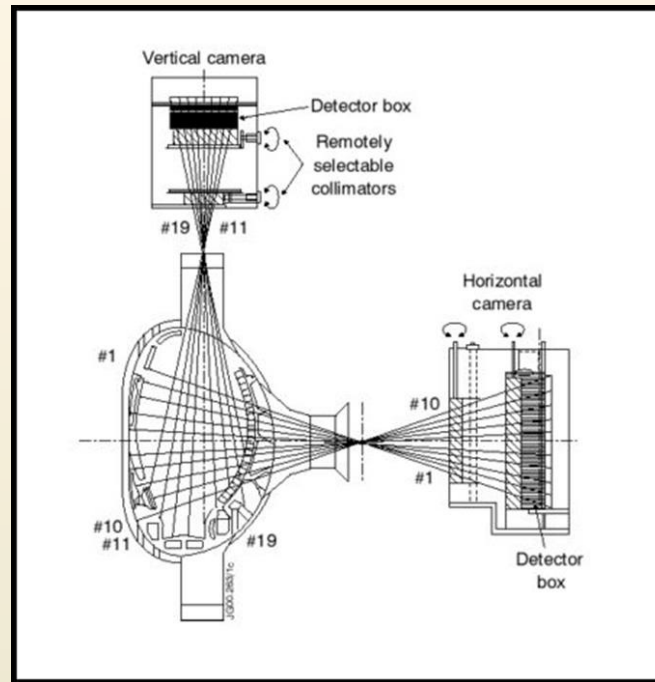


# Neutron Telescopes, Neutrons & Sawteeth

Transp User Course 2014  
Jim Conboy

# Neutron Telescopes

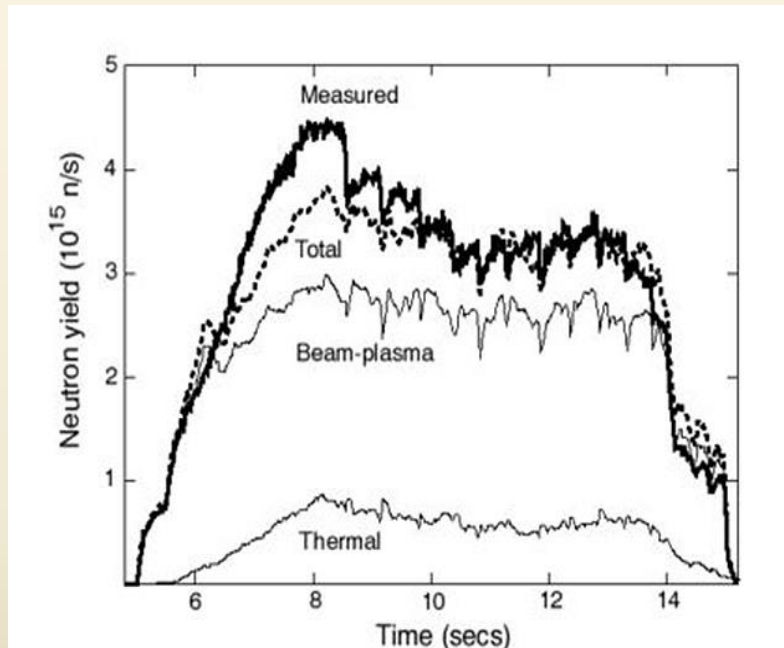


KNL3 – 10 Horizontal and 9 Vertical Collimated Neutron Telescopes

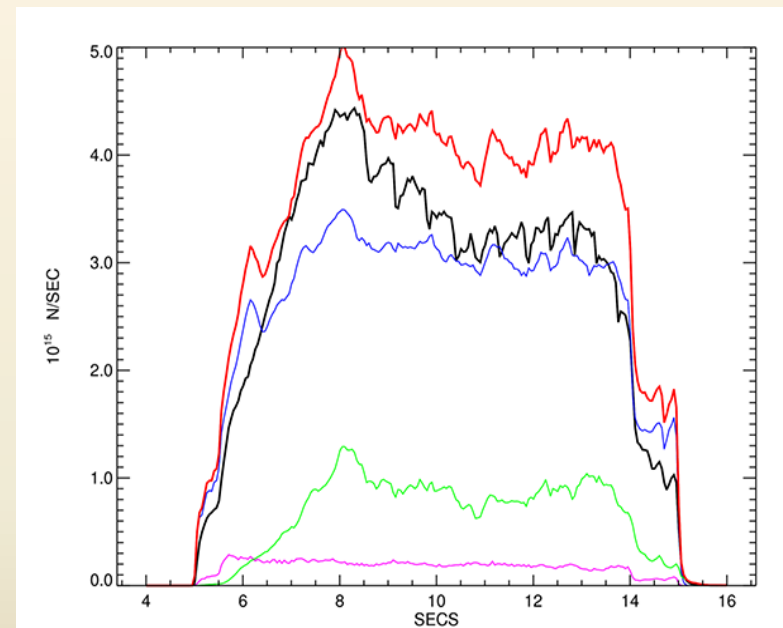
(from "Prediction/modelling of the neutron emission from JET discharges" June 2001)

