



The HL-LHC High Order Correctors production status

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CERN – Jul 14th 2021

TEST 1

date	Magnets	Training and quench memory	Other results
Jul 2020	MQSXF1c MCDXF01	compliant	First test on a series magnet
Nov 2020	MCDXF02 MCOXF01 MCSXF01 MCTXF01	compliant	Wedge movement observed (MCOXF01 MCTXF01) and feedback on assembly of batch1a First test on a long dodecapole
Jan 2021	MCDXF03 MCOXF03 MCSXF03 MCTXF2	compliant	MCOXF03 wedge movement – accepted (<i>updated in Aug 2021</i>)
Mar 2021	MCOXF02 MCOXF04 MCSXF02 MQSXF2	compliant	Wedge movement observed First test on a skew quadrupole

TEST 2

date	Magnets	Training and quench memory	Other results
Mar-Apr 2021 CERN	MCDXF02b MCDXF04 MCSXF01b MCDXF05 MCDXF06 MCSXF04 MCDXF01b MCTXF1	compliant	Tested at CERN
Apr 2021	MQSXF1 MCSXF05 MCTSXF1 MCTSXF2	compliant	MQSXF1 performance ok but wedge supports not tightened after thermal cycles. Magnets is repaired and tested again First short dodecapole tested
Jun 2021	MCOXF04b MCOXF07 MCSXF06 MQSXF3	compliant	Added wedge supports for MCOXF04b and MCOXF07 Modified wedge supports for MQSXF3

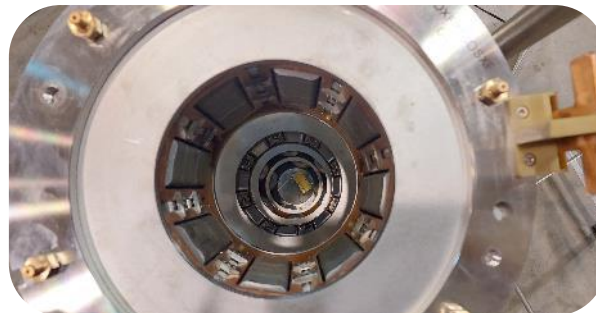
TEST 3

date	Magnets	Training and quench memory	Other results
Sep 2021	MCDXF07, MCDXF08, MCSXF07, MCTXF3		

Test n.6 at LASA

Produced magnets

	Batch	Serial		Batch	Serial		Batch	Serial
M06	1a	1	M10	1a	1	M04	1a	1
		2			2		1b	2
	1b	3		1b	3		2	3
		4			4		4	4
	2	5		2	5		3	5
		6			6		6	6
	3	7		3	7	9	9	
		8			8	10	10	
		9			9	11	11	
		10			10	12	12	
		11			11			
		12			12			
M08	1a	1	M12	1a	1	M13	1a	1
		2		2	1b		2	1b
	1b	3		2	3		2	3
		4			4		3	5
	2	5		2	5		3	6
		6			6		1a	1
	3	7	3	7	1b	2		
		8		8	2	3		
		9		9	3	4		
		10		10	3	5		
		11		11		6		
		12		12				



