Stellarators Divertors

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Discussion session: Stellarator divertor

What is the most critical issues toward helical DEMO?

Particle exhaust:

LHD: About 50% of fueled particles can be pumped. To be improved in next experiments.
EMC3-EIRENE predicts better divertor compression (~1 Pa) in DEMO size divertor

W7-X: "High recycling" divertor provides sufficient pumping efficiency.
In next experiments, pumping capability will be increases by a factor of 3 – 4 with cryo-pumps.

Pumping during detachment?

Compatibility with high radiation fraction ~90%, N & Ne seeding.

He exhaust?

Very few experiments in LHD demonstrated He exhaust enhancement with RMP

Impurity control:

Both **LHD** and **W7-X** have not been suffered from significant core impurity accumulation so far.

LHD: Very low iron density in core ($n_{Fe} / n_e < 10^{-3}$) despite the stainless steel first wall.

W7-X: Friction force > thermal force, impurity flow always directed towards divertor plate even in low density.

Screening against high Z impurity?

Balance with core impurity transport, especially in long pulse/steady state operation?

Discussion session: Stellarator divertor

What is the most critical issues toward helical DEMO?

Power exhaust:

LHD: Strong non-uniform heat deposition in helical direction (attached phase).
Ne seeding is better to reduce heat load uniformly in toroidal direction.
N seeding gives rise to toroidal modulation of heat load.
→ Slow puff rate with long duration can mitigate the toroidal non-uniformity.
Stabilization of detachment is not very successful with impurity seeding.
→ Good indication for detachment stability in mixture seeding (Ne + Kr), but very few shot. Needs to be investigated further.
RMP can stabilizes the detachment. Toroidal modulation in heat load pattern during detachment in H,
but not (or reduced) in D plasmas. Isotope effect?

W7-X: Long L_C widens energy channel width (?).
Ne seeding is very successful for stable & complete detachment for long duration (close to 100% radiation).
N seeding works well, can be well feedback controlled on total radiation, radiation distribution, peak target load etc.
High-field side MARFEs have only been a stability problem in W7-AS, but not observed in W7-X
The large island size is a key parameter for the detachment stabilization?
→ Optimum island size for impurity screening and neutral compression.

What fraction has to be dissipated in DEMO? (Divertor heat load scaling?)
Is the current observation scaled to DEMO? → Mechanism of the stabilization need to be understood.
Compatibility with core plasma performance?

Any other issues?