


The LBNE Prototype at CERN

★ Context

- Only found out I was giving this talk yesterday…
- Entire day taken up by meetings with the student horde

★ Consequently the slides are a bit rough around the edges…

This Talk

★ **This Talk:**

- **Introduction**
  - The LBNE FD concept
  - LBNE → LBNF/ELBNF
- **Current R&D**
  - 35-ton prototype
- **CERN prototype**
  - Key Aims
  - Current concept
  - Status
- **European perspective**

★ **Thanks to:** Michelle Stancari, Mark Convery, Thomas Kutter, Jim Stewart

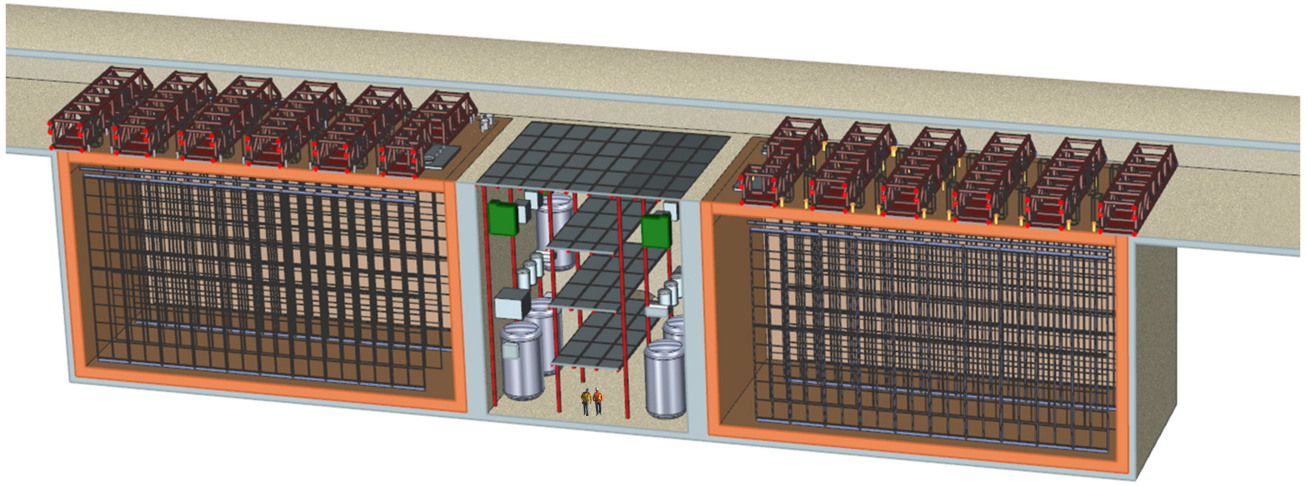
Focus on high-level issues

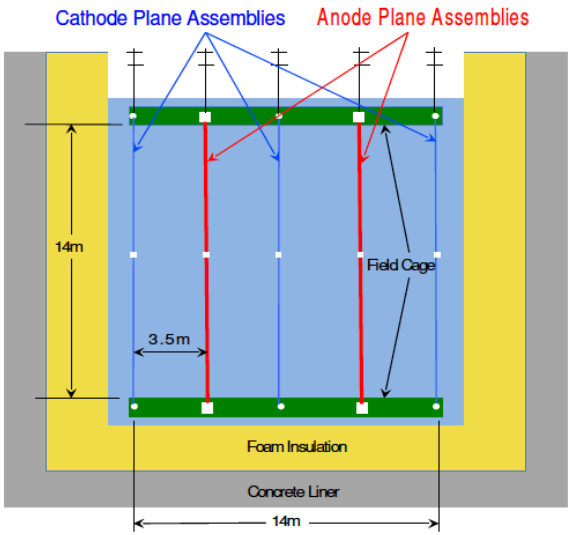

LBNE TPC Concept

From LBNE → ELBNF

★ The LBNE TPC Design

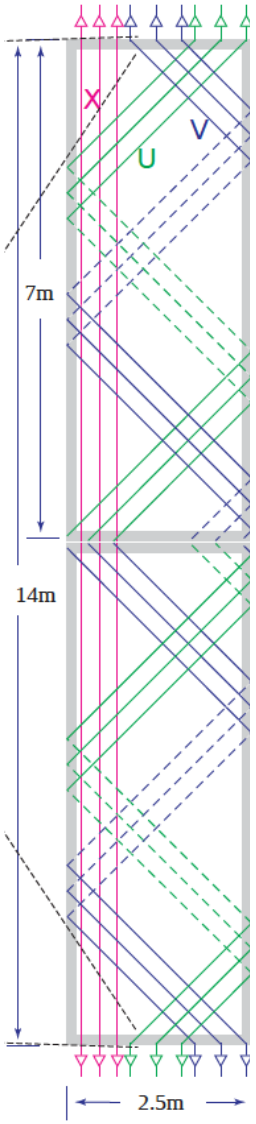
- Single-Phase ICARUS-inspired design
- Scale up by a factor ~50:
