# **TE-CRG** Activities

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http://indico.cern.ch/event/436424/

## Outline

- 1. General frame: cryogenic installations under operation, maintenance, consolidations, projects
- 2. Main activities definition for maintenance and consolidations
- 3. LS2 baseline
- 4. Schedule, resources & budget for maintenance, consolidations and projects
- 5. Conclusions



# General frame: cryogenic installations under operation, maintenance, consolidations, projects

Operation, Ma	Projects	
Physics LHC accelerator LHC detectors SPS-North Area HIE-Isolde	Tests facilities SM18 B.163	HL-LHC SM18 upgrade B.163 upgrade B.180; FAIR Neutrino platform

B.165 central liquefier services (including AD supply)

Important milestone for the CRG Group:

New Operation & Maintenance contract to be implemented by 1<sup>st</sup> of July 2016, including:

✓ Maintenance (preventive, corrective, predictive) for all cryogenic installations at CERN

✓ Full delegation-results oriented operation for non-LHC cryogenics

(thus allowing staff resources to be made available for Projects)

✓ Tasks oriented operation for LHC accelerator & detectors under CERN's supervision



## Main activities definition; Maintenance, consolidations

- LHC accelerator & detectors YETS:
  - 3 days to 1 week maximum stop per installation for basic preventive & scheduled corrective maintenance (two teams of each Mechanics – Electricity/Instrumentation in parallel)

#### EYETS:

• Equivalent to YETS; extended to additional Safety Valves revision

Periodicity recently changed (SSI-M-2-3 Specific Safety Instruction for safety accessories)

#### LS2:

- Dominated by the major overhauling of helium compressors & associated electrical motors, cold compressors cartridges (12 months)
- Performing the full preventive maintenance plan (based on LS1 experience with less instrumentation activities) & scheduled corrective interventions (earlier diagnostic required for adequate scheduling)

#### Consolidations (according to the existing list, slide 10)



## YETS 2015-2016

#### LHC accelerator; helium management

Baseline: beam stop Mon.14/12/2015 Helium inventory: 90% remains in the magnets (IT, DFB, LSS @ 20 K) In case of plant stop (cryogenics or utilities) and restart within 12 h: no helium losses

Alternative: all sectors @ 20 K, helium inventory removed to surface; constraint for helium management: beam stop Wed. 09/12/2015

#### LHC accelerator; specific interventions

(Cat. A: Perturbation of Cryo-Maintain or Cat. B: Cryo-only)

- P8 (Cat. A): two weeks for repair of helium leak to insulation vacuum, cold box 18 kW @ 4.5 K (S81)
- P4 (Cat. A): two weeks oil pollution check and change of surface activated charcoal adsorber on 18 kW @ 4.5K (S34)
- P18/P2: replacement of one electrical motor
- P8: replacement of one helium compressor



## YETS 2015-2016

#### LHC detectors

#### CMS specific interventions

- Chemical cleaning of the cold box (underground) in collaboration with VSC group; duration under definition
- Liquid nitrogen distribution & heat exchanger repair, leak to insulation vacuum of the cold box (underground): 2 weeks (external specialised firm)
- Primary oil removal system replacement (surface); order in preparation in the frame of an existing supply contract; duration under definition
- Repair of partially damaged cryogenic valve on top of intermediate cryostat (underground)
- Dryer commissioning
- ATLAS specific interventions
- Dryer commissioning







### Major overhauling of helium compressors-motors stations





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## Helium Compressors major overhauling forecast (& experience from LS1)

Helium Compressors sent for major overhaul during LS1 per manufacturer with average major overhaul period per compressor and total major overhaul period

Manufacturer	Major overhaul per Compressor [wks]	Nbr of compressors for major overhaul	Total Periode [wks]
Aerzen	2.4	17	11 wks
Acizen	2.4	17	41 1013
Stal	1.5	24	36 wks
Kaeser	3	6	18 wks
Mayekawa-Mycom	6	3	18 wks
Howden	6	4	24 wks

#### LS2 forecast for helium compressors major overhaul to manufacturer's premises

Manufacturer	YETS 2015/16 RH >40'000	EYETS 2016/17 RH >40'000	YETS 2017/18 RH >40'000	LS2
Aerzen	2* repair	0	1	18
Stal	0	0	L 7	27
Howden	0	0	0	5
Mayekawa-Mycom	0	0	0	4
Kaeser	0	0	0	8



