

# ePIC TOF Structure Thermal Test

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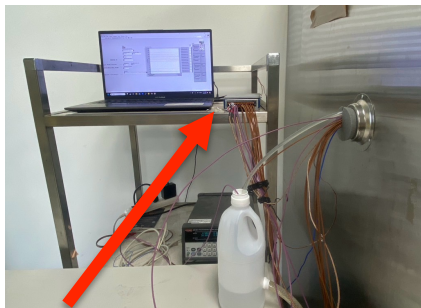
23 July 2024

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National Cheng Kung University





# Test Setup for Mini Stave (30 cm)



## NI 9213 DAQ



- 16 channels
- Accuracy:
  - High-resolution mode :  $<0.02\text{ }^{\circ}\text{C}$
  - High-speed mode :  $<0.25\text{ }^{\circ}\text{C}$



## Heat source (x 9)

- Ceramic plate (5 $\Omega$ ):  $\sim 500\text{ }^{\circ}\text{C}$

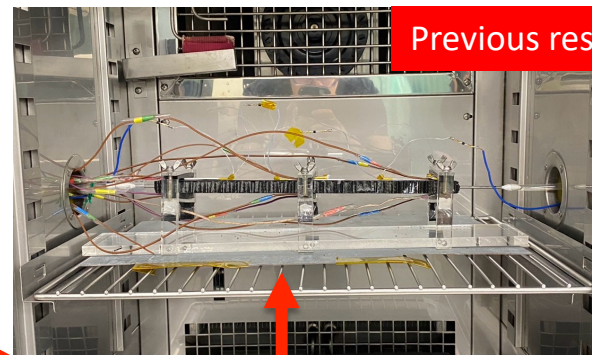
## Thermocouple (x 16)

- Type E:  $-250\text{ }^{\circ}\text{C} \sim 900\text{ }^{\circ}\text{C}$



## Cooling system

- Temperature:  $3\text{ }^{\circ}\text{C} \sim 32\text{ }^{\circ}\text{C}$



Previous results

## Environmental chamber

- Inner dimensions:  $40 \times 50 \times 60\text{ cm}^3$
- Temperature:  $-40\text{ }^{\circ}\text{C} \sim 100\text{ }^{\circ}\text{C}$  ( $\pm 0.2\text{ }^{\circ}\text{C}$ )
- Humidity:  $10\% \sim 98\%$  ( $\pm 2.5\%$ )

## Flow meter

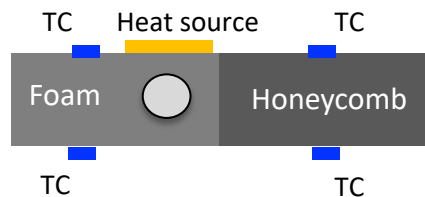
- $20 - 300\text{ cc/min}$



# Test Setup for Mini Stave (30 cm)

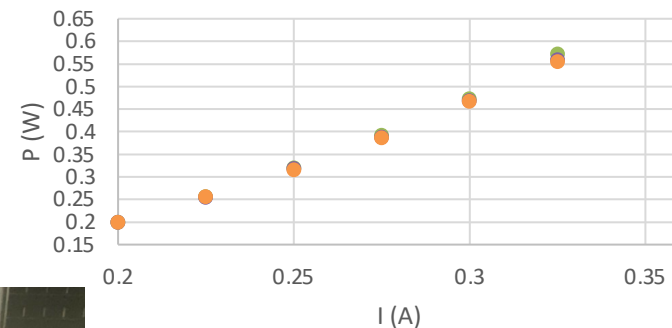


3D-printed holder



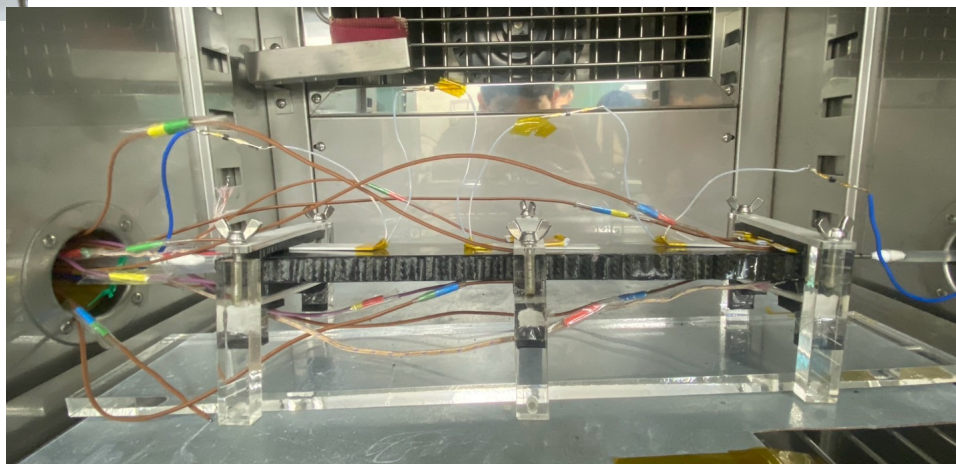
Previous results

Power vs current



● source 2 ● source 3 ● source 5

Water out ←



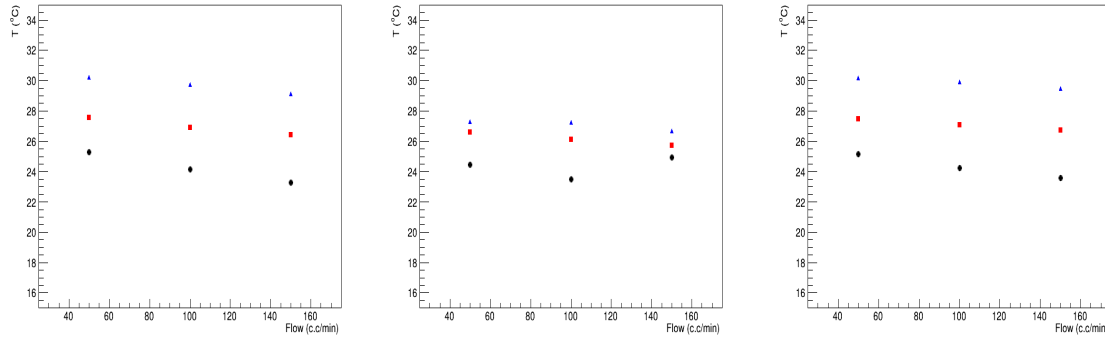
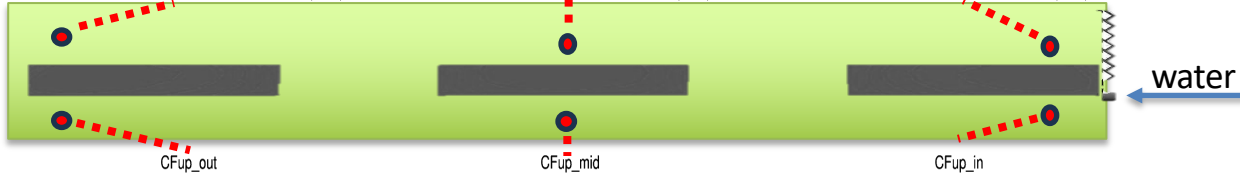
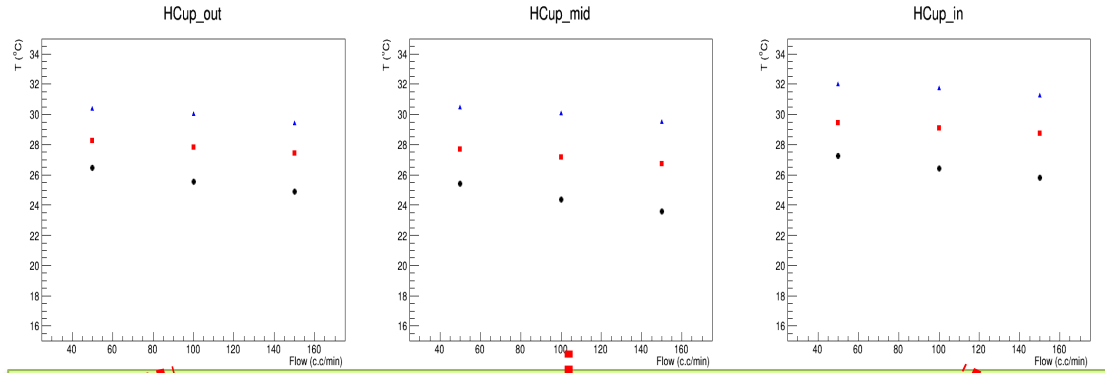
← Water in



# Top Side, Power: 6 W

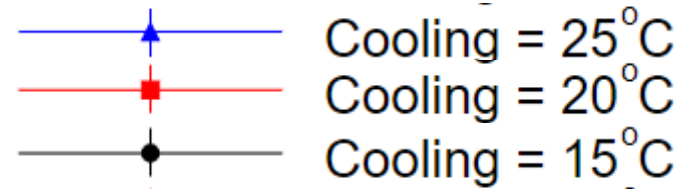
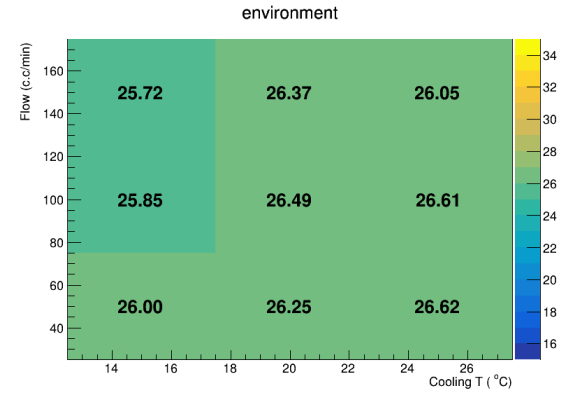


