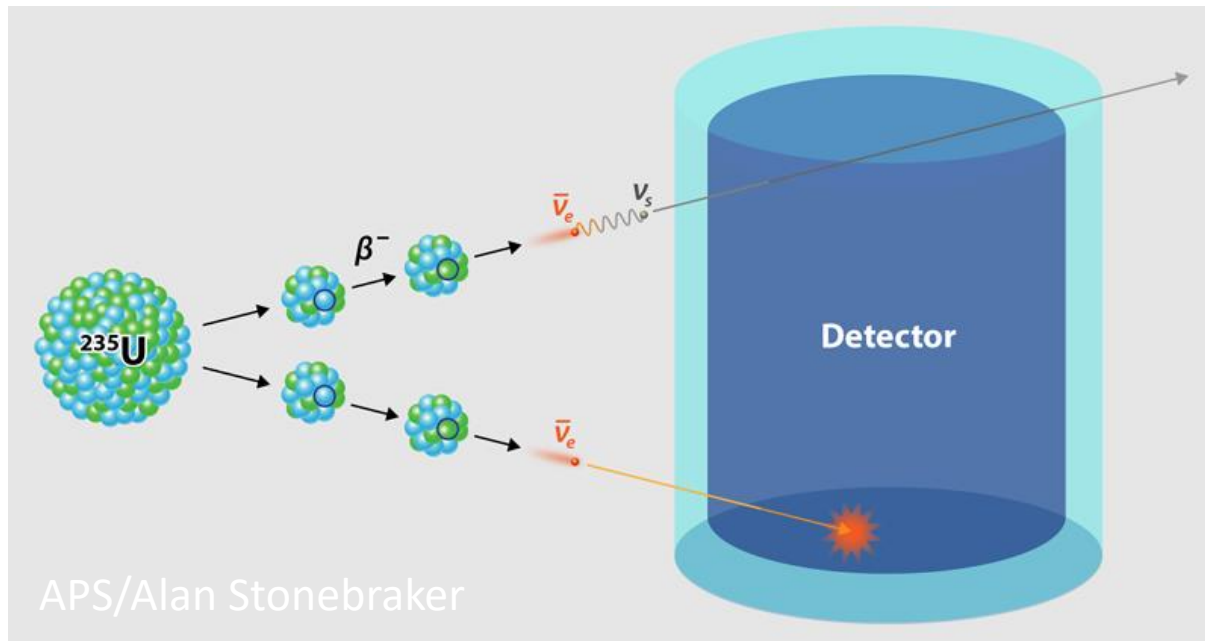


VIDARR and BUTTON

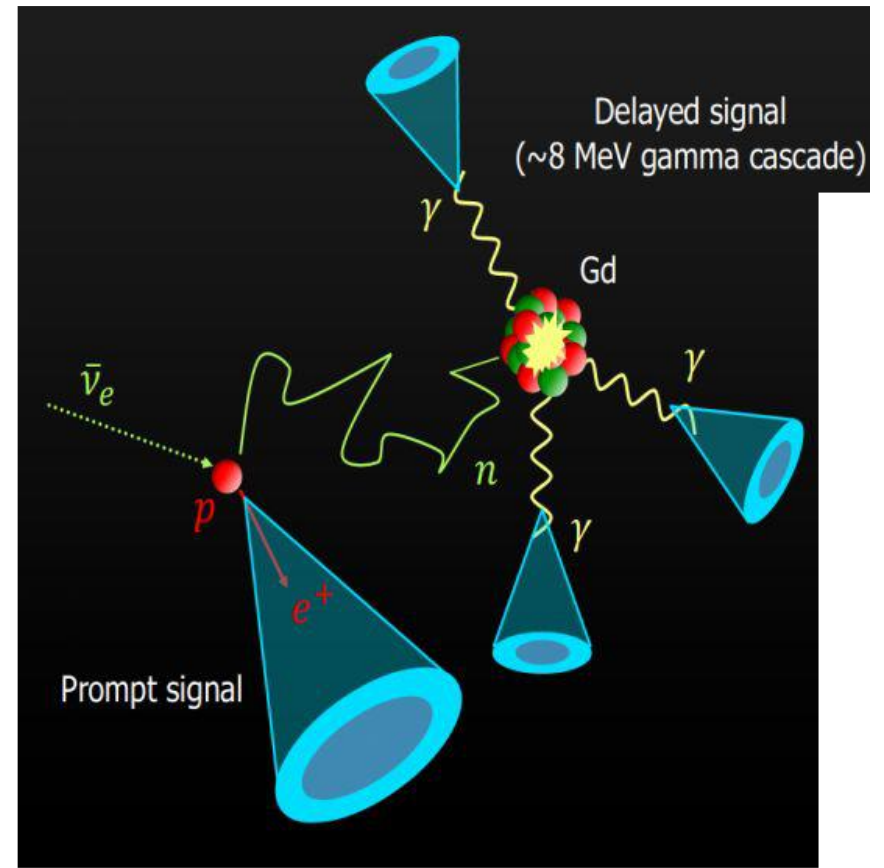
James Gooding
HEP annual meeting

Reactor monitoring



- Approximately 6 antineutrinos per fission event (up to 10 MeV).
- Inverse beta decay in some detector medium (can be fairly inexpensive).
- $\bar{\nu}_e + p \rightarrow e^+ + n$

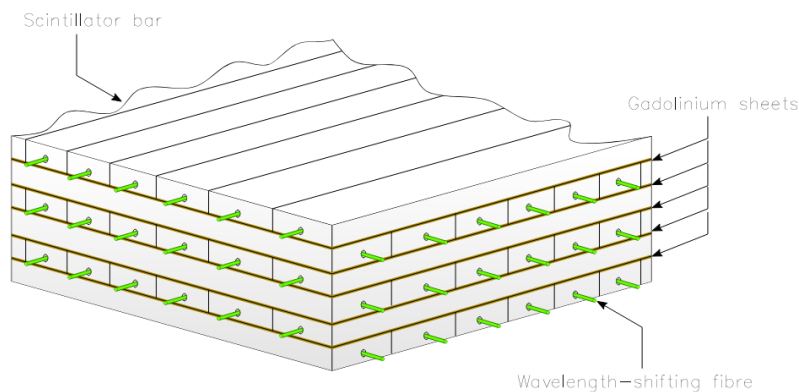
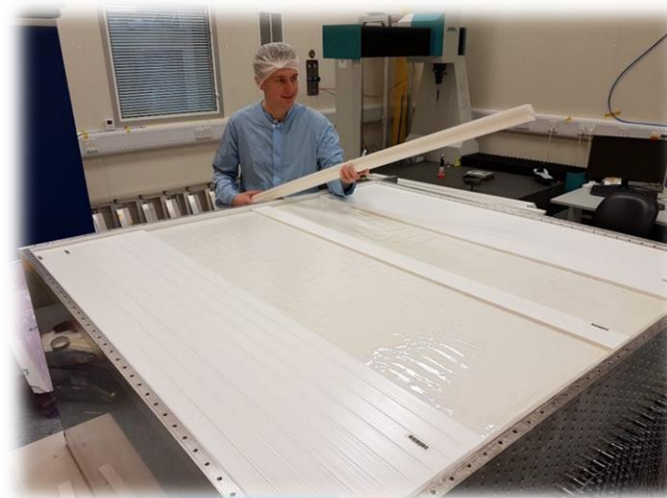
Gadolinium doped water provides a much higher neutron capture cross section which allows better inverse beta decay detection.



