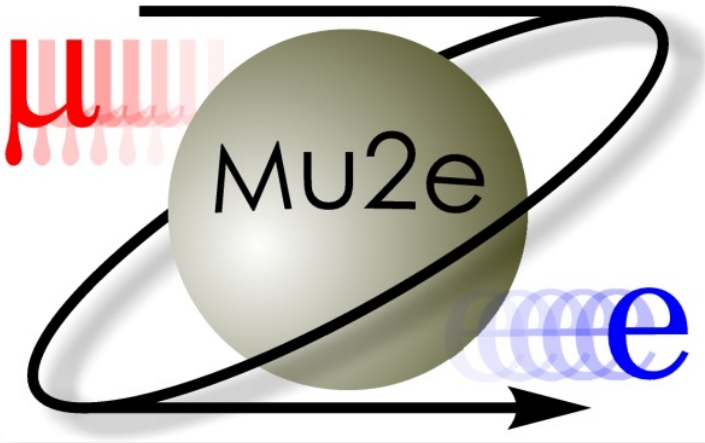


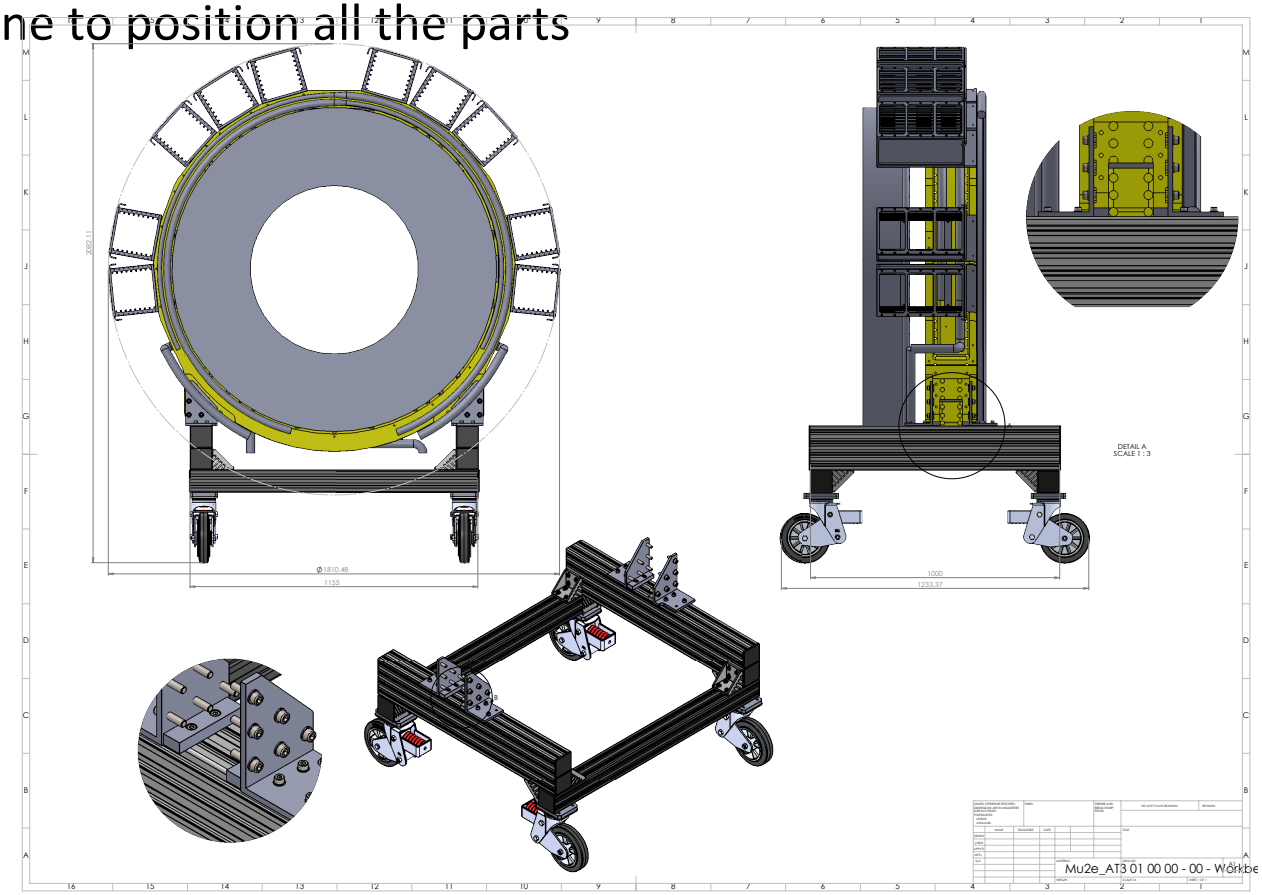
Calorimeter Installation

Calorimeter Transport to Mu2e and Installation flow

F. Happacher

Sidet Calo Preparation

- At Sidet we are going to assemble the 2 calorimeter disks in a dedicated clean room. The disks will be sitting on 2 assembly stands equipped with wheels and shock absorbers to allow the loading and transportation on the semi-trailer
- We have a small crane to position all the parts



Calorimeter disk ready to go

- Each disk will be equipped with:
  - Crystals
  - FEE plate with FEE electronics and SiPM
  - Source plate
  - 10 crates with all the electronic boards
  - diffusive spheres and fibers cabled to the Sipm holders
  - Optical fibers from diffusive spheres to patch panels
  - All FEE cabling from FEE electronics to mezzanine board
  - Patch panels with all the HV/LV cables cabled to the distribution board of each crate
  - Manifolds for cooling and source pipes
  - Flexible pipes hanging from manifold
  - cooling lines connected to the crates

We have a detailed Procedure for the Assembly of each Calorimeter Disk.

checks

- All the cooling pipes and circuits are going to be preassure and leak tested independetly before and, as a whole, after their installation and connection to the crate manifolds and FEE plate.
- All the electronics is going to be tested trough cosmic runs and laser runs
- The source pipes are going to be pressure and leak tested

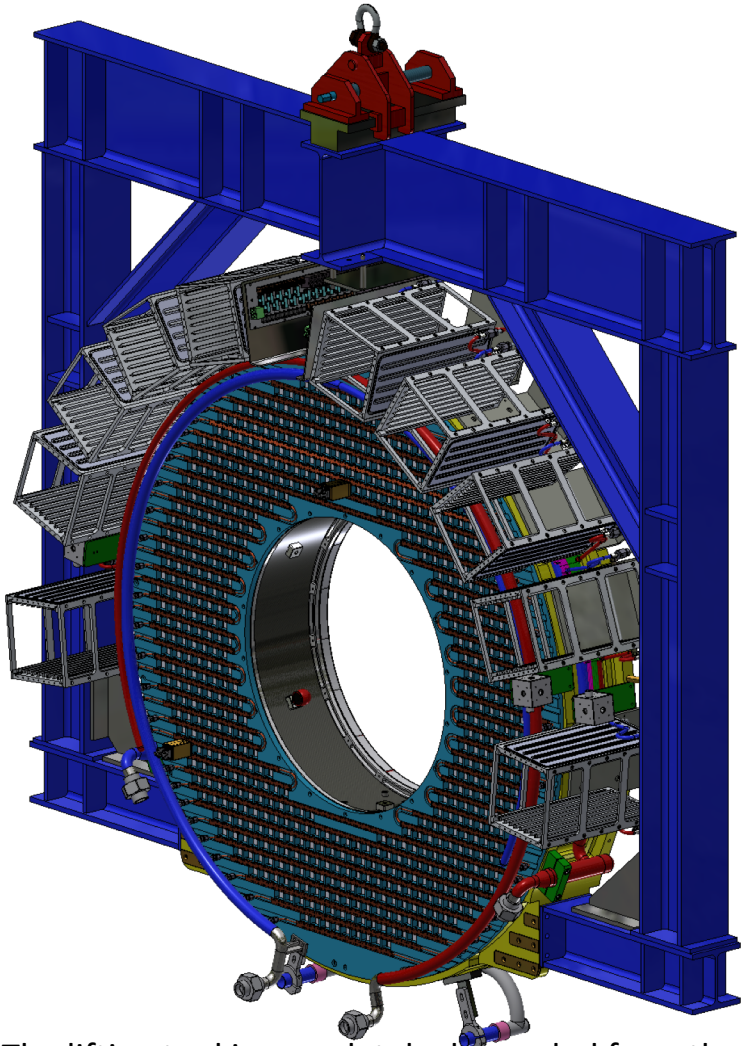
Moving the disks

- Once we close each Disk installing the FEE and Source plates we will begin flowing nitrogen inside the active volume (through valves on the Al structure) to keep moisture and dirt away from crystals and SiPM. We will bag the disks to protect it with a material to be chosen.
- The idea is to bag it so that only the parts inserting on the feet is left free and the the protection can stay during the installation on the rails
- Then we will push it out the clean room and reach the crane position. We designed the clean room to have enough space for the trailer to park in the hangar and have crane clearance to lift the calo and load it on the trailer.
- We will install the lifting fixture, -see next- that is independent from the assembly stand and load the calo on the truck.

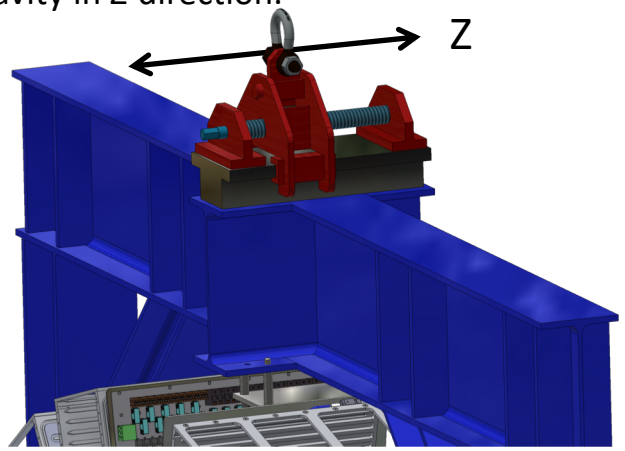
Arrival at Mu2e

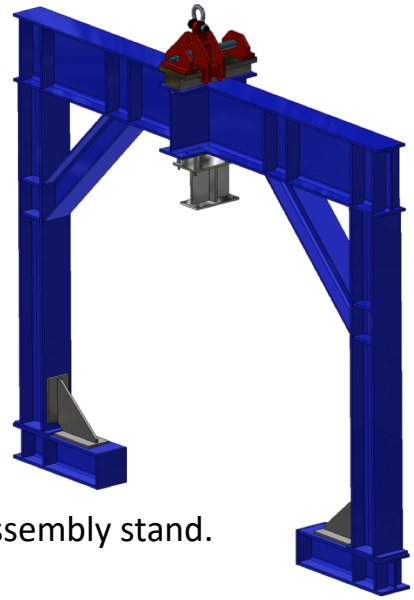
- With Dervin we checked that the trailers we have on site are OK to fit in Lab A. We load the disk on the trailer and we are designing a tool to hold it in position and reduce vibrations in addition to the shock absorbers.
- The truck will cover the distance from Sidet to Mu2e building… The idea is to close the streets and drive at a very low speed.
- We will transport one disk at a time
- Once at Mu2e we can park each calo disk or we can pull it down to the rails right away. We may ask to keep flowing nitrogen in it and keeping it wrapped if it has to wait before installation on the rails.
- The feet are not going to be mounted on the calo; they will be waiting for it on the rails.
- During the installation on the rails the nitrogen/dry air flux fill be disconnected

Installation: lifting tool



It allows to adjust the position of the centre of gravity in Z-direction.





The lifting tool is completely decoupled from the assembly stand.

