ASPHERiX

PRODUCT INFORMATION

DCS COMPUTING

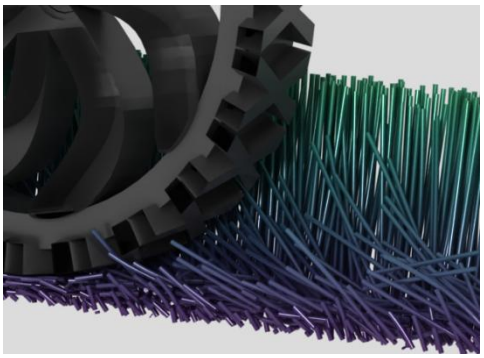
ASPHERIX

PARTICLE SHAPES

Aspherix® supports a large variety of particle shapes

Convex triangulated

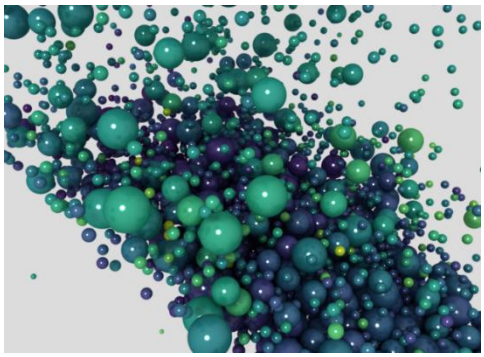
Fiber and bonded



Concave triangulated

Multisphere

Sphere



Box, cylinder, ellipsoid

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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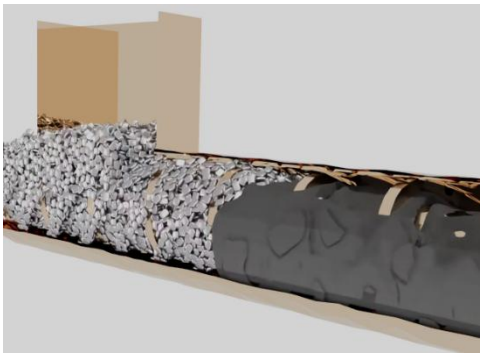
HIGHLIGHTS

Aspherix® has numerous cutting-edge physics models and great options for integration. Here are some highlights:

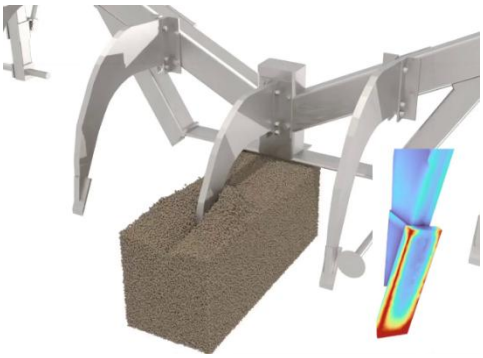
Complex geometry motion & 6dof solver for meshes

Advanced coarsegraining & loadbalancing

Phase change & chemical reactions

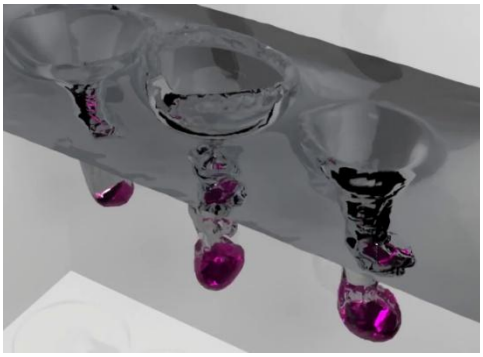


Wear modeling & attrition



Solid & liquid coating & powder handling

Coupling interfaces: CFD, FEM, API



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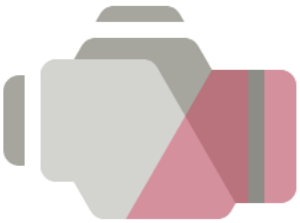
COMPONENTS AND OPTIONS

Aspherix® consists of the following components:

Strong simulation engine for DEM



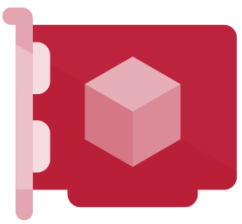
Easy to use GUI for DEM

GUI workflow for coupled CFD-DEM simulations

Aspherix® runs on:

CPU

GPU



Desktop machines

Clusters

Clouds

ASPHERIX® is available for Linux and Windows

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* functionality GPU optimized

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SYSTEM REQUIREMENTS

Aspherix® Solver – MPI

Windows

- Delivered with installer

Linux

- MPI is required
- has to support MPI 3 standard (e.g. min OpenMPI 1.8, or MPICH 3.0)

Aspherix® Solver - GPU

Windows

- CUDA (min version 13.1)

Linux

- CUDA (min version 12)

Aspherix® GUI

- OpenGL library (version 3.2 or higher)

Aspherix® Solver - API

Linux

- cmake is required (min cmake 3.9)

Aspherix® Calibration – for Python Support

- Python is required (min Python 3.8)

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* functionality GPU optimized

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SYSTEM REQUIREMENTS

Operating systems

- Windows 11
- Ubuntu 22.04, 24.04, 26.04
- Centos Stream 9, 10
- Rocky Linux 9, 10
- Red Hat 9, 10
- Suse Enterprise 15 SP2+, 16; Open Suse tumbleweed
- Amazon Linux 2023
- glibc 2.28 or higher is required

Operating Systems – Special cases

- Windows Server 2022, 2025 (Aspherix® GUI needs OpenGL 3.2)

Hardware requirements (only for GPU usage)

- NVIDIA GPU minimal recommended compute capability 7.5 (7.0 is included, but EOL has already been announced by Nvidia)

Available compute architectures

- VOLTA70 (Linux only)
- TURING75
- AMPERE86
- ADA89
- HOPPER90 (Linux only, Windows by request)
- BLACKWELL120

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* functionality GPU optimized

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SYSTEM REQUIREMENTS

Prerequisites for coupling interfaces only

CFDEMcoupling:

- cmake 3.13
- OpenFOAM 10*
- Linux only (systems as specified on previous page), Windows subsystem for Linux allows for usage on Windows
- System prerequisites of specified OpenFOAM version apply

Palabos:

- Palabos 2.1
- Linux only (systems as specified on previous page)
- System prerequisites of specified Palabos version apply

Additional remark

Please note that all features described in the feature list are available in Aspherix® Solver. Most features are also available in Aspherix® GUI but for technical reasons there are some restrictions.

License usage & Installations

- Arbitrarily many installations on arbitrarily many systems allowed within organisation of Customer, license only restricts number of active processes
- Each license can be used on all supported OS

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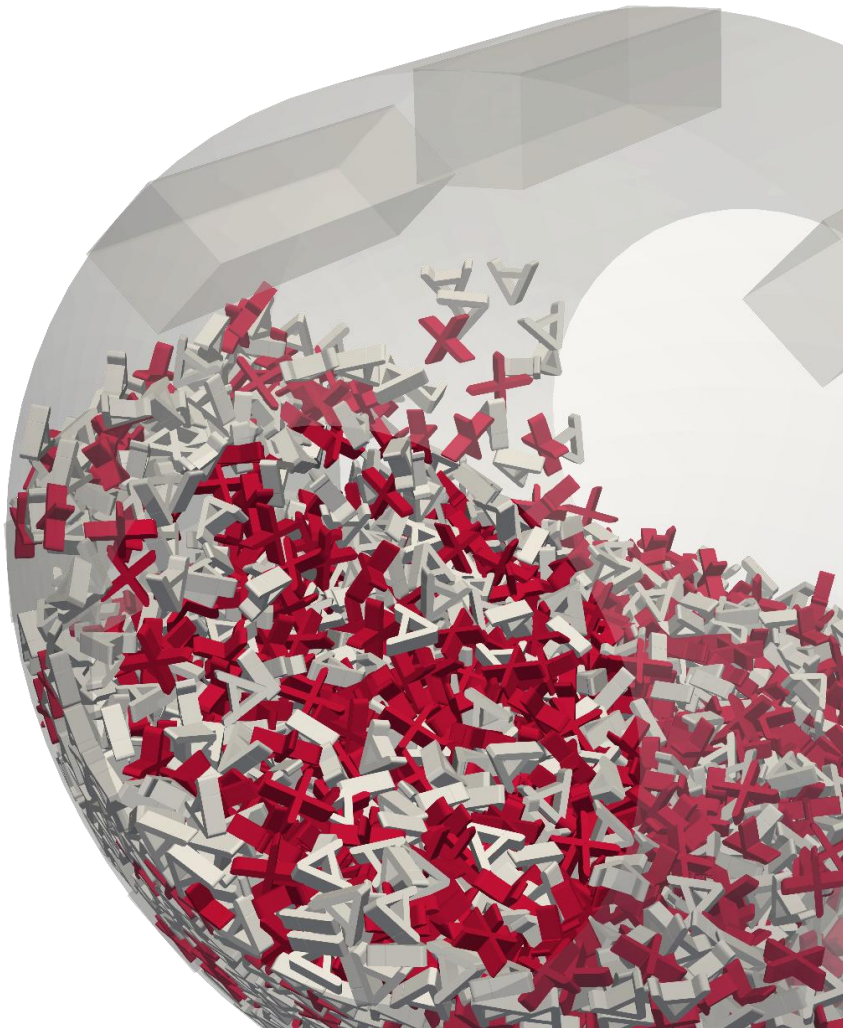
* functionality GPU optimized

FEATURE LIST OVERVIEW



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FEATURE LIST - OVERVIEW

Physics models

6 degrees of freedom solver	body forces
bond models	bubble models[S]
cohesion	damping
drag forces	electricity
equipment wear and attrition	fast DEM[S]
fiber cutting	fiber models
heat transfer	liquid bridges and liquid transport
magnetic dipole	mass transfer and chemical reactions
material property models	mesh deformation
normal models	pair styles
particle breakage and attrition	particle deformation
photon reflection	powder compaction
rolling friction	sedimentation (CFD 4-way coupling only)
spray coating	surface models
tangential models	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - OVERVIEW

Particle shapes

bonded	box
capsule	concave triangulated
convex triangulated	cylinder
ellipsoid	fiber
fragments	general*
multisphere	rod
sphere	superquadric
tablet	

Meshes and geometry

mesh controllers	mesh deformation
mesh import*	mesh manipulation
mesh modules	region
walls	

Functionalities

boundary conditions*	integration
neighbor list	particle deletion
particle insertion	particle manipulation

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - OVERVIEW

Postprocessing

collision statistics	energy balance
fiber data[S]	mesh residence time
meshes	particle data
post simulation evaluation	residence time distribution
scalability and speed*	spatial and temporal averaging
stresses and force network	

IO

meshes	reader
write expert	write standard

Scalability and speed

coarsegraining*	loadbalancing*
parallelization	

Coupling interface

CFD 1-way coupling	CFD 4-way coupling (Linux only)
FEM coupling (Linux only)[S]	MBD coupling[S]
electric field coupling	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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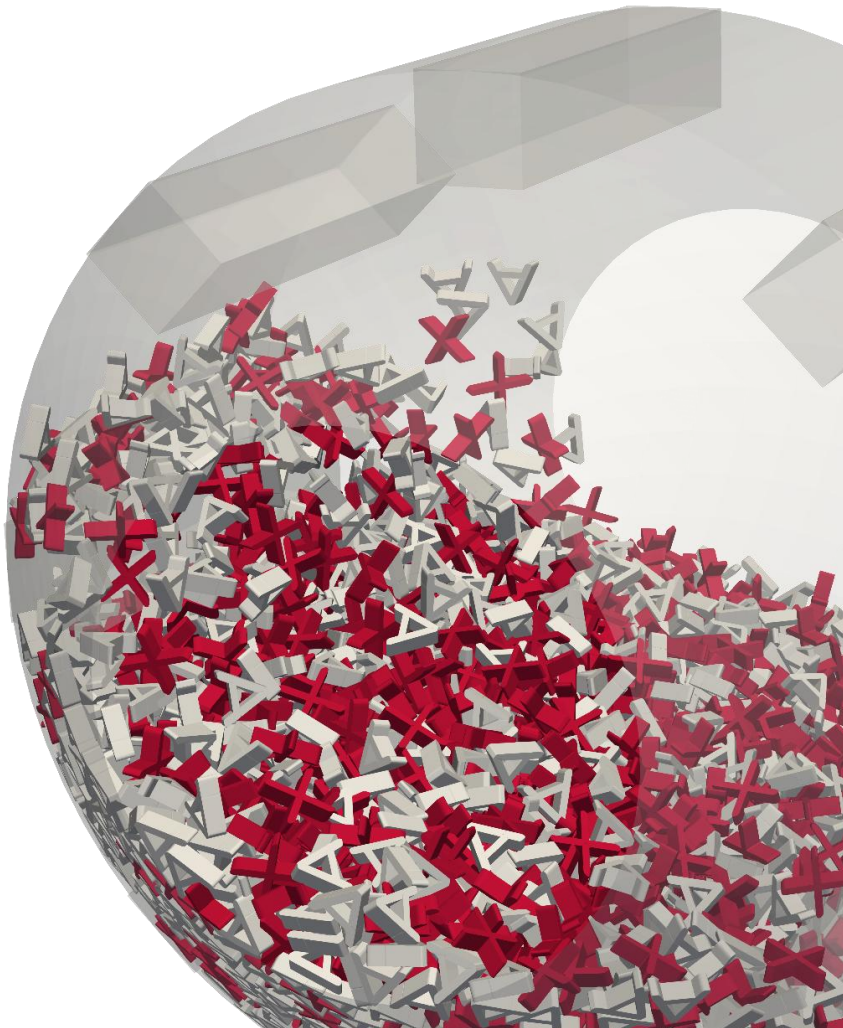
FEATURE LIST - OVERVIEW

Apis

API: C++[s]	API: Python[s]
custom contact models[s]	custom equations[s]
custom mesh access[s]	custom particle properties[s]

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

FEATURE LIST DETAILS



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FEATURE LIST - PHYSICS MODELS

6 degrees of freedom solver

mesh module 6dof	

Body forces

freeze[s]	buoyancy*
gravity*	simplified fluid model[s]

Bond models

bond	bond relative

Bubble models[s]

bubble[s]	bubble breakup[s]
bubble coalescence[s]	

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Cohesion

adaptive	asphalt
bond	bond relative
bubble coalescence[S]	easo capillary viscous
fiber	fiber buckle base
fiber plastic base	fiber wet base
general liquid bridge (normal: adams_perchard, pitois, washino, washino_powerlaw; tangential: goldman, xu, washino, xu_powerlaw)	Liquid bridge solidification
lubrication	sjkr*
sjkr2	powder
sjkr selective	sjkr temp
sjkr time dependent	washino capillary viscous

Damping

cundall damping	

Drag forces

DiFelice	Schiller Naumann
Zastawny	const Cd

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Electricity

calculate electric_current	calculate electric_resistance
calculate voltage	electric field
enable_electrical_conductivity	

Equipment wear and attrition

archard wear model	combined wear model
deformation wear model	finnie wear model
finnie_unresolved wear model	mesh wear

Fast dem[S]

addforce steadystate[S]	fast heat conduction[S]
addforce steadystate experimental[S]	

Fiber cutting

mesh module cutting	

Fiber models

fiber	fiber buckle base
fiber plastic base	fiber wet base

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Heat transfer

heat conduction*	particle melting
surface heating	roasting
mesh heat transfer	radiation

Liquid bridges and liquid transport

addliquid wall[S]	liquid transport
liquid transport evaporation	liquid transport porous
liquid transport sponge	easo capillary viscous
general liquid bridge (normal: adams_perchard, pitois, washino, washino_powerlaw; tangential: goldman, xu, washino, xu_powerlaw)	Liquid bridge solidification
washino capillary viscous	mesh module liquid transfer

Magnetic dipole

addforce magnetic	

Mass transfer and chemical reactions

change size	change size multisphere
change size superquadric	change size superquadric anisotropic

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Material property models

composition properties[s]	custom material properties[s]
material interaction properties*	material properties*
materials*	custom materials[s]
interdependent material properties[s]	

Mesh deformation

mesh module deform	

Normal models

adhesive elasto plastic	hertz*
hertz fragmentation bruchmueller	hertz fragmentation bruchmueller unresolved
hertz stiffness	hertz time dependent
hertz velocity dependent[s]	hooke
hooke hysteresis	hooke scale invariant
hooke stiffness	jkr
jkr/general	luding
thornton-ning	

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Pair styles

hybrid[S]	hybrid overlay[S]
stokes dynamics[S]	particle contact model*

Particle breakage and attrition

particle breakage force	hertz fragmentation bruchmueller
hertz fragmentation bruchmueller unresolved	history attrition
history attrition angle	

Particle deformation

multicontact halfspace	surface model multicontact

Photon reflection

photon properties	

Powder compaction

powder cluster model	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - PHYSICS MODELS

Rolling friction

simplistic	cdt
epsd	epsd2*
epsd3	

Sedimentation (cfd 4-way coupling only)

sedimentation	mesh module contact deletion[S]

Spray coating

detect surface	liquid transport
liquid transport evaporation	DEM spray particles
different spray nozzle shapes	spray particle to surface film conversion

Surface models

surface model multicontact	superquadric orthogonal

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

FEATURE LIST - PHYSICS MODELS

Tangential models

adhesive_elasto_plastic	burgers asphalt
history*	history attrition
history attrition angle	history powder
history tempdep	history time dependent
no history	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - MESHES AND GEOMETRY

Mesh controllers

mesh mover linear	mesh mover rotation
mesh mover file	mesh module 6dof
mesh module servo	

Mesh deformation

mesh module deform	

Mesh import*

mesh*	

Mesh manipulation

defeaturing[S]*	mesh module deform
mesh module motion*	mesh module motion coin
mesh module motion file*	mesh module motion linear*
mesh module motion riggle*	mesh module motion rotate*
mesh module motion wiggle*	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - MESHES AND GEOMETRY

Mesh modules

mesh module 6dof	mesh 6dof external (Simulink/Simscape, MSC Adams)[s]
mesh module binning[s]	mesh module contact
mesh module contact deletion[s]	mesh module cutting
mesh module deform	mesh heat transfer
mesh module liquid transfer	mesh module motion*
mesh module servo	mesh module stress_average
mesh wear	mesh modules

Region

block*	cone
cylinder*	halfspace
intersect	prism
sphere*	subtract
union	wedge
mesh vtk	

Walls

wall reflect[s]	sieving
wall reflect mesh[s]	primitive wall*
wall contact model*	

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - FUNCTIONALITIES

Boundary conditions*

boundary conditions*	simulation domain*

Integration

nve sphere limit[s]	reset timestep[s]
integrator	nonspherical integrator predictor/corrector
nonspherical integrator richardson	nonspherical integrator symplectic
nonspherical integrator woodem	velocity limit
simulate*	simulation timestep*

Neighbor list

multilevel neighborlist	neighbor list*

Particle deletion

delete particles*	mesh module contact deletion[s]
remove[s]	

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - FUNCTIONALITIES

Particle insertion

create particles*	insert stream predefined[S]
prepare packing[S]	dense packing (experimental)*
dilute packing*	insertion*
insertion laser	insertion pack*
insertion rate in region*	insertion spray nozzle
insertion stream	insertion stream regionfill
particle_distribution*	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - FUNCTIONALITIES

Particle manipulation

displace particles[s]	add force
lineforce[s]	move
planeforce[s]	set force
viscous	replicate[s]
set[s]*	variable[s]*
velocity[s]	group definition
group deletion[s]	addforce steadystate[s]
add weighted force	change size
change size multisphere	change size superquadric
change size superquadric anisotropic	change type[s]
grow particles	set velocity
addforce steadystate experimental[s]	set multisphere[s]
torque[s]	update particle

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - POSTPROCESSING

Collision statistics

calculate collision statistics	coordination number

Energy balance

calculate external_work	calculate energy dissipated
calculate energy wall dissipated	calculate energy elastic cohesion
calculate energy elastic normal	calculate energy wall elastic cohesion
calculate energy wall elastic normal	

Fiber data[S]

bond fiber topology[S]	bond fiber[S]

Mesh residence time

mesh module contact	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - POSTPROCESSING

Meshes

calculate average	calculate electric_current
calculate electric_resistance	calculate external_work
calculate maximum*	calculate minimum*
calculate sum	calculate voltage
mesh area	mesh velocity

Particle data

store state[s]	variable[s]*
calculate	calculate average
calculate center of mass	calculate marked particles
calculate massflow	calculate maximum*
calculate minimum*	calculate mixing index*
calculate particle bond network	calculate particle contact network
calculate residence distance	calculate residence time
calculate spatial average	calculate spatio temporal average
calculate strain	calculate stress
calculate sum	calculate temporal average*
calculate voronoi decomposition	calculate wall bond network
calculate wall contact network	cross-section
group definition	group deletion[s]

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - POSTPROCESSING

Post simulation evaluation

calculate massflow	calculate residence time
calculate spatial average	write to files*

Residence time distribution

calculate residence distance	calculate residence time
mark inserted particles	mark particles

Scalability and speed*

check timestep*	

Spatial and temporal averaging

calculate	calculate average
calculate center of mass	calculate maximum*
calculate minimum*	calculate mixing index*
calculate spatial average	calculate spatio temporal average
calculate sum	calculate temporal average*
calculate voronoi decomposition	detect steady states
temporal steady state detections	continuum weighted averages

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

FEATURE LIST - POSTPROCESSING

Stresses and force network

calculate particle bond network	calculate particle contact network
calculate wall bond network	calculate wall contact network
pressure simplistic	mesh module binning[S]
mesh module stress_average	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - IO

Meshes

output settings*	modify output settings[s]

Reader

read*	reader pvd[s]

Write expert

dump image[s]	dump modify[s]
modify dump vtk[s]	write data*
dump euler vtk[s]	dump field vtk cell[s]
dump mesh volume vtk[s]	dump region neighbor field list[s]

Write standard

origin[s]	restart[s]
status[s]	status log[s]
status modify[s]	status style[s]
undump[s]	write restart*
write on signal[s]	dump decomposition
output settings*	write meshed particles*
modify output settings[s]	write output timestep*
write to file[s]*	write to terminal timestep*

[s] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - SCALABILITY AND SPEED

Coarsegraining*

coarsegraining*	

Loadbalancing*

rcb loadbalancing*	

Parallelization

partitions[S]	processors

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - COUPLING INTERFACE

CFD 1-way coupling

velocity fields	resample vtk[s]
compressible flows	incompressible flows
one-way coupling with rotating zone	temperature fields
transient one-way coupling	

CFD 4-way coupling (linux only)

include foam variables[s]	CFD coupling
DEM drag	

FEM coupling (linux only)[s]

FEM coupling to Elmer[s]	Howto for FEM coupling (Linux only)[s]

MBD coupling[s]

mesh 6dof external (Simulink/Simscape, MSC Adams)[s]	

Electric field coupling

electric field	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - APIs

API: c++s

aspherixs	

API: pythons

aspherixs	

Custom contact modelss

aspherix contact model externals	aspherix particle interactions
aspherix contact model external connectors	normal model externals

Custom equationss

aspherix fixs	aspherix fix externals

Custom mesh accesss

aspherix meshs	aspherix mesh elements
aspherix mesh element lists	

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized

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FEATURE LIST - APIs

Custom particle properties[S]

aspherix global properties[S]	aspherix particle[S]
aspherix particle list[S]	aspherix quaternion[S]
aspherix variable[S]	aspherix vector[S]

[S] functionality available in Aspherix® Solver only
* functionality GPU optimized