TCV-X21 modeling

Simulation setup

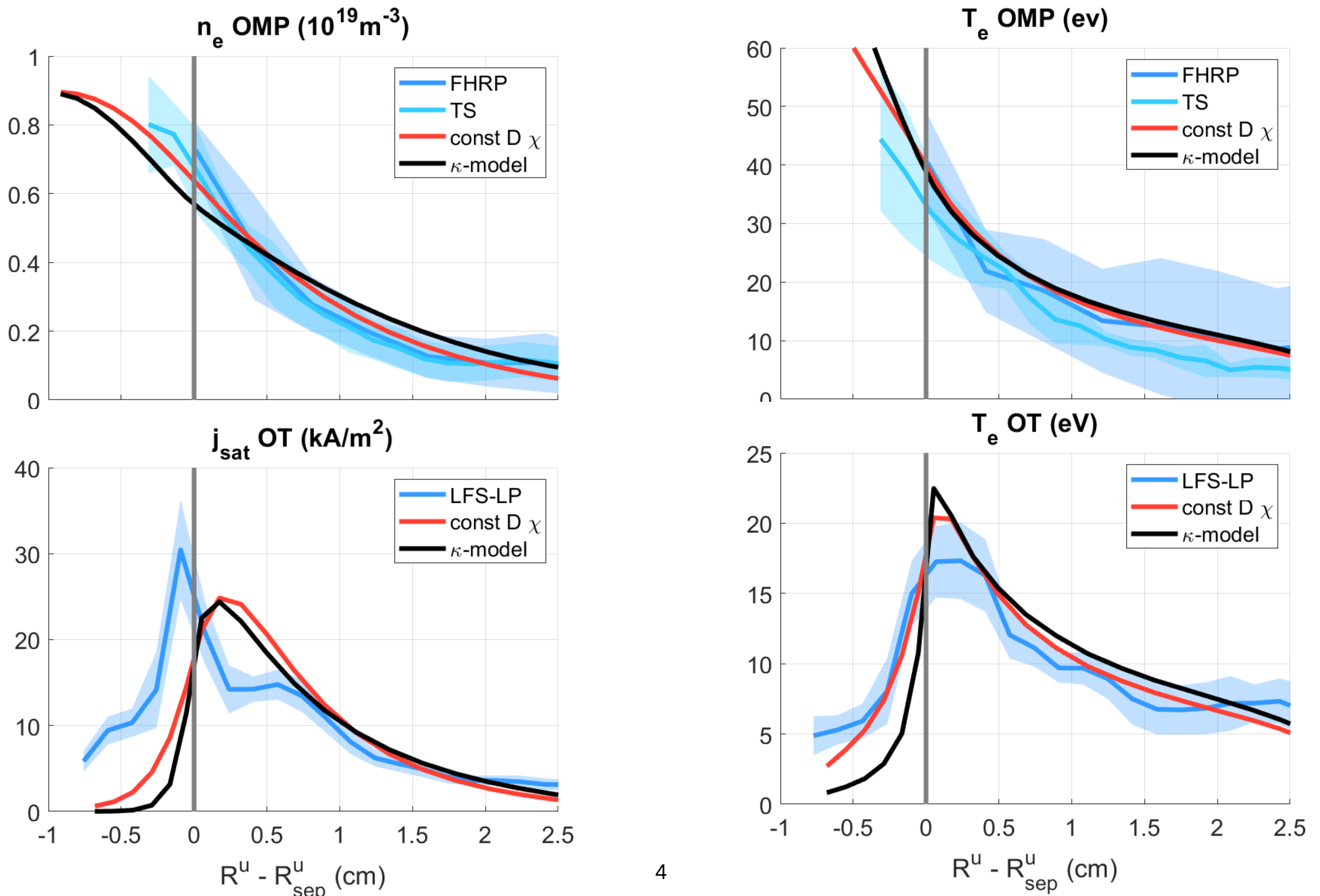
- Data from TCV-X21 repository
- Pure D plasma
- ‘Coarse’ 60×24 grid
- Boundary conditions
  - Gas puff at outer wall boundary (or fixed core density) + $P_{core} \sim 125\ kW$
  - Targets: standard sheath BC
  - PFR/WALL: leakage BC
- Wall recycling 0.99
- AFNs with separate neutral energy equation (better for very low densities)
- NO DRIFTS

