

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

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The research on runaway electrons in tokamaks continues to be important for safe and reliable operation of large fusion devices due to the potential risk of impact of so called runaway electron beams on plasma facing components which could cause a serious damage and lead to putting the machine out of operation. In order to investigate the properties of runaway electrons and provide useful information about their behavior under different experimental conditions (e.g. efficiency of various mitigation techniques or exploration of runaway electrons free regimes) many dedicated diagnostics has been utilized. 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, diagnostic capabilities at GOLEM [1] were upgraded by installation of two scintillation detectors with CeBr₃ crystals (1" x 1"), which were also successfully tested during the dedicated runaway electron campaigns at the COMPASS tokamak [2]. Moreover, both scintillation detectors were also installed at the TCV tokamak to extend for the first time the hard x-ray radiation diagnostics and provide an estimates of the maximal energy of runaway electrons. The aim of this contribution is to describe the diagnostic used and experimental conditions of the different devices. Additionally, illustrative examples of experiments from these three different devices are presented and acquired data by the diagnostic system for HXR spectroscopy is discussed and put into the context. The comparison with other relevant diagnostics is shown. At the GOLEM tokamak the spectroscopy system was used to observe the influence of the initial pressure of the 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 characterizing runaway electron beams 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 runaway electrons beams. This contribution also briefly shows a progress in modeling the radiation transport using FLUKA [5], carried out in order to better interpret the obtained data.

References

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