Research & Coordination Activity

N. Vianello

01 June 2012

ITER Research Plan framework

- European Fusion Research focused on unresolved physic and technological problems in support of ITER
- ITER research plan (IRP) has individuate 12 top operation risks which should be addressed by the world-wide fusion program (L. Horton FED 2012)

1. Inadequate disruption mitigation
2. H-mode power threshold at high end of uncertainty range
3. Inadequate ELM mitigation schemes
4. Inadequate vertical stability control
5. Lack of reliable high power heating during non-active phase of program
6. Unacceptable divertor performance with tungsten PFCs
7. Lack of plasma rotation leads to a degradation of plasma performance
8. High levels of tritium retention require more frequent tritium removal procedures than foreseen
9. Incompatibility of core plasma requirements for Q=10 with radiative divertor operation
10. Inability to achieve densities near Greenwald value for required Q=10
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Personal research interest

- Actively involved in fusion plasma science since the M.Sci. thesis in 1999
- Personal research interests can be summarized in four main macro-areas
  - (A) Flows & Turbulence induced transport $\Rightarrow$ points 2,7
  - (B) Emerging of electromagnetic structures $\Rightarrow$ points 2,7
  - (C) 3D physics and helical plasmas $\Rightarrow$ points 2,3,7,10

Flows & Turbulence induced transport

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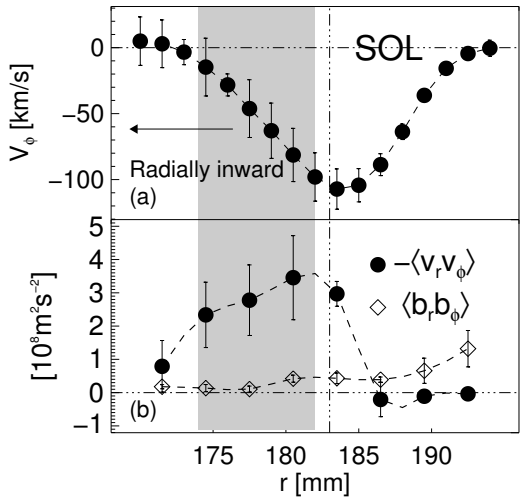
(i) Momentum flux generated by off-diagonal terms in the stress tensor: Reynolds stress, Maxwell stress and non-linear momentum flux $\langle \tilde{v}_\perp \tilde{v}_r \tilde{n} \rangle$



PRL 94 p. 135001, NF 45 p. 761, PPCF 48 p. S193

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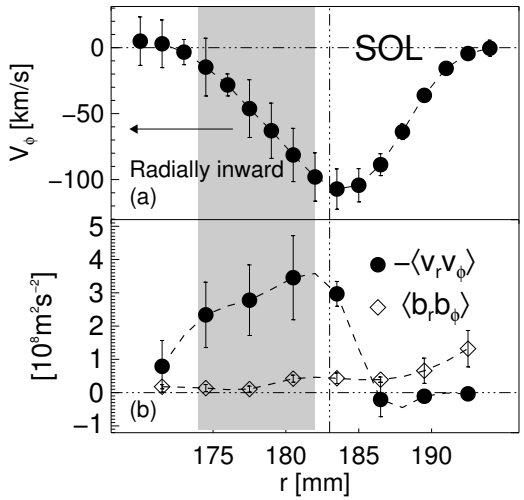

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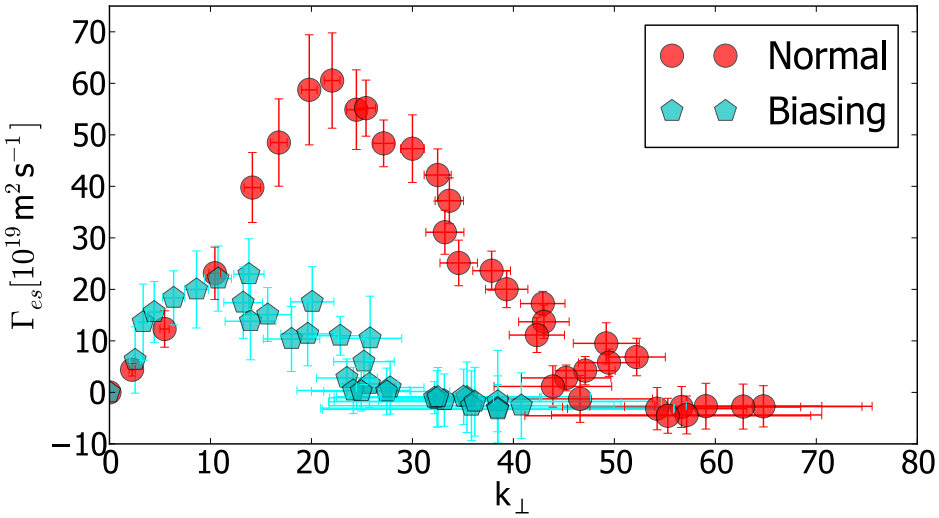
(ii) Transport reduction induced by active modification of sheared flow

