

A decorative horizontal line consisting of a teal segment on the left and an orange segment on the right.

BDE Prototyping Plans

Preliminary Design Review

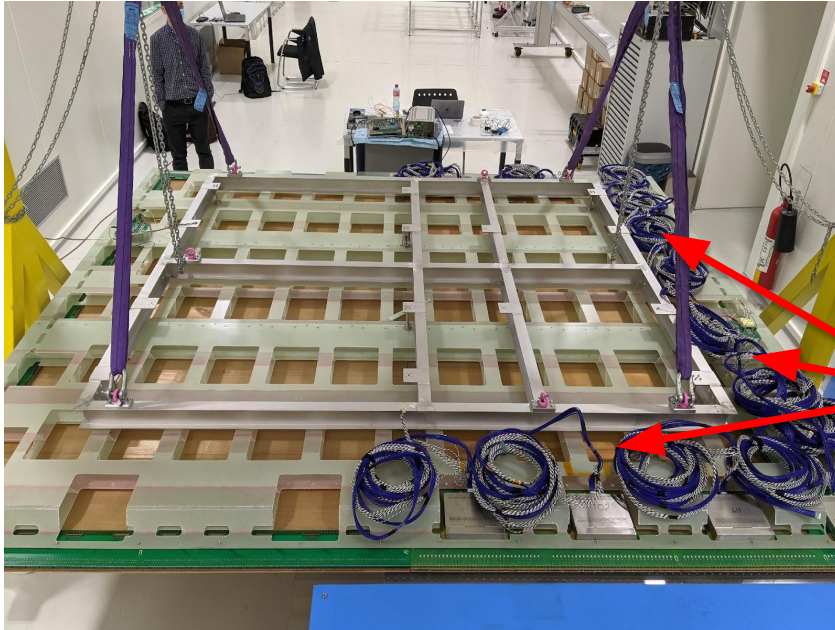
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Outline

- **Current and Recent Tests (CRP1 and CRP1B)**
- **Coldbox Tests at BNL**
- **Coldbox Tests at CERN**
- **Module-0 (ProtoDUNE-2-VD)**

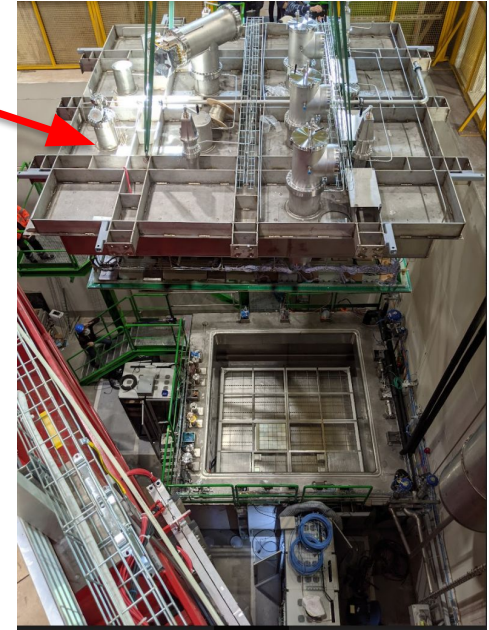
CRP1 Setup

- Half of CRP1 was instrumented with bottom drift electronics, with the last test in December 2021
- Tested in NP02 coldbox, which was filled with liquid argon and acts as a mini-TPC



