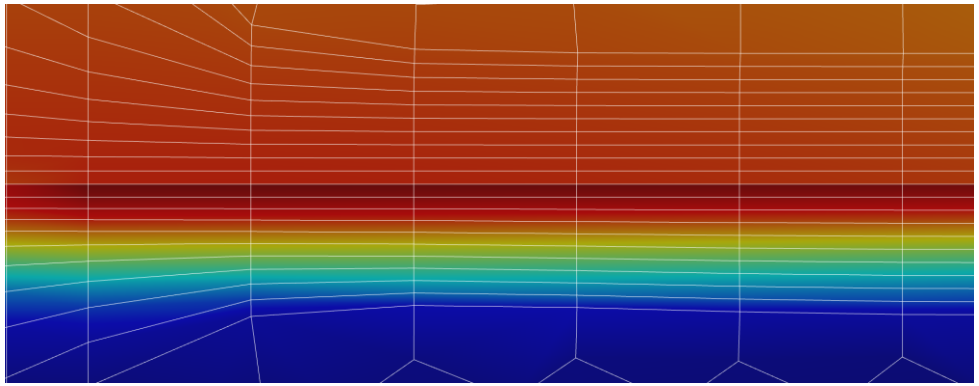
Tuesday 22nd March 2022

ITS3: PRELIMINARY CFD SIMULATIONS



Aitor Amatriain Carballo

Outline

ITS3: PRELIMINARY CFD MODEL

- **Geometry**
- **Parameters**

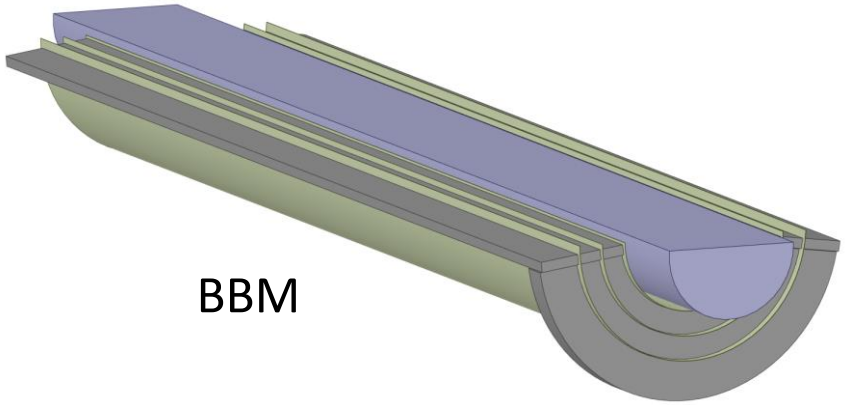
ITS3: PRELIMINARY NUMERICAL RESULTS

- **Parametric study**

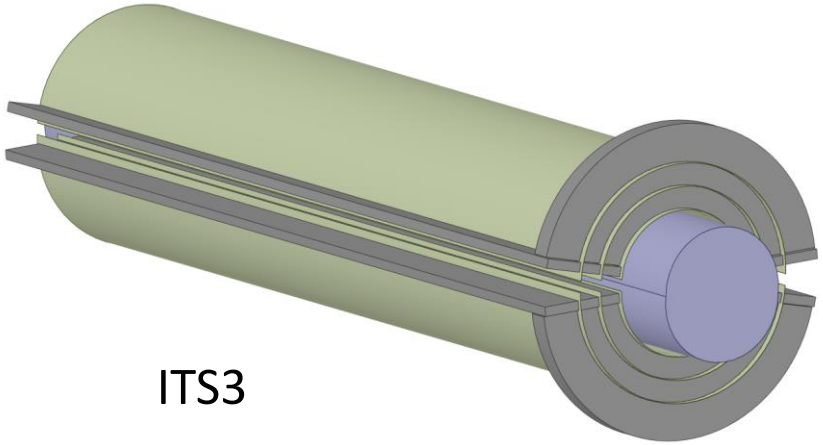
CONCLUSIONS AND FUTURE WORK

ITS3 PRELIMINARY CFD MODEL: GEOMETRY

- BBM ⟶ Half of the circumference with a wall on the upper side
- ITS3 ⟶ Two halves ⟶ Full geometry



