




# Flow Rate Analysis for Liquid Cooled CPU



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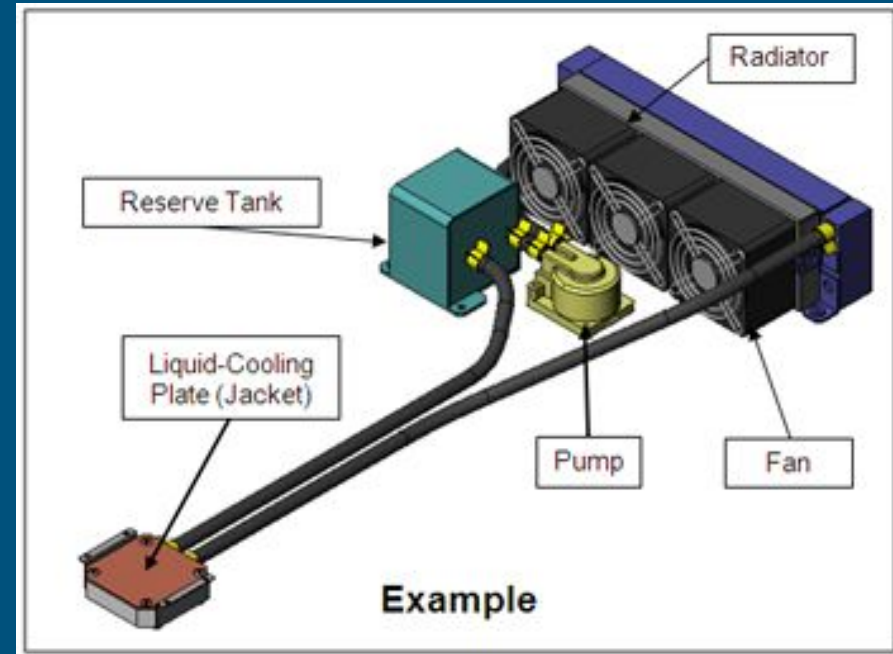


# Problem Statement

Air cooled PCs have significant drawbacks that could be eliminated with the introduction of water cooled systems due to the significantly higher specific heat of water.

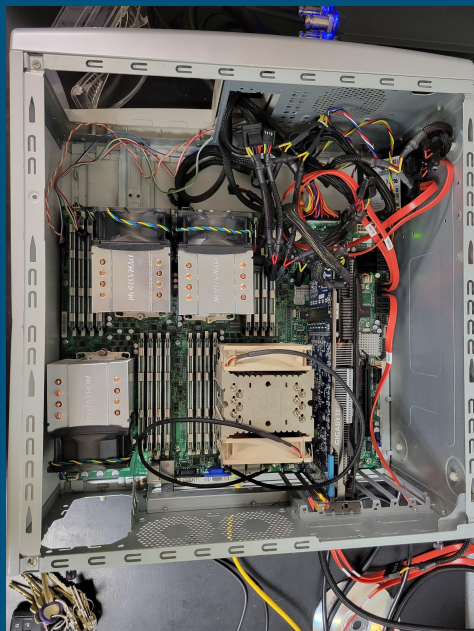
The science center here at AU contains a large computer/server dedicated to large computations for research using programs such as ElmerSolver.

In order to free up space in the computer case a water cooled system is being introduced



# Science Center Computer

- ❖ Contains 4 12-Core CPUs (AMD Opteron 6344)
  - 70.4°C Max Operating Temperature
  - Default TDP of 115 W of each
- ❖ Cooled by 4 large CPU fans over heatsinks



