

Diagnosics of collisionless processes in plasma

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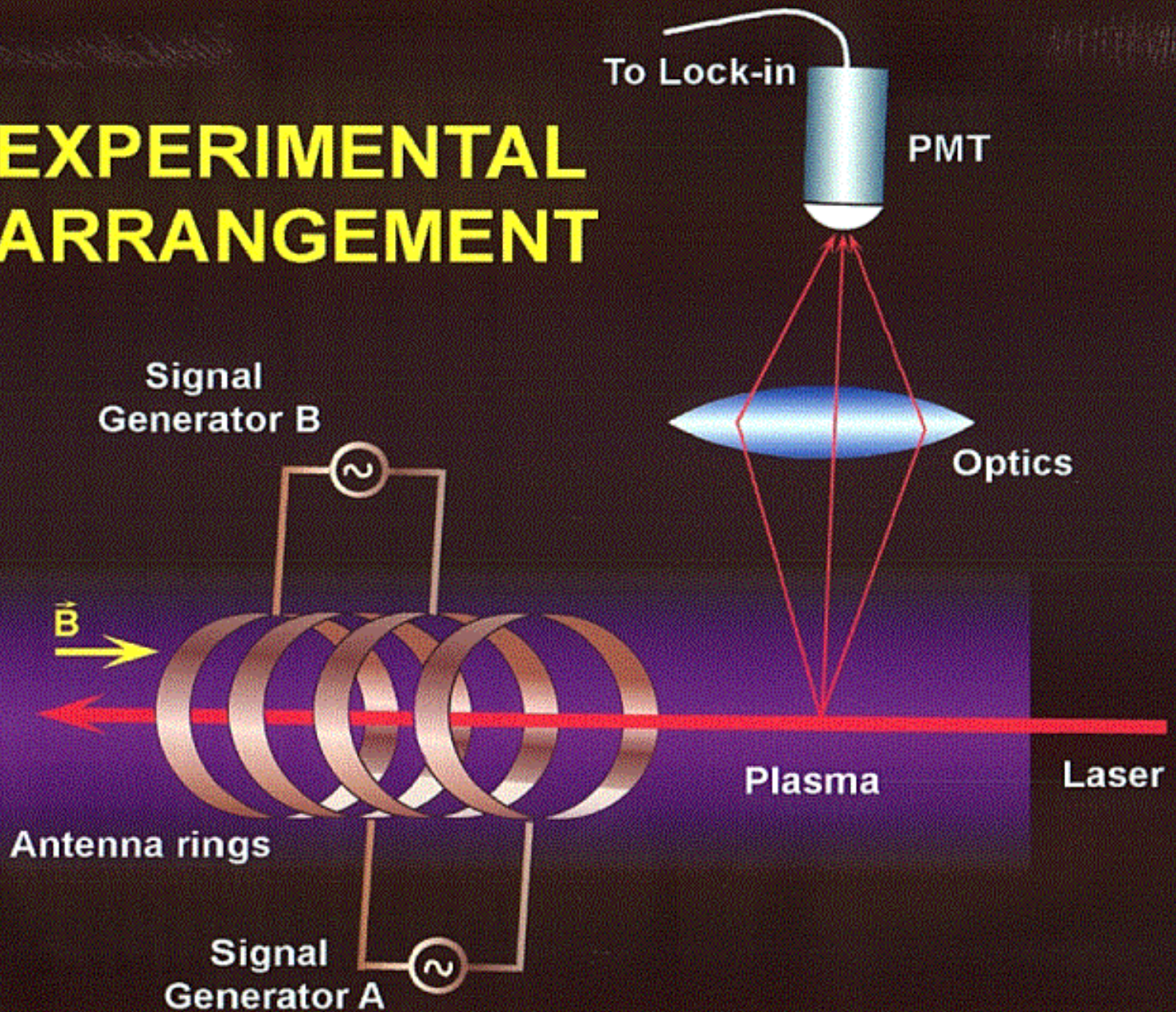
University of Iowa

Workshop on Nonlocal, Collisionless Electron Transport in Plasmas
Princeton, August 2-4, 2005

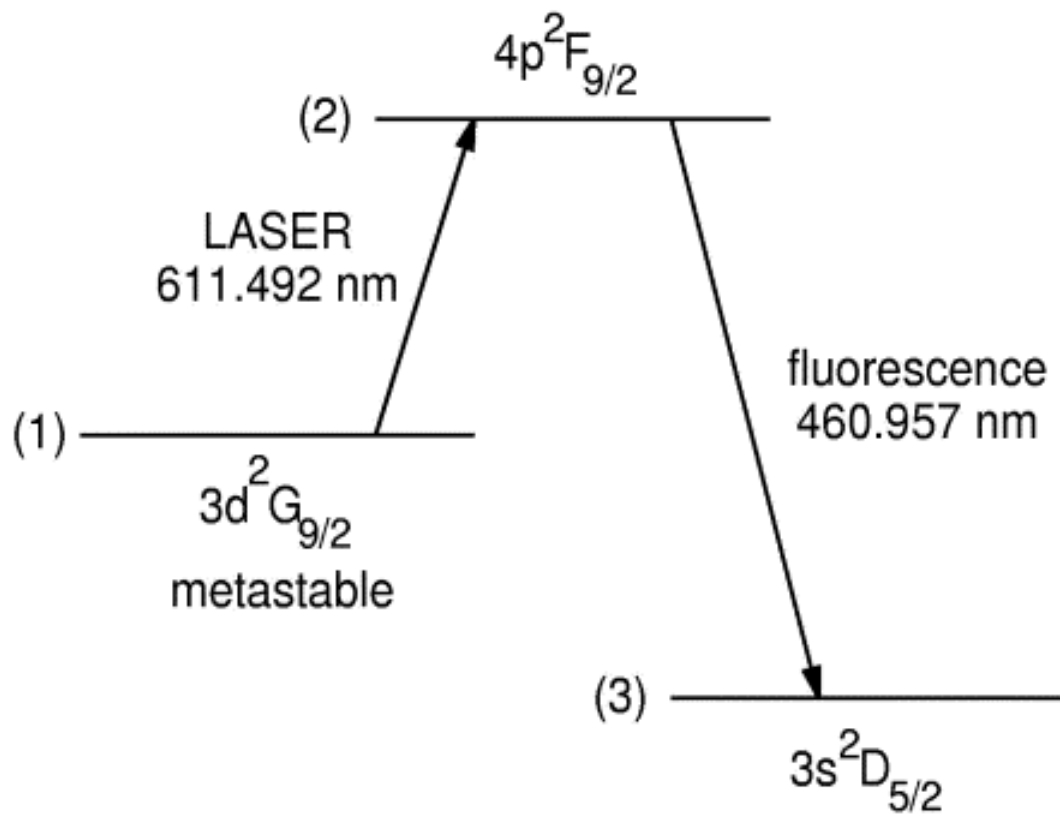
Three examples of phase-space diagnostics

