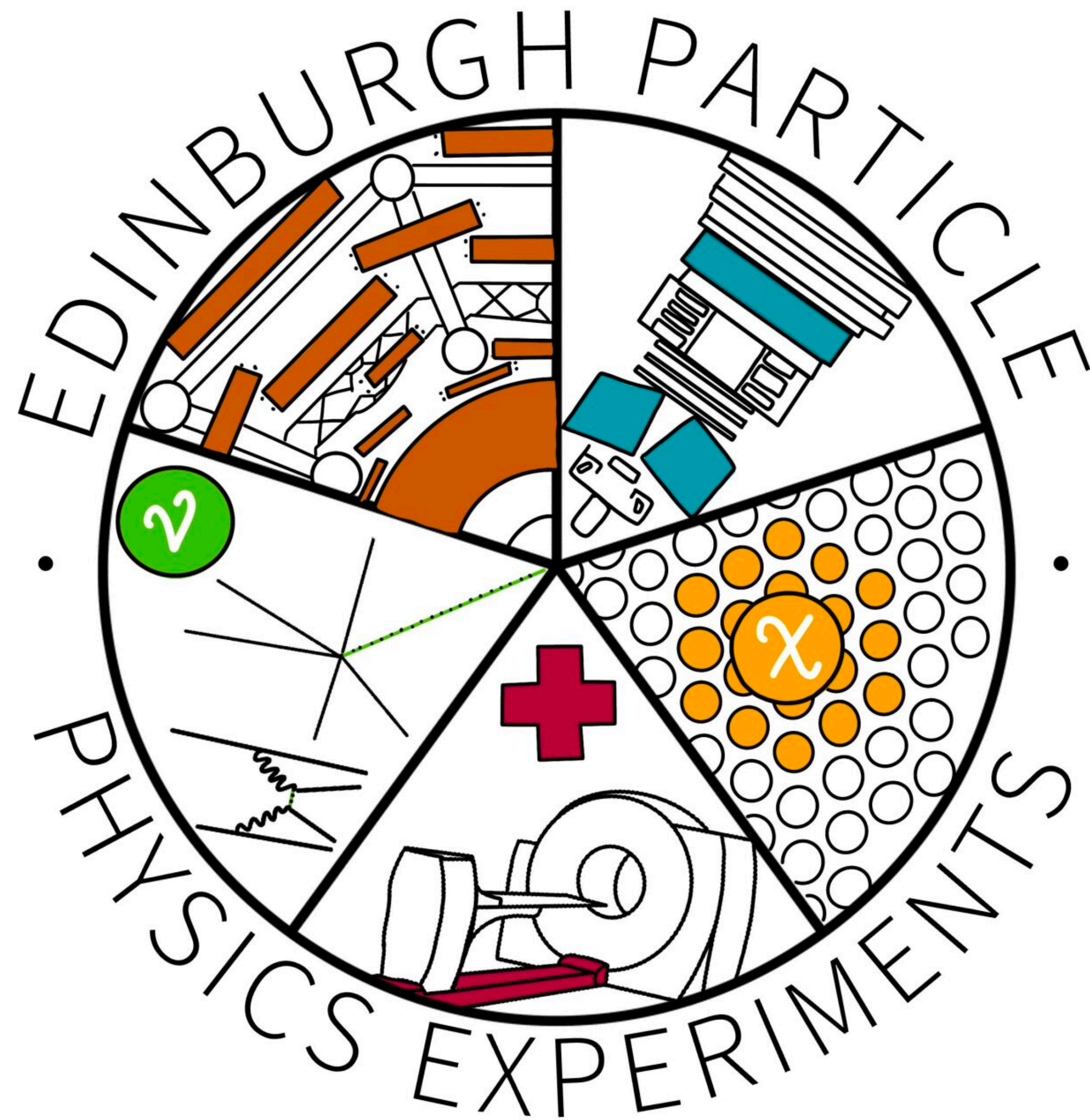


- ATLAS
- LHCb
- Neutrino Physics
- Dark Matter
- Medical Physics



People



- 17 academics
 - (9 men; 8 women)
- ~30 PDRAs
 - (10 women, 20 men)
- 30 PhD students
 - (16 men; 14 women)
- 5 engineering/tech/computing (all men)

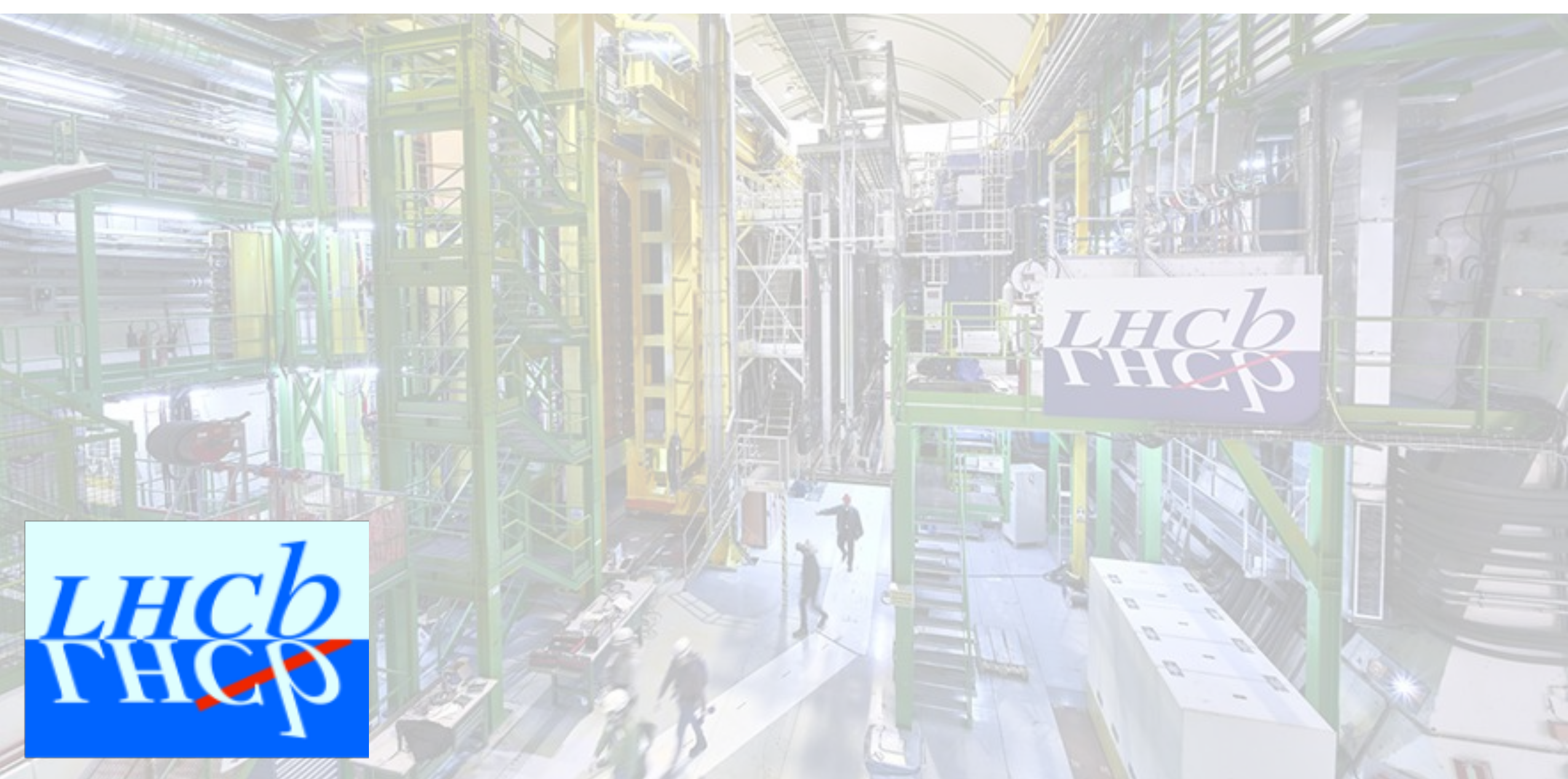
Academics

(List of investigators from the recent consolidated grant application)

Victoria & Christos are co-group leaders

Prof. V.J. Martin, Dr. W. Barter^{new}, Prof. P.J. Clark, Prof. P. Clarke,
Dr. S. Eisenhardt, Prof. S. Farrington, Dr. S. Gambetta^{new}, Dr. Y. Gao,
Prof. C. Leonidopoulos, Dr. L. Mijovic^{new}, Prof. F. Muheim,
Prof. A. Murphy, Prof. M. Needham^{new}, Dr. C.E. Patrick^{new}, Dr. S. Shaw^{new},
Dr. A.M. Szelc^{new}, Dr. M.R.J. Williams^{new} and Dr. C. Wimberley^{new}

8 new people in the last 5 years!



