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Blob control by convective cells

- Basic plasma physics devices can help understanding electrode biasing effects
- In TORPEX, we achieved control of profiles and blobs using toroidal/poloidal asymmetric biasing
- Radial and vertical blob velocities are significantly modified
- Biasing generates a convective cell that
 - is fairly uniform along B
 - is shifted w.r.t. the position of the biased flux tube due to plasma flows
 - is limited in magnitude (i.e., $\delta V_{\perp} \ll V_{\text{bias}}$) due to a high level of effective cross-field currents

C. Theiler et al, PRL 108, 065005 (2012); C. Theiler et al., Phys. Plasmas (2012)

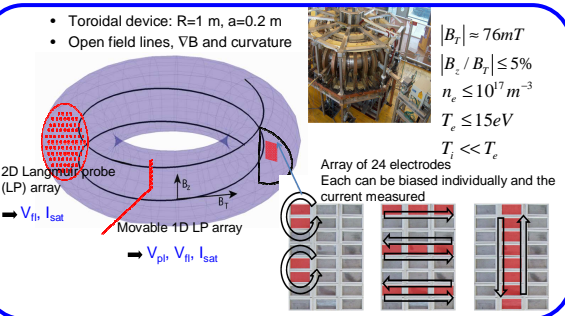
Suprathermal ion dynamics

- Suprathermal ion transport in ideal interchange-mode unstable plasmas is characterized in the simple toroidal plasma device TORPEX using a dedicated suprathermal ion source and detector
- Using numerical fluid simulations, we discover that depending on suprathermal ion energy and turbulence fluctuation level, the transport may exhibit a nature ranging from sub- to super- diffusive
- First experimental data reveal the presence of sub-diffusive and super-diffusive transport

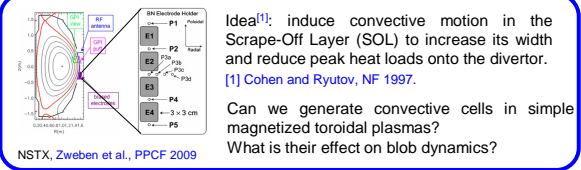
A. Bovet et al., Nucl. Fusion 52 (2012) 094017
K. Gustafson et al., PRL 108, 035006 (2012); K. Gustafson et al., PoP 19, 062306 (2012)

The biasing experimental setup

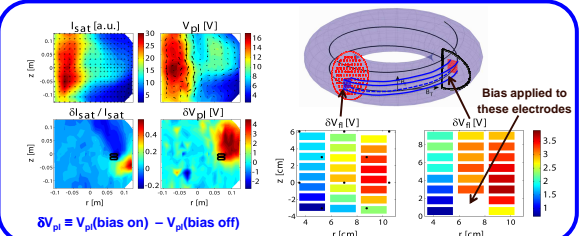
- Toroidal device: R=1 m, a=0.2 m
- Open field lines, ∇B and curvature



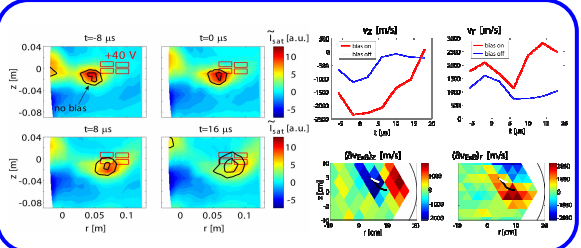
Motivation for asymmetric biasing



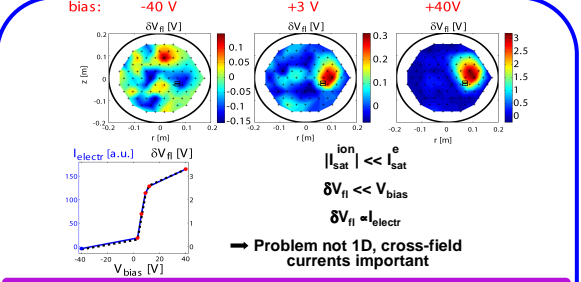
Generation of convective cells



Blob velocity changes consistent with ExB



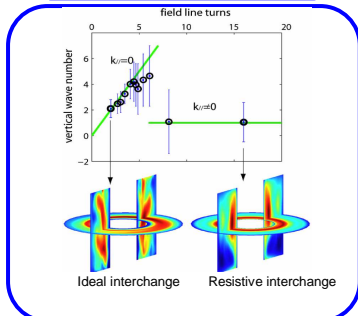
Perpendicular currents are important



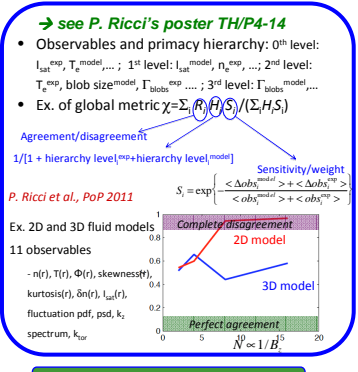
Perpendicular current estimates do not explain observed effect

