ALICE

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UPDATES FOR ITS3 PLENARY

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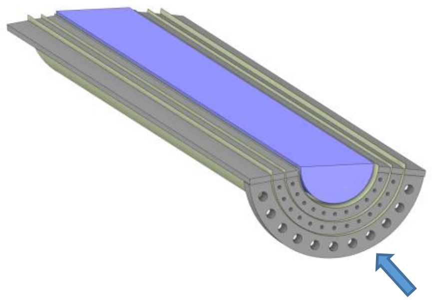
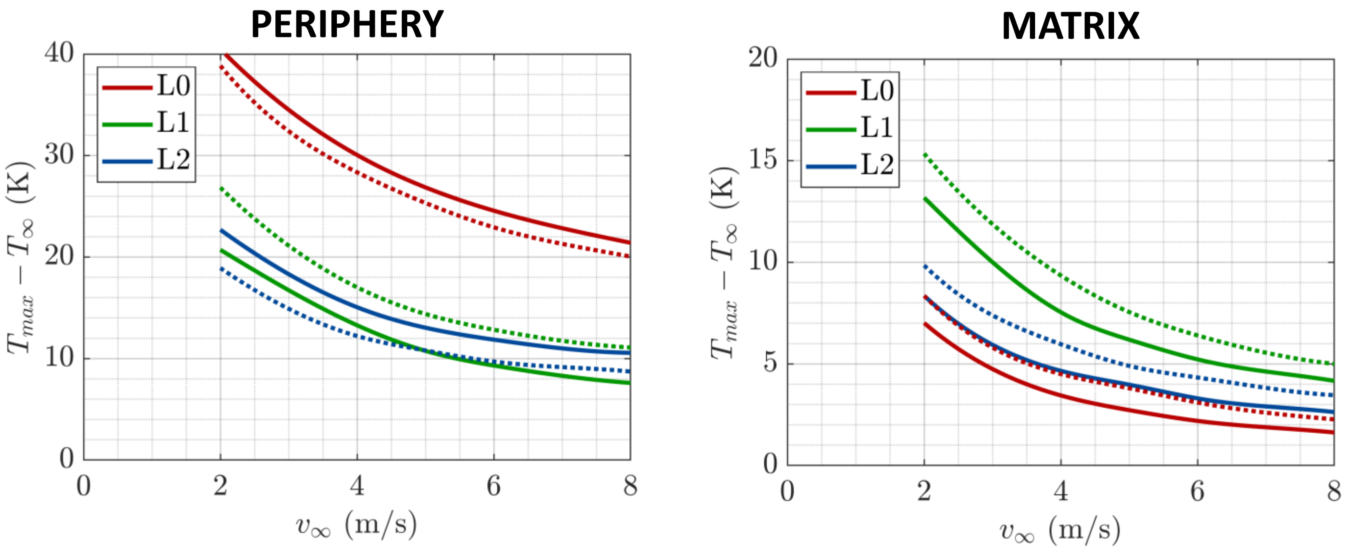
CONTENTS

ALICE ITS3 COOLING: BBM2 - RESULTS

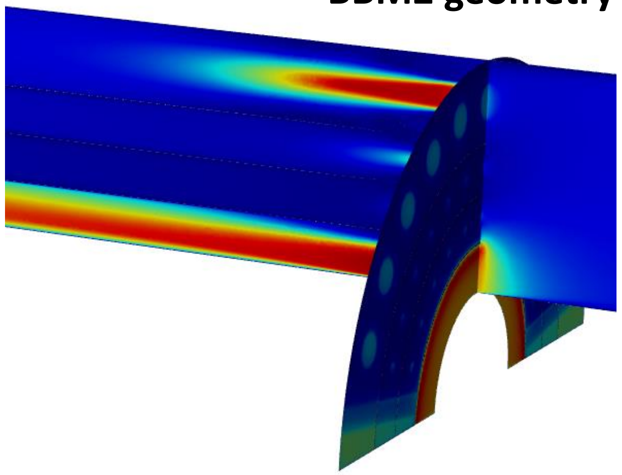
- Representative geometry of one half-barrel (length of the periphery 2.5 mm)
- Upper bounds of ITS3 heat dissipation: $Q_p = 2000\ \mathrm{mW/cm^2},\ Q_m \sim 12\ \mathrm{mW/cm^2}$ (Gianluca)
- Testing is performed with $\boldsymbol{Q_p = 2500\ \mathrm{mW/cm^2},\ Q_m \sim 18.75\ \mathrm{mW/cm^2}}$ (Safety margins)
- Temperature variation measured with temperature sensors and compared with CFD model



