



# **CONS and HL-LHC day**

## **Analysis of needs from TE-EPC**

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26/09/2017

# CONS and HL-CONS approved requests

(for HL-CONS except spares)

Item n.	Description	Approved Budget	Funding (CONS/HL-CONS) %	Budget to be allocated in the years
1	FMCM converter replacement for the LHC (complete)	1.6MCHF	CONS	2014-17
2	R2E: HL-LHC60A converters in ARC	7MCHF	HL-CONS	2018-25
3	R2E: HL-LHC120A converters in RR	1.35MCHF	HL-CONS	2018-25

Other R2E activities that will be completed during LS2 not mentioned here:  
 FGClite, 600A converters in RR, 4-6-8kA converters in RR

# CONS and HL-CONS requests pending approval or refused

Item n.	Description	Budget request	Budget to be allocated in the years	Pending	Refused
4	Consolidation of the LHC SVC @ P2	2.5MCHF	2018-20		X
5	Consolidation of the LHC SVC @ P4, P6 and P8	7.5MCHF	2021-25		X

Submitted to CONS as a single request for 10MCHF. Split in two here to facilitate prioritising.

# ITEM: 4

## Consolidation of the LHC SVC @ P2

Total Budget request	2.5MCHF	Budget to be allocated in years (from-to)	2018-25
Material budget request	2.5MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	none		

Consequences of suppression of request

High probability of significant failure, stopping LHC operation

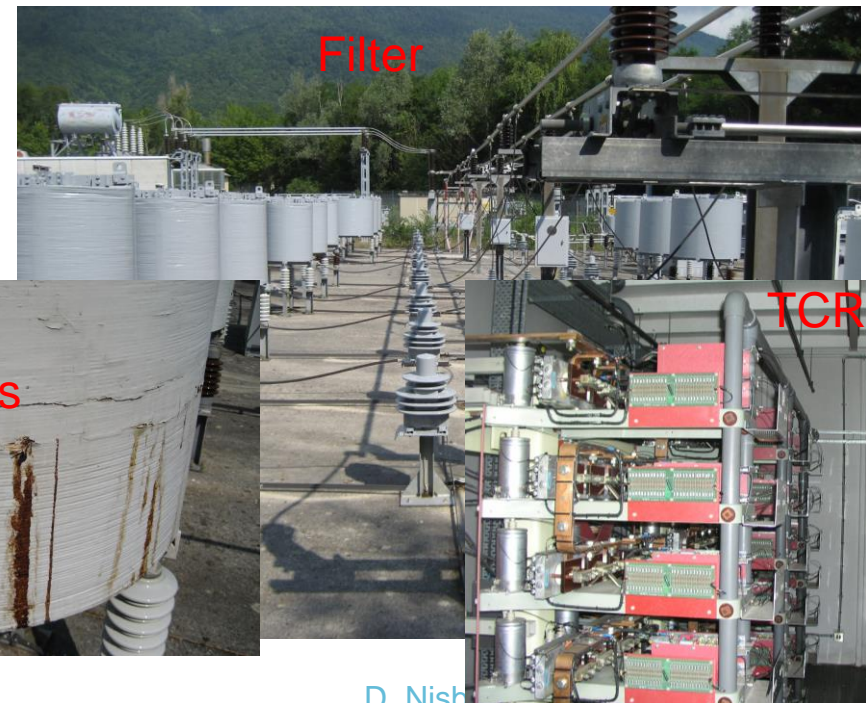
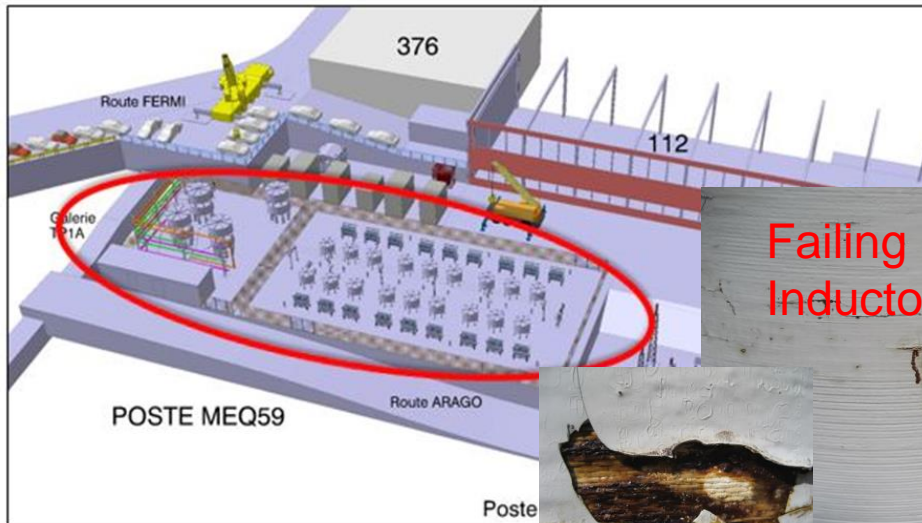
Consequences of delay of request

