Ongoing GENE-Tango simulations of ITER baseline scenario

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with

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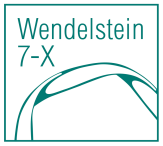


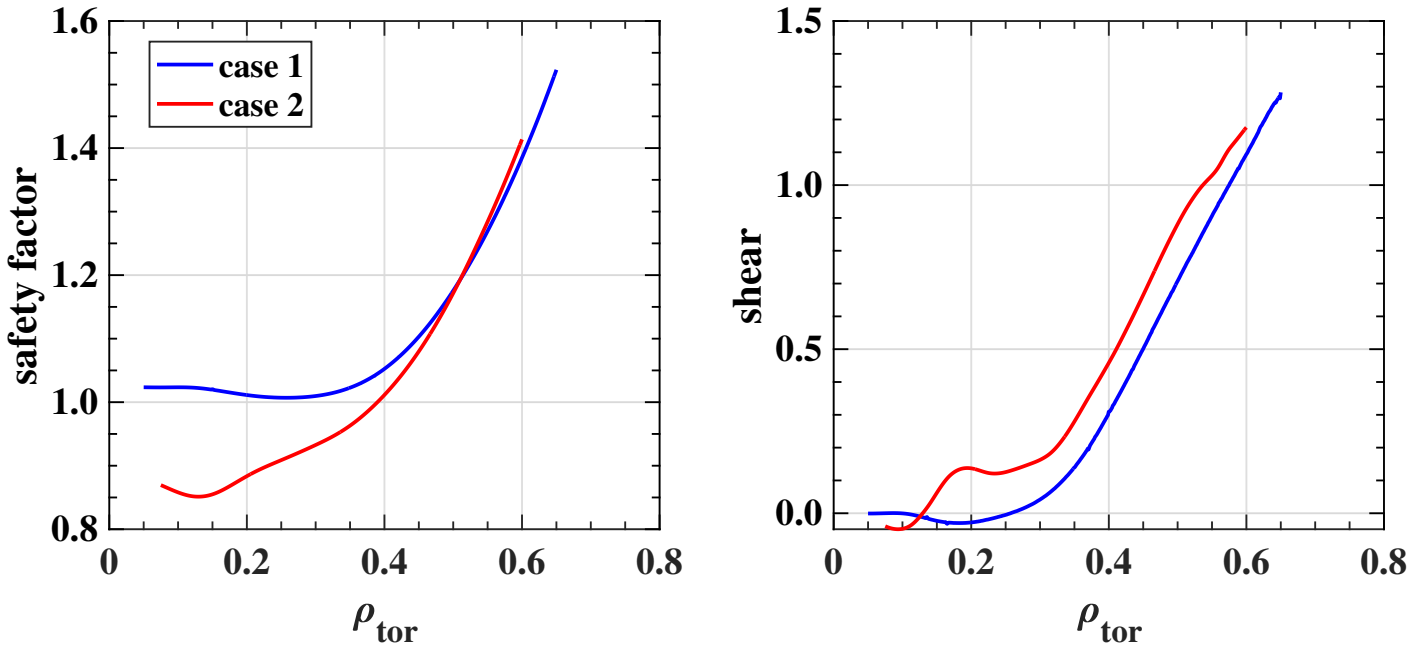
EUROfusion

Overview

- Description plasma scenarios: i) post-SW crash; ii) pre-SW crash
- GENE-Tango coupling
- GENE-Tango simulations case i)
- GENE-Tango simulations case ii)
- Conclusions

Plasma scenarios: i) post-SW crash; ii) pre-SW crash

- GENE-Tango simulations at ITER for baseline $Q = 10$, $I_p = 15MA$ are currently on-going.
- Plasma profiles initialized to the ones computed by QualiKiz-JINTRAC.
- Simulations: (i) without alpha particles in GENE, (ii) with alpha particles in GENE.