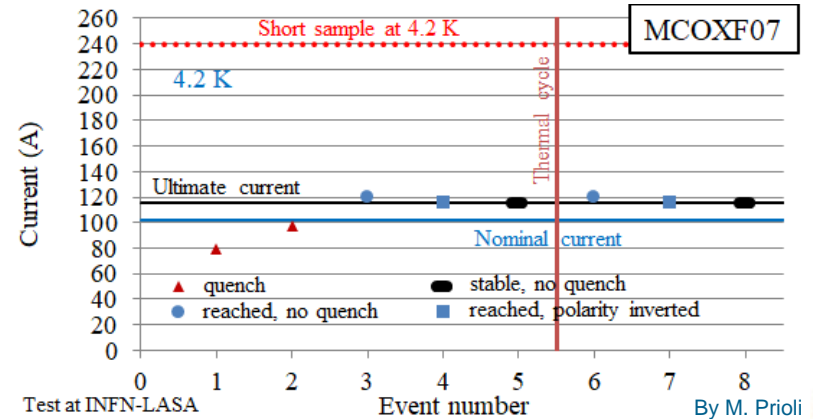
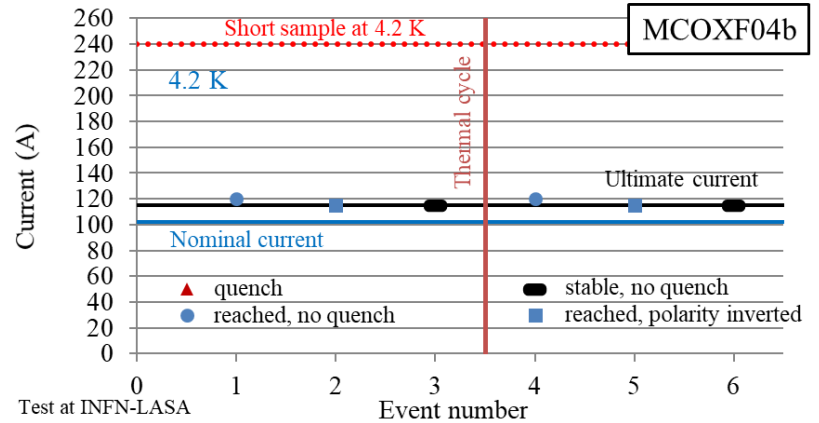
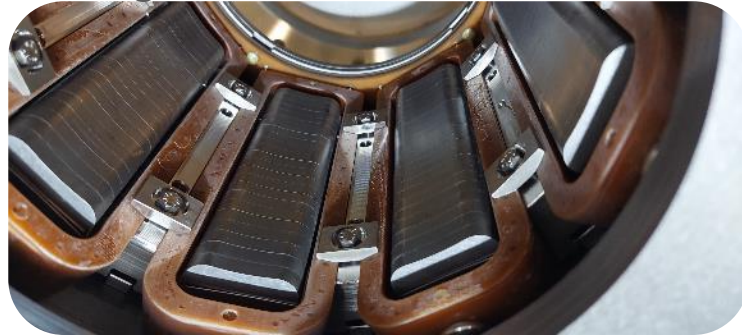
M08_04b
M08_07
M06_06
M04_3

- Test in He wk24 (14 June) e wk26 (28 June)
 - Modified supports for wedges in M04 e M08 (2 versions) ✓
 - M04 had one powering
- two cooldowns ✓
- quench memory ✓
- stability ✓
- Magnetic measurement of all four magnets
- Test of coil fixing ✓

