EFDA

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Task Force
INTEGRATED TOKAMAK MODELLING

EFDA Integrated Tokamak Modelling Task Force

(status, what can be used?, development strategy)

Presented by D. Kalupin

on behalf of

ETS team members and EFDA-ITM contributors

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What is ITM-TF?

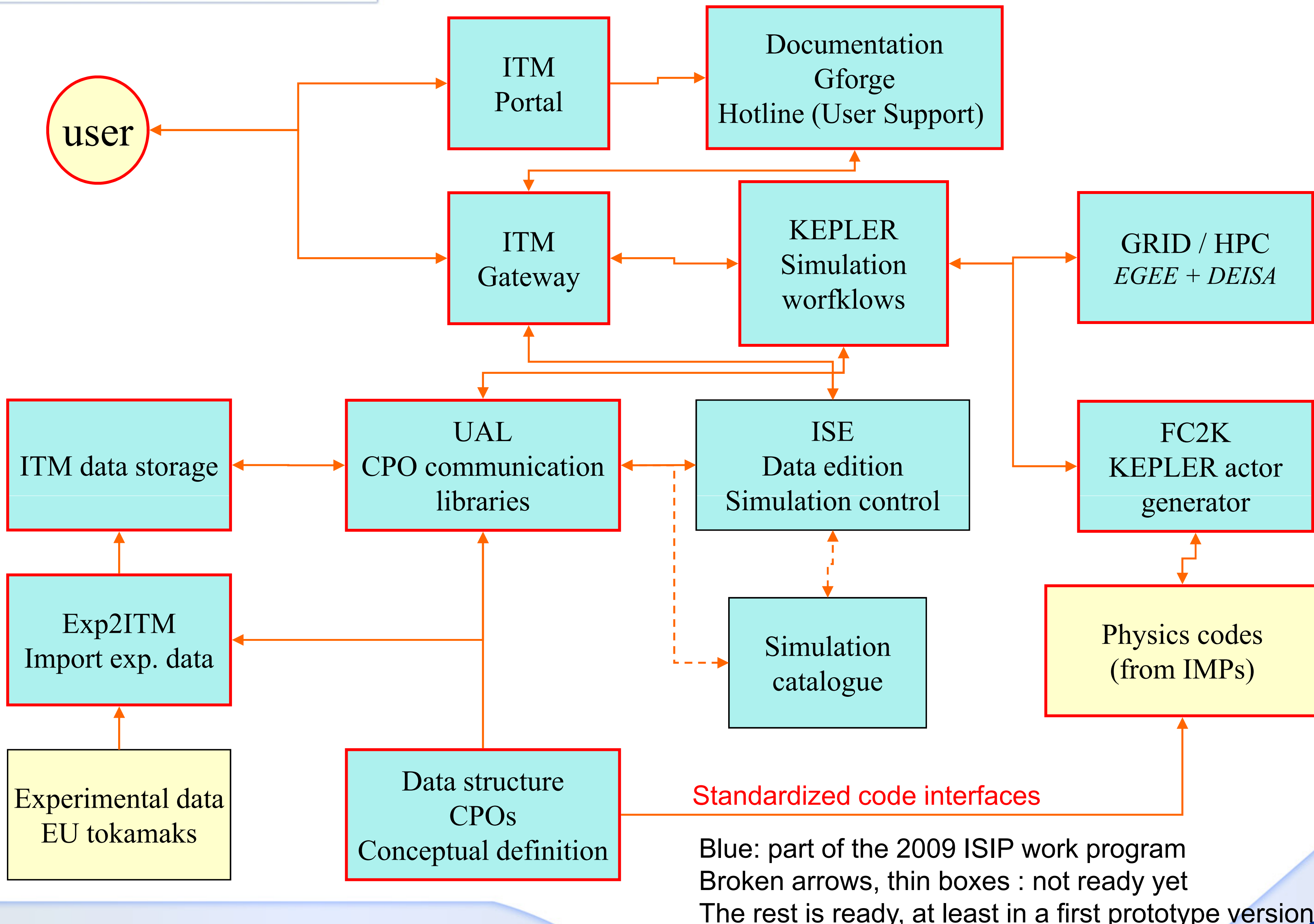
ITM-TF charge

ITM Users benifits:

- access to the ITM library of modules and complete workflows, adopted to the ITM structures, verified and allowing easy connection using the graphical interface;
- possibility to test their own modules within ITM structures/ workflows, after adopting modules to the ITM standards;
- easy reputation of analysis for several machines

experiments.

