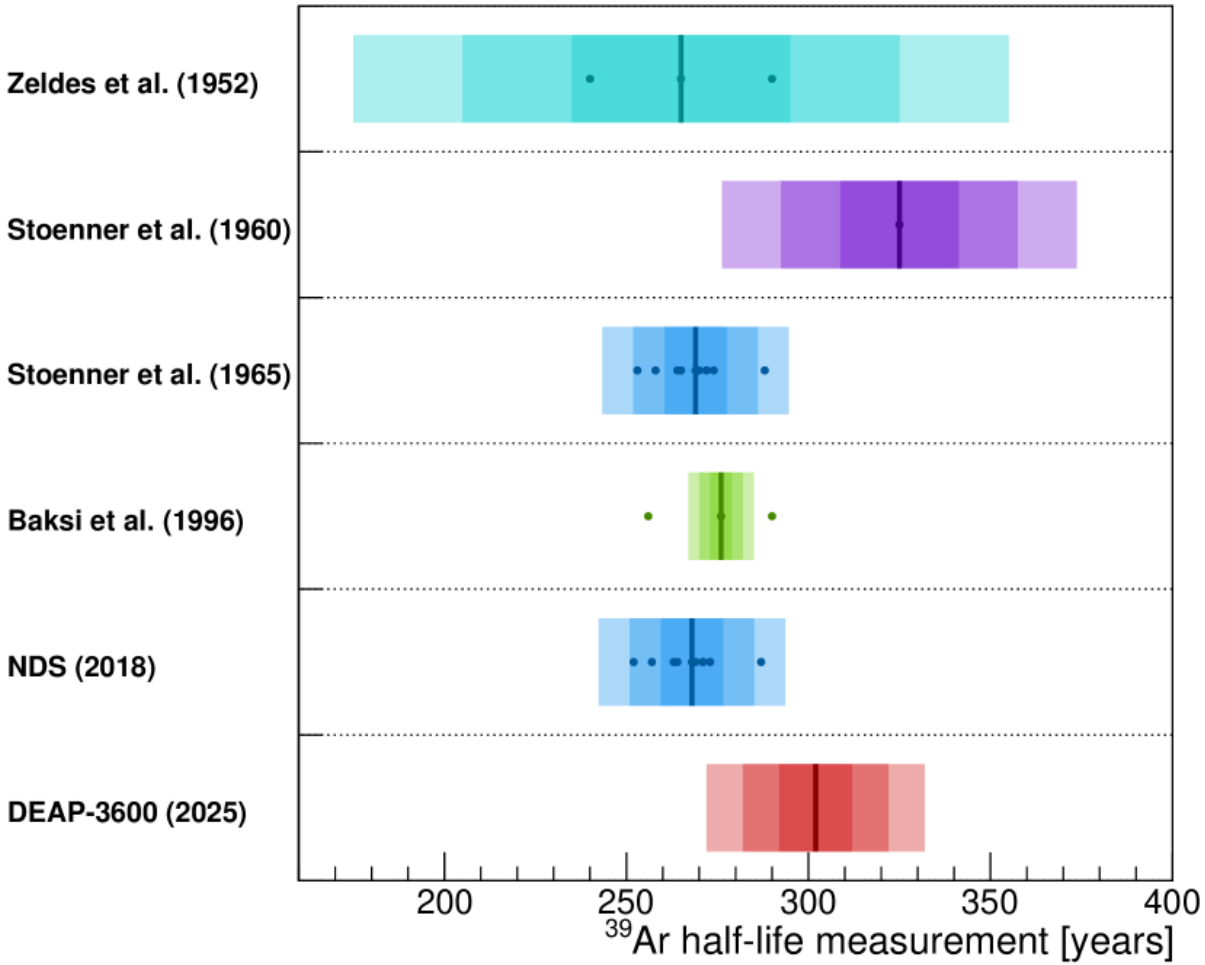
on behalf of the DEAP-3600 Collaboration

- Recent results
- Analysis goals for existing dataset
- Hardware upgrades
- Run and analysis plan

First Direct Measurement of Ar-39 decay curve

We have already received communication from a group doing Ar-Ar dating in ice cores.





