SQXF Coil Design and Fabrication

Winding and Curing

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February 17, 2014

Outline

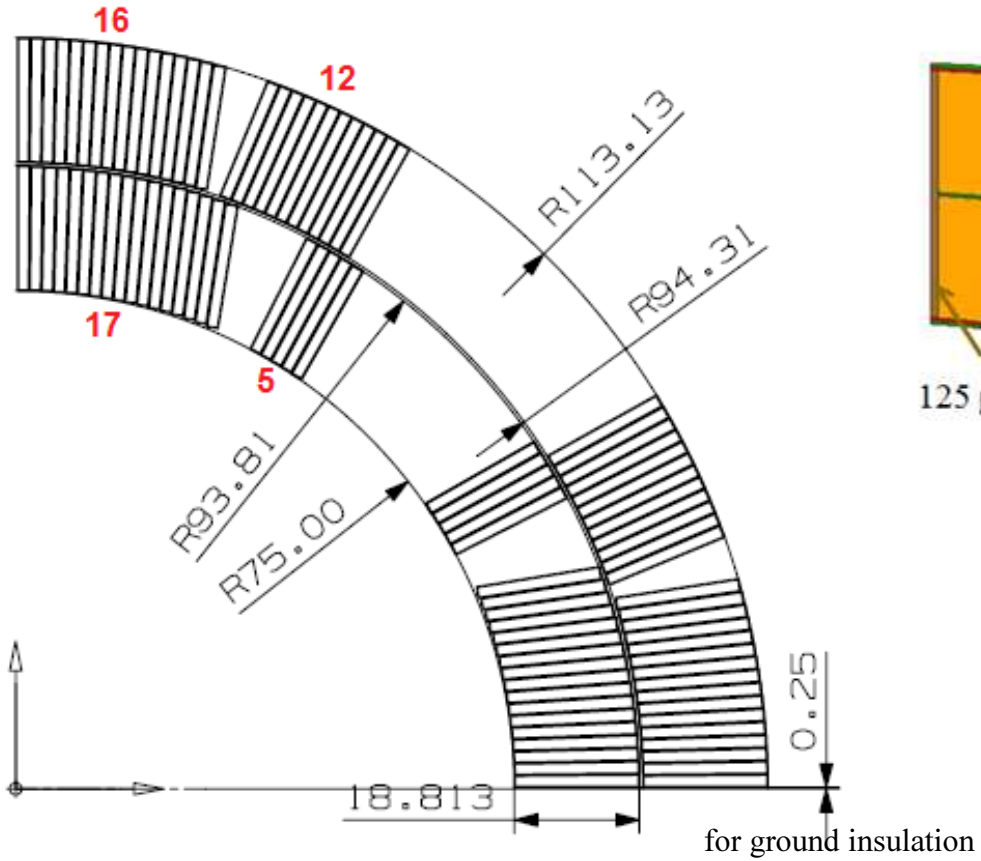
- Introduction
- QXF Coil Design
  - Coil Cross-section
  - Coil Layout
  - Coil Pole and End Parts
- QXF Coil Fabrication-Winding and Curing
  - Winding and Curing Tooling
  - Winding and Curing Procedures (Traveler)
  - Winding Test
- Summary

Introduction

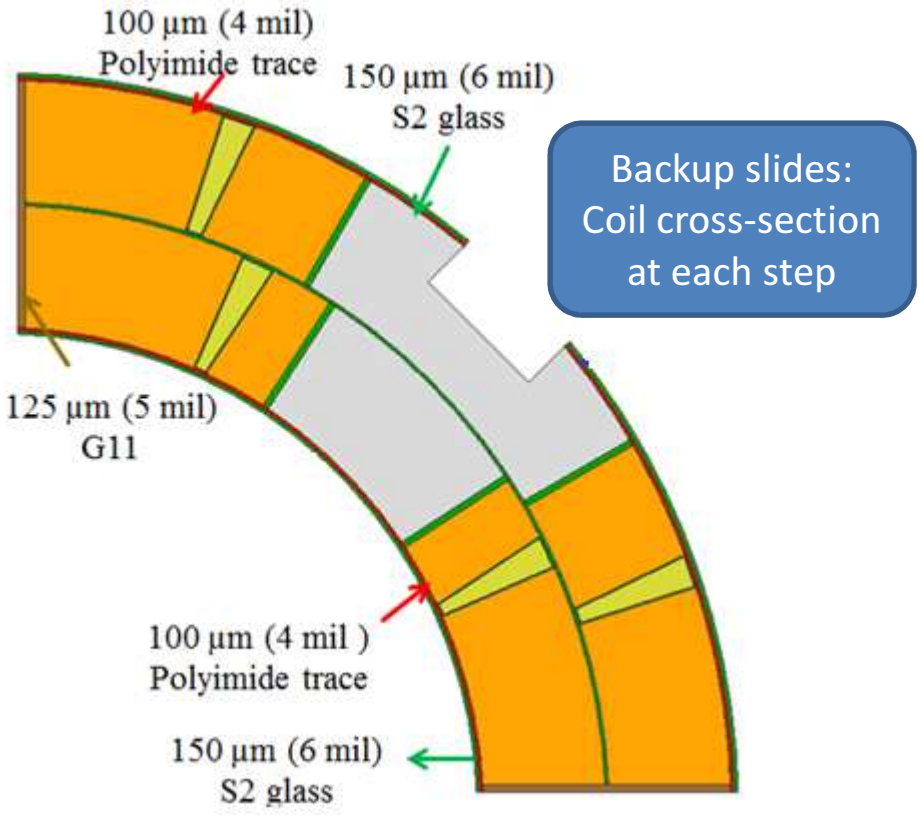
- Based on LARP successful R&D Quadrupole coil TQ/LQ/**HQ/LHQ** experience.
  - Coil parts design (BEND program)
  - Tooling design
  - Fabrication technology and procedure (winding – curing – reaction – impregnation)
  - Coil size control at each fabrication step (insulation and shim) to reach the final coil size
- To meet CERN's requirement
  - Field quality (x-section and end design)
  - Magnetic length (coil length)
  - Electrical requirement (plasma coating of metallic end parts)
  - Heat extraction (cooling channels in coil pole)

