Enabling Research Project

Nonlinear interaction of Alfvénic and turbulent fluctuations in burning plasmas (NAT)

Ph. Lauber

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organisation: Info from PMU

- project duration: 2 years: intermediate and the final reports (due b the end of each calendar year)
- all publications must be cleared through the EUROfusion pinboard: **http://users.euro-fusion.org/publications/** [users.euro-fusion.org]

- the formal contract (Task Agreement) for your project will be ready by Feb.-March.
- draft will be sent to you and your beneficiary for validation. (by then we will introduce all necessary corrections like actual names, missing in the proposal phase, clean up possible double bookings with other EUROfusion projects and etc.)

- reopen accepted proposals on IMS to readjust resources (in Feb 2017)

- Action: please check, if your resources (ppys) have changed compared to our final proposal

tentative resources (status April 2016)

Manpower (IPP, Germany):
Ph. Lauber (0.5+0.5ppy); A. Biancalani (0.2+0.3ppy); A. Bottino (0.0+0.2ppy); T. Hayward (PhD, 0.0+0.0ppy)*; F. Palermo (0.3+0.3ppy); G. Papp (EUROFUSION PostDoc, 0.2ppy*+0.2ppy); B. Scott (0.2*+0.2*ppy); X. Wang (0.2+0.2 ppy); A. Könies (0.0+0.2 ppy); R. Kleiber (0.2+0.2 ppy); A. Mishchenko (0.2+0.2 ppy).
Total: 1.6+2.3 ppy

Manpower (ENEA, Italy):
N. Carlevaro (0.0+1.0 ppy); G. Montani (0.4+0.5 ppy); F. Zonca (0.35+0.5 ppy).
Total: 0.75+2.0ppy

Manpower (Wigner RCP, Hungary):
G. Pokol (0.2+0.3 ppy), P. Poloskei (pre-doctoral student, 0.0+0.0ppy)*;

'*': covered by other means

Average Project manpower per year: 3.575 ppy for 16 researchers involved [IPP (8+3), ENEA (3), Wigner RCP (2)].

organisation: missions

·Each project has a mission budget allocated, which can be used for meetings of the project members, working sessions or other collaborative activities
·NOTE! Scientific conferences are not eligible in this respect
·It is a task of the PI to monitor the budget and approve the missions of participants
·Current mission application system is located at: **http://users.euro-fusion.org/eurofusion-mission-application-e-form/** [users.euro-fusion.org] if you do not have the password **(the form is placed at JET computing cluster), you can request it at https://users.euro-fusion.org/auth [users.euro-fusion.org]**
·We will amend the list of the projects to include all new ER projects
·The travel costs shall be reimbursed to the person by his/her laboratory, at the end of the calendar year the laboratory will claim those costs to EUROfusion. Here is a short summary of reimbursment rules:
o **Tickets are reimbursed only for long trips, >30 days.**
o **Daily alowence = [# of mission days]* 127.65EUR* [country-specific correction factor (see table below)]**
·It is how the mission budget of your project will be charged, therefore if you have a choise of several meeting places, please keep in mid country correction factors

approved in our proposal:

Mobility: 65 days of mobility are foreseen each year, for an average of 4 mobility days per year per researcher involved. Total mobility days: 130 days. Note that actual use of mobility days will be flexible within the project team and not evenly distributed, but within the ceiling of 130 days and 4 days/researcher/year.
The mission costs (2.55kEuro/ppy) do not exeed the ceiling of 2.7kEuro/ppy.

scientific organisation

similar to ENR NLED:

- ~5 regular meetings per year
- seminars: whenever material is ready to be published
- conference rehearsals
- discussion of preliminary results
- wiki page (to be setup by Ph. Lauber): to announce seminars, publications/presentations, reports; should be updated by all team members (preferred) or provide me the material to be uploaded

structure:

6 workpackages (WPs):

suggested contact persons:

F Zonca
Ph Lauber
X Wang
A Biancalani
A Mishchenko
G Pokol

scope

interplay of SAW/DAW with DWT fluctuation spectra and explore their mutual feedbacks via generation of ZSs:

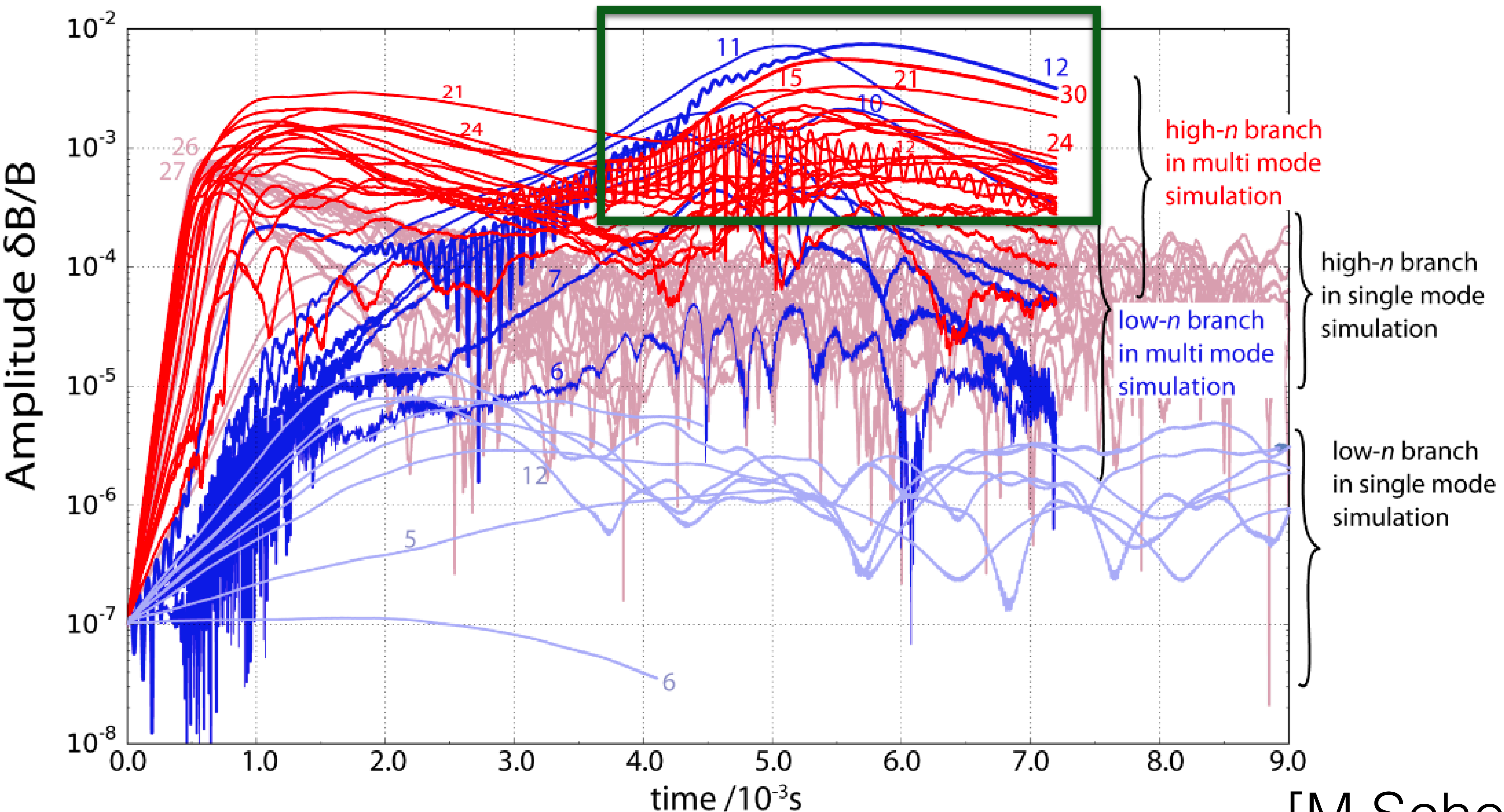
- study interaction channels separately
- further develop analytical theory
- compare numerical results to analytical theory
- develop reduced models, validate models
- compare to experimental data: develop and apply coherence methods to experimental/ numerical data

