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GEM based detecting system for tungsten radiation focused tomography at WEST tokamak

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Tungsten, being a main candidate for the plasma facing material in ITER and future fusion reactor for some time [1], has recently started to be used as such on many machines, including on the WEST project, where an actively cooled tungsten divertor is being implemented. Inevitably, this forced a creation of the ITER-oriented research programs aiming to effectively monitor the impurity level of tungsten in plasma. Yet, the situation is even more complicated as, due to interaction between particle transport and MHD activity, such impurities might accumulate which could lead to disruption, especially, in case of long pulse tokamaks. Therefore, an appropriate diagnostic tool has to be developed which will not just monitor the level of impurity but will also reconstruct its distribution. Combining the spectral information on plasma radiation with good spatial resolution of its detection should allow recovering fundamental information in order to estimate the level of the plasma contamination and consider its effects on plasma scenarios. For this purpose, an SXR tomographic diagnostics with energy discrimination has been extensively considered for a while [2]. Detection system based on Gas Electron Multiplier (GEM) technology [3] has been recently proposed to be used as SXR tomographic system for ITER-oriented tokamaks and is under development by our group [4], [5]. Detectors built on this technology will satisfy the main constraints on dimension, spatial position and required energy sensitiveness imposed on any X-ray detector for tokamak plasma in ITER and/or DEMO.
Our research is devoted to design a new diagnostics for poloidal tomography focused on the metal impurities radiation monitoring, especially tungsten emission. This work reports on the current status of the design of such detecting system to be installed at WEST project tokamak. Two detectors constituting this system are to be installed in a poloidal section of WEST project tokamak –one of planar and other of cylindrical geometry to be put inside of the vertical and outside of the horizontal ports, respectively. For the internal structure of the detectors simulations selecting the optimal gas mixtures and window material were performed with Ar:CO2 and Ar:CO2:CF4 chosen as candidates for the initial tests and with one-side aluminized Mylar window chosen for a window material. Influence of magnetic field on detectors estimated by Garfield++ code is discussed. First concept of the detecting module electronics is presented with the elaborated data acquisition method allowing 1 ms of time resolution in online mode and up to 100 μs in offline mode for satisfactory data statistics. Ultimately, when implemented, the detecting system will add to the safe operation of tokamak bringing creation of sustainable nuclear fusion reactors a step closer.

Primary authors: Dr CHERNYSHOVA, Maryna (Institute of Plasma Physics and Laser Microfusion); Dr CZARSKI, Tomasz (IPPLM)

Co-authors: Mr WOJENSKI, Andrzej (ISE); Dr MAZON, Didier (CEA); Dr KOWALSKA-STRZĘCIWILK, Ewa (IPPLM); Dr KASPROWICZ, Grzegorz (ISE); Mr MALINOWSKI, Karol (The Andrzej Soltan Institute for Nuclear Studies (IPJ)); Dr POZNIAK, Krzysztof (ISE); Dr MALARD, Philippe (CEA); Dr ZABOLOTNY, Wojciech (ISE)

Presenter: Dr CHERNYSHOVA, Maryna (Institute of Plasma Physics and Laser Microfusion)

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