Previous results



○ Best cooling performance

- High flow rate
- Lower cooling temperature



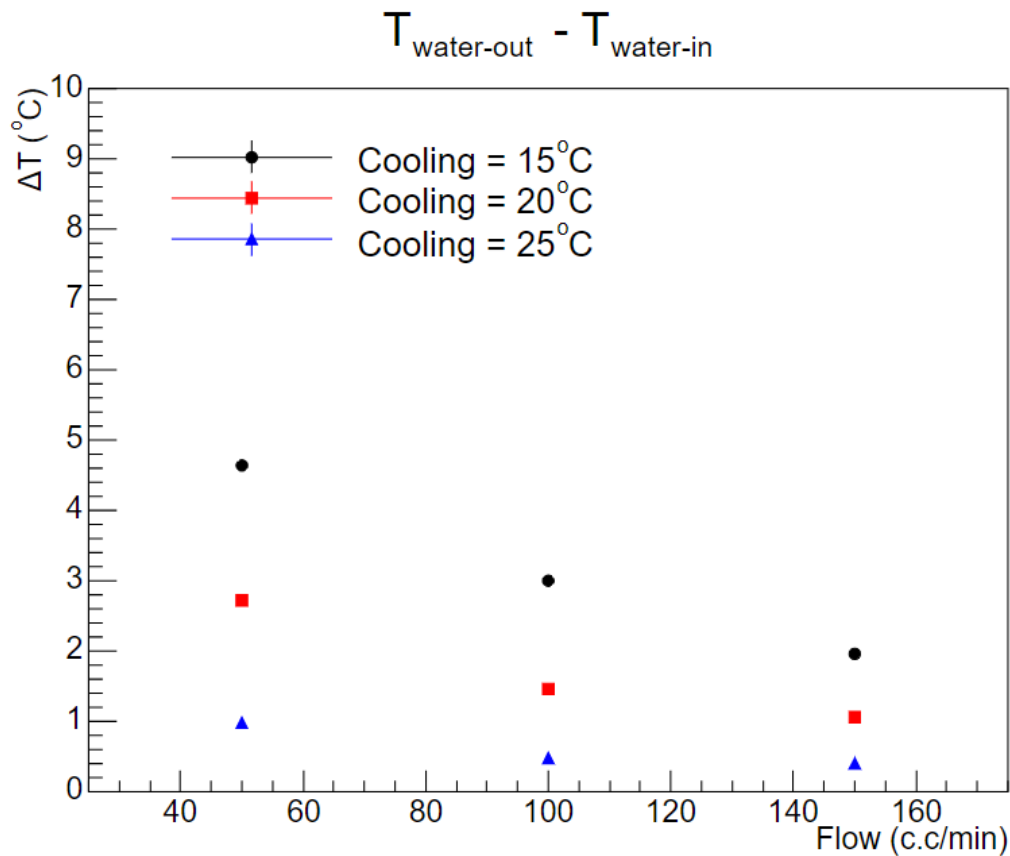




# $\Delta T$ between Water-in and Water-out

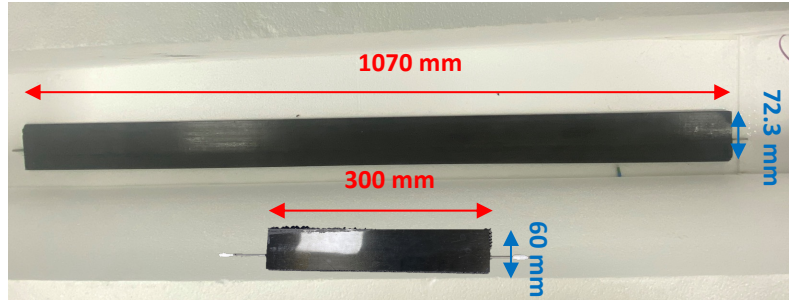


Previous results



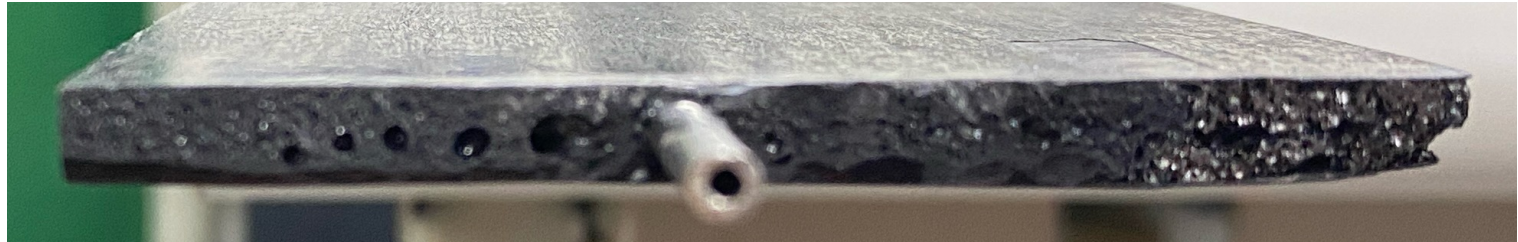
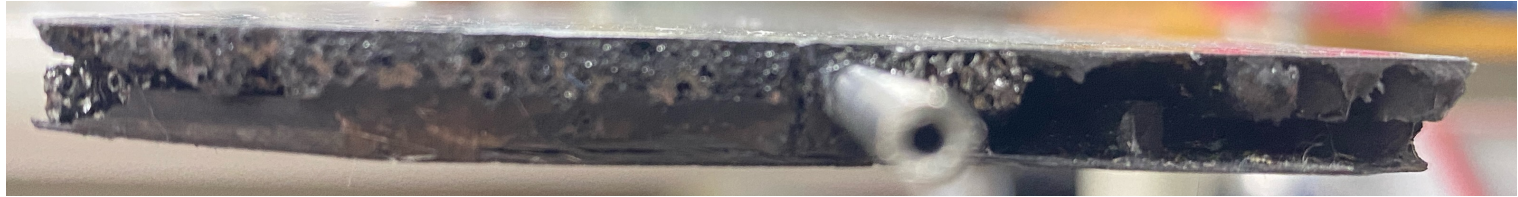


