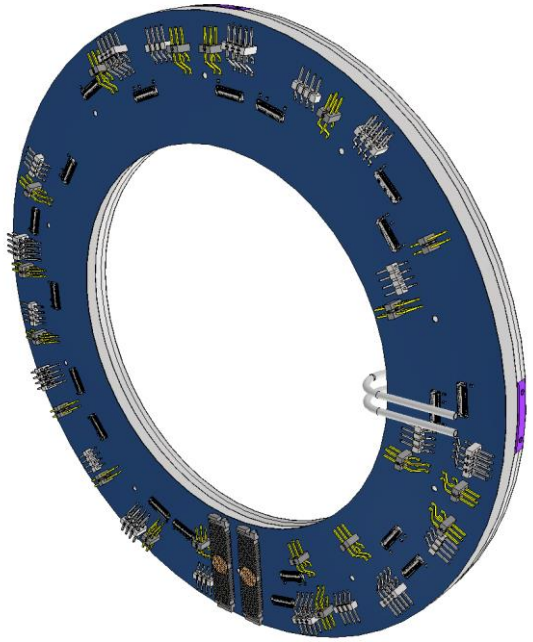
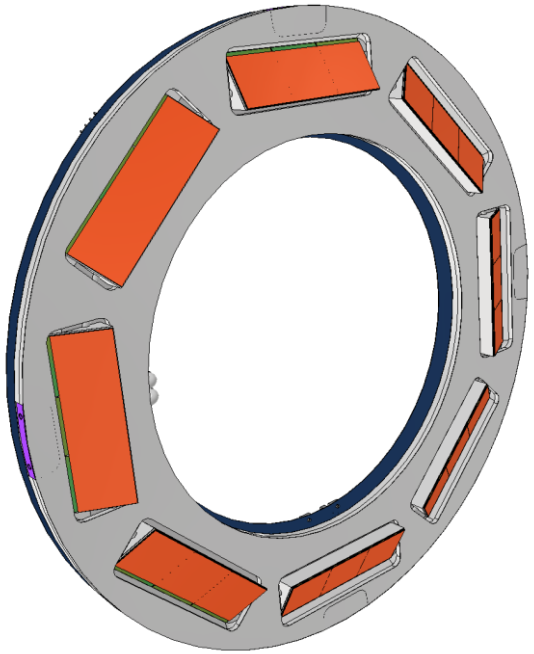
Heat Transfer Analysis Pixel Luminosity Ring

University of Oslo

Purpose of analysis

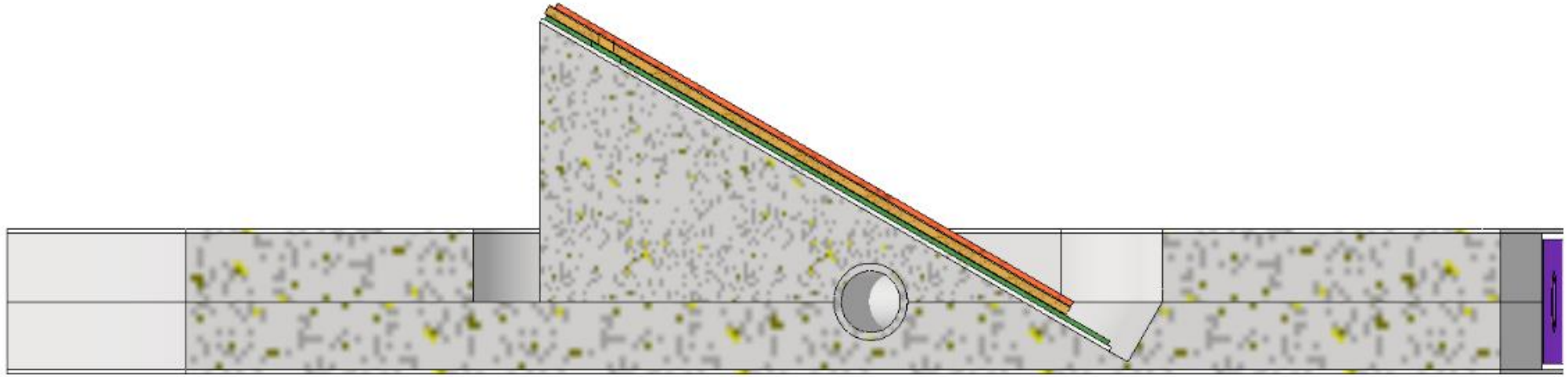
- Evaluate design for luminosity detector, which needs sufficient cooling.





