



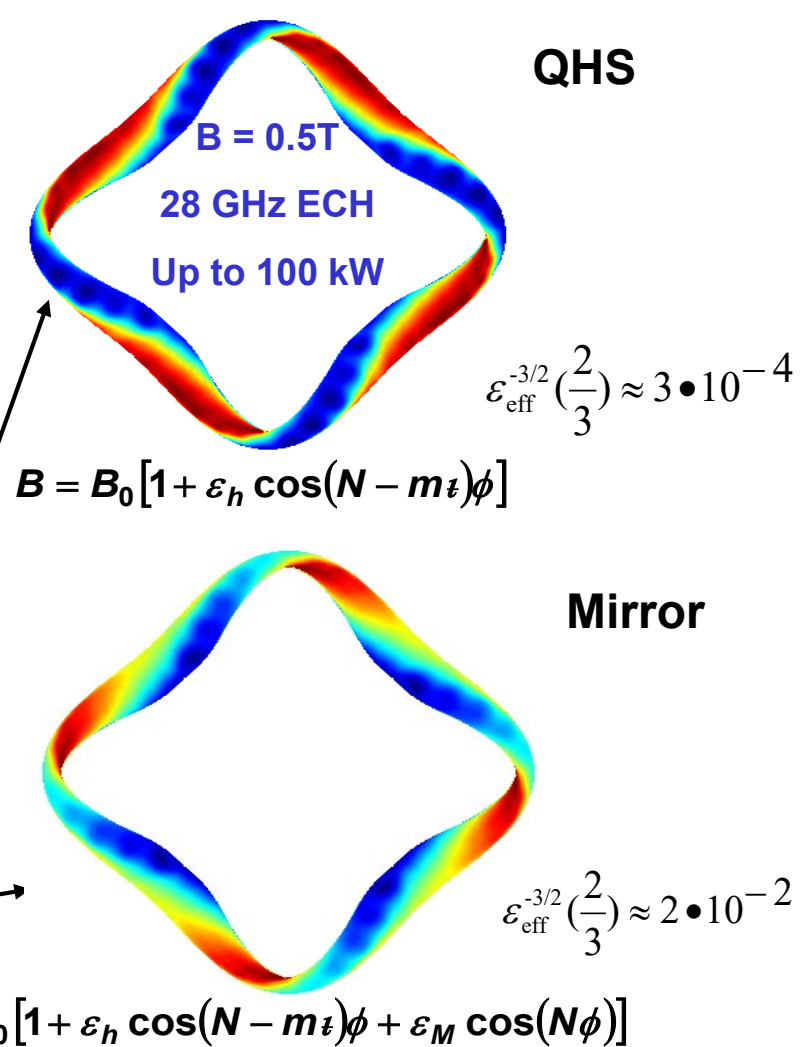
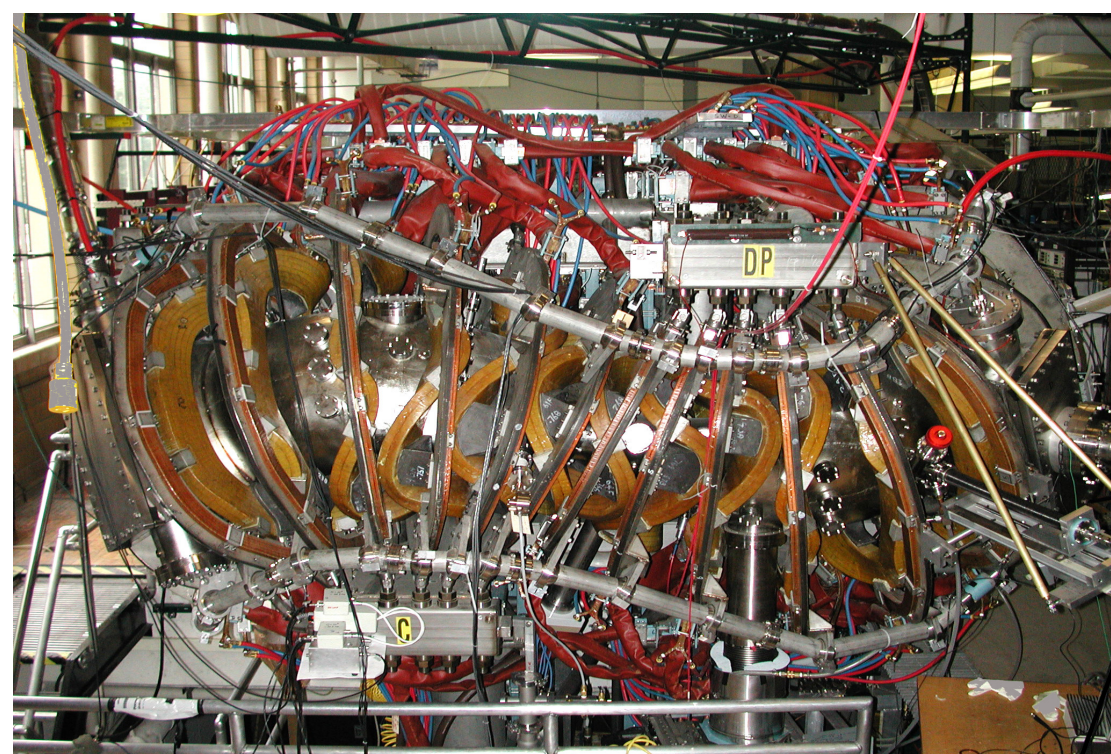
Overview of Recent Results from HSX and the Planned Experimental Program

