11 T Dipole Project Status

M. Karppinen on behalf of CERN-FNAL collaboration

"Demonstrate the feasibility of Nb_3Sn technology for the DS collimation upgrade with an accelerator quality 5.5-m-long twin-aperture 11 T prototype dipole by 2015"

Contributions & Acknowledgements

FNAL:

N, Andreev, G. Apollinari, E. Barzi, R. Bossert, G. Chlachidze,

J. Coghill, J. DiMarco, D. Mitchel, F. Nobrega, I. Novitski, G. Wilson, A. Zlobin,…

CERN:

B. Auchmann, A. Ballarino, A. Bonasia, S. Bermudez,

N. Bourcey, A. Cherif, S. Clement, A. Gerardin, M. Guinchard, L. Bottura, C. Kokkinos, B. Favrat, L. Favre, C. Fernandes, P. Fessia, R. Gauthier, B. Holzer, S. Izquierdo Bermudez, G. Kirby, F. Lackner, T. Lyon, G. Maury, J. Mazet, N. Mena, R. Moron-Ballester, J-M. Mucher, J. Murtomaki, L. Oberli,

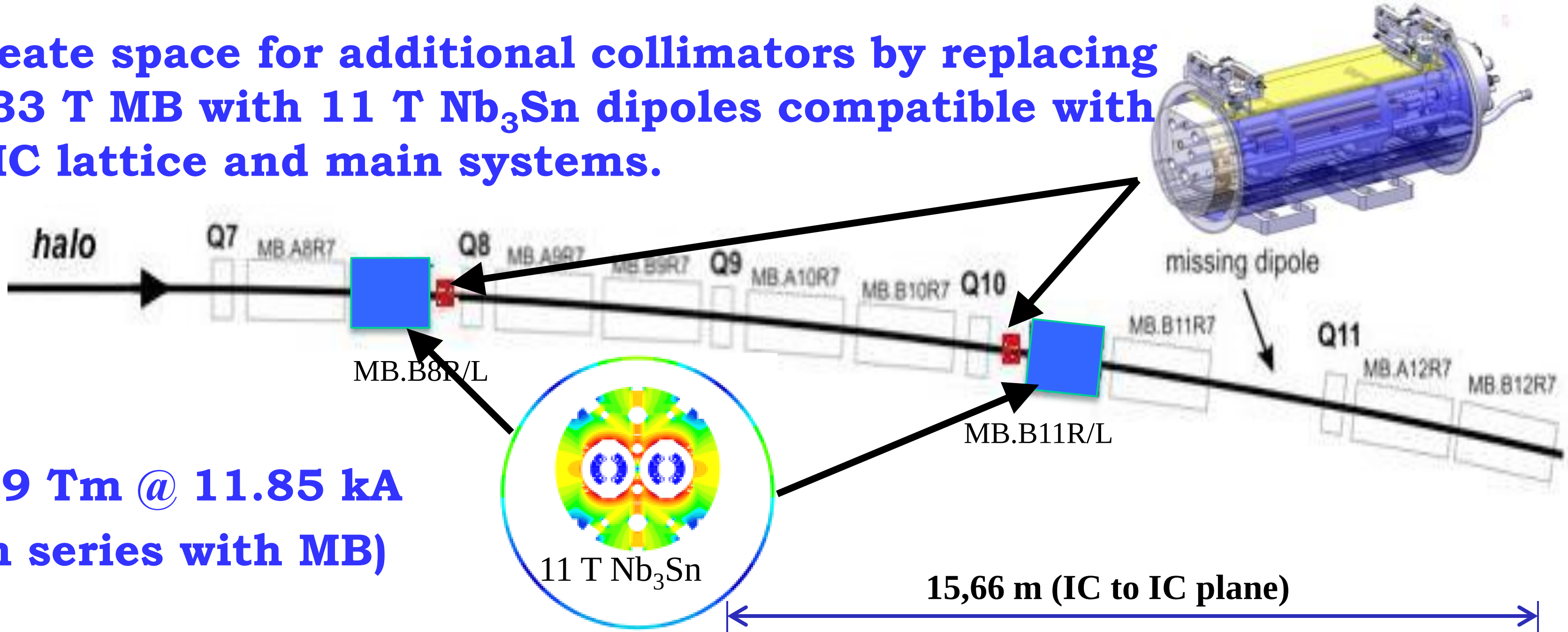
J-C. Perez, L. Rossi, T. Sahner, F. Savary, J.-M. Scigliutto, L. Remandet, S. Russenschuck, S. Sgobba, E. Todesco, D. Tsirigkas,…

Outline

- DS upgrade
- Design challenges
- Magnetic design
- Mechanical design
- Pole loading concept and CERN coil design
- Model program status and plans:
  - FNAL
  - CERN
- Summary

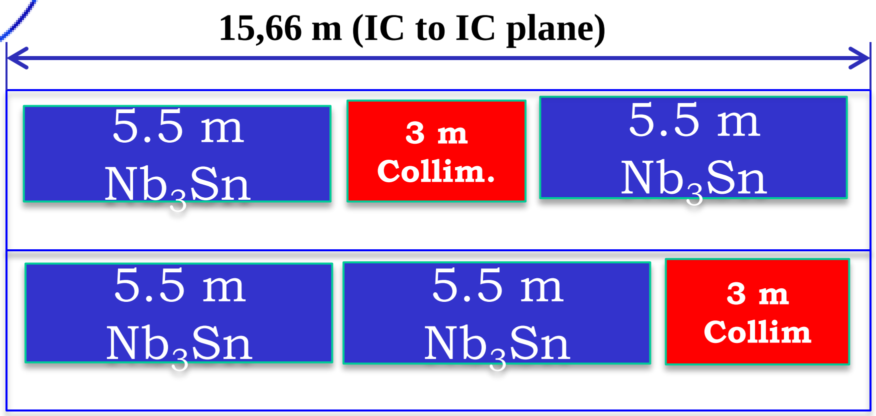
DS Upgrade

- Create space for additional collimators by replacing 8.33 T MB with 11 T Nb_3Sn dipoles compatible with LHC lattice and main systems.



- 119 Tm @ 11.85 kA
  (in series with MB)

- LS2 : IR-2
  - 2/4 MB => 4/8 x 5.5 m CM + spares
- LS3 : IR-1,5 and Point-3,7
  - 4 x 4 MB => 32 x 5.5 m CM + spares

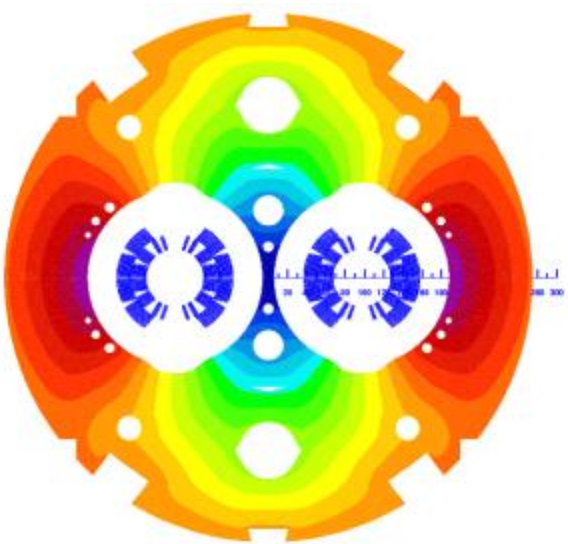


- Joint development program between CERN and FNAL underway since Oct-2010.

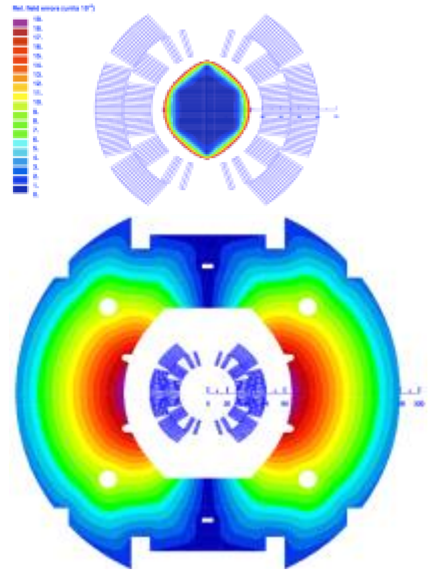
11 T Nb_3Sn Dipole Design Challenges

- **Iron saturation effects**
  - Modified MB Yoke
  - Cross-talk between apertures
- **Transfer function matching with MB**
  - More turns (56 vs. 40)
  - Iron saturation
- **Dynamic effects**
  - Strand development
  - Cored cable
- **Coil fabrication**
  - Cable development
  - Electrical insulation
  - Nb_3Sn specific tooling and fabrication process
  - Reproducibility & Handling
- **Quench protection**
  - Heater development
  - Instrumentation
- **Mechanical structure**
  - Forces almost 2 X MB
  - First 2-in-1 Nb_3Sn magnet
- **Thermal**
  - Resin impregnated coils
- **Integration**
  - Optics
  - Cold-mass
  - Collimator
  - Machine systems

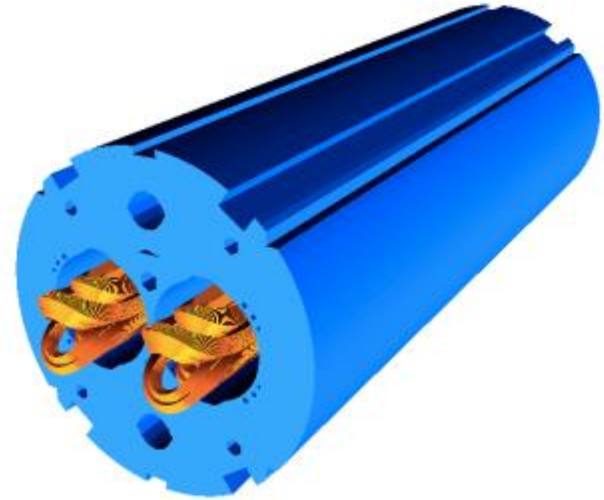
Magnetic design: Coil Optimization



B_0(11.85 kA) = 11.25 T

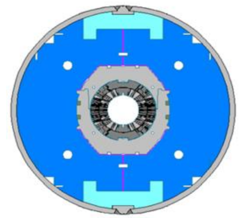
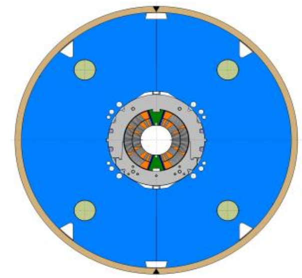
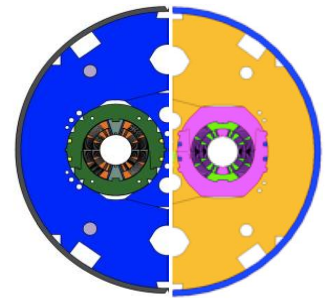


B_0(11.85 kA) = 10.86 T



- 11.25 T at 11.85 kA with 20% margin at 1.9 K in
- 60 mm bore and straight 5.5-m-long coldmass
- Systematic field errors below the 10^{-4} level
- 6-block design, 56 turns (IL 22, OL 34)
- 14.85-mm-wide 40-strand Rutherford cable, no internal splice
- Coil ends optimized for low field harmonics and minimum strain in the cable

11 T Model Dipole Magnetic Parameters

Parameter	Single-aperture FNAL 		Single-aperture CERN 	Twin-aperture 
	MBHSP01	MBHSP02		
Aperture (mm)	60			
Yoke outer diameter (mm)	400		510	550
Coil length (m)	1.80	0.88	1.8	0.88 - 1.8 - 5.4
Nominal bore field @11.85 kA (T)	10.86	11.07	11.25	11.25
Short-sample bore field at 1.9 K (T)	13.6 (1	14.1(2	13.9(1	13.9(1
Margin B_{nom}/B_{max} at 1.9 K	0.80(1	0.78(2	0.81(1	0.81(1
Stored energy at 11.85 kA (kJ/m)	473	482	484	969
F_x per quadrant at 11.85 kA (MN/m)	2.89	3.11	3.16	3.16
F_y per quadrant at 11.85 kA (MN/m)	-1.57	-1.56	-1.59	-1.59

