Status and Update CERN

MDP - FCC - EuroCirCol Meeting

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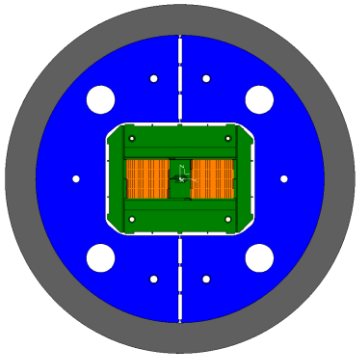
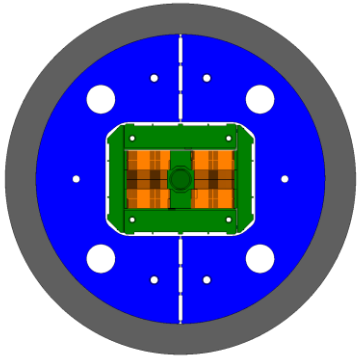
General overview

- eRMC
  - Three coils (2 + 1 spare) finished.
  - First assembly with Aluminum dummy coils, including thermal cycle to 80 K done.
  - We plan to increase the pre-load (+ 20-30 MPa, before the end of the year) and perform a second thermal cycle.
  - Magnet assembly planned for January-February 2019
- RMM
  - Coil parts available
  - 2 cable unit lengths (1 + 1 spare) should be produced before the end of 2018
  - Procurement of lateral pad launched, all rest of the magnet parts are those of eRMC.
- SMC
  - Plan to use it to qualify new resin systems and develop high field internal splices (and any additional new feature coming).
  - SMC11 T cable planned for beginning of 2019



eRMC



RMM

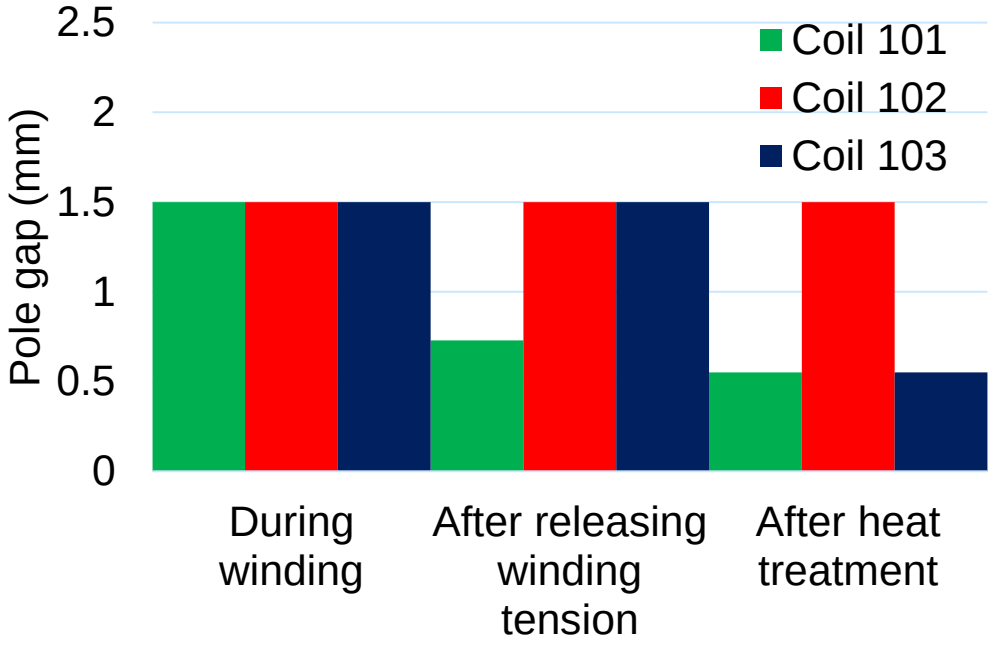
eRMC – Coil winding

- Three coils has been wound
- No issues found during winding, but low packing of the coil in the longitudinal direction (∼ 0.2 mm/turn longer longitudinally)

