

Dual Phase Field Cage Trial Installation Proposal

NH1 Integration Meeting
Sept. 15, 2017

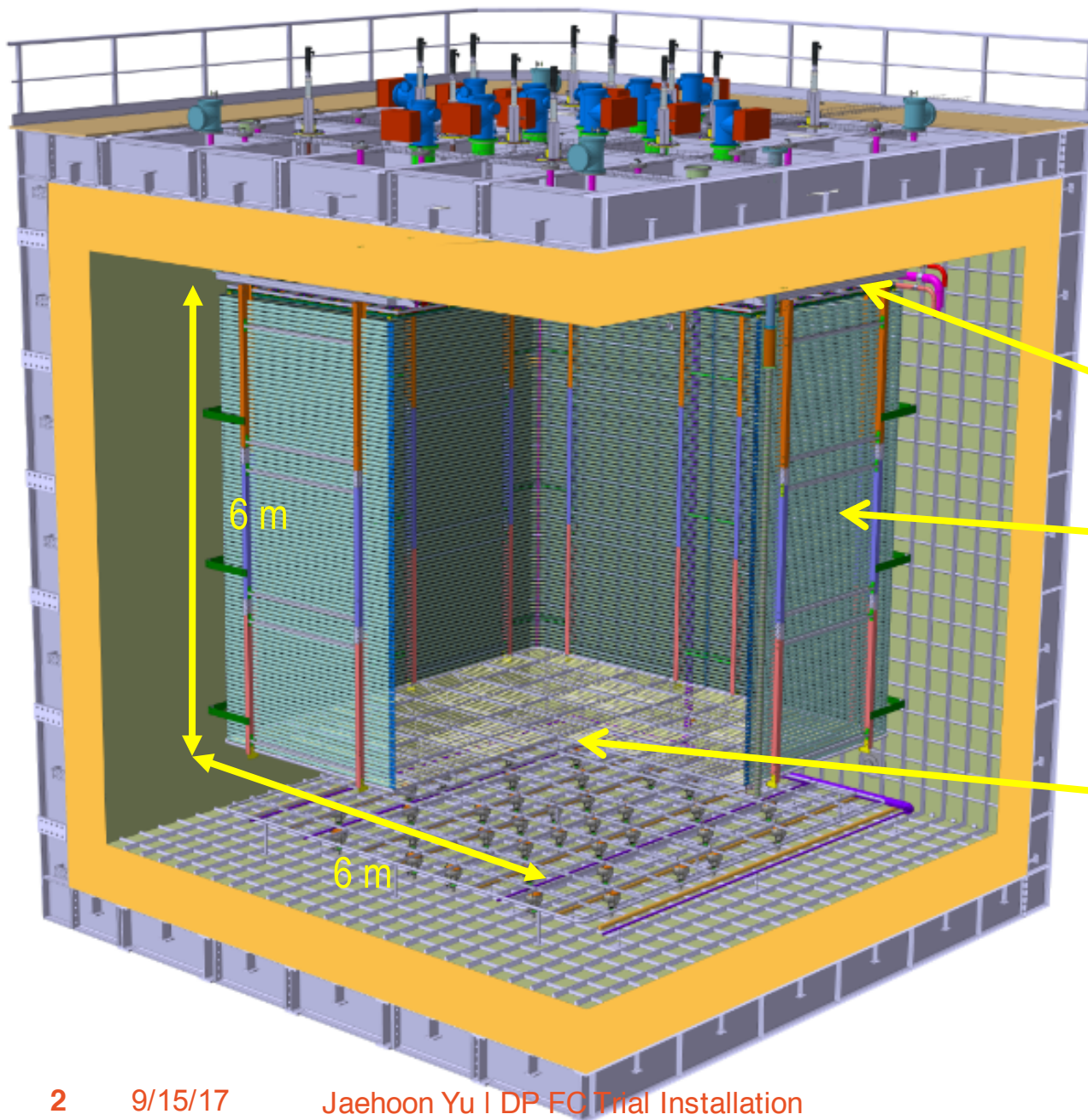
Jaehoon Yu for

A. Chatterjee, G. Brown & UTA Team

A. Gendotti, S. Murphy, C. Cantini & ETH Team

F. Pietropaolo & CERN Team

Field Cage in protoDUNE DP



- Field Cage and cathode hangs off of the ceiling
- Essential to have light yet sturdy structure
- Based on modular concept as SP

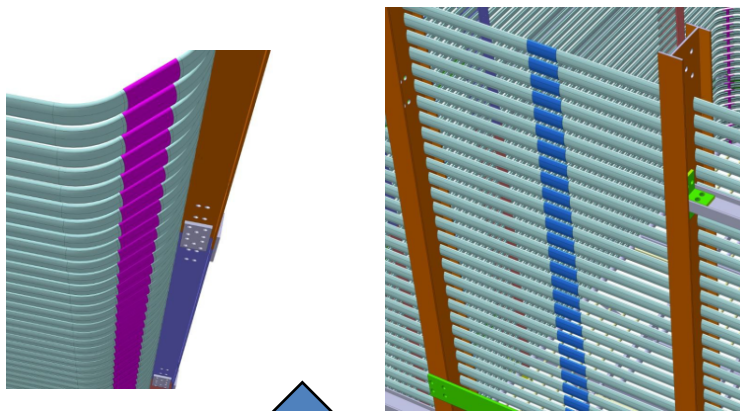
Charge Readout Planes

Field Cage (common structural elements with SP)

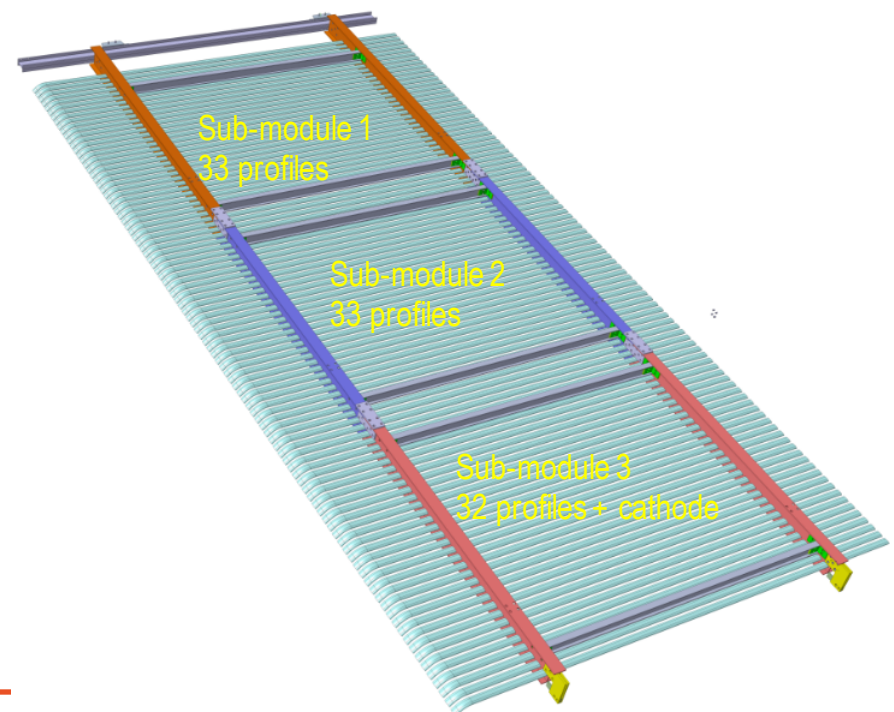
Cathode

Field Cage Design

- Shares common basic structural elements w/ ProtoDUNE-SP
- Consists of 8 vertical modules of 6310 x 3010 m² (2 modules per detector face)
- Each module is assembled out of 3 distinct sub-modules with 33, 33, and 32 profiles each held by a frame with two 6" and two 3" horizontal FRP I-beams
- 98 electrically continuous rings in 60mm pitch using straight aluminum clips
- 11 profiles with one end bent at 45 degrees are electrically connected by 2 divider boards
- Inter-module connections made with FRP plates connected with FRP threaded rods

