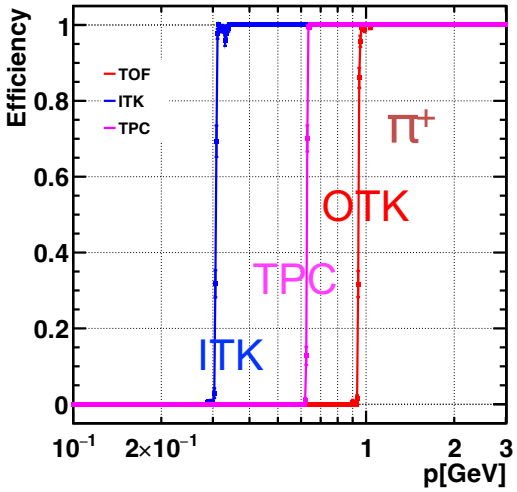
CEPC Silicon Tracker Progress Report (12)

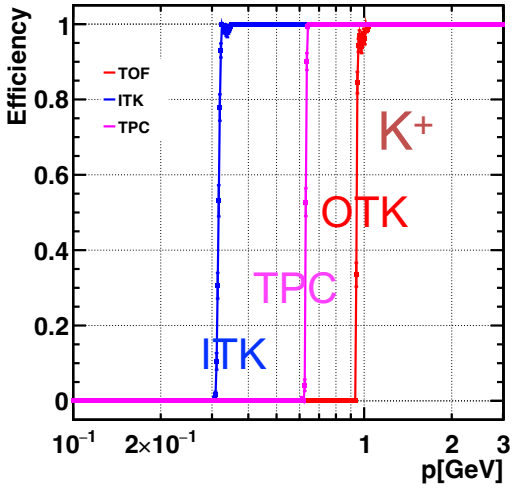
Qi Yan *on behalf of the Silicon Tracker Group*

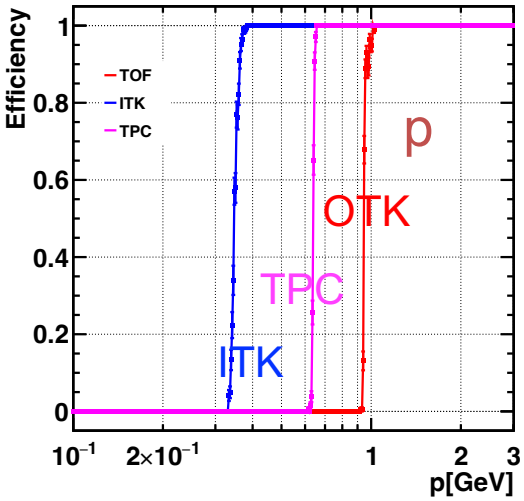
Nov 26, 2024, IHEP

The Latest PID Performance of TPC and OTK (TOF)

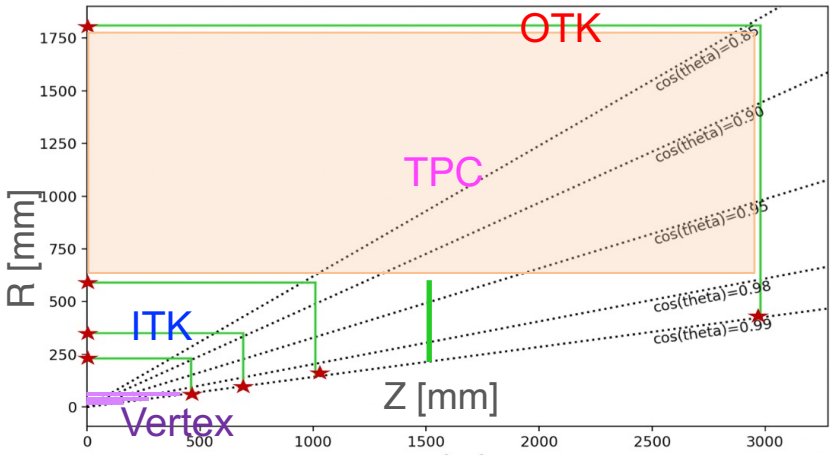
- Efficiencies of particles penetrating the ITK (3 barrels), TPC (half TPC), and OTK (barrel) at a polar angle of θ=60°. The cutoff momenta are P~0.3 GeV/c (P_T ~0.3 GeV/c) for the ITK, P~0.7 GeV/c (P_T ~0.6 GeV/c) for the TPC, and P~1 GeV/c (P_T ~0.9 GeV/c) for the OTK, respectively.

