Early studies of detector calibrations for DEAP3600

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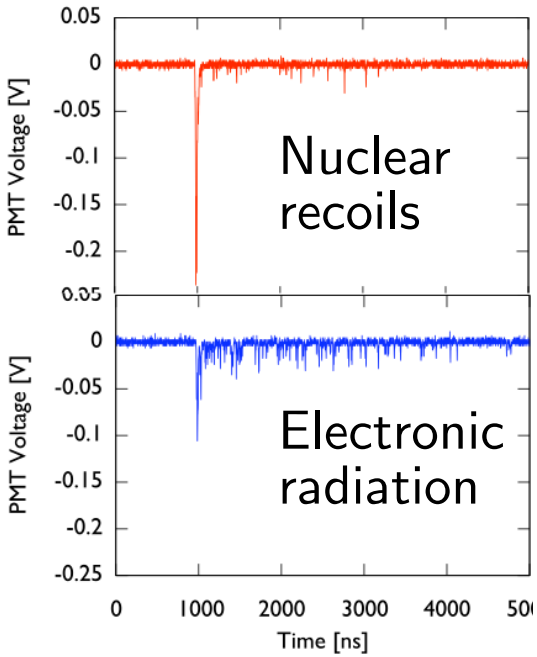
Liquid Argon (LAr) as a scintillator to search for dark matter

$$\frac{dE}{dx} \longrightarrow \text{LAr dimers} \longrightarrow \text{UV light}$$

Singlet $\tau_1 = 6\text{ns}$ Triplet $\tau_3 = 1.5\mu\text{s}$

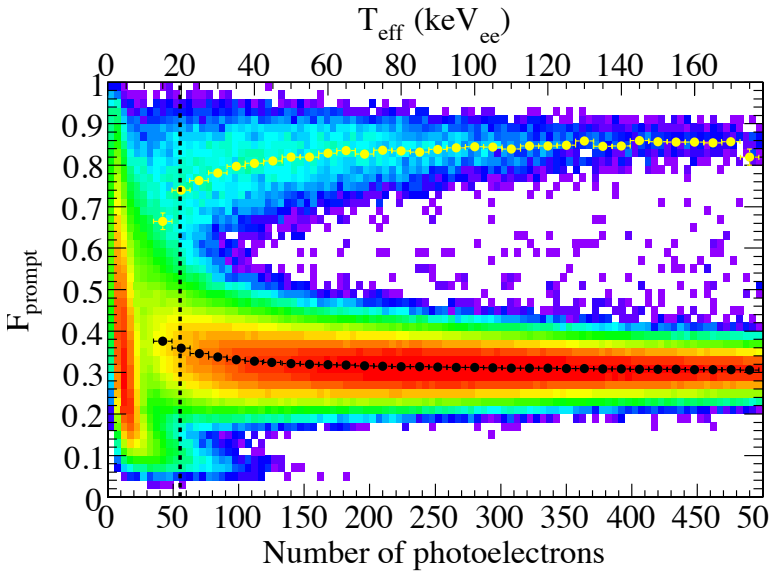
LAr allows for excellent pulse shape discrimination (PSD)

