WP4 (global modes with turbulence and EP, with ORB5): main results of 2017, and plans for 2018

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Outline:
1) Deliverables of NLED of interest for NAT, for 2017
2) Deliverables of NAT, for 2017
3) Works in progress and plans for 2018

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1. Deliverables of *NLED* for 2017 of interest for *NAT*

ERP on "Nonlinear Energetic Particle Dynamics" → (2015-2017)

- Deliverables for 2016 of the NLED ERP:
  A16) Characterization of EP transport in the presence of many modes with different numerical codes and models.→ PARTLY (AE + ZF)
  B16) Attempt first analysis of TAE and BAE saturation in the presence of turbulence, multi-n studies. → IN PROGRESS
  C16) Analysis of nonlinear dynamics of EGAMs in different collisionality regimes and characterization of nonlinear dynamics by means of velocity space diagnostics. Turbulence regulation by EGAM. Comparison with experiments in ASDEX Upgrade. → PARTLY (NL-EGAM, diagn.)

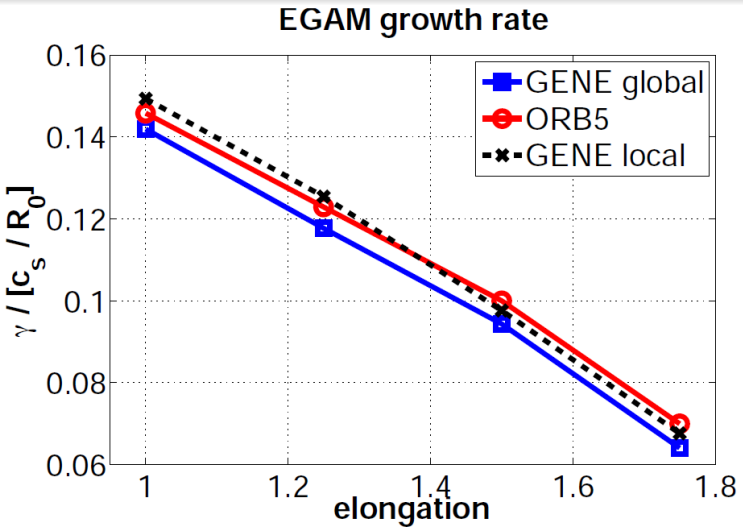
- Deliverables for 2017 of the NLED ERP :
  A17) Numerical study of strongly driven TAEs/BAEs in the nonlinear phase including background turbulence. Role of mode-mode couplings and generation of low-n quasi-modes. → NOT STARTED
  B17) Continue investigation of nonlinear EGAM dynamics and its characterization. Comparison with experiments in JET. Interaction between EPs and tearing modes via the excitation of EGAMs. → PARTLY (NL-EGAM, diagn.)

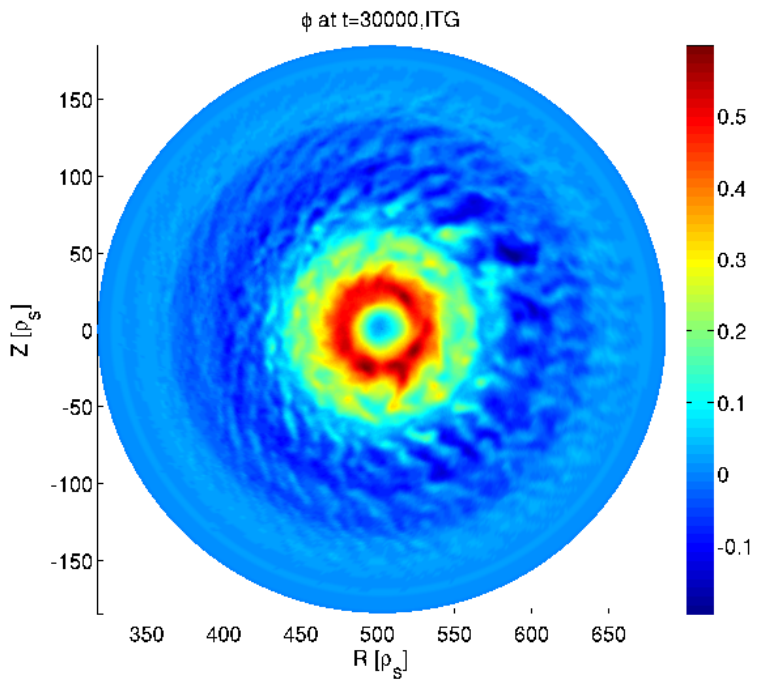
2. Deliverables with ORB5 for *NAT* for 2017

