

ProtoDUNE-SP Installation and Commissioning

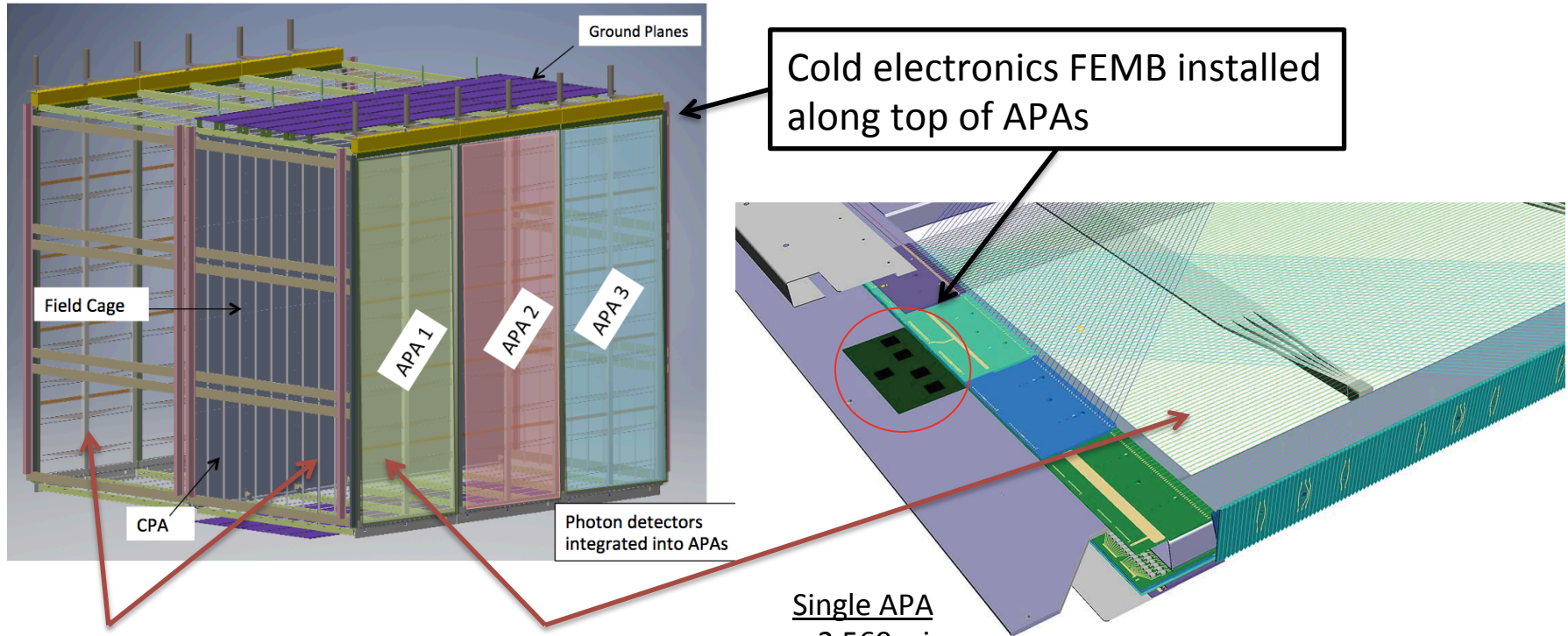
Matthew Worcester (BNL)

Cold Electronics Review
October 13, 2016

Outline

- ProtoDUNE-SP design
- Installation plan
- Installation team
- Commissioning
- Conclusions

ProtoDUNE-SP Design



Two drift volumes

- 3.6 m long
- 500 V/cm field
- 3 ms e^- lifetime

3 APA per drift volume

- 6 m long
- 2 induction/1 collection/
1 grid plane
- electrically isolated from
each other

