Radial profiles of turbulence level in Texas Helimak

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ABSTRACT

- A study on the characteristics of the electrostatic turbulence in the magnetically confined plasma of the Texas Helimak device;
- A previously suggested relation between the radial profile of plasma density, the confinement turbulence level and the magnetic field responsible for the confinement is verified through the analysis of several experimental data sets;
- An analysis of the estimated Probability Density Functions for the ionic saturation current holds evidence of a coexistence of turbulence regimes previously observed under different experimental conditions for the same machine.

BACKGROUND

- Work published in a Masters Dissertation based on revision of previous papers regarding the subject of plasma density radial profiles in the Texas Helimak as well as use of computational analysis techniques over so far unused experimental data sets;
- Analysed data of ion saturation current (proportional to plasma density) was collected via Langmuir probes inserted in the machine's chamber;

METHODS

FOR RADIAL DENSITY PROFILES

To obtain coherent radial profiles for plasma density from the otherwise noisy measured data, the mean value of ion saturation current was calculated for various small, non-overlapping data windows over the time series of a single discharge, so that a median over all the windows would show the more significant variations of the current while considerably smoothing the stathistic fluctuations (see Fig.1).

FOR TURBULENCE LEVEL

The level of turbulence was estimated as the ratio between the standard deviation and the mean of the plasma density, both calculated as medians of small time windows, providing the relative dispersion of the density around its average with lessened noise effect (see Fig.2).

FOR THE DENSITY PDF'S

Were estimated over the histograms of normalized ion saturation current for different radial positions of each discharge (see Fig.3).

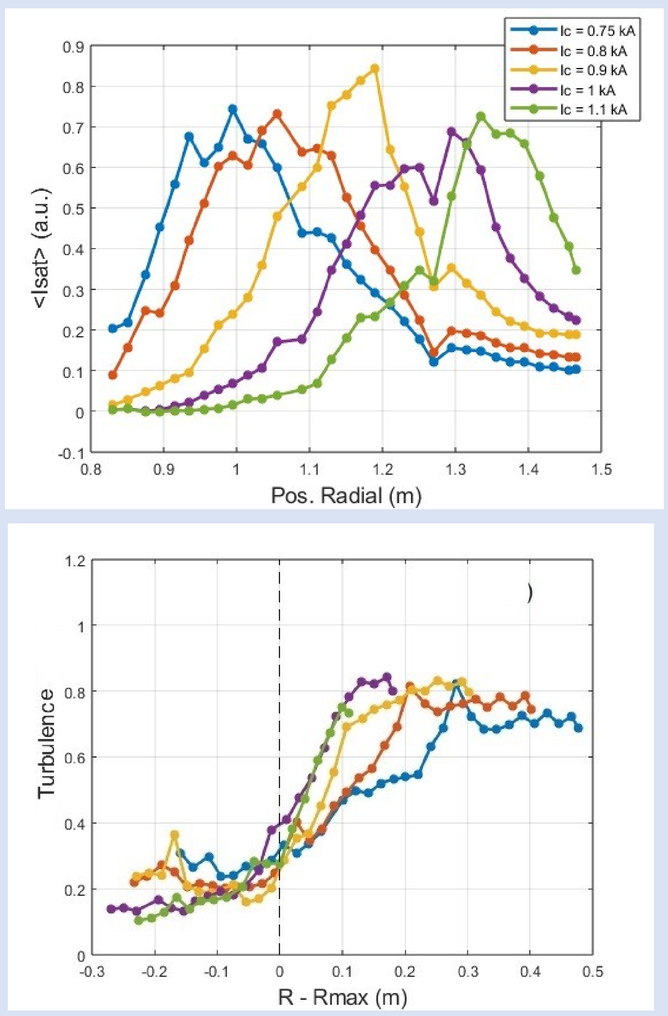


Figure 1 (top): Radial ion saturation current profiles for various discharges
Figure 2 (bottom): Radial turbulence level profiles for various discharges

OUTCOME

REGARDING RADIAL PROFILES

The proposed analysis techniques were successfully applied over several discharges needing few adaptations and providing radial profiles for both plasma density and turbulence levels highlighting the confined plasma behavior while lessening the fluctuation distortions.

