



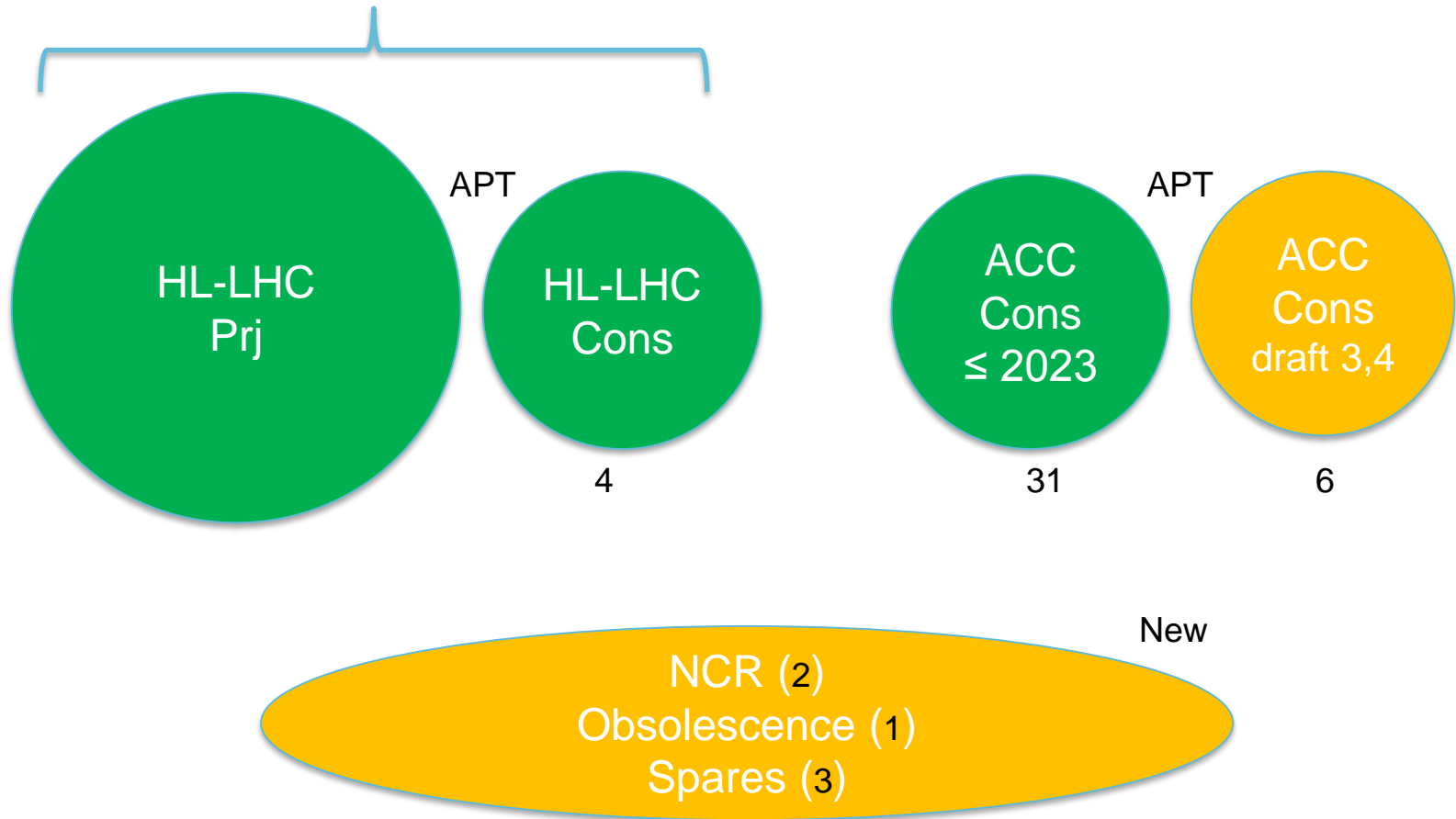
CONS and HL-LHC day Analysis of needs from TE-VSC

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26/09/2017

ACC-CONS and HL-CONS: TE-VSC

WP12 (CtC v11, C&S oct '16)



