

**High
Luminosity
LHC**

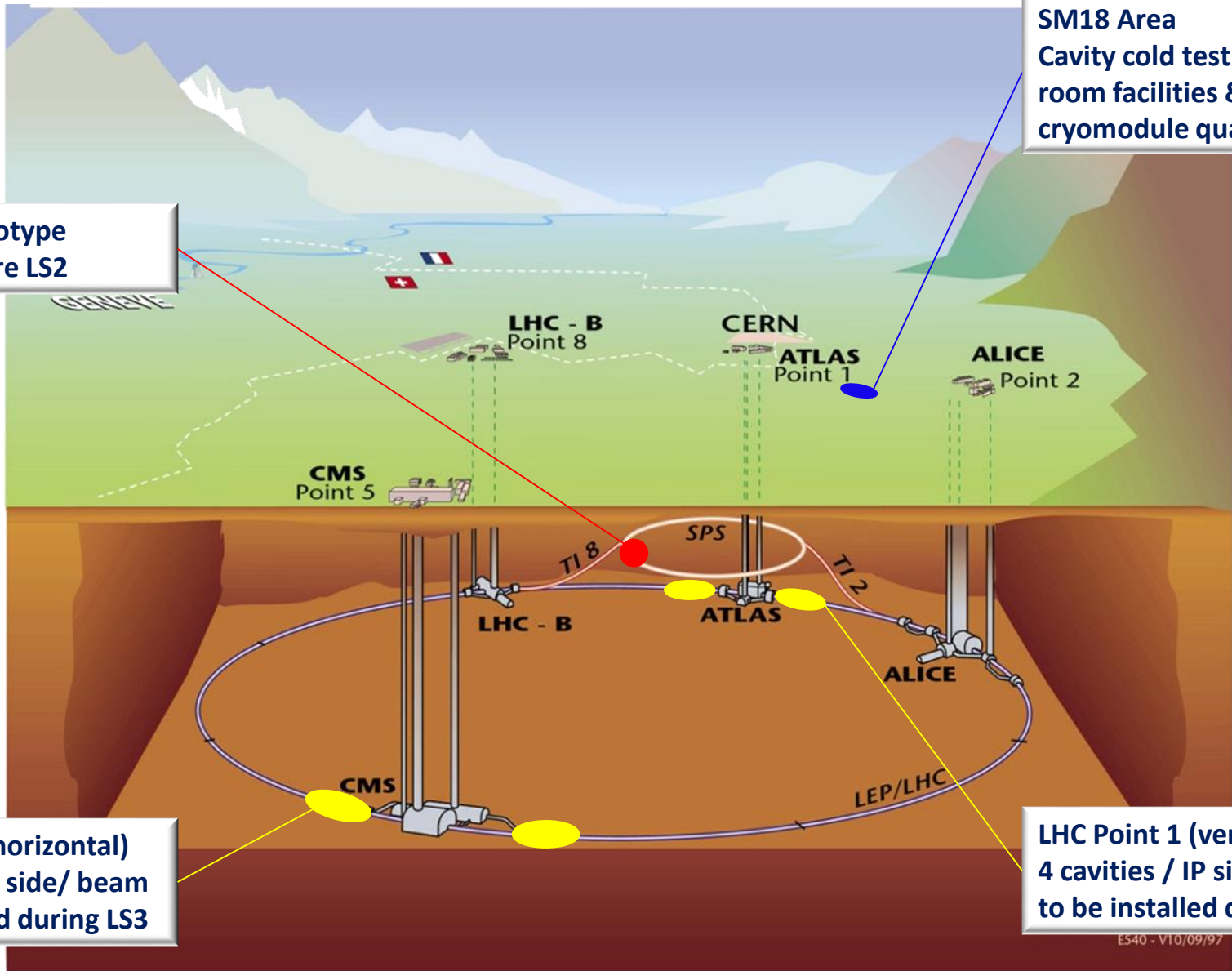
Cryomodule for crab cavities schedule overview

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SM18 Area
 Cavity cold testing, clean room facilities & cryomodule qualification

