
LARP Prototype Assembly Steps Towards Q1 and Q3 Production

Dan Cheng

MQXF Design Review
December 10-12, 2014
CERN

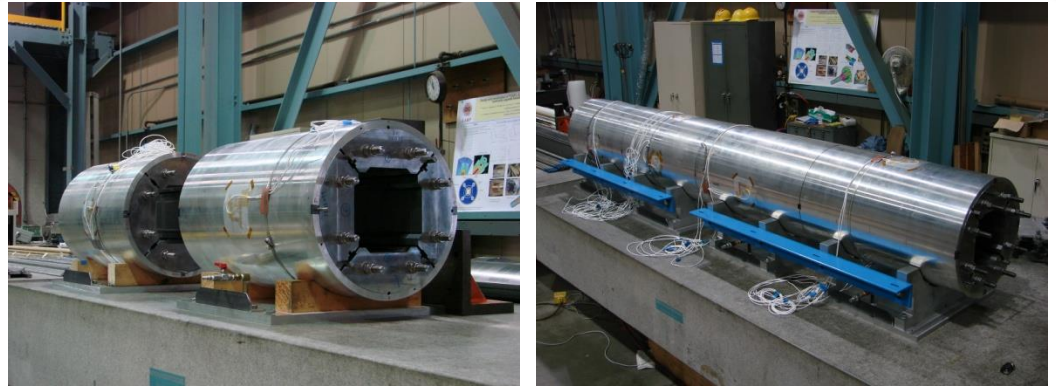
H. Felice, R. Hafalia, D. Horler, T. Lipton, S. Myers

Outline

- LARP magnet assembly experience
- MQXF Short Prototype Assembly Plans
- MQXFA Prototype Assembly Scale-up
- Status
- Summary

LARP Magnet Assembly Experience

- Tooling and processes developed from experience gained from TQS, HQ, LR, LQ

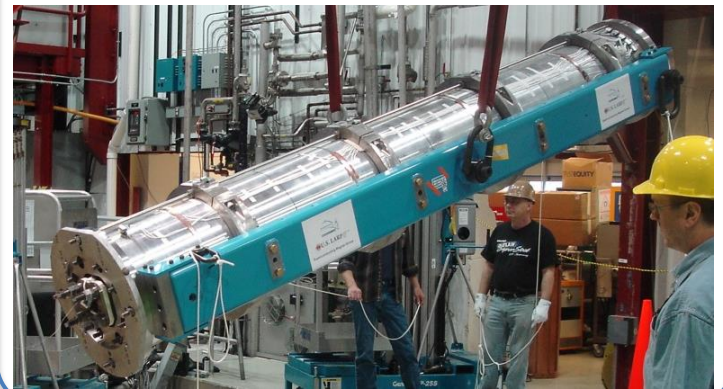


LQ Shell & Yoke assembly

Coilpack assembly and insertion

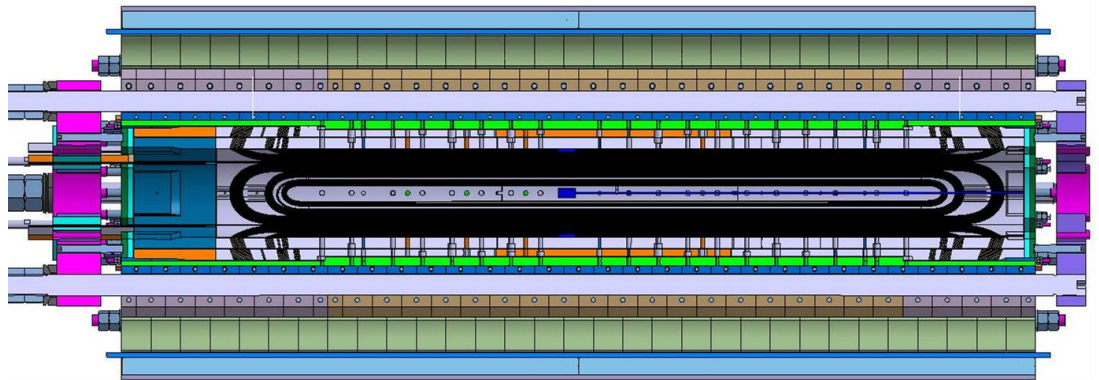


Magnet handling



Outline

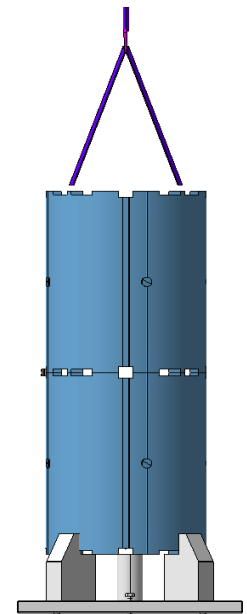
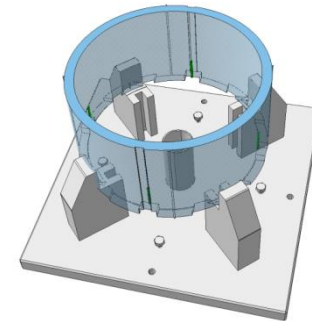
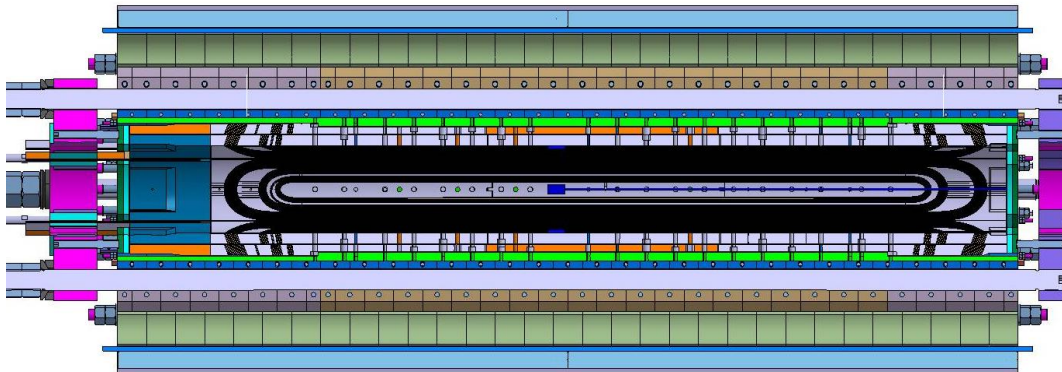
- LARP magnet assembly experience
- **MQXF Short Prototype Assembly Plans**
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MQXF Short Prototype Assembly Plans

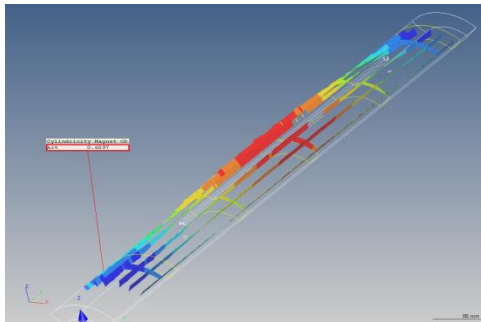
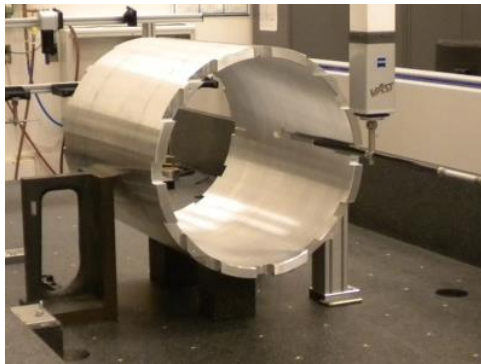
- 1.5 m long magnetic structure
- Builds on HQ and LQ experience
 - Recovers old tooling where possible & cost effective
- Incorporates CERN tooling designs
- All tooling is expected to be scaled-up for the MQXFA prototype

See J.C. Perez' talk on Shell/Yoke assembly

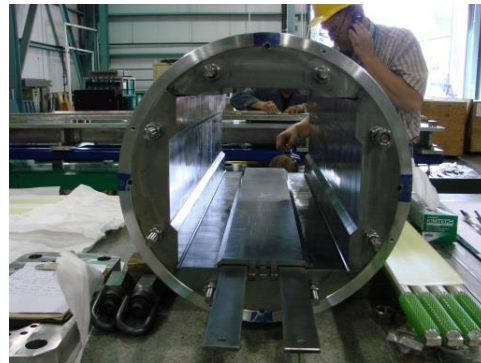
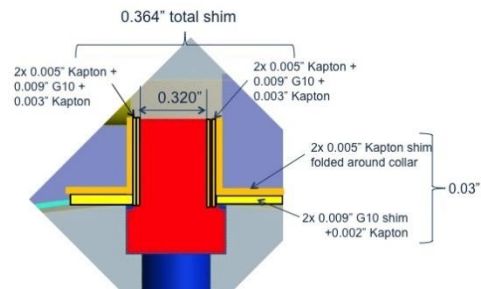


Parts CMM Plan

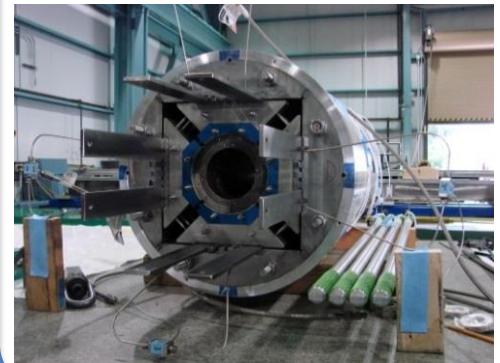
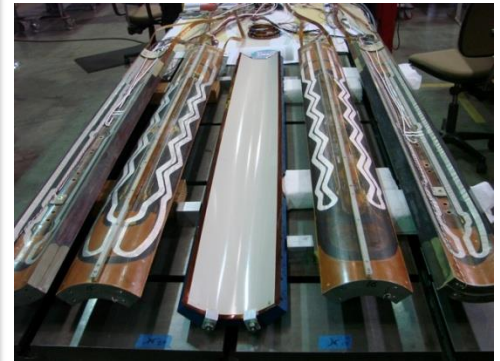
Key features are measured and characterized for each component



Measurement data is used to determine best fits, required shims, etc. for assembly

