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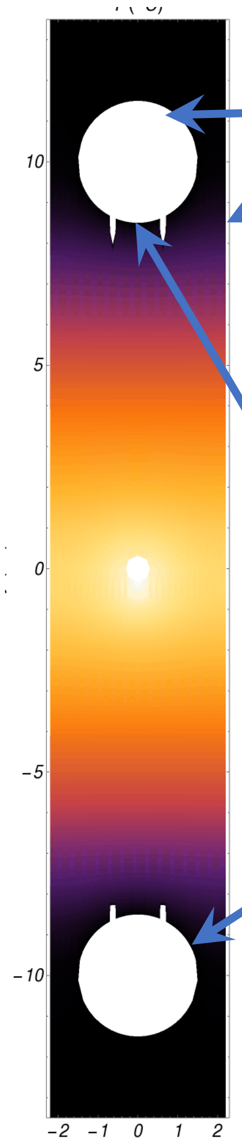
TEMPERATURE EVALUATION FOR KLCPS59 MODEL

Presented method

- The goal of this method is to obtain temperature distribution estimates for the CPS core using a quicker method than full ***ANSYS***
  - Only concentrate on the copper core area to get 3D solutions for the equations in a uniform medium.
- Use Poisson's equation with boundary condition to determine the T-distribution.
  - Use finely binned data from FLUKA simulations by Pavel.
  - The solutions for the equations are assumed to be time-independent.
- Solve the equations using ***Mathematica*** software.
  - JLAB owns license for CUE Linux machines.
  - Can solve Poisson's equation in both Cartesian, Spherical and Cylindrical coordinates.
  - Small details like small 2mm cuts e.t.c. are ignored in geometry.
  - Assumes heat exchange at the boundary with the cooling water which is at some average temperature.
  - Water flow is assumed to be sufficient.
- I this point the warming of the water in the pipes is not taken into account
  - Use effective temperature.
- Already checked against Tim's ***ANSYS*** calculations for many KLF heated items.



$\nabla T \cdot \mathbf{n} = 0$ Neumann boundary conditions

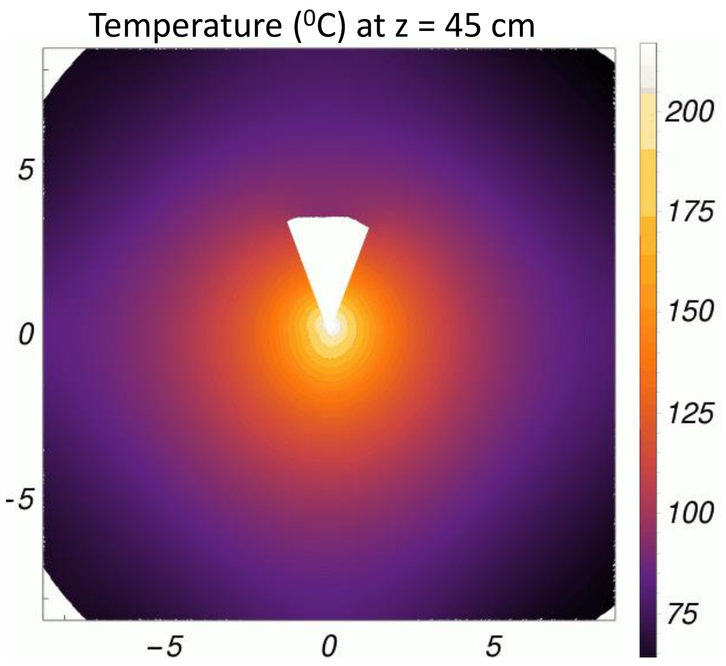
$T = T_0$ Dirichlet boundary conditions or $\nabla T \cdot \mathbf{n} = \frac{\alpha}{\kappa}(T_W - T_C)$ Robin boundary condition

