Heating in the Study 2a/b absorber window

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• look at effects of heating in the Study 2a/b absorber window
• start with simplest design
  • 3 layer, flat window
  • cooled on the outer edge only
• try to determine if it has a problem
• start with simple model
  • 1-D heat conduction equation with source terms
  • include temperature variation of material properties
  • break into 1 cm wide rings
  • solve numerically
Power terms

- all layers get $dE/dx$ heating
  - e.g. 58 W in 1 cm thick LiH
- Be layer facing cavity gets rf heating
  - e.g. 220 W for Study 2a cavity
- include radiation losses
Heat conduction equation

\[
\frac{\partial T}{\partial t} - \frac{\kappa(T)}{\rho c(T)} \nabla^2 T = \frac{P}{mc(T)}
\]

- power terms = \(\frac{dE}{dx}\) heating + rf heating – radiation cooling
- solve implicitly for temperatures at new time step

\[
\frac{T_j^{n+1} - T_j^n}{\Delta t} - D \left[ \frac{T_{j+1}^{n+1} - 2T_j^{n+1} + T_{j-1}^{n+1}}{(\Delta r)^2} \right] + \frac{1}{r} \left( \frac{T_{j+1}^{n+1} - T_{j-1}^{n+1}}{2\Delta r} \right) = S_j
\]
Material properties

Note big drop in conductivity
Results for LiH

- maximum temperature well below melting point (962 K)
Effects of radiation

- assume cavity walls are maintained at room temperature
- radiation plays important role for hot Be layer
Results for hot Be layer

- require \( \sim 300 \, \mu m \) thick layer
Results for cold Be layer

- no problem with 25 µm thick layer on outside
Future work

• this window model
  – 2-D solution
    • includes heat transfer between layers
    • allows longitudinal gradients near boundaries
• many other window designs have been suggested
  – more “sandwich” layers
  – curved windows
  – convective gas layer
• how is window constructed?
• eventually need a full ANSYS model
  – buckling?