

IST, Lisbon, 22-24 October 2018

4th DualSPHysics Users Workshop

Novelties on DualSPHysics:
solver, pre-processing
and post-processing

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OUTLINE

Novelties on v4.2

Novelties on pre-processing

Novelties on post-processing

Novelties on v4.3

How to download beta v4.3

BEFORE

How to prepare a release of an open-source code?

1. Source code (debugging, comments, previous ok)
2. Working examples (easy for users, many options)
3. Many files of help (XML templates)
4. User guides (PDFs, WIKI):
 - SPH formulation
 - Details of the implementation
 - How to compile the code (linux and windows)
 - Details of the working examples
 - How to generate new cases
5. Upload files in the website and GitHub
6. Check that everything works ok

Novelties on v4.2

SPH FORMULATION

GITHUB

WIKI

NEW STRUCTURE

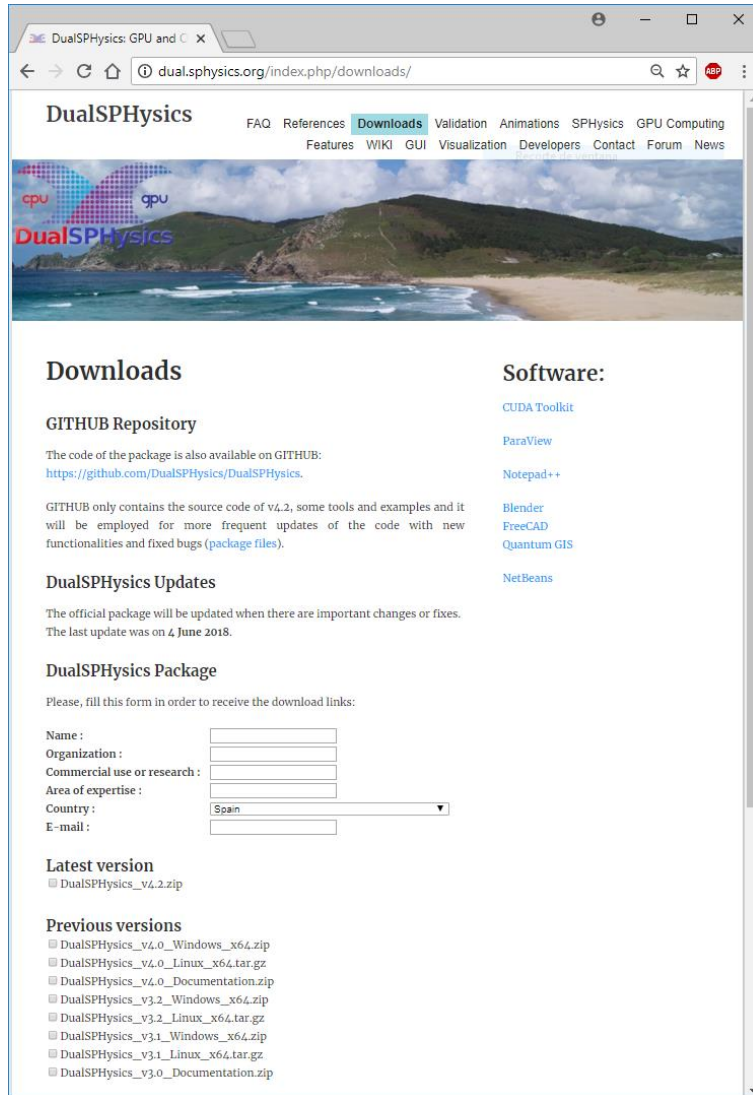
NEW LICENSE LGPL

Novelties on v4.2 – SPH Formulation

- Parallelisation with OpenMP and CUDA (one GPU card) ([Domínguez et al., 2013](#))
- Time integration scheme: Verlet ([Verlet, 1967](#)) & Symplectic ([Leimkhuler, 1996](#))
- Variable time step ([Monaghan and Kos, 1999](#))
- Kernel functions: Cubic Spline ([Monaghan and Lattanzio, 1985](#)) & Quintic Wendland ([Wendland, 1995](#))
- Density treatment: Delta-SPH formulation ([Molteni and Colagrossi, 2009](#))
- Viscosity: Artificial ([Monaghan, 1992](#)) & Laminar + SPS turbulence model ([Dalrymple and Rogers, 2006](#))
- Weakly compressible approach using Tait's equation of state ([Batchelor, 1974](#))
- Shifting algorithm ([Lind et al., 2012](#))
- Dynamic boundary conditions ([Crespo et al., 2007](#))
- Floating objects ([Monaghan et al., 2003](#))
- Periodic open boundaries ([Gómez-Gesteira et al., 2012](#))
- Coupling with Discrete Element Method ([Canelas et al., 2016](#))
- External body forces ([Longshaw and Rogers, 2015](#))
- Double precision ([Domínguez et al., 2013](#))
- Multi-phase (soil-water) ([Fourtakas and Rogers, 2016](#))
- Multi-phase (gas-liquid) ([Mokos et al., 2015](#))
- Piston- and flap-type long-crested second-order wave generation ([Altomare et al., 2017](#))
- Passive and Active Wave Absorption System ([Altomare et al., 2017](#))

Novelties on v4.2 - GITHUB

DualSPHysics Package
<http://dual.sphysics.org>



The screenshot shows the DualSPHysics website with the 'Downloads' tab selected in the navigation menu. The page features a header with the DualSPHysics logo and a navigation bar. Below the header, there is a large image of a beach and a section titled 'Downloads'. The 'Downloads' section includes a 'GITHUB Repository' link, a 'DualSPHysics Updates' section, and a 'DualSPHysics Package' section with a form to request download links. The 'Latest version' section shows the download link for DualSPHysics_v4.2.zip. The 'Previous versions' section lists various download links for different versions and operating systems.

Downloads

GITHUB Repository

The code of the package is also available on GITHUB:
<https://github.com/DualSPHysics/DualSPHysics>.

GITHUB only contains the source code of v4.2, some tools and examples and it will be employed for more frequent updates of the code with new functionalities and fixed bugs (package files).

DualSPHysics Updates

The official package will be updated when there are important changes or fixes.
The last update was on 4 June 2018.

DualSPHysics Package

Please, fill this form in order to receive the download links:

Name :
Organization :
Commercial use or research :
Area of expertise :
Country :
E-mail :