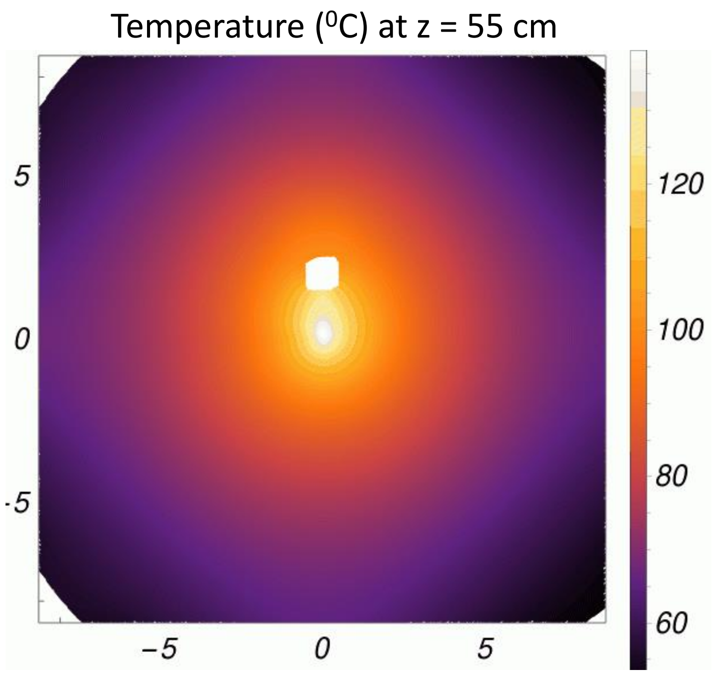
used $k = 385 \, \frac{\mathrm{W}}{\mathrm{K\,m}}$

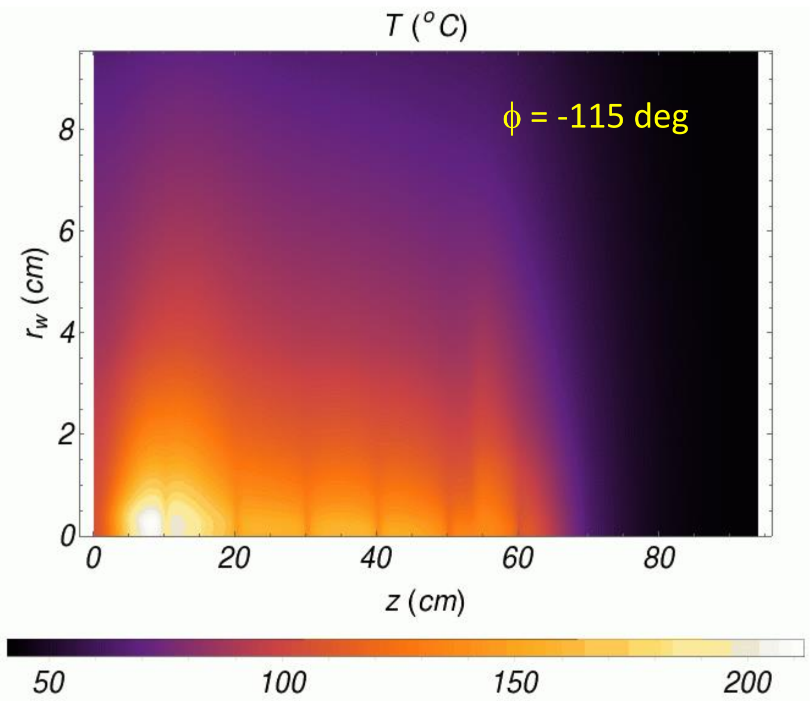
used $\alpha = 5000 \, \frac{\mathrm{W}}{\mathrm{K\,m^2}}$

$$-\nabla^2 T(x,y,z) = \frac{1}{k} q(x,y,z)$$

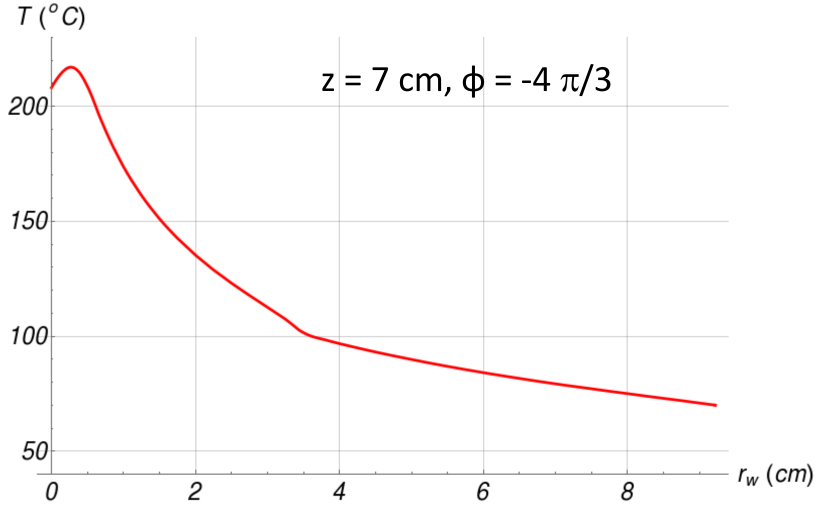
$$-\nabla^2 T(r,\phi,z) = \frac{1}{k} q(r,\phi,z)$$

