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Edge turbulence in different density regimes in Alcator C-Mod

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Alcator C-Mod

PPPL PRINCETON PLASMA PHYSICS LABORATORY

INTRODUCTION

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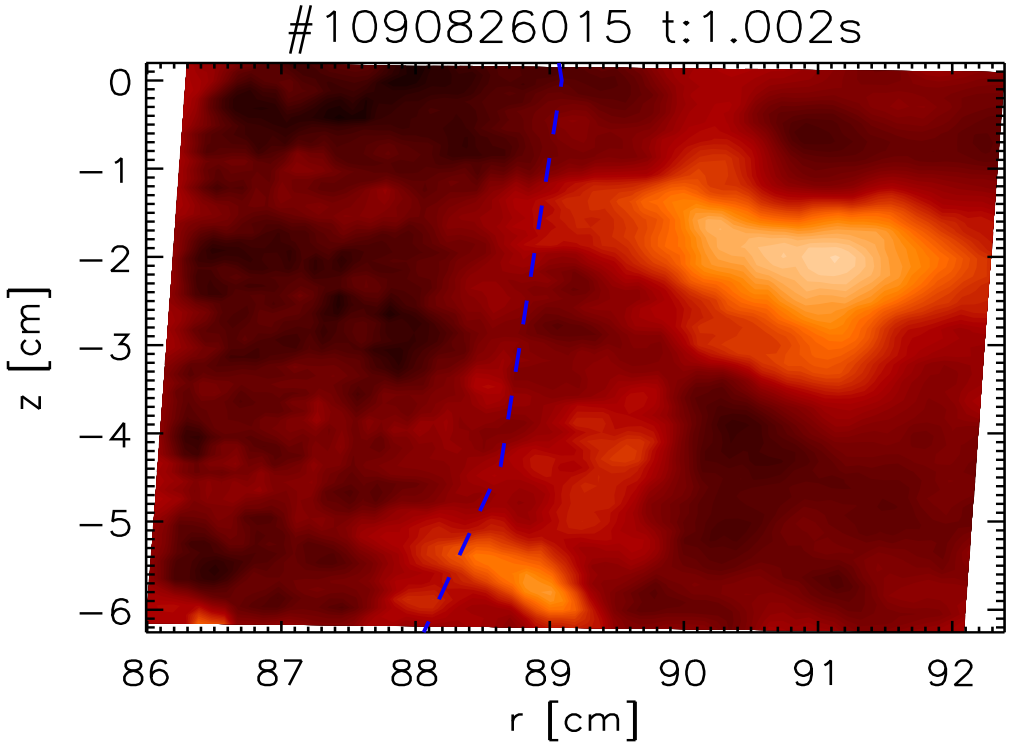
- The role played by the plasma edge in the Greenwald density limit is studied

- Properties of the edge fluctuations:
  - ✓ poloidal velocity
  - ✓ radial velocity
  - ✓ spatial correlation