Increased probability of significant failure. Increased cost due to impossibility to take advantage of existing contracts.

# ITEM: 4

## Consolidation of the LHC SVC @ P2

- LHC SVC @ P2 is critical to LHC operation due to pulsing of T12
  - Filter is based on a series of tuned LC filters: in a poor state
  - TCR is reaching end of life
  - See EDMS 1547746 for CONS request
- Propose to consolidate with same design as used for MEQ59 (Meyrin site)
  - Can use existing contracts (very efficient)
- Filter can still be installed during LS2 (1.25 MCHF)
  - TCR in LS3 (1.25 MCHF)



# ITEM: 5

## Consolidation of the LHC SVCs @ P4, P6 and P8

Total Budget request	7.5MCHF**	Budget to be allocated in years (from-to)	2021-25
Material budget request	7.5MCHF**	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	none		

### Consequences of suppression of request

High probability of significant failure, stopping LHC operation.

### Consequences of delay of request

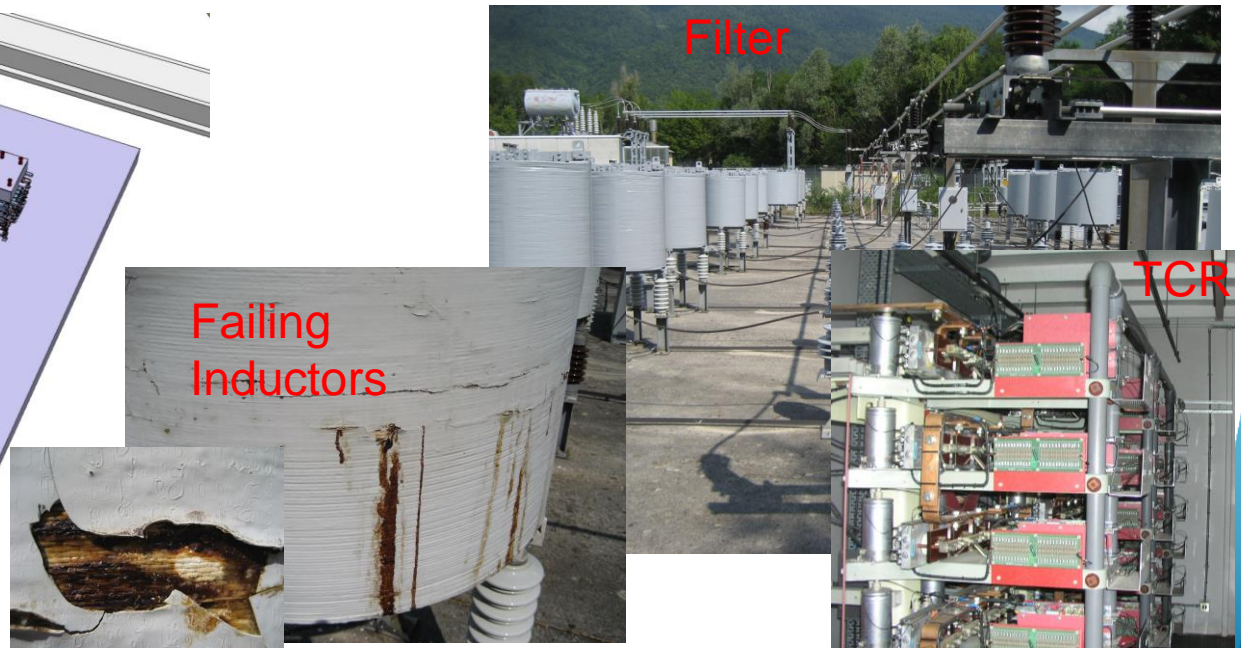
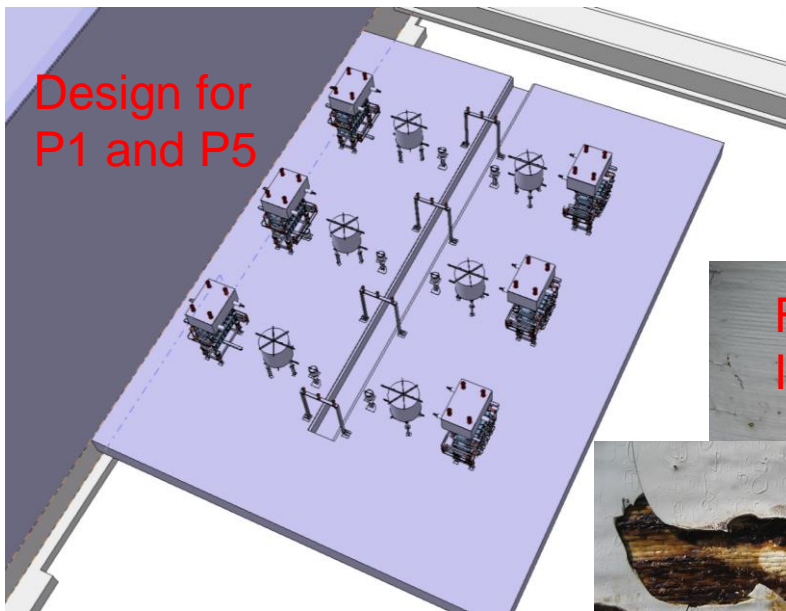
Increased probability of significant failure, stopping LHC operation.