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1. Goal of HSX

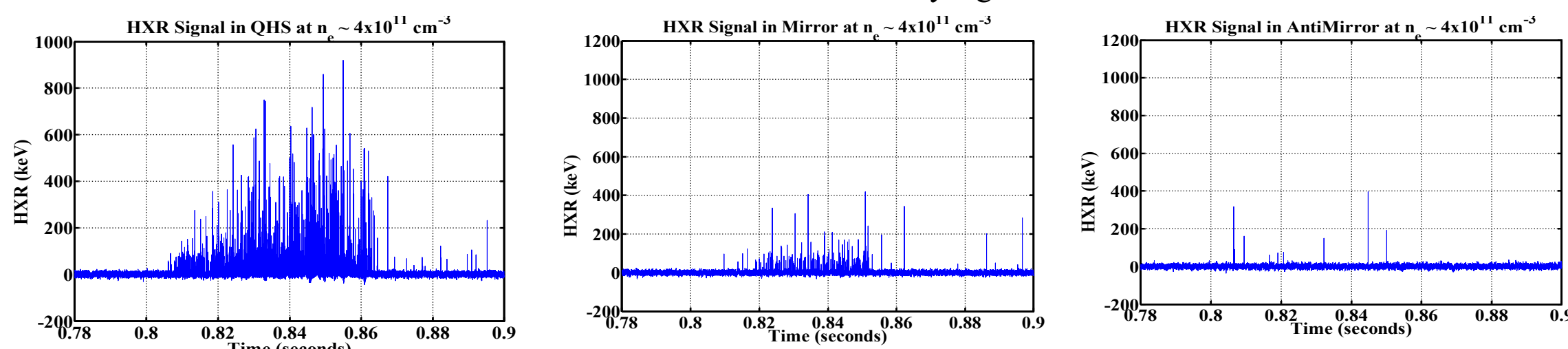
Demonstrate the potential benefits of quasisymmetry



