METIS documentation for scalar parameters in expert mode

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1. Section: Composition

Parameters described in this section allow to tune the plasma composition, the behaviour of helium, impurities accumulation and presence or absence of tungsten

1.1. Sn_fraction

The purpose of this parameter is to allow study of liquid Sn divertor: if > 0, fraction of Sn in heavy impurities compostion: n_Sn = Sn_fraction * n_heavy; n_W = (1 -Sn_fractio) * n_heavy and n_heavy is identified to zerod.nwm and profile.nwp

1.2. W_effect

if = 1, take into account specific effect of Tungsten (as variation of the ionisation state in plasma).if used, SOL parameters must be adjusted (at least cw_factor and cw_offset);if Sn_fraction > 0, a tin fraction will be add to the tungsten.

1.3. acc_col

turn on or off collisionality dependance of factor in neoclassical formulation for tungsten accumulation or tunsten and tin if Sn_fraction > 0.

1.4. faccu

factor of accumulation for heavy impurity in the core plasma: 1) with W_effect = 0: works with zeff key values that allow profile effect (1,2,3,4 & 8); n_heavy = faccu * n_accumulation(x) + (1 - faccu) * r .* n_e(x); if = 0, no accumulation; if > 0, use d neoclassical simplified formula depending on density peaking and temperature peaking; if < 0, use d neoclassical simplified formula depending only on density peaking; 2) with W_effect = 1:a) if acc_col is off, factor in exponential exp(acc_inte * faccu);b) if acc_col is on, amplitude of turbulent transport added to neoclassical part with D_W = faccu * Chi_ion (thermal);if Sn_fraction > 0, a tin fraction will be add to the tungsten..

1.5. fne_acc

with W_effect = 1: exponent applied to the normalized electron density for the shape of tungsten density;n_W(x) = (C(SOL,divertor)+ cw_offset * ne_edge) * (n_e(x)/n_edge)^fne_acc * exp(acc_inte * faccu);if Sn_fraction > 0, a tin fraction will be add to the tungsten.

1.6. frhe0

ratio of residual helium, other than alpha from fusion DT

1.7. gaz (named gas in GUI)

1 -> H, 2 -> D , 3 -> D-T, 4 -> He, 5 -> D-He3 & 11 -> p-B11

1.8. gradient_Wacc

factor applied to gradients computation (2 points formula) in pedestal; used in W accumulation formula (value must be the same as ffit_ped)if = 0 use standard 3 points derivative

1.9. heat_acc

factor for the plasma heating decontamination (works with W_effect = 1 only): if > 0, electron heating tends to reduce impurity accumulation and ion heating tends to increase impurity accumulation in core plasma; reverse sign adds inverse effect.

1.10. natural_nD_o_nH

ratio between density deuterium and hydrogen for proton boron fusion (option.gaz ==11); remark: the default value in the natural concentration on Earth.

1.11. rimp

ratio between density of main impurity (n_zmax) and density of light impurity (n_zimp);has to be between 0 and 1

1.12. rot_acc

factor for the plasma rotation decontamination (works with W_effect = 1 only): if > 0, rotation tends to reduce impurity accumulation;otherwise if < 0,rotation tends to increase impurity accumulation; if = 0, no effect of rotation on impurity accumulation.

1.13. tauhemul

helium confinement time: tau_He_star = tauhemul * taue; if = 0 , use the scaling law;if < 0 take into account recycling of neutral in the divertor : tau_He_star = tauhemul * taue + Recycling / (1 - Recycling) * tau_p

1.14. zeff

Zeff: 0-> reference & flat,1 -> average given + profile effect, 2,3 & 4 -> scaling + profile effect for wall/divertor in C,Be or W; 5 -> Tore Supra scaling, 6-> Matthews scaling if not used for radiative power, 7 -> universal scaling law (J. G. Cordey rapport JET-P(85) 28), 8 -> universal scaling law + profile effect, 9 -> I. Erofeev scaling expressed in Greenwald fraction (for rampup)

1.15. zimp

charge number of light impurity (example: C, Be);if 0 chosen, the default value of 3 will be imposed

1.16. zmax

charge number of main impurity responsible for radiated power (example: O, Ar, Ne, Xe);if 0 chosen, the default value of 3 will be imposed;Zmax is used to constrained the max Zeff value possible (plasma of only Zmax ions will have Zeff = Zmax)

2. Section: Density

Parameters described in this section allow to control the plasma electron density behaviour and plasma electron density shape

2.1. Recycling

Global recycling coefficient used with neasser > 0; also used for recycling coefficient at divertor target in two points model, if Recycling_target parameter is equal to 0

2.2. ane

density peaking: (central density / volume average density) choice:0 -> f(nsat / nbar) in L-mode, where nsat is the saturation density (LOC/SOC) and f(n_Gr / nbar) in H-mode;1 -> flat profile;2 -> peaking factor function of li;3 -> peaking factor function of collisionality scaling law;4 -> fixed value given by parameter vane;5 -> proportional to Ti;10 -> C. Angioni formula 5 NF 2007 (depends on Greenwald fraction, NBI fuelling and R0);11 -> Angioni 2007 formula 5 in H mode and new fit scaling law from Lmode data base for L-mode;12 -> SPARC scaling similar to Angioni 2007 (J. Plasma Phys. (2020), vol. 86, 865860502) in H mode and new fit scaling law from Lmode data base for L-mode

2.3. ane_factor

multiplication factor applied to density peaking prediction for ane >= 10 (used to modulate scaling law prediction)

2.4. density_model

model used to identify density transport coefficients (post processing; have no impact on density profile)

2.5. eta_gas_puff

Gas puff fuelling efficiency (allows to use directly measurements from gas injection)

2.6. fn0a

cold neutral source: factor multiplying the core plasma source of neutral for limited plasma (allows to choose the fraction that goes directly in core plasma and in SOL)

2.7. fn0a_div

cold neutral source: factor multiplying the core plasma source of neutral for diverted plasma (allows to choose the fraction that goes directly in core plasma and in SOL)

2.8. fnbar_nat

multiplication factor applied to natural density scaling law

2.9. ftaup

factor multiplying particle confinement time (taup)

2.10. natural

natural density: if = 1, impose density to be higher than natural density;if = 2, impose natural density instead of nbar reference

2.11. ne_free

number of parameters to define density profile in H mode (with pedestal, but depending on value of parameter ne_shape):if = 3, central density, edge density and peaking factor;if = 4,central density, edge density, peaking factor and pedestal density;if=0, TEP model: formule 6.5 in Phd of Alexey Zabolotskiy p 121, up to the top of the pedestal

2.12. ne_shape

method used to compute density profile shape: Auto -> depending of L or H mode; Hmode -> force Hmode shape also in Lmode; Lmode -> force Lmode shape also in Hmode

2.13. nea_factor

edge density: multiplication factor applied to edge density scaling law:if > 0, ne_edge = nea_factor * LCFS_denstity_scaling_law;if < 0,   ne_edge =   abs(nea_factor) * n_bar

2.14. nea_model

LCFS density model for H-mode diverted plasma: Mahdavi model (default) orEich model based on critical density limit due to ballooning mode;fixed ratio: min(n_Greenwald,n_bar)/3

2.15. neasser

ODE for density evolution: if = 0: zs.nbar = cons.nbar (no ODE solved);if = 1: density controlled by gas puff with reference cons.nbar using electron density confinment times; if = 2, as 1 and density limited to prevent disruption

2.16. neped_expo

density at pedestal top: exponent in scaling law for pedestal density:ne_ped = ne_a * (ne_a / ne_Gr)^neped_expo

2.17. vane

if ane = 4, value of density peaking factor

3. Section: Pellet

Parameters described in this section allow to switch on or off pellet injection, to prescribed the amount of fuelling due to pellet and to tune the pellet deposition profile