QXF Coil Design

- Coil Cross-section



Magnetic design



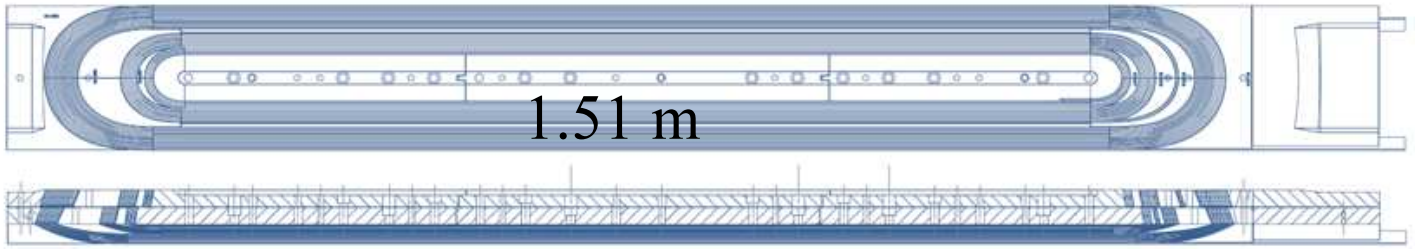
Backup slides:
Coil cross-section
at each step

Fabricated Coil

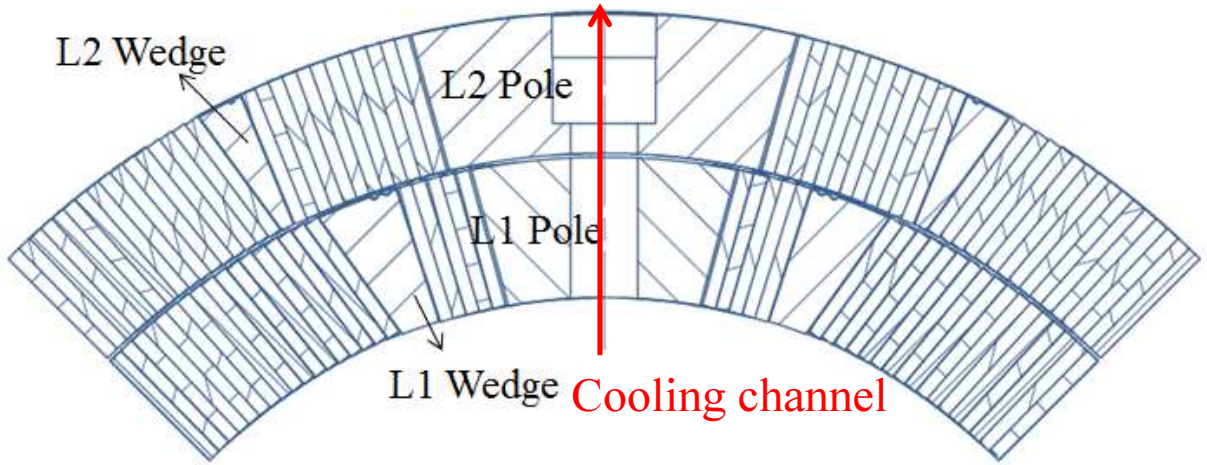
QXF Coil Design

- QXF Coil Layout

RE



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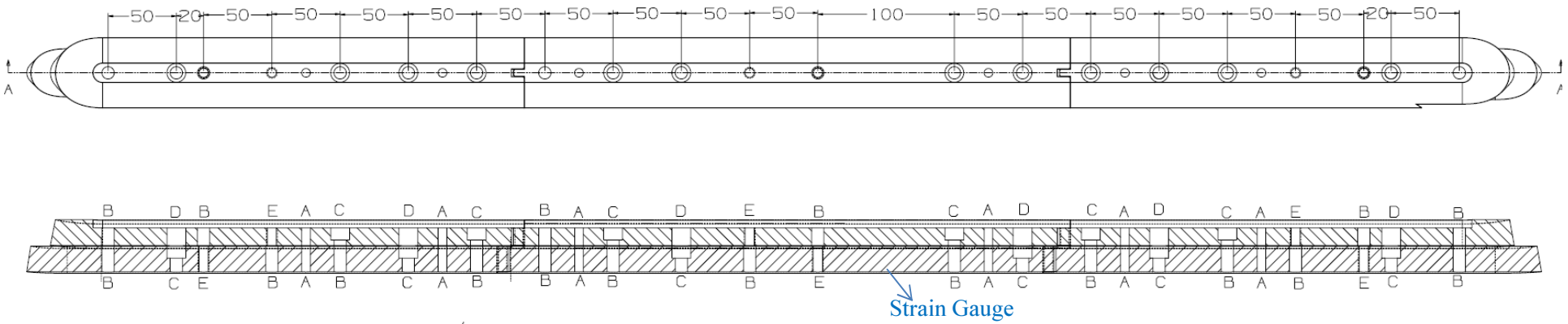


- Ti-6Al4V pole and bronze wedge: used for LQ/HQ/LHQ.
- Stainless steel end spacer, saddle and splice block: used for HQ/LHQ.
- LQXF is 4.3 m long by adding 7 more center pole pieces.

QXF Coil Design

- Coil Pole

- ***> 80 % of the heat is evacuated via the pole piece with Φ8 mm holes and 50 mm spacing***



Pin Hole A: Ø6.35mm for 1/4" dowel pin
Clearance Hole B: Ø9.0mm thru for 5/16" or M8 SHCS
Clearance Hole C: Ø9.0mm thru, ⌴ 13.8mm, ↧ 8.8mm for 5/16" or M8 SHCS
Clearance Hole D: Ø13.8mm thru for 5/16" SHCS
