Workflows in Fusion applications

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on behalf of

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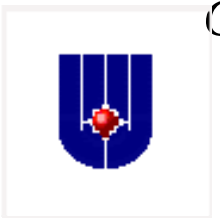


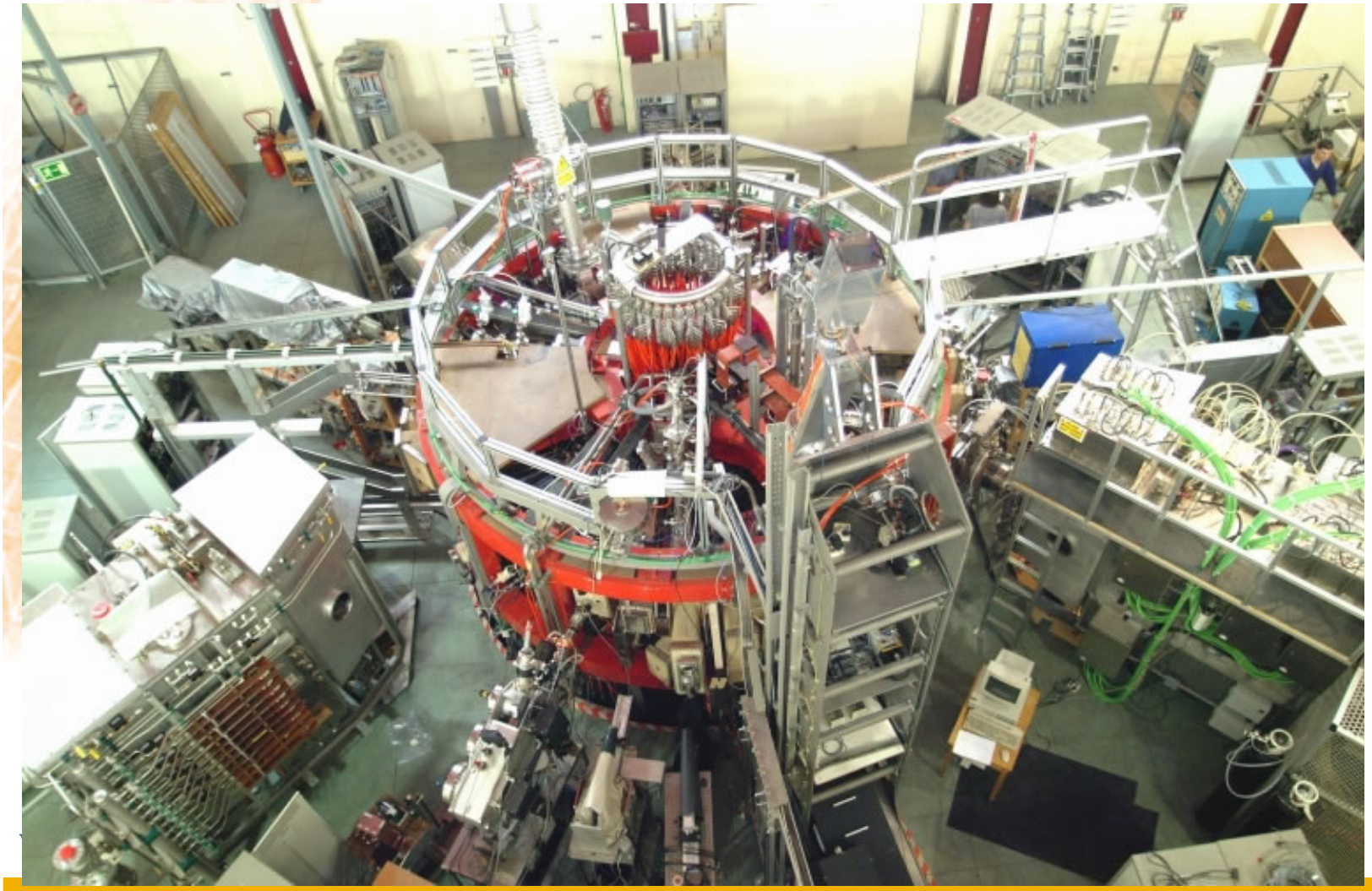
- **What are we going to see?**

Young Activity... EGEE II – only 5 months old!!!

