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# DEAP-3600 Dark Matter Experiment

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For the DEAP-3600 collaboration

IOP 2015, Manchester  
March 30, 2015

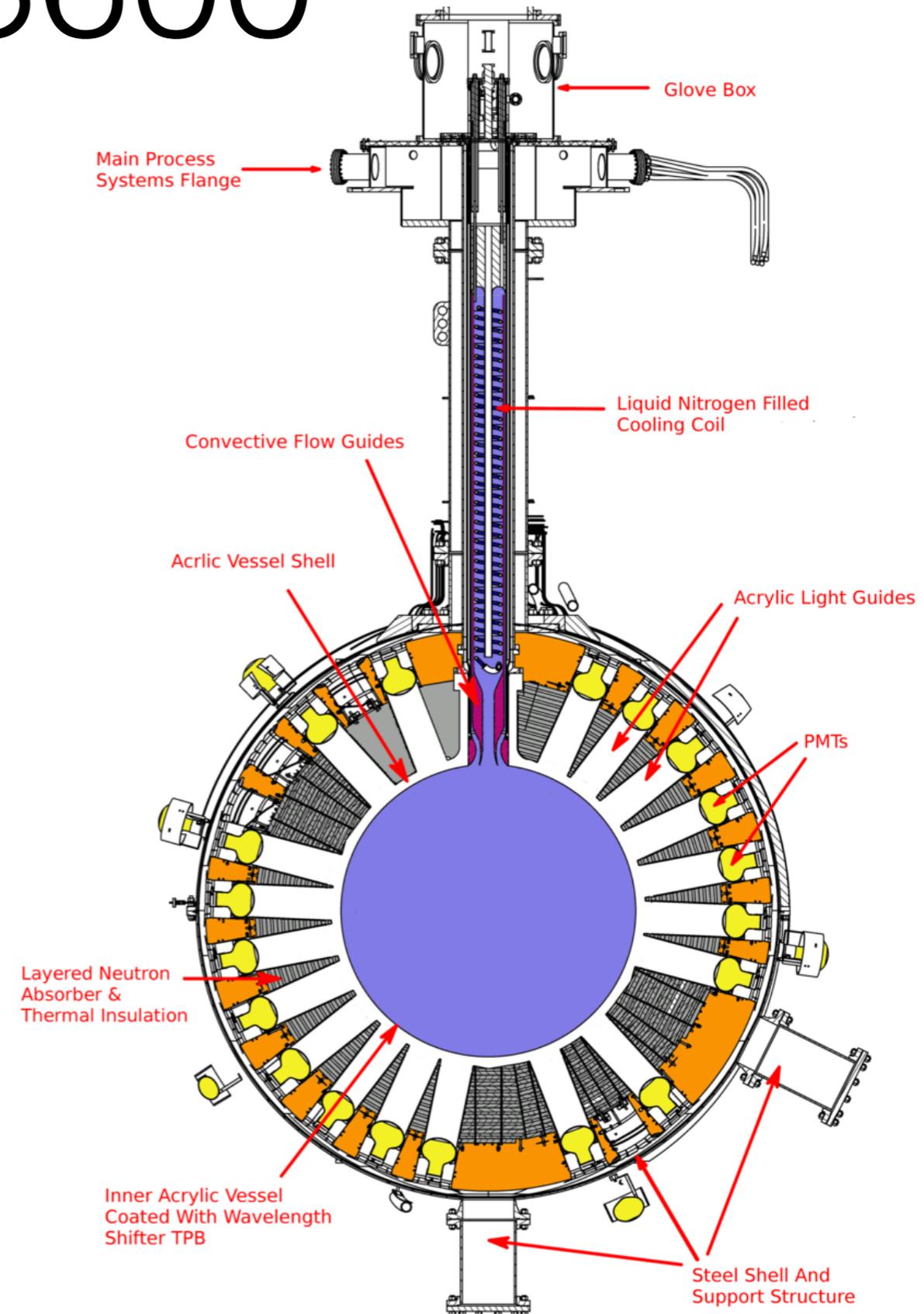
# DEAP-3600

- Single phase liquid argon (LAr) dark matter detector
- Located in Vale's Creighton mine at Sudbury, ON, Canada
- 2070 m underground



# DEAP-3600

- 3600 kg LAr target (1000 kg fiducial volume)
- Ultraclean Acrylic vessel (AV)
  - Resurfaced in-situ to remove Rn daughters after construction
- Deposit TPB uniformly on AV surface before filling with LAr
- 255 PMTs (8")
- Shielding against
  - Neutrons: Light guides and polyethylene filler blocks
  - Gammas and cosmic muons: 8 m diameter ultra pure water veto tank, instrumented with PMTs, surrounds the steel spherical shell



