**Research Milestone R(12-2)** Project deuterium pumping capabilities for NSTX-U using lithium coatings and cryo-pumping (September 2012)

*Description:* Access to reduced collisionality in NSTX Upgrade will be achieved with a combination of increased temperature from increased field and plasma current, and from operation with controlled and reduced normalized plasma density (Greenwald fraction). Key to achieving controlled and reduced normalized density is sufficient particle control. Lithium wall coatings have been utilized in NSTX to pump deuterium, and low deuterium Greenwald fractions of 0.3-0.5 have been achieved and maintained for the full flat-top duration of NSTX. However, the lack of ELMs with thick lithium coatings can lead to increased carbon confinement and Zeff and higher total Greenwald fraction ~1 (all of which can be reduced with natural or triggered ELMs). A key question for the usage of lithium coatings in NSTX-U is the deuterium pumping persistence of the coatings, i.e. whether such coatings can pump throughout the entire flat-top of an NSTX-U plasma. To address this issue, modeling of the deuterium pumping from Li coatings in NSTX will be performed with edge codes such as SOLPS and UEDGE. These codes will be used to interpret and reproduce heat and particle flux profiles from high current and high beam-power discharges from NSTX to project scrape-off-layer profiles for NSTX-Upgrade. This SOL profile analysis will be combined with time-dependent analysis of divertor deuterium recycling with lithium in NSTX, and these trends will be used to project lithium pumping persistence in NSTX-U. A second deuterium pumping technique – divertor cryo-pumping – will also be assessed for NSTX-U. Preliminary cryo-pumping designs for NSTX-U will be developed compatible with the NSTX-U vessel geometry and a range of divertor magnetic topologies, including the snowflake divertor. Further, this analysis will be used to assess which NSTX-U operating scenarios and density values can be sustained with stationary deuterium inventory using cyro-pumping. This analysis and modelling for lithium coatings and cryo-pumping will provide a quantitative basis for projecting particle control in NSTX-U with application to future next-step STs.