Cooling simulation of the VTX - long barrel

Power dissipation: 50 mW/cm2
Total heat generation of the VTX: 421 W
Inlet air temperature 5 ℃
In current simulation beam pipe temperature not considered

Layer of barrel	Chip coverage (mm)	Number of ladders	Heat generation-of barrels(W)	Simulation results the Max temp (Celsius)
inner	14.8x260	8	27	82
middle	14.8x494	16	117	34.5
outer	14.8 x749	25	277	37.2

- Based on a rough calculation, given 15 degrees Celsius rise, the estimated air flow rate is 1.49 m3/min. *In the sectional area of the barrels the average speed about 2.3 m/s.*
- In the simulation, transfer the flow rate to 12 inlet pipes with ID-8mm, the air speed is 41 m/s (it can be reduced by increasing the inlets)
- Cooling setup with a lower flow rate was also tried but resulted with much higher temperature then this case.

Cooling simulation of the VTX - long barrel -updated

Power dissipation: 50 /40/30 mW/cm2
Total heat generation of the VTX: 421 /337/253 W
Inlet air temperature 5 ℃
Beam pipe temperature not considered

Layer of barrel	Chip coverage (mm)	Number of ladders	Heat generation- of barrels(W)	Simulation results the Max temp (Celsius)		
inner	14.8x260	8	27	82	66.6	51.4
middle	14.8x494	16	117	34.5	27.8	22.1
outer	14.8 x749	25	277	37.2	30.2	24

Cooling simulation of the VTX - long barrel -updated

Power dissipation: 50 /40/30 mW/cm2
Total heat generation of the VTX: 421 /337/253 W
Inlet air temperature 5 ℃
Beam pipe temperature 26 ℃

Layer of barrel	Chip coverage (mm)	Number of ladders	Heat generation- of barrels(W)	Simulation results the Max temp (Celsius)		
inner	14.8x260	8	27	60.6	49.1	42.2
middle	14.8x494	16	117			
outer	14.8 x749	25	277			

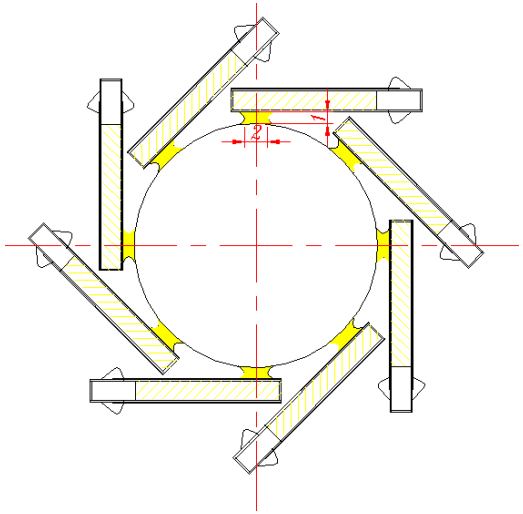
Considerations on cooling

- Change the ladder support material – high conductivity (X, more material increase)
- Adding a thin layer of material that has a high thermal conductivity (no much contribution - previous study)
- Low temperature environment? (thermal isolation required to avoid condensation within tracker / or flushed N2 within tracker, also high flow, too much material / cost)
- *Adjust the gap to beam pipe*
- *Higher air flow rate*

➢ ***A potential solution for the inner most layer detector is adding thermal conductive glue between the detector and beam pipe.***

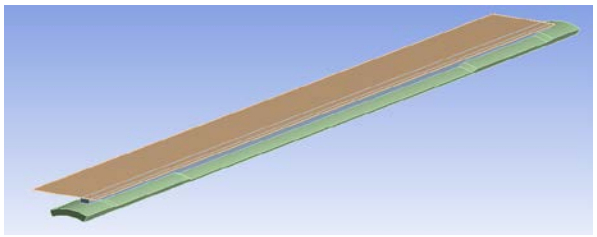
The cooling scheme of gluing detector to beam pipe

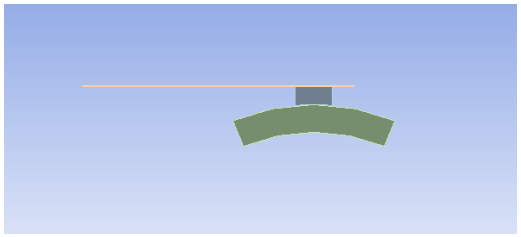
- ✓ *Add thermal conductive glue between the inner most layer detector and beam pipe.*
- ✓ *Material is being investigated*
- ✓ *New analysis to evaluate the contribution of cooling by heat conductivity to the beam pipe is being prepared.*

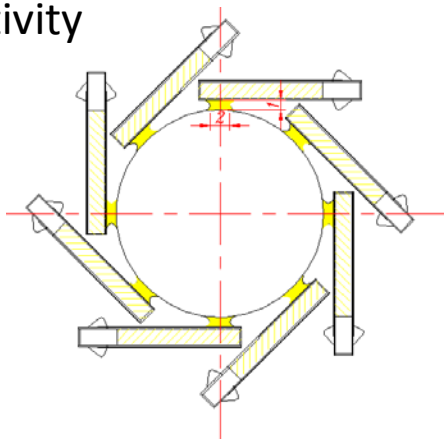


FEA of the inner layer cooling by heat conductivity

1/8 model of the inner layer sensor and beam pipe with glue between them.
Heat generation 50mW/cm^2 , cooling by only heat conductivity







Sensor: R 12.5 mm, 148 W/m.k, 14.8x260x0.05 mm
Beam pipe (beryllium): R 10.7 mm, 16 ℃
Glue: 2 W/m.k, 2 x 260 mm

The max temperature of the sensor: ~ 24.5 ℃