CPPG / MICS Activities

Presented by

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topics

- PPPL NERSC Usage
- CPPG Activities
- Interaction with SciDAC ISICS
- Fusion Simulation Project (FSP) update

PPPL NERSC Usage

	FY2002	FY2003 (request)
PVP	12,000	0
MPP	3,400,000	6,100,000

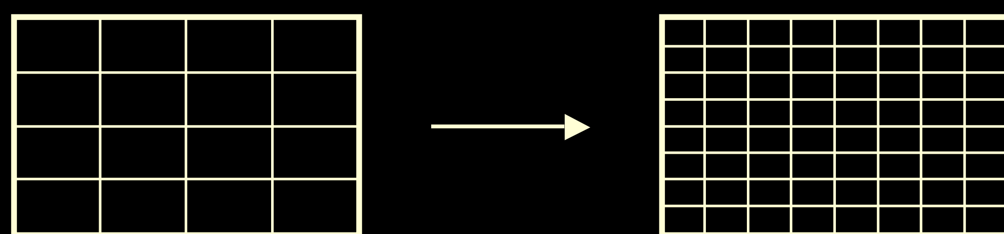
Most PVP work has shifted to local Intel LINUX Cluster

FY 2003 MPP Requests (in order of time requested)

1. Turbulent transport
2. Stellarator Optimization
3. MHD stability
4. Experimental Analysis
5. Beam physics
6. Magnetic Reconnection
7. RF Heating and CD

PPPL NERSC Issues

1. Transfer time for large data sets excessive @ ~ 30Mb/s
2. Computer resources will be an issue this year
3. MPP platforms are not ideal for time-dependent fluid type codes…scale well only by increasing zones with N



N processors….Δt

4N processors….$\Delta t/2$

Since running time is proportional to Δt^{-1}, typical fluid codes can only use more processors if running time (ie, wall clock time) increases with the processor number!!

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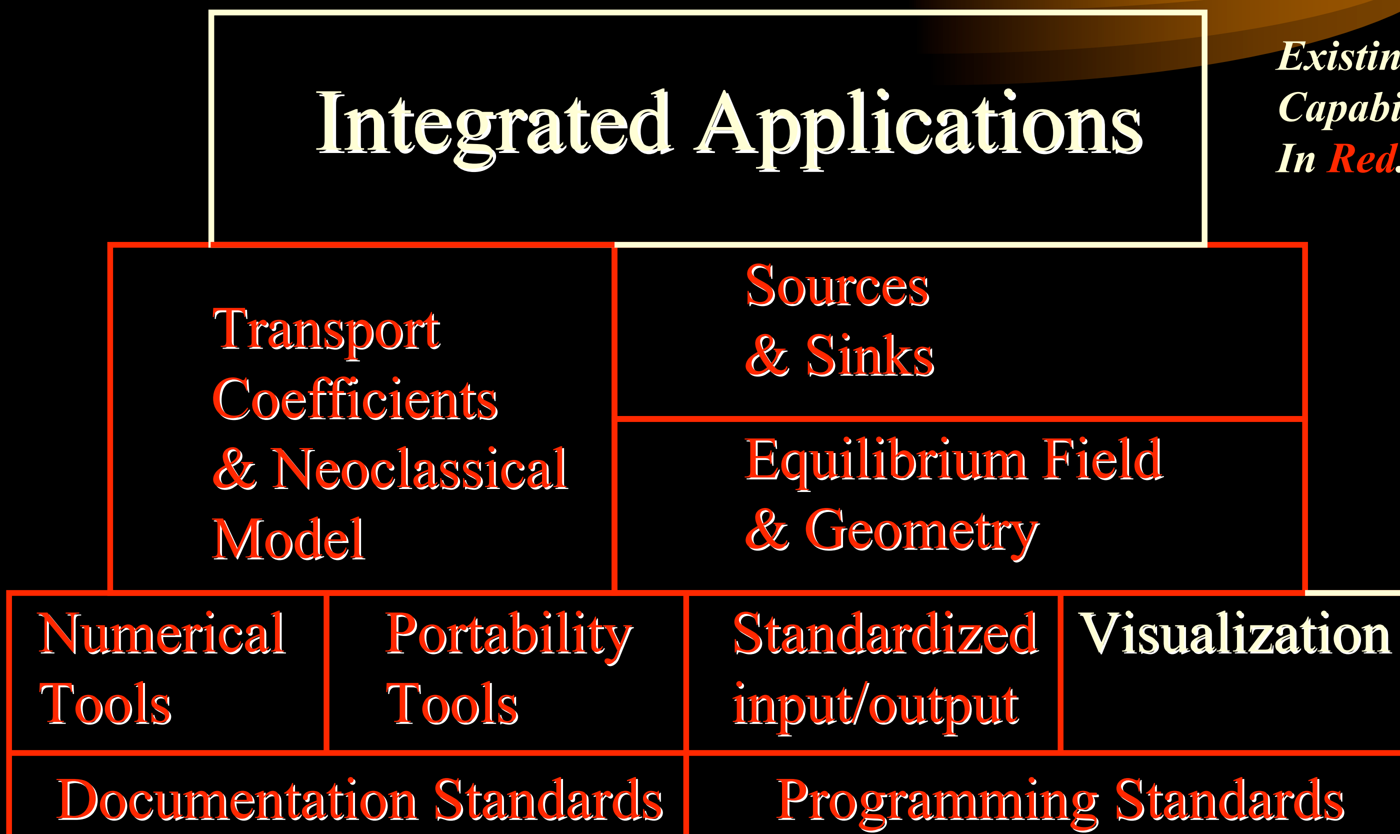
CPPG Activities

