Simulation of Heating and Current Drive Sources for Scenarios of the ITER Research Plan

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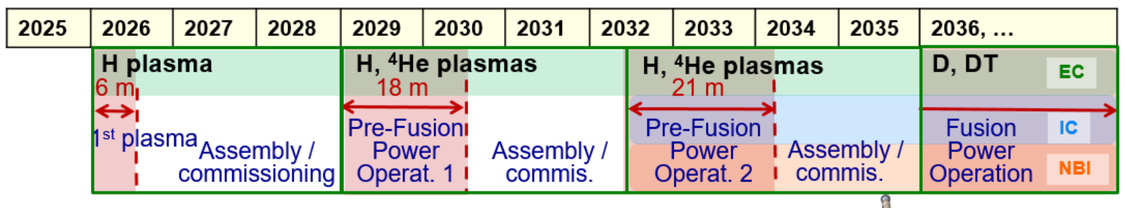
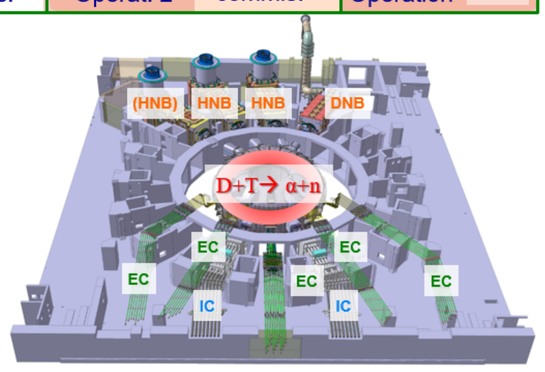
The H&CD systems in the ITER Research Plan

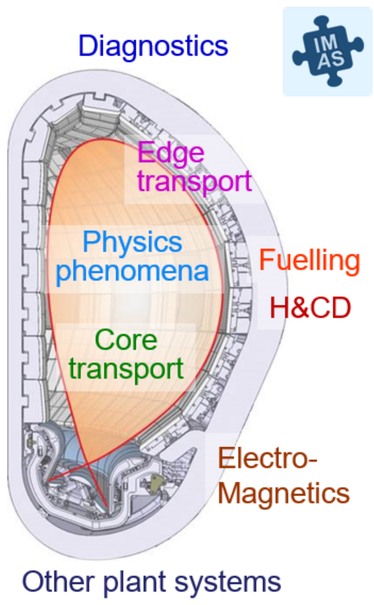


- Three external H&CD systems:
  - Electron Cyclotron wave: 170 GHz, 20MW (+20)
  - Ion Cyclotron wave: 40-55 MHz, 20 MW (+20)
  - Neutral Beam Injection: 870 keV H^0, 1 MeV D^0, 33 MW (+16.5)
- One intrinsic H&CD process:
  - Fusion reactions! 3.5 MeV ~80-100 MW for DT 15 MA/5.3T baseline scenario