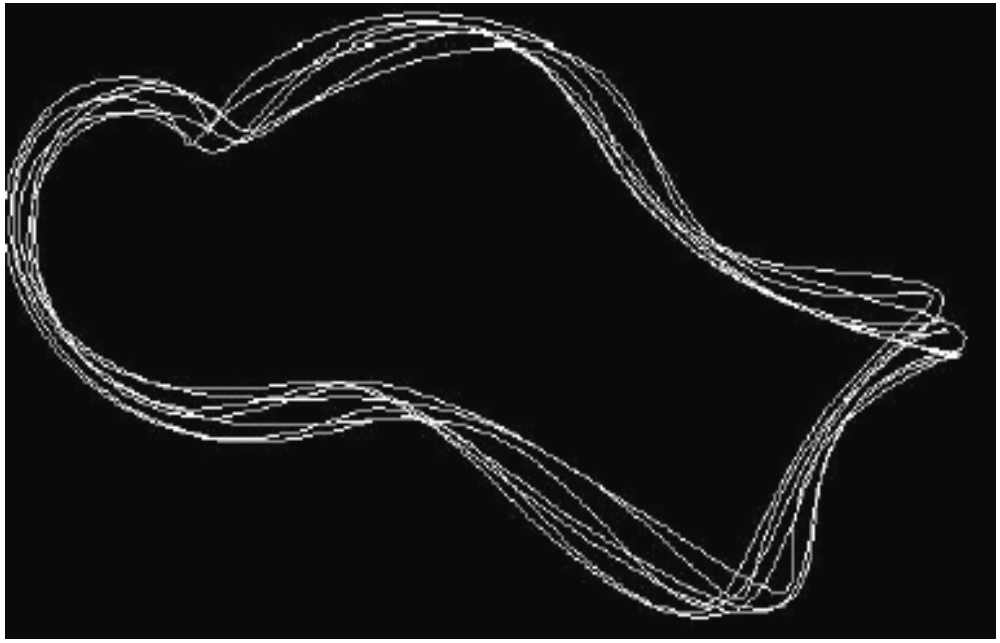
Real applications ported – SIMPLE ones but... 3!!!
Different options considered for each app