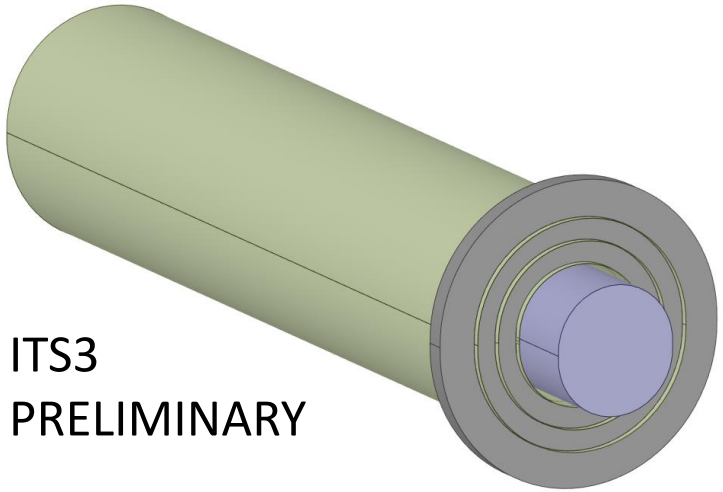
BBM



ITS3

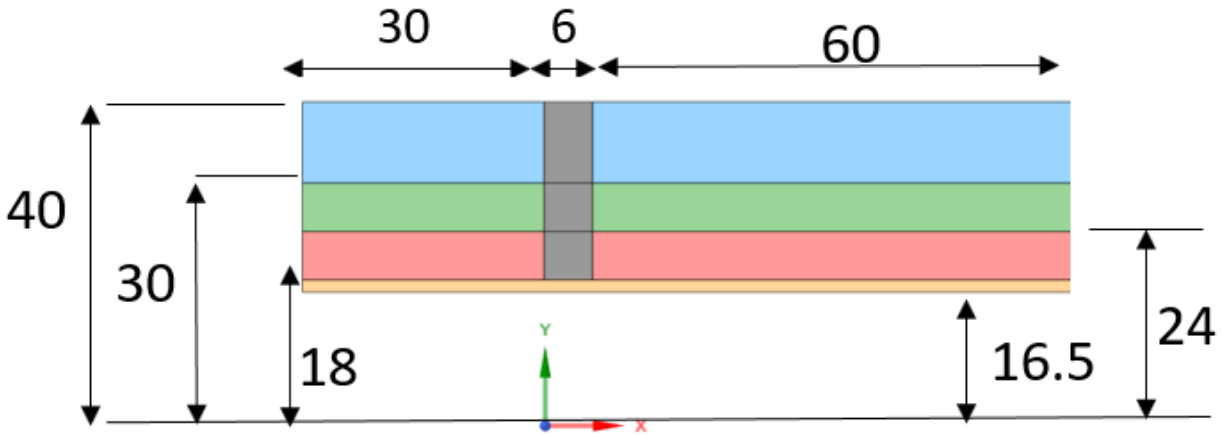
- RVC supports are not taken into account
- Rings cover all the circumference
- No holes in the foam