  - Industry "standard" membrane cryostat
  - Modular wire plane readout "Anode Plane Assemblies" APAs
  - Analogue and digital electronics inside cryostat
  - APAs: wrapped – reading out two drift volumes
  - Wire mesh cathode planes -185kV
  - FR4 PCB/copper Field Cage





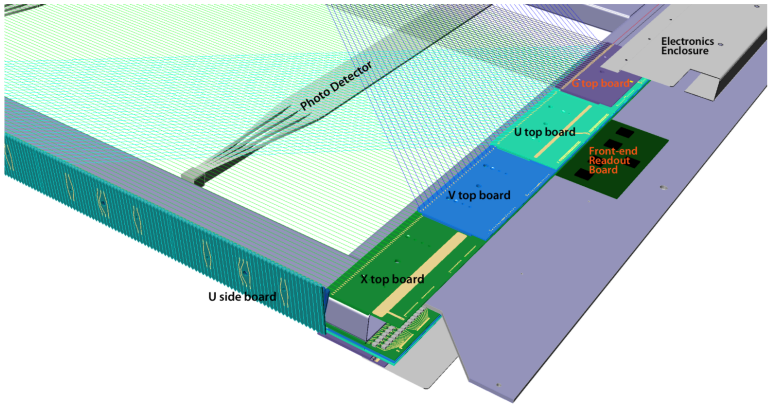
cross section view of the TPC components inside the cryostat

LBNE APAs



★ LBNE CDR APA Design

- Stacked 2.5m x 7m modules
- Three readout wire planes
  - X (vertical) : collection
  - U (45º) } Induction
  - V (45º) } Wrapped
- Wire pitch ~4.5 mm
- Readout at ends of APAs



★ Questions

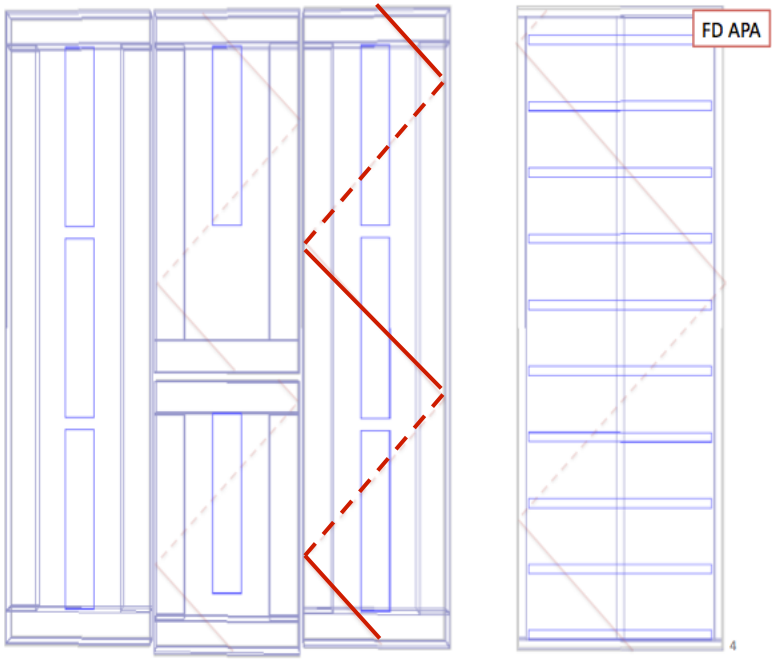
- Impact of wrapping
  - Ambiguities/disambiguation
- Gaps between APA modules
  - Impact on physics
- Optimal wire spacing/pitch/angle
  - Impact on physics