- Properties of the blobs:
  - ✓ propagation velocity
  - ✓ birth region

GPI DIAGNOSTIC

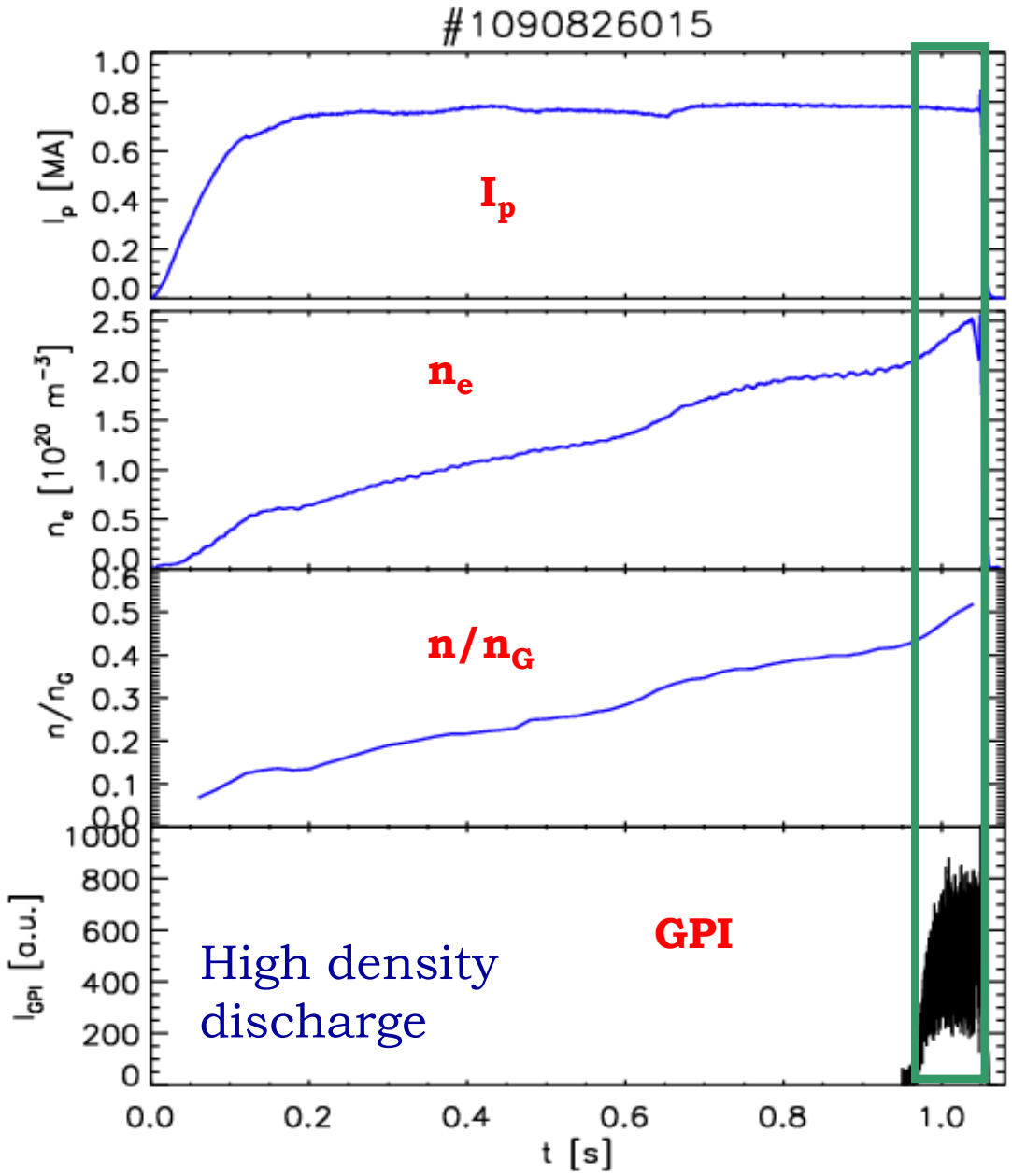


- Edge fluctuations of Alcator C-Mod studied with the GPI diagnostic
- Phantom 7.3 camera:
  - 64x64 pixels
  - 250 kHZ
  - 120 ms acquisition time

- GPI measures D_α fluctuations in the perpendicular plane at the outboard midplane

*[S.J.Zweben et al., PoP **9** 1981 (2002), J.L.Terry et al, PoP **10** 1739 (2003)]*

ANALYZED DISCHARGES



- Discharges with different n/n_G have been analyzed
- $0.2 < n/n_G < 0.8$
- Ohmic L-mode
- Single null magnetic configuration
- Edge fluctuations measured varying normalized density

FLUCTUATIONS PROPAGATION

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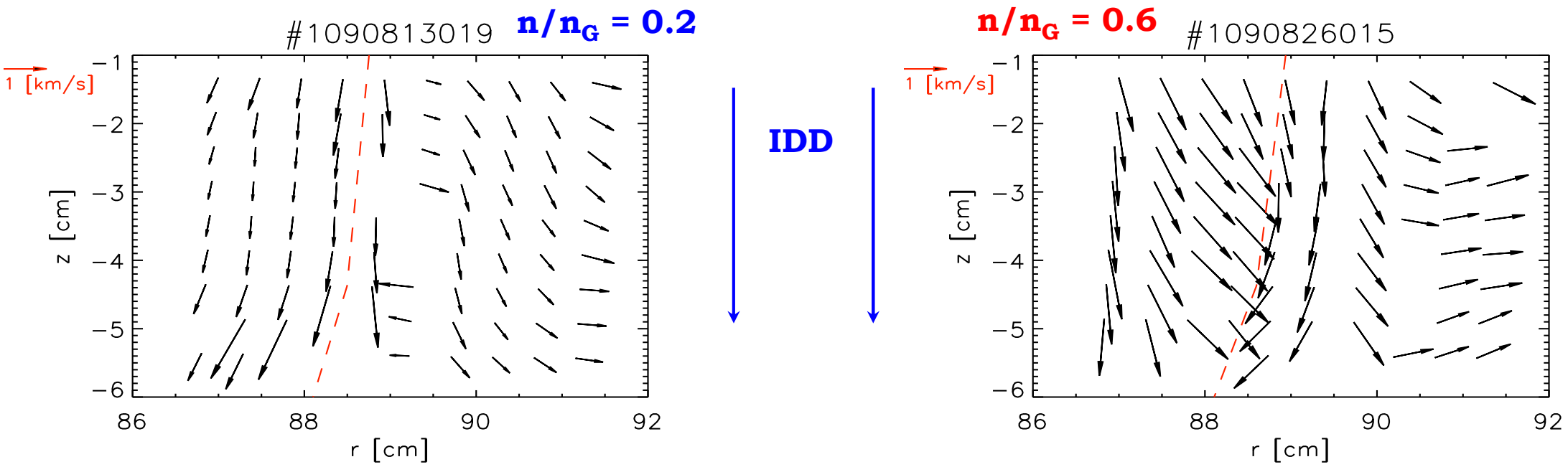