SPS Test Prototype Module before LS2

LHC Point 5 (horizontal)
 4 cavities / IP side/ beam to be installed during LS3

LHC Point 1 (vertical)
 4 cavities / IP side/ beam to be installed during LS3

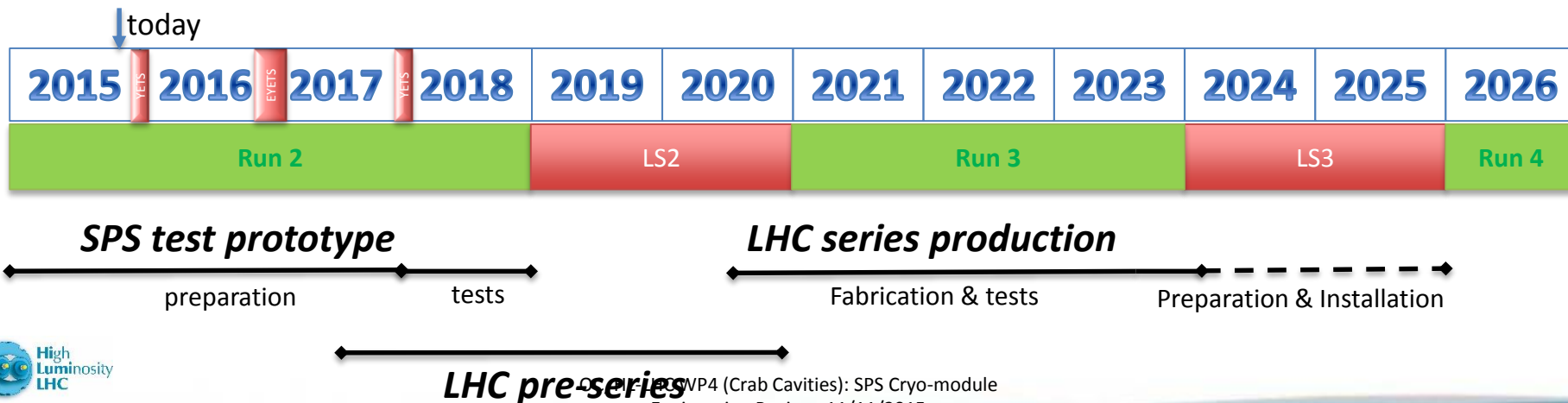
E540 - V10/09/97

Actual plans

- 2 cryomodules for SPS tests - test 1 cryomodule in 2018, the 2nd after LS2
 - 1 cryomodule with 2 identical cavities (type «vertical» - DQW)
 - 1 cryomodule with 2 identical cavities (type «horizontal» - RFD)
- 2 cryomodules pre-series for LHC (one of each type)
- 16 cryomodules for installation in LHC (8 of each type) + spares

post C&S review:

- all 32 dressed cavities to be produced
- only 8 cryomodules foreseen for installation in LS3 with subsequent cryomodules in the following technical stops
- this also allows schedule mitigation and flexibility to accommodate for crossing plane changes