## General Specifications

6344

**Platform:** Server

**Product Line:** AMD Opteron™ 6300 Series Processor

**# of Threads:** 12

**Base Clock:** 2.6GHz

**Total L2 Cache:** 12MB

**Default TDP:** 115W

**Unlocked for Overclocking** ⓘ: No

**Max. Operating Temperature (Tjmax):**  
70.4°C

**Product Family:** AMD Opteron™

**# of CPU Cores:** 12

**Max. Boost Clock:** Up to 2.0GHz

**Total L1 Cache:** 576KB

**Total L3 Cache:** 16MB

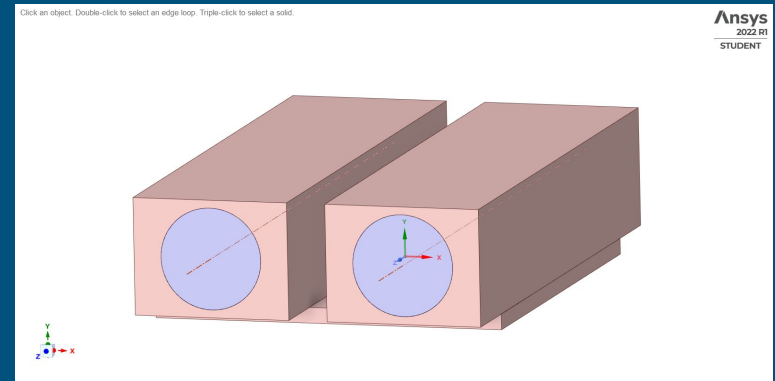
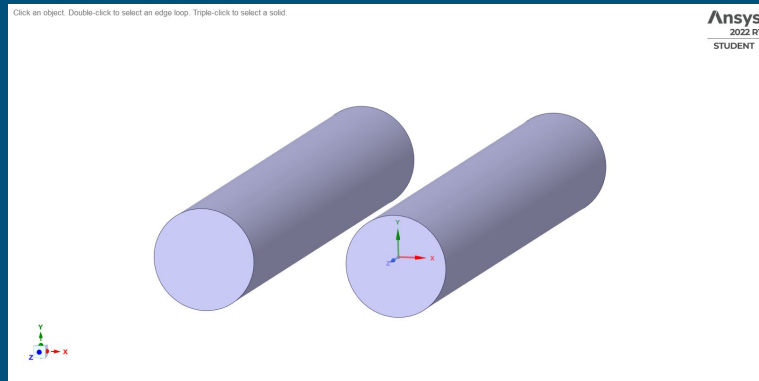
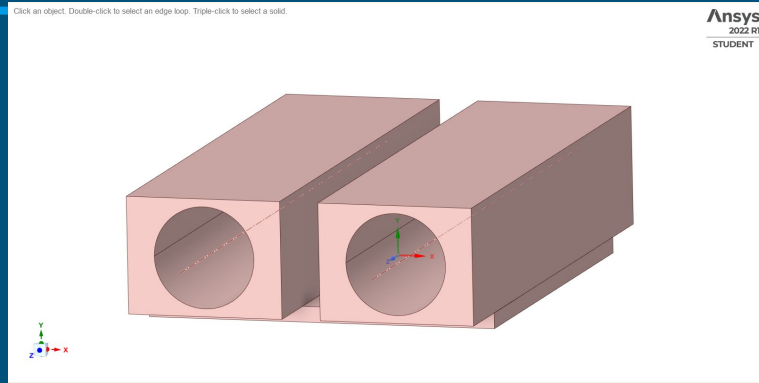
**Processor Technology for CPU Cores:**  
32nm

**CPU Socket:** G34



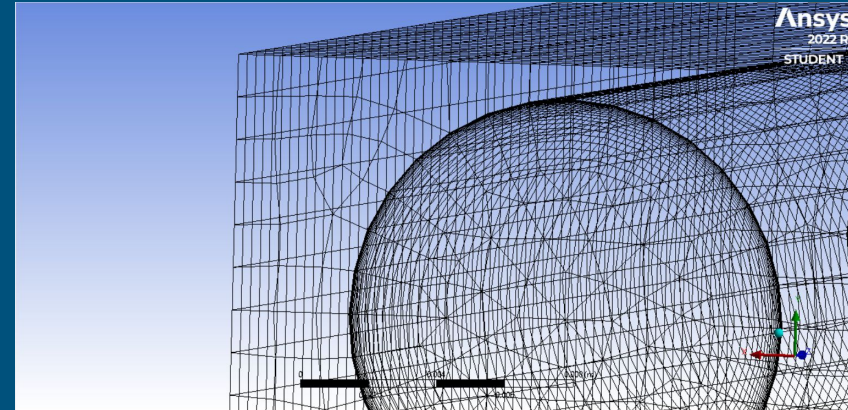
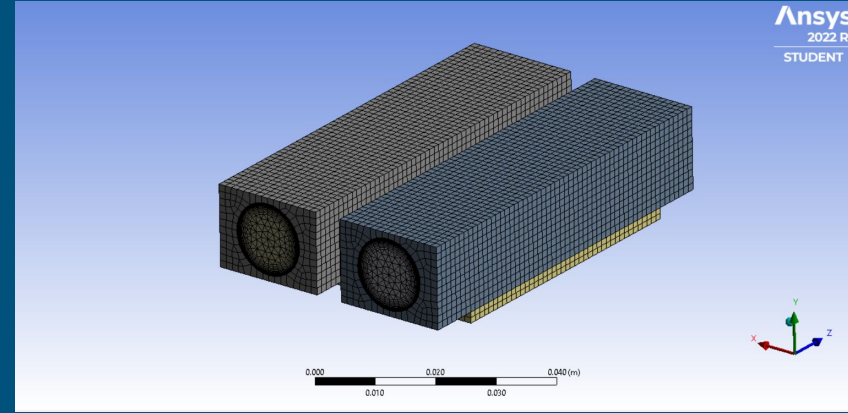
# Geometry

