Investigation of ETG turbulence isotropy

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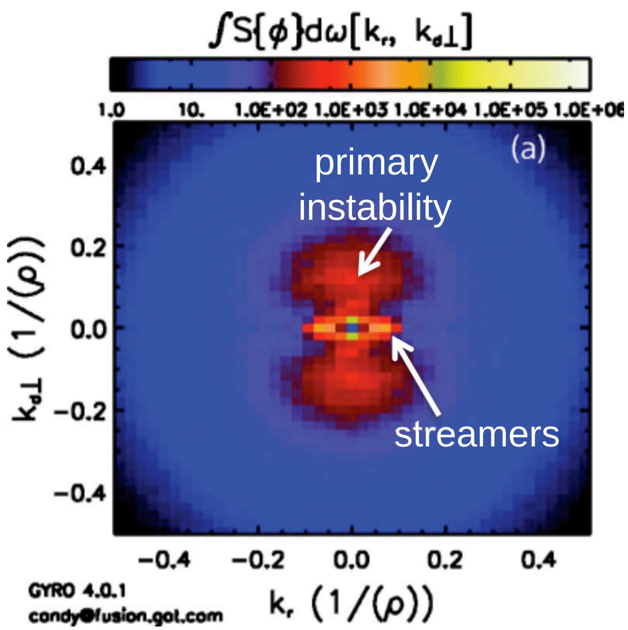
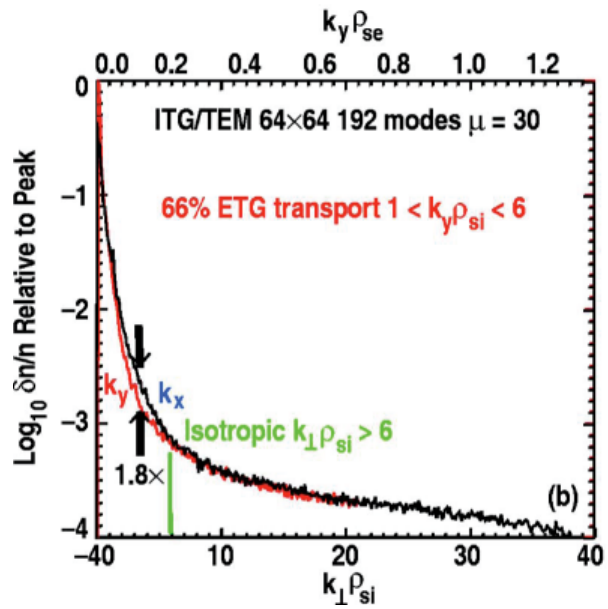
The k_r-k_θ isotropy of ETG turbulence is an area of active debate in the GK community

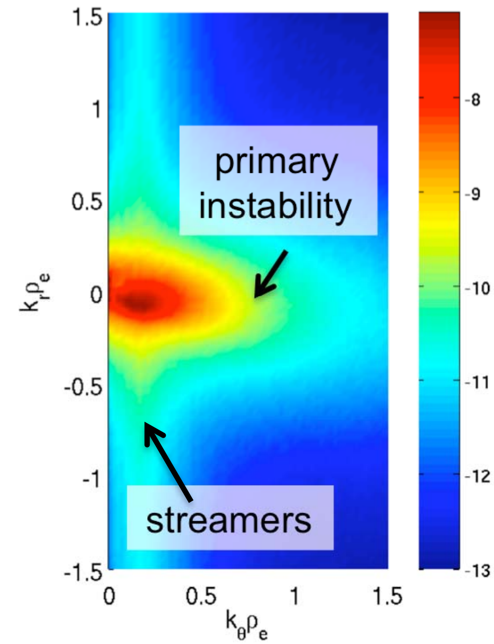
Nevins et al, PoP, 2006
predict ETG anisotropy



