

SBND Detector at Fermilab

Ting Miao (FNAL) & Bo Yu (BNL)

SBND - Short-Baseline Near Detector

- A LArTPC detector as part of the three-detector Short Baseline Neutrino (SBN) program using Fermilab's Booster Beamline (BNB)
- A new scientific international collaboration of 33 institutions from US, UK, Switzerland and Brazil



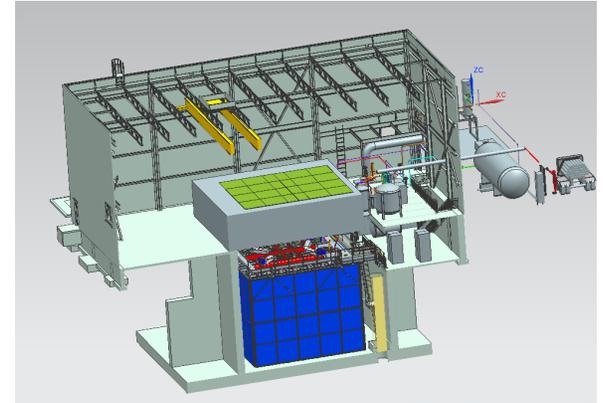
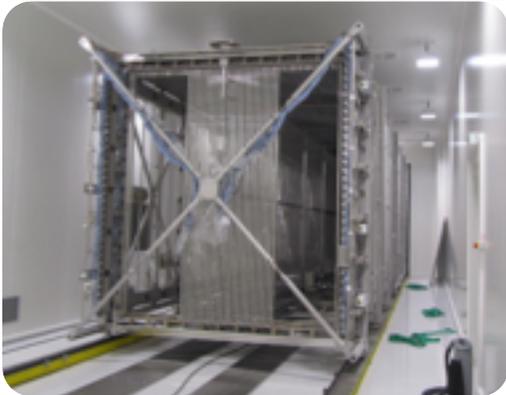
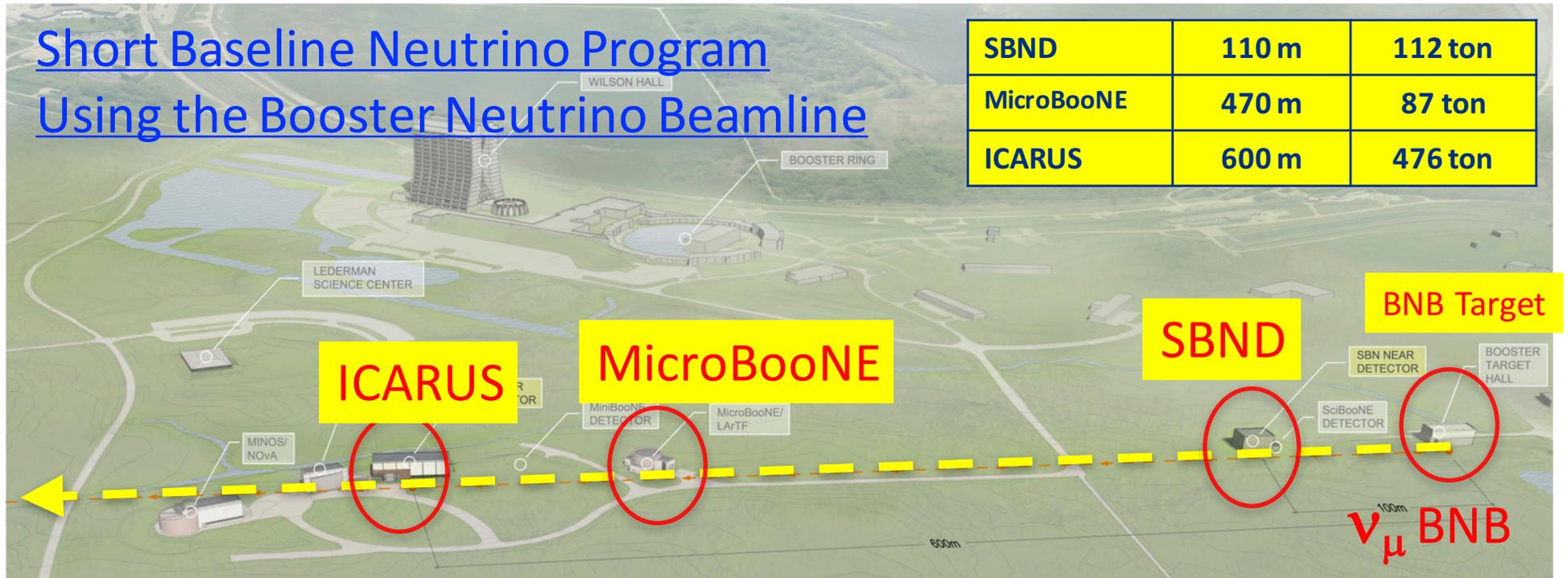
SBND Logo



Fraction of the 178 collaborators

Scientific Mission of SBND Experiment

- Serve as a near detector in sterile neutrino search through $\nu_\mu \rightarrow \nu_e$ oscillation
- Study ν -Argon interaction physics using millions of events



SBND

Fermilab

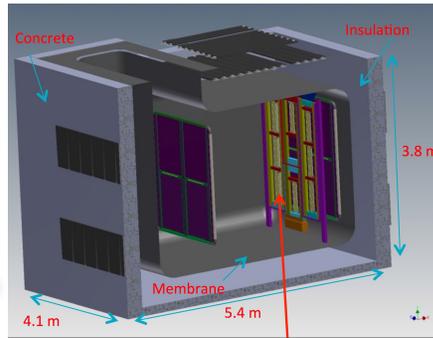
Detector R&D Mission of SBND

- Detector design and construction serve as a key prototype for long baseline neutrino program (i.e.DUNE)
- Many key detector components have designs and construction procedures similar or complementary to (proto)DUNE



