Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

Barrel Outer Tracker / MPGD (μRWELL)

Triple I Engineering Meeting Update (05192025)

Seungjoon Lee (Jlab)

Electron-Ion Collider

Update

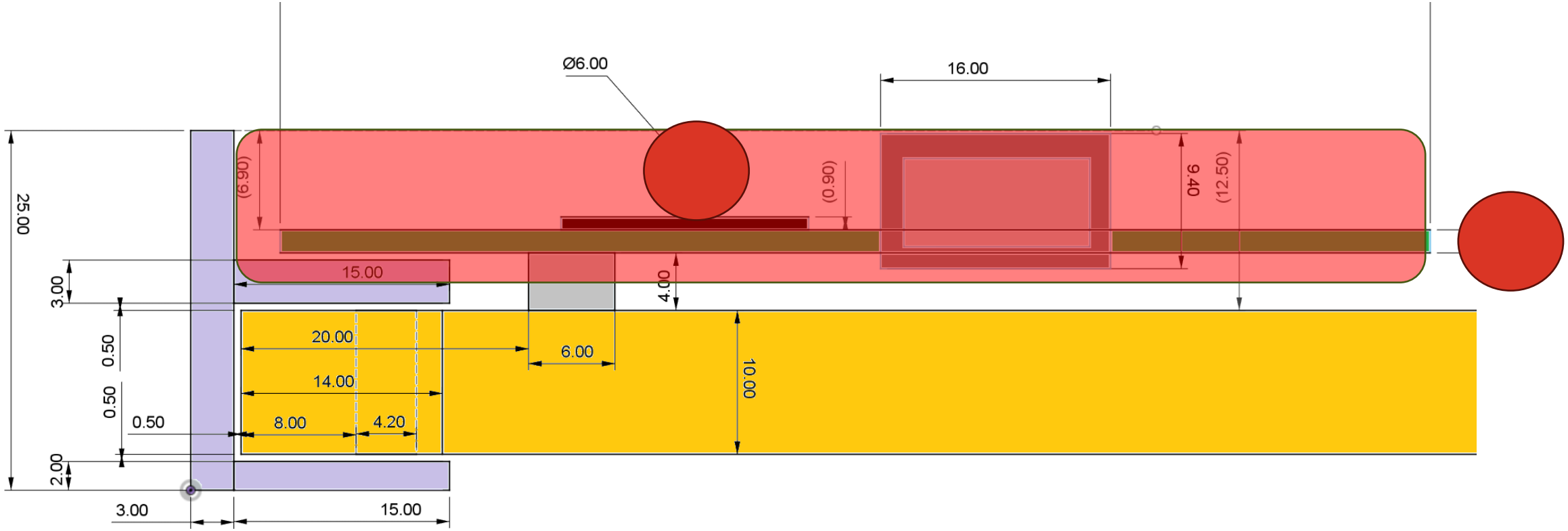
- Jlab MPGD Facility is moving foreword.
- Most of purchased items delivered.
- MPGD frames delivered
- Clean Room (MPGD assembly) is designed.
- Clean Room (previously used for 12GeV upgrade) will be remodeled. (in progress)
- There is no big issue yet.