GENE-Tango coupling

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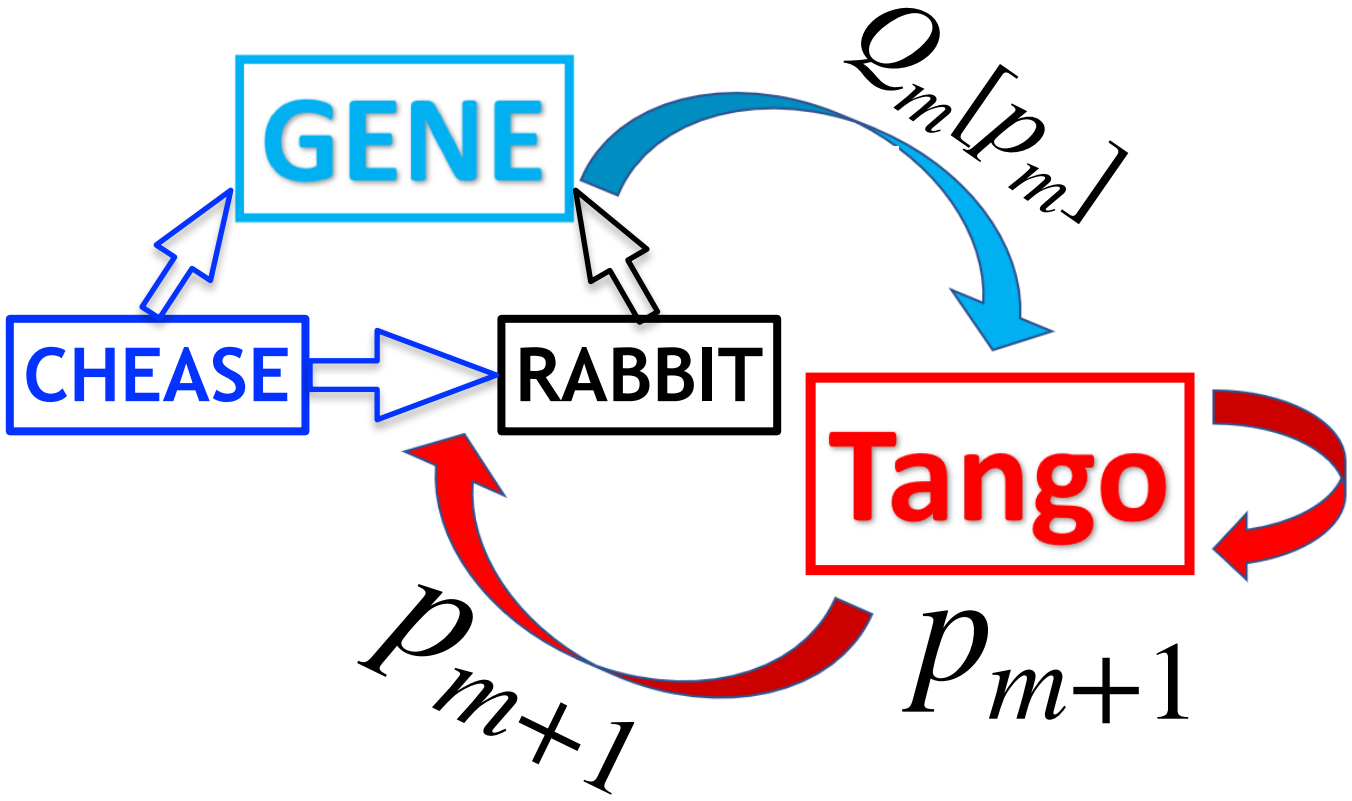
(i) GENE evaluates turbulence levels for given pressure profile

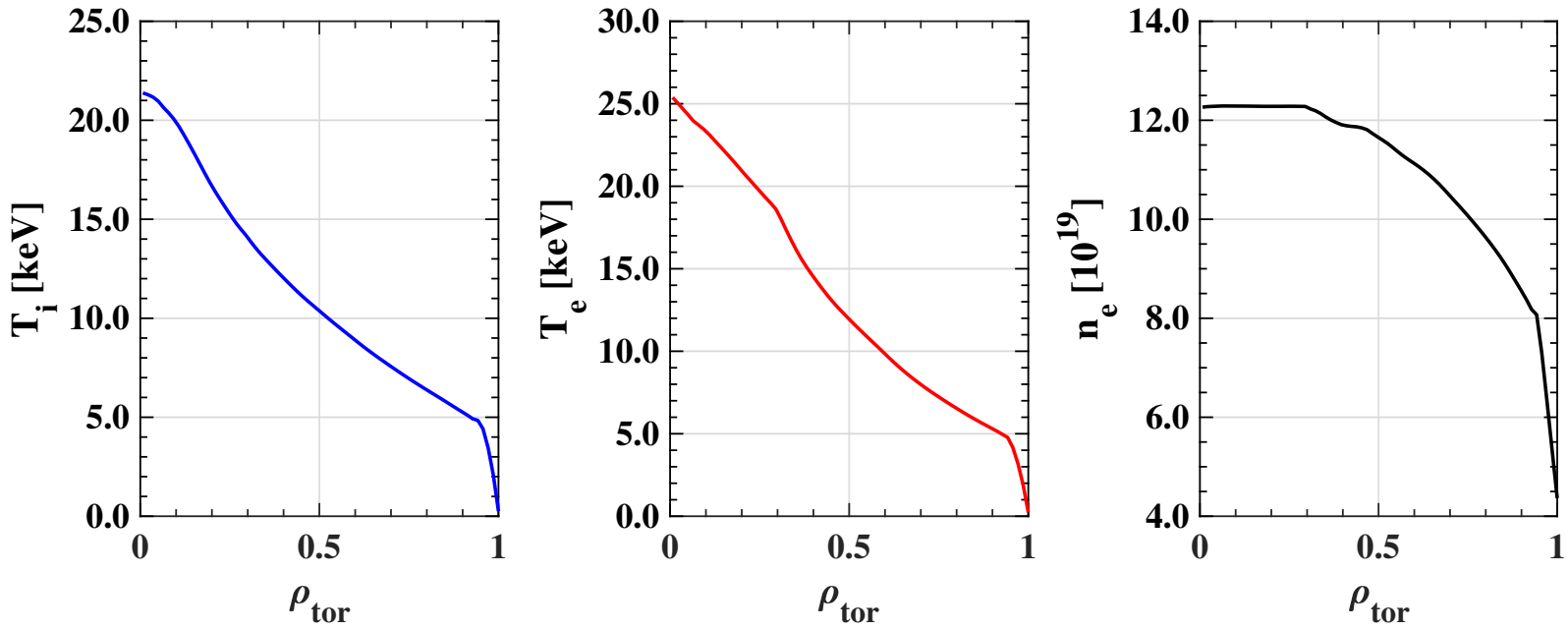
(ii) Tango evaluates new plasma profiles consistent with given turbulence levels and experimental sources.