Waltz et al, PoP, 2007
predict ETG isotropy



Guttenfelder and Candy,
to be submitted
predict ETG isotropy

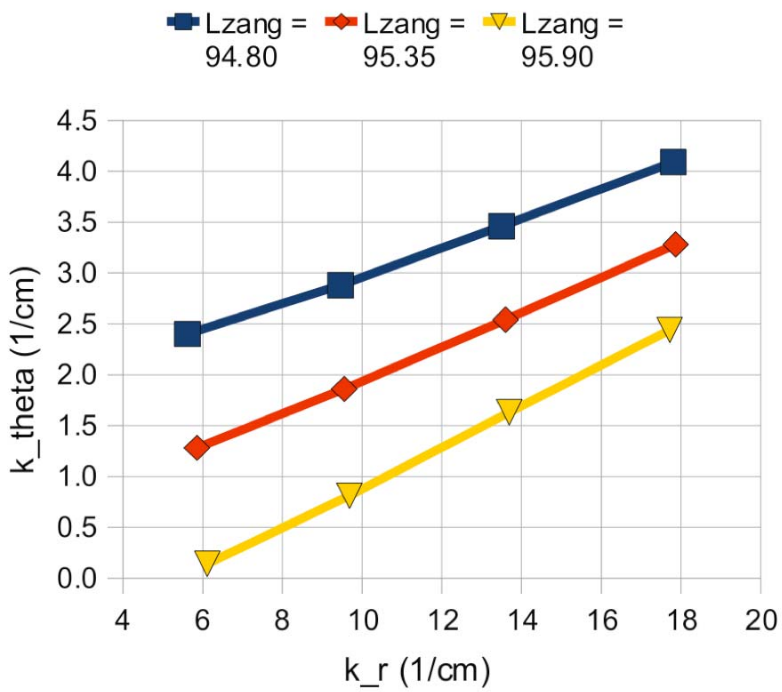


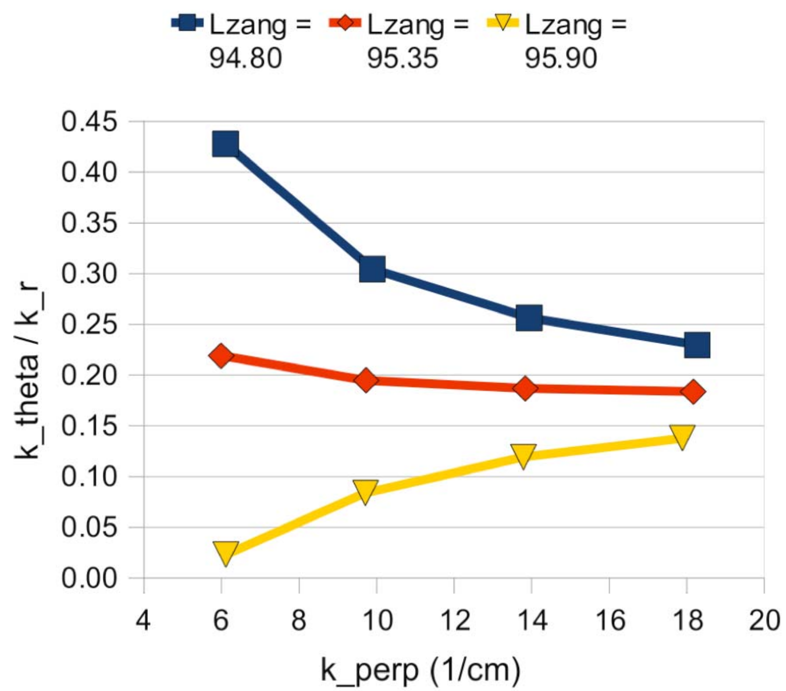
ST parameters
with flow shear