Detector Views

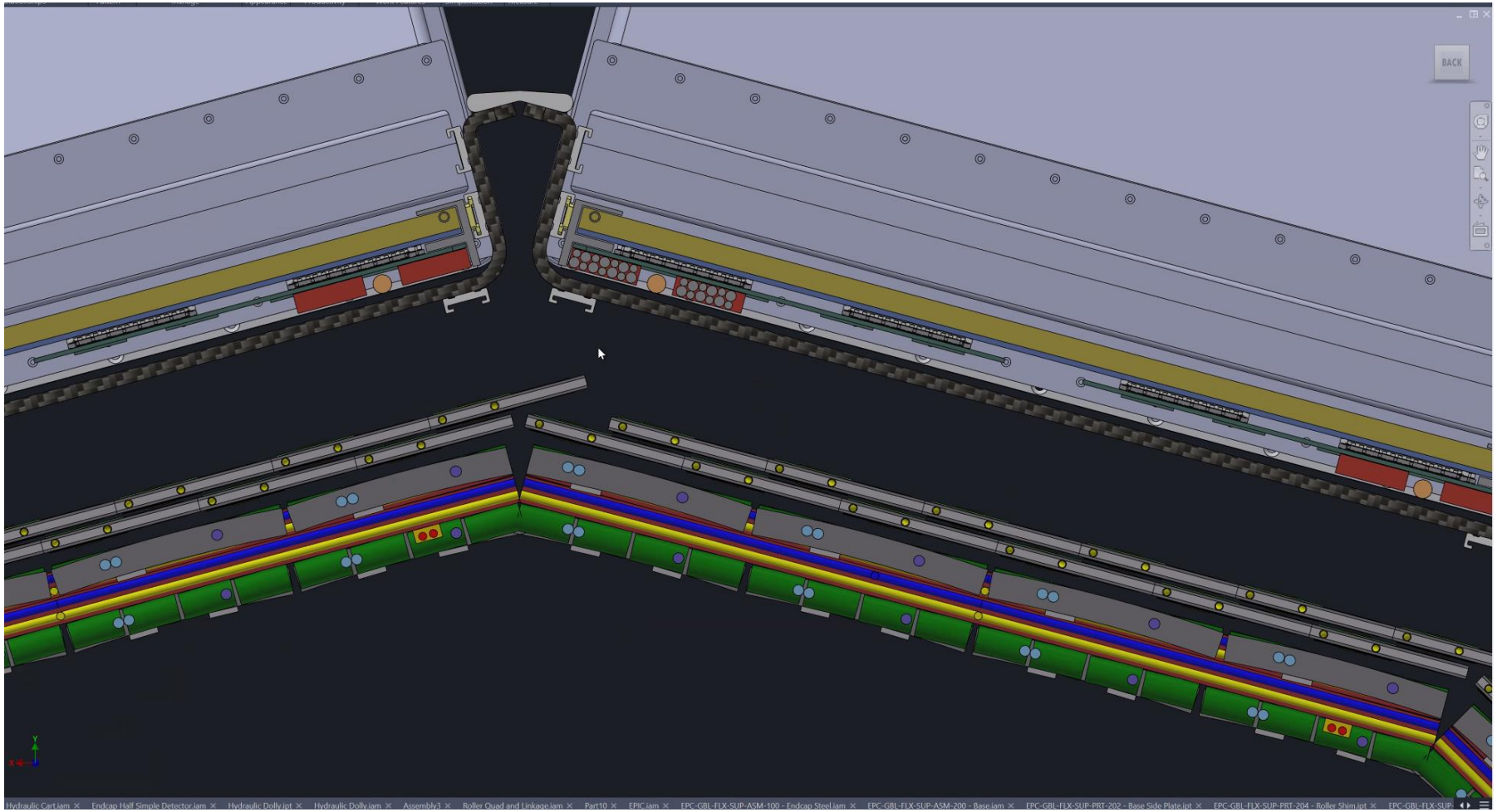
- Service Area is facing CF tube: To utilize extra space on CF tube side

- We need more space at least for cooling pipes

Drawing (upside down)



New Design Draft (from Dan)



- CF housing encapsulates MPGD, removing extra space for service
- It would be a good chance to review MPGD envelope

Cooling requirement

- Data and power cables can be spread out to MPGD surface.
- Cooling pipe/connectors are limiting factor.
- Size and position of cooling system must be carefully designed.

