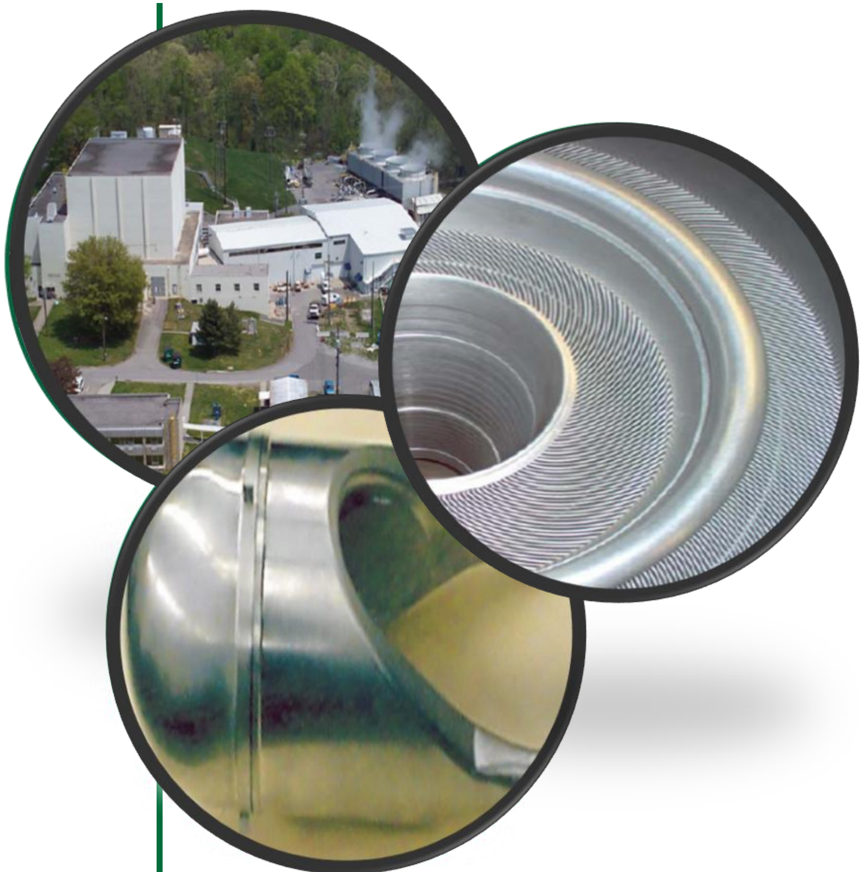
Presented at the COMSOL Conference 2010 Boston

Exploiting New Features of COMSOL Version 4 on Conjugate Heat Transfer Problems



presented by:

James D. Freels[1]

Rao V. Arimilli[2], Isaac T. Bodey[2]

[1] Oak Ridge National Laboratory
Nuclear Science and Engineering Directorate
freelsjd@ornl.gov
865-576-8645

[2]University of Tennessee, Knoxville
Mechanical, Aerospace & Biomedical Engineering

