Heating in the Study 2a/b absorber window

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MC Friday Meeting

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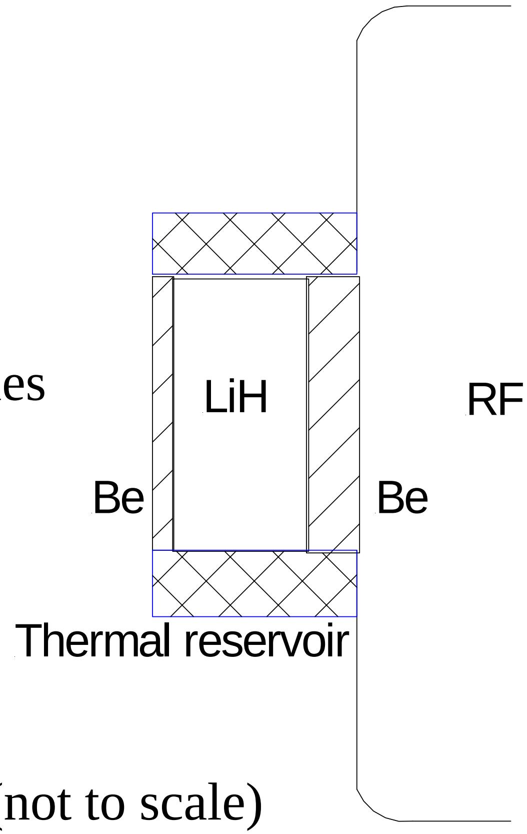
Outline

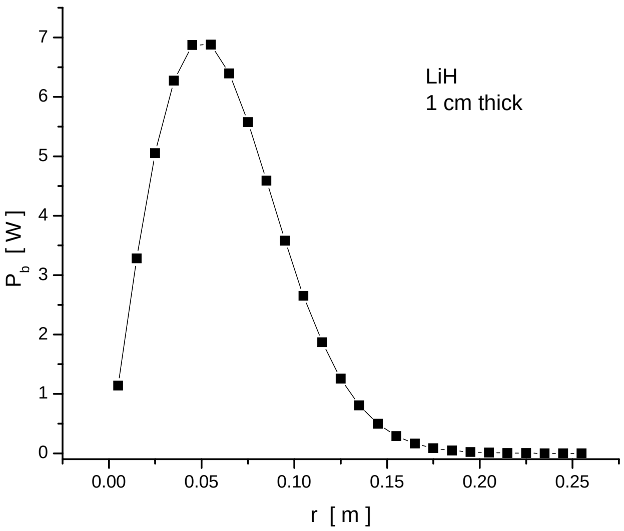
- look at effects of heating in the Study 2a/b absorber window
- start with simplest design
  - 3 layer, flat window
  - cooled on the outer edge only
- try to determine if it has a problem
- start with simple model
  - 1-D heat conduction equation with source terms
  - include temperature variation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

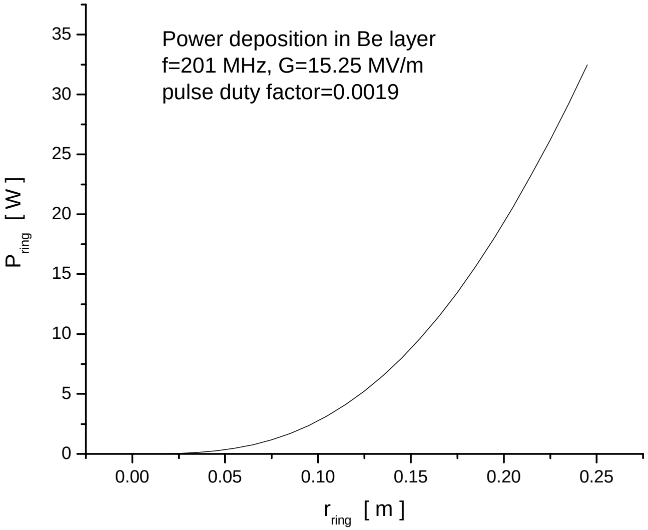


(not to scale)