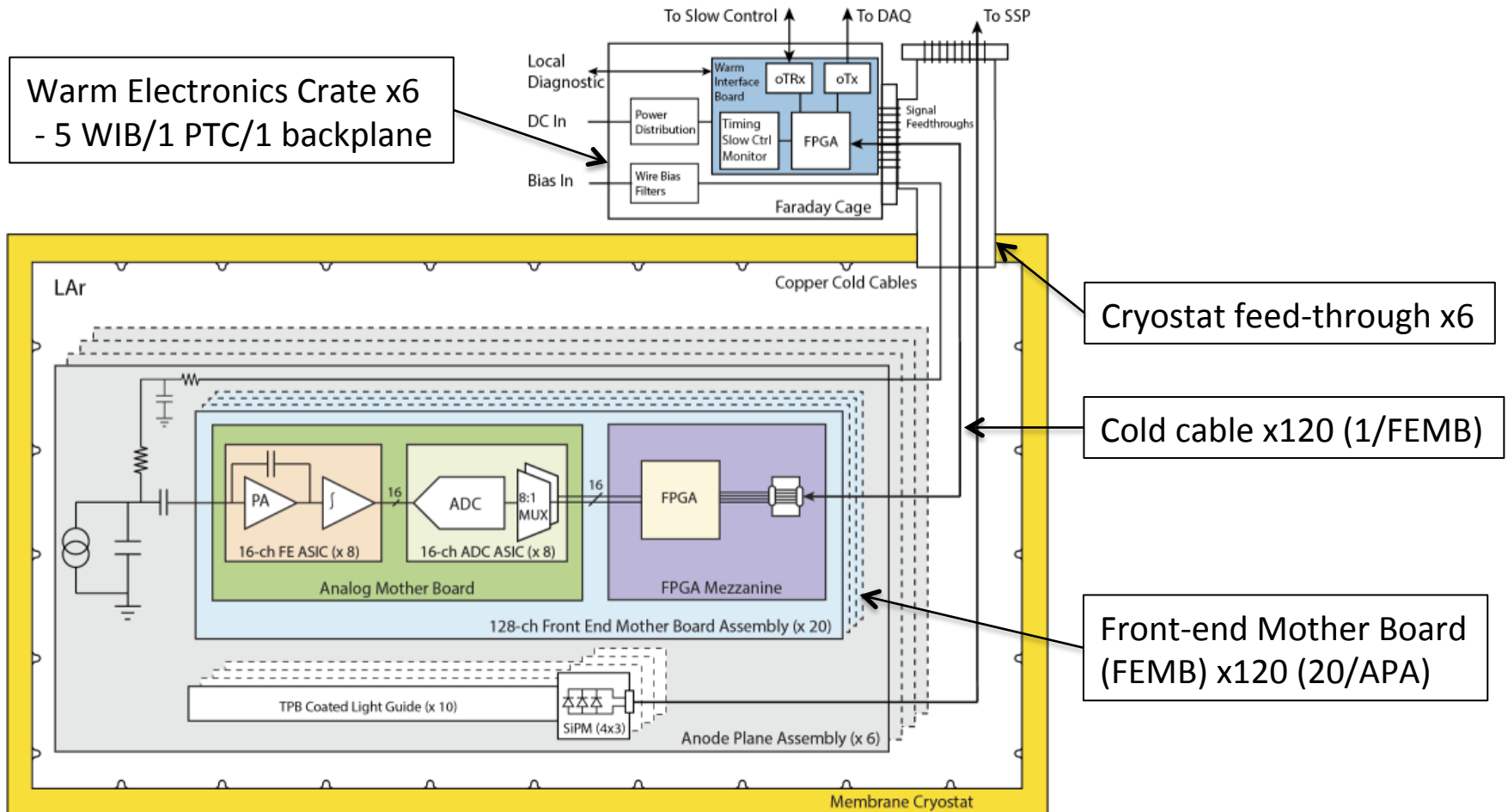
Single APA

- 2,560 wires
- 20 FEMBs x 128 channels/board

Entire ProtoDUNE-SP TPC

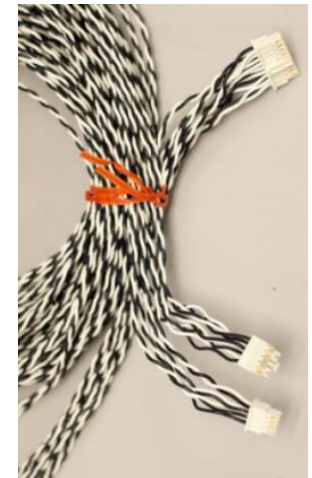
- 15,360 readout channels from 6 APAs
- 1 APA readout per signal feedthrough (20 cold cable)

ProtoDUNE-SP Cold Electronics

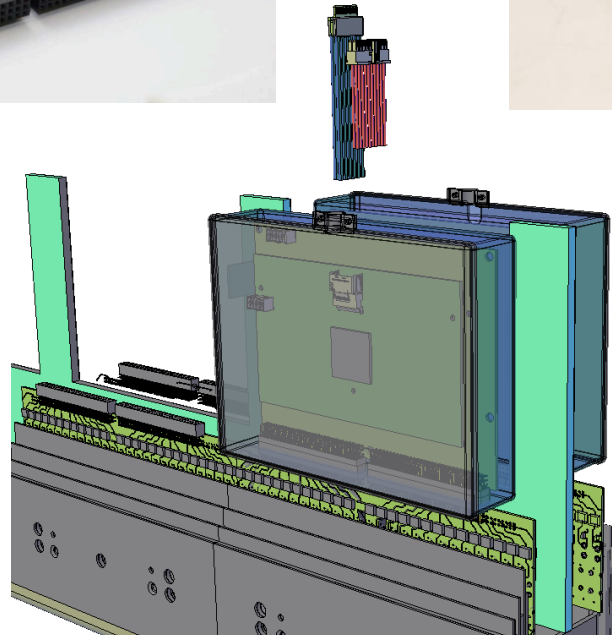


Cold Components

FEMB: 128 channels

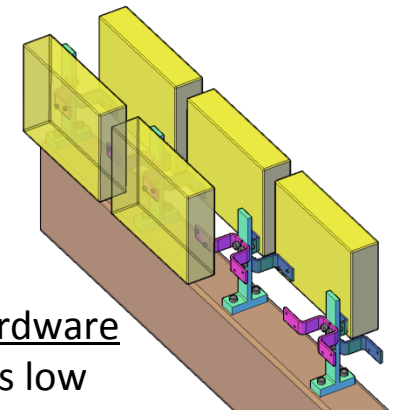


FEMB are individually enclosed in a Faraday box which provides connection to the APA frame and cable strain relief