Submitted to EPJ C
ArXiv 2501.13196

Alpha quenching in Liquid Argon

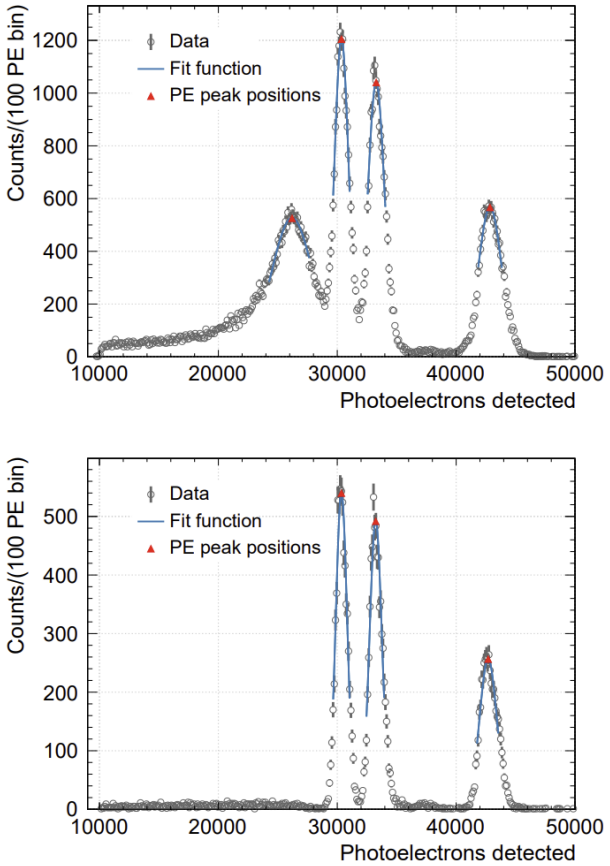


Fig. 1 Distribution of the number of PE detected from α-decay events the position of which is reconstructed within radius 0–850 mm (top histogram) and 0–600 mm (bottom histogram) from the origin of the detector. From left to right, the peaks are from the decay of the ^{210}Po, ^{222}Rn, ^{218}Po and ^{214}Po isotopes. Each peak is fitted by a Gaussian distribution (blue line). Red solid points are the detected peak PE positions from each Gaussian fit.

Have developed a data-driven quenching model for alpha events, which are significant contributors to our background model.
Relevant for future experiments.

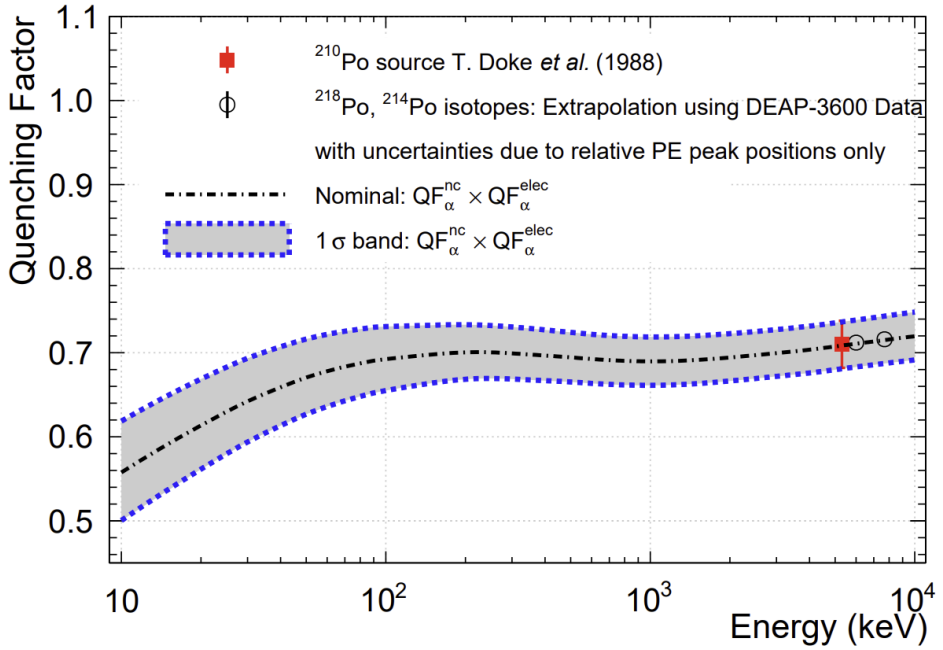


Fig. 6 Energy-dependent scintillation QF curve for α-particles within LAr, as a function of their energy on a logarithmic scale. The nominal and $\pm 1\sigma$ QF curves are the product of the electronic QF (see Fig. 5) with the nuclear QF from TRIM (see Fig. 2).

