Towards Diagnostics for Fusion Reactors

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Magnetic fusion research advances by the construction and exploitation of machines with increasing size and power. As the fusion power increases the environment within the vacuum vessel that contains the plasma becomes more hostile and the design and implementation of the plasma facing technical systems become more challenging. One such system is the plasma diagnostic system. This system is used to make measurements of the key plasma parameters and the interactions of the plasma with the plasma facing material surfaces. The measurements are used to control the plasma performance, for preventing off-normal potentially damaging events, and for testing and validating theories of physical phenomena occurring within the plasma that limit plasma performance. In existing machines, the environmental impact on the diagnostic system is minimal but as the field progresses towards the ultimate goal of a fusion reactor the impact becomes considerable and eventually will limit the performance of the measurement system and thereby, potentially, the performance of fusion reactors.

In this presentation, we briefly review the requirements for measurements on fusion plasmas and the diagnostic techniques employed in today's fusion machines. We proceed to summarise the steps that are being made to prepare for making measurements on the next generation of fusion devices, especially ITER, that will produce significant amounts of fusion power, and we take a look forward to the challenges that will have to be faced to make measurements on the demonstration fusion reactors that will follow ITER. When completed the findings of this work will have implications for the design of fusion reactors and for the development of plasma diagnostics, and early conclusions in these areas will be given.