SPS WP4 (Crab Cavities): SPS Cryo-module
Engineering Review, 11/11/2015

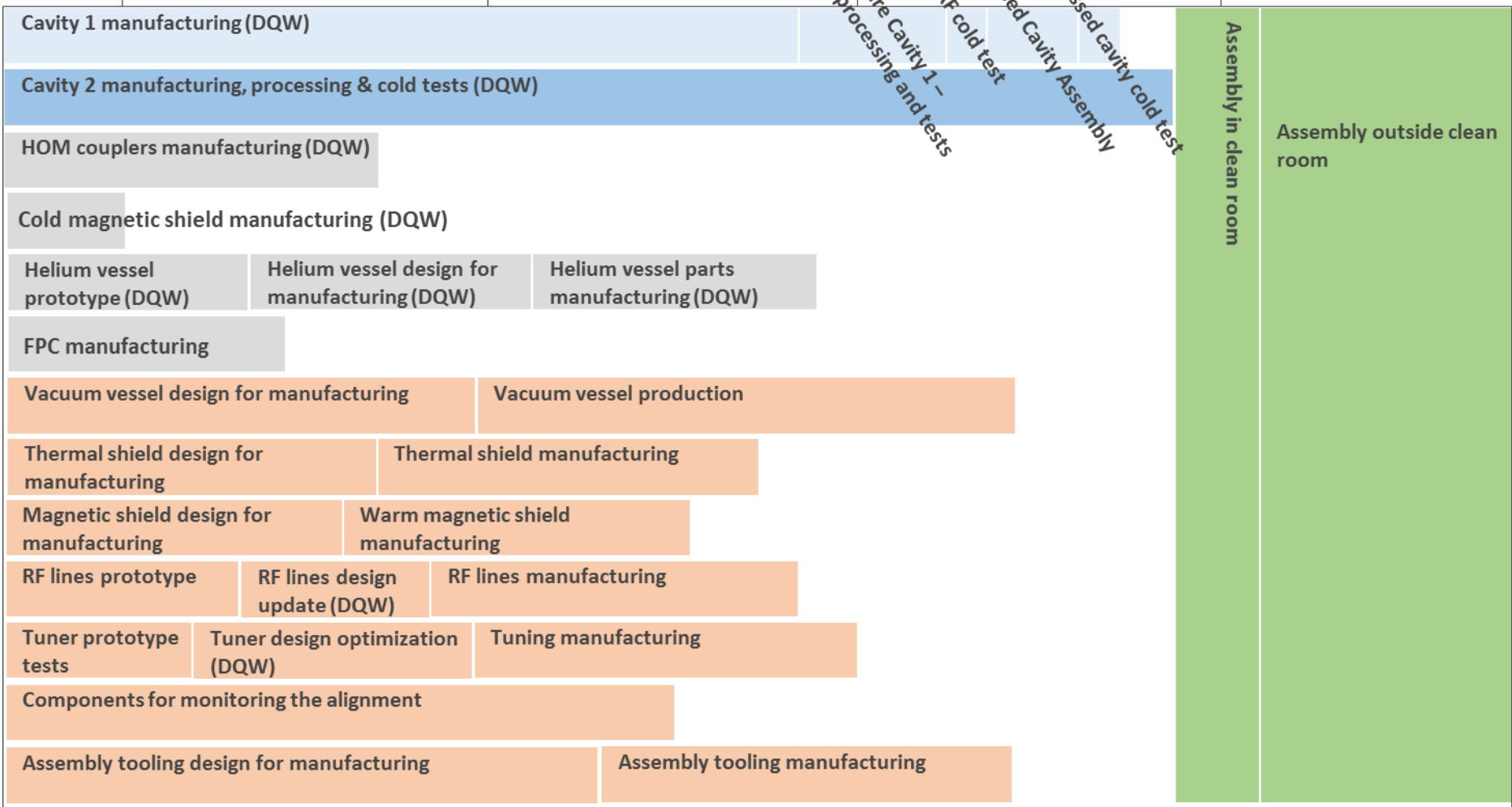
Plans for SPS

Qtr 1, 2016

Qtr 3, 2016

Qtr 1, 2017

