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Simulation of Heating and Current Drive Sources for various Scenarios of the ITER Research Plan using the IMAS H&CD Workflow

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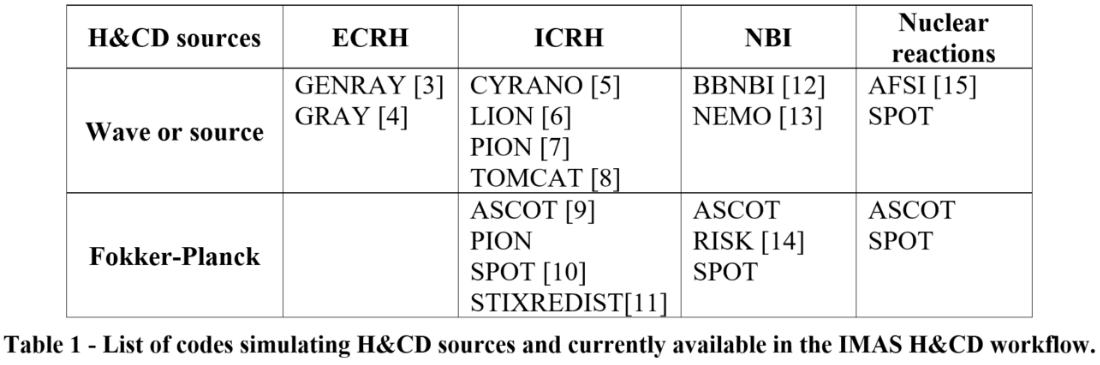
The ITER Integrated Modelling & Analysis Suite (IMAS) has been developed to provide a standard framework for supporting scenario preparation and plasma operation through a standardised data model designed to support both simulated and experimental data 1. The IMAS platform provides a high degree of modularity between physics models and physics workflows. One of the most sophisticated physics workflows developed so far in IMAS is for Heating and Current Drive (H&CD) modelling. The H&CD workflow developed by the ITER Organization is based upon an earlier development carried out within the European Integrated Modelling activities 2. It has been written in Python for its availability and portability, and its extensive use within the modelling community worldwide.

The IMAS Python H&CD workflow offers the capability to be coupled to any transport solver adapted to IMAS, which is a natural consequence of the modular nature of the IMAS standardised approach. It can simulate the synergy between H&CD sources and provides a high degree of modularity between various H&CD models for all the heating sources available in ITER, i.e. the Electron Cyclotron Resonance Heating (ECRH), the Ion Cyclotron Radio Heating (ICRH), the Neutral Beam Injection (NBI), and the fusion-born alpha particles, thus covering any scenario of the ITER Research Plan. The list of H&CD codes currently available in the IMAS H&CD workflow is provided in Table 1.



H&CD sources	**ECRH**	**ICRH**	**NBI**	**Nuclear reactions**
Wave or source	GENRAY [3] GRAY [4]	CYRANO [5] LION [6] PION [7] TOMCAT [8]	BBNBI [12] NEMO [13]	AFSI [15] SPOT
Fokker-Planck		ASCOT [9] PION SPOT [10] STIXREDIST[11]	ASCOT RISK [14] SPOT	ASCOT SPOT

Table 1 - List of codes simulating H&CD sources and currently available in the IMAS H&CD workflow.

Figure 1: Table 1

The modelling results of the H&CD workflow are presented for various scenarios of the ITER Research Plan. They are primarily based upon scenarios computed with the METIS transport solver [16], available within the IMAS scenario database [17]. The scenarios considered cover both Pre-Fusion Power Operation (PFPO) and the Fusion Power Operation (FPO) phases and address the optimization of H&CD for their realization. For PFPO the specific issues related to the time evolution of 3rd harmonic ECRH absorption for 5 MA / 1.8 T scenarios and the fast ion distributions resulting from NBI modelling for 7.5 MA / 2.65 T scenarios are addressed. The results of this NBI modelling are further exploited to study the MHD stability of ITER NBI ions in such scenarios with two beam configurations in an accompanying paper at the conference [18]. Finally, the evaluation of the plasma heating sources (ECRH, ICRH, NBI and alpha heating) during the whole plasma evolution in the ITER baseline DT Q = 10 scenario is presented. As an illustration, Figure 1 shows the NBI deposition and power profiles calculated by the NEMO and RISK codes within the IMAS H&CD workflow.

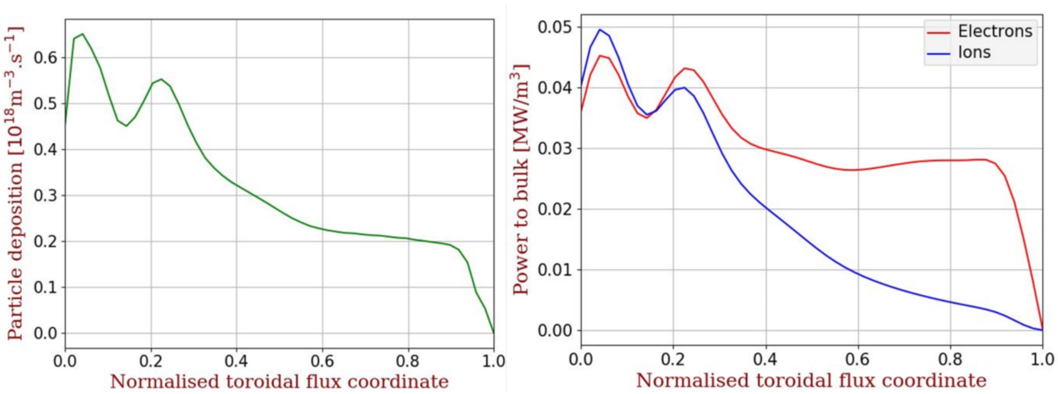


Figure 1. Neutral beam heating for ITER baseline DT scenario when injecting 16.5 MW power on-axis and 16.5 MW power off-axis. Left figure: Neutral beam deposition profile as calculated by the NEMO code. Right figure: power to bulk electrons and ions as calculated by the RISK ion Fokker-Planck code.

Figure 2: Figure 1

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