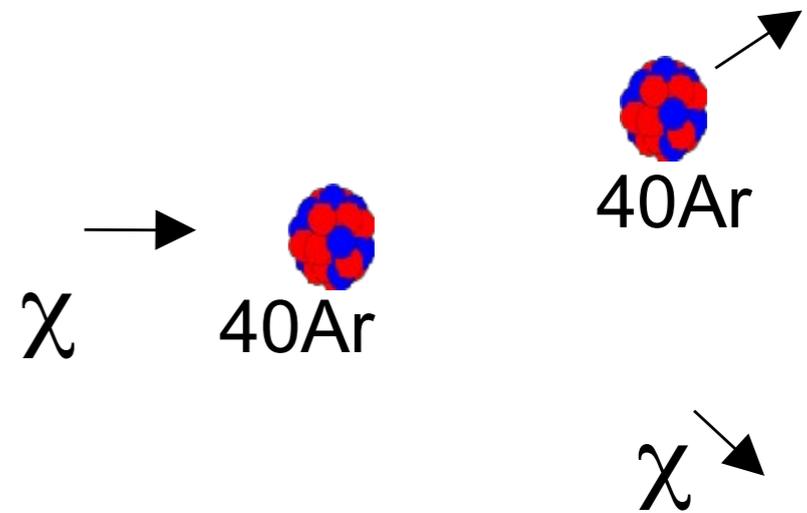
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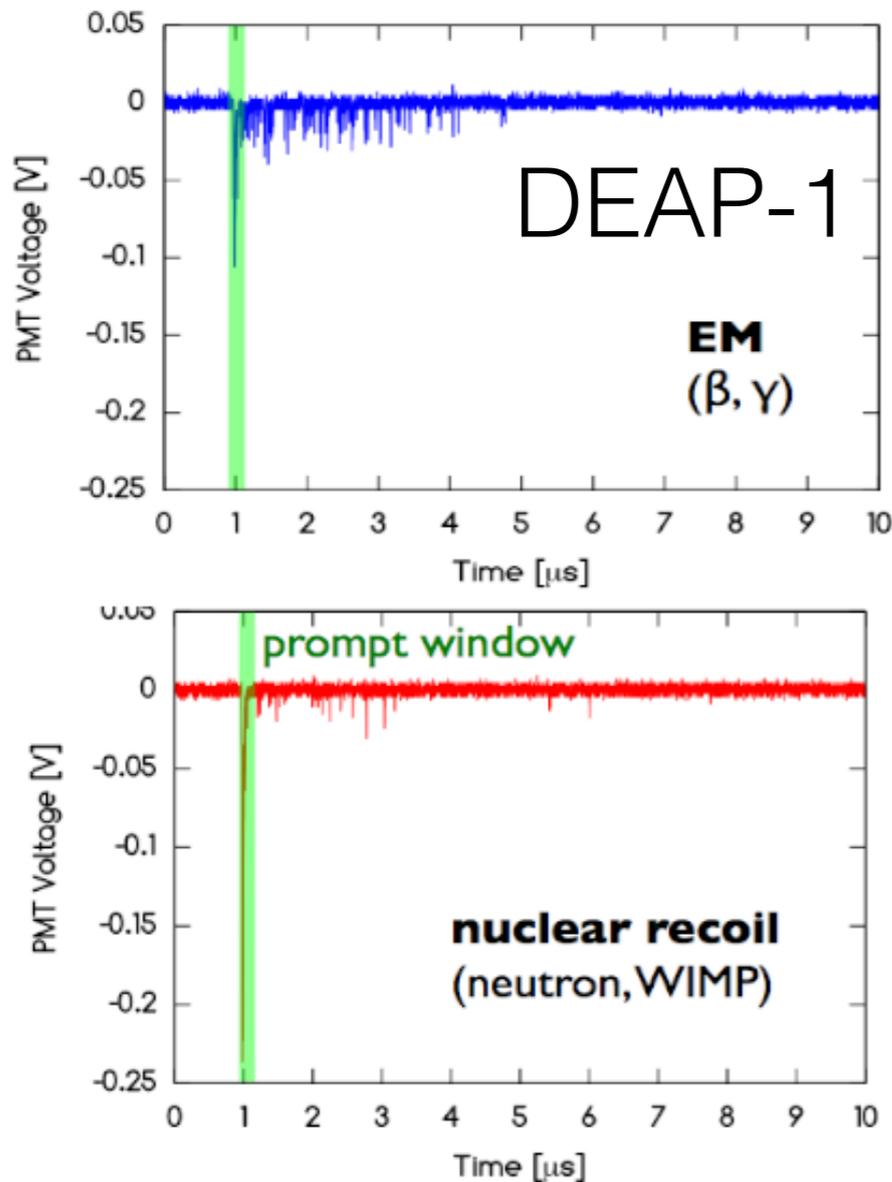
# LAr as dark matter target

