Dust Injection in STOR-M

STOR-M (Saskatchewan TORus - Modified) is a small tokamak which began operation in 1987 and is currently the only operating tokamak in Canada. STOR-M's core plasma parameters are similar to that of the edge region in modern tokamaks, such as WEST and ASDEX Upgrade. The most recent STOR-M campaigns have been dedicated towards plasma-dust interaction studies using pre-characterized tungsten microparticles. These campaigns are especially relevant, as tungsten is a primary wall material for future fusion reactors. Experiments begin with the injection of tungsten microparticles (dust) prior to the initiation of Ohmic heating, which occurs at a controlled delay time and determines the amount of in-vessel dust present in the discharge. Within the plasma, dust particles are heated and become incandescent, allowing for their observation with two fast cameras. Loop voltage, plasma current and discharge duration are some of the plasma parameters found to be detrimentally affected, proportional to an increased amount of dust within the plasma volume. Additionally, a strong toroidal force affects tungsten dust trajectories when a sufficiently small amount of dust is present. Doppler spectroscopy measurements further reveal that an increased amount of in-vessel dust reduces the acceleration of plasma ions within the core. The statistical mean net force on dust, measured from dust trajectories, was analyzed and compared to the Barnes and Hutchinson/Khrapak ion-drag force models [1]. It is found that the mean force acting on dust is systematically larger than predicted by either model, though within a factor of approximately 2-3. Plasma current reversal in STOR-M is found to change the direction of dust motion, which qualitatively supports an ion-drag model. Supplemental post-mortem sampling of dust in STOR-M indicates a substantial reduction in the sizes of dust particles measured downstream of the dust-injector (in the direction of plasma current), indicating selective transport of dust by size and/or ablation of the toroidally transported dust.

[1] André Melzer et al. Physics of dusty plasmas. Vol. 962. Springer, 2019.