$$\text{Fprompt} = \frac{\text{Prompt Light}}{\text{Total Light}}$$

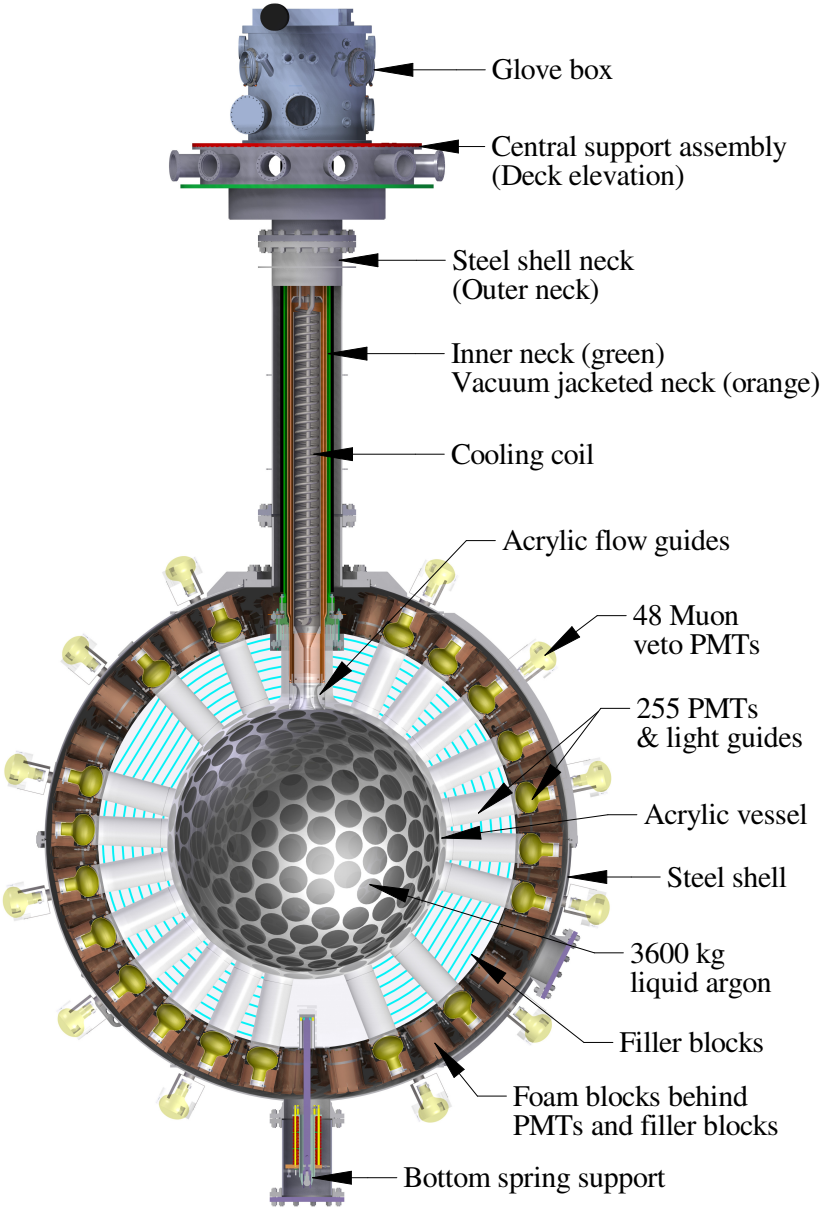


$$\frac{\text{Singlets}}{\text{Triplets}} = 3$$

$$\frac{\text{Singlets}}{\text{Triplets}} = 0.3$$



DEAP3600 as built



- Single phase liquid scintillation detector
- Carefully crafted to minimize backgrounds
- Construction completed
- 255 PMTs on since Feb 2015
- Cool down and argon filling expected to start at the end of September 2015

DEAP3600 background budget (3 years of data taking)

Background	Raw No. Events in energy ROI	Fiducial No. Events in energy ROI
Neutrons	30	< 0.2

- Dominated by PMT (α, n) and rock neutrons
- Shielded by Light guides, filler blocks and water shielding.

DEAP3600 background budget (3 years of data taking)

Background	Raw No. Events in energy ROI	Fiducial No. Events in energy ROI
Neutrons	30	< 0.2
Surface α	150	< 0.2