3.1. fpolarized

effective fraction of material in pellet that is polarized and then enhance fusion reactivity by a factor 1.5 (reference: L. Baylor N.F. 2023 https://doi.org/10.1088/1741-4326/acc3ae)

3.2. pif

fraction of fuelling due to pellet injection; if = 1, automatic detection of pellet injection (detection of peaks in nbar waveform)

3.3. piw

width of pellet deposition profile (gaussian); if = 0, NGS model is used to compute the shape of deposition

3.4. pix

position of maximum of pellet deposition profile

4. Section: Confinement & Transport

Parameters described in this section allow to tune the model for core and pedestal confinment and to choose the sphape of transport coefficients

4.1. HH_delta

if # 0, add triangularity effect on energy confinement: W = ((1+delta)/(1+delta0)) ^ HH_delta * W_scaling,where delta0 is the neutral triangularity (delta0 = 0.35) and recommended value for HH_delta = -0.35(https://doi.org/10.1088/0029-5515/39/11y/321);remark: delta = z0dinput.geo.d

4.2. HH_gas_puff

if > 0, energy confinement reduction with gas puff fuelling: W = (1 -tanh(HH_gas_puff .* P_ioniz ./ P_in)) * W_scaling

4.3. HH_li

if > 0, li variation effect on plasma energy content W = (li/HH_li) ^ (2/3) * W_scaling

4.4. adiabatic

if = 0, turn off adiabatic compression term in the ODE for energy content evolution; if = 1, turn on adiabatic compression term in the ODE for energy content evolution; this term is generally negligible but not during breakdown, fast build-up of plasma volume or disruption; Warning:this term can add some numerical noise in simulation

4.5. coef_shape

Shape of transport coefficient (Kappa) when kishape = 0:1/ Bohm-gyroBohm = Bohm-gyro Bohm shape,2/ CDBM model = CDBM model shape,3/ Stiff model associated to Stiff confinment,4/ Alpha is associated with model where transport is provided by limitation of pressure gradient due to ballooning limit from s-alpah diagram,5/ Stiff_limited correspond to the stiff model limited by the alpha limit;Remarks:1/ in stiff and aplha case, parameter xieorkie is ignored2/ if +neo, then neoclasical transport coeficient for ions, computed with Hinton model, is added turbulent tranport model (both to electron and ion channel).

4.6. dilution

dilution effect on energy confinement:if = 0, no dilution effect;if = 1, take into account the ions density dilution on plasma energy contents (W_new = (1 + ni/ne) * W_scaling)

4.7. disrup

Radiative limit induced disruption:if = 0, no effect on energy confinement time when radiative power exceed input power;if = 1, reduction of confinement time at time slices where radiative power exceed input power;if = 2, reduction of confinement time since first time where radiative power exceed input power;must be used with parameter ploss_exp set to max_power or to max(pel)+max(pion);if = 3, reduce confiment accordingly to fraction of volume where enegy flux become negative.

4.8. exp_shape

if = 1, when external Te and Ti are provided, keep only the shape and rescale Te and Ti to get W_th computed in METIS

4.9. extended_qei

if = on, the collisional heat exchange term between eletrons and ions is computedwith the formula including relastivistic correction and large T_i/T_e effect.reference: Modification of classical Spitzer ionelectron energy transfer ratefor large ratios of ion to electron temperatures, T.H. Rider and P.J. Catto,Phys. Plasmas 2, 18731885 (1995), https://doi.org/10.1063/1.871274

4.10. fpped

if > 0, pedestal pressure multiplier (pressure deduced from scaling law); if = 0, switch off limitation of pedestal pressure due to MHD and experimental limit; if < 0, stiff model is activated (in this case, pedestal pressure multiplier is abs(fpped))

4.11. fprad

fraction of line radiative power (core plasma) substracted from input power to compute Ploss (Ploss = Pin - fprad * Pline)

4.12. fstiff

stiff transport model: when stiff model is activated (fpped < 0),abs(fstiff) gives the temperature gradient in the core in eV per electron banana width; default value = 1; if fstiff<0, use ftrap*rho_banana+(1-ftrap)*rho_larmor instead of rho_banana; if "alpha" or "alpha+neo" shape is selected, then it becomes the multiplication factor of pressure gradient provided by the s_alpha limit formula.

4.13. grad_ped

method to compute the pressure gradient at the top of pedestal:if = 0, use the method that does not take into account the discontinuity in gradient;if = 1, take into account the discontinuity in gradient; if = 2, improved integration method for equation is used; if = 3, improved integration method for equation is used and no limitation in flux;

4.14. hmore_pped

if = 0, no effect;if = 1, pedestal pressure is multiplied by the H factor waveform: pped_use = H_factor * pped_predicted;if = 2, pedestal pressure is multiplied by the H factor waveform when H factor is less than 1: pped_use = min(1,H_factor) * pped_predicted;if = 3, pedestal pressure is multiplied by the H factor waveform when H factor is greater than 1: pped_use = max(1,H_factor) * pped_predicted;if = 4, as option 1, but maximum pedestal pressure is not affected by fpped;if = 5, as option 2, but maximum pedestal pressure is not affected by fpped;if = 6, as option 0, but maximum pedestal pressure is not affected by fpped

4.15. hollow

if = 0, does not allow hollow temperature profiles; if = 1, allows hollow temperature profiles; hollow profiles may exist in presence of heavy impurities (i.e W or Mo) accumulation in core plasma.

4.16. isotope_stiff

if stiff transport is activated and fstiff < 0, isotope_stiff is the exponent of masse dependance on ITG part (fraction of trapped particules): confinement time is proportional to (meff/2)^isotope_stiff.

4.17. ki_expo

if > 0, exponent of Kappa shape fonction;if < 0, the shape is Kappa = C*(x-2 / 3*x^2+abs(ki_expo) / x / 30+kishape*x^20); in this case ki_expo controls the centre and kishape controls the edge;this gives a rather linear temperature profile in the gradient zone

4.18. kishape

radial shape of heat tranport cofficient:if > 0, Kappa = C (1 + kishape * x ^ ki_expo);if = 0, Kappa = C * model_based_shape (see coef_shape);if < 0 , Kappa = q^abs(kishape)

4.19. ode_pped

if = 0, no effect;if = 1, pressure at the top of pedestal evolves in time with pedestal confinement time:d(3/2*Vp*Pped)/dt = - (3/2*Vp*Pped)/ tau_ped + Power_LCFS with tau_ped = W_ped_steady_state / Power_LCFS

4.20. ploss_exp

method used to compute ploss :if = with_prad, radiative power is subtracted from input power (pin), including brem, cyclo and fraction (fprad) of line radiation; if = no_prad, ploss = pin; if = max_power, ploss is the maximum of volume integrated total source power (Qe + Qi) as a function of radial position;if = max(pel)+max(pion), ploss is the maximum of volume integrated electron source power Qe + the maximum of volume integrated ion source power Qi

4.21. scaling

choice of scaling law for energy confinement time:0 = ITERL-96P(th) + ITERH-98P(y,2);1 = Ohmic (to be used for startup phase);2 = ITPA 2 terms;3 = DS03 (no beta dependence); 4 = adjusted to match experimental value of Wdia;5 = scaling ITER EIV,Std;6 = Ohmic scaling in Tokamak Wesson;7 = ITERH-98P(y,2)/2 L-mode + ITERH-98P(y,2) H-mode;8 = user defined scaling (as matlab function);9 =   J. Garcia PRL J_pol = 0 (for hybrid scenario);10 = Sauter & Martin in H-mode + quasi analytical in L-mode;11 = Sauter & Martin in H-mode + Elbeze EIV 2005 L-mode;12 = same as 11 with limitation on beta_N for burning plasma with high radiative fraction;13 = reserved;14 = Robust scaling H1 and L1 (A.Murari, NF 57,2017,120617); must be used with ploss_exp= 'no_prad';15 = Robust scaling H1 and L1 (A.Murari, NF 57,2017,120617) with limitation on beta_N; must be used with ploss_exp= 'no_prad';16 = ITER89-P + ITERH-98P(y,2);17 = ITER89-P in Lmode and ITER89-P + Cordey tau_pedestal in H mode;18 = ITER89-P in L-mode and Petty 2008 gyroBohm scaling in H-mode19 = ITER89-P in L-mode and   ITER89-P   + W_ped scaling incorporating experimental data and prediction from MHD code for ITER and DEMO20 = must not be used (preprint version of ITPA20);21= ITPA20 scaling for ITER 2020 with triangularity dependance