(iii) New profiles transferred back to GENE and the process is repeated.



Initial setup

- We start the GENE-Tango simulations using the QLK-JINTRAC profiles.
- NBI, ECRH, Ohmic heating are taken from QLK-JINTRAC and kept fixed.
- Alpha heating, Prad (Bremsstrahlung, line radiation, syncrotron radiation) and energy exchange are computed in GENE-Tango at each interation.
- Particle source for case 1 is fixed to the one of QLK-JINTRAC (NBI+Pellett).
- Geometry and vtor are kept fixed for case 1.



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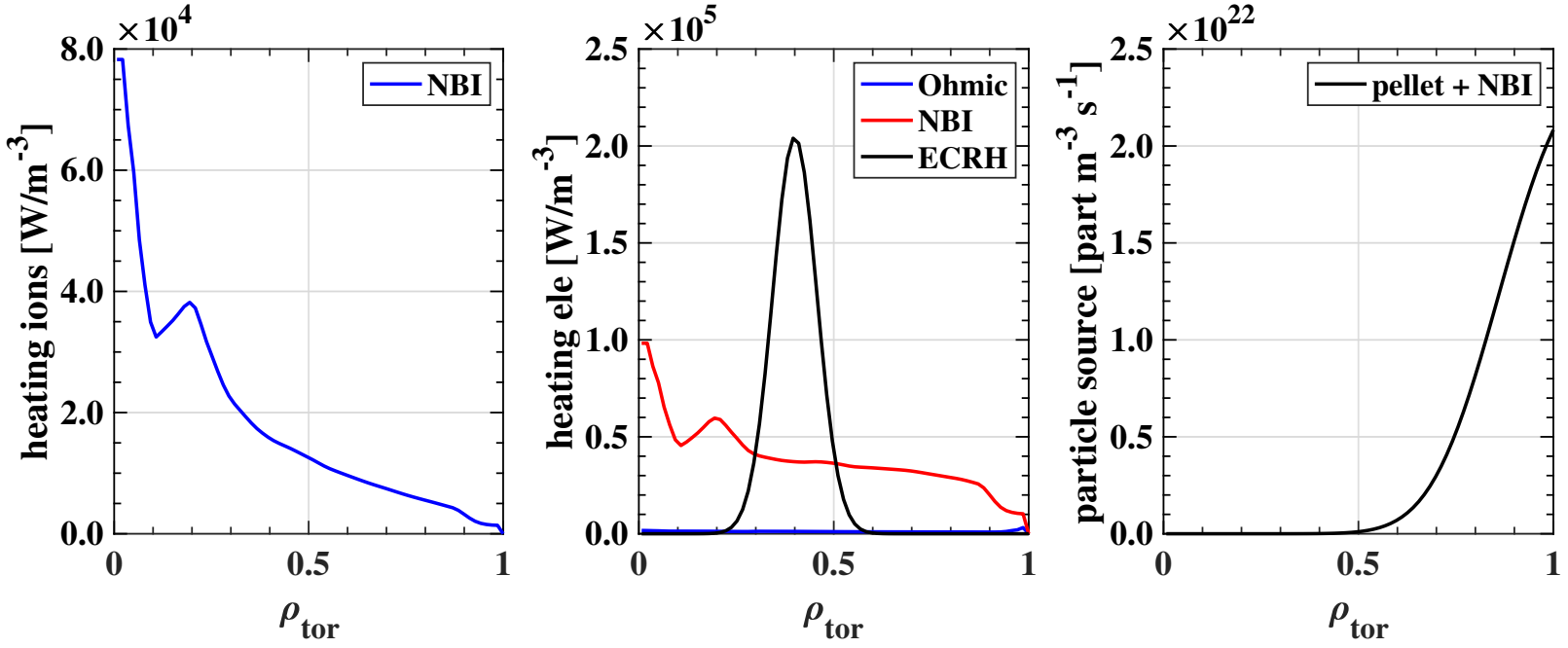
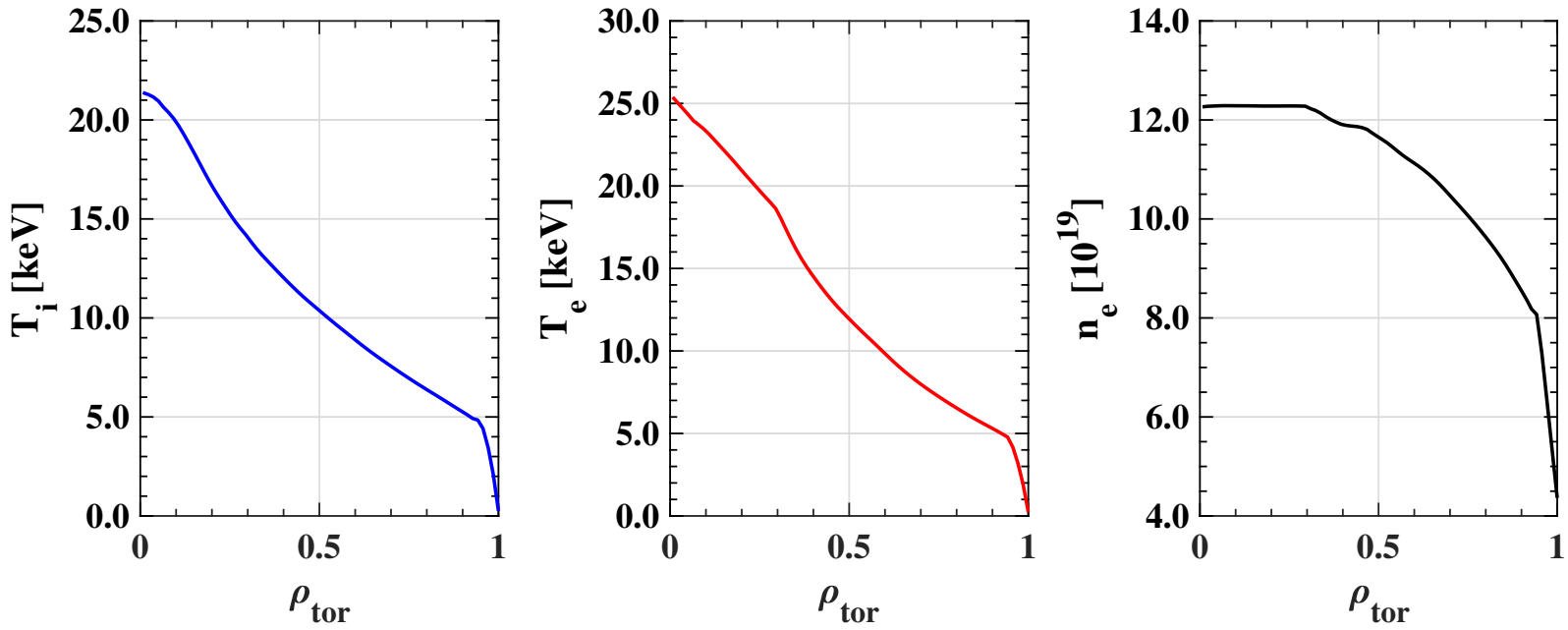


