

DUNE CE Box

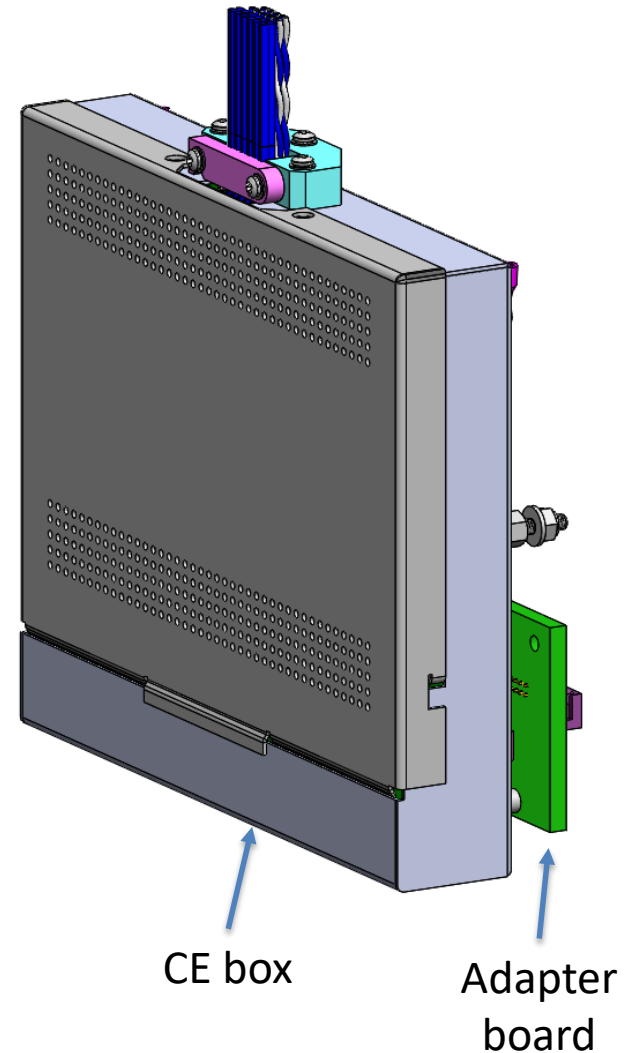
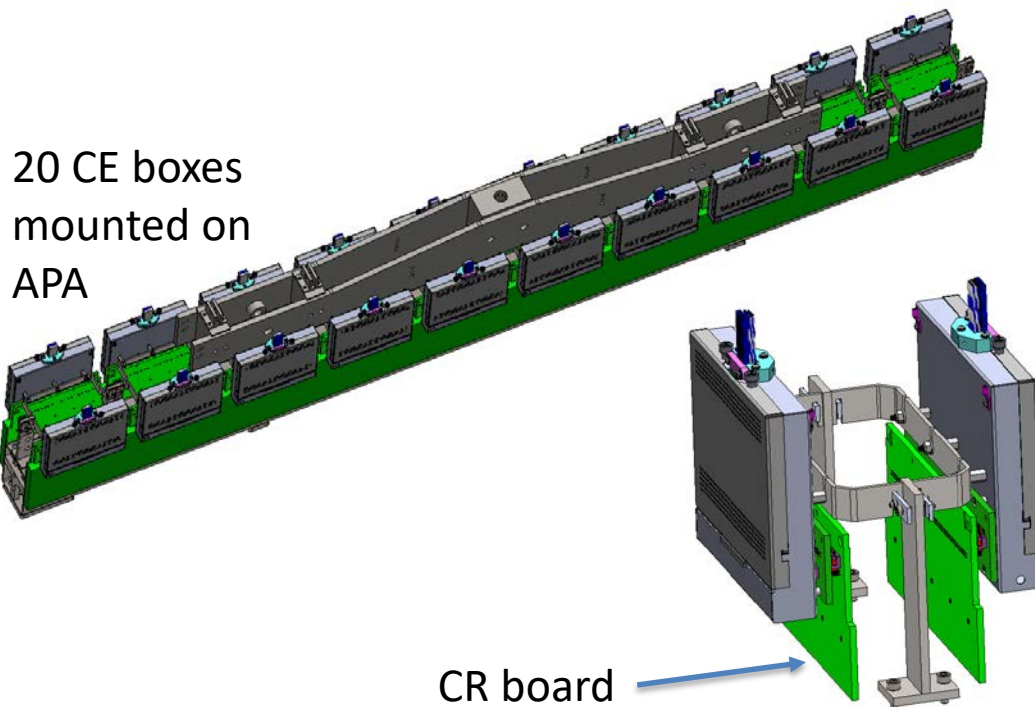
Manhong Zhao on behalf of CE Team

Cold Electronics Mechanical Review

Feb 11th, 2019

What is a CE Box?

The Cold Electronics (CE) box is a Faraday box that contains the Front-End Motherboard (FEMBs) to provide shielding from noise, and to mount the FEMB on the Anode Plane Assembly (APA) through an adapter board between each FEMB and the corresponding Capacitor-Resistance (CR) board.