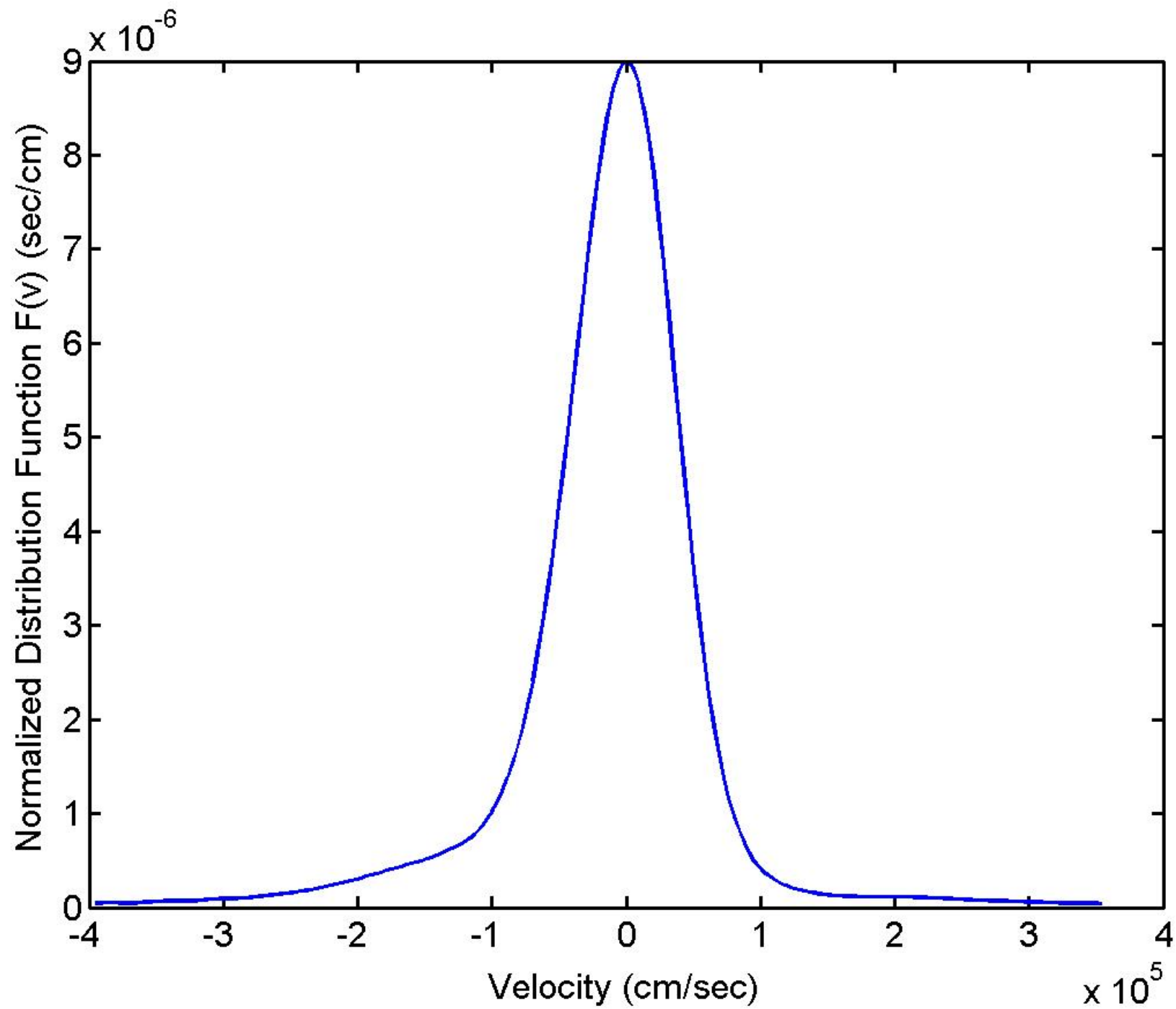
- External harmonic excitation of plasma ion waves.
- Observation of ion phase-space fluctuations.
- Using whistler wave absorption to measure the electron velocity distribution function.