- WIMP signal: ionization from  $^{40}\text{Ar}$  recoiling nucleus

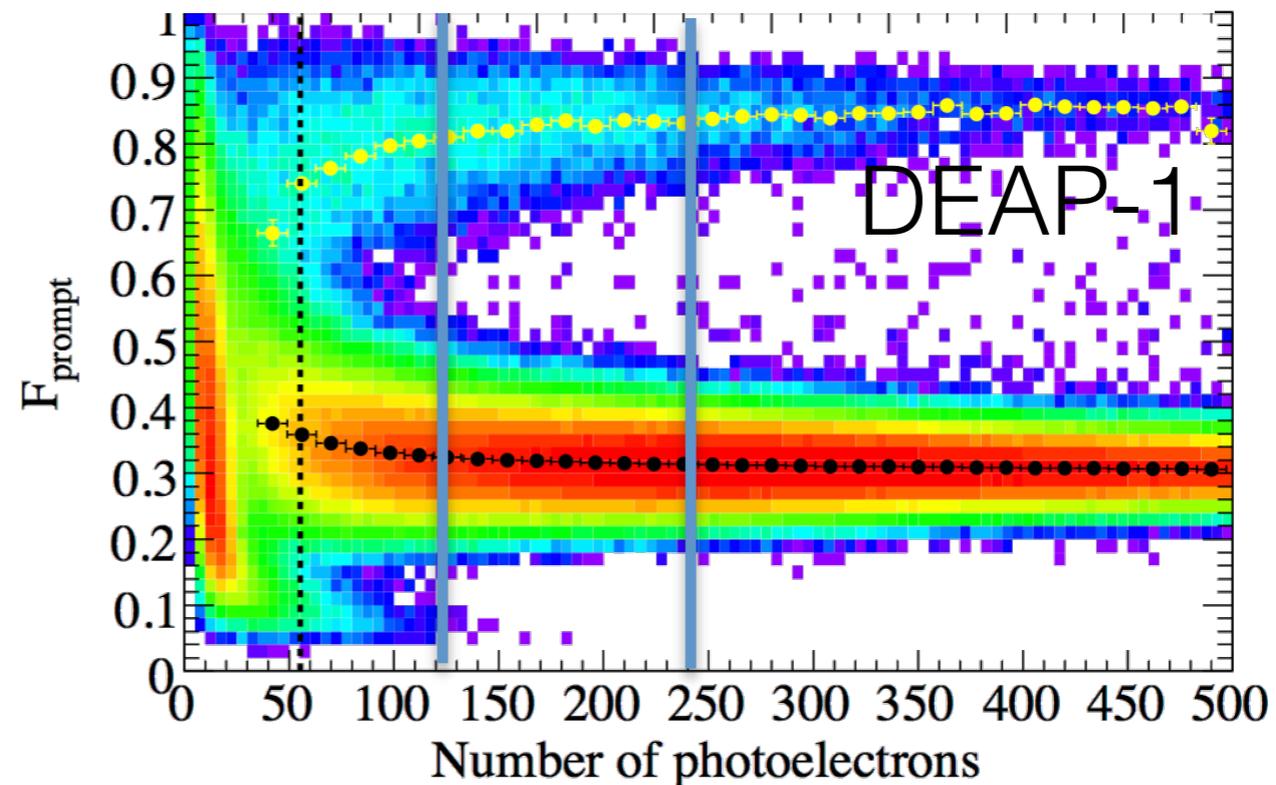


- Projected light yield: 8 pe/keVee
- 128 nm light wavelength (shifted to 425 nm by TPB before detection by PMTs)
- Most sensitive to high mass WIMPs (60-120 keVr energy ROI)

- Ar singlet and triplet excited states have well-separated lifetimes (7ns versus 1.5  $\mu$ s)
- Electronic and nuclear recoils produce different ratios of singlet and triplet states



Electronic signal from PMT: photo electron counting ( $F_{\text{prompt}} = N_{\text{prompt}}/N_{\text{total}}$ )



**Excellent pulse shape discrimination (PSD)**  
**Single phase LAr: scintillation channel is sufficient no ionisation is needed**

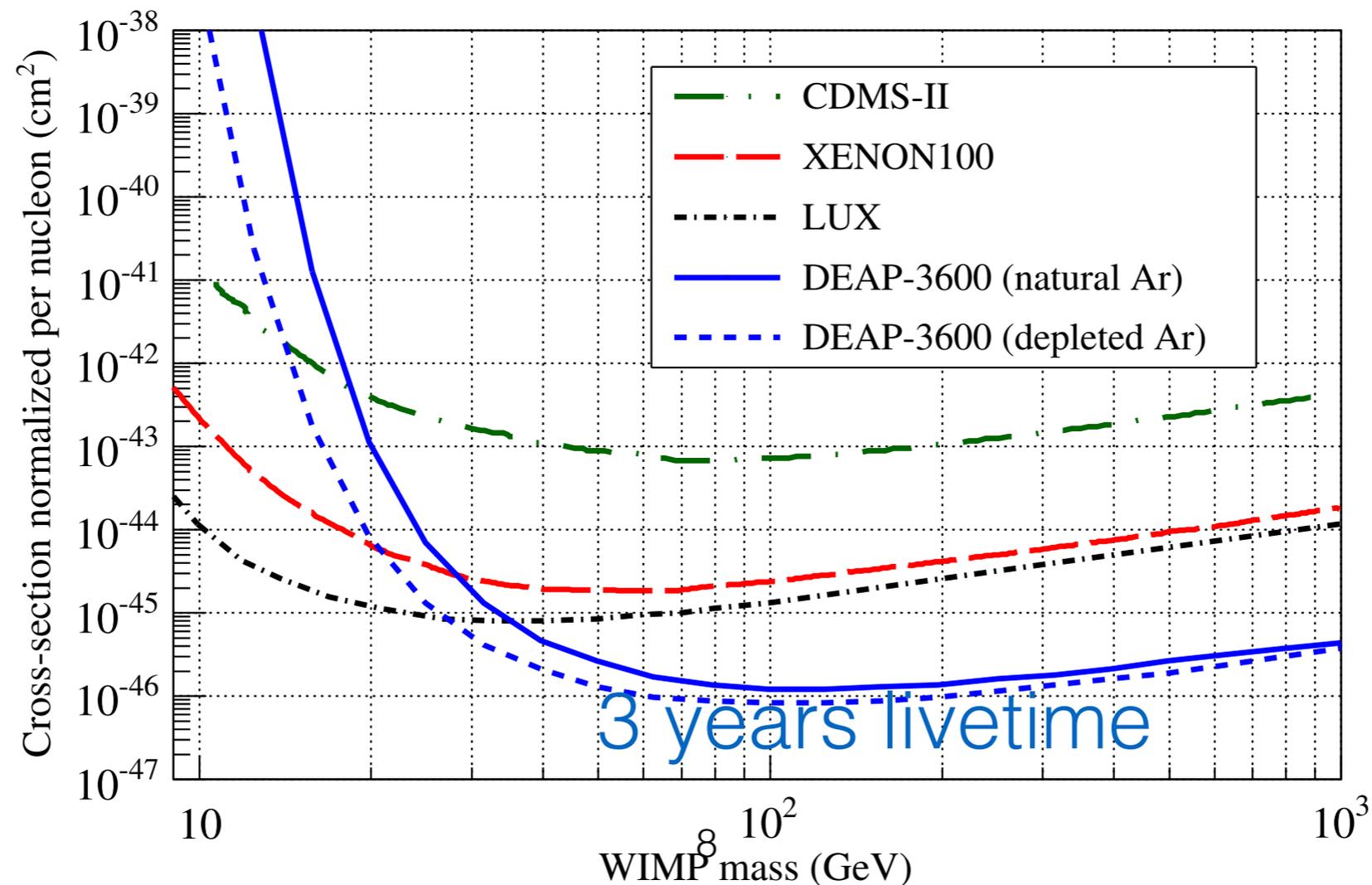
# Background

- $\beta/\gamma$  events:  $^{39}\text{Ar}$ 
  - Rate: 1 Bq/kg
  - PSD reduces  $^{39}\text{Ar}$  by  $> 10^{-9}$
- Neutron recoils:  $(\alpha, n)$  fission and  $\mu$ -induced
  - Strict material screening and assay
  - Shielding
- Surface events: Rn daughters and other surface contamination
  - Sanded 200  $\mu\text{m}$  off inner AV surface
  - Position reconstruction + fiducialization
  - Limited exposure to radon