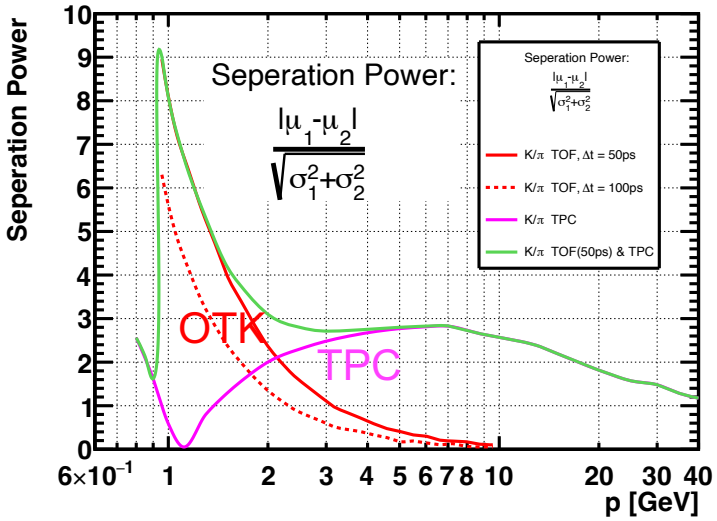






- The latest PID separation power of the TOF and TPC at a polar angle of θ=60° .



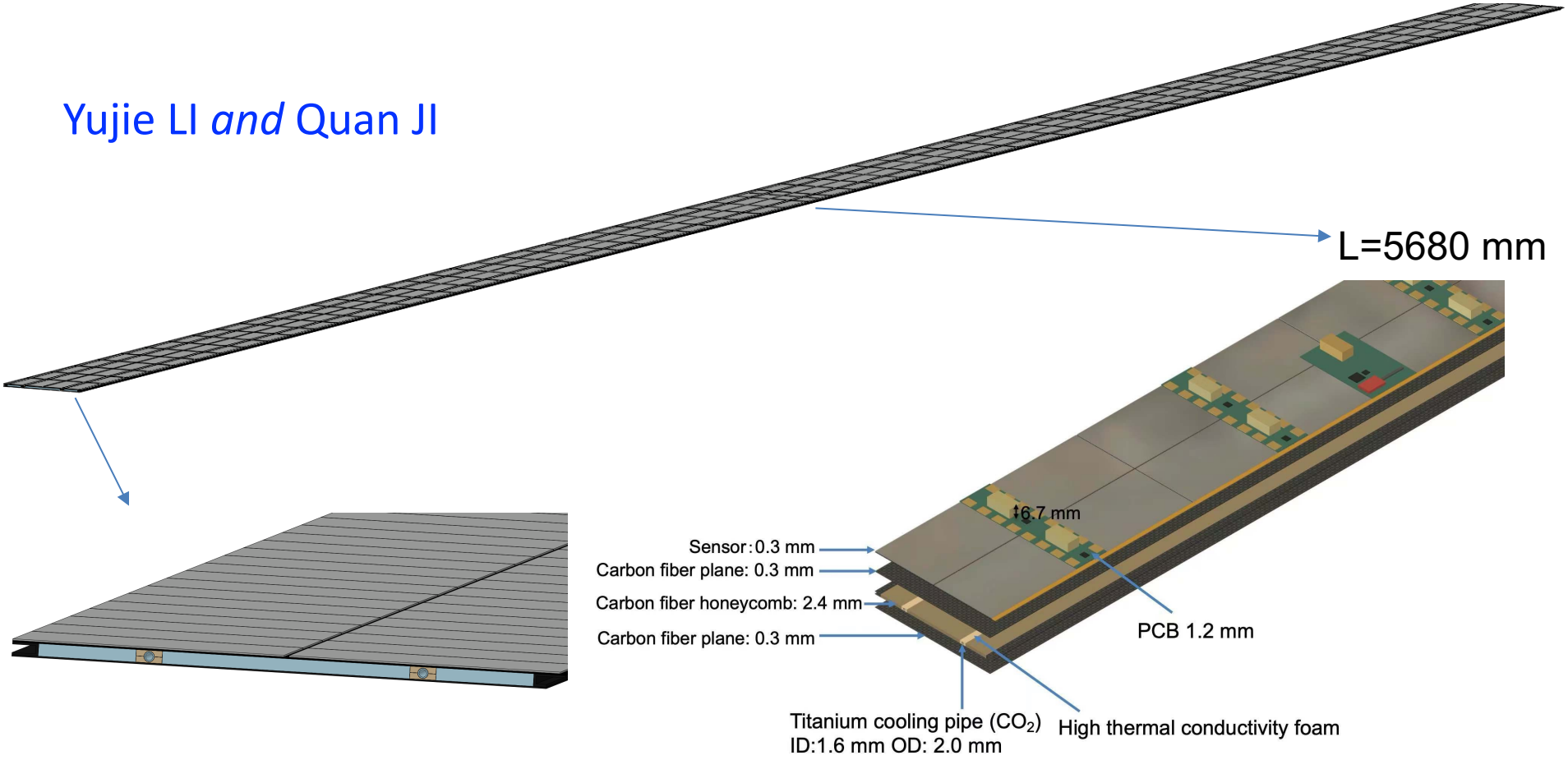


OTK Thermal Simulation

Full thermal simulation of the OTK barrel stave (~6 m):

Incorporating all detailed mechanical and cooling structures, including sensors, carbon fiber honeycomb, cooling pipes, and coolant fluid, ...