Lifting Hole E: ØM8x1.25 lifting threaded hole

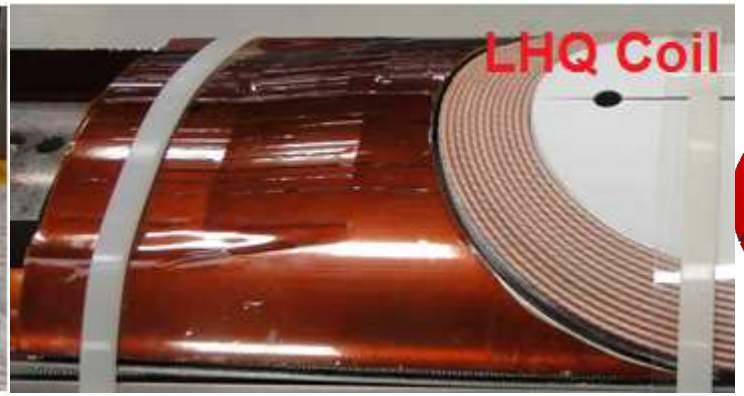
Hole B,C,D and E will be used as cooling hole after magnet assembly

QXF Coil Design

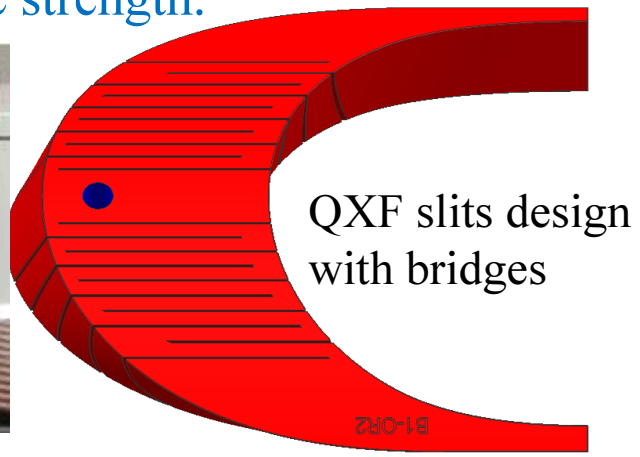
- Coil End Spacer and Saddle

- End parts are designed based on the nominal coil size after coil reaction
- During winding, the coil is not fully constrained inside the envelope. This effect is most pronounced at the ends. Prior to curing, the cable separates from radial surface of the mandrel in these areas (springback), causing the shape of the turn to not match the shape of the end parts.
- The springback is larger with larger coil aperture and cable size.
- Therefore flexible features (slits) have been introduced in LHQ and QXF coil.
  - ❖ Incremental change with respect to single slit design previously used.
- End parts are plasma coated to increase the dielectric strength.





