NSTX and DIII-D similarity experiment

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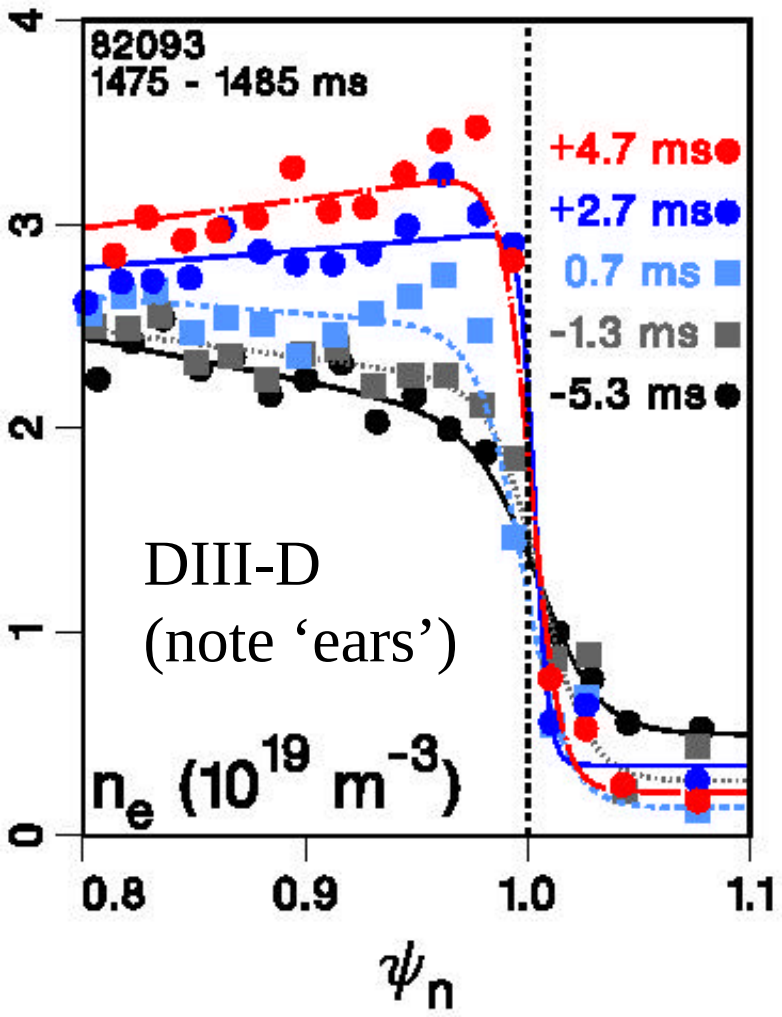
DIII-D and C-MOD found similar pedestal widths with dimensionless scaling experiments

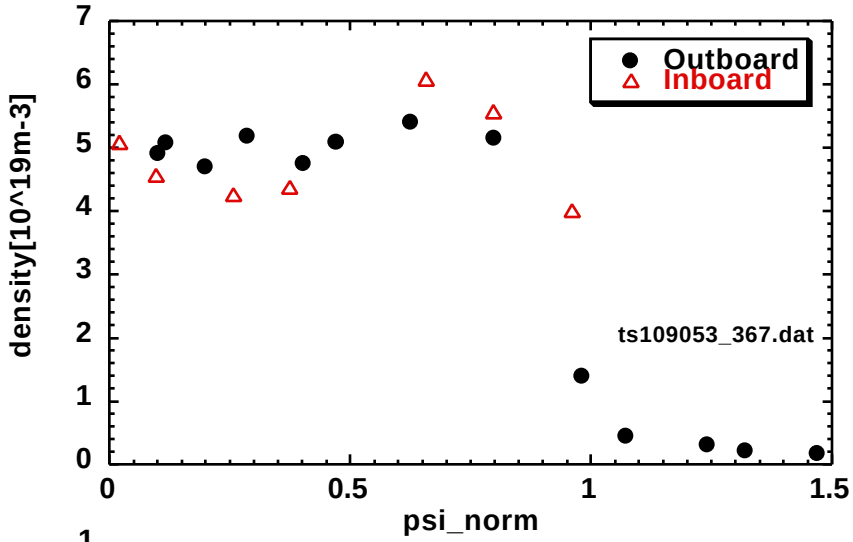
- Seemed to prove that plasma physics determined pedestal properties, NOT atomic physics
- However, model by Mahdavi (Groebner, APS2001 Invited) showed that poloidal location of fueling important
- C-MOD fueled by main chamber, DIII-D by divertor