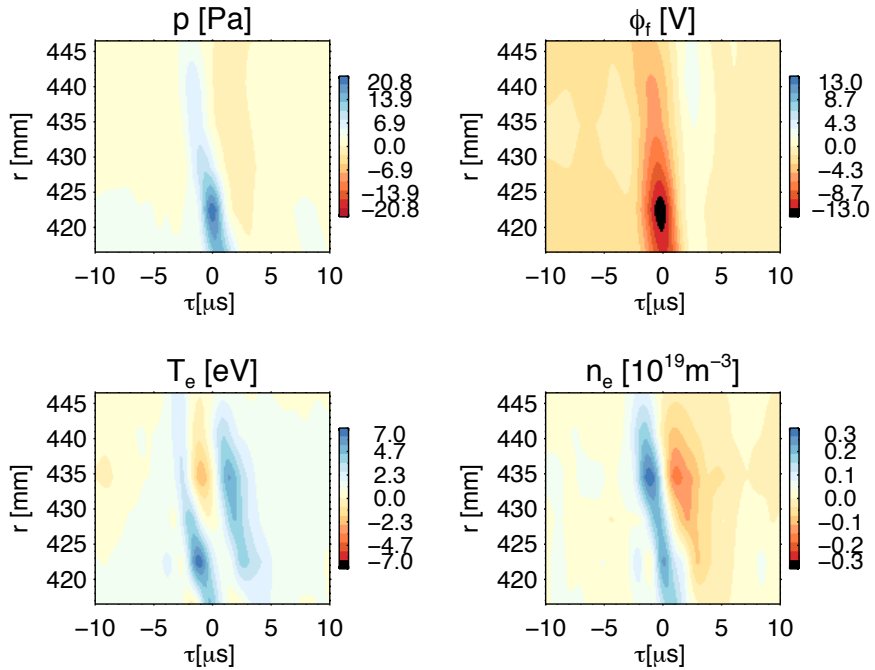


PPCF 42, p. 83

Coherent structures characterization

B

- Complete characterization in the perpendicular plane of blobs responsible for plasma intermittent behavior



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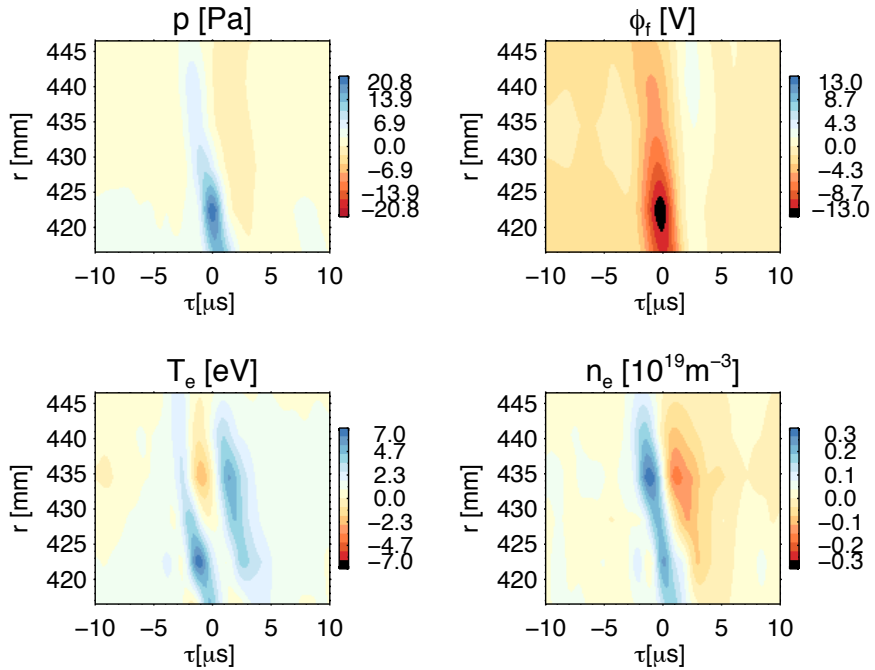
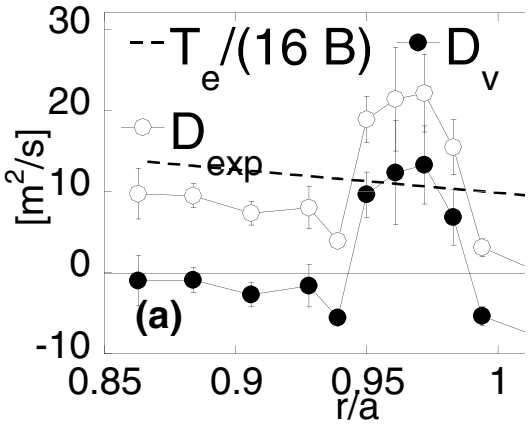