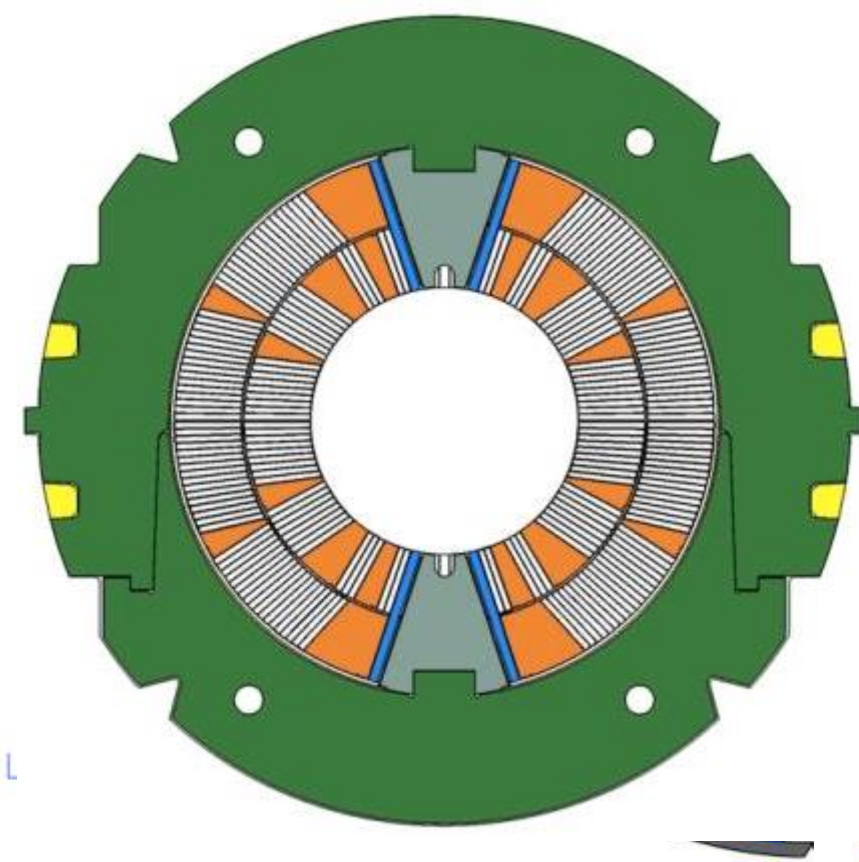
1) OST Ø0.7 mm RRP-108/127
2) OST Ø0.7 mm RRP-150/169

Mechanical Design Choices & Goals

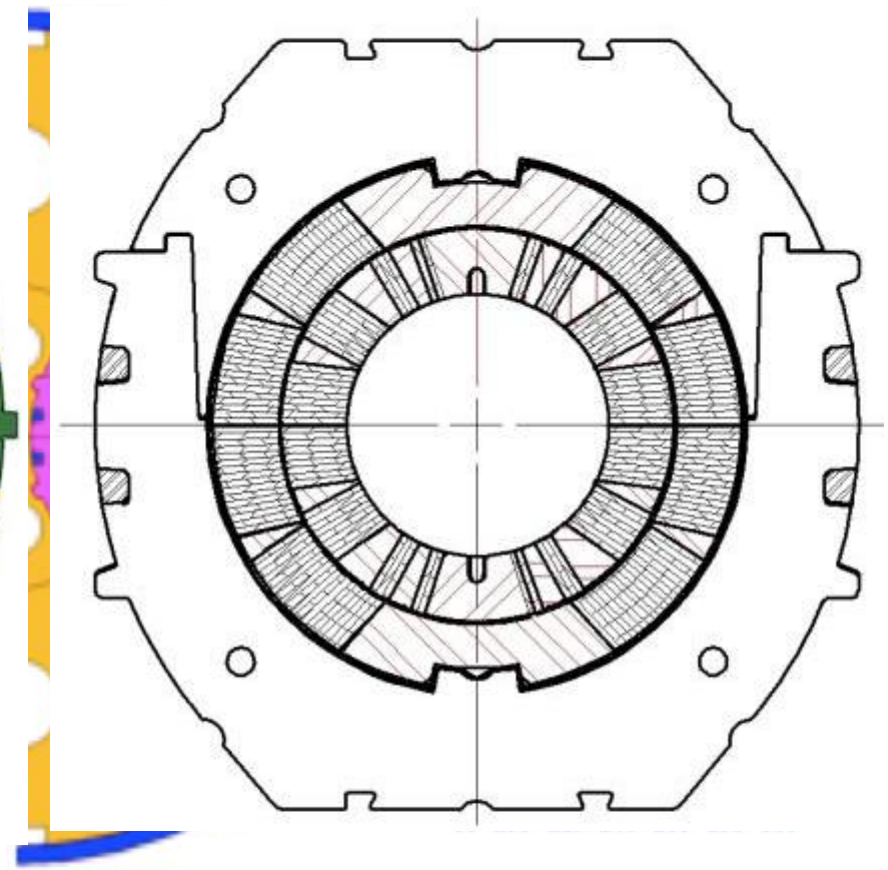
- **Separate collared coils**
  - **Most of the coil pre-stress obtained by collaring**
  - **Symmetric loading**
  - **Better control of pre-stress**
  - **Testing of collared coils in 1-in-1 structure**
- **Vertically split yoke**
  - **Assembly process less influenced by friction (vs. horizontal split)**
  - **Closed gap at RT and up to 12 T to provide rigid support for the collared coil**
  - **Better controlled (collared) coil deformation**
- **Welded stainless steel skin**
- **Coil pre-stress**
  - **Within 0..-165 MPa at all times**
  - **Minimal elliptic deformation**
  - **Minimal stress gradient in the coils**
  - **Easy tuning of pre-loading by shimming**
  - **Minimize discontinuous loading and shear stress (end regions)**

