3D effects on transport and plasma control in the TJ-II stellator

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ASYMMETRIES IN TJ-II

- 3D Physics Relevant for Stellarators and Tokamaks (TBM, RMP, Islands)
- Physics and simulation methods
- Impurities
- Pellets
- Impurity Transport
- Dispersion Relation of waves and instabilities
- Changes in AEs, GAMs, Impurity Transport
- Fuelling and Transport
- NBI (0.6 + 0.6 MW)

MOTIVATION

3D Geometry relevant for Stellators and Tokamaks (TBM, RMP, Islands) => Physics and simulation methods
NC Transport Enhanced and onset of ambipolar Er, => impact on Fuelling and Transport:
Dispersion Relation of waves and instabilities => Changes in AEs, GAMs, Impurity Transport.

ASYMPTROM AND IMPURITY TRANSPORT

Impact impurities accumulation in stellators (NC effect in ion root)

Experiments w/o impurity accumulation: Mode HDH in W7-AS and Impurity Hole in LHD.

Look for regimes without impurity accumulation:
1. Revisit impurity hole [M Yoshimuta et al. NF 2009]
2. 3D NC predictions that arrest asymmetries potentially the influence of the impurity flux. [M Yoshimuta et al. NF 2009]

Electric field is negative but small in Impurity Hole conditions, despite the large gradient.
Because of this, the outward and inward pinch are almost balanced. Resulting in small inward impurity flux.

Core Fuelling

Experiments beyond core fuelling: Direct observation of the relaxation of Potential Fluctuations.

- Evolution of plasma potential and field due to amplitude observed in BII plasmas.

NEUTRALS BLOBS CREATED BY χI

- Diminishing of neutrals
- Evolution of potential density, Ne and Field.

LIQUID METALS FOR PFCs & POWER EXHAUST

- Experiments on TJ-II using liquid metals with a CPS.
- LiDn alloys tested: Liquid limit.
- Results: Clean plasma, small impurity retention (< 0.01% H in Li at T > 450°C)
- Insertion of LiDn sample w/o significant perturbation of the plasma parameters.
- These results provide good perspectives for use of liquid LiDn alloys as a PFC in a Reactor.

LIQUID METALS FOR PFCs & POWER EXHAUST

MAGNETIC WELL SCAN: STABILITY

- Stable plasmas in Mercier-unsuitable configurations.
- No change in the plasma size (no effect of rational).

CANDIDATES TO GAMs

GAM strongly damped at different temp in TJ-II.
Need an error field to drive GAMs.

EFFECT OF 3/2 RATIONAL ON PLASMA FLOW AND FLUCTUATIONS

- Effect of 3/2 rational on plasma flow and reduction of fluctuation (shot number).
- Candidates to GAMs found in TJ-II despite the large damping. Drivers exist: Fast ions and poloidal flows.

FAST PARTICLE CONTROL

AEs and Magnetic WELL

- Fast Particle Physics: Controlling AEs using ECRH and Magnetic configuration flexibility, potential variations, magnetic well and magnetic islands

CONCLUSIONS

- 3D Physics Relevant for Stellarators and Tokamaks: NC transport and Er (Bull Plasma & Impurities): Waves and instabilities.
- Impurity Transport: Understanding Impurity hole.
- Influence of Asymmetry: Potential Asymmetry detected in TJ-II.
- Fueling: Pellets operate as a tool for core fuelling (NC-effect). Neutral Beams.
- Innovative PFC power exhaust: LiDn alloys relevant for a reactor.
- Stability: Stable plasmas found in Mercier-unsuitable configurations.
- Candidates to GAMs found in TJ-II despite the large damping. Drivers exist: Fast ions and fast electrons.
- Effect of 3/2 rational on plasma flow and reduction of χI.