

FD2-VD BDE Mechanical Components

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FD2 Bottom Drift Electronics Final Design Review

May 16, 2023

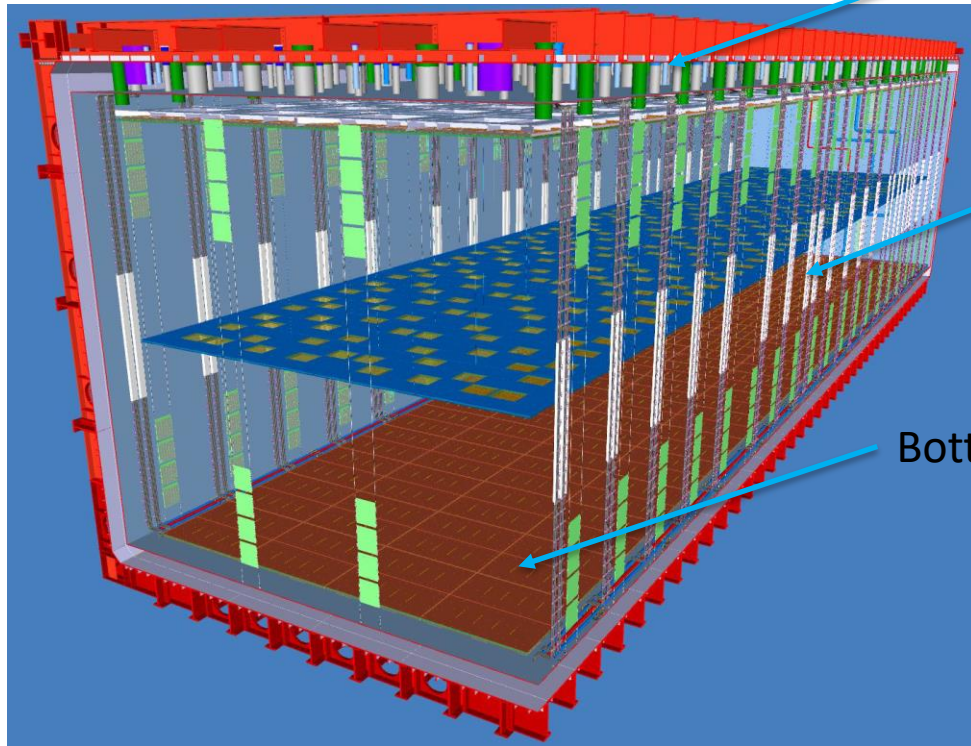
Outline

[Charge Question: #2, #4]

- Overview of BDE mechanical components
- CE box and installation
- Patch panel installation and cabling
- Cryostat Penetration and penetration cable support
- FD2 cabling
- Structural analysis and validation

Overview of BDE mechanical components

The BDE Mechanical components consists of CE boxes, patch panel mechanical supports, signal penetrations and penetration cable supports, etc.