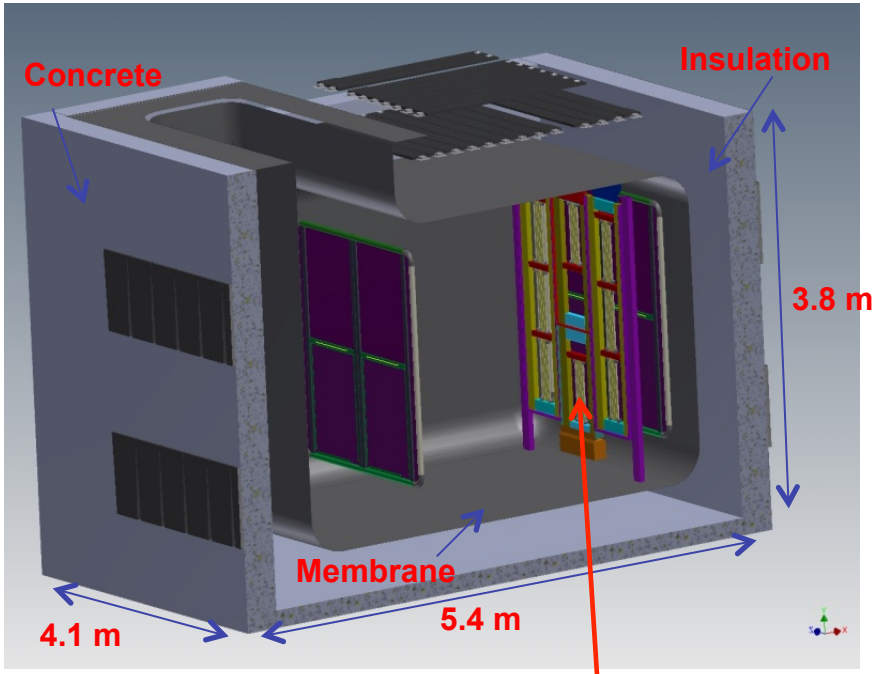

From Concept to Reality

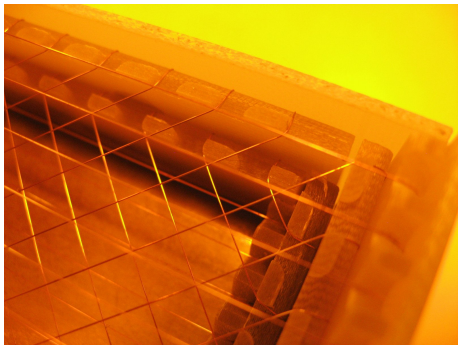
35 ton Prototype

★ 35 ton prototype

- Crucial test of LBNE TPC concept
- Installed at Fermilab
- 2m x 2m x 2m TPC
- Two drift volumes (long/short)
- 4 APA modules



