DE LA RECHERCHE À L'INDUSTRIE

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DEVELOPPMENT OF A BUFFER ZONE IN ORB5

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Project plan

ID	Milestone/Deliverable - description	Target date
M2.6	Implementation of a limiter like boundary condition in the global code ORB5, comparison with GYSELA	12/2021
M2.9	Study the development of a radial electric field in response to key parameters such as injected power, collisionality and safety factor, using the GYSELA and ORB5 codes including simplified limiter/SOL - comparison with fluid code results	06/2022
M2.14	Compare numerical electric field obtained with GK to experimental ones in limited plasmas	12/2022
D2.6	GK simulations of edge electric field development in a limited plasma and comparison with experiments	12/2022

Development of an outer buffer zone

- The plasma domain is extended and a damping of fluctuations is applied in the outer buffer
- No poloidal asymmetry
- No modification of QN equation
- Flat density and temperature profiles are assumed in the buffer area
- For MHD equilibrium: No current in the buffer

Three options for the buffer zone

- Naive Krook

$$\frac{\partial}{\partial t}(\delta F) = -\nu(s)\delta F$$

- Krook conserving particles:

$$\frac{\partial}{\partial t}(\delta F) = -\nu(s)\delta F + \mathrm{C}\,(s)$$

with C (s) is a scalar chosen to conserve $\int \delta F d^3v$ over spatial bins

- Collisionnal buffer

$$\frac{\partial}{\partial t}(F) = \nu(s)\hat{C}\,(F, F_{init})$$ (Handled via Langevin kicks)

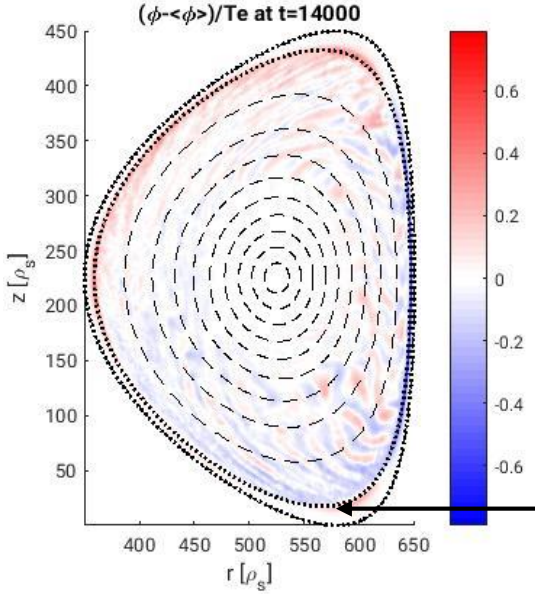
In all cases,

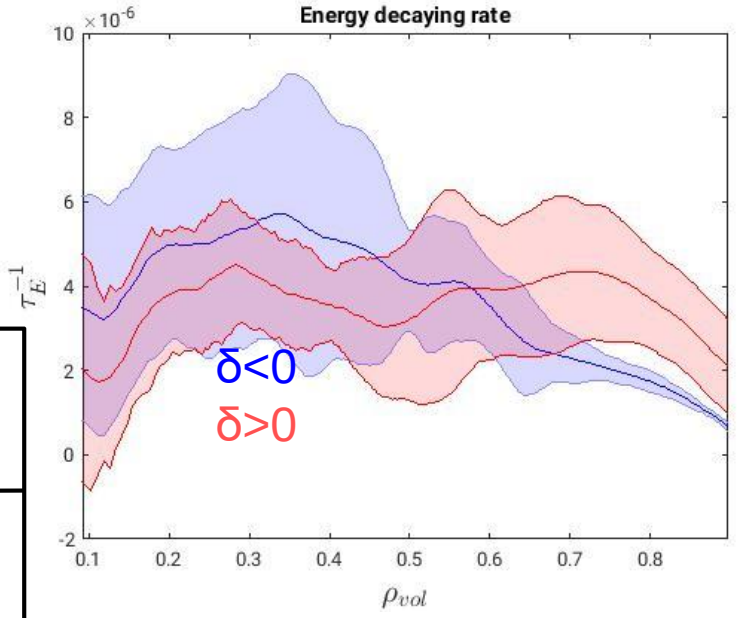
$$\nu(s) = \nu_0 \left(\frac{s - s_{buf}}{s_{max} - s_{buf}}\right)^2 \text{ if } s > s_{buf}$$

