Data Structure for LHD Plasmas in the International Stellarator/Heliotron Profile Database

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The 2D-UFILEs are created from the experimental data of the Large Helical Device for the International Stellarator/Heliotron Priofle Database (ISHPDB). The data which were already published will be collected and opened to public on some WWW servers. The directory structure for the WWW server of ISHPDB is designed.

Keywords: stellarator, heliotron, profile database, UFILE, core electron-root confinement

1. Introduction

The International Stellarator/Heliotron Profile Database (ISHPDB) activity has been started as the extension of the International Stellarator/Heliotron Confinement Database (ISHCDB) [1] . This activity is intended to compare various physical phenomena which may be commonly observed among several stellarator/heliotron devices, such as the Large Helical Device (LHD), W7-AS, TJ-II, Heliotron J, CHS, HSX, H-1 and so on. For example, with respect to the features of CERC (Core Electron-Root Confinement) in helical plasmas are investigated in ref. [2]. The data which will be included in the ISHPDB database should be limited as the already published data in principle. In the case of LHD, the data for CERC were published in ref. [3].

The database will be developed in the following two steps: (1) collection and open to public of data files in the text format on the WWW servers for ISHCDB (http://iscdb.nifs.ac.jp/ on NIFS site). (2) detailed database which has ability of search and so on [4]. In this paper, the outline of the step 1 is introduced. The format and actual contents of the profile database are described in section 2. In Section 3, the structure of the directories is shown. A summary is provided in Section 4.

2. The format and contents of the profile database

At first, collection of text files has been started for ISHPDB. As for the data format of the LHD data, the UFILE format, which is adopted in the ITER profile database [5] is chosen. The data from the profile database will be used as the input file for transport codes. This UFILE format is also adopted for the input data form for the integrated simulation system for helical plasmas [6] which is an extension of the 1-dimensional transport code TASK (Transport Analyzing System for tokamaK) [7] to helical plasmas.

The profile data, such as the electron temperature, T_e, the ion temperature, T_i, the electron density, n_e, the radiation loss, P_{rad} and so on are derived based on the experimentally measured data. The profiles which are evaluated by some codes are also included such as the deposition power of NBI (Neutral Beam Injector) to electrons, P^e_{NBI}, and ions, P^i_{NBI}, the density of fast ions, n_{fast}, the particle source from NBI, S^e_{NBI}, the absorbed power of ECH (Electron Cyclotron Resonance Heating), P_{ECH}, and so on.

Figure 1 shows an example 2D-UFILE, which includes a profile of T_e data. This example is taken from the database of the CERC plasmas. The informations of the device, date, the independent variable labels, the dependent variable label and the number of data are written in the first 9 lines. The data of the 51 positions of the normalized average minor radius, ρ, are shown at the top of the data section. In this file, the T_e data at one timing of t = 2.003 sec. are shown. This timing information follows to the ρ data. The last 11 lines of the data section represent the T_e data. The comment lines are located at the last position.

The normalized average minor radius, $\rho = (\Phi/\Phi_a)^{1/2}$, ($\Phi$: toroidal magnetic flux) is derived from a magnetic flux surface data, which is selected based on the symmetry of the electron temperature profile. The name of the selected magnetic flux surface file is registered in the comment section of the UFILE. In this case, the file 'lhd-r375q100b016a2020.flx' was chosen. Many magnetic flux surface files were prepared in advance by using VMEC [8] or HINT2 [9] codes. The most suitable data is selected