ArXiv: 2406.18597

Eur. Phys. J. C **85**, 87 (2025)

https://doi.org/10.1140/epjc/s10052-024-13518-7

Many Analyses for Theses and HQP

- Position reconstruction technical paper submitted
  https://arxiv.org/abs/2503.10383
- Ar-36 neutrinoless double EC
- Muon flux measurements

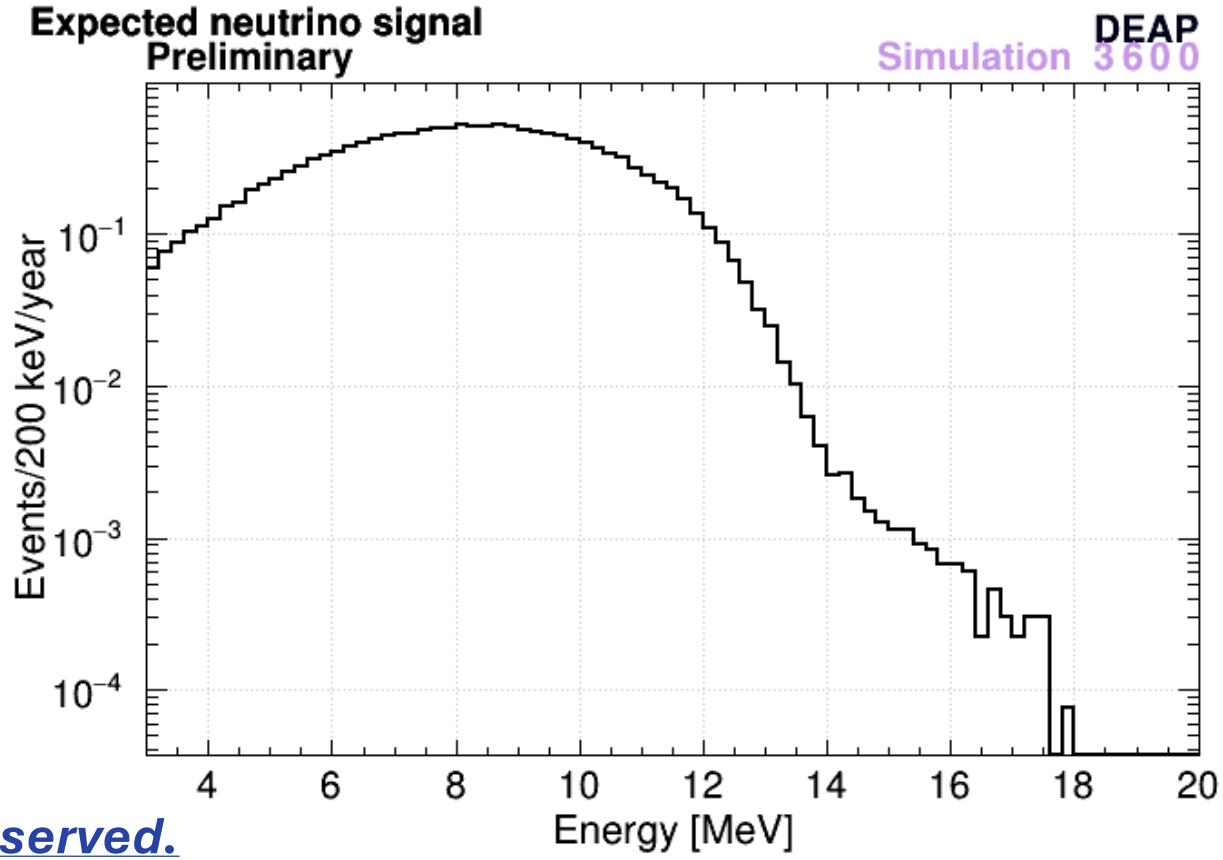
Currently the bulk of collaboration analysis effort is on two important results:

a solar neutrino measurement, and

a WIMP search with profile likelihood analysis

Boron-8 Solar Neutrinos

- Our high-energy B-8 solar neutrino ROI has been unblinded.
- Two analyses (differing mostly in method to constrain the high-E n-capture) are completed/very advanced.
- A series of double-checks is underway to ensure there are no misunderstood backgrounds in the ROI.
- Andrew Erlandson (Carleton) and Emma Ellingwood (Queen's) defended their PhD theses. Journal publication draft is advanced.



This reaction has never been observed.

