Status of the EUROfusion pedestal database

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with contributions from B. Labit, M. Dunne, R. Scannell

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OUTLINE

- People involved
- Brief summary of the workflow
- Status
- Examples
- Present use of the database
- Publications and wikipages references

- Proposed next steps

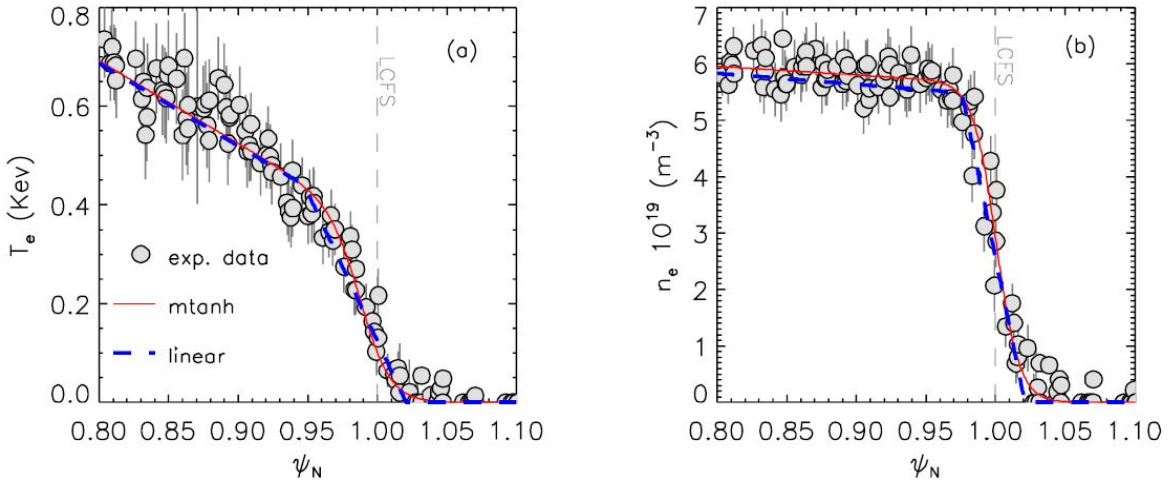
People involved

- Coordinator: L. Frassinetti
- JET
  - **L. Frassinetti** (KTH): workflow, main scripts for local DB in IDL, pre-ELM data processing, script to transfers DB to IMAS, coordination
  - **P. Bilkova** (IPP.CR), **P. Bohm** (IPP.CR), R. Fridström (KTH) for pre-ELM data processing
  - S. Saarelma (UKAEA), **H. Nyström** (KTH) for PB stability analysis
  - E. Giovanozzi (ENEA), equilibrium
- TCV
  - **B. Labit** (SCP): main scripts in matlab, pre-ELM data processing, PB stability analysis, script to transfers DB to IMAS
- AUG
  - **M. Dunne** (IPP): main scripts in matlab, pre-ELM data processing, PB stability analysis, script to transfers DB to IMAS
- MAST-U
  - **R. Scannell** (UKAEA) main scripts in matlab, pre-ELM data processing, PB stability analysis, script to transfers DB to IMAS
- IMAS
  - **F. Imbeaux, M. Owsiak**

Brief summary of the work flow

- Identify stationary time interval
- ELM selection
- Experimental profile analysis (pre-ELM selection, mapping…)
- Pre-ELM profile fit and check quality

Example of pre-ELM profiles and fits for JET-ILW (#84600)



- Apply selection rules (see the details at this link) to decide if to include the data
- Collect other physcs parameters
- PB stability analysis