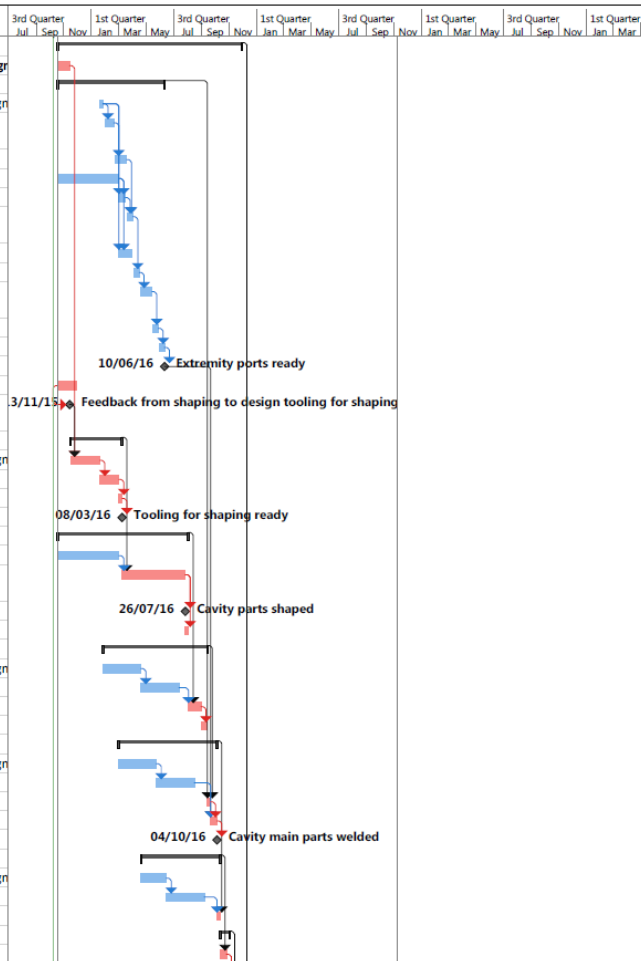
Qtr 3, 2017



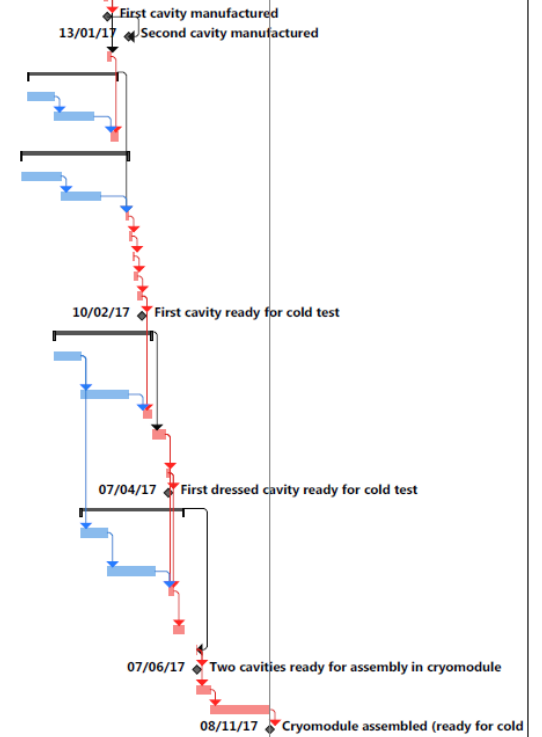
Contingency if cavities from USLARP are available

1st Cryomodule ready for cold test in SM18 (November 2017)

