Thermal simulations of the DQW HOM coupler

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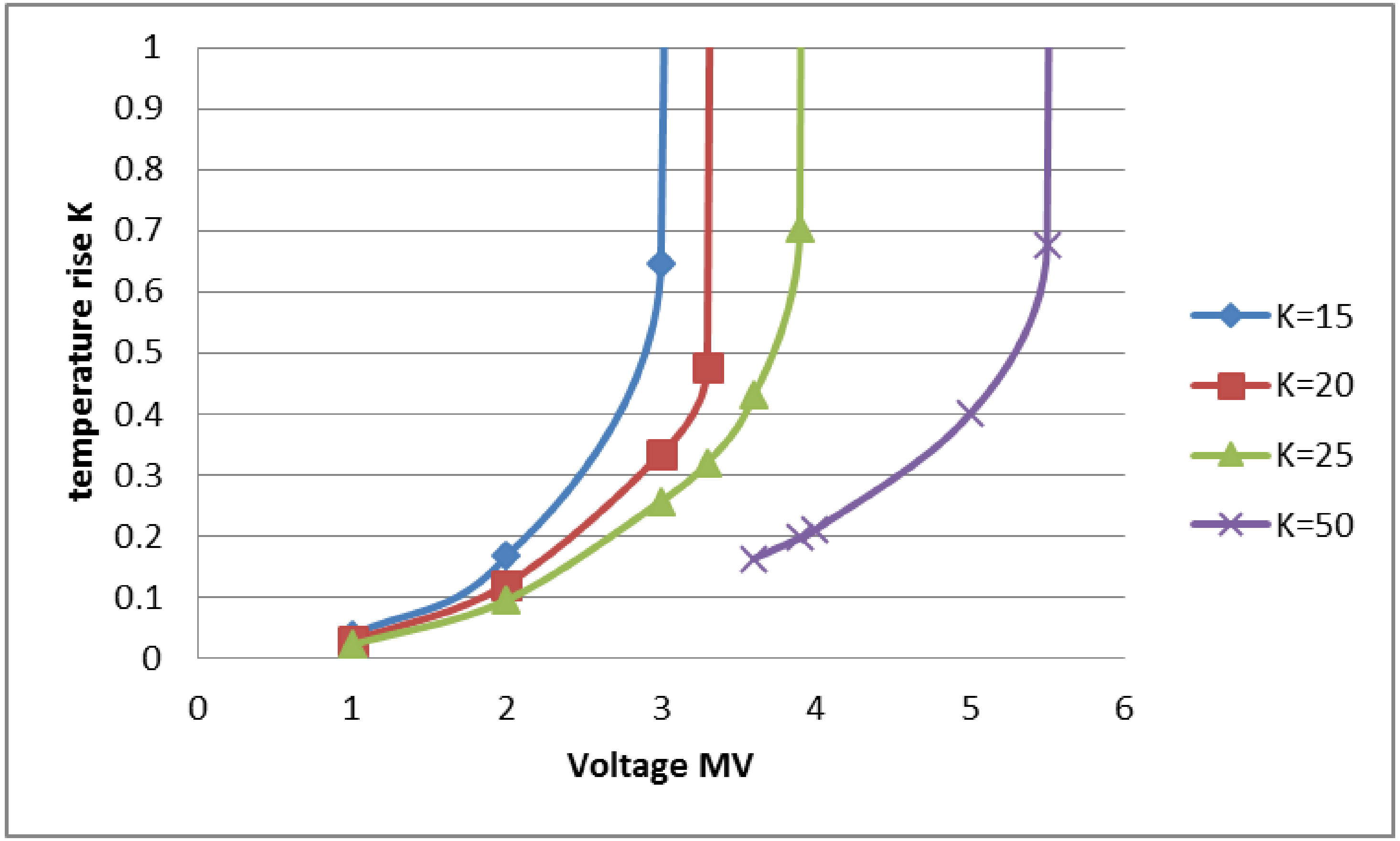
Original thermal modelling

- Did a simulation with the properties at 2K Nb and calculate dT/dR .
- Then do an iterative solve to find steady state temperature using