WP 2: mode-mode coupling model for HAGIS

motivation:

very high amplitudes - mode mode coupling crucial

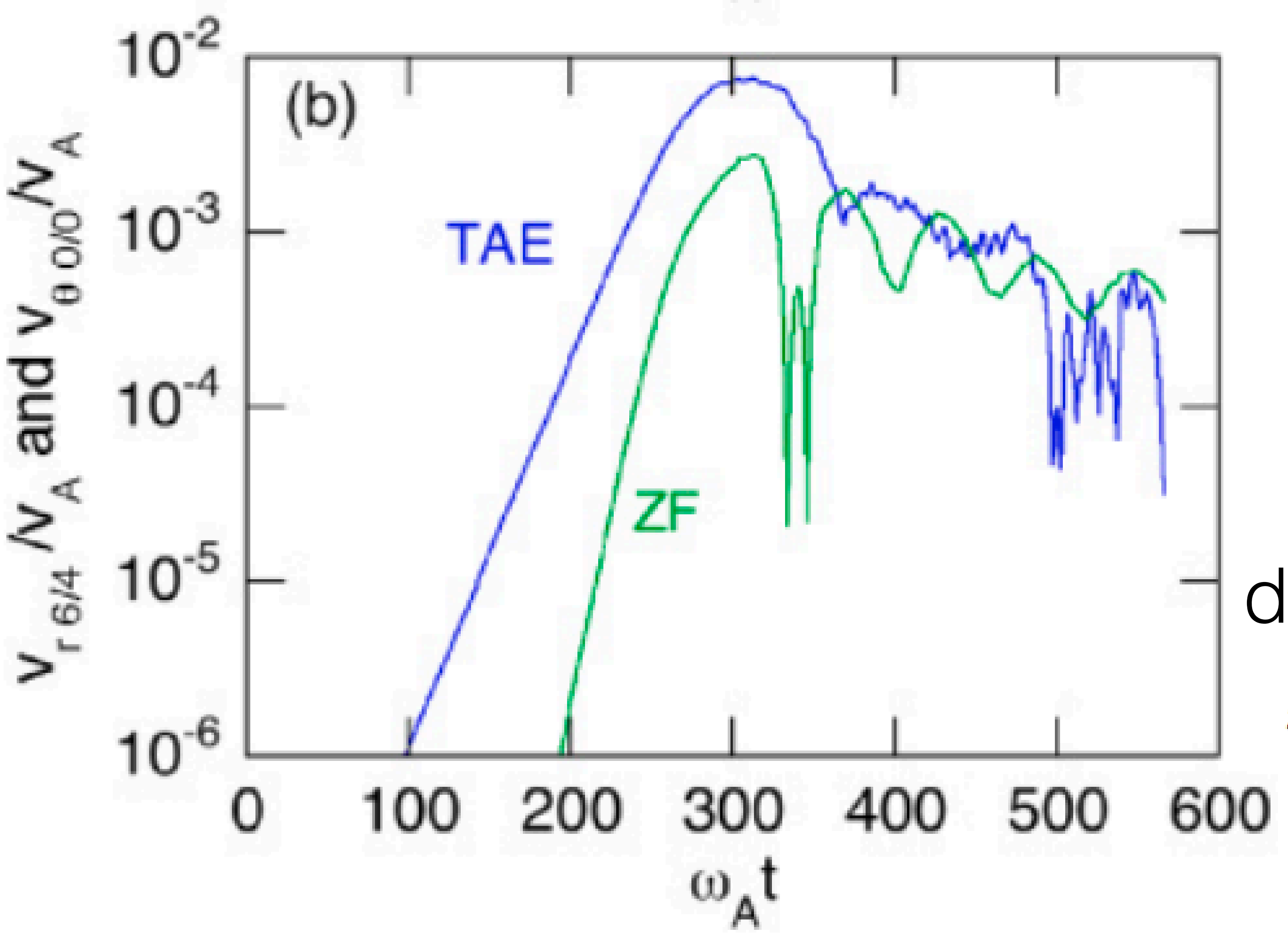
Multi v.s. single mode case (default EP density profile, damping scaled to negligible values): *n*=5..12, *n*=12..30