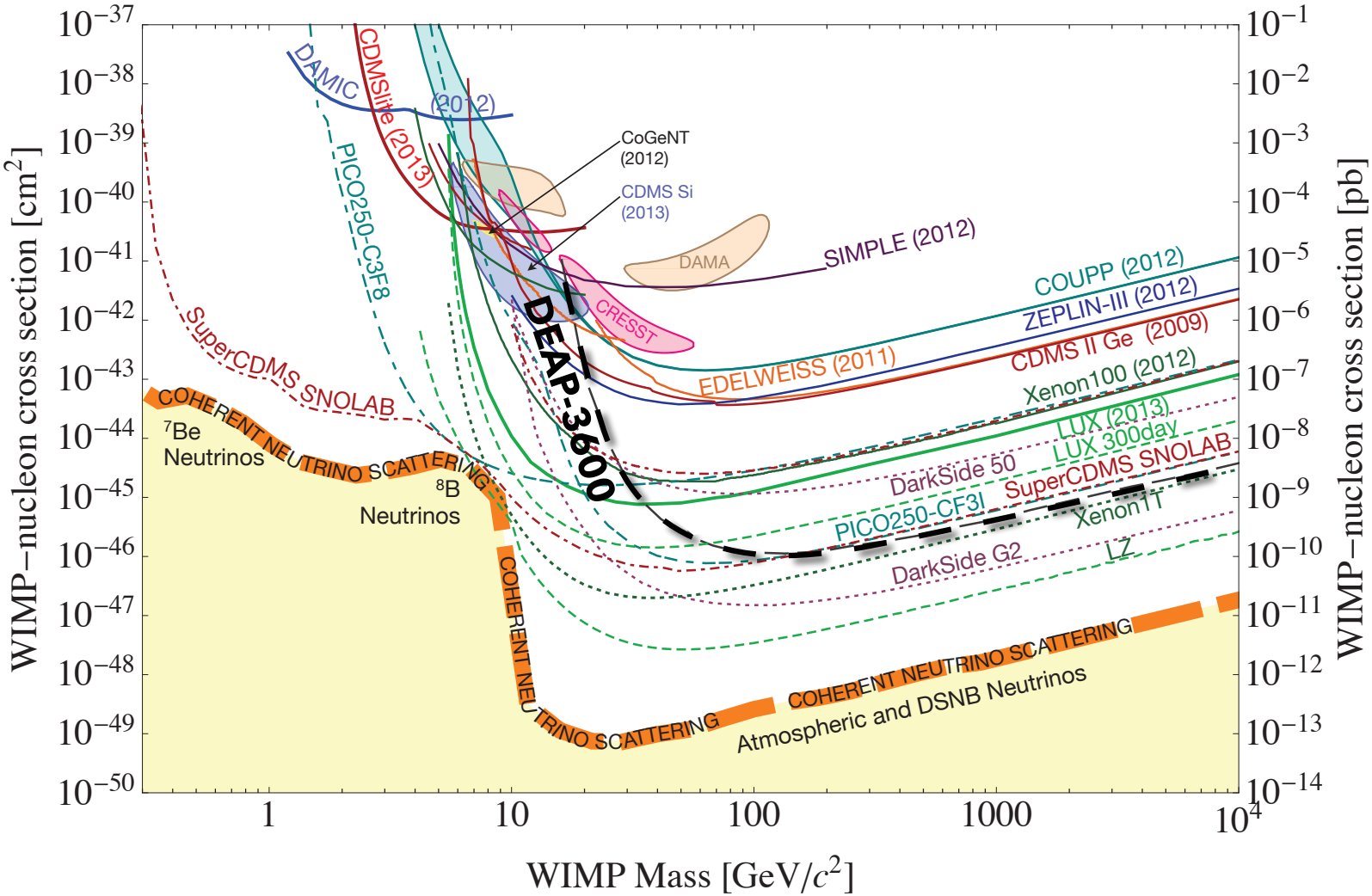
- Very clean acrylic, assessed to have $^{210}\mathrm{Pb} < 10^{-19}\mathrm{g/g}$
- Inner surface from the vessel has been sanded and kept in a Rn free environment since (see Pietro Giampa talk)

DEAP3600 background budget (3 years of data taking)

Background	Raw No. Events in energy ROI	Fiducial No. Events in energy ROI
Neutrons	30	< 0.2
Surface α	150	< 0.2
$^{39}\mathrm{Ar}$ β (natural argon)	1.6×10^9	< 0.2

Pulse shape discrimination (PSD)