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 032940 LHD 2                   ;-SHOT # TOK DIMENSIONS- 15-OCT-07
 18/01/02                       ;-SHOT DATE-  UFILES ASCII FILE SYSTEM
  0                             ;-NUMBER OF ASSOCIATED SCALAR QUANTITIES-
RHO                             ;-INDEPENDENT VARIABLE LABEL: X-
TIME                   SEC      ;-INDEPENDENT VARIABLE LABEL: Y-
TE                              ;-DEPENDENT VARIABLE LABEL-
2                               ;-PROC CODE- 0:RAW 1:AVG 2:SM 3:AVG+SM
        51                      ;-# OF X PTS-
         1                      ;-# OF Y PTS- X,Y,F(X,Y) DATA FOLLOW
 0.00000e+000  2.00000e-002  4.00000e-002  6.00000e-002  8.00000e-002
 1.00000e-001  1.20000e-001  1.40000e-001  1.60000e-001  1.80000e-001
 2.00000e-001  2.20000e-001  2.40000e-001  2.60000e-001  2.80000e-001
 3.00000e-001  3.20000e-001  3.40000e-001  3.60000e-001  3.80000e-001
 4.00000e-001  4.20000e-001  4.40000e-001  4.60000e-001  4.80000e-001
 5.00000e-001  5.20000e-001  5.40000e-001  5.60000e-001  5.80000e-001
 6.00000e-001  6.20000e-001  6.40000e-001  6.60000e-001  6.80000e-001
 7.00000e-001  7.20000e-001  7.40000e-001  7.60000e-001  7.80000e-001
 8.00000e-001  8.20000e-001  8.40000e-001  8.60000e-001  8.80000e-001
 9.00000e-001  9.20000e-001  9.40000e-001  9.60000e-001  9.80000e-001
 1.00000e+000
 2.00300e+000
 3.55164e+003  3.52288e+003  3.44586e+003  3.33319e+003  3.19583e+003
 3.04315e+003  2.88295e+003  2.72161e+003  2.56415e+003  2.41435e+003
 2.27484e+003  2.14731e+003  2.03256e+003  1.93069e+003  1.84120e+003
 1.76318e+003  1.69537e+003  1.63634e+003  1.58457e+003  1.53853e+003
 1.49679e+003  1.45807e+003  1.42130e+003  1.38562e+003  1.35042e+003
 1.31532e+003  1.28016e+003  1.24495e+003  1.20986e+003  1.17512e+003
 1.14099e+003  1.10771e+003  1.07542e+003  1.04414e+003  1.01373e+003
 9.83830e+002  9.53927e+002  9.23343e+002  8.91265e+002  8.56828e+002
 8.19197e+002  7.77667e+002  7.31799e+002  6.81488e+002  6.27042e+002
 5.69235e+002  5.09313e+002  4.48866e+002  3.89494e+002  3.32426e+002
 2.77660e+002
;----END-OF-DATA-----------------COMMENTS:-----------
  modeled profile based on YAG TS data
  type of fitting function :
  flx file name : lhd-r375q100b016a2020.flx
```

Fig. 1 An example of 2D-UFILE of T_e.

among them based on the T_e profile. The T_e profile are derived by fitting the experimental data by using a certain function.

The data file of 2D-UFILE is named like 'lhd_032940_002003_2d.dat', where the discharge number and the timing informations are included. When the 2D-UFILE contains the time evolution data, it becomes 'lhd_032940_2d.dat'.

The profiles of P^e_{NBI} and P^i_{NBI} are calculated by a three-dimensional Monte Carlo simulation code [10]. Figure 2 shows an example of the UFILE for P^e_{NBI}. QNBIE means the NBI heating power to electrons. This data is calculated by a set of codes of HFREYA, MCNBI and FIT. The comment 'PNBI = PFIT' means that the calculation result is used for the total amount of the NBI deposition power, which Z_{eff} largely affects.

The standard set of variables of 2D-UFILE includes some geometry informations, such as the normalized average minor radius, ρ, the geometric major radius, R, the geometric minor radius, r, the volume, V, the magnetic field strength, B, the elongation of the magnetic surface, κ, the geometric quantities, $\langle|\nabla\rho|\rangle$ and $\langle|\nabla\rho|^2\rangle$, and so on. It is important to make clear definition of them especially for the high β plasmas on LHD. In order to construct the database which includes data from several different devices, they should be commonly defined or at least their definition should be clearly documented when the data are registered.

More informations are needed to be included in the ISPDB server with respect to developing the database, such as the change of diagnostic analysis (calibration, abel conversion process, ...), the conversion from the real coordinate to ρ, revision of the equilibrium data, selection of the equilibrium data and so on. The assumptions which are used in deriving the profiles should be obviously described. For example, another assumption for the NBI power deposition of $P^{dep}_{NBI} = P^{dep}_{NBI\ FIT} \times P^{dep}_{NBI\ exp} / P^{birth}_{NBI\ FIT}$ is also used.

