TOAD Status Update

N. Khan on behalf of the TOAD Group (Imperial, RHUL, FNAL, Uni of Pittsburgh, QMUL, Oxford, Warwick, UCL, Uni of Minnesota, Uni. Of Colorado and more)

DEEP UNDERGROUND NEUTRINO EXPERIMENT

Overview

- What is TOAD
- What are our goals for this test beam
- Status and recent progress
- Next steps

TOAD

- Test-stand of an Overpressure Argon Detector (TOAD) will operate in the MCenter tertiary beam at FNAL this beam year (22-23)
  - Low energy hadron beam
  - Where LArIAT currently is
- Previously based at RHUL

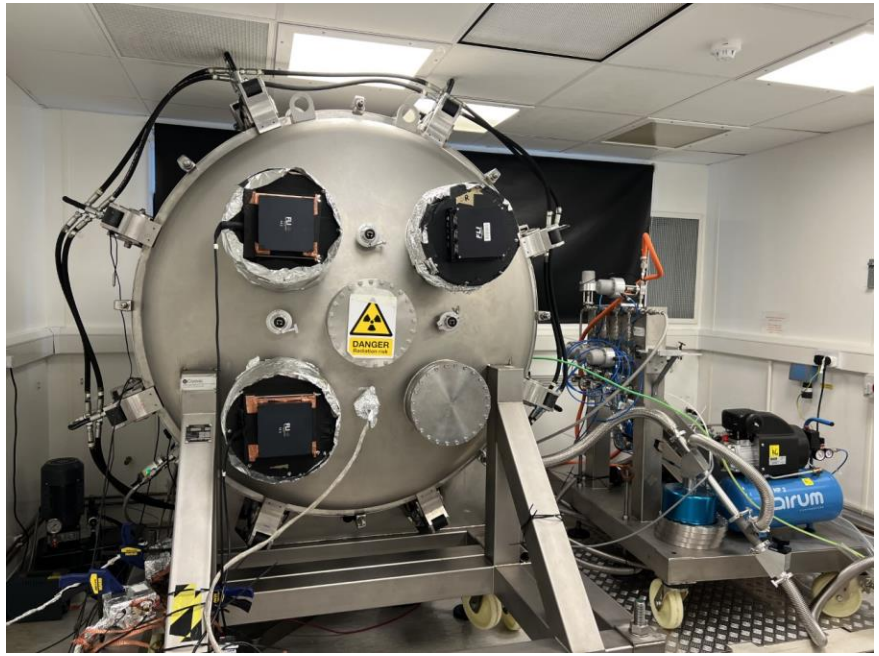
Meson Lab Construction November, 1972

TOAD

- A full slice of the detector will be tested, with one outer readout chamber (OROC) taken from ALICE
- Largely based on the detector used in the 2018 HPgTPC beam test at CERN, but with some important improvements
  - Now largely based on charge readout rather than a light readout system

