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GLOBAL HPC SIMULATIONS IN 5-DIMENSIONS MODEL PLASMA TURBULENCE FROM THE DEEP CORE TO THE SCRAPE-OFF LAYER.

EXTENDING THE GLOBAL AND GYRO-KINETIC CODE GYSELA FOR CORE TURBULENCE TOWARDS THE OPEN FIELD LINE REGION WITH A PENALIZATION TECHNIQUE, TURBULENT FLUCTUATIONS COVER ALL THE PLASMA VOLUME.

The complete understanding of the complex and fully non-linear plasma turbulence phenomena is still one of the missing milestones for the success of fusion experiments. In this perspective, High Performance Computing simulations provide a fundamental support to both theoretical and experimental investigations. The 5D gyro-kinetic and global code GYSELA [1], developed in the CEA-IRFM institute (France), simulates plasma turbulence over the whole toroidal volume of the Tokamak. The code processes ~1Terabyte of data every iteration, being fully parallelized over more than 10thousands processors. Particular emphasis is given to the self-organization of the system: the presence of a source in the very core plasma builds the temperature profile which in turn gives rise to turbulence in a self-consistent way. The heat is transported from the source all way through the plasma volume until it reaches the outer radial boundary, where it is extracted. The way this physics is implemented is crucial in determining the turbulence development and evolution. We have modified the outer radial boundary condition of the code to mimic the experimental limiter configuration: at first, poloidal asymmetry is given to the boundary using a penalization technique [2]. The immersed boundary of limiter shape acts as a perfect heat absorber and extracts all the heat reaching the boundary, consistently with the self-organization of the system. Also, the poloidal asymmetry of the immersed boundary creates a layer in which the magnetic field lines close inside the immersed boundary, the Scrape-Off Layer. The picture shows in colors the fluctuations of the electric potential extended from the deep core up to the Scrape-Off Layer, in grayscale the geometry of the penalized immersed boundary, the black limiter and the gray first wall.

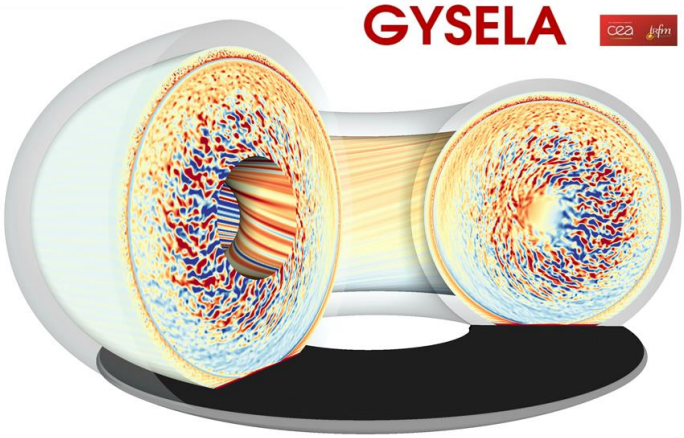

Figure: 3D visualization of the turbulent fluctuations of the electric potential resulting from the 5D GYSELA simulations with penalized immersed boundary.

REFERENCES

[1] V. Grandgirard et al, *Computer Physics Communication*, 2015.

[2] E. Caschera et al*, Journal of Physics Conference Series,* 2018.

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