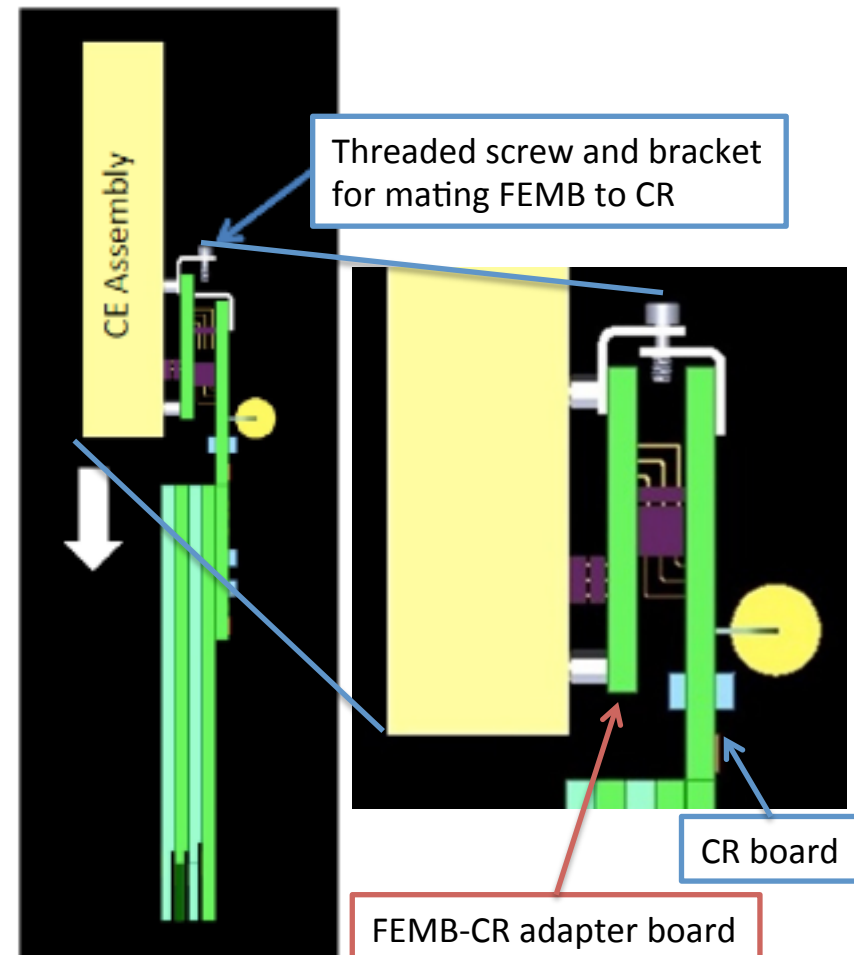
Cold data and LV cable: 7m long
- one bundle of each per FEMB

Attachment hardware
to APA provides low impedance connection



Pre-Installation

- All FEMB will be pre-assembled into the Faraday box
 - Cables attached and full validation at BNL
- FEMB-CR adapter board reduces stress on CR board during installation on APA
 - Will be attached to Faraday box at BNL and connectivity test done
- Complete FEMB/cable/adapter units will be shipped to CERN after validation
 - Units will not be disassembled
 - ~25 in April 2017 for APA1
 - ~120 in Aug-Sept 2017 for installation on APA2-5
- Full cryo validation of assembled units in LN2 at BNL and in gas N2 cold box outside of cryostat
 - Components will only need to be visually inspected for damage and warm connectivity tests done after receiving at CERN
- Storage will be needed in ENH1
 - FEMB units not large or heavy