# Half Stave (100 cm)





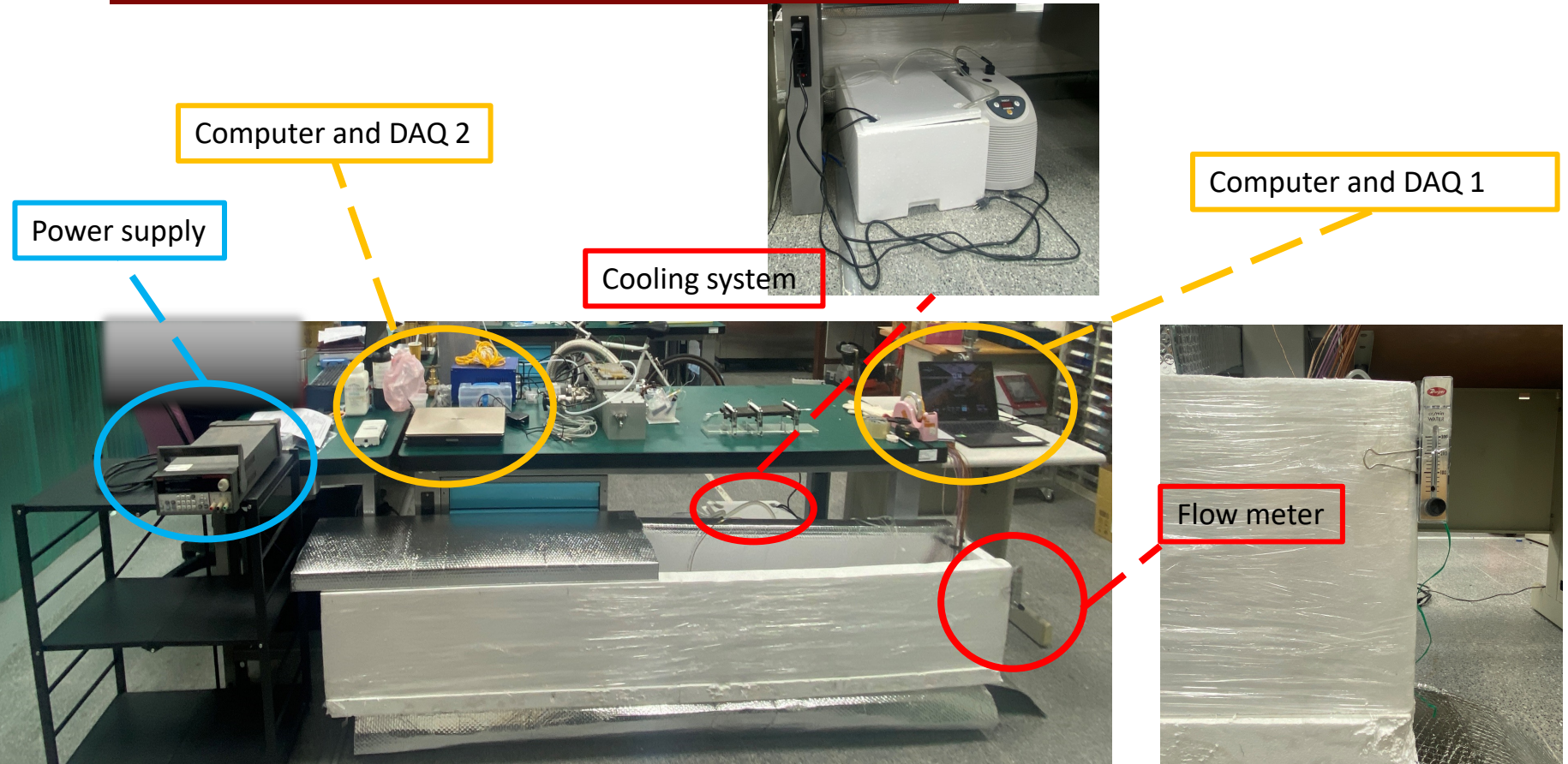
# Cross-section of Half Stave







# Test Setup for Half Stave (100 cm)





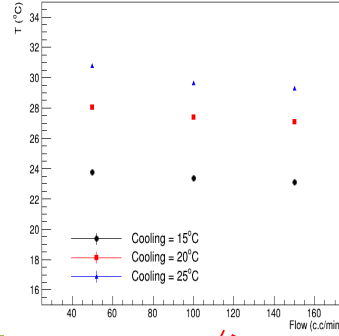
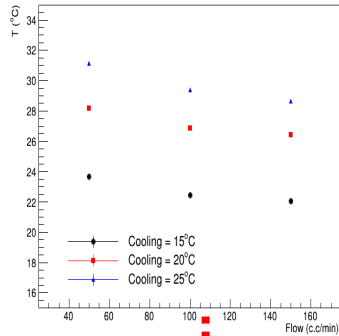
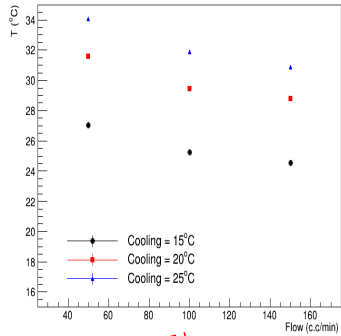
# Top Side, Power: 20.1 W



out\_UR

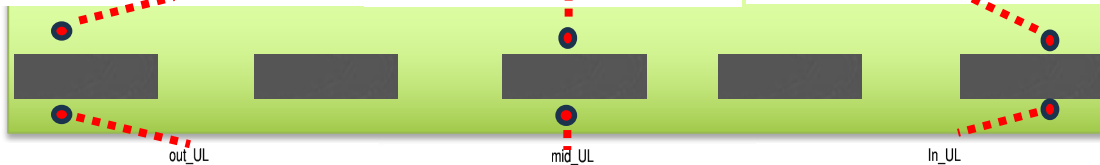
mid\_UR

In\_UR



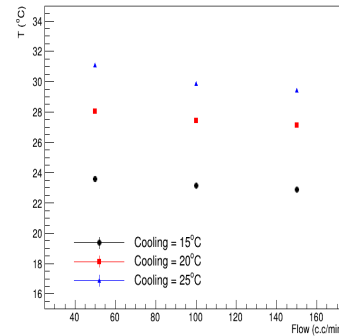
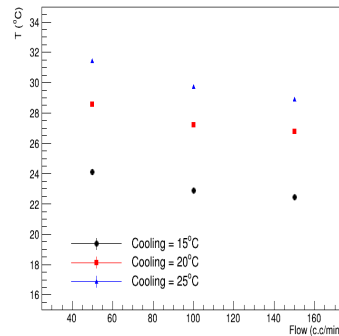
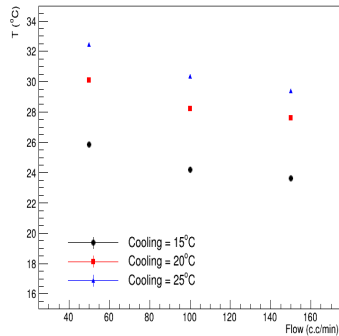
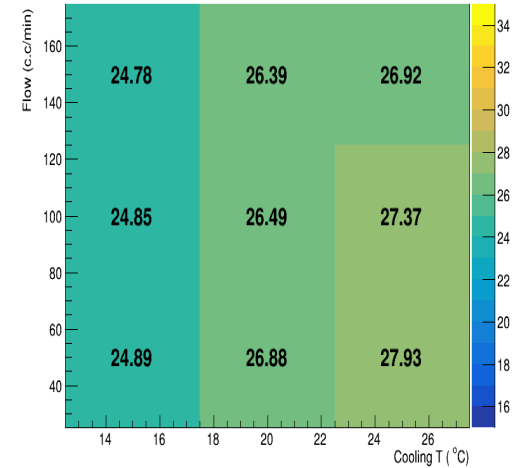
○ Best cooling performance

- High flow rate
- Lower cooling temperature



water

environment





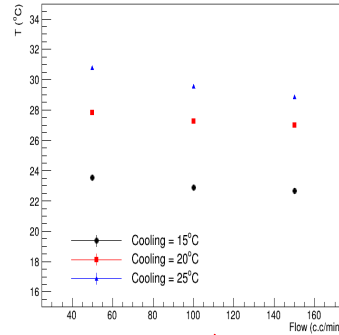
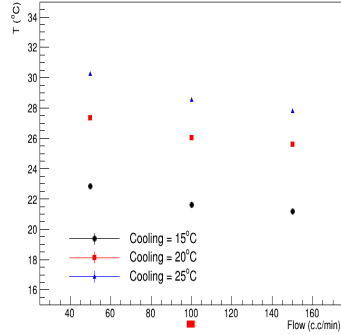
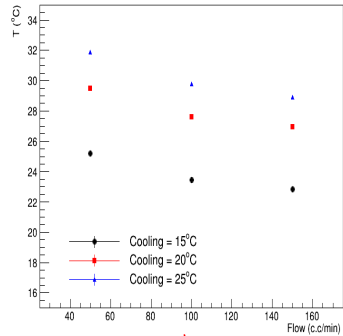
# Bottom Side, Power: 20.1 W



out\_DL

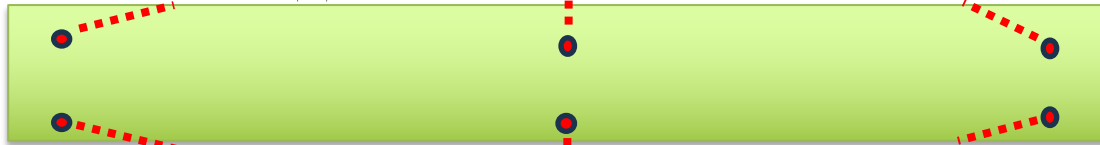
mid\_DL

In\_DL



○ Best cooling performance

- High flow rate
- Lower cooling temperature

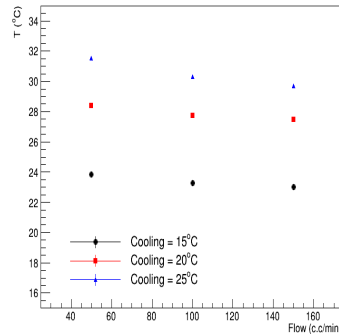
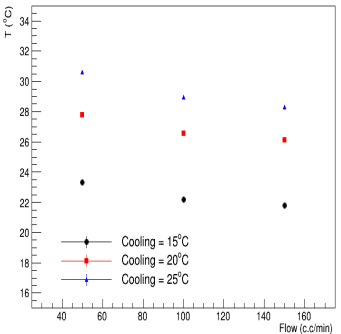
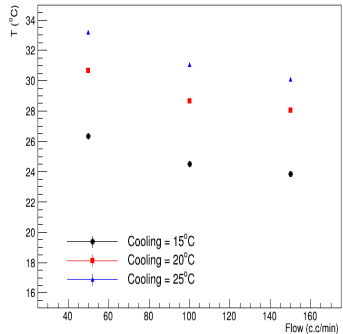