# Neutron Rates

Shot 50623 – used for Neutron Rate calibration



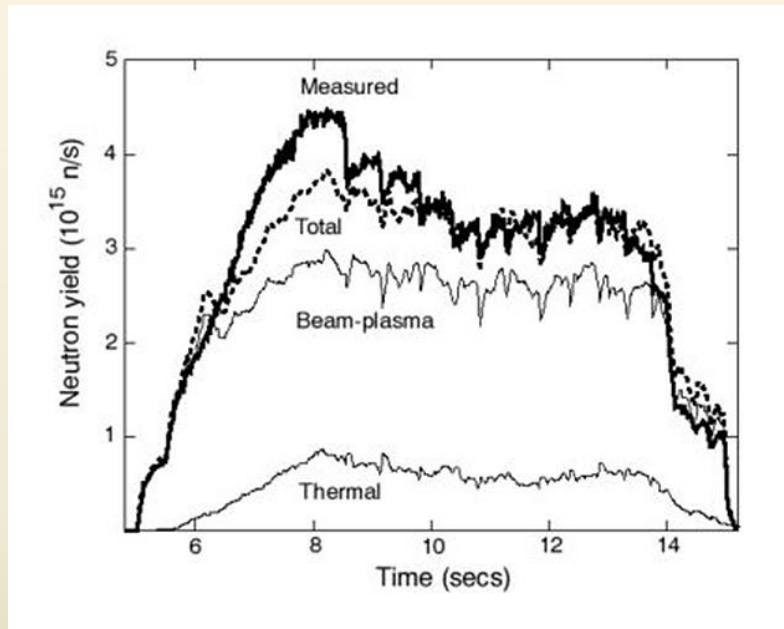
Measured Neutron rates & NEPAM prediction



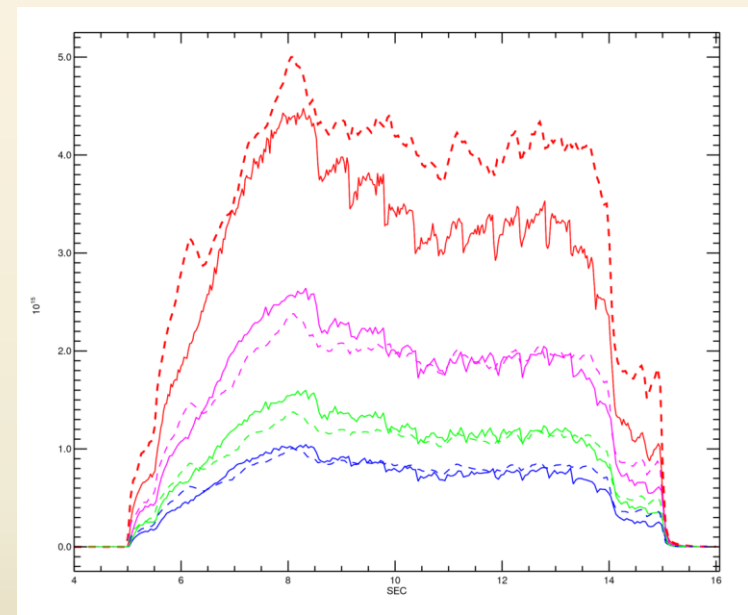
Transp Neutron Rate prediction –  
Total, B-Plasma, Thermal, B-B