REGARDING DENSITY PDF'S

As the technique of PDF estimation was applied for a larger variety of radial positions and data sets, some discharges presented PDFs with bimodal tendencies, as oppose to the either gaussian or long-tail exponential behaviors expected which represent respectively burstless and burst-dominated turbulence regimes.

Figure 3 : Estimated PDFs for high-field and low-field sides

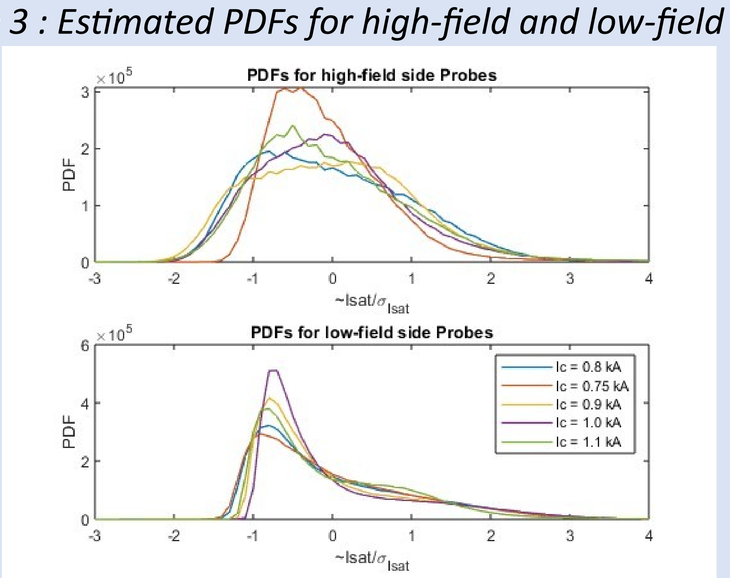
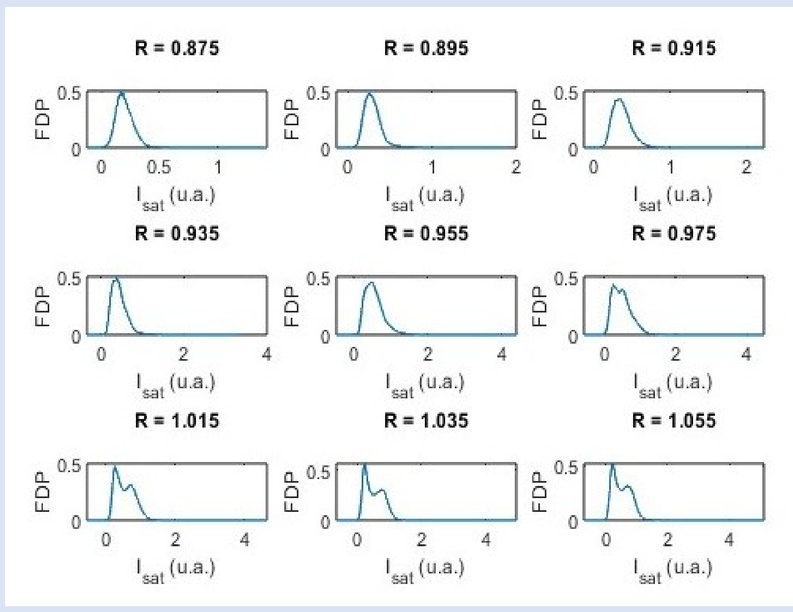


Figure 4: Estimated PDFs for various radial positions showing bimodal tendencies



CONCLUSION

- All of the analysed data sets verify that shifting the electric current responsible for the confinement magnetic field of the plasma in the Texas Helimak also shifts the plasma density and the turbulence level radial profiles;
- All of the discharges show significant increase of the confinement turbulence levels in the low-field side;
- The presence of bimodal plasma density PDFs suggests an intermittent coexistence between burst-dominated and burstless turbulence regimes, previously seen in other Texas Helimak discharges under different experimental settings. Its causes and effects are yet to be investigated.

ACKNOWLEDGEMENTS / REFERENCES

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- SILVA, G.M.E "Perfis radiais do nível de turbulência no Texas Helimak / Radial profiles of turbulence level in Texas Helimak". São Paulo, 2024.