Optimization setup

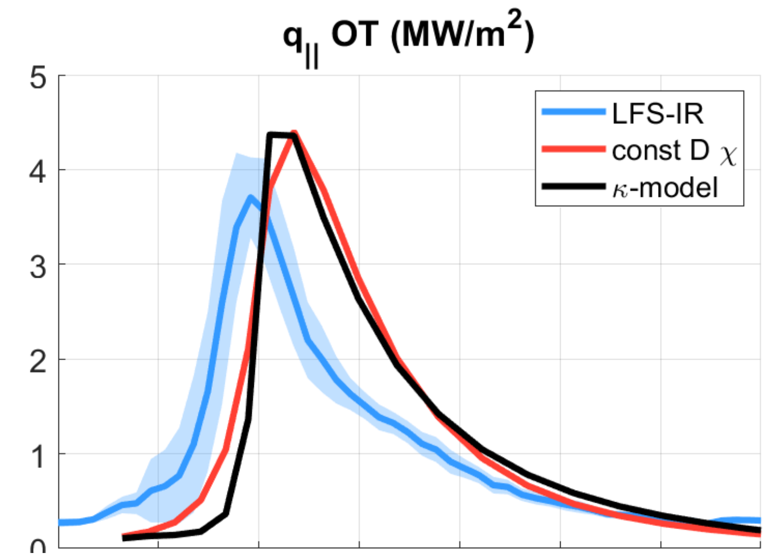
- Optimize ad-hoc diffusion coefficients, constant on whole domain, and gas puff: $D_\perp$, χ_e, χ_i, Γ_{puff,D^0}
- Optimize subset of main κ-model parameters and gas puff: $\kappa_{BC,core}$, $C_{he} = \frac{\chi_e}{D_{E\times B}}$, $C_{hi} = \frac{\chi_i}{D_{E\times B}}$, $C_{diss,SOL} = C_{\sigma_\parallel,2}$, $C_{diss,core} = C_{\sigma_\parallel,2,core}$, Γ_{puff,D^0}
  - For now keep $C_D = \frac{D_{E\times B}}{\rho_i\sqrt{\frac{\kappa}{m_i}}}$ fixed, as this was shown to be strongly correlated with κ BC at core → eventually estimate/constrain one of the two from experimental data

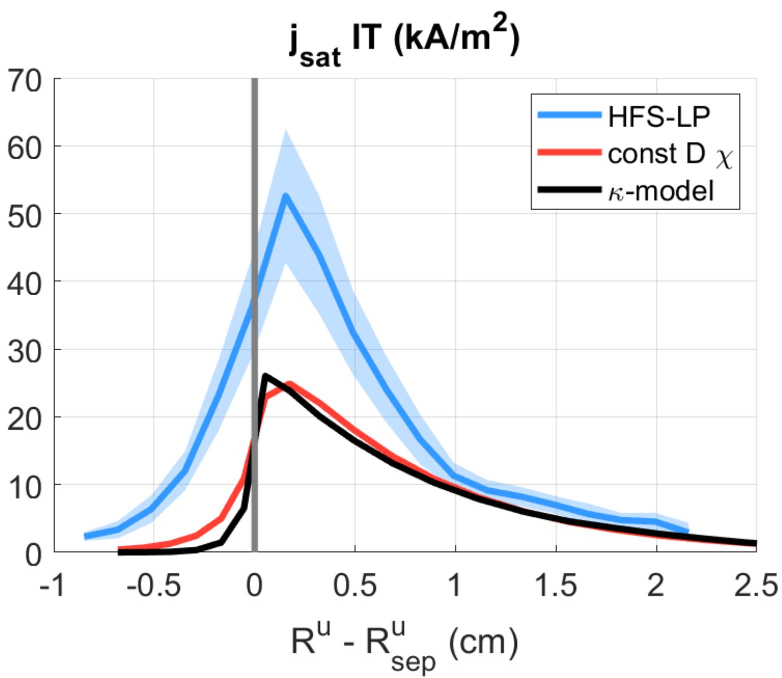
Experimental data matched: n_e-T_e at OMP, j_{sat}-T_e at outer target