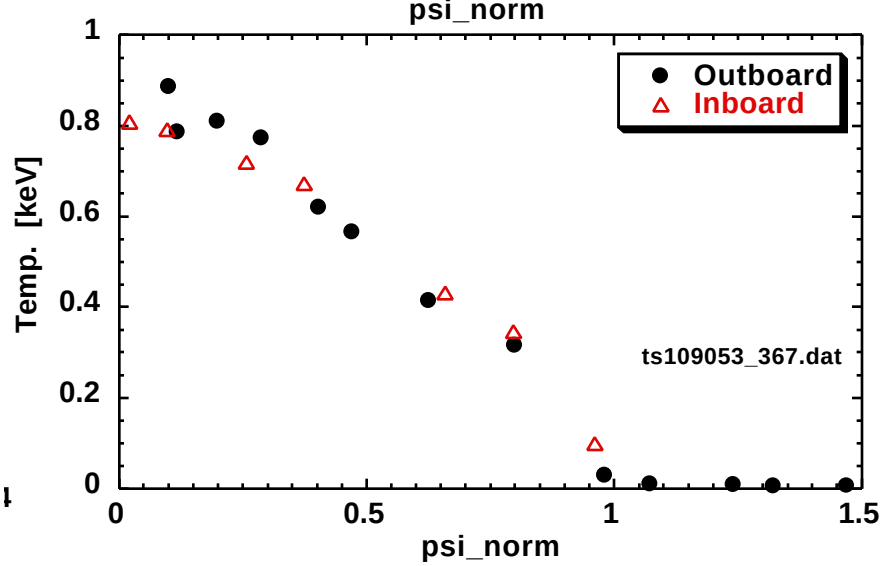
-> expect similar pedestal widths from model even though mean free path much shorter in C-MOD than DIII-D

- NSTX recycling source unquantified at moment
- Proposal:
  - Run same shape as DIII-D/C-MOD, matching dimensionless plasma physics variables and compare edge n_e profiles
  - If dimensionless parameters don't match for existing C-MOD/DIII-D dataset, do separate (new) comparison with DIII-D

DIII-D density profile much narrower in normalized flux and physical space than typical NSTX profile