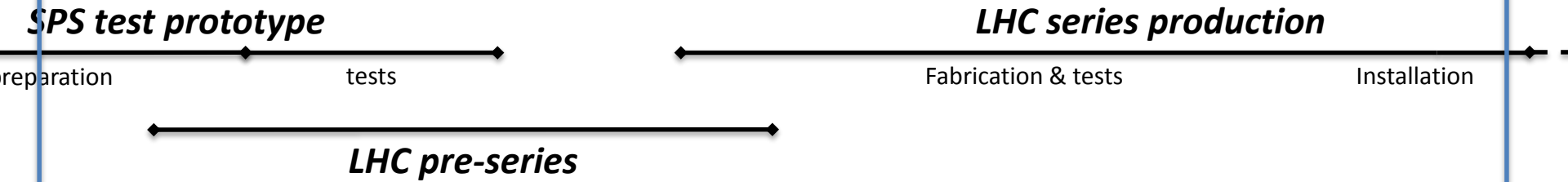
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	3rd Quarter			1st Quarter			3rd Quarter			1st Quarter			3rd Quarter			1st Quarter		
								Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May
1		Cavity construction - no 1	275 days	Mon 19/10/15	Tue 29/11/16																				
2		Design cavity for manufacturing	1 mon	Mon 19/10/15	Fri 13/11/15		Designer 1,Design																		
3		Extrmity ports	153 days	Mon 19/10/15	Fri 10/06/16																				
4		Design of extremity ports for manufacturing	1 wk	Wed 20/01/16	Tue 26/01/16		Designer 1,Design																		
5		Design of tooling for manufacturing of extremities	3 wks	Mon 01/02/16	Fri 19/02/16	4	Designer 3																		
6		Manufacturing of toolings	1 mon	Mon 22/02/16	Fri 18/03/16	5																			
7		Material procurement + acceptance tests	16 wks	Mon 19/10/15	Tue 01/03/16																				
8		Tube shaping	2 wks	Wed 02/03/16	Tue 15/03/16	7,4																			
9		EB welding of tube (including chemical polishing)	2 wks	Mon 21/03/16	Fri 01/04/16	8,6																			
10		Machining of parts	1 mon	Wed 02/03/16	Tue 29/03/16	7,4																			
11		Welding of thick interface	2 wks	Mon 04/04/16	Fri 15/04/16	9																			
12		Brazing of SS flange (includes assembly of insert, US tests)	4 wks	Mon 18/04/16	Fri 13/05/16	11																			
13		Machining of CF flange	2 wks	Mon 16/05/16	Fri 27/05/16	12																			
14		Metrology	2 wks	Mon 30/05/16	Fri 10/06/16	13																			
15		Extrmity ports ready	0 days	Fri 10/06/16	Fri 10/06/16	14																			
16		First shaping trials	1.5 mons	Mon 19/10/15	Fri 27/11/15																				
17		Feedback from shaping to design tooling for shaping	0 days	Fri 13/11/15	Fri 13/11/15	16SS+1 mon																			
18		Tooling for shaping	65 days	Mon 16/11/15	Tue 08/03/16																				
19		Design of tooling for shaping	1.5 mons	Mon 16/11/15	Tue 19/01/16	2,17	Designer 1,Design																		
20		Manufacturing of tooling	1.5 mons	Wed 20/01/16	Tue 01/03/16	19																			
21		Metrology	1 wk	Wed 02/03/16	Tue 08/03/16	20																			
22		Tooling for shaping ready	0 days	Tue 08/03/16	Tue 08/03/16	21																			
23		Shaping of parts	190 days	Mon 19/10/15	Tue 02/08/16																				
24		Material procurement + acceptance tests	16 wks	Mon 19/10/15	Tue 01/03/16																				
25		Several trials with intermediate metrology and possible remachining of tooling	5 mons	Wed 09/03/16	Tue 26/07/16	18,24																			
26		Cavity parts shaped	0 days	Tue 26/07/16	Tue 26/07/16	25																			
27		Chemical polishing of complete parts	1 wk	Wed 27/07/16	Tue 02/08/16	25																			
28		Machining of individual parts	165 days	Wed 27/01/16	Tue 13/09/16																				
29		Design of machining tooling	3 mons	Wed 27/01/16	Tue 19/04/16		Designer 1,Design																		
30		Manufacturing of tooling for machining	3 mons	Wed 20/04/16	Tue 12/07/16	29																			
31		Machining of parts	1 mon	Wed 03/08/16	Tue 30/08/16	30,23																			
32		Metrology	2 wks	Wed 31/08/16	Tue 13/09/16	31																			
33		EB welding of parts	156 days	Tue 01/03/16	Tue 04/10/16																				
34		Design of tooling for welding	3 mons	Tue 01/03/16	Mon 23/05/16		Designer 3,Design																		
35		Manufacturing of tooling for welding	3 mons	Tue 24/05/16	Mon 15/08/16	34																			
36		Chemical polishing	1 wk	Wed 14/09/16	Tue 20/09/16	28,3																			
37		EB welding of parts	2 wks	Wed 21/09/16	Tue 04/10/16	36,35,15																			
38		Cavity main parts welded	0 days	Tue 04/10/16	Tue 04/10/16	37																			
39		RF measurements of half cavity	125 days	Wed 20/04/16	Tue 11/10/16																				
40		Design of tooling for RF measurement	2 mons	Wed 20/04/16	Tue 14/06/16		Designer 1,Design																		
41		Manufacturing of tooling	3 mons	Wed 15/06/16	Tue 06/09/16	40																			
42		RF measurements of half cavity	1 wk	Wed 05/10/16	Tue 11/10/16	33,41																			
43		Machining (triming)	15 days	Wed 12/10/16	Tue 01/11/16																				
44		Machining	2 wks	Wed 12/10/16	Tue 25/10/16	39																			