DEAP3600 3 year run projected sensitivity

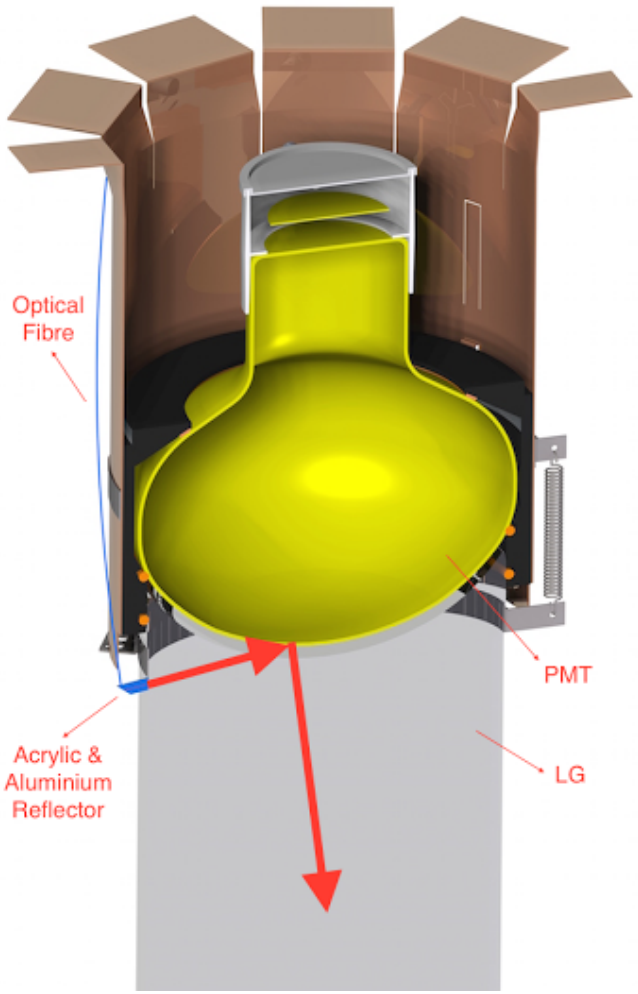


plot: J Cooley, arXiv: 1410.4960v2

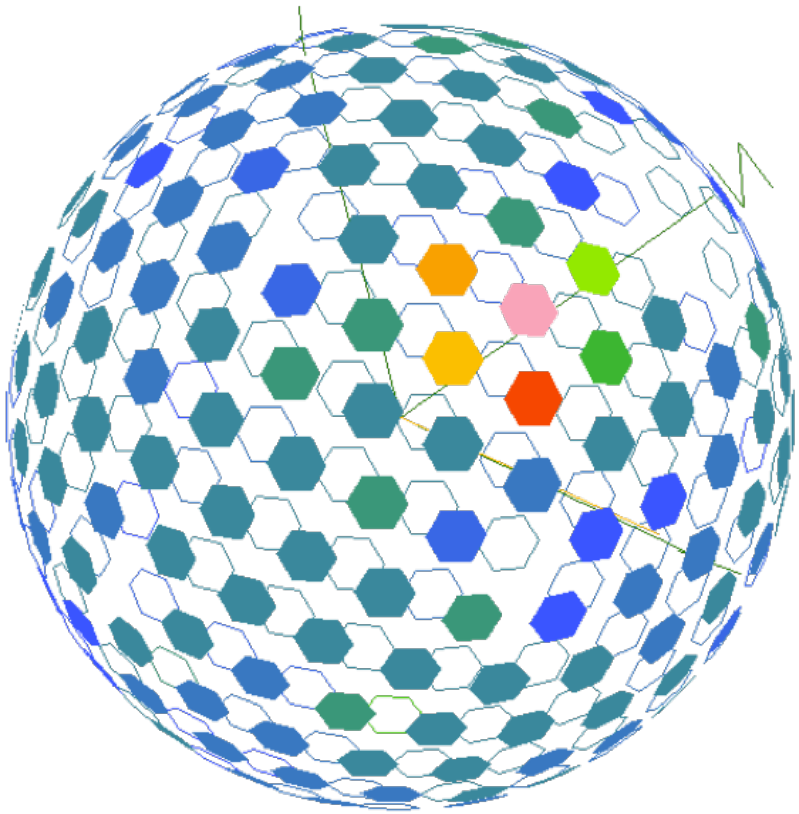
Calibration program ongoing since Feb 2015

- LED Optical calibration
- Laser ball deployed in the center of the AV during August
- Cherenkov studies with a gamma source

