# Comparison of Global Variance Reduction methods for Monte Carlo Radiation Transport Simulations of ITER

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In assessing components and systems for ITER, Monte-Carlo simulations are used to obtain neutronics parameters (such as flux) at various locations within the ITER model. Monte-Carlo codes follow the behaviour of particles in a system from birth to death, by use of randomly sampling cross-section data and probability distributions, and keeping a tally of particle contributions to a result. The stochastic nature of the method gives rise to a statistical error associated with tally results. In order to ensure statistically accurate tallies one needs to ensure that enough histories have contributed to the result. There are a number of methods to improve the history contribution rate, known as Variance Reduction (VR) methods and play an increasingly important role in fusion neutronics analysis.

The following global variance reduction methods are assessed using MCNP and the ITER Alite MCNP model; Forward Weighted Consistent Adjoint Driven Importance Sampling (FW-CADIS), Mesh based weight window (MBWW), Weight Window In Cell (WWIC) and the MAGIC method. The MCNP Automatic Generation of Importances in Cells (MAGIC) method was created at CCFE in order to transport particles across the entire model in all directions. The MAGIC method works by first using an analogue run to determine an approximate value for the average weight of particles in a given cell. This is then used to provide a cell importance for every cell in the problem, thus when the full calculation is run, the particles should fill the model geometry in an optimum way.

Each VR technique was tested on the same problem and the results compared through the use of a figure of merit (FOM), which is defined such that it is an independent measure of the efficiency of the variance reduction method. It was found that the MAGIC method has the highest FOM, the two weight based methods (WWIC and MBWW) performed similarly, and parallelise quite well. Overall variance reduction techniques have an important role to play in neutronics analysis. All techniques give a major benefit in terms of accuracy, but some perform better than others in parallel computing applications.