

Single-Phase Photon System Future Testing/Development Plans

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Single-Phase Photon Detector Consortium

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Primary Development Efforts

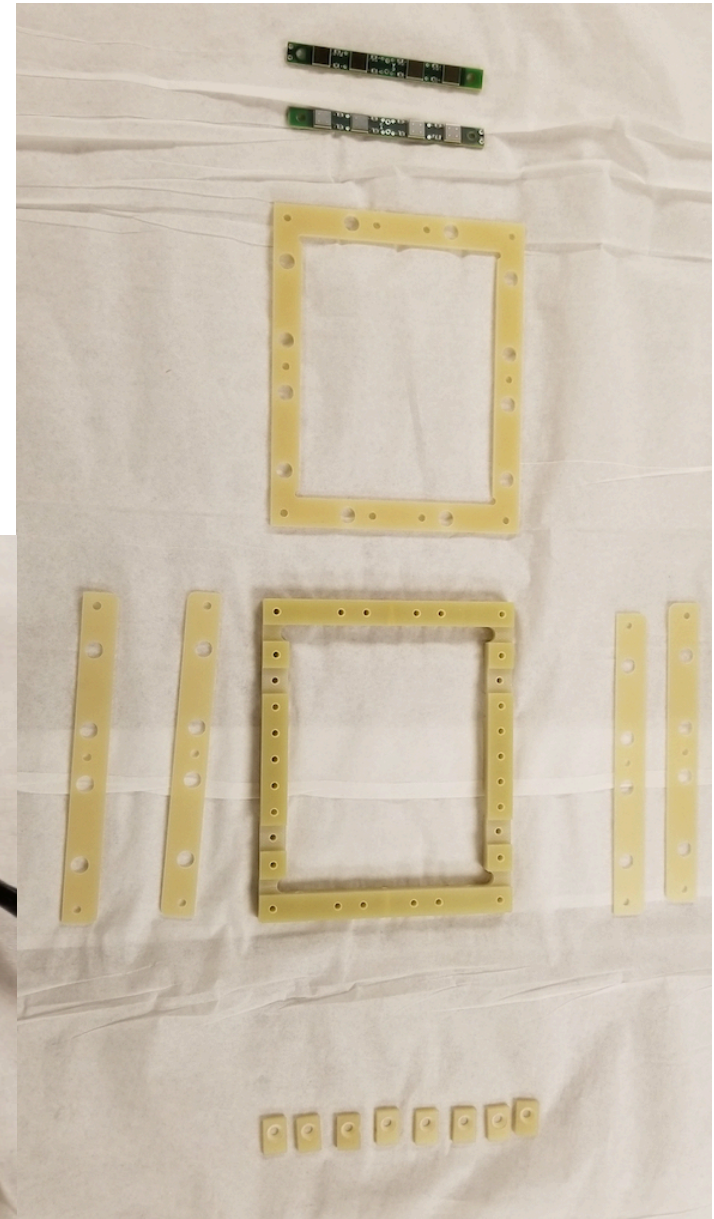
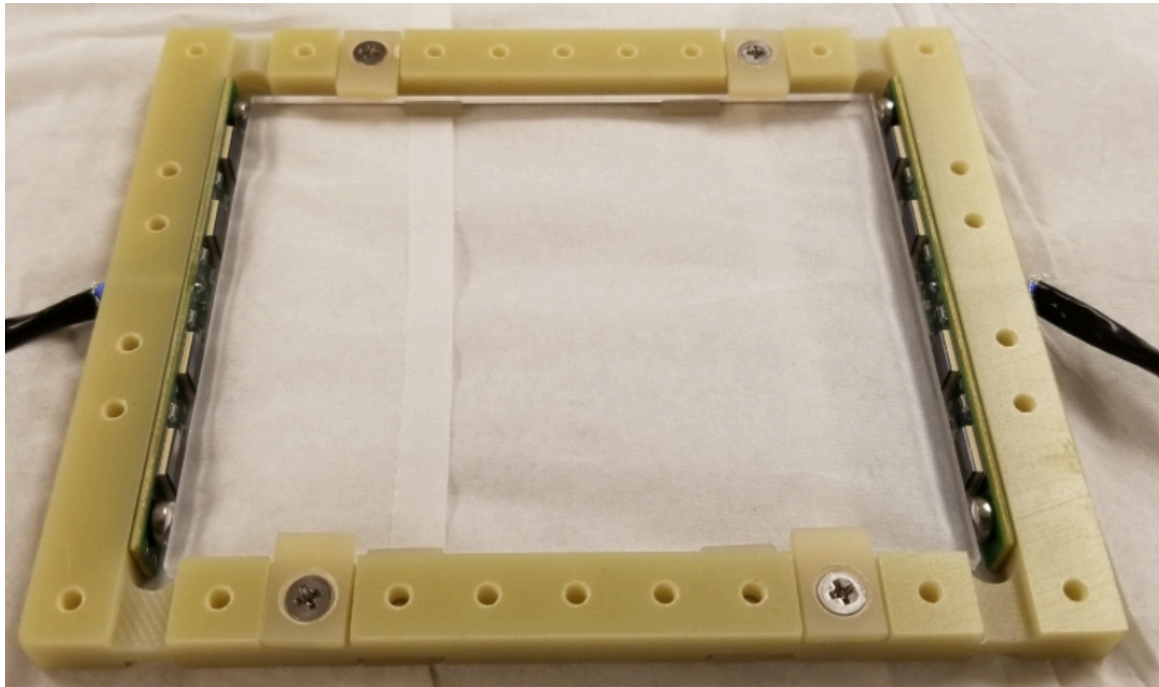
- Immediate (before TDR):
 - ProtoDUNE
 - Brazil single-cell X-ARAPUCA (X-A)
 - Iceberg-- Run 1
- Medium-term (Before CD-2)
 - Vacuum Monochromometer X-A testing (Brazil)
 - ICEBERG-- Run 2,3(?)
 - PD/APA/CE interface testing (Ash River)
 - Cable/connector testing (CSU)
 - Radiological/environmental testing (SDSM)
 - WLS coating performance/stress testing (Syracuse, Brazil)
- Long-term (Before pre-production reviews)
 - ProtoDUNE II
 - Additional testing at ICEBERG