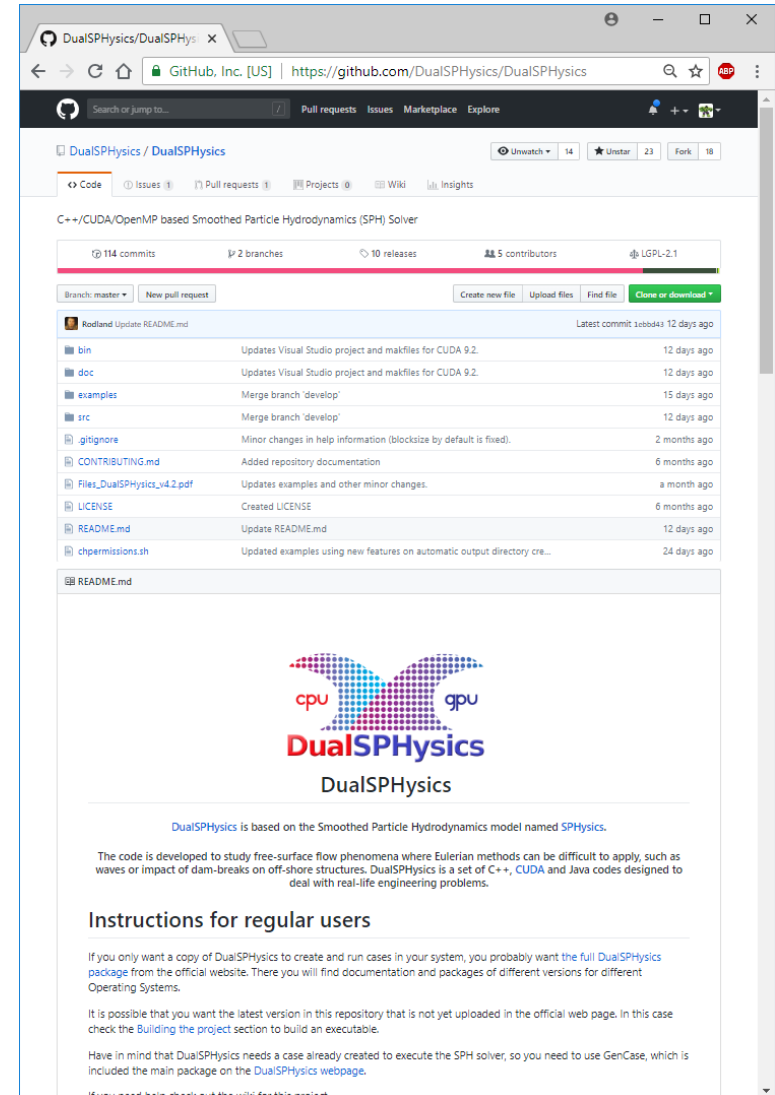
Latest version

[DualSPHysics_v4.2.zip](#)

Previous versions

- [DualSPHysics_v4.0_Windows_x64.zip](#)
- [DualSPHysics_v4.0_Linux_x64.tar.gz](#)
- [DualSPHysics_v4.0_Documentation.zip](#)
- [DualSPHysics_v3.2_Windows_x64.zip](#)
- [DualSPHysics_v3.2_Linux_x64.tar.gz](#)
- [DualSPHysics_v3.1_Windows_x64.zip](#)
- [DualSPHysics_v3.1_Linux_x64.tar.gz](#)
- [DualSPHysics_v3.0_Documentation.zip](#)

DualSPHysics Code on GitHub (since v4.2)
<https://github.com/DualSPHysics/DualSPHysics>



The screenshot shows the GitHub repository page for DualSPHysics. The page displays the repository name, the number of commits, branches, releases, contributors, and forks. It also shows a list of files and folders, including bin, doc, examples, src, gitignore, CONTRIBUTING.md, Files_DualSPHysics_v4.2.pdf, LICENSE, README.md, and chpermissions.sh. The README.md file is selected, showing the DualSPHysics logo and the text: 'DualSPHysics is based on the Smoothed Particle Hydrodynamics model named SPHysics. The code is developed to study free-surface flow phenomena where Eulerian methods can be difficult to apply, such as waves or impact of dam-breaks on off-shore structures. DualSPHysics is a set of C++, CUDA and Java codes designed to deal with real-life engineering problems.' The 'Instructions for regular users' section provides information on how to use the code and where to find documentation.

DualSPHysics / DualSPHysics

Search or jump to... Pull requests Issues Marketplace Explore

DualSPHysics / DualSPHysics

Code Issues Pull requests Projects Wiki Insights

C++/CUDA/OpenMP based Smoothed Particle Hydrodynamics (SPH) Solver

114 commits 2 branches 10 releases 5 contributors LGPL-2.1

Branch: master New pull request Create new file Upload files Find file Clone or download