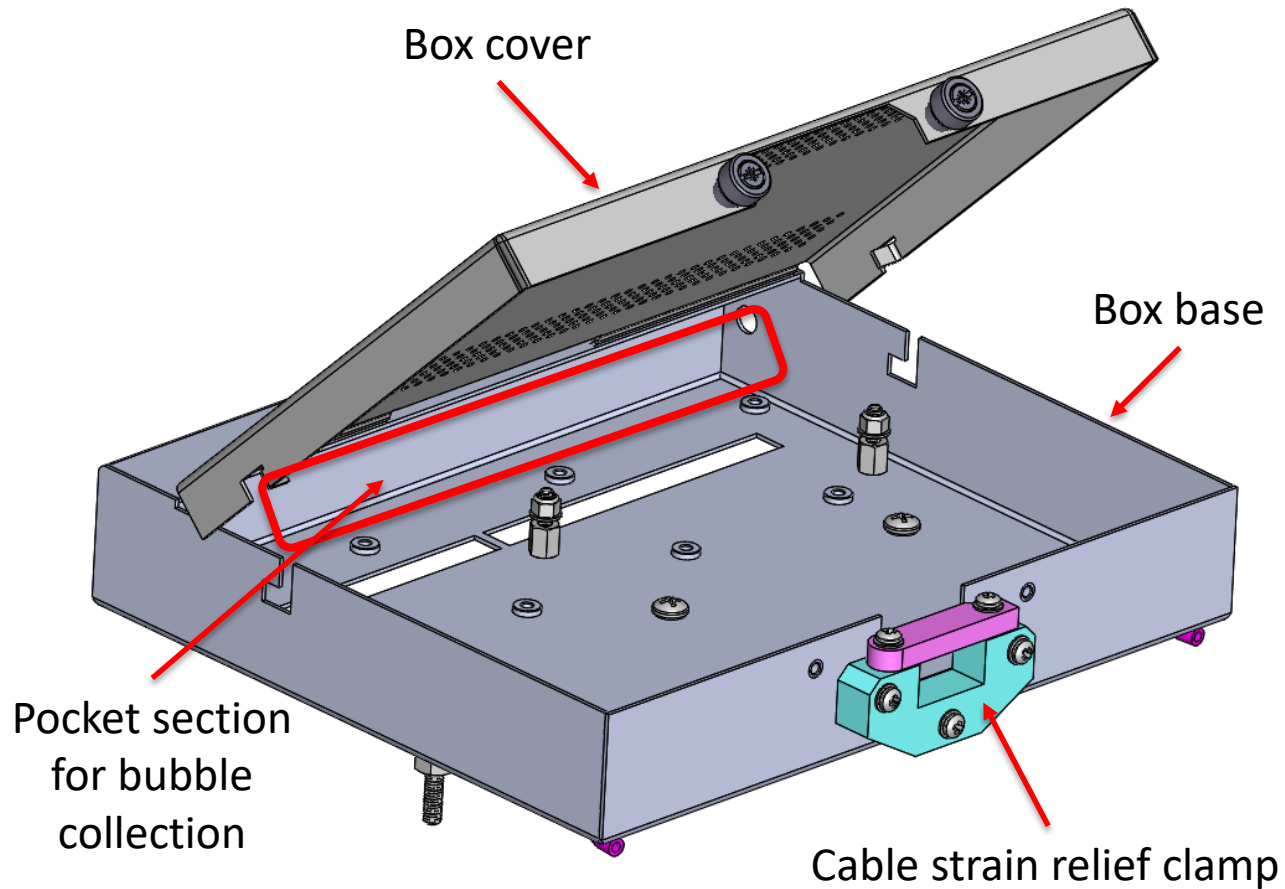


Requirements

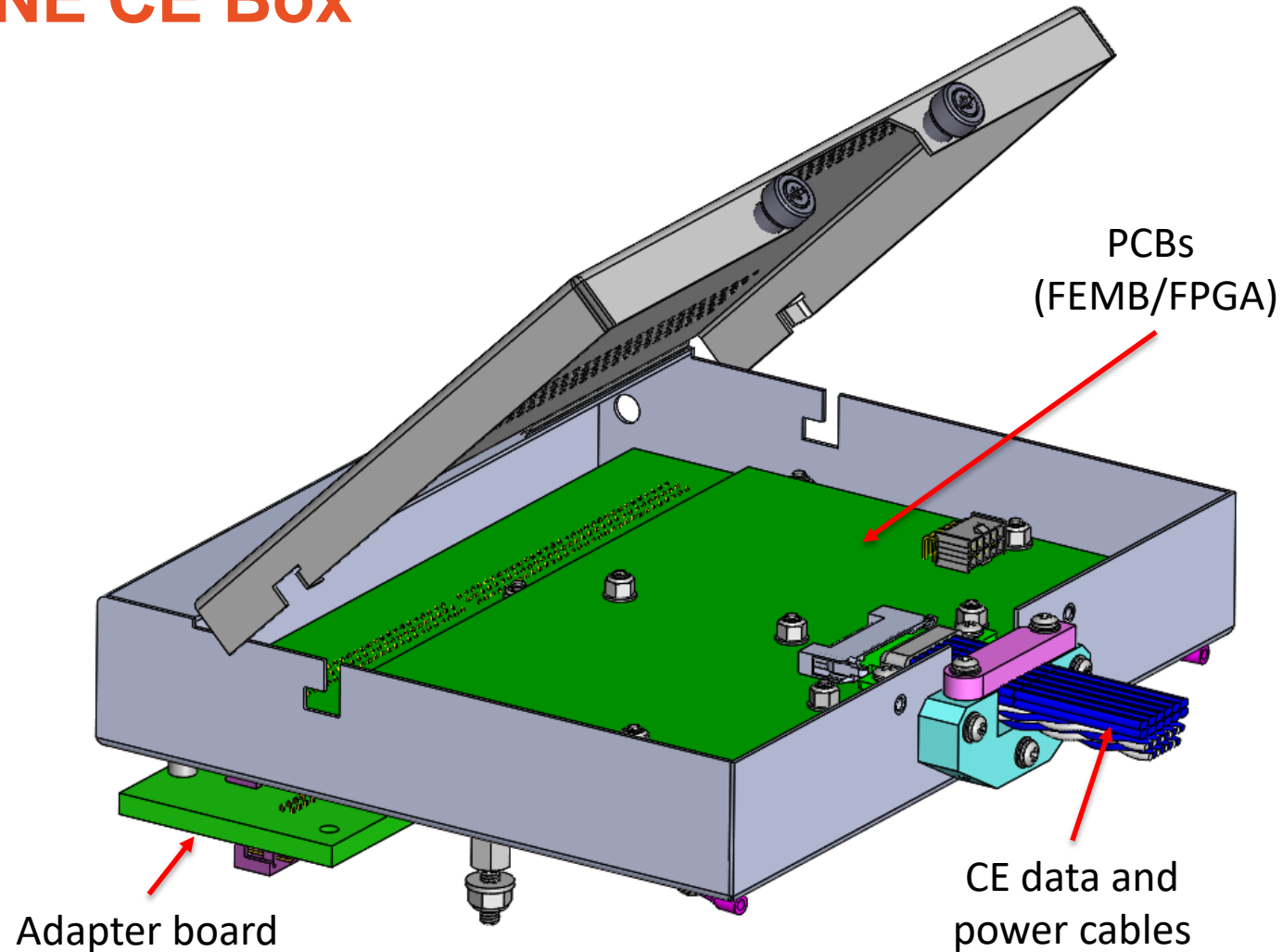
The CE box design shall meet the following requirements:

- Provide a mechanical support of FEMB for mounting on APA
- Serve as a Faraday cage to provide shielding of FEMB from noise
- Provide strain relief to the cold data cable and cold power cable
- Provide bubble management for CE boxes that installed on the lower APA
- Provide hardware to make connection between FEMB and CR board on APA through an adapter board
- Provide electrical connection with redundancy between CE box casing and APA frame