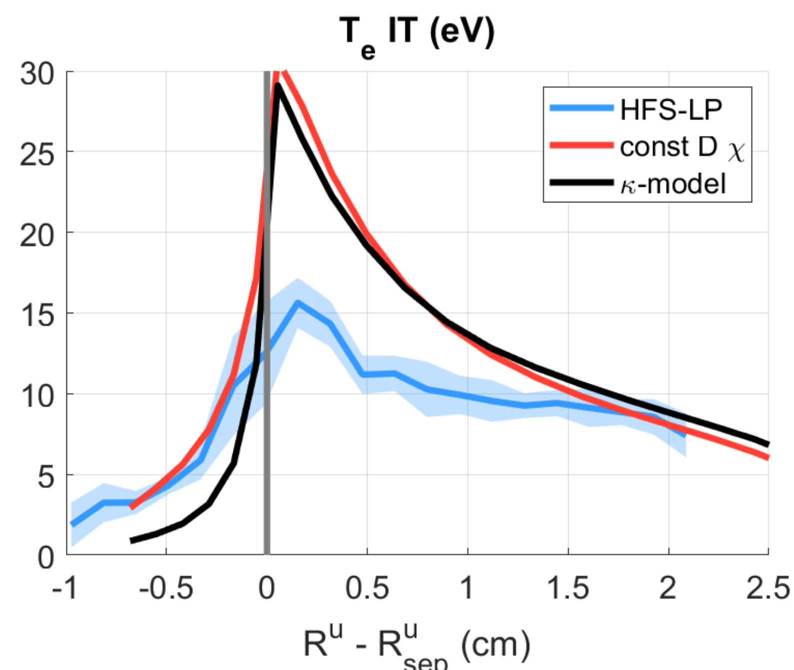
Results after optimization



Heat load and inner target

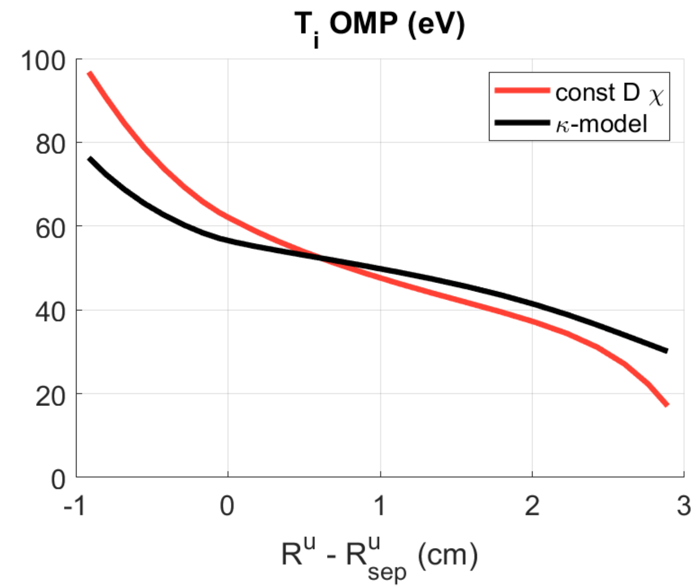






Some comments

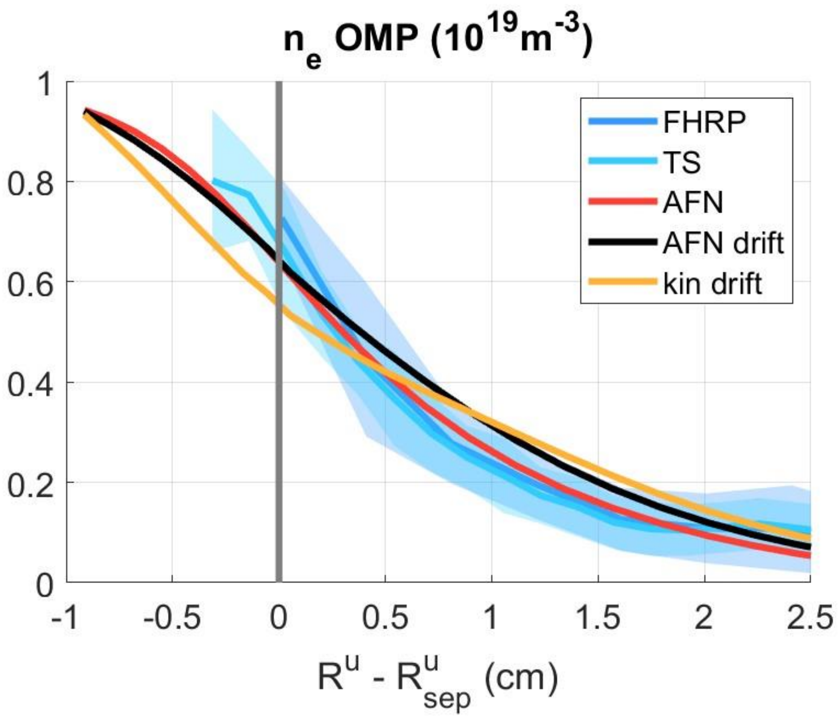
- Optimization tries to bring the SOL dissipation very small $C_{diss,SOL}$~0.01
- $\kappa_{BC,core}$: imposed flux, estimated value is very small <1W