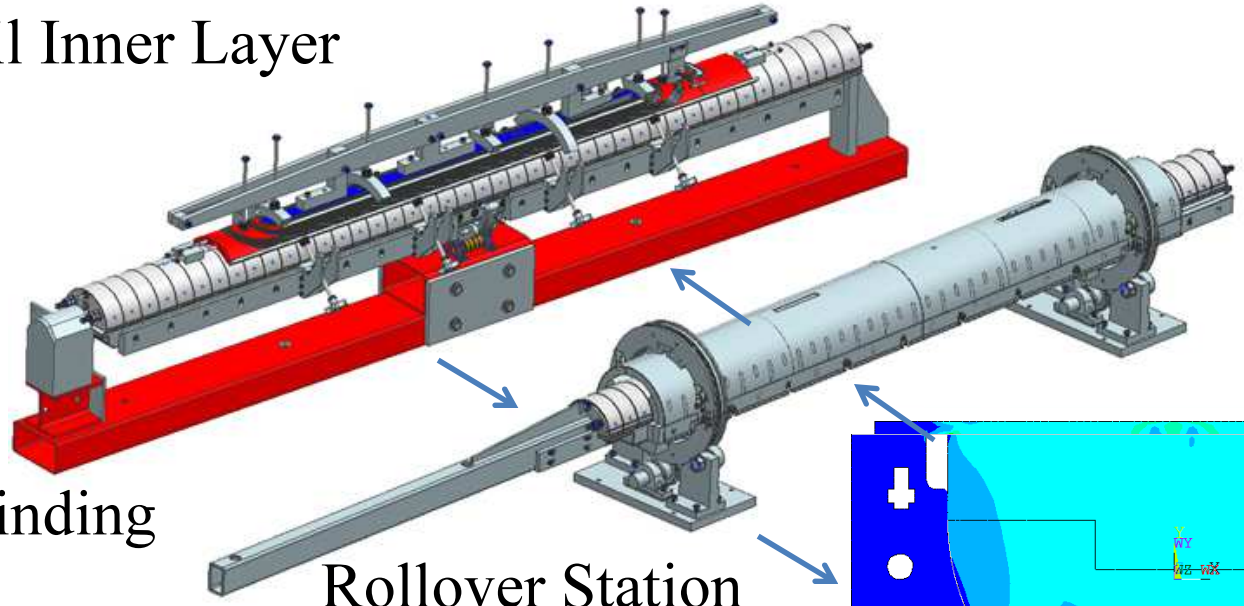
temporary saddle during W&C



QXF Coil Fabrication

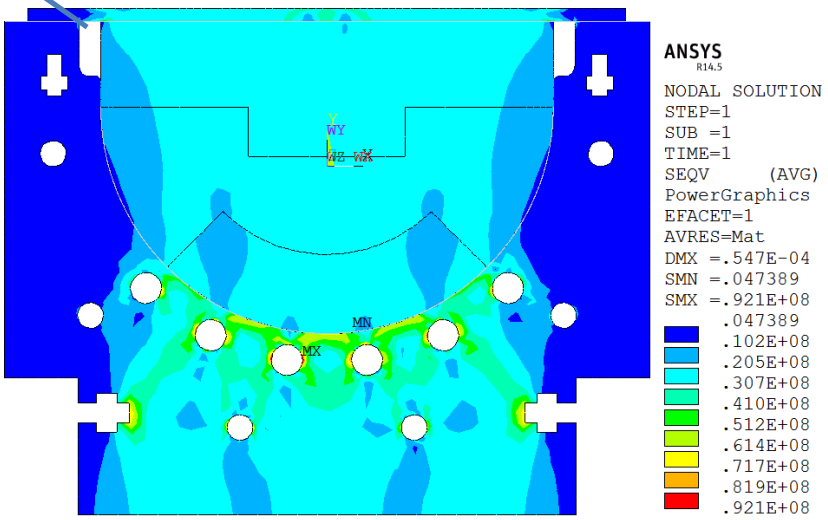
- SQXF Winding and Curing Tooling Design

