



CEPC AHCAL Cooling Simulation

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- 1 Brief introduction of the CEPC AHCAL structure
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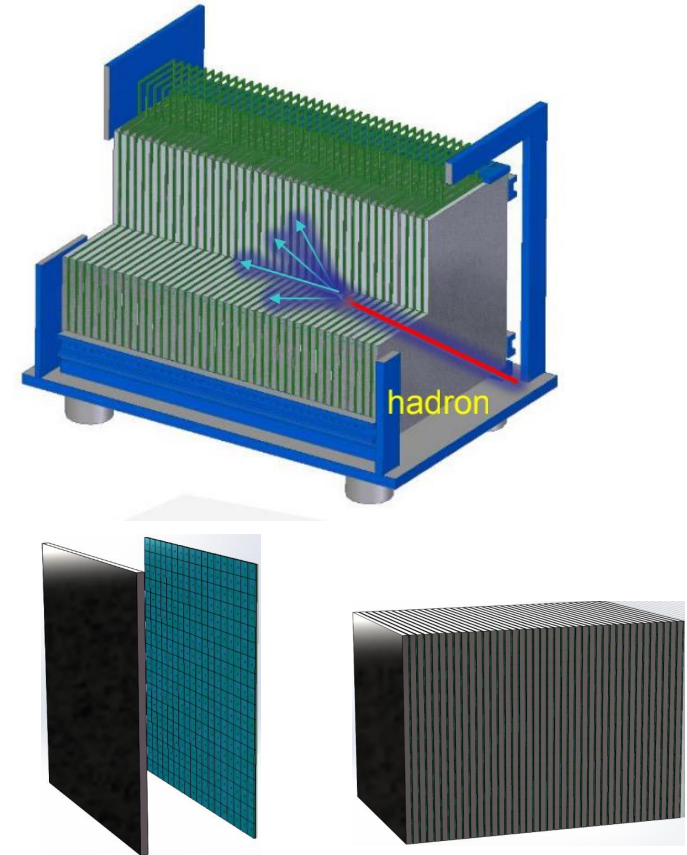


AHCAL Prototype



■ The Scintillator–Steel AHCAL

- PFA oriented: high granularity
 - Cell size: 4cm x 4cm
 - Layer size: 72cm x 72cm (18 x 18 cells)
- 40 sampling layers
- In each layer:
 - 20mm absorber
 - 3mm scintillator
 - 2mm PCB
- Analog readout: SiPM+SPIROC

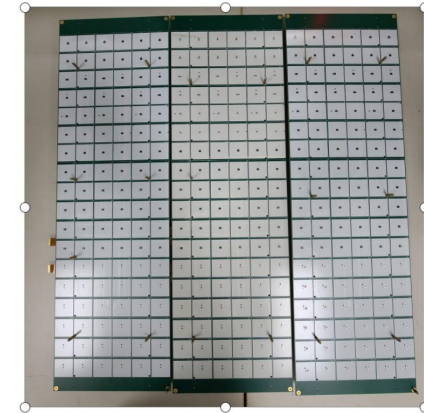
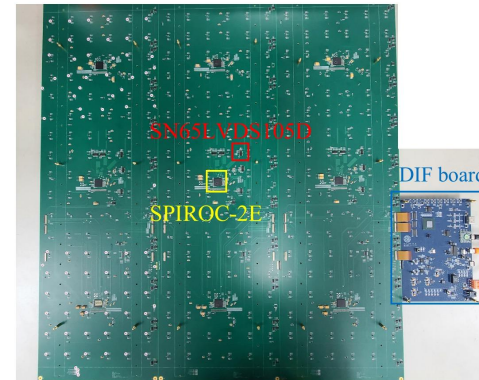