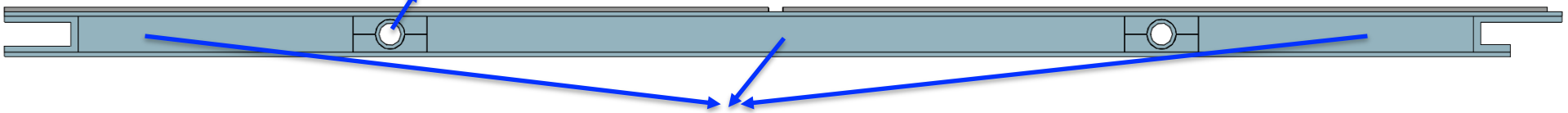
Yujie LI *and* Quan JI



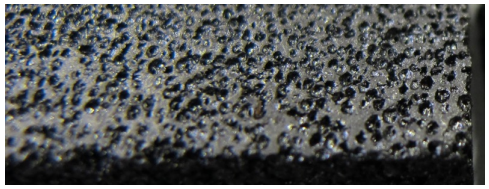
The total height of ladder and its cooling support: 1.12 cm

OTK Thermal Simulation with Nominal Pipes (1)

ID: 1.6 mm OD: 2 mm



Honeycomb filled with poco foam to increase thermal conductivity



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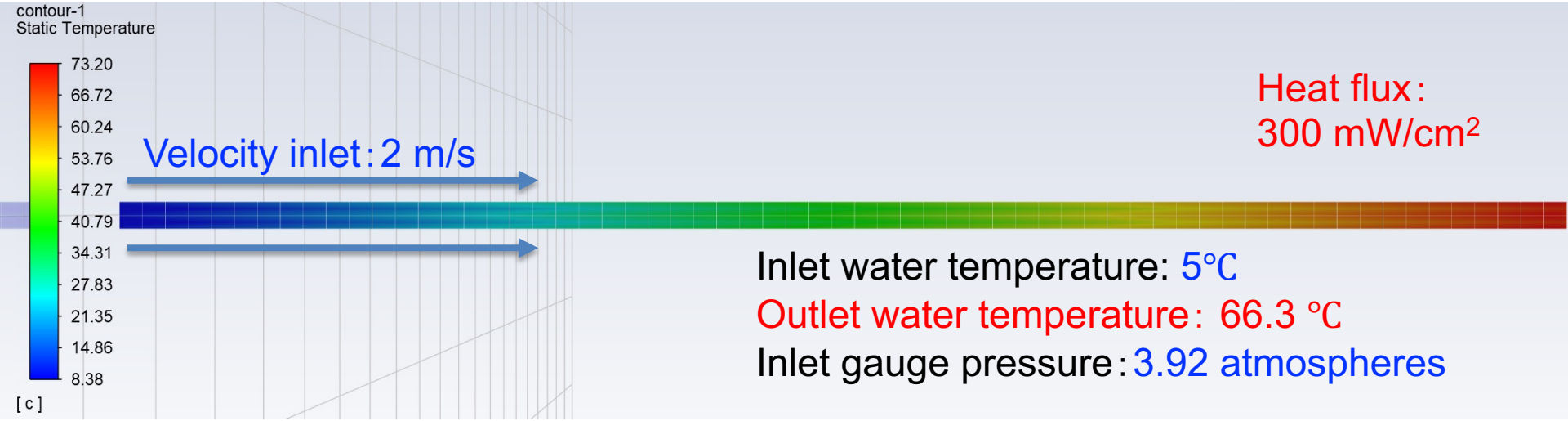
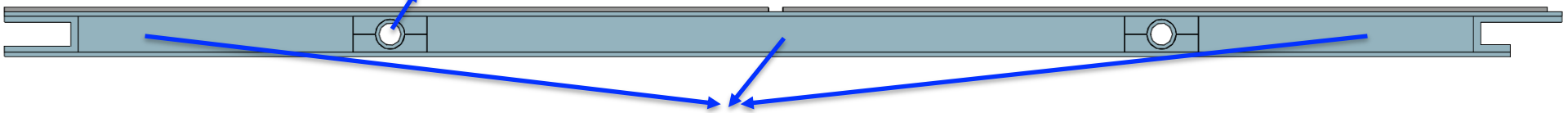
Name	Density (g/cm^3)	Kx @20C (W/mK)	Ky @20C (W/mK)	Kz @20C (W/mK) "TIM tower"
Poco08	0.56	54.5	57.5	135
Poco09	0.41	51	53.5	55