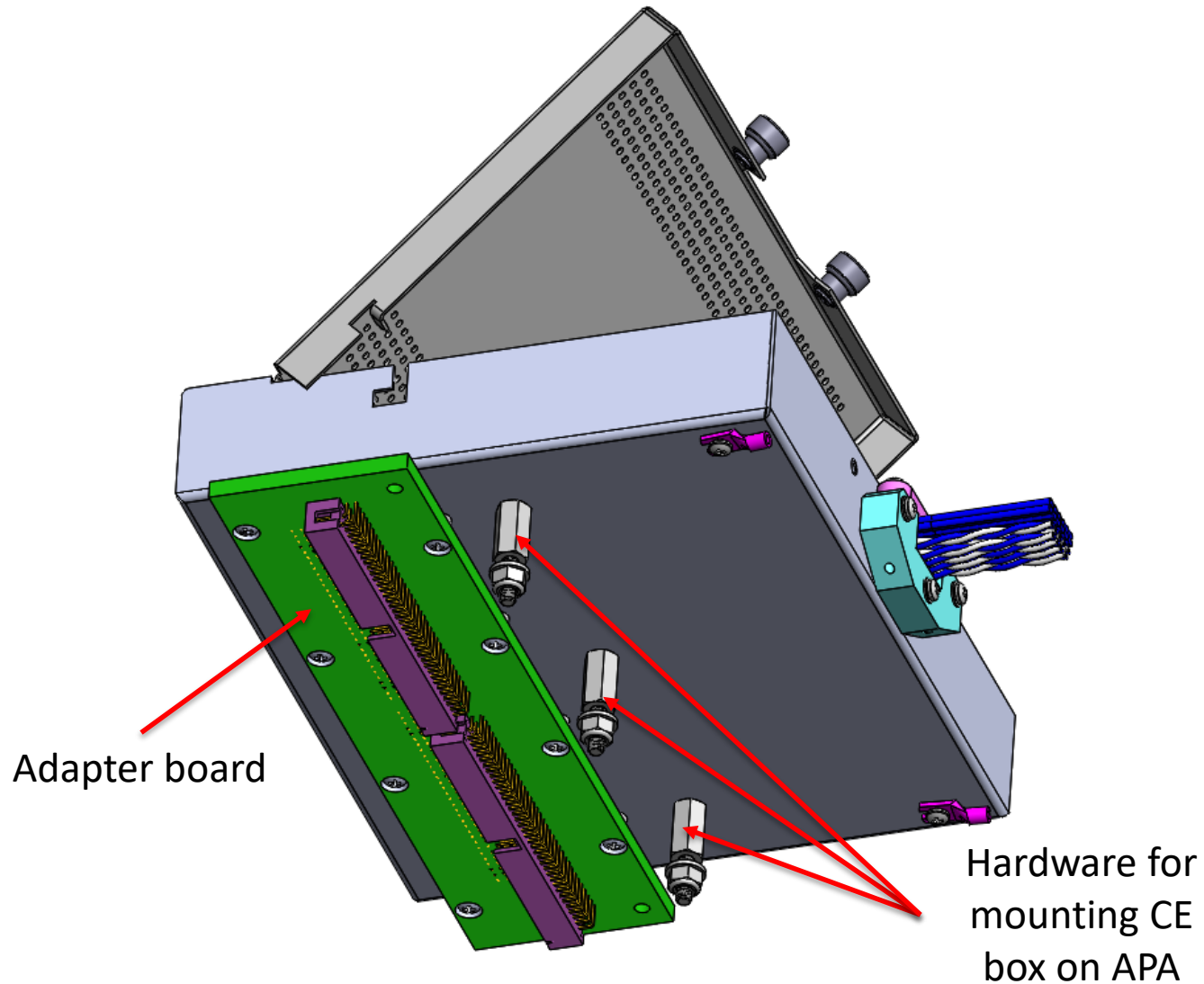
DUNE CE Box



DUNE CE Box



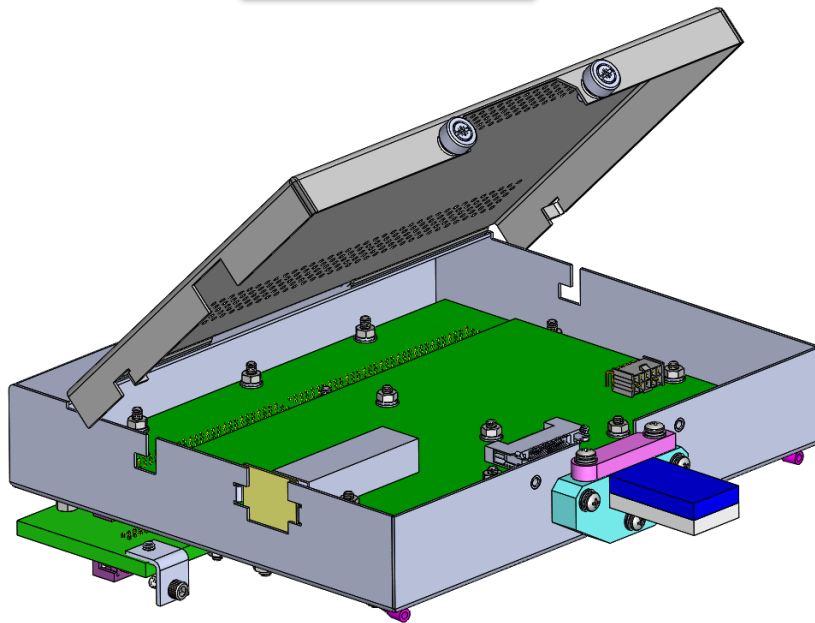
DUNE CE Box



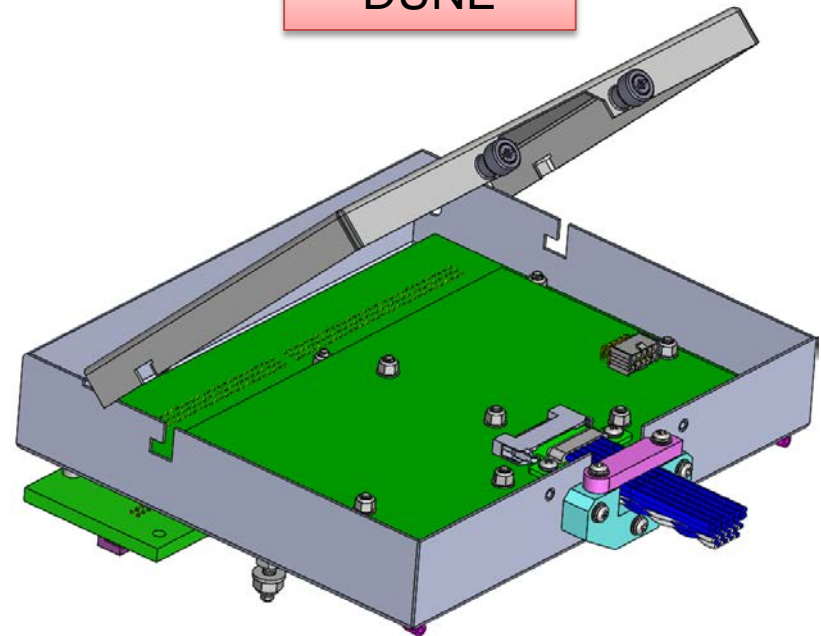
Design Changes/Improvements

The CE box design largely follows the ProtoDUNE CE box design with implementing changes/improvements to eliminate obsolete features and simplify installation.

ProtoDUNE



DUNE



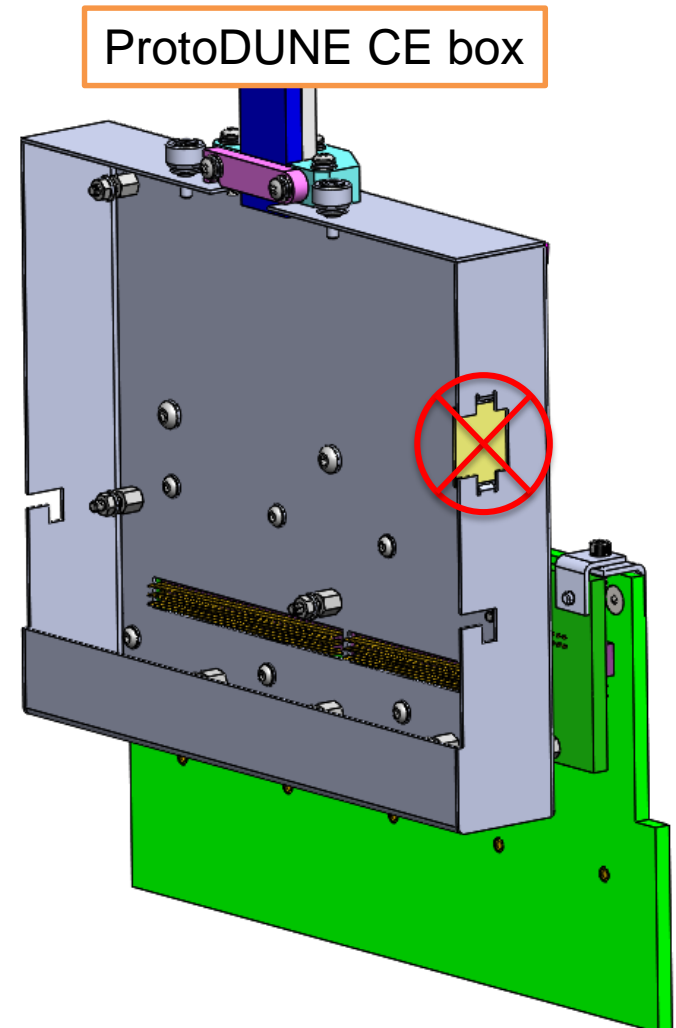
Design Changes/Improvements

ProtoDUNE

A side-opening cutout at the CE box base for accessing the SFP module.

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The SFP module will not be populated on FEMB in the new design. Therefore, the loose piece cover that was used to cover the side-opening is no longer needed.



Design Changes/Improvements

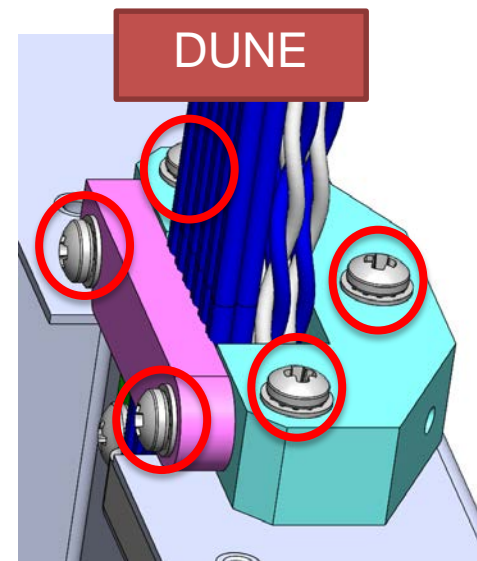
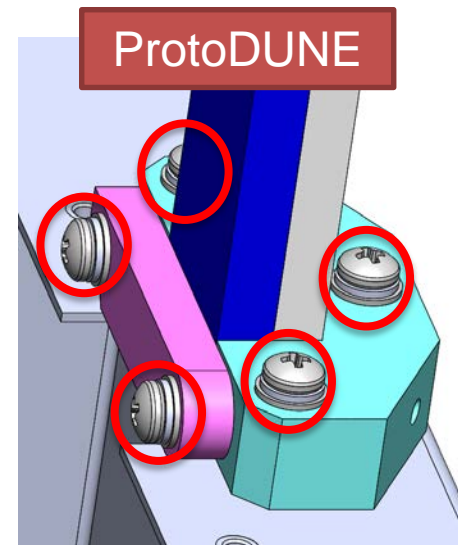
ProtoDUNE

Screw/split lock washer/flat washer.

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Screw with integrated internal tooth lock washer.

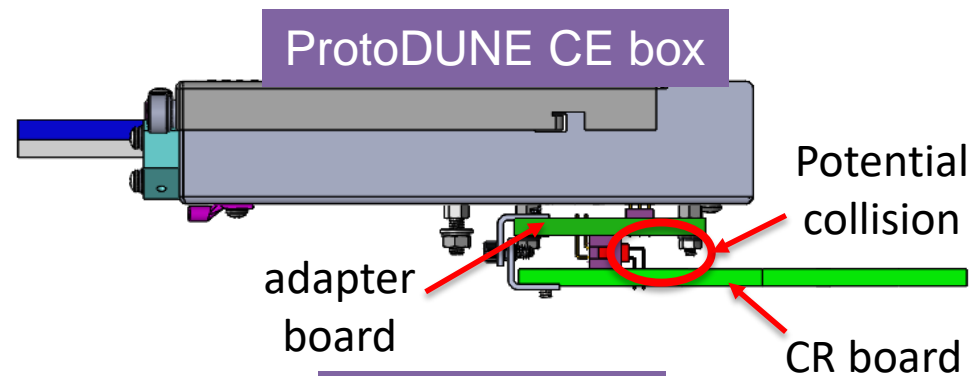
This change simplifies the installation and reduces the risk of parts falling inside the APA sensitive volume.



