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**See Annex of J. Pamela et al., "Overview of Recent JET Results and Future Perspectives", Fusion Energy 2000 (Proc. 18th Int. Conf. Sorrento, 2000), IAEA, Vienna (2001).*

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INTRODUCTION

For the study of ELM physics, localised measurements of the edge pressure and edge current density profile are essential. So far, at JET a direct comparison of measurements of these parameters with theory on peeling and ballooning limits has not been possibledue to lack of spatial resolution of edge diagnostics. From the spring 2002 campaign up to the spring 2003 campaign dedicated experiments have been performed on JET to improve the edge pedestal density, temperature and pressure measurements. For this purpose a Diagnostic Optimised plasma Configuration (DOC-U) has been designed. This is a configuration with a high X-point position and the last closed flux surface aligned to the edge LIDAR Thomson scattering line of sight. It is close to the optimum shape for edge gradient measurements.

It should be noted that in general different edge diagnostics are positioned at different locations on the machine and have different penetrations. To be able to compare the measurements they are mapped onto the plasma flux surfaces derived from the EFIT equilibrium code [1]. For the edge LIDAR system this mapping improves the effective spatial resolution from 12 cm along the laser line of sight to ~2cm across the flux surfaces [2]. So now it is possible to resolve the edge plasma parameters. By producing a large database of edge LIDAR data (density and plasma current scan), we aim to study the general behaviour of the JET Tokamak ELMy H-mode plasmas and use this database for comparison with other Tokamaks such as DIII-D and JT60-U. Figure 1 shows the DOC-U configuration on JET.

1. THE EDGE LIDAR THOMSON SCATTERING DIAGNOSTIC

To determine whether the edge LIDAR system actually resolves the pedestal gradient the density data, ne, along the laser line of sight is compared to a theoretical resolution limit. This limit is derived from the system response function convoluted with a step function. Figure 2 shows a typical result of such a comparison, where the gradient is clearly resolved. Edge LIDAR data Max resolved gradient Step function.

2. ANALYSIS METHODS

Because of the higher spatial resolution the plasma penetration has been reduced, which results in the edge LIDAR system not reaching the pedestal top and only edge gradient measurements can be done. This is most easily achieved by applying a linear fit to the data. However, when other diagnostics are available, such as the ece and FIR interferometer, these diagnostics can be combined with the edge LIDAR to fit a Tanh curve and expand the data base to pedestal width, Δ_{95}, and pedestal height, $n_{e,ped}$.

1) *Linear fit to the data:* This is a very straightforward approach to the data analysis, no other diagnostics are used, so it can always be used as long as there is edge LIDAR data. It can also be used when analysing the edge electron pressure, which can only be measured directly by the edge LIDAR system. This analysis does not give pedestal height and pedestal width data.

2) *Tanh fit to the data:* A modified hyperbolic Tangent (Tanh) fit, see fig. 3, has also been used (see also [3] and [4]). This analysis uses more diagnostics, the FIR interferometer for density measurements and ECE for temperature measurements.

This analysis produces pedestal height and pedestal width data, but it is subject to failure, as the ECE fails at low toroidal field. The pedestal width (Δ_{95}) is defined as the width at 95% of the height of the fitted (modified) Tanh curve.

3. PEDESTAL ANALYSIS

In these DOC-U plasmas the edge gradient is resolved by the edge LIDAR system, but it does not penetrate the plasma far enough to reach the pedestal top. To be able to say something about the density pedestal top values and its width, the average of the core and edge channels of the interferometer is taken for pedestal estimation. In fig.4 a plot is made of edge LIDAR pedestal top data and interferometer The edge LIDAR data is shown to be between the core and edge interferometer data, which justifies the use of the average of the interferometer channels.

To justify the two analysis methods used, it is necessary to compare the Tanh fit data with the linear fit data. This is done for the density data only because there is no Tanh data for temperature at low toroidal field. See fig. 5 for the results of this comparison. The linear fit Gradient measurements are lower than the Tanh fit Gradient measurements, because the linear fit calculates an average gradient. It is clear however that their results will show the same trends, although the quantitative values might be different. The pedestal top density values, obtained from the Tanh fit are used for the horizontal axis in all graphs. From now on in the graphs shown the type I and type III ELMy H-modes have different markers to distinguish between them.

3.1 DENSITY PEDESTAL MEASUREMENTS

Please note that for the JET pulses analysed, the edge LIDAR data has been averaged over the whole pulse, so without taken relative timing with respect to ELMs into account. The graphs in fig. 6 show the change in pedestal width (Δ_{95}) and gradient as the fuelling is increased. The different plasma currents produce two separate curves, however they do show the same trends with increasing pedestal height (i.e. fuelling): we see that the pedestal width increases and the gradient decreases, with increasing $n_{e,ped}$.

