

# Survey of Low-, Intermediate-, and High- $k_r$ Microturbulence, Simultaneously and Everywhere

(S. Kubota)

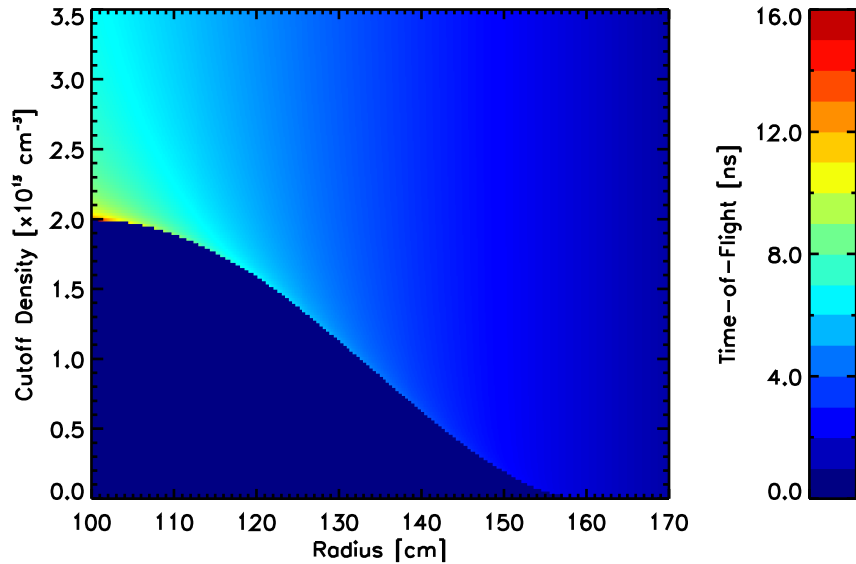


- **Systematic effort to survey to microturbulence on NSTX is necessary.**
  - As it stands, situation will probably remain so for lifetime of machine.
- **For a richer understanding of the role of turbulence in the ST, we want**
  - Information over the full range of  $k$ 's.
  - Across the entire plasma.
  - Simultaneously, not interspersed over different shots or the campaign.
  - **These conditions CAN be obtained for certain conditions on NSTX.**
- **Frequency-modulated continuous-wave backscattering diagnostic:**
  - Development over past two years. Hardware extensively checked in 2009.
  - Extensive wavenumber range:  $k_r=0-22 \text{ cm}^{-1}$  (profile dependent)
  - Extensive radial coverage:  $r/a=0-1$  (profile dependent)
  - Excellent time resolution:  $7 \mu\text{s} <$
  - **Measurements over wide  $k$  range and all radii, near-simultaneously.**
- **Use for new T&T XP's will be severely limited this year:**
  - Multi-purpose diagnostic with dedicated priorities for WPI and Boundary/Li TSG's this year. Reconfigured for specific uses.
  - Support of on-going XP's carried over from previous years.

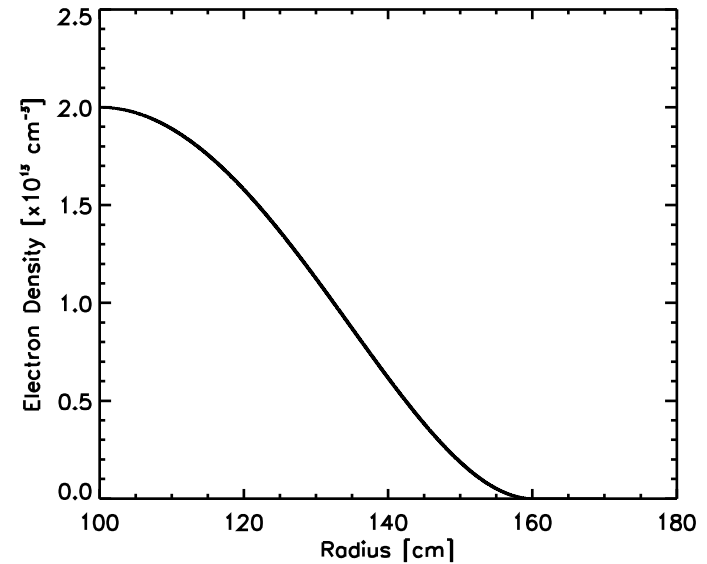
# FMCW Backscattering Technique ( $k_r=0\sim 22\text{ cm}^{-1}$ , $r/a=0\sim 1$ )