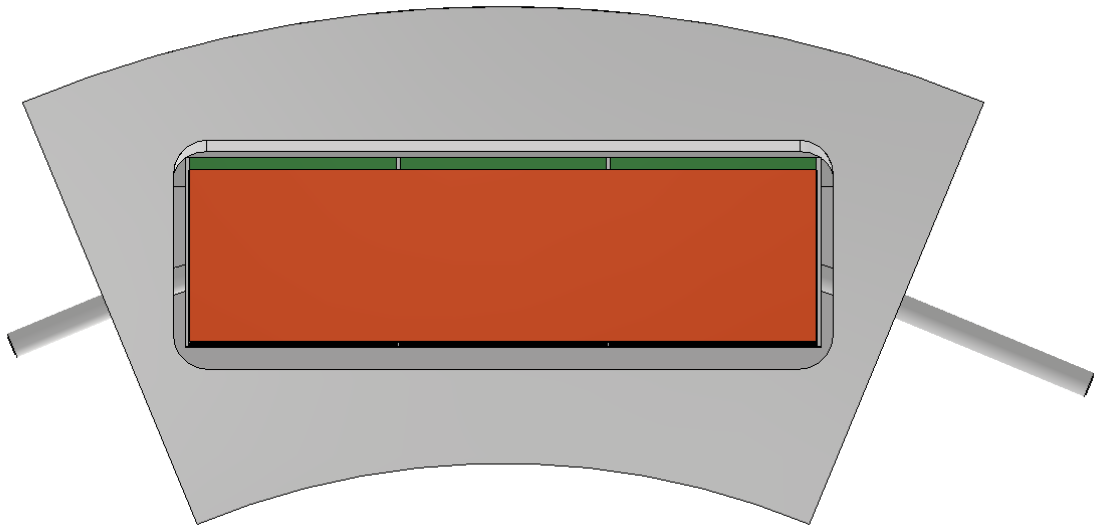
SIMULATION MODEL

- The simulations are run in Autodesk CFD software.
- For initial simulations, only a section of the PLR is used. This is the same model that was used to assess and decide optimal tilt angle of 30˚.



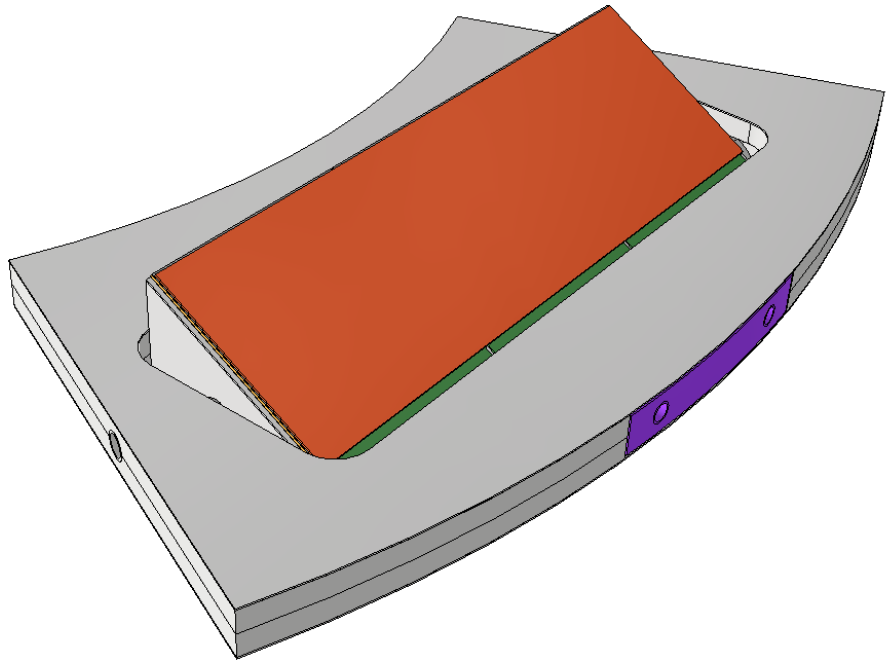
CO_2 cooling pipe

- Latest simulations are run with constant cooling pipe temperature.
- In case future analysis will include flow:
  - Cooling inlet and outlet have been extended, in order to optimize model for correct flow simulations.

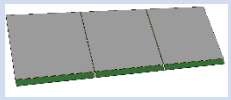
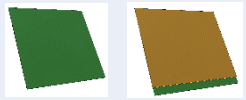
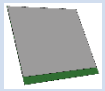


Material

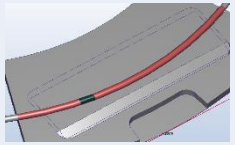
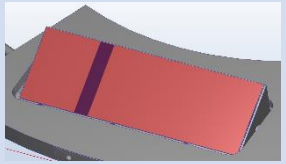
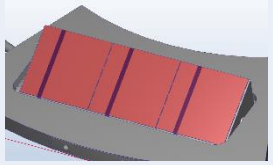
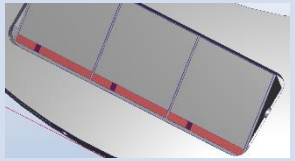
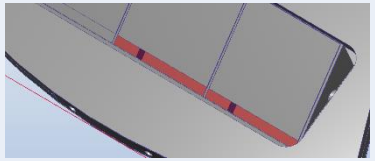
- Values from previous simulations:
  - ”Normal” values for facesheets
  - Foam k of 40 W/mK
  - Glue k of 2 W/mK
  - Hybrid k of 0.8 W/mK (Kapton)