USA laws and rules

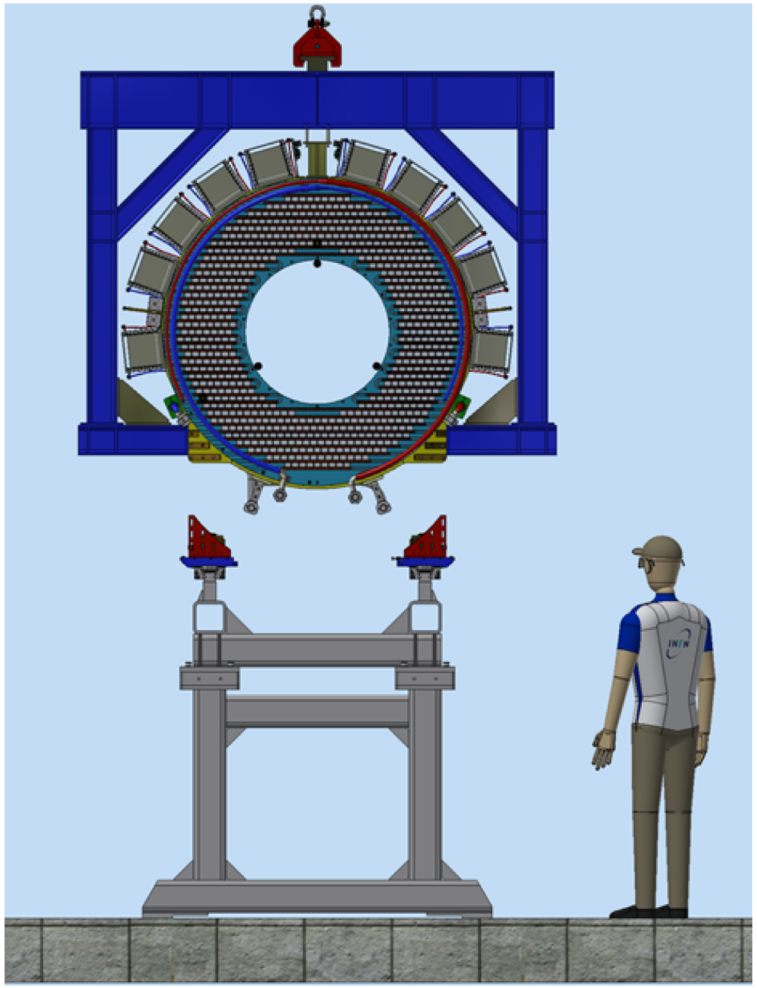
The handling tool shall be considered a lifting system therefore it must be comply with:

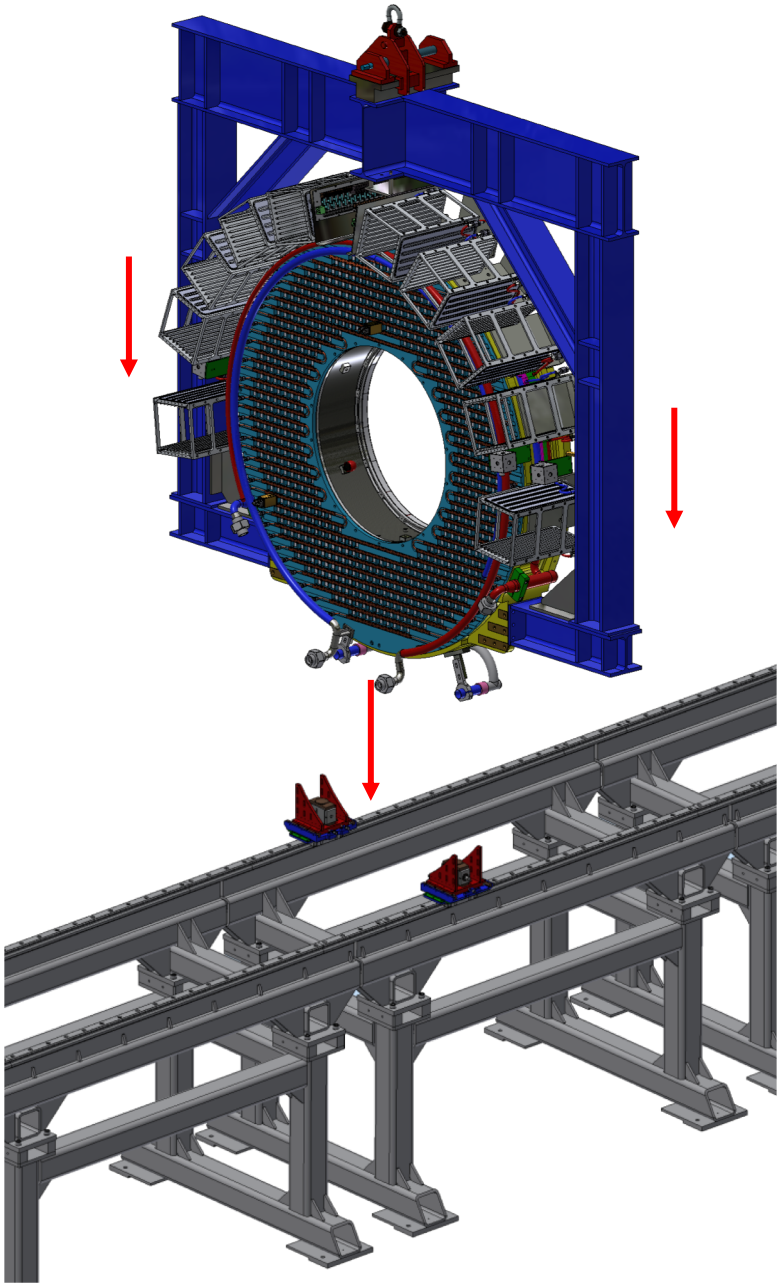
- ASME BTH-1–2014
- ASME B30.20-2013

That means it is mandatory:

- the Technical file (it is being prepared);
- Verification (through calculation, tests, etc.).

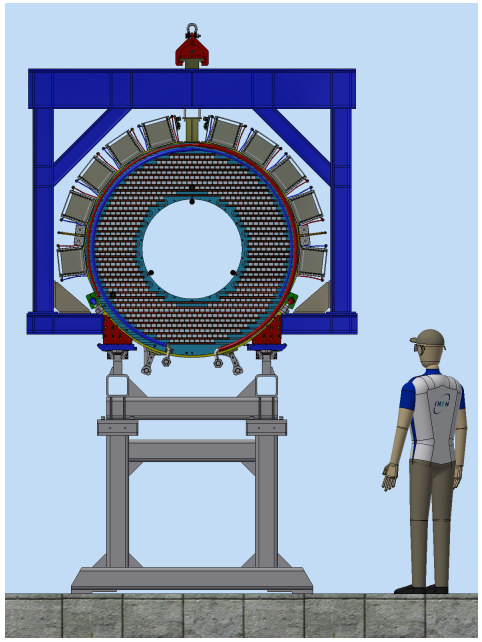
Installation: handling tool



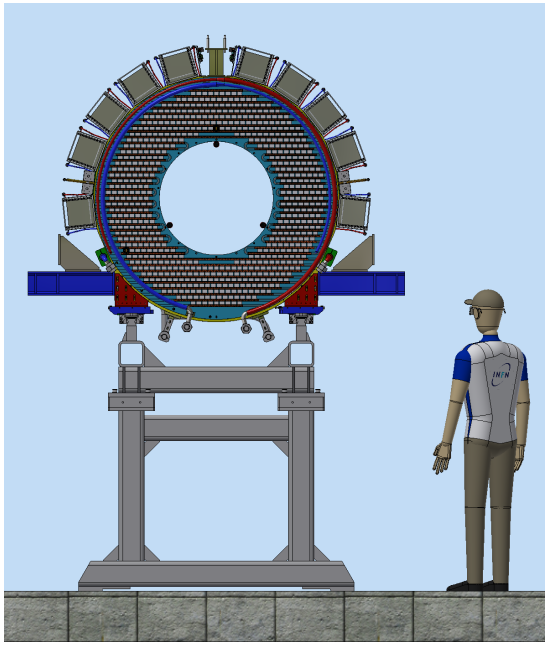


The feet will be installed on the rails before the installation of the disk.

