

# Measurement Capabilities and Results of Beam Emission Spectroscopy Diagnostics on the System of Turbulence, Flows and Profiles.

S. Zoletnik

KFKI RMKI, P.O.Box 49, H-1525 Budapest, Hungary

During the past decade a general agreement has been reached within the fusion community that turbulence in fusion plasmas represents an important element of transport processes. Simulations show that turbulence at fixed profile parameters develops into a nonlinearly interacting system of flows and unstable drift waves. This loop determines anomalous transport processes which act on profiles. The resulting profile changes affect the stability of drift waves and therefore a second regulating loop appears. This complex double-feedback structure is suspected to be the background of self-regulating profiles and state transitions in fusion plasmas.

Beam Emission Spectroscopy (BES) is a diagnostic tool originally developed for the measurement of the electron density profile in fusion plasmas. Starting from the basic scheme different additional measurement capabilities have been developed in the past years which go well beyond density measurement and cover several aspects of the above wave-flow-profile system. Fluctuations are measured by optimizing light collection and detection of the beam light and flows can be measured via following the movement of eddies in the plasma. With these capabilities BES can measure both fluctuation amplitude, correlation time, flows and profiles therefore it is one of the few techniques capable of giving insight into the above complex system. This contribution describes the BES diagnostics developed and planned during the past years in Europe for the study of turbulence and show some results obtained so far.

On MAST a trial system is installed measuring density turbulence by BES on the heating beam. Although this system can discern only edge turbulence, it validated the light level calculations and provided a solid basis for a final 2D measurement to be installed in 2009.

On TEXTOR an optimized optical and detection system of the Li-beam diagnostic can resolve turbulence down to the 0.1% level, which has already been demonstrated by resolving core plasma fluctuations. In this diagnostic fast (~200 kHz) poloidal scanning of the beam gives the possibility of flow measurements.

On ASDEX Upgrade and JET 4-channel systems are being installed on the Li-beam diagnostic which will provide data on edge turbulence. JET has especially good observation properties as poloidally displaced measurement channels give the chance for poloidal flow velocity measurement without beam scanning.

On the reinstallation of COMPASS in Prague an additional feature is foreseen for the BES system. Given the relatively small size of the device the ions stemming from beam ionization can be collected for medium mass beam species. This gives the possibility to combine BES and the Heavy Ion Beam Probe (HIBP) concepts into an Atomic Beam Probe diagnostics which could resolve edge current modulations as well.

Additionally to the turbulence measurement capabilities these diagnostic can also give insight into MHD and fast transient transport phenomena, exemplified by ELM measurements.