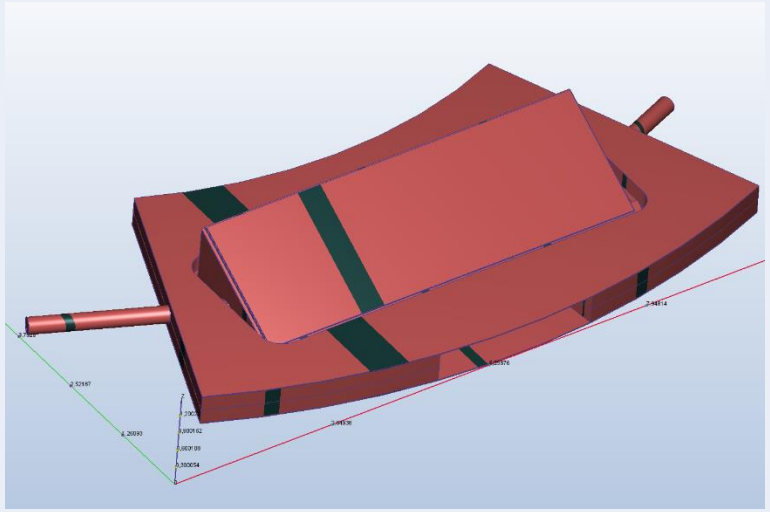
Material

Parts	Figure	Assigned material in Autodesk CFD
Detector hybrid		Kapton 0.8 W/mK
Linear triplet modules		Glue 2 W/mK
Linear triplet modules - Detector sensor		Silisium/Silicon
Linear triplet modules - Soldering		Tinn: 66,6 W/mK K/20 = 3,33 W/mK
Face-sheet		7 W/mK
Carbon-foam wedge		Foam 40 W/mK
Backside and active side foam		Foam 40 W/mK
CO_2 cooling pipe in the Quad ring.		Titan 21,9 W/mK

