May 25, 2008

Documentation of the International Stellarator Confinement Database (ISCDB)

Version ISS_DB07_22

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Contents

I. INTERNATIONAL STELLARATOR CONFINEMENT DATABASE COLLABORATION

The collaboration is carried out under auspices of the
IEA implementing Agreement for
Cooperation in Development of the Stellarator Concept (2.10.1992).

The database is jointly hosted by
National Institute for Fusion Science (NIFS, Toki, Japan)
(`http://iscdb.nifs.ac.jp/`)
and Max-Planck-Institut für Plasmaphysik, EURATOM Association (IPP, Greifswald, Germany)
(`http://www.ipp.mpg.de/ISS/`).

The International Stellarator Confinement Database Collaboration is formed by:

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Discussions and contributions are gratefully acknowledged from:

C.D. Beidler, R. Brakel, V. Dose, J. Geiger, P. Grigull, D. Hartmann,
M. Hirsch, K. Ida, Y. Igithkhanov, H. Maaßberg,
K. McCormick, D. Mikkelsen, S. Murakami, V. Tribaldos,
F. Wagner, A. Weller, and K. Yamazaki

and the Teams of

ATF, CHS, Heliotron-E, Heliotron-J, HSX, H-1, LHD, TJ-II, W7-A, W7-AS, W7-AS and W7-X.

II. CHANGES TO PREVIOUS VERSIONS

Release 22

8 density scan shots of W7-AS (H. Dreier) and 394 LHD transport data added.
The database contains now 4049 observations.

Two data items from US_2003 series had STDSET= 1, but RowState=excluded:
39964, 0.679,
39966, 0.229.
In both cases STDSET=0 has been set.

In order to distinguish between several kinds of confinement for W7-AS HDH shots, the corresponding values in column COMM have been changed to 'HDH normal confinement', 'HDH attached', 'HDH detached', accordingly.

Release 21

Thorough discussions on the uncertainties of W7-AS, LHD and CHS. For the other machines the worst estimations of the discussed uncertainties were taken. An high beta survey on the W7-AS data was performed leading to 313 datasets added to the database. A formula (with parameters fitted by Penningsfeld) for the global heat efficiency was employed to determine PABSNBI for W7-AS shots of US_2003, apart from 13 entries which were taken directly from FAFNER evaluations.

Release 20

The following shots were found to occur doubled in the database ISS DB07_17_release. These shots were erased from the DB17_19_release leading to a diminishing of the total number of datasets from 3226 to 3197 (incl. 4 predictive values for W7-X).

1. ATF (11210, 0.372)
2. ATF (11217, 0.37)
3. ATF (11223, 0.37)
4. CHS (37025, 0.071)
5. W7-AS (25687, 0.44)
6. W7-AS (25843, 0.348)
7. W7-AS (25923, 0.3)
8. W7-AS (25927, 0.3)
9. W7-AS (25957, 0.497)
10. W7-AS (25993, 1.197)
11. W7-AS (25995, 1.197)
12. W7-AS (25998, 0.917)
13. W7-AS (26004, 0.309)
14. W7-AS (26005, 0.822)
15. W7-AS (26129, 0.3)
16. W7-AS (26191, 0.57)
17. W7-AS (26303, 0.597)
18. W7-AS (26305, 0.597)
19. W7-AS (26384, 0.558)
20. W7-AS (26422, 0.58)

21. W7-AS (26426, 0.5)
22. W7-AS (26437, 1.3)
23. W7-AS (26439, 1)
24. W7-AS (26439, 1.265)
25. W7-AS (26440, 0.7)
26. W7-AS (26440, 0.702)
27. W7-AS (26441, 0.25)
28. W7-AS (26919, 0.672)
29. W7-AS (26931, 0.56)

to read as *Device (shot, time)*.

As a preparation for a storage in a rational data-base system, the following column names have been renamed due to conflicts with reserved names.

- COMMENT → COMM
- UPDATE → UP_DATE
- DATE → SHOT_DATE
- TIME → SHOT_TIME
- WITH → WIONTH

III. DESCRIPTION OF COLUMNS

56 columns are compatible with the ISS95 database [8]. The designations and definitions are intended to be compatible with the ITER databases [4]. Present numbering refers to the database file ISS_DB05_17.JMP. Please note that some columns represent *Derived Quantities* which means that their value is calculated within the spread-sheet.