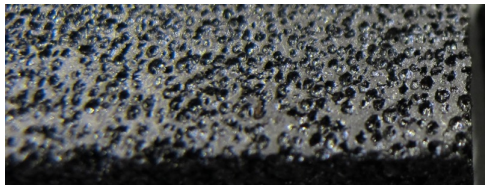


OTK Thermal Simulation with Nominal Pipes (2)

ID: 1.6 mm OD: 2 mm



Honeycomb filled with poco foam to increase thermal conductivity



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Name	Density (g/cm^3)	Kx @20C (W/mK)	Ky @20C (W/mK)	Kz @20C (W/mK) "TIM tower"
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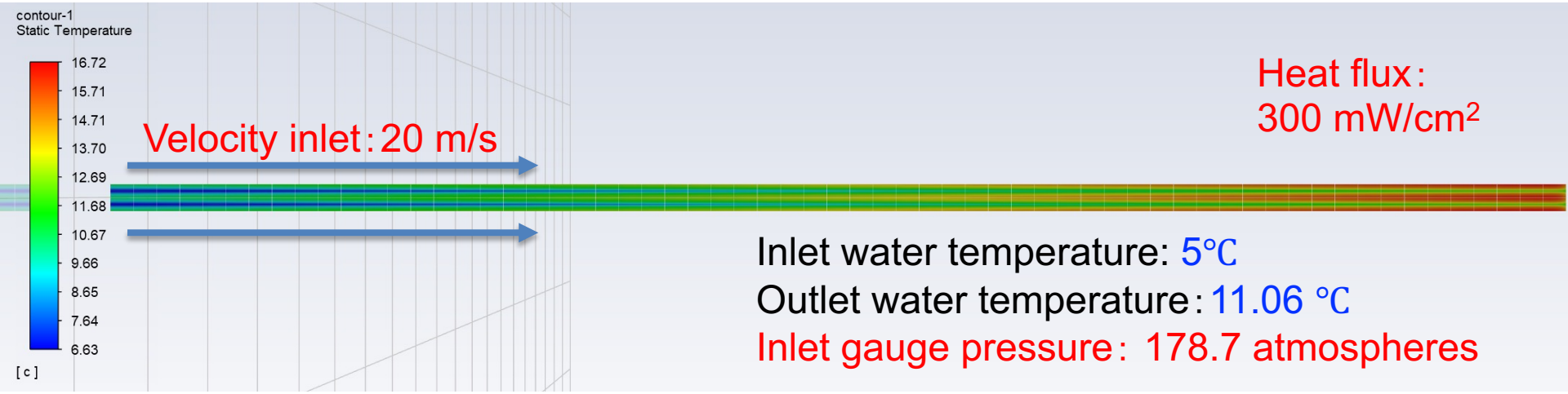

This flow rate is theoretical, and the inlet gauge pressure of 178 atm cannot be achieved.