LHC Experiments

LHC Run3 started Summer 2022
LHC Run4 continues into 2030s

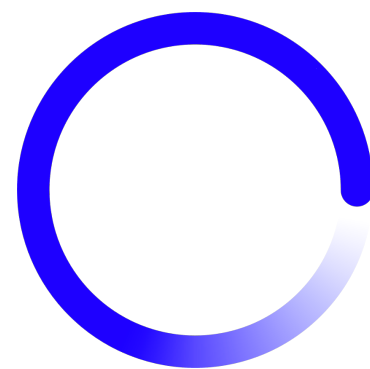


Neutrino Experiments

DUNE will operate in 2030s
Lots of smaller-scale experiments in the meantime

Future Collider Studies

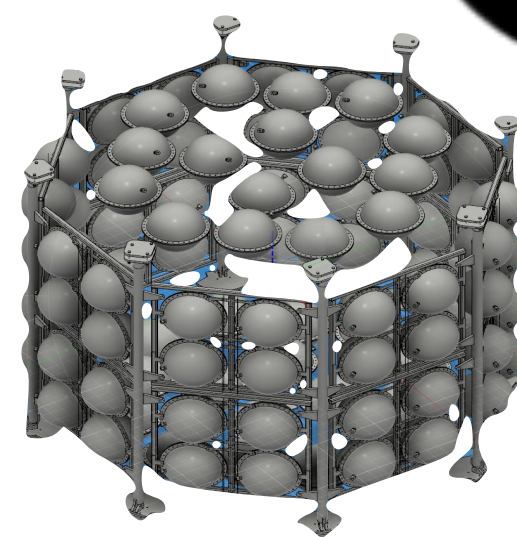
The future starts in the 2040s or beyond



