So you want a stable lab?

HVAC Airflow Simualtions

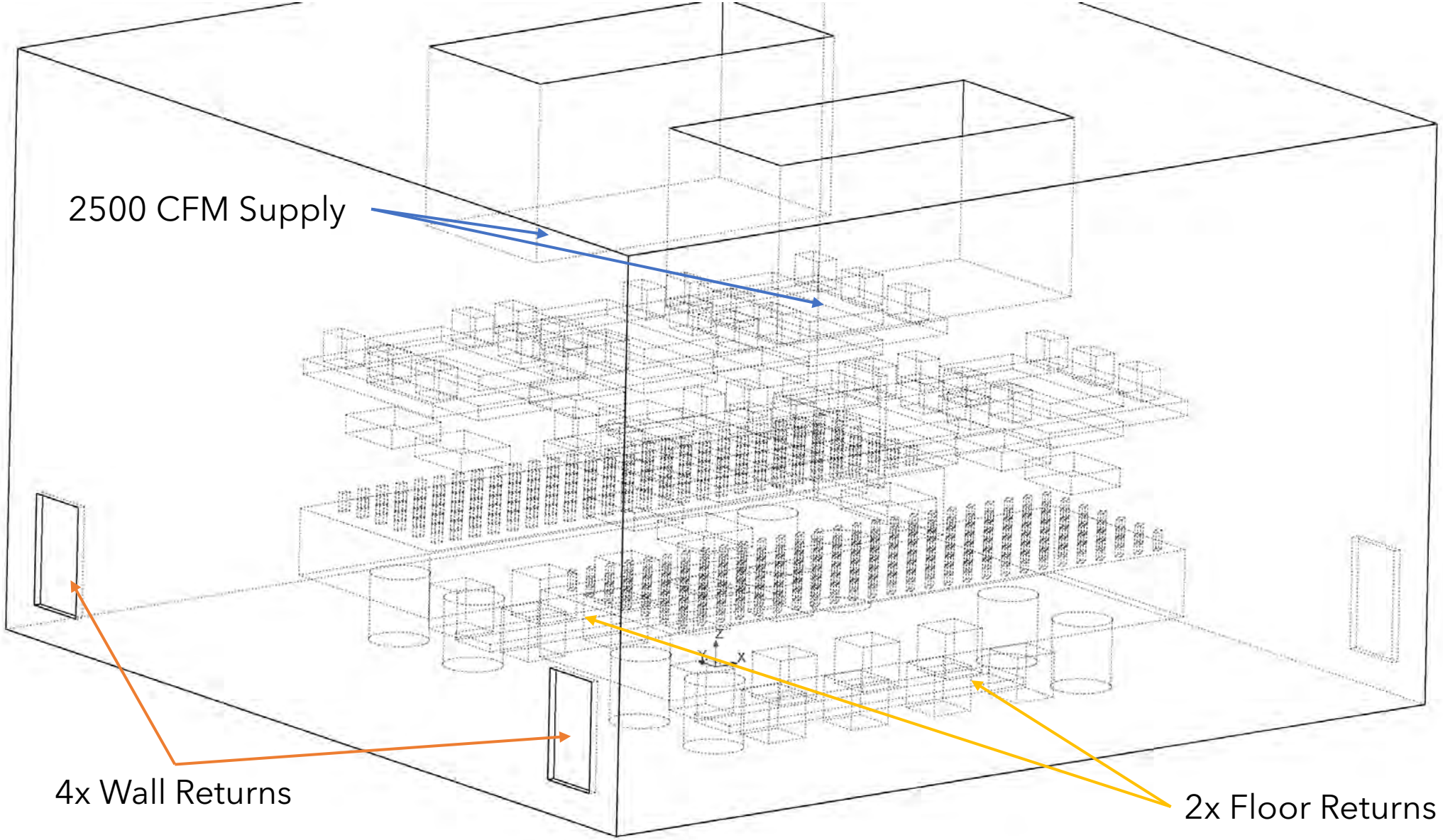
Simulation Criteria

- Room is 22.5ftx22.5ft (500sqft), 13ft high
- Room has two 4.8x14ft optical tables ~centered
- 2500cfm of air from AHU
- Heat loads on top for cloud, on table, under table
  - Heat loads are modeled as passive (no forced air)
- Three ULPA filters/diffusers per table with 240 cfm each
  - 2’x4’ Terraflow modules (0.5ft/sec exit for optics stability)
  - NO Panels on Optical tables- while these can be put on if needed after for additional stability, the
- Airflow simulations Parameters
  - K-e turbulence model
  - Thermal convection/conduction
  - Gravity
  - Exclude: Blackbody

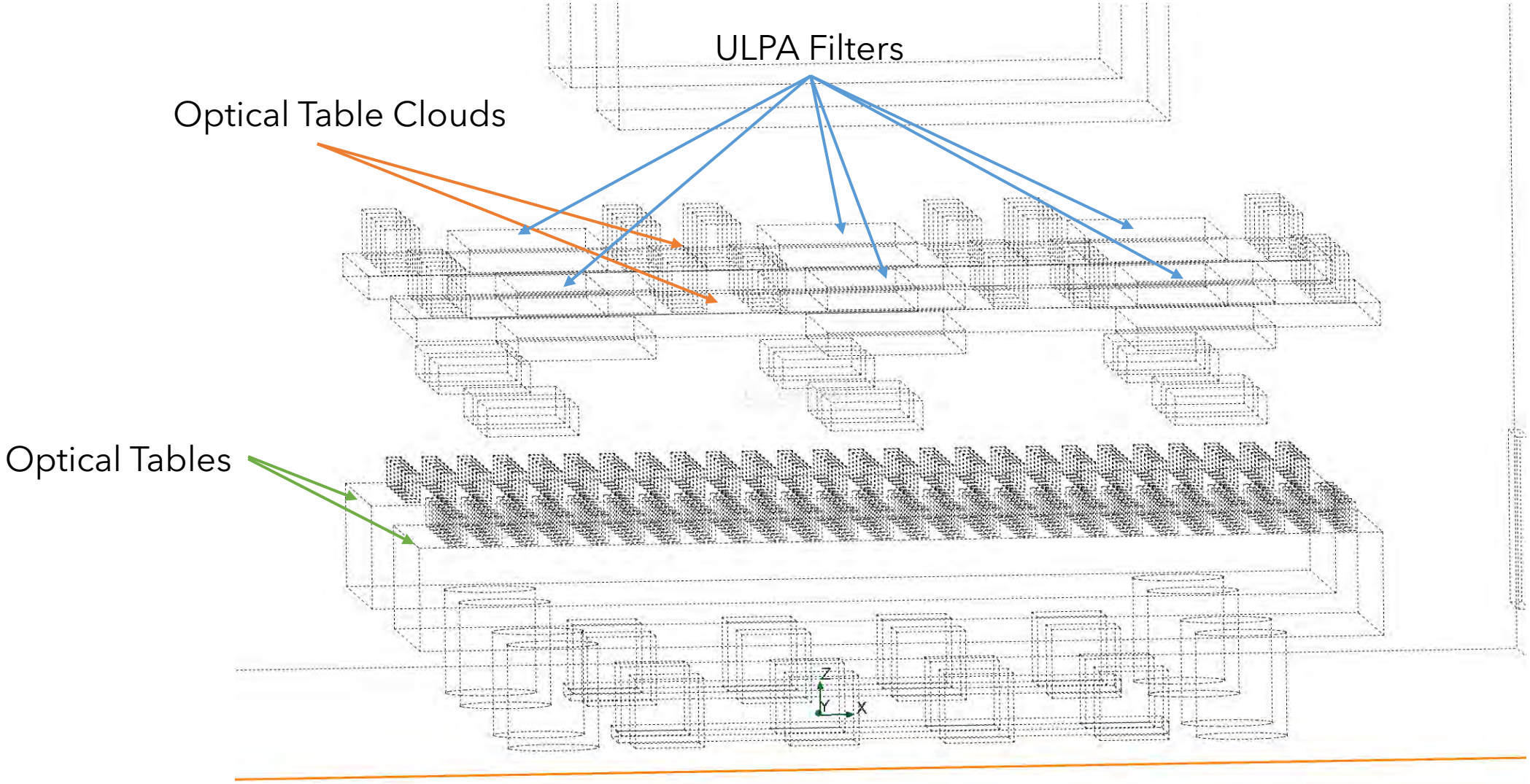
Metrics Used to Evaluate Options

- Assume all heat loads will turn on and off, what is the deviation in temperature at the optics
- What is the uniformity of the Optical table temperature
  - If PID on table temperature
- Hotspots/Dead zones (low airflow spots)