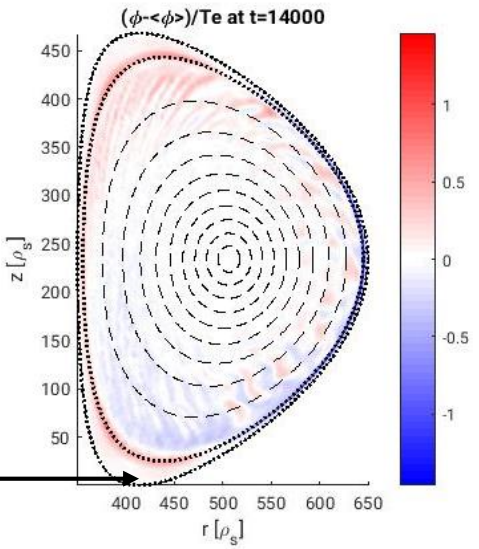
where $s = \sqrt{\psi}$

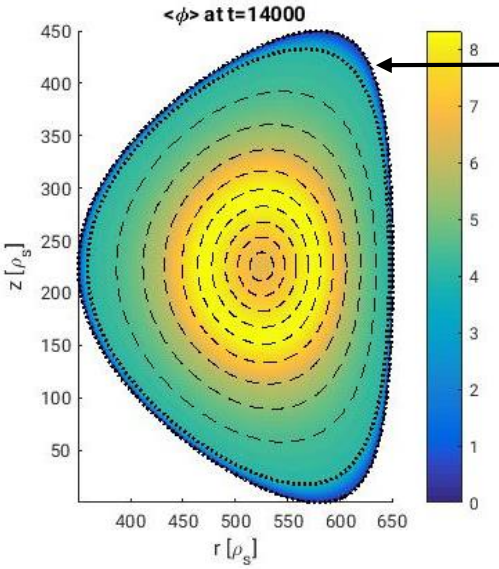
Hybrid e- + collision + ECRH + shaping

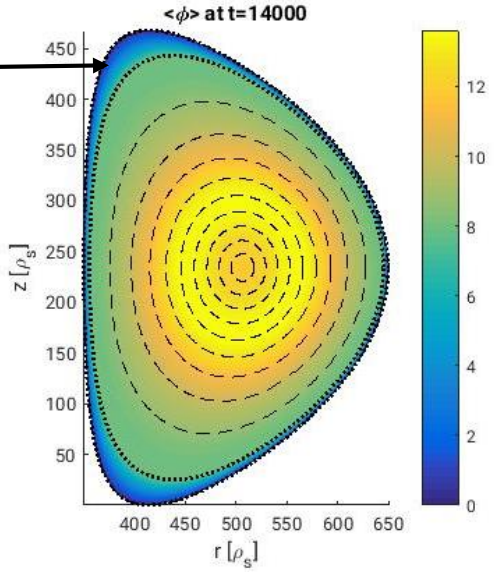
$$\tau_E^{-1}(r,t) = \frac{\int_0^r Energy\ flux(r',t)dr'}{\int_0^r Energy(r',t)dr'}$$