- Three-wave interaction of a nonzonal instability ($n \neq 0$) with a ZF. Two kinds of instability: ITGs, driven by a bulk ion temperature gradient, and Alfvén modes, driven by EPs. $\rightarrow$ PARTLY:
  - Linear theory of GAM freq. and damping in exp. configuration, and comparison with AUG: done (Novikau)
  - Linear theory of GAM radial propagation: done (Palermo)
  - Investigation of the excitation of zonal structures by ITG turbulence with ORB5: partly done (Novikau)
  - Investigation of the excitation of zonal structures by ITG turbulence with reduced models: partly done (Novikau)
  - Investigation of the excitation of zonal structures by AE: partly done (Biancalani)
  - Implementation of an antenna for excitation of ZS by one ITG: to be done (Novikau)
  - Implementation of bicoherence diagnostics: in progress (Palermo)

3. Works in progress: 1, Zonal Structures

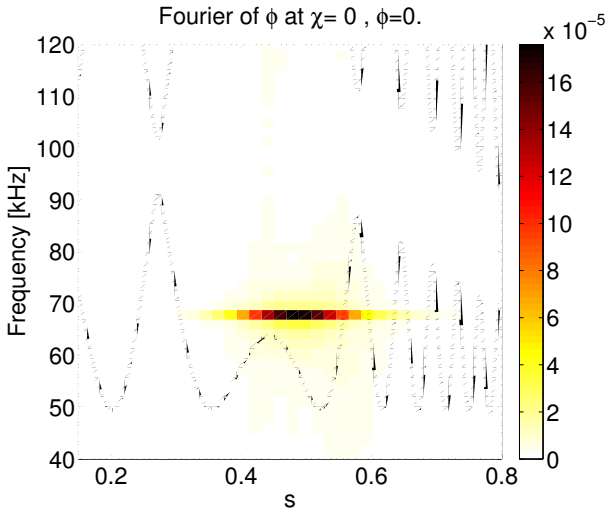
- Lin. GAMs studied in exp. equil/profs (Novikau)
- Lin. EGAMs studied in exp. equil/profs (Di Siena)
- Nonlinear EGAM and comparison with beam-plasma instability (Carlevaro)
- Zonal structures excitation by turbulence in progress (Novikau)
- ZS, turbulence and EP in progress (Biancalani, EPS 2018)

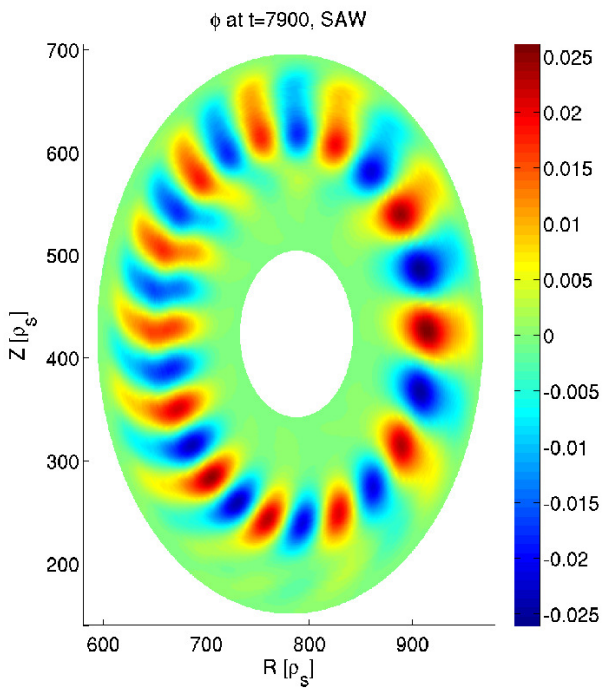




4. Works in progress: 2, AE with exp. equil./profs.

- Towards AE with turbulence: effects of T,n profs on AE, in progress (Vannini)
- First test: benchmark on RSAE in DIII-D, in progress.
  $\rightarrow$ Elongation does not substantially modify freq., but slightly stabilizes RSAE.
  $\rightarrow$ Temperature gradients increase freq. and growth rates.
- Second step: NLED-AUG case, in progress.
- Comparison with ORB5 with fluid electrons to be done (with A. Mishchenko)





5. Works in progress: 3, AE with turbulence and ZS

- First feasibility tests of AE with EP and turbulence performed
- High-aspect-ratio circ. equil. like in Biancalani-PoP-2016
- i., e.: $\rho^* = 1/175$, $a/L_T = 2$, $a/L_n = 0.3$
- EP: $T_{EP}/T_e = 100$, $n_{EP}/n_e = 0.005$, $a/L_T = 0$, $a/L_n = 10$
- EM simulations with $\beta = 10^{-3}$.
- Study of interaction of AE and turbulence and ZS in progress (Biancalani, IAEA 2018).