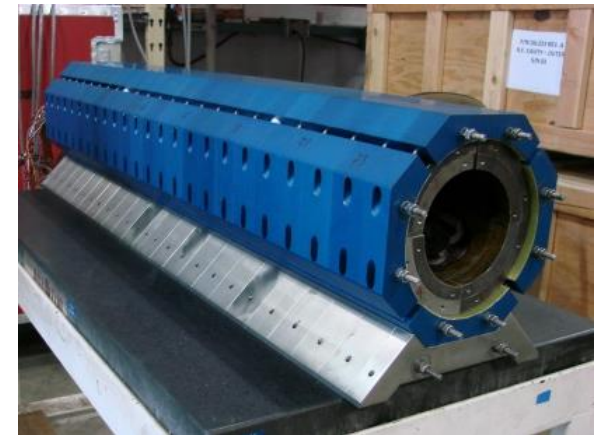
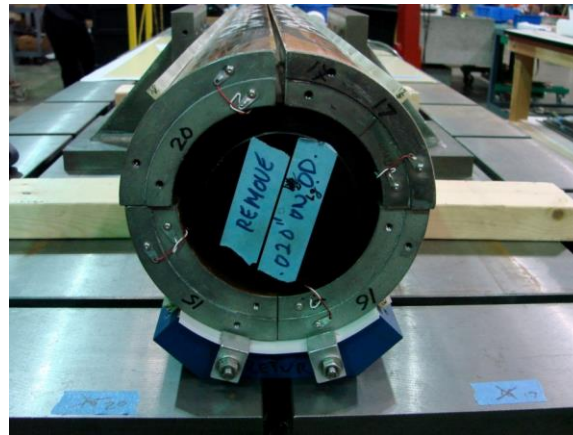
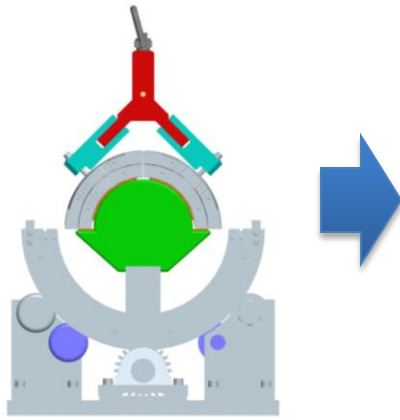
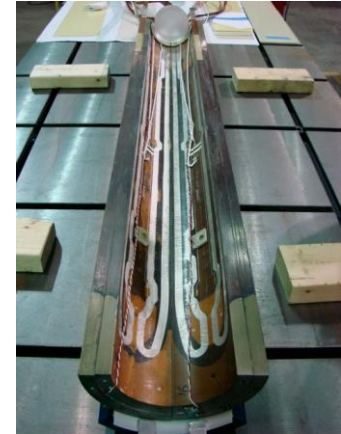
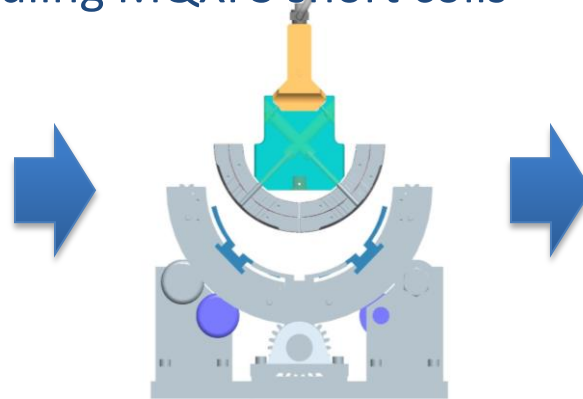
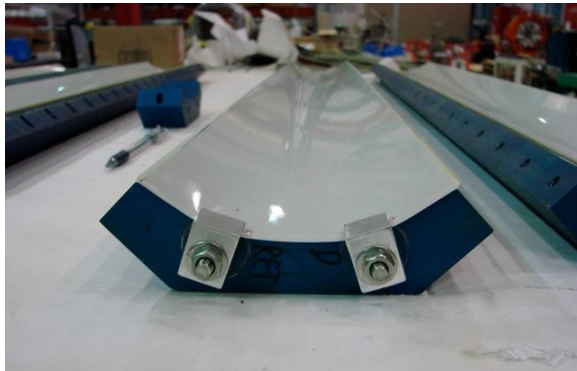


Components are shimmed, assembly operations are performed

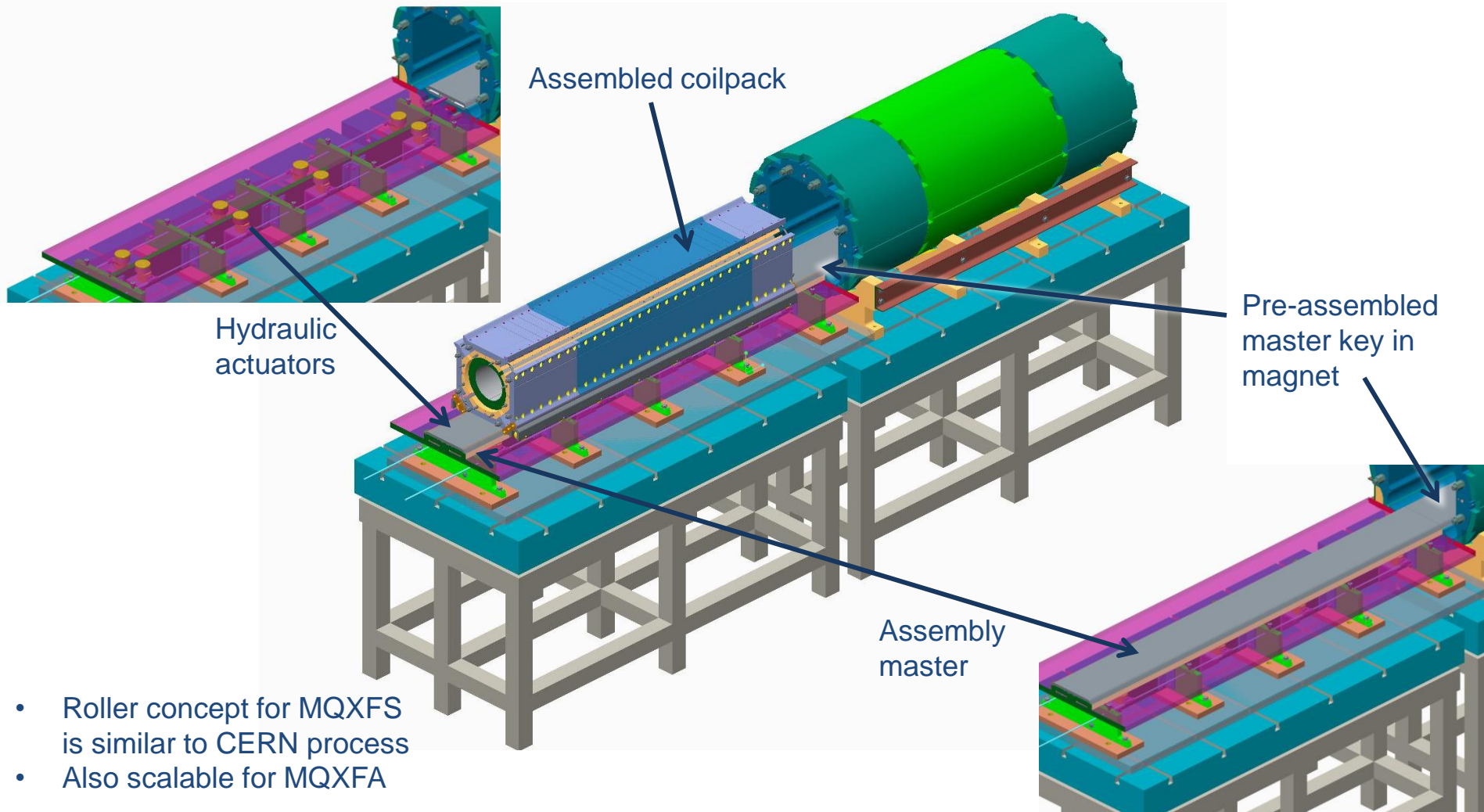


Coil-pack Assembly (with HQ examples)

- Tooling has been designed and built to handle single- and pairs of coils for coil-pack assembly operations
- LQ tooling re-used for handling MQXFS short coils



