核燃焼プラズマ統合コード研究会
九大応力研
2004/03/18-19

核燃焼プラズマ統合コード構想
状況報告

福山　（京大工）

- 会議報告
- 欧米の状況
- TASKコード現況
- 今年度の課題
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会議報告

- 2003/07/31-08/31
  - 統合コード研究会（京大）
- 2003/12/15-17
  - 日米ワークショップ（京大会館）
- 2004/01/27
  - 核融合研究開発基本問題研究会（東京）
- 2004/03/8-11
  - ITPA TG meeting（那珂）
- 2004/03/12
  - 核融合フォーラム定常運転サブクラスター会合（那珂）

欧米の状況

- 米国
  - SciDAC
  - Fusion Simulation Project
    - Steering Committee (Chairman: D. Post)

      2003/11発足

      2004 夏の終わりまでに計画策定

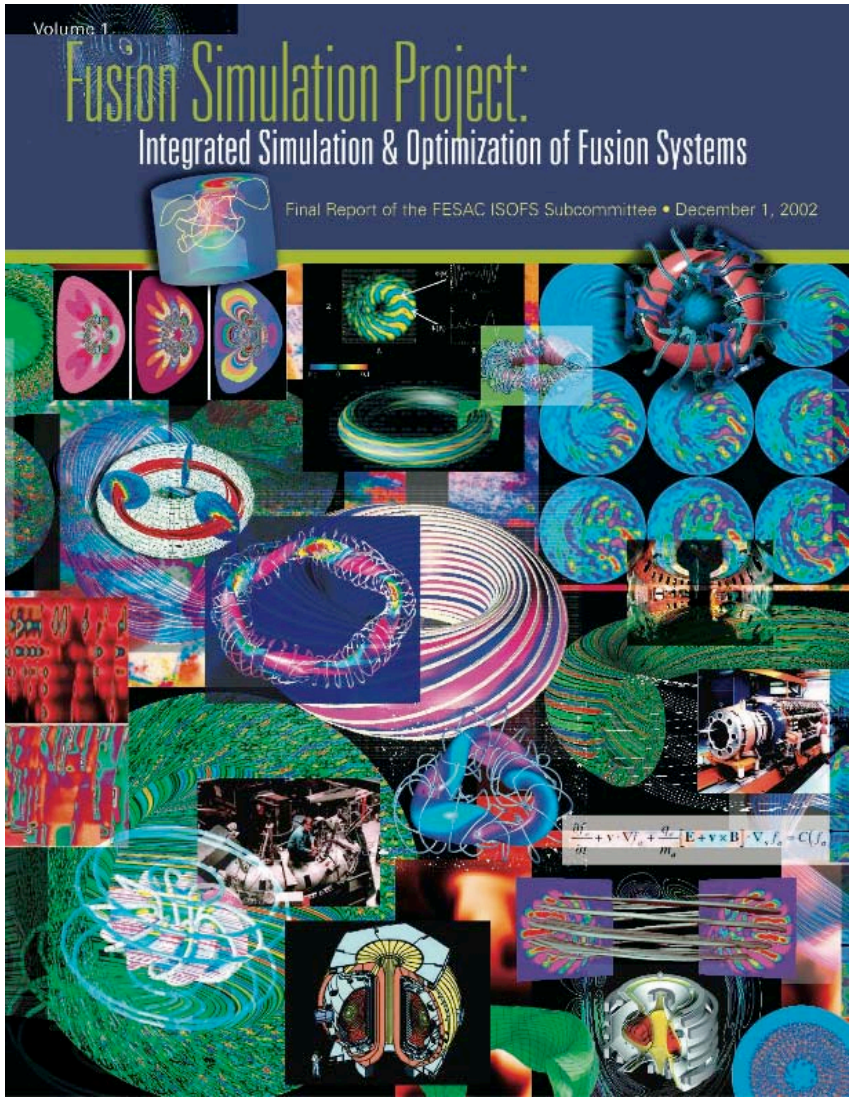
- EU
  - Integrated Transport Modelling Task Force
    - 2003/12 活動開始
    - TF Leader (A. Becoulet)