(a) AHCAL Structure

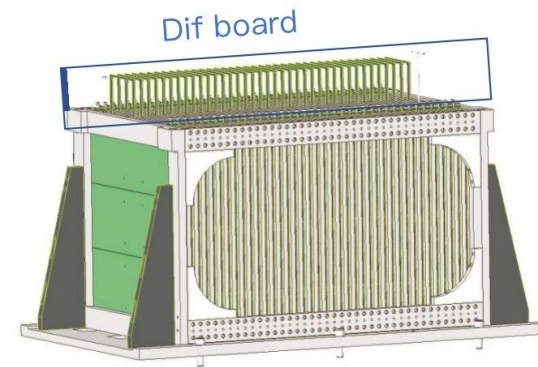
Heating sources in AHCAL



- **Electronics**
 - **Chips on PCB**
 - Several chips distributed on one PCB
 - Releasing heat when working: Dominant
 - As heating sources in this simulation
 - **SiPMs on PCB**
 - Gain: temperature sensitive
 - Self-heating power ~ 10mW: Ignorable
 - **Dif board**
 - Releasing heat but installed outside
 - Could be ignored in cooling simulation



(a) PCB: chips on one side, scintillators+SiPMs on another



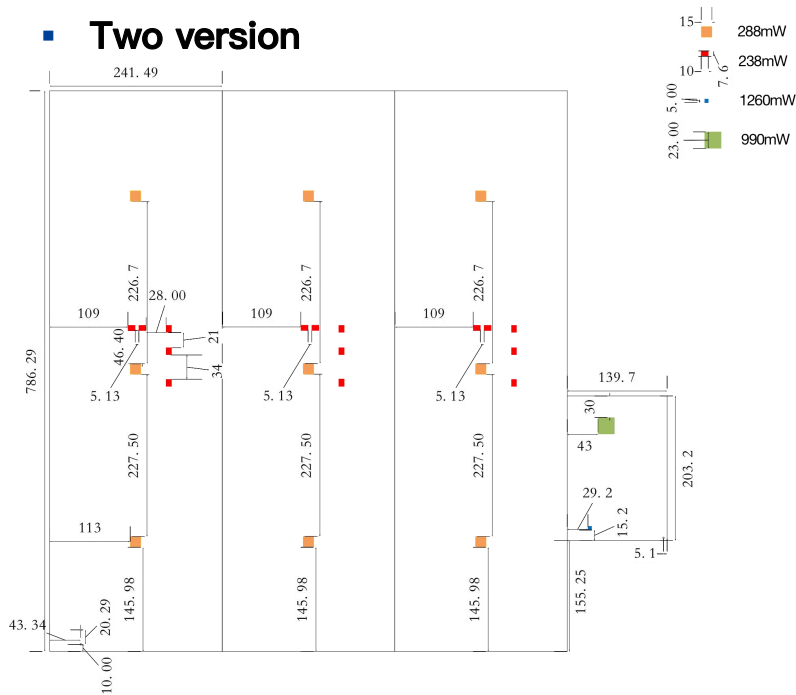