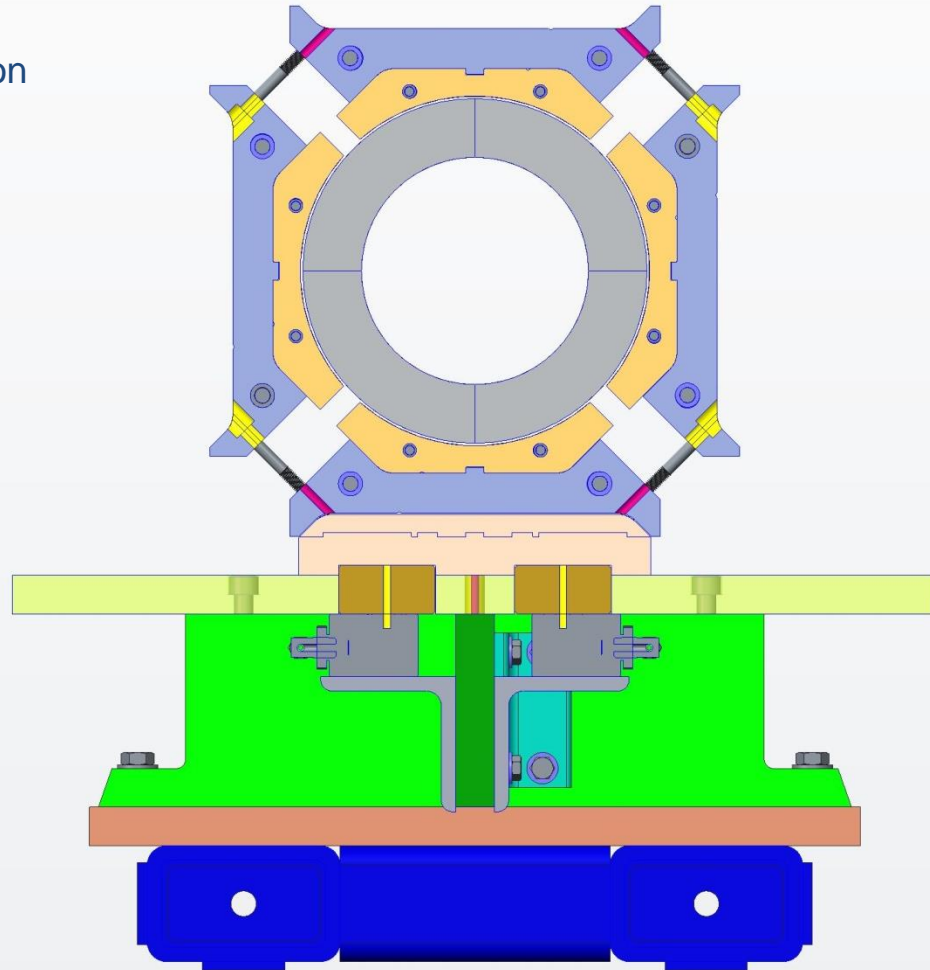
Coil-pack Assembly and Insertion



- Roller concept for MQXFS is similar to CERN process
- Also scalable for MQXFA

Coil-pack Insertion

- Coil pack assembled on assembly master

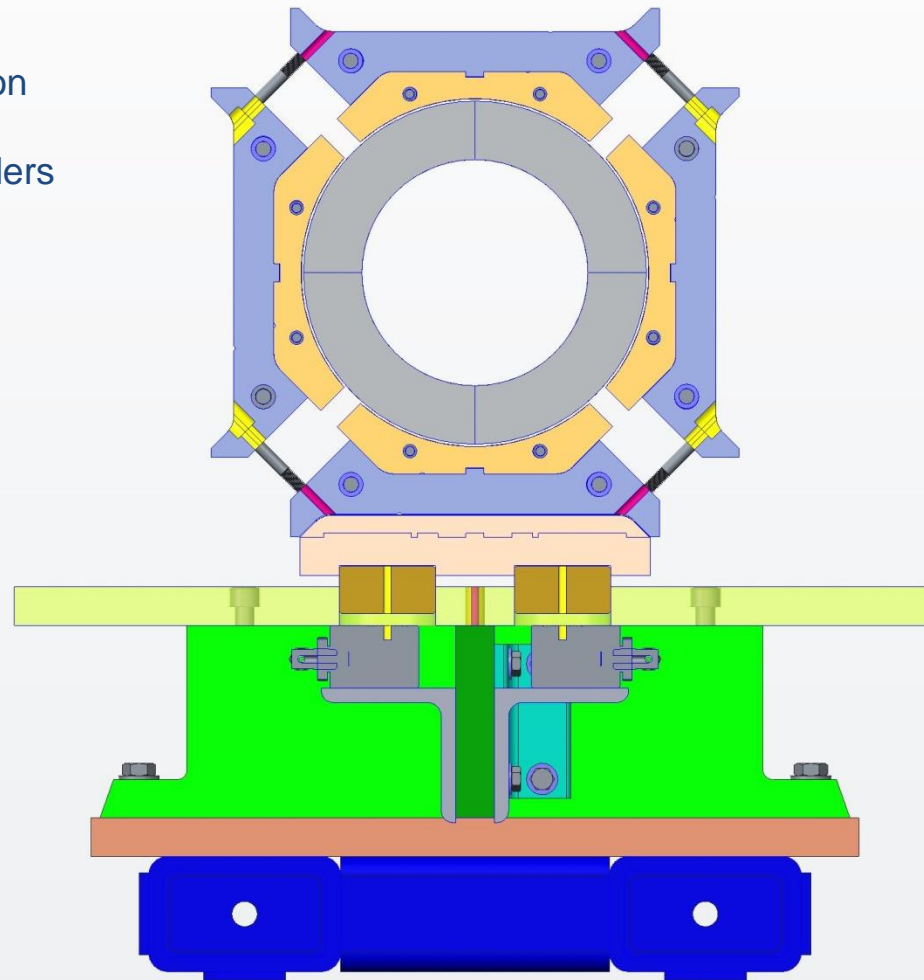


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Coil-pack Insertion

- Coil pack assembled on assembly master
- Activation of the cylinders

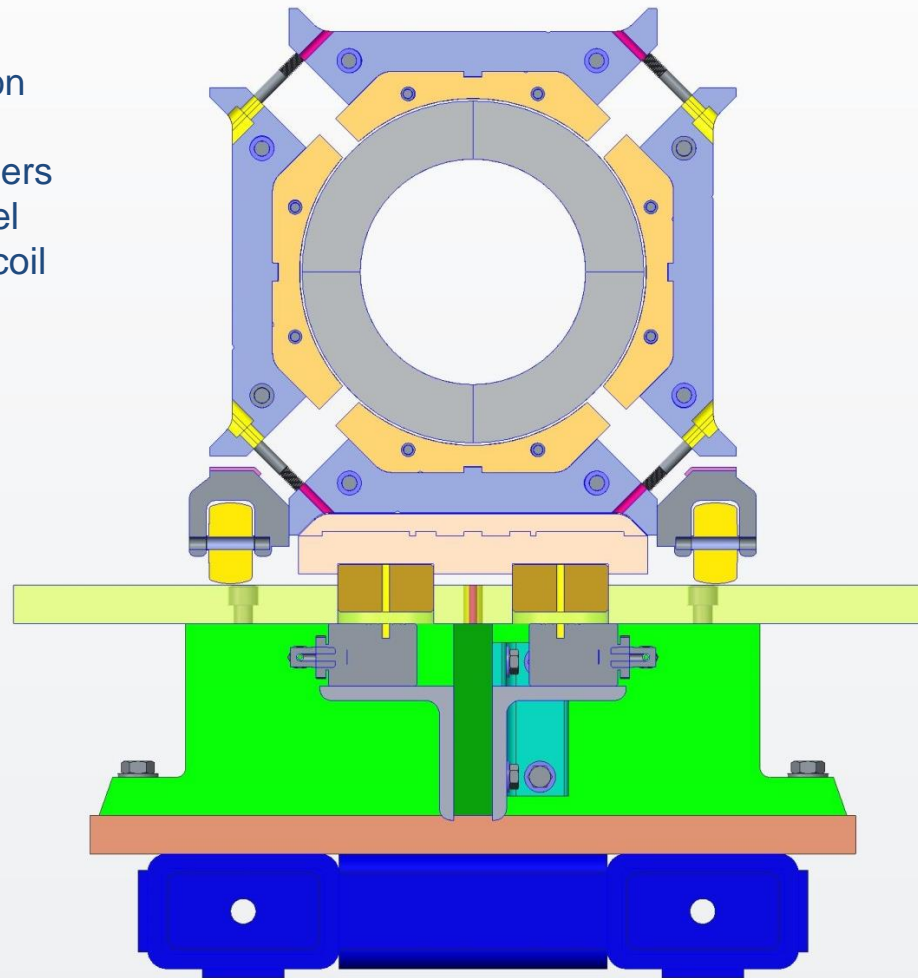


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Coil-pack Insertion

- Coil pack assembled on assembly master
- Activation of the cylinders
- Installation of the wheel racks underneath the coil pack

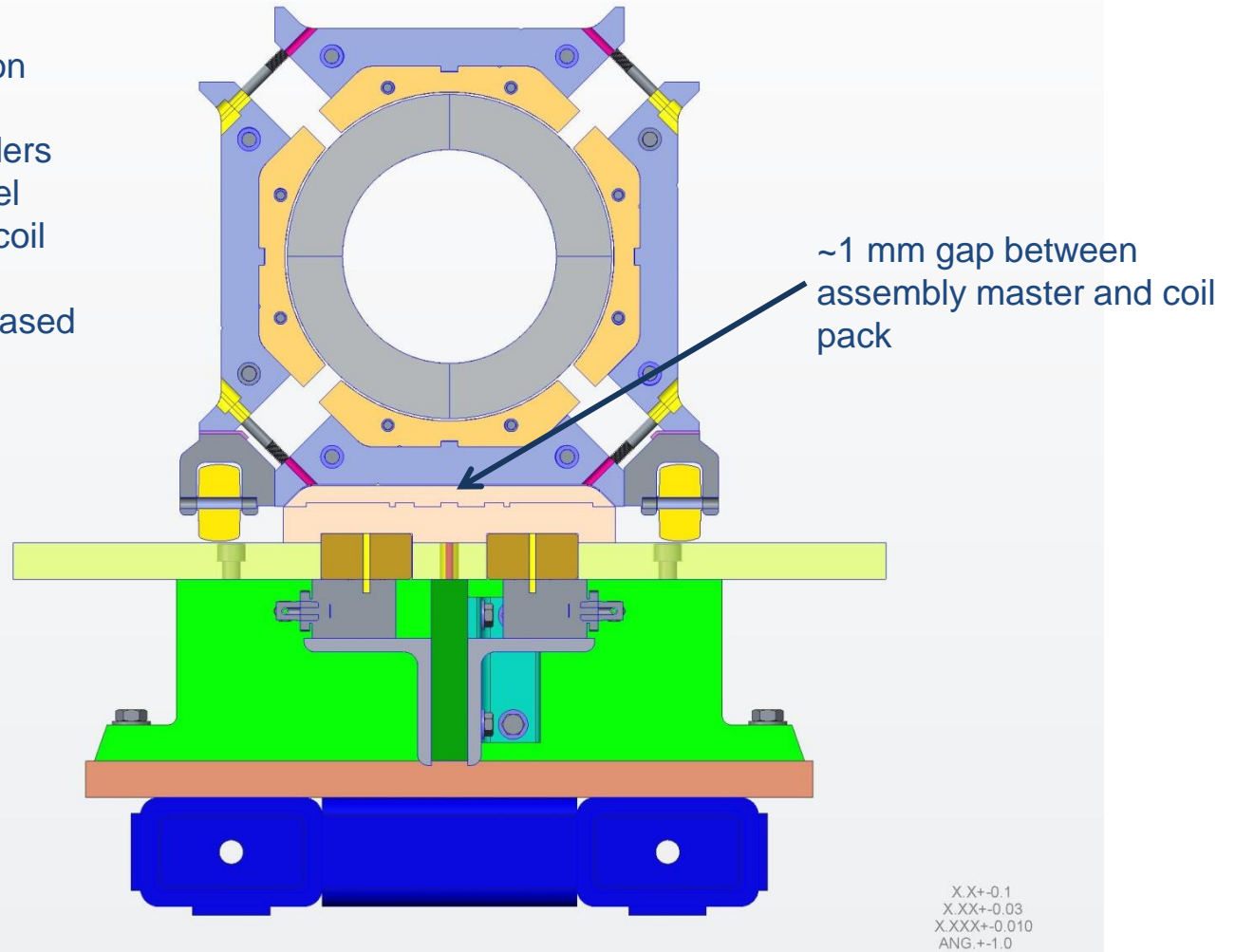


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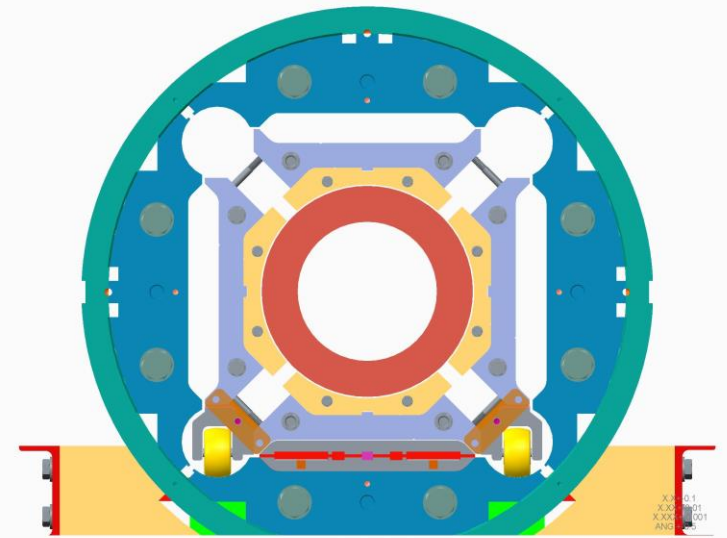
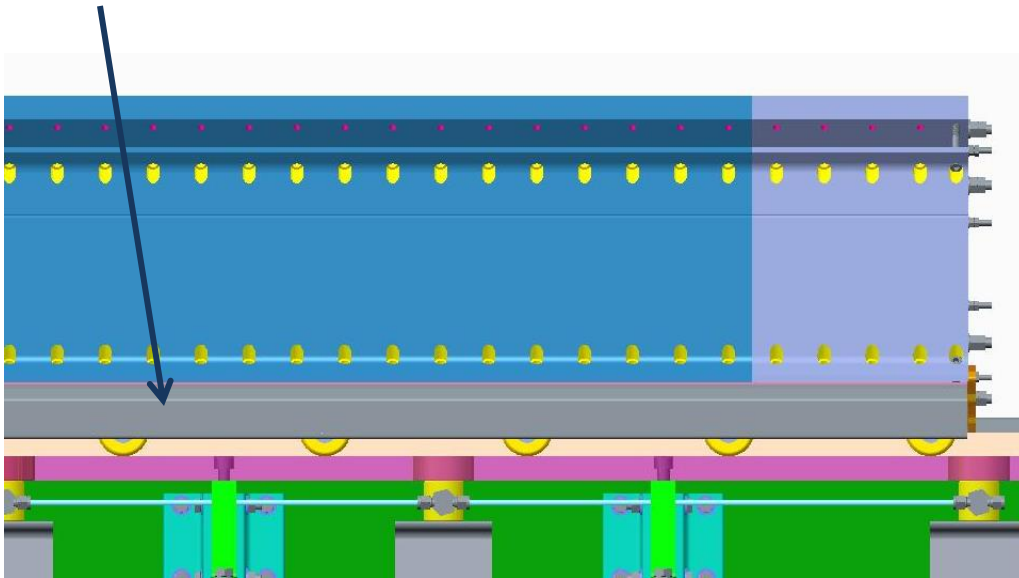
Coil-pack Insertion