Background (in Fid Vol)	DEAP-3600 Goal
Radon in Ar	$< 1.4 \text{ nBq/kg}$
Surface $\alpha$ 's	$< 100 \mu\text{Bq/m}^2$
Neutrons (all sources)	$< 2 \text{ pBq/kg}$
Ar-39	$< 2 \text{ pBq/kg}$
Total (3 tonne-yr)	<b><math>&lt; 0.6 \text{ events}</math></b>

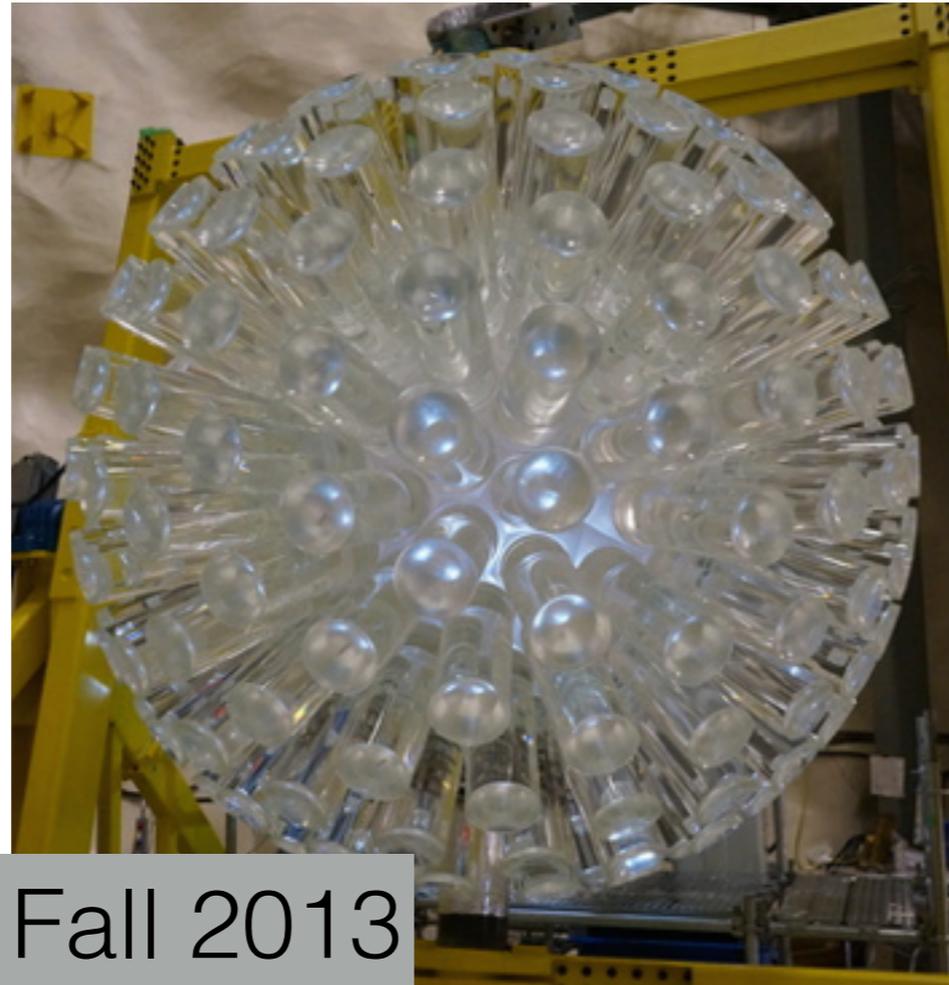
# DEAP-3600 sensitivity projection

- Order of magnitude increase in sensitivity over current results at 100 GeV
- 2 months to achieve current LUX sensitivity
- 1 year to exceed LUX projected full sensitivity



