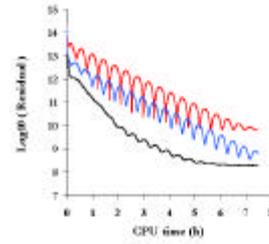


MIGAL for Phoenics 3.3

The New Coupled Algebraic
Multi-grid Solver

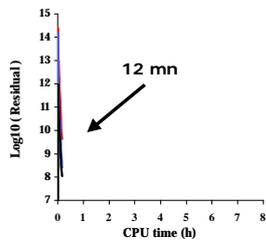
8 HOURS !!!!



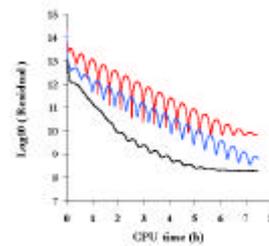
Which computer could run
PHOENICS
5, 10 or 30 times faster ?

Yours

Yours with MIGAL



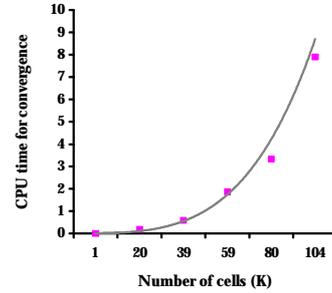
Instead of SIMPLEST



The Problem

- Simple, Simpler, Simplec, Simplest, PISO are segregating algorithms
- Then they need under-relaxation to ensure stability of the velocity-pressure coupling (FALSDT)
- They are at least N^2 algorithm

3D Lid-Driven Cavity Re=1,000



The Idea

- A better performance of the solver for each equation separately IS NOT the solution
- We must solve implicitly the velocity-pressure coupling before accelerating with multi-grid

How ?

- Linearize the momentum equations but do not solve
- Build the continuity equation
- Solve the algebraic system composed of 3x3 or 4x4 blocs : $\sum A_{nb} \phi_{nb} = S$

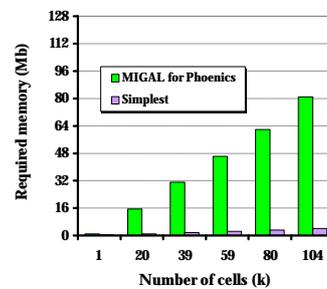
$$A_{nb} = \begin{bmatrix} Xu & Xv & Xp \\ Yu & Yv & Yp \\ Cu & Cv & Cp \end{bmatrix} \quad \phi_{nb} = \begin{bmatrix} U \\ V \\ P \end{bmatrix} \quad S = \begin{bmatrix} Sx \\ Sy \\ Sc \end{bmatrix}$$

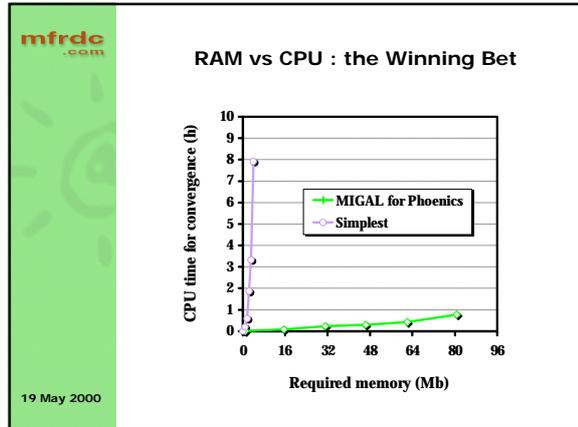
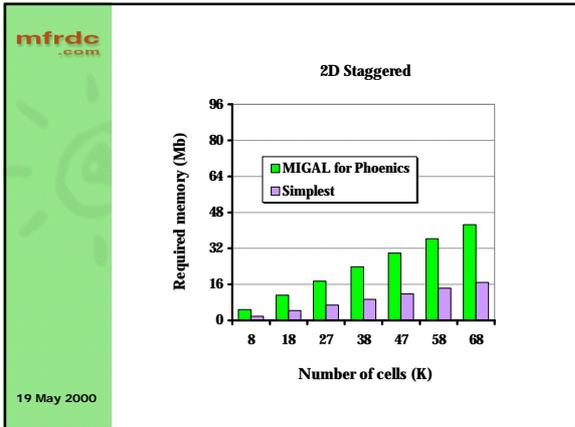
But...

