Integrated Tokamak Modelling IMP3: Transport code and discharge evolution

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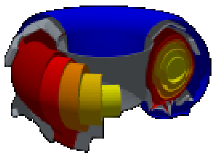

What is the goal of the Task Force?

The aim of the task force is to co-ordinate the development of a coherent set of validated simulation tools for the purpose of benchmarking on existing tokamak experiments, with the ultimate aim of providing a comprehensive simulation package for ITER plasmas.

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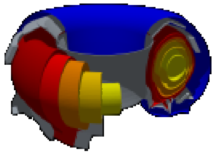

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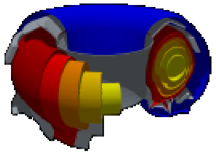

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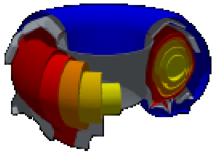


IMP3: Transport code and discharge evolution

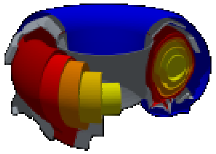
Topic 3A: MHD equilibrium and stability modules (**G. Perverzev**)

Topic 3B: Non-linear modules (saw-teeth, ELMs, NTMs) (**V. Parail**)

Topic 3C: Transport models (**D. Kalupin**)

Topic 3D: Sources and sinks (**V. Basiuk**)

Topic 3E: Interfaces to boundaries (**D. Coster**)



Some personal thoughts

- The USA is talking of real money ($20M/yr) and real, well managed teams, leveraging ASCI experience
- Europe is trying to do it "on the cheap"
  - Voluntary contributions
  - No additional money
  - Can probably do this in the beginning phases
  - **Need to think about changing this in the next Framework Programme**
- At some stage large computational resources will be needed
  - European Fusion Supercomputer Centre? European Fusion Grid?

TIME for FUSION

- IPP proposal for "**T**heory and **I**ntegrated **M**odelling in **E**urope for Fusion"
- Modelled on JET
  - EFDA Associate Leader (head of ITM-TF)
  - Theory/Modelling "Campaigns"
  - Short and Long Term Secondees
  - IPP as equivalent of JOC
- Dedicated share of next RZG super computer
- Smaller systems (Linux clusters, etc) to provide for ITM needs
- Funding (hopefully) from the EU

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Backup Slides

Capability Computing

The projected needs for capability resources for the next steps are as follows:

- State of the art:
  - Geometry: flux tube or annulus
  - Time scales resolved: 10 ns – several ms
  - Required computing power: **several Teraflop/s (peak)**
  - Runtime per simulation: 1 day
- Next step (to be realized with the upcoming supercomputers, ~2007):
  - Geometry: full torus of present mid-size device (e.g. ASDEX Upgrade) or major fraction of JET
  - Time scales resolved: 10 ns – several ms
  - Required computing power: **about 100 Teraflop/s (peak)**
  - Runtime per simulation: 1 day – 1 week (depending on device size)
- Final goal (on the time scale of commencement of ITER D-T operation, ~2015):
  - Geometry: full torus (ITER)
  - Time scales resolved: 10 ns – several s
  - Required computing power: **about 10 Petaflop/s (peak)**
  - Runtime per simulation: 1 week

Capacity Computing

- Central Linux cluster:
  - 256 -- 1024 cpus available to all
    - mix of serial and parallel jobs
    - also used for analysing results from super computer
    - 10 -- 100 TB disk space
    - backed up
    - extensive libraries and toolboxes available
    - set of standard codes
  - such other resources as might be hosted for individual groups/associations
- Other:
  - Visualization server(s)/environment
  - Data base server(s)
    - MDSplus
    - SQL
  - Web server(s)
  - CVS/Subversion server(s)
  - Documentation server(s)
  - Archive/Backup server(s)
  - Europe wide single log-on server(s)
  - European wide file system