- Validated data stored in IMAS and transfered to the gateway server

Catalogue query tool: example

tool version branches/R2:263M
api version 1.0
username g2lfrass

Database Select

pedestal

AND OR

Add rule Add group

Machine | equal | pedestal | Delete

Reset Download Search

Results

#	ID	User	Machine	Shot	Run	DS_Version
1	610	g2michal	pedestal	83296	0	3
2	611	g2michal	pedestal	83293	0	3
3	612	g2michal	pedestal	83294	0	3
4	613	g2michal	pedestal	83295	0	3
5	614	g2michal	pedestal	83297	0	3
6	615	g2michal	pedestal	75215	1	3
7	616	g2michal	pedestal	78120	0	3
8	617	g2michal	pedestal	75743	0	3
9	618	g2michal	pedestal	91483	0	3
10	619	g2michal	pedestal	74637	1	3
11	620	g2michal	pedestal	83167	0	3
12	621	g2michal	pedestal	75964	1	3
13	622	g2michal	pedestal	90224	0	3

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Catalogue query tool: shot selection

Catalogue Query Tool

tool version branches/R2:263M
api version 1.0
username g2lfrass

Database Select

pedestal

AND OR

Add rule | Add group

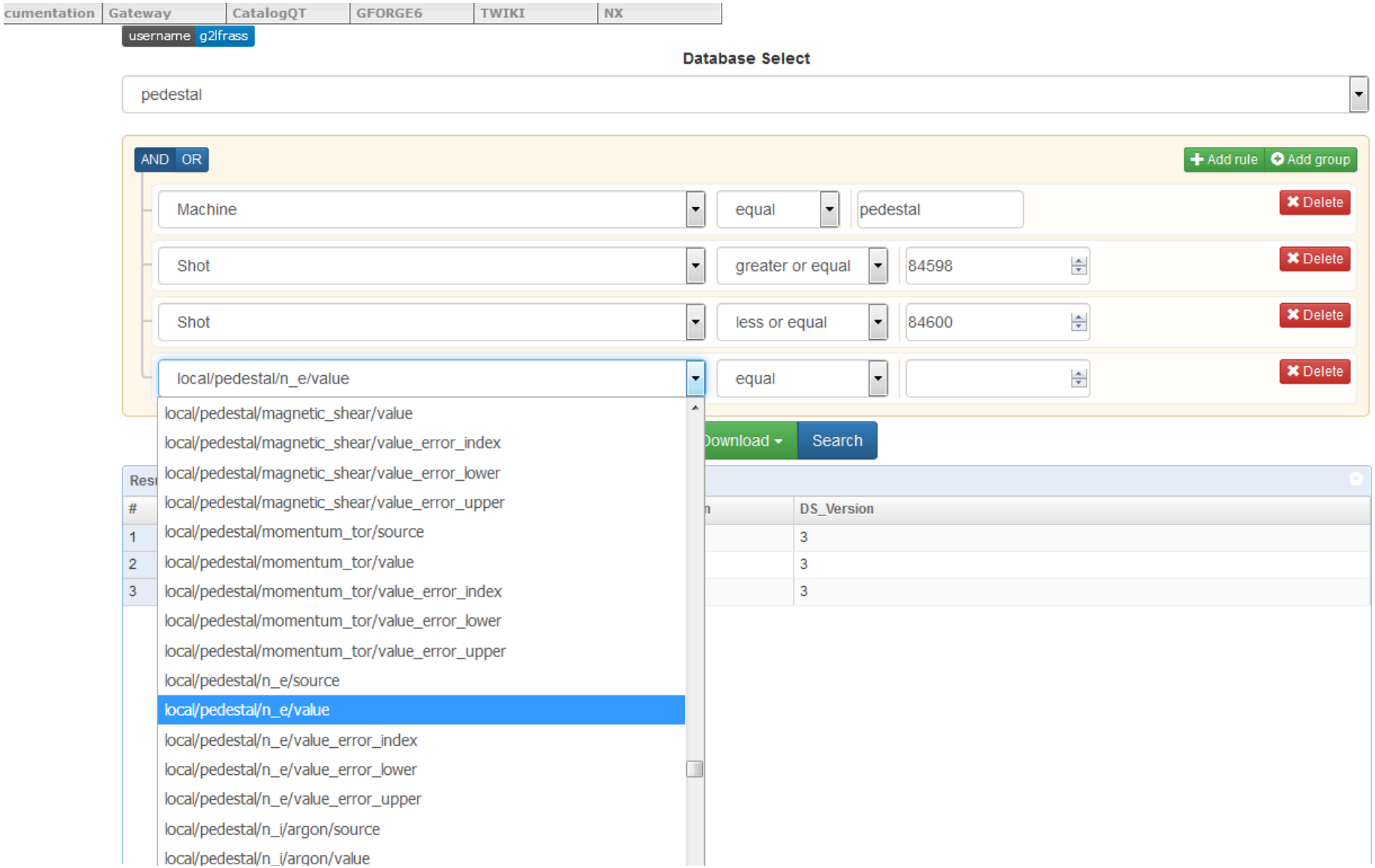
Machine	equal	pedestal	Delete
Shot	greater or equal	84598	Delete
Shot	less or equal	84600	Delete

