EUROfusion

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

N. Vianello, V. Naulin for Topic-21 Scientific Team

14 November 2017

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Include scientific team and logos

2017 Top Objectives 12.12.2016

Deliverables listed during the call for manning of last December

1. Provide cross-machine L-Mode shoulder dependence on current both at constant B_t and at constant q_{95}
2. Establish robust scenario for density shoulder profile in H-Mode and establish dependence on fuelling/neutral profiles/divertor conditioon
3. Use the new HHF probe on AUG to study filamentary transport under high-power H-Mode conditions and under different plasma configurations (SN, DN)
4. Study the role of ELM regimes, neutral compression and particle density in filamentary transport and related shoulder formation
5. Identify the contribution of collisionality and seeding on filamentary transport and related shoulder formation
6. Determine the effect of filaments and shoulder formation on target heat loads in different H-mode plasmas

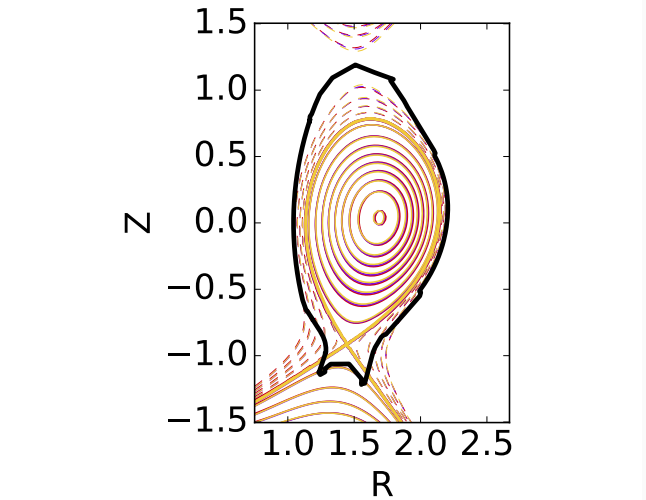
2017 Top Objectives 12.12.2016

Deliverables listed during the call for manning of last December

1. Provide cross-machine L-Mode shoulder dependence on current both at constant B_t and at constant q_{95}
2. Establish robust scenario for density shoulder profile in H-Mode and establish dependence on fuelling/neutral profiles/divertor conditioon
3. Use the new HHF probe on AUG to study filamentary transport under high-power H-Mode conditions and under different plasma configurations (SN, DN)
4. Study the role of ELM regimes, neutral compression and particle density in filamentary transport and related shoulder formation
5. Identify the contribution of collisionality and seeding on filamentary transport and related shoulder formation
6. Determine the effect of filaments and shoulder formation on target heat loads in different H-mode plasmas

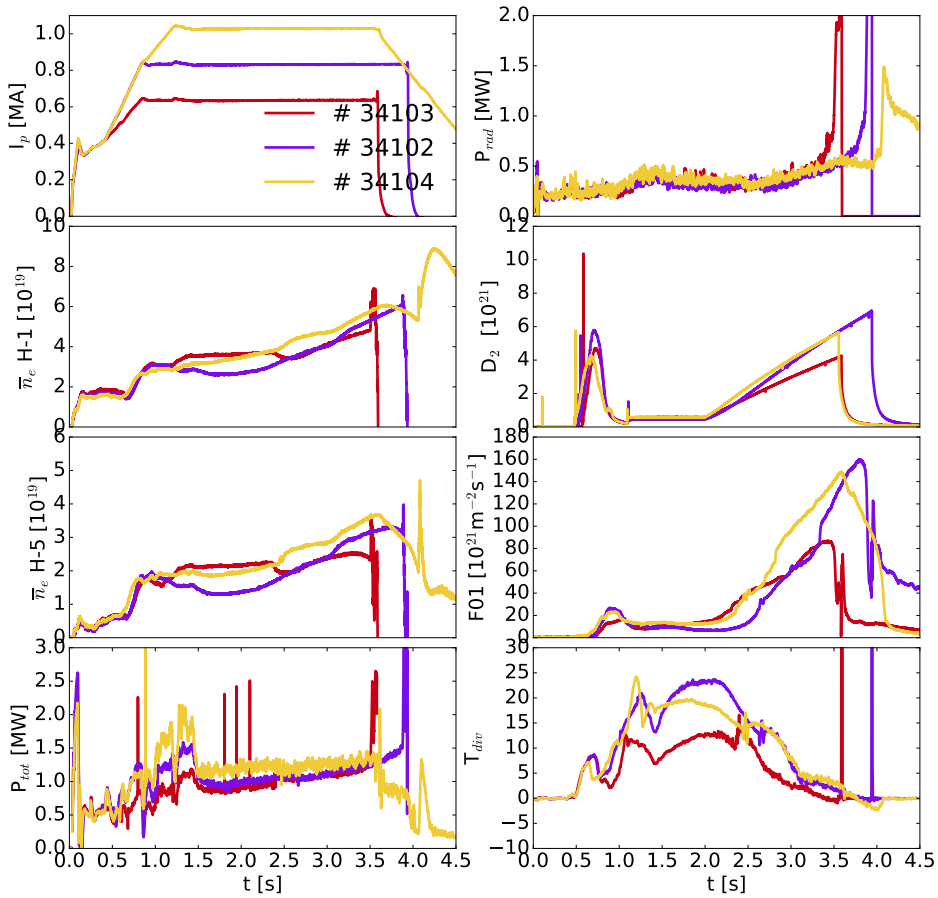
So far H-Mode operation has been limited to AUG since no operational scenarion in high-density NBH heated plasma on TCV has been established

L-Mode analysis: I_p scan at constant q_{95}



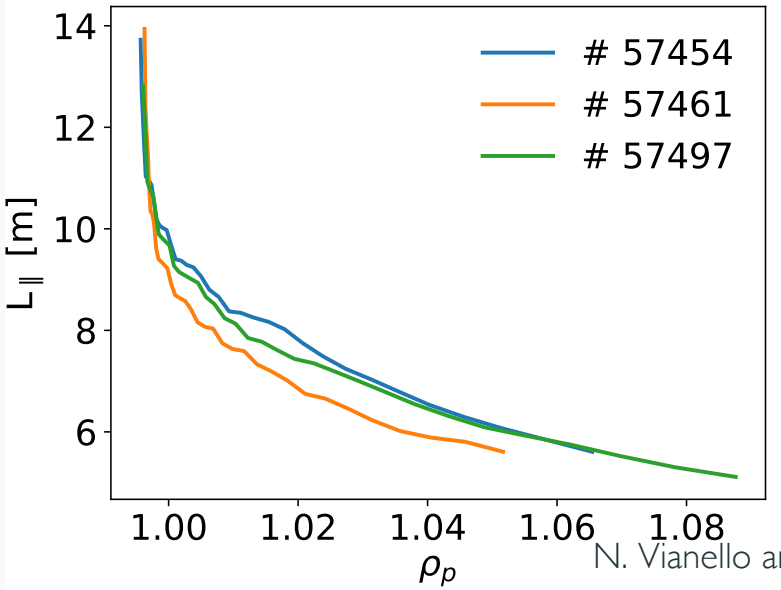
- ✓ AUG: All the shots were performed in the so-called Edge Optmized Configuration (EOC) shape
- ✓ AUG: We matched correctly the shape and the $L_{||}$ here shown from outer divertor plate up to X-point