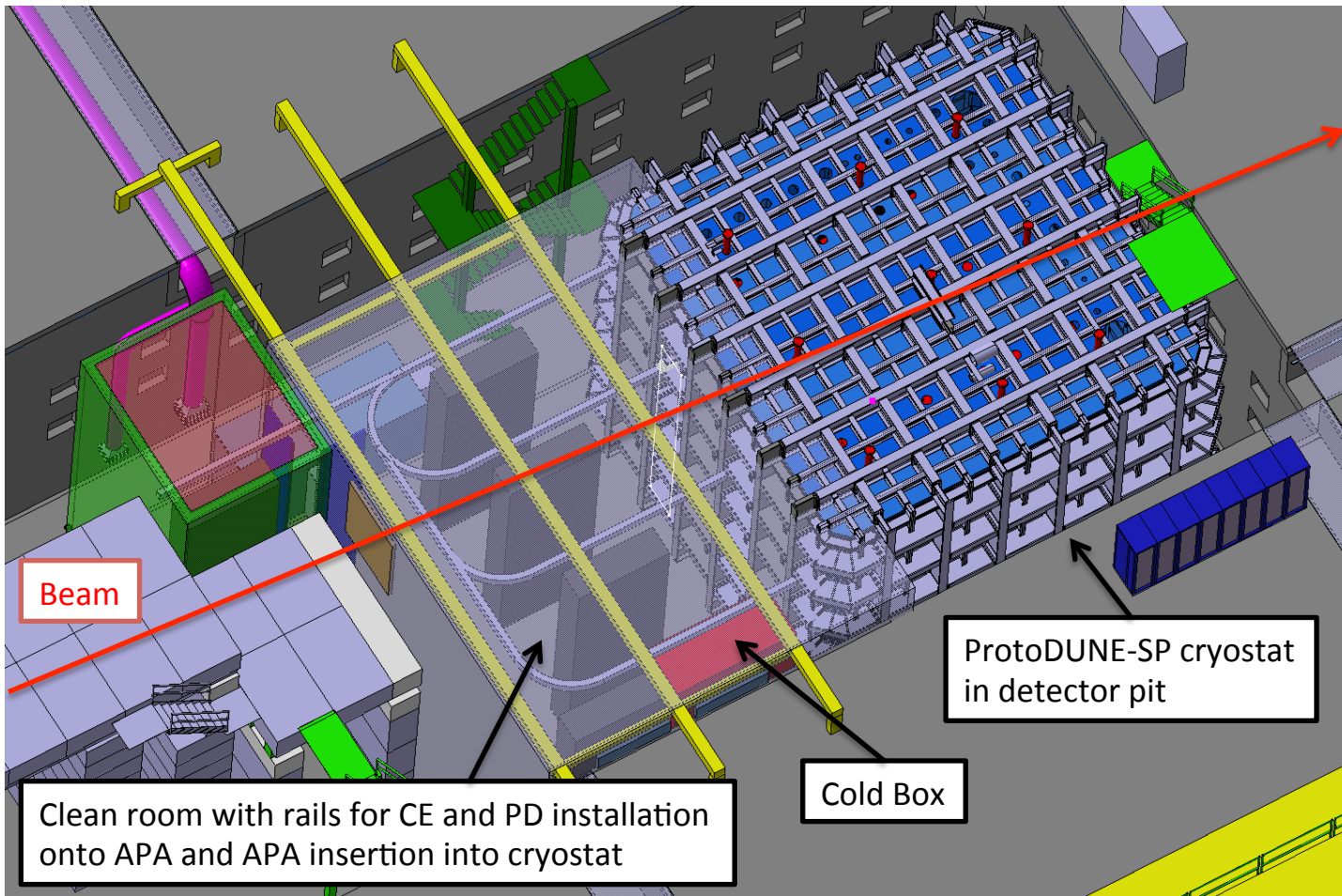
Electronics Mobile Teststand

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

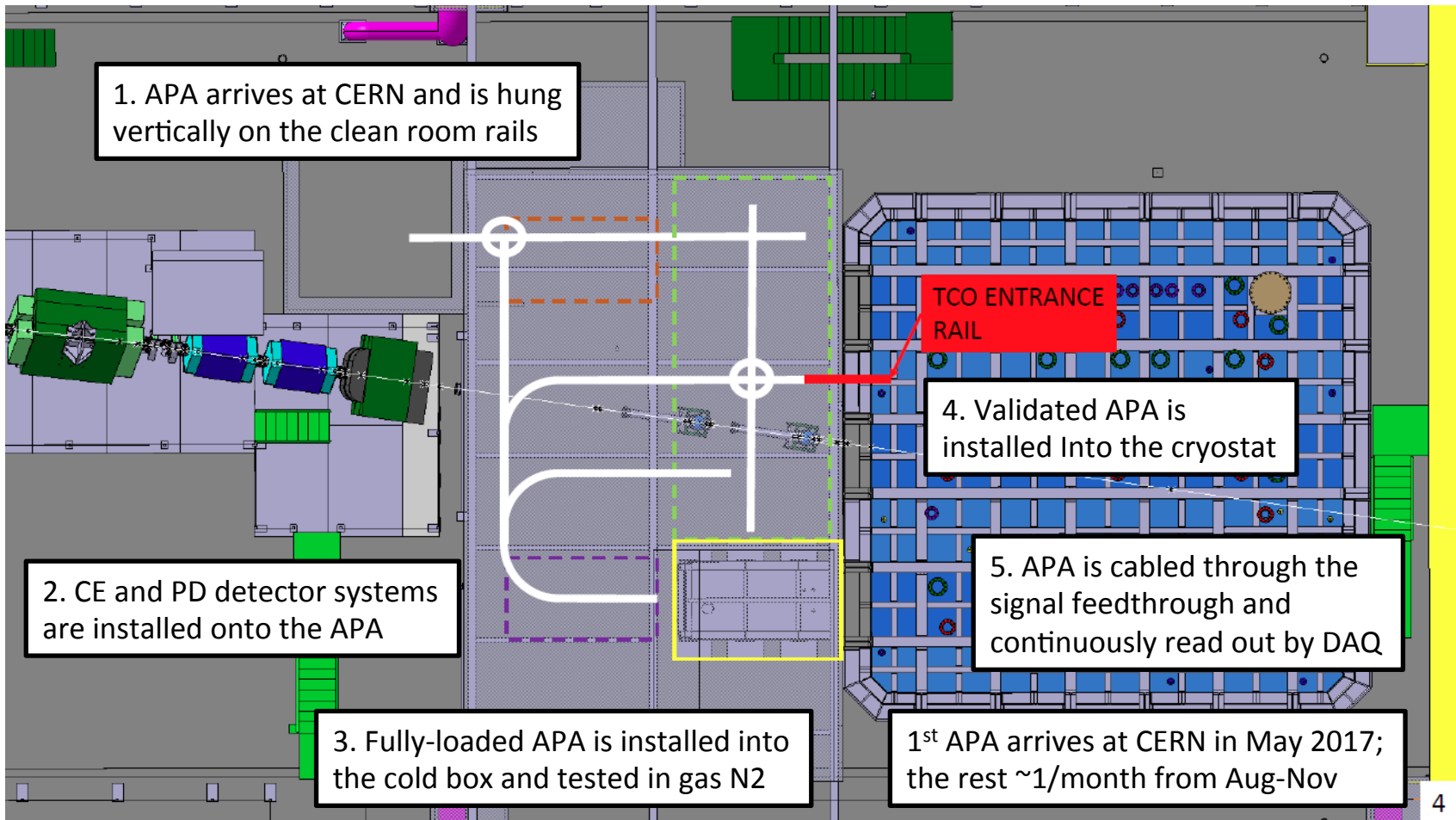


- Can be positioned at the bottom of APA where FEMB are being installed at the top
 - Full checkout of FEMB including LV power and I/O from WIB and high-speed data to WIB over 7m cable bundle