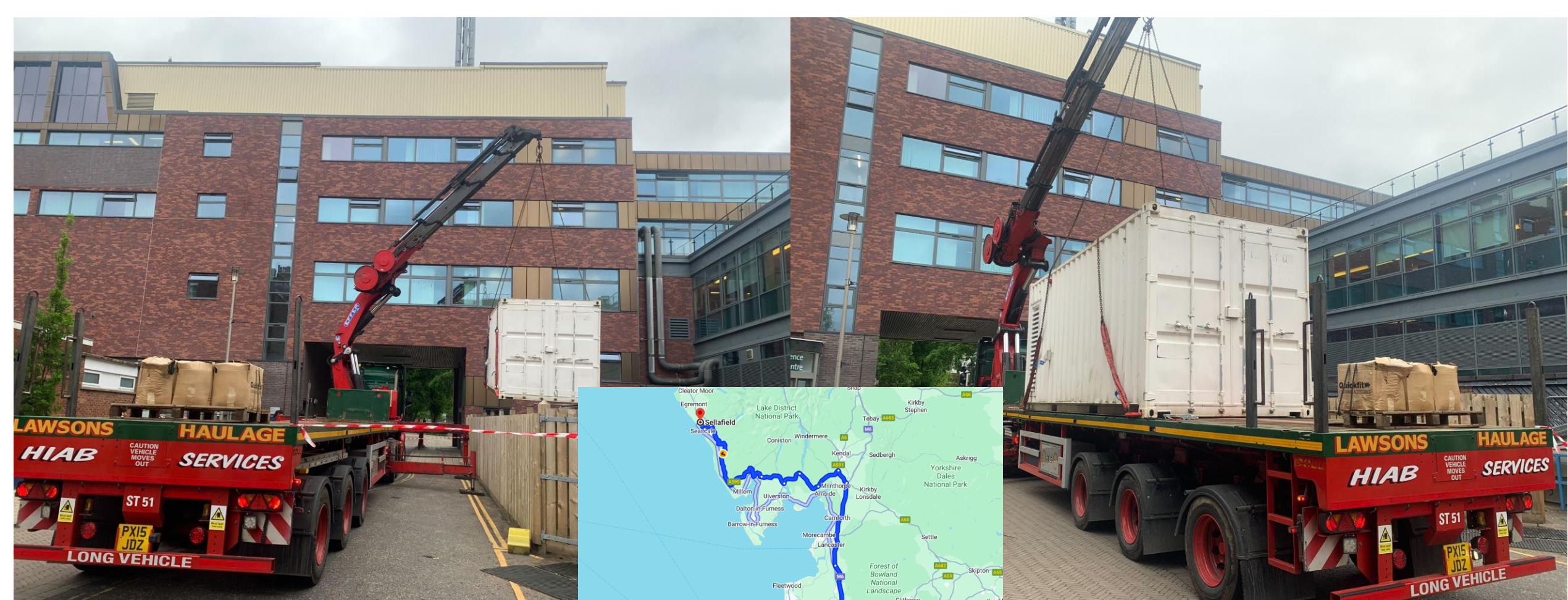
VIDARR — Verification Instrument for the Direct Assay of Radiation at Range



- Plastic scintillator detector with layered gadolinium oxide layers developed Liverpool university
- Polystyrene doped with PPO and pop-op
- Will be placed at Sellafield site for detecting antineutrinos from Sr90 waste
- Monte-Carlo and Machine learning model developed by Ron Collins allows for neutrino identification from measurement of coincident positrons and annihilation gammas



See Joel Dasari's talk



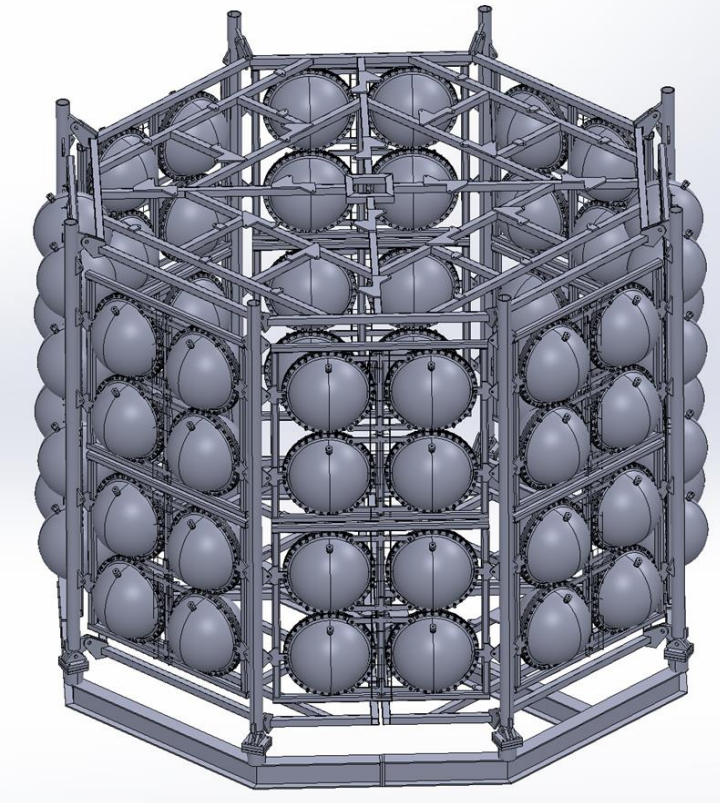
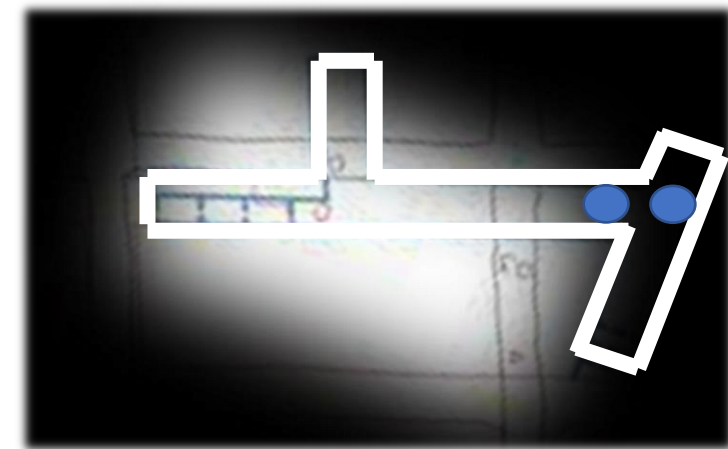
VIDARRs grand trip