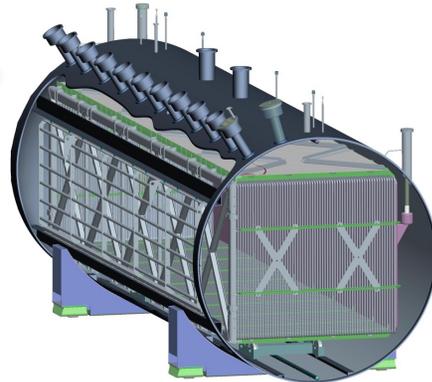
ICARUS@LNGS

LBN

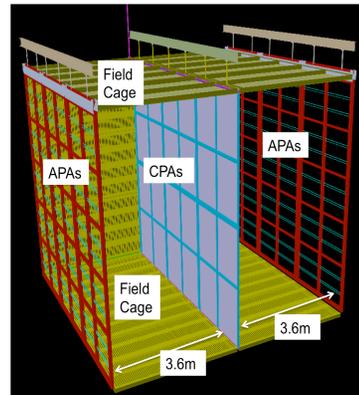


2015 LBNE 35ton

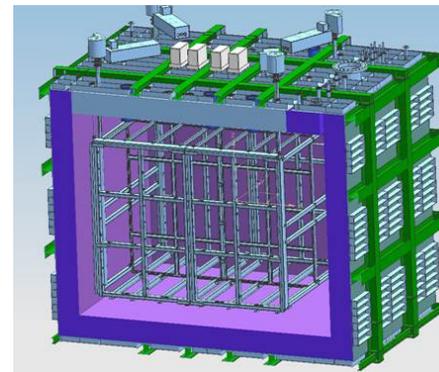
SBND



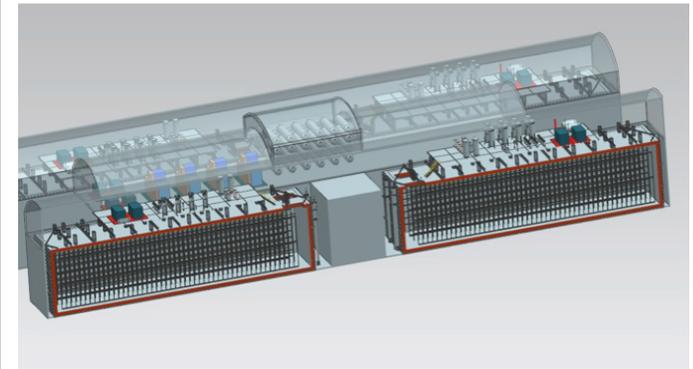
2015 MicroBooNE



2018 protoDUNE



2019 SBND

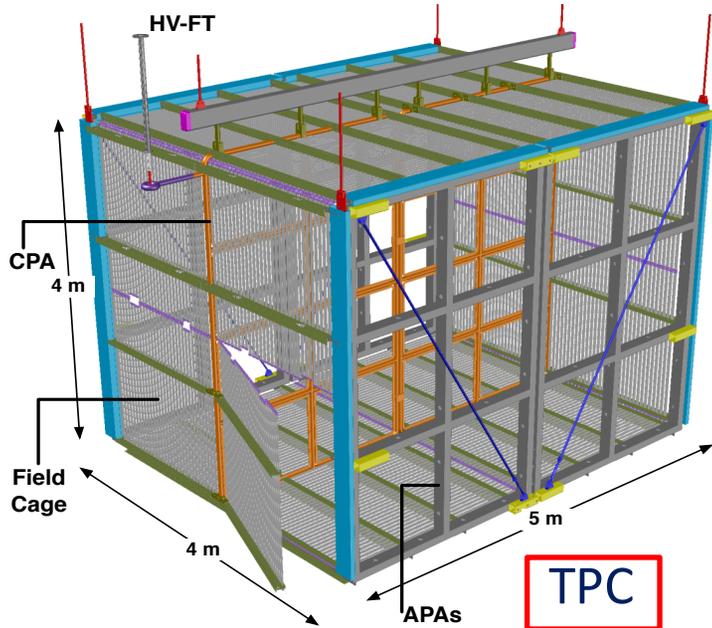


DUNE 20kt 2026

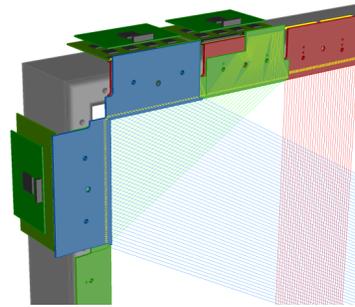


2018 ICARUS@SBN