CRP being lowered into coldbox

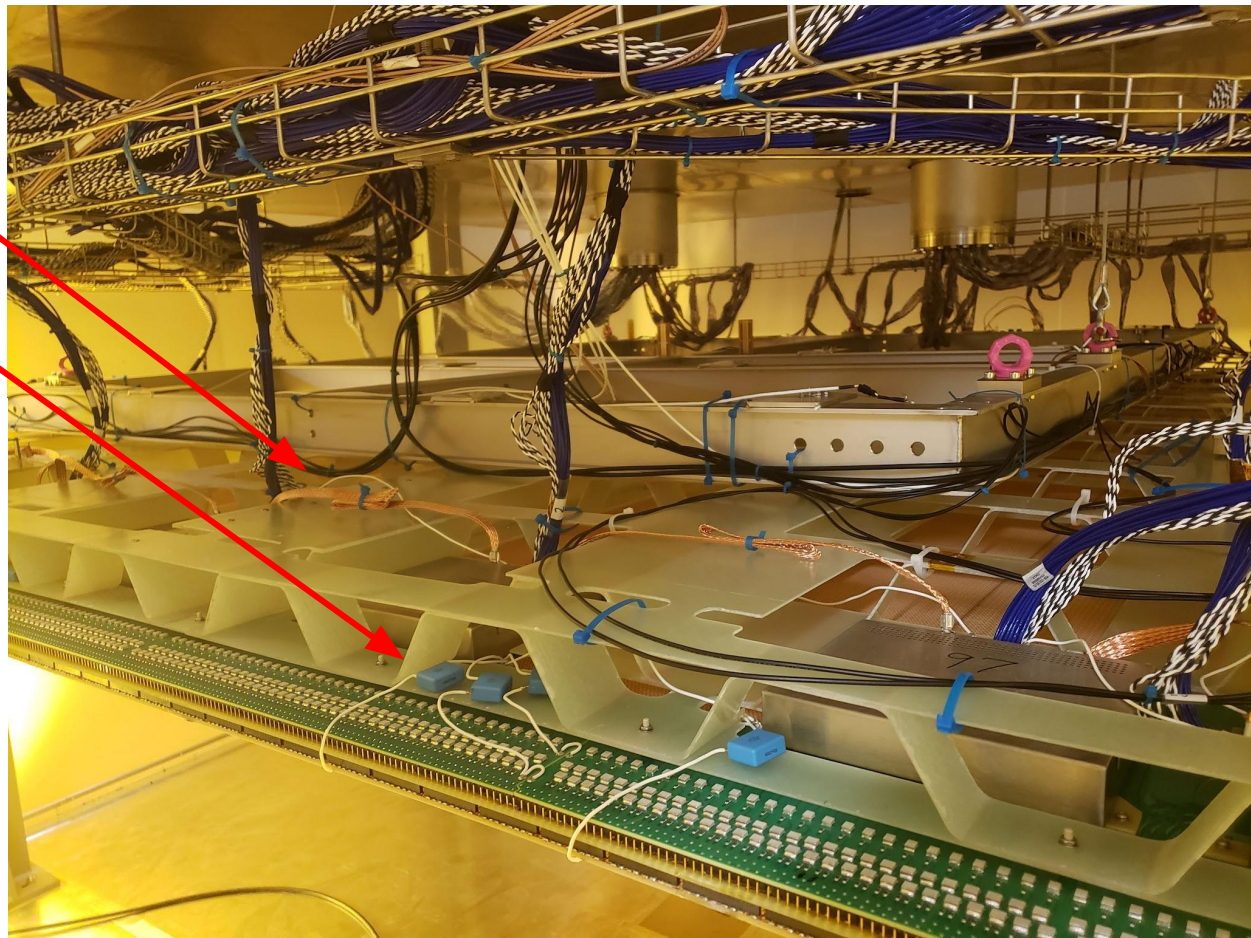
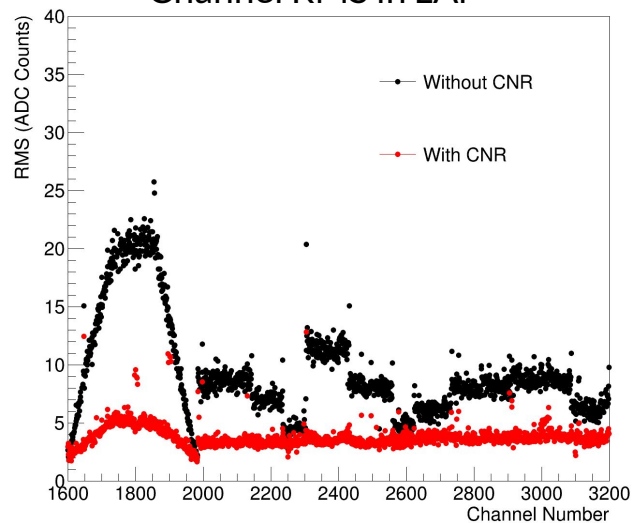
BDE



