



High Luminosity LHC

HL_LHC, WP17.2, DC cables

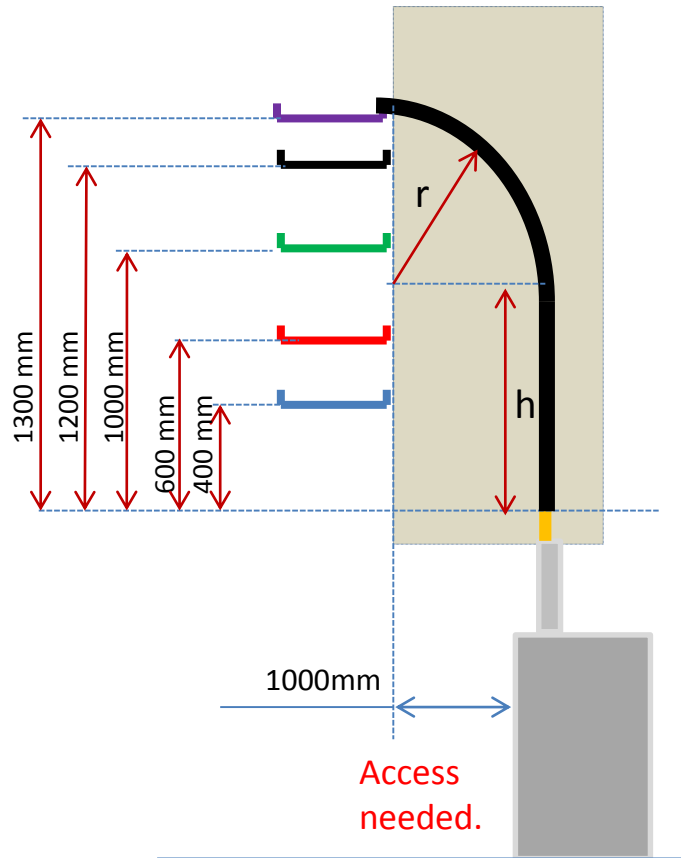
Review of CV loads
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17 Dec 2015 – EDMS xxxxx

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Minimum geometric constraints of DC lines HL-LHC

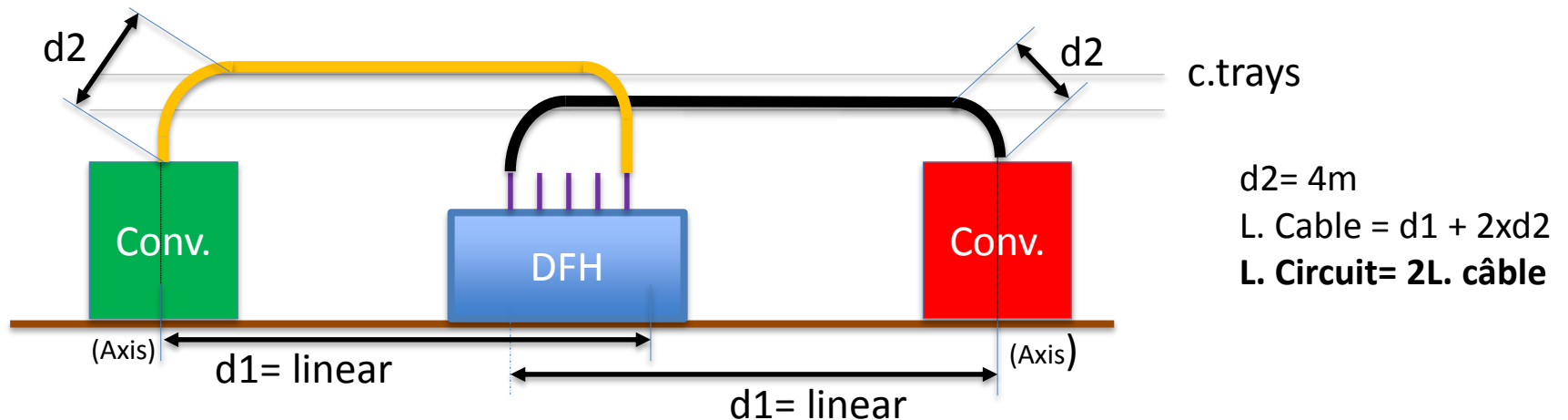
- Cables for circuits 13 & 18kA
- Cables for circuits 6kA
- Cables for circuits 2kA
- Cables for circuits 400A
- Cables for circuits 200/120A



