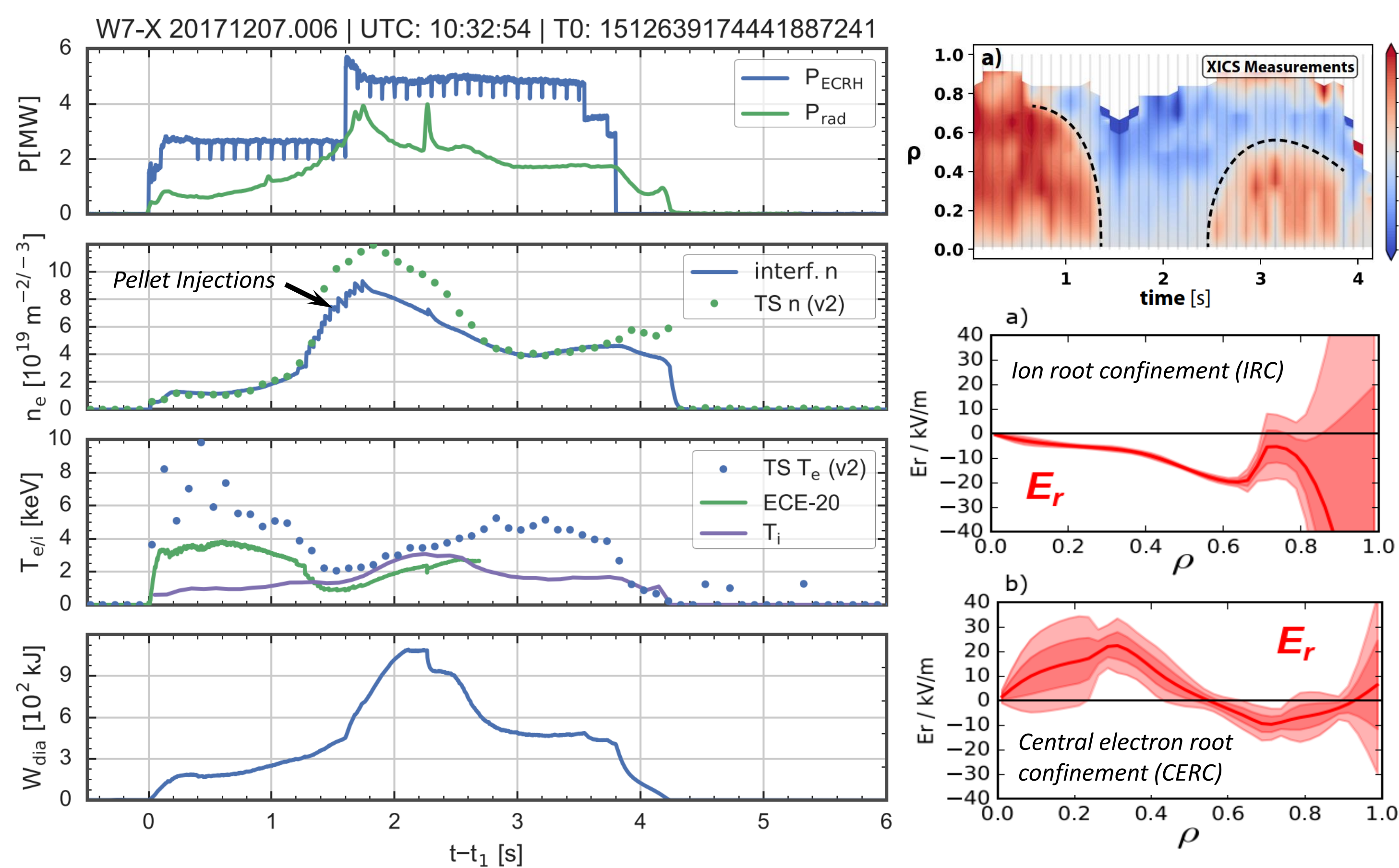


Abstract/Motivation

This paper reports on the observation of enhanced argon impurity confinement in high density ion-root confinement (IRC) scenarios in Wendelstein 7-X.

