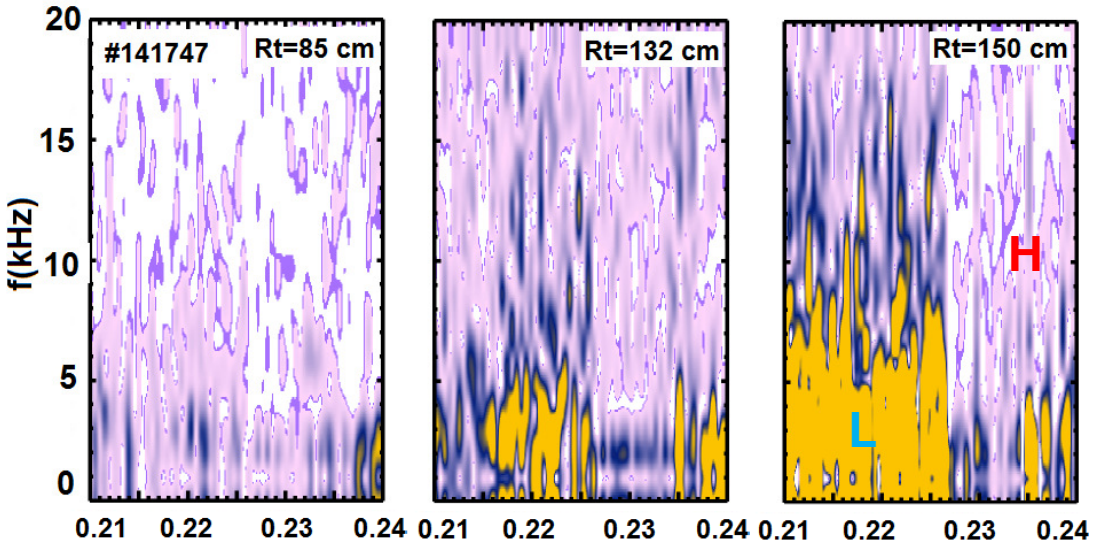
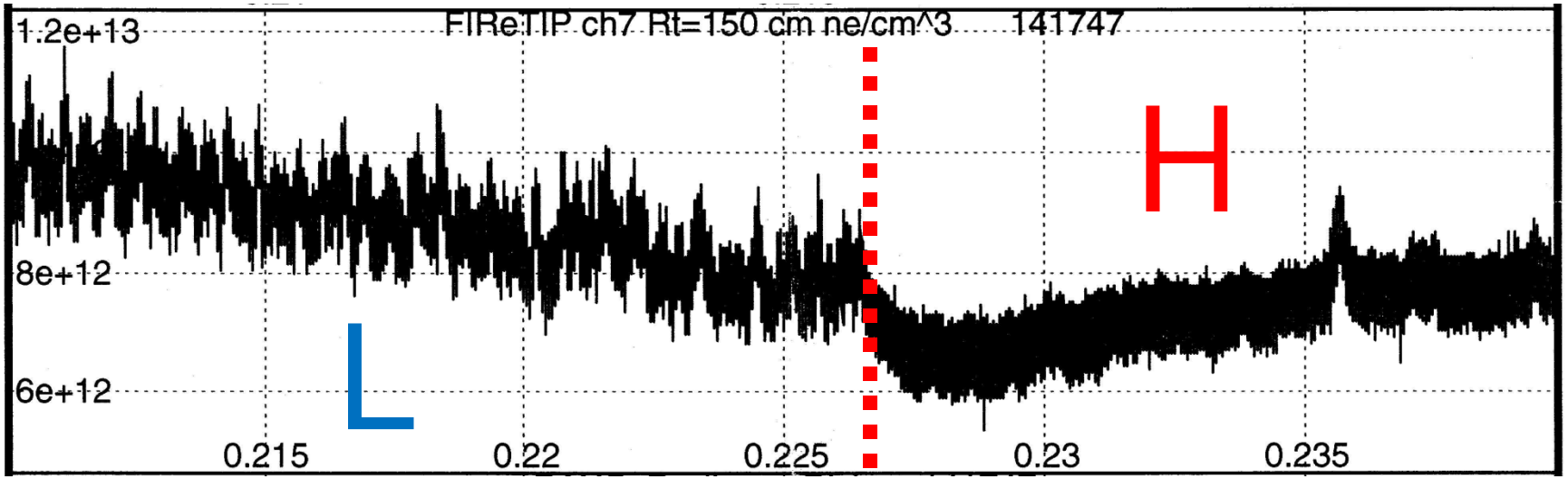
Measurement of density fluctuation for the study of transport and L\H power threshold