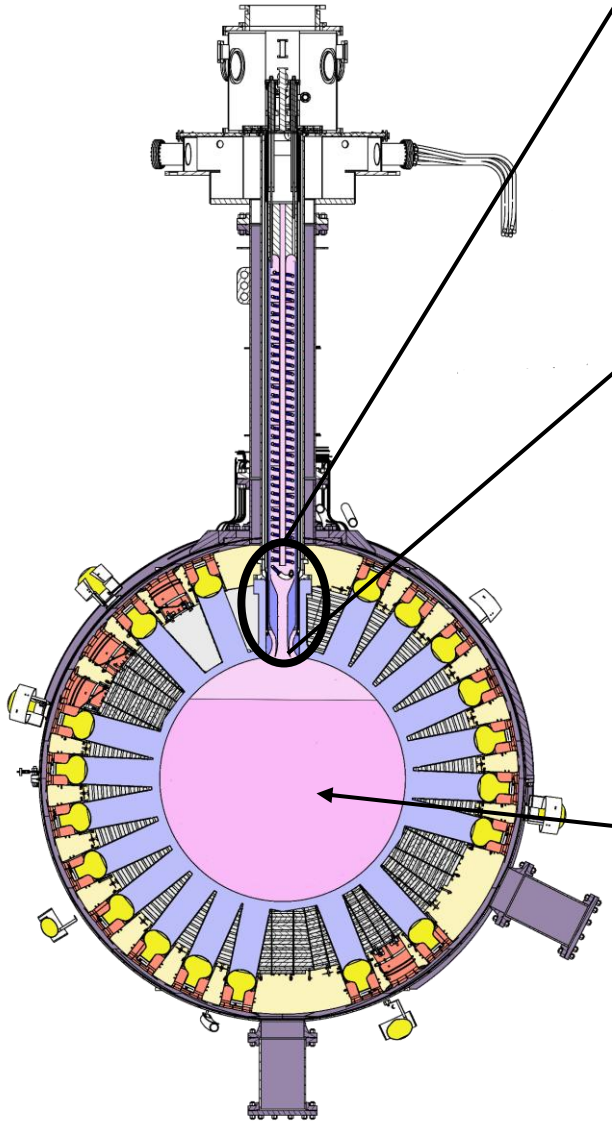
Our measurement will be the first: allows experimental constraint on the cross section.

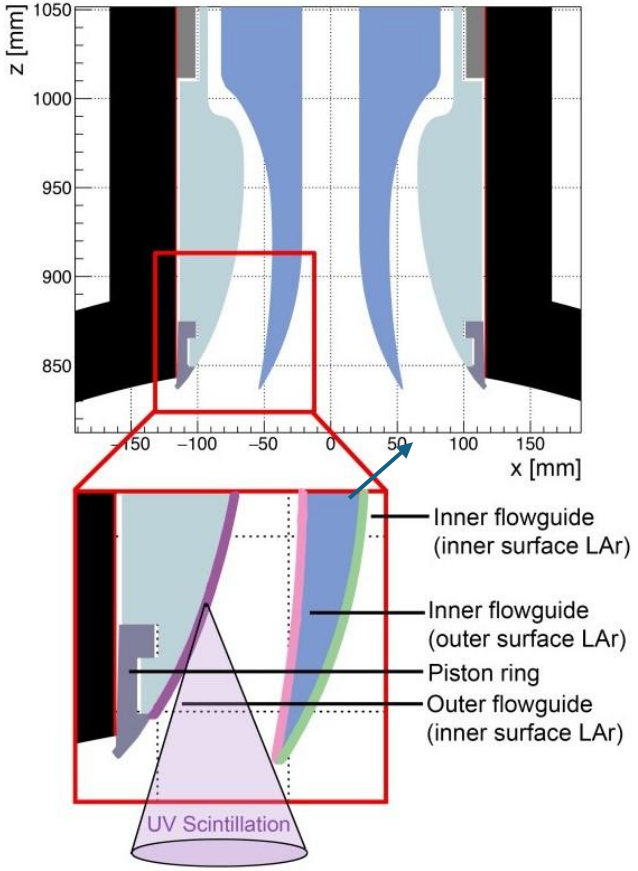
First observation of solar neutrinos with argon