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





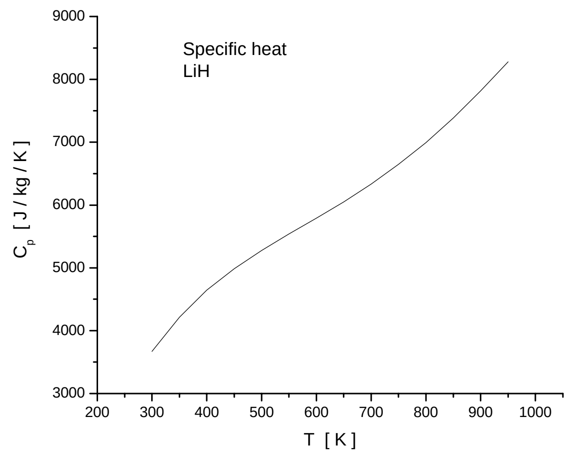
Heat conduction equation

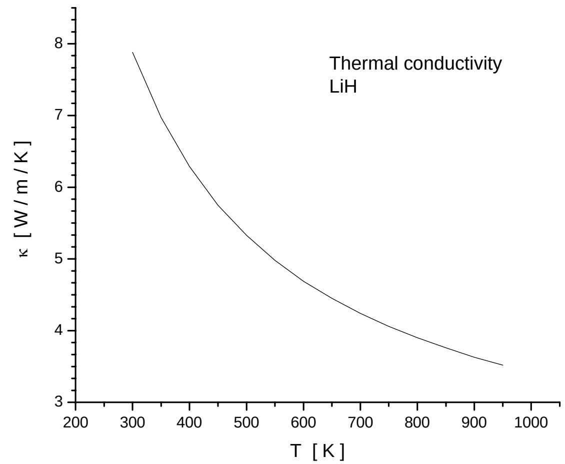
$$\frac{\partial T}{\partial t} - \frac{\kappa(T)}{\rho c(T)} \nabla^2 T = \frac{P}{mc(T)}$$

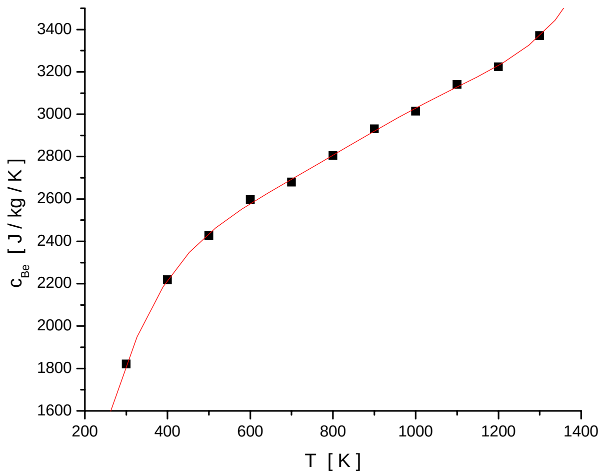
- power terms = dE/dx heating + rf heating – radiation cooling
- solve implicitly for temperatures at new time step

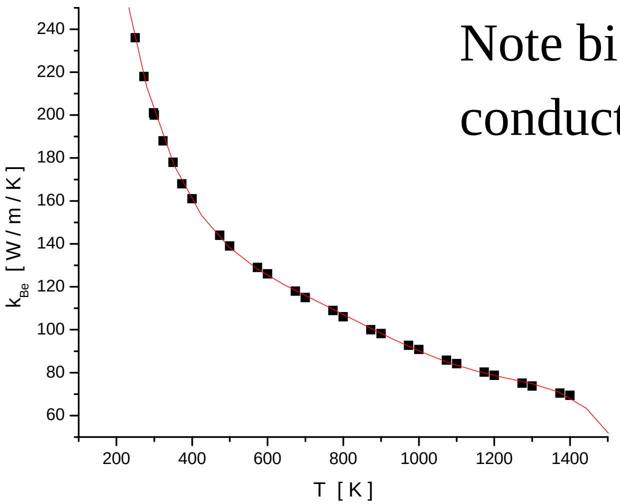
$$\frac{T_j^{n+1} - T_j^n}{\Delta t} - D\left[\frac{T_{j+1}^{n+1} - 2T_j^{n+1} + T_{j-1}^{n+1}}{(\Delta r)^2} + \frac{1}{r}\left(\frac{T_{j+1}^{n+1} - T_{j-1}^{n+1}}{2\Delta r}\right)\right] = S_j$$