- ❖ Rectangular Tubes
  - 20 mm x 15 mm x 70 mm
  - Hole diameter is 13 mm
- ❖ Cooling Tube Stand
  - 52 mm x 45 mm x 2 mm

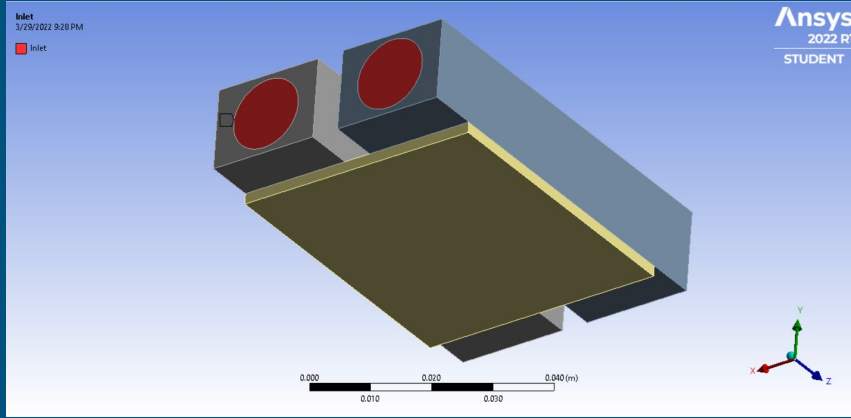


# Ansys Meshing

- ❖ Mesh Parameters
  - selected to the preference of Fluent CFD solver
- ❖ Inflation Condition
  - allows for better handling of boundary layer



