U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

UCLA Diagnostic Development and Research Plans 2016-2019

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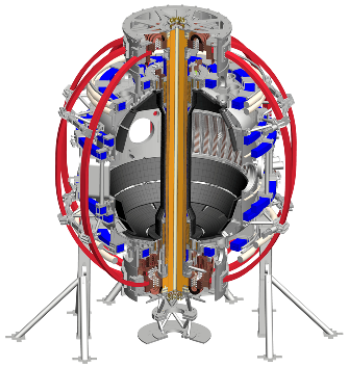
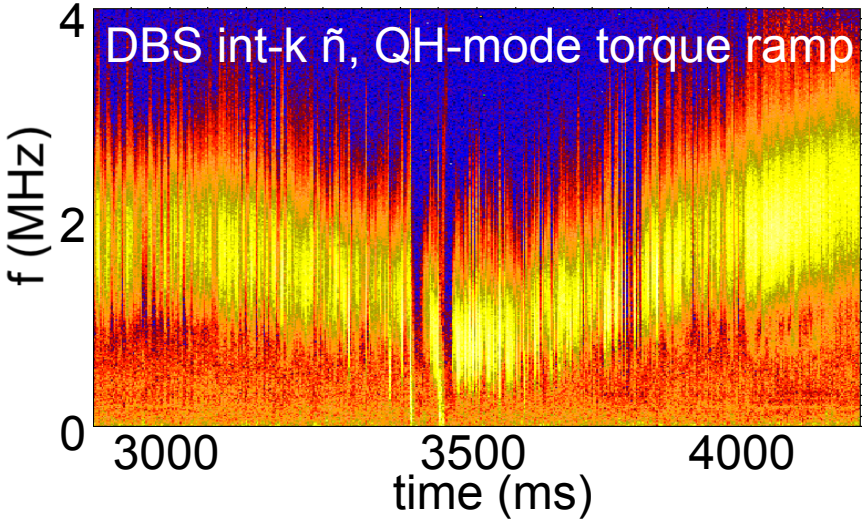
UCLA

PPPL



Three Main Components of UCLA Research Plans

- **Diagnostics** – Add two new measurement capabilities (Doppler backscattering ñ and cross-polarization scattering $\tilde{B}$) and expand existing fluctuation reflectometer (from 16 to 20 channels)



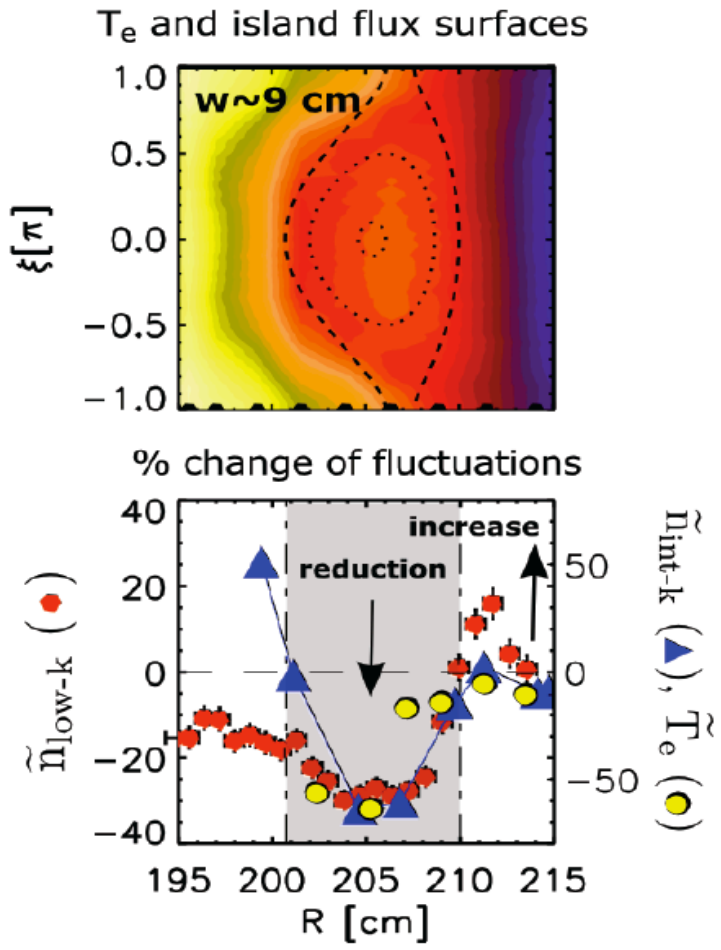
- **Science** – Continue collaborative science role in fast particle and Alfvénic instabilities, pedestal turbulence and transport, ELMs, and EHO physics. Cross-device comparisons/experiments on the NSTX-U and DIII-D tokamaks. Close collaboration with NSTX-U team on testing and validating turbulence and transport simulations using both new and existing measurements.
- **Education** – UCLA will expand the NSTX-U science collaboration with the addition of an on-site Postdoctoral fellow and an on-site Graduate Student