20 PMTs in the detector have optical fibers pointing at them (AARF)

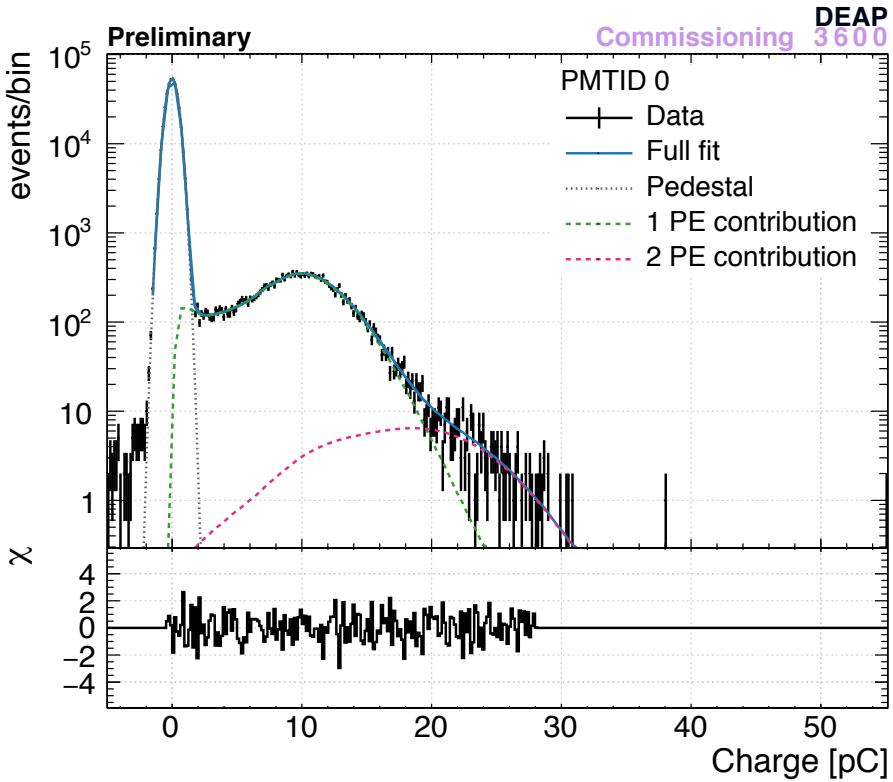


Charge distribution for a 440 nm LED connected to one optical fiber

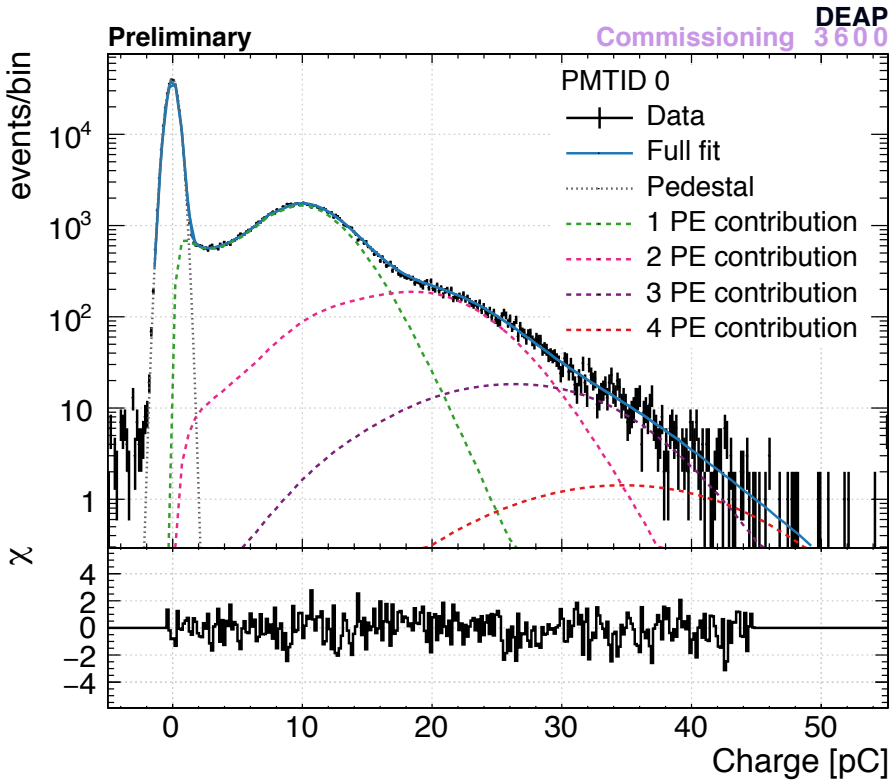


LED AARFs data: Measuring PMT spe charge

Low occupancy data

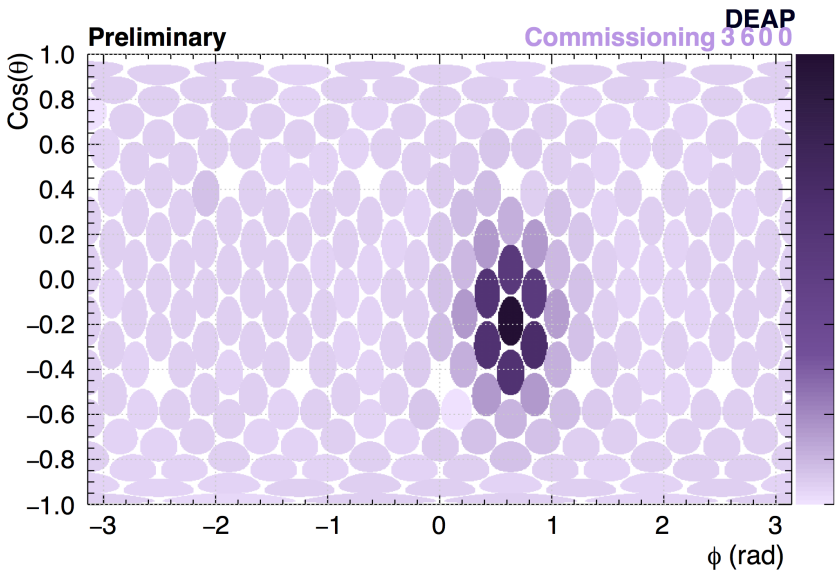


High occupancy data

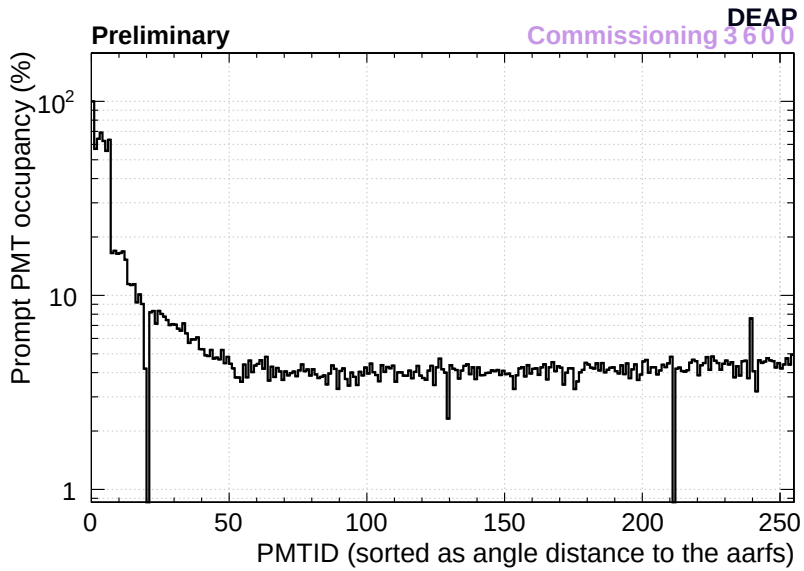


LED AARFS data: Determination of the detector's optical parameters