Mechanical Design Concepts

CERN | **FNAL**

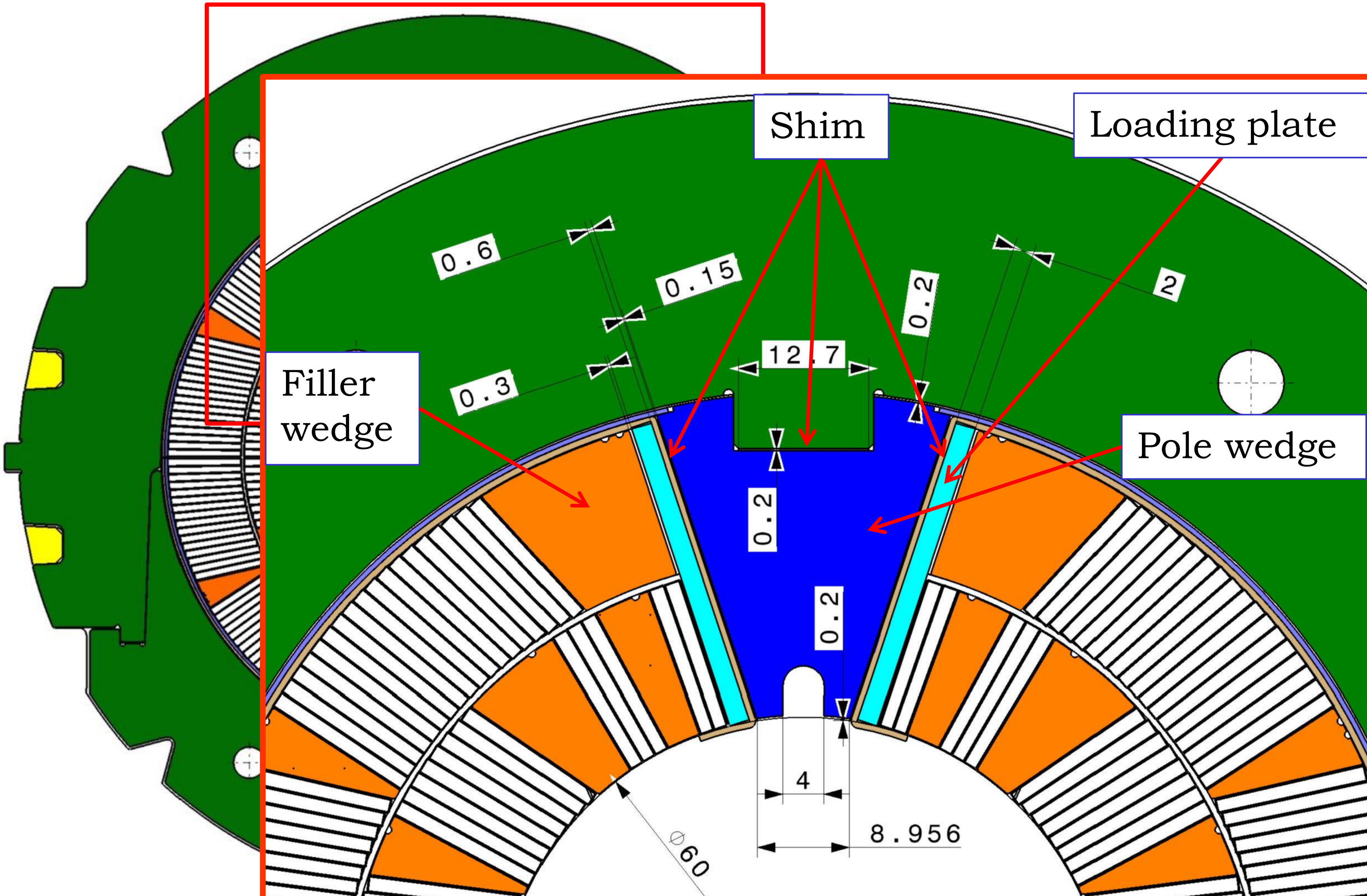


Pole loading design

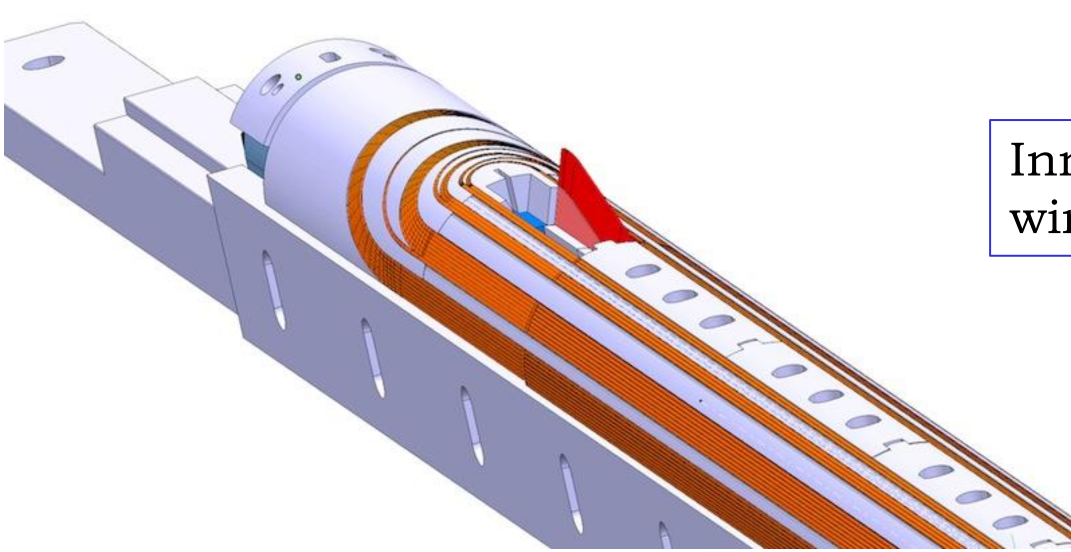


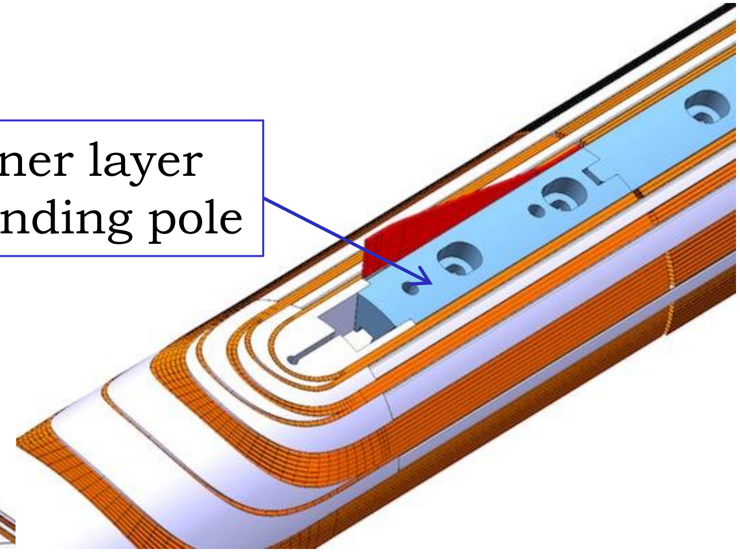
Integrated pole design

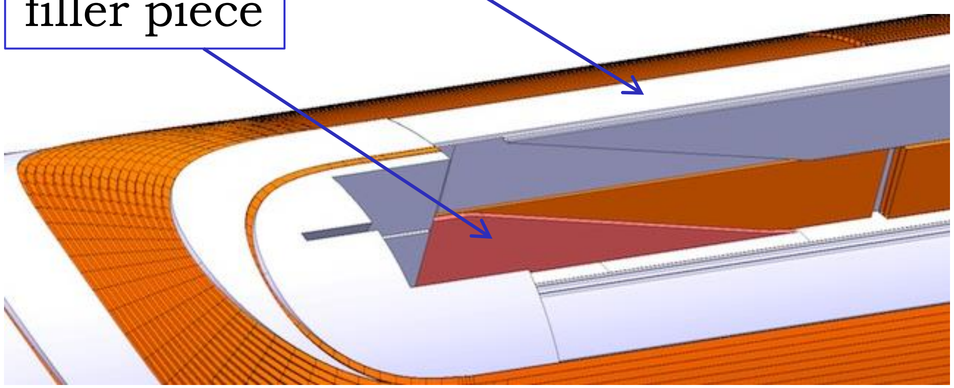
Pole Loading Concept

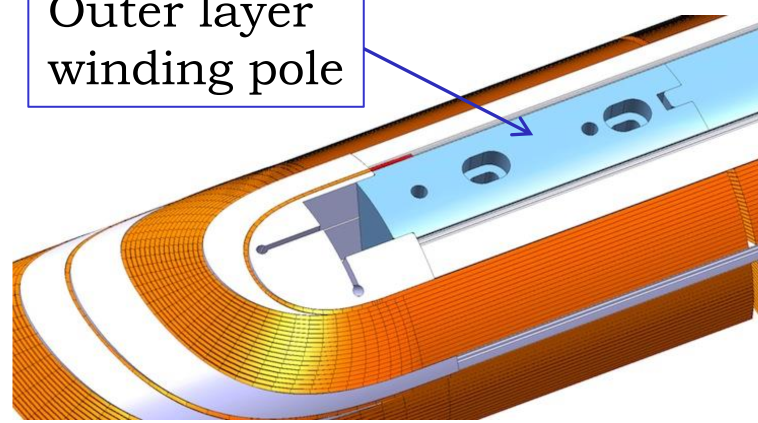


Pole Loading Concept: Lead End Winding



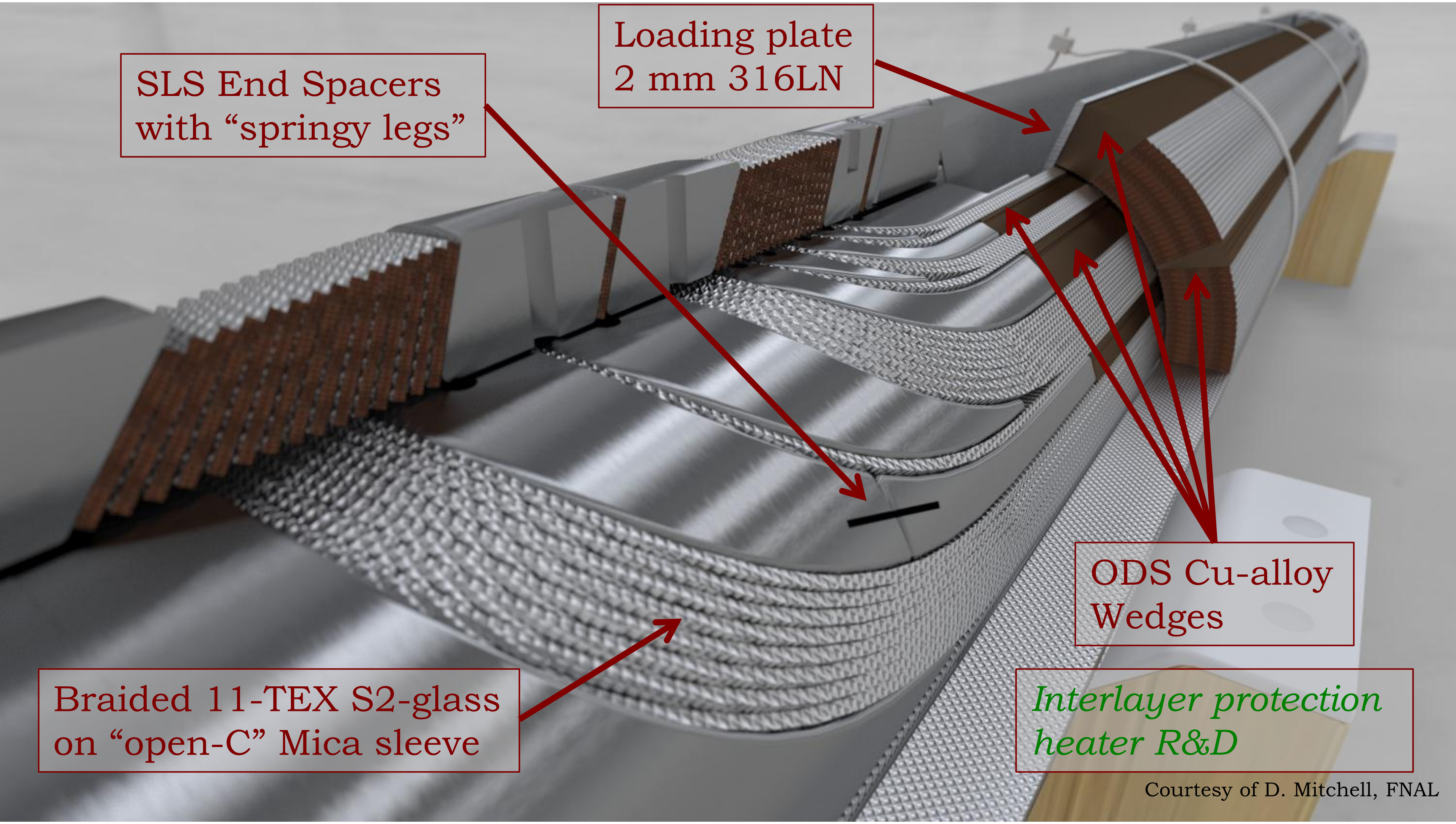


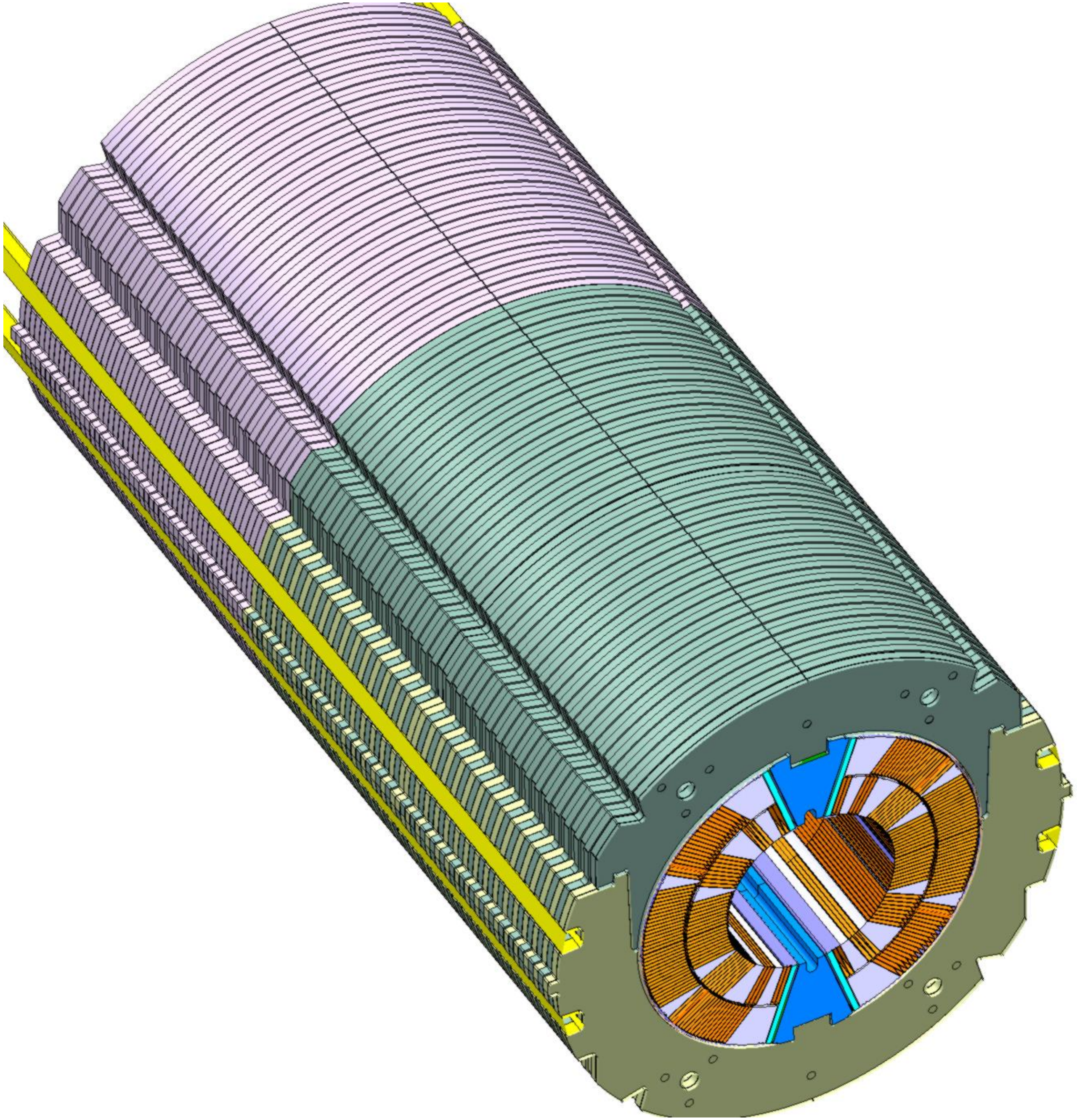




Layer-jump region with cable removed

CERN 11 T Dipole Coil

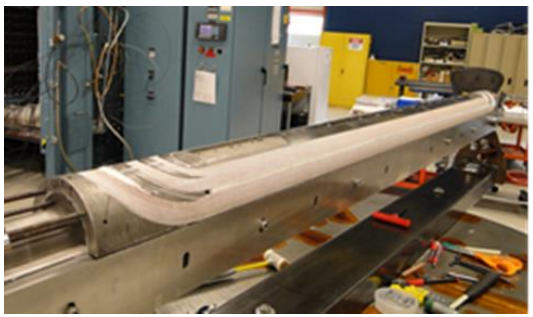




FNAL MBHSP01
1-in-1 Demonstrator (2 m)

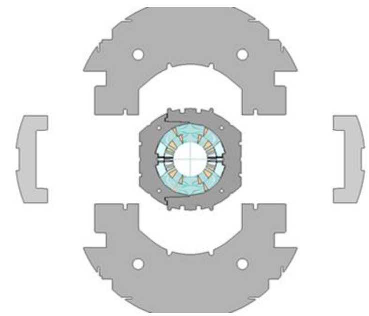
OST RRP-108/127

40-strand cable produced with FNAL cabling machine



Coil fabrication

Collared coil assembly



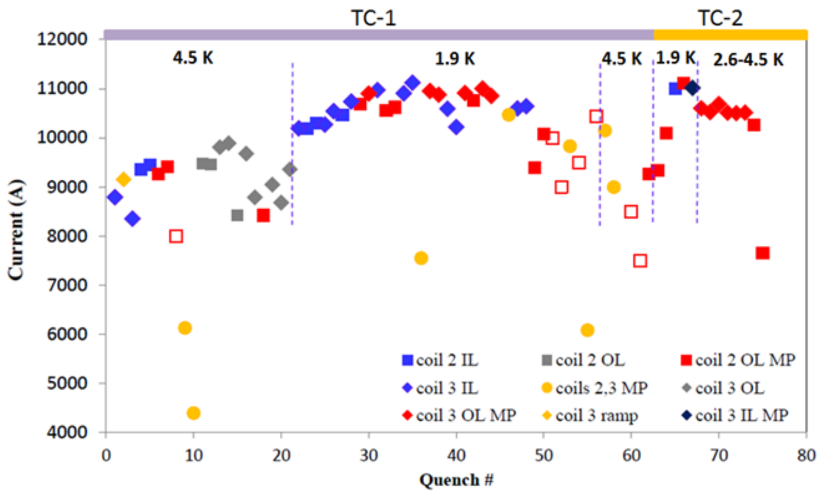
Cold mass assembly

Magnet development and fabrication was done in record time – 18 month!

