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Background:

The injector Bubble Chamber copper radiator window assembly (JL0015733) was analyzed for temperature rise as a function of deposited power. A range of input power (up to 1kW) was evaluated under two assumptions for the volume of power deposition: Case (1) The power is deposited along a 1 mm diameter tubular volume along the length of the copper (6mm), Case (2) The power is deposited along a 1 mm diameter tubular volume over a length of 2mm.

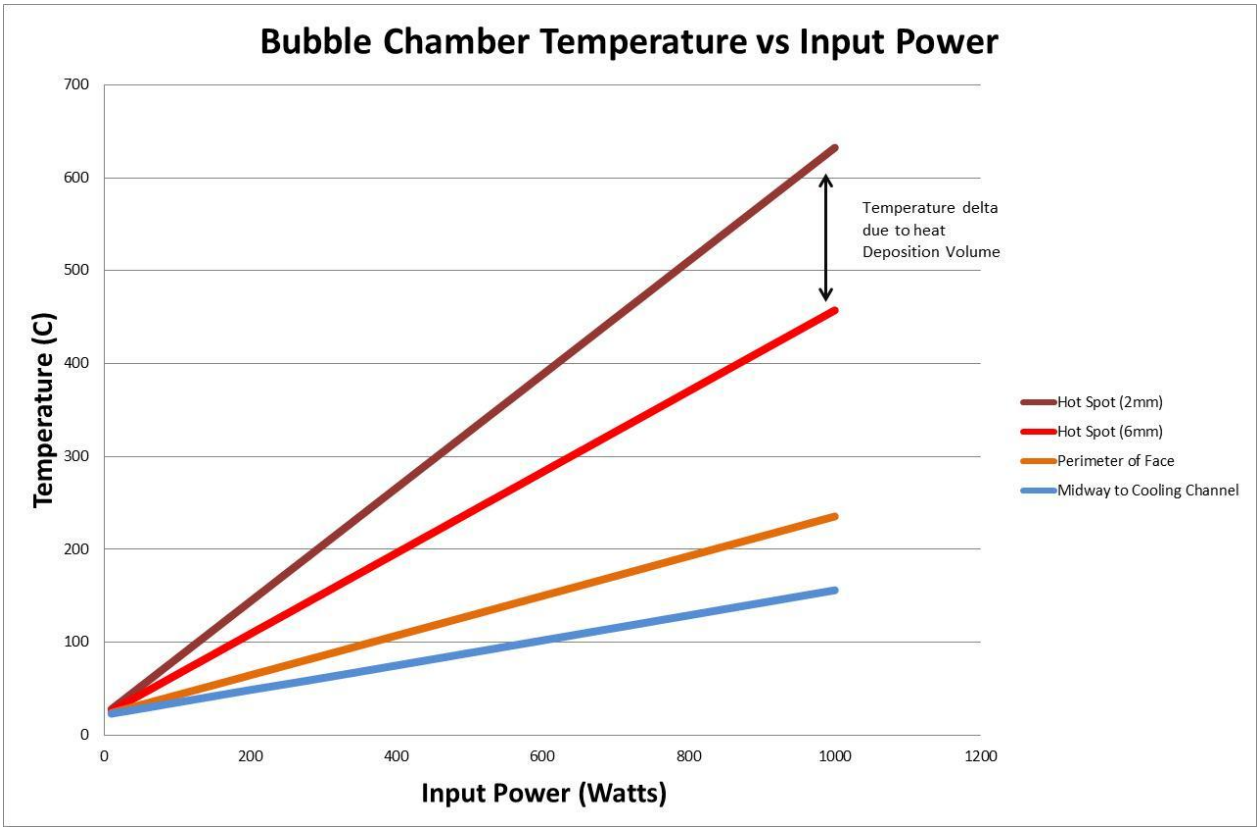
Thermal Modeling:

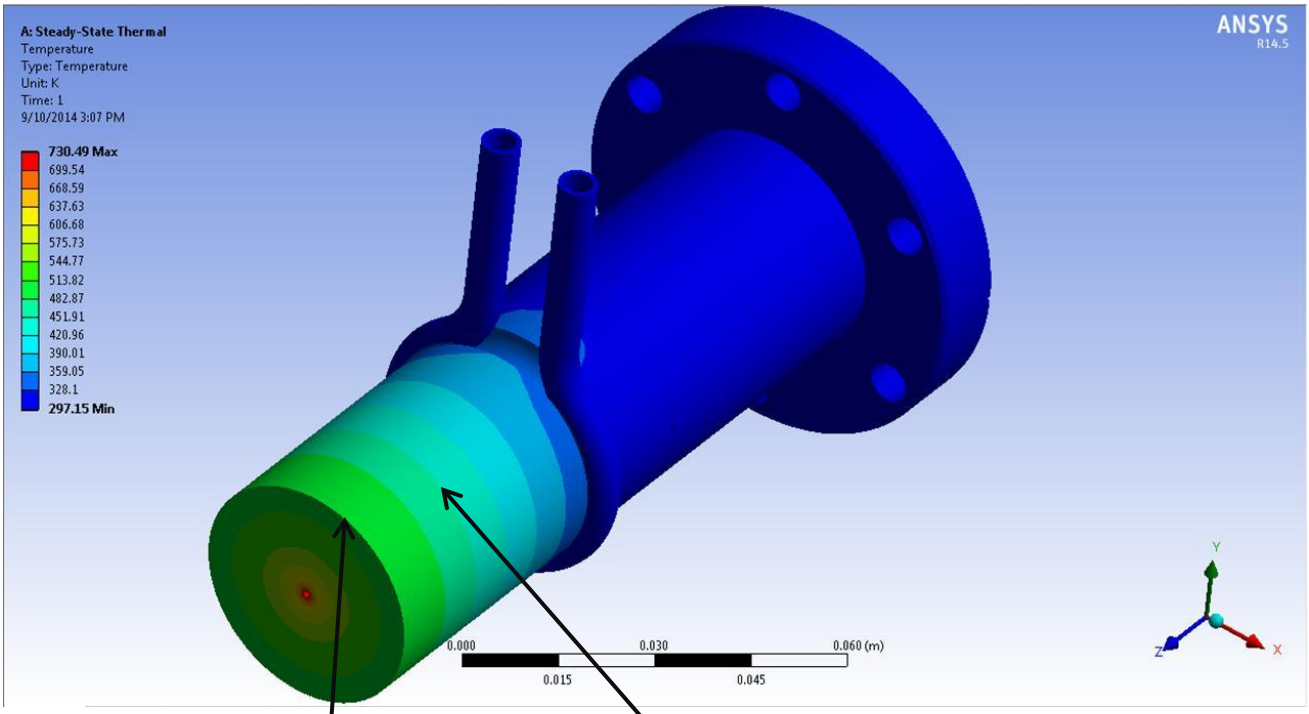
A spreadsheet calculation was performed to calculate the expected temperature rise in the copper. This calculation did not account for the localized heating that would be expected in close proximity of the deposition volume. The results of this calculation predicted roughly a 200C temperature rise (for 1kW) in the face of the radiator. In order to get a more detailed temperature gradient an ANSYS model of the assembly was generated.

Both cases were evaluated and the results are shown below. The deposition volumes considered (2mm length vs 6mm length) did have a fairly significant effect on the local maximum temperature (632C vs 457C). It is also apparent from the models that the temperature dependence on the deposition volume is localized, such that at a few centimeters from the deposition point the thermal profiles for each of the two cases is substantially similar.

The graph below summarizes the model results. The maximum temperature (hot spot) for each of the cases is plotted along with the temperature as a function of power for two other locations (the perimeter of the face & a location halfway from the face to the cooling channel). The temperature profile for each of the locations (away from the deposition point) is roughly the same regardless of which case is considered. The face of the radiator achieves a temperature of 235C in agreement with the spreadsheet calculation.

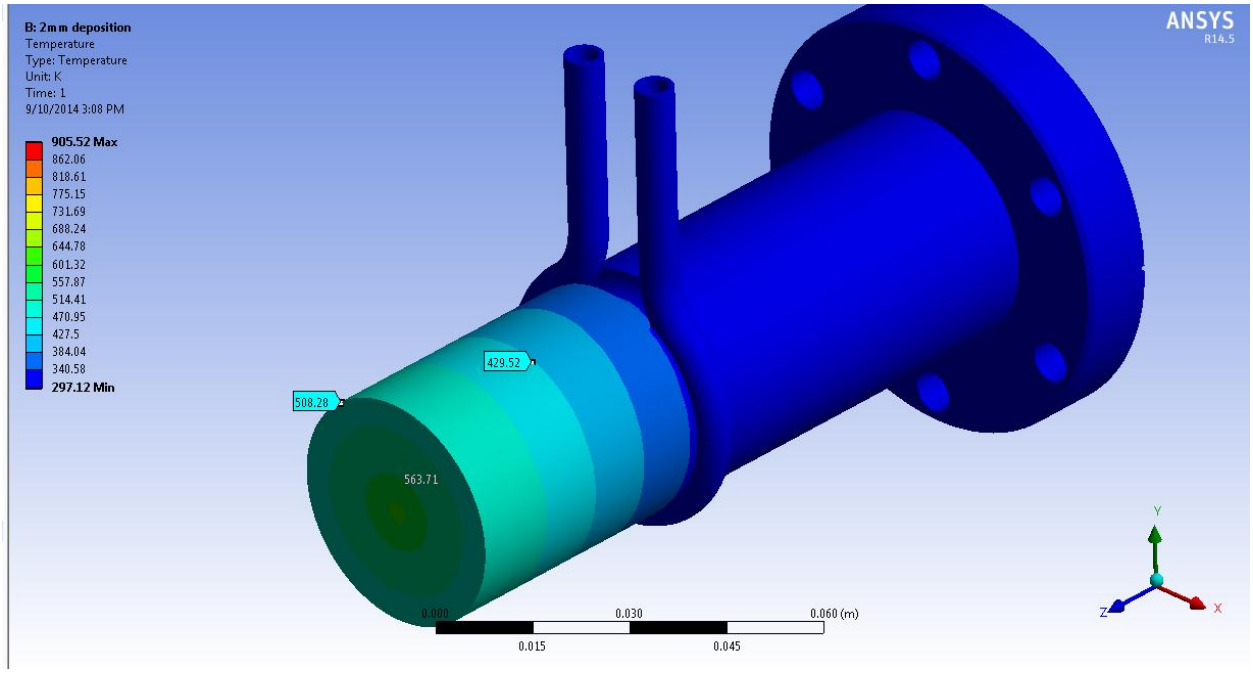
The assumptions made for the cooling water were: 2GPM & 40C.





