Descoping Options for the Multi-Purpose Detector

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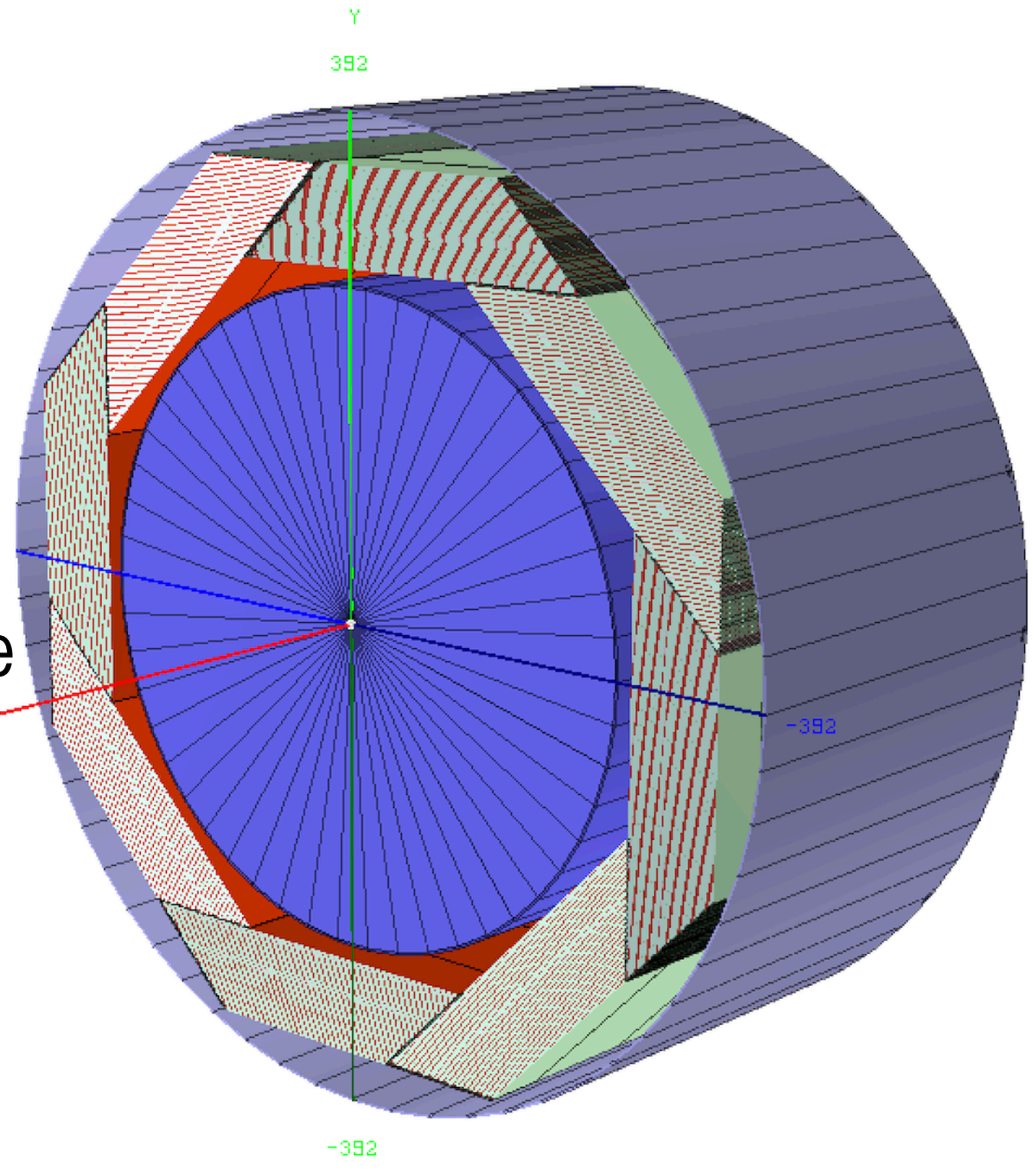
Outline

