Visible Imaging of Internal MHD, the Fast Ion Profile and Injected Neutrals in the DIII-D Tokamak*

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Through recent breakthroughs in the use of fast framing camera technology, visible imaging has been used to provide the 2D spatial structure and temporal evolution of MHD instabilities [1,2] the fast ion profile [3], and the profile of high-energy injected neutrals in DIII-D plasmas. Time evolved measurements of the detailed (256×256 sightlines) 2D poloidal structure of rotating tearing modes are obtained using spectrally filtered fast imaging of broadband visible bremsstrahlung emission (N_B). The method described here is capable of imaging with high resolution the structure of coherent oscillations in the core of current and next-step fusion plasma experiments and can be applied to virtually any mode with a finite perturbed N_B and frequency in the laboratory frame. Measurements of the fast ion profile are obtained through imaging of Doppler shifted fast ion D_α light (FIDA) emitted by neutralized energetic ions. Both the 2D spatial structure and temporal evolution of the FIDA emission in MHD quiescent plasmas are in excellent agreement with Monte Carlo simulations assuming classical energetic ion slowing down. Measurements during strong bursting energetic particle mode activity have also been made and will be addressed. Similarly, the profile of injected neutrals used for heating has been imaged in Doppler shifted D_α light induced by collisional excitation. Wide-angle imaging of the injected beam provides measurements of the full 2D spatial structure, something fundamental to calculations of heating, current drive and momentum input as well as the interpretation of many diagnostics, yet never previously measured in detail.

Through the combined set of these imaging techniques, it will become possible to observe, in 2D, not only the growth, saturation, and structure of instabilities, but also their subsequent impact on the fast ion profile.

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