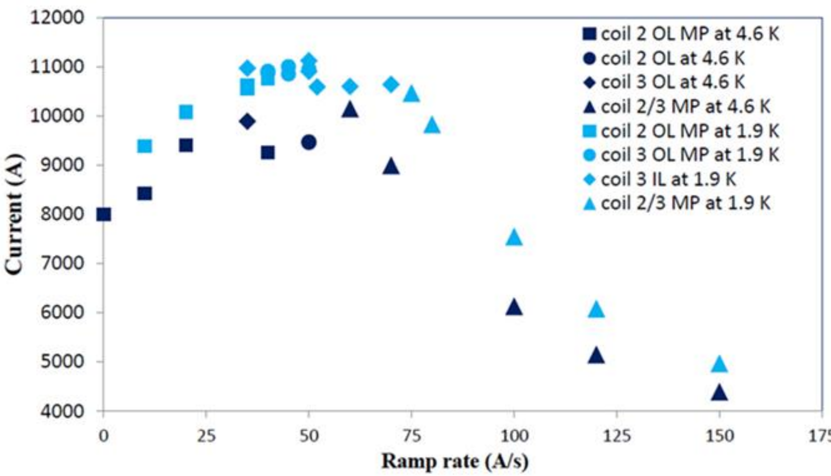
MBHSP01 Quench Performance

- **Design goal:**
  - B_{nom}=11 T with 20% margin
- **Limited quench performance**
  - B_{max}=10.4 T at 1.9 K and 50 A/s (78% of SSL)
  - long training
  - conductor degradation
  - irregular ramp rate dependence
- **Quench performance was limited by conductor degradation in coil OL mid-plane blocks and leads**
  - lead damage during reaction - confirmed by autopsy
- **Appropriate improvements implemented in MBHSP02**

A.V. Zlobin et al., ASC2012, Sept 2012



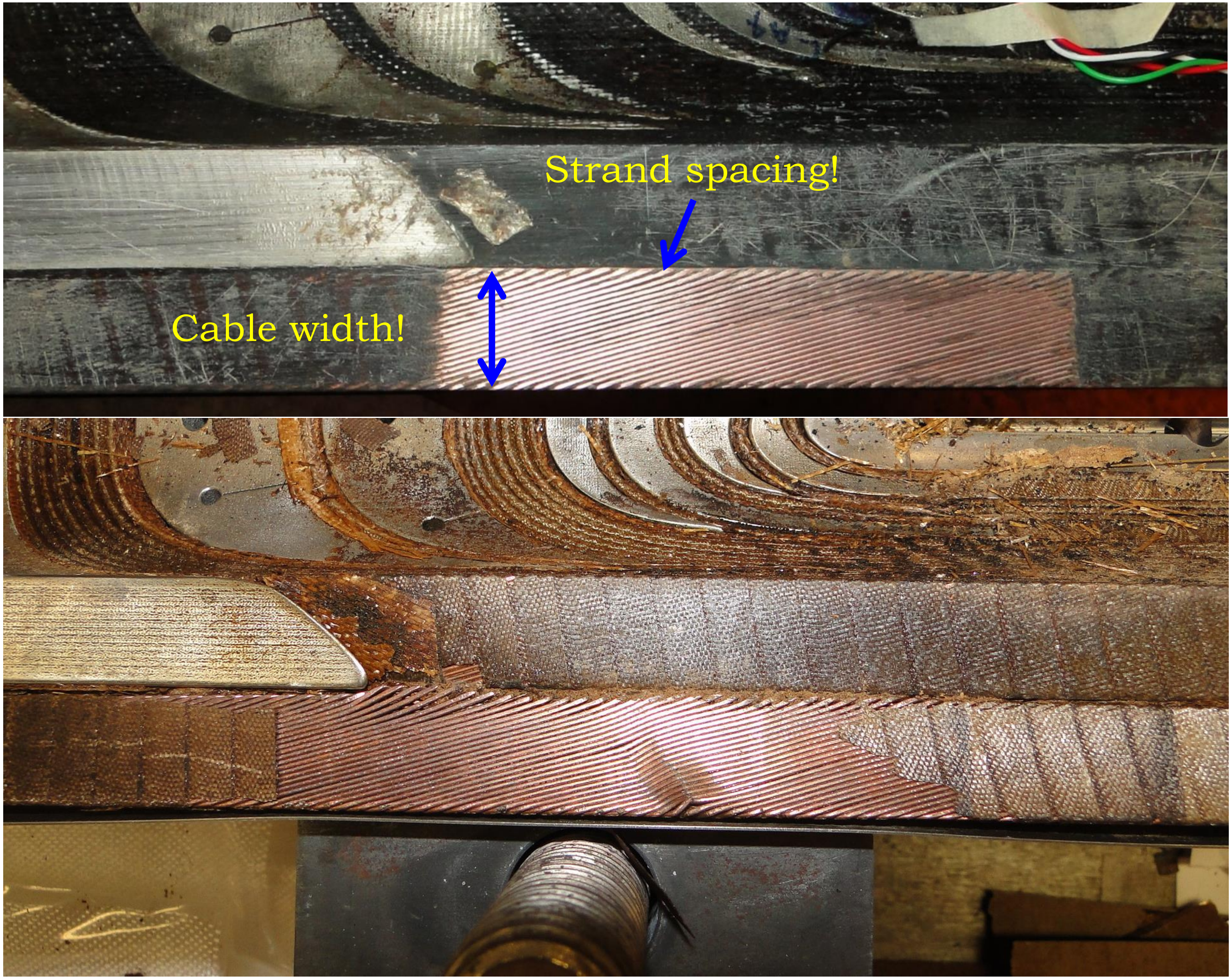
Quench history



Ramp rate dependence

MBHSP01 Autopsy

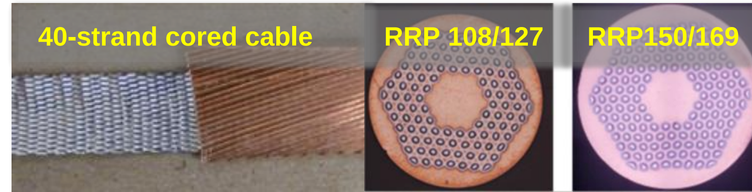
Coil #3
Used in
MBHSP01

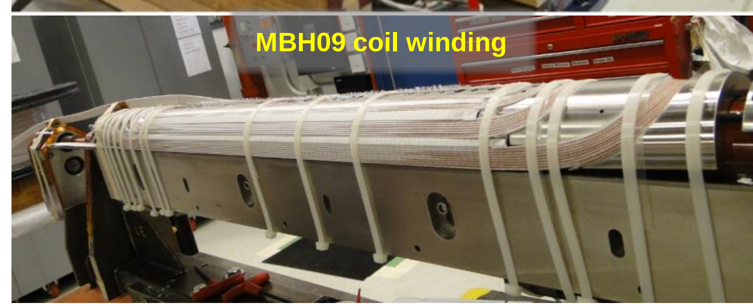


Coil #4
(scrapped)

MBHSP02-03 - 1 m Versions of MBHSP01

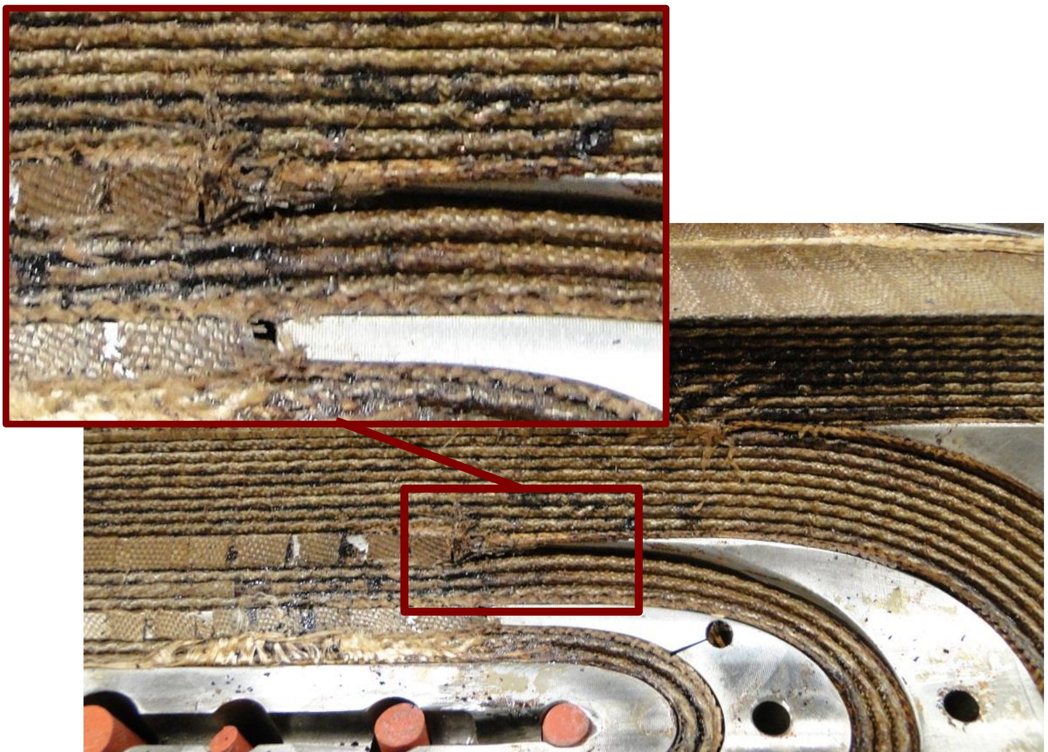
- **Goals: demonstrate new R&D strand, cored cable, improved process and reproducibility**
- **Strand (ø0.70 mm):**
  - **MBHSP02 – R&D RRP-150/169 strand**
  - **MBHSP03 – baseline RRP-108/127**
- **Cable: both models use 40-strand cable with 12-mm-wide and 0.025-mm-thick stainless steel core**
- **Coil: optimized end parts and process**
- **Structure:**
  - **MBHSP02 – modified MBHSP01 collar**
  - **MBHM01 – mirror magnet (with bolt on skin)**
  - **MBHSP03 – new collar (with bolt on skin)**
- **MBHSP02 fabrication - 6 months!**

