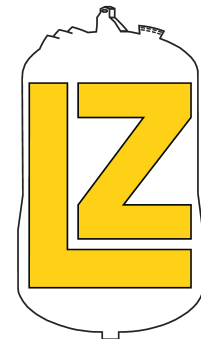




UNIVERSITY OF  
LIVERPOOL

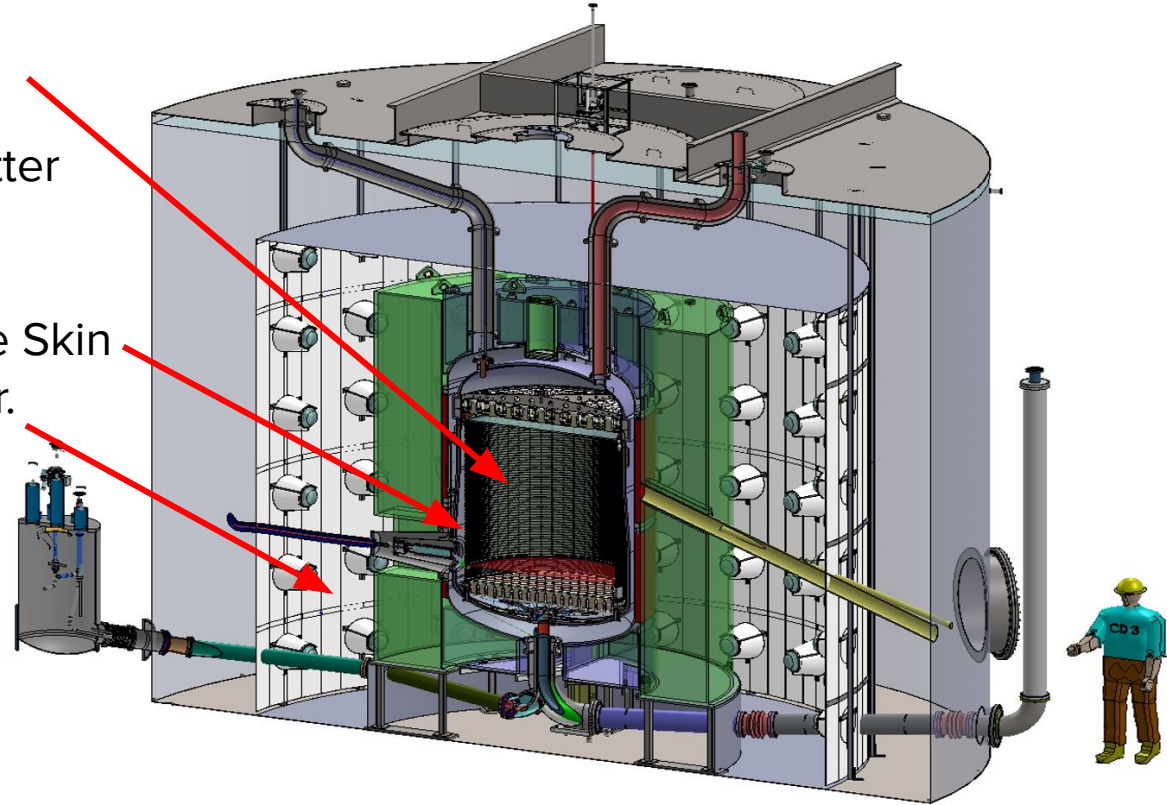


# LZ Veto + Offline Data Quality

Ewan Fraser

# LUX-ZEPLIN!

- ❑ Dual Phase LXe TPC.
- ❑ Looking for WIMPs. Dark Matter Candidate.
- ❑ Surrounded by 2 vetoes. LXe Skin and an Gd-LS Outer Detector.



