Research & Coordination Activity

N. Vianello

May 28, 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 programme
  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 programme
  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
  11. Inadeguate particle control to sustain high-Q plasma scenario

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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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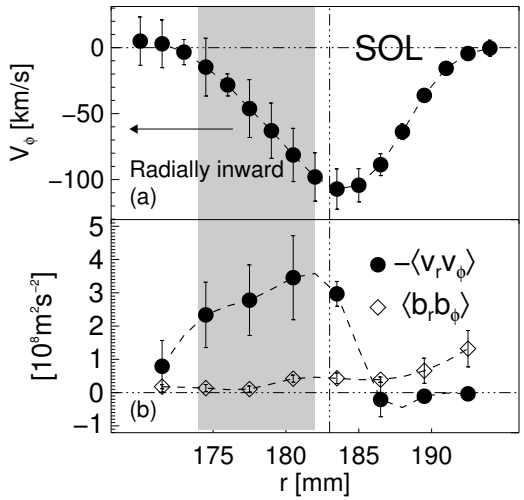
(i) Role of electrostatic Reynolds stress in momentum generation in RFPs, including first measurements of non-linear momentum flux $\langle \tilde{v}_\perp \tilde{v}_r \tilde{n} \rangle$



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

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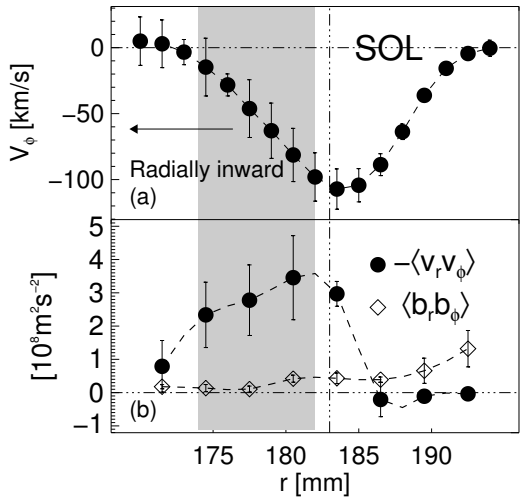

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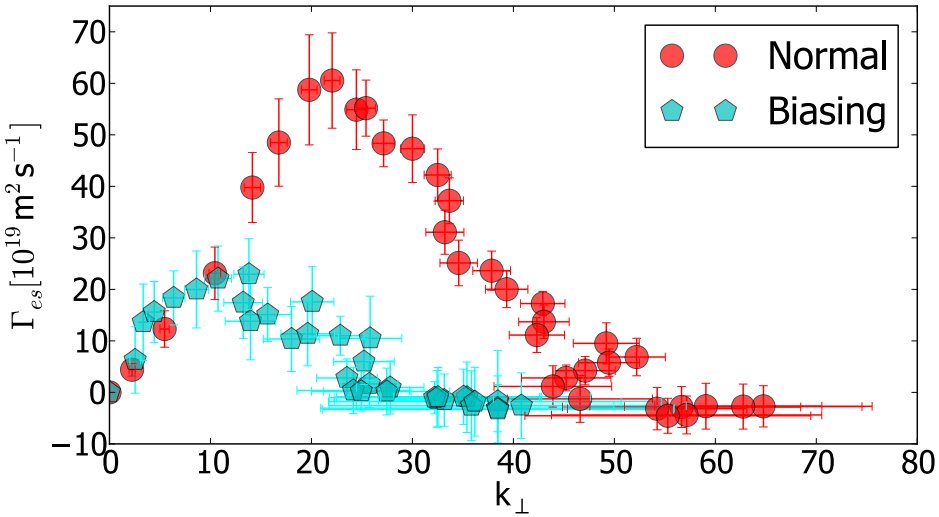
(ii) Transport reduction induced by active modification of sheared flow