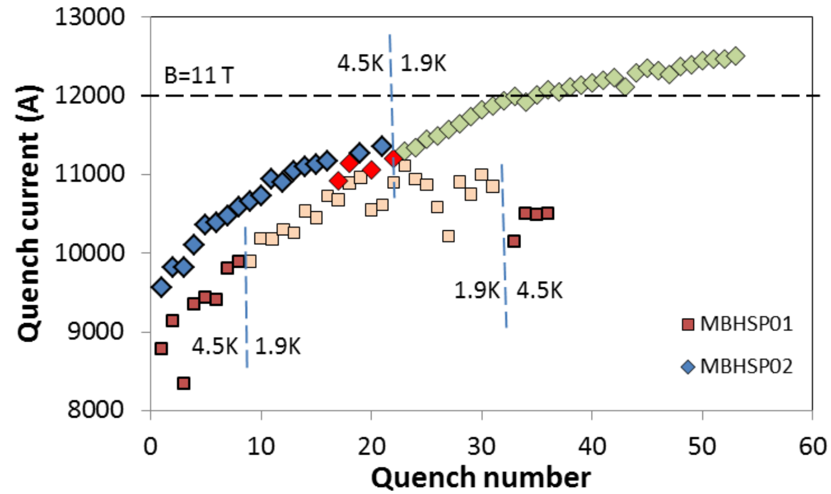




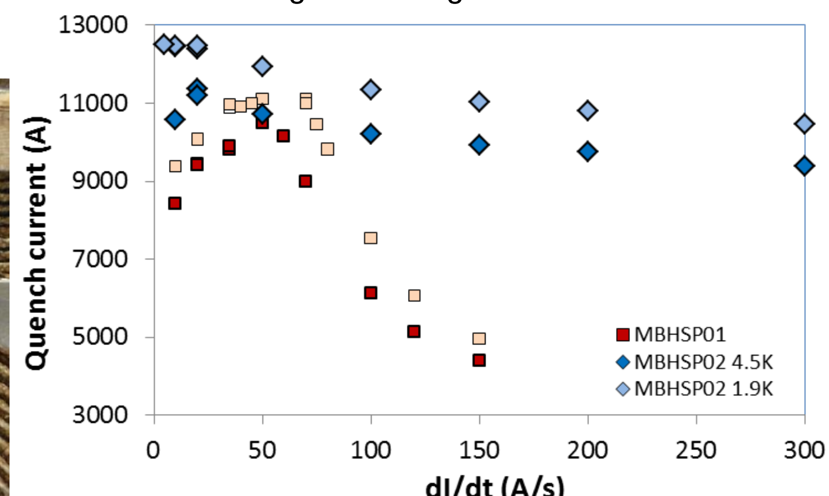
MBHSP02 Quench Performance

- **Improved quench performance**
  - o **B_{max}= 11.7 T – 97.5% of design field B=12 T (78% of SSL at 1.9 K)**
- **Issues to be addressed**
  - o **Long training**
  - o **Some conductor degradation**
  - o **Negative ramp rate dependence at dI/dt<20 A/s and 4.5 K**





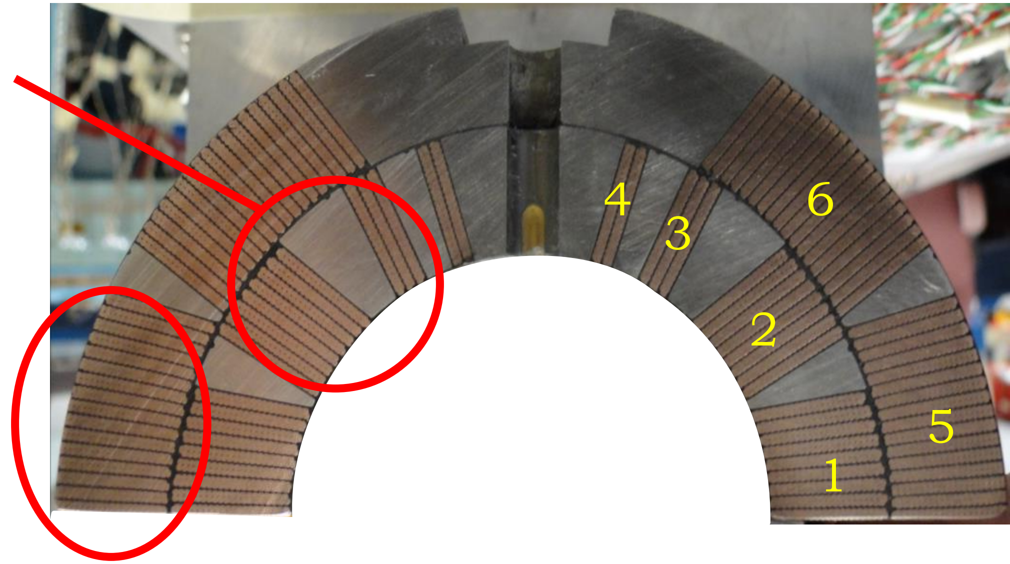
Magnet training

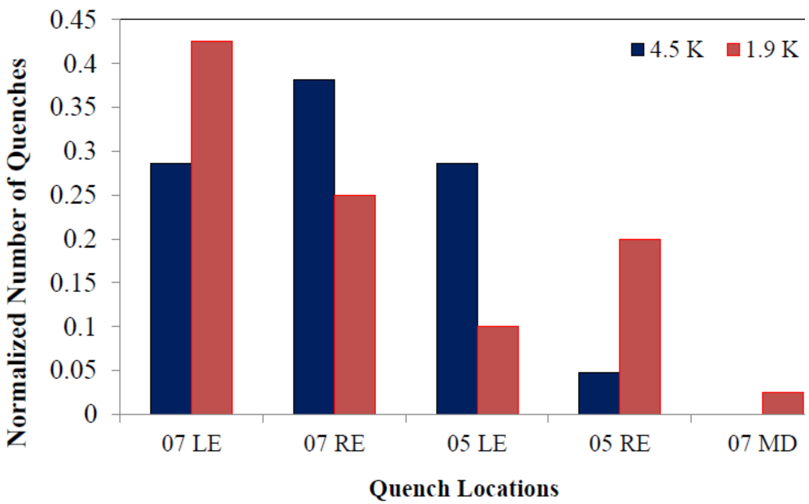


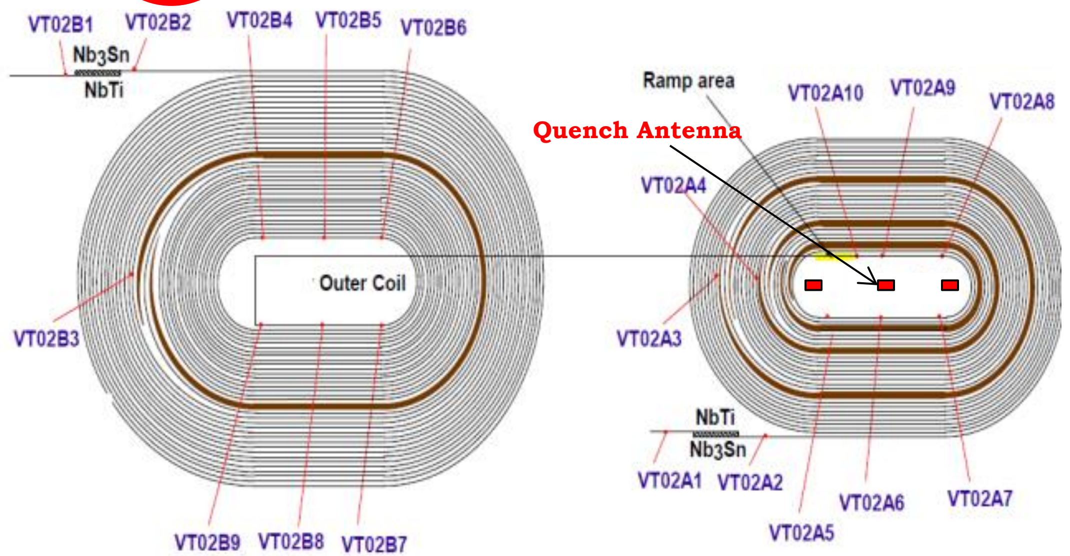
Ramp rate dependence

MBHSP02 Quench Locations

- Most training quenches in winding blocks 2 & 3 of coils #5 and #7 both at 1.9 K and 4.5 K
- Quench locations moved to the mid-plane area (block 5) of coil #7 at the end of 4.5 K training
- All holding quenches in outer layer mid-plane area of coil #7
- Practically all quenches in the end regions



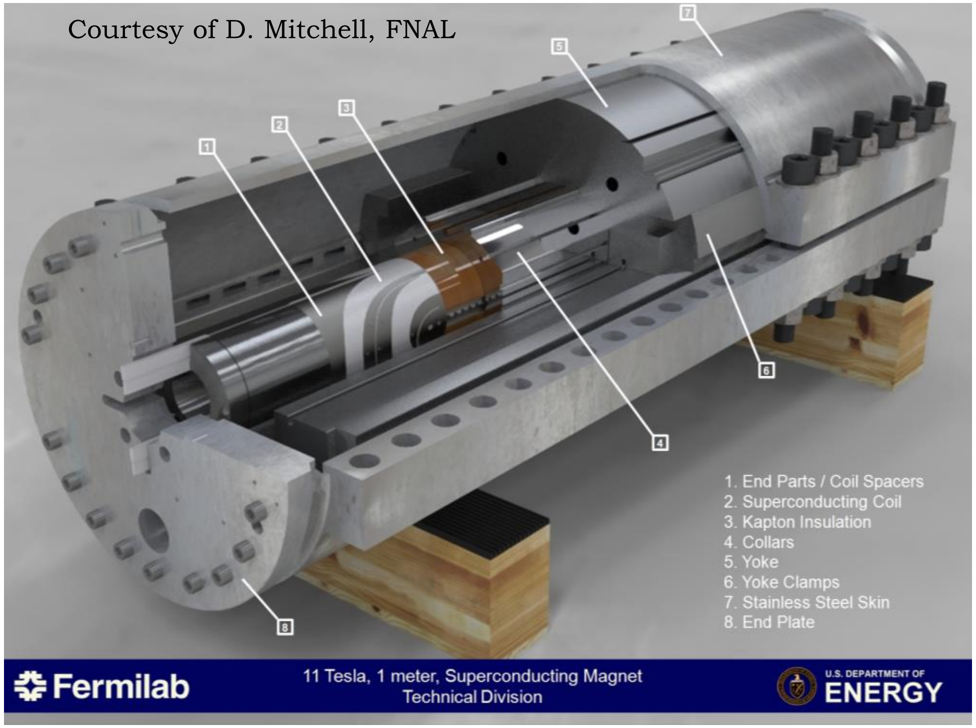




Voltage tap location

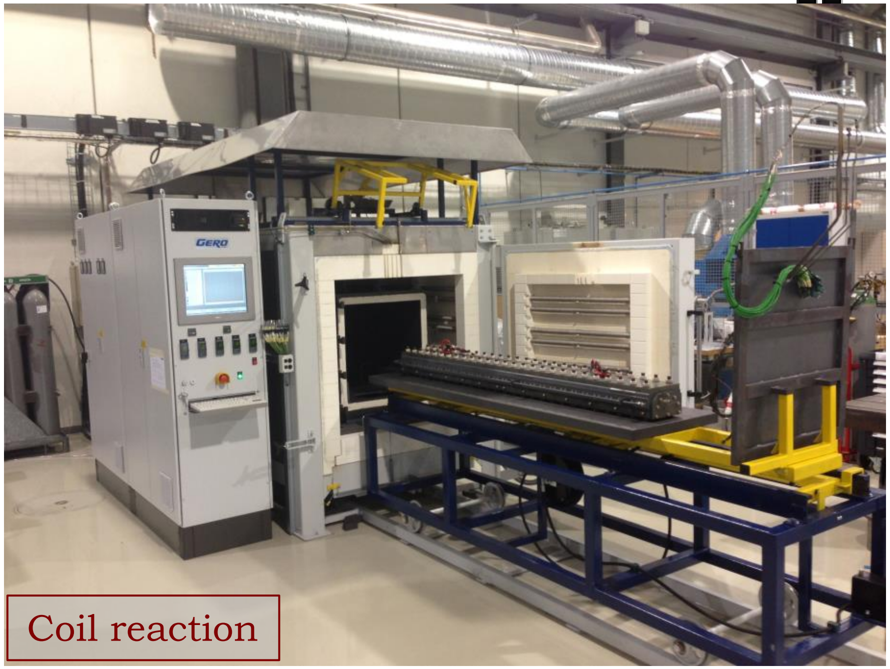
FNAL Short Model Program

- MBHSP01 (2 m) and MBHSP02 (1 m) have been tested.
- Coil #8 will be tested in Mirror, MBHSM01. Assembly in progress. Test Oct-2013
- Assemble and test MBHSP03 (1 m, 1-in-1) using coils #9-10, Dec-2013
- Assemble and test the MBHDP01 (1 m, 2-in-1) using collared coils from MBHSP02 and MBHSP03, Feb-2014
- *Assemble and test MBHSP04 (1 m, 1-in-1) using coils #11-12, Apr-2014*
- *Assemble and test MBHDP02 (1 m, 2-in-1) using collared coils from MBHSP04 and coils #13-14, Jul-2014*