- Intro and HPgGTPC Status Update
- Descoping Options
- Phasing Options

Multi-Purpose Detector System

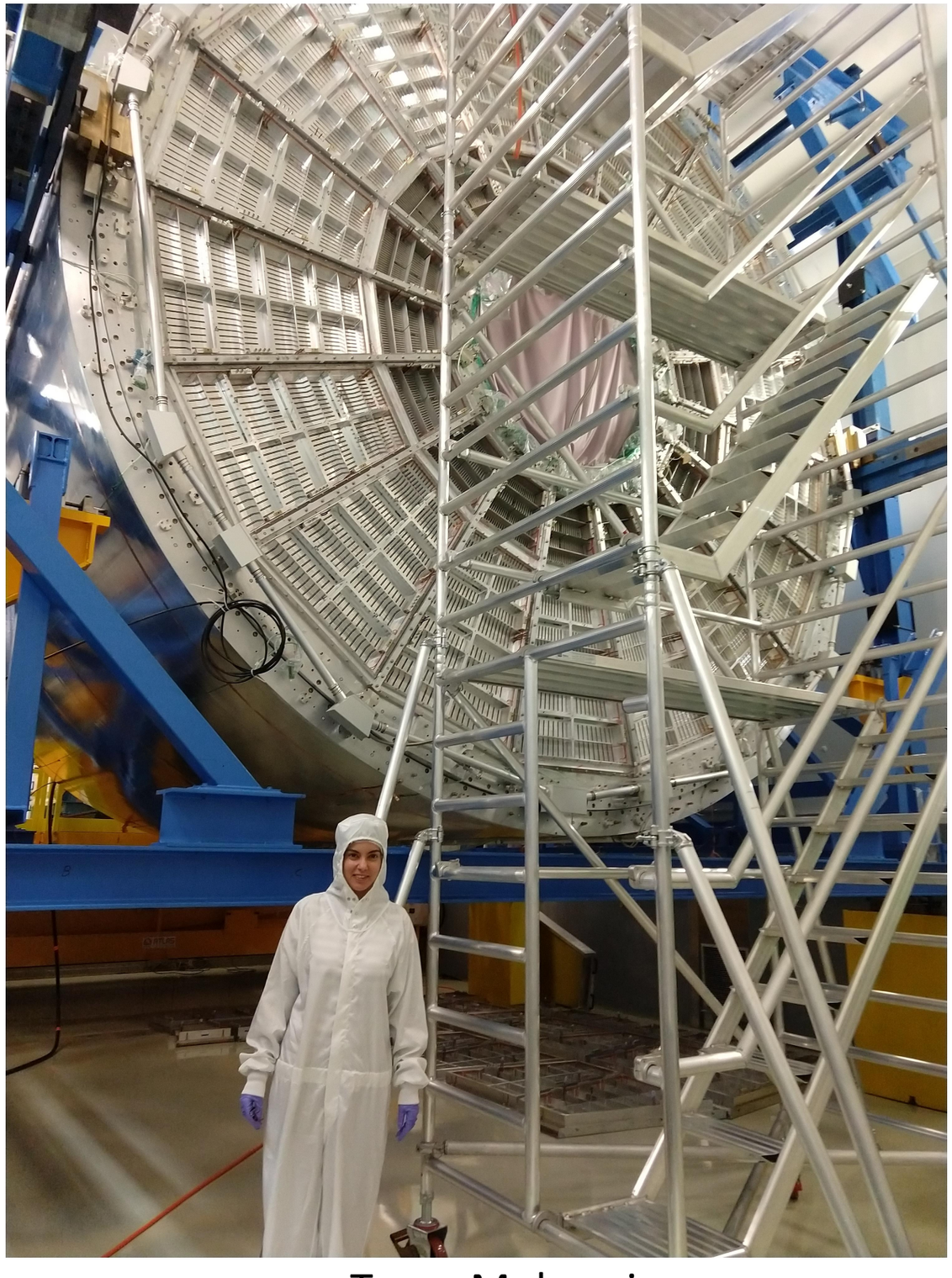
- Key components:
  - High-pressure **gaseous argon TPC** at 10 atm, reusing ALICE readout chambers and much of the engineering (5m dia x 5 m long)
  - Al **pressure vessel** with a thickness of ~0.3 X_0
  - **Calorimeter** that surrounds pressure vessel
  - Helmholtz coil-like super-conducting **magnet** with a field of ~0.5 T
  - Could also have a **muon tagger** if there was interest in this



