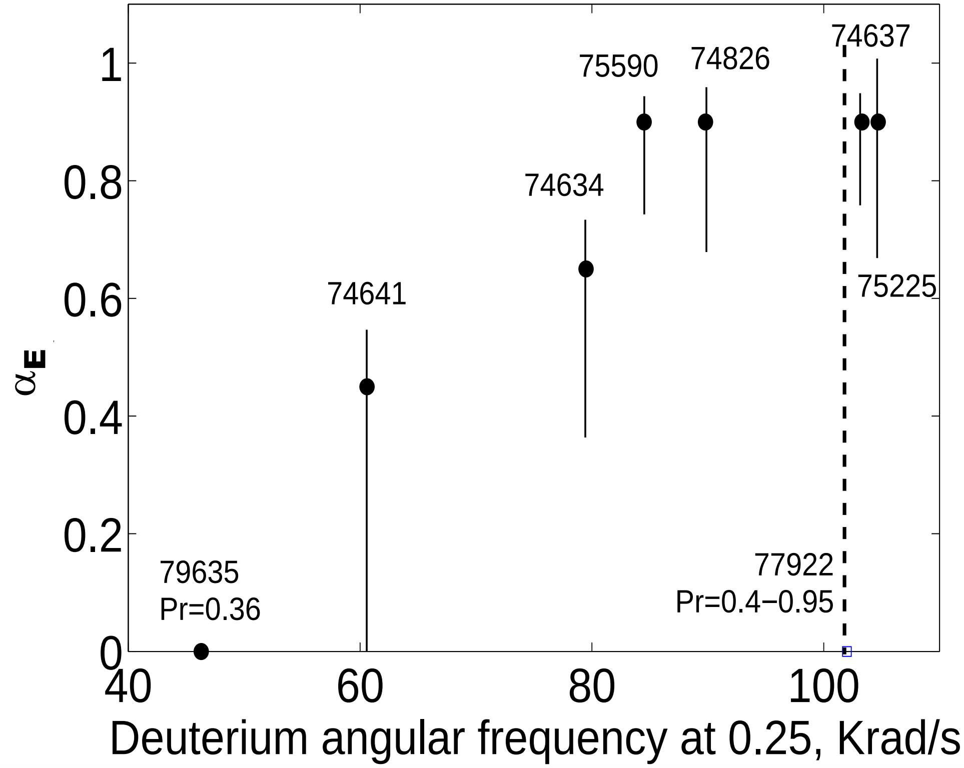
Four-field simulations (ni, Te, Ti, Vtor, j) of ITER HS with GLF23 model: effect of toroidal rotation on fusion performance

EFDA Task Force
EUROPEAN FUSION DEVELOPMENT AGREEMENT
INTEGRATED TOKAMAK MODELLING

JET hybrid scenarios with GLF23: non-linear ExB shear stabilisation with rotation

I. Voitsekhovitch et al, ISM WS, November 2012

- **Four-field simulations (T_e, T_i, n_i, V_{tor}) with GLF23 (ASTRA): small-step scan in α_E and Pr**
- **Non-linear ExB shear quench rule would give more accurate prediction: α_E increases with rotation**
- **Pr=0.3 for low δ and high rotation/high δ shot. Larger Pr uncertainty (0.4-0.95) at low rotation**
- **Effect of toroidal rotation shear on fusion performance in ITER hybrid scenario?**