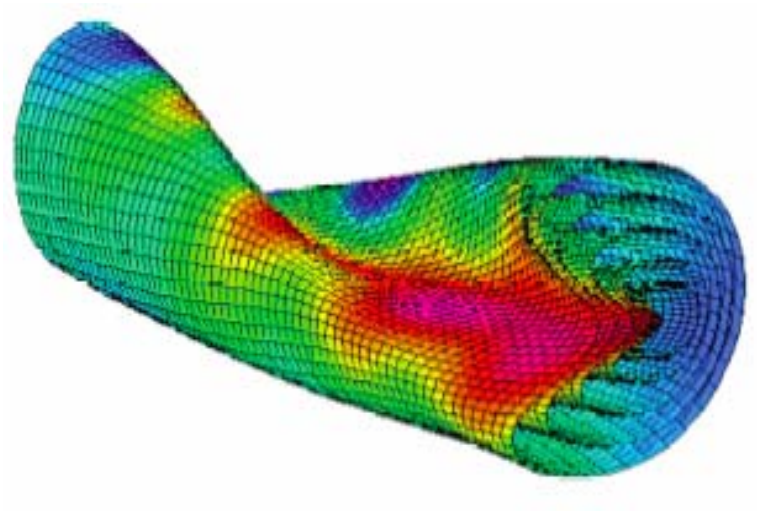
Workflows: Why we are here ☺

Energy Input < Energy Output

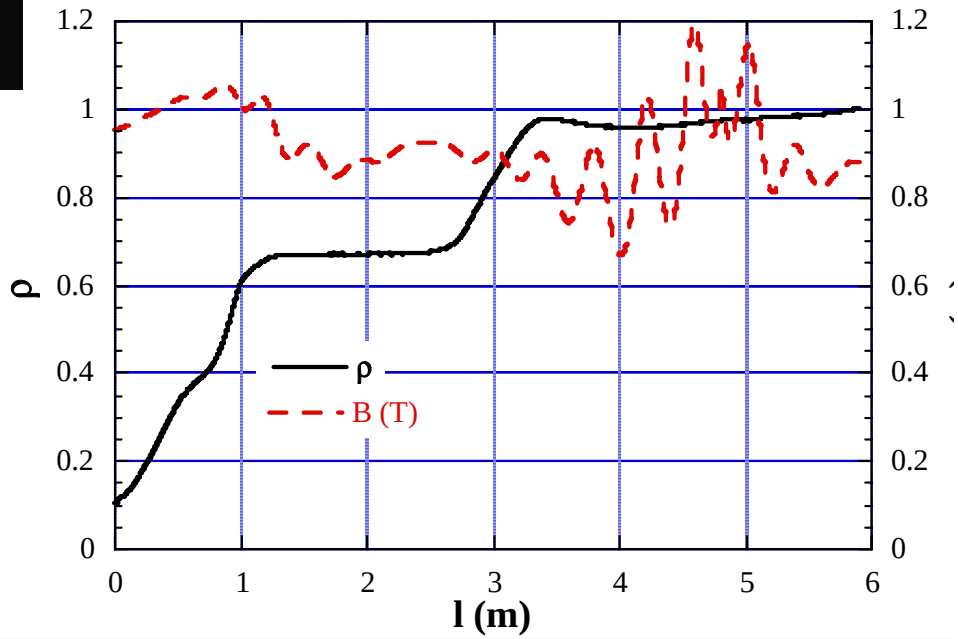


Kinetic Transport





Example of orbit in the real 3D TJ-II Geometry (single PE).
Collisions included: 1 ms of trajectory takes 4 sec CPU.
Particle life: 150 - 200 ms. Single particle ~ 10 - 20 min.
10^6 - 10^7 particles needed.

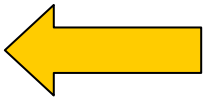


Kinetic Transport

- **Monte Carlo code that solves microscopic Langevin Equations for every ion, including:**
  - the movement inside the magnetic and electric fields created by the magnetic confinement device and the plasma.
  - random term to simulate collisions with the background plasma.
- **The particles are distributed randomly in the plasma according to experimental results:**
  - The spatial distribution of particles is done accordingly to plasma density.
  - The distribution of particles in momentum space follows a Maxwellian distribution function according to the measured temperature (which astonishingly happens to be almost constant).
- **Estimate every trajectory independently in a single CPU (about 10 - 20 min of elapsed time).**

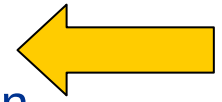
Kinetic Transport

- **Every case (particle) needs:**
  - A seed for random space distribution.
  - A seed for random momentum distribution.
  - An initial seed for collisions.



Input parameters

- **The background plasma is common for every particle:**
  - Background density and temperature, i. e., collisionality.
  - Background electric field.
  - Background magnetic field and magnetic configuration.