\*\* Study started to find a reduced cost solution. May be possible to reduce to 2 MCHF implementing only filters similar to those proposed for P1 and P5.

# ITEM: 5

## Consolidation of the LHC SVCs @ P4, P6 and P8

- LHC SVC @ P4, P6 and P8 are important for LHC operation
  - Filter is based on a series of tuned LC filters in a poor state
  - TCR is reaching end of life
- Original proposal
  - consolidate with same design as used for MEQ59 (7.5MCHF)
- In study
  - Use filters similar to those proposed for P1 and P5 for HL-LHC (2MCHF)
  - *We will need to organise some tests at P8 during the YETS*



# New requests in view of HL-LHC installation

(to meet HL-LHC goals)



# New requests for conversion of LHC into HL-LHC

Item n.	Description	Budget request	Budget to be allocated in years (from-to)	Priority (1-3) 1 top 3 low
6	RB Converter cooling plates	0.3 MCHF	2018-20	1
7	600A power converters in the UA areas	10 MCHF	2021-25	1
8	LHC RF HV converters	2 MCHF	2021-25	1
9	ALICE experiment solenoid converter	2.5 MCHF	2021-25	1
10	R2E: Radtol auxiliary power supplies	1.1 MCHF	2018-20	1
11	Converter current measurement	3 MCHF	2023-25	2
12	FMCM converters to switch-mode	1.5 MCHF	2021-25	2

