

## BAE dynamics in presence of external magnetic field perturbations in AUG, EAST and JET plasmas

L. Piron<sup>a,b</sup>, P. Buratti<sup>c</sup>, M. Falessi<sup>c</sup>, F. Zonca<sup>c</sup>, R. Henriques<sup>e</sup>, L. Gil<sup>e</sup>, S. E. Joffrin<sup>i</sup>, Y.Q. Liu<sup>j</sup>, M. Marascheck<sup>d</sup>, R. Paccagnella<sup>b</sup>, L. Pigatto<sup>b</sup>, G. Pucella<sup>c</sup>, B. Sieglin<sup>d</sup>, G. Szepesif<sup>f</sup>, D. Terranova<sup>b</sup>, J. Vicente<sup>g</sup>, H. Wang<sup>k</sup>, P. Zanca<sup>b</sup> and ASDEX Upgrade Team\* and JET contributors\*\*

<sup>a</sup> Dipartimento di Fisica "G. Galilei", Università degli Studi di Padova, Padova, Italy, <sup>b</sup> Consorzio RFX, Corso Stati Uniti 4, 35127, Padova, Italy, <sup>c</sup> ENEA, Fusion and Nuclear Safety Department, C.R. Frascati, Rome, Italy <sup>d</sup> IPP Garching | Max-Planck-Institut für Plasmaphysik Garching, Germany <sup>e</sup> CCFE, Culham Science Centre, Abingdon, OX14 3DB, United Kingdom, <sup>f</sup> Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, 1049-001, Lisboa, Portugal, <sup>g</sup> Association EURATOM-CEA sur la Fusion, Cadarache, France, <sup>j</sup> General Atomics, San Diego, US, <sup>k</sup> Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, China

The interaction of Alfvén waves and energetic particles, such as in the alpha particle channelling [1], is a matter of interest toward the realization of magnetic confinement fusion reactors. A class of MHD instabilities, named beta-induced Alfvén eigenmodes (BAEs) [2, 3], can be destabilized by energetic particles and can cause the redistribution and loss of such particles. To guarantee good confinement of energetic particles and alpha heating efficiency in burning plasmas, investigating the BAEs triggering mechanism and their dynamics in present fusion devices is thus of particular importance.

In this work, BAEs behaviour in AUG, EAST and JET devices in Ohmic plasmas is presented. In such a plasma, without an energetic particle population, BAEs is due to the non-linear excitation of Alfvén waves by a locked magnetic island, induced by externally applied  $n=1$  magnetic field perturbations.

The dataset analysed shows that BAEs appear above a threshold value of the external magnetic field, as shown for AUG, EAST and JET discharges, reported in Fig.1, which in turn depends on density. In some experiments, BAEs disappear from the MHD spectrum, despite the magnetic island being present, as in Fig.1(a). Such evidence can be explained through a theoretical evaluation of the continuum distortion in the presence of magnetic field perturbation, based on the general fishbone like dispersion relation [4]. In JET, in particular, a complex BAEs dynamics has been observed: BAEs appear in the MHD spectra as two lines with slightly different frequencies, i.e. 9 kHz and 12 kHz, as shown in Fig.1(c). When the two BAEs lines intersect, the magnetic signal intensifies. Usually, the frequency separation of the BAEs lines is twice the frequency of the tearing mode frequency [5]. However, no MHD activity in the 1.5 kHz range is present. A possible explanation of such a dynamic is provided in this study.

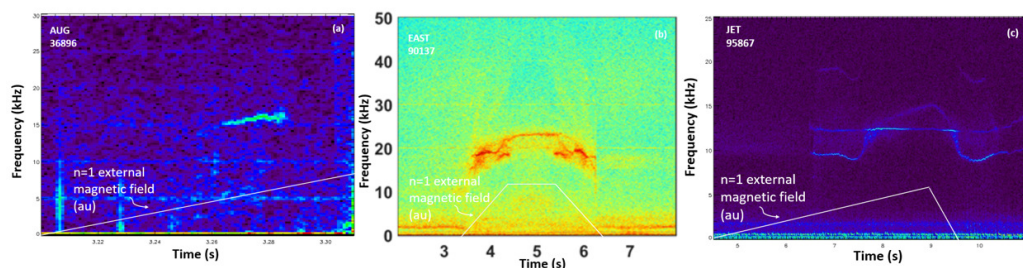


Fig. 1. Magnetic spectrogram of Ohmic discharges in AUG (a), in EAST (b) and in JET (c) with externally applied  $n=1$  magnetic field perturbations.

[1] White R. et al 2021 Phys. Plasmas 28 012503 [2] Heidbrink W. W. et al 1993 Phys. Rev. Lett. 71 855 [3] Zonca F. et al 1996 Plasma Phys. Controlled Fusion 38 2011 [4] Zonca F. and Chen L. 2014 Phys. Plasmas 21 072121 [5] Buratti P. et al 2005 Nucl. Fusion 45 1446–1450 (\*) See author list of H. Meyer et al 2019 Nucl. Fusion 59 112014 (\*\*\*) See author list of E. Joffrin et al 2019 Nucl. Fusion 59 112021