Gyrokinetic simulations for burning plasmas

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This work has been carried out within the framework of the EUROfusion consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Content

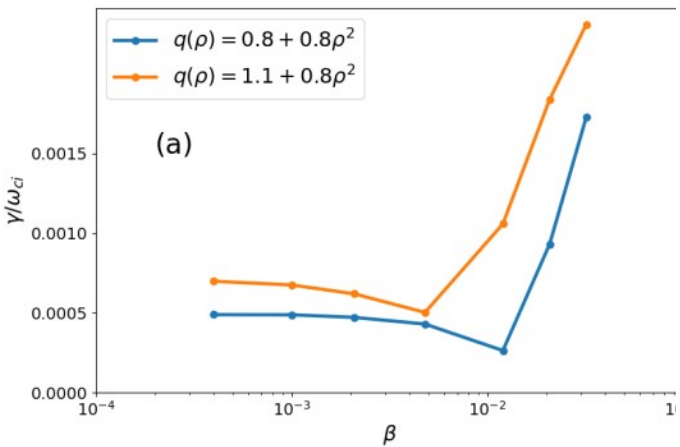
- PRACE project for GK PIC simulations
- Some examples of simulations (ORB5/EUTERPE)
- Novel numerics: PIC denoising with FBL (M. Campos Pinto)
- Excitation of TAE modes using an antenna in ORB5 (M. Sadr)
- Convolution-based solution of Ito process (M. Sadr)

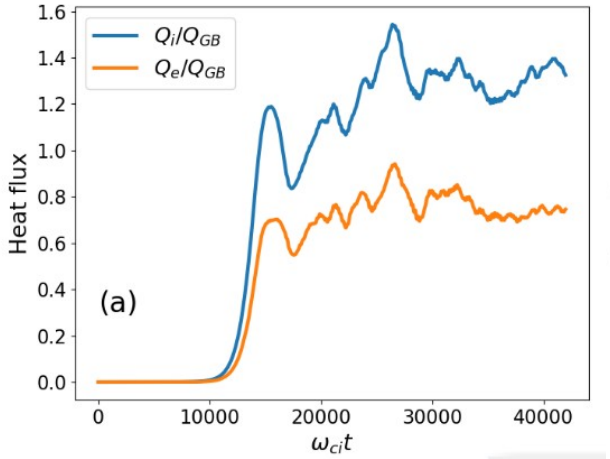
PRACE Tier-0 project for EM GK PIC

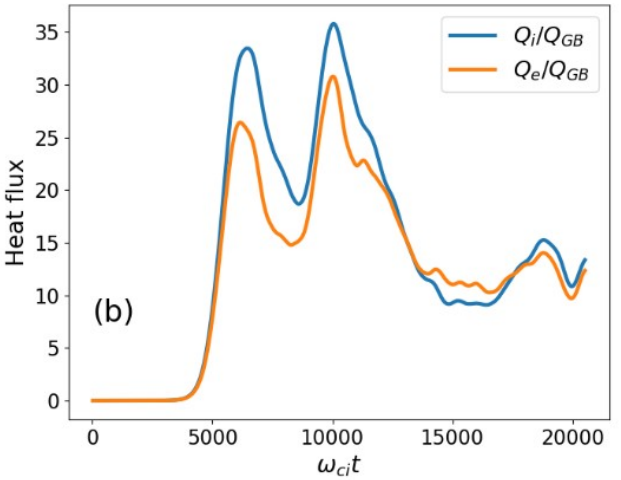
- Goal: EM turbulence in tokamaks and stellarators
- Start: 01.10.2020 ; End: 30.09.2021
- 30 million core hours on Joliot-Curie **SKL** (GENCI@CEA, France)
- 200 million core hours on Marconi100 **GPU system** (CINECA, Italy)
- 76.08% of SKL and 39.9% of GPU allocation used (28.04.2021)
- Direct relation of the PRACE project goal to TSVV#10 program
- All GK experts of TSVV#10 participate in the PRACE project

We acknowledge PRACE for awarding us access to Marconi100 at CINECA, Italy, and to Joliot-Curie at GENCI@CEA, France.