Occupancy distribution of the light in the vessel. The PMTs with the optical fiber and the surrounding ones get most of the light.



We can refine the Optical model of the detector by understanding how the Laser AARF photons propagate in the vessel.

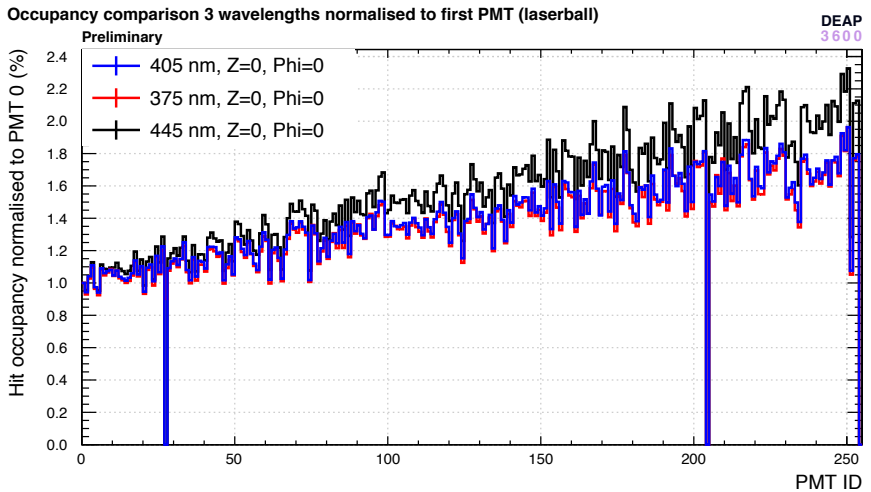


Laser ball calibration

We have deployed an optical fiber inside a PFA flask inside the vessel. We have shined 3 different lasers (375, 405, 445 nm) through the fiber.