Design Changes/Improvements

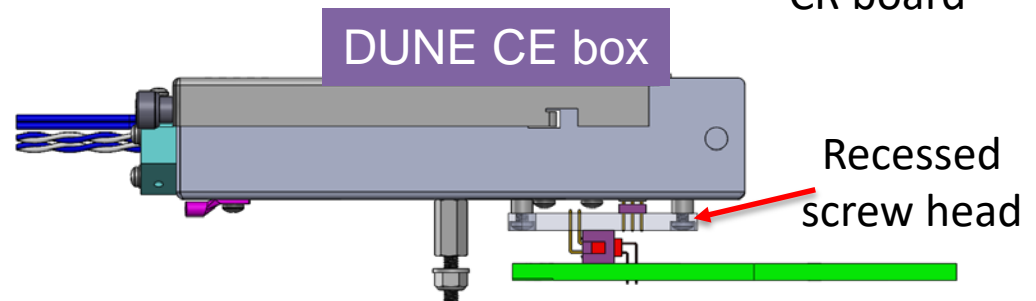
ProtoDUNE

Potential collision risk between adapter board hardware and CR board connector.



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Screw heads are recessed to eliminate this interference risk.

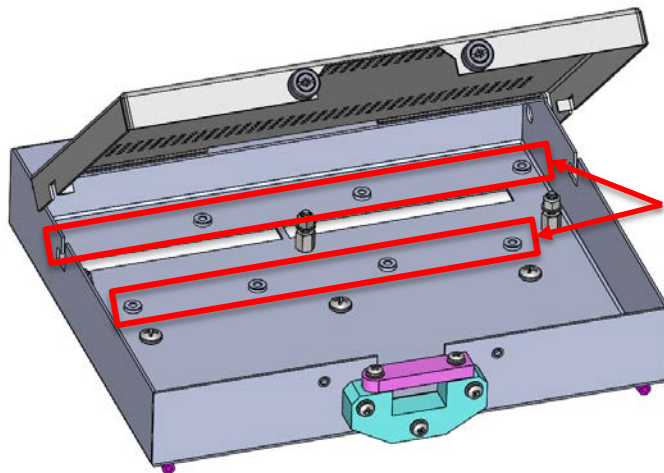


Design Changes/Improvements

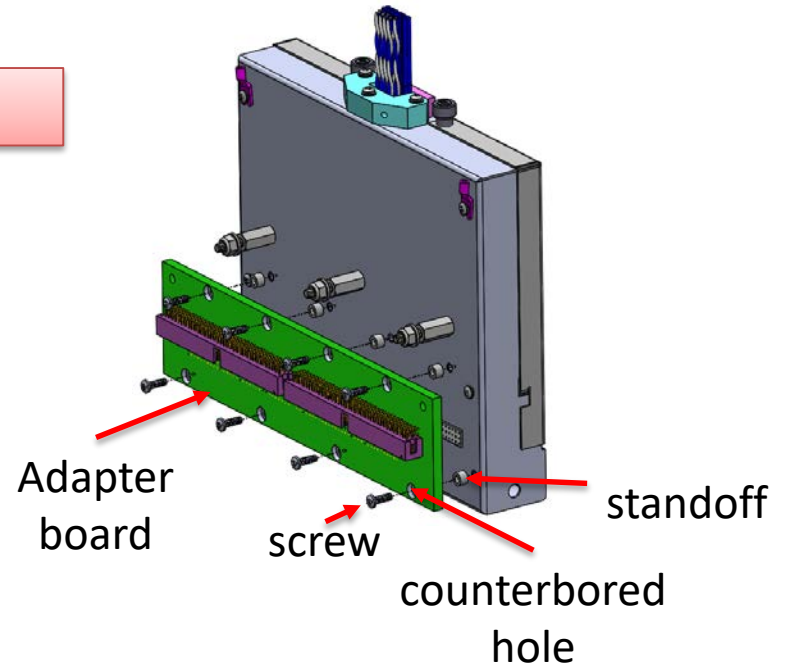
Pemnuts installed to replace the through holes in the ProtoDUNE CE box.

The M3 screws go from the outside through the adapter board, through 4mm tall x 3.2mm ID x 6mm OD spacers and into the Pemnuts in the CE box. Screw head recessed in the counterbored holes in the adapter board.

DUNE



8 Pemnuts
for attaching
adapter
board



Design Changes/Improvements

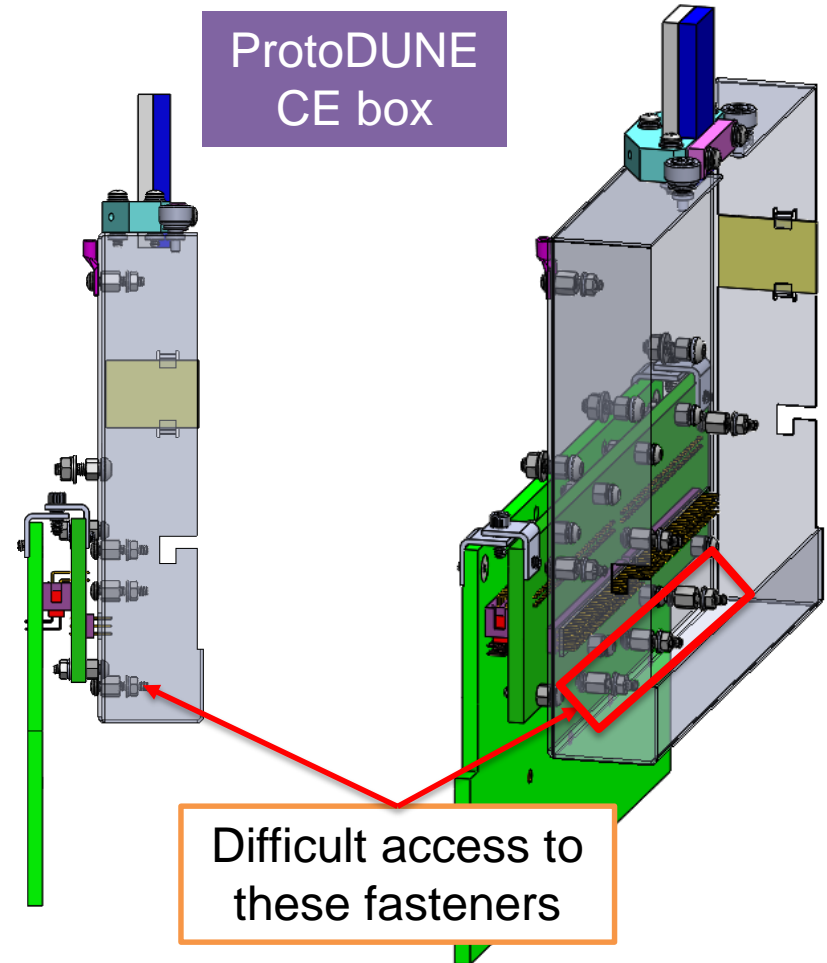
ProtoDUNE

Three sets of fasteners are difficult to access.

These fasteners, which are there to support FEMB, were found to be not necessary in the installation test. The FEMB is sufficiently supported by other 5 fasteners.

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These three sets of fasteners are removed.



