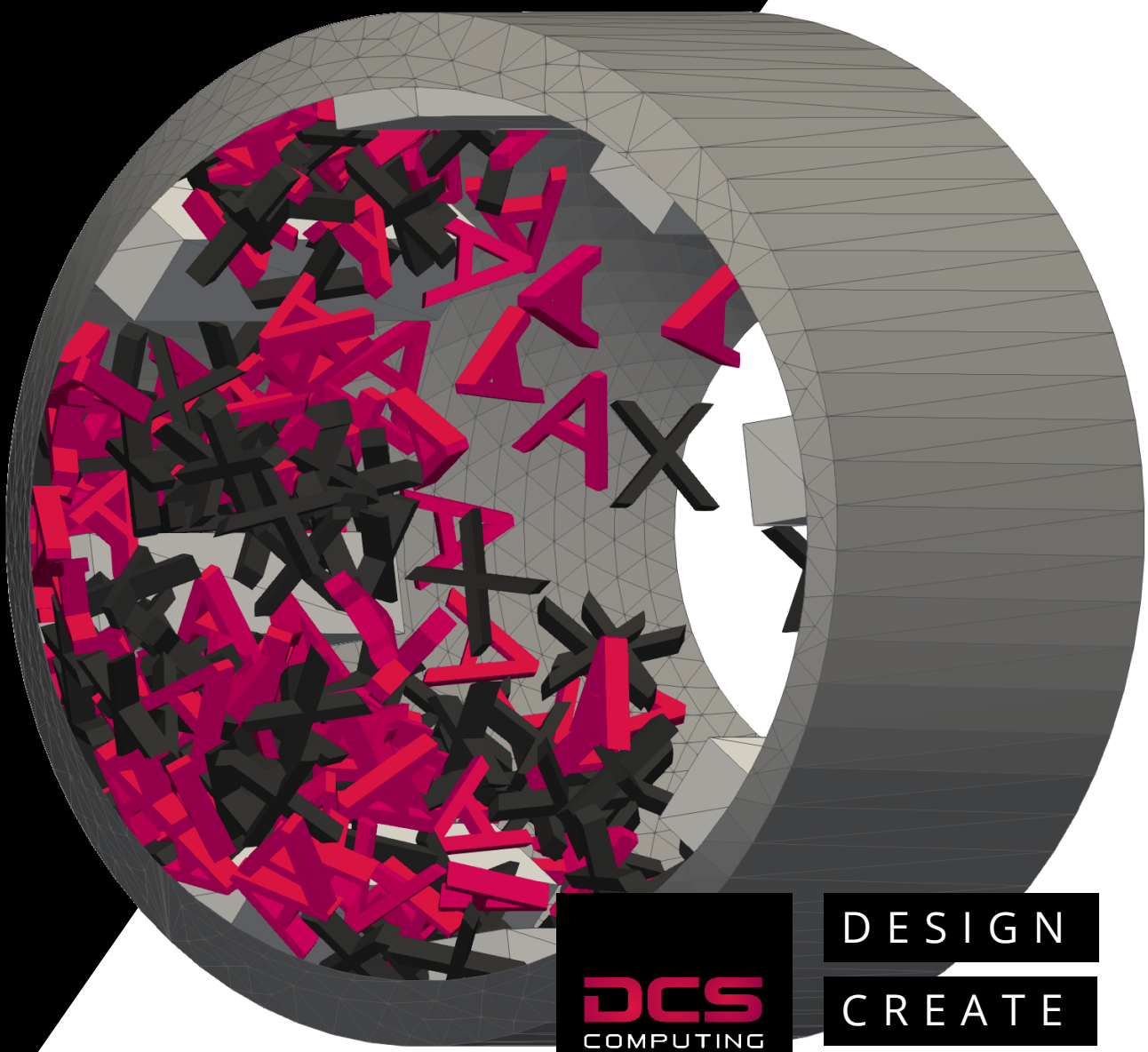
ASPHERiX

PRODUCT INFORMATION



DCS COMPUTING

DESIGN

CREATE

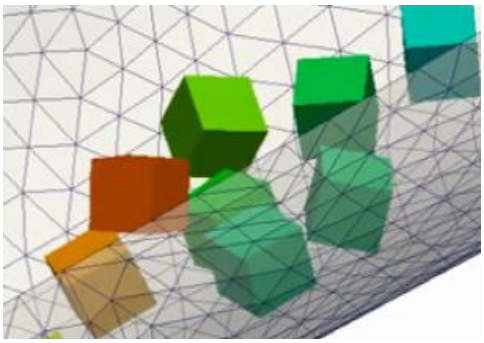
SIMULATE

ASPHERIX

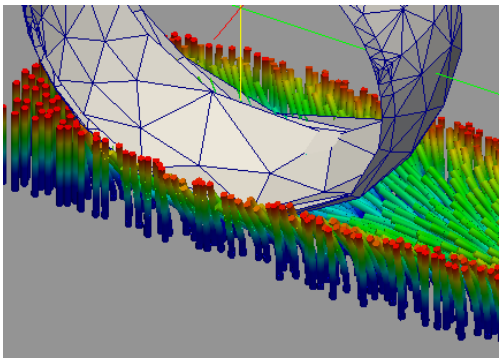
PARTICLE SHAPES

Aspherix® supports a large variety of particle shapes

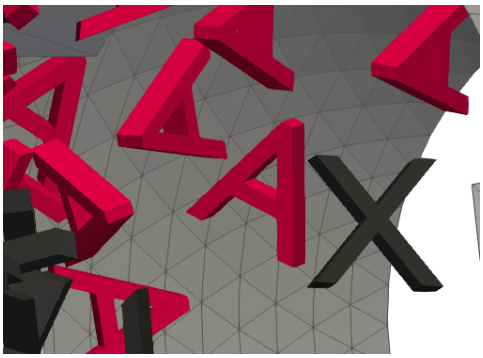
Convex triangulated



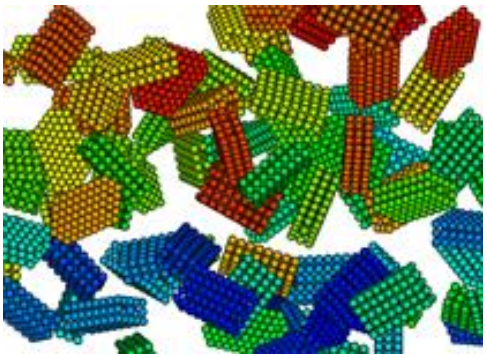