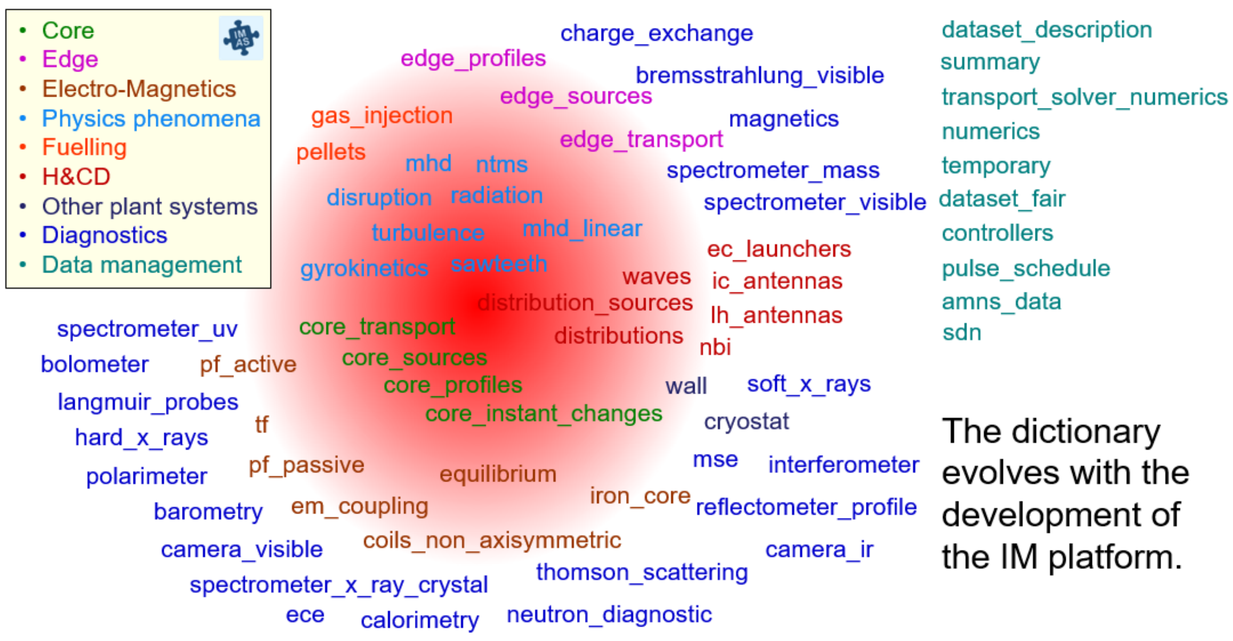


The ITER Integrated Modelling & Analysis Suite IMAS

- IMAS provides a standard and managed access to experimental and simulated data via Interface Data Structures (IDS)
- Aims at integrating free-boundary evolution, core-edge-SOL transport, divertor physics and PFC models to allow high fidelity physics simulations
- Is suitable for any fusion tokamak device
- Will be used for ITER data processing and analysis
- To know more: https://imas.iter.org

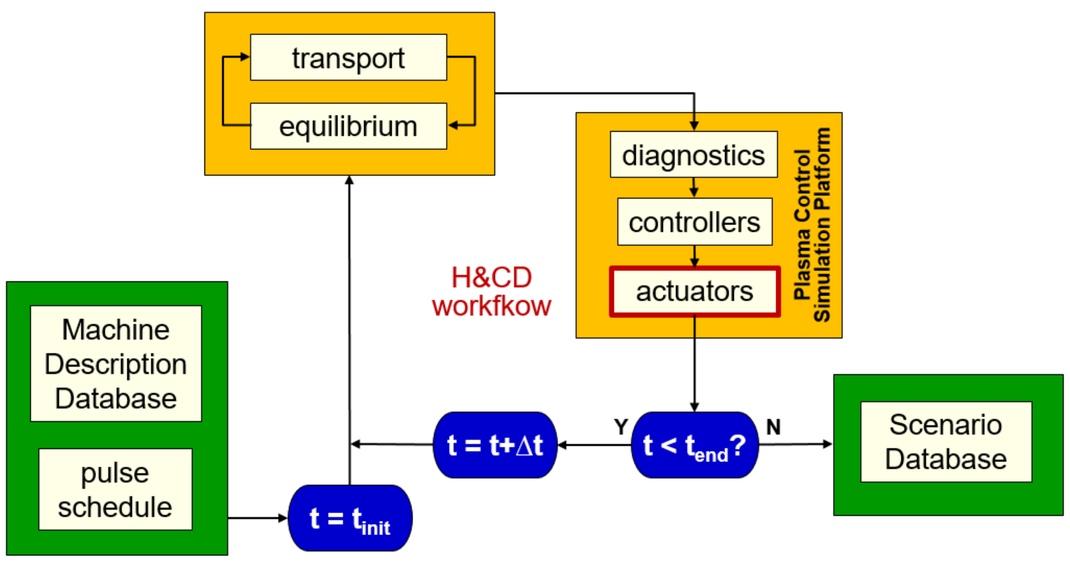


The IMAS Data Dictionary

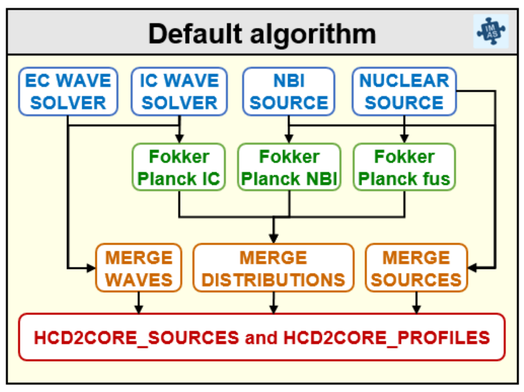


The dictionary evolves with the development of the IM platform.