Previous assumptions ⟶ Axisymmetric geometry



ITS3
PRELIMINARY

ITS3 PRELIMINARY CFD MODEL: PHYSICS

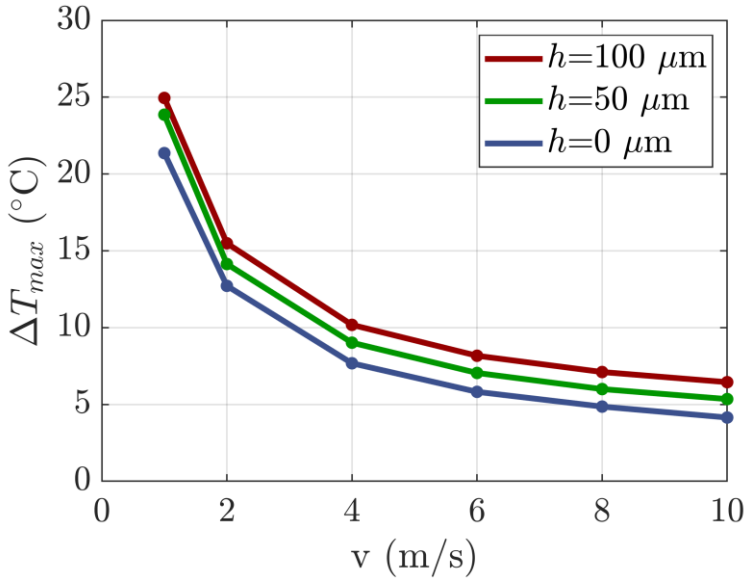


Dimensions in mm

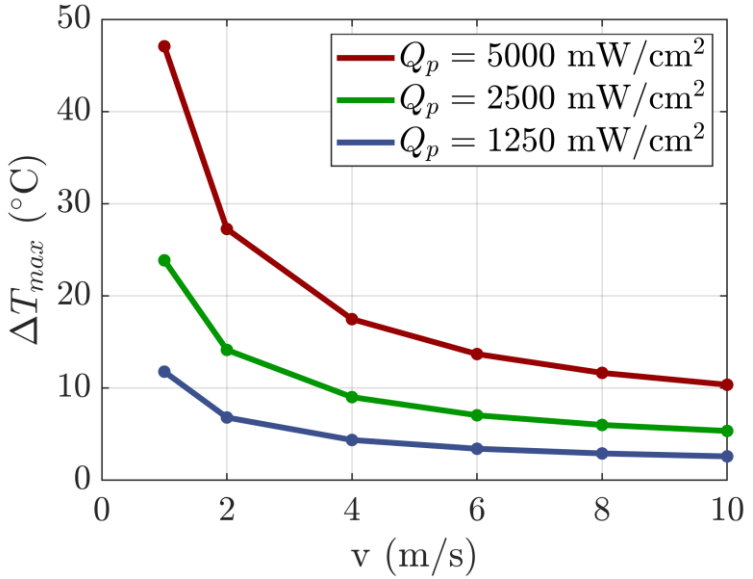
- Length of the domain and mesh size obtained from length-independence and mesh-independence studies
- 3D mesh for computational reasons (submodels not available in 2D)

- Updated design from last weeks: four separated air flows (orange, red, green, blue)
- Carbon foam: ALLCOMP LD
- $Q_p = 2500\ \mathrm{mW/cm^2}$
- Assumption for all simulated cases: $\frac{Q_p}{Q_m} = 1000$
- Glue between chips and foams of thickness h=50 µm and k=1 W/(m*K)
- Same velocity in all inlets