ITM infrastructure overview



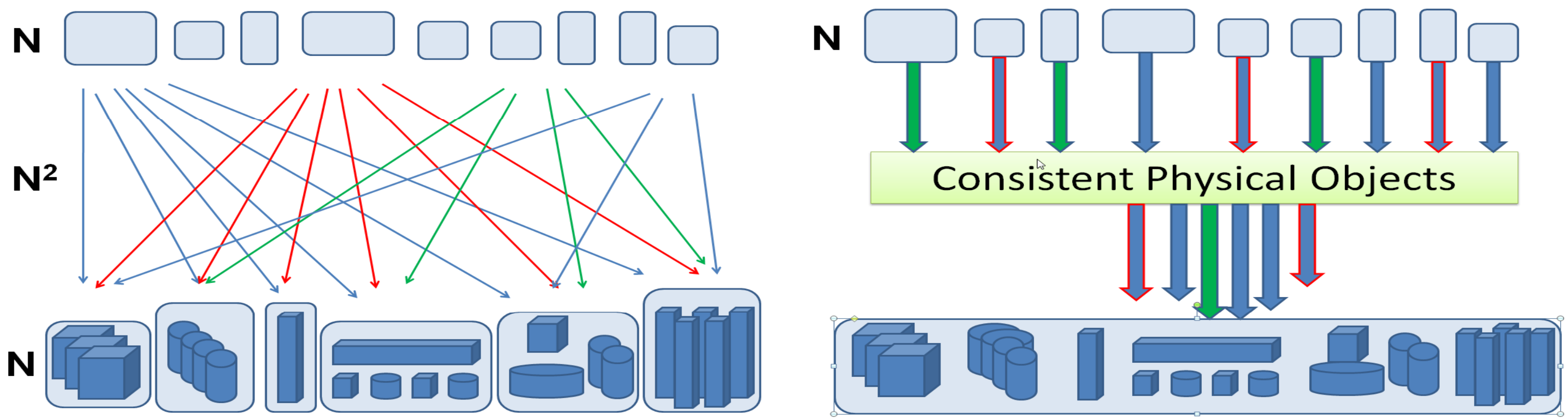
How ITM tools work?

There are many codes describing various physics available

Usually, difficulties appear while codes are coupled

N modules integrated in
N different applications

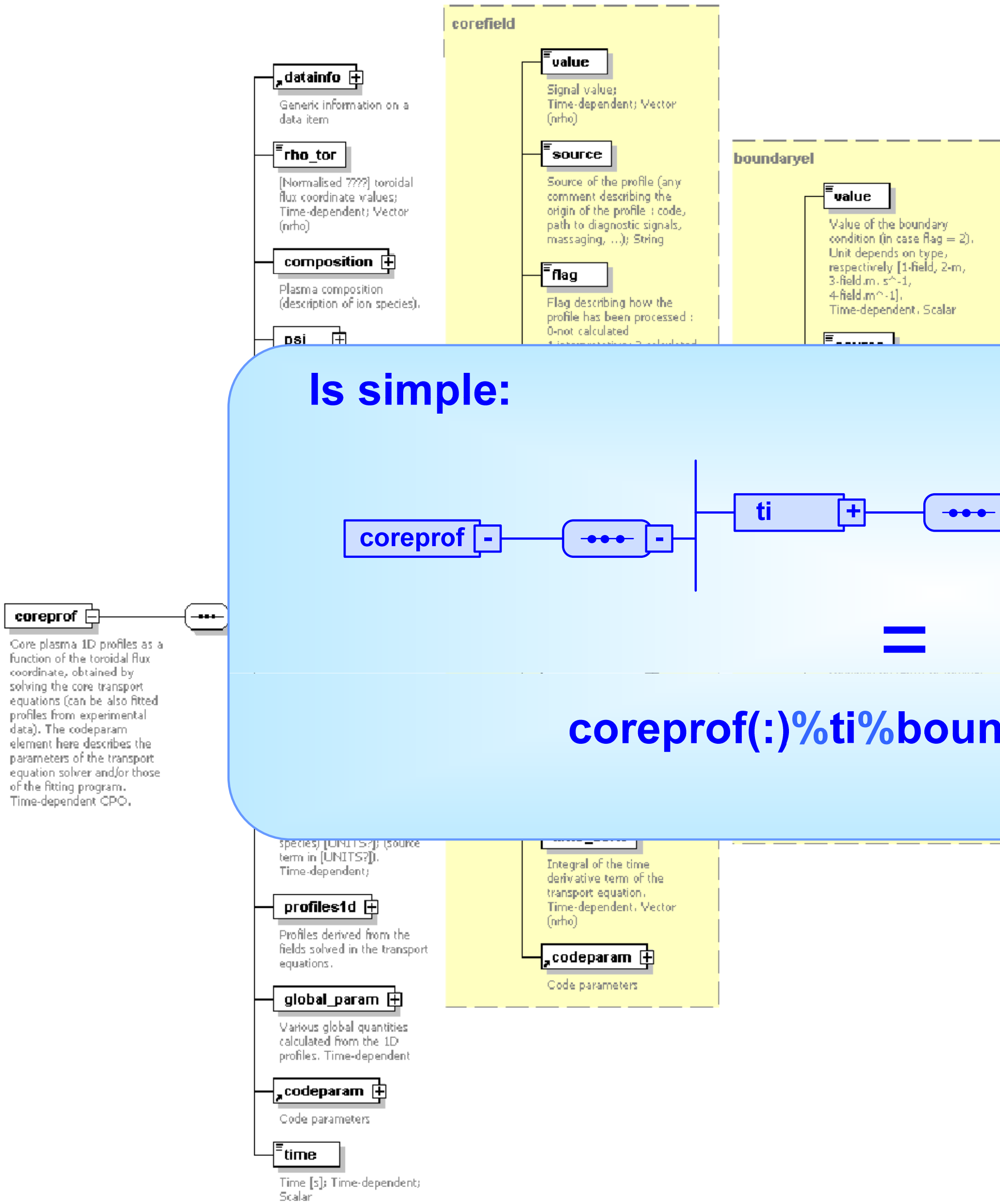
N modules coupled into a
dynamic application framework



