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***TO: J. Menard, S. Kaye, S. Gerhardt***

***FROM: Walter guttenfelder and the transport & Turbulence TSG***

***Subject: impact of potential polar region modifications on research and scenarios for transport & turbulence Topical Science group***

1. **Determine how proposed polar region changes impact Transport & Turbulence research goals**
2. The removal of ceramic breaks and CHI operation does not directly impact priority T&T research goals.
3. Limiting operations to traditional “forward-BT” (clockwise) does not directly impact priority T&T research goals. There are instances where T&T may be interested in reverse BT scenarios (e.g. L-H transition studies). However, LSN vs USN could be used as an alternative.
4. Given constraints on turbulence diagnostics like BES and high-k scattering on mangetic helicity, we would likely want to maintain helicity, which would be consistent with any forward-BT divertor solution. (We recognize fixed helicity at reverse-BT would require counter-Ip beam injection, necessitating analysis of fast particle losses and their effect on vessel structures)
5. Limiting discharge length at higher Ip and heating power (due to PFC constraints) could limit some T&T research goals, which will be detailed below.
6. **Document the plasma shapes (A, R0, kappa, delta, squareness, DRSEP,  Rstrike), plasma current ranges, magnetic fields, power/heating levels and/or NB voltages, and min and max pulse or flat-top durations (and anything else I forgot) required by Transport & Turbulence physics goals and diagnostic requirements.**
7. There are three high level research thrusts that guide the operational desires for the Transport & Turbulence (T&T) Topical Science Group:

* Thrust 1: Characterize H-mode global energy confinement scaling in the lower collisionality regime of NSTX-U
* Thrust 2: Identify regime of validity for instabilities responsible for anomalous electron thermal, momentum, and particle/impurity transport in NSTX-U
* Thrust 3: Establish and validate reduced transport models

1. XP1520 was written to address the highest priority Thrust 1. It requires Ip/BT up to 2 MA/1 T with initially 4 MW of NBI1 power. Ultimately, T&T TSG will want to do Ip, BT scaling studies with much higher power, likely up to the full capability of 12 MW. Initially, modest fixed shape (LSN, elongation~ 2.3-2.4, triagularity~0.6-0.7) will be used to obtain confinement scaling. Presumably ASC TSG will explore stronger shaping to achieve performance and non-inductive goals, so we plan to carry out Ip/BT confinement scaling experiment at fixed, strong shaping with the feedback from ASC TSG.
2. We would like to be able to study confinement and transport changes while varying shaping, e.g. elongation, triangularity. We believe that this can be done at modest power (<=6 MW), highest heating power is not needed.
3. In the longer 5 year plan, we will want to do dimensionless confinement studies (ν\*, ¯, q, ρ\*). Each of these has particular constraints on how Ip, Bt, Te, ne must scale to match conditions. Estimates (assuming H98y,2, or HST06 scaling) can be carried out to infer power required at the extremes. However, we think highest power is not required
4. For energy confinement studies above, stationary flat tops that last many confinement times are required (~500 ms) are required.
5. Although we only need a few hundred ms of stationarity to study energy confinement scaling, much longer stationary period is required to study particle transport (i.e. will we achieve stationary electron density) and also transports in discharges where the current profile is equilibrated, especially in long-pulse/non-inductive scenarios that ASC will be pursuing. In addition, to do NBI and gas puff modulation experiments also requires long stationary period, namely >2 sec flat top. We note that these studies can be done at lower power (~6 MW).
6. We would like to run long pulse stationary center-stack-limited and diverted L-mode plasmas. These L-mode plasmas will typically be at lower power (<3-4 MW) to avoid L-H transition and beta limits. No particular shaping is required for the L-mode plasmas as long as we achieve long stationary flattop and MHD quiescence. These L-mode plasmas are perfect for basic transport studies and code validation efforts. As an example, the following are typical parameter achieved for NSTX-U long pulse stationary diverted L-mode plasmas: LSN, A~1.6, R0~ 100 cm, elongation~ 1.7, triagularity~0.3-0.4, DRsep~-0.4 - -0.3 cm, Rstrike~0.92 m(outer), 0.4 m(inner).
7. Divertor heat flux mitigation technics, e.g. strike-point sweeping, are fine as long as no visible confinement changes.

Distribution

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NSTX-U File