RESULTS: INFLUENCE OF VELOCITY, GLUE AND DISSIPATED HEAT



Influence of glue thickness

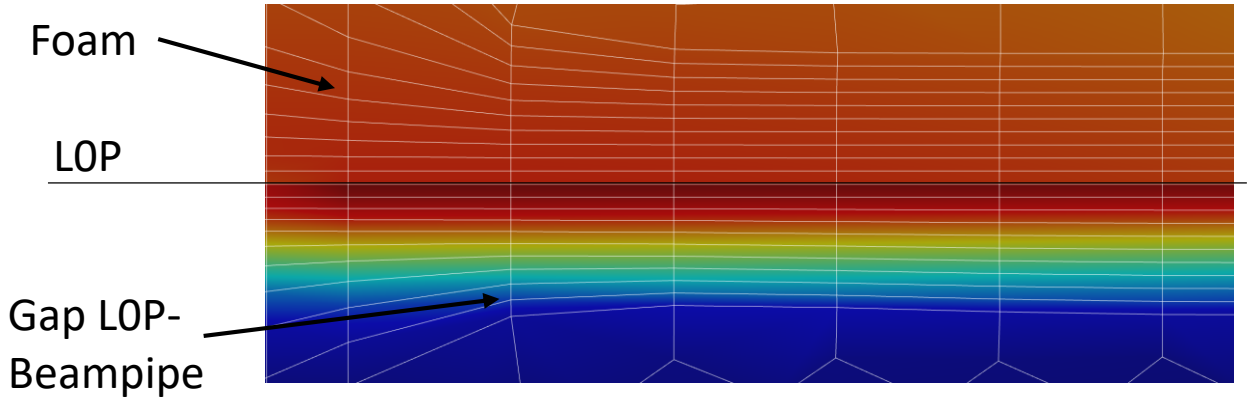


Influence of dissipated power

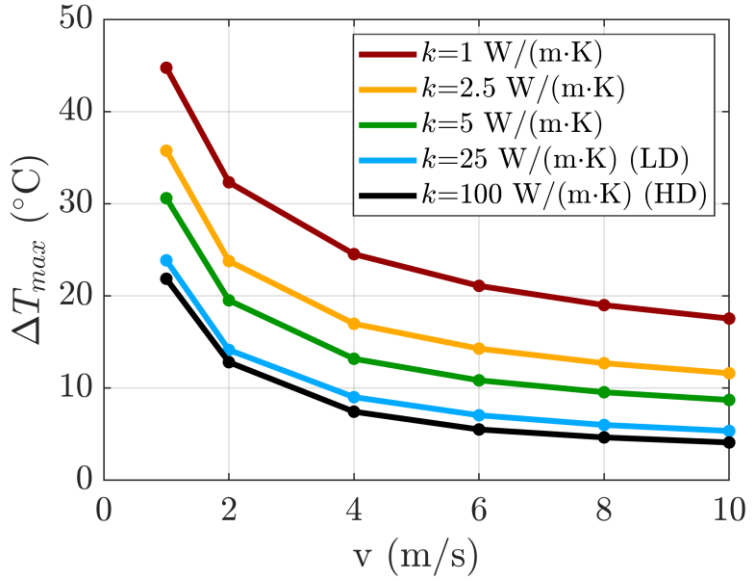
- $\Delta T_{max} = T_{max} - T_{inlet}$
- Effect of ≈ +1 °C/50 µm

- $v > 2$ m/s ⟶ ALICE ITS Ventilation?
- Optimum $v \approx 5$ m/s ($\Delta P \sim v$)

- If v increases, convective heat transfer increases
- The slope of the curves decrease with v as heat is not removed from the bottom side of L0, and k_{chip} is finite