4.22. tau_limitation

SOC / LOC transition:if = Off, no limitation of confinement time;if = On, the confinement time is the minimum of confinement time given by Neo-Alcator scaling and L-mode scaling law (useful for ramp up or at low density);if = Saturate, the confinement time is the minimum of confinement time given by SOC / LOC transition point and L-mode scaling law

4.23. te_max

Maximum allowed internal electron temperature (and ion temperature) in METIS solver (in eV).The default value is 1e5 eV corresponding to the maximum tabulated temperature for thermal cross section and radiative cooling rate.The upper limit allowed by this parameter is set just below the energy threshold for pair prodcution.This limit should be increase for some aneutronic fusion reaction and accordingly models for cross section, radiative cooling rate,relativist bremsstrahlung and enhanced collisional heat exchange between eletrons and ions should be selected

4.24. usepped_scl

if = 0, pedestal energy content is the difference between H-mode and L-mode energy content or half of this difference (see scaling options); if = 1, tau_ped scaling law (ITPA McDonald) is used to compute Pped (does not work with stiff model);if = 2, minimum between standard rule (Pped = K (W_Hmode - W_Lmode) and scaling law prediction is used;if = 3, P_ped scaling incorporating experimental data and prediction from MHD code for ITER and DEMO is usedif = 4, minimum between standard rule (Pped = K (W_Hmode -

W_Lmode) and scaling incorporating prediction from MHD code for ITER and DEMO is usedif = 5, use model from reference F.D. Halpern et al, PoP 15 (2008) p 062505

4.25. xieorkie

if = 0, radial shape of heat tranport cofficient is Kappa;if = 1, instead of given Kappa shape, Chi shape is fixed (Kappa ~ Ne * Chi)

4.26. xiioxie

ratio Xii over Xie (more precisely: (ni*Xii) / (ne*Xie)); if = 0 -> compute from ITG / TEM stability diagram; if > 0, assigned value of xii // xie; if < 0 , xii // xie is computed using the critical gradient model in which the stiffness parameter is given by xiioxie; in this case the theoretical value is 4.5

4.27. xiioxie_ped

ratio Xii over Xie for edge an pedestal (more precisely: (ni*Xii_ped) / (ne*Xie_ped)); if = 0,the value for the core plasma is used (xiioxie)

5. Section: H mode transition

Parameters described in this section allow to manage the transition from L-mode to H-mode and the back transition from H-mode to L-mode

5.1. fpl2h_lim

factor applied to L-> H scaling power threshold in limiter configuration

5.2. hysteresis

Control of histeresis for the back transition H-> L mode:P_H->L = hysteresis * P_in + (1 - hysteresis) * P_lh,thr

5.3. l2hmul (named L-H offset in GUI)

offset added to the threshold power for the transition L-> H (MW)

5.4. l2hscaling

L to H power threshold scaling law:if = 0   -> LH99(1);if = 1   -> LH2002;if = 2   -> LH2002 + Zeff;if = 3   -> YR Martin 2008;if = 4   -> NLM-7 Murari 2012;if = 5   -> NLM-11 Murari 2012;if = 6   -> Jpol change of sign in edge region (E. R. Solano rule);if = 10 -> Multimachine scaling law from Murari 2013 (BUEMS);if = 28 -> Low density case - Ryter et al, NF 54 (2014) 083003, equation 4if = 30 -> Fit of metalic tokamaks database for horizontal targets (E . Delabie et al, 2025 ?);if = 31 -> Fit of metalic tokamaks database for vertical targets and corner configuration (E . Delabie et al, 2025 ?);if < 0, criterion based on plasma rotation (abs(l2hscaling) = value of Gamma_ExB / Gamma_ITG for transition)

5.5. l2hslope

slope of linear transition between tau_L and tau_H controlled by difference between conducted and threshold power; if = 0, on / off transition;if < 0 , additionally decrease of confinement when density is close to Greenwald limit

5.6. modeh

L-Mode to H-mode allowed transition:0 -> force L-mode;1-> L-Mode to H-mode transition allowed;2 -> force H-mode

5.7. pl2h_mass_charge

L to H transition:if = 0, scaling law as defined by l2hscaling;if = 1, adds dependences on mass and charge of main ion (R. Behn et all, PPCF 2015)

5.8. plhthr

Power compared to scaling for L to H transition, either:Ploss as defined for scaling law (pel + pion - fraction of prad);twice ion power (2*pion);power conducted to LCFS without dWdt term(P_LCFS);power conducted to LCFS with dWdt term(P_LCFS_dwdt)

5.9. toff_modeh

if it is defined, end time for the H mode phase: mode H phase cannot continue latter than toff_modeh(undefined value = Inf; mode H state between ton_modeh and toff_modeh is controlled by the parameter modeh)

5.10. ton_modeh

if it is defined, start time for the H mode phase: transition to mode H cannot start earlier than ton_modeh;(undefined value = Inf; mode H state between ton_modeh and toff_modeh is controlled by the parameter modeh)

6. Section: Rotation

Parameters described in this section allow to tune the model for toroidal rotation (confiment time and intrinsic rotation) and to select the mode for poloidal rotation

6.1. fintrinsic

multiplication factor applied to intrinsic rotation scaling.The constant in the scaling in not determined; Suggested value with Rice scaling is between 0.15-0.25; Suggested value with deGrassie scaling is about 1; if = 0,a factor depending on collisionality is used, computed from J. C. Hillesheim et al, arxiv:1407.2121v1 physics.plasma-ph 8 Jul 2014

6.2. impur_rot

toroidal rotation, choice of impurity for rotation data output: imp = light impurity (charge zimp); max = impurity for radiation (charge zmax)

6.3. mode_vtheta

poloidal rotation - selection of the method used to compute poloidal rotation:'Neoclassical V_pol' = use neoclassical formulation from ref: Y. B. Kim et all, Phys. Fluids. B 3 (8) 1991 p 2050- 'same v_tor' = assume all species have the same toroidal rotation

6.4. omega_shape

shape of rotation profile: if = 0, proportional to Ti;if = 1, given by scaling law from H. Weisen et al paper (NF 52 2012 p 042001);if = 2, proportionnal to Pion;if = 3, proportional to Ptot;if = 4, proportional to n_ion;if = 5, proportional local value of deGrassie scaling;if = 6, interpolation between Ti shape and deGrassie shape depending of relative weight of NBI source on rotation compared to intrinsic rotation

6.5. rot_jr_loss

Toroidal rotation:if = on, take into account forces due to backward current generated to compensate for for radial current induced by particles losses (fast and thermal);if = off, this effect is not included in the toroidal rotation computation

6.6. rotation_scl

intrinsic rotation scaling: switch between differents scaling for spontaneous (intrinsic) rotation

6.7. solid_rotation

In radial electric field computation: if = 1, assume plasma solid rotation; i.e. neglect term in poloidal rotation;if = 0, take into account term   in poloidal rotation (main ion contribution from Kim model); if = -1, take into account term in poloidal rotation (simplified formulation with k_neo * grad(T) / eB formulation for each species); if = -2,take into account term in poloidal rotation (simplified formulation with k_neo * grad(T) / eB formulation for each species) and additionnal term for poloidal rotation induced by NBI