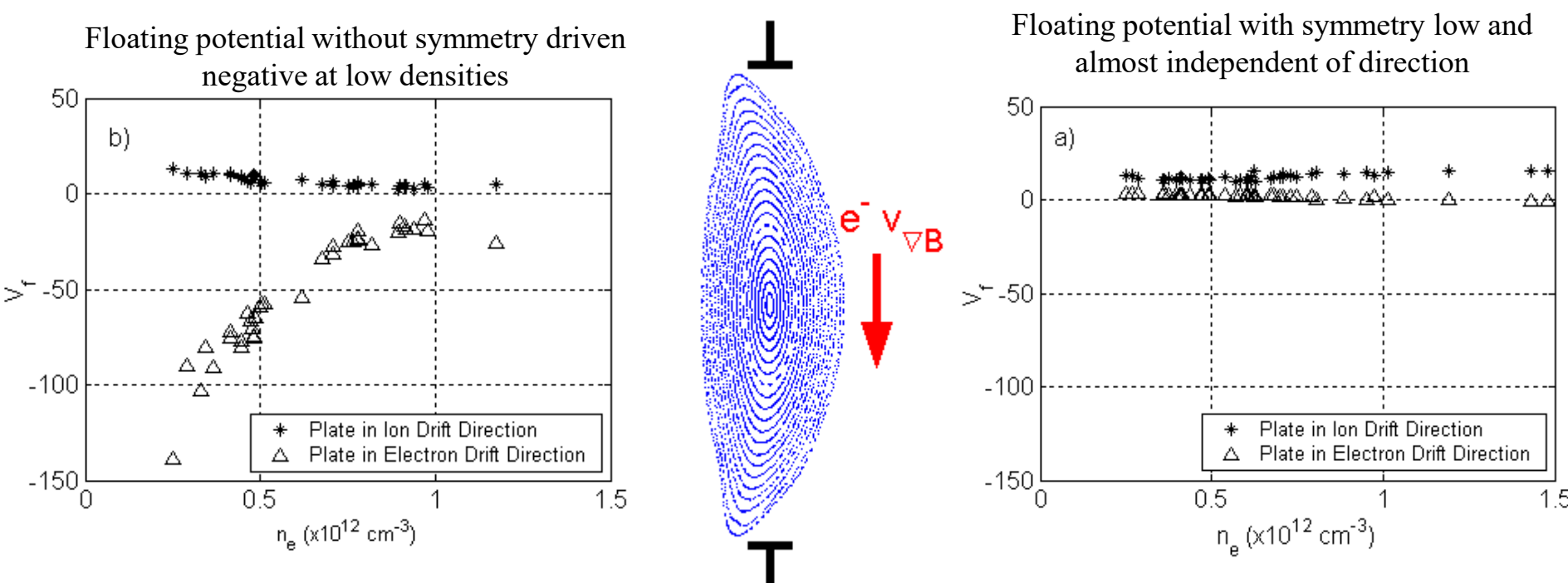
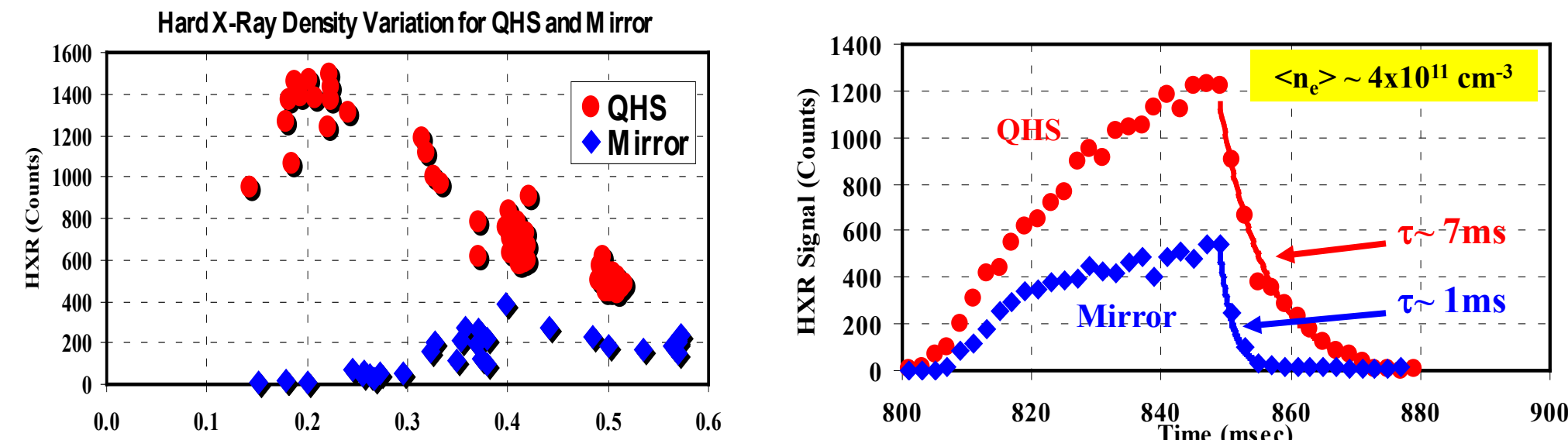
- HSX has a helical axis of symmetry in $|B|$ and a resulting predicted very low level of neoclassical transport. $\tau_{\text{eff}} \sim 3$
- For experimental flexibility, the quasi-helical symmetry can be broken by adding a mirror field.