L-Mode analysis: I_p scan at constant q_{95}



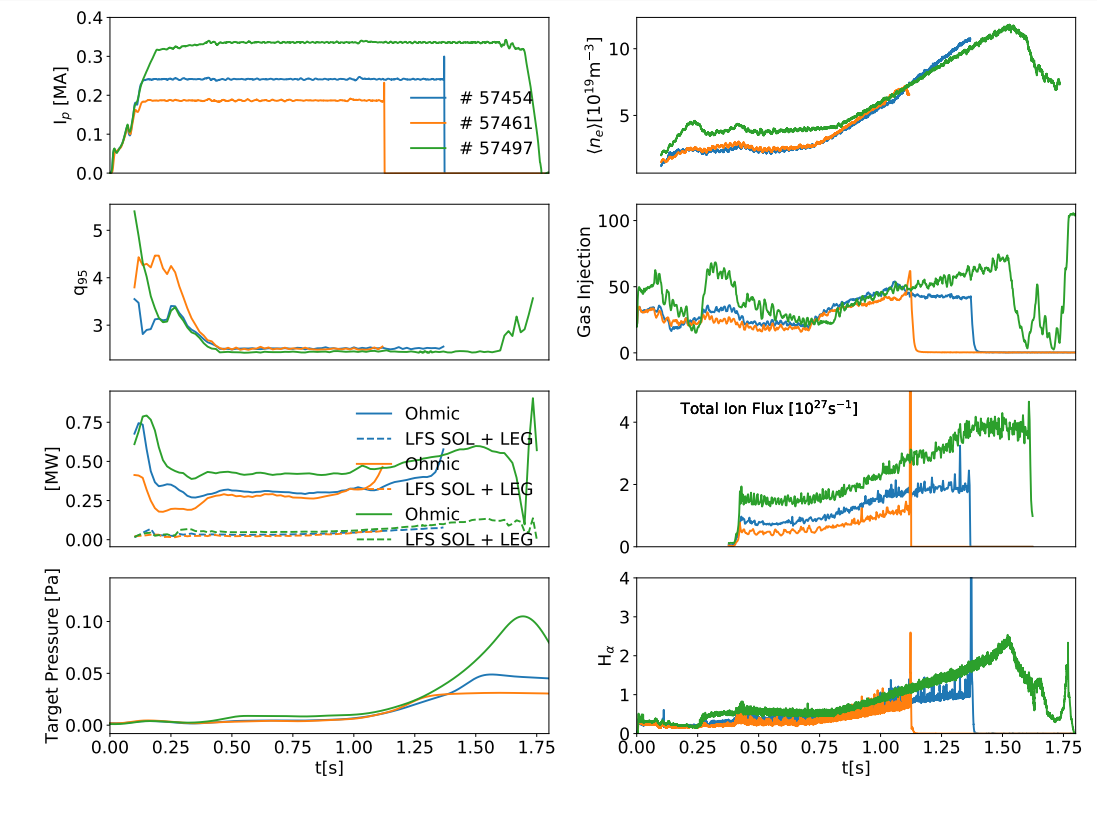
- ✓ AUG: The scan was performed with similar puffing rate (0.8-1 MA) whereas we reduced it at lower current to avoid early disruption
- ✓ AUG: The total power (Ohmic plus NBI) was kept constant throughout the scan
- ✓ AUG: We have comparable edge density, divertor neutral pressure and divertor temperature

L-Mode analysis: I_p scan at constant q_{95}



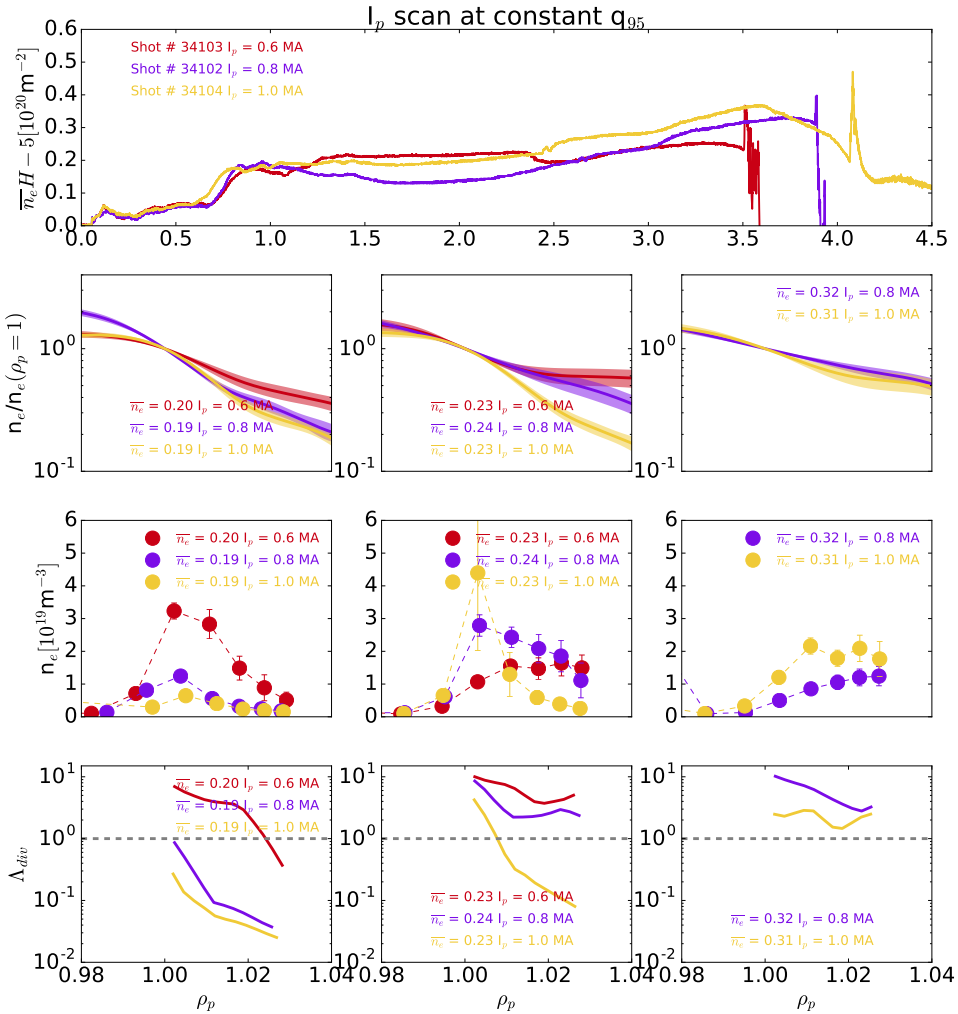
- ✓ TCV: We repeat the same excercise at TCV with a slight difference in the profile of parallel connection length. This required operation at unusual low toroidal field (up to 0.8T)

