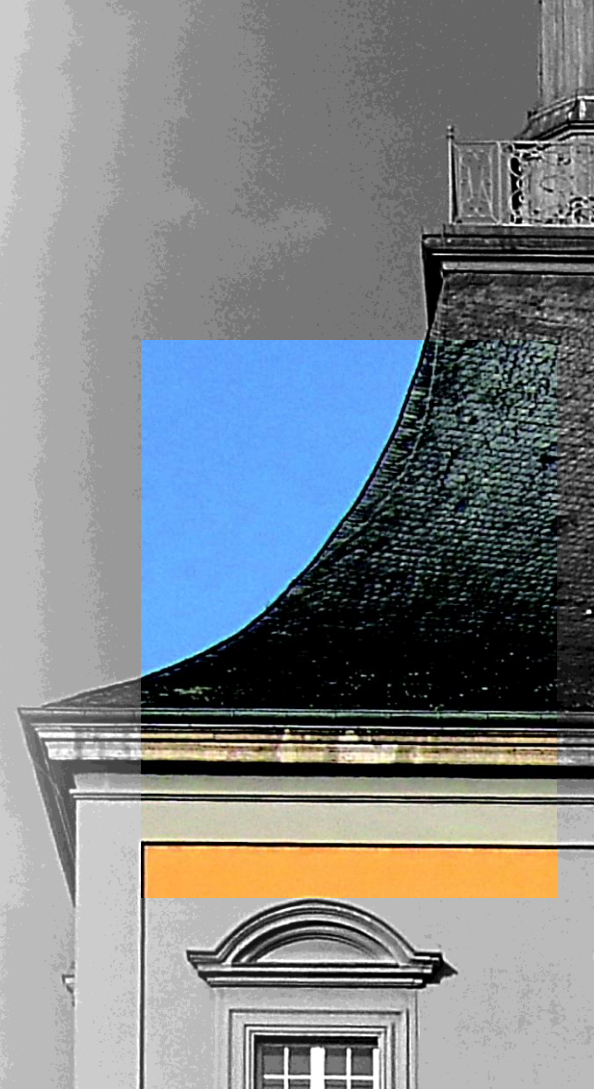


ITK PIXEL
LO POWER DISCUSSION



TYPE-0 BUDGET

- there was a mistake in the previously presented power budget
 - estimated losses on Module Flex was based on 2% requirement – correct number (for L0 only) is 3%
 - that means losses on module flex go up, resistance budget for Type-0 goes down

Layer	Section	Subsection	Number of FE per power unit	Number of power units per chain	SP Current [A]	Allowed Total Losses per SP chain [W]	Losses in DCS System per SP chain [W]	Assumed Losses on Module Flex per SP chain [W]	Total Resistance Budget for Type-0 LV lines per SP chain [mOhms]
L0	flat		3	4	5.10	3.49	0.50	0.56	93.2
L1	flat		4	6	5.86	5.59	0.50	1.00	118.9
L2	flat	long chain	4	9	5.53	7.75	0.50	1.33	193.7
L2	flat	short chain	4	9	5.53	7.75	0.50	1.33	193.7
L3	flat	long chain	4	12	5.10	9.31	0.50	1.51	280.1
L3	flat	short chain	4	6	5.10	4.65	0.50	0.76	130.4
L4	flat	long chain	4	12	4.94	8.91	0.50	1.41	287.3
L4	flat	short chain	4	6	4.94	4.45	0.50	0.71	133.4
L0	barrel rings		3	3	5.10	2.62	0.50	0.42	65.1
L1	barrel rings		4	10	5.95	9.49	0.50	1.71	205.8
L2	barrel rings	long chain	4	6	5.57	5.22	0.50	0.90	123.1
L2	barrel rings	short chain	4	6	5.57	5.22	0.50	0.90	123.1
L3	barrel rings	long chain	4	10	5.06	7.67	0.50	1.24	231.6
L3	barrel rings	short chain	4	6	5.06	4.60	0.50	0.74	131.1
L4	barrel rings	long chain	4	12	4.85	8.71	0.50	1.36	291.0
L4	barrel rings	short chain	4	6	4.85	4.36	0.50	0.68	134.9
L0	rings		3	5	5.03	4.29	0.50	0.69	122.3
L1	rings		4	10	6.03	9.67	0.50	1.76	203.6
L2	rings		4	8	5.66	7.11	0.50	1.24	167.6
L3	rings		4	11	5.15	8.63	0.50	1.41	253.4
L4	rings		4	13	4.89	9.54	0.50	1.50	315.0

TYPE-0 BUDGET

- there was a mistake in the previously presented power budget
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Layer	Section	Subsection	Number of FE per power unit	Number of power units per chain	SP Current [A]	Allowed Total Losses per SP chain [W]	Losses in DCS System per SP chain [W]	Assumed Losses on Module Flex per SP chain [W]	Total Resistance Budget for Type-0 LV lines per SP chain [mOhms]
L0	flat		3	4	5.10	3.49	0.50	0.85	82.3
L1	flat		4	6	5.86	5.59	0.50	1.00	118.9
L0	barrel rings		3	3	5.10	2.62	0.50	0.64	56.9
L1	barrel rings		4	10	5.95	9.49	0.50	1.71	205.8
L0	rings		3	5	5.03	4.29	0.50	1.03	108.7
L1	rings		4	10	6.03	9.67	0.50	1.76	203.6