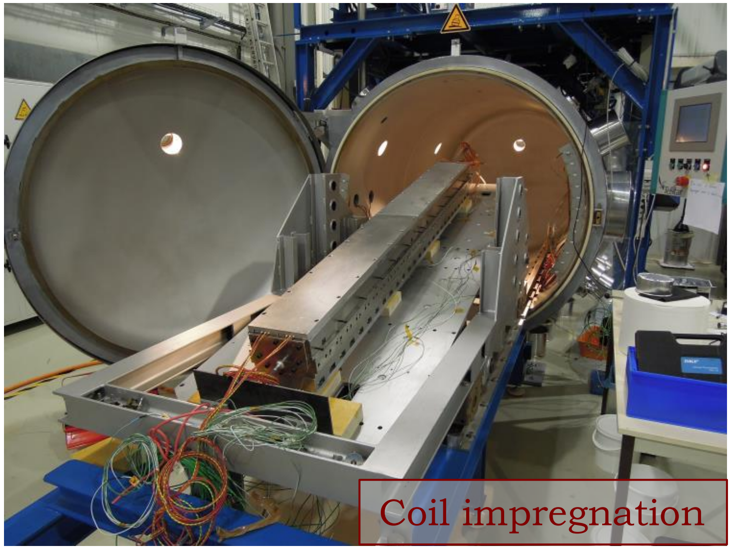


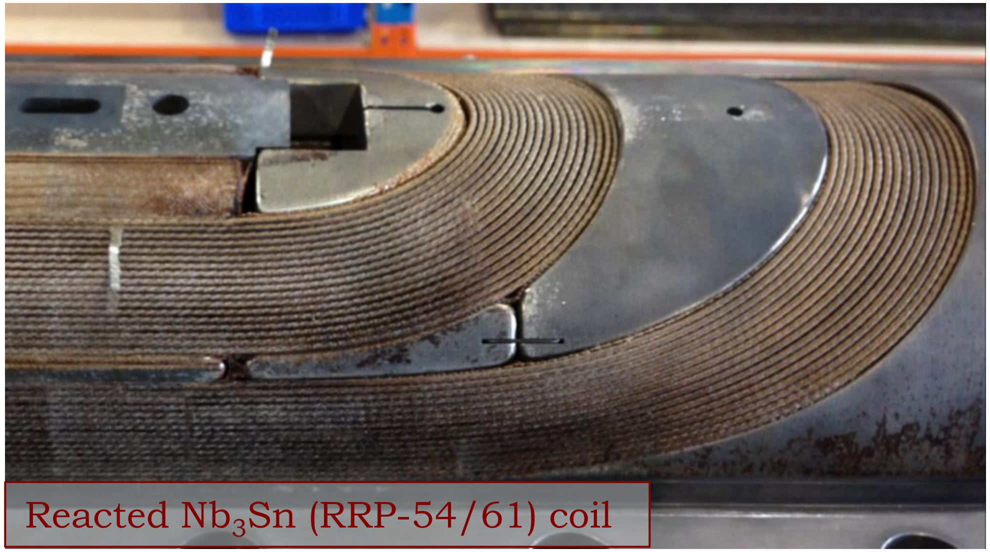
CERN Construction Status

- **Coil fabrication tooling:**
  - **Winding, curing, and reaction operational**
  - **Vacuum impregnation system commissioned**
- **Practice coil fabrication**
  - **PC-#1-2 (Cu-cable) reacted and impregnated**
  - **PC #3 Nb_3Sn (low-Jc WST strand) scrapped**
  - **Nb_3Sn (RRP-54-61) CMM done, to instrument**
- **Magnet R&D:**
  - **Cable insulation (braided S2-glass & Mica)**
  - **ODS (oxide dispersion strengthened) wedges**
  - **Selective laser sintering (SLS) end spacers**
  - **Coil pre-loading concept ("pole-loading")**
  - **Magnet protection (inter-layer heater)**



Coil reaction


Coil impregnation


Reacted Nb_3Sn (RRP-54/61) coil

CERN Construction Status..

❖ Coil fabrication:

- **MBHSP104 (RRP-108/127 #1) ready to react**
- **MBHSP105 (RRP-108/127 #2) wound and cured**
- **MBHSP106 (RRP-108/127 #3) wound and cured**
- **Winding trials underway with trial lengths of cable with reduced keystone angle to assess the mechanical stability.**

❖ Cold mass:

- **Collars (EDM) for the 1st aperture assembled in packs.**
- **Fine-blanking of collars for AP-2..5 underway**
- **Laminations (EDM) for two 1-in-1 yokes in stock**
- **Laminations (EDM) for one 2-in-1 yokes in stock**
- **End plates for two 1-in-1 magnets in stock**
- **Welding trials for 1-in-1 cold mass carried out**
- **12-mm-thick 304 L shells for 1-in-1 models in production**
- **15-mm-thick 316 LN shell for 2-in-1 models ordered and welding trials planned.**
- **Tooling in commissioning**

CERN Short (2 m) Model Program

- Assemble RRP-54/61 coil with RRP-108/127 coil #1 as a practice model to validate the assembly process and tooling. Ideally carry out WMM and short cold test *Dec-13* . This is the present Plan A

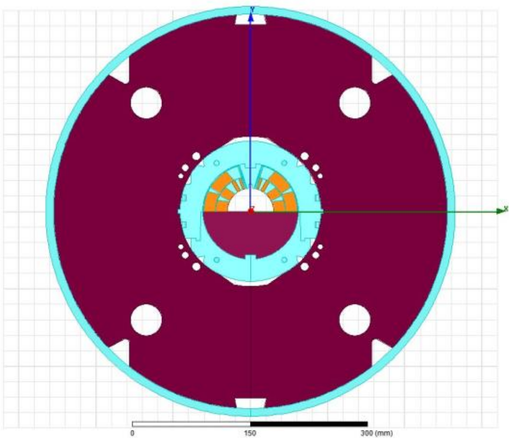
OR

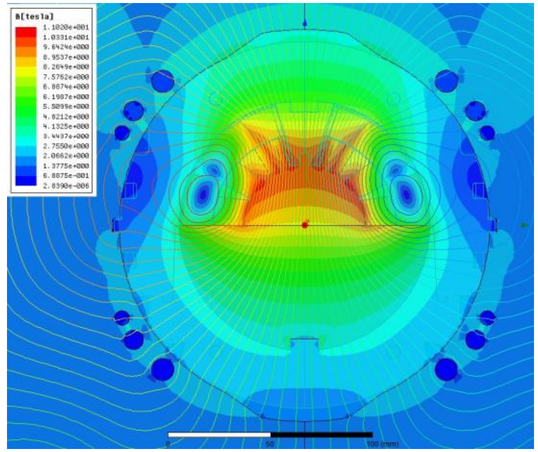
- Assemble and test the RRP-54/61 (or RRP-108/127 coil #1) coil as single coil assembly (MBHSS101) using existing collars, yoke, welded outer shell, and end plates. Plan B

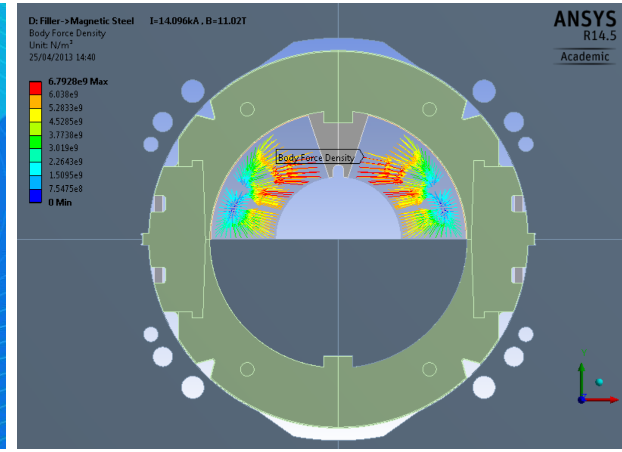
- Two RRP-108/127 coils to assemble and test the 1st 1-in-1 model (MBHSP101) *Feb-14*
- Two RRP-132/169 coils to assemble and test the 2nd 1-in-1 model (MBHSP102) *May-14*
- Collared coils from MBHSP101 & 102 to assemble and test the 1st 2-in-1 model (MBHDP101) *Aug-14*
- Idem for PIT-cable: 2 x 1-in-1 model (MBHSP103-4) to have tested collared coils for the 2nd 2-in-1 model (MBHDP102). *Mar-15, May-15, Jul-15*

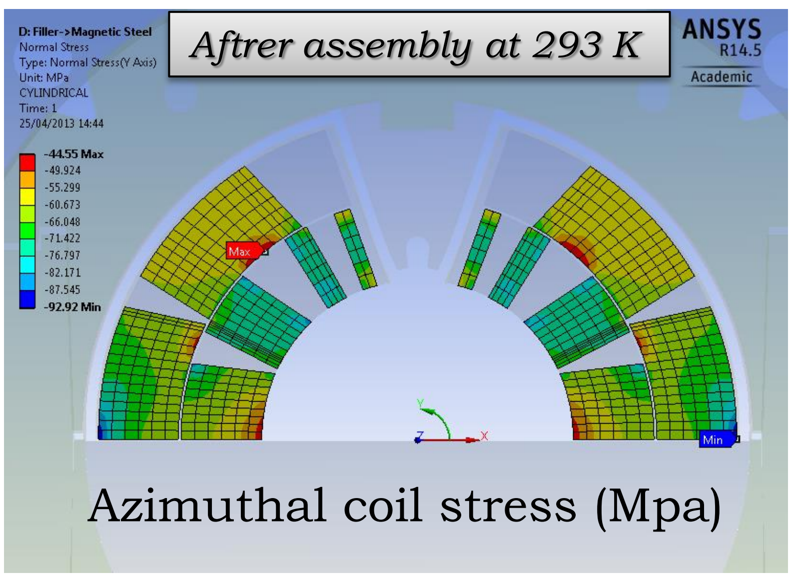
CERN Single Coil Assembly

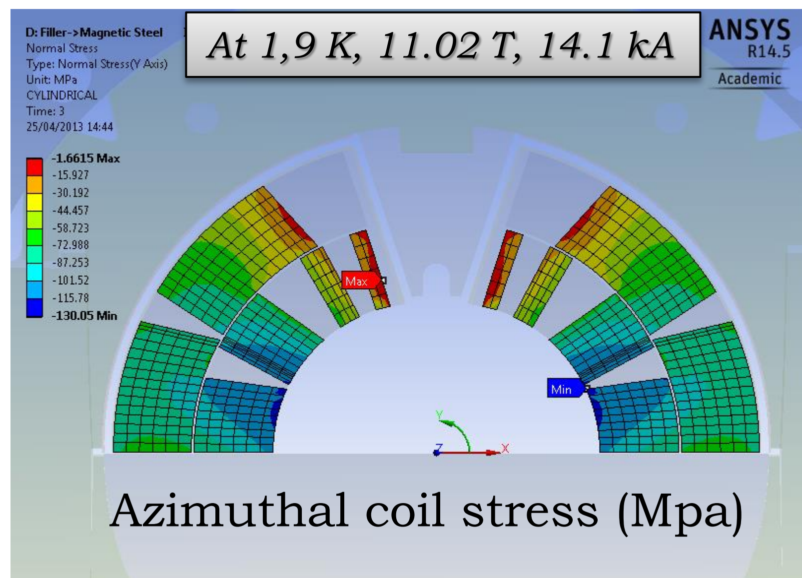
Courtesy of C. Kokkinos & T. Lyon CERN TE-MCS