Coil Inner Layer



Winding

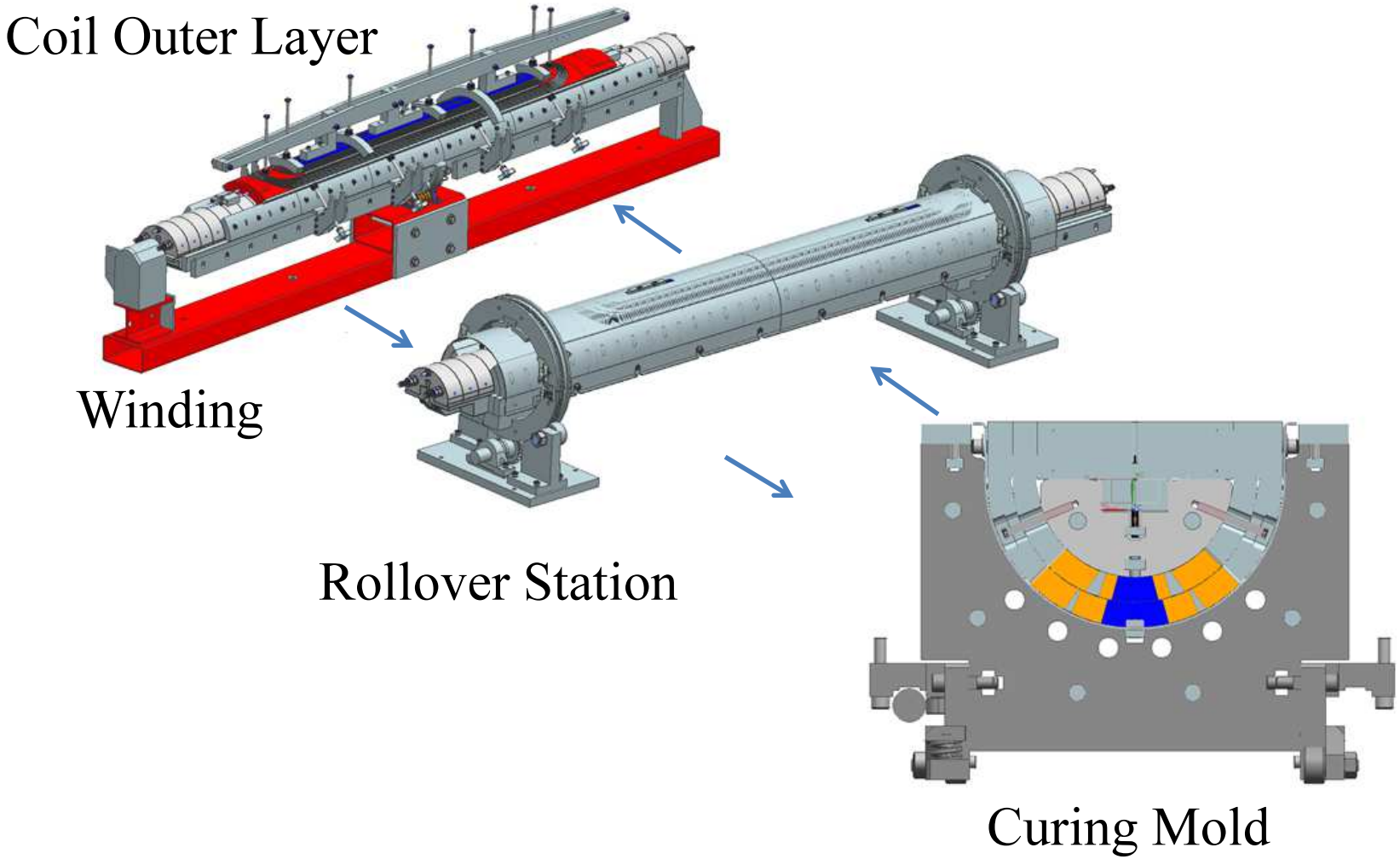
Rollover Station



Curing Mold

QXF Coil Fabrication

- SQXF Winding and Curing Tooling Design



QXF Coil Fabrication

- Winding and Curing Tooling

- Tooling for SQXF coil was inspected and assembled.