- with these numbers we fully exploit the 10% budget for the module flex + pigtail + type-0 services
 - there is zero headroom on the type-0 services

TYPE-0 BUDGET

- the resistance budget for a triplet in L0 is 8.2 mOhms
 - with the estimated current of 5.1A, this corresponds to **0.21 W** per triplet
 - current flex design suggests this might end up somewhere between **0.28 W and 0.38 W** per triplet
 - corresponds to 11mOhms and 15mOhms per triplet
- Consequences:
 - locally: Additional power on the module flex → impact on thermal FEA of module?
 - increase of 0.07W to 0.17W compared to 8.72W nominal module power. Is this really an issue???
 - globally: 226 triplets in L0
 - total power increase wrt. budget: somewhere between 16W and 40W increase

TWO CASES

– IF we need to reduce the Type-0 budget further due to the increase module flex resistance

– **11 mOhms per triplet**

Layer	Section	Subsection	Number of FE per power unit	Number of power units per chain	SP Current [A]	Allowed Total Losses per SP chain [W]	Losses in DCS System per SP chain [W]	Assumed Losses on Module Flex per SP chain [W]	Total Resistance Budget for Type-0 LV lines per SP chain [mOhms]
L0	flat		3	4	5.10	3.49	0.50	1.14	70.9
L1	flat		4	6	5.86	5.59	0.50	1.00	118.9
L0	barrel rings		3	3	5.10	2.62	0.50	0.86	48.4
L1	barrel rings		4	10	5.95	9.49	0.50	1.71	205.8
L0	rings		3	5	5.03	4.29	0.50	1.39	94.5
L1	rings		4	10	6.03	9.67	0.50	1.76	203.6

– **15 mOhms per triplet**

Layer	Section	Subsection	Number of FE per power unit	Number of power units per chain	SP Current [A]	Allowed Total Losses per SP chain [W]	Losses in DCS System per SP chain [W]	Assumed Losses on Module Flex per SP chain [W]	Total Resistance Budget for Type-0 LV lines per SP chain [mOhms]
L0	flat		3	4	5.10	3.49	0.50	1.56	54.9
L1	flat		4	6	5.86	5.59	0.50	1.00	118.9
L0	barrel rings		3	3	5.10	2.62	0.50	1.17	36.4
L1	barrel rings		4	10	5.95	9.49	0.50	1.71	205.8
L0	rings		3	5	5.03	4.29	0.50	1.90	74.5
L1	rings		4	10	6.03	9.67	0.50	1.76	203.6

ANOTHER CASE

– IF we cannot do that, can we borrow from the Type-1 budget?

Layer	Section	Subsection	Round Trip Losses on Cables per Half-Layer [W]				
			LV	HV	VDCS	VCAN	Tilock
L0	flat		42.58	0.00	0.05	0.38	0.00
L1	flat		100.04	0.01	0.28	0.48	0.00
L0	barrel rings		43.52	0.00	0.09	0.70	0.00
L1	barrel rings		149.62	0.04	1.15	0.70	0.00
L0	rings		11.23	0.00	0.07	0.18	0.00
L1	rings		32.92	0.01	0.25	0.15	0.00

this was calculated assuming quads in L0 flat
with triplets, this goes down by about 19W per
side → 38W in total

Layer	Section	Subsection	Total / Allowed losses
L0	flat		0.78
L1	flat		0.90
L0	barrel rings		0.50
L1	barrel rings		0.46
L0	rings		0.23
L1	rings		0.24

going to triplets in the flat section, keeping the type-1 cables as they are, we don't touch the global cooling budget if we have to increase the budget for the module flexes by 1% or 2% in all of L0

WORST CASE COOLING REQUIREMENTS

- budget and cable properties are based on the NOMINAL slope and shunt current headroom of 10%
 - worst case for cooling is for HIGHER slopes and shunt current headroom of 20%

Per Side!!!	Resistance of L0 Module Flex	
	8.2 mOhms	15 mOhms
Total Power [W]		
L0 L1 flat	2722	2735
L0 L1 barrel rings	6576	6597
L0 L1 rings	2926	2938
L2 flat	4058	4058
L3 flat	5047	5047
L4 flat	6162	6162
L2 barrel rings	2766	2766
L3 barrel rings	4430	4430
L4 barrel rings	5994	5994
L2 rings	5011	5011
L3 rings	4427	4427
L4 rings	5520	5520
	55639	55686

‘worst case’ considered for operations based on 2018 FE power estimates: **an additional ~50W per side**

13 W in L0 flat

21 W in L0 barrel rings

12 W in L0 rings