- Evaluation of transport contribution due to coherent structures

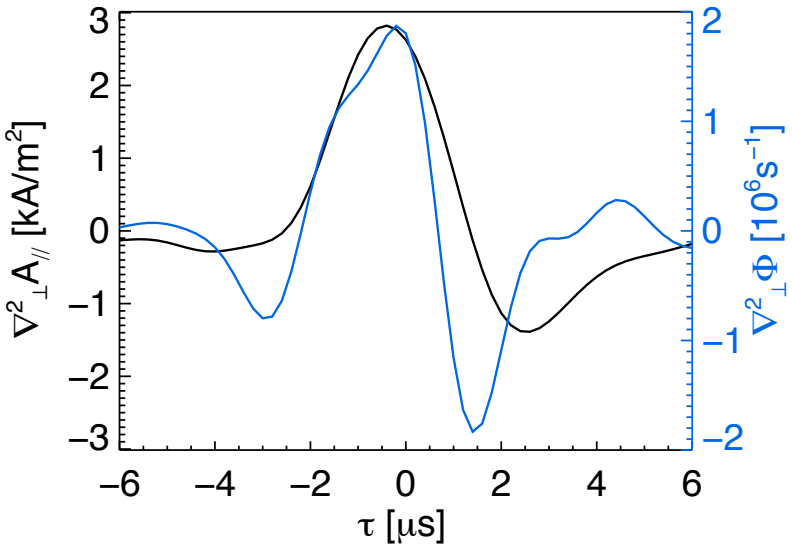


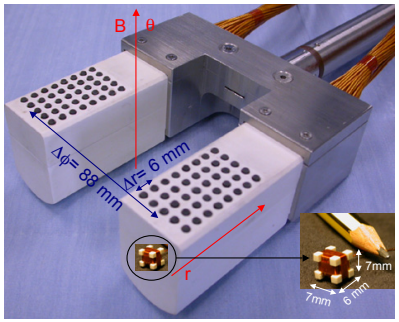
PRL 93 p.215003, PoP 9 p.4110

Current filaments

B

- Measurements of parallel plasma current associated to *blobs* & *filaments* in different experiments with different magnetic configuration





RFX-mod Reversed Field Pinch

- First direct measurements of current filaments associated to plasma blob identified as DKA vortex PRL 102 2009, NF 50 2010

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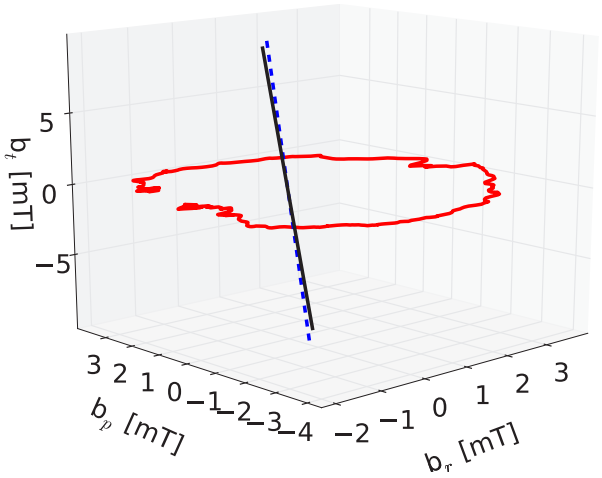