Reset | Download | Search

Results

#	ID	User	Machine	Shot	Run	DS_Version
1	655	g2michal	pedestal	84600	0	3
2	1084	g2michal	pedestal	84598	0	3
3	1273	g2michal	pedestal	84599	0	3

Catalogue query tool: further selections

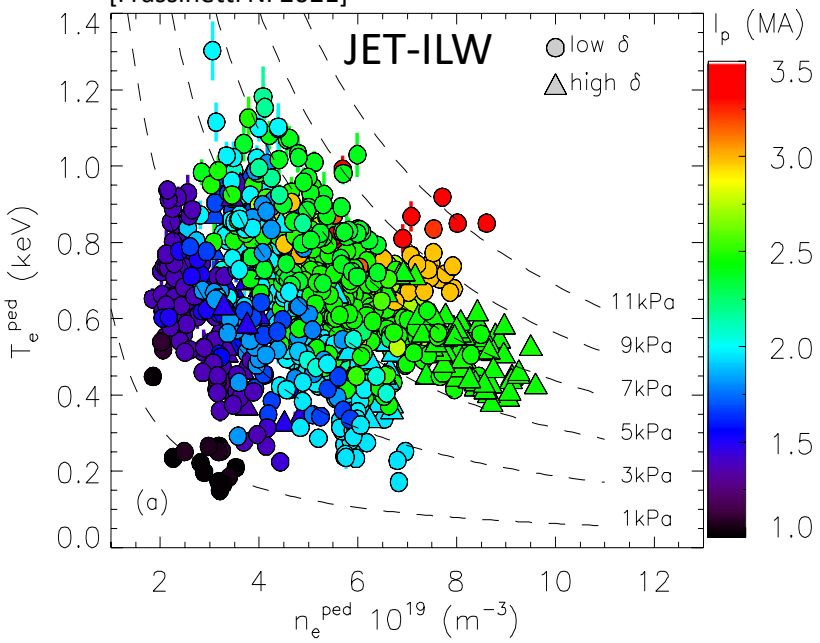


STATUS

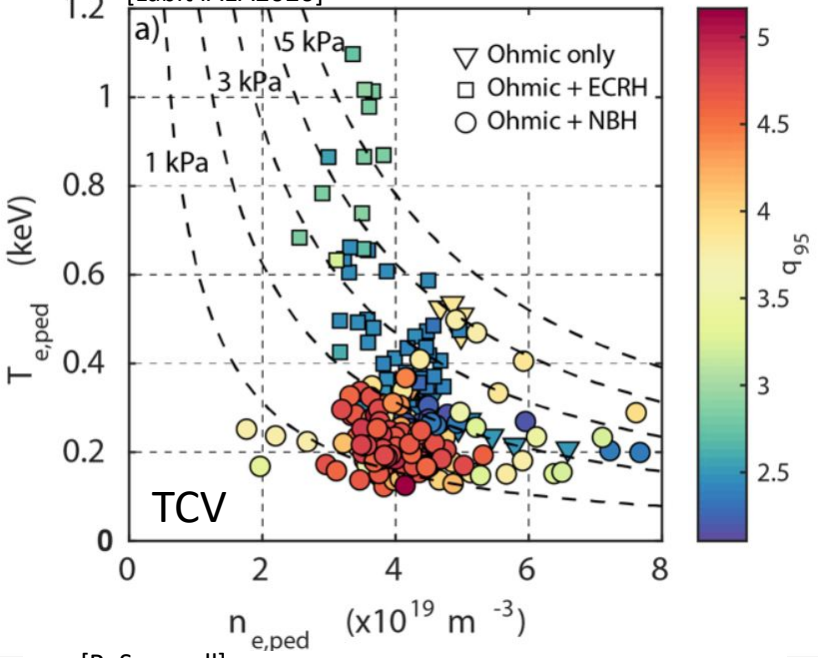
- JET
  - Scripts for local version of database: ready
  - Scripts to transfer the validated data in IMAS: ready
  - Present local version of the database: ≈3550 entries (validated and non validated) with ≈170 parameters each. All H-modes with good TS data till Dec 2020.
  - IMAS version on the gateway: ≈1200 validated shots (validated data till 2016)
- TCV
  - Scripts for local version of database: ready
  - Scripts to transfer the data in IMAS: in preparation
  - Present local version of the database: ≈750 entries
- AUG
  - Scripts for local version of database: ready
  - Scripts to transfer the data in IMAS: in preparation
  - Present local version of the database: ≈150 entries
- MAST-U
  - Scripts for local version of database: ready
  - Scripts to transfer the data in IMAS: ready
  - Present local version of the database: ≈40 entries

