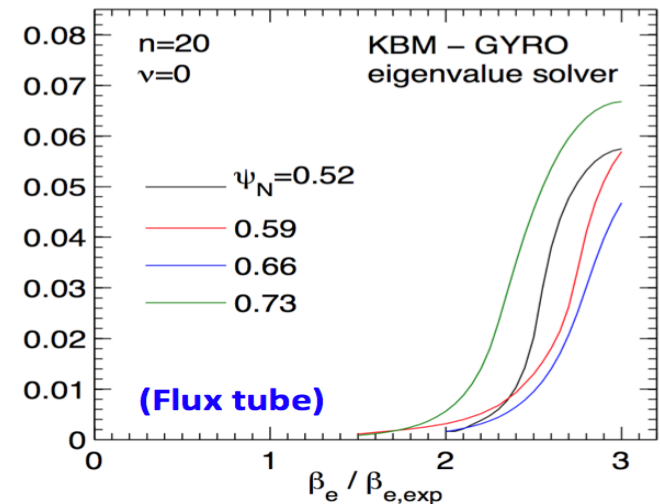
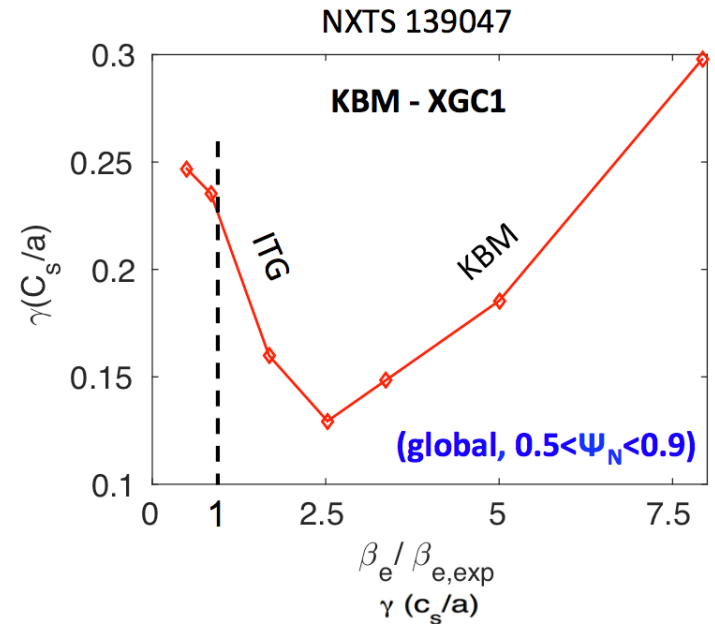


# NSTX studies using XGC

Seung-Hoe Ku

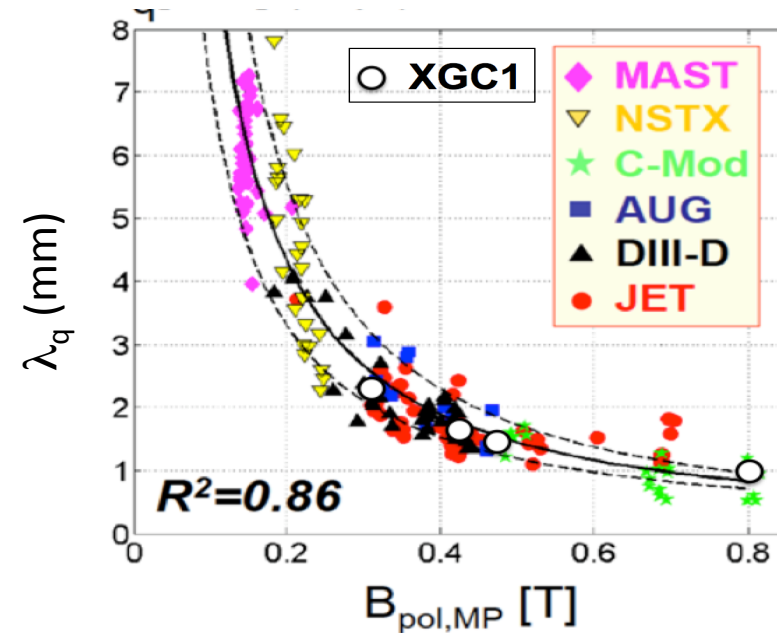
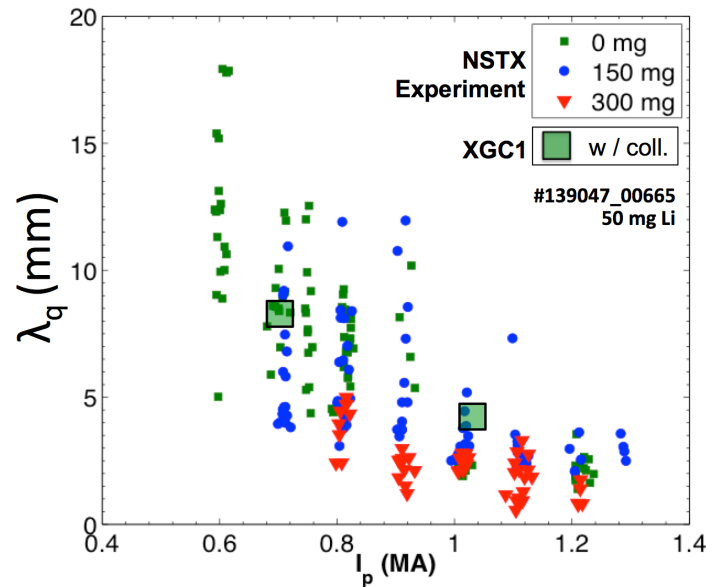
# Understanding turbulence modes in NSTX edge plasma