water

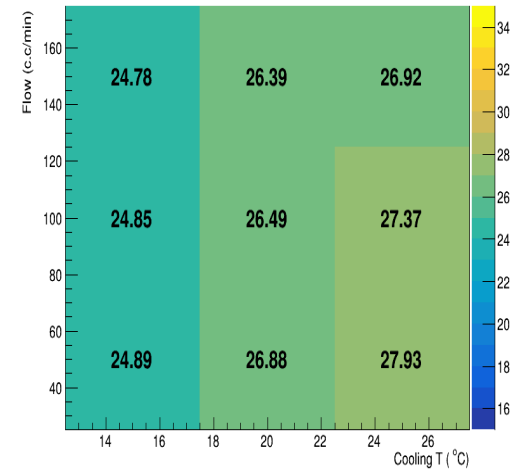
out\_DR

mid\_DR

In\_DR



environment



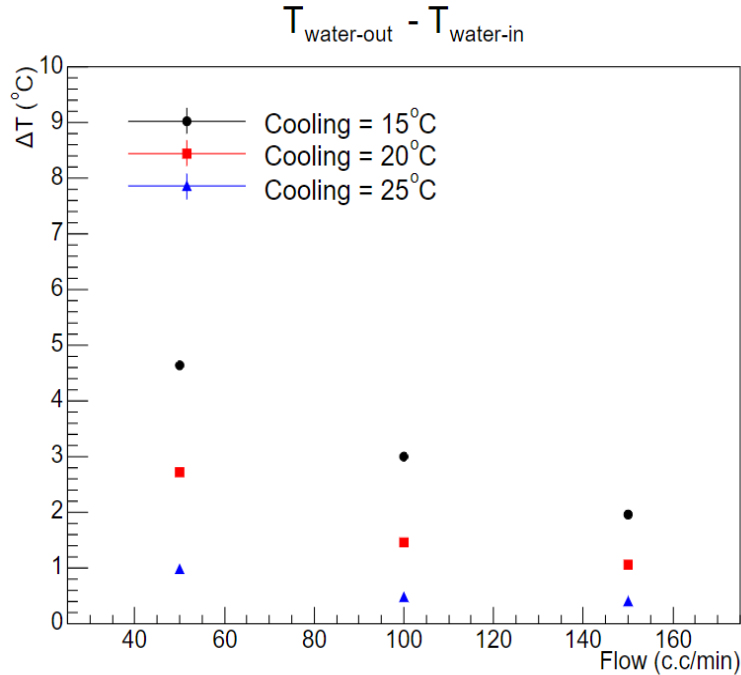




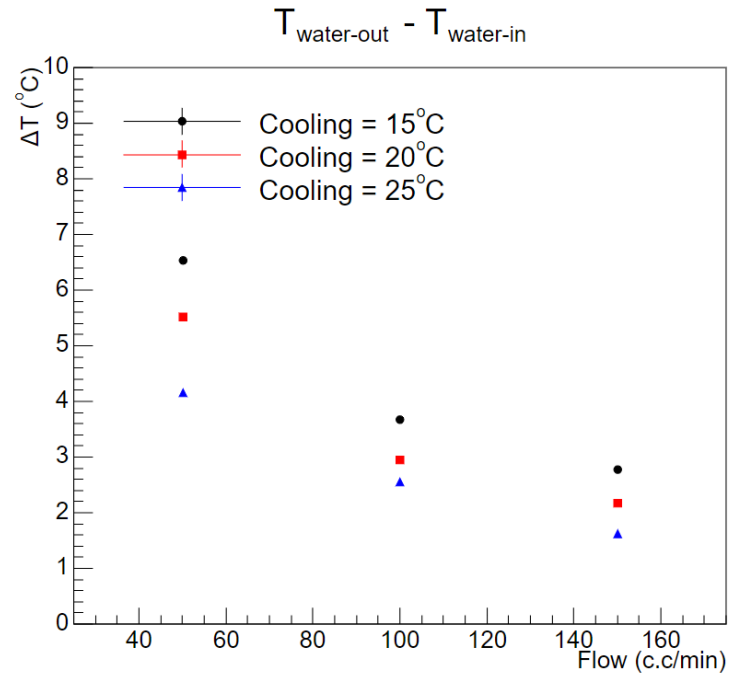
# $\Delta T$ between Water-in and Water-out