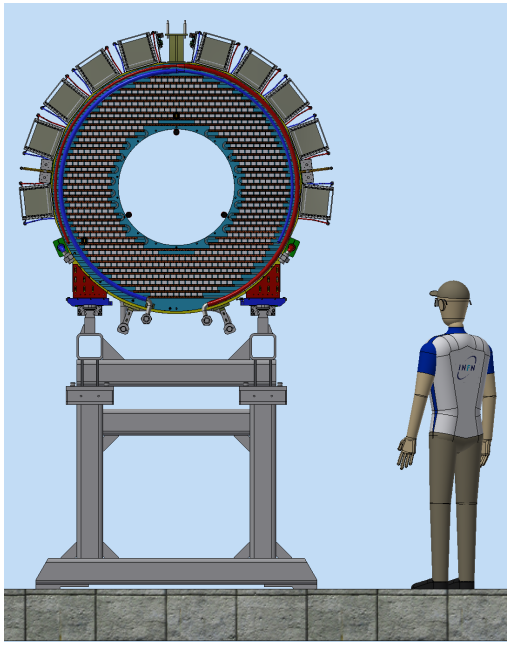
Installation: handling tool



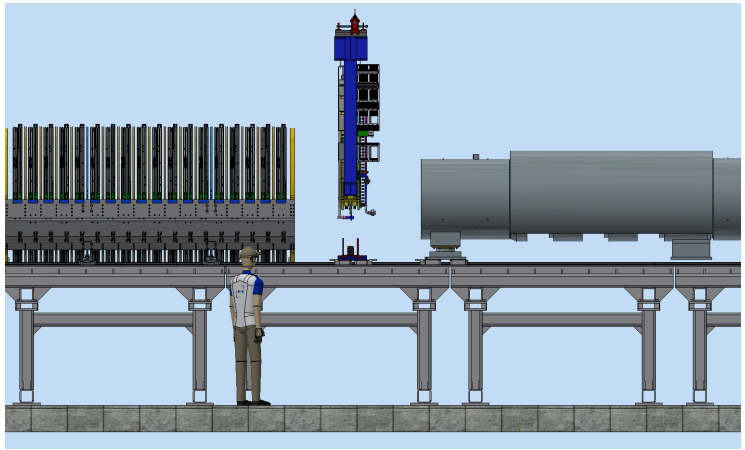
Step1

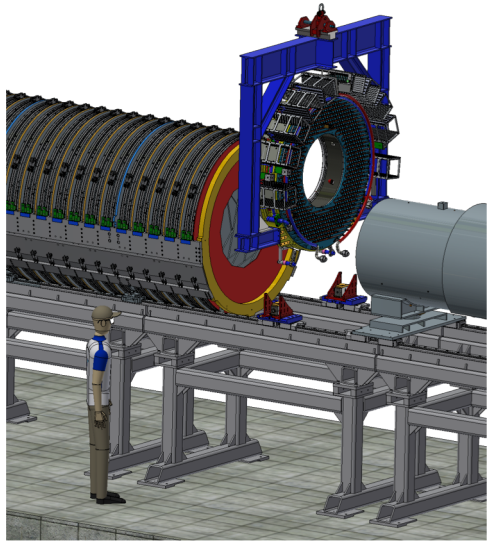


Step2



Step3

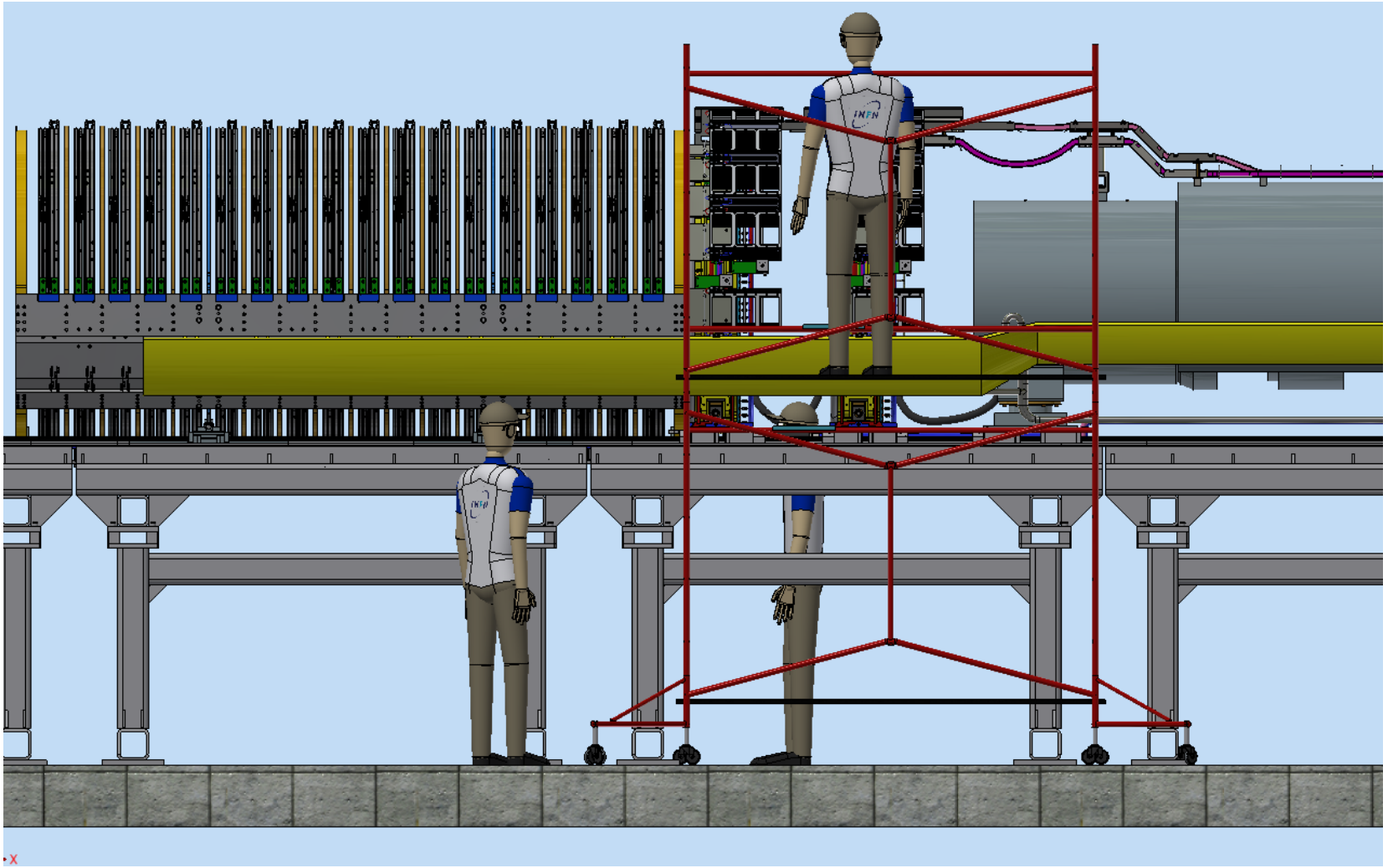




Up-to-IFB Installation macro-Flow

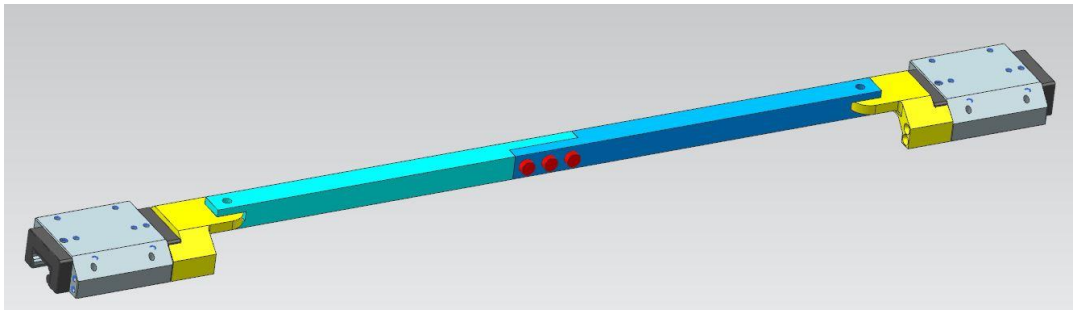
- Positioning of scaffolding prior the calorimeter installation
- Lifting tool assembly on Upstream Disk
- Upstream disk lowering on rails and connections/bolting to master and slave feet
- Lifting tool Disassembly
- Lifting tool assembly on downstream Disk, lowering on rails and connections/bolting to master and slave feet
- axial Downstream-Upstream feet coupler installation
- Overall alignment and tightening of X-Y coordinates (Master feet and Y wedge)
- Cable tray installation – top connection between the disks
- Installation of all services supports:
  - top of the MBS: support for cable trays
  - Upstream MBS feet: support for Calo pipes and tracker services
- Hard sections of source pipes installation:
  - IFB to MBS end
  - IFB to Upstream disk
- Hard Section of cooling pipes installation: IFB to MBS end
- Tracker cooling pipes installation
- All SS - 3 piece union - 1” (HART 3333-5) connection of flexible pipes for cooling to FEE plate and Crate cooling circuit
- Welding of source pipes to source plate manifold
- Installation of protection between Calorimeter and tracker
- HV/LV Cables pulling and connection between Downstream disk patch panel and IFB
- HV/LV Cables pulling between Upstream disk patch panel and IFB
- TDAQ fibers connection from IFB to patch panel
- Laser optical fibers connection from IFB to diffusive spheres

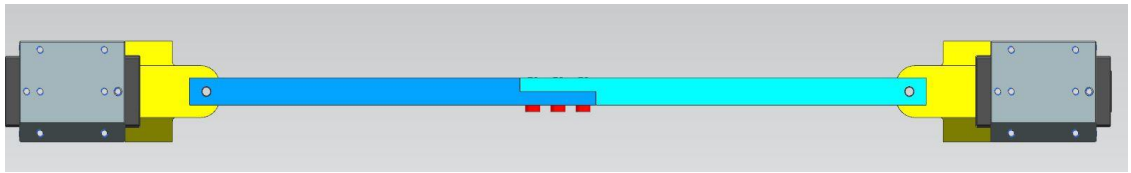
Scaffolding

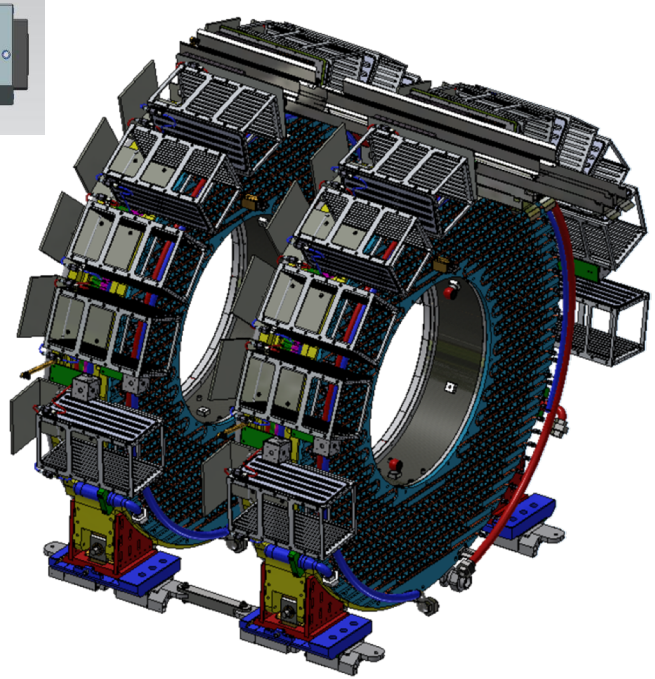


Two scaffolding on wheels, positioned on both sides of the calorimeter, will be used to access the disks during the installation and maintenance