- Most likely, the turbulence modes seen at pedestal top [Dialo, Nucl. Fusion 2013] are nonlinear ITGs, not KBMs [XGC '15: DPP '15, Notable Outcome '15]
  - Cross verification between XGC1 [global, J. Lang, S. Ku] and GYRO [flux-tube, W. Guttenfelder] confirmed that  $\beta/L$  at pedestal top is well below  $\beta_{c,KBM}/L$
- Peeling type kinetic E&M modes can exist in steep NSTX pedestal, but KBMs are not found, contrary to claim by GENE [Notable Outcome 2015]
- Verified dominance of blobby turbulence in extended SOL ( $\psi_N > 0.98$ )



Credit to W. Guttenfelder

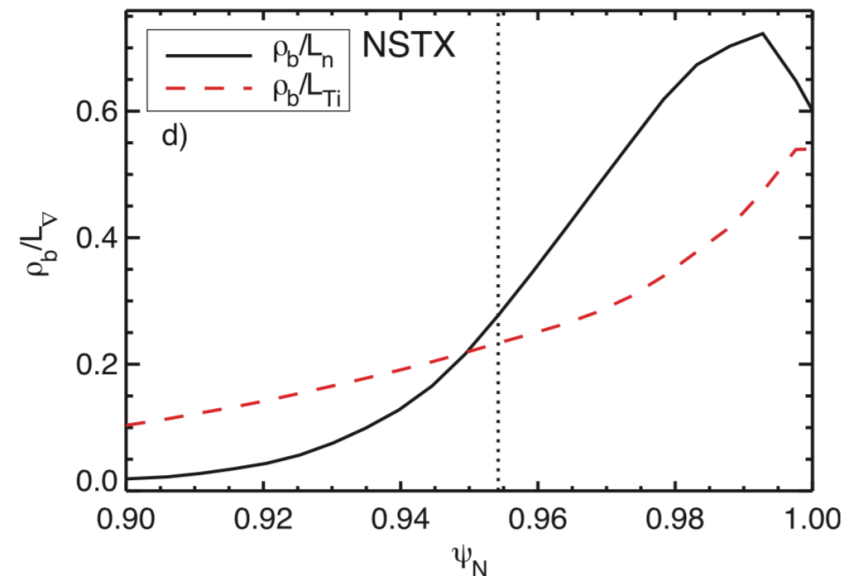
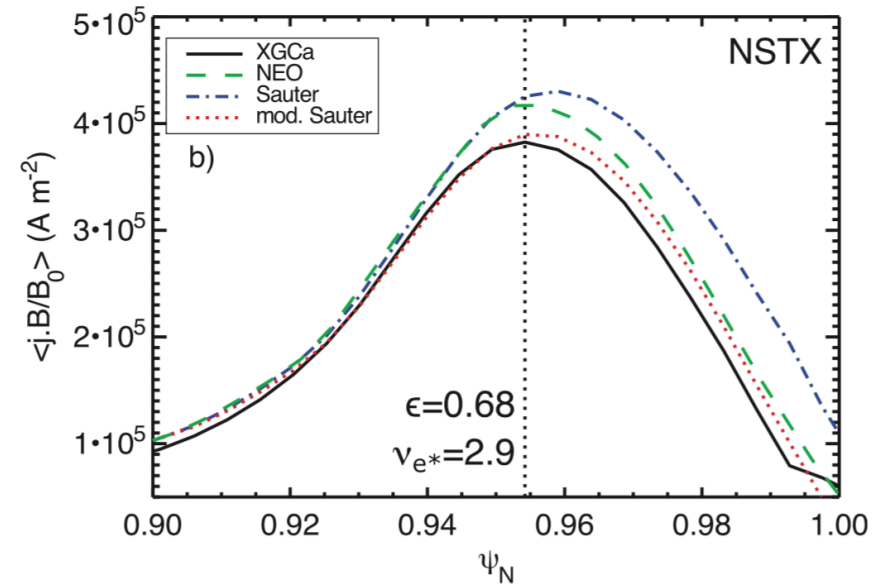
# Divertor heat-flux width