(b) AHCAL: Dif board position diagram

Heating sources on PCB in one layer

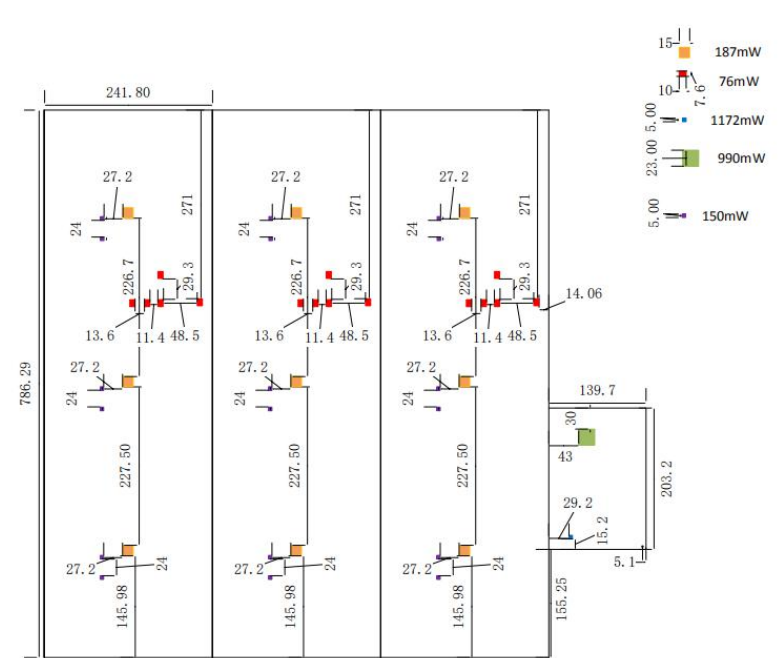


Chips distribution

Two version



HBU_V1



HBU_V2 (Updated in November)

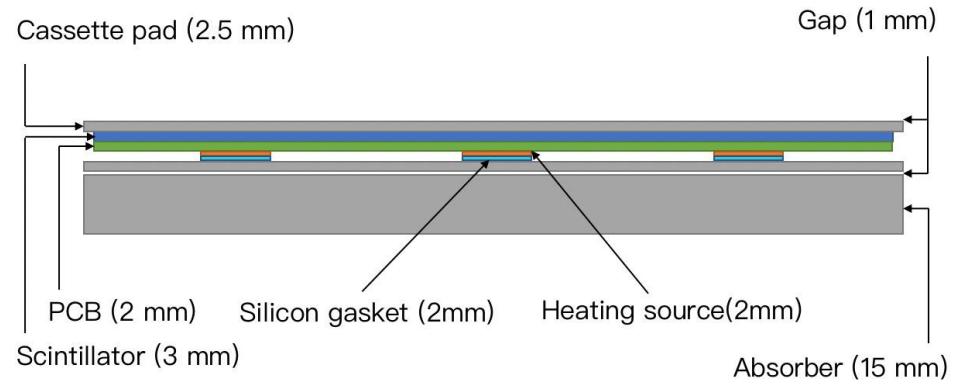
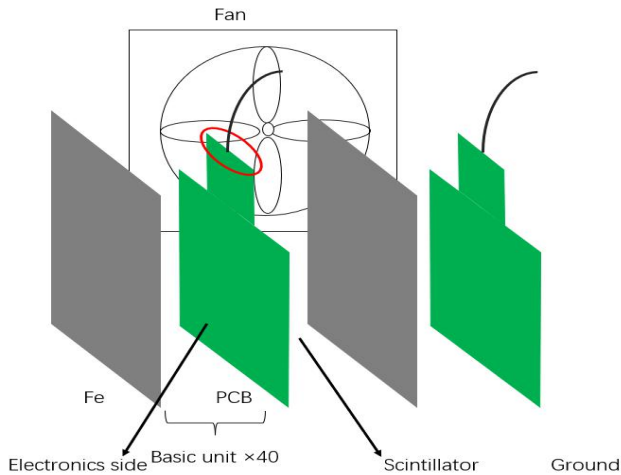
- Total power: 6162mW +2250 mW (Dif board)

- Total power: 5523mW +2162 mW (Dif board)

Cooling methods



- **Simulation software**
 - The ICEPAK in Ansys
- **Adding fans next to AHCAL**
- **Adding silicone gaskets between chips and Cassette pad**