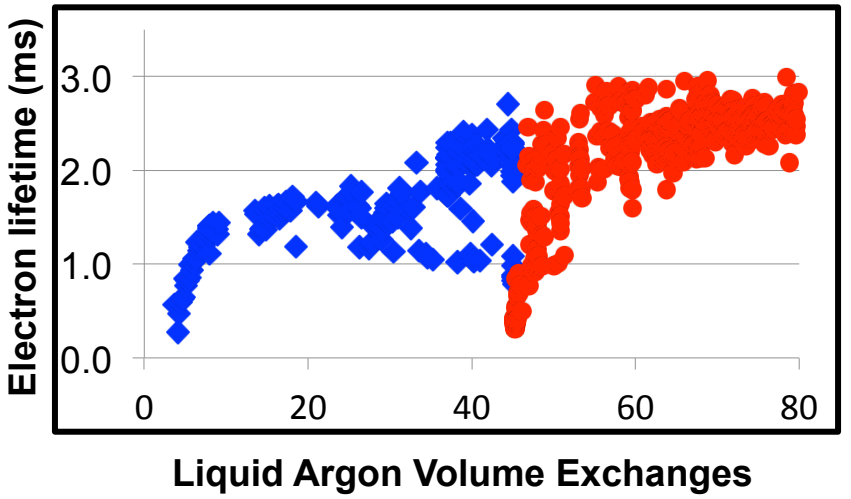




35 ton Prototype Goals

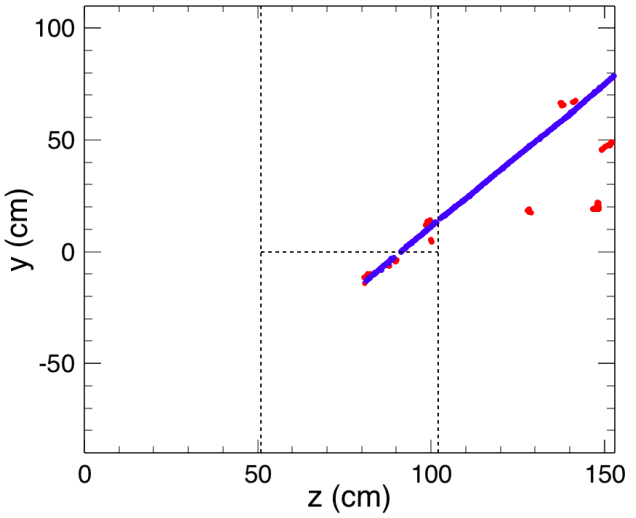
★Phase-I (completed early 2014)

- Validation of cryostat design/performance
- Demonstrate argon purity required for physics (Phase-II)
- No TPC



★Phase-II (~second quarter 2015)

- Crucial test of LBNE TPC concept
- Exposed to cosmic-rays
- First test of LAr reconstruction
- Evaluate physics performances using cosmic rays
- Not a beam test



R&D Issues Addressed

★ **35 ton Prototype addresses many R&D issues**

- **APA performance:**
  - wrapping ambiguities,
  - gaps, tracks crossing APAs,
  - energy resolution
- **Photon detector performance:**
  - event time resolution
  - photons/MeV
- **Electronics/DAQ performance:**
  - Signal/Noise with cold pre-amp and ADC
  - triggerless operation
- **Cryostat performance:**
  - Argon purity
  - acoustic noise
- **FR4 printed-circuit field cage performance.**

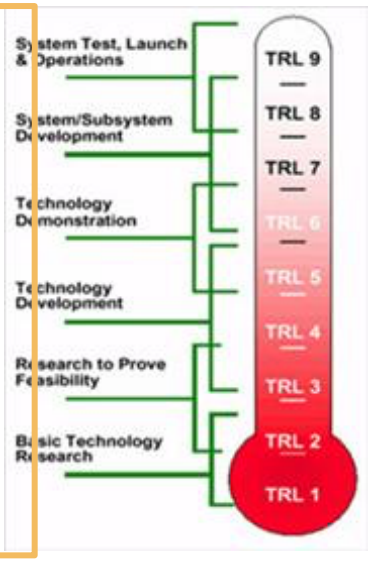
All crucial to demonstrating LBNE TPC concept


LBNE Prototype at CERN

Single Phase Option for ELBNF

★ **The road to a single-phase ELBNF FD…**

- **ICARUS**
  - Established single-phase concept
  - Demonstrated long-term operation/stability
- **35 ton prototype**
  - Validate novel aspects of LBNE concept
  - Experience ⇨ motivate design improvements
- **What Next?**



★ **Key questions**

- **TRL: Is this enough to "launch" large ELBNF FD ?**
  - Maybe, but risk…
- **Do we understand the performance sufficiently to control systematic uncertainties ?**
  - Almost certainly not

✦ **"LBNE" prototype at the CERN Neutrino Platform addresses these issues**

Single Phase Prototype at CERN

★ EoI

- "Expression of Interest for a Full-Scale Detector Engineering Test and Test Beam Calibration of a Single-Phase LAr TPC" submitted to SPSC in October
  - 186 authors, 43 institutes, 6 countries (including Italy, Switzerland, UK)
  - from LBNE, LBNO and ICARUS collaborations
- SPCS invites technical proposal ~spring/summer 2015