Cryostat and Clean Room at CERN

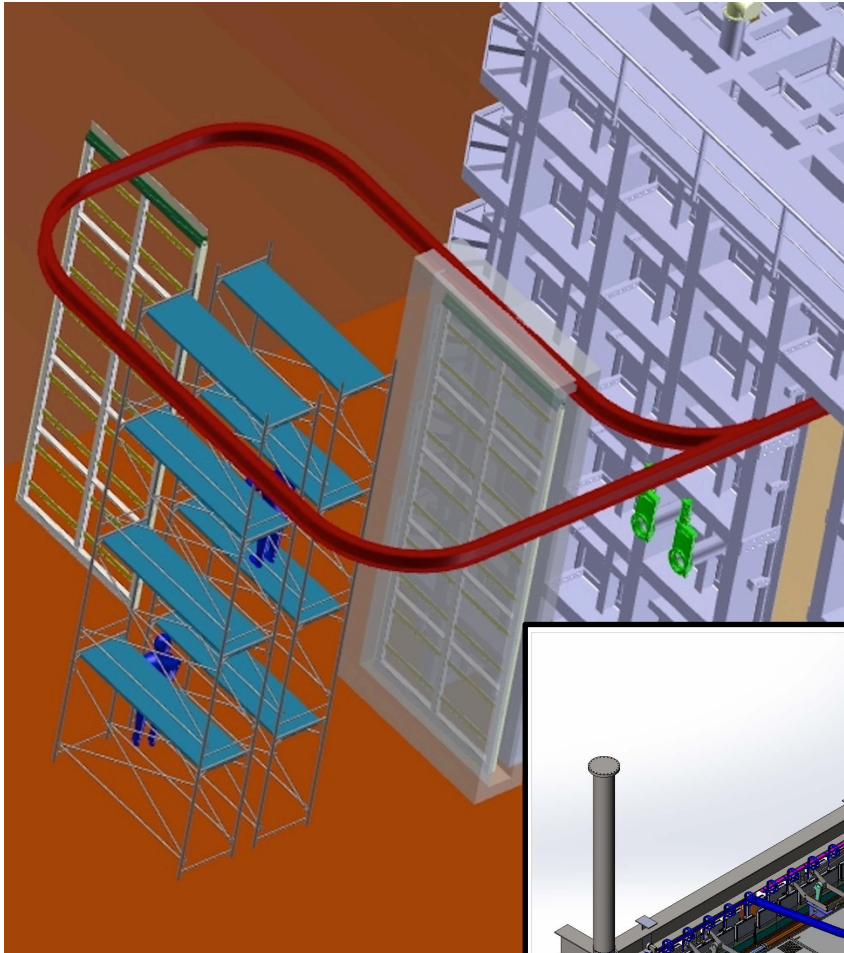


TPC Installation Plan

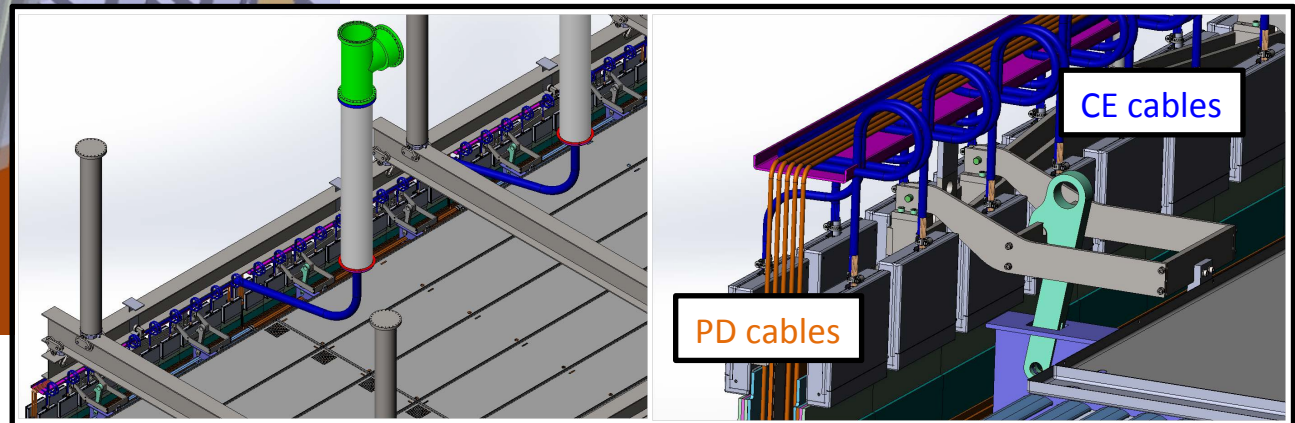