# ITEM: 6

## RB Converter cooling plates

Total Budget request	0.3 MCHF	Budget to be allocated in years (from-to)	2018-20
Material budget request	0.3 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	none		

Consequences of suppression of request

High probability of significant failure, stopping LHC operation

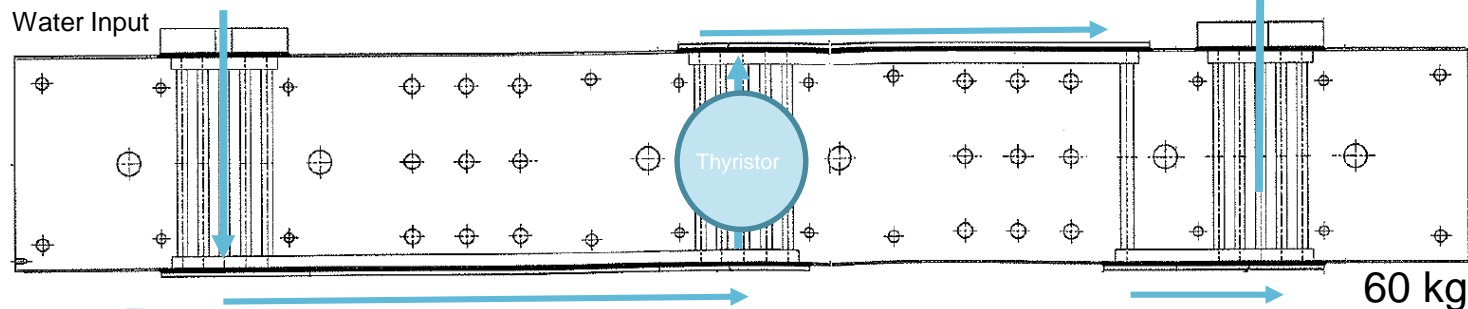
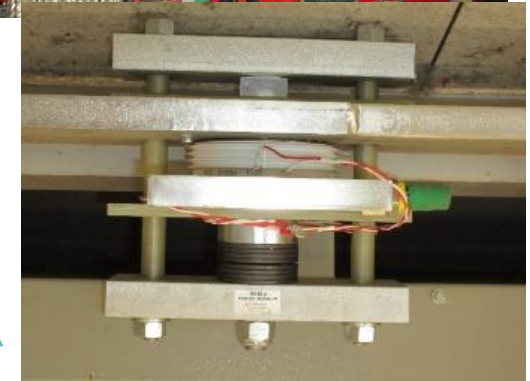
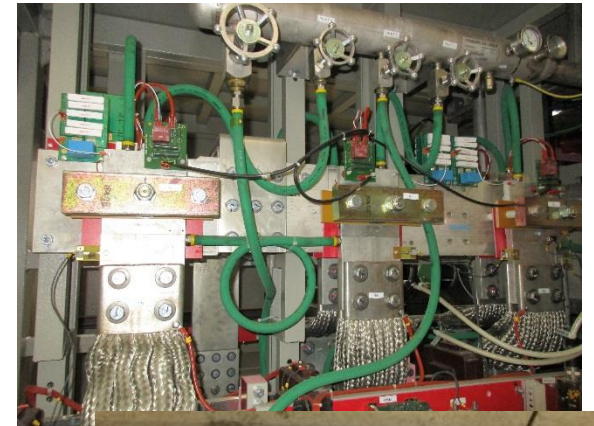
Consequences of delay of request

Increased probability of significant failure.

# ITEM: 6

## RB Converter cooling plates

- Water leaks occurring on main dipole power converters
  - Presented to LMC on 21 June 2017
- When failure occurs the current in the dipole must ramp slowly through the crowbar for many hours unless energy is extracted
- Repairs required every year. Situation is slowly degrading.



