The LAr1-ND experiment

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7th Symposium on Large TPCs for Low-Energy Rare Event Detection

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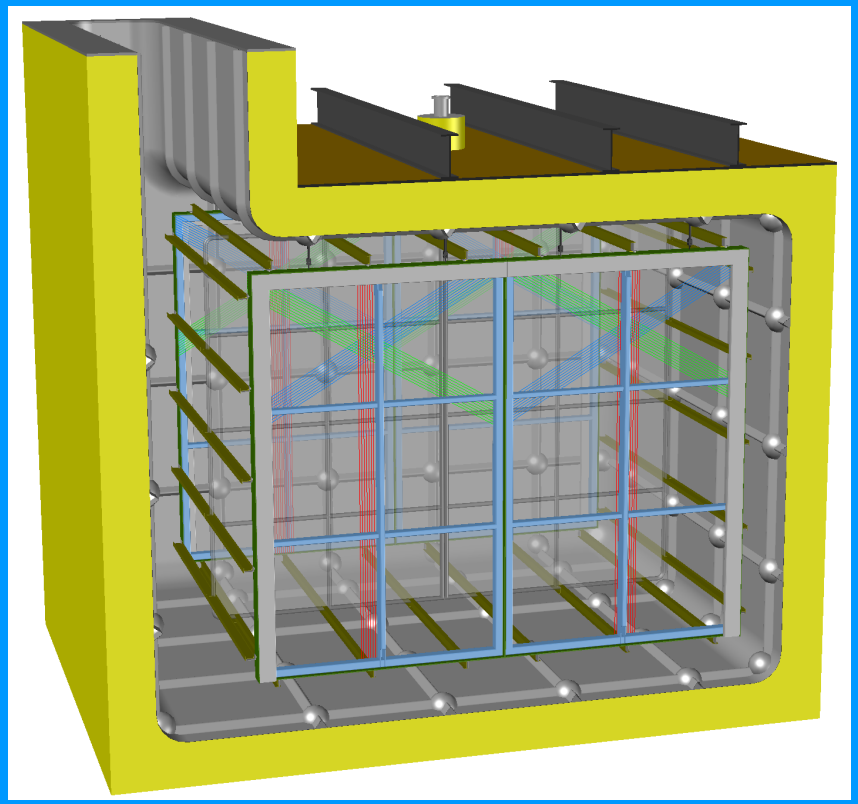
Overview

- LAr1-ND measurement programme
- LAr1-ND Detector
  - Cryostat
  - TPC design
  - Photon readout
  - Detector calibration system
  - Electronics
- Timeline



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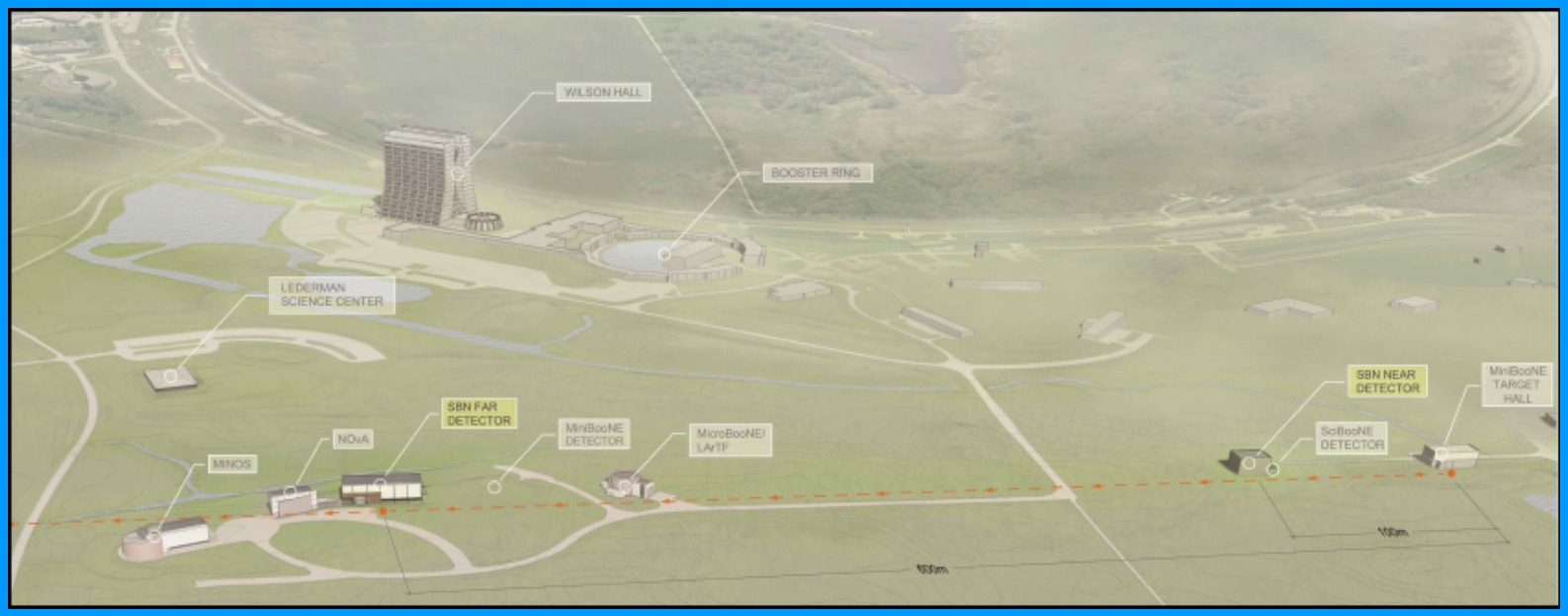
LAr1-ND in the context of SBN

