

# Research & Coordination Activity



N. Vianello

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# ITER Research Plan framework

- ▶ European Fusion Research focused on unresolved physical and technological problems in support of ITER
- ▶ ITER research plan (IRP) individuated 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 leading to a degradation of plasma performance
  8. High levels of tritium retention requiring 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. Inadequate particle control to sustain high- $Q$  plasma scenario

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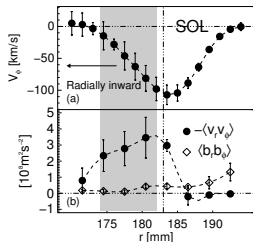
# Personal research interest

- ▶ Actively involved in fusion plasma science since the M.Sci. thesis in 1999
- ▶ Personal research interests can be summarized into three 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

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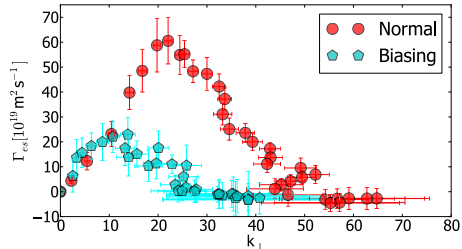
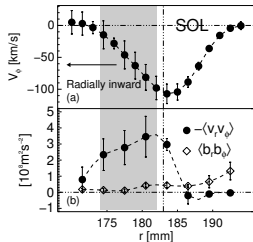


PRL **94** (2005), NF **45** (2005), PPCF **48** (2006)

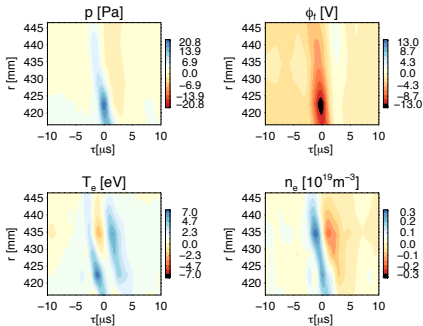
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(ii) Transport reduction induced by active modification of sheared flow



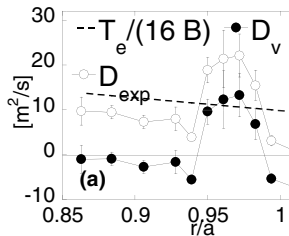
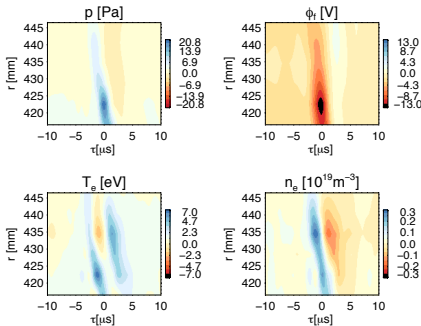
- ▶ Complete electrostatic characterization of intermittent blobs



NF 50 (2010)



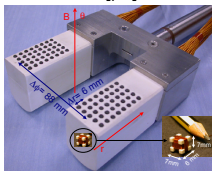
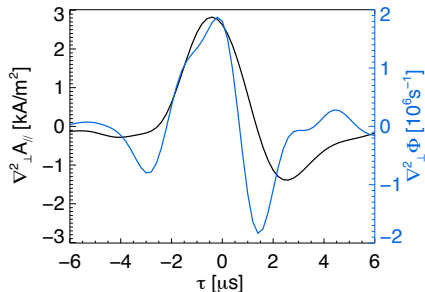
- ▶ Complete electrostatic characterization of intermittent blobs
- ▶ Evaluation of transport contribution due to coherent structures



PRL 93 (2004), PoP 9 (2002)

NF 50 (2010)

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

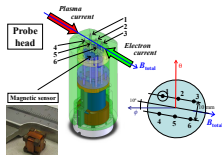
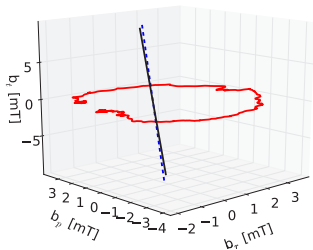


## RFX-mod Reversed Field Pinch

- First direct measurements of current filaments associated to plasma blob identified as DKA vortex

PRL 102 (2009), NF 50 (2010)

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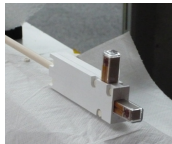
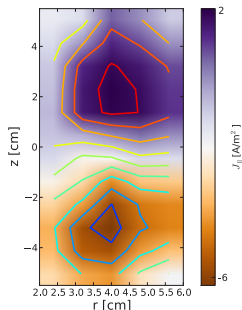


## ASDEX-Upgrade Tokamak

- ▶ First direct measurements of current associated to type-I filaments

PRL 106 (2011)

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



## TORPEX simple magnetized torus

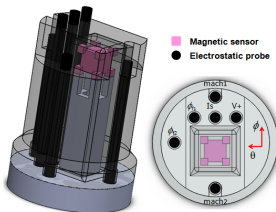
- ▶ First direct 2D map of parallel current associated to an interchange-induced plasma blob

*PRL* **106** (2011)