- Optimization also tries to bring ion heat diffusivity coefficient very high C_{hi}~10 (limited by an upper bound). However, there is no 'explicit' information for ion temperature in the cost function
  - Reason: change in sound speed at the OT?

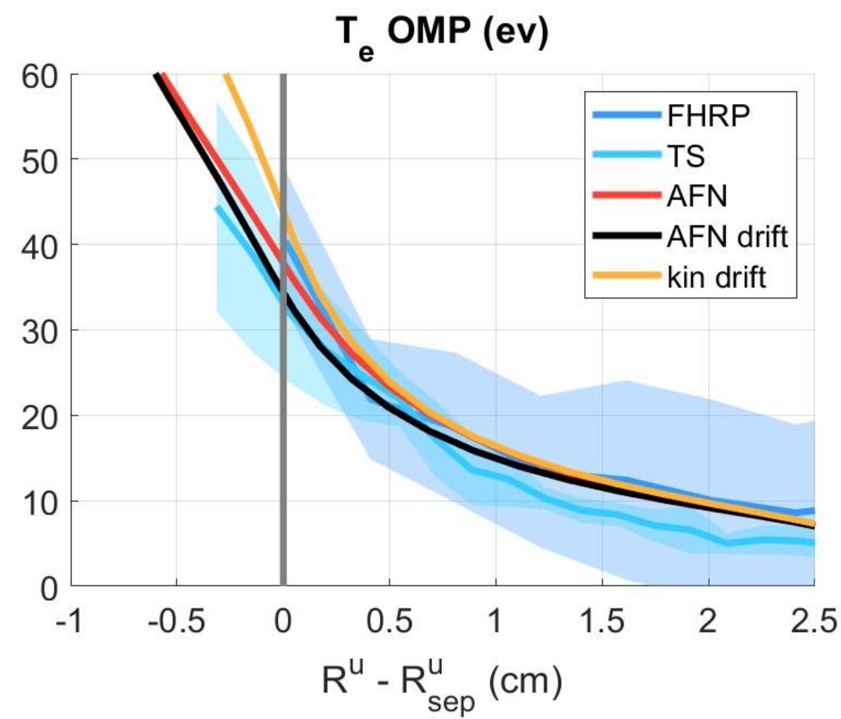


DRIFTS & KINETIC

What do drifts and kinetic provide?

