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Diagnostic Ideas for NSTX Integrated Scenario Development (ISD) research for the FY09-13 5-year plan

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Presented by:
J.E. Menard, PPPL

**Integrated Scenario
Development Task Group**

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Princeton Plasma Physics Laboratory

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NHTX mission, and relation to NSTX

- NHTX aims to integrate fully non-inductive operation with high beta, high confinement, and **high-heat-flux solutions**

NSTX issues directly relevant to design/operation of NHTX:

1. NSTX has not yet demonstrated 100% NI operation
2. NSTX diagnosis/control of divertor, SOL, pedestal incomplete

- **If major goal of the next 5 year period of NSTX operation is to support NHTX/CTF, should these 2 topics be our focus?**

- NSTX and NHTX also need to carry forward development of solenoid-free startup techniques needed for ST-CTF
 - Iron core transformer, PF-only, LHCD, NBICD, and CHI all possibilities
- Advanced control of shape, vertical stability, and MHD modes also critical to success of NHTX mission

Diagnostic considerations

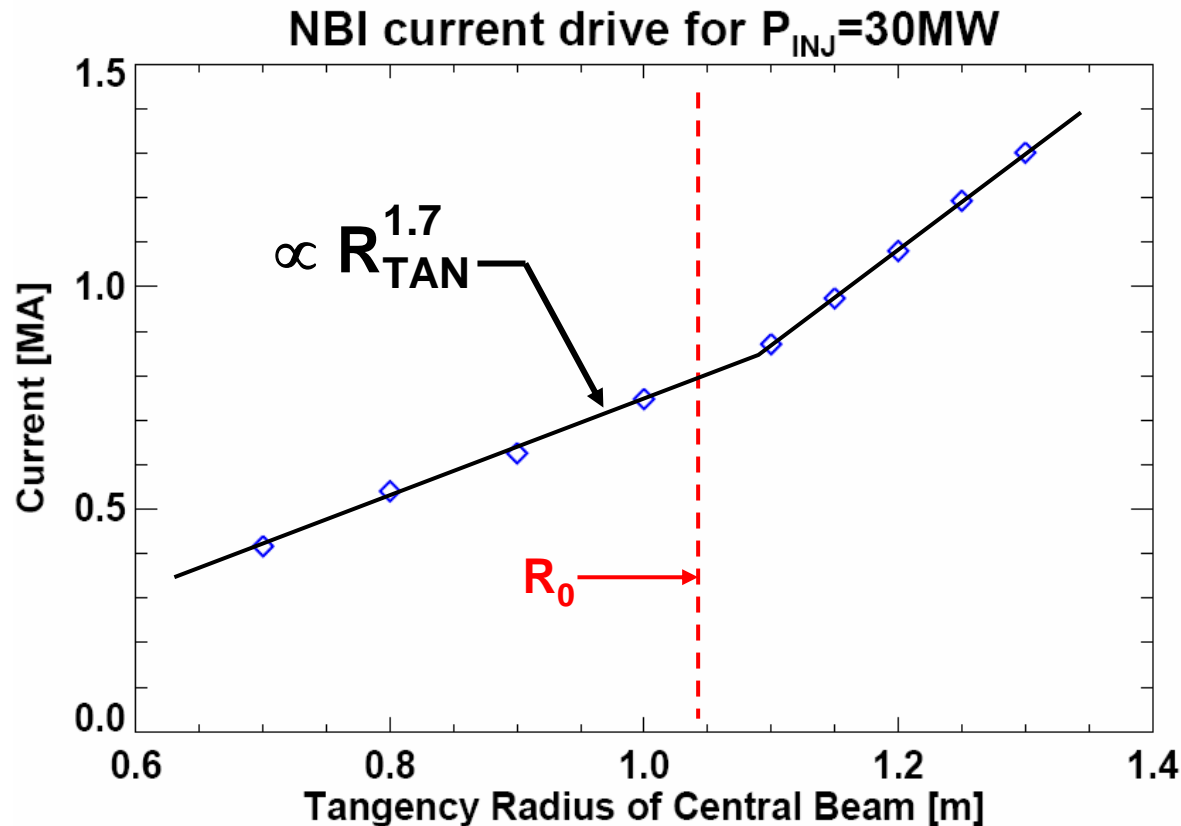
- Overlap in NICD physics and edge/boundary physics:
 - Edge J particularly important for CD, MHD, ELMs, etc.
 - Higher ρ , t resolution MSE & MPTS for improved $J(\rho, t)$
 - Other diagnostic ideas for improved near-edge J profile?
- NBICD
 - MSE, FIDA, NPA, neutrons, core MHD ξ_{\perp} , crucial to studies
- Startup
 - High time resolution MPTS for following plasma evolution
 - Improved spectroscopy for assessing impurities, burn-thru?
- Advanced control
 - Non-magnetic means of boundary ID – SXR, D_{α} , other?
 - Real-time ne-bar (MPTS or FIR), rotation (CHERS)

Can NBICD be optimized further for NSTX?

- For NHTX, NBI Z_{TAN} and R_{TAN} variations allow control of J_{NBICD} , and more current is driven for large R_{TAN}
 - Analyzing engineering tradeoffs of ΔR vs. ΔZ beam shift
- Will revisit possible advantages of NBI re-orientation as function of I_p and B_T for NSTX
 - Previous studies found no significant advantage at present NSTX current and field
 - If field and current are increased with centerstack upgrade, then beam realignment could become more advantageous.
- **All diagnostics using beam could be impacted**
 - CHERS, MSE, PCHERS, NPA, etc.
 - Move beam to bay L or K? Keep same beam dump?

NHTX NBICD increases $\times 3$ for $R_{\text{TAN}}=0.7 \rightarrow 1.3\text{m}$
and increases more quickly w/ radius for $R_{\text{TAN}} > R_0$

NBICD for $\bar{n}_e = 1.4 \times 10^{20} \text{m}^{-3}$, $\bar{T}_e = 4.2 \text{keV}$, $f_{\text{GW}} = 0.43$



Beam tangency radius variation would enable control of core current and q profile