# Maintenance, Consolidations & Spares: schedule, resources and budget

Maintenance & Operation activities 2015-2020					L	<mark>S2</mark>		
	2015	<b>2016</b>	2017	2018	2019	2020		
Present maintenance contract C199 (ending by 30/06/2016)	2.1	1.05	0	0	0	0	3.15	MOUE
New maintenance & operation contract Exxx (starting by 01/07/2016)	0	3.05	6.1	6.6	7.4	6.1	29.25	
Total	2.1	4.1	6.1	6.6	7.4	6.1		

					L	S2		Approv	ved									
	2015	2016	2017	2018	2019	2020		Draft:	Still to I	be appl	roved							
Consolidations & spares overall	3.55	1.65	0.65	2.25	2.55	0.00		Team account		Int								
															L	62		
Consolidations & spares details		2015			2016		2017				<b>2018</b>			2019		2020		
	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF
NA62 consolidation 99571	0.05	0.1	0.2															
New central liquefier recovery compressor 99508	0.05	0.1	0.35															
Migration to Unicos/PVSS controls 99572	0.05	0.2	0.35	0.05	0.2	0.3												
LHC Continuation of compressor stations consolidation: spares 99500	0.05		1.2															
LHC DFB: spares 99500				0.1		0.5												
Electricity & Instrumentation consolidation: spares 99511	0.05	0.1	0.3															
LHC detectors purifier consolidation Team	0.3	0.3	1															
Central liquefier upgrade 99534	0.1	0.2	0.15															
Spare stock increase before Exxx Operation and Maintenance contract					0.1	0.35												
New AD cryo-distribution xxxxx							0.1	0.3	0.55	0.1	1	0.25						
HIE-Isolde compressors station consolidation: spares xxxxx				0.1		0.4												
LHC 24 V surface redundancy consolidation xxxxx					0.1	0.1		0.1	0.1									
LHC Quench line consolidation xxxxx													0.1	0.7	0.575			
LHC Continuation of compressor stations consolidation 99500										0.1	0.5	2	0.1	0.5	1			
LHC sectorization upgrade xxxxx													0.1	0.3	0.971			
Total	0.65	1.00	3.55	0.25	0.40	1.65	0.10	0.40	0.65	0.20	1.50	2.25	0.30	1.50	2.55	0.00	0.00	0.00