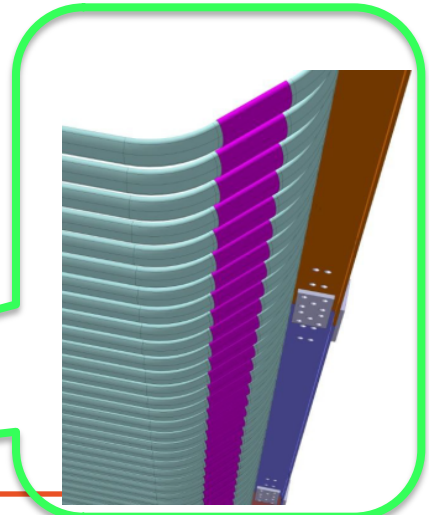
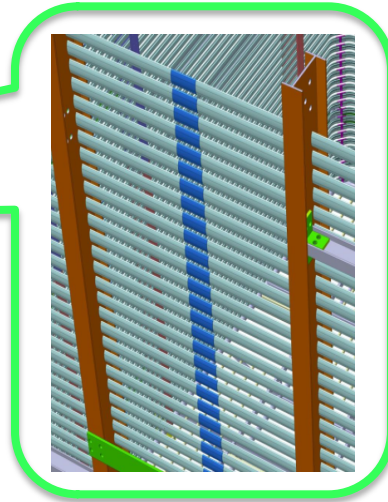
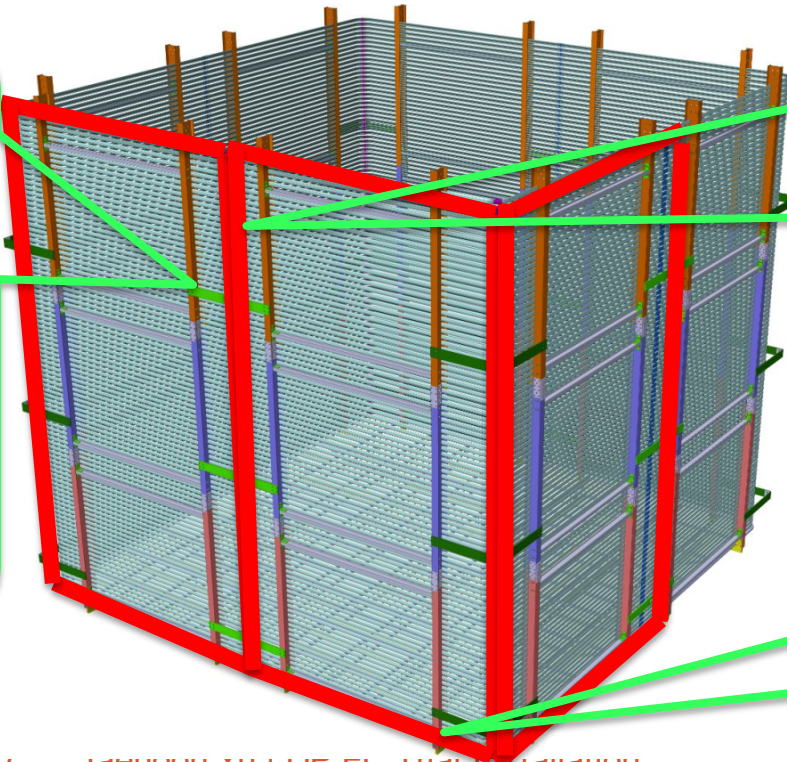


Continuity at center and borders w/ Al clips



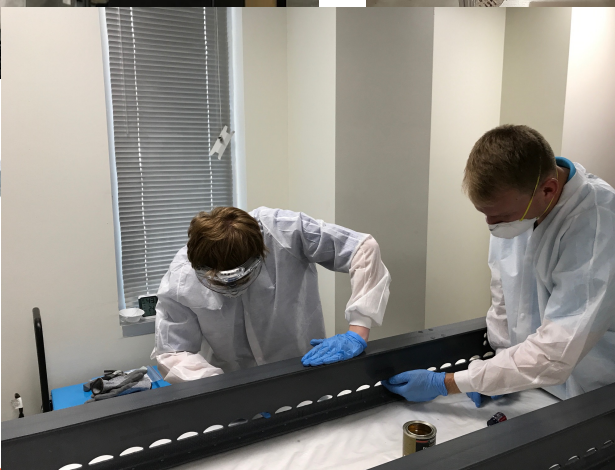
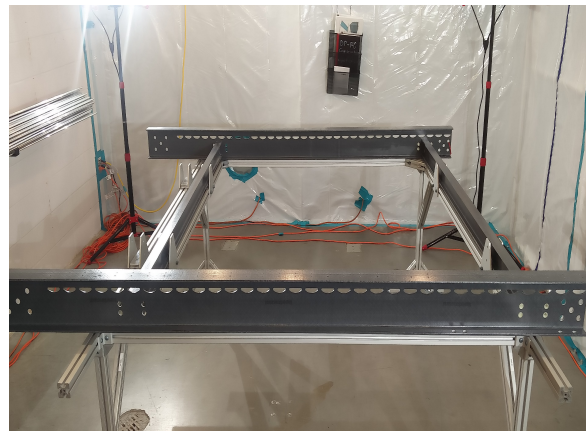
DP-FC Trial Installation Proposal

- Assemble and install 3/8 of the DP-FC and test the installation procedure
- One full side with two 6mx3m modules
- Plus one 90 degree corner formed with an additional 6mx3m module
- Connect all field shaping rings with the connecting clips and secure them with the slip nuts and screws
- Connect one complete row of HVDB from top to bottom
- Allow virtually all combinations of installation scenarios