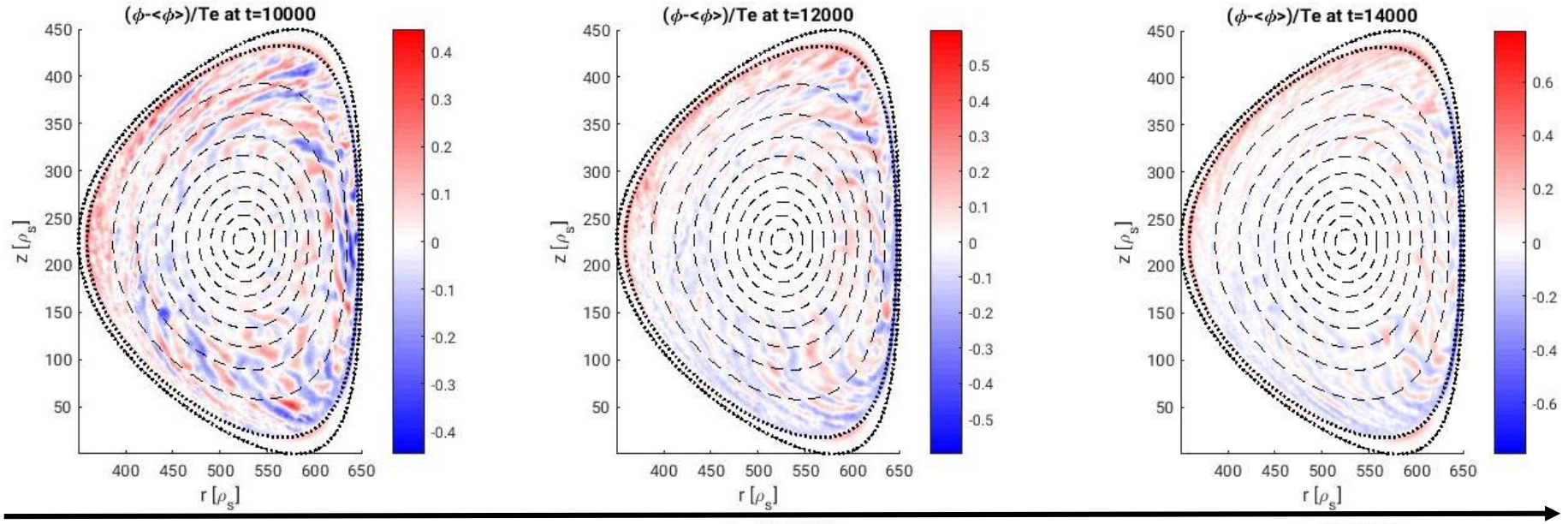




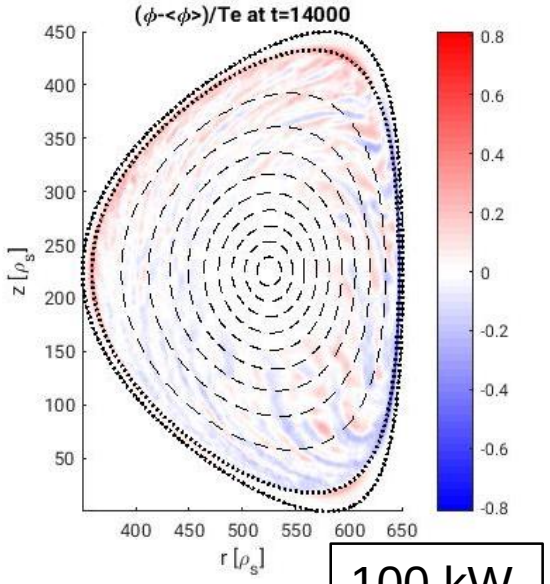
Buffer zone

$\nu_0 = 10\ \Omega_{c0}^{-1}$
$s_{buf} = 0.98$
$s_{max} = 1.0$

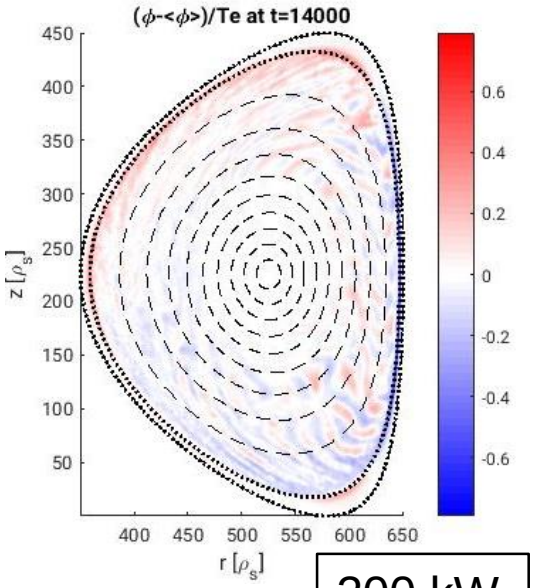
Important effect of time on the buffer potential, less for core potential



