ELM Control by the SMBI Induced Pedestal Small Scale Turbulence

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Large edge instabilities as type-I ELMs can cause significant erosion at the divertor target in tokamaks. How to reduce the transient peak divertor heat load due to by type-I ELMs is a critical issue in tokamaks. Mitigation of ELMs has been demonstrated in the EAST Tokamak in quasi-steady state with multi-pulses of supersonic molecular beam injection (SMBI). These experiments have revealed the underlying physics mechanism for ELM mitigation, demonstrating how the SMBI induced pedestal small scale turbulence controls ELMs.

The turbulence in the pedestal is measured by a Doppler reflectometry in X-mode. The small scale high frequency turbulence (f >300 kHz) is measured by the backscattering, with the turbulence poloidal wavenumber of $k_\theta \sim 7.3cm^{-1}$, while the large scale low frequency turbulence (f <300 kHz) is measured by the forward scattering, with the turbulence poloidal wavenumber varying from 0 to 0.8 cm^{-1}.

We find that the particle fluxes caused by ELMs are strongly correlated with large scale turbulence and anti-correlated with small scale turbulence. The large scale turbulence is directly generated by ELMs. The transition from large to small ELMs appears to be due to an enhancement of the particle transport in the pedestal and possibly due to the extension of the Peeling Ballooning instability limit [1] as well, with both being caused by small scale turbulence induced by SMBI or mitigated ELMs themselves. ELMs can be completely suppressed when the small scale turbulence becomes sufficiently strong. The influence time of SMBI for ELM mitigation is governed by this turbulence.

[1] P.W. Xi, X.Q. Xu, P.H. Diamond, Phys. Rev. Lett. **112**, 085001 (2014)