Summary of Recent Activities

CEMM Project Meeting

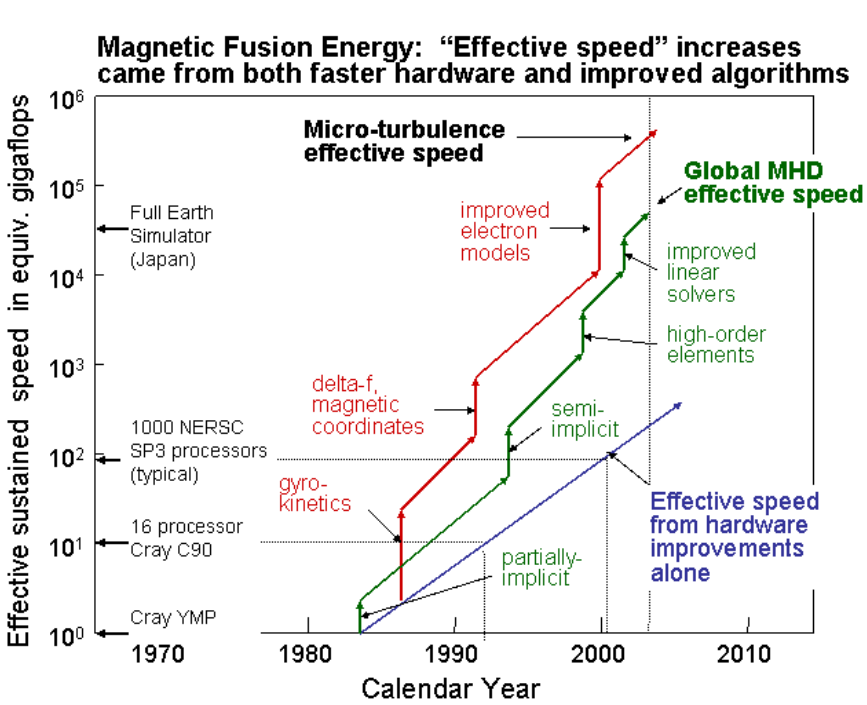
October 26 2003

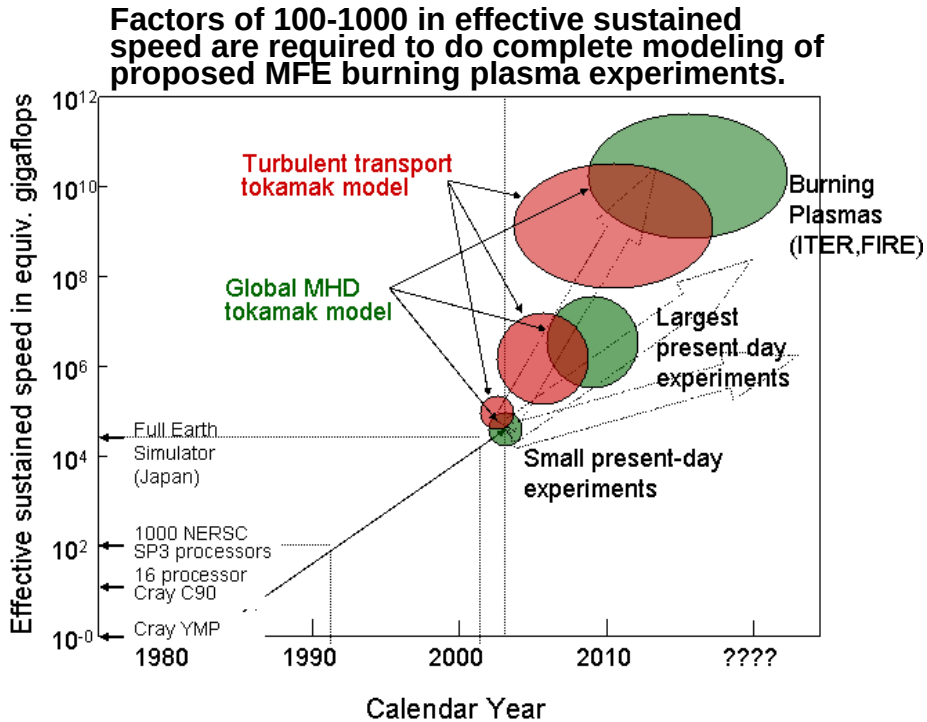
- Summer PAC meeting
- ScaLes Workshop
- Fusion Simulation Project Status
- SciDAC re-competition
- CEMM Challenge Problems
- Towards a common graphics capability
- AMR progress
- A new kind of Finite Element
- Other Developments