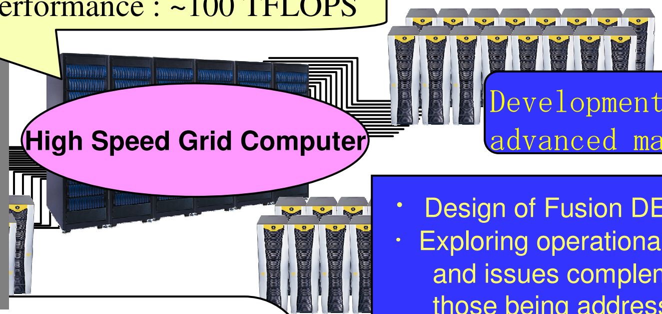
Computing: CSC for FS

Computer Simulation Center for Fusion Science

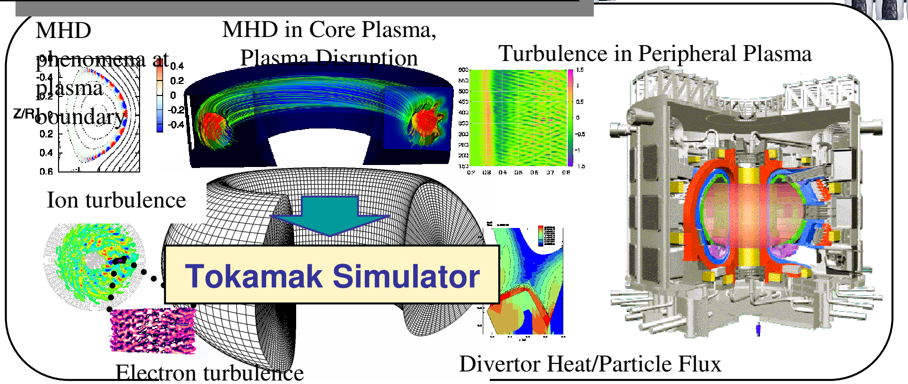
Computational Simulation Center for Fusion Science will provide EU and JA researchers with an excellent environment for computer simulations on burning plasmas and advanced steady-state plasmas, fusion DEMO plant design, development of advanced fusion materials, etc. by using high speed grid computers, aiming at contributing to efficient and effective execution of the ITER project and early realization of fusion energy.

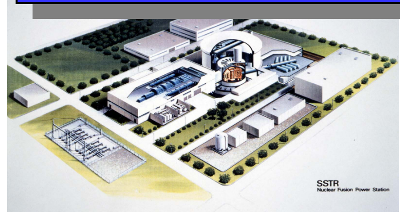
Processor Performance : ~100 TFLOPS

- Optimization of Operation Scenarios for ITER
- Optimization of ITER auxiliary systems which come later in the construction of ITER
- Understanding burning plasma in ITER etc.



- Design of Fusion DEMO Plant
- Exploring operational regimes and issues complementary to those being addressed in ITER (steady state operation with higher normalized plasma pressure, control of power fluxes to walls, etc.)