Room Overview



Overview



Heat Load Locations

7.2kW Total
~2 Tons
~25kBTU/h

Cloud Heat Loads

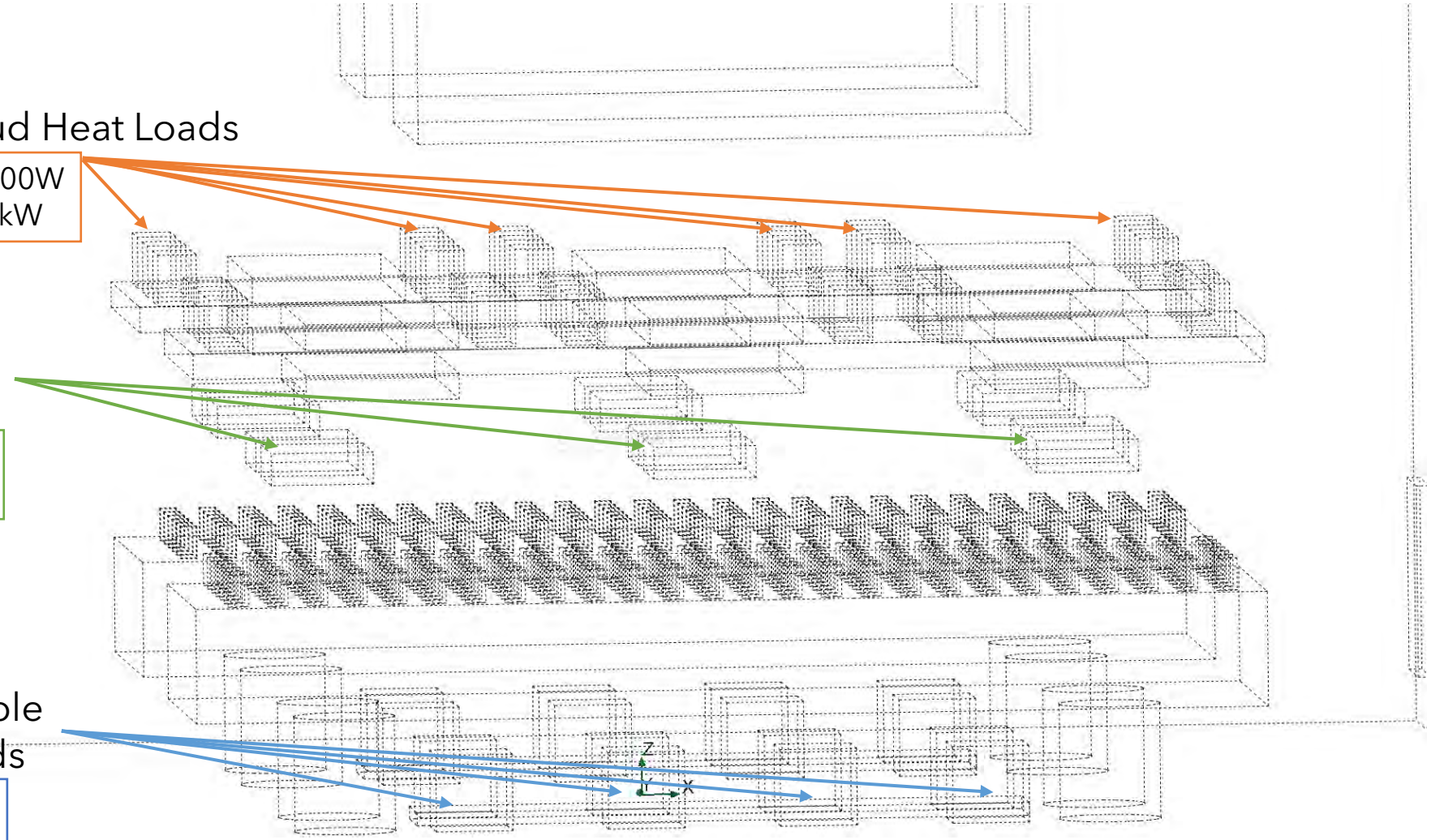
36*100W
3.6kW

Optical Table
Heat Loads

Off / 12*100W
0 / 1.2kW

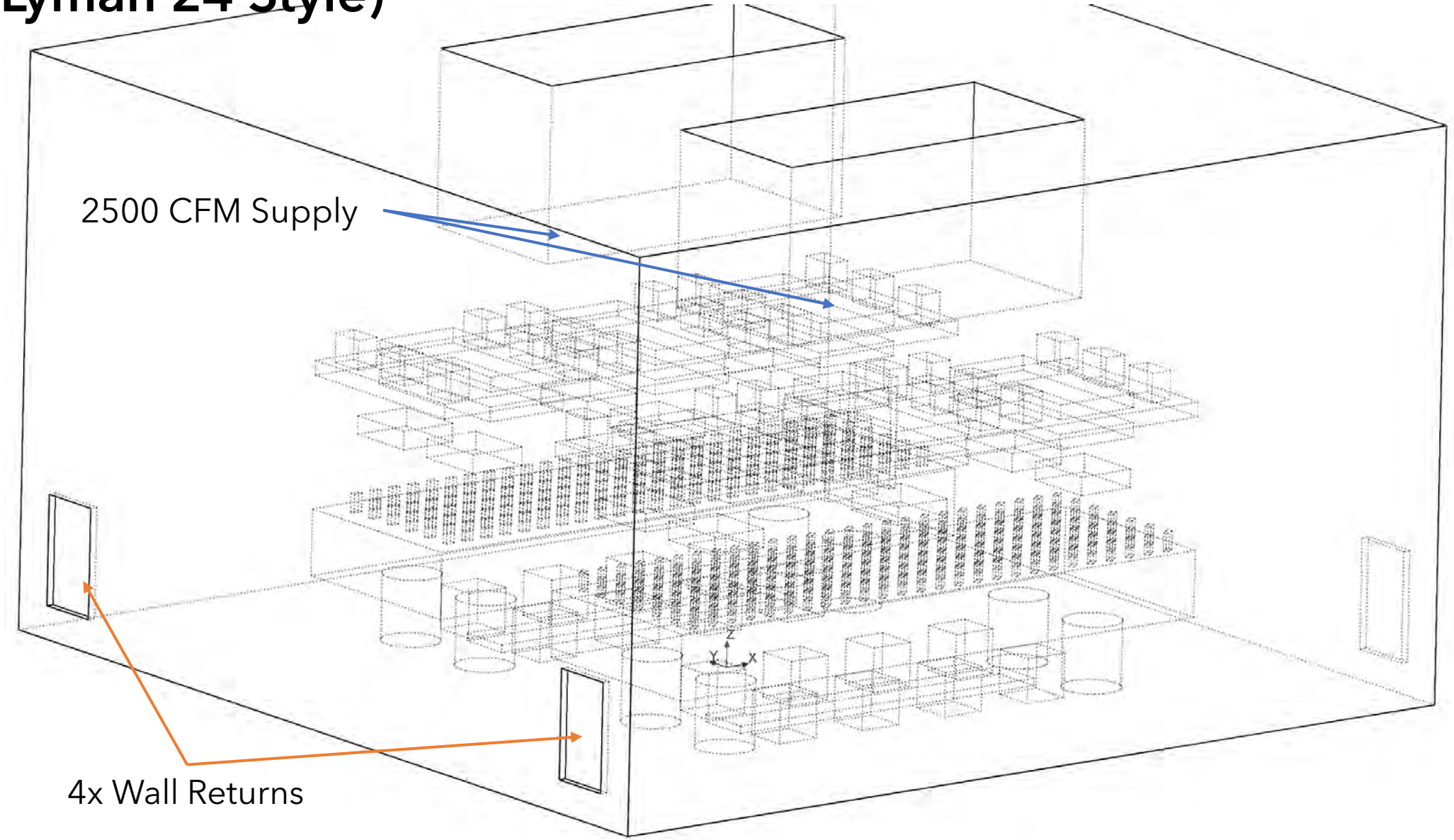
Under Table
Heat Loads

16*200W
3.6kW

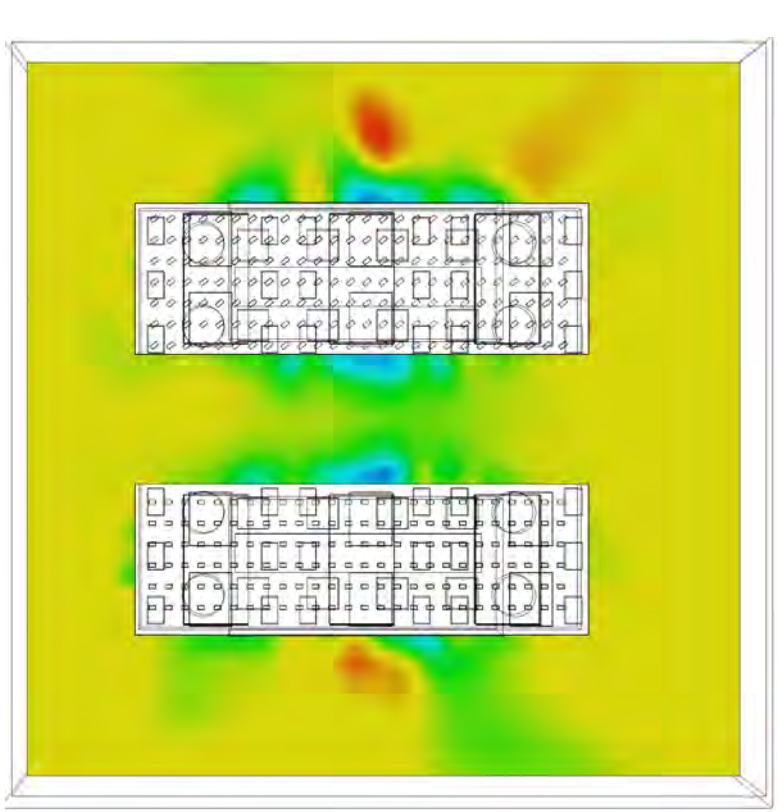


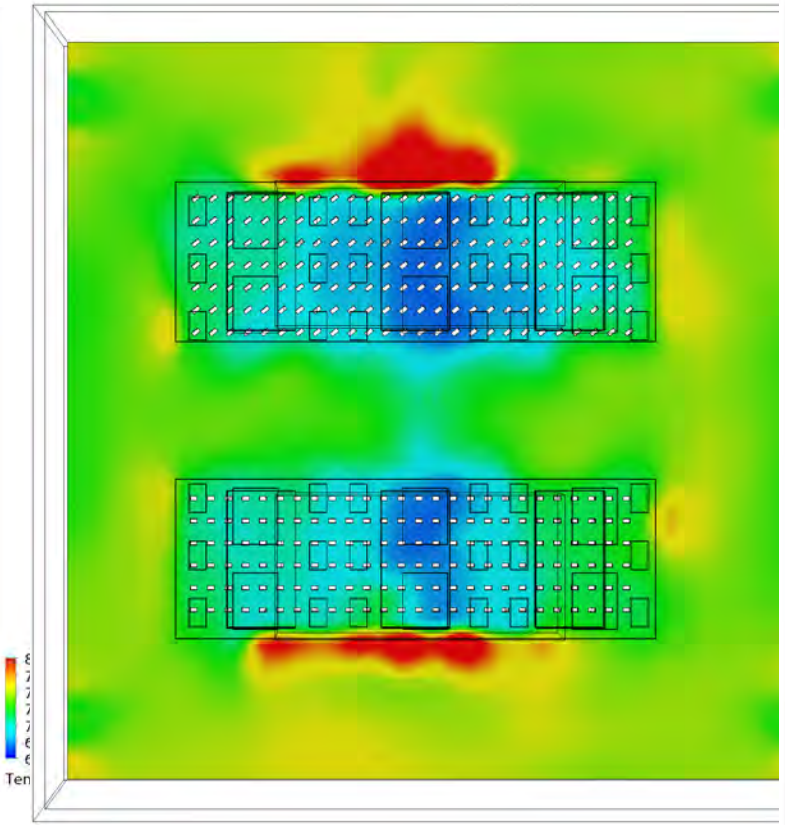
Design 1 – Supply high, return wall

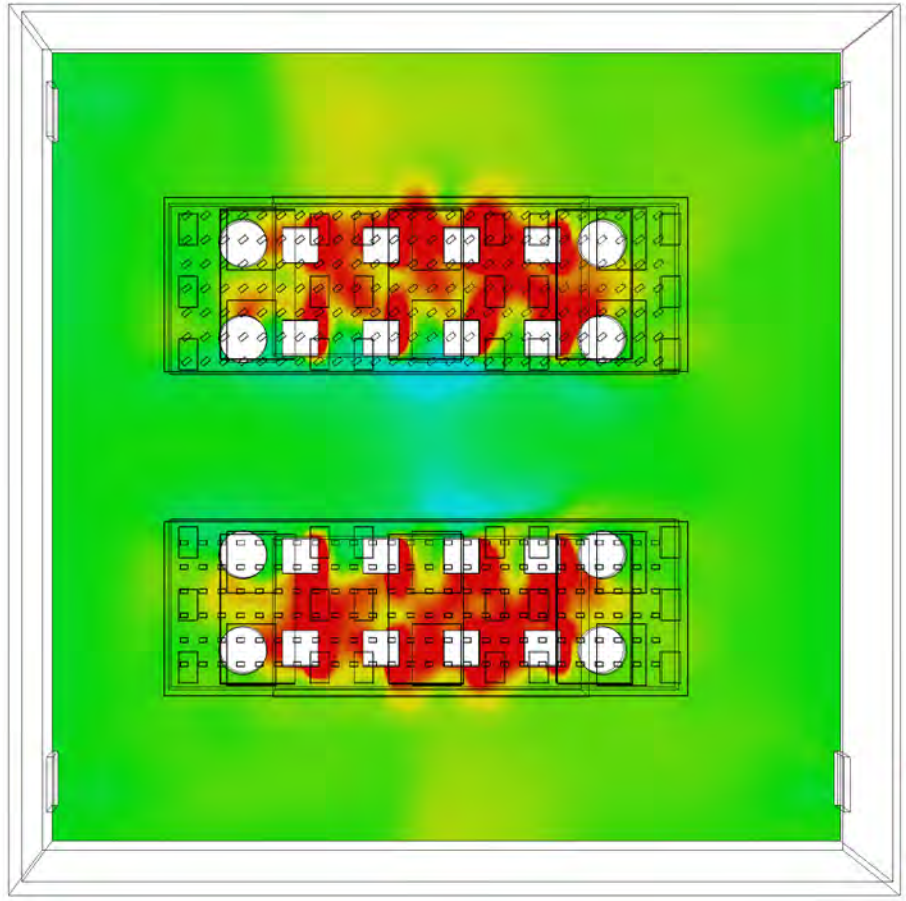
(Lyman 24 Style)



Temperature: Return Wall (Design 1)
7.2kW, 65F Inlet







Temperature: Return Wall (Design 1)
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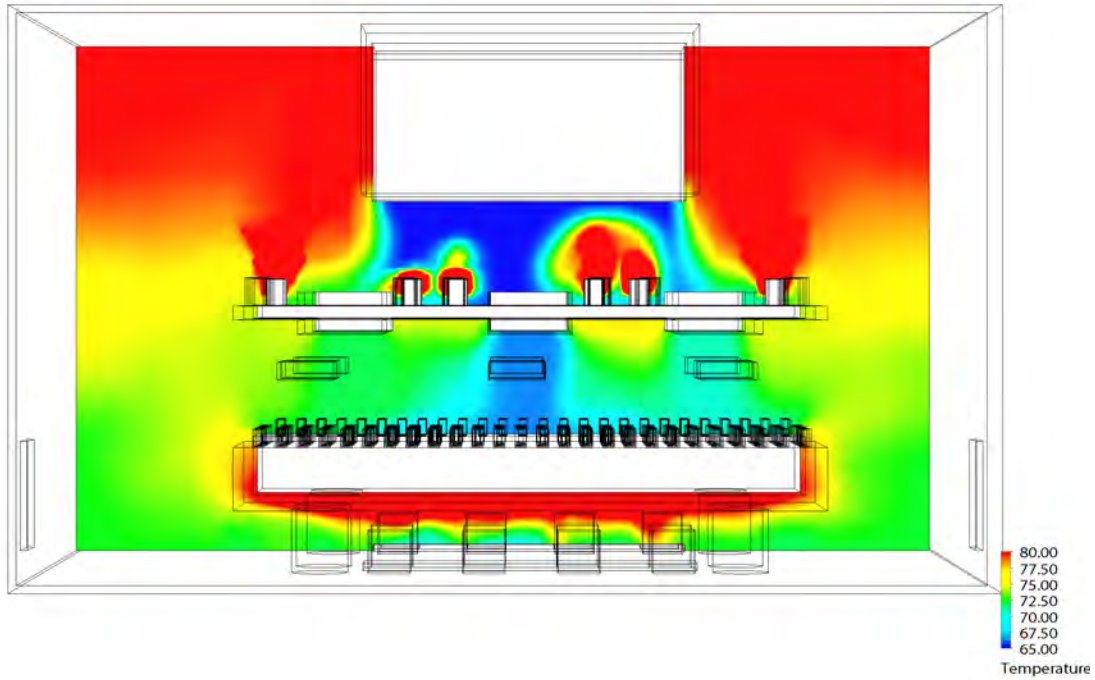
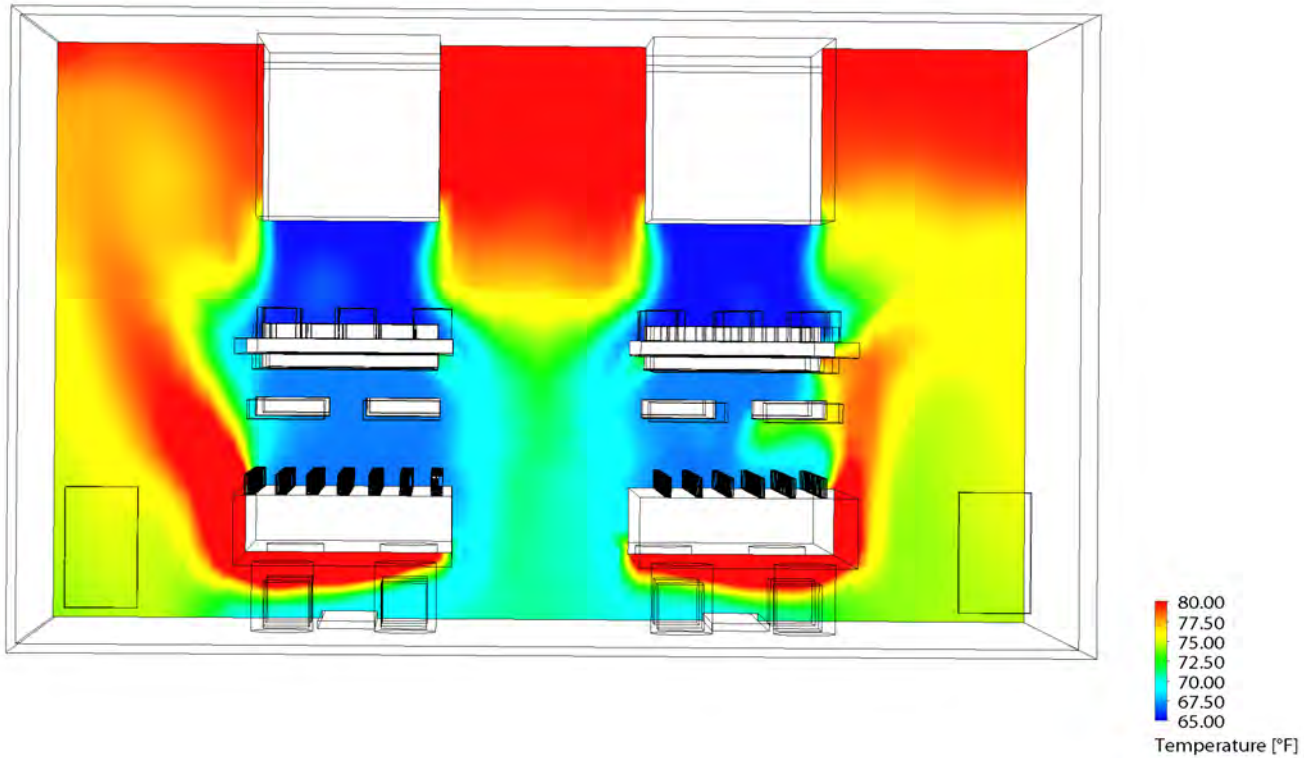
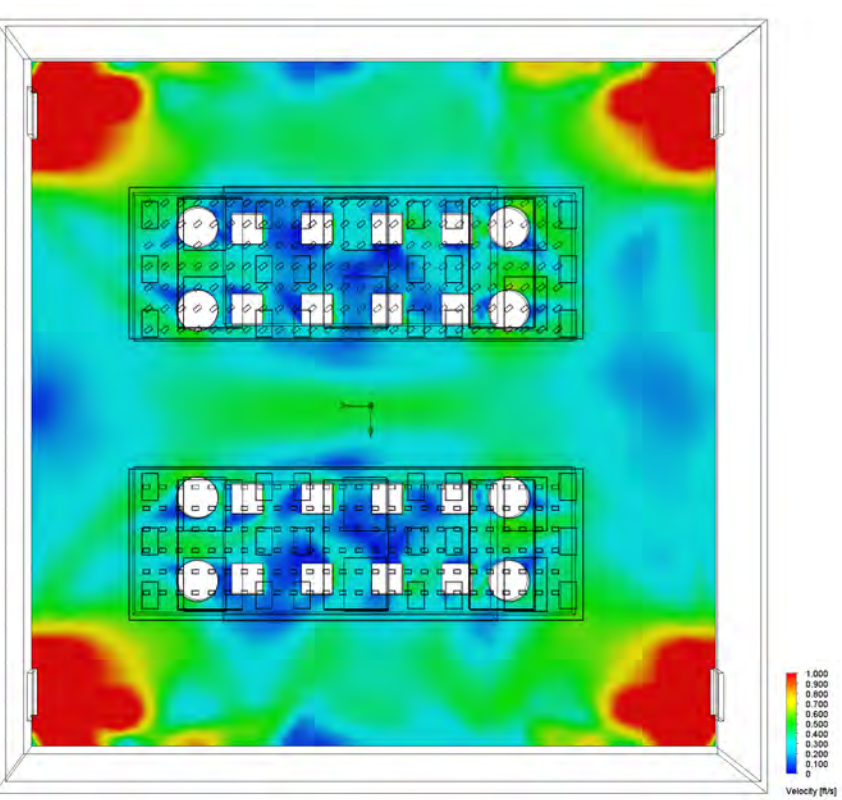
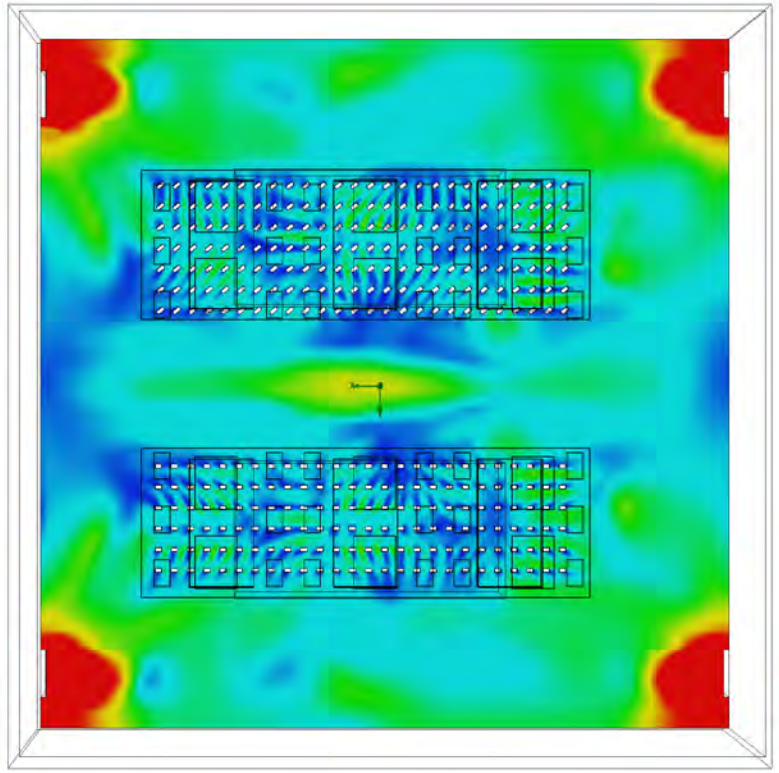
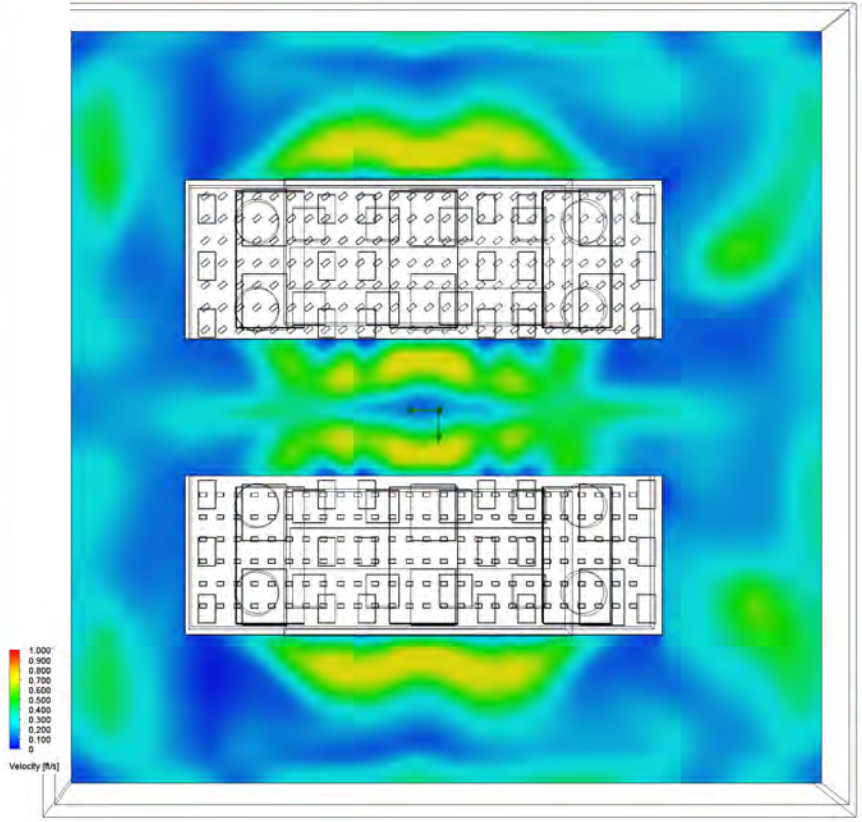