Analytical estimates for TORPEX parameters yield perpendicular currents too small compared to experimental data. 2D fluid simulations show that polarization drift, ion-neutral collision, or diamagnetic drift cannot explain observed cross-field currents. Kinetic simulations of the biasing experiments will be attempted.

Turbulence regime

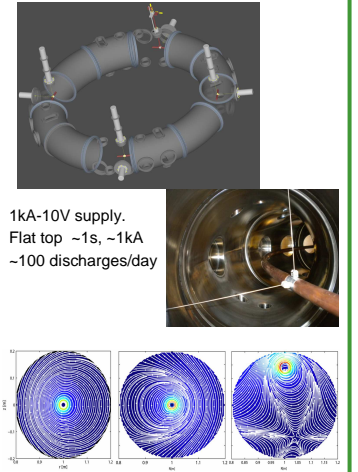


Code validation



OUTLOOK

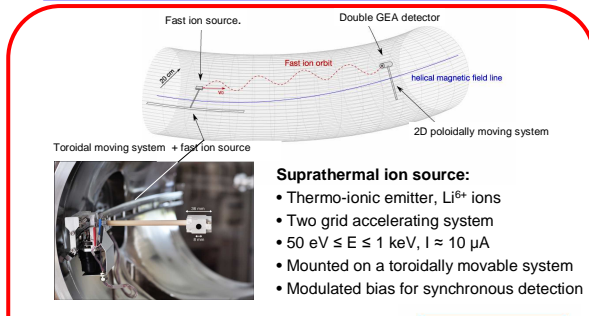
At present, TORPEX can produce SMT configurations. To better mimic the scrape-off-layer and edge magnetic geometry of tokamaks, twisted field line configurations will be created using a toroidal copper wire. The wire is suspended inside the chamber through four insulated 1mm diameter stainless steel wires.



Magnetic geometries with single and double magnetic null-lines as well as, for particular combinations of currents in the existing set of poloidal coils, snowflake divertor.

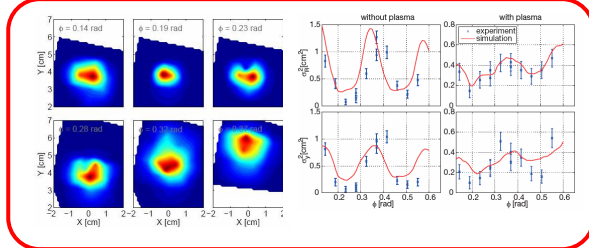
This work is partly supported by the Swiss National Science Foundation

Suprathermal ion experiment - setup



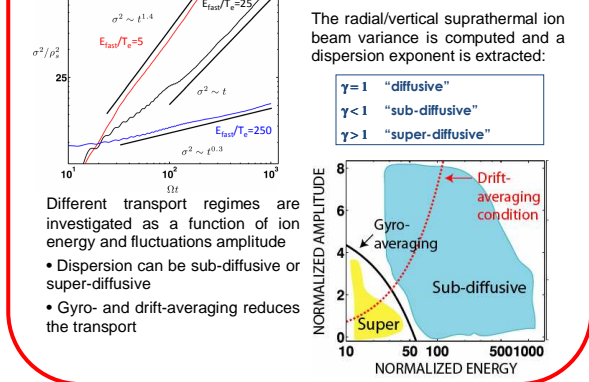
- Suprathermal ion source:**
- Thermo-ionic emitter, Li⁺ ions
 - Two grid accelerating system
 - 50 eV ≤ E ≤ 1 keV, I ≈ 10 μA
 - Mounted on a toroidally movable system
 - Modulated bias for synchronous detection

Experimental results



Theory and transport regimes

Suprathermal ion tracers are injected in simulated 2D ideal interchange driven turbulence. Trajectories are solved using Lorentz force equation in SMT configuration. Comparison with experiment is made with a synthetic diagnostics.



Evidence of sub- and super-diffusion