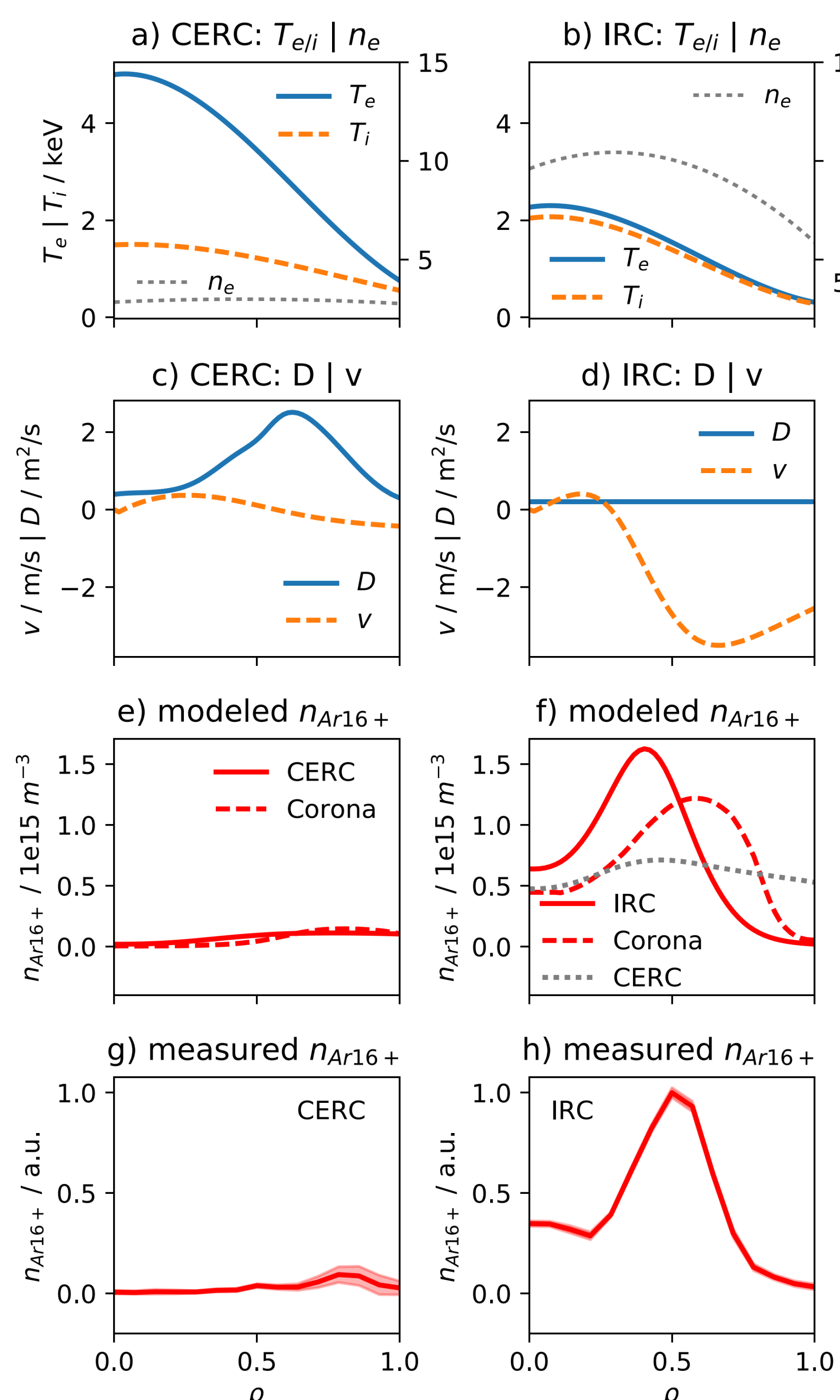
Compared to the core electron-root confinement (CERC), argon densities are increased by a factor of 10 and argon flux profiles switch from slightly positive to pronounced negative fluxes in IRC. As a consequence of the negative, inwards directed Ar flux in IRC, a strong impurity profile peaking at the position of the minimum value of E_r is observed in agreement to STRAHL simulations.

High Performance Scenario: CERC to IRC Transition [1]



- High performance scenario with reduced turbulence and increased energy confinement after series of cryogenic pellet injections
- Transition from CERC to IRC and back to CERC
- Equilibration between T_i and T_e during IRC
- Negative E_r along entire plasma radius in IRC

STRAHL Modeled CERC vs. IRC



Performed STRAHL simulations for initial guess of transport parameter profiles D+V with respect to optimal match between modeled and measured $n_{Ar^{16+}}$ profiles.

CERC:

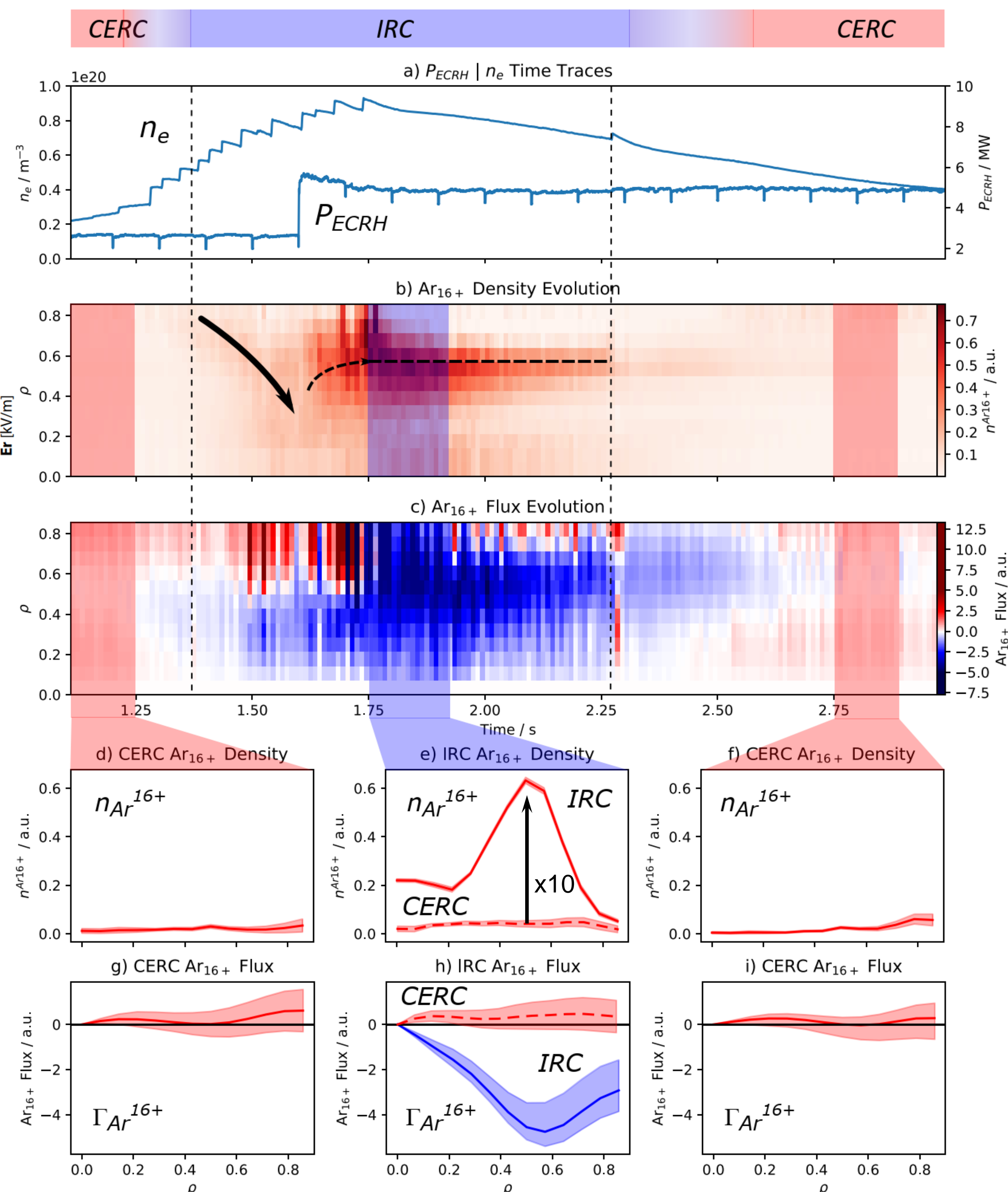
- Assumed typical D+V profiles with significant anomalous transport as observed in W7-X
- Resulting modeled broad $n_{Ar^{16+}}$ profiles match observed ones.
- As $n_{Ar^{16+}}$ profile is broad already in Corona equilibrium, strong D doesn't affect $n_{Ar^{16+}}$ profile shape much.

IRC:

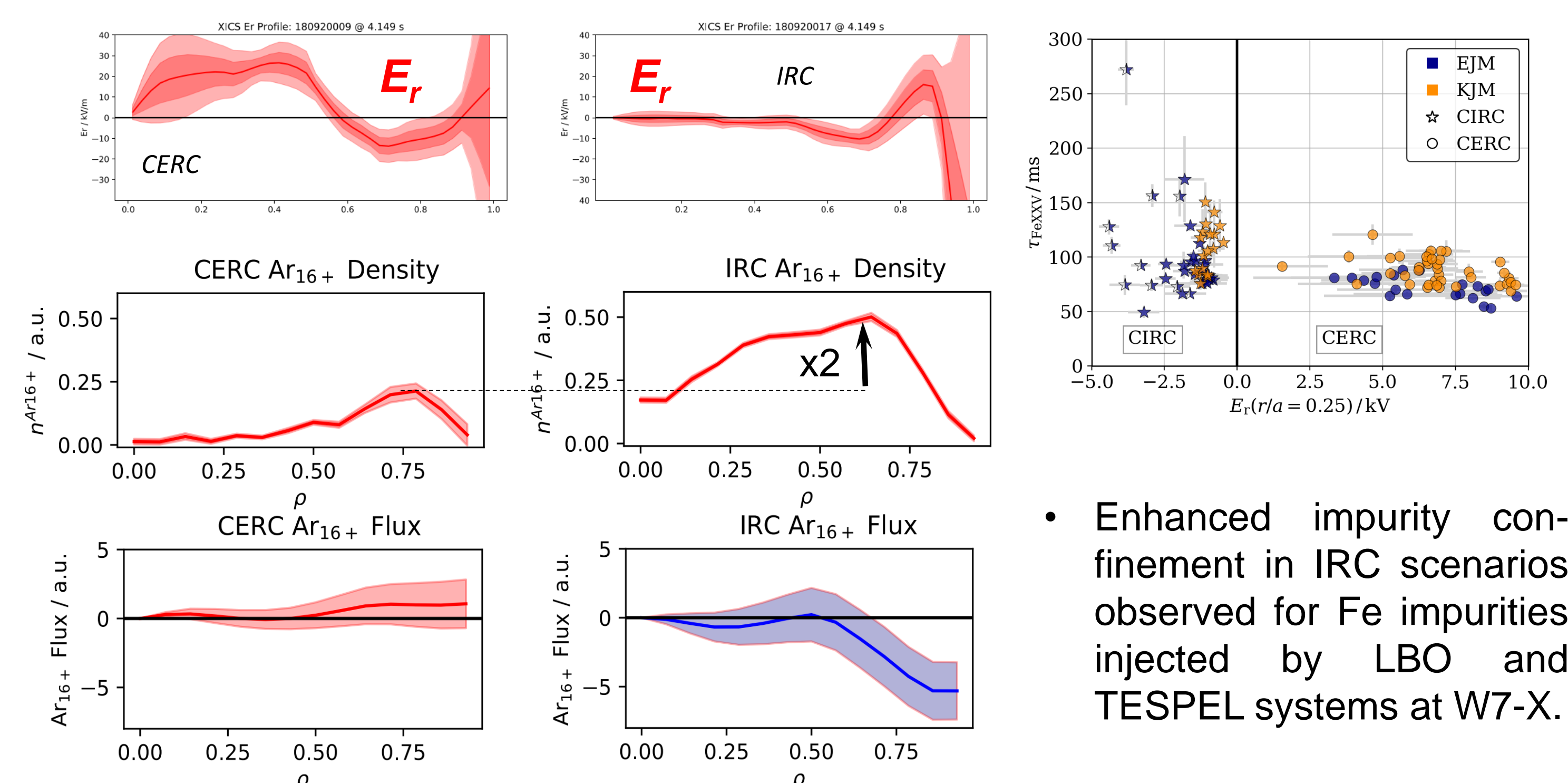
- Assumed reduced D and significantly negative V (from negative Ar^{16+} flux).
- Resulting modeled peaked $n_{Ar^{16+}}$ profiles at $\rho = 0.5$ match observed ones.
- Corona approximation yields too broad $n_{Ar^{16+}}$ profile shape.
- Assuming CERC D+V profiles yields broad $n_{Ar^{16+}}$ profile shape.

[1] N.A. Pablant, A. Langenberg, A. Alonso *et al.* *Nuclear Fusion* **60** 036021 (2020)
[2] A. Langenberg, Th. Wegner, N.A. Pablant *et al.* *Physics of Plasmas* **27** 052510 (2020)
[3] A. Langenberg, F. Warmer, G. Fuchert *et al.* *Plasma Phys. Control. Fusion* **61** 014030 (2019)
[4] Th. Wegner, B. Geiger, F. Kunkel *et al.* *Rev. Scient. Instrum.* **89** 073505 (2018)

Experimental Ar Density and Flux Profiles: CERC vs. IRC



Ar Density and Flux Profiles: CERC vs. IRC, no Pellets



- Without pellets, reduced turbulence suppression and weaker negative E_r in IRC.
- Weaker E_r yields also reduced negative radial Ar^{16+} fluxes and less enhanced $n_{Ar^{16+}}$ profiles (x2) compared to the CERC scenario.
- Enhanced impurity confinement in IRC is a combined effect of negative E_r and turbulence suppression.

Conclusions

- Factor of x10 enhanced Ar impurity densities in IRC scenarios with respect to CERC.
- Strong negative radial Ar fluxes for IRC, slightly positive for CERC.
- Radial Ar impurity fluxes follow temporal evolution of E_r profiles, as observed by XICS [1].
- Ar^{16+} density profile shapes can be reproduced with STRAHL simulations for IRC and CERC, assuming reduced diffusion and inwards directed transport parameters in IRC.
- Assumptions correlates with observed reduced turbulence and increased confinement in IRC scenarios at W7-X.