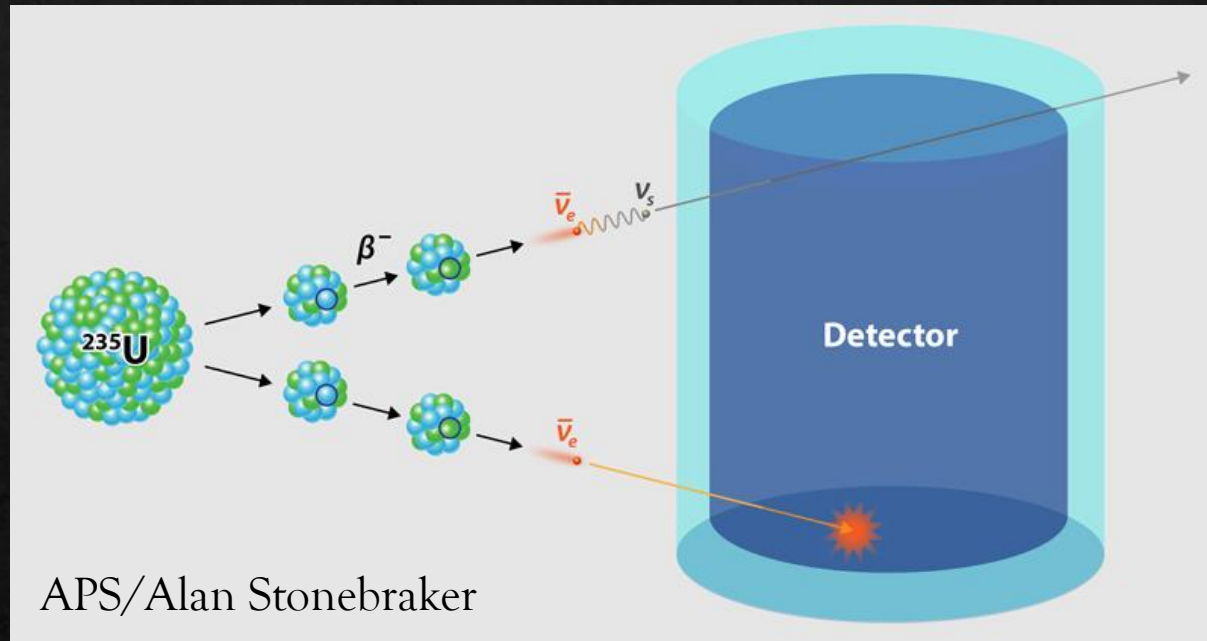


# VIDARR and BUTTON

James Gooding

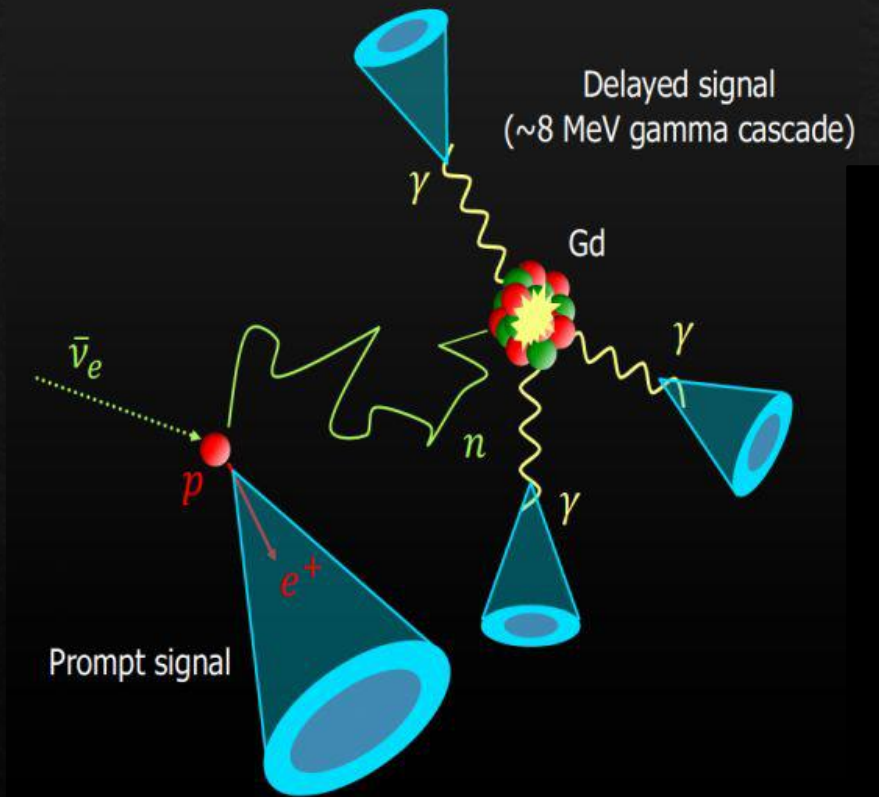
HEP annual meeting

# Reactor monitoring



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

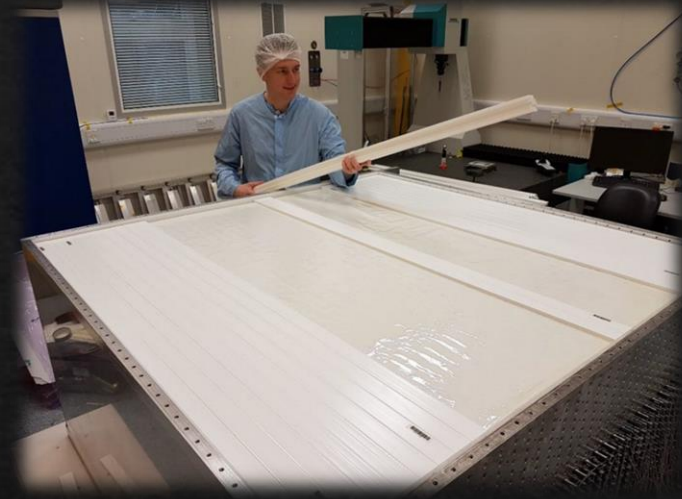
