Comparison of SOL turbulence in Alcator C-Mod with three dimensional gyro-fluid computations

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Overview

- First comparison of GEMR with tokamak SOL turbulence
- Code inputs only SOL (n, T_e) for a “double-blind” test
- Turbulence in GEMR analyzed just like experiment

Outline:

- GEMR code
- C-Mod experiment
- Comparisons of code with experiment

GEMR Computational Model

Equations:

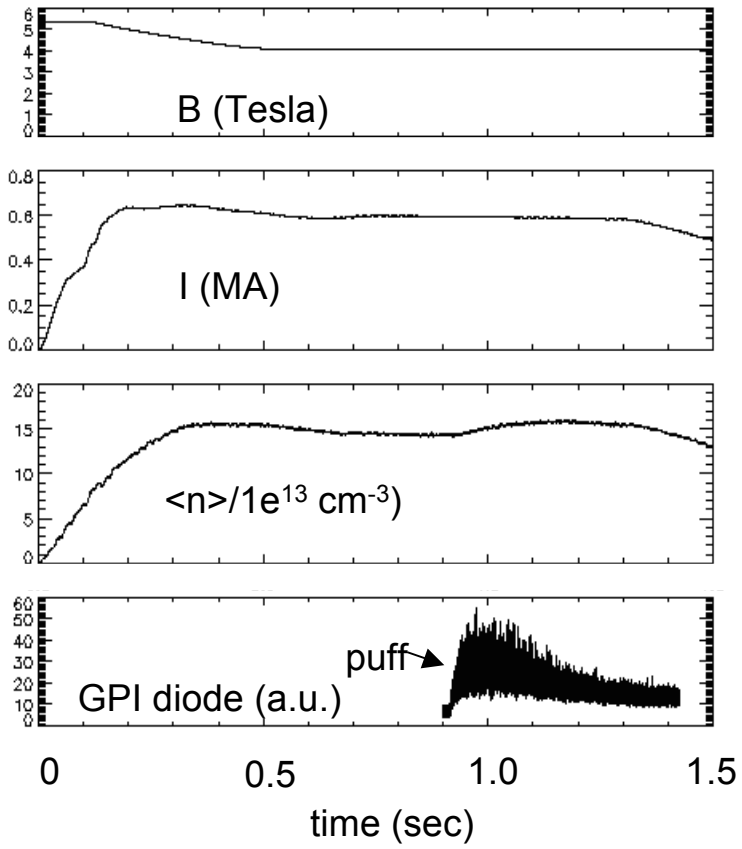
- ”Delta-f" formulation of electromagnetic gyrofluid equations
- Six variables (n, $v_{||}$, $T_{||}$, $T_{\perp}$, $q_{||}$, $q_{\perp}$) for ions and electrons
- Fields φ and $A_{||}$ solved at each time step

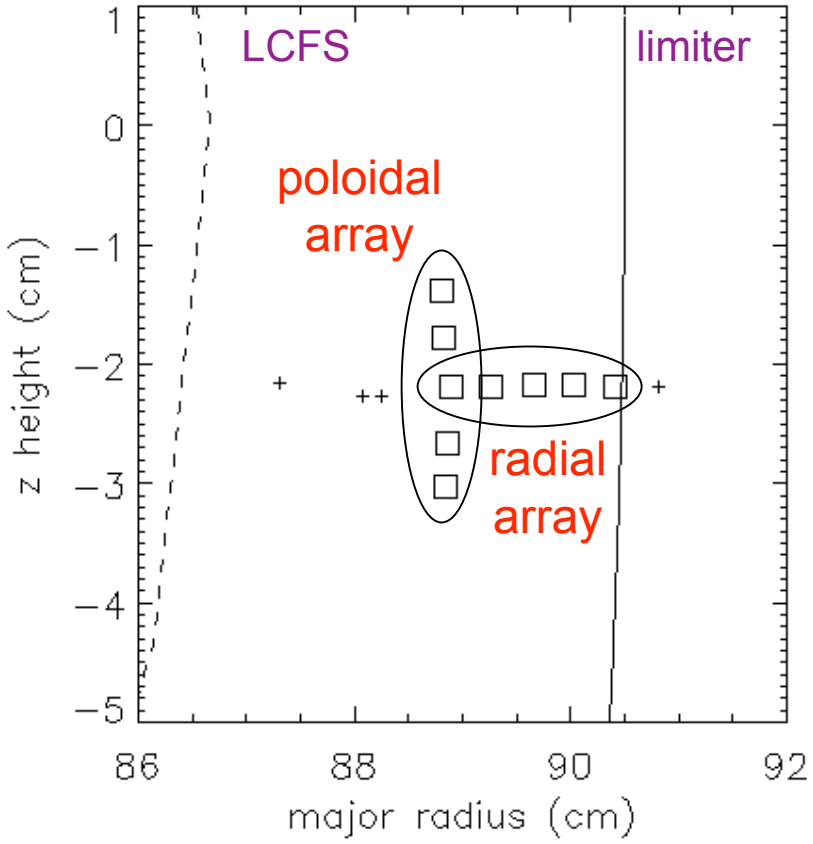
Geometry:

- Full flux surface model with circular plasma
- Radial grid covering $0.94 < r/a < 1.06$
- Inner wall SOL sheath for $r/a > 1.0$

C-Mod Experiment

- Near-circular, inner wall limited, Ohmic @ B=2.7 - 5.4 T
- Gas puff imaging (GPI) diagnostic for SOL turbulence

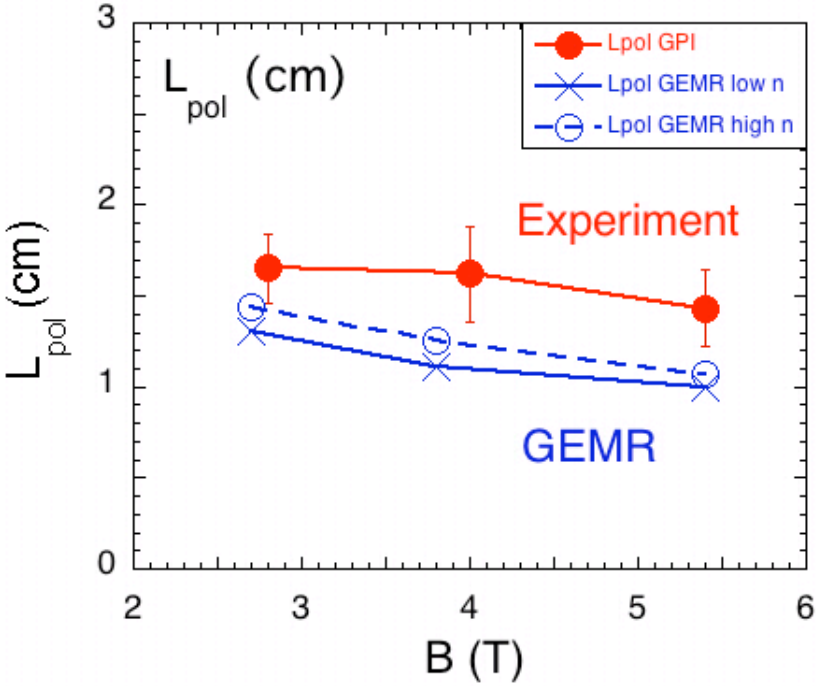




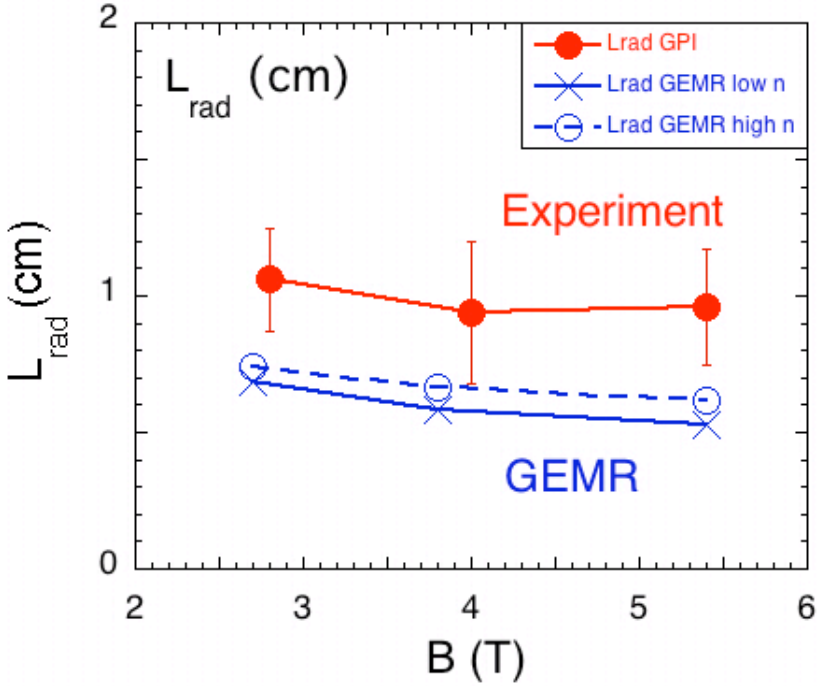
Correlation Length Comparison

- Correlations lengths agree to within ~ factor of two
- Only small variation with B in either code or C-Mod