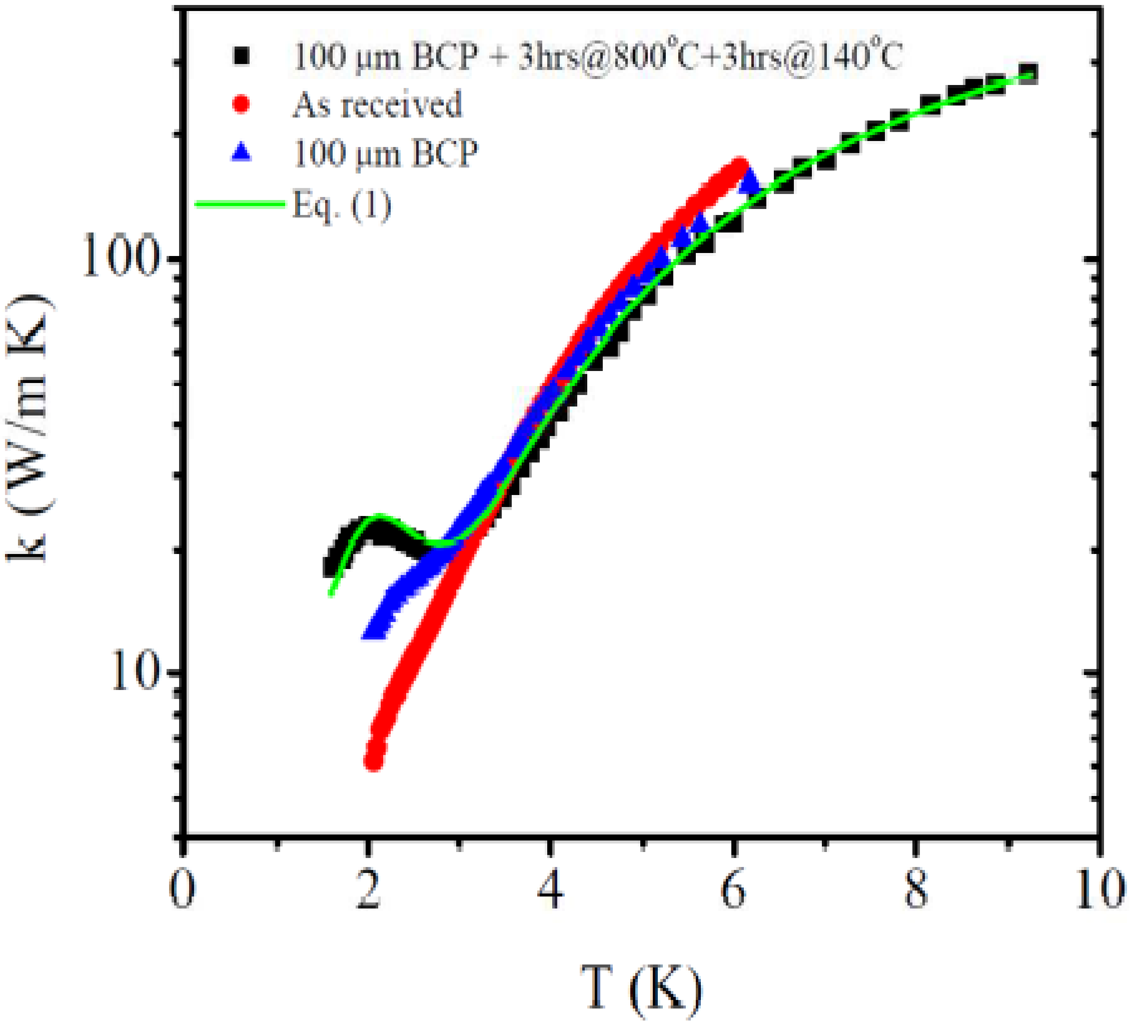
$$R_{BCS} = 2\times10^{-4}\frac{1}{T}\left(\frac{f}{1.5}\right)^2 \exp\left(-\frac{17.67}{T}\right)$$