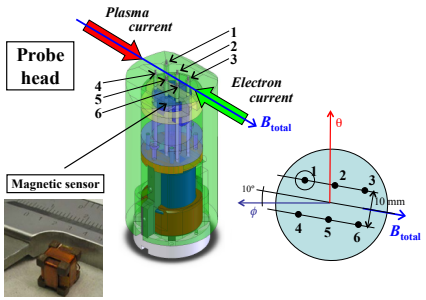

ASDEX-Upgrade Tokamak

- First direct measurements of current asociated to type-I filaments (PRL 106, 2011)

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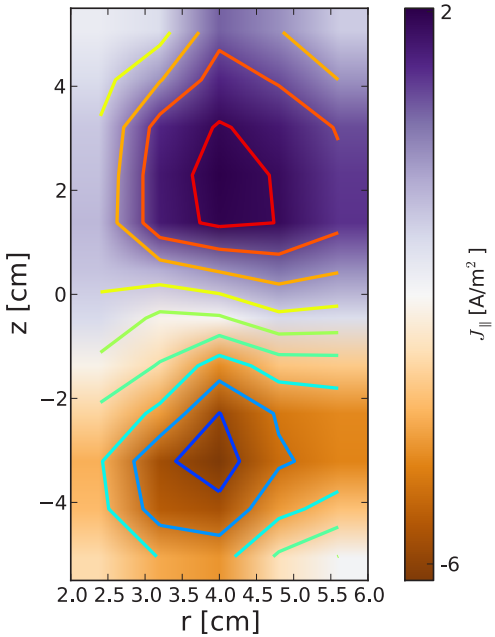
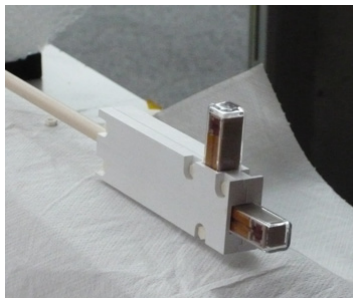




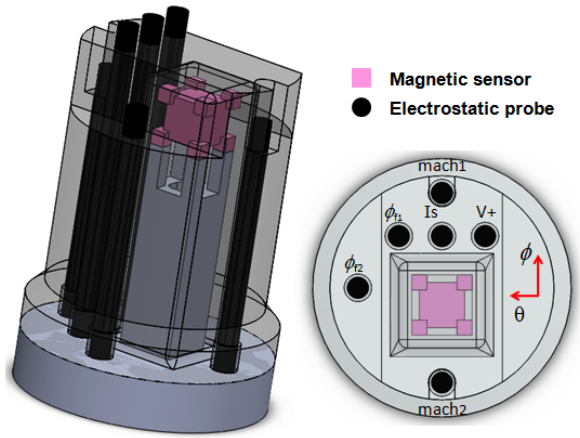
- First direct 2D map of parallel current associated to an interchange-induced plasma blob (PRL 106, 2011)

Current filaments

B

- Collaboration established to extend studies of current filaments to other devices, namely `TJ-II stellarator`, with a probe which combines vorticity and current measurements and `EAST tokamak` for the studies of ELMs