General parameters

1. DATASOURCE
   Sources of data:
   - ISS_DB05 (855 observations, 808 enter the standard set): ISS95 Database Note: One ATF observation was lost from version 1 to version 17 (shot # 6864)
   - W7AS_ECRH_AFTER_DIVERTOR_INSTALLATION (29 observations, 29 enter ISS04 scaling): W7AS data (ECRH heating only) (Dinklage, Kus)
   - US_2003 (167 observations, 165 enter the standard set): W7-AS data collected by Stroth after ISS95 (for 34609 and 40031 NEBAR is missing)
   - W7AS_HIGH_BETA (199 observations, 86 enter the standard set): W7-AS data collected by Weller. Some entries excluded from the standard set (see high beta survey below)
   - LHD_6th_EXP_CAMP_V2 (162 observations, 162 enter ISS04 scaling): data collected by Yamada
   - W7AS_NI (1 observation, 1 enters the standard set): W7-AS data containing NBI heating only data collected by Kus
   - HELJ data by Sano (111 observations, 54 enter the standard set)
   - HSX data by Talmadge (539 observations, 0 enter the standard set) (HSX power & density scans in different configurations)
   - predictive (W7-X by Dinklage) (4 'observations', 0 enter the standard set)
   - TJ-II_Jan04_2 data collected by Ascasibar (1130 observations, 316 enter the standard set):

- BRAKEL data by Brakel (75 observations, 0 enter ISS04 scaling) (W7-AS ι- scan)
- NF 41(1999)429 data entered by Dinklage (1 'observation', 0 enter ISS04) (ITER operation point)
- HIRSCH data by Hirsch (2 observations, 0 enter ISS04) (L/H-mode in W7-AS)
- GRIGULL/McCORMICK data by Grigull and Mc Cormick (60 observations, 0 enter ISS04) (HDH density scan in W7-AS (normal confinement, HDH attached, HDH detached in hydrogen discharges with hydrogen NBI heating)
- PREUSS data by Preuss (preuss@ipp.mpg.de) (312 observations, 0 enter ISS04) (high beta survey of W7-AS data)
- LHD TRANSPORT DATA (394 observations, 0 enter ISS04)
- DREIER density scan data by Dreier (8 observations, 0 enter ISS04)

Grand total:
4049 data sets

2. COMM
more detailed specifications, e.g. 'Power Scan,0.6x10E12,QHS,2003'

3. STELL
Stellarator that has supplied the data:
ATF, CHS, HELE, HELJ, LHD, TJ-II, W7-A, W7-AS, HSX
W7-X and ITER are predictive data

4. STDSET
Standard data set:
0, not included in analyses for ISS04; (applies for 1476 data)
1, included in present analyses (applies for 1750 data)

5. SHEAR_INDICATOR
Magnetic field shear indicator:
0 for shearless stellarators (W7-A, W7-AS, W7-X);
1, otherwise

6. UP_DATE
Last update:
[YYYYMMDD]

7. SHOT_DATE
Date of shot:
[YYYYMMDD]

8. SHOT
Shot number or the first shot number of a sequence

9. SEQ
Sequence number (designated for a series of similar shots)

10. SHOT_TIME
Time during the shot at which the data are taken

11. PHASE
Phase of the discharge:
STAT, stationary phase

Plasma composition

12. PGASA
Mass number of the plasma working gas:
1, H; 2, D; 3, ^{3}He; 4, He

13. PCHARGE
    Charge number of the plasma working gas:
    1, H; 1, D; 2, He
    Derived quantity:
    switch PGASA
        case 1, 2: PCHARGE = 1
        case 4: PCHARGE = 2
        otherwise PCHARGE = missing
    end

14. BGASA
    Mass number of the NBI gas:
    1, H; 2, D

Device geometry

15. RGEO
    Major radius of the last closed flux surface (m):
    ATF, (Rmax+Rmin)/2;
    Heliotron-E, 2.17 m + radial displacement;
    W7-AS, 2 m + radial displacement;
    For W7-AS high-beta data, the major radius is taken from VMEC calculations

16. RMAG
    Major radius of the magnetic axis in the vacuum geometry (m):
    Heliotron-E, 2.2 m + radial displacement; W7-AS, 2.05 m + radial displacement

17. AEFF
    Effective minor radius (m):
    ATF, the t = 1 radius, which is usually not in contact with the wall;
    CHS,radius limited by the inner wall;
    Heliotron-E, radius of the last closed flux surface before the ergodic region;
    W7-AS, last closed flux surface from simple formula interpolating between available configurations;
    W7-AS high beta data, the minor radius is taken from VMEC calculations

