Comparison of Turbulence Measurements from DIII–D L–Mode and High Performance Plasmas to Turbulence Simulations and Models

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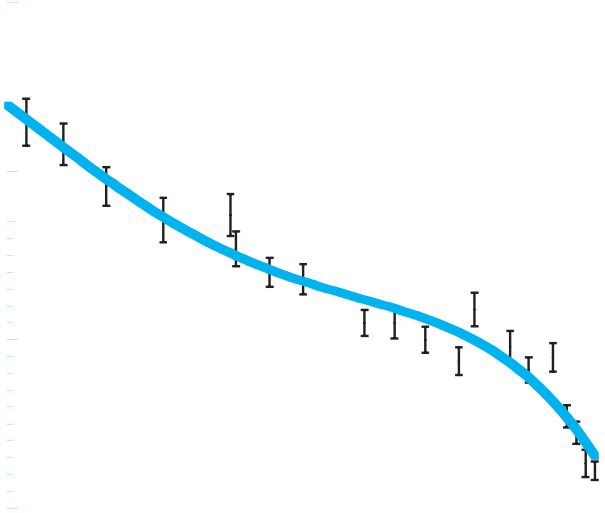
FIRST EXAMINE L–MODE CONDITIONS



L–mode discharge — sawteeth avoided via early neutral beams.

Radial profiles of density and temperatures at the time of interest.

Plasma in a regime relevant to:

- Trapped electron mode (< 0.9).
- Collisionless drift wave (0.9 < < 1).
- Ion temperature gradient mode (< 1).

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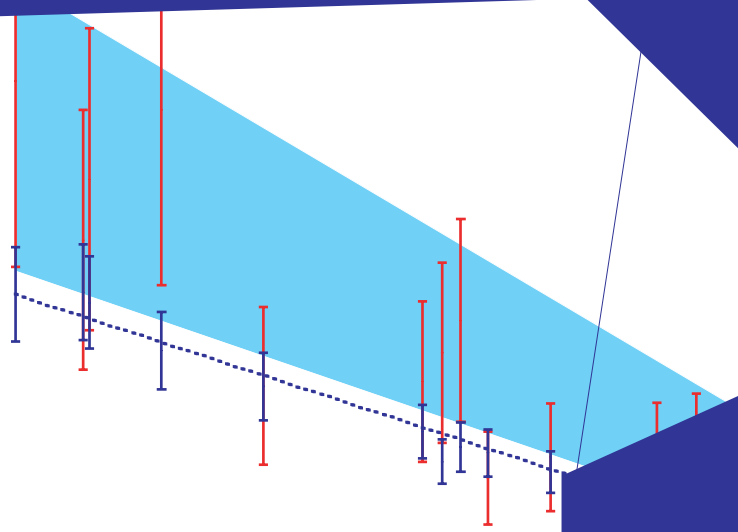
LATION LENGTH DECREASES WITH RADIUS



Shown are experimental

radial correlation lengths

e of o

indeterminacy of

$_{,s}$ or $_{s}$ is interesti

important question which

return to later.

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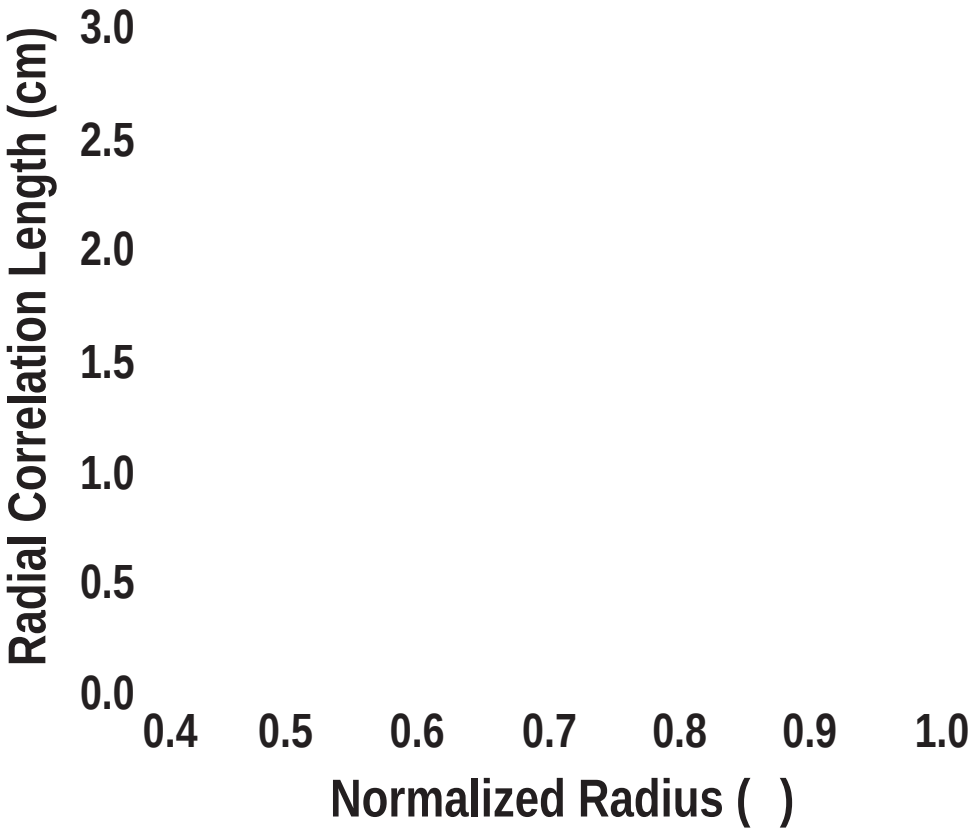
EXPERIMENTAL r SIMILAR TO SOME ANALYTIC PREDICTIONS



Analytical ITG estimates predict decrease in r with increasing radius.

- Similar to experiment.

Slab ITG estimate and neoclassical ITG are numerically close to experiment.

- Neoclassical ITG likely relevant only near edge > 0.9 where collisionality is higher.

Experimental r similar to electron drift wave $x_i = (L_s/L_n)(T_e/T_i)^{1/2}$ s.

- x_i = inverse width of turbulent EDW wavenumber spectrum.

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MESOSCALE LENGTHS HAVE SOME SIMILARITIES AS WELL

'Mesoscale' type r arise in linear stage of turbulence development or from constructive interference of micromodes [Connor, '99; Furnish, '99; Horton, '99].

- could give Bohm diffusion and explain thermal diffusivity increase with radius [Kim '98].

Mesoscale type r (¡ L_{Ti} / ŝ)$^{1/2}$ [Furnish, '99] similar to experiment.

- quite different from the other predictions.

More work needed as other data indicate r 5-10 $_s$, more on this later.

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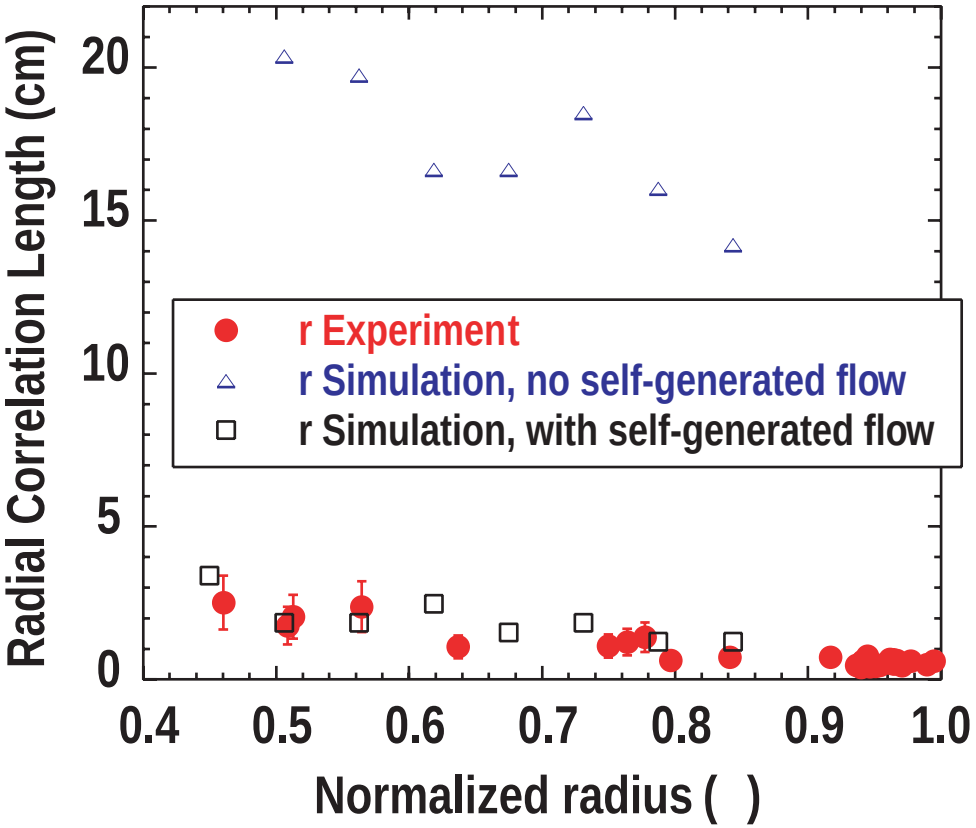
SIMULATION PRODUCES SIMILAR RESULTS WHEN ZONAL FLOWS INCLUDED



Two different simulations runs shown (both circular cross section).

- One with, one without zonal flows.
- Zonal flows: radially localized (k_{radial} 0), axisymmetric (m=n=0), ExB flows.

Without zonal flows r long, spanning most of 65 cm radius.

With zonal flows r drop to near measured r in magnitude and radial behavior.

Zonal flows clearly change turbulence characteristics and are necessary for agreement with experiment.

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DOES r SCALE WITH , s OR WITH s?

Uncertainty between r scaling with , s or 5-10 s intriguing.

- Also several analytic theories have , s dependence.
- Previously found r i (McKee, 2001).

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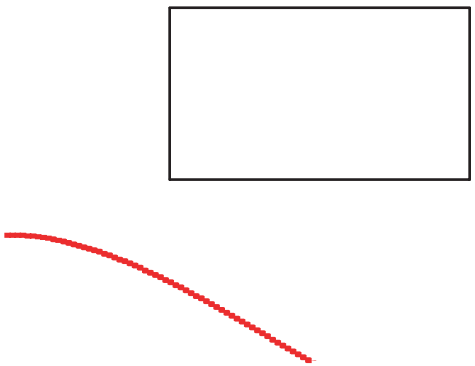

Experiment to investigate ,s scaling and to break indeterminacy.

- L–mode plasmas, varied B via I_p.

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