TJ-II Stellarator

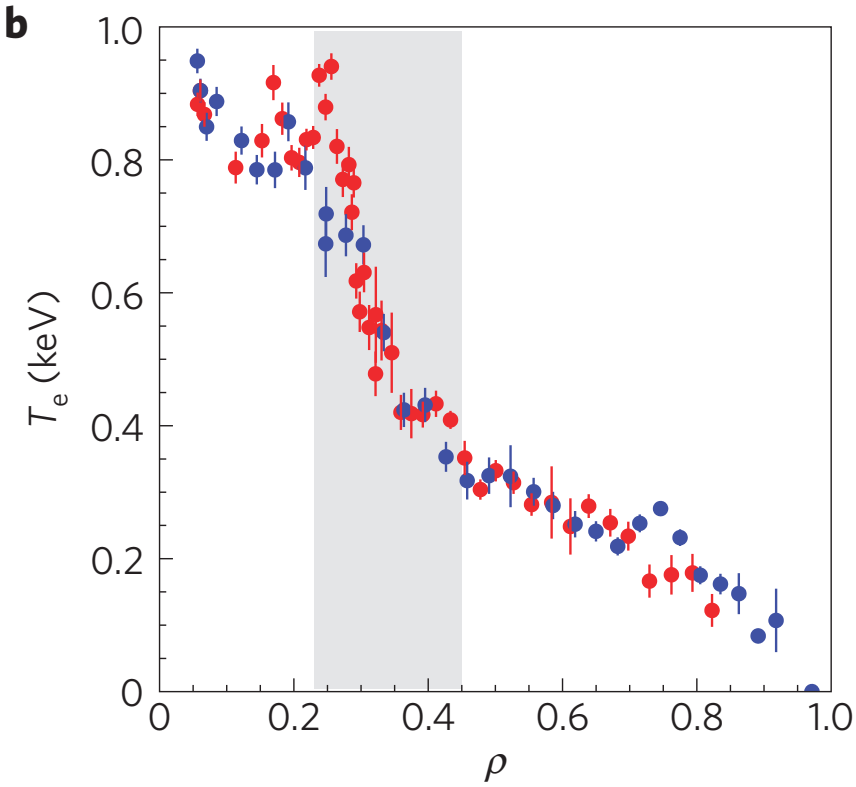


EAST-Tokamak

Helical plasmas

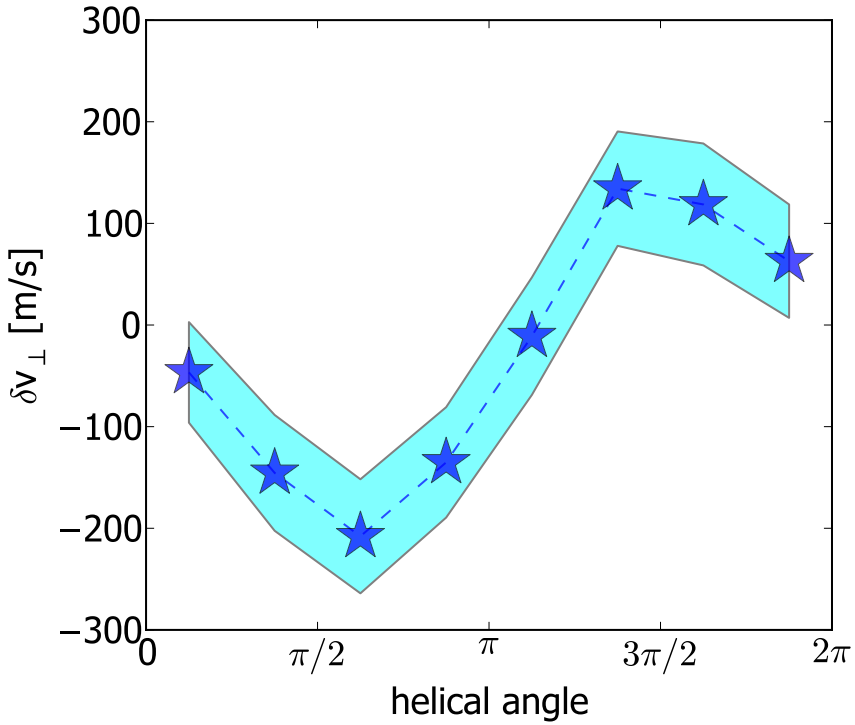
- Observation and characterization of spontaneous helical plasmas developed in high current Reversed Field Pinch operation Nat. Phys. 5 pp. 570