# Neutron Rates

Shot 50623 – used for Neutron Rate calibration



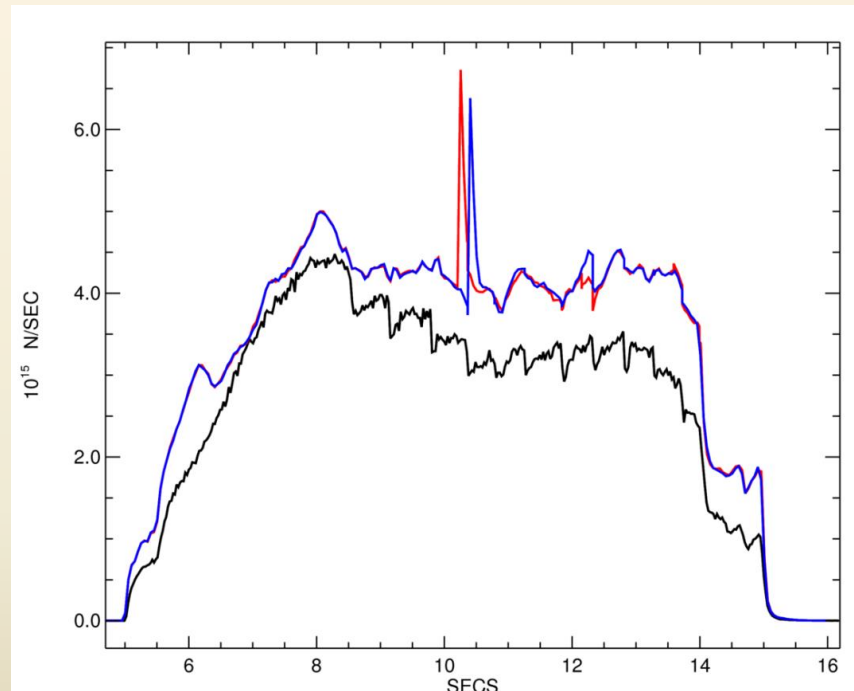
Measured Neutron rates & NEPAM prediction



Transp predictions ( - - ) for **Total neutrons** & telescope sums – **All, Horizontal, Vertical**

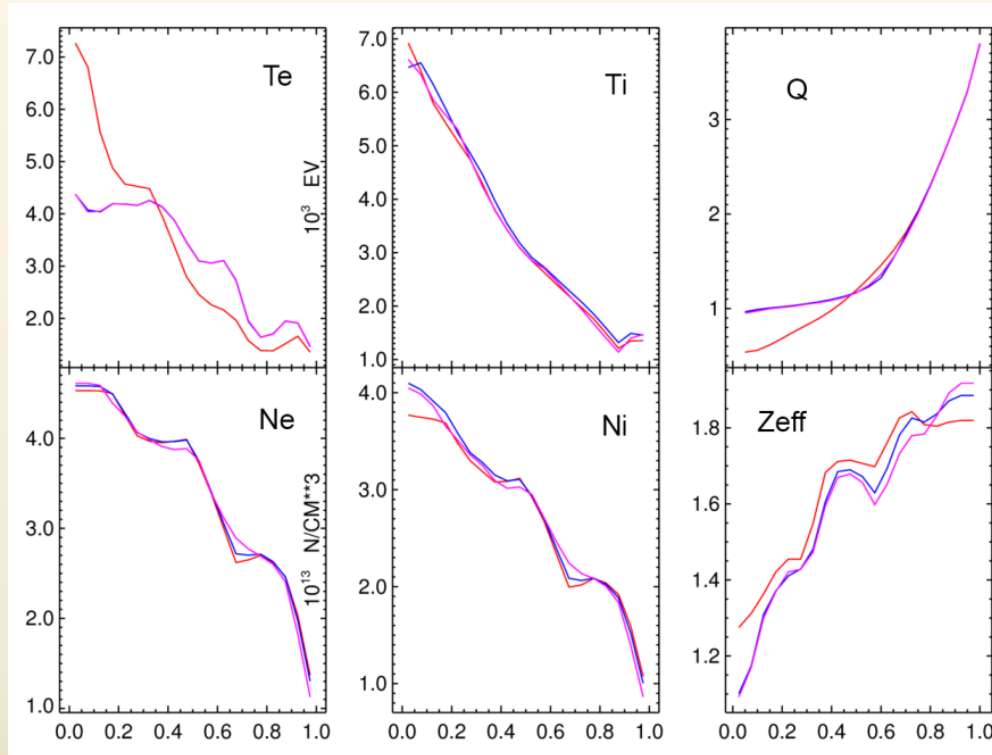
# Sawtooth Models

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 ?



