Dynamics of Zonal Flow-Drift Wave System Preceding L-H Transition

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Overview: Examine the dynamic interactions between the zonal flows and drift wave turbulence leading up to the L-H transition, and study the dependence on input power and density.

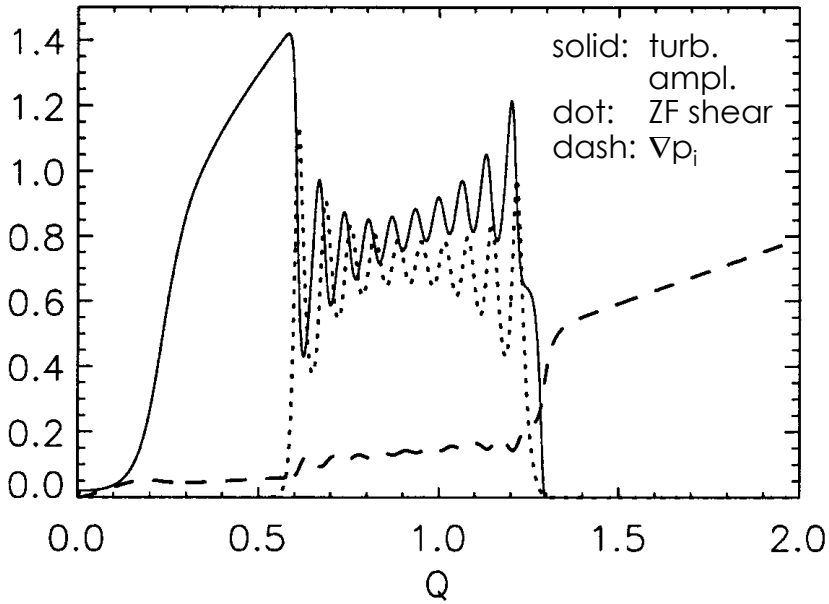
Highlights:

- **Operate near L-H transition power threshold with NBI**
  - **Look for Limit-Cycle oscillations in ZF and turbulence**
  - **Slow down transition to illuminate/resolve dynamics**
- **Diagnose edge flows & turbulence preceding L-H transition**
  - **GPI measurements**
  - **Corroborate with BES & reflectometer**
  - **Look for Long Range Correlations**

Background and Motivation

Kim & Diamond L-H transition model

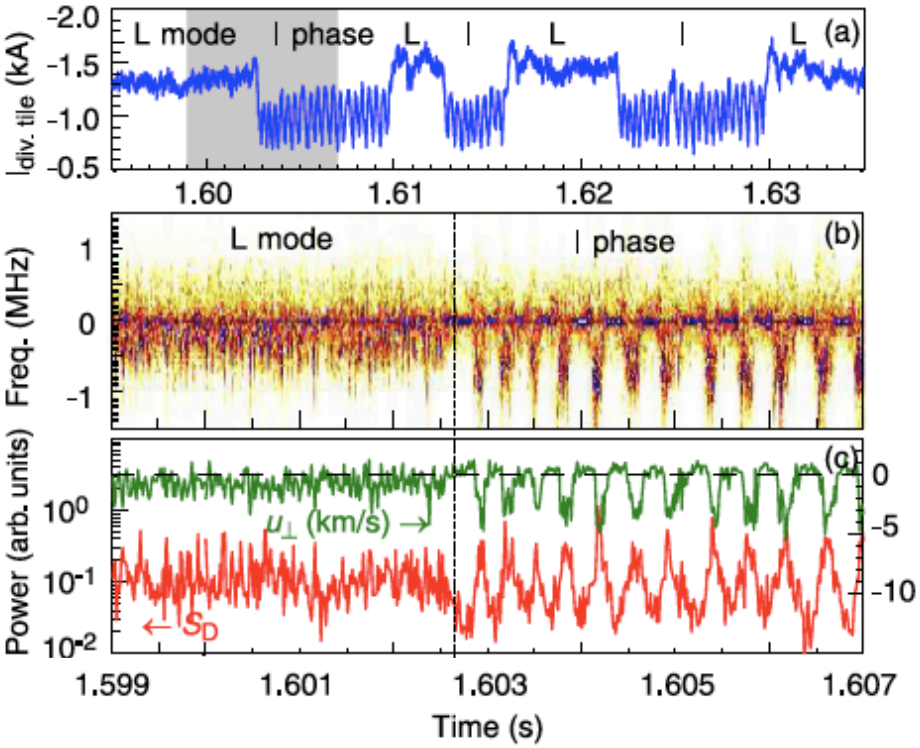
- Zonal Flow-Drift Wave interaction limits turbulence amplitude
  - Limit-Cycle behavior
- Mean flow shear develops as input power and pressure gradient increase
- H-Mode: Mean flow shear extinguishes turbulence and zonal flow
- Mean/Zonal Flows play key role in bifurcation
- Experimental evidence supports this picture
  - Increase of E_r well-depth at transition
  - Absence of ZF features in H-Mode
  - Limit-cycle observed in recent studies on TJ-II and ASDEX-U
- Few studies have been done to observe the dynamics of edge flows and turbulence near transition power threshold



