Integrated Predictive Modelling at JET

V. Parail, G. Corrigan, D. Heading, J. Spence,
P. Belo, G. Huysmans, F. Imbeaux, J. Lonnroth, F. Nave,
M. O'Mullane, G. Pereverzev, V. Petrzilka, S. Sharapov,
P. Strand, H. Wilson, L. Zakharov

Outline

- Why do we need integration?

- Approach, chosen by the Project;

- Project description;

- Progress report;

- Future plans;

Why do we need integration (1)

❚ The main motivation comes from the recognition that we are dealing with more and more complex phenomena, which require integrated approach;

❚ The second motivation is the multiplicity of available codes in JET:

   ❚ 1.5D core transport (ASTRA, CRONOS, JETTO, RITM),

   ❚ MHD stability codes (MISHKA, ELITE, CHEESE, HELENA, IDBALL),

   ❚ 2D SOL codes (B2/EIRENA, EDGE2D/NIMBUS)

   ❚ turbulence simulation codes (KINEZERO, GS2, CUTIE);

   ❚ A number of post-processing tools (UTC, Stat-pack);

Approach, chosen by the Project (1)

▉ We decide that the first step towards unification and integration would be to bring all codes under the same shell so that similar codes can share the same input/output files and (in some cases) the same user-friendly environment;

▉ They will be all linked with JET and ITER Profile databases and will all share the same link with MHD stability codes, turbulence simulation codes and post-processing facilities;

▉ They will share the same data storage and catalogue system;

Approach, chosen by the Project (2)

▍ This would allow users to use any code in a similar way and **compare codes** in a very easy way;

▍ Sharing the same platform and input/output files will allow easier **exchange of specific modules**, which would originally developed for just one specific code;

▍ If successful, such a joint cluster of codes will act as an attraction point for modellers and code developers and will make easier process of **code integration**;

▍ Eventually I hope we will be able to choose few "better" combinations of codes (or modules) and make them user-friendly and easily available across Europe;

Approach, chosen by the Project (3)
JAMS Architecture
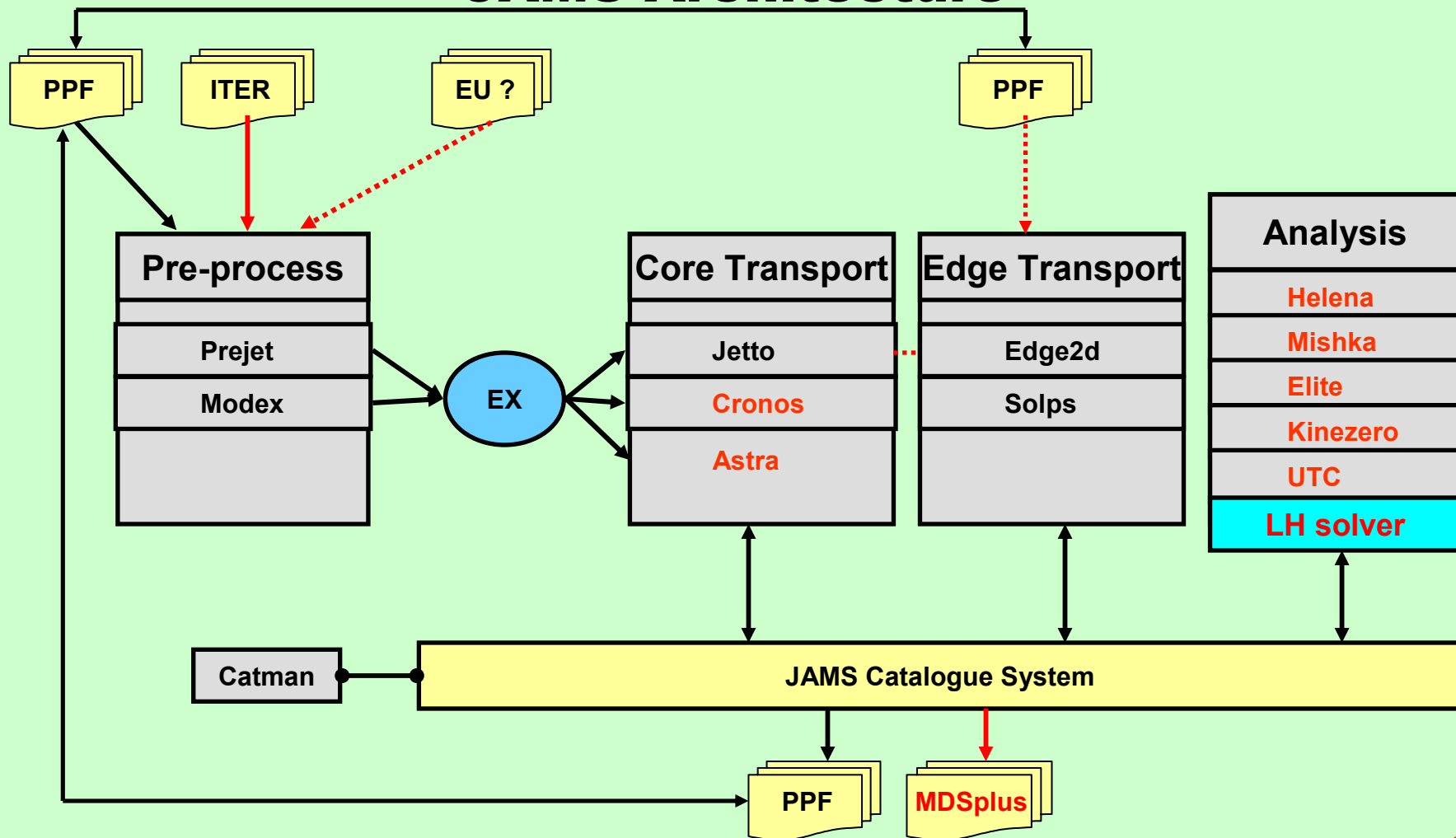
Future Plans