Numerical setup

- GENE resolutions in (nx, ny, nz, nv, nmu) = (512, 96, 32, 48, 32).
- Spectra covered goes from n = 5 to n = 475, ky rho (x = 0.34) = 0.02 to 2 (ITG + TEM).
- Toroidal rotation included, collisions, electromagnetic effects, realistic geometry, realistic electron-ion mass ratio.
- Radial domain rho = [0.05 to 0.65].



Plasma scenario: post-SW crash

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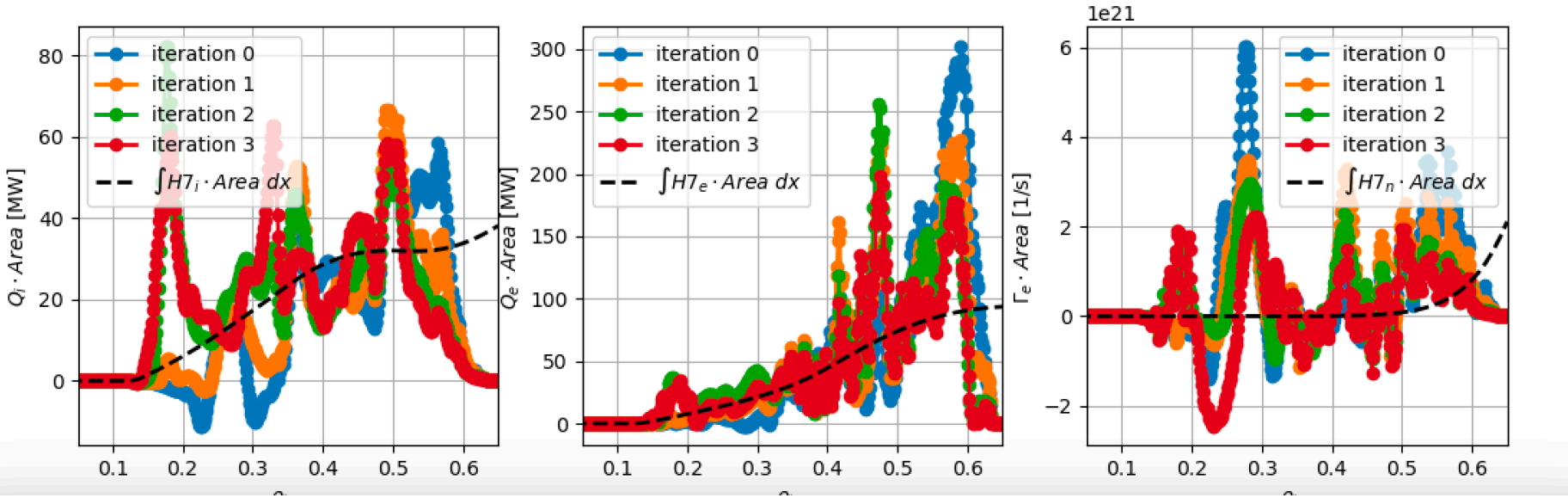
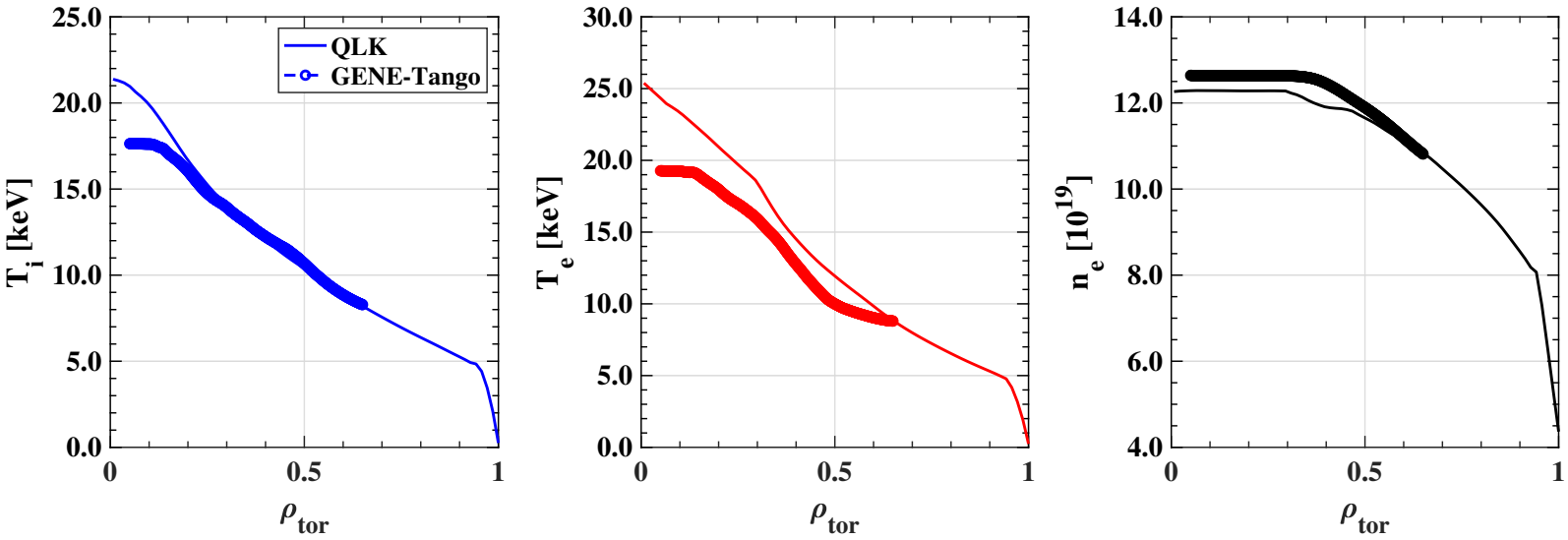