- Coil pack assembled on assembly master
- Activation of the cylinders
- Installation of the wheel racks underneath the coil pack
- Actuator pressure released



Coil-pack Insertion

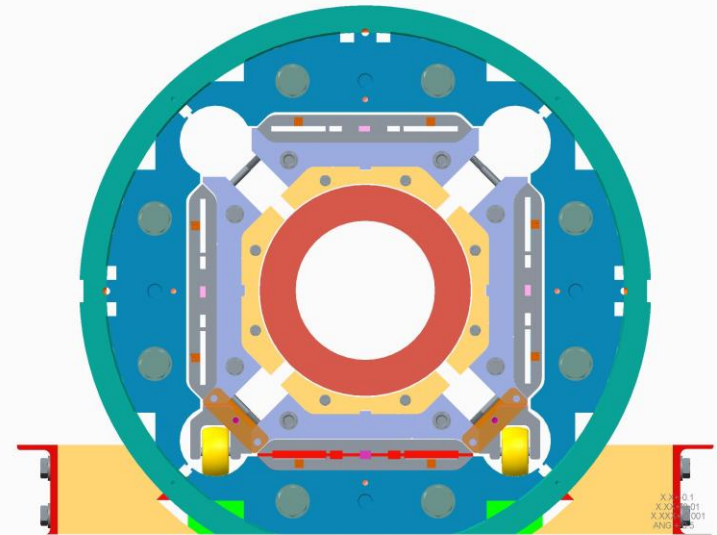
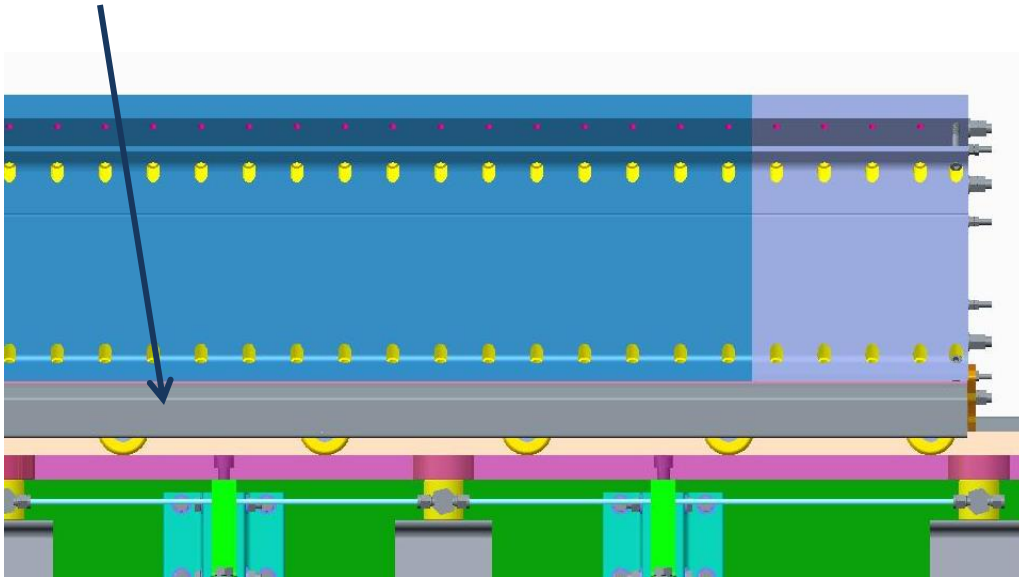
- Coil-pack is rolled into magnet structure
 - Wheels roll in the cooling channels
- Wheels assembly is modular
 - Can be extended for longer coil-packs



Coil-pack is rolled into the magnet structure

Coil-pack Insertion

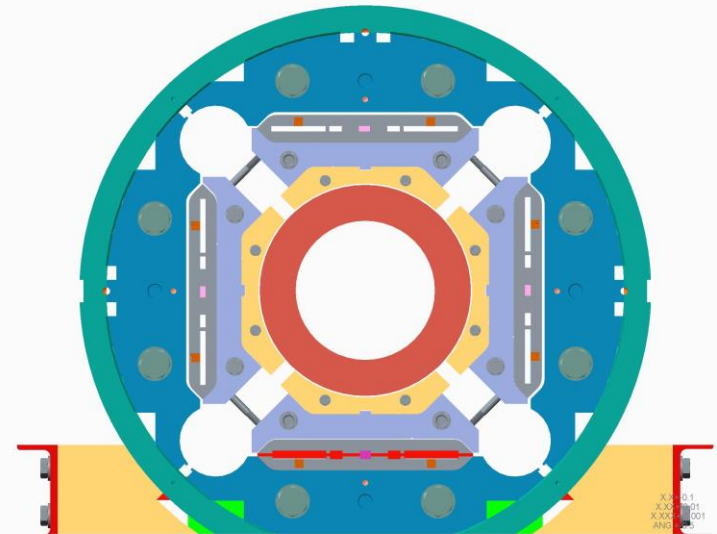
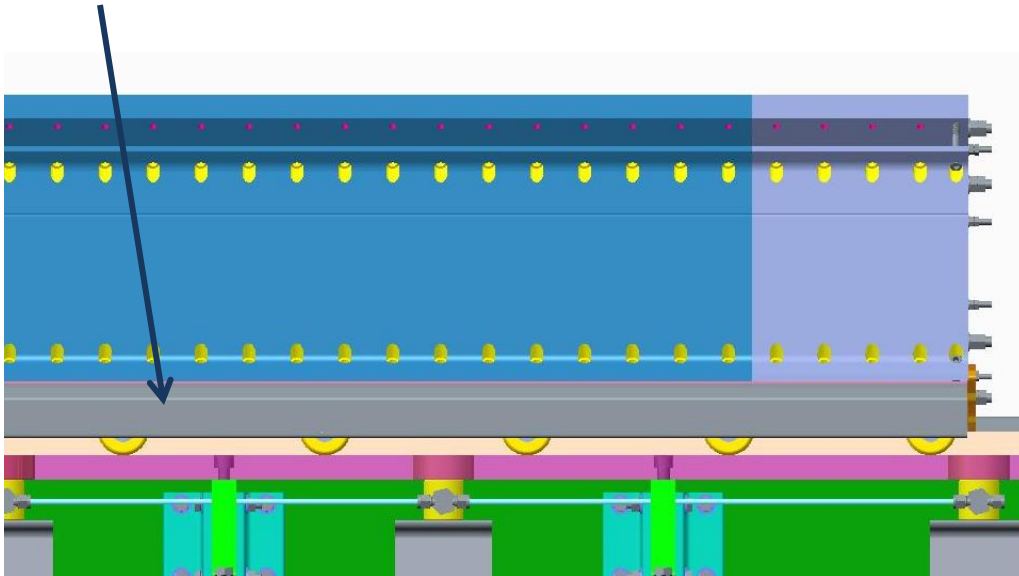
- Coil-pack is rolled into magnet structure
 - Wheels roll in the cooling channels
- Wheels assembly is modular
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Master keys and bladders are inserted. Bladder operations are performed

Coil-pack Insertion

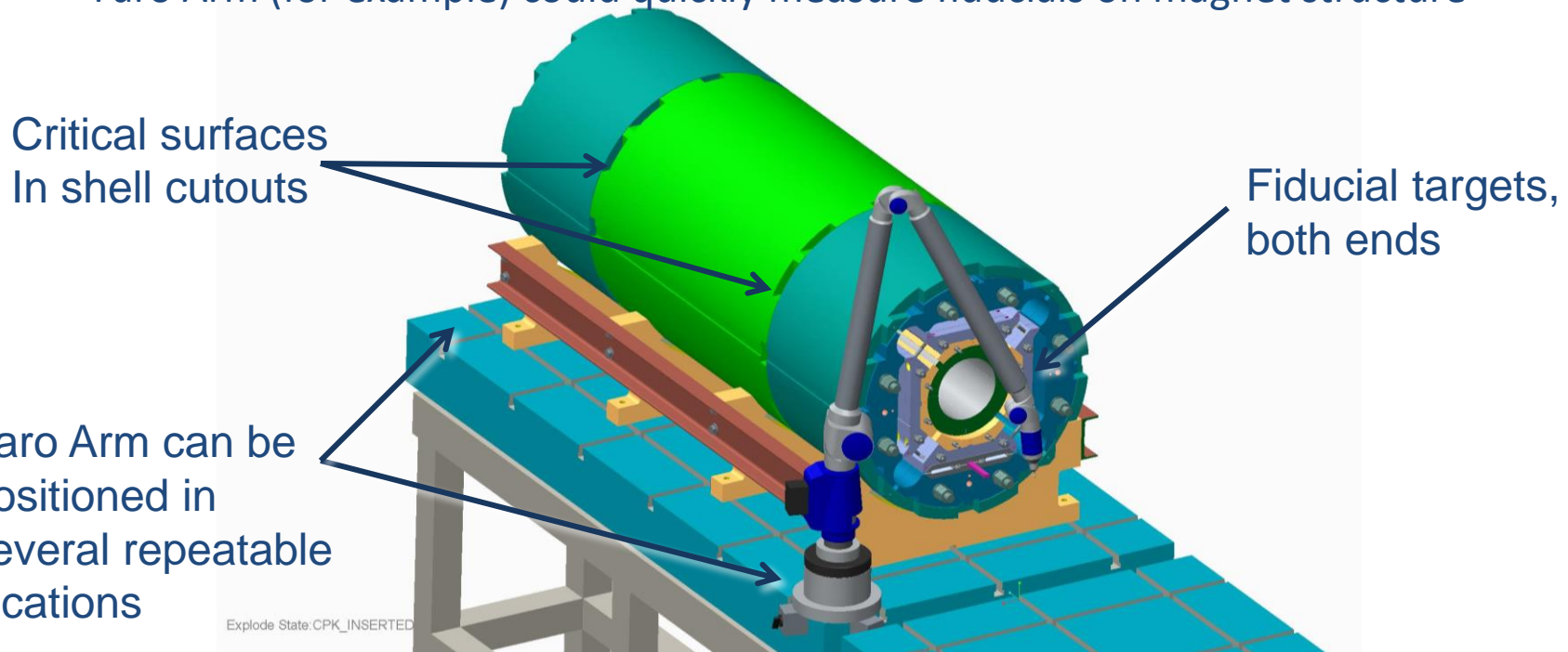
- Coil-pack is rolled into magnet structure
 - Wheels roll in the cooling channels
- Wheels assembly is modular
 - Can be extended for longer coil-packs