MCOXF04b and MCOXF07

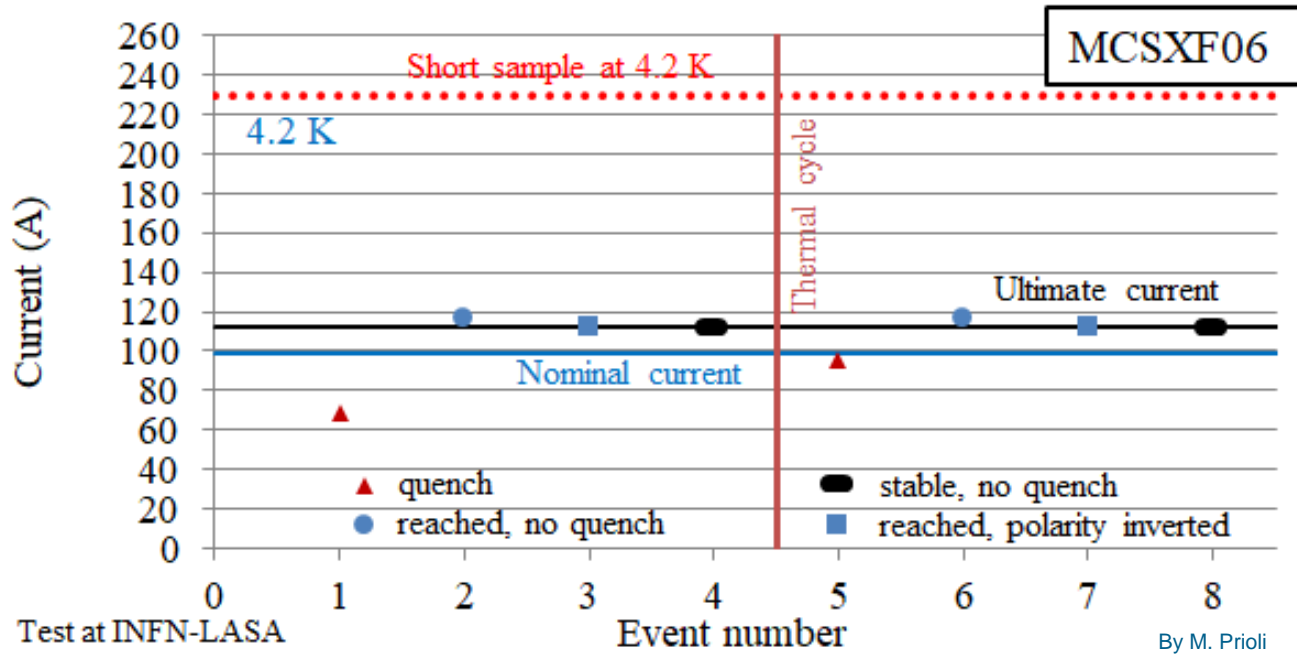


Both additional supports designs consolidated



MCSXF06

One quench after thermal cycle



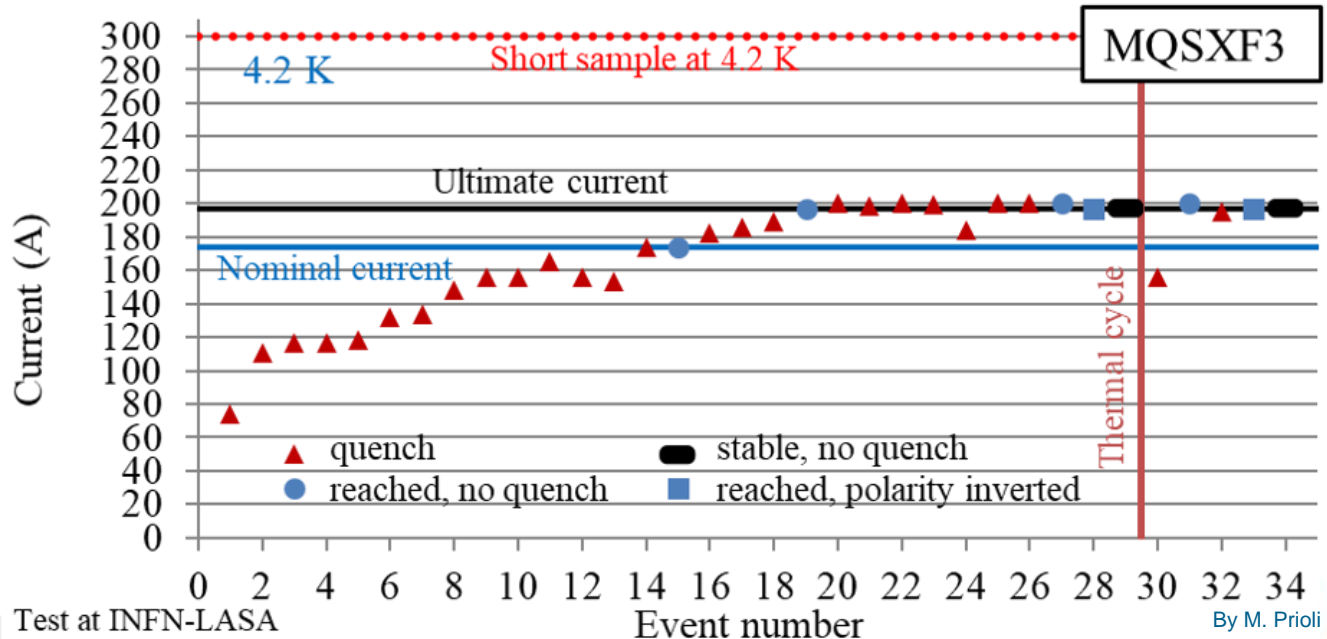
MQSXF3

Training

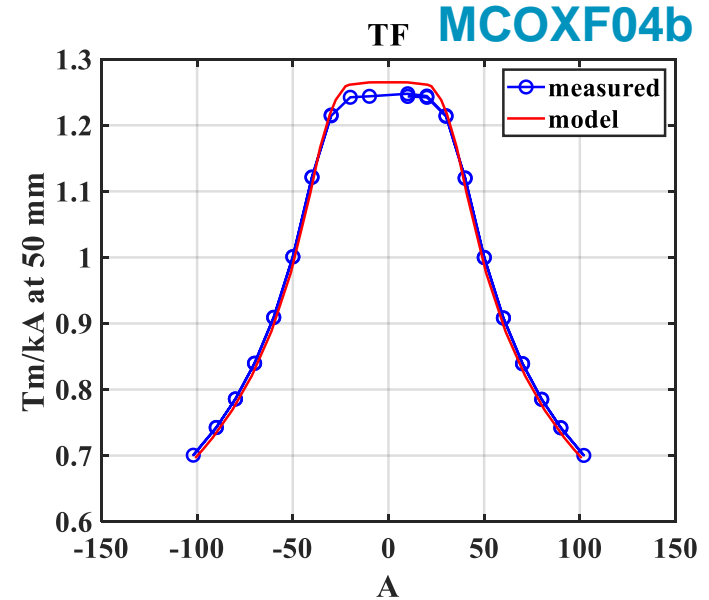
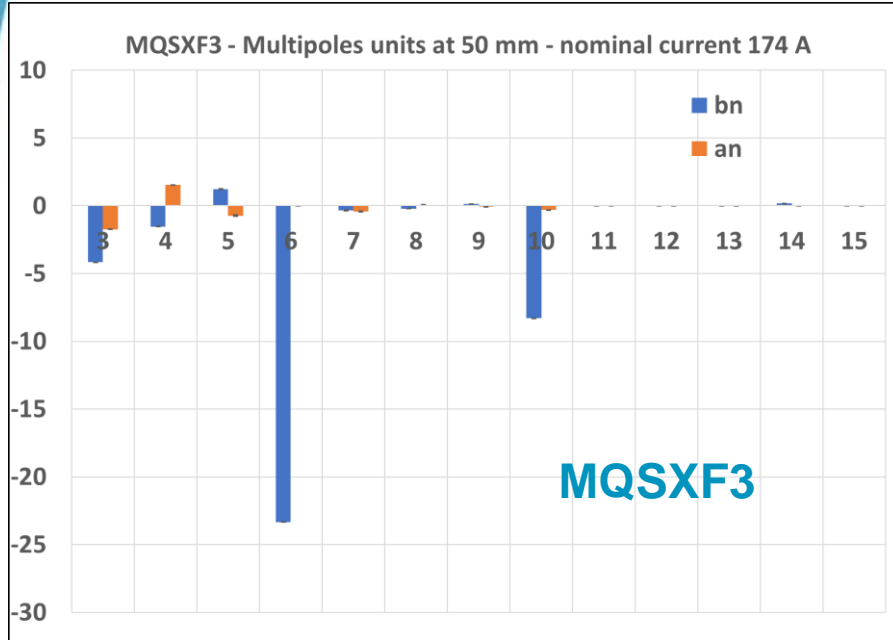
- Not a single coil/half magnet issue
- Dedicated analysis by MM system (S. Mariotto): some quenches involving not only one coil

- High stability (both polarities)
- Good quench memory After thermal cycle
- 1 quench before nominal
- 1 quench before ultimate

Quench N	Current [A]	Quench Coil number
1	74	3
2	111	3
3	117	3
4	117	2
5	118	2
6	132	3+4
7	134	3
8	148	3
9	156	2
10	156	1
11	165	4
12	156	4
13	153	4
14	174	2
15	182	2+3+4
16	186	4
17	189	All
18	200	All
19	199	1+2+4
20	200	All
21	199	All
22	184	1
23	200	2+3+4
24	200	All