Review of previous simulation

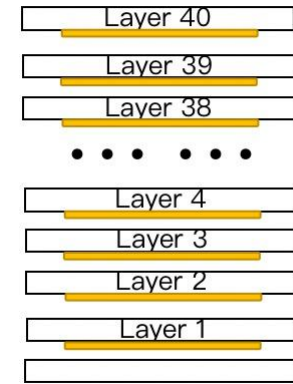


■ Purpose

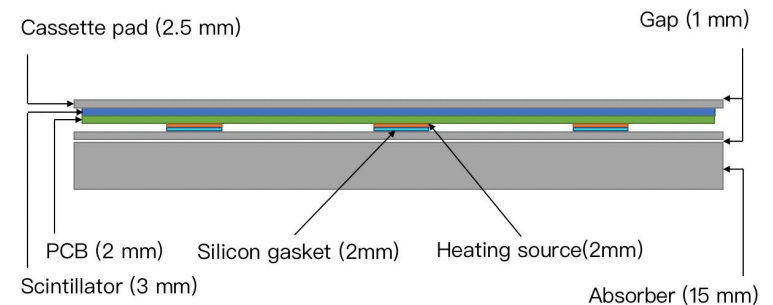
- Know the temperature the AHCAL would reach
- Verify the feasibility of the cooling method
- Provide cooling advice for AHCAL design

■ Include main ingredients

- Absorber
- Cassette pad
- Scintillator
- PCB
- Heating sources



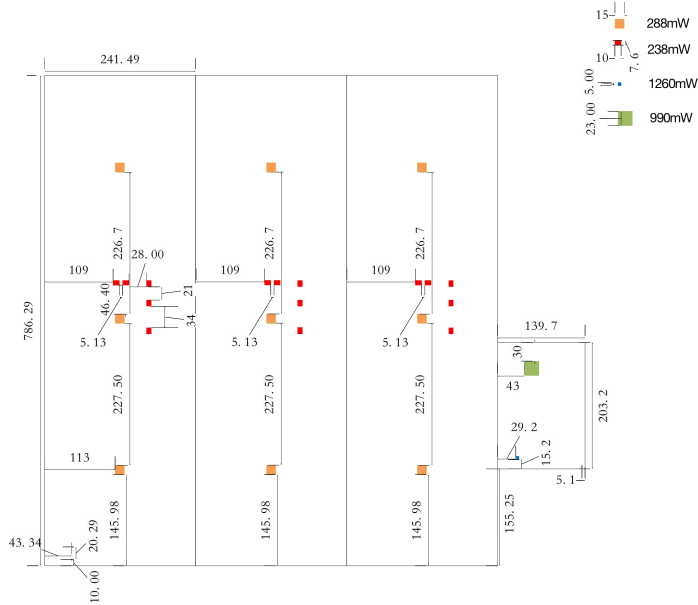
(a) Layer pile up diagram



Review of previous simulation

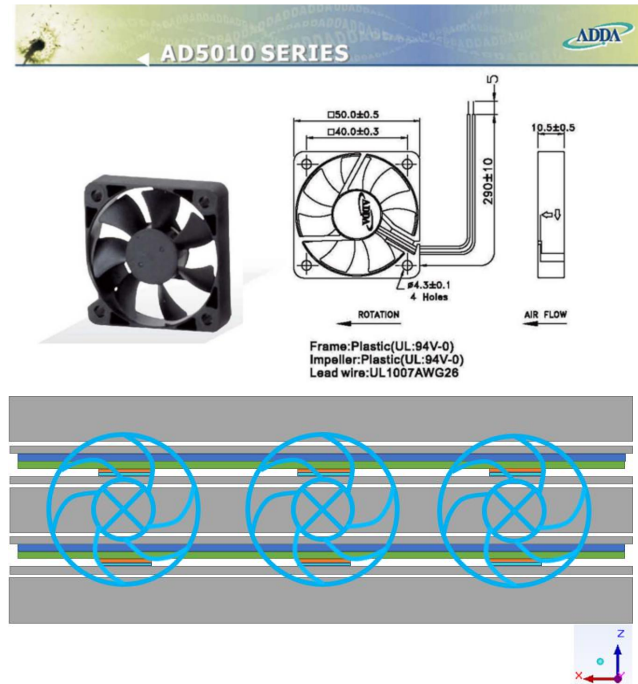


- Chips distribution used: HBU_V1
 - Dif board is ignored
 - Total power in one layer: 6162mw