The data model – or ontology - is the key to providing a consistent framework!

Strand, ITM General Meeting 2009
Based on material from David De Roure

ITM-TF data base



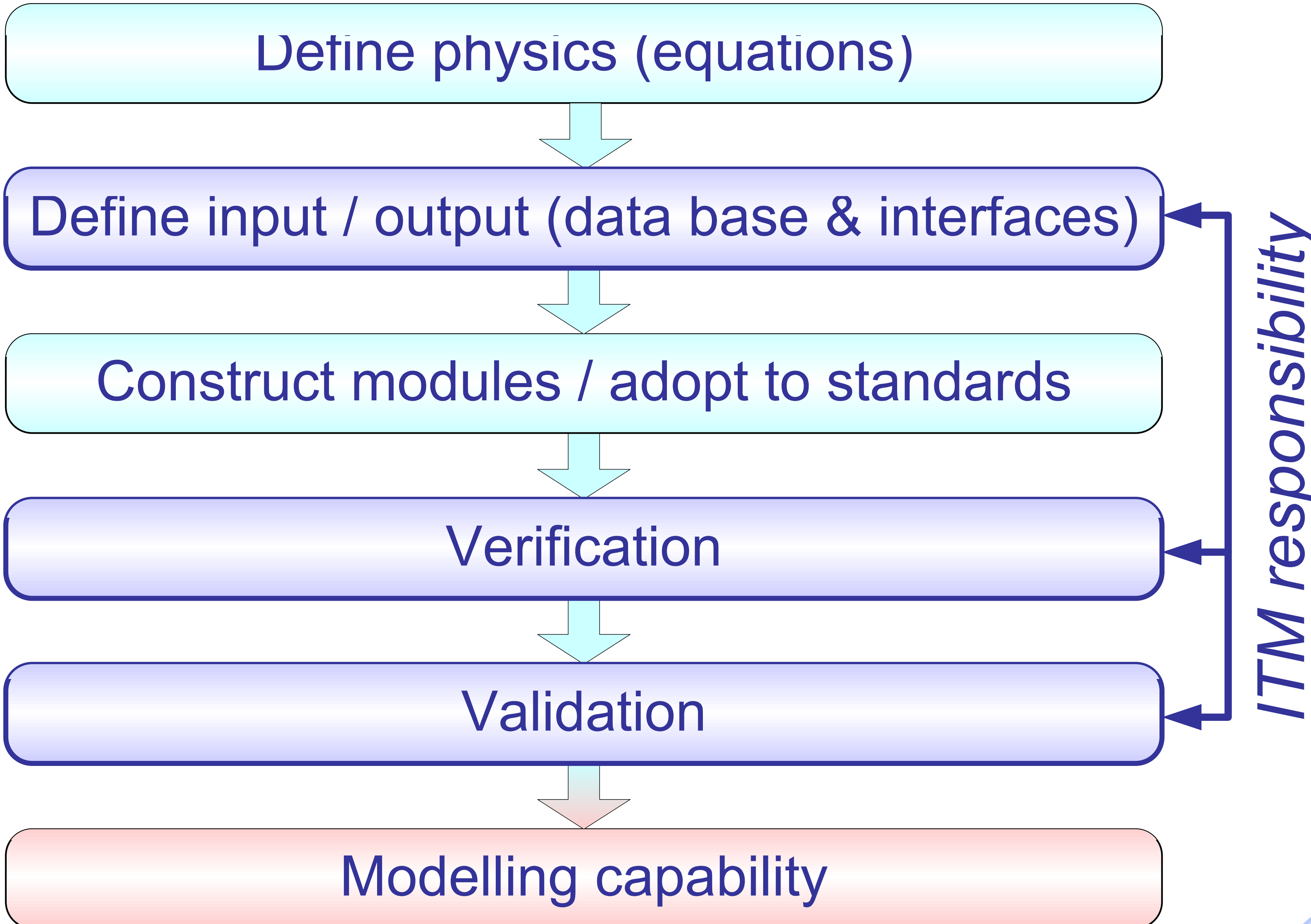
Is simple:

=

coreprof(:)%ti%boundary%type(:)

- The ITM has invested many man years of effort in defining the data to be transferred between different classes of codes → Consistent Physical
- ...es ...t
- ...ML and ...data ...are automatically generated
- At the code level deal with derived data types
- Using Kepler as the workflow engine

Development stages



How do we support ITM developments?

Financial support:

- EFDA priority support: 735 keuro in 2010;
  700 keuro in 2011
- infrastructure support team
- gateway implementation

Learning support:

- code camps and training sessions for ITM members supported by EURATOM mobility

Next ITM general meeting will take place in Lisbon, at the Congress Centre of the Instituto Superior Técnico (IST), between the 13th and the 15th September 2010. Followed by the training sessions on the ITM tools scheduled for 16th-17th September, held at the Computer Centre of the Electronics Engineering Department of IST.

What ITM tools can be used?

!!! Available description and documentation on ITM server:

https://portal.efda-itm.eu/portal/authsec/portal/itm/GFORGE

!!! Available to user through version control repository:

http://gforge.efda-itm.eu/svn/

Equilibrium and MHD codes

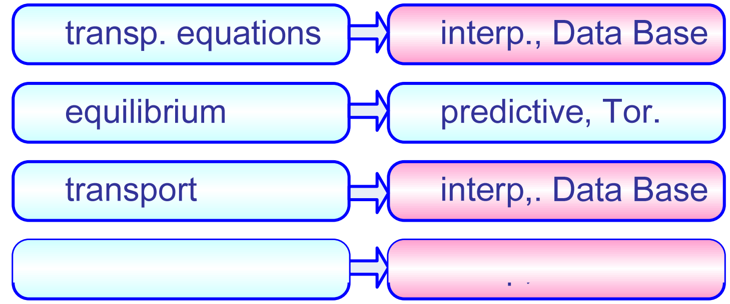
Several equilibrium reconstruction codes are available to ITM users:

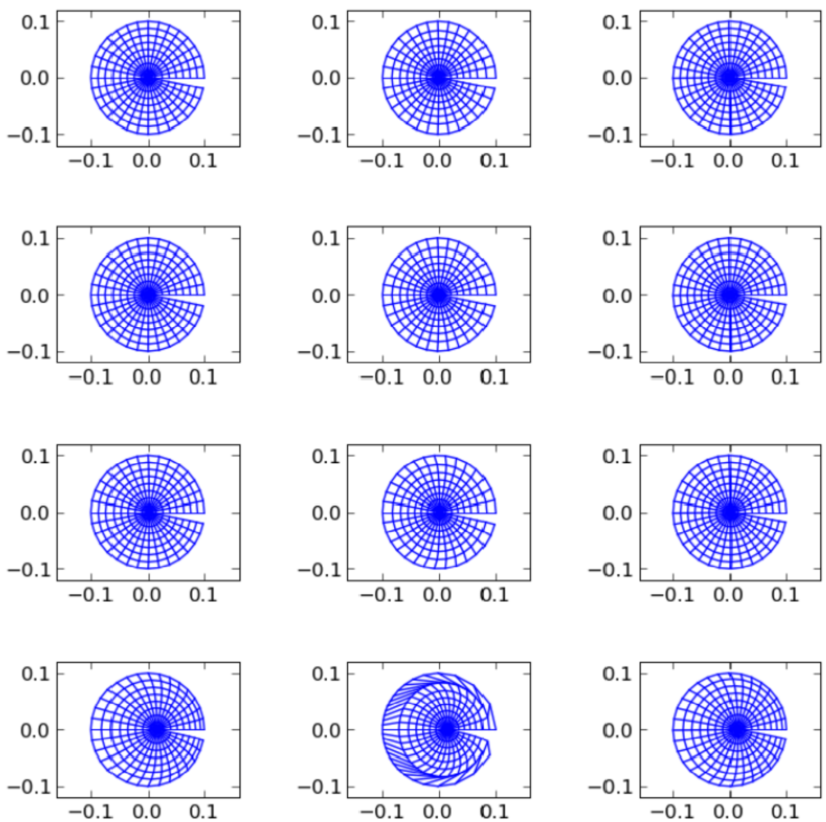
- CHEASE : svn (copy at ITM), Kepler actor
- CAXE : svn (to be copied to ITM), Kepler actor
- HELENA : svn ITM, Kepler actor, manual
- KINX : svn to be copied ITM, Kepler actor, manual
- ILSA : svn ITM, Kepler actor, manual
- EQUAL : svn ITM, Kepler actor

