CEPC Silicon Tracker Progress Report (23)

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Silicon Tracker Group Organization for R&D

Following the Ref-TDR, our main focus will be on R&D. We recently held a dedicated Silicon Tracker meeting on May 19 to advance these efforts.

- R&D goals:
  - Development of the sensors and ASICs
  - Development of a complete silicon tracker prototype system by the end of 2027, including the detector chip, module, mechanical structure, and cooling system
- R&D tasks:
  - Design, fabrication (tape-out), and testing of the detector chips
  - Assembly of detector modules
  - Detector module electronics: PCB (or FPC) and other auxiliary electronic components
  - Mechanical structures, and testing of mechanical and thermal performance
  - A prototype CO_2 cooling system
  - Readout and data acquisition system for the detector prototype
  - Offline software for the detector prototype
- R&D individual roles and responsibilities, along with the organization structure, have been defined.

Production process: **recipe**

IB Spaceframe & Cold Plate

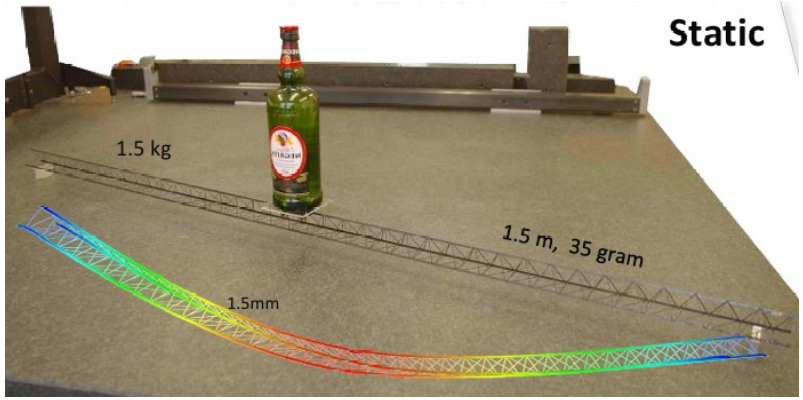
1. Manual lay-up on mould 1: Cfleece/K13D2U 90°
2. Manual lay-up on mould 2: Pipes/Cpaper/Cfleece
3. Mould 1 and 2 closure
4. Curing at 24°C for 24h
5. Post Curing at 125°C for 3h
6. Remove pipes mandrels
7. Cold Plate Finishing
8. Locate the Cold Plate in the winding moulds
9. Place the three vertex M55J longitudinal threads
10. Wind with M60J
11. Cure at 24°C for 24h
12. Remove inside mandrel
13. Cut wound thread at moulds interfaces
14. Space Frame Finishing
15. Connectors gluing
16. Hydraulic Fitting gluing
17. Cold Plate Coating
18. QA test
19. Store
20.

Recently, we visited two carbon fiber manufacturers (Gongyi and Ningbo) to establish a cooperation mechanism, including joint development. During the visit, we discussed next phase of R&D, focusing on:

1: Negotiation of framework contracts, including the joint R&D efforts and testing between manufacturers and IHEP

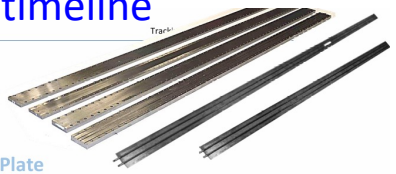
2: The R&D timeline

Production process: **recipe**



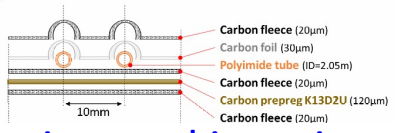
OB Spaceframe

1. Prepare impreganted carbon thread and prepreg
2. Cover external moulds with vaseline/teflon tape 10 micron
3. Place resin with aerosil in the 3 external moulds at ribs extremities
4. Place impregnated thread ribs in the groves of the 3 external moulds
5. Press and cover with teflon (30mm width in the central region of 42mm mould)
6. Prepare the 3 internal 1/3 wedge mandrels with veseline/teflon
7. Place prepreg strips and thread on the edge of the moulds, apply resin on both sides
7. Screw the two side external lateral moulds to form a V
8. Insert the 1/3 internal wedge-mandrel
9. Install the tubolar enflatable internal mandrel
10. Install the other two 1/3 internal wedge mandrel
11. Install the bottom external mould
12. Thighten the bolts
13. Rump up temp at 100°C and apply 3-4 bar pressure in the enflatable mandrel
14. Cure at 130°C for 3 hours
15. Open mould extremities for enflatable mandrel extraction
16. Rump down the temperature 90°C, wait 30 min
17. Open the mould at 90°C, remove spaceframe
18. Cool to room temperature
19. Finishing, cleaning
20. Connectors gluing
21. Coating
22. QA test
23. Store



OB Cold Plate

1. Prepare carbon paper, prepreg, fleece, pipes and resin
2. Cover mould for substarte with vaseline/teflon tape 10 micron
3. Place plyies of fleece prepreg and fleece inside the bottom mould
4. Close the mould with the top part
5. Cure at 130°C 3h, extract the substrate for next use
6. Prepare polyimide tubes with internal steel wire mandrel
7. Cover the mould (Plate side) vaseline/teflon film
8. Cover the mould (pipe side) with Penta 111 (silicon oil) and teflon
9. Place the iompregnated substrate from step 5 in the mould
10. Place fleece on bottom mould/ put resin
11. Place carbon paper on bottom mould/put resin
12. Place tubes with mandrels in the mould
13. Join top and bottom mould, screw together
14. Cure 24h at Room Temperature
15. Finishing clening
16. Connectors + Hydraulic Fitting gluing
17. Cold Plate Coating
18. QA test
19. Store



The IHEP team will be fully involved in the design, simulation, fabrication, testing, and iterative development of the prototypes!