- The CPU time cost per sweep increase (x10)
- Additional storage is needed (70 Mb for 100,000 3D cells)

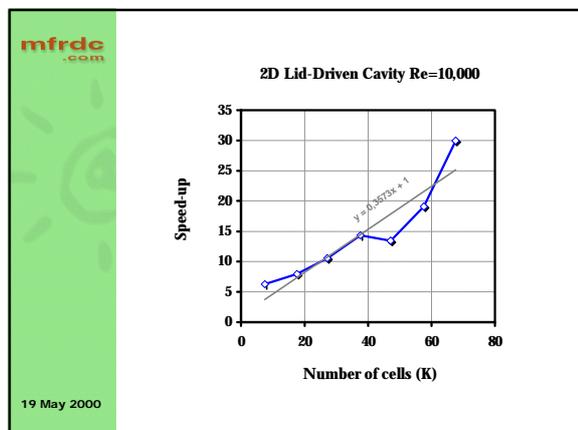
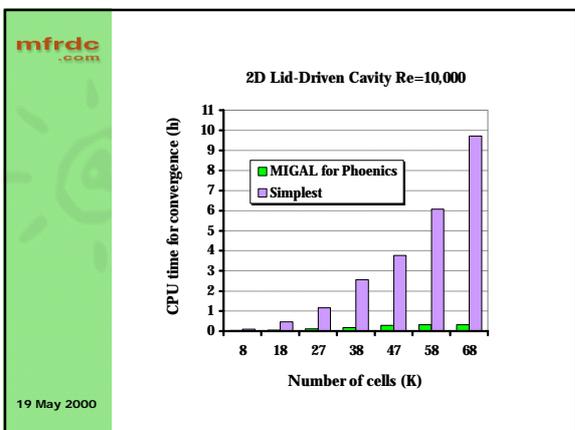
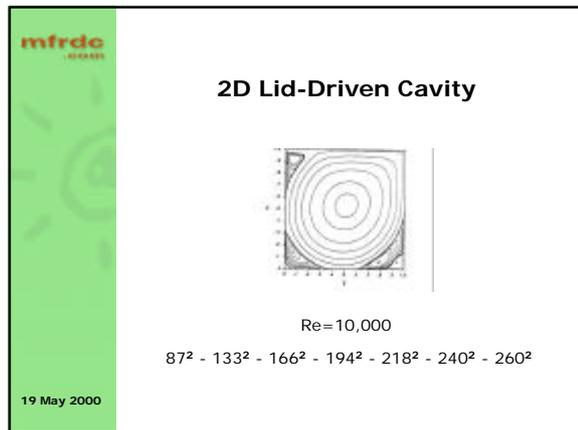
Mb/cell	Staggered	Co-locative
2D	4.E-4	3.E-4
3D	7.E-4	5.E-4