- Near detector in Booster Neutrino Beam (BNB) at FNAL
  - 110m downstream from target
  - 112t active volume LAr TPC detector



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LAr1-ND measurements

- High statistics measurement of ν_μ and ν_e content of BNB
- Allows for near-to-far extrapolation between LAr1-ND and MicroBooNE, and T600
- A precision search for high mass-squared neutrino oscillations through both appearance and disappearance channels
- Precision neutrino interaction cross section measurements
- Detector technology development for future long baseline neutrino detectors
- Aim to start data taking in 2018 (!)

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Cryostat and Infrastructure

- New building adjacent to (existing) SciBooNE hall
- Membrane cryostat technology
- GAr / LAr purification separate (as in 35t)
- Pump outside cryostat

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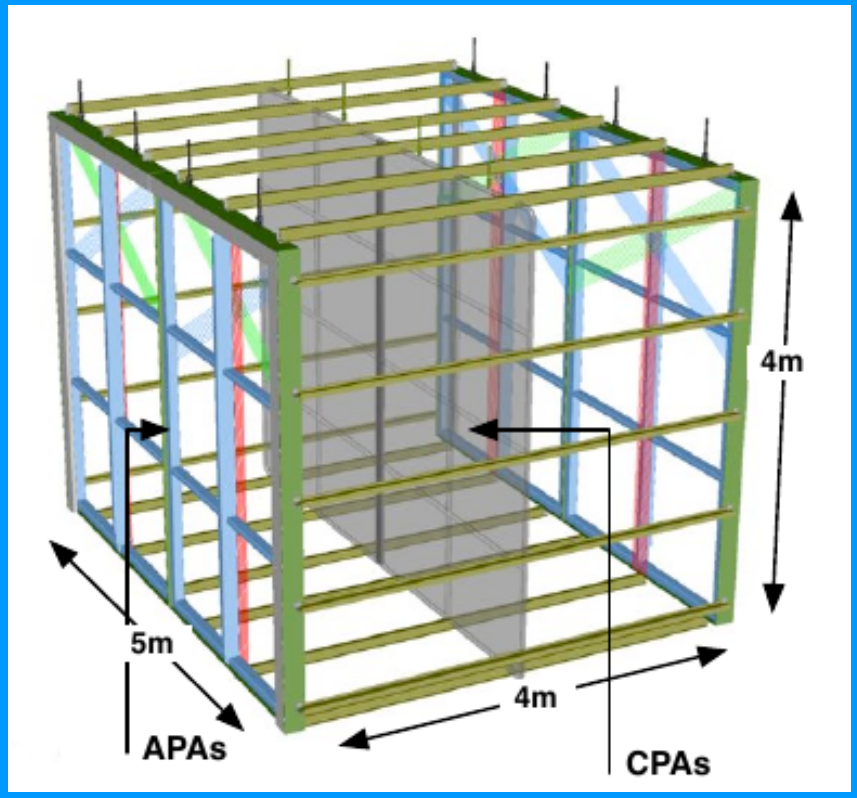
TPC baseline design