★ Status

- Detailed plans/design still evolving
- Submit technical proposal for June 1st
- Beam late 2017/early 2018 - challenging but plausible timeline

Still early days… things are evolving

Goals

★ Main goals of Prototype:

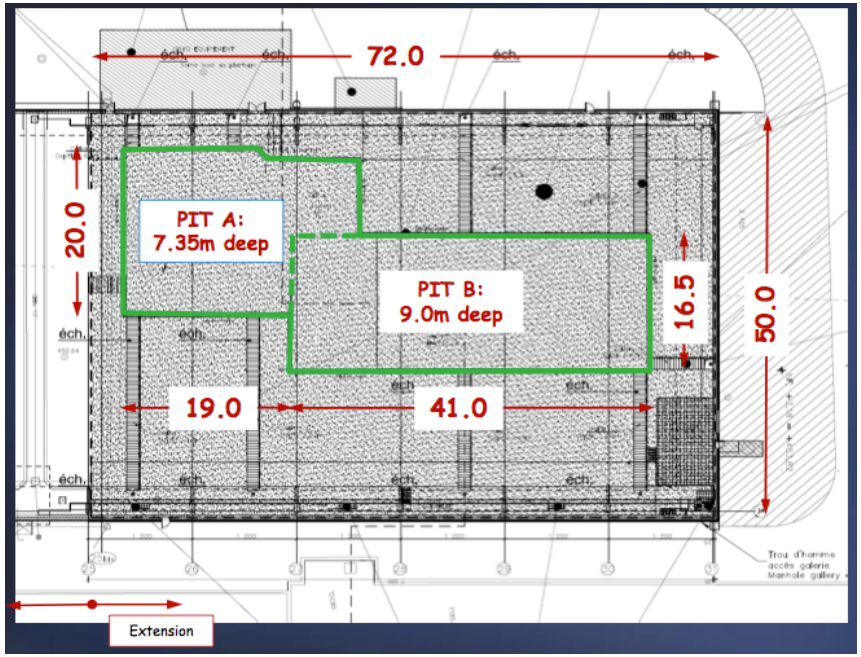
- Full-scale prototype of LBNE-concept for single-phase TPC
  - Address engineering design issues
  - Full validation of concept prior to possible deployment as the initial ELBNF 10 kton FD

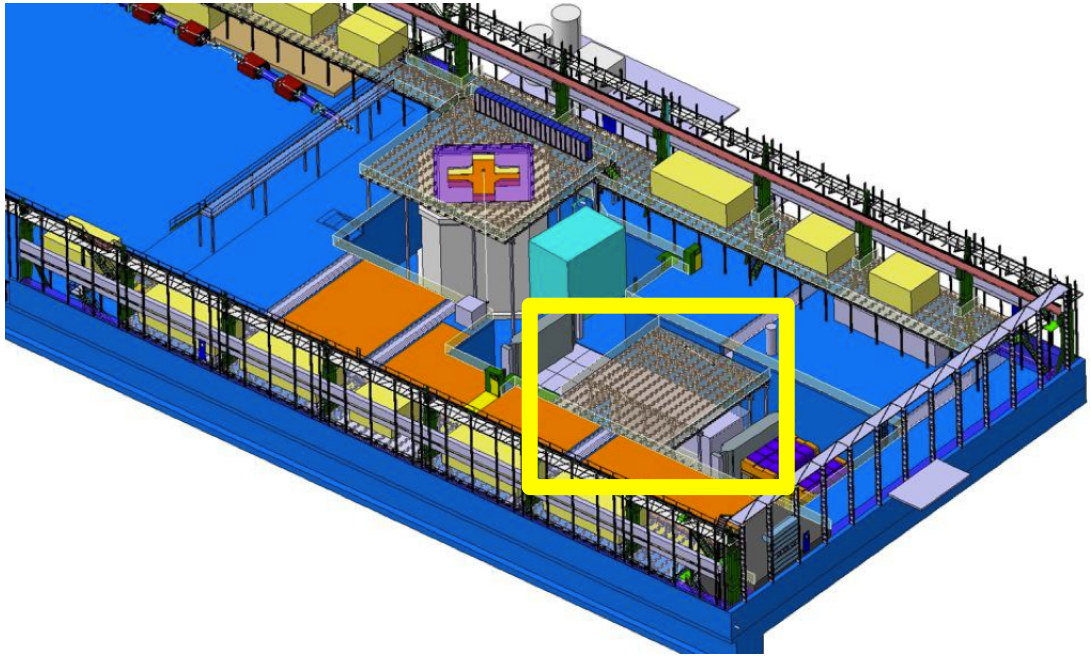
- "Calibrate" physics performance:
  - Calibrate performance with know charged particle beam
  - Systematic study of detector response
  - Validate/improve MC simulation, e.g. low-E hadronic showers in Argon