CRP1 Setup

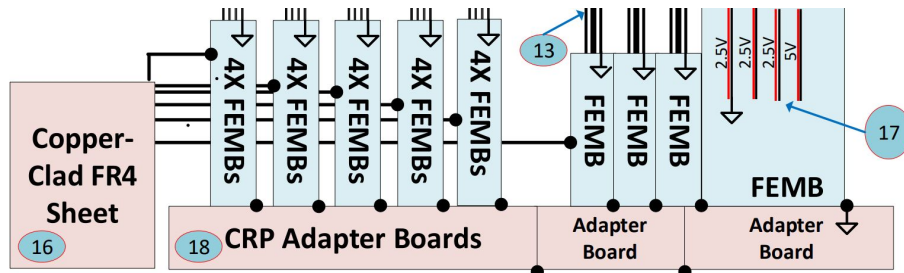
- Copper braids interconnect the grounds of each FEMB
- Capacitors added between ground and high-voltage bias lines

Channel RMS in LAr



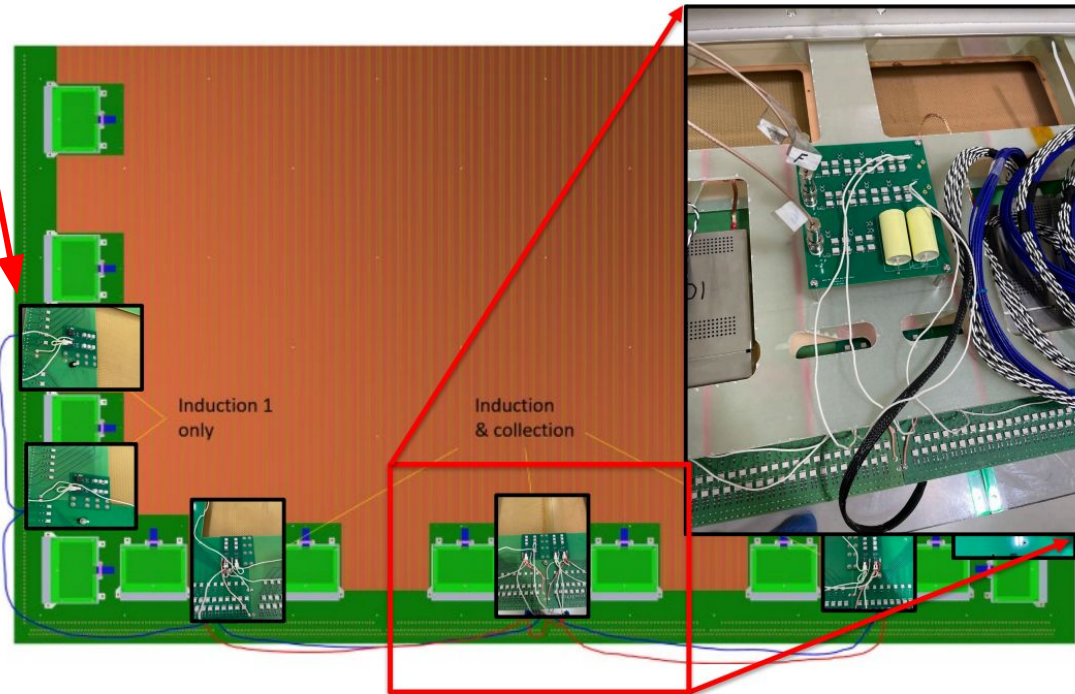
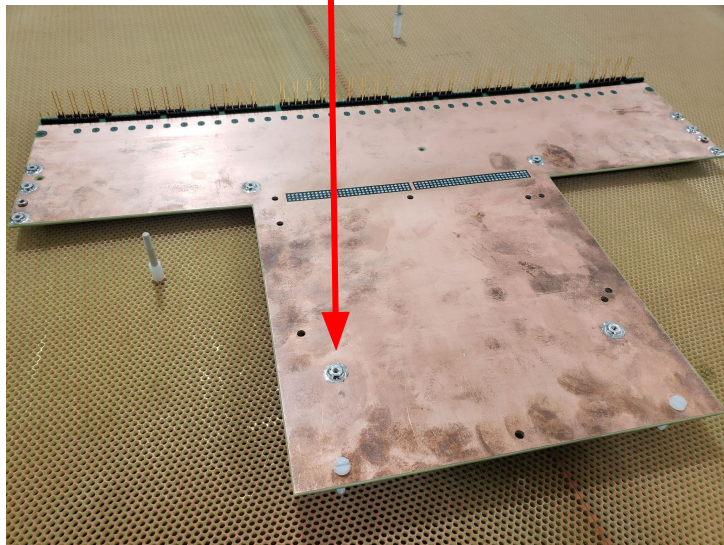
CRP1B Setup

