EFDA Task Force Integrated Tokamak Modelling

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Benchmarking European core turbulence codes within ITM Framework

Purpose: cross-verification of the leading core and edge turbulence codes, benefitting of the use of ITM standards

The core benchmark test case

The test case consists of a synthetic shot of a medium size, ASDEX like tokamak operating in circular L-like-mode.

Profiles

$$\begin{pmatrix} T_i \\ T_e \end{pmatrix} = \begin{pmatrix} T_0 \\ T_0 \end{pmatrix} \exp\left(-\frac{8\rho_{tor}^2}{Ra}\right)$$

$$\frac{d\log T}{d\log n} = 4 - \frac{2\rho_{tor}}{a} \qquad q = 1.3\exp\left(-\frac{\rho_{tor}^2}{a^2}\right)$$

Toroidal flux radius: $\Phi = \pi B_0 \rho_{tor}^2$

Parameters:

R = 1.65 m, a = 0.5 m, B_0 = 2 T, Z_{eff}=2,

T_0 = 5 keV, n_0 = 6 x 10^{19} m^{-3}

Participating fluid and gyrokinetic European turbulence codes

ATTEMPT[1]: four field fluid edge code

CENTORI[2]: full toroidal, two-fluid code

GEM(R)[3,4]: gyro-fluid core/edge code

dFEFI[5]: delta-f gyrokinetic core/edge code

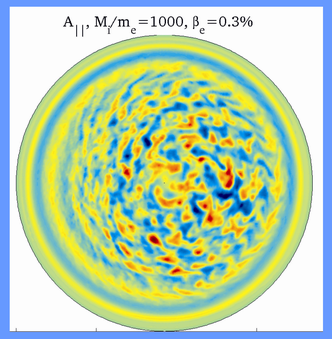
ELMFIRE[6]: PIC full-f gyrokinetic core code

GENE[7]: delta-f gyrokinetic core code

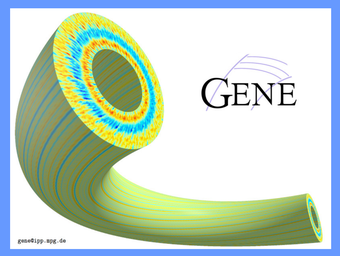
NEMORB[8]: PIC full-f gyrokinetic core code

Advantages of code cross-verification within ITM framework:

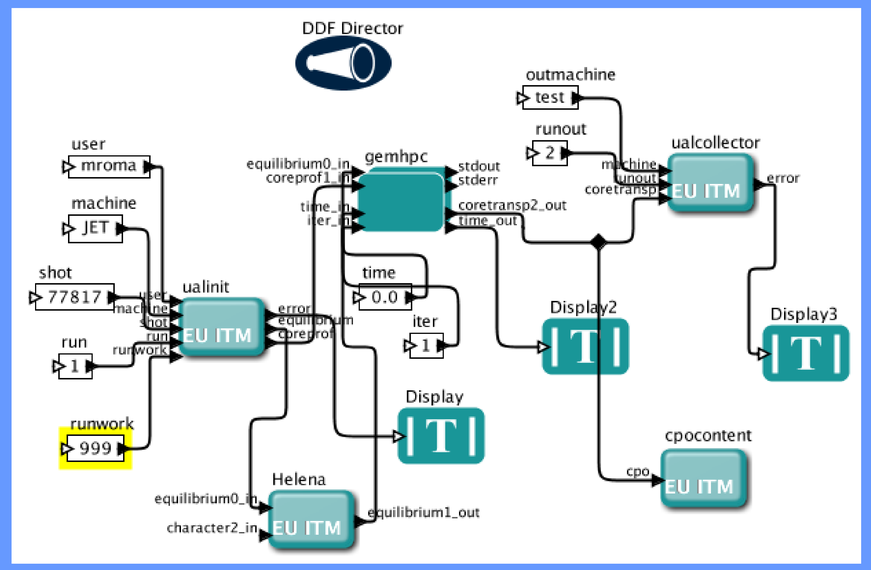
- All involved codes share the *same input file* in the form of CPOs and a well defined HDF5 file is used as output (in future *turbulence_CPO*)
- A general interface has been developed which provides the link of the particular turbulence code to ITM communication standards via XML and CPO's
- Easily extended to other benchmark cases, including experimental data from the ITM database



Vector potential from NEMORB[8]



Electrostatic potential from GENE[7]
36.000 CPUh on HPC-FF



Kepler workflow, using experimental/synthetic JET data, coupling the equilibrium code Helena and the turbulence code GEM[3]. GEM is executed in batch on the HPC-FF.

Common Interface

- Communication between the ITM infrastructure and the turbulence codes is handled by a special designed interface, i.e. CPO read/write and XML-parsing.
- The codes keep their original structures and are provided as subroutines using standard Fortran or C arguments for the necessary input parameters and for the output of computations.
- Initial profiles are stored in ITM database in the form of CPOs to run in Kepler workflows (Gateway) and in ASCII files for FORTRAN workflows to run on the HPC-FF

Status and perspectives

- So far, approximately 1M CPU/hours used on the HPC-FF
- Ongoing effort, first stage will be finalized by the end of this year
- Extend by a similar verification effort using experimental data of leading European fusion devices from ITM database

References

[1] Reiser PP 12 122308 (2005), [2] Fitt pro. Ins. Mat. ECMI 1047 (2008)

[3] Scott PP 12 102307 (2005), [4] Kendl PP 17 072302 (2010)

[5] Scott PP 17 102306 (2010), [6] Heikkinen Contrib PP 44 (2004)

[7] Dannert PP 12 072309 (2005), [8] Hatzky PP 9 898 (2002)

EFDA ITM-TF Expo "The European Integrated Modelling effort : challenges and achievements" – 38th EPS 2011

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