- 5m x 4m x 4m active volume
- Two 2m drift volumes
- Wire anode readout at sides
  - 3 wire planes per APA, U and V at 60˚ to vertical Y
  - 150μm CuBe wires
  - Wire tension 0.5kg at room temp.
- Cathode bias -100kV
  - 500 V/cm drift field

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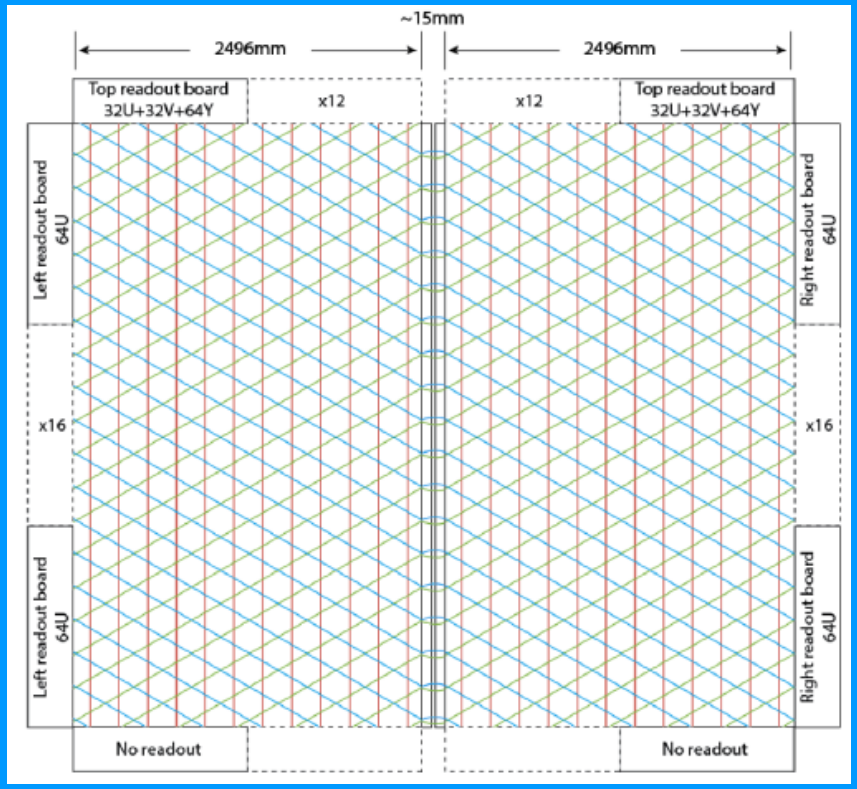
Bridged Anode Plane Assembly concept

- Two APA frames
- Electrically coupled at join
  - Spring loaded pins
  - Flexible jumper cables
- Read out on 3 sides (total)



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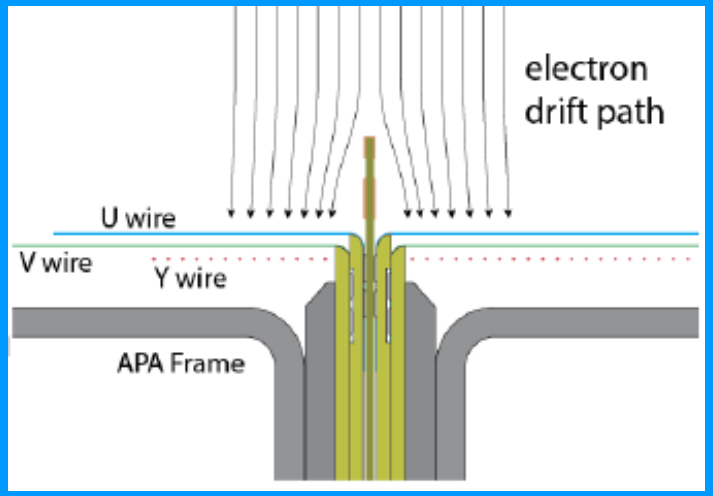
Bridged APA concept

