Neutron Telescopes

KNL3 – 10 Horizontal and 9 Vertical Collimated Neutron Telescopes

(from “Prediction/modelling of the neutron emission from JET discharges” June 2001)
Neutron Rates

Shot 50623 – used for Neutron Rate calibration

Measured Neutron rates & NEPAM prediction

Transp Neutron Rate prediction – Total, B-Plasma, Thermal, B-B
Neutron Rates

Shot 50623 – used for Neutron Rate calibration

Measured Neutron rates & NEPAM prediction

Transp predictions (- - ) for Total neutrons & telescope sums – All, Horizontal, Vertical
Including a sawtooth model in Transp might reduce the total neutron rate, by mixing hot ions from the plasma core with lower energy ions at larger radius?

**Kadomtsev model**: Runs J03, J04. Neutron spike follows 1st sawtooth time in both cases. Not quite physical?
Plasma profiles before (red) & after the 1st sawtooth; Q(0) > 1. is the KM constraint; $T_e(0)$ is halved
Plasma axis variables, $J_{05}$ (Kad.) & $J_{06}$ (Por.); ‘Island width’ parameter 0.5

no change to total neutrons – except the unphysical spike
Telescope Profiles for data & J06 (Porcelli, Fp=0.5), averaged over 5 timepoints.
Telescope ‘Centrality’: 

Statistics on individual telescopes are challenging, so define ‘Centrality’ $C_x = \text{Peak/All}$, for vertical, horizontal & all T/s:

\[ C_v = \frac{\sum_{i=3}^{5} R_i}{\sum_{i=1}^{9} R_i}, \quad C_h = \frac{\sum_{i=14}^{16} R_i}{\sum_{i=10}^{19} R_i} \quad \text{and} \quad C_t = \frac{\left(\sum_{i=3}^{5} R_i + \sum_{i=14}^{16} R_i\right)}{\sum_{i=1}^{19} R_i} \]

(Can be calculated in jetdsp – form cumulative integral over telescope axis)
The data is more central than any Transp run, both at and between the sawteeth.

Transp shows some sawtooth structure, even if no sawtooth model is invoked (run J02).

The Kadomtsev model gives a sawtooth behaviour of comparable magnitude to the data.

The Porcelli model produces smaller sawtooth, and is not very sensitive to the island size parameter ($F_p$).

All Transp runs give a similar telescope profile between sawteeth.

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<thead>
<tr>
<th>Color</th>
<th>Run</th>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>Black</td>
<td>Data</td>
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<tr>
<td>Blue</td>
<td>J02</td>
<td>No sawtooth model</td>
</tr>
<tr>
<td>Pink</td>
<td>J05</td>
<td>Kadomtsev model</td>
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<tr>
<td>Green</td>
<td>J06</td>
<td>Porcelli, $F_p = 0.5$</td>
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<tr>
<td>Red</td>
<td>J07</td>
<td>Porcelli, $F_p = 0.66$</td>
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'Centrality' for all telescopes.
Conclusions

- Total Neutron flux predictions remain a problem
- Neutron Telescope rates are reproduced quite well
- Neither Sawtooth model helps the Neutron predictions (between sawteeth)
- Kadomtsev model reproduces the telescope ratios better, but introduces artifacts in the total neutron distribution
- Porcelli model doesn’t reproduce the telescope ratios as well as Kadomtsev

( Based on a limited number of runs, on a single shot. Altering other settings may improve the results )