INTEGRATED MODELLING PROJECT 3: TRANSPORT CODE AND DISCHARGE EVOLUTION

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Call for participation

Objective

To provide the computational basis for a modular transport code, taking account of the core, the pedestal and the scrape-off layer. Ultimately, to enable the simulation of complete tokamak scenarios, *e.g.* for ITER.

Scope

The intention is to adopt a modular approach to the construction of a transport code. In the period covered by this call, modules will mainly be adapted from parts of existing transport codes, but some new modules could be developed. These modules will be continually updated and extended as improved physics models or more efficient algorithms are developed. The model development will be performed in collaboration with the teams working in the other Integrated Modelling Projects (IMPs). The goal is to have a range of modules for each physics area ranging from very detailed (but computationally expensive) to faster (but less detailed modules). From the experience gained in the period covered by this call, together with the input from the Code Platform Project (CPP), it is expected that the design of the overall framework (platform) for the transport code will occur within the period covered by the next call for participation, though some activity is likely to occur during the period covered by this call.

Summary

Since a number of core and edge transport codes already exist, and since it is the task of IMP#1, IMP#2, IMP#4 and IMP#5 to develop new modules, the main activity within IMP#3 in the next two years will be to

1. define standard interfaces;
2. package modules from the existing codes and bring them into compliance with the standard interface;
3. change the existing codes (or a subset of them) to use the new modules; and
4. document, verify and validate the modules

in each of a number of areas:

A. interface to the equilibrium and linear MHD stability modules;
B. interface to non-linear models (saw-teeth, ELMs *etc*);
C. interface to transport models (neoclassical, turbulence, *ad hoc*);
D. interface to sources/sinks (atomic physics, heating, current drive, fuelling); and
E. interface to boundaries:
   I. Core-edge coupling;
   II. Improved coupling between the plasma and plasma facing components (PFCs); and
   III. Whole device modelling.

These modules will then be available for the framework developed by the CPP, as well as for the existing transport codes (and any other codes that might benefit).

Work plan for IMP 3

The work plan is broken into separate work plans for five sub-topics (A through E above), with each having a number of phases. Participation is called for in each of the five sub-topics, with the intention of forming five working groups. Each of these working groups might further sub-divide at a later stage.

Guidance for the phases for sub-topics A—D

1. It is hoped that the definition of standard interfaces will be completed within 3 months of the start of the project, and travel for 1 to 2 weeks under European Mobility would be expected for the entire working group. Deliverables from this phase will be the specification of the standard interfaces.
2. The phase of packaging modules and bringing them into compliance is expected to last between 3 to 12 months and would largely be done at home laboratories, though some travel of limited numbers of people for 2 to 4 weeks is to be expected. For some of the modules, particularly in the sources/sinks sub-topic (D), a period longer than 12 months might be necessary and the work might extend beyond the period covered by this call. The deliverable from this phase would be the modules.
3. The phase of changing the existing codes to use the new interfaces is expected to take 1 to 2 months and, again, would largely be done at home laboratories with limited numbers of people requiring 2 to 4 weeks of mobility. The deliverable for this phase would be the demonstration of the new module functioning in the existing code(s).
4. The documentation, verification and validation phase would overlap the other phases: in particular, documentation of the standard interface is crucial for the subsequent phases. Verification and Validation (V&V) of the prepared modules would take place in both the "packaging" (2, above) and the "integration" (3, above) phases. The V&V of particular modules is likely to be facilitated by the involved people coming together under Mobility for 1 to 2 weeks. Deliverables for this phase would be: the documentation of the standard interface; the documentation that the packaged and re-integrated module produces the "same" answer as the original module; the documentation of any comparisons between modules implementing the same physics in the same code; the documentation of the behaviour of the same module in different codes; "certification" at some level of the modules as to domains of validity.
5. As new modules are developed by the other IMPs, work will be required to bring them within the framework of IMP 3.

Guidance for sub-topic E

This area is a catch-all for other activities that are expected to play a larger role once activities in A—E are completed. It is however expected that a start in this area will be made within this time-period.

