Bubble Chamber Radiator Thermal Analysis

5.0 MeV, 9.5 MeV Beam Energy

Fredrik Fors

Mechanical Engineering

8/20/2015

Outline

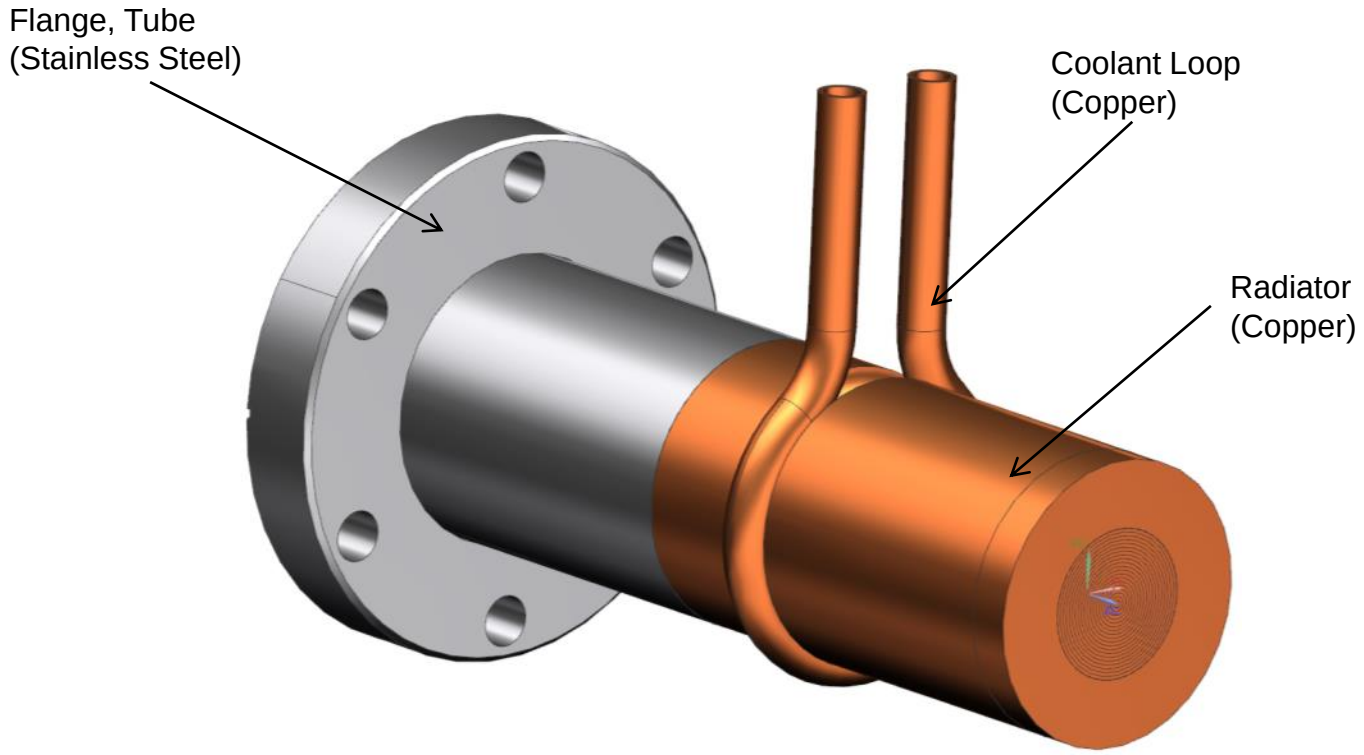
- Background/Objective
- Analyzed Geometry
- Analysis Model
- Results
- Conclusion

Overview

- Thermal analysis of radiator of a bubble chamber installation.
- A 3D solid FE model has been created and analyzed in ANSYS Workbench 16.1
- Analysis includes deposited beam energy, surface-to-air convection and coolant tube.
- Results indicate maximum temperatures of:
  - **704.2 K** with 5.0 MeV, 200 µA beam
  - **627.3 K** with 9.5 MeV, 105 µA beam