	Section (mm ²)	h (mm)	r (mm)	Diam. ext. (mm)
18kA	2x1300	500	800	2x95
13kA	2000	500	800	115
6kA	1000	500	700	95
2kA	500	500	500	70
600A	400	300	300	36
200A	95	200	200	25
120A	70	150	150	22

Principle of distance calculation

- Currently, no attribution of the electrical circuit to the current leads,
- Position of the cable trays/convertors not exactly defined.



DC links (Version DC-ST0689858_01 A02-V2 ; 30-11-2015)

Optic	Magnet	Max current (KA)	number of circuits	DFH	Type convertisseur	Cable size (mm2)	Cable length (m) (prev version)
Q1-Q3	MQXFA	18	1	DFHX	T1	2600	78
Trim Q3		2	1	DFHX	T4	500	56
Q2a-Q2b	MQXFB	18	1	DFHX	T1	2600	78
Trim Q2		0.12	1	DFHX	T7	70	36
Corrector	MCBXFA	2	3	DFHX	T4	500	56
Corrector	MCBXFB	2	3	DFHX	T4	500	56
CP	MCQSX	0.12	1	DFHX	T6	70	40
CP	MCTX	0.12	1	DFHX	T6	70	40
CP	MCTSX	0.12	1	DFHX	T6	70	40
CP	MCDX	0.12	1	DFHX	T6	70	40
CP	MCDSX	0.12	1	DFHX	T6	70	40
CP	MCSX	0.12	1	DFHX	T6	70	40
CP	MCSSX	0.12	1	DFHX	T6	70	40
CP	MCOX	0.12	1	DFHX	T6	70	40
CP	MCOSX	0.12	1	DFHX	T6	70	40
D1	MBXF	13	1	DFHX	T2	2000	70
D2	MBRD	13	1	DFHM	T2	2000	72
Corrector D2	MCBRD	0.6	4	DFHM	T4	400	44
Q4	MQYY	6	2	DFHM	T3	1000	50
Corrector Q4	MCBYY	0.6	4	DFHM	T4	400	44
Q5	MQY	6	2	DFHM	T3	1000	50
Corrector Q5	MCBY	0.12	6	DFHM	T7	70	40
Q6	MQML	6	2	DFHM	T3	1000	50
Corrector Q6	MCBC	0.12	2	DFHM	T7	70	40
Total			43				

- Correctors Q4 MCBR & Q5 MCBY: 2kA -> 600A
- Correctors MCO/MCQ/MCT/MCD/MCS: 200A -> 120 A

DC cables: Based on the datas given by TE-EPC. EN-EL studies and integration are in progress.

Cable Section (mm2)	Cable type	Total length/si de IP (m)
2000	WCC	142
1300	WCC	312
1000	WCC	300
500	WCC	392
400	Warm	352
70	Warm	716

Losses/IP sides:

I Operating I Max

RI2: 652 kW 825 kW

Air: 73 kW 89 kW

05-10-2015



DC links (Version DC-ST0689858_01 A02-V2 ; 17-12-2015)

Main modifications:

- Modification of calculation of Q_{air} : ~~10%~~ -> using of $Q = q \times DT \times \text{Surface cable hoses}$ with the following parameters: $q = 10$; $DT = 12K$