### Projects: schedule, resources and budget

											·												
										L	_S2												
						2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025							
	Proje	cts over	rall			5.0	64	2.6	11.2	14.4	0.2	0.1	24.0	25.9	20.0	43							
	1 10]0					0.0	0.4	2.0		1 4.4	0.2	0.1	24.0	20.0	20.0	4.0							
							2015			2016			2017			2018			2019			2020	
Projects	s details	S			-	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF	2	3&4	MCHF	2	3&4	МСН	F 2	3&4	MCHF
HIE-ISOLD	E		C	ryogenics	99580	1.25	1.6	0.15							_			_					
			Cryo Infra	structure	92705			0			0			0			0.963			0.96	3		0
			Cryopl	ant at P4	92706			0.15			0.9			0.863			1.238			2.47	5		0
			Cryoplants	s at P1/P5	92707			0			0			0			0			0			0
HL-LHC		Cryogen	ic Distribut	ion at P4	92708			0			0			0.325			0.975			1.95			0
-		Cryogenic	distribution	n at P1/P5	92709			0			0			0			0			0			0
	Cryoge	enic Instrum	ientation &	Controls	92/10	1.2	2.7	0.1	1.6	2.1	0.1	2.2	4.6	0	2.6	7.2	0.199	2.0	7.0	0.46	1 27	5.6	0
			r	M4P	92700	1.3	2.1	0.32	1.0	3.1	0.32	2.3	4.0	0.22	3.0	1.2	0.45	3.9	7.9	0.86	2.1	5.0	0.18
		RF Crv	ogenic Infra	astructure	69828	12	0.55	0.02	12	0.55	0.02			0.22			0.10			0.00			0.10
				HFM	99510	1.5	1.4	0.8	0.55	0.55	0.38									1			
SM18_Test	s			Cluster D	99510	0.45	0.3	0.42	0.75	0.9	0.9												
			HL-LH	C String	XXXXX	0.1	0.1	0	0.1	0.1	0	0.5	0.5	0.2	2	3	1	0.8	1.3	1.3			
SM18_UPC	3	Cry	oplant/infr	a upgrade	99514	0.3	0.4	0.2	0.4	0.5	0.3	0.4	0.7	0.4	1	2	6.4	1	2	6.4			
B163_Test	s C	ryogenic In	frastructure	e in B163	XXXXX				0.4	1	0.45	0.1	2	0.45									
P18-BA7		LHC Heliur	n manager	nent P18	XXXXX	0.5				0.1			0.2	0.1									
	-		Neutrino P	lateform	XXXXX	0.5	0.5		1	1		1	1		1	1		1	1	1	0.5	0.5	
Other			FC		10815	0.5		0.15			0.36			0.08									
Projects				FCC staff	90023	0.2		0.15	0.2		0.30	0.2		0.00	0.2						-		
				ILC staff	XXXXX	0.1			0.1			0.1			0.1								
		B 180 Cryogenics FAIR 99565			00565	2.1	2.2		· · -											1			
		B 1	ou Cryoger	NICS FAIR	99000	Z. I	2.6	2.7	1.7	2.0	2.7												
Total		В1	to Cryoger		99000	9.5	2.6 <b>10.2</b>	2.7 <b>5.0</b>	1.7 <b>8.0</b>	2.0 9.8	2.7 6.4	4.6	9.0	2.6	7.9	13.2	11.2	6.7	12.2	14.4	3.2	. 6.1	0.2
Total	2024	B 1	80 Cryoger		99565	9.5	2.6 <b>10.2</b>	2.7 <b>5.0</b>	1.7 8.0	2.0 9.8	2.7 6.4	4.6	9.0	2.6	7.9	13.2	11.2	6.7	12.2	14.4	3.2	. 6.1	0.2
Total	2021	MCHE	2	2022	MCHE	9.5	2.6 10.2 2(	2.7 <b>5.0</b> 23	1.7 8.0	2.0 9.8	2.7 6.4 2024 384	4.6	9.0	2.6 2025 384	7.9 MCHE	13.2	11.2	6.7 Total	12.2	14.4	3.2	2 6.1	0.2
Total 2	2021 3&4	MCHF	2	2022 3&4	MCHF	9.5	2.6 10.2 20	2.7 5.0 223 &4 N	1.7 8.0	2.0 9.8 2	2.7 6.4 2024 3&4	4.6 MCHF	9.0 2	2.6 2025 3&4	7.9 MCHF	<b>13.2</b> 2	11.2 3&4	6.7 Fotal Staf	12.2 f M(	14.4 CHF	3.2	2 6.1	0.2
Total 2	2021 3&4	MCHF	2	2022 3&4	MCHF	9.5	2.6 10.2 20 36	2.7 5.0 23 &4 N	1.7 8.0 ICHF	2.0 9.8 2	2.7 6.4 2024 3&4	4.6 MCHF	9.0 2	2.6 2025 3&4	7.9 MCHF	<b>13.2</b> 2 1.25	<b>11.2</b> <b>3&amp;4</b> 1.6	6.7 Total Staf 2.85	12.2 f M( 5 0	<b>14.4</b> CHF	3.2	2 6.1	0.2
Total 2	2021 3&4	MCHF	2	2022 3&4	99303 MCHF 3.1	9.5 2	2.6 10.2 20 30	2.7 5.0 223 &4 N	1.7 8.0 ICHF 3.9 0	2.0 9.8 2	2.7 6.4 2024 3&4	<b>4.6</b> <b>MCHF</b>	9.0 2	2.6 2025 3&4	7.9 MCHF 0	<b>13.2 2</b> 1.25 0 0	<b>11.2</b> <b>3&amp;4</b> 1.6 0	6.7 Total 2.85 0 0	<b>12.2</b> f M( 5 0 8	<b>14.4</b> <b>CHF</b> 15 3.9	3.2	2 6.1	0.2
Total 2	2021 3&4	MCHF	2	2022 3&4	99565 MCHF 3.1 0 16 13	2.1 9.5 2	2.6 10.2 20 30	2.7 5.0 23 &4 M	1.7 8.0 ICHF 3.9 0 6.13	2.0 9.8 2	2.7 6.4 2024 3&4	4.6 MCHF 0 0 21.5	9.0 2	2.6 2025 3&4	7.9 MCHF 0 0	<b>13.2 2</b> 1.25 0 0 0	<b>11.2 3&amp;4 1.6 0 0 0</b>	6.7 Fotal 2.85 0 0 0	12.2 f Mo 5 0 8 5 5	<b>CHF</b> 15 3.9 5.6 3.8	3.2	6.1	0.2
2	2021 3&4	MCHF 0 0 0 0 0	2	2022 3&4	<b>MCHF</b> 3.1 0 16.13	2.1 9.5 2	2.6 10.2 20 30	2.7 5.0 23 &4 M	1.7 8.0 ICHF 3.9 0 6.13 0	2.0	2.7 6.4 2024 3&4	<b>4.6</b> <b>MCHF</b> 0 0 21.5 0	9.0 2	2.6 2025 3&4	7.9 MCHF 0 0 0 0	13.2       2       1.25       0       0       0       0	<b>11.2 3&amp;4</b> 1.6 0 0 0 0 0	6.7 Fotal Staf 2.85 0 0 0 0 0 0 0	12.2 f M( 5 0 8 5 5 5	<b>CHF</b> 15 3.9 5.6 3.8 3.8	HL	<u>e 6.1</u>	0.2
2	2021 3&4	0 0 0 0 0	2	2022 3&4	99363 MCHF 3.1 0 16.13 0 3.75	2.1 9.5 2	2.6 10.2 20 30	2.7 5.0 23 &4 M 1	1.7 8.0 1CHF 3.9 0 6.13 0 3.75	2	2.7 6.4 2024 3&4	4.6 MCHF 0 0 21.5 0 7.5	2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 3.75	13.2       2       1.25       0       0       0       0       0       0       0	<b>11.2 3&amp;4 1.6 0 0 0 0 0 0 0 0 0 0</b>	6.7 Total 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2 f M( 5 0 5 5 5 5 5 1	<b>CHF</b> 15 3.9 5.6 3.8 3.3 8.8	HL	<u>6.1</u> -LH(	0.2