- Biased electrodes in gap between APA frames
- Eliminate dead region between frames by distorting electron drift path
- Currently implemented in 35t for testing



Important R&D towards future larger volume detectors with readout of tiled APAs

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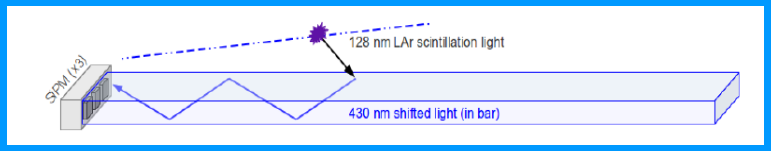
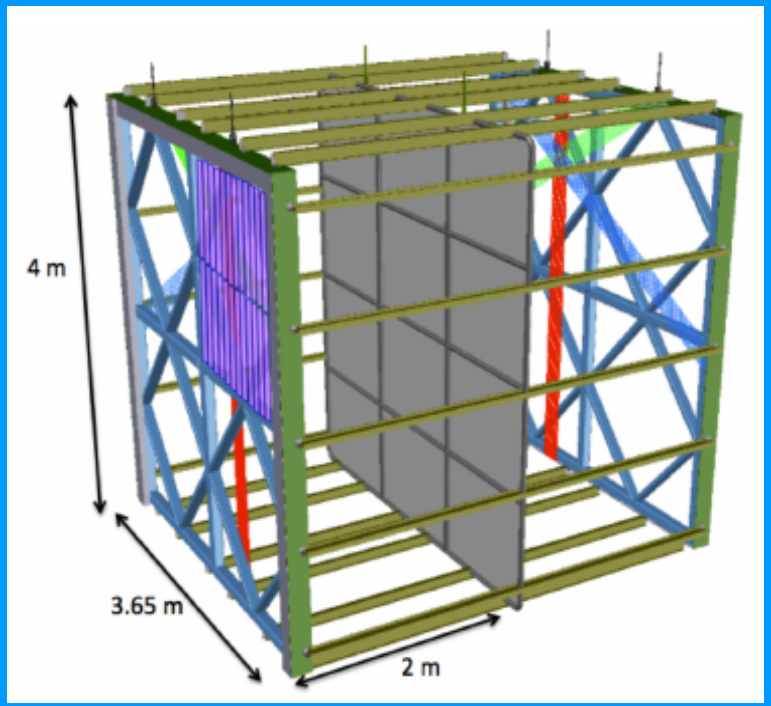
Photon readout: baseline design

- Acrylic bars mounted in APA
- Dip coated in TPB (WLS)
- Each bar read out by 3 SiPMs
- Position resolution of 2.5cm in vertical direction
- Improvement of light collection would open up scope for a range of physics measurements
  - LAr1-ND excellent opportunity for testing light collection R&D
  - Final design under evaluation





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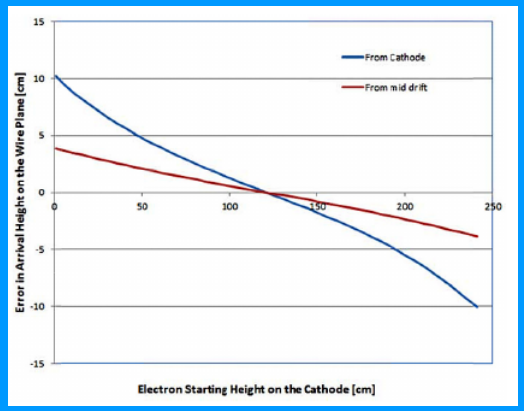
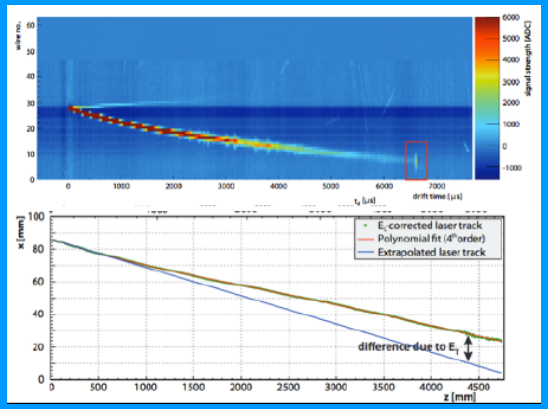
Detector calibration system