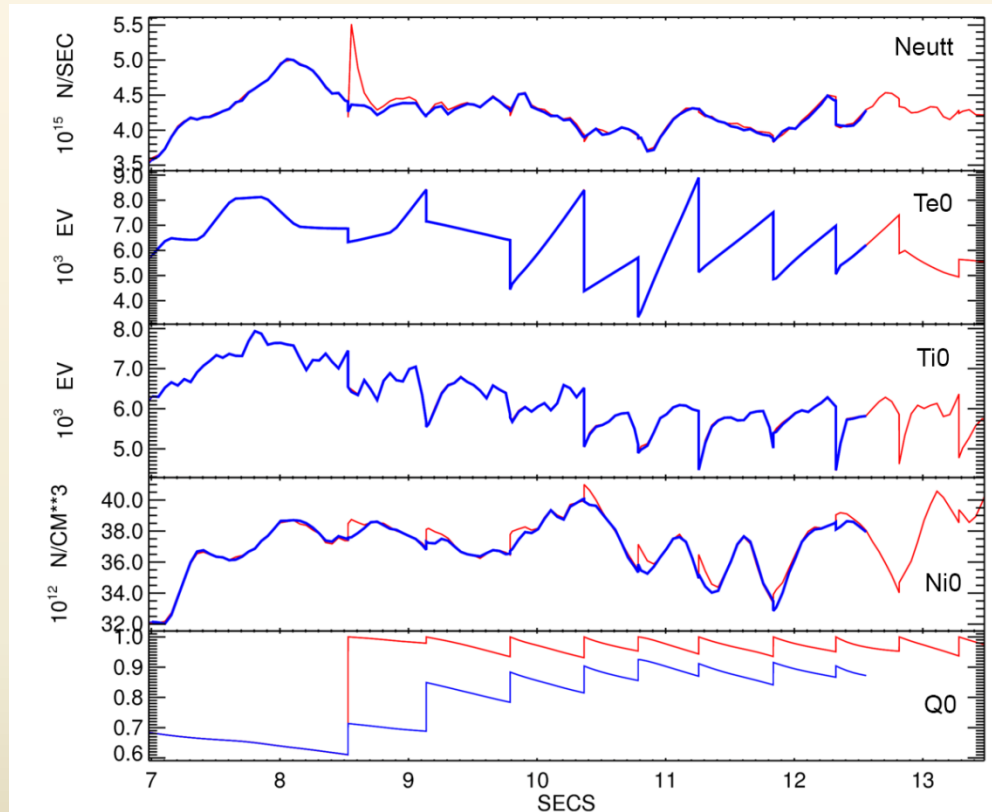
**Kadomtsev model:** Runs J03,J04. Neutron spike follows 1<sup>st</sup> sawtooth time in both cases. Not quite physical ?

# Sawtooth – Kad. model



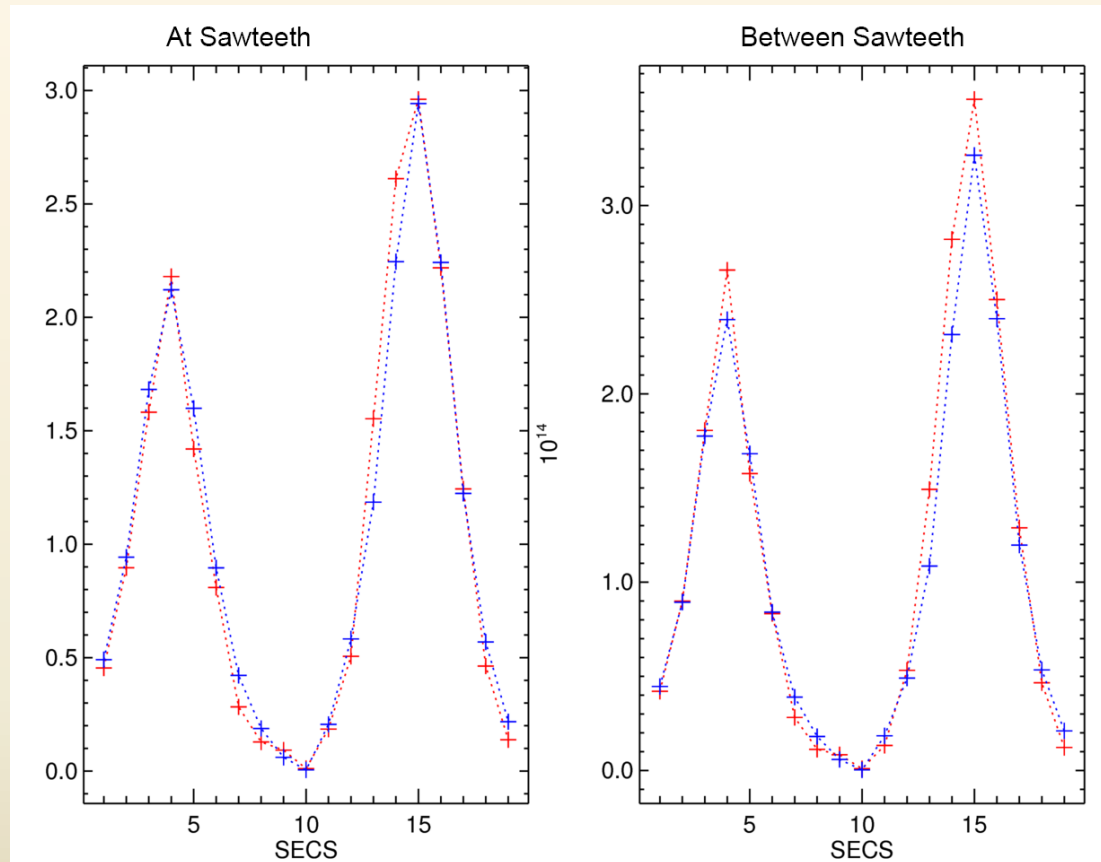
Plasma profiles before (red) & after the 1<sup>st</sup> sawtooth;  
 $Q(0) > 1$ . is the KM constraint;  $T_e(0)$  is halved