Rodland Update README.md Latest commit 1eb043 12 days ago

bin	Updates Visual Studio project and makfiles for CUDA 9.2.	12 days ago
doc	Updates Visual Studio project and makfiles for CUDA 9.2.	12 days ago
examples	Merge branch 'develop'	15 days ago
src	Merge branch 'develop'	12 days ago
gitignore	Minor changes in help information (blocksize by default is fixed).	2 months ago
CONTRIBUTING.md	Added repository documentation	6 months ago
Files_DualSPHysics_v4.2.pdf	Updates examples and other minor changes.	a month ago
LICENSE	Created LICENSE	6 months ago
README.md	Update README.md	12 days ago
chpermissions.sh	Updated examples using new features on automatic output directory cre...	24 days ago

README.md

DualSPHysics

DualSPHysics is based on the Smoothed Particle Hydrodynamics model named SPHysics.

The code is developed to study free-surface flow phenomena where Eulerian methods can be difficult to apply, such as waves or impact of dam-breaks on off-shore structures. DualSPHysics is a set of C++, CUDA and Java codes designed to deal with real-life engineering problems.

Instructions for regular users

If you only want a copy of DualSPHysics to create and run cases in your system, you probably want the full DualSPHysics package from the official website. There you will find documentation and packages of different versions for different Operating Systems.

It is possible that you want the latest version in this repository that is not yet uploaded in the official web page. In this case check the Building the project section to build an executable.

Have in mind that DualSPHysics needs a case already created to execute the SPH solver, so you need to use GenCase, which is included the main package on the DualSPHysics webpage.

If you need help check out the wiki for this project.