- Half stave has larger  $\Delta T$



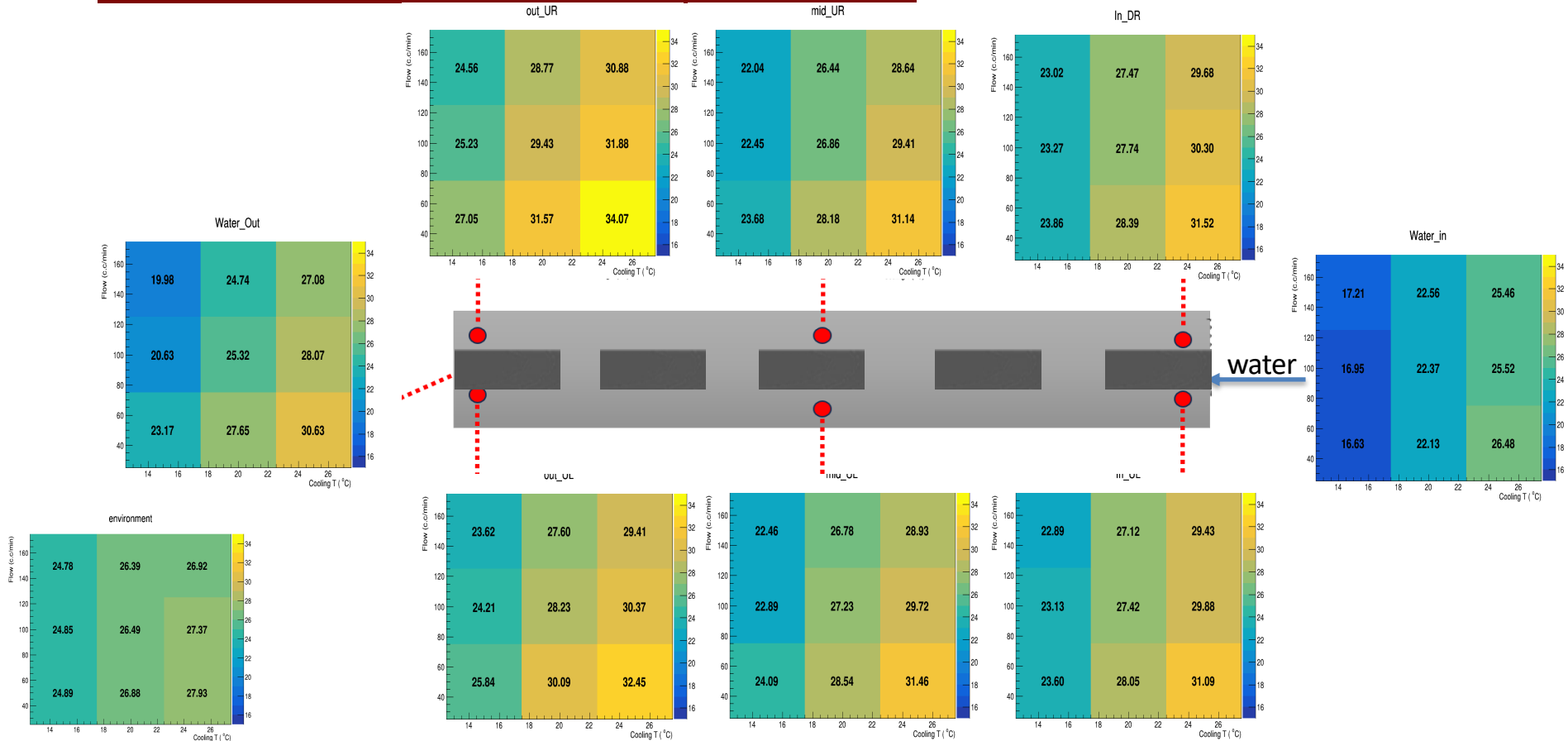
Mini stave



Half stave

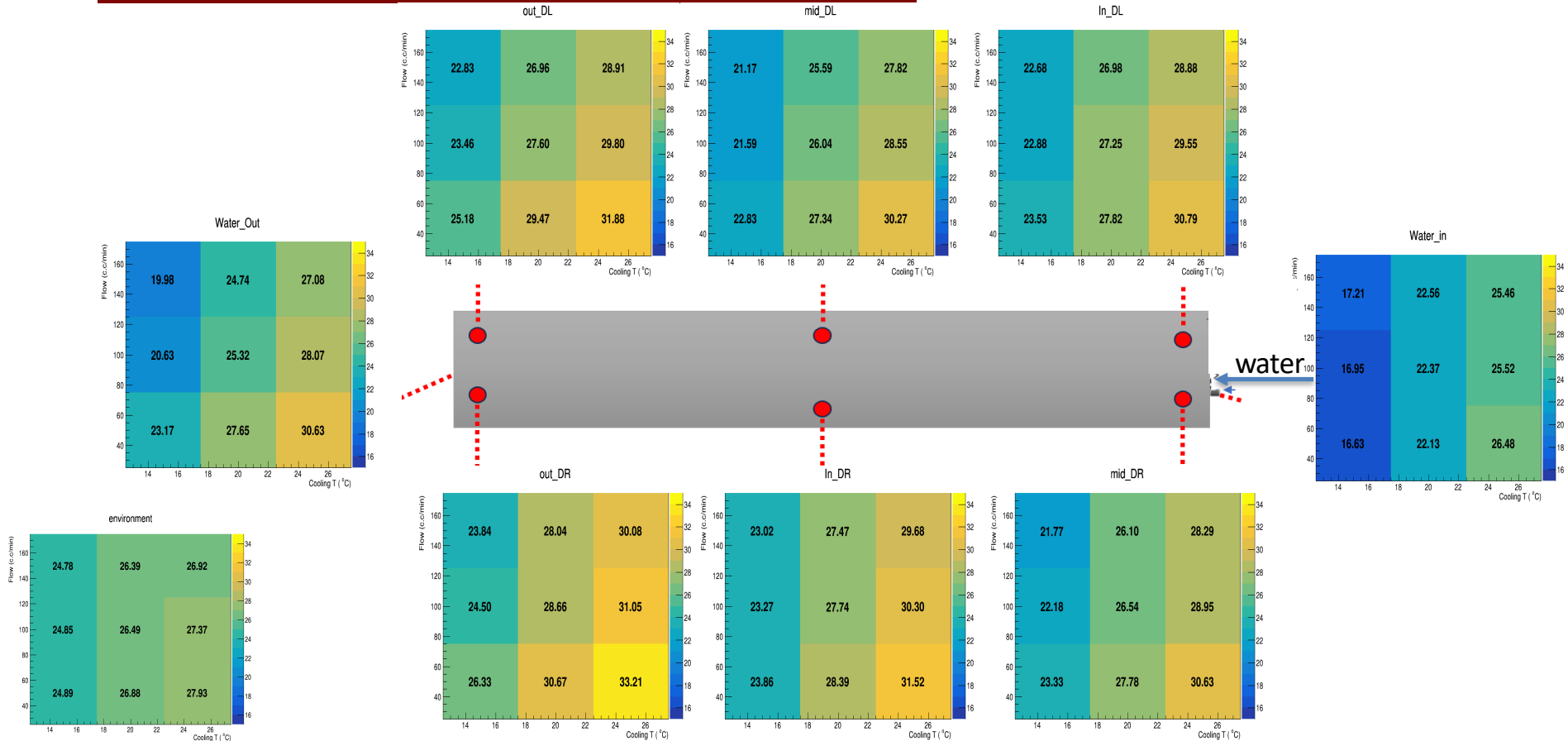


# Temperature in different Flow and Cooling Temperature ( Power: 20.1 W, top side )





# Temperature in different Flow and Cooling Temperature ( Power: 20.1 W, bottom side )

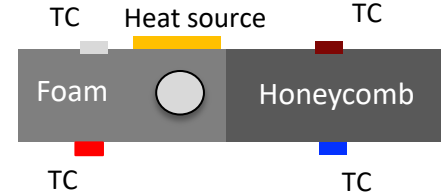
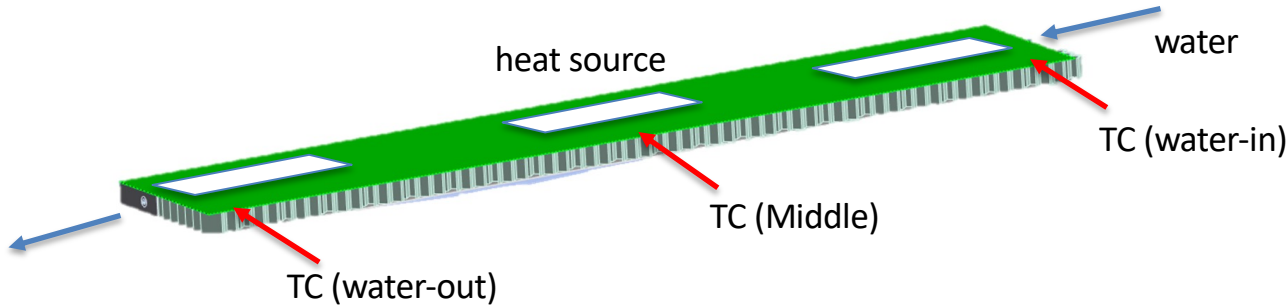




# Back up



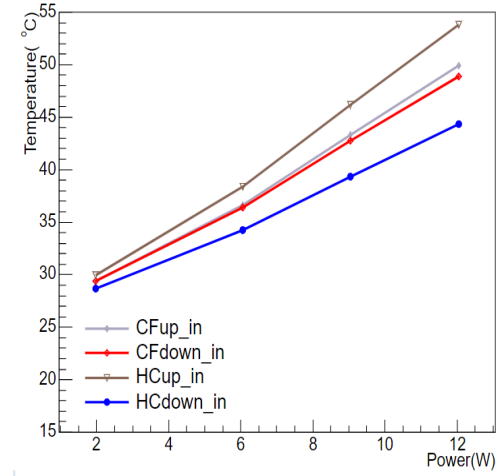
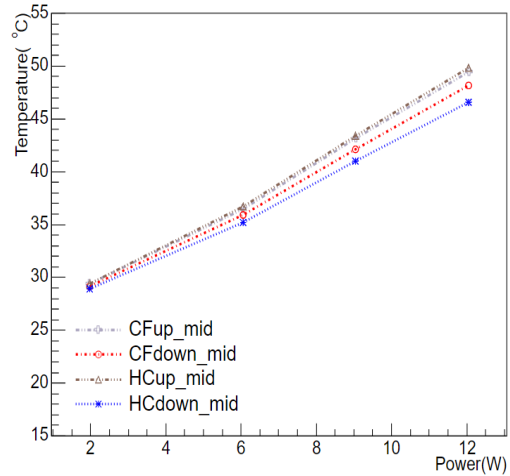
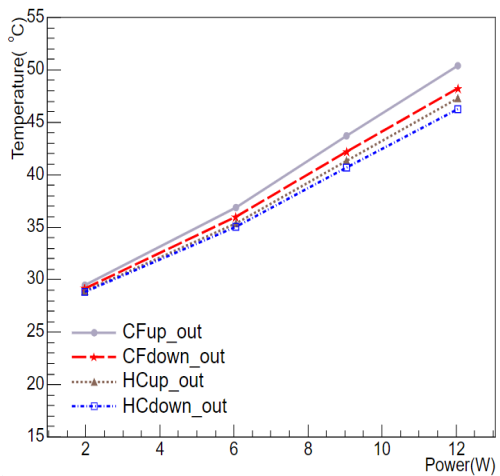
# No Cooling water



Water-out

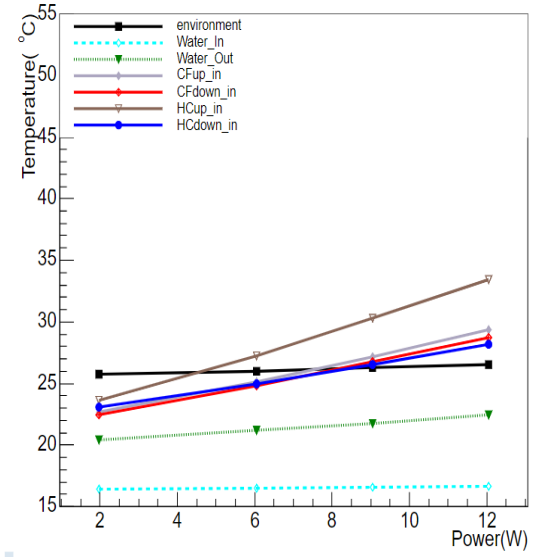
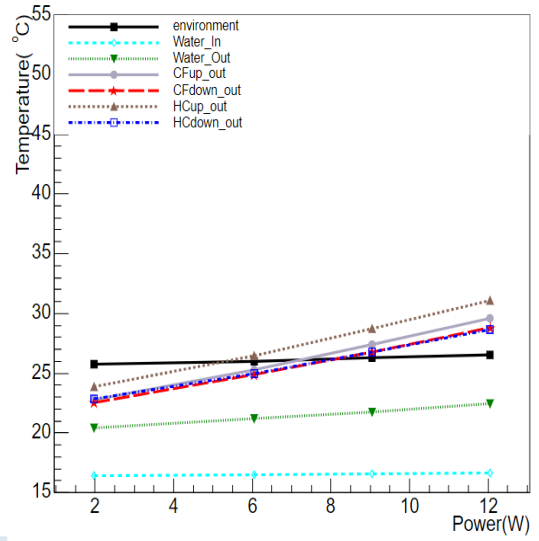
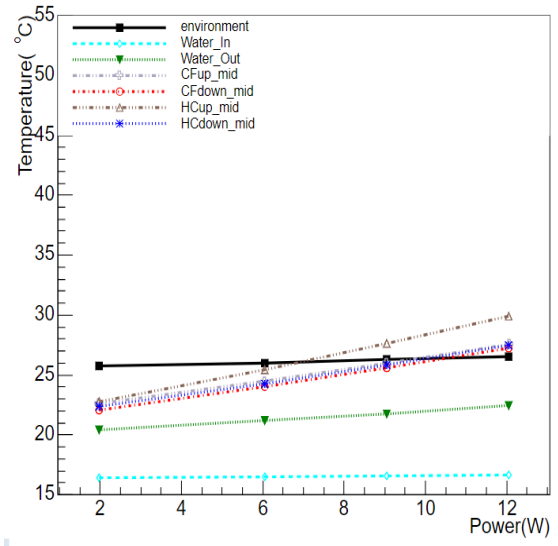
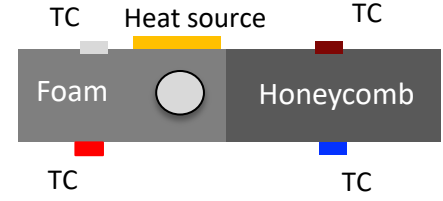
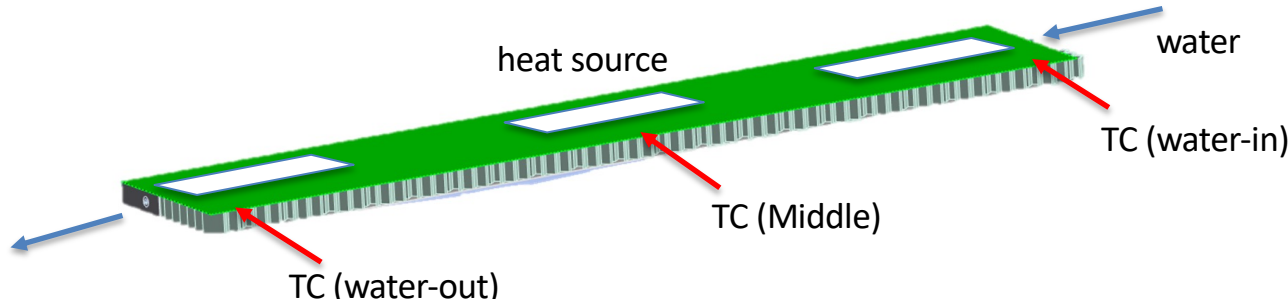
Middle

