Comparison of Unfolding Methods for the Inference of Runaway Electron Energy Distribution from γ-ray Spectroscopic Measurements

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Runaway Electrons (REs) represent a major threat for large tokamak operations and in particular for ITER and the study of the mechanisms that lead to the formation of RE beams on current tokamaks can help developing effective strategies for their mitigation.

Due to Bremsstrahlung collisions with background ions, REs emit hard X-rays with energies up to tens of MeV, which can be detected using fast inorganic scintillators. Spectral deconvolution algorithms can be employed to infer the RE energy distribution from such emission, allowing the study of RE dynamics during a disruption and the comparison of simulated and reconstructed RE distributions in the energy space.

In this work we present a comparison of matrix factorization techniques, iterative algorithms and regularization methods for the unfolding of experimental spectra measured at the ASDEX Upgrade machine. Systematic errors introduced by the transfer matrix and the formation of artefacts in the reconstructed RE distribution, especially in the high energy tail, are discussed, leading to the conclusion that the deconvolution benefits from the higher smoothing levels that can be reached with the regularization methods. Finally, the robustness of different statistics against artefacts in the RE energy distribution has been studied, those statistics are then used to calculate the maximum energy of the beam and the RE current.