See Joel Dasari's talk

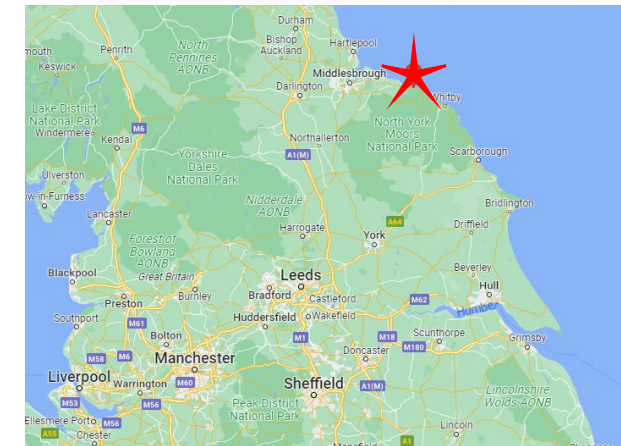
BUTTON- Boulby underground technology testbed for observing neutrinos



Rose from the remains of the WATCHMAN project



- Cherenkov detector based in Boulby mine, UK.
- 96 Hamamatsu PMT's remaining from the Watchman project.
- Novel fill mediums (Gd doped WbLS).
- PMT enclosure and advanced photosensor development.



BUTTON/VIDARR team at Liverpool

We are involved in all elements from:

- Management and systems integration
- Mechanical design and engineering
- Firmware and electrical design
- Light injection calibration systems
- Simulation and analysis of particle transport
- Simulation of EM fields
- Design and commissioning of an Gd compatible ultrapure water system



Jon is the project PI and lead for BUTTON and VIDARR.



Carl



Kieran



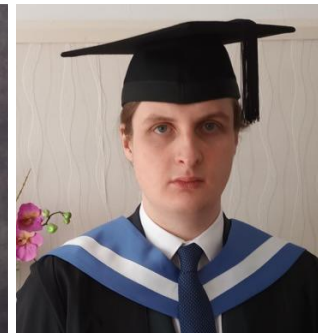
Neil



Jay



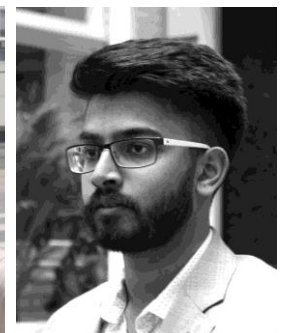
Ilya



Alex



Adam



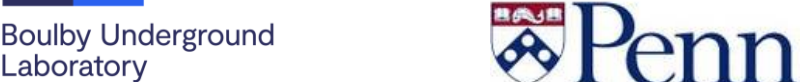
Joel

BUTTON Collaboration



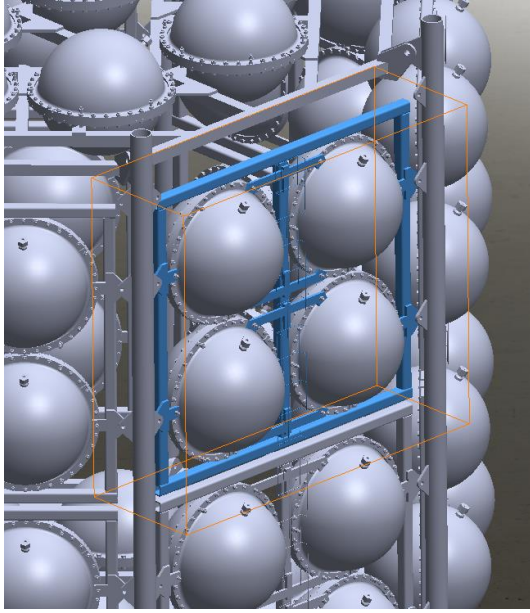
Boulby collaboration meeting 2023 with some familiar faces!