Kim & Diamond, PRL 2003

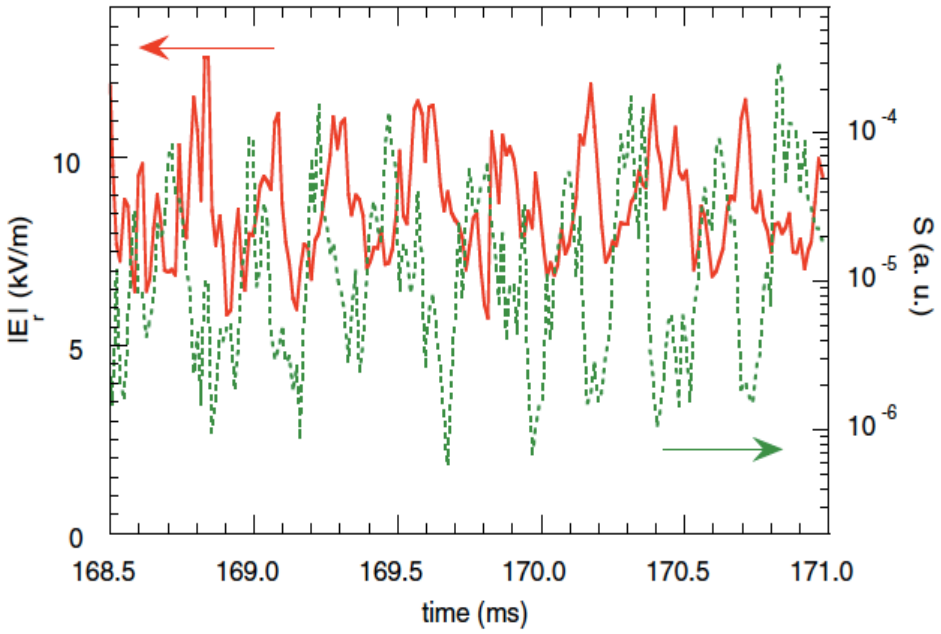
Recent Evidence on Other Devices

Doppler Reflect. spectrogram, v_{pol}, fluctuation ampl. on ASDEX-UG



G. Conway, et al., PRL 2011

E_r and n_e fluctuation amplitude on TJ-II stellarator



T. Estrada, et al., Eur. Phys. Lett. 2010

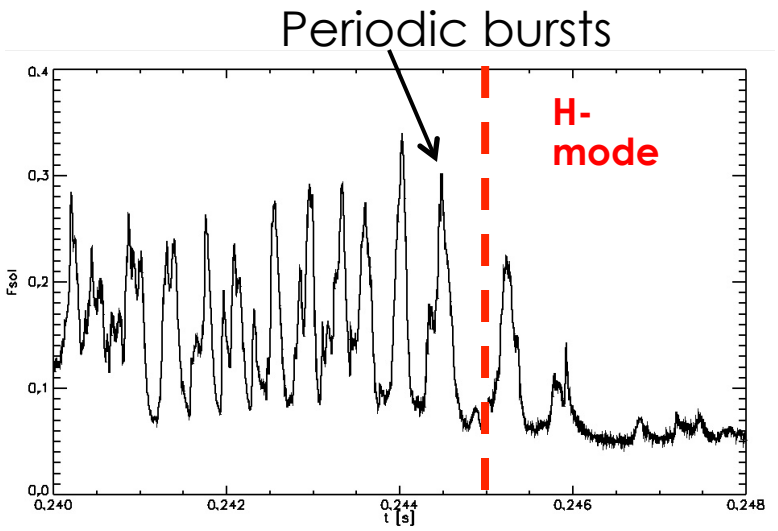
Experiments on NSTX

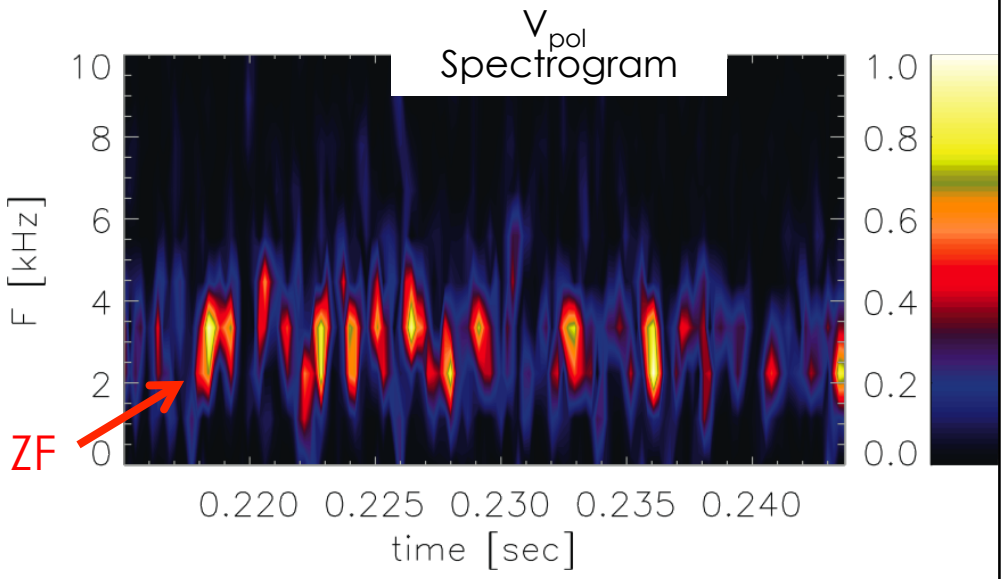
2009 XP results:

- L-H transition captured by GPI
- Periodic modulation of turbulent bursts correlated with edge flow
- Evidence of Zonal Flows

Proposed XP:

- Diagnose edge flows and turbulence using GPI
- Corroborate with BES & reflect.
- LRC between GPI and BES data
  - Confirmation of ZF
- Look for limit-cycle behavior
  - Phase shifted oscillations of ZF amp. and turbulence
- Look for scaling with density
  - Lower density -> more intense oscillations





Experimental Plan

- Operate NSTX with NBI heating *near transition threshold*
  - Start with most reliable NBI H-mode (not necessarily lowest threshold), similar to 135042 for example
  - Run as close to 95-100% threshold power as possible
  - 1-2 shots at >100% $P_{threshold}$ for contrasting behavior
- Scan downward in density to enhance limit-cycle oscillations
- Diagnostics: GPI, BES, Reflectometer : shared flux surfaces near separatrix required for LRC
  - Excellent diagnostic set for looking at edge turbulence behavior in higher detail than previous studies
- Later in run for reliable L-H operation
- Request: 0.5 run day