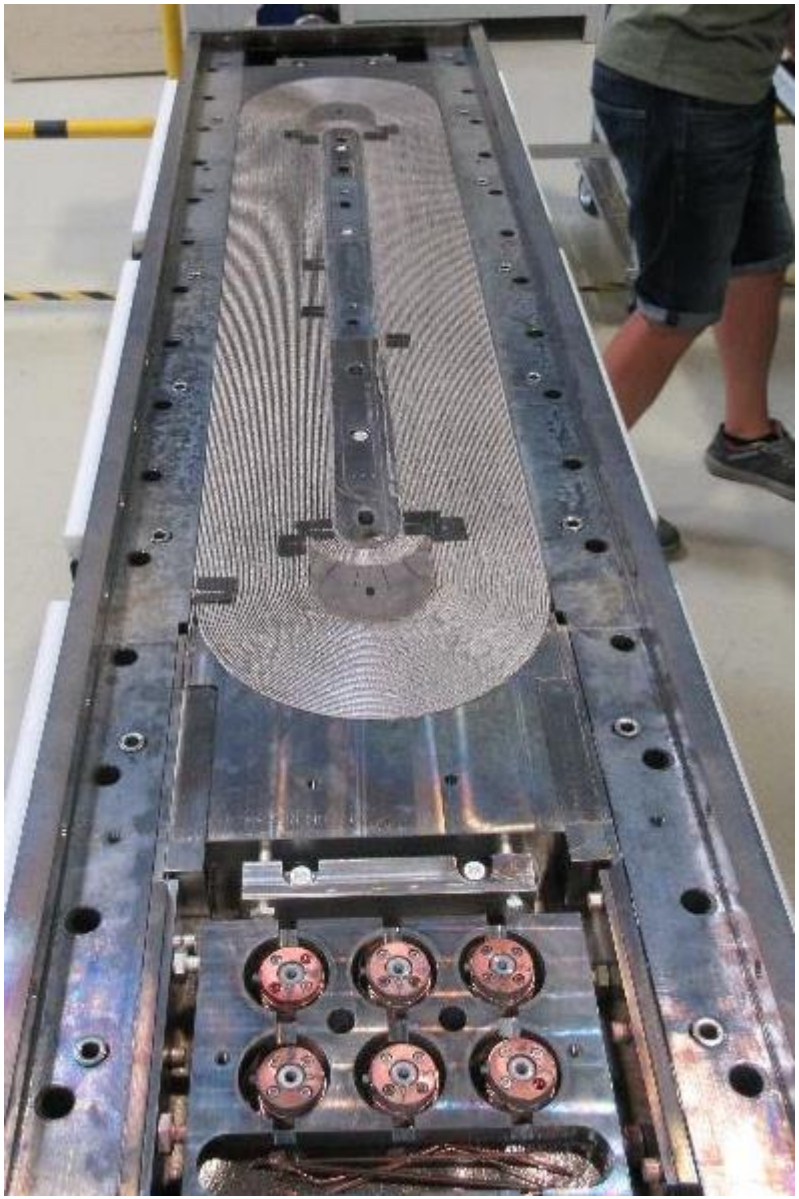
- "Novel" features:
  - Mica around the pole, to minimize the bonding strength between cable and pole.
  - End spacers polished to maximize the bonding strength between cable and end parts.
  - End parts not coated, but 0.5 mm of extra S2 glass between cable and metallic parts to enhance the electrical insulation.

eRMC – Reaction

- Three coils have been reacted
- Gaps in between poles to allow longitudinal movement during reaction.
  - Goal: gaps are almost closed after reaction; achieved for coil 101 and 103, different behavior of coil 102.

