§22. Development of Real-Time Magnetic Coordinate Mapping System in LHD

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For the analyses of position-dependent experimental data, conversion of real coordinates into magnetic coordinates is important. In LHD, this is achieved by a proper choice of the equilibrium minimizing the discrepancy between inboard and outboard sides of the electron temperature profile. For this purpose, it is necessary to construct a database composed of a lot of equilibria.

In this work we have developed a new large-scale database for LHD under wide ranges of central beta (p_0), pressure peaking factor (pf), plasma current (ip) and current peaking factor (ipf), which can cover special conditions such as strongly peaked pressure profile. Firstly we have calculated the free-boundary LHD equilibria by the latest VMEC code, which generates more than 7000 equilibria for each vacuum configuration designated by magnetic axis position (R_{ax}), quadruple magnetic field (B_q) and pitch parameter (γ). Then a library routine for the database access has been developed to run an inverse mapping program and get equilibrium parameters such as effective minor radius, components of magnetic field, etc. by giving ten input parameters: real coordinates (R, Z,Φ), R_{ax}, B_q, γ, p_0, pf, ip and ipf. In this routine, any values are allowed as an input and the output parameters are automatically interpolated or extrapolated.

Because this process is not fast enough for real-time mapping of all the time frames, we have also prepared "sight database" which tabulates the pre-calculated results of mapping along the selected lines of sights (Thomson, CXS, FIR, etc.). A function to read the output parameters by designating the name of the sight was added to the library. In the procedure to search the best-fitted equilibrium from the experimental data, pf and ipf are assumed to be appropriate initial values and Rogowski coil data is used for ip. By reading the sight database, error between inboard and outboard side of the electron temperature profile is calculated with scanning p_0 step by step for each frame. This procedure is repeated until the minimum error is obtained to determine the best-fitted equilibrium parameters. The other parameters such as electron kinetic energy, magnetic axis, etc. are calculated at the same time. After all the frames are processed, the results are automatically registered as an analyzed data with a diagnostic name "tsmap".

Database generation including the sight database has been completed for 23 vacuum configurations. We have also developed a viewer program to display Thomson scattering data in magnetic coordinates. A screenshot of the viewer program is shown in Fig. 1, where time evolutions of several parameters (p_0, pf, magnetic axis, electron kinetic energy) for the best-fitted equilibrium are also displayed.

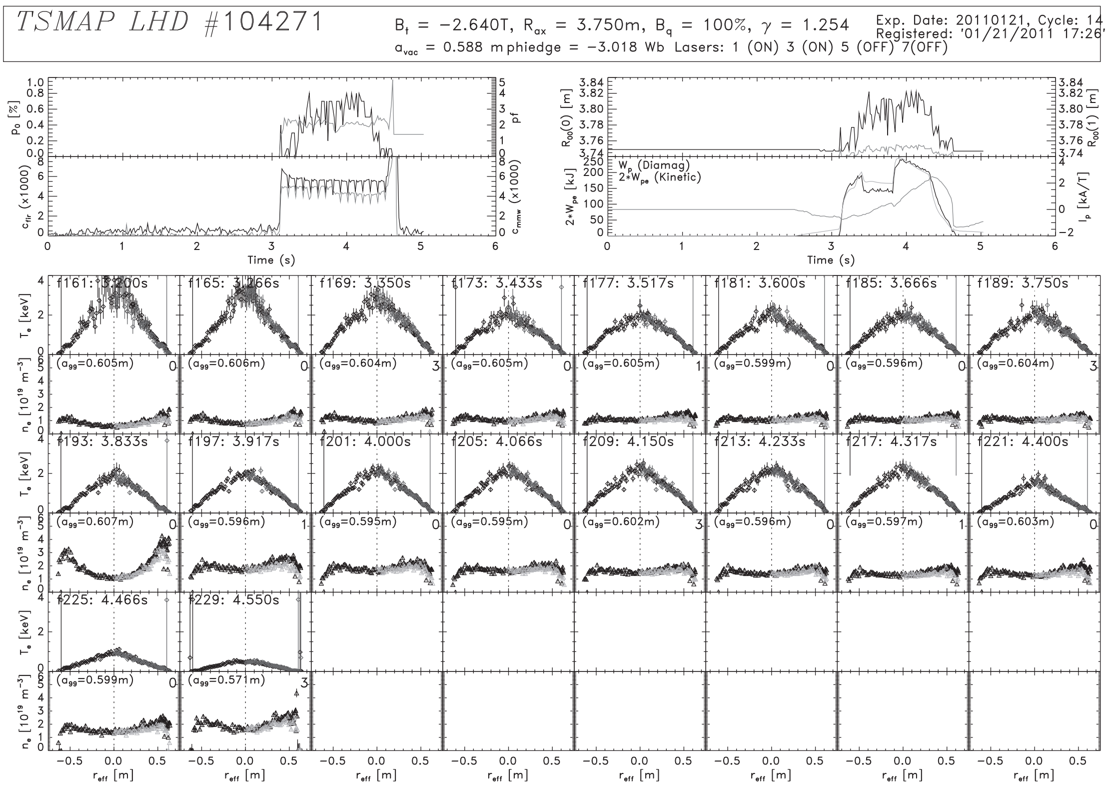

Fig. 1: Screenshot of the viewer program.