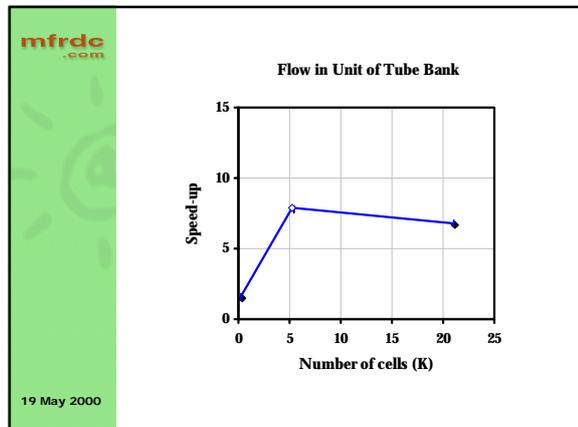
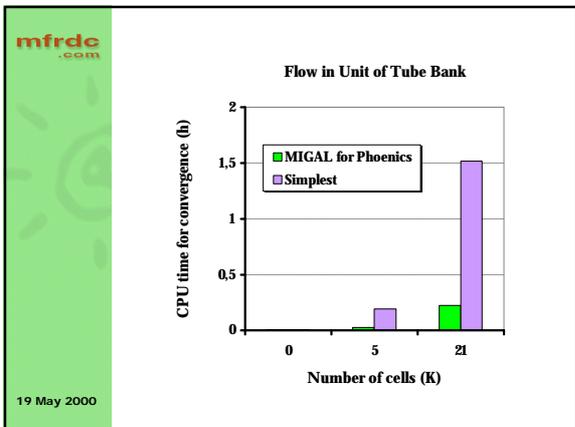
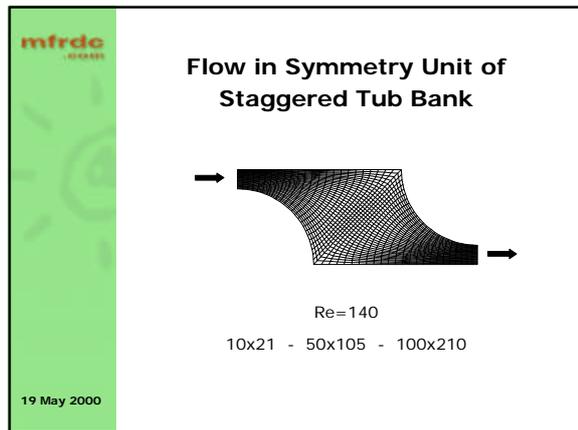
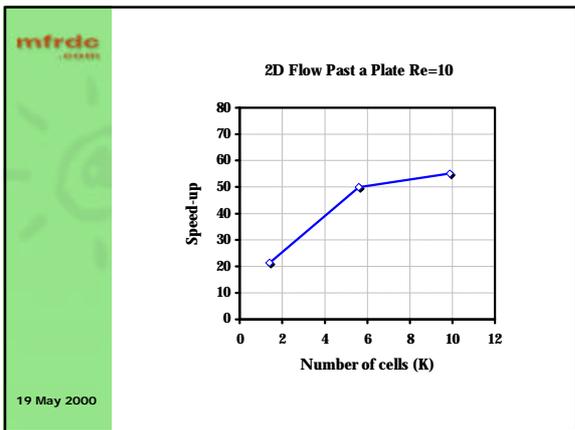
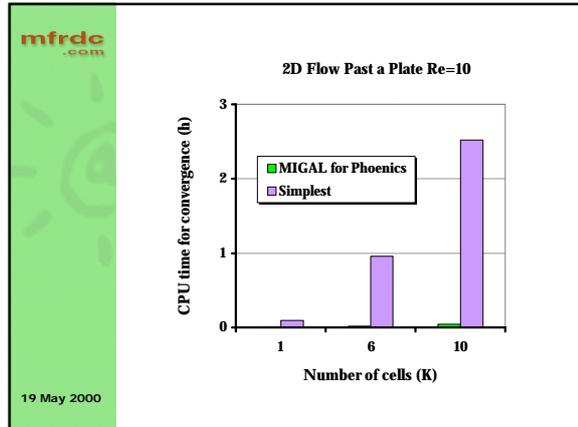
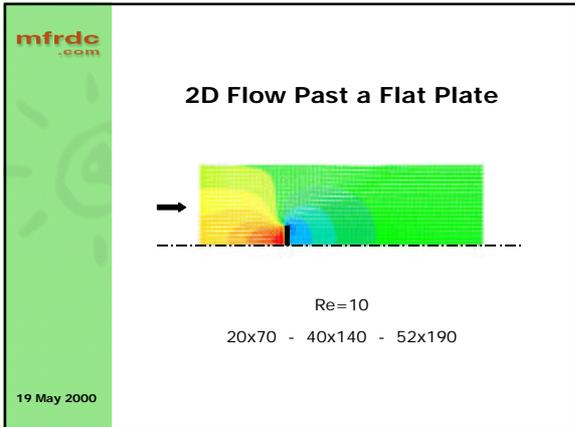
3D Staggered