$$T_{n+1} = \frac{dT}{dR}[RB_{CS}(T_n) + Rr_{es}] * \frac{K_{CST}}{K_{scaled}}$$



Variation of thermal conductivity

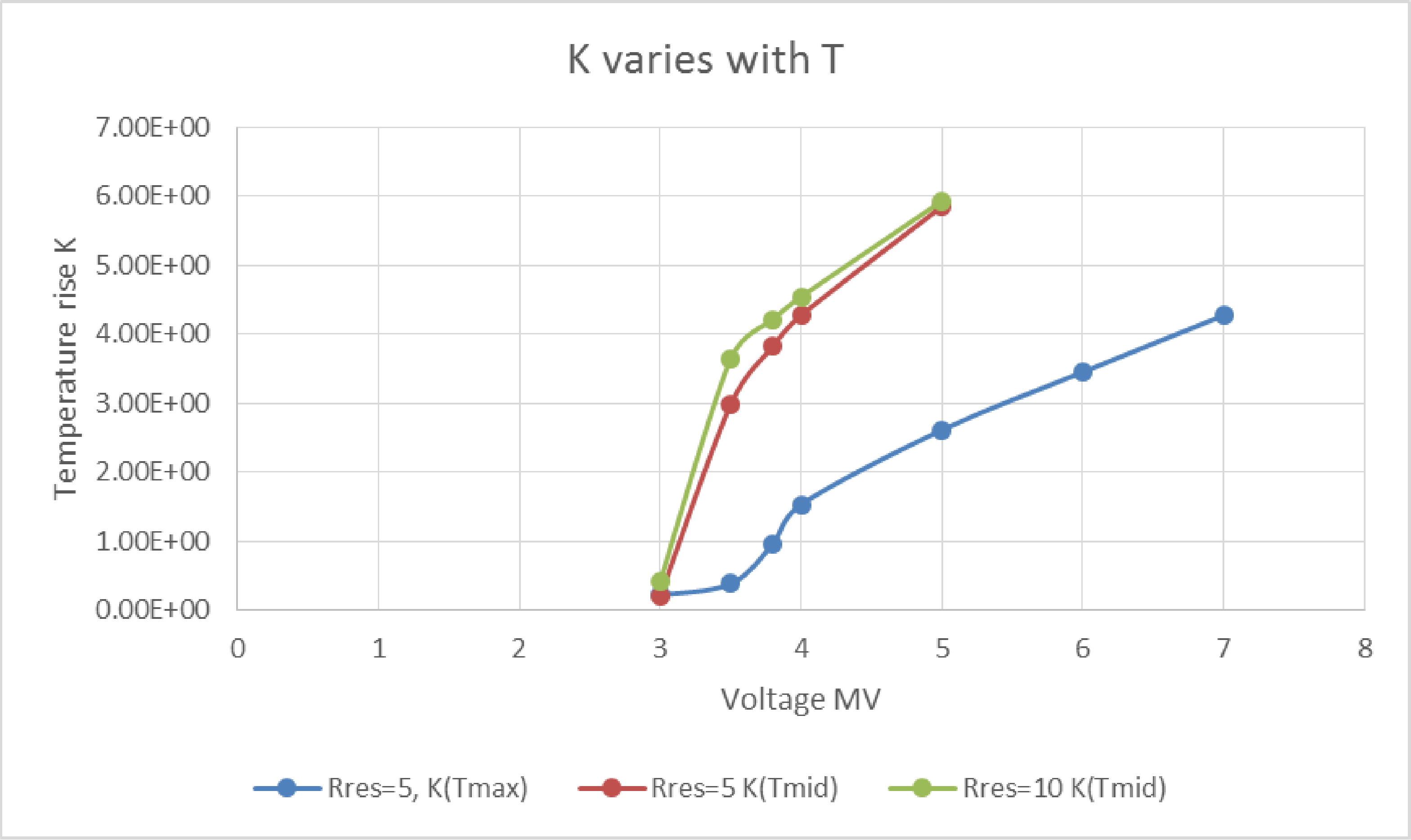
- Use a fit to the green line opposite



Analytical model for scaling assuming constant thermal and electrical properties