- One half instrumented with BDE again, but with modifications incorporating the lessons from CRP1
- Improved FEMB grounding and addition of capacitors to high-voltage lines
- Will be tested in NP02 coldbox imminently - BDE noise performance will validate this design



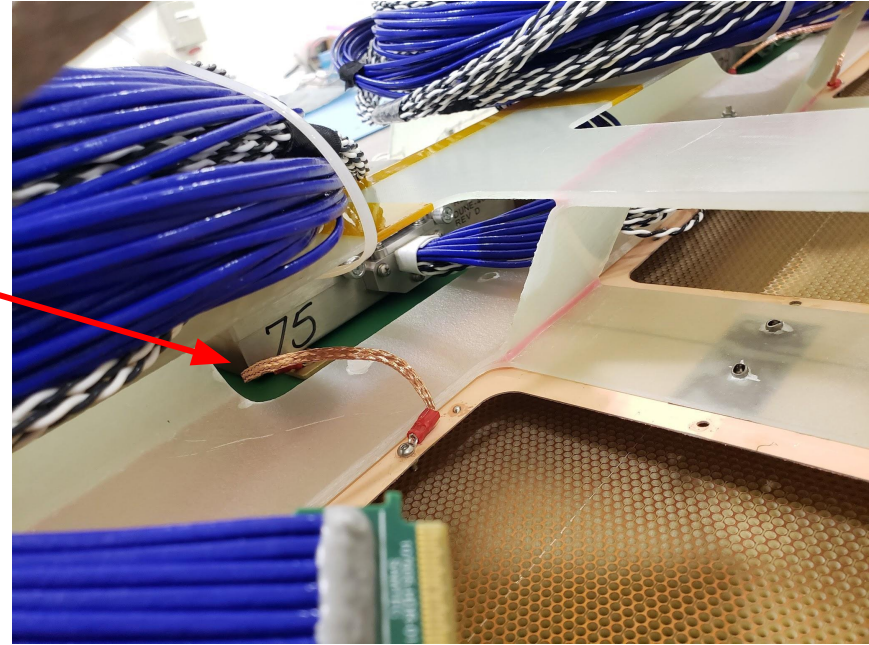
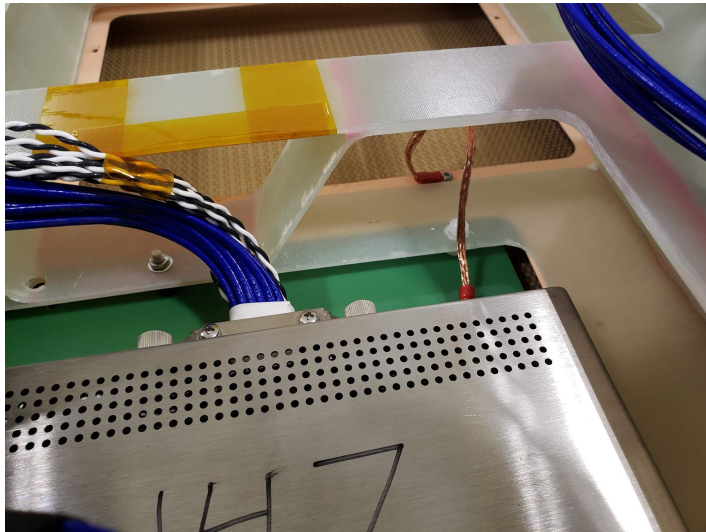
CRP1B Grounding

- Adapter board grounds interconnected by mini-filter boards
- FEMBs grounded to the adapter boards at screw-in points



CRP1B Grounding

- Each FEMB is tied by a copper braid to a shared copper plane underneath the composite frame, which is otherwise not connected to anything
- This provides an additional shared grounding point for all FEMBs at the CRP level



- Results from this test will be available soon!