ACC-CONS – Planned, Active, Completed (1/2)

Status	Project	Budget code	WU descriptins	2017	2018	LS2		LS3					TOTAL		
						2019	2020	2021	2022	2023	2024	2025		2026	2027
Planned	EA-CONS	99834 - VSC Prj: EA-CONS BL 5 - vacuum	BL4 Controls upgrades	32	100										132
	LHC-CONS	99716 - VSC Prj: Acc Cons - LHC beam vacuum	Replacement of mobile pumping stations for arcs												50
		99727 - VSC Prj: Acc Cons - LHC Insulation Vacuum	Dry mobile pumping group												50
	PS-CONS	99741 - VSC Prj: Acc Cons - PS	Fixed pumping groups PS												50
99746 - VSC Prj: Acc Cons - ISOLDE - Controls		Isolde Vacuum control consolidation												78	
Active	ADCONS	99715 - VSC Prj: AD Ion Pumps	AD Ion pumps	4											44
		99762 - VSC Prj: Acc Cons - AD (and ELENA)	AD Vacuum Consolidation	150	140	52	52								681
	LHC-CONS	22108 - Non-approved activities for accelerator consolidation	LHC gauges beam vacuum		90	90									180
			NEG facility - power supplies and turbos		90										90
		99716 - VSC Prj: Acc Cons - LHC beam vacuum	Consolidation LHC beam vacuum	440	80	34		250	250	250					1657
		99727 - VSC Prj: Acc Cons - LHC Insulation Vacuum	Consolidation LHC insulation vacuum	150	150	172		130	130	130					1010
		99728 - VSC Prj: Acc Cons - LHC LSS additional sectorisation	Additional vacuum sectorisation in LHC LSS	60	60	60	60								240
		99763 - VSC Prj: Acc Cons - LHC bake out	Consolidation LHC Bakeout	200	400	200	173	150	150	150					1545
		99764 - VSC Prj: Acc Cons - LHC Beam Vacuum instrumentation	LHC Beam vacuum instrumentation	299	164	151		100	100	100					1049
		99776 - VSC Prj: Acc Cons - LHC Electron Cloud	Electron cloud mitigation actions	63	26	55	55	75	75	75					739
		99804 - VSC Prj: Acc Cons - LHC MKB dilution kickers - Turbos	LHC vacuum of dilution kicker	98	160	100									520
		99810 - VSC Prj: Acc Cons- Replacement BV mobile pumping groups-arcs	Replacement of mobile pumping stations for arcs	298	300	120		450	450						1670
		99825 - VSC Prj: Acc Cons - Dry mobile pumping group	Dry mobile pumping group	100	488										600
		99826 - VSC Prj: Acc Cons -Remote Control for MKI Sublimators	Remote control for MKI/TD sublimators	40	37										120
99843 - VSC Prj: LHC cons - Dump consolidation	Consolidation LHC beam dump	10	110										120		

ACC-CONS – Planned, Active, Completed (2/2)