6.8. taurotmul

toroidal rotation momentum confinement time: multiplication factor applied to energy confinement time to obtain toroidal rotation momentum confinement time (tau_rotation = taurotmul * taue); if = 0, toroidal rotation momentum confinement time = ion heat confinement time

7. Section: MHD & ITB

Parameters described in this section allow to tune the model for sawteeth, for ITB threshold and for MHD beta limit

7.1. alpha_channeling

factor of enhancement of ion heating due to alpha channeling:if = 0, no effect; if = 1, all power goes to ions

7.2. betap1crit

critical betap for sawtooth triggering: if = 0, use criterium on q_st,otherwise trigger a ST when magnetic betap1 @ q=1 is above betap1crit;q_st must be < 0 to activate this mechanism (Jardin PoP 2020)

7.3. ddsmode (named q_st_mode in GUI)

Sawthooth reconnection:0 = simple clamping;1 = Porcelli;2 = Kadomtsev;3 = partial Kadomtsev

7.4. dwow_elm

ELMs model: if > 0, fraction of pedestal energy losses during one ELM (crash is triggered when pped exceeds ppedmax value);if = 0, no ELM (default mode); if = 1, use MHD limit for threshold and energy scaling for energy content after crash; if < 0, use scaling law f(nustar) * abs(dwow_elm)

7.5. epsq

Sawtooth reconnection: slope of q inside mixing radius (Porcelli PPCF 1996)

7.6. itb_density

ITB control: sensitivity for the barrier on density with NBI [1]

7.7. itb_sensitivity

ITB control: sensitivity for the creation of the barrier [1]

7.8. itb_slope_max

ITB control: controls the maximum pressure gradient inside barrier [2];larger value gives lager gradient

7.9. kidds (named Chi_st in GUI)

Sawtooth model: transport multiplicator inside q <= q_st flux surface

7.10. peeling

ELMs type:if = 0, ballooning limit only;if = 1, ballooning and peeling limits;if = 2, peeling limit only (use as peeling limit the proxy <j>_top_pedestal > (Ip / Splasma))

7.11. q0_dds_trig

value of q0 triggering a sawtooth independently of others conditions (with qdds < 0)

7.12. qdds (named q_st in GUI)

Sawtooth model:if > 0,time averaged effect with clamping of safety factor at q_st value inside q_st radius;if = 0, no effect;if < 0, time resolved sawteeth, triggered when q0 <= abs(q_st)

7.13. s1crit

critical shear for sawtooth triggering: if = 0, use criterium on q_st,otherwise trigger a ST when magnetic shear @ q=1 is above s1crit;q_st must be < 0 to activate this mechanism (Porcelli PPCF 1996)

7.14. sitb

ITB control:if = 0, no ITB;if = 1, allow ITB with null or negative magnetic shear;if = 2, same as 1 + rotation effect on ITB; if = 3, same as 2 + MHD rational q effect

7.15. smhd

threshold for ideal no wall limit: if > 0, decreases confinement time when beta_N exceeds limit smhd (in percent);if = 100, no MHD limit;if = 0, threshold at 4*li;if < 0, threshold at abs(smhd)*li

7.16. tae

TAE control: if = 0 no TAE;if = 1, take into account TAE effect in alpha fusion power losses (decrease fast alpha pressure gradient)

7.17. tau_elm_factor

ELMs model: factor between turbulent tranport and neoclassical transport in pedestal;i.e. multiplicator of energy confinement time used to obtain effective confinement time in H-mode between ELMs crashes (taue_etb = tau_elm_factor * taue)

7.18. tmhd

threshold for ideal no wall limit: first time ideal no wall limit allowed (s)

7.19. w1

Sawtooth reconnection: width of null magnetic shear zone in unit of psistar(q=1) [0.1,1] 0.5 (Porcelli PPCF 1996)

8. Section: Current diffusion & Equilibrium

Parameters described in this section allow to change boundary condition for current diffusion equation, choose parameters for equilibrium and turn on or off model for runaway electrons

8.1. Kappa_xpoint

if LCFS is defined by moments, and option.configuration = 2 or 3, value of elongation above which x-point is set if triangularity if sufficient (see delta_xpoint) andplasma width is sufficient (see R_HFS_xpoint and R_LFS_xpoint); if = 0, this is not taken into account

8.2. R_HFS_xpoint

if LCFS is defined by moments, and option.configuration = 2 or 3, value of minimum LCFS radius above which x-point is set if condition on LFS radius is met and if shapping is sufficient (see Kappa_xpoint and delta_xpoint); if = 0, this is not taken into account

8.3. R_LFS_xpoint

if LCFS is defined by moments, and option.configuration = 2 or 3, value of maximum LCFS radius under which x-point is set if condition on HFS radius is met and if shapping is sufficient (see Kappa_xpoint and delta_xpoint); if = 0, this is not taken into account

8.4. cor_rel_spitzer

if = on, applied relativistic correction to Spitzer resistivity, and by extension to the neoclassic resistivity, even if the computation for neoclassic transport is not available

8.5. cronos_regul (named q(0) regularisation in GUI)

method used to compute q(0); q(0) is constrained to be above 0.5:if = 0, use simple extrapolation (metis default);if = 1, use analytic formula (cronos default);if = 2, average of two previous formulas;if = 3, remove limitation to be above 0.5 and extrapolate q(0) imposing null second derivative on magnetic axis (for use with time resolved sawtooth model);if = 4, minimal modification using physical assumptions;if = 5, change in poloidal flux near magnetic axis in order to use all formulas whitout extrapolation

8.6. delta_xpoint

if LCFS is defined by moments, and option.configuration = 2 or 3, value of triangularity above (id >0) or under (if < 0) which x-point is set if elongation if sufficient (see Kappa_xpoint) andplasma width is sufficient (see R_HFS_xpoint and R_LFS_xpoint); if = 0, this is not taken into account

8.7. equi_ppar

equilibrium solver: input pressure for Grad Shafranov equation:if = 0, perpendicular or isotropic pressure;if = 1, parallel pressure;if = 2, total pressure;if = 3, parallel pressure + rotational energy

8.8. laochange

Current diffusion coordinate:if = 0,current diffusion equation is solved using Lao coordinate (r/a);if = 1, current diffusion equation is solved using flux coordinate (rho)

8.9. mode_expo_inte

Current diffusion, numerical method:if = 0,poloidal flux diffusion equation is solved using Crank-Nicholson method;if = 1, poloidal flux diffusion equation is solved using exponential integrator method

8.10. moments_mode

Choice of formula for moments (elongation K(x) and triangularity d(x) profiles) computation in equlibrium:if =0, leading order (K is constant and d is lineary decresing from LCFS to magnetic axis);if =1, solves ODE for K(x) and d(x) (small inverse aspect ratio approximation)

8.11. morphing

2D equilibrium shape: exponent of morphing curve for the matching of LCFS(when LCFS is given by points, not used if LCFS is defined only by moments)

8.12. protect_sepa_z0

Allowing to vertically recenter LCFS given by point. LCFS must be centered in METIS; the vertical position is given by geo.z0. Possible choices are:none = no correction;mimax = z0 iscomputed as (max(Z)+min(Z))/2;rmax = z0 is the value of Z where R is maximum on LCFS

8.13. refined_ptot

method for computing suprathermal pressure profile:if = 0, suprathermal pressure profile is proportional to thermal profile pressure;if = 1, suprathermal pressure profile is the sum of profiles computed from suprathermal energy content (0D) taking the shape of source deposition (1D).

