

# National Spherical Torus eXperiment Upgrade

## NSTX-U Research Program Update

NSTX-U Team Meeting – Sept. 20, 2019

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S.M. Kaye

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# NSTX-U PAC-40 Charge

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- The NSTX-U Research Program requests advice from PAC-40 in three areas:
  1. Please comment on the quality and importance of recent research results, including collaborative activities, and how they advanced the NSTX-U Mission and Milestones
  2. How well the FY20 and 21 Research Milestones address issues critical to the ST and fusion as well as the preparation for operations of NSTX-U, and the suitability of expertise and resources needed to achieve these milestones successfully.
  3. **The role, uniqueness and importance of NSTX-U in developing a national fusion strategy and to contribute to the design of a next-step tokamak device. In particular, is the proposed R&D program well-positioned to close gaps needed for a compact pilot plant as outlined in the recent NAS and FESAC TEC studies?**

# Presentations

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## I. Research Program Update – S. Kaye

- Programmatic events since PAC-39 (OPA Mission Review 3/18)
- Developments in domestic fusion program (NAS Study, FESAC TEC)
  - How does NSTX-U fit in? How has the NSTX-U Mission changed?
  - 10 year mission and research goals
- Response to PAC-39 recommendations
  - State of NSTX-U Science Team and plans for its reconstitution

## II. Status of NSTX-U Recovery – S. Gerhardt

## III. NSTX-U researcher activities

- I. R19-21/22 Milestone research [Battaglia – Charge 1 & 2]
- II. Non-Milestone research results that can impact NSTX-U, ITER research; collaborations/public-private partnerships [A. Diallo – Charge 1]

## IV. Liquid Metal program – R. Maingi (30 + 15 min) – Charge 3

- I. How to accelerate the LM NSTX-U program

# PAC-40 Key Findings

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- First, the PAC thanks the NSTX-U team for the very informative update. The project appears to be on track to resume a scientific program in approximately 2 years.
- The dispersed NSTX-U team, through collaborations with other programs, has been productive and has made contributions to new results that are relevant to the NSTX-U mission and help advance its milestones. The quality is high. Moreover, the FY20 and FY21 milestones continue to be important issues for the ST. We note that not much has changed regarding its uniqueness and ability to close gaps towards a compact pilot plant. (Charges 1, 2 and 3)
- The PAC concludes that rebuilding the scientific team to operate and exploit NSTX-U is on a critical path. A plan is needed to assess diagnostic and operational needs; this should be started soon, rather than waiting for the full re-development of the research team (though consulting key experts). This needs to resolve how and when to have key capabilities in place to meet the research timeline. The experience of the NSTX-U team was a former strength—reassembling that team should be a high priority. The PAC believes that the NSTX-U team should be more aggressive on this planning as the team will be needed sooner rather than later (probably needed 18-24 months prior to the commencement of research operations)
- The Mission need for the NSTX-U program has nothing to do with proposed Li wall program. The PAC recommends CDO'ing a liquid metal wall tokamak now to drive the program forward (design activity to evaluating options, etc).

# FES wants NSTX-U to develop Five Year Research Plan

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- Cover span of 2020 – 2024: Focus on short-term program
  - Demonstrate **high-performance steady-state non-inductively sustained regimes** at large bootstrap fraction ( $f_{BS} > 0.7$ ), large Greenwald density fraction ( $f_{GW} > 0.7$ ) and  $\beta_N$  values surpassing typical conventional-A scenarios with sufficient stability margin for low disruptivity
  - Investigate if a **strong scaling of confinement and stability improvement with reduced collisionality** in regimes dominated by electron thermal transport at high- $\beta$  and low-A persists at lower collisionality
  - Burning plasma (i.e., ITER)-related physics issues
  - **Unify predictive modeling of transport, stability and fast ion physics** at low-A, low- $v_e^*$  and high- $\beta_N$  with conventional-A tokamaks to improve confidence in projections to next-step fusion devices, including ITER and a CPP
- Discuss enabling technology leading to first phase of LM program
- Have approved Plan by end of FY20
  - Panel review in Spring '20
  - Need to start developing Plan now! (Will hold meetings/discussions on how to move forward)