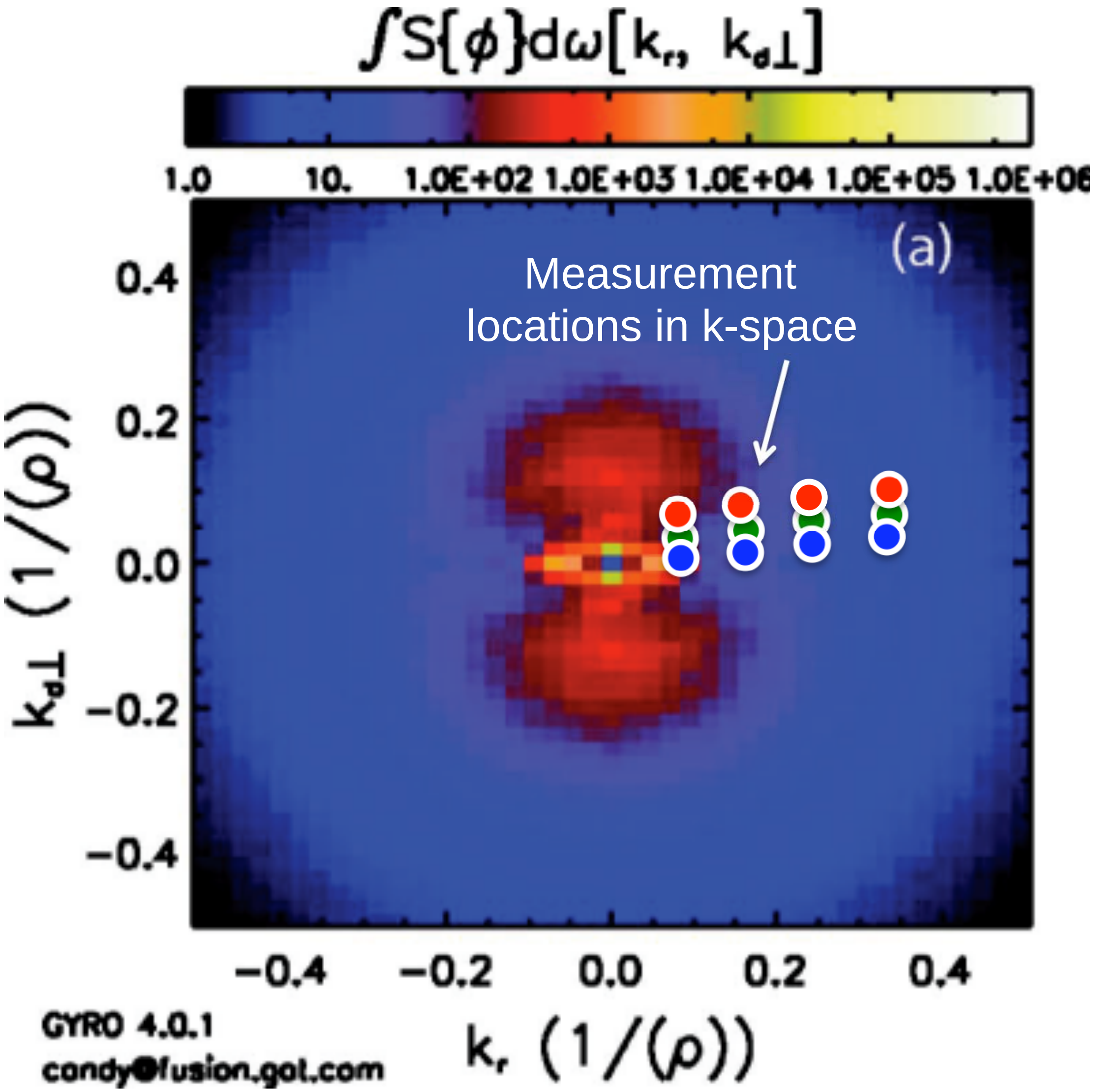
ETG radial streamers are anisotropic features
(simulations above do not use the same plasma conditions)

The NSTX high-k scattering system can access a wide range of k_θ/k_r ratios in the lower-k channels