Gadolinium doped water provides a much higher neutron capture cross section which allows better inverse beta decay detection.



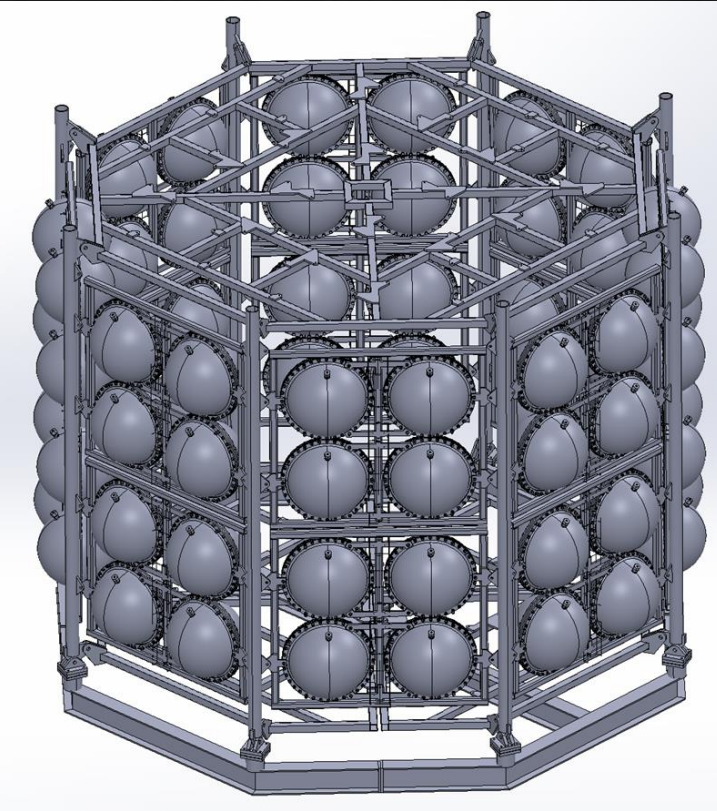
# VIDARR – Verification Instrument for the Direct Assay of Radiation at Range