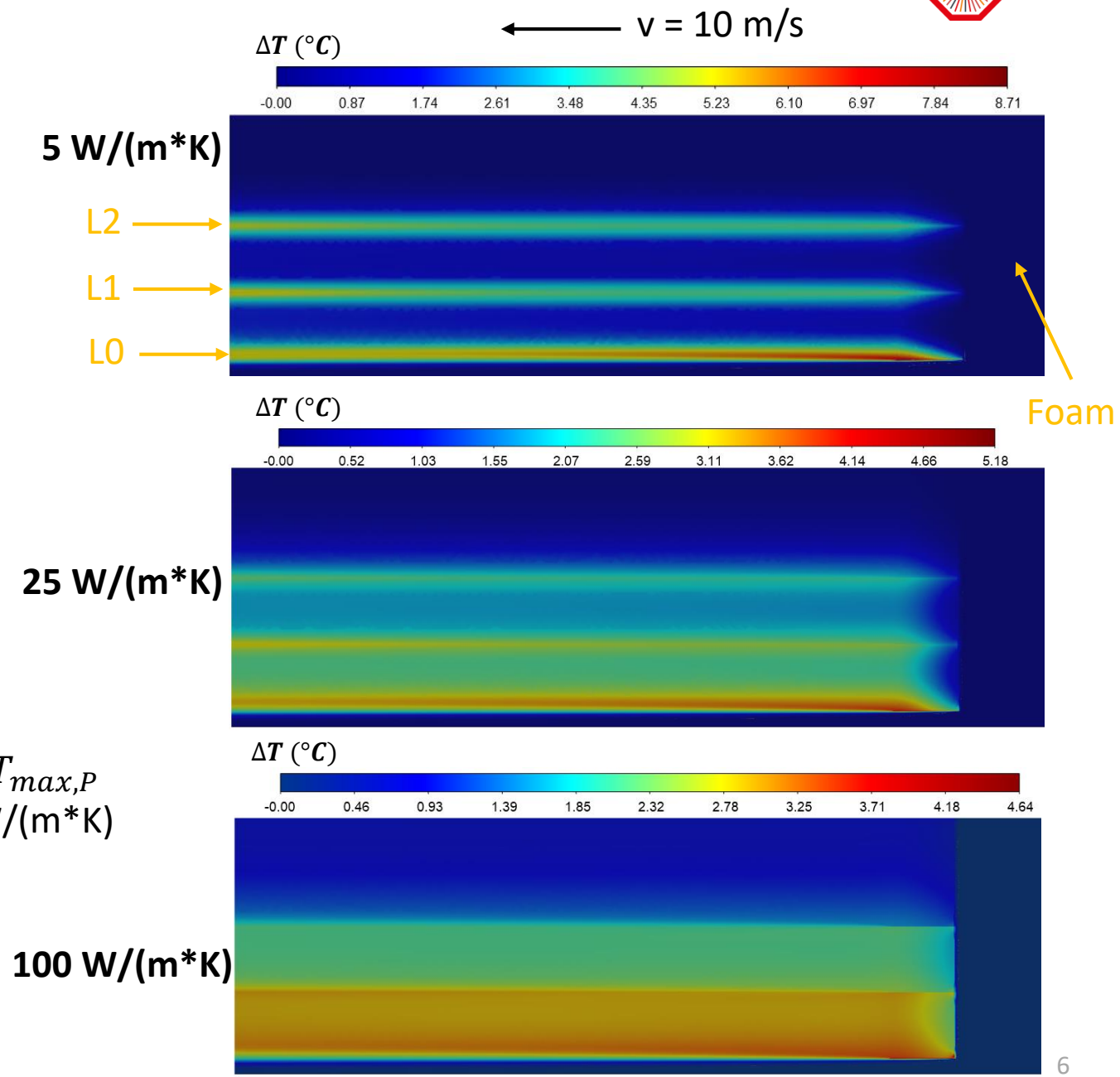


RESULTS: INFLUENCE OF FOAM THERMAL CONDUCTIVITY

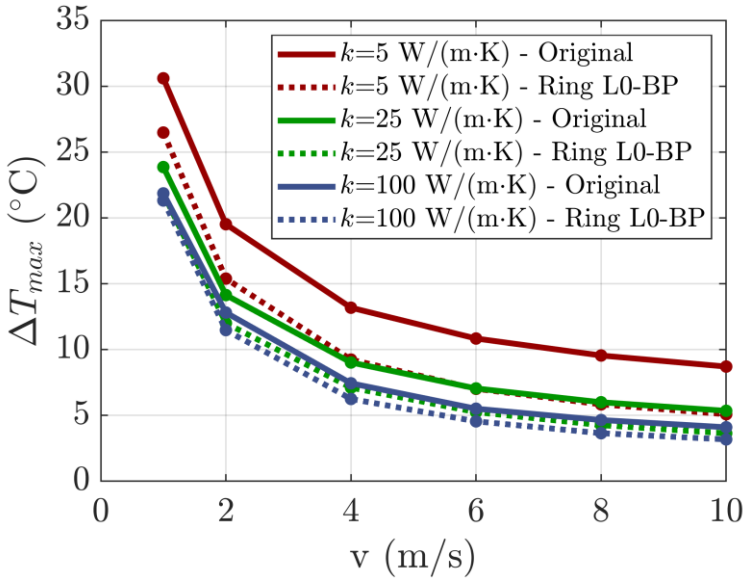


Influence of foam thermal conductivity

- Important variations in T_{max} for $k \leq 5$ W/(m*K)
- Then efficiency is lost as the air is heated
- The matrix is cooling the air ⟶ Holes if $T_{max,M} > T_{max,P}$
- Pressure loss $\Delta P \sim k$ ⟶ Optimum around $k = 5$ W/(m*K)