Nucl. Phys. B  
Proceedings  
Supplement 00  
(2014) 1–7

# Construction milestones



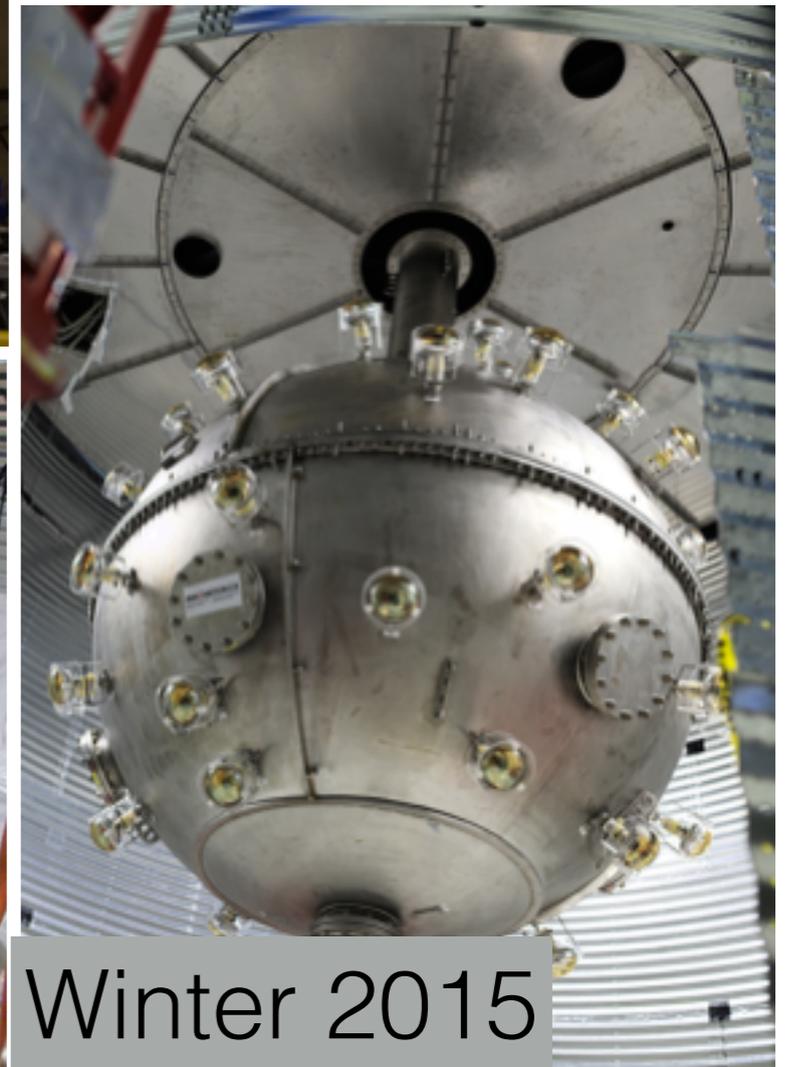
Fall 2013



Summer 2014



Fall 2014



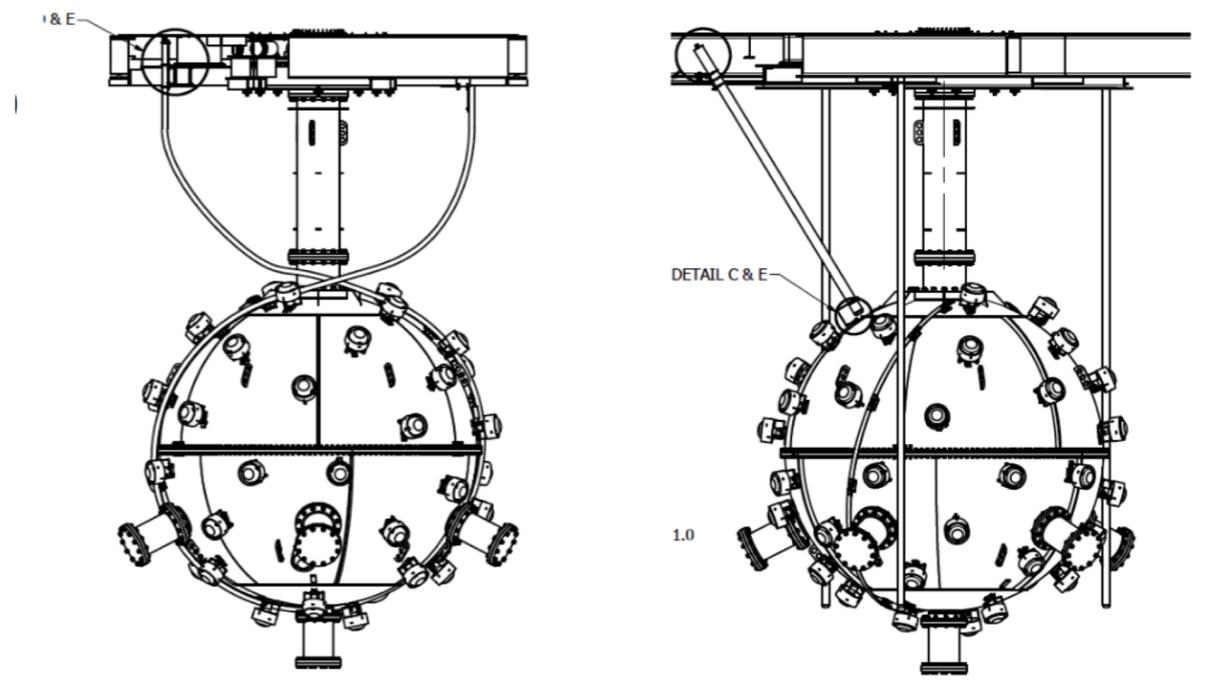
Winter 2015

# Calibration systems

- $^{22}\text{Na}$  ( $\gamma$ ) and AmBe (n) sources and their deployment systems are fabricated (RHUL, RAL)
- The delivery of the sources are imminent and the deployment systems are already at site and integrated with DAQ

