# Benchmark tests of Parallel PHOENICS for Windows
## (collected by jzw, 2006; edited by dbs)

**Speed-up data are reported below for PHOENICS Library cases with increased cell numbers, and for some industrial applications, as follows.**

Case 100

The case simulates 3D steady heat conduction in a cube with fixed temperature at opposite corners. A single equation of enthalpy is solved.

Case 278

This case simulates the natural convection in a 3D cubical cavity. One of the vertical walls is heated and the other cooled. At all other end walls there is friction, but are adiabatic. Only one half of the domain is included by reason of symmetry.
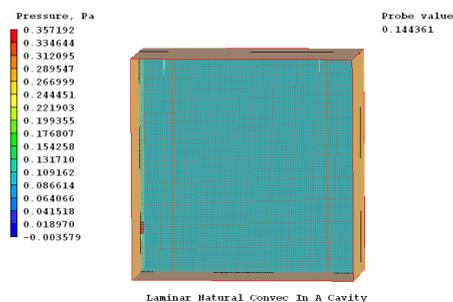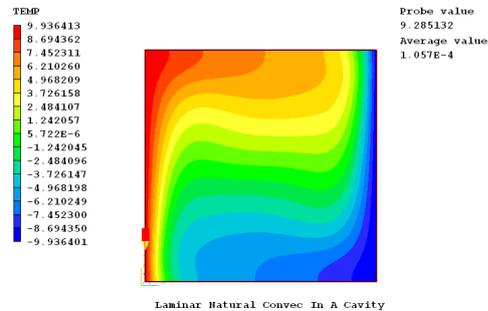


Geometry & Grid (100x100x100)          Temperature contours

Case 805

This case simulates laminar steady flow around a sphere in a uniform stream. The fluid is atmospheric air.
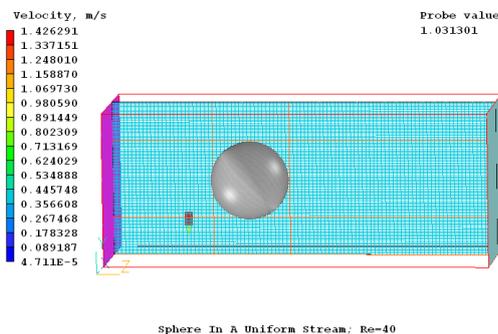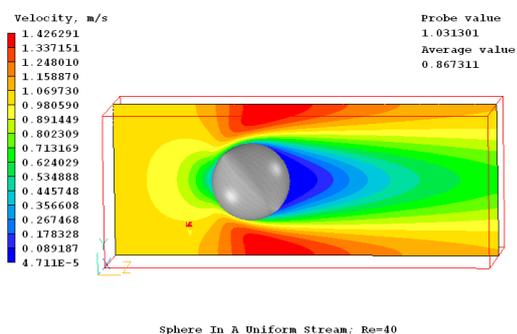


Geometry & Grid(100x100x100)          Velocity contours

## Case V104

This case simulates a drill bit with 3 cutters. The fluid is water.



Geometry & Grid (90x90x96)
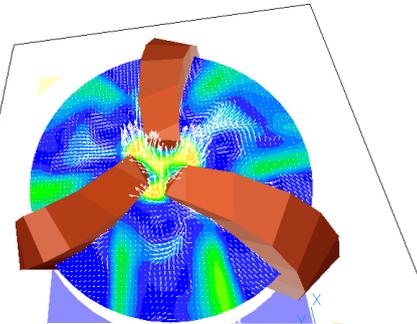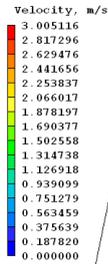


Velocity distributions

## Case H205

This case simulates an electronic box which contains 12 chips dissipating heat and mounted on two PCB's. Flow is forced through the box by a fan.
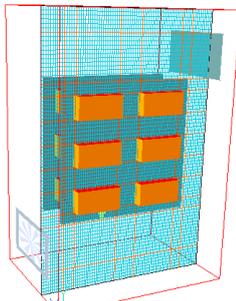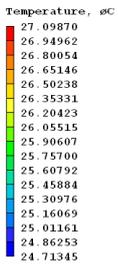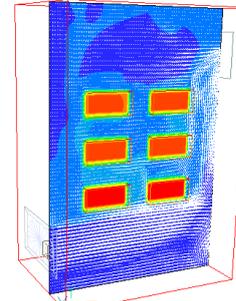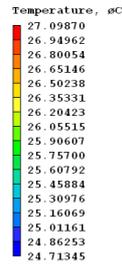


Geometry & Grid(80x80x80)