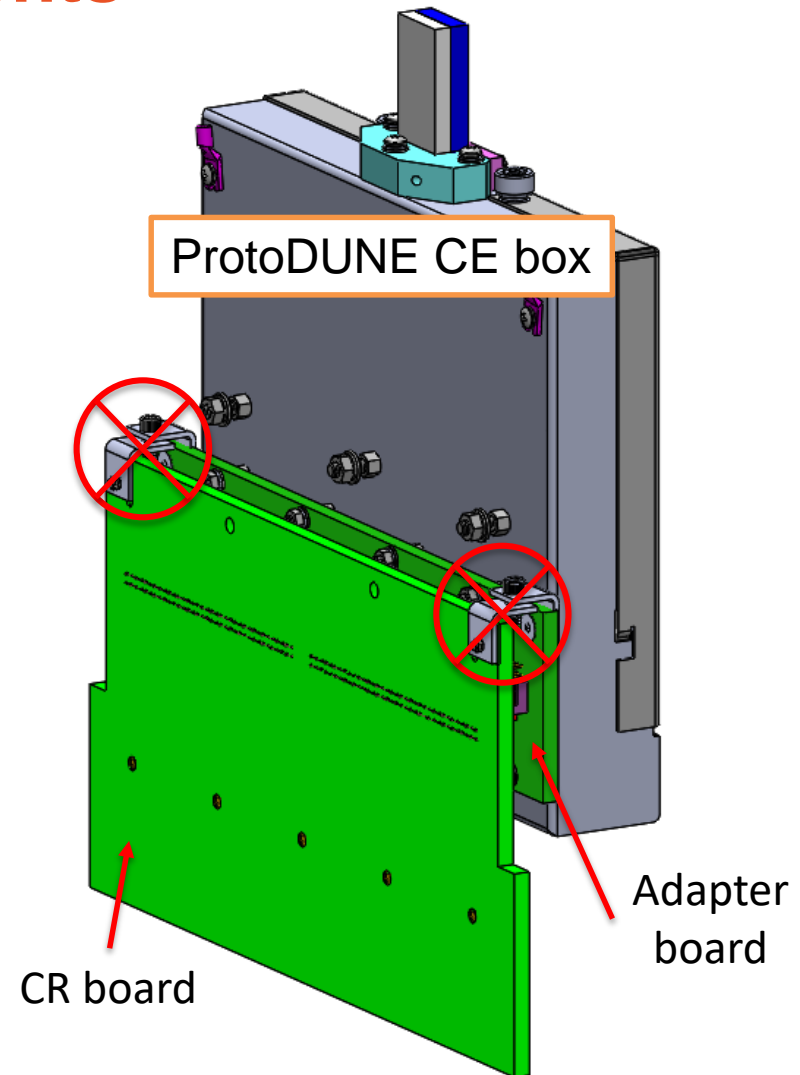
Design Changes/Improvements

ProtoDUNE

The small angle brackets and hardware that were intended to fix the adapter board to the CR board were found not giving any benefit and represented a significant risk as potentially falling objects. The connection of the two 72-pin connectors is strong and sufficient.

DUNE

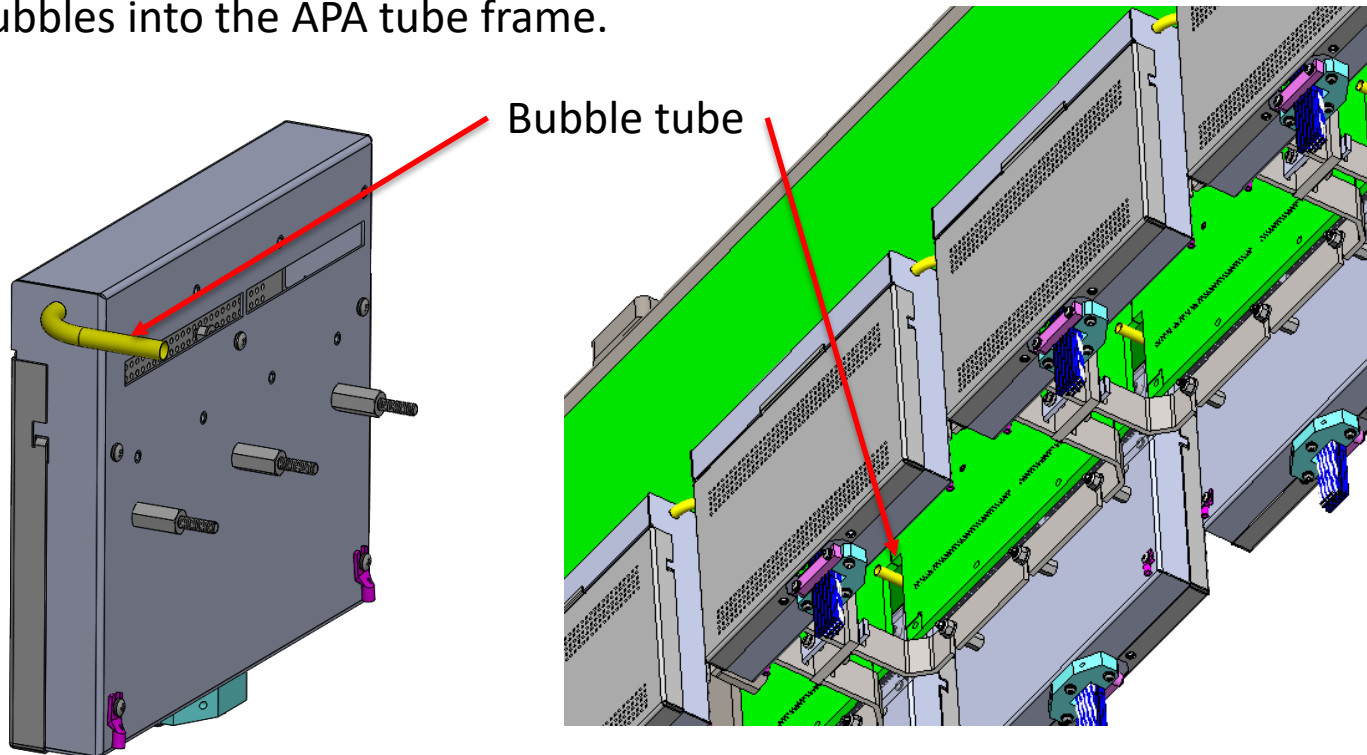
The small angle brackets and hardware are eliminated.



Design Changes/Improvements

Heat dissipated by the FEMBs may generate Argon bubbles in the CE boxes. In the CE boxes that are mounted on the lower APA, the bubbles must be routed up to the LAr surface without entering the sensitive TPC volume.

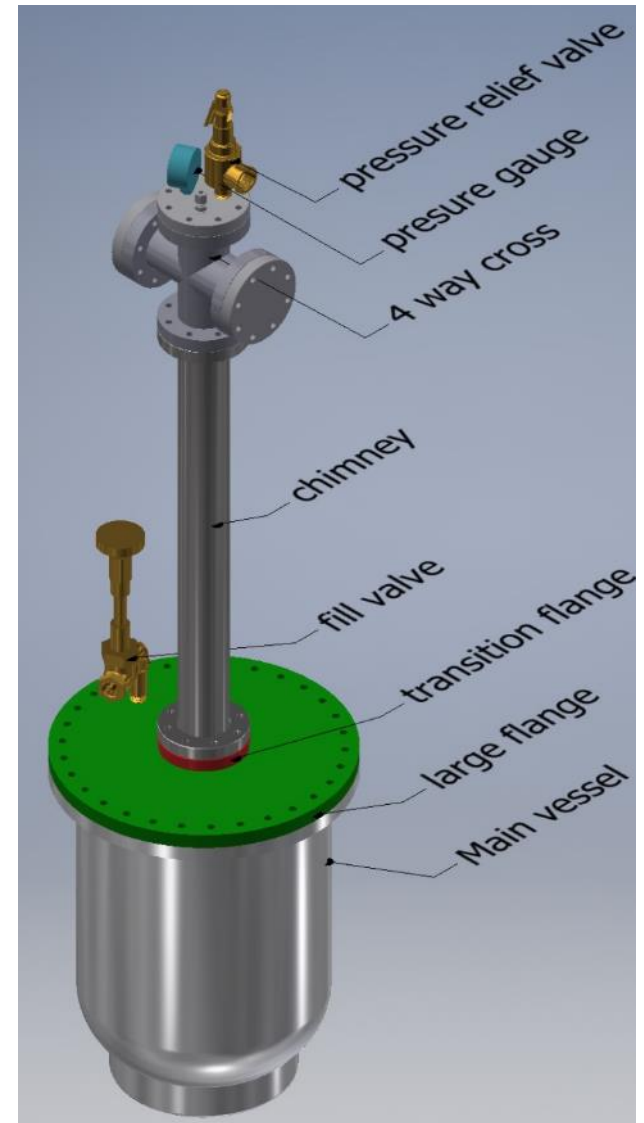
A bubble tube is added to the pocket section of the CE box to route the bubbles into the APA tube frame.