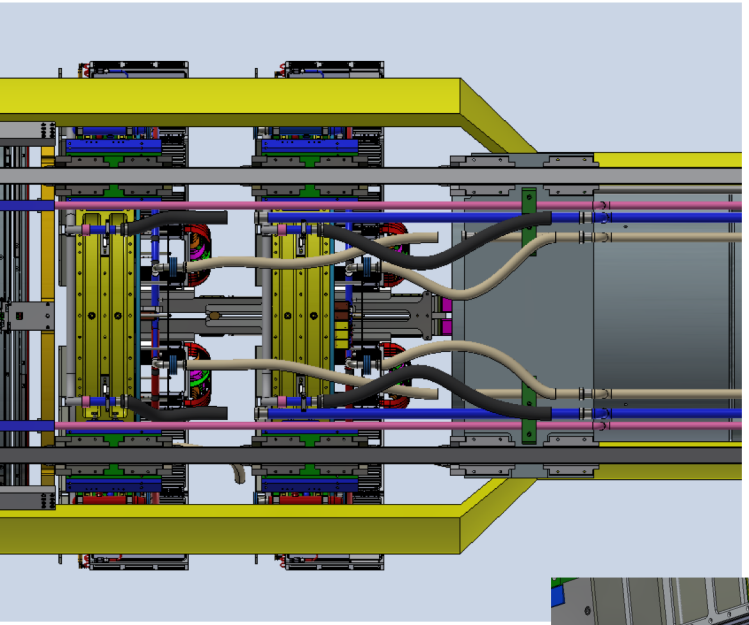
Axial coupler + cable tray connections



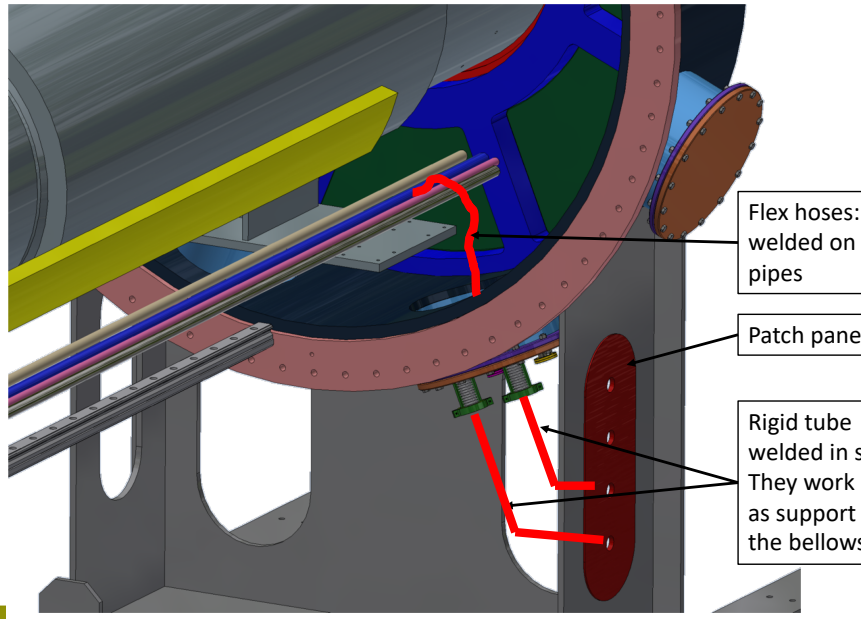


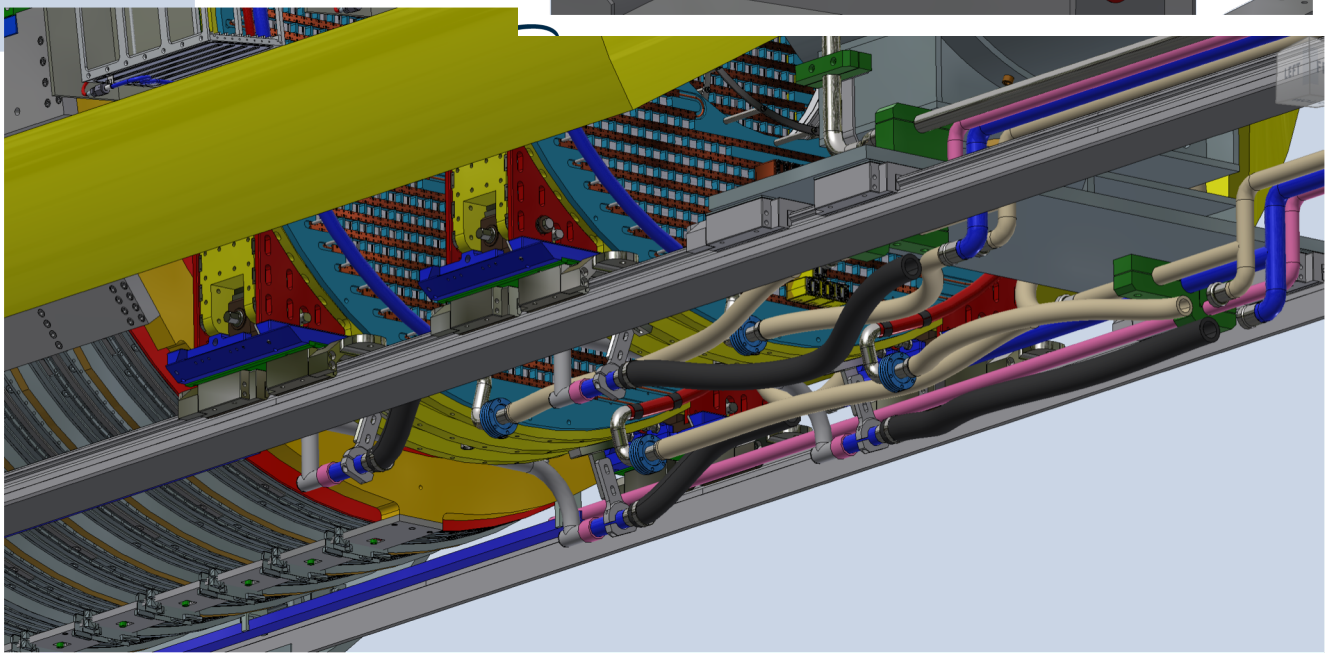


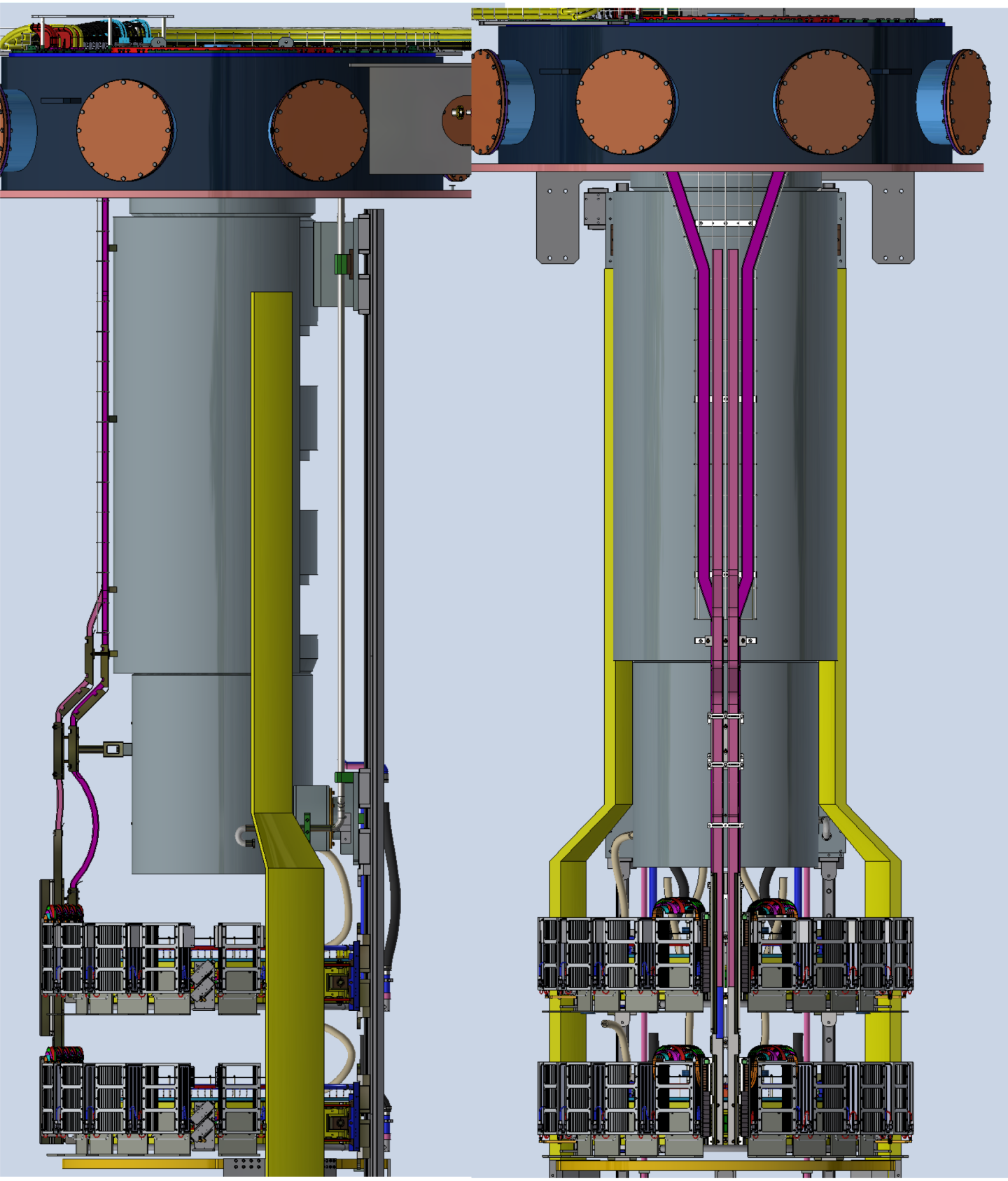
Hard services details



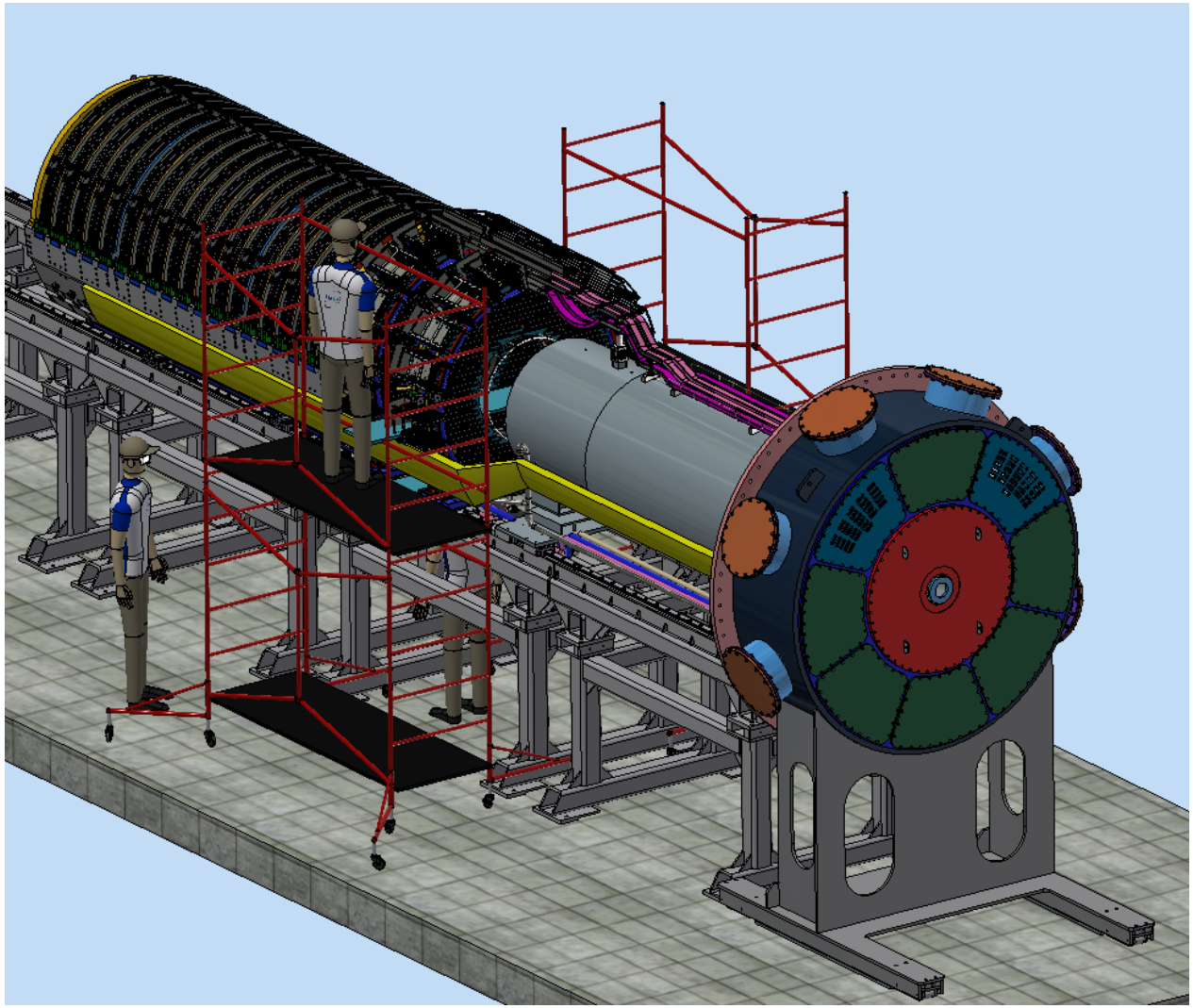
EM-Calorimeter: Flex hoses and pipes





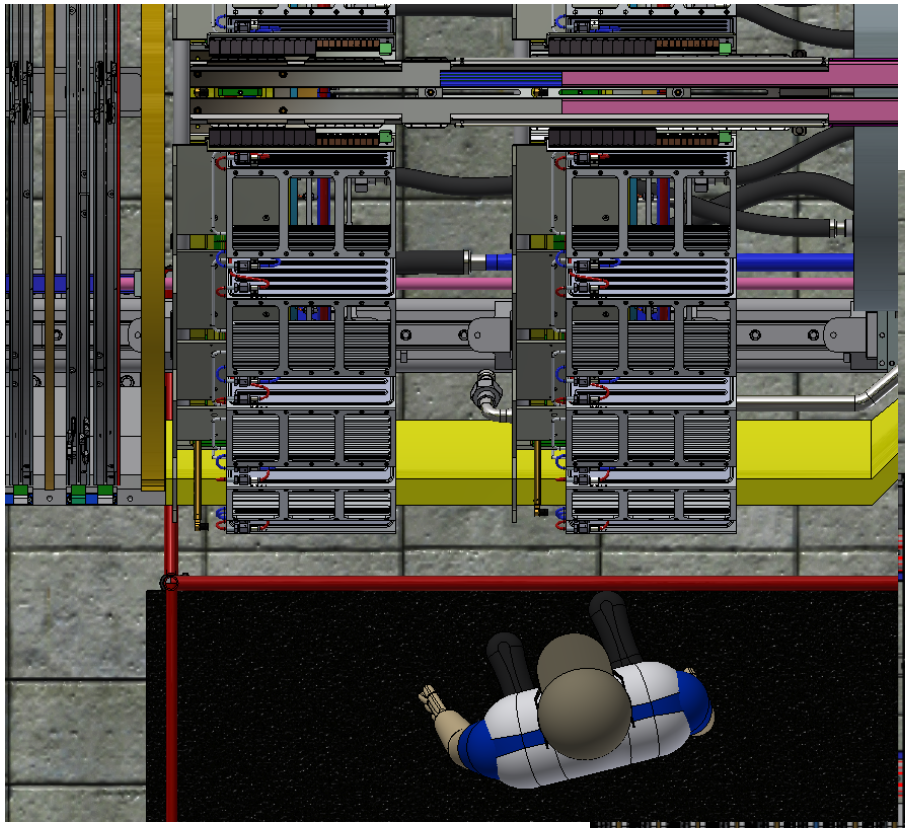


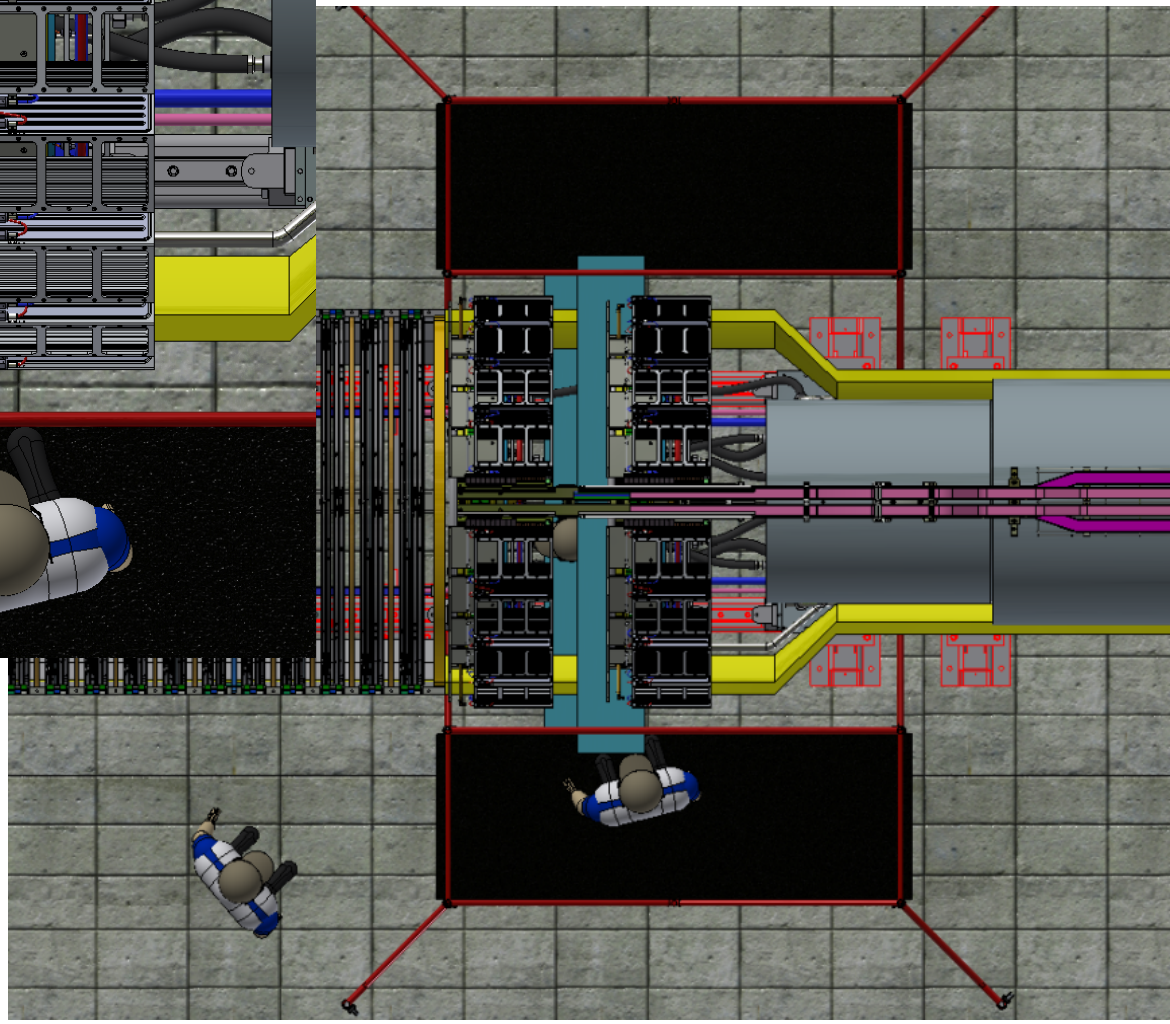
Scaffolding



- Crates and FEE are both accessible from the scaffolding
- The scaffolding will be used also during the installation of the cables

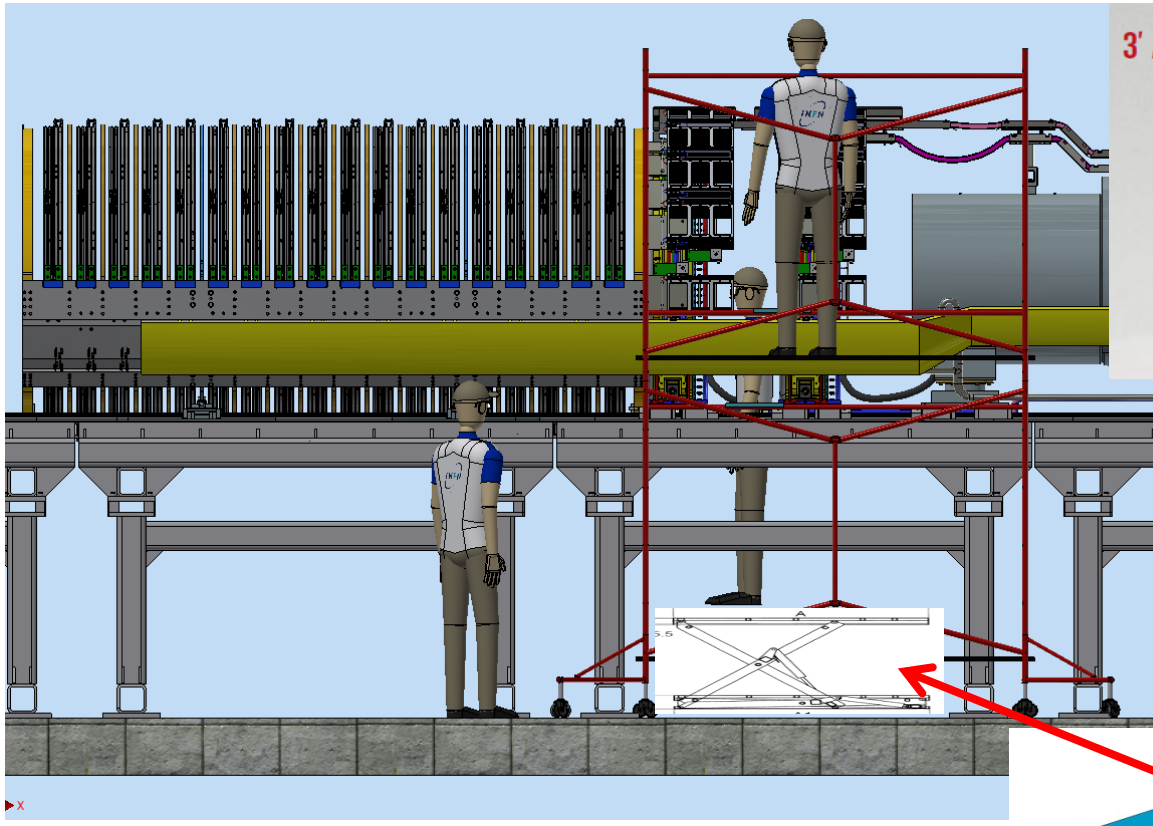
Access from side and above





