

3rd Trilateral International Workshop on Energetic Particle Physics

Online, November 7 – 10, 2022

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Introduction

This workshop series originated with the ENEA-IFTS Workshop on Fusion Theory and Simulation, held in Taormina, Italy, on October 2-4, 2013. It was then decided to extend participation to experimental devices (EAST, HL-2A/2M, KSTAR, FTU, RFX, DTT, CFETR, etc.), not limiting presentations to theory and simulation. Thus, the meeting became the “Trilateral International Workshop on Energetic Particle Physics” to promote collaboration between China, Korea and Italy, with the 1st meeting held in Hangzhou on Nov. 9-12, 2017, organized by IFTS; the 2nd meeting held in Seoul on Nov. 10-12, 2019, organized by KFE; and the 3rd meeting held online on Nov. 7-10, 2022, organized by CNPS at ENEA. The 3rd workshop counted 75 registered participants.

Follow-up from the 2nd Trilateral EP Workshop in Seoul

The meeting was structured in oral sessions only, with 18 regular talks of 30 mins and 3 review talks of 40 mins. Each day was concluded by a discussion session, followed by a final discussion session on Nov. 10.

The proposed topics for collaborative projects among ZJU/NFRI/ENEA at the Seoul meeting were fruitfully pursued:

- (i) Observation of energetic circulating particle-driven fishbones/EPs (and AEs): strong trilateral activity on KSTAR (H. Jhang, G.Y. Fu, L.L. Zhang) has been reported at the meeting; along with a discussion on connected activity carried out at HL-2A/2M (L.M. Yu, Z. Qiu, F. Zonca). Connected with this point, the rich EP physics on KSTAR and EAST were reported in overviews of experiments, diagnostics and simulations (J. Kim, W. Shen). Further analyses of experimental data are on-going, which may lead to joint publications.
- (ii) Validation of MHD models in experiments: progress from IFTS/CNPS was reported on kinetic/hybrid MHD/GK simulations (Z.W. Ma on CLT-K code; G. Vlad on HYMAGYC/ORB5 codes); it was noted that EP transport has

impact on zonal field structures (thus, EP contribute to the formation of a nonlinear equilibrium); interesting activity on KSTAR (sustaining high- β_N , high-performance, J. Kang); Alfvén eigenmode excitation Reversed Field Pinch and by sawteeth in tokamak were reported (A. Kryzhanovskyy); it was remarked that inclusion of KAW physics may enhance the insights into the physics underlying these results

- (iii) Zonal cross-scale coupling between EP and turbulence: results of existing activities involving collaboration of IFTS and CNPS were reported (Z. Qiu, M. Falessi, Y. Li, L. Chen and F. Zonca); EUROfusion activities on this subject were summarized by Ph. Lauber (MPG-IPP); it was noted that it could be mutually beneficial to promote exchanges between the trilateral collaboration and ongoing EUROfusion research projects; in particular, experiment-based reference cases for cross-machine V&V of codes and models could be identified and shared; detailed analysis of nonlinear chirping mode dynamics (S. Briguglio, J.P. Lee); special attention was given to linear stability analyses of low frequency e.m. fluctuations, with focus on their relevance for the interpretation of recent experimental results in DIII-D and KSTAR (R.R. Ma, G.J. Choi)
- (iv) RMP-induced fast ion losses due to nonlinear wave particle resonances: the interesting results on EP transport in rotating RMP activity at KSTAR were reported at the meeting (T. Rhee); it was remarked that connected activities on DTT are ongoing in the collaboration effort between RFX and ENEA teams (M. Gobbin, G. Spizzo)

Final discussion session

Noting the success of existing trilateral activities from the previous meeting, it was suggested to continue this structured collaboration with a minimum readjustment of collaboration topics:

- (i) Interplay of energetic particles and MHD modes and impact on plasma operations: specific issues of interest here have been identified in the threshold for neoclassical tearing mode excitation in the presence of a large population of energetic particles and in the conditions for achieving improved confinement in the core; the ongoing work on the connection of

MHD activity with excitations of Alfvénic fluctuations was also mentioned.

Contact persons: L.L. Zhang, J. Kim, J. Kang, D. Bonfiglio/A.

Kryzhanovskyy

- (ii) Cross-scale couplings between energetic particles and drift wave turbulence: one topic of interest, here, is that Alfvénic fluctuations excited by energetic particles and drift wave turbulence may have both direct and indirect interactions (mediated by zonal field structures); the resulting anomalous heating of core plasmas may have significant interest for applications in burning plasmas.

Contact persons: M. Falessi, R.R. Ma, Z. Qiu, G.J. Choi

- (iii) 3D effects on plasma stability and energetic particle losses: it was noted that important problems in this area are the investigation of particle dynamics on long time scales and taking into account the effects of collisions and realistic plasma response; in particular, it was proposed that the trapped energetic particle induced ripple loss in DTT was evaluated using, initially, the ideal plasma response on short time scale; it was suggested that direct contact be made with stellarator experts (A. Mishchenko).

Contact persons: T. Rhee, M. Gobbin/G. Spizzo, Z.W. Ma

This list was proposed and agreed about in order to ease future collaborative projects among CHI/KOR/ITA and potentially bring about tangible outcomes in the spirit of previous meetings. In this respect, it was unanimously recognized that, among the actions to improve/enhance collaborations, it would be useful to

- (i) Focus on and promote collaboration/exchanges of young researchers
- (ii) Supporting exchanges between Trilateral collaboration network and ongoing EUROfusion research projects (Ph. Lauber, M. Falessi, A. Mishchenko)
- (iii) Using CNPS bi-weekly seminars as possible framework for reporting progress of the Trilateral collaboration activities

Next meeting

IFTS will host the next workshop in China in a period to be announced in due time. In

this perspective, the scope of the present “trilateral collaboration on energetic particle physics” is to pursue the aforementioned collaborative activities and possibly others, which may arise in the meantime; with the confidence that new results will be presented at the next 4th Trilateral International Workshop on Energetic Particle Physics.