

Strong impact of separatrix conditions on full-radius L-mode predictive integrated modelling

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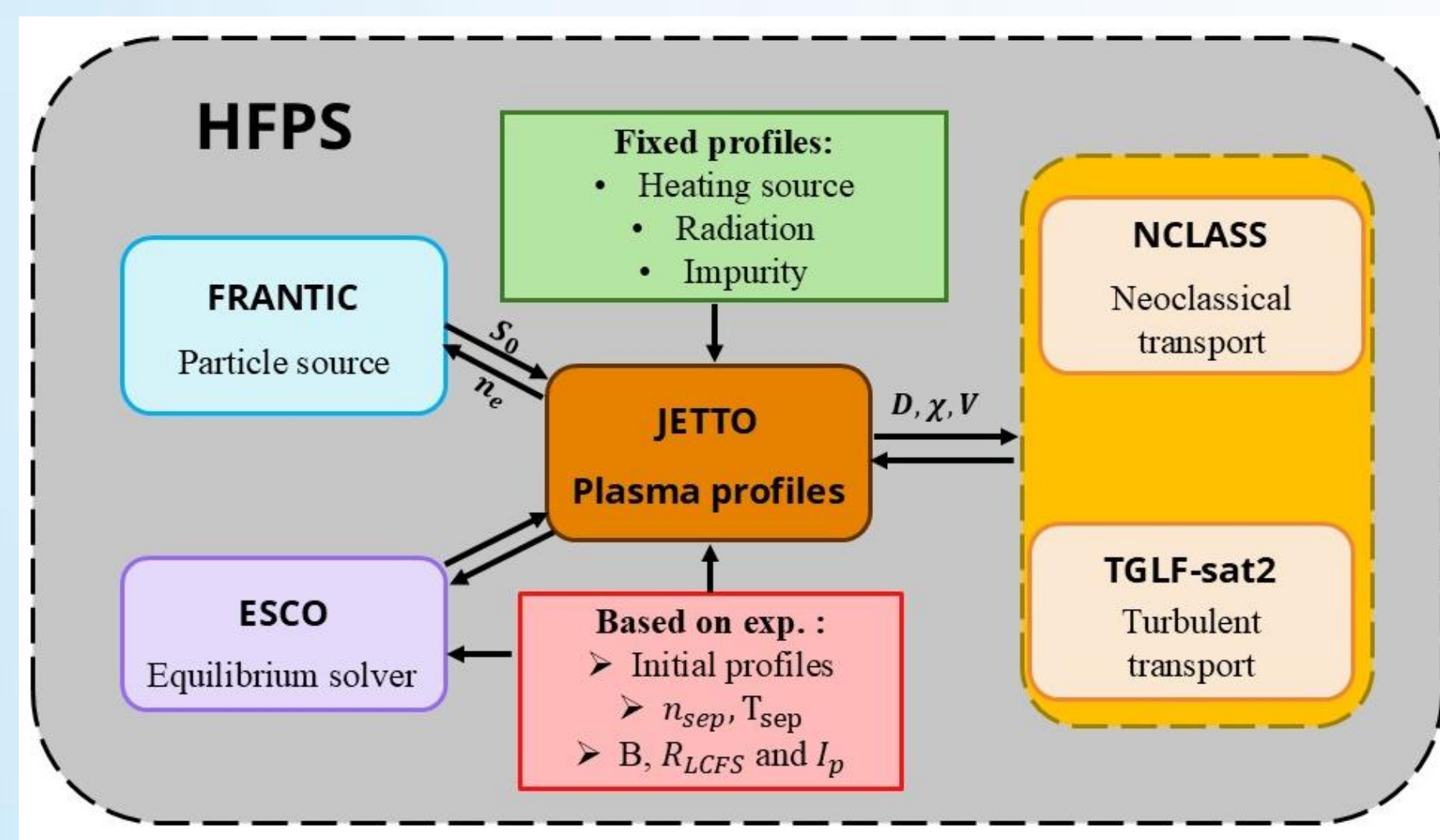
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Motivation

- Separatrix parameters affecting core confinement and operational limits
- ASDEX Upgrade & C-Mod & SPARC: The separatrix operational space (SepOS), L-mode density limit and L-H transition
- ASDEX Upgrade & C-Mod: Separatrix conditions induce a rapid core plasma response