Remotely controlled, multi-channel DBS for intermediate-k ñ, flow, GAM and zonal flows, ExB velocity, ELM, EHO activity

Transport and Turbulence, Energetic particles

- $k_\theta \rho_s$ ~ 0.5–10, and spatial and temporal resolutions Δr≤1 cm and Δt≤1μs
- Fills wavenumber gap between low-k BES and high-k scattering.
- Remote control of probed wavenumber
- Directly impacts testing and validation of codes/simulations
- Recent multi-field/multi-scale NTM interaction (graduate student L. Bardoczi, PRL'16)
- Potential to access kinetic Alfven Waves with $k_r \rho_s$~1

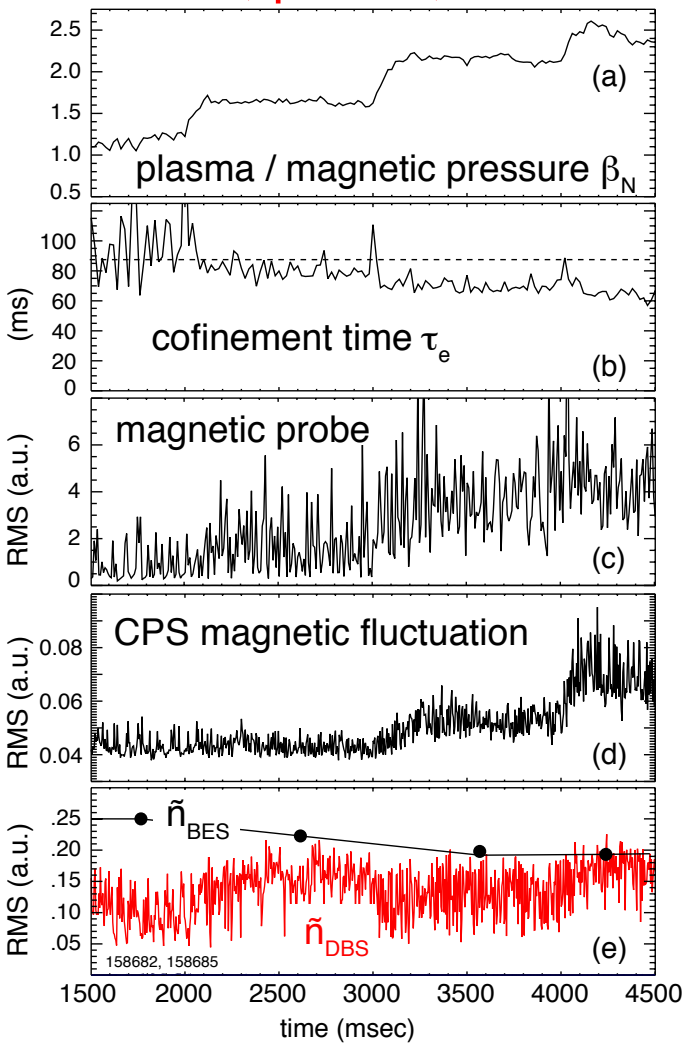
H-mode, DIII-D



Cross-polarization scattering (CPS) to measure internal magnetic fluctuations will be installed on NSTX-U

