Diagnostic of fast-ion energy spectra and densities in magnetized plasmas

The measurement of the energy spectra and densities of α-particles and other fast ions are part of the ITER measurement requirements, highlighting the importance of energy-resolved energetic-particle measurements for the mission of ITER. However, it has been found in recent years that the velocity-space interrogation regions of the foreseen energetic-particle diagnostics do not allow these measurements directly. We will demonstrate this for γ-ray spectroscopy (GRS), collective Thomson scattering (CTS), neutron emission spectroscopy and fast-ion Da spectroscopy by invoking energy and momentum conservation in each case, highlighting analogies and differences between the different diagnostic velocity-space sensitivities. Nevertheless, energy spectra and densities can be inferred by velocity-space tomography which we demonstrate using measurements at JET and ASDEX Upgrade. The measured energy spectra agree well with corresponding simulations. At ITER, α-particle energy spectra and densities can be inferred for energies larger than 1.7 MeV by velocity-space tomography based on GRS and CTS. Further, assuming isotropy of the α-particles in velocity space, their energy spectra and densities can be inferred by 1D inversion of spectral single-detector measurements down to about 300 keV by CTS. The α-particle density can also be found by fitting a model to the CTS measurements assuming the α-particle distribution to be an isotropic slowing-down distribution.

General information
Publication status: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Quantum Physics and Information Technology, Culham Science Centre, Max Planck Institute for Plasma Physics, University of Milan - Bicocca, Eindhoven University of Technology, Consiglio Nazionale delle Ricerche, Uppsala University
Corresponding author: Salewski, M.
Number of pages: 17
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Journal of Instrumentation
Volume: 14
ISSN (Print): 1748-0221
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
Original language: English
Keywords: Nuclear instruments and methods for hot plasma diagnostics, Computerized Tomography (TG), Computed Radiography (CR)
DOIs:
10.1088/1748-0221/14/05/C05019
Research output: Contribution to journal › Conference article – Annual report year: 2019 › Research › peer-review