# Offline Data Quality - PREM - **P**hysics **R**eadiness **M**onitor

## Motivation:

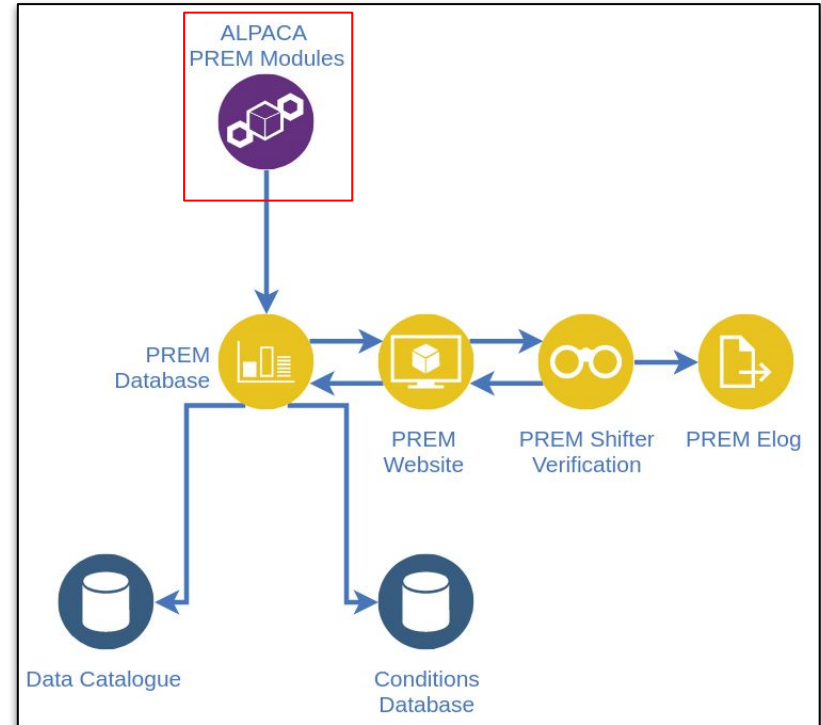
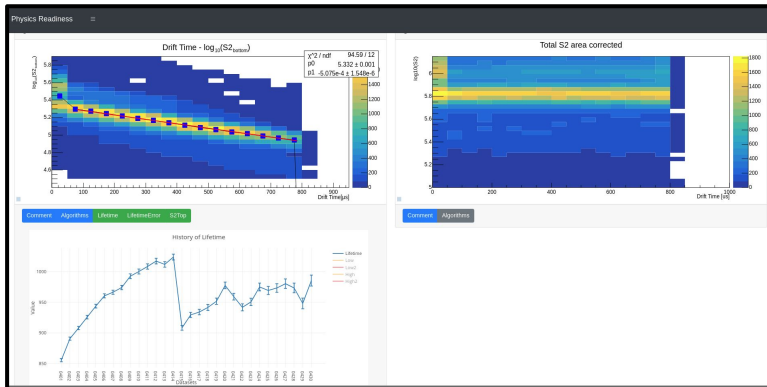
- ❑ Validate that LZ's data Runs are ready for their respective physics analysis.
- ❑ Verify the stability of the LZ detectors.
- ❑ Identity and catalogue any defects in the data.

## Components:

- ❑ Automatically run, data analysis modules (ALPACA).
- ❑ Data Quality Leads - write and coordinate these analysis. Outer Detector - Me.
- ❑ Shifters - monitoring of PREM.
- ❑ Website to display the results of these analysis.
- ❑ Database - store associated metadata.

# ALPACA - LZ's Analysis Package

- ❑ Modify ALPACA to output JSON metadata files.
- ❑ Analyse time varying parameters.
  - ❑ Across multiple Runs.
  - ❑ Within a Run.
- ❑ Flag significant changes in time varying parameters.