[M Scheller]

Todo, NF 2010, Biancalani, 2016:

forced driven n=0 with $\gamma_{n=0}=2\ \gamma_{TAE}$



spatial structure during linear phase:

$$z_0 = (2\gamma_{\mathrm{TAE}} I + M_{\mathrm{eq}})^{-1}(s_0).$$

for HAGIS

implement model for TAE saturation: start with forced given system (as Todo)

exploit Lagrangian formulation of the HAGIS code:

add 3rd order term to account for mode-mode coupling (Boyd & Stenflo, 1972)

$$\mathscr{L}_2 = f_0(\boldsymbol{v})\left\{\frac{m}{2}(\mathrm{D}_\Omega \boldsymbol{r})^2 + e\left((\boldsymbol{r}\,.\,\nabla)\phi^{(1)} - \frac{1}{c}\boldsymbol{v}\,.\,(\boldsymbol{r}\,.\,\nabla)\boldsymbol{A}^{(1)} - \frac{1}{2c}(\boldsymbol{r}\,.\,\nabla)^2\boldsymbol{A}_0 - \frac{1}{c}\mathrm{D}_\Omega\boldsymbol{r}\,.\,\{\boldsymbol{A}^{(1)} + (\boldsymbol{r}\,.\,\nabla)\boldsymbol{A}_0\}\right)\right\} + \frac{\chi(\boldsymbol{v})}{8\pi}\left\{\left(-\nabla\phi - \frac{1}{c}\frac{\partial \boldsymbol{A}}{\partial t}\right)^2 - (\nabla\times\boldsymbol{A}^{(1)})^2\right\}$$

corresponds to HAGIS formulation

$$\mathscr{L}_3 = ef_0(\boldsymbol{v})\left\{\frac{1}{2}(\boldsymbol{r}\,.\,\nabla)^2\phi^{(1)} - \frac{1}{c}\boldsymbol{v}\,.\,\left(\frac{1}{2}(\boldsymbol{r}\,.\,\nabla)^2\boldsymbol{A}^{(1)} + \frac{1}{6}(\boldsymbol{r}\,.\,\nabla)^3\boldsymbol{A}_0\right) - \frac{1}{c}\mathrm{D}_\Omega\boldsymbol{r}\,.\,\left((\boldsymbol{r}\,.\,\nabla)\boldsymbol{A}^{(1)} + \frac{1}{2}(\boldsymbol{r}\,.\,\nabla)^2\boldsymbol{A}_0\right)\right\}.$$

$$m\mathrm{D}_\Omega^2\boldsymbol{r} = -e\left(\boldsymbol{E} + \frac{1}{c}\boldsymbol{v}\times\boldsymbol{B}\right)$$

variation leads to:

$$\frac{dB_1^*}{dt} = \frac{i\rho_2 B_3^* \omega_1}{\rho_0} C_{AmA},$$

$$\frac{d\rho_2^*}{dt} = \frac{2iB_1 B_3^* (\omega_2^2 - k_{2z}^2 c_A^2)\, k_2^2}{\mu_0 \partial D_m(\omega_2, \mathbf{k}_2)/\partial\omega_2} C_{AmA},$$