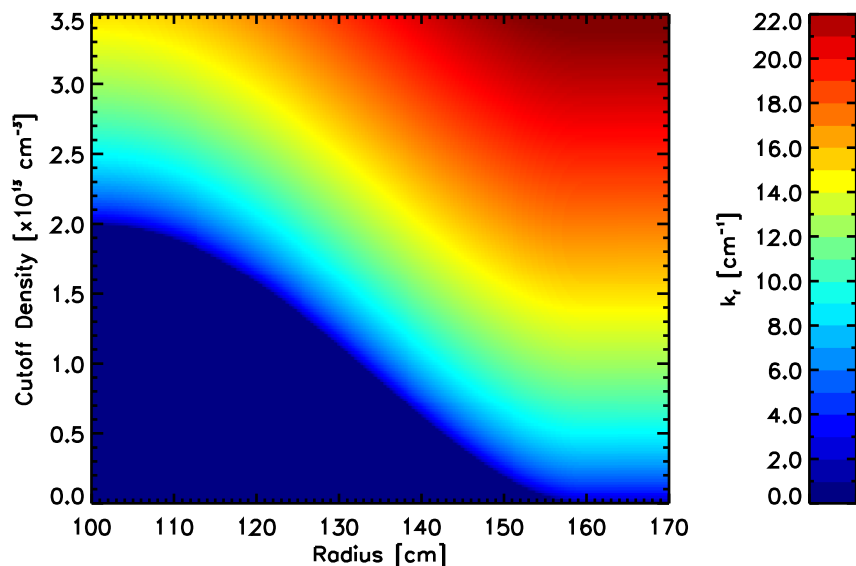
### Radial Position from TOF



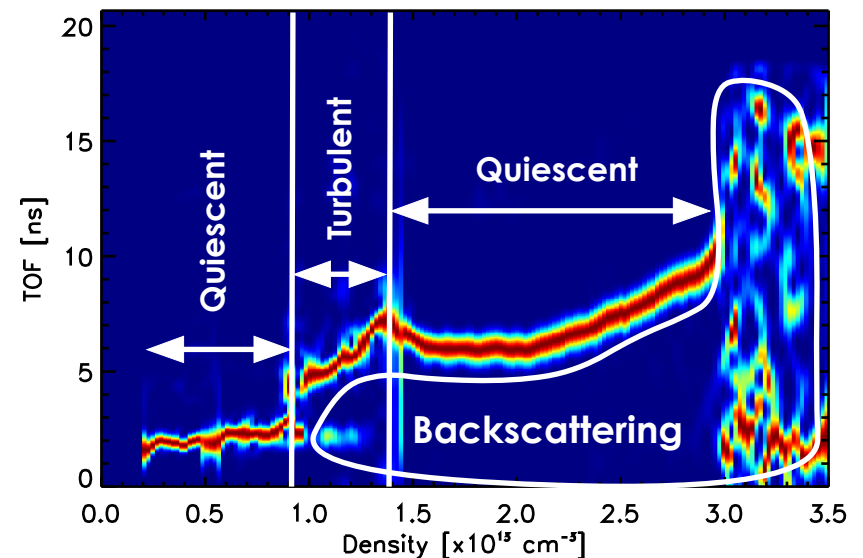
### Example Density Profile



### $k_r$ from Radial Position vs Frequency



### Measurement Example



# XP Plan



- **Purpose:**
  - $B_t$ ,  $I_p$ , collisionality,  $T_e/T_i$ ,  $T_e'$ ,  $T_i'$ ,  $\beta$ ,  $\beta'$ , etc. dependence of turbulence.
- **How this XP MUST be run:**
  - Available for 1-2 day XP early in run.
  - Possibly available (for a week?) late in run for additional shots and to support other XP's that want to take advantage of capabilities.
- **Additional Diagnostics:**
  - MPTS, CHERS, MSE, ORNL reflectometer, GPI, reciprocating probe, high-k scattering, BES if available, etc.
- **Post-processing:** FDTD2D, TRANSP, gyrokinetic codes.
- **Requested time: 36+ shots, most likely 1.5-2 days.**
  - 1) Fixed base shot at 4.5 kG, low density L-mode,  $n_{e0}=2-3 \times 10^{13} \text{ cm}^{-3}$ : 4 shots.
  - 2)  $I_p$  scan (3 values) at fixed  $B_t$ :  $2 \times 3 = 6$  shots.
  - 3)  $B_t$  scan (3 values) at fixed  $I_p$ :  $2 \times 2 = 4$  shots.
  - 4) Fixed  $B_t/I_p$   $\rho^*$  and  $v^*$  scans:  $3 \times 2 \times 2 = 12+$  shots.
  - 5) Vary  $T_e$  and  $T_i$  with different combinations of NBI, HHFW: 10+ shots.
- **Relevance:**
  - 1) Research Milestone R(11-1).
  - 2) Connects to on-going L-H transition studies from 2009.
  - 3) Critical for future diagnostics planning.