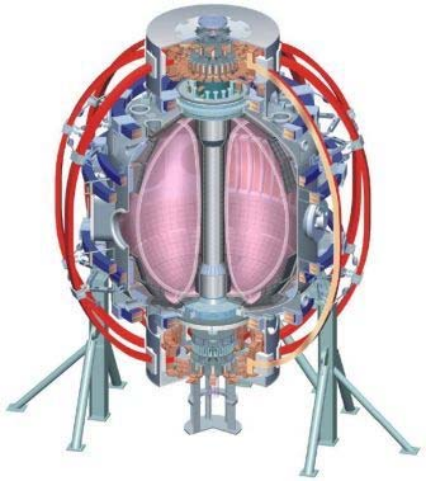
NSTX
PPPL PRINCETON PLASMA PHYSICS LABORATORY
Supported by
U.S. DEPARTMENT OF ENERGY
Office of Science

ExB Shear Effect on Micro-turbulence in L and H mode plasmas

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

Y. Ren[1]
W. Guttenfelder[1], S.M. Kaye[1], E. Mazzucato[1], J-K Park[1], K.C. Lee[2]
1. PPPL 2. U.C. Davis

NSTX Research Forum, March 16th , 2011



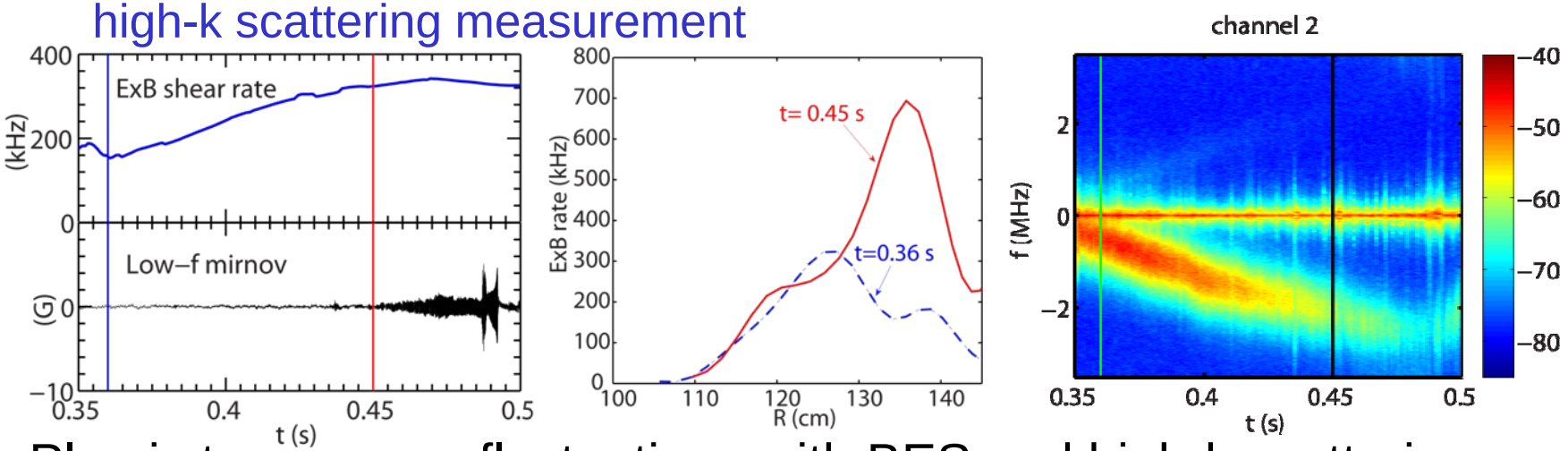
Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Background and Motivations

- ExB shear predicted to be an effective mechanism for suppressing micro-turbulence
  - Possibly the mechanism to explain the observed neo-classical ion thermal transport in NSTX H-mode plasmas
  - The ExB shear quench rule goes as: $\gamma_E/\gamma_{max}=\alpha_E$
    - α_E has dependence on plasma elongation and triangularity [Kinsey et al., PoP 2007]
    - Less ExB shear is needed to quench transport at high elongation and low aspect ratio, which is favorable for NSTX-U
- Previous studies on ExB shear carried out on NSTX
  - ExB shear found to suppress electron-gyro scale [Smith et al., PRL 2009]
    - Spontaneous and change not controlled
  - Ion diffusivity found to be correlated with local ExB shear changed by applying 3D field [Kaye et al., NF 2009]
    - No turbulence measurement (BES in 2010, but no high-k)
    - No study on the effect of plasma shaping