2	2021 3&4	0 0 0 0 0 0 0	2	2022 3&4	99363 MCHF 3.1 0 16.13 0 3.75 0.705	2.1 9.5 2	2.6 10.2 20 30	2.7 5.0 23 &4 M 1 1	1.7 8.0 ICHF 3.9 0 6.13 0 3.75 1.49	2	2.7 6.4 2024 3&4	4.6 MCHF 0 0 21.5 0 7.5 0.465	2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 3.75 0.465	13.2       2       1.25       0       0       0       0       0       0       0       0       0	11.2 3&4 1.6 0 0 0 0 0 0 0 0 0 0 0 0 0	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2 f M( 5 0 8 5 5 5 5 5 5 1 1 1 2	14.4           CHF           15           3.9           5.6           3.8           3.3           8.8           .0	HL 94.3	<u>е 6.1</u> - L H (	0.2
Total 2 3	2021 3&4	MCHF 0 0 0 0 0 0 0 0	2 5.7	2022 3&4	99363 MCHF 3.1 0 16.13 0 3.75 0.705	2.1 9.5 2 2	2.6 10.2 20 3. 3. 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	2.7 5.0 123 &4 N 1 1 1 2.5	1.7 8.0 ICHF 3.9 0 6.13 0 3.75 1.49	2.0 9.8 2 4.4	2.7 6.4 2024 3&4 	4.6 MCHF 0 0 21.5 0 7.5 0.465	<b>9.0</b> <b>2</b>	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 3.75 0.465	13.2       2       1.25       0	11.2 3&4 1.6 0 0 0 0 0 0 0 0 75.3	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 111.	12.2 f M( 5 0 6 5 5 5 5 1 1 2 9 (0)	14.4           CHF           1.15           3.9           5.6           3.8           3.3           8.8           1.0           0.0	94.3 111.9	-LHC MCHF	0.2
Total 2 3	2021 3&4 7	MCHF 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7	2022 3&4 	99363 MCHF 3.1 0 16.13 0 3.75 0.705 0.705	2.1 9.5 2	2.6 10.2 2( 3. 	2.7 5.0 123 &4 N 1 1 2.5	1.7 8.0 ICHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4	2.7 6.4 2024 3&4 8.9	4.6 MCHF 0 0 21.5 0 7.5 0.4 5	<b>9.0</b> <b>2</b> 2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13	<b>13.2 2</b> 1.25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	<b>11.2 3&amp;4 1.6 0 0 0 0 0 0 0 0 0 0</b>	6.7 Total 2.85 0 0 0 0 0 0 0 1111. 0	12.2           f         Md           5         0           6         8           5         5           5         5           3         3           9         0	14.4           CHF           115           3.9           5.6           3.8           3.8           8.8           1.0           0.0           1.0	94.3 111.9 4.0	-LHC MCHF FTE MCHF	0.2
Total 2 3 3	2021 3&4 7 7	MCHF 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7	2022 3&4 	99363           MCHF           3.1           0           16.13           0           3.75           0.705           0           0.34	2.1 9.5 2 	2.6 10.2 20 3.6 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2	2.7 5.0 23 &4 N 1 	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4	2.7 6.4 2024 3&4 8.9 8.9	4.6 MCHF 0 0 21.5 0 21.5 0 7.5 0.465	<b>9.0</b> <b>2</b> <u>2</u>	2.6 2025 3&4 	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           2.4	11.2           384           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1	6.7 Fotal 2.85 0 0 0 0 0 0 0 0 1111. 0 3.5	12.2           if         M0           5         0           8         5           5         5           3         1           2         2           9         0	14.4       CHF       15       3.9       5.6       3.8       3.3       8.8       1.0       0.0       0	94.3 4.0	-LHC MCHF FTE MCHF	0.2
Total 2 3 3	2021 3&4 7 7	MCHF 0 0 0 0 0 0 0 0 0 0 0	2 5.7	2022 3&4 11.7	99363 MCHF 3.1 0 16.13 0 3.75 0.705 0.34	<b>9.5</b>		2.7 5.0 23 &4 N 1 	1.7 8.0 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4	2.7 6.4 2024 3&4 8.9	4.6 MCHF 0 0 21.5 0 7.5 0.4 0.4	<b>9.0</b> <b>2</b> 2	2.6 2025 3&4 	7.9 MCHF 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           2.4           2.05	11.2           384           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95	6.7 Total 2.85 0 0 0 0 0 0 0 111. 0 3.5 4	12.2           if         M0           5         0           6         5           5         5           3         3           9         0           2         2           11         2           9         1	14.4       CHF       15       3.9       5.6       3.8       8.8       1.0       0.0       1.0       0       18	94.3 111.9 4.0	-LH( MCHF FTE MCHF	0.2