OTK Thermal Simulation with Larger Pipes

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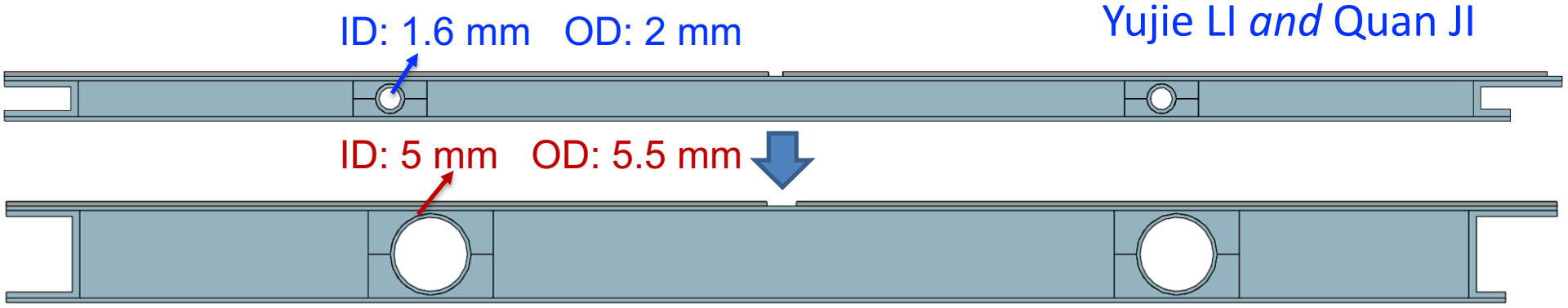
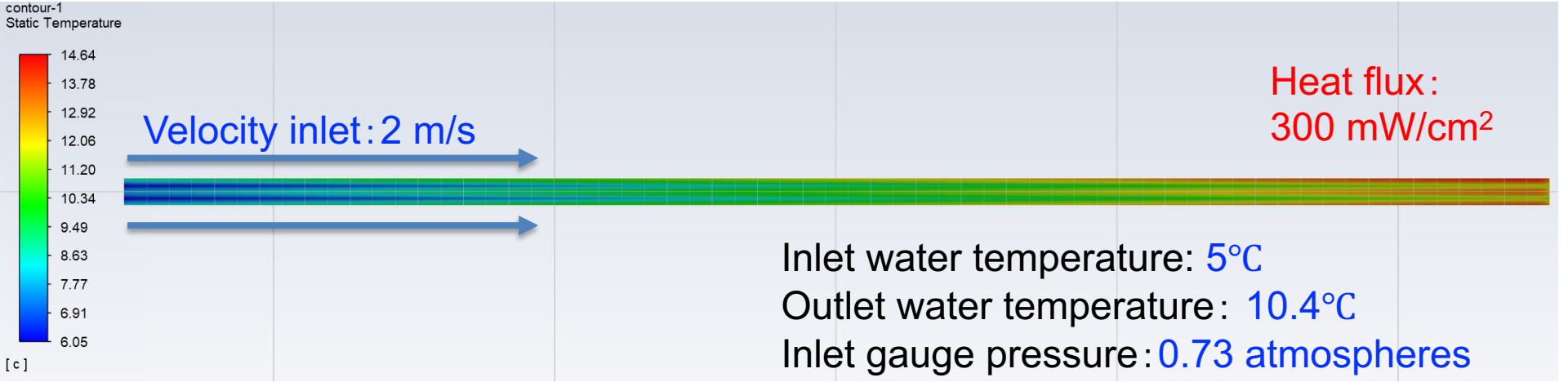
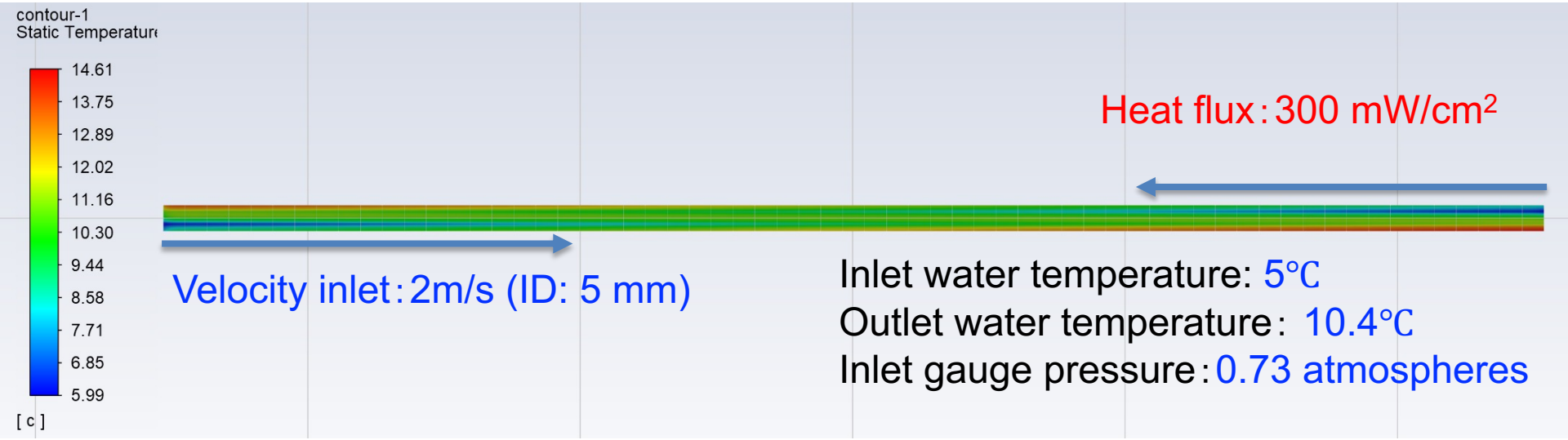