18. VOLUME
    Plasma volume (m^{-3}):
    Derived quantity:
    $\text{VOLUME} = 2 \times \pi^2 \times \text{AEFF}^2 \times \text{RGEO}$

19. ASEPARATRIX
    Separatrix area (m^{-2}):
    Derived quantity:
    $\text{ASEPARATRIX} = 4 \times \pi^2 \times \text{AEFF} \times \text{RGEO}$

20. SEPLIM
    Minimum distance between the separatrix and the wall or the limiter(m)

21. CONFIG
    Device configuration:
    STD, standard configuration; LIM/STD, standard configuration with limiter

Machine conditions

22. WALMAT
    Material of the vacuum vessel wall:
    IN, Inconel; INCARB, Inconel with carbon; SS, stainless steel; SSCARB, stainless steel with carbon

23. LIMMAT Limiter material:
    C, carbon; BORC, boron carbide; SS, stainless steel; TIC, titanium-coated graphite

24. EVAP Evaporated material:
    C, carbonized; BOR, boronized; TI, titanium; CR, chromium; NONE, no evaporation

Magnetic configurations

25. BT
    Vacuum toroidal field at RGEO:
    ATF, calculated from coil current

26. IP
    Total plasma current (A):
    Positive values if it increases the vacuum iota (equivalent to the direction of the tokamak current)

27. VSURF
    Loop voltage at plasma boundary (V):
    positive values correspond to positive IP

28. IOTAA
    Rotational transform at the plasma edge (AEFF):
    W7-AS, from simple formula interpolating between available configurations

29. IOTA0
    Rotational transform at the plasma centre:
    W7-AS, from simple formula interpolating between available configurations

30. IOTA23
    Rotational transform at $\mathrm{r_{eff}} = 2/3\mathrm{AEFF}$:
    For the W7-AS high-beta data, the value is taken from VMEC calculations
    For the other devices see Ref. [8].

31. EPS_EFF23
    effective helical ripple for $1/\nu$ transport at $r_{eff} = 2/3AEFF$:
    (see, for example, Ref. [1], especially the equation on page 344).
    For W7-AS, data were provided by C.D. Beidler (DKES results)
    For LHD, data were provided by M.Yokoyama and S.Murakami (DCOM results). Finite beta effect is estimated from the interpolated expression of DCOM results.

32. PLATEAU23
    Plateau factor at $\mathrm{r_{eff}} = 2/3\mathrm{AEFF}$
    (see Eq. (25) in Ref. [3]).
    Data provided by M. Yokoyama.

33. KAPPA
    For LHD calculated by $(\kappa(\phi = 0) \times \kappa(\phi = \pi/20))^{1/2}$, i.e. averaging of local values at the vertically elongated position ($\phi = 0$) and the horizontally elongated position ($\phi = \pi/20$) where ϕ is the toroidal angle and $\kappa = (z_{max} - z_{min})/(R_{max} - R_{min})$ at the last closed flux surface.

Densities

34. NEBAR
    Line average electron density (m^{-3}):
    W7-AS, if available, from microwave interferometer, otherwise from a central HCN chord

35. DNEBAR
    Time derivative of NEBAR ($\mathrm{m}^{-3}\mathrm{s}^{-1}$):
    ATF, only steady state, set to 0;
    Heliotron-E, only steady state, set to 0;
    W7-AS, only steady state, set to 0
    Corresponds to DNELDT variable in the International Global H-mode Confinement Database [6].

Impurities

36. ZEFF
    Average plasma effective charge

37. PRAD
    Total radiative power as measured with bolometry (W)

Input power

38. PECHl
Port-through power for primary ECH (W):
Heliotron-E, sum of 53 GHz powers;
W7-AS, sum of 70 GHz powers

39. PECH2
Port-through power for secondary ECH (W):
W7-AS, sum of 140 GHz powers

40. MECHl
Mode of primary ECH:
1, fundamental;
2, second harmonic

41. MECH2
Mode of secondary ECH:
1, fundamental;
2, second harmonic

42. PABSECH
Total absorbed ECH power (W):
CHS, from radiation level at plasma collapse;
Heliotron-E, from power switch-off experiments;
W7-AS, 90 and 100% absorption in first and second harmonics, respectively