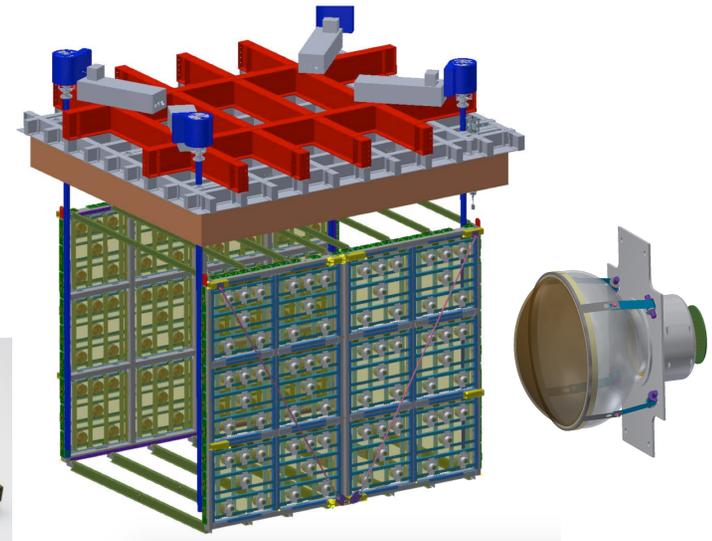
SBND Detector Components



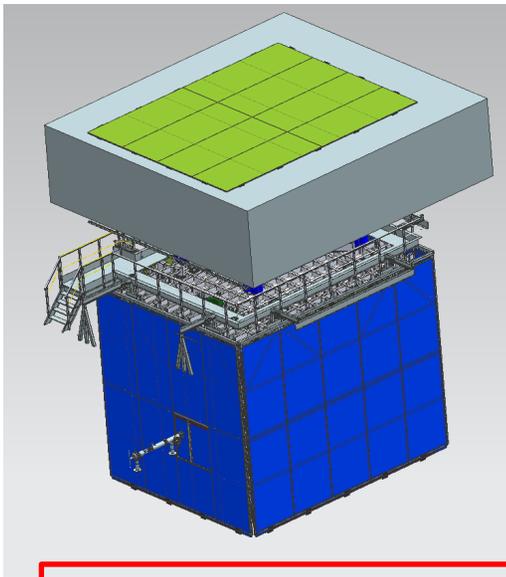
TPC



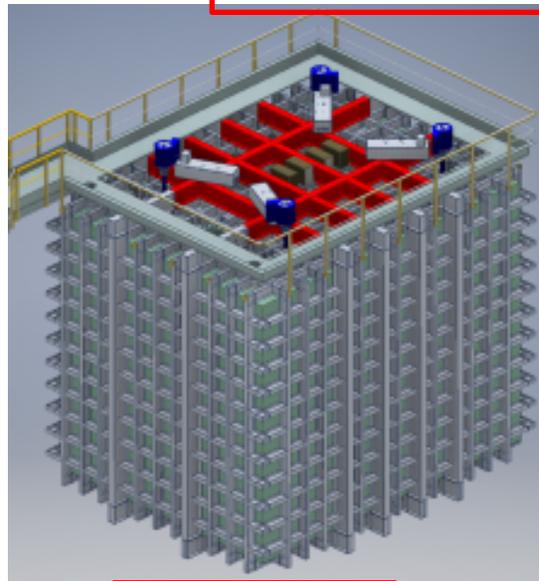
Cold Electronics



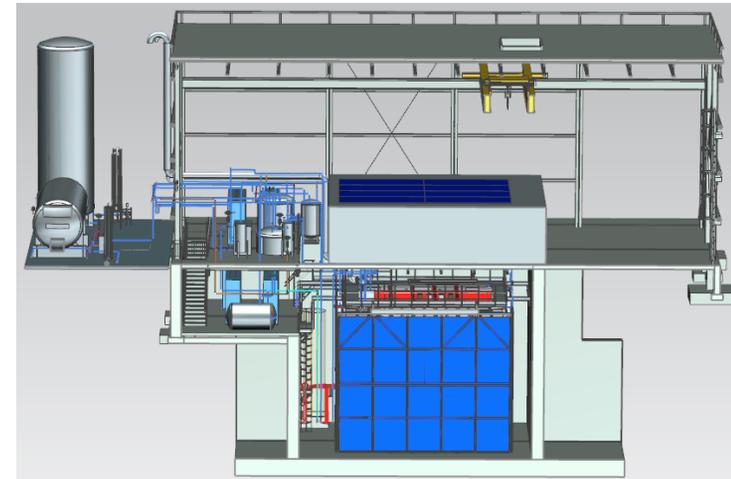
Cryogenic PMTs



Cosmic Ray Tagger



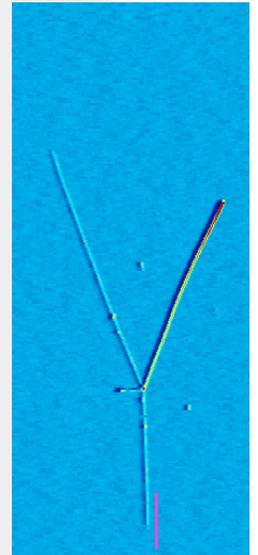
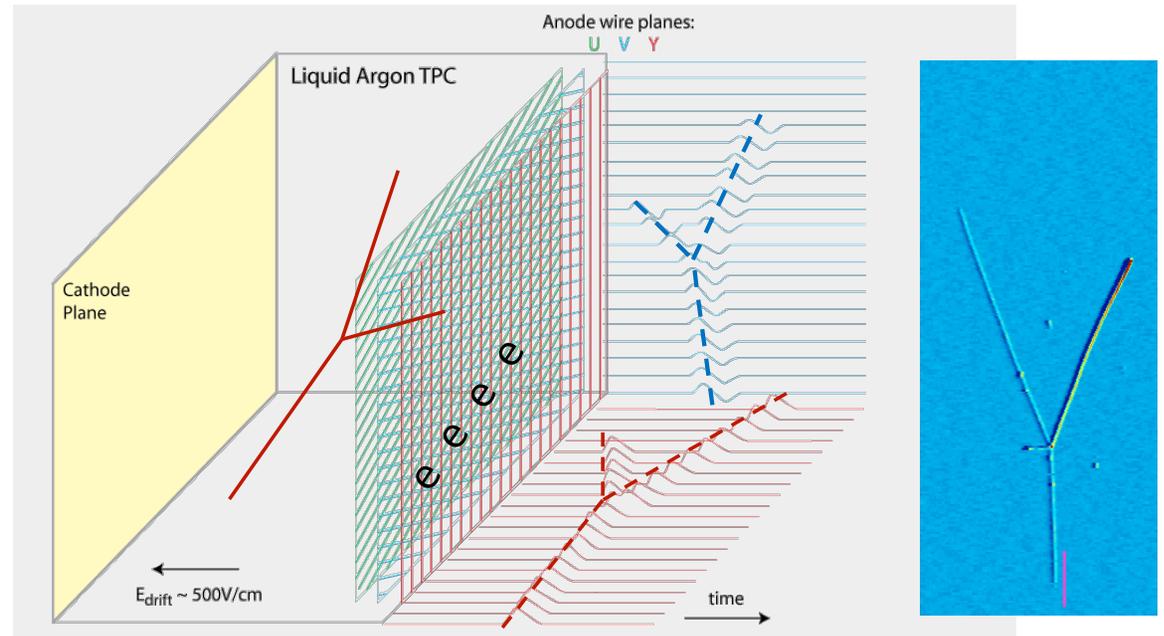
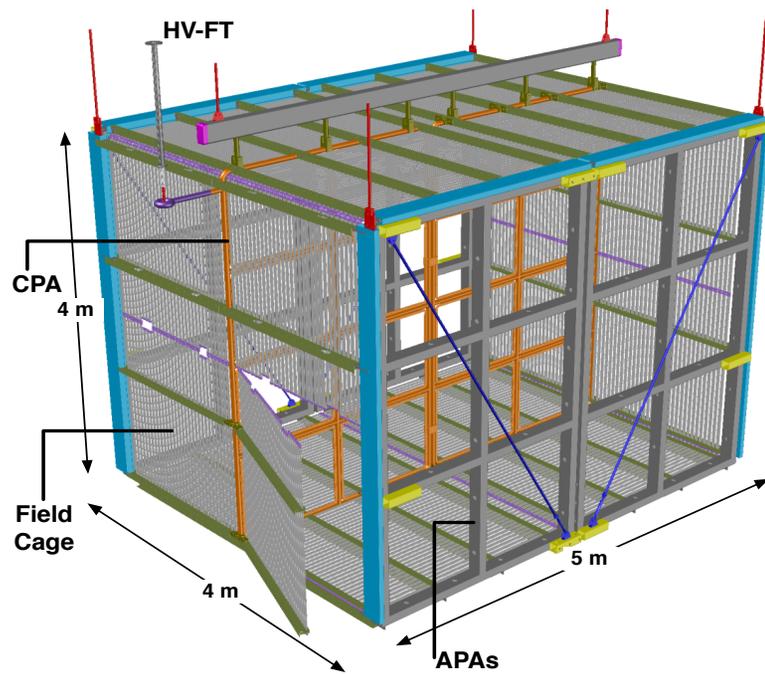
Cryostat