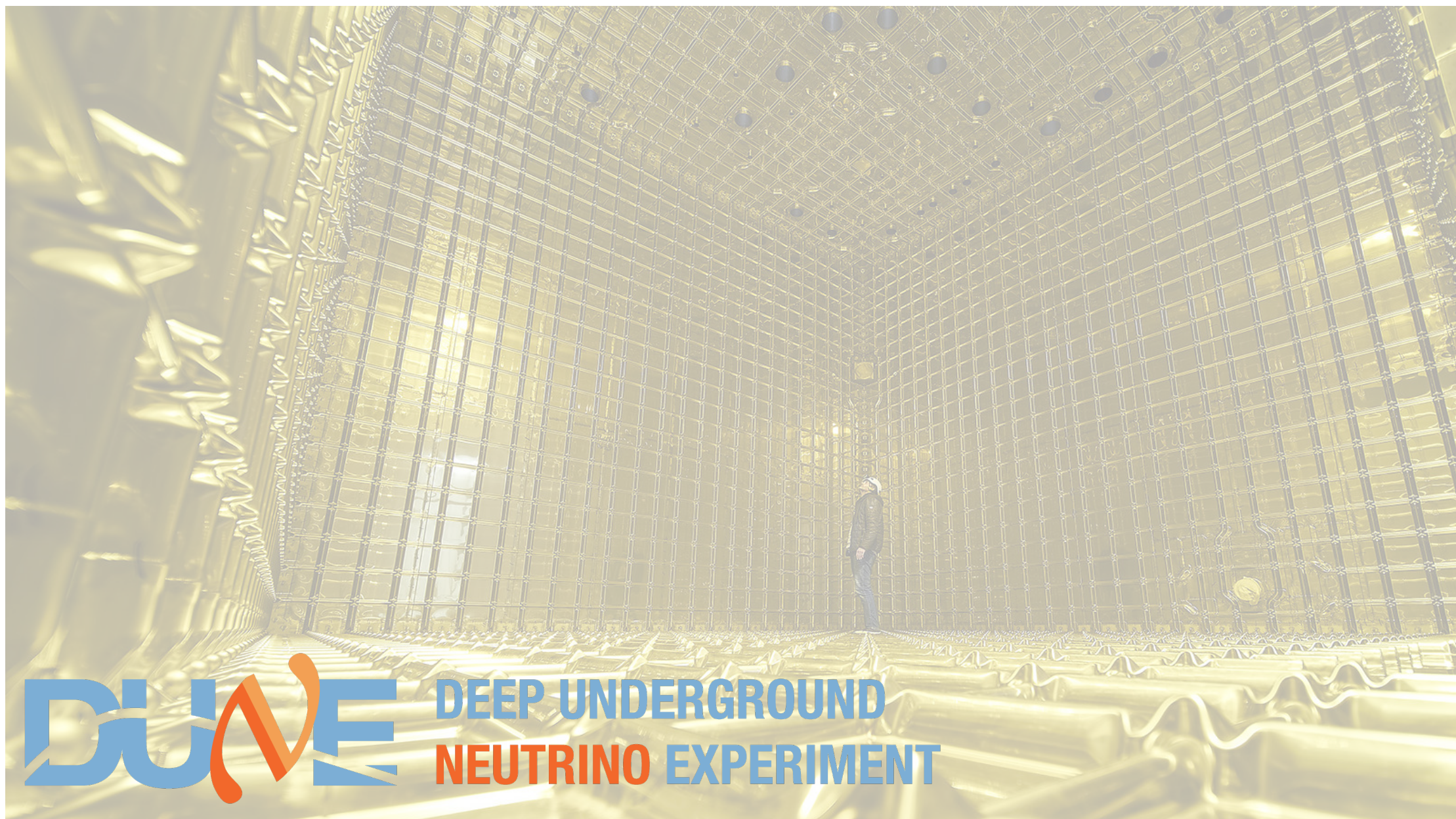
FUTURE
CIRCULAR
COLLIDER



**Dark Matter
Searches** & low
background science



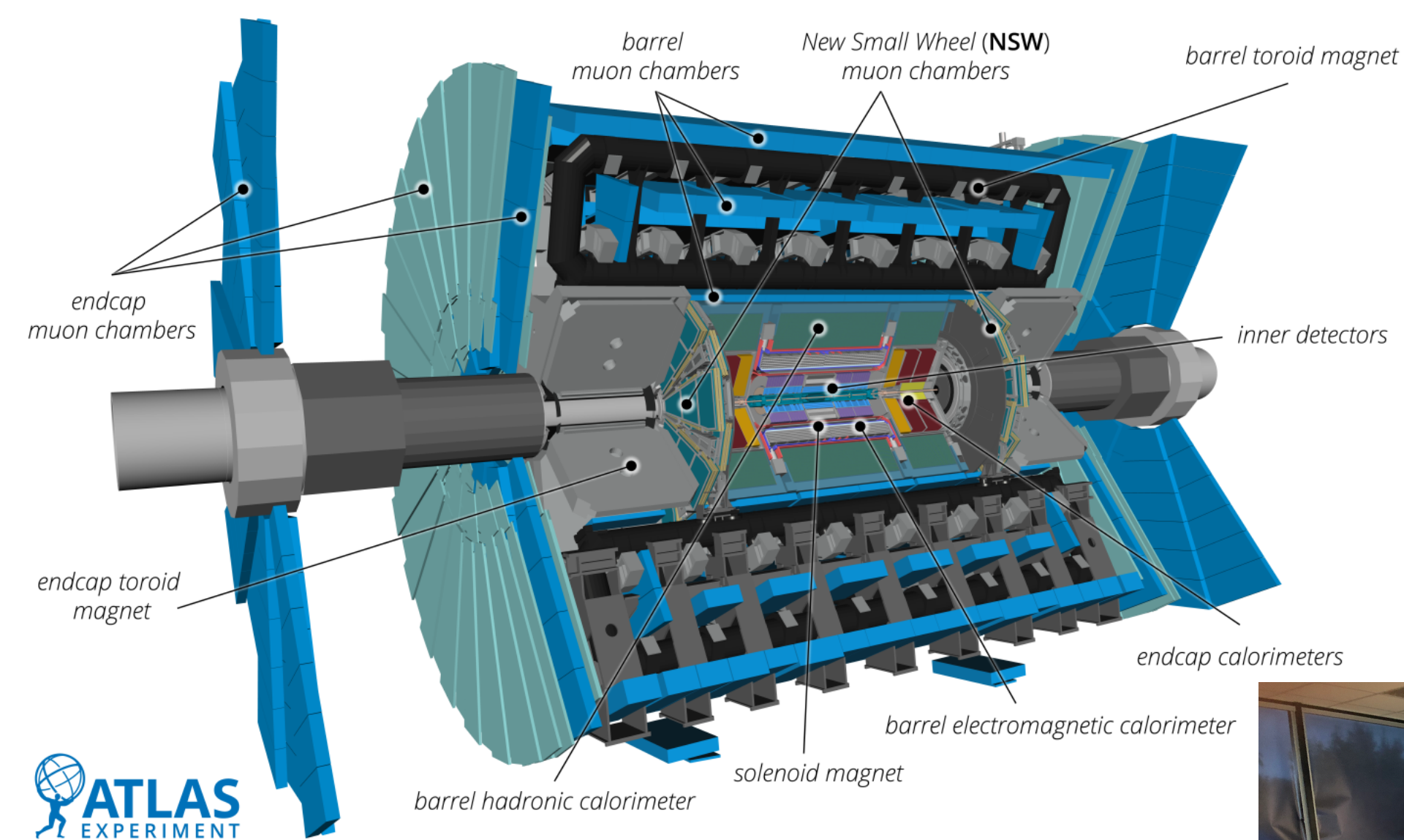
BUTTON



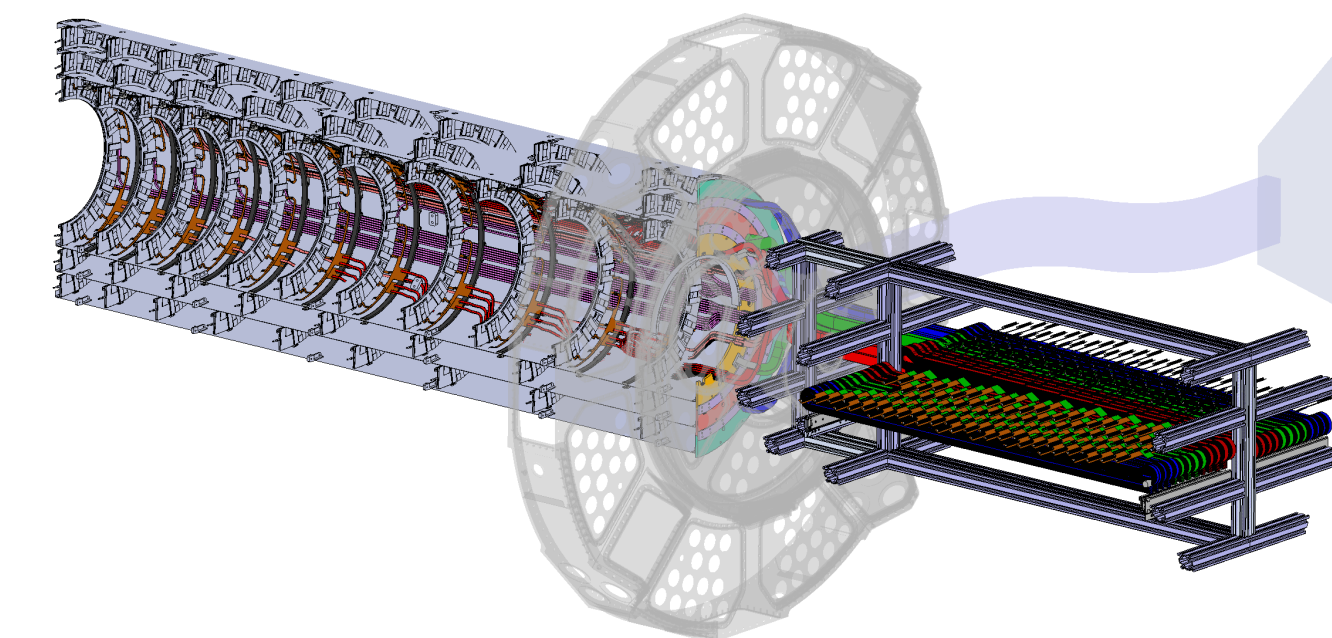
DEEP UNDERGROUND
NEUTRINO EXPERIMENT



@ LHC

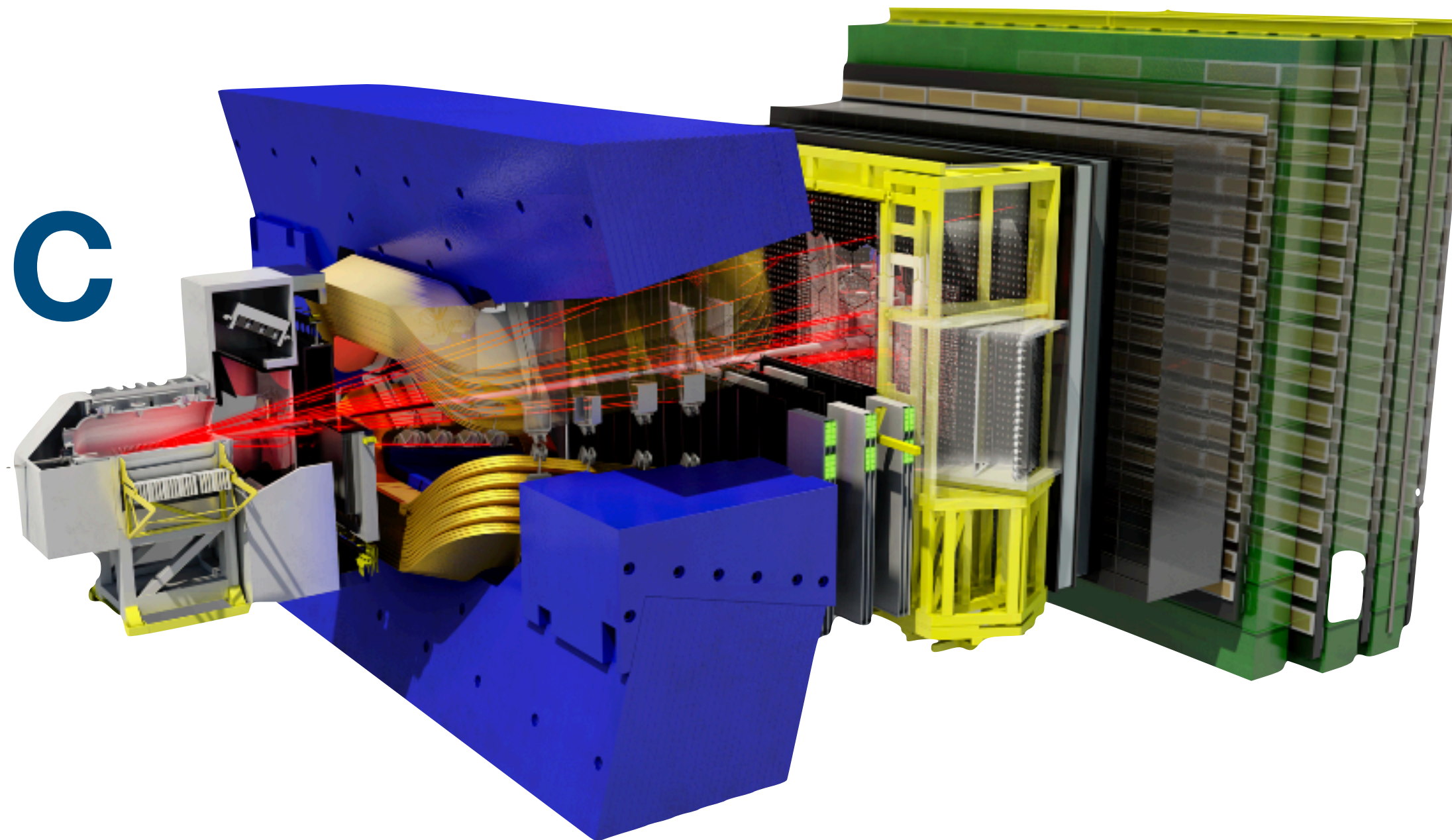


- Higgs boson precision measurements with $H \rightarrow \gamma\gamma$
- BSM searches - dark photons, W_R^\pm , long-lived particles: $X \rightarrow \tau^+ \tau^-$, anomaly detection
- Simulation & computing ; trigger & reconstruction
 - ML: tracking reconstruction signal/background separation; anomaly detection; generative simulation
- Silicon pixel detector development & tracker construction for HL-LHC





@ LHC



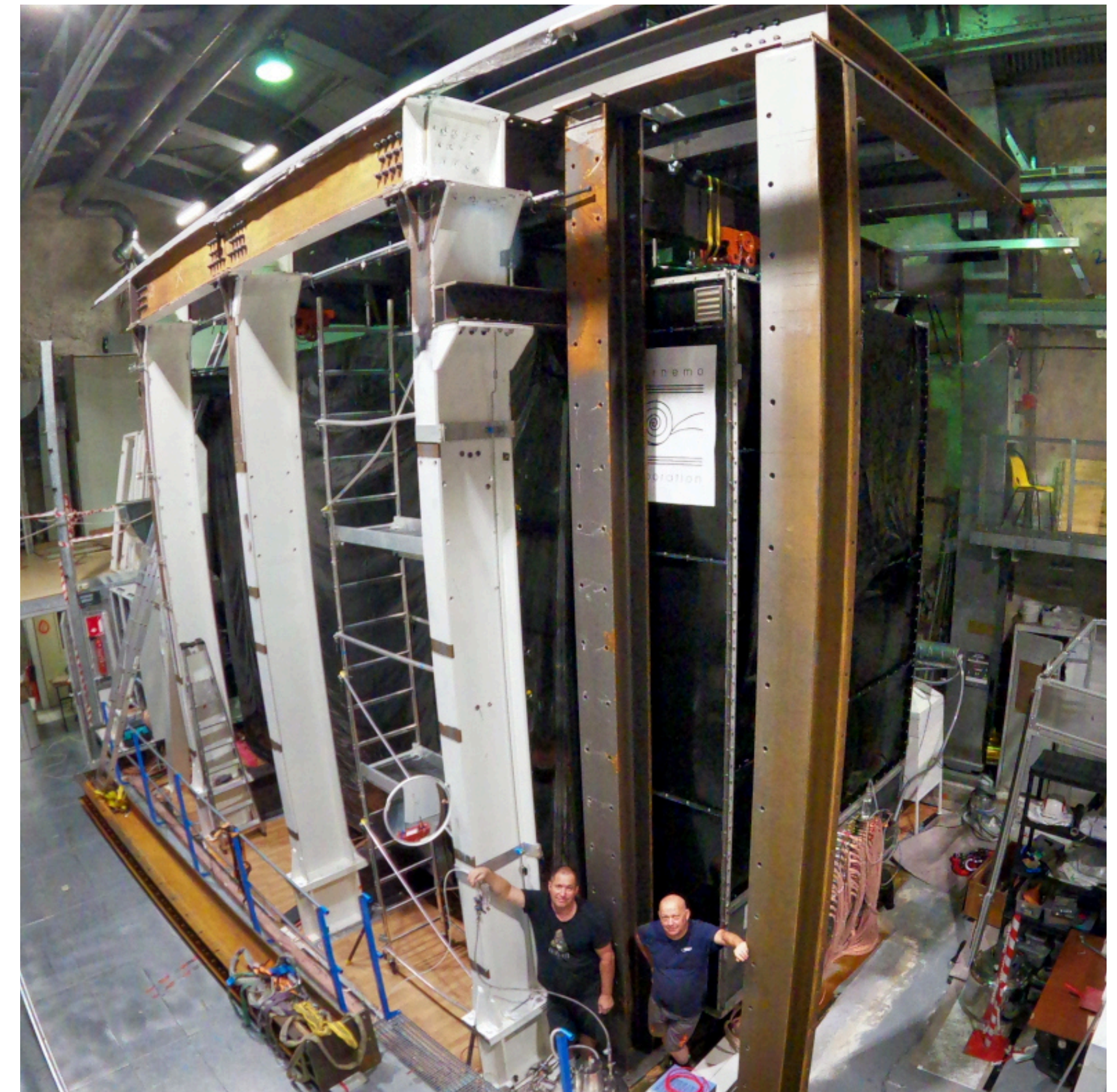
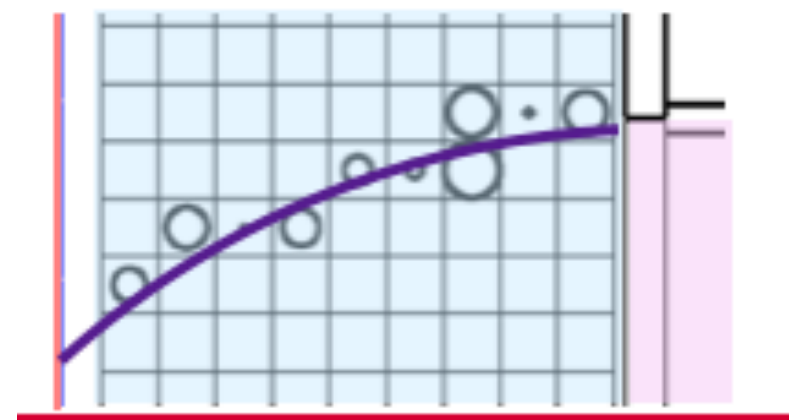
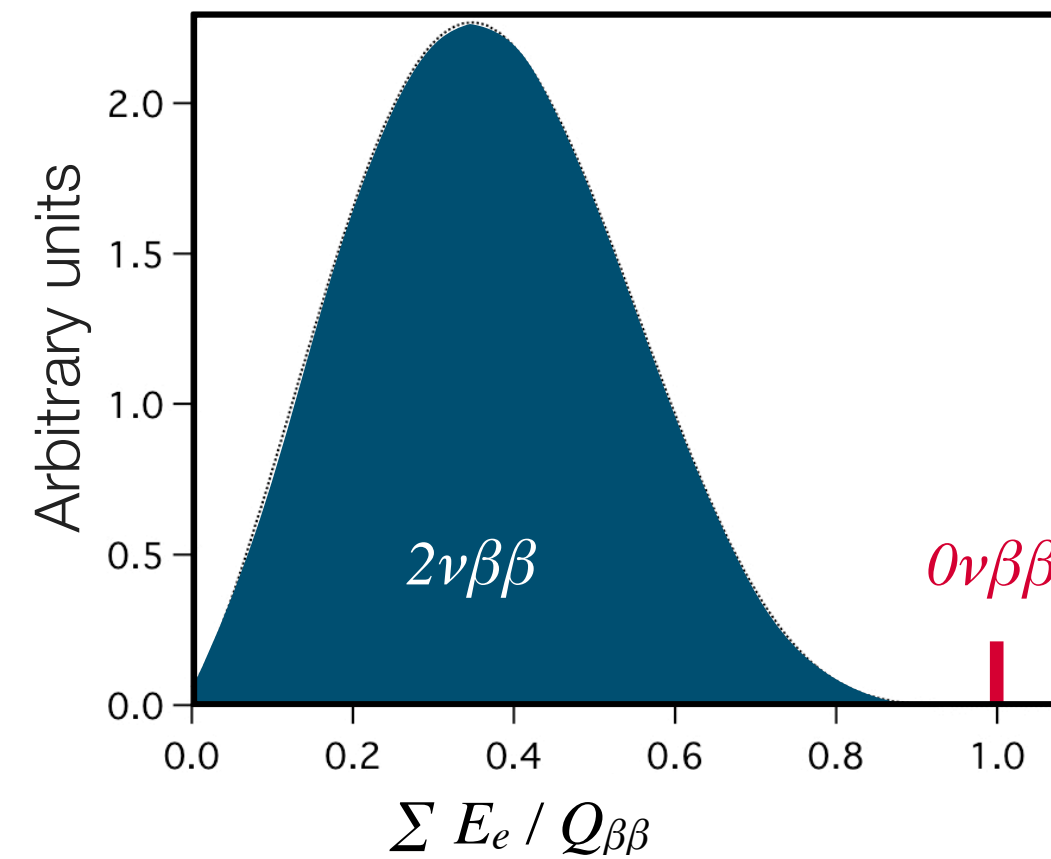
- **CP** violation in **B**-mesons and Charm mesons
- Spectroscopy of new hadronic states
- Charmless and rare **B**-hadrons & lifetimes
- Electroweak physics (*W*-mass & *Z* production)
- RICH - ring-imaging Cherenkov detector - operations and upgrade
- Mighty tracker development for high-luminosity running