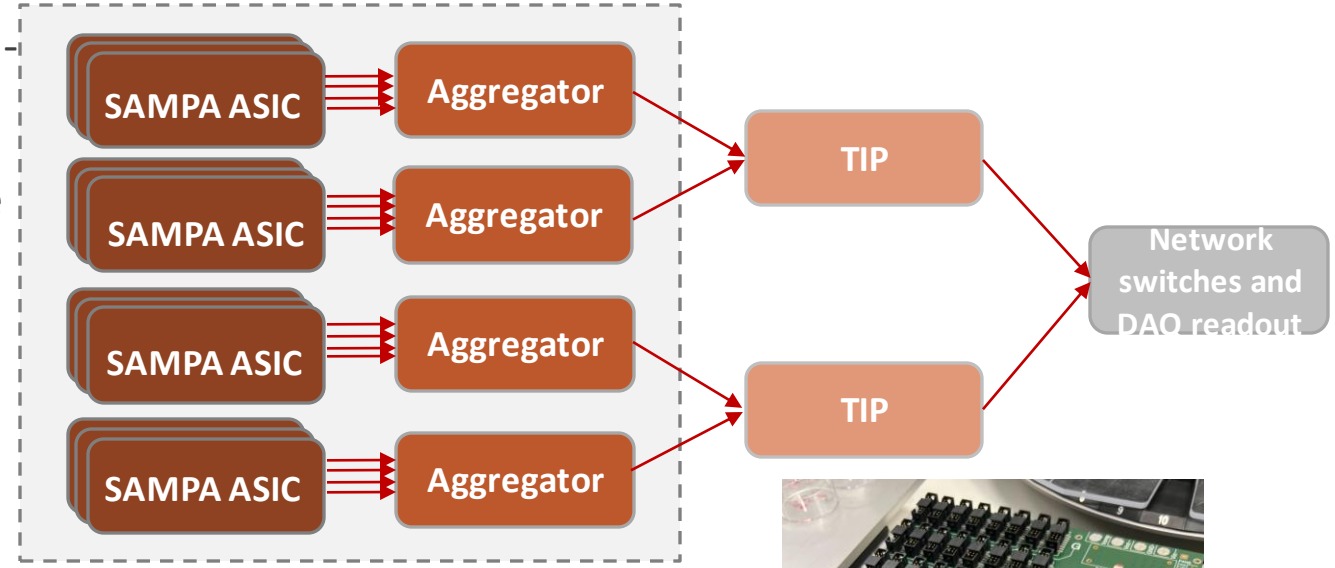
TOAD Vessel and HPgTPC

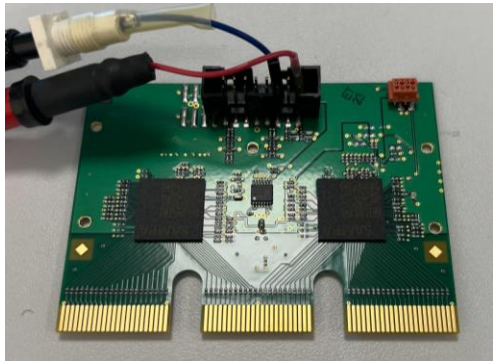
- TOAD uses a ~1m^3 pressure vessel which operates at 5 bar.
- TOAD will use an Ar-CH_4 gas mixture, with molar ratio 96:4 There may be an opportunity to test other gas mixtures during the beam year.
- Charged particle enters the chamber → ionises electrons in the gas → drift towards the endplates → Multi-Wire Proportional Chambers (MWPCs) → initiate avalanches at anode wires → induced onto cathode pads
- OROC consists of MWPCs and cathode pad planes, the signal on the pad plane is digitised and read out via new electronics.
- Potential to test light readout system

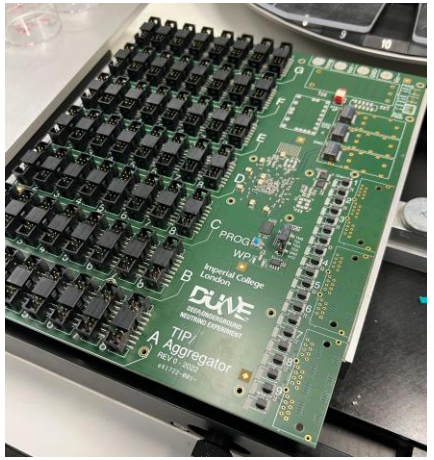


New Readout Electronics

- Frontend Cards (FECs) host 2 ALICE SAMPA ASICS - retrieve and digitize signals from the OROC.
- Aggregator cards – FPGA based - will perform the first level aggregation and buffering for FECs
- Timing, Interface and Power Cards (TIPs) - FPGA based - will aggregate further, control the system and provide timing information
- Off the shelf network servers and switches which will run the dunedaq software
- TOAD: ~10k channels from OROC, 156x FECs, 3x Aggregators, 1x TIP
- Will scale to the full ND-GAr







Goals of the test beam

- Demonstrate long term operation of the ALICE readout chambers and new readout electronics at high pressure for a prolonged period of time.
- Show track reconstruction with the new readout and electronics setup.
- Collect data for low energy hadron interactions and use for modelling of cross section constraints