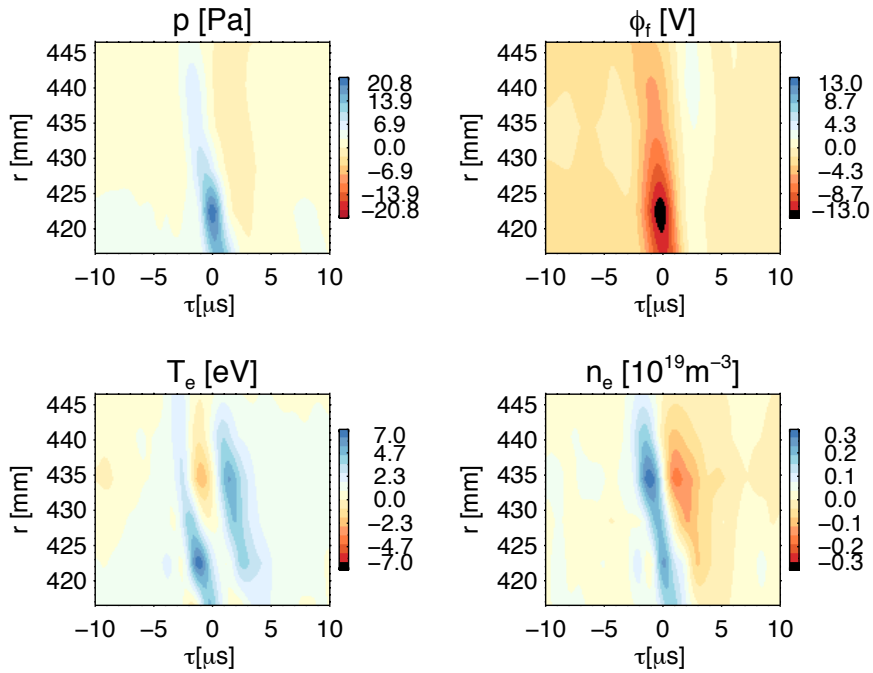


PPCF 42, p. 83

Coherent structures characterization

B

- Complete characterization of coherent structures responsible for intermittency



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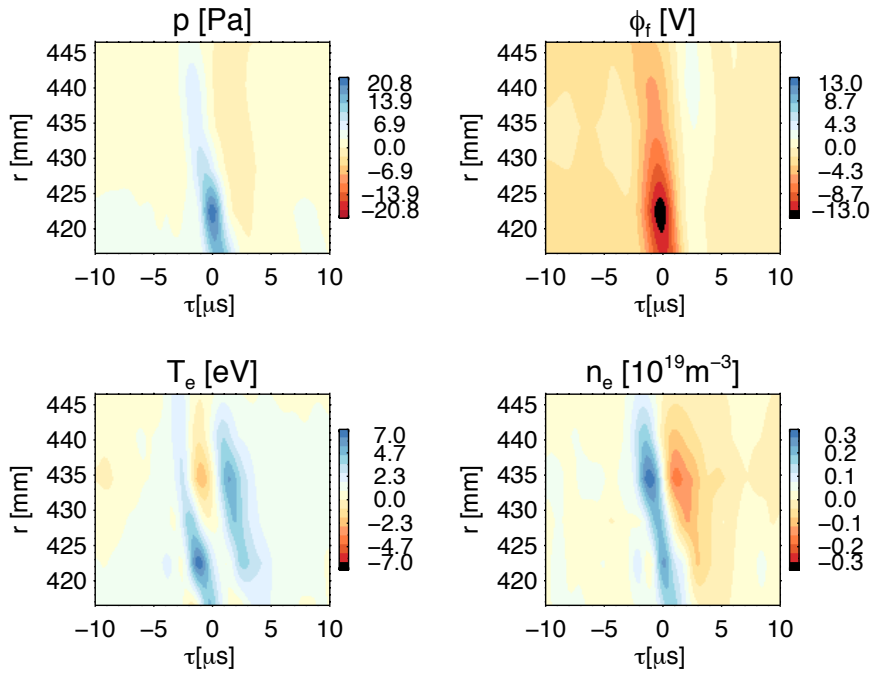
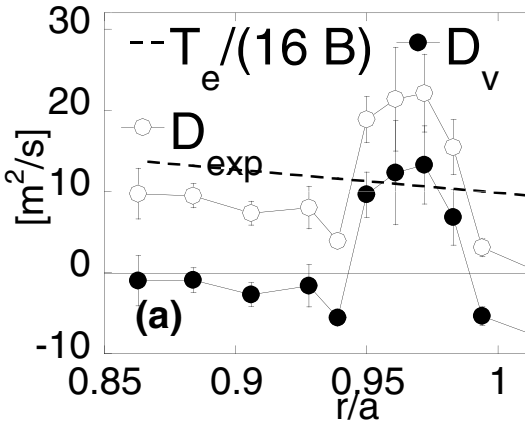


