SBND INSTALLATION & COMMISSIONING PLAN

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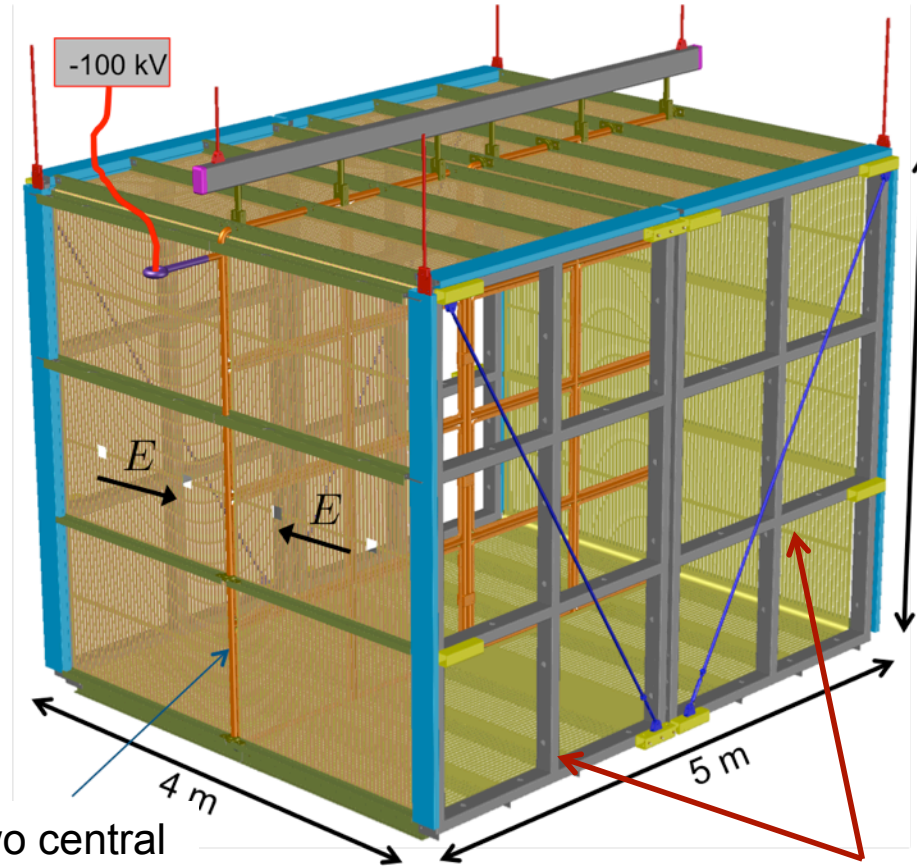
SBND/DUNE Cold Electronics Review

October 12-14, 2016

Overview

- Charge question: Is the proposed joint ProtoDUNE-SP/ SBND production, installation, and commissioning plan reasonable?
- Reminder of SBND design
- Installation/commissioning plan
- Reminder of SBND schedule
- Installation/commissioning team

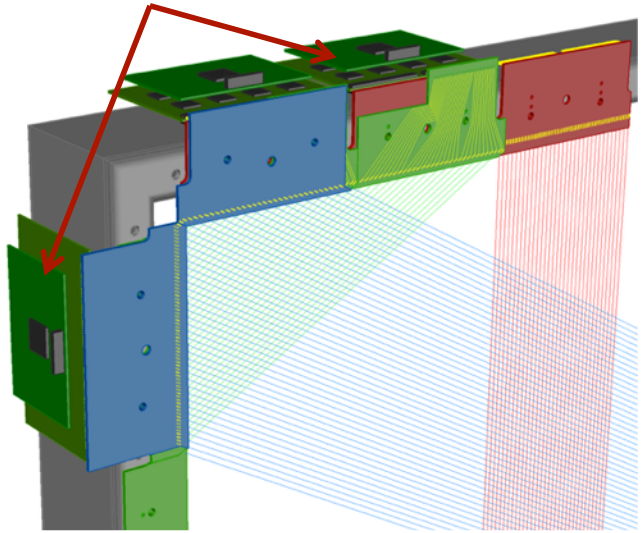
SBND Design



Two central CPAs with two 2-m drift regions

4 APAs (each 4 m x 2.5 m)
2 APAs on each side joined

Cold electronics attached on top and side of APAs



2 bridged APAs
- 5,632 channels
- 26 top mother boards x 128ch per board
- 18 side mother boards x 128ch per board

Entire SBND TPC
- 11,264 readout channels from 4 APAs
- 4 cold cable bundles to 4 signal feedthroughs

SBND Electronics Design

To slow control

To DAQ (Nevis)