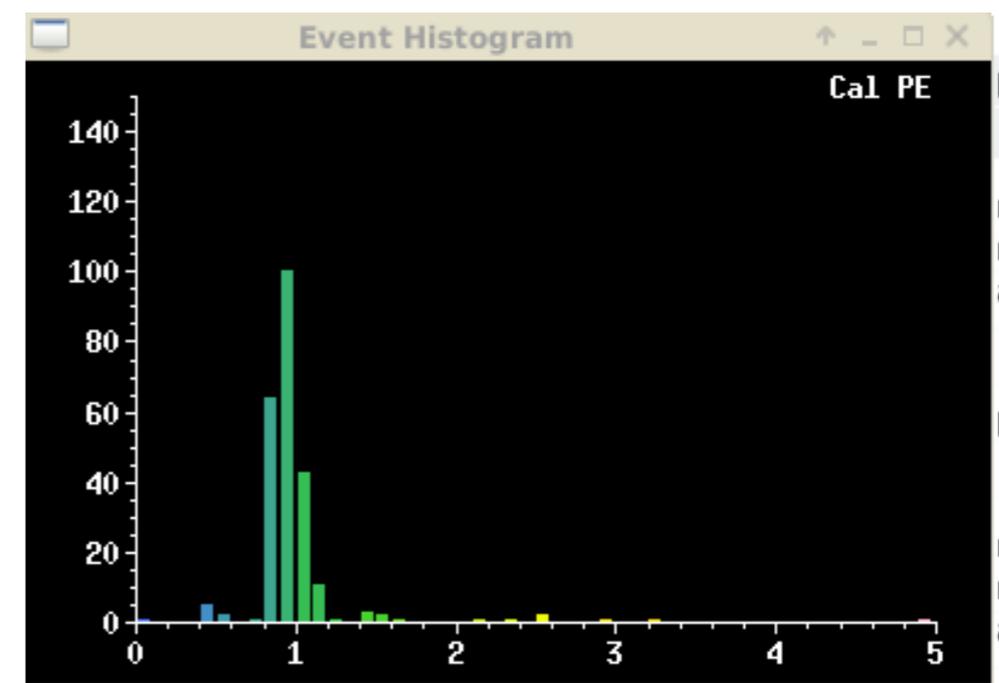
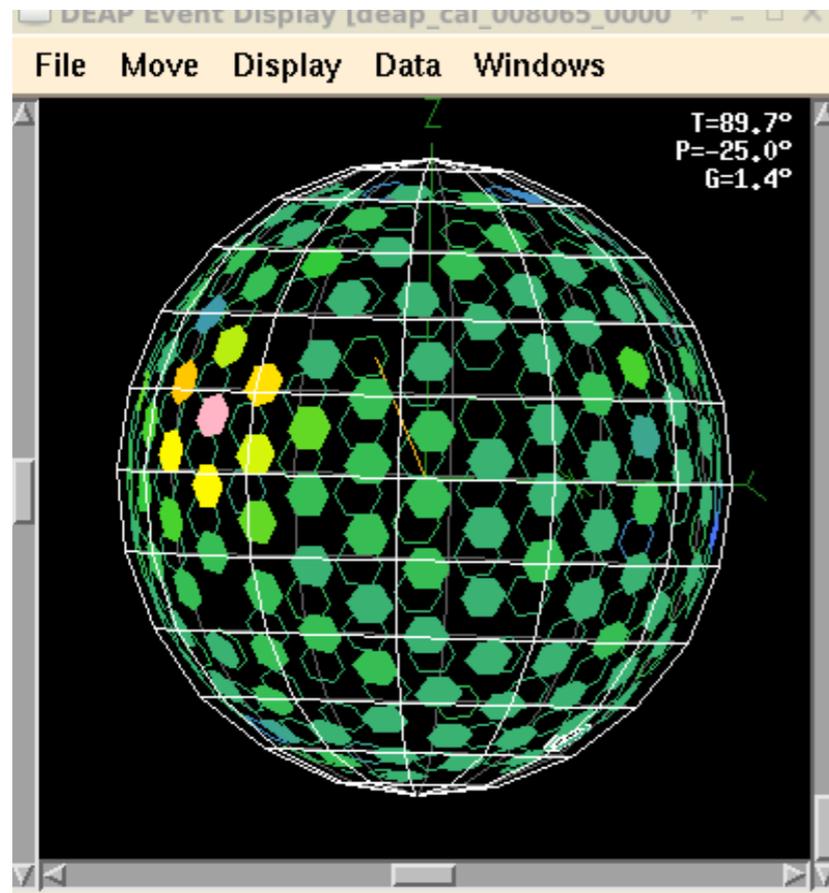
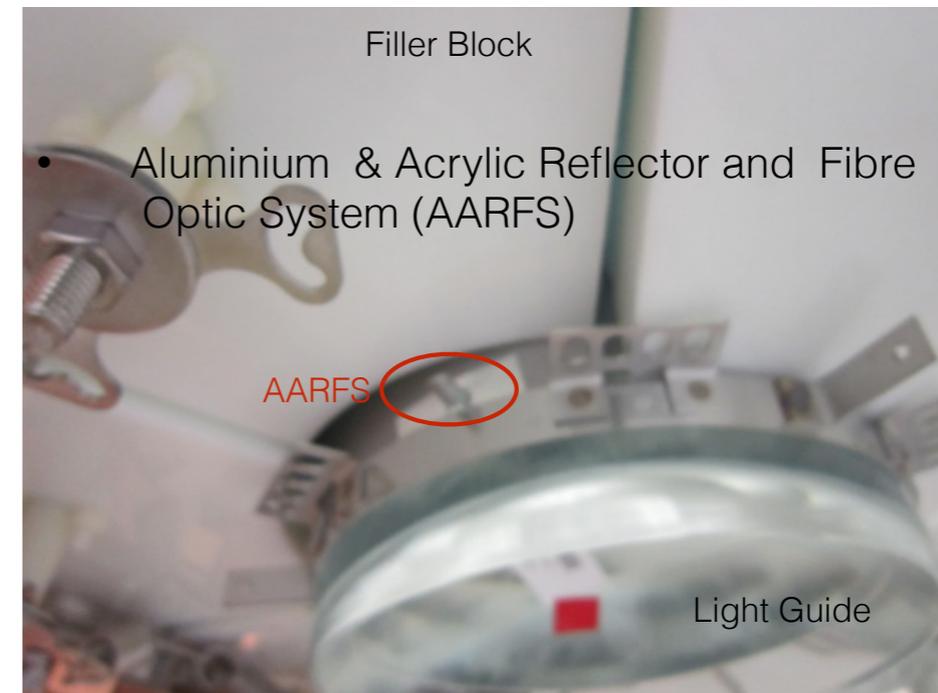