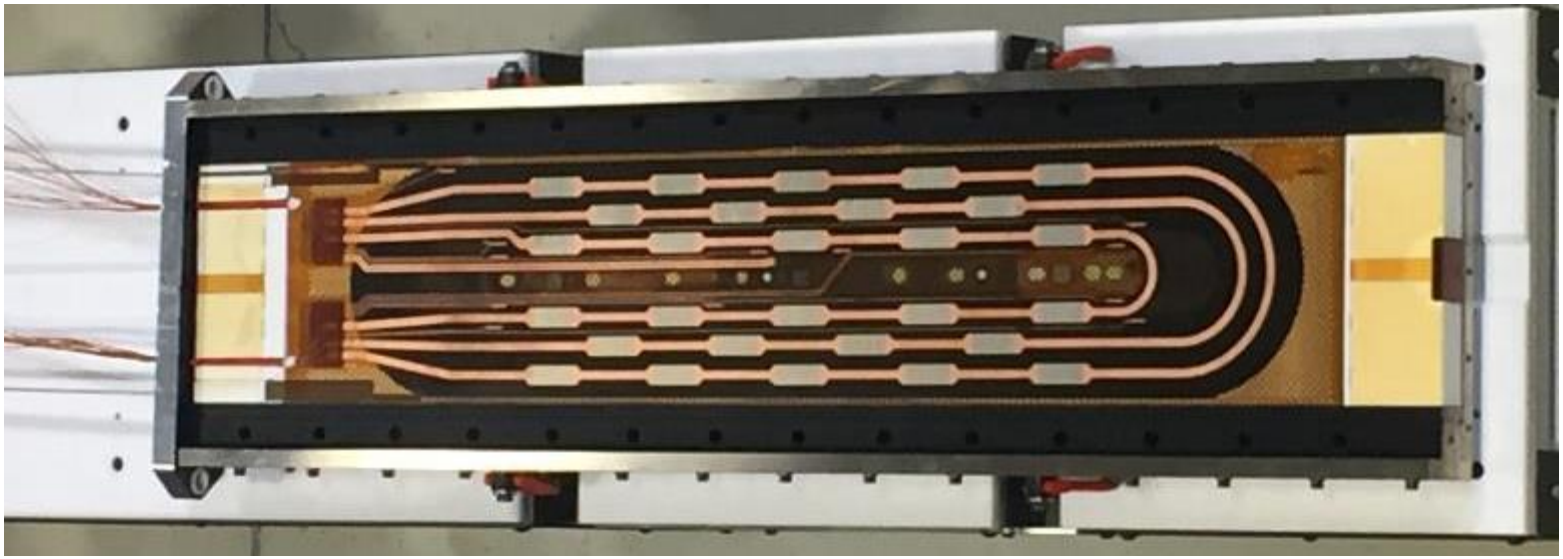


Coil after reaction



eRMC – Impregnation

- Three coils have been impregnation without any particular issue.
- Only the geometry of one out of the three coils have been measured
  - Coil azimuthal oversize + 0.130 mm, with a longitudinal variation of ± 0.05 mm
  - Iteration on azimuthal alignment in the impregnation tooling for coils 102 and 103 in order to improve the coil asymmetry
  - Coil 102 and 103 will be measured this week



eRMC – Electrical tests & Instrum.

- In spite of the large amount of insulation between coil and pole (1 layer of Mica (0.1 mm) + 2 layers of Fiber glass (2x0.250 mm) + cable insulation), weak electrical insulation coil to pole.
- Instrumentation:
  - Fiber optics in the coil lost for coil 101 and not installed in coil 103
  - Heaters and VTAPS OK.
  - Hall sensors and PCB probes have been produced, getting ready for the assembly.

		Coil 101	
Insulation resistance	U[test]	Before Reaction	After Impregnation
	[V]	[GΩ]	[GΩ]
coil ---> Central Post (GROUND)	100	0.027	X
coil ---> SPACER NCS	100	36.6	X
coil ---> SPACER CS	100	35.9	X
coil ---> Central Post	500	X	594KΩ /348V
coil ---> all QHs	3000	X	6.54
coil ---> Endshoe CS	1000	X	36.1
coil ---> Endshoe NCS	1000	X	768KΩ /750V
QHs ---> Endshoe CS	2500	X	17.6
QHs ---> Endshoe NCS	2500	X	6.38

eRMC – Dummy structure

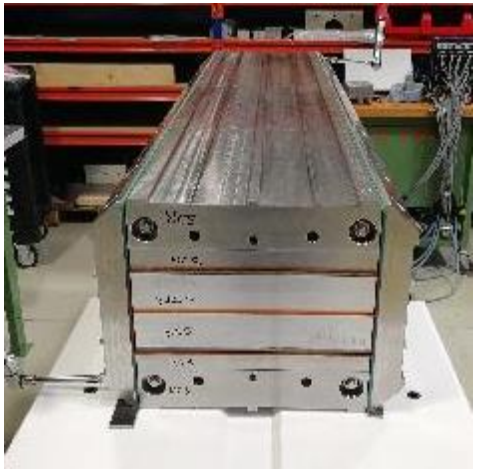
- In order to explore different assembly parameters:
  - Full aluminum shell and half length shell options available.
  - Aluminum and Stainless Steel rods available for the longitudinal loading.
- A first assembly with dummy coils (including thermal cycle to 80 K) has been done, using full length shell and aluminum rods.
  - The plan is to slightly increase the pre-load and do a second thermal cycle.