- Summer PAC meeting (June 5-6…on CEMM Web Site)
  - – Computational and algorithmic efficiency of the codes should be clearly identified and discussed
    - Parallel efficiency
    - algorithmic efficiency
  - – How to contribute to “Integrated Modeling” efforts where traditional separations between “microturbulence”, “transport”, and macroscale MHD break down
    - edge pedestal phenomena
    - neoclassical tearing
    - sawtooth crashes
  - –Benchmarking of M3D and NIMROD for the 1-1 mode in CDX-U needs to be brought to closure
  - –More emphasis on diagnosing and understanding the nonlinear dynamics in the computational simulations
  - –Should move expeditiously toward regular simulation of fusion systems with a two-fluid model

- SCaLeS Workshop

Science-Based Case for Large-Scale Simulation. Workshop June24/25 2003. Volume 1 of report delivered to Ray Orbach on July 31, 2003. see: http://www.pnl.gov/scales. Vol 2 in progress. (plasma science section done, see: http://w3.pppl.gov/~jardin/scales)





Fusion Simulation Project Status ($4 M budgeted in FY05)

- On 23 October, John Willis appointed an interm Fusion Simulation Steering Committee to function for the next year:
  - Don Batchelor, ORNL
  - Doug Post, LANL
  - Randy Bramley, Indiana U.
  - Phil Collela, LBL
  - Steve Jardin, PPPL
  - John Cary, U. Colorado
  - Ron Cohen, LLNL
- Investigate technical and management aspects of other integrated scientific simulation projects
- Prepare a report regarding organization and management structure of a project such as the FSP
  - tasks of committees
  - responsibilities of key management personnel
- Consider and evaluate (using community workshops):
  - potential focused integration initiatives (FIIs)
  - computational frameworks that might be used
  - computer hardware needed to carry out the project
- Prepare a report that contains
  - detailed plans for implementing one or more focused integration initiatives in the initial phase of the FSP
  - physics content and objectives of the FIIs, approach to integration, and computational framework to be used
- A comparative review process will be used to form funded teams that will begin the work on 1 or 2 FIIs selected for the initial stage.

- SciDAC funding and re-competition
  - Existing funding was for 3 years. Most universities received funding in FY 2001, 2002,2003. That's it!
  - Labs received only 3-months funding in 2001. Will receive 9-months of funding in FY 2004.

- Announcement for next round of proposals ($3M) will come out in early Dec. Due in 10 weeks (~March 1). Selection to be made in 9-10 weeks (Early May 2004)

- More focused criteria: toroidal physics of importance to burning plasmas such as in ITER.
  - microturbulence
  - extended MHD
  - edge physics
  - other areas where a case can be made
  - connection to other fields will be dropped as a selection criteria

- I expect our team to stay together, and for the funding to roughly double. We need to form a proposal writing team, and to write a strong proposal.
  - let me know if you want to be involved in writing team
  - also let me know if you don't want to be part of new proposal
  - dinner meeting this week to discuss CEMM functioning?