Novelties on v4.2 - WIKI

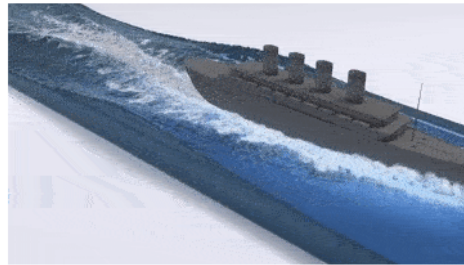
The users guide has been moved to a WIKI:

<https://github.com/DualSPHysics/DualSPHysics/wiki>



DualSPHysics is based on the Smoothed Particle Hydrodynamics model named SPHysics.

The code is developed to study free-surface flow phenomena where Eulerian methods can be difficult to apply, such as waves or impact of dam-breaks on off-shore structures. DualSPHysics is a set of C++, [CUDA](#) and Java codes designed to deal with real-life engineering problems.



Welcome to the DualSPHysics Wiki. Here you will find documentation and information about the DualSPHysics project: codes, structure, workflow, compilation, working examples, etc.

Suggestions and errors in the Wiki

If you have suggestions (a new section, corrections or contributions) please notify it using the [ISSUES section of the repository](#). Please include something like [WIKI] into the title to help us to prioritize the work.

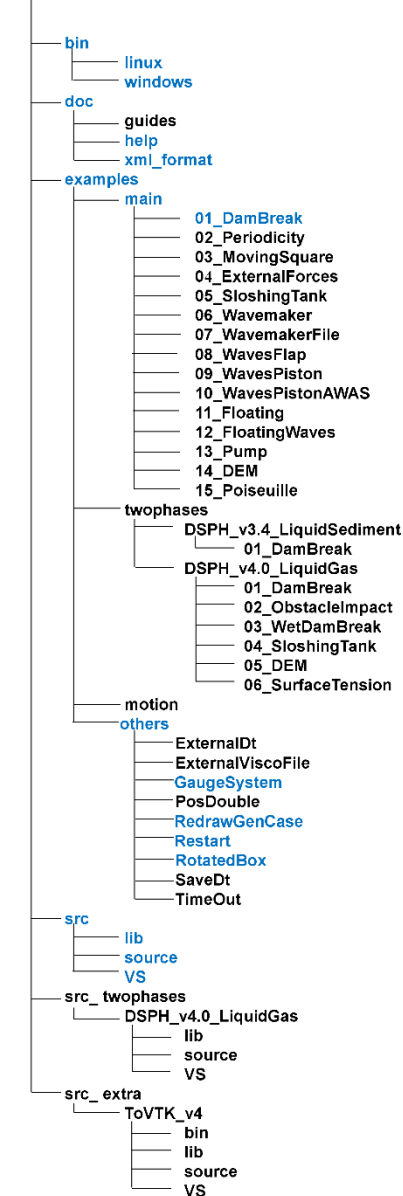
1. Introduction
2. Developers and institutions
3. SPH formulation
 - 3.1 The Smoothing Kernel
 - 3.2 Momentum Equation
 - 3.3 Continuity Equation
 - 3.4 Equation of State
 - 3.5 DeltaSPH
 - 3.6 Shifting algorithm
 - 3.7 Time stepping
 - 3.8 Boundary Conditions
 - 3.9 Wave Generation
 - 3.10 Passive and Active wave absorption
 - 3.11 Coupling with DEM
 - 3.12 Multi-phase: liquid-sediment
 - 3.13 Multi-phase: liquid-gas
 - 3.14 Coupling with Project Chrono
4. CPU and GPU implementation
5. Running DualSPHysics
6. DualSPHysics open-source code
7. Compiling DualSPHysics
8. Format Files
9. Pre-processing (GenCase)
10. Processing (DualSPHysics)
11. Post-processing
 - 11.1 PartVTK
 - 11.2 Boundary/VTK
 - 11.3 MeasureTool
 - 11.4 ComputeForces
 - 11.5 FloatingInfo
 - 11.6 IsoSurface
 - 11.7 FlowTool
12. Testcases
 - 12.1 DAMBREAK
 - 12.2 PERIODICITY
 - 12.3 MOVINGSQUARE
 - 12.3 MOVINGSQUARE