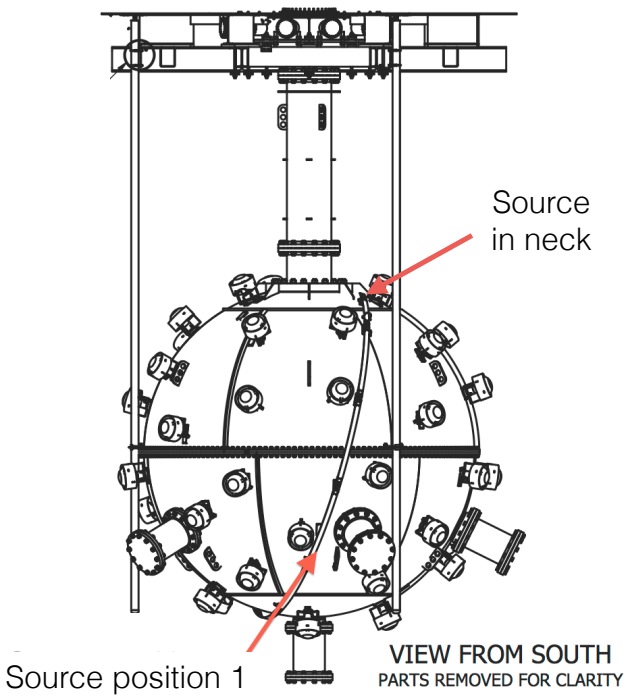
Main goals:

- Measure PMTs relative efficiency
- Measure PMTs relative t_0.

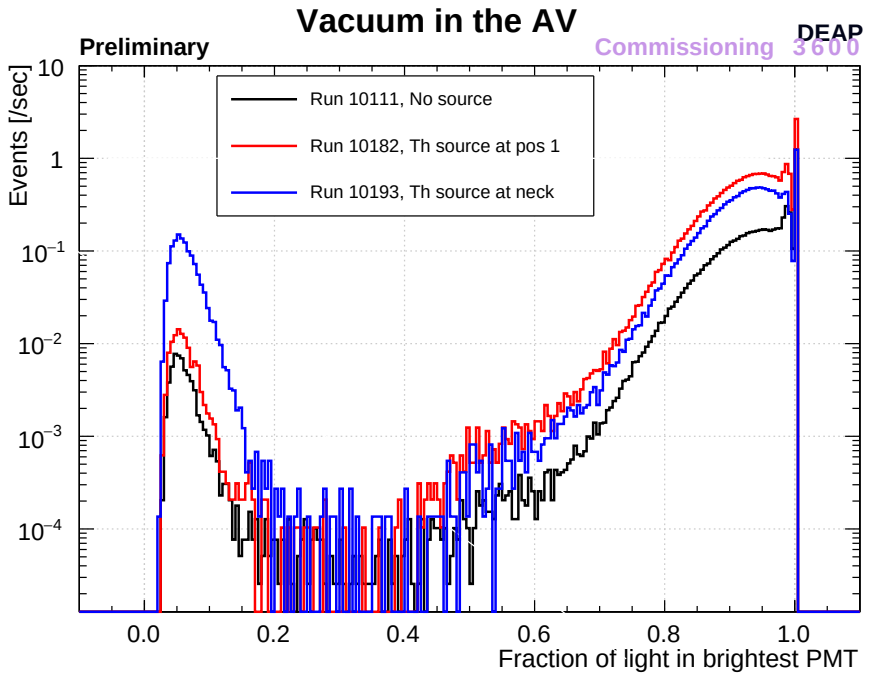


Gamma calibration

We expect Cherenkov events from rock γ as the water tank shielding is not filled yet.



- We see events in the Light Guides and in the AV neck
- We have confirm their origin by means of a $^{232}\mathrm{U}$ calibration.



Summary

- The construction of the DEAP3600 detector has finished.
- Cool down expected to start at the end of September 2015.
- The DAQ and the PMTs have been running in a stable configuration since Feb 2015.
- While we have vacuum in the detector an extensive calibration program has been carried on.
  - We are in the process of calibrating the PMTs relative efficiency and t_0
  - We are refining the optical model of the detector

DEAP3600 collaboration