From the scaffolding it is easy to access at the first three crates

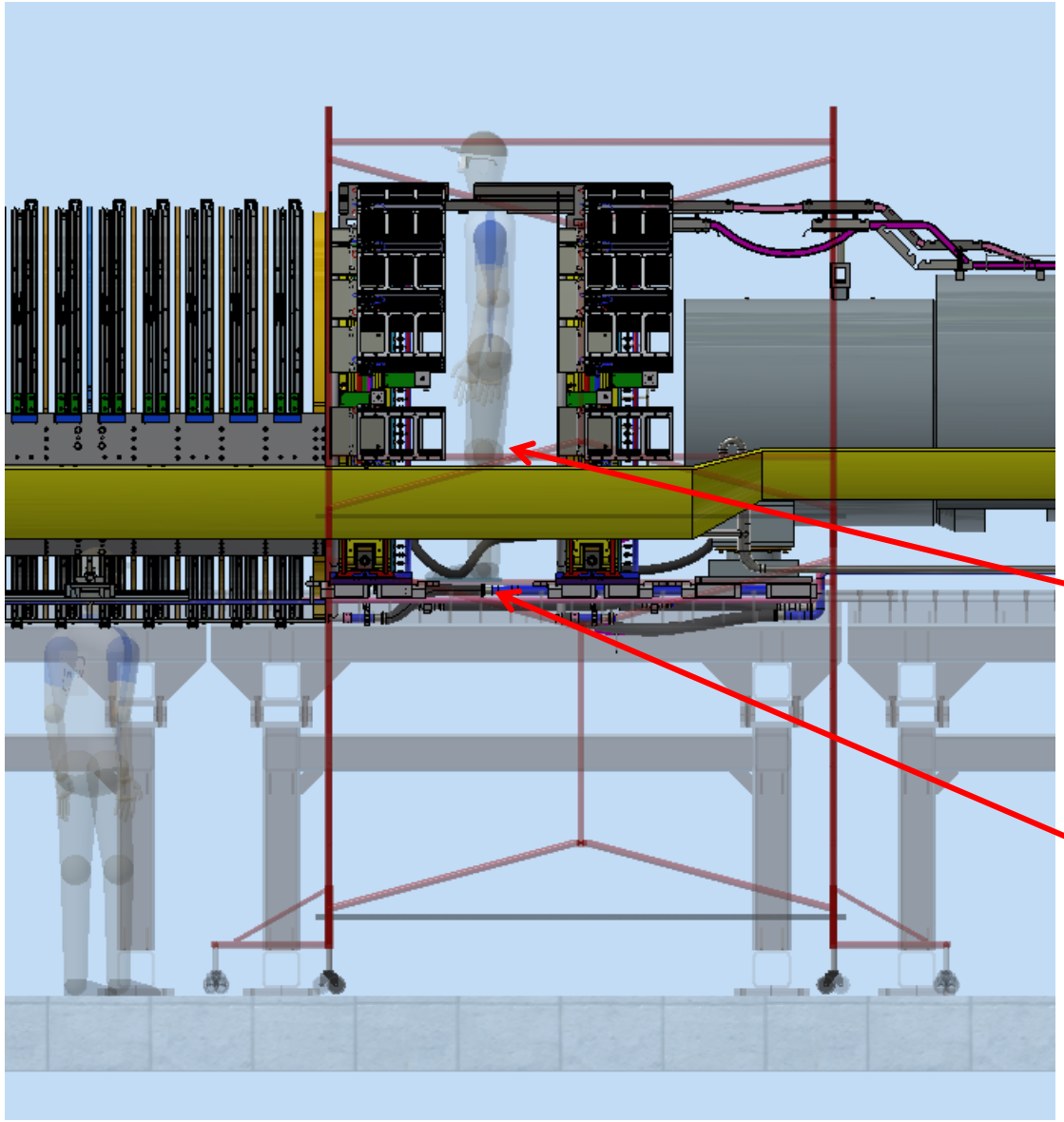
Access from the bottom



Electric scissor lift table

- To access from bottom, a scissor lift table (on wheels) or a step positioned below the calorimeter, could be used.
- The scissor lift table could be used to do the FEE maintenance.

Access to the patch panels and cable trays



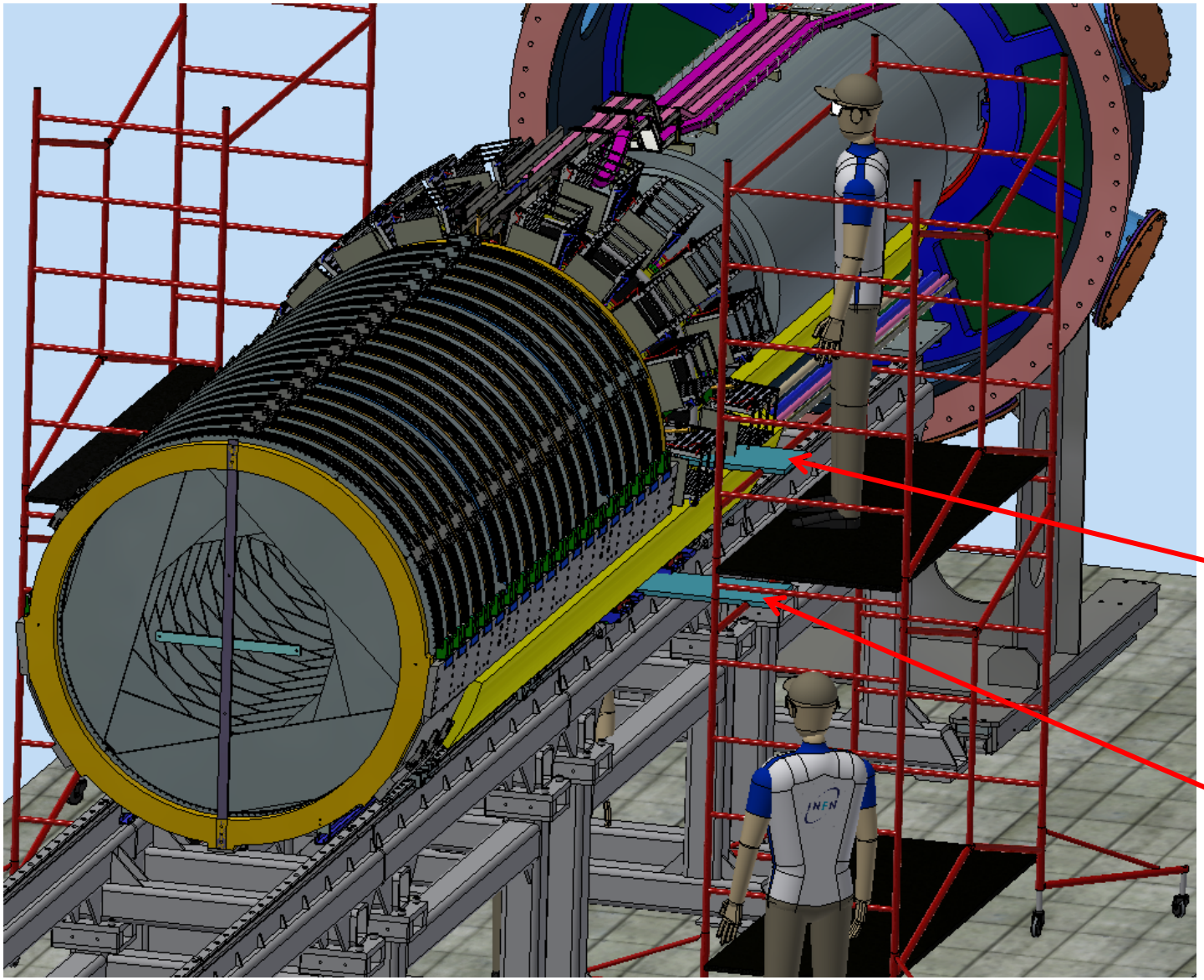
- The crates closest to the centre of the calorimeter and cable trays, could be access installing a plank between the two scaffoldings.
- The plank can be positioned:

1. above the tracker cables

or

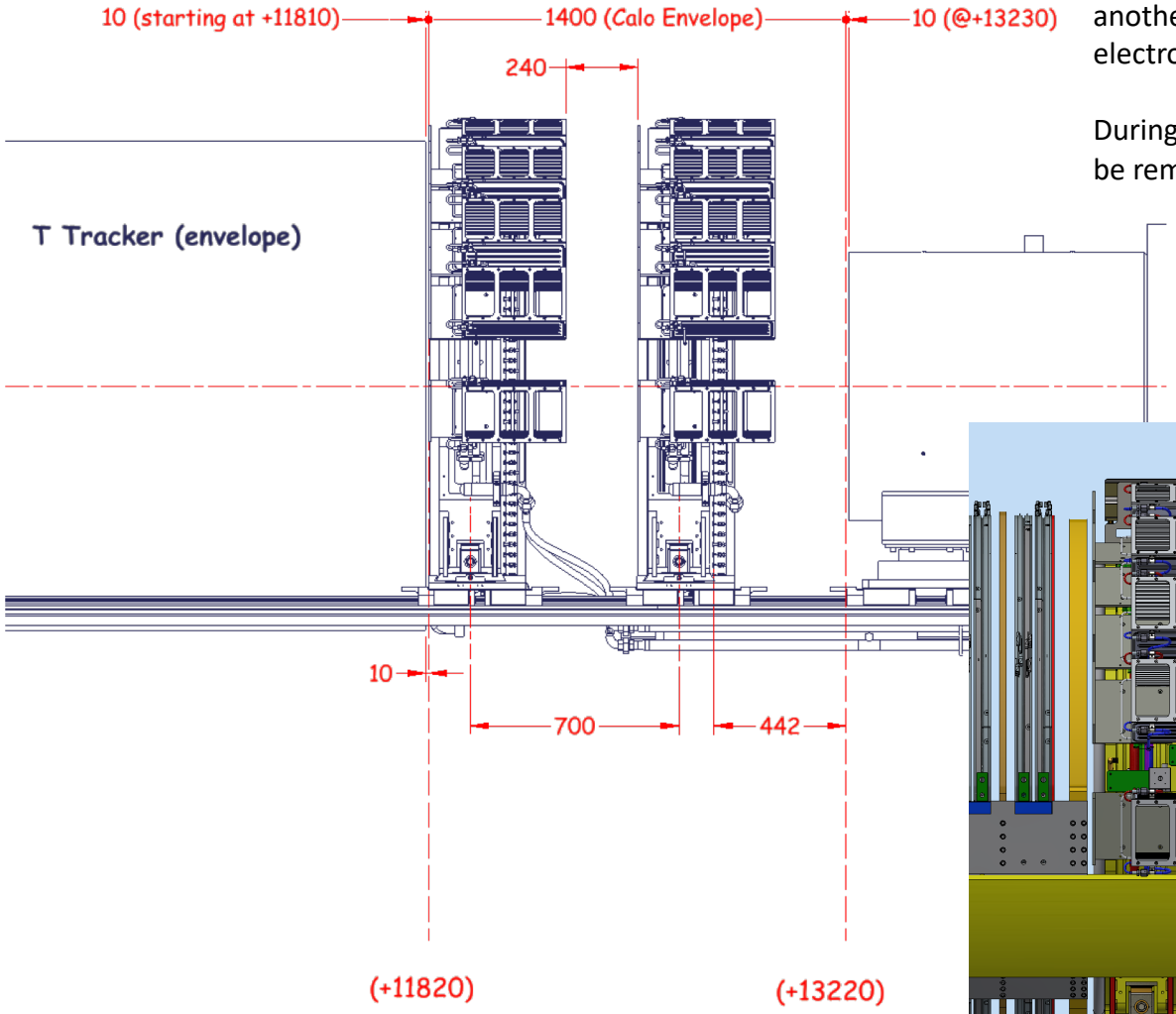
2. above the rails.

Access to the patch panels and cable trays



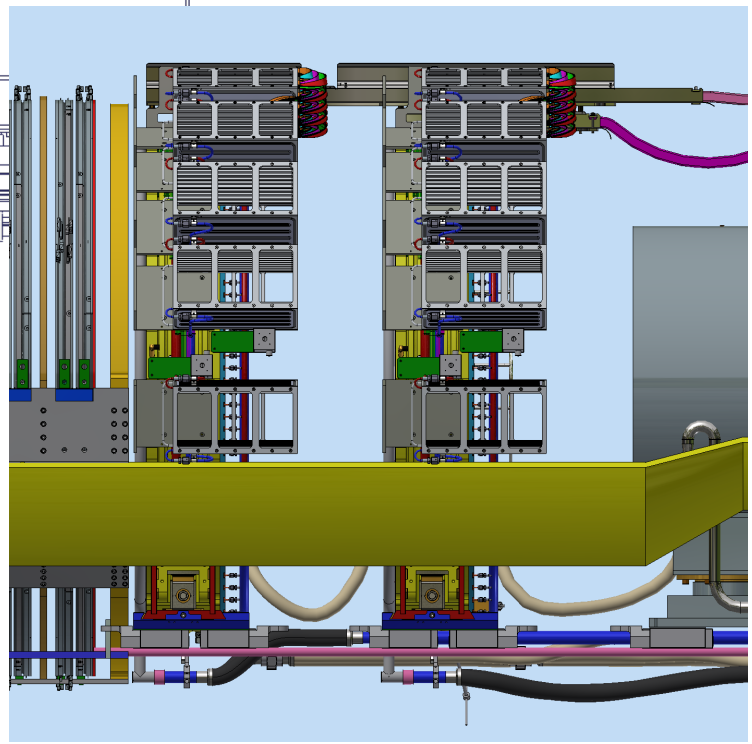
CALORIMETER POSITIONS

RUN POSITION



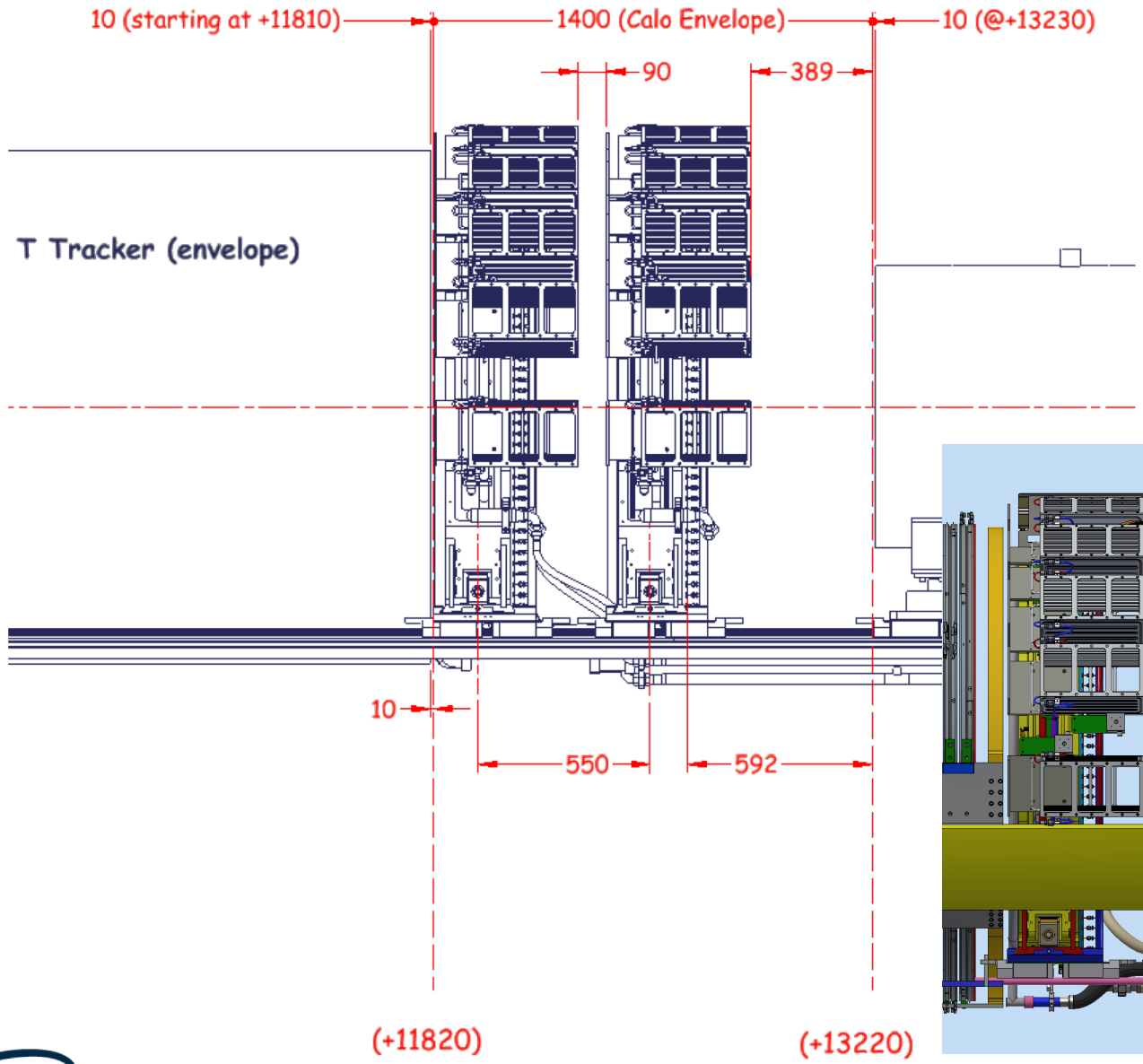
Most likely, during the maintenance operation, the two disks should be moved relative to one another to allow the access to the front end electronic boards.

During this operation, the connection bars will be removed.

