# Non-linear MHD simulations of the plasma instabilities by pellet injection in LHD plasma

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The pellet injection is an experimentally proven method of plasma refueling in tokamaks [1,2] and stellarators plasmas [3]. The pellet injection into the plasma is also used for plasma control, i.e. ELM (Edge Localized Mode) mitigation for tokamaks by means of the excitation of the Magnetohydrodynamic (MHD) activities via pellet injection. However, the plasma instabilities which are inimical phenomena via pellet injection are problems that have come into focus simultaneously. It is crucial to identify the complex physics mechanism between the plasma stability and the pellet ablation physics with non-linear MHD analysis.

In this work, the global MHD dynamics of the Large Helical Device (LHD), which is a large superconducting Heliotron in Japan, has been analyzed with MIPS code [4] which solves the full MHD equations coupled with the pellet ablation model. The pellet ablation model which is based on neutral gas shielding model has been implemented in MIPS. The two important features are reflected in the implementation of the model into MIPS code in a similar manner with JOREK [5,6]. The first feature is that the pellet is modelled as a localized adiabatic time-varying density source. The pellet density source is toroidally and poloidally localized. The second feature is that the pellet moves at fixed speed and the direction.

Initial MIPS-Pellet runs for non-linear MHD dynamics have been performed. The modelled LHD plasma has the edge electron pressure ($p_e$) of 1 kPa and $p_e$ of the core region is 7.8 kPa. The electron temperature ($T_e$) at the edge is 0.4 keV and the core is 2.1 keV. The results of the pellet size dependence in the LHD plasmas show that the pellet penetration depth ranges for 0.5-0.7 m according to the pellet size which is scanned for $1.0 \times 10^{21}$D, $1.5 \times 10^{21}$D and $2.0 \times 10^{21}$D particles in a pellet. The simulation result is reasonably comparable values with the experiment observation [7]. The transport of the pellet cloud in the whole plasma domain in a time scale of the pellet ablation which is typically 400-600μs has been observed.

The performance of the parallel computing has been analyzed using MareNostrum IV which is the most powerful supercomputer in Barcelona, Spain. The numerical resolution of the simulation domain for the test case is 128x128x256. The number of cores has been varied for 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384 cores. The speed of the MPI computing increases linearly according to the number of cores until 4096 cores. A detailed analysis and an optimization will be carried out as a future work.

References:

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