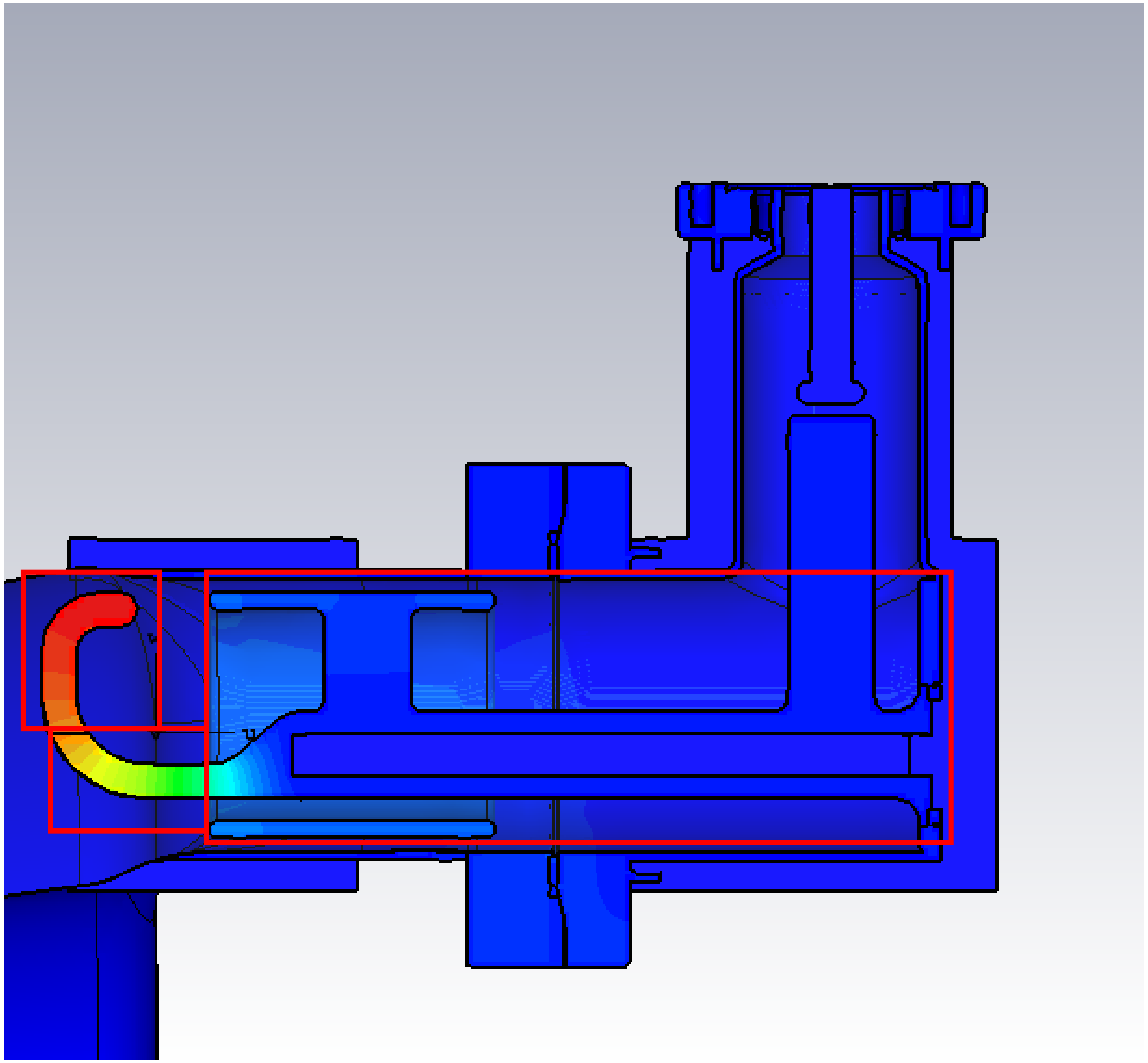
- Previous simulations did the simulations with a constant thermal conductivity
- Here we now use a temp dependant K
- Tmax means using the thermal conductivity at the tip, Tmid means using thermal conductivity of the mid point