Normalising the density at the top of the pedestal to the Greenwald density reduces the spread in pedestal width for the different plasma currents, see fig.7. However, the spread in pedestal gradient is still clearly visible.

4.2 TEMPERATURE AND PRESSURE PEDESTAL MEASUREMENTS

For all the currents a similar temperature gradient behaviour is observed, see fig.8. For the pedestal pressure gradient there is a difference between the low current (1.2 MA) and high current (2.0 MA or more) configurations.

CONCLUSIONS OF PEDESTAL MEASUREMENTS

In these experiments it is shown that, when the Edge LIDAR system is combined with a dedicated plasma configuration (DOC-U), it is possible to routinely resolve ELMy H-mode plasma edge pedestal gradients and perform analysis on the plasma edge pedestal parameters. A large database of DOC-U plasma shots (37) has been created in order to perform analysis of density scans at different plasma currents.

The results reported in this paper show a density pedestal width increase with increasing density pedestal height. Also, a decreasing pedestal gradient for density, temperature and pressure is observed with increasing pedestal height. This density data contradicts earlier experiments done by Saibene et al'[5] and results presented by Kallenbach et al [6] on this conference. The cause behind this may be found in the differences in diagnostics used (edge LIDAR → Li-Beam), the difference in plasma configurations (DOC-U -> DOC-L) and the difference in analysis methods. A closer investigation is required and being planned. The difference in pressure gradient for different plasma currents suggests a difference in edge physics between low and high current.

ACKNOWLEDGEMENTS

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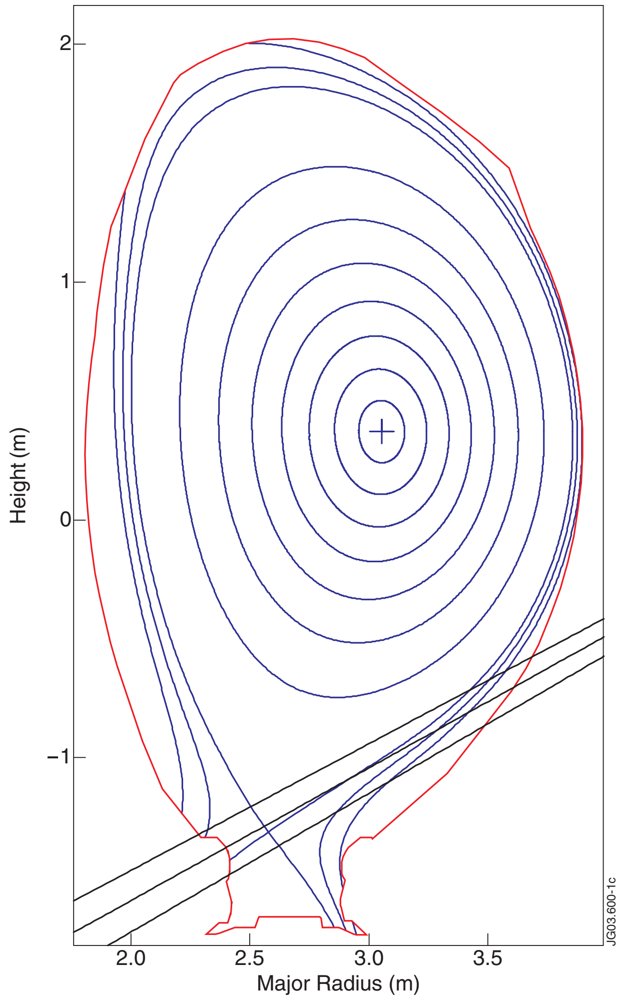

Figure 1: DOC-U configuration, with edge LIDAR lines of sight (black).

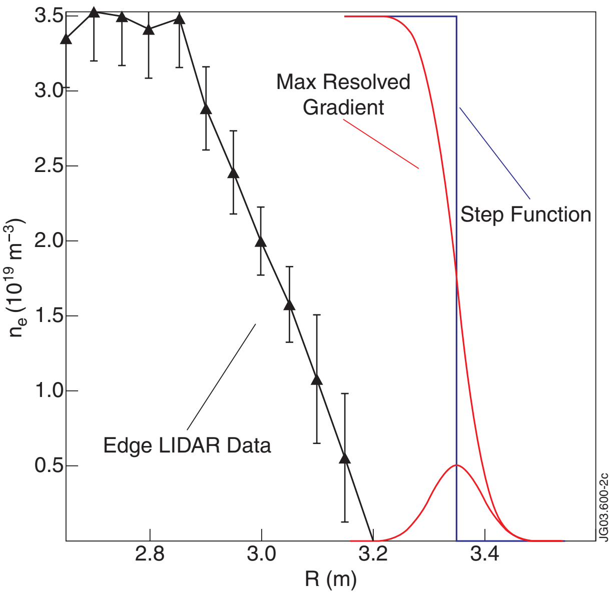

Figure 2: Theoretical system resolution versus actual data.