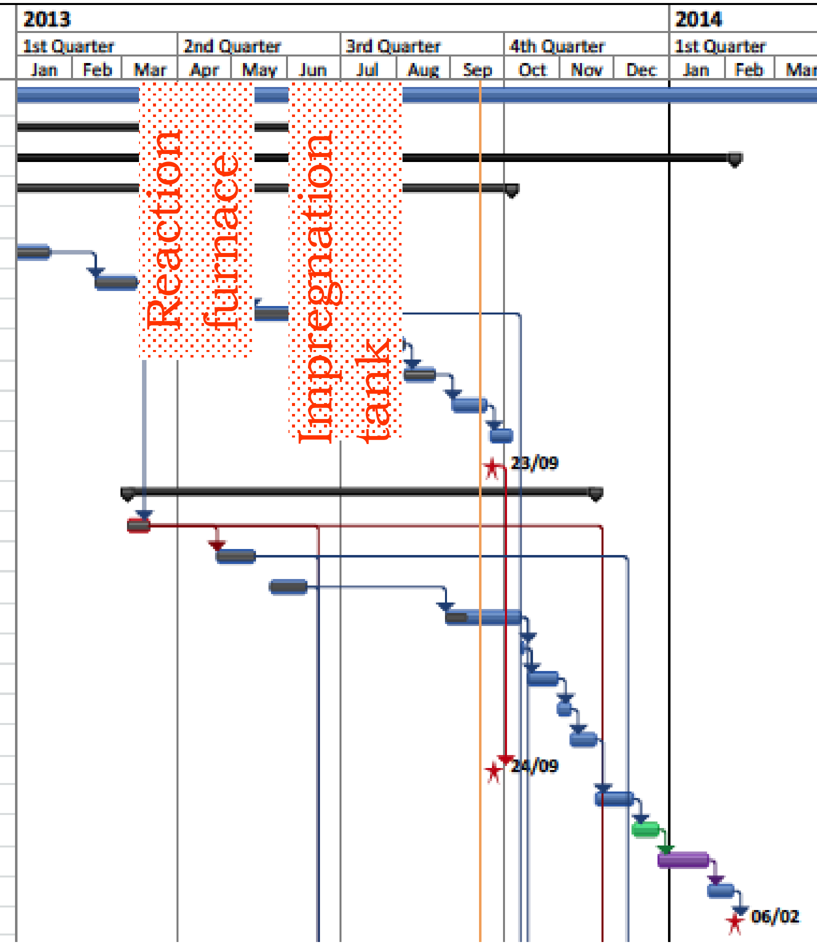






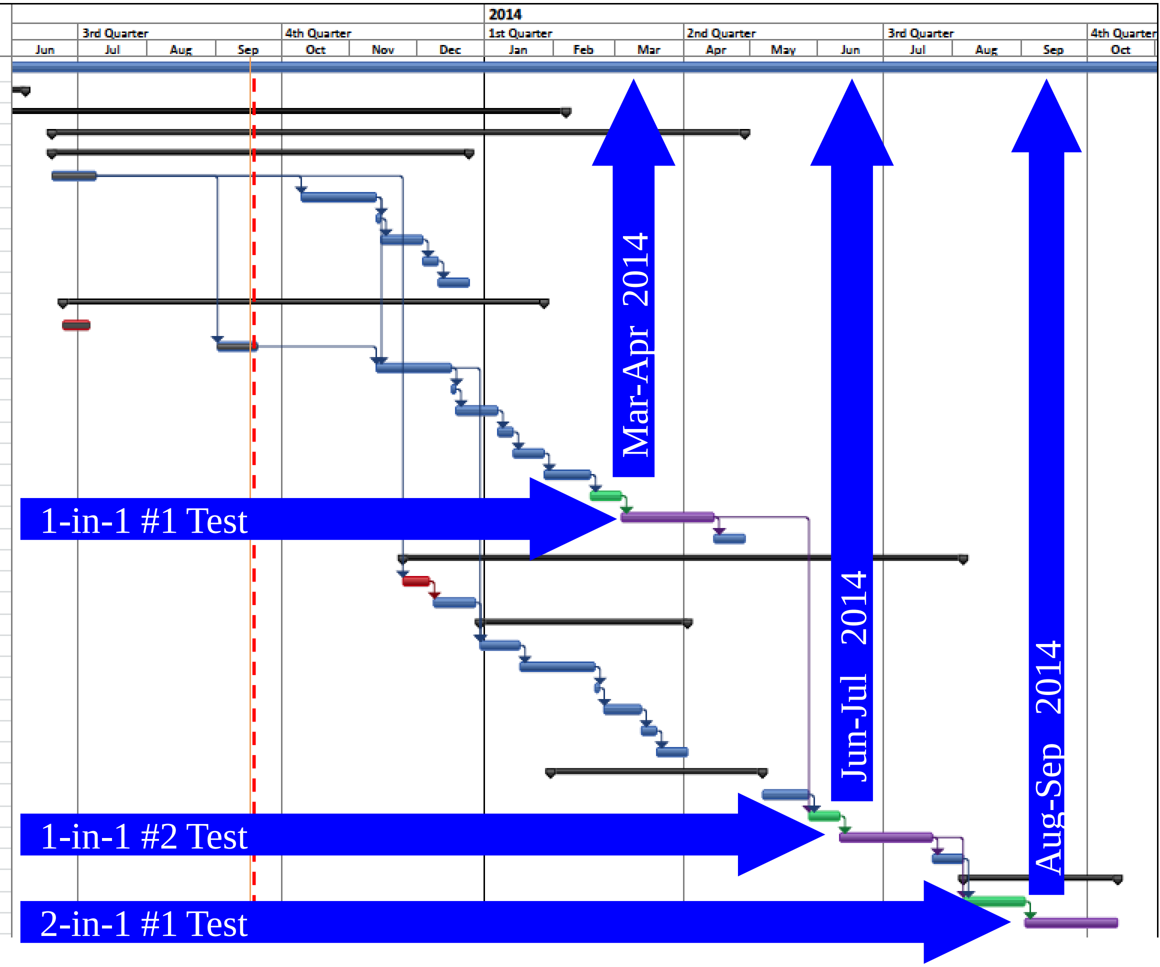
CERN Practice Model Schedule

ID	Task Name	Duration	Start	Finish
1	**CERN Short (2 m) 11 T Dipole Model Program**	825 days	05/03/12	01/05/15
2	**Trials & Mock-ups**	**329 days**	**05/03/12**	**06/06/13**
22	**1-in-1 Practice Model 1 (RRP-54/61 & 108/127)**	**449 days?**	**21/05/12**	**06/02/14**
23	**Coil PC2 (RRP 54/61 cored, Mica & 11-TEX)**	**360 days**	**21/05/12**	**04/10/13**
24	220 m cored RRP 54/61 cable	2 wks	21/05/12	01/06/12
25	Insulated cable (Mica & 11-TEX)	7.2 wks	30/11/12	18/01/13
26	Wind/cure	17 days	14/02/13	08/03/13
27	React	16 days	13/05/13	03/06/13
28	Splice	3 days	01/08/13	05/08/13
29	Impregnate	13 days	06/08/13	22/08/13
30	Inspect	15 days	02/09/13	20/09/13
31	Instrument	2 wks	23/09/13	04/10/13
32	Coil review at CERN	1 day	23/09/13	23/09/13
33	**Coil 1 (RRP 108/127)**	**188 days**	**04/03/13**	**20/11/13**
34	440 m cored RRP 108/127 cable	2 wks	04/03/13	15/03/13
35	Insulated cable (Mica & 11-TEX)	3 wks	23/04/13	13/05/13
36	wind/cure	14 days	23/05/13	11/06/13
37	React	30 days	29/08/13	09/10/13
38	Splice	2 days	10/10/13	11/10/13
39	Impregnate	13 days	14/10/13	30/10/13
40	Inspect	5 days	31/10/13	06/11/13
41	Instrument	2 wks	07/11/13	20/11/13
42	Magnet assembly readiness review	1 day	24/09/13	24/09/13
43	collared coil assembly	3 wks	21/11/13	11/12/13
44	1-in-1 cold mass assembly	2 wks	12/12/13	25/12/13
45	Cold test 1-in-1	4 wks	26/12/13	22/01/14
46	Disassembly	2 wks	23/01/14	05/02/14
47	Magnet test review	1 day?	06/02/14	06/02/14



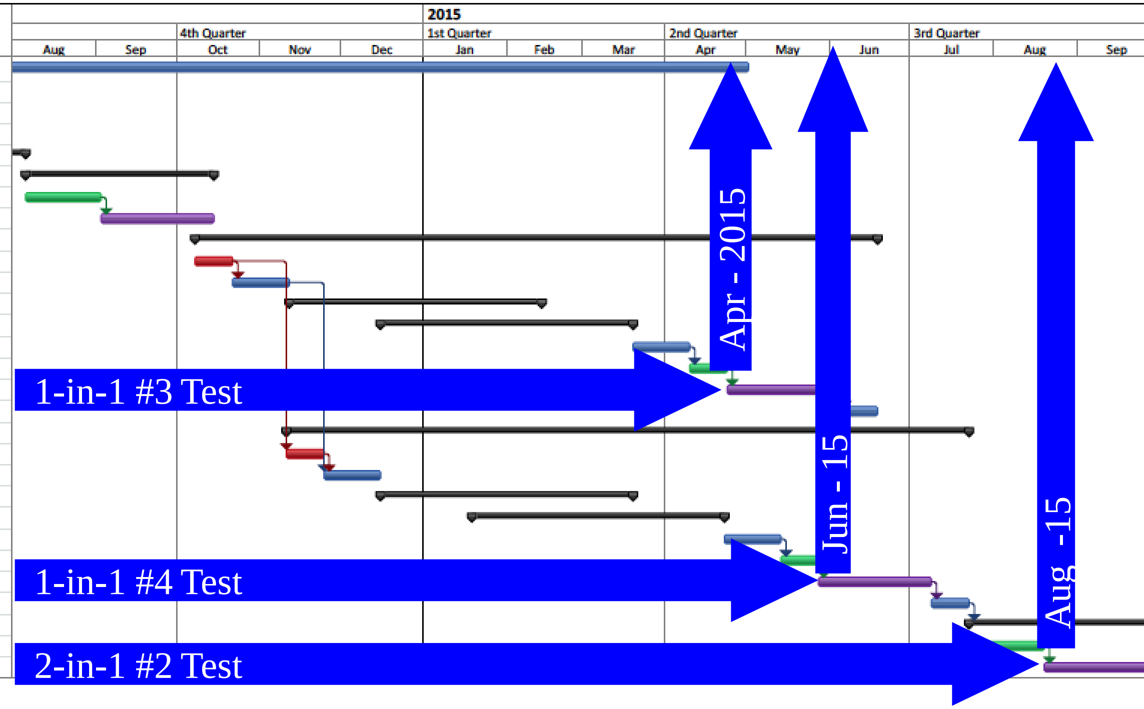
CERN 1st 2-in-1 Model Schedule

ID	Task Name	Duration	Start	Finish
1	**CERN Short (2 m) 11 T Dipole Model Program**	825 days	05/03/12	01/05/15
2	**Trials & Mock-ups**	**329 days**	**05/03/12**	**06/06/13**
22	**1-in-1 Practice Model 1 (RRP-54/61 & 108/127)**	**449 days?**	**21/05/12**	**06/02/14**
48	**1-in-1 Model 1 (RRP-108/127)**	**224 days**	**19/06/13**	**28/04/14**
49	**Coil 2 (RRP 108/127)**	**135 days**	**19/06/13**	**24/12/13**
50	wind/cure	14 days	19/06/13	08/07/13
51	React	24 days	10/10/13	12/11/13
52	Splice	2 days	13/11/13	14/11/13
53	Impregnate	13 days	15/11/13	03/12/13
54	Inspect	5 days	04/12/13	10/12/13
55	Instrument	2 wks	11/12/13	24/12/13
56	**Coil 3 (RRP 108/127)**	**156 days**	**24/06/13**	**27/01/14**
57	220 m cored RRP 108/127 cable	2 wks	24/06/13	05/07/13
58	wind/cure	14 days	02/09/13	19/09/13
59	React	24 days	13/11/13	16/12/13
60	Splice	2 days	17/12/13	18/12/13
61	Impregnate	13 days	19/12/13	06/01/14
62	Inspect	5 days	07/01/14	13/01/14
63	Instrument	2 wks	14/01/14	27/01/14
64	collared coil assembly	3 wks	28/01/14	17/02/14
65	1-in-1 cold mass assembly	2 wks	18/02/14	03/03/14
66	Cold test 1-in-1	6 wks	04/03/14	14/04/14
67	Disassembly	2 wks	15/04/14	28/04/14
68	**1-in-1 Model 2 (RRP(132/169)**	**182 days**	**25/11/13**	**05/08/14**
69	660 m cored RRP (132/169) cable	2 wks	25/11/13	06/12/13
70	Insulated cable (Mica & 11-TEX)	2 wks	09/12/13	27/12/13
71	**Coil 4 (132/169)**	**68 days**	**30/12/13**	**02/04/14**
72	wind/cure	14 days	30/12/13	16/01/14
73	React	24 days	17/01/14	19/02/14
74	Splice	2 days	20/02/14	21/02/14
75	Impregnate	13 days	24/02/14	12/03/14
76	Inspect	5 days	13/03/14	19/03/14
77	Instrument	2 wks	20/03/14	02/04/14
78	**Coil 5 (132/169)**	**68 days**	**31/01/14**	**06/05/14**
85	collared coil assembly	3 wks	07/05/14	27/05/14
86	1-in-1 cold mass assembly	2 wks	28/05/14	10/06/14
87	Cold test 1-in-1	6 wks	11/06/14	22/07/14
88	Disassembly	2 wks	23/07/14	05/08/14
89	**2-in-1 Model 1 (RRP 108/127 & 132/169)**	**50 days**	**06/08/14**	**14/10/14**
90	2-in-1 cold mass assembly	4 wks	06/08/14	02/09/14
91	Cold test 2-in-1	6 wks	03/09/14	14/10/14