ProtoDUNE Run 1 (See Cavanna talk)

- 2 single-sided ARAPUCA modules operating successfully in ProtoDUNE
- Expect short-term results on:
 - Relative performance of PD bar technologies
 - Absolute detection efficiency (with cosmics)
 - Long-term stability (coatings, photosensors, etc.)
 - Validation of monitoring system
 - Validation of fundamental design

Single-Cell X-ARAPUCA

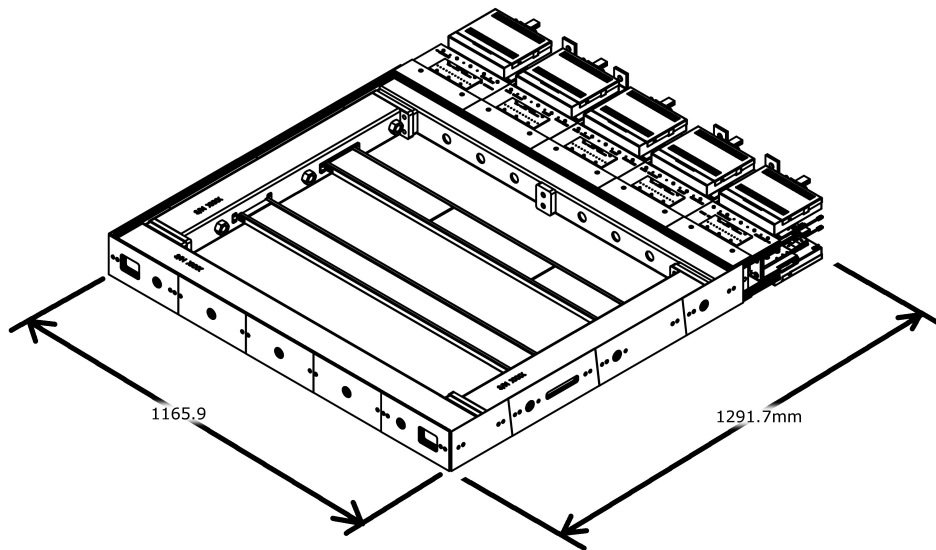
- First tests of X-ARAPUCA cell in LAr planned for week of 11/19 in Brazil
- 100 X 78mm double-sided cell