- Evaluation of transport contribution due to coherent structures

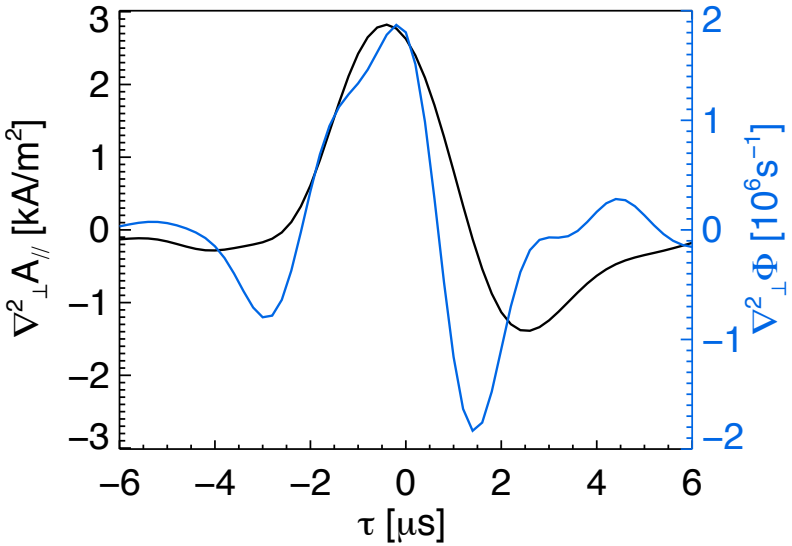


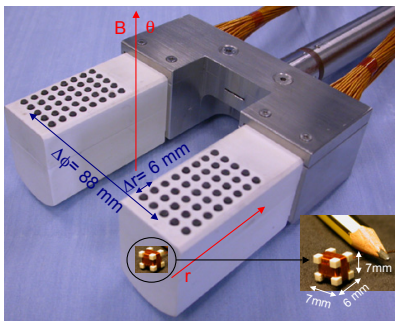
PRL 93 p.215003, PoP 9 p.4110

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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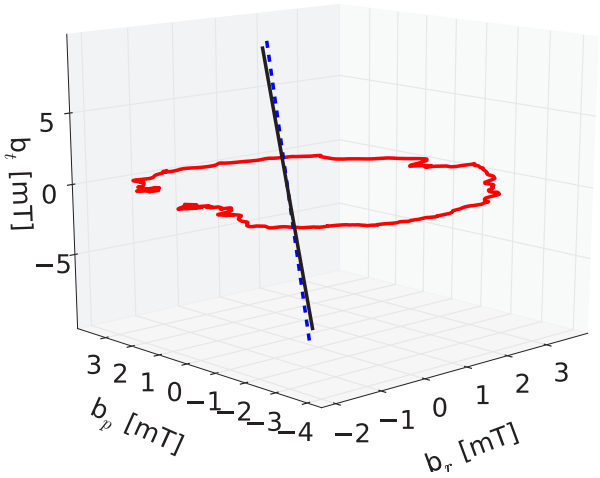