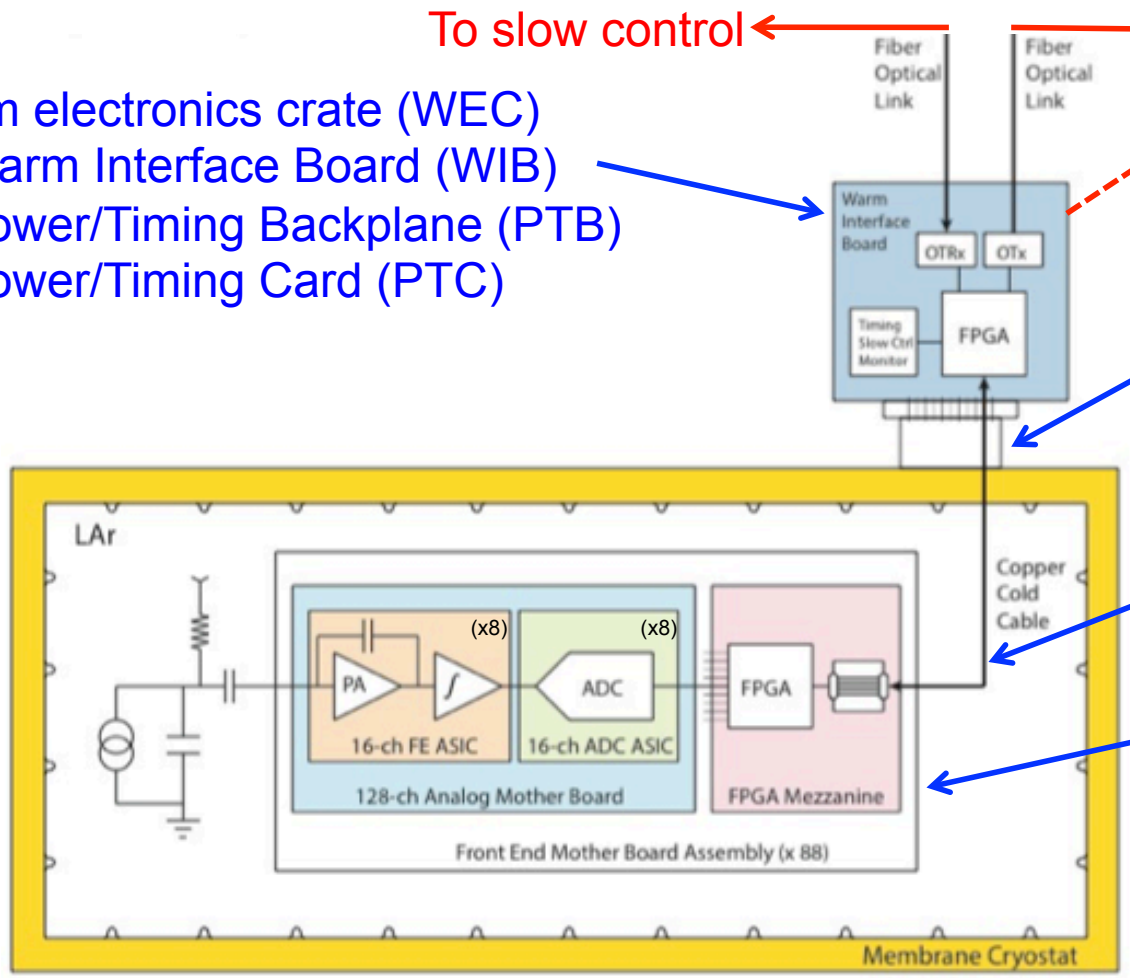
Warm electronics crate (WEC)
- Warm Interface Board (WIB)
- Power/Timing Backplane (PTB)
- Power/Timing Card (PTC)

Real-time diagnostic readout via Gig-E

Cryostat feed-through

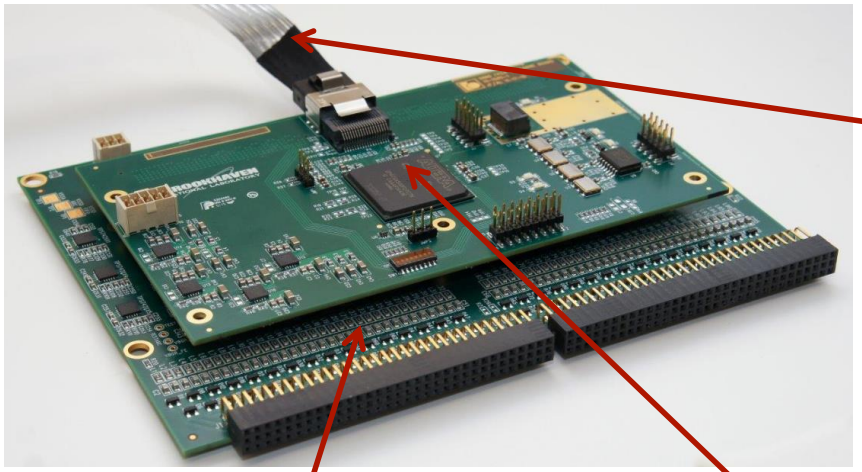
Cold cable

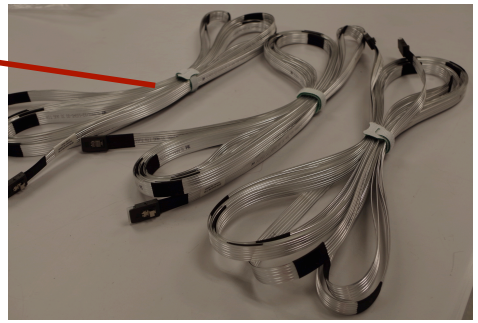
Front-end Mother Board (FEMB) x88 (22/APA)



SBND Components

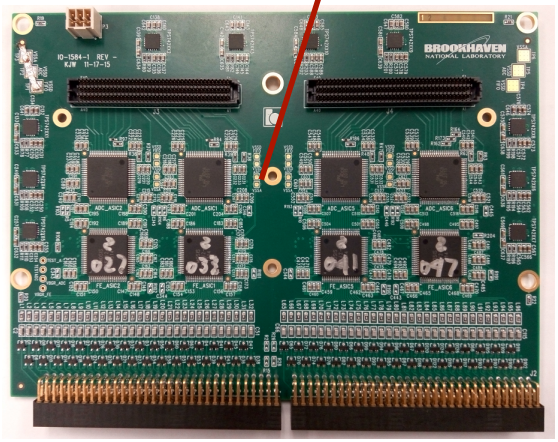
FEMB



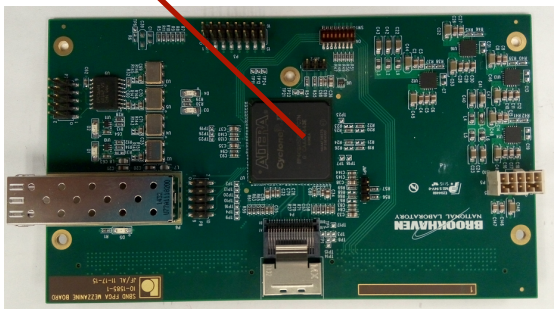


Data cable (3M)

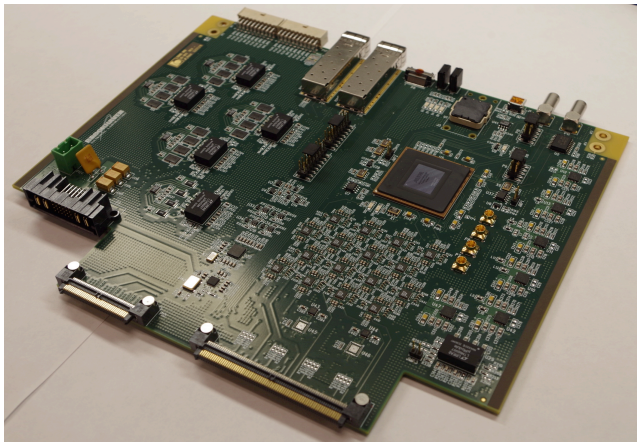
Power cable (Samtec)