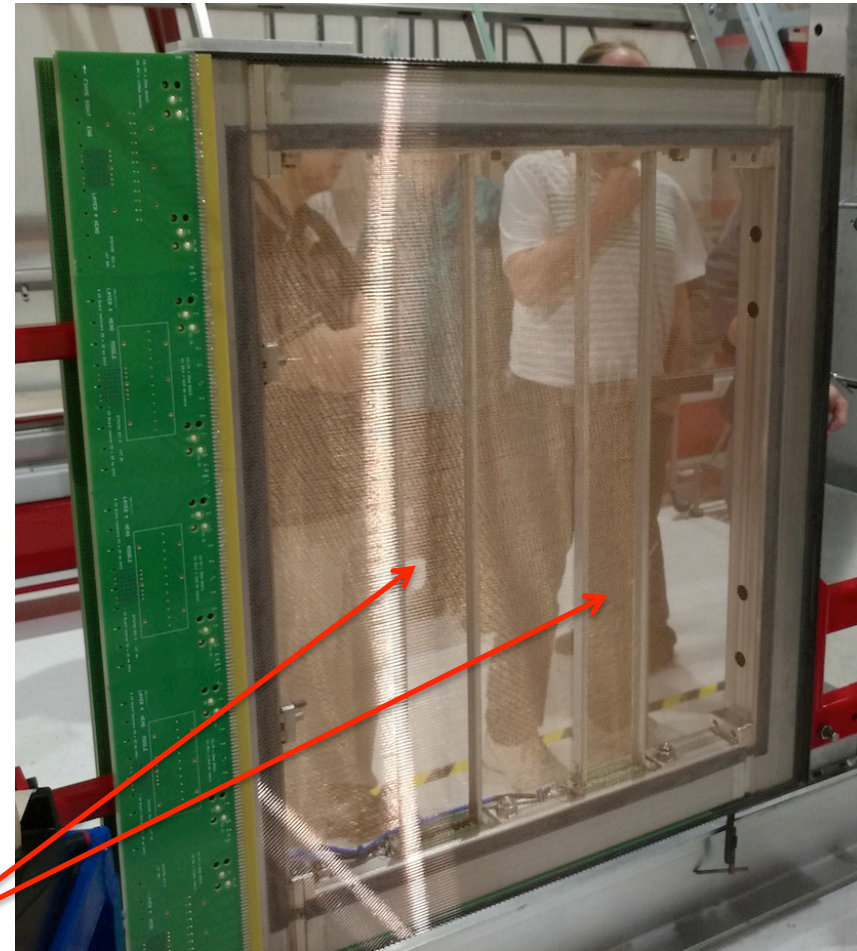
SP-PD ICEBERG Tests

- Primary goals of testing:
 - Tests of single-sided ARAPUCA and single-sided X-ARAPUCA with TPC track information-- Similar to ProtoDUNE
 - Comparison of SSP and mu2e electronics
 - Mu2e DAQ interface available for second run (Winter 2019)
 - Interference testing between CE and PD electronics
 - Comparison of active ganging circuit prototypes
 - Available in second test run
 - DAQ/TPC interface
 - DUNE FD PD cabling scheme

ICEBERG APA Frame

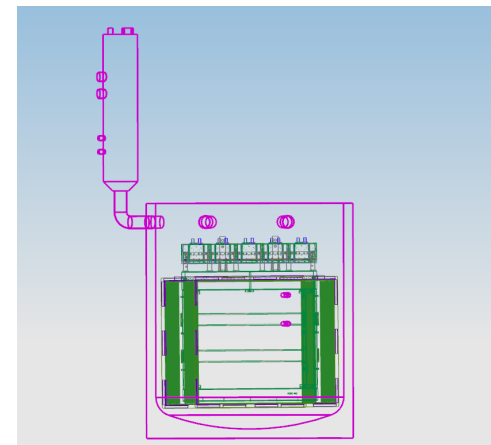
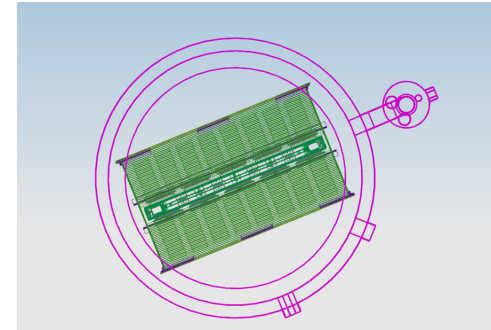
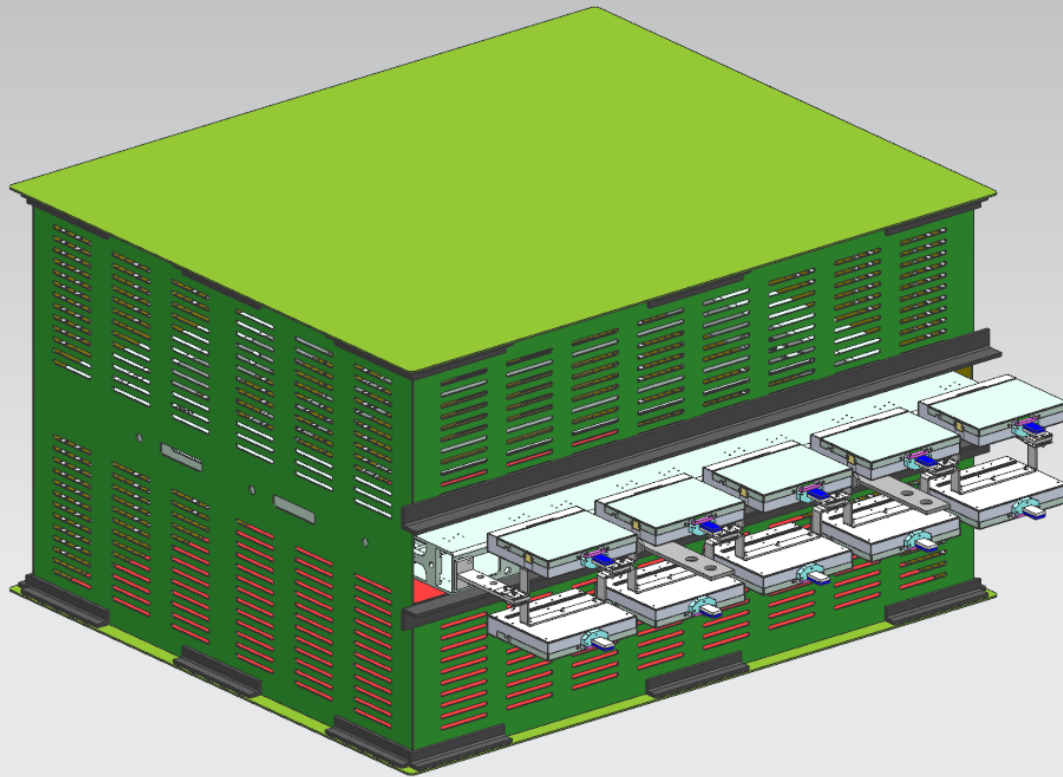


