

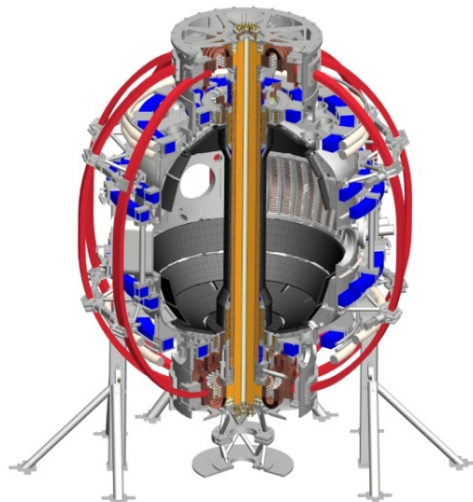
NSTX-U Collaboration Status and Plans for: Turbulence & Instability Studies - U. Wisconsin

G. McKee, D. Smith, R. Fonck
University of Wisconsin-Madison



WISCONSIN

NSTX-U Collaborator Research Plan Meetings
PPPL – LSB B318
May 5, 2014

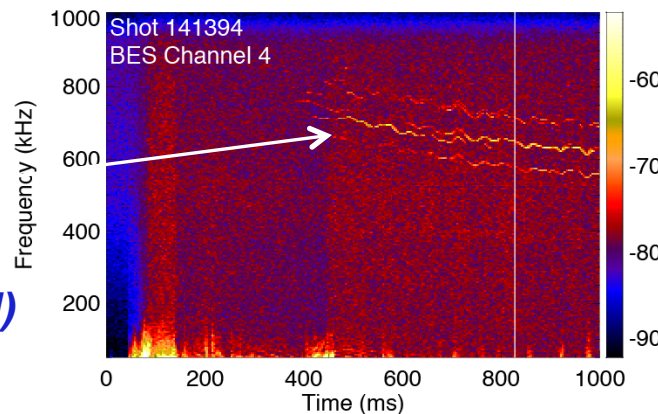
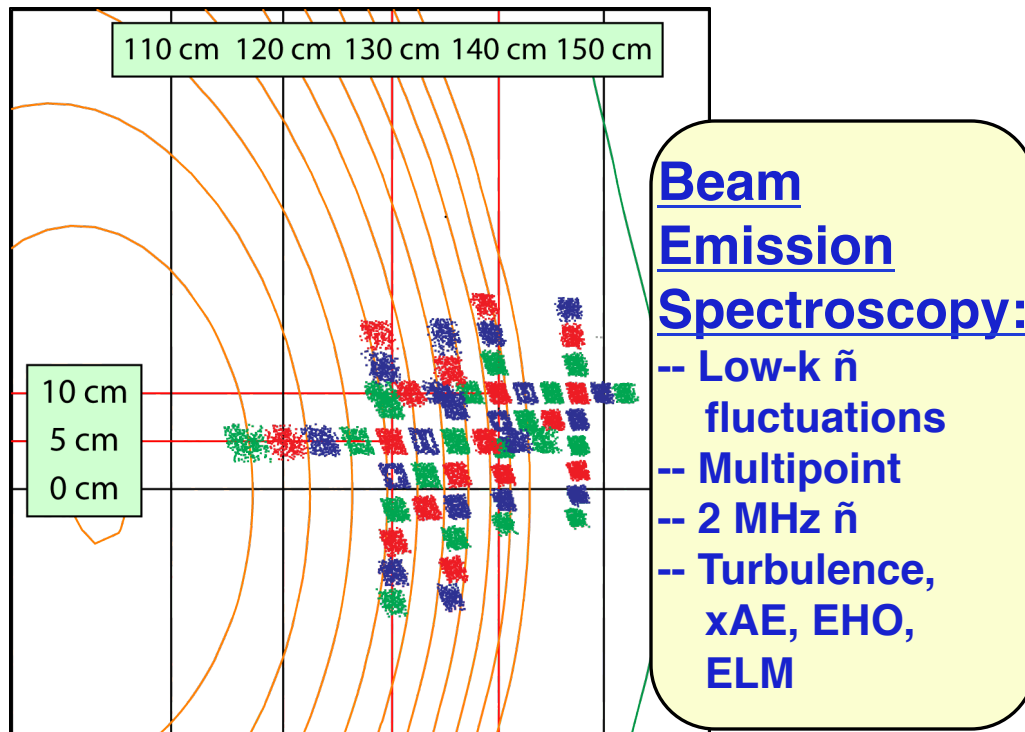


Coll of Wm & Mary
 Columbia U
 CompX
 General Atomics
 FIU
 INL
 Johns Hopkins U
 LANL
 LLNL
 Lodestar
 MIT
 Lehigh U
 Nova Photonics
 ORNL
 PPPL
 Princeton U
 Purdue U
 SNL
 Think Tank, Inc.
 UC Davis
 UC Irvine
 UCLA
 UCSD
 U Colorado
 U Illinois
 U Maryland
 U Rochester
 U Tennessee
 U Tulsa
 U Washington
 U Wisconsin
 X Science LLC