- Support and develop integrated modeling codes TRANSP / TSC
- Develop and optimize major PPPL codes on parallel platforms, in particular the SciDAC codes M3D and GTC
- Advanced Scientific Visualization and Display Wall
- Grid Computing , GLOBUS, and the Fusion Collaboratory
- Develop Adaptive Mesh Refinement (AMR) code for MHD
- NTCC (plasma physics discipline specific) modules library
- Support new projects in modern computing

NTCC Modules Library:

Physics on a Foundational of Computational Science...



Existing Capabilities In Red.

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Interaction with SciDAC ISICs

- An Algorithmic and Software Framework for Applied PDEs
  - Incorporation of MHD into LBL Chambo Parallel AMR framework
  - Jointly developed 8-wave generalized upwind method
  - Initial applications to reconnection problem and pellet injection
- Terascale Optimal PDE Solvers (TOPS)
  - Direct comparison between PETSc and HYPRE routines for solving sparse linear systems…led to factor of 2 improvement in running time for M3D (so far)
  - Comparing Algebraic Multigrid (AMG) from HYPRE, Incomplete LU (ILU) from HYPRE, Additive Schwartz (ASM) from PETSc
  - Additional discussions with D. Keyes, et al. on restructuring, investigating non-linear solvers (Newton-Kyrlov)
- Terascale Simulation Tools and Technologies (TSTT)
  - Evaluating higher order finite elements by interfacing with RPI SCOREC software
  - Initially using simplified 2D MHD problem , but similar in structure to M3D
  - Discussions regarding spectral elements

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Fusion Simulation Project (update)

Feb 22, 2002 charge letter from James Decker to FESAC:

- What is the current status of integrated computational modeling and simulation
- What should be the vision for integrated simulation of toroidal confinement fusion systems?

- What new theory and applied mathematics are required for simulation and optimization of fusion systems?
- What computer science is required for simulation and optimization of fusion systems?
- What are the computational infrastructure needs for integrated simulation of fusion systems?
- How should integrated simulation codes be validated, and how can they best be used to enable new scientific insights?