Note: Dimension is to the edge of the CE box. Cables or strain reliefs extending past the CE box take additional space.



PD rails

Full ICEBERG TPC



Schedule (as of November 12)

No	Major Milestones	Date
1	DAQ system Ready at PAB	8/31/18
2	APA Delivered to Fermilab	9/17/18
3	128 Channel of FEMB/WIB readout with DAQ with FEMB cold in CTS	9/17/18
4	1280 Channels of Full Electronics received from BNL	9/17/18
5	TPC Build at Fermilab	10/1/18
6	1280 Channels of CE and WIB Electronics tested at Fermilab without TPC but its cables in Cryogenic Test Stand with DAQ	10/1/18
7	1280 Channels of CE Electronics Installed on TPC	10/12/18
8	1280 Channels CE and WIB tested on TPC (Warm) with DAQ	10/26/18
9	Cryostat Ready for TPC	11/9/18
10	TPC Moved in cryostat	11/12/18
11	Test of TPC in cryostat with CE warm	11/16/18
12	Start of cooldown of Cryostat with TPC	11/19/18
13	Test of ProtoDUNE CE with TPC in Lar	12/14/18
14	Test of New CE with TPC in Lar	3/15/19

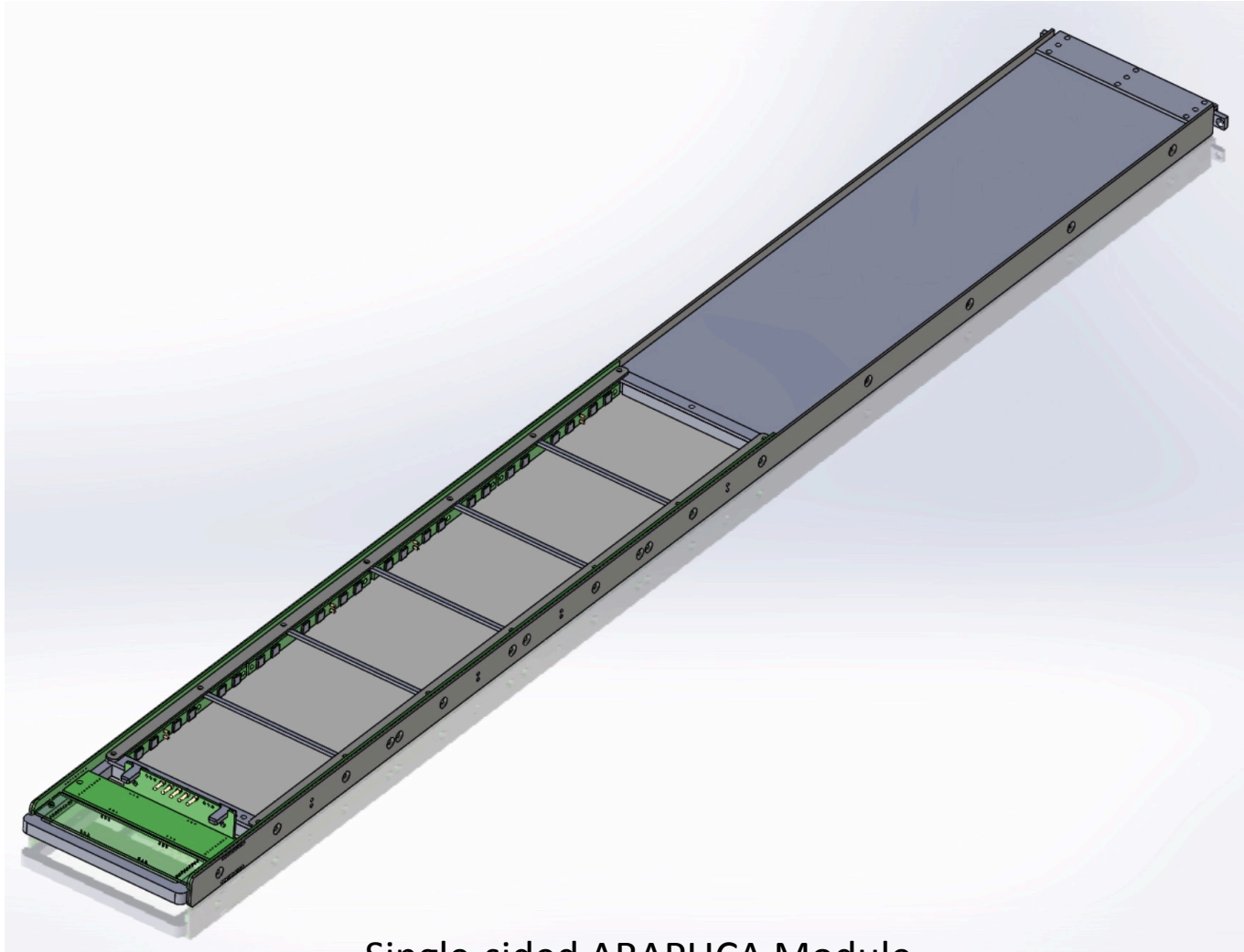
PDs needed for installation ~ 11/26/18

Initial Cool-down begins (11/29/18)

First Test Run ~ 12/14 – 12/24(?)

Second Test Run ~ March 2019

PD Mechanical



Single-sided ARAPUCA Module

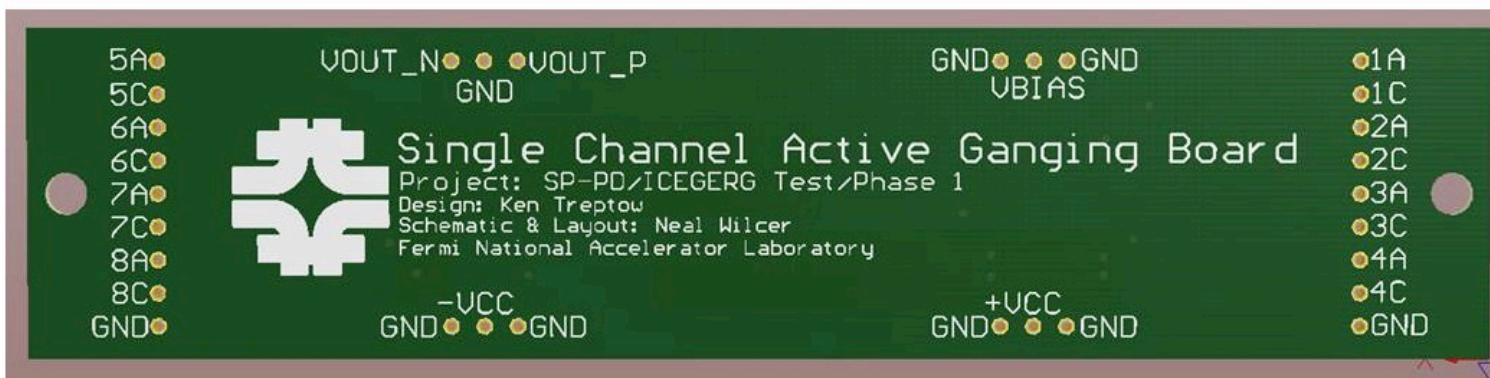
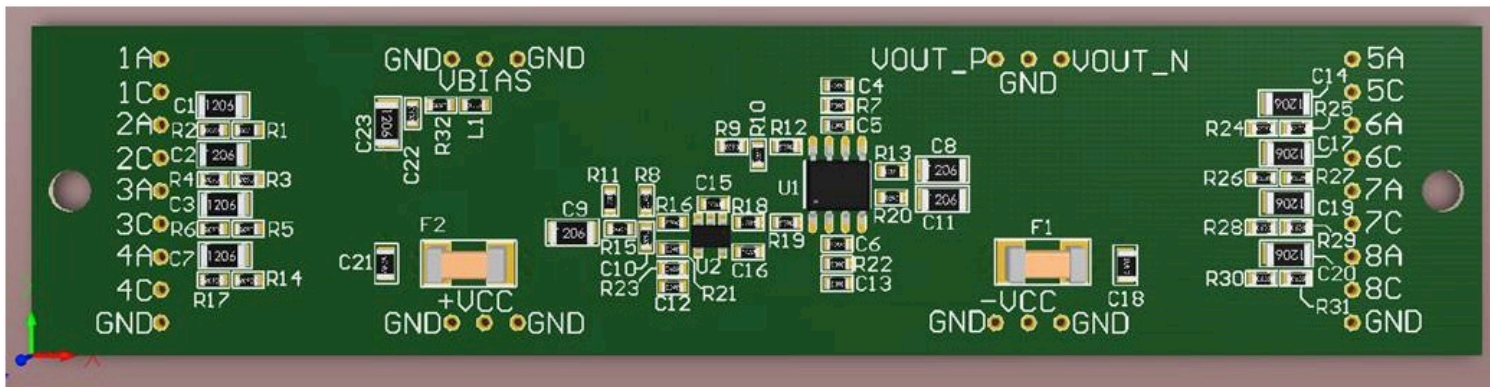
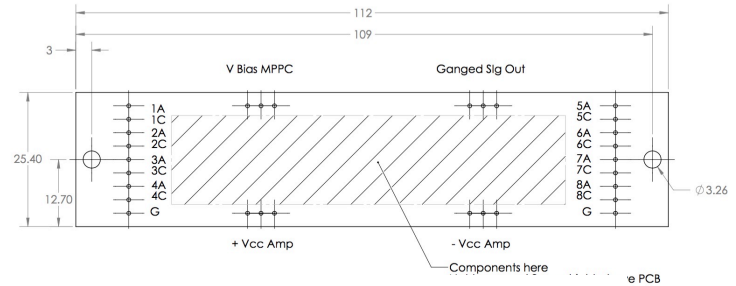
Current Module Status