Scenario I: L-mode Plasmas

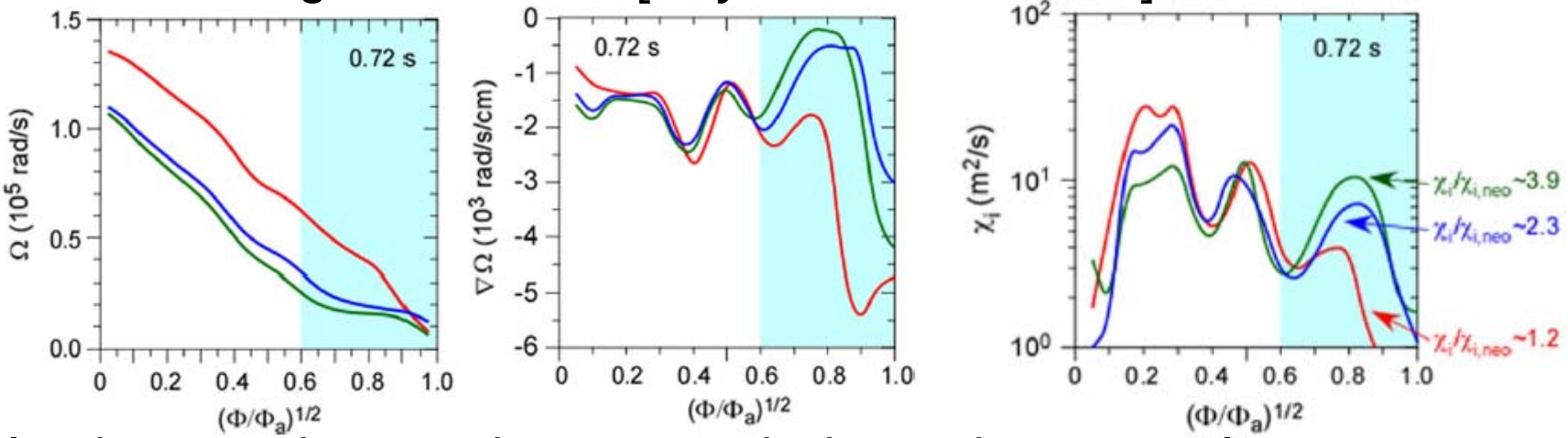
- Beam-driven L-mode plasma developed for WPI research ideal for high-k measurement and for ExB shear suppression study.
  - Large range of ExB shear with long MHD free period ~ 100 ms
  - Strong fluctuations and large plasma rotation (Doppler shift): ideal for high-k scattering measurement



- Plan is to measure fluctuations with BES and high-k scattering system at different radial positions as ExB shear increases due to NBI injection, and if possible, scan NBI power.
  - If the same L-mode plasma used for the group XP, we can piggyback for this scenario.

Scenario II: H-mode Plasmas

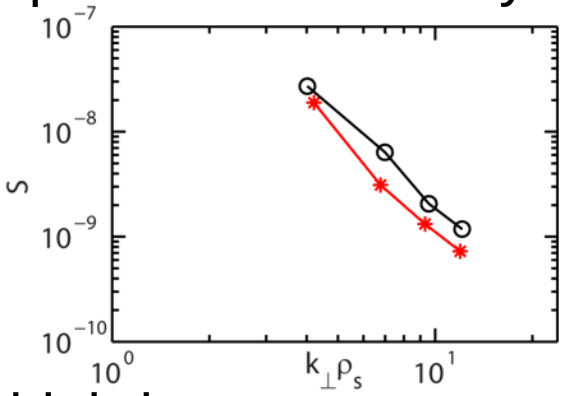
- H-mode plasma with 3D field braking demonstrated the ability to control the edge ExB shear [Kaye et al., NF 2009]