Novelties on v4.2 – New structure

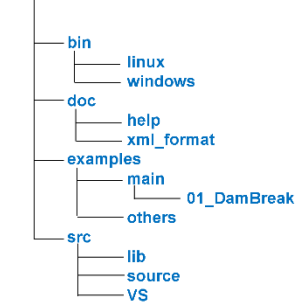
<http://dual.sphysics.org/index.php/downloads/>

<https://github.com/DualSPHysics/DualSPHysics>

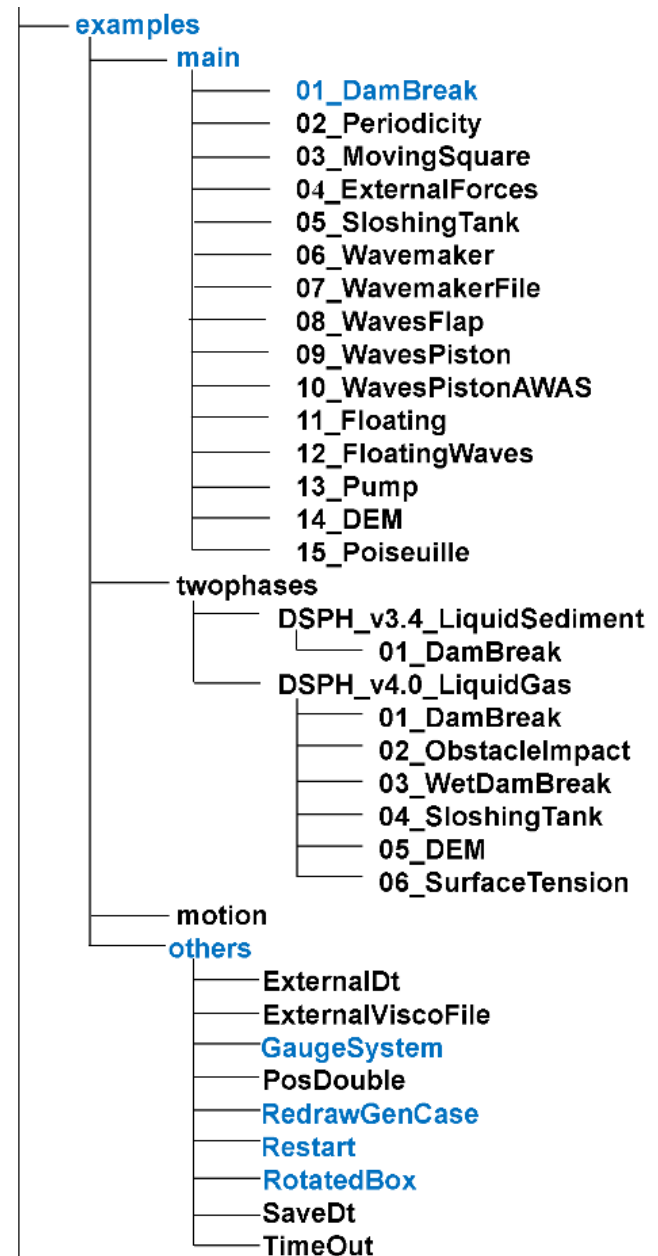
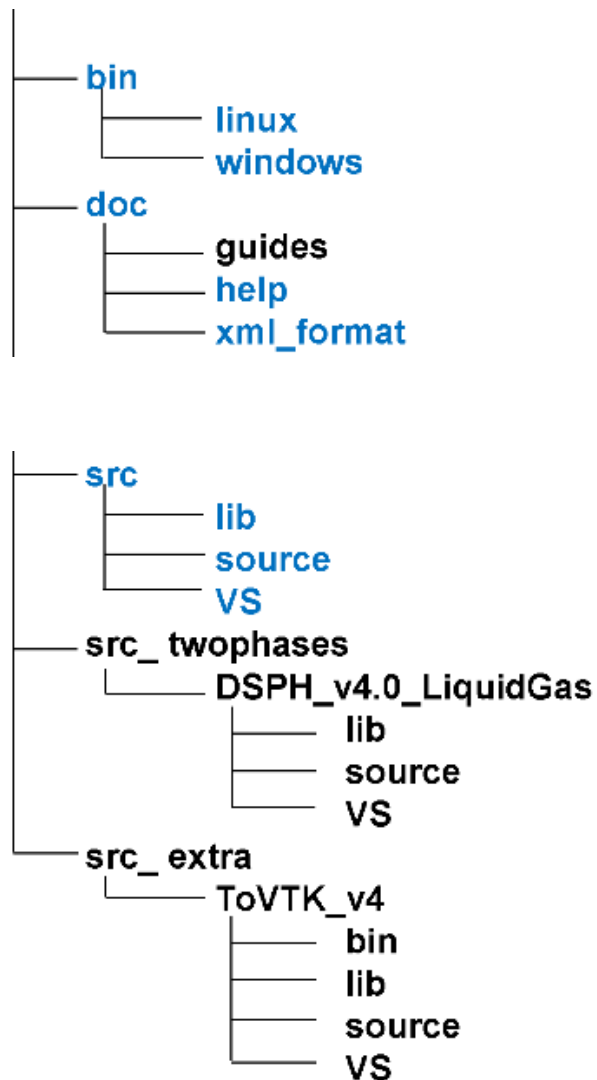
DualSPHysics_v4.2



