Contribution ID: **621** Type: **not specified**

P2.049 A comparative study of different deconvolution methods used for reconstruction of neutron spectrum

Tuesday, 18 September 2018 11:00 (2 hours)

Portable neutron generators (NGs) are widely used in many applications e.g. medicine, materials analysis and plasma diagnostics calibrations. The NGs based on DT reaction provide a controllable 14-MeV neutron emission of high-intensity flux. The knowledge of the total neutron yield is important, and in some of the applications energy distribution of produced particles are also essential. Neutron measurement techniques like activation method provide the information about total neutron emission. The reconstruction of the neutron spectrum is more difficult and requires sophisticated deconvolution methods which are unstable and should be carefully chosen for the specified case. The measurements are characterized by nonzero uncertainty and usually, the number of data is bounded thus causing the problem to be extremely ill-conditioned.
The activation foils were irradiated in the flux of 14-MeV neutrons emitted by NG working in continuous mode. The results of the activation measurement have been used for the reconstruction of emitted spectrum by different deconvolution methods. Minimum Fisher Regularization, Maximum Entropy Method and its connection with Conjugate Gradients Method, Maximum Likelihood Expectation Method and most researched Tikhonov regularization have been implemented in the Python programming language algorithms which were used for the reconstruction of the spectrum emitted by NG. The Codes have been tested with simulation data before the main analysis of the measurement. The results of the reconstruction of own-made codes and UMG Package programs have been compared. The obtained neutron spectra are not identical.
The deconvolution is a very complex problem, requiring experience in inverse problems and understanding the theory of the unfolding methods to correctly evaluate the solution. Discovering the most reliable solution also requires a good knowledge of the phenomena in the object under study. The described deconvolution methods can be implemented to the reconstruction of the neutron spectra from fusion devices like tokamaks or stellarators.

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Session Classification: P2