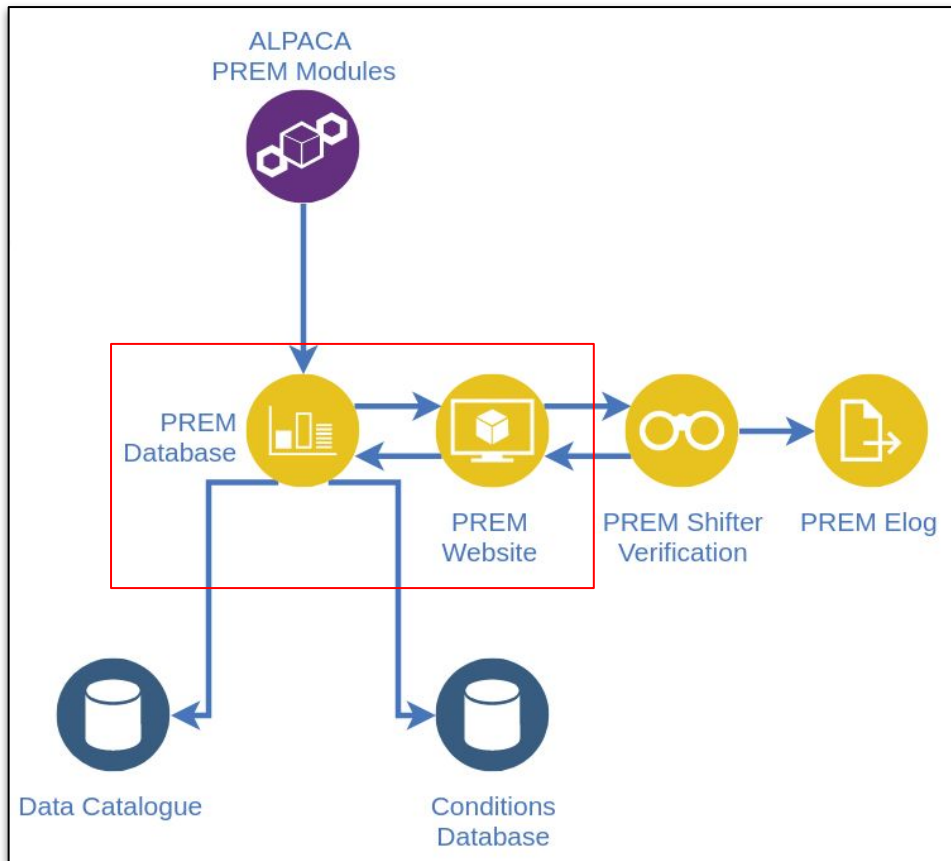
# PREMweb

## PREM Database:

- ❑ Store JSON Metadata files for each run.
- ❑ Semi-structured, MongoDB

## PREM Website:

- ❑ Frontend: Bootstrap CSS and Javascript.
- ❑ Backend: NodeJS App.
- ❑ Express + Mongoose to interact with DB.



# PREM Stack deployed at NERSC

<input type="checkbox"/>	State	Name		Image
Namespace: premweb				
<input type="checkbox"/>	▶ Active	app 80/http	← Contains frontend and backend.	efraser/premweb-nodejs 1 Pod / Created a month ago / Pod Restarts: 0
<input type="checkbox"/>	▶ Active	db 32457/tcp	← MongoDB.	mongo:4 1 Pod / Created 2 months ago / Pod Restarts: 0
<input type="checkbox"/>	▶ Active	web 80/http, 443/https	← Hosts site and 2-factor authentication.	lbinest/nginx:1.18.0_1 1 Pod / Created a month ago / Pod Restarts: 0

PREM Stack deployed on SPIN2, viewed in Rancher2.

## SPIN2:

- ❑ NERSC's container-based platform for science gateways.
- ❑ Deploy each project using a Docker image.
- ❑ Creates a Kubernetes cluster.

# Photos! Outer Detector installation



Alice installing the OCS fibres to monitor scintillator and acrylic degradation.



Harvey working on OCS and OD PMT installation.