HFPS modelling

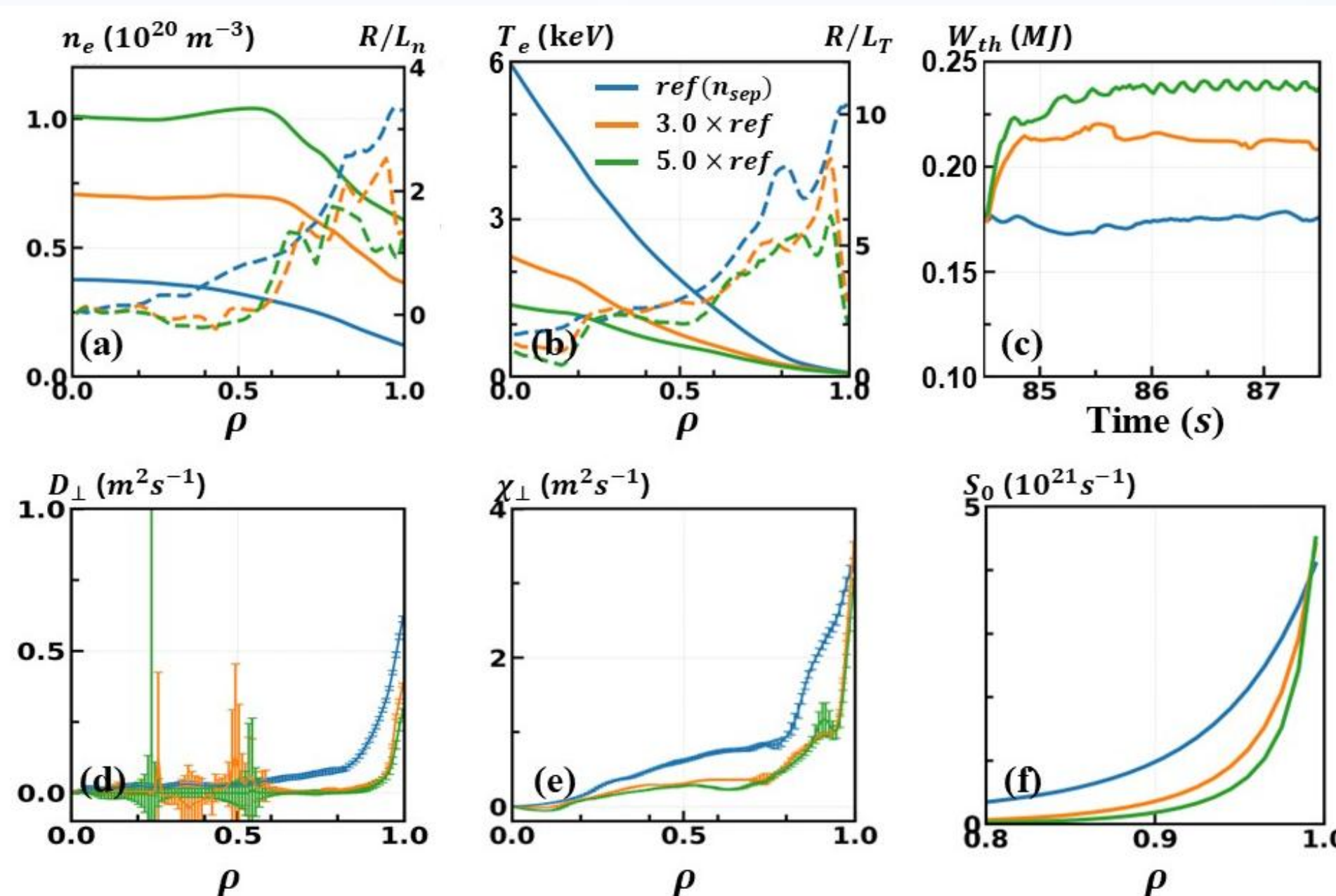


- High-Fidelity Pulse Simulator (HFPS), a Python workflow based on the JINTRAC/JETTO suite of codes, coupled to the Integrated Modelling and Analysis Suite (IMAS)
- WEST L-mode discharge #57757 (validated by HFPS)
- Fixed heating, gas puffing, radiation
- Standalone TGLF-sat2 for turbulent transport
- Thought experiments for dynamic response and confinement estimate