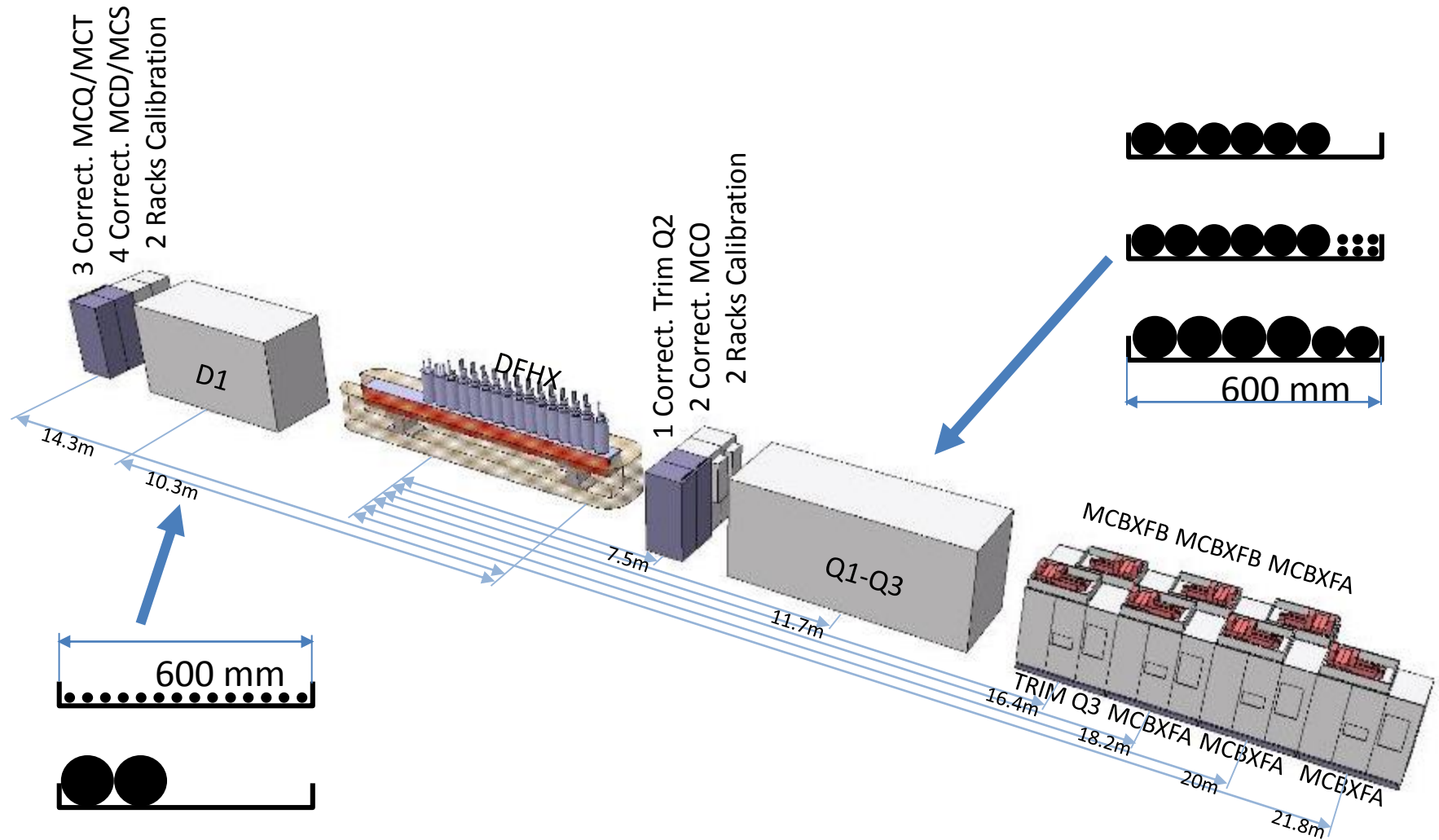
Other parameters:

- Using of Max current.
- Temp. (inl) water: 27 °C
- Delta T water (between inlet-outlet): 10 °C
- Max velocity in inlet/outlet connections: 2.5 m/s
- Air temperature in the tunnel: 20 C°

Results: Losses/IP sides:	I Max	I Operating	
RI2	825 kW	(825)	(652)
Water:	778 kW	(736)	(579)
Air:	47 kW	(89)	(73)
		(Prev. Version)	

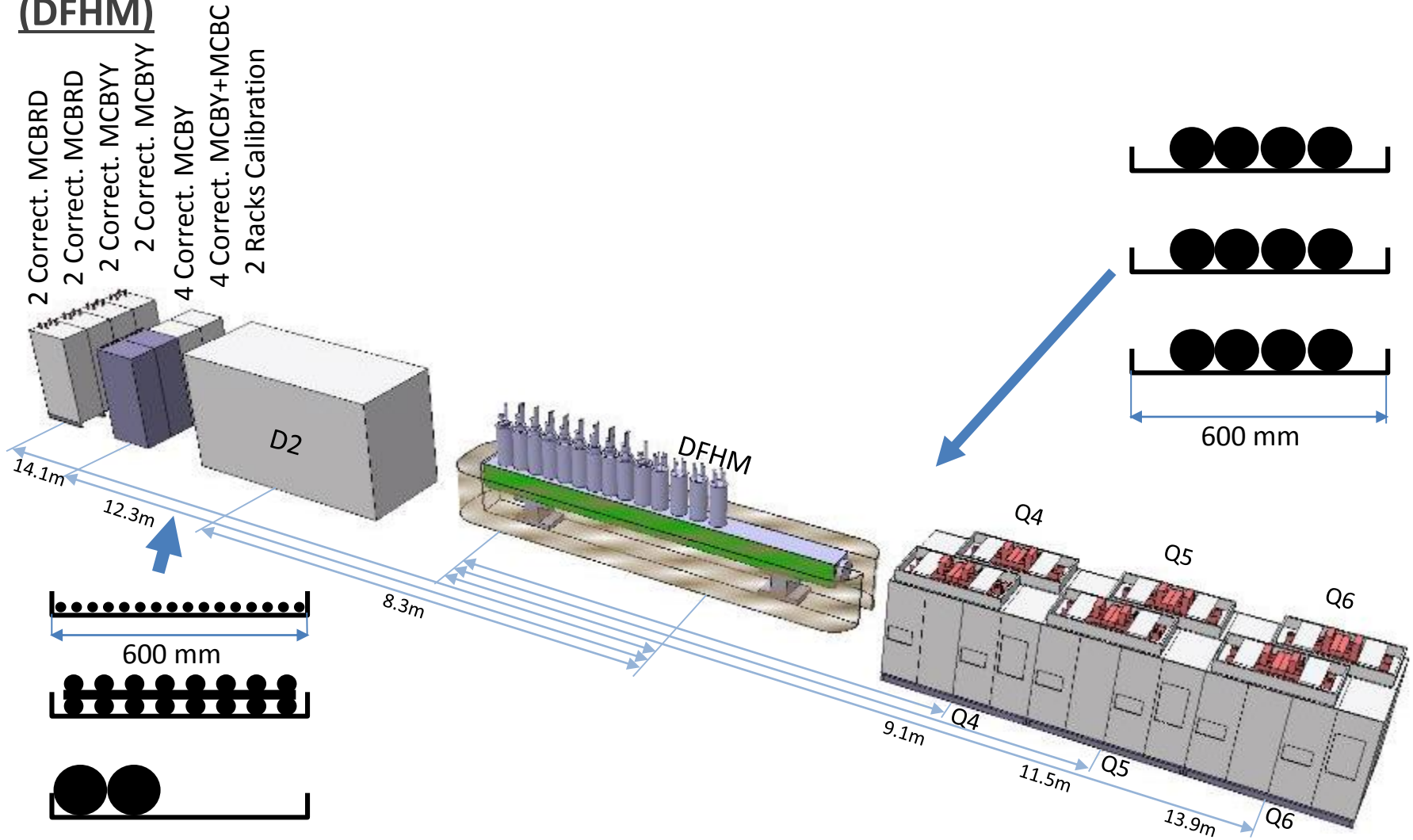
DC links (Proposition EL: long. optimisée + convertisseurs 2 cadrans) (1)