For the initial phase, expected to last less than 6 months but not necessarily to start immediately, it is expected that a limited number of people will need to travel under mobility for 1 to 2 weeks to identify the issues involved, and to select the approaches to be pursued in subsequent phases.

The interface standardisation phase is expected to last longer than for the other sub-topics, and to involve a substantial amount of home laboratory work exploring various options.

The module "packaging" phase might also be accompanied by a module "creation" phase where no existing modules are available. Thus this phase is expected to last longer than the equivalent phase in the other sub-topics, and perhaps to require a re-specification of the interface. Work within this phase might not be completed within the scope of this call and would be expected to continue in the framework of a subsequent call.
The module "integration" phase is also likely to be a larger undertaking than for the other sub-topics and is likely to occur outside this particular call for participation (but in the next one). Of course some activity within this area is possible.

Work plans for the individual sub-topics follow:

Work plan for topic 3A: MHD equilibrium and stability modules (EFDA-TF-ITM-IMP3-A)

i) In collaboration with IMP#1 to define standard interfaces between the transport codes and
   a. Equilibrium codes
   b. Linear stability codes
ii) To "package" at least
   a. one equilibrium code from the existing transport codes, and then to change its interface to the new standard
   b. one linear stability package from the existing codes, and then to change its interface to the new standard
iii) To modify at least one of the transport codes to use the new interfaces for the equilibrium and stability packages
iv) To document the modules produced, as well as to verify and validate them.

Work plan for topic 3B: Non-linear modules (saw-teeth, ELMs, NTMs) modules (EFDA-TF-ITM-IMP3-B)

i) In collaboration with IMP#2 to define standard interfaces between the transport codes and
   a. Saw-teeth models
   b. ELM models
   c. NTM models
   d. Any others
ii) To "package" at least one example of each from the existing codes, and bring its interface into compliance with the new standard
iii) To modify at least one of the transport codes to use the new interfaces for the non-linear modules
iv) To document the modules produced, as well as to verify and validate them.

Work plan for topic 3C: Transport models (EFDA-TF-ITM-IMP3-C)

i) In collaboration with IMP#4 to define standard interfaces between the transport codes and various transport models
ii) To "package" at least one example of each from the existing codes, and bring its interface into compliance with the new standard

iii) To modify at least one of the transport codes to use the new interfaces for the transport models
iv) To document the modules produced, as well as to verify and validate them.

Work plan for topic 3D: Sources and sinks
(EFDA-TF-ITM-IMP3-D)

i) In collaboration with IMP#5 to define standard interfaces between the transport codes source/sink modules:
   a. Atomic physics
   b. Neutral beam injection (particle source, heating and current drive)
   c. ICH and ICCD
   d. ECH and ECD
   e. LHH and LHCD
   f. pellets
ii) To "package" at least one example of each from the existing codes, and bring its interface into compliance with the new standard
iii) To modify at least one of the transport codes to use the new interfaces for the sources and sinks modules
iv) To document the modules produced, as well as to verify and validate them.

Work plan for topic 3E: Interfaces to boundaries
(EFDA-TF-ITM-IMP3-E)

i) To investigate the best approach to be followed for
   a. Core-edge coupling
   b. Plasma-PFC interactions (including boundary conditions at material surfaces, sputtering, mixed materials, etc.) (in collaboration with EU-TF-PWI)
   c. Whole device modelling
ii) To the extent possible as indicated by i) above, to define standard interfaces for:
   a. Core-edge coupling
   b. Plasma-PFC (in collaboration with EU-TF-PWI)
   c. Whole device modelling
iii) To the extent that any of the approaches have already been implemented, to "package" the implementation from that code and bring it into compliance with the new standard; and, to the extent possible and necessary, prepare new modules
iv) To modify at least one of the transport codes to use the new modules
v) To document the modules produced, as well as to verify and validate them.

Call for participation

In their response to this call for participation, interested parties are requested to

- Identify the sub-topic(s) they wish to be involved in
- Identify the particular aspects of the sub-topic(s) they are interested in
- Identify what specific expertise they might bring to the sub-topics
- Indicate that they will/will not be able to travel under mobility as indicated above