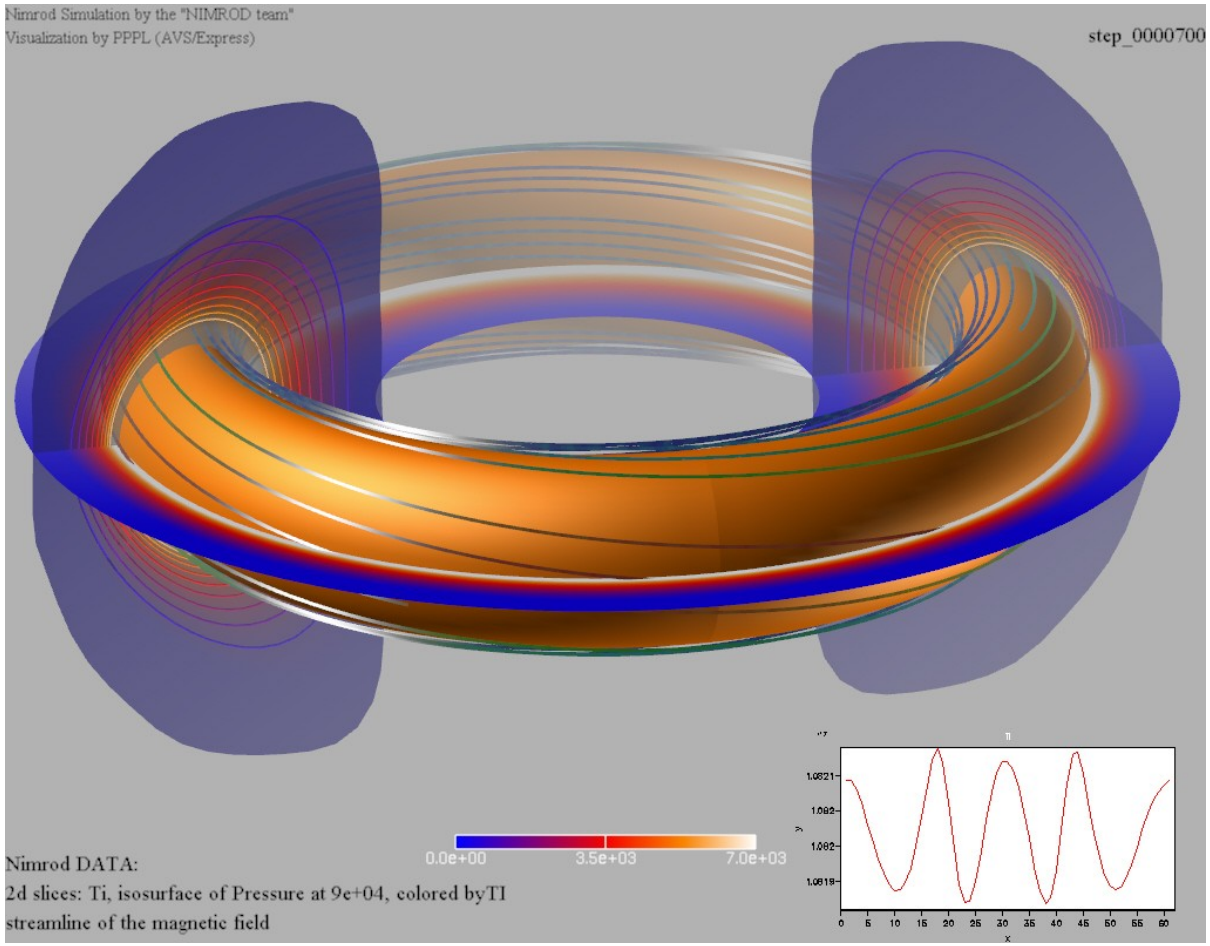
- CEMM Challenge Problems

- Posted on the WEB: (Updated 08/30/03)