Registered at the LFC FUSION VO data catalog

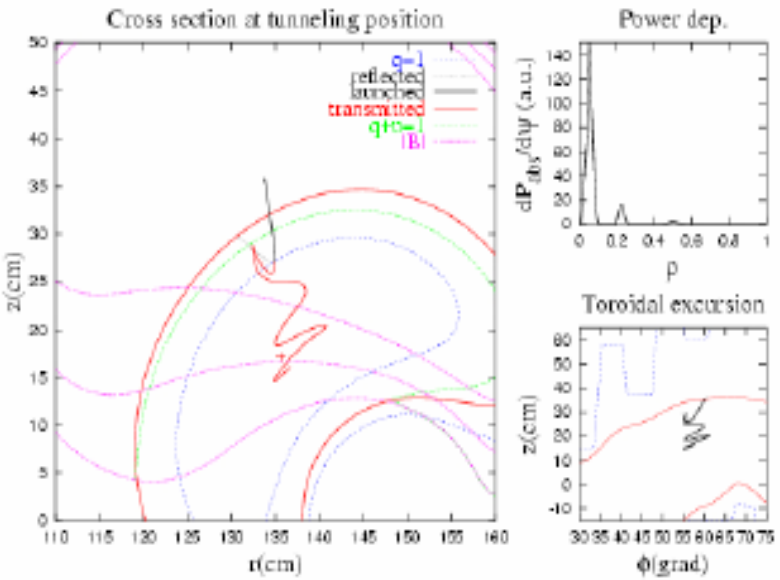
- **~10^7 particles launched in bunches of about 10^3 to be run in every CPU.**
- **Post process. Statistical measures: Fluxes, velocity distribution, space distribution, etc.**
- **No problem if some (few) cases are lost.**

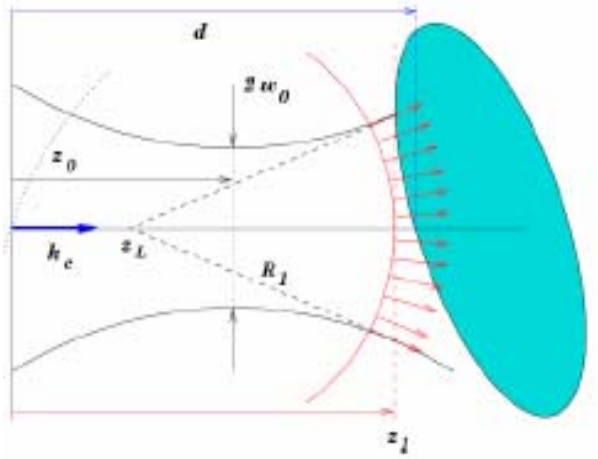
Optimization!

Use of InputData & DataAccessProtocol

JDL attributes

MaRaTra: Massive Ray Tracing





Beam Simulation:

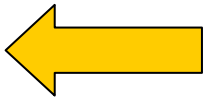
Bunch of rays with beam waist close to the critical layer (100-200 rays) x (100-200 wave numbers) ~10^5

Single Ray (1 CPU):
Hamiltonian Ray Tracing Equations.

Application in production phase.
Gridification based on Gridway:
Stand at this conference (Demo@n.23)
by J.L Vázquez-Poletti et al. UCM (Spain)

MaRaTra

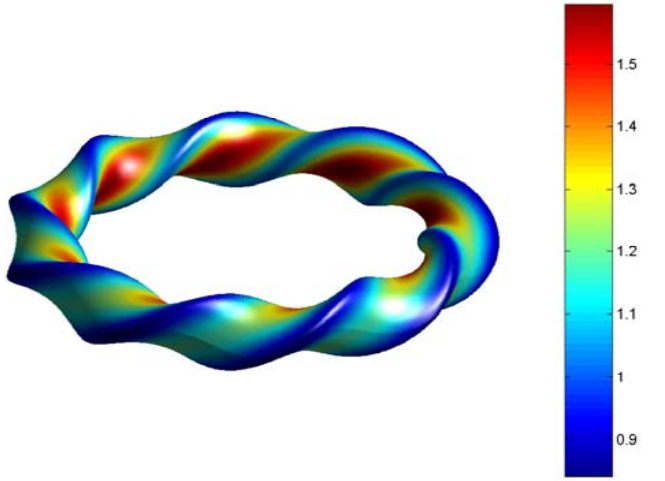
- **A single ray is solved in every CPU: Hamiltonian Equations.**
- **The rays are distributed accordingly to the microwave beam structure: Every case needs:**
  - Initial space position.
  - Wave vector.