BBM2 geometry

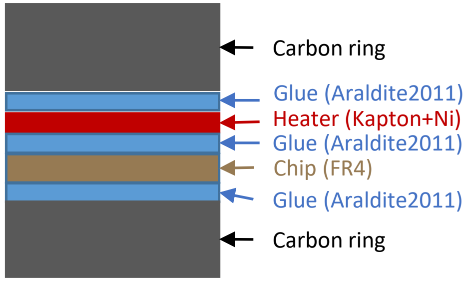


Maximum temperature variation. Experiments (continuous lines) and simulations (dashed lines)



Velocity contour

- Problem: High temperature differences, specially in the periphery of L0
- Cause 1: **40 %** of the flow rate in the BP-L0 layer and **42%** in the L1-L2 layer -> Air flow not optimized
- Cause 2: Many layers with thermally-insulative materials -> High thermal resistance, not present in ITS3



Thermal interfaces in L1 and L2 peripheries

ALICE ITS3 COOLING: BBM2 – IMPROVEMENTS AREAS

GLUE

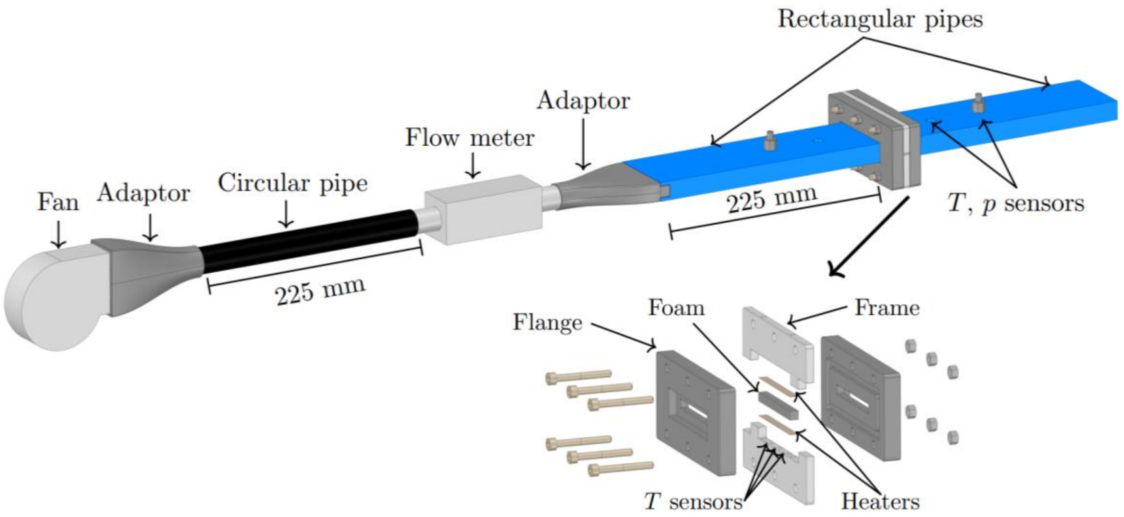
- Currently used adhesive (Araldite 2011) has low thermal conductivity (0.22 W/(m*K))
- Testing of thermally-conductive glues (>1 W/(m*K)) would be beneficial
- Multiple candidates studied based on viscosity, thermal conductivity, electrical conductivity, curing temperature, moisture absorption, shear strength, CTE…
- Four glues purchased. Araldite 2011 used to validate the measurement machine

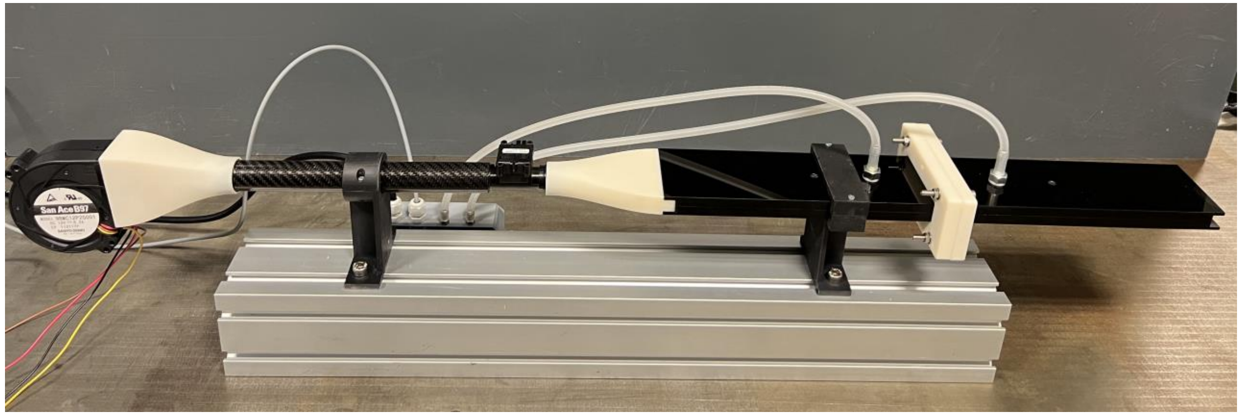
Glue	k (technical datasheet)	k (3 samples tested at CERN)
Araldite 2011	0.22	0.21, 0.22, 0.21
Epoxies 50-3150 FR	2.16	0.83, 0.85, 0.84
Epotek T7109-19	1.3	Expected delivery in two weeks
Epotek 930-4	1.7	Expected delivery in two weeks
Polytec 423-2	3.1	Expected delivery in two weeks