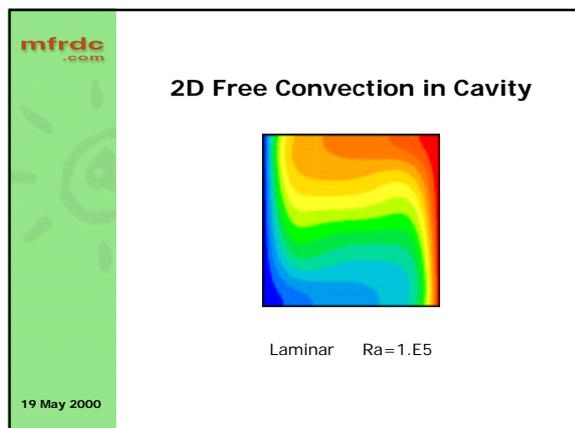
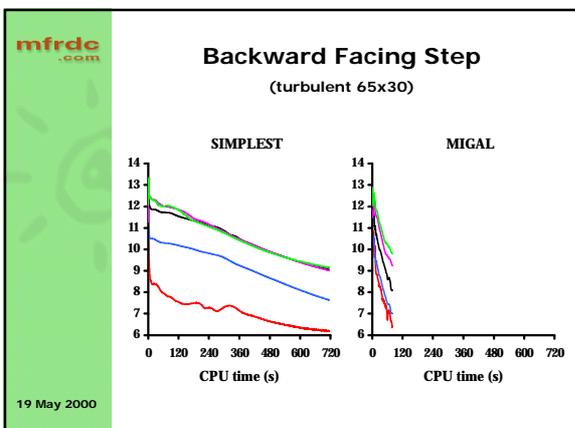
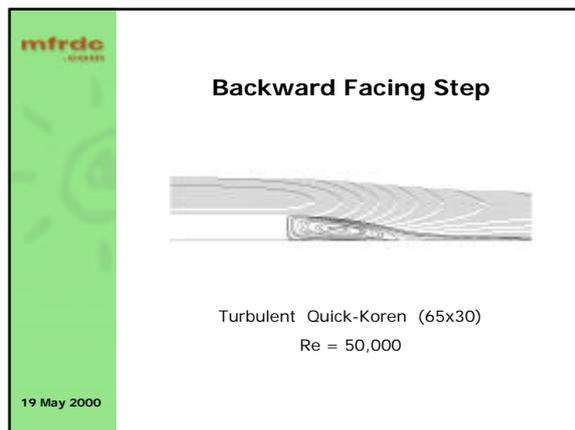
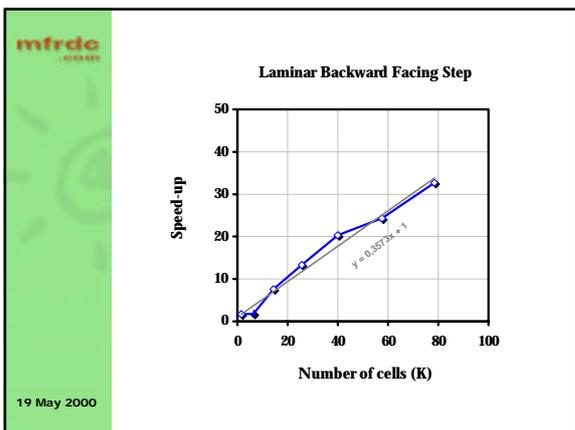
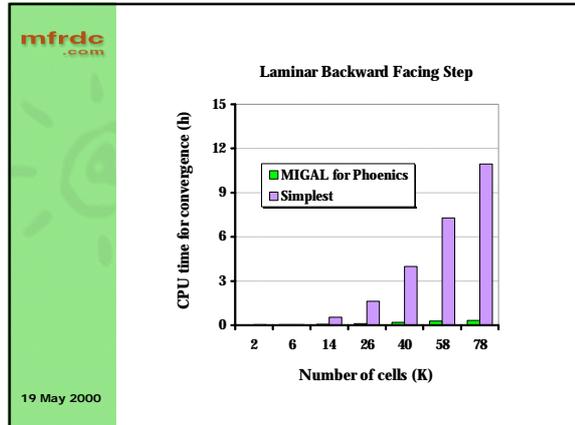
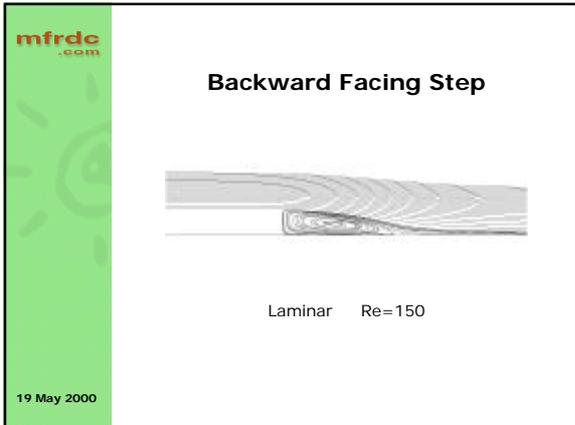