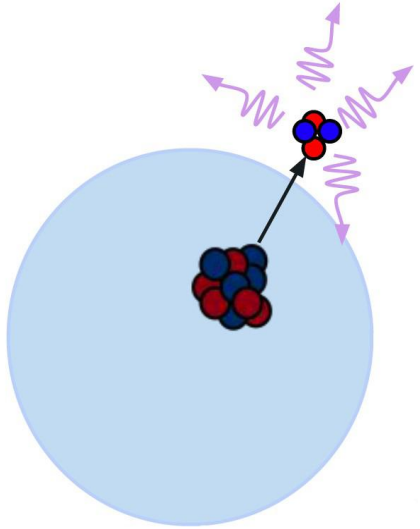
WIMP Search with Profile Likelihood Analysis

- Improve sensitivity w.r.t. our 231-day result with a larger fiducial volume and a more detailed background model.
- Dominant backgrounds are degraded alphas:
  - Neck events where only a fraction of light enters the detector
  - Dust events where alphas in particulates leave only a small amount of energy in the detector.

Mechanism for Neck and Dust events







Mitigating these backgrounds led to the hardware upgrades:

- New neck flow guides with pyrene doped polystyrene coatings
- A deployable and removable dust removal pipe to draw liquid form the bottom of the detector
- Redundant systems for neck events and dust removal if needed.
- *Goals*:
  - *Verify the background model for DEAP-3600*
  - *Run DEAP-3600 with zero background in the WIMP ROI*
  - *Inform strategies for DarkSide-20k and ARGO*

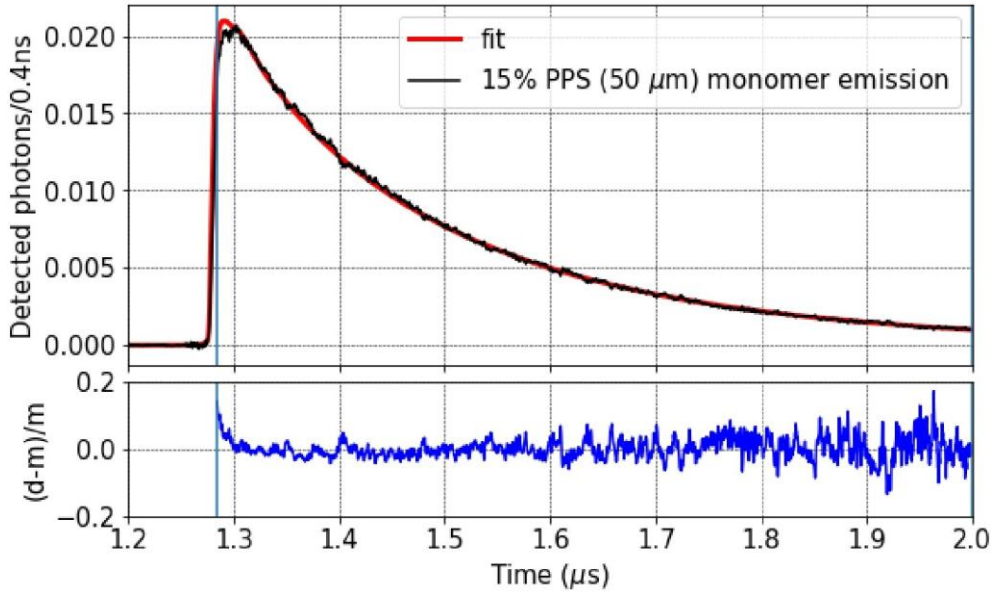
New Flowguides with Pyrene allow for Pulse-Shape Discrimination to reject neck events.

Machined in low-Rn shop at U Alberta

Coated in Pyrene-doped polystyrene at Carleton

Installed into DEAP at SNOLAB

Shipped in a sealed can with in clean N2 at overpressure



The time constants in the pyrene decay model are ~ 100 to 250 ns: *distinct from liquid argon.*