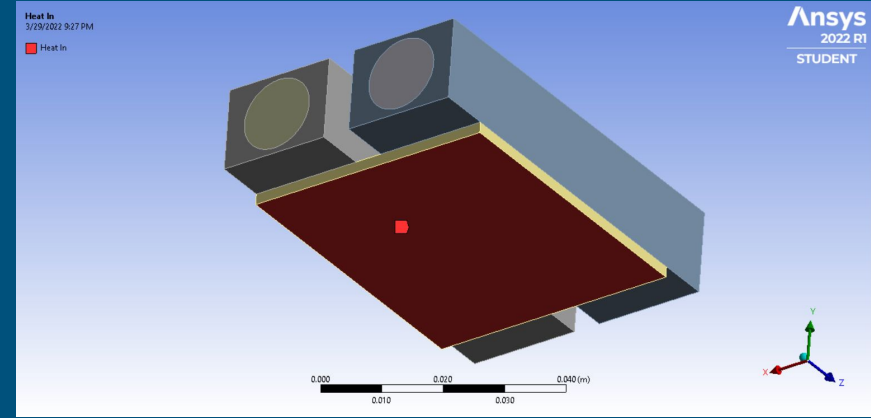
# Ansys Boundary Conditions



## Inlet:

- ❖ Determines flow rate through the pipes
- ❖ Determines starting temp of water

Pump Flow Rate (gal/min)	Inlet Velocity (m/s)
1	0.5934
4.4	0.2617
6.6	0.3919

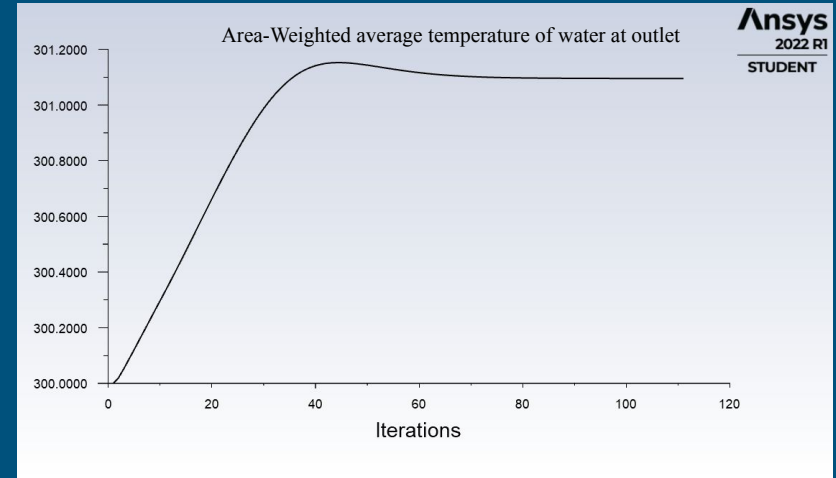
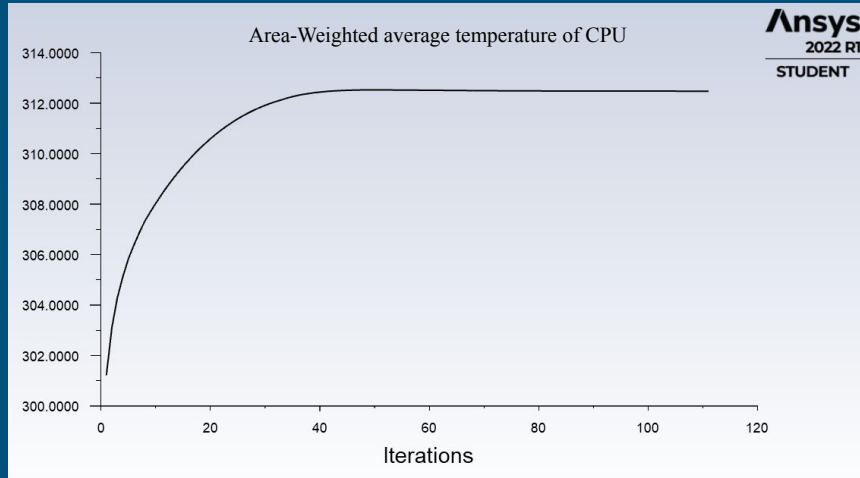
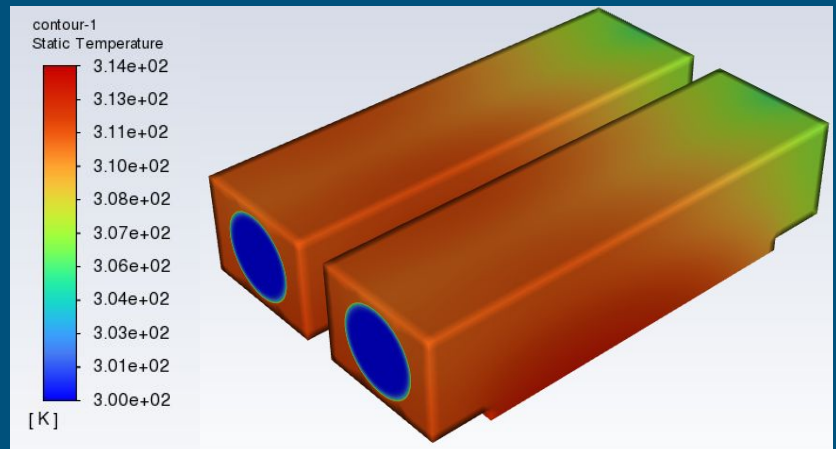


## Heat-In:

- ❖ Determines heat flux into the system

Energy output of CPU (W)	Assigned Heat Flux (W/m^2)
115	49145.3

# Simulation Results (4.4 gal/min)



# Conclusion

Our simulation shows that the CPU temperature decreases with higher flow rates. However, all three sampled flow rates succeeded in keeping the CPU below its maximum operating temperature.

Therefore, the Cytex pump is the most viable solution for the liquid cooling system based on financial purposes and feasibility.

			Max CPU Operating temp: 343.55 K
Pump Brands	Flow Rate (gal/min)	Outlet Temperature (K)	CPU Temperature (K)
Cytex	1	304.75	325.2
Corsair	4.4	301.5	312.5
Raijintek	6.6	300.65	310.0