43. ENBIl
Power-weighted neutral beam energy for the primary beams (V):
W7-AS, sources 1+5; 1: 1/2 : 1/3 = 1:1:1

44. ENBI2
Power-weighted neutral beam energy for the secondary beams (eV):
W7-AS, sources 3+7; 1: 1/2 : 1/3 = 1:1:1

45. ENBI3 Power-weighted neutral beam energy for the secondary beams (eV)

46. RTANl
Tangency radius for the primary beams

47. RTAN2
Tangency radius for the secondary beams

48. RTAN3 Tangency radius for the secondary beams

49. PNBIl
Port-through NBI power for the primary beams (W)

50. PNBI2
Port-through NBI power for the secondary beams (W)

51. PNBI3
Port-through NBI power for the tertiary beams (W)

52. GL_HEAT_EFF
Parametric formula for the global heat efficiency for W7-AS derived by Penningsfeld. It is used to determine PABSNBI for the datasource US_2003 and in the calculation of the uncertainty of PTOT for all W7-AS shots

53. DGL_HEAT_EFF
Derivative of GL_HEAT_EFF with respect to the minor radius AEFF

54. PABSNBI
Total absorbed NBI power corrected for shine-through, orbit and charge exchange losses (W):
CHS, according to an expression deduced from HELIOS Monte Carlo calculations;
Heliotron-E, according to the HELIOS Monte Carlo beam orbit following code;
W7-AS, according to an parametric fit deduced from Fafner calculations. Original Fafner evaluations were available for the following shot numbers and used for entry: 31271, 31387, 31463, 31464, 31465, 31466, 31467, 34187, 34313, 34607, 34608, 34609, 37551

55. PABSNBI_V19

56. PICH
Port-through ICRF power (W)

57. FICH
ICRF frequency (Hz)

58. PABSICH
ICRF absorbed power (W)

59. POH
Ohmic heating power (W)

60. PTOT
Total absorbed power (W):
Derived quantity:
PTOT = PABSECH+PABSNBI+PABSICH +POH

61. PFLUX
Power flux through separatrix (Wm^{-2}):
Derived quantity:
PFLUX = PTOT/ASPEPARATRIX

Profile information

62. NE0
Central electron density at RMAG (m^{-3}):
Heliotron-E, taken from FIR;
W7-AS, taken from a fit to a Thomson scattering profile

63. TE0
Central electron temperature at RMAG (eV):
Heliotron-E, taken from a fit to a Thomson scattering profile;
W7-AS, taken from a fit to a Thomson scattering profile

Energies

64. WDIA
Total plasma energy as determined by diamagnetic measurements (J):
Heliotron-E, from kinetic profiles and the beam contribution calculated by the PROCTR code

65. DWDIA
Time derivative of WDIA (W):
0, for PHASE=STAT and PHASE=c;
missing, otherwise

66. WMHD
Total plasma energy as determined from MHD equilibrium (J):
ATF, saddle loop is not calibrated, use for reference only

67. WETH
Total thermal electron plasma energy (J):
W7-AS, from Thomson scattering profiles

68. WIONTH
Total thermal ion plasma energy (J):
W7-AS, from simulation with neoclassical transport coefficients

69. WTH
Total thermal plasma energy from kinetic measurements (J)

70. DWTH
Time derivative of WTH (W)
0, for PHASE=STAT and PHASE=c;
missing, otherwise

71. WFPER
Calculated total perpendicular fast ion energy (J)

72. WFPAR
Calculated total parallel fast ion energy (J)

Energy confinement times

73. TAUEDIA
Global confinement time based on diamagnetic measurement (s):
Derived quantity:
$\text{TAUEDIA} = \text{WDIA}/(\text{PTOT} - \text{DWDIA})$

74. TAUETH
Thermal energy confinement time (s):
Derived quantity:
$\text{TAUETH} = \text{WTH}/(\text{PTOT} - \text{DWTH})$

Not standard quantities

75. COFRANBI
Ratio of co-injected beam port through power to total NBI power:
Heliotron-E, perpendicular injection is set to 1;
W7-AS sources(5 + 6 + 7 + 8)/all sources (BT $>$ 0)