Poloidal Correlation

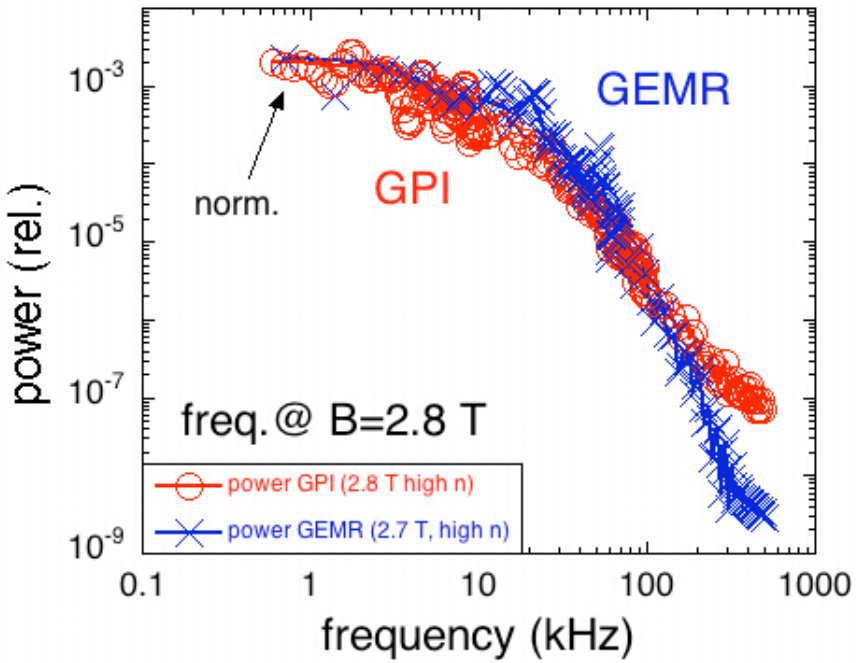


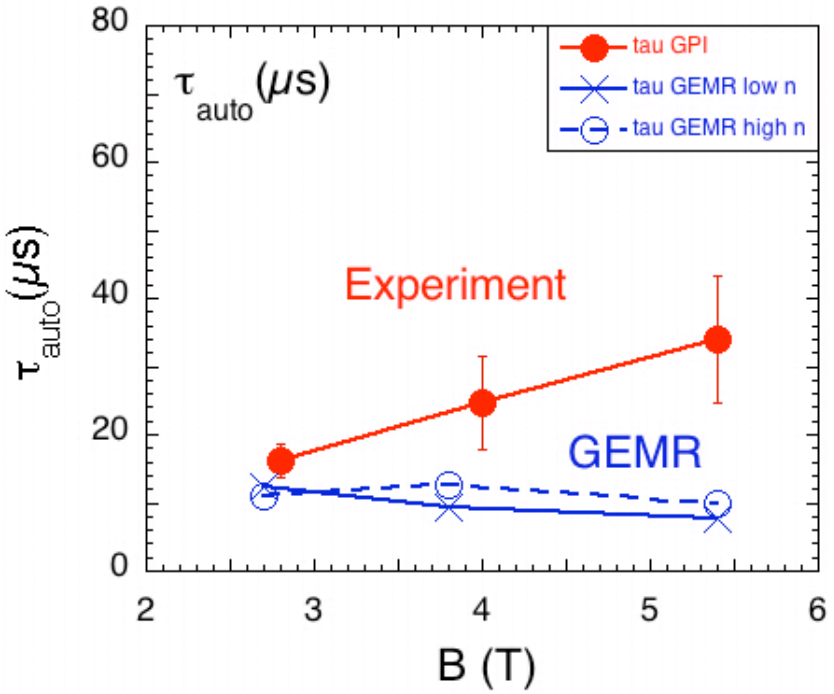
Radial Correlation



Timescale Comparison

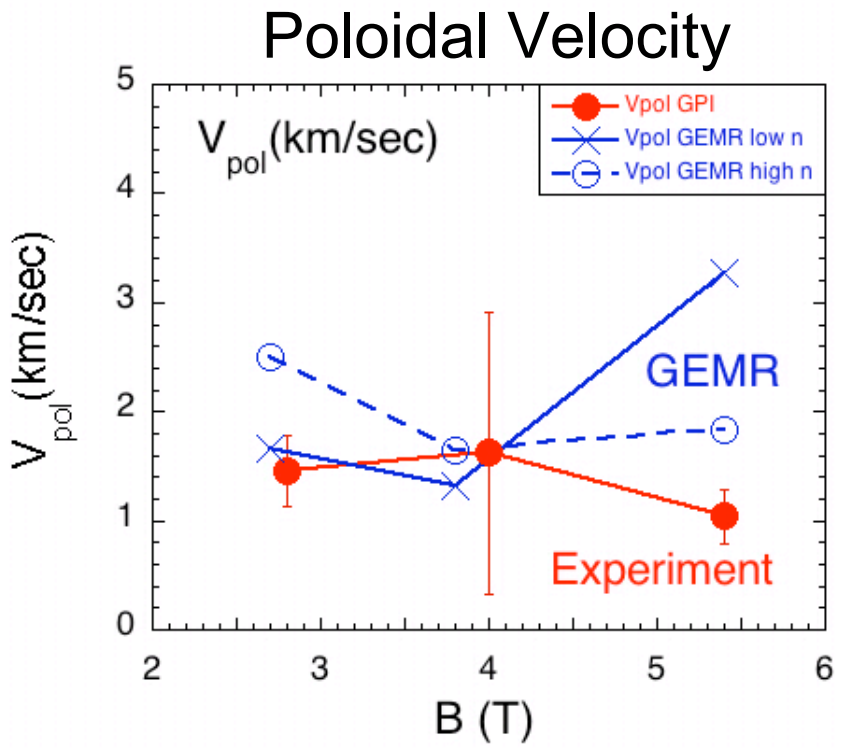
- Similar frequency spectra in code and experiment at 2.7 T
- Autocorrelation times similar at 2.7 T but x3 off at 5.4 T