- Under commissioning in the Fréjus tunnel near Modane, France.

- Science runs 2024-2026.
- Looking for $0\nu\beta\beta$ + studying $2\nu\beta\beta$
- Unique design to track both $\beta\beta$
- Baseline sample: Selenium-82
- Current Edinburgh work on commissioning, helium management, background determination





@ Fermilab

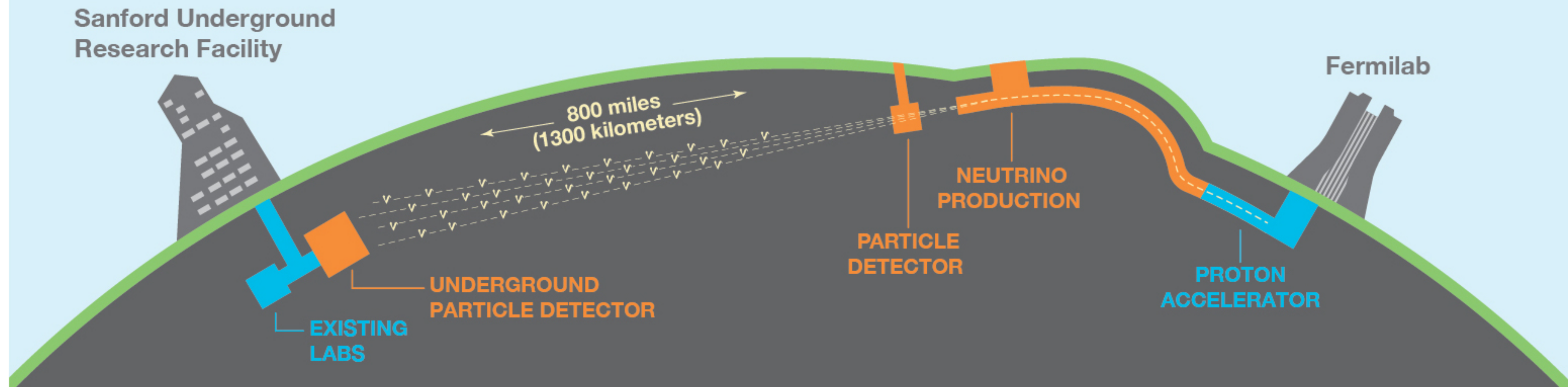


Short-baseline neutrino experiments: $\nu_\mu, (\bar{\nu}_\mu)$ beam created at target

➡ Liquid Argon (LAr) detectors at **110m** and **470m**

➡ Look for $\nu_e (\bar{\nu}_e)$ appearance, $\nu_\mu (\bar{\nu}_\mu)$ disappearance for new, sterile, neutrino(s).

Edinburgh contributions: measuring $\nu_e / \bar{\nu}_e$ cross sections from accelerators & astrophysical, measuring & modelling LAr scintillation light; searches for heavy neutral leptons & axions

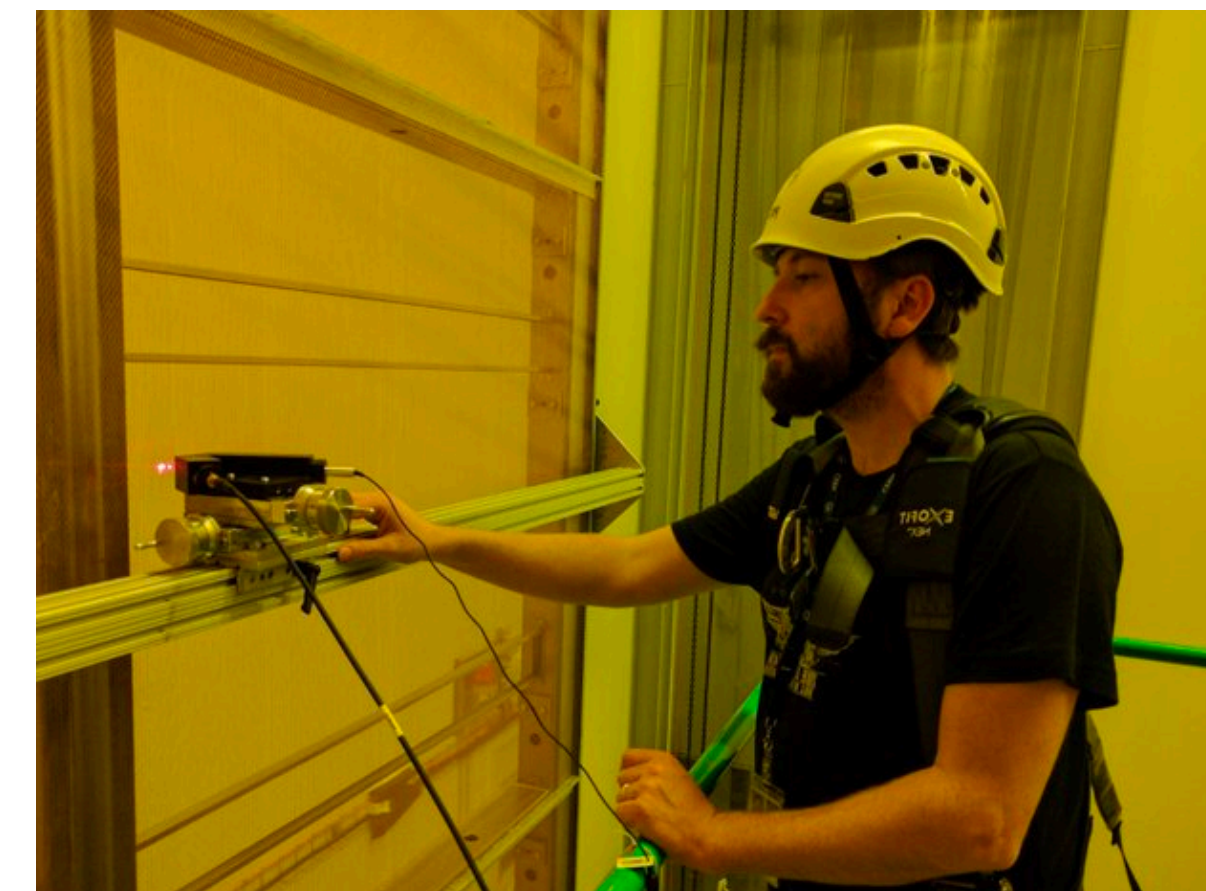


Long-baseline (1300 km) neutrino experiment: $\nu_\mu, (\bar{\nu}_\mu)$ produced at target

- ➡ Looking for $\nu_e (\bar{\nu}_e)$ appearance for neutrino mass ordering & CP violation
- ➡ Liquid Argon Time Projection Chamber detectors

Under construction - commissioning in 2030?

Edinburgh working on computing, data management, data acquisition construction and R&D for final far-detector module.