Mechanical Test Assembly

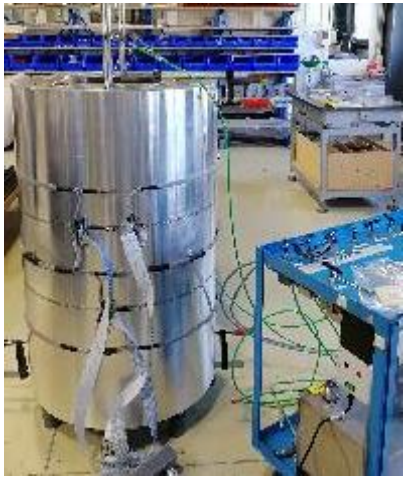
Instrumented Aluminum Dummy Coils

Coil rotation tooling and ground insulation

Coil Pack



Shell-yoke pre-assembly



Mechanical Test Assembly

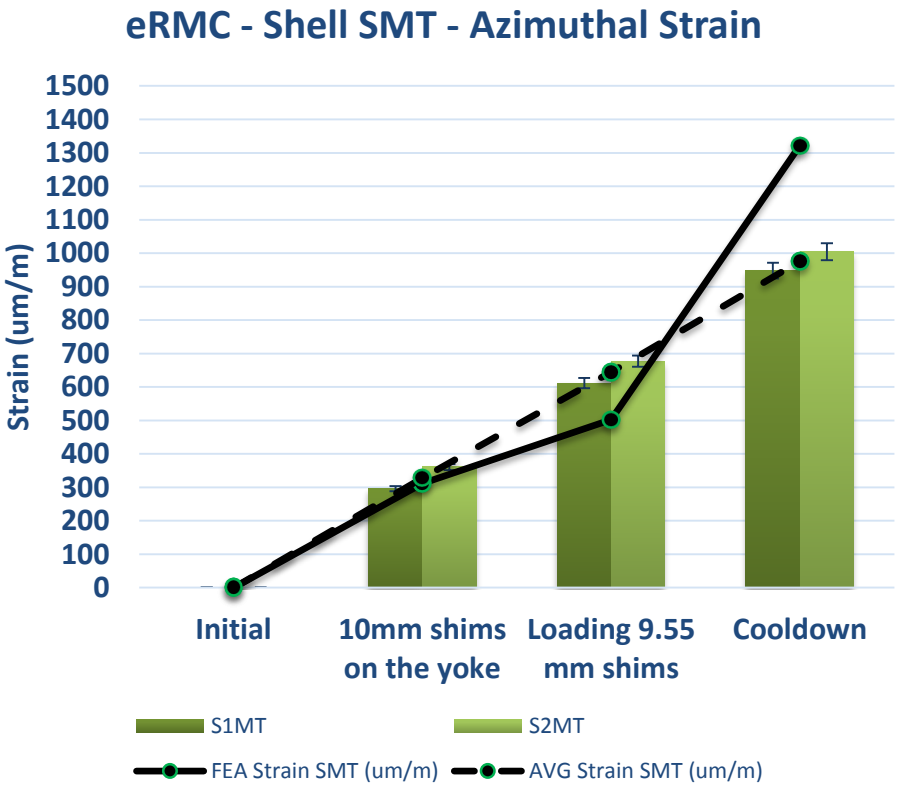
Shell-yoke rotation

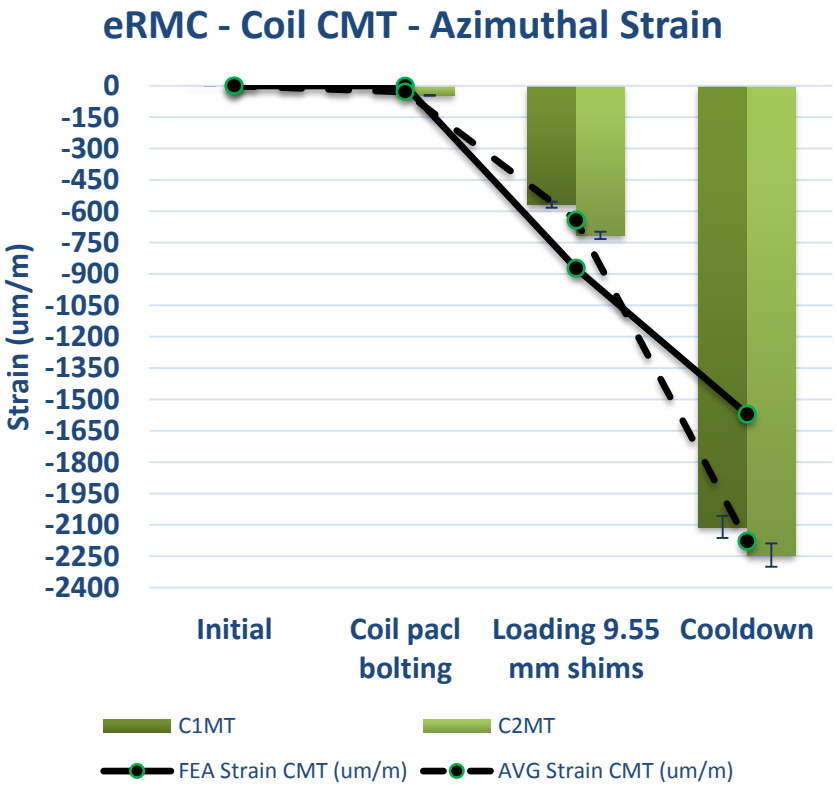
Magnet pre-assembly, including yoke keys (to be removed before the first loading step)

Magnet including axial loading system