Status	Project	Budget code	WU descriptins	2017	2018	LS2		LS3							TOTAL		
						2019	2020	2021	2022	2023	2024	2025	2026	2027			
Active	LHC-SPARES	99710 - VSC Prj: Acc Cons - LHC Spares - Ins. vacuum turbos	LHC insulation vacuum Turbos : spares	300	650	500	251									2304	
		99820 - VSC Prj: Acc Cons - LHC spares - MBX chambers	Vacuum chambers for MBX	44	40												133
		99821 - VSC Prj: Acc Cons - LHC spares - cavity	Vacuum spares: cavity spare	30	23												90
		99822 - VSC Prj: Acc Cons - LHC spares - RT magnet chambers	RT Magnet chamber	60	55			75	75	75							365
		99823 - VSC Prj: Spare Q1 beam screen tubes	Spare Q1 beam screen tubes	5	355												360
	PS-CONS	99741 - VSC Prj: Acc Cons - PS	PS complex vacuum system	215				150	150	150						1408	
		99824 - VSC Prj: Isolde pumps & front-end consolidation	Isolde pumps & front-end consolidation	60	110	60	60									290	
		99830 - VSC Prj: Acc Cons - PS fixed pumping	Fixed pumping groups PS	105	105	105	105	105	105							772	
		99831 - VSC Prj: Acc Cons - PS magnet consolidation	PS magnet consolidation - flanges, chambers, IS	137	135	105	84										524
		99832 - VSC Prj: Acc Cons -LINAC3 Ion Pumps	Linac3 ion pumps and bending chamber	50	39												130
		99833 - VSC Prj: Acc Cons - Linac2 vacuum consolidation	Linac 2 vacuum consolidation	40	40												121
	SPS-CONS	99747 - VSC Prj: Acc Cons - TI2 & TI8	Pumping and Instrumentation layout in TI2 and TI8	20	53	30										320	
		99840 - VSC Prj: Acc Cons - SPS ion pumps	SPS VPIA Ion pumps & IP power supply staged replacement	329	480	480	480	480	480							2880	
		99841 - VSC Prj: Acc Cons - SPS spares	SPS vacuum system / enamelled flanges, vacuum chambers, NEG cartridges	29	100	50											300
		99842 - VSC Prj: SPS cons - Pumping Groups cons - inj & ext zone	SPS: Pumping Groups cons - inj & ext zone	75	135	115											325
	SPS-SPARES	62722 - VSC Prj: Acc Cons - SPS & TD2	Vacuum components SPS and North area	197	225	120		150	150	150						1035	
	Completed	PS-CONS	62713 - VSC Prj: Acc Cons - PS - Controls	Vacuum controls for PS Complex												245	
	TOTAL				3640	4940	2599	1320	2115	2115	1080					22227	

ACC-CONS – Not Approved

Need to be evaluated:
Provision for inspection of 3800 devices

Status	Project	Budget code	WU descriptins	2017	2018	LS2		2021	2022	2023	LS3			2027	TOTAL
						2019	2020				2024	2025	2026		
Draft 3	LHC-CONS	22108 - Non-approved activities for accelerator consolidation	Evaluation and exchange of pressure valves and rupture discs		380										380
			Replacement of mobile pumping stations for arcs						450			450	450		1350
	PS-CONS	22110 - Non-approved activities for accelerator consolidation	Fixed pumping groups PS								105	105	105		315
	SPS-CONS	22111 - Non-approved activities for accelerator consolidation	SPS VPIA Ion pumps & IP power supply staged replacement								480	480	480		1440
Draft 4	EA-CONS	99834 - VSC Prj: EA-CONS BL 5 - vacuum	East Area Renovation project	32	100										132
	LHC-CONS	22108 - Non-approved activities for accelerator consolidation	Vacuum control of the LHC	100	700	900	300	100	100	900	900				4000
	SPS-CONS	22111 - Non-approved activities for accelerator consolidation	Vacuum control of the SPS	600	300	1000	800								2700
TOTAL				2749	1480	1900	1100	100	100	1935	1485	585	450	450	12334

Staged consolidations started in 2016.
So far approved up to 2022

ACC-CONS requests pending approval

(mark in red items that are more important in view of HL-LHC)

Item n.	Description	Budget request	Budget to be allocated in the years	Pending draft 4	Refused
1	Consolidation of the LHC Vacuum controls	2150	2018: 450 2019: 500 2020: 500 2021: 300 2022: 200 2023: 200	X	
2	Consolidation of the SPS Vacuum controls	800	2018: 200 2019: 250 2020: 250 2021: 100	X	

- Both requests reviewed & reduced wrt to existing APT numbers.
- Detailed 'consolidation request' documents updated

ACC-CONS draft 4: LHC Vacuum Controls

Rational of the request

Total Budget request	2150	Budget to be allocated in years (from-to)	2018-2023
Material budget request	1250	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	900	EoL replacement for ion pump controllers, PLC, SCADA servers. Cons of beam permit crate	

Consequences of suppression of request

Obsolescence of vacuum controls hardware and software
 Limited working memory so additional features/software updates not possible
 Limitation in data logging rates

Consequences of delay of request

Maintainability & reliability risk – vac control system availability
 Limited flexibility to adapt to operational needs

