Investigation of Correlation Between RMPs and Density Pump-out on MAST and DIII-D

by
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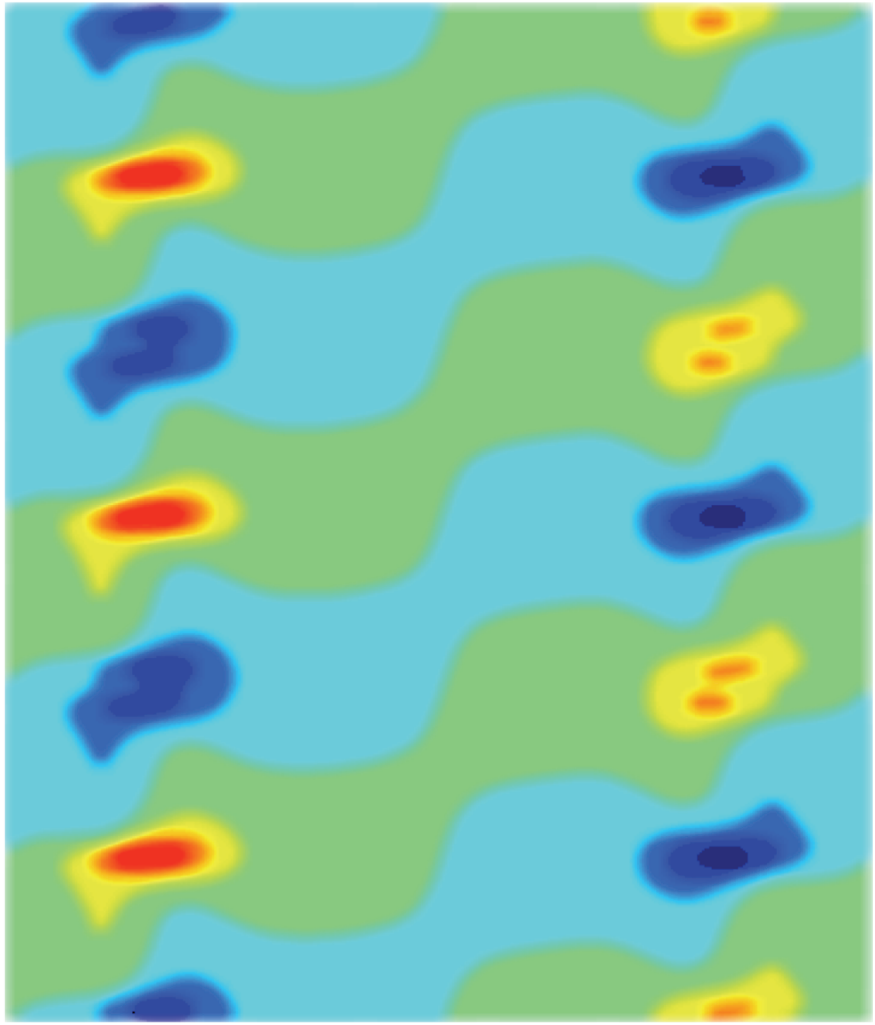
with
E.A Unterberg (ORNL), A. Kirk (UKAEA), R.A. Moyer (UCSD), L.W. Owen (ORNL), E. Nardon (UKAEA) and the DIII-D and MAST teams



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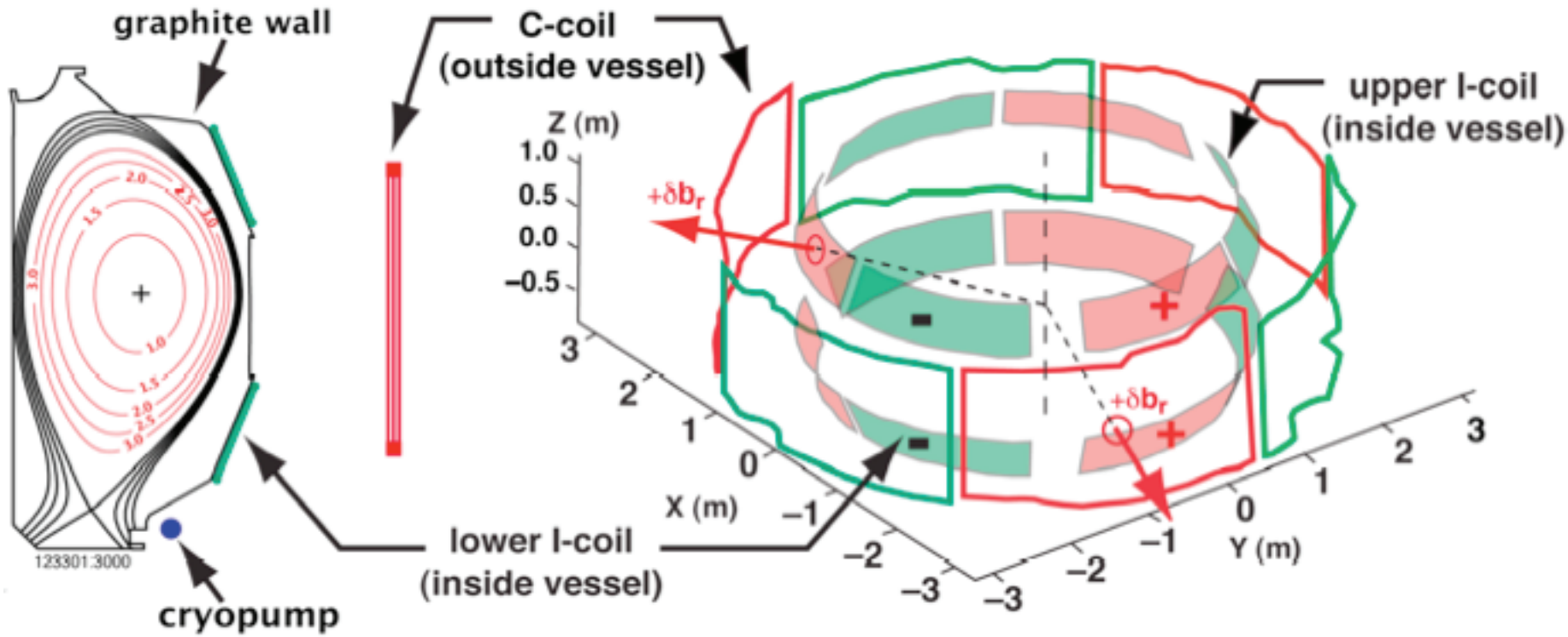
UC San Diego

RMPs suppress ELMs, but also lead to decreased particle confinement

- Resonant Magnetic Perturbations suppress ELMs
- RMPs reduce particle confinement, leading to a density pump-out
- Understanding this change in transport is important for performance in current and future devices

Internal coil (I-coils) system on MAST: 2 rows of 6 coils operated in n=3

- Experiments conducted in low collisionality H-mode



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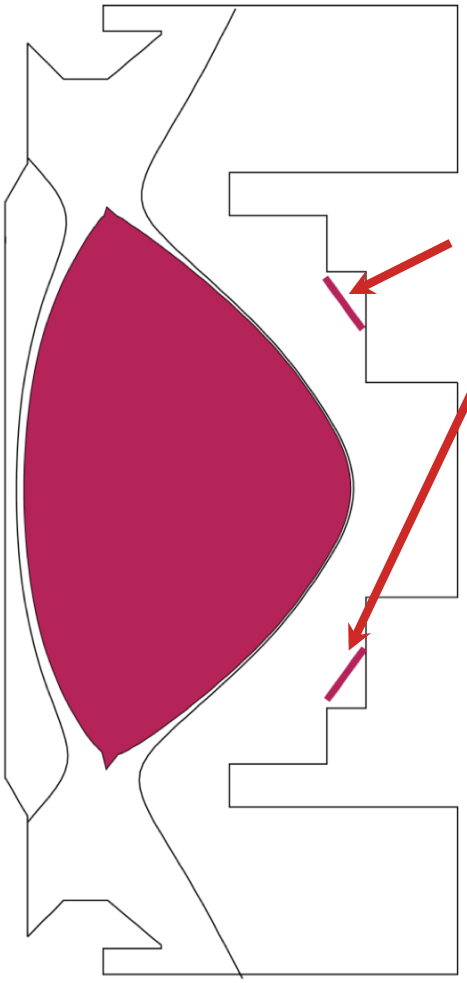
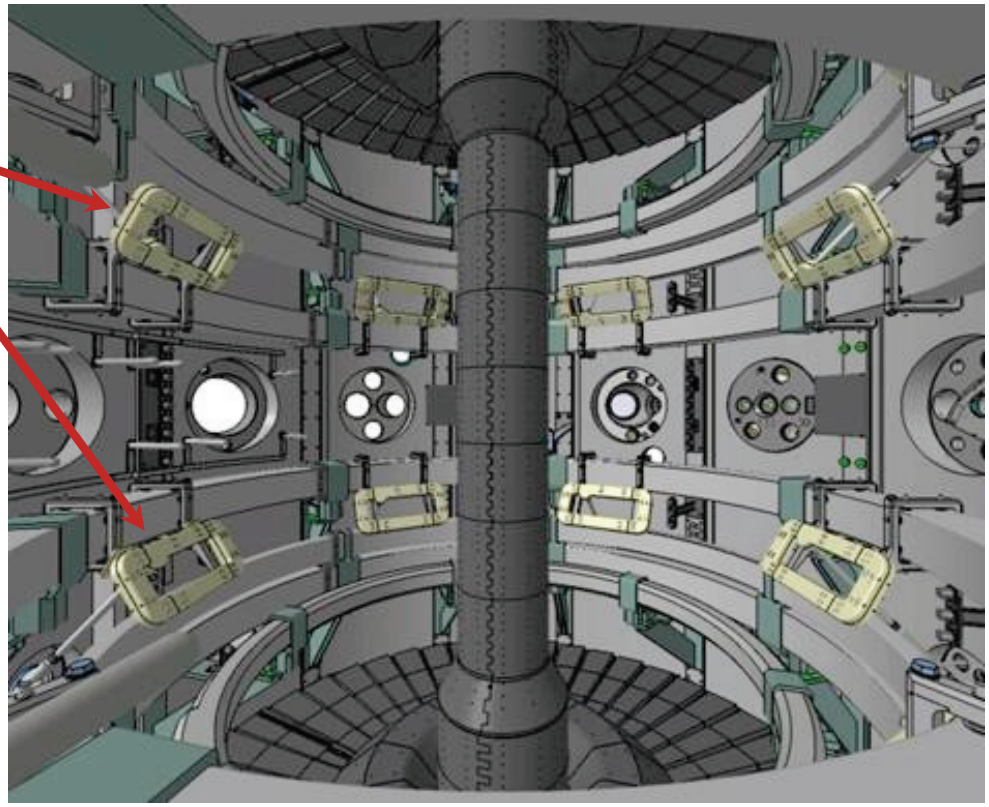


