International Stellarator-Heliotron Database

History, current status, outlook

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on behalf of all database contributors

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Outline

- Confinement Database
  - Global energy confinement scalings
  - Stellerator-Heliotron databases
  - International Stellarator-Heliotron Confinement Database (ISHCDB)

- From Confinement DB to Profile and Configuration DB
  - Steps in the database development
  - Covered physics topics
  - Current status

- ISH-DB (confinement + profile + configuration database)
  - Database structure
  - ISH-DB collaboration
  - ISH-DB in World Wide Web

- Summary and outlook

Global energy confinement scalings

- An adequate energy confinement is one of essential conditions to perform a nuclear fusion reaction in laboratory
- Accordingly, many studies have been conducted to identify plasma parameters affecting this important quantity
- Since the energy confinement cannot be satisfactory described in terms of first-principle formulas, scalings based on experimental data from existing devices have to be derived
- Confinement scalings have a long tradition in plasma physics
  Probably, the first significant scaling was done by Gorbunov et al., using data from only one tokamak (T-3, installed 1962): tau ~ a^2 *B ([NF **10** 43 (1970)])

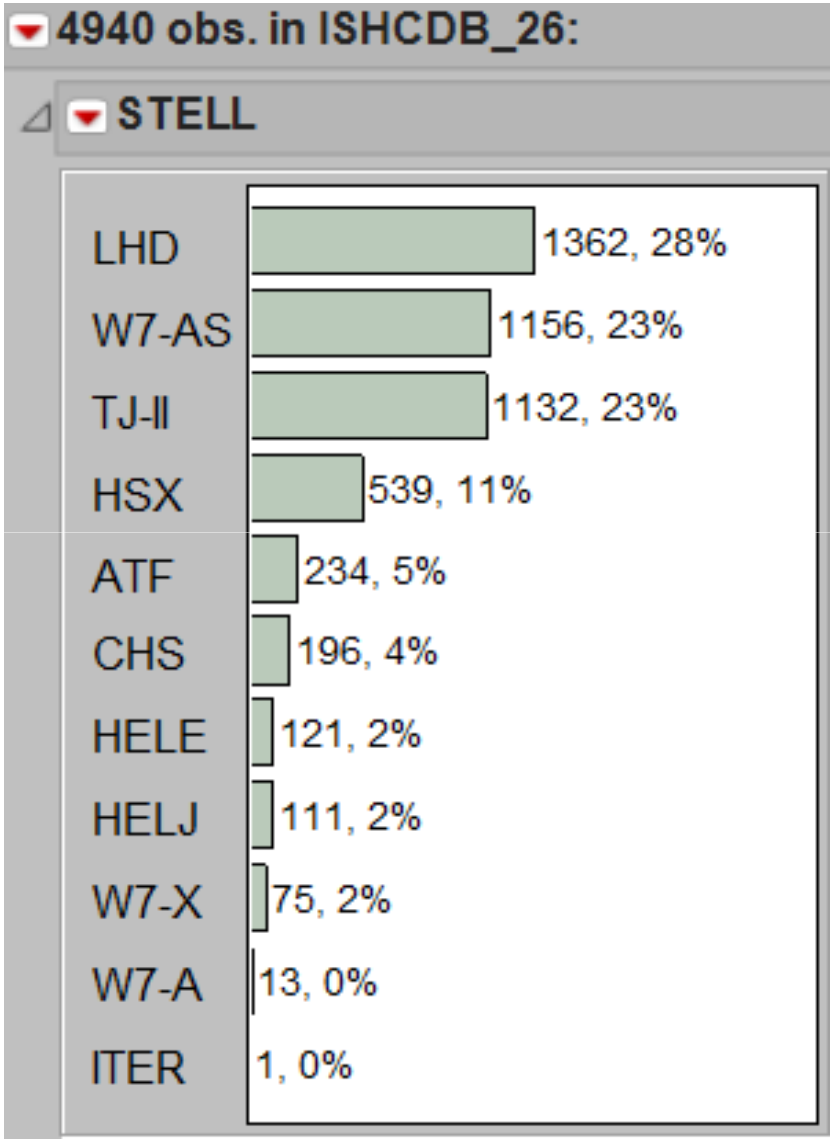
- To assess confinement in future devices multi-machine databases are necessary
- In the 1980's tokamak concept was more popular than S-H;
  1985: Reagan – Gorbachev initiative for a common fusion project (ITER) gave a big push in scalings; Essential scalings for ITER (H-, L-Mode,...) and the associated problems are described in [NF 39, 2175 (1999)]