Basic Design: Cryostat

★ Cryostat

- Preferred option is a second cryostat
  - Obvious advantages over sharing single cryostat with two-phase prototype

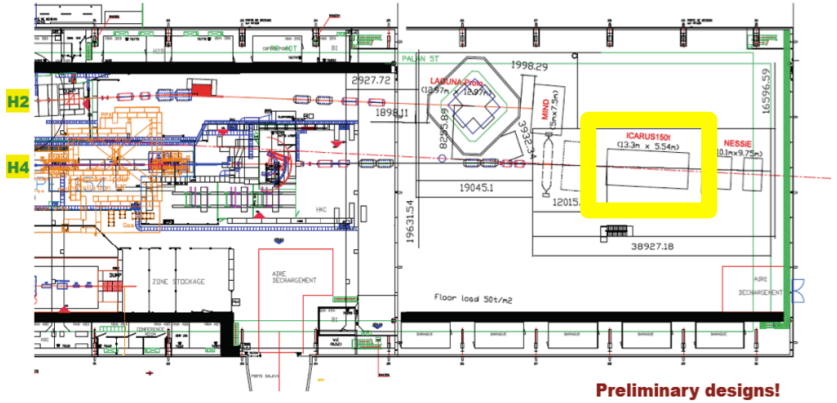


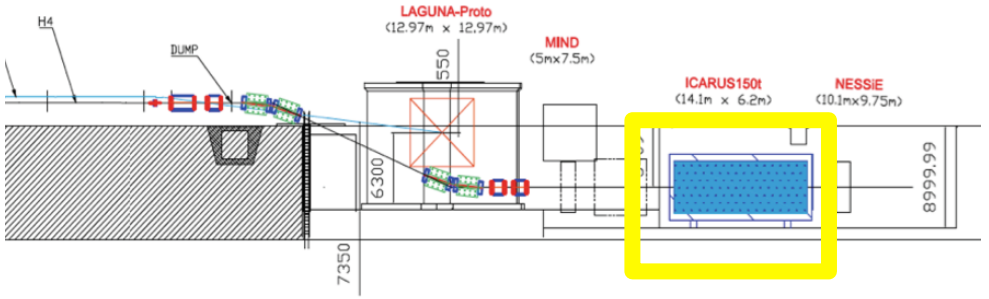


Basic Design: Beam

★ Beam

- Possible desire for two/three beam angles
- Ideally, extending to low energies p<1 GeV/c
  - Highly relevant to second oscillation maximum
- Details need to be worked through based on a more concrete TPC design