2. Evidence for Improved Single Particle Confinement

Energetic electrons produced by 2nd harmonic ECH are well confined with quasisymmetry and lead to intense hard x-ray signals



Longer decay time in QHS is indicative of better confinement of the energetic electrons

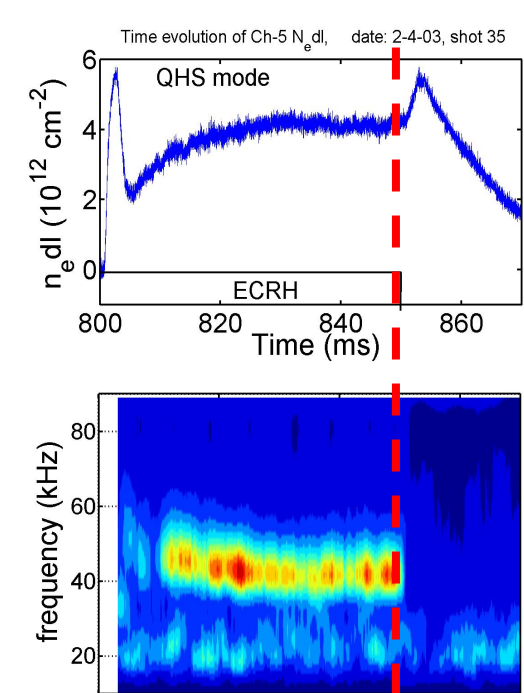
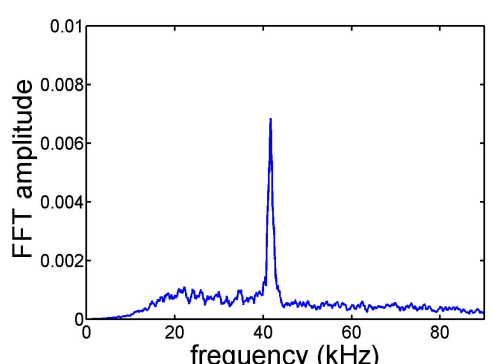


3. Energetic Particles Drive MHD

Possible $n=1, m=1$ GAE mode observed only in QHS discharges

(STELGAP code D. Spong, ORNL)