$$T_{n+1} = \frac{dT}{dR}[RB_{CS}(T_n) + Rr_{es}] * \frac{K_{CST}}{K(Tn)}$$



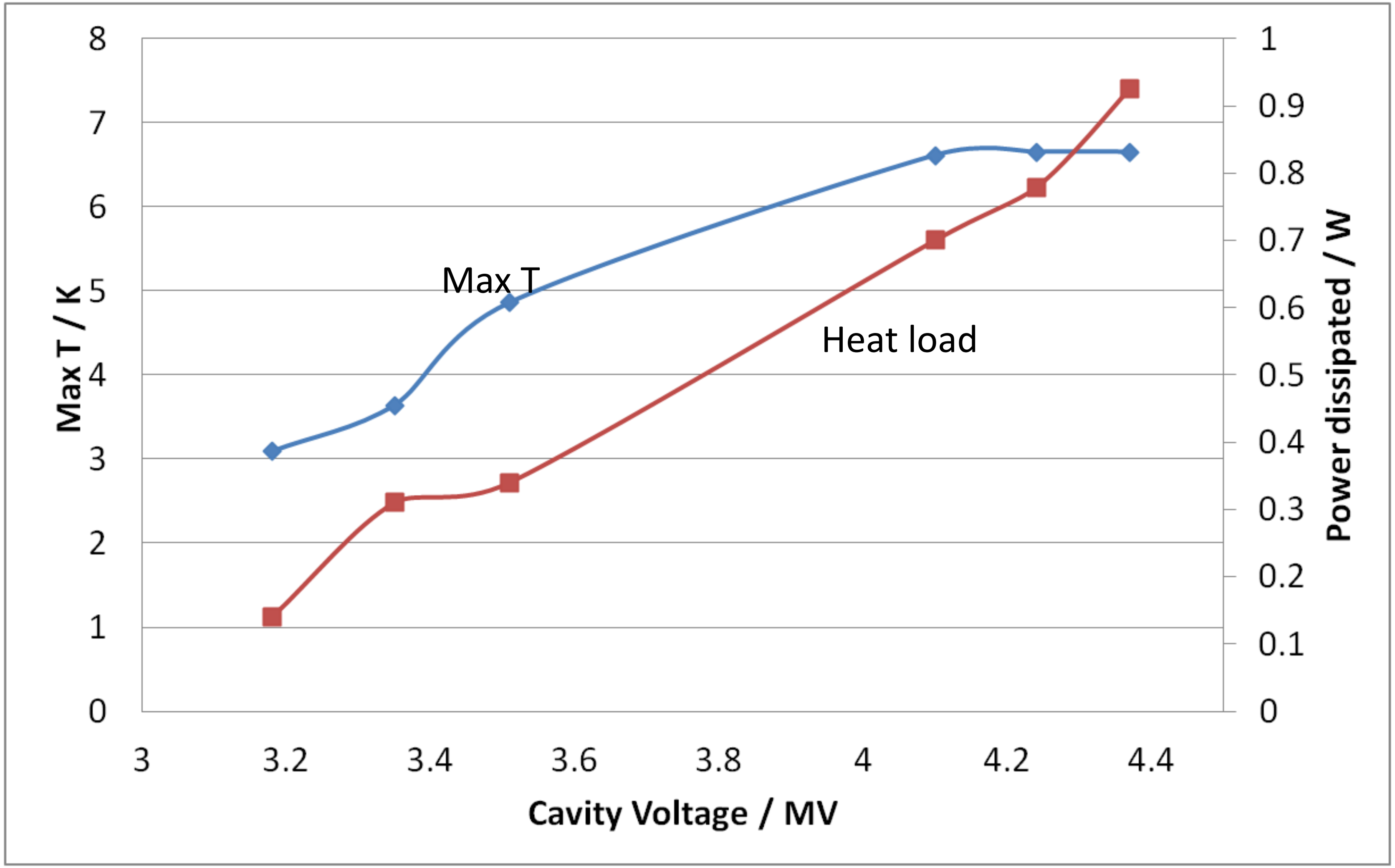
CST simulation

- Split the coupler into 3 regions and set thermal conductivity and surface resistance of each based on the previous simulation and iterate