8.14. runaway

runaway current model:if = 0, no runaway current;if = 1, runaways appear if electric field is above critical field limit;if = 2, model for runaway including LH waves effect;if = 3, include model for LH and delay for runaway acceleration;if = 4, as 3 profiles (Te, Ne, Zeff) instead of averaged quantities;if = 5, as 4 with additional collisions with neutrals (dedicated to breakdown studies)

8.15. short_dt

Anti aliasing filter: if = on, switch on antialiasig filter to reduce numerical noise with short time step, applied to elected fields;if = full, switch on antialiasig filter to reduce numerical noise with short time step, applied on every fields;if = off, no filtering is applied

8.16. signe (named sign in GUI)

sign of toroidal field projected on plasma current direction

8.17. tswitch

Current diffusion, boundary condition: time at which switching from Ip reference to poloidal flux reference (or vref) is allowed (s) (used only with option.vloop > 0, inactive in evolution mode)

8.18. vloop

Current diffusion, boundary condition:if = 0, Ip waveform given;if = 1, vloop = 0 as reference, Ip free;if = 2, vloop = vref, Ip free;if = 3, PLH is computed to follow Ip waveform @ vloop = 0; if = 4, poloidal edge flux given by flux waveform;if = 5, hybrid boundary condition for the coupling with FREEBIE;if = 6, P_NBI is computed to follow Ip waveform @ vloop = 0

8.19. vref

Current diffusion, boundary condition: reference value for Vloop;Switch from Ip reference to poloidal flux reference when Vloop <= vref

9. Section: Bootstrap

Parameters described in this section allow to select the model used to compute boostrap current for core plasma, pedestal and fast ions

9.1. bootmul

multiplication factor applied to bootstrap current

9.2. f_eta_turb

if ~= 0, adding (if >0) or sustracting (if < 0) turbulent resistivity computed from reference: L.Colas 1993 Nucl. Fus. 33 156.f_eta_turb is a multiplicative factor and D_tild = electron heat diffusivity; It is generally assumed that turbulence decrease resistivity in a tokamak.

9.3. ffit_ped

bootstrap current model: multiplication factor applied to gradients computation in pedestalif = 0 use standard 3 points derivative

9.4. force_spitzer

if = 1, replace neoclassical resistivity by Spitzer formula where Z = Zeff (use equation 18 of Sauter PoP 1999)

9.5. fspot

multiplication factor applied to bootstrap like current due to fast alpha particles (0.05 - 0.15; must be computed with the help of SPOT or other MC codes)

9.6. modeboot (named model in GUI)

bootstrap current model:if = 0, scaling law G. T. HOANG;if = 1, Sauter formula;if = 2, Sauter formula + asymmetric current;if = 3, Hager & Chang modified Sauter formula;if = 4, Hager & Chang modified Sauter formula + asymmetric current;if = 5, NEO fit (A; Redl et al, PoP 2021);if = 6, NEO fit (A; Redl et al, PoP 2021) + asymmetric current

9.7. neutral_friction

if > 0, add neutral friction effect on resistivity (V. A. Belyakov et al , PhysCon 2003 Saint Petersburg Russia (IEEE)); neutral_friction is a mutiplicator factor applied to the formula;This effect is already taken into account if breakdown model is switch on:in this case if neutral_friction = 0, the factor 1 is used.

10. Section: Breakdown and burn-through

Parameters described in this section allow to turn on or off model describing breakdown and burn-through and to tune physical quantities as prefill pressure,passive structure parameters, ect ...

10.1. B_eddy

multiplication factor of error magnetic field created by eddy current (B_RorZ = B_eddy * mu0 * I_eddy / R / pi)

10.2. C_eddy

fraction of eddy current that is removed from plasma current waveform (I_p = I_p_ref - C_eddy * I_eddy)

10.3. I_eddy

Initial eddy current:if = 0, set inital eddy current to 0;if = 1, take the maximum between breakdown voltage divided by R_eddy, and initial plasma current waveform as inital eddy current;if = -1, take minus the maximum between breakdown voltage divided by R_eddy, and initial plasma current waveform as inital eddy current

10.4. L_eddy

characteristic inductance value of passive structure that can carry current during breakdown (H);if = 0, use typical value taking into account major radius of the plasma

10.5. PSI_eddy

multiplication factor of pertubation due to eddy current on poloidal flux waveform (Flux = Flux_ref - PSI_eddy * I_eddy)

10.6. R_eddy

characteristic resistance value of passive structure that can carry current during breakdown (Ohm);if = 0, use typical value taking into account major radius of the plasma

10.7. VV_volume

vacuum vessel volume; if = 0, the maximum plasma volume defined by LCFS is used (m^3)

10.8. berror

residual magnetic field at breakdown time (T);if = 0, computation taue_breakdown is desactivated

10.9. breakdown (named initial Vloop in GUI)

Value of Vloop at the first time step:if > 0, electric field at the breakdown time normalised to the Dreicer electric field;if < 0, initial Vloop in Volt per turn

10.10. initiation_only

if = 1, stay in initiation mode for the whole simulation

10.11. li (named initial li in GUI)

value of normalised internal inductance at the first time (used to compute initial current profile)

10.12. p_prefill

prefill pressure (Pa, 1 Torr = 133.3 Pa)

10.13. temp_vac

temperature of vacuum vessel and cold neutrals (K)

11. Section: Radiation

Parameters described in this section allow to select model for line radiation and tune parameters for radition sources

11.1. cor_rel_brem

if = improved, use improved formula for Bremsstrahlung relativistic correction

11.2. frad

multiplication factor for line radiative power

11.3. fte_edge

multiplication factor applied to LCFS temperature (for studies of egde radiation and poloidal flux comsumption)

11.4. gaunt

Gaunt factor:if = 0, use fixed Gaunt factor (1.1027);if = 1, compute Gaunt factor depending on Te and main ion Z for bremsstrahlung

11.5. matthews (named line radiation model in GUI)

line radiation model:if = 1, line radiative power (Pline) is normalised to Matthews scaling law;if = 2, Pline is normalised to Rapp scaling law;if = 0, Pline is given by cooling rate formulation (coronal equilibrium) for the core plasma. Difference between Matthews scaling and cooling rate formulation is used for SOL + Divertor radiative power;if = -1, same as 0 but use improved computation for radiative mantle

11.6. noncoronal

non coronal radiative power:if = -1, use non coronal equilibrium (only available for He, Li, Be, C, O, N, Ne, Ar);if = 0, use coronal equilibrium;if = 1, use a simplified model for non coronal radiative power computation;if > 1 , use a simplified model for non coronal radiative power computation in divertor only;if = 2,   full effect; if = 3, half effect; if = 4, 0.2 * full effect;if = 5, 0.1 * full effect

11.7. rw

wall reflection coefficient of the cyclotron radiation; if < 0, use LATF model instead of Albajar scaling

11.8. te_edge_fixed

if > 0, force the value of LCFS electron temperature to te_edge_fixed (eV) whatever is other settings (if Te profile is provided as a external data, LCFS electron temperature is read from the profile. A upper limiting rule is also applied to keep max(Te(x)) > Te_a)

11.9. z_prad

Charge number used in scaling formula: zmax (original version), zimp or Z_Stangeby = formula defined in Stangeby book

12. Section: SOL

Parameters described in this section allow to select model for SOL and divertor and tune physical associated parameters

12.1. Recycling_target

Recycling coefficient at divertor target; if = 0, the recycling coefficient at divertor target is the global recycling coefficient

12.2. Sq

two points model: if >= 0, parallel heat flux spreading due to turbulence (mm);if = -1, use scalings from A. Scarabosio paper (Journal of Nuclear Materials 463 (2015) 49-54)

12.3. alpha_e

two points model: multiplication factor applied to parallel heat flux in formula for the kinetic effect correction to fluid formulation

12.4. carbonblow

two points model - carbon density enhancement in divertor due to sputtering:if> 0, the density of carbon in divertor is increased proportionally to physical sputtering * carbonblow;if <0, the density of carbon in divertor is increased proportionally to total sputtering (physical + chemical + ...) * abs(carbonblow)

12.5. configuration

PFC configuration:if = 0,poloidal limiter in L and H mode;if = 1, toroidal limiter in L and H mode;if = 2, poloidal limiter or divertor depending on LCFS shape (X point automatic detection);if = 3, toroidal limiter or divertor depending on LCFS shape (X point automatic detection);if = 4, divertor in both L and H mode

12.6. cw_ecrh

Tungsten density: tungsten concentration due to sources linked with ECRH, expressed in concentration relative to electron density (<nw_ecrh> / <n_e> per MW of ECRH); if Sn_fraction > 0, applied to W + Sn.

