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Real Time Compatible Tomographic Algorithms for the Control of Burning Plasma Tokamaks

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In tokamaks the interpretation of many diagnostic signals requires some form of inversion, because the measurements are taken from outside the plasma but what is desired is local internal information. Some examples are the magnetic equilibrium from coils and polarimetry, video cameras and the unfolding of various neutron and gamma detectors. A specific set of diagnostics are also needed to reconstructed internal distributed quantities from line integrals measurements. The techniques to tackle this task are quite sophisticated tomographic algorithms, which have been applied to the measurements of neutrons, gamma rays, SXRs, and bolometric sensors. Unfortunately, these tomographic inversion tasks are typically very ill-conditioned problems. Consequently, to obtain local information, sophisticated inversion algorithms have to be deployed and their computational times, of the order of minutes, are not compatible with real time applications.

This contribution presents a new evolution of the Maximum Likelihood tomography explicitly conceived for feedback applications. It does not require the magnetic topology as input, because the regularisation is achieved by a convolution with Gaussian filters. Its computational times are of the order of ms and its accuracy is acceptable for most applications. The method has been particularised for the bolometric tomography, which presents the most challenging tomographic inversion problems, given the complexity of the radiation patterns to be reconstructed in reactor relevant scenarios (detachment, X-point radiator, MARFEs etc.). The quality of the approach is demonstrated by a battery of numerical tests and application to JET bolometric measurements collected in various high power discharges, including the last DT campaigns.

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