ITG-KBM Transition

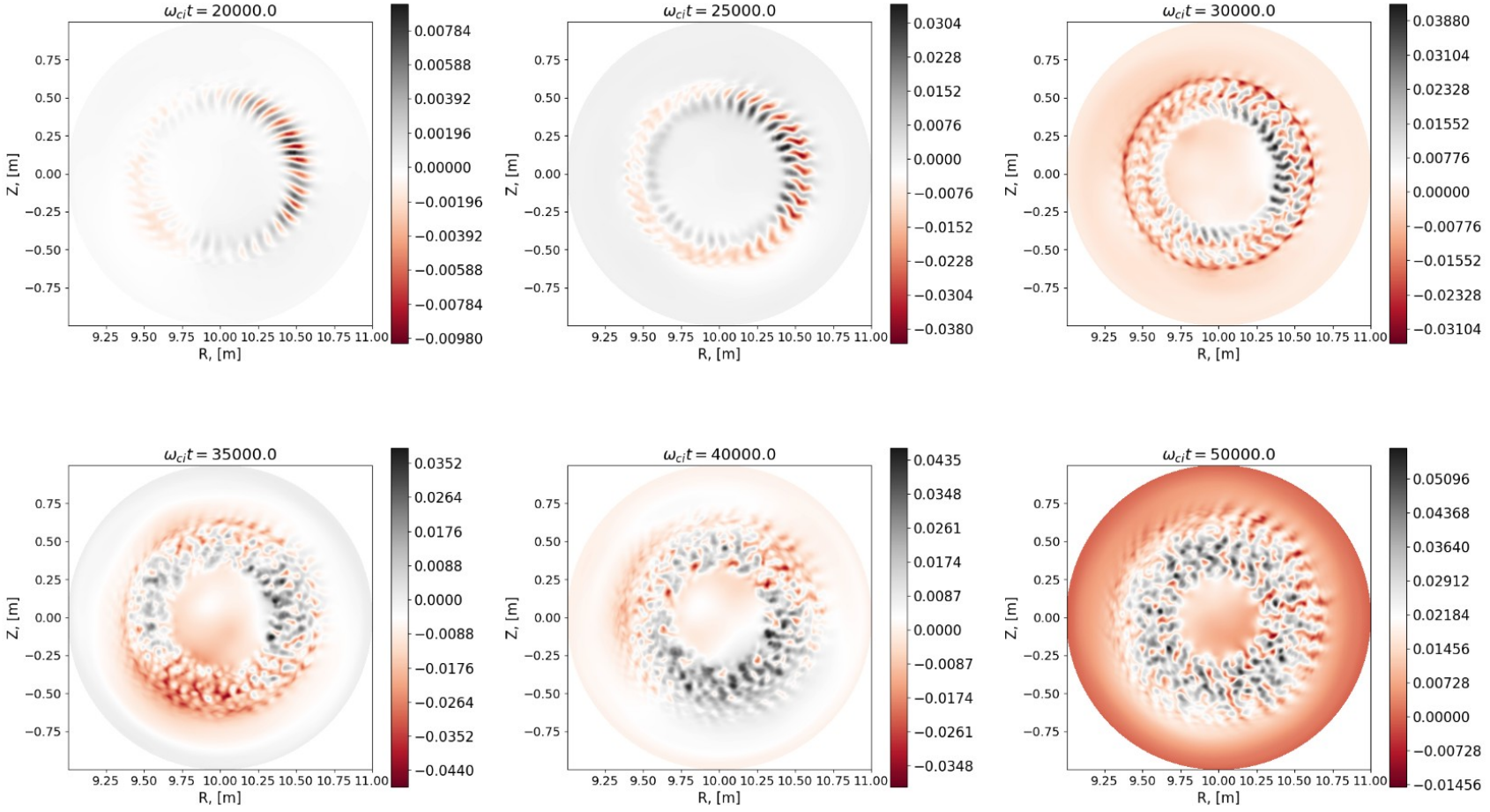




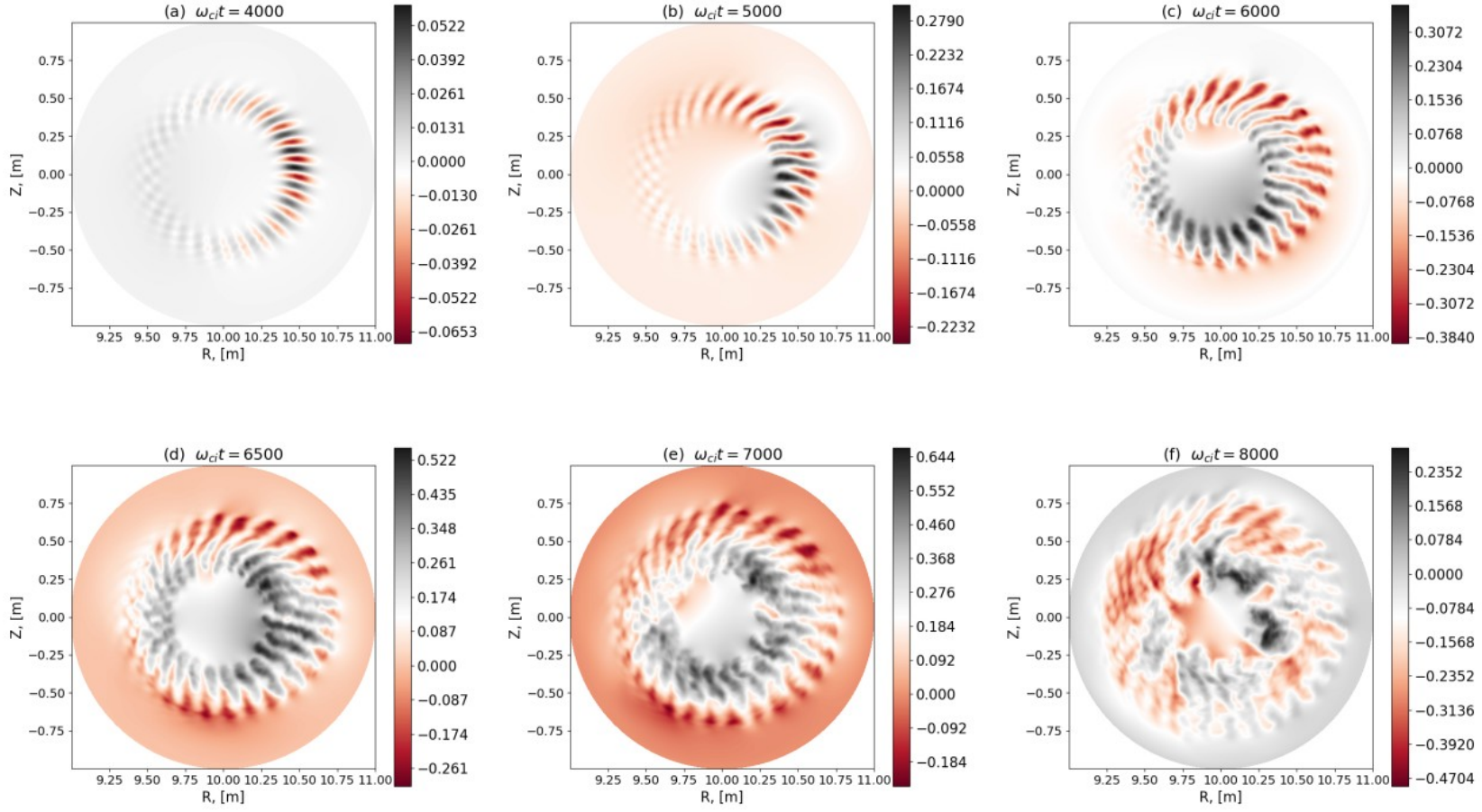