BNL Coldbox Test - CRP2B

- After completion of CRP2, a half-CRP **CRP2B** will be fabricated and sent to BNL
 - Will likely arrive at BNL in **August**, given current delays on CRP production
- BNL coldbox can fit one CRU and will be filled with LN2 for cold-testing
- CRP2B will be fully instrumented with the newest BDE for an integration test
 - Prototype of the whole setup before full bottom CRP production begins
 - Will include tests of bottom CRP support structure and the BDE patch panel designs
 - This will be used for debugging and performance optimization
- CRP2B will later be integrated into the full CRP5



BNL Cold Box for CRU

A horizontal decorative bar consisting of a teal segment on the left and an orange segment on the right.

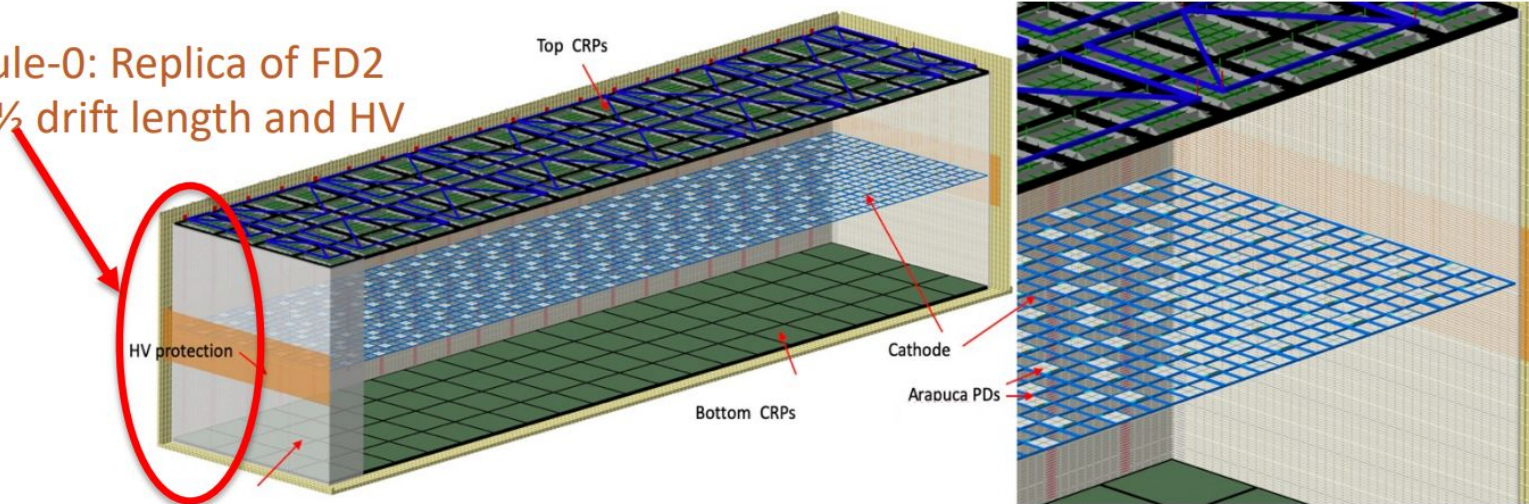
BDE Test Plans - CRP4 and CRP5

- CRP4 and CRP5 will be bottom CRPs and will be assembled in the USA, including installation of bottom drift electronics
- These will be cold tested in either the BNL or Yale coldboxes
 - BNL coldbox using LN2
 - Yale coldbox design not yet finalized - either LN2 or cold gas
- Afterwards, they will be shipped to CERN in preparation for Module-0
 - **CRP4 will be tested** in the NP02 LAr coldbox as well
 - **CRP5 will not be tested** in the NP02 coldbox due to time constraints, under the current plan.
Note: this is how the FD2 CRPs will be done, with cold testing only at the factories before final installation
- **Original schedule:**
 - CRP4 assembled in USA in October, shipped to CERN in November, tested in NP02 coldbox in December
 - CRP5 assembled in USA in November, shipped to CERN in December
- **Now probably delayed by at least a month**, due to issues with the company producing the anodes