Wheels assembly can be removed after bladder preload operations

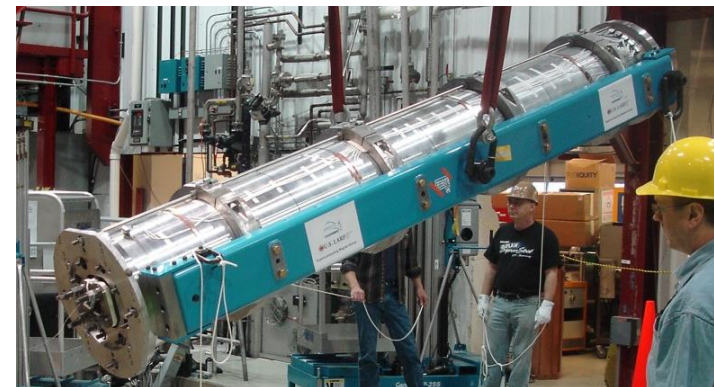
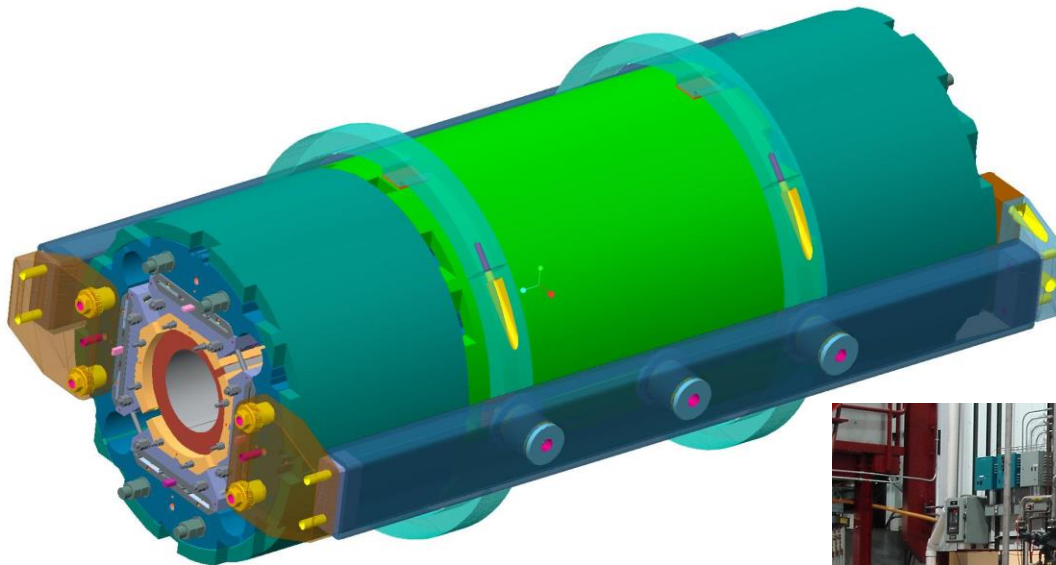
Considerations for Mechanical Measurements and Fiducialization

- After azimuthal preload operations, survey & alignment must be performed on this structure
 - Fiducial features of coils/collars/pads may be unavailable after axial loading and splice connection box is installed
- Determines mechanical center of magnet based on the initial CMM data of measured parts
- Faro Arm (for example) could quickly measure fiducials on magnet structure



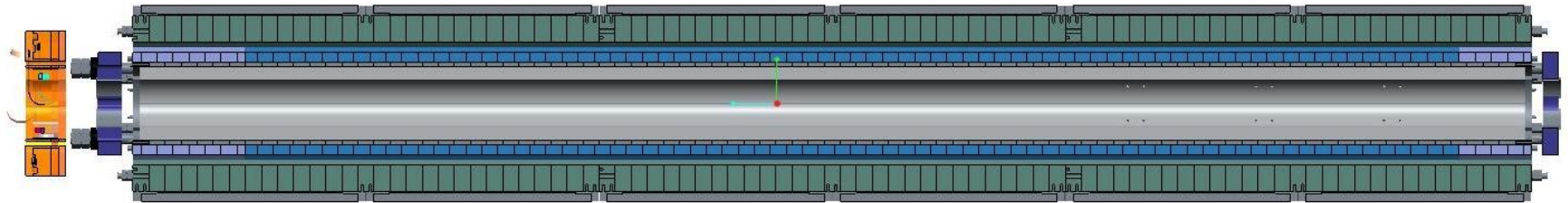
Magnet Handling and Prep for Shipment

- Magnet must be shipped to other sites for testing
- LQ-style magnet handling is being designed for the MQXFS structure
- Incorporates strongback beams and collars
- Beams and collars will be removed prior to magnet testing



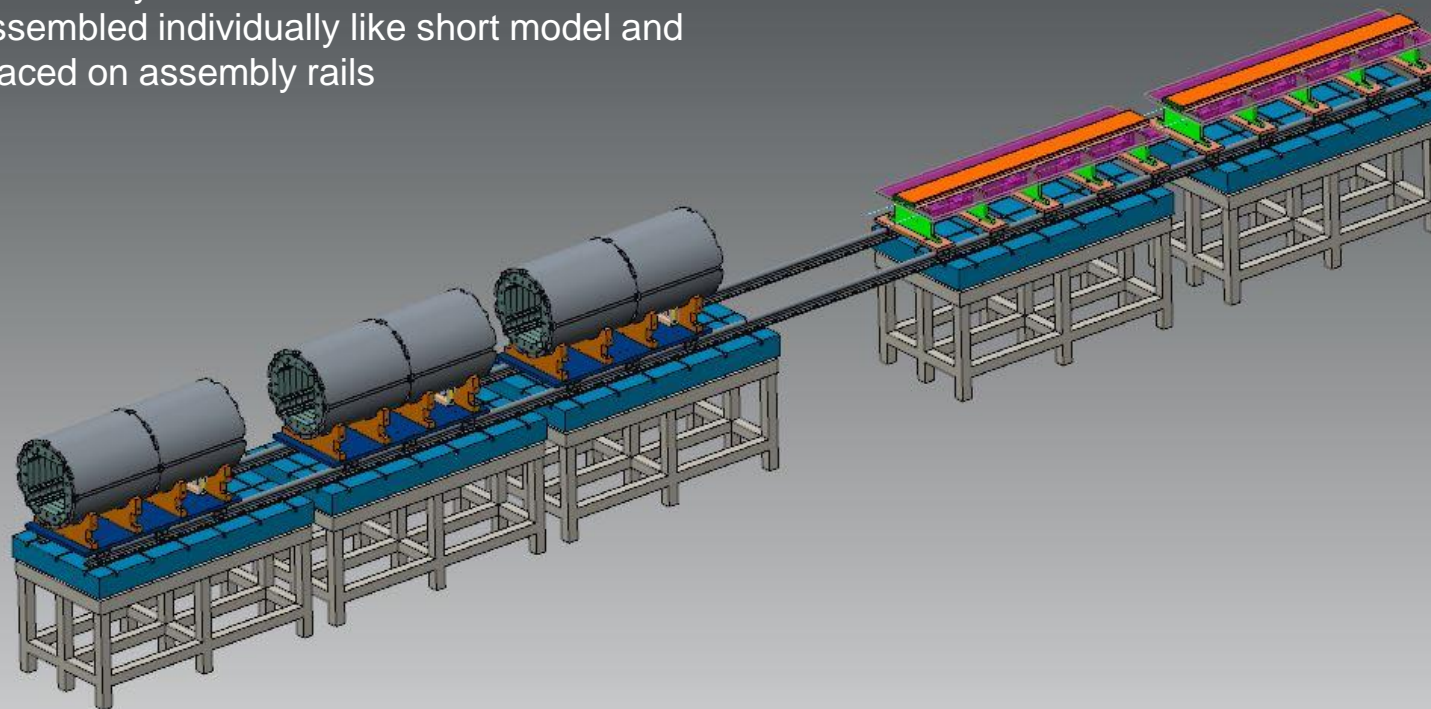
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Shell/Yoke Segments Assembly (Long)

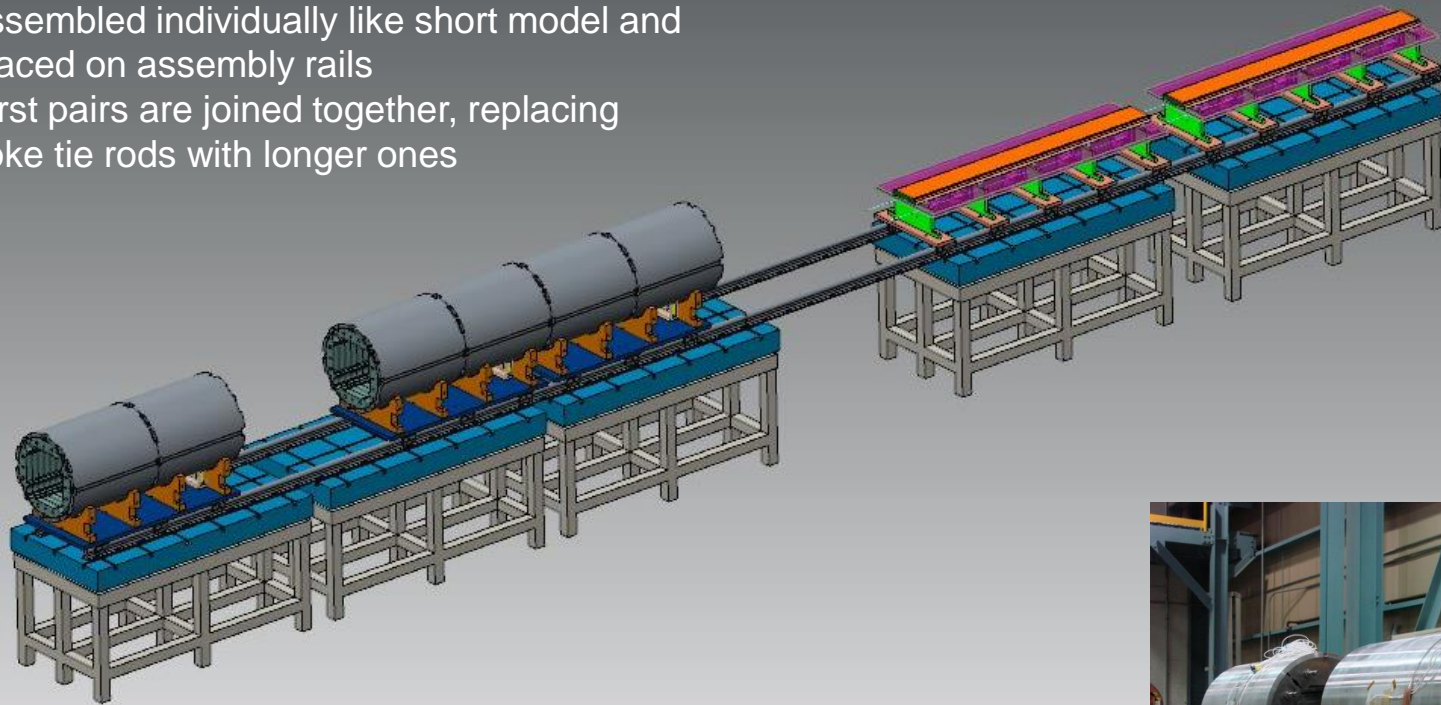
- Shell and yoke subassemblies will be assembled individually like short model and placed on assembly rails



- Rail assembly concept for MQXFA shells is similar to CERN processes planned for MQXFB

Shell/Yoke Segments Assembly (Long)

- Shell and yoke subassemblies will be assembled individually like short model and placed on assembly rails
- First pairs are joined together, replacing yoke tie rods with longer ones