Funded in the UK by STFC from the UKRI Fund for International Collaboration and the MoD, and in the U.S. by NNSA (National Nuclear Security Administration).



Around 50 members across 15 institutions in the UK and U.S.

Liverpool PMT support production



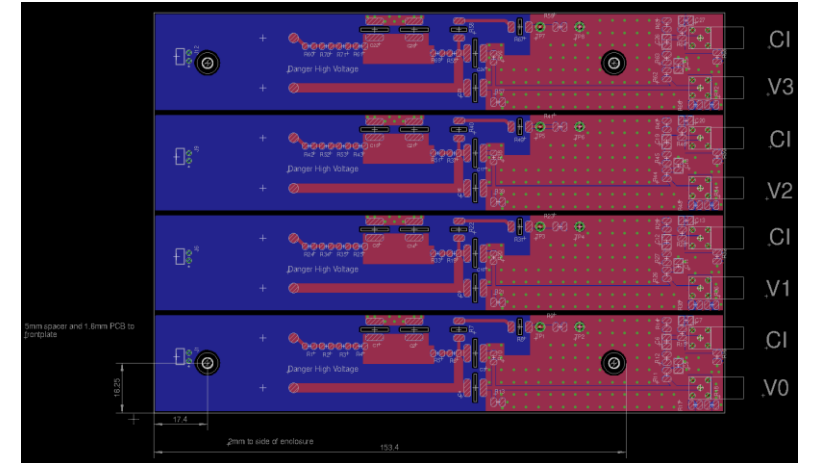
- Production of the PSUP (support structure) has begun at Liverpool
- Much of the design and construction has been completed by Kieran and Paul



Liverpool PMT support production



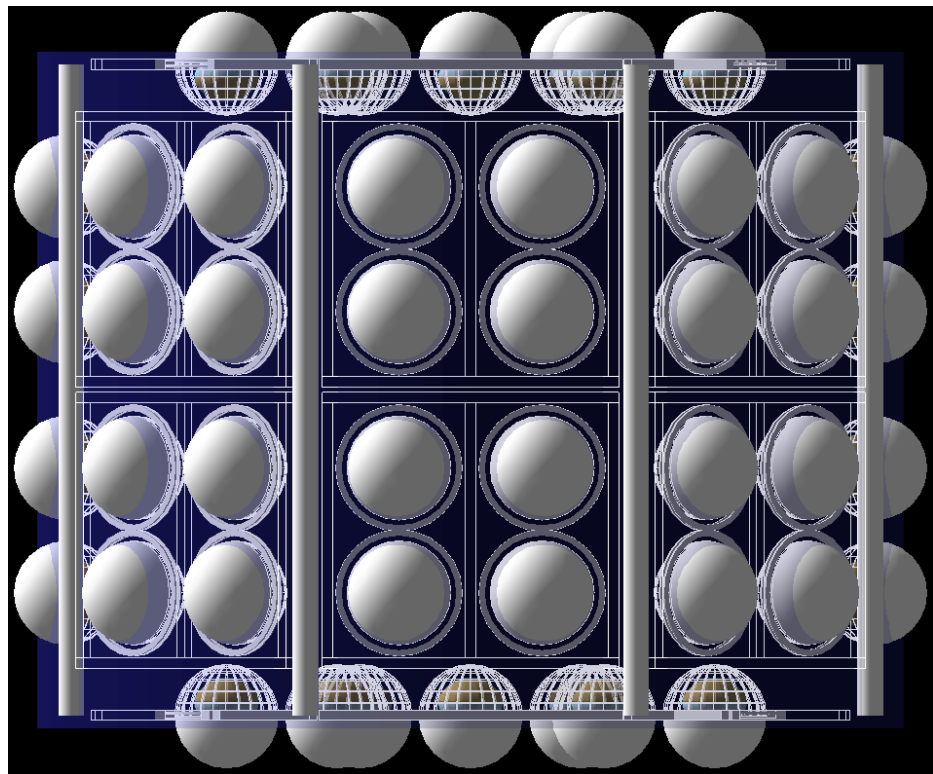
Liverpool DAQ production



Data acquisition and electronics system is in development by Carl Metelko and Warwick university.

Installation due in summer.