Material properties





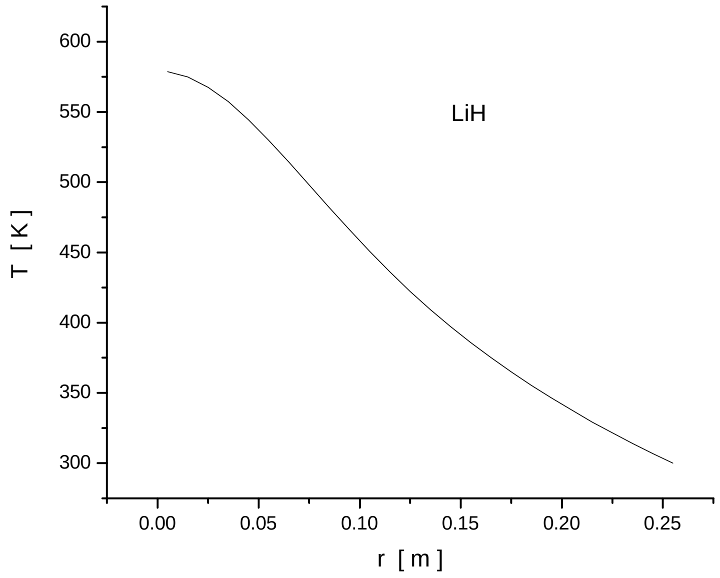


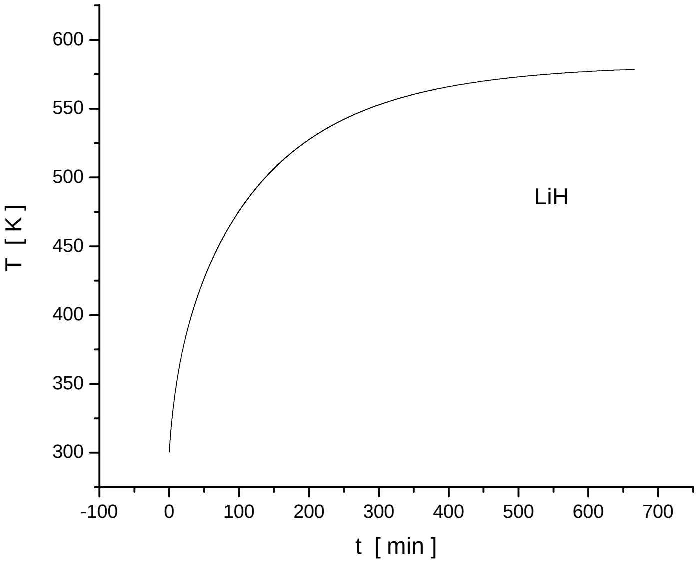


Note big drop in conductivity

Results for LiH

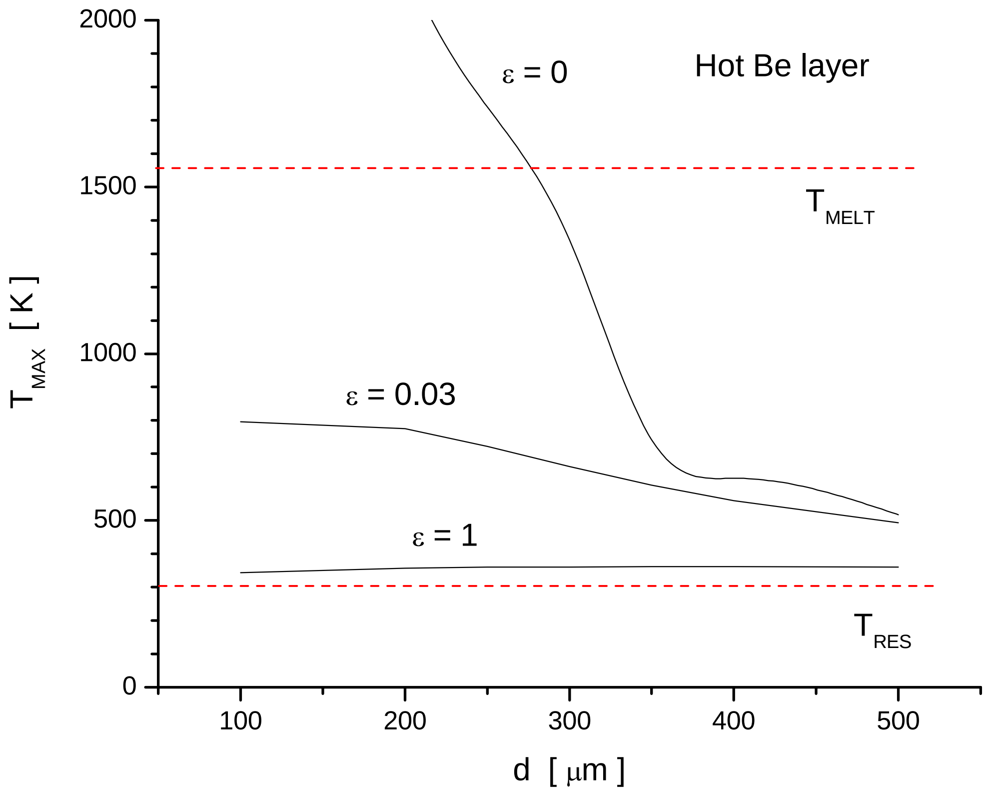
- maximum temperature well below melting point (962 K)