- Frame components fabricated and tested (ARAPUCA and X-ARAPUCA)
- Scheduled to arrive FNAL 11/13
- Filter plates/Vikuiti being coated at FNAL-- ready 11/14(?)
- Assembly 11/13-14
- Installation no later than 11/26



PD Design Status

Active Ganging PCB



From Neal Wilcer/Gustavo Cancelo

PD Module Plans

- For Test 1 (December 2018)
 - Two supercells (one in each slot)
 - One Single-Sided X-ARAPUCA
 - One Single-Sided ARAPUCA
 - FNAL Active Ganging
 - SSP/mu2e stand alone comparisons
 - Mu2e not fully integrated into DAQ
- For Test 2 (March 2018)
 - Four supercells (two in each slot)
 - Two ARAPUCA, two X-ARAPUCA
 - FNAL and Latin American Active Ganging
 - Fully-integrated SSP and mu2e readout through DAQ

Readout Electronics

- Primary readout in test 1 will require an SSP modified for MPPCs (50V) and ideally for RJ-45 connectors)
 - Funding secured to upgrade existing 35T SSP to ProtoDUNE standard
- Secondary readout will be provided by the mu2e electronics system.
 - System is making good progress-- still on track for December use.
- Working to understand data analysis/DAQ integration plan.