# ITEM: 7

## 600A power converters in the UA areas

Total Budget request	10 MCHF	Budget to be allocated in years (from-to)	2021-25
Material budget request	9.5 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	0.5 MCHF		

Consequences of suppression of request on HL performance

Reduced performance due to 600A general unreliability, leading to money spent in patching the current design to survive. Reduced availability.

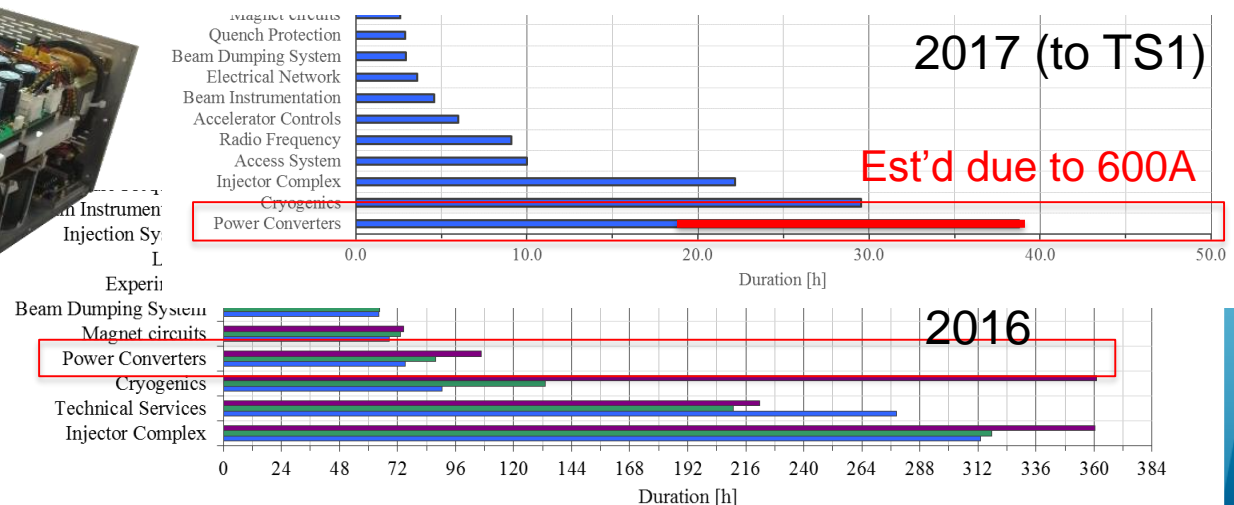
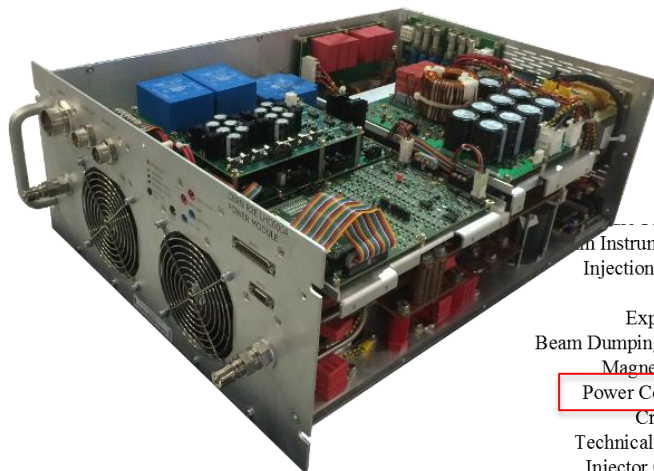
Consequences of delay of request to LS4 or later

Same as above. Reduced availability.