L-Mode analysis: I_p scan at constant q_{95}



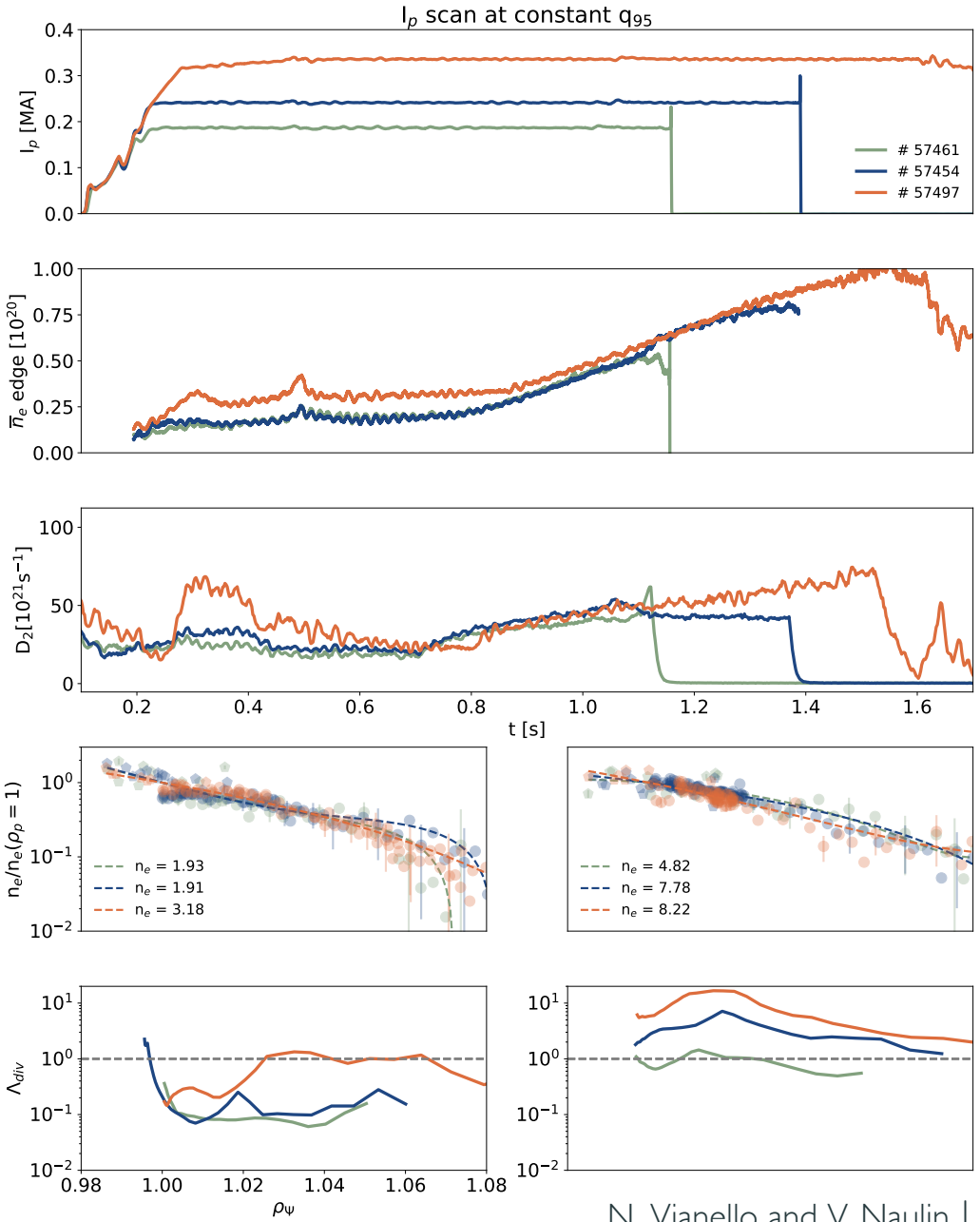
- ✓ TCV: no additional heating used. Nevertheless the difference in power crossing the separatrix is small
- ✓ TCV: The difference in target pressure similar to AUG behavior

L-Mode analysis: I_p scan at constant q_{95}



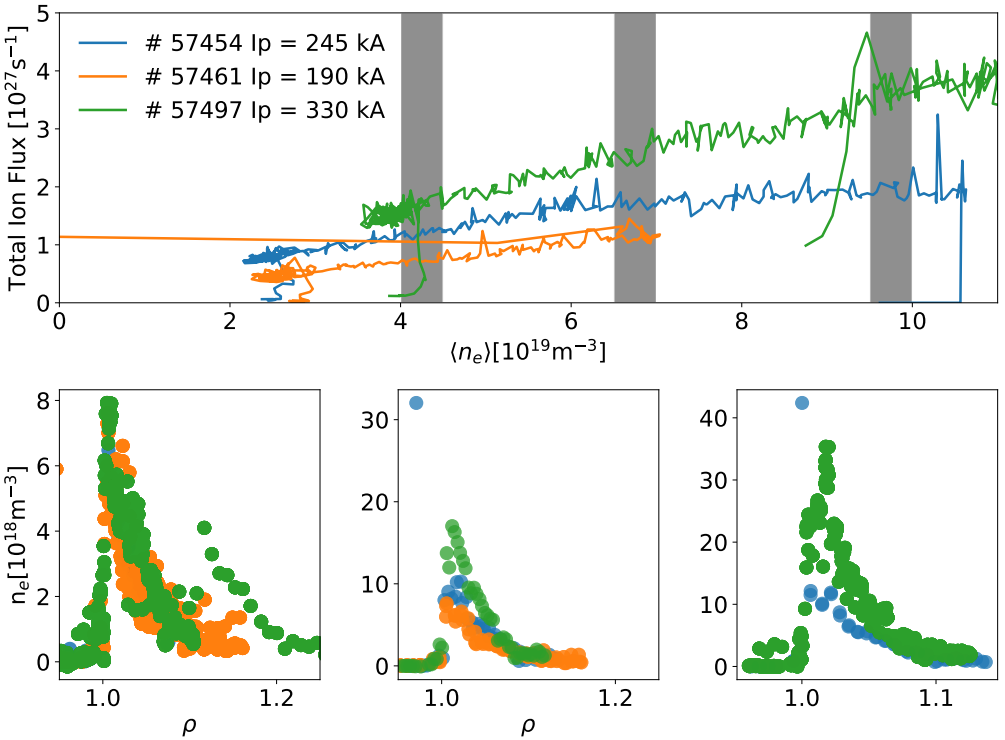
- ✓ AUG: At comparable edge density Upstream profiles are different with the tendency to develop shoulder easier at lower current. We have flattening of the upstream profiles only when Λ_{div} is well above one on all the profile