2 2 3	2021 3&4	MCHF 0 0 0 0 0 0 0 0 0	2 5.7	2022 3&4	99363 MCHF 3.1 0 16.13 0 3.75 0.705 0.34	<b>9.5</b>	2.6 10.2 20 3. 3.	2.7 5.0 123 8.4 N 1 1 2.5 (	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 4.4	2.7 6.4 2024 3&4 8.9	4.6 MCHF 0 0 21.5 0 7.5 0.465 0.4	<b>9.0</b> <b>2</b> 2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           1	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           1.1           1.95	6.7 Total 2.85 0 0 0 0 0 0 0 0 1111. 0 3.55 4 2.4	12.2           f         Md           5         0           6         5           5         5           3         3           9         (0           2         2           1         1	14.4 CHF 15 3.9 5.6 3.8 3.8 3.3 8.8 1.0 0.0 1.0 0 1.18 3.2	94.3 111.9 4.0 18.7	CHF MCHF MCHF MCHF	0.2
Total 2 3 3	2021 3&4 7 7	мснг 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 <b>proj</b>	2022 3&4	MCHF 3.1 0 16.13 0 3.75 0.705 0.34	9.5 2 6.1	2.6 10.2 20 3.0 10.2	2.7 5.0 123 8.4 N 1 1 2.5 (	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4	2.7 6.4 2024 3&4 8.9	4.6 MCHF 0 0 21.5 0 7.5 0.465 0.465	9.0 2 2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 0 3.75 0.465	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           2.05           1.2           3.5	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           5	6.7 Total 2.85 0 0 0 0 0 0 0 0 0 0 111. 0 3.5 4 2.4 8.5	12.2           if         Mu           5         0           5         5           5         5           3         3           11         2           9         0           1         1           2         2	14.4 CHF 15 3.9 5.6 3.8 3.3 8.8 1.0 0.0 1.0 0 1.18 3.2 2.5	94.3 111.9 4.0 18.7 27.1	CHF MCHF MCHF MCHF FTE	0.2
Total 2 3 3 Ove	2021 3&4 7 7	мснг 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 proj	2022 3&4	MCHF 3.1 0 16.13 0 3.75 0.705 0.34	9.5 2 6.1	2.6 10.2 2( 3. 10.2 10.2 10.2 10.2 10.2 10.2 10.2 10.	2.7 5.0 223 8.4 N 8.4 N 2.5 2.5	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	20 9.8 2 4.4	2.7 6.4 2024 3&4 8.9	4.6 MCHF 0 21.5 0 7.5 0.465 0.4	9.0 2 2	2.6 2025 3&4	7.9 MCHF 0 0 0 0 0 0 3.75 0.465	13.2           2           1.25           0.2           1.2           3.5           3.1	11.2           3&4           1.6           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6	6.7 Total 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2           if         Mu           5         0           5         5           5         5           3         1           2         2           9         0           11         2           12.2         1           12.2         1           2         1           1         2           1         1	14.2           CHF           15           3.9           5.6           3.8           8.8           1.0           0           1.18           3.22           2.5           3.7	94.3 111.9 4.0 18.7 27.1	CHF FTE MCHF FTE MCHF FTE	0.2
Total	2021 3&4 7 7 erall ( SM18	мсн 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 proj PG (2	2022 3&4 111.7 ect s :015-	MCHF 3.1 0 16.13 0 3.75 0.705 0.34	9.5 9.5 6.1 0) 2	2.6 10.2 20 3.0 10.2 10.2 10.2 10.2 10.2 10.2 10.2 10	2.7 5.0 123 8.4 N 1 1 2.5 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4 27.1	2.7 6.4 2024 3&4 8.9 8.9	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4	9.0 2 2 8.7 N	2.6 2025 3&4 4.1	7.9 MCHF 0 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0.0           2.05           1.2           3.5           3.1           0.5	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3	6.7 Total 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2           f         Mu           5         0           5         5           5         5           6         1           2         1           2         1           2         1	14.4 CHF 15 3.9 5.6 3.8 3.8 3.8 3.3 8.8 4.0 0.0 1.0 0 1.18 32 2.5 3.7 0.9	94.3 111.9 4.0 18.7 27.1	CHF FTE MCHF FTE MCHF FTE	0.2
Total 2 3 3 Ove	2021 384 7 7 erall ( SM18	MCHF 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5.7 proj	2022 3&4 11.7 ect s :015-	MCHF 3.1 0 16.13 0 3.75 0.705 0.34	9.5 9.5 6.1 0) 2	2.6 10.2 2( 3.4 10.2	2.7 5.0 123 8.4 N 1 1 2.5 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67	2.0 9.8 2 4.4 27.1	2.7 6.4 2024 3&4 8.9 8.9	4.6 MCHF 0 0 21.5 0 7.5 0.465 0.4 0.4	<u>2</u> 2 3.7 N	2.6 2025 384 4.1 4.1	7.9 MCHF 0 0 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0.5	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3.3	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2           ff         Mu           5         0           5         5           5         5           3         1           2         2           1         1           2         1           1         2           1         1           2         1	14.4       CHF       15       3.9       5.6       3.8       3.3       8.8       1.0       0.0       1.0       0.0       1.15	94.3 111.9 4.0 18.7 27.1	-LH( MCHF FTE MCHF FTE TE	