EXPERIMENTAL ARRANGEMENT

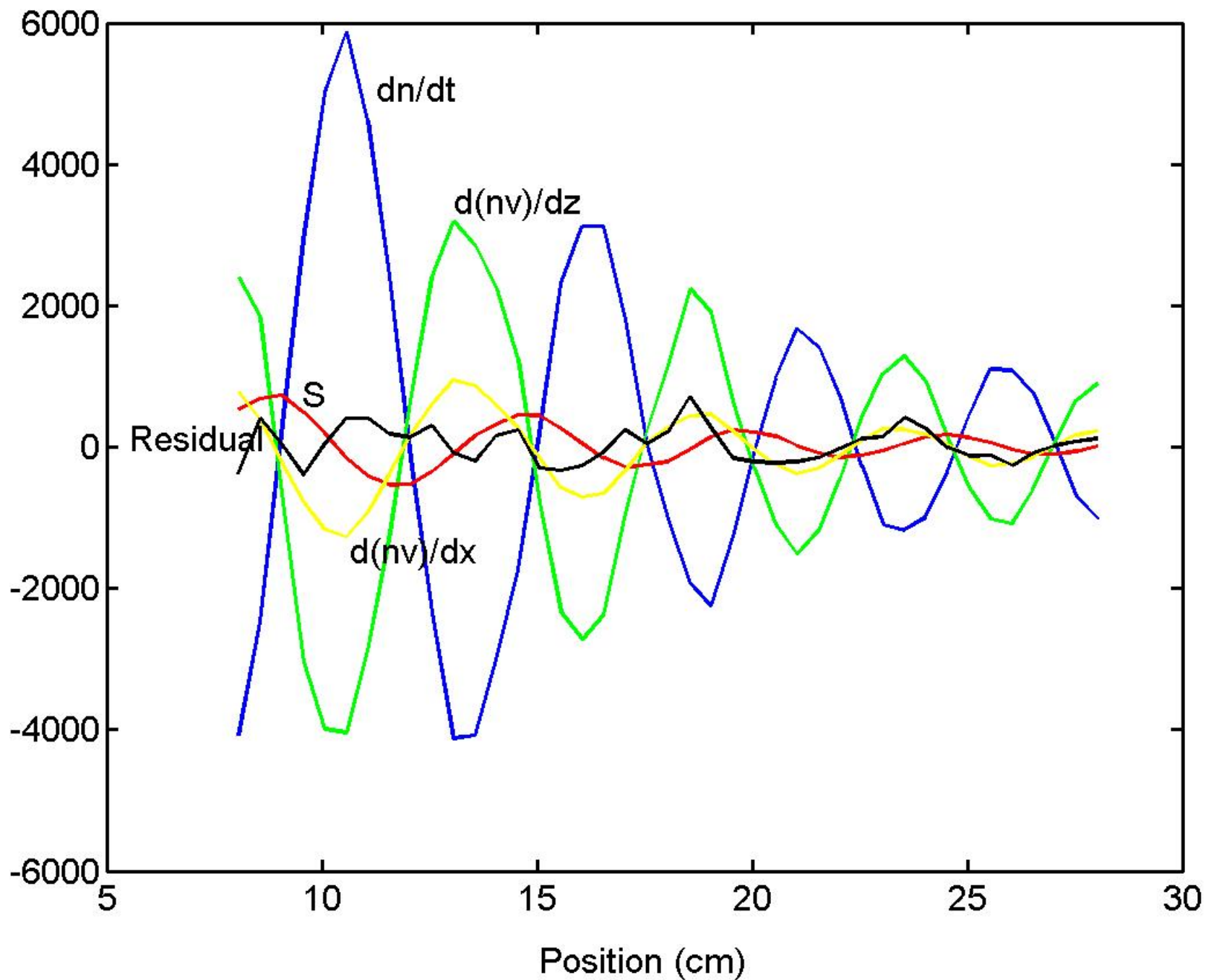


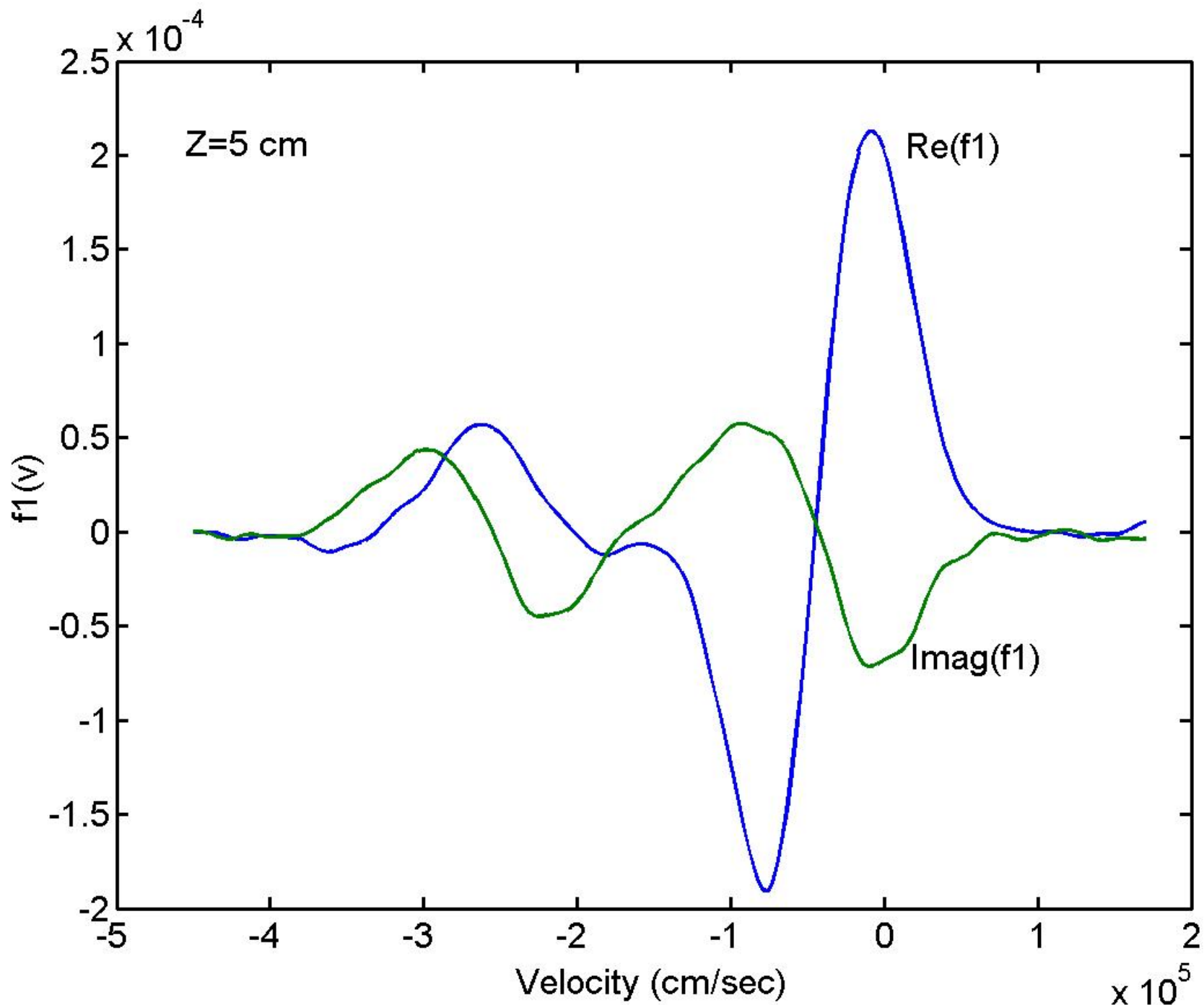


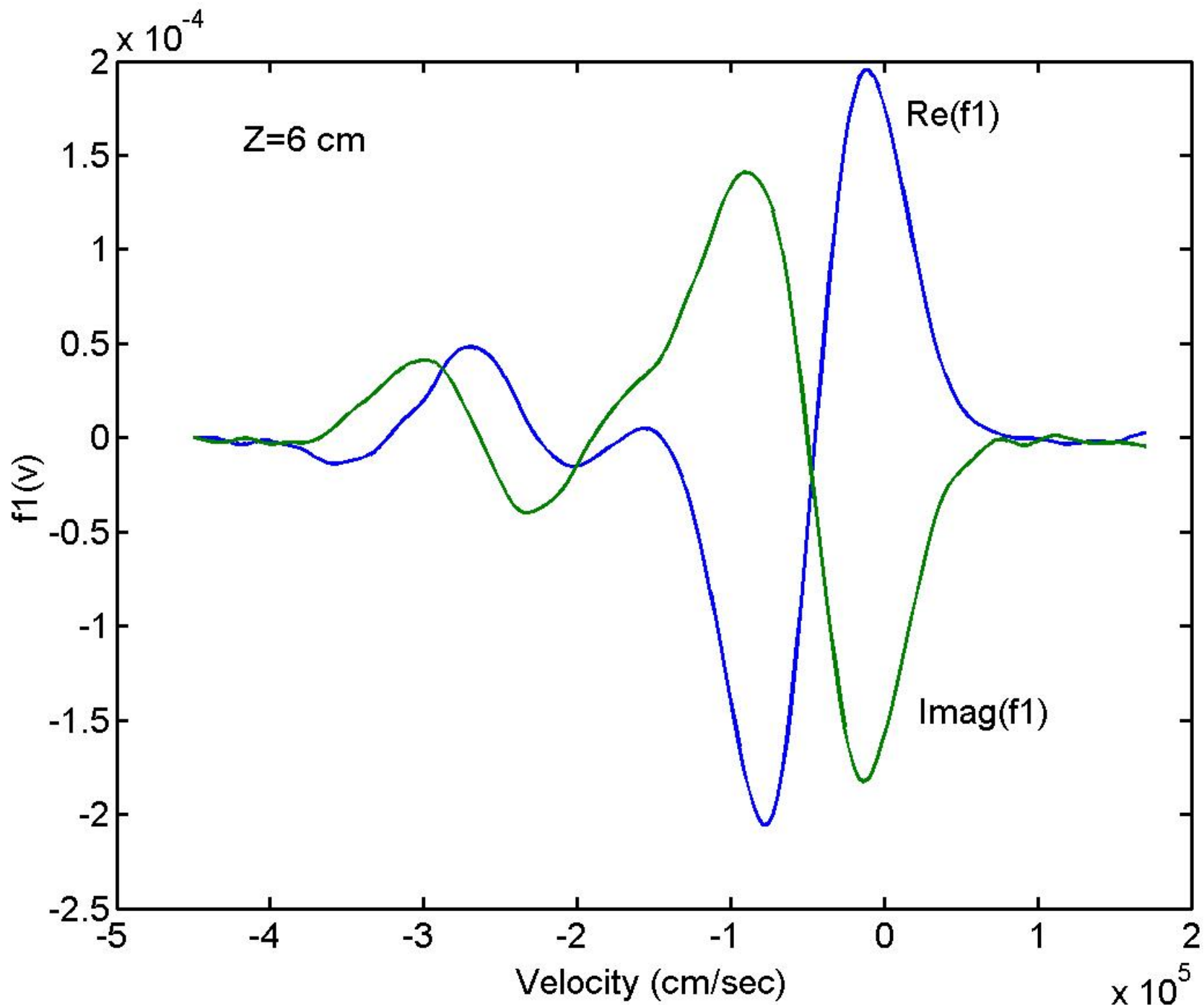




Terms of the Continuity Equation (sec^{-1})