Fiber and bonded



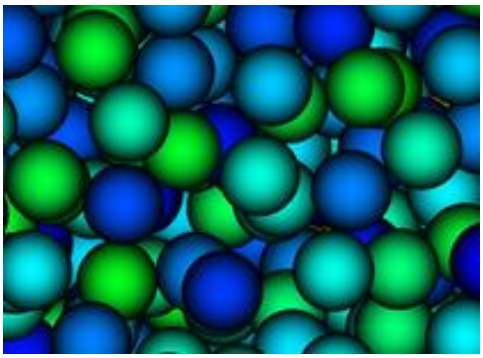
Concave triangulated



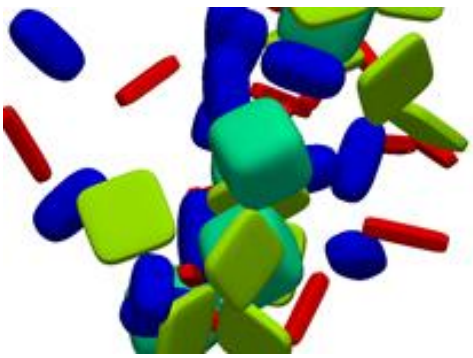
Multisphere



Sphere



Box, cylinder, ellipsoid

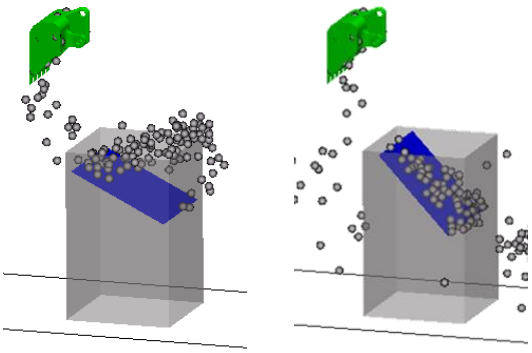


ASPHERIX

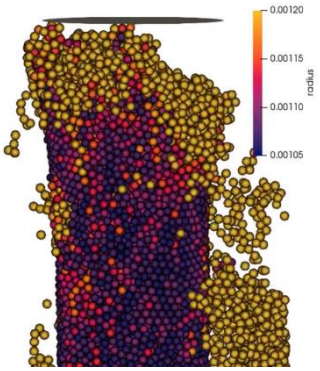
HIGHLIGHTS

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

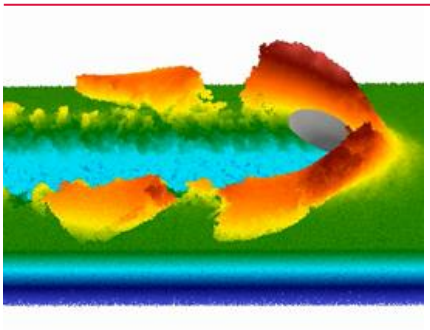