**Gamma and neutron system**



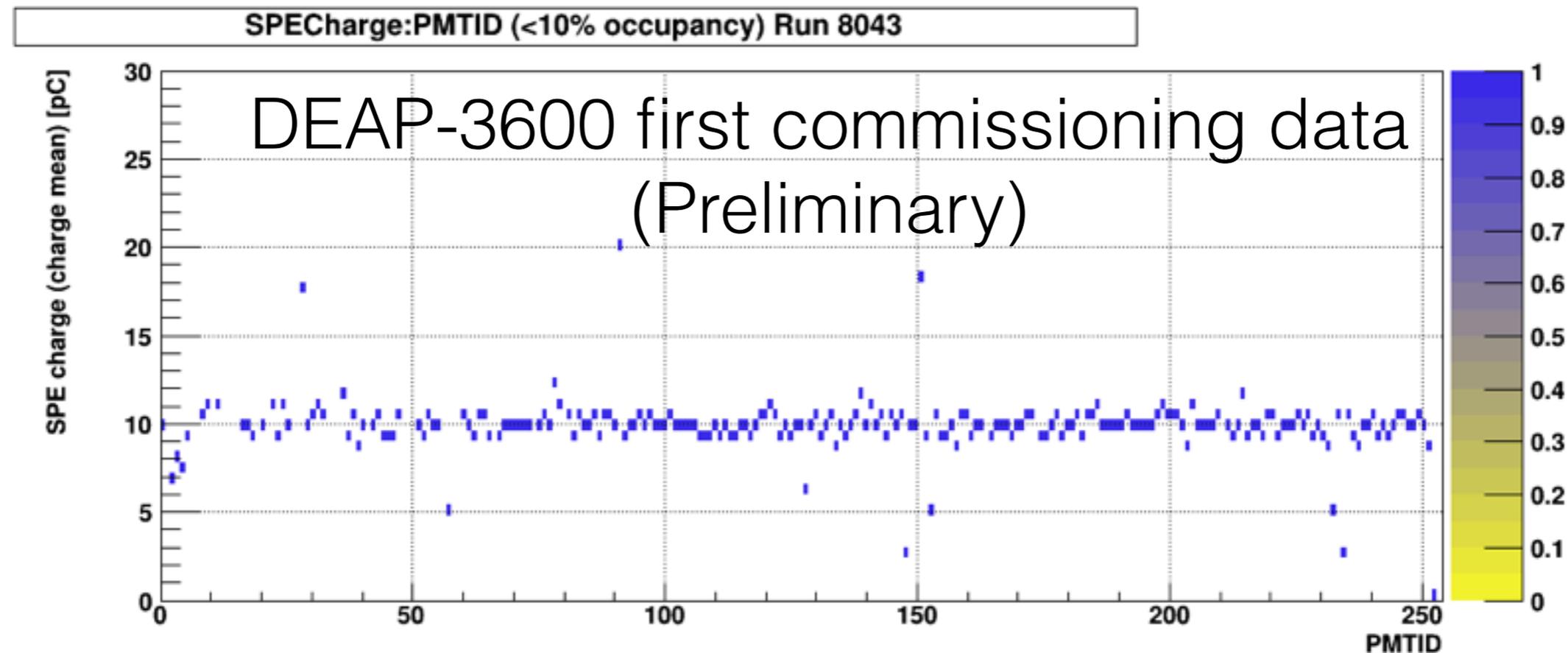
# Calibration systems

- External optical calibration system (Sussex) is installed
- Injecting light to 20 PMTs
- First data with 253/255 PMTs mid-March



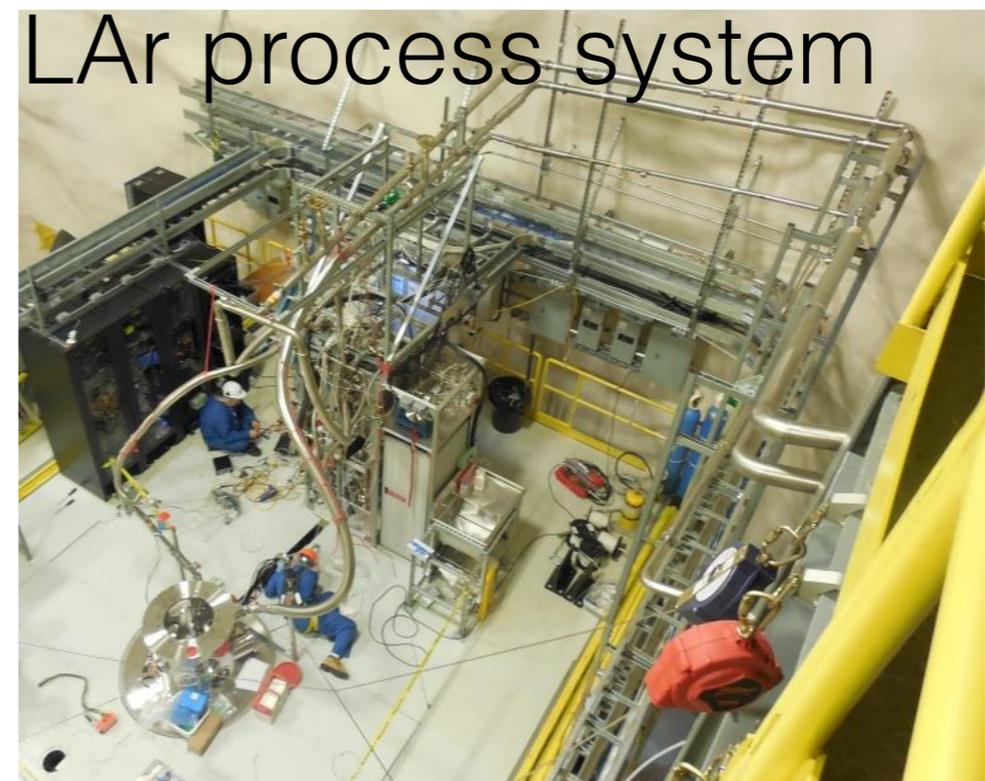
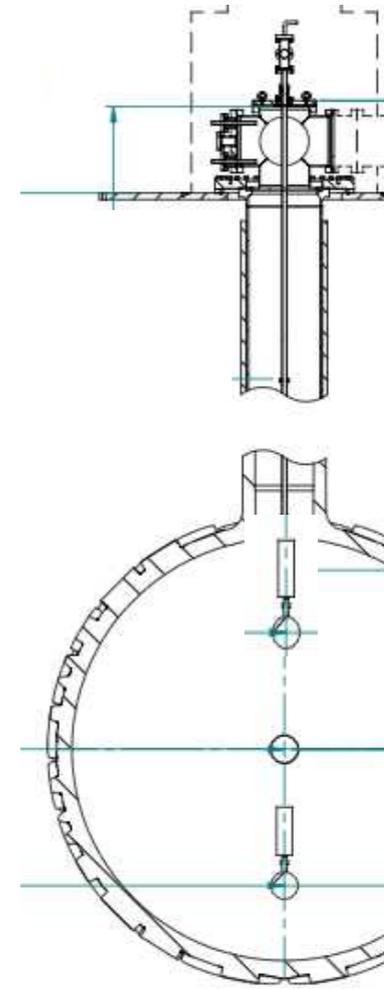
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# Next..