ACC-CONS draft 4: SPS Vacuum Controls

Rational of the request

Total Budget request	800	Budget to be allocated in years (from-to)	2018-2021
Material budget request	500	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	300	EoL repl PLC master (20yr) Cons elec distr racks Cons gauge control cards	

Consequences of suppression of request

Obsolescence of vacuum controls hardware and software
 Limited working memory so additional features/software updates not possible
 Limitation in data logging rates

Consequences of delay of request

Maintainability & reliability risk – vac control system availability
 Limited flexibility to adapt to operational needs

Approved HL-LHC CONS for WP12

- CONS for:
 - Shielded beam screens
 - RT LSS1 and 5
 - Insulation vacuum
- Total amount of CONS: 13.4 MCHF
 - includes the R2E contribution, ~2.5 MCHF
 - Approved and WUs created: 4 budget codes
- Ref. document: CtC V11 (*Cost and Schedule Review Oct 2016*)



97730 - HL-LHC WP12-Vacuum Screens-Consolidation

97732 - HL-LHC WP 12-Vacuum for LSS Consolidation

97733 - HL-LHC WP 12-Insulation Vacuum Consolidation

97740 - HL-LHC WP12-Vacuum (Personnel) CONS

Approved HL-LHC CONS for WP12

Sub title	total	Projet	Activity or Deliverable
SBS	VSM	CONS	BINP - a-C PSD at cryo temperature
RT LSS	ICM	R2E	FELL/PJAS: R2E (design + implementation + documer)
RT LSS	ICM	CONS	FELL/PJAS: SCADA / PLC / DB framework evolution
RT LSS		CONS	Mobile groups (VGPM)
RT LSS		CONS	Magic box (Rga+ Vac chamber)
RT LSS		CONS	NEG cartridges including ALARA 3 and 7
RT LSS	ICM	CONS	VPI re-cabling Pt3/Pt7 new controllers
RT LSS	ICM	CONS	VPI re-cabling Pt3/Pt7 new cables
RT LSS	ICM	R2E	electronics R2E (VRJGE)
RT LSS	ICM	R2E	electronics R2E (VPGF_local)
RT LSS	ICM	R2E	new fieldbus for electronics R2E (VRJGE) 2*27km
RT LSS	ICM	R2E	new cables for electronics R2E (VPGF @LSS)
RT LSS	ICM	CONS	cables rad-tol 30m,40CHF/m: COL3,7 ; IT1,5
RT LSS	ICM	CONS	PLC-Master replacement (all machine)
RT LSS	ICM	CONS	PLC-Master replacement (all machine)
RT LSS	ICM	CONS	PLC-Slave replacement (all machine)
RT LSS	ICM	CONS	PLC-Slave replacement (all machine)
RT LSS		CONS	IS Supervision (50 %)
RT LSS		CONS	FSU logistic (meca+BO) (50 %)
RT LSS		CONS	IS testing / validation (50 %)
RT LSS		CONS	IS mechanical installation (50 %)
RT LSS		CONS	IS bakeout installation (50 %)
RT LSS		CONS	FSU bakeout removal installation (50 %)
RT LSS		CONS	PJAS QAP (50 %)
RT LSS	ICM	CONS	FSU ICM (50 %)
IV	DLM	CONS	Pumping fixed groups
IV	DLM	CONS	Gauges (50 %)



Hardware	MPA	FSU	IS	p*y cern	Section	PBS
330					VSM	Shielded BS
1963	520.8				ICM, R2E	LSS RT
2484						
3538.6	453.6	748			ICM, CONS	LSS RT
4740.2						
1618.7	188.16	913	2218.75		Other	LSS RT
4938.61						
915		11	12.5	0.15	DLM	IV
938.65						
8365	5042.31				TOTAL	
13408						

