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In-Situ Monitoring Hydrogen Isotope Retention in ITER First Wall

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The routine operation of ITER leads to retention of a sufficient fraction of the tritium fuel. This requires an inventory of radioactive material which must be limited and monitored. As a nuclear device, ITER must limit in-vessel tritium retention to minimize the consequences of potential accidents during normal operation and maintenance as well as to reduce the potential for environmental contaminations. Even if safety is not a key issue, the economy of a fusion reactor ultimately depends on comparison of the tritium consumed by retention and by fusion.
A well-established way to extract the retained hydrogen is heating. The recently proposed in-situ technique for measuring hydrogen isotope retention in the tokamak first wall is based on the first wall local baking with the use of cw laser and analysis of thermally extracted gas components. The power density required to heat the tungsten ITER walls up to the ˜350 ℃ is of 0.1 – 0.4 kW/cmˆ2, depending on thickness and thermal conductivity of the deposited films. Two different methods are considered for detecting the quantity of released gas: 1) mass spectrometry and 2) atomic spectroscopy. Detection by mass spectrometry requires that the contribution to the torus pressure due to the heated spot is detected by a residual gas analyzer. To use instead atomic spectroscopy, it is necessary to locally concentrate the released gas. To accumulate the gas we propose to surround the heated target with a buffer gas (e.g., He, Ne or Ar) of 100 Pa pressure significantly exceeding that of hydrogen to be extracted. The extracted gas density and composition can be spectroscopically measured in locally generated plasma. Two local plasma sources, laser torch and ECR discharge, are discussed with the focus on their implementation in large fusion machines. To get absolute density from spectral line radiation without modeling of excited level populations, the intensity of hydrogen isotope lines has to be normalized to the radiation of known minor hydrogen additive.

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