From first principles calculations to synthetic diagnostics Analysis of fast electron dynamics in a tokamak

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Lecture: From first principles calculations to synthetic diagnostics

The synthetic diagnostic is the ultimate step for quantitative comparisons between first principle calculations and experimental results. Indeed, it integrates not only all aspects of the plasma physics, but also the physics of the diagnostic itself. Such an approach is necessary when the inverse problem is ill-conditioned, i.e. when experimental results cannot guarantee uniqueness of the plasma characteristics that must be investigated. This general difficulty which comes principally from the mixing of various effects (anisotropy, inhomogeneity) is particularly critical for recovering the velocity distribution function of the fast electrons driven by RF waves or Ohmic electric field in tokamaks. While non-thermal bremsstrahlung is one of the most powerful tool to have a detailed insight of this population, intrinsic limitations have led to the development of a whole chain of codes in order to compare quantitatively theoretical expectations with experimental observations. This approach has turned out to be extremely fruitful, as it offers the possibility to test different physics models and ultimately guide studies to get a clearer picture of the physical processes at play. Different steps of the various calculations are presented as well as main results. Next step challenges are discussed.

Tutorial: Analysis of fast electron dynamics in a tokamak

This tutorial is an illustration of the methodology that is applied to compare experimental results with synthetic diagnostics ones. The example of LH current drive in HL-2A tokamak is discussed in detail, and the power of the method is discussed. Complex interplay between modelling and data analysis is shown, which led to identify what appends in the plasma. The unambiguous remarkable results that have been obtained give strong confidence in the synthetic diagnostic approach.