Potential common radiation problems for components and diagnostics in future magnetic and inertial confinement fusion devices

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The aim of this is work is to identify common potential problems that materials for use in future fusion devices will encounter for both magnetic (MC) and inertial confinement (IC) approaches, and to discuss the extent of present and possible future areas of mutual research. This study should help both communities to join efforts and avoid duplication of research in this area. We first present the expected fluxes and energy spectra of electro-magnetic radiation, neutrons, electrons, and ions for both types of devices as a first step towards the identification of common material and component areas of overlap. In the case of neutrons for example, although time-integrated fluences are similar in both MC and IC devices, they have quite different time profiles (neutron fluences in IC reactors are produced in pulses, compared with the continuous flux in MC). The influence of these different operating conditions on radiation induced damage will be discussed, and in particular mechanisms less sensitive to dose rate (flux) selected.

The electromagnetic radiation present in both systems, gamma rays from nuclear reactions and X-rays for the high temperature plasma, is another area of common interest, both from the point of view of radiation damage as well as detection methods (diagnostics). The effect of this type of radiation on transmission components (windows, fibres, lenses), in particular comparison of dose rate, dose, and temperature as a means of selecting more radiation hard materials, will be considered. This is of particular concern for LIDAR applications in MC, and laser transmission for ignition in IC. In this context common areas of research on fused silica, the most common material for windows and fibres, as well as for laser optical systems, will be discussed.

The ITER first wall is mainly Be, with only part of the divertor using tungsten, while DEMO is expected to use only W. In present IC devices Al is used, but all new designs are based on W. However both MC and "dry wall" IC fusion reactors plan to employ W as armour for the first wall. The potential for common research on this material will be presented and discussed. Finally a brief discussion of experimental techniques employed to simulate the radiation effect of materials will be presented, highlighting present limitations for both MC and IC environments.