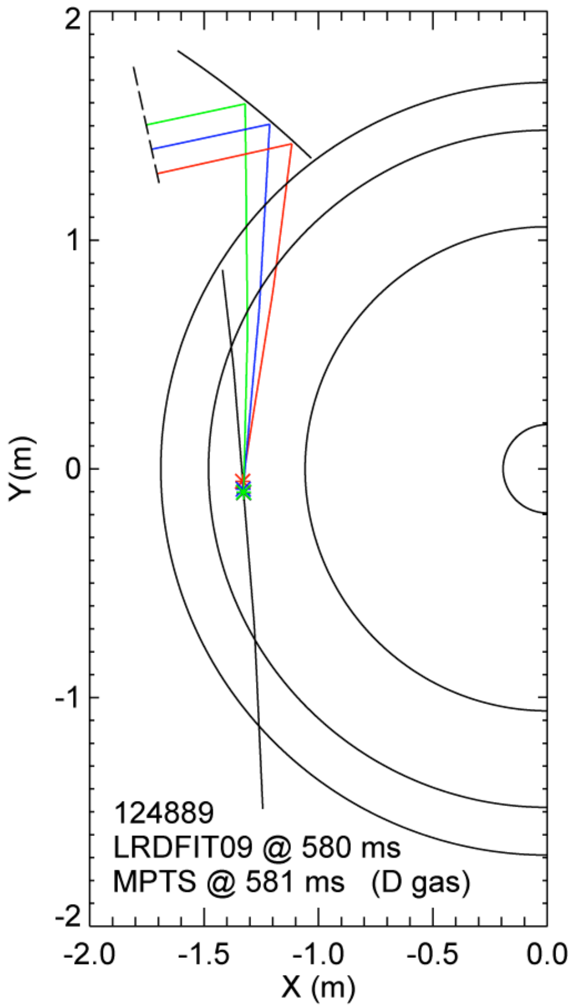
unique capability among worldwide turbulence diagnostics





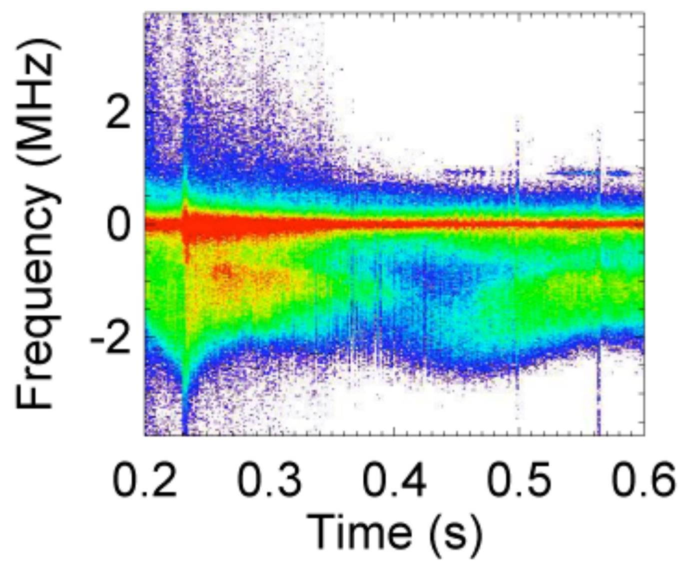

∫S{ϕ}dω[k_r, k_θ⊥]
1.0
10.
1.0E+02
1.0E+03
1.0E+04
1.0E+05
1.0E+06
(a)
Measurement locations in k-space
0.4
0.2
0.0
−0.2
−0.4
k_θ⊥ (1/(ρ))
k_r (1/(ρ))
GYRO 4.0.1
candy@fusion.gat.com

Previous measurements provide a starting point



124889: 700 kA, 5.5 kG, &
4 MW NBI

high-k measurements
at R=133 cm and r/a=0.55



Magnetic shear may control ETG isotropy and ETG-driven electron thermal transport