Winding and Curing Tooling



Rollover Fixture

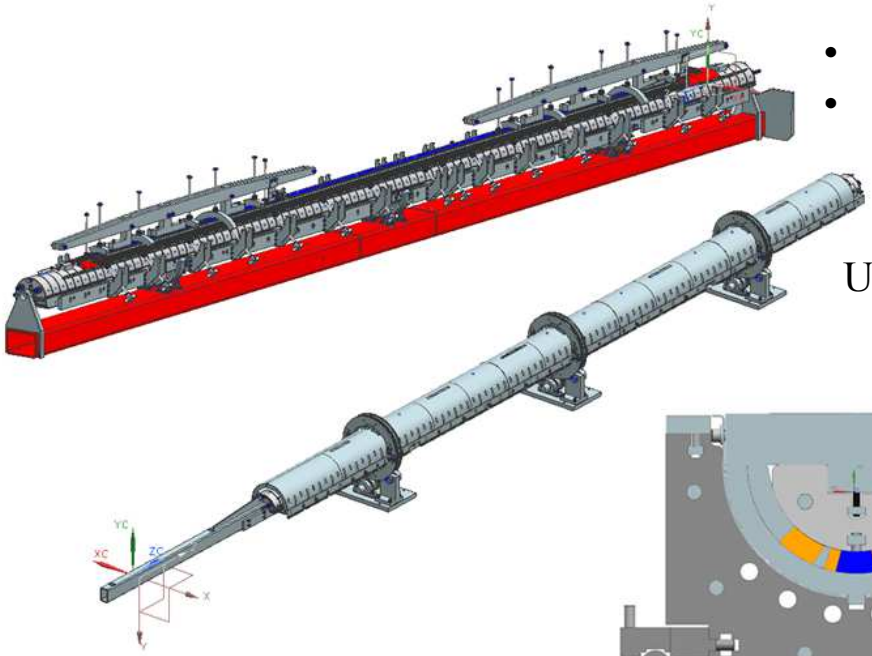


Curing Mold

QXF Coil Fabrication

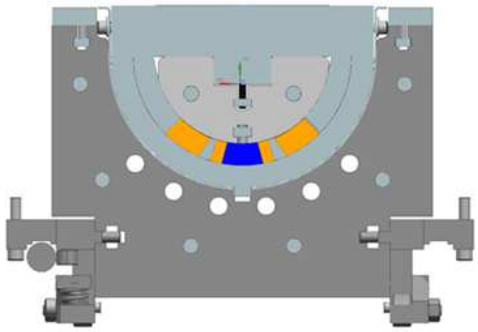
- LQXF Winding and Curing Tooling

- The design of LQXF W&C tooling was finished
- Procurement will start this summer



- Winding table will be tested in April
- Selva winder will be commissioned by this Dec

Use the same rollover fixture for SQXF



Curing mold

- 348” long
- 5 sections (2: 66” and 3: 72”)
- Stacking, welding and inspection
- Final assembly and inspection

QXF Coil Fabrication

- Winding and Curing Procedures (Traveler)

- Online version based on HQ/LHQ winding and curing traveler
- Typically, it takes 15 days for winding and curing

1.0 General Notes

2.0 Parts Kit List

3.0 Mandrel Preparation

4.0 Pre-Coil Winding Preparation for Inner Layer

5.0 Inner Coil Winding

6.0 Coil Packaging

7.0 Inner Coil Curing Set-Up

8.0 Curing the Inner Coil

9.0 Inner Coil Curing Cycle Complete

10.0 Cured Inner Coil Inspection

11.0 Pre-Coil Winding Preparation for Outer Layer

12.0 Outer Coil Winding Set-Up

13.0 Outer Coil Winding

14.0 Coil Packaging

15.0 Outer Coil Curing Set-Up

16.0 Curing the Outer Coil

17.0 Outer Coil Curing Cycle Complete

18.0 Coil Unpackaging

19.0 Cured Coil Inspection

20.0 Post Curing

21.0 Releasing Tension from the Cured Coil

22.0 Removing the coil from the Winding/Curing Mandrel

23.0 Production Complete

QXF Coil Fabrication

- Winding Test

Coil Winding







Reduce the risk of turn-turn short due to popped strands

Cured Coil



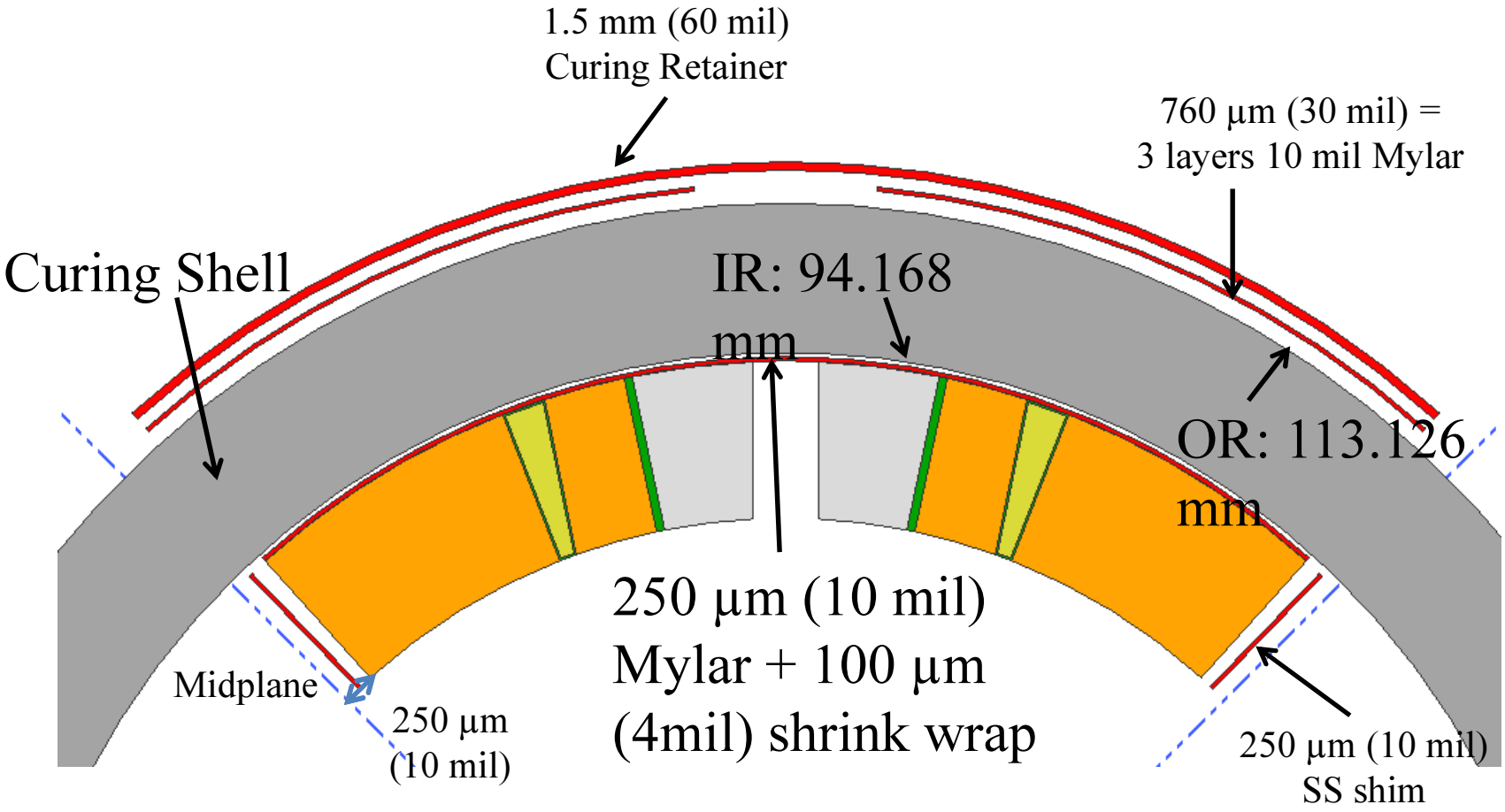
- Two 1 m coils, winding-curing
- End parts inspection and design optimization
- Pre-check tooling and W&C procedures
- Fabrication of SQXF coils is starting this February