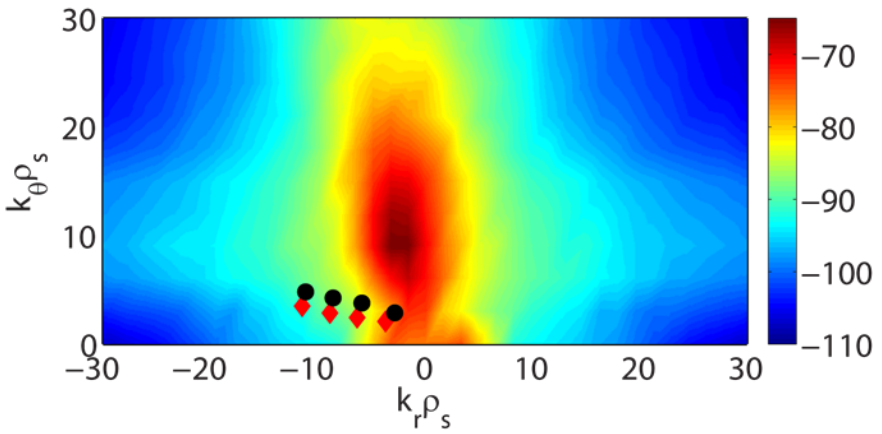


- Plan is to study ExB shear quench dependence on plasma shaping, *i.e.* elongation and triangularity
  - Apply 3D field braking with different plasma shaping
  - Emphasize on the dependence on elongation
  - BES and high-k for turbulence measurement

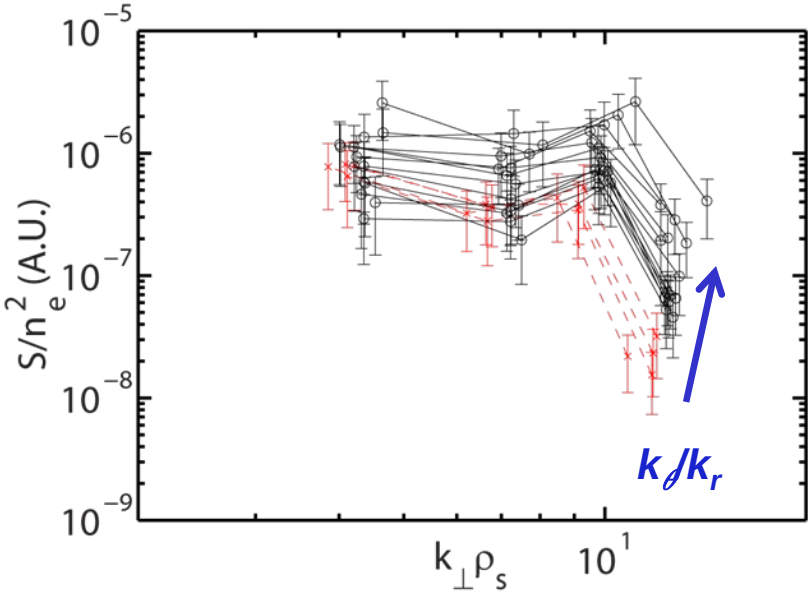
XP: Assessing the 2D k Spectrum of High-k Turbulence

- The shape of the 2D k spectrum is important for uniquely identifying a particular instability





- Preliminary high-k measurements in RF-heated L-mode plasmas indicate some systematic increase in spectral power with higher k_θ/k_r ratio
  - Small Doppler shift made it difficult to measure scattering power
  - Lack of MSE and CHERS: hard to do detailed analysis and nonlinear GYRO simulation



Experimental Plan

- Produce desired plasma target: beam-heated L-mode plasma
  - Pretty reproducible plasmas
  - Strong high-k signal
  - Large toroidal rotation
  - MSE and CHERS measurements available
- First position high-k scattering system at smaller k_θ/k_r ratio then go to larger k_θ/k_r ratios
  - Two configurations are needed and the third is desired if time permits
- The same technique as used in Dave Smith's XP, which concentrates on H-mode plasmas.
  - Possible to combine the two XPs?

Diagnostic Needs and Analysis

- Must-have diagnostics:
  - High-k, BES
  - CHERS, MPTS, MSE
  - Magnetics

- Planned analysis
  - LRDFIT, TRANSP, GS2, GYRO