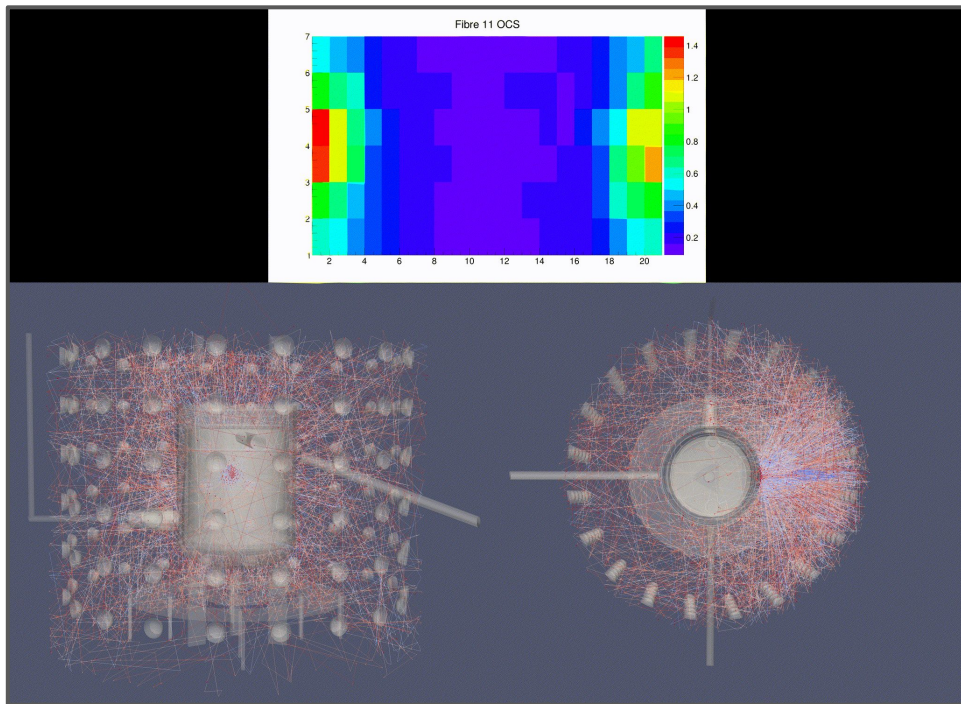
# OD PMT QA: Analysis

## Motivation:

- ❑ Provide QA for the OD PMTs.
- ❑ Calibrate → Improve our model of the OD.

## Simulations:

- ❑ SPE: 1k photons, 100k events.
- ❑ Afterpulsing: 10k photons, 500k events.



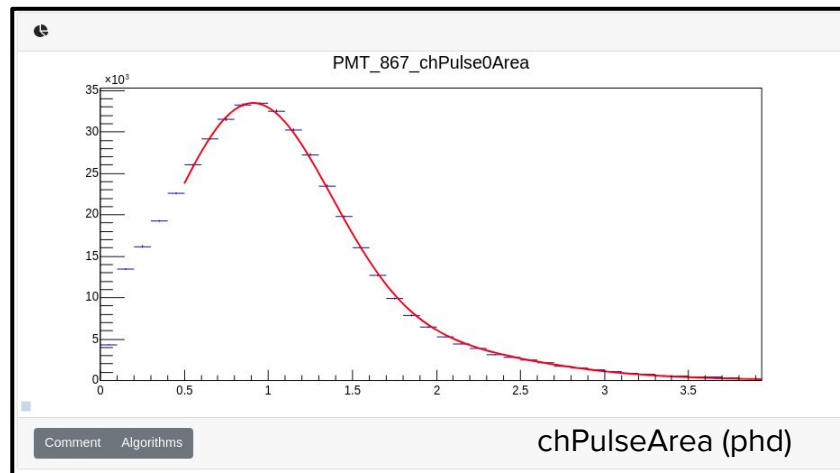


# OD PMT QA: SPE

- ❑ Measure the response of the OD PMTs to a single photoelectron (SPE).
- ❑ Spectra in LZ are measured in photons detected (phd).
- ❑ Calibrating this response is the first step towards energy calibration.