Limited impact of the source level



100 kW



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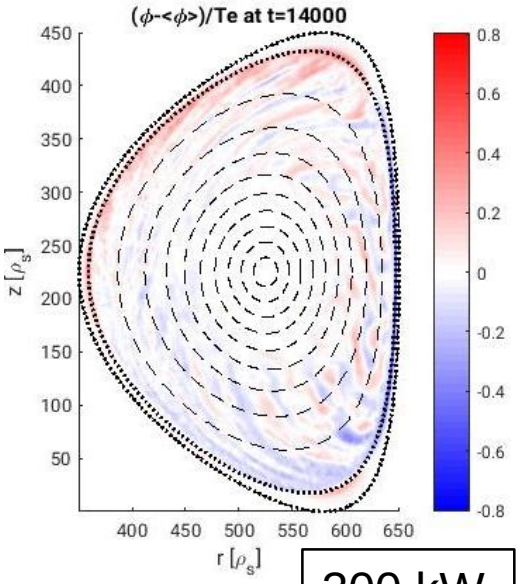

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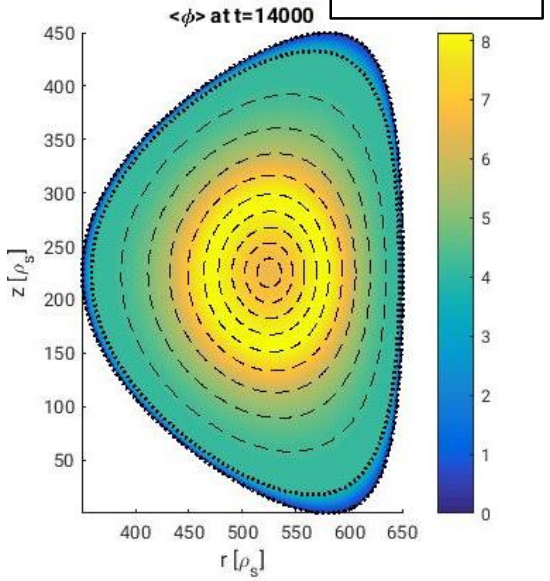
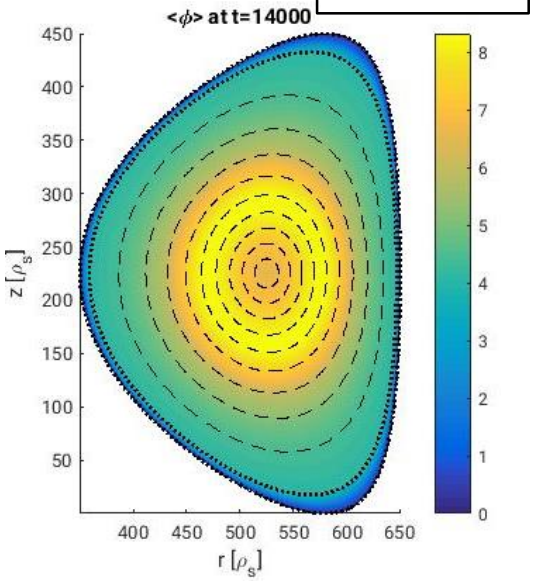
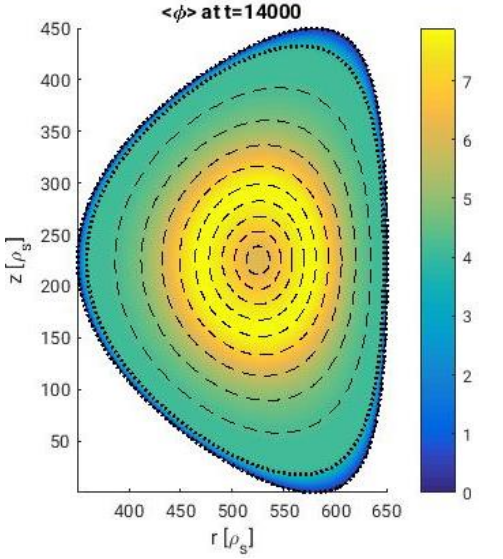