Perimeter of Face

Midway to Cooling Channel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775.15
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688.24
644.78
601.32
557.87
514.41
470.95
427.5
384.04
340.58
297.12 Min
ANSYS
R14.5
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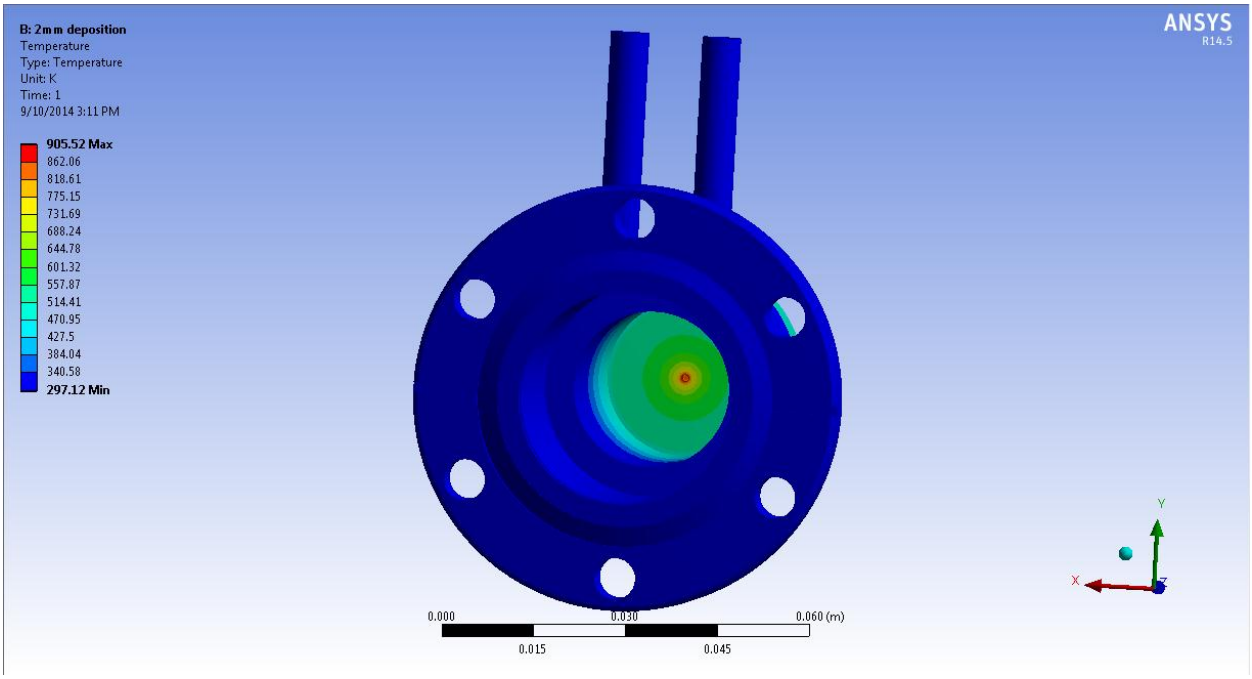
0.015
0.045
Y
Z
X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775.15
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644.78
601.32
557.87
514.41
470.95
427.5
384.04
340.58
297.12 Min
ANSYS
R14.5
0.000
0.030
0.060 (m)
0.015
0.045
Y
X
Z