ABSTRACT
Infererring/Fluctuation Wave Number with an HISP or an MST

VOLUMES DURING THE IMPROVED CONFINEMENT PERIOD
SAMPLE VOLUME ORIENTATION
- A substantial data set has been collected during improved confinement (PPC) but:
  - a large relative displacement
  - very little variation in the relative displacement between sample volumes
  - sample spacing is radial and parallel, not in the direction of k
- Fluctuation wave numbers can be estimated by

SECONDARY SIGNALS
Measured phase shift between detector sets is nearly 20°

POSSIBLE METHODS TO RECOVER WAVE NUMBER INFORMATION
1) Operate the HISP so that the sample spacing is optimized for wave number estimate:
   - May require hardware modifications
   - Higher current power supply for beam steering
   - Reposition of the energy analyzer
   - k may result in subcritical signal strength
2) Use k estimates from theory or from other diagnostics
   - Assuming a linear dispersion relation
   - Only requires a value for the phase velocity
3) Estimate k by observing a Doppler shift frequency for discharges with varying rotation velocities
   - This is referred to as the Frequency Shift Method

FREQUENCY SHIFT METHOD (DOPPLER SHIFT)
1) Assume that the k spectrum doesn’t vary with plasma rotation speed (for plasma with similar temperature and density profiles)
2) Assume a linear dispersion function
3) Measure frequency shifts in the fluctuation spectra between plasmas with different rotation velocity
4) Estimate the measured shift to a Doppler shift caused by plasma rotation.
   - For two power spectra with different Vθ:
   - For a given frequency range, δf can be calculated and then used to estimate k.
   - Note: because fluctuation signals on only one detector is used in the frequency shift method, it reduces the error due to the uncertainty of magnetic field reconstruction (major cause of the sample volume location uncertainty).

COMPARISON
Measurements taken during ~300kA PPC at sample volume at |r| = 25cm, Tθ = 80k eV, νθ = 1.5 cm⁻¹ k estimated by frequency shift is ~0.09 to ±0.041 cm⁻¹ which gives P = 0.14 to ±0.06
This number is consistent with the numbers given in previous study (Lot’s thesis, Mixing length argument) k = p = ±0.3
This is also consistent with the gyrokinetic simulations of the ion temperature gradient (ITG) mode in MST IPPC plasmas.

IMPLICATIONS
Particle flux estimates:
Error in flux estimates is proportional to the error in the wave number estimate:
- First order error in flux is

CONCLUSIONS
The HISP or MST has measured fluctuations of density and potential at 2 sample locations during PPC improved confinement operation on MST.
The sample spacing for the existing data isn’t conducive for estimating the wave number spectra. The wave number spectra is needed to estimate electro-static driven particle flux.
A method of using Doppler shift associated with plasma rotation is being explored to recover an estimate of the wave number spectra.