Transport and Turbulence, Energetic particles

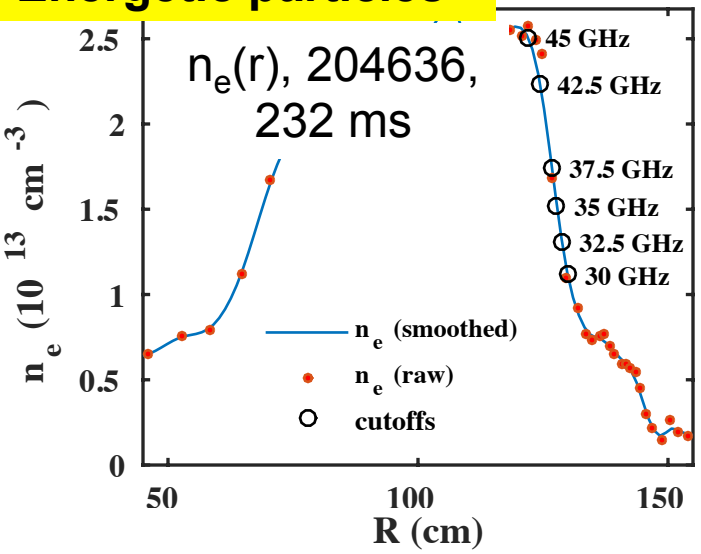
DIII-D, β scan, Hmode



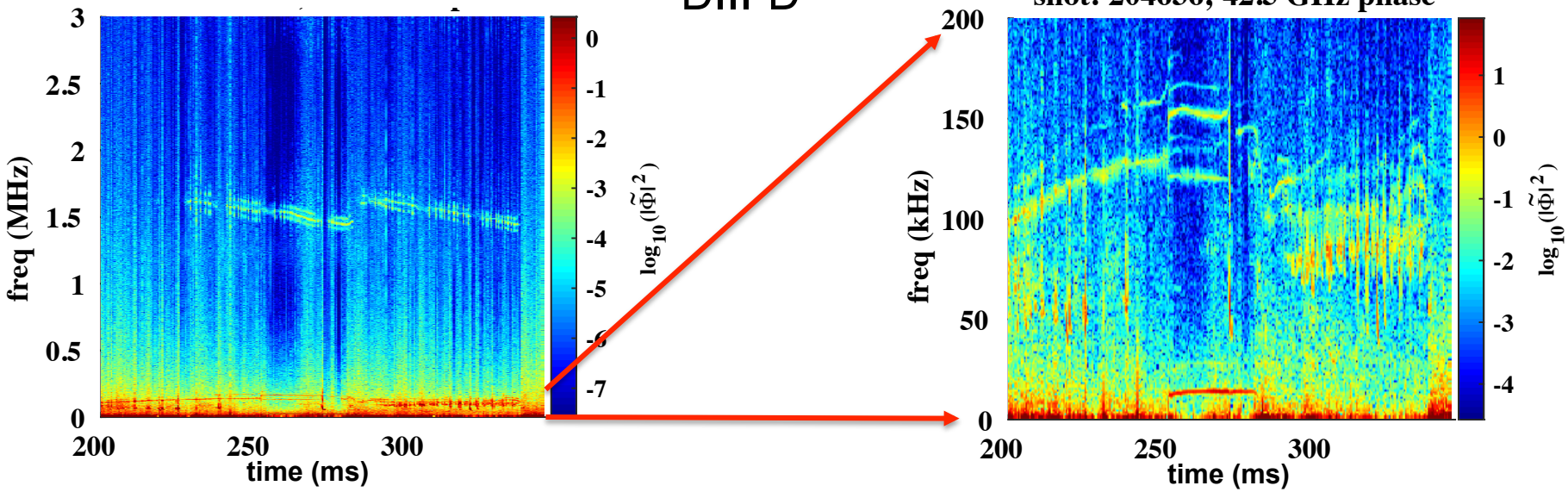
- Addresses key physics questions on existence and behavior of microtearing modes, KBM, EM ETG/DW behavior, etc. and possible affect on transport.
  - Especially important at higher β as EM effects are increasingly important.
- CPS was developed under a DOE Diagnostic Development Grant
- Measure internal B_tilde over broad wavenumber range $k_\theta \rho_s$ ~ 0.2–17; time, space resolutions (Δr≤1 cm, Δt≤1μs)
- Directly impacts testing and validation of codes/simulations