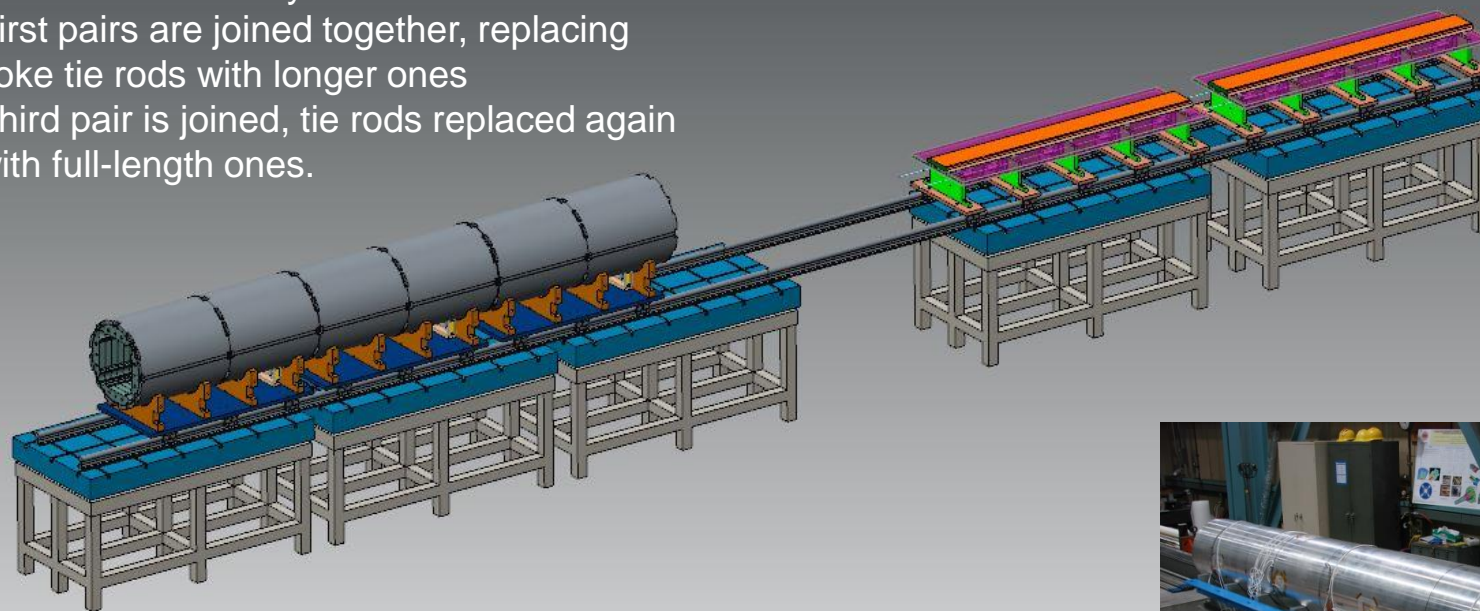


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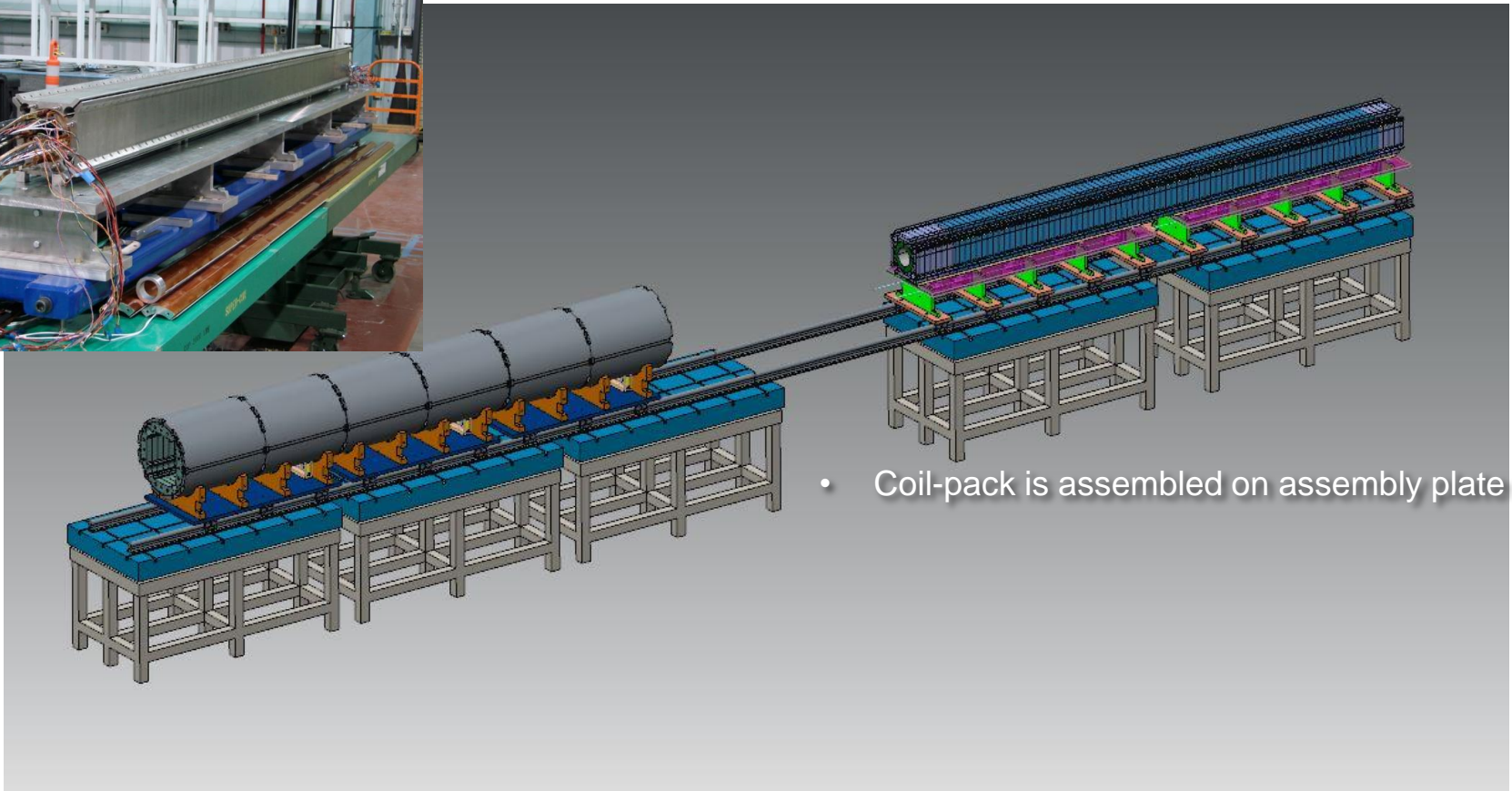
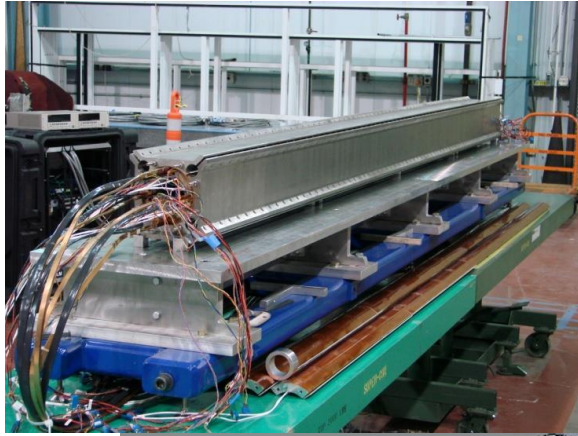


Shell/Yoke Segments Assembly (Long)

- Shell and yoke subassemblies will be assembled individually like short model and placed on assembly rails
- First pairs are joined together, replacing yoke tie rods with longer ones
- Third pair is joined, tie rods replaced again with full-length ones.

