

Potential of a Bayesian integrated determination of the  
ion effective charge via bremsstrahlung  
and Charge Exchange Spectroscopy  
in tokamak plasmas

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**Abstract**

Reliable and accurate estimates of the ion effective charge  $Z_{\text{eff}}$  in tokamak plasmas are of key importance with respect to impurity transport studies and the establishment of thermonuclear burn criteria. However,  $Z_{\text{eff}}$  estimates derived from bremsstrahlung spectroscopy on the one hand and from the weighted summation of individual impurity concentrations obtained via Charge Exchange Spectroscopy (CXS) on the other hand, often are not compatible. In the present work, Bayesian Probability Theory is used in an integrated approach as a powerful tool for an advanced error analysis in the derivation of  $Z_{\text{eff}}$ , even in the presence of systematic errors on the data. The obtained  $Z_{\text{eff}}$  estimates are consistent with both the bremsstrahlung and CXS data sets and have reduced error bars, approaching ITER requirements.