Summary

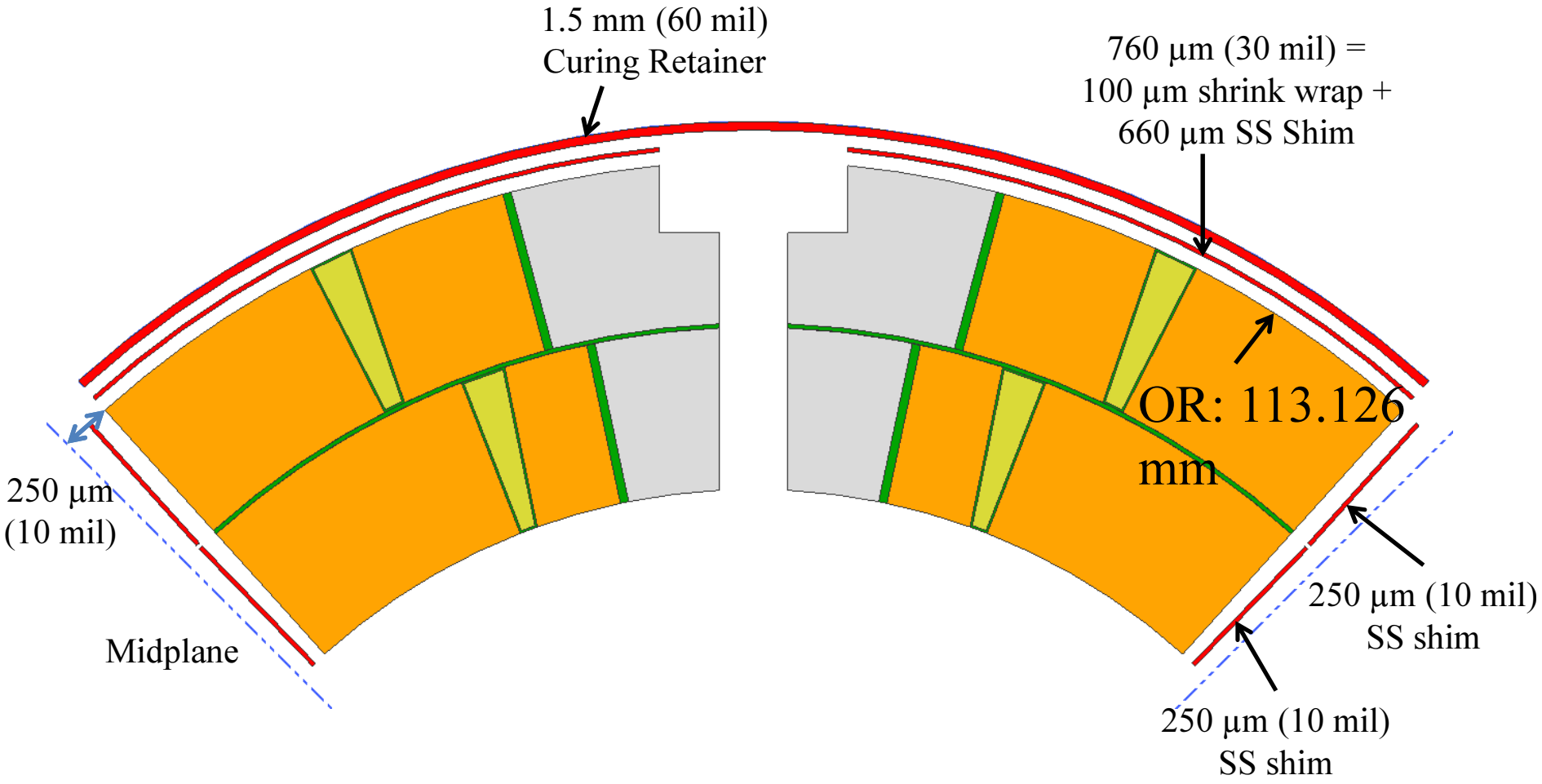
- QXF coil is designed based on HQ/LHQ coil experience
- Tooling is ready for SQXF coil winding and curing
- LQXF coil winding and curing tooling will be procured this summer.
- Winding and curing procedures are based on HQ/LHQ coil procedures
- SQXF coil fabrication is starting this month.