Liverpool simulation work

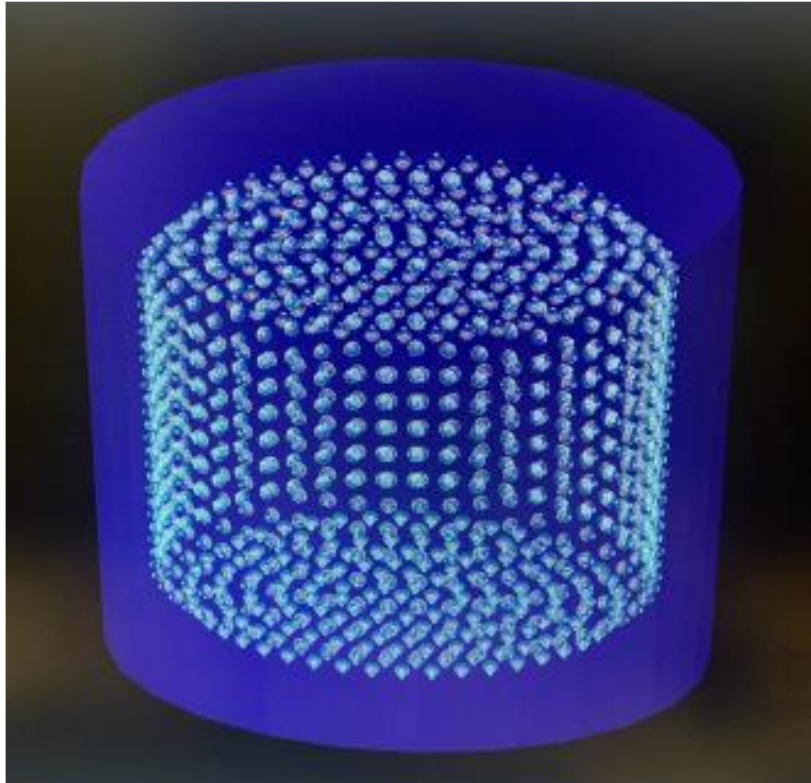


RATPAC (GEANT4 based) simulation

- Detector geometry (support structure, non-reflective Tyvek lining and PMT encapsulations) have been implemented by the Liverpool team
- Simulations of reflections, light diffusers, background radiation and much more have been conducted by the Liverpool team
- RATPAC 2! Integration with CRY for cosmic ray simulations

See Alex Morgans talk

BUTTON 1kT Simulation



Plans to develop a kilotonne scale neutrino detector with approximately 100 tonne fiducial volume at Boulby

A program to automatically make simulation geometries for different size/shape/photo-coverage detectors was developed

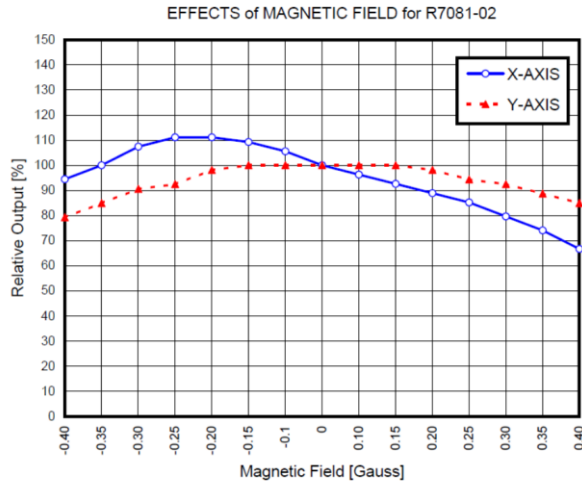
Development of “deployment ready” detector system for potential nonproliferation applications:

- maritime reactors
- test site transparency

STFC Committed to excavation of new underground laboratory at Boulby. Excavations start in Summer 2024 and last for 2 years.