- 2D velocity field of edge fluctuations measured with the cross correlation technique
- Two distinct regions separated by the separatrix
- Different behavior at **low** and **high** normalized density

SOL VELOCITY SCALING

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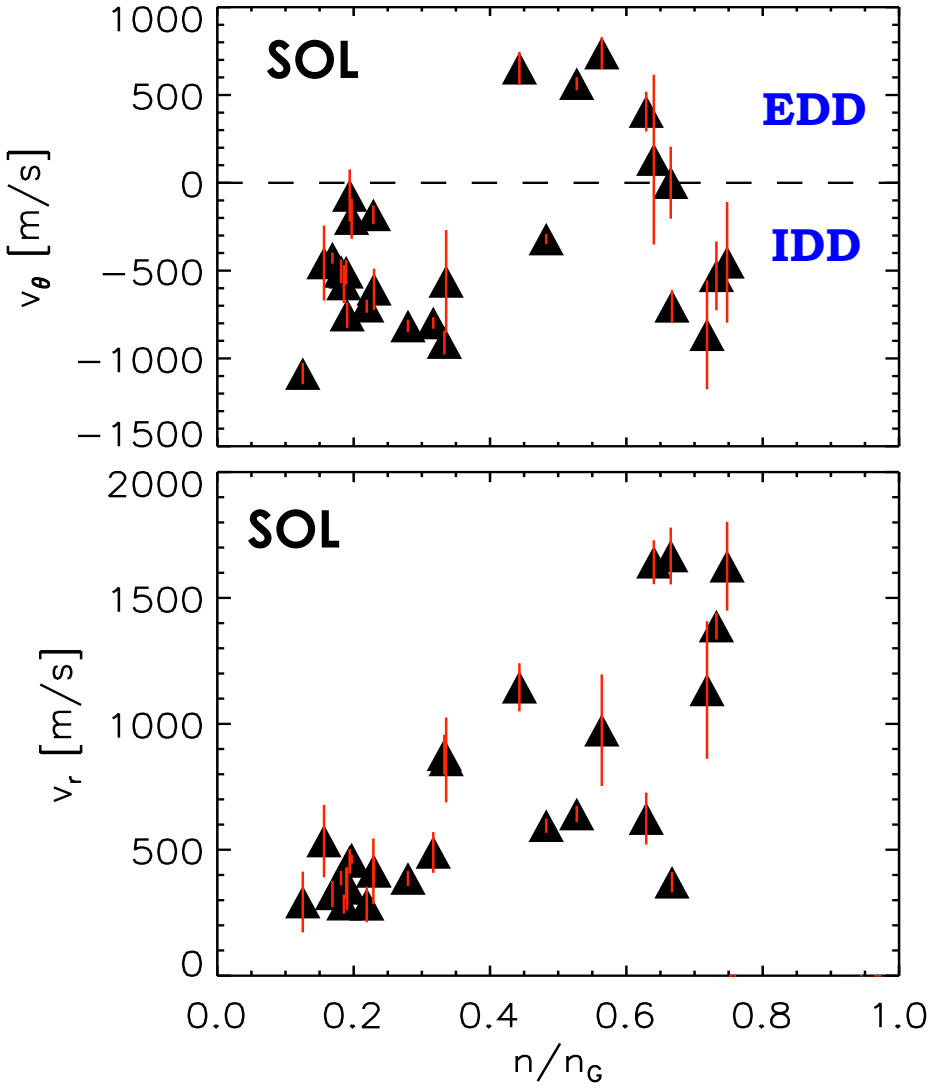
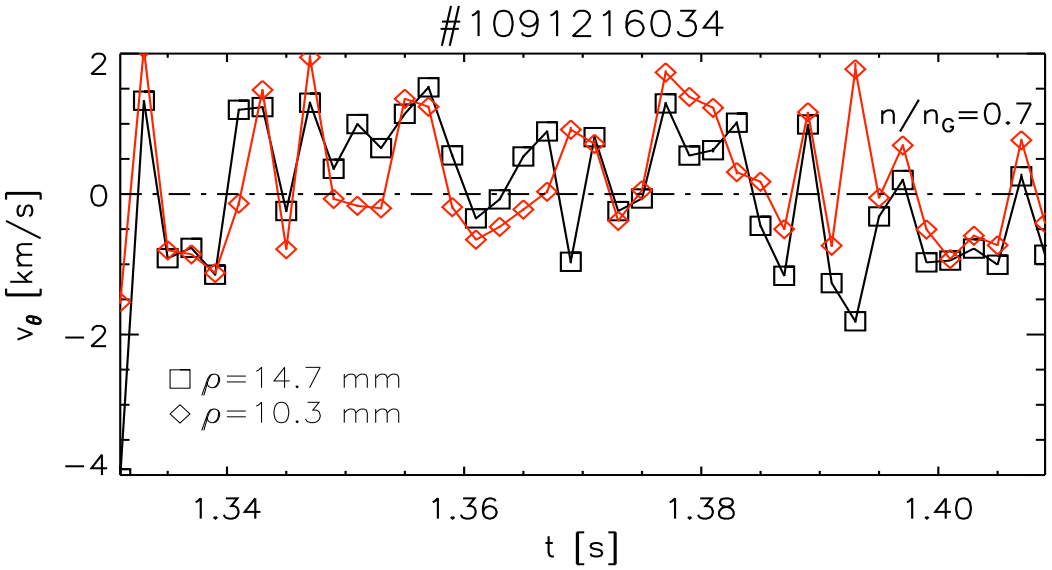
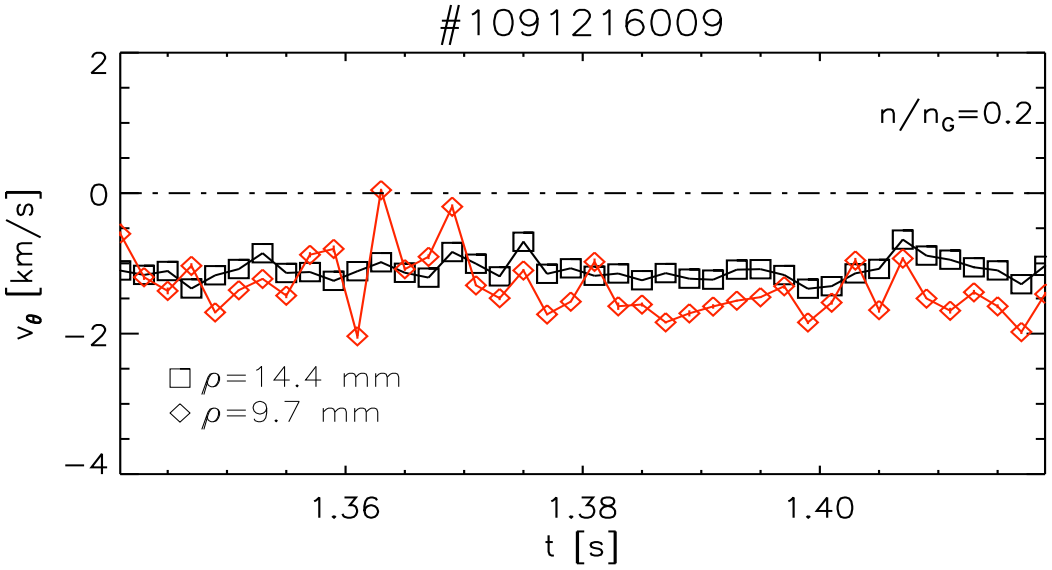


- ✓ SOL Radial velocity increases with increasing n/n_G
- ✓ Possible increase of the radial transport due to edge fluctuations
- ✓ For n/n_G>0.3-0.4 poloidal velocity can invert its sign: from **ion** to **electron** diamagnetic drift direction
- ✓ Common "density threshold"?
- ✓ Same threshold in n/n_G for edge behavior found in MAST and RFX-mod experiments

*[P.Scarin et al., JNM **363-365** 669 (2007)*
*G.Y.Antar et al., PoP **12** 08253 (2005)]*

VELOCITY TIME BEHAVIOR





- ✓ SOL velocity fluctuates in time during the discharge
- ✓ EDD propagation only for high density plasmas

Inversion in the edge velocity at high density not peculiar of Alcator C-Mod: same observations also in RFX-mod RFP device

Common issues in different magnetic configurations ?