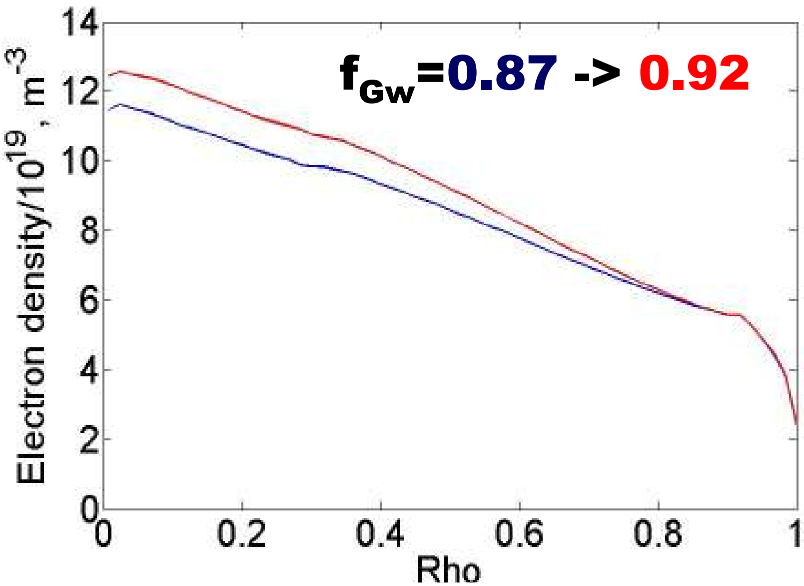


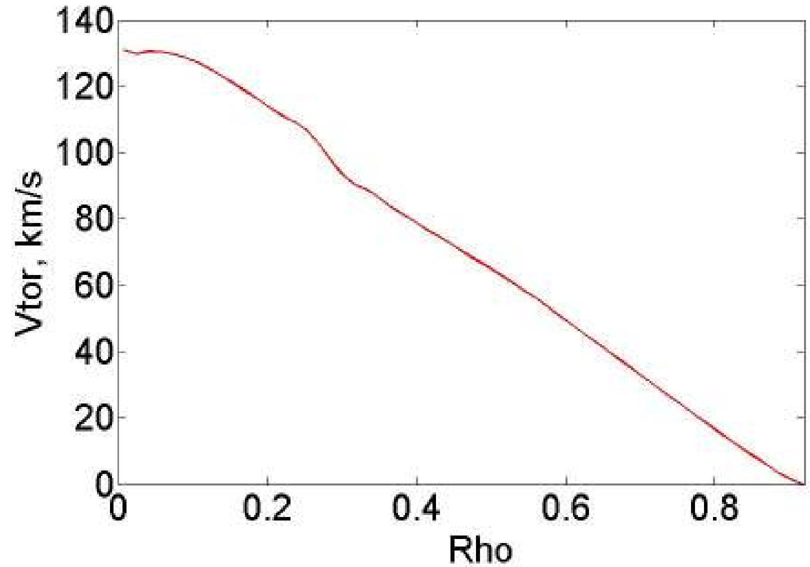
α_E uncertainty is determined by 15% deviation of T_e, T_i, n_i and ω from their measured values. Pr=0.3 for all shots except 79635 and 77922 where a larger Pr numbers with a large uncertainty are obtained

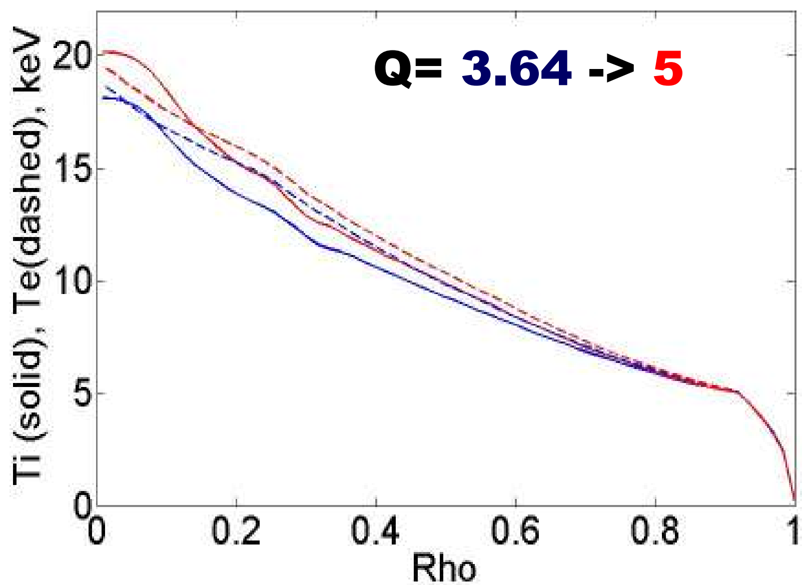
Hybrid scenario (12 MA) with optimised heat mix [J. Citrin et al, NF 2010]

- **Optimised heat mix: 33 MW of NBI (Fokker-Planck), 37 MW of ECCD (Gaussian profile)**
- **NBI particle source only**
- **ECCD 1.2 MA (prescribed), simulated bootstrap (NCLASS) and beam driven current (FP)**
- **Prescribed impurity concentration: 2% Be, 0.12% Ar, 3.5% He**
- **Simulation region ρ < 0.92, Tped = 5 keV, pedestal density is roughly limited by Greenwald density (fGw ~0.9)**
- **NBI torque (FP), pessimistic assumption for toroidal rotation at the boundary, Vtor = 0 at $\rho \geq$ 0.92**
- **Steady state only is simulated**

