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FIRST OBSERVATIONS OF THE TRANSITION TO H-MODE ON THE GLOBUS-M2 TOKAMAK USING DOPPLER BACKSCATTERING

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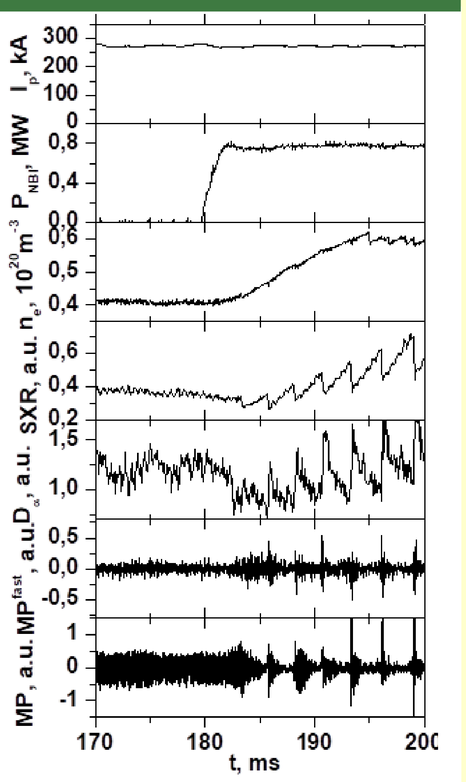
ABSTRACT

- The first results of the study of the transition to H-mode on the new Globus-M2 tokamak were obtained with the parameters of the discharge as follows: B_t = 0.75 T, I_p = 300 kA, $< n_e >$ = (3-6)$\cdot 10^{19}$ m^{-3}.
- A four frequency Doppler backscattering system was implemented to measure the plasma rotation velocity and the turbulence amplitude.
- An increase in plasma rotation velocity shear near the periphery along with a sharp decrease of the peripheral turbulence amplitude can be observed after the transition.
- It was discovered that the plasma rotation velocity and the backscattered power are linked to the appearance of ELMs.
- Bursts of quasi coherent fluctuations have been discovered in the DBS signals during inter-ELM periods. These bursts have been interpreted as filaments.

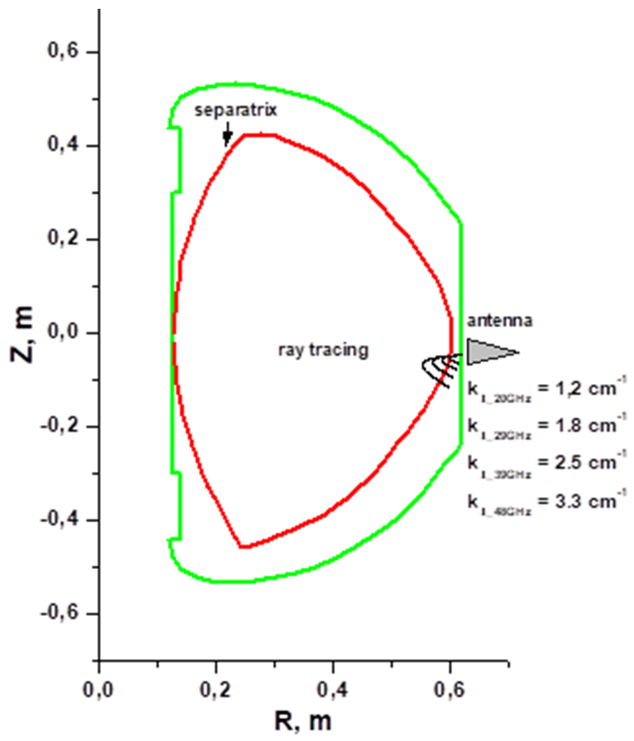
H-MODE ON THE GLOBUS-M2 TOKAMAK

- The LH transition was initiated by deuterium beam injection with particle energy 28 keV and heating power 0.8 MW.
- The transition was characterized by the electron density n_e increase and by the Dα emission drop .
- The appearance of edge localized modes (ELMs) triggered by sawtooth oscillations was observed.
- After transition to H-mode, an increase in the plasma density was observed followed by the rise of the total stored energy.
- The energy confinement time in H-mode reaches 7 ms and the H-factor increases from 0.5 to 1.2-1.4.



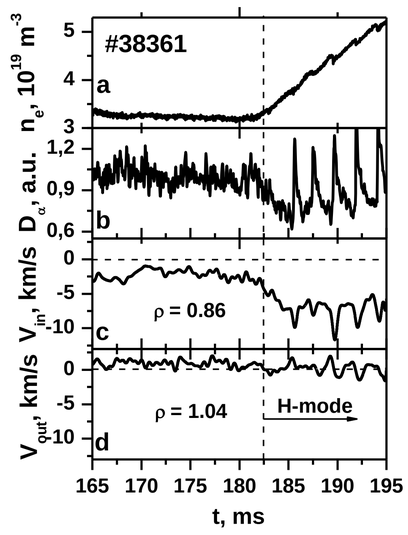
DBS DIAGNOSTICS ON THE GLOBUS-M2 TOKAMAK

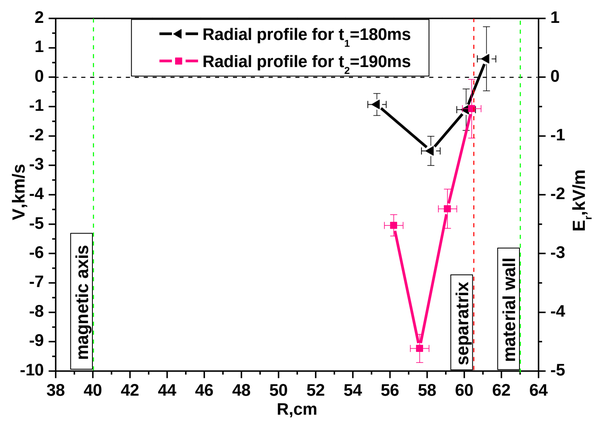
- Doppler backscattering (DBS) is a diagnostics method based on the backscattering of microwave radiation at oblique incidence in the case of existence of a cut-off layer for the probing beam.
- It is possible to calculate the fluctuation velocity component $V_\perp$ in the direction of the diamagnetic or the E×B drift in the radial electric field using the measurements of the Doppler frequency shift of backscattered radiation by the formula $\Delta\omega_D = k \bullet V = k_\perp V_\perp$.