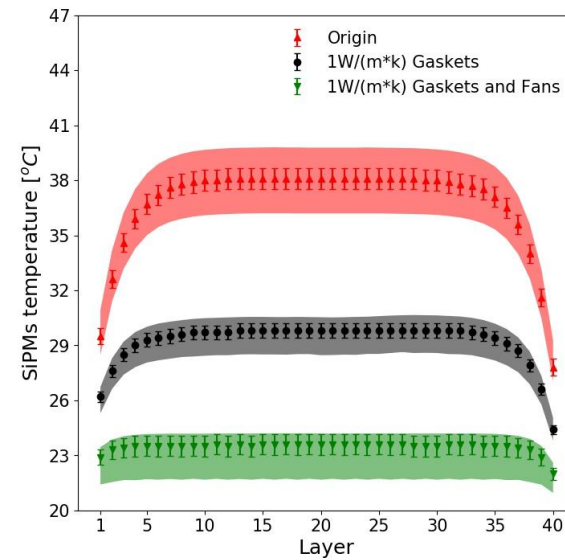
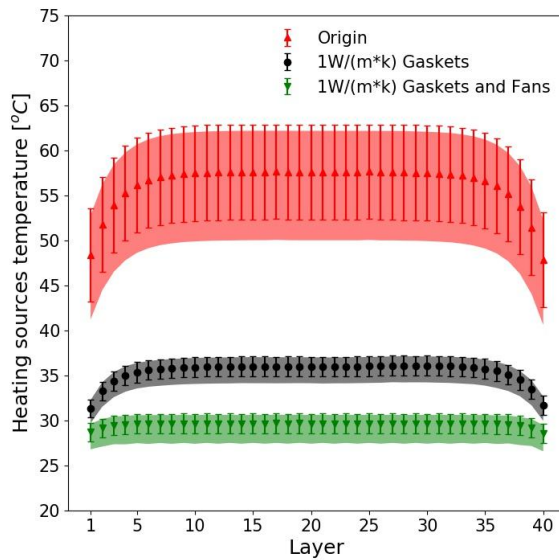
(a) HBU_V1

- Fan parameters
 - Size: 50mm*50mm
 - Volume flow: 16 cfm



(b) Fan displacement diagram.

Review of previous simulation



- Room temperature: 20°C
- Heating sources
 - The average increasing temperature of the origin: 28°C to 38°C.
 - Silicone gaskets reduce the average temperature by about 20°C.
 - Fans further reduce the average temperature by about 6°C.
- SiPMs
 - The average increasing temperature of the origin: 8°C to 18°C.
 - Silicone gaskets reduce the average temperature by about 8°C.
 - Fans further reduce the average temperature by about 6°C.

Progress on cooling simulation



- **Two updates on AHCAL design**
 - **HBU_V1 → HBU_V2**

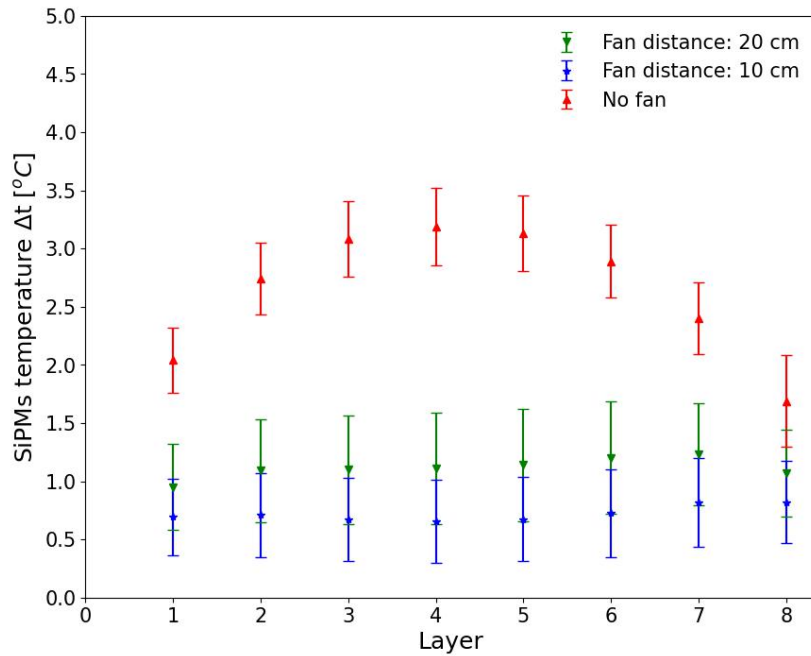
In one layer:

 - **Lower power: 6162mW → 5523mW**
 - **More chips: 24 → 42**
 - **Fan model**
 - **Larger size: 50mm*50mm → 200mm*200mm**
 - **Larger flow volume: 16 cfm → 360 cfm**
 - **Fewer fans required: 60 → 20**
 - **4 fans are placed next to every 8 layer**
- **In subsequent cooling simulation**
 - **Check cooling effect of new fan model on AHCAL with HBU_V2**

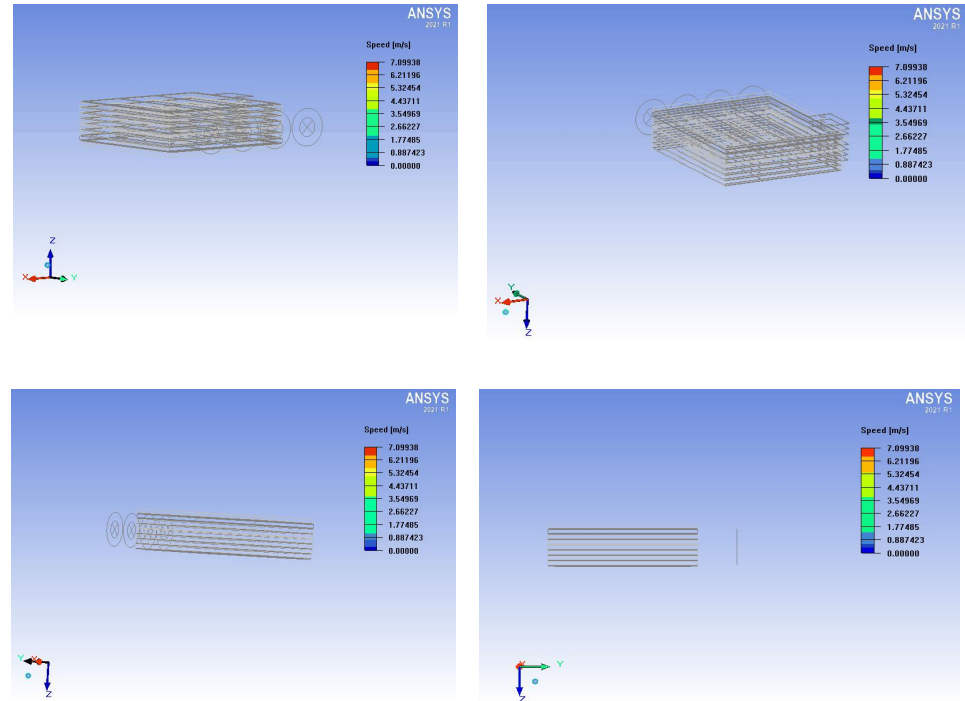
Progress on cooling simulation



■ HBU_V2 simulation



(a) SiPM mean temperature

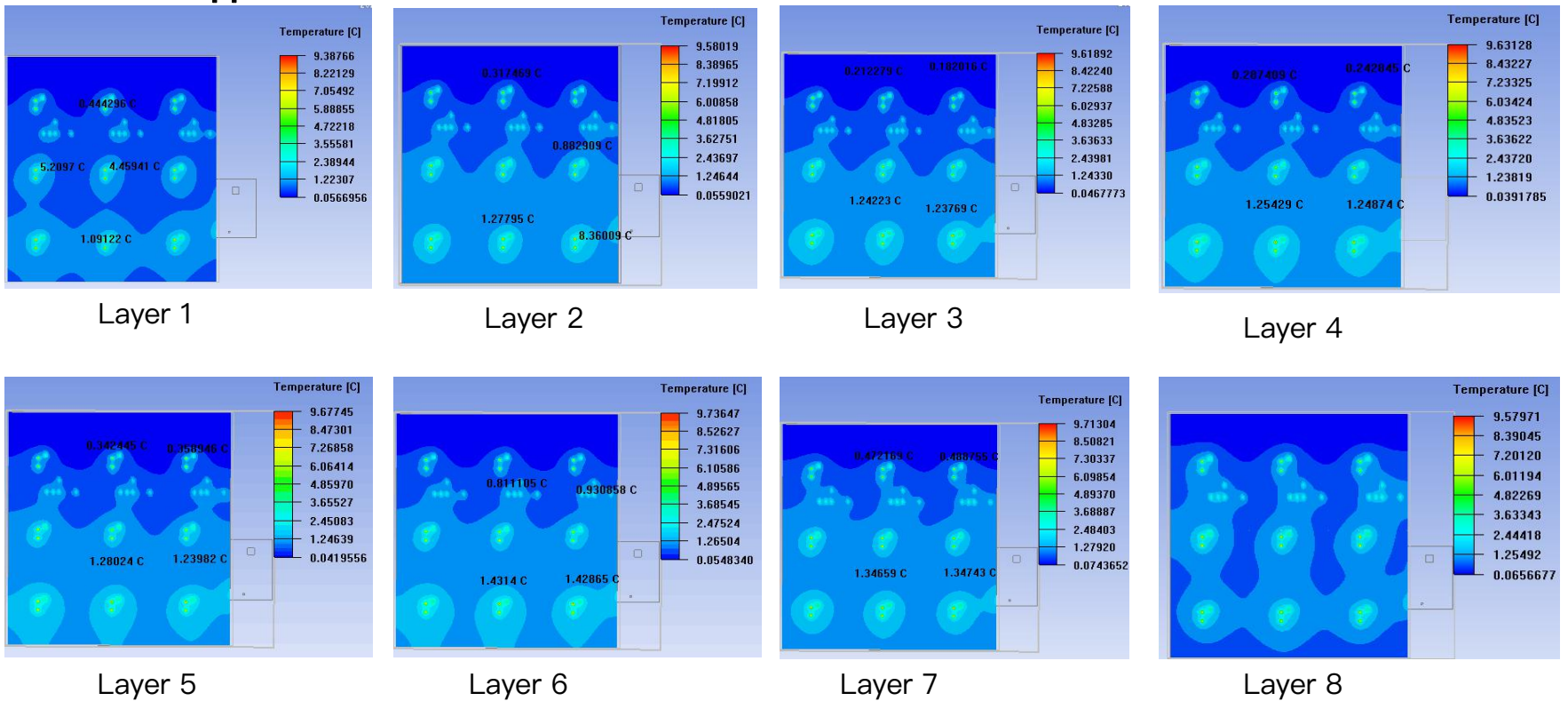


(b) Air flow. The distance between fans and AHCAL is 20 cm

Progress on cooling simulation



- HBU_V2 simulation
 - Upper side is close to the Fans



(a) PCB chips side. Using 4 fans, distance: 20 cm, the temperatures rise within 10 °C

Summary and outlook



- **8-layer simulation for HBU_V2 was done**
 - Fans reduce the mean temperature about $1^{\circ}\text{C} - 2^{\circ}\text{C}$
 - New fan model can reduce the temperature of the SiPM in each layer
- **One CAD design version for AHCAL was finished**
 - Cooling simulation for such design is on going
 - Hope to get 40-layer cooling simulation results for this design next meeting

Thanks

Thanks