HL-LHC CONS – in APT

Budget code	Work Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Grand Total
63226 - HL-LHC-14-Vacuum for absorbers (TDIS)-CONS	HL-LHC-WP14-M-InjectionSystem-TDIS - Vacuum works			0	200	200	58							459
63226 - HL-LHC-14-Vacuum for absorbers (TDIS)-CONS	63226 - HL-LHC-14-Vacuum for absorbers (TDIS)-CONS Total			0	200	200	58							459
91715 - HL-LHC WP14-Vacuum for absorbers(TCDS)-CONS	HL-LHC-WP14-M-LHCBeamDumpingSystem-TCDS vacuum works - LS3										21	21	5	48
91715 - HL-LHC WP14-Vacuum for absorbers(TCDS)-CONS	HL-LHC-WP14-M-LHCBeamDumpingSystem-TCDS vacuum works - Prep LS3						8	8	8	8				32
91715 - HL-LHC WP14-Vacuum for absorbers(TCDS)-CONS	91715 - HL-LHC WP14-Vacuum for absorbers(TCDS)-CONS Total						8	8	8	8	21	21	5	80
97730 - HL-LHC WP12-Vacuum Screens-Consolidation	1 HL-LHC-WP12-M-Vacuum screens-Shielded Beam Screen (VSM) - BINP collaboration		45											45
97730 - HL-LHC WP12-Vacuum Screens-Consolidation	1 HL-LHC-WP12-M-Vacuum screens-Shielded Beam Screen (VSM)-Collaboration	0	0	90	100	0	95							285
97730 - HL-LHC WP12-Vacuum Screens-Consolidation	97730 - HL-LHC WP12-Vacuum Screens-Consolidation Total	0	45	90	100	0	95							330
97732 - HL-LHC WP 12-Vacuum for LSS Consolidation	4 HL-LHC-WP12-M-RT LSS1 & LSS5-Infrastructure		0	0	0	0	757	486	1'021	1'432	1'109	534	534	5'873
97732 - HL-LHC WP 12-Vacuum for LSS Consolidation	4 HL-LHC-WP12-M-RT LSS1 & LSS5-Infrastructure-DR6061183 - NEG Pumps					53	53	53						160
97732 - HL-LHC WP 12-Vacuum for LSS Consolidation	4 HL-LHC-WP12-M-RT LSS1 & LSS5-Infrastructure-DR6210212-UHV All metal gate valves					340	340	340						1'020
97732 - HL-LHC WP 12-Vacuum for LSS Consolidation	97732 - HL-LHC WP 12-Vacuum for LSS Consolidation Total		0	0	0	393	1'150	879	1'021	1'432	1'109	534	534	7'053
97733 - HL-LHC WP 12-Insulation Vacuum Consolidation	5 HL-LHC-WP12-M-Insulation Vacuum (LVI)-Infrastructure		0	0	0	0	0	175	370	370	0	0	0	915
97733 - HL-LHC WP 12-Insulation Vacuum Consolidation	97733 - HL-LHC WP 12-Insulation Vacuum Consolidation Total		0	0	0	0	0	175	370	370	0	0	0	915
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	HL-LHC-WP12-M4P-Vacuum-Manpower FSU Contractor				0	165	165	0	11	6	495	745	341	1'928
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	HL-LHC-WP12-M4P-Vacuum-Manpower IS Contractor				0	0	0	0	13	200	750	1'013	0	1'976
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	HL-LHC-WP12-M4P-Vacuum-Manpower MPA				134	134	134	67	84	67	168	168	155	1'112
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	HL-LHC-WP12-M4P-Vacuum-Ongoing M4P Total	0	0	101	0	0	0	0	0	0	0	0	0	101
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	HL-LHC-WP12-M4P-Vacuum-Travels for Staff				0	0	0	0	0	0	0	0	0	0
97740 - HL-LHC WP12-Vacuum (Personnel) CONS	97740 - HL-LHC WP12-Vacuum (Personnel) CONS Total	0	0	101	134	299	299	67	107	273	1'413	1'926	496	5'116