Helical plasmas



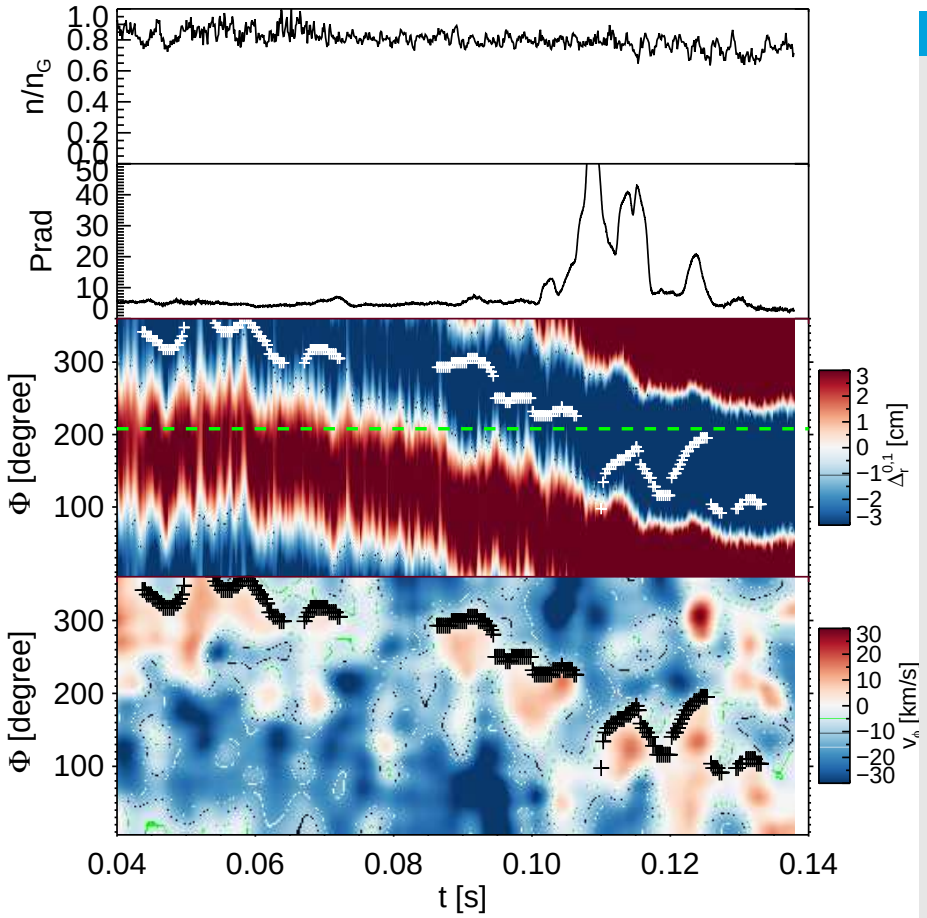
- Helical core associated with a transport barrier located in the region of a local maxima of *q* value

Helical plasmas



- Ambipolar electric field builds up as a response to the magnetic perturbation causing a perpendicular flow with the same periodicity of the helical perturbation

Helical plasmas



- Similar phenomenology appears in High density regime
- In this case, radiative collapse caused by density accumulation induced by perpendicular flow inversion
- Accumulation point coincides with the X-point of the magnetic islands (asterisks track accumulation point toroidal location) NF 2012 p. 054015

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  - 2010 TFL for task force *Physics integration for high performance RFP*

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- Activities monitored and reported to STAC committee

Scientific objectives I

Using draft of JET 2013 work program the following scientific topics has to be pursued

Headline 2.2 **Assess plasma scenario with regards to power loads, their mitigation and control**

- Complete the characterization of the ELMs in ILW. Why do they seem *slower*? Is this related to different pedestal pressure/current profile?
- Determine the plasma flow response to RMPs highlighting differences with respect to collisionality. Can eventual differences account for different behavior with respect to collisionality?
- Determine the role of MHD islands in the density limit. Is radiative collapse really determined by density accumulation?

Headline 3.4 **Confinement pedestal and ELM physics**

- Complete characterization of ILW pedestal.

Scientific objectives II

- Determine the reason for *cooler* pedestal. Different/enhanced thermal transport mechanism?
- If the pedestal is the result of a balance between $\omega_{E\times B}$ and turbulence determine flow profiles in ILW and compare with CW.
- Is there any correlation with a different SOL? Different neutral profiles determine different conditions at the separatrix?
- Why L-H power threshold is lower in ILW? Is it possible to relate it to the claimed relation between GAM/turbulence/flow?

Headline 3.5 **MHD and fast particle physics**

- Establish the amount of fast-ion losses caused by RMP experiments