Report on first 2 by July 15 (done) and complete by Dec 1

Fusion Simulation Project FESAC Subcommittee:

Jill Dahlburg, General Atomics *(Chair)*
James Corones, Krell Institute, *(Vice-Chair)*
Donald Batchelor, Oak Ridge National Laboratory
Marsha Berger, New York University
Randall Bramley, Indiana University
Martin Greenwald, Massachusetts Institute of Technology
Stephen Jardin, Princeton Plasma Physics Laboratory
Sergei Krasheninnikov, University of California - San Diego
Alan Laub, University of California - Davis
William Lokke, Lawrence Livermore National Laboratory
Jean-Noel Lebouef, University of California - Los Angeles
John Lindl, Lawrence Livermore National Laboratory
Marshall Rosenbluth, University of California - San Diego
David Ross, University of Texas - Austin
Dalton Schnack, Science Applications International Corporation
Harold Weitzner, New York University

Fusion Simulation Project –

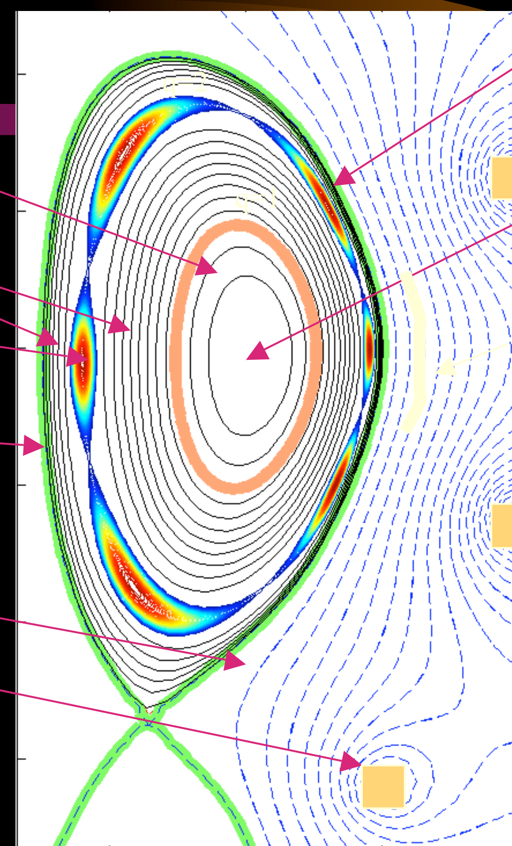
Summary of First Report

The subcommittee recommends that a major initiative be undertaken:

- Objective is to predict the behavior of plasma discharges in toroidal magnetic fusion devices on all relevant time and space scales
- Three major elements:
  - fundamental capabilities,
  - applications modules development, and
  - project integration
- New funding needed is $20 M for first year (FY04), ramping up to about twice that by FY06
- New research should be split between OFES and OASCR

Elements of an Integrated Tokamak Model

- Sawtooth region q < 1
  - (MHD and global stability)
- Core confinement region
  - (turbulent transport)
- Magnetic islands q = 2
  - (MHD and global stability)
- Edge pedestal region
  - (edge physics, MHD, turbulence)
- Scrape-off layer
  - (parallel flows, turbulence)
- Vacuum/Wall/Conductors/Antenna
  - MHD equilibrium, RF and NBI physics