WP12 13'414

WP14 539

GR, TE-VSC



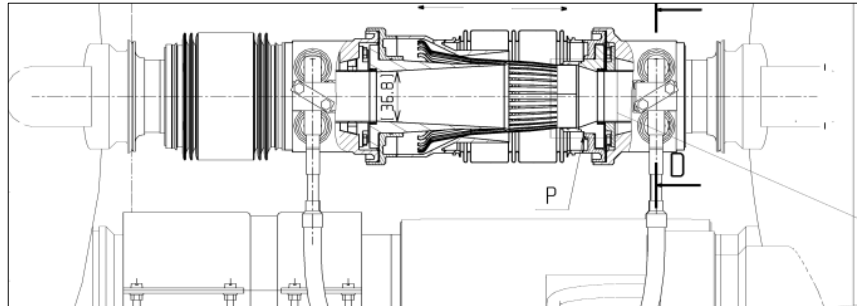
New requests for conversion of LHC into HL-LHC

Item	Description	Budget request	Budget to be allocated in years (from-to)	Priority (1-3) 1 top 3 low
1	Spares: LHC PIMs & nested bellows	1345k	2018-2023	1
2	Spares: MSD interconnection modules	376k	2021-2023	2
3	Spares: HL triplet: only 1 unit in VSC baseline			guidelines ?
4	Obsolescence: cPS vacuum controls	600k	2018-2021	1
5	NCR: 21L1 (MB #1060) beam screens	TBD	TBD	?
6	NCR: Q5L8 cryosorbers	TBD	TBD	?

ITEM 1: Arc beam vac interconnection spares

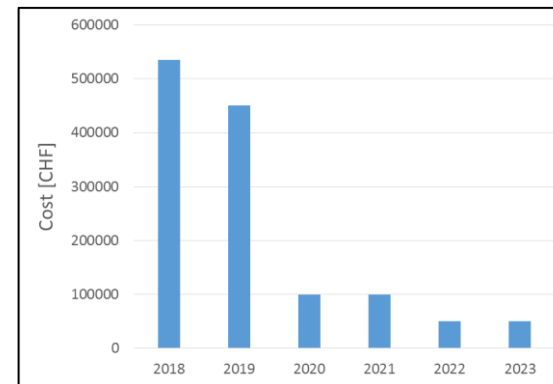
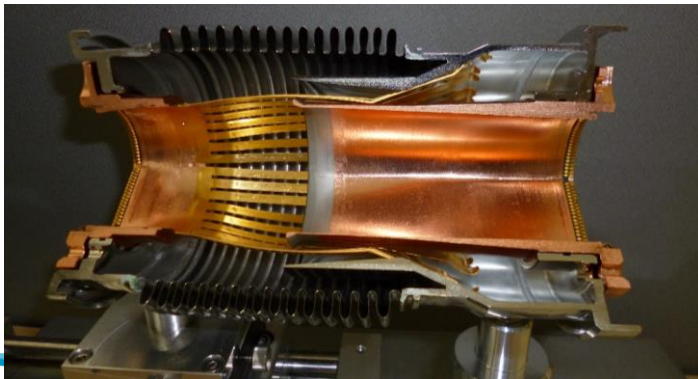
Arc & LSS beam screens available (separate parts to assemble in SMA18 beam screen facility)

- Focus on arc beam screen extremities and interconnections
- Assumptions: LS2 = 11T plus 20 dipoles LS3 = 4 Q10 plus 15 dipoles & 5 SSS



Review of stocks shows replenishment required for: **nested bellows** (35k) & **PIM refurbishment** (1310k)

- Detailed consolidation request in preparation
- Proposal & costing based on reworking of existing PIMs (procurement profile to agree)
- Stock status of SSS pumping manifold and k hoses to do



Item 1: Arc beam vacuum interconnect spares

Rational of the request

Total Budget request	1345k	Budget to be allocated in years (from-to)	2018-2023
Material budget request	1185k	Personnel available [y/n] in addition to personnel budget request	Yes
Personnel budget request (M2P budget for MPAs and fellows)	160k		

Consequences of suppression of request on HL performance

None

Consequences of delay of request to LS4 or later

Spares stock not sufficient for LS3 magnet exchange campaign
LS2 also requires small number of PIM refurbishments

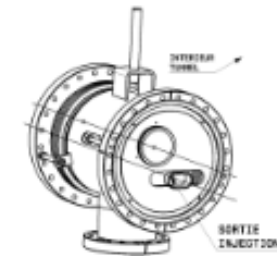
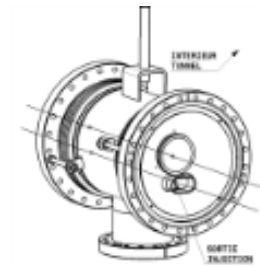
ITEM 2: MSD interconnection module spares