- Gap between L0 and beampipe does not absorb heat



RESULTS: ADDITION OF A FOAM BETWEEN L0 AND BEAMPIPE (BP)

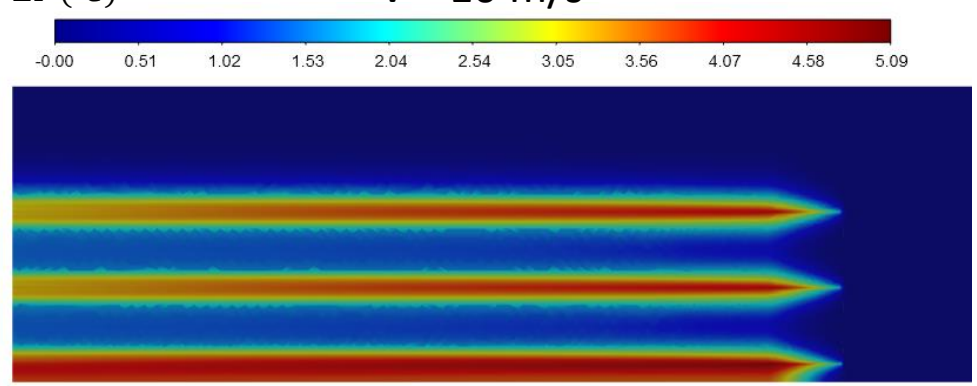


Influence of a foam between L0 and BP

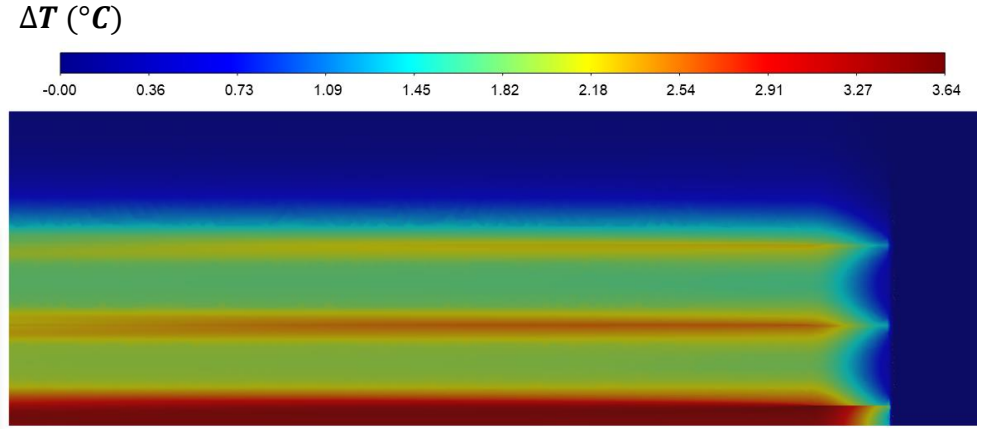
- Difficult to implement but interesting to study
- Important variations in T_{max} for $k = 5$ W/(m*K)
- Then efficiency is lost as gap (only 1.5 mm of height) is fully heated