L-Mode analysis: I_p scan at constant q_{95}



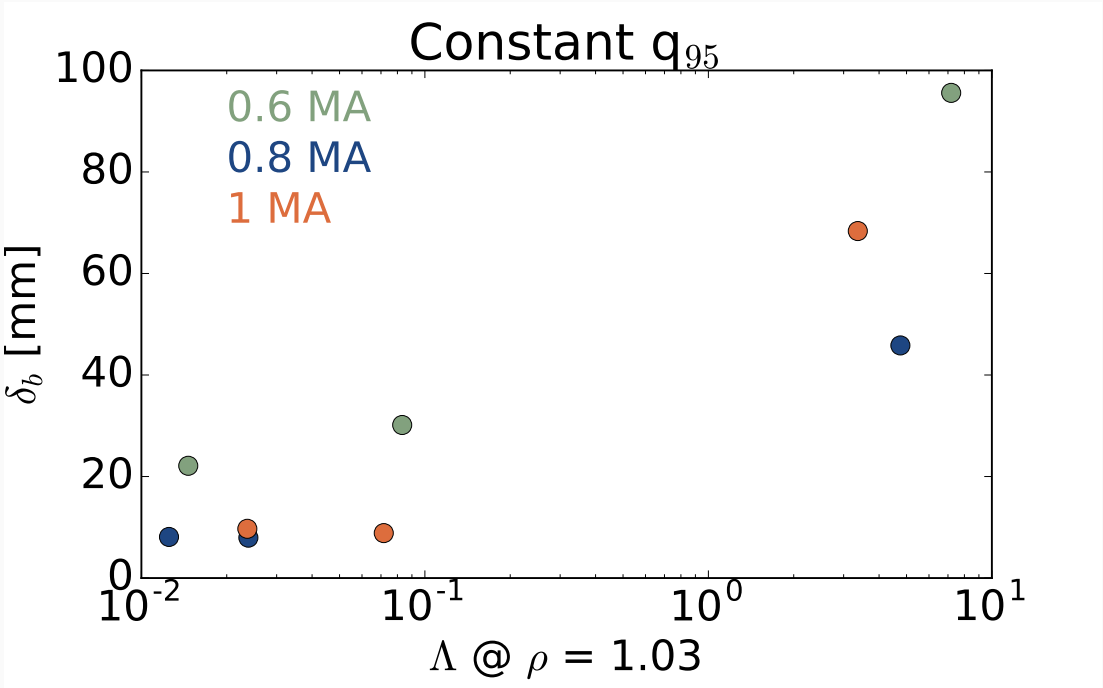
- ✓ TCV: This tendency is not observed for TCV where profiles seem resilient to modification of Bt even though we reached pretty high value of Λ_{div} all along the profile.

L-Mode analysis: I_p scan at constant q_{95}



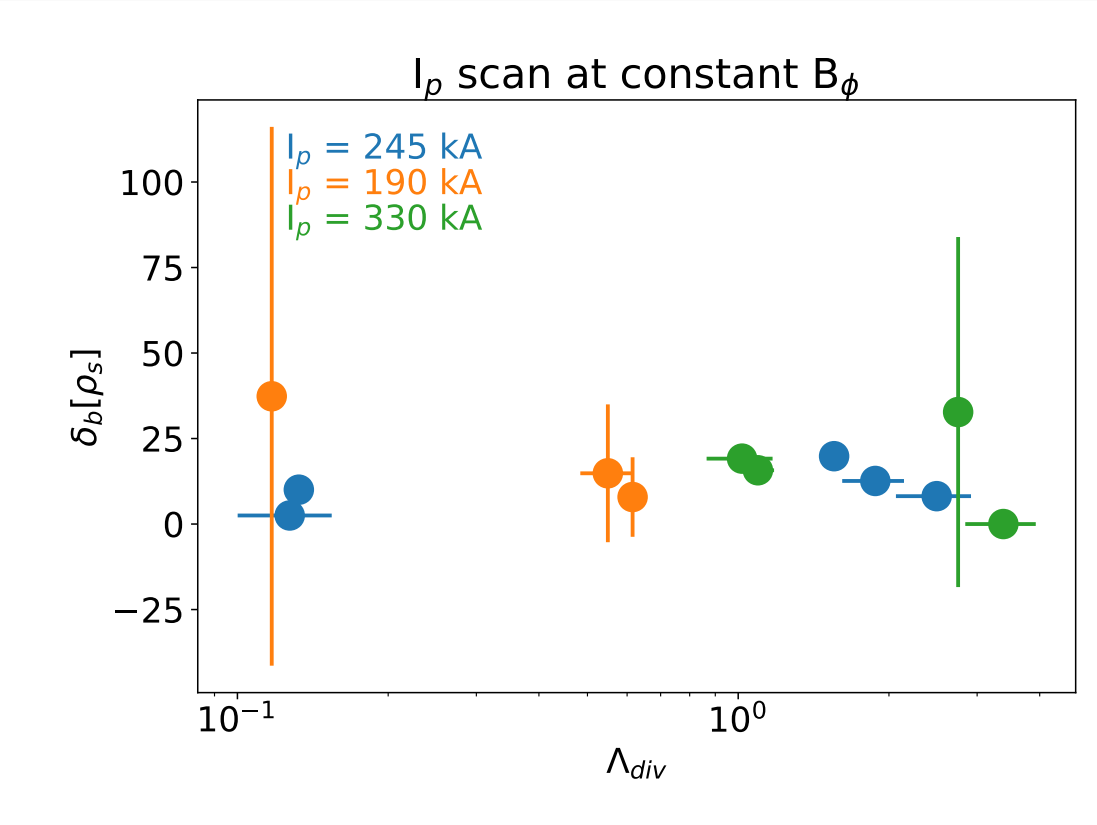
- ✓ TCV: This is due to the fact that we can't observed during the density ramp any signature of rollover or detachment, whereas upstream profile modification at TCV are only observed well after rollover