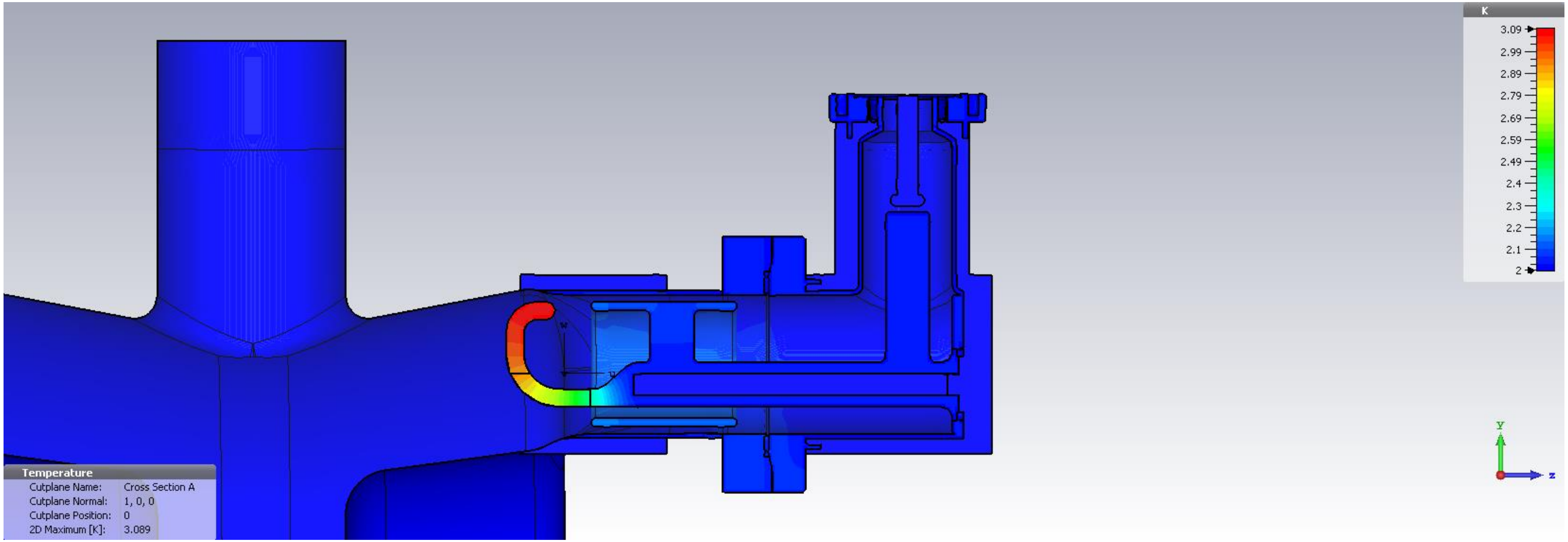


CST simulations with Rres=5 nOhms

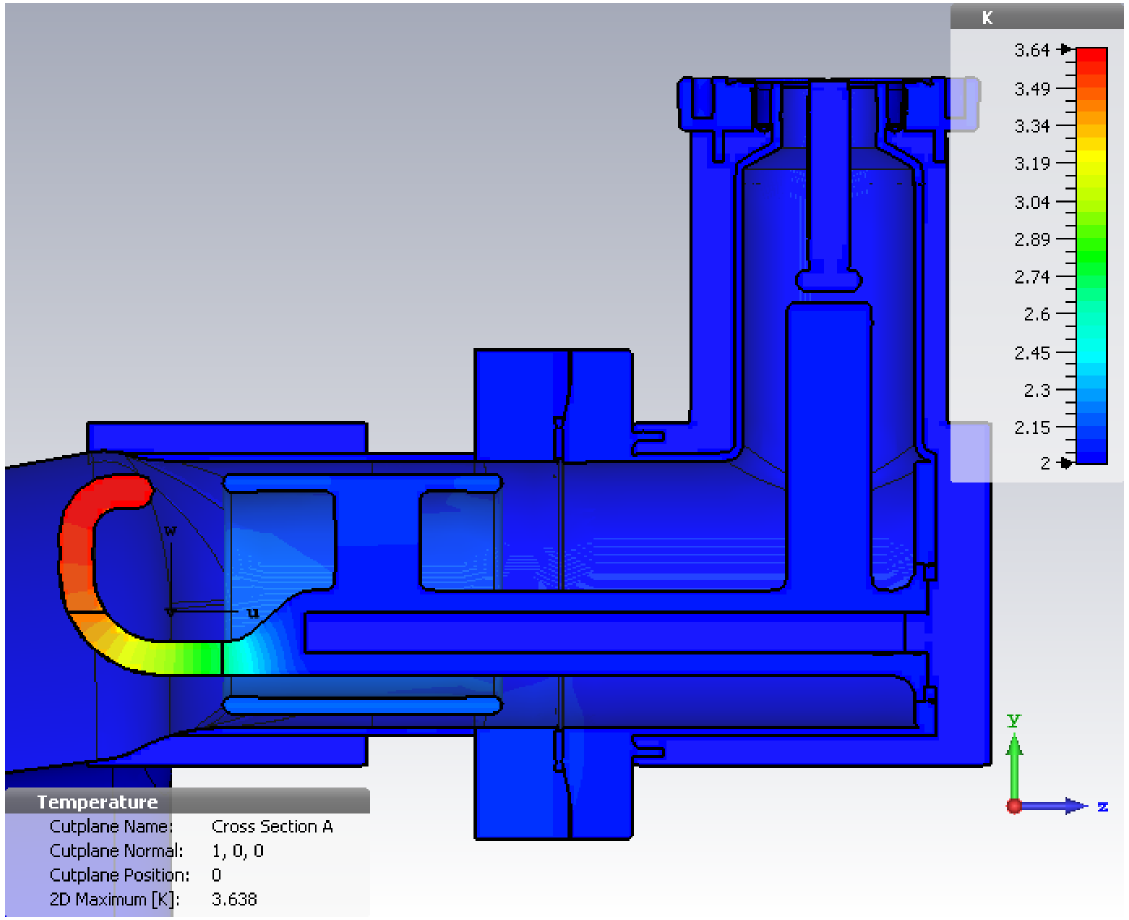
- In self-consistent CST sims where K varies with T along the hook we find the low temperature end dominates as it has a very low K.
- We also find that at high voltage the temperature stabilises as the base heats up.
- At just under 4.5 MV the heat load is 1 watt per HOM coupler in CST which would be above the limit for heat transport in the hollow inner conductor (1 Watt/cm^2)