TABLE III. $\langle \chi_e \rangle$ vs magnetic shear.

	s=0.1	s=0.2	s=0.3	s=0.4	s=0.5	s=0.6	s=0.7	s=0.8
Adiabatic ions	3.9±0.1	5.3±0.6	6.8±1.0	10.2±1.3	128±35	>800	>800	>600
Kinetic ions	4.4±0.2	5.5±0.2	7.0±0.6	9.2±1.2	10.7±2.0	14.3±2.2	10.5±0.9	13.6±2.2

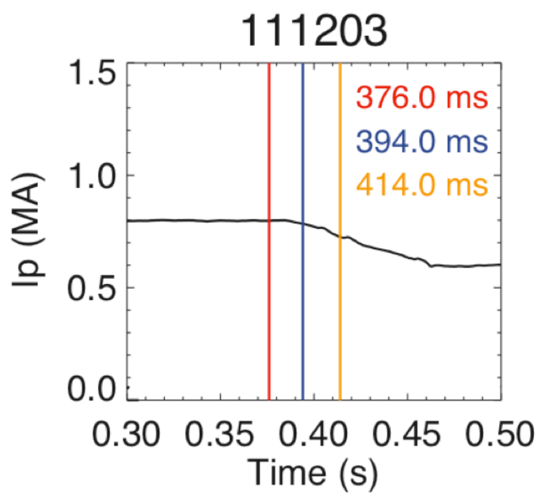
wave numbers $(k_\perp \rho_e > 0.2)$.

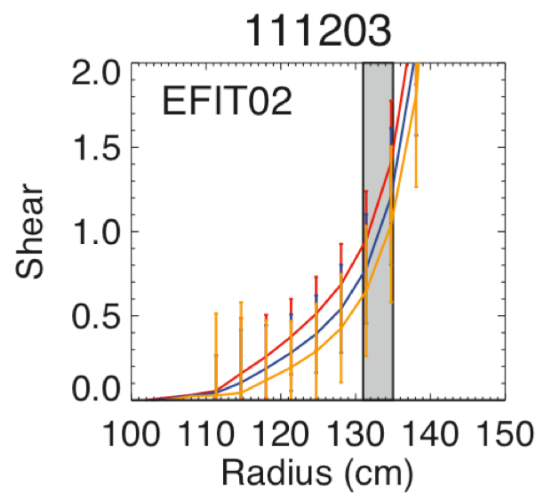
The transition to a nearly monochromatic spectrum occurs abruptly as the magnetic shear is increased and is closely associated with the sharp increase in the electron heat transport as the magnetic shear is increased from s=0.3 to 0.4. Very high electron heat transport $[\chi_e \gg 10(\rho_e/L_T)\rho_e v_{te}]$ is, in our experience, always accompanied by a nearly monochromatic fluctuation spectrum with $k_r \approx 0$. This spectrum corresponds to coherent "streamers" with a macroscopic radial scale in the perpendicular plane within configuration space.

This rapid increase in the electron heat transport with increasing shear would appear to be the most dramatic result of our study of ETG turbulence. As such, we employed the

Nevins et al, PoP, 2006

Transiently decrease magnetic shear with current ramp-downs to probe isotropy-anisotropy transition





S. Sabbagh used current ramp-downs in XP414 to obtain high β_p and β_N

Baseline shot and shot grid

- Baseline shot 134740:
  - 1.1 MA and 5.5 kG
  - 4 MW NBI w/ 6 MW early heating (A+B w/ 100 ms C)

	Ip = 1.1 MA & no ramp-down	Ip ramp-down with several ramp timings
PB Z angle -4.8°	×2	~ 5
-5.35°	×2	~ 5
-5.9°	×2	~ 5

- Aim for late, fast Ip ramp-downs to 0.8 or 0.9 MA
- k_r and k_θ values on slide #3 for 1.1 MA Ip