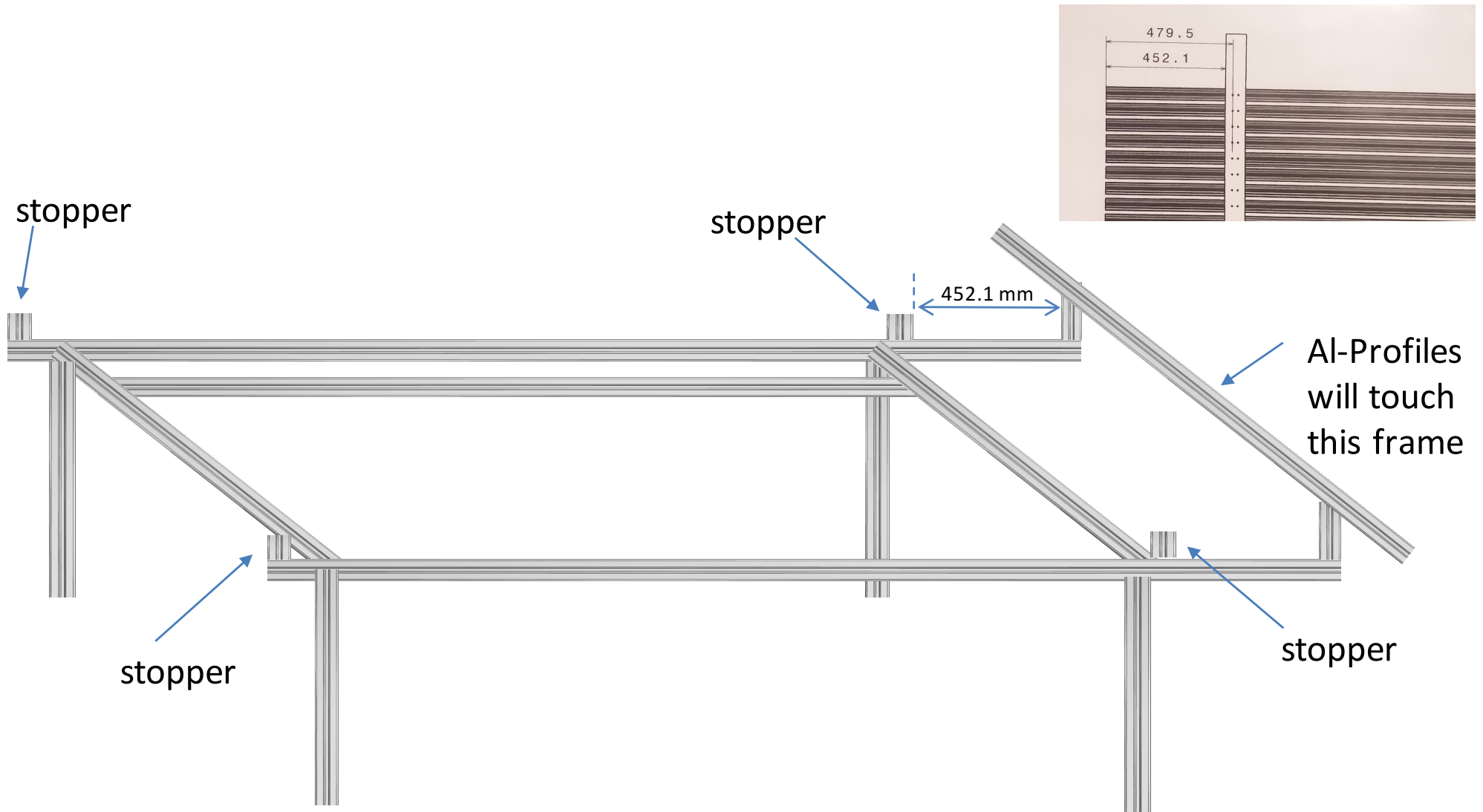


DP-FC Parts QA/QC process

- Measure all critical dimensions compared to the drawings
- Debur, defiber, sand, clean with simple green and varnish
- Pre-assemble with the sample profiles at UTA to check the fit
- Disassemble and package all parts except for the Al profiles



Assembly Table w/ Profile Alignment



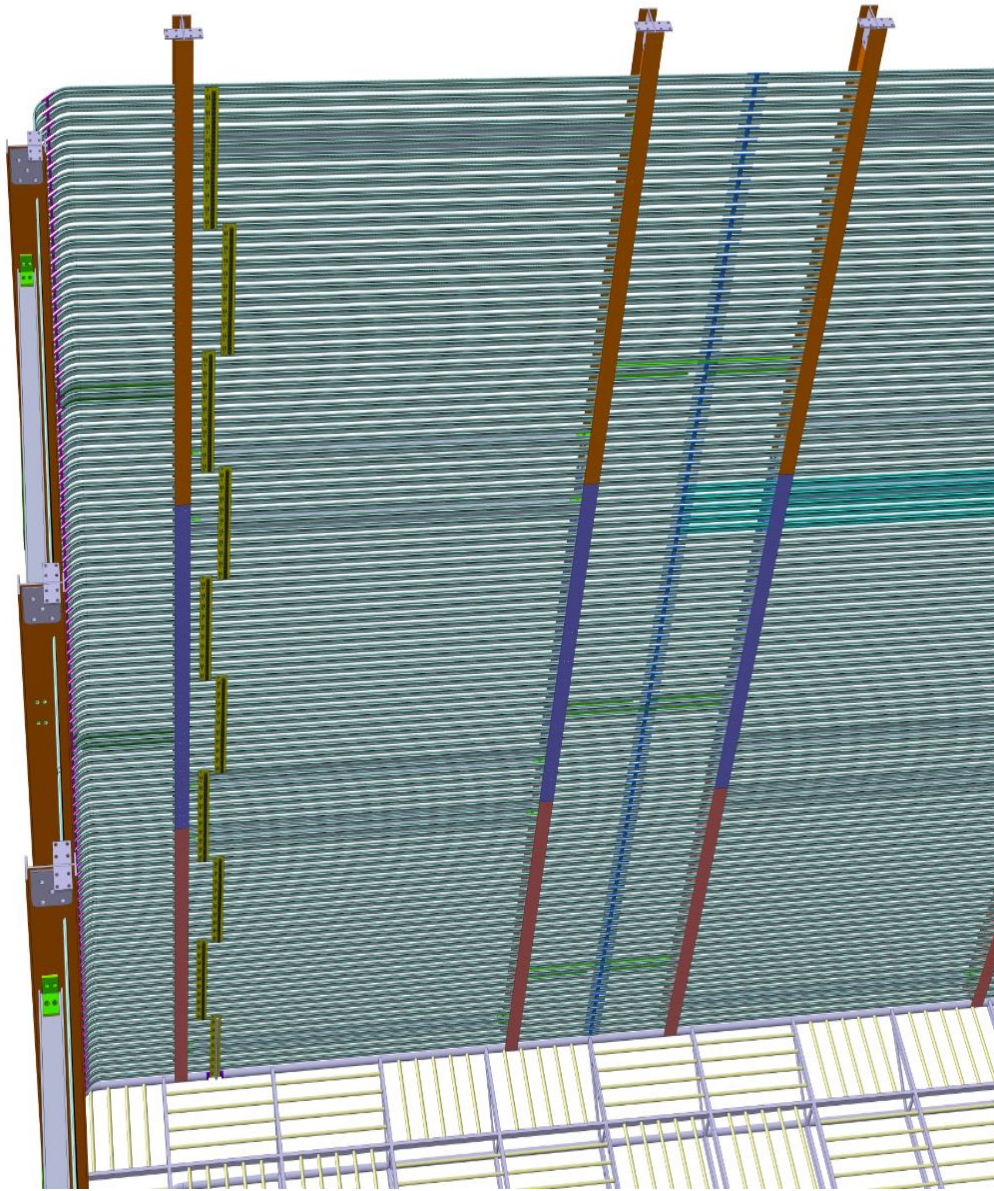
Current Status of DP-FC Part Prep

Part Number		Measured/ Inspected	Cleaned & Varnished
6" I- beams	DP-FC-002	18 (out of 18)	7 (out of 18)
	DP-FC-003	11 (out of 18)	9 (out of 18)
	DP-FC-004	18 (out of 18)	9 (out of 18)
3" I- beam	DP-FC-008	46 (out of 54)	8 (out of 54)