S-H confinement databases and scalings

Year	Ndata	Ns(*1)	Nds(*1)	Devices	New refererence scaling
1990	?	28	4	Heliotron DR, Heliotron E, L2, W7-A	[NF **30** 11 (1990)]
1992	Implementing Agreement for Cooperation in Development of the Stellarator Concept (signed 2.10.1992)				
1995	859	812	5	ATF, CHS, Heliotron E, W7-A, W7-AS	ISS95 [NF **36** 1063(1996)]
2004	3226	1721	8	ATF, CHS, Heliotron E, Heliotron J, HSX(*2), LHD, TJ-II, W7-A, W7-AS	ISS04 [NF **45** 1684 (2005)]
...					
2014	4940	---	---	ATF, CHS, Heliotron E, Heliotron J, HSX(*2), LHD, TJ-II, A, W7-AS , W7-X simul.	---

(*1) Number of observation/devices used in scaling derivation
(*2) HSX not used in analyses (scales with dens. ~10^17/m3 and ECH <100 KW too differently)

Confinement DB: current status

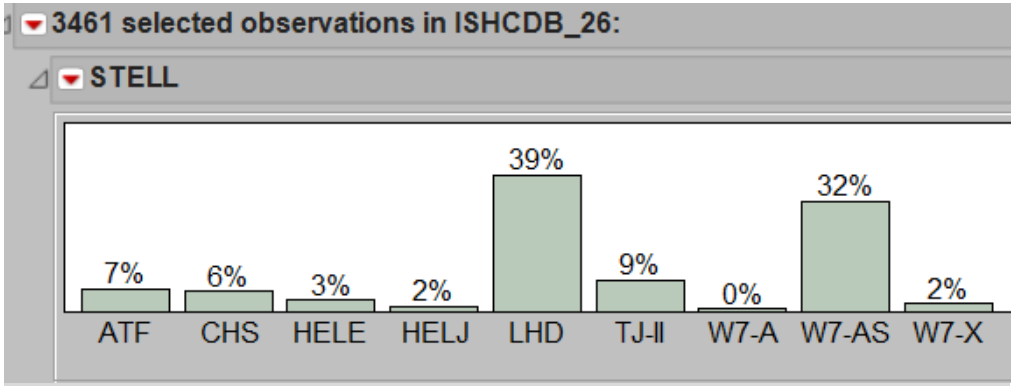


Current version is ISHCDB_26 (19.12.12)

Activities

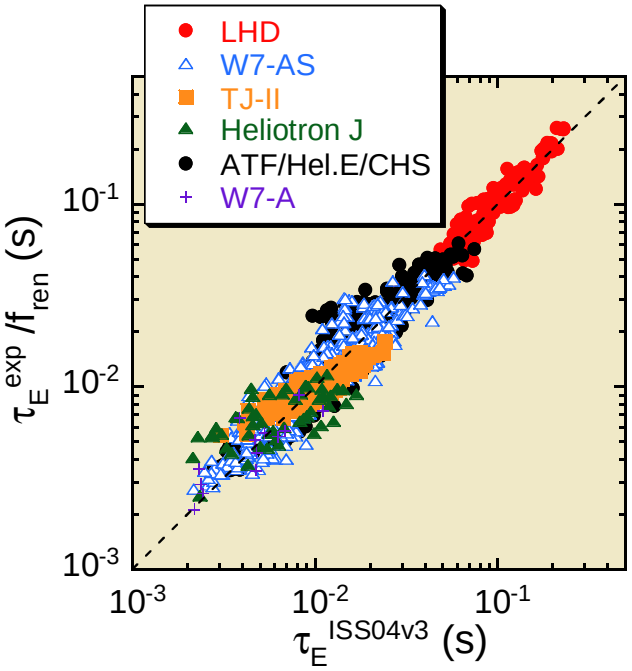
- Statistical analyses **(*)** of the internal structure of the database regarding unified scalings (PCA, cluster, discriminant, regressions analyses)
- Preparations for the new version #27 (new TJ-II data, new LHD data)