ALICE ITS3 COOLING: BBM2 – IMPROVEMENTS AREAS

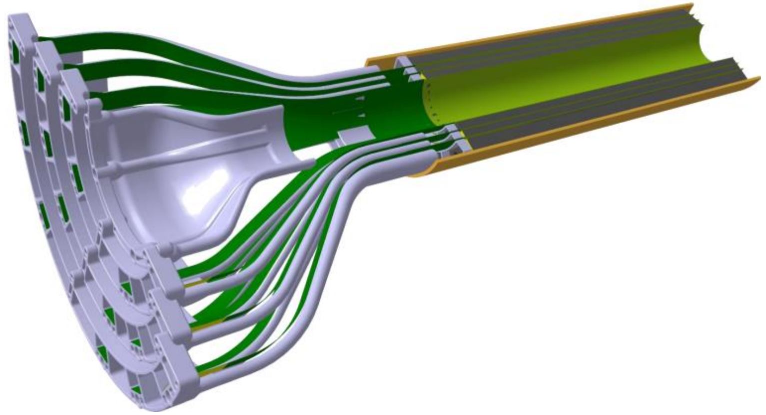
CARBON FOAM

- The optimum glue thickness of the foam-glue interface is unknown.
- The pressure loss of the carbon foam is currently obtained from a CFD model that has been validated with other foams but not exactly the same of the rings
- Thermal setup built for dedicated tests of foam samples of 6x6x60 mm
- First measurements of pressure loss expected to be performed this week





ALICE ITS3 COOLING: BBM2 – IMPROVEMENTS AREAS

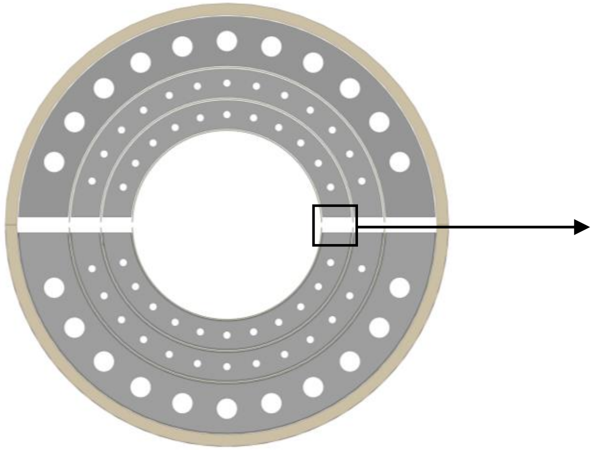


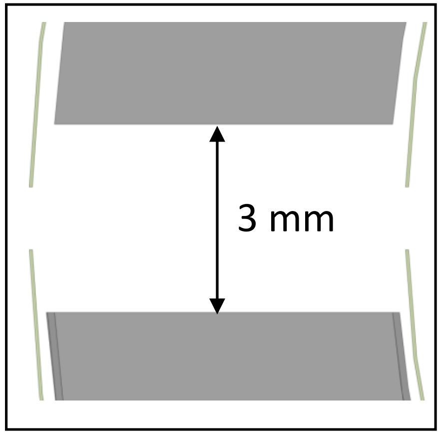
INLET AIR FLOW DISTRIBUTION

- The absence of a carbon ring in L0 drives the air to the BP-L0 layer where heat transfer is not effective
- Apart from the channel between L0 and the beam pipe, the flow rate is strongly dependent on the diameter of the holes of the rings
- Four separated flow lines will allow a better control of the flow distribution