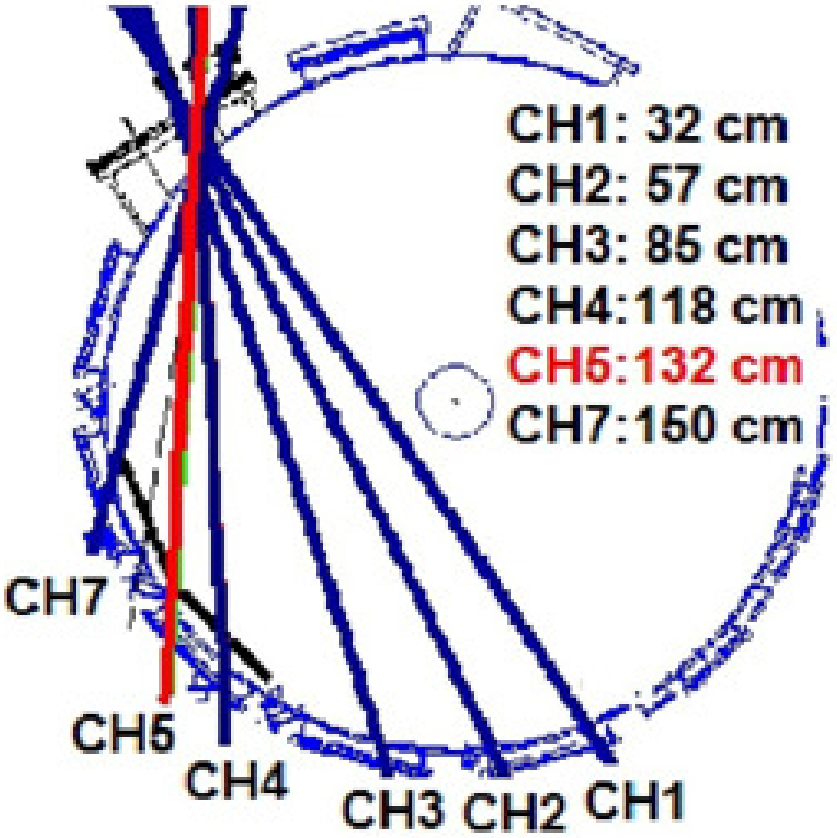
Density fluctuation is important parameter for transport and L\H power threshold