I-coils



Courtesy of E. Nardon (UKAEA)

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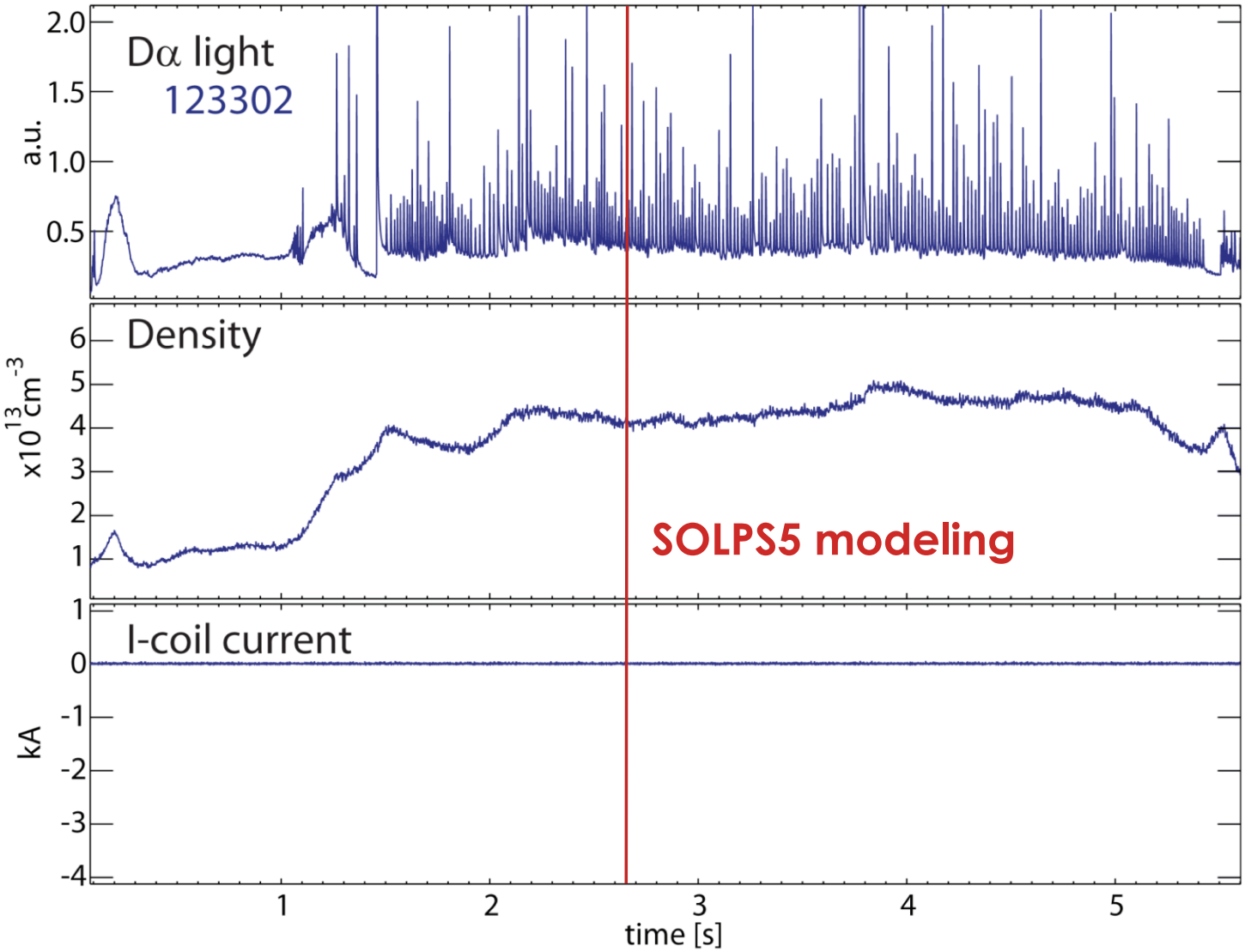
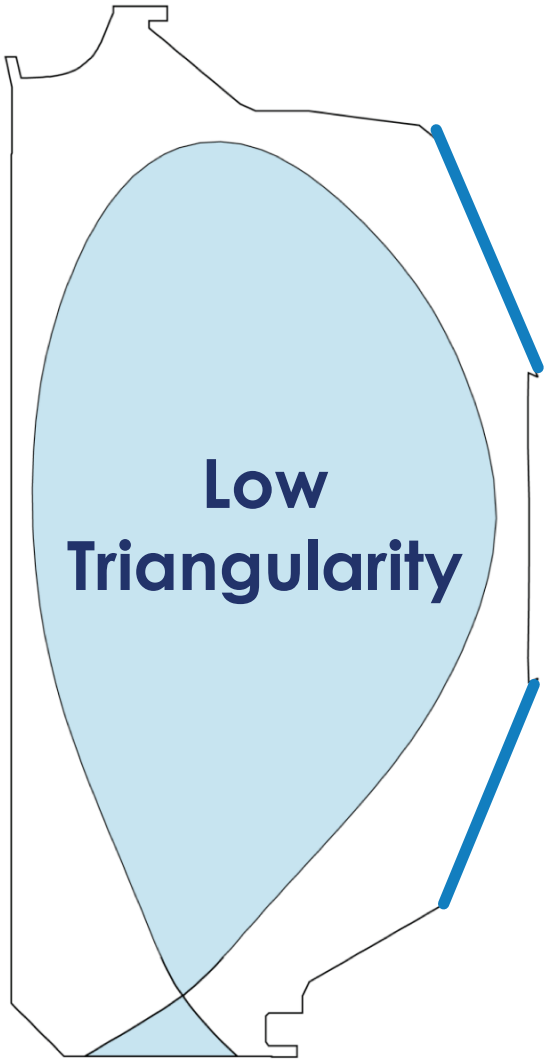
ELM suppression and density pump-out as a result of RMP on DIII-D





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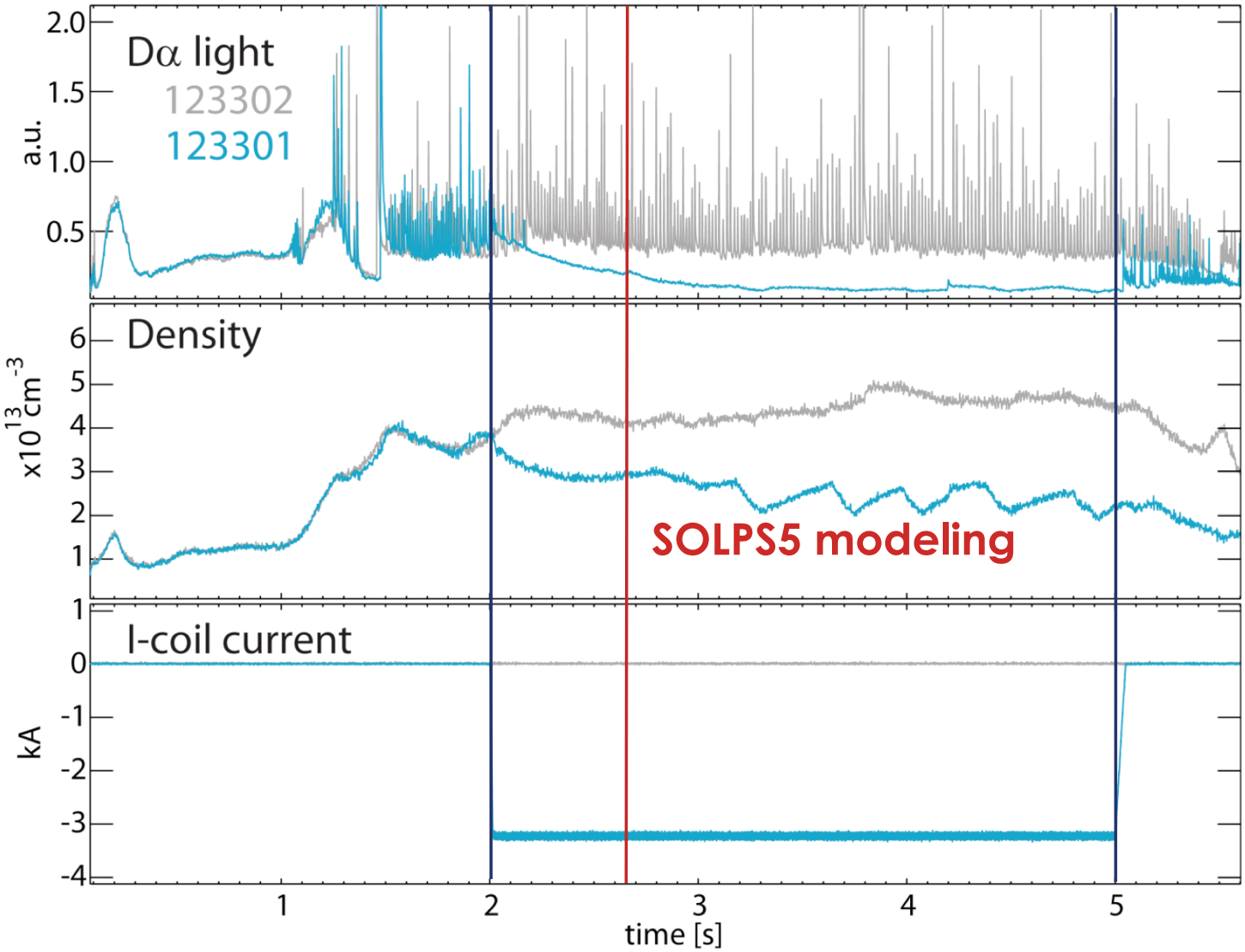