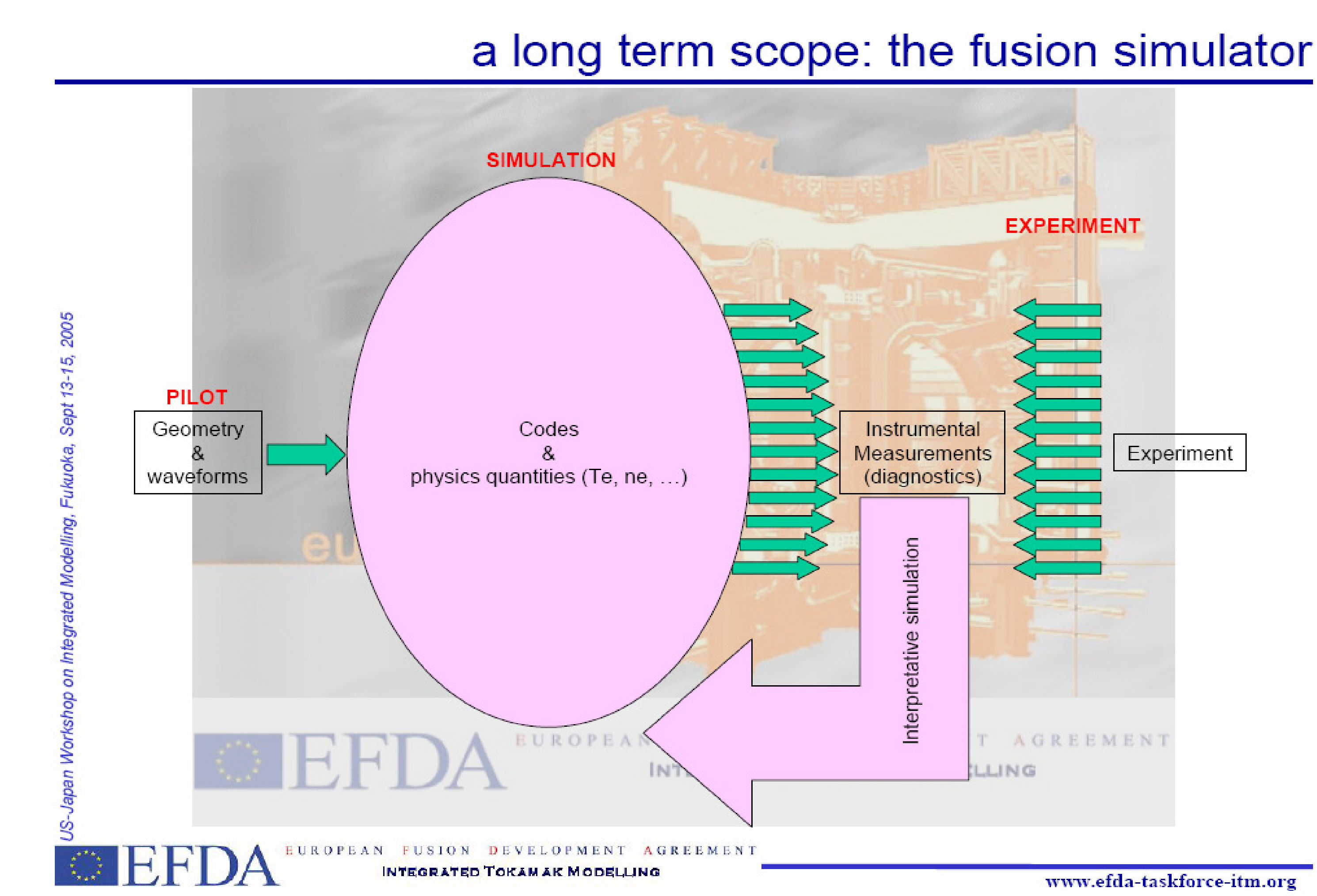


Fusion Energy Development in Japan

Masahiro SEKI