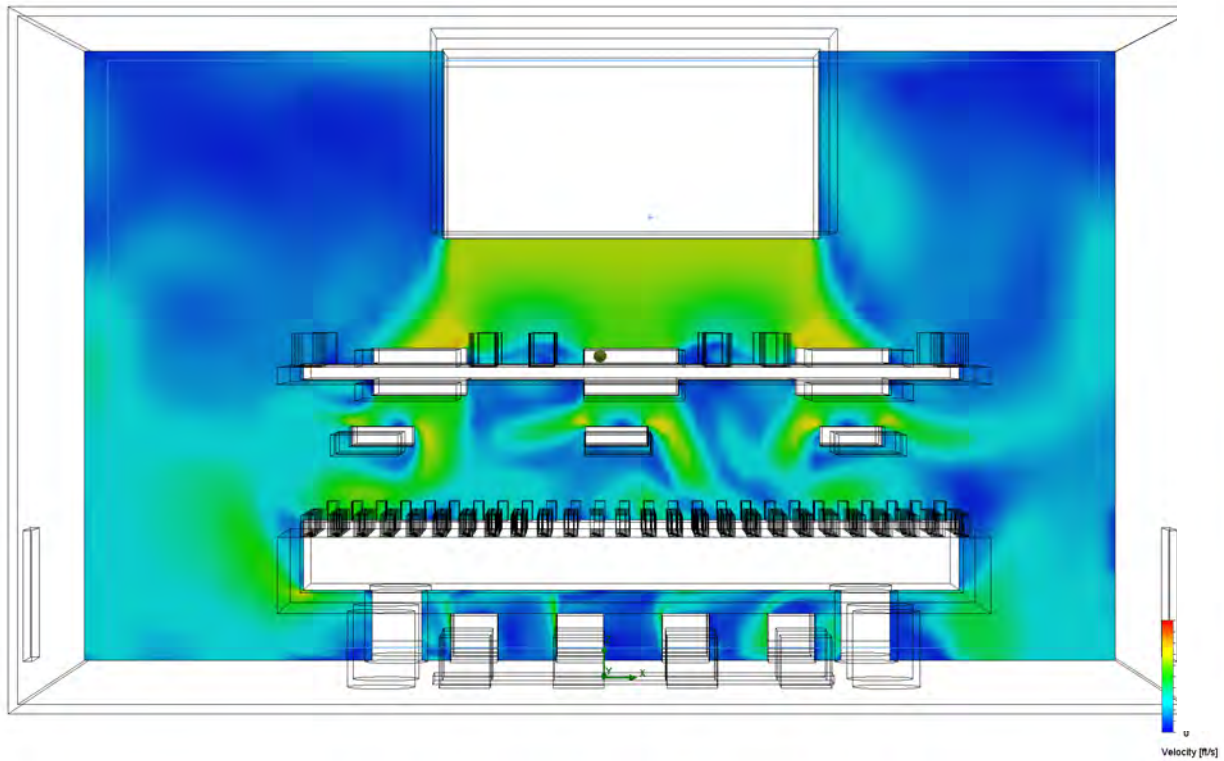
Velocity: Return Wall (Design 1)

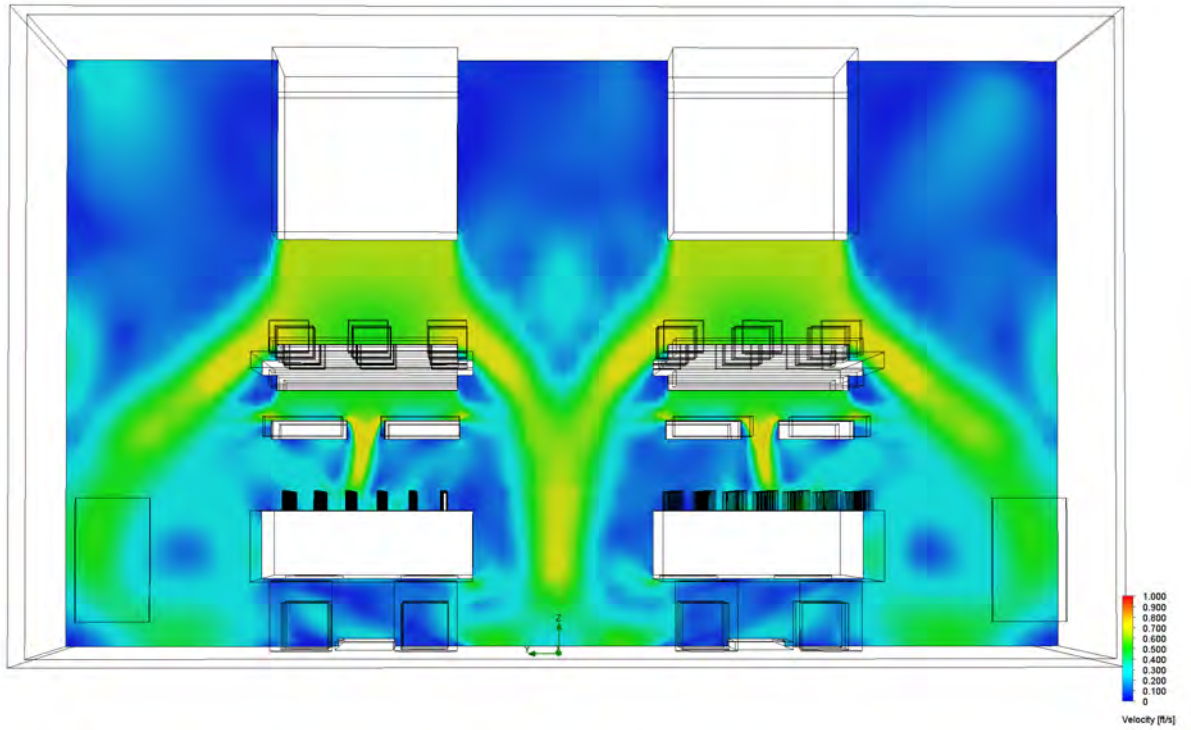




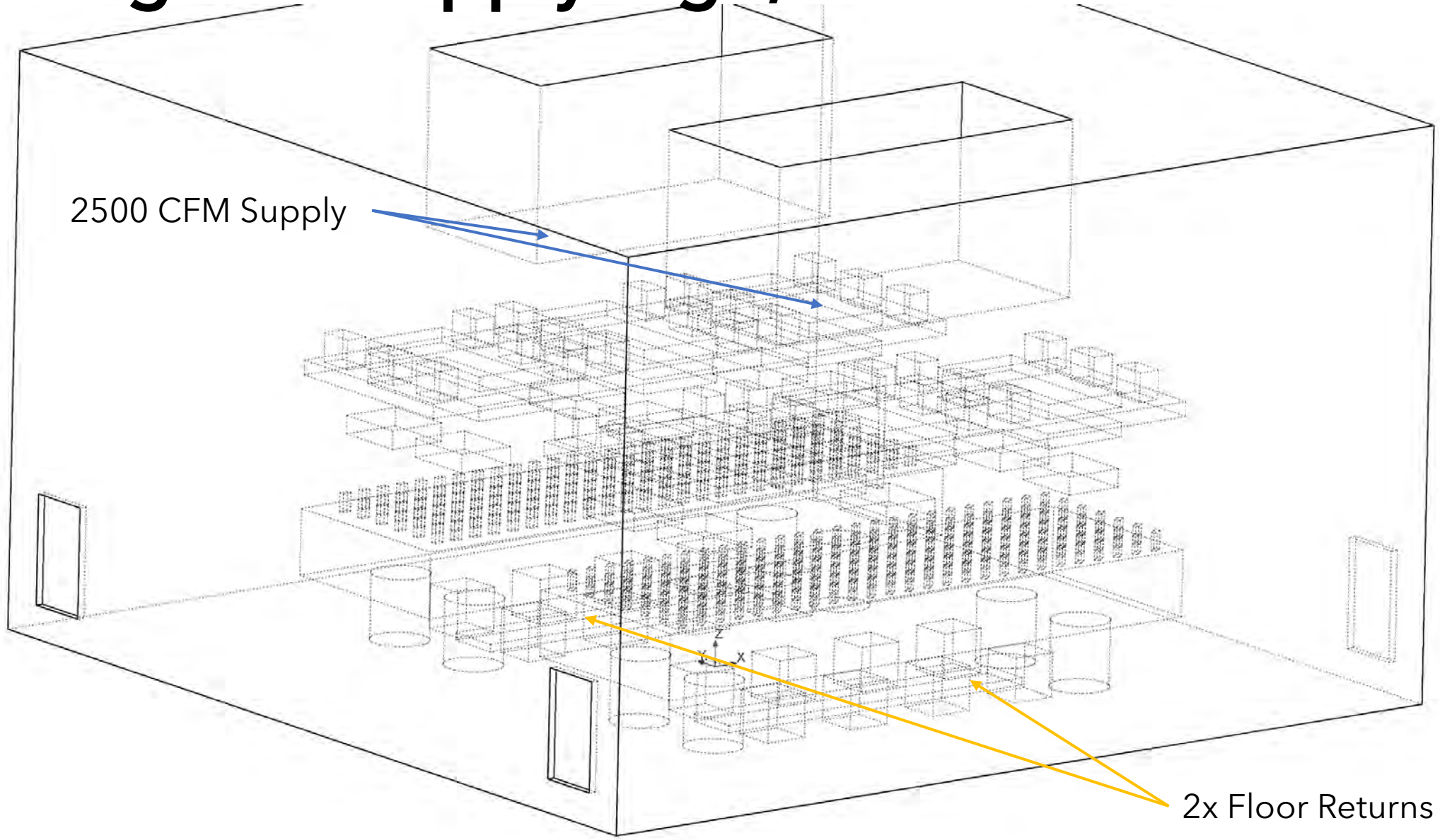


Velocity: Return Wall (Design 1)

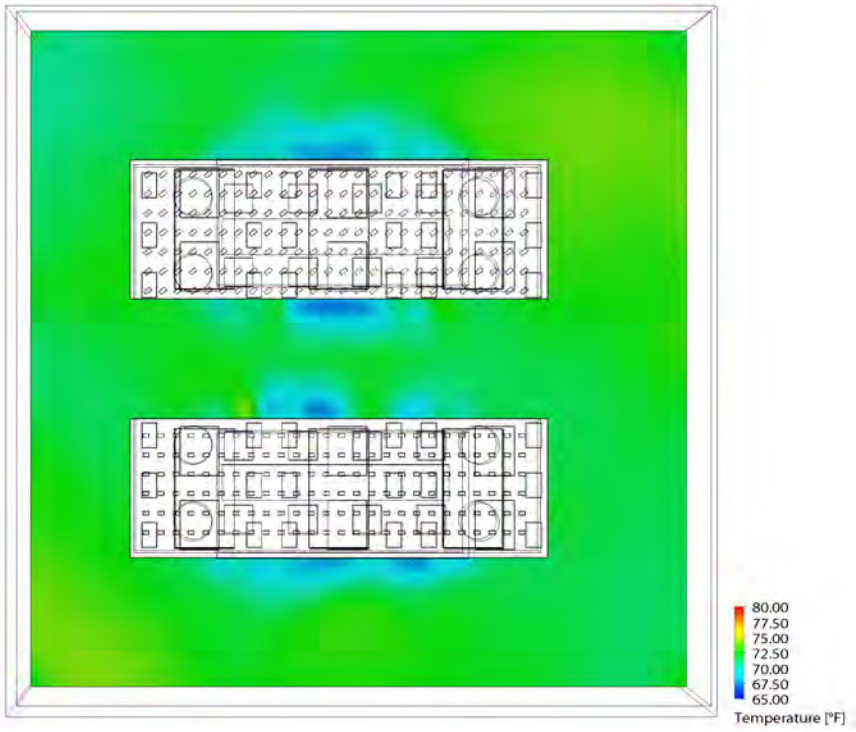


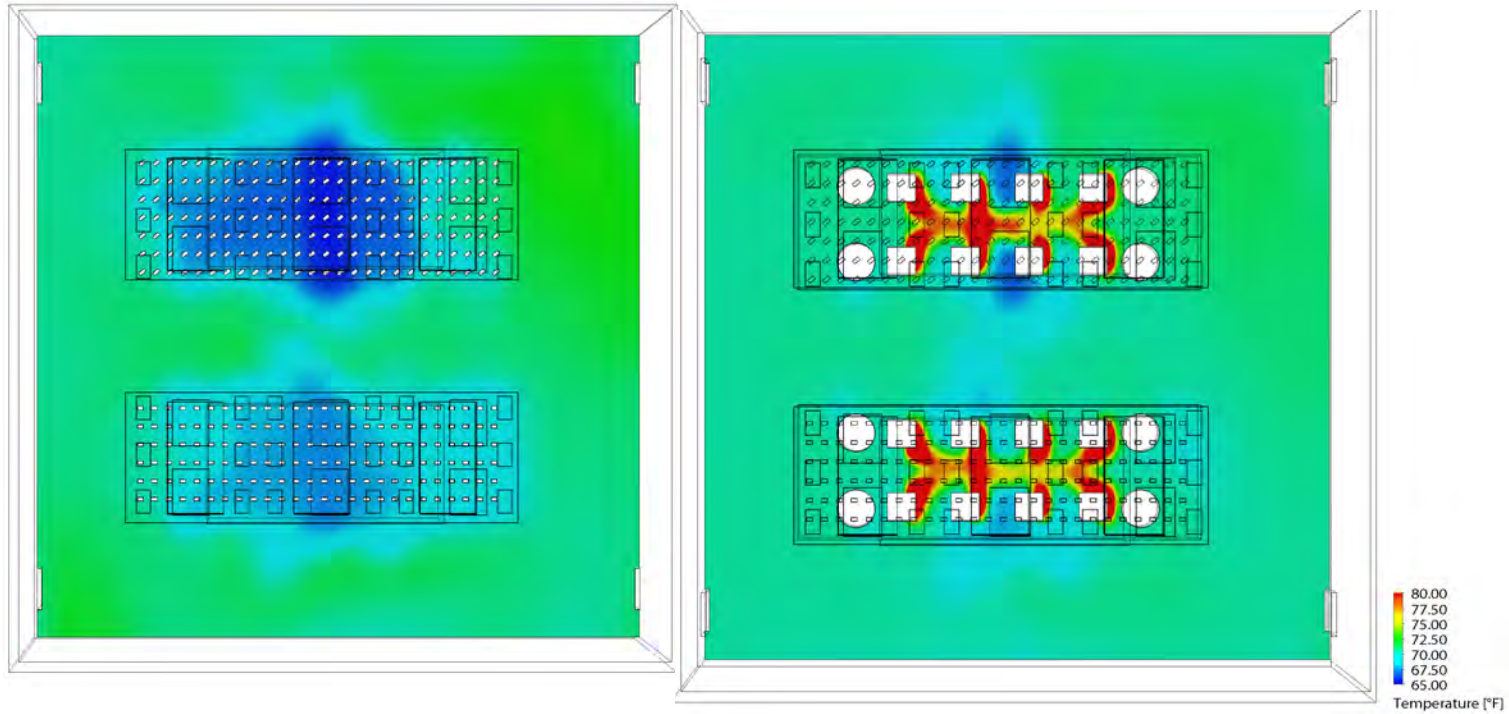


Design 2 – Supply high, Return under table

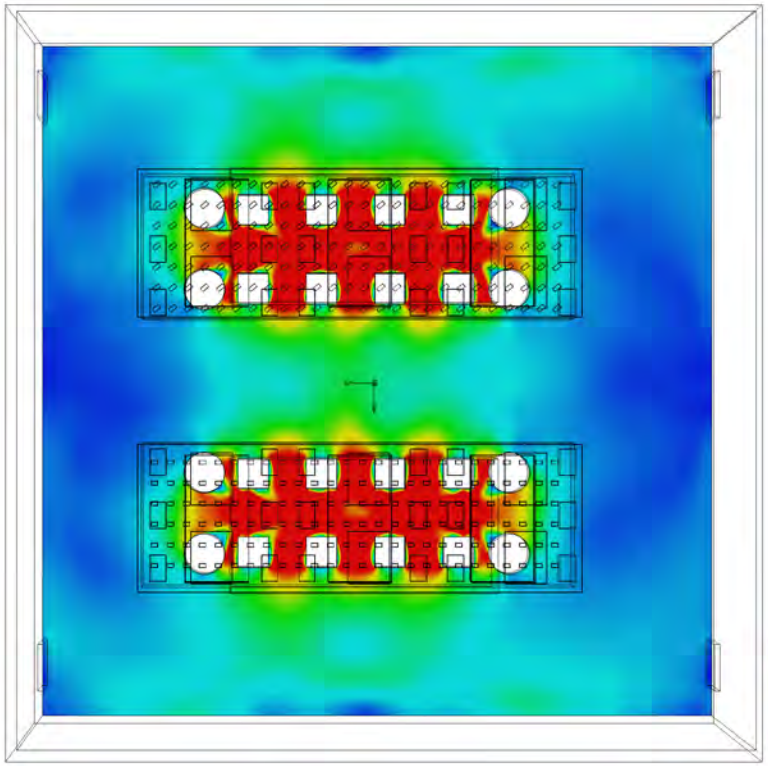


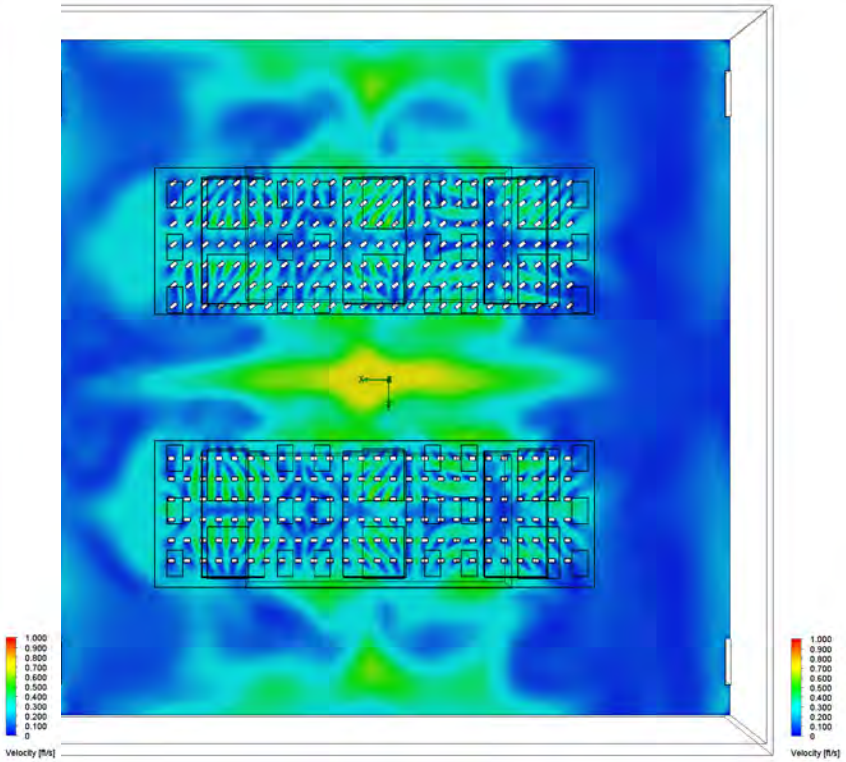
Temperature: Return Wall (Design 2) 7.2kW, 65F Inlet