Analyzed Geometry

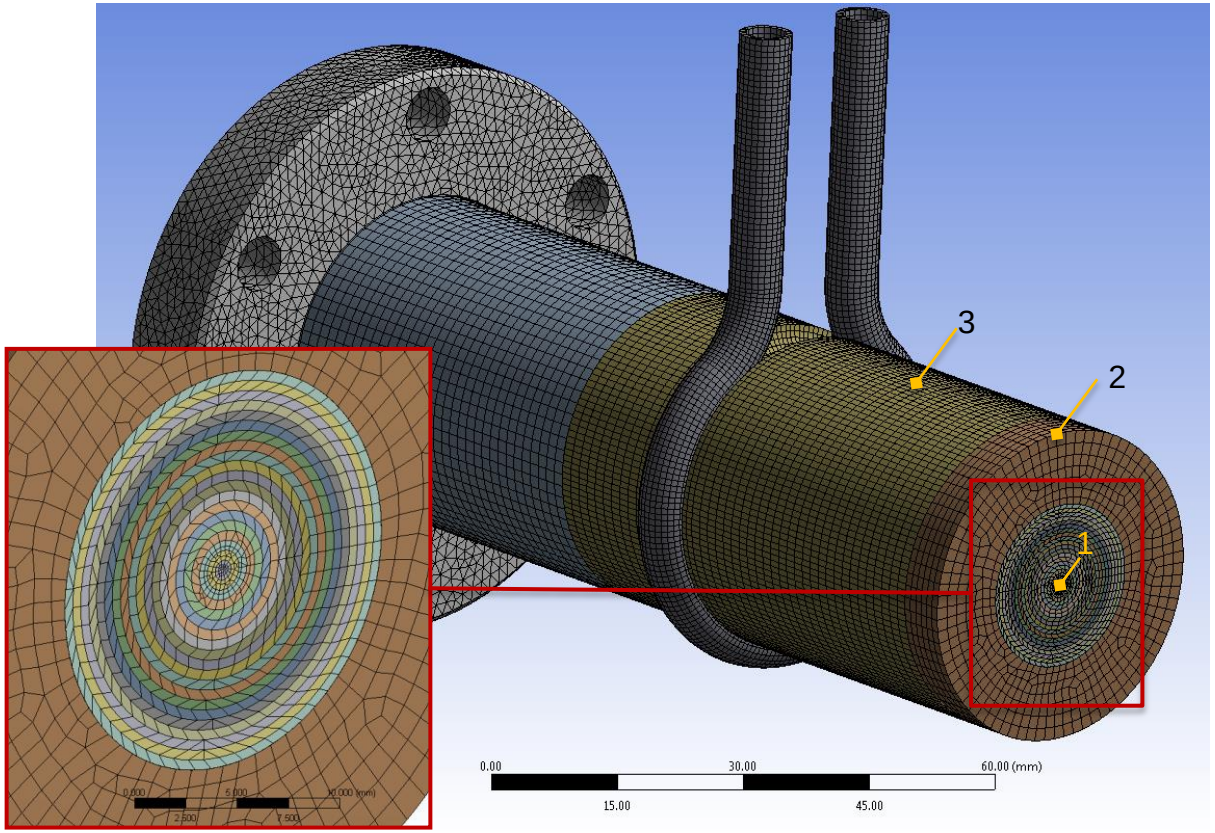
- The component assembly displayed below is included in the thermal analysis



Analysis Model

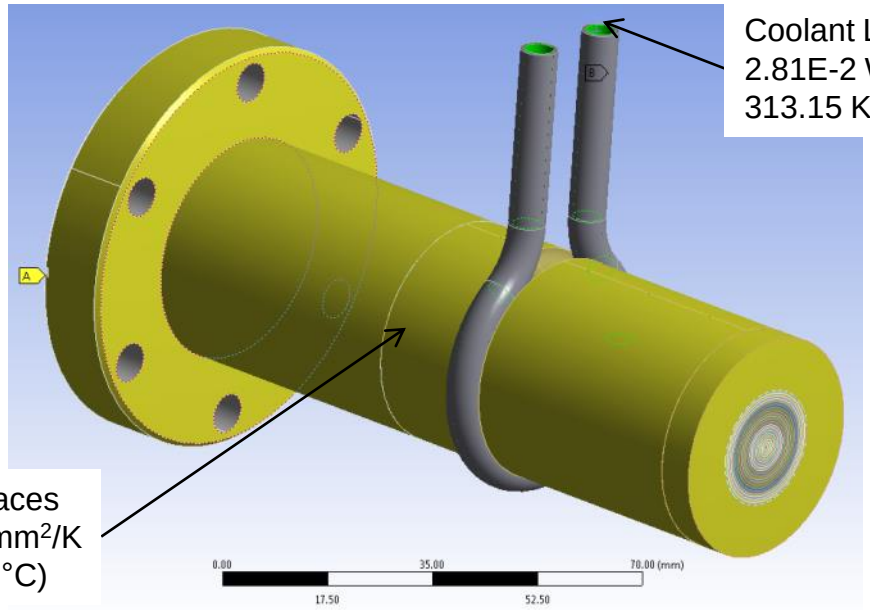
The CAD geometry is composed into the FE model presented below

- Mesh size 0.75-1.5 mm, smaller at beam center
- Bonded thermal contact between all bodies
- ANSYS standard material properties used
- Flange part tet meshed, others hex dominant
- Resulting temperature probed at points 1, 2 & 3.



