



# Filamentary transport in high-power H-mode conditions and in no/small-ELM regimes to predict heat and particle loads on PFCs for future devices

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J. Madsen and N. Vianello

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6. First we will report a summary of the achievements and then personal comments and plans



I-mode

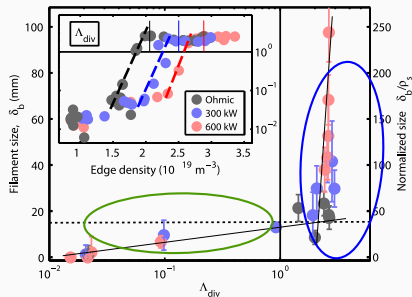
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$$\Lambda_{div} = \frac{L_{||}/c_s}{l/\nu_{ei}} \frac{\Omega_i}{\Omega_e}$$

dominates this process and a transition from **sheath-limited** to **inertial regime**



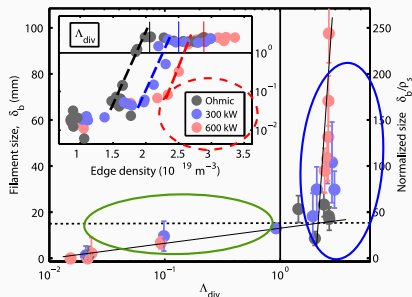


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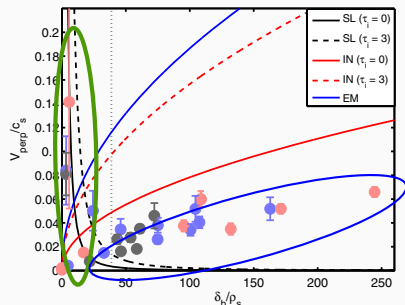


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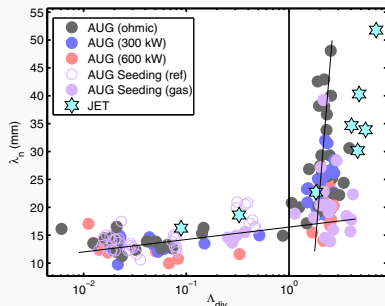


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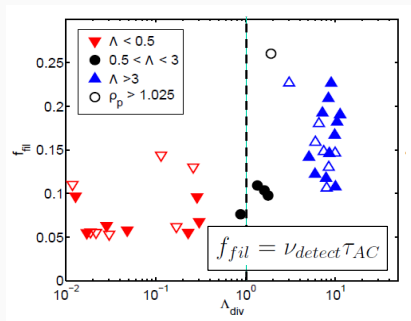
- ✓ Tested by changing  $n_e$  and  $T_e$  through **fueling/seeding/heating**
- ✓ This determines a change of the velocity-size scaling.  $\Lambda_{div}$  **rules the density profile scale length**





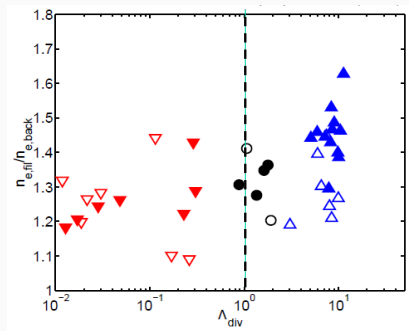
- ✓ Profile modified by increase of blob-size and change of packing

fraction:  $f_{fil} = \nu_{fil} \tau_{AC}$



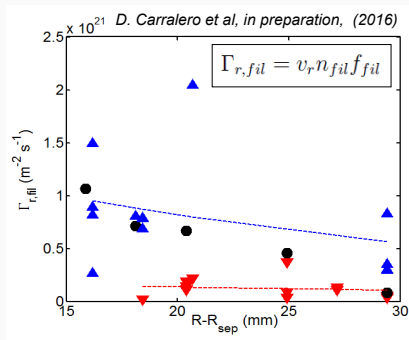


- ✓ Profile modified by increase of blob-size and change of packing fraction:  $f_{fil} = \nu_{fil} \tau_{AC}$  and filament relative density (Carralero 2016 in preparation)





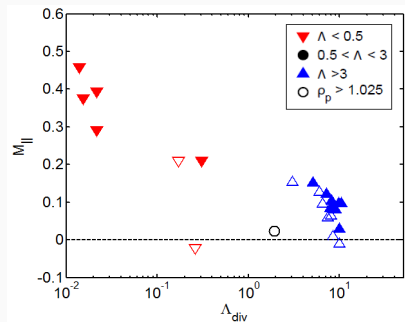
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- ✓ Parallel flow is strongly reduced whenever we increase the divertor collisionality

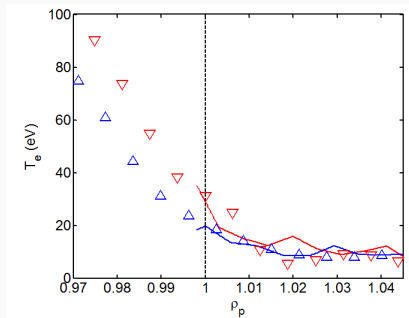




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- ✓  $T_{e,fil} \sim 1.2T_{e,bk}$  roughly constant across the SOL and slightly affected by the increase of divertor collisionality



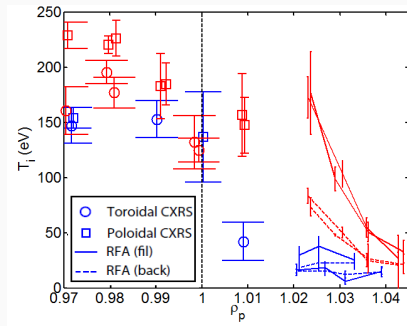


- ✓ Electron and ions behave differently
- ✓ Ions are strongly affected: for  $\Lambda_{div} < 1$

$T_{i,fil} > T_{i,bk}$  and  $\lambda_{T_i} \sim 30$  mm.

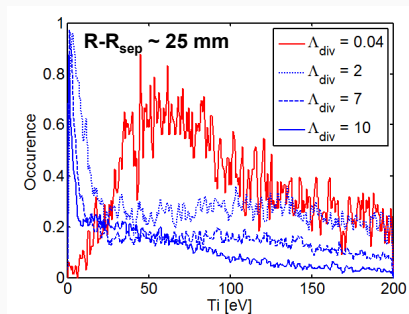
$\Lambda_{div} > 1$   $T_{i,fil} \sim T_{i,bk} \sim 25$  eV and

$\lambda_{T_i} \sim 8$  mm



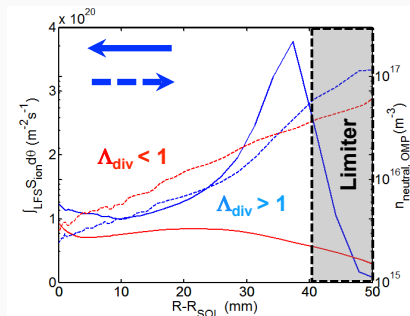


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- ✓ Ion energy spectrum from  $\mathbf{E} \times \mathbf{B}$  analyzer shrinks towards lower energy for  $\Lambda_{div} > 1$
- ✓ EMC3-Eirene simulation suggests that such a reduction can't be accounted for thermalization process. An ionization front builds in front of the limiter shadow





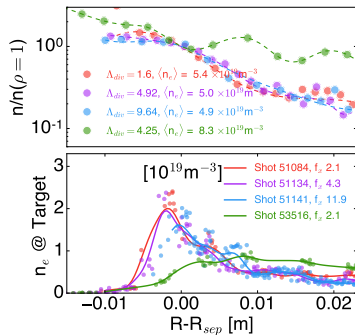
- ✓ Flexibility has allowed to test  $\Lambda_{div}$  dependence on  $L_{||}$  by varying flux expansion  $f_x$ :

$$f_x = \frac{(B_p/B_t)_{MP}}{(B_p/B_t)_{SP}}$$

in ohmic density ramps (Vianello *et al.* 2016)



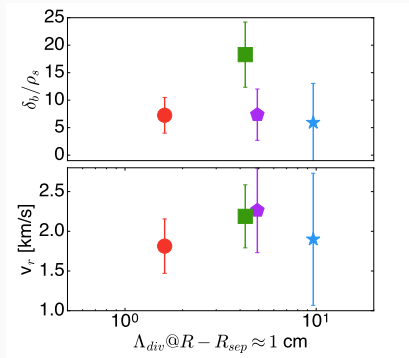
- ✓ Slight variation of density profiles at the target but due to direct dependence on  $L_{||}$  large increase of  $\Lambda_{div}$ . Upstream profiles only varies whenever we reach a certain amount of  $\langle n_e \rangle$





