

User support in the Fusion community

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Introduction

Applications

BIT1

GEM

ISDEP

Optimization using Metaheuristics

Fusion Applications

- High computation capability needed.
- Large diversity of disciplines in plasma physics: complex systems, kinetic theory, fluid theory, waves, non-linear problems → wide diversity of applications.
- Some of these applications are suitable for the grid:
 - MC codes.
 - Parameter scan.

The Strategy

- But:
 - No use of the grid before 2005.
 - Limited use in 2009.
- Port applications that can be easily ported and produce results.
- Choose applications that act on different research fields with different porting techniques.
- Establish complex workflows to show the grid flexibility.
- Produce relevant physics results that can give value to the work.

Plasma-Wall interaction and Edge physics

- EIRENE, BIT1

Transport

- Collisional (ISDEP, DKES)
- Turbulent (GEM)

Heating

- Microwaves (MaRaTra)
- NBI (FAFNER)

Equilibrium

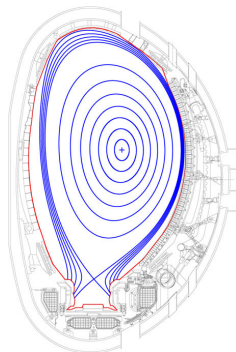
- VMEC

BIT1 is an electrostatic Particle-in-Cell + Monte Carlo (PIC + MC) code for plasma edge simulations.

Characteristics

- Dimensionality: 1D+3DV for plasma, 2D+3DV for neutrals and impurities.
- High Complexity: about 30.000 lines, CPU time \approx 1000 h.
- Resolution: down to electron gyro-motion.

[F. Castejón et al. Proc. of the EGEE UF, 2009]



Typically

- 10^5 - 10^{10} particles in 10^2 - 10^7 spatial grid cells.
- 100 - 5000 particles per cell.

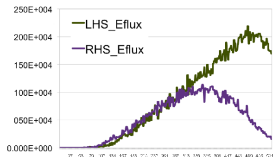
Grid Use Case

- A wide range of parameters must be scanned → typical parameter scan model (independent island model ★).
- Input file changes for the different cases.

★Bio-inspired Algorithms in Grid (Tuesday 22nd)

Results

Time evolution of several quantities, estimated in the inner and outer walls: particle and energy fluxes, temperature



Case Study

- Our Present Problem: 8 Scrape-off-Layer widths \times 8 impurity concentrations.
- Different impurity concentrations have been used for different impurities.
- Close contact with the code owner to decide the tests to be carried out.

Ideas

- Gyrofluid turbulence code.
- GEM will give instabilities behaviour.
- Versions: Serial (small cases) and MPI (High scalability, to hundreds of proc.).
- Gaining experience in porting existing MPI codes.

- Status: code running in the Euforia VO.
- Process (remote program managing the execution):
 - Uncompress the input data and binaries.
 - Prepare the execution and execute the application.
 - Extract and compress the relevant results.
 - Store results in the SE.

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Key point: close contact with the code owner.

[M. A. Rodríguez et al. Submitted to PDP, 2010]

Ideas

Integrator of Stochastic Differential Equations in Plasmas.

- A MC following independent particle orbits in a fixed plasma background.
- Developed from scratch thinking of the grid.

Characteristics

- 10^7 orbits (jobs) \times 10 - 20 min \approx 10 CPU-years.
- Based on gLite, launched also with Ganga and Diane (Demo in EGEE UF in Catania).
- Random parameters for every orbit.
- No matter if some jobs are missed.
- Results: statistical measurements.

[F. Castejón et al. Plasma Physics and Controlled Fusion, 2007]

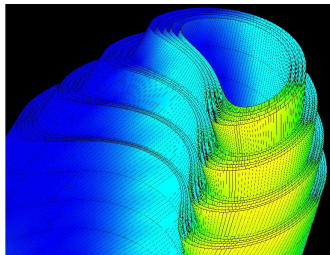
Divertor Studies

- Study the fluxes on the vacuum vessel and try to stop them.
- Following ions until the vessel: 3D Map of Flux.
- Thermal and fast ions: link with FAFNER (first application workflow developed)

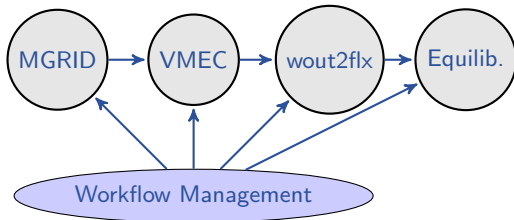
[F. Castejón et al. Nuclear Fusion, 2009]

Equilibrium Function

$$F_{fitness_function} = \sum_{i=1}^N \left\langle \left\langle \frac{|\vec{B} \times \vec{\nabla}| |B|}{B^3} \right\rangle \right\rangle_i$$



Workflow



Genetic and Evolutionary Algorithms

- Master-slave models implemented using gLite.
 - Master → control and management methods of the algorithms.
 - Slave → evaluations of the different configurations (execution of the previous workflow).
- Iterative models.
- Generic implementations.
- Highly configurable.

[A. Gómez-Iglesias et al. Journal of Cluster Computing.]

Artificial Bee Colony Algorithm

- Distributed and asynchronous model.
- Communication WN-UI by means of the SE.
- Barriers system developed using the SE.

[A. Gómez-Iglesias et al. Submitted to PDP, 2010]

Thank you for your attention!

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