SIMILARITY WITH RFX-MOD

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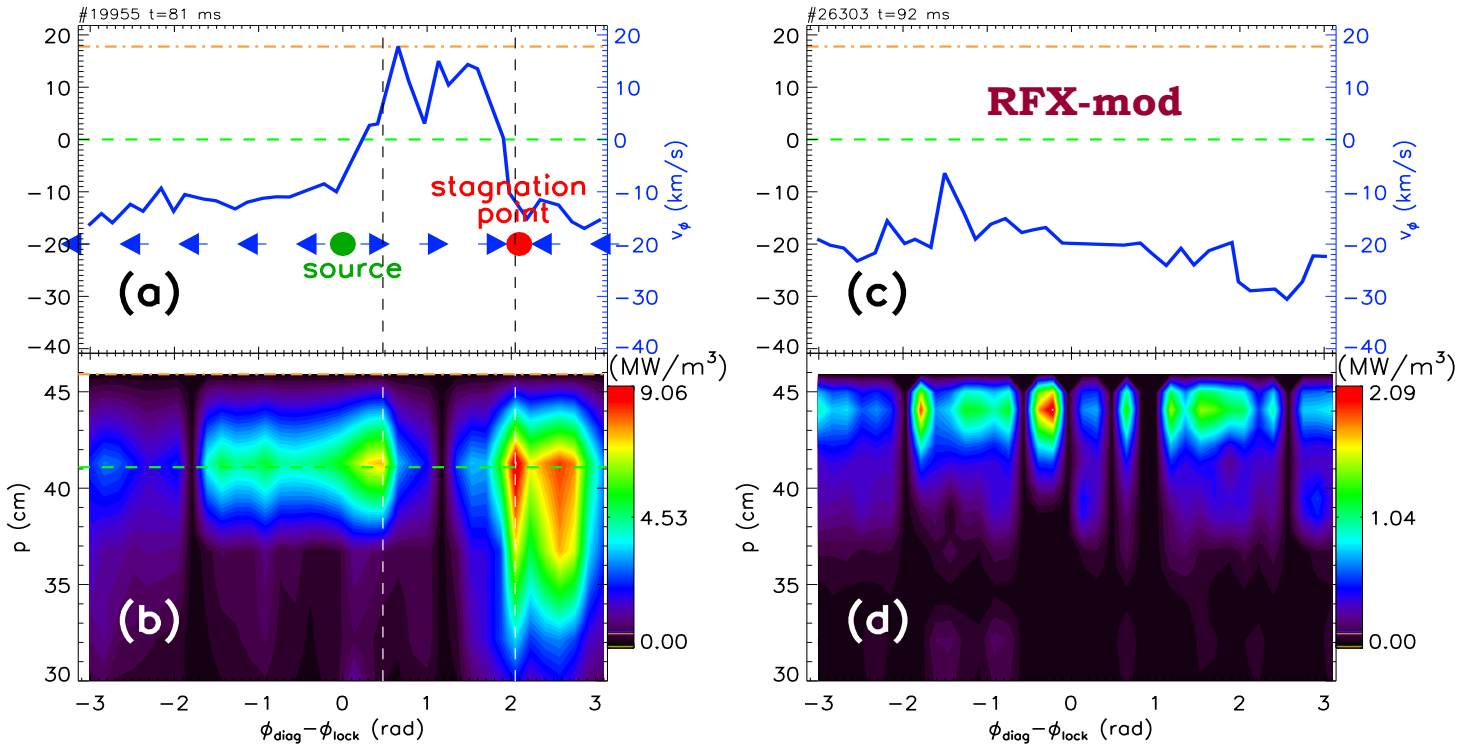
- In RFX-mod local inversion of edge velocity at high density plasma
- Velocity inversion leads to local density accumulation in the edge



- Plasma edge cooling
- Increase of resistivity
- Soft landing of the discharge

*[M.E.Puiatti et al., NF **49** 045012 (2009)*
*G.Spizzo et al., PPCF **52** 095011 (2010)]*