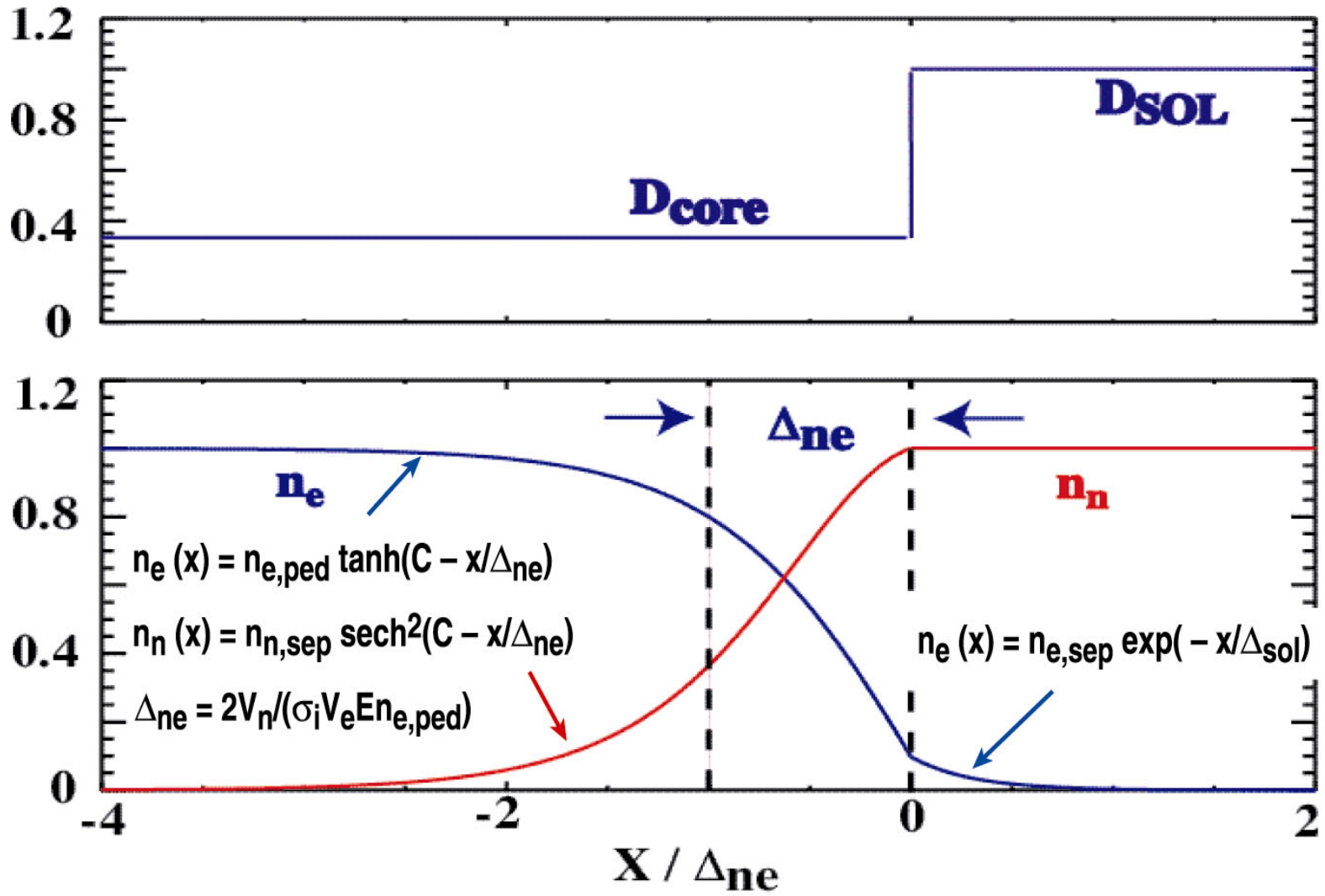


AN ANALYTIC MODEL IS FORMULATED TO RELATE PEDESTAL WIDTH TO PEDESTAL HEIGHT

- Use coupled, steady-state, particle continuity equations for electron density and neutral hydrogen atoms (Engelhardt[1])
  - Solve on open and closed field lines with matching at LCFS
- Model extended by Mahdavi[2] to include poloidal variation in neutral source, separate *D* in SOL and core.
- Assume neutral temperature at LCFS is same as ion temperature, due to charge exchange in SOL
- Goal is to model n_e from LCFS inwards
- For low temps, there is about one CX event per ionization
  - Thus, multiple charge exchange is ignored

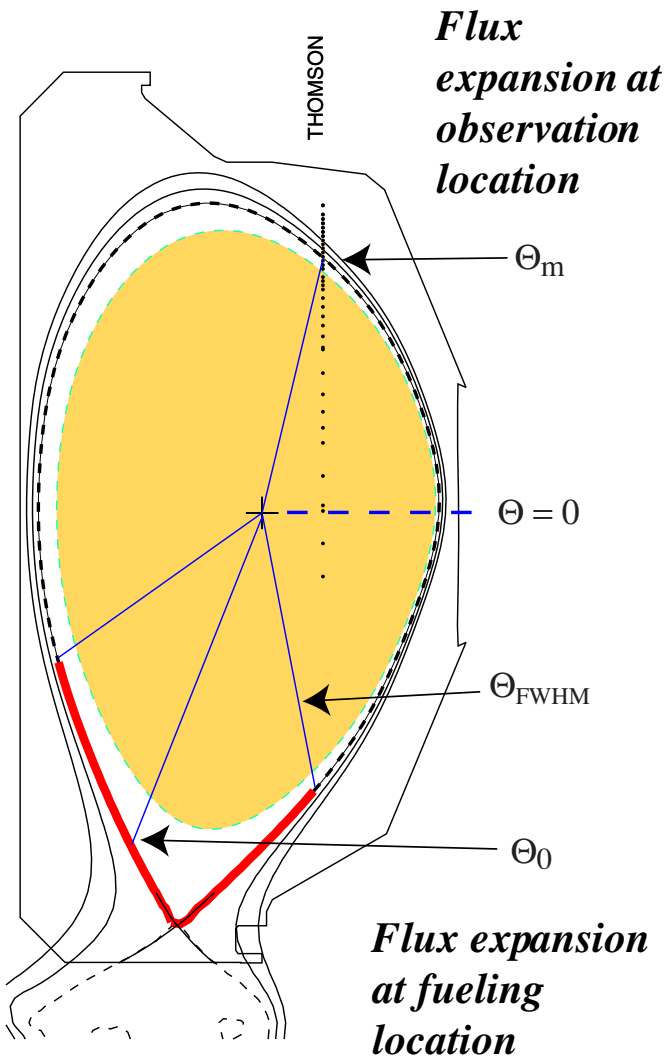
[1] W. Engelhardt, W. Fenenberg, J. Nucl. Mater. 76-77 (1978) 518.
[2] M.A. Mahdavi et al., 2000 IAEA meeting, to be published in Nucl. Fusion