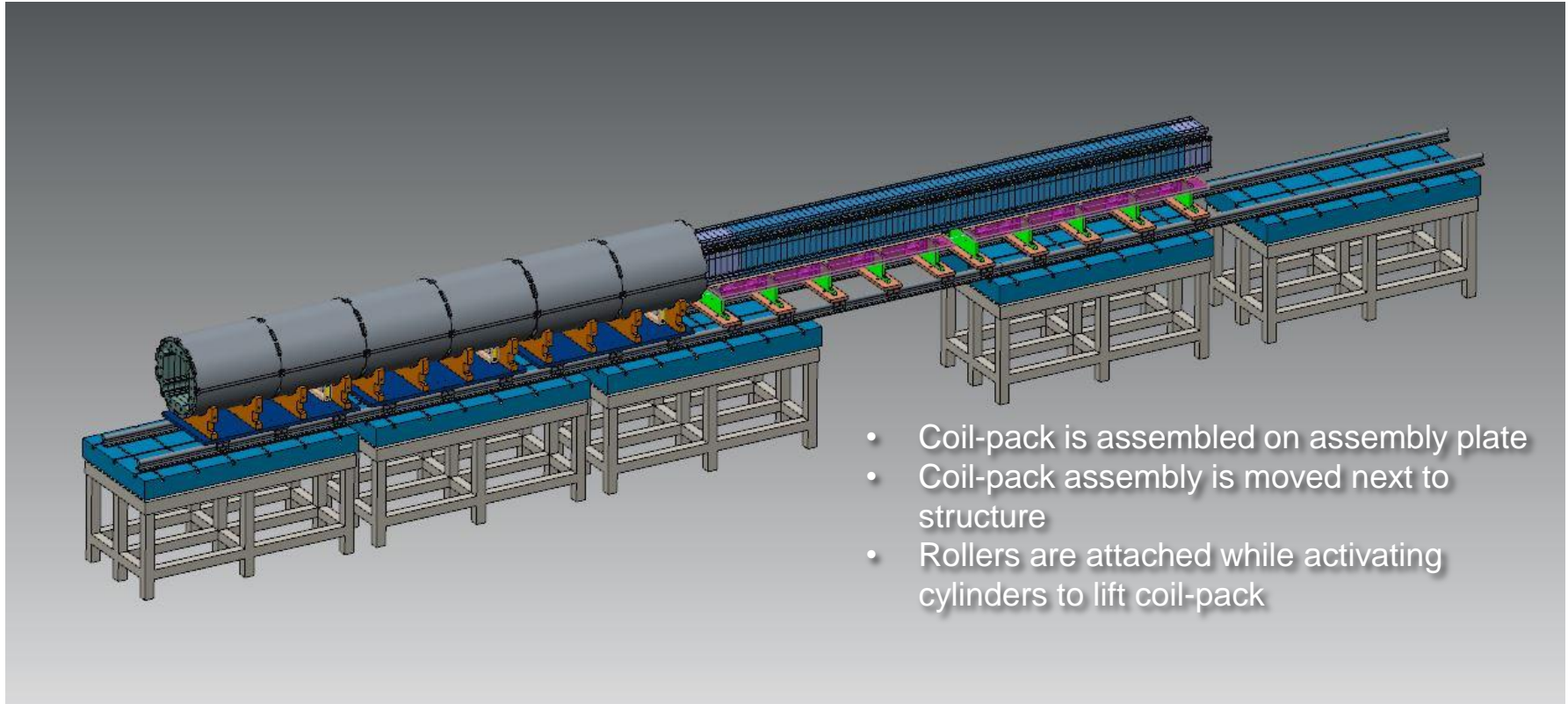


Coil Pack Assembly and Insertion



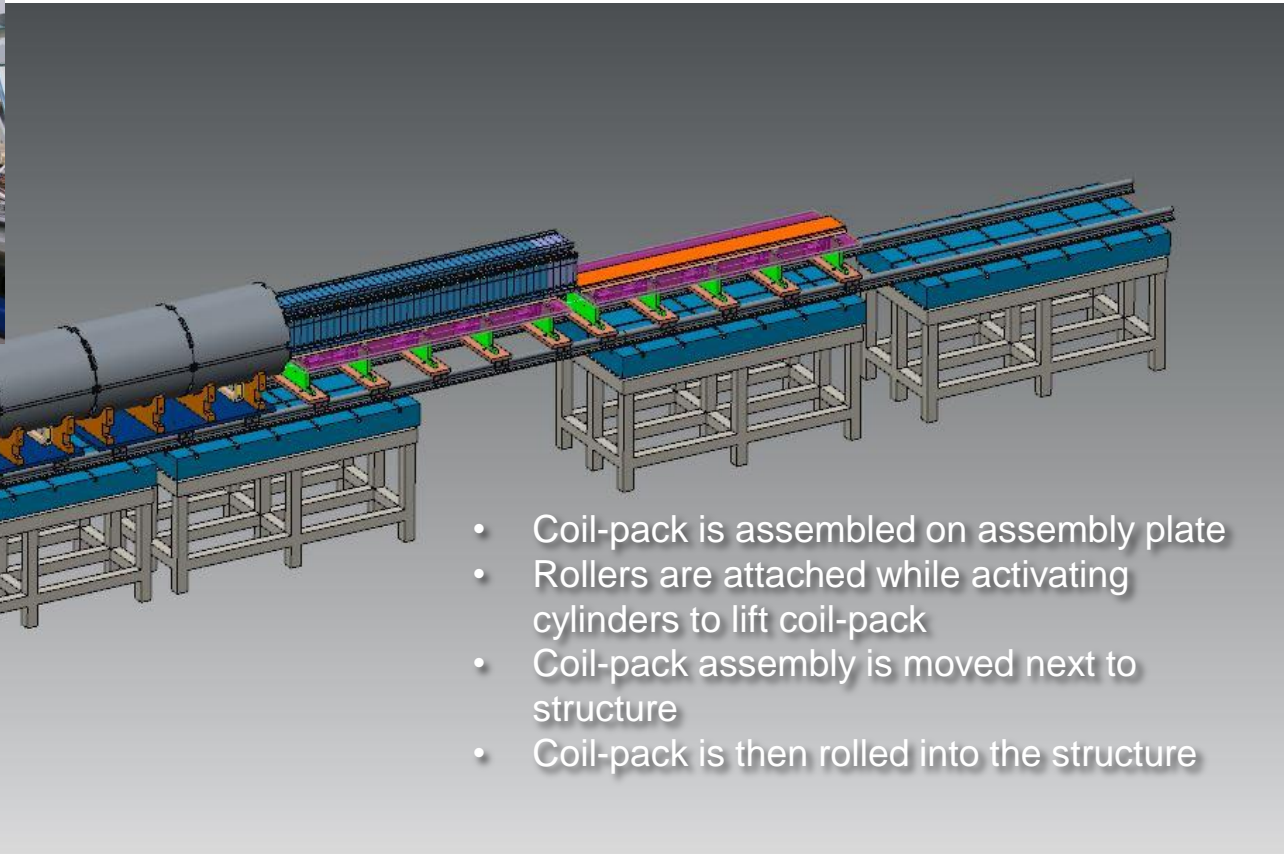
- Coil-pack is assembled on assembly plate

Coil Pack Assembly and Insertion



- Coil-pack is assembled on assembly plate
- Coil-pack assembly is moved next to structure
- Rollers are attached while activating cylinders to lift coil-pack

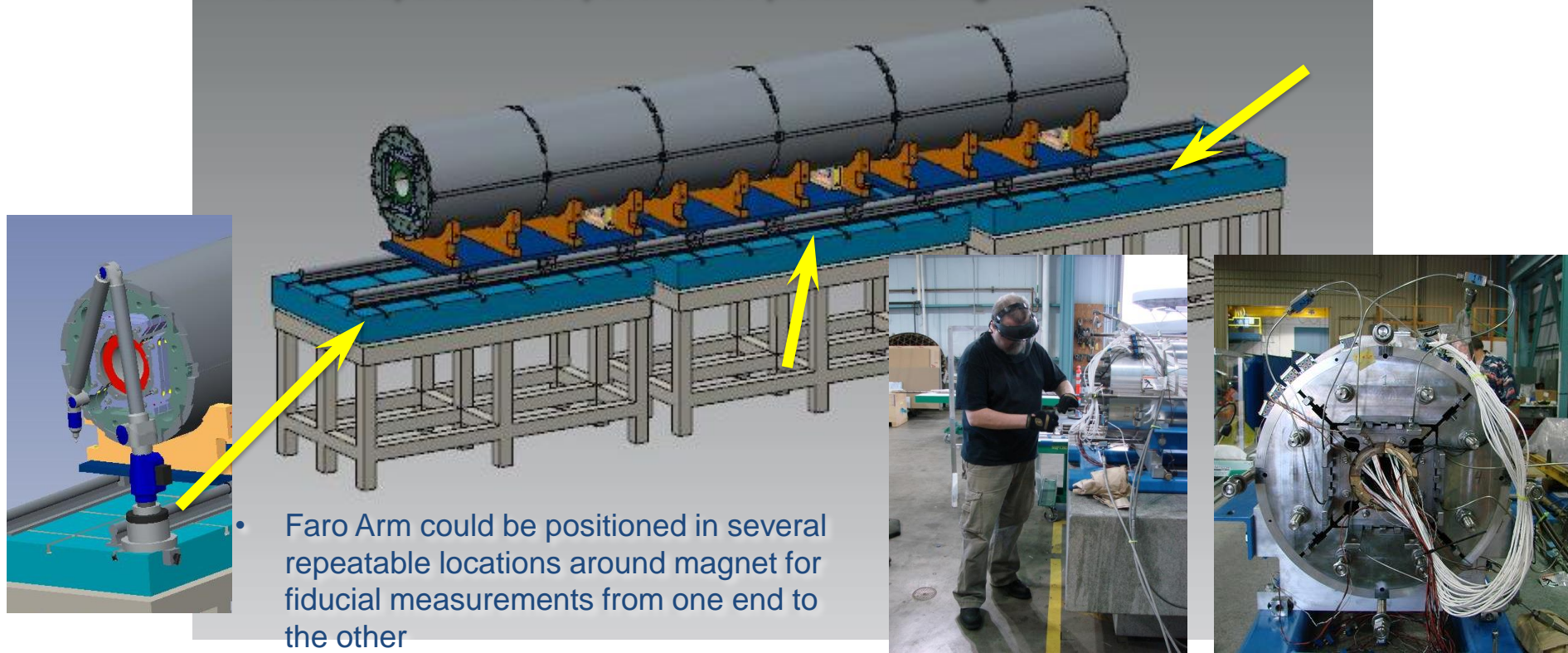
Coil Pack Assembly and Insertion



- Coil-pack is assembled on assembly plate
- Rollers are attached while activating cylinders to lift coil-pack
- Coil-pack assembly is moved next to structure
- Coil-pack is then rolled into the structure

Magnet Preloading and Measurements

- Coil-pack assembly rack is moved away from the magnet structure
- Rails spanning the assembly tables are removed for access to both ends
- Master keys and bladders are inserted from both ends
- Bladder operations are performed to preload the magnet

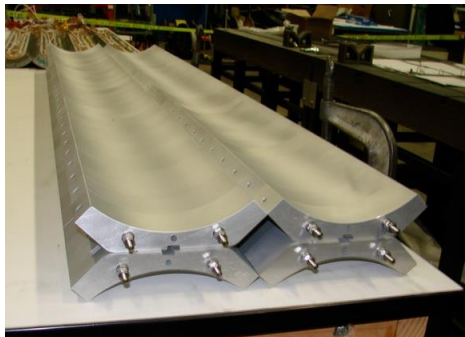
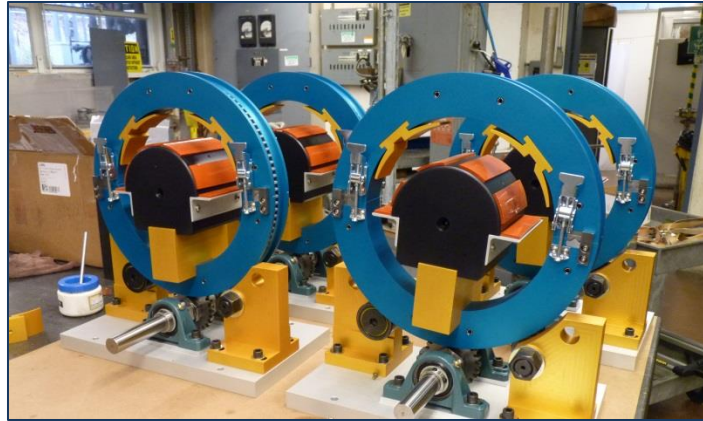


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MQXF Short Prototype Status

- Parts arrived/arriving from CERN → See J.C. Perez' talk for CERN Procurments
- Tooling & infrastructure being fabricated
- CMM/Qualification of received parts is in process
- Mechanical model will be assembled beginning of 2015



See M. Juchno's talk for shell cut rationale

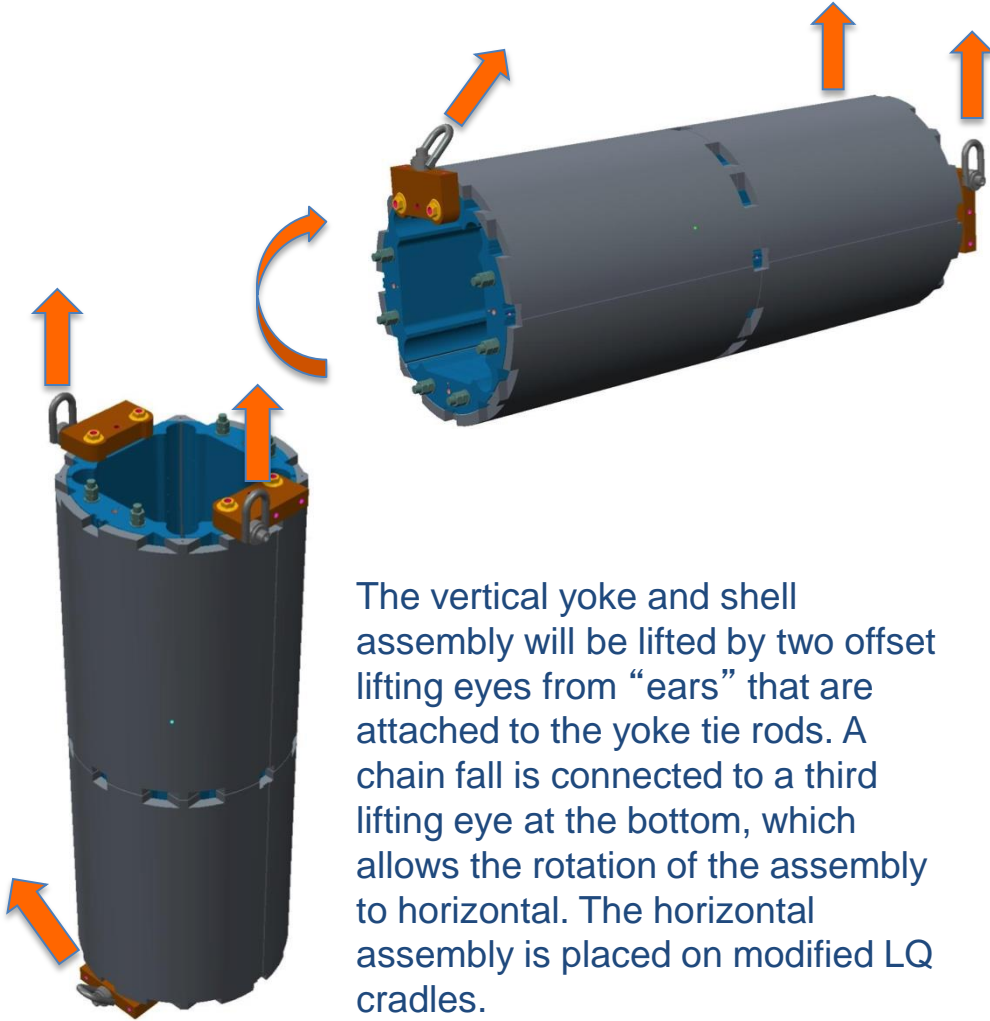
LARP MQXF Prototypes Assembly Summary

- Short and long MQXF prototypes assembly steps were presented
 - Tooling and processes built from LARP designs and experience
 - Existing tooling re-purposed where possible
 - Processes have been refined for MQXFS short prototype
 - Also working with CERN-designed tooling where appropriate
 - Scalability
 - All short model processes can be scaled to long model
 - Designs are currently under development for MQXFA magnet structures assembly
- Short models production is currently in progress
 - Tooling is being prepared for the MQXFS assembly
 - Parts and components are being received from CERN
 - First mechanical model expected first part of 2015