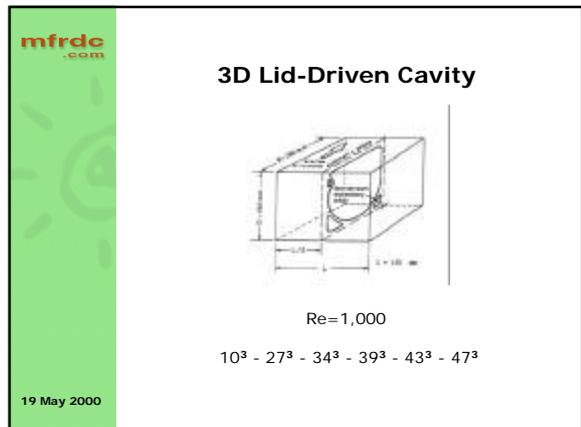
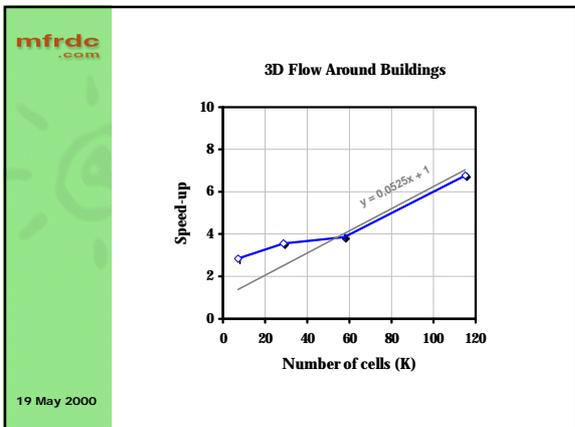
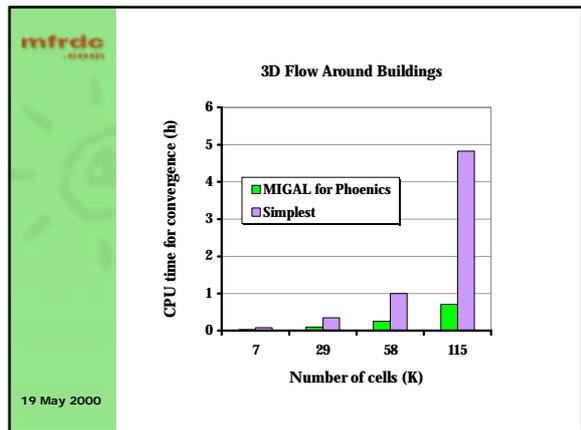
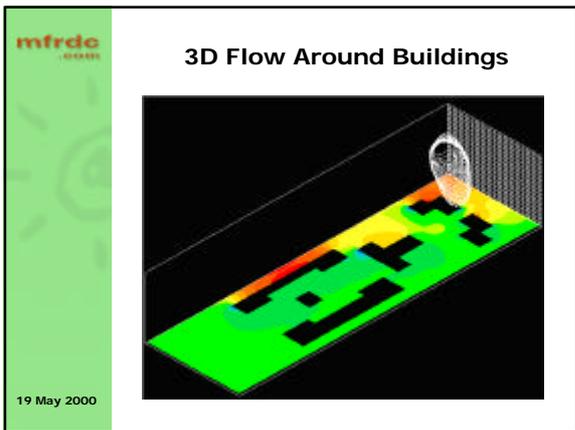
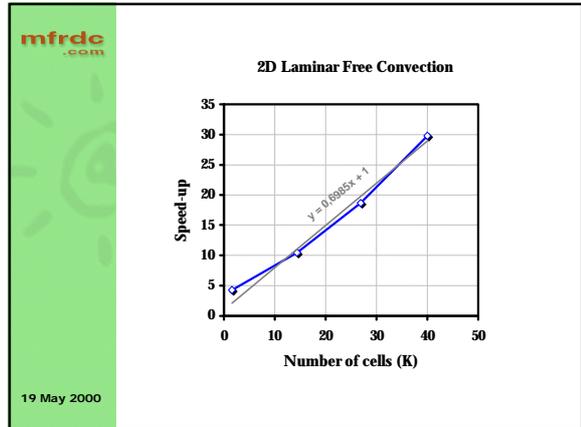
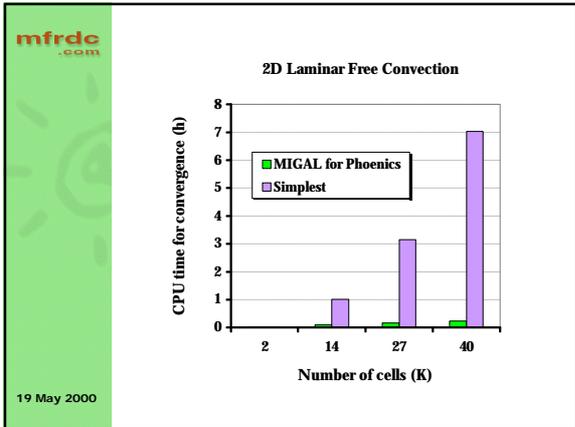