(DFHX)



DC links (Proposition EL: long. optimisée + convertisseurs 2 cadrans) (1)

(DFHM)



DC links (Version DC-long-optimisées; 17-12-2015)

Optic	Magnet	Max current (KA)	number of circuits	DFH	Type convertisseur	Cable size (mm2)	Cable length (m) (prev version)	Cable Length (m)
Q1-Q3	MQXFA	18	1	DFHX	T1	2600	78	40
Trim Q3		2	1	DFHX	T4	500	56	49
Q2a-Q2b	MQXFB	18	0	DFHX	T1	2600	78	45
Trim Q2		0.12	1	DFHX	T7	70	36	31
Corrector	MCBXFA	2	3	DFHX	T4	500	56	60
Corrector	MCBXFB	2	3	DFHX	T4	500	56	53
CP	MCQSX	0.12	1	DFHX	T6	70	40	45
CP	MCTX	0.12	1	DFHX	T6	70	40	45
CP	MCTSX	0.12	1	DFHX	T6	70	40	45
CP	MCDX	0.12	1	DFHX	T6	70	40	45
CP	MCDSX	0.12	1	DFHX	T6	70	40	45
CP	MCSX	0.12	1	DFHX	T6	70	40	45
CP	MCSSX	0.12	1	DFHX	T6	70	40	45
CP	MCOX	0.12	1	DFHX	T6	70	40	31
CP	MCOSX	0.12	1	DFHX	T6	70	40	31
D1	MBXF	13	1	DFHX	T2	2000	70	37
D2	MBRD	13	1	DFHM	T2	2000	72	33
Corrector D2	MCBRD	0.6	4	DFHM	T4	400	44	45
Q4	MQYY	6	2	DFHM	T3	1000	50	35
Corrector Q4	MCBYY	0.6	4	DFHM	T4	400	44	41
Q5	MQY	6	2	DFHM	T3	1000	50	39
Corrector Q5	MCBY	0.12	6	DFHM	T7	70	40	41
Q6	MQML	6	2	DFHM	T3	1000	50	44
Corrector Q6	MCBC	0.12	2	DFHM	T7	70	40	41
Total			42					

Cable Section (mm2)	Cable type	Total length/si de IP (m)
2000	WCC	70
1300	WCC	170
1000	WCC	236
500	WCC	388
400	Warm	344
70	Warm	736

Losses/IP sides:

RI2: 414 kW
 Q Water: 381 kW
 Q Air: 34 kW



Summary: Values for one IP

Main parameters:

- Using of Max current.
- Temp. (inl) water: 27 °C
- Delta T water (between inlet-outlet): 10 °C
- Max velocity in inlet/outlet connections: 2.5 m/s

Versions	Température	Delta T	Delta T	q	RI2	Q dans l'air	Q dans l'eau	Débit nécessaire
	entrée eau	air/eau	ES câble					
	[°C]	[K]	[K]	[W/m2/K]	[kW]	[kW]	[kW]	[l/min]
DC-ST0689858_01 A02-V2 (17-12-2015)	27	12	10	10	1651.00	95	1556	2343
Long-optimisées (17-12-2015)	27	12	10	10	829	68	761	1165

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- Type of convertors '2 cadrans' to be confirm.
 - Integration for 'long-optimisée' version to be confirm !



Thanks for your attention