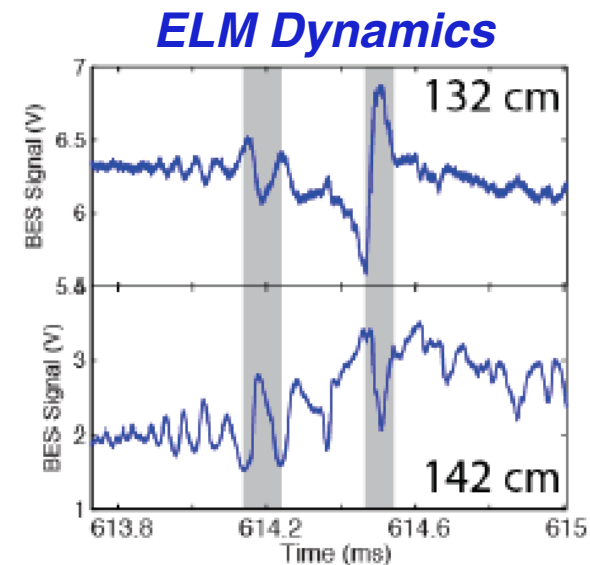
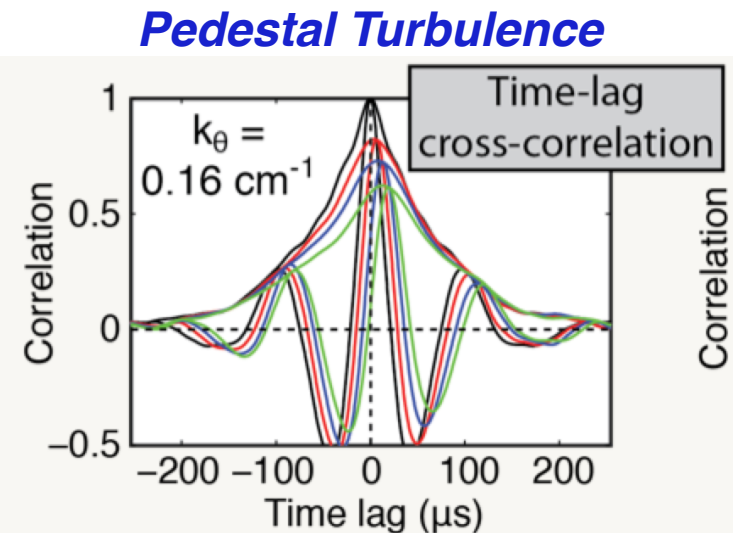
Culham Sci Ctr
 York U
 Chubu U
 Fukui U
 Hiroshima U
 Hyogo U
 Kyoto U
 Kyushu U
 Kyushu Tokai U
 NIFS
 Niigata U
 U Tokyo
 JAEA
 Inst for Nucl Res, Kiev
 Ioffe Inst
 TRINITI
 Chonbuk Natl U
 NFRI
 KAIST
 POSTECH
 Seoul Natl U
 ASIPP
 CIEMAT
 FOM Inst DIFFER
 ENEA, Frascati
 CEA, Cadarache
 IPP, Jülich
 IPP, Garching
 ASCR, Czech Rep

U. Wisconsin Research at NSTX-U:

Investigations of long-wavelength turbulence/instabilities in the ST



GAE?
(w/K. Tritz, JHU)



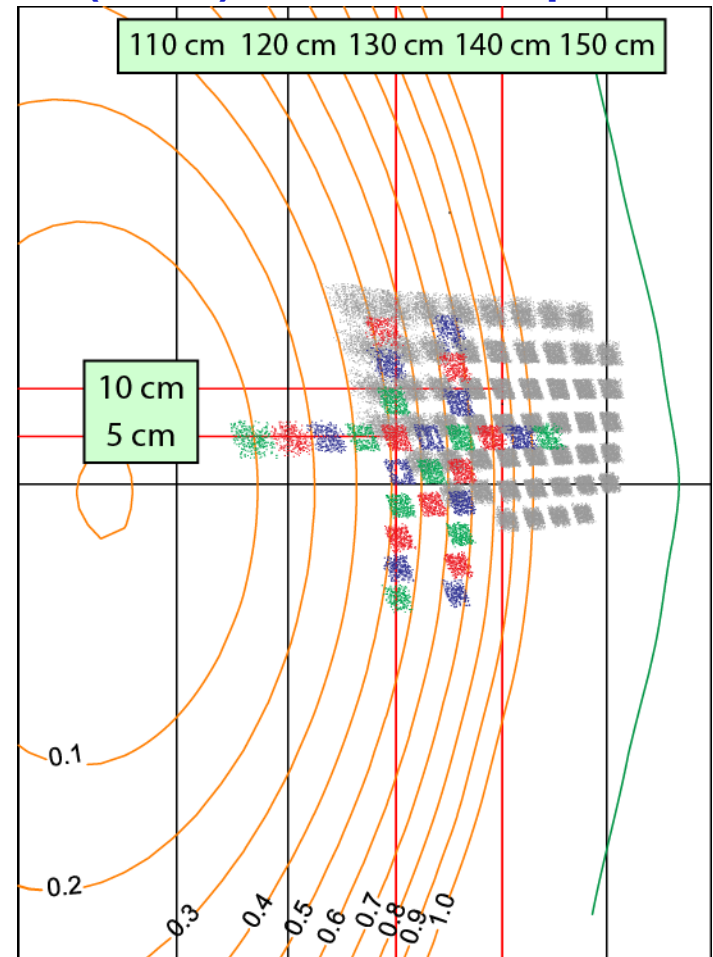
Research plans and needs for this year (FY2014) in preparation for NSTX-U operations in FY2015