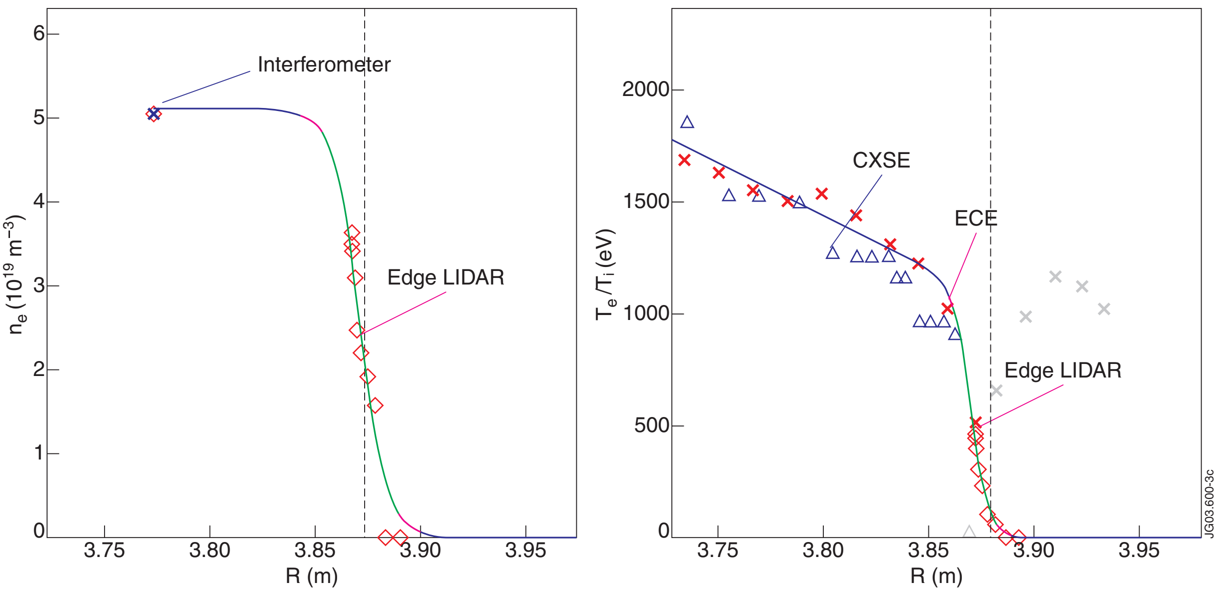

Figure 3: Tanh fit through edge LIDAR data, also using interferometer and ECE.

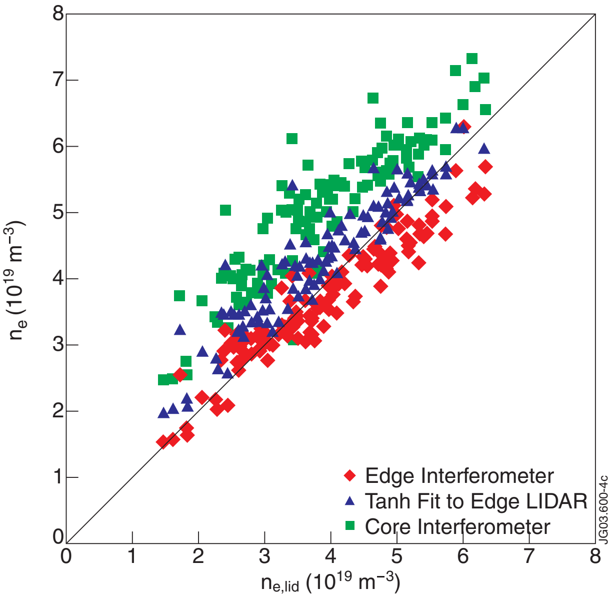

Figure 4: Edge LIDAR data compared to interferometer data, core and edge. The black line is indicates the pedestal tops directly measured by the edge LIDAR.