EXAMPLES: pedestal height

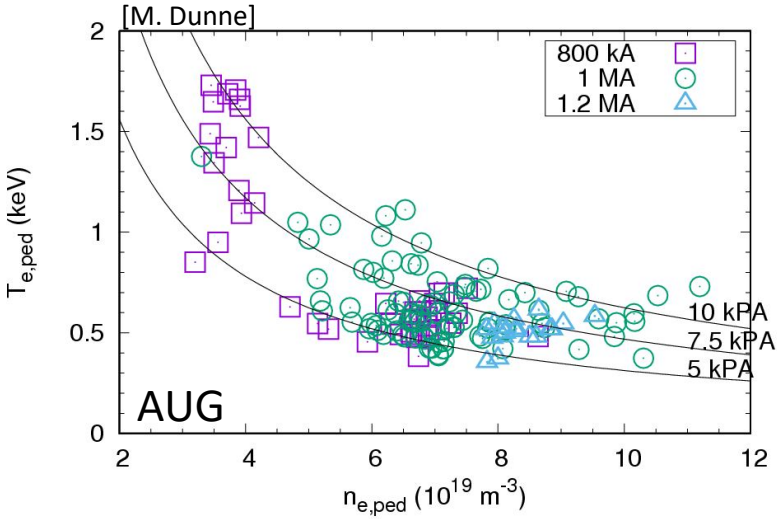
[Frassinetti NF2021]



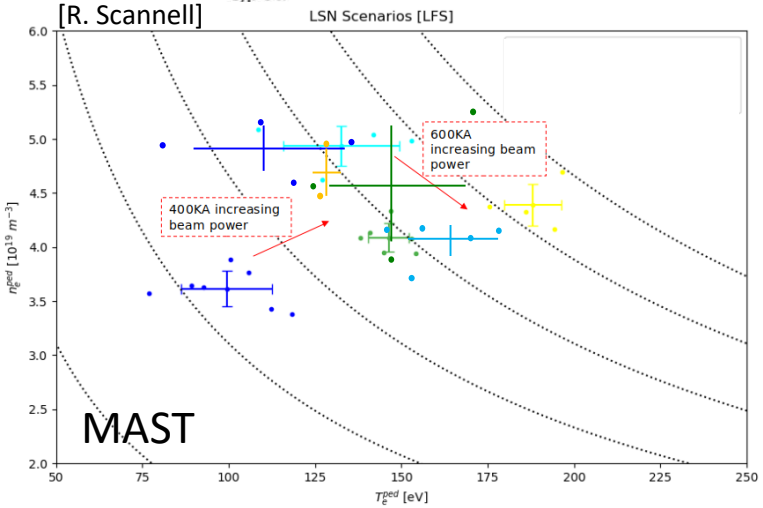
[Labit IAEA2020]