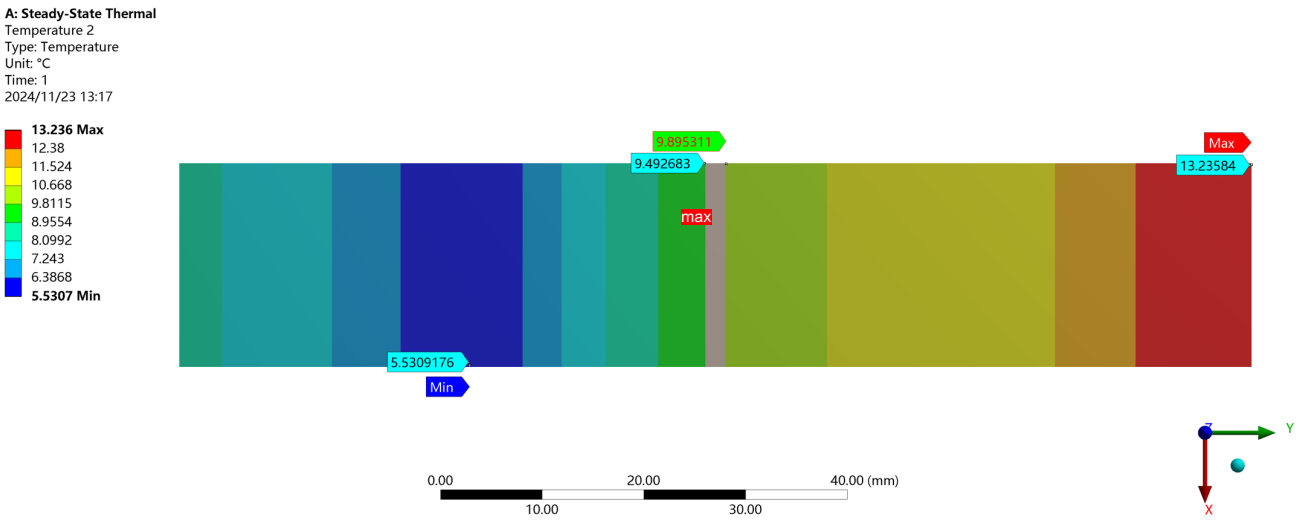
Too small diameter flow cannot meet the cooling requirements, so increase the pipe diameter.



This configuration fulfills the requirement.

Water Inlet From Two Ends





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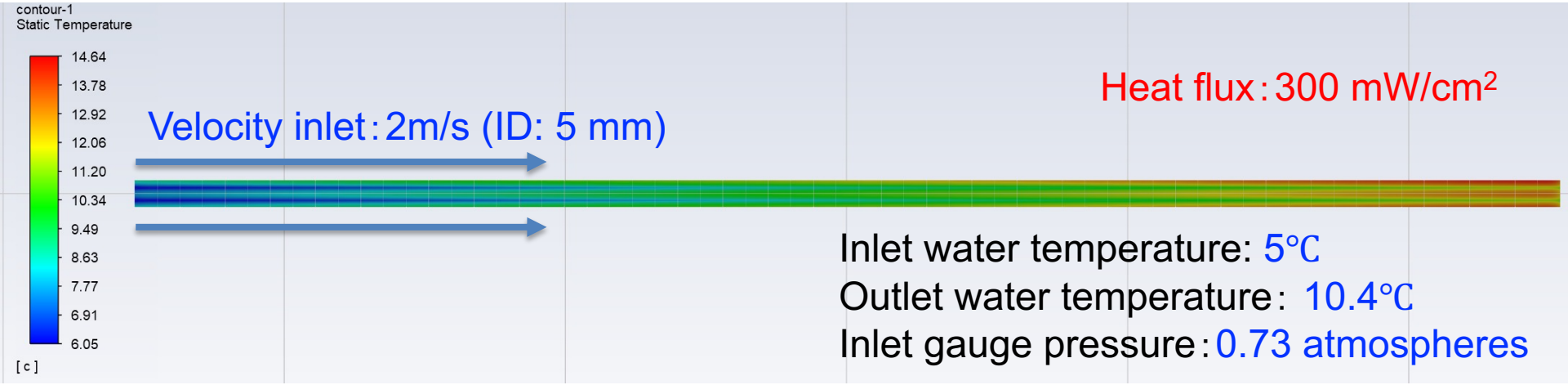
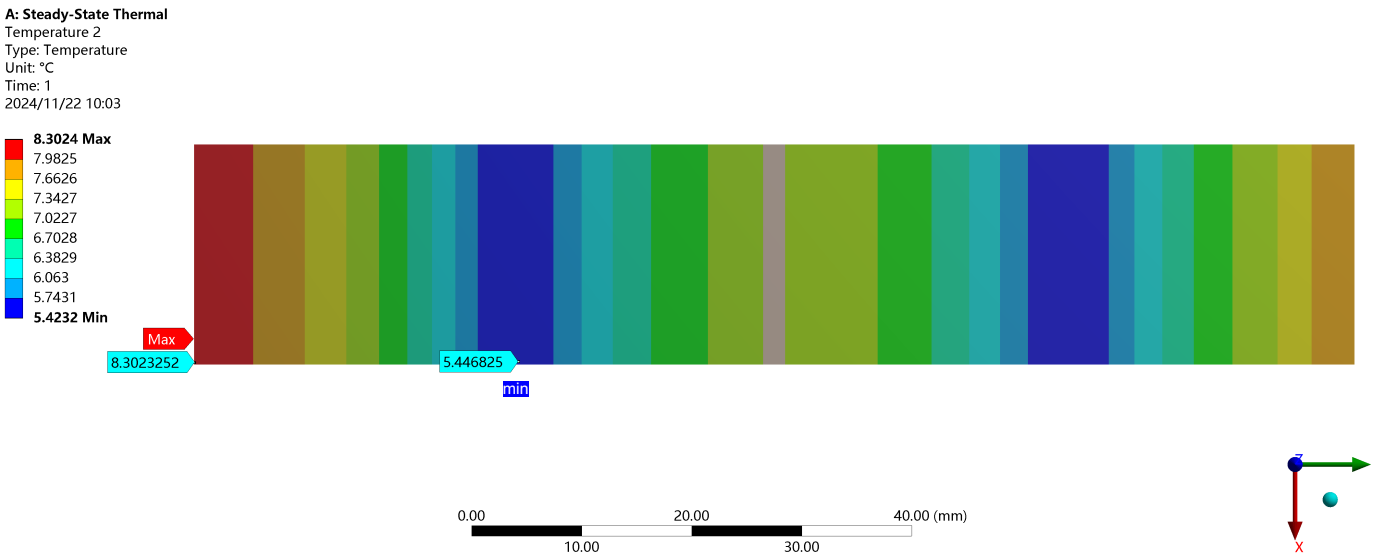
Using a 5 ℃, 2 m/s water inlet (ID: 5 mm) from two ends, the maximum temperature difference on one sensor is ~4 ℃.

