Leveraging 3D magnetic topologies in support of long-pulse high performance plasma operation

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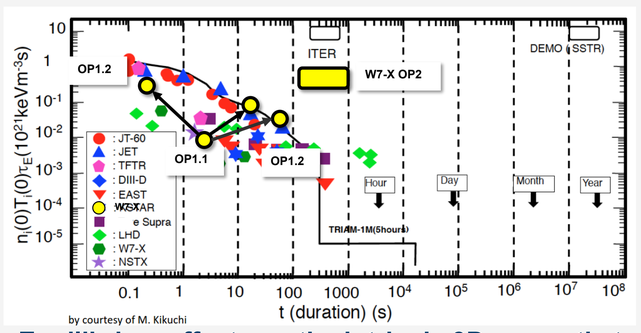
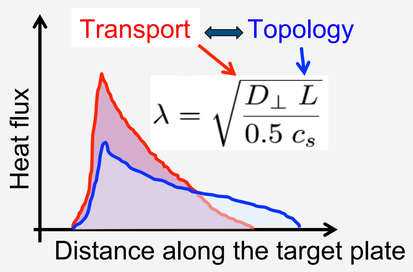
Summary

In the last two years, through the international joint experiments of EAST, W7-X and LHD, the research of 3D edge physics and its application in active control of divertor flux redistribution have all made great progress. It turns out that the synergy between 3D magnetic topology and edge plasma transport may provide a new means for heat-flux control, which is a key issue for next-step fusion development.

Introduction

Plasma-Wall Interactions (PWI): A Great Challenge for High Performance High Power Long-Pulse Operation



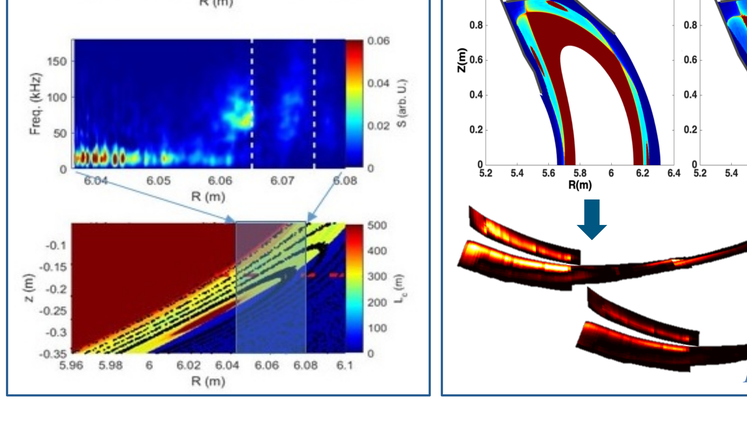


- **3D edge physics is important for optimization of PWI in view of long-pulse operation**

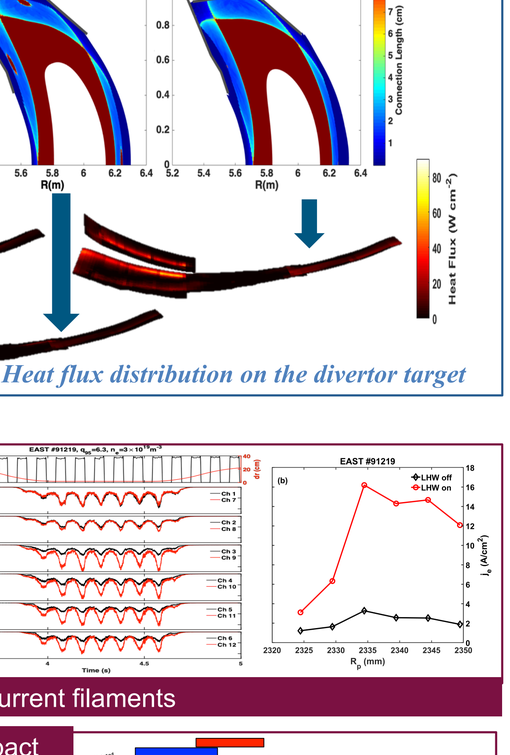
A. Equilibrium effects on the intrinsic 3D magnetic topology and its impacts on the divertor heat load pattern for high-performance long-pulse discharges on W7-X
- Supported by the Eurofusion WPS1 project
  - *S1-WP19-20.X.2.A-T001-D005: Analysis of beta effects on SOL in OP1*
  - *S1-WP19-20.X.3.B-T001-D003: Analysis of magnetic topology changes in experiments in OP1*