L-Mode analysis: I_p scan at constant q_{95}



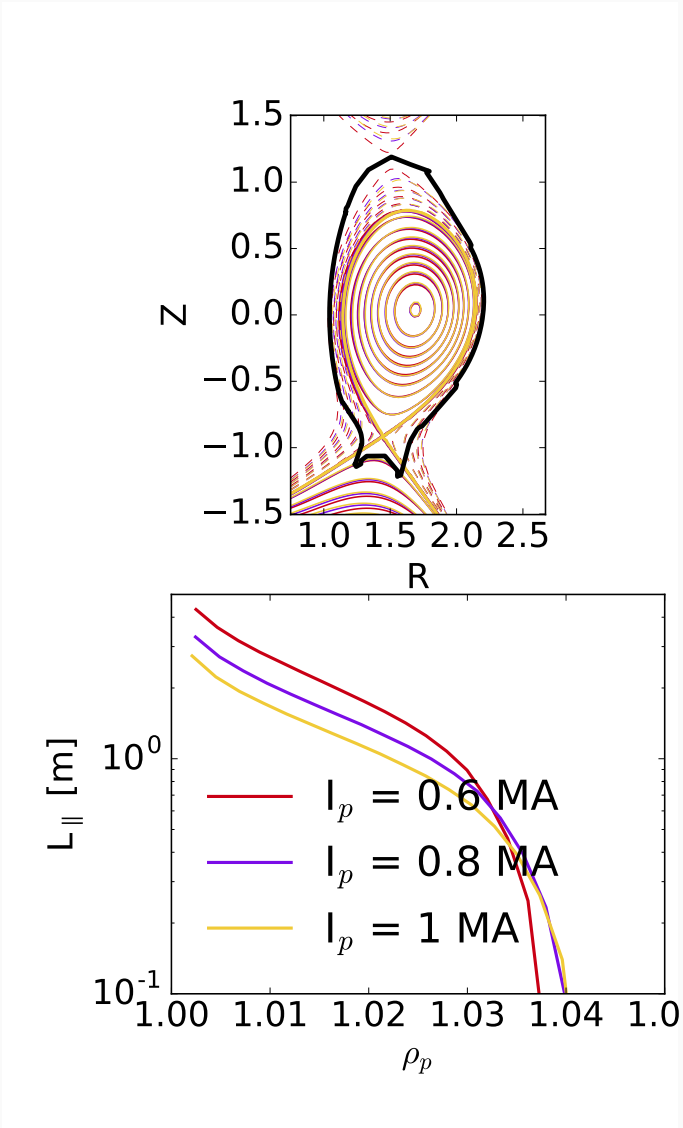
- ✓ AUG: There is the tendency towards larger blobs at lower current

L-Mode analysis: I_p scan at constant q_{95}



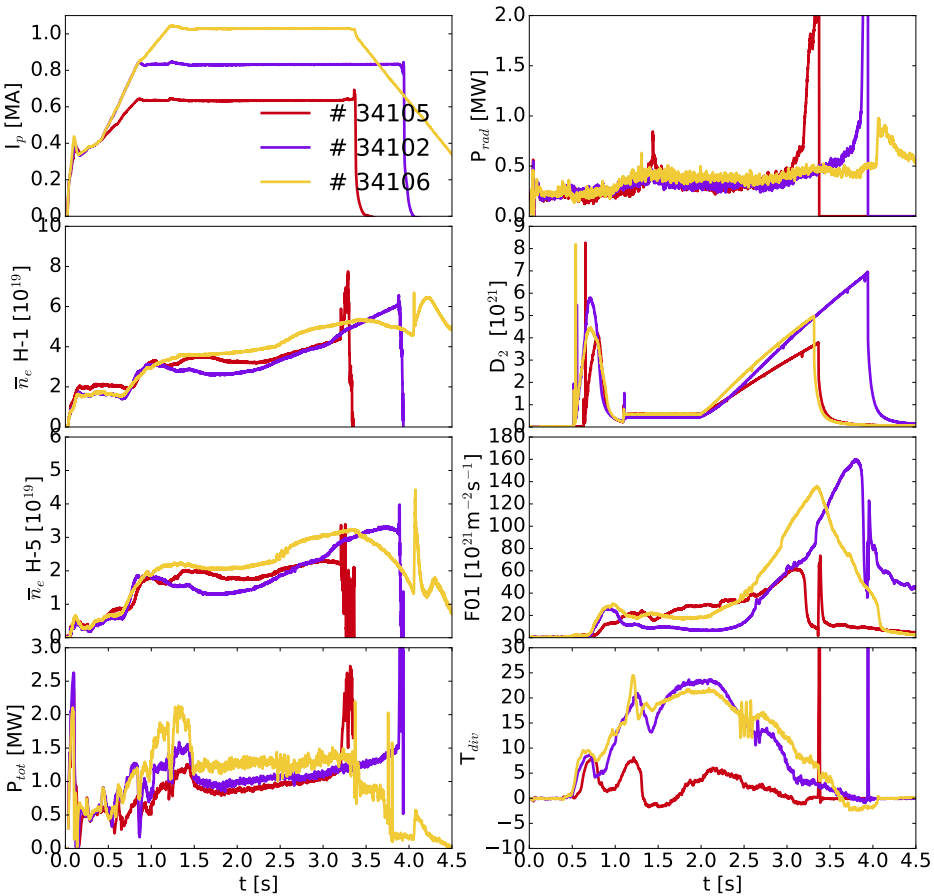
✓ TCV: this is not confirmed for TCV but in line with the lack of shoulder and detachment

L-Mode analysis: I_p scan at constant B_t



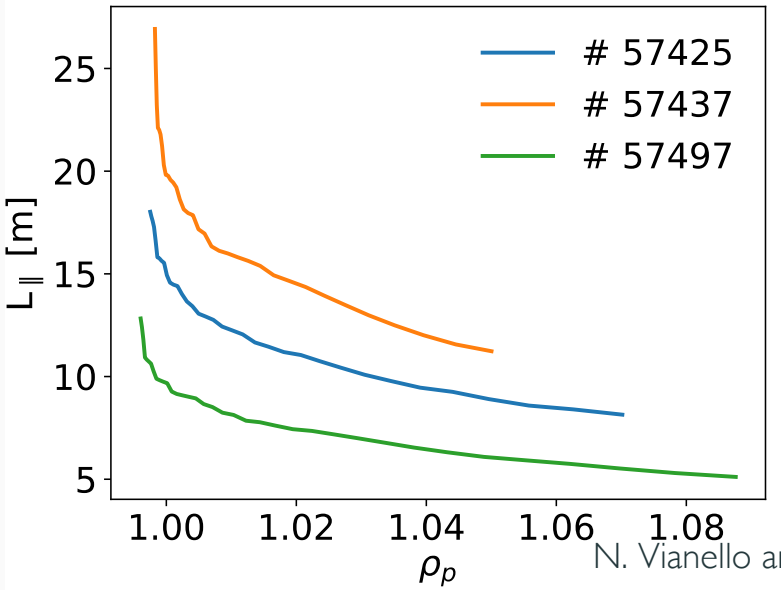
- ✓ AUG: All the shots were performed in the so-called Edge Optmized Configuration (EOC) shape
- ✓ AUG: We matched correctly the shape and the $L_{||}$ here shown from outer divertor plate up to X-point