Regression variables and scalings

76. LOG_A
Derived quantity:
LOG10 AEFF

77. LOG_R
Derived quantity:
LOG10 RGEO

78. LOG_P
Derived quantity:
LOG10 PTOT

79. LOG_N
Derived quantity:
(LOG10 NEBAR) - 19

80. LOG_B
Derived quantity:
LOG10 BT

81. LOG_I
Derived quantity:
switch STELL
case ATF, W7-A, W7-AS (except high-beta): LOG10(IOTAA+(1-2/3)^2 (IOTA0-IOTAA))
case CHS: LOG10(IOTAA+(1-2/3)^3 (IOTA0-IOTAA))
case HELE, HELJ: LOG10(IOTAA+(1-2/3)^4 (IOTA0-IOTAA))
case LHD, TJ-II, HSX, W7-X, W7-AS high-beta: LOG10(IOTA23)
end

see also E. (1) in Ref. [8].

82. LOG_TAU
Derived quantity:
switch STELL
case HELE, TJ-II: LOG10(TAUETH)
otherwise: LOG10(TAUEDIA)
end

83. LOG_TAUE_ISS95
ISS95 scaling:
Exponents used: $a_0 = -0.079$, $a_a = 2.21$, $a_R = 0.65$, $a_P = -0.59$[12], $a_n = 0.51$, $a_B = 0.83$, $a_i = 0.4$

84. LOG_TAUE_W7
ISS95W7 scaling.
Exponents used: $a_0 = 0.115, a_a = 2.21, a_R = 0.74, a_P = -0.54, a_n = 0.50, a_B = 0.73, a_i = 0.43$

85. LOG_TAUE_LHD
LHD scaling.
Exponents used: $a_0 = 0.034, a_a = 2.00, a_R = 0.75, a_P = -0.58, a_n = 0.69, a_B = 0.84,$ iota not used

86. LOG_TAUE_LG
Lackner-Gottardi scaling.
Exponents used: $a_0 = 0.68 * 0.0627, a_a = 2.00, a_R = 1.00, a_P = -0.60, a_n = 0.60, a_B = 0.80, a_i = 0.40$
see also Ref. [8].

Dimensionless regression variables

87. TBAR
Volume averaged temperature (eV):
Derived quantity:
$\mathrm{WDIA} \times \left(6 \times \pi^2 \times \mathrm{AEFF}^2 \times \mathrm{RGEO} \times \mathrm{NEBAR} \times 1.602 \times 10^{-19}\right)^{-1}$
(for HELE and TJ-II WTH is used instead of WDIA)

88. LDEBYE
Average Debye length:
Derived quantity:
$\left(\frac{8.8542\times10^{-12}\times\mathrm{TBAR}}{1.602\times10^{-19}\times\mathrm{NEBAR}}\right)^{1/2}$

89. LN_LAMBDA
Average Coulomb logarithm:
Derived quantity:
$\ln\left(9 \times \frac{4}{3} \times \pi \times \mathrm{NEBAR} \times \mathrm{LDEBYE}^3\right)$

90. RHOSTAR
Ion gyro radius normalized by minor radium:
Derived quantity:
$\left(\frac{\mathrm{TBAR}\times2\times1.602\times10^{-19}}{\mathrm{PGASA}\times1.66055\times10^{-27}}\right)^{1/2} \times \frac{\mathrm{PGASA}\times1.66055\times10^{-27}}{\mathrm{PCHARGE}\times1.602\times10^{-19}\times\mathrm{BT}\times\mathrm{AEFF}}$
see also Eq. (14) in Ref. [6], note that the ion charge is included in the aforementioned definition.

91. BETA_ORIG

92. BETA_FORM

93. BETA
Plasma beta:
LHD beta corrected according to formula, Heliotron-E, calculated by the PROCTR code.
Derived quantity:
switch STELL
case LHD:
$$0.722 \times \left(\frac{2}{3} \times \frac{10^{\mathrm{LOG\_P+LOG\_TAU}}}{\mathrm{VOLUME}} \Big/ \frac{\mathrm{BT}^2}{2\times 1.2566\times 10^{-6}} \right) - 0.023 \times \left(\frac{2}{3} \times \frac{10^{\mathrm{LOG\_P+LOG\_TAU}}}{\mathrm{VOLUME}} \Big/ \frac{\mathrm{BT}^2}{2\times 1.2566\times 10^{-6}} \right)^2$$
otherwise: $\frac{2}{3} \times \frac{10^{\mathrm{LOG\_P+LOG\_TAU}}}{\mathrm{VOLUME}} \Big/ \frac{\mathrm{BT}^2}{2\times 1.2566\times 10^{-6}}$
end