- The  $1/I_p^\gamma$  type scaling in NSTX is from collisional neoclassical orbit spread, but with  $\gamma \gtrsim 1.5$ .
- Only  $\sim 30\%$  effect from blobby spread [*Chang, IAEA16*].
- Why  $\gamma \gtrsim 1.5$ , not  $\sim 1$  as in conventional tokamaks?
  - There could be hidden variable

- **Bootstrap current in NSTX pedestal** is significantly lower than Sauter [*Hager, PoP '15*], and can alter stability boundary.

- **Verified importance of neoclassical physics in NSTX edge:** ExB shearing in L-H transition and EPH mode [*Battaglia, XGC0*]

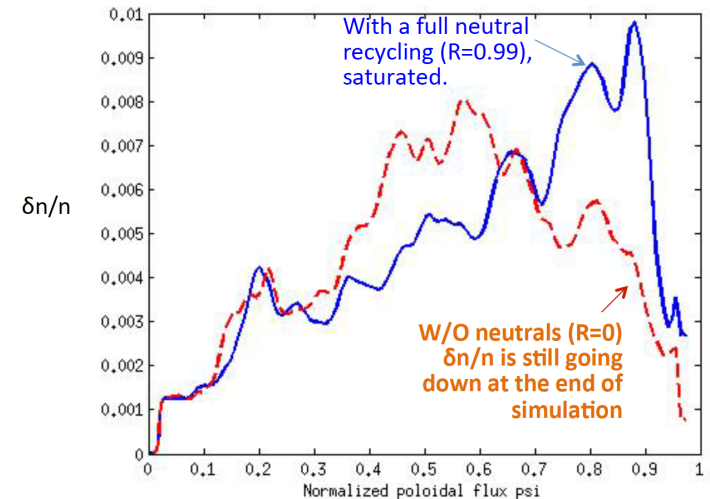


# On-going work for NSTX

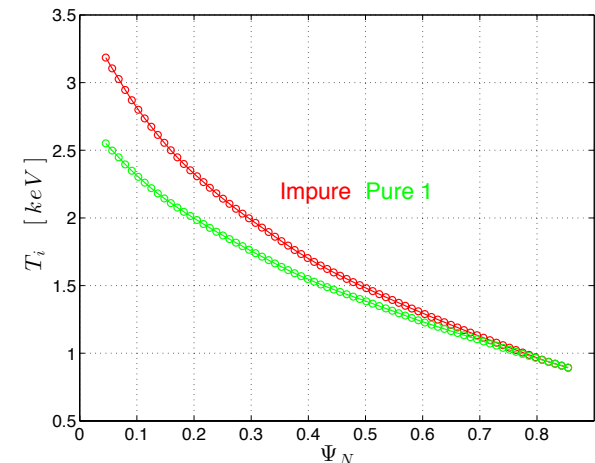
- How important are the global E&M modes in NSTX?
- Collisional  $\mu$ -tearing, Kinetic Peeling, KBMs, resistive ballooning in pedestal [*P. Porazik, R. Hager, J. Chowdhury et al., APS16*]
- How important is ETG in steep pedestal? [*Chowdhury, APS16*]
- Impact of the new bootstrap current on edge peeling [*Hager, IAEA16*]
- Why does the heat-flux width in NSTX have stronger  $I_p$  dependence? [*Chang, IAEA16*]
- Kinetic RMP penetration and transport [*Hager, APS16*]
- Blobby turbulence physics [*M. Churchill, APS16*]

# NSTX-U experimental proposals

- How will the change of neutral recycling from Li and High-Z affect edge turbulence and confinement
- Divertor heat-flux width
- Use the 2nd beam to control edge  $T$ ,  $n$  and  $\eta$ 
  - External modification of the X-loss driven ExB shearing
  - Study the turbulence response
- Other possible topics for NSTX-U by XGC include
  - High- and low-Z Impurity studies (turbulence, neoclassical, edge ExB; together)
  - L-H transition physics
  - Edge rotation



**Large difference in edge turbulence seen by XGC1 between zero and full neutral recycling.**



**Impurity could weaken ITG turbulence and increase the central  $T_i$ . [XGC1 2016, Carbon]**