# ITEM: 7

## 600A power converters in the UA areas

- The R2E project consolidates all 600A converters for LS2 (120 in RR & UL)
  - Many 600A converters are not part of this program (280 in UA)
- Power converter unavailability is top of the list in 2017 ☹
  - Estimate >50% of downtime due to 600A systems (non redundant + critical)
- New systems will be more reliable (modular and redundant design)
  - A new version of this converter is already required for HL-LHC (around 26)
  - This project would be straightforward -> just increase production quantities



# ITEM: 8

## LHC RF HV converters

Total Budget request	2.5 MCHF	Budget to be allocated in years (from-to)	2021-25
Material budget request	2 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	0.5 MCHF		

Consequences of suppression of request on HL performance

Increased risk of oil leak. Increased risk of equipment failure.

Consequences of delay of request to LS4 or later

Increased risk of oil leak. Increased risk of equipment failure.

# ITEM: 8

## LHC RF HV converters

- Diode tank problem in May 2017
  - see TE-TM of 11/5/2017
- Systems date from LEP
- Consolidation to improve availability and reduce environmental impact
  - Propose cast resin transformers (no oil)
  - Update electronics
  - Further study required for design and update of diode tank

Power electronics converter

EPC Input transformers

Output transformers + diodes  
rectifier



# ITEM: 9

## ALICE experiment solenoid converter

Total Budget request	2.5 MCHF	Budget to be allocated in years (from-to)	2021-25
Material budget request	2.0 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	0.5 MCHF		

Consequences of suppression of request

High probability of significant failure, stopping ALICE operation

Consequences of delay of request

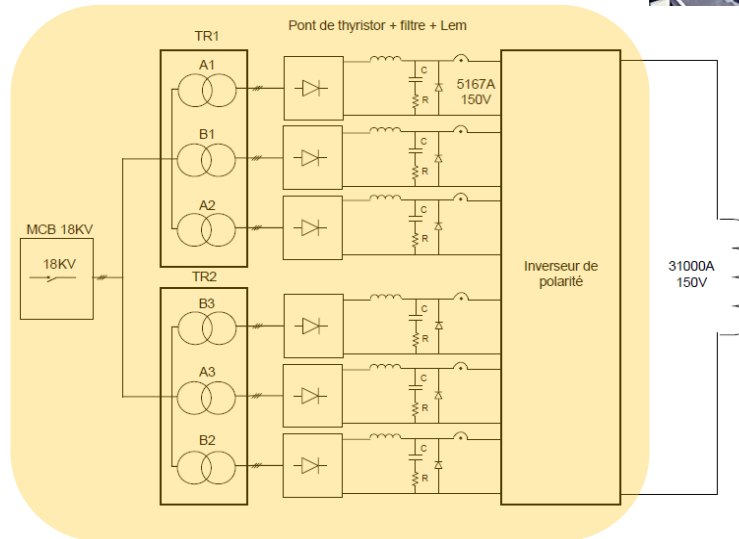
Increased probability of significant failure.



# ITEM: 9

## ALICE experiment solenoid converter

- ALICE solenoid converter is aging rapidly and badly
  - System installed in 1988, consolidated once in 2000
  - Failed 9 times in 2016
  - Discussed during TE-TM 16/2/2017 and LMC 26/10/2016
- New system will require a dedicated building.
  - Studies ongoing
  - Cost estimate includes some provision for infrastructure (to be refined).



# ITEM: 10

## Radtol Auxiliary Power Supplies

Total Budget request	1.1 MCHF	Budget to be allocated in years (from-to)	2018-20
Material budget request	1.1 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	none		