12.7. cw_factor

Tungsten density: abs(cw_factor) = multiplication factor applied to the source of tungsten,used to compute tungsten density profile in core plasma;if > 0, no redeposition of tungsten on target;if < 0 uses a simple prompt redeposition model on target; if Sn_fraction

> 0, applied to W + Sn.

12.8. cw_icrh

Tungsten density: tungsten concentration due to sources linked with ICRH, expressed in concentration relative to electron density (<nw_ecrh> / <n_e> per MW of ICRH); if Sn_fraction > 0, applied to W + Sn.

12.9. cw_lhcd

Tungsten density: tungsten concentration due to sources linked with LHCD, expressed in concentration relative to electron density (<nw_ecrh> / <n_e> per MW of LHCD); if Sn_fraction > 0, applied to W + Sn.

12.10. cw_nbi1

Tungsten density: tungsten concentration due to sources linked with first NBI, expressed in concentration relative to electron density (<nw_ecrh> / <n_e> per MW of NBI); if Sn_fraction > 0, applied to W + Sn.

12.11. cw_nbi2

Tungsten density: tungsten concentration due to sources linked with second NBI, expressed in concentration relative to electron density (<nw_ecrh> / <n_e> per MW of NBI); if Sn_fraction > 0, applied to W + Sn.

12.12. cw_offset

Tungsten density: tungsten concentration due to sources other than divertor targets and auxiliary heating system, expressed in concentration relative to electron density (<nw_residual> / <n_e>); if Sn_fraction > 0, applied to W + Sn.

12.13. cx_ion

if = 1, take into account power loss by ions due to charge exchange with neutrals

12.14. de

two points model: secondary electron emission coefficient

12.15. detach

if > 0 switch on additional term for detachement from Apiwat/Pegourie model. In this case the value of parameter detach gives the exponent of the model (original model use the value of 1)

12.16. eioniz

average ionisation energy per atom;if = 0, tabulated value dependent on Te and ne is used

12.17. fR_target

two points model: multiplication factor that gives the target radius as R_target = abs(fR_target) * R0;if < 0, the radial position of the target is taken into account in two point model (model from T.W. Petrie et al, Nuc. Fus. 53 (2013) 113024)

12.18. factor_scale

multiplication factor applied to the SOL width when it is defined by a scaling law, for H mode only (Dsol_Hmode = factor_scale * Goldston scaling)

12.19. fcond

two points model: fraction of conductive // power versus convective+conductive;if > 0, without kinetic correction;if < 0, with kinetic correction

12.20. fmom

two points model: fmom * (1 + Tiu/Teu);fmom = factor to take into account momentum loss by ions (friction on neutrals, ...);Tiu = LCFS Ti; Teu = LCFS Te;if fmom = 0, uses the simple model based on the balance between charge exchange and ionisation rate at the target (used for detachment studies)

12.21. fnesol

interpolation factor to compute average density in SOL along magnetic field line:(used for SOL radiative power computation)ne_sol = (1 -fnesol) * ne_LCFS + fnesol * ne_target

12.22. fpower

two points model: fraction of power crossing the LCFS that goes to the target (only one target is considered in two points model, generally the outer one)

12.23. ftwleak

Tungsten density - interpolation factor used to compute W leakage from target to LCFS: Tleak=(abs(ftwleak)*Zw(Te_LCFS)+(1-abs(ftwleak))*Zw(Te_plate))*sqrt(ne*S);if > 0, fw_leak = exp(-(Tleak /Tplate)^2); if < 0, fw_leak = fit_DIVIMP(Tleak /Tplate).; if Sn_fraction > 0, applied to W + Sn using the averaged charge weighted by Sn_fraction

12.24. fzmax_div

two points model: fraction (in percent) of radiative impurity, associated to charge zmax, in divertor;controls the radiative fraction in divertor;if > 0, the minimal temperature in the radiative power integral along field line is 0, as in original model(R. Clark et al, Journal of Nuclear Materials 1995); if < 0, the fraction is abs(fzmax_div) and the minimal temperature in integral is te_lim

12.25. imp_div

two points model:if = 'auto', compute radiative impurity (zmax) concentration from core concentration and leakage from divertor; otherwise use parameter fzmax_div to fixe divertor concentration enrichment in radiative impurity

12.26. lambda_scale

scaling used for SOL width:if = 0, uses fraction of a or R (see sol_lscale);if = 1, uses Goldston model (gives similar result to Eich scaling);if = 2,   uses Goldston model in H-mode diverted plasma, otherwise uses given width;if = 3, uses Goldston model in H-mode diverted plasma, otherwise uses Halpern scaling lawif = 4, uses D. Brunner et al 2018 Nucl. Fusion 58 094002, equation 4 on volume averaged plasma pressure

12.27. lcx

connexion length multiplication factor to take into account LCFS safety factor divergence due to X point (connexion length ~ lcx * R * q_eff for diverted plasma)

12.28. mach_corr

two points model: supersonic flow;if = 0, assume Mach number = 1 at the target;if = 1, take into account possible Mach number > 1 near the target

12.29. residence_time

Impurity residence time in SOL and divertor (s). This parameter is used to compute radiative power in divertor with two points model out of ionisation equilibrium; if = 0, the impurity residence time is then set to the connexion length divided by sound speed averaged on mahgnetic line

12.30. sol_lscale

scaling parameter of folding length in the SOL:if = 0, a / 100 (previous metis version);if > 0, scale as a * sol_lscale (typical value 0.01);if < 0, scale as R0 * sol_lscale (typical value 0.003)

12.31. sol_model

model used to compute egde (LCFS) values

12.32. sol_rad

SOL radiative power: if = coupled, the radiative power in SOL and core plasma are coupled (Cooling rate is used to compute core plasma radiative power and difference between scaling law and core radiative power gives SOL radiative power);if = decoupled, the radiative powers in SOL and divertor are separately computed (must be used with 2-points model)

12.33. yield_model

Tungsten density - model used to compute sputtering yields:if = fit, use fit of DIVIMP simulation;if = Javev, use model from Janev paper;if = Matsunami, use model from Matsunami report

13. Section: ECRH/ECCD

Parameters described in this section allow to tune EC/ECCD source

13.1. angle_ece (named poloidal location in GUI)

ECCD efficiency - trapped particles effect: ECRH effectif deposition poloidal location: 0 -> LFS, 90 -> top, 180 -> HFS.