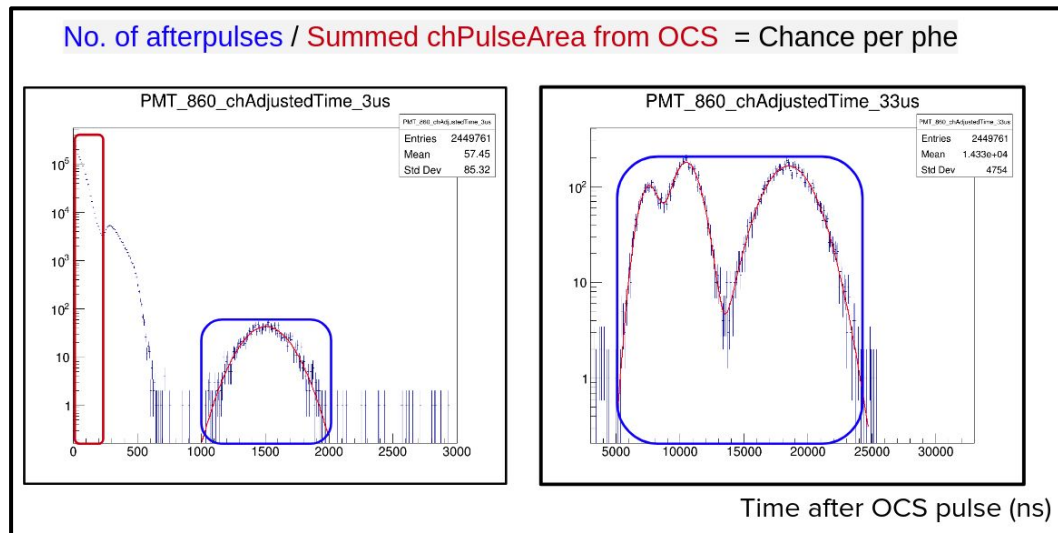
## Analysis Note - Qing He, Daya Bay

$$\begin{aligned} S_{ideal}(x) &= P(n; \mu) \otimes G_n(x) \\ &= \sum_{n=0}^{\infty} \frac{\mu^n e^{-\mu}}{n!} \frac{1}{\sigma_1 \sqrt{2n\pi}} \exp\left(-\frac{(x - nQ_1)^2}{2n\sigma_1^2}\right). \end{aligned}$$



# OD PMT QA: Afterpulsing

- ❑ Photoelectron ionizes a molecule when travelling between photocathode and first dynode.
- ❑ The more molecules the more afterpulsing.
- ❑ Measure of the quality of the vacuum in a PMT.
- ❑ Has it degraded since production in Korea?



# Neutron Selection in the LZ Veto

- ❑ Begun to look at extending the Neutron Selection analysis for the LZ Veto.
- ❑ Improve our understanding of the dominant background in the Veto, gammas from cavern rock.
- ❑ Simulating the U238, Th232 and K40 decay chains in the cavern Rock. CPU intensive, not many make it through the water shield.
- ❑ Use event biasing to improve the efficiency of the simulation.