Proto DUNE @CERN



Dark Matter Experiment @ Sanford Lab

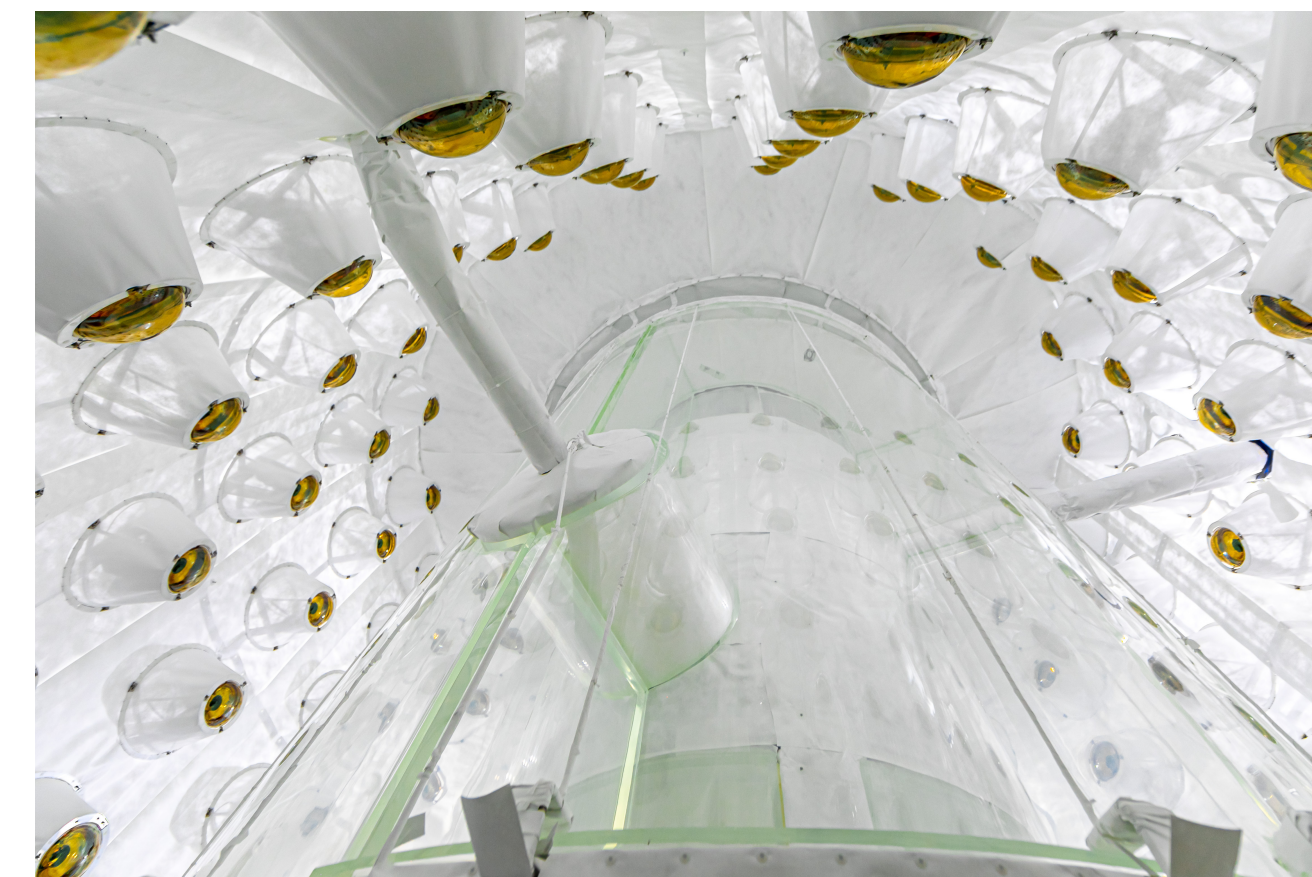
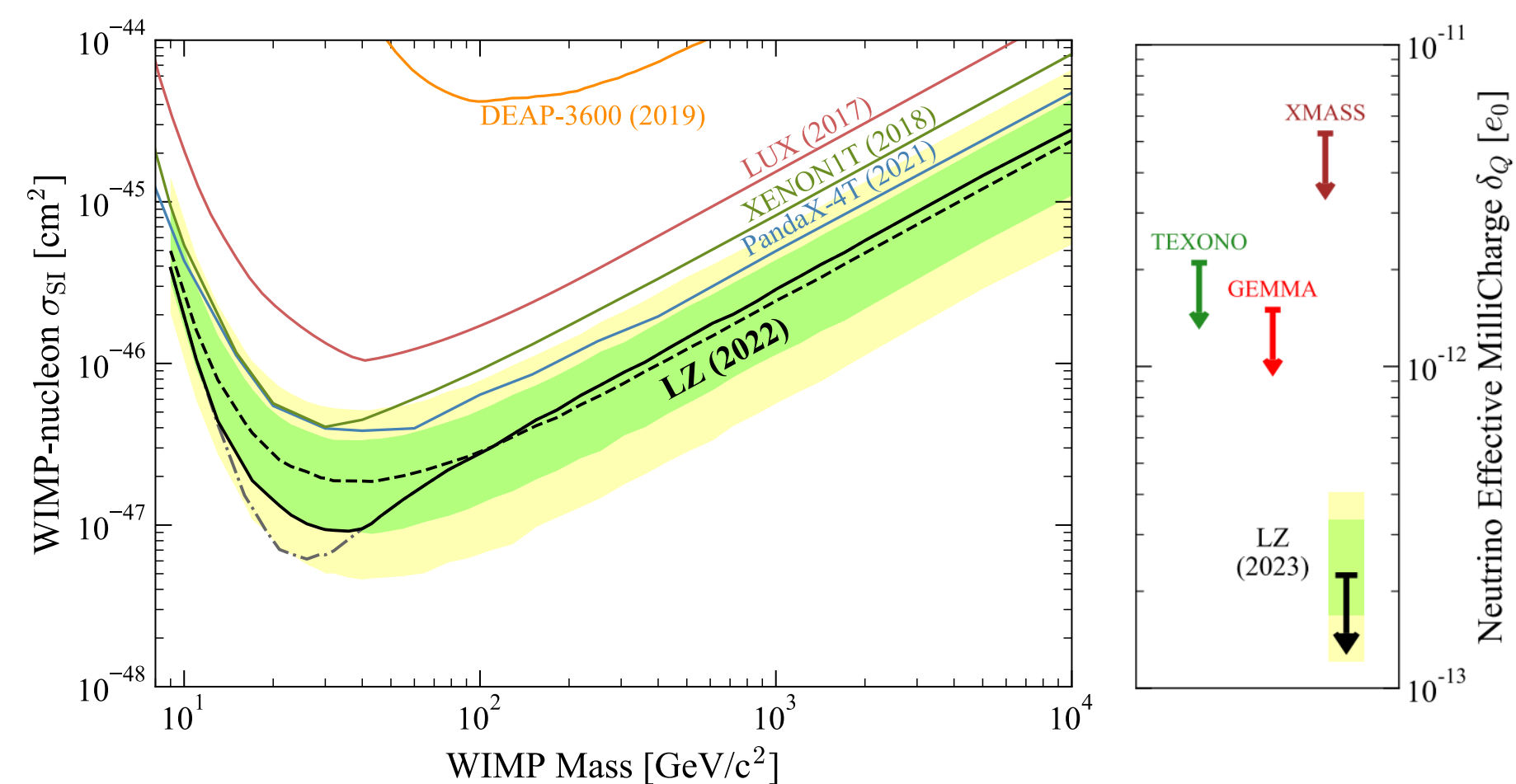
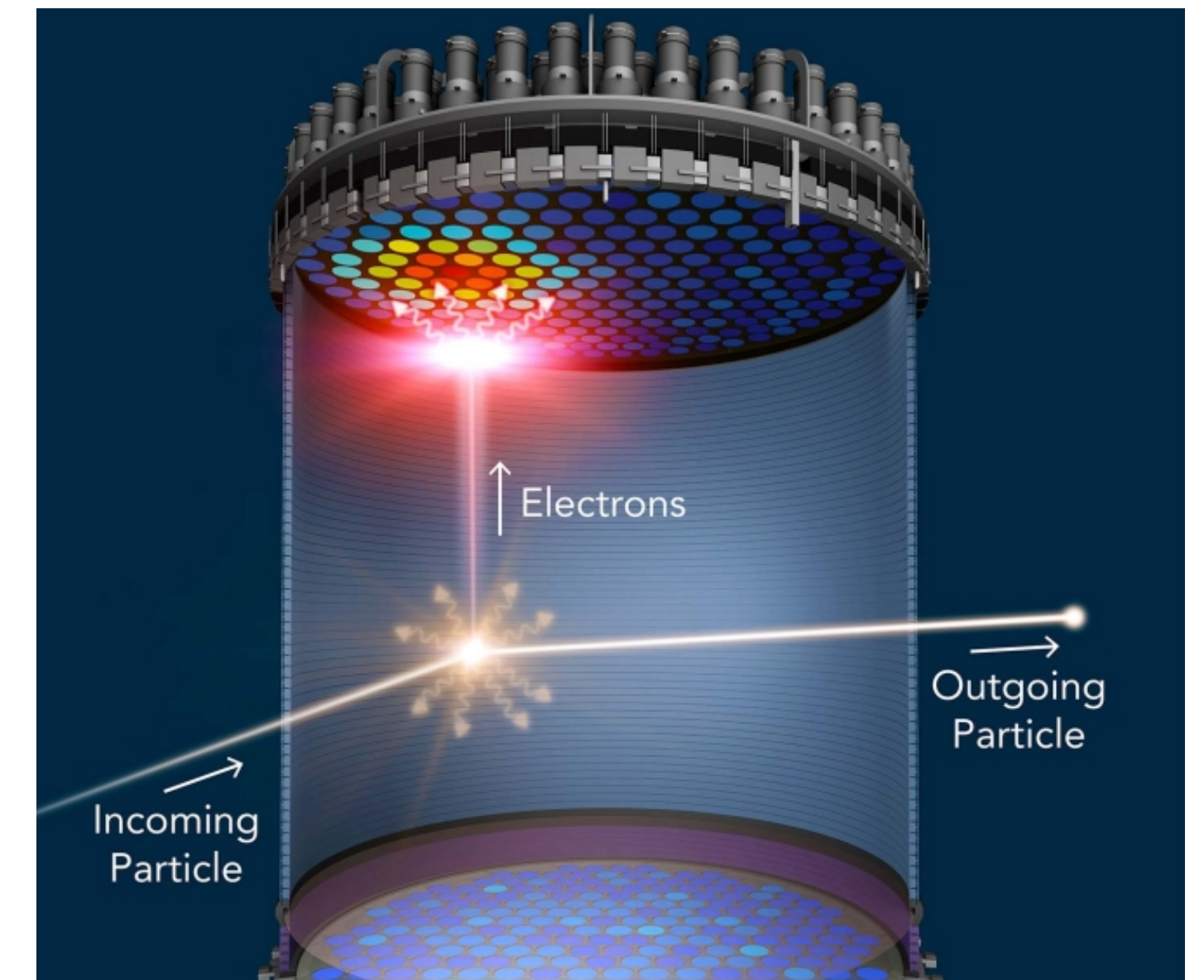
7 tonne tank of Liquid Xenon