94. MFP_ION
Ion mean free path
Derived quantity:
$16\times\pi\times(8.8542\times10^{-12})^2\times(1.602\times10^{-19}\times\mathrm{PCHARGE})^{-4}\times(1.602\times10^{-19}\times\mathrm{TBAR})^2\times\mathrm{NEBAR}^{-1}\times\mathrm{LN\_LAMBDA}^{-1}$

95. NUSTAR Normalized collisionality: connection length/trapped particle mean free path [6]:
Derived quantity:
$\mathrm{RGEO} \times 10^{-\mathrm{LOG\_I}} \times \left(\frac{\mathrm{RGEO}}{\mathrm{AEFF}}\right)^{3/2} \times \mathrm{MFP\_ION}^{-1}$

96. LOG_RHO
Derived quantity:
$\log_{10}(\mathrm{RHOSTAR})$

97. LOG_NU
Derived quantity:
$\log_{10}(\mathrm{NUSTAR})$

98. LOG_BETA
Derived quantity:
$\log_{10}(\mathrm{BETA})$

Uncertainties of the machine parameters

99. PHI_PARA
LHD: Parallel flux (1/s). Needed for evaluation of uncertainty SIGMA_W.

100. PHI_HEL
LHD: Helical flux (1/s). Needed for evaluation of uncertainty SIGMA_W.

101. PHI_TOR
LHD: Toroidal flux (1/s). Needed for evaluation of uncertainty SIGMA_W.

102. SIGMA_AEFF
Uncertainty of the effective minor radius (m):
W7AS: Shot numbers less than 29000 were limiter shots. Magnetic islands are not considered in VMEC-calculations. Since they occur more frequently for IOTAA greater than 0.4: 1cm, otherwise 0.03 $\times$ AEFF. For BETA $>$ 0.01: 0.02 $\times$ AEFF. All other shots: 1cm
ATF: 1cm
CHS: 0.2 cm
HELE: 1cm
W7-A: 1cm
LHD: 0.024 $\times$ AEFF
HELJ: 1cm
TJ-II: 1cm

103. SIGMA_PTOT
Uncertainty of the total absorbed power (W):
W7AS: For ECH 5%, for NBI: corrected for shine through, 10%
ATF: ECH 20%, NBI 10%
CHS: ECH 20%, NBI 10%
HELE: ECH 20%, NBI 10%
W7-A: ECH 0.3 $\times$ 1.25/BT
LHD: NBI 8%
HELJ: ECH 20%
TJ-II: ECH 20%

104. SIGMA_NEBAR
Uncertainty of the line average electron density (m^{-3}):
The uncertainty stems mainly from the error in the effective minor radius and is therefore with help of error propagation law: SIGMA_AEFF $\times$ NEBAR/AEFF, eccept for CHS: 0.7% and LHS: 0.1% of NEBAR plus 6×10^{16}. W7-AS, if available, from microwave interferometer, otherwise from a central HCN chord

105. SIGMA_W
Uncertainty of WDIA (J):
W7AS: 200/2.553 $\times$ BT + const $\times$ WDIA with const=0.1 for shots before 1999 and const=0.01 afterwards. The time step is due to technical changes for the coil signal by Heike Laqua and improvements of the signal analysis by J. Geiger, both done within the year 1998.
ATF: 40 $\times$ BT
CHS: 40 $\times$ BT
HELE: 0.1 $\times$ WDIA
W7-A: 0.1 $\times$ WDIA
LHD: $\sqrt{(0.02 \times \text{WDIA})^2 (8 \times 10^7 \times \text{BT}/3)^2 \times [(0.01 \times \text{PHI\_TOR})^2 + (0.01 \times \text{PHI\_PARA})^2 + (0.02 \times \text{PHI\_HEL}/0.07)^2]}$
HELJ: 0.1 $\times$ WDIA
TJ-II: 0.1 $\times$ WTH

106. SIGMA_LOGA
Uncertainty of LOGA:
SIGMA_AEFF/(AEFF $\times$ LOG2(10))

107. SIGMA_LOGP
Uncertainty of LOGP:
SIGMA_PTOT/(PTOT $\times$ Log2(10))

108. SIGMA_LOGN
Uncertainty of LOGN:
SIGMA_NEBAR/(NEBAR $\times$ Log2(10))

109. SIGMA_LOGT
Uncertainty of LOGT. Since TAU is composed of WDIA/PTOT error propagation law gives $\sqrt{[SIGMA\_W/(10^{LOG\_TAU} \times PTOT)]^2\,[SIGMA\_PTOT/PTOT]^2}/log_2(10)$

Grouping

110. ISS04_ALL
File Format (JMP) specific rows.
Indicate rowstates and device grouping.
All data are visible.

111. ISS04
File Format (JMP) specific rows.
Indicate rowstates and device grouping.
Only data entering ISS04 are visible.

