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An integrated Ar detector for the DUNE near detector

Alan Bross

CENF-Near Detector WG5

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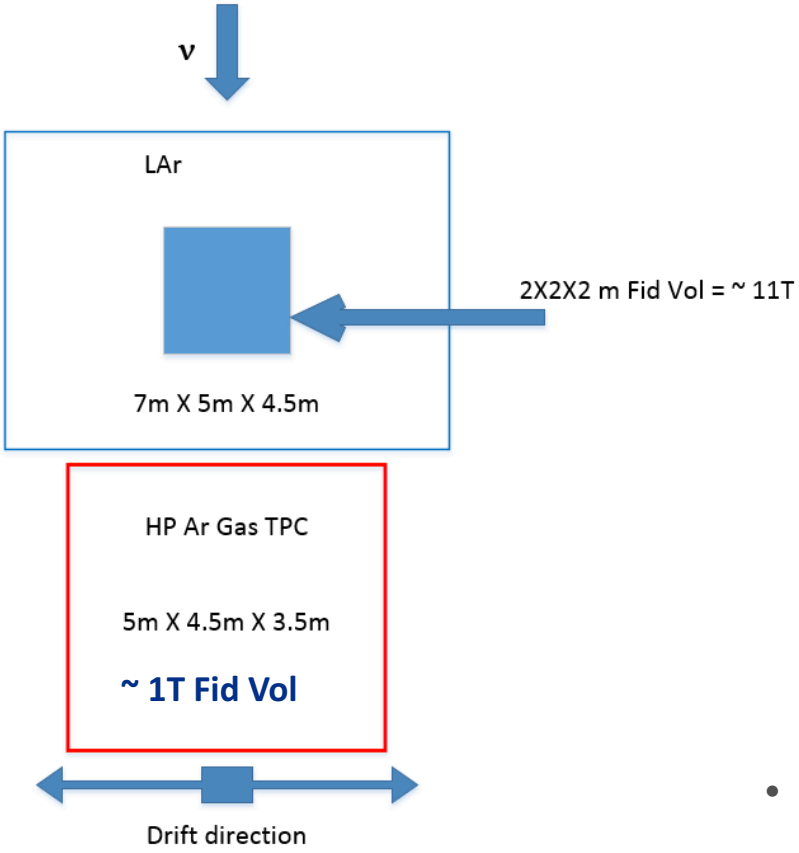
Current situation in DUNE ND working group

- A consensus has been reached that LAr is an essential part of the DUNE near detector
- The ArgonCube concept is the baseline
  - Pixel readout
  - 30T
  - 7 X 5 X 4.5 m^3 total size
  - Non-magnetized
- A HP Gas TPC can function as
  - Event containment for the LAr (hadronic energy + μ spectrometer)
    - Note: 2X2X2m fid. Vol. yields ~ 50-100M ν_μ CC events in 3 yr ν running
  - Stand-alone experiment
    - High pressure (10 ATM) yields ~5-10M ν_μ CC events in 3 yr ν running

Concept for HP Gas TPC

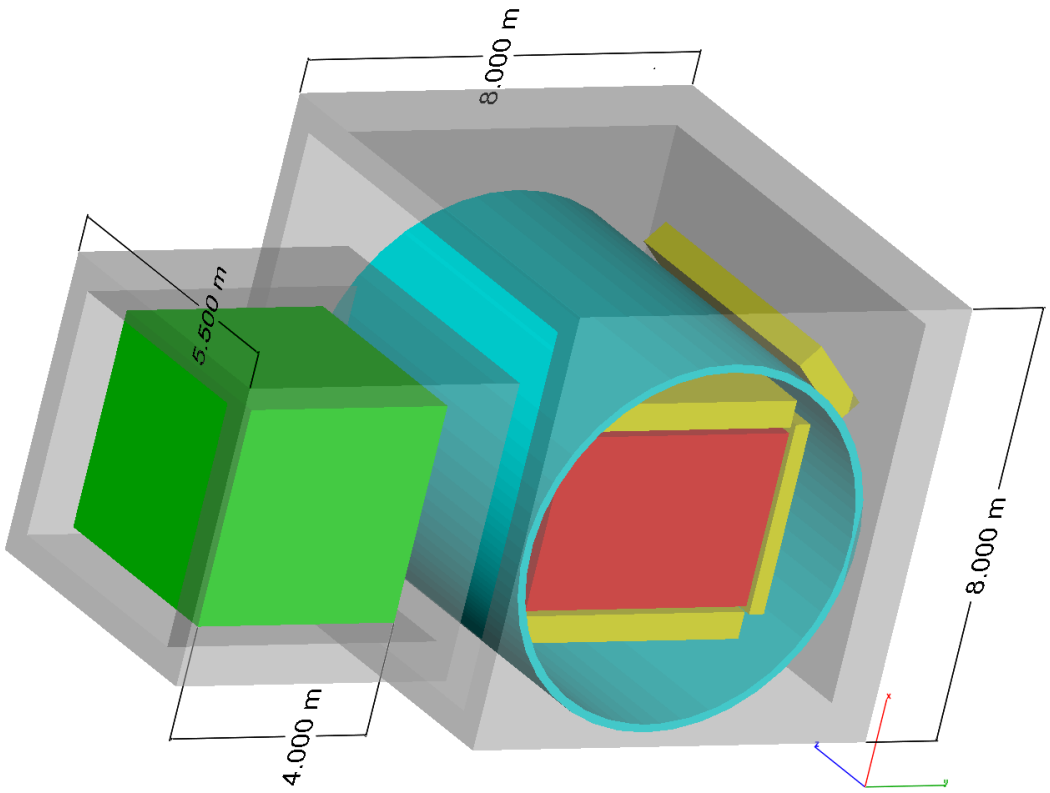
- Re-purpose ALICE readout chambers
  - Existing chambers will be replaced in 2019 for High-lumi LHC
  - Have only operated at 1 ATM, but calculations indicated that operation at 10ATM looks possible without introducing electrostatic instability
    - Test stand now being setup at Fermilab using one of ALICE's inner readout chambers (IROC)
- Tremendous synergy with ArgonCube
  - Target nucleus
  - Raw 3-D data
  - Similar (identical) readout electronics
  - Common data structure
  - Common pattern recognition, track finding, event recon. Algorithms
- A HP Gas TPC offers unprecedented "3D vertex visualization" for an electronic detector
  - Only surpassed by emulsion detectors

iArDet Configuration



- 11T of 30 T produces ~ 50-100M ν_μ CC evts in 3 yr ν run
- From Chris Marshall's presentation at the DUNE-ND meeting of 9/13:
  - Hadrons, 90% contained all E_ν bins:
    - Within ~ 1.2m transverse
    - ~1.75m longitudinal
  - Hadrons, 99%
    - 2.05 m transverse
    - 3.45 m longitudinal
  - Leptons, 90%
    - 2.7 m transverse (close with this config.)
    - >5 longitudinal (need GTPC)
  - Conclusions
    - Need ~3.25m to contain 99% of events in 3-5 GeV E_ν
    - Transverse dimension could be ~2.5m
      - Need side μ tagger
- TPC can be extended in drift direction to help
  - Cost increase solely due to increase in magnetic volume

Very preliminary solid model (some dimensions already out of date)



- This assumes
  - "Dipole" filed provided by solenoid
    - UA1-style magnet also an option
  - Instrumented steel for flux return: hadronic calorimetry and μ tagger
    - Asymmetric – no steel between liquid and gas
    - Detectors not defined
- EM calorimetry is not defined