Sub-Module Delivery Schedule

- Sept. 15: Complete FRP critical dimension measurements
- Sept. 25: Complete FRP deburring, defibering, cleaning and varnishing
- Oct. 4: Complete preassembly and packaging of the first 15 sub-modules
- Week of Oct. 9: Ship the first 15 (5 of each kind) sub-modules
- Oct. 20: Complete preassembly and packaging of the remaining 12 sub-modules, including the 3 spare
- Oct. 27: Ship the remaining 12 sub-modules + precision assembly table

HV Divider Board Mounting to DC



A. Gendotti

- Two parallel columns of 10 boards, totaling 20 boards
- The total potential from the extraction grid to cathode: 294kV to 588kV
- Two $2\text{G}\Omega$ resistors each stage for each board, providing $0.5\text{G}\Omega$ effective resistance per stage
- Current through the entire circuit: $6\mu\text{A}$ – $12\mu\text{A}$ (100 times the expected current from cosmic rays)

HVDB Preparation

- Total number of boards needed: 18 long (11 profile) + 2 short (8 profile)
 - Preparing 35 – 29 long and 6 short including spare
- 2GΩ resistors
 - Total Needed: $29*20+6*16 = 676$
 - Total in hand: 1066 (530 qualified with 1% criteria, enough for what is needed but no spares)
 - Additional order of 500 resistors placed
- Varistors (1.8kV clamping voltage each)
 - Total needed: $29*40+6*32=1352$
 - Total in hand: 1800 (expect 1440 to pass the criteria – 200mA at 1.75kV)
- Anticipated completion date for testing & selection: 25/9

HVDB Schedule

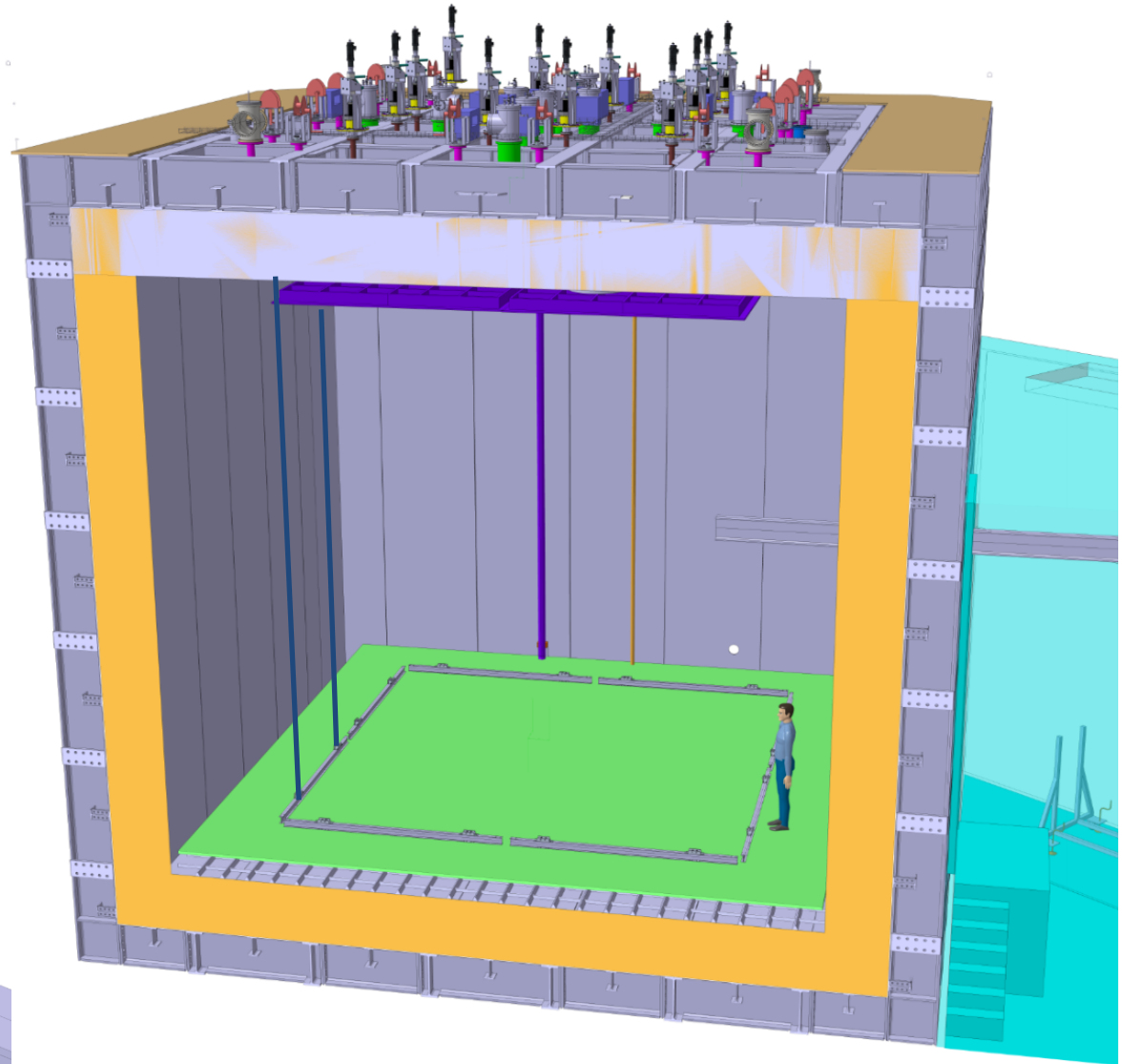
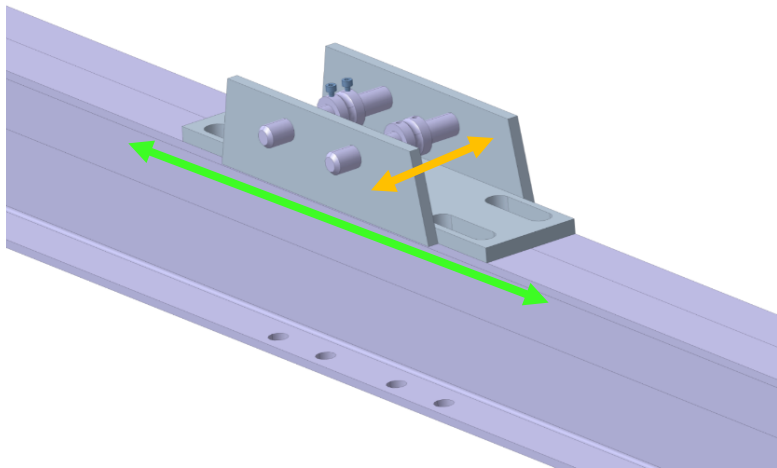
- Sept. 25: Complete testing and selection of the first batch of resistors and varistors and ship to the vendor
- Sept. 28: Board delivered to the vendor
- Oct. 9: First set of 18 long +2 short stuffed board delivered to UTA
- Oct. 23: Complete warm and cold testing and qualification of the stuffed boards
- Oct. 30: Ship 18 long + 2 short boards to CERN
- Week of Oct. 30 – Week of Nov. 13: receive the remaining 11 long + 4 short stuffed boards
- Week of Nov. 13: Ship the remaining 11+4 to CERN