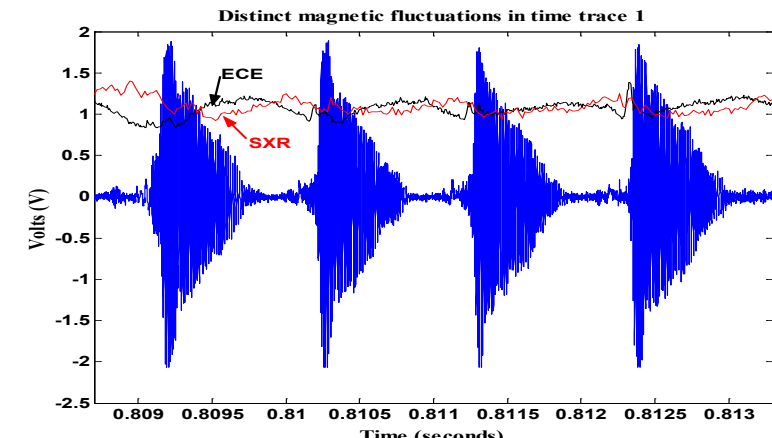
Mode observed only in QHS plasmas



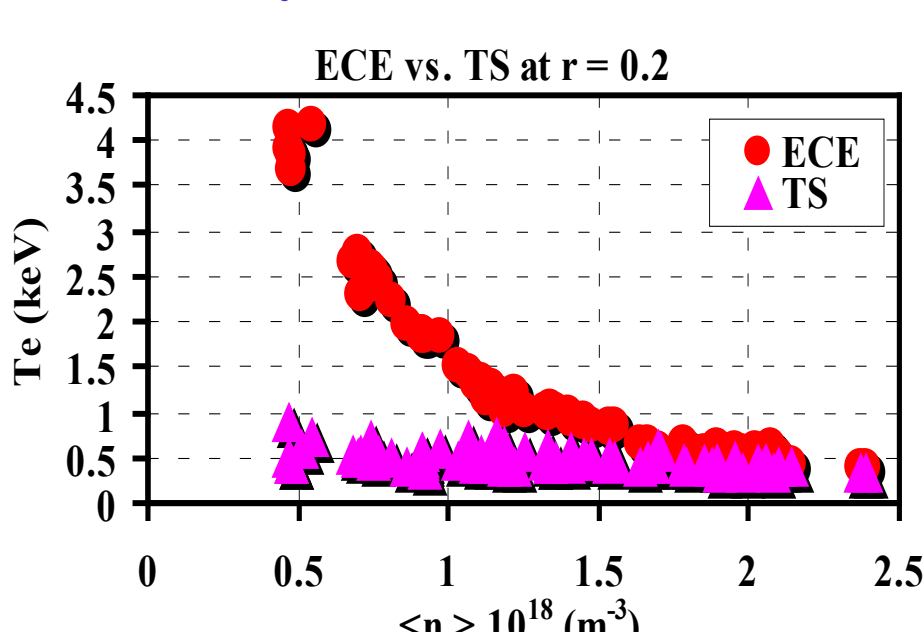
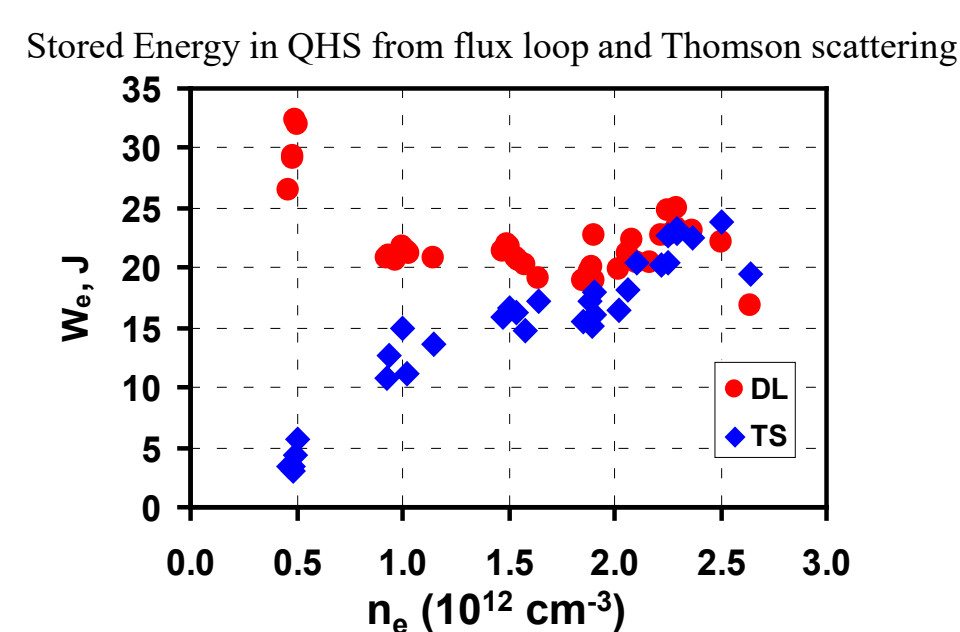
Scaling consistent with Alfvénic modes
 $v_A = B / \sqrt{4\pi n_i m_i}$