Access higher density with four additional fluctuation reflectometer channels, continue science investigations of beam driven modes

Energetic particles



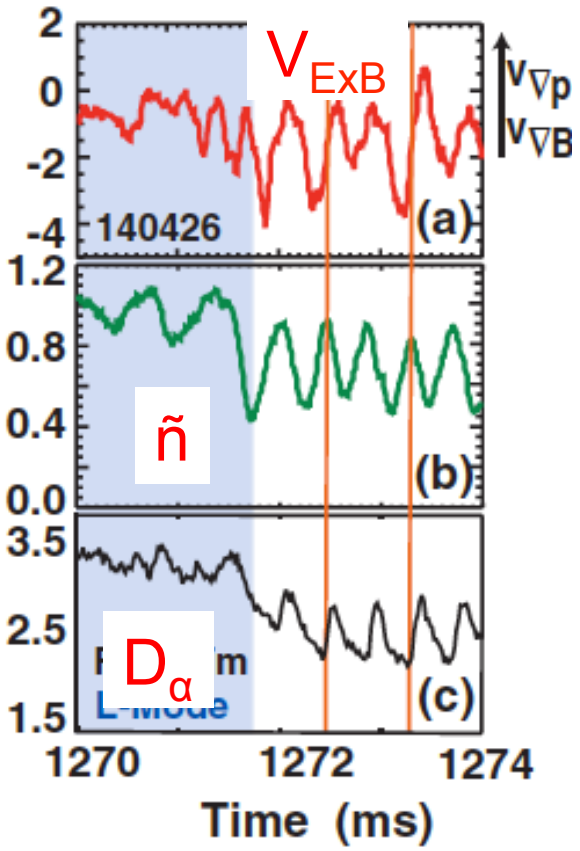
- Fluctuation reflectometer is now operational.
- Will have 20 channels with new DBS system configured as reflectometer (remote selection)
- Current and new UCLA diagnostics will address understanding of beam driven mode physics and code validation
- Cross-Machine studies between NSTX-U and DIII-D