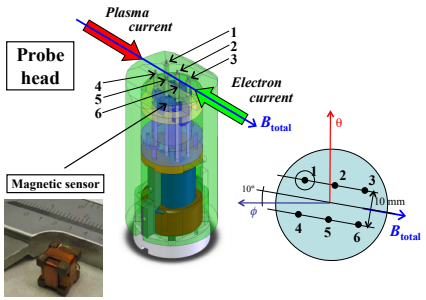

ASDEX-Upgrade Tokamak

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

Current filaments

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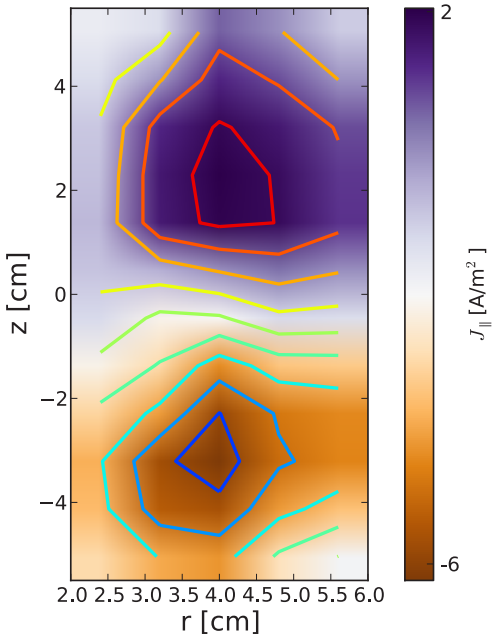
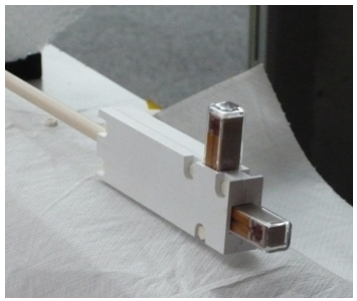




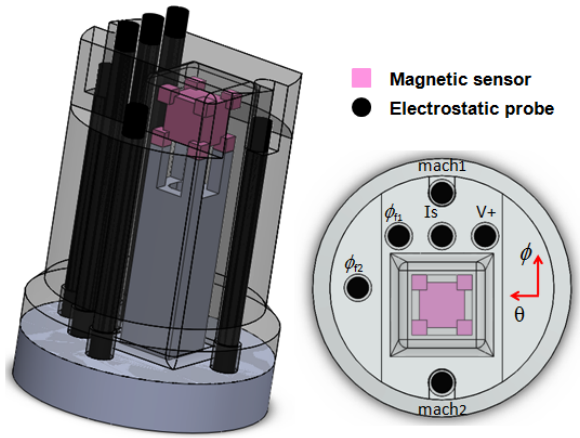
- First direct 2D map of parallel current associated to an interchange-induced plasma blob (PRL 106, 2011)