13.2. eccdmul

ECCD efficiency: multiplication factor applied to ECRH current drive efficiency

13.3. sens (named CD direction in GUI)

ECCD current drive orientation:if = -1, counter-current;if = 0, normal injection (no current);if = 1, co-current (same as Ip)

13.4. synergie

ECCD efficiency - synergy effect:ECCD effciency multiplication factor due to synergy with LHCD;if = 1, no synergy;if = 0, computed from overlap of current sources due to ECCD and LHCD

13.5. width_ecrh

ECCD deposition width: if = 0, use internal metis formula to compute ECRH/ECCD width;if > 0, width_ecrh is the width of Gaussian deposition;if < 0, the internal metis formula value is mutiplied by width_ecrh to obtain the width of ECRH/ECCD deposition

14. Section: NBI/NBICD

Parameters described in this section allow to tune first NBI/NBICD source

14.1. angle_nbi

first NB injector: NBI beam angle (<0 -> counter-current , 0 = normal, >0 -> co-current); used to compute the fraction of power injected perpendiculary (cos(angle_nbi)) and not perpendiculary (sin(angle_nbi))

14.2. cur_nbi_time

Choose temporal evolution of I_NBICD:if = 0, same behaviour as PNBI waveform;if = 1; same behaviour as thermal PNBI_th;intermediate value gives behaviour proportional to cur_nbi_time * PNBI_th + (1-cur_nbi_time) * PNBI (reference);Possibly inacurate in evolution mode (inside Simulink/Kepler): must be set to 0 in this case

14.3. drs1

first NB injector: half width of neutral beam in toroidal direction expressed in units of minor radius (computed as variation of tangential radius);if = 0, use default METIS value (1/6)

14.4. dzs1

first NB injector: normalised half width of neutral beam in vertical direction;if = 0, use default METIS value (0.05)

14.5. e_shielding

current shielding factor model :if = Lin-Liu, use Y.R Lin-Liu & F. L. Hilton model (Physics of Plasmas 4 (11) 1997);if = Honda-Sauter, use model with collisionality depedence (M. Honda et al NF 52 (2012) p 023021);if = Honda-NEO, same as Honda-Sauter but with L31 fitted on NOE code (A. Redl et al, Phys. Plasmas 28, 022502 (2021); https://doi.org/10.1063/5.0012664)

14.6. einj

first NB injector: NBI beam energy (eV)

14.7. fast_ion_sbp

Take or not into account increment of the stopping cross section due to fats ions (K. Okano et al, ECA vol 25A (2001) p 809):if = 0, no increment & Janev 1989 cross section (without impurities effect);if = 1, take into account increment & Janev 1989 cross section (with impurities effect); if = 2, no increment & Janev 1989 cross section (with impurities effect);if = 3, take into account increment & Suzuki 1998 cross section (with impurities effect); if = 4, no increment & Suziki 1998 cross section (with impurities effect)

14.8. forced_H_NBI

if == 1, force the composition of neutral beams to be hydrogen what ever is set in option.gaz or reference ftnbi

14.9. nbicdmul

first NB injector: multiplication factor applied to NBI current drive efficiency

14.10. rtang

first NB injector: tangency radius of neutral beam;if = 0, use angle_nbi to compute Rtang (m)

14.11. shinethrough

For testing; allows to turn off first orbit losses and/or shinethrough:if = 0, both first orbit losses and shinethrough are taking into account;if = 1, only shinethrough is taking into account (first orbit losses are discarded);if = 2, no losses are taking into account (both first orbit losses and shinethrough are discarded)

14.12. zext

first NB injector: vertical shift at the center of the plasma of the neutral beam trajectory (normalized radius)

15. Section: NBI/NBICD@2

Parameters described in this section allow to tune second NBI/NBICD source

15.1. angle_nbi2

second NB injector: NBI beam angle (<0 -> counter-current , 0 = normal, >0 -> co-current); used to compute the fraction of power injected perpendiculary (cos(angle_nbi)) and not perpendiculary (sin(angle_nbi))

15.2. drs2

second NB injector: half width of neutral beam in toroidal direction expressed in units of minor radius (computed as variation of tangential radius);if = 0, use default METIS value (1/6)

15.3. dzs2

second NB injector: normalised half width of neutral beam in vertical direction;if = 0, use default METIS value (0.05)

15.4. einj2

second NB injector: NBI beam energy (eV)

15.5. nb_nbi

number of NBI injectors used in METIS

15.6. nbicdmul2

second NB injector: multiplication factor applied to NBI current drive efficiency

15.7. rtang2

second NB injector: tangency radius of neutral beam;if = 0, use angle_nbi to compute Rtang (m)

15.8. zext2

second NB injector: vertical shift at the center of the plasma of the neutral beam trajectory (normalized radius)

16. Section: LHCD

Parameters described in this section allow to tune LHCD or second ECCD source

16.1. angle_ece2 (named angle_ecrh2 in GUI)

second ECCD system efficiency - trapped particles effect: ECRH effectif deposition poloidal location: 0 -> LFS, 90 -> top, 180 -> HFS

16.2. dlh

LH power deposition model: width of the LH current profile;(for Tore Supra, if = 0, use of profile from hard x-ray diagnostic; or width of second ECRH deposition profile if lhmode = 5)

16.3. etalh

LHCD efficiency or directivity:if lhmode = 2, value of normalised LHCD efficiency (etaLH in A/Wm^2);otherwise launcher directivity defined as the fraction of total LH power in the co-current peak;if lhmode = 5, multiplication factor applied to ECRH current drive efficiency for the second EC system (gives also sign of current source: if > 0, co-current and if < 0 counter-current)

16.4. freqlh

Lower Hybrid frequency (GHz)

16.5. fupshift

parallel refractive index upshift model: parameter for upshift model.When upshiftmode = 'newmodel', then factor applied to kinetic resonance position: n_par_Landau = fupshift * 6.5 / sqrt(Te).In this case, for backward compatibility, if fupshift=0, then fupshift is reset internally to 1

16.6. lhmode

LHCD efficiency model:if = 0, Fisch like law when wlh is defined, otherwise ITER basis scaling (Constant * <Te>);if = 1, adjusted to fit of chosen value of Vloop (vref);if = 2, fixed value (etalh);if = 3, Goniche scaling law;if = 4, simulTS scaling (for Tore Supra only);if = 5, this is use to describe a second ECCD system instead of LHCD system

16.7. npar0

launched parallel refractive index of LH at antenna

16.8. npar_neg

LH power deposition model:parallel refractive index of negative peak in the spectrum at the launcher; if = 0, used npar_neg = -npar0

16.9. upshiftmode

parallel refractive index upshift model:if = "newmodel", then use the new formulation taking into account ALOHA/C3PO/LUKE 2012/2013 results;if = "newmodel + tail", same as "newemodel" with tail model effect;if = linear, upshift increases linearly from napr0 at the edge to fupshift*npar0 at plasma center;if = 1/q, npar proportional to 1/q; = Bpol, npar proportional to Bpol; = x^2, npar proportional to x^2;if=sqrt(x), npar proportional to sqrt(x);if = null, no upshift;if = step@edge, npar becomes npar0 + fupshift

16.10. wlh

LH power deposition model:if = 0, LH source profile is computed with xlh et dlh;otherwise wlh is the width of LH antenna active part (m);in this case, the source shape is computed with a simple model; if lhmode = 5, must be set to 0

16.11. xlh

LH power deposition model: position of the maximum of LH current profile.(or position of the maximum of the second EC deposition profile, if lhmode = 5)

17. Section: ICRH/FW/FWCD

Parameters described in this section allow to tune IC source (minority heating, fast wave heating or fast wave heating and current drive)

17.1. MC_onoff

Mode conversion: compute (on) or do not compute (off) fraction of input power lost due to mode conversion (IBW)

17.2. cmin

ICRH heating scheme: fraction of the first minority species (nX/nD or nX/n_main if no deuterium in plasma discharge);if = 0, no suprathermal ions in plasma, direct heating of electrons and ions

17.3. fMC_loss

Mode conversion: with model Dumont-Vu, fraction of power coming from mode conversion (IBW) that is lost (otherwise, this power is assume to heat the electron);Use the model from: L.G. Eriksson and T. Hellsten, Physica Scripta vol. 52, 70-79, 1995.