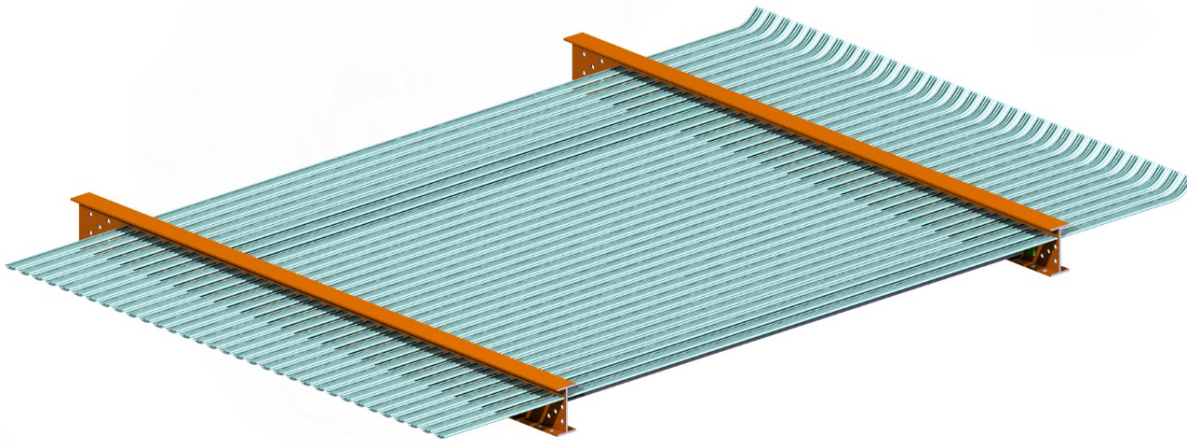
DP-FC Module Installation Sequence

1. Place all eight SS I-beam of the Hanging system in the nominal position on the temporary floor in the cryostat and mark the position → Bring out the five that are not needed
2. Connect the SS I-beam to the corresponding winches and lift it up ~2.5m
3. Assemble submodule inside the CRB and attach the steel reinforcement bar in its horizontal position
4. Connect the steel reinforcement bar to the I-beam rail, rotate 90 deg for lifting and transporting the sub-module through the TCO
5. Insert and secure the sub-module onto the wheeled support trolley while it is suspending from the transport I-beam crane
6. Position the sub-module under the hanging SS top frame bar
7. Remove the sub-module top reinforcement
8. Connect the sub-module to the SS top frame bar and lift it up ~2.5m for the next sub-Module
9. Repeat procedure 3 – 8 for the other two sub-modules

1) SS I-Beam for Hanging System

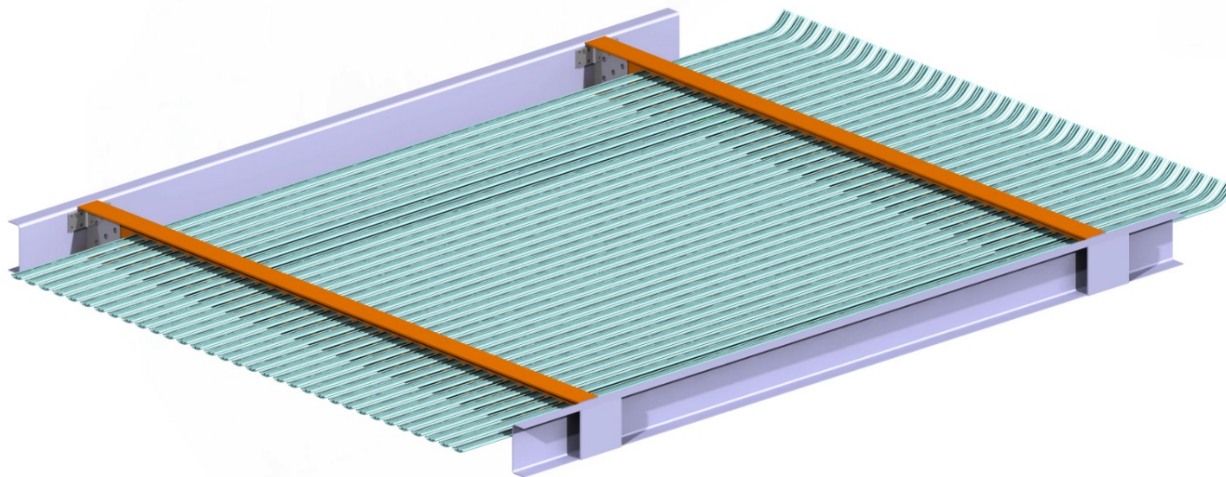
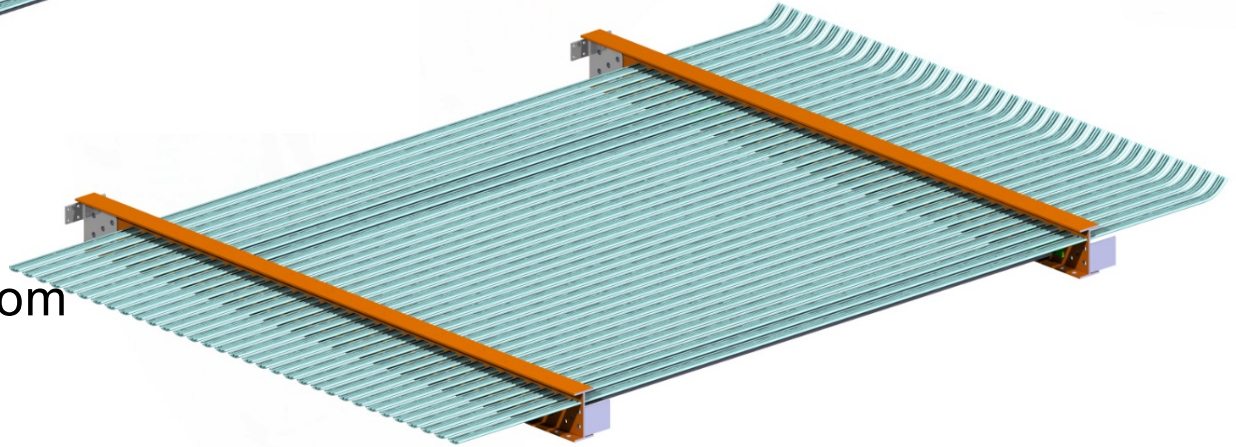
- Accordingly to the position of the CRP
→ Mark the position of the field cage on the construction floor
- Position the SS I-Beam (hanging system) in the right position
- Lower the hanging SS wire and connect to the I-Beam → Connection point centered at the wire