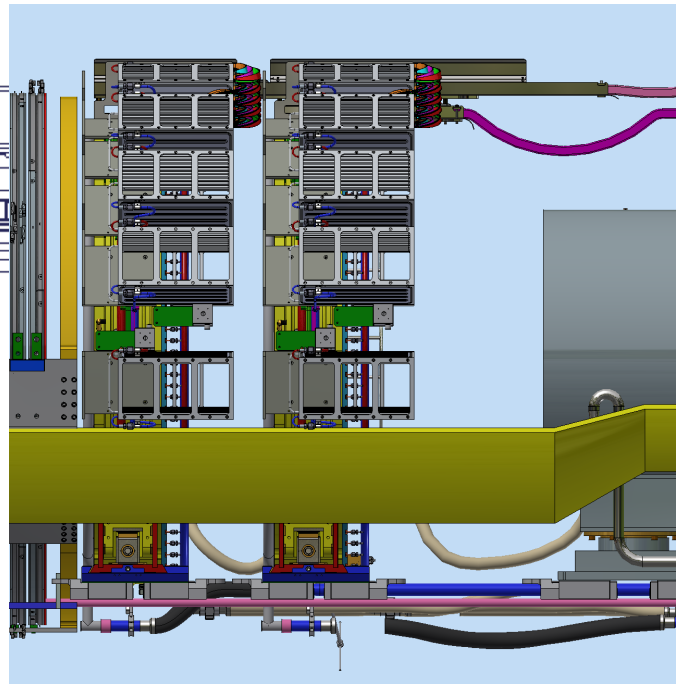


nil volentibus arduum

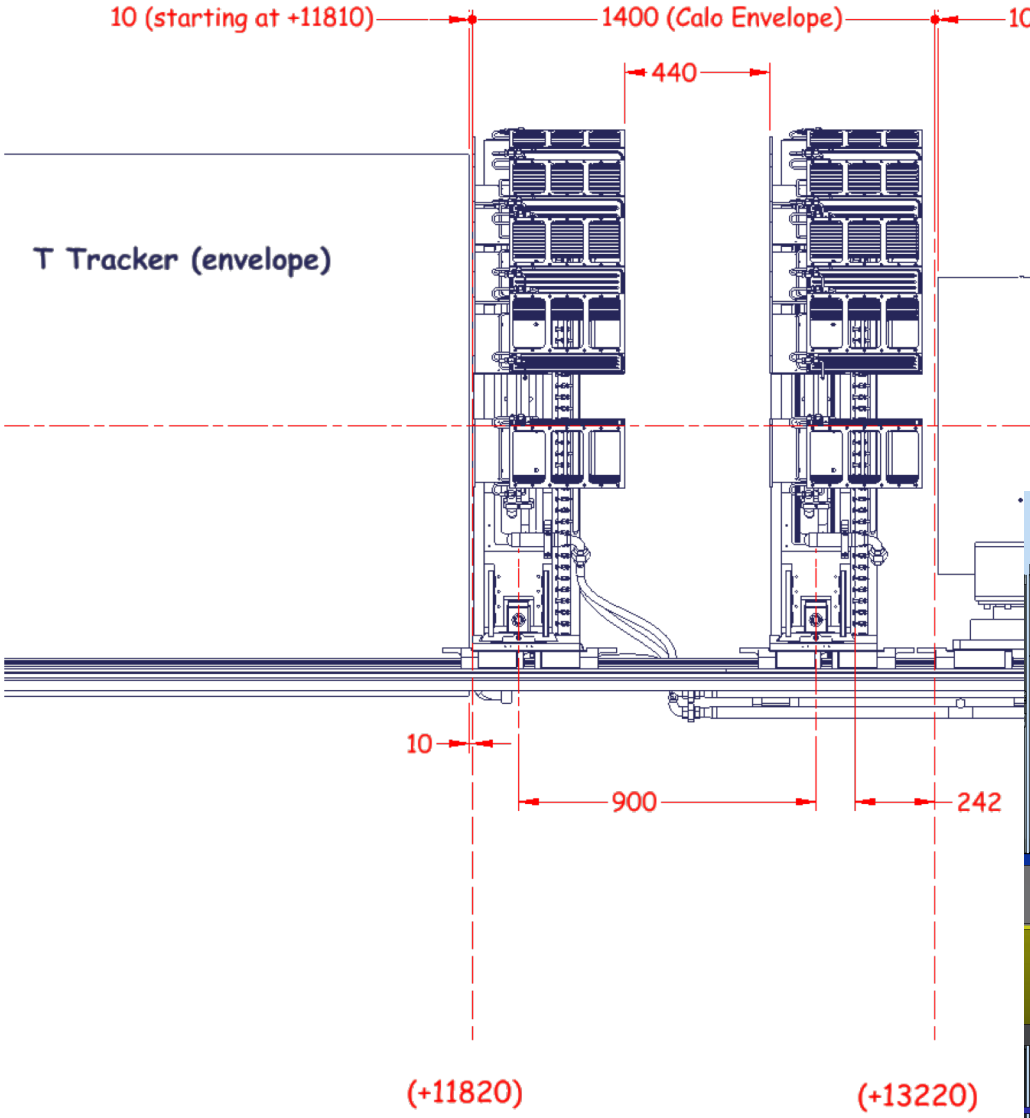
CLOSED POSITION



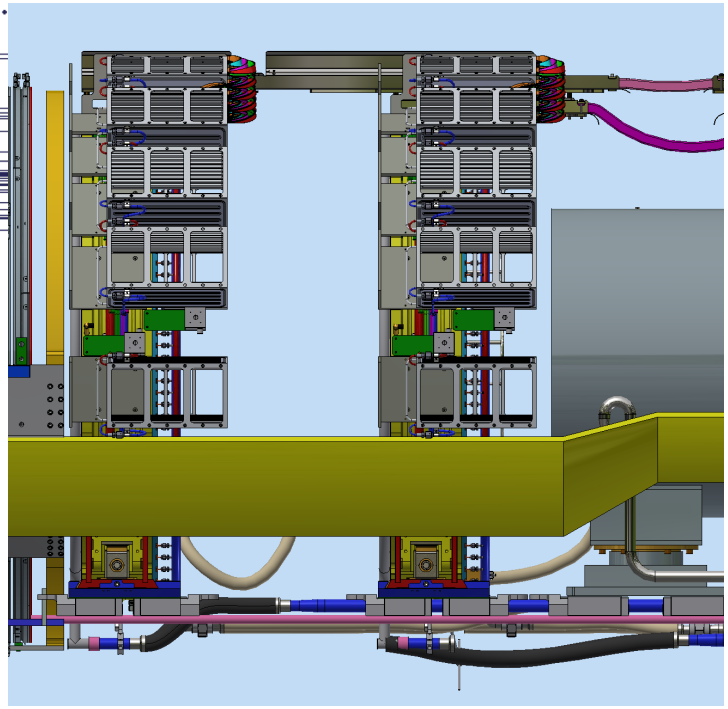
To facilitate the maintenance of electronic boards of the downstream disk, the disk can be moved apart by ~ 15 cm (toward the upstream disk).
To move the disk, will be used a special tool installed below the calorimeter before the opening operations.



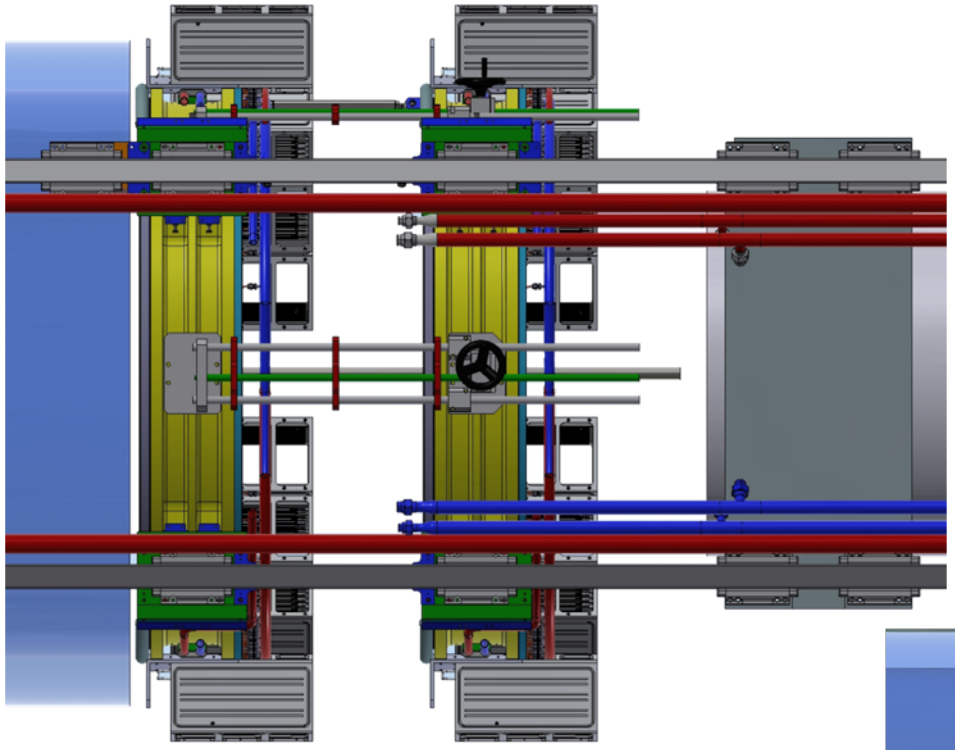
OPENED POSITION



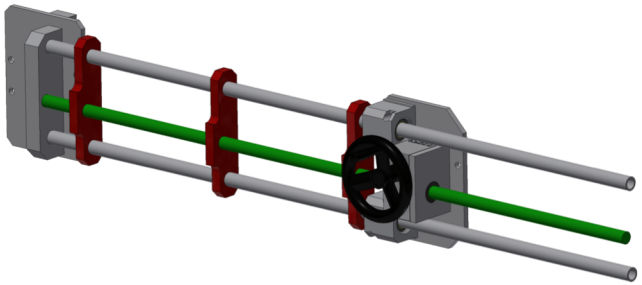
To facilitate the maintenance of electronic boards of the upstream disk, the downstream disk can be moved apart by ~ 20 cm (toward the MBS).
To move the disk, will be used a special tool installed below the calorimeter before the opening operations.