Mechanical Test Assembly

- The increase of stress during cool down is lower than expected in the shell (30 MPa instead 80 MPa) of and higher than expected in the coil (80 MPa instead of 50 MPa).
  - Investigations on going to understand the source of the discrepancy.

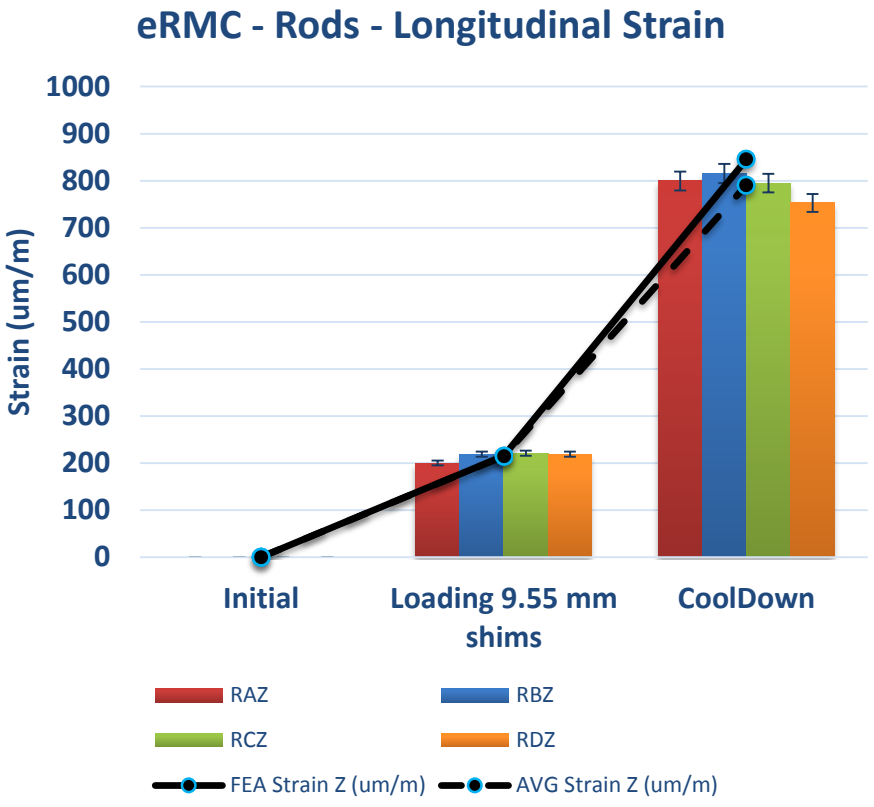




Mechanical Test Assembly

- Longitudinal rods behave as expected.
  - For the first assembly, we tested the case “low pre-load” with aluminum rods.