```
***************************************
 036159 LHD 2                   ;-SHOT # TOK DIMENSIONS- 11-JUL-07
 10/10/02                       ;-SHOT DATE-  UFILES ASCII FILE SYSTEM
  0                             ;-NUMBER OF ASSOCIATED SCALAR QUANTITIES-
RHO                             ;-INDEPENDENT VARIABLE LABEL: X-
TIME                   SEC      ;-INDEPENDENT VARIABLE LABEL: Y-
QNBIE                           ;-DEPENDENT VARIABLE LABEL-
2                               ;-PROC CODE- 0:RAW 1:AVG 2:SM 3:AVG+SM
       29                       ;-# OF X PTS-
        1                       ;-# OF Y PTS- X,Y,F(X,Y) DATA FOLLOW
 1.72400e-002  5.17200e-002  8.62100e-002  1.20700e-001  1.55200e-001
 1.89700e-001  2.24100e-001  2.58600e-001  2.93100e-001  3.27600e-001
 3.62100e-001  3.96600e-001  4.31000e-001  4.65500e-001  5.00000e-001
 5.34500e-001  5.69000e-001  6.03400e-001  6.37900e-001  6.72400e-001
 7.06900e-001  7.41400e-001  7.75900e-001  8.10300e-001  8.44800e-001
 8.79300e-001  9.13800e-001  9.48300e-001  9.82800e-001
 2.01000e+000
 1.00598e+005  1.18998e+005  1.41986e+005  1.46595e+005  1.56466e+005
 1.80822e+005  1.85729e+005  1.71238e+005  1.79137e+005  1.70279e+005
 1.59298e+005  1.66738e+005  1.58404e+005  1.50115e+005  1.36035e+005
 1.30726e+005  1.24899e+005  1.22783e+005  1.19995e+005  1.15461e+005
 1.07934e+005  1.06885e+005  1.06432e+005  1.06354e+005  1.02053e+005
 1.03616e+005  1.04584e+005  6.44148e+004  2.29218e+004
;----END-OF-DATA-----------------COMMENTS:-----------
  code : HFREYA, MCNBI, FIT
  PNBI = PFIT
***************************************
```

Fig. 2 An example of 2D-UFILE of P^e_{NBI}.

3. Structure of the directories

In this section, the directory structure for ISHPDB which is planned in order to open to public on a WWW server is described. Figure 3 shows an example of the directory structure for ISHPDB. Four directories are contained in the directory with the device name, e.g. 'LHD'. The contents of each directory are as follows.

(1) The 'data' directory includes the UFILEs of 2D, 1D, 0D. The time development of the data and the general information of the discharge should also be included. This directory is divided into the directories with the shot number.

(2) The 'config' directory includes the magnetic flux surface data for the mapping.

(3) The 'topics' directory includes the list of shot numbers and timings for each topics. This list will have the name like 'lhd_cerc_2006.lst' *etc*.

(4) The 'analysis' directory will contain the results of transport analysis and so on.

4. Summary

Making of the profile data of LHD for ISHPDB has been started. The 0D- and 2D-UFILEs from the LHD data are created for the registration of the ISHPDB. The definitions and assumptions in making these files are expressed in the comment lines. In order to construct the database which includes data from several different devices, the in-

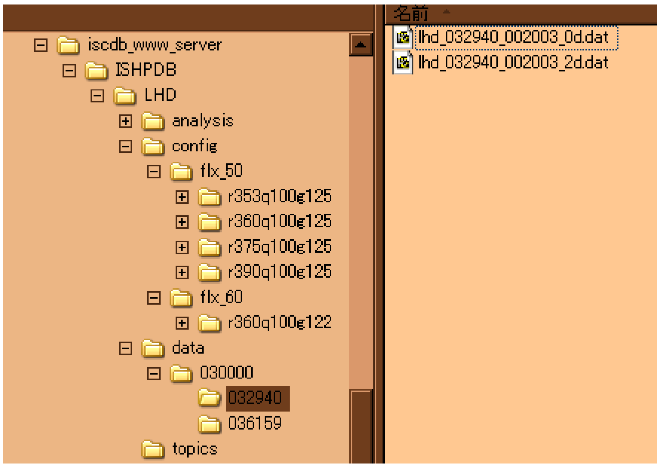

Fig. 3 Structure of directories for ISHPDB.

formations (especially the geometry informations) should be commonly defined or at least their definition should be clearly documented when the data are registered. The directory structure for the WWW server of ISHPDB is also designed.

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