Runaway electron studies via HXR spectroscopy at Golem, COMPASS and TCV

J. Cerovsky[1,2], O. Ficker[1,2], E. Tomesova[1], L. Simons[3], V. Svoboda[2], J. Mlynar[1,2], U. Sheik[3], M. Hoppe[3], J. Decker[3], J. Caloud[1,2], V. Weinzettl[1], M. Hron[1] & the COMPASS team, TCV team and WPTE team

[1] *Institute of Plasma Physics of the CAS, Prague, Czech Republic*
[2] *FNSPE, Czech Technical University in Prague, Prague, Czech Republic*
[3] *SPC, EPFL, Lausanne, Switzerland*

The research on runaway electrons in tokamaks is constantly proving to be important for safe and reliable operation of large fusion devices due to a potential risk of impact of so called runaway electron beams on plasma facing components which could cause a serious damage and could lead to putting the machine out of operation. In order to investigate properties of runaway electrons and provide useful information about their behavior under different experimental conditions (e.g. efficiency of various mitigation techniques or exploration runaway electrons free regimes) many dedicated diagnostics were utilized in past. One way of inferring features of runaway electrons is a measurement of their bremsstrahlung radiation which is generated by collisions with plasma ions or by their impact on the first wall when runaway electrons are deconfined and lost. Recently, the diagnostic capabilities at GOLEM [1] were upgraded by integration of two scintillation detectors with $CeBr_3$ crystals (1” x 1”), which were also successfully tested during dedicated runaway electron campaigns at the COMPASS tokamak [2]. Newly, the both scintillation detectors were installed at the TCV tokamak to extend hard x-ray radiation diagnostics and provide estimate about maximal energy of runaway electrons. The aim of this contribution is to describe the used diagnostic set and experimental conditions at different devices. On top of that a report on conducted experiments from these three devices will be given and findings about runaway electron properties gained by HXR spectroscopy diagnostic system will be pointed out. At the GOLEM tokamak spectroscopy system was used for observation of influence of initial pressure of working gas and maximal energy of HXR photons was estimated about 300 keV. On the other hand at the COMPASS tokamak [3] the data recorded in experiments focused on investigation of runaway electron beams helps to characterized their properties and the efficiency of various mitigation techniques (e.g. graphite pellet injection). At TCV [4], the installed set of scintillation detectors proved to be useful as a source of complementary information to standard radiation diagnostics and helped to characterized generated RE beams . The contribution will also briefly show effort in modeling of radiation transport by FLUKA [5] carried out in order to better understand obtained data.

References

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