

# Namelist input parameters for the cluster 3D code

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These notes serve to explain the input structure of the cluster/molecule 3D code. It explains the full capabilities of the code. We want to publish only a subset. All options addressed in namelist **EXTENSIONS**, **FSIC2**, and **SURFACE** should not appear in the public version. The switches to these parts are immersed in the code with preprocessor variables **extended**, **fsic**, and **raregas**. We should keep the code in the repository always in its complete version and write a little piece of software which reads the source files and produces new sources without the line enclosed by the **#if(extended)**, **#if(extended)**, and **#if(raregas)** closures.

Note also the old input files have to be changed. The namelist “&EXTENSIONS” has to follow namelist “&DYNAMIC” and all non-public input parameters have to be moved to there. Moreover, The namelist “&FSIC” has to be renamed “&FSIC2”. A few examples with input in old style are collected in the directory **examples** while examples with input in new style can be found in **samples**.

The input is arranged in the following three input files:

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<b>for005</b>	defines the qualifier <b>&lt;name&gt;</b> for the other <b>for005...</b> files
<b>for005.&lt;name&gt;</b>	general input for settings, static and dynamics
<b>for005ion.&lt;name&gt;</b>	ionic configuration of cluster
<b>for005surf.&lt;name&gt;</b>	atomic configuration of substrate (optional)

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The input for **for005.<name>** is sorted into Fortran namelists. The following tables list all input variables entered through these namelists and give a short explanation. Comments and issues for development are marked in red. A mere **???** indicates a variable which should be considered to be shifted to namelist **extension**.

Namelist GLOBAL		in for005.<name>
<i>choice of system</i>		
kxbox	nr. of grid points in $x$ direction	
kybox	nr. of grid points in $y$ direction	
kzbox	nr. of grid points in $z$ direction	
	box sizes must fulfill $kxbox \geq kybox \geq kzbox$	
dx,dy,dz,	grid spacing (in Bohr) for the 3D numerical grid - if negative this will be set to an optimal value and a value will be suggested for KXBOX in file NX - the code stops and has to be restarted	
	the grid size is defined before compilation in <code>params.F90</code>	
	it has to be correlant with pseudopotentials	
	corresponds to <code>ecut</code> in solid state	
tcoulfalr	switch to FALR Coulomb solver (else exact solver)	
iswitch_interpol	switch to interpolated grid for PsP	
numspin	number of spin components (2=full spin treatment) (1=spin averaged, possible problem for ADSIC) ???	
kstate	maximum nr. of s.p. states which is possible (greater than <code>nclust</code> )	
nclust	number of QM electrons	
nion2	selects type of ionic background 0 $\rightarrow$ jellium background 1 $\rightarrow$ background from ionic pseudo-potentials 2 $\rightarrow$ background read in from <code>potion.dat</code>	
temp	electronic temperature in static iteration	
nion	number of cluster ions	
nspdw	number of spin down electrons	
radjel	Wigner-Seitz radius of jellium background	
surjel	surface thickness of jellium background	
bbeta	quadrupole deformation of jellium background	
gamma	triaxiality of jellium background	
itback	nr. of iterations for jellium background	
rotclustx,y,z	vector fo angle of initial rotation of ions	
scaleclustx	scaling of ionic configuration along x-axis	
scaleclusty	scaling of ionic configuration along y-axis	
scaleclustz	scaling of ionic configuration along z-axis	
scaleclust	if $\neq 1$ : scaling of ionic configuration along x-y-z	
shiftclustx	shift of ionic configuration along x-axis	
shiftclusty	shift of ionic configuration along y-axis	
shiftclustz	shift of ionic configuration along z-axis	