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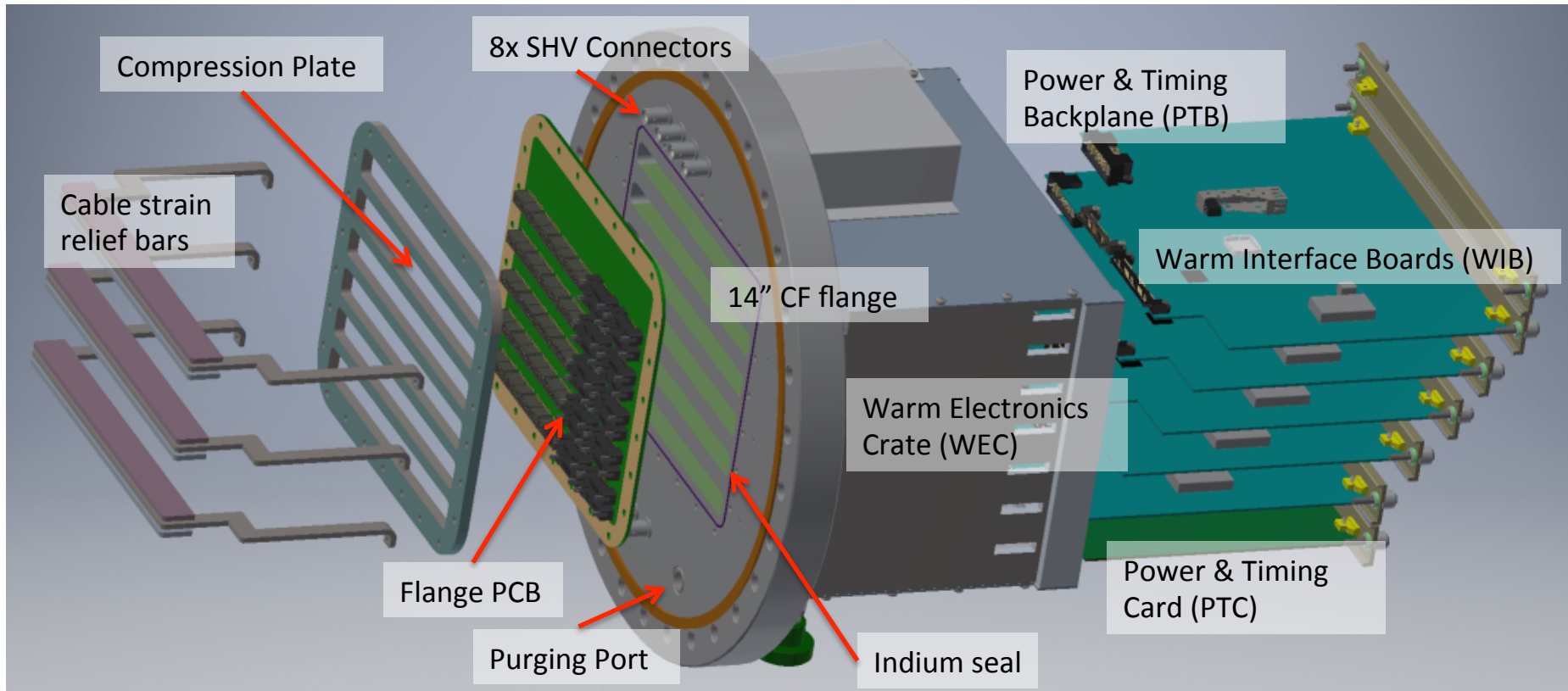
CE Installation on Vertical APA