SCALE LENGTHS ARE SAME IN ANALYTIC MODEL



LOCATION OF FUELLING AFFECTS DENSITY WIDTH

- *E* is ratio of flux expansion at fuelling location θ_0 to expansion at measurement location θ_m
- In reality, *E* is some average over extended neutral source
  - FWHM is ~ 55° in this example from a DEGAS calculation
- From neutral model in UEDGE, average *E* is estimated at 3 to 4 for divertor fuelling
- If fuelling were from outer midplane, *E* would be ~ 0.5
  - Would disagree with results

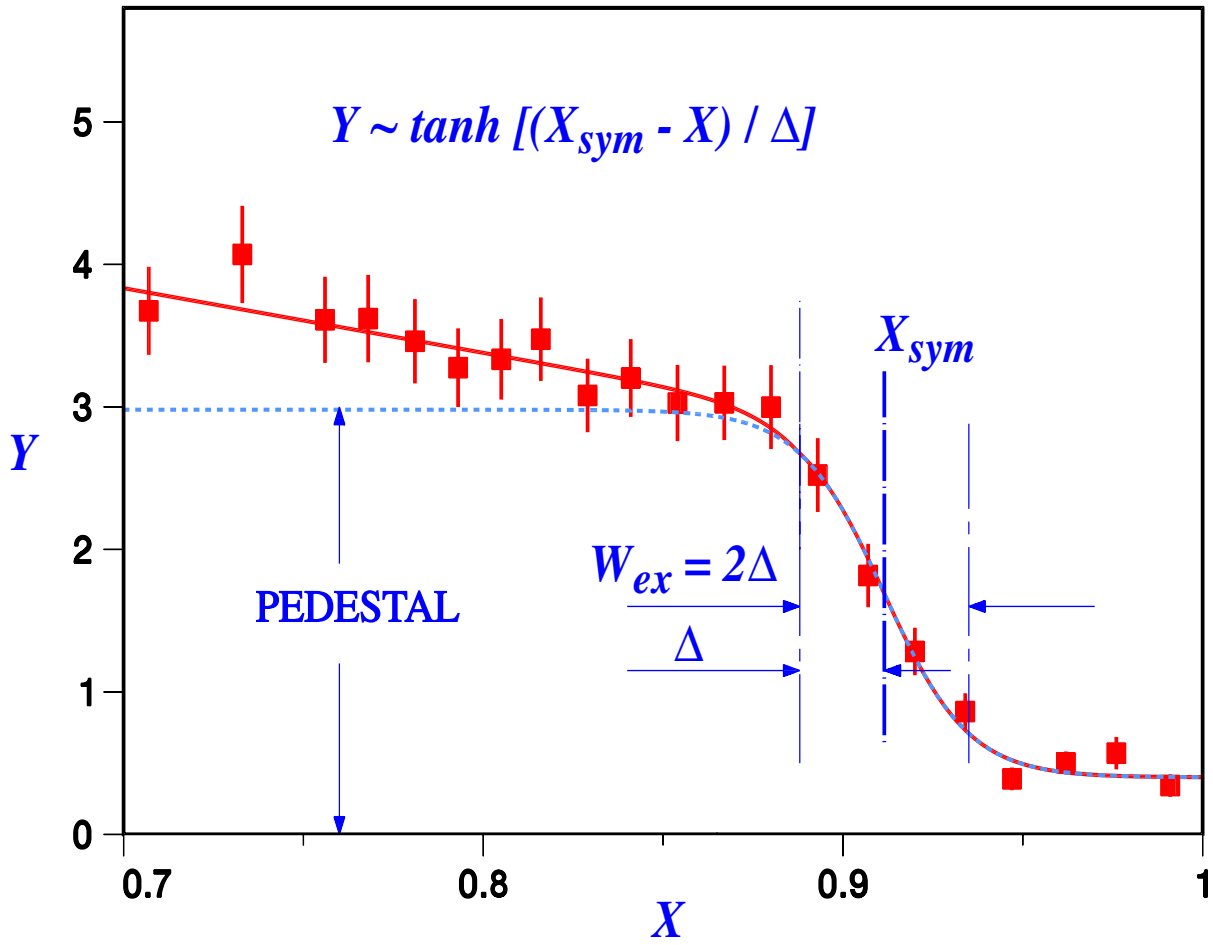


DIII-D NATIONAL FUSION FACILITY SAN DIEGO

GENERAL ATOMICS

MODEL PREDICTS THAT n_e PROFILES HAVE "TANH" SHAPE - AS OBSERVED

- Experimental edge n_e profiles routinely are fit well with the "TANH" shape
- A "modified" TANH is used to give continuous first derivative everywhere