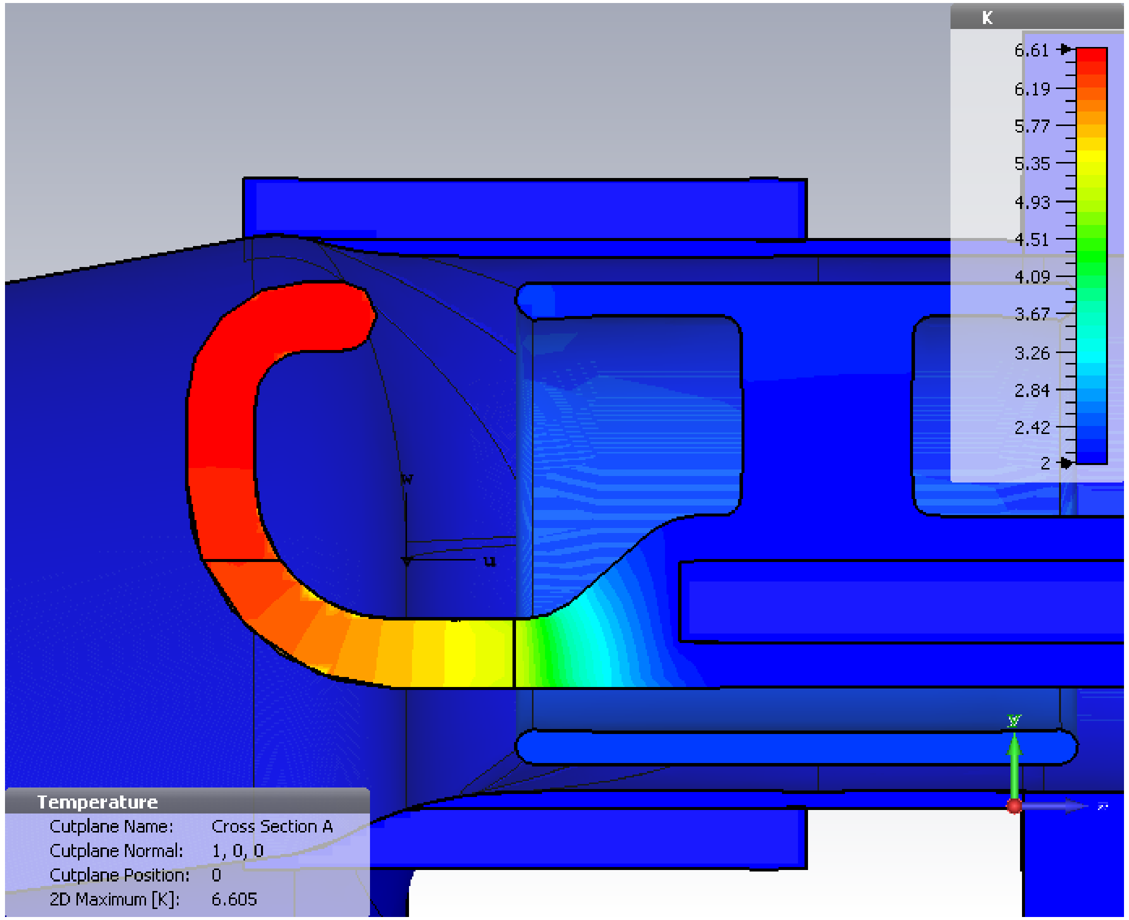
3.18 MV


K
3.09
2.99
2.89
2.79
2.69
2.59
2.49
2.4
2.3
2.2
2.1
2
Y
Z
Temperature
Cutplane Name: Cross Section A
Cutplane Normal: 1, 0, 0
Cutplane Position: 0
2D Maximum [K]: 3.089

3.5 MV

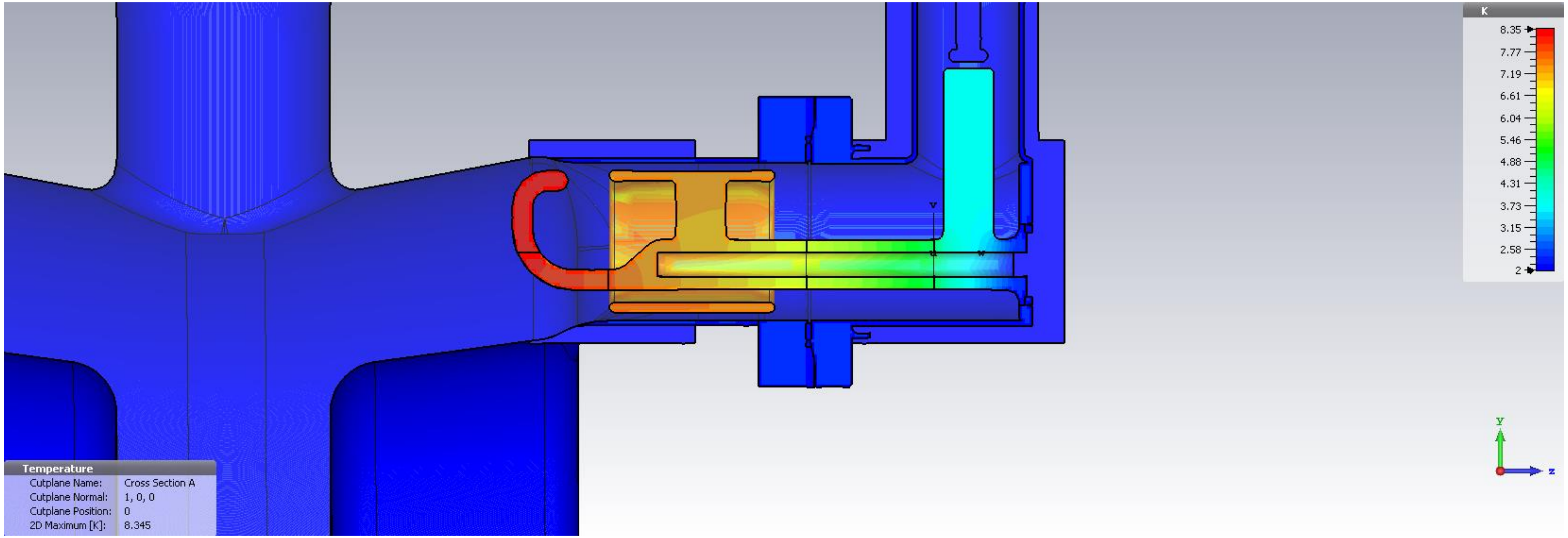

K
3.64
3.49
3.34
3.19
3.04
2.89
2.74
2.6
2.45
2.3
2.15
2
Temperature
Cutplane Name: Cross Section A
Cutplane Normal: 1, 0, 0
Cutplane Position: 0
2D Maximum [K]: 3.638
y
z

4.1 MV



K
6.61
6.19
5.77
5.35
4.93
4.51
4.09
3.67
3.26
2.84
2.42
2
Temperature
Cutplane Name: Cross Section A
Cutplane Normal: 1, 0, 0
Cutplane Position: 0
2D Maximum [K]: 6.605

Cooling channel filled with gas



- Quenches at around 3.5 MV

Next steps

- Look at rotating the coupler
- Look at 4.2 K operation
- Look at the effect of the notch being off resonance
- Look at multipactor