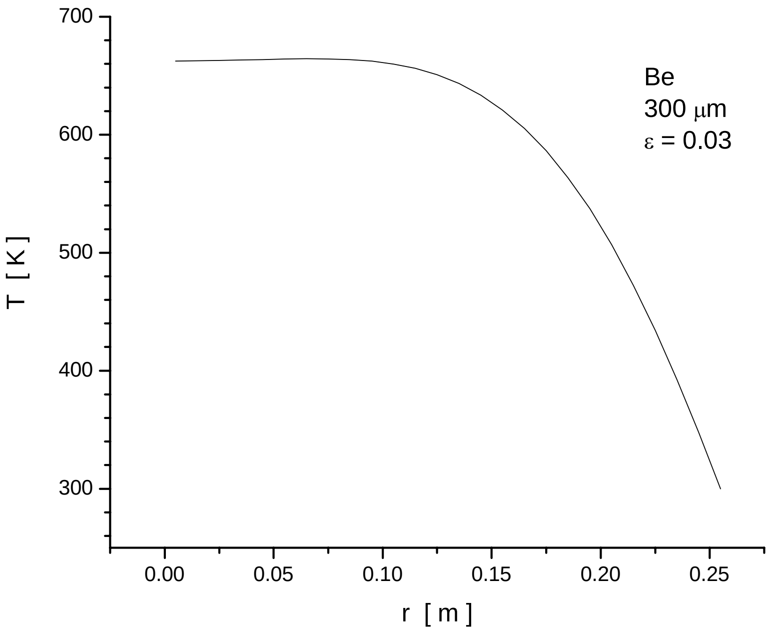
Effects of radiation

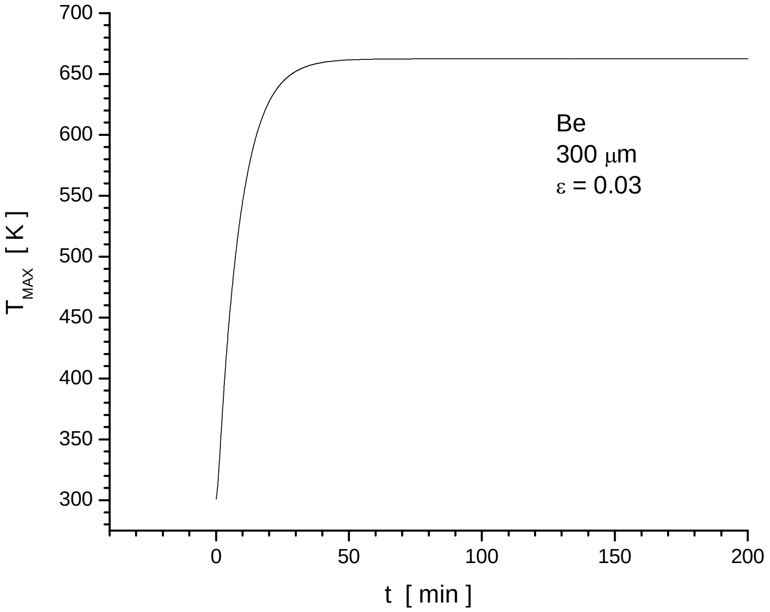
- assume cavity walls are maintained at room temperature
- radiation plays important role for hot Be layer