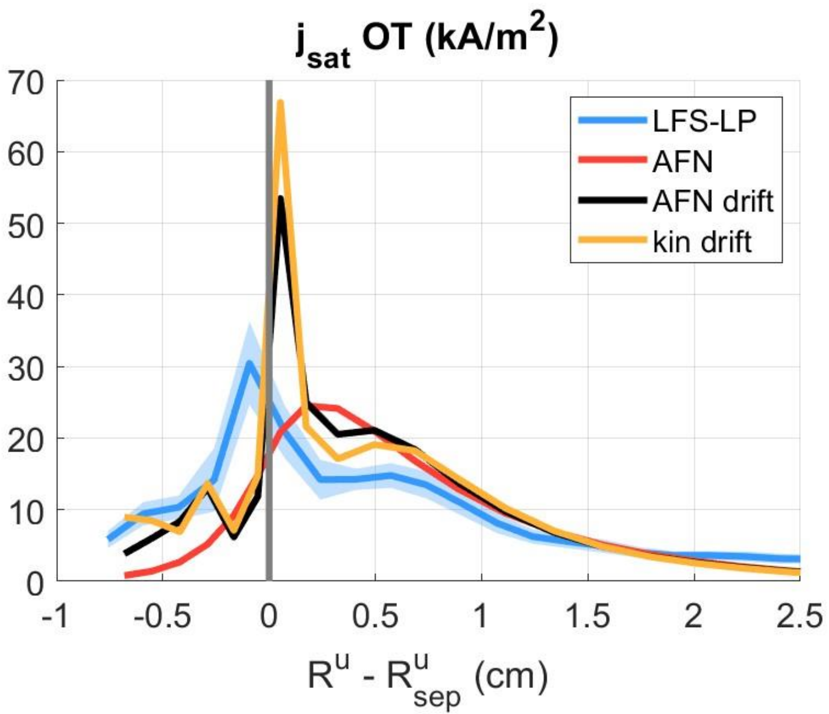
- <u>NO OPTIMIZATION</u>! use optimal values from no-drift case for both AFN and kinetic drift cases
- Large anomalous conductivity needed $\sigma_{AN} = 2 \times 10^{-4}$

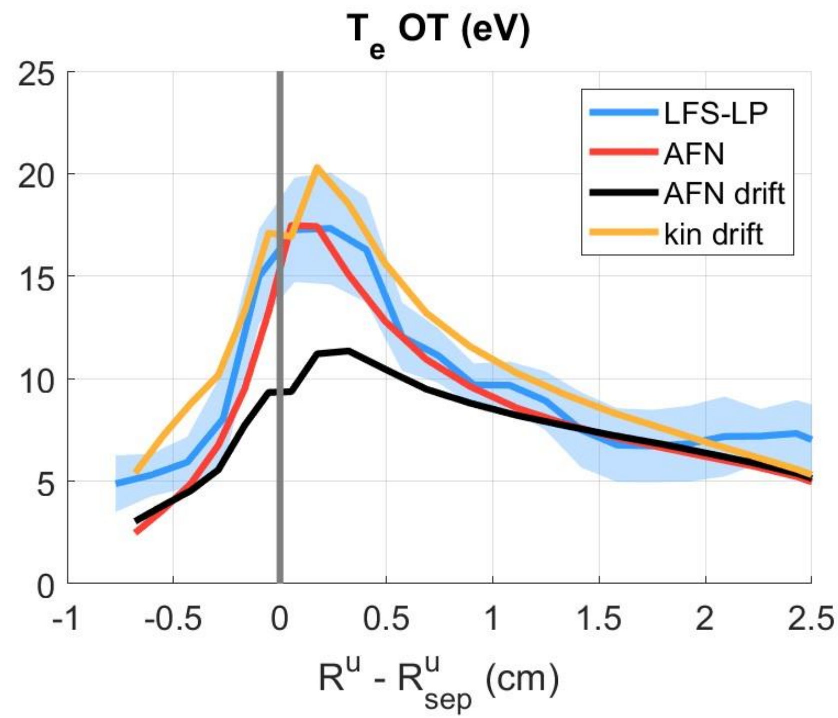




What do drifts and kinetic provide?