Total 2 3 3 OVE	2021 384 7 7 erall ( SM18 HL-L	мсн 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 proj 2G (2 2015	2022 3&4 11.7 ect s 015- 5-202	MCHF 3.1 0 16.13 0 3.75 0.705 0.34 0.34	9.5 9.5 2 6.1 0) a	2.6 10.2 20 3.0 10.2	2.7 5.0 23 8.4 N 2.5 2.5 2.5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67	2.0 9.8 2 4.4 27.1 .9 F	2.7 6.4 2024 3&4 8.9 8.9 FTE	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4	9.0 2 2 8.7 M	2.6 2025 384 4.1 4.1	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13 - 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           36.6           0           2.4           2.05           1.2           3.5           3.1           0.5           5	11.2           38.4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3           0.3           5	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 0 0 0 1111. 0 3.5 4 2.4 8.5 8.7 3.5 8.7 10 10 10 10 10 11 11 11 11 11	12.2           ff         Mu           5         0           6         8           5         5           3         1           2         2           9         0           1         1           2         1           1         1           2         1           1         1           1         1           1         1	14.4       CHF       .15       3.8       3.8       3.3       8.8       1.0       0       118       .32       .2.5       3.7       0.9       0       0       1.15	94.3 111.9 4.0 18.7 27.1 SM	-LH( MCHF FTE MCHF FTE 18-L	JPG
Total 2 3 3	2021 384 7 7 erall ( SM18 HL-L	мсн <b></b> 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 PG (2 2015	2022 3&4 11.7 ect s 2015- 5-202	MCHF 3.1 0 16.13 0 3.75 0.705 0.34 0.34 0.34	9.5 9.5 2 6.1 0) a acco		2.7 5.0 23 84 M 2.5 2.5 0 0 2.5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67 0.67 0.67	20 9.8 2 4.4 27.1 .9 F	8.9 FTE	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4 0.4	9.0 2 2 8.7 M MCI	2.6 2025 384 4.1 4.1 HF)	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13 - 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.2           3.5           3.1           0.5	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3           0.3           5           0	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2 ff M0 5 0 5 5 5 5 5 5 5 5 5 1 1 2 2 9 ( 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1	14.4       CHF       .15       3.8       3.3       8.8       1.0       0.0       1.18       .32       2.5       3.7       0.9       0       0       0       0       0       0       0       0       0	94.3 111.9 4.0 18.7 27.1 SM	-LH( MCHF FTE MCHF FTE	JPG
Total	2021 384 7 7 8 7 8 7 8 8 1 1 4 1 4 1 4 1 4 1 4	мсн 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 Proj PG (2 2015	2022 3&4 11.7 ect s 2015- 5-202	3.1 0 16.13 0 3.75 0.705 0.34 0.34 0.34	9.5 9.5 2 6.1 0) a acco		2.7 5.0 23 84 M 1 2.5 2.5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67 0.67	2.0 9.8 2 4.4 27.1 .9 F	8.9 FTE (	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4	9.0 2 2 8.7 M MC	2.6 2025 384 4.1 4.1 HF)	7.9 MCHF 0 0 0 0 3.75 0.465 0.13 - 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.2           3.5           3.1           0.5           0           5           0.5           0	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3           0.3           0.3           0           0	6.7 Total Staf 2.85 0 0 0 0 0 0 0 0 0 0 0 1111. 0 0 3.55 4 2.4 8.5 8.7 3.5 10 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2 ff MM 5 0 5 5 5 5 5 5 5 7 11 2 2 9 (0 11 11 12 11 11 12 11 11 11 12 11 11	14.4       CHF       .15       .8.9       .6       .3.8       .0       .0       .0       .0       .0       .0       .18       .32       .3.7       .9       0       0       0       0       0       .59	94.3 111.9 4.0 18.7 27.1 SM	-LH( MCHF FTE MCHF FTE	JPG