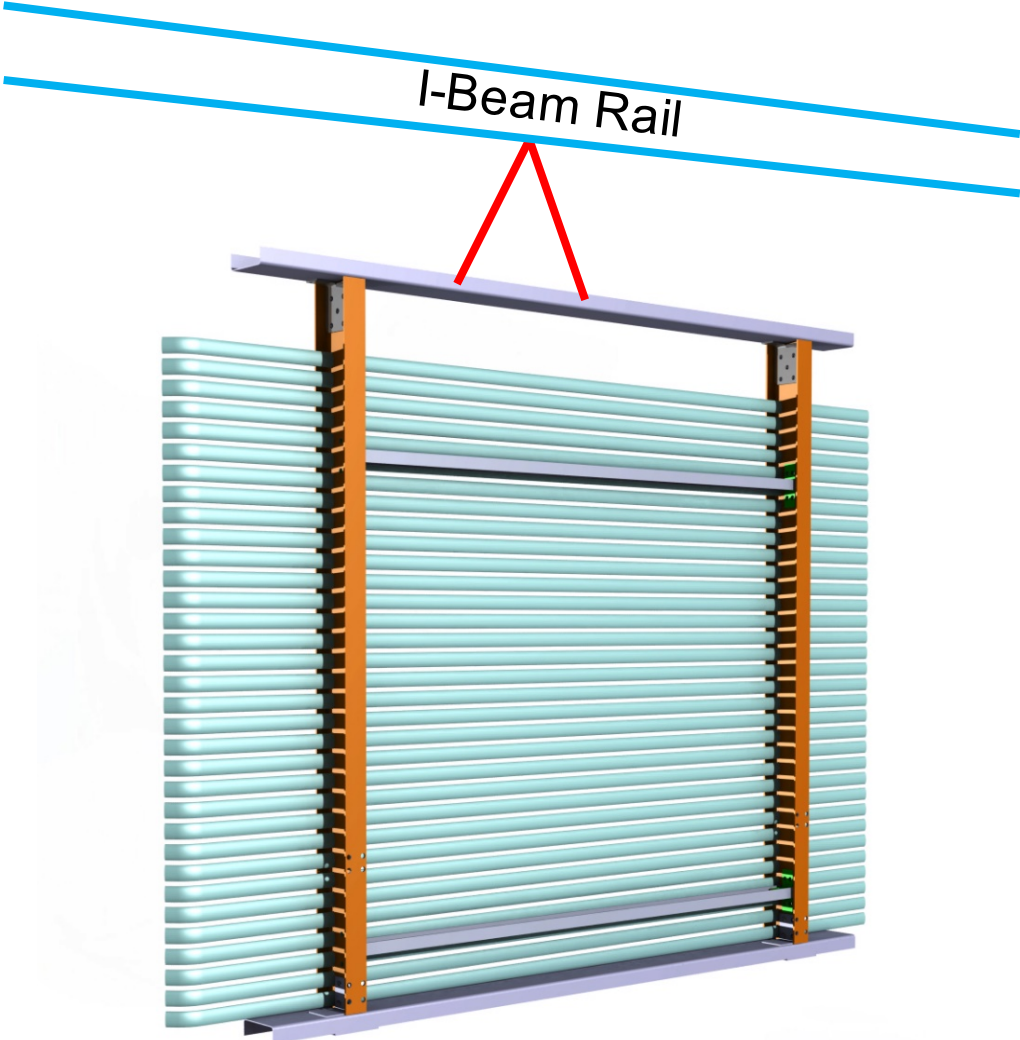
3.Assembled on the wheeled Table

4.Attach L-Profile Top and Bottom



4. Reinforcement U-Profile Top and Bottom

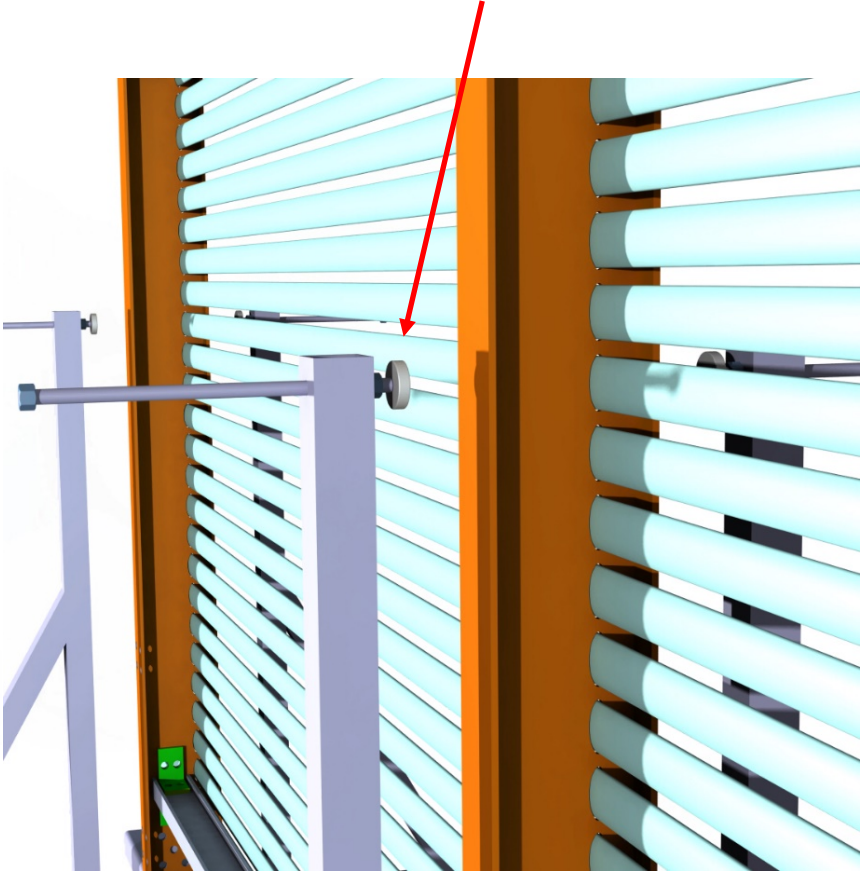
5) Sub-module transport through the TCO



6) Wheeled trolley support



Teflon Plate for vertical stability and and vertical alignment