6 degree of freedom solver



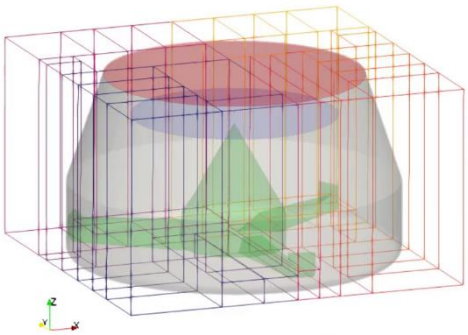
Powder compaction



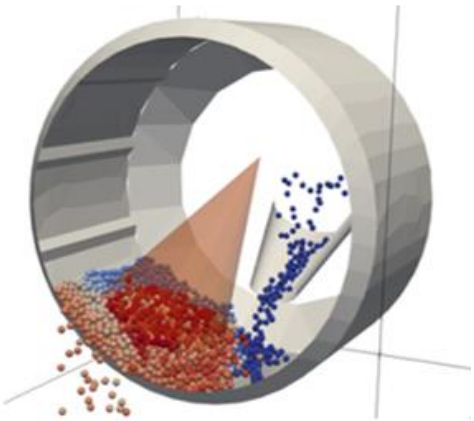
Cohesion models



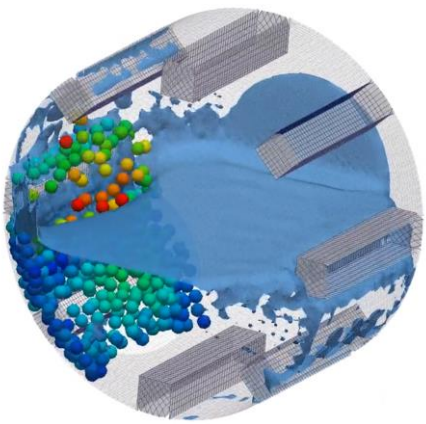
Loadbalancing



Spray coating



Coupling interface

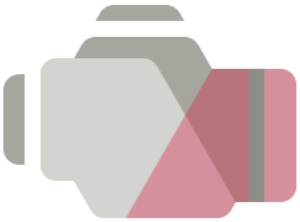


ASPHERIX

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:

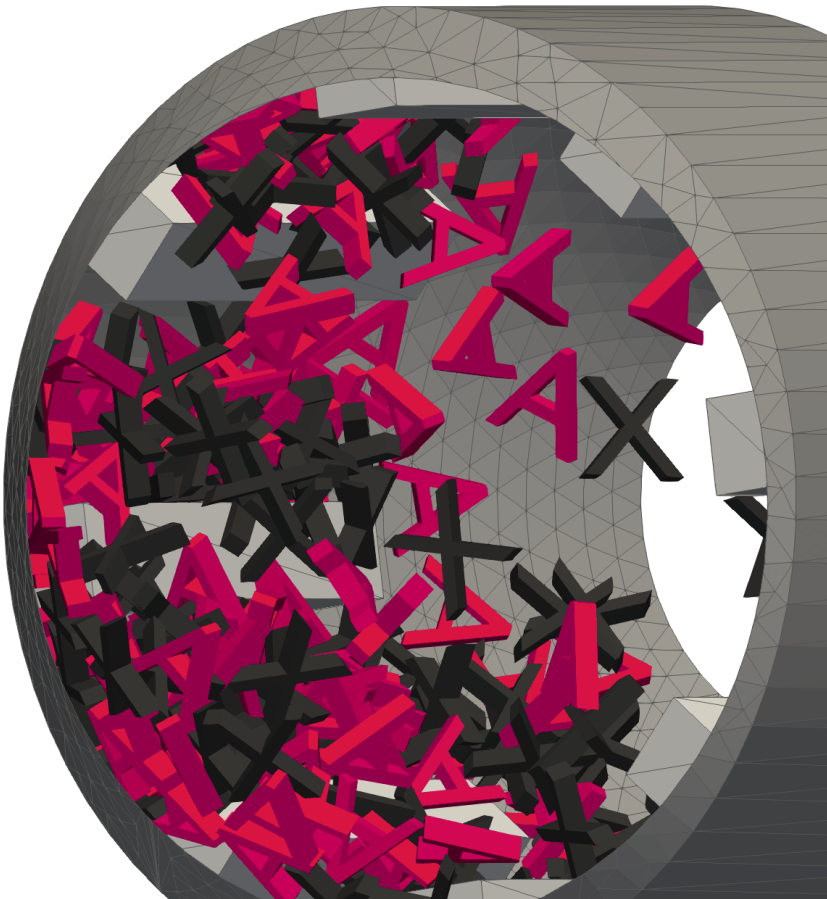
Desktop machines

Clusters

Clouds

ASPHERIX® is available for Linux and Windows

FEATURE LIST OVERVIEW



ASPHERIX

FEATURE LIST - OVERVIEW

Physics models

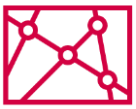
- 6 degrees of freedom solver
- body forces
- bond models
- cohesion
- equipment wear and attrition
- fast DEM
- fiber cutting
- fiber models
- frictional heating
- heat transfer
- liquid bridges and liquid transport
- mass transfer and chemical reactions
- material properties
- mesh deformation
- normal models
- pair styles
- particle breakage and attrition
- particle deformation
- powder compaction
- rolling friction
- sedimentation
- spray coating
- tangential models

ASPHERIX

FEATURE LIST - OVERVIEW

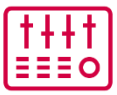
Particle shapes

• bonded	• fiber
• box	• multisphere
• capsule	• rod
• concave triangulated	• sphere
• convex triangulated	• superquadric
• cylinder	• tablet
• ellipsoid	



Meshes and geometry

• mesh	• mesh modules
• mesh controllers	• region
• mesh import	• walls
• mesh manipulation	



Functionalities

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

ASPHERIX

FEATURE LIST - OVERVIEW

Postprocessing

• collision statistics	• other
• energy balance	• particle data
• fiber data	• residence time distribution
• intra-particle coating variability	• spatial and temporal averaging
• mesh residence time	• stresses and force network
• meshes	

IO

• meshes	• write expert
• reader	• write standard

Scalability and speed

• coarsegraining	• loadbalancing

ASPHERIX

FEATURE LIST - OVERVIEW

Coupling interface

- CFD 1-way coupling
- CFD 4-way coupling (Linux only)
- MBD coupling

API

- API: C++
- API: Python
- custom contact models
- custom equations
- custom mesh access
- custom particle properties

ASPHERIX

SYSTEM REQUIREMENTS

Aspherix® Solver - MPI

Windows	Linux
• delivered with installer	• MPI is required
	• has to support MPI 3 standard (e.g. min OpenMPI 1.8, or MPICH 3.0)

Aspherix® Solver - API

	Linux
	• cmake is required (min cmake 3.0)

System requirements - Operating systems

- Windows 10
- Ubuntu 16.04, 18.04. 20.04
- Centos / Red Hat 7,8
- Suse Enterprise 12,15
- GUI requires glibc 2.17 or higher

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

ASPHERIX

SYSTEM REQUIREMENTS

Prerequisites for coupling interfaces only

CFDEMcoupling:

- OpenFOAM 8*
- Linux only (systems as specified on previous page)
- 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