1. Anisotropic heat Conduction
2. Two-Dimensional Tilt Mode
3. Magnetic Reconnection in 2D

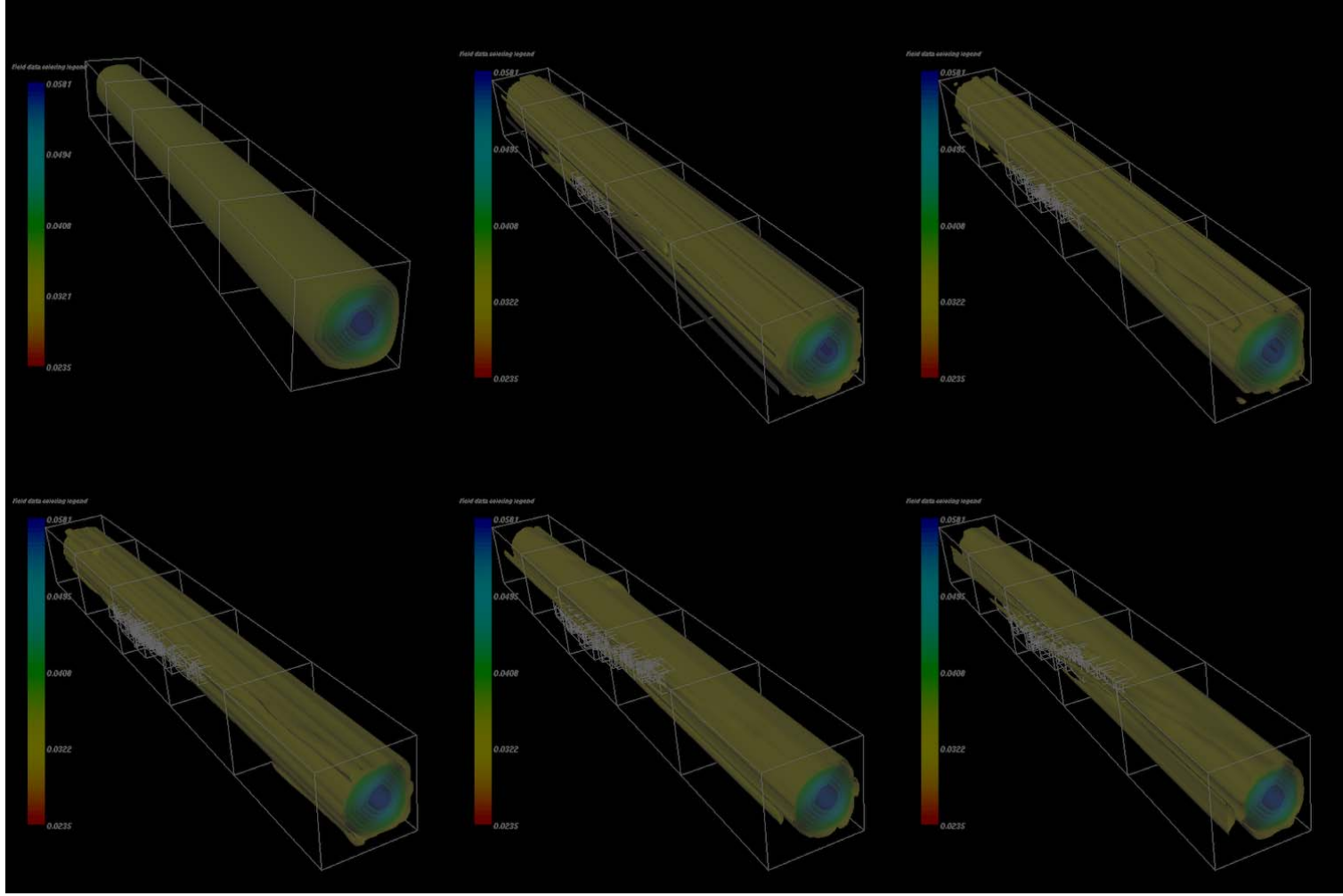
- Goal is to engage Applied Math community in incrementally more difficult problems typical of those encountered in CEMM codes.
- Paul Fischer (ANL) co-author of a book on High-Order Finite Elements, has completed #1, working on #2
  - Plans to make it a publication
- RPI (Trellis group) has done #2, working on #1

- Towards a common graphics capability



- Klasky has read NIMROD HDF5 file (supplied by Kruger) into AVS and produced graphic output
- Next step is to add the capability to the M3D-AVS graphics package to accept NIMROD data as well as M3D data
- Follow-on will be to add comparative plotting capabilities:
  - for example, differences of a scalar function between M3D and NIMROD

- AMR progress



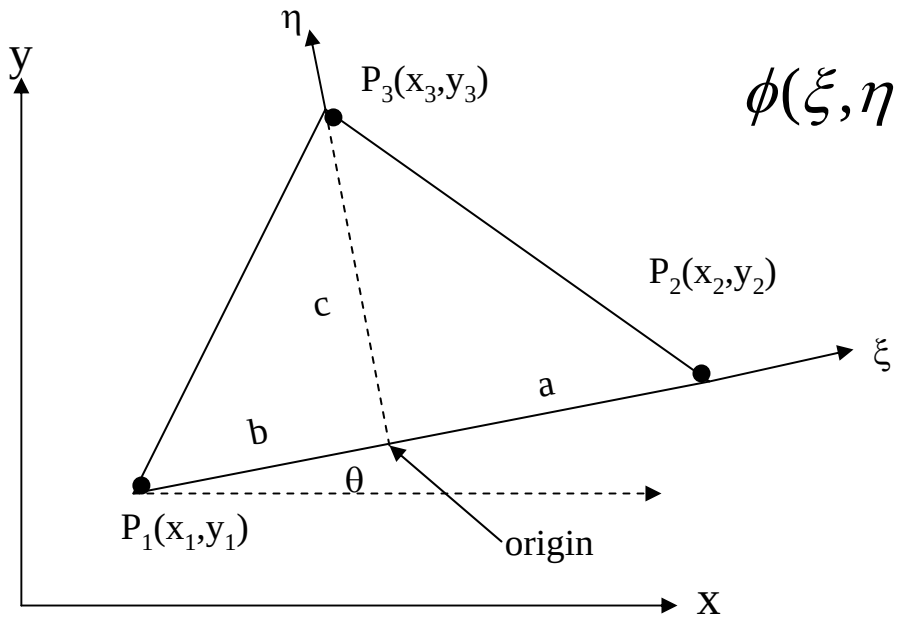
• Samtaney now has high-resolution AMR calculations of both inside and outside pellet injection into a torus