- ◇ 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 Sr90 waste via anti-neutrino detection (**This has not been done before**).
- ◇ Anti-neutrino Monte Carlo developed.
  - ◇ Developed by Ron Collins and Joel Dasari.
  - ◇ On site Sellafield location finalised.
  - ◇ Approximately 8 anti-neutrinos per day prediction.
- ◇ Machine learning model developed by Ron Collins allows for neutrino identification from measurement of coincident positrons and annihilation gammas.

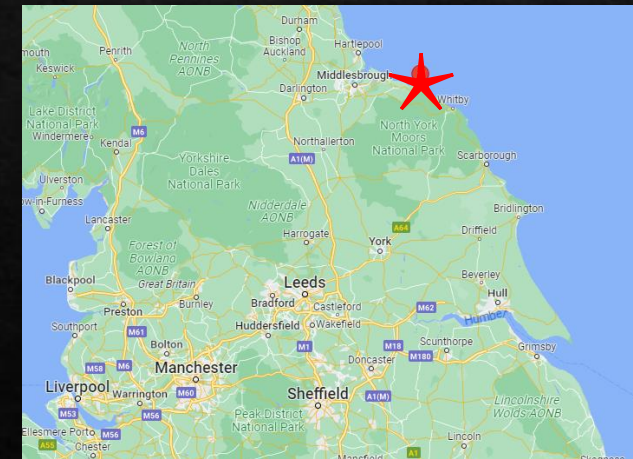
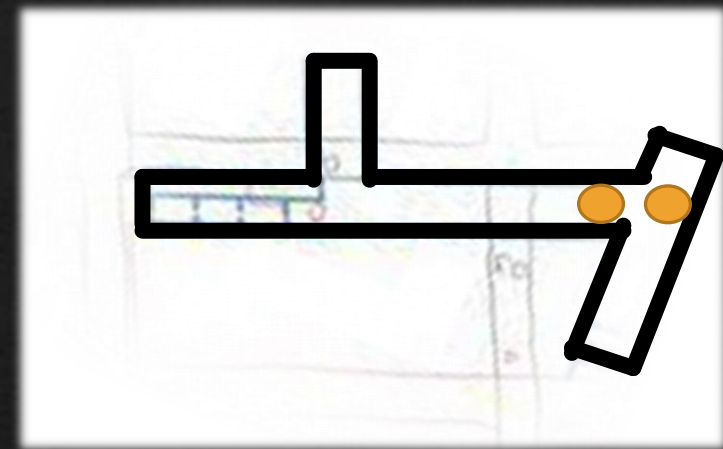


# BUTTON- Boulby underground technology testbed for observing neutrinos



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
- Simulation and analysis of particle transport
- Simulation of EM fields



Jon is the technical coordinator for BUTTON and has been invited to be the project PI and lead.