Analog motherboard



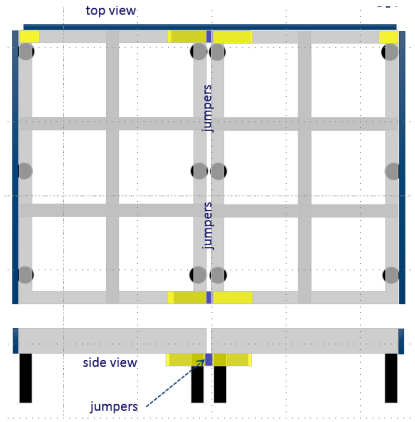
FPGA mezzanine

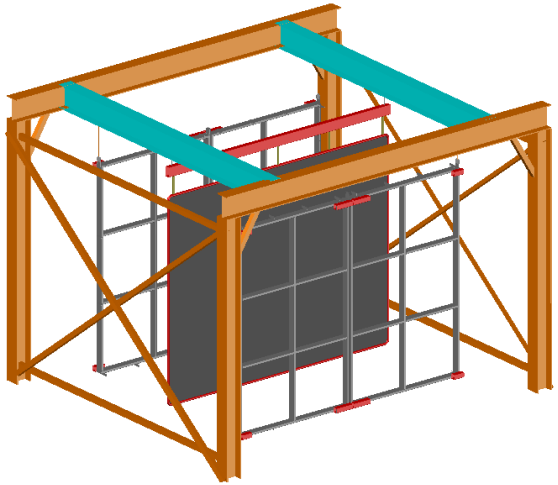


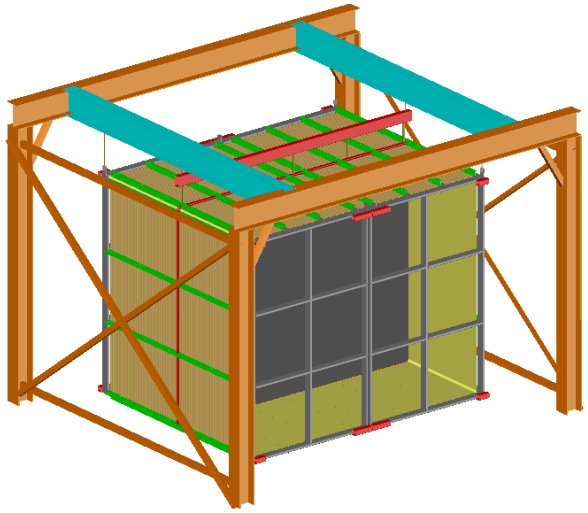
Warm Interface Board (WIB)

TPC Installation Plan

At D0 assembly building (DAB):







1. Join 2 APA side by side (while horizontal*)
2. Install jumpers and
3. Rotate to vertical

*Desirable to install FE electronics while horizontal if schedule allows

4. Hang first APA pair from beams between MicroBooNE monorails
5. Hang intermediate cathode suspension beam and then two CPA sections
6. Hang second APA pair

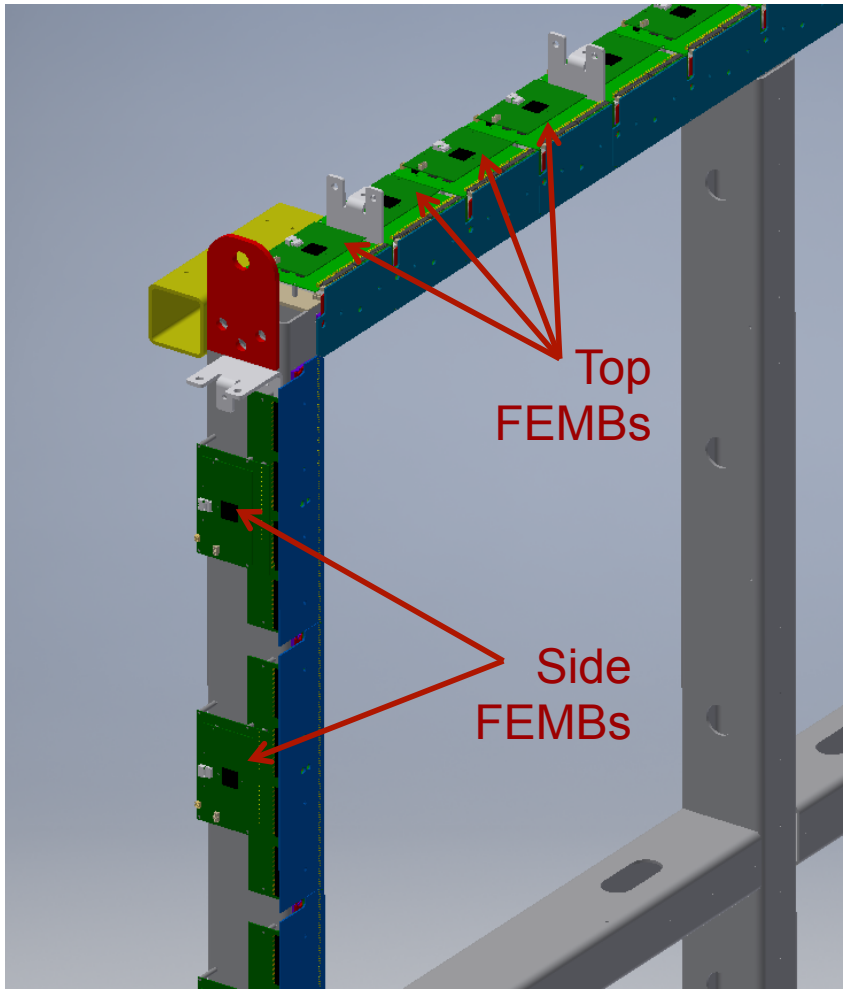
6. Attach field cage support beams
7. Install field cage panels (except side field cages)
8. Install FE electronics
9. Install LDS assemblies