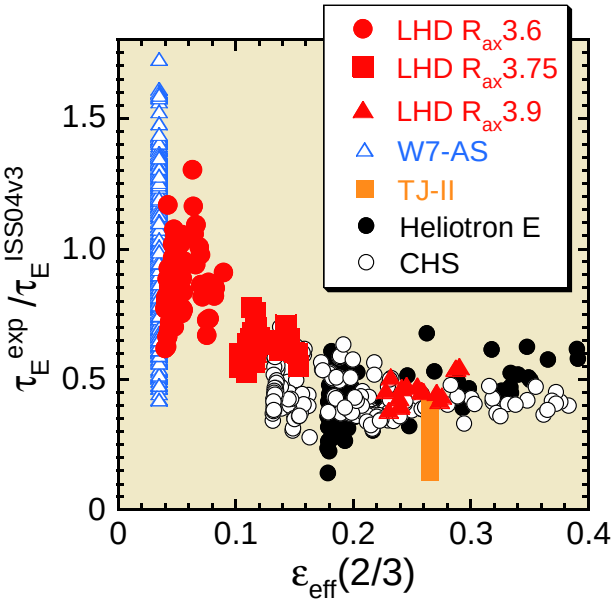
(*) Tomorrow's presentation



1479 excluded from analyses
(5 ATF, 1 HELE, 57 HELJ, 539 HSX, 814 TJ-II,
58 W7-AS, 4 W7-X, 1 ITER entry)

From Confinement DB to Profile DB





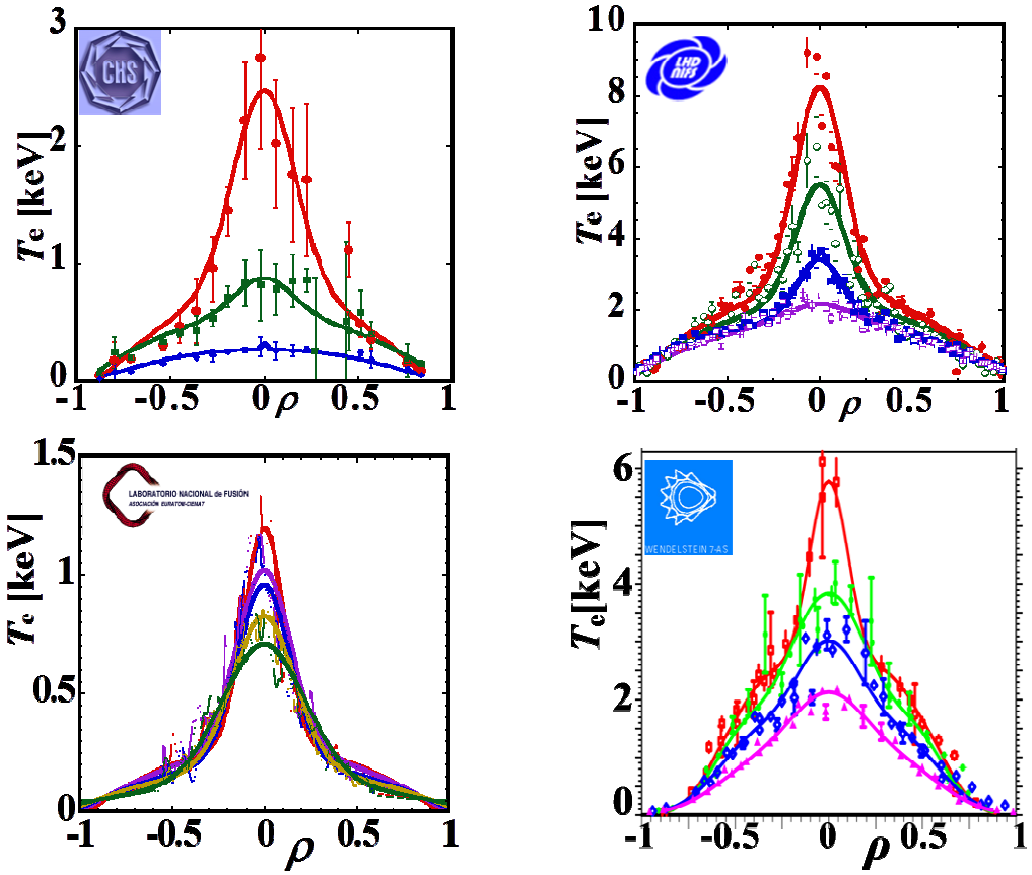
The plot on the right side shows that the calculated renormalization factors decrease while the effective helical ripple increases.