- Two DBS systems were installed on the Globus-M2 tokamak where dual-frequency probing was used in each system with two chosen pairs of fixed frequencies – 20, 29 GHz and 39, 48 GHz.
- The cut-off area for each DBS channel is calculated with a 3D ray-tracing code which uses experimental electron density profiles obtained by the Thomson diagnostics and magnetic surface reconstruction data obtained with the EFIT code.

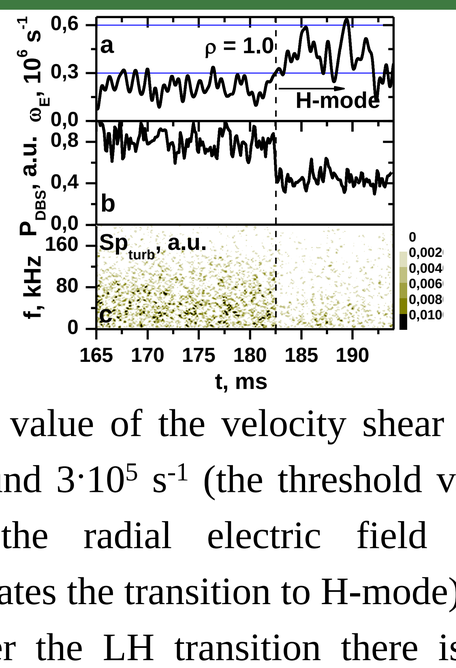
RESULTS OF VELOCITY MEASUREMENTS

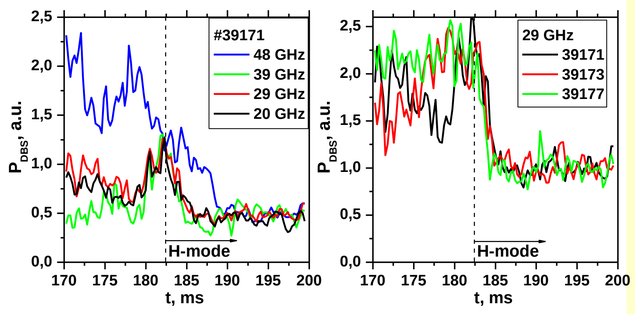




- The velocity increases from 3 km/s in L-mode to 9 km/s after transition to H-mode

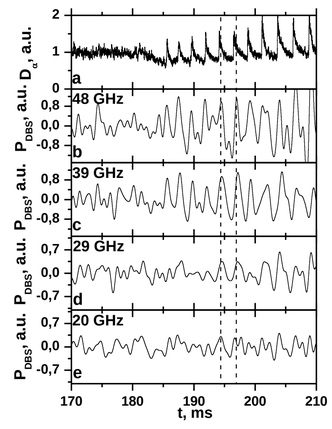
VELOCITY SHEAR AND TURBULENCE MEASUREMENTS

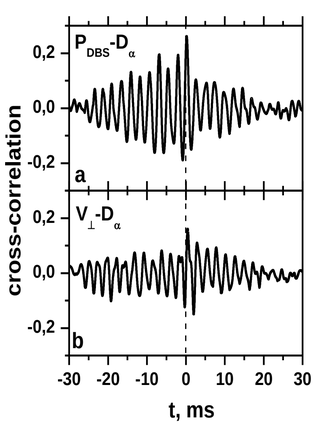


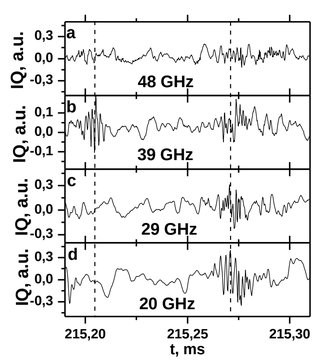


- The value of the velocity shear was around $3 \cdot 10^5$ s^{-1} (the threshold value of the radial electric field that initiates the transition to H-mode)
- After the LH transition there is an increase in velocity shear along with a decrease in fluctuation amplitude
- A decrease in fluctuations during the LH transition most prominent for the 39, 29, 20 GHz frequencies
- A drop in the turbulence level during the LH transition is observed for all discharges at the 29 GHz frequency

EDGE LOCALIZED MODES







- The plasma rotation velocity and the backscattered power are linked to the appearance of ELMs
- Bursts of quasi coherent fluctuations during inter-ELM periods believed to be filaments

CONCLUSIONS

- **A four-frequency Doppler reflectometer was installed in the new spherical tokamak Globus-M2. The study of small-scale plasma fluctuations demonstrates the peripheral nature of turbulence suppression during LH transition.**
- **The velocity of the plasma rises significantly from 3 km/s in L-mode to 9 km/s in H-mode. The measured value of the velocity shear before the transition was close $3 \cdot 10^5$ s^{-1}, which is closed to the threshold value, observed in other tokamaks of different sizes and configurations.**
- **It was discovered that the plasma rotation velocity and the backscattered power are linked to the appearance of ELMs. Bursts of quasi coherent fluctuations have been discovered in the DBS signals during inter-ELM periods. These bursts have been interpreted as filaments.**