Gyrokinetic modelling of baseline H-mode JET plasmas with C Wall and ITER-like wall

D. Tegner1, P. Strand1, H. Nordman1, C. Giroud2, Hyun-Tae Kim2, G.P. Maddison2, M. Romanelli2, G. Szepesi2 and JET Contributors*

EUROfusion Consortium, JET, Culham Science Centre, Abingdon, OX14 3DB, UK
1Department of Earth and Space Sciences, Chalmers University of Technology, SE-412 96 Göteborg, Sweden.
2CEF, Culham Science Centre, Abingdon, OX14 3DB, UK.
*See the Appendix of F. Romanelli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia

Introduction

Materials of plasma facing components at JET changed from carbon to metallic — beryllium and tungsten.

So-called ITER-like wall, similar to wall envisioned at ITER.

Differences in plasma operations such as higher gas puffing rate to mitigate W accumulation in ILW discharges affect global confinement — worse for baseline H-mode ILW discharges.

Deterioration due to lower edge (pedestal) temperatures.

This also changes NBI heat deposition so changed core energy confinement also observed with smaller \( r_p, \) similar \( \tau_p. \)

Need to understand differences in core confinement.

Discharge parameters

Database of matched CW-ILW discharges created at JET.

Similar plasma current, toroidal magnetic field, applied NBI power, average electron density, safety factor, and triangle.

Input profiles taken from TRANSP\(^4,5\) runs and smoothed in time (1 s) and space.

Geometry parameters extracted from EFIT\(^6\) reconstructions.

Discharge dimensionless parameters at

<table>
<thead>
<tr>
<th>Shot</th>
<th>( \gamma )</th>
<th>( k_y )</th>
<th>( \rho_{tor} )</th>
<th>( R/L )</th>
<th>( L/L_c )</th>
<th>( \beta_{vac} )</th>
<th>( n_{e0} )</th>
<th>( \gamma_{c s/R} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>74313</td>
<td>0.56</td>
<td>1.42</td>
<td>0.097</td>
<td>5.6</td>
<td>6.19</td>
<td>2.62</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>85407</td>
<td>0.66</td>
<td>1.32</td>
<td>0.091</td>
<td>1.00</td>
<td>5.96</td>
<td>8.28</td>
<td>2.68</td>
<td>0.78</td>
</tr>
<tr>
<td>74324</td>
<td>0.55</td>
<td>1.44</td>
<td>0.097</td>
<td>5.69</td>
<td>4.92</td>
<td>5.64</td>
<td>1.19</td>
<td>1.7</td>
</tr>
<tr>
<td>85406</td>
<td>0.64</td>
<td>1.34</td>
<td>0.083</td>
<td>0.98</td>
<td>7.68</td>
<td>8.38</td>
<td>2.68</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Linear sensitivity scans

Linear sensitivity scans performed, investigating relative change in growthrate for a number of parameters.

Relative change in plasma \( \beta, \alpha_{MHD}, R_{/L_f} \), and \( \dot{s} \) serve to destabilize the ILW discharges.

Change in collisionality and \( T_{e}/T_{i} \) stabilize ILW discharges.

Nonlinear results

Stiffness of ILW discharges larger than CW discharges.

Follow linear trends, larger fluxes for the ILW discharges.

Core \( \tau_p \) similar while \( \tau_{p,e} \) shorter for ILW discharges.

Experimental heat fluxes lower at high \( R/r_{p} \), more realistic results with rotational effects.

Conclusions

Core confinement affected by changes in key plasma parameters due to degradation of edge pedestal.

Expect core confinement to improve if pedestal recovered.

Acknowledgements and references

The simulations were performed on resources provided by the Swedish National Infrastructure for Computing (SNIC) at PDC Centre for High Performance Computing (PDC-HPC), on the HELIOS supercomputer system at Computational Simulation Centre of International Fusion Energy Research Centre (IFERC-CSIC), Aesmini, Japan. The broader approach collaboration between Europe and Japan, implemented by Fusion for Energy and JAEA, and on the supercomputer JUROPA at Jülich Supercomputing Centre (JSC). This work was funded by a grant from The Research Council (C0338001).