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	3rd Quarter Jul Sep Nov	1st Quarter Jan Mar May	3rd Quarter Jul Sep Nov	1st Quarter Jan Mar May	3rd Quarter Jul Sep Nov	1st Quarter Jan Mar May	3rd Quarter Jul Sep Nov	1st Quarter Jan Mar May
45		Metrology	1 wk	Wed 26/10/16	Tue 01/11/16	44									
46		Final EB welding	15 days	Wed 02/11/16	Tue 22/11/16										
47		Chemical polishing	1 wk	Wed 02/11/16	Tue 08/11/16	43									
48		Welding	2 wks	Wed 09/11/16	Tue 22/11/16	47									
49		Final cavity metrology	1 wk	Wed 23/11/16	Tue 29/11/16	46									
50		First cavity manufactured	0 days	Tue 29/11/16	Tue 29/11/16	49									
51		Second cavity manufactured	0 days	Fri 13/01/17	Fri 13/01/17	50FF+1 mon									
52		Cavity RF measurements	1 wk	Wed 30/11/16	Tue 06/12/16	1									
53		Heavy BCP	135 days	Wed 15/06/16	Tue 20/12/16										
54		Design of BCP tooling	2 mons	Wed 15/06/16	Tue 09/08/16		Designer 1,Designer								
55		Manufacturing of BCP tooling	3 mons	Wed 10/08/16	Tue 01/11/16	54									
56		Heavy BCP of bare cavity	2 wks	Wed 07/12/16	Tue 20/12/16	55,52									
57		Tuning	150 days	Wed 01/06/16	Fri 13/01/17										
58		Design of tuning tooling	3 mons	Wed 01/06/16	Tue 23/08/16		Designer 3,Designer								
59		Manufacturing of tuning tooling	3 mons	Wed 24/08/16	Tue 15/11/16	58									
60		Tuning of bare cavity	1 wk	Mon 09/01/17	Fri 13/01/17	59,53									
61		Metrology after tuning	1 wk	Mon 16/01/17	Fri 20/01/17	60									
62		Cleaning	0.5 wks	Mon 23/01/17	Wed 25/01/17	61									
63		Heat treatment	1 wk	Wed 25/01/17	Wed 01/02/17	62									
64		Light BCP, HPWR	1.5 wks	Wed 01/02/17	Fri 10/02/17	63									
65		First cavity ready for cold test	0 days	Fri 10/02/17	Fri 10/02/17	64									
66		Cold test of bare cavity	135 days	Wed 10/08/16	Fri 03/03/17										
67		Design of adaptation of vertical test stand for bare cavity cold test	2 mons	Wed 10/08/16	Tue 04/10/16		Designer 1,Designer 2								
68		Manufacturing of adaptation	3 mons	Wed 05/10/16	Fri 13/01/17	67									
69		Cold test of bare cavity	3 wks	Mon 13/02/17	Fri 03/03/17	68,64									
70		Helium tank + magnetic shielding assembly + helium tank welding	1 mon	Mon 06/03/17	Fri 31/03/17	66									
71		Metrology of dressed cavity	1 wk	Mon 03/04/17	Fri 07/04/17	70									
72		First dressed cavity ready for cold test	0 days	Fri 07/04/17	Fri 07/04/17	71									
73		Cold test of dressed cavity	142.5 days	Wed 05/10/16	Wed 10/05/17										
74		Design of adaptation of vertical test stand for dressed cavity cold test	2 mons	Wed 05/10/16	Tue 29/11/16	67	Designer 1,Designer 2								
75		Manufacturing of adaptation	3 mons	Wed 30/11/16	Fri 10/03/17	74									
76		Assembly in clean room of cavity + HOMs + pick-up	1.5 wks	Mon 10/04/17	Wed 19/04/17	75,70,71									
77		Cold test of dressed cavity	3 wks	Wed 19/04/17	Wed 10/05/17	76									
78		Cavity construction, processing and tests - no 2	1 day	Tue 06/06/17	Wed 07/06/17	73FF+1 mon									
79		Two cavities ready for assembly in cryomodule	0 days	Wed 07/06/17	Wed 07/06/17	78									
80		Assembly of FPC and cavity string in clean room	1 mon	Wed 07/06/17	Wed 05/07/17	78									
81		Assembly of cryomodule outside clean room	4.5 mons	Wed 05/07/17	Wed 08/11/17	80									
82		Cryomodule assembled (ready for cold test)	0 days	Wed 08/11/17	Wed 08/11/17	81									