For deeper understanding this facts and other physical processes, information about profiles and magnetic configuration is necessary

→ **Profile and Configuration Database (shortly: Profile Database)**

0 D (Confinement DB) ⇒ 1 D (Profile DB)

τE (0D: global) → Profile (1D) information, equilibrium
systematic physics understandings



M.Yokoyama et al.,
CERC collaboration

Systematic understandings
on electron root feature

Some steps in Profile DB development

Year	Activity
2005	First concrete activities towards a profile database (H. Yamada, M. Yokoyama, CIEMAT colleagues, A. Dinklage, H. Maasberg, ...)
2006	Development of a concept for the database Coordinated Working Group established CWGM 1, Kyoto
2007	CWGM 2/3, Greifswald/Toki First profile data collected (used in published papers) added on • Core Electron Root Confinement (M. Yokoyama) • High Beta (A. Weller)
2008	First configuration data introduced
2009	W7-AS High Performance data
...	
2013	Validation of Neoclassical Transport

Profile DB: Currently documented topics

Topic	Data available from
Core Electron Root Confinement (CERC)	HSX, LHD, TJ-II, W7-AS
High Beta	LHD, W7-AS
Validation of Neoclassical Transport Theory	LHD, TJ-II
High Performance Data (high **n** x **tau** x **T**)	W7-AS
High Ti	LHD
H-mode	CHS, LHD, TJ-II
Edge Turbulence (M. Ramisch, Stuttgart)	AUG, HSX, MAST, TJ-K, URAGAN, W7-AS, WEGA
Stellarator Turbulence	(IPP theory departments)
Magnetic Configuration Data	LHD, TJ-II, W7-AS

New topics under preparation/discussion (cf. agenda of this meeting).

ISH-DB (conf. + profile + config. Databases)

- ISH-DB consists of
  - General information (Infos about devices, list of joint papers from activity, *….)*
  - Confinement data (0D)
  - Profile data (1D and 2D Ufiles, graphics)
  - Configuration data
  - Other documentations (e.g. summary of used fitting functions)

- A single entry in the database is identified by {**dev.Name, shot number, timepoint**}

- Database is jointly hosted by IPP-Greifswald and NIFS
- Physically, data are stored in the IPP's afs networked file system, but are accessible from NIFS via SCP, openAFS, IPP-user account
  - About 3000 datasets
  - Public/Working areas contain ca. 2200/800 datasets (~100 Ufiles)
  - A variety of data formats, in addition to commonly used: doc, docx, txt, jpg, png, dat ...,
    - UFILEs (0D, e.g. for confinement data, 2D for profiles)
    - Different approaches/formats to save magnetic configuration data

Web access to the database (tbc)

IPP entry
http://www.ipp.mpg.de/ISHPDB

NIFS entry
http://ishpdb.nifs.ac.jp

Immediate switch http → https

NIFS Web security policy is changing

Web access to the database (cont.)