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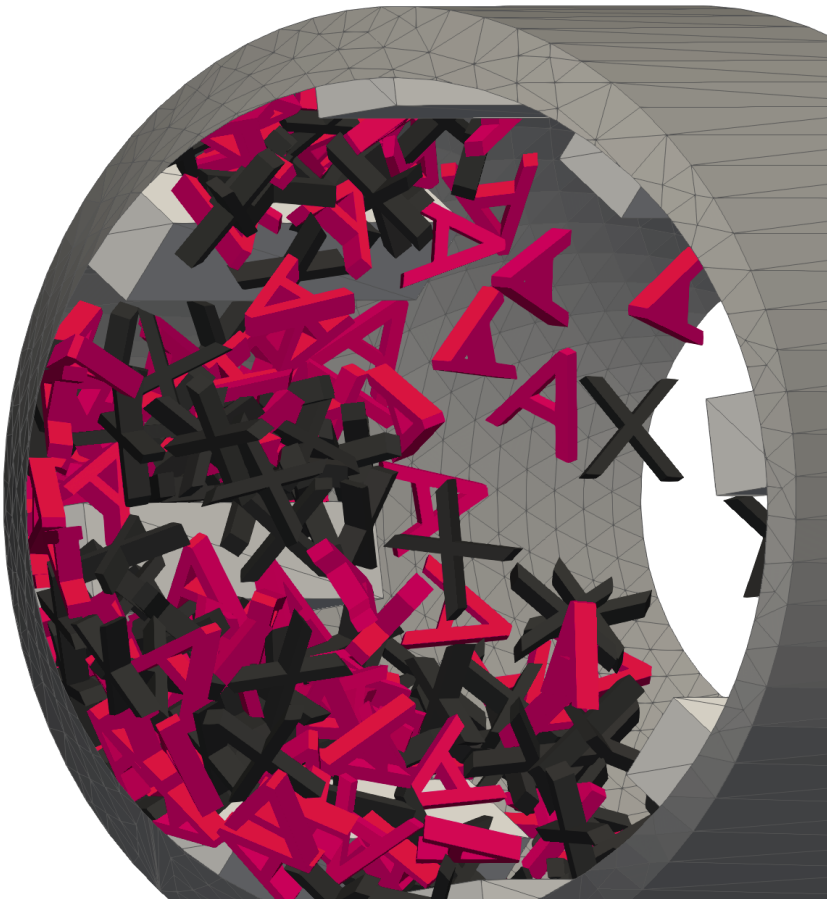
FEATURE LIST DETAILS



FEATURE LIST - PHYSICS MODELS

6 degrees of freedom solver

- mesh module stress 6dof

Body forces

- enable buoyancy
- enable gravity
- freeze

Bond models

- bond
- bond relativ

Cohesion

- adaptive
- asphalt
- bond
- bond relativ
- 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)
- lubrication
- powder
- sjkr
- sjkr selective
- sjkr temp
- sjkr time dependent
- sjkr2
- washino capillary viscous

FEATURE LIST - PHYSICS MODELS

Equipment wear and attrition

- archard
- finnie
- mesh stress wear

Fast DEM

- ave euler custom

Fiber cutting

- mesh module cutting

Fiber models

- fiber
- fiber buckle base
- fiber plastic base
- fiber wet base

Frictional heating

- surface model surfaceheating

Heat transfer

- enable heat conduction
- mesh heat transfer
- roasting
- shell

FEATURE LIST - PHYSICS MODELS

Liquid bridges and liquid transport

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

Mass transfer and chemical reactions

- change size
- change size multisphere
- change size superquadric
- change size superquadric anisotropic
- melting

Material properties

- material interaction properties
- material properties
- materials

Mesh deformation

- mesh module stress deform

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FEATURE LIST - PHYSICS MODELS

Normal models

- hertz
- hertz fragmentation bruchmueller
- hertz stiffness
- hertz time dependent
- hooke
- hooke hysteresis
- hooke scale invariant
- hooke stiffness
- jkr
- jkr/general
- thornton-ning

Pair styles

- particle contact model
- stokes dynamics

Particle breakage and attrition

- hertz fragmentation bruchmueller
- hertz fragmentation bruchmueller unresolved
- history attrition

Particle deformation

- multicontact halfspace
- surface model multicontact

Powder compaction

- powder cluster model

FEATURE LIST - PHYSICS MODELS

Rolling friction

- cdt
- epsd
- epsd2
- epsd3
- simplistic

Sedimentation

- mesh module contact deletion

Spray coating

- DEM spray particles
- detect surface
- liquid transport

Tangential models

- burgers asphalt
- history
- history attrition
- history powder
- history tempdep
- history time dependent
- no history

ASPHERIX

FEATURE LIST - MESHES AND GEOMETRY

Mesh

- volume vtk

Mesh controllers

- mesh control
- mesh module stress 6dof
- mesh module stress servo
- mesh mover file
- mesh mover linear
- mesh mover rotation