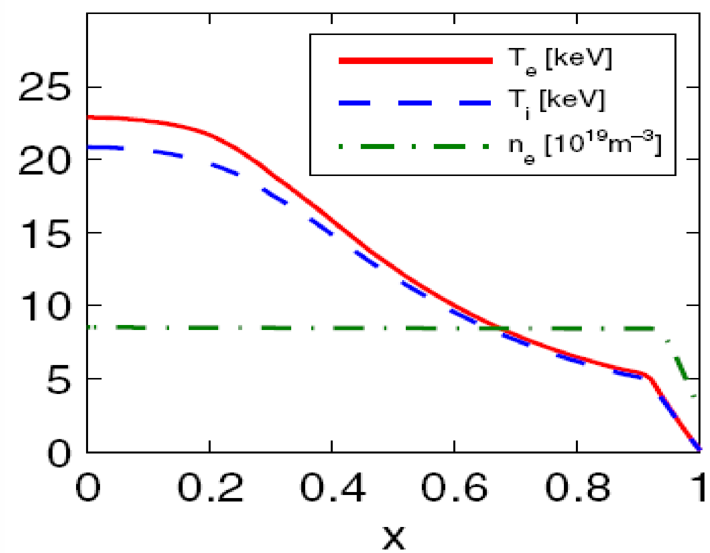
GLF23/ASTRA with αExB=1, Vtor=0 (blue curves), Pr=0.3 (red curves)



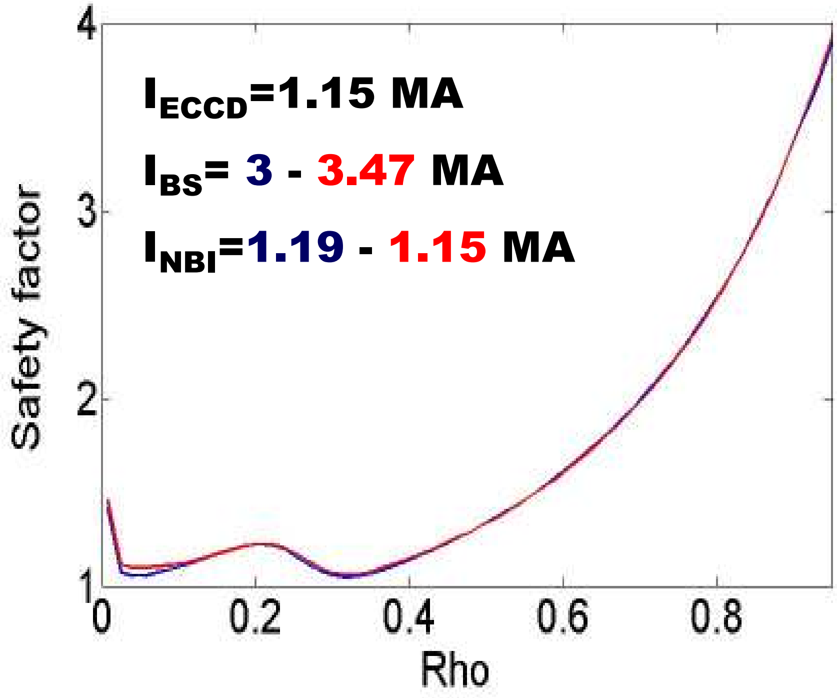




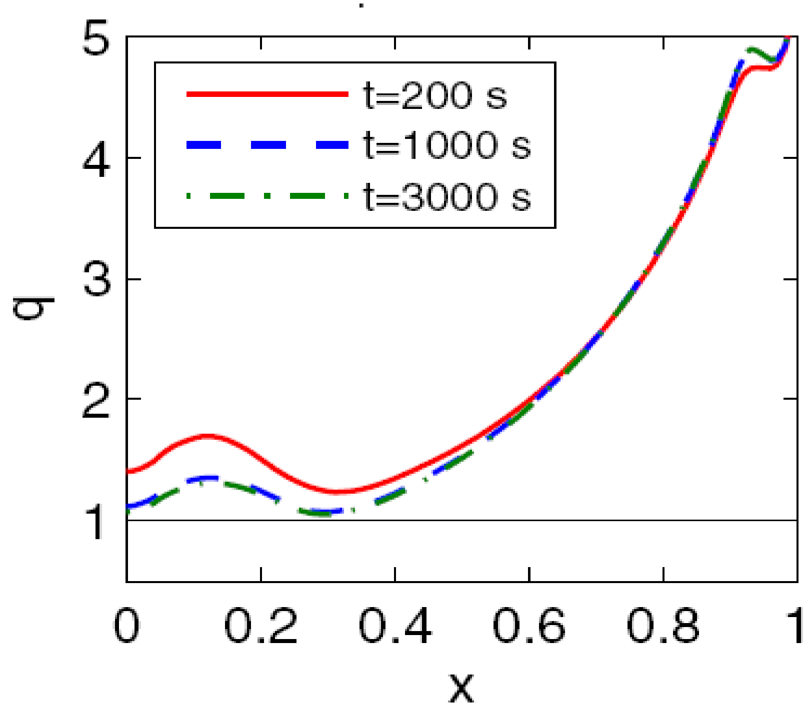
Citrin et al, NF 2010



q0 > 1 is obtained with GLF23 peaked ne profile



Citrin et al, NF 2010



Summary

- **In HS with optimised heat mix Q increases by 37 % when toroidal rotation is simulated self-consistently with density and temperature as compared to the case with zero rotation**

- **Weakly reversed q with q0 >1**