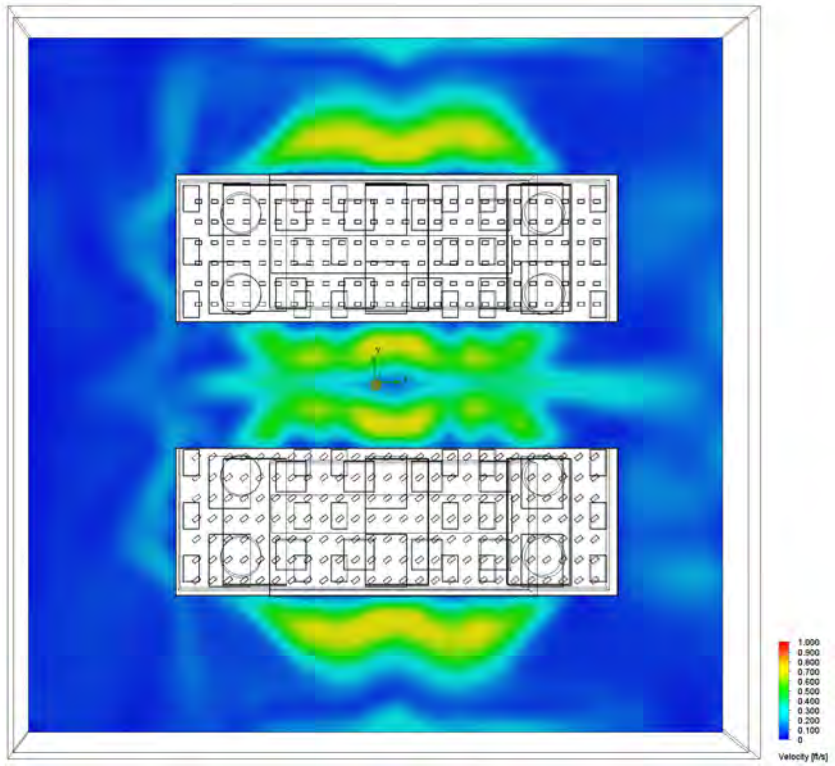




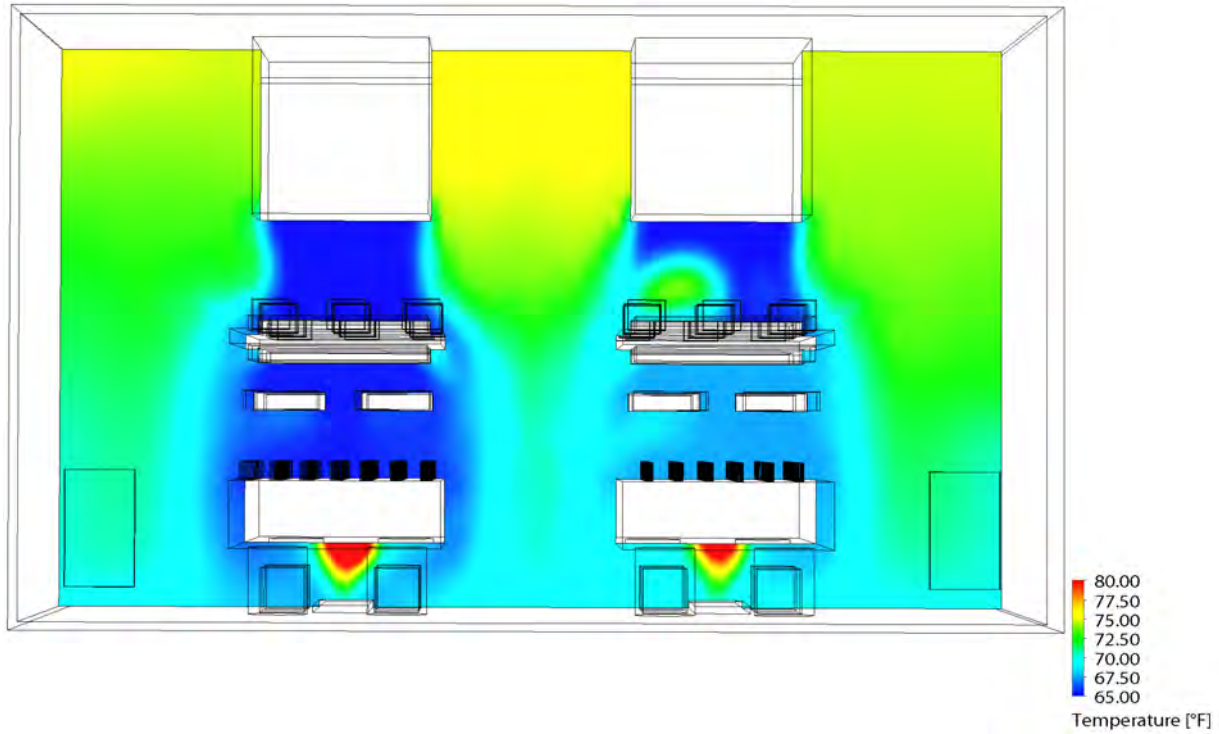
Velocity: Return Floor (Design 2)

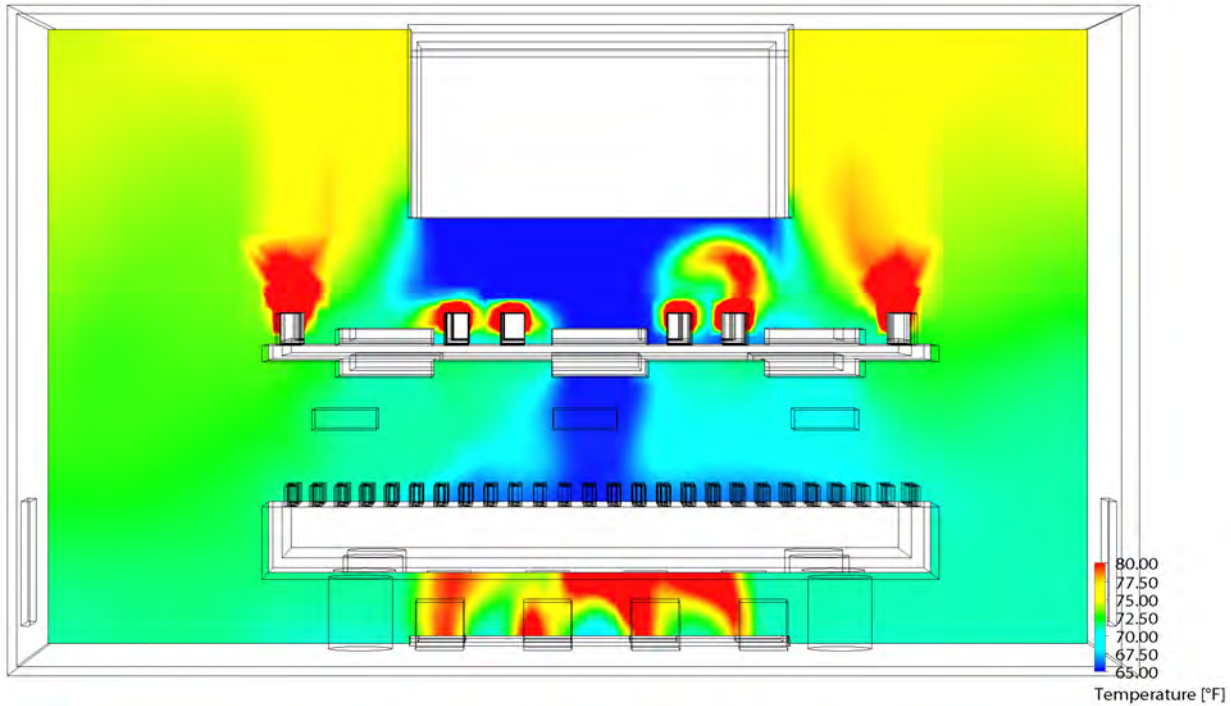




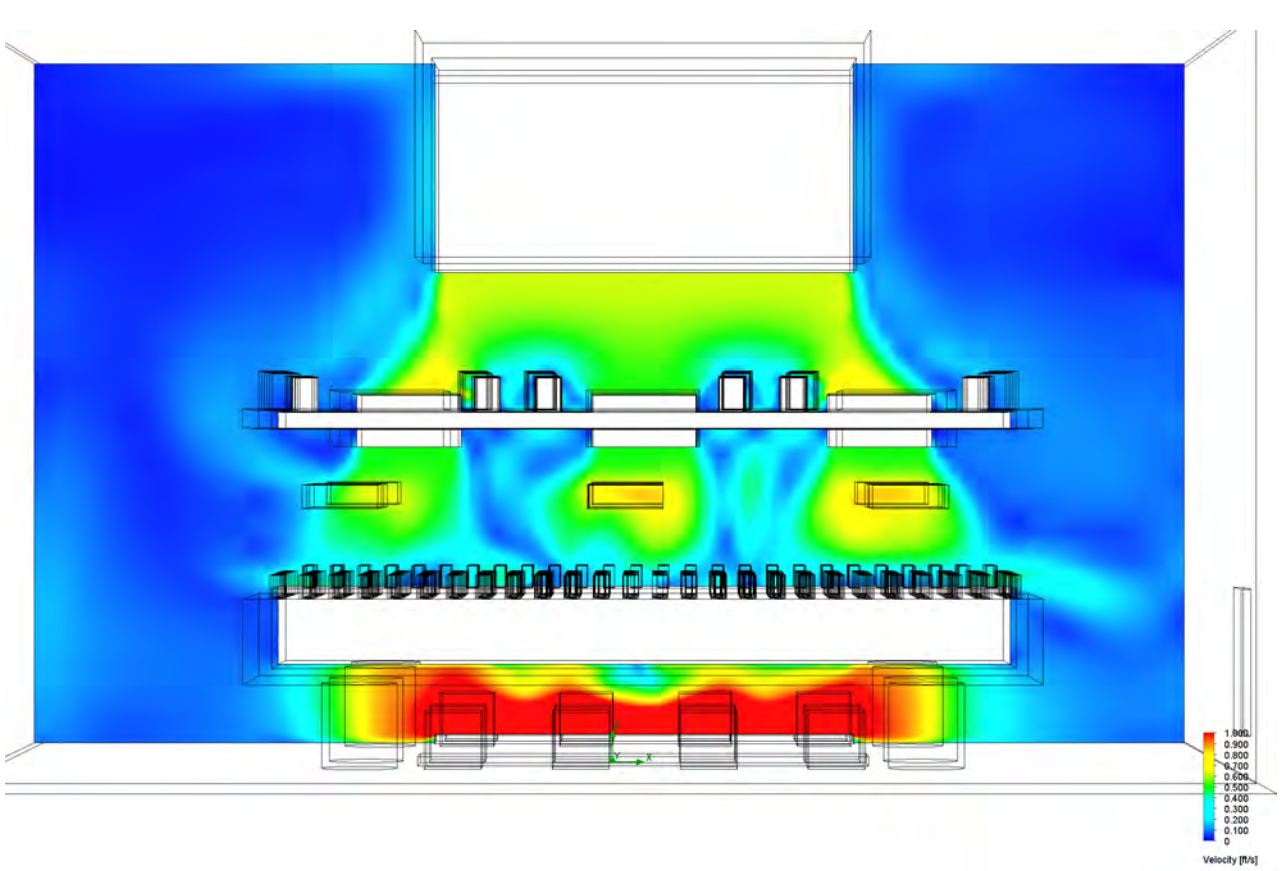


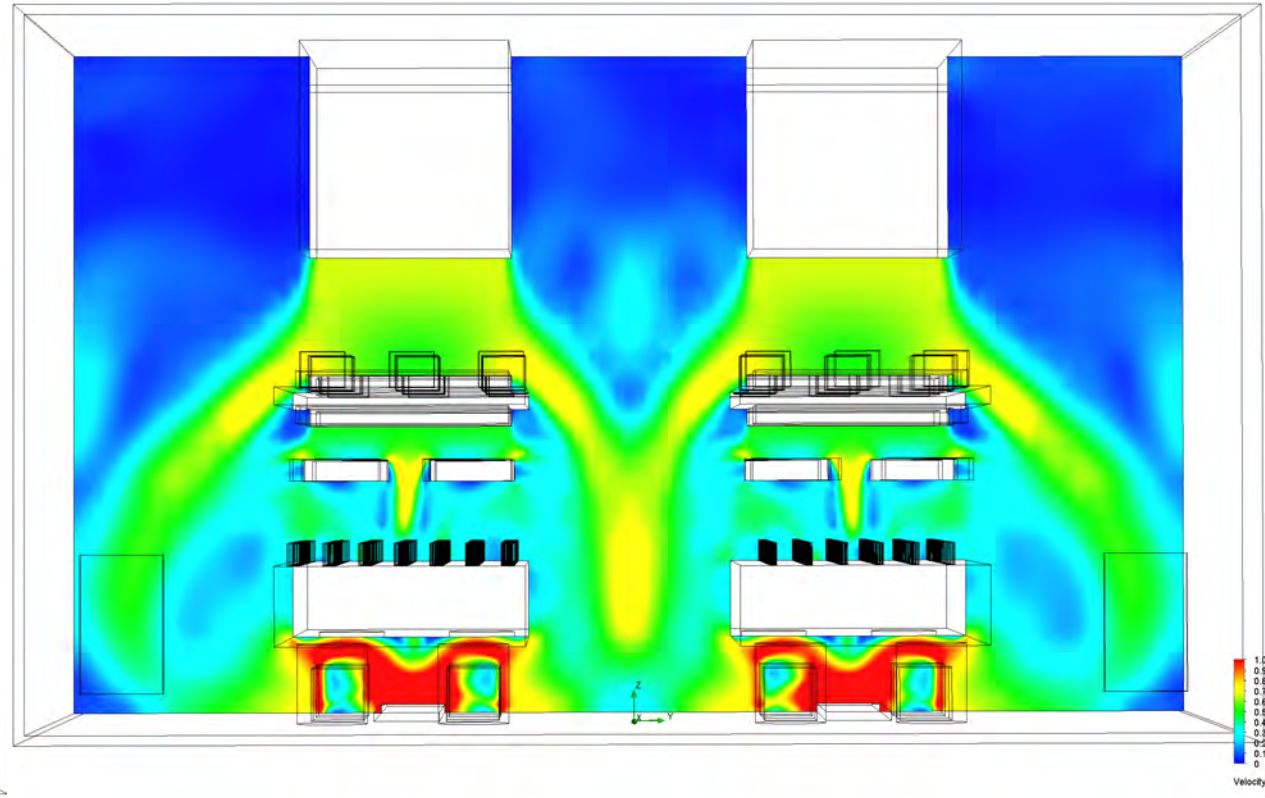
Temperature: Return Wall (Design 2)
7.2kW, 65F Inlet