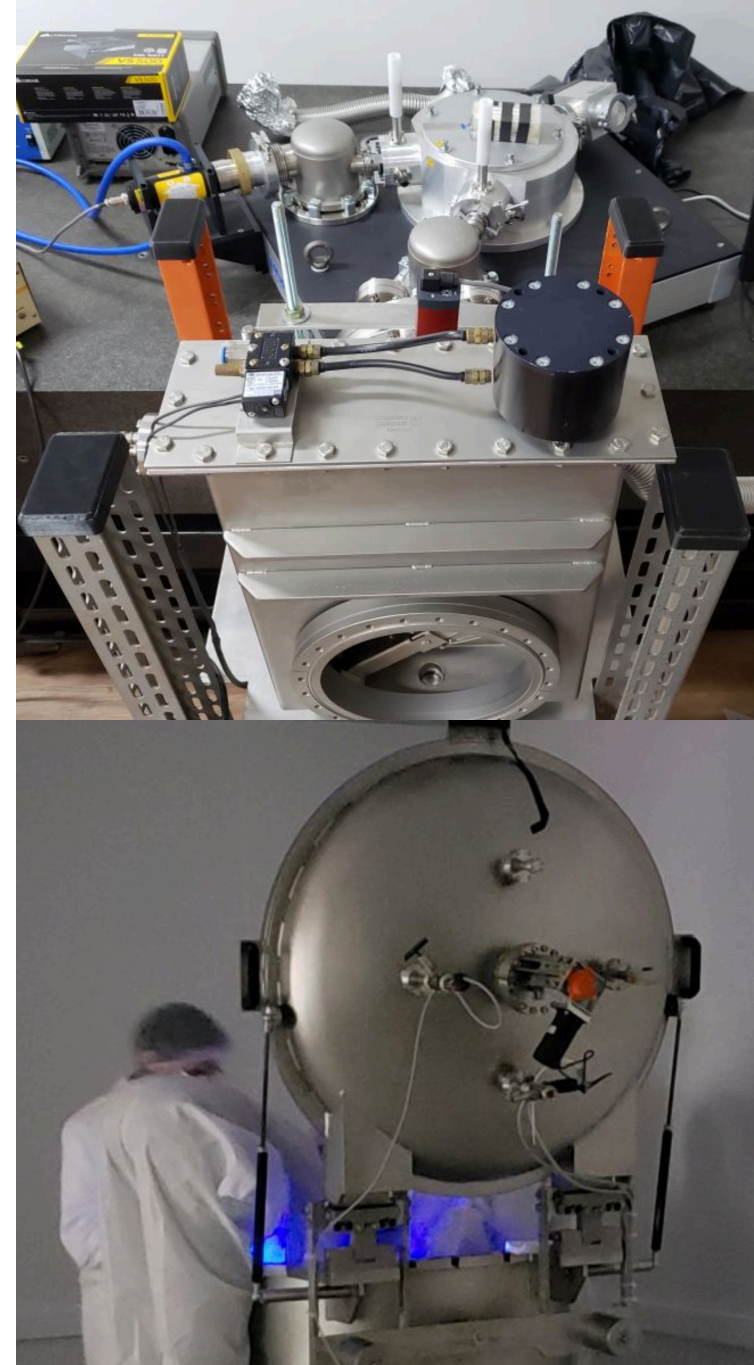
WLS Coating (Syracuse)

- WLS performance studies of different coating/substrate combinations
 - VUV measurements in scanning X-Y scanning chamber (shown)
 - 430nm light transmission measurements through filters/coatings (reflector foil studies)
- Testing thermally-stressed (rotated in LAr bath) coated substrates in X-Y scanner before and after stressing.



VUV Monochrometer Coatings,

- Component and prototype testing is underway in Brazil, focusing on
 - Coating filters and reflectors using in-house vacuum deposition
 - Testing of coated samples in VUV monochrometer
 - Testing of ARAPUCA and X-ARAPUCA prototypes in monochrometer

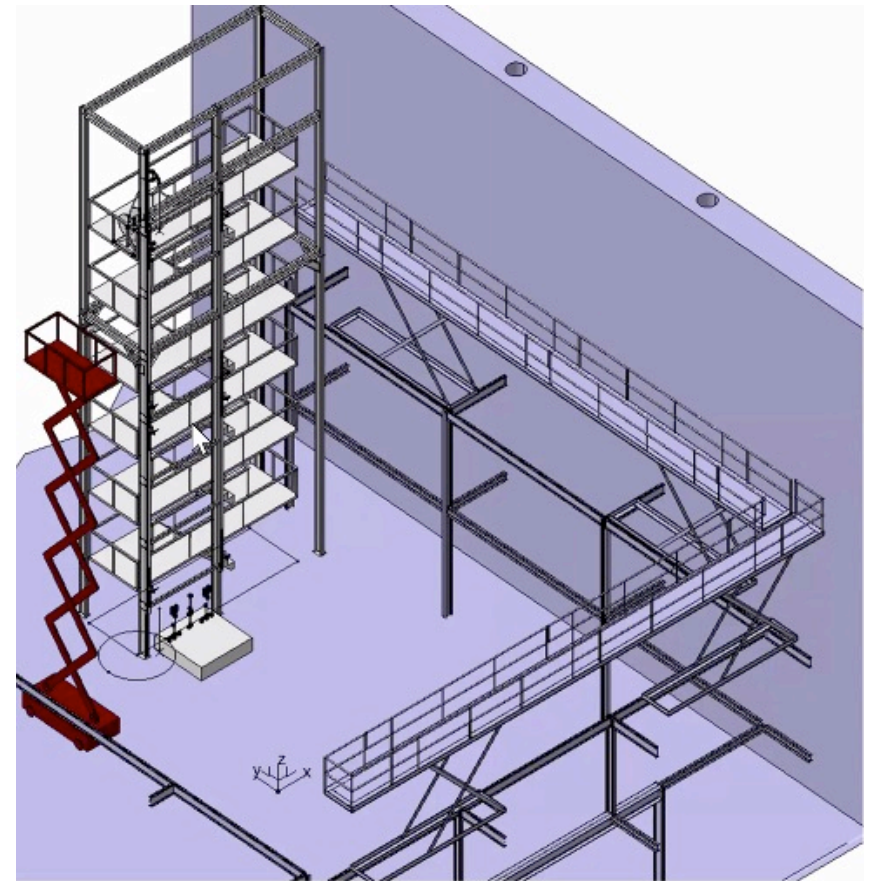


Materials/Environmental testing

- Materials testing will continue at SDSM
- Important studies will include
 - Effects of elevated temperature on PD WLS coatings
 - Humidity effects
 - Lighting requirements, both long and short term, to validate pre-35T measurements