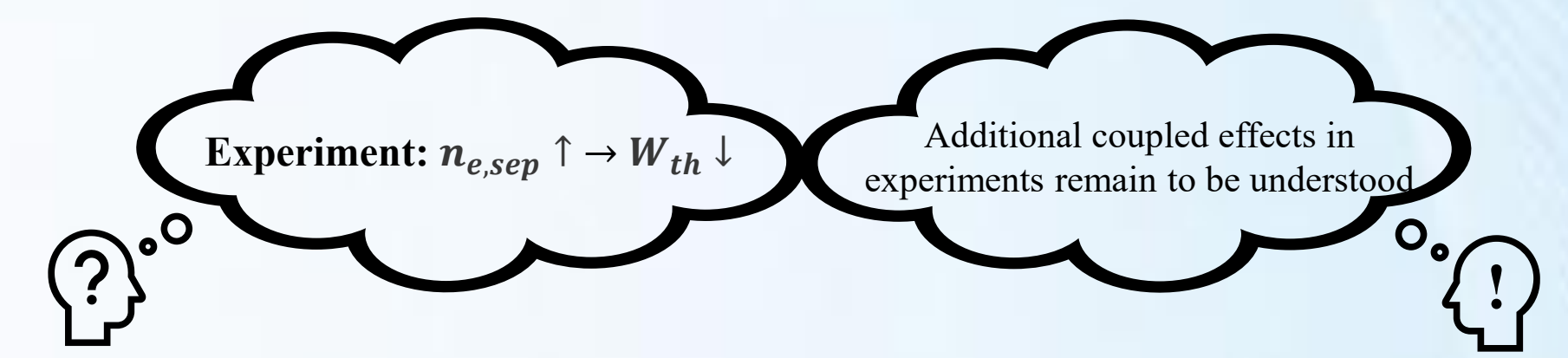
Take-home message

- Separatrix parameters actively impact core plasma through transport
- Collisionality plays the key role: higher $n_{e,sep}$ or lower $T_{e,sep}$ raises collisionality, reduces D_{eff} , and promotes inward turbulent particle transport
- Higher $n_{e,sep}$ increases not only core density and W_{th} , but also effective energy confinement