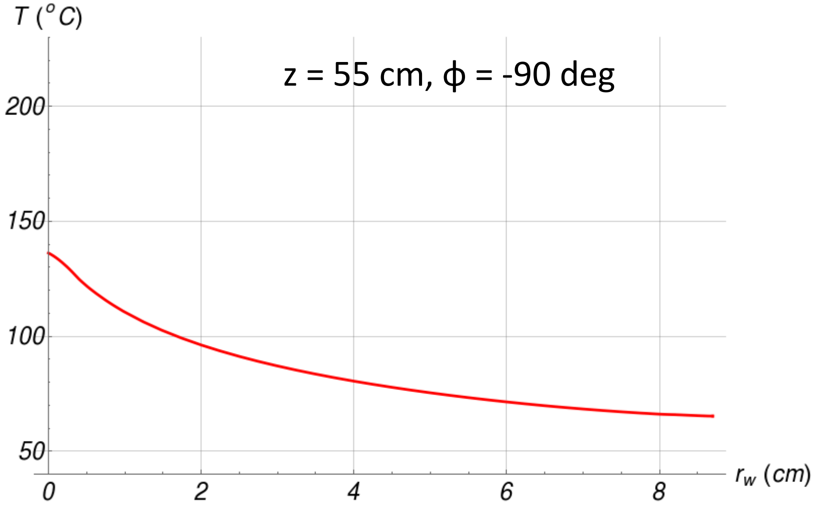


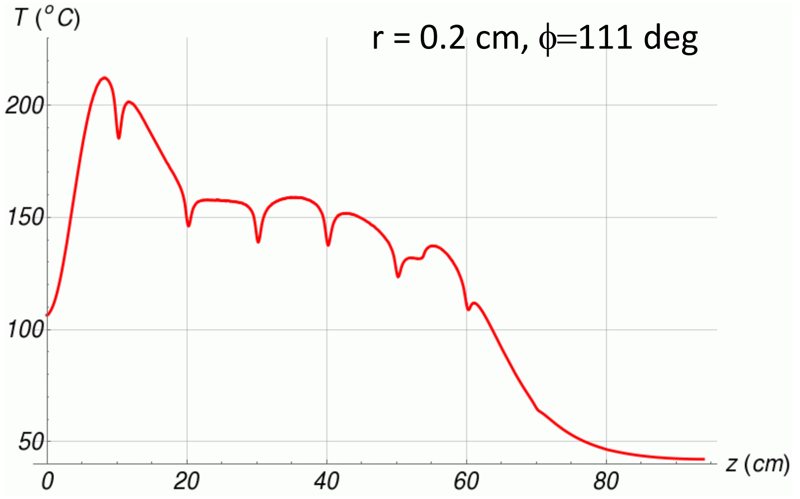




- There is a hot spots at z=7cm, close to the upstream edge of the absorber
- Maximum temperature is about $T_{max} \approx 220\ ^0C$.
- Temperature at the water-to copper interface is about 80 ^0C.
- The heat exchange happens over the outer surface of the copper rectangular block
- used $\alpha = (5000/4)\ \frac{W}{K\,m^2}$ to be conservative on the heat exchange surface







- Cooling channels:
  - 2 horizontal slits are 12cm x1cm
  - 2 round holes R=1cm
- used $\alpha = 5000 \frac{W}{K\,m^2}$ for heat exchange at the surface.
- Maximum temperature is about $T_{max} \approx 190\,^0C$.
- Temperature at the water-to copper interface is about 50 degrees.
- Assuming $\Delta T = 5\,^0C$ temperature change for water, this will require ~60gal/min flow.
  - Need to decrease the mass flow of water by increasing ΔT.
  - Need to increase the water velocity.
- Will be optimized later when Pavel's model is final.