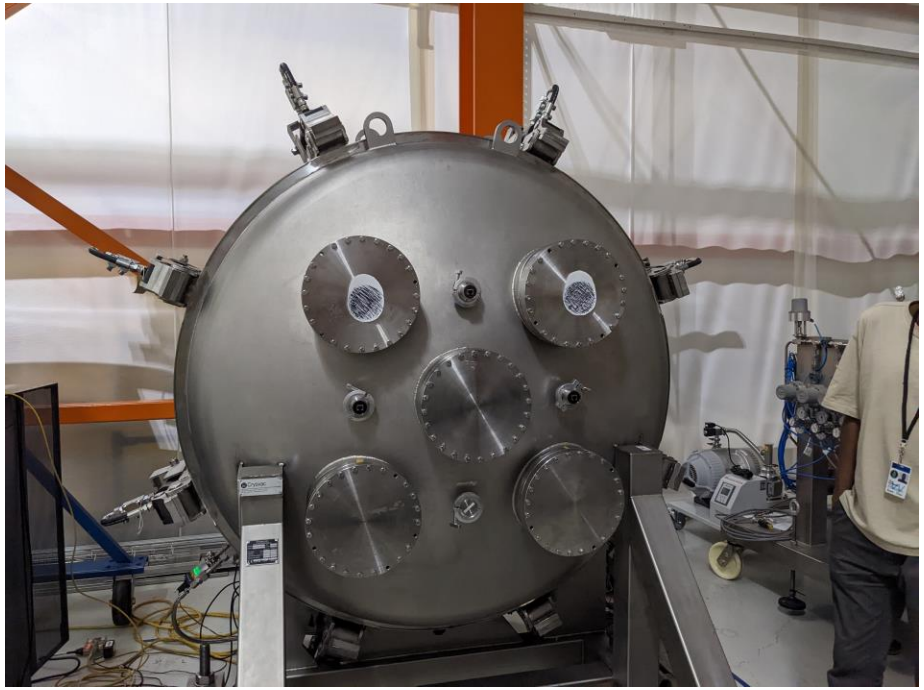
Status

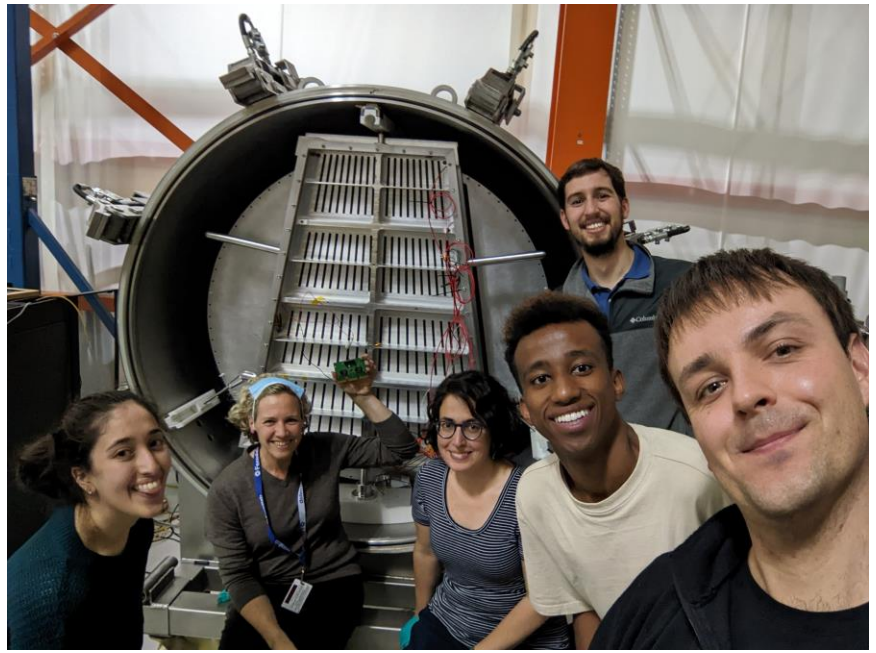
- Vessel arrived at FNAL on 11th Oct
- There has been a large effort to reassemble to vessel, TPC and electronics.
- Container unloaded and transported to DAB