- KBM destabilized in the region of zero-shear, makes these simulations particularly challenging.

Plasma scenario: post-SW crash

- GENE-Tango profiles are still not fully converged but we can observed a strong flattening (expecially in Te) respect to QLK.
- Flattening in the plasma core is mainly due to KBMs.



- Fusion output is not strongly affected, since plasma density is slightly higher in GENE-Tango.

Plasma scenarios: i) post-SW crash; ii) pre-SW crash

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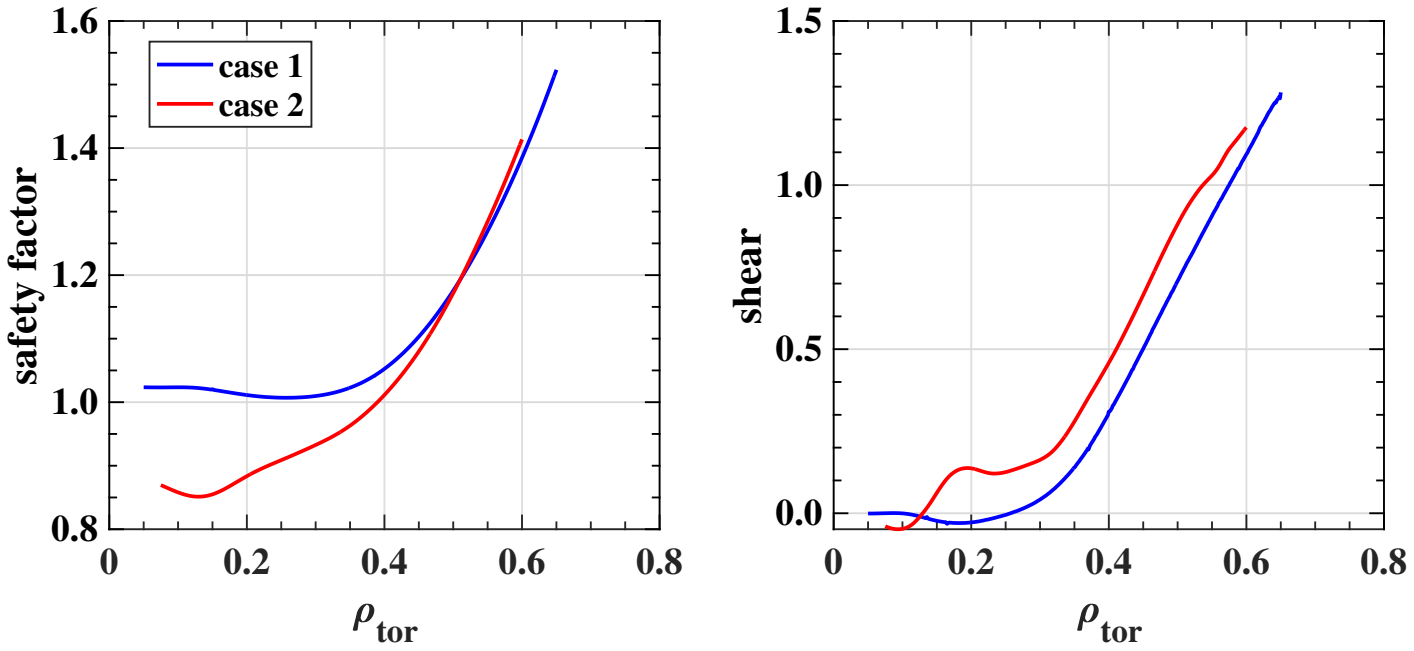