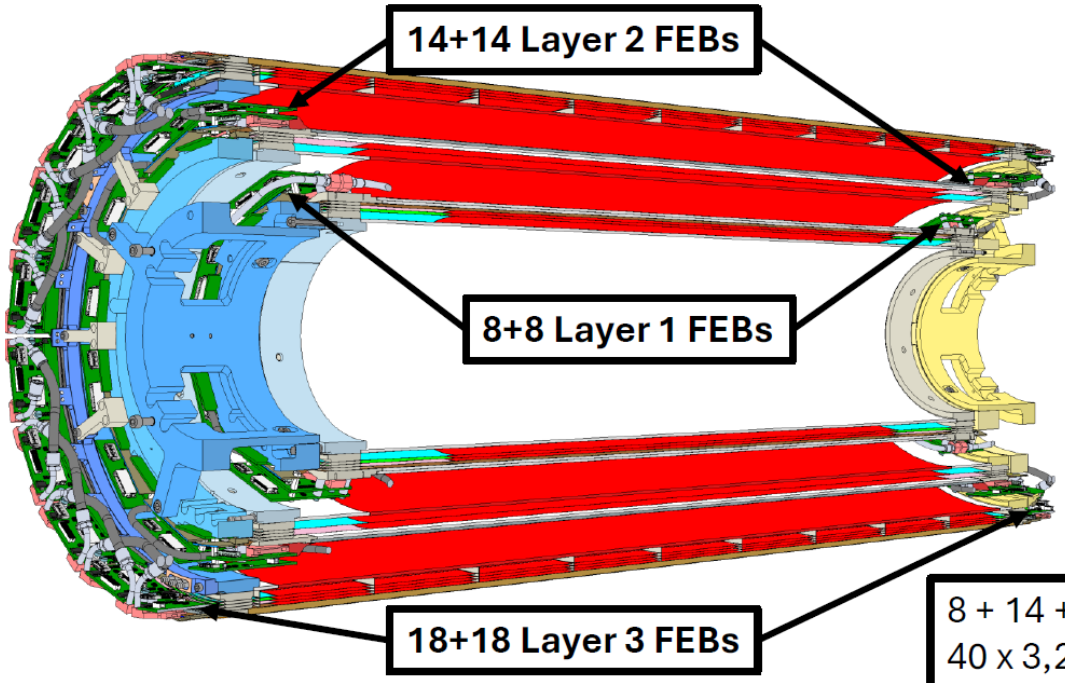
Cooling system reference – BESIII CGEM data from Stefano

Total Thermal Output Pt. 1

Cooling System of the
Cylindrical GEM Inner Tracker
of the BESIII Experiment

Courtesy of the CGEM-IT Working Group

Stefano Gramigna - sgramigna@roma2.infn.it



EAST SIDE

8 + 14 + 18 = 40 FEBs / endcap
40 x 3,2 W = **128 W / endcap**
256 W total power output