HFPS reveals a transport-driven core response to separatrix condition

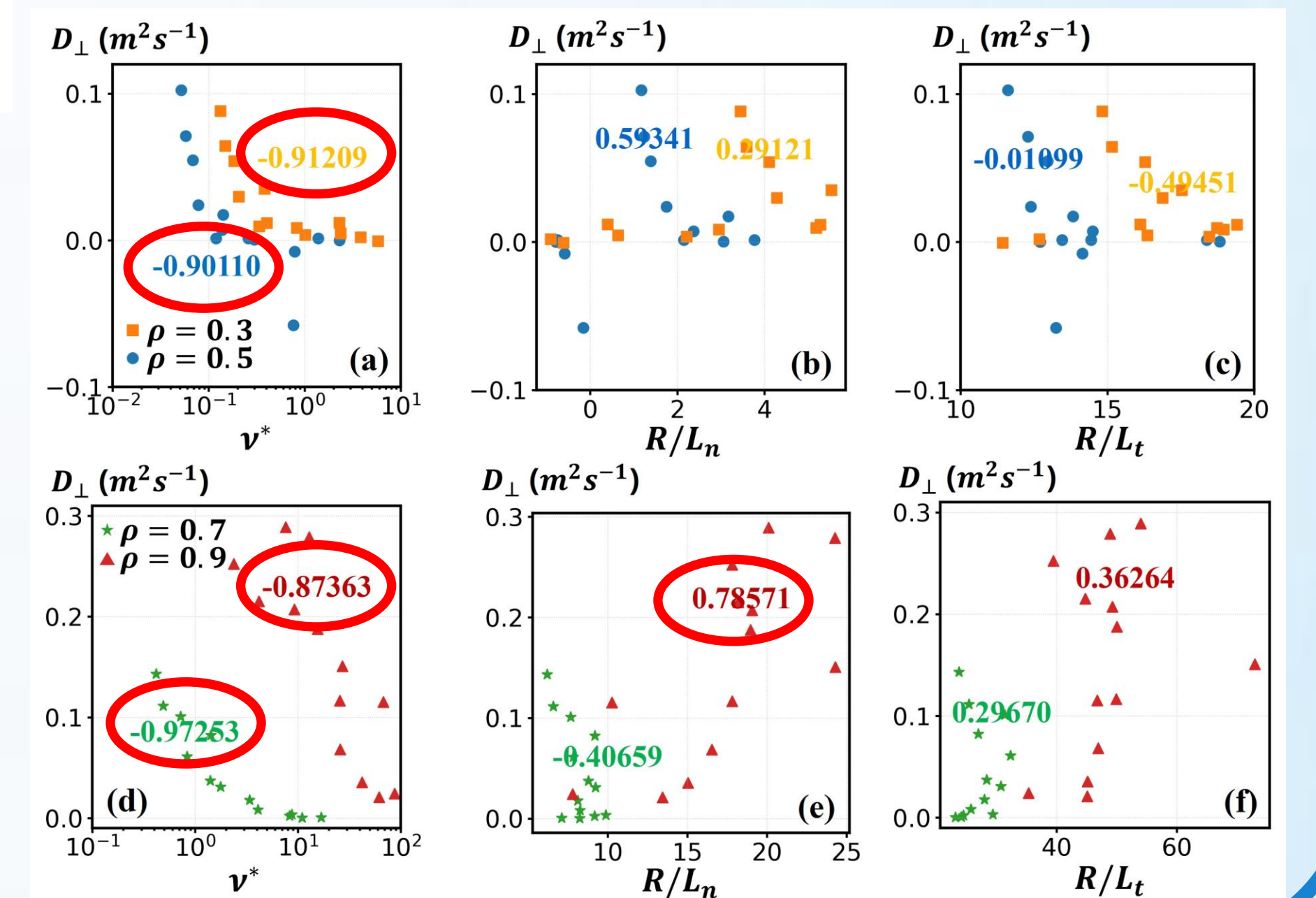


- $n_{e,sep} \uparrow$: density peaking \uparrow up to $\rho = 0.6$
- With fixed heating, $T_e \downarrow$ but $W_{th} \uparrow \sim 35\%$
- Neutral source: modest
- Transport-driven core response