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

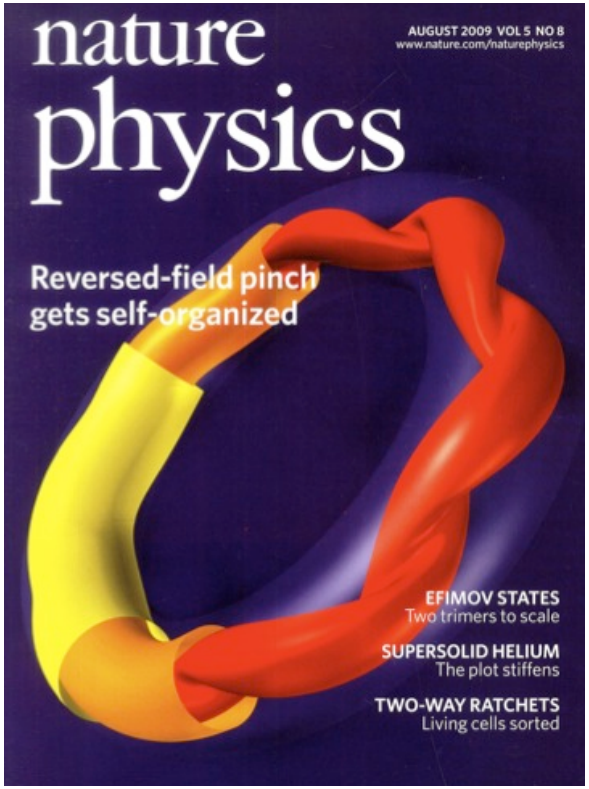
TJ-II Stellarator



EAST-Tokamak

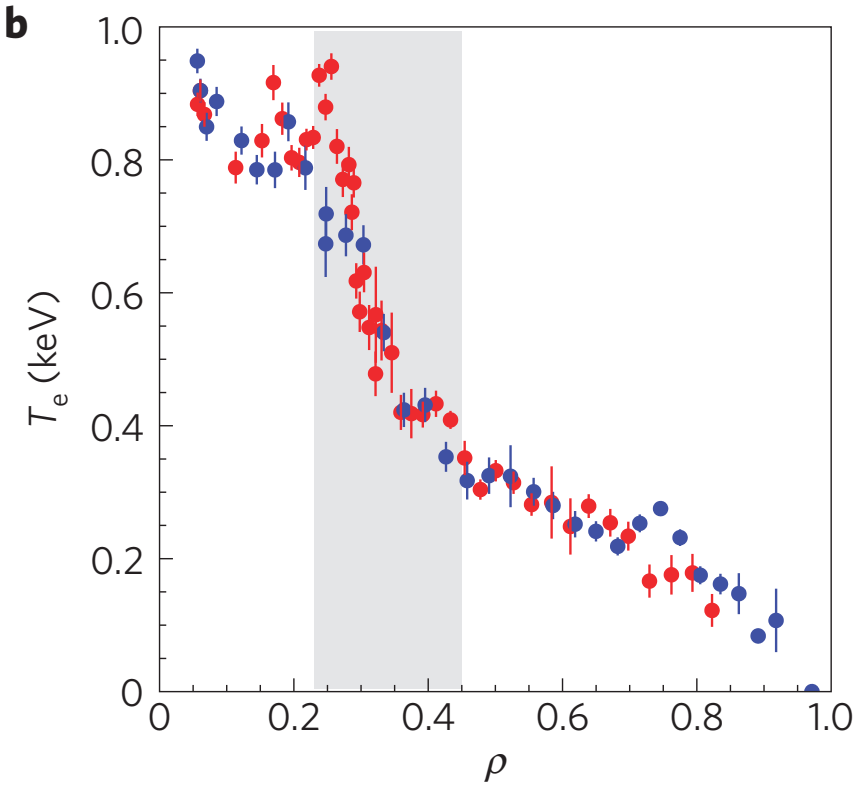
Helical plasmas

C



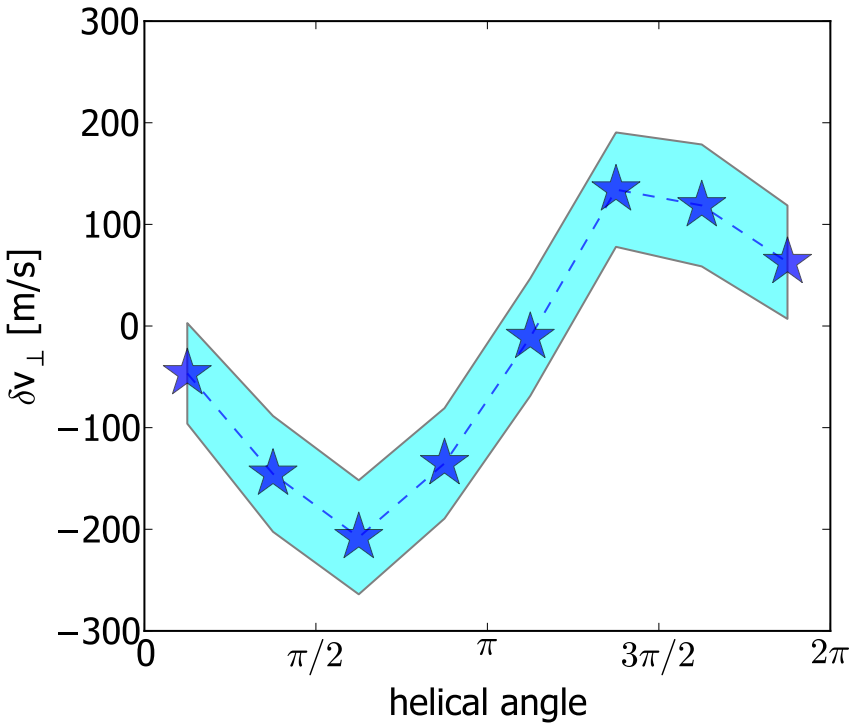
- Observation and characterization of spontaneous helical plasmas developing in high current Reversed Field Pinch operation Nat. Phys. 5 pp. 570