Density fluctuations and magnetic signals coherent

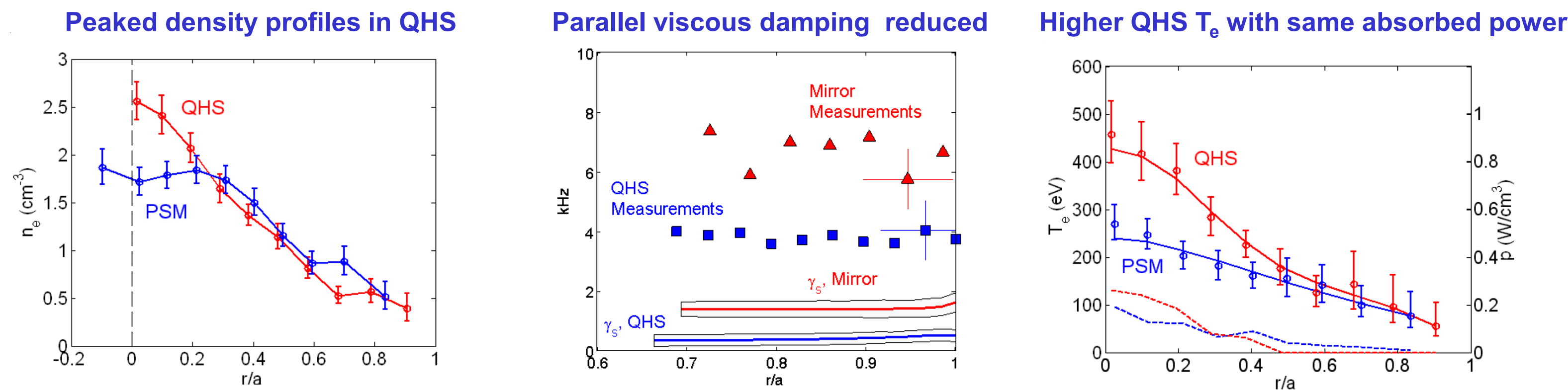
- "Fish-bone" like discharges are observed in low density QHS operation
- Crashes in the flux-loop stored energy during these discharges correlated with SXR and ECE and magnetic fluctuations.



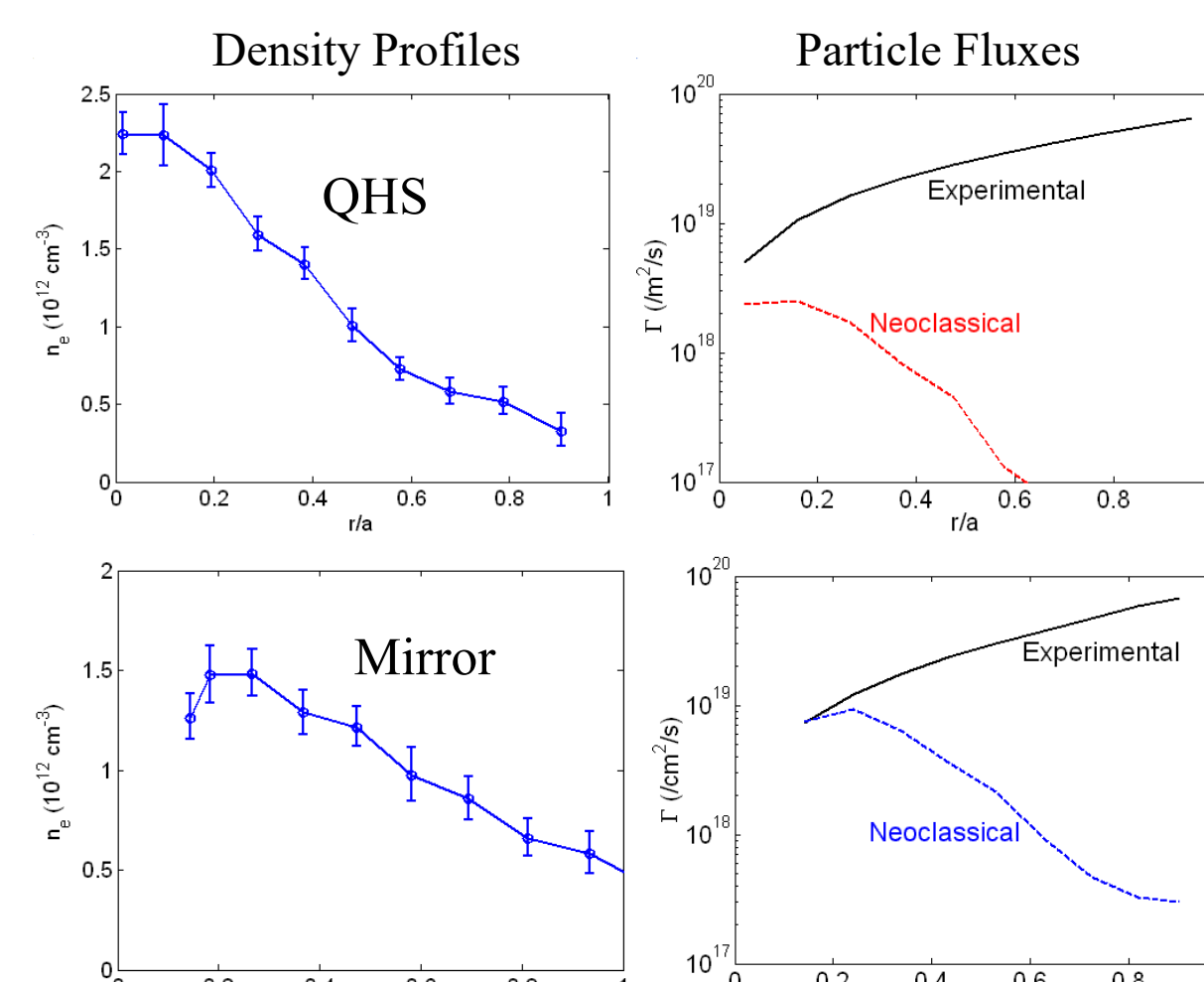
Plasma is More Thermal as Density is Increased