Cryogenics and Building

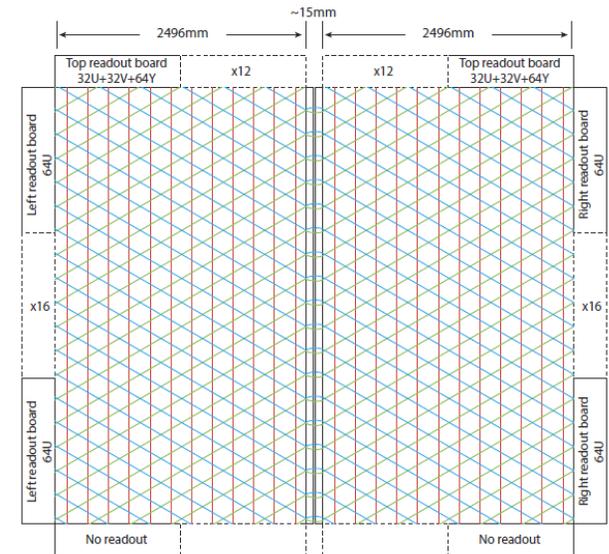
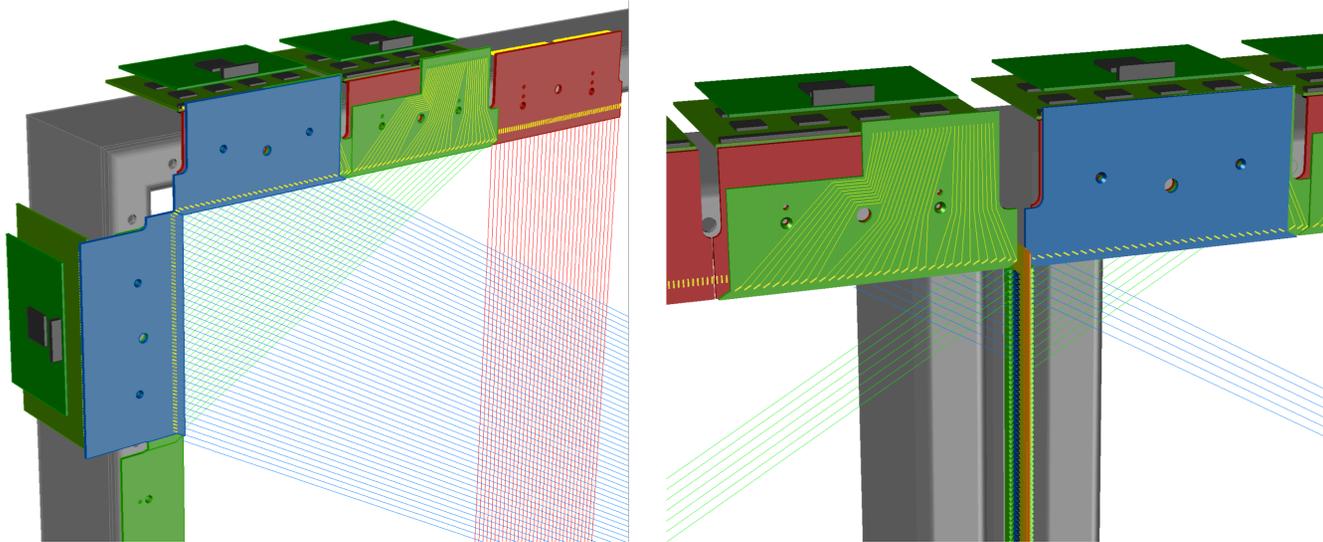
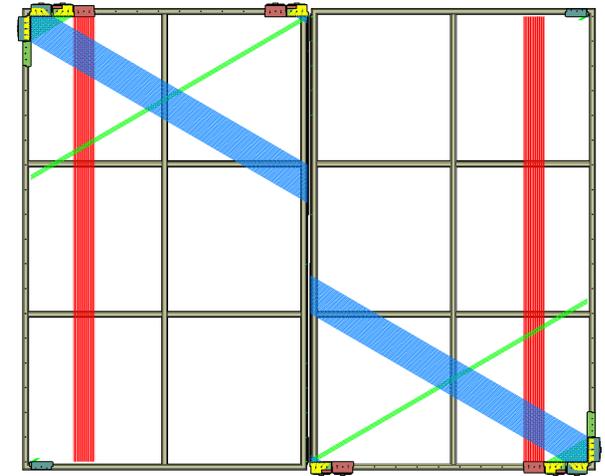
TPC Design

- TPC in LAr for neutrino interaction tracking
 - 112-ton active LAr volume, 270-ton total LAr
 - 4m (tall) x 5m (long - beam) x 4 m (wide -drift) : two 2m drift volumes (500v/cm drift field)
 - Cathode Plane Assemblies (CPA) in the middle
 - Anode Plane Assemblies (APA) on the two ends
 - APA has 3 wire planes with 3mm spacing: vertical (Y-layer) and $\pm 60^\circ$ (U-layer & V-layer)



Anode Plane Assemblies

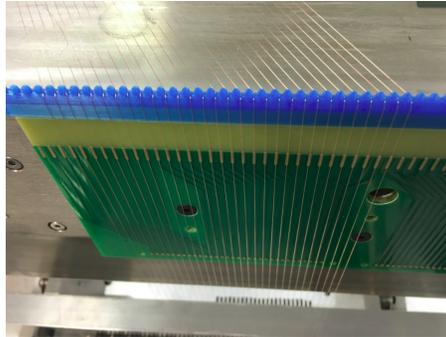
- Two 2.5m wide wire frames on each side of the drifting field
- U/V wires are electronically connected from the two wire frames for a continuous coverage
 - The connected wires are readout as one
 - Total 11,263 channels readout



Anode Plane Assemblies

Anode Plane Assemblies Progress

- APAs are being built by UK-STFC and US-NSF supported Universities
 - UK: Manchester U, U Sheffield, Liverpool U, and U Lancaster
 - US: Yale U, Syracuse U and U Chicago
- APA frames are fabricated by UK company and to be delivered in June
 - Flatness of ± 0.5 mm requirement reached by shimming
 - Tighter requirement than DUNE due to the smaller 3mm wire plane spacing



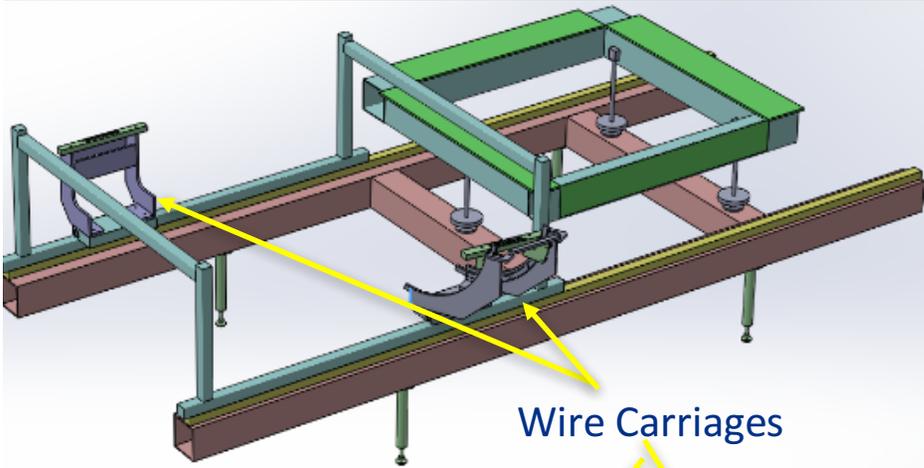
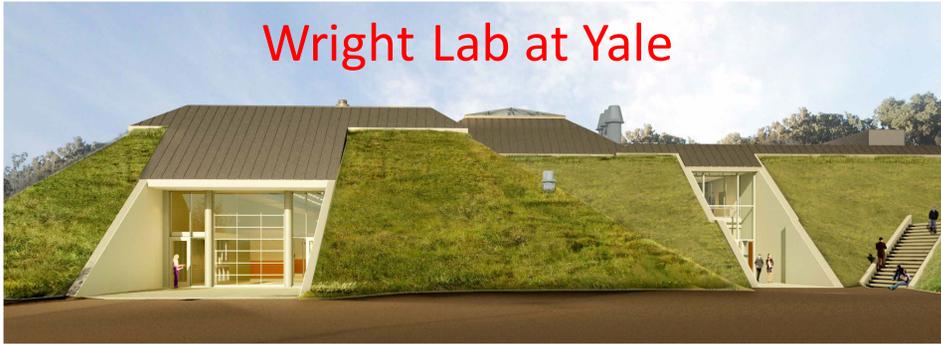
Production APA Frames

Winding Prototyping at US and UK

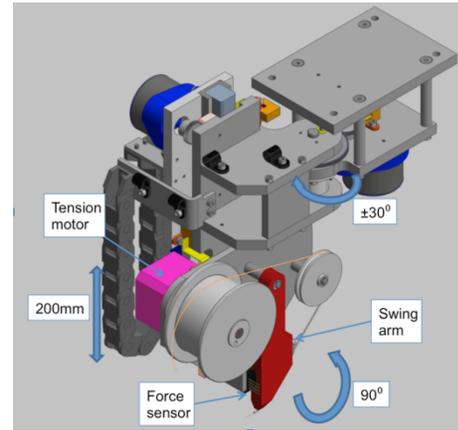
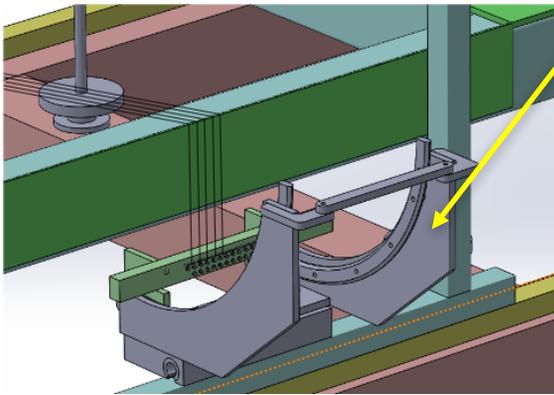
Wire Winding