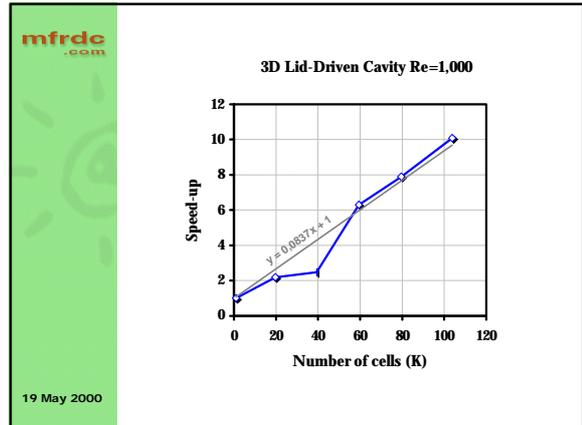
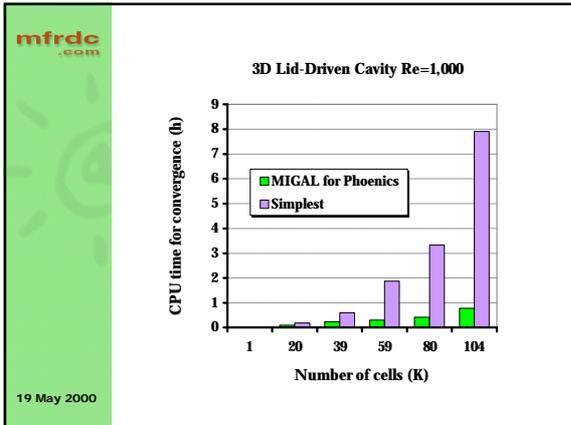
- mfrdc.com
- ### Library Cases
- 2D Lid-Driven Cavity Re=10,000
 - 2D Flow Past a Flat Plate Re=10
 - 2D Flow in Unit of Staggered Tube Bank
 - 2D Laminar Backward Facing Step
 - 2D Turbulent Backward Facing Step
 - 2D Laminar Free Convection
 - 3D Flow Around a Group of Building
 - 3D Lid-Driven Cavity Re=1,000
- 19 May 2000











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How to use MIGAL for Phoenics ?

19 May 2000

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Activating MIGAL (1/2)

- Set large false time steps
 - relax(U1, falsdt, 1.E+10)
 - relax(V1, falsdt, 1.E+10)
 - relax(W1, falsdt, 1.E+10)
- Activate MIGAL for pressure-velocity
 - spedit(MIGAL, SOLVED1, c, HYDRO)

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Activating MIGAL (2/2)

- Activate MIGAL for scalar variables
 - spedit(MIGAL, SOLVED3, c, SMOKE)
- Change default parameters
 - spedit(MIGAL, RELAX1, r, 0.9)
 - spedit(MIGAL, LITER3, i, 3)

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Conclusion

- Coupled Multi-grid Method are already of great interest for 2D and 3D flows.
- and will be unbeatable in the future.
- MIGAL is boosting Phoenics with large speed-ups increasing with the number of cells.

19 May 2000

Roadmap for MIGAL

	1991	1994	1997	2000	2003
RAM	8Mb	32Mb	128Mb	512Mb	2Gb
CELLS	8K	40K	160K	640K	2.5M
MIGAL	1h30	1h30	1h30	1h30	<2h
SIMPLEST	2h	6h	21h	>90h	>500h

With an affordable PC under 2500\$

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