FEMB Installation

SBND FEMB:

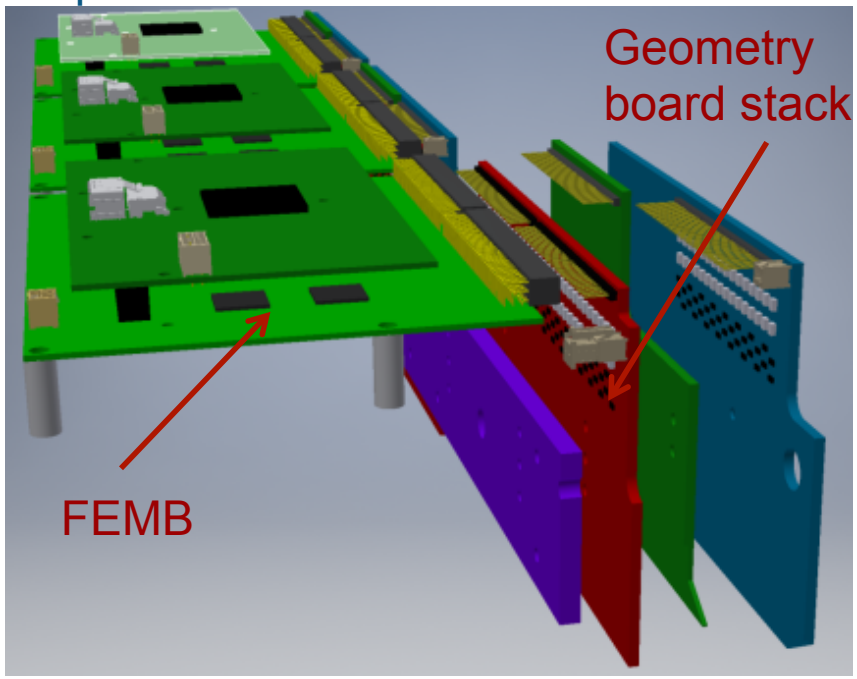
- FEMB includes analog motherboard and FPGA mezzanine; will be preassembled and tested at BNL as a unit before shipment to FNAL
- Two designs: top-mounted and side-mounted
- Each board will be checked by portable test stand immediately upon installation
- Cold cable will be installed at time of board installation

FEMBs on vertical APA frame:



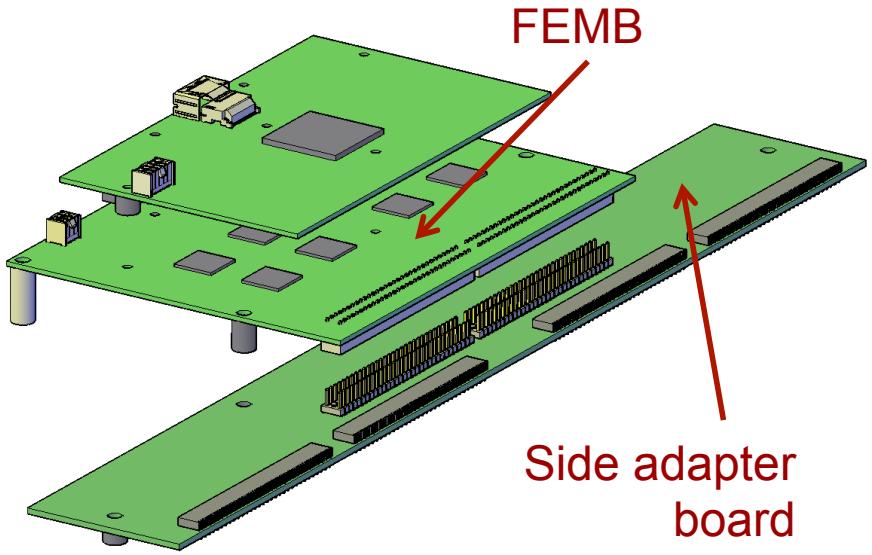
Top and Side Mounting

Top mounted:



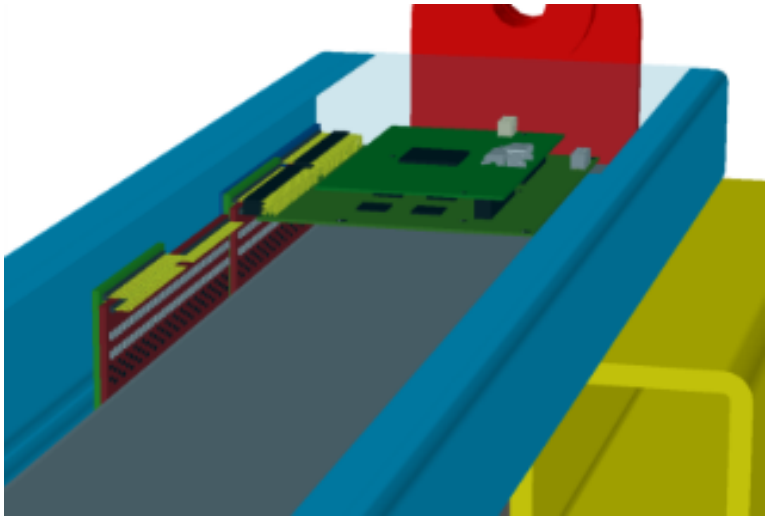
- Geometry board stack attached to APA frame as part of APA assembly
- FEMB plugs in to geometry board
  - Supported by APA frame with standoffs
  - Attached with screws