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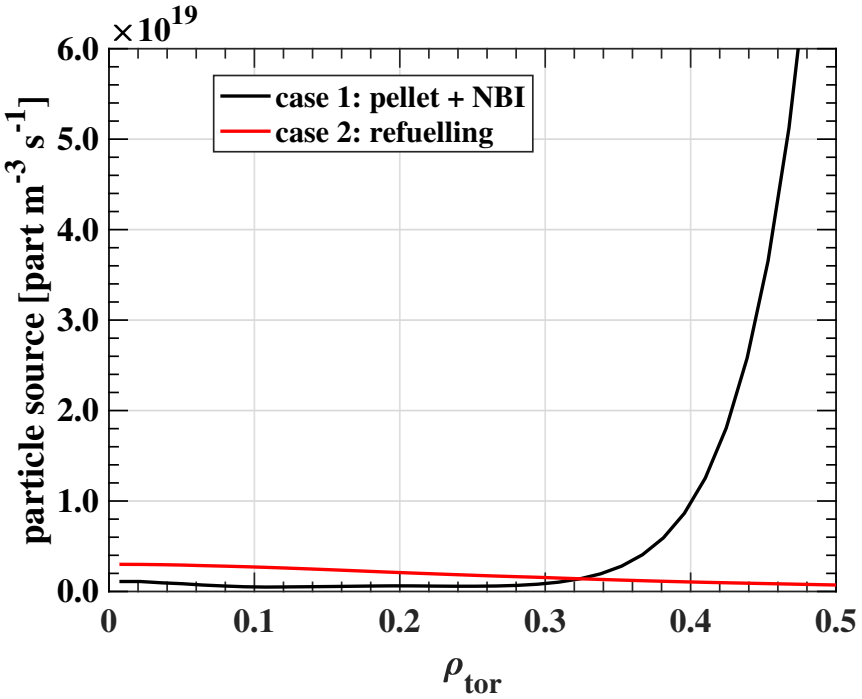
- Alpha heating, Prad (Bremsstrahlung, line radiation, syncrotron radiation) and energy exchange are computed in GENE-Tango at each interation.
- Particle source for case 2 computed by Tango assuming perfect refuelling.
- Geometry evolved with CHEASE and vtor kept fixed.



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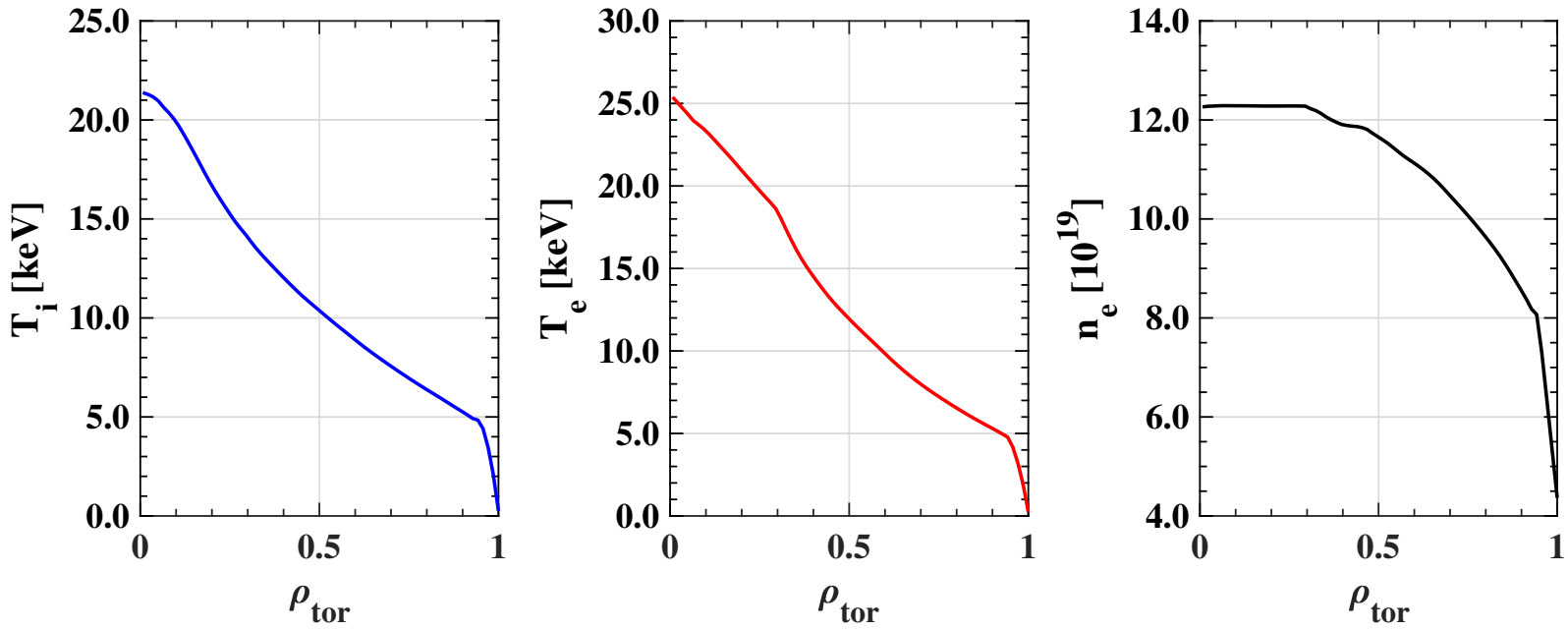
- Spectra covered goes from n = 5 to n = 475, ky rho (x = 0.34) = 0.02 to 2 (ITG + TEM).
- Toroidal rotation included, collisions, electromagnetic effects, realistic geometry, realistic electron-ion mass ratio.
- Radial domain rho = [0.075 to 0.6].



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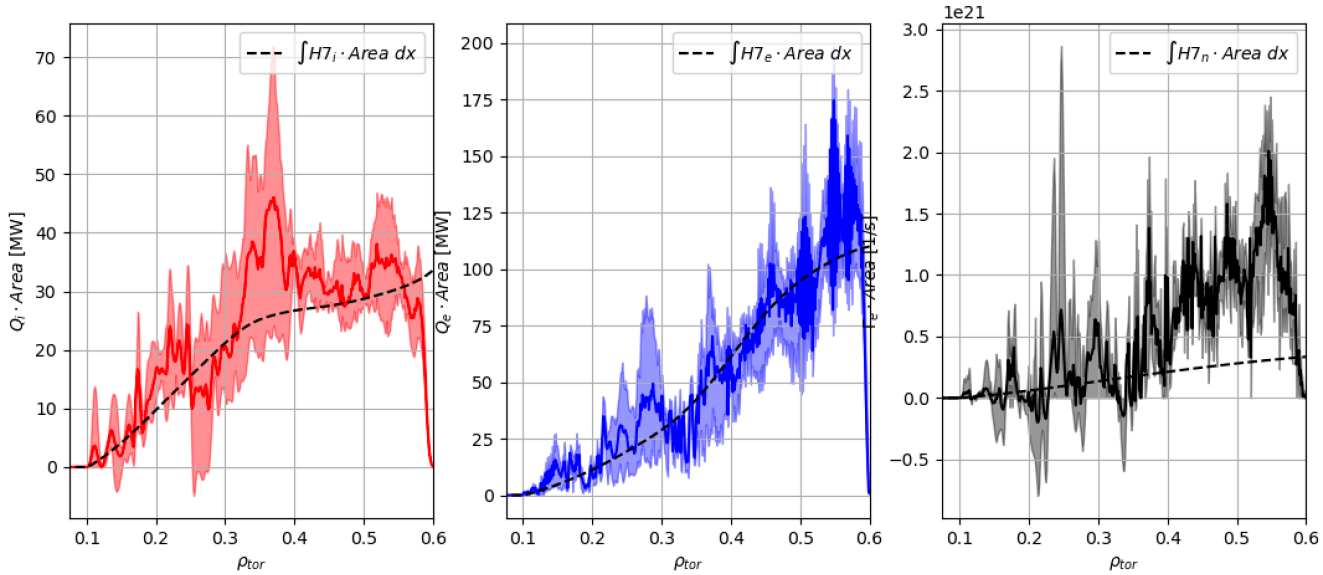
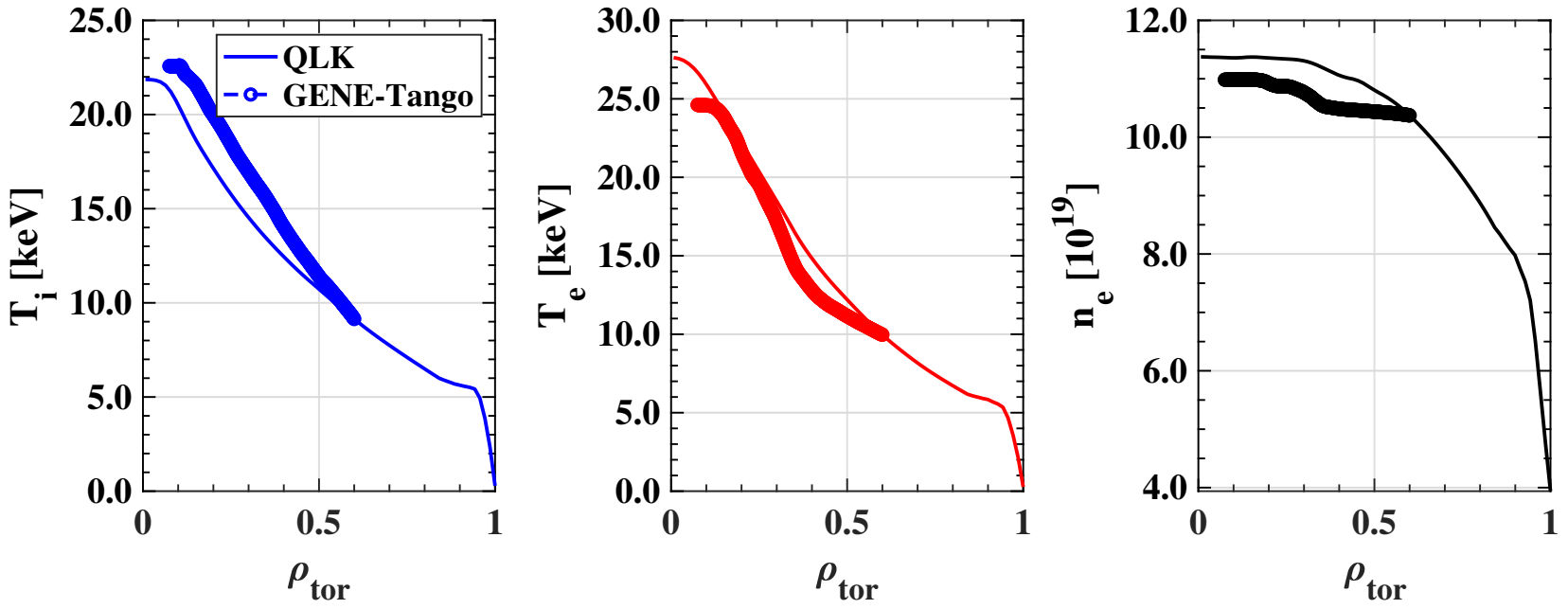