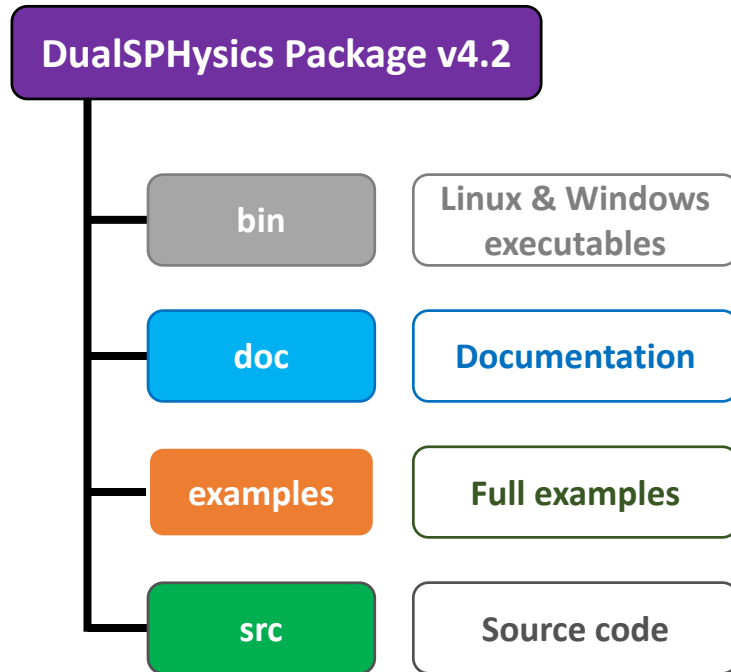
DualSPHysics



Novelties on v4.2 – New structure



Novelties on v4.2 – New structure



Linux & Windows executables:

Pre-processing:

- GenCase4

SPH solver:

- DualSPHysics4.2
- DualSPHysics4.0_LiquidGas
- DualSPHysics3.4_LiquidSediment

Post-processing (visualization):

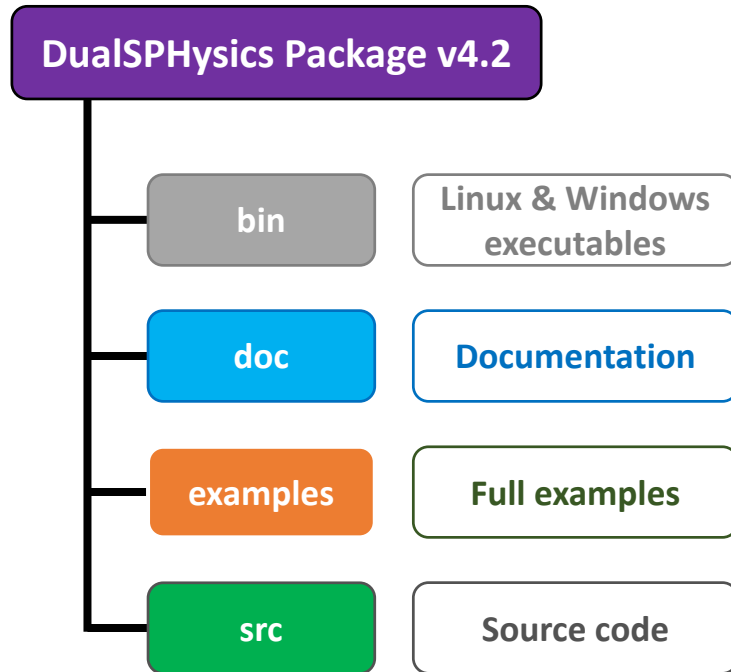
- PartVTK4
- PartVTKOut4
- IsoSurface4

Post-processing (calculations):