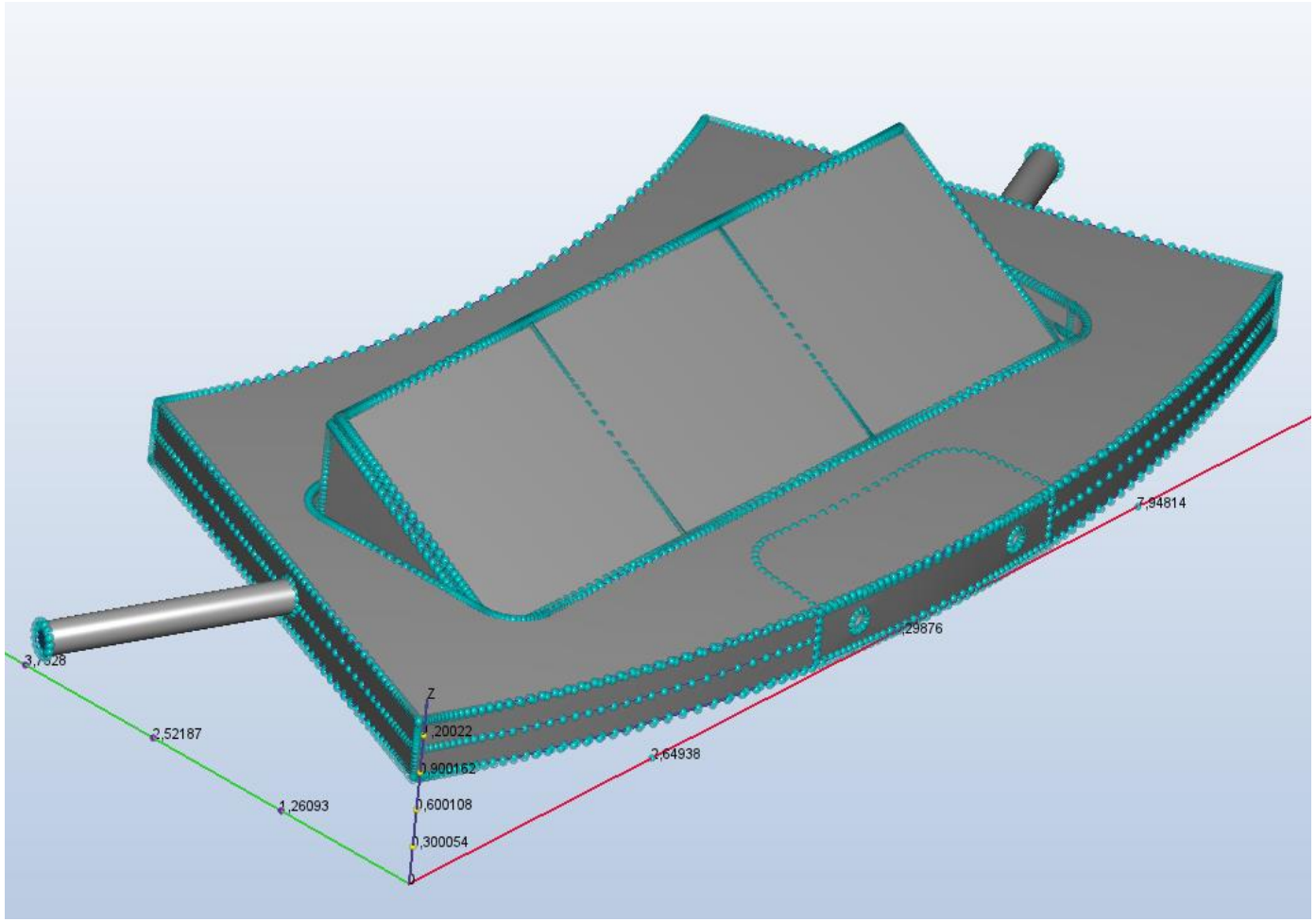
Boundary conditions

Part	Material	Figure	Value
Cooling	CO_2		Temperature -25°C
Flex	Kapton		770 W/m^2
Sensor	Silisium/ Silicon		3448 W/m^2
End of chip	Silisium/ Silicon		Normal operation case: 37500 W/m^2
			Failure case: 106 000 W/m^2