- ITG-KBM transition
- ITG heat flux ~ Q_GB ; KBM heat flux ~ 10 Q_GB

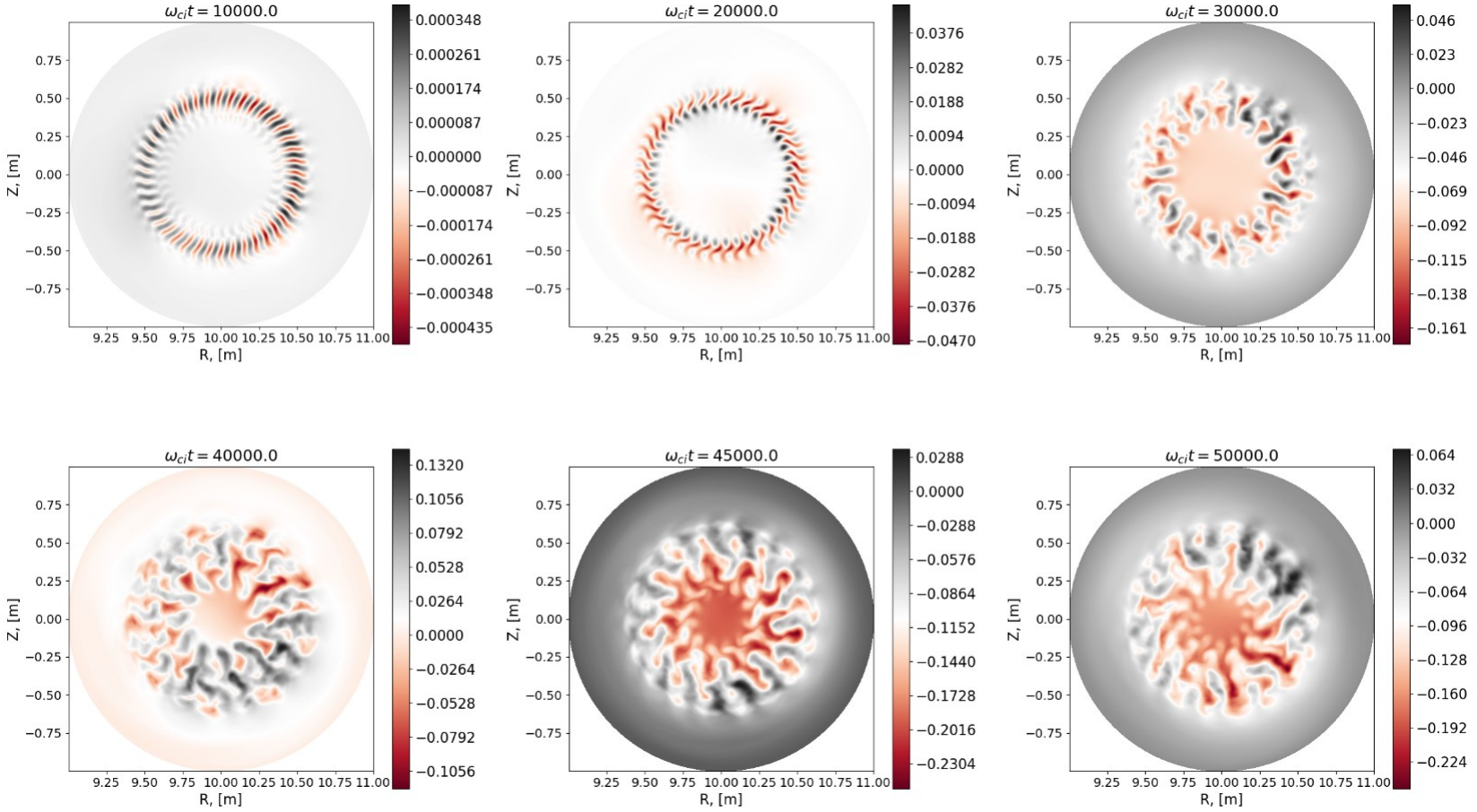
Electromagnetic ITG turbulence + ZF evolution