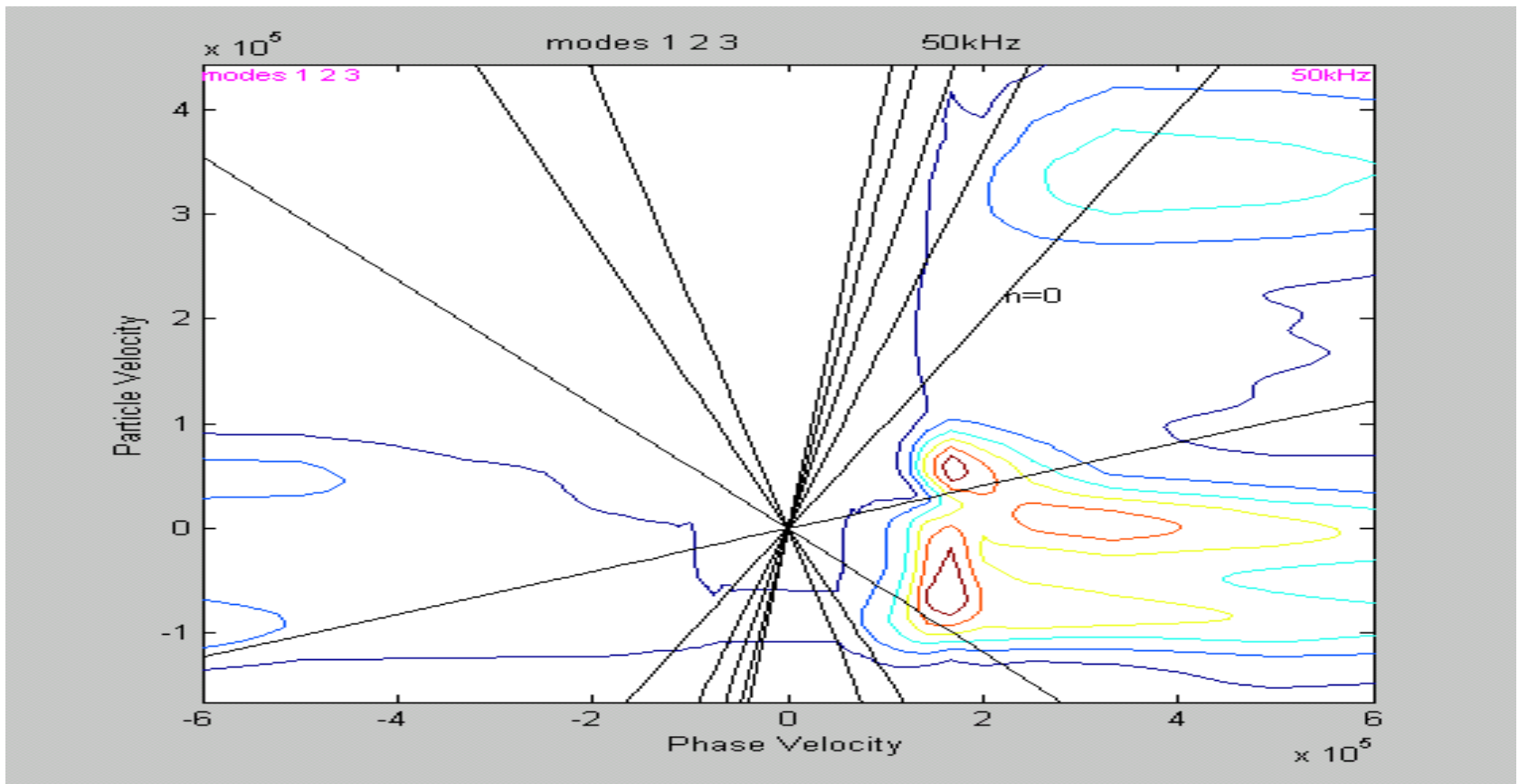


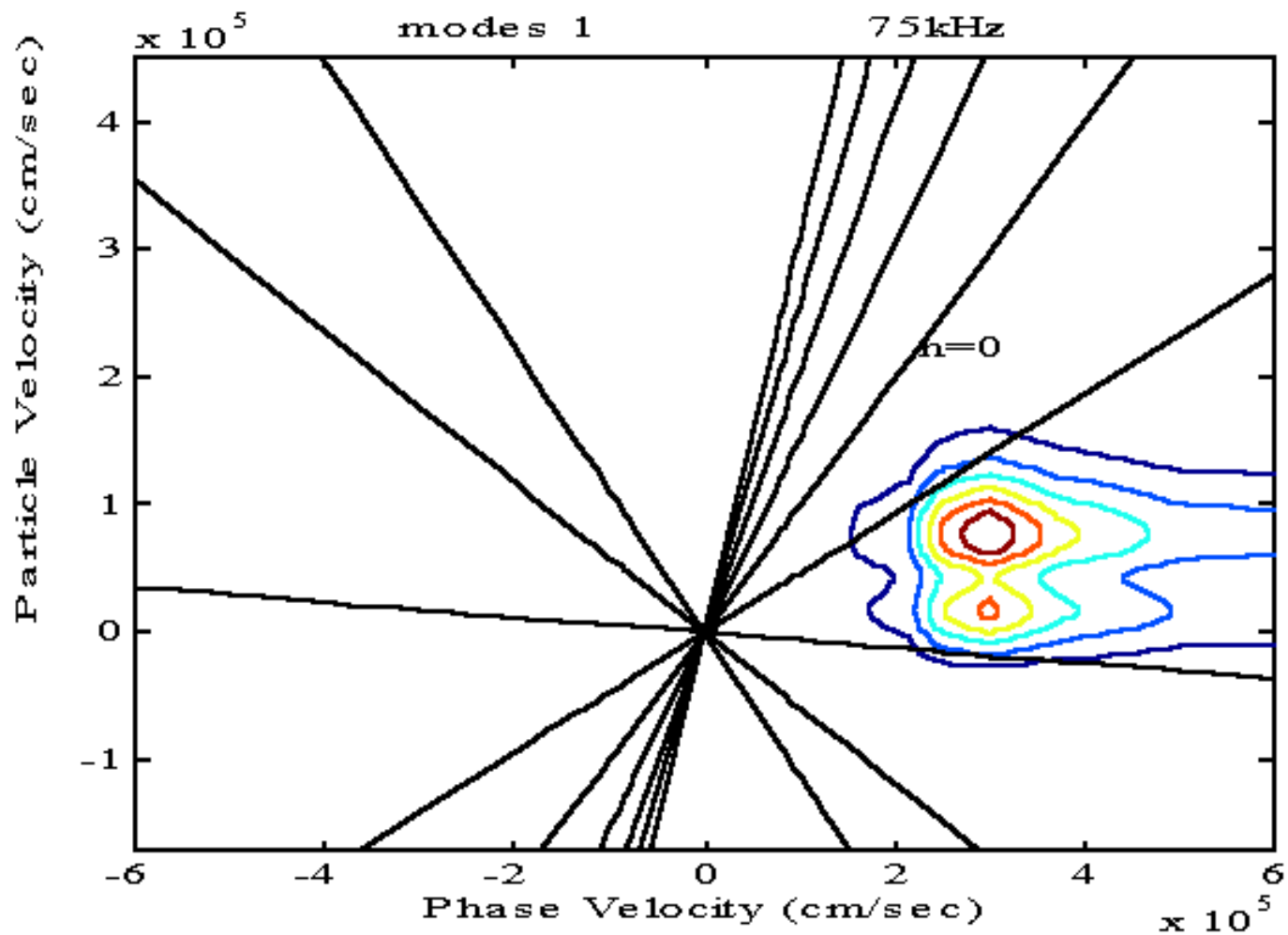


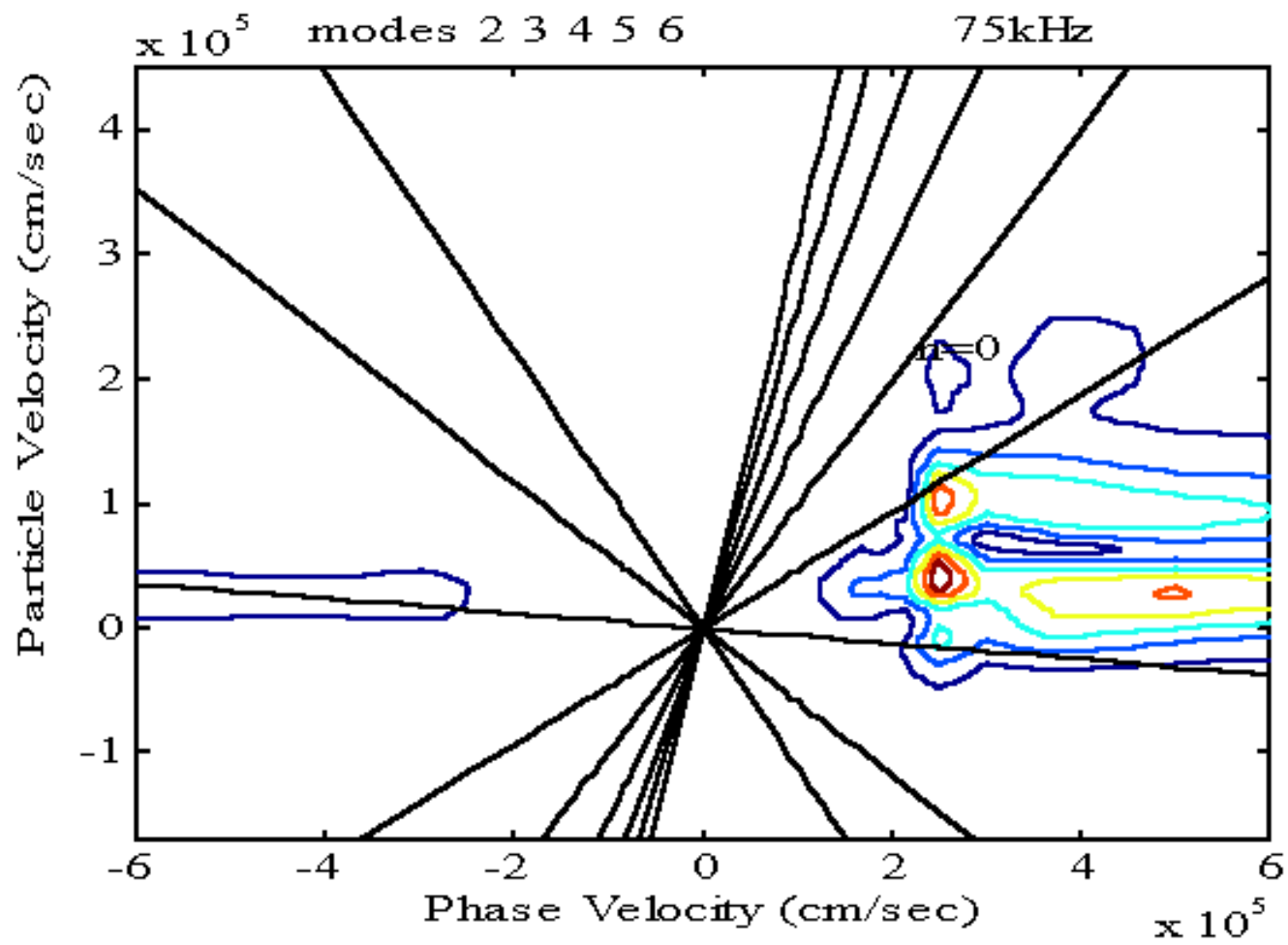
Magnitude contours of $F(\omega/k, v; \omega)$

Plotting data in the particle velocity –phase velocity plane reveals both mode structure and the nature of interactions at the wave-particle resonances. Resonances define straight lines in the plot according to:

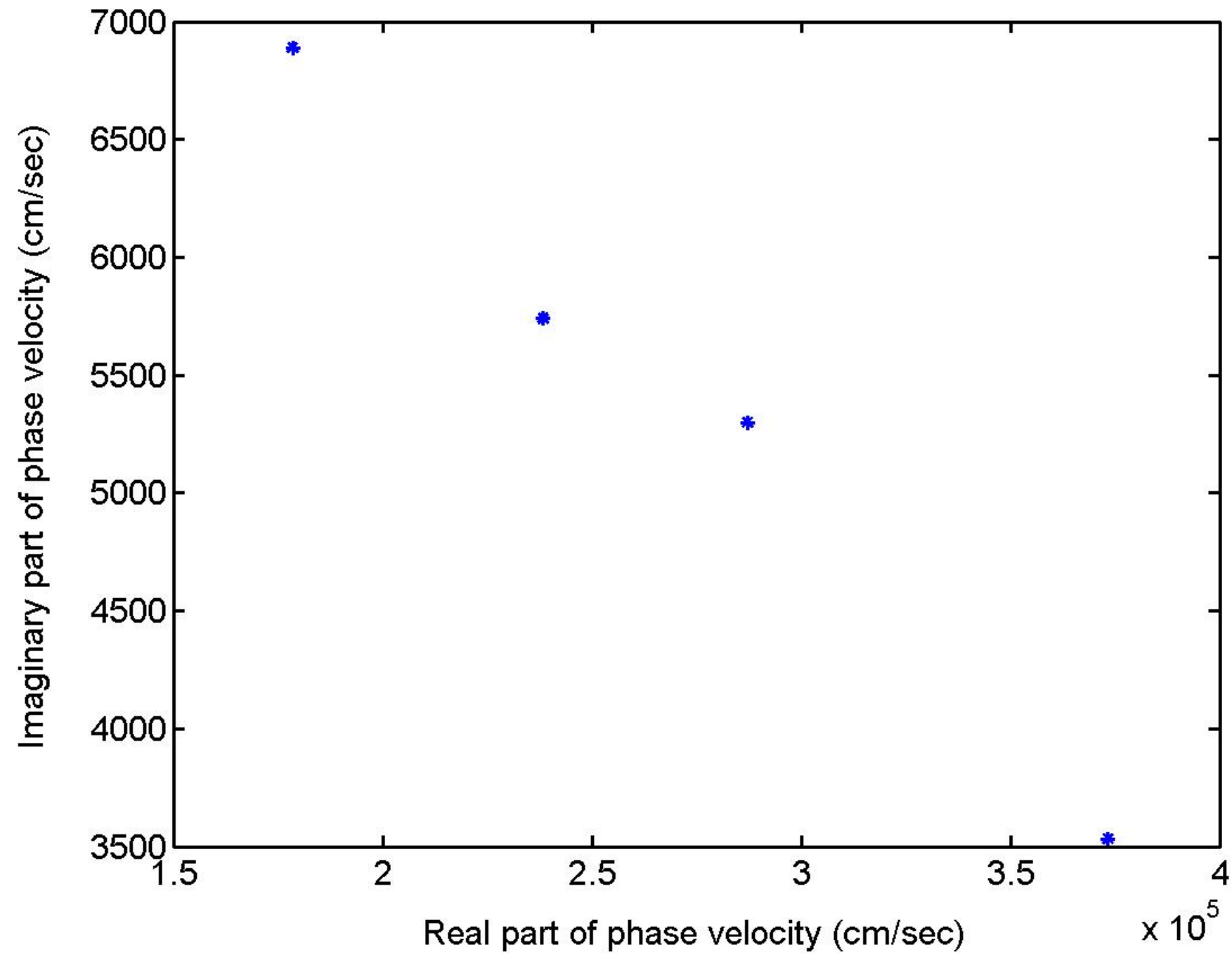
$$v_{\parallel} = \frac{\omega}{k_{\parallel}} \left(1 - n \frac{\Omega_c}{\omega} \right)$$