Symmetry Matters in Particle, Momentum and Energy Transport!

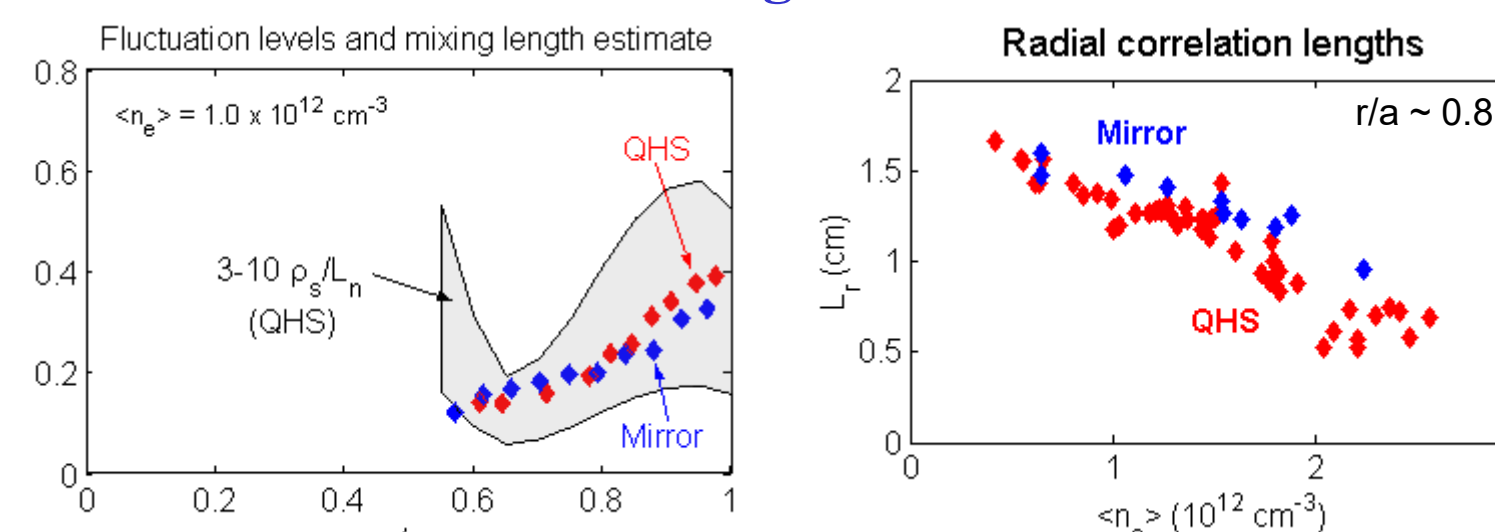


4. Particle Transport



- QHS neoclassical transport reduced below anomalous
- In Mirror, neoclassical thermomifusion drives hollow profiles

Edge turbulence characteristics similar in QHS and Mirror



QHS has longer confinement time: $\tau_E^{\text{QHS}} \sim 1.5$ ms, $\tau_E^{\text{PSM}} \sim 0.9$ ms

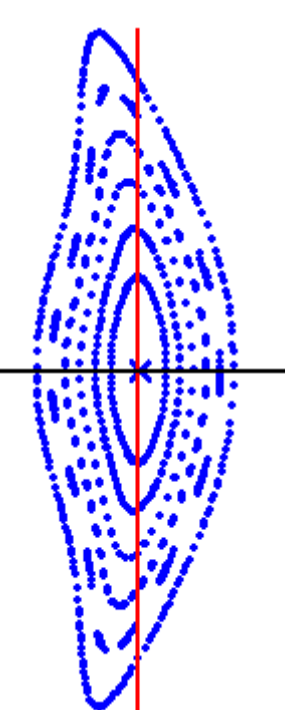
- Fluctuation levels (from ion saturation current) at the edge are same in QHS and Mirror – similar to mixing length estimates.
- Correlation lengths ($L_r \approx k_r^{-1}$) and times are similar over a range of densities (see poster by Lechte).
- Turbulent diffusivities (L_r^2/τ) are ~ 20 m²/s at high density – on the order of global transport analysis at the edge.