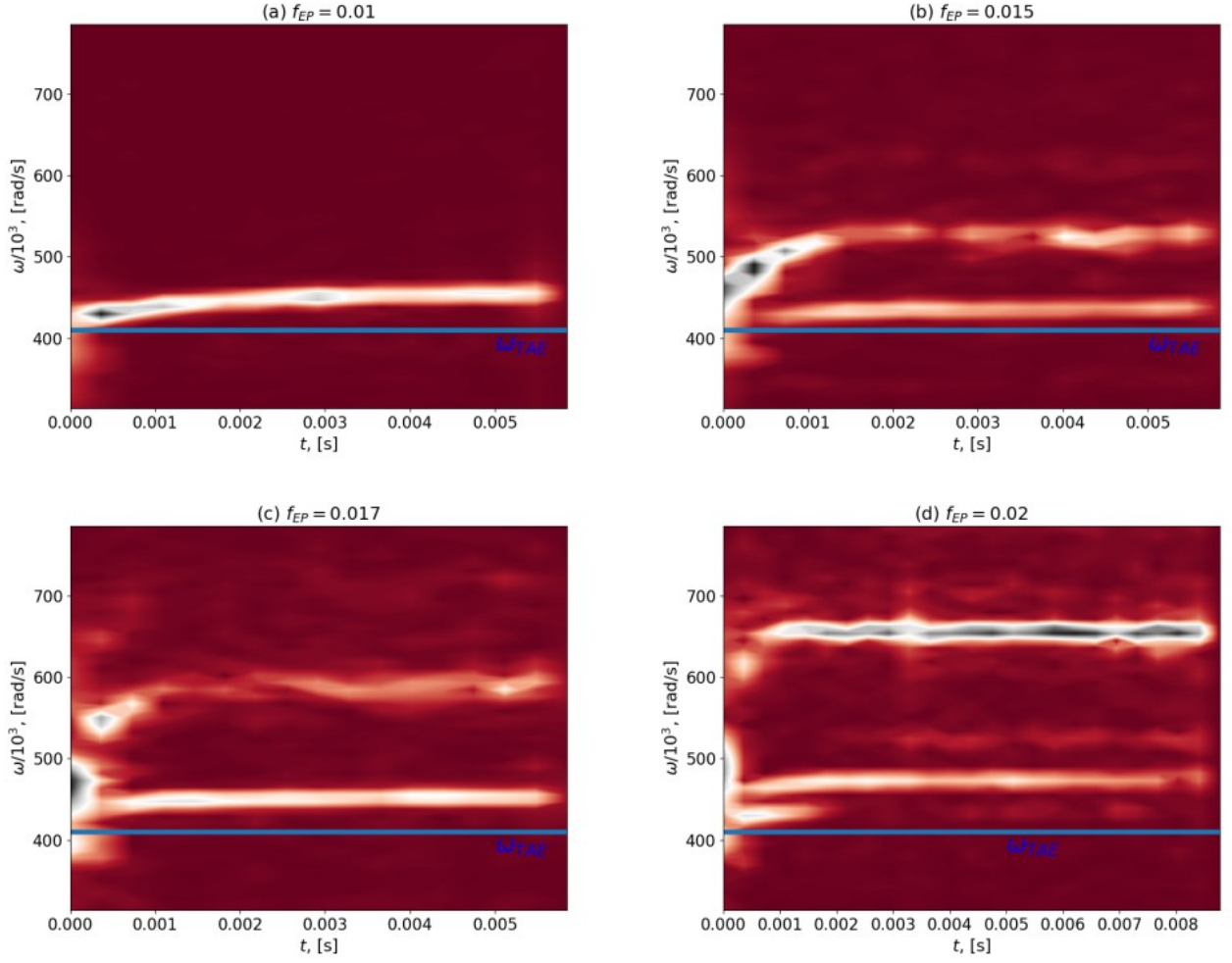
KBM turbulence evolution



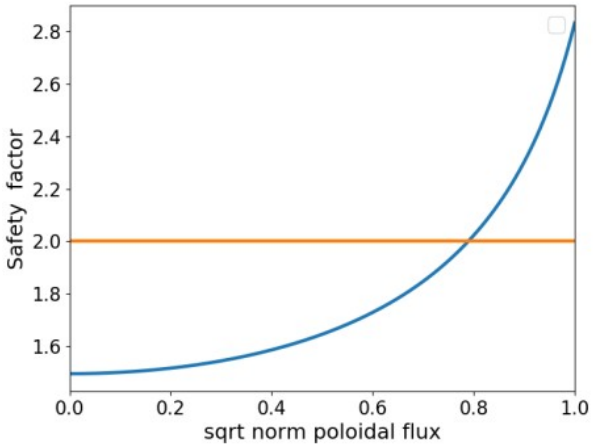
Global BAE, KBM turbulence, ZF coexisting

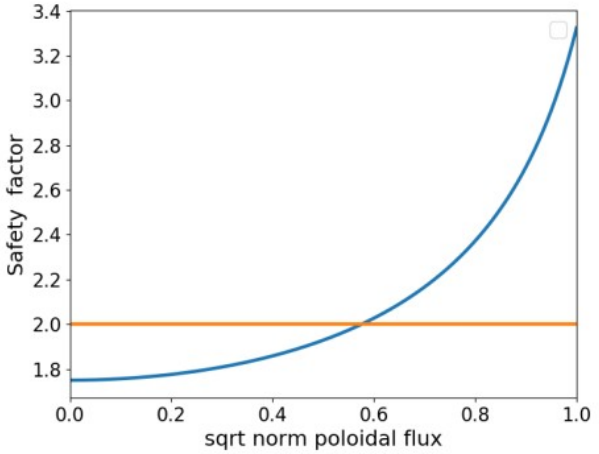


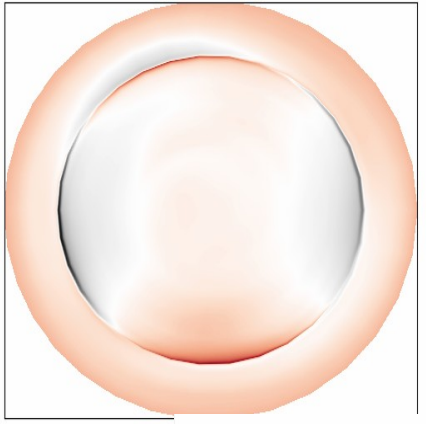
Chriping modes (here ORB5; also EUTERPE)

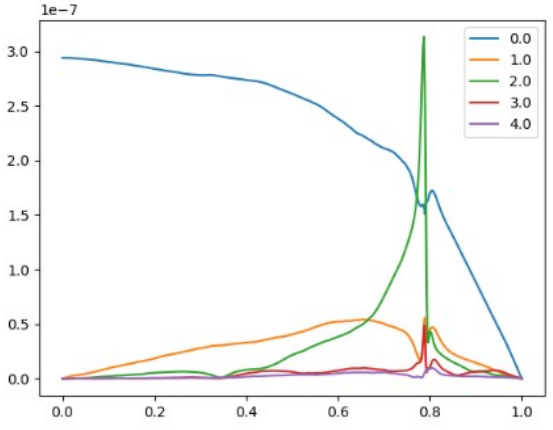


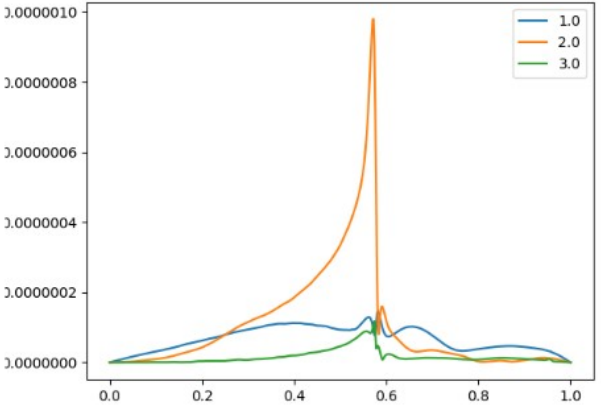
Collisionless tearing instability in tokamak