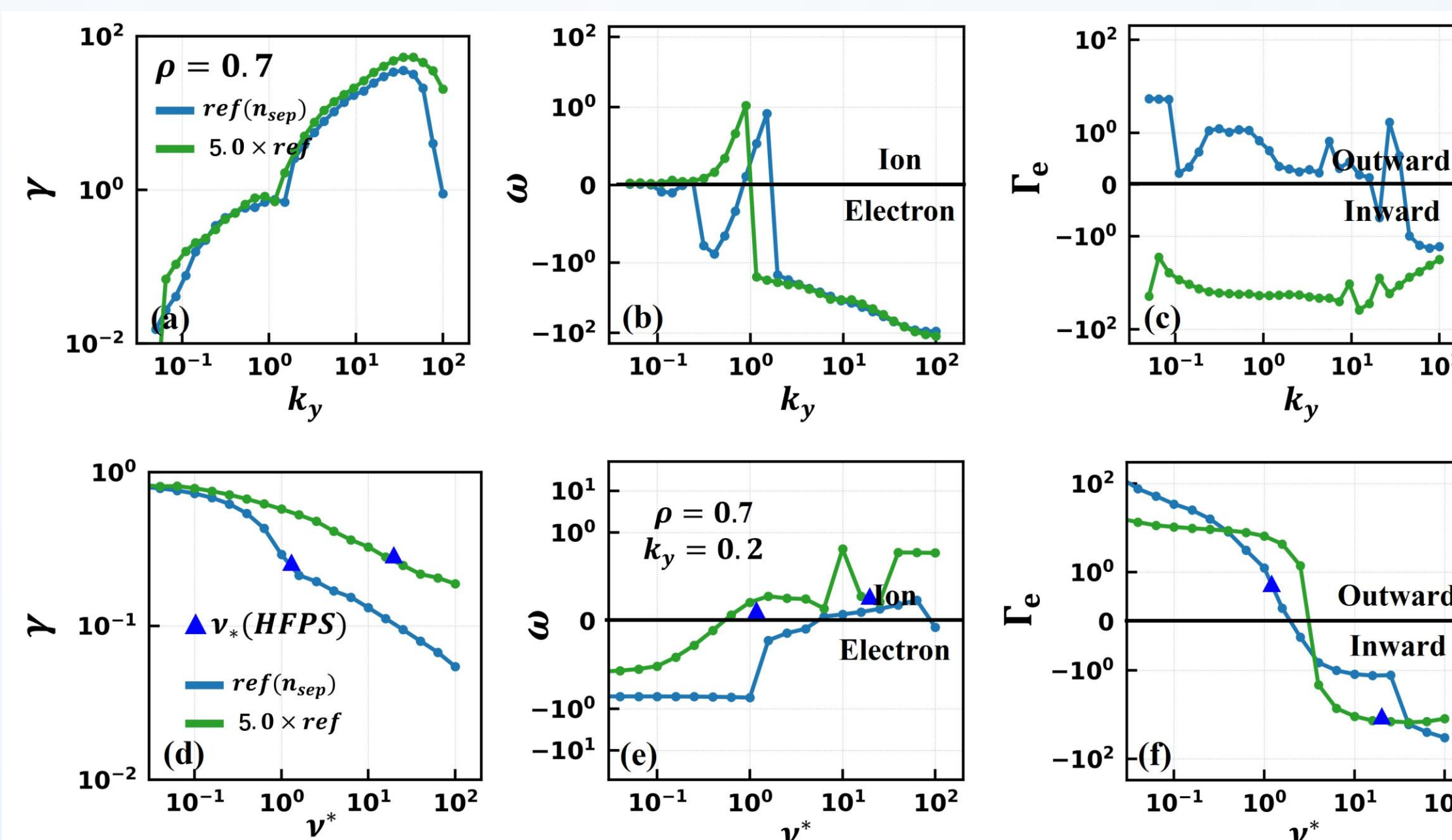


- $T_{e,sep} \uparrow$: density \downarrow and temperature \uparrow
- More physical separatrix conditions: SOLEDGE & empirical scaling laws from WEST C4 campaigns database

- Collisionality is the key role: $D_{eff} \downarrow$ with $\nu^* \uparrow$
- Weaker correlations with R/L_n and R/L_T