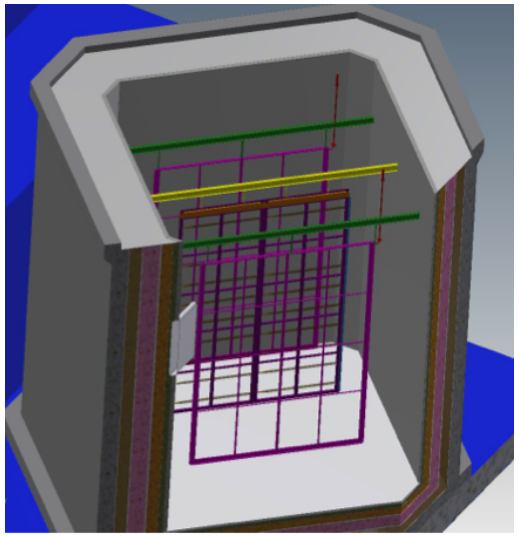


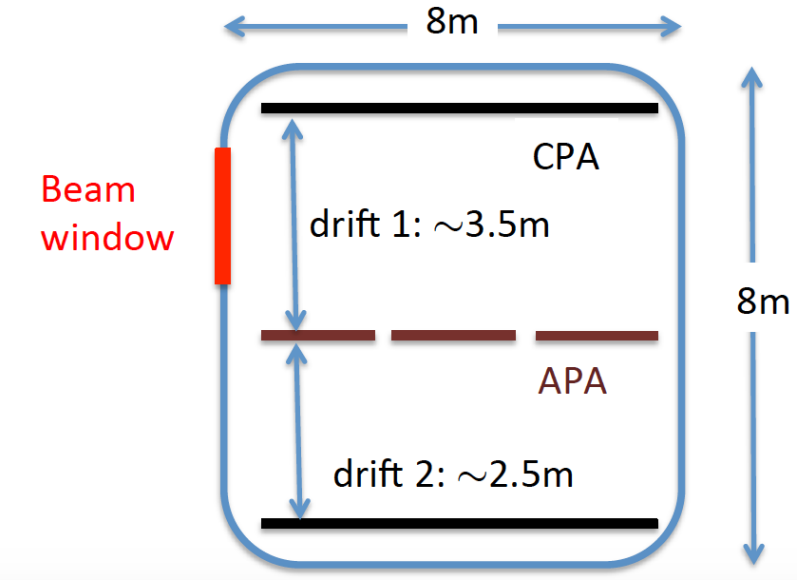


Basic Design: TPC

★ Evolution from 35 ton prototype

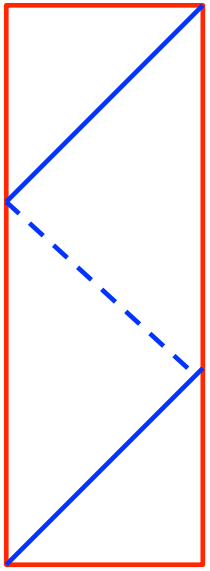
- Full-scale prototype of LBNE concept
- Possible TPC/cryostat configuration
  - 3 "LBNE" APAs with two drift regions
  - Biggest challenge - beam window ?

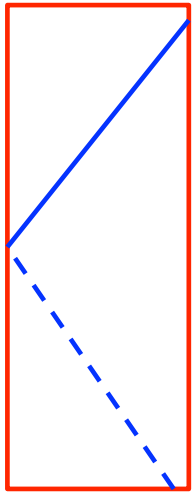




Details: APAs

- ★ **Intended as a full-scale prototype**
  - ⇨ **match ELBNF single-phase design**
- ★ **APA design being revisited:**
  - Rigidity of 7.0 m x 2.5 m frame
  - Concerns about disambiguation
  - Practical considerations, e.g. transport
- ★ **New design "direction"**
  - Smaller frame, e.g. **6.0 m x 2.3 m**
    - Standard transport, more rigid
  - Wire angle, **45° → 30°**
    - Removes ambiguities
- ★ **Other considerations**
  - Increased cost of electronics
  - More modules, more gaps, impact?





Next Steps

- **January 21st discussion at Fermilab**
  - Consider preferred options, which will allow
    - Design of beam window
    - Concrete discussions with CERN beam group

- **ELBNF meeting at Fermilab 22nd – 23rd January**
  - Establishment as official ELBNF WG?


European Perspective

European Perspective

- **Full-scale Single Phase Prototype**
  - Engineering test of ELBNF single-phase TPC option
    - Major step towards construction-ready FD TPC
  - Important contribution to ELBNF on "home soil"
  - Involvement of 15 European groups (including CERN)
    - Italy, Switzerland, UK
  - Need to consider how Europe contributes to:
    - the TPC construction
    - physics programme
  - Also need to consider:
    - Funding model for TPC
    - Interaction with ELBNF and double-phase prototype

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