World-leading direct DM detection, new results coming this year

Currently operational: will take 1000 days of data by 2028

Edinburgh focus:

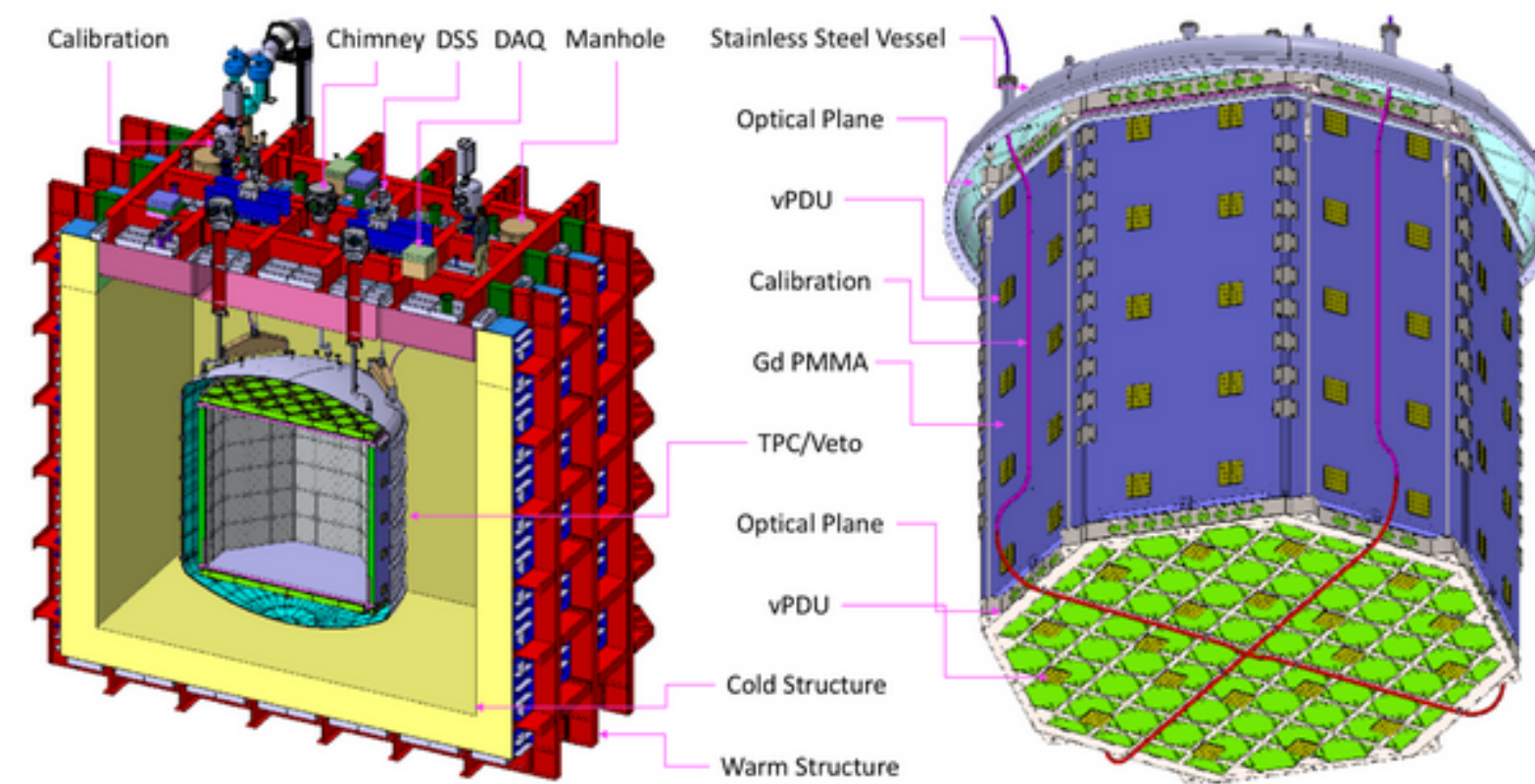
- leads in neutron backgrounds and veto detectors
- low energy electron recoils: axions, ALPs, hidden photons, exotic neutrino properties



Future Dark Matter



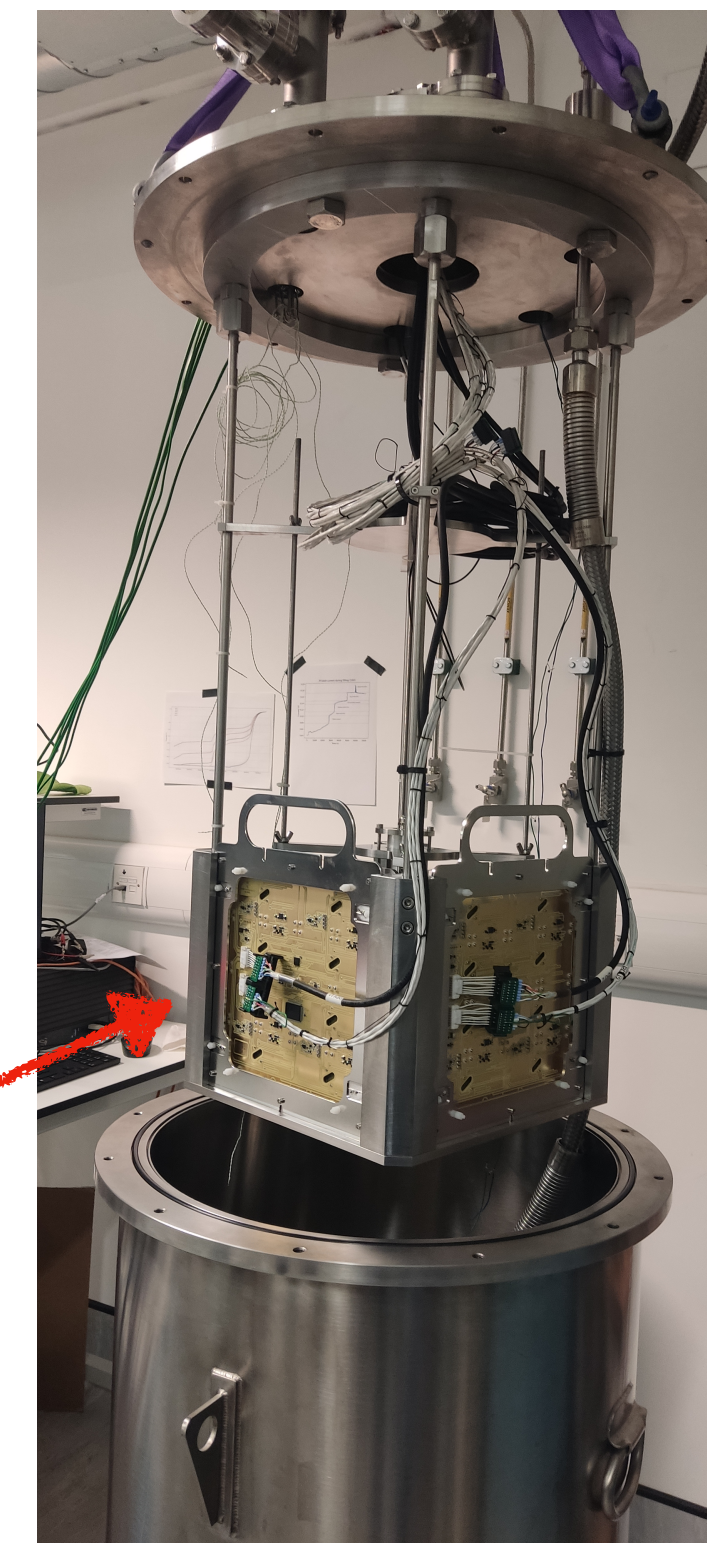
@ GranSasso



20 tonne tank of Liquid Argon under construction

Edinburgh constructing cryogenic test stands to qualify silicon photon detector veto.

Plus supernova neutrino searches in the veto.



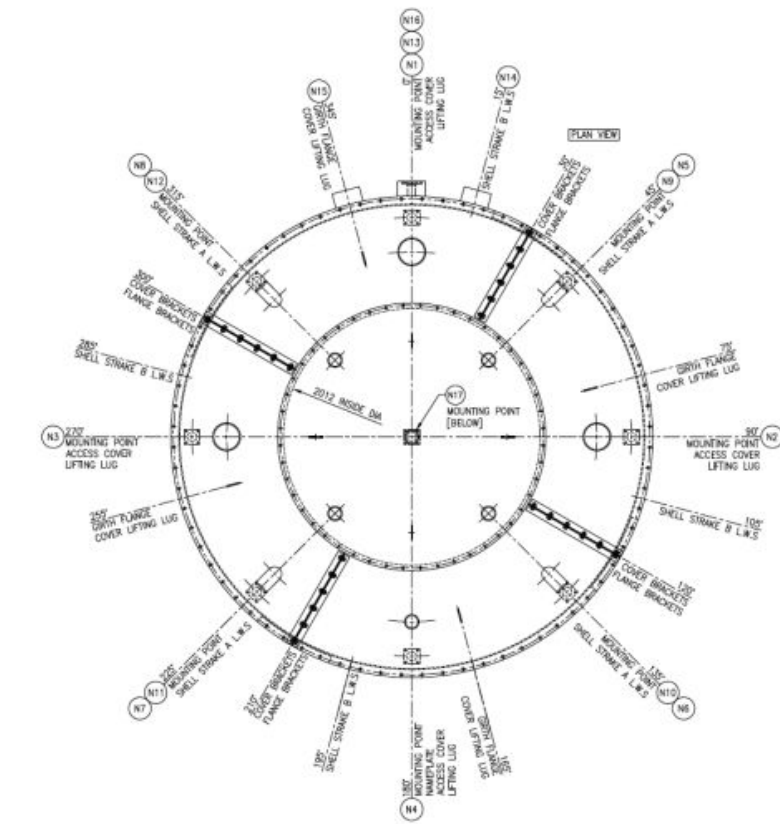
XLZD Proposal for next gen detector: 40-100 tonnes of Liquid Xenon