Bubble Test Setup

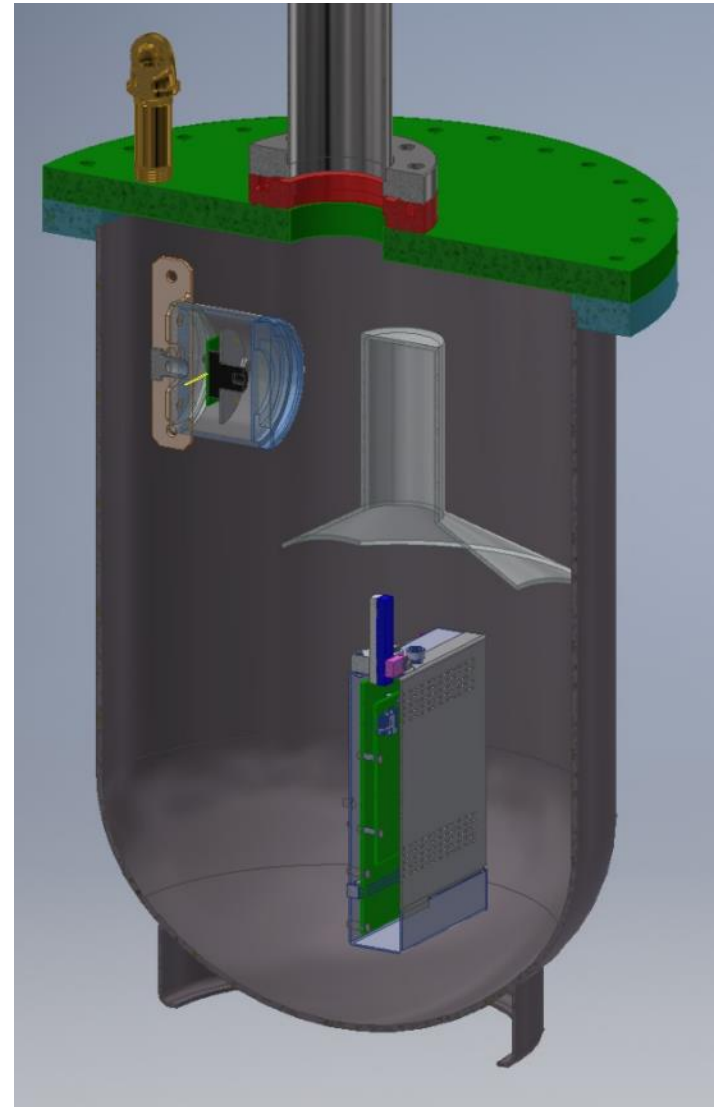
- The key component of this test setup is a pressure vessel that can be:
 - filled with liquid argon
 - pressurized to 3 bar absolute (MOP=30psig)
 - kept at a constant temperature of 87K

The pressure vessel, made of aluminum for better thermal conduction and lower weight, is submerged in an open Dewar filled with liquid argon @ 87K. The pressure vessel has a 24" long stainless steel chimney mounted on the top flange with LAr filled about midway. A heater in the middle of the tube raises the local temperature of the liquid and boil off some liquid. This increases the pressure inside the pressure vessel. An equilibrium pressure can be reached, which is mostly dependent on the power into the heater.



Inside of the Test Vessel

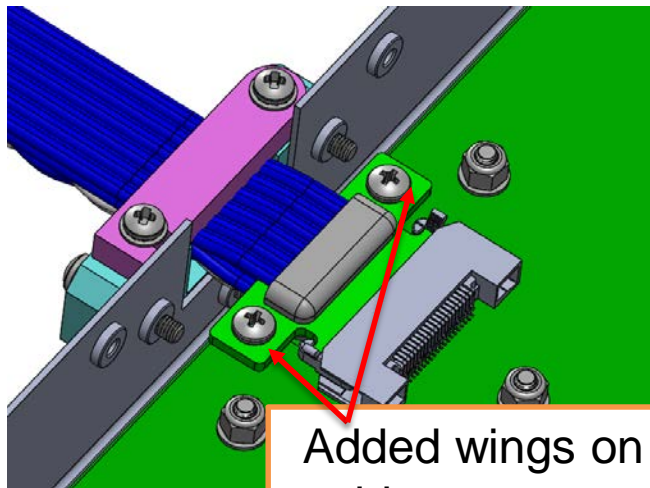
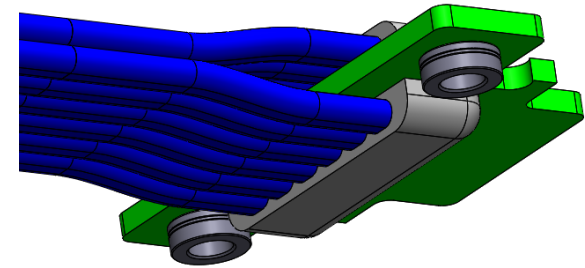
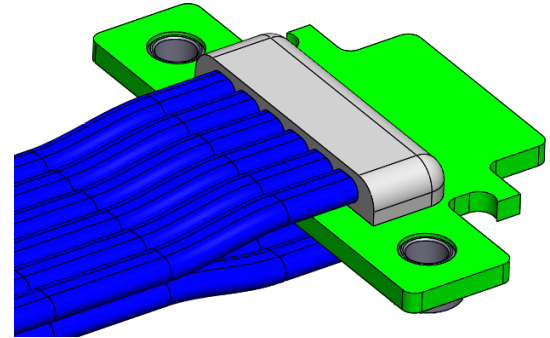
The test subjects include the prototype electronics modules, sample electronics components, heating elements with known power densities and surface textures. An inverted funnel collects the boiloff gas into an inverted cup with markings. The boiling is observed through a cryogenic camera mounted inside the pressure vessel.



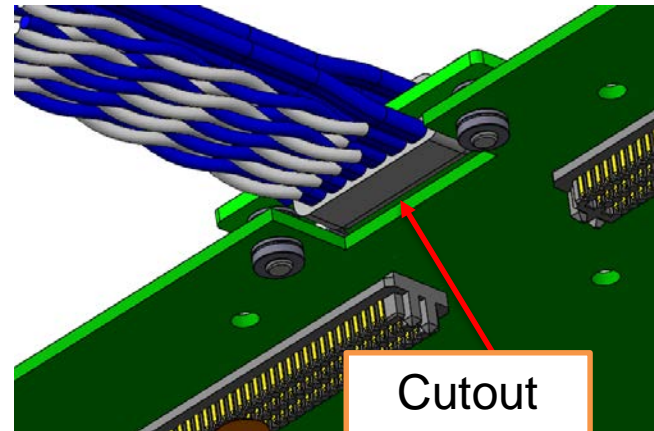
Design Changes/Improvements

The connector PCB of the cold control/data cable is extended with two wings that could be used to screw the cable connector to the FEMB.

A small cutout on the FEMB is added to accommodate the uneven application of epoxy on the control/data cable.



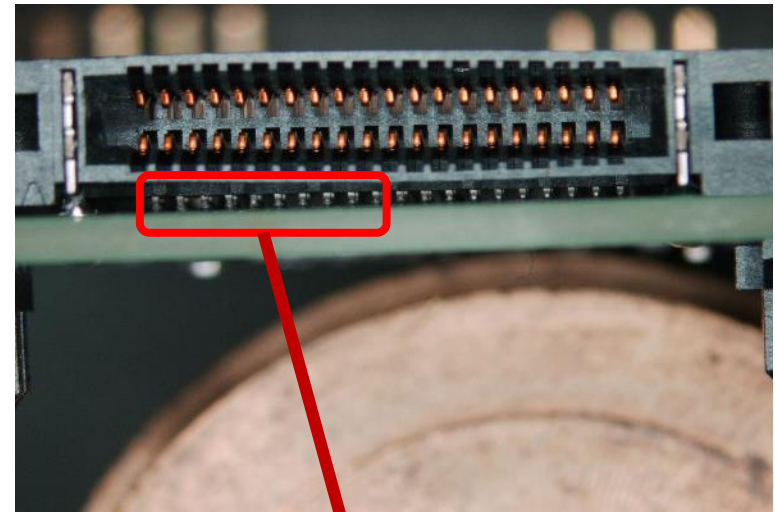
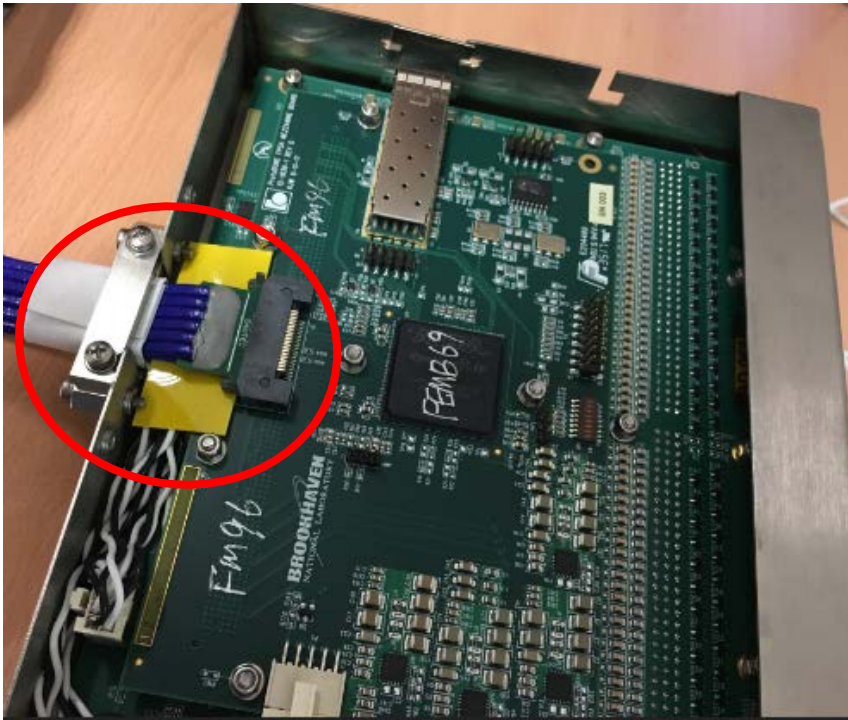
Added wings on
cable connector