• Chambo improvements to recognize anisotropy underway

• Working with Carol Woodward's group at LLNL to incorporate implicit time advance with AMR

•A new kind of Finite Element

Reduced Quintic 2D Triangular Finite Element



$$\phi(\xi,\eta) = \sum_{k=1}^{20} a_k \xi^{m_k} \eta^{n_k}$$

k	m_k	n_k
1	0	0
2	1	0
3	0	1
4	2	0
5	1	1
6	0	2
7	3	0
8	2	1
9	1	2
10	0	3
11	4	0
12	3	1
13	2	2
14	1	3
15	0	4
16	5	0
17	3	2
18	2	3
19	1	4
20	0	5

Require that the normal slope along the edges have only cubic variation:

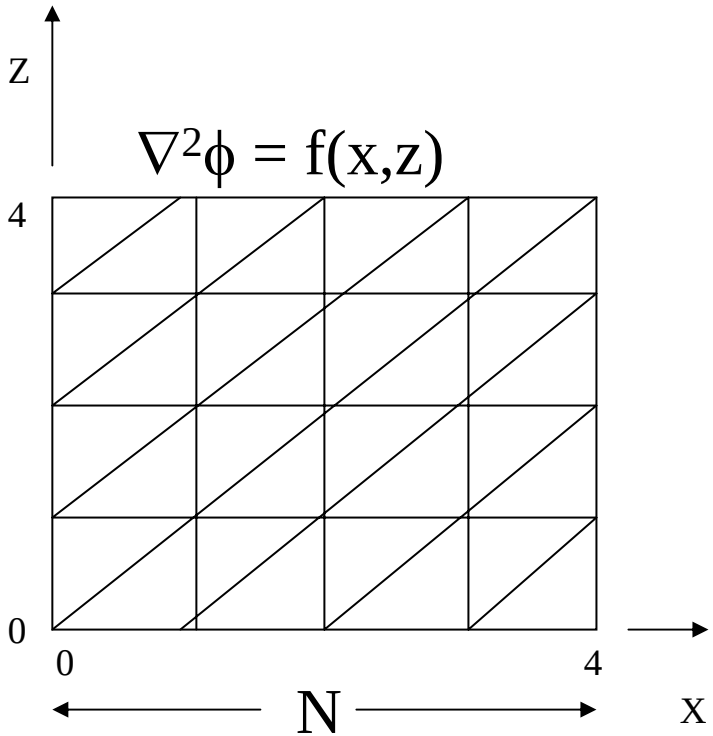
$5b^4ca_{16} + (3b^2c^3 - 2b^4c)a_{17} + (2bc^4 - 3b^3c^2)\,a_{18} + (c^5 - 4b^2c^3)a_{19} - 5bc^4a_{20} = 0$

$5a^4ca_{16} + (3a^2c^3 - 2a^4c)a_{17} + (-2ac^4 - 3a^3c^2)\,a_{18} + (c^5 - 4a^2c^3)a_{19} - 5ac^4a_{20} = 0$

Implies C_1 continuity at edges and C_2 at nodes !