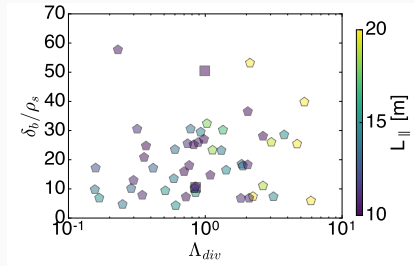


- ✓ Weak dependence of blob-size from  $\Lambda_{div}$ .



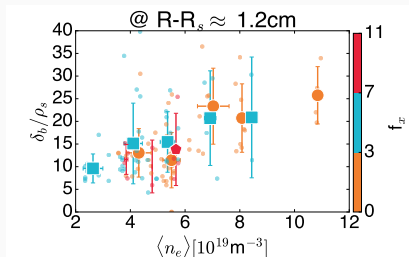


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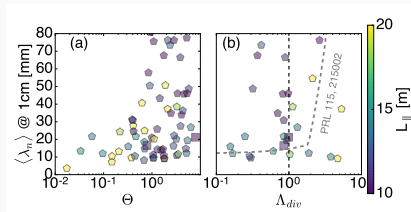


- ✓ Weak dependence of blob-size from  $\Lambda_{div}$ , **also on a statistical basis**. Strong dependence on average density, independent of  $L_{||}$



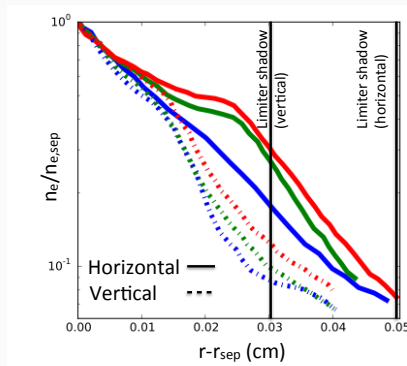


- ✓  $\lambda_n$  depends clearly on blob-size  
whereas the dependence on divertor  
condition is less obvious.  $\Lambda_{div}$   
necessary but not sufficient



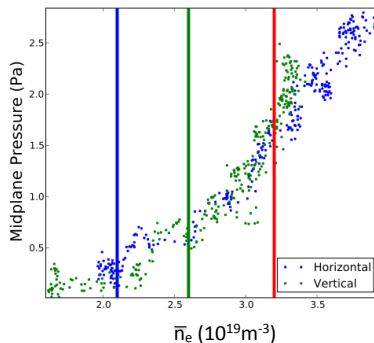


- ✓ The shoulder formation strongly depends on divertor geometry, disappear with vertical target and strike point closest to cryogenics pumps (Wynn *et al.* 2016)



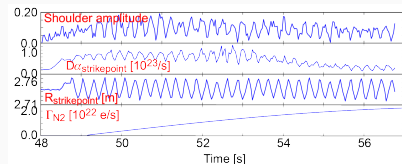


- ✓ The midplane pressure from baratrons is equivalent between the different divertor. This would indicate that SOL neutral density does not play any role



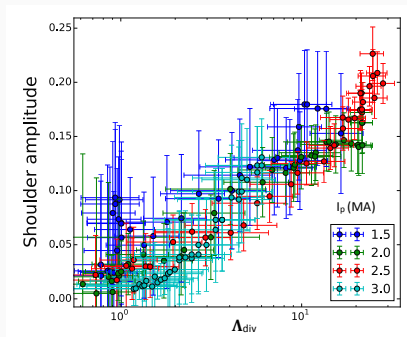


- ✓ In the horizontal target configuration the results indicate that the shoulder forms right at the transition from sheath-limited to high-recycling where also  $\Lambda_{div}$  strongly increase





- ✓ Shoulder amplitude correlates with strike points position. Shoulder, ionization and  $\Gamma_{ion,plate}$  larger when  $R_{strike}$  smaller away from the pump







- ✓ In seeded discharges the transition observed at very high level of  $\Lambda_{div} \gg 1$