17.4. fabs_fw

Direct electron power absorption in minority scheme: with model Dumont-Vu, abs(fabs_fw) = fraction of power absorbed directly by electrons;if > 0, fast wave current drive, otherwise if < 0, fast wave electron heating

17.5. fact_mino

ICRH heating scheme (only used in PION_fit-Stix model): multiplication factor applied to formula giving fraction of minority ions accelerated by ICRH wave;if = 0, default value depending on species is used

17.6. freq

ICRH heating scheme: ICRH frequency in MHz

17.7. fwcd

ICRH heating scheme:if = -1, counter current FWCD;if = 0, minority ion heating;if =1, FWCD mode;if = 2, FW mode

17.8. icrh_model

Selection of the ICRH model:if = PION_fit-Stix, deposition width fitted from PION + Stix formulation for ion distribution function;if = Dumont-Vu, new model using resonance width and convergence on quaisilinear diffusion coefficient

17.9. icrh_width

ICRH heating scheme: multiplication factor for ICRH power deposition profile width (for PION_fit-Stix model)or vertical extention of ICRH power deposition in units of normalised radius (for Dumont-Vu model)

17.10. ifast_icrh

Fast ion induced current: with model Dumont-Vu, multiplication factor applied to current due to fast minority ions; must be computed with the help of SPOT

17.11. mino

ICRH heating scheme: minority species for ICRH scheme

17.12. nphi

ICRH heating scheme: main toroidal wave number at ICRH launcher(n_phi ~ (2*pi*freq*R*n_par) / c with assumption K_phi ~ K_par)

17.13. orbit_width

Orbit width effect - with model Dumont-Vu:if = 0, no orbit width effect;if = 1, broaden the fast ion source profile according to analytical formula

18. Section: Axisymmetry

Parameters described in this section allow to turn on or off magnetic ripple effect computation (works only for Tore Supra)

18.1. rip (named ripple in GUI)

Ripple (Tore Supra only):if = 0, no ripple effect;if = 1 , take in account the ripple in Tore Supra

19. Section: Miscellaneous

Parameters described in this section allow to change machine name, shot number, choose a file for first wall description, override all parameters with parameters given in a file and set reactor power balance parameters

19.1. aux

Power plant: fraction of electric power used by auxiliary systems other than additional heating sources

19.2. available_flux

available poloidal flux provided by central solenoid and poloidal field coils (Wb)

19.3. carnot (named thermodynamic efficiency in GUI)

Power plant: thermal power to electricity power conversion efficiency

19.4. effinj

Power plant: conversion efficiency of additional heating sources

19.5. first_wall

matfile name that contains (R,Z) points describing poloidal section of the first_wall.if empty, it is not usedVariable names should be R and Z. R and Z must be vectors of same length

19.6. machine (named machine name in GUI)

name of the Device

19.7. mul_blanket

Power plant: fusion power multiplication factor due to neutron multiplication in breeding blanket

19.8. orientation

orientation of toroidal magnetic field: follows ITER convention (for ITER the value is -1, i.e. clockwise for tokamak see from above)

19.9. reference_parameters

file name that contains Parameters that will overwrite user defined Parameters (if empty, it is not used)

19.10. shot

shot number or simulation identification number

20. Section: Convergence

Parameters described in this section allow to change METIS internal convergence parameters

20.1. dwdt_method

Numerical method for evolution mode: method used to compute the time derivative of energy (dW / dt):if = implicit, same method as in full shot simulation;if = explicit, explicit polynomial filtered method;if = none, dW / dt is set to 0;if = v4.2, explicit method used in previous versions of METIS; if = working_point, for Operation mode computation, method to find the steady state solution (all d/dt = 0 except dpsi/dt)

20.2. nbmax

Numerical method: maximum number of convergence loops

20.3. tol0d

Numerical method: tolerance on relative error to stop the convergence loop;if = 0, use default values : 1e-2 for fast mode, 1e-3 for full run and evolution mode

21. Section: UAL

Parameters described in this section allow to tune IMAS METIS interface

21.1. COCOS

UAL control: choice for the output COCOS

21.2. COCOS_check

if COCOS_method = Sauter, siwtch on the control of COCOS in obtained IDS for core_profiles and equilbrium.

21.3. COCOS_method

Method use to make the COCOS mapping:= native METIS method.= use O.Sauter tools (see https://gitlab.epfl.ch/spc/cocos)

21.4. COCOS_verbose

if COCOS_method = Sauter, level of verbosity of COCOS transformation (0 = no text output).

21.5. Convex_LCFS

2D equilibrium: force LCFS used for 2D extrapolation to be convex:= 0, keep LCFS as it is provided;= 1, force LCFS to be convex

21.6. core_profiles

IDS selection:= 0, do not write core_profiles IDS;=1, write core_profiles IDS

21.7. core_sources

IDS selection:= 0, do not write core_sources IDS;=1, write core_sources IDS

21.8. core_transport

IDS selection:= 0, do not write core_transport IDS;=1, write core_transport IDS

21.9. edge

IDS selection:= 0, do not write edge IDSs;=1, write edge IDSs (edge_profiles and edge_transport)

21.10. equi_extrap

2D equilibrium - method for extrapolation of Psi oustside the LCFS:= 0, interpolation of Psi using a polynomial G-S solution on each LCFS point;= 1, hybrid method: Analitical solution of GS, or simple extrapolation if non converged;= 2, recompute equilibrium with fixed boundary equilibrium solver of FEEQS.M code (if available, FEEEQS.M should have been installed separately);= 3, as option 2 but used polynomial solution of G-S constained with flux and magnetic field on each point of LCFS for extrapolation ouside the LCFS instead of a simple interpolation

21.11. equilibrium

IDS selection:= 0, do not write equilibrium IDS;=1, write equilibrium IDS

21.12. fixed_grid

2D equilibrium, for rectangular grid:= 0, uses floating grid following plasma displacement;= 1 uses same grid for all time slices

21.13. init_output_ids

UAL control:= 0, continue to write at the end of existing record;=1 on init call, initialise output IDS (reset and write the 1st time slice)

21.14. nb_points_pol

2D equilibrium: number of points in poloidal direction for inverse (rho,theta) grid of equilibrium

21.15. nb_points_radial

2D equilibrium: number of points in radial direction for rectangular (R,Z) grid of equilibrium

21.16. numerics

IDS selection:= 0, do not write numerics IDSs;=1, write numerics IDSs (transport_solver_numerics)

21.17. radiation

IDS selection:= 0, do not write radiation IDS;=1, write core_sources IDS

21.18. restart

UAL control:name of the restart file;empty, no restart file is saved; otherwise, after each call, the restart file is saved

21.19. summary

IDS selection:= 0, do not write summary IDS;=1, write summary IDS

22. Section: Occurrence UAL

Parameters described in this section allow to select occurrence for IDS in IMAS METIS interface

22.1. core_profiles_occurrence

UAL control: output ids occurrence for core_profiles IDS;empty, use default occurence (0)

22.2. core_sources_occurrence

UAL control: output ids occurrence for core_sources IDS;empty, use default occurence (0)

22.3. core_transport_occurrence

UAL control: output ids occurrence for core_transport IDS;empty, use default occurence (0)

22.4. edge_occurrence

UAL control: output ids occurrence for edge IDSs (egde_profiles and edge_transport);empty, use default occurence (0)

22.5. equilibrium_occurrence

UAL control: output ids occurrence for equilibrium IDS;empty, use default occurence (0)

22.6. numerics_occurrence

UAL control: output ids occurrence for transport_solver_numerics IDSs;empty, use default occurence (0)

22.7. pulse_schedule_occurrence

UAL control: output ids occurrence for pulse_schedule IDS;empty, use default occurence (0)

22.8. radiation_occurrence

UAL control: output ids occurrence for radiation IDS;empty, use default occurence (0)

22.9. summary_occurrence

UAL control: output ids occurrence for summary IDS;empty, use default occurence (0)