SPATIAL CORRELATION

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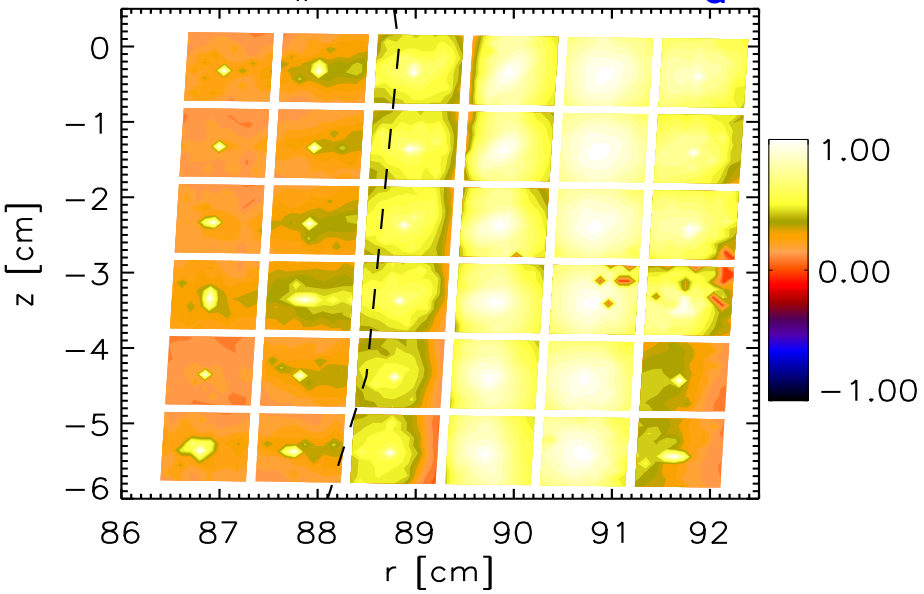
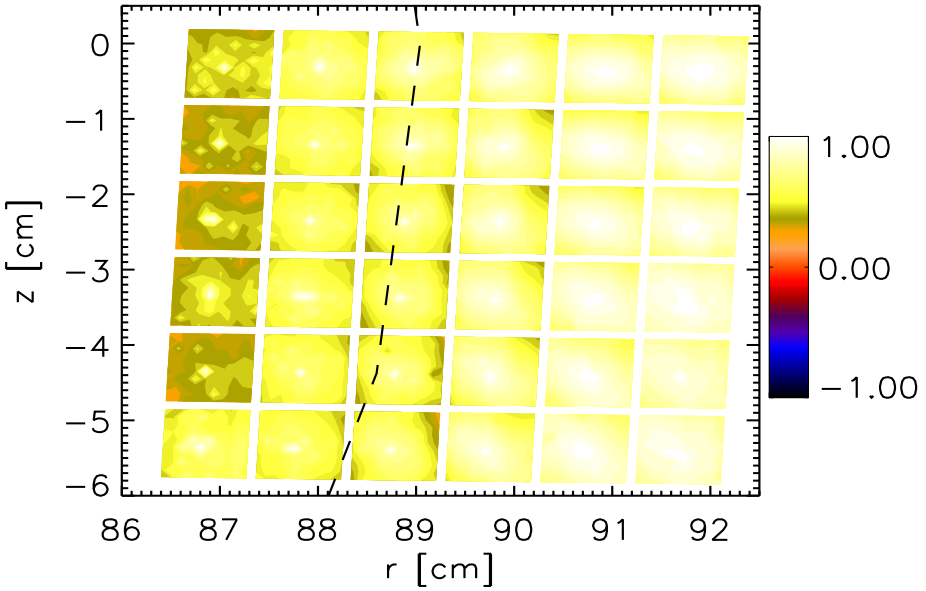
#1090813019 $n/n_G = 0.2$