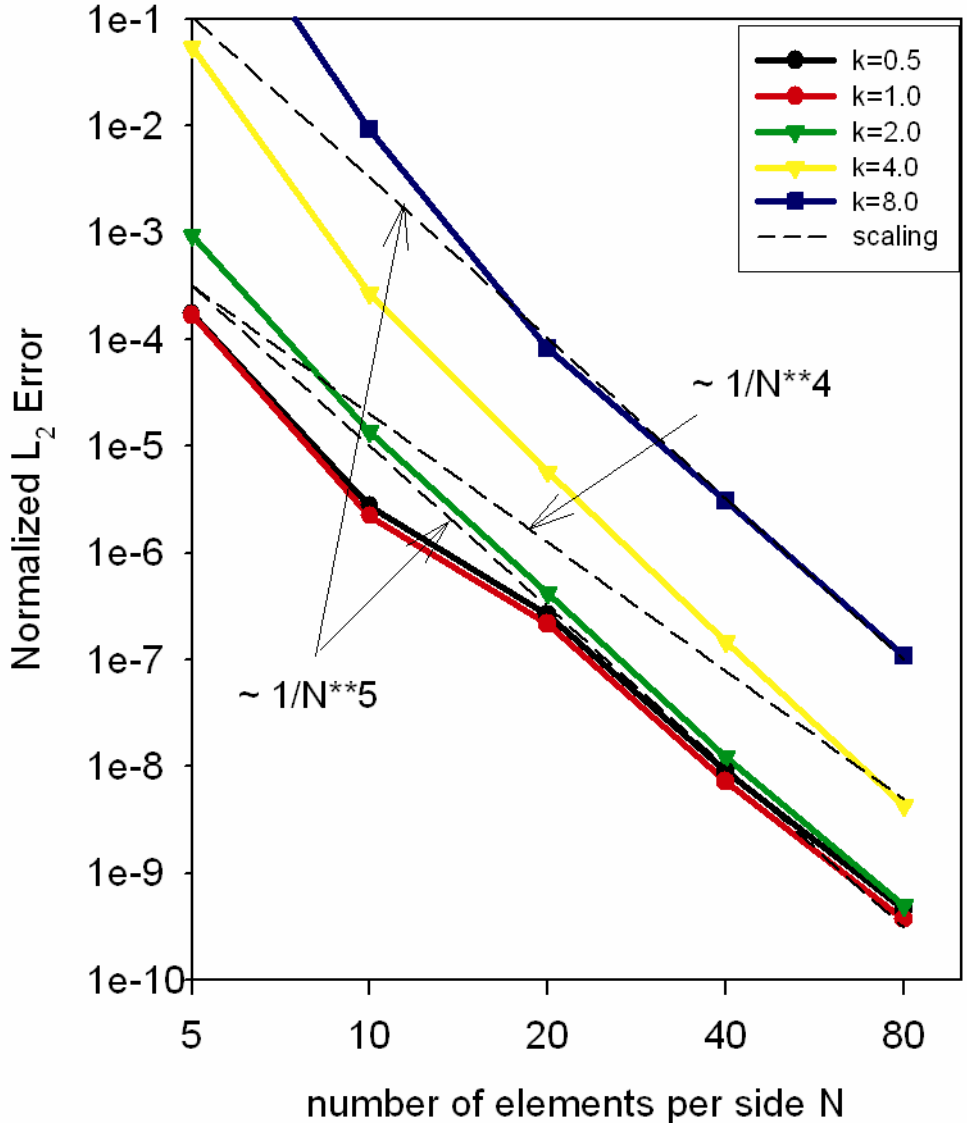
20 – 2 = 18 unknowns:

These are determined in terms of [ϕ, ϕ_x, ϕ_x , ϕ_{xx}, ϕ_{xy}, ϕ_{yy}] at P_1,P_2,P_3



Reduced Quintic Triangular Element

$\phi = x(x-L_x)z(x-L_z)\sin kx$: Elliptic solve



- Other Developments

- 2004 SciDAC PI meeting will be Mar 22-24 in Charleston, SC
  - Two-pagers will again be required

- US/Japan Exchange FP2-9, Extended MHD Modeling of Fusion Plasmas proposed to take place around April 25, 2004 in conjunction with the CEMM/Sherwood meeting (April 25-28) in Montana

- JIFT workshop on “Theory-Based Modeling and Integrated Simulation of Burning Plasmas” in Japan Dec 15-17 2003 http://p-grp.nucleng.kyoto-u.ac.jp/bpsi/en/