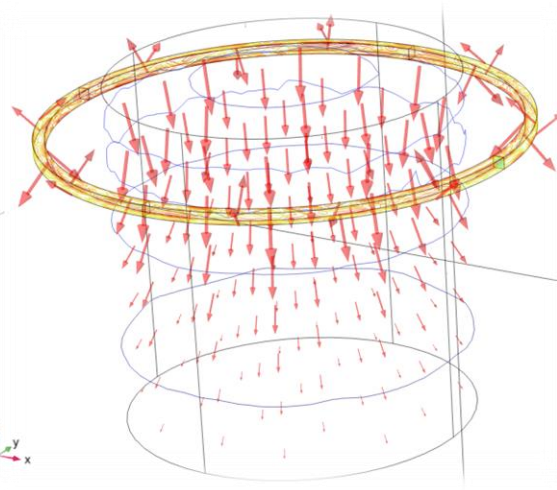
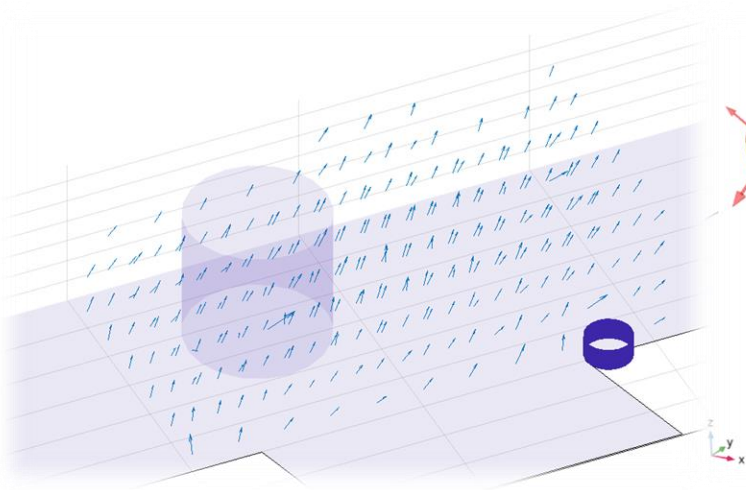
New 1-kilotonne experiment could be accommodated from 2026 onwards.