Consequences of suppression of request on HL performance

R2E consolidation needs to be completed for electronics powering

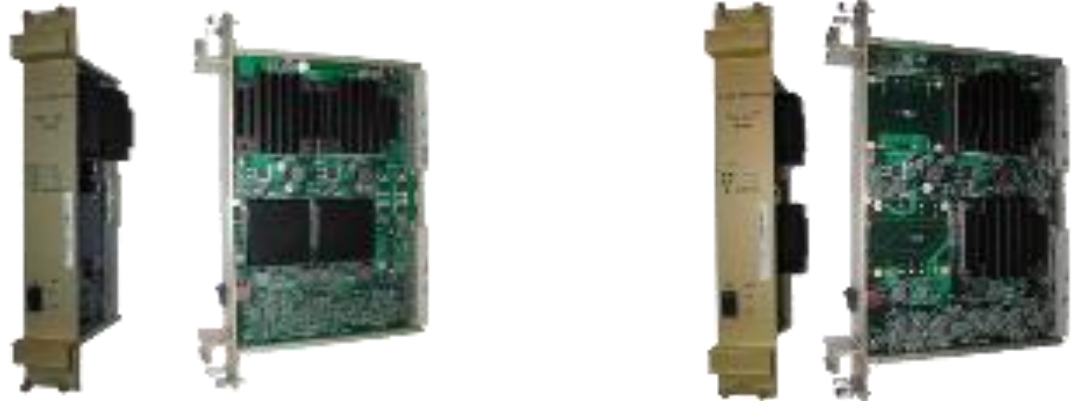
Consequences of delay of request to LS4 or later

R2E consolidation needs to be completed for electronics powering

# ITEM: 10

## R2E Radtol Auxiliary Power Supplies

- R2E project is consolidating the controller (FGClite) and the power converters (60A, 120A, 600A and 4-6-8kA)
  - The auxiliary power supplies were not included in the requirement
- Design is complete however need to launch production
- Request is going to R2E CSR in October
  - Mentioned here in case this falls under HL-CONS



# ITEM: 11

## Power Converter Current Measurement

Total Budget request	3 MCHF	Budget to be allocated in years (from-to)	2023-25
Material budget request	3 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	none		

Consequences of suppression of request on HL performance

Radiation and End Of Life will cause increased downtime. This is mitigated by existing redundancy (two DCCTs per converter).

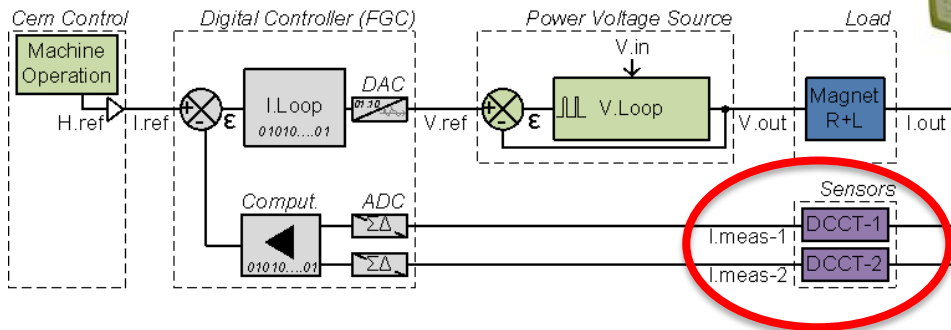
Consequences of delay of request to LS4 or later

Increasing failure rate due to radiation and End of Life. This is mitigated by existing redundancy (two DCCTs per converter).

# ITEM: 11

## Power converter current measurement

- Based on experience, the DCCTs are expected to have a lifetime between 15 and 25 years
- In LS3 all DCCTs will be 20 years old
  - radiation tolerance not yet quantified (test campaign to be foreseen)
  - an accelerated aging effect is anticipated in the ARC and RRs due to radiation
- A proactive approach would replace all DCCTs in the ARC and RRs during LS3
  - ARC (60A): 1 MCHF
  - RR (120A, 600A, kA): 2 MCHF



# ITEM: 12

## FMCM converters to switch-mode

Total Budget request	1.9 MCHF	Budget to be allocated in years (from-to)	2021-25
Material budget request	1.4 MCHF	Personnel available [y/n] in addition to personnel budget request	Y
Personnel budget request (M2P budget for MPAs and fellows)	0.5 MCHF		