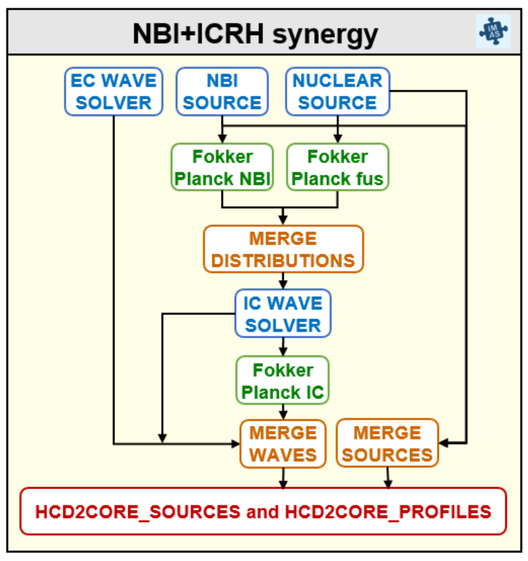
Towards a High Fidelity Plasma Simulator

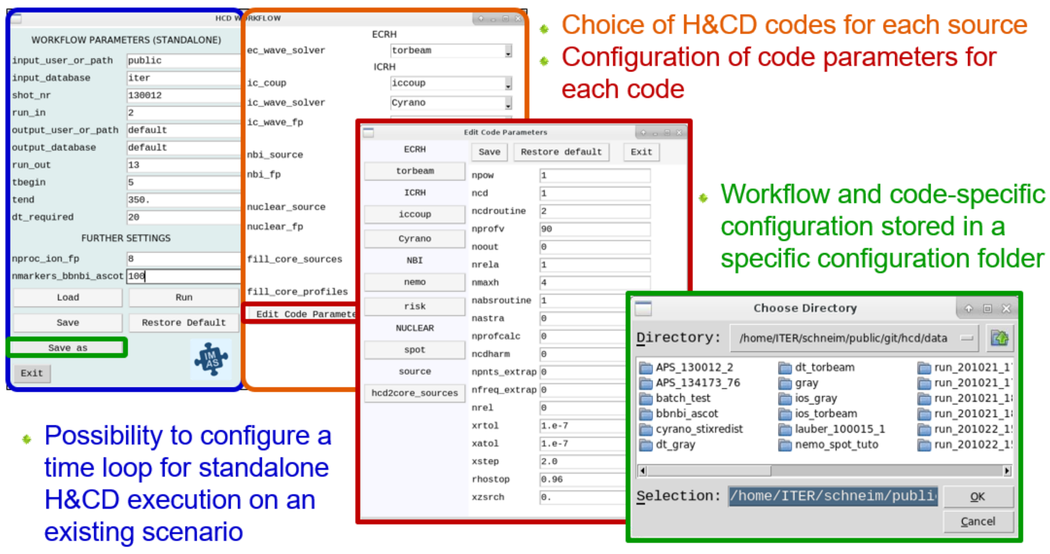


The H&CD workflow and its Graphical Interface



The flexible/composable workflow approach allows for various algorithms implementations.