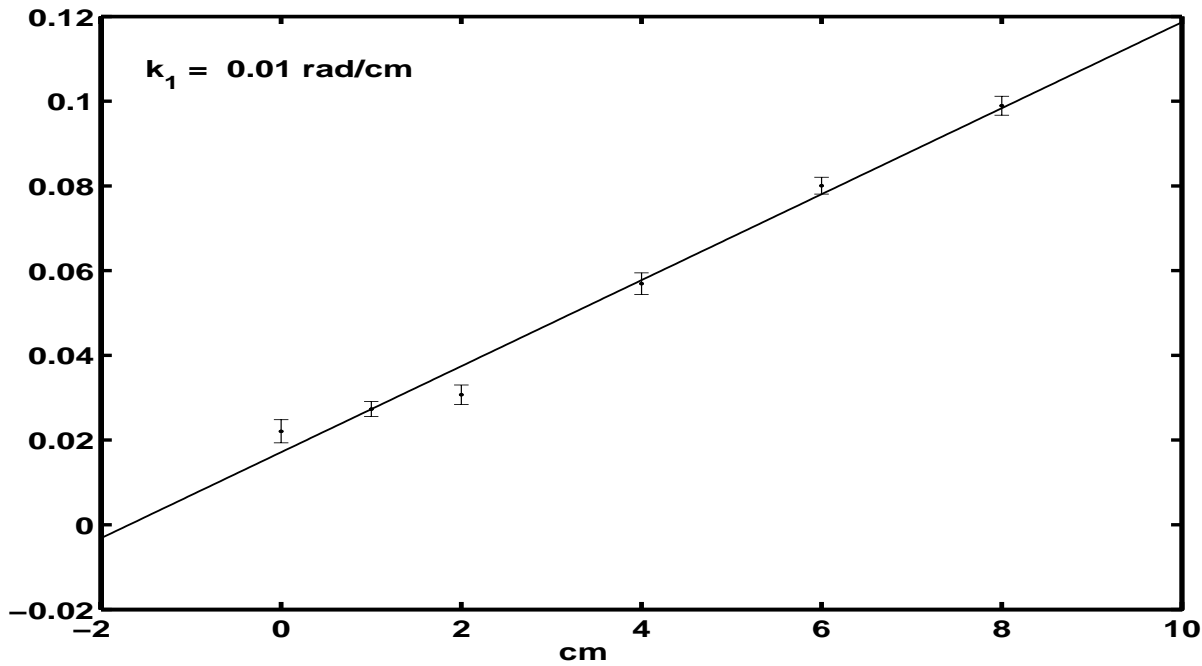






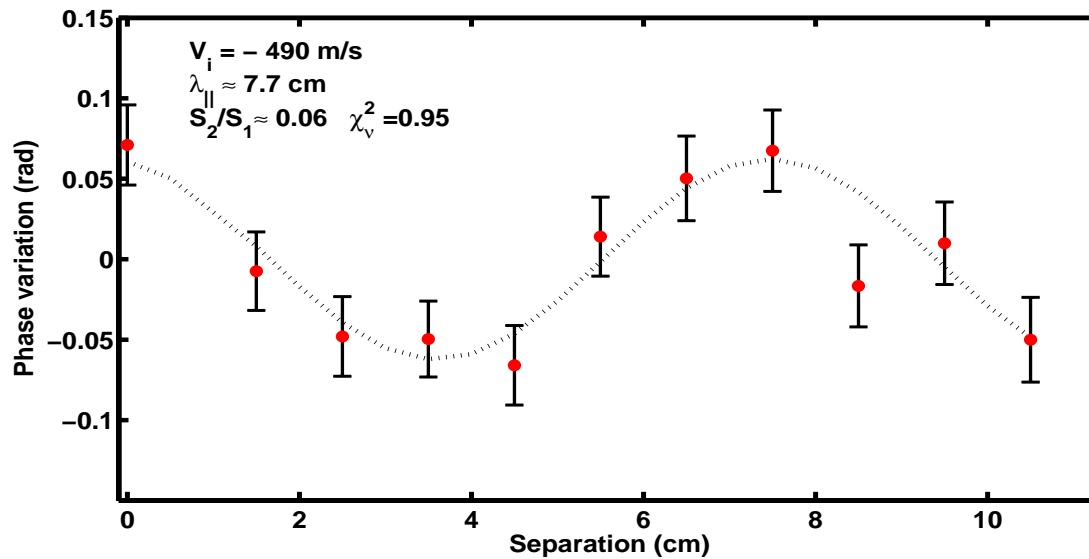
Poles in the response function



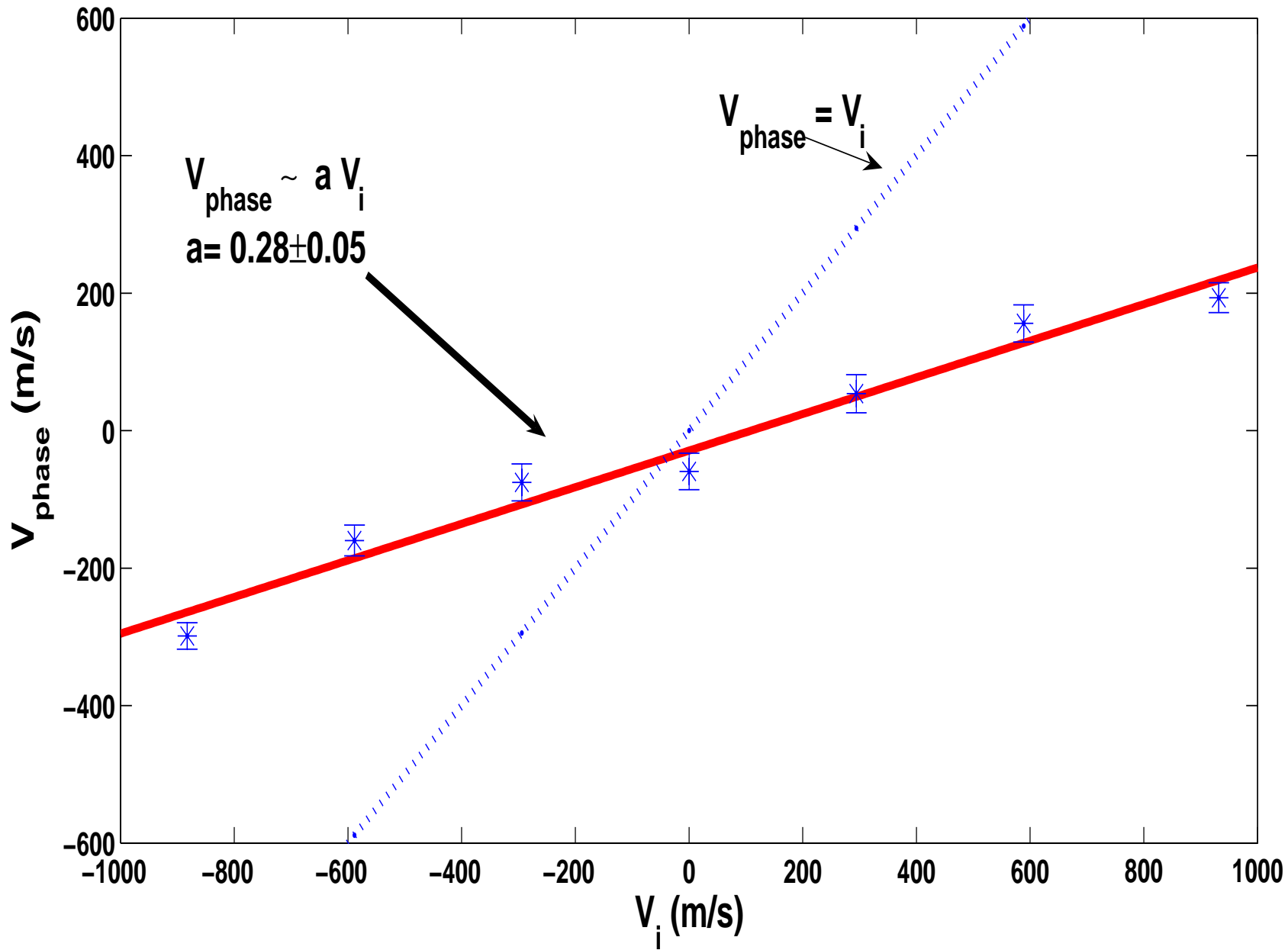


➤ “Fluid” component
 $k_d = 0.01 \pm 0.001 \text{ rad.cm}^{-1}$

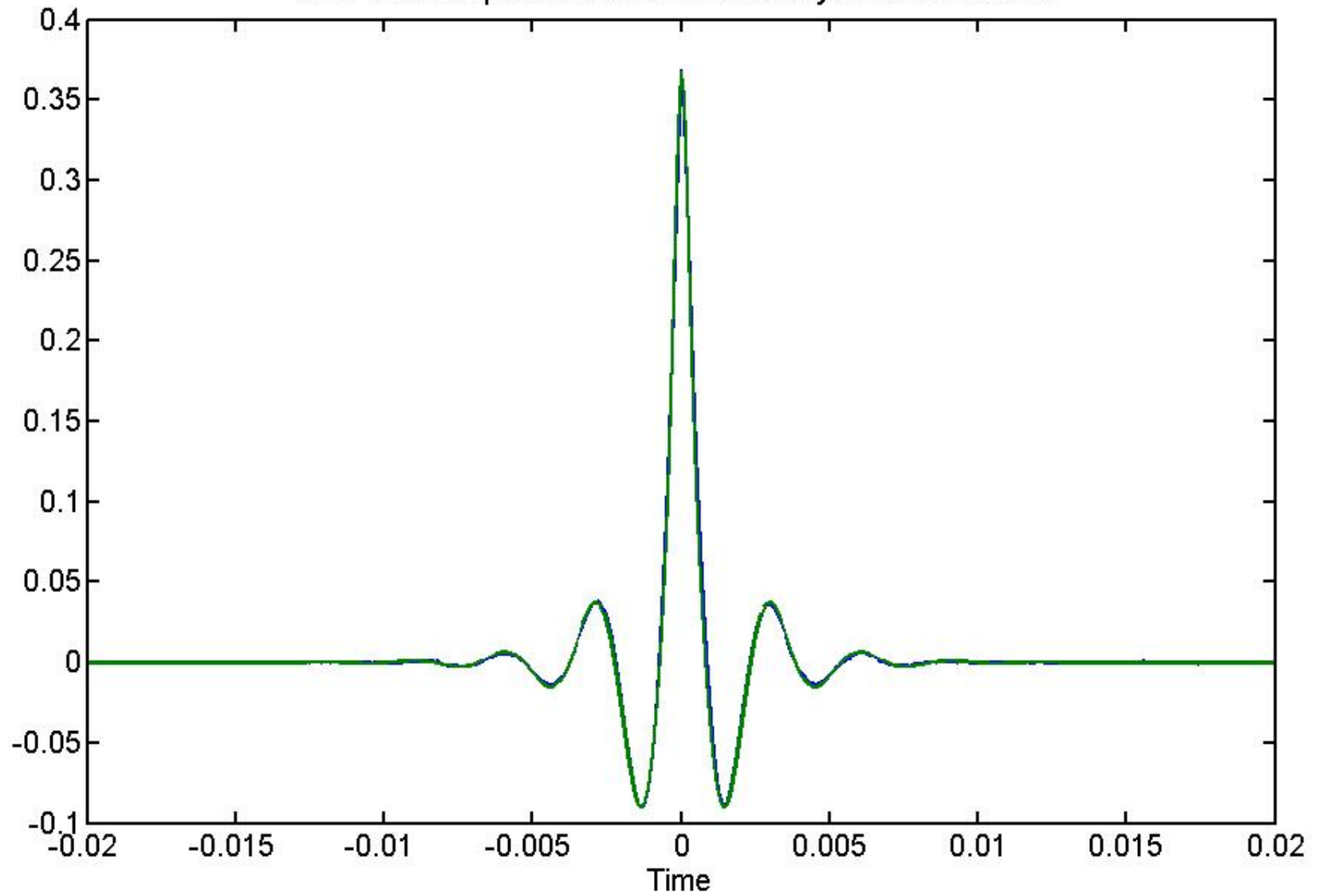
➤ Residual phase shift for
 490 m/s



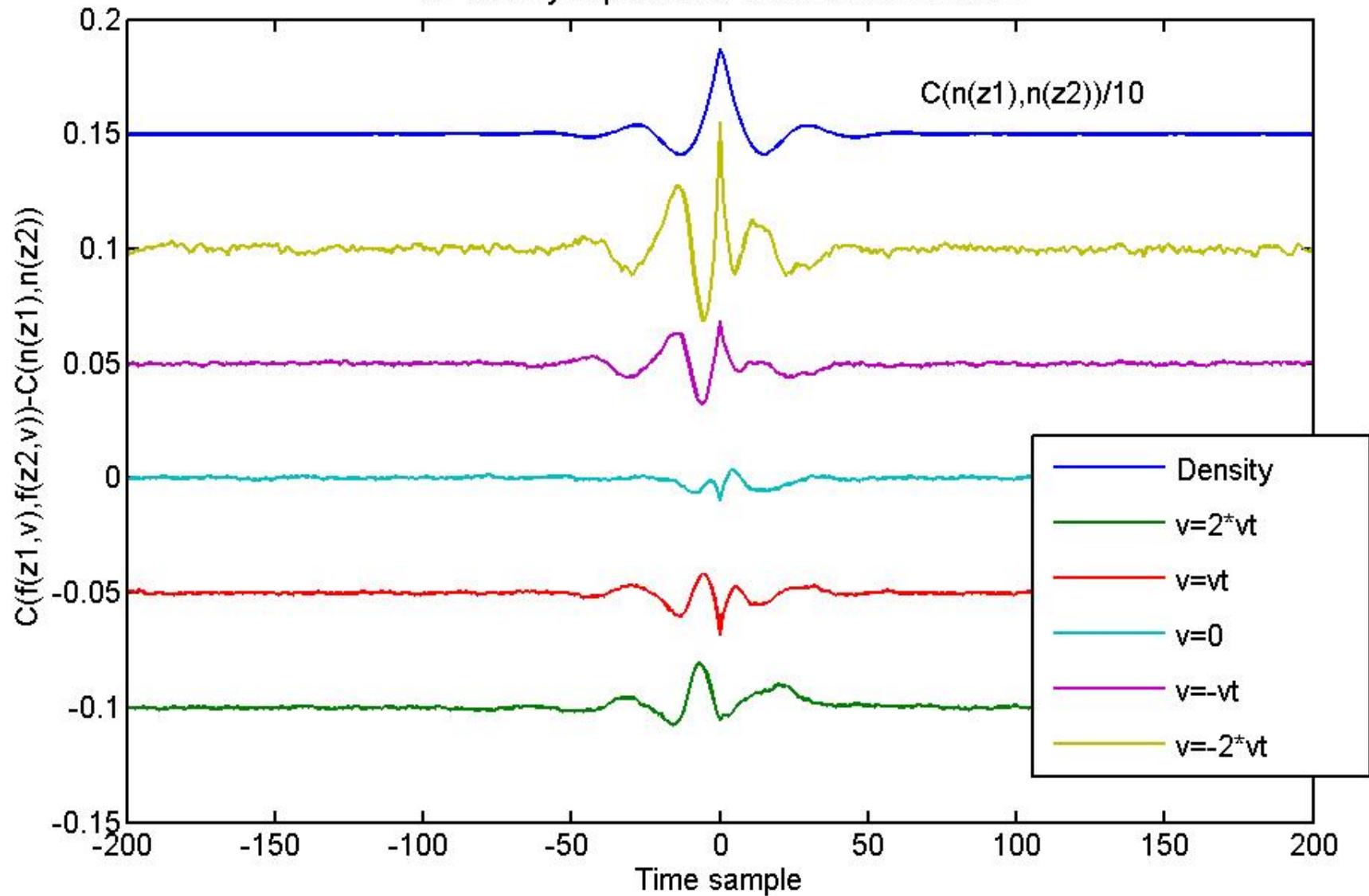
See DPP 05