Results for hot Be layer

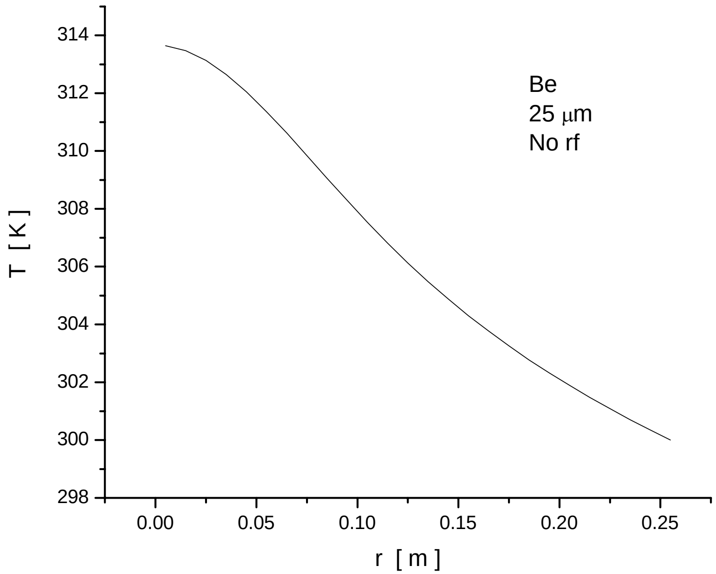
- require ~300 μm thick layer

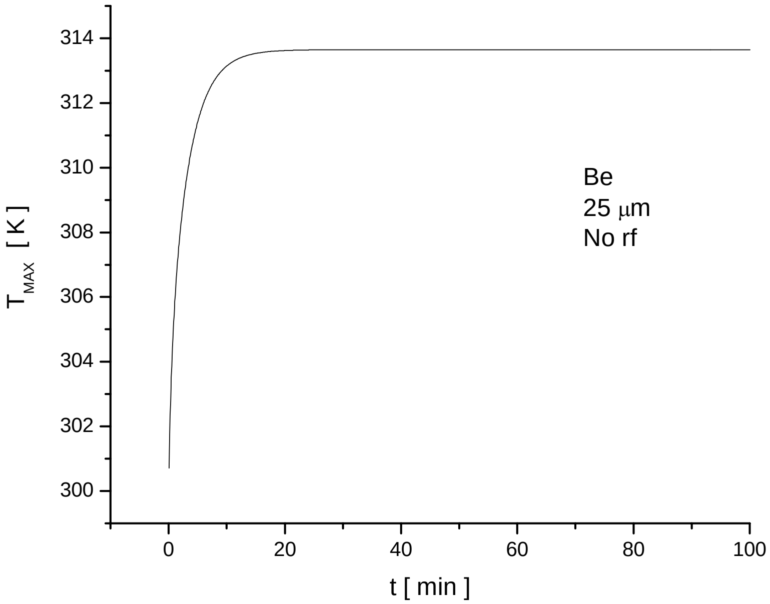




Results for cold Be layer

- 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?