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Burning-plasma diagnostics: photon & particle detector development needs

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The worldwide fusion community has been developing understanding of plasma physics and fusion plasmas due to the development of theoretical models, rapid advances in computer simulation techniques and pioneering work in plasma diagnostics. A large fraction of such know-how is derived from a complete suite of spectroscopic and particle diagnostics. It is thus crucial to maintain the utilization of well-established plasma diagnostics techniques for basic diagnosis and operation of burning plasma experiments in the near future. The main issues constraining or even eliminating many conventional measurements are lack of port access, long-pulse operations, high D-D and D-T neutron fluxes, gamma-induced noise and possibly, the presence of high- magnetic fields. Conventional silicon detectors are used due to the availability of good quality homogeneous material, and high charge carrier transport properties. Unfortunately, these detectors can only withstand maximum neutron fluences in the range of 1013 to 1014 neutrons/cm2. The main concern in future uses of Si-detectors is, therefore, that their lifetimes could be severely shortened by neutron damage since future sensors will have to withstand fluences of 1015 up to 1017 neutrons/cm2. The fusion community is thus forced to invest in new solutions that are compatible with CERN's very-high-luminosity experiments, using new kinds of radiation-hardened silicon sensors or semiconductor materials other than pure silicon like Diamond, silicon-carbide, semi-insulating GaN, CdTe among others. These novel radiation-hardened detectors and associated electronics have not been tested in a fusion experiment. In this talk we will review key concepts of magnetically confined fusion plasmas, introduce detector challenges for ITER, and discuss possible synergies with the high-energy physics community (e.g. RD50), like testing detectors in present fusion experiments with the aim of providing radiation-hardened detectors for ITER-DT phase as well as DEMO-like fusion reactors.

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