FD2 VD detector

BDE/PDS penetrations

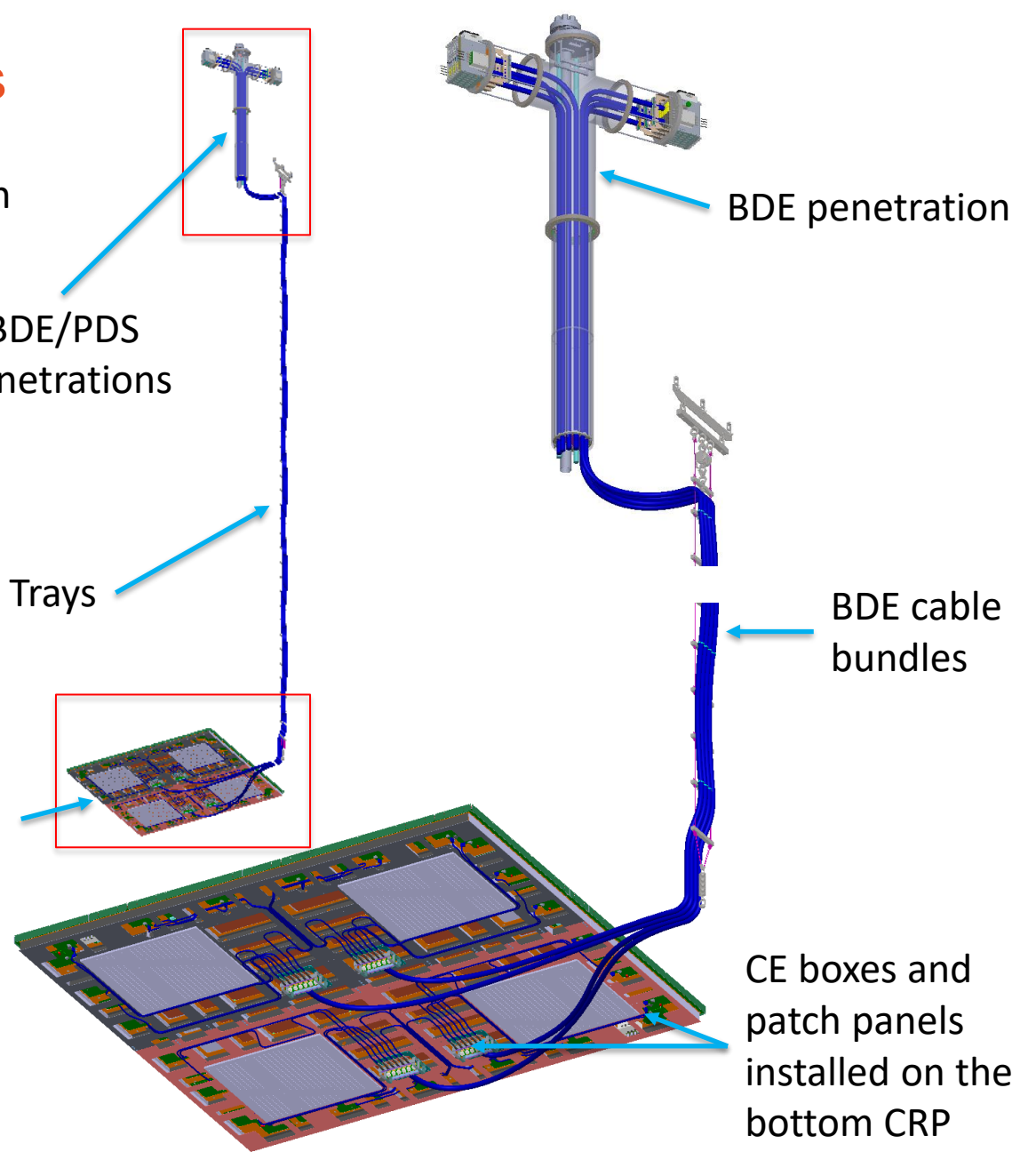
Cable Trays

Bottom CRPs

BDE penetration

BDE cable bundles

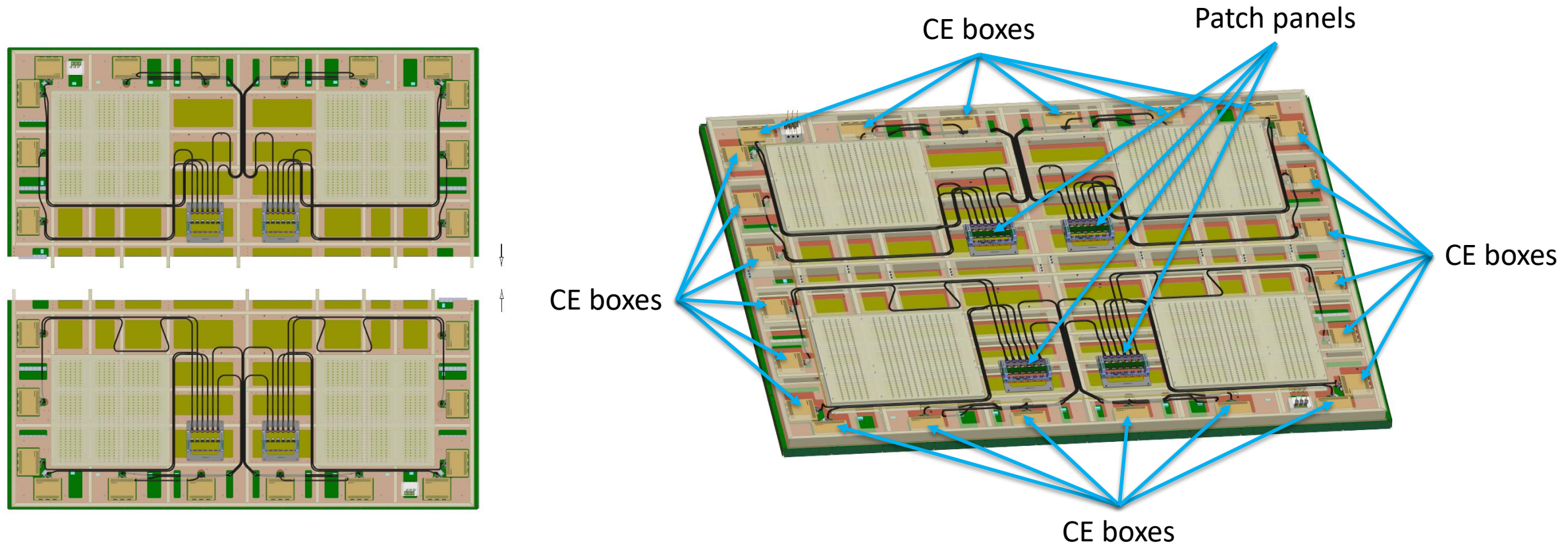
CE boxes and patch panels installed on the bottom CRP



Overview of BDE mechanical components

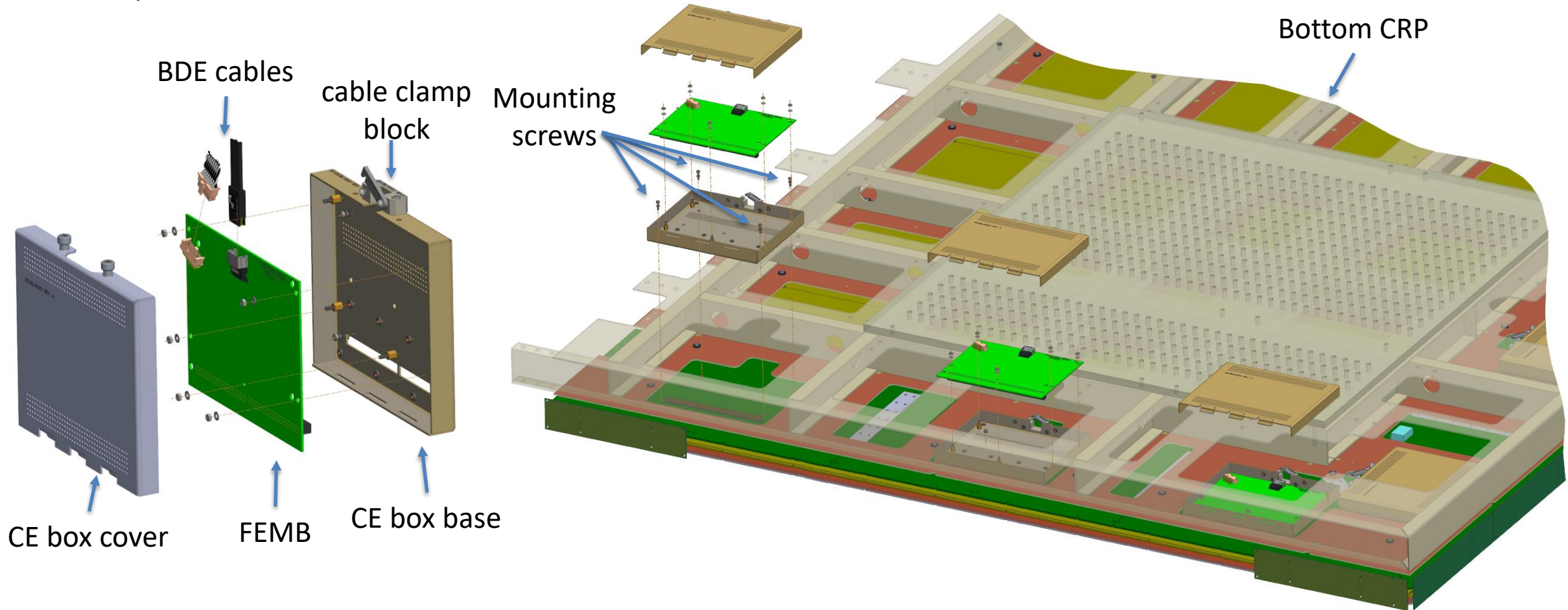
CE boxes and patch panels are installed on half CRPs before full CRPs are assembled.
BDE cables connect the CE boxes to the patch panels.

Each half CRP is readout by 12 CE boxes. Each 6 CE boxes are connected to one patch panel by 2.5m BDE cables.