Module-0 Setup

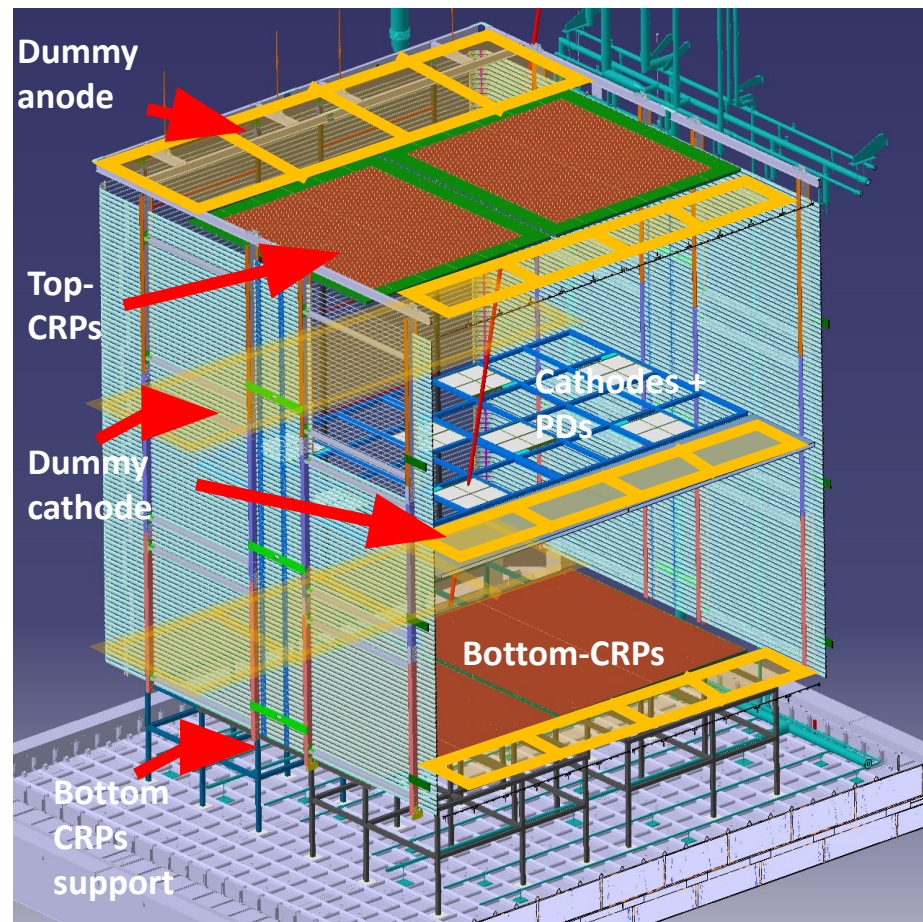
- Two CRPs on top (using top drift electronics), two CRPs on bottom (using BDE) in NP02 cryostat
- 3 m drift length, with cathode at -150 kV
- 70% field cage on upstream wall
- [Current NP02 setup will be disassembled by November](#), with Module-0 installation beginning shortly after

Module-0: Replica of FD2
with $\frac{1}{2}$ drift length and HV



Module-0 CRP Layout

- All 4 CRPs in the middle of the cryostat, with the 2 bottom CRPs directly beneath the 2 top CRPs
- Distance from the beam plug will allow for some beam events to be visible in both the top and bottom drift volumes
- CRP placements will be aligned with the cryostat penetration, which is also in the middle
 - Better emulates the CRP to penetration distance that will be in FD2, for readout electronics testing purposes



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BDE Prototyping Plans Summary

- Currently wrapping up the last tests using the “old” CRP strip layout on CRP1B
- The next test will be with CRP2B in the BNL coldbox, aiming for August
 - New strip layout, with 12 total FEMBs for readout
 - Using the newest BDE
 - Testing various aspects of BDE interfacing with other subsystems
- The completed CRP4 and CRP5 using BDE readout will be tested in coldbox setups in the USA as they are completed
 - CRP4 will be additionally tested in the NP02 LAr coldbox at CERN
- We will have a full FD2-like test of the BDE with ProtoDUNE-II-VD in the NP02 cryostat
 - Installation will begin at the end of 2022 or early 2023