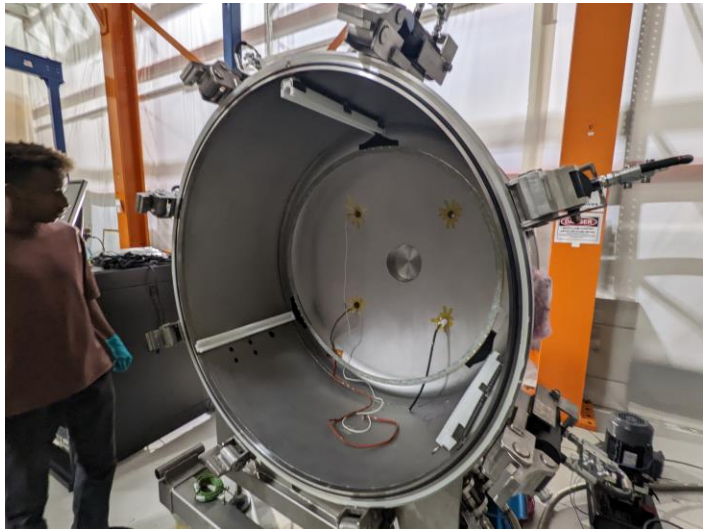



Status

- Vessel reassembled at DAB, where it will remain until we transport it to FTBF in late Nov/early Dec
- Two FECs have been fit into the OROC





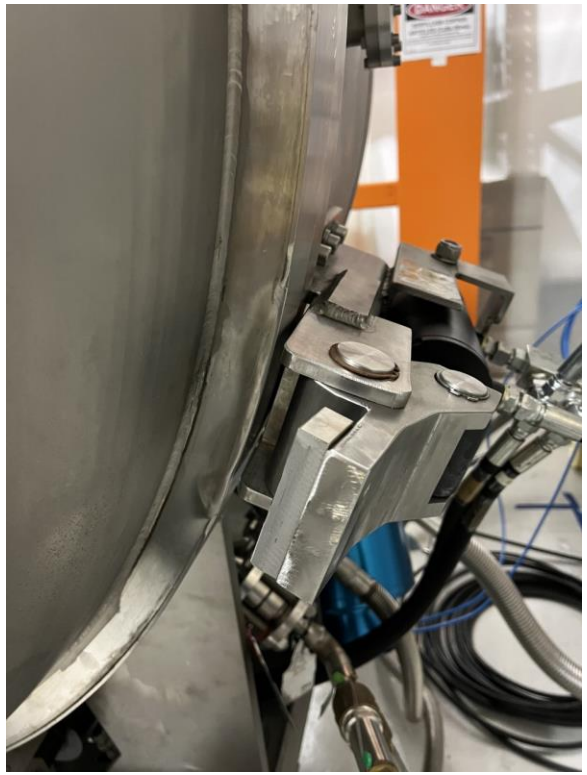


Status

- TPC, hydraulics, pressure system have been fully reassembled!
- Electronics rack – slow control and DAQ software still being set up
  - Taken longer than anticipated due to unexpected difficulties with using our servers on Fermilab network and integrating the old slow control with our new servers.
- Awaiting safety documentation before we can begin carrying out pressure operations e.g. evacuating to atmosphere/vacuum
- Some delays to the production and testing of the Aggregators
- We had hoped to test our set up with cosmics before moving to FTBF, but this is reliant on reassembly completion as soon as possible