Water-in





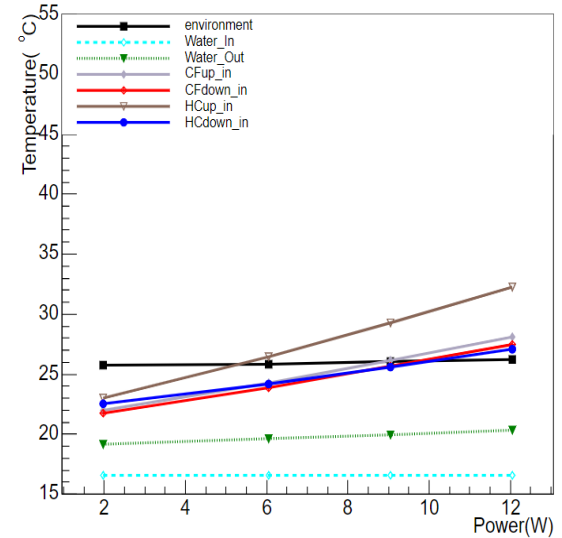
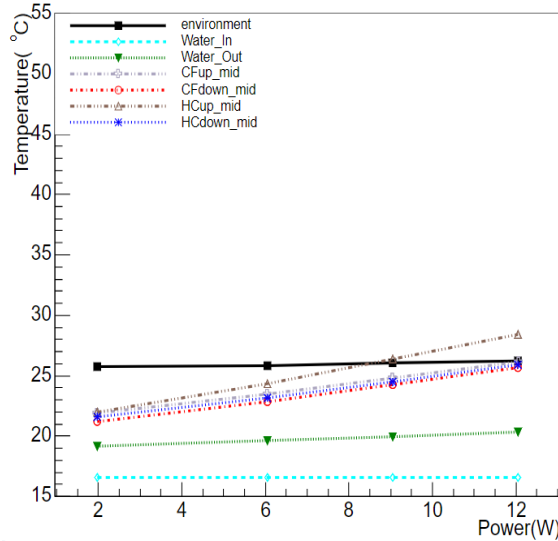
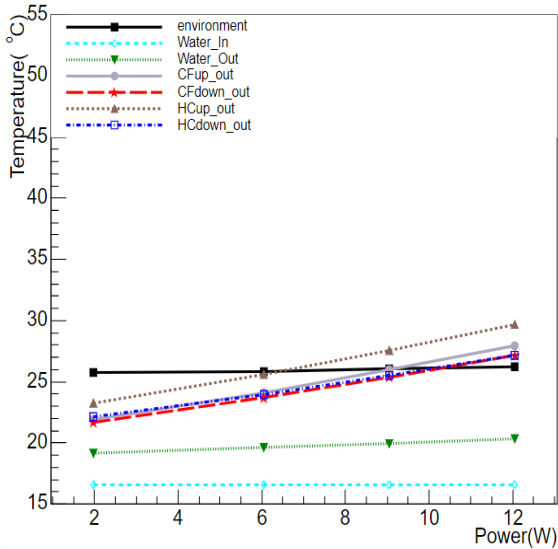
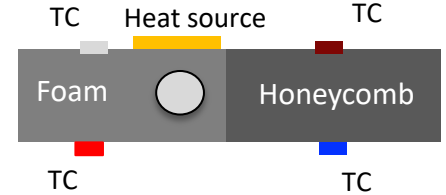
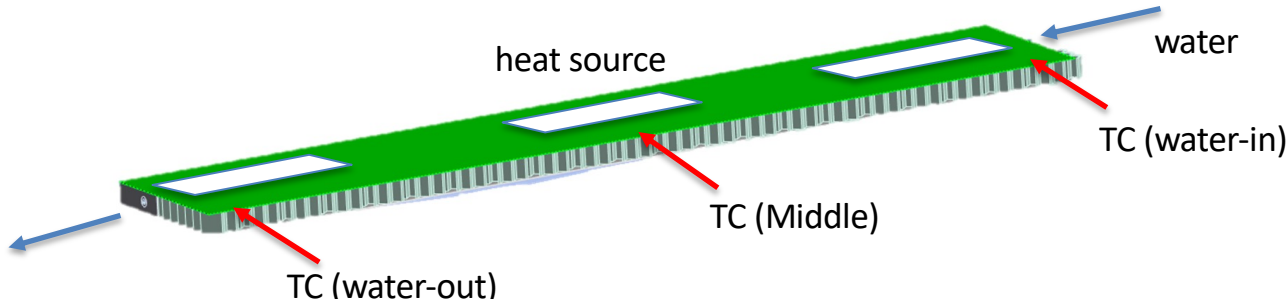
# Cooling water @ 15 °C, 50 c.c./min





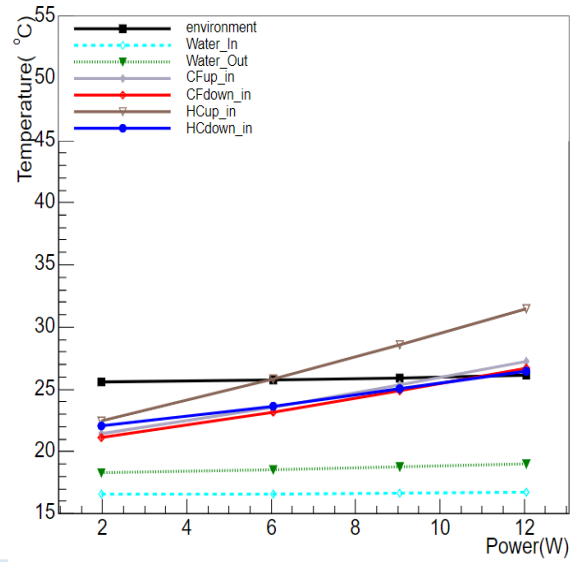
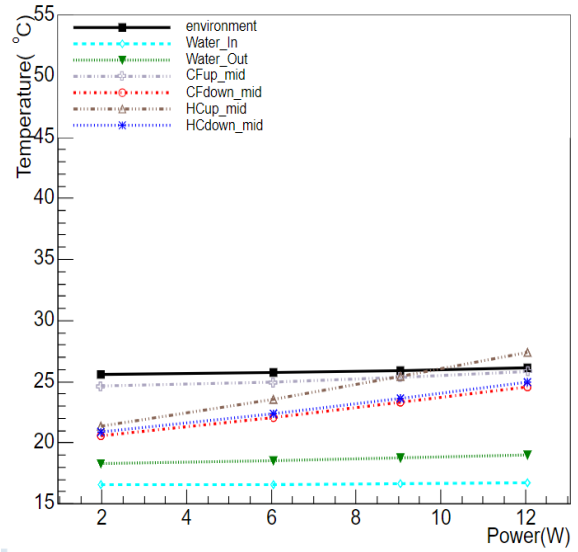
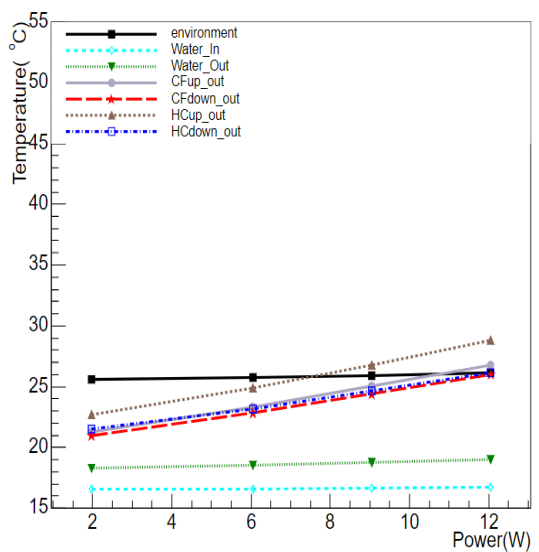
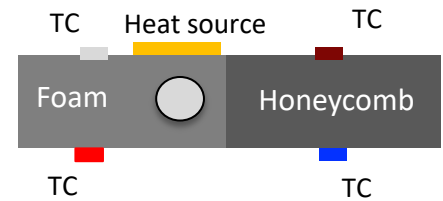
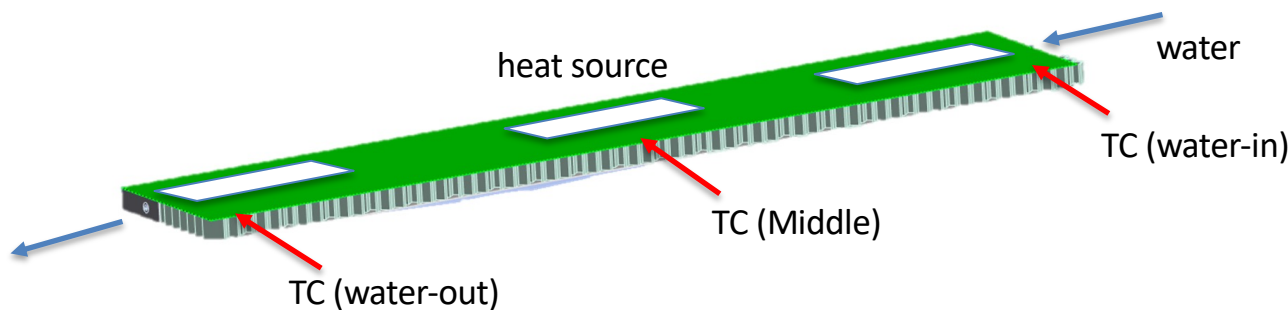