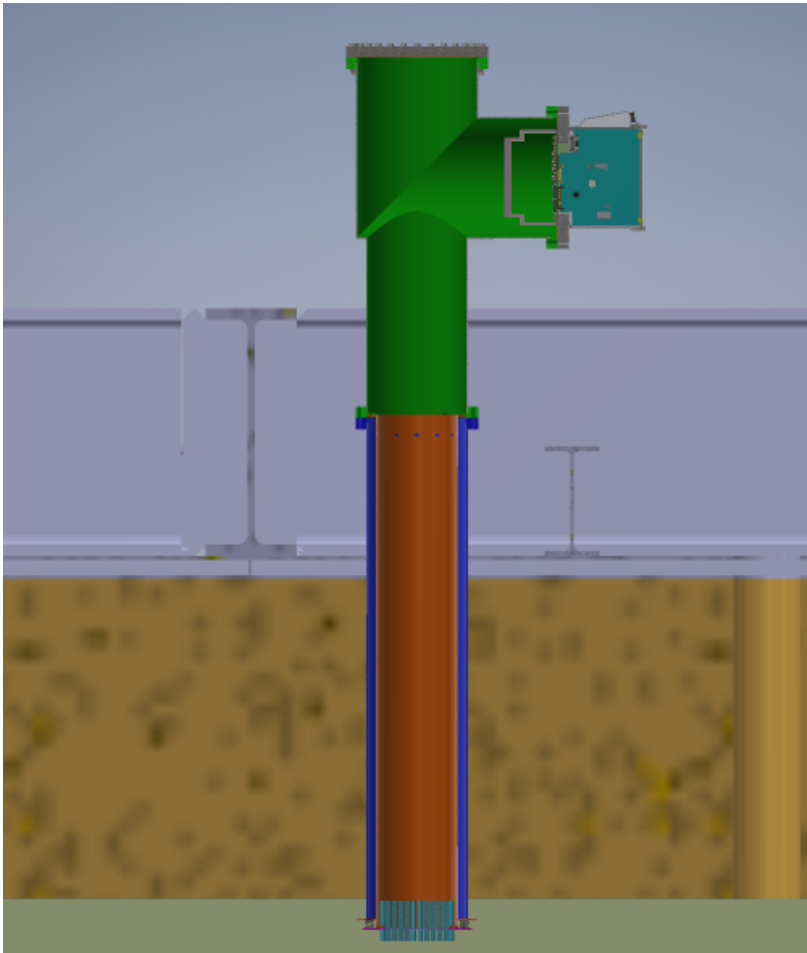
- Utilize access equipment to reach the APA top: scaffolding or lift
 - PD detectors (10/APA) require access to multiple heights
 - CE installation will all be done at the top level
- CE box will be attached to the top of the APA with cables attached
 - Plugged into CR board and hardware attached
 - Cable lowered to mobile teststand and full checkout done
 - Cable routed along cable tray
 - Extra cable supported by the APA frame while APA is moved into the cold box and cryostat
- Modular design allows easy replacement by spares if necessary



Warm Components



Feed-through Installation



- Signal feed-through T will be connected to perforated inner tube and lowered on top of crossing tube
 - Requires overhead crane and 2-3 people
- Flange PCB and WEC will be attached to stainless steel flange
 - CF flange will be held off T port by a fixture allowing access to both sides of flange
- Warm electronics installed
 - As each WIB is installed in the WEC it will be tested with the laptop DAQ from the mobile teststand
 - Full functionality test of full crate will be done with DAQ after assembly
 - WIB and PTC are easily swappable with spare boards for testing and debugging
- First fully loaded flange will arrive at CERN by April 2017
 - Installed on cold box for APA1 tests
- Signal feed-throughs and flanges for cryostat roof will arrive prior to APA1 installation in the cryostat in August 2017