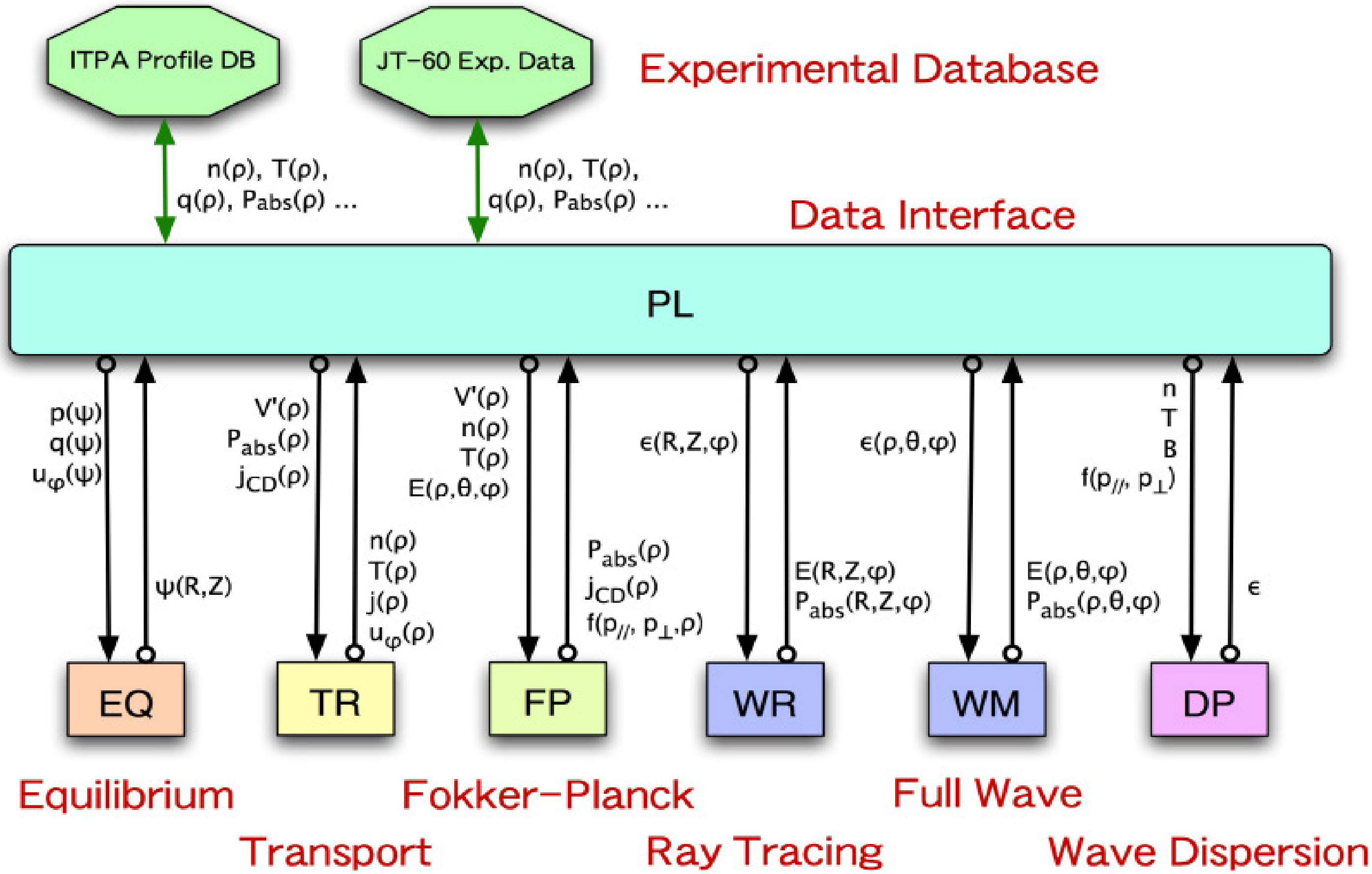
Fusion Power Associates Annual Meeting and Symposium October 11-12 in Washington, DC