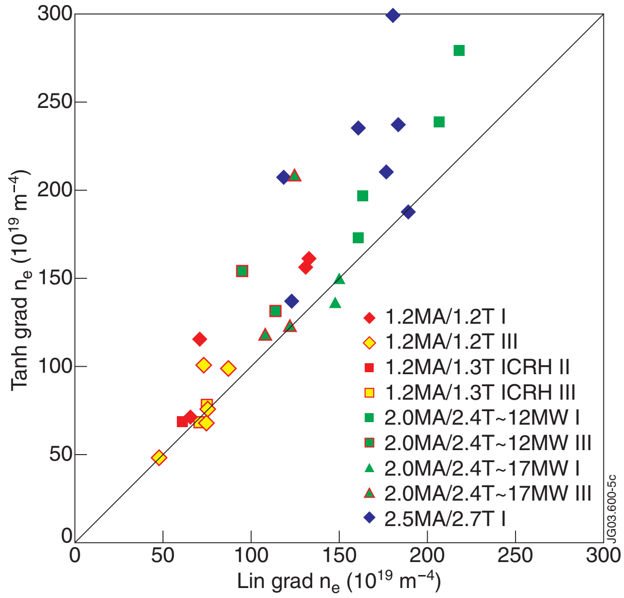

Figure 5: Comparing the Tanh fit and the linear fit.

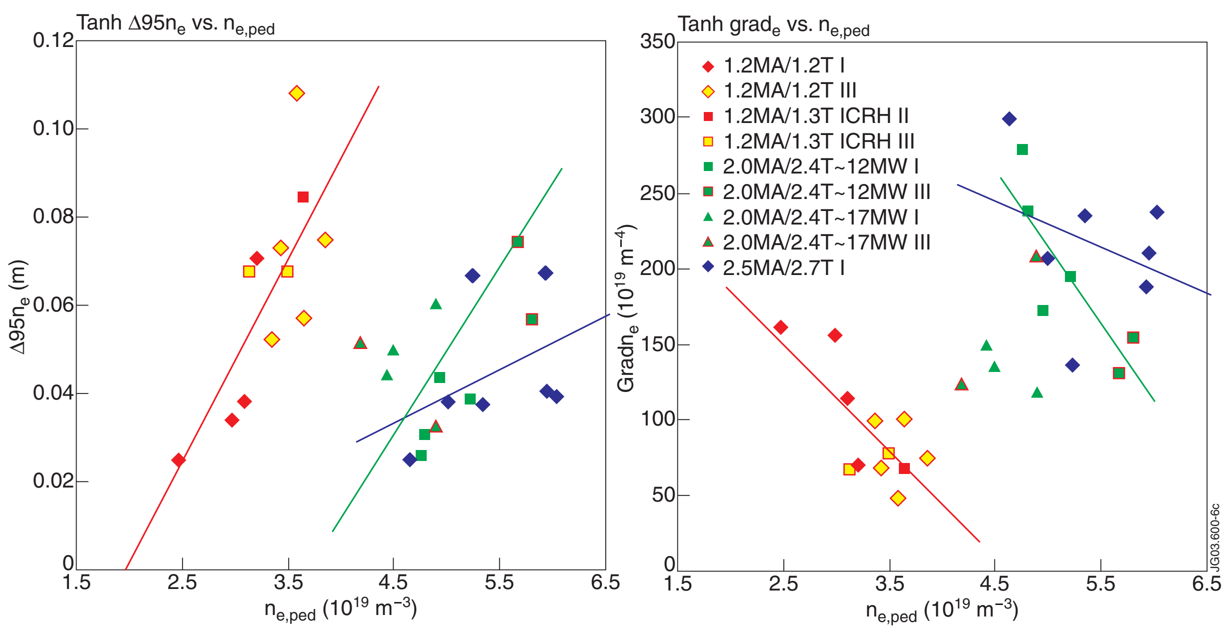

Figure 6: The results of Tanh fits to the edge LIDAR density data. Tanh gradne vs. ne,ped

