

# Improved Neutral Particle Modeling in TRANSP

by

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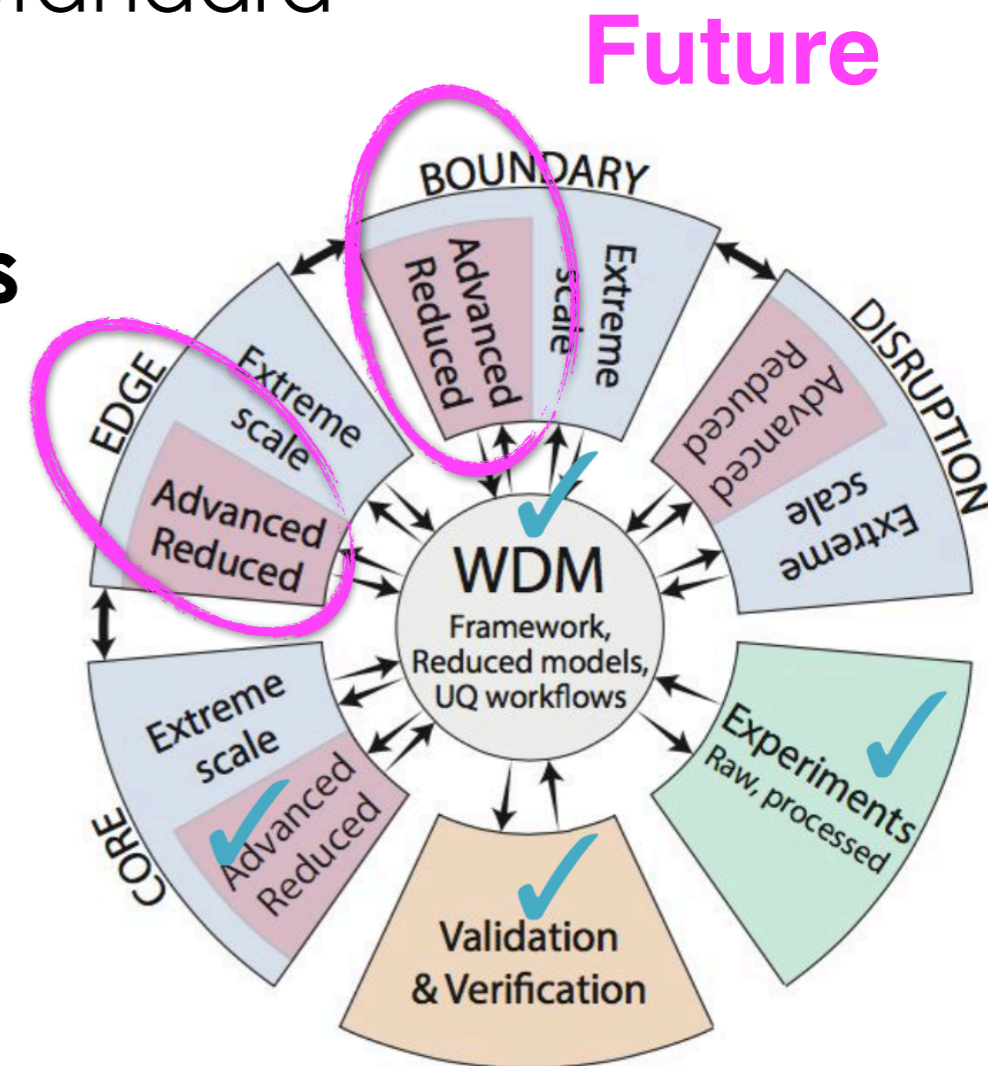
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# As Seen at This Meeting TRANSP is An Internationally Recognized Key Core Transport Tool for Analysis and Prediction

- Long pedigree of success and held in high regard
  - Often referred to as “The Gold Standard”
- TRANSP continues to develop its capabilities for core transport
- How can TRANSP tackle the core/edge integration challenge to retain leadership for analysis modeling?