US Fusion Community has proposed a "Fusion Simulation Project"

- FESAC and DOE have proposed the "Fusion Simulation Project"
- Ramp up to $20 M per year in 3 to 4 years, begin with $4M in FY05

Fusion Simulation Project, Integrated Simulation and Optimization of Fusion Systems

Jill Dahlburg, *General Atomics (Chair)*
James Corones, *Krell Institute, (Vice-Chair)*
Donald Batchelor, *Oak Ridge National Laboratory*
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*
Jean-Noel Leboeuf, *University of California - Los Angeles*
John Lindl, *Lawrence Livermore National Laboratory*
William Lokke, *Lawrence Livermore National Laboratory*
Marshall Rosenbluth, *University of California - San Diego*
David Ross, *University of Texas - Austin*
Dalton Schnack, *Science Applications International Corporation*



Fusion Simulation Project Steering Committee task is to "design" project

- In November, 2003, DOE formed the Fusion Simulation Project Steering Committee to take the next step to make the project a real project
  - Douglass Post, chair, Los Alamos National Laboratory
  - Donald Batchelor, Oak Ridge National Laboratory
  - Randall Bramley, University of Indiana
  - John Cary, University of Colorado
  - Ronald Cohen, Lawrence Livermore National Laboratory
  - Phillip Colella, Lawrence Berkeley National Laboratory
  - Steven Jardin, Princeton Plasma Physics Laboratory
- Report due to DOE in later summer, 2004

Fusion Simulation Project Steering Committee task is to "design" project

- Report due to DOE in later summer, 2004
- Recommend:
  - Project goals
  - Project structure
    - What kind of modules, codes, etc.?
  - Project organization/governance/management structure
- Provide basis for "Request for Proposal" to be issued in late 2004
- Project to begin in 2005 with award of contract
  - Multi-institutional—labs, universities, industry
  - Multi-disciplinary—plasma physics, computer science, computational mathematics
  - Supported by DOE Office of Fusion Energy Sciences and DOE Office of Advanced Scientific Computing Research

Aims and Scope of the European Integrated Tokamak Modelling Task Force

Task Force Leader and Deputies: A. Bécoulet, P. Strand, H. Wilson

EFDA Field Coordinator: D. Campbell

What does “integrated modelling” mean?

- Physics Integration:
  - Integration of MHD, transport, exhaust, energetic particle physics, etc
  - Need to foster interactions between different physics areas
- Code Integration:
  - Creating a set of validated, benchmarked codes
  - Standardised inputs/outputs to allow modules from different codes to be linked
- Discipline Integration:
  - Success of the TF relies on input from:
    - Theoreticians to build/improve the appropriate mathematical models
    - Modellers to construct efficient, accurate codes for the models
    - Experimentalists to provide data to validate models.
  - Involvement of each community will be important for the success of the TF

How will the work be organised? (1)

- We have organised the work into four “areas”
- Area 1: Identification of codes and models
  - Take an initial census of codes and classify them
  - Identify a number of integration projects to develop
  - Make recommendations for code/model development and documentation
- Area 2: Interfacing procedure and numerical support
  - Propose the global structure of integrated modelling
  - Develop the interfacing procedure
  - Identify a code version handling procedure
  - Make recommendations for language, libraries, etc
  - Develop the necessary numerical tools
  - Evaluate the present numerical expertise and hardware within EFDA

How will the work be organised? (2)

- Area 3: Code validation and benchmarking
  - Determine the validation process (the procedure and documentation)
  - Develop an appropriate database for the validation procedure
  - Make recommendations for validation experiments
  - Provide a priority list for code integration (common task with Area 1)
  - This process will provide/test physics understanding for existing data
- Area 4: ITER integrated scenario activity
  - Not yet activated (later in 2004)
  - Aim is to provide an assessment of ITER scenarios
  - Will support ITER scenario development in existing devices