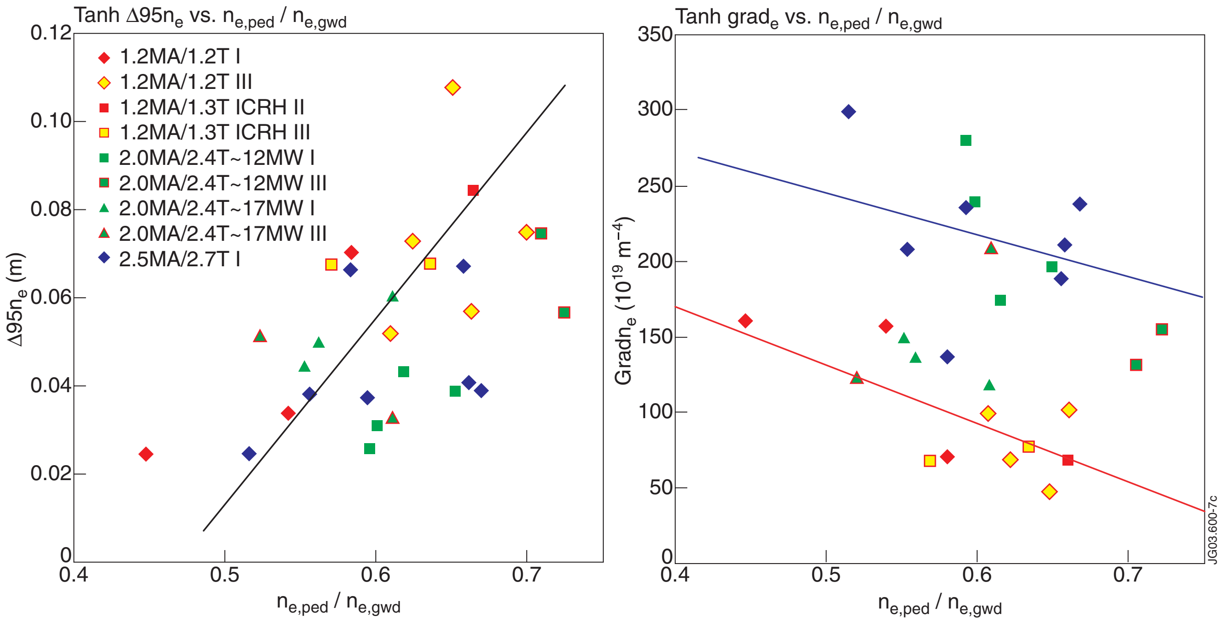

Figure 7: The same graphs as in fig. 6, but now normalised to the Greenwald density. Tanh gradne vs. ne,ped/ne,gwd

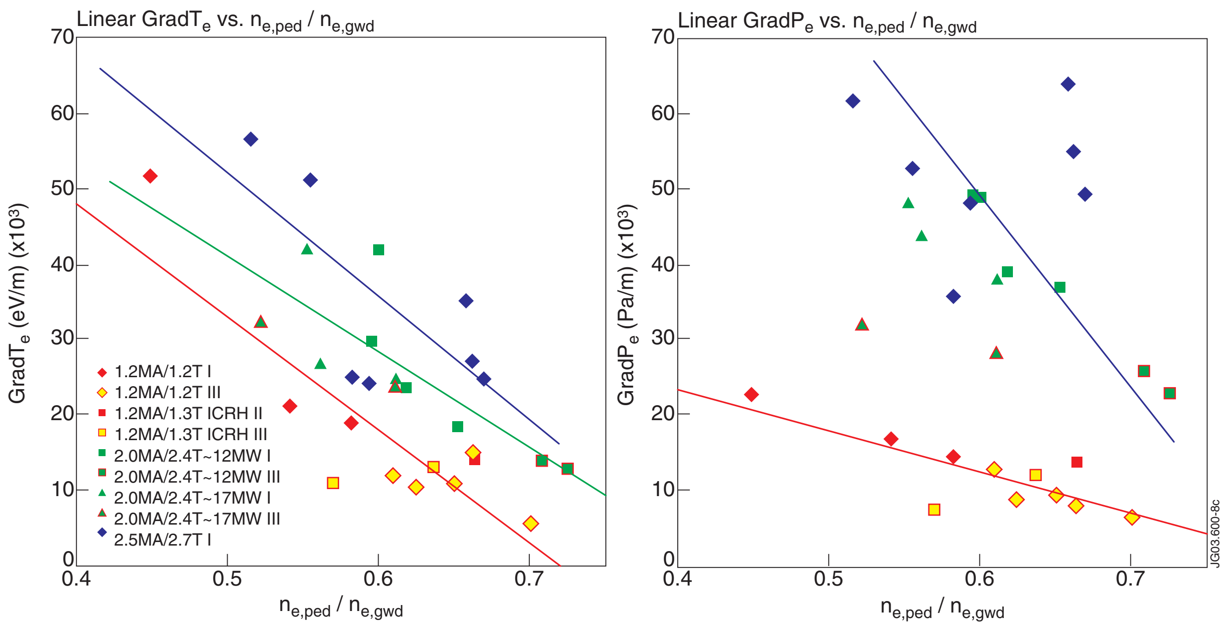

Figure 8: Temperature and pressure pedestal measurements, linear fit, normalised to the Greenwald density.