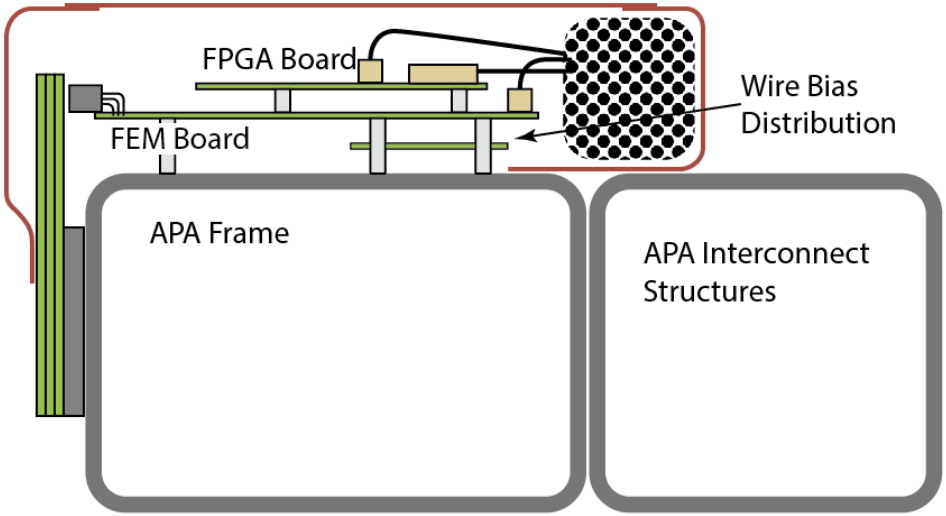
Side mounted:



- Side FEMB adapter board plugs in to geometry board
- FEMB plugs in to side adapter board
- Side FEMB same size as top board; only difference is connector
  - Same design as protoDUNE FEMB

Faraday Cages and Cables

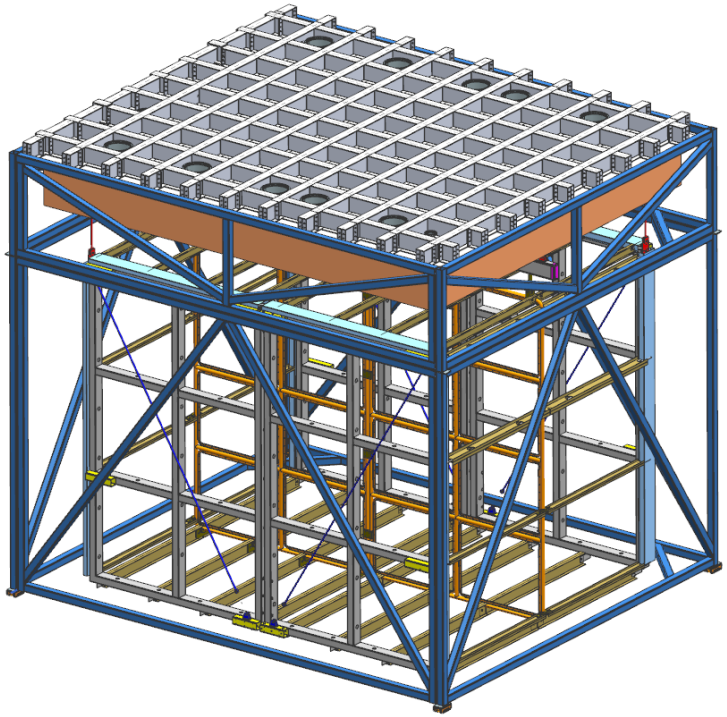




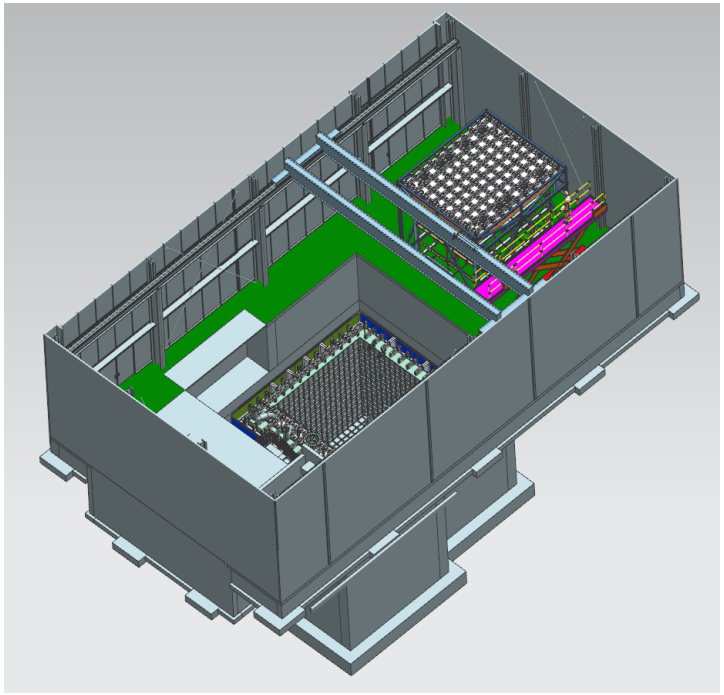
- Sides of faraday cages pre-installed as part of APA assembly
- Cables will be routed inside faraday-cage assembly during cold electronics installation and exit at top two corners of the APAs
- Faraday cage top covers will be installed after electronics and cables are in place

TPC Installation Plan

At D0 assembly building (DAB):