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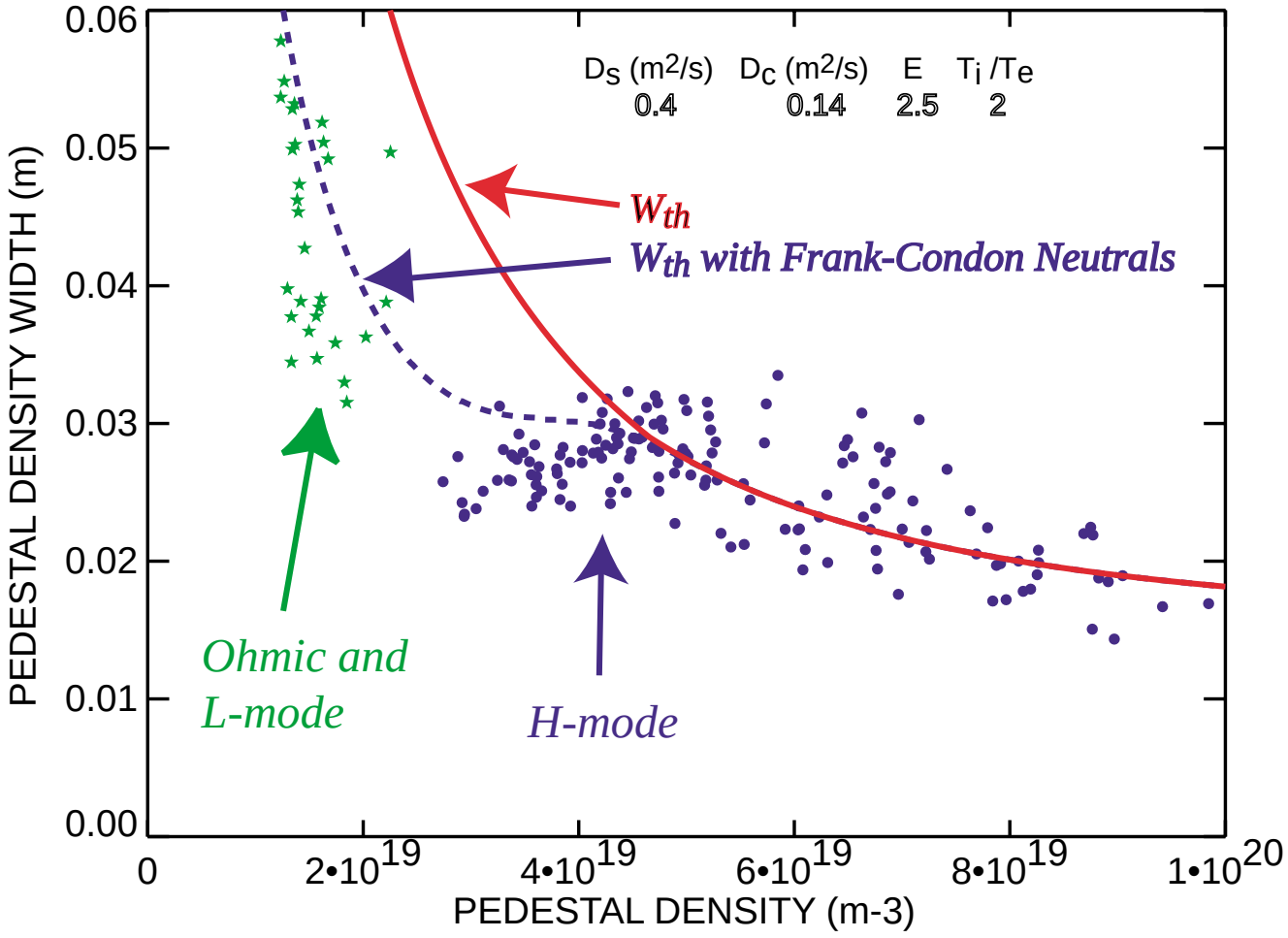
GENERAL ATOMICS

MODEL PREDICTS QUALITATIVE AND QUANTITATIVE DEPENDENCE OF EXPERIMENTAL WIDTH W_{ex} ON $n_{e,ped}$

- Theoretical width W_{th} is defined to emulate W_{ex}
- W_{th} is distance from 12% to 88% of $n_{e,ped}$ in model function
- Parameters in model are typical values



MODEL PREDICTS THE QUALITATIVE DEPENDENCE: MAXIMUM $\nabla n_e \sim n_{e,ped}^2$