CERN 2nd 2-in-1 Model Schedule

ID	Task Name	Duration	Start	Finish
1	**CERN Short (2 m) 11 T Dipole Model Program**	825 days	05/03/12	01/05/15
2	**Trials & Mock-ups**	**329 days**	**05/03/12**	**06/06/13**
22	**1-in-1 Practice Model 1 (RRP-54/61 & 108/127)**	**449 days?**	**21/05/12**	**06/02/14**
48	**1-in-1 Model 1 (RRP-108/127)**	**224 days**	**19/06/13**	**28/04/14**
68	**1-in-1 Model 2 (RRP(132/169)**	**182 days**	**25/11/13**	**05/08/14**
89	**2-in-1 Model 1 (RRP 108/127 & 132/169)**	**50 days**	**06/08/14**	**14/10/14**
90	2-in-1 cold mass assembly	4 wks	06/08/14	02/09/14
91	Cold test 2-in-1	6 wks	03/09/14	14/10/14
92	**1-in-1 Model 3 (PIT-114)**	**182 days**	**08/10/14**	**18/06/15**
93	660 m cored PIT-114 cable	2 wks	08/10/14	21/10/14
94	Insulated cable (Mica & 11-TEX)	2 wks	22/10/14	11/11/14
95	**Coil 5 (PIT-114)**	**68 days**	**12/11/14**	**13/02/15**
102	**Coil 6 (PIT-114)**	**68 days**	**16/12/14**	**19/03/15**
109	collared coil assembly	3 wks	20/03/15	09/04/15
110	1-in-1 cold mass assembly	2 wks	10/04/15	23/04/15
111	Cold test 1-in-1	6 wks	24/04/15	04/06/15
112	Disassembly	2 wks	05/06/15	18/06/15
113	**1-in-1 Model 4 (PIT-114)**	**182 days**	**11/11/14**	**22/07/15**
114	440 m cored PIT-114 cable	2 wks	11/11/14	24/11/14
115	Insulated cable (Mica & 11-TEX)	2 wks	25/11/14	15/12/14
116	**Coil 7 (PIT-114)**	**68 days**	**16/12/14**	**19/03/15**
123	**Coil 8 (PIT-114)**	**68 days**	**19/01/15**	**22/04/15**
130	collared coil assembly	3 wks	23/04/15	13/05/15
131	1-in-1 cold mass assembly	2 wks	14/05/15	27/05/15
132	Cold test 1-in-1	6 wks	28/05/15	08/07/15
133	Disassembly	2 wks	09/07/15	22/07/15
134	**2-in-1 Model 2 (PIT-114)**	**50 days**	**23/07/15**	**30/09/15**
135	2-in-1 cold mass assembly	20 days	23/07/15	19/08/15
136	Cold test 2-in-1	6 wks	20/08/15	30/09/15

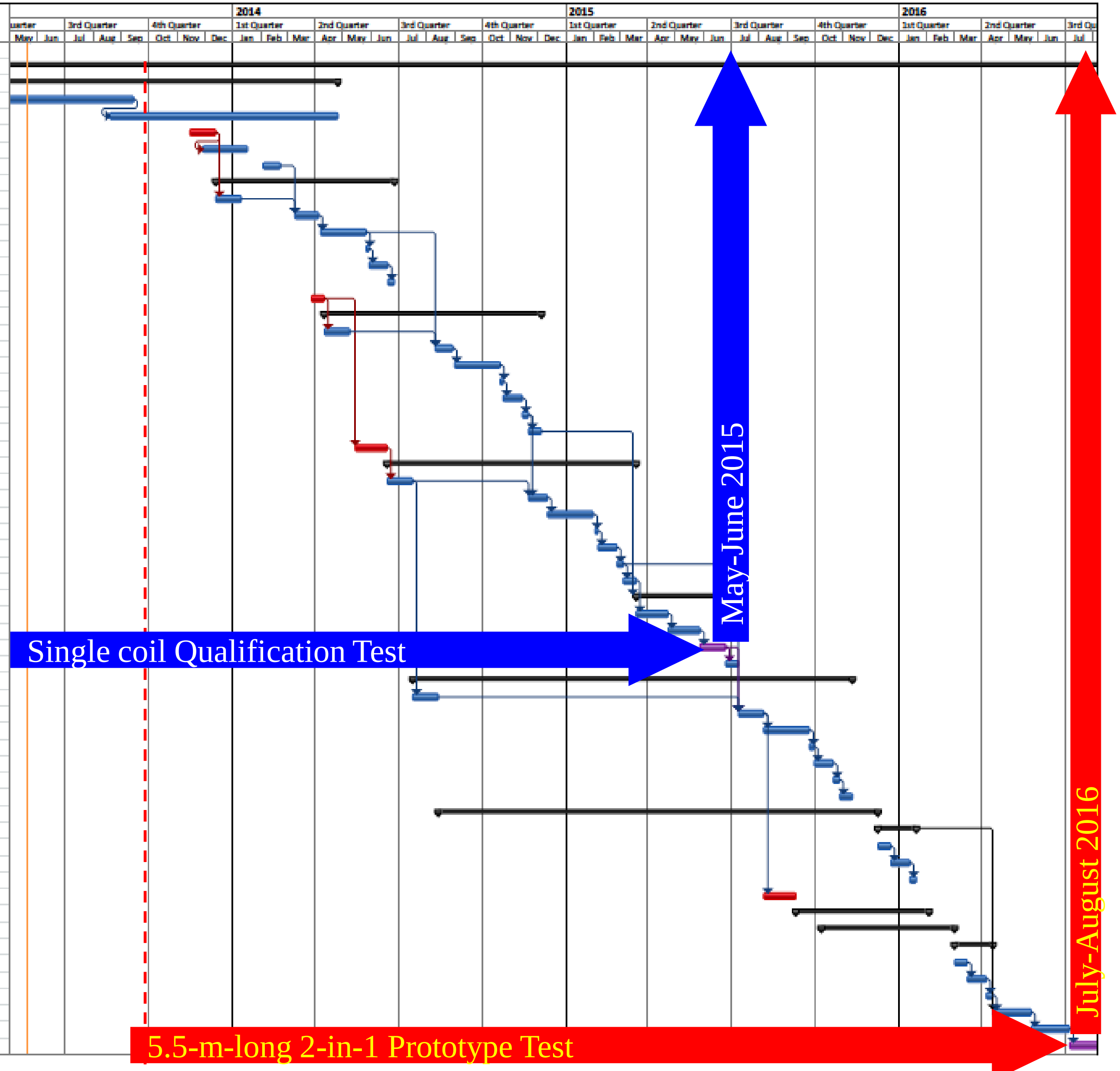


CERN Prototype (5.5 m) Schedule

- Start with winding trials using Cu-cable:
  - simplified trials
  - coil with bare cable
  - first practice coil with insulated Cu-cable to react and pot (PC-1).
- First Nb_3Sn practice coil with possibly low-performance (cheaper) cable (PC-2)
- First "real" coil (PC-3) to cold test as a single coil (mirror?)
- Four (or eventually more..) more coils for 2 collared coils to construct the full-scale proto and test it around Mid-2016.
- the 5.5 m schedule is compatible with the present LMF plans including the major procurements
- Additional coil production lines will be required for series magnets
- It is also vital to get the industry on board during the prototype construction to be ready for the series units

CERN 5.5 m Prototype Schedule

ID	Task Name	Duration	Start
1			
2	**5.5 m Prototype**	**957 days**	**07/01/13**
3	**Design & Procurement**	**340 days**	**07/01/13**
4	tooling design	36 wks	07/01/13
5	procurement	36 wks	19/08/13
6	Cu-Cable 1450 m	4 wks	15/11/13
7	Winding trial 1 (Simplified)	7 wks	29/11/13
8	Winding Trial 2 (Bare cable)	3 wks	03/02/14
9	**Practice Coil 1 (Cu)**	**140 days**	**13/12/13**
10	Insulated cable (Mica & 11-TEX)	4 wks	13/12/13
11	Wind/cure	4 wks	10/03/14
12	React	36 days	07/04/14
13	Splice	3 days	27/05/14
14	Impregnate	3 wks	30/05/14
15	Inspect	5 days	20/06/14
16	620 m cored WST cable	2 wks	28/03/14
17	**Practice Coil 2 (Low Perf. Nb3Sn)**	**170 days**	**11/04/14**
18	Insulated cable (Mica & 11-TEX)	4 wks	11/04/14
19	Wind/cure	3 wks	11/08/14
20	React	36 days	01/09/14
21	Splice	3 days	21/10/14
22	Impregnate	3 wks	24/10/14
23	Inspect	5 days	14/11/14
24	Instrument	2 wks	21/11/14
25	1860 m cored RRP 132/169 cable	25 days	15/05/14
26	**Practice Coil 3 (RRP 132/169)**	**195 days**	**19/06/14**
27	620 m Insulated cable (Mica & 11-TEX)	4 wks	19/06/14
28	Wind/cure	3 wks	21/11/14
29	React	36 days	12/12/14
30	Splice	3 days	02/02/15
31	Impregnate	3 wks	05/02/15
32	Inspect	5 days	26/02/15
33	Instrument	2 wks	05/03/15
34	**Mirror Magnet**	**80 days**	**19/03/15**
35	Mirror Coldmass Assembly	5 wks	19/03/15
36	Cryostat assmebly Mirror	5 wks	23/04/15
37	Cold test Mirror	4 wks	28/05/15
38	Disassembly	2 wks	25/06/15
39	**Coil 4 (RRP 132/169)**	**344 days**	**17/07/14**
40	620 m Insulated cable (Mica & 11-TEX)	4 wks	17/07/14
41	Wind/cure	4 wks	09/07/15
42	React	36 days	06/08/15
43	Splice	3 days	25/09/15
44	Impregnate	3 wks	30/09/15
45	Inspect	5 days	21/10/15
46	Instrument	2 wks	28/10/15
47	**Coil 5 (RRP 132/169)**	**344 days**	**14/08/14**
55	**Collared Coil 1 (RRP 132/169)**	**30 days**	**09/12/15**
56	Coil assembly	2 wks	09/12/15
57	Collaring	3 wks	23/12/15
58	Inspection	1 wk	13/01/16
59	1860 m cored PIT-114 cable	5 wks	06/08/15
60	**Coil 6 (PIT-114)**	**104 days**	**10/09/15**
68	**Coil 7 (PIT-114)**	**104 days**	**08/10/15**
76	**Collared Coil 2 (PIT-114)**	**30 days**	**02/03/16**
77	Coil assembly	2 wks	02/03/16
78	Collaring	3 wks	16/03/16
79	Inspection	1 wk	06/04/16
80	Coldmass assembly	6 wks	13/04/16
81	Cryostat assembly	6 wks	25/05/16
82	test	9 wks	06/07/16



Summary

- Two 1-in-1 model magnets have been constructed and tested at FNAL reaching 10.5 T and 11.7 T. Reasons for conductor degradation under investigation
- Two 1-m-long 2-in-1 magnets scheduled at FNAL by Mid-14
- FNAL coil fabrication technology has been transferred to CERN and the first Nb_3Sn coil has been completed
- Commissioning of infrastructure longer than expected
- First CERN 2-m-long 1-in-1 magnet test expected in Mar-13
- Several R&D topics are being investigated as part of CERN 11 T magnet development serving also the interest of other HFM programs
- Two short 2-in-1 magnets scheduled by the end of 2015
- Work on the 5.5-m-long tooling is underway and the first 5.5-m-long 11 T prototype dipole is expected by Mid-2016

CERN