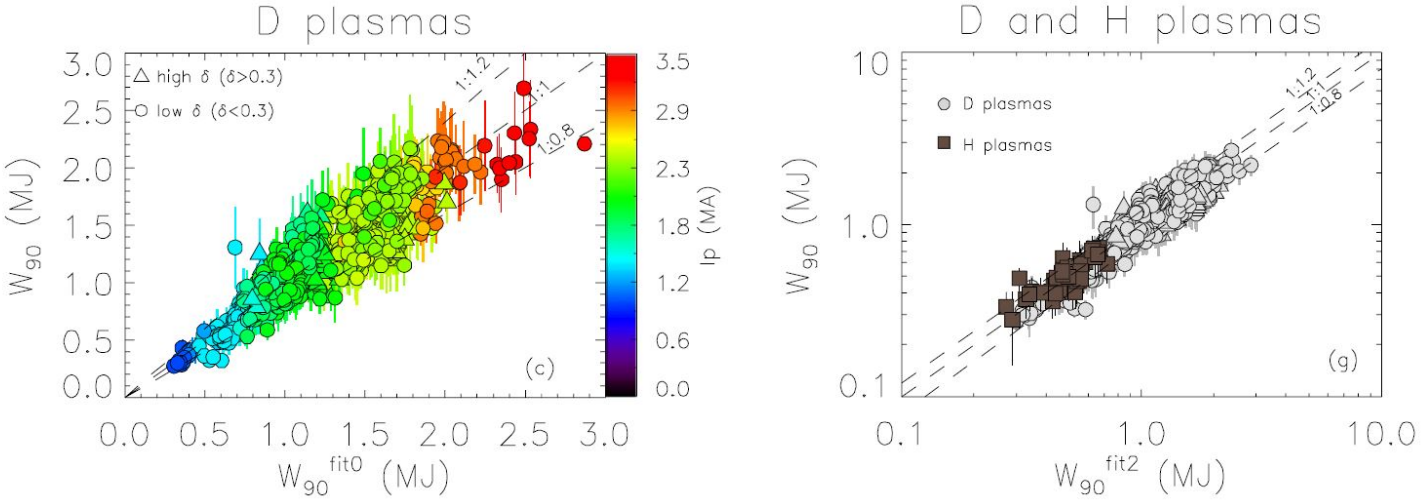
[M. Dunne]



[R. Scannell]