L-Mode analysis: I_p scan at constant B_t



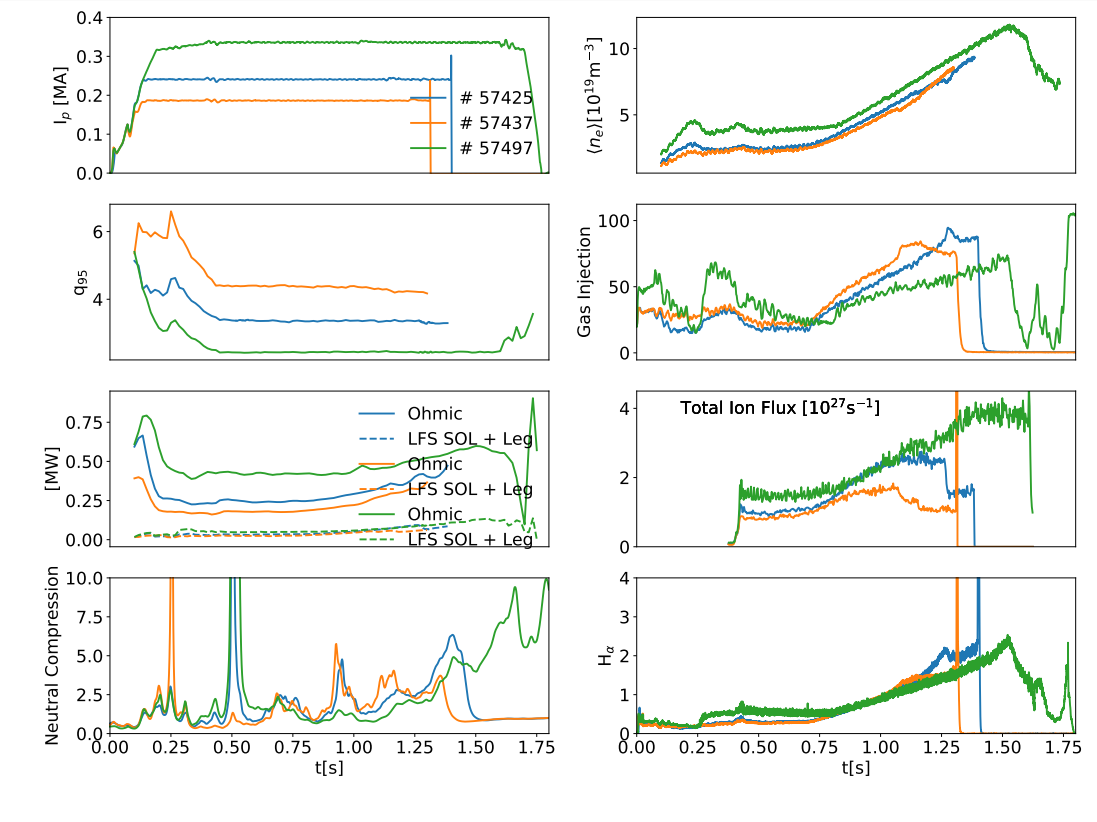
- ✓ AUG: The scan was performed with similar puffing rate (0.8-1 MA) whereas we reduced it at lower current to avoid early disruption
- ✓ AUG: The total power (Ohmic plus NBI) was kept constant throughout the scan
- ✓ AUG: We have comparable edge density, divertor neutral pressure and divertor temperature

L-Mode analysis: I_p scan at constant B_t



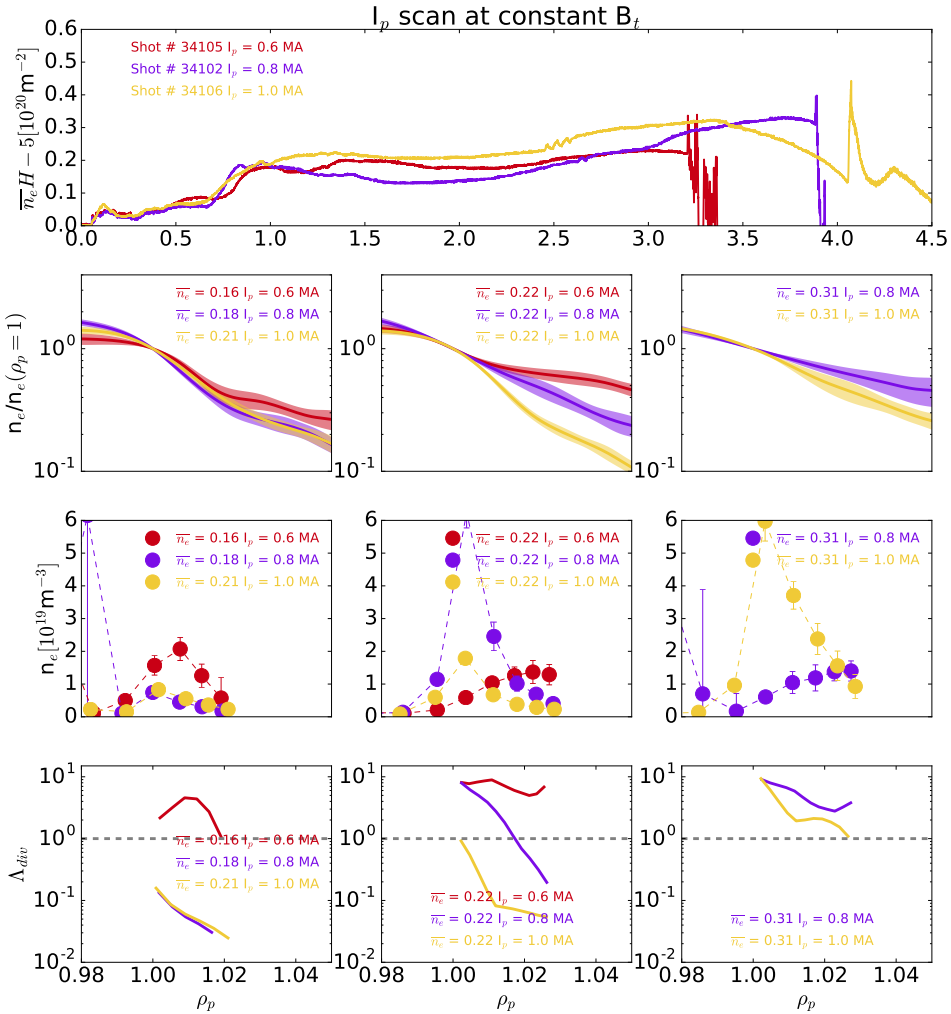
- ✓ TCV: We repeat the same excercise at TCV with a slight difference in the profile of parallel connection length. This required operation at unusual low toroidal field (up to 0.8T)

