IAEA FEC 201

Contribution ID: **944** Type: **Poster**

D-D Neutron Emission Measurement in the Compact Tokamak TUMAN-3M

Friday, 21 October 2016 14:00 (4h 45m)

Recent experiments on the TUMAN-3M compact tokamak were aimed at study of fast ion (FI) capture and confinement in co-current NBI heating scheme. Target plasma parameters in the experiments were as follows: R0 = 0.53 m, al = 0.22 m, BT ≤ 1 T, Ip ≤ 180 kA, ne ≤ 4•1019 m-3, Te(0) ≤0.7 keV, Ti ≤ 0.2 keV. Maximum output power of deuterium neutral beam Pinj = 700 kW. Measurement of 2.45 MeV DD neutron flux was used to study of FI behavior. The experiments allowed establishing of parametric dependencies of neutron rate and concluding absence of significant losses of FI during slowing down. Use of powerful ion source in second set of experiments allowed beam current by a factor of two higher than that with old one. This arrangement provided a possibility to alter output beam power at given beam energy.
Losses of FI during slowing down were estimated using measurements of neutron rate decay time �n after NBI switch-off. Experimental Rn and �n measured at Eb = 21.5 keV indicate equal portions of FI power transferred to target electrons and ions during slowing down and small if any influence of anomalous losses on Rn magnitude. Numerical modeling of neutron rate in NBI experiment was performed using ASTRA transport code. Modeling of the influence of nav, Eb, BT and Ip on Rn in assumption of classical slowing down has shown good agreement with the experiment. Database of neutron rate measurements obtained with beam energy range of 14-20 keV was utilized to establish dependence of Rn on nav, BT, Ip and Eb: Rn=6�105 nav0.36�BT1.29�Ip1.34�Eb4.69. The scaling doesn't contain dependence of Rn on input power since the NBI module is unable to provide independent variation of Eb and Pinj. Replacement of ion source opened possibility to get another dataset in the same energy range but with approximately doubled power. Contrary to expectations increased input power does not result in an increase in the neutron rate. The deficit could be understood assuming significant dilution of target plasma in conditions of increased input power. Another option is substantial reduction of input beam intensity due to its attenuation in the input port. Further experiments are planned to clarify the reason of Rn deficit in conditions of increased input power.

Paper Number

PDP-25

Country or International Organization

Russian Federation

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Session Classification: Poster 8

Track Classification: EXW - Magnetic Confinement Experiments: Wave–plasma interactions; current drive; heating; energetic particles