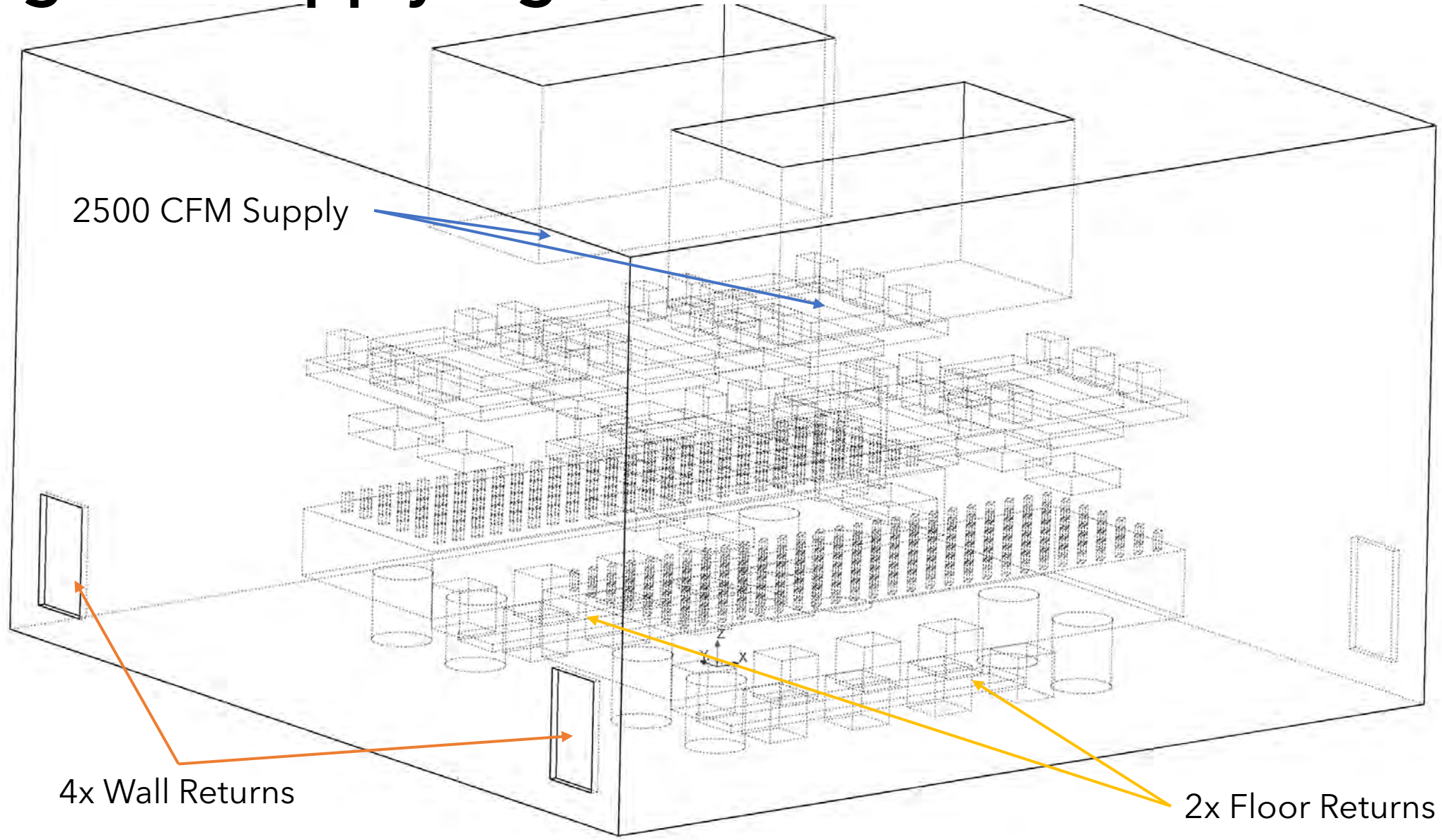


Velocity: Return Floor (Design 2)

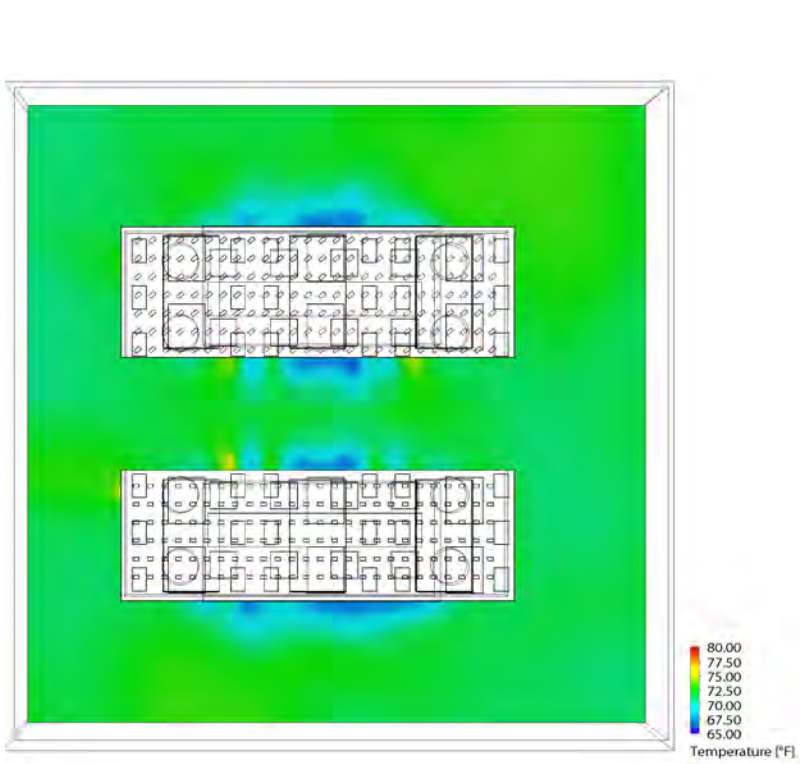


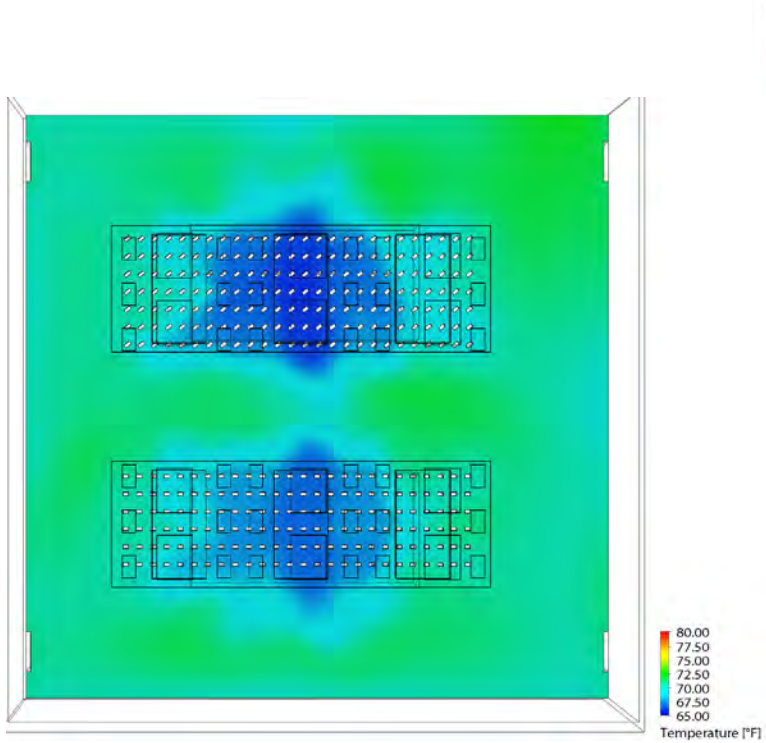


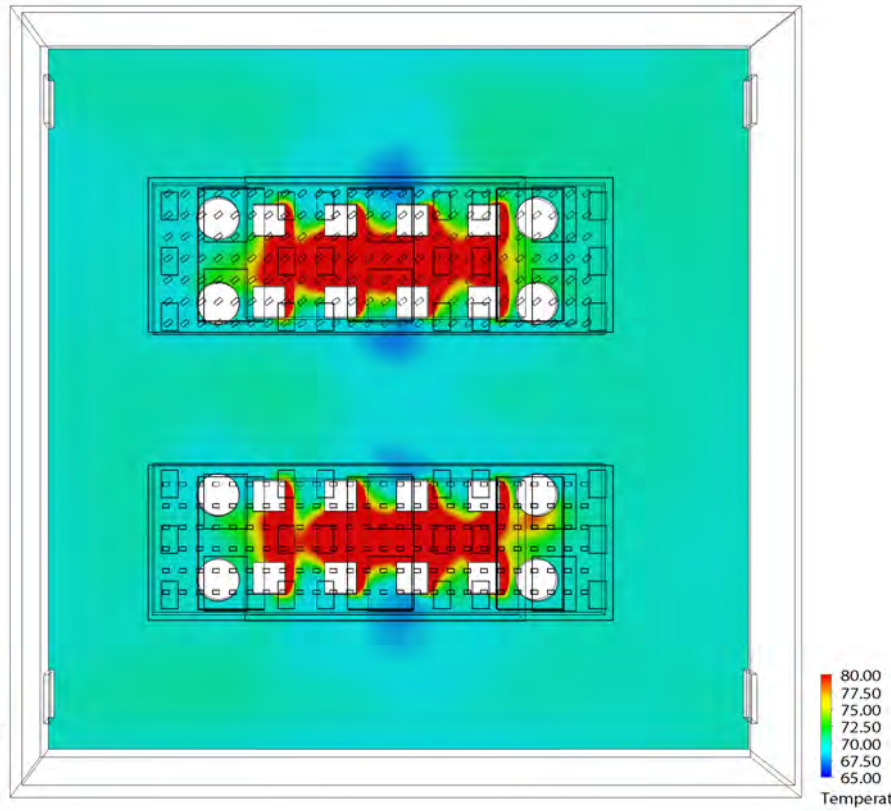
Design 3 – Supply high, Return under table and wall



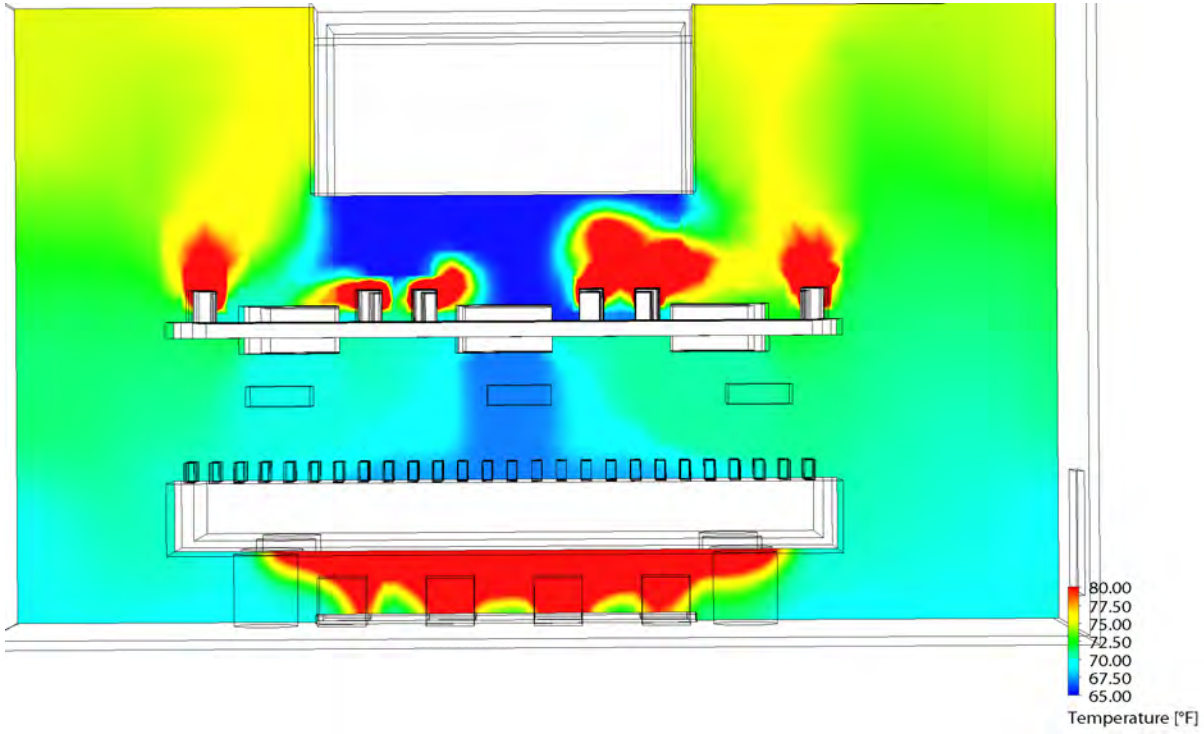
Temperature: Return Floor+Wall (Design 3) 7.2kW, 65F Inlet

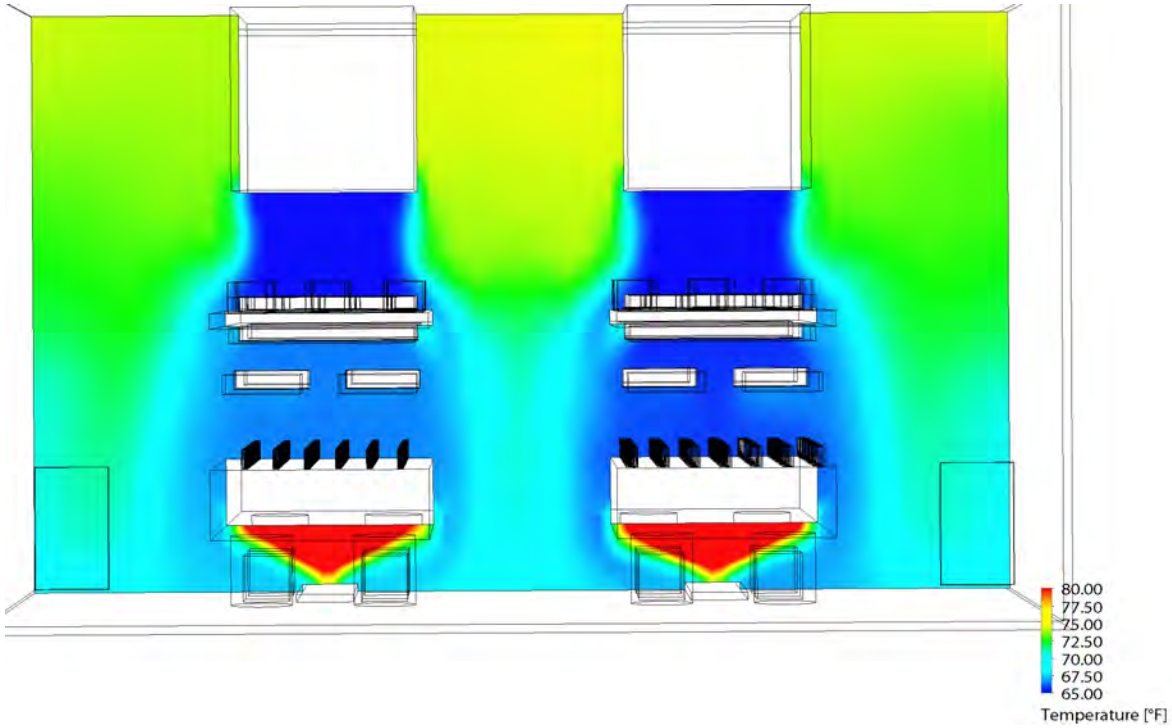




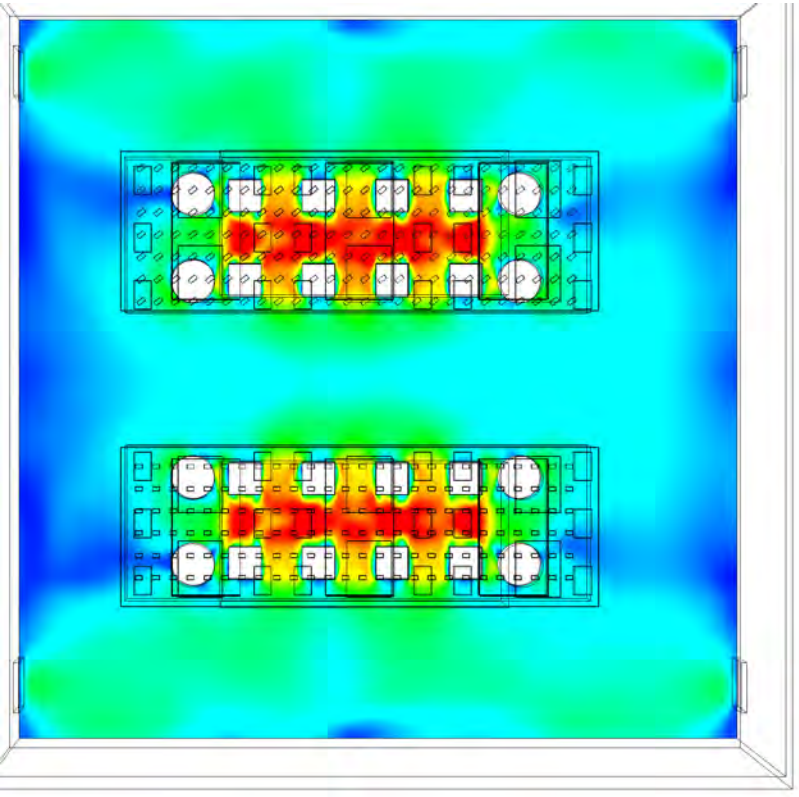


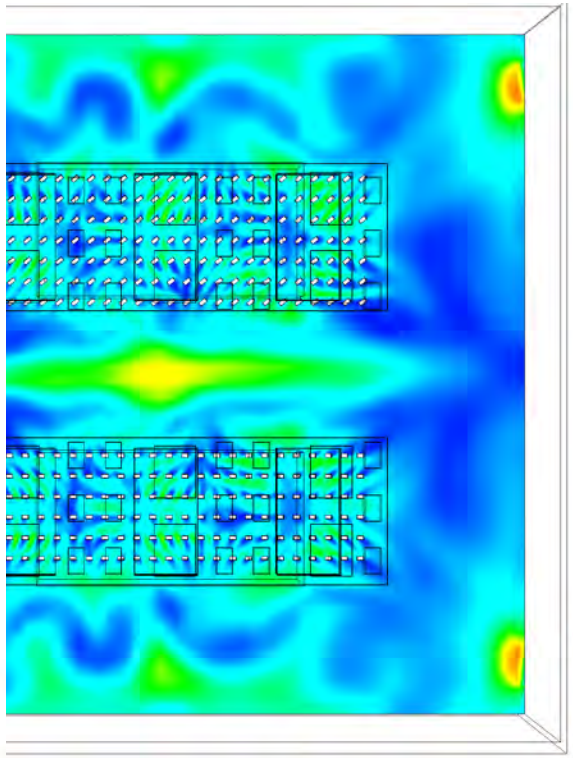
Temperature: Return Floor+Wall (Design 3) 7.2kW, 65F Inlet