The role of Theory

- A Code is as good as the theory on which it is based, and the TF relies on input from the theory community:
  - Understanding of regimes of validity of models
  - Developing new theories or extending the validity regime of existing ones
  - Close interaction with modellers essential
- Simplified theoretical models are an important part of the validation process
  - Many “theoreticians’ codes” employ complex plasma models in simplified geometry, for example
  - While these may not be directly relevant to experiments, they are of great importance in validating codes with full magnetic geometry (and sometimes simplified plasma models)
- Theory spans all toroidal devices (RFP, stellarator, tokamak)

The role of Numerical Modellers

- A Code is as good as the numerical scheme:
  - The code must provide an accurate solution to the model equations
  - Fast, efficient algorithms are likely to be crucial for some topics
  - This group will provide the link between theory and experiment

The role of Experimentalists

- The validity of a code will be demonstrated by comparison with experiments
  - High quality data, with an understanding on the error bars will be important
  - New experiments are likely to be proposed as part of the validation exercise
  - Development of new diagnostics may be desirable (eg turbulence characteristics)
  - As well as validating the models, this also provides a physics interpretation of the experiment.
  - Non-tokamak communities (eg stellarator and RFP) are encouraged to participate

How will the work proceed?

- The work will be conducted under EURATOM general support
- Collaborative visits are eligible for mobility funding
- Agenda:
  - Nov 2003: Call for Interest (80 professionals from 17 institutions expressed interest to be involved)
  - Dec 2003: Presentation at EFPW meeting
  - Jan 2004: Three expert working groups were formed (associated with Areas 1-3) to start the preparations and planning
  - Jan 2004: Web site, hosted by ULB, set up: www.efda-taskforce-itm.org
  - April 2004: workshop to identify/initiate collaborative projects
  - October 2004: presentation of longer-term work plan to STAC, including manpower estimates.
  - November 2004: FEC satellite meeting on ITM

Collaborative Activity

- There are a number of related initiatives, both in Europe and World-wide, where collaboration is important:
  - Related JET activity, including TF-T, JAMs
  - The “sister” task force on plasma-wall interactions
  - ITPA groups
  - ITER team
  - Several integrated modelling initiatives exist in the US (eg, the Fusion Simulation Project, FSP)
  - Japan is just starting a similar project (TASK)
  - Collaborative satellite meeting at IAEA FEC
  - We can also learn from integrated modelling activity in other fields (eg weather forecasting, nuclear safety, etc), which we are exploring with help from EIROFORUM.

Conclusions

- The work is now under way to lay the foundations for what is to come in future years
- Although the work is “voluntary”, there has been an encouraging initial response
- A main aim of the Task Force is to provide a framework to co-ordinate existing activity and encourage collaborative projects, not to generate additional work
- The Task Force must not lose contact with the physics; this is crucial to its success
- There will be challenges, and difficult questions to address…but that is what good science is all about!

今年度の課題

- 会合
  - 夏：NIFS 研究会（輸送サブクラスター）
  - ９月：日米ワークショップ
  - 11月：IAEA FEC（Informal meeting)
- 活動
  - 統合コード・インターフェース策定
  - ヘリカル系解析
  - 物理課題の集中的取り組み
  - 計算機科学との連携
  - TASKコード整備
    - ・ オープン化，マニュアル，WEB操作，講習会

今回の作業課題

- 統合コード・インターフェース
  - データ
    - 装置データ
    - 平衡データ
    - 流体プラズマデータ
    - 運動論的プラズマデータ
  - インターフェース仕様
    - モジュール実行
    - データ交換
- ヘリカル系解析
- TASKコード整備
- TOPICSとの連携