Design, fabricate, and install new multi-channel DBS for the pedestal and SOL

Transport and Turbulence, Pedestal Structure and Control

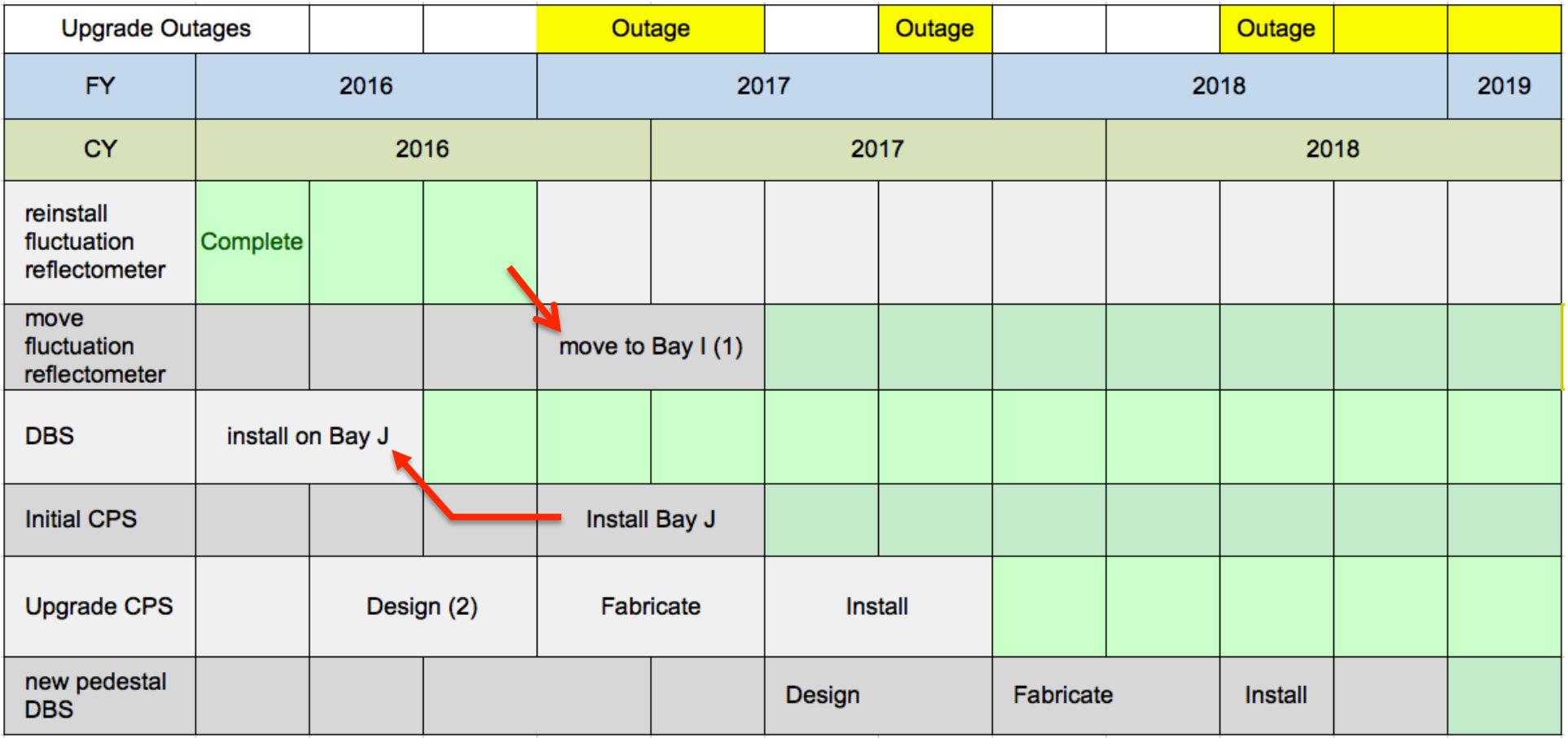
Onset of predator-prey oscillations



Lothar Schmitz et al, Phys Rev Letters, 2012

- New, multi-channel pedestal and SOL DBS, design and install in later years
  - Addresses important boundary issues including pedestal turbulence and flows, role of resonant magnetic perturbations, lithium granule plasma boundary effects, EHO, and ELM physics, etc.
- Example shown from top of pedestal on DIII-D

Timeline: New UCLA diagnostics deployed in stages



Notes: = Green shading denotes ready for physics

(1) Move from Bay J port to Bay I port is likely.

(2) Envision need for internal antennas/access

Personnel – we plan to expand our effort on NSTX-U

- We will expand the NSTX-U science collaboration with the addition of a fulltime, on-site Postdoctoral fellow (Fall, 2016) and a fulltime on-site Graduate Student will join us in 2017
- Neal Crocker offsite at 66% with periodic visits
- Tony Peebles offsite at 15%
- Shige Kubota on-site at 50% (50% on LTX-U, a good synergism)
- T. Rhodes offsite at ~33% with periodic visits

In conclusion, UCLA is excited about the science prospects on NSTX-U

- Multi-field diagnostics and science for: turbulence, flows, control, transport.
- Comparison and testing (validation) of simulations and theory of plasma turbulence, and transport using new and existing diagnostics will be a focus of the UCLA collaborative effort.
  - Will work closely with the NSTX-U theory and simulation team
- Physics and diagnostics for beam driven modes, comparison to simulations - understand role of AEs on thermal transport.
- Address transients (ELMs, etc.) with high spatial/temporal resolution fluctuation diagnostics - Extend multi-scale, multi-field parameters to pedestal and SOL
- Cross-device comparisons/tests are important features of this effort – facilitated by UCLA's physics & diagnostic roles on NSTX-U and DIII-D.

Thank you!