Limited number of interconnection modules for MSD

- Only 2 module bodies, plus some internal components
- 1 arm of the dump requires 15 modules

VSC propose to prepare spare modules for 2 arms

PART	DRAWING	Qté	Stock	missing for 100%	TOTAL
BODY	LHCVMSP0002	32	4	30	105000
Flange mask	LHCVMSDO0007	2	0	2	1000
Flange mask	LHCVMSDO0014	2	0	2	1000
Flange mask	LHCVMSP0004	18	0	18	9000
Flange mask	LHCVMSPDR0002	20	0	20	10000
Flange mask	LHCVMSPDT0002	18	0	18	9000
Flange mask	LHCVMSPDU0005	2	0	2	1000
Flange mask	LHCVMSPDU0004	2	0	2	1000
Tube+RF fingers	LHCVMSPIP0010	30	0	30	150000
Tube+RF fingers	LHCVMSPDO0011	2	1	1	5000
Tube for RF fingers	LHCVMSPIP0009	24	0	24	72000
Tube for RF fingers	LHCVMSPDO0006	2	0	2	6000
Tube for RF fingers	LHCVMSPDQ0002	2	3	0	0
Tube for RF fingers	LHCVMSPDS0002	2	0	2	6000
Tube for RF fingers	LHCVMSPDU0002	2	2	0	0
				TOTAL	376000



Item 2: MSD interconnection module spares

Rational of the request

Total Budget request	376k	Budget to be allocated in years (from-to)	2021-2023
Material budget request	376k	Personnel available [y/n] in addition to personnel budget request	Yes
Personnel budget request (M2P budget for MPAs and fellows)	No		

Consequences of suppression of request on HL performance

None

Consequences of delay of request to LS4 or later

Spares insufficient in case of beam dump incident – 4 month manufacturing

Item 4: cPS Vacuum Controls

NEW

Item n.	Description	Budget request	Budget to be allocated in the years	Pending	Refused
3	Consolidation of the cPS Vacuum controls	600	2018: 150 2019: 200 2020: 200 2021: 50		(NEW)

→ Detailed 'consolidation request' document has been prepared

Item 4: cPS Vacuum Controls

Rational of the request

Total Budget request	600	Budget to be allocated in years (from-to)	2018-2021
Material budget request	450	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	150	EoL PLC masters & slaves, gauge controllers, ion pump controllers, sector valve controllers	

Consequences of suppression of request

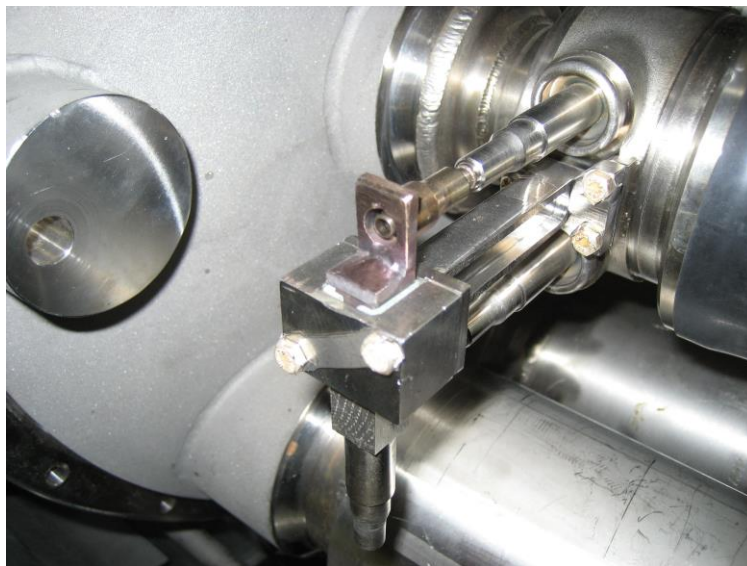
Obsolescence of vacuum controls hardware and software
 Limited working memory so additional features/software updates not possible
 Limitation in data logging rates

Consequences of delay of request

Maintainability & reliability risk – vac control system availability
 Limited flexibility to adapt to operational needs

ITEM 5: NCR 21L1 (#MB1060) beam screen

Due to a He to BV leak in Dec'07, V2 upper cooling capillary was isolated, together with the upper cooling capillary of V1 for flow balancing.