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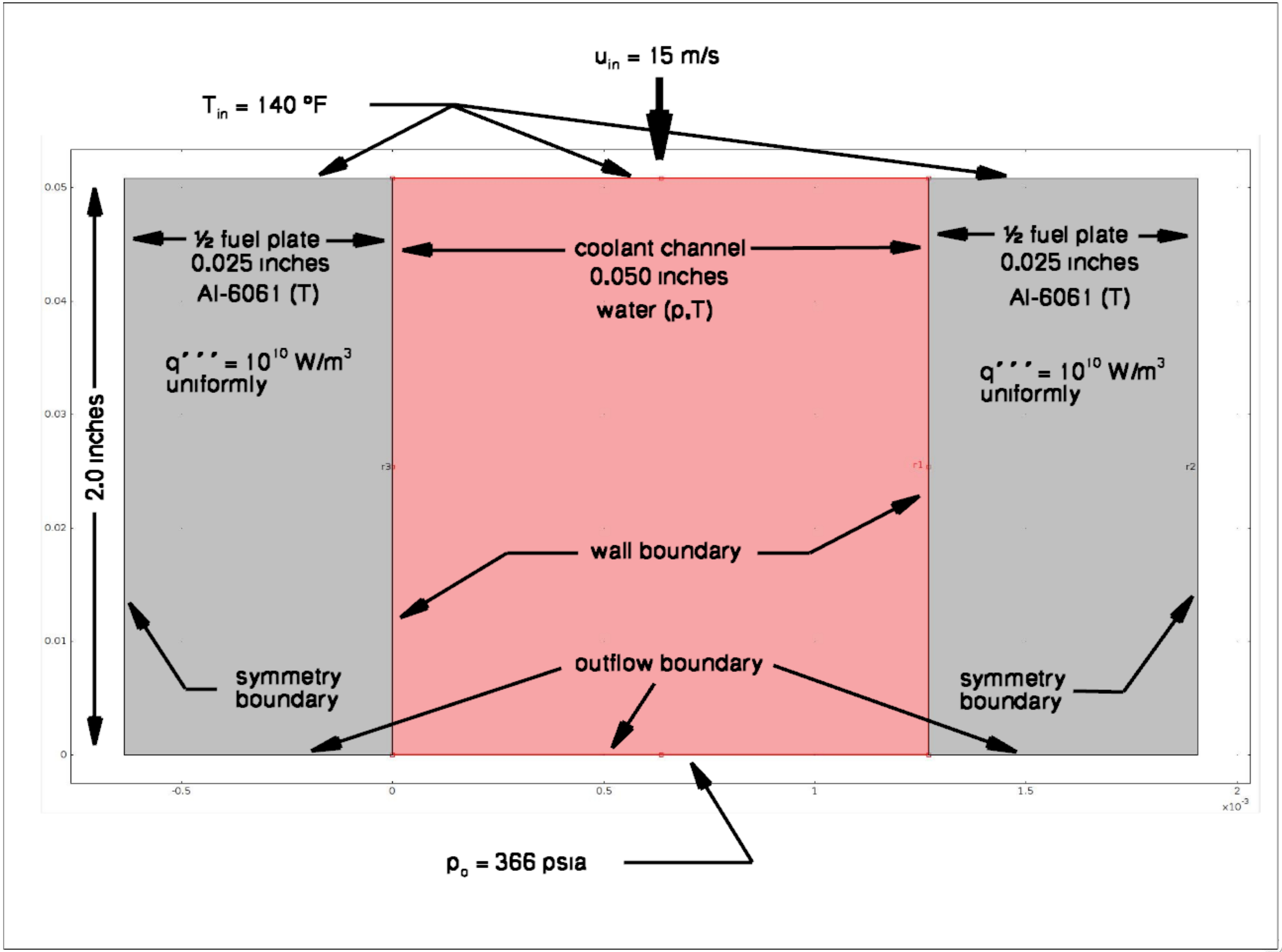
Topics today include:

- Low-Reynolds Number extension to k-ε turbulence model,
- Distributed parallel processing performance,
- Solver scaling, and
- OpenGL in Linux environment.