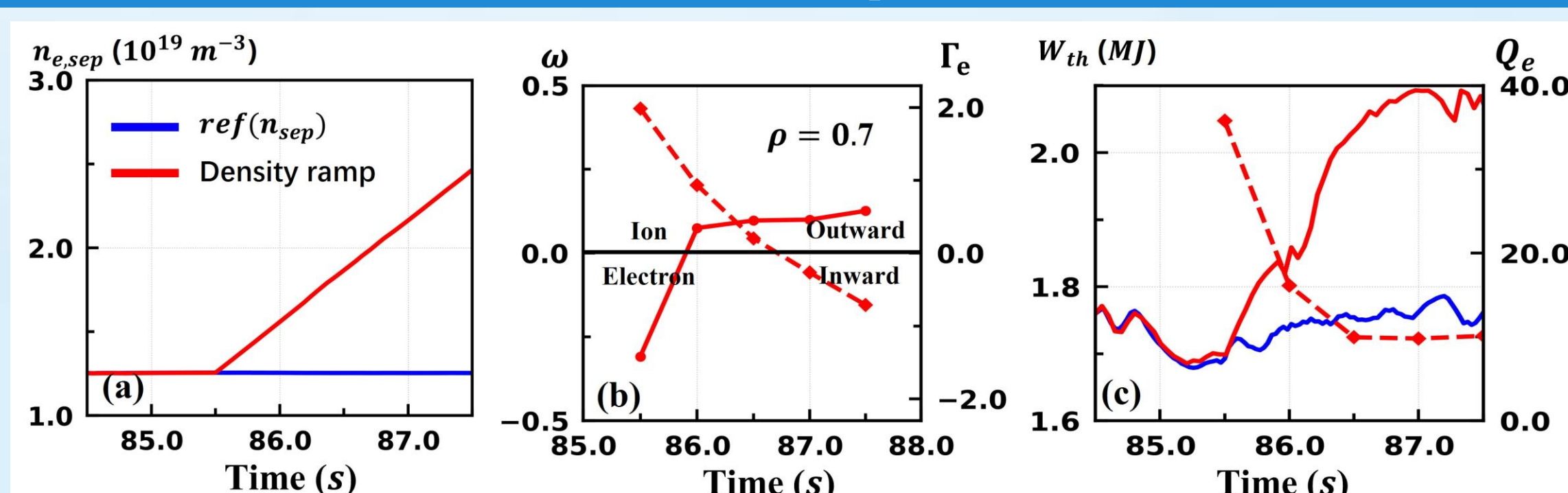


Collisionality shifts turbulence from outward to inward particle transport

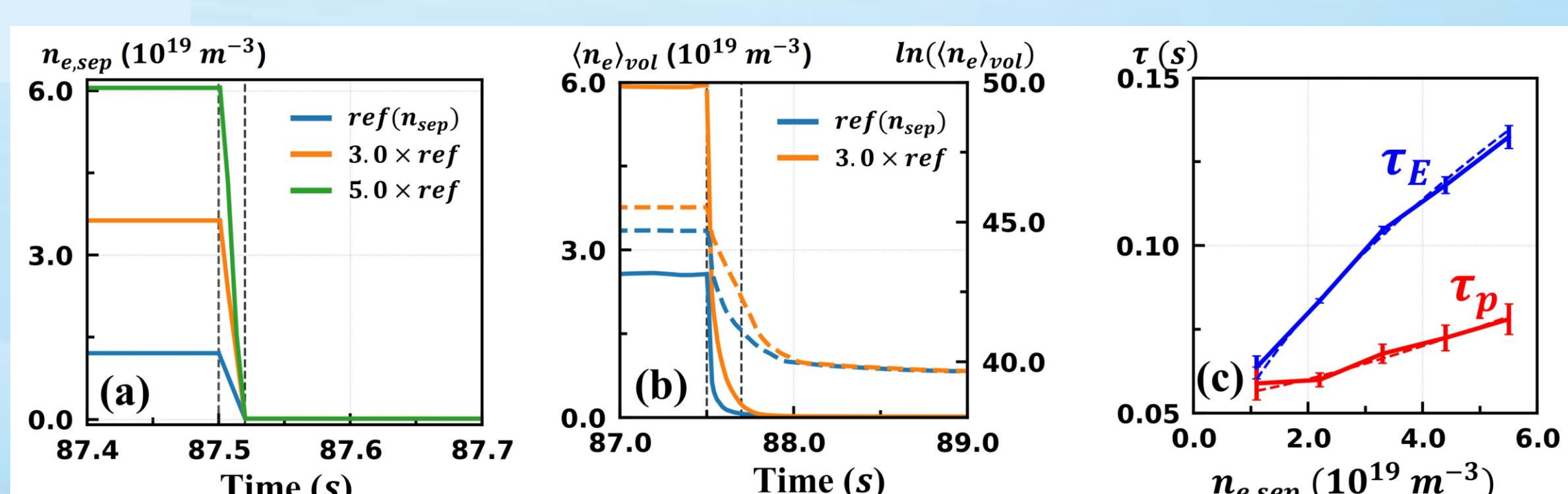


- TEM-like outward flux in reference
- High $n_{e,sep}$: more ITG-like inward flux
- Collisionality causes frequency shift and flux reversal
- $\rho = 0.5$ & 0.9 support the key role of collisionality

Higher $n_{e,sep}$ increases density and confinement



- $n_{e,sep}(t) \uparrow$ drives sustained core density rise
- ω : electron \rightarrow ion propagation
- Γ_e : reverses outward \rightarrow inward



- Free decay: switched off particle and heating source & reduce sep. values
- $W_{th} \propto \exp(-t/\tau_E)$
- $n_{e,sep}$ improves not only density but also confinement