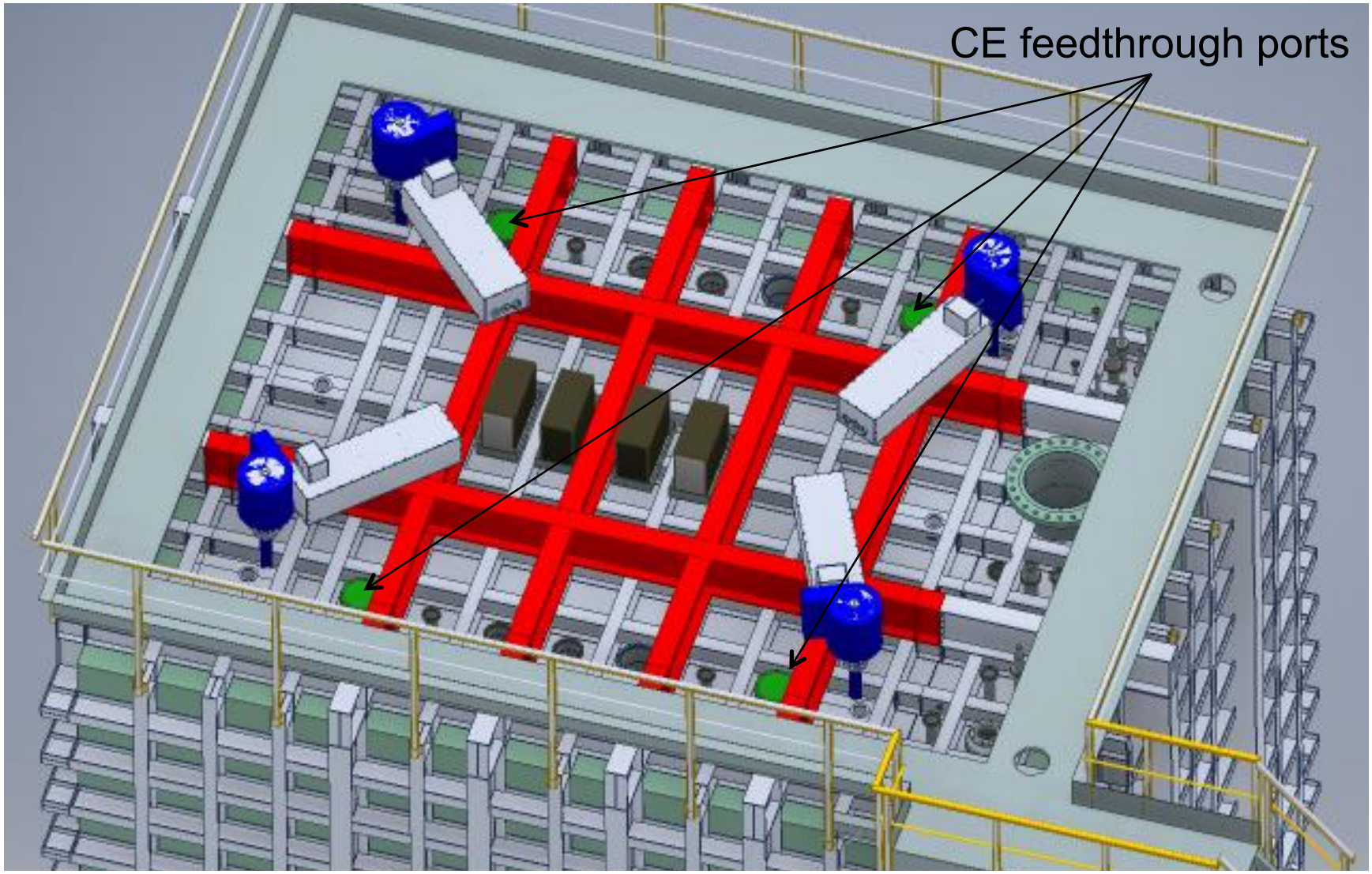


At detector building:



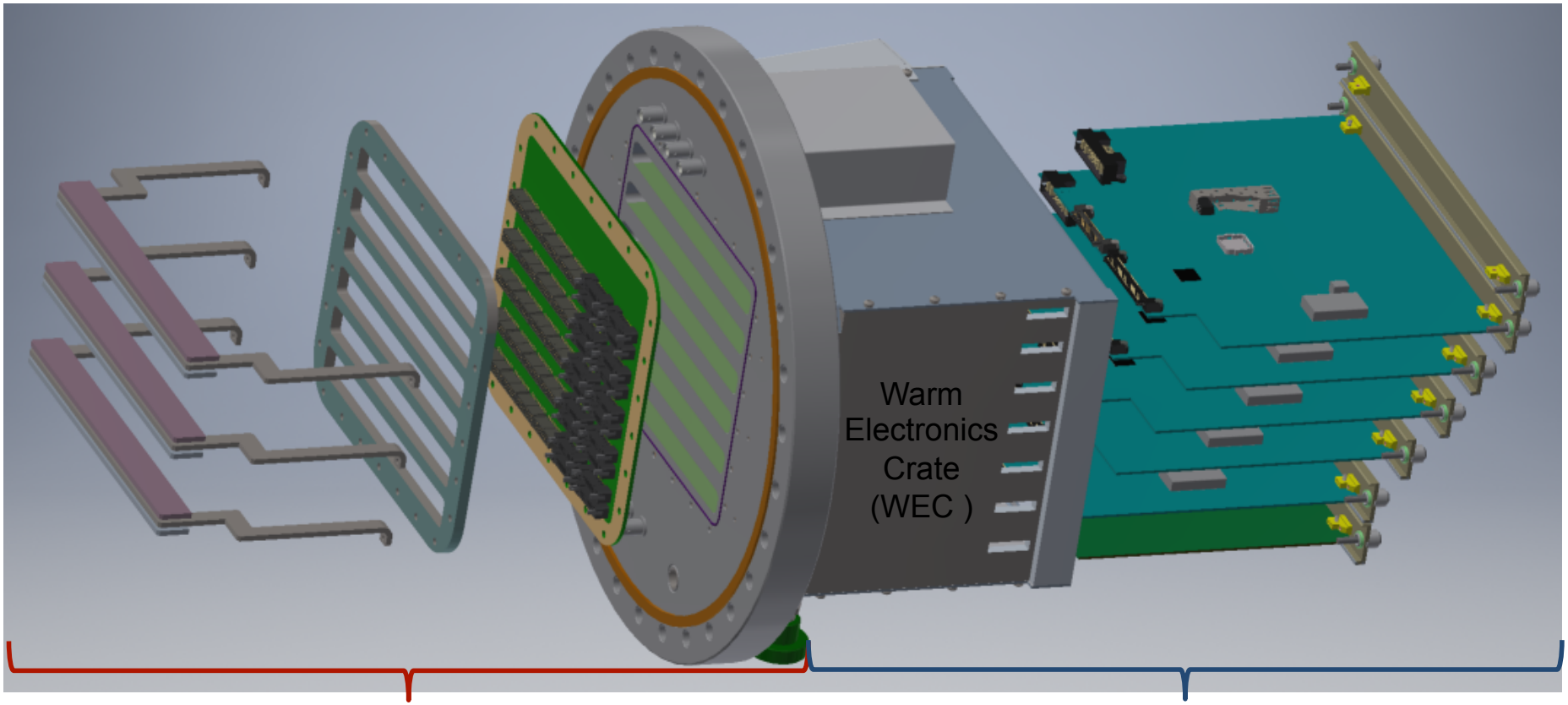
- TPC support and transport frame allows the cryostat top to be connected to the TPC at DAB in order to allow full test of readout system
- Once full system test is complete, TPC and cryostat top will be transported to SBND detector building where full test of readout system will be repeated
- Warm electronics will be temporarily mounted on each port for testing, but must be removed before transport