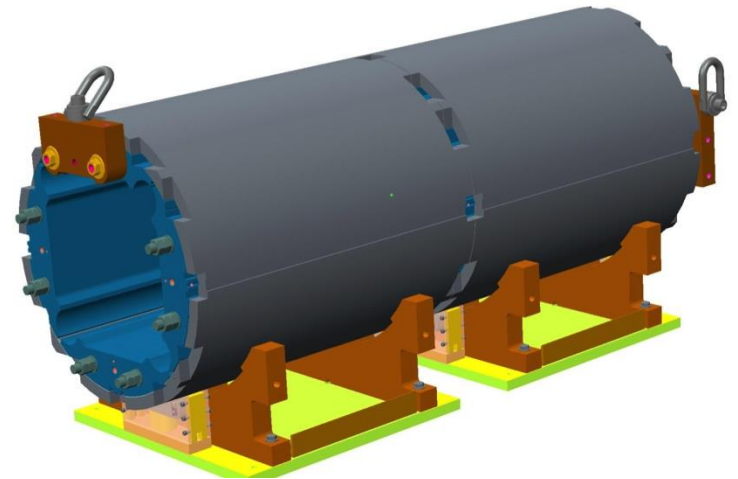
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- Thank you for your attention!

Additional Slides

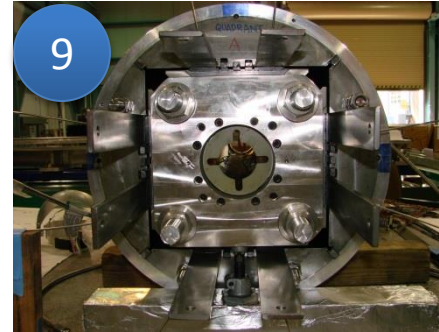
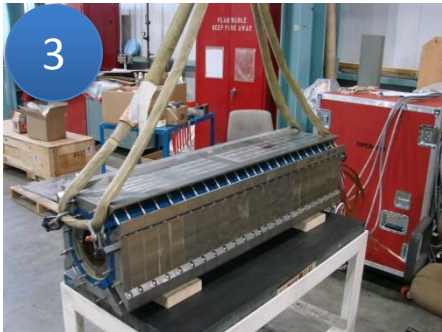
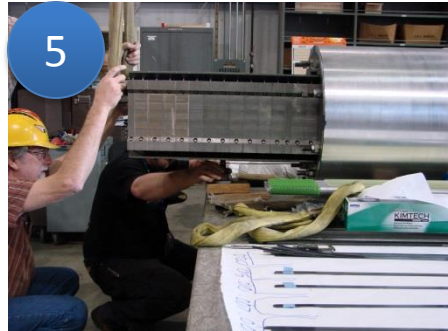
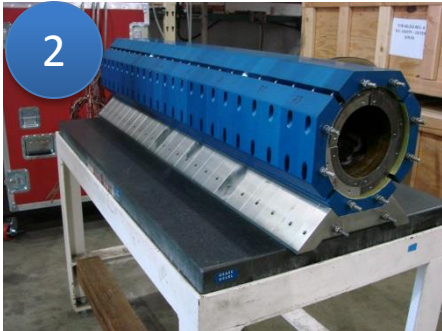
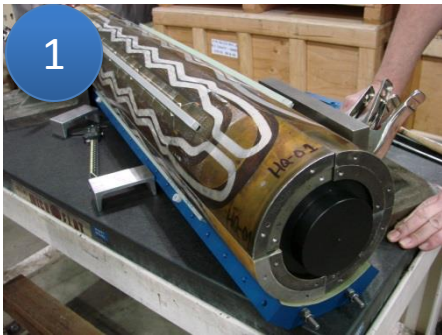
Yoke/Shell Subassembly Handling



The vertical yoke and shell assembly will be lifted by two offset lifting eyes from “ears” that are attached to the yoke tie rods. A chain fall is connected to a third lifting eye at the bottom, which allows the rotation of the assembly to horizontal. The horizontal assembly is placed on modified LQ cradles.



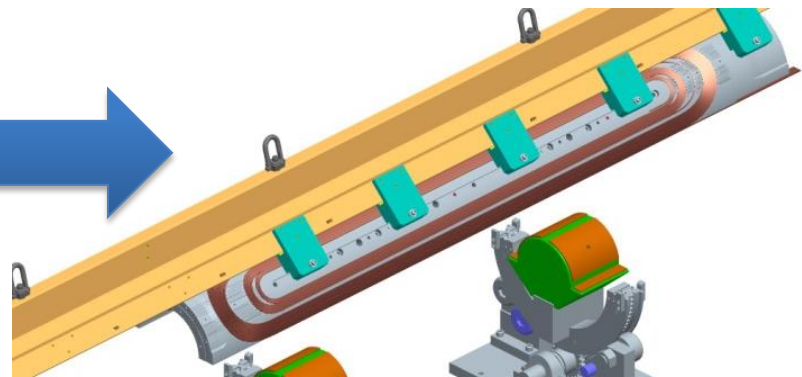
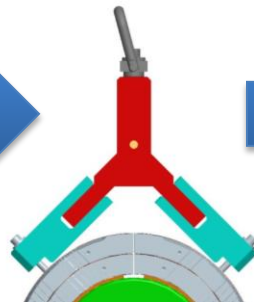
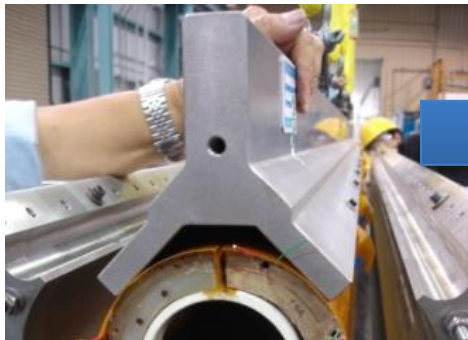
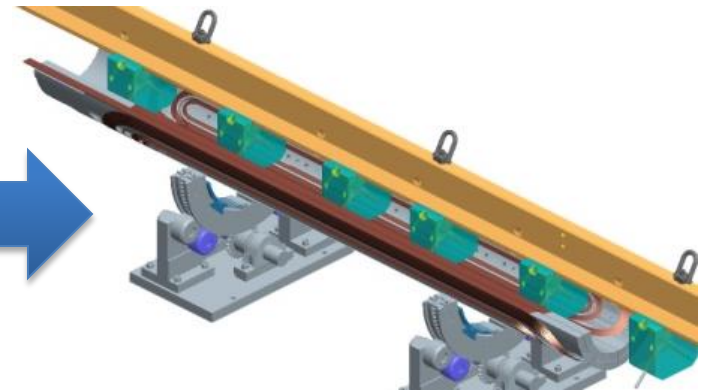
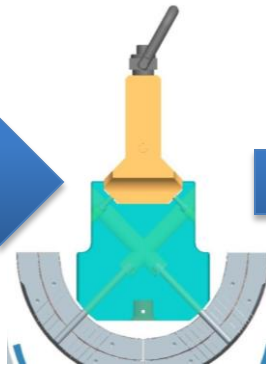
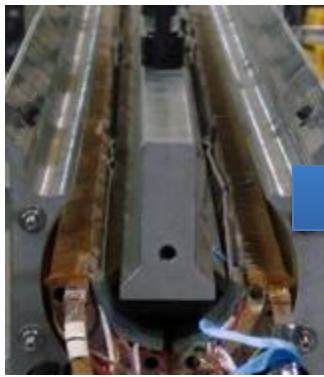
Typical Steps (HQ)



- 1 Assemble Coils
- 2 Assemble Collar pack
- 3 Assemble Load pads
- 4 Shim initial master keys in shell/yoke
- 5 Insert Coil pack
- 6 Insert master keys
- 7 Perform bladder preload
- 8 Apply axial end loads
- 9 Prepare splice joints

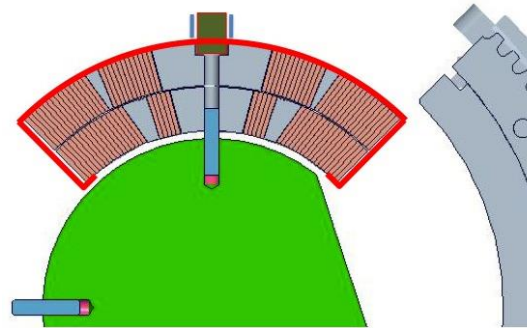
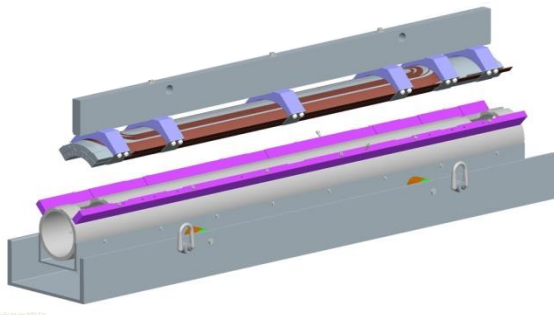
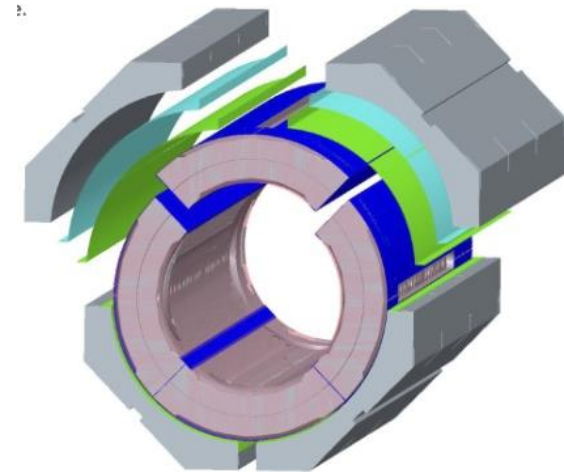
Coil pack Assembly, Coil Handling

- Tooling has been designed and built to handle single- and pairs of coils for coil-pack assembly operations
- LQ tooling re-used for handling MQXFS short coils



Coil Pack Assembly

- Coil handling for roll-over operations
 - For applying ground plane insulation, pairing coils prior to assembly, etc.



Magnet Splice Joints

- After axial loading, the coil leads will be soldered
- MQXFS splice connection box is currently being designed
 - Will accommodate both current leads and CLIQ leads for vertical testing at FNAL and BNL facilities
- Production MQXFA magnets may be subject to slightly different lead packaging constraints