- Winding to start in July at UK and US facilities

Wright Lab at Yale



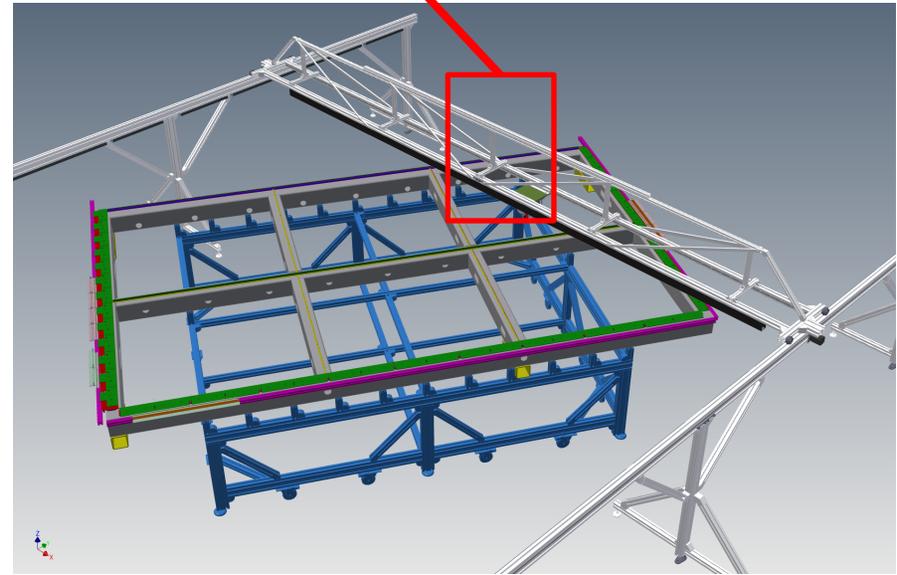
Wire Carriages



Wire Head

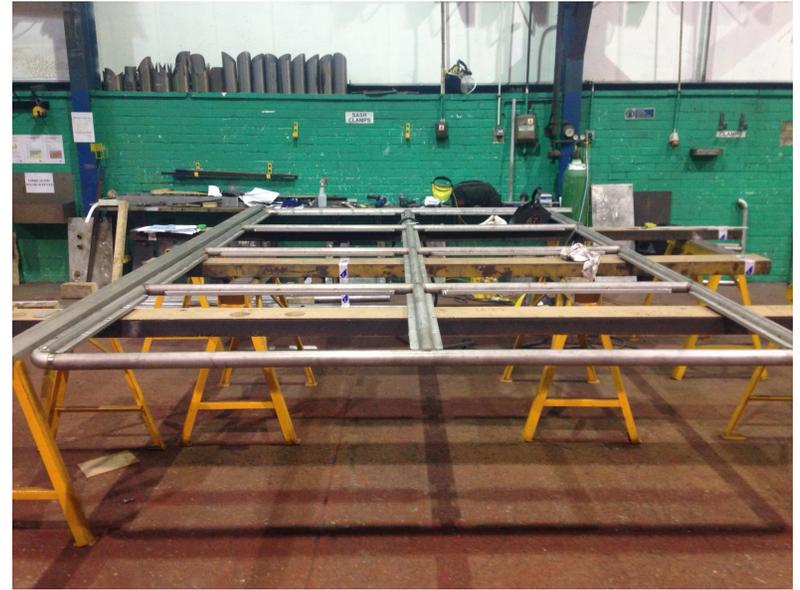
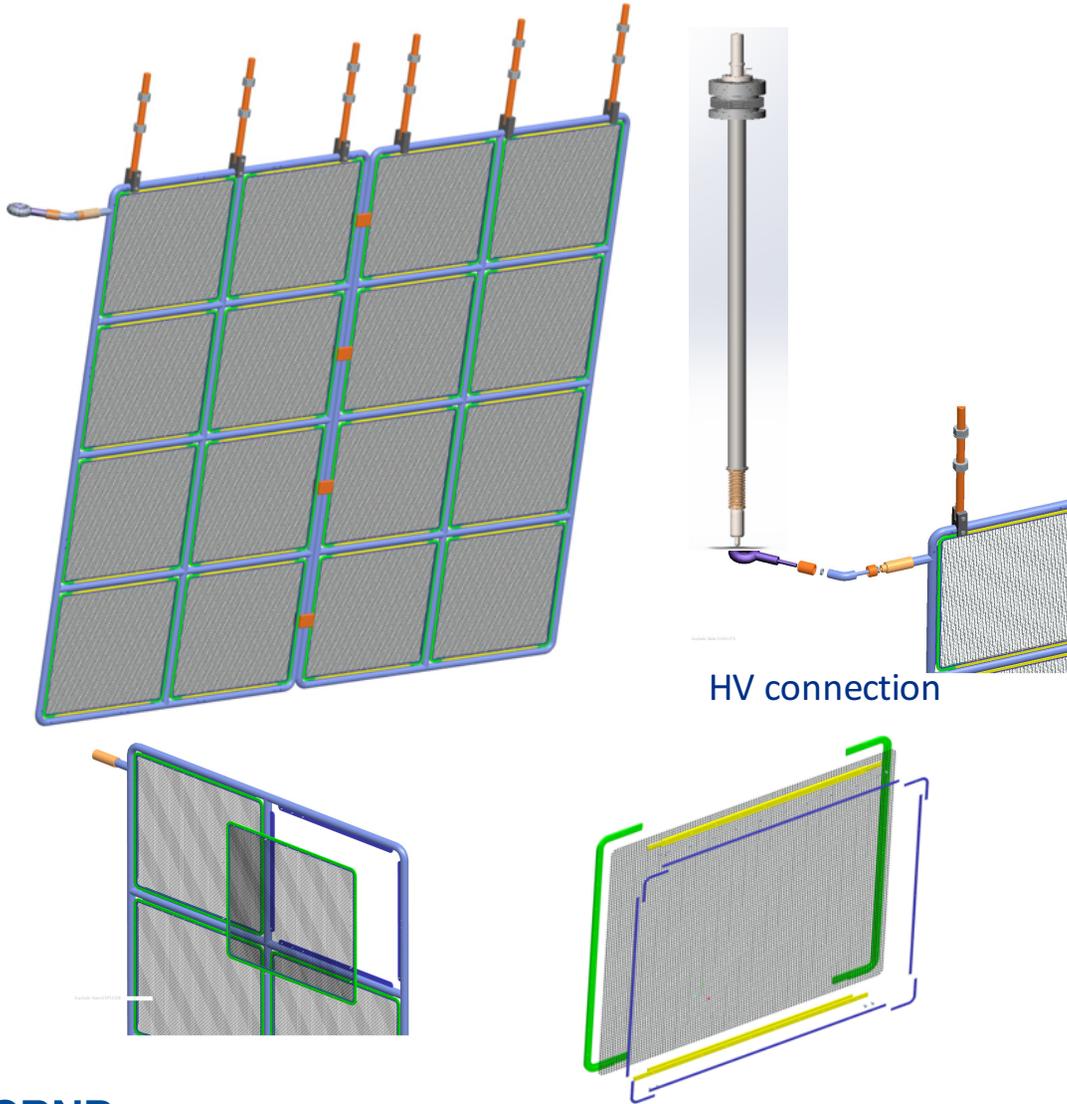