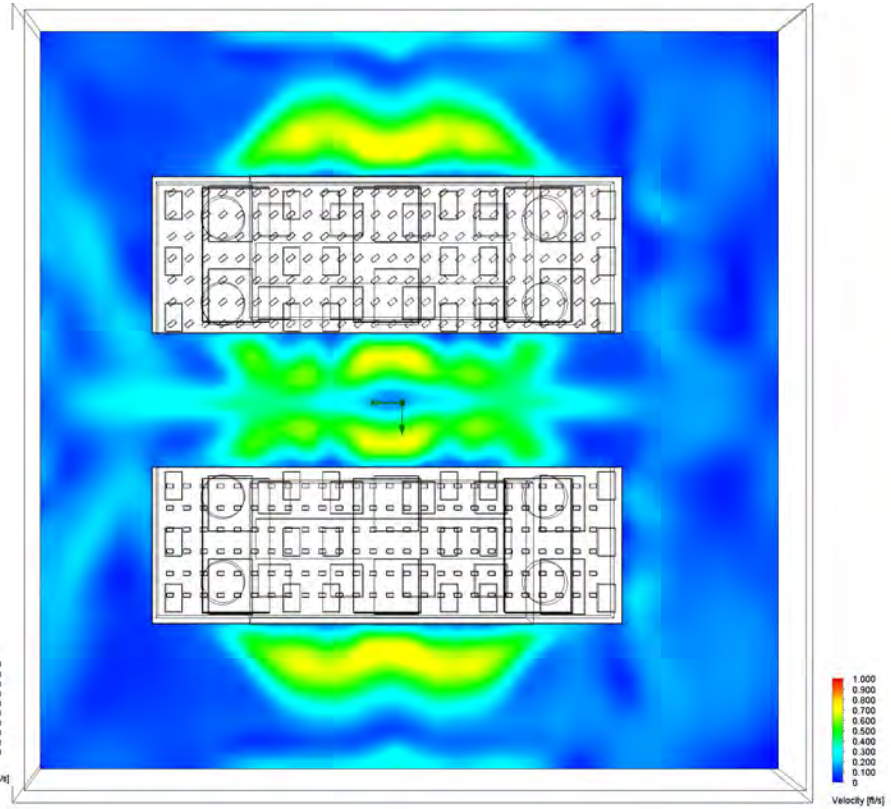




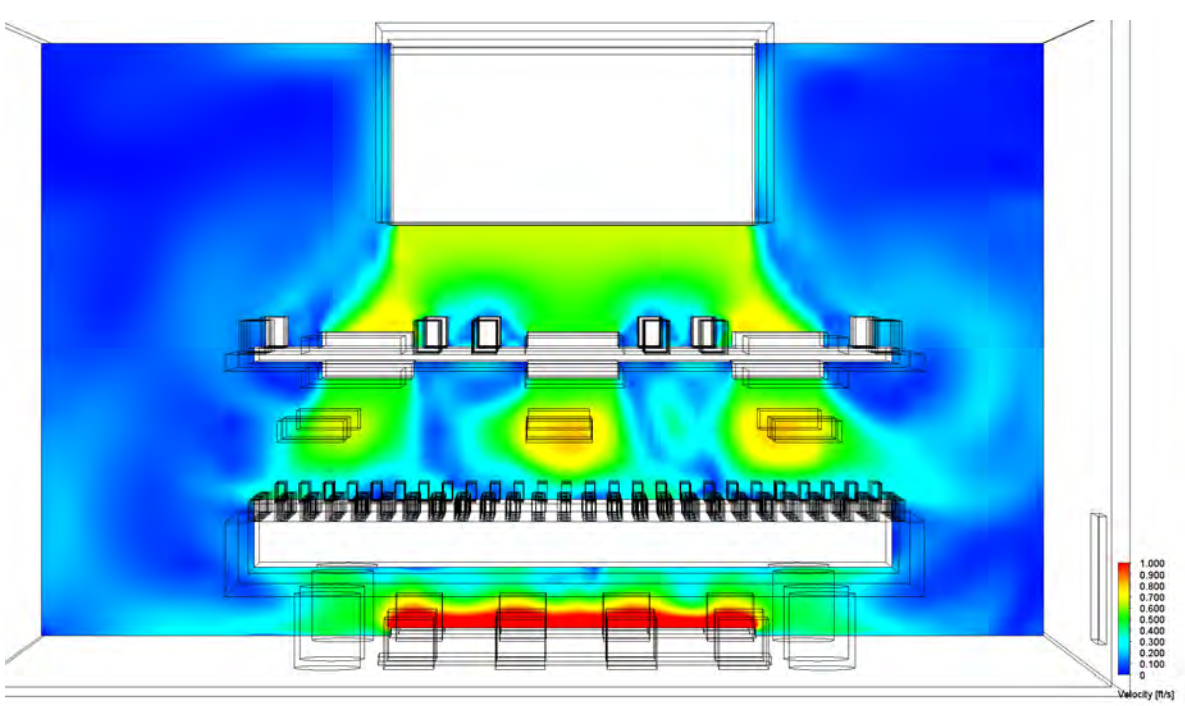
Velocity: Return Floor+Wall (Design 3)

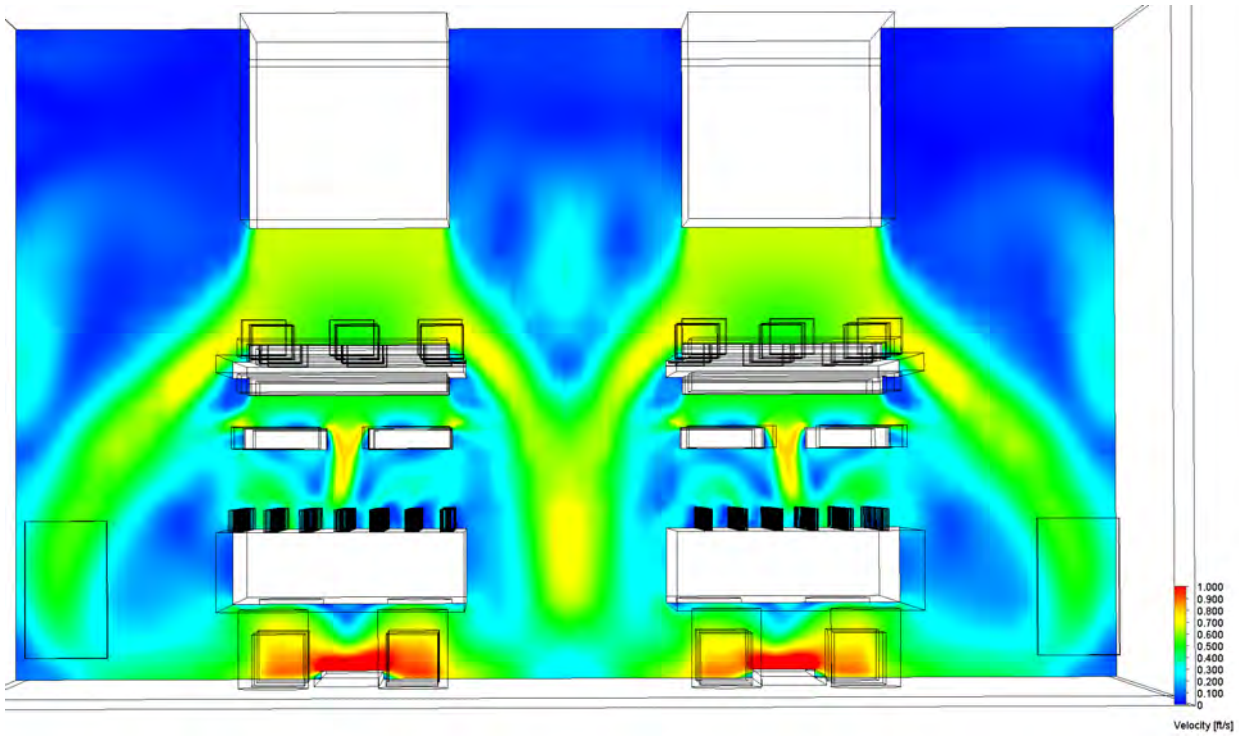




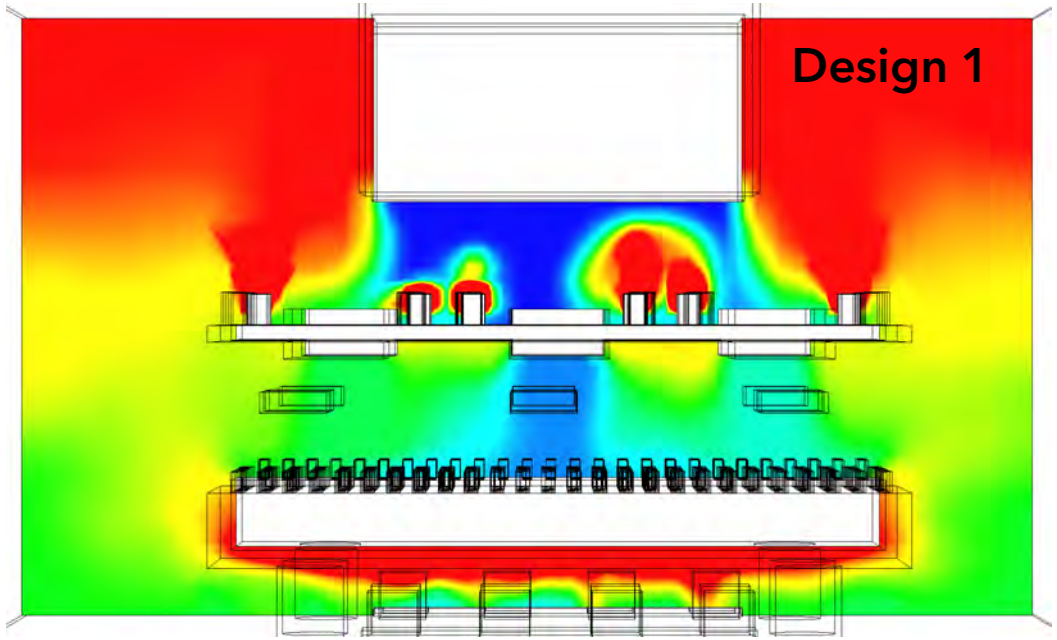


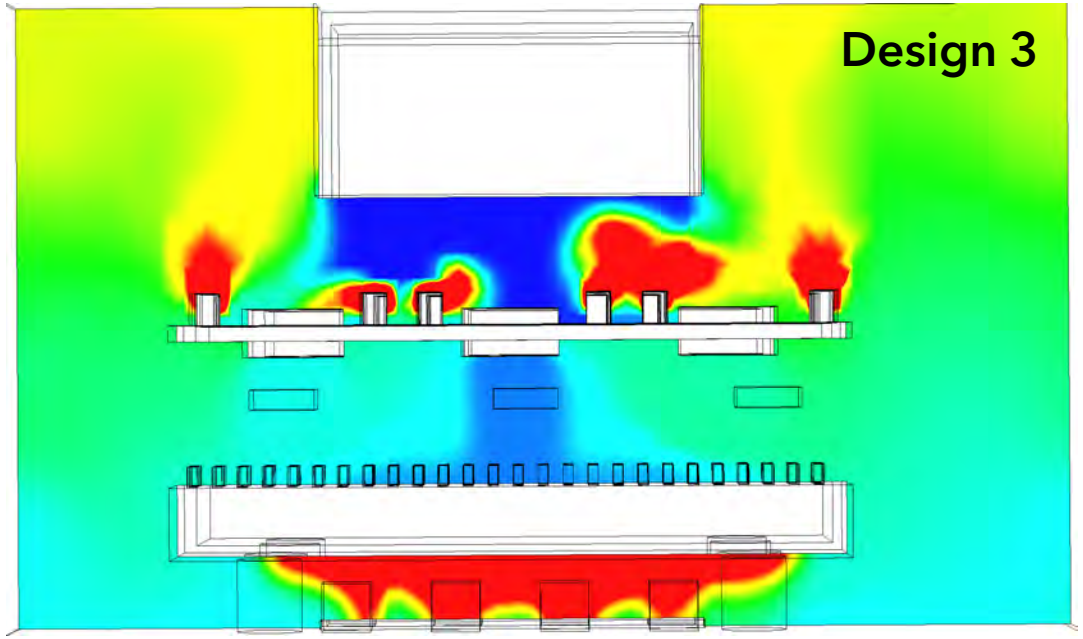
Velocity: Return Floor+Wall (Design 3)