Heat Exchanger and FEB Geometry Pt. 1

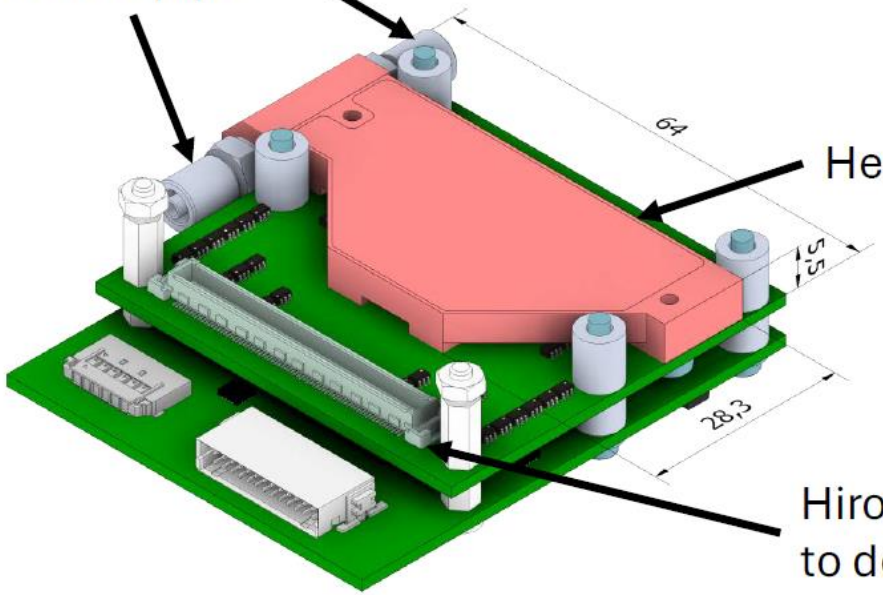
Layer 1/ Layer 2

Layer 3

Heat exchangers are installed opposite to the hot spots

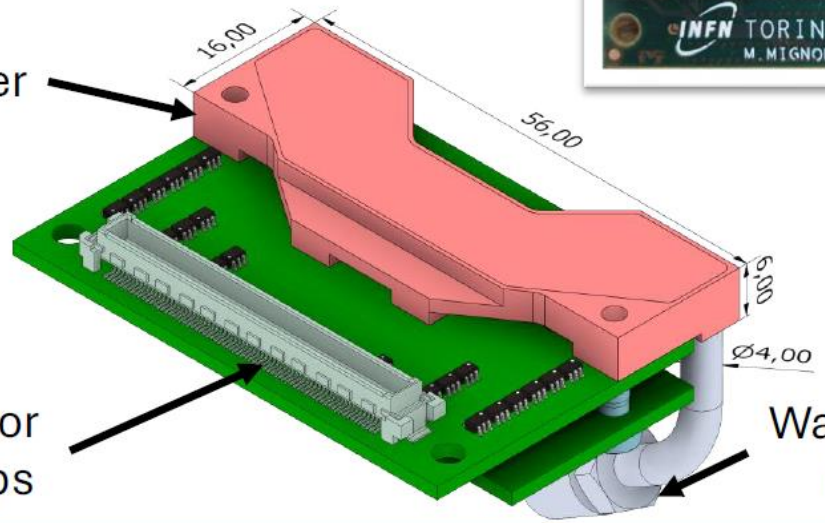
Cooling occurs through the PCB

Water inlet/outlet
Ø4 PU pipe



Heat exchanger

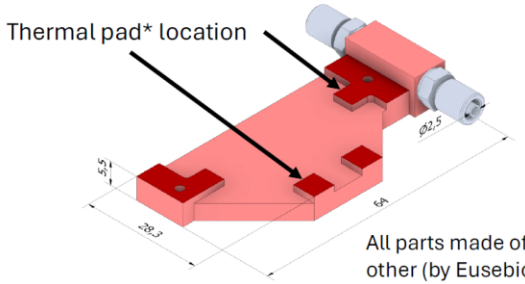
Hirose connector
to detector strips



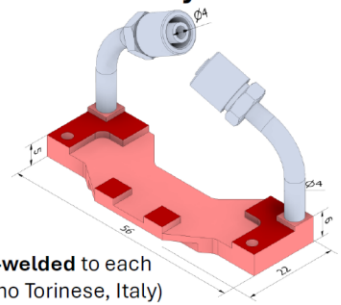
Water inlet/outlet
Ø6 PU pipe

Heat Exchanger and FEB Geometry Pt. 2

Layer 1/ Layer 2



Layer 3



All parts made of copper and **laser-welded** to each other (by Eusebio SALD S.r.l., Settimo Torinese, Italy)

All heatsinks **tested for leaks at 4 bar**

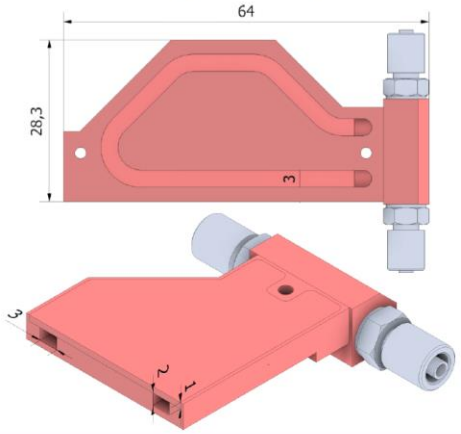
Brazing

Laser Welding

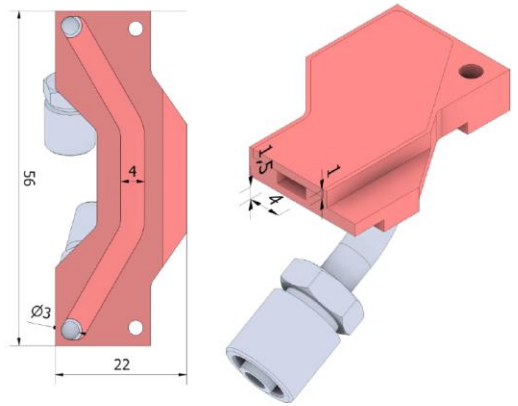
*RS PRO Thermal Interface Sheet, 0.5mm Thick, 8W/m-K, Silicone, 150 x 150 mm, RS Stock No.: 915-6073