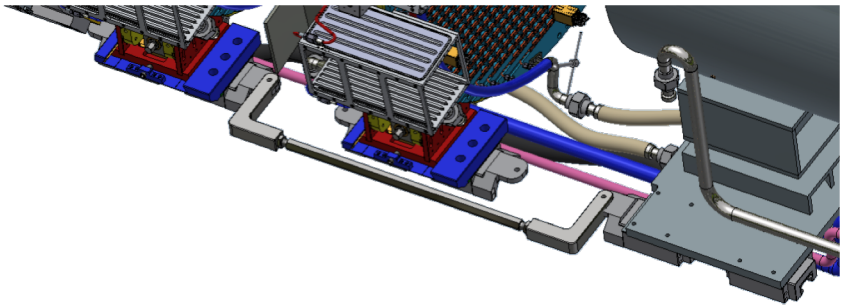


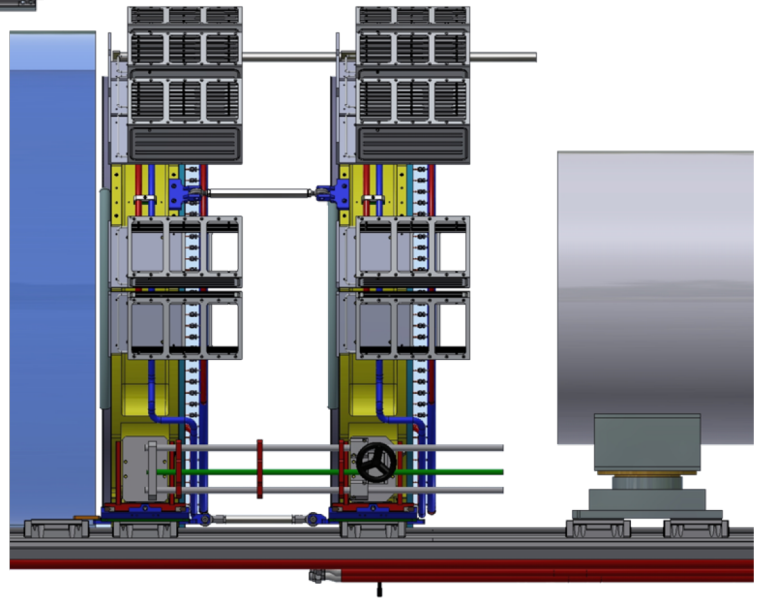
Opening/Closing Tool: jack screw



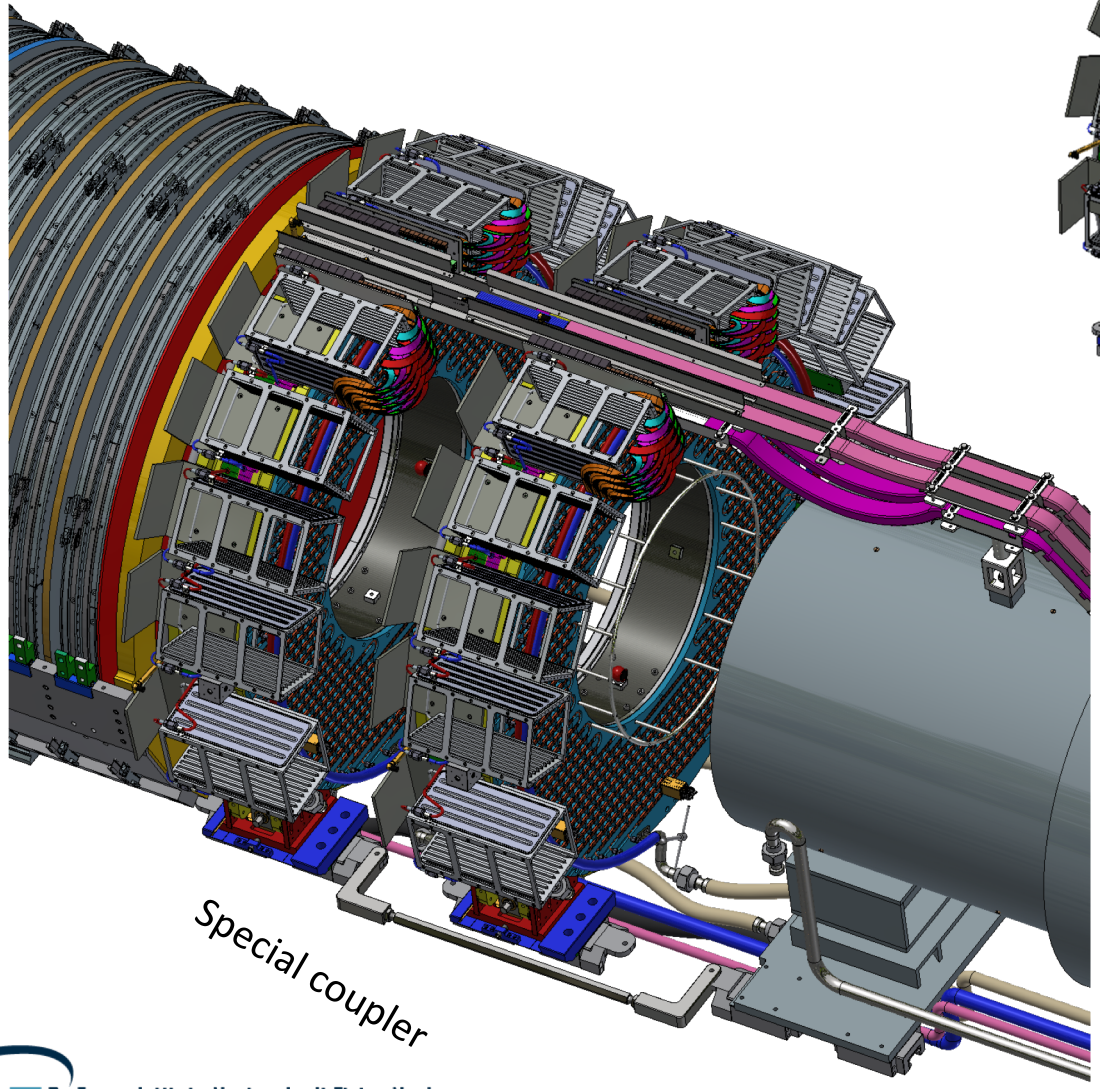
To open the disks will be used a special tool installed on the side (or below) of the calorimeter.

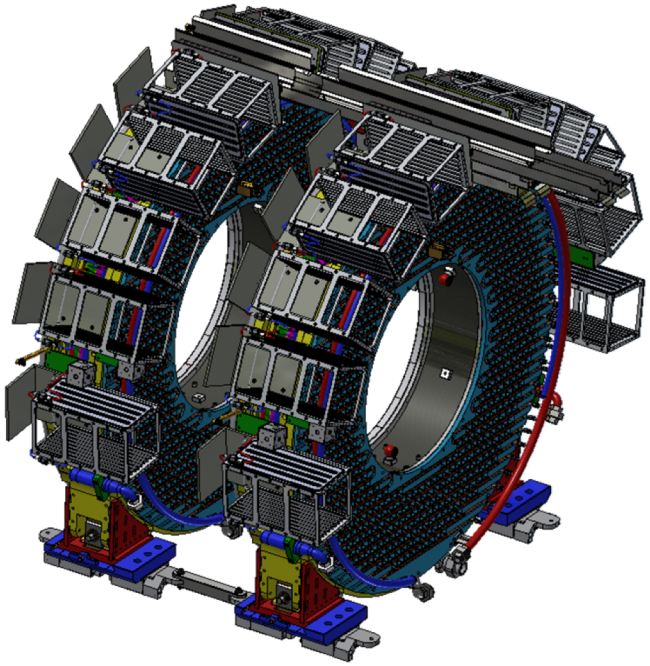






Opening/Closing Tool: coupler





To move the downstream disk, removal of the couplers is needed:

1. Removal of first coupler bar;
2. Installation of the special coupler bar;
3. Removal of second coupler bar;
4. Installation of the special coupler bar.

spares

From: **George Ginther** ginther@fnal.gov
Subject: Preparing for detector installation
Date: 1 October 2020 at 17:08
To: Stefano.Miscetti@lnf.infn.it
Cc: Karen L. Byrum byrum@anl.gov, Gary R Drake drake@fnal.gov, Russell A Rucinski rucinski@fnal.gov, Gregory Rakness grakness@fnal.gov

GG

Hi Stefano:

As we prepare for the installation of the detectors in advance of the detector KPP, it would be useful to further clarify interfaces and refine the plans in advance of the next IPR. To make progress in these areas and to assist in improving the fidelity of the baseline schedule by adjusting the predecessor links appropriately, it would be very helpful to learn your point of view on the following topics and observations. Perhaps it would be helpful to have a meeting to explore these topics? Your feedback is solicited.

- In preparation for the detector KPP:
  - What are calorimeter expectations and plans with respect to the IFB mock-up?
  - What is the calorimeter responsibility with respect to procurement of services between the calorimeter and the IFB?
    - Will cables and services be delivered to the detector hall labelled, terminated and tested? Or do you anticipate that cables will be terminated after routing?
  - What is the calorimeter responsibility with respect to installation and routing of services between the IFB and the DAQ room?
    - Will cables and services be delivered to the detector hall labelled, terminated and tested? Or do you anticipate that cables will be terminated after routing?
    - Are any intermediate patch panels anticipated?
  - Which subsystem(s) will be responsible for procurement and fabrication and testing and mounting of the rear feedthrough plate assemblies for the calorimeter?
    - Which subsystem(s) will be responsible for the optical fibers between the detector and the IFB?
    - Which subsystem(s) will be responsible for the optical fibers between the IFB and the DAQ room?
  - Which subsystem(s) will be responsible for procurement and fabrication and testing and mounting of the radial port plate assemblies for the calorimeter?
  - When and how does the calorimeter team anticipate the laser will be installed and the lines be routed to and into the trench?
  - Are there constraints (for example with respect to welding on features attached to the detector train) once the calorimeter is installed on the external rails?

- For the KPP configuration:
  - How many servers does the calorimeter team anticipate will be required to be installed to accommodate the calorimeter inputs associated with this test?

- And some observations and questions primarily related to the BCR105 baseline schedule
  - Where are the tasks to procure and test the cables for the calorimeter?
  - Where is the task to install the HV system?
    - Note that the BCR103 working schedule shows the delivery date for the system, as 7-Oct-21
  - What is the scope of task 47507.8.002236 Install bunker elements (FNAL)?
    - 40 day duration task with 45 days mech tech resources assigned
    - Is this intended to be the installation task for the cal DT source infrastructure?
    - And why is the task 47507.8.002230 Install source tubing and manifolds on Disk 2 support a predecessor?
  - What is the scope of task 47507.8.002299 Connect Disk 1 to Disk 2 – Fermilab?
    - Note that the only resource assigned to this task is 2 days metrologist
  - What is the scope of task 47507.8.002301 Connect Disk 1 crystals to power and DAQ
    - 5 day duration task with 5 days of uncosted graduate student resources assigned
    - Could be the task for installation and connection of services between the calorimeter disk and the IFB, and between the IFB feedthrough and the cables to the DAQ room
      - If so, then the resources seem underestimated
    - Note that the milestone 47507.3.1.000500 T5 – Calorimeter cooling station installed is not currently a predecessor for this task
      - Perhaps this milestone should be added as a predecessor to flag need for cooling system to operate power?
  - What is the scope of task 47507.8.002303 Connect Disk 2 crystals to power and DAQ
    - no resources assigned
    - Could be the task for installation and connection of services between the calorimeter disk and the IFB, and between the IFB feedthrough and the cables to the DAQ room
    - Even though access to the downstream disk may require that it be moved upstream (relative to the detector train), note that this task is scheduled in parallel with task 47507.8.002301 Connect Disk 1 crystals to power and DAQ, which might require moving the downstream disk downstream (to provide access to the upstream disk)
      - Strongly suspect a missing link on this task
    - Note that the milestone 47507.3.1.000500 T5 – Calorimeter cooling station installed is not currently a predecessor for this task
      - Perhaps this milestone should be added as a predecessor to flag need for cooling system to operate power?
  - 47507.8.002305 Test Disk 1 system with laser light
    - No assigned resources
    - Will there be any constraints on other activities on the calorimeter (or other activities) while this test is in progress?
  - 47507.8.002310 Test Disk 2 system with laser light
    - No assigned resources
    - Will there be any constraints on other activities on the calorimeter (or other activities) while this test is in progress?
  - What is the scope of task 47505.8.002370 Cable calibration system?
    - 5 day duration task with 3 days of two mech tech resources assigned
    - Predecessors appear to imply that this task includes cabling between the calorimeter to the IFB
    - If this task is intended to include connection of laser fibers to both minimize the number of times that the downstream disk needs to be moved upstream and downstream relative to the remainder of the detector train during this installation process?
      - But note that this task is in parallel with 47507.8.002305 Test Disk 1 system with laser light and 47507.8.002310 Test Disk 2 system with laser light, so it seems unlikely that the cable calibration system task is for the laser system?
      - So, perhaps it is the task for cabling of the cal DT-source components. If so, then why does the task have predecessors 47507.8.002301 Connect Disk 1 crystals to power and DAQ and 47507.8.002303 Connect Disk 2 crystals to power and

minimize the number of times that the downstream disk needs to be moved upstream and downstream relative to the remainder of the detector train during this installation process?
    - But note that this task is in parallel with 47507.8.002305 Test Disk 1 system with laser light and 47507.8.002310 Test Disk 2 system with laser light, so it seems unlikely that the cable calibration system task is for the laser system?
    - So, perhaps it is the task for cabling of the cal DT-source components. If so, then why does the task have predecessors 47507.8.002301 Connect Disk 1 crystals to power and DAQ and 47507.8.002303 Connect Disk 2 crystals to power and DAQ?

What is the scope of task 47505.8.002380 Plumb calibration system?

- 5 day duration task with 3 days of two mech tech resources assigned
- Predecessors appear to imply that this task includes cal DT source fluid connections between the calorimeter to the IFB
- Does this pluming process involve any welding? If so, there are likely missing resources, and perhaps the scheduling of the task should be re-visited? Should the hard services be connected before or after the cables and fibers are connected? Please verify predecessors are appropriate.
- Note that this task is scheduled in parallel with 47507.8.002305 Test Disk 1 system with laser light and 47507.8.002310 Test Disk 2 system with laser light. Is this reasonable?

What is the scope of 47507.8.002390 Test calibration system?

- Based upon predecessor tasks, seems that this may be a test of the cal-DT source. If so, will there be any constraints on other activities on the calorimeter (or other activities) while this test is in progress?
    - What fraction of the time will the cal-DT source be running during this period, and how will it impact access in the vicinity of the detector train