112. Grouping for ISS04
Description of ISS04 subgroups.

Data analysis

113. CHI Argument for least square fit:
$LOG\_TAU - \alpha_A \times LOG\_A\alpha_R \times LOG\_R\alpha_P \times LOG\_P\alpha_B \times LOG\_B\alpha_I \times LOG\_I\alpha_C$

114. CHI_SIGMA Argument for least square fit with uncertainties of the machine parameters:
$\frac{LOG\_TAU - \alpha_A \times LOG\_A\alpha_R \times LOG\_R\alpha_P \times LOG\_P\alpha_B \times LOG\_B\alpha_I \times LOG\_I\alpha_C}{SIGMA\_LOGT^2 + (\alpha_A \times SIGMA\_LOGA)^2 + (\alpha_P \times SIGMA\_LOGP)^2 + (\alpha_N \times SIGMA\_LOGN)^2}$

IV. SELECTION OF THE STANDARD SET

A. ISS95

The standard data set used in all the regressions of Ref. [8] can be obtained from the entire database under the following conditions:

1. Delete discharges in helium.
2. For ATF, delete discharge 6842. (3) For Heliotron-E, delete discharge 53 705.
3. For W7-AS delete all discharges with high power densities given by the condition $PTOT/NEBAR > 3 \times 10^{14}$Wm^{-3}.
4. For W7-AS, delete discharges 21089, 24734, 25966, 25969, 26000 and 26925.
5. Use the diamagnetic energy confinement time; only for Heliotron-E has the thermal confinement time be used. For observations included in the standard set, the parameter STDSET is set to 1. Otherwise this parameter is set to 0.

B. W7-AS high-beta data

The data were collected by A. Weller. This data set refers to high beta campaigns in W7-AS. Only data with beta $>$ 1.5 % were considered (199 observations). High beta data always may be afflicted from configuration effects, such as islands or corrugated boundary structures. This has to be taken into consideration for iota values larger than 0.5. The iota value of the data set is iota at $r_{eff} = 2/3AEFF$.

The following shots are excluded from the standard data set:

- for not being in the criteria of the high beta survey: 43348, 51348, 51373, 54130, 54925, 56315, 56316, 56317, 56325, 56326, 56328, 56329, 56336, 56337, 56340, 56341, 56345, 56345, 56346, 56347, 56348, 56349, 56350, 56351, 56700, 56702, 56711, 56712
- high beta survey time point more stationary, higher beta (see below): 53007
- high beta survey time point with higher beta: 53008
- for entry at multiple times without change in scenario: 53052 at 0.249s, 53054 at 0.249s, 53055 at 0.249s, 54012 at 0.349s, 54019 at 0.229s, 54022 at 0.349s, 54023 at 0.349s, 54024 at 0.349s, 56403 at 0.597s and 0.598s, 56703 at 0.326s, 56723 at 0.399s
- for current Ip too high: 54147, 54152, 54153, 54156, 55852, 55876, 55904, 55905, 55907, 55908, 55909, 56286, 56293, 56298, 56299, 56302, 56306, 56307, 56308, 56309, 56310, 56311, 56312, 56952
- control coils not optimized: 53053
- for not being stationary: 54020, 54932 at 0.262s, 56936 at 0.279s, 56953 (last W7AS shot) $\rightarrow$ 0.28s and smaller times
- for ramp in vertical field Bz: 56736 at 0,444s, 56935, 56938 at 0,356s, 56939 at 0,291s, 56940 at 0,319s, 56945 at 0.279s and 0.339s and 0.533s, 56949, 56950
- 56952 not stationary at 0.229s and at larger times current Ip too high

Shot 51373 can be regarded to document the effect of control field coils; the control current of which is zero and has to be compared with shot 51385 in order to document the optimization of the plasma position due to the control coils.

C. LHD data

PHASE was set to ”STAT”.