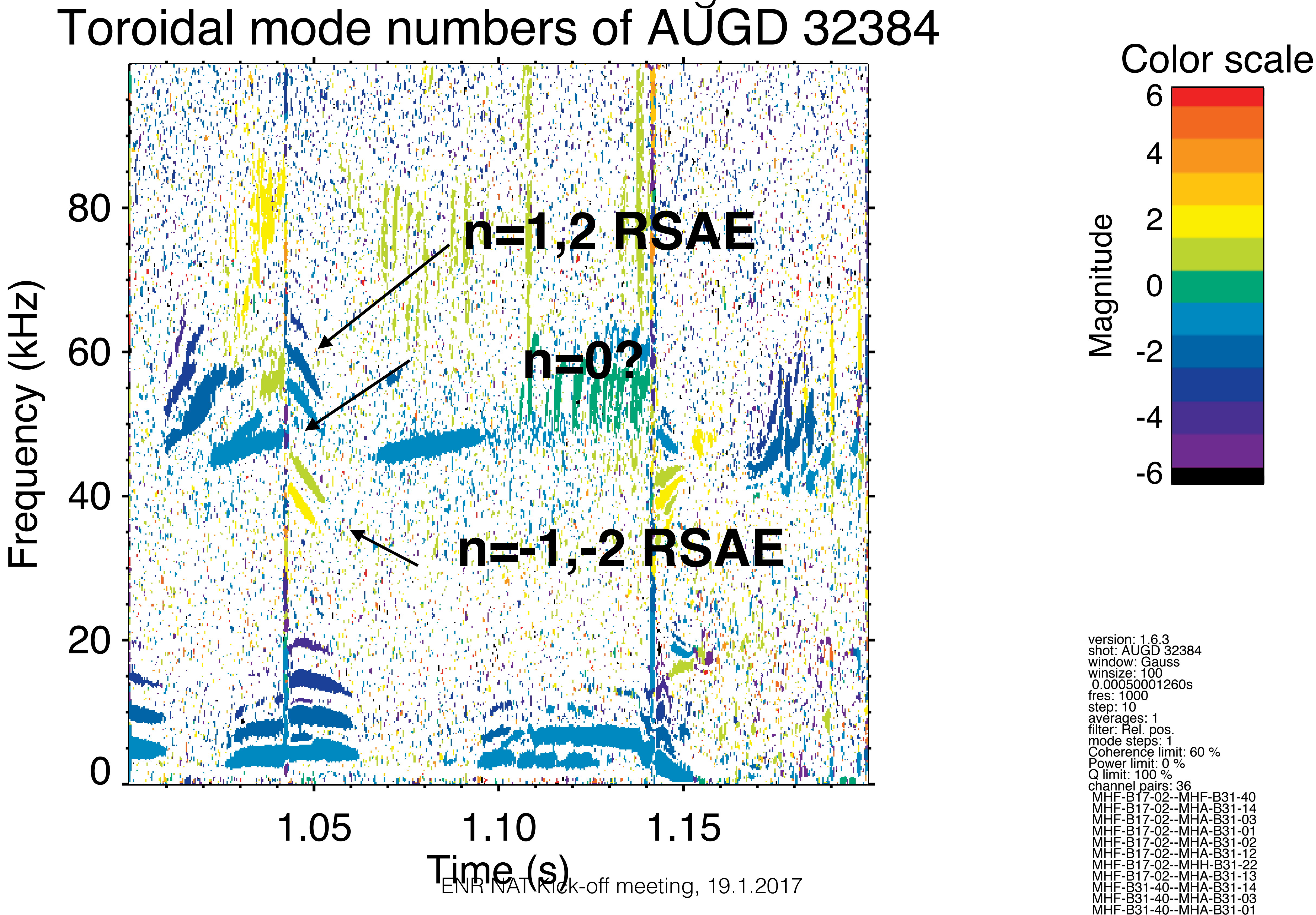
$$\frac{dB_3}{dt} = -\frac{iB_1 \rho_2 \omega_3}{\rho_0} C_{AmA}.$$

$$C_{AmA} = \frac{1}{k_{1\perp} k_{3\perp}} \left[\mathbf{k}_{1\perp} . \mathbf{k}_{3\perp} - \frac{\omega_2^2 (\mathbf{k}_1 \times \mathbf{k}_3)_z^2}{k_2^2 c_A^2 k_{1z} k_{3z}} \right].$$