To be done:

- verification : standard test cases to be run regularly
- validation on JET data

Comparison of equilibrium codes





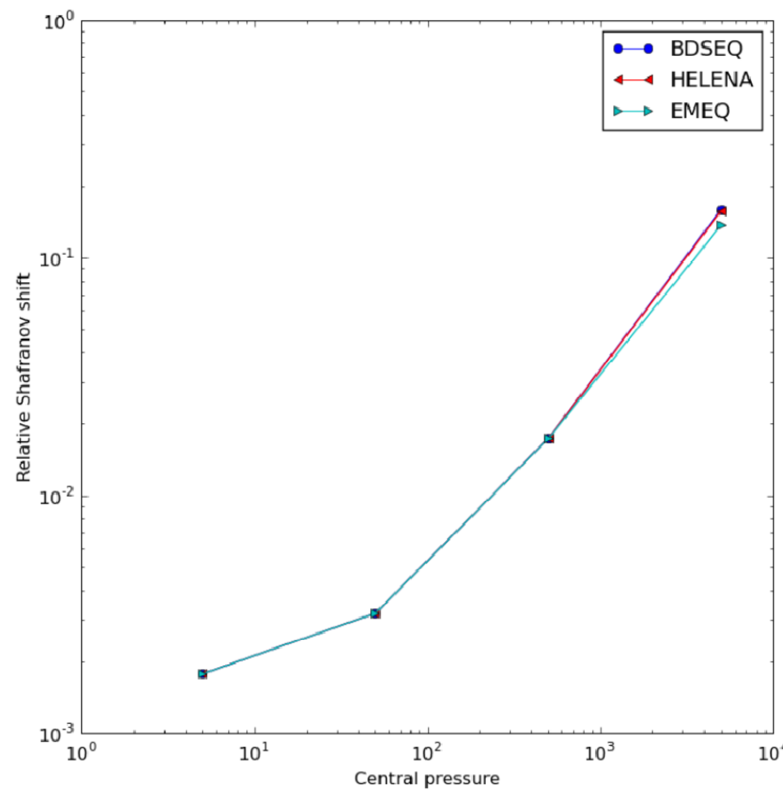
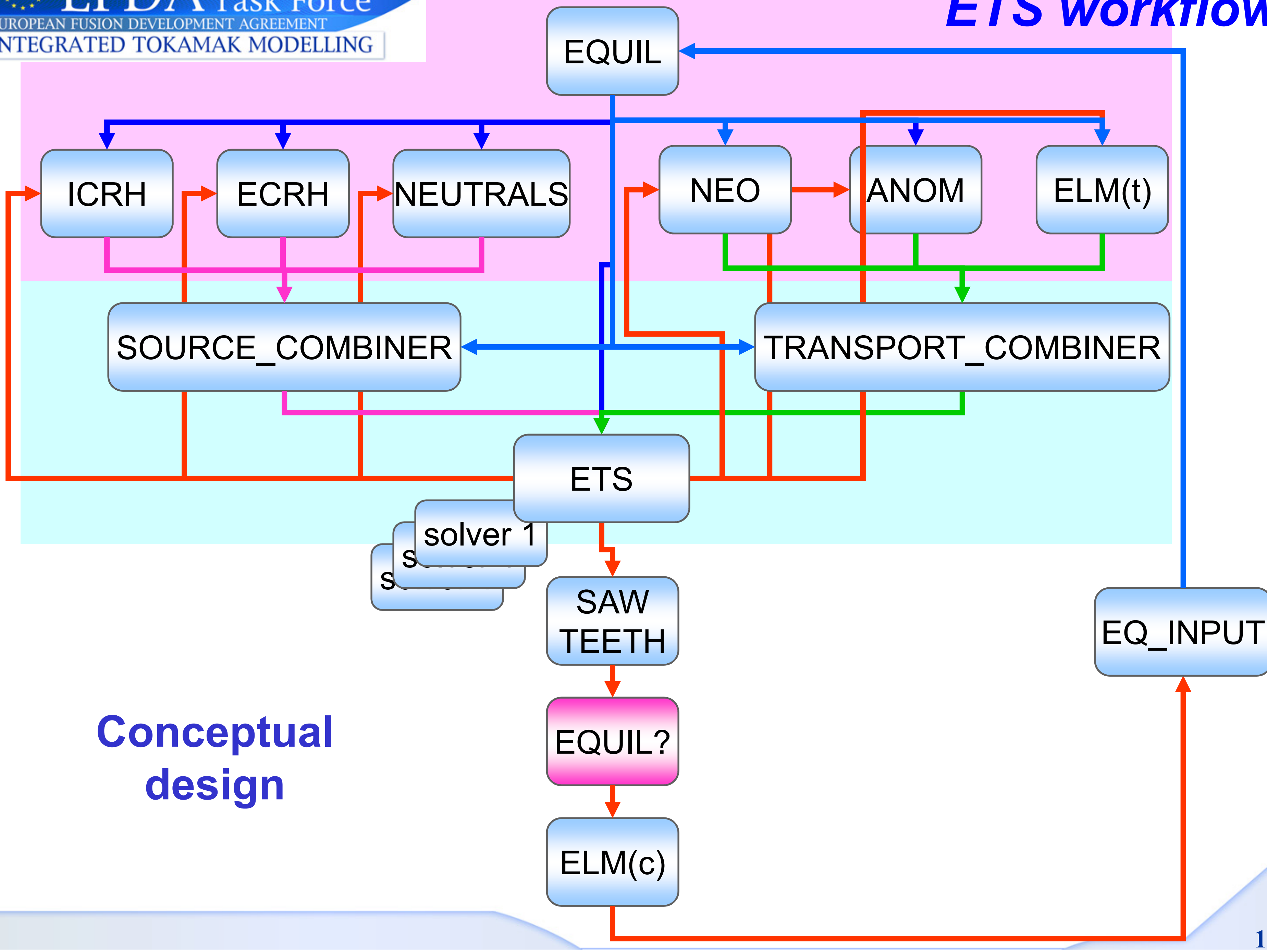