Namelist GLOBAL		in for005.<name>
<i>initialization of wave functions</i>		
b2occ	deformation for initial harmonic oscillator wf's	
gamocc	triaxiality for initial harmonic oscillator wf's	
osfac	factor on initial oscillator radius	
deocc	nr. of states above Fermi energy (determines nr. of states)	
shiftWFx	shift of initial wavefunctions in x direction	
ishiftCMtoOrigin	switch to shift center of mass of cluster to origin of box	
ispinsep	initialize wavefunctiosn with some spin asymmetry	
init_lcao	choice of basis for wavefunction initialization	
	=0 $\implies$ harmonic oscillator functions (center can be moved by <b>shiftWFx</b> )	
	=1 $\implies$ atomic orbitals = WFs centered at ionic sites	
<i>convergence issues</i>		
e0dmp	damping parameter for static solution of Kohn-Sham equations (typically about the energy of the lowest bound state)	
epswf	step size for static solution of Kohn-Shahm equations (of order of 0.5)	
epsoro	required variance to terminate static iteration (order of $10^{-5}$ )	
occmix	mixing factor: new (thermal) occupation to old	
endcon	requires precision variance, termination criterion	
Namelist GLOBAL		in for005.<name>
<i>yet to be sorted</i>		
dpolx	add stationary dipole field in x-direction	(better placed in dynamic?)
dpoly	add stationary dipole field in y-direction	
dpolz	add stationary dipole field in z-direction	

	Namelist DYNAMIC	in for005.<name>
<i>numerical and physical parameters for statics and dynamics</i>		
dt1	time step for propagating electronic wavefunctions, $\frac{\Delta t}{\Delta x^2} \leq 1$	
ismax	maximum number of static iterations	
idyniter	switch to s.p. energy as E0DMP for 'iter>idyniter'	
ifhamdiag	diagonalization of m.f. Hamiltonian in static step (presently limited to fully occupied configurations)	
isitmax	nr. of imaginary-time steps to improve static solution	
itmax	number of time steps for electronic propagation	
ifexpevol	exponential evolution 4. order instead of TV splitting	
iffastpropag	accelerated time step in TV splitting (for pure electron dynamics, interplay with absorbing b.c. ??)	
irest	switch to restart dynamics from file 'save'	
istat	switch to read wavefunctions from file 'rsave' it continues static iteration for 'ismax>0' it starts dynamics from these wf's for 'ismax=0'	
idenfunc	choice of density functional for LDA 1 → Perdew & Wang 1992 (default setting) 2 → Gunnarson & Lundquist 3 → only exchange in LDA	
isave	saves results after every 'isave' steps on file 'rsave' in and after static iteration on file 'save' in dynamic propagation	
ipseudo	switch for using pseudo-densities to represent substrate atoms	
ipsptype	type of pseudopotentials: 0 = soft local (errf); 1 = full Goedecker; 2 = local Goedecker; 3 = read from file goed.asci (no need to specify) ; 4 = semicore read from file goed.asci	
directenergy	.true. = direct computation of energy (only for LDA, Slater, KLI)	
ifsicp	selects type of self-interaction correction 0 = pure LDA, 1 = SIC-GAM, 2 = ADSIC; 3 = SIC-Slater; 4 = SIC-KLI; 5 = exact exchange, 7 = localized SIC, 8 = full SIC (real), 9 = full SIC(complex) ???: Options IFSICP=7,8,9 yet to "extended" version.	
icooltyp	type of cooling (0=none, 1=pseudo-dynamics, 2=steepest descent, 3=Monte Carlo)	
ifredmas	switch to use reduced mass for ions in dynamics	
ionmdtyp	ionic propagation (0=none, 1=leap-frog, 2=velocity Verlet) (Should we move "leap-frog" to the extended version???)	
ntref	nr. time step after which absorbing bounds are deactivated	
nabsorb	number of absorbing points on boundary (0 switches off)	
powabso	power of absorbing boundary conditions	
ispherabso	switch to spherical mask in absorbing bounds	

	Namelist DYNAMIC	in for005.<name>
	<i>way of excitation</i>	
centfx	initial boost of electronic wavefunctions in x-direction	
centfy	initial boost of electronic wavefunctions in y-direction	
centfz	initial boost of electronic wavefunctions in z-direction	
shiftinix	initial x-shift of electronic wavefunctions	
shiftiniy	initial y-shift of electronic wavefunctions	
shiftiniz	initial z-shift of electronic wavefunctions	
tempion	initial temperature of cluster ions	
ekmat	initial kinetic energy of substrate atom (boost in $x$ , in eV)	
itft	choice of shape of laser pulse 1 = ramp laser pulse, sine switching on/off 2 = gaussian laser pulse 3 = $\cos^2$ pulse	
tnode	time (in fs) at which pulse computation starts	
deltat	length of ramp pulse ( $itft = 1$ ), in fs	
tpeak	time (in fs, relative to $tnode$ ) at which peak is reached (for $itft = 1$ and 2, pulse length becomes $2*tpeak$ )	
omega	laser frequency (in Ry)	
e0	laser field strength in Ry/Bohr	
e1x,e1y,e1z	orientation of pulse	
e0_2	field strength of second laser pulse (only $itft=3$ )	
phase2	phase of second pulse	
omega2	frequency of second pulse	
tstart2	initial ime of second pulse	
tpeak2	peak time of 2. pulse (pulse length is $2*tpeak2$ )	
iexcit	modus of excitation (0=shifts, 1=rotation)	
iangmo	switch to compute angular momentum	
irotat	axis of rotation for excitation (x=1,y=2,z=2,xyz=4)	
phirot	angle of rotation for excitation (in units of degree)	
phangle	angle of “rotation” into a $1ph$ state	
phphase	phase of “rotation” into a $1ph$ state	
nhstate,npstate	nr. of hole and particle state for $1ph$ excitation this option can only be run from $istat=1$ to be checked	

	Namelist DYNAMIC	in for005.<name>
<i>flags for observables</i>		
iplotorbitals	switch to print plot-file <b>pOrbitals</b> for all static states	
iemomsRel	multipole momentes of electron density relative to origin (0) or c.m. of cluster (1)	
istinf	modulus for printing information in static iteration	
ifspemoms	switch to compute and print spatial s.p. moments	
iftransme	switch to compute and print transition m.elements	
irhoint_time	modulus for printing slices of integrated densities	
jstinf	modulus for printing information in dynamic	
jinfo	modulus for printing dynamical information on <b>infosp.&lt;name&gt;</b>	
jdip	modulus for printing dipole moments on <b>pdip.&lt;name&gt;</b>	
jquad	modulus for printing quadrupole moments on <b>pquad.&lt;name&gt;</b>	
jesc	modulus for printing ionization <b>pescel.&lt;name&gt;</b>	
jdiporb	modulus for printing dipoles for s.p. states on <b>pdiporb.xyz</b>	
jenergy	modulus for printing energy information on <b>penergies.&lt;name&gt;</b>	
jener	modulus for printing ionic energies	
iflocaliz	activates computation of Becke's localization	
jelf	modulus for anaylzing and printing electron localization in dynamics various files are written of the form <b>pelf*.&lt;name&gt;</b>	
iflocaliz	modulus for anaylzing and printing electron localization in statics	
jstinf	modulus for printing s.p. energies and variances	
jpos	modulus for printing ionic positions on <b>pposion.&lt;name&gt;</b>	
jvel	modulus for printing ionic velocities on <b>pvelion.&lt;name&gt;</b>	
jstateoverlap	switch to compute overlap of static state with the state directly after dynamical initialization	
jforce	modulus for printing ionic forces	
jgeomion	modulus for printing global measures of ionic configuration	
jang	modulus for printing electronic angular momentum	
jangabso	modulus for printing angular distribution of emitted electrons	
jspdp	modulus for printing spin dipole momenta	
jposcm	modulus for printing electronic center of mass	
ipasinf	modulus for printing general information along dynamics	
jgeomel	modulus for printing global measures of electronic geometry	
jelf	modulus for evaluating an printing electron localization	
jmp	modulus for storing information for PES	
jnorms	modulus for printing s.p. norms and ionization probabilities	
jcharges	modulus for printing radially averaged charge distribution	
drcharges	radial distance for scanning radially averaged charge distribution	
jplotdensitydiff	modulus for printing $\rho(t) - \rho(0)$ along x-axis	
jplotdensitydiff2d	modulus for printing 2D cuts of $\rho(t) - \rho(0)$	
jplotdensity2d	modulus for printing 2D cuts of density	

Namelist DYNAMIC		in for005.<name>
<i>yet unsorted</i>		
phi	phase of laser pulse, inactive for electrons, strange for ions ???	
projcharge	charge of ionic projectile	
projvelx	x-velocity of ionic point-charge projectile	
projvely	y-velocity of ionic point-charge projectile	
projvelz	z-velocity of ionic point-charge projectile	
projinix	initial x-coordinate of ionic point-charge projectile	
projiniy	initial y-coordinate of ionic point-charge projectile	
projiniz	initial z-coordinate of ionic point-charge projectile	
modionstep	modulus for ion step (nr. of electron steps per ion step)	
ispidi	=1 switches to initialization by spin-dipole boost	
izforcecorr	=1 enforce zero-force condition, =0 tests condition, =-1 disables all	
dinmargin	margin defining inner box in connection with Gaussian pseudo-densities check default	
iangabso	option for origin for angular distribution (1=box, 2=c.m.)	
ipes	activates preparation of measuring points for PES	
nangtheta	number of PAD angular cones in $\theta$ direction	
nangphi	number of PAD angular cones in $\phi$ direction	
delomega	space angle of angular cones in PES check	
angthetal	lower angle $\theta$ for PES evaluation	
angthetah	upper angle $\theta$ for PES evaluation	
angphil	lower angle $\phi$ for PES evaluation	
angphihi	upper angle $\phi$ for PES evaluation	
ifreezekspot	=1 freezes KS potential at stage of time=0	
ifixcmion	switch to fix c.m. during ionic motion	
ekin0pp	kinetic energy for initial boost of electrons <u>and</u> ions	
vx0	boost velocity x-direction relative to ekin0pp	
vy0	boost velocity y-direction relative to ekin0pp	
vz0	boost velocity z-direction relative to ekin0pp	
nmptheta	number of PES measuring points in $\theta$ direction	
nmpphi	number of PES measuring points in $\phi$ direction	
Namelist DYNAMIC		in for005.<name>
<i>RTA parameters</i>		
jrtaint	modulus for invoking RTAS step	
rtamu	$\mu$ parameter for quadratic term on $\rho$ -constraint	
rtamuj	$\mu_j$ parameter for quadratic term on $\mathbf{j}$ -constraint	
rtasumvar2max	criterion for maximal variance of s.p. energies	
rtaeps	step size in DCMF iteration	
rtae0dmp	damping energy in DCMF iteration	
rtatempinit	initial temperature in RTA step	
rtaforcetemperature	is that really used?	
rtasigee	effective electron-electron cross section in RTA	
rtars	effective Wigner-Seitz radius for estimating damping rate	

	Namelist EXTENSIONS	in for005.<name>
	<i>extended options (not to appear in public version)</i>	
trequest	variable checking CPU time to trigger save operations	
timefrac	variable checking CPU time to trigger save operations	
iscatterelectron	switch to scattering with electron wavepacket	
jattach	modulus to compute attachment probability	
scatterelectronenergy	kinetic energy of impinging electron wavepacket	
scatterelectronvxn	x-velocity of electron wavepacket (relative to energy)	
scatterelectronvyn	y-velocity of electron wavepacket (relative to energy)	
scatterelectronvzn	z-velocity of electron wavepacket (relative to energy)	
scatterelectronx	initial x-coordinate of impinging electron	
scatterelectrony	initial y-coordinate of impinging electron	
scatterelectronz	initial z-coordinate of impinging electron	
scatterelectronw	initial width of impinging electron	
jescmask	modulus for detailed print of lost electrons	
jescmaskorb	modulus for state-wise detailed print of lost electrons	
eproject	energy of incoming projectile (= last ion in the list)	
vpx,vpy,vpz	direction of the incoming projectile	
taccel	time span over which the projectile is accelerated to <b>eproject</b> for <b>taccel=0</b> one has to use <b>init_lcao=1</b>	
nproject	element number of atomic projectile	
nproject_states	nr. of electronic states in atomic projectile	
idenspl	modulus for printing 2D cuts of density in MTV format	
i3dz	print z-integrated 2D density, following <b>idenspl</b>	
i3dx	print x-integrated 2D density, following <b>idenspl</b>	
i3dstate	print x- and z-integrated density per state, following <b>idenspl</b>	
jstboostinv	modulus for evaluating boost-invariant s.p. energy and variance ???	



	Namelist <b>SURFACE</b>	in for005.<name>
<b>idielec</b>	switch to dielectric background	
<b>xdielec</b>	distance of dielectric background to lowest GSM layer	
<b>epsdi</b>	dielectric constant of dielectric background	
<b>isurf</b>	switch to activate dielectric background	
<b>ne</b>	Number of fixed shells in substrate	
<b>nc</b>	number of O cores in MgO(001)	
<b>nk</b>	number of Mg cations in MgO(001)	
<b>ivdw</b>	handling of Van-der-Waals with substrate atoms 0 $\implies$ no VdW 1 $\implies$ enables full computation of VdW 2 $\implies$ enables effective VdW through PsP parameters	
<b>ifadiadip</b>	switch to adiabatic treatment of substrate dipoles	
<b>shiftx</b>	global shift in $x$ for all substrate atoms	
<b>shifty,shiftz</b>	as <b>shiftx</b> for $y$ and $z$ direction	
<b>mion</b>	mass of surface anion (16 for O in MgO(001))	
<b>mkat</b>	mass of surface kation (24.3 for Mg in MgO(001))	
<b>me</b>	mass of valence shell	
<b>cspr</b>	spring constant for interaction between core and valence shell	
<b>chgc0</b>	charge of (anion) core	
<b>chge0</b>	charge of valence shell	
<b>chgk0</b>	charge of cation	
<b>sigmak</b>	gauss width of cation	
<b>sigmac</b>	gauss width of core	
<b>sigmav</b>	gauss width of valence shell	
<b>iUseCell</b>	switch for reading/building lattice of substrate atoms 0 $\implies$ lattice atoms are read in from input file 'for005surf.*' 1 $\implies$ lattice is built from replicating unit cell and lattice parameters <b>rlattvec</b> ... are read in (see <b>md.F</b> )	
<b>iPotFixed</b>	switch for Madelung summation of substrate atoms read/write electrostatic potential from particles with <b>imob</b> =0, so that their run-time calculation can be skipped 0 $\implies$ do not read; calculate full potential at each iteration 1 $\implies$ read in <b>potFixedIon()</b> from previously prepared file -1 $\implies$ calculate <b>potFixedIon()</b> write result to a file which can be later read in by option 1, stop after that 2 $\implies$ calculate <b>potFixedIon()</b> at the beginning, do not write	
<b>ifmdshort</b>	includes short range interaction electron-substrate	
<b>isrtyp(i,j)</b>	type of interaction between the different kinds of particles 0 $\rightarrow$ no short range interaction 1 $\rightarrow$ GSM core 2 $\rightarrow$ GSM valence shell =1 $\implies$ Born-Mayer type 3 $\rightarrow$ GSM kation =2 $\implies$ Argon case 4 $\rightarrow$ Na core 5 $\rightarrow$ DFT electron	
<b>unfixCLateralRadx</b>	radius of cylinder with mobile cores	
<b>unfixELateralRadx</b>	radius of cylinder with mobile valence electrons	
<b>fixCBelowx</b>	fixes cores which lay below given $x$ value	

Namelist PERIO		in for005.<name>
ch	effective charge of ion	
amu	mass of ion in units of hydrogen mass	
dr1,dr2	radii of soft local PsP	
prho1,prho2	strenghts of soft local PsP	
crloc	radius for local part of Goedecker PsP	
cc1,cc2	strengths for local part of Goedecker PsP	
r0g,r1g,r2g	radii for non-local parts of Goedecker PsP	
h0_11g,h0_22g,h0_33g	strenghts for non-local parts of Goedecker PsP	
h1_11g,h1_22g,h2_11g	strenghts for non-local parts of Goedecker PsP	
radiong	carrier radius for projecteur in non-local Goedecker PsP	

Namelist FSIC		in for005.<name>
step	step size in iteration of localizing or symmetry condition	
precis	precision in iteration of localizing or symmetry condition	
SymUtBegin	nr. iteration where symmetry condition starts for pure localizing step set <b>SymUtBegin</b> > <b>ismax</b>	
radmaxsym	limiting value in radius division for actual step	

Ionic structure and $e^-$ -initialization in for005ion.<name>	
This initialization does not use NAMELIST but reads input in fixed order. Each line stands for one ion. Each column has a definite meaning.	
Col. 1	$x$ -coordinate
Col. 2	$y$ -coordinate
Col. 3	$z$ -coordinate
Col. 4	number of element in periodic system (e.g.: Na $\leftrightarrow$ 11)
Col. 5	only <b>init_lcao=1</b> : ordering of nodes in repeated initialization at this ion
Col. 6	only <b>init_lcao=1</b> : radius of initial Gaussian at this ion
Col. 7	only <b>init_lcao=1</b> : starting spin for initalization at this ion