Potentially sited at STFC Boulby lab in Yorkshire

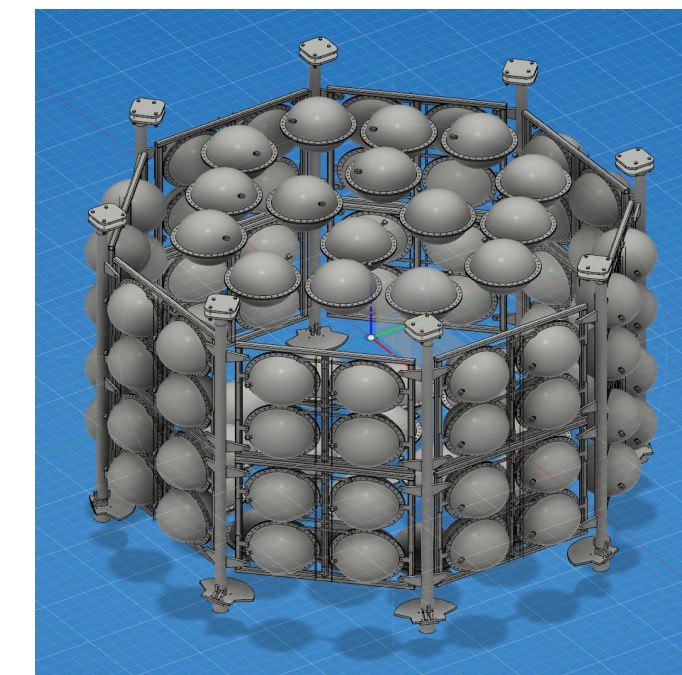
Edinburgh working with Boulby on understanding the background environment

Button @ Boulby

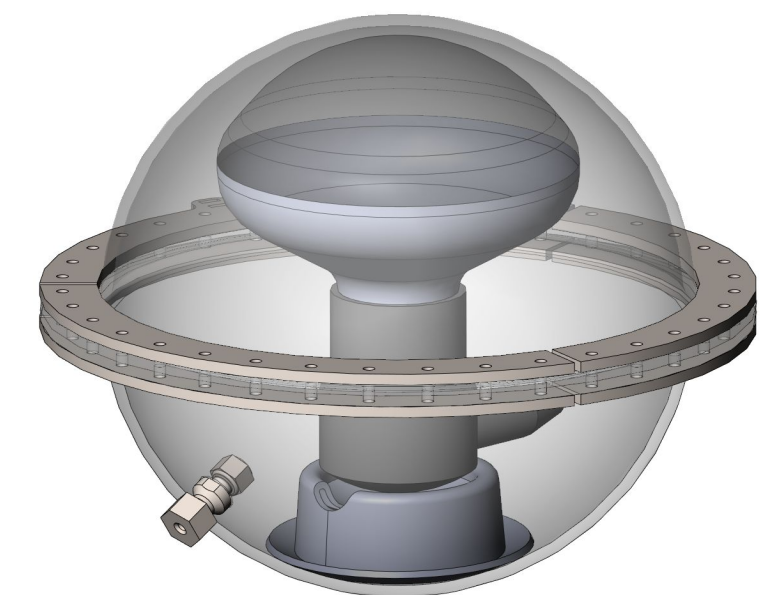
- Prototype detection of **anti-neutrino flux from reactors** using Gadolinium-doped water-based liquid scintillator (Gd-WbLS).
- Testbed for water-based liquid scintillator technology - suitable anti-proliferation detection.
- Largest detector to-date at Boulby lab. Potential neutron-veto for proposed dark matter DarkSphere experiment.
- Edinburgh working on PMT testing and encapsulation of the PMTs into housing



~30 tonnes
~100 Hamamatsu R7081 10" PMTs

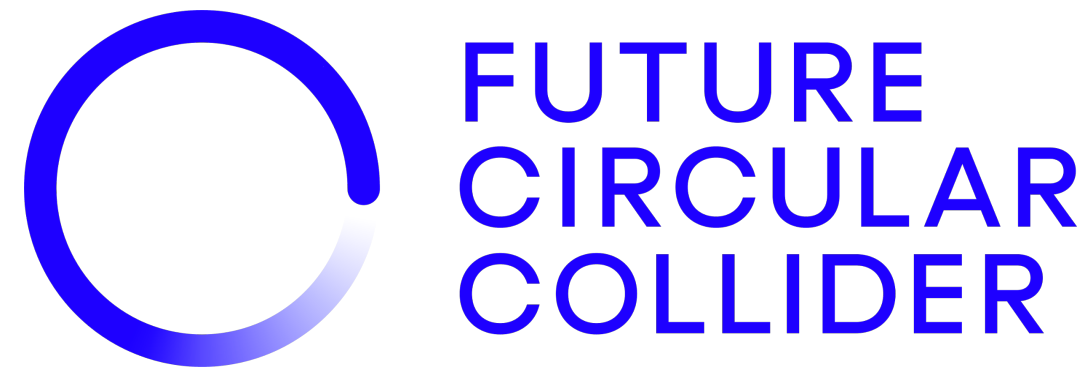


- Modular support structure to facilitate swapping out **advanced photosensor technology**.



- Compatible with **novel fill materials**.

Future Colliders



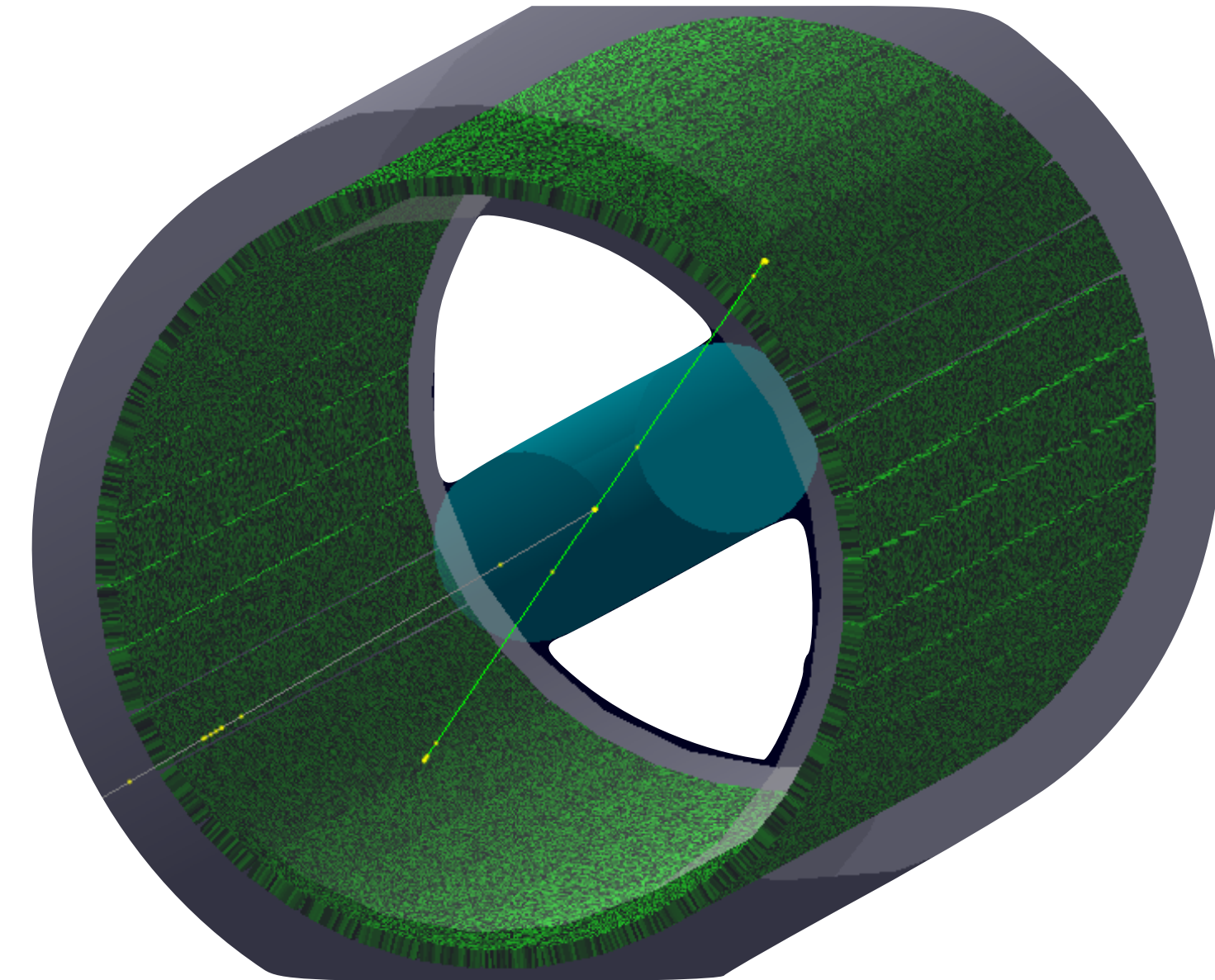
Working on physics studies; tracking detectors and data acquisition students for next generation colliders

Medical Physics

Working with Edinburgh Imaging (EI) (part of UoE Medical School)