Cryostat Top



Warm Electronics Installation

Feed-through and warm electronics (~identical to protoDUNE except 6 WIBs)



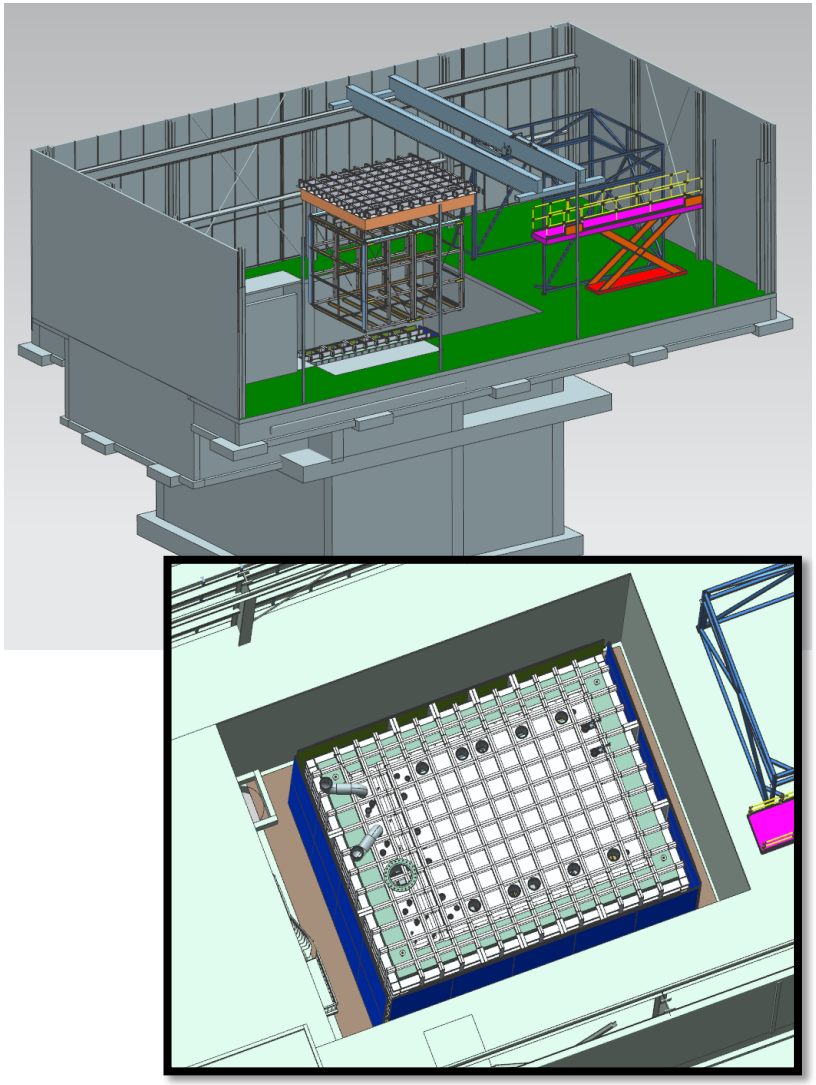
Flange pre-installed on cryostat top

Cables connected and strain relief applied once lid on at DAB

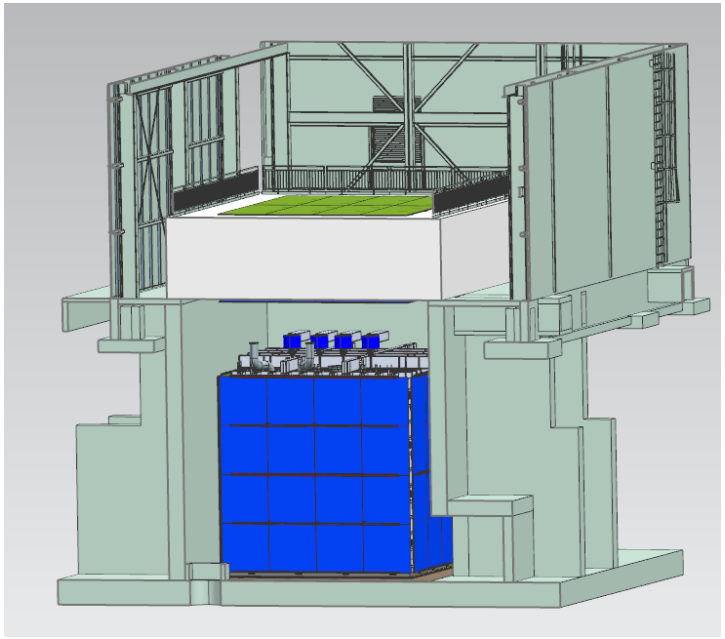
At DAB, single WEC will be moved among the 4 ports for testing

Final WEC installation at detector building

TPC Installation Plan



- At detector building, warm electronics and warm cables will be installed
- Building crane will be used to lift detector and lower it into the cryostat
- After installation in cryostat, warm cables will be connected to DAQ
- Top overburden will be placed above cryostat after filling with liquid argon



Electronics Mobile Teststand

protoDUNE design: expect similar setup for SBND

- Mobile teststand cart
  - Laptop DAQ (simple set of Python scripts and ROOT for analysis)
  - LV power supply capable of 5V/3A
  - WIB + cable adapter connected to DAQ via gig-E