2 3 3 Ove	2021 384 7 7 8 7 8 M18 HL-L	MCHF 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 PG (2 2015	2022 3&4 11.7 11.7 ect s 015- 5-202	99900 MCHF 3.1 0 16.13 0 3.75 0.705 0.34 0.34 0.34 0.34	9.5 9.5 6.1 0) a acco		2.7 5.0 23 &4 M 1 1 2.5 ( 2.5 ( 0 ) 2.5 ( 0 ) 0 ) 0 ) 0 ) 0 ) 0 ) 0 ) 0 ) 0 ) 0	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67 0.67	20 9.8 2 4.4 27.1 .9 F	8.9 FTE (	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4 0.4	9.0 2 2 8.7 M MC	2.6 2025 384 4.1 4.1 HF)	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           36.6           0           2.4           2.05           1.2           3.5           3.1           0.5           0.5           0.5           0.5           0.5           0.5           0.8	11.2           3&4           1.6           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3           0.3           5           0           0           0	6.7 Total Staf 0 0 0 0 0 0 0 0 0 0 0 0 1111. 0 3.55 4 4 2.44 8.55 8.7 3.5 10 0.5 0 0 0.8 10 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2 f M( 5 0) 8 5 5 5 5 5 2 1 1 2 9 ( 2 1 1 2 9 ( 2 1 1 2 1 1 2 1 1 2 2 9 ( 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 1 2 1 1 1 2 1 1 1 2 1 1 1 2 1 1 1 1 2 1 1 1 2 1 1 1 2 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1	14.4 CHF 15 3.9 5.6 3.8 3.3 8.8 3.3 8.8 3.3 8.8 3.3 8.8 3.3 9.0 1.0 0 1.18 3.2 2.5 3.7 9.9 0 0 0 0 5.9 0 0	94.3 111.9 4.0 18.7 27.1 SM	-LHC MCHF FTE MCHF FTE	JPG
2 2 3 3 Ove	2021 384 7 7 8 7 8 M18 HL-L	MCHF 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 PG (2 2015	2022 3&4 11.7 11.7 ect s 015- 5-202	99965 MCHF 3.1 0 16.13 0 3.75 0.705 0.34 0.34 0.34 0.34			2.7 5.0 123 84 N 1 1 1 2.5 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67	20 9.8 2 4.4 27.1 .9 F	2.7 6.4 2024 3&4 8.9 8.9 FTE	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4	9.0 2 2 8.7 M MC	2.6 2025 3&4 4.1 4.1 HF)	7.9 MCHF 0 0 0 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           2.4           2.5           3.5           3.1           0.5           5           0.5           0.5           0.8           0.4	11.2           3&4           1.6           0           0           0           0           0           0           0           0           1.1           1.95           1.2           5           5.6           3           0.3           5           0           0           0           0           0           0           0           0           0           0           0	6.7 Total 2.85 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2           f         Md           5         0           5         5           5         5           3         1           2         9           1         1           1         1           2         1           0         0	14.4 CHF 15 3.9 5.6 3.8 3.3 8.8 3.3 8.8 3.3 8.8 3.3 8.8 5.0 0.0 0 1.0 0 0 1.8 3.2 2.5 3.7 0.9 0 0 0 5.59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	94.3 111.9 4.0 18.7 27.1 SM	-LH( MCHF FTE MCHF FTE 18-L	JPG
2 2 3 3	2021 384 7 7 8 7 8 M18 HL-L	мснг 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 5.7 PG (2 2015	2022 3&4 11.7 11.7 ect s 2015- 5-202	99963 MCHF 3.1 0 16.13 0 3.75 0.705 0.34 0.34 0.34			2.7 5.0 123 8.4 N 1 1 2.5 0 0 1 1 1 2.5 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1	1.7 8.0 1CHF 3.9 0 6.13 0 3.75 1.49 0.67 0.67	20 9.8 2 4.4 27.1 .9 F	2.7 6.4 2024 3&4 8.9 8.9 FTE TE (	4.6 MCHF 0 21.5 0 7.5 0.465 0.4 0.4 0.4	2 2 8.7 M MC	2.6 2025 3&4 4.1 4.1 HF)	7.9 MCHF 0 0 0 0 0 3.75 0.465 0.13	13.2           2           1.25           0           0           0           0           0           0           0           0           0           0           0           0           2.44           2.05           1.2           3.5           3.1           0.5           0           0.8           0.4           3.8	11.2           3&4           1.6           0           0           0           0           0           0           0           0           1.95           1.2           5           5.6           3           0.3           5           0.3           0	6.7 Total Staf 0 0 0 0 0 0 0 0 0 0 0 0 0	12.2           f         Mu           5         0           5         5           5         3           11         2           9         0           11         1           2         1           11         2           11         1           0         0           0         0           5.         5.	14.4 CHF 15 3.9 5.6 3.8 3.3 8.8 0.0 1.0 0 1.0 0 1.0 0 1.0 0 0 0 0 0 0 0 0 0 0 0 0 0	94.3 111.9 4.0 18.7 27.1 SM	-LH( MCHF FTE MCHF FTE 18-L	JPG