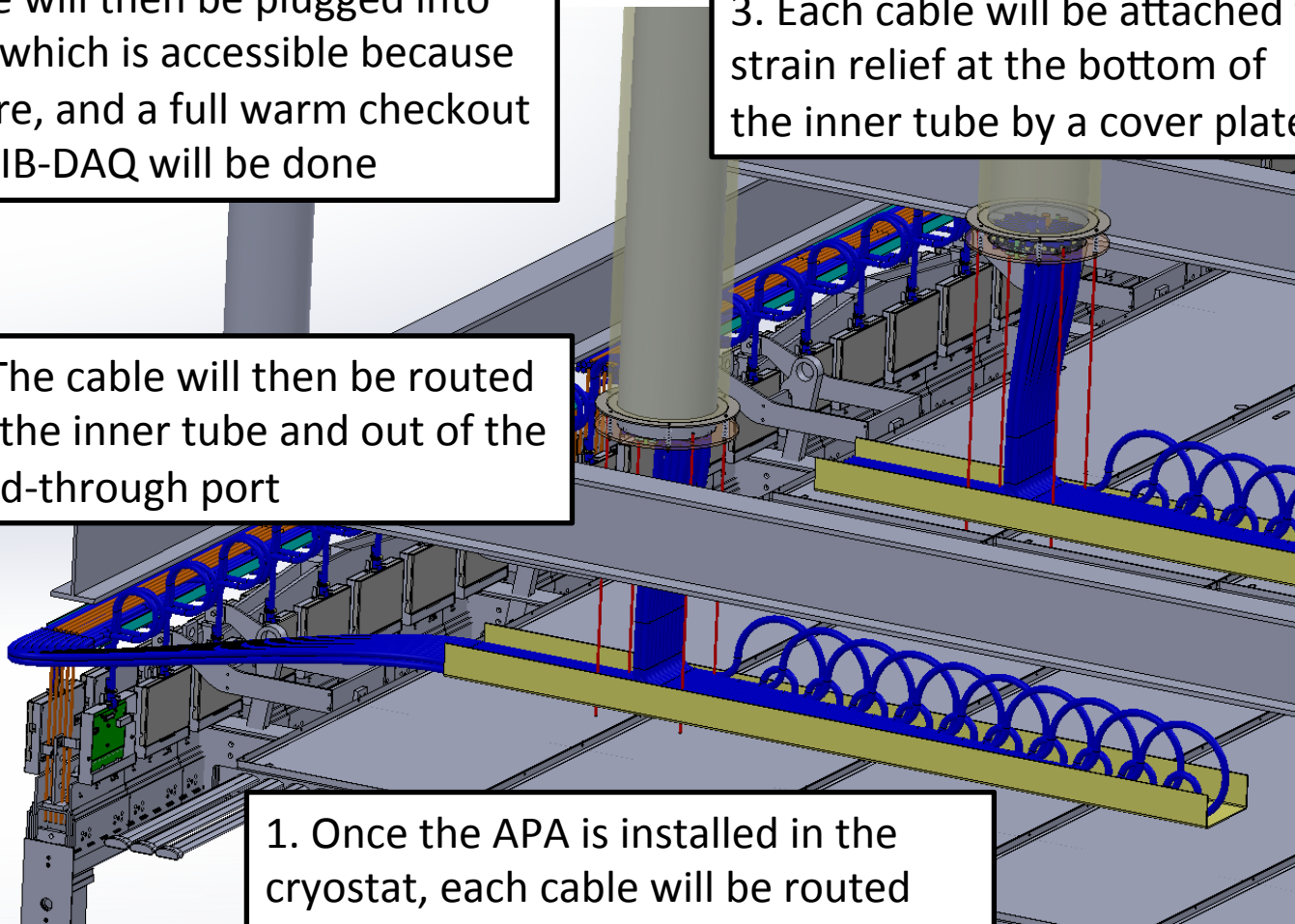
Installation Inside the Cryostat

4. The cable will then be plugged into the flange, which is accessible because of the fixture, and a full warm checkout of FEMB-WIB-DAQ will be done

3. Each cable will be attached to strain relief at the bottom of the inner tube by a cover plate

2. The cable will then be routed up the inner tube and out of the feed-through port

1. Once the APA is installed in the cryostat, each cable will be routed along a cable tray under the chimney



CE Installation Team

- BNL
 - Hucheng Chen, Bo Yu, Jack Fried, Ken Sexton, Augie Hoffman, Jyoti Joshi, Shanshan Gao, Mike Mooney, Brian Kirby, Mary Bishai, Elizabeth Worcester, [Matt Worcester](#)*
 - 2 new additional post-doc hires planned
- MSU
 - Dean Shooltz, Mike Nila, [Jake Calcutt](#), Kendal Mahn, and [Carl Bromberg](#)*
- LSU
 - Justin Hugon and [Martin Tzanov](#)
- Fermilab
 - Terri Shaw and Linda Bagby (focus on grounding)
- Others for help as needed
 - Hans Berns (UC Davis), Eric Hazen and Dan Gastler (Boston), BNL scientific staff

* CE installation co-coordinators
> 5 months at CERN in 2017

Cold Commissioning

- Detector commissioning after filling: May-July 2018
 - MicroBooNE commissioning “took ~one year to understand and remove/reduce the excess noise effects, to be left with the remaining FE ASIC noise” (V. Radeka)
 - 35-ton commissioning was hampered by lack of real-time local diagnostics once the cryostat was filled
 - Current design includes option to read out 2 channels of analog waveforms/ FEMB plus real-time digitized waveform readout at flange
- Cold electronics tests to be performed:
 - Baseline uniformity and RMS noise on all channels
 - Identify any channel with loss of performance after LAr filling
 - Both MicroBooNE and 35-ton lost channels at or immediately after cooldown
 - Gain calibration with FE ASIC pulser
 - Cross-check with injectable pulser from FPGA
 - ADC linearity measurement
 - Including stuck code analysis

Conclusions

Is the proposed joint ProtoDUNE-SP/SBND production, installation, and commissioning plan reasonable?

- An installation and commissioning plan has been developed to meet the ProtoDUNE-SP schedule
 - Strategy to install both cold and warm components
 - Full warm checkout of each component
 - Easy replacement of all units with spares
 - Full APA checkout cold before installation into cryostat
 - Mobile teststand for validation and debugging
 - Manpower planned to handle installation activities
- Need to develop documentation for installation procedures