Consequences of suppression of request on HL performance

FMCM system remains sensitive to electrical disturbances

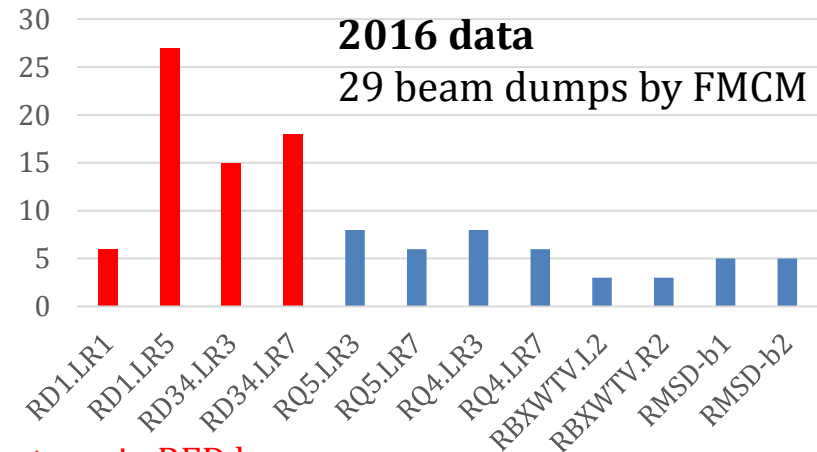
Consequences of delay of request to LS4 or later

FMCM system remains sensitive to electrical disturbances

# ITEM: 12

## FMCM converters to switch-mode

- Consolidation of RD1 and RD34 has eliminated FMCM events for these circuits
  - New systems use switch-mode technology with some energy storage
  - 9 beam dumps so far in 2017, **none due to RD1 or RD34** (cf. 29 for the 2016 run)
    - (preliminary estimate for 2017 to date) 7 dumps (80%) could have been prevented if all converters designed for electrical perturbation immunity
- In LS3, the RD1 will be replaced by a superconducting circuit
  - Propose to move the converters to the Q4 circuit in P3 and P7 (200kCHF infrastructure)
- Consider update to all other circuits with FMCM monitoring
  - A further 6 circuits in addition to Q4 (1.2 MCHF)



Systems in RED have  
been consolidated

# Summary

Priority (1-3) in decreasing order of importance	Item n.	Description	Approval Status: <ul style="list-style-type: none"> <li>• <i>Approved by CONS</i></li> <li>• <i>Approved by HL-CONS</i></li> <li>• <i>Not Approved by CONS</i></li> <li>• <i>Not Approved by HL-CONS</i> <ul style="list-style-type: none"> <li>• <i>New</i></li> </ul> </li> </ul>
1	1	RD1-RD34 converter replacement for the LHC FMCM (complete)	Approved by CONS
1	2	R2E: HL-LHC60A converters in ARC	Approved by HL-CONS
1	3	R2E: HL-LHC120A converters in RR	Approved by HL-CONS
1	4	Consolidation of the LHC SVC @ P2	Not Approved by CONS
1	5	Consolidation of the LHC SVCs @ P4, P6 and P8	Not Approved by CONS



# Summary

Priority (1-3) in decreasing order of importance	Item n.	Description	Approval Status: <ul style="list-style-type: none"> <li>• <i>Approved by CONS</i></li> <li>• <i>Approved by HL-CONS</i></li> <li>• <i>Not Approved by CONS</i></li> <li>• <i>Not Approved by HL-CONS</i> <ul style="list-style-type: none"> <li>• <i>New</i></li> </ul> </li> </ul>
1	6	RB Converter cooling plates	New
1	8	LHC RF HV converters	New
1	9	ALICE experiment solenoid converter	New
1	10	R2E: Radtol auxiliary power supplies	New
1	7	600A power converters in the UA areas	New
2	11	Power converter current measurement	New
2	12	FMCM converters to switch-mode	New