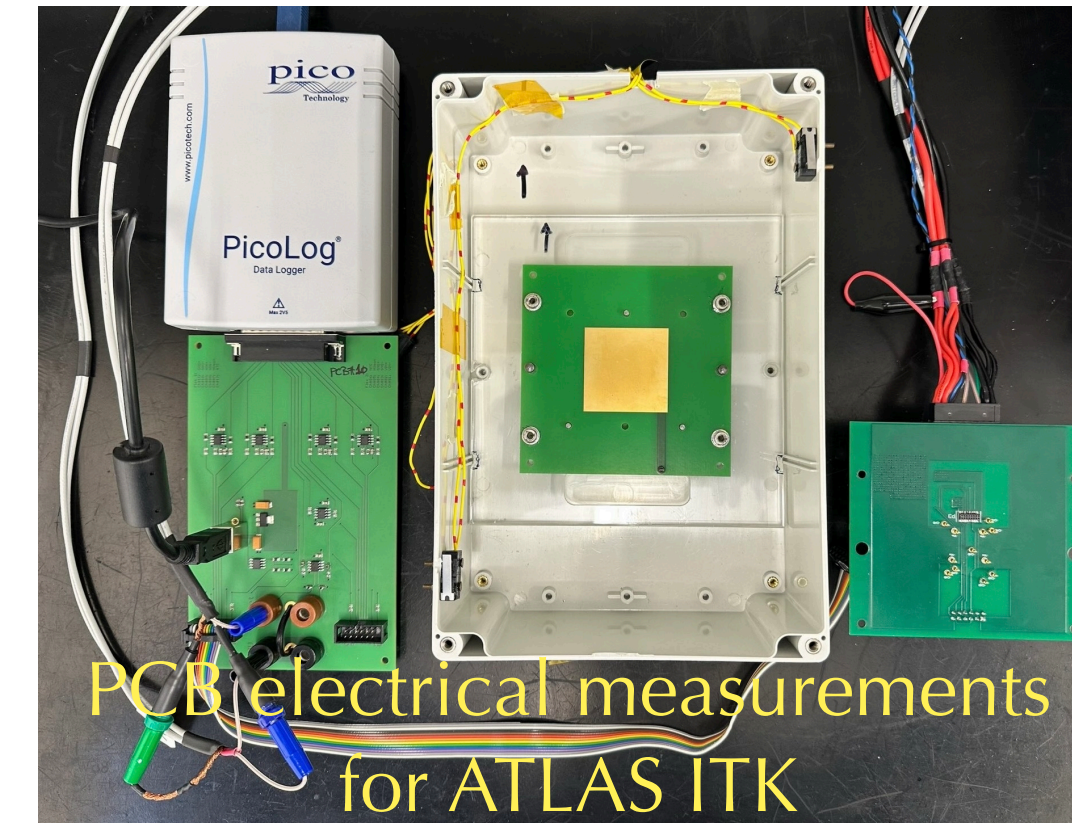
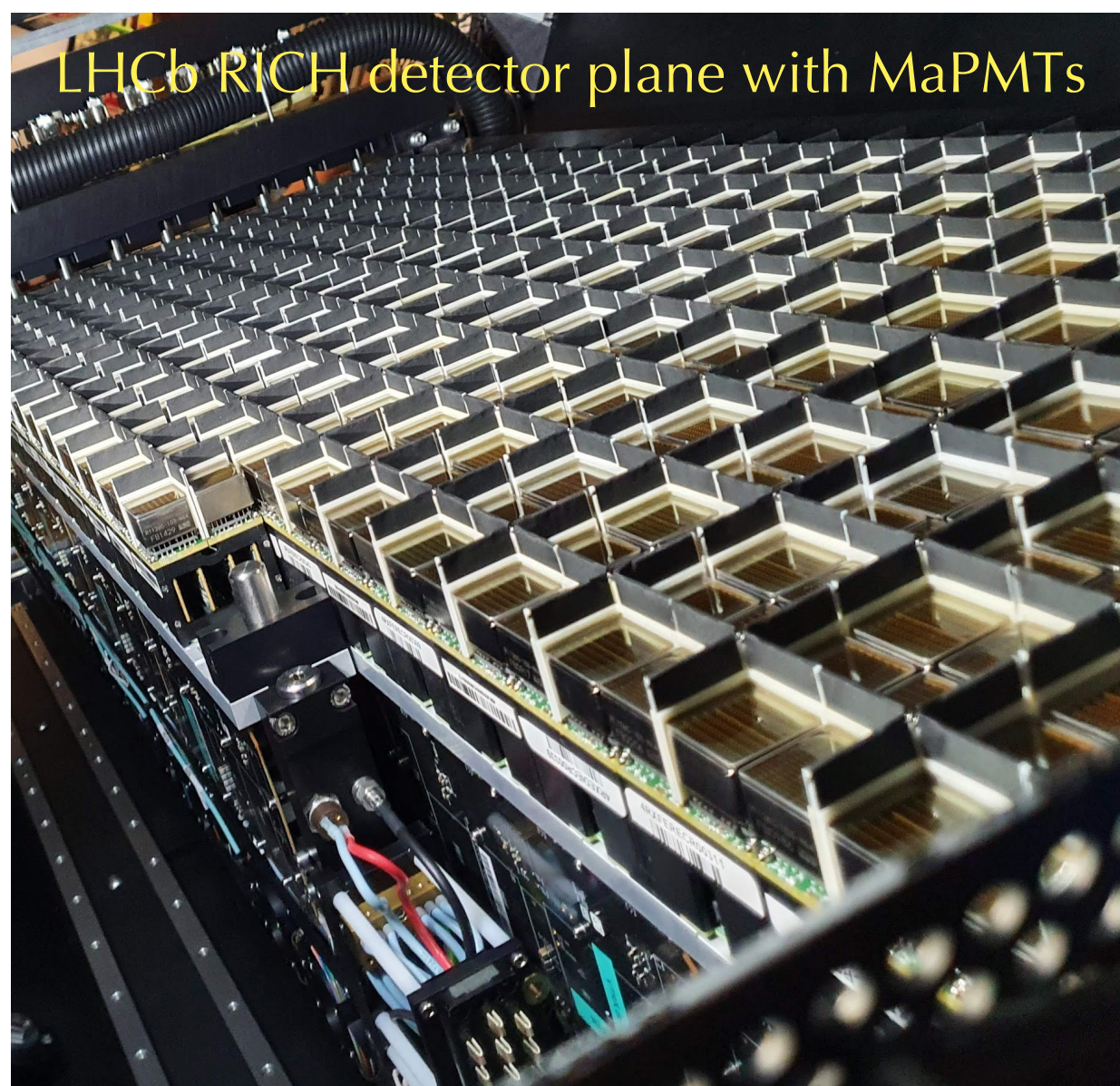
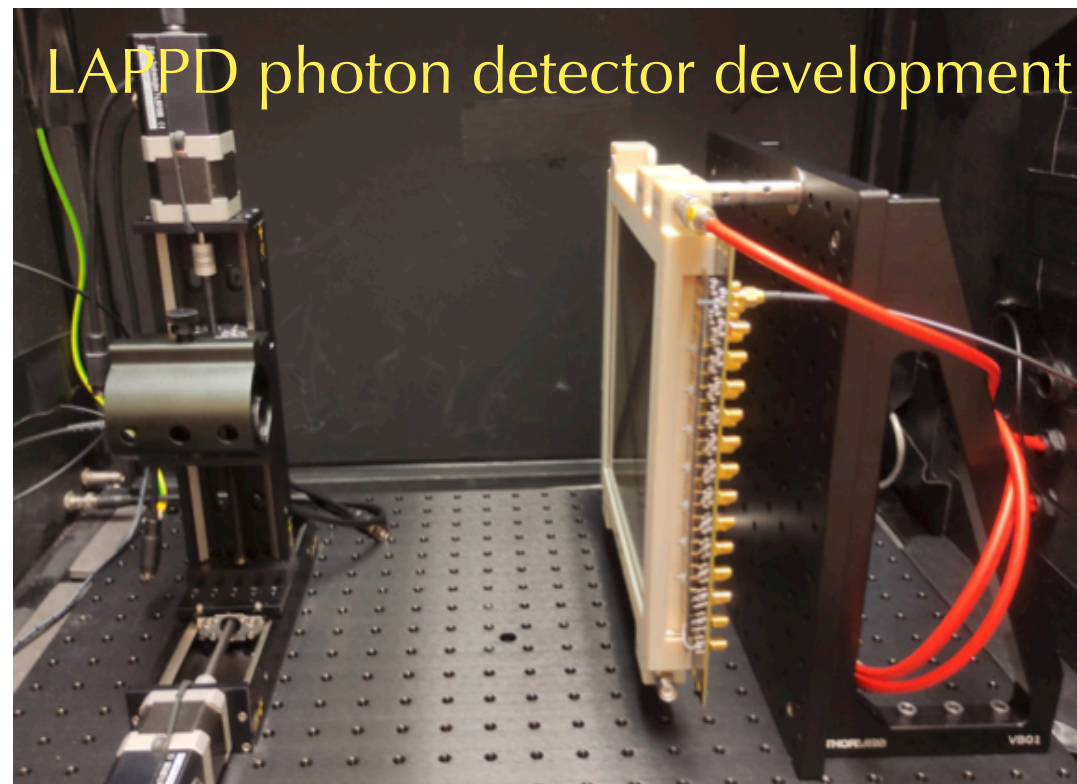
EI will probably host: a PET-MRI scanner and
Siemens Total-Body PET scanner for humans (1 of 2 in UK)

PPE working on: Geant-4 simulation, PET test-stand with photon detection technologies from LHCb



Detector Development

Labs on JCMB 5th floor



- 55 m² ISO-7 Clean Room, with 10 m² ISO-6 Clean Room enclosure
- small-pitch Low Gain Avalanche Detectors (LGAD)
- Operational cryogenic test stand for photon detectors at LN₂ temperatures.
- Low-temperature evaporator able to coat large areas with organic wavelength-shifting compounds (e.g. TPB(Tetra-Phenyl-Butadiene)).
 - Already used for SBND, NEXT (@CANFRANC) & CCM (@LANL).

Areas for Collaboration?

- Electron-Ion Collider at Brookhaven
- Physics:
 - ➔ LHC (& Higgs factory) phenomenology: HEJ ...
 - ➔ Using proton pdfs
 - ➔ Lattice calculations of hadron masses and form factors
 - ➔ QCD predictions and QED corrections in weak decays (already collaboration with Roman)
 - ➔ Neutrino phenomenology including interaction models-nuclear effects
 - ➔ dark sector models for neutrino/DM detectors & LHC
- Tools:
 - ➔ Machine Learning
 - ➔ Development of fast simulation models
- Detectors technology:
 - ➔ Low energy electron / photon detection
 - ➔ Silicon detectors
 - ➔ Noble liquid R&D

Backup



HL-LHC: High Luminosity LHC
LS: Long Shutdown
TeV: Tera electron Volt