 Invited paper by
 A. Diallo

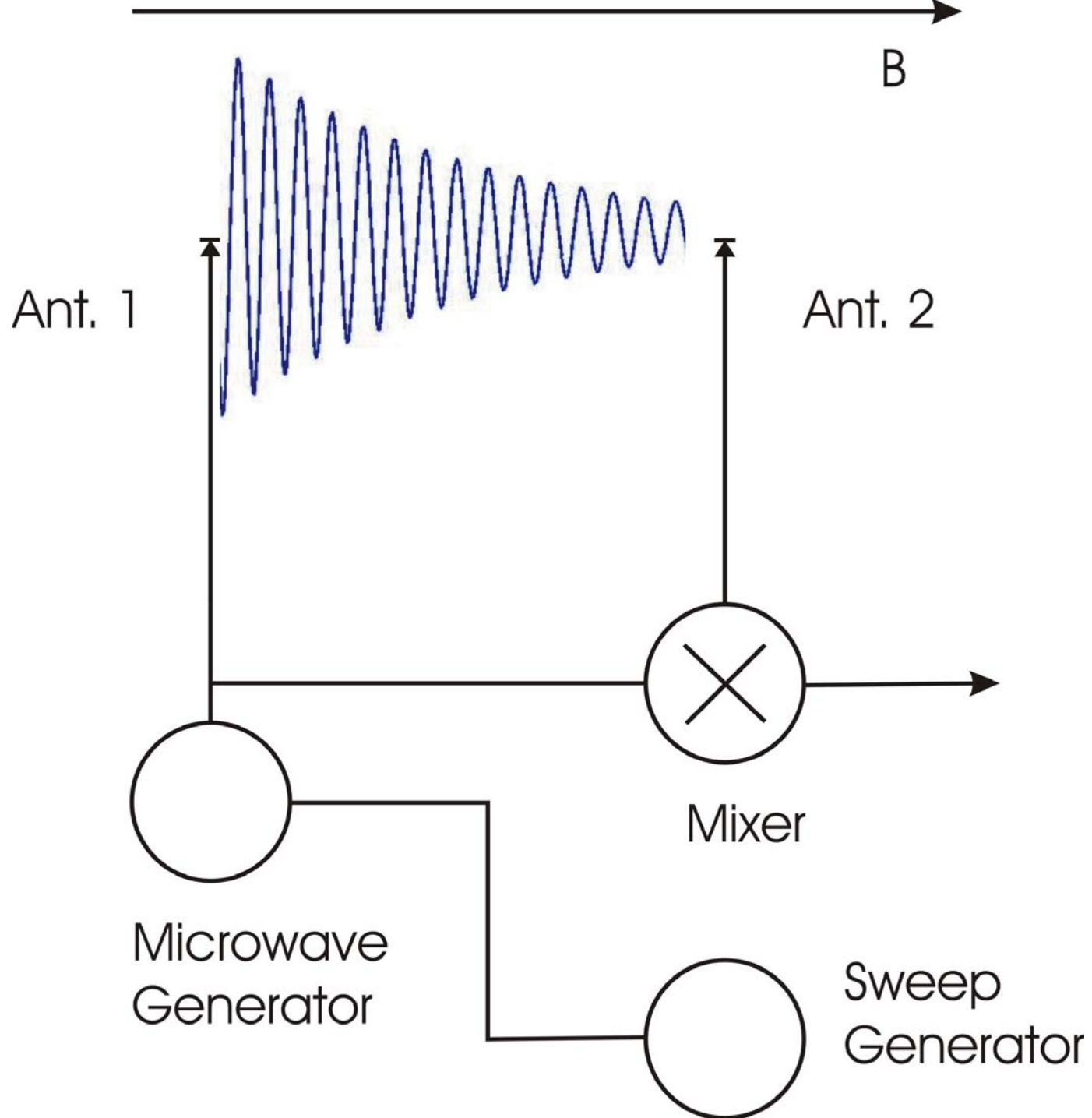


Drift-wave response function and density cross-correlation

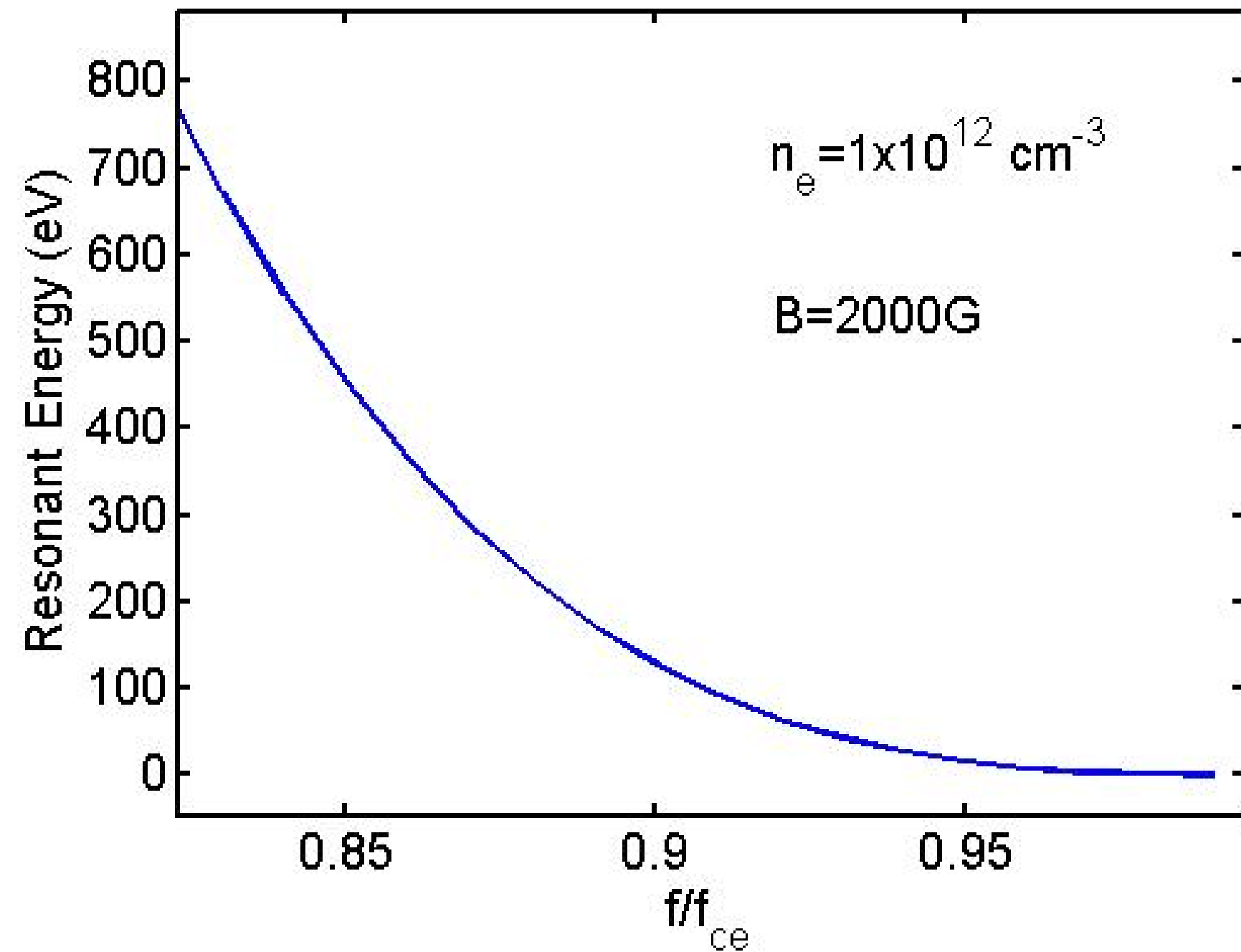


Ion velocity dependence of correlation function

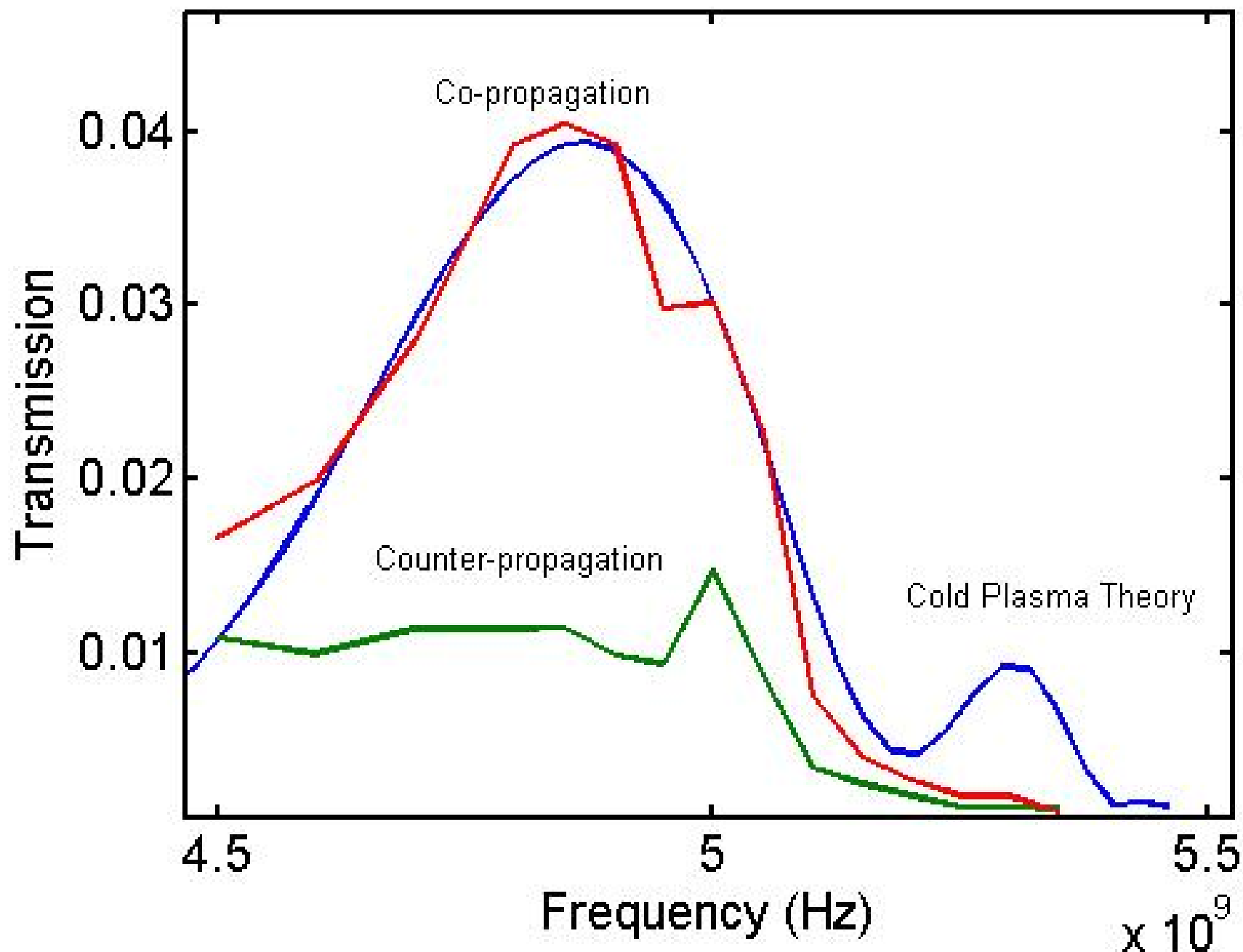




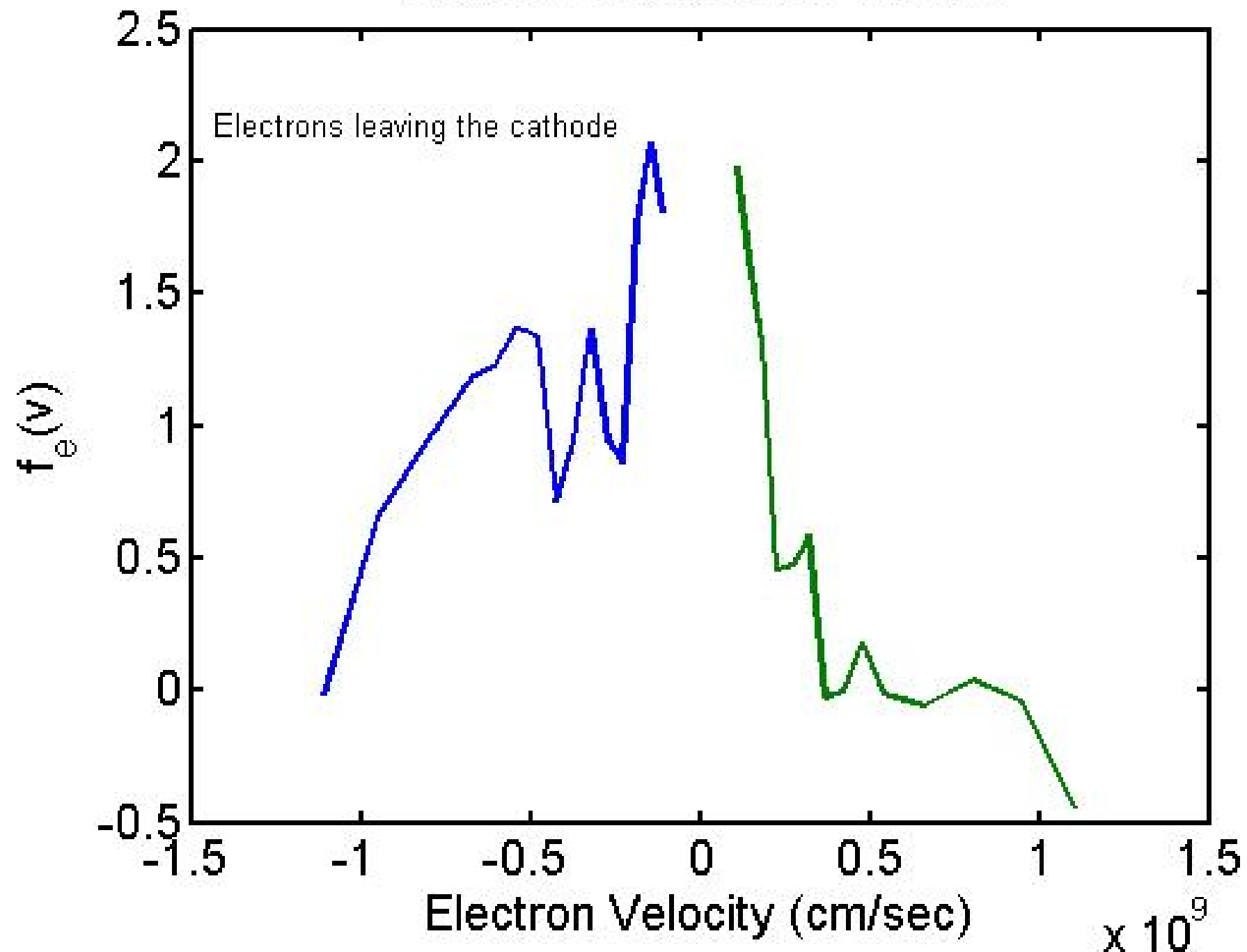
Whistler Mode Wave-Particle Interaction



Transmission vs frequency and $\text{sign}(k_z)$



Electron Distribution Function



Conclusions

- Phase-space resolving diagnostics can be performed in several ways.
- There exist kinetic degrees of freedom that are difficult to observe after velocity averaging.
- In addition to LIF for ions, wave absorption on electrons can provide a velocity resolving diagnostic.