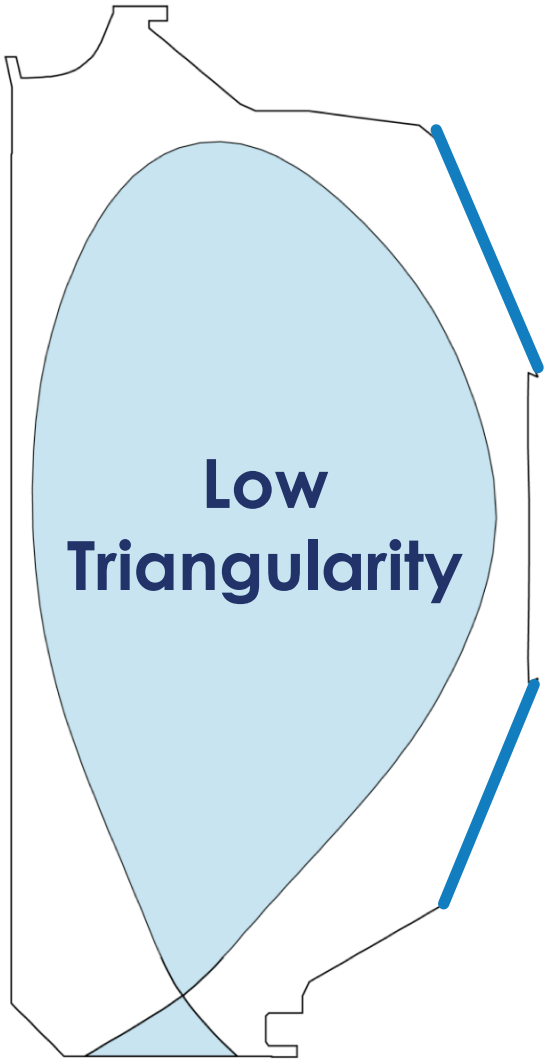

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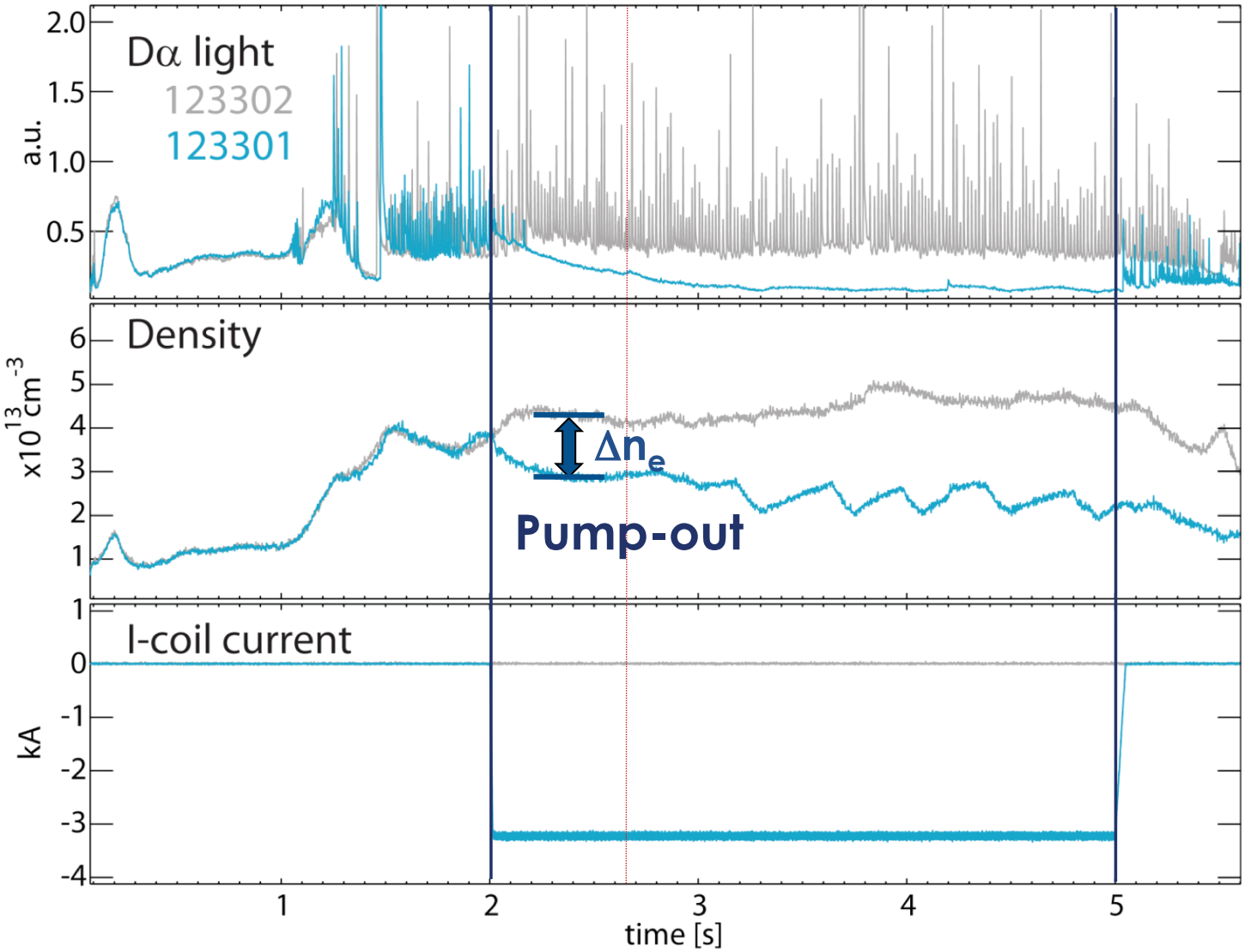

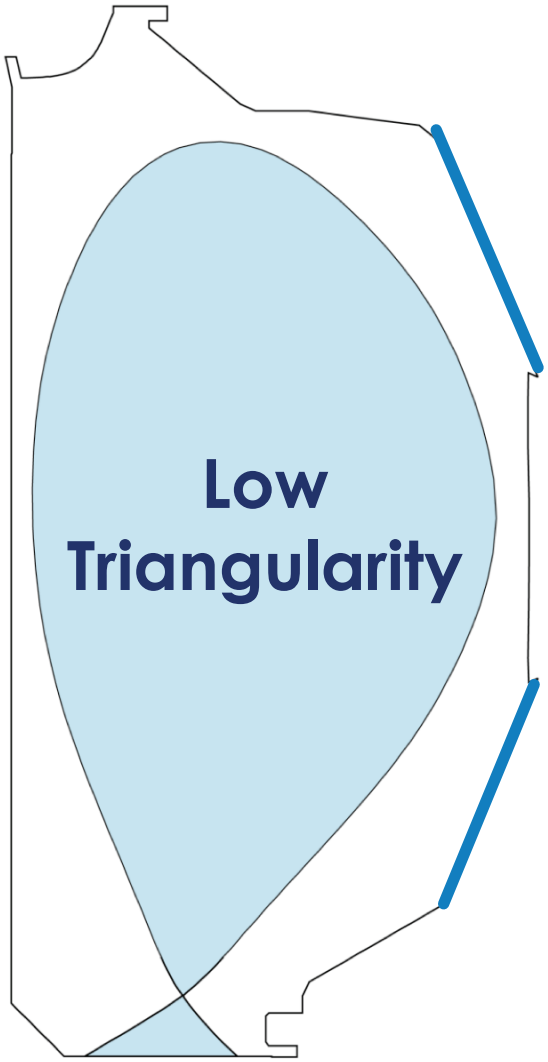

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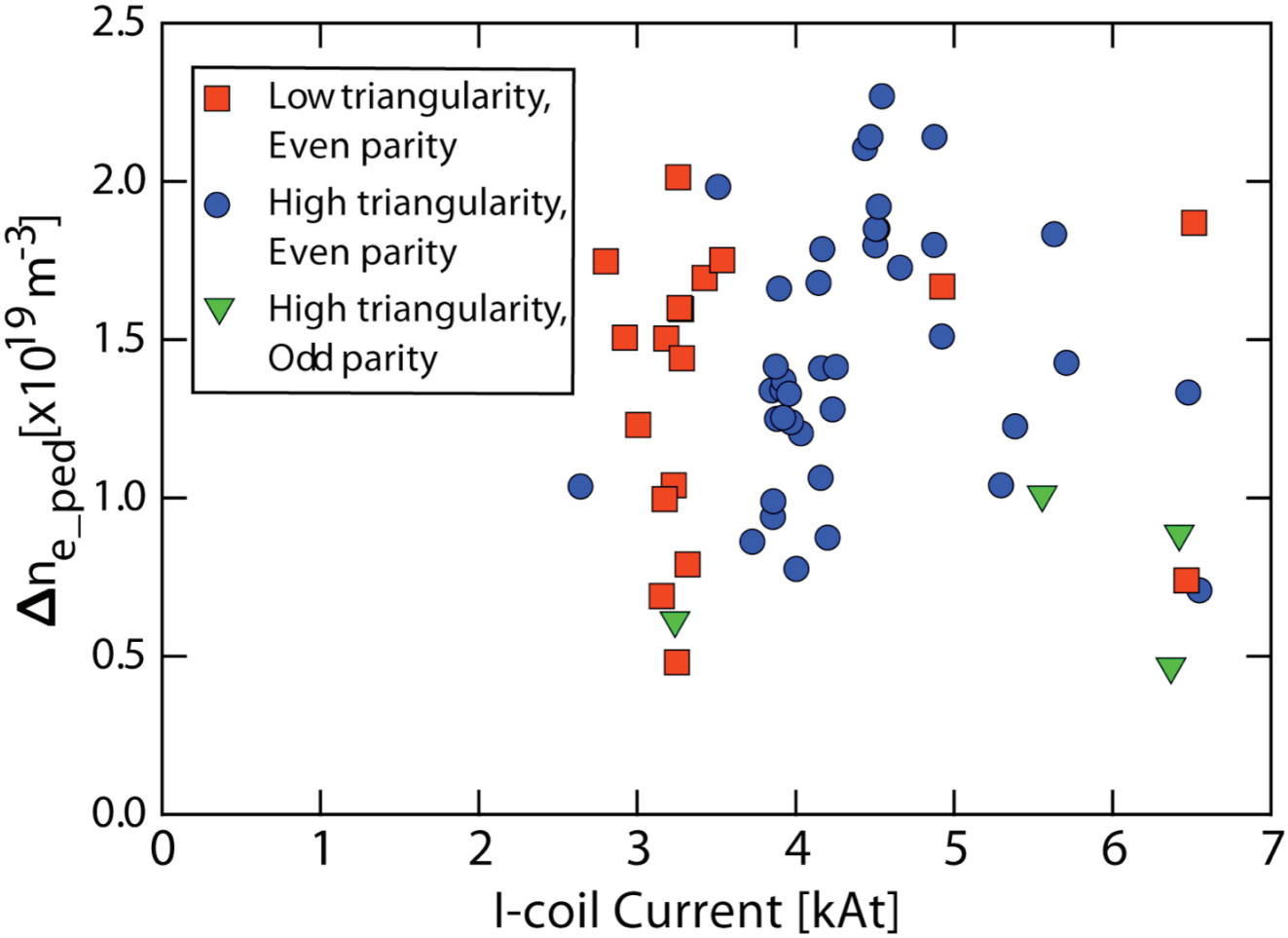
No correlation between density pump-out and applied I-coil currents in DIII-D H-modes

ELM suppressed H-modes



Courtesy of E. Unterberg (ORNL)

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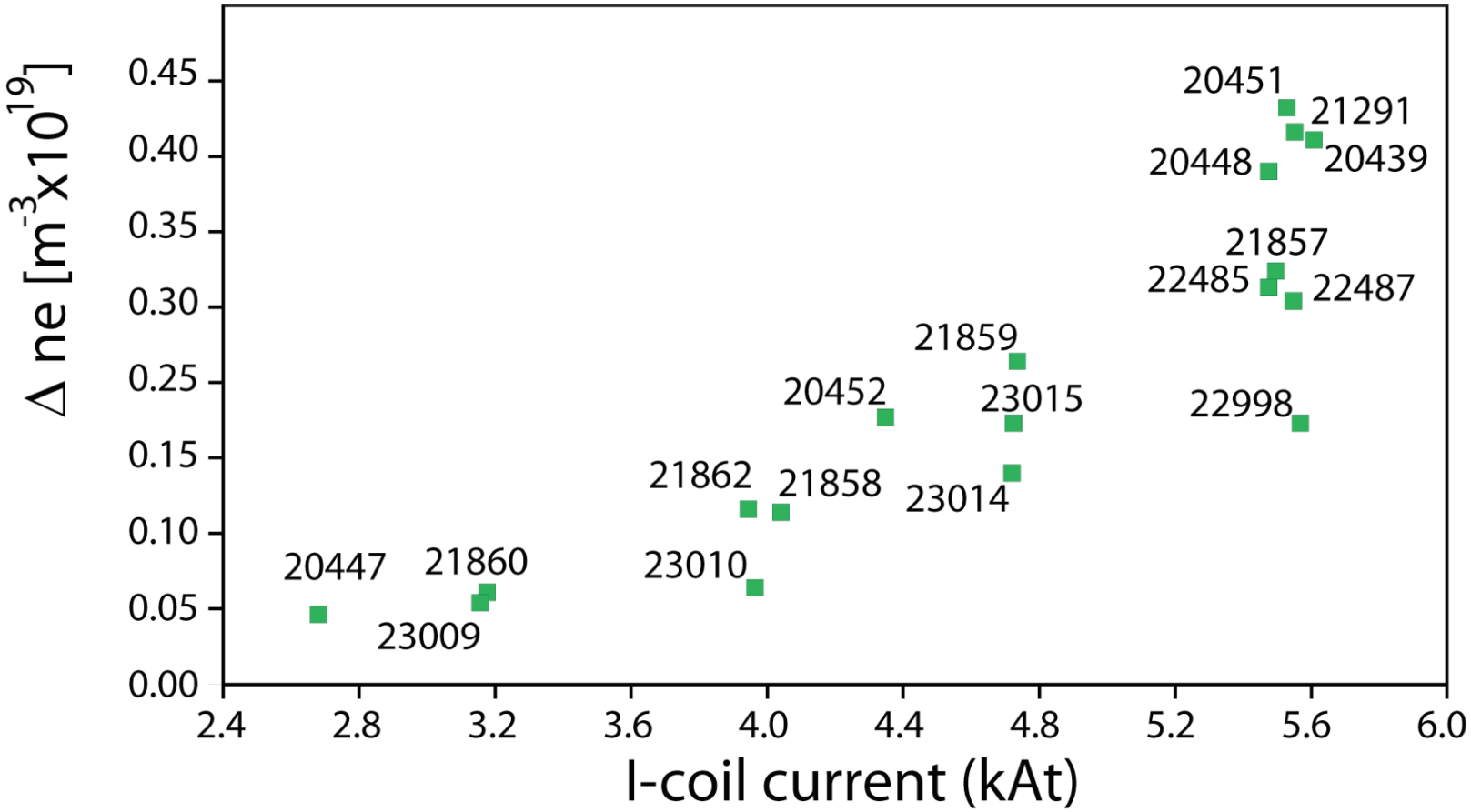
Correlation between density pump-out and applied I-coil currents in MAST L-modes

Trend in density pump-out with I-coil current magnitude, but large scatter in the data



Courtesy of A. Kirk (UKAEA)

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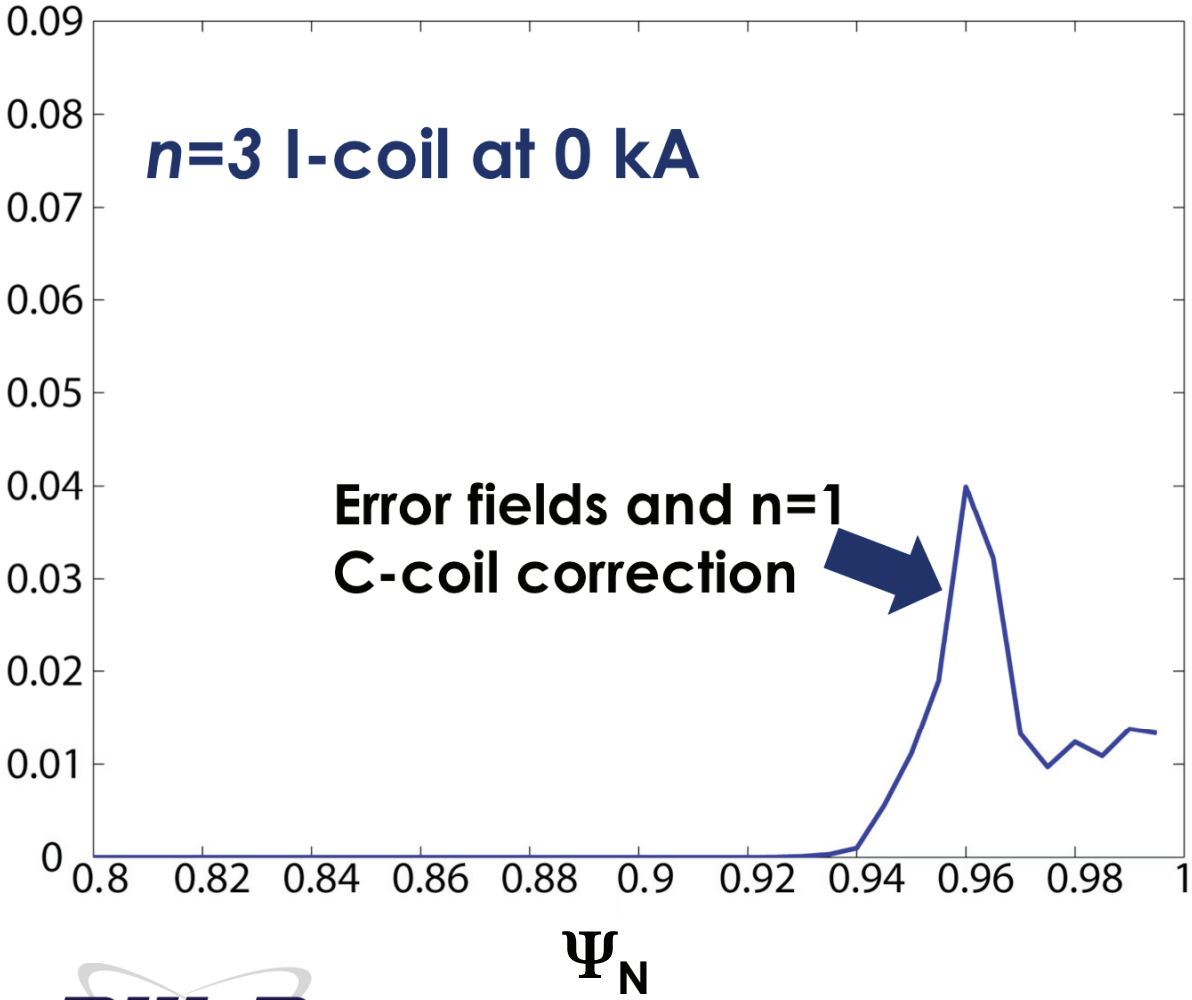
Free streaming calculations for DIII-D show an increase in transport during RMP

Free streaming particle transport [m^2/s]



TRIP3D : Vacuum field line tracing code

$$D_\perp = \underbrace{\frac{N_{open}}{N} \underbrace{\frac{1}{N}\sum_{i=1}^{N} \frac{\Delta r_i^{\,2}}{2L_i}}_{D_M}}_{D_{OFL}} c_s$$

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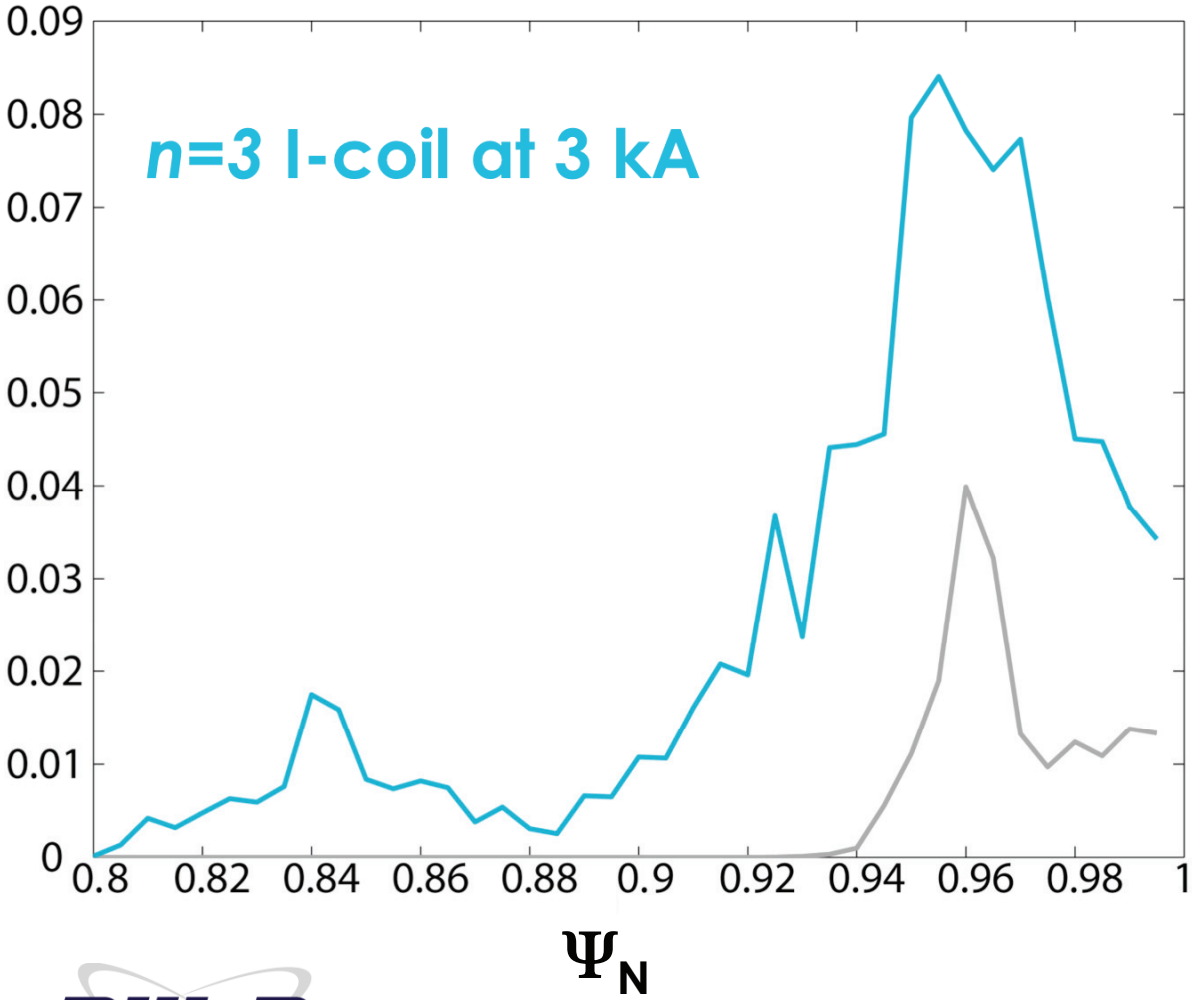

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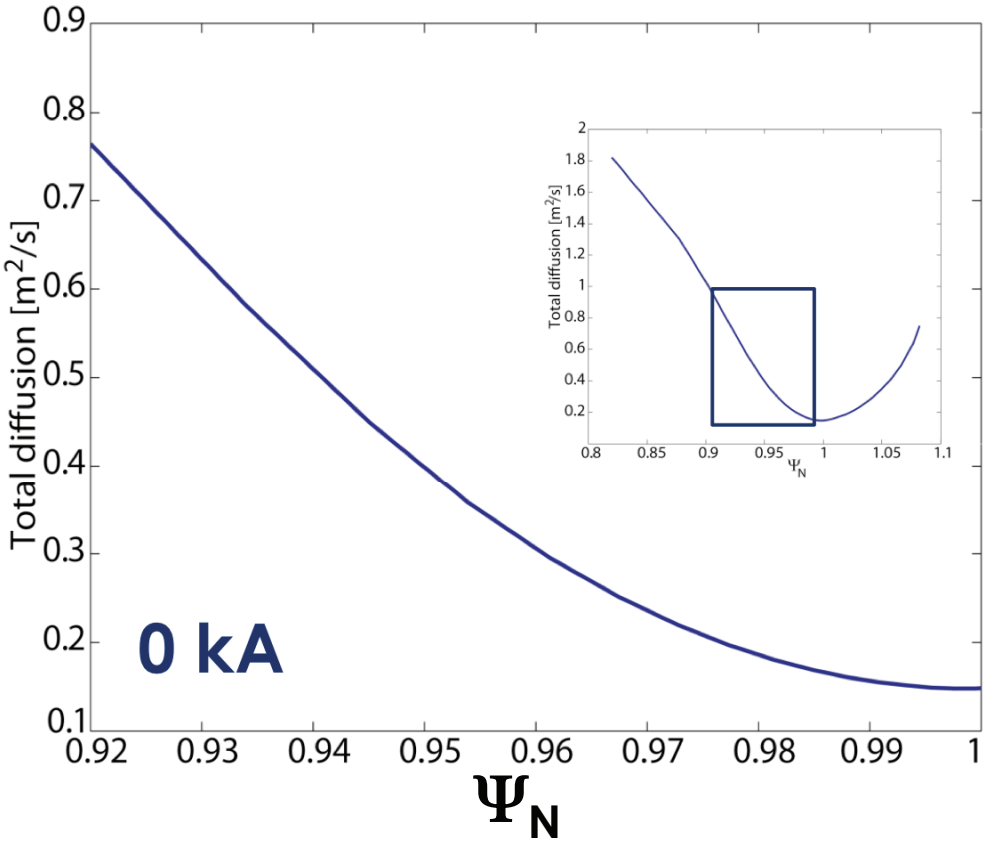
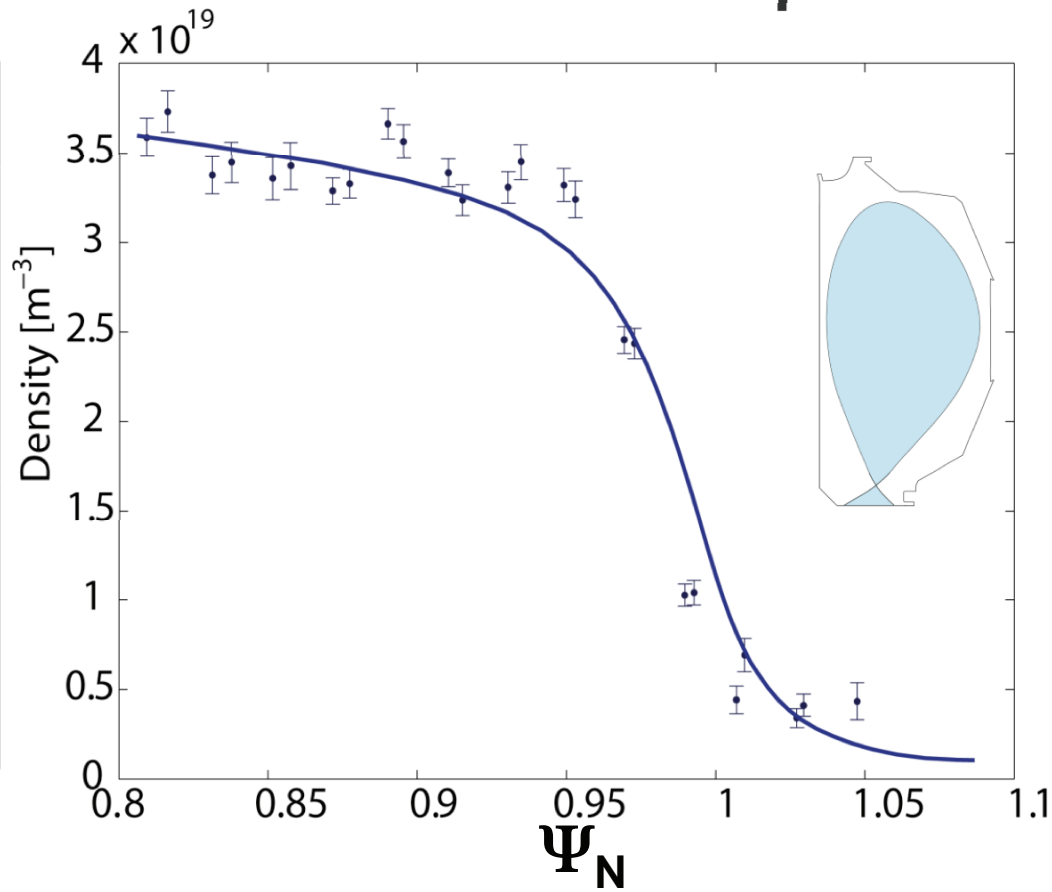


Calculated SOLPS5 profiles



SOLPS5 : - B2 is a 2D fluid edge code

- EIRENE is a Monte-Carlo neutral code

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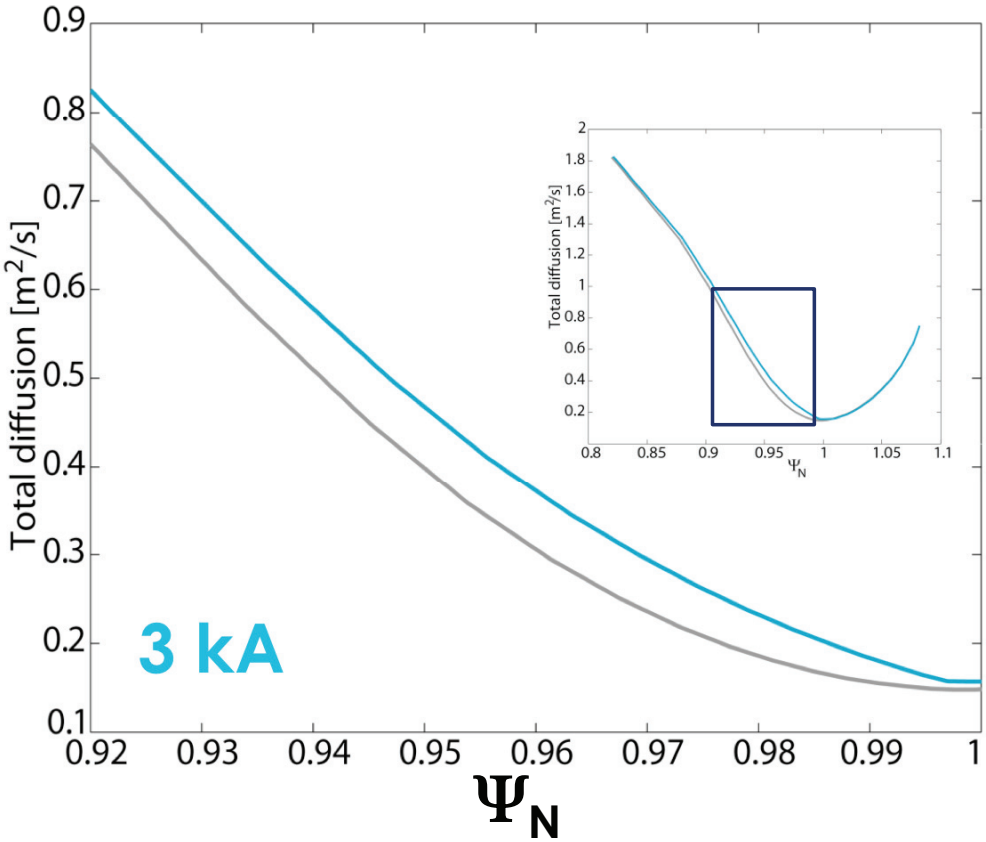
Free streaming as transport increase for RMPs gives good agreement with experiments

Particle transport



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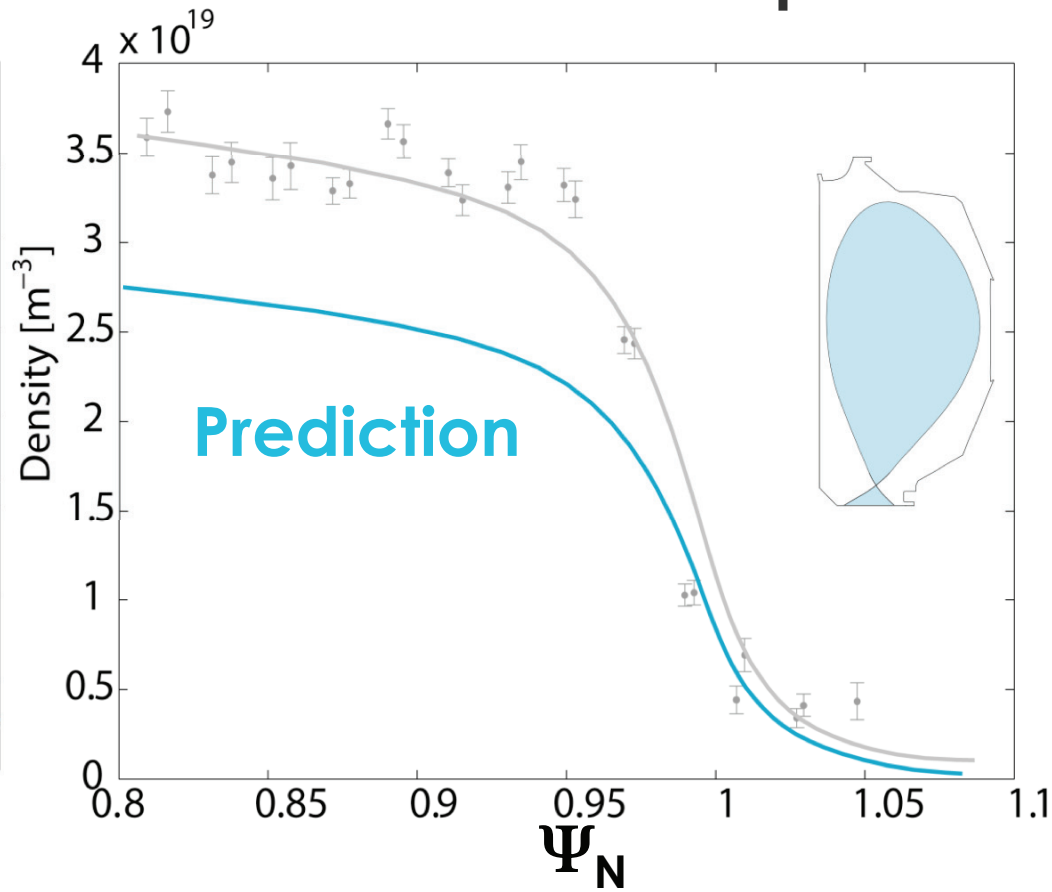

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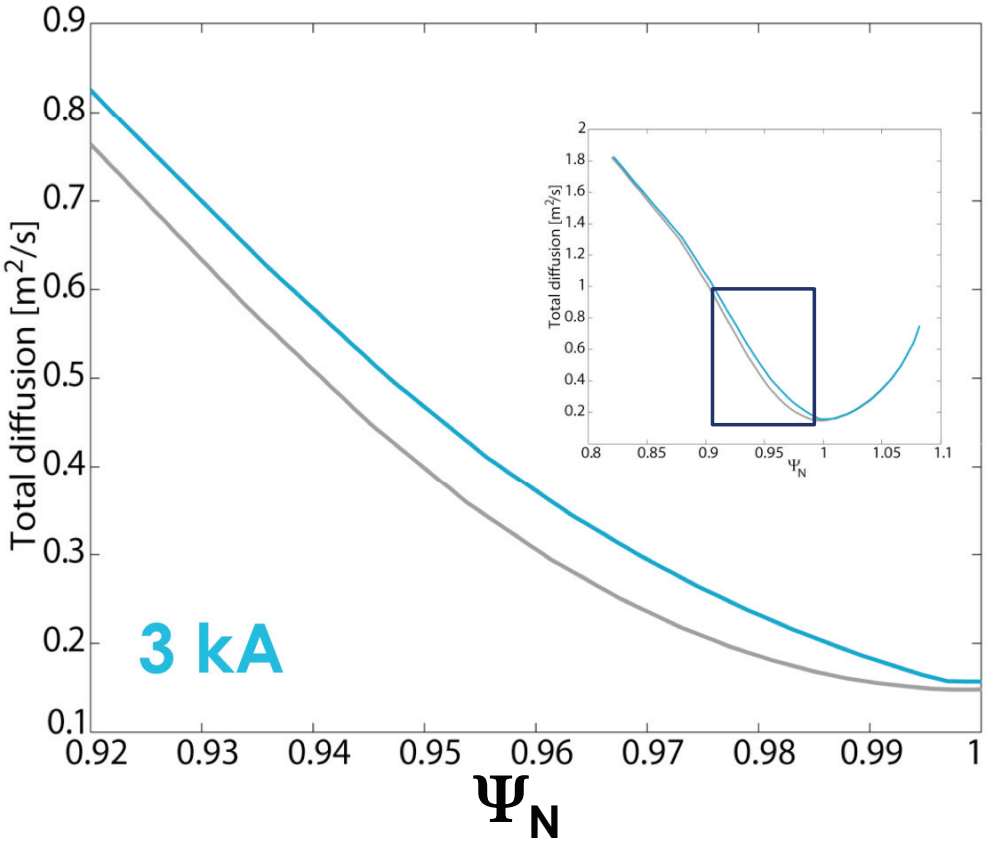

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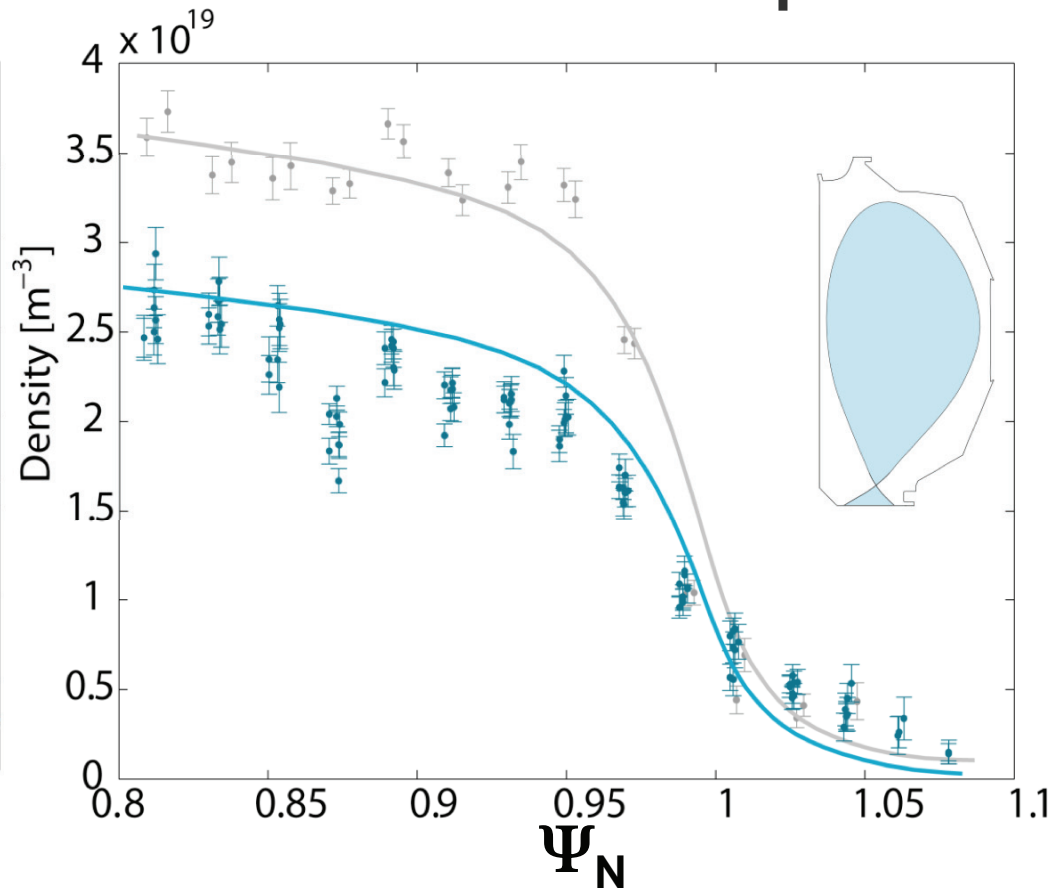

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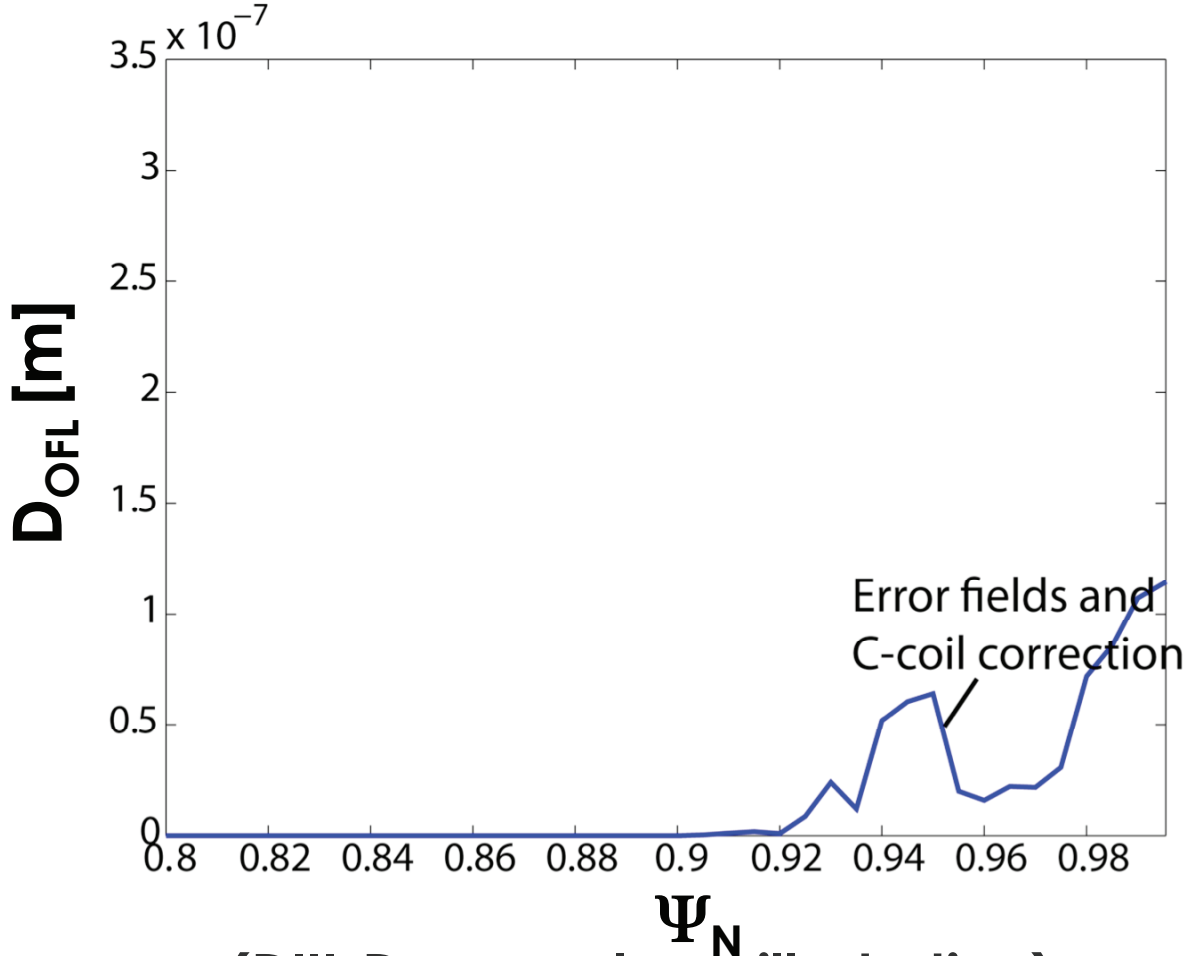
Quantifying magnetic perturbation allows direct comparison to density pump-out

Calculation of D_{OFL}



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(DIII-D example as illustration)

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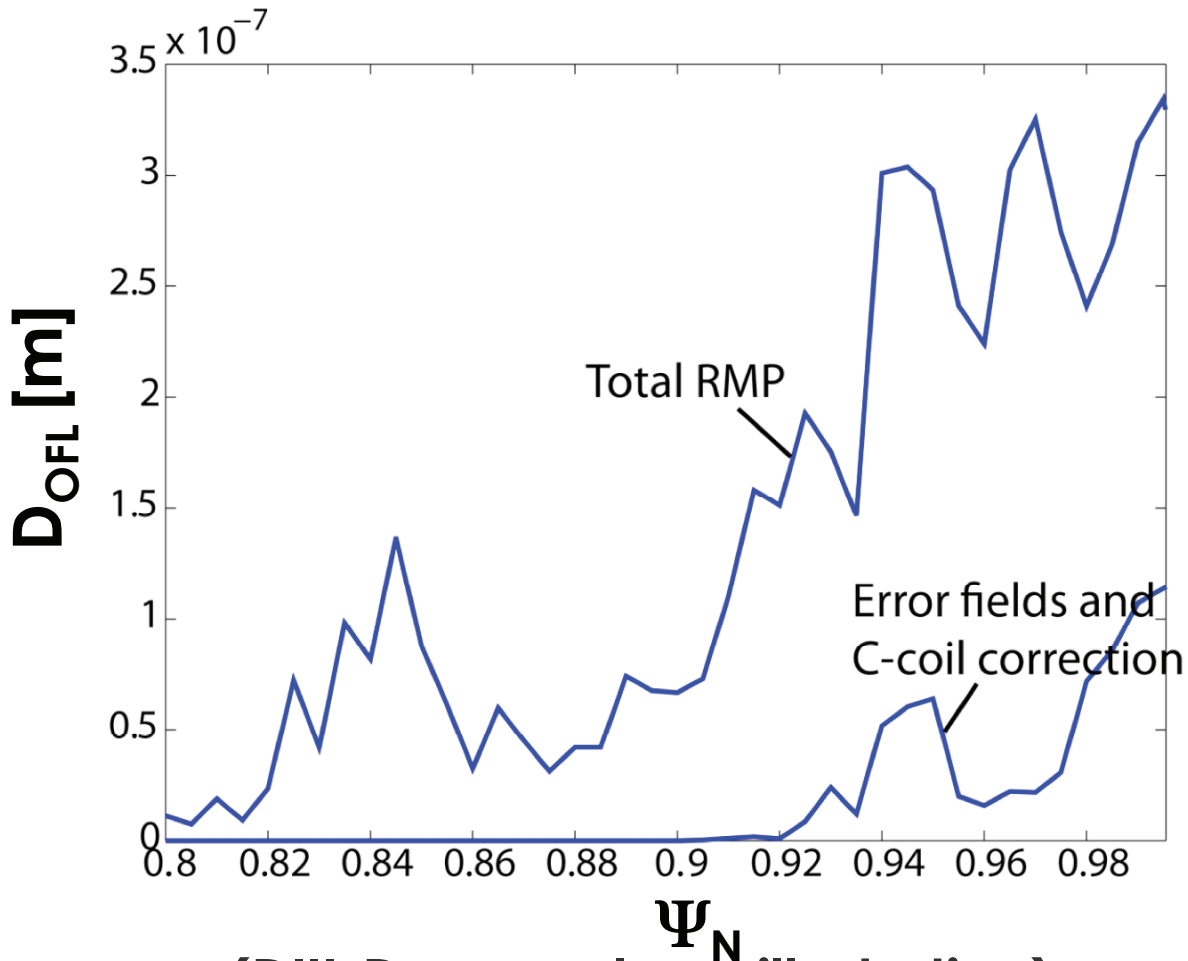

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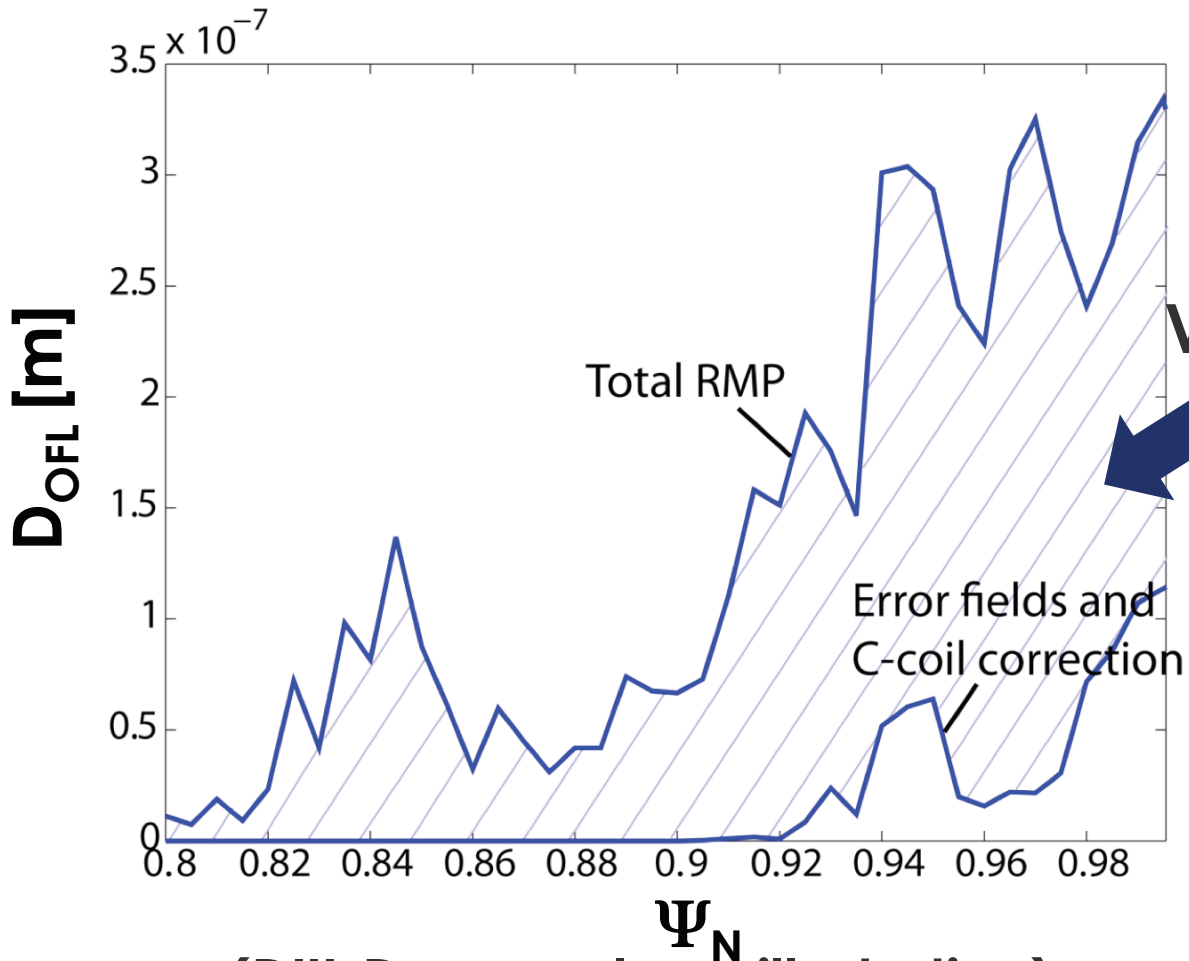
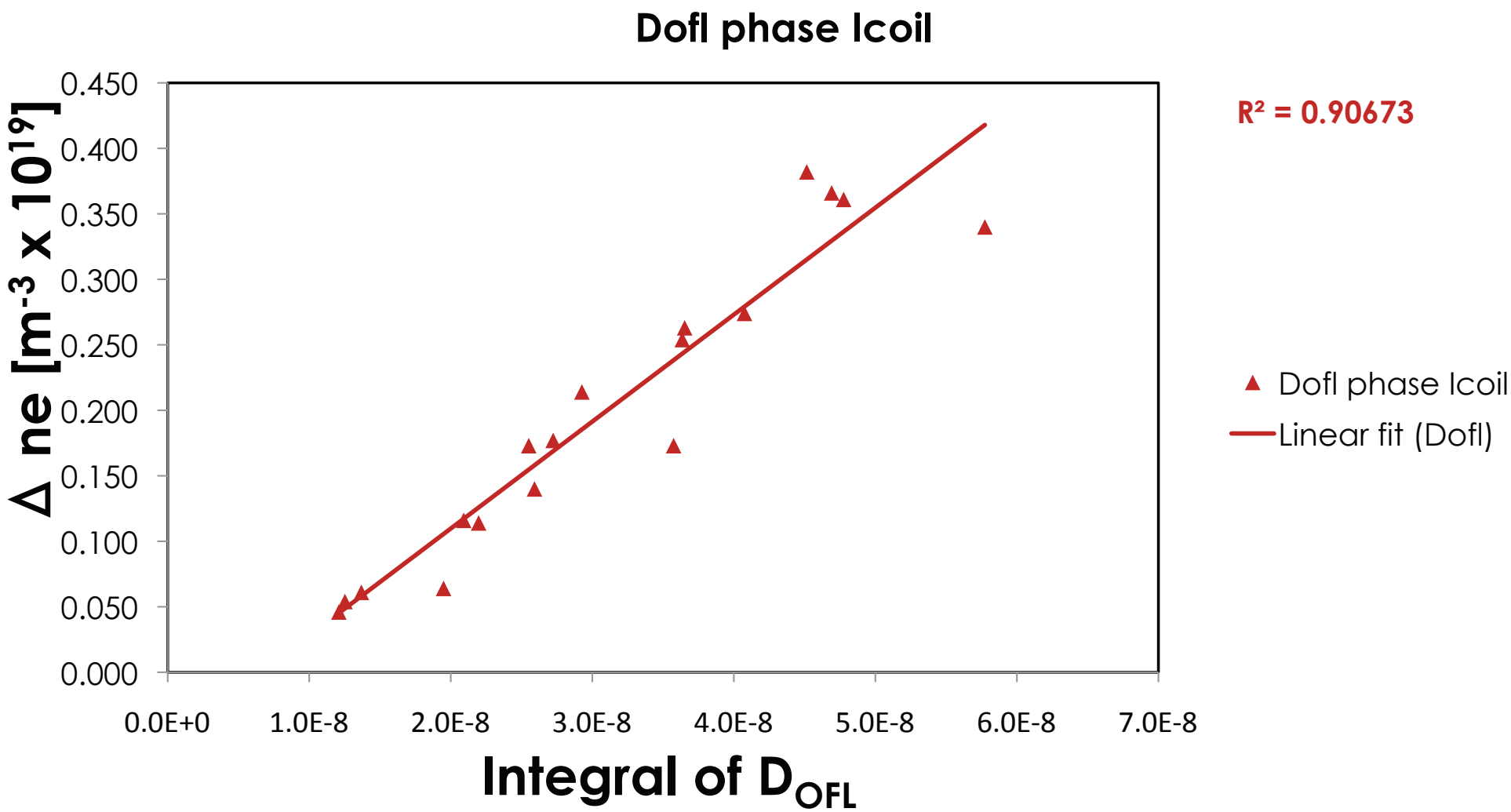