- Turbulent fluxes are close to the steady-state solution → particle flux requires few more iterations.

Plasma scenario: post-SW crash

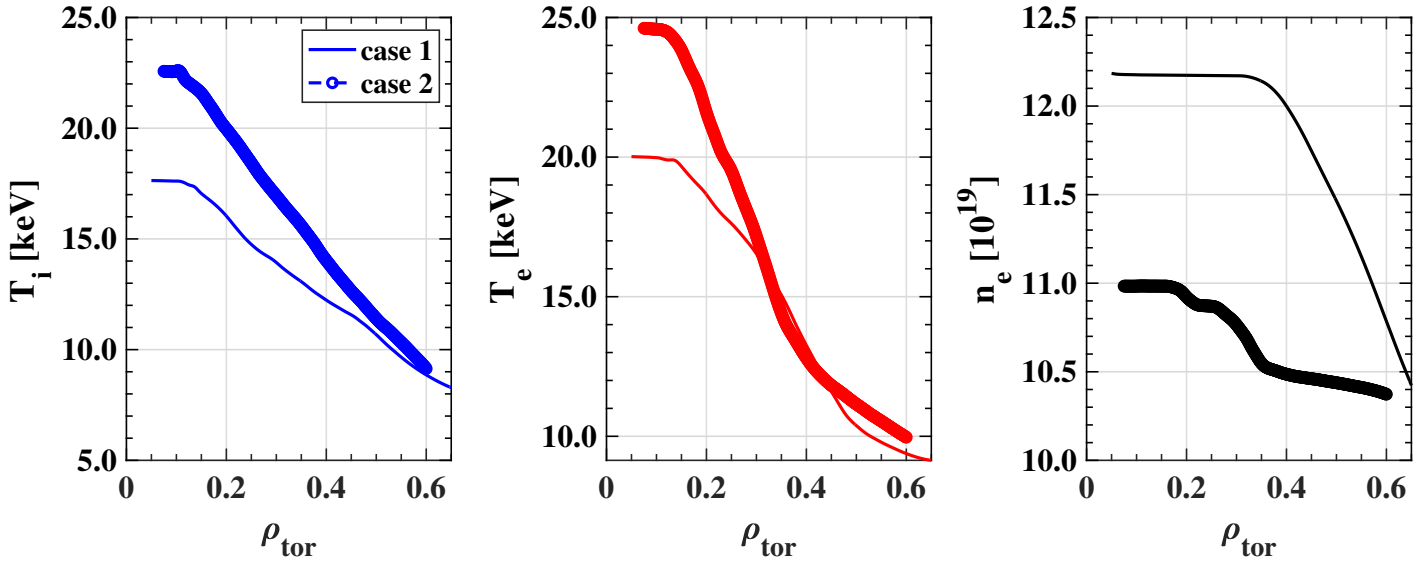
- GENE-Tango profiles are still not fully converged but we can observed a much closer agreement with QLK for this case.
- GENE-Tango predicts large particle flux → more pronounced flattening of plasma density.



- Convergence studies are on-going.

Comparison of GENE-Tango profiles

- Removing the shear-zero region in the q-profile leads to KBM suppression and pronounced peaking of the temperature profiles.
- The changes in the particles source between case 1 and case 2 leads to strong flattening of the plasma density.



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Summary

- GENE-Tango simulations without alpha particles in GENE are on-going.
- With flat q-profile in the plasma core, KBMs are easily unstable leading to flattening of plasma pressure.
- Presence of KBMs make GENE-Tango simulations very challenging.
- Without the flat q-profile KBMs are stable and GENE-Tango is close to convergence.
- Large increase in temperatures with new q-profile.

Future studies:

- Convergence studies are on-going.
- Repeat the GENE-Tango simulations including alpha particles in GENE.

Resources?