Spatial correlated fluctuations only outside the separatrix

$n/n_G = 0.6$ #1090826015

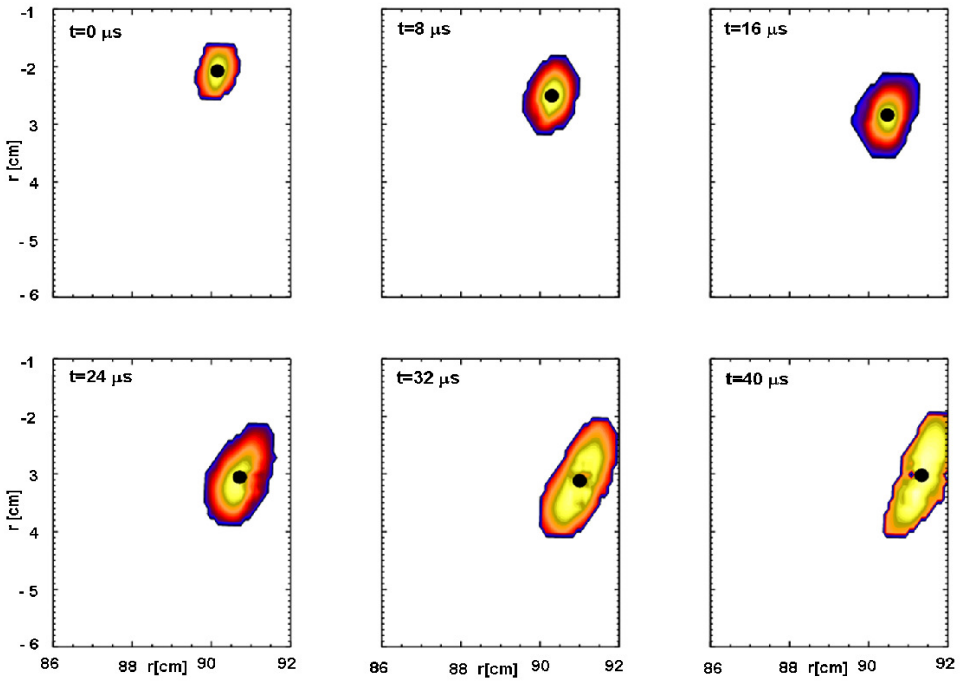


Spatial correlated fluctuations also inside the separatrix

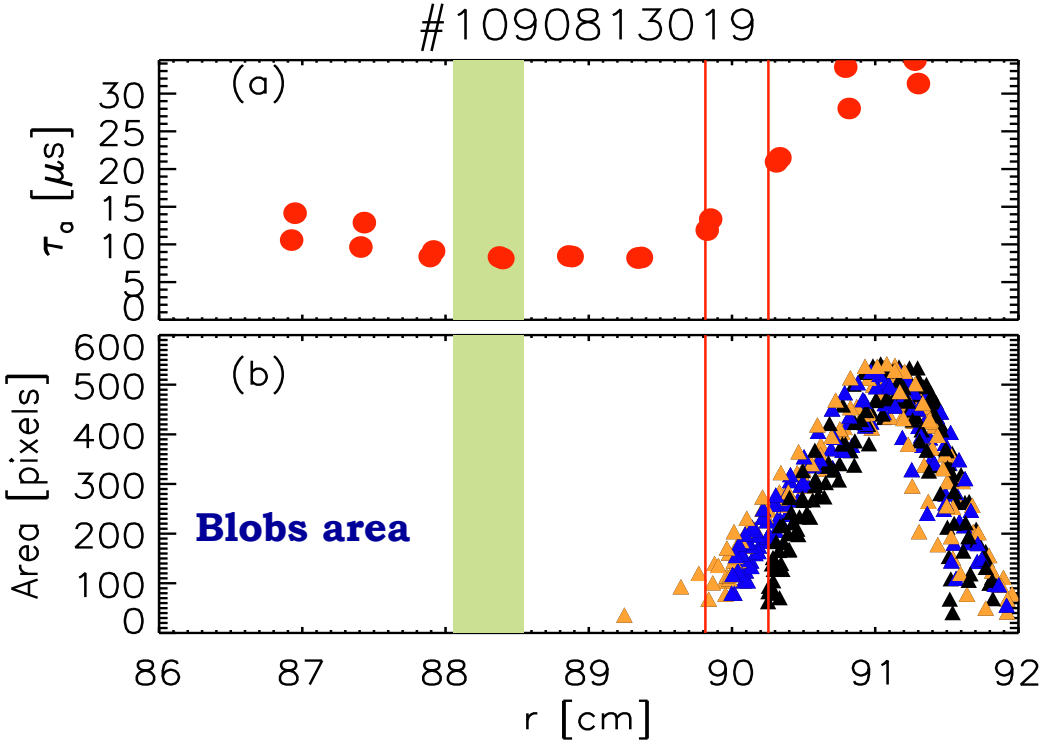
- ✓ At high density correlated fluctuations involve larger area of the plasma edge
- ✓ They involve region inside the separatrix
- ✓ Similar phenomenology found with Langmuir probes