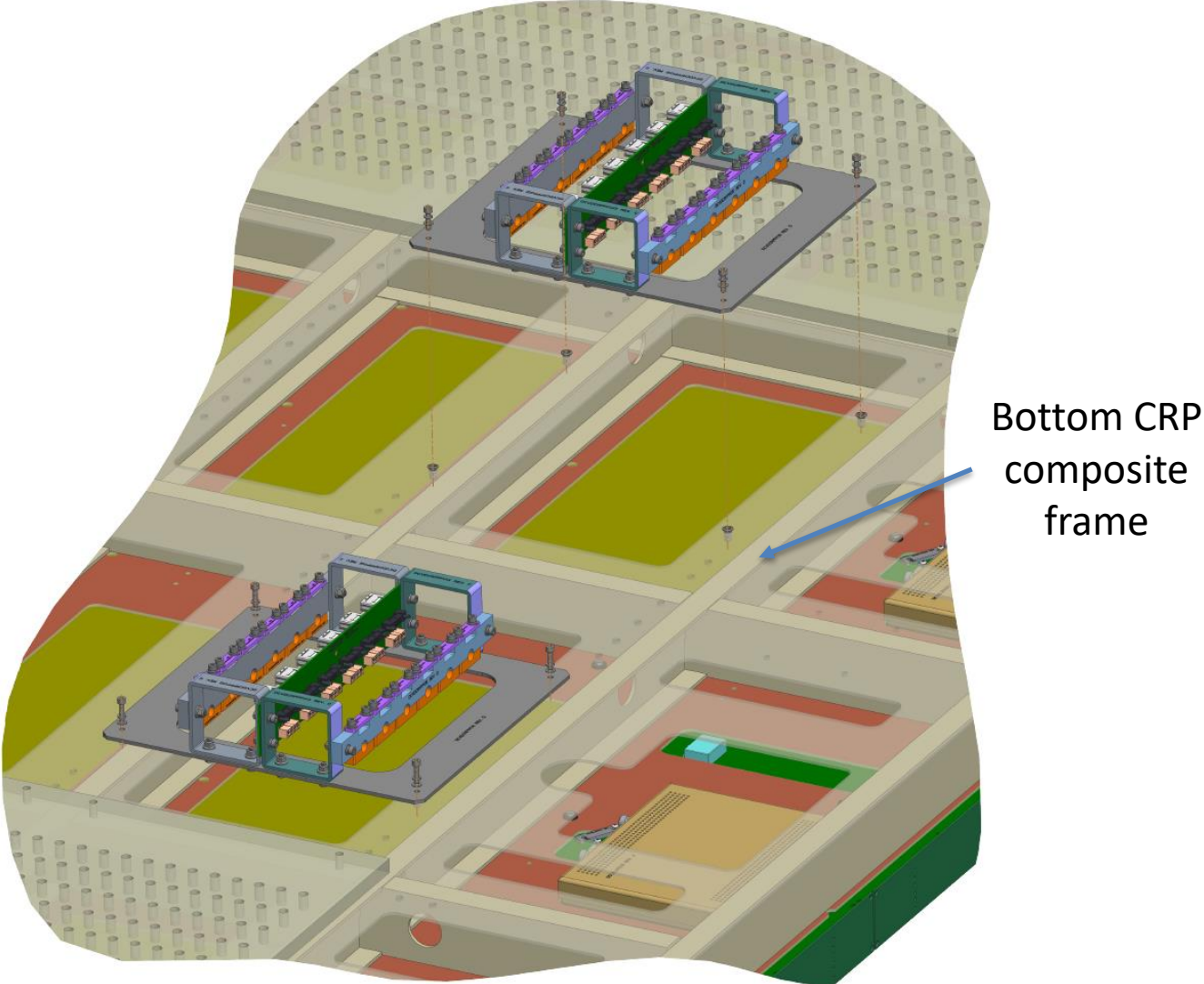
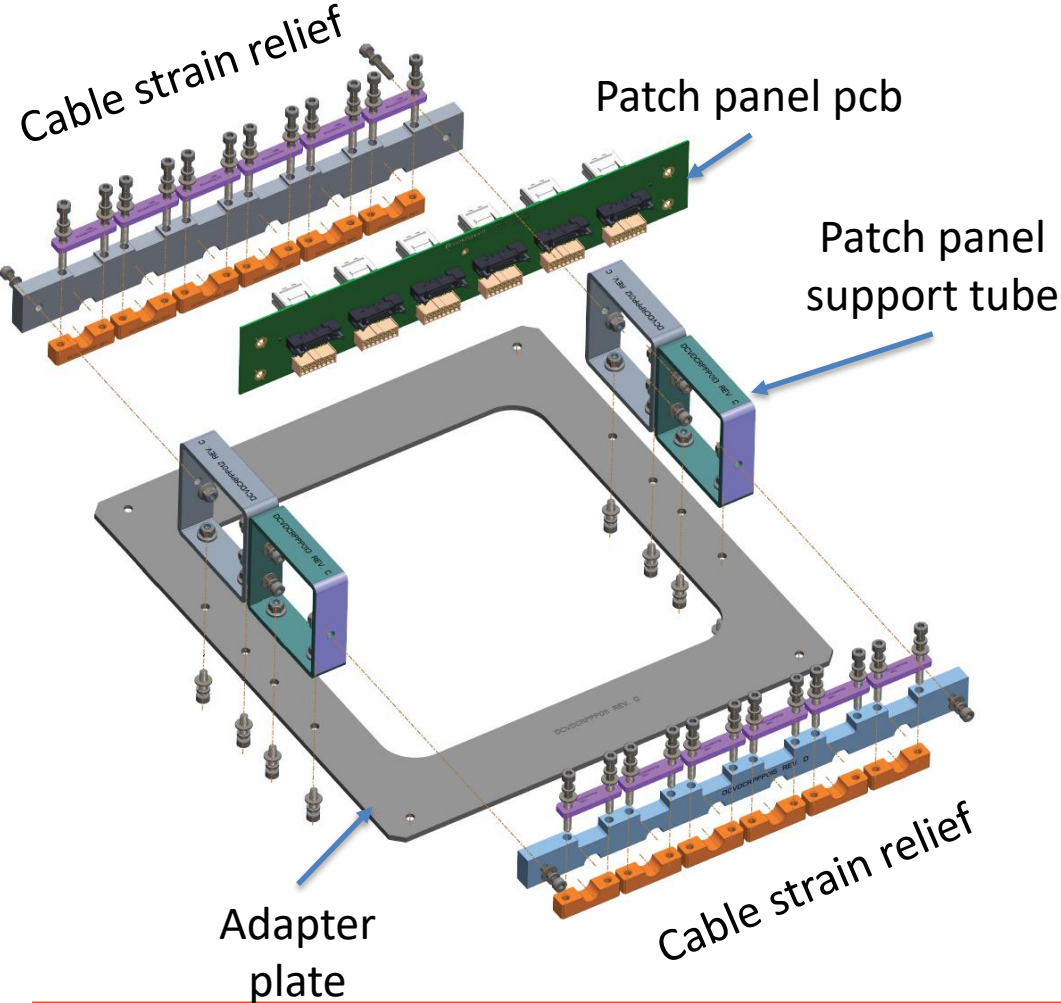
CE Box and Installation

FEMB is installed in CE box. BDE cables are strain relieved at the cable clamp blocks of the CE box. CE box is installed on CRP with four mounting screws. The FEMB is connected to the CRP adapter board via two 96-pin sockets.



Patch panel installation

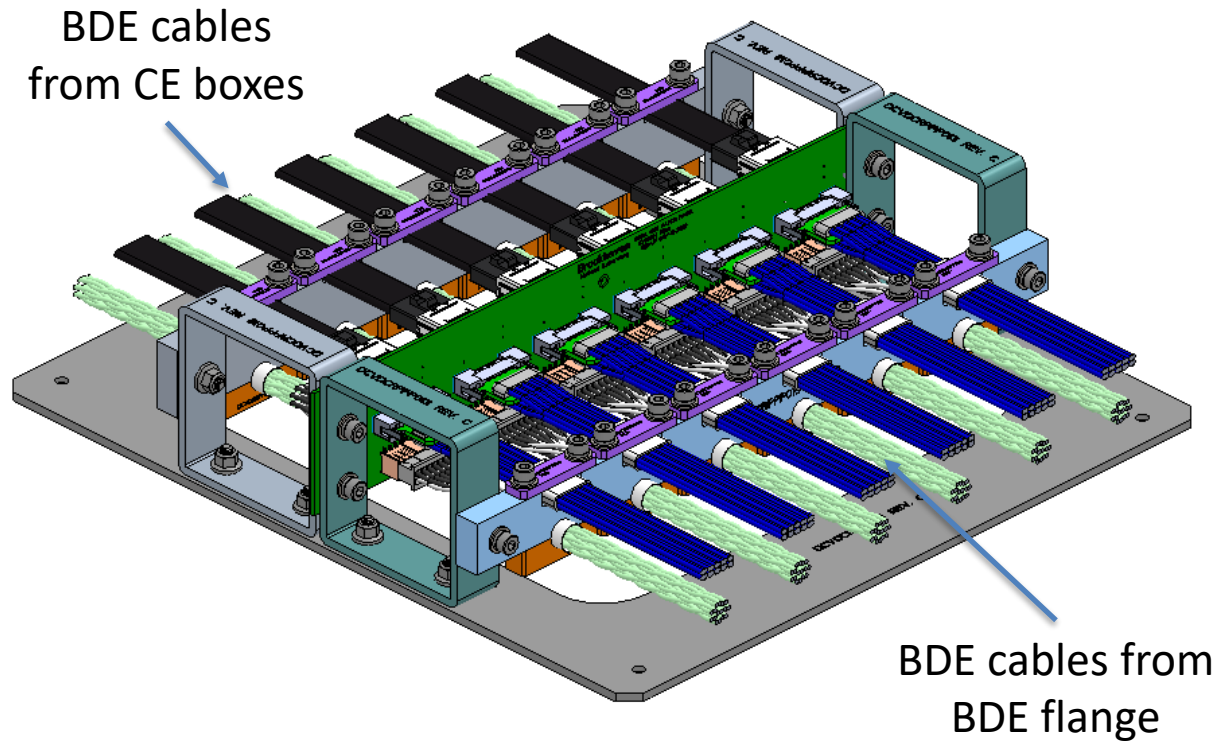
Two CRP patch panels with mechanical supports are installed on each half CRP. Each patch panel assembly is secured on CRP composite frame with four mounting screws.



