White Paper for Massive Gas Injection studies in NSTX-U in support of ITER research

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This white paper describes our plans for studying the benefits of Massive Gas Injection (MGI) from the private flux region of NSTX-U and the impact of varying the poloidal gas injection location on the efficiency of injected gas assimilation by the tokamak discharge, and the resulting dynamics of the thermal quench phase. Comparisons with an un-mitigated disruption will be used to assess reduction of divertor heat loads and halo currents.

At present, MGI is the most promising method for safely terminating disruptions in ITER. On ITER, because of the large minor radius of the device, the long transit times for the slow moving neutral gas, and the large scrape-off-layer flows, it is not known if a simple MGI pulse would be adequate for securely terminating an ITER discharge. While MGI experiments are being conducted at a number of tokamak facilities, the impact of varying the poloidal injection location has not been adequately studied, and injection into the private flux region has not been studied.

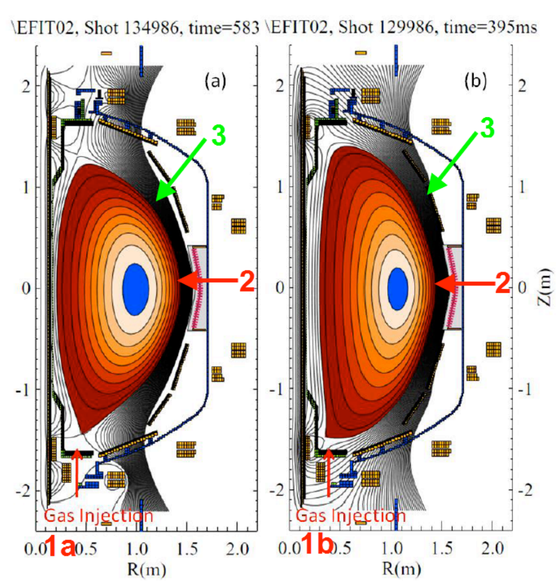

Fig. 1. Shown are the planned Massive Gas Injection locations on NSTX-U. (1a) Private flux region, (2) mid-plane injection, (1b) high field lower SOL region and (3) outer SOL above the mid-plane.

Additional insight into ways for reducing the total amount of injected gas and appropriate injection locations would further help optimize the MGI system for ITER. NSTX can offer new data by injecting gas into the private flux region and into the lower X-point region to determine if this is a more desirable location for massive gas injection.

Injection from this new location has two advantages. First, the gas is injected directly into the private flux region, and so it does not need to penetrate the scrape-off-layer region. Second, because the injection location is located near the high-field side region, the injected gas should be more rapidly transported to the interior as known from high-field side pellet injection research and from high-field side gas injection on NSTX. By comparing gas injection from this brand new location to results obtained from injecting a similar amount of gas from the conventional outer mid-plane region and from other poloidal locations, NSTX results on massive gas injection can provide additional insight and a new set of database for improving computational simulations and add new knowledge to disruption mitigation physics using massive gas injection.

Figure 1 shows the proposed injection locations. Figure 2 shows the MGI assembly installed for private flux region injection on NSTX. We are at present improving the MGI hardware and examining the possibility of improving the gas injection valves. We are also modeling the gas penetration physics using the DEGAS-2 code, to optimize the injection plenum size, to minimize the amount of injected He gas and other high-Z impurities. The present plans are the determine the optimum injection location for NSTX-U and eventually to have the system on stand-by so that it could be automatically triggered based on sensor information that predicts an impending disruption. Such capability is also needed for a future ST based FNSF.

Fig. 2. The Private Flux Region MGI assembly on NSTX. The blue ring above the three parallel gas injection valves is the PF2L coil on NSTX.