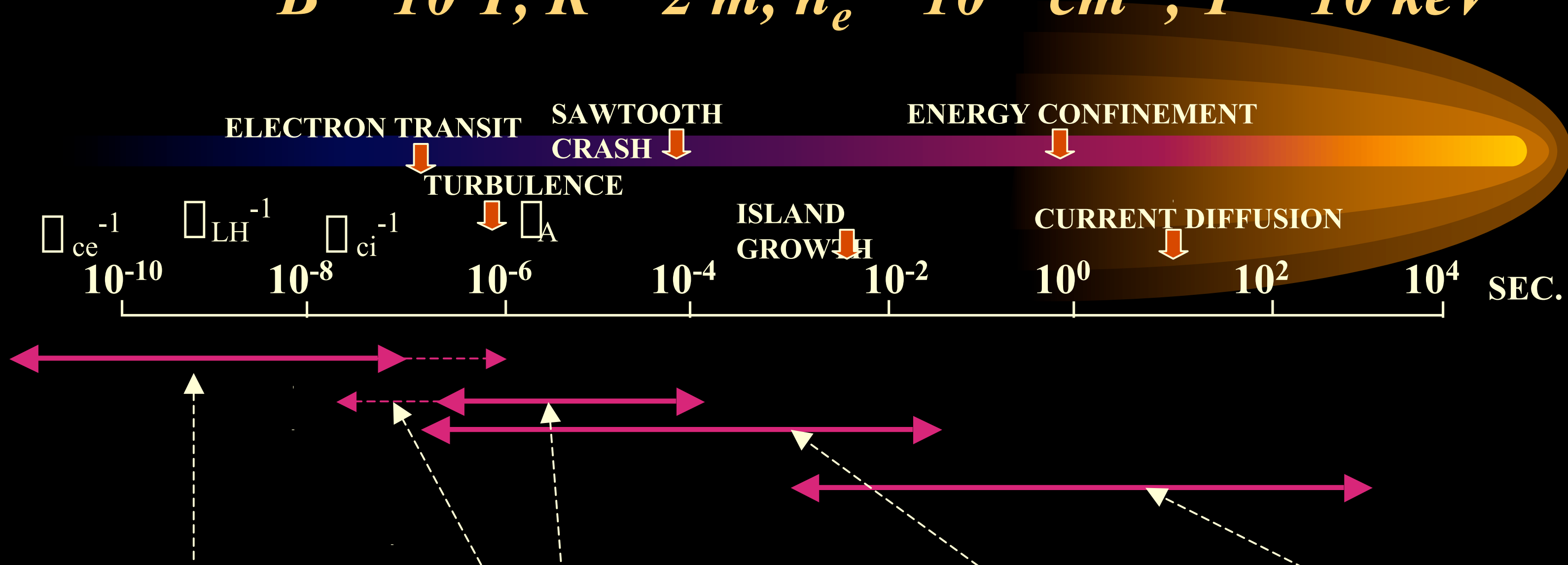
Note: regions interior to separatrix are determined by plasma "safety factor" profile q(ψ)…typically ~0.8 < q(ψ) < ~3.2

q(ψ) measures the average helical pitch (or twist) of the magnetic field on a constant ψ surface

Contours are of constant poloidal flux ψ. Magnetic field lines lie within constant ψ surfaces.

Pletzer

Typical Time Scales in a next step experiment with
$B = 10$ T, $R = 2$ m, $n_e = 10^{14}$ cm^{-3}, $T = 10$ keV



Single frequency and prescribed plasma background	Neglect displacement current, average over gyroangle, (some) with electrons	Neglect displacement current, integrate over velocity space, neglect electron inertia	Neglect displacment current, integrate over velocity space, average over surfaces, neglect ion & electron inertia
RF Codes	Gyro-kinetics Codes	Extended MHD Codes	Transport Codes
wave-heating and current-drive	turbulent transport	macro stability	discharge time-scale

Initial FSP Activity will concentrate on ~4 thrust areas. These will draw on SciDAC for fundamentals, and on Applied Math/CS for algorithms and frameworks.

- Interaction of RF waves with plasma
- Plasma micro-turbulence
- MHD in collisionless plasma
- National Transport Code Collaboration

- Plasma Edge
- Turbulence on transport timescale
- Island growth
- Whole device modeling and optimization

Summary---FSP Activities

- Web site at www.isofs.info
- 23 May 2002 Community Meeting
- First report issued 12 July 2002
- 15 August Subcommittee meeting at ORNL
- 17-18 September FSP Workshop (planned)
- Dec 2002 Final Report Due