Temperature contours

## Case i212

This case simulates an office room with ASHRAE displacement diffuser. There is a computer placed on each desk. One of the staff is standing by the desk, and the other sitting at the desk. Other objects is the room include the diffuser, 2 file cabinets, 4 lights and 2 chairs. A ventilation opening locates at the ceiling.
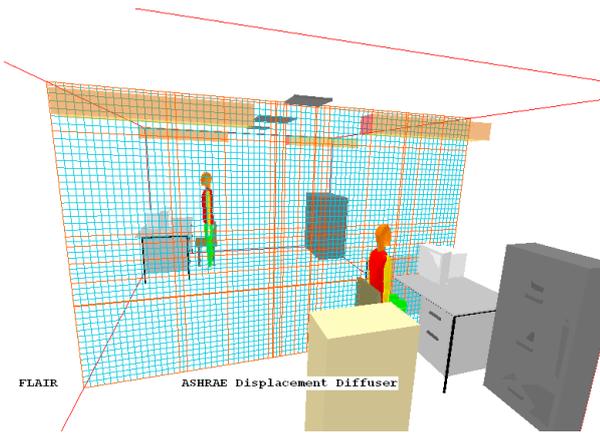
Geometry & Grid (100x80x50)

**Graphic representation of the Industrial applications used for the above benchmark**

**Multi-story carpark**
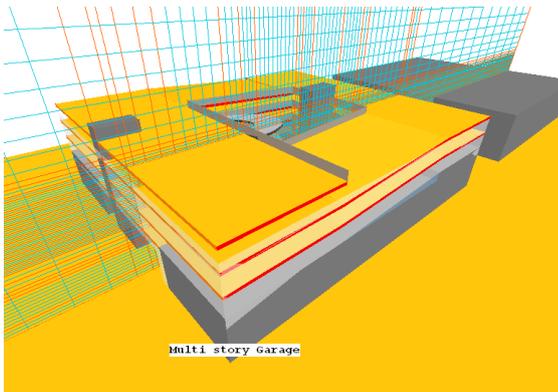


Geometry & Grid (84x50x110)
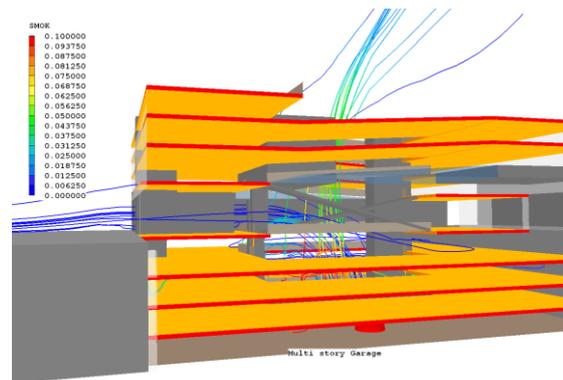


Smoke tracking

**Flow around ship**

The solution domain is a cylindrical quadrant in which the hull half-section occupies the region near the axis. The ship hull is complete. The computational domain starts far in front of the ship.  This is a BFC case.
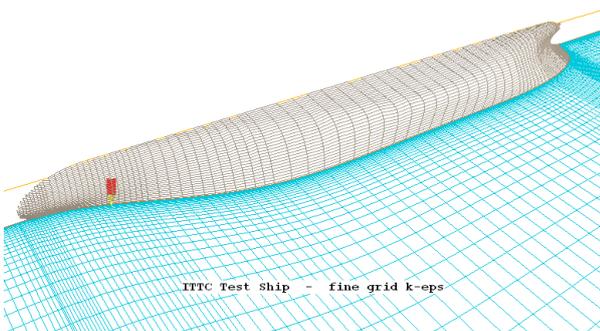


Geometry & Grid (30x30x150)

## Pipe assembly
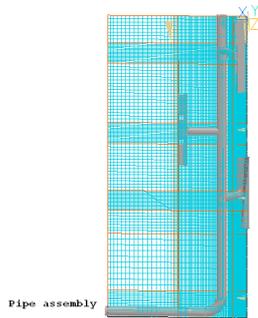


Geometry & Grid (98x98x119)
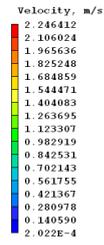


Velocity contours
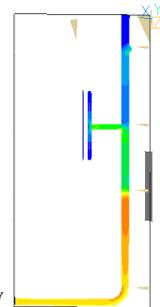
## Fan-ventilated tunnel
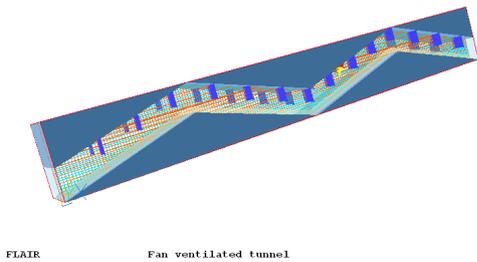


