

## Neutral Beam Injection on JET : Effect on Neutron Discrepancy and Energy Balance

D.B. King<sup>1</sup>, C.D. Challis<sup>1</sup>, E.G. Delabie<sup>2</sup>, D. Keeling<sup>1</sup>, G.F. Matthews<sup>1</sup>, S. Silburn<sup>1</sup>  
and JET contributors\*

*Eurofusion Consortium JET, Culham Science Centre, Abingdon, OX14 3DB, UK*

*<sup>1</sup>Culham Centre for Fusion Energy, UK, <sup>2</sup>ORNL, USA,*

The dependence of JET neutron discrepancy and energy balance on neutral beam (PINI) selection has been investigated experimentally.

There has been a consistent discrepancy between neutrons predicted and measured during JET pulses, with the measured neutrons typically being lower than interpretive simulation results. A number of investigations into this have been carried out [1] with many explanations excluded. Further to this the energy balance on JET has shown a discrepancy of ~25% [2]. The neutron production on JET is split between thermal fusion reactions and beam-target reactions, with beam-target reactions making the larger contribution in most deuterium-deuterium discharges.

Given this dominance of beam-target reactions and the ubiquity of NBI heating in JET plasmas it is important to have a good understanding of both the behaviour of JET NBI in the plasma and the NBI power calibration. To improve this understanding a series of experiments were carried out involving a single PINI at a time into a stable, L-mode plasma. These pulses were then analysed using the TRANSP [3] code to determine how the predicted & measured neutrons varied with PINI selection. To further aid the analysis beam emission spectroscopy was also carried out and the change in plasma stored energy at beam turn-on was analysed and compared with the beam power.

The variation of neutron discrepancy with PINI selection will be shown, with some off-axis PINIs showing a 50% or higher difference in the discrepancy. Other PINI positions showed ~5% variation in both neutron discrepancy and energy balance. Where possible a comparison between the same PINI positions on different beamlines will be shown to indicate any separation between technical and plasma physics causes of a deficit. The details of the method used for NBI power calibration will also be shown with the systematic errors recalculated to be ~10%. First results of the stored energy analysis show no disagreement with the beam power calibration within these errors.

\*See the author list of "Overview of the JET results in support to ITER" by X. Litaudon et al. to be published in Nuclear Fusion Special issue: overview and summary reports from the 26th FEC (Kyoto, Japan, 17-22 Oct 2016)

[1] H. Weisen et al, Nuclear Fusion **57**, 7 (2017)

[2] G.F. Matthews et al, Nuclear Materials and Energy **12**, 227-233 (2017)

[3] R.J. Goldston et al, J. Comp. Phys **43** (1981) 61