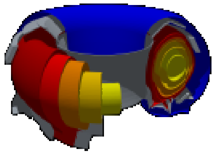
Vision 1: Becoulet



Vision 2: Fukuyama

New Modular Structure of TASK





Vision 3: Suttrop

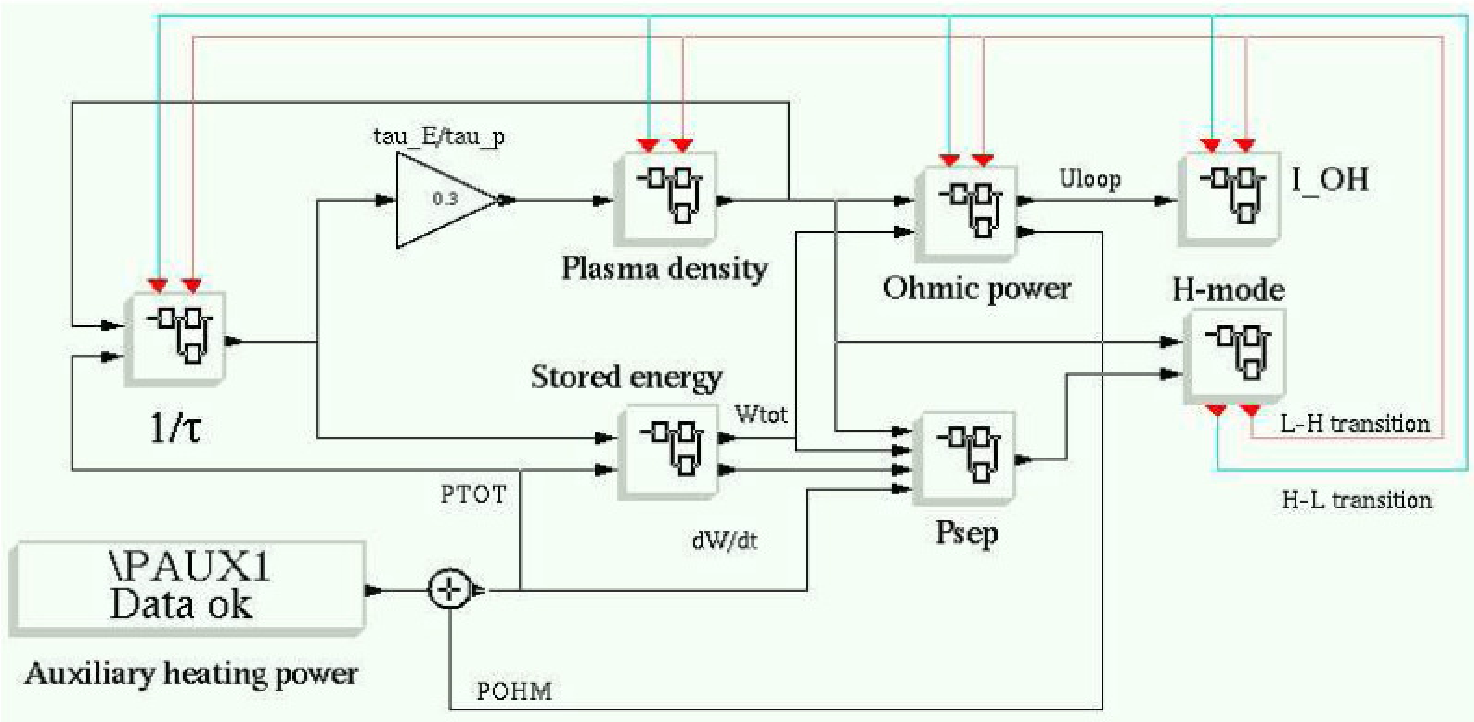
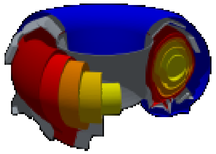


Figure 3: *Scicos model for L- and H-mode plasma density, stored energy and ohmic transformer flux consumtion.*

