Proposal dinklage_014 ***submitted*** *last changed on:* *April 27, 2022*

Role of low-order rational surfaces and islands on the bifuration to internal transport barriers

Proponent

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Classification

EUROfusion work package:	WPW7X
Topic(s):	• Exploration of reduced turbulence / high performance scenarios w.r.t. stationary plasma conditions, kinetic-, density-, and impurity-profile control • Integrated scenarios for long-pulse operation with PFC heat load control, efficient particle exhaust, and impurity screening • Complete the core transport and stability physics basis in the extended operational space

Deliverable(s):	• Assessment of the effects of heating and fueling actuators (profile shaping, fast ions) and magnetic configuration on turbulent transport.
	• Confirmation of neoclassical optimization at increased ion temperatures.
	• High plasma performance in the order of seconds, including
	  • T_i above clamping limit (1.5 keV)
	  • $_E$ equal or better to ISS04 scaling

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Physics Description

Scientific background and objectives

ITBs have can be employed for scenarios with improved confinement. The bifurcation to internal transport barriers is due to effects on turbulent flows (tokamaks, stellarators) or are bifurcations of the radial electric field (stellarators). Low order rational values of the rotational transform and related magnetic islands may trigger confinement bifurcations within the plasma volume. Findings in Tokamaks: triggering of ITBs, control & Stellarators: phenomenology is found in H-J, TJ-II, LHD, W7-X
This proposal is to change the iota profile by ECCD to assess if a local intentional change of iota can trigger an ITB. The specific subject is to study impact of shear (and underlying resistive MHD instabilities) by co- and counter ECCD to trigger the transition to e-root confinement.
This proposal is a joint proposal of the EUROfusion Workpackages WPTE and WPW7X and will be supplemented by

experiments on other stellarator devices. A background document is found at https://indico.euro-fusion.org/event/2058/contributions/7511/attachments/3196/5800/2022_03_31_TG_MHD_TE-W7X_Proposal_04.pdf

Relevance to W7-X program

Deepen the understanding of transport close to rational values of the rotational transform and islands (regions that are not covered by neoclassical theory).
Validate ECCD codes and explore limitations and their impact.
Explore the potential of ECCD as a tool for scenario development (for the generation of positive radial electric fields w/ beneficial impact on high-Z impurity transport)

Approach and Methodology

create target plasma in ion root conditions (~5MW ECRH, 5e19 density)
apply in std confguration co-ECCD at rho ~ 1/3 to cross iota=1 in the core
repeat at high iota but with counter ECCD

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Experiment configuration

special diagnostics requirements:			
magnetic field			
main magnetic field configuration:	FTM000+2642 (released) KJM000+2764 (released)		
comment:	adjustments of configuration details in due course		
Beyond error field correction			
trim coil operation:	Y		
control coil operation :	no preference		
plama densitiy			
plasma density range [m^-3] :	**min:** 5e19	**max:**7e19	
divertor state:	no preference		
gases and fueling			
gas fueling:	Y	H2	
gas fueling system:	main gas inlet system		
pellet fueling:	N		
seeding:	N		
diagnostic use:	Y	Ar	
plasma heating			
ECRH heating:	X2	**min [MW] :**5	**max [MW] :**7
ECRH off-axis heating:	Y		
ECRH current drive:	Y		
NBI	N	**min [MW] :**	**max [MW] :**
NBI diagnostics blibs allowed :	Y		
ICRH :	N		
Number of dedicated programs:	10		
Number of preparatory programs :	10		

Remarks: Settings of ECCD to be varied, preparatory programs to get to ion root condition close to e-root bifurcation

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Proposal chapter	Images
Approach and Methodology	null

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Proposal chapter	Images
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