Initial conditions

Part	Material	Figure	Value
Overall structure	All		Initial volume temp: 0°C

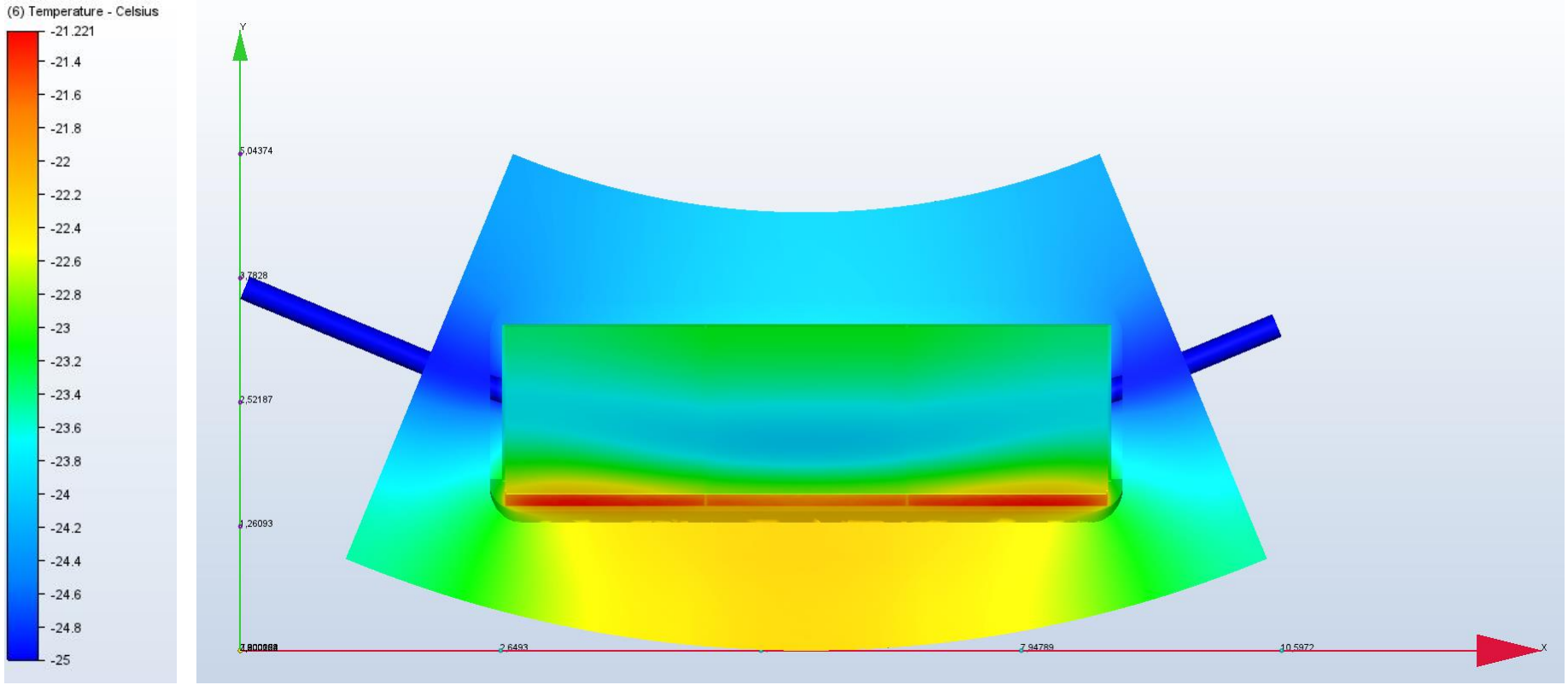
Mesh


7,94814
,29876
2,64938
2,52187
1,26093
,20022
,900152
,600108
,300054
Z

Preliminary results

Case 2 - Normal operation scenario