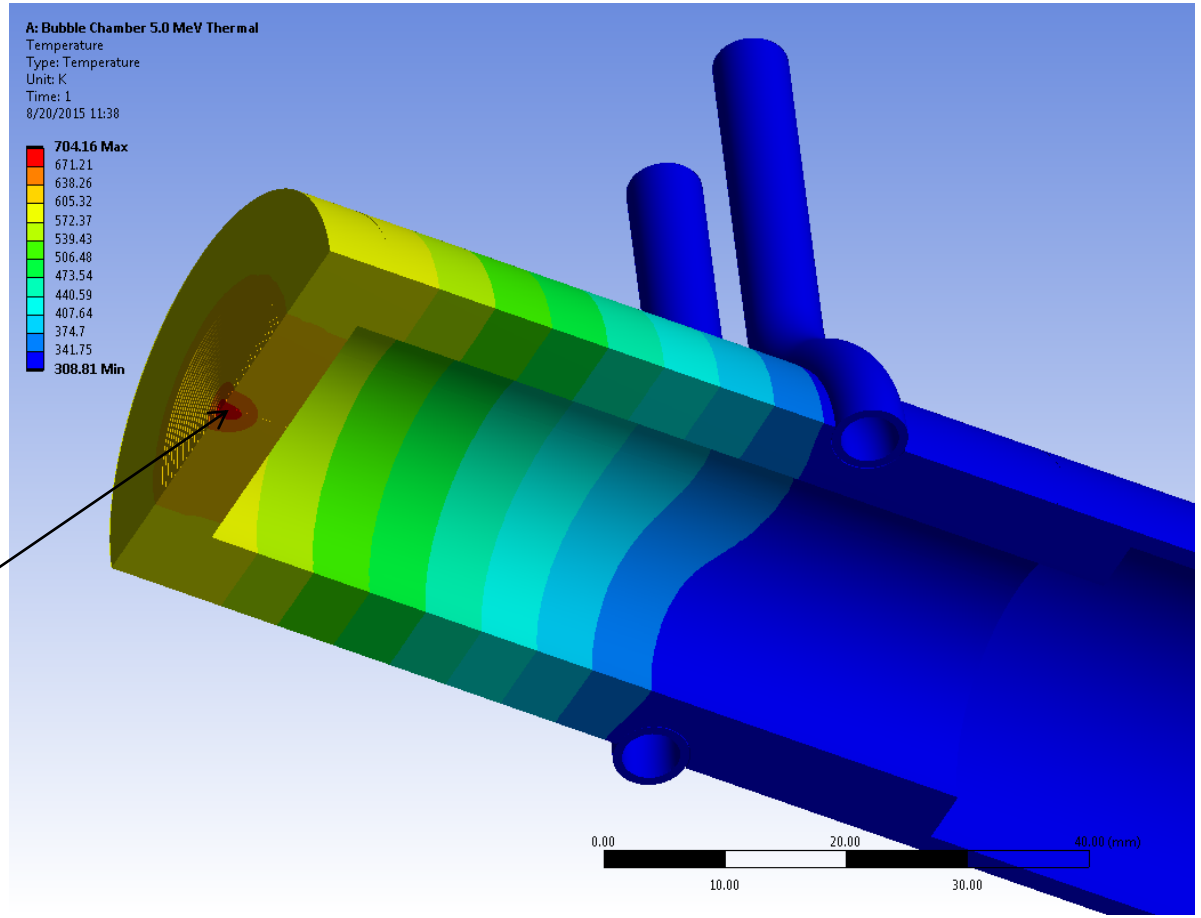
Boundary Conditions

- The center front of the radiator is discretized into six 1 mm thick slices divided into 20 concentric areas, with 1 mm radial thickness.
- The power deposited by the beam is applied to these 120 bins according to a pre-calculated distribution.
- Only the rings with a power deposition of more than 10^{-3} W/mm^3 are included for simplicity. In total this comprises 99.8% of the power to the radiator
- The analysis has been solved for 5.0 MeV and 9.5 MeV beam energy
- Convection BC representing surrounding air applied to outer surfaces of radiator and flange
- Convection BC representing coolant flow added to inner surface of coolant loop