EXAMPLES: scalings in JET-ILW

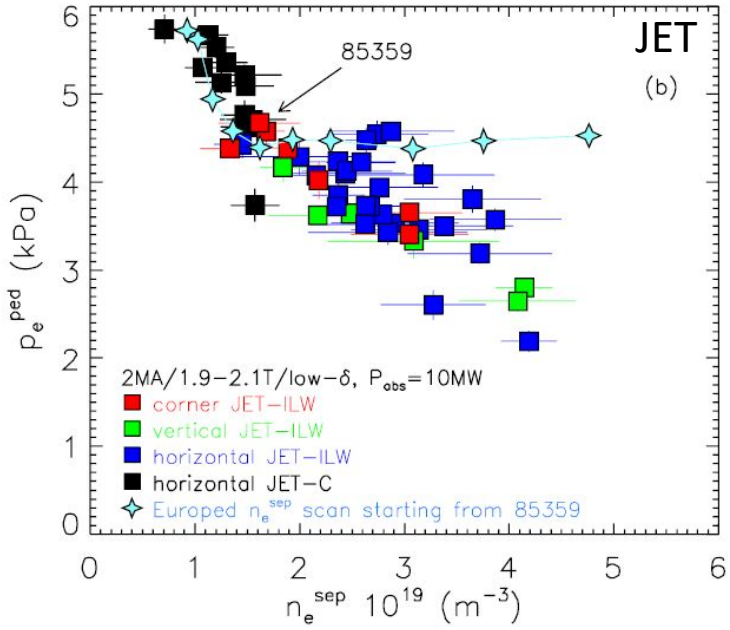


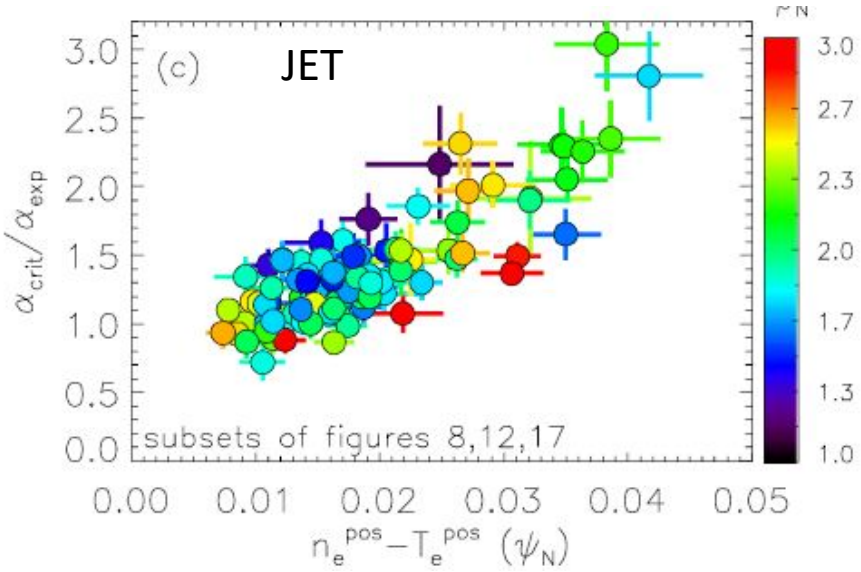
[Frassinetti NF2021]

Table 3. Exponents of the scaling laws for plasma current (α_I), loss power (α_P), triangularity (α_δ), gas fuelling rate (α_Γ), separatrix density normalized to the pedestal density ($\alpha_{(\mathrm{nsep/nped})}$), pedestal Greenwal fraction ($\alpha_{(\mathrm{nped/nGW})}$) and isotope mass ($\alpha_M$). The last two columns show the R^2 and the percentage of the experimental data in the database that are predicted correctly by the scaling law within ±20%. The label 'fit0' refers to scaling done using only D plasmas. The labels 'fit 1' refer to the scaling done using D and H plasmas and including the gas fuelling rate in the scaling law. The labels 'fit 2' refer to the scaling done using D and H plasma and including the ratio $n_e{}^{\mathrm{sep}}/n_e{}^{\mathrm{ped}}$ in the scaling law, while 'fit 3' the ratio $n_e{}^{\mathrm{ped}}/n_e{}^{\mathrm{GW}}$.

	α_I	α_P	α_δ	α_Γ	$\alpha_{\left(\frac{n^{sep}}{n^{ped}}\right)}$	$\alpha_{\left(\frac{n^{ped}}{n^{GW}}\right)}$	α_M	R^2	±20%
W_{ped}^{cordey}	1.41 ± 0.06	0.5 ± 0.04	–	–	–	–	0.2	0.74	67%
W_{90}^{fit0}	1.27 ± 0.15	0.30 ± 0.08	0.29 ± 0.12	-0.07 ± 0.04	–	–	–	0.89	86%
W_{90}^{fit1}	1.26 ± 0.15	0.31 ± 0.08	0.29 ± 0.11	-0.07 ± 0.04	–	–	0.5 ± 0.2	0.90	84%
W_{90}^{fit2}	1.14 ± 0.13	0.30 ± 0.08	0.32 ± 0.12	–	-0.23 ± 0.11	–	0.5 ± 0.2	0.90	88%
W_{90}^{fit3}	1.11 ± 0.15	0.36 ± 0.10	0.27 ± 0.15	–	–	-0.08 ± 0.15	0.5 ± 0.3	0.89	81%
$n_e^{ped\ (fit1)}$	1.24 ± 0.19	-0.34 ± 0.11	0.62 ± 0.14	0.08 ± 0.04	–	–	0.2 ± 0.2	0.80	78%
$n_e^{ped\ (fit2)}$	1.40 ± 0.18	-0.34 ± 0.11	0.57 ± 0.16	–	0.03 ± 0.03	–	0.2 ± 0.3	0.78	75%
$T_e^{ped\ (fit1)}$	0.00 ± 0.2	0.74 ± 0.12	-0.23 ± 0.15	-0.16 ± 0.05	–	–	0.3 ± 0.4	0.70	64%
$T_e^{ped\ (fit2)}$	-0.3 ± 0.2	0.77 ± 0.14	-0.15 ± 0.19	–	-0.11 ± 0.09	–	0.3 ± 0.4	0.61	69%
$T_e^{ped\ (fit3)}$	0.08 ± 0.19	0.44 ± 0.12	0.25 ± 0.16	–	–	-0.87 ± 0.17	0.5 ± 0.4	0.76	77%
$n_e^{sep\ (fit1)}$	1.1 ± 0.3	-0.43 ± 0.16	0.82 ± 0.27	0.23 ± 0.07	–	–	0.0 ± 0.3	0.64	58%