Issue discussed with TE/CRG & TE/MS

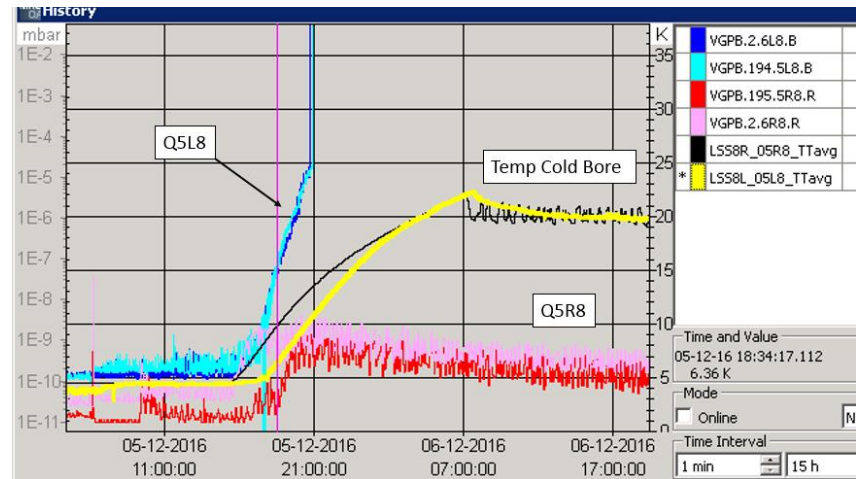
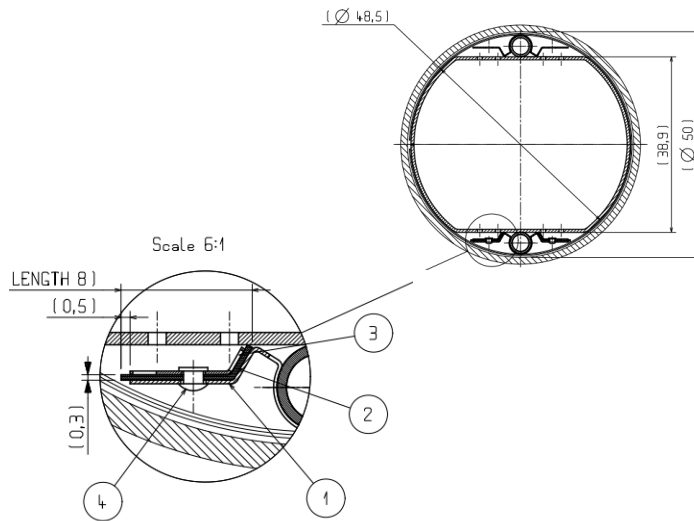
- Reduced heat extraction capacity
- Not considered as priority for LS1
- Duration and manpower requirements are known (eg S12, A31L2)

Solutions

- Exchange the #1060 cryomagnet in LS2 or LS3
- Evaluation of alternatives eg modification of QRL control valve
- **Requires evaluation by VSC & CRG**

ITEM 6: NCR Q5L8 cryosorbers

The Q5L8 magnet was exchanged in LS1. The replacement magnet was not equipped with beam screen cryosorbers (required on 4.5 K cold mass magnets for H₂ pumping).



Issue discussed with TE/MS

- Q5L8 exchange is heavy activity (DFBM removal, QRL jumper 2nd cut)
- Duration and manpower requirements are known (LS1)

Solutions:

- Exchange Q5L8 cryomagnet in LS2 or LS3
- VSC will study if reduction of the beam screen SEY (in-situ a-C coating or LESS laser engineering) would be an alternative solution.

Thanks for your attention

VSC gratefully acknowledge the guidance and support of the ACC-Cons and HL-LHC projects for the vacuum system consolidation program