Water Inlet From One End





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Using a 5 ℃, 2 m/s water inlet (ID: 5 mm) from one end, the maximum temperature difference on one sensor is ~2.9 ℃.

Mei ZHAO

LGAD 工作温度	温控要求
-40℃到 30℃（目前已测范围)	单颗 LGAD 温度分布偏差（<5℃)

LGAD 工作电压随温度变化而变化，在-40℃到 30℃都可以工作，改变工作电压均可达 40-50ps 以下的时间分辨（相对来说低温下时间分辨更好一些)。但对于单颗 LGAD 器件，单芯片内部温度偏差不能太大，否则会影响时间分辨特性。

也就是说，Ladder 上面从头到尾温度可以不一致，但每个单颗 LGAD 这一局部区域最好将温度控制在 5℃以内（越小越好)。

Silicon Tracker TDR Drafting

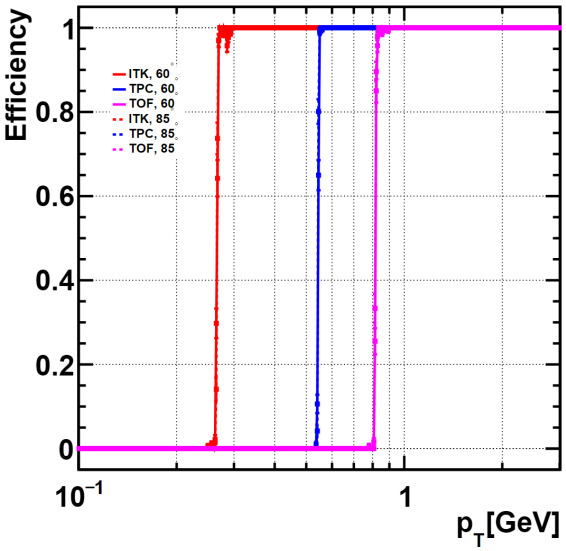
Chapter 5 Silicon Trackers

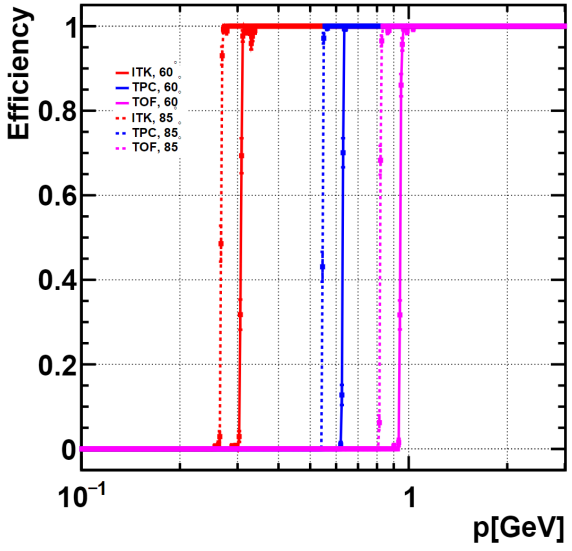
5.1 Requirements
5.2 Overview of ITK and OTK
5.2.1 Tracker system layout optimization
5.3 Inner silicon tracker (ITK)
5.3.1 CMOS chip R&D
5.3.1.1 HV-CMOS pixel R&D
5.3.1.2 CMOS strip R&D
5.3.2 ITK design
5.3.2.1 ITK barrel design
5.3.2.2 ITK endcap design
5.3.3 Readout electronics
5.3.4 Mechanical and cooling design
5.3.5 Prospects and plan
5.4 Outer silicon tracker (OTK) with TOF
5.4.1 AC-LGAD sensor and ASIC R&D
5.4.1.1 AC-LGAD Sensor R&D
5.4.1.1.1 AC-LGAD development at IHEP
5.4.1.2 AC-LGAD ASIC R&D
5.4.1.2.1 General requirements
5.4.1.2.2 ASIC architecture
5.4.1.2.3 Single-channel readout electronics
5.4.1.2.4 Data process and digital blocks
5.4.1.2.5 Radiation tolerance