D. W7-AS NI data

(shot #50886) PHASE set to ”STAT”, PNBI1, PNBI2 set to missing, PABSNBI calculated by Werner.

E. TJ-II data

There are 1130 discharges from TJ-II in the database, belonging to 43 different magnetic configurations. For the standard data set (used e.g. in the ISS04 scaling) we have selected the configuration named 100_44_64, which has the largest number of discharges and $t_{2/3} = 1.60$. For TJ-II, the thermal confinement time has been used.

F. Heliotron J data

The data were collected by F. Sano. This data set refers to electron cyclotron heating (ECH) campaigns in Heliotron J (shots 5287-5302 and 6049-6140 in 2001 and shots 7776-8084 in 2002) under the on-axis and off-axis heating conditions by using 70-GHz, 0.4-MW focused 2$^{\rm nd}$ harmonic ECH of X-mode. Only data with the standard (STD) magnetic configuration were considered, where the vacuum edge iota value is about 0.557 with low magnetic shear as well as with magnetic well depth of about 1.5% at the boundary. The internal plasma energy content was measured using the diamagnetic loop at the peak energy timing. The ECH absorption power was estimated using the TRECE code [9], where the calculated single-pass absorption efficiency for the flat density profile and the parabolic temperature profile is 0.429 for NEBAR $= 0.2 \times 10^{19}\,\mathrm{m}^{-3}$ and $T_e(0) = 1200$eV,0.495 for NEBAR $= 0.8 \times 10^{19}\,\mathrm{m}^{-3}$and $T_e(0) = 500$eV, and 0.598 for NEBAR $= 2 \times 10^{19}\,\mathrm{m}^{-3}$ and $T_e(0) = 250$eV. In the present data set, the effective absorption efficiency of ECH was assumed to be 66% taking into account the assumed 20-40% multi-reflection effects. The off-axis heating shots (BT $= 1.17$T and BT $= 1.30$T) and shots 8082 and 8084 are excluded from the standard data set of on-axis heating ($1.17 <$ BT < 1.30).

G. HSX data

The vast majority of the shots come with ECH power less than 100 kW. Since the densities are in the $10^{17}\,\mathrm{m}^{-3}$ range, the major fraction of the stored energy can be suspected to be nonthermal. HSX confinement time does not scale with density and power in the way that the other stellarators do. Data were excluded for ISS04 (STDSET = 0).

H. W7-X data

The data refer to operational parameters given adopted from Grieger *et al.* [5]. The data do not incorporate any optimization considerations but are the scaling extrapolations. It is to be emphasized that these extrapolations are considerably smaller than the figures in the W7-X proposal. Data should not be used in any scaling (STDSET = 0).

I. BRAKEL

W7-AS data from the ι-scan shown in Fig. 2 of [2]. Data not used for ISS04 (STDSET = 0).

J. ITER

Reference for ITER operation from [7]. Data should not be used in any scaling (STDSET = 0).

K. HIRSCH

Comparative H- and L-mode data. Data not used for ISS04 (STDSET = 0). AEFF is an upper limit.

L. GRIGULL/McCORMICK

Density scan for divertor operation covering the transition from normal confinement (NC) to attached HDH to detached HDH operation. AEFF was determined from vacuum field calculations (Gourdon code). The absorbed power was estimated from extrapolations of the Penningsfeld formula. Data not used for ISS04 (STDSET = 0).

M. PREUSS

W7-AS high-beta survey: the data were collected by R. Preuss. The search criteria have been: toroidal magnetic field at 36 degrees in between -1.5T and 1.5T, ICOR1 smaller than -1kA, IP in between -0.5kA and 0.5kA and PNBI larger than 2MW. Only those shots were taken into account which obeyed a stationarity criteria, i.e. variation of less than 10% relative for $\pm$ 0,05s around shot time. Data added to the standard set after completion of ISS04 (STDSET = 0).

N. LHD transport data

LHD transport data collected by A. Weller during a stay at NIFS in autumn 2007 in cooperation with S. Sakakibara and H. Funaba. Data added to the standard set after completion of ISS04 (STDSET = 0).

O. DREIER

W7-AS density scan data collected by H. Dreier. Data added to the standard set after completion of ISS04 (STDSET = 0).

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[12] Note: Since PTOT in the ISS95 scaling was used in MW, LOG_P is replaced by (LOG_P - 6) in LOG_TAUE_ISS95, LOG_TAUE_W7, LOG_TAU_LHD, LOG_TAU_LG