6. Future Directions

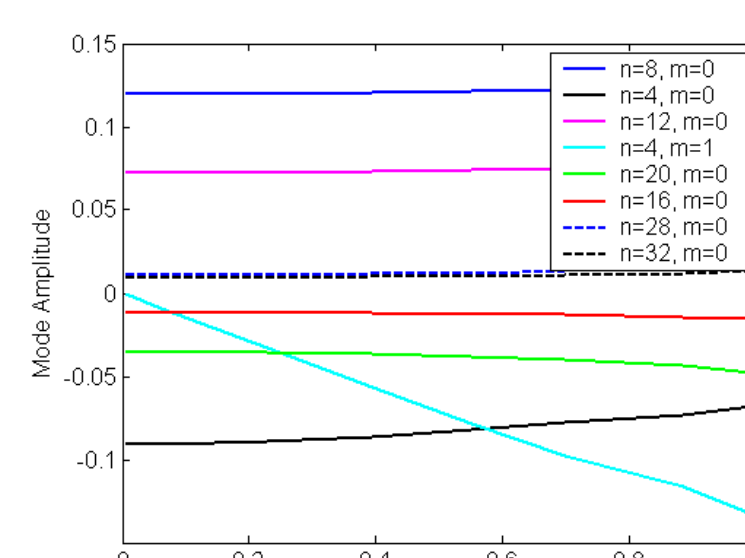
Increasing Range of Effective Ripple:

By varying the current in modular coil type 3 (of 6 per period) a broad range of effective ripple can be achieved with well-formed magnetic surfaces

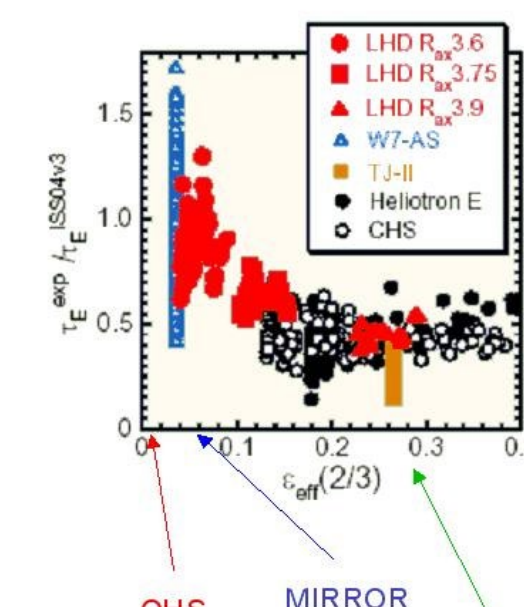
Magnetic Surfaces with no current in Coil 3



Magnetic Spectrum with no current in Coil 3



HSX could then span an extremely large range of effective ripple



High Density, High Power Operation

Increase operating field to $B=1.0$ T

- O-mode operation at 1 T gives factor of 2 in n_e and reduction of tail population
- Reduction in anomalous transport

Presently installing upgraded ECH transmission line to bring system up to full power (200kW)

Implement a 2nd 28 GHz gyrotron

- Available power increased from 200 to 400 kW
- Modulation of one tube to give electron thermal conductivity from heat wave propagation in addition to power balance
- Steerable launcher to control heating location

New Diagnostic Initiatives

- Implementing a CHERS system for measurement of the radial electric field
- diagnostic neutral beam on loan to HSX from the MST Program

Reflectometer system is near completion for measurement of profile in the gradient region and density fluctuations

Upgrade ECE system to 16 channels to measure the whole profile including central values for $B=1.0T$

- thermal conductivity with heat pulse propagation technique
- measure absorbed power deposition



Diagnostic neutral beam ready to be installed on HSX