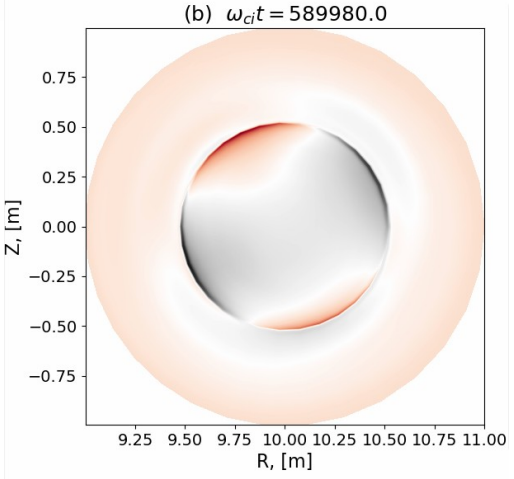




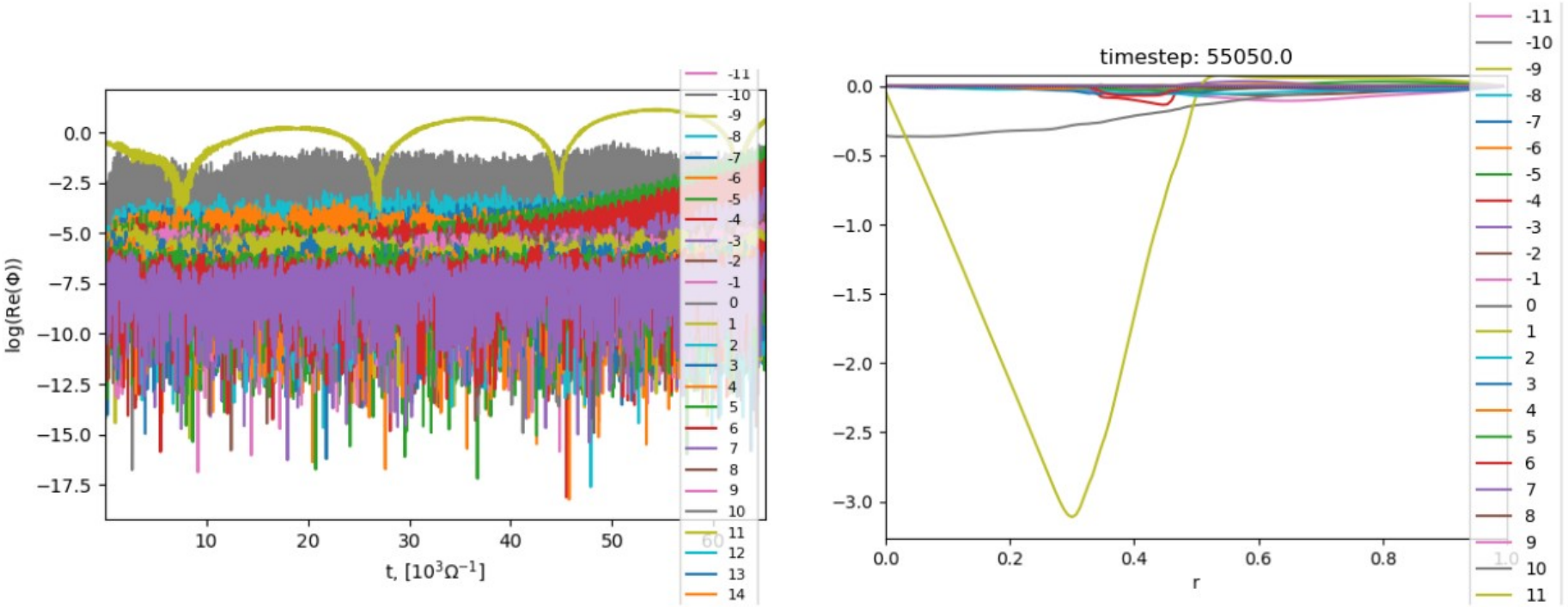








Stellarator application: kink instability in W7-X



- Current quenches observed in W7-X during ECCD
- Rotation transform ~ 1 in W7-X : internal kink mode

Conclusions

- Extensive EM turbulence simulations has been run on PRACE
- Cases considered: EM ITG, KBM, AE + ZF + turbulence, tearing instability in tokamak, internal kink mode in W7-X
- Large amount of simulations on GPUs (ORB5)
- EM turbulence also considered in W7-X
- Learning phase for both EM turbulence and GPU usage
- TODO (physics): add fast particles, collisions, consistent equilibrium, B_||
- TODO (numerics): understanding noise in EM, stable GPU memory