Conclusion

- Flux-driven, global GK simulations of shaped plasmas in presence of collisions have been performed for the first time with ORB5

- Improved confinement of negative triangularity retrieved (only when including trapped kinetic electrons and collisions)

- Important impact of shaping on the development of the radial electric field

- Limited impact of the source amplitude (in this case)

- Difficulty to reach a quasi-steady state

➢ Necessity to improve the boundary condition

Next steps

- Study the impact of numerical parameters (type, ν_0, s_{buf}) in adiabatic electrons simulations (see Giovanni's presentation), then with hybrid electrons

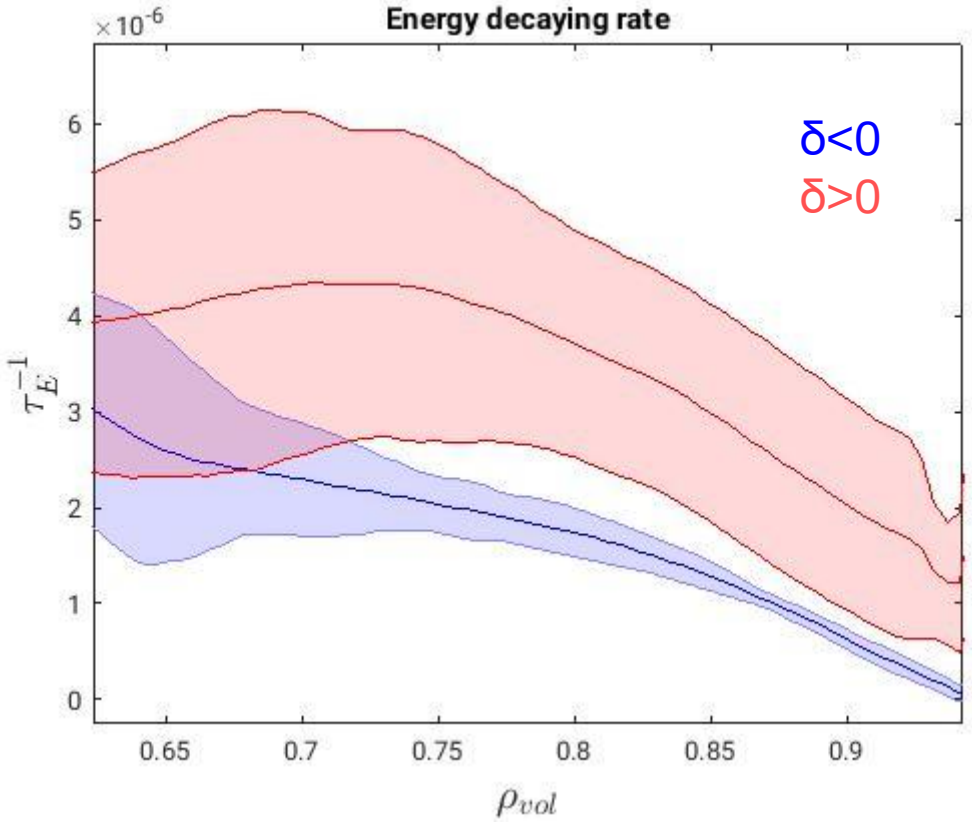
- Study the impact of physical parameters (power, collisionality, gradients, magnetic geometry…) on the development of the electric field

- Comparison between ORB5 and GYSELA results

- Improvement of the buffer model :
  - limiter like for adiabatic e- (GYSELA)
  - type of buffer for FD simulations with hybrid e-? (PhD in the GYSELA team)

- Comparison gyrokinetic simulation vs experiments

Zoom on the energy decaying rate



Particle confinement time