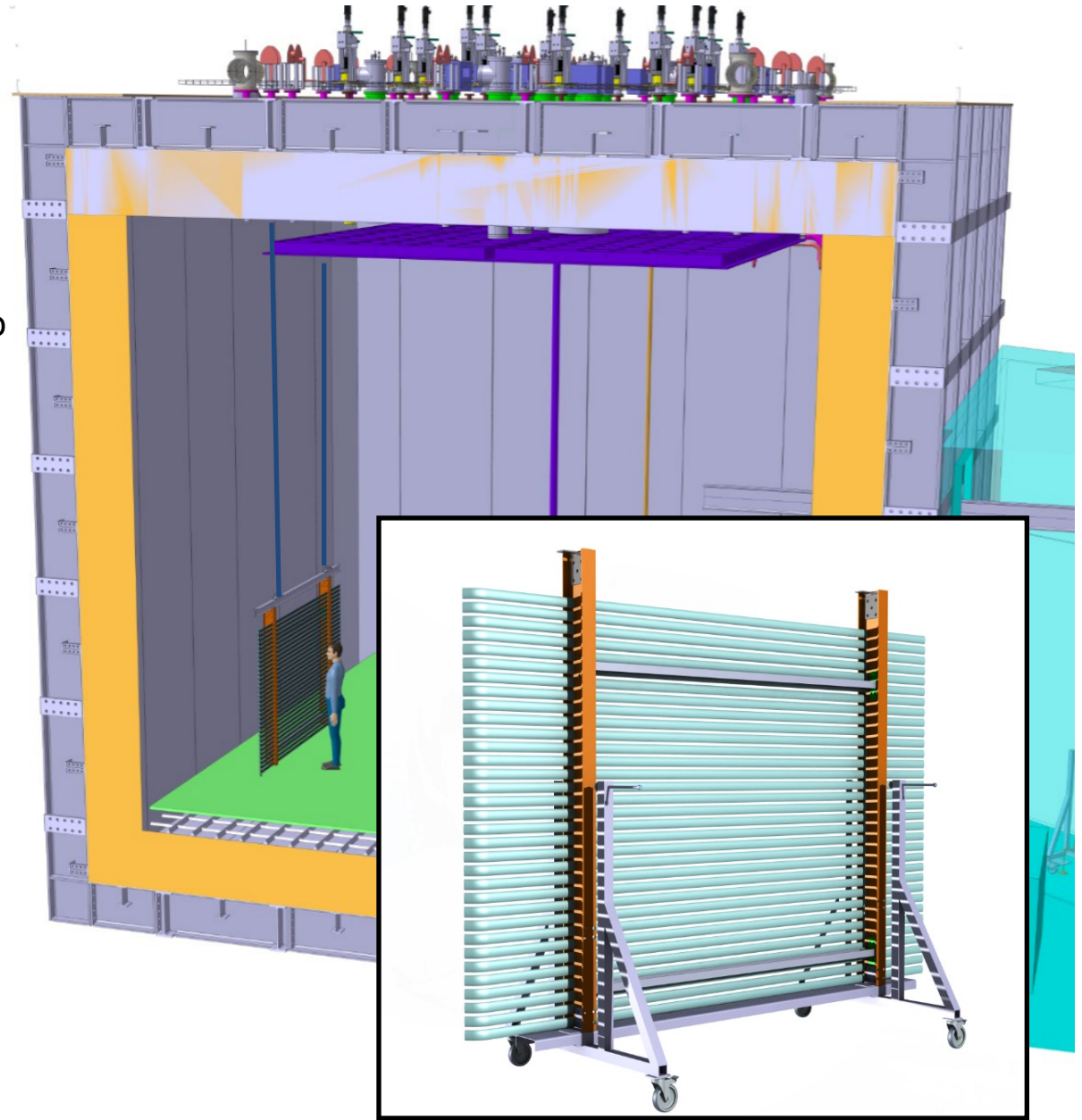


8) Connection to the SS bar of the hanging system

- Lift the SS I-Beam ~2.5 m
- Bring in first sub modules and connect to hanging system
- Already install the PCB boards of the HV divider (if it's needed in module)

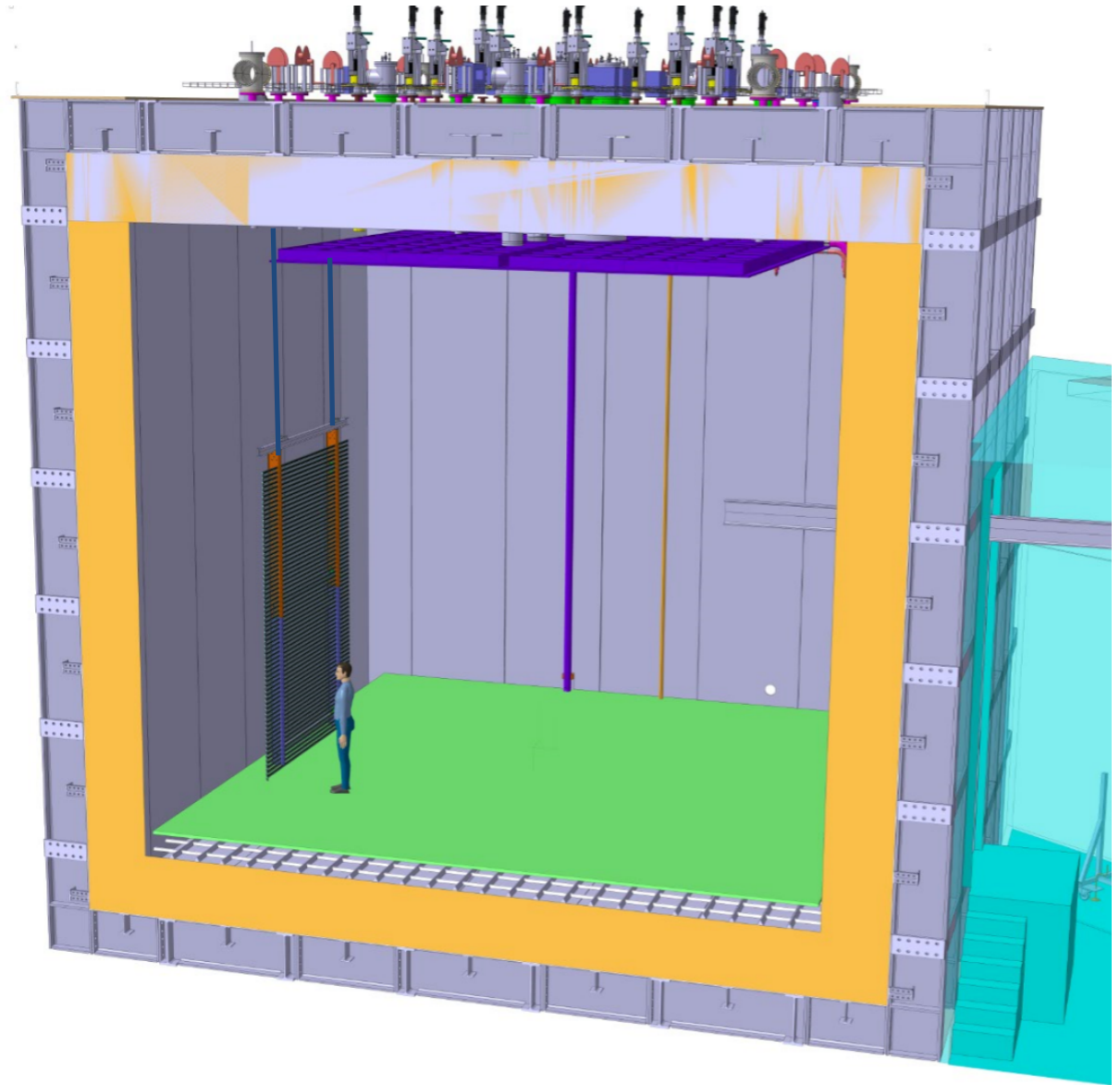
Sub module Installation:

- 2 Person on Top Lifting
- 3 Person inside the Cryostat



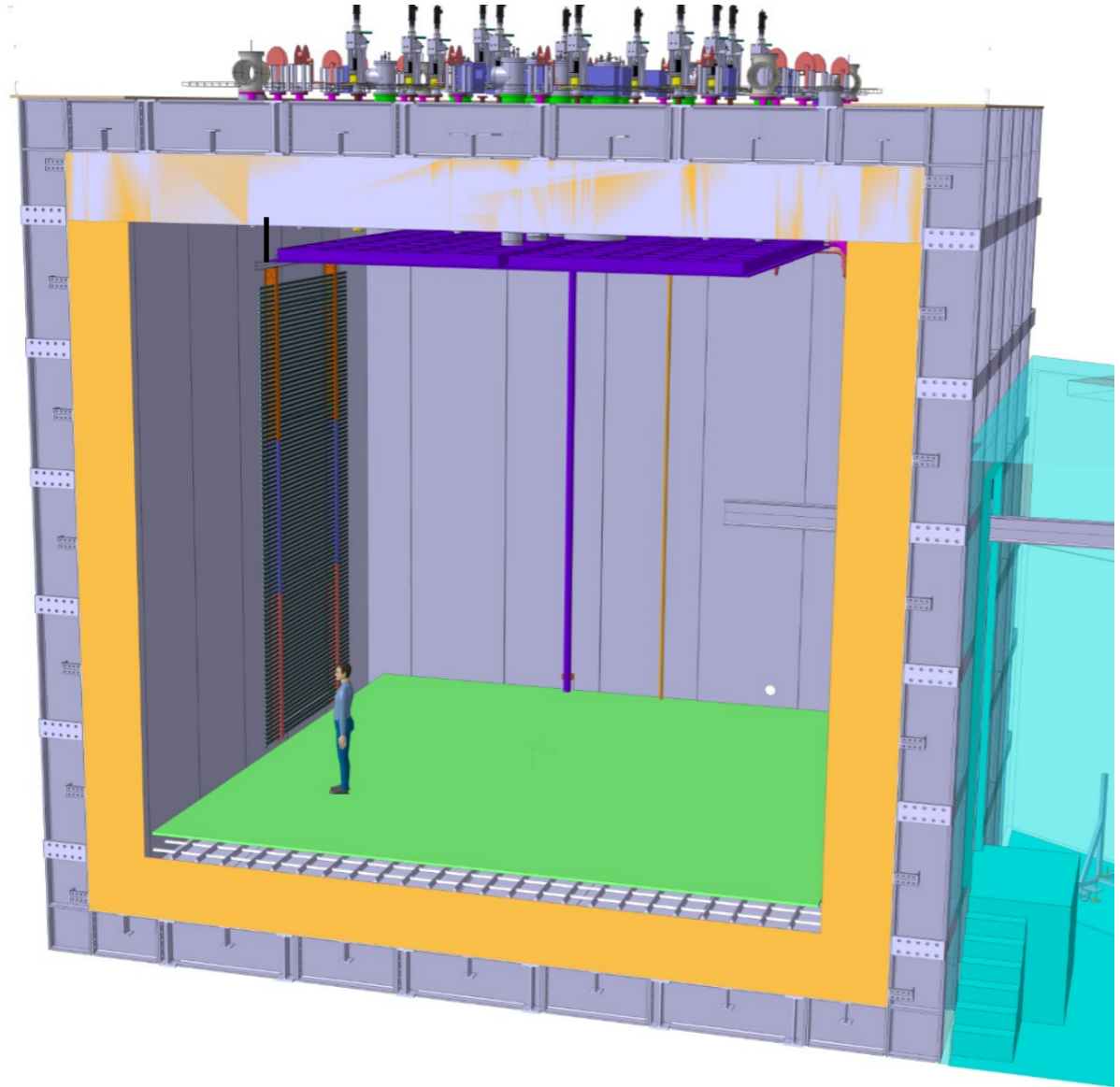
2nd Sub Module

- Same for 2nd sub module
- Lift for another 2.5m



3rd Submodule

- 3rd sub module
- Lift the entire module at his nominal position



Material Prep Matrix for Trial Installation

		Resp. design	Resp. Purchase	Status	Remark
DC modules	bent coated Al profiles	ETHZ/CERN	CERN	ordered	ordered 1000 (20% spare). First 33 being shipped to CERN for verification
	Al clips	ETHZ/CERN	CERN	ordered	ordered 600 of 85 mm + 600 of 70 mm
	slip nuts for Al corner and straight section clips	ETHZ	UTA	design tested needs final drawings	proto Ok.
	FRP I beams	UTA	UTA	delivered at UTA	to be shipped to CERN, arrives by Oct. 20th & Nov. 20th
	FRP/G10 connection between FRP I beams	UTA	UTA	delivered at UTA	to be shipped to CERN, arrives by Oct. 20th & Nov. 20th
	Slip nuts (fix profiles to FRP I-beam)	UTA	UTA	delivered at UTA	to be shipped to CERN, arrives by Oct. 20th & Nov. 20th
DC hanging system	Top SS I beams	ETHZ	ETHZ	ordered	arrives by November 10th
	SS L connection	ETHZ	ETHZ	ordered	arrives by November 10th
	hanging and lifting anchoring point	ETHZ	ETHZ	order by Friday	arrives by November 10th
	hanging cable	ETHZ	ETHZ	designed	arrives by November 10th
	SS connection plate between modules and corners	ETHZ	ETHZ	order by Friday	arrives by November 10th
	DC suspension FT	ETHZ	ETHZ	ordered	arrives by November 10th
DC electronics	HVDB boards	UTA	UTA	ordered	prototype under revision. Full production within a month
	electrical components for divider	UTA	UTA	75% arrived	under testing and qualification
Material for installation	2-Person Scissor lift (>=2)	CERN	CERN	on-site	
	cryostat with temporary floor	CERN	CERN		
	transport trolleys inside cryostat	ETHZ	ETHZ/UTA	needs designing	
	sub-module assembly table inside CRB	UTA	UTA	at UTA	to be shipped to CERN, arrives by Nov. 20th
	CRB furniture (cupboards and tables)	CERN	CERN		
	Tools for DC sub-module assembly				

Proposed Schedule

- 20/11 – 8/12: Maximum two people from UTA out to prepare and to help CERN technicians to learn sub-module assembly
- 30/11 – 22/12: Jae Yu coming to CERN as early as Nov. 30 and to stay through CERN shut down on Dec. 22, having one full week of overlap with the UTA people
- Goal: Install 3/8 of the DP-FC – two modules on a straight section and one connected module with a 90 degree turn to explore all possible combinations of installation scenario
- To the extent possible, leave the three modules of 6mx3m installed for expedited installation in 2018

Summary

- Proposed trial installation of three full 6mx3m DP-FC modules allow exploration of all combinations of installation scenarios
- All DP-FC parts to be delivered to CERN by mid-Nov.
- Up to 2 UTA people will be at CERN for 3 weeks from Nov. 20 to help prepare for this installation
- Yu to join them for 1 week overlap and stay through CERN shut down for the completion of the task
- Need all administrative documentations must be in place well ahead of Mid-Nov.
- All training arrangements must be made to minimize time spent for these necessary preparations
- All equipment needed for the task must be prepared ahead