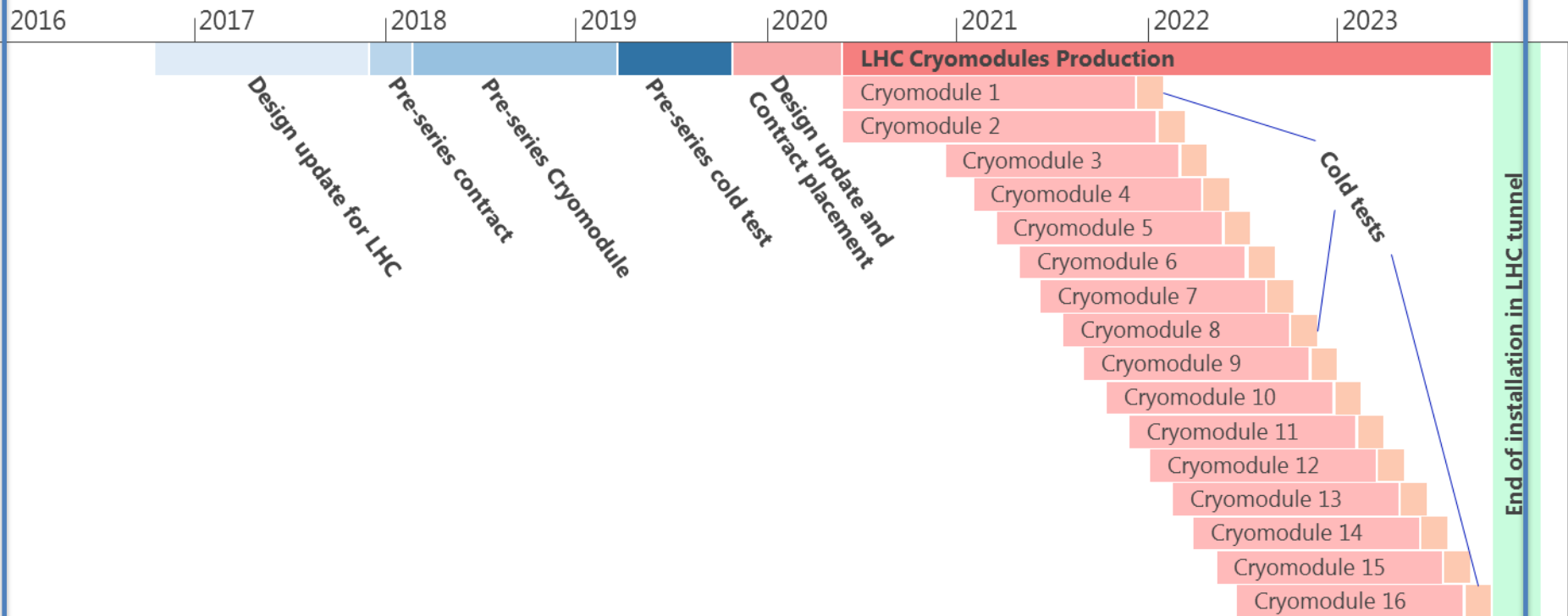


Initial plans for LHC (March 2015)



Preparation tests Fabrication & tests Installation

LHC pre-series



- LHC cryomodules production sequence*