B.Impact of heating power/finite beta on the edge transport in the standard and outward-shifted configurations on LHD with a helical divertor
- *Eurofusion EU-JP: Beta Effects on the Magnetic Topology and Edge Transport on W7-X and LHD*
- *NIFS International Collaboration*

C.Active control of the redistribution of the divertor flux by the synergy of the supersonic-molecular-beam-injection (SMBI) and the 3D magnetic topology induced by the LHWs on EAST
- *Eurofusion EU-CN:* 1-A-2: ELM physics and control with LHCD
- *ASIPP International Collaboration*

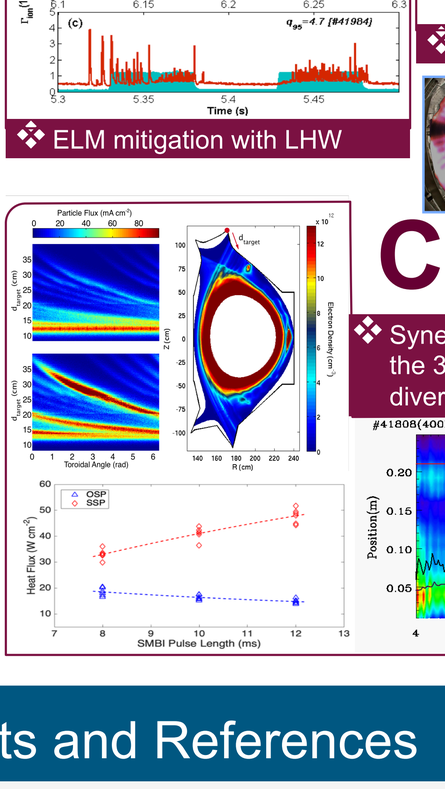


❖ Effects of toroidal currents on the magntic topology and the strike-line movements on W7-X

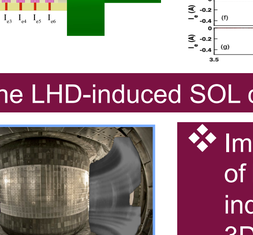


❖ Plasma-beta effects on the W7-X island divertor topology

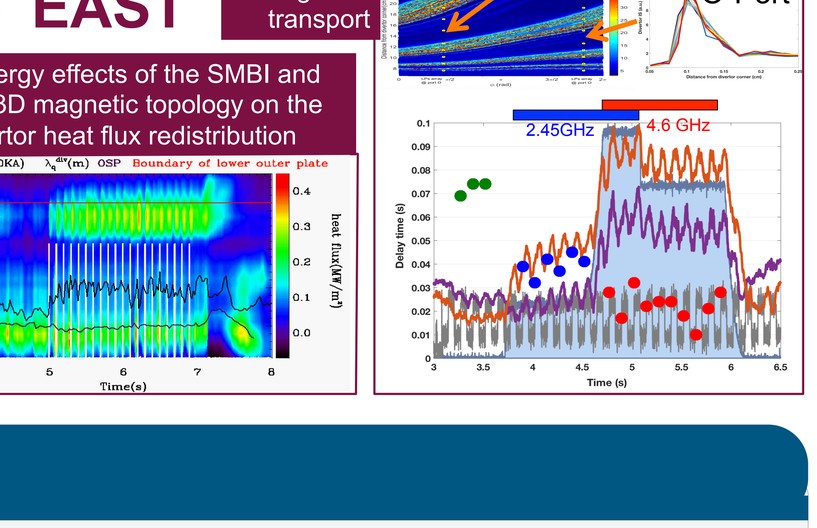
❖ Impact of 3D magnetic topology on the edge profiles and turbulent transport