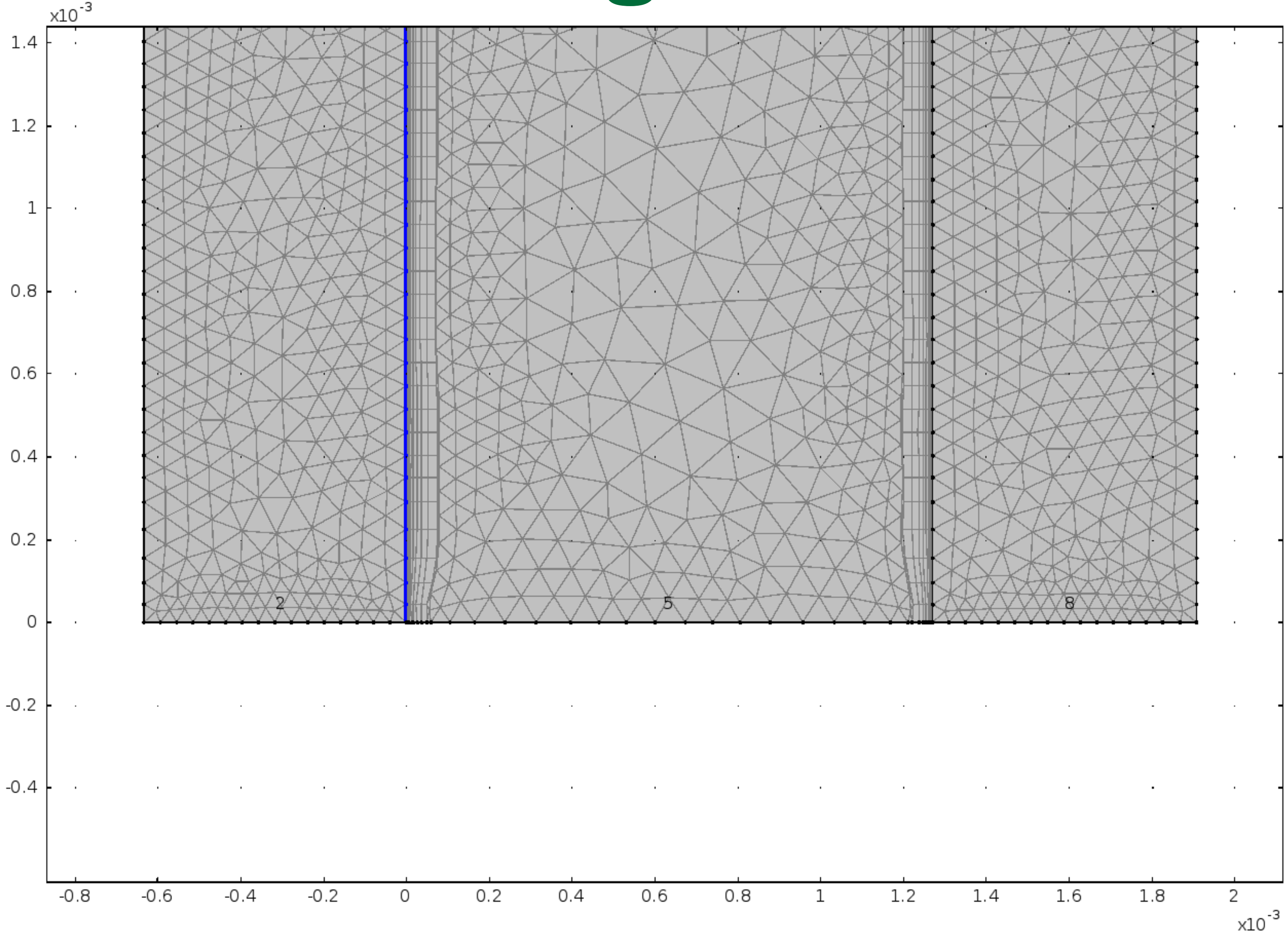
Low-Re extension to k-ε turbulence model

- Define a simple 2D model problem similar to HFIR fuel during operation
- Reynolds Number ≈ 4×10^4
- Heat generation ≈ 1×10^{10} W/m^3
- HFIR fuel plates are 0.050" thick
- Model the entrance region = 2.0 inch length