A write access to the ISH-DB via Web is not possible at all.

Read access permission:

- Public area
  - Via IPP entry: anyuser
  - Via NIFS entry: user having ISH-DB-specific username and password

- Working area
  - NIFS & IPP: user having ISH-DB-specific username and password

- Magnetic configuration data
  - NIFS & IPP: user having Configuration-specific username and password;
    Access right to working area is not sufficient;
    For NIFS data, a request for access, using a special document, must be sent to M. Yokoyama to initiate the permission procedure

Example Web page: CERC data

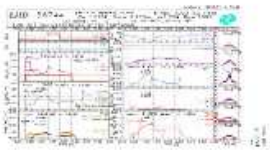
Weblinks to:

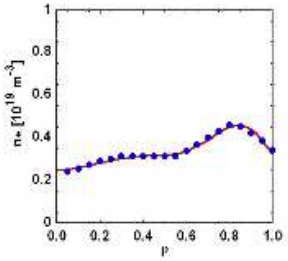
Fit coefficients,
Ufiles (1d, 2d),
Configuration data,
(0d data , XML, ...)

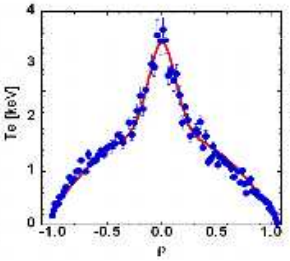
Overview Plots

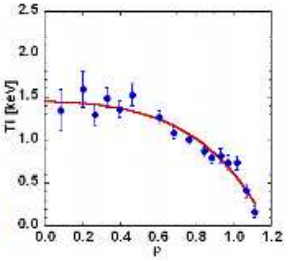
Profiles: ne, Te, Ti, Er

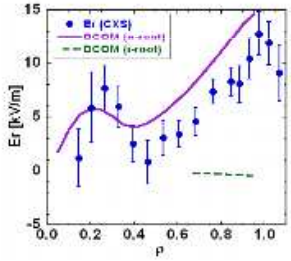
032940
Fit Coefficients
UFILE
lhd_032940_002003_v0001_0d.dat
lhd_032940_002003_v0002_0d.dat
lhd_032940_002003_v0001_2d.dat
lhd_032940_002003_v0002_2d.dat
lhd_032940_002503_v0002_0d.dat
lhd_032940_002503_v0002_2d.dat
lhd_032940_002503_v0003_2d.dat
Configuration Data
xml
036744
UFILE
xml
Confinement Data

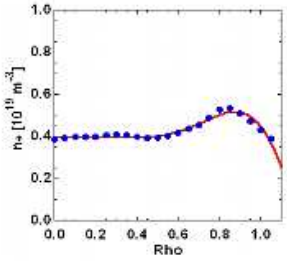


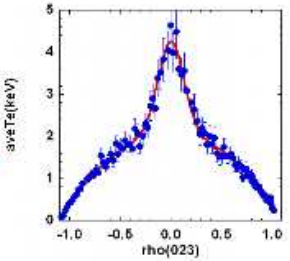




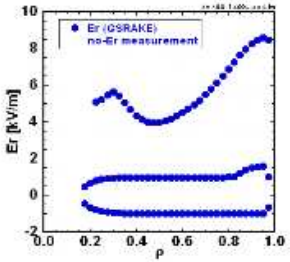








Ti (0) = 1.72 keV [Crystal]



Summary and outlook

Summary: ISH-DB is a success

- From year to year, the collaboration becomes better and more effective
- The chosen forms of cooperation (CWGM meetings, research stays, joint publications, ad-hoc contacts, as well as the systematic contacts between M. Yokoyama and A. Dinklage) ensure the necessary stability in the development
- Much valuable information collected so far
- In the next future new topics and attached data will extent the database

Outlook: ISH-DB will remain successful because

- The collaboration between all colleagues work very well
- The team wants to achieve something
- The team has the ability to reach all the planned goals