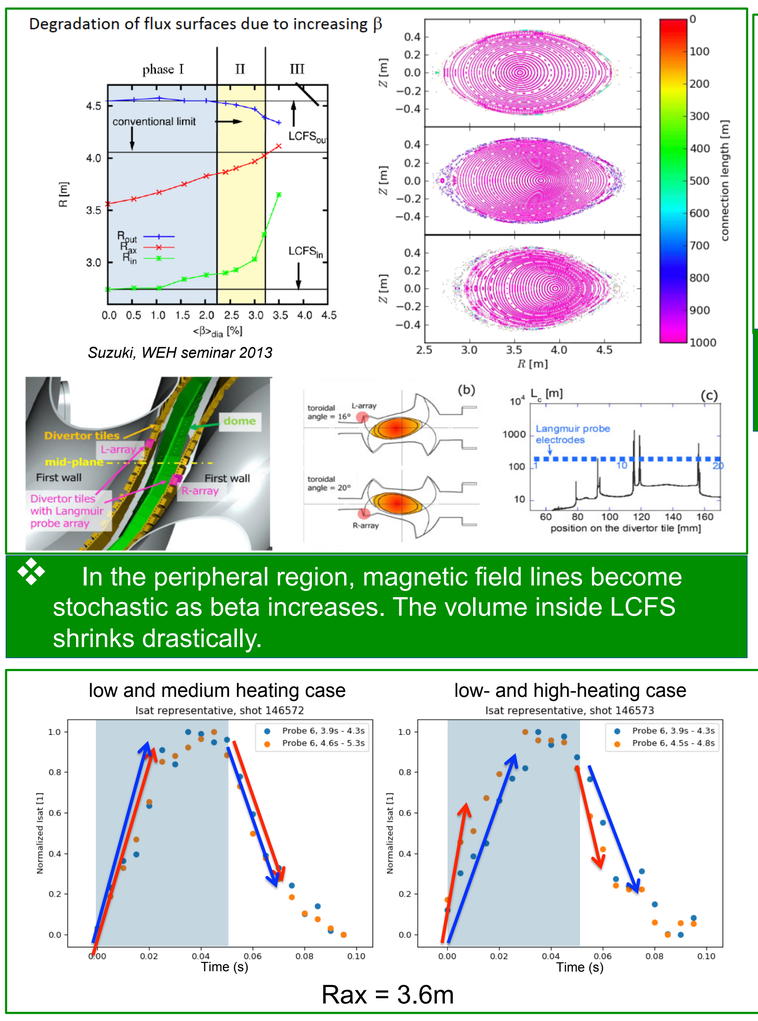


A W7-X

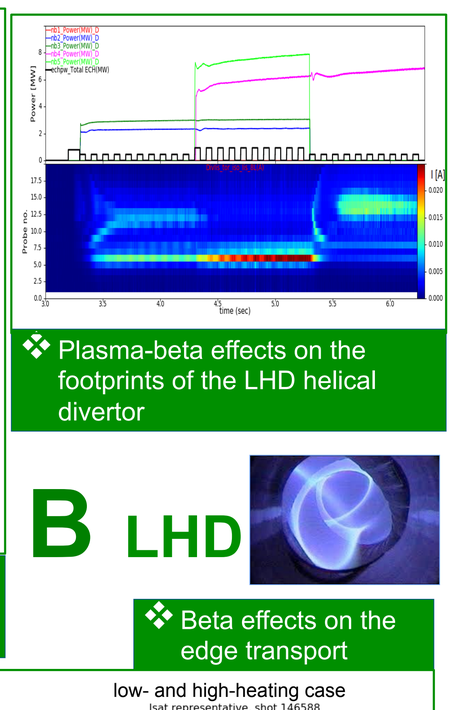


❖ Magnetic topology changes induced by beta effects not only have a significant influence on the heat flux pattern on divertor targets, but also affect the power dissipation in the SOL.





❖ In the peripheral region, magnetic field lines become stochastic as beta increases. The volume inside LCFS shrinks drastically.



❖ Plasma-beta effects on the footprints of the LHD helical divertor

B LHD

❖ Beta effects on the edge transport

❖ ELM mitigation with LHW

❖ The LHD-induced SOL current filaments

C EAST

❖ Impact of LHW induced 3D fields on the edge transport

❖ Synergy effects of the SMBI and the 3D magnetic topology on the divertor heat flux redistribution

Acknowledgments and References

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