Preliminary MM

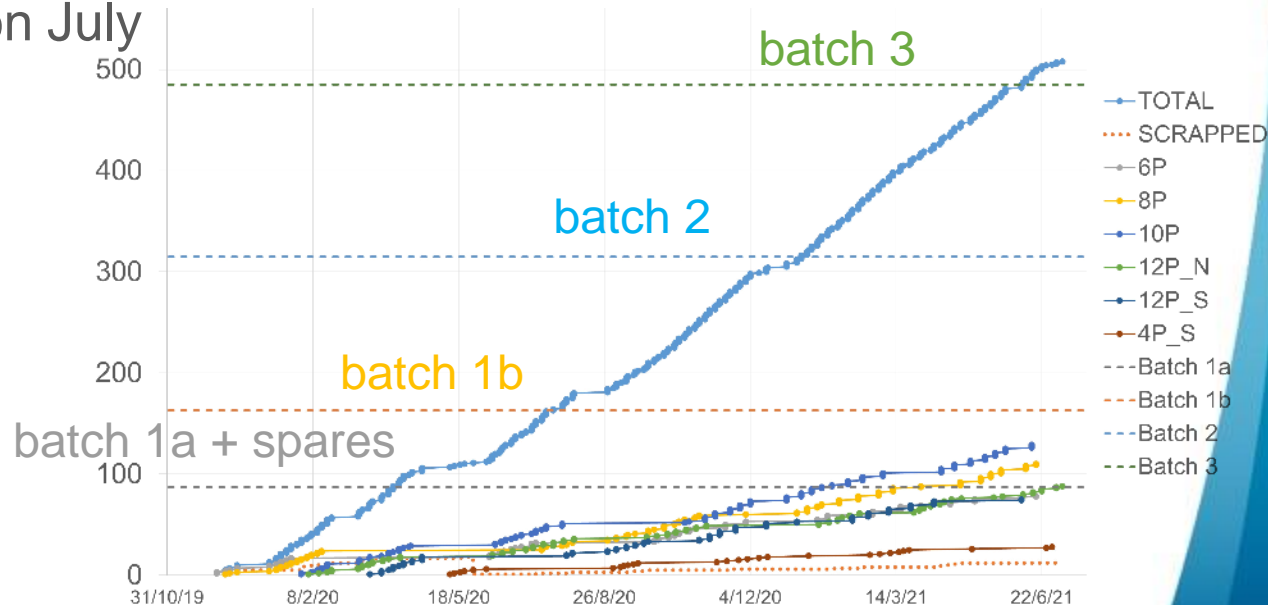


All magnets are conform
Field integral within few %
Analysis by E. De Matteis in next talk

Coils

Magnet	6P	8P	10P	12P-N	12P-S	4P
Produced coils (9/7/2021)	78	110	129	88	75	28
NC (total 29+1)	3	4	6	12+1	1	3

- End of coils' production July
- Produced coils 508
 - 30 NC (6%)
- Still ongoing:
 - Spares
 - Coils to be repaired
 - additional coils



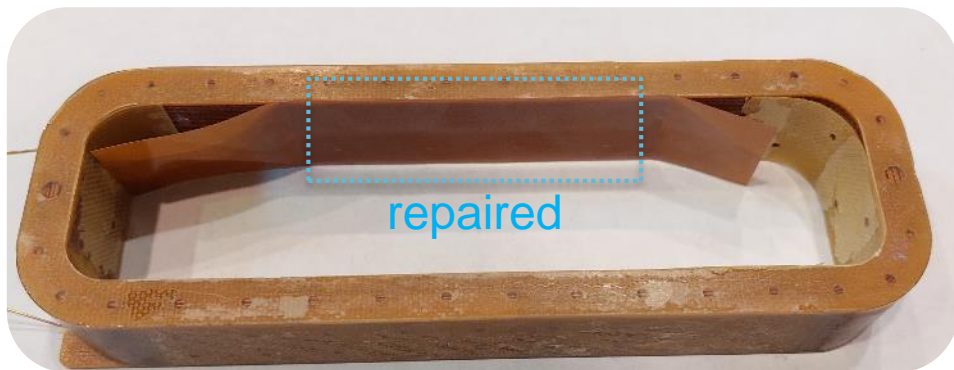
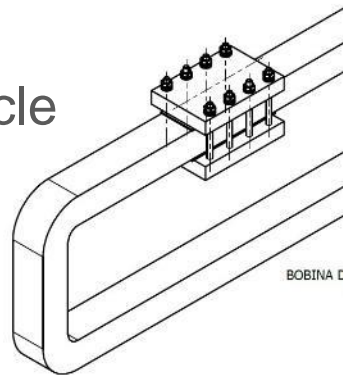
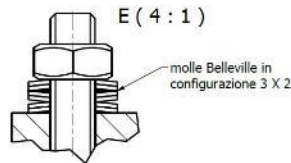
14 July 2021