- TPB deployment
- Internal laserball calibration (Sussex, RHUL)
  - Complementary to the reflector and fibre optics system
- Cool down



# Conclusion

- DEAP-3600 will be the first large scale single-phase LAr dark matter detector
- DEAP-3600 construction is almost complete
- Commissioning of the process systems, PMTs, electronics and external optical calibration has started
  - TPB deployment and LAr fill within the next few months
- Physics summer 2015!

# DEAP-3600 collaboration

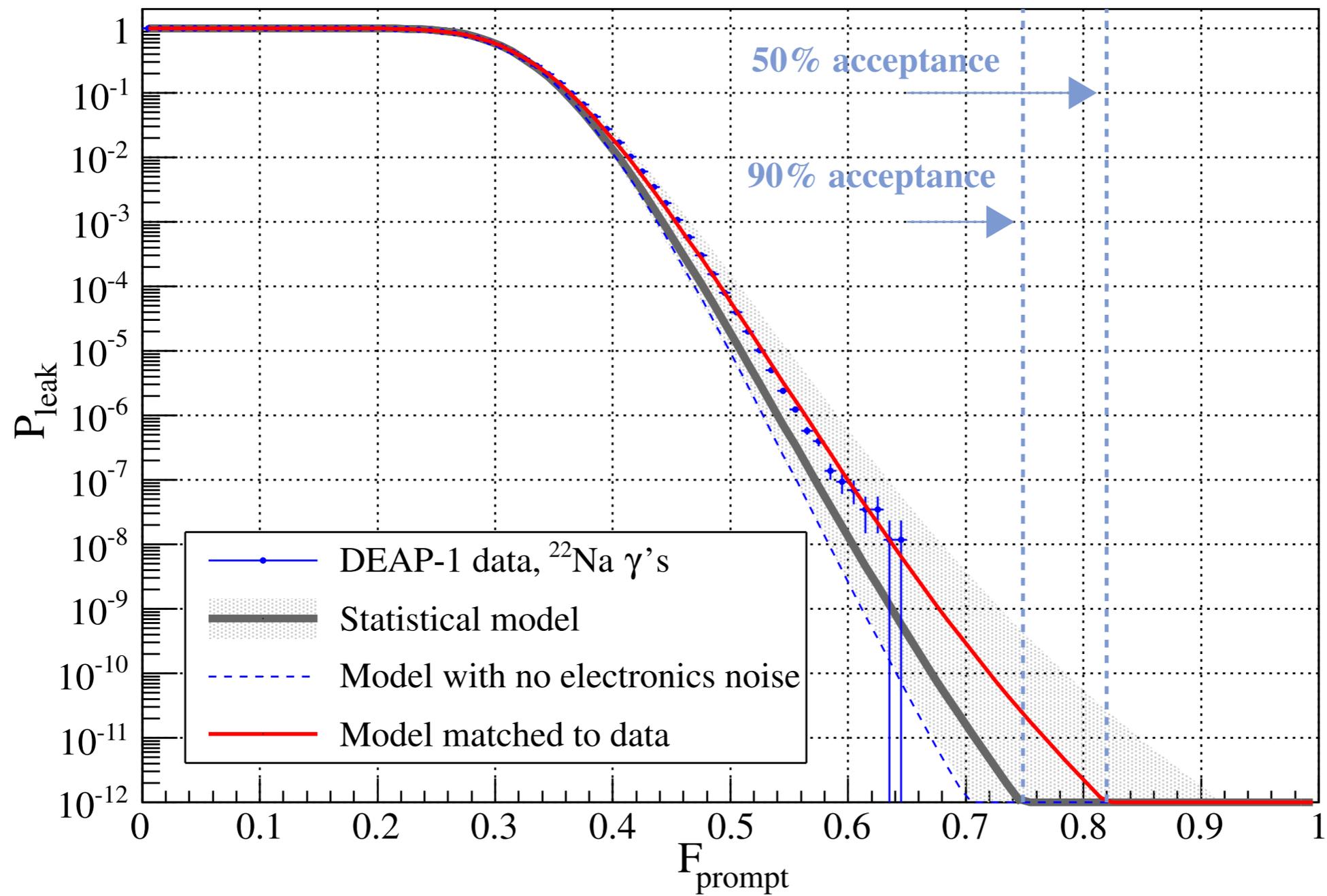


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Back up



# Resurfacing AV