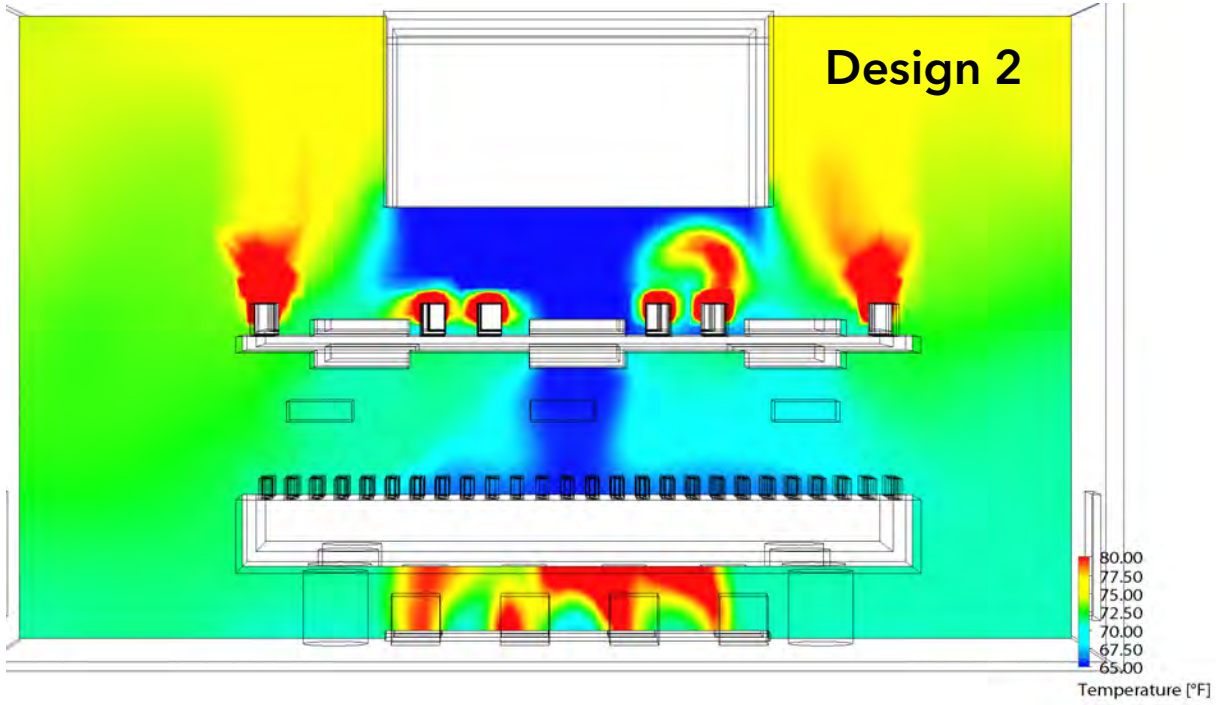




Comparisons



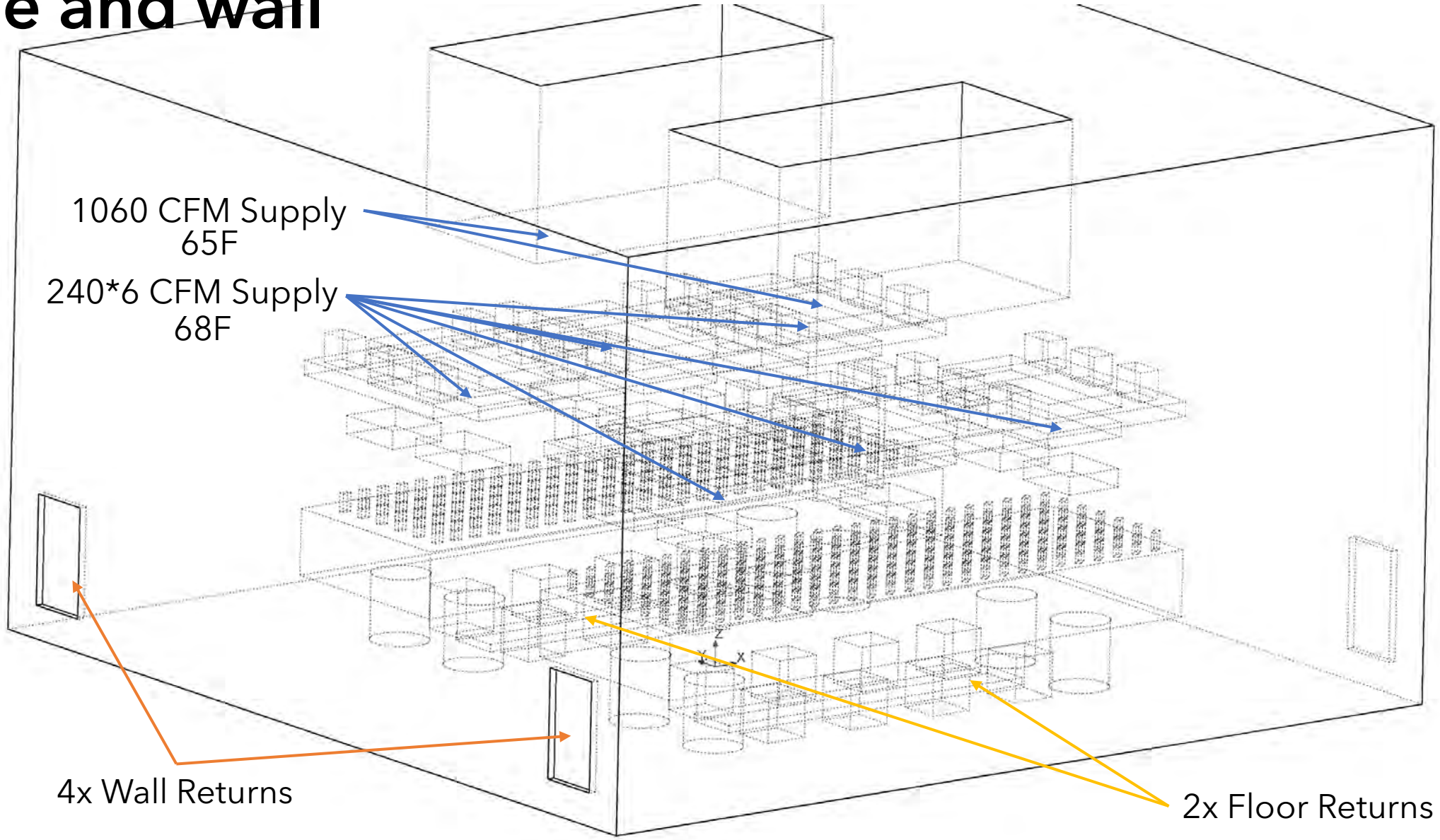




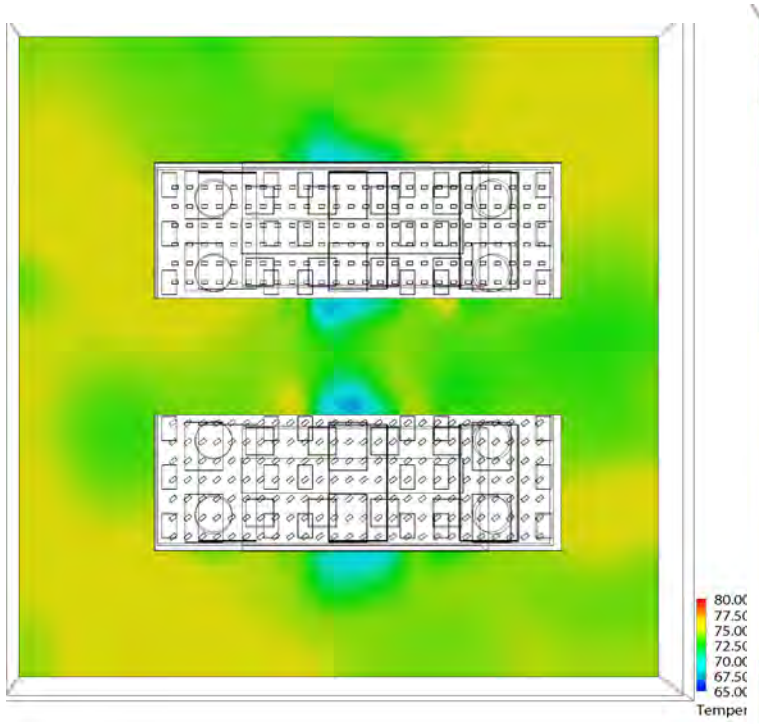
Returns under optical table are needed

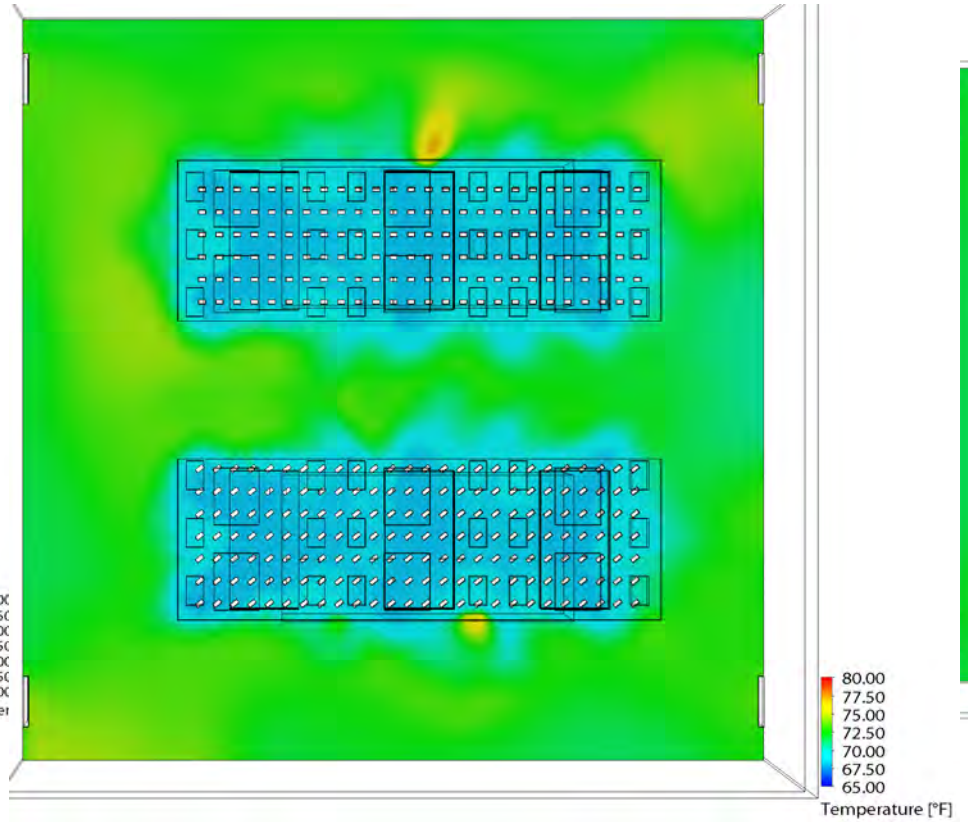
ULPA filters: blower vs ducted

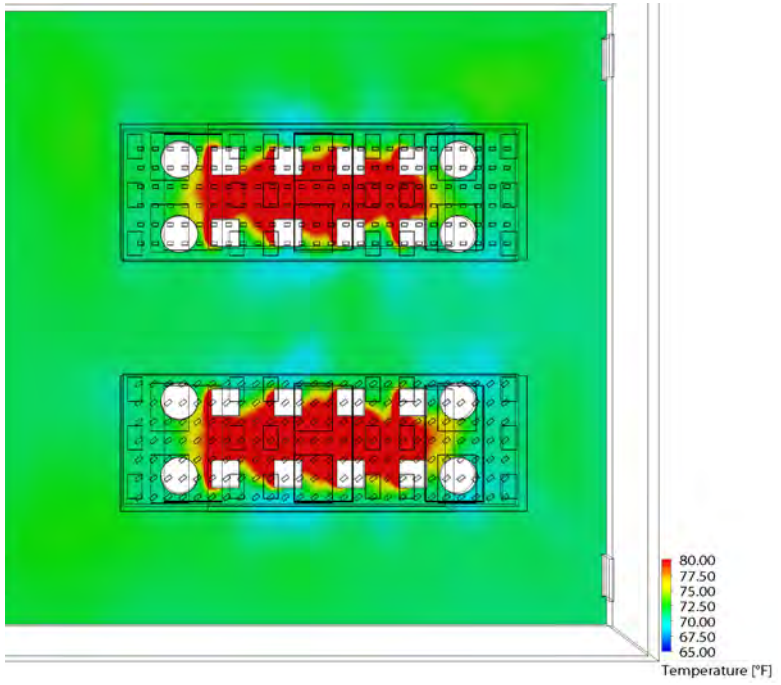
Design 3.1 – Supply high+Ducted ULPA, Return under table and wall



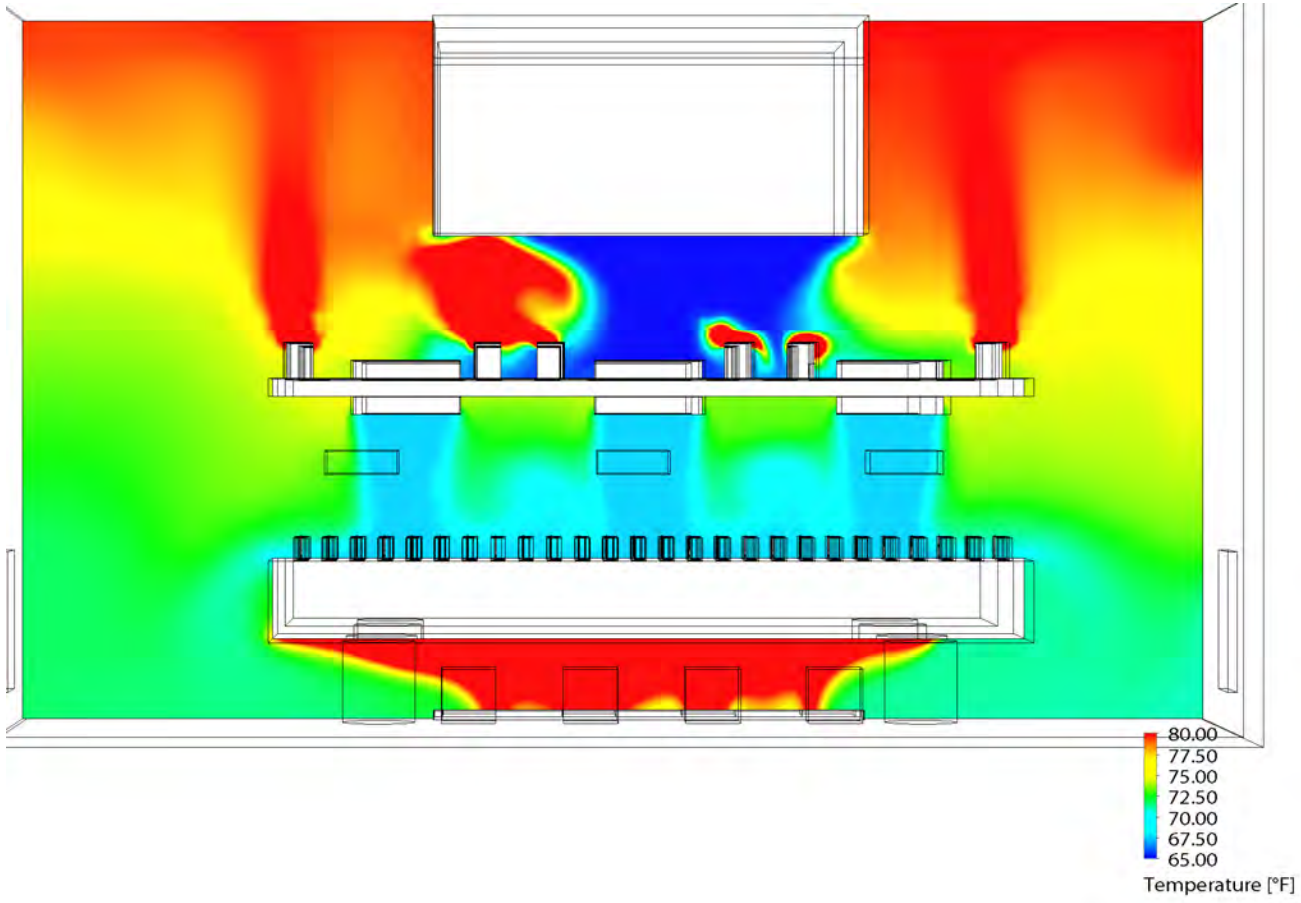
Temperature: Ducted ULPA+ Return Floor+Wall (Design 3.1)

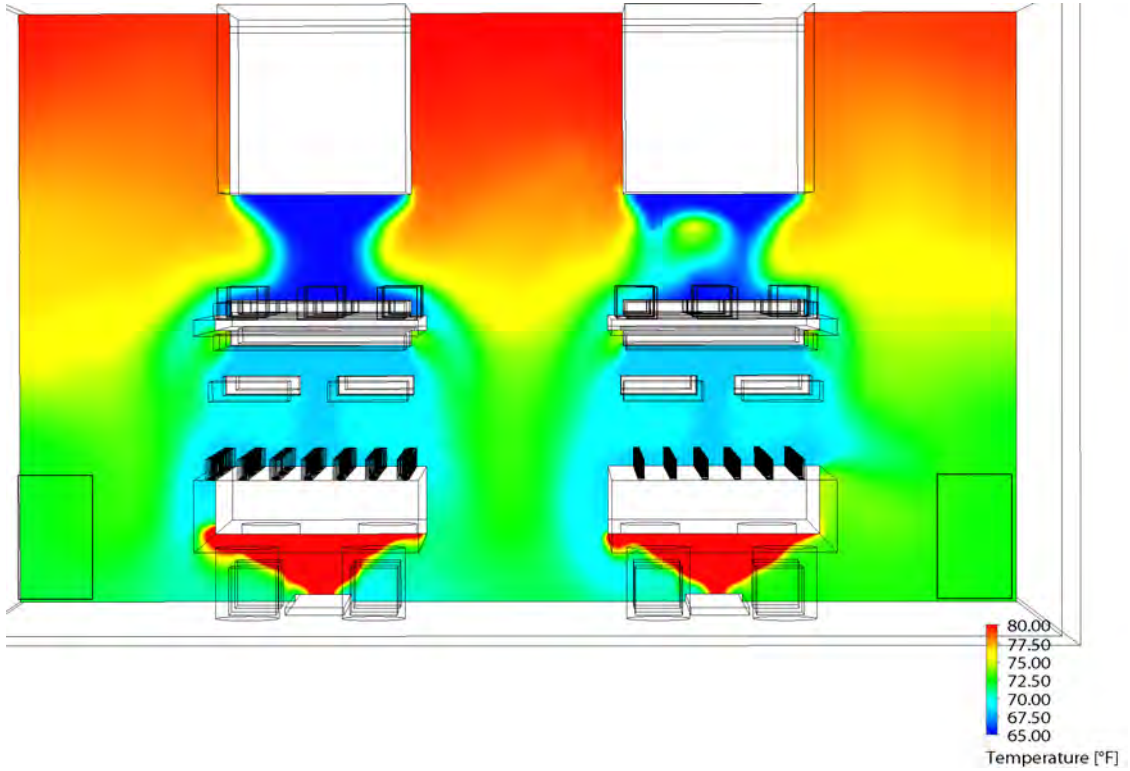




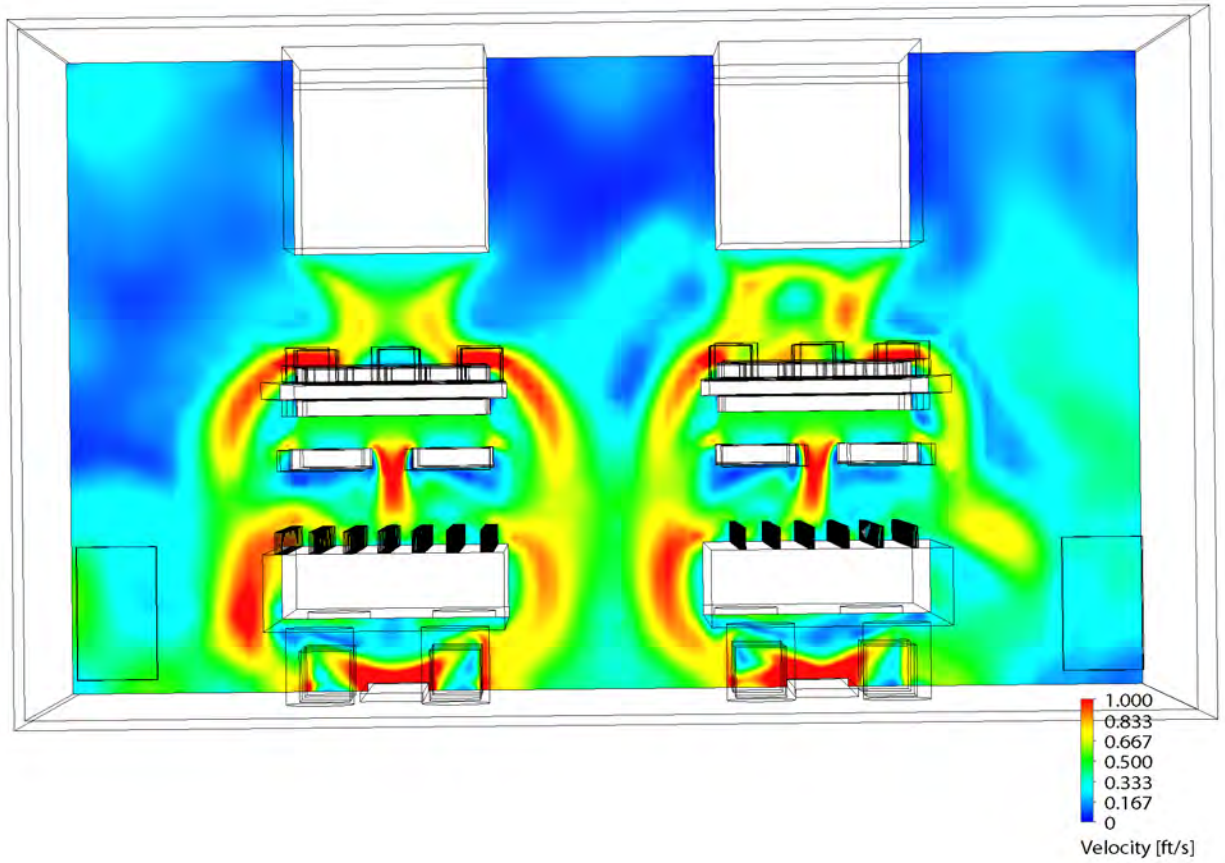


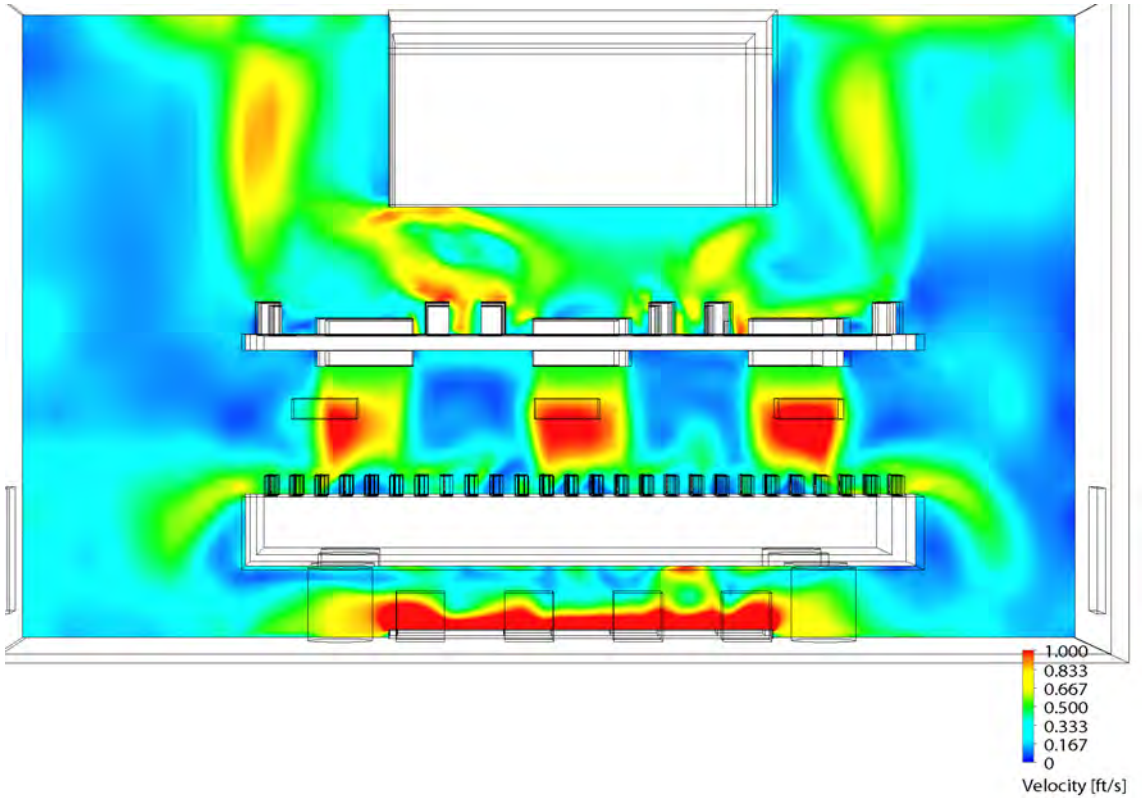
Temperature: Ducted ULPA+ Return Floor+Wall (Design 3.1)