Survey and Preparation for Mechanical Test

Static and dynamic stress testing is required to evaluate the properties of the carbon fiber structure. The survey and preparation of the test setup are currently underway.

万能试验机（Universal Testing Machine）

参数	电子万能试验机
最大载荷	0.1 kN ~ 300 kN
精度	±0.5% FS（高精度）
测试速度	0.001 ~ 500 mm/min
控制模式	力、位移、应变闭环控制
数据采样率	最高1000 Hz
适用温度范围	常温
体积与重量	紧凑，适合实验室

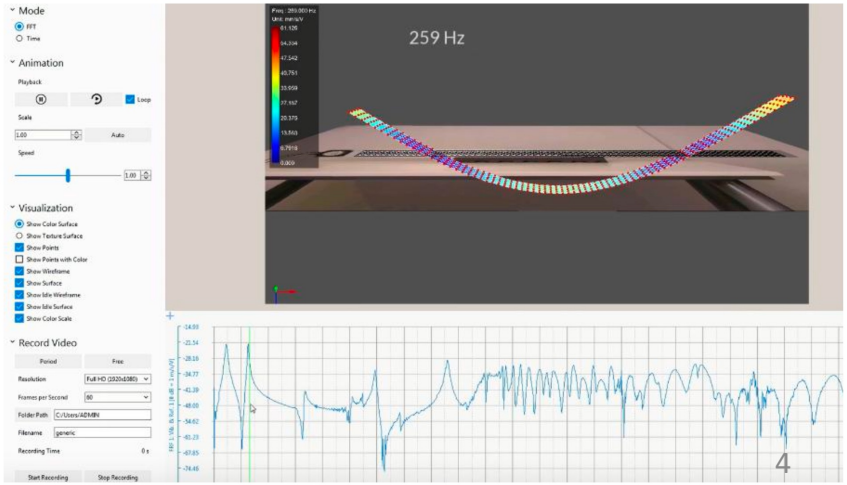
激光测振仪 （Laser Vibrometer）

参数	多点	扫描式
测量范围	位移：1 nm~5 mm	位移：0.01 nm~1 mm
频率范围	0.5 Hz~500 kHz	0.1 Hz~25 MHz
精度	±1%	±0.1%
工作距离	0.2 m~20 m	0.5 m~10 m（高精度近场）
采样率	最高50 kHz	最高1 MHz（全场扫描）
激光波长	同单点	532 nm（绿色高灵敏度）
抗干扰能力	中等	弱（需实验室环境）

非接触式激光位移传感器 (Laser Displacement sensor)

参数	三角反射式	干涉式
测量范围	0.1 mm ~ 300 mm	0.01 μm ~ 10 mm
精度	±0.1 μm ~ ±1 μm	±1 nm ~ ±10 nm
分辨率	0.01 μm	0.1 nm
响应频率	1 kHz ~ 50 kHz	100 Hz ~ 1 kHz
激光波长	650 nm（红光）	632 nm（He-Ne激光）
适用表面	漫反射表面	高反射或镜面
环境适应性	抗环境光干扰中等	需稳定实验室环境

扫描式激光测振仪

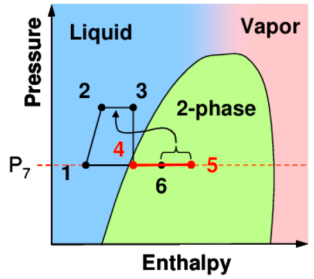


Plan for the Development of CO_2 Cooling System

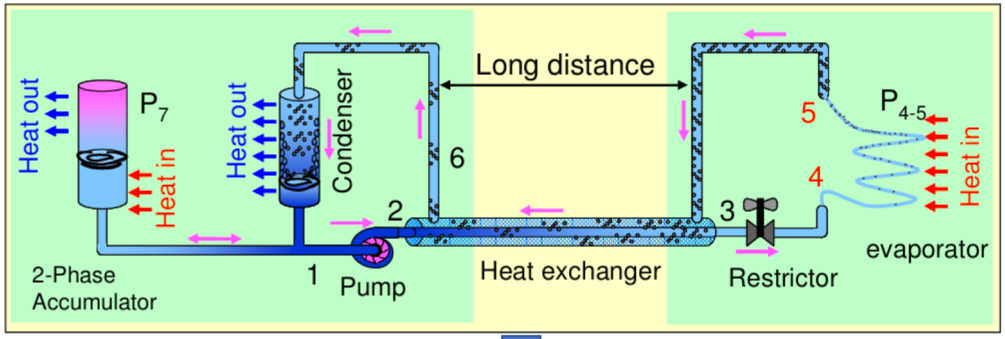
The survey of the CO_2 cooling system is ongoing. In the next few months, we plan to initiate a detailed development roadmap for the system, including collaboration with joint units such as industry partners or research institutions.

•**蓄能器**：与系统并联，始终包含液态和气态CO_2的饱和混合物。蓄能器温度直接决定系统饱和压力（即蒸发温度）。

•**关键组件**：泵、内部热交换器、蒸发器、冷凝器、蓄能器。



1.泵入口（节点1）
2.泵加压（节点1→2）
3.内部热交换器（节点2→3）
4.膨胀至蒸发器入口（节点3→4）
5.蒸发器吸热（节点4→5）
6.热交换器回流（节点5→6）
7.冷凝器（节点6→1）



集成 **CO2** 冷却系统