Axial preload	Coil	Room temp. preload	Cool down @ 4.2 K	Powering @ 16T
Al rods, low pre-load	Nb_3Sn	[41] (11%)	[302] (83%)	[323] (88%)
	Al	[37] (10%)	[200] (55%)	
Al rods, high pre-load	Nb_3Sn	[227] (62%)	[505] (138%)	[526] (144%)
	Al	[221] (60%)	[393] (108%)	
SS rods, low pre-load	Nb_3Sn	[73] (20%)	[172] (47%)	[207] (57%)
	Al	[60.8] (17%)	[13.6] (4%)	
SS rods, high pre-load	Nb_3Sn	[349] (95%)	[461] (126%)	[495] (135%)
	Al	[362] (99%)	[324] (89%)	



Summary

- A first assembly test using Aluminum dummy coils, including a cool down to 80 K was done
  - We plan to slightly increase the pre-load and perform a second cool down.
- Three eRMC coils have been produced, the plan is to assemble the magnet in January-February 2019.
- If the cable is available, RMM winding can start beginning of 2019.
- We plan to keep SMC as a tool for R&D development activities.

Additional slides

Variation of Insulation Layers with respect to nominal

- Pole insulation (mm)

Nominal:
0.2 MICA + 0.4 Fiberglass

Assembled:
0.08 MICA + 2 x 0.25 Fiberglass

- Spacer (mm)

Nominal:
0.6 Fiberglass

Assembled:
2 x 0.25 Fiberglass

- Layer Jump Cable (mm)

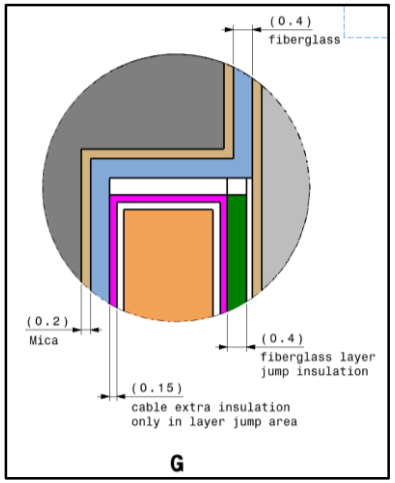
Nominal:
Fiberglass: 0.15 (around cable) + 0.4 Fiberglass

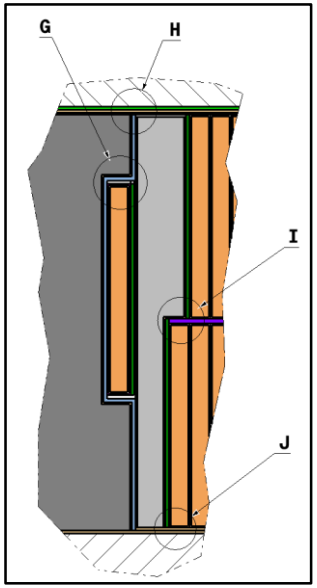
Assembled:
3 x 0.15 Fiberglass (around cable)

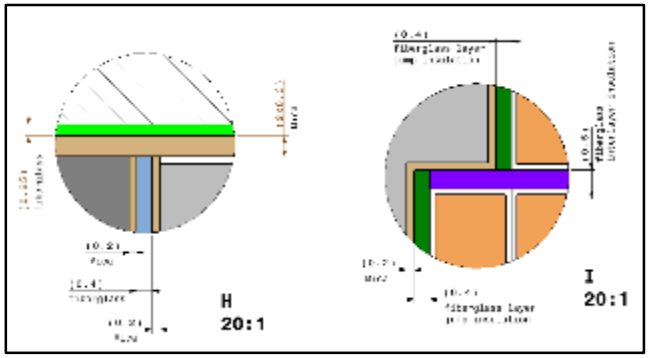
- Layer Jump Plate (mm)

Nominal:
Inner surface: 0.2 MICA
Outer surface: 0.2 MICA + 0.4 Fiberglass

Assembled:
Inner surface: 0.08 MICA
Outer surface: 0.08 MICA + 2 x 0.25 Fiberglass







Modification of the Drawings is needed