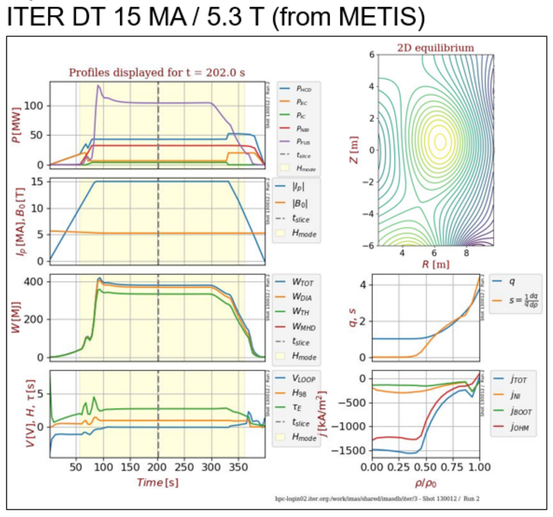




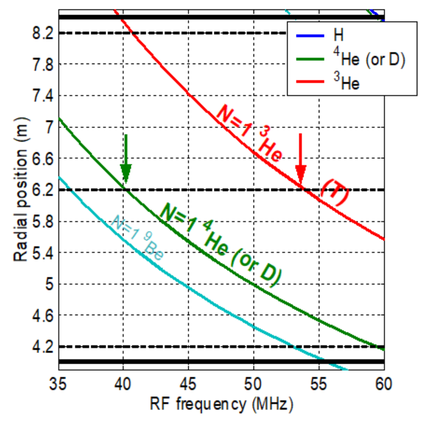
- Choice of H&CD codes for each source
- Configuration of code parameters for each code
- Workflow and code-specific configuration stored in a specific configuration folder
- Possibility to configure a time loop for standalone H&CD execution on an existing scenario

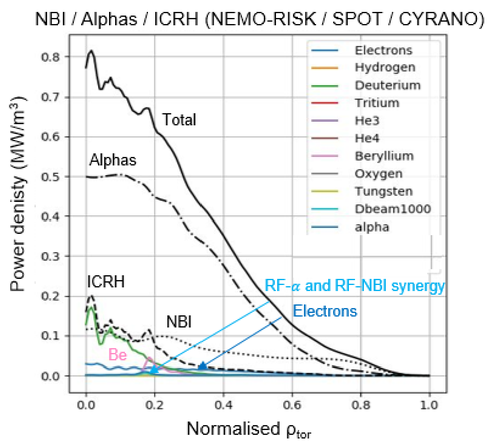
NBI+ICRH+α synergy for an ITER 15MA / 5.3T DT scenario

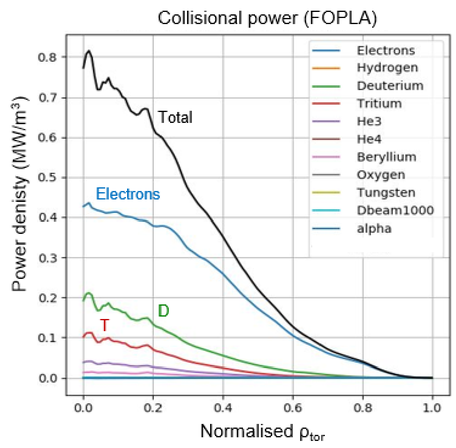
Input scenario from IMAS scenario database: ITER DT 15 MA / 5.3 T (from METIS)



- ICRH modelling: 10 MW:
  - 40 MHz, for N=1 D(+Be)
  - 53 MHz for N=2 T heating







Weak RF-α and RF-NBI synergy (<5% ICRH)

Note: higher NBI+ICRH synergy in PFPO-2: *[A. Polevoi et al, submitted to NF (2020)]*

- Dominant electron heating (alphas)
- Significant core ion heating (~40%) due to combined ICRH, NBI and α heating

Conclusion

- IMAS provides a standard for integrated modelling delivering a high level of modularity and flexibility
- A key deliverable is a high-fidelity plasma simulator including self-consistent calculation of free-boundary equilibrium + core-edge transport
- The H&CD workflow has been developed as an essential element of any high-fidelity plasma simulator, enabling the modelling of the synergy between H&CD sources
- The H&CD workflow has been integrated within the core-edge JINTRAC transport solver
- The DINA free boundary equilibrium code is being coupled to the JINTRAC transport solver
- A first version of a high-fidelity plasma simulator is expected soon!

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