Value used to investigate correlation

(DIII-D example as illustration)

Correlation of D_{OFL} with Δne in L-mode on MAST



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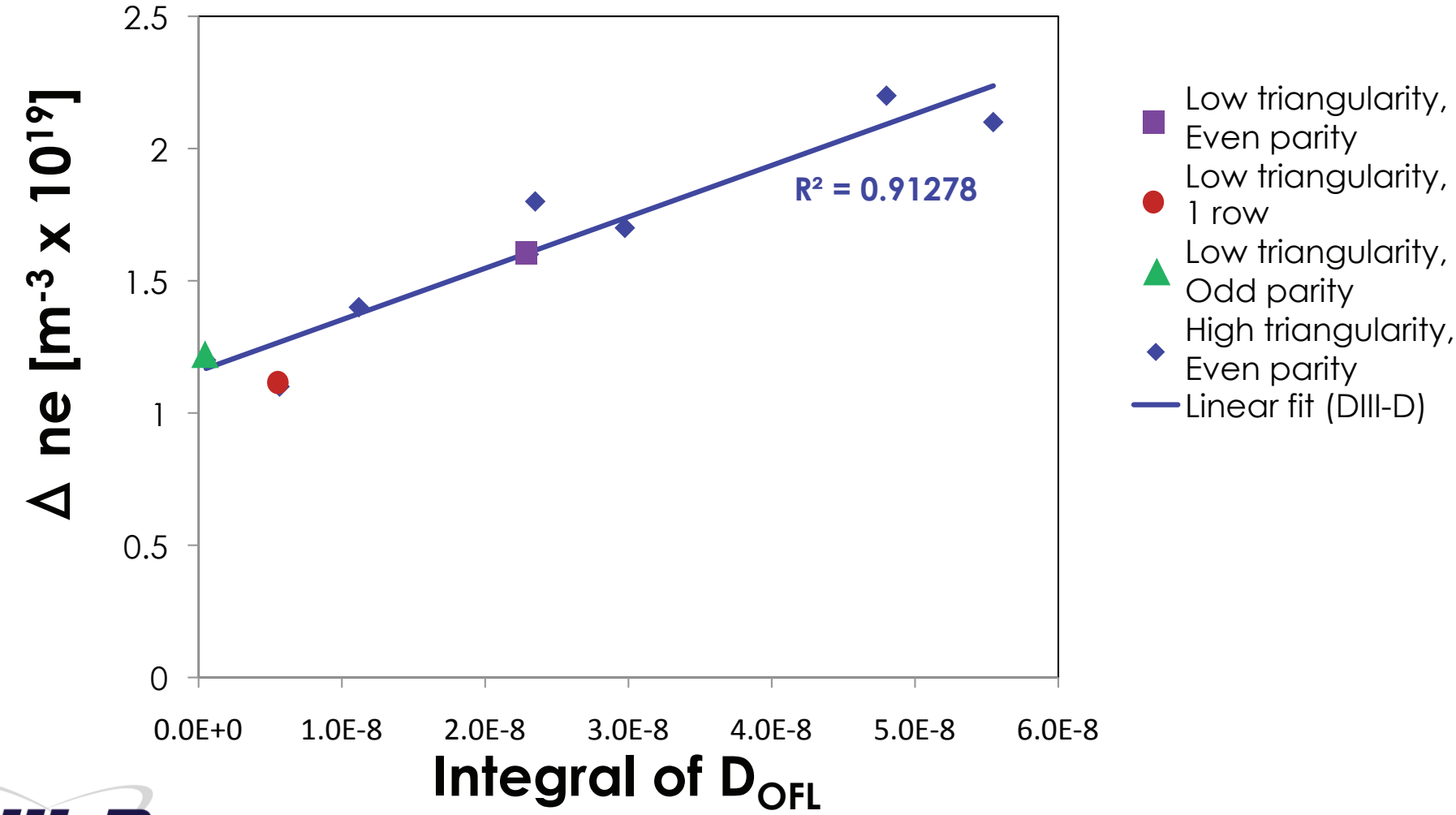
Correlation of pedestal density reduction with applied magnetic perturbations in DIII-D

Low collisionality H-mode plasmas with different shapes and RMP parities



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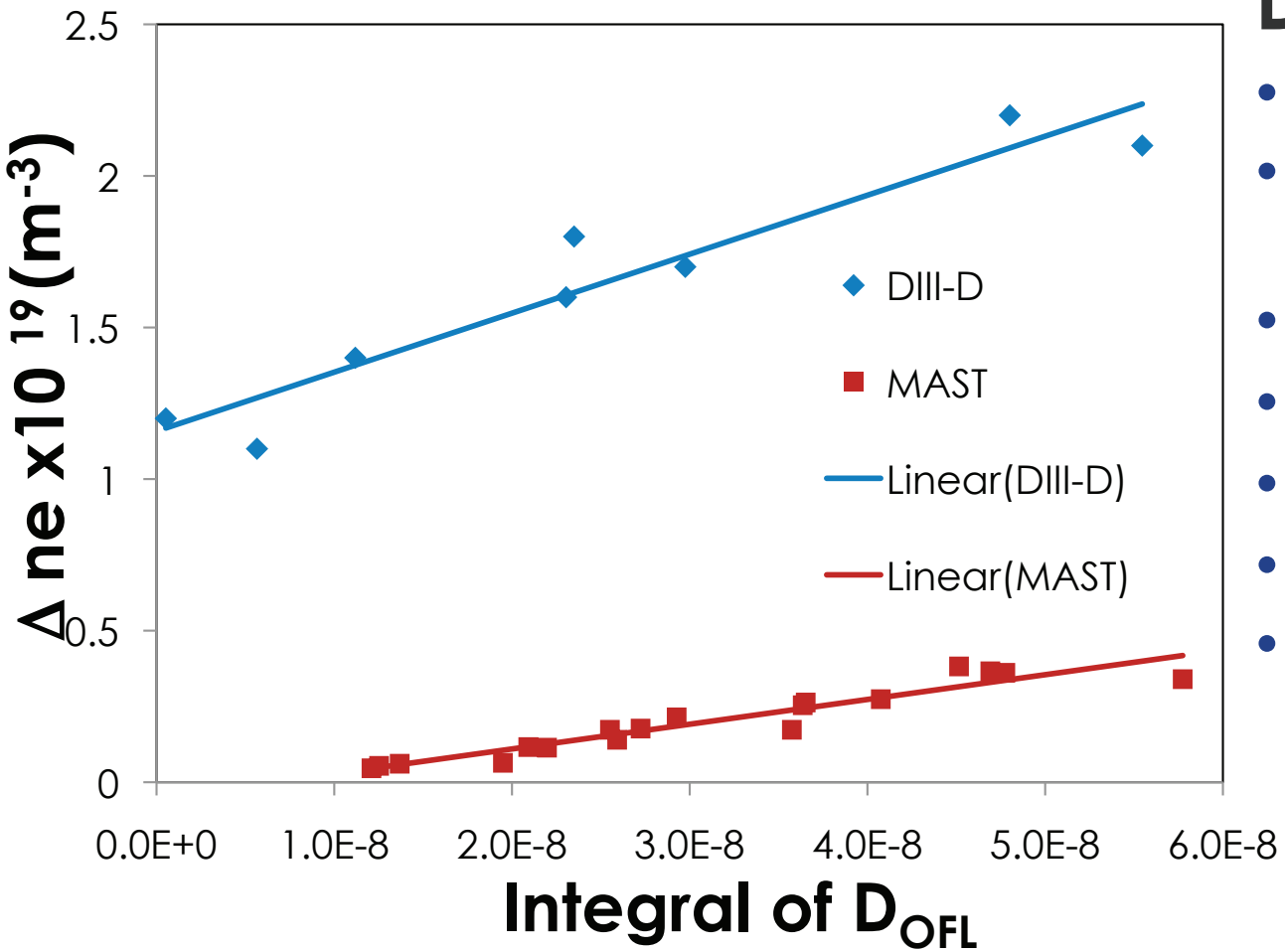
Density pump-out increase linearly with increased D_{OFL}



Difference:

- H-mode versus L-mode
- Active pumping versus wall pumping
- Aspect ratio
- Rho*
- Collisonality
- Single versus double null
- Etc …

Discussion/Conclusion

- Vacuum code gives good match to experimental observations
- More precise calculation of magnetic perturbation in the edge leads to a correlation with density pump-out
- Including n=1 error-field correction and right parity and phasing of n=3 I-coil is important
- Technique can identify conditions where plasma response is important