



Temperature Calculations with Mathematica

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Last Weeks Studies with KLCPS64 Model

- Study temperature in the absorber only using Mathematica.
- Check consistency with Tim's calculations with ANSYS
 - Tim calculated temperature for KLCPS64 with rectangular grid.
 - I calculated temperature for KLCPS64 with cylindrical grid with the same cooling model (cooling holes off-center by 8cm in each direction).
 - The results for $T_{\max} = 205 \text{ }^\circ\text{C}$ match within $5 \text{ }^\circ\text{C}$.
- Checked rectangular grid in Mathematica (without cooling holes).
 - T_{\max} seems to be dependent on the mesh size (currently 2mm).
 - My cylindrical grid for now provides better sensitivity (x10) at the location of the triangular wedge.
 - The results for rectangular and cylindrical model in Mathematica match within $15 \text{ }^\circ\text{C}$.
- I noticed an x-asymmetry in the solutions for temperature around triangular wedge when solving in cylindrical coordinate system.
 - This is related to how 2π periodic boundary conditions are imposed in the cylindrical coordinates.
 - It apparently can cause about $10 \text{ }^\circ\text{C}$ difference in T_{\max} , based on my tests.
 - After fixing the asymmetry T_{\max} seems to go up by $10 \text{ }^\circ\text{C}$
 - I will switch to $\phi \in [-\pi/2, 3\pi/2]$ range and stitch the solution at those limits instead of $\phi \in [-\pi, +\pi]$.
 - It would be great if Pavel can provide cylindrical grid with those limits.

Temperatures from Pavel's Tests

- I looked at some of the tests that Pavel did with KLCPS64 model to estimate the temperature in the absorber.
 - $\pm 10\%$ B-field and $\sigma^{(x,y)}_{\text{beam}}$ widths are kind of extreme conditions that are highly unlikely to occur during running.
- Used water temperature $T_{\text{water}} = 40^\circ\text{C}$ with cooling holes offset at 7cm in each direction.
- All tests were solved using similar conditions and parameters for consistency.
- None of the tests produces high maximum temperature or requires high temperature at the water boundary.
 - The highest T_{max} so far happens with -1 mrad angle in Y as well as 110% B-field, when the beam hits the forward corner of the absorber.
- The current vertical beam position may not be optimal for the B-field.
 - Can be addressed at a later stage when B-field is better defined.
- There are other tests that Pavel did that I have not checked yet.

Test Name	Hot Spot Location Section	R_{max} (cm)	ϕ_{max} (deg)	Z_{max} (cm)	T_{max} ($^\circ\text{C}$)	T_{holes} ($^\circ\text{C}$)	Comment
Nominal ($\sigma^{(x,y)}_{\text{beam}} = 1$ mm)	Triangular	0.3	70	8	190 ± 25	55	x-asymmetry
$\sigma^{(x,y)}_{\text{beam}} = 100$ μm	Triangular	0.0	N/A	44	240 ± 25	65	No asymmetry
90% B-field	Rectangular	0.2	90	59	230 ± 25	60	x-asymmetry
110% B-field	Triangular	0.2	70	8	305 ± 25	70	x-asymmetry
-1mm shift in Y	Triangular	0.2	70	8	255 ± 25	65	x-asymmetry
+1mm shift in Y	Rectangular	0.1	90	57	180 ± 25	60	x-asymmetry
-1mrad angle in Y	Triangular	0.15	70	8	335 ± 25	70	x-asymmetry
+1mrad angle in Y	Rectangular	0.2	90	59	240 ± 25	60	x-asymmetry