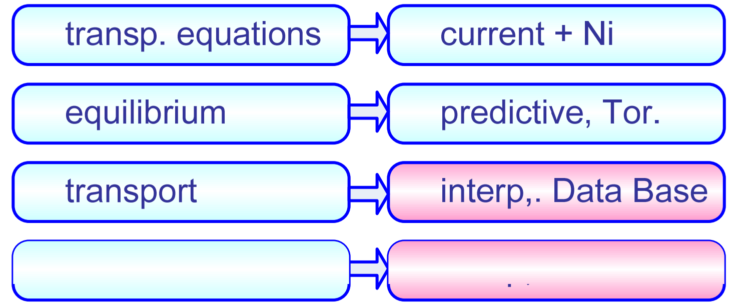
Figure 44: From left to right, BDSEQ, HELENA, EMEQ. From top to bottom, central pressures of 5, 50, 500 and 5000.

ETS workflow

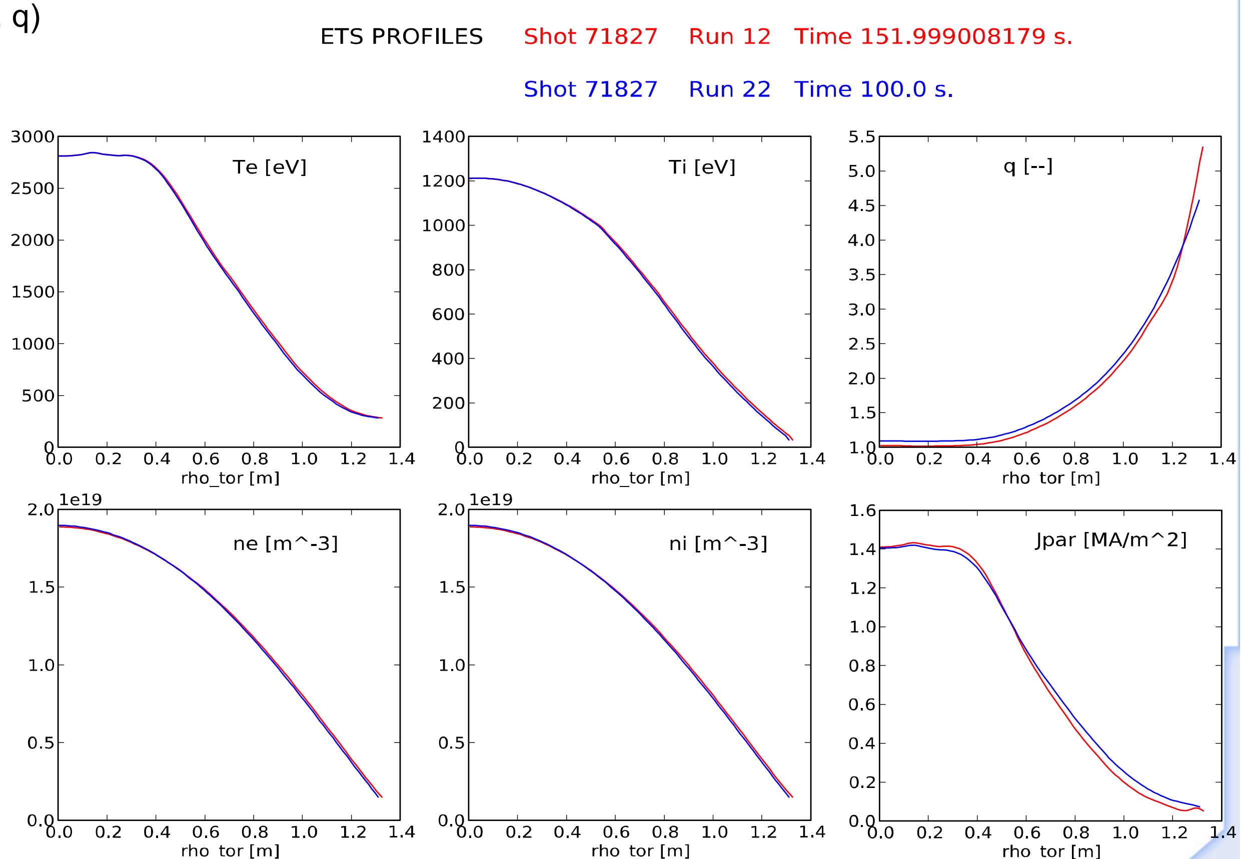


Conceptual design

ETS-JETTO comparison



Settings for the computations:
Shot: **71827**
Time **52 - 152s**
NRHO **101**
Equations:
Current equation – predictive (total current = 2.56 MA)
! note that PSI does not evolve in this case, as it is only computed by ESCO as output and not used by JETTO (current equation is solved for the safety factor, q)
Ion density equation – predictive
(boundary density = 1.5*1012 cm-3)
Diffusion coefficient (radialy constant)