Fixed -25˚C CO_2 cooling temperature has been used



Preliminary results

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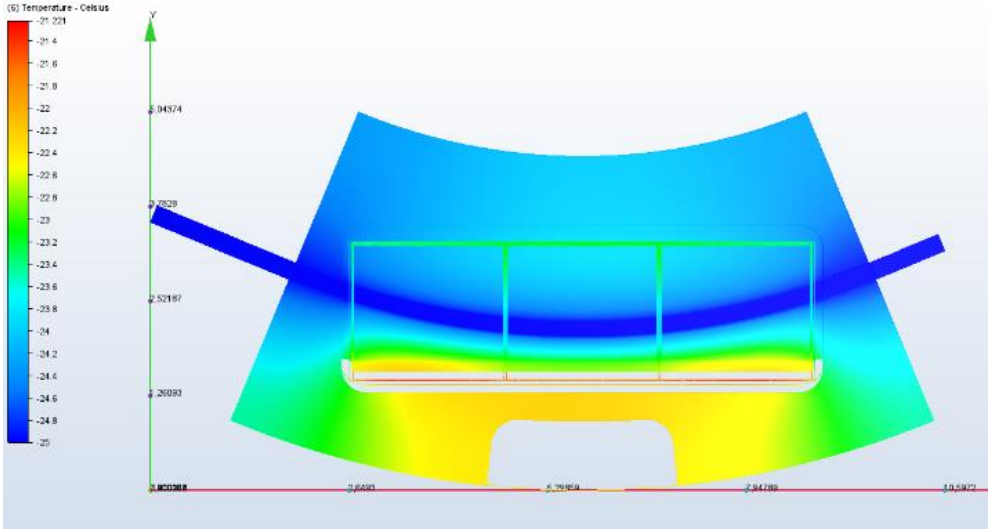
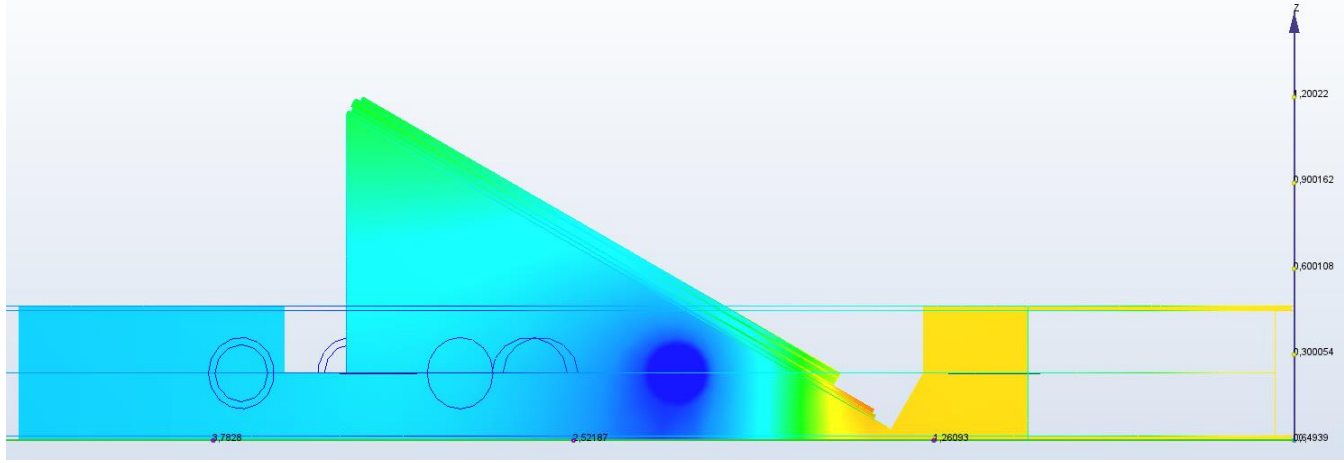
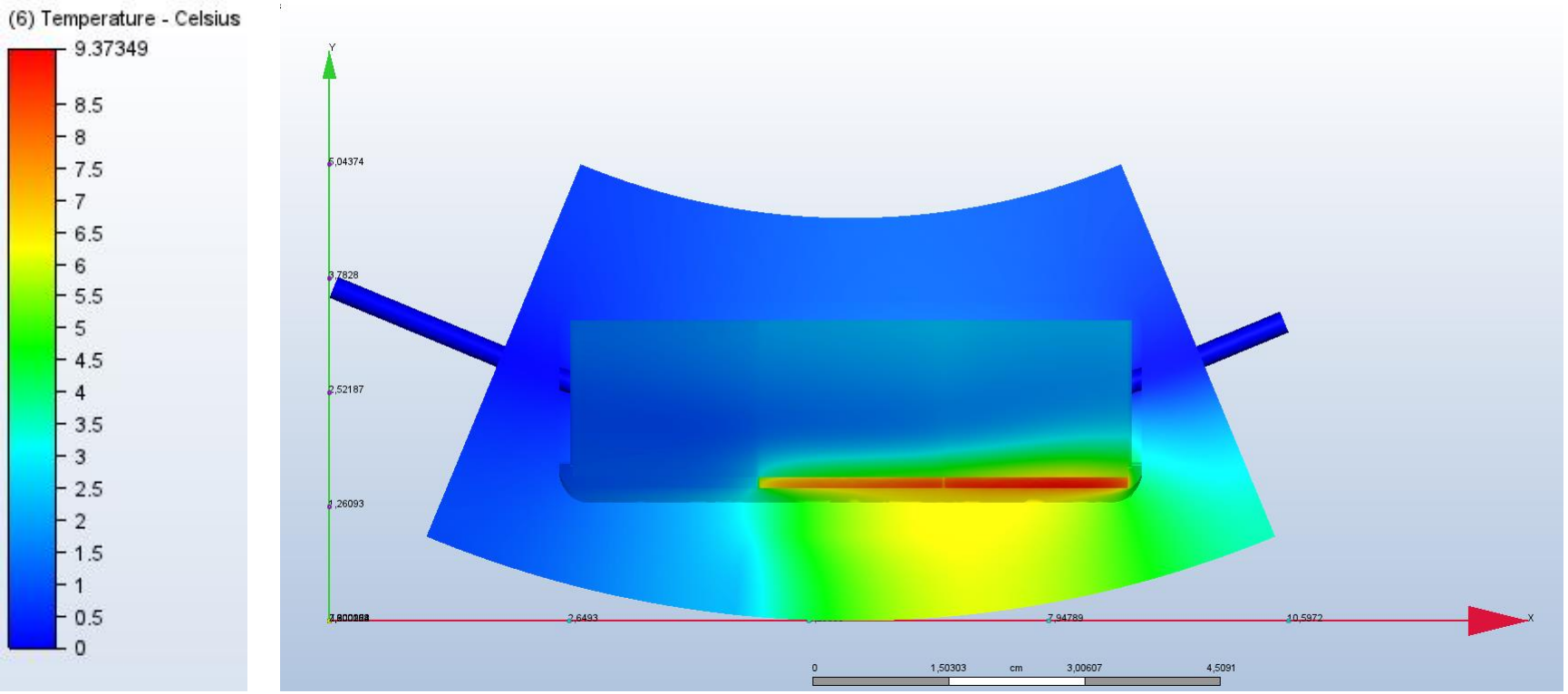