v = 10 m/s

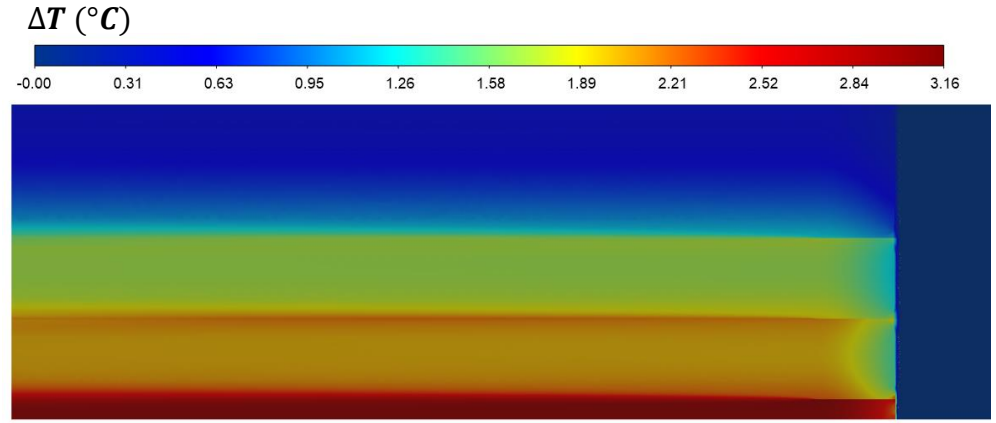
5 W/(m*K)



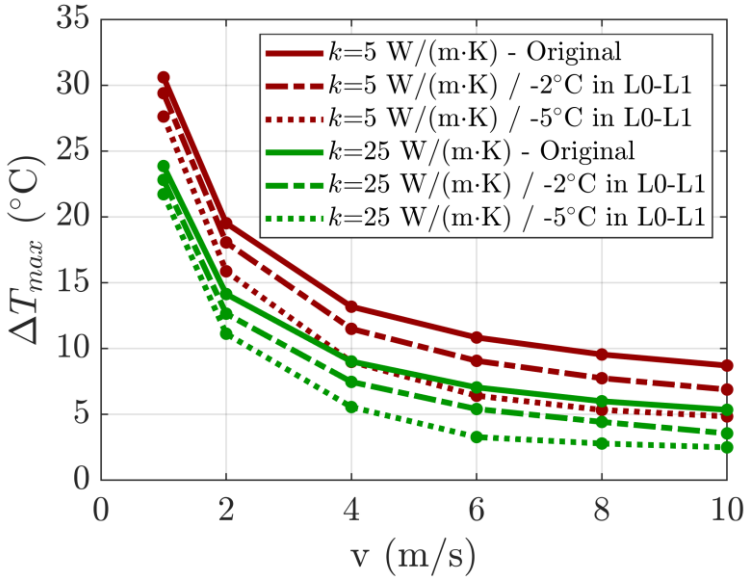
25 W/(m*K)



100 W/(m*K)



RESULTS: INFLUENCE OF L0-L1 INLET TEMPERATURE



Influence of L0-L1 inlet temperature

- Another parameter to control T_{max}
- Effectiveness of around 1/1 (°C) in the optimum region (5 m/s)
- Humidity controlled in ITS Ventilation ⟶ If not, multiphase simulations in ANSYS Fluent

CONCLUSIONS AND FUTURE WORK

CONCLUSIONS

- 50 µm of glue give an increase of 1 °C in the maximum T, which is always in L0
- Velocities of more than 2 m/s required ⟶ Optimum around 5 m/s for pressure loss and aerodynamic load minimization
- Higher thermal conductivities reduce maximum T ⟶ Optimum around 10 W/(m*K) for pressure loss minimization
- The control of inlet T can lead to higher efficiencies in the system

FUTURE WORK

- Simulation of full geometries (supports)
- Validation of baseline models with experiments (new thermal setup)