▌ We can go along the line of completing the user-friendly suite of transport, MHD and turbulence simulation codes, which are needed for a fully integrated tokamak modelling;

▌ we can start exploring existing codes in order to make codes more modular and use existing and anticipated modularity to optimise our system;

▌ we can prepare interfaces between JAMS and other EU tokamak databases so that users can use our tools EU-wise;

Completing user-friendly suite of codes (1)

▌ Implement user-friendly interface for EDGE2D, GRID2D and COCONUT (a coupling of JETTO and EDGE2D);

▌ Extend SOL computational grid to include double-null configuration;

▌ Extend a range of post-processing tools for EDGE2D and COCONUT;

▌ Interface EDGE2D with a 3D Monte-Carlo solver EIRENE, which is currently used with 2D SOL code B2;

▌ Interface 2-D LH ray tracing code with full 2D transport code COCONUT;

Completing user-friendly suite of codes (2)

▌ Interface 2-D LH ray tracing code with full 2D transport code COCONUT- the main objectives:

- ▍ it should help to resolve many of the problems related to a modelling of LH waves coupling;
- ▍ it will allow a self-consistent simulation of plasma density evolution in front of LH grill;
- ▍ it should facilitate an estimation of the role of the ponderomotive force on the density re-distribution in front of LH launcher;
- ▍ this modelling can serve as an input for PIC simulation with a possible feedback loop between SOL transport solver and PIC results;
- ▍ it will make ray tracing much more consistent with experimental situations (both with and without gas puffing);

Optimisation of existing system (1)

▐ Core transport codes (JETTO, CRONOS, ASTRA):

▌ a) Integration of new Monte-Carlo solver for fast ions (which includes interaction between RF and NBI and is being developed in CEA,) and ICRH solver PION into JETTO and ASTRA

▌ b) Prepare a universal interface between transport codes and equilibrium solvers, benchmark different equilibrium solvers (agreed with EU ITM TF to mark it as a "joint venture");

▌ c) Interface impurity transport code SANCO with ASTRA;

▌ d) Modularise transport models and boundary conditions and prepare universal interfaces to use it with all core transport codes in a unified way (agreed with EU ITM TF to mark it as a "joint venture");

Optimisation of existing system (2)

- e) Investigate the possibility to use core transport codes (starting from ASTRA) in interactive way within JAMS environment;

MHD stability codes:

- Install the interface between core transport codes and F. Porcelli sawtooth reconnection model (done in CRONOS);
- Install MHD solver, which simulates transport due to NTMs, into core transport codes;
- Interface JETTO with ELITE so that they can be used in a closed feedback loop;
- Investigate the possibility to link a non-linear MHD stability codes with core transport codes to simulate ELMs;