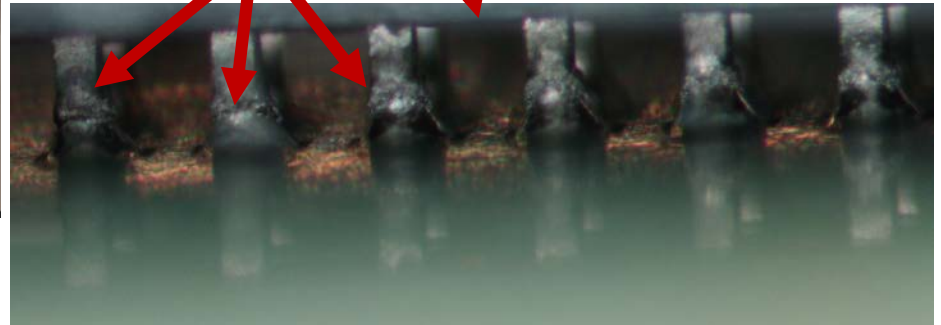
Cutout
on FEMB

Connector Failure Issue in the ProtoDUNE

Solder Joint Failures Observed at Connector



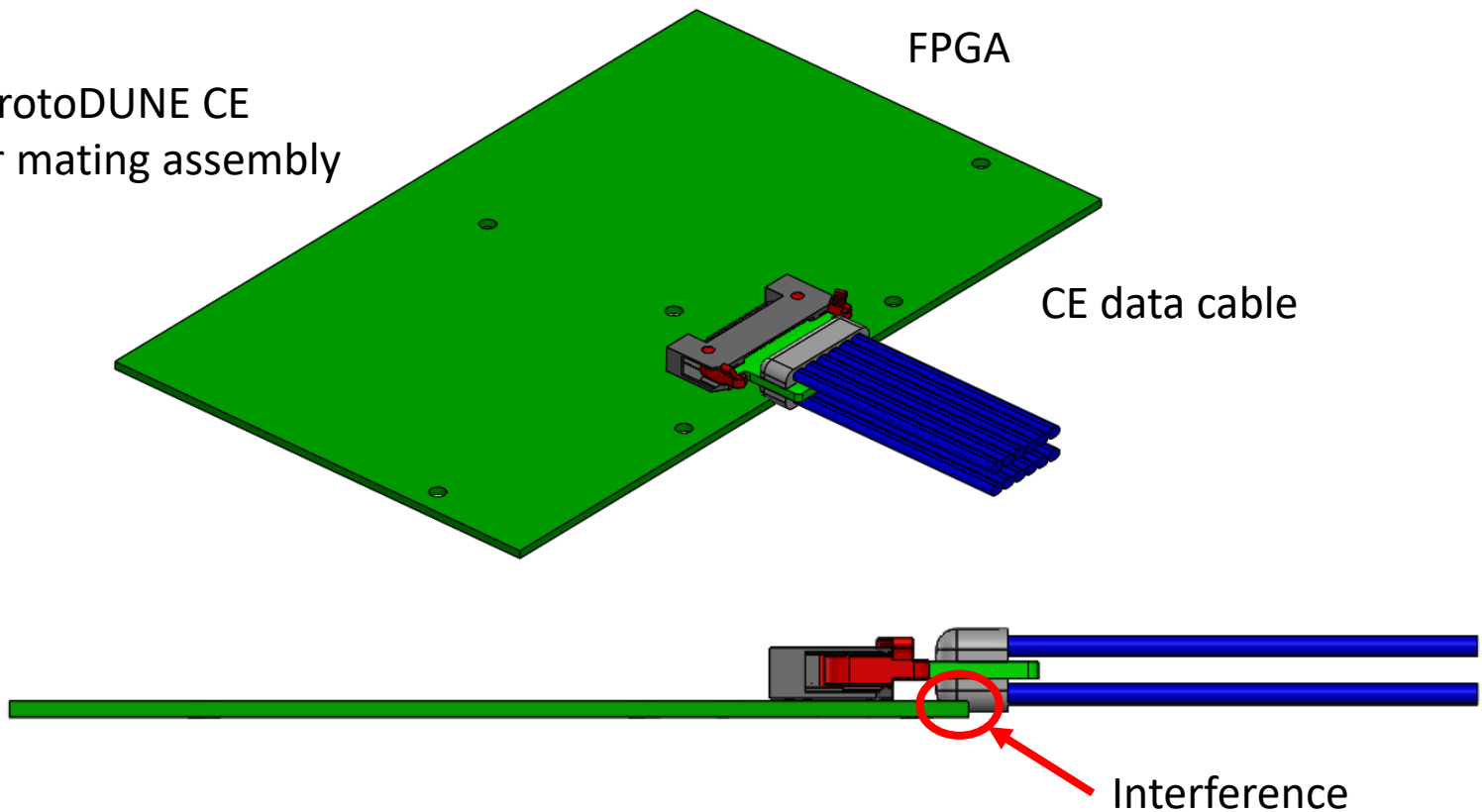
Solder cracks
due to stress



Connector Failure Issue in the ProtoDUNE

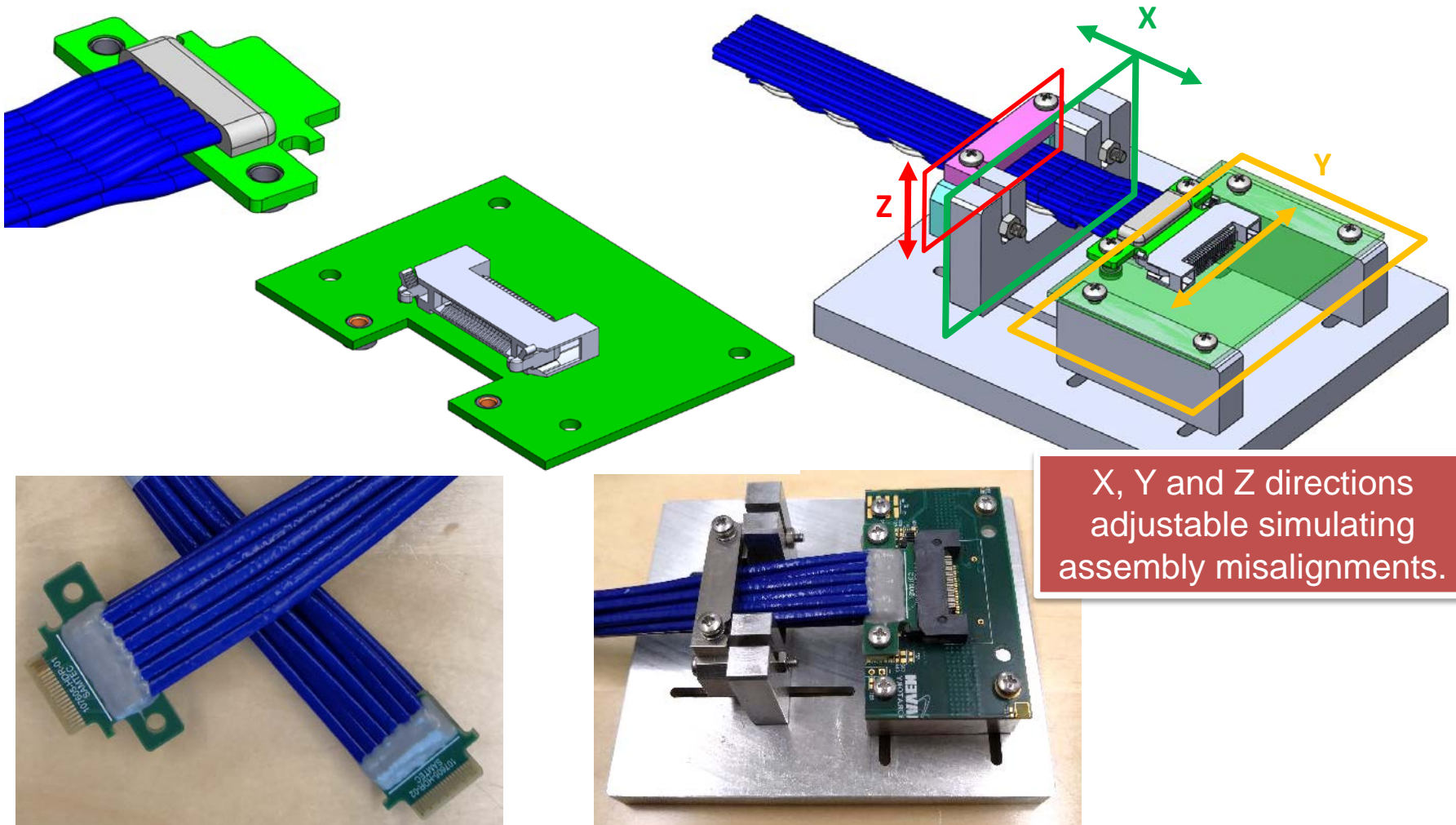
Interference between FPGA and connector epoxy joint is identified as the cause of connector solder joint failure.