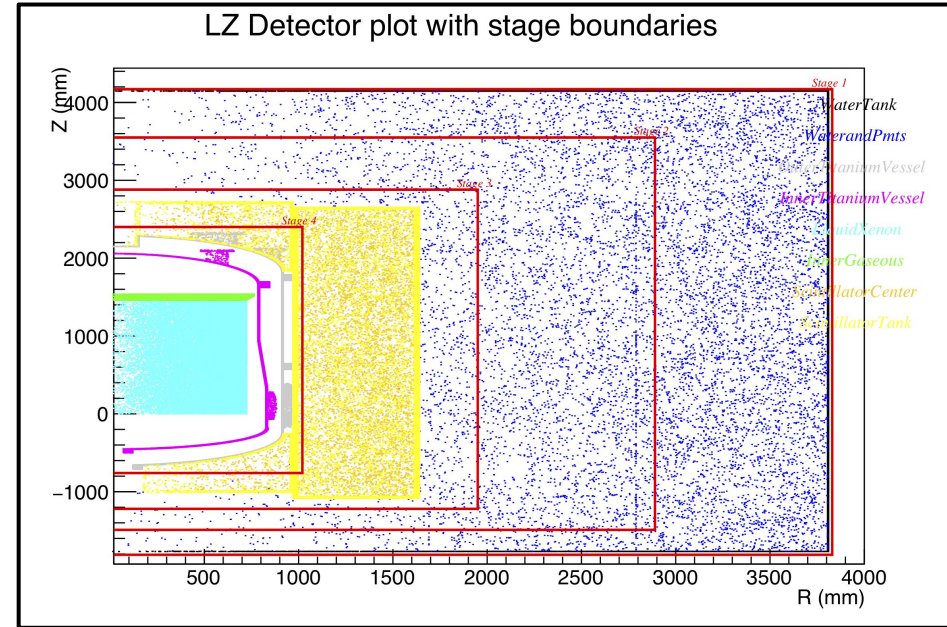


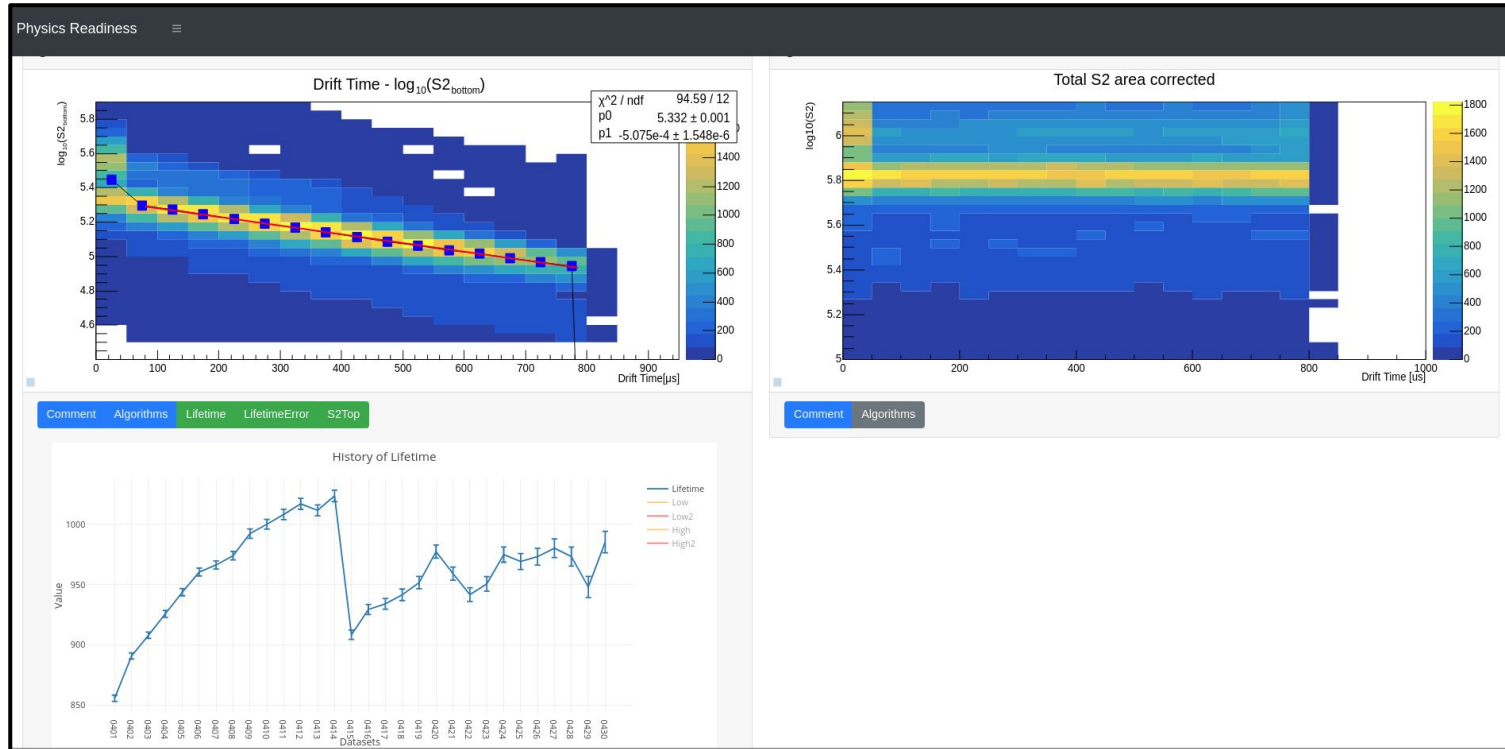
Diagram of surfaces in LZ used for event biasing, Andrew N - Sheffield.

# Summary

---

- ❑ Developed LZ's Offline Data Quality tool PREM.
- ❑ Helped coordinate Data Quality analysis group and the various analysis modules produced.
- ❑ Responsible for the Data Quality analysis in the Outer Detector.
- ❑ OD PMT QA is about to begin!
- ❑ Developed an SPE analysis and Afterpulsing analysis for this effort.
- ❑ Begun work on looking at the neutron selection in the LZ Veto.
- ❑ Simulating the main veto backgrounds using an Event Biasing technique.

- ❑ Analysis: Andrew S - Oxford - LZ
- ❑ Electron Lifetime: Measure of LXe purity - Important correction for analysis



# Current Development for PREM

Sam Woodford - Liverpool:

- ❑ Automation of analysis.
- ❑ Database Queries!

Anna D - UCL:

- ❑ Creating a data structure.
- ❑ Handle calibration values for all PMTs.