Carl



Kieran



Neil



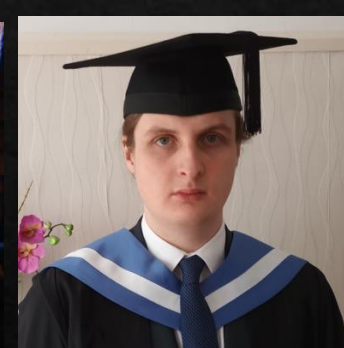
Jay



Ilya



Abbie



Alex



Adam

# BUTTON Collaboration



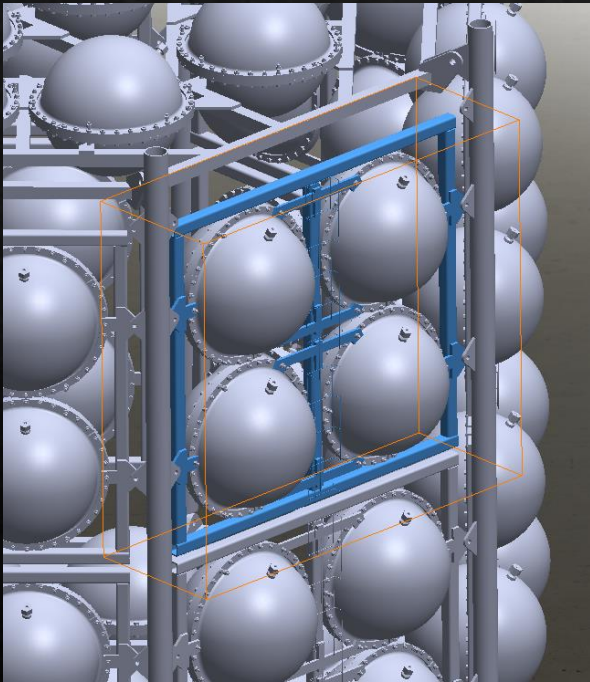
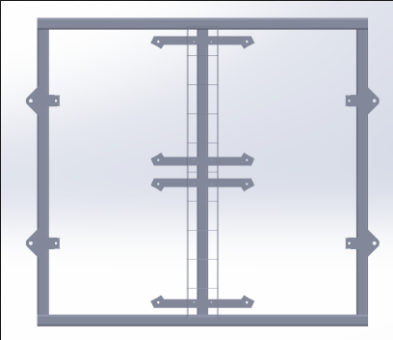
Boulby collaboration meeting 2022 with some familiar faces!

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

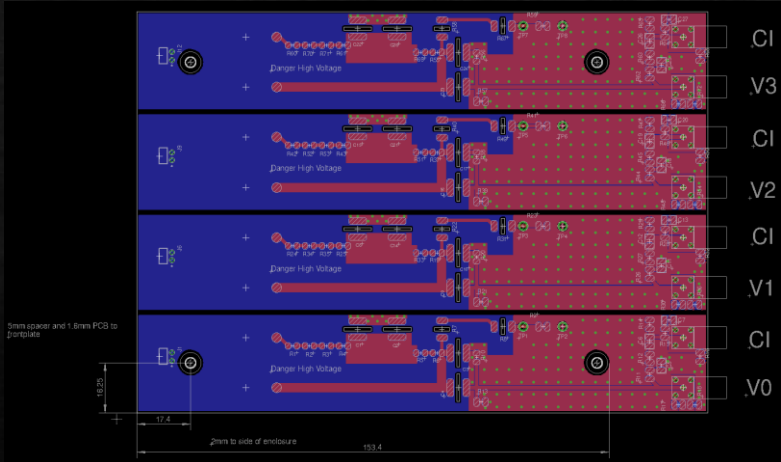


30 members across 10 institutions in the UK and U.S.