Helical plasmas



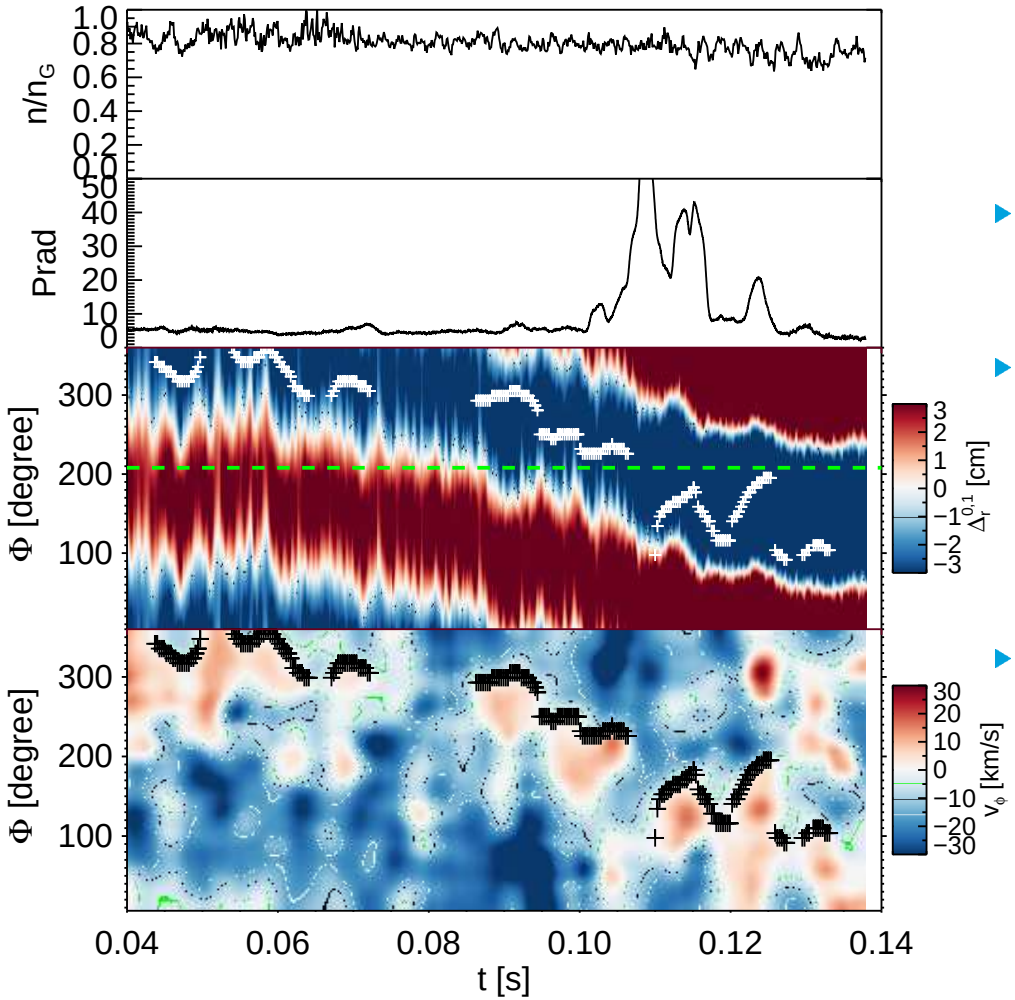
- With the appearence of a transport barrier located in the region of a local maxima of *q* value

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)

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- Activities monitored and reported to STAC committee

Scientific topics to be explored

- Assessment of ITER operation scenarios with the ILW
  - Complete the characterization of the different physics of ILW with respect to CW
  - Why the pedestal is cooler? Is there a different physics?
  - Is the SOL different? And what about the separatrix?
  - If pedestal is somehow a balance between shear flow and turbulence, what is different? Access to detail investigation of pedestal flow.
- Develop and exploit ELM mitigation techniques:
  - Mandatory is the understanding of the *possible different ELMs*
  - Why ELMs are *slower*?
  - Establish the dynamics of the recovery phase: possible inter-machine comparisons
  - Can the different ELMs be caused by different edge current profiles?
  - Role of 3D fields for ELMs for the complete comprehension of RMP mitigation experiments
- Confinement, pedestal and ELM physics: