RTDR-Vertex 机械相关内容

1.5 Mechanics, cooling and services

1.5.1 Mechanics

1.5.1.1 General support structure

1.5.1.2 Ladder and support

1.5.1.3 Ladder based barrel and fixation on beam pipe

1.5.1.4 Bent MAPS cylinders and fixation on beam pipe

1.5.2 Cooling

1.5.2.1 Cooling requirements

1.5.2.2 Air cooling and simulation

1.5.3 Services

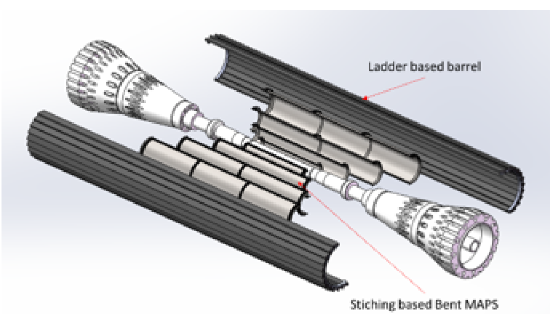
1.5.1.1 General support structure

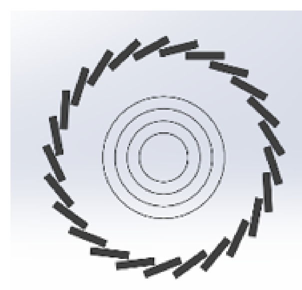
介绍VTX整体支撑结构组成：

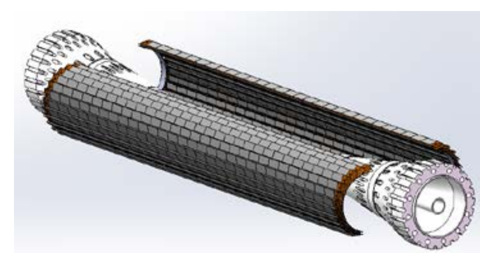
- 外层基于ladder的barrel
- 内部4层弯曲芯片组成的圆柱

1.5.1.1 General support structure

The baseline design of the CEPC Vertex detector consists of, from outer radial to inner direction, a one-layer double-sided ladder-based barrel and four layers of stitching technology-based bent MAPS cylinders. The innermost cylinder has a radius of 11 mm, and there is a 0.3 mm gap to the beam pipe. A side view along the beam direction, as shown in Fig.1, illustrates the detailed layout of the detector. Since the Vertex detector is the first detector located outside and closest to the beam pipe, to be consistent with the physics requirements and goals, the general mechanical support design for the Vertex detector aims to use ultra-light materials to create a strong enough structure, realizing a low material budget without weakening the spatial resolution.







(a) (b)

Fig.1 General structure of the CEPC vertex detector. (a) The exploded view of the VTXD and

1.5.1.2 Ladder and support

介绍double-sided ladder组成元素：
支撑结构、芯片、打线、flex

ladder支撑结构：
材料、结构形式、厚度与物质量、
模拟分析

and that will lead to smaller deformation. For the individual sensitive layer of the detector, the equivalent thickness of the Ladder support structure is approximately 0.185 mm, equal to 0.037 X_0.

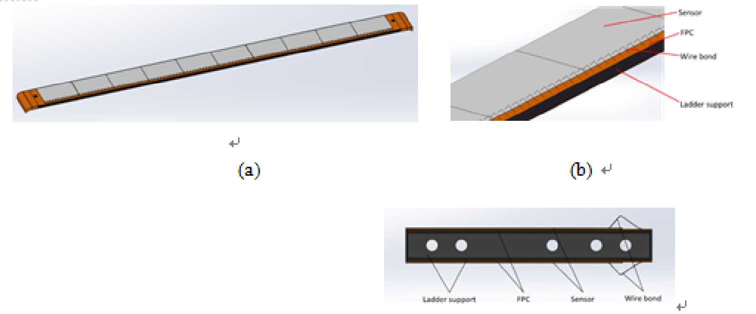


Fig. 2 The ladder structure. (a) Ladder assembly. (b) Local details of the ladder (c) side view of the ladder.

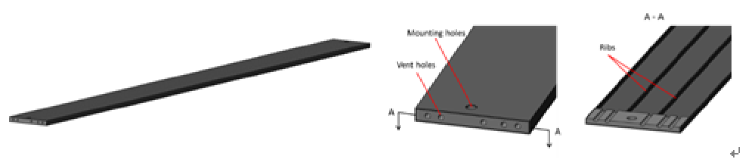


Fig. 3 Ladder support

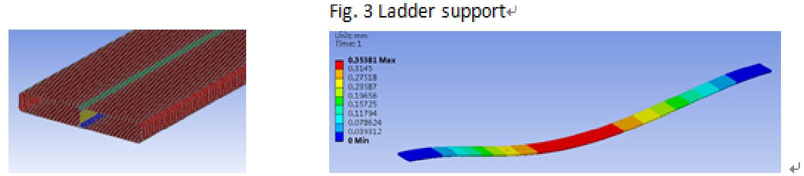


Fig.4 Static analysis results of the ladder support under full load including sensors FPC and glue.

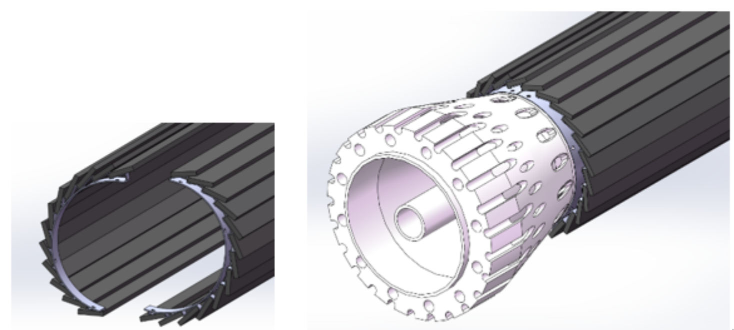
1.5.1.3 Ladder based barrel and fixation on beam pipe

介绍Barrel 结构：

2个half barrel圆周对接、安装固定在（中间件）风道放大腔上

Half barrel结构：端环+ladder

The barrel-shaped outer layer detector formed by the double sided ladders which overlaps with each other in the circumferential direction for a continuous sensitive layer. To facilitate barrel assembling and its installation on the beam pipe integration, the barrel structure is designed as Fig.6 shows. It is assembled by two half-barrels, each of which consists of half side-rings located at both ends and several ladders. The ladders are positioned and secured by two surfaces of the toothed structures on the side-rings. After the two independent half-barrels are pre-assembled on dedicated tooling, they are installed and fixed onto the beam pipe assembly, as illustrated by Fig.6.



(a) (b)

1.5.1.3 Ladder based barrel and fixation on beam pipe

介绍 MOST2 VTX prototype支撑结构和经验，可用于TDR barrel

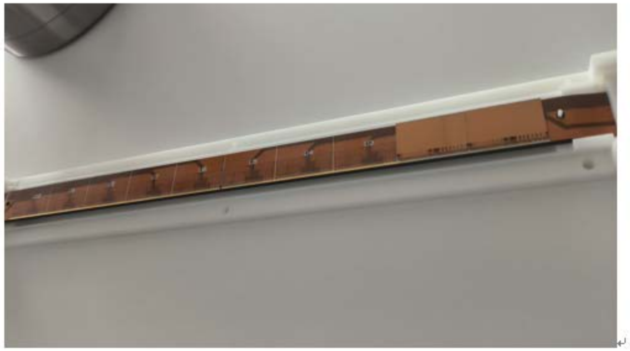


Fig.7 ladder prototye

Fig.8 Prototyped Ladder support

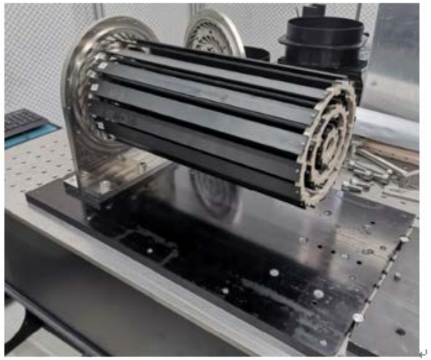


Fig.9 Barrel prototype

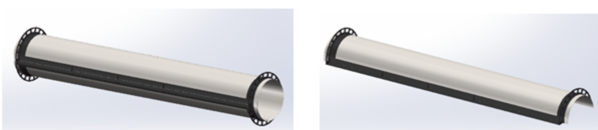
1.5.1.4 Bent MAPS cylinders and fixation on beam pipe

4层弯曲芯片结构：

每层2部分对接，安装固定在束流管外延管上

每个部分组成：弯曲芯片、局部支撑、 flex、外延之撑

in Fig.14. In addition, some R&D studies of making the bent MAPS have been done; so far, the dummy wafer with a thickness of 40 μm and a radius of 12 mm have been tested and proven to be feasible shown in Fig.15.



(a) (b)

Fig.10 The half cylinder formed by the bent MAPS is supported by local support

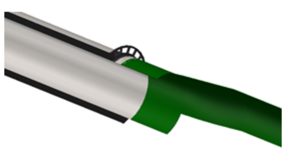


Fig.11 The half cylinder with FPC connected and wire bonds

Fig.12 The half cylinder with FPC and the extended support

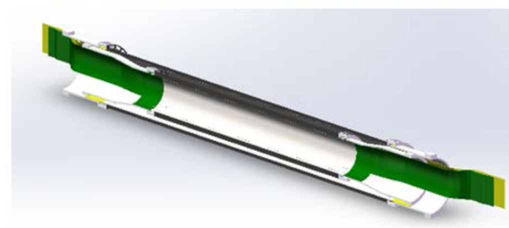


Fig.13 The inner two layers of half bent MAPS cylinder: no contact between layers