Daresbury Lab



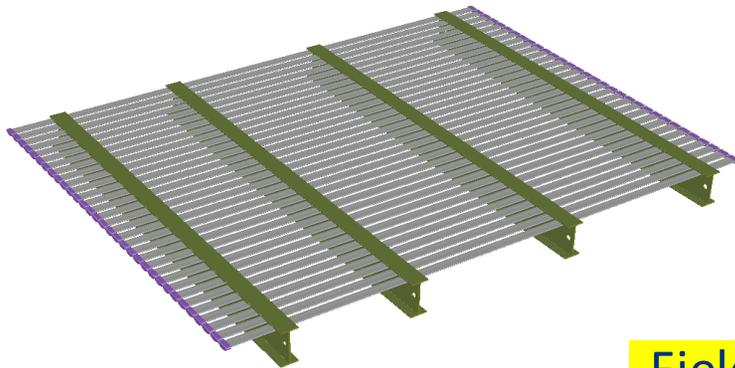
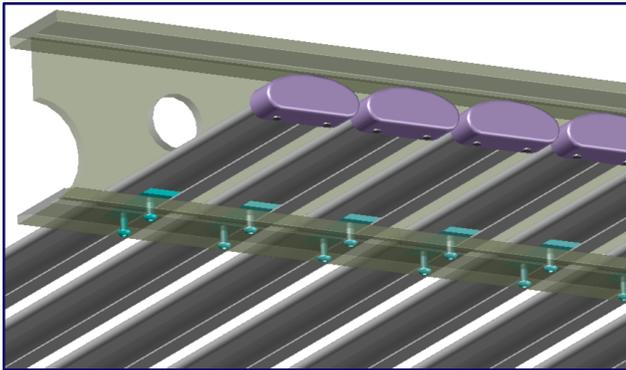
Cathode Plane Assemblies

- Stainless steel frames with meshed sub-frames
- In final production stage at Liverpool University

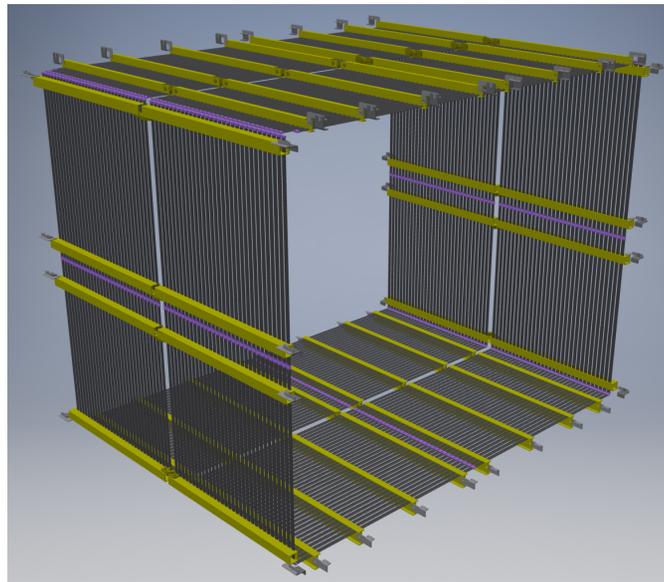


HV System

- 100KV is supplied by HV feed-through tube going through cryostat roof
- Roll-formed field cage tubes surrounds the drifting area
 - SBND design works with stainless steel or aluminum roll-form
- Both field cage and feed-through in production soon



Field Cage



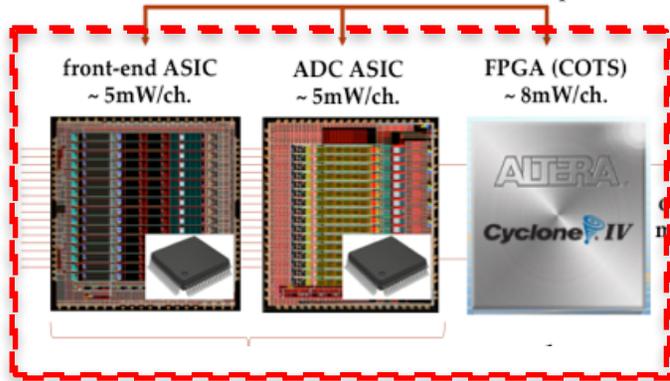
HV Feedthrough Test

TPC Electronics

Readout Chain
 COLDATA becomes available)

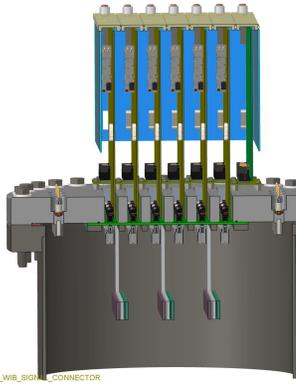
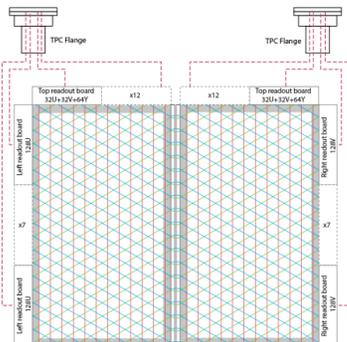
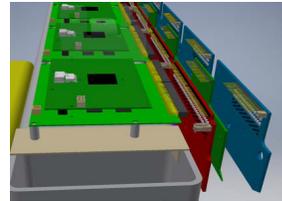


voltage regulation
 (COTS)
 (< 100mV dropout)

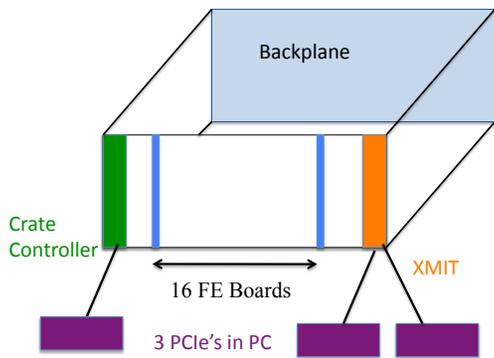
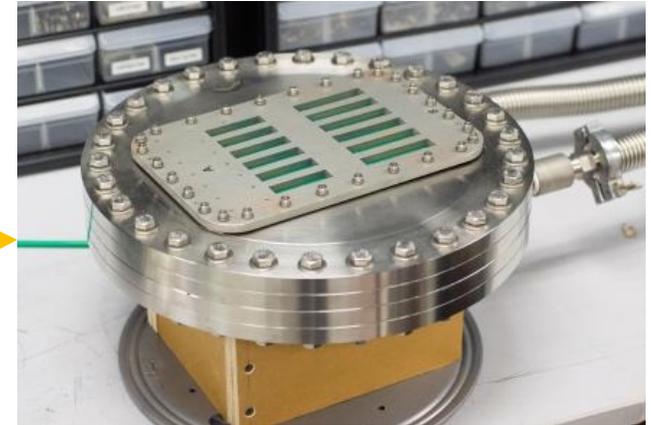


overall 128:4
 multiplexing

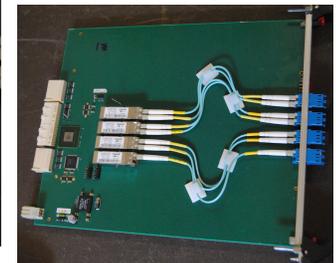
Cold Electronics
 (BNL)