APA-PD-CE Interface Ash River

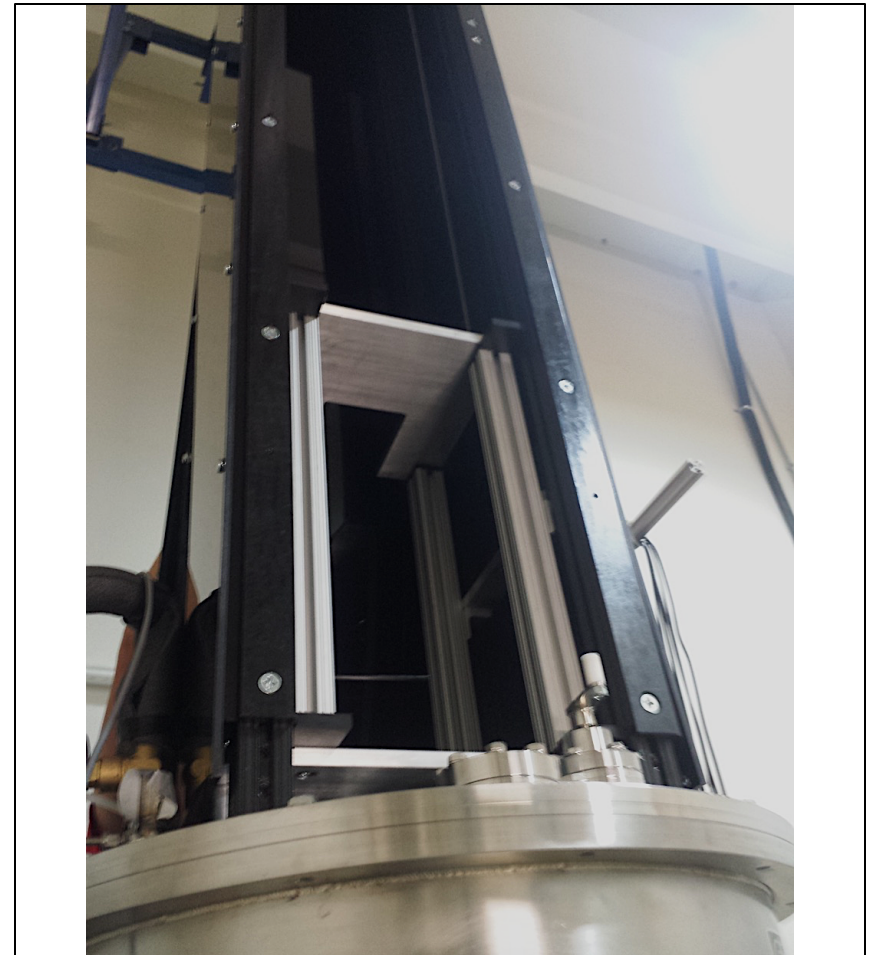
- Full-scale testing of APA-PD-CE integration/ installation will occur at Ash River
- Will allow testing of
 - Connection of upper and lower APA frames with PD cables
 - Practice of PD installation
 - Testing of full length PD cable suite
- Planned for Spring, 2019



APA Assembly Area at Ash River

Cabling, Full-Scale Module Testing

- Full scale (Up to 2.5m) modules can be tested in the CDDF Cryosat at CSU
- Allows for testing of
 - Internal cable connectors
 - Full-scale module contraction effects
 - Full-scale cryogenic performance qualification
- Capable of operation with LAr for PD module design qualification



ProtoDUNE Second Run

- A potential second ProtoDUNE run offers several opportunities to the PD consortium
 - Tests of multiple full-size PD modules inside a TPC to confirm the final design
 - Opportunities to test PD performance enhancers
 - CPA reflector foils
 - Xenon doping
- Significant resources would be required for such a run, and would need to be identified
 - Financial
 - Labor/Engineering/ Scientist

Summary

- Additional development of the X-ARAPUCA/PD system design is planned for the short, Medium and long term.
- All major areas of uncertainty will be covered by these plans
 - Mechanical design/component selection
 - Interfaces
 - Electronics/readout
 - Performance
- Our development plan will leave us with a 60% design by the time of the TDR, and ready for CD-r in late FY2019

Radiological Testing

- From Juergen, coming