- Space charge in detector leads to non uniform electric fields
  - Cosmic ray muons (~2100 /s)
- UV laser calibration allows monitoring of this
  - Correction of distortion
  - Improves event reconstruction





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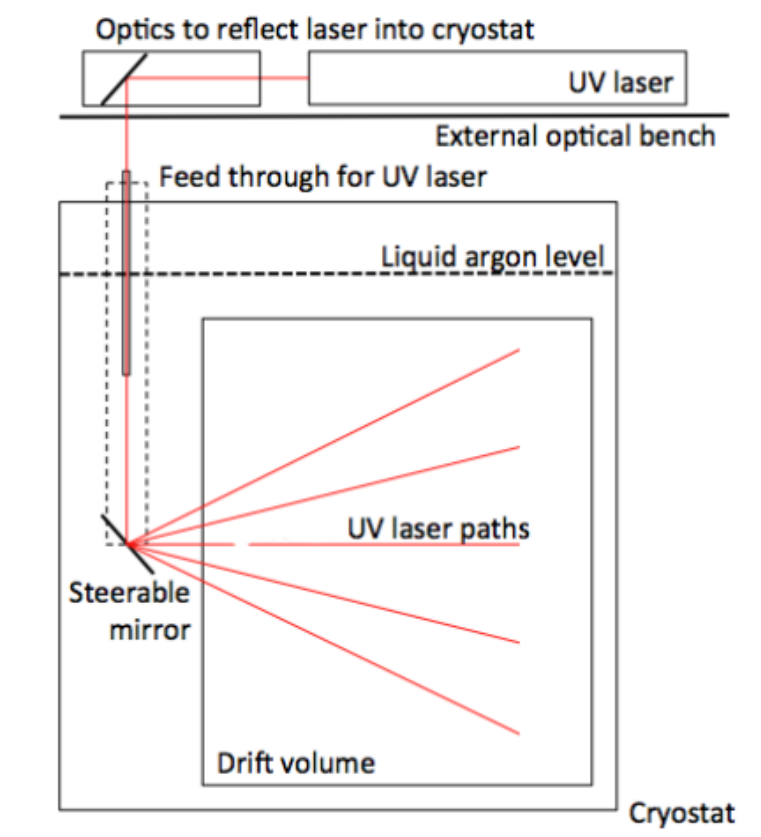
Detector calibration system



- 266nm photons from UV pulsed laser
- Straight tracks
- Steerable, with mirrors to monitor entire detector
- Similar system in use in Argontube and MicroBooNE
- Apertures in FR4 field cage for mirrors

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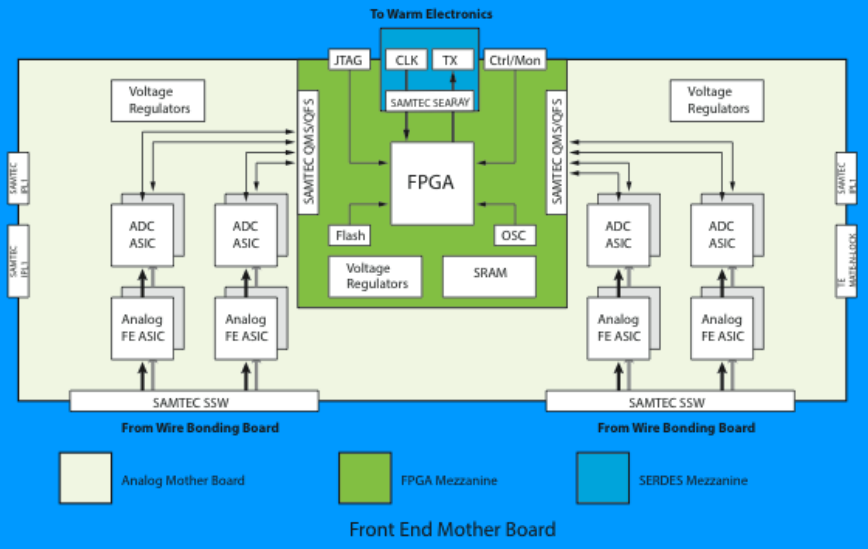
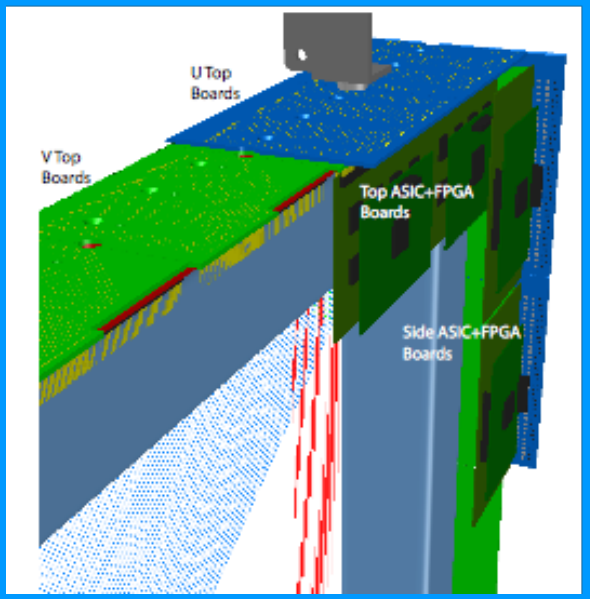
Brief mention of Electronics