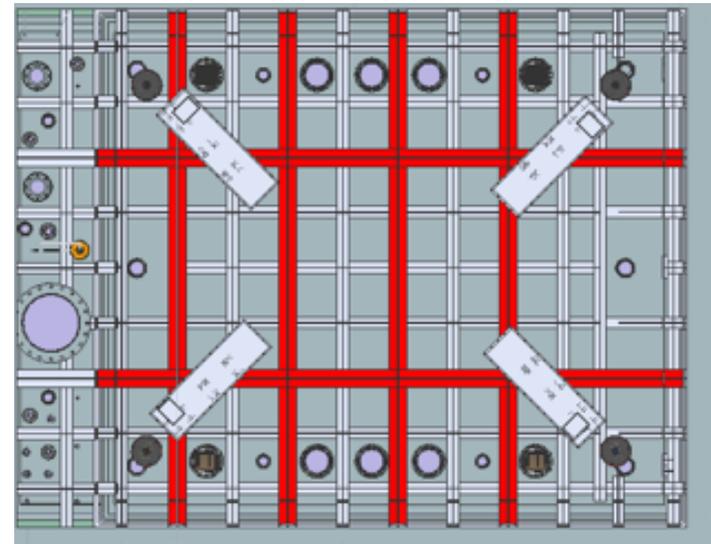
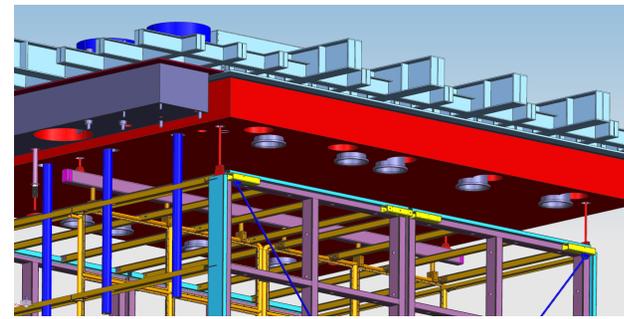
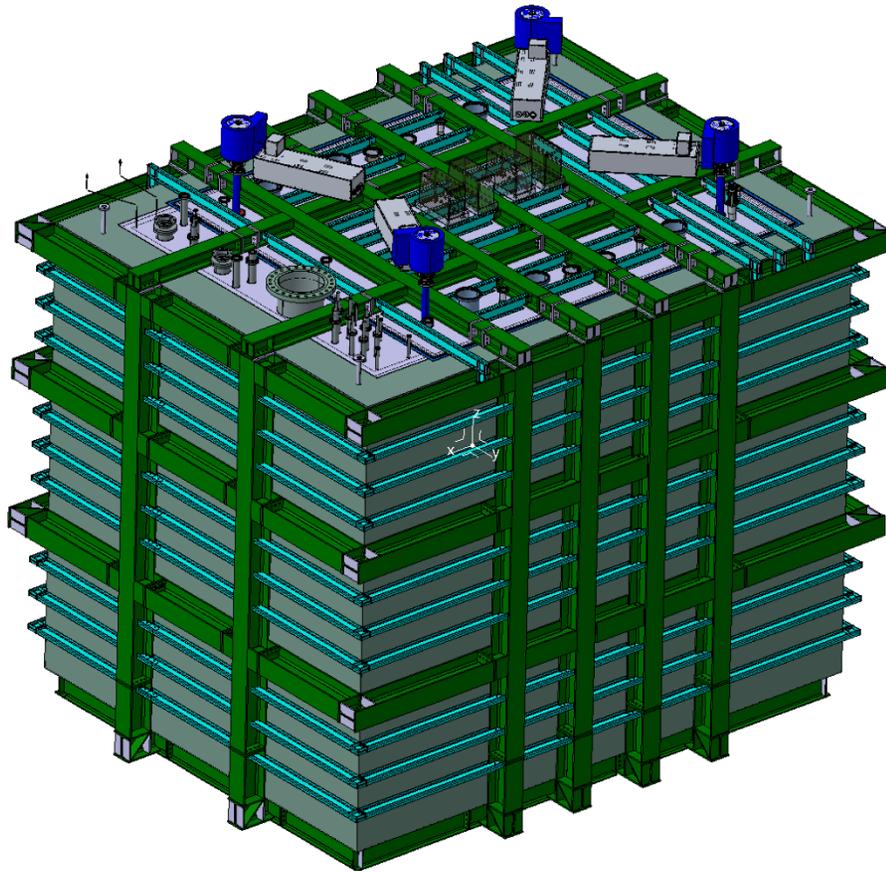
Feed-through &
 Warm Interface
 (BNL)



Readout & Trigger
 (Columbia U)



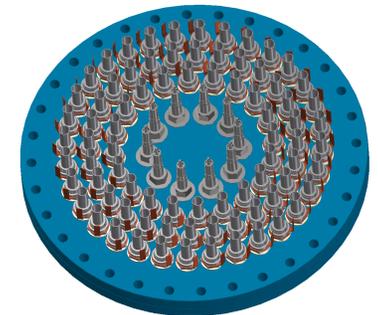
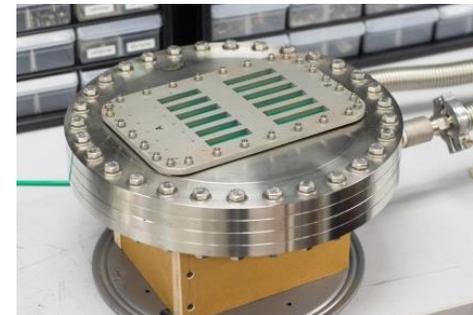
SBND Cryostat Design