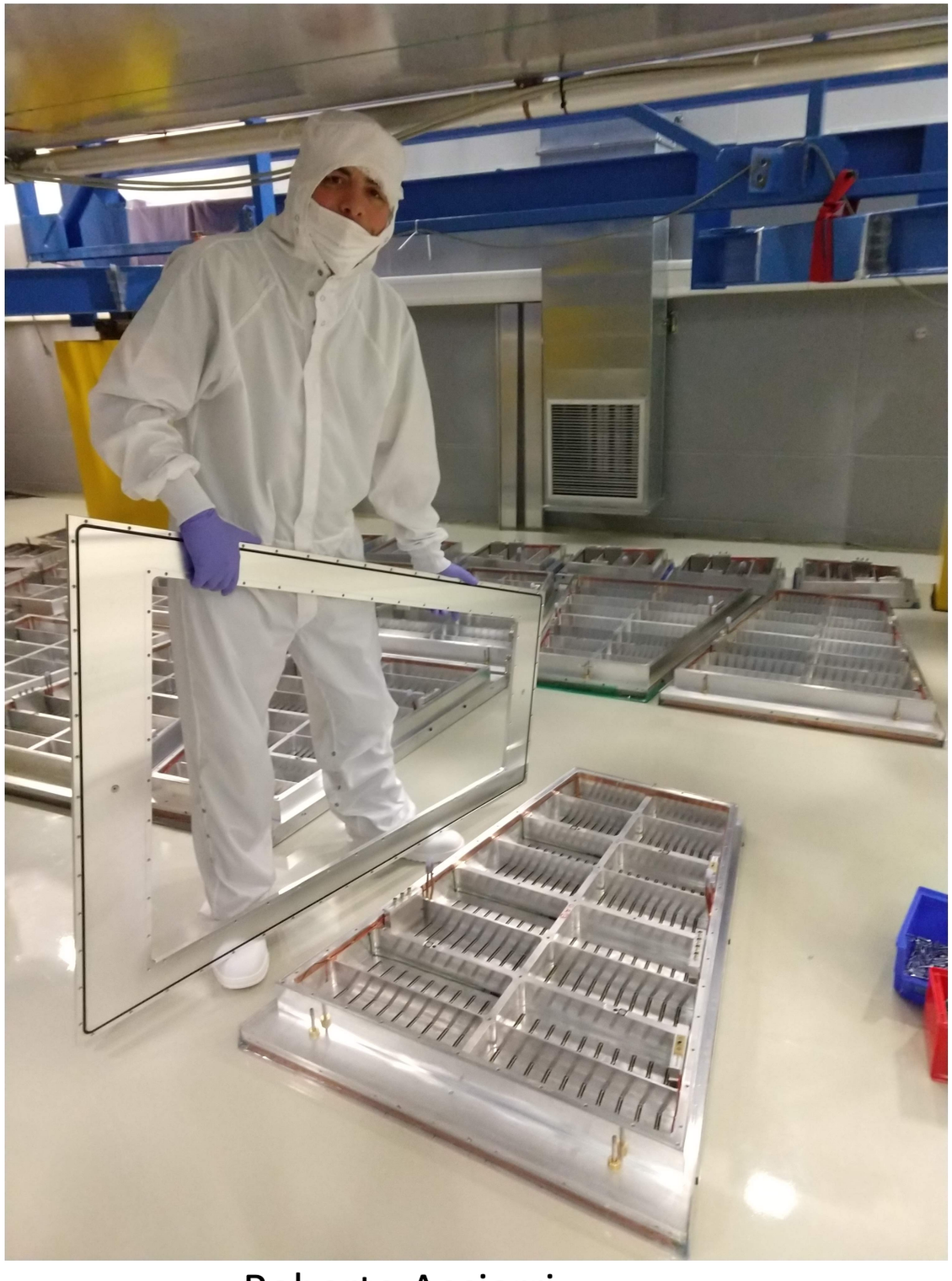
ALICE upgrade underway

- ROCs available for use in DUNE
- Original ROCs have been removed from one end of the TPC, awaiting space in protective transport boxes of new OROCs (gas tight specialized boxes with exact match to IROC and OROC shapes)
- As each new ROC is installed, old ROC goes into its box
- Schedule: finish “A-side” installation in June, “C-side” in July
- ALICE group wants to keep the chambers for a month or two, to run some tests related to field distortions they saw during the run (they will share results with us)
- After tests are done, ROCs are ours.