# Cooling water @ 15 °C, 100 c.c./min



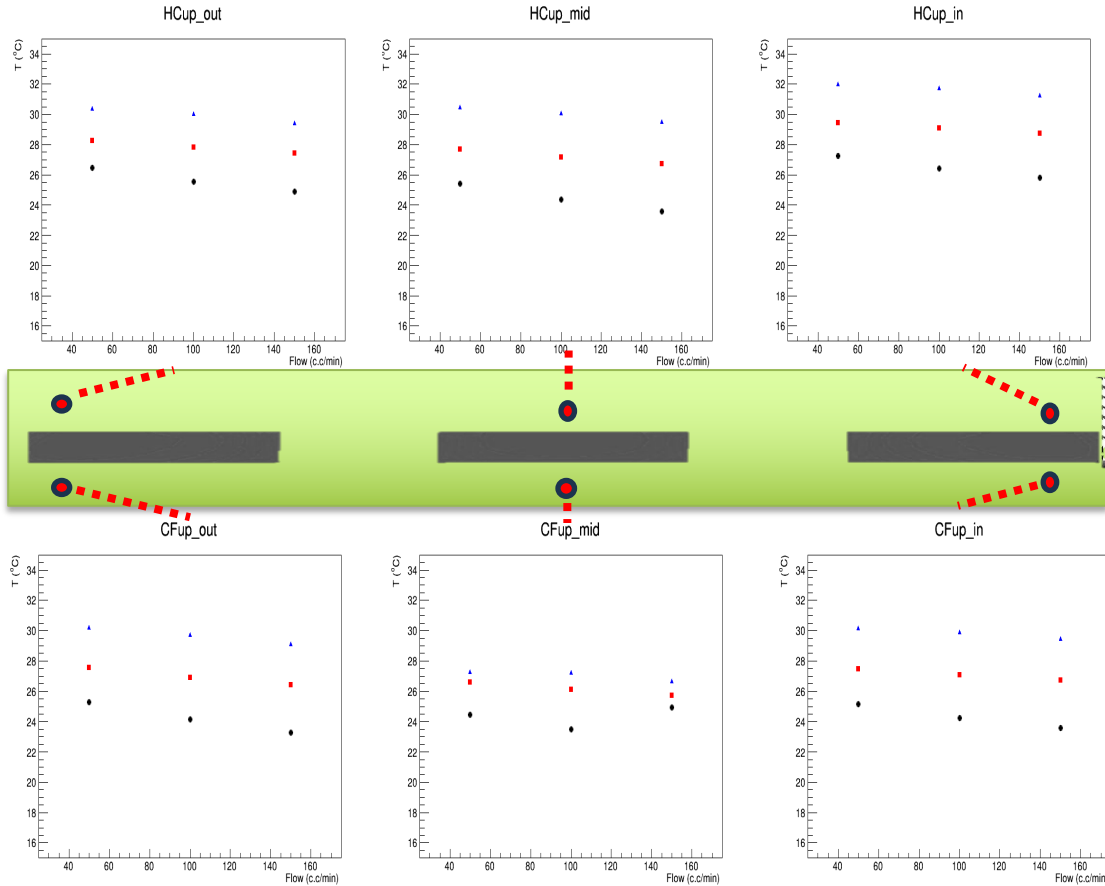


# Cooling water @ 15 °C, 150 c.c./min



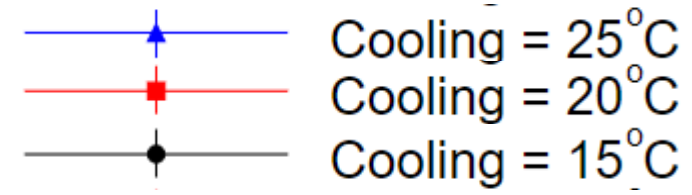
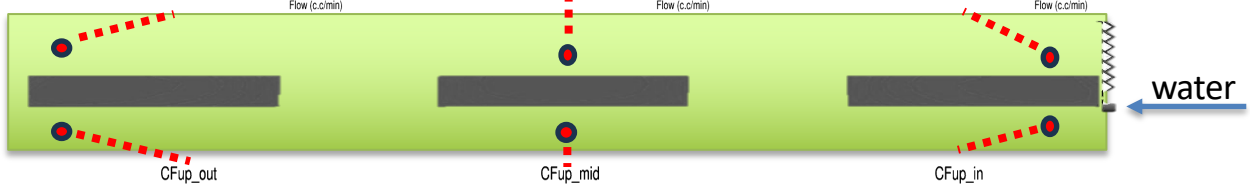


# Top side , Power : 6 W



○ Best cooling performance

- High flow rate
- Lower cooling temperature

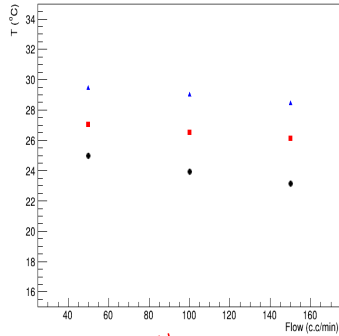




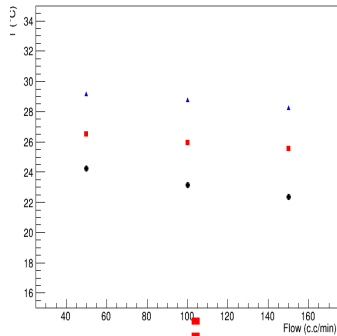
# Bottom side , Power : 6 W



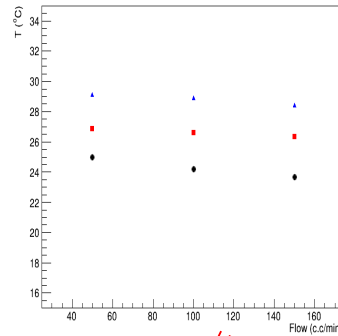
HCdown\_out



HCdown\_mid

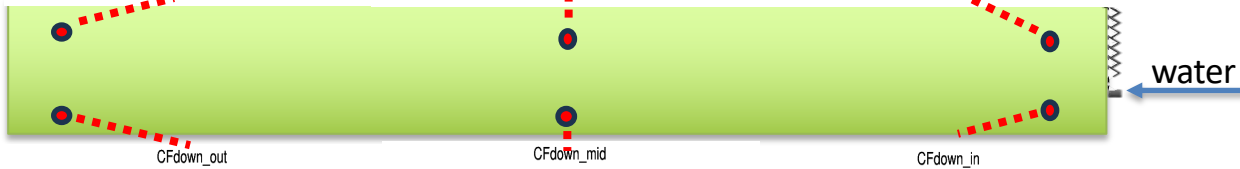


HCdown\_in

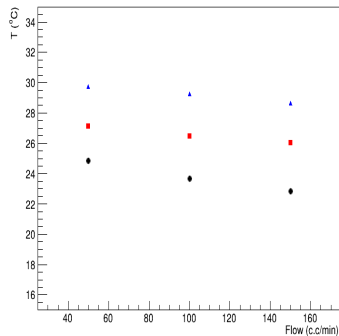


○ Best cooling performance

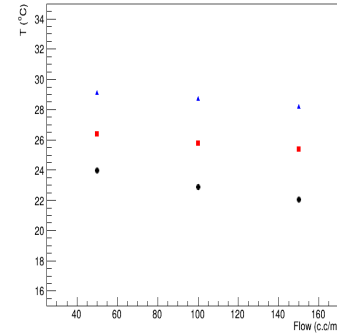
- High flow rate
- Lower cooling temperature



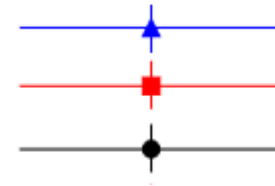
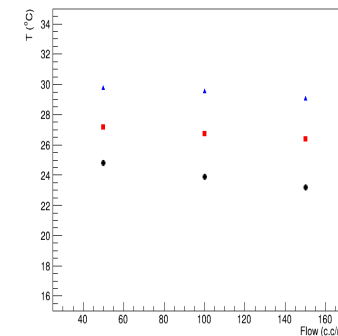
CFdown\_out