L-Mode analysis: I_p scan at constant B_t



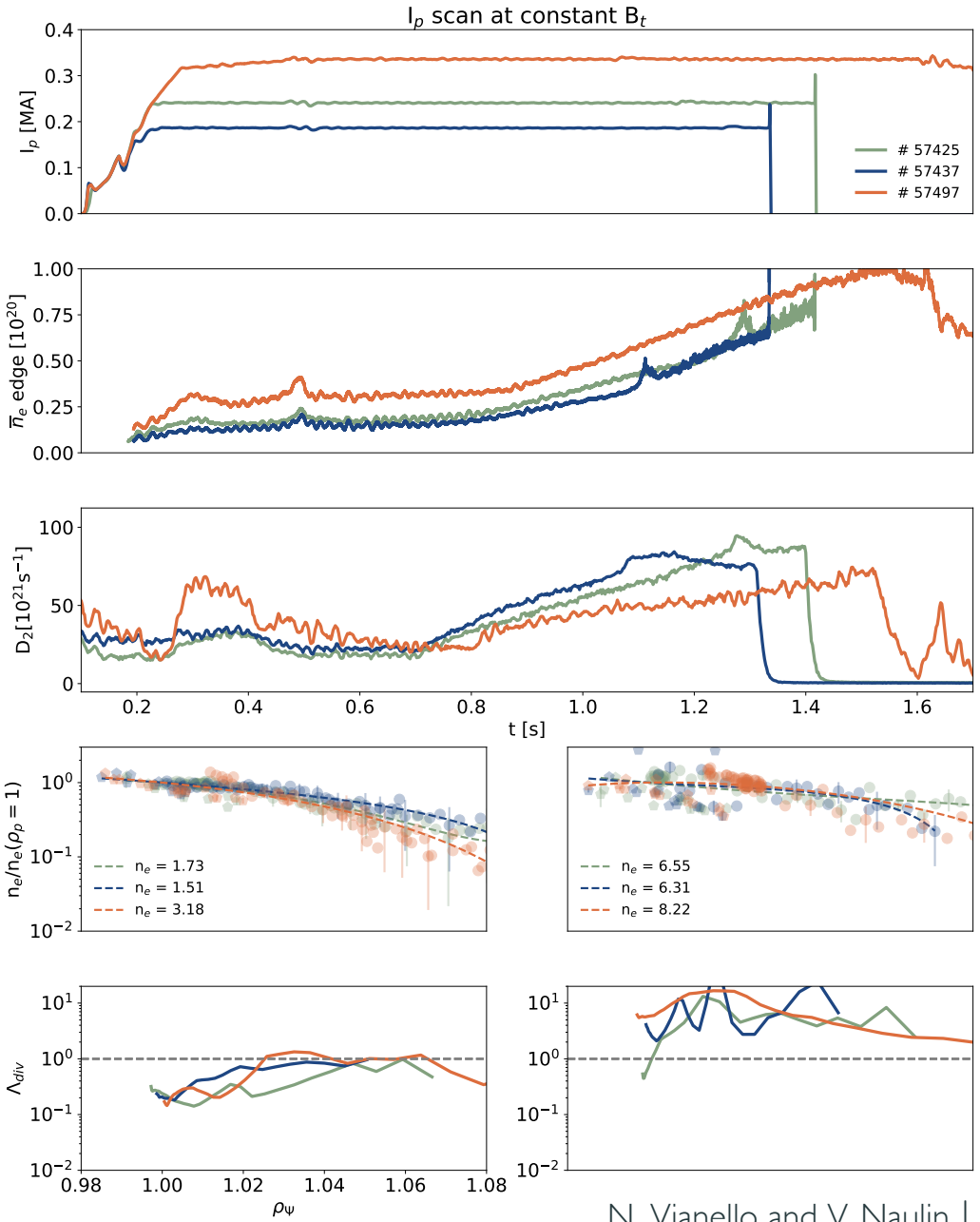
- ✓ TCV: no additional heating used. Nevertheless the difference in power crossing the separatrix is small
- ✓ TCV: The difference in target pressure similar to AUG behavior

L-Mode analysis: I_p scan at constant B_t



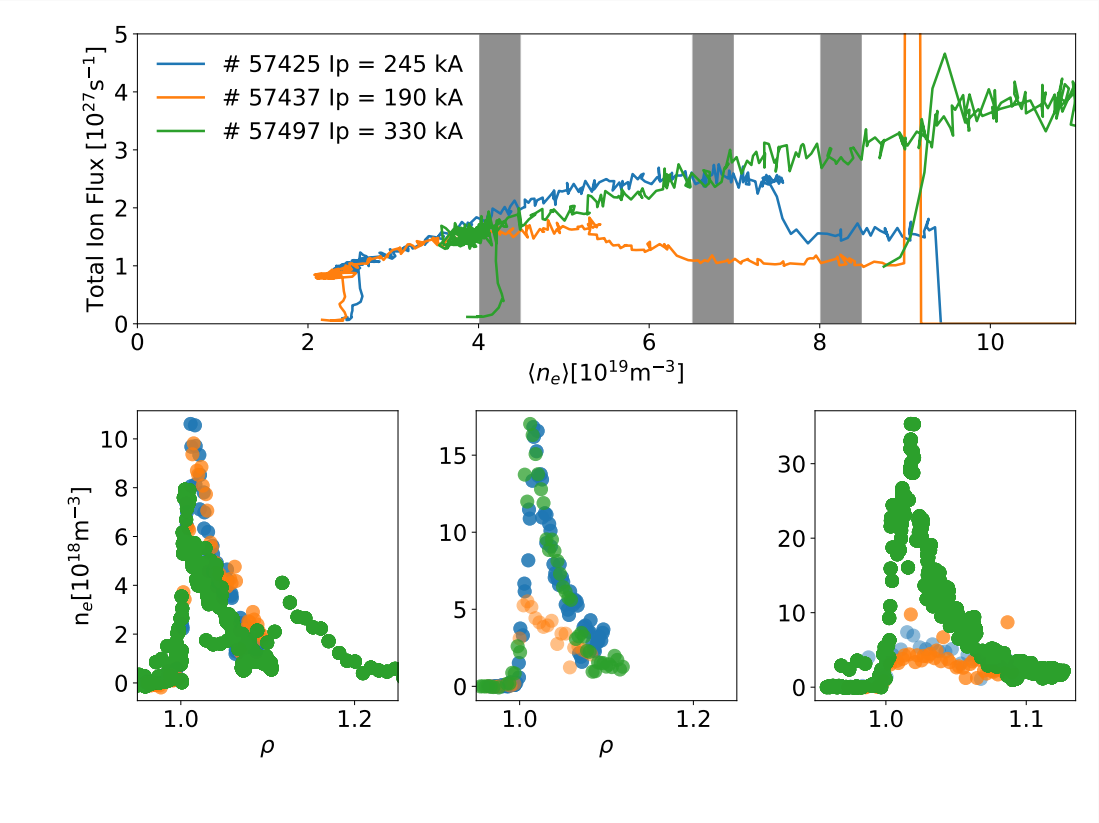
- ✓ AUG: At comparable edge density Upstream profiles are different with the tendency to develop shoulder easier at lower current. We have flattening of the upstream profiles only when Λ_{div} is well above one on all the profile