5.4.1.2.6 Power distribution and grounding
5.4.1.2.7 Prototype performance
5.4.1.2.8 Monitoring
5.4.1.2.9 Roadmap towards production
5.4.2 OTK design
5.4.2.1 OTK barrel design
5.4.2.2 OTK endcap design
5.4.3 Readout electronics
5.4.3.1 Front-end board
5.4.3.2 Concentrator card and power distribution
5.4.3.3 Slow control and monitoring
5.4.3.4 Clock distribution
5.4.4 Mechanical and cooling design
5.4.5 Prospects and plan
5.5 Performance
5.5.1 The global performance of the tracking system
5.5.2 The performance of silicon tracker (barrel)
5.5.3 The performance of the transition zone (barrel+end-cap)
5.5.4 The performance of forward tracking (end-cap)

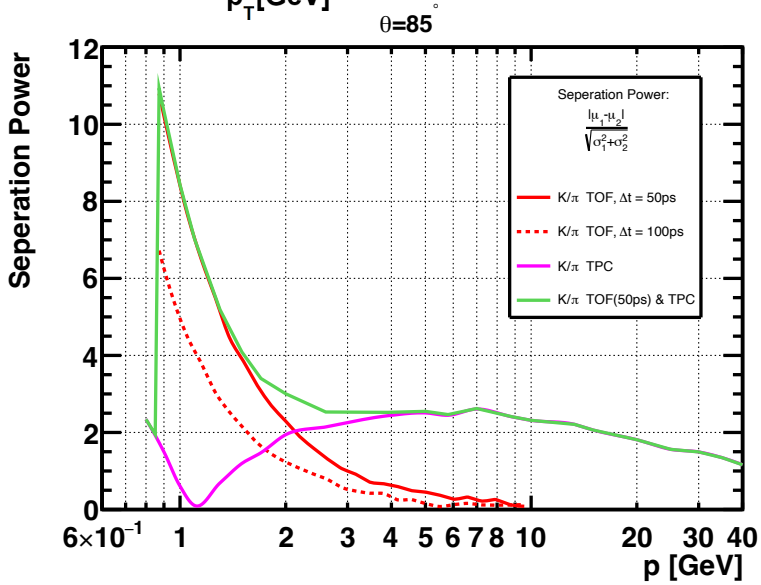
On going!

The Latest PID Performance of TPC and OTK (TOF)

- Efficiencies of particles penetrating the ITK (3 barrels), TPC (half TPC), and OTK (barrel) at a polar angle of θ=85°. The cutoff momenta are P_T ~0.3 GeV/c for the ITK, P_T ~0.6 GeV/c for the TPC, and P_T ~0.9 GeV/c for the OTK, respectively.







The Latest PID Performance of TPC and OTK (TOF)

- Efficiencies of particles penetrating the ITK (3 barrels), TPC (half TPC), and OTK (barrel) at a polar angle of θ=60°. The cutoff momenta are P_T ~0.3 GeV/c for the ITK, P_T ~0.6 GeV/c for the TPC, and P_T ~0.9 GeV/c for the OTK, respectively.