CEPC Silicon Tracker Progress Report (15)

Qi Yan on behalf of the Silicon Tracker Group Dec 17, 2024, IHEP

Remaining Ongoing Tasks for the Silicon Tracker TDR (Highlighted in Blue)

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Silicon Tracker Power Cabling Scheme



Power Rail for ITK Barrel Stave



ITKB1: 7 modules per stave (987 mm) ITKB2: 10 modules per stave (1,410.4 mm) ITKB3: 14 modules per stave (1,974.0 mm)

The staves of ITKB2 and ITKB3 use 2 Power Bus, each serving 5 or 7 modules from one end.

Power requirement per Power Bus: 5-module: ~60 W 7-module: ~84 W

For the 7 modules, the currents are: 48V:1.75 A 12V (with 2 lanes): 3.5 A

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1: Power Bus: HV input 150 V LV input 48 V

Power Rail for OTK Barrel Stave

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One OTK stave consists of 8 ladders (700 mm or 720 mm), with 4 ladders read out in one direction.

OTK Voltage Transmission

- The primary low-voltage (LV) input to the stave is 48 V, which is delivered to the secondary data aggregation board of each ladder via the Stave FPC (long FPC).
- The secondary data aggregation board in each ladder converts the 48 V input to 12 V.
- The converted 12 V LV is then transmitted to the FPCs of all modules within the ladder through the Ladder FPC (short FPC).



Data Link:

 Data output, clock and commands inputs are transmitted between sensor modules and optical module on the secondary data aggregation board through the Ladder FPC.

One OTK Barrel Power Bus for each individual Ladder

- Power consumption: ~300 mW/cm², 224.5 W per Ladder.
- Based on a metal layer of 75 microns in the Power Bus (FPC) and the voltage drop <1 V (power transmission efficiency >98%), the minimum width of the metal layer in Stave (long) FPC for the farthest ladder (48 V) was determined as follows:

Voltage(V)	current (A)	Resistance (Ω)	Length(mm)	Thickness(µm)	Cu Width(mm)	Al Width(mm)
48V	4.67	0.214	2,480	75	2.7	4.4

Power Rail for OTK Endcap (1/16 Sector)



Connector Requirement

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12 V connector between secondary and primary boards: 12 mm width for ~6.9A (83 W).





48V connector with the same 12 mm width, 24 pins x 0.5 mm pitch: ~4.8 A, 230 W.

Features

OTK Endcap Power Rail: Carbon Fiber Frames

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OTK Endcap Power Rail: Power Buses (FPCs)

Power Bus transmits: HV=200V and LV =48 V.

0.180 mm thick25 μm copper(aluminum is also more than sufficient)

OTK Endcap Power Rail: Power Buses on 3 Frames



12 mm width (match with connector:24 pins x 0.5 mm pitch)Max length: 1,330 mmMax power transmission: 4.8 A, 230 W(more than required)



Power Rail for ITK Endcap



Silicon Tracker Power and Cooling Rail Routing Outward

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Number of Power Cables, Fibers, and Cooling Pipes

	Detector	Number of power cables (supply both LV & HV)	Number of optical fibers	Number of cooling pipes
	ITKB1	44	308	88
ITK Barrel	ITKB2	128	640	128
	ITKB3	204	1,428	204
	ITKE1	128	192	64
ITK Endcap	ITKE2	160	288	64
(Strips)	ITKE3	320	736	64
	ITKE4	256	608	64
OTK Barrel	ОТКВ	440	880	220
OTK Endcap	OTKE	544	544	Cooling plate
Total		2,224	5,624	

Consolidation of power cables, fibers, and cooling pipes to route outside the CEPC detector may be considered in the future.