Liverpool simulation work



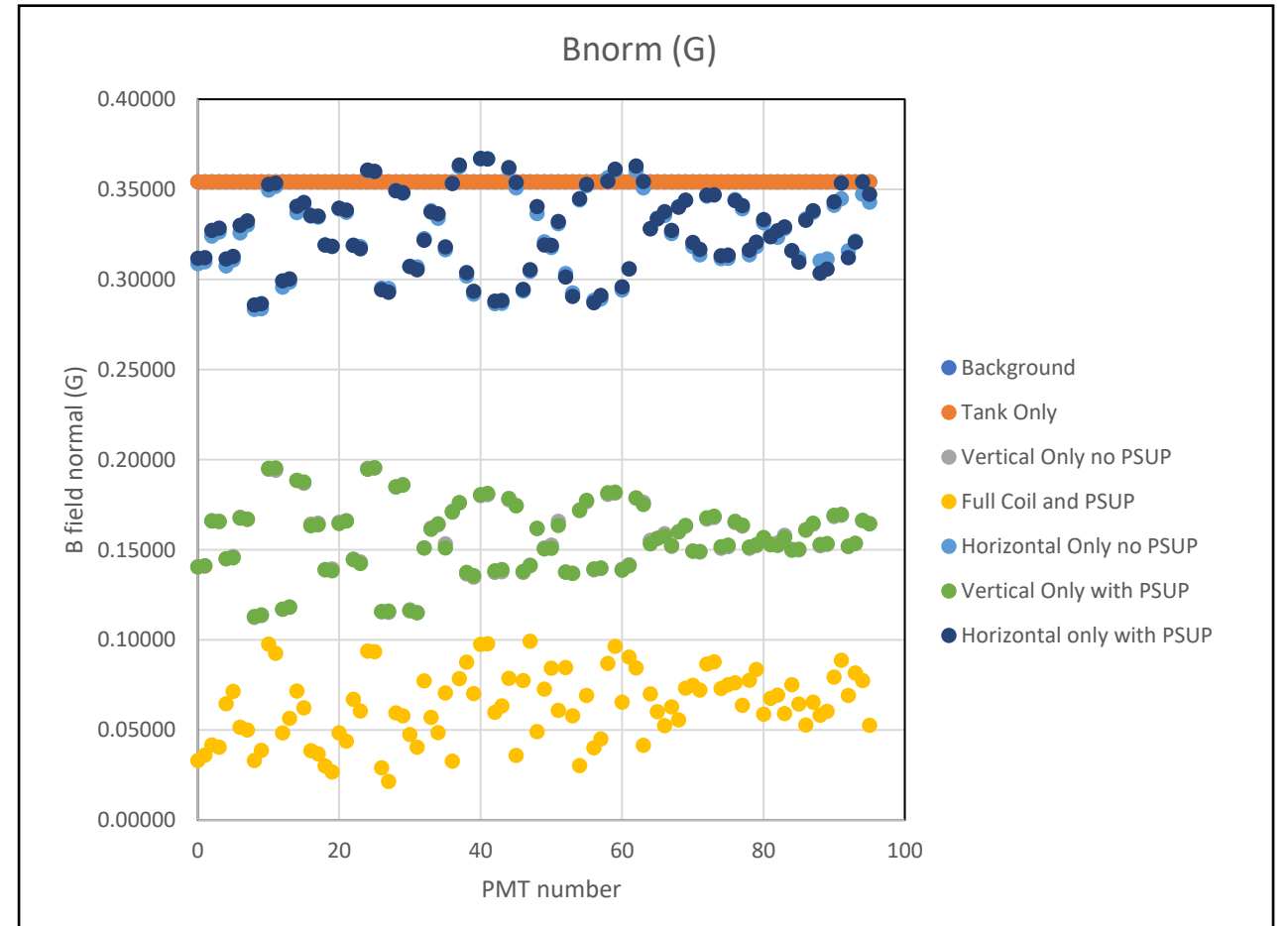
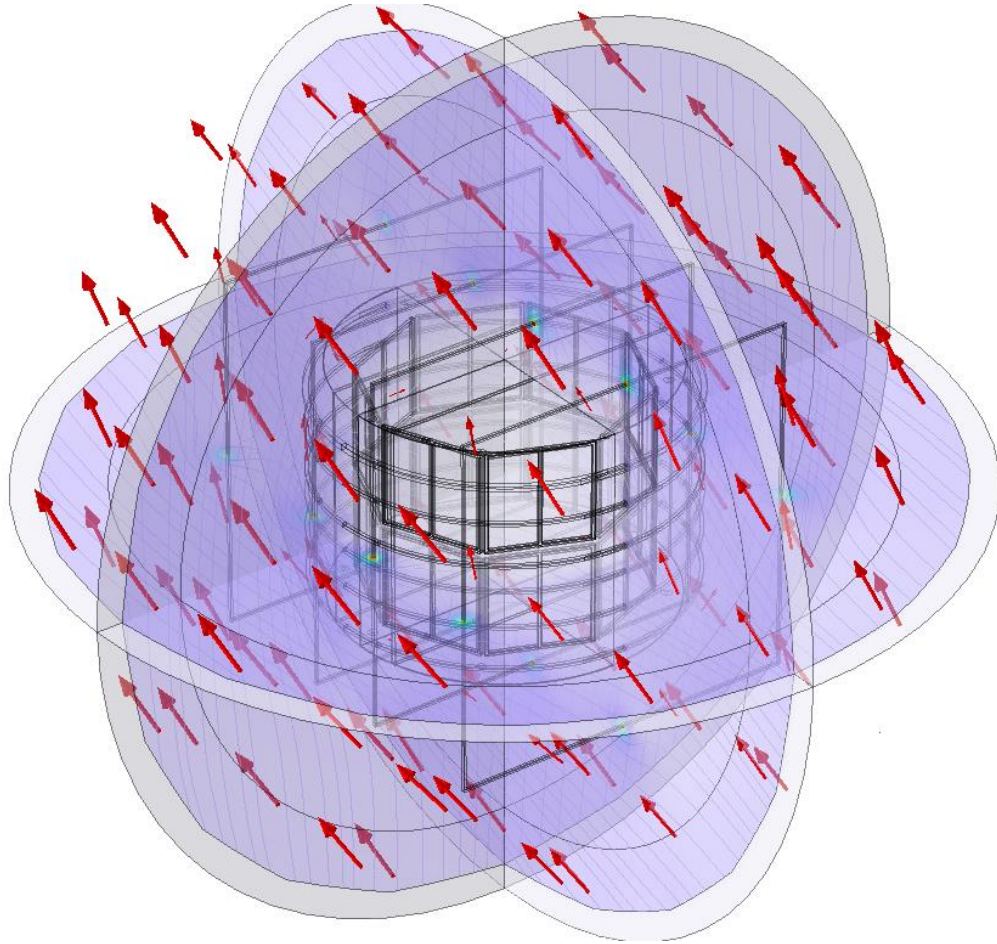
COMSOL simulation

- PMT response is dependent upon external magnetic fields.
- The background magnetic field was measured in the experimental area.
- Simulations of magnetic coils to compensate for these background fields have been undertaken.
- A complete compensation system has been proposed which increases PMT relative output by up to 20% (0.35 Gauss to < 0.1 Gauss).



Field results

With moderate coils, all PMT magnetic field normal are reduced below 0.1 G



The Build



Upcoming

- Liverpool continues to be a large part in the BUTTON project.
- PSUP and water system to be delivered in the coming months.
- Finish construction.
- Turn on and take some data.





Any questions?