CFdown\_mid



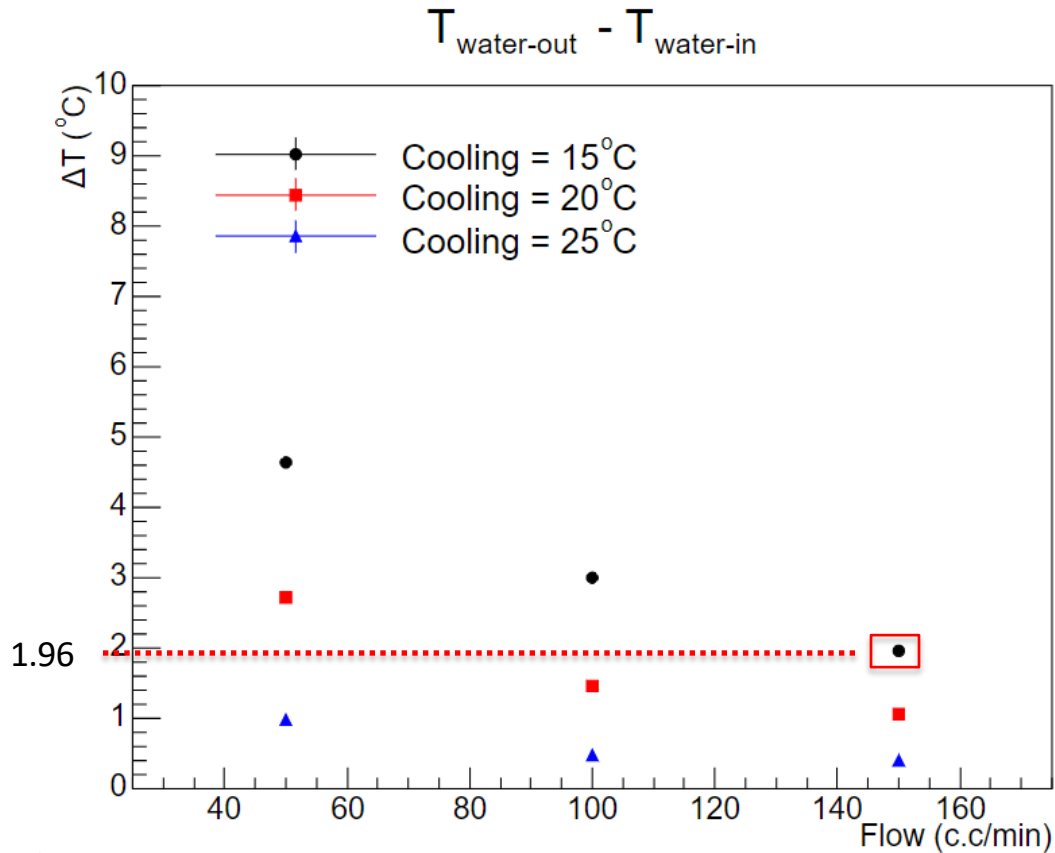
CFdown\_in



Cooling = 25°C  
Cooling = 20°C  
Cooling = 15°C

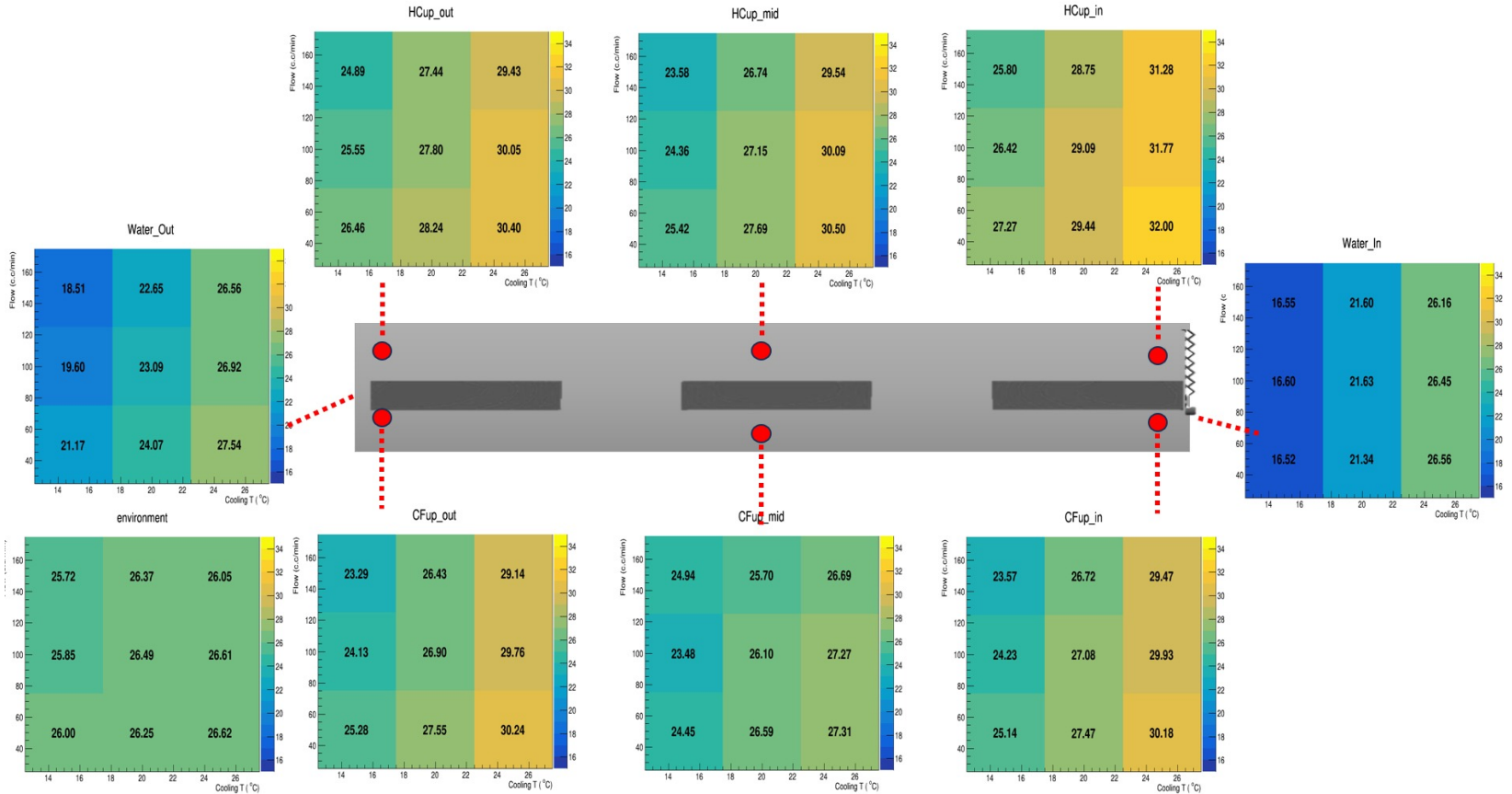


# $\Delta T$ between Water in and Water out





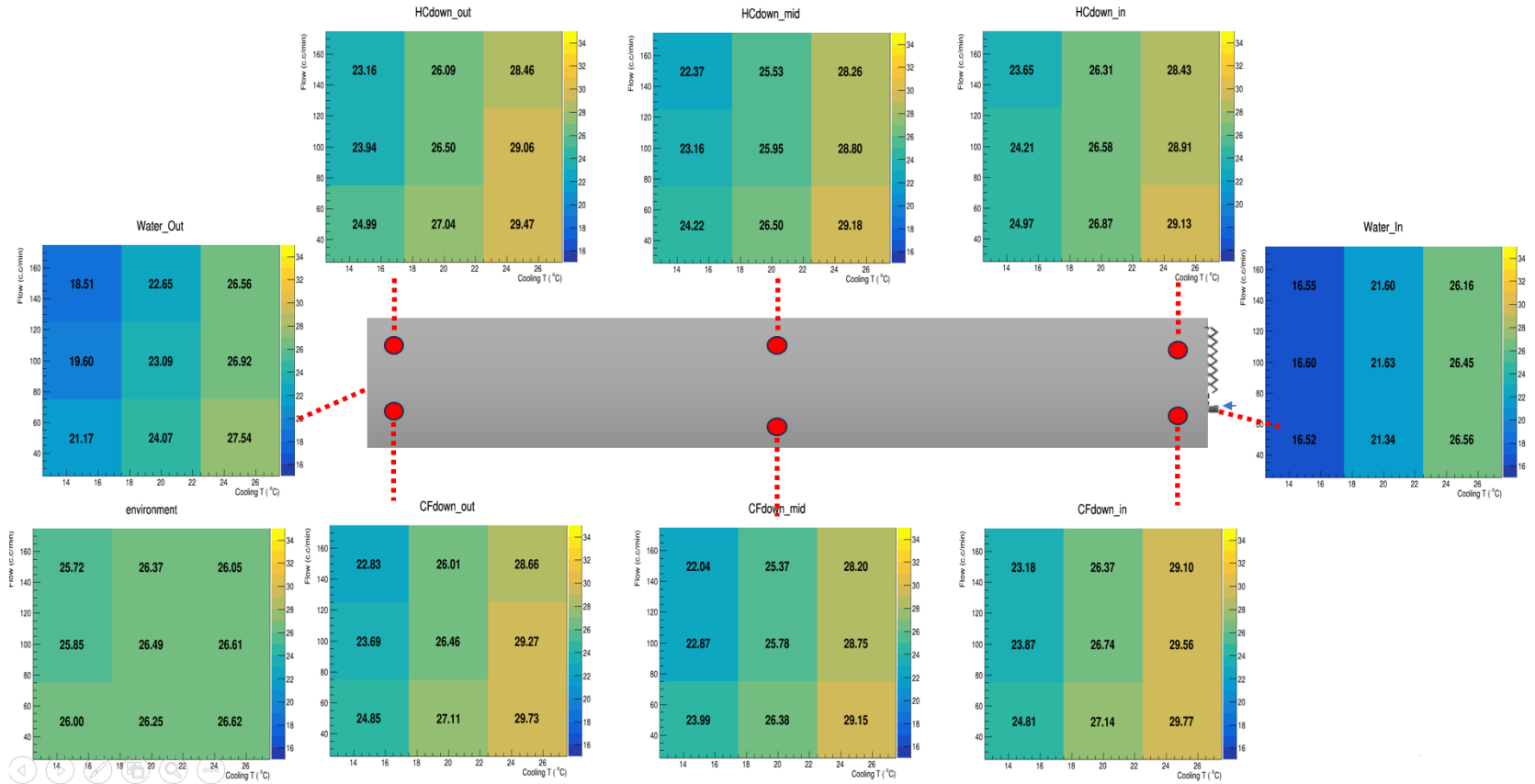
# Temperature in different Flow and Cooling Temperature ( Power: 6 W, top side )







# Temperature in different Flow and Cooling Temperature ( Power: 6 W, bottom side )





# $\Delta T$ between Water in and Water out