Detector Penetrations

3rd generation prototype for DUNE

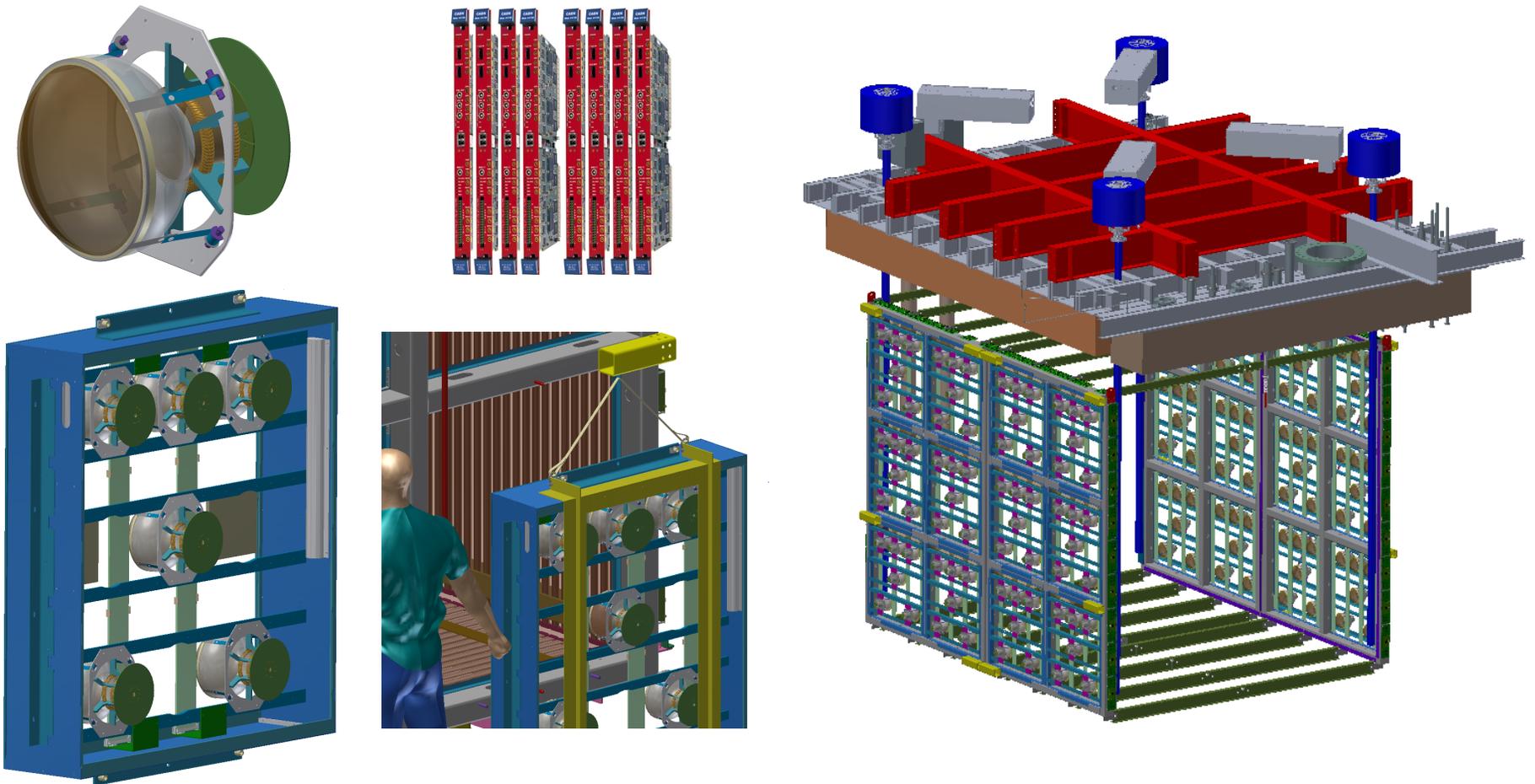
- Experience from two DUNE prototypes
- Lighter beam and support structure ribs
- CERN designs and fabricates



Feed-through (TPC-left, PMT-right)

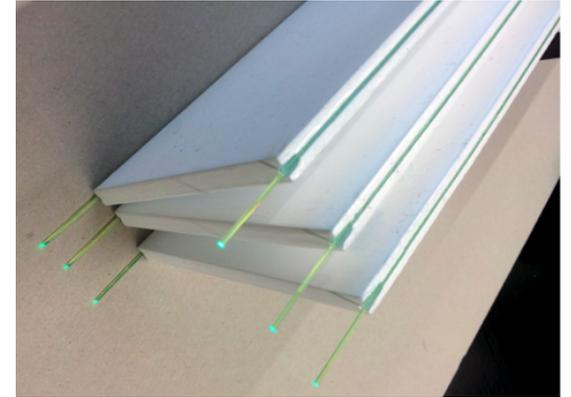
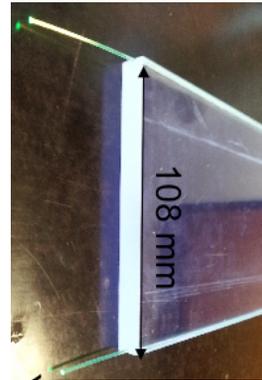
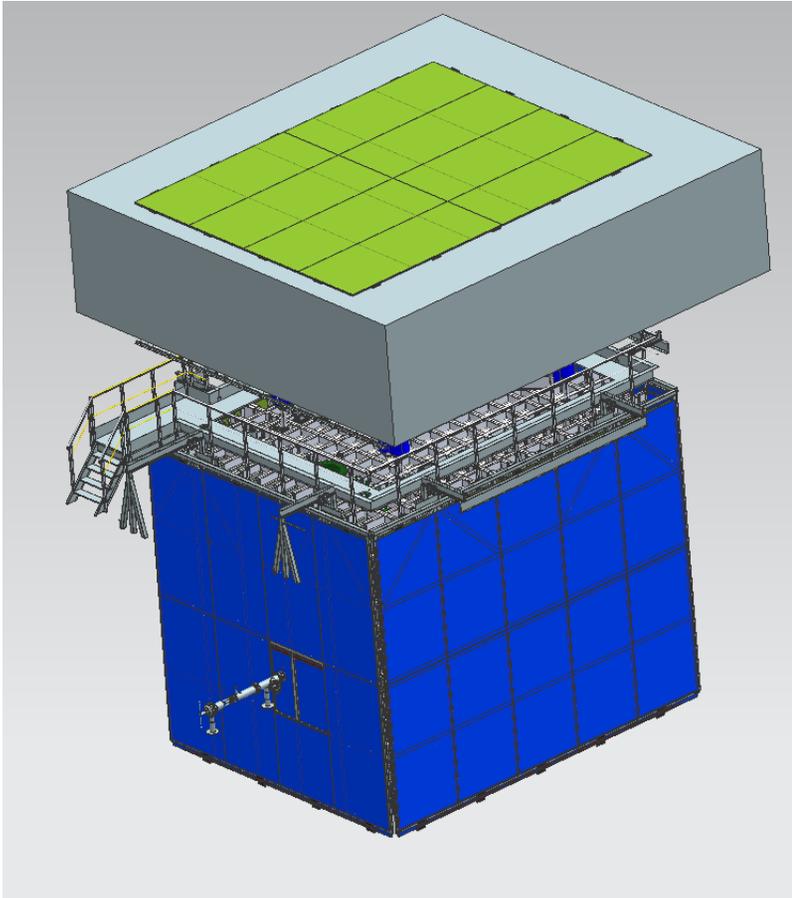
Scintillation Light Detection

- 120 PMT 8" Hamamatsu PMTs and CAEN readout electronics for scintillation light detections
 - Supported by Los Alamos National Lab funding
 - All PMTs and electronics are in hand



Cosmic Ray Tagger

- Scintillation bars surrounding the cryostat to provide cosmic tagger function: 94% muon flux coverage



Scintillation bars with optical fiber



CRT Panels

Summary and Outlook

- SBND detector is a new LArTPC detector for sterile neutrino measurement and detector R&D
- The detector is being designed, fabricated and assembled by an international collaboration of US, UK, Swiss and Brazil institutions
- The experience of designing, building and operating a large LArTPC is valuable to the future of the neutrino program
- We are on track to finish the detector construction and start cold commissioning in first half of 2019
- A lot of exciting things to be expected in the coming years