Preliminary results

Case 4a – One ASIC open failure mode scenario

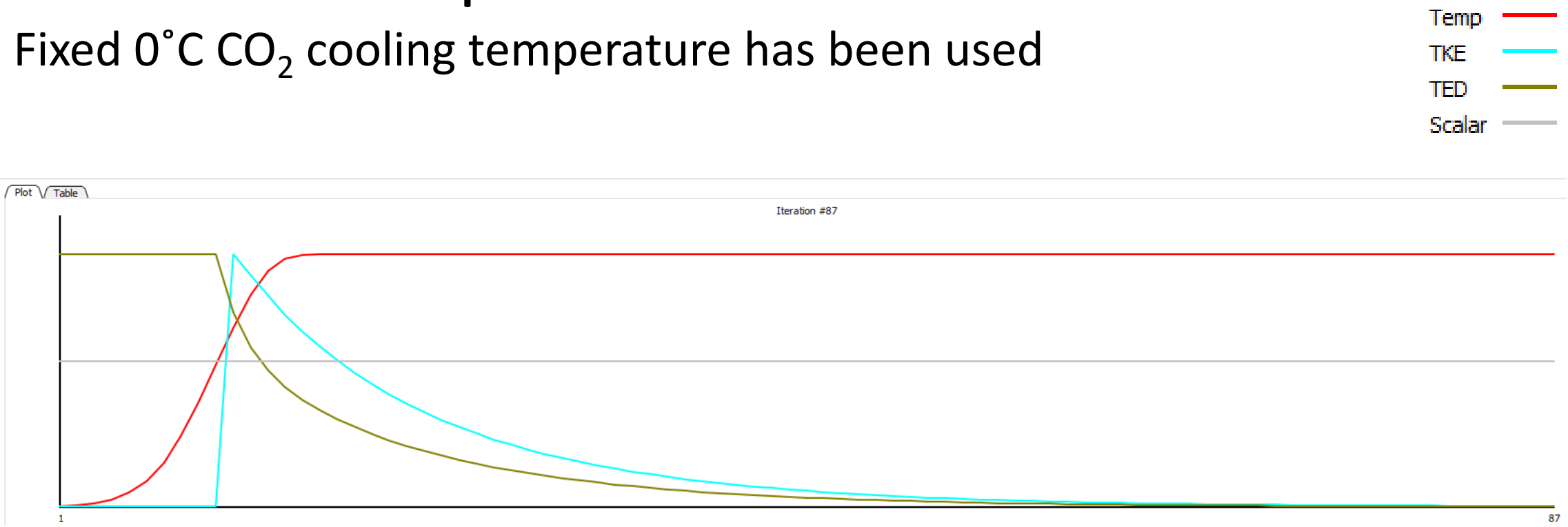
Fixed 0˚C CO_2 cooling temperature has been used