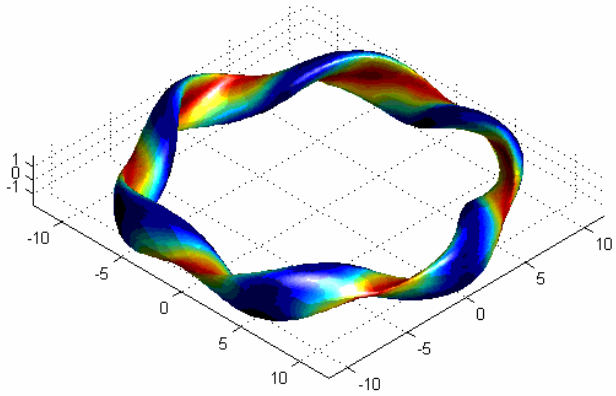


Input parameters

- **The background plasma is common for every particle, therefore it can be downloaded from a close Storage Element:**
  - Background density and temperature.
  - Background magnetic field and magnetic configuration.
- **~10^5 rays launched.**
- **Post process: Spatial Distribution of absorbed power (add all the absorbed powers of the single rays).**
- **No case must be lost, all the results are necessary. This is one reason for using the GridWay metascheduler.**
- **Grid application profile = Parameter sweep app**

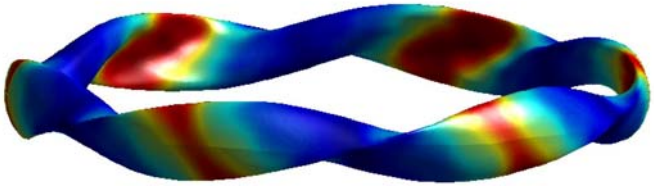
Plasma devices optimisation

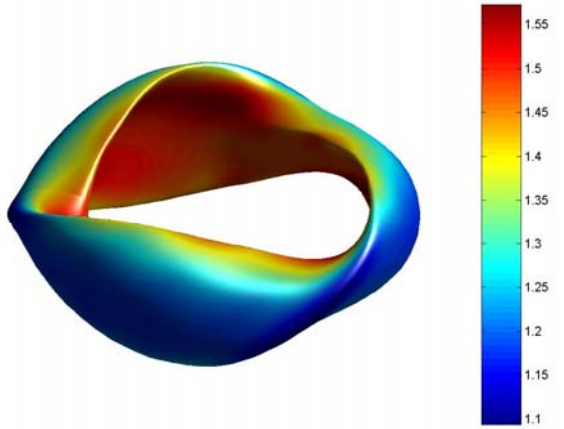




↑Conventional: field maximums mirror some part of the ions, so they “shift out” of the surfaces

Optimisation: make magnetic field more symmetric ↓→↑





V. Voznesensky. Kurchatov Institute. Russia

Plasma devices optimisation

- **Every Stellarator simulated by a set of Fourier coefficient that defines its properties (Equilibrium). Typically 100 Coeff.**
- **These coefficients are varied randomly and the properties of every configuration are estimated in every single CPU.**
- **A genetic algorithm is used to extract the optimum configuration.**
- **Weight functions are fixed as criteria for choosing the best configurations:**
  - Equilibrium,
  - Stability
  - Neoclassical transport properties.

- **The elapsed time for every calculation depends on the weight functions. Typically 40 min per case.**

Conclusions

- **So?**
  - Early application porting: VERY SIMPLE Workflow needs

"Step by step the way is done" – Antonio Machado (Spanish writter)

- **In the future?**
  - Happy users = New applications to be ported!
  - New applications to be ported = MORE COMPLEX Workflow needs!
  - Workflow needs are yet to come...

Wait !!! More requirements are coming!

THANK YOU VERY MUCH!!!