# Liverpool physical production

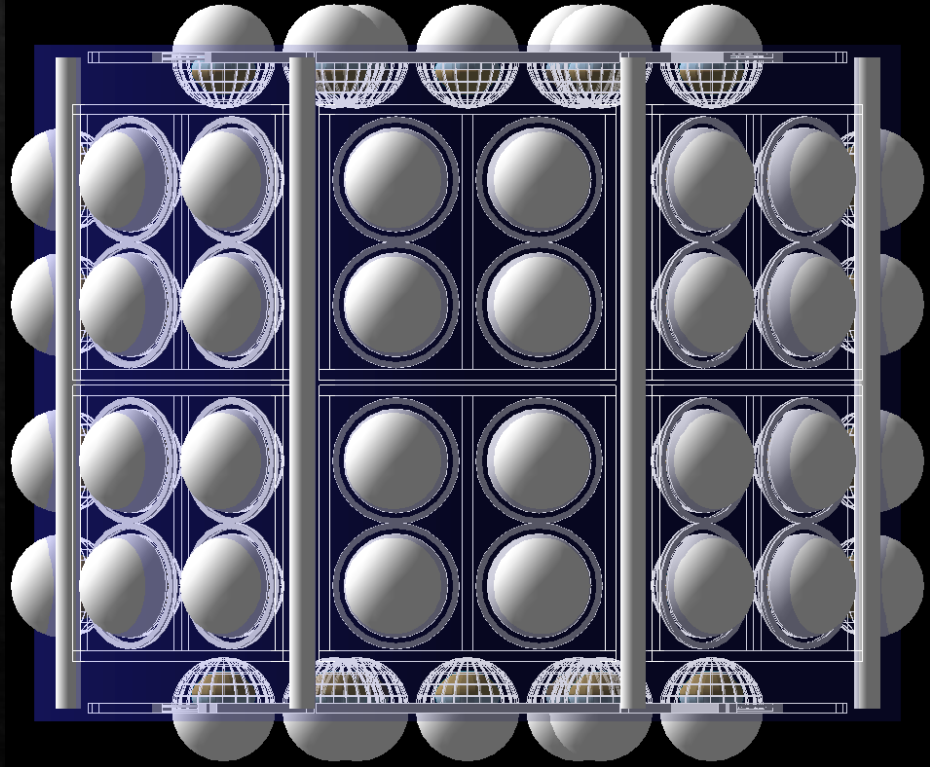


- ◆ Production of the PSUP (support structure) has begun at Liverpool
- ◆ Much of the design has been completed by Kieran Bridges and construction as begun by our wonderful workshop team



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

# Liverpool simulation work

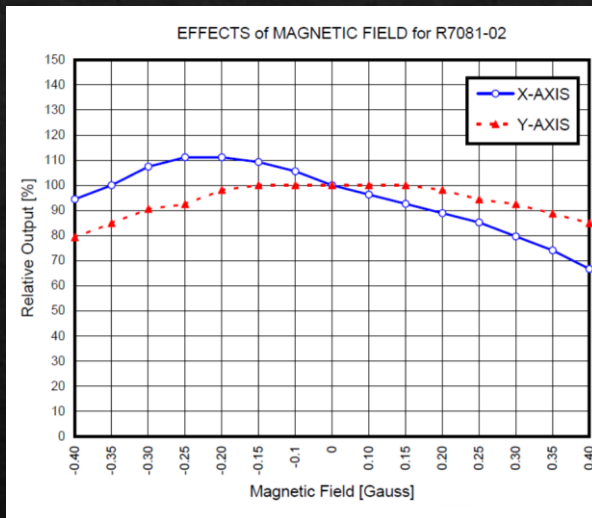


## RATPAC (GEANT4 based ) simulation

- ◇ 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.

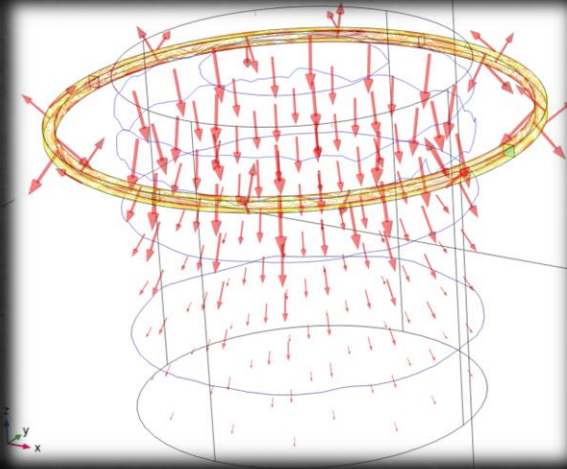
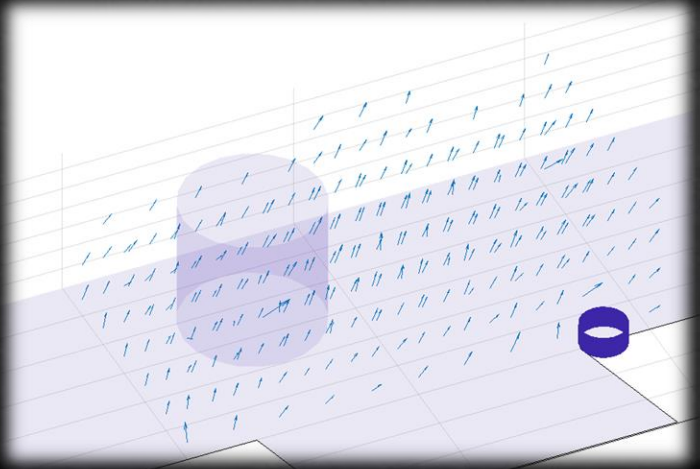