Heat Exchanger and FEB Geometry Pt. 3

Layer 1/ Layer 2



Layer 3



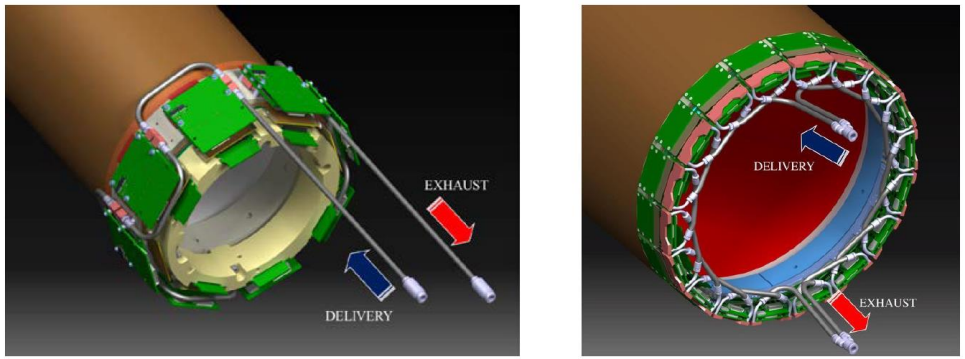
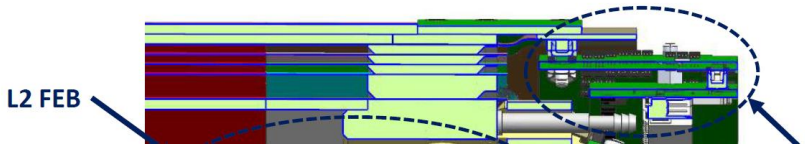


Figure 1.17: 3D view representation of the cooling system for the CGEM-IT Layer 1 (left) and 3 (right).