M. Statera



Repairing Procedure

- Repairing procedure
- Pre-preg polyimide
- Constant pressure during thermal cycle
- 9 h at 100° C
- Full helium thermal cycle



Assembly, Delivery and Test

	Batch	Serial	Delivered	TEST	MM
M06	1a	1	OK	OK CERN*	
		2	OK	OK LASA	TF
	1b	3	OK	OK CERN	
		4	OK	OK CERN	
	2	5	OK	OK	TF
		6	OK	OK	TF
		7	OK	LASA	
		8	OK	LASA	
	3	9			
		10			
		11			
		12			
M08	1a	1	OK	LASA*	
		2	OK	OK LASA	
	1b	3	OK	wedge	TF
		4	OK	OK LASA	TF
	2	5	OK	LASA	
		6	OK	LASA	
		7	OK	OK LASA+	TF
		8	OK	LASA	
	3	9			
		10			
		11			
		12			
M10	1a	1	OK	OK CERN*	
		2	OK	OK CERN*	
	1b	3	OK	OK LASA	TF
		4	OK	OK CERN	
	2	5	OK	OK CERN	
		6	OK	OK CERN	
		7	OK	LASA	
		8	OK	LASA	
	3	9			
		10			
		11			
		12			

M12	1a	1	OK	OK CERN*	
	1b	2	OK	OK CERN*	TF
	2	3	OK	LASA	
		4	OK	LASA	
	3	5			
		6			
M13	1a	1	OK	OK	TF
	1b	2	OK	OK	TF
	2	3	OK	LASA	
		4	OK	LASA	
	3	5			
		6			
M04	1a	1	OK	OK LASA	
	1b	2	OK	OK LASA	TF
	2	3	OK	OK LASA	TF
		4	OK	LASA	
	3	5			
		6			

Next shippings

wk 29 9 to 11 magnets LASA-> CERN

2+1 MCOXFs

wk 30 8 magnets to LASA

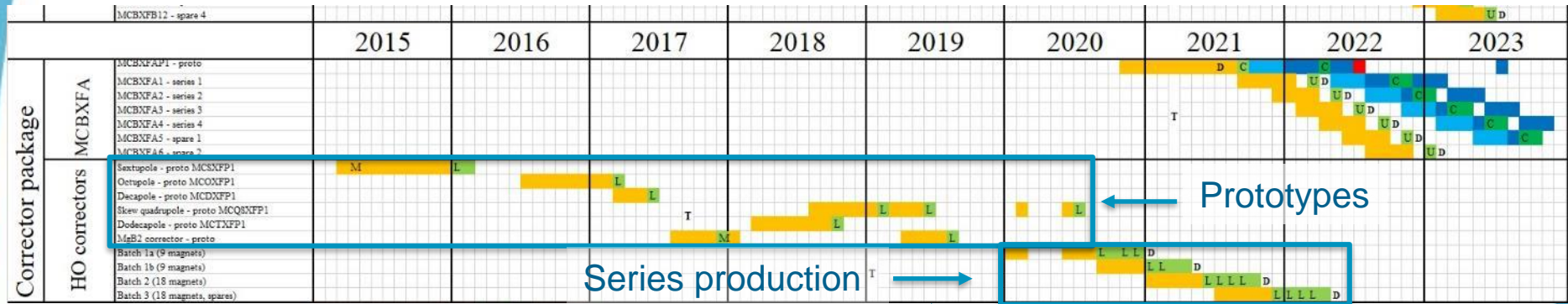
Next test in Spt 2021 **wk36** (6/9)

CERN	18,5%	10				54
tested	40,7%		22			54
produced	66,7%			36		54

MM@LASA 13 magnets (24%)

Schedule 1

- No updates
- 8 cooldown to test 32 magnets
- Completion of assembly expected in Oct 2021
- Expected end of testing at LASA mid 2022



← Prototypes
→ Series production
↑ Contract signed
↑ Batch 1 May 2021
↑ Batch 2 Nov 2021
↑ Batch 3 May 2022

Conclusion - aggiornare

- HO correctors series production ongoing
 - Almost all coils produced
 - Assembly within schedule
- Batch 2 in 3 were delivered at LASA, testing ongoing. 10 magnets at CERN
- No delays in HOC schedule