Patch panel cabling

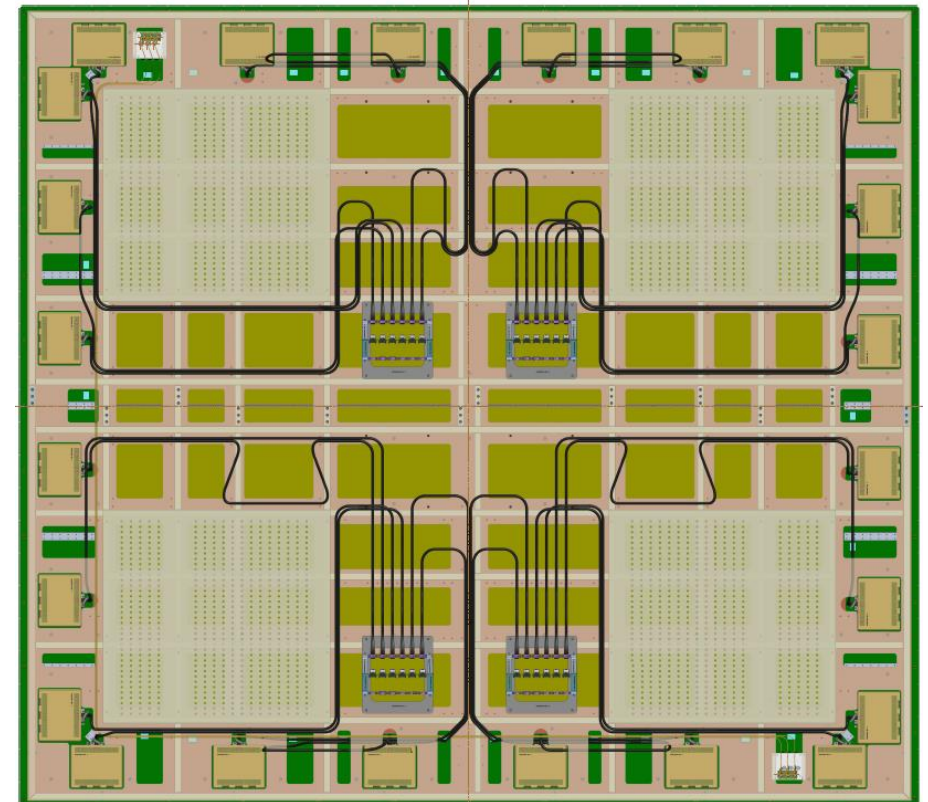
One cable strain relief subassembly is used to clamp the short BDE cables between CE boxes and patch panel. The other strain relief subassembly will be used to clamp the long BDE cables between patch panel and BDE flange installed on BDE penetration.

Each half CRP is readout by 12 CE boxes. Each 6 CE boxes are connected to one patch panel by short BDE cables.



Patch panel

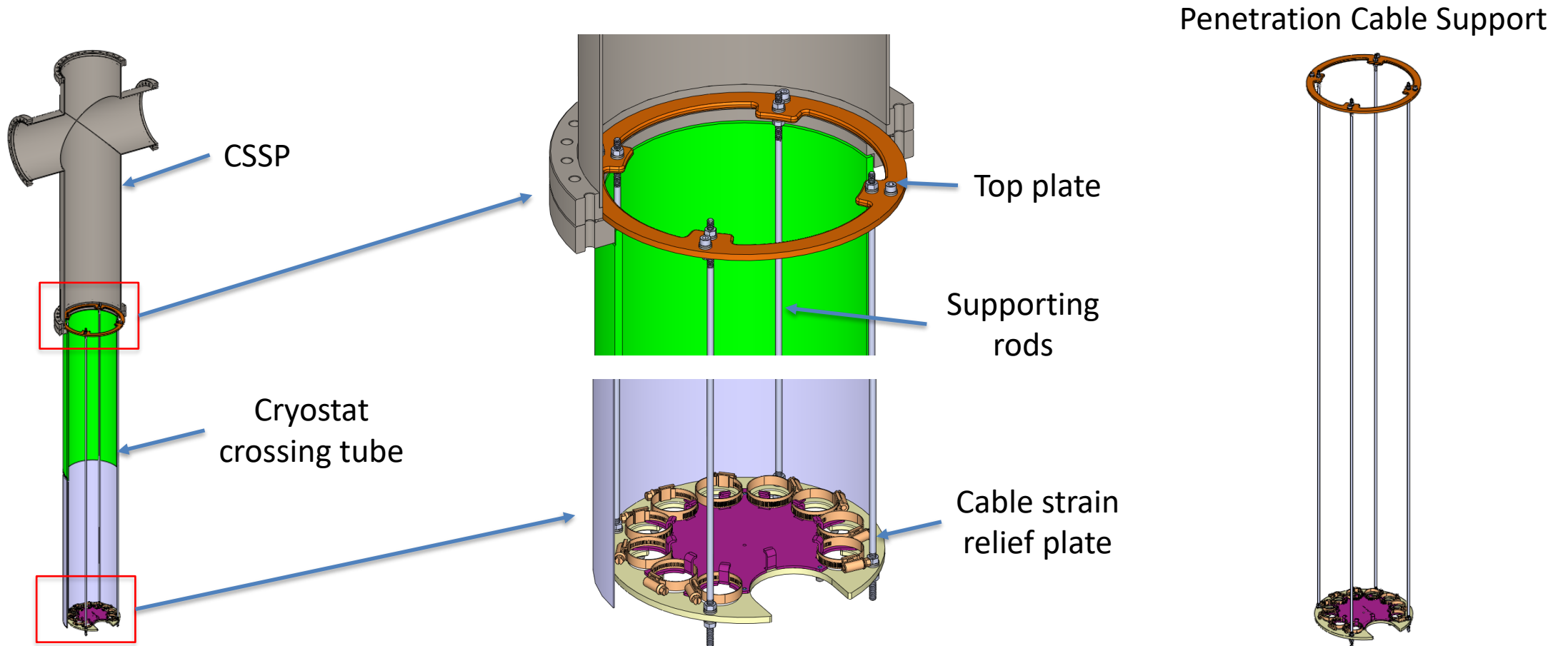
CRP Cabling



Cross-Shaped Spool Piece (CSSP) and Penetration Cable Support (PCS)

A CSSP is installed on the flange of the cryostat crossing tube providing three ports for two BDE flanges and one PDS flange.

A PCS consists of a cable strain relief plate, four rods and a top plate. The BDE cables passing through the penetration are strain relieved at the cable strain relief plate of the PCS.