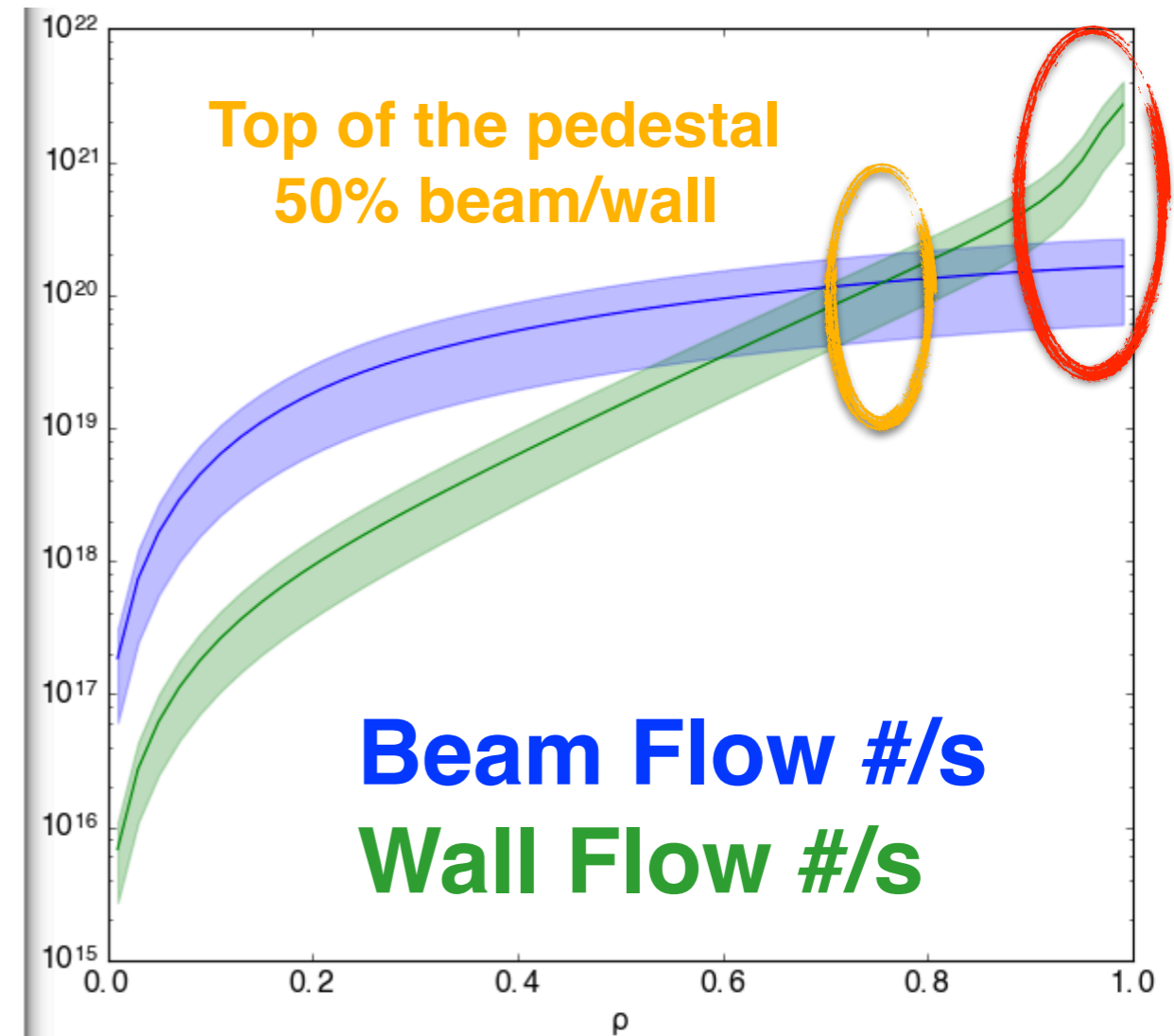
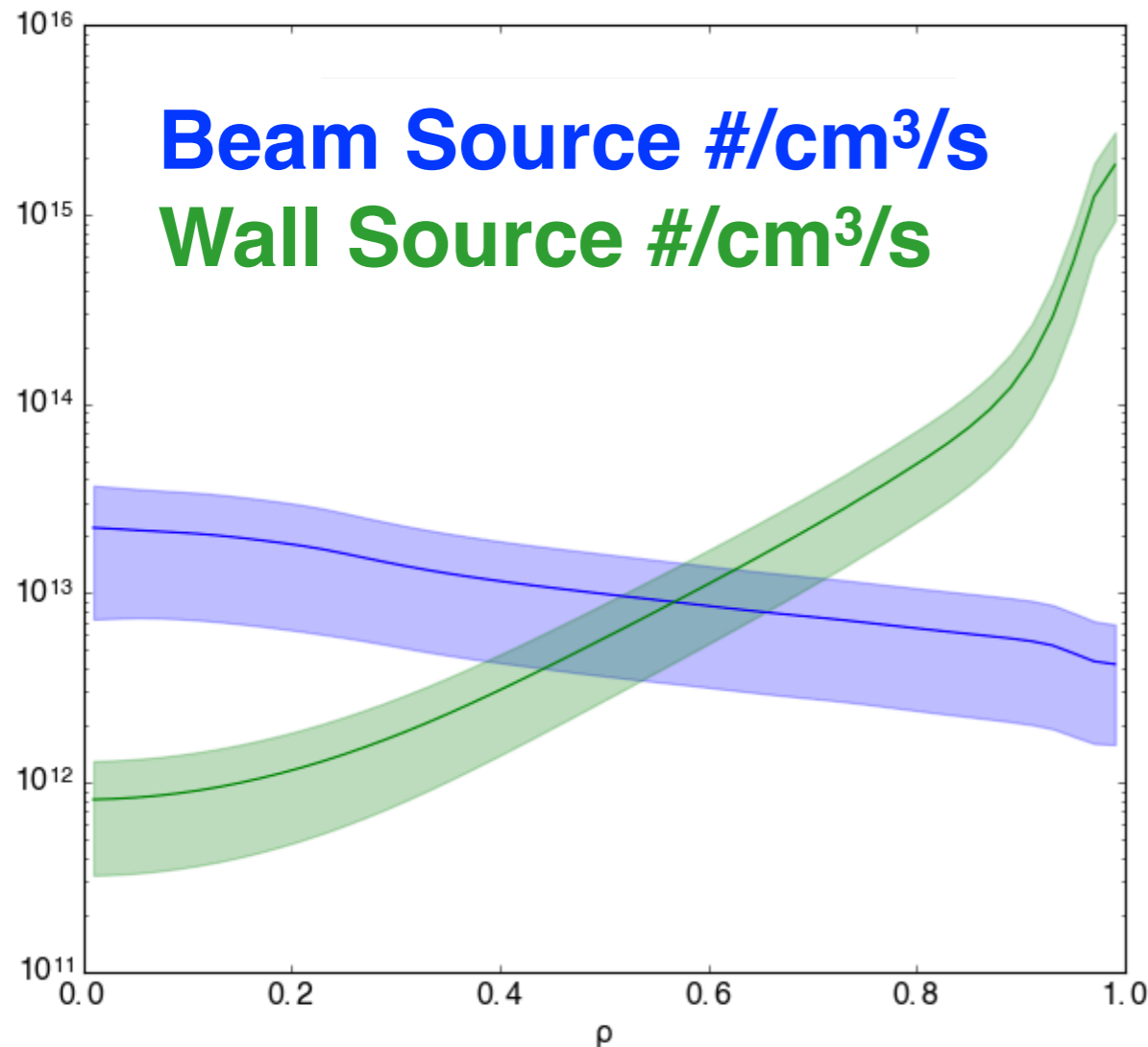


# The Recycling Neutral Source Can Strongly Influence Density Predictions in Present Devices

- Common practice for core transporters is to assume  $\tau_p \sim (0.5, 1.5) \tau_e$  for (L,H)-mode or use `\\PEDESTAL:IPERP`<sup>1</sup>
- Resulting flux dominates particle balance

— Flux matching gradient determined by wall source

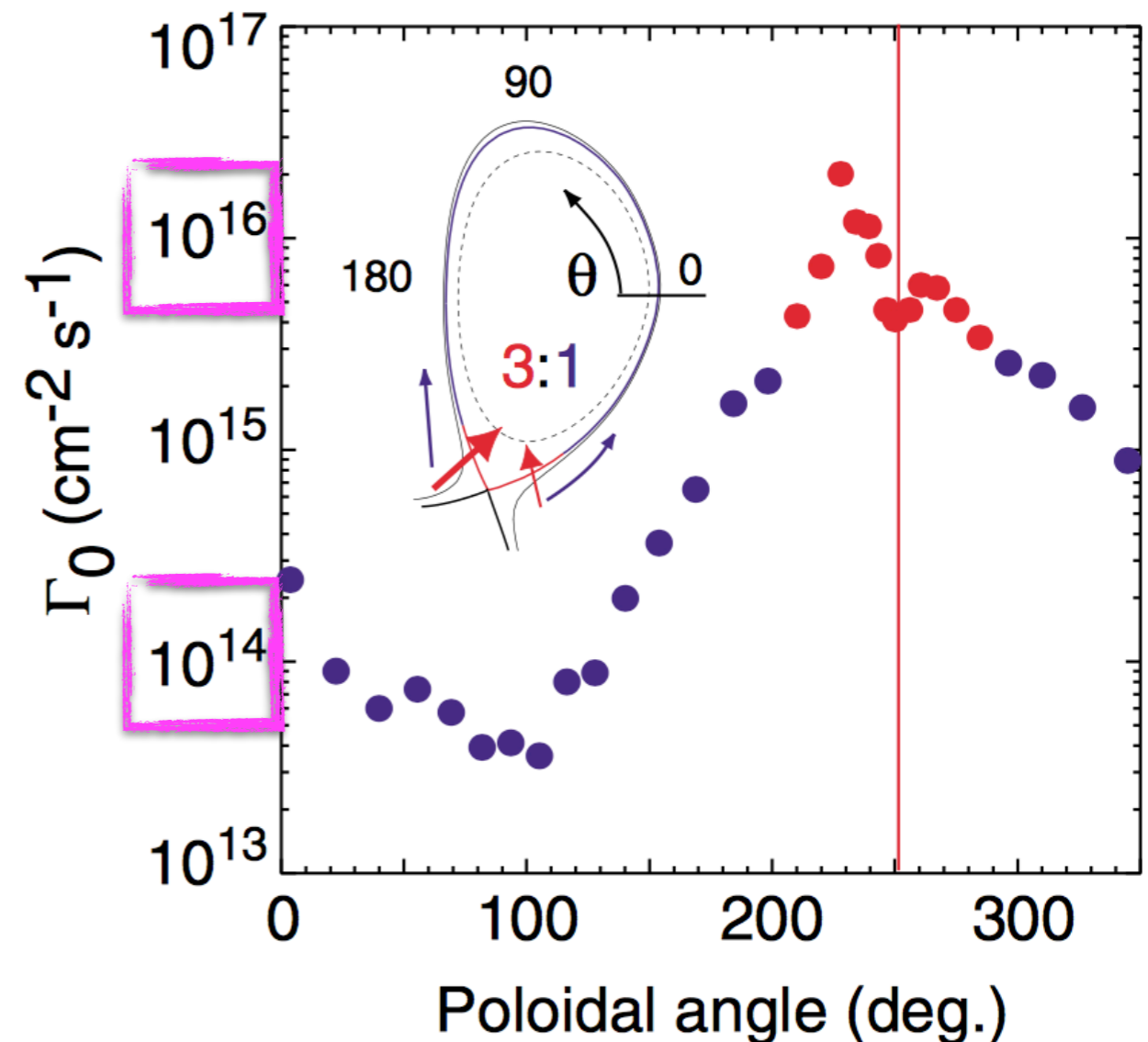
**Steep Gradient  
Wall  $\gg$  Beam**



<sup>1</sup>Porter *Phys. Plasmas* 5(12) (1998)

# ...but the Neutral Density is Strongly Poloidally Asymmetric and Dominated by Divertor Recycling

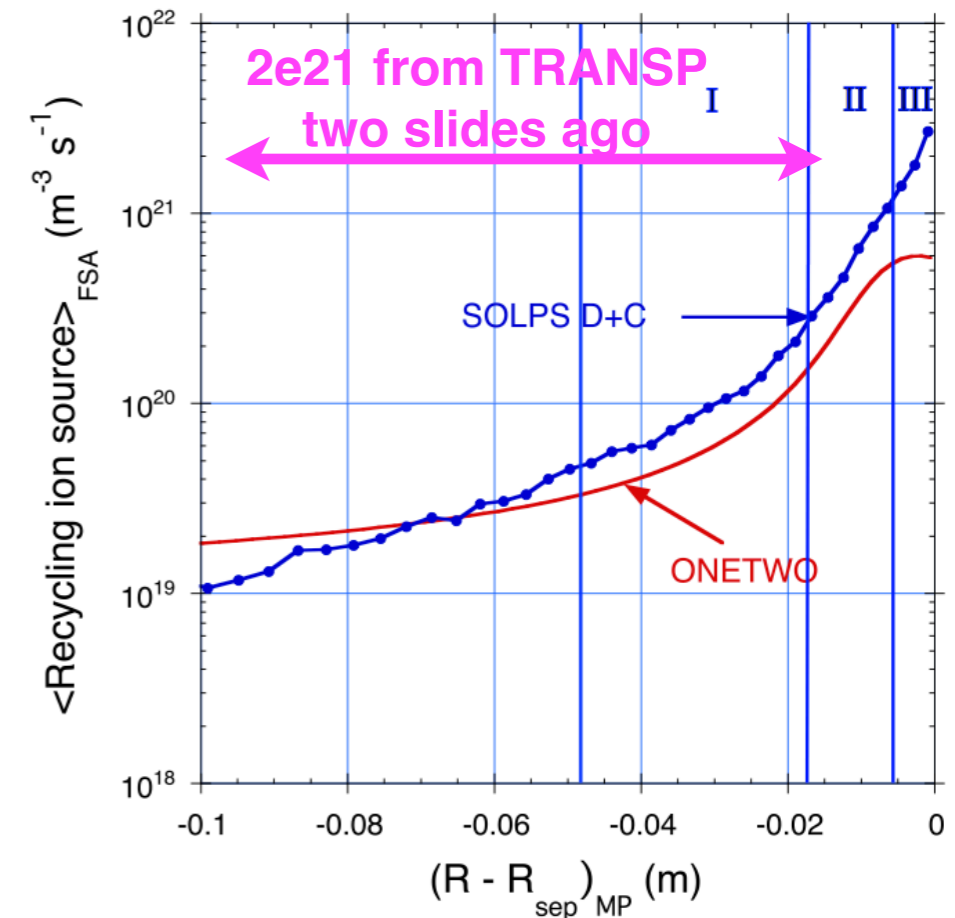
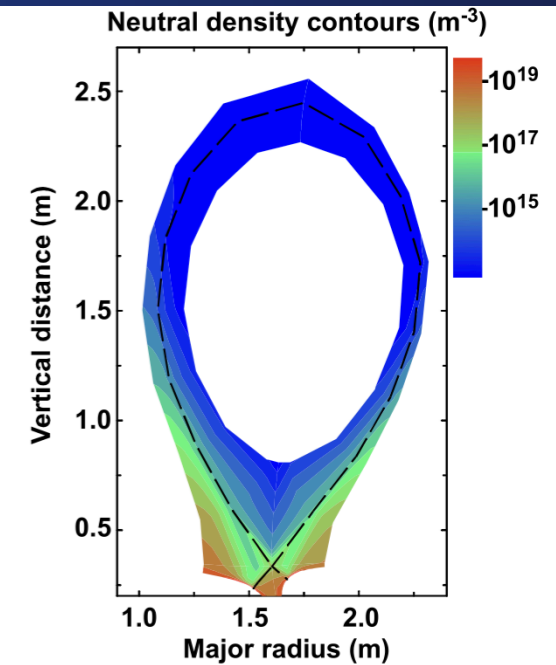
- Measurements and modeling both point to a strong recycling *divertor* source
- How do we use this information in core and pedestal transport analysis, modeling and prediction? Are we using the proper transport equations?



*Two orders of magnitude increase between midland and X-point*

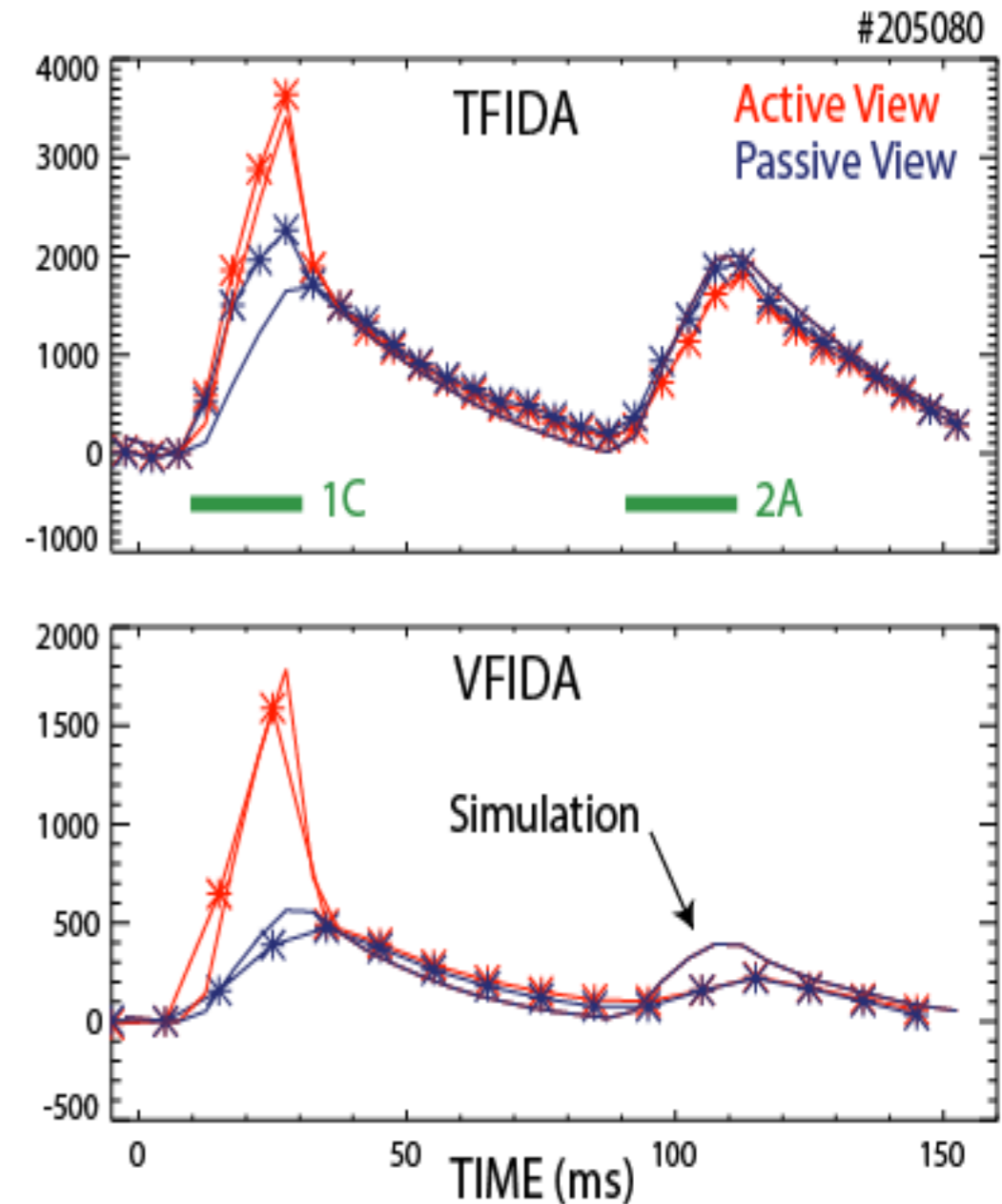
# Callen Has Justified 2D Flux-Surface Averaging of Strongly Poloidally Asymmetric Source from SOLPS/UEDGE/GTEDGE

- Detailed study of pedestal thermal and particle sources and transport<sup>1</sup>
- Comparison of semi-interpretive SOLPS with 2D Monte-Carlo neutral on same order as ONETWO



# 2D Neutral Source Required for Interpreting FI Diagnostics, Losses and Heat Flux Due to CX in the Core/Pedestal/SOL

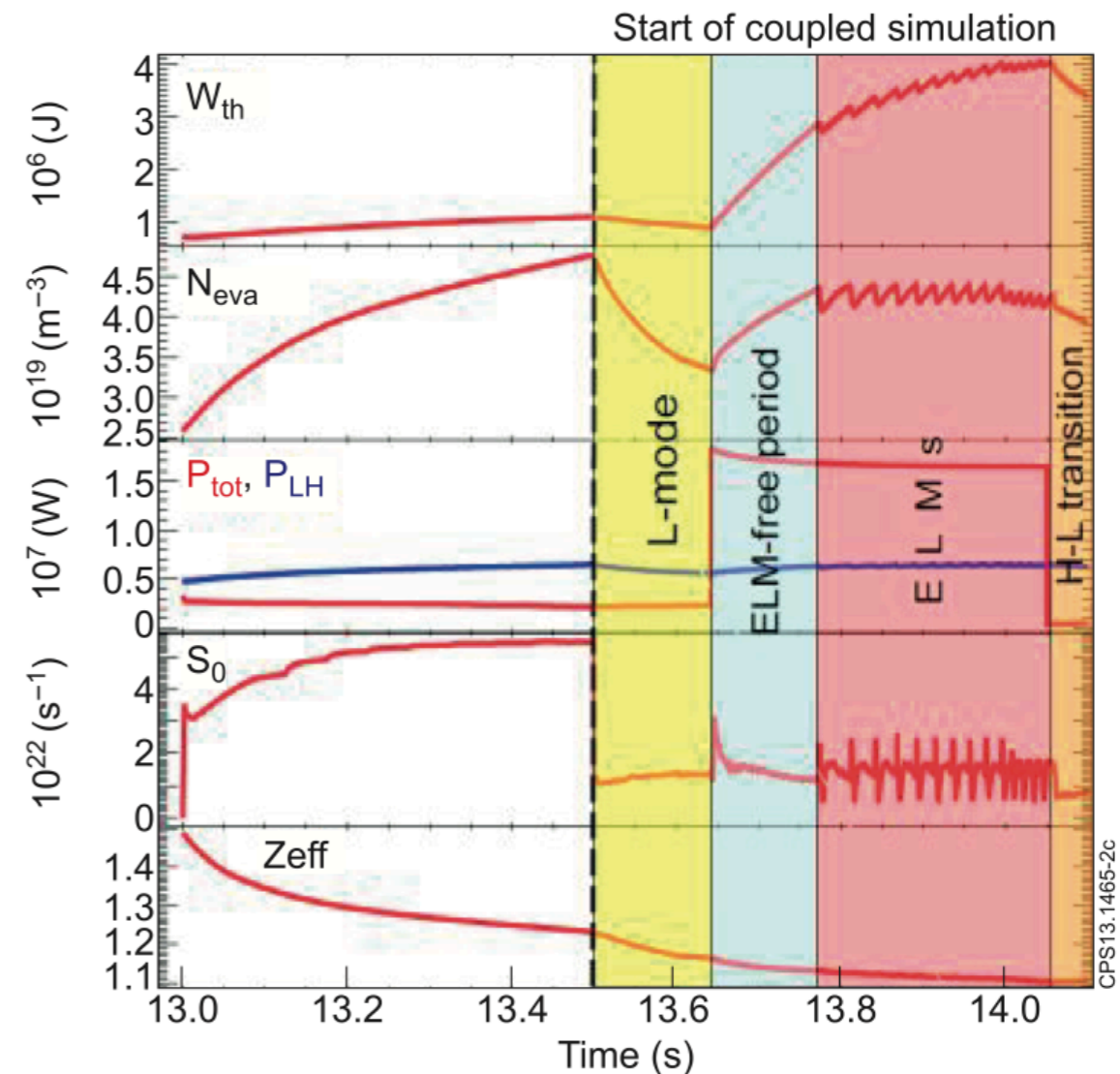
- Fast-particle diagnostics measure passive FIDA  $\propto n_b * n_0$  and Heidbringk/Liu (TUG 2017) indicated need for advanced 2D neutral model
- NUBEAM already on 2D (R,Z) grid so real need is 2D SOL meshing for plasma and neutral transport





# Forward Looking WDM Necessitates SOL Neutrals for Density Pedestal Prediction and Power/Particles Fluxes to Wall

- **JINTRAC<sup>1</sup> is one example of time-dependent Core/Edge/SOL capability**
- **The edge code (EDGE2D) drives the core (JETTO) setting the radial boundary condition**
  - Akin to a predictive TRANSP run with experimental pedestal
- **Other loose coupling iterative schemes are being developed and used (AToM TGYRO/EPED/)**



M. Romanelli, *Plasma and Fus. Res.* (2014)