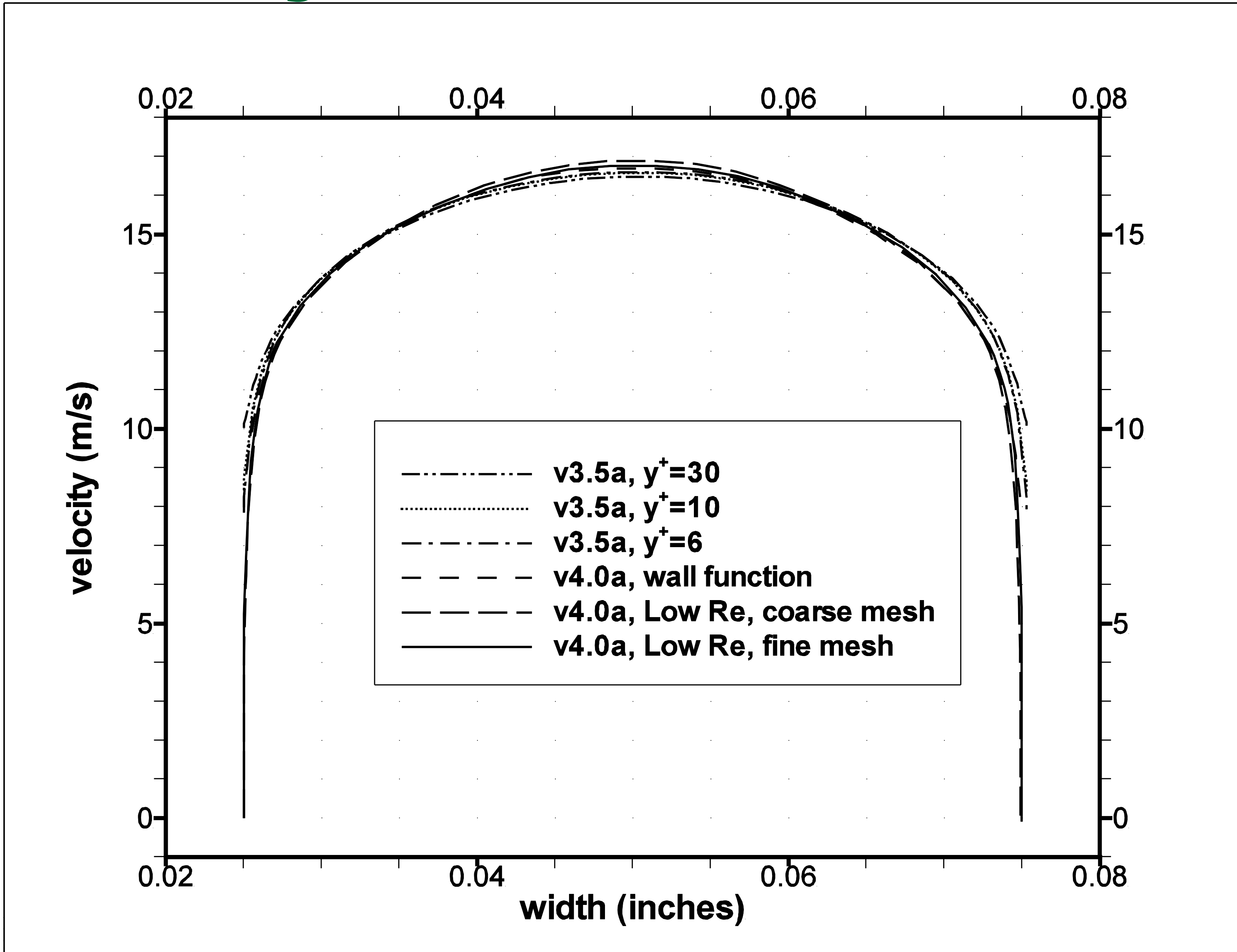
Problem statement:



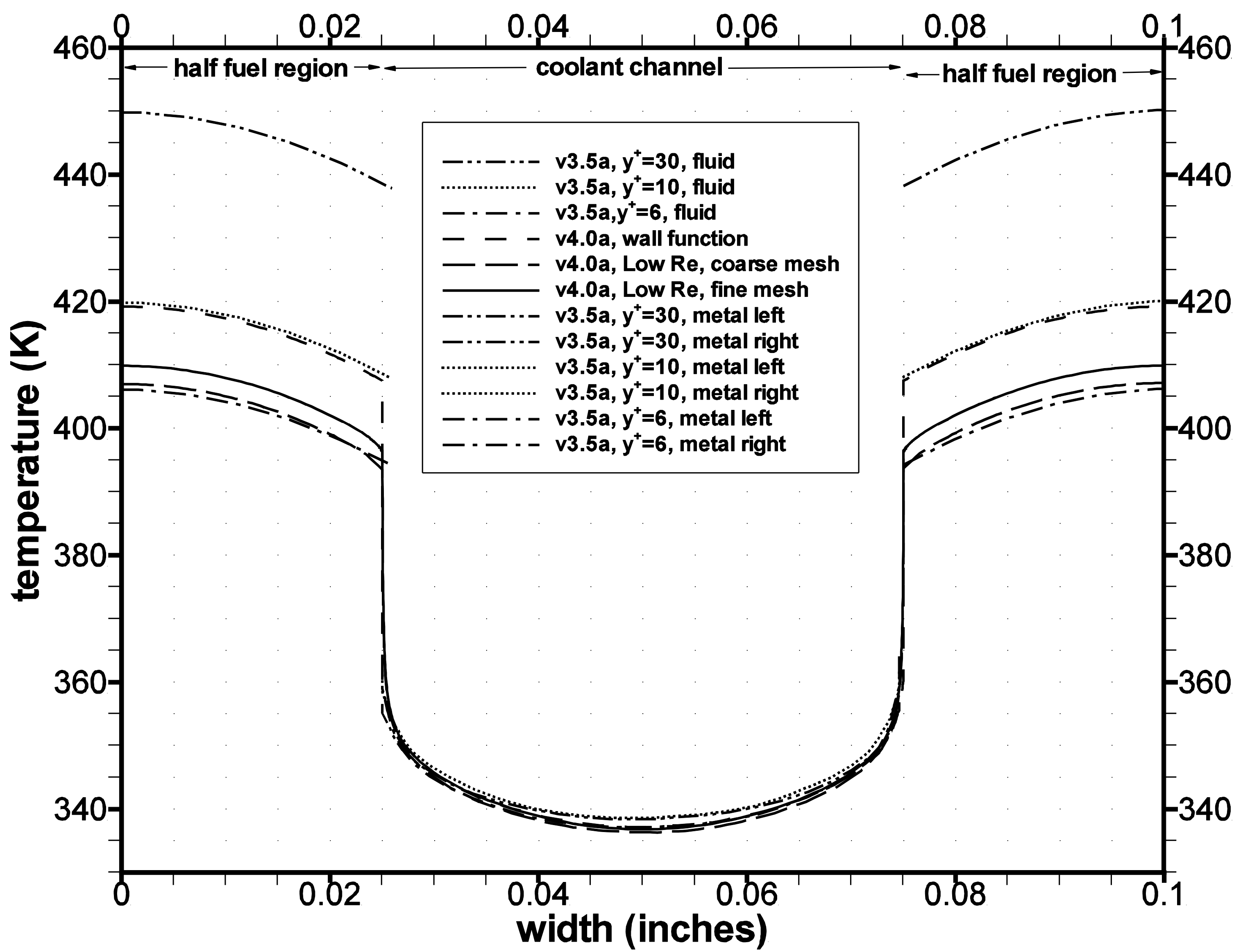
Mesh is consistent for all cases investigated:



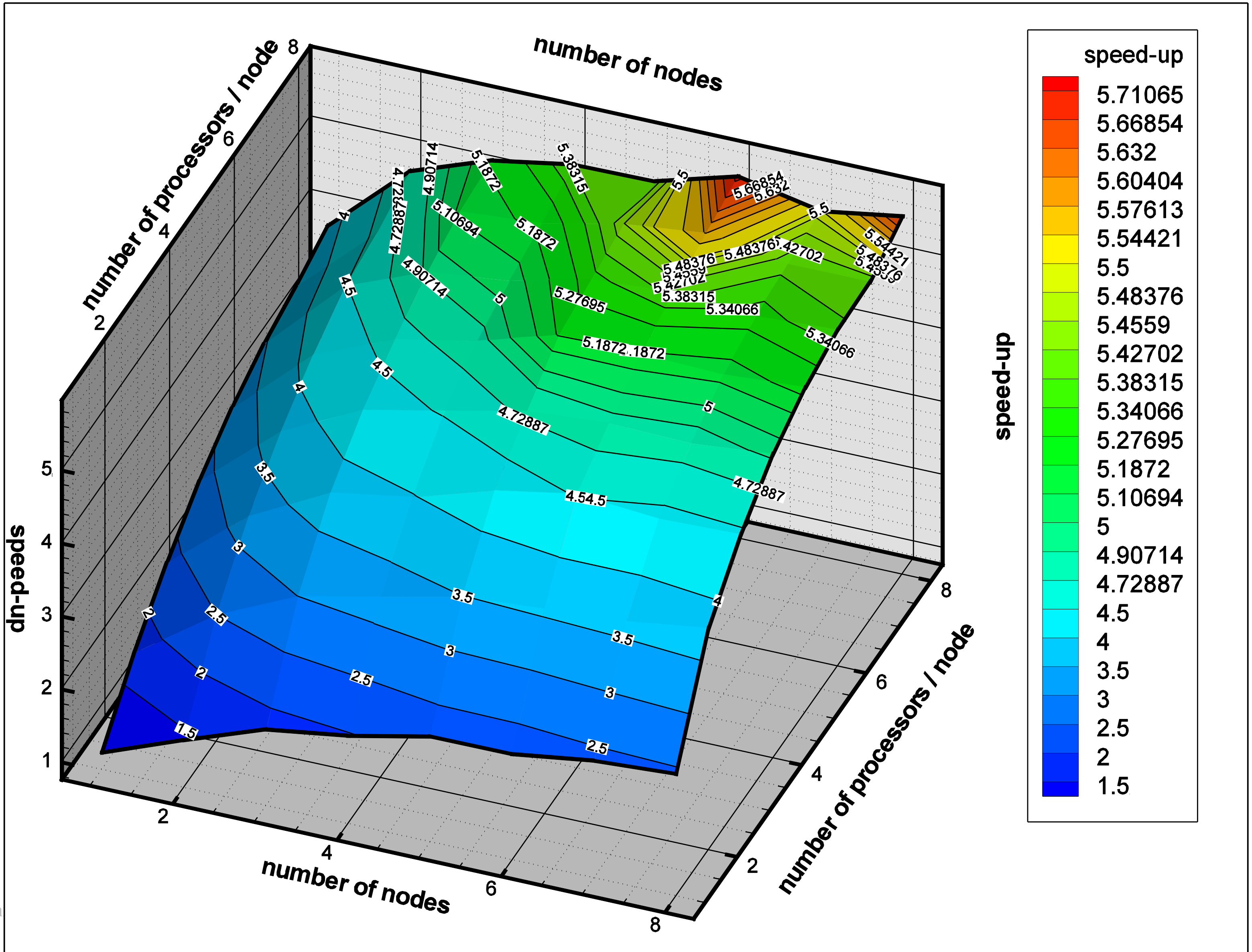
Velocity solutions:



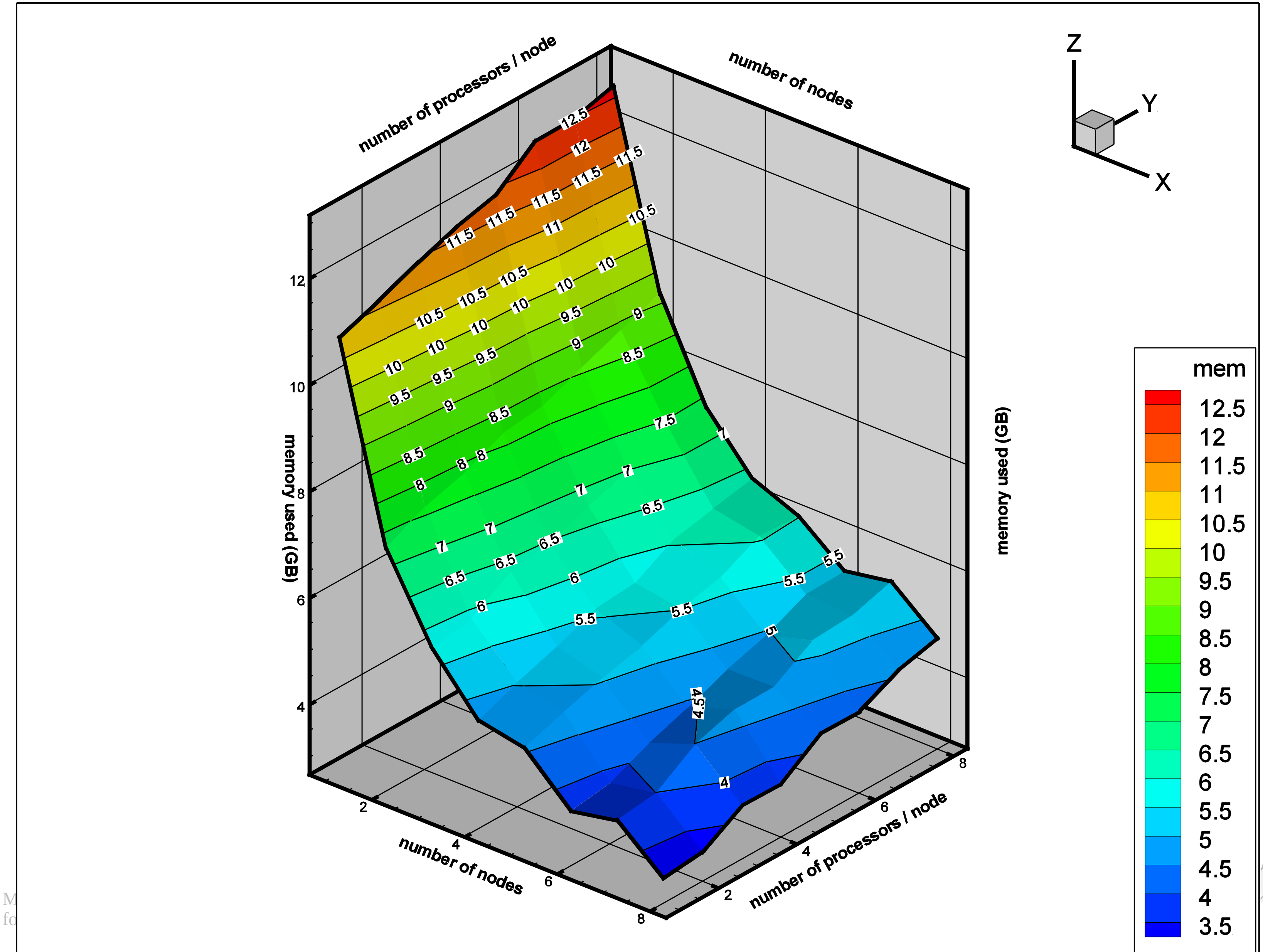
Temperature solutions:



Distributed parallel processing performance: speed-up



Distributed parallel processing performance: memory utilization



Solver scaling improved in v4+

- For turbulent conjugate heat transfer problems in v3.5a and earlier, I used manual scaling to improve convergence rates
- Typical entry looked like this in v3.5a:

$$\{u\ 20\ v\ 20\ p\ 1.0e5\ log(k)\ 10\ log(d)\ 10\ T_s\ 400\ T_f\ 400\}$$

- Version 4 brought additional scaling options which improves performance. Apparently, manual scaling is no longer as beneficial.

version	type	iteration
v3.5a	manual	45
v3.5a	auto	70
v4.0a	manual	66
v4.0a	auto	68
v4.0a	parent	75

For Linux clients, OpenGL (v1.5 or higher) compatibility may require new hardware.

Check for new graphics drivers with the vendor and override the distribution packages.

I was able to continue using 7-year old graphics card in one case.

Conclusions:

- Low-Reynolds number extension to k-ε turbulence model will yield increased accuracy for conjugate heat transfer problems
- Distributed parallel processing will reduce problem solving time and memory
- Improved solver scaling will reduce complexity of obtaining solutions
- New OpenGL requirements are achievable for older graphics cards by getting the latest drivers directly from the vendor