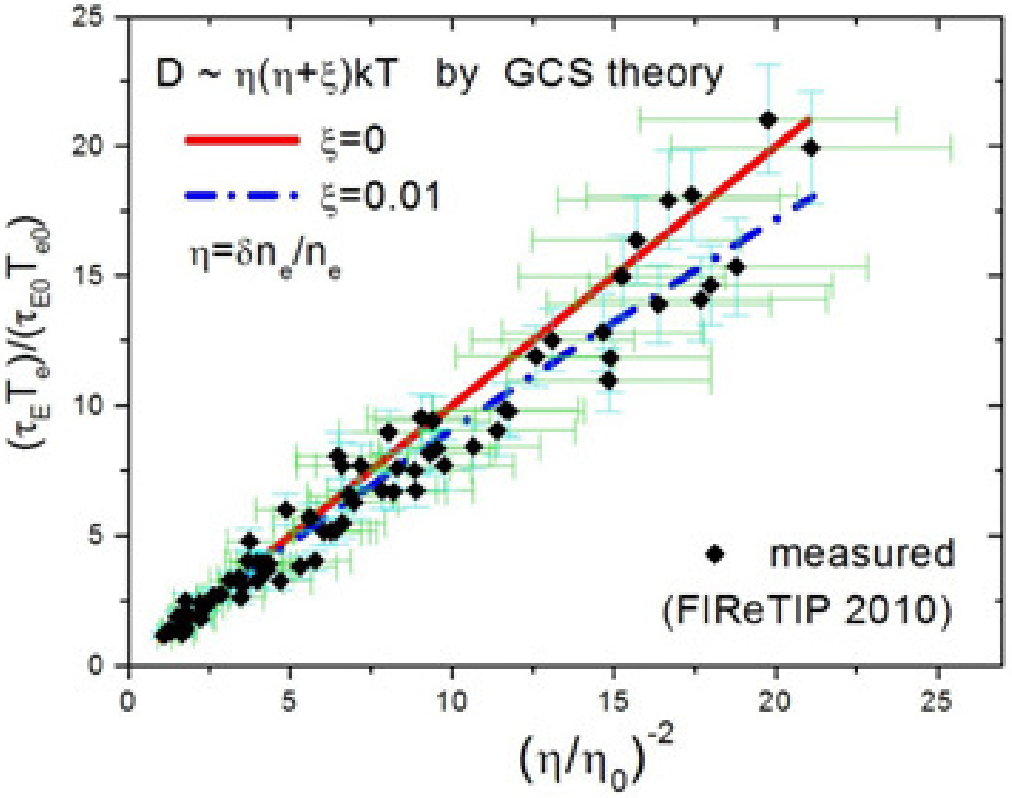


2010 FIReTIP density fluctuation data showed

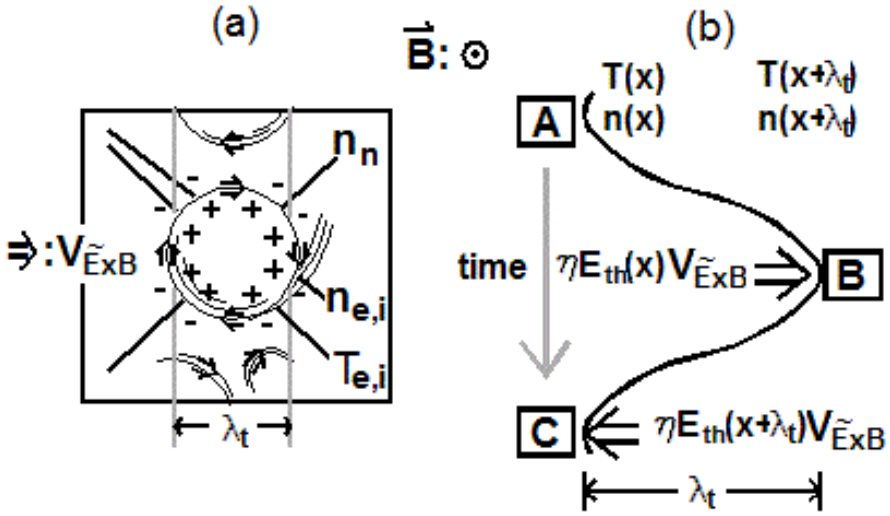
$$D \sim \eta^2 kT$$

$$\eta \equiv \frac{\tilde{n}}{n},$$





Thermal energy transport



$$\Gamma_E = \frac{\eta}{\pi}\frac{\tilde{E}\lambda_t}{B}(kT_0 n' + kn_0 T')$$

$$kT_0 n' + kn_0 T' = d(nkT)/dx$$

with Boltzmann relation; $e\tilde{E}\lambda_t / 2kT_i = \eta$

$$\Gamma_E = D_E E'_{th}$$

$$D_E = \frac{2}{\pi}\eta^2 \frac{kT_i}{eB}$$

(E_{th} = thermal energy)

	x	$x+\lambda_t$
n : density	n_0	$n_0 + \lambda_t n'$
T : temperature	T_0	$T_0 + \lambda_t T'$
$nT:[A]$	$(nT)_x = n_0 T_0$	$(nT)_{x+\lambda} = n_0 T_0 + \lambda_t n_0 T' + \lambda_t T_0 n' + \lambda_t^2 n' T' \approx n_0 T_0 + \lambda_t n_0 T' + \lambda_t T_0 n'$
$nT:[B]$	$n_0 T_0 - \eta n_0 T_0$	$n_0 T_0 + \lambda_t n_0 T' + \lambda_t T_0 n' + \eta n_0 T_0$
$nT:[C]$	$n_0 T_0 - \eta n_0 T_0 + \eta n_0 T_0 + \eta\lambda_t n_0 T' + \eta\lambda_t T_0 n' + \eta^2 n_0 T_0 \approx (nT)_x + \eta\lambda_t n_0 T' + \eta\lambda_t T_0 n'$	$n_0 T_0 + \lambda_t n_0 T' + \lambda_t T_0 n' + \eta n_0 T_0 - \eta n_0 T_0 - \eta\lambda_t n_0 T' - \eta\lambda_t T_0 n' - \eta^2 n_0 T_0 \approx (nT)_{x+\lambda} - \eta\lambda_t n_0 T' - \eta\lambda_t T_0 n'$

Density fluctuation and L\H power threshold

$$J_r^{GCS} = en_i \frac{r_{Li}}{\lambda_{i-n}}\left(\frac{E}{B} - \frac{1}{eB}\frac{\nabla P_i}{n_i} + \frac{kT_i}{eB}\frac{\nabla n_n}{n_n}\right)$$

v*

Inertia force ↘

$$\mathrm{Re} \equiv \frac{n_i m_i \upsilon^{*2} / r_{Li}}{n_i m_i \nu_{i-n} \upsilon^*} = \frac{eB}{kT_i}\lambda_{i-n}\upsilon^*$$

viscosity force ↗

(saturation condition : $J_r^{GCS} = D\nabla\rho$)

↓

Reynolds number of ion-neutral collision

$$\mathrm{Re} = \frac{4\varepsilon_0}{\pi}\eta^2 \frac{B}{m_i n_i (\sigma_{i-n} n_n)^2 \upsilon_\perp}\nabla^2 E$$

XP to compare P_{th} and confinement

for

(1) H-mode shots with low Li (high η)

(2) H-mode shots with high Li (low η)