Results – 5.0 MeV

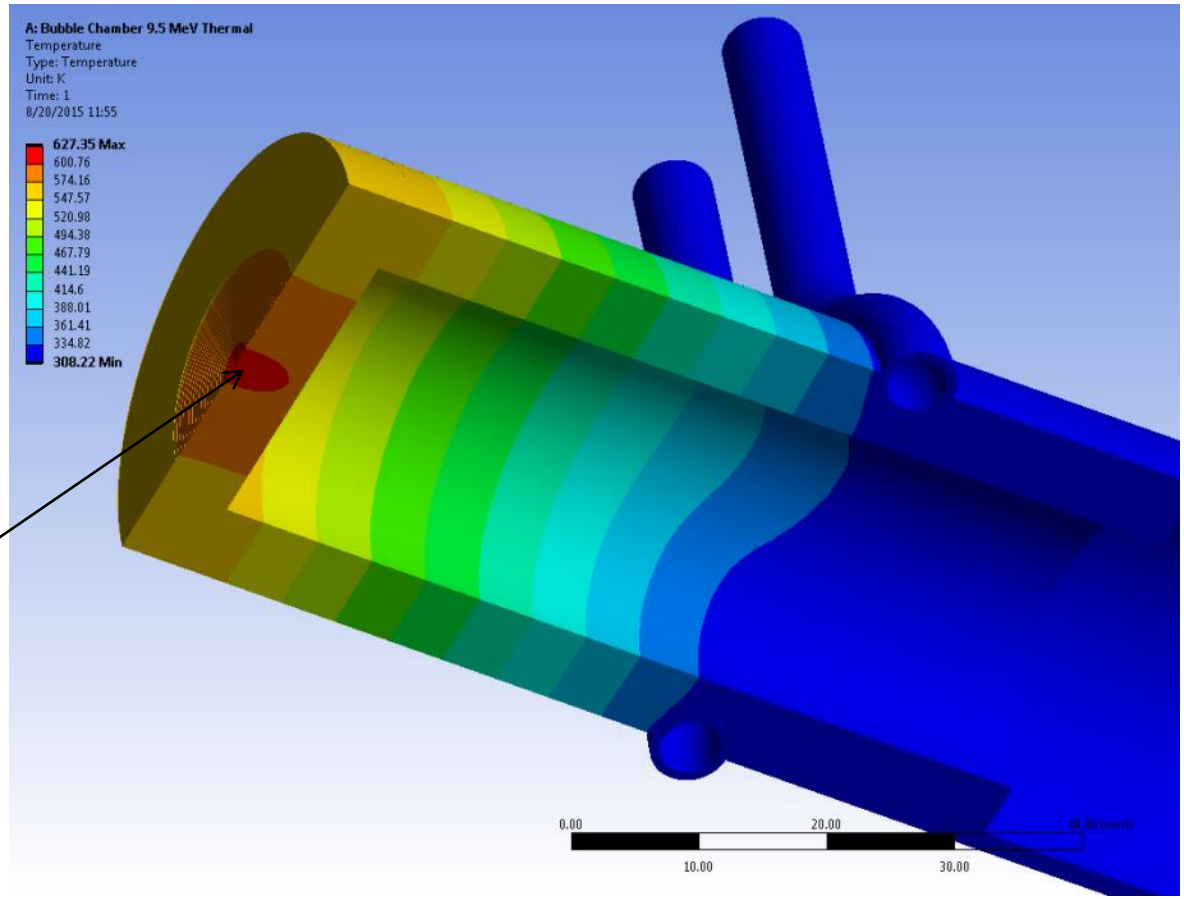
- In the plot below the resulting steady-state temperature is plotted on the model. Note that the display is sectioned through the central horizontal plane.
- Probe results:
  1. 704.2 K (431.0°C)
  2. 601.3 K (328.2°C)
  3. 474.3 K (201.2°C)



Max. temp:
704.16 K

Results – 9.5 MeV

- In the plot below the resulting steady-state temperature is plotted on the model. Note that the display is sectioned through the central horizontal plane.
- Probe results:
  1. 627.3 K (354.2°C)
  2. 567.8 K (294.6°C)
  3. 455.5 K (182.4°C)



Max. temp:
627.35 K

Conclusions