- Enhancing BES fluctuation diagnostic for NSTX-U
 - 16 new detector channels: 32→48 spatial channels
 - Expanded simultaneously sampled field of view
 - 2D \tilde{n} measurement capability
 - New 2D fiber mount being designed & fabricated
- Investigating low-k pedestal turbulence & instabilities
 - Scaling properties of turbulence characteristics with local parameters
 - Comparison with simulation (GEM, BOUT++)
 - D. Smith et al., Nucl. Fusion (2013), Phys. Plasmas (2013) [IAEA, APS]
 - ELM time series analysis: similarity, cluster linkage [TTF-2014]
- Needs: 2D array (potential schedule delay)
 - Engineering w/UW-PSL, tech. assist, schedule, spatial calibration
 - Would greatly benefit from calibration between CD4 and 2015 Ops
 - Additional fiber bundles (26 new fiber bundles 56→84)-B. Stratton

BES Upgrade: Expansion and 2D Measurement Array

- Expansion from 32 → 48 Spatial Channels
 - Optics, detectors, preamplifiers
 - Sig. conditioning/control electronics
 - 2 MHz digitizer (D-tAcq)
- 2D Measurement array
 - Design in progress @UW-PSL
 - Installation: Summer, 2014
 - Research capabilities
 - Turbulence imaging, $S(k_r k_\theta)$
 - Sheared flow measurement
 - ELM dynamics: SOL propagation
 - Core radial/poloidal arrays

**New BES Spatial Coverage:
2D (outer) + core radial/poloidal**



Research Plans for FY2015-FY2017

- Characterize core/edge turbulence properties in ST
 - L-mode, H-mode, EP, QH
 - Neoclassical vs. Anomalous transport: particle, momentum, heat
 - L-H transition dynamics, parametric dependencies
 - Edge flows: equilibrium, zonal flow, GAM
 - ELM/Pedestal instability dynamics (e.g., EHO, ELM post-cursors)
 - Simulation comparison (GYRO, GEM, GTS, BOUT++)
 - Advanced analysis: Time-delay-estimation, velocimetry, non-linear
- Expanded collaborations with UW & DIII-D
 - Recruiting new UW graduate student for future NSTX-U activity
 - Pegasus collaboration (H-mode physics, pedestal/edge dynamics)
 - DIII-D: Core, Pedestal, comparison/contrast (BES), e.g., A. Diallo
 - 3D field effects (RMP, EFCC → turbulence response, ELM effects)

Ideas to enhance participation in NSTX-U research/program by U.S. Universities, early-career researchers, and students

- On-campus scientist support needed for stronger ties
 - Integrated graduate student theses research
 - Increase “attractiveness” of NSTX-U to prospective graduate students
 - Combine research (e.g., NSTX-U, Pegasus, DIII-D)
- Broaden research connections and integration
 - Studies of nonlinear ELM dynamics across NSTX-U, Pegasus and DIII-D via integrated UW team
 - $N(r,t)$, $P(r,t)$ and $j(r,t)$: pedestal dynamics, filament formation, etc.
 - Expanded theory/simulation collaboration
 - NIMROD, BOUT++ for nonlinear ELM dynamics
- Physics-based research programs (facility-agnostic)
 - Pedestal/edge stability: turbulence, ELMs, P-B, KBM
 - 3D field physics via RMP, EFCC: ELM-mitigation/suppression
 - Simulation validation: aspect ratio, beta, ρ^* scaling
 - ITG, TEM, Micro-tearing(ST), KBM (tokamak), hybrid

Highest-priority incremental measurement capability

(For diagnostic solicitation grantees funded for 2012-2015)

- Higher-resolution edge \tilde{n} measurement
 - Higher-k intra-pedestal instability \tilde{n} measurements
- Simultaneous full-radius low-k \tilde{n} measurement
 - Expand BES coverage: procure additional fiber bundles
 - 26 new bundles fully exploit 2D + inboard radial/poloidal capability ($\sim 100k$)
 - Additional detector channels (16 to bring to 64)
- Comprehensive spectroscopy measurements
 - High-resolution spectrometer & detector
 - Beam manifold/impurity lines: E \sim feasibility (Fonck-UW diagnostic dev.)
- Toroidal n-number measurement capability
 - Toroidally displaced BES viewport observing new heating beam
 - Determine structure, e.g, n=0 for zonal flow/GAM?
 - Finite n measurement for xAE modes, EHO