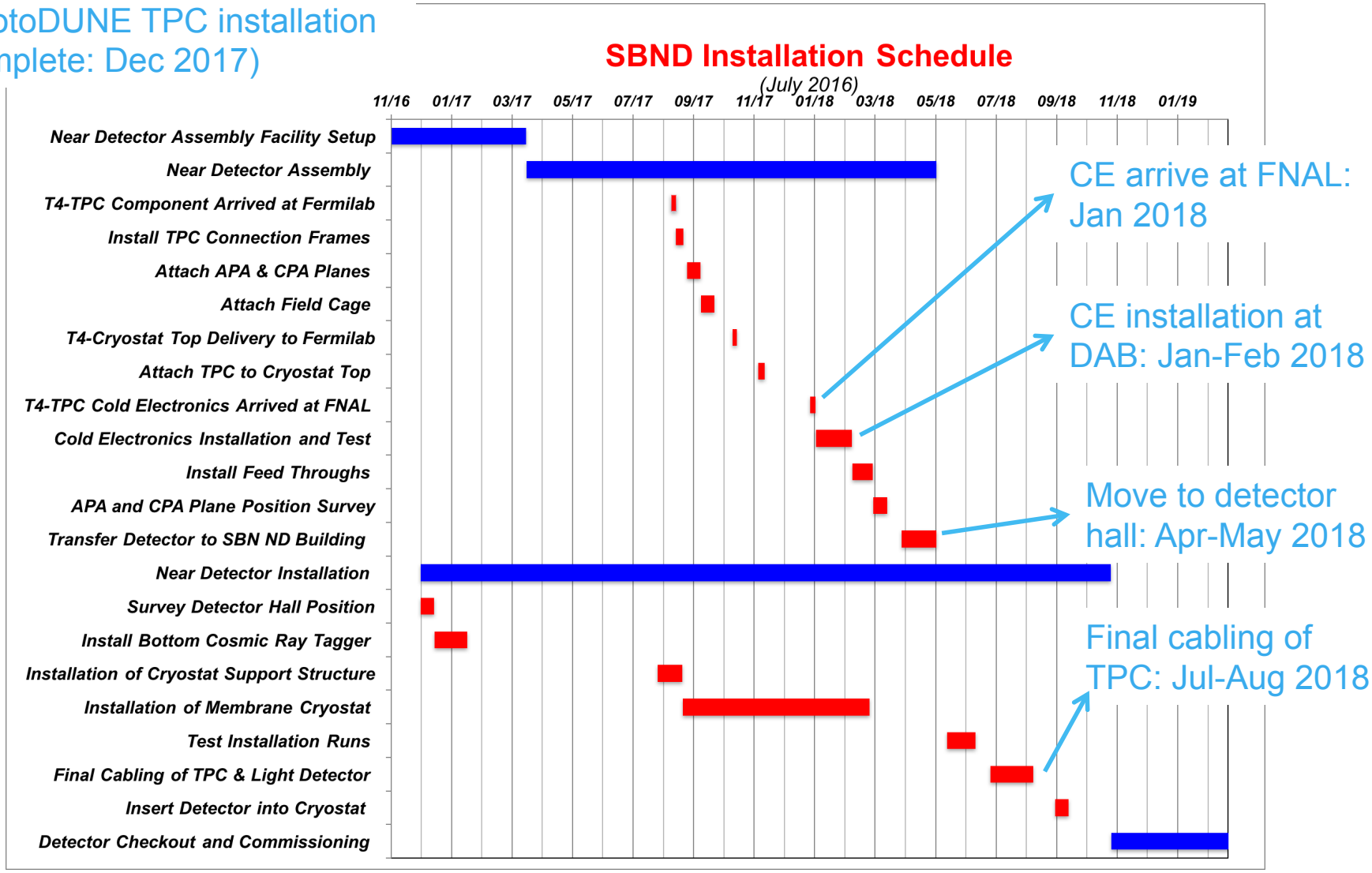
- Can be positioned at the bottom of APA where FEMB are being installed at the top
  - Full checkout of FEMB including LV power and I/O from WIB and high-speed data to WIB over 7m cable bundle

Full Readout Tests

- Work ongoing to define scope of these tests
- Minimum requirement: all electronics channels functional at installation (verify using mobile test stand)
  - Take pedestal data for each gain, shaping time, and baseline setting (32 total)
  - Real-time analysis to provide feedback to installation team
  - Results written to database for effective tracking of channel functionality (integrated with benchtop QC testing)
  - Also take data with internal pulser
- Laptop DAQ can perform same tests with WIBs once cryostat top is on
- Possibility for full readout through SBND DAQ at DAB and SBND detector building
- In this plan, installation and commissioning are not separate steps – we validate the functionality of the system at each step, commissioning as we install.

SBND Schedule

(protoDUNE TPC installation complete: Dec 2017)



Installation/Commissioning Team

- BNL
  - Hucheng Chen: SBND L2 manager
  - Elizabeth Worcester: SBND Deputy L2/L3 (Installation/Testing)
  - Matt Worcester: DUNE L3 manager
  - Other Staff Scientists: Mary Bishai (WIB testing), Veljko Radeka (system design), Bo Yu (CE integration)
  - Postdocs: Shanshan Gao (ASIC/FEMB testing), Jyoti Joshi (BNL test stand), Brian Kirby (35t, test stand software & databases), Mike Mooney (FNAL test stands), 2-3 additional hires planned
  - Engineers/Technical Staff: Jack Fried (board design, firmware), Augie Hoffman (feedthru/cables), Ken Sexton (feedthru/cables)
  - Many others in physics/instrumentation contribute to the system; those listed are expected to take an active role in installation and/or commissioning
- FNAL
  - Bill Badgett, Linda Bagby, Raquel Castillo Fernandez, Michelle Stancari (FNAL test stands)
- University of Pennsylvania
  - Shannon Glavin and David Rivera (FEMB testing at BNL and Penn)
- University of Texas, Arlington
  - Jonathan Asaadi, Andrea Falcone, Zack Williams (baby TPC)

Conclusions

- The proposed SBND installation and commissioning plan is reasonable and is designed to allow installation and commissioning to take place concurrently, allowing testing and documentation of detector functionality at each step.
- Separate cryostat lid allows test of full readout system before and after move from DAB to SBND detector building.
- Significant synergy with protoDUNE installation plans/experience since most system components are identical or nearly identical.
- SBND installation occurs somewhat later than protoDUNE, allowing some experts to participate in both installations.
  - protoDUNE CE installation: August-December 2017
  - SBND CE installation: January-August 2018
  - SBND installation team sufficiently disjoint from protoDUNE team to alleviate risk of over-commitment
- SBND installation team gaining expertise now as we work to study electronics performance and design electronics testing procedures; much of the testing infrastructure being developed now will be used during the installation.