Velocity: Ducted ULPA+ Return Floor+Wall (Design 3.1)

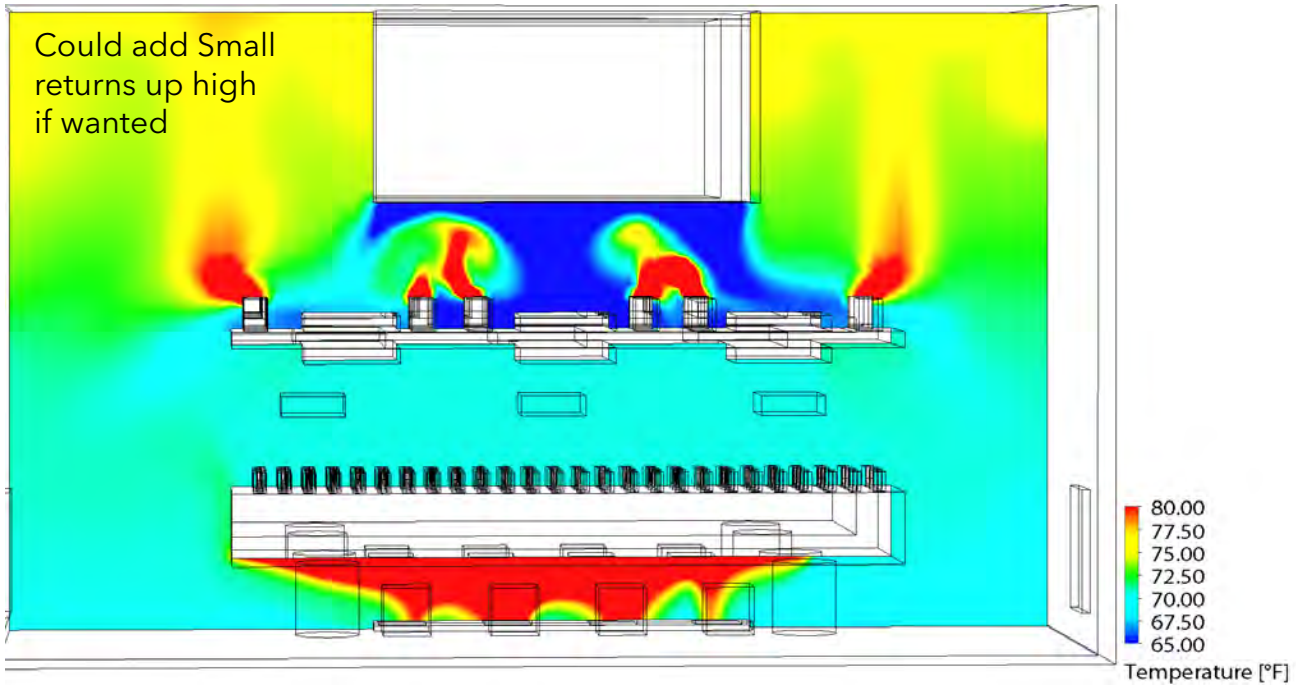


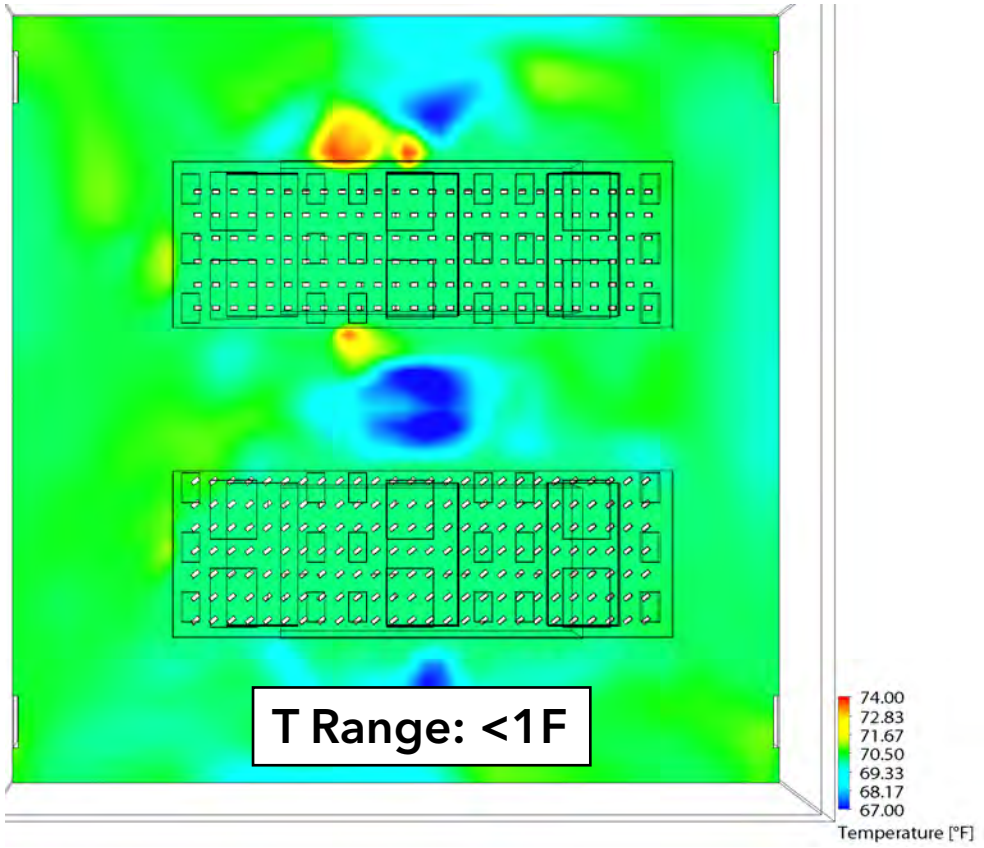


How can we do better?

Increasing room air flow to 2000 CFM+1400 for Optical tables.
Matched optical table air temperature to room temperature

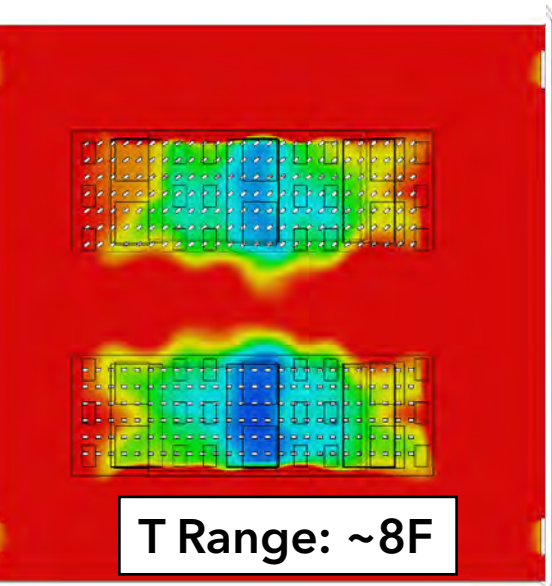
- Airflow 1: 2000 CFM, 63.5F discharge
- Airflow 2: 1400 CFM, 70F discharge



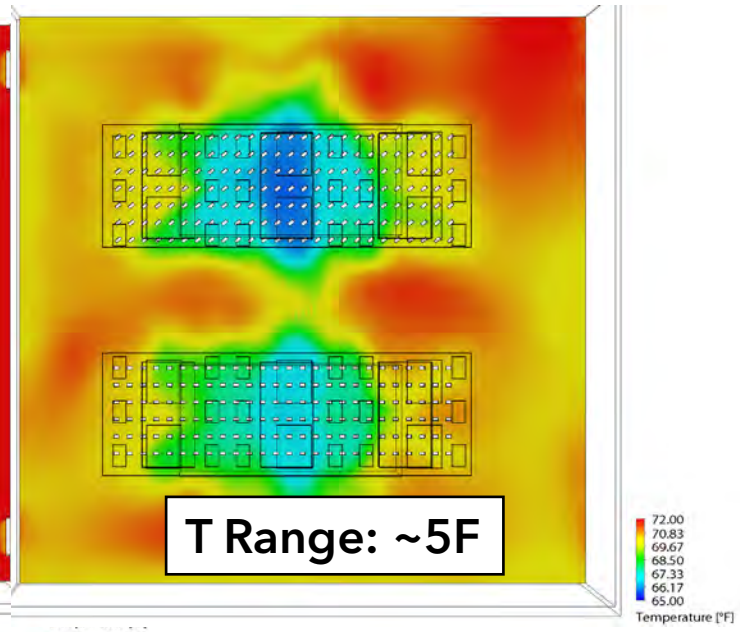


Comparison at Optical Table

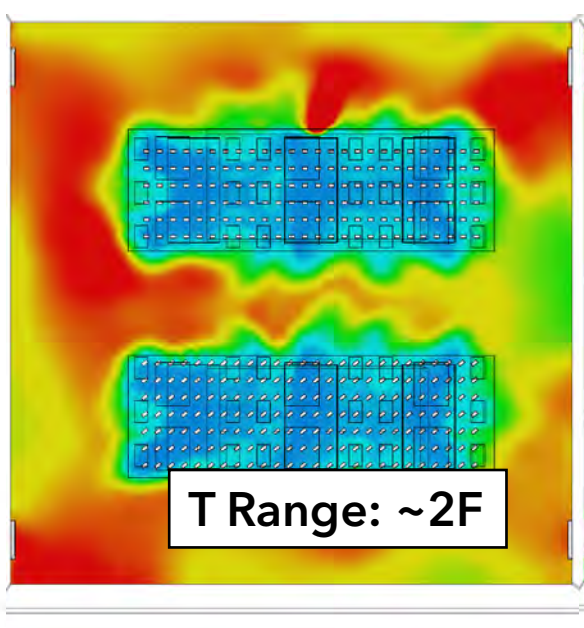
Design 1, 2500cfm



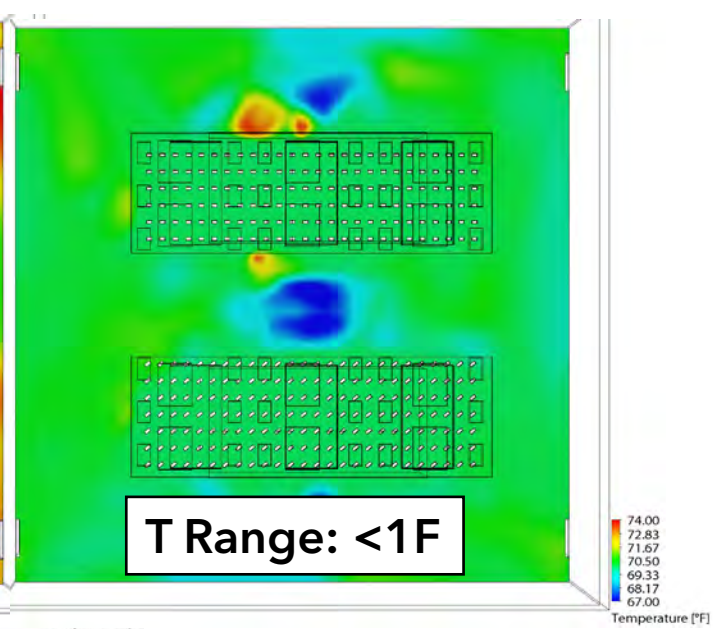
Design 3, 2500cfm



Design 3.1, 2500cfm



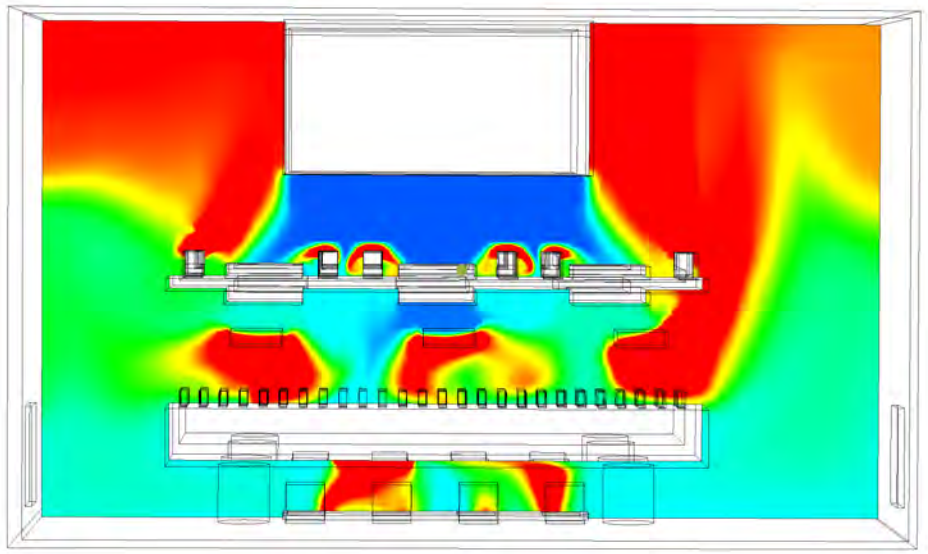
Design 3.1, 3500cfm
Temp Setpoint Change

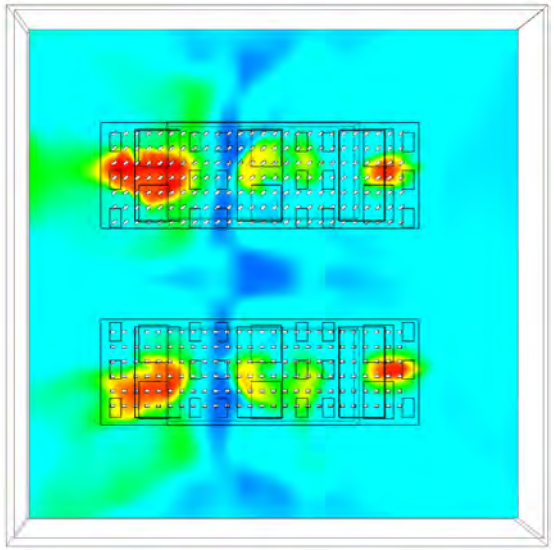


Note: Higher average temperature due to higher set point

Other Considerations

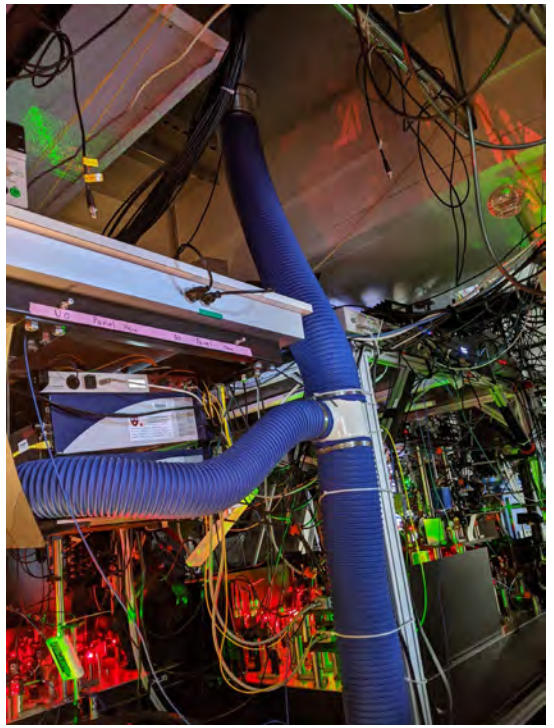
Design 3.1, +600W Loads on table





Heat loads on the optical table should be avoided at all costs. If unavoidable, enclose and vent

Flexible ducts connections should be available near optical tables



Conclusion: What is need for High Stability

- Ducted ULPAs to optical tables with independent PID loop
- Air returns under the optical tables and walls
- ~3500 CFM total (2000 for room and 1400 for Optical tables)
- User accessible duct connections to vent heat loads where needed