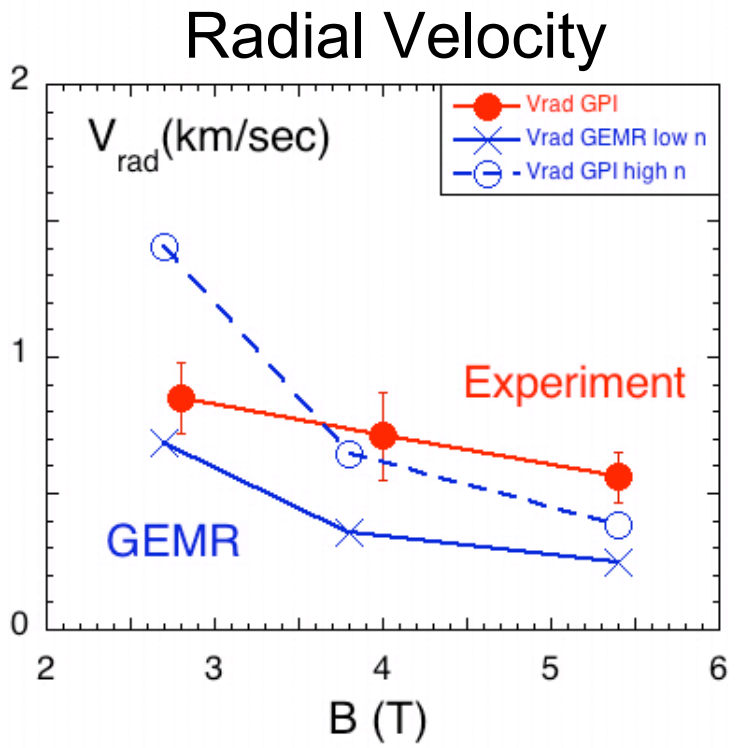




Turbulence Velocity Comparisons

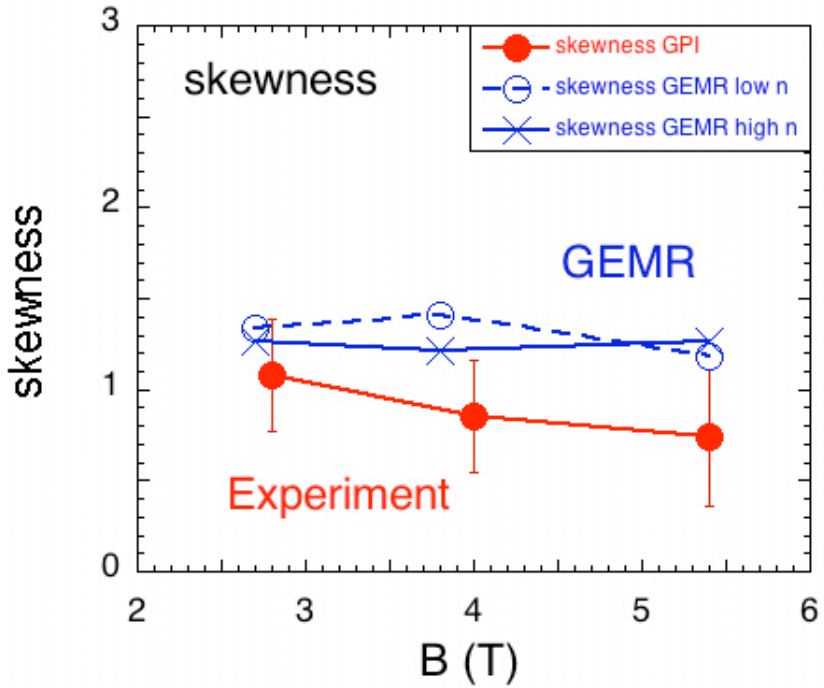
- Poloidal velocities similar (ion diamagnetic direction)
- Radial velocities similar (outward)

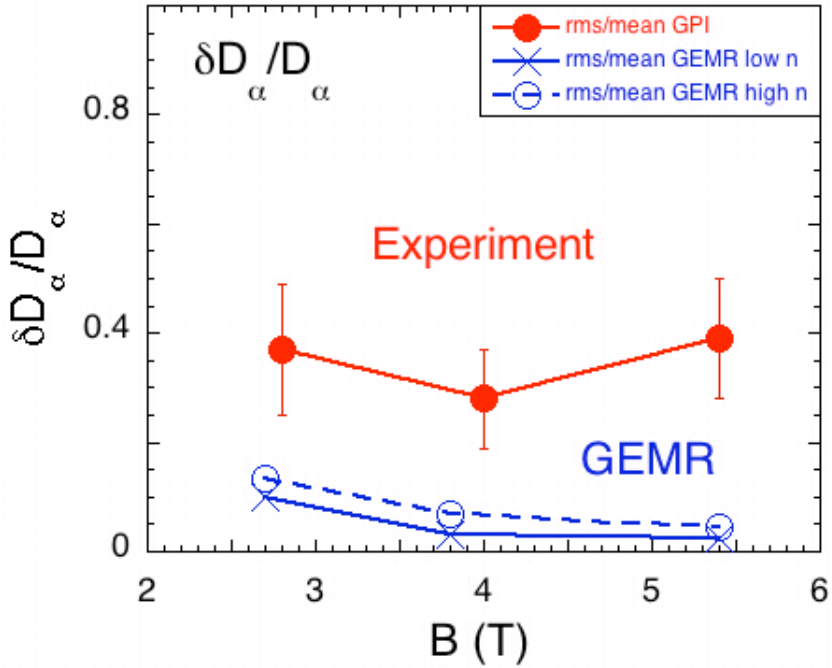




Fluctuation Statistics Comparison

- Positive skewness ~1 similar in code and experiment
- Relative D_α fluctuation levels x5-10 lower in code





Summary and Conclusions

- Several turbulence quantities are reproduced by GEMR

  - correlation lengths to well within a factor of x2
  - timescales to within a factor of roughly x2
  - velocities to within a factor of roughly x2

- But relative fluctuation levels x5-10 too low in code

- Code can not capture large amplitude ‘blob’ events

- Improved codes (GEMX, FEFI) are under development