Application of GEM detectors for Fusion Research

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Abstract

In future fusion reactors, the number of diagnostics might be extremely limited mainly due to the breeding blanket that will need to be maximized. Radiation spectra measurements will certainly remain among the most important ones. Indeed, essential plasma parameters can be inferred from X-ray spectrum measurements like magnetic axis, electron temperature, impurity concentration and spatial distribution after tomographic inversion, fast electrons distribution, while several complementary parameters can be deduced from the neutron spectrum measurement: ion temperature from thermal broadening, fuel ion ratio and rotation velocity.

Despite being extremely rich in information, the access to continuous spectral measurements is nevertheless a technical challenge rarely implemented in actual tokamaks.

This talk reports on X-ray and neutron spectra measurements with gas detectors of different nature: at WEST tokamak X-ray spectra up to 20keV acquired by GEM detectors in an automatic and continuous manner are used to deduce W concentration. At CEA laboratories, multi-chamber LVIC measurements working in current mode efficiently reconstruct W spectrum thanks to optimized algorithms. Finally, at IFJ-PAN laboratories, first successful attempts to measure neutron spectra up to 15MeV by thin-foil proton recoil with GEM detectors are described.

Synthetic diagnostics of these different gas detectors specially developed for the occasion to validate the obtained measurements will be described. They also allow extrapolation to some application on the ITER tokamak.