Geometry & Grid (200x25x50)



Smoke contours
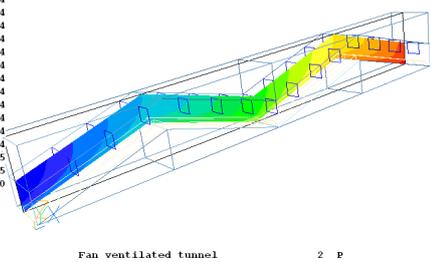
## Residential buildings
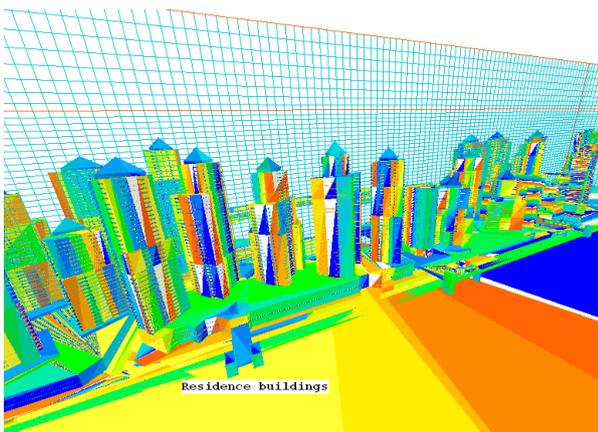


Geometry & Grid (208x167x46)

# Adapter
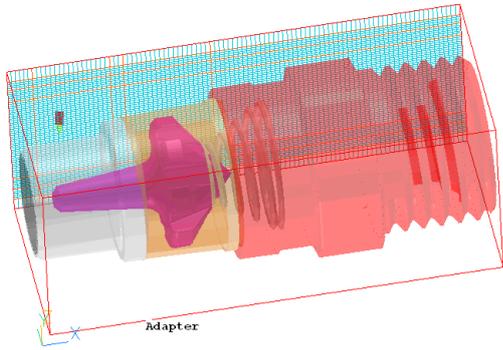


Geometry & Grid (100x60x60)

# Heat exchanger
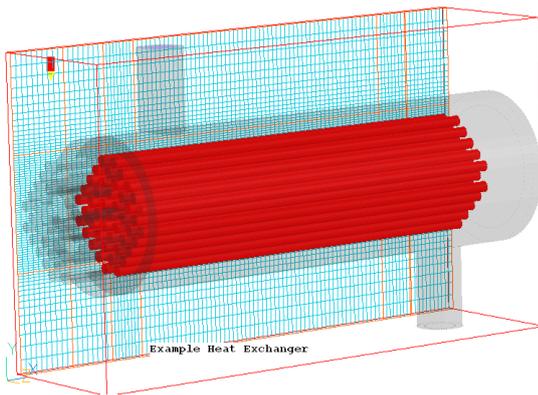


Geometry & Grid (104x80x63)

# Valve study
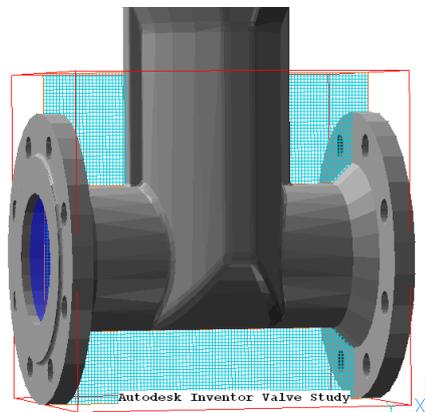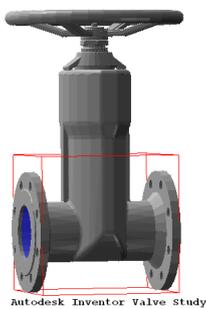




Geometry & Grid (100x100x100)