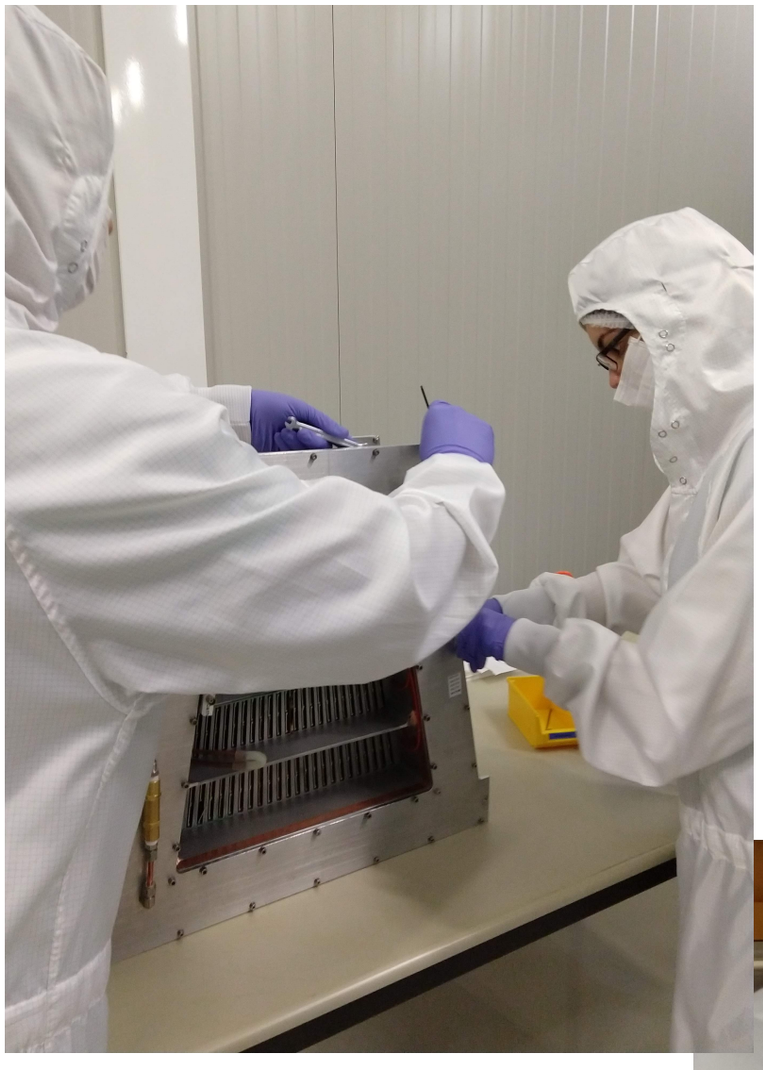
ROC Removal

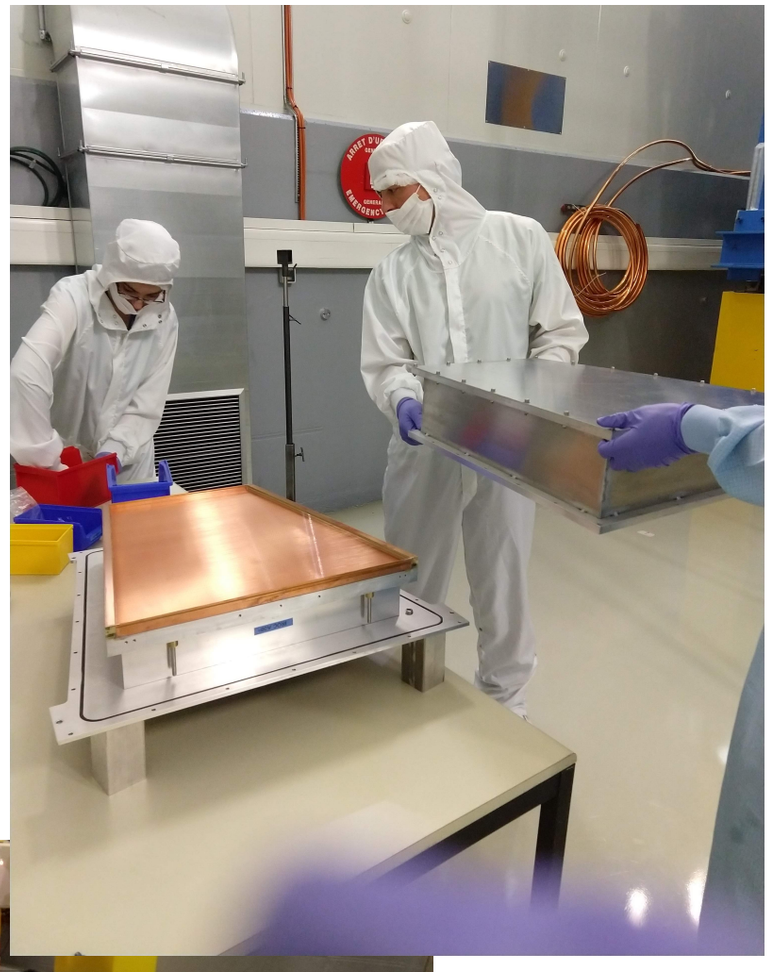


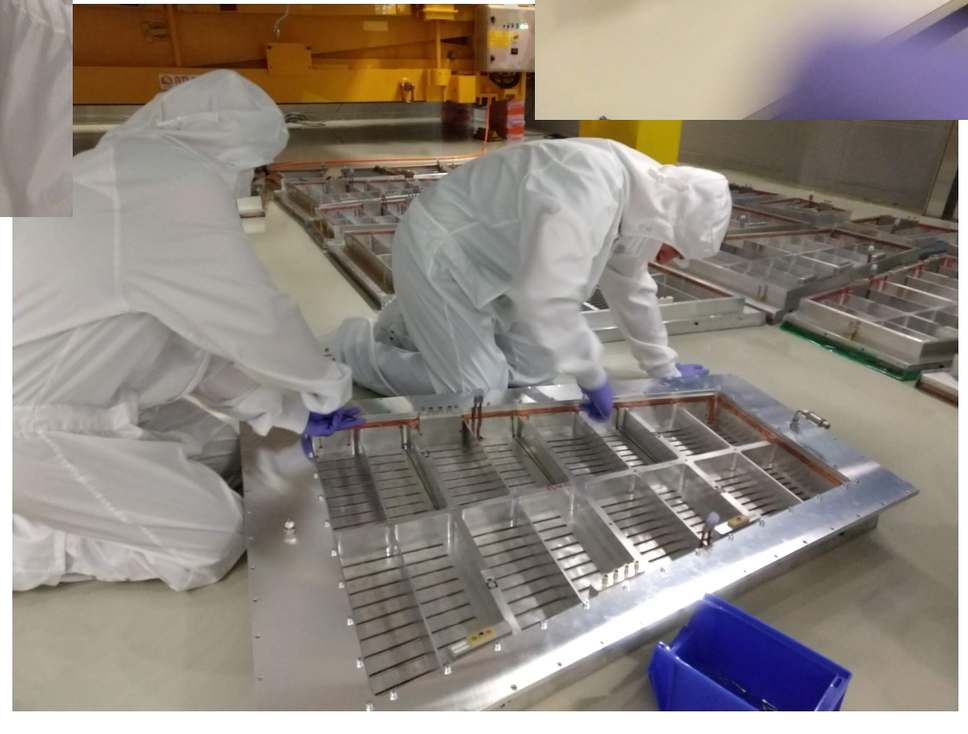
Tanaz Mohayai



Roberto Acciarri

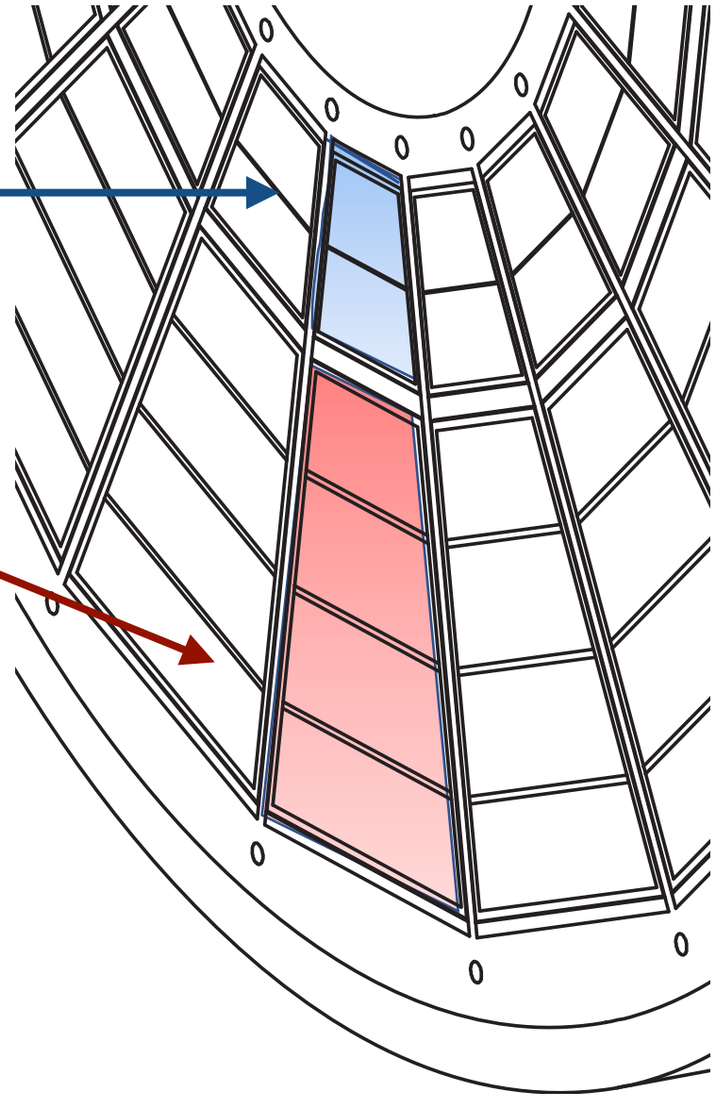






Readout Chamber Testing

- Spare Inner Readout Chamber (IROC) at Fermilab
- Spare Outer Readout Chamber (OROC) recently shipped to Royal Holloway
  - 5 bar pressure vessel will accommodate one OROC
- Plan tests of gas mixtures & gas gain



Goals of Multi-Purpose Detector

- Measure particles that **exit the liquid argon** and enter the MPD
- Provide data to **constrain neutrino-argon nucleus interactions**
- Precisely measure **all-components** of the **neutrino flux**
- Reconstruct **neutrino energy** via momentum and calorimetry
- **Constrain liquid argon detector** response and efficiency
- **Measure neutrons** with time-of-flight to the ECAL

Descoping Options

1. 1 Atm of Argon gas in HPgTPC
2. 1 Atm of Argon gas, No ECAL and reduced B-field
3. 10 Atm of Argon gas, Downstream-only ECAL and reduced B-field

Option 1: 1 atm of Argon gas, full ECAL+B