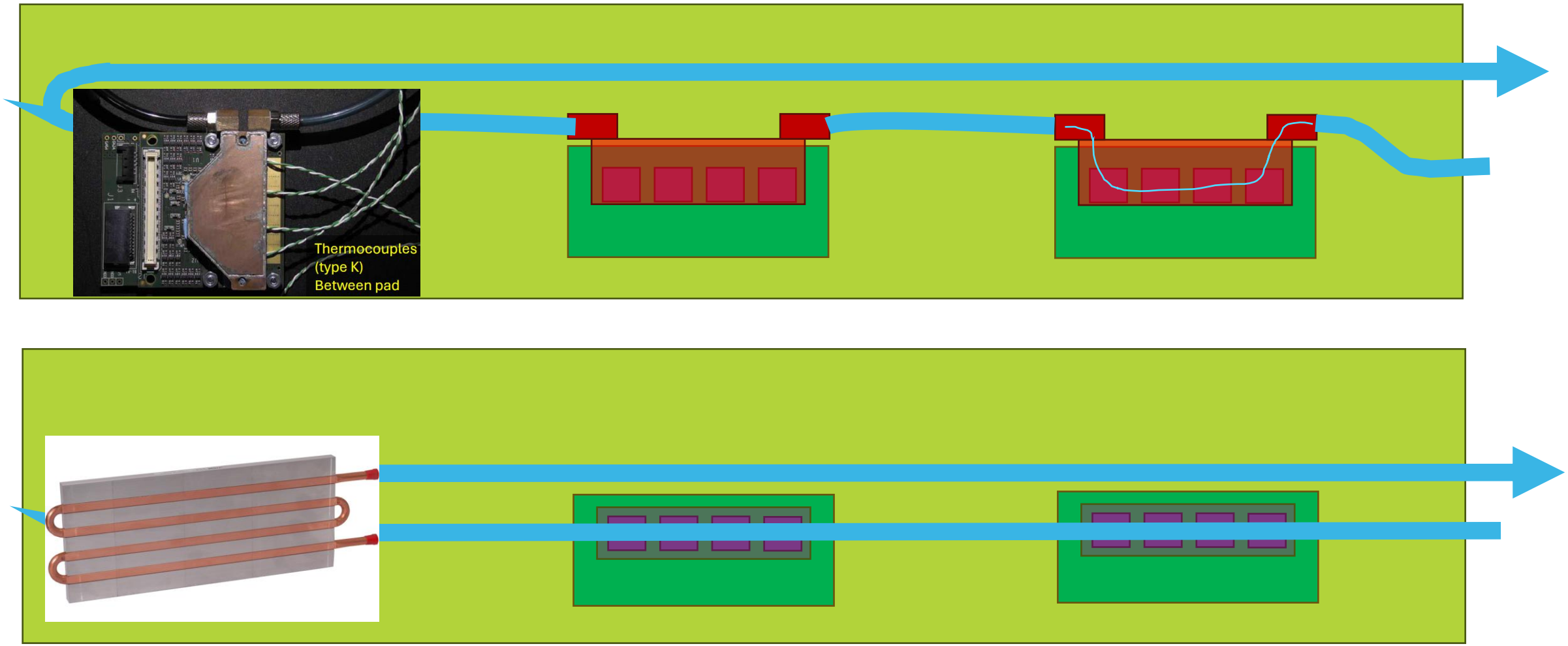


Other parameters

- Should DSC provide cooling or ePIC?
- Water chiller location (distance)
- ePIC operation temperature/humidity (drew point)

Backup

Comparison of cold plate



Intro

- Cooling Design for BOT

- Assumption:
- 7 FEB per cooling loop. Total 4 loops per sector (12 sectors)
- Each board has 4 SALSA (ASIC)
- Each FEB requires 8.5 W (including safety margin)
- Total power for each loop = 60 W
- Each sector = 60 x 4 = 240 W
- Total = 12 x 240 = 2880 W

- Water Inlet temperature = 18 °C
- Target ASIC temp = 30 °C

- Q = m x Cp x dT

- Q = 63 W
- m = flow rate (kg/s)
- Cp (water) = 4186 J/kg.K
- dT = ~5 °C
- m = 0.003 kg/s = 3 g/s = 0.18 L/min
- m_safe = 0.6 L/min

- ~~Total = 12 x 4 x m_safe = ~30 L / min~~

Tubing

- Inner diameter

- 4~8 mm depends on volume, pressure, type of pressure (positive, negative)
- If negative pressure: PVC or PEEK ?

- Pressure drop by connectors: connector inner diameter is smaller than tubing ID

- Pressure drop by 90 degree angle, 4 elbows per FEB

-

Condensation

- 25 °C and 50% humidity
- Dewpoint = 14 °C
- Minimum water temp = 15 °C
- 16~18 °C will be OK.
- Insulation required from chiller to BOT

Options for heatsink

- Direct heatsink with stainless steel tubing

- simple, smaller tubing
- less bending (lower pressure drop)
- requires insulation

- Custom made heatsink with soft tubing

- complicate heatsink required, larger tubing
- more bending (high pressure drop)
- insulation not required

Services Estimates

- Per sector (12 sectors total)
- Total 28 FEBs, 2 MPGD Chambers
- 4 Gas lines (in&out) for chamber: ∅8 mm
- 4 HV: ∅8 mm
- 56 LV: ∅2.4 mm or 28 LV: ∅2.8 mm (if supply power to 2 x DC/DC converters)
- 28 Data: ∅3 mm (Optical Fiber)
- 1 Ground: copper braid
- 4 Cooling pipe: ∅6 mm (Stainless Steel)
- 2 Temperature & Humidity Sensors

- The main unknown: FEB power requirement => DC/DC converter spec. => Cable/cooling specification

CyMBaL

BOT