DUSTT Code

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1. Purpose / Application

DUSTT code is a dust transport simulation code which consider dust cooling by thermal radiation and destruction processes such as physical and chemical sputtering, melting and evaporation, electron emission, etc. The time evolution of the dust position, velocity, temperature, electric charge and radius in plasmas can be simulated for spherical shaped dusts and various fusion relevant materials (Li, Be, B, C, Fe, Mo and W, etc.) of dusts.

2. Developer / Improver

R. D. Smirnov, A. Yu. Pigarov (UCSD), Y. Tanaka (Kanazawa Univ.)

3. General Description (function, usage, etc.)

The DUSTT code can be used to study dust behavior in plasmas taking into account various plasma-dust interaction processes including physical and chemical sputtering, radiation enhanced sublimation, melting and evaporation/sublimation, thermal radiation, and dust charging processes such as plasma collection, secondary electron emission, thermionic emission, etc. For the simulation, a three or two-dimensional grid model which includes plasma parameter profiles calculated by a peripheral plasma fluid code such as EMC3-EIRENE, B2, UEDGE, etc. is necessary. For the reference, a three-dimensional grid model for an LHD plasma with a closed helical divertor components is shown in Figure 1.

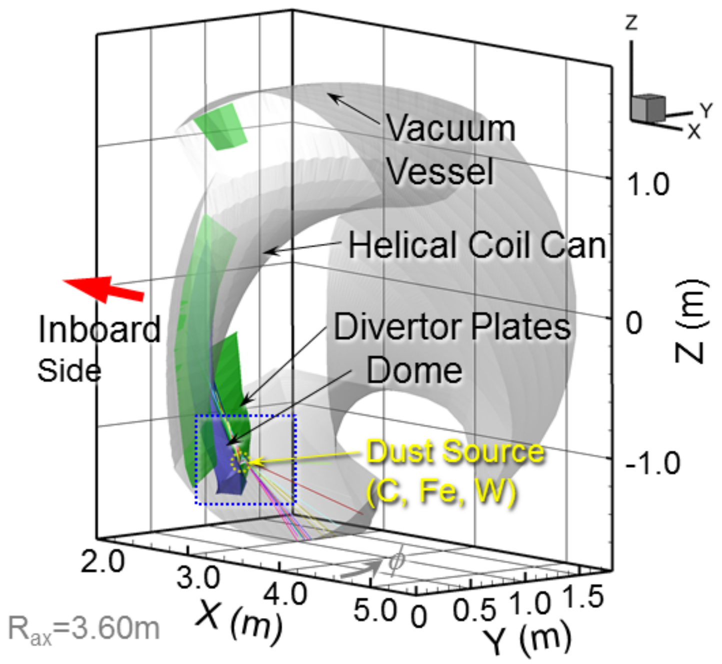

Figure 1 A three-dimensional grid model of a LHD plasma calculated by the EMC3-EIRENE code for dust transport simulation.

There are two calculation modes for the study of the dust transport in plasmas;

- Single calculation mode

In this mode, dusts are released from a dust source to a grid model for a peripheral plasma fluid code. The plasma parameter profiles in the grid model are fixed in this calculation mode, which means that effect of dusts on the plasma is not considered. One can calculate dust trajectories for various dust radii, dust materials and initial dust velocities, and the time trend of the dust position, velocity, temperature, etc. in the grid model is obtained (see Figure 2).

- Iteration calculation mode.

In this calculation mode, one can calculate impurity radiation power profiles induced by the evaporation/sublimation of dusts in plasmas. For this purpose, three-dimensional profile of background plasma parameters calculated by a peripheral plasma fluid code is necessary. By coupling with the DUSTT code with a peripheral plasma fluid code, one can investigate the effect of the impurity radiation caused by the emission of a large amount of dusts on the plasma. It requires huge CPU time for iteratively obtaining a solution being consistent with the impurity radiation power profiles induced by the dusts and the plasma parameter profiles including the radiation power.

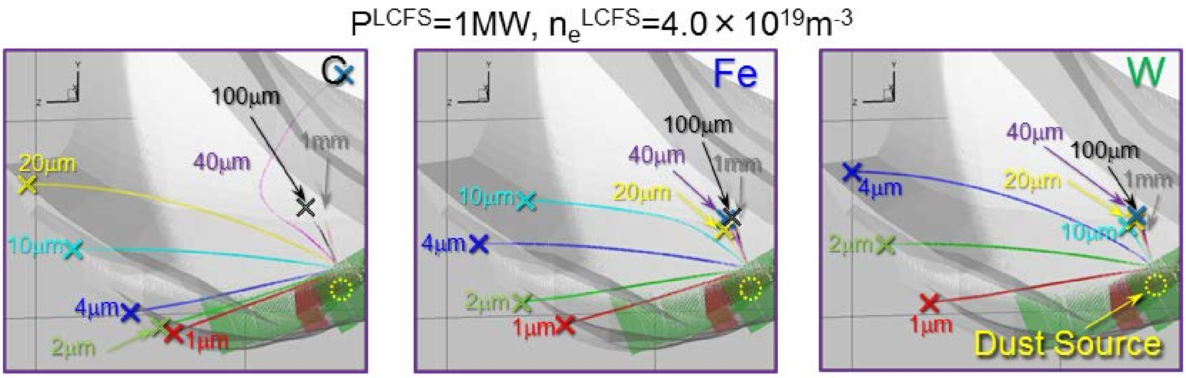

Figure 2 Three-dimensional trajectories of carbon (a), iron (b) and tungsten (c) dusts which are released from a lower closed divertor region in an LHD plasma grid model.

4. Requirement in Use

4.1. Platform(s)

LHD numerical analysis sever (Fujitsu, PRIMEHPC FX100)

4.2. Required resources

A few minutes for single DUSTT run, several hours for simulation including iteration processes with the plasma code in the LHD numerical analysis server.

4.3. Usability

The three-dimensional grid models for LHD plasmas are necessary for simulating dust transport in the peripheral plasmas.

5. Type in Use

We can modify the source code and can easily include user defined modules in the code. Some papers written by the developer should be referred in publications and presentations. The usage of the code needs developer's permission.

References

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[2] A. Y. Pigarov et al., Journal of Nuclear Materials 363-365 (2007) 216.

[3] R. D. Smirnov, et al., Plasma Phys. Control. Fusion 49 (2007) 347.

[4] Y. Tanaka, et al., J. Nucl. Mater. 415 (2011) S1106.