# HL-LHC, cryogenics general schedule



+ 11T dipoles @ P2 ?

+ possible work on some Q5@P6, LSS2-LSS8 beam-screens?



# Conclusions (1/2)

- Cryogenic operation, maintenance & consolidation activities for LHC accelerator and detectors adapted to YETS & EYETS definition and duration
- Specifically for YETS 2015-2016 special attention is given to CMS interventions, in order to fulfil the Collaboration's requirements and schedule
- The CRG group has an important milestone by the implementation of a new Operation & Maintenance contract by the 1<sup>st</sup> of July 2016, fulfilling two major objectives:
  - ✓ To cover all EYETS, YETS and LS2 maintenance activities
  - The full delegation-results oriented operation for non-LHC cryogenics (thus allowing staff resources to be made available for Projects)



# Conclusions (2/2)

- The major overhauling of the cryogenic equipment to manufacturer's premises is well adapted to the new LS2 duration and experience gained from LS1 performance can be applied
- During the warming-up phase, in case of discovery of mechanical damages to QRL or DFB components a dedicated team has to be allocated (in collaboration with VSC and MME groups)
- In parallel with the cryogenic operation activities CERN wide, during 2015-2020, a strong CRG support to projects is on schedule, in particular for the SM18 upgrade and HL-LHC activities





## Thank you for your attention