D⊥ = 1 m2/s
Particle source (radialy constant)
Si = 5*1019 m-3s-1
All other transport equations:
interpretative (profiles from t=52 s. are kept through the computations)
Equilibrium:
from ESCO (called 50 times during time evolution)
ESCO settings:
D shape model
Major radius = 287 cm
Minor radius = 99 cm
Elongation = 1.65
Triangularity = 0.2
Zaxis = 0
Number of iterations = 50
Geometrical radius = 295 cm
Btor = 2.56 T



IMP4: Transport Processes and Micro stability

Types of Codes:

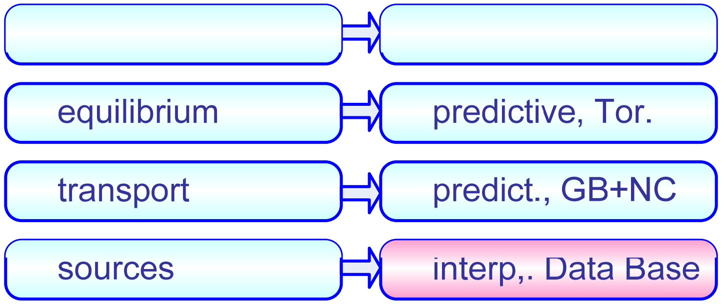
- Linear Micro-instabilities
- Neoclassical Transport
- Turbulence

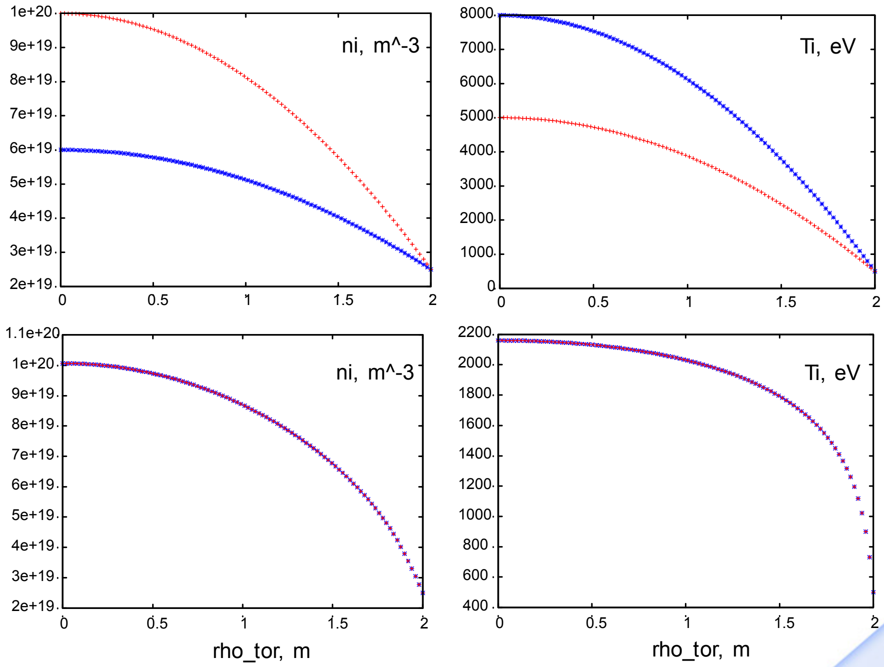
Most of codes are adopted to the ITM data base:

- This forced code developers to agree on input/output;
- Made benchmarking between various codes easy (main task for IMP4)

Two simplified modules have been developed and integrated in ETS workflow:

- ETAIGB;
- NEOWES





IMP5: Heating, Current Drive and Fast Particles

A collection of codes developed within the EFDA Associations in the field of ECRH, LHCD, ICRH, NBI, alpha particles and fast particle interaction with instabilities are being integrated in the ITM framework.

The goal is to have at least one module for each physics area at two levels:

1.one basic and less detailed, enabling fast computations, providing, e.g., *sources for the ETS code*, i.e., profiles of absorbed power and driven current densities, dP/dV and J_{cd}

2.one advanced, but computationally expensive, enabling detailed computations of the distribution functions of electrons and ions during heating and current drive, ultimately incorporating non-linear effects of instabilities.

The ultimate goal is the self-consistent simulation of heating and current drive in the presence of fast particle instabilities, in particular for ITER.

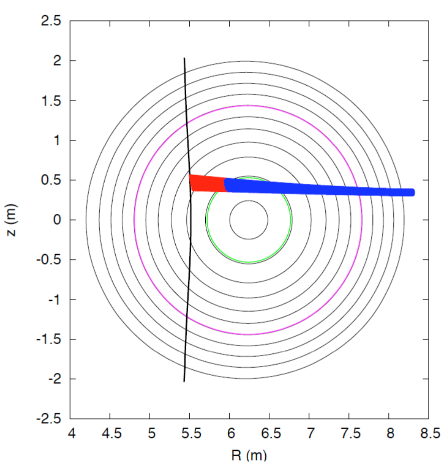
IMP5: Heating, Current Drive and Fast Particles

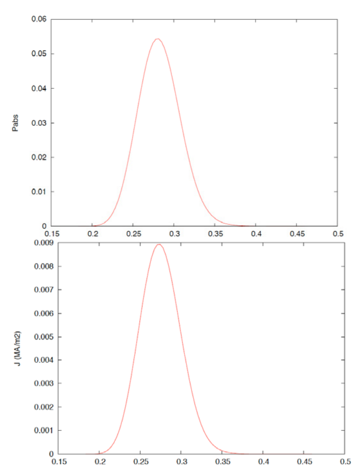
Codes are being tested with inputs from with ETS simulations in the areas

- electron physics, EC and LH interaction
- ion physics ICRH, and NBI interaction
- fast particle interaction and related MHD instabilities

ECRH&CD – *GRAY code*

ITER-like parameters, B_0=5.3 T, R_0=6.2 m equilibrium from *HELENA*, profiles from *ETS*

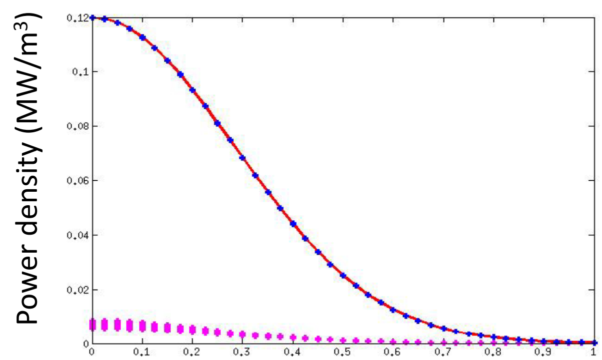




ICRH – *FPSIM code*

The simplified Fokker-Planck code FPSIM for evaluating ion distribution functions distorted by ICRF has been adapted to 4.08a data structures.

It is at present coupled to a mock-up ICRF deposition code.



ICRF-wave power deposition, red line, and FPSIM calculated collisional power transfer to ions and electrons

The code has been tested stand alone with 4.08a data structures and as a Kepler actor in 4.07b data structures.

Summary

- ITM infrastructure is ready
- Many codes are already adopted to the infrastructure
- At the moment, main effort goes in to coupling of tools and V&V
- ITM tools are started to be used for analysis of experiments