Backup Slides
- Coil Size at Each Step

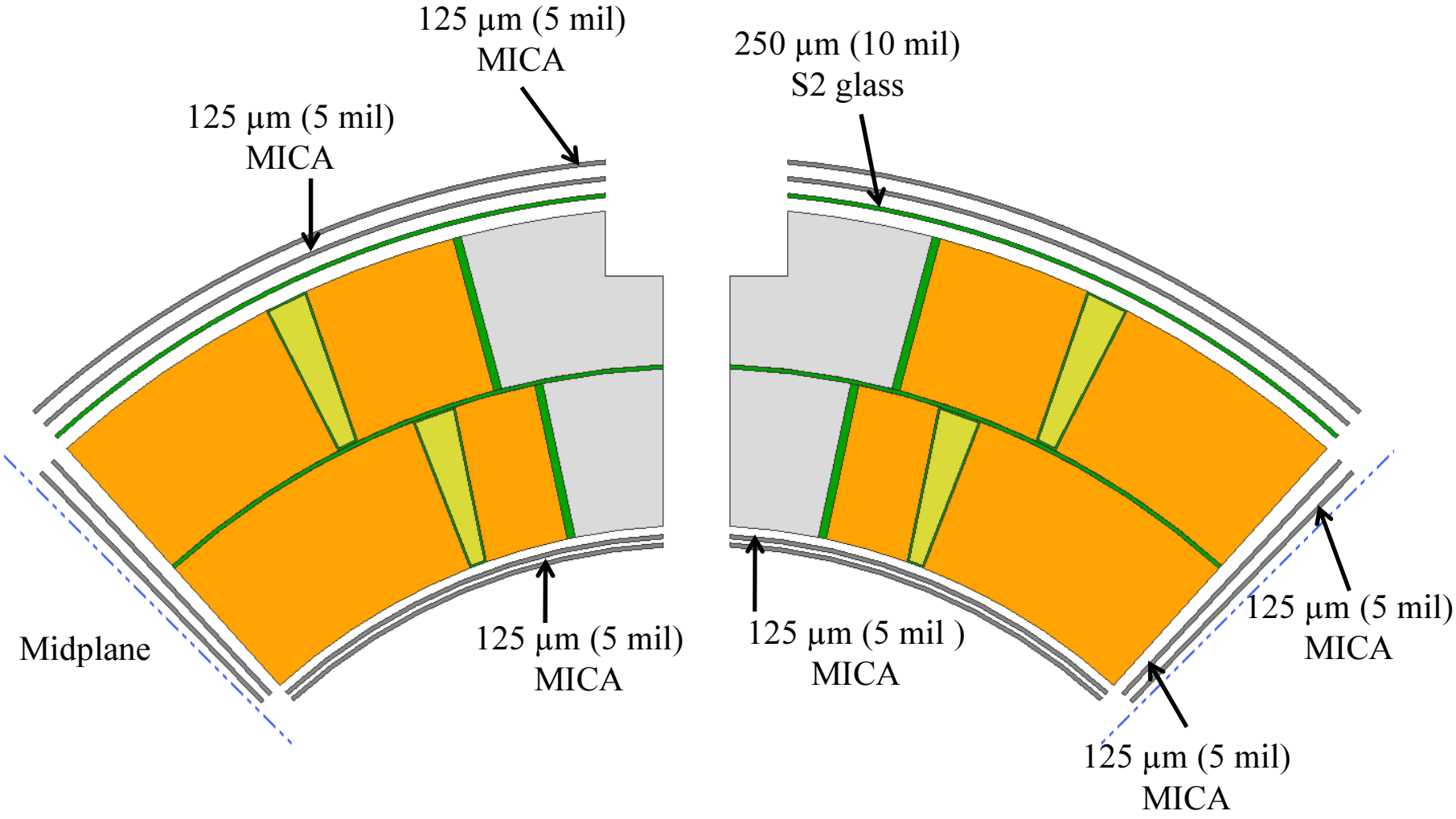
IL Winding and Curing



OL Winding and Curing



Coil Reaction



Coil Impregnation