| Library Case | Grid size (NxxNYxNZ) | No. of CPU | Speed-up | Remarks |
|---|---|---|---|---|
| 100 | 100x100x100 | 1 | 1.00 | Heat conductivity (1 equation) |
|  | 100x100x100 | 2 | 1.84 |  |
|  | 100x100x100 | 4 | 3.41 |  |
| 278 | 100x100x100 | 1 | 1.00 | Natural convection in a 3D cubical Box |
|  | 100x100x100 | 2 | 1.93 |  |
|  | 100x100x100 | 4 | 3.49 |  |
| 805 | 100x100x100 | 1 | 1.00 | 3D laminar flow around a sphere |
|  | 100x100x100 | 2 | 1.90 |  |
|  | 100x100x100 | 4 | 3.50 |  |
| v104 | 90x90x96 | 1 | 1.00 | Drill-bit case |
|  | 90x90x96 | 2 | 1.81 |  |
|  | 90x90x96 | 4 | 3.28 |  |
| h205 | 80x80x80 | 1 | 1.00 | Cooling of 12 Chips |
|  | 80x80x80 | 2 | 1.78 |  |
|  | 80x80x80 | 4 | 3.63 |  |
| i212 | 100x80x50 | 1 | 1.00 | People in Office |
|  | 100x80x50 | 2 | 1.70 |  |
|  | 100x80x50 | 4 | 2.93 |  |

**Industrial applications**

| Project title | Grid size (NXxNYxNZ) | No. of CPU | Speed-up |
|---|---|---|---|
| Multi-story garage | 84x50x110 | 1 | 1.00 |
|  | 84x50x110 | 2 | 1.67 |
|  | 84x50x110 | 4 | 2.20 |
| Flow around ship | 30x30x150 | 1 | 1.00 |
|  | 30x30x150 | 2 | 1.99 |
|  | 30x30x150 | 4 | 3.51 |
| Pipe assembly | 98x98x119 | 1 | 1.00 |
|  | 98x98x119 | 2 | 2.43 |
|  | 98x98x119 | 4 | 3.50 |
| Fan-ventilated tunnel | 200x25x50 | 1 | 1.00 |
|  | 200x25x50 | 2 | 1.62 |
|  | 200x25x50 | 4 | 2.45 |

| | | | |
|---|---|---|---|
| Residence buildings | 208x167x46 | 1 | 1.00 |
| | 208x167x46 | 2 | 1.85 |
| | 208x167x46 | 4 | 3.48 |
| Adapter | 100x60x60 | 1 | 1.00 |
| | 100x60x60 | 2 | 1.85 |
| | 100x60x60 | 4 | 3.00 |
| Heat exchanger | 104x80x63 | 1 | 1.00 |
| | 104x80x63 | 2 | 1.74 |
| | 104x80x63 | 4 | 2.85 |
| Valve study | 100x100x100 | 1 | 1.00 |
| | 100x100x100 | 2 | 1.70 |
| | 100x100x100 | 4 | |

**The system, compiler and PHOENICS version used for the above benchmark were:**

4 Pentium PCs cluster. (3.00 GHz; 1.00GB of Ram)
Ethernet network card and connection:  100Mbit
Switch for connecting PCs in local network:
Windows XP professional

Fortran compiler:  Compaq Visual Fortran compiler V6
PHOENICS version:  V3.6.1

Please note that for all the above benchmark figures, the speed-up values are deduced from comparisons between run times of Parallel PHOENICS on one and on many processors. Comparisons with run times for sequential PHOENICS are not made because differences between the parallel and sequential linear-equation affect the reults.

Parallel PHOENICS makes optimal decomposition automatically, i.e. users can run the parallel PHOENICS for any case (within the parallel limitations) using usual Q1 without additional settings.

**Additional information**

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1. Generally,
   - the more grid numbers, the better performance.
   - the whole-field solver provides better performance
   - the parallel calculation using a multi-CPU cluster requires less computer memories on each CPU of the cluster than that the sequential calculation requires on a single CPU.

2. For evenly distributed number of grid in all directions such as 100x100x100, odd numbers, such as 3, 5, of CPUs are not recommended for the parallel calculation. However, if NX=1000 and NY=NZ=10, the 3 and 5 CPUs will give a good performance. The principle is that the time of data exchange must be less than the calculation time of 1 CPU of the cluster.


3. Although the parallel PHOENICS makes optimal decomposition automatically, a better performance can be achieved by selecting the whole-field mode of solution for the solved variables as long as the convergence is secured. In that case, the user should use the following statements, for example:
 SOLUTN(P1  ,Y,Y,Y,N,N,N)
 SOLUTN(U1  ,Y,Y,Y,N,N,N)
 SOLUTN(V1  ,Y,Y,Y,N,N,N)
 SOLUTN(W1  ,Y,Y,Y,N,N,N)
 SOLUTN(TEMP,Y,Y,Y,N,N,N)

If the user does not select the whole-field solver for solution of ALL variables then decomposition in Z-direction will not be possible.




**Parallel PHOENICS can not currently handle problems involving:**

GENTRA
Surface-to-surface radiation
FGEM