AIR FLOW DISTRIBUTION IN EACH CHANNEL

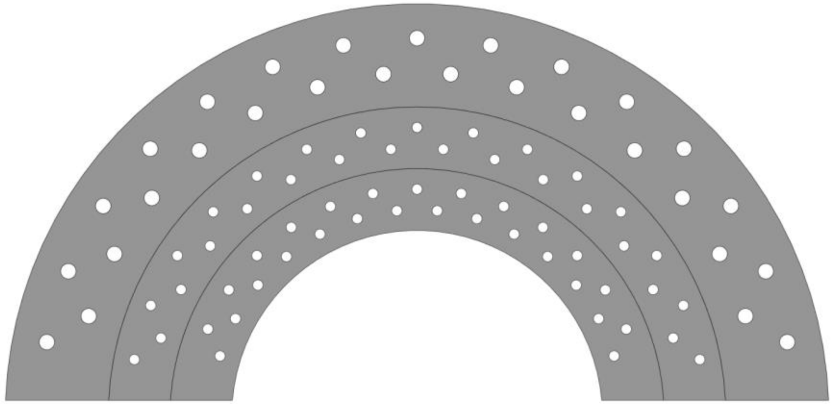
- In each layer there is a region of 3 mm of height where there is no foam -> Pressure loss of carbon foam should be minimized -> Optimization of hole size and distribution
- Smaller holes provide heat transfer and higher velocities -> Aeroelastic analysis will be started in the following weeks



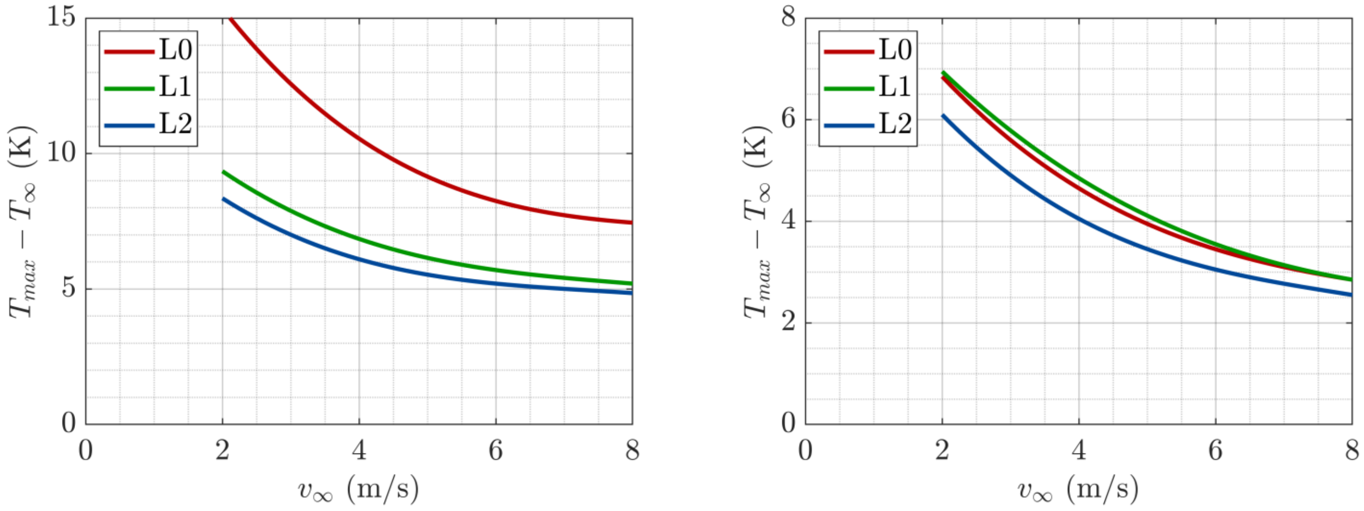


ALICE ITS3 COOLING: BBM3 – CFD SIMULATIONS

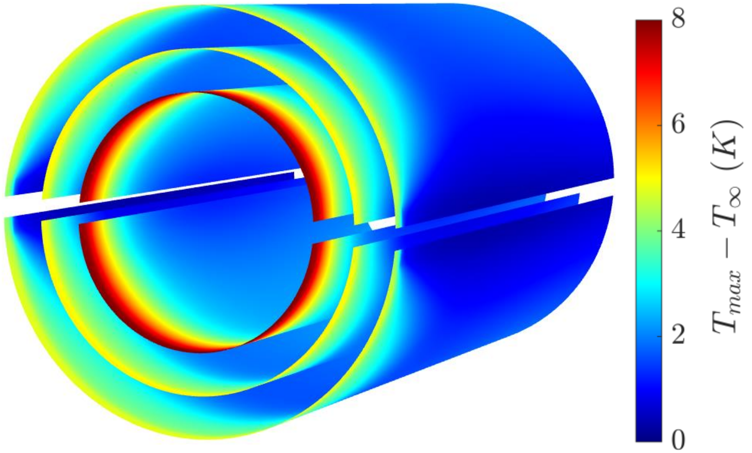
- Two half barrels
- Same heat dissipation as in BBM2: $Q_p = 2500$ mW/cm^2, $Q_m \sim 18.75$ mW/cm^2
- Glue: k=0.85 W/(m*K) and thickness of 250 µm (conservative)
- Many small holes of 1 mm of diameter to improve heat transfer
- Four separated flow lines with same inlet velocity



PERIPHERY **MATRIX**



Maximum temperature variation



Temperature contours for v_∞= 6 m/s