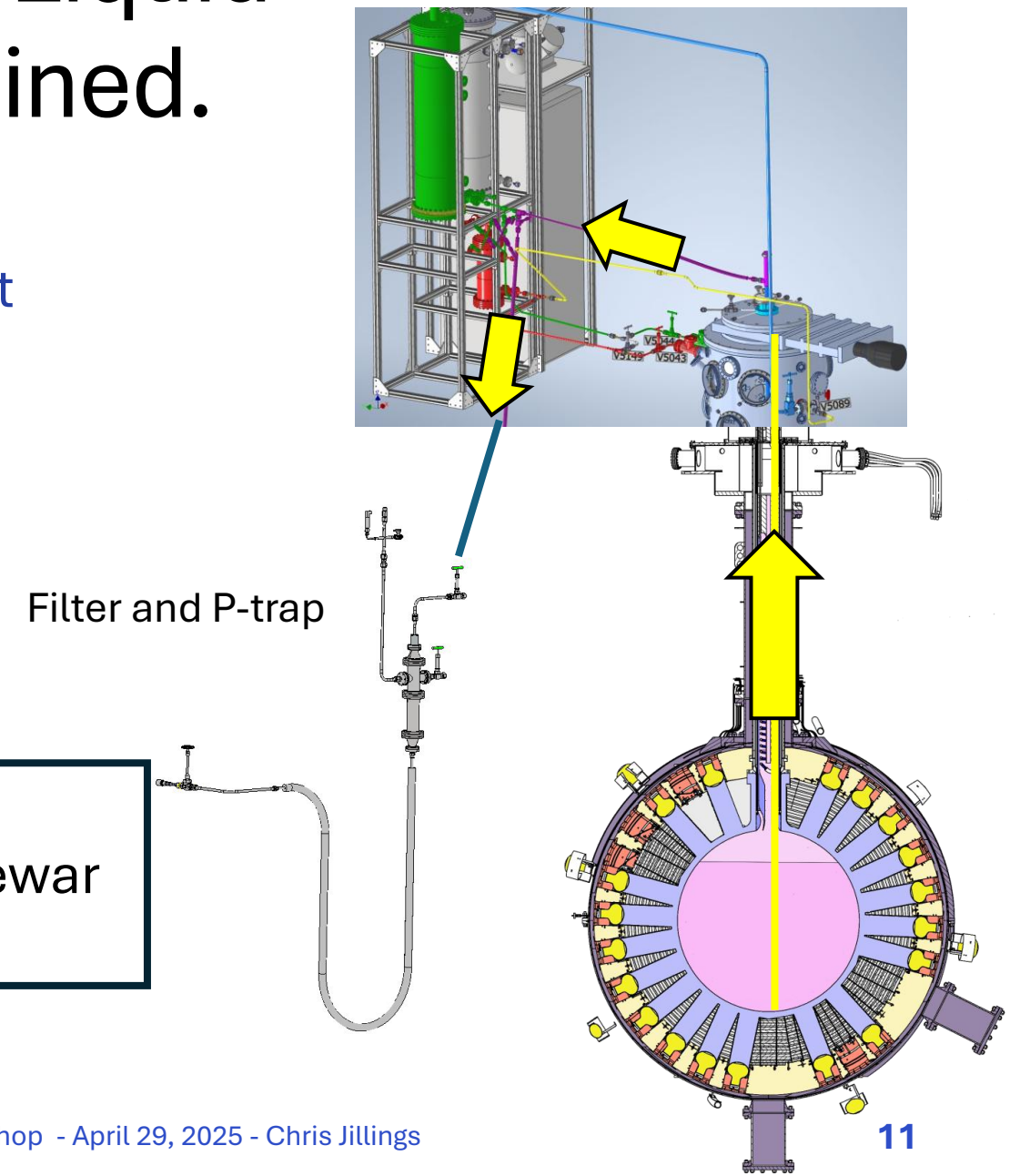
JINST 16, P12029 (2021)/ arXiv:2110.08103

NIM A 1034 (2022) 166683 / arXiv:2109.06819

The Dust Pipe Allows for Liquid Removal with Dust Entrained.

The liquid argon will be filtered and returned to the storage dewar from which it can be re-purified and injected back into DEAP-3600.

After a few cycles, the dust pipe will be removed from the detector



Status

- We are cooling the detector now

- Final steps are being taken to prepare for the dust pipe deployment.

Run Plan and Data Taking

- We will fill to 3269 kg as we did in our 2016-2020 dataset.
- From the 2016-2020 dataset, we have, with suitable cuts, ~20 neck events and ~20 dust events per week in the sidebands.
- We have automated our analysis for PMT calibration, light yield, pulse-shape analysis, and sideband search for backgrounds, as well as WIMP search.
- Analysis will be reviewed weekly.
- In early summer 2026, we will inject mKr-83 for whole-detector low-energy calibration.
- In summer 2026, we will start decomissioning to make room for ARGOlite.

Summary

- Analysis of the 2016-2020 dataset is yielding interesting and important results.
- The hardware upgrades will allow us to make crucial tests of the background model which will inform DarkSide-20k and ARGO.
- We are looking forward to a zero-background run of DEAP-3600



CobraTig-150