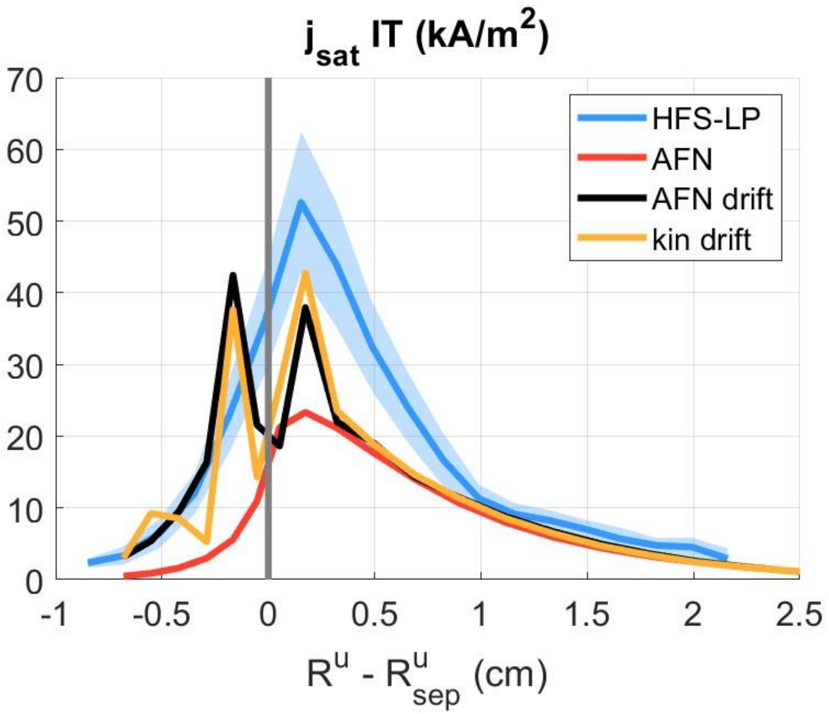
- j_{sat} shape similar as experiment apart from spike in PFR and shifted peak, AFN slightly overshoots
- T_e good match for kinetic, too low for AFN
- Overall, very good match for kinetic

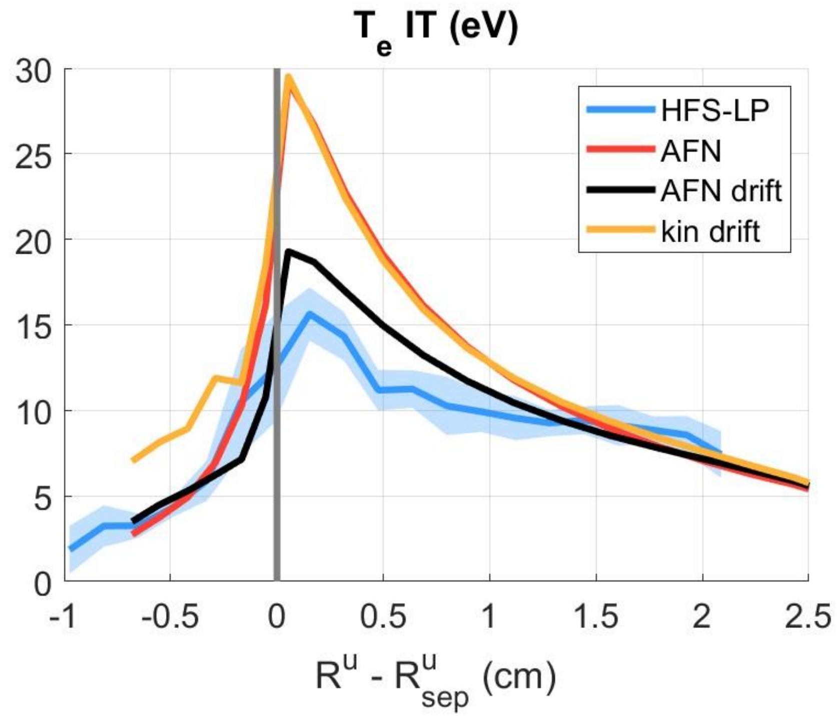




What do drifts and kinetic provide?

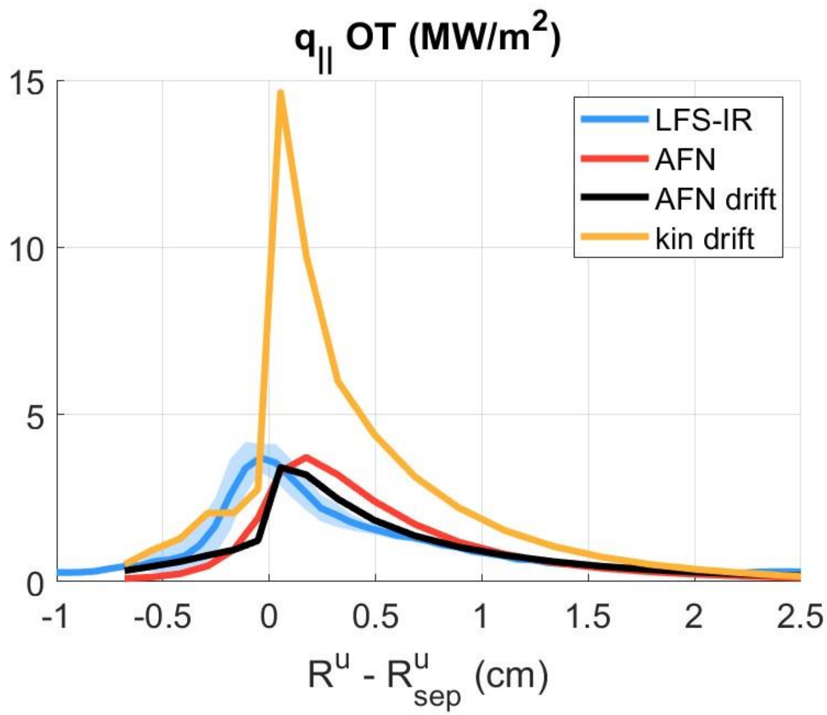
- Double peak in j_{sat} appears at inner target in both fluid and kinetic drift cases
- Note that AFN converges to machine precision
  → peaks not due to time-dependent oscillations

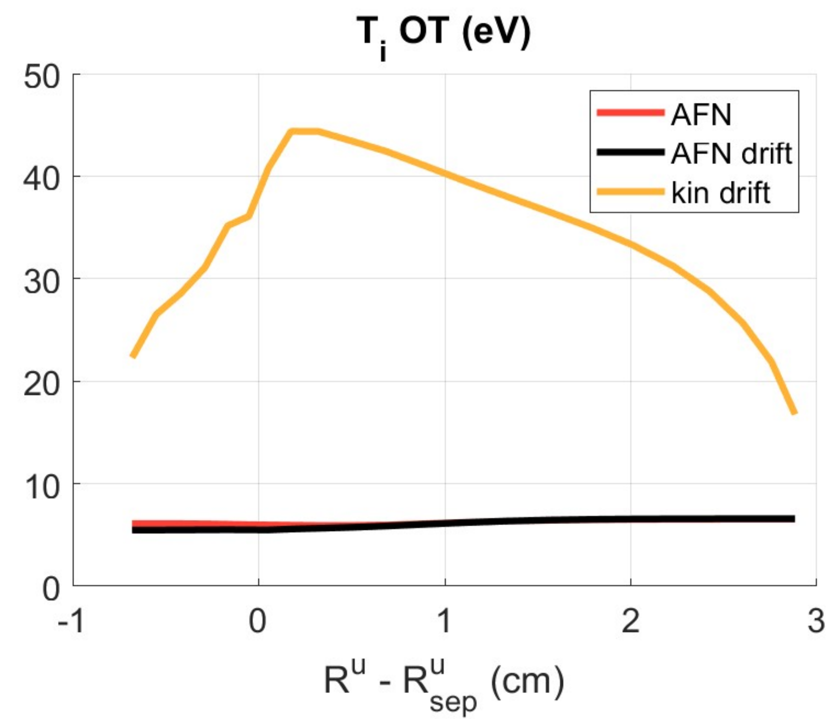




What do drift and kinetic provide?

- Heat load significantly overshoots for kinetic case
- Possible issue with using b2frates from AFN case
  - → in kinetic still need to account for neutrals!
- NOTE: radiation not included!





Conclusions and next steps

- Basic AFN setup without drifts gives decent comparison with experiment
- Turning on drifts makes comparison qualitatively better, but no optimization seems possible (unstable convergence)
- Clear neutral kinetic effects present (not shown)

- Optimize full set of κ-model parameters
- Try to turn on drifts with κ-model (with kinetic neutrals eventually)
- Try higher density TCV-X21, density very low and fluid (neutral) approximation likely invalid
- Mimic on TCV-X23

First TCV-X23 grid