# Liverpool simulation work



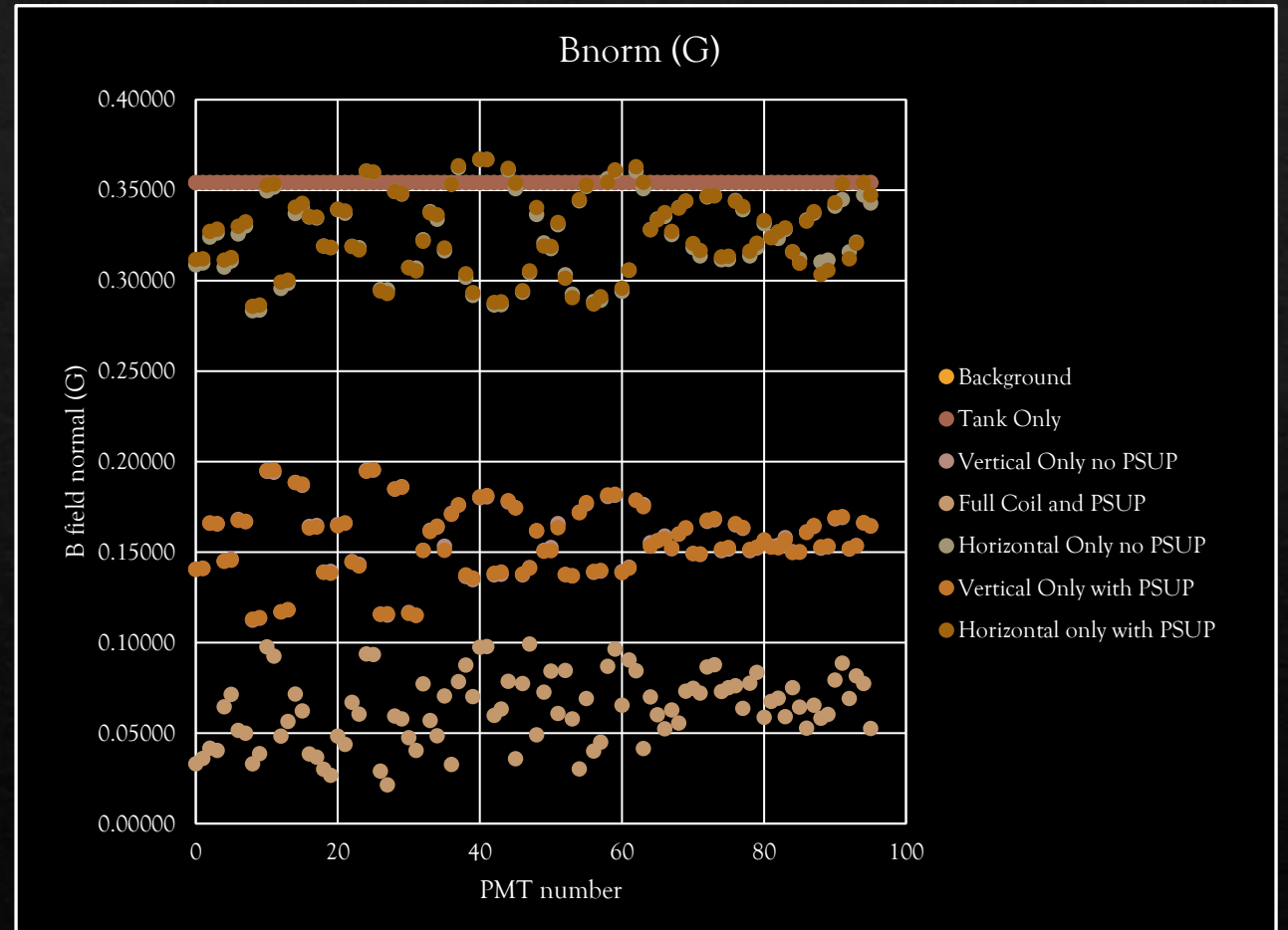
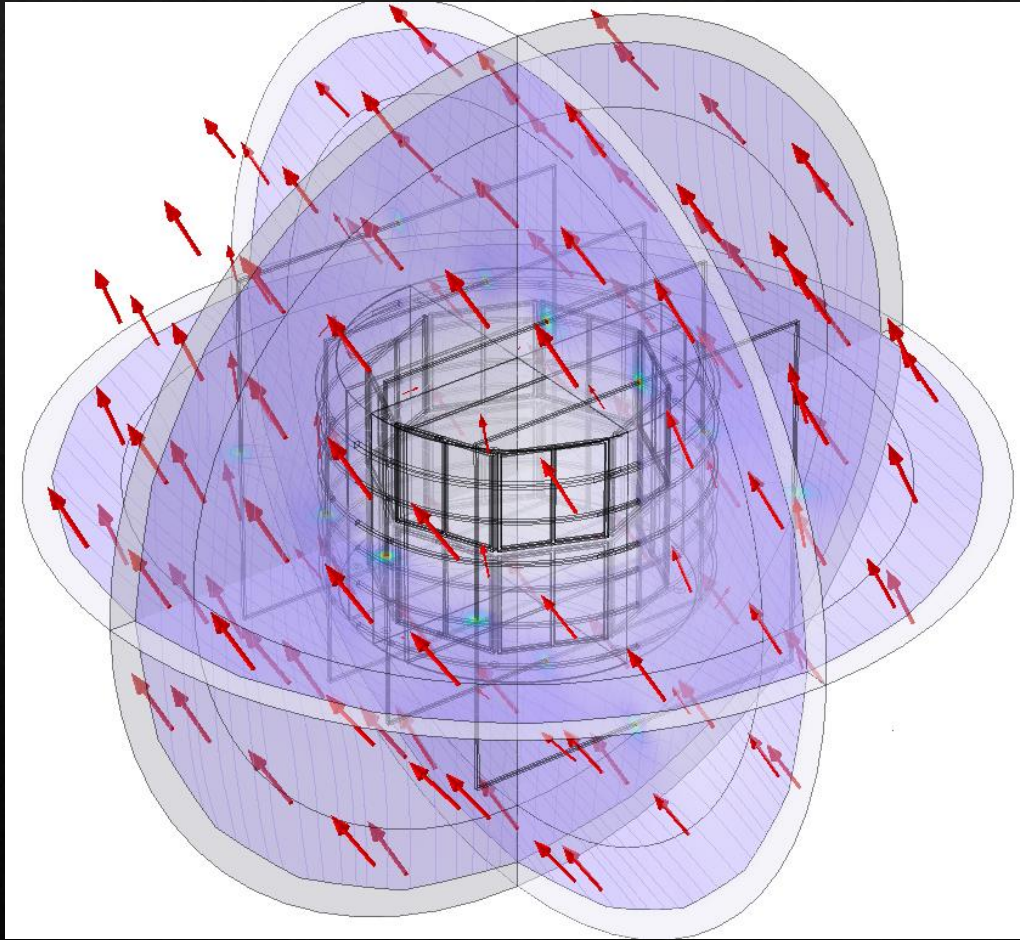
## COMSOL simulation

- ◇ 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



# Upcoming

- ◆ Liverpool continues to be a large part in the BUTTON project.
- ◆ Frame is being constructed.
- ◆ Taking a  $3 \times 3 \times 3 m^3$  experiment down a mine shaft in non-trivial.
- ◆ **The build begins.**
- ◆ The simulation continues.





*Any questions?*