EXAMPLES: some physics results





- Investigate the role of physics parameters on pedestal performance
  - Correlation between pedestal pressure and separatrix density observed in JET
  - Physics mechanism under investigation

- Discrepancy between experimental data and ideal MHD
  - Several earlier have observed that in JET ELM can be triggered before the ideal PB stability is reached [Beurskens NF2014, Maggi NF2015…]
  - Clear role of the ”relative shift” has been identified thanks to the database

Present use of the database

These are only examples related to the JET version of pedestal database

- Scaling laws
  - provided JET specific pedestal scaling laws to the JET core modellers (F. Casson and co-workes)
  - provided JET-ILW scaling law to the DT scenario extrapolation task (Kim H.T. and co-workers)
- Pedestal predictions with NN for use in the ETS
  - Provided data to the Chalmers group. Work at a good stage and paper (I think) is in preparation. (P. Strand and co-workers)
  - Provided data for pedestal prediction with genetic algorithm (ENEA group)
- Link to SOL activities:
  - Provided data and support to the ER project of S. Wiesen
  - Provided data and support to the group of M. Groth
- Pedestal physics:
  - Validation of EPED on a large dataset (S. Saarelma)
  - Links between pedestal stability and SOL (L. Frassinetti)
- General support to JET activities:
  - Help the equilibrium task (D. Terranova and G. Szepesi)
  - Provided data for baseline and hybrids scenarios for pedestal performance comparison (M18-01 and M18-02)
  - Extract specific shots for comparison with new pulses (list too long)

Publications and wiki

- Publications where the EUROfusion pedestal databases were a key element:
  - L. Frassinetti, EPS2018
  - S. Saarelma, APS2018
  - F. Napoli, EPS2019
  - S. Saarelma, Phys. Plasmas 2019
  - L. Frassinetti, Nucl. Fusion 2021
  - B. Labit, IAEA2020

- Links to the wiki pages

  - List of variables and IMAS names (latest version, Jan 2019): https://iterphysicswiki.euro-fusion.org/images/5/59/Pedestal_db_variables_list_on_wiki.pdf

  - Selection rules and data quality rules: https://iterphysicswiki.euro-fusion.org/images/8/85/Data_validation_rules_25may2018.pdf

  - Information for the users of the JET version of the database: https://users.euro-fusion.org/tfwiki/index.php/T17-05_Pedestal_analysis_and_isotope_effect#EUROfusion_JET_pedestal_database_and_pedestal_scaling

Possible next steps (to be discussed)

- **JET**
  - Add data from Jan 2021
  - Check the HRTS validation and update the database (done once per year)
  - Extend the PB stability analysis (so far only till 2016)
  - Update the database on the gateway
- **TCV, AUG, MAST**
  - Finilize the IMAS part
  - Update the databases
  - Transfer the data to the gateway
- **Identify local staff in TCV, MAST and AUG**
  - I have proposed 2pm per year. Sufficient to cover the JET part and coordinate the work on the other machines.
  - Data processing is
    - time consuming (at least on JET)
    - machine dependent (for example, Matlab is common at TCV, while IDL at JET)
    - dependent on local TS diagnostics, data validation, shot selection
  - expert local staff is necessary.