0d, time dependent model for AUG

W. Suttrop, L. Hoellt, and the ASDEX Upgrade Team: EPS 2005



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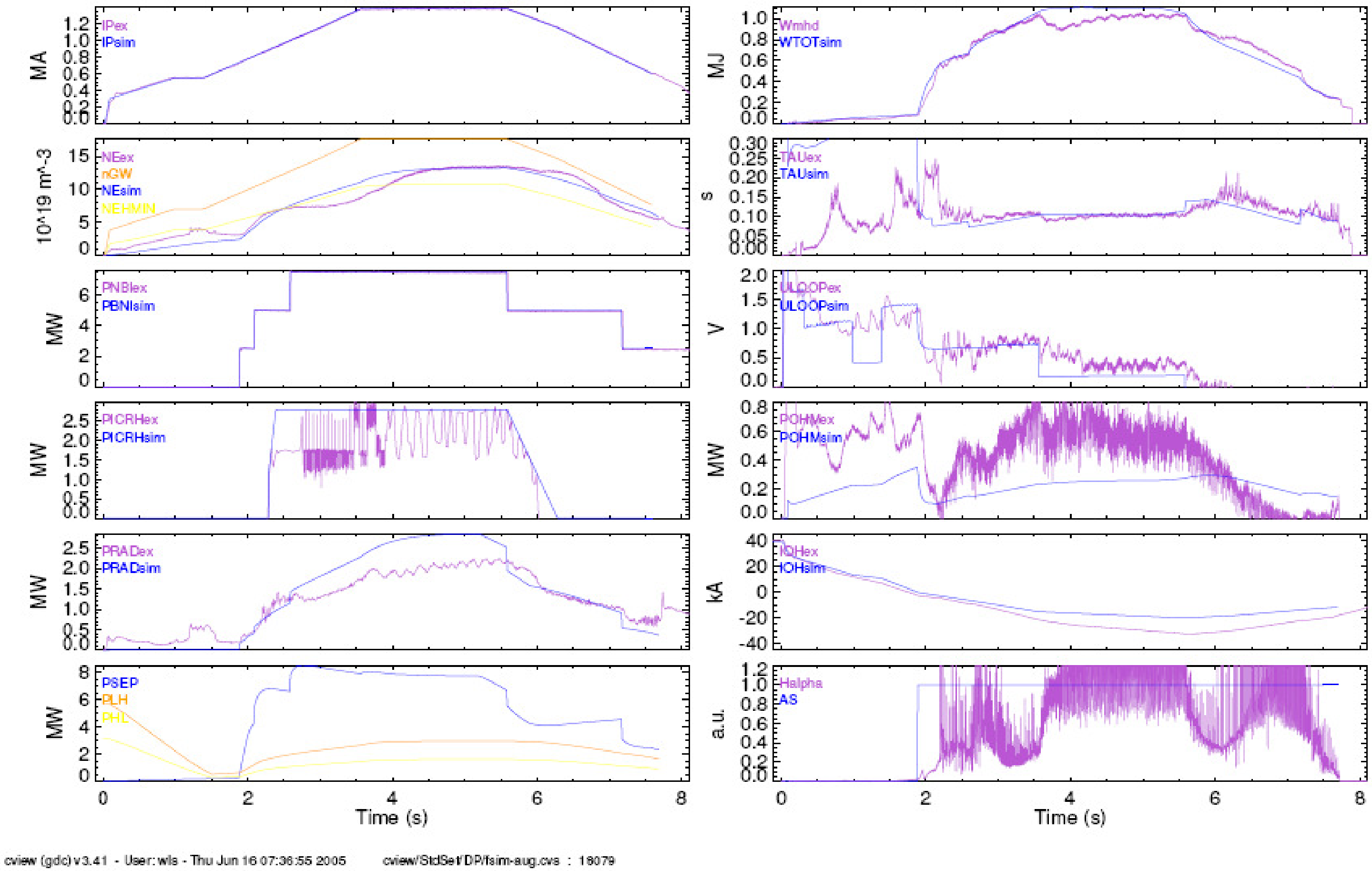
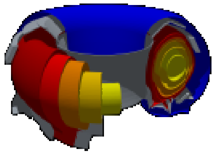


Figure 4: *Comparison of predicted and measured waveforms of ASDEX Upgrade shot 18079*

W. Suttrop, L. Hoellt, and the ASDEX Upgrade Team: EPS 2005

Vision 4: Jardin



Login:

A.Physicist

Password:

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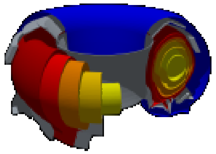
Define new project

Continue with existing project

S. Jardin, FSP Meeting

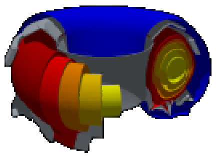


New project definition page

Project Type:

- Whole Device Modeling
- Global Stability Analysis
- Turbulence Modeling
- RF Heating
- Edge Physics
- Pellet Injection
- Coupled MHD-RF
- Coupled MHD-turbulence
- Coupled MHD-Edge
- Coupled Edge-turbulence

S. Jardin, FSP Meeting



Global Stability Home Page

Initial Equilibrium:

From WDM Simulation

From Exp. reconstruction

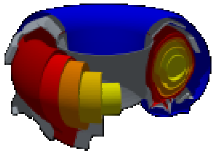
Define-fixed boundary

Define-free boundary

Run Log number

ITER003912

record	time	q(0)	Te(0)	IP
1	50.0	5.2	3.2	10.0
2	100.	1.01	3.5	20.0
3	101.	0.99	10.2	20.0
4	102.	0.98	12.1	20.0
5	103.	0.97	12.2	20.0
6	104.	0.96	12.3	20.0
7	200.	1.01	15.0	20.0
8	250.	1.01	5.0	18.0
9	300.	1.01	3.0	10.0



Initial equilibrium from WDM simulation ITER003912

Record = 5, time=1.03, q(0) = 0.97, Te(0) = 12.2, I_p *= 20MA*

Choose Global Stability Simulation Package

NIMROD	info
M3D	info
M3D-C1	info
LBNL AMR Code	info

Graph 1

Graph 2

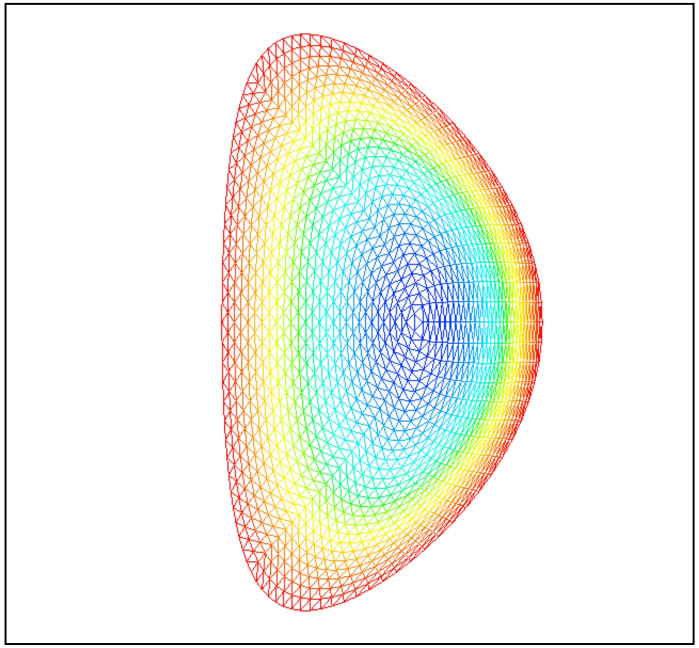
Graph 3

Graph 4

Initial equilibrium from WDM simulation ITER003912

Record = 5, time=1.03, q(0) = 0.97, Te(0) = 12.2, I_p *= 20MA*

M3D Initial Grid Definition:



Align with surfaces

Geometric packing

quad

Triangular

Graph 1

Graph 2

Graph 3

Graph 4

Radial points:

Poloidal points:

Number of packing surfaces

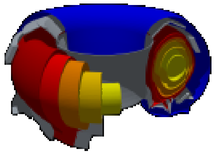
q-values

Compute and draw

Manual adjust

Save and continue

S. Jardin, FSP Meeting



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Graph 2

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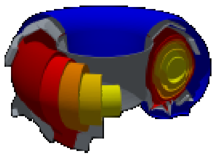
Graph 4

M3D Extended MHD Model definition:

Ion equation	Electron equation
Gyroviscous stress tensor	Hall Term Included
Drift ω* approximation	Electron inertia included
Neoclassical parallel	Neoclassical parallel



Initial equilibrium from WDM simulation ITER003912

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M3D Additional Input Parameters:

quantity	default	input	
Problem run time			description
Output frequency			description
Timestep factor			description
Hyperviscosity coeffficient			description
Number of toroidal modes			description
……..			description
……..			description
……..			description
……..			description

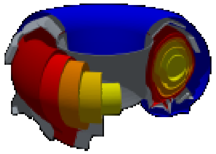
Graph 1

Graph 2

Graph 3

Graph 4

S. Jardin, FSP Meeting



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Final Review of M3D Problem Setup:

Grid drawing

Graph 1

Graph 2

Graph 3

Graph 4

N = …..

M = ….

Etc……

Extended MHD Model:….

Problem time:…..

Output disposition:…..

submit