Original protoDUNE CE
connector mating assembly

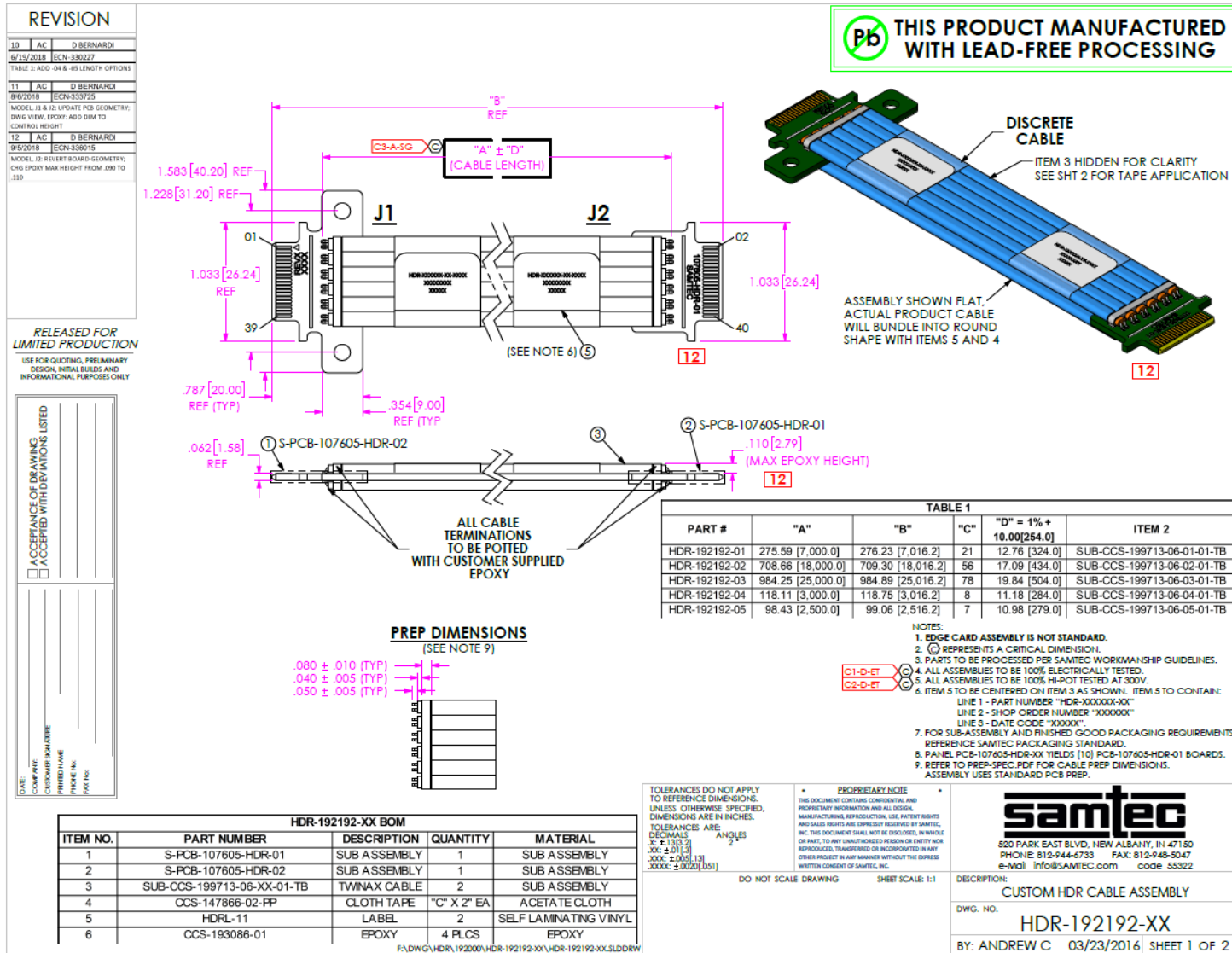


Connector Testing Fixture

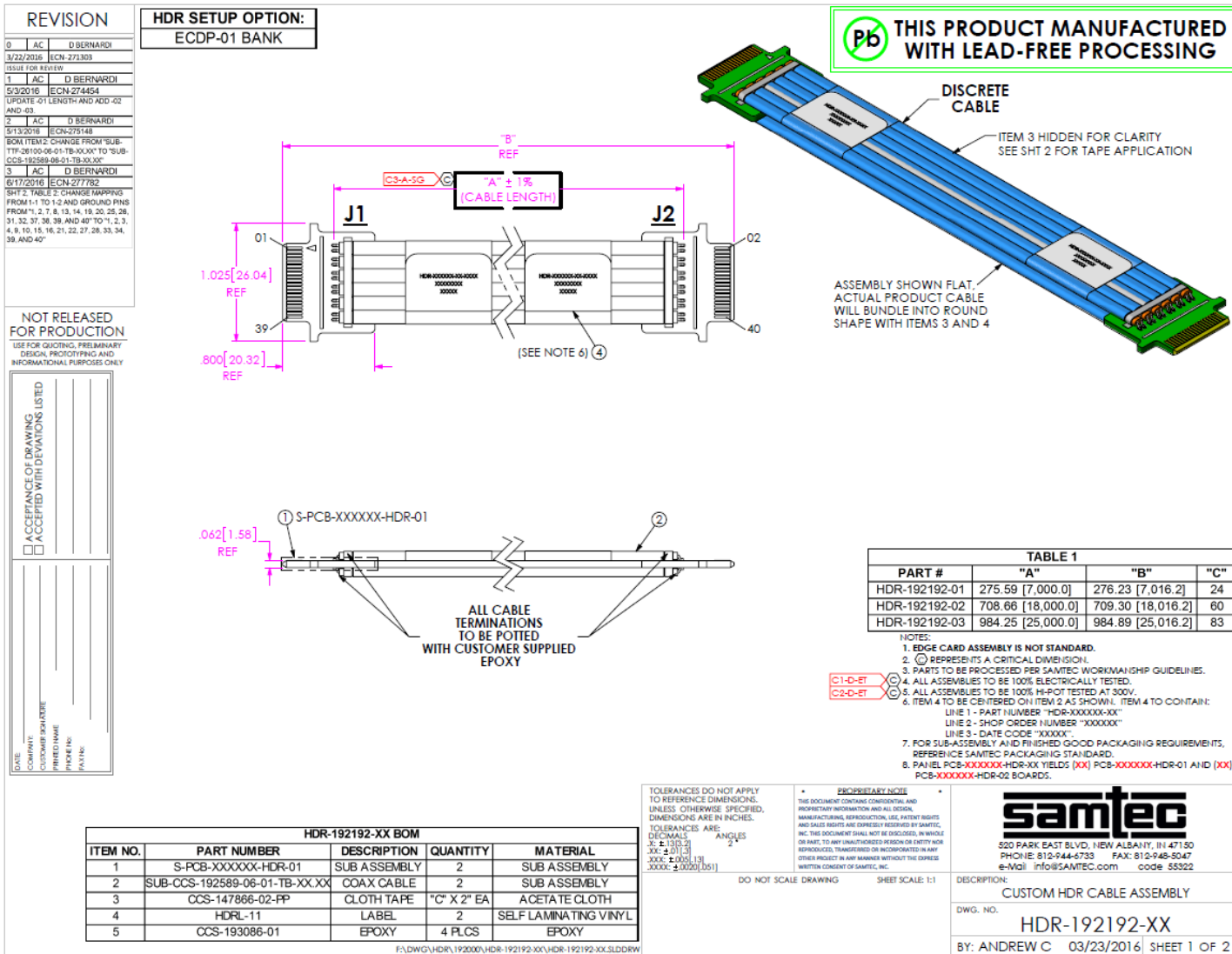
A testing fixture to verify connector connection reliability.



New Cable Drawing



Old Cable Drawing



Thank You!