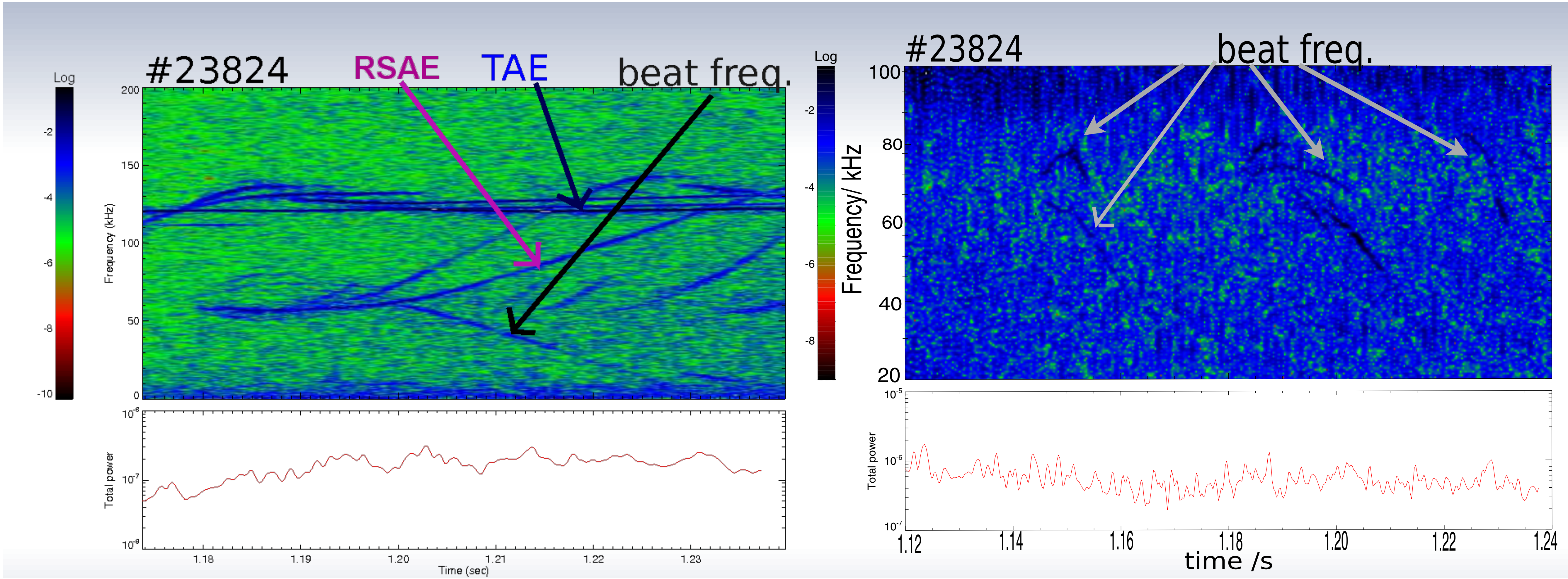
two Alfvén modes interacting with magnetosonic wave
[text book example, Brodin, Stenflo, 1992]

visible in experiment?

two pairs of co/counter propagating RSAEs
to be checked in other diagnostics…



beat wave signals in AUG



fast ion loss detector

high field side magnetic pick-up coils

modes that create the beating signal:
n=4 RSAE (sweeping up) and
n=4 TAE (constant at 120kHz)

[M. Schneller, Varenna 2012]

next steps:

- benchmark to MHD codes/ benchmark to kinetic codes
- investigate possibility to implement model by (Chen&Zonca PRL 2012) for spontaneous excitation
- include linear ITG spectrum (weak turbulence limit)

General Discussion

‘external’ collaborations

within IPP Garching the following links exist:

- Z Lu - mixed variable approach very useful as intermediate step between theory and codes
- with MPPC: Ilija Chavdarovski/ Mirjam Schneller: EGAMs and turbulence (electrostatic)
- NLED: D. Zarzoso (electrostatic)
- TOK: GENE group (discussion tomorrow)

travel plans?