*[B.LaBombard et al., PoP **8** 2107 (2001)]*

2D CONDITIONAL AVERAGE



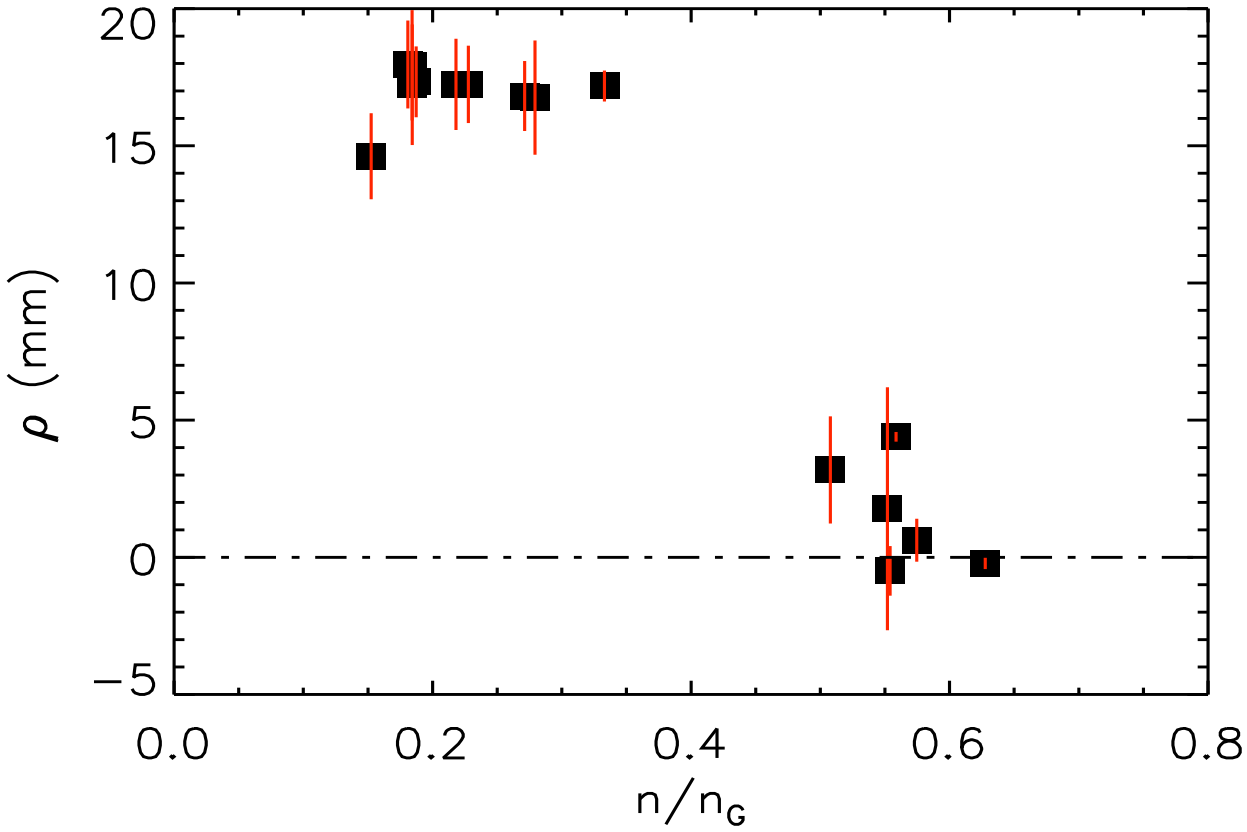
- Space-time evolution of average blob measured with conditional average technique
- Blobs birth region and area are measured



Blobs area increases moving into the SOL

Blobs are detected outside the separatrix where autocorrelation time increases

BLOBS BIRTH REGION



Low density: blobs birth place is 15 mm **outside** the separatrix

High density: birth region moves **near** the separatrix

- Different density regime means different behavior of the edge coherent structures
- At high density blobs birth region moves from SOL to separatrix

[M.Agostini et al., NF, to be published]

CONCLUSIONS

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✓ Properties of the edge fluctuations strongly depend on the normalized density

✓ Density "threshold" at $n/n_G = 0.3\text{-}0.4$

At high density:

✓ SOL fluctuations can change propagation direction: from IDD to EDD

✓ Coherent fluctuations and blobs involve a larger edge area

✓ Blobs birth place close to the separatrix

Perpendicular transport due to edge and SOL turbulence linked with the empirical density limit

Common behavior and similar physics mechanism with other experiments?