Does not affect overall costs much. Simpler vessel, but gas system costs are similar. Signal is reduced by an order of magnitude, but external backgrounds are similar so poorer signal/background.

- Can still measure particles that exit the liquid argon
- Can constrain argon-nucleus interactions, but with an order of magnitude lower statistics
- Cannot constrain electron neutrino flux due to reduced statistics
- Can construct neutrino energy, but with degraded dE/dx resolution
- Can constrain liquid argon response, but again with degraded statistics
- Can measure neutrons, but with degraded statistics

Option 2: 1 atm of Ar, no ECAL, reduced B

Again poorer signal/background, and degraded momentum resolution.
Might also need a muon tagger.

- Can still measure particles that exit the liquid argon
- Cannot easily constrain argon-nucleus interactions
- Cannot constrain components of flux due to reduced statistics
- Cannot reconstruct neutrino energy of events on argon gas
- Cannot constrain liquid argon response
- Cannot measure neutrons

Option3: 10 atm of Ar, down-stream ECAL, reduced B

Does simplify integration. Additional studies needed to evaluate coverage and acceptance of this option.

- Can still measure particles that exit the liquid argon
- Can constrain argon-nucleus interactions, but over more limited phase space
- Cannot constrain easily electron neutrino flux due to reduced ability to reject π^0's
- Can construct neutrino energy using calorimetry over limited forward-going phase space
- Can still likely constrain liquid argon response, but again with limited phase space
- Can measure neutrons, but only over limited phase space

Staging Options

- Cannot easily stage the magnet. A magnet should be there on day one.
- Could potentially have a coarse scintillator tracker inside the magnet on day one and can later phase in the **HPgTPC**.
- Could possibly stage in parts of the **calorimeter** (downstream first, then barrel and upstream parts later)
- Might able able to stage in a **muon tagger** as well.

Backup

Resizing the Gas TPC

- Current 5m diameter + 5 m long matches the size of the existing ALICE readout chambers, which are available for reuse.
- If we wanted a smaller diameter for the pressure vessel, could reduce the magnet and vessels costs a bit. But would cost ~$5–7 million to re-engineer and fabricate the wire planes and pads, which would likely exceed the savings.