BDE flange and Warm Interface Electronics Crate (WIEC)

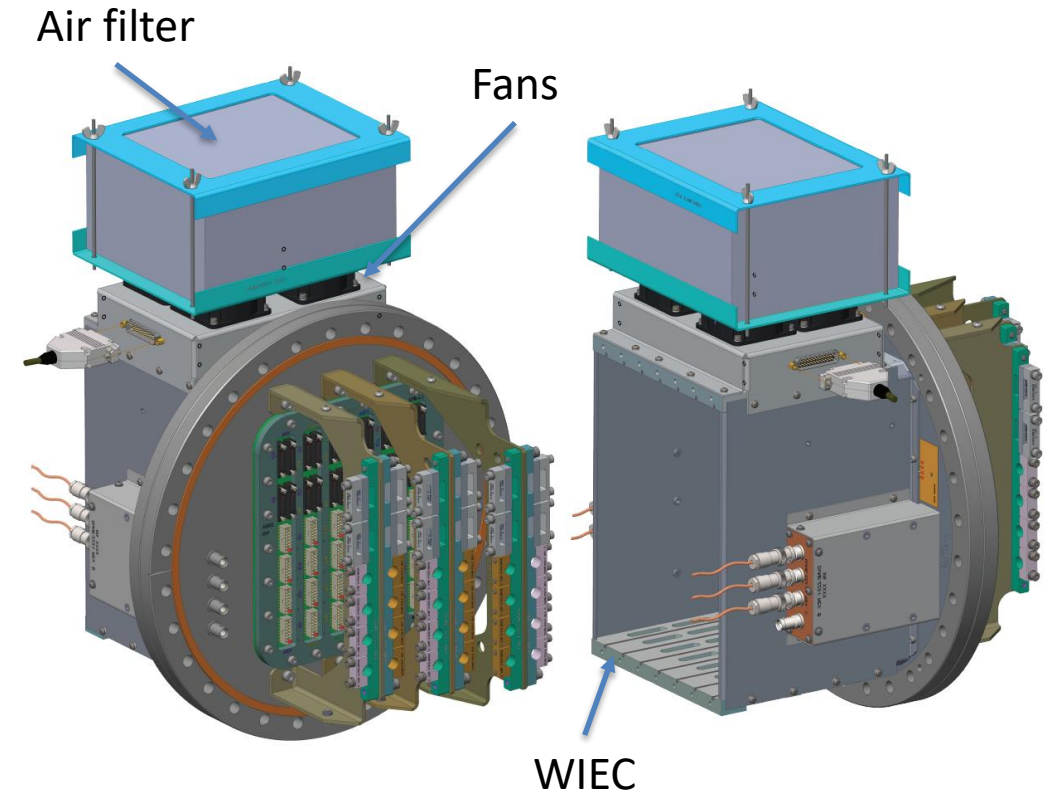
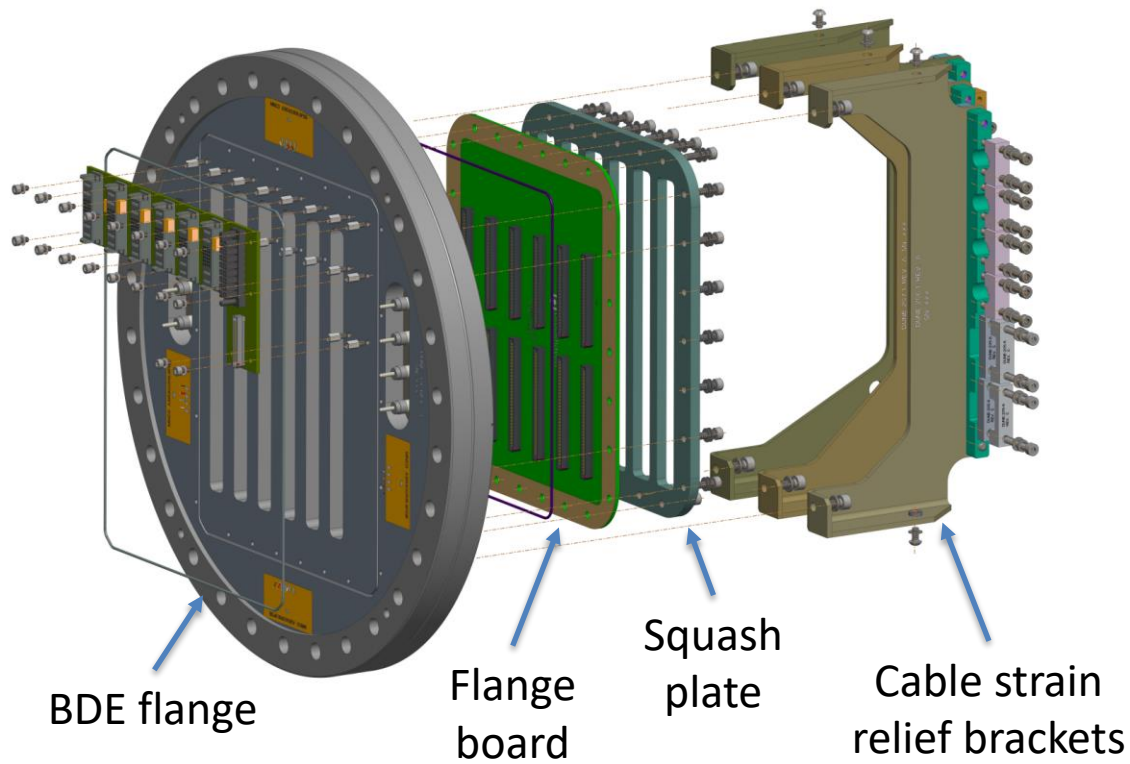
BDE flanges and WIECs are installed on the side ports of CSSPs.

A flange board and a set of cable strain relief brackets are installed at the cold side of the flange.

Long BDE cables from CRP patch panels are to be connected to the flange board and strain relieved at the cable strain relief brackets.

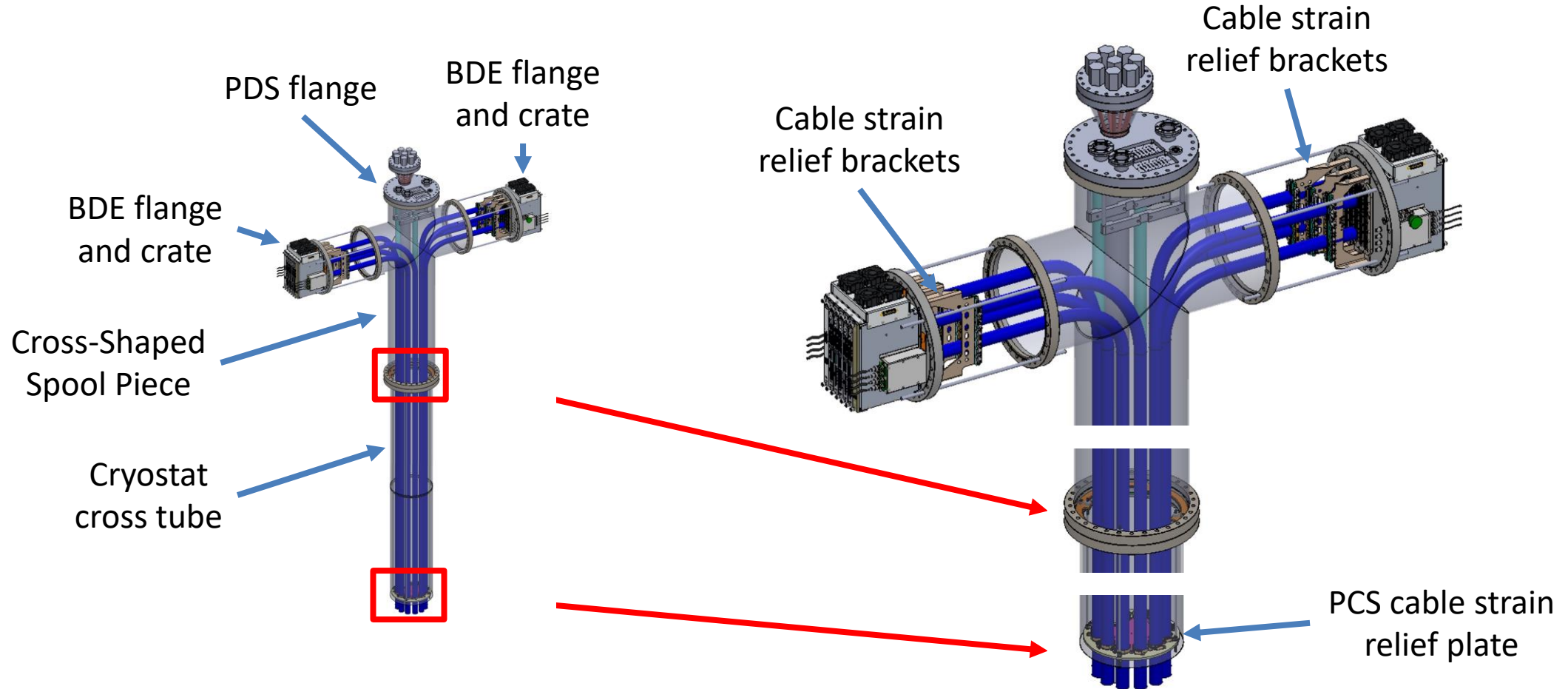
A WIEC is installed at the warm side of the flange to accommodate PTB, WIBs and PTC.