Fig.14 The inner two layers of half bent MAPS cylinder-no contact between layers

1.5.2 Cooling

VTX 芯片学发热 40 mW/cm²；工作温度： 30 摄氏度以内

风冷模拟：

Barrel 在2.5m/s 预期能够冷却

弯曲芯片（最内层）：同时考虑梯度（10、5°），在3-5 m/s 预期满足需求

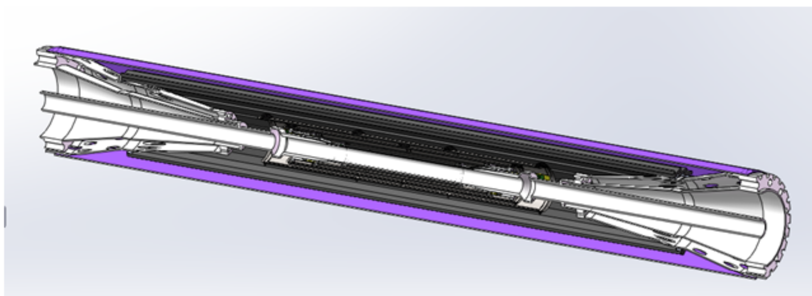


Fig.15 VTXD integrated with the beam pipe (the pink cylinder is the reinforced tube of beam pipe)

Power dissipation (mW/cm²)	Total heat generation of the barrel (W)	Max temperature on ladder (Celsius)
40	222	30.2

Fig.16 Simulation results of the barrel-maximum temperature on the ladder. Inlet air temperature of 5 degrees Celsius; air speed of 2.3 m/s.

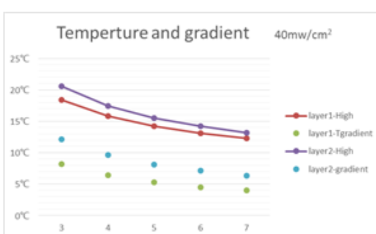


Fig.17 Simulation results of bent MAPS. Estimated airflow range based on the simulation, to

振动方面：

通过实验件测试振幅，同时介绍Prototype对ladder风冷振动测试结果、经验

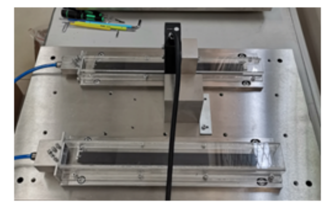


Fig.18 Air cooling vibration test platform.

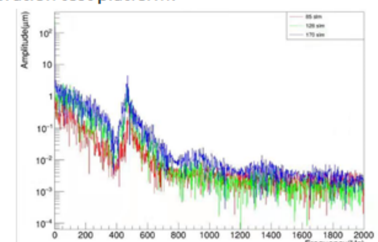


Fig.19 Vibration spectrum of ladder support with different air flow rates.

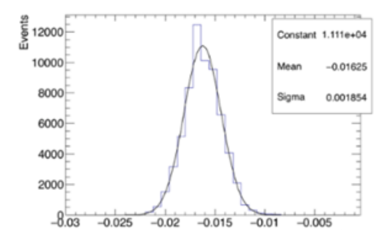


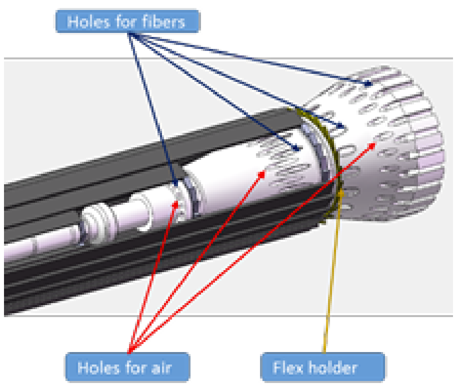
Fig.19 Vibration amplitude of the ladder support (max ~ 4m/s air flow).

1.5.3 Services

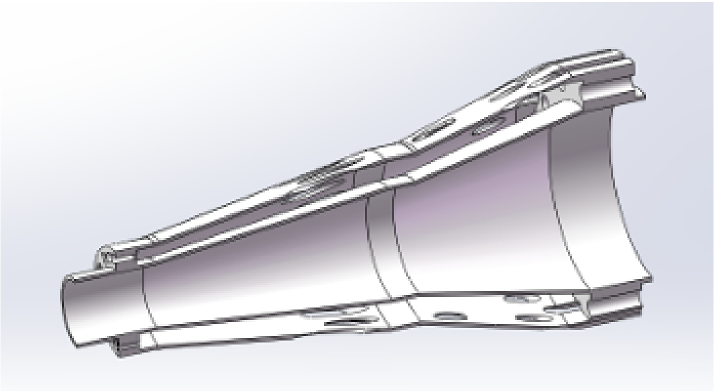
两个主要需求：通风、走线

之前flex转光纤后引出，现调整初步确定暂按flex引出

Figure 1.85. Since space inside the beam pipe assembly is limited, further optimization of structural layout, cable management, and airflow channels will be needed.



(a)



(b)

Figure 1.85: Ventilation and cable/fiber routing channels within the conical support structure.

当前VTX机械各部分都能自洽，和束流管的对接无干涉