Understanding and Controlling Edge Turbulence in NSTX

S.J. Zweben, R.J. Maqueda, J. Myra, D. Stotler, C. Bush
L. Roquemore, R. Cohen, D. Ryutov, M. Umansky et al

- Understanding edge turbulence
  - direct comparisons with numerical simulations
  - comparisons with theory via data analysis
  - new experiments / empirical exploration
  - new measurements / diagnostics

- Controlling edge turbulence
  - near-term edge biasing experiments
  - long-term possibilities for SOL control

NSTX 5 year plan boundary meeting Feb 12, 2007

Direct Comparisons with Numerical Simulations

- BOUT: 3-D fluid edge turbulence code (Umanksy LLNL)
- GEMR: 3-D gyrofluid edge turbulence code (Scott, Garching)
- Lodestar: 2-D fluid edge turbulence code (Myra, Lodestar)
- XGC-1: PIC gyrokinetic edge turbulence code (CPES)
- LLNL-led continuum-based gyrokinetic edge code (ESL)
  - For specific NSTX shots, compare with measurements:
    - k_r and k_p wavenumber spectrum and correlation lengths
    - frequency spectra, phase speed, autocorrelation times
    - fluctuation levels vs. radius, $e\varphi/T_e$, scaling with n, B etc
    - intermittency, e.g. 'blob' formation and propagation

Comparisons with Theory via Data Analysis

- Blob dynamics, e.g. V_r vs. theory (Myra model)
- Blob formation mechanism (Krommes, Stoltfus-Dueck)
- Zonal flows, e.g. at L-H transition (Hahm, Munsat)
- Turbulence spreading, e.g. from edge to core (Hahm)
- Increased blob transport near density limit (D'Ippolito)
- Effect of X-point shear on parallel structure (Ryutov)
- Rotation via Reynolds stress (Hahm, Hidalgo et al)
- Avalanches, SOC processes (Carreras et al)
- Connection between ELMs and turbulence ?
- Connection between high k - low k turbulence ?

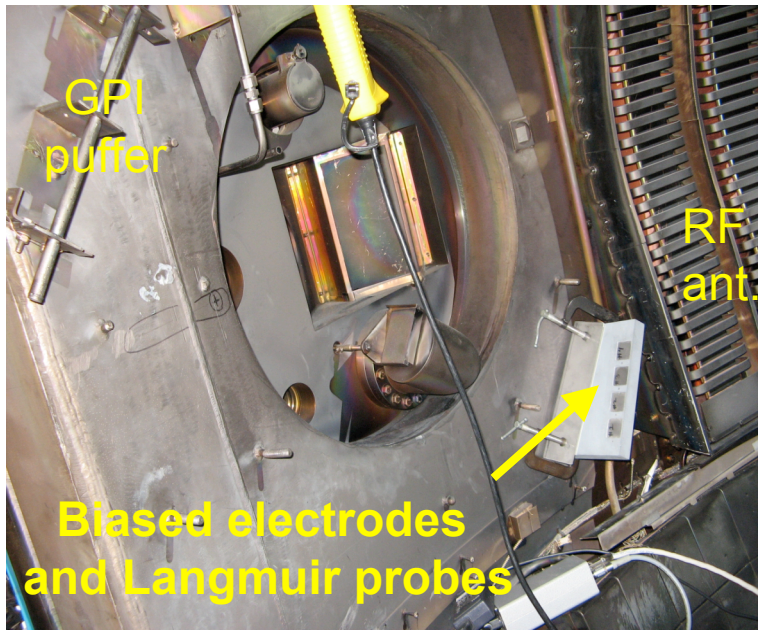
New Experiments / Empirical Exploration

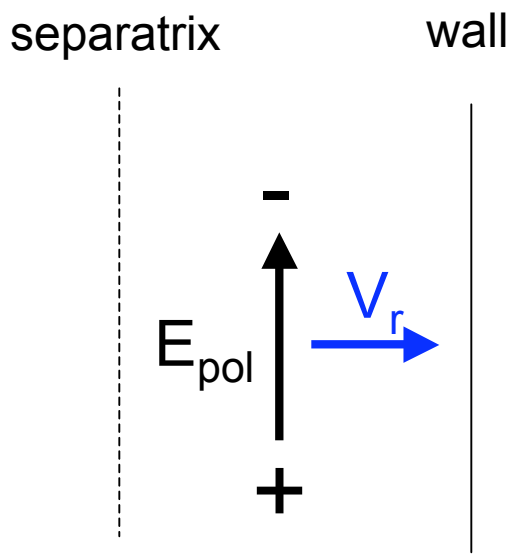
- Test effect of neutrals / radiation on edge turbulence
- Test effect of magnetic topology on edge turbulence
- Test dimensionless parameters scaling (e.g. Scott, R&D)
- Look for effects of lithium on edge turbulence
- Look for correlation of edge rotation with edge turbulence
- Look at interaction of dust with edge turbulence
- Look at interaction of RWM coils with edge turbulence

New Measurements / Diagnostics

- GPI near divertor X-point and inner midplane (Maqueda)
- Parallel flow fluctuations via Doppler shift method (Paul)
- Temperature fluctuations via line ratio method (Brix)
- High-speed IR imaging of blob impact at wall (PSI)
- Measure $k_{||}$ with widely separated GPI or probes
- Correlate turbulence at divertor plate with midplane
- Measure impurity transport by blobs (line emission)

Near-term Edge Biasing Experiments





- Look for local effect of edge bias in GPI images / probes
- If seen, make larger array to modify SOL near midplane
- If larger array works, try at divertor plate (w/LLNL)

Long-term Possibilities for SOL Control

- Induce large-scale non-axisymmetric edge perturbations, e.g. biasing, wavy divertor plates, gas puffing (LLNL)
- Parallel blob disconnection by puffing at divertor, similar to detached divertor conditions (Myra)
- Tilting divertor plates radially to destabilize sheath-driven modes in divertor legs, broadening SOL (LLNL)
- Creation of local convective cells by RF sheaths (Myra)
- Create ergodic magnetic field in SOL w/RWM antennas
- Modify edge turbulence with ~100 kHz from RF antenna