Preliminary results

Case 4a – One ASIC open failure mode scenario

Fixed 0˚C CO_2 cooling temperature has been used

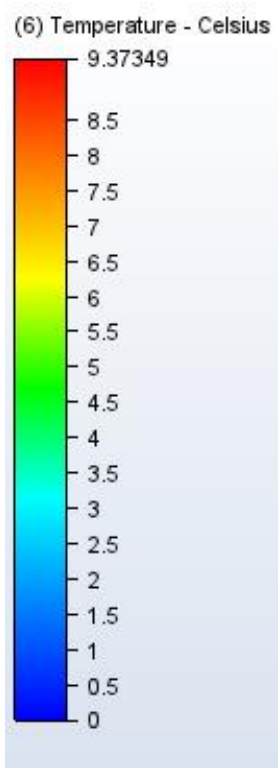


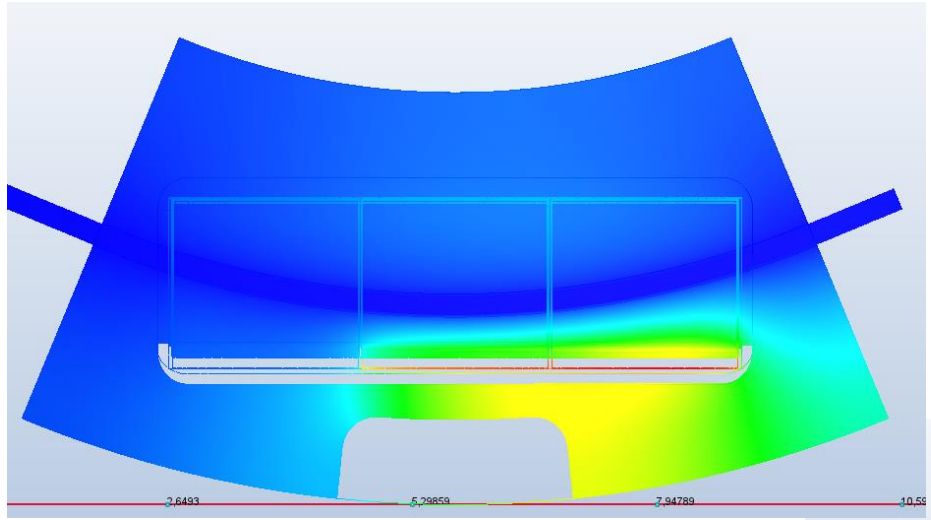
Convergence plot

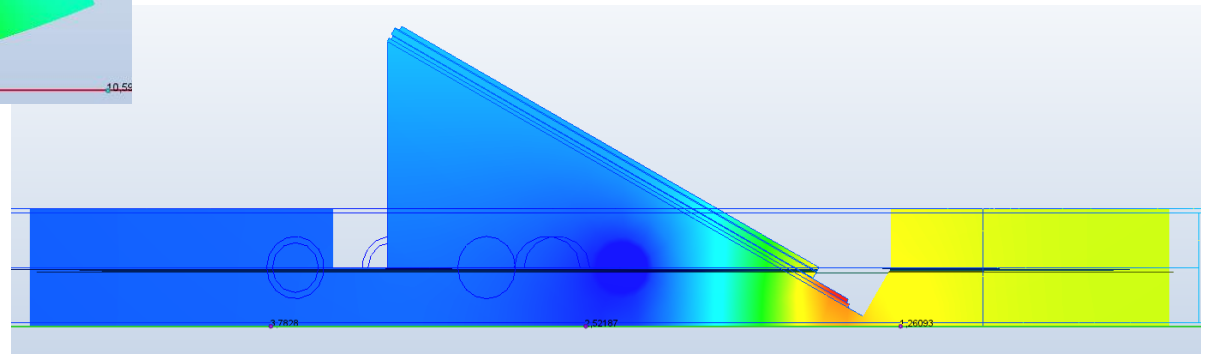
Preliminary results

Case 4a – One ASIC open failure mode scenario

Fixed 0˚C CO_2 cooling temperature has been used

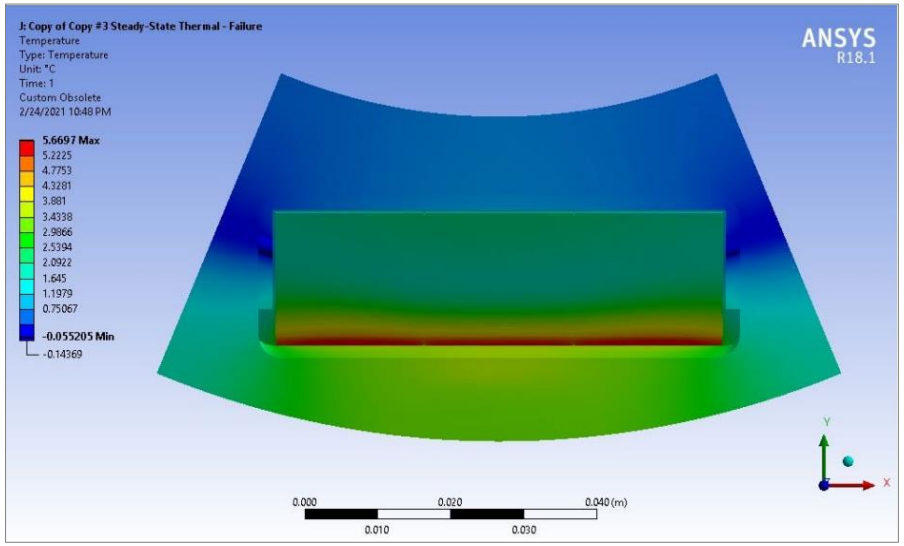




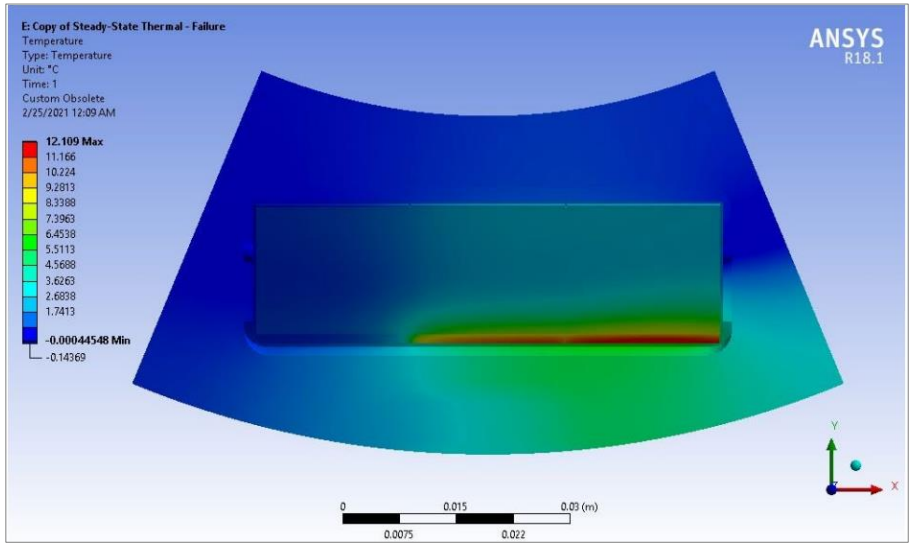


Questions for discussion

- Thermal simulation report / documentation from earlier simulations?



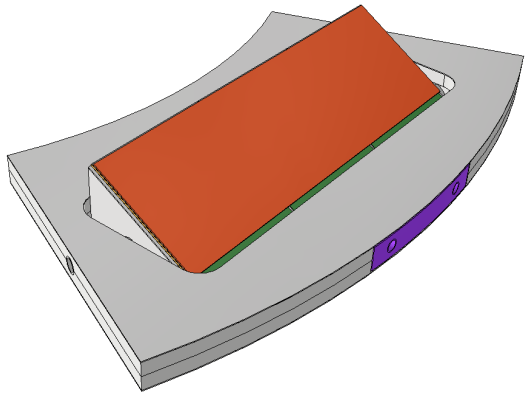
Normal operation scenario for the Shunt-LDOs.

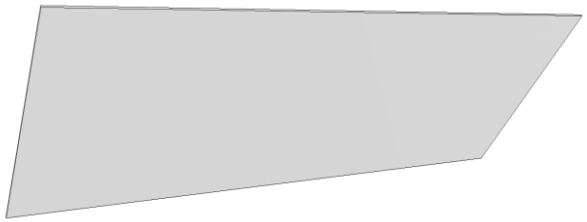


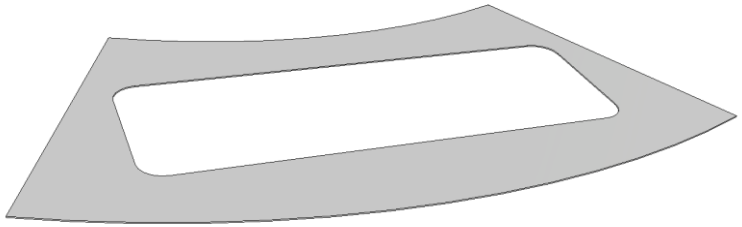
One-ASIC-open failure mode scenario for the Shunt-LDOs.

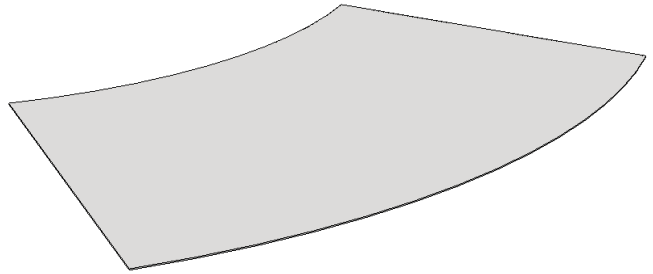
Questions for discussion

- ”Normal” values for facesheets?
  - Need to verify what values to use
  - Kxx 90 W/mK , Kyy 180 W/mK and Kzz 1,2 W/mK
    - Ref. AT2-IP-ER-0029









Questions for discussion

- Carbon-foam wedge
  - Same thermal properties as active side foam and backside foam?
    - K=40 W/mK