- Readout of 11,264 wire channels
- Entire front end electronics chain operated in cold
  - 31 FE mother boards on 2 sides
  - 128 / 64 channels per board
- Analogue front end ASIC and ADC ASIC developed for LBNE
- Commercial FPGAs for multiplexing in cold
- On board multiplexing, digitised signal out to warm via ALTERA Cyclone V FPGA





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Planned timescale

2015	2016	2017	2018
Develop full technical design & project schedule. *Ground breaking on building.*	*Procurement and fabrication of detector sub-components.* *Building construction.* *Begin cryostat construction.*	*Complete TPC component assembly (APAs, CPA, FCA).* *Cryogenic system construction.* *Active detector installation.*	*Liquid Ar fill commissioning run.*

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Thanks for listening

For more details of LAr1-ND see CDR

The LAr1-ND Collaboration

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including scientific and technical personnel

*spokespeople

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Backup

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LAr1-ND vs LBNE: TPC

TPC	LAr1-ND	LBNE	Comparison
Construction	Pre-fabricated/tested modules assembled in cryostat	Pre-fabricated/tested modules assembled in cryostat	Same concept, different implementation
TPC Support	Suspended under cryostat roof	Suspended under cryostat roof	Same concept, different implementation
TPC configuration	CPA in the middle, single sided APAs against the walls	CPAs against the walls, double sided APAs in the middle	LAr1-ND's TPC configuration avoids a costly fiducial cut around the non-active thickness of the APA in the center of the active region. The APAs can be placed closer to the cryostat walls to maximize active region in the limited available space. For LBNE, it is cheaper to build fewer APAs if they are double sided and in the middle.
APA configuration	single sided, no helical wire wrapping, readout on 3 edges	double sided, helical wire wrapping on two induction planes, readout on one edge	LBNE's wire wrapping design allows the APAs to be tiled on 3 sides, but raised concerns about the reconstruction efficiency. LAr1-ND's APA design avoids the wire wrapping, while allowing APA tiling on all 4 sides. If the LBNE 35 ton TPC shows that the wrapped wires do not work well, the LAr1-ND design provides a verified alternative to the LBNE APAs.
APA wire configuration	3 sense wire planes, +/- 60 degree, 3mm wire pitch, identical to MicroBooNE	3 sense wire planes, +/- 45 degrees, 4.5-5mm wire pitch	LAr1-ND's wire configuration is set to be identical to MicroBooNE to avoid additional systematic errors when running together. LBNE's wire angles are supposed to be better suited for beam neutrino events. The large wire pitch is compatible with the larger diffusion over longer drift.
APA wire bonding	CuBe wires epoxyed and soldeded to PCB with notched edges	CuBe wires epoxyed and soldeded to PCB with notched edges	Same design
CPA design	stainless steel frame + conductive sheet	stainless steel frame + conductive sheet	Same design concept, light transmission TBD.
Field cage design	Cu strips on FR4 panels	Cu strips on FR4 panels	Similar design.