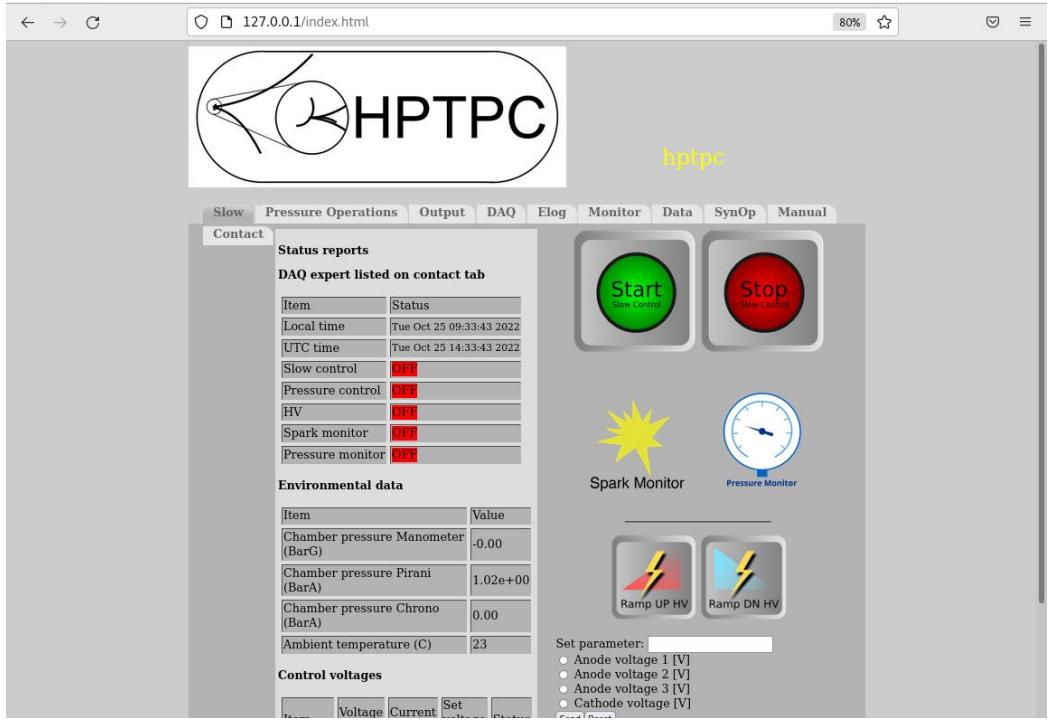
Status: Hydraulics

- The vessel has been utilising both hand clamps and hydraulic closure to create a tight seal.
- There are 8 hydraulic rams around the vessel which are used to clamp the vessel door to the main body, along with 8 hand clamps.
- The safety team noticed some slight deformation to the vessel at the points where the hydraulic rams are. This is due to the outward pressure from inside the vessel on the clamps when the vessel is at 5 bar. This deformation has happened over prolonged use.
- Developing new hand clamps (17) which should be sufficient to withstand the high pressure without the need for the hydraulic clamping system
  - These will take ~3 weeks to produce in the UK
  - We cannot operate/fill to pressure until the new clamps arrive



Status: Slow Control and DAQ

- Two Servers: hpslow and hpdaq
- Slow Control website will run on hpslow, with a web GUI
  - Start DAQ software
  - Monitor Vessel conditions (e.g. pressure and temperature)
  - Control each aspect of the operation e.g. pressure and gas system, high voltage, cameras etc.
- DUNE-DAQ will run on hpdaq.
  - This will be the first physical test stand for the DUNE ND DAQ
  - Data streamed from TIP card will be unpacked and processed with DUNE-DAQ
  - As the light readout system is not interfaced with DUNE-DAQ, the camera images will be sent directly to hpslow from the camera. This will then be analysed alongside our charge readout after data collection.
- Debugging and setting up Slow Control on the new server is almost complete. We need to finish integrating TOAD into DUNE-DAQ and set this up on the new servers



Next Steps

- Main goal for the upcoming week is to complete assembly of the electronics rack.
- When the necessary safety aspects have been approved, we hope to begin carrying out pressure operations
- We will insert a radioactive source inside the vessel, which will be used to check gain before the vessel is moved into the beamline
- As always, this is a really exciting project and we welcome any new members to help with data collection during the beam year!