- 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

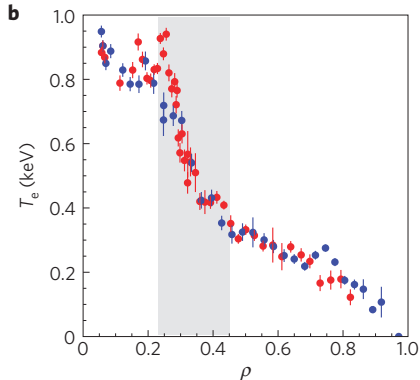


EAST-Tokamak

- Observation and characterization of spontaneous helical plasmas developed in high current Reversed Field Pinch operation

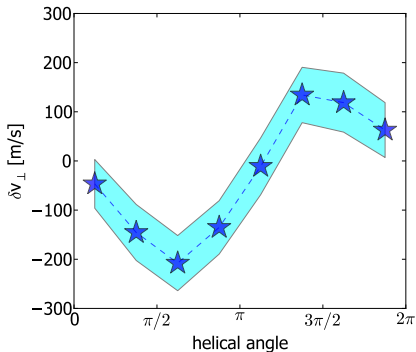
*Nat. Phys.* **5** (2009)





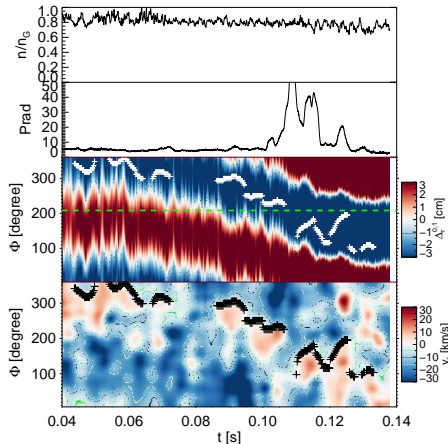
- ▶ Helical core associated with a transport barrier located in the region of a local maxima of  $q$  value

*Nat. Phys. 5 (2009)*



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



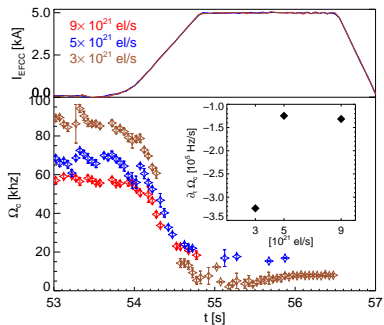
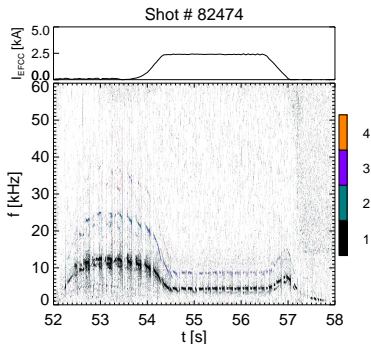


- ▶ Similar phenomenology appears in High density regime
- ▶ In this case, radiative collapse caused by density accumulation induced by perpendicular flow inversion
- ▶ Accumulation point coincides with the X-point of the magnetic islands

NF 52 (2012)

## Toroidal braking during EFCC experiment in ILW

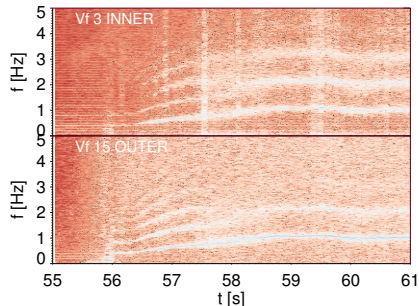
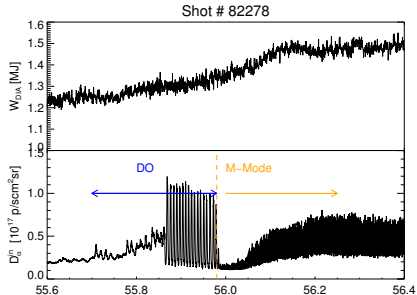
- ▶ Toroidal rotation braking estimated from magnetic including diamagnetic correction
- ▶ Different braking observed as a function of dosing rate



# JET activities

## Divertor oscillations and M-Mode

- ▶ ICRH plasmas exhibit oscillations in the divertor  $D_\alpha$  signals
- ▶ They are sort of *precursor* for the M-mode (m,n)=(0,0) mode at few kHz



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  - 2009 Task force **Particle, momentum and energy transport**
  - 2010 Task force **Physics integration for high performance RFP**

## Coordination experience: EFDA TTG

- ▶ In 2011 I've been appointed as coordinator of the working group *3D field effects in edge and SOL and diagnostic development* for the EFDA Transport-topical group
- ▶ Duties and responsibilities
  - Monitoring and coordination of activities from 11 different European Associations
  - Discussion stimulated through remote meetings and shared wiki pages information
  - Activities monitored and reported to STAC committee
- ▶ Programme committee of the forthcoming 17th Joint EU-US Transport Task Force Meeting: chairman of the session on *Edge and SOL turbulence and transport*

# Scientific objectives I

Using draft of JET 2013 work program the following scientific topics have 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