Mesh import

- mesh
- mesh modules

Mesh manipulation

- defeaturing
- mesh
- mesh module motion
- mesh module stress deform

Mesh modules

- mesh 6dof external (Simulink/Simscape, MSC Adams)
- mesh heat transfer
- mesh module binning
- mesh module contact deletion
- mesh module cutting
- mesh module liquid transfer
- mesh module stress 6dof
- mesh module stress contact
- mesh module stress deform
- mesh module stress servo

FEATURE LIST - MESHES AND GEOMETRY

Region

• block	• prism
• cone	• sphere
• cylinder	• subtract
• intersect	• union
• mesh vtk	• wedge
• plane	

Walls

• primitive wall	• wall reflect
• Sieving	• wall reflect mesh
• wall contact model	

FEATURE LIST - FUNCTIONALITIES

Boundary conditions

- boundary conditions
- simulation domain

Integration

- integrator
- nonspherical integrator woodem
- nonspherical integrator predictor/corrector
- nve sphere limit
- nonspherical integrator richardson
- simulate
- nonspherical integrator symplectic
- simulation timestep

Neighbor list

- multilevel neighborlist
- neighbor list

Particle deletion

- delete particles
- remove
- mesh module contact deletion

Particle insertion

- create particles
- insert stream predefined
- dense packing (experimental)
- insertion
- dilute packing
- particle_distribution
- insert rate in region
- prepare packing
- insert stream moving

Particle manipulation

- change size
- change size multisphere
- change size superquadric
- change size superquadric anisotropic
- change type
- displace particles
- group
- grow particles
- move
- replicate
- set
- set force
- set multisphere
- set velocity
- torque
- update_particle
- variable
- velocity
- viscous

FEATURE LIST - POSTPROCESSING

Collision statistics

- contact atom counter
- coordination number

Energy balance

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

Fiber data

- bond fiber
- bond fiber topology

Intra-particle coating variability

- dump particle meshed

Mesh residence time

- mesh module stress contact

Meshes

- calculate external_work
- mesh area
- mesh velocity

FEATURE LIST - POSTPROCESSING

Other

- check timestep

Particle data

- calculate
- calculate average
- calculate center of mass
- calculate marked particles
- calculate massflow
- calculate maximum
- calculate minimum
- calculate mixing index
- calculate particle contact network
- calculate residence distance
- calculate residence time
- calculate spatial average
- calculate sum
- calculate temporal average
- calculate wall contact network
- cross-section
- group
- reduce
- store state
- variable

Residence time distribution

- calculate residence distance
- calculate residence time
- mark inserted particles
- mark particles

FEATURE LIST - POSTPROCESSING

Spatial and temporal averaging

- ave euler custom
- calculate
- calculate average
- calculate center of mass
- calculate maximum
- calculate minimum
- calculate mixing index
- calculate spatial average
- calculate sum
- calculate temporal average
- voronoi
- voronoi/base

Stresses and force network

- calculate particle contact network
- calculate wall contact network
- mesh module binning
- mesh module stress_average
- pressure simplistic

FEATURE LIST - IO

Meshes

- output settings

Reader

- read

Write expert

- dump euler vtk
- dump field vtk cell
- dump image
- dump mesh volume vtk
- dump region neighbor field list
- write data

Write standard

- dump decomposition
- dump particle meshed
- origin
- output settings
- write output timestep
- write restart
- write to file
- write to terminal timestep

FEATURE LIST - SCALABILITY AND SPEED

Coarsegraining

- coarsegraining

Loadbalancing

- rcb loadbalancing

ASPHERIX

FEATURE LIST - COUPLING INTERFACE

CFD 1-way coupling

- dragforce field compressible
- dragtorque field compressible
- enable one-way coupling
- enable one-way coupling moving reference frame (MRF)
- enable one-way coupling transient
- temperature fluid field

CFD 4-way coupling (Linux only)

- include foam variables

MBD coupling

- mesh 6dof external (Simulink/Simscape, MSC Adams)

FEATURE LIST - API

API: C++

- aspherix

API: Python

- aspherix

Custom contact models

- aspherix contact model external
- aspherix contact model external connector
- aspherix particle interaction
- normal model external

Custom equations

- aspherix fix
- aspherix fix external

Custom mesh access

- aspherix mesh
- aspherix mesh element
- aspherix mesh element list

Custom particle properties

- aspherix global properties
- aspherix particle
- aspherix particle list
- aspherix quaternion
- aspherix variable
- aspherix vector