# Sawtooth – Kad. & Por. models



**Plasma axis variables, J05 (Kad.) & J06 (Por.);** 'Island width' parameter 0.5  
*no change to total neutrons – except the unphysical spike*

# Telescope profiles



**Telescope Profiles** for data & J06 (Porcelli,  $F_p=0.5$ ), averaged over 5 timepoints.



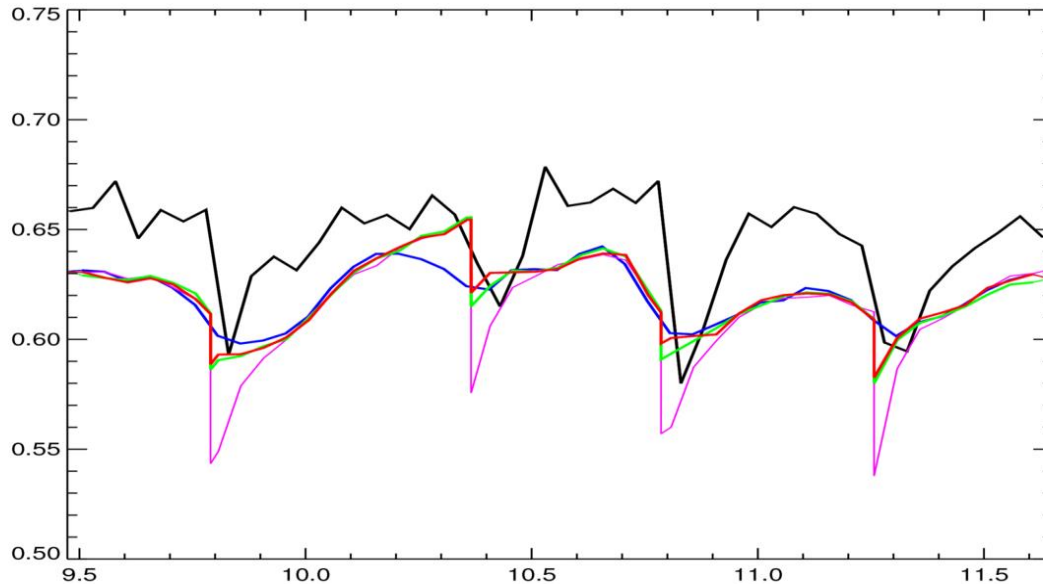
# Telescope 'Centrality':

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

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

(Can be calculated in jetdsp – form cumulative integral over telescope axis)

# Centrality & Sawteeth



Black	Data	
Blue	J02	No sawtooth model
Pink	J05	Kadomtsev model
Green	J06	Porcelli, $F_p = 0.5$
Red	J07	Porcelli, $F_p = 0.66$

'Centrality' for all telescopes

- 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

# 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 )