L-Mode analysis: I_p scan at constant B_t



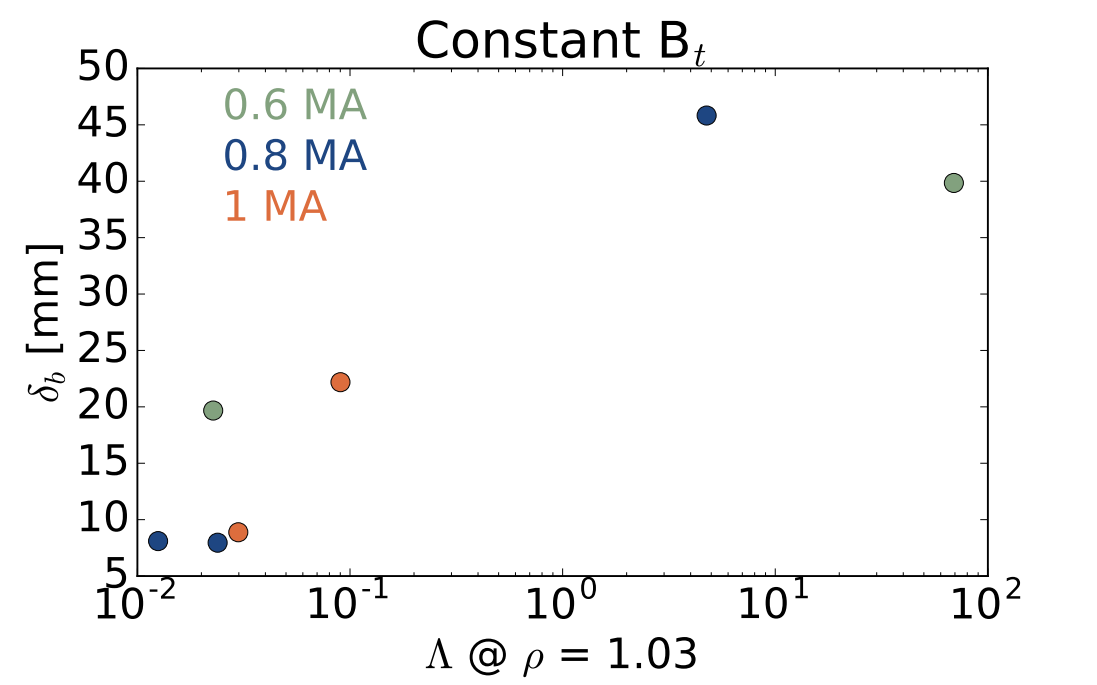
- ✓ TCV: This tendency is not observed for TCV where profiles seem resilient to modification of Bt even though we reached pretty high value of Λ_{div} all along the profile.

L-Mode analysis: I_p scan at constant B_t



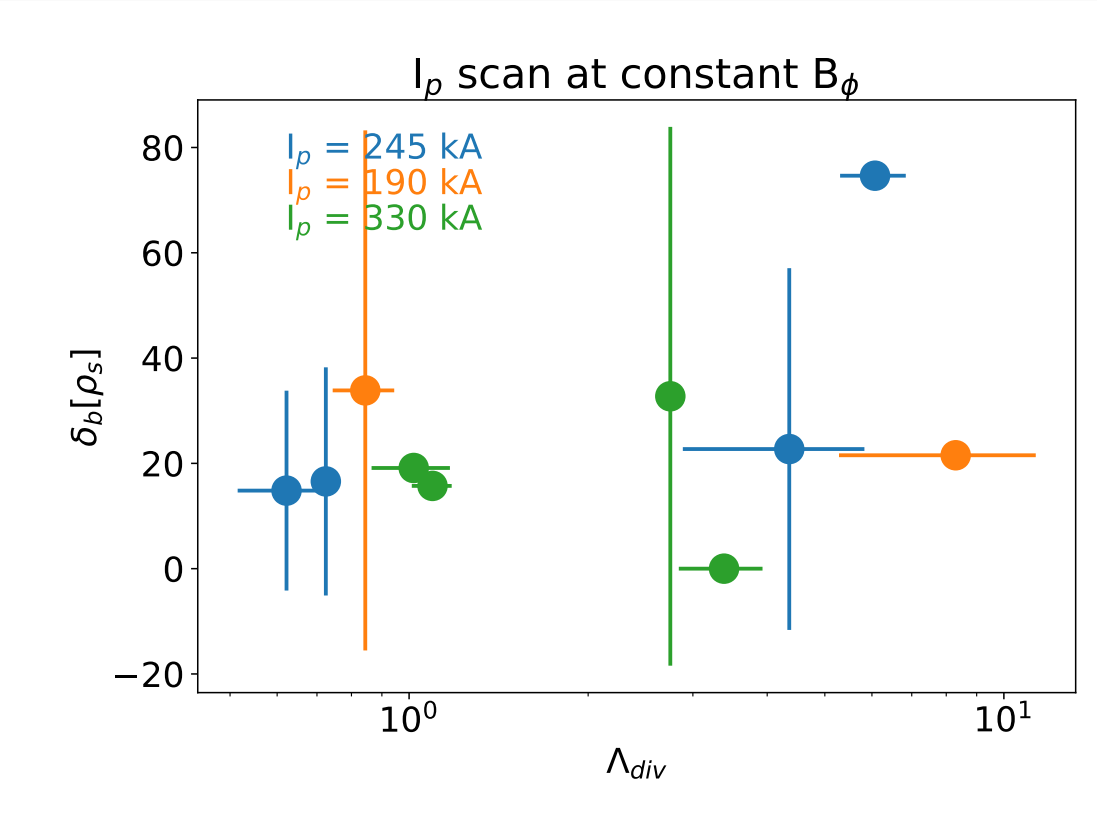
- ✓ TCV: This is due to the fact that we can't observed during the density ramp any signature of rollover or detachment, whereas upstream profile modification at TCV are only observed well after rollover

L-Mode analysis: I_p scan at constant B_t



- ✓ AUG: There is the tendency towards larger blobs at lower current

L-Mode analysis: I_p scan at constant B_t



- ✓ TCV: this is not confirmed for TCV but in line with the lack of shoulder and detachment