Fans and air filter provide cooling for the warm interface electronics.



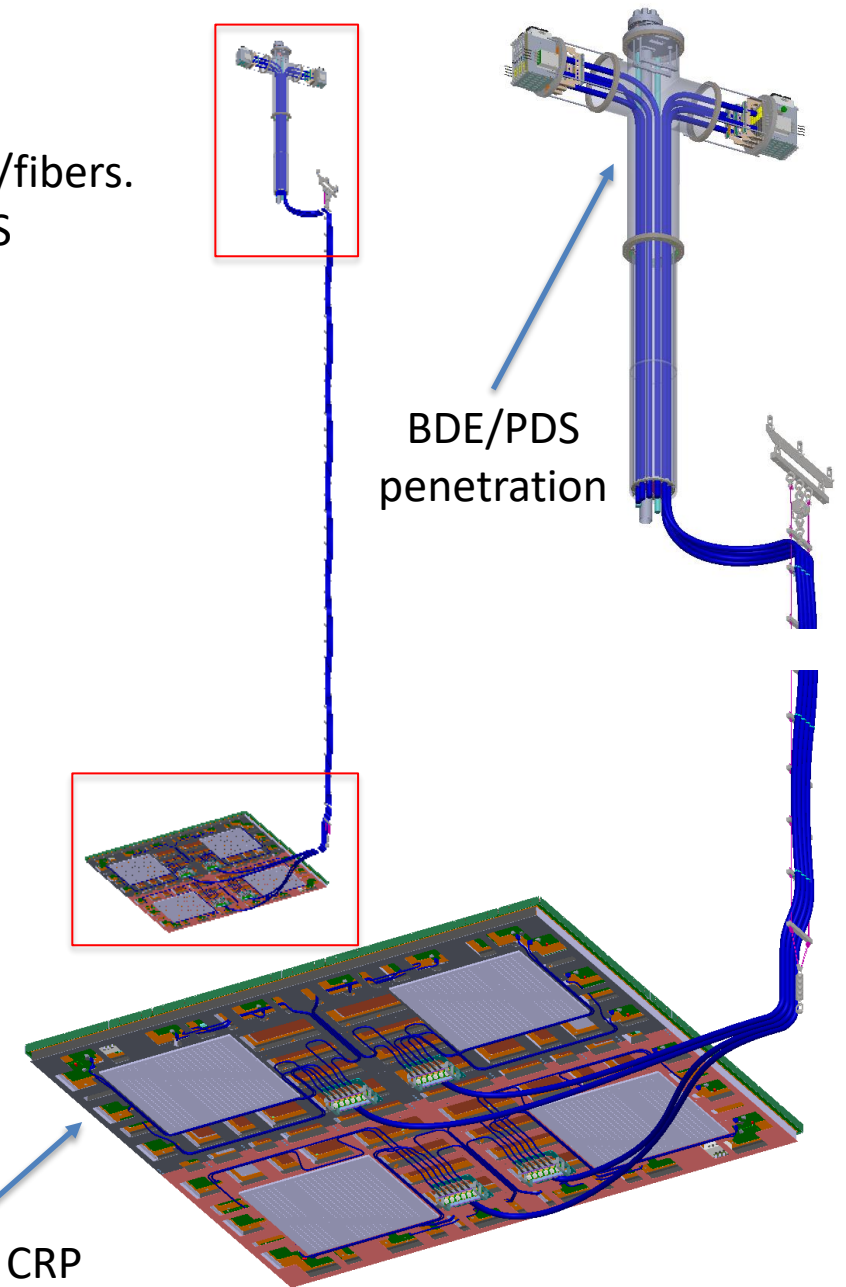
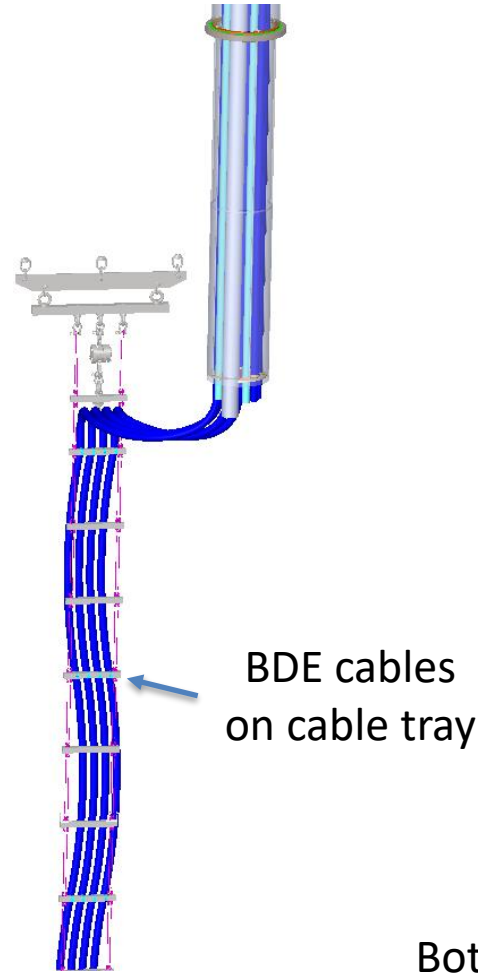
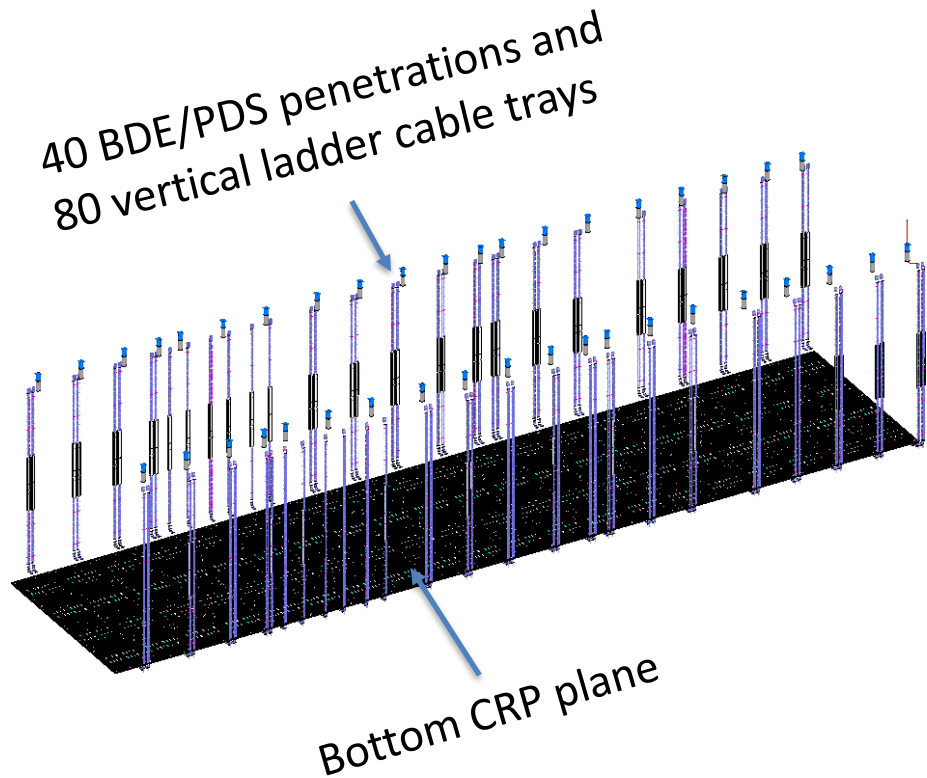
BDE/PDS penetration

All BDE cables from the CRP patch panels are routed through the penetrations in the top of the cryostat and connect to BDE flanges. The cables are strain relieved at the cable strain relief plate of penetration cable support (PCS) and a set of flange cable strain relief brackets.



FD2 cabling

40 penetrations on the VD cryostat are provided for BDE cables and PDS cables/fibers. 80 vertical ladder cable trays are provided by I&I to support BDE cables and PDS cables/fibers.



Cable length estimation

The long BDE cable length is recalculated based on the latest layout of the vertical ladder cable tray.

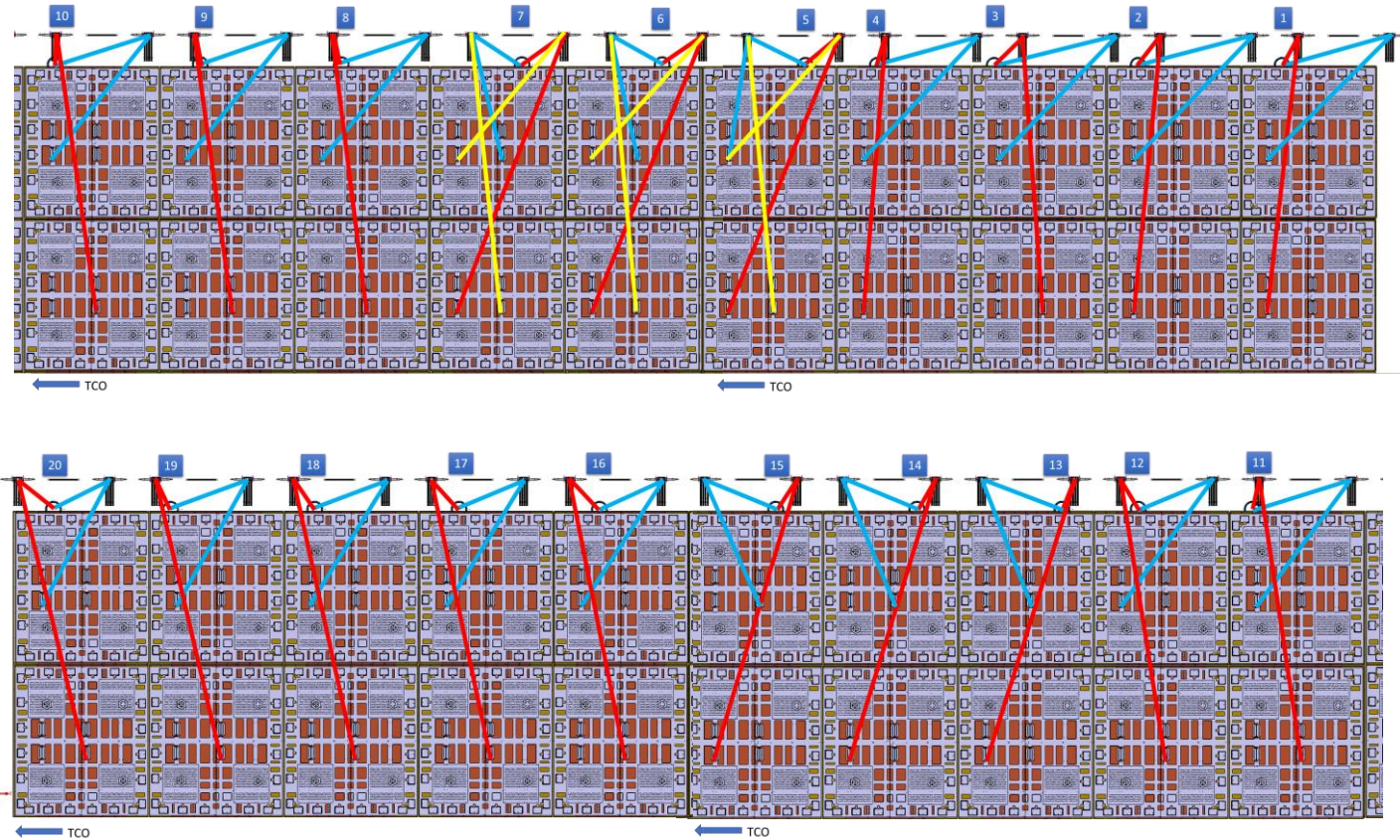
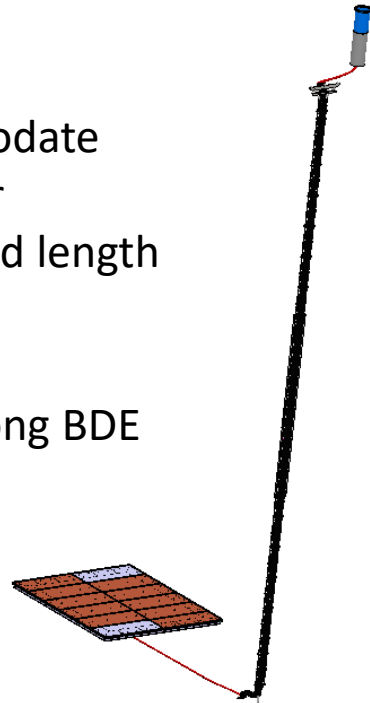
It is found that the required length of cable bundles for CRP row 5 is the longest.

A detailed cable routing model of the longest cable bundle for CRP row 5 is created for more accurate estimation.

Measured from the 3D model plus 3% extra length on the vertical cable tray, cable length from BDE flange to patch panel = 25.5 m.

Adding 1m length to accommodate thermal contraction and other contingency need, the required length becomes 26.5 m.

Therefore, the length of the long BDE cable is set to 27m.



3D models and drawings

All 3D models and the 2D drawings of BDE mechanical components/assemblies are uploaded to EDMS.

Parts and Assembly Drawings

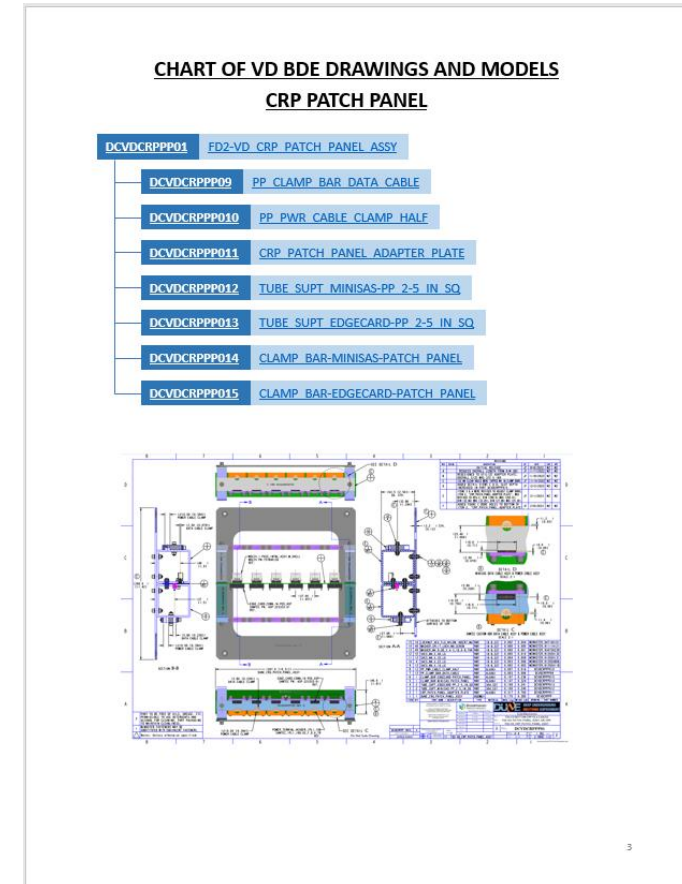
<https://edms.cern.ch/project/CERN-0000229695>

3D Models

<https://edms.cern.ch/project/CERN-0000241959>

A chart of drawings/models is created to help navigate through drawings and models of all BDE mechanical components and assemblies.

https://edms.cern.ch/file/2894537/1/CHART_OF_VD_BDE_DRAWINGS_AND_MODELS.pdf



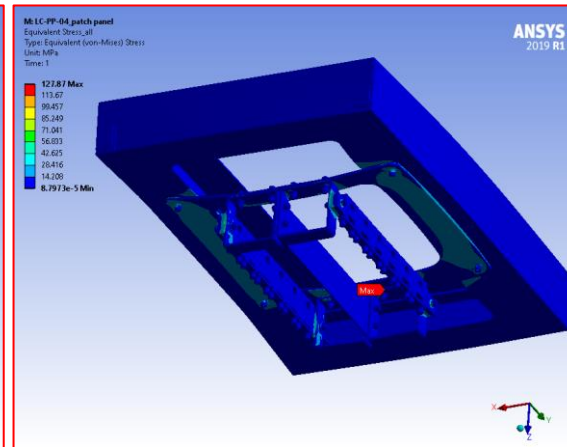
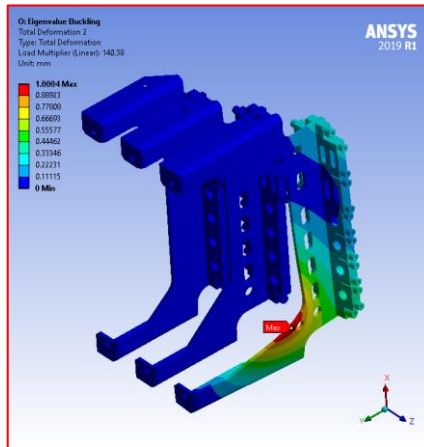
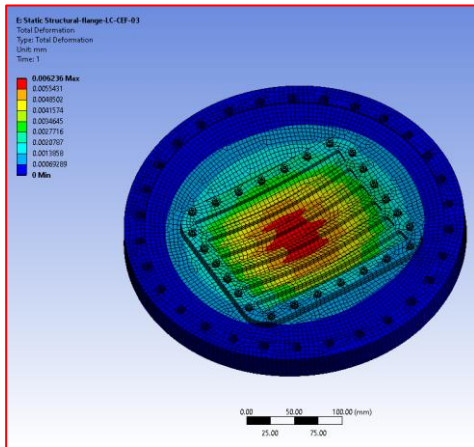
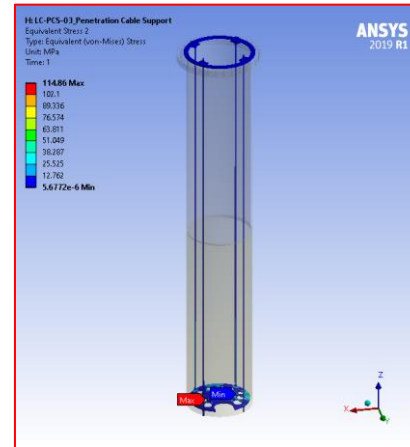
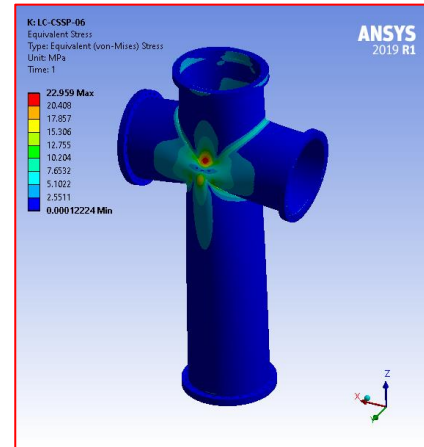
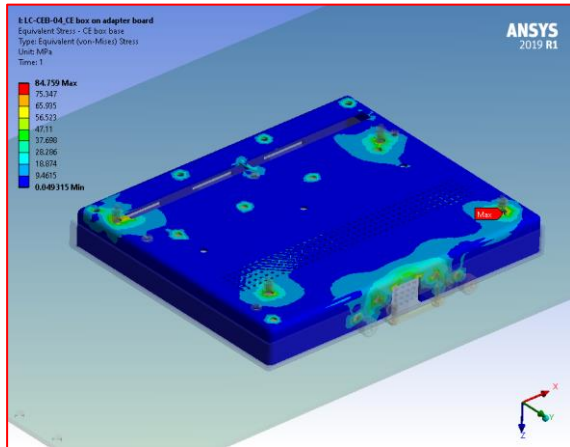
Structural Analysis and Validation

Structural analysis and buckling analysis are performed to study the deformation, stress and buckling of BDE Mechanical system under various load cases. Based on the results from these analyses, the design of the BDE Mechanical system ensures sufficient strength for the BDE Mechanical system to be safely used in all load cases.

LBNF / DUNE Compliance Office BDE Validation document - DESIGN

<https://edms.cern.ch/document/2823202/1>

<https://edms.cern.ch/document/2823884/1>



EDMS No.: 2823202 v.1
Date: 05.08.2023

LBNF / DUNE Compliance Office System Structural Validation document – DESIGN

DUNE FD2 Bottom Drift Electronics (BDE) mechanical components

From: O. Beltramello, M. Zimbru, G. Buccino

Project Leaders: Cheng-Ju Lin
Project Engineers: M. Zhao

1. System identification:

The Bottom Drift Electronics (BDE) for the Far Detector 2 (FD2) consists of CE boxes, patch panel mechanical supports and signal penetrations for each of the bottom Charge readout panels (CRPs)

2. Provided documentation:

EDMS 2823730 v.1 - Plan for Analysis for the BDE mechanical components
EDMS 2823884 v.1 – Structural analysis of BDE mechanical components

3. Applicable Standards and additional relevant applicable documentation:

ANSI/AISC 360-16 - American Institute for Steel Construction - Specification for Structural Steel Buildings.
ASCE 7 – American Society of Civil Engineers - Minimum design loads for buildings and other structures
AISC Design Guide 27 - Structural Stainless Steel
ANSI/AWS D1.1 Structural Welding Codes
EUROCODE equivalency White Paper - Acceptance of Steel and Aluminium Structures Designed per the EUROCODES at FERMILAB
ADM 1 Specification for aluminum structures

4. System Operational requirements:

EDMS 2590797 v.1 – Bottom CRP Electronics specification and requirement

Summary

- BDE Mechanical components consists of CE boxes, patch panel mechanical supports, signal penetrations and penetration cable supports, etc.
- CE boxes and patch panels are installed on CRPs and connected with short BDE cables.
- Long BDE cables connect patch panels and BDE flanges.
- Long BDE cables are supported on vertical ladder cable trays and strain relieved at the penetration cable supports and flange cable strain relief brackets.
- Length of long BDE cables is calculated as 27m.
- The design of the BDE mechanical system ensures sufficient strength for all BDE mechanical components to be safely used in all load cases.