- BoundaryVTK4
- ComputeForces4
- FloatingInfo4
- FlowTool4
- MeasureTool4

LINUX & WINDOWS in the same package

Novelties on v4.2 – New structure



Documentation (guides and other help files) :

Pre-processing:

- XML_v4.0_GUIDE.pdf
- ExternalModelsConversion.pdf

SPH solver:

- DualSPHysics_v4.2_GUIDE.pdf
- DualSPHysics_v4.0_LiquidGas_GUIDE.pdf

Post-processing:

- PostprocessingCalculations_v4.2.pdf

Help of executables

XML Templates for configuration

DualSPHysics_v4.2_GUIDE.pdf -> WIKI

Novelties on v4.2 – New structure

DualSPPhysics Package v4.2

bin

Linux & Windows
executables

doc

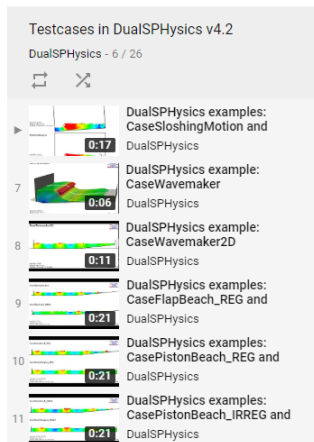
Documentation

examples

Full examples

src

Source code



[Playlist in YouTube](#)

Full examples (also pre-processing & post-processing):

DamBreak

WaveMaker

Floating

Periodicity

WavesFlap

FloatingWaves

MovingSquare

WavesPiston

Pump

ExternalForces

WavesPistonAWAS

DEM

SloshingTank

WaveMakerFile

Pouseuille

Full examples - LiquidSediment & LiquidGas:

Dambreak

ObstacleImpact

DamBreak

SloshingTank

WetDambreak

SurfaceTension

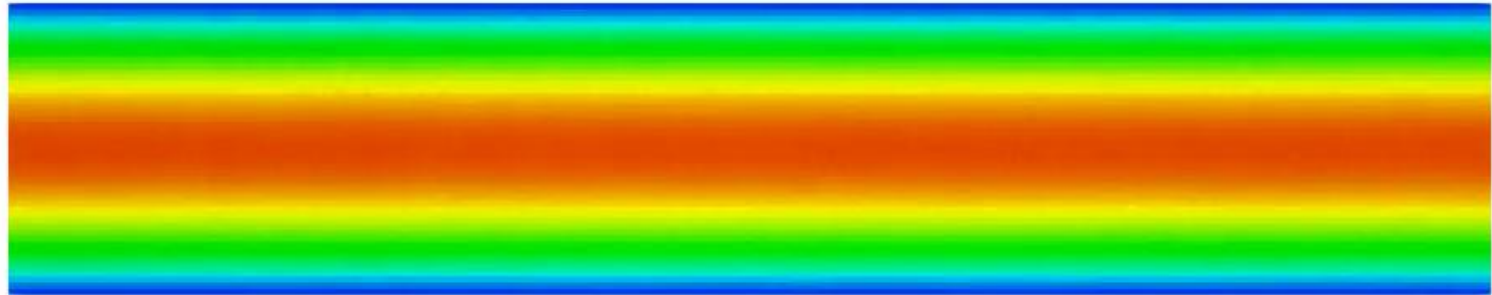
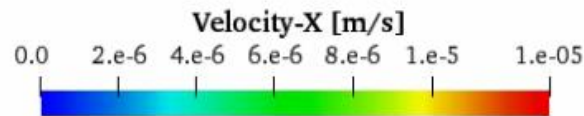
DEM

Novelties on v4.2 – New structure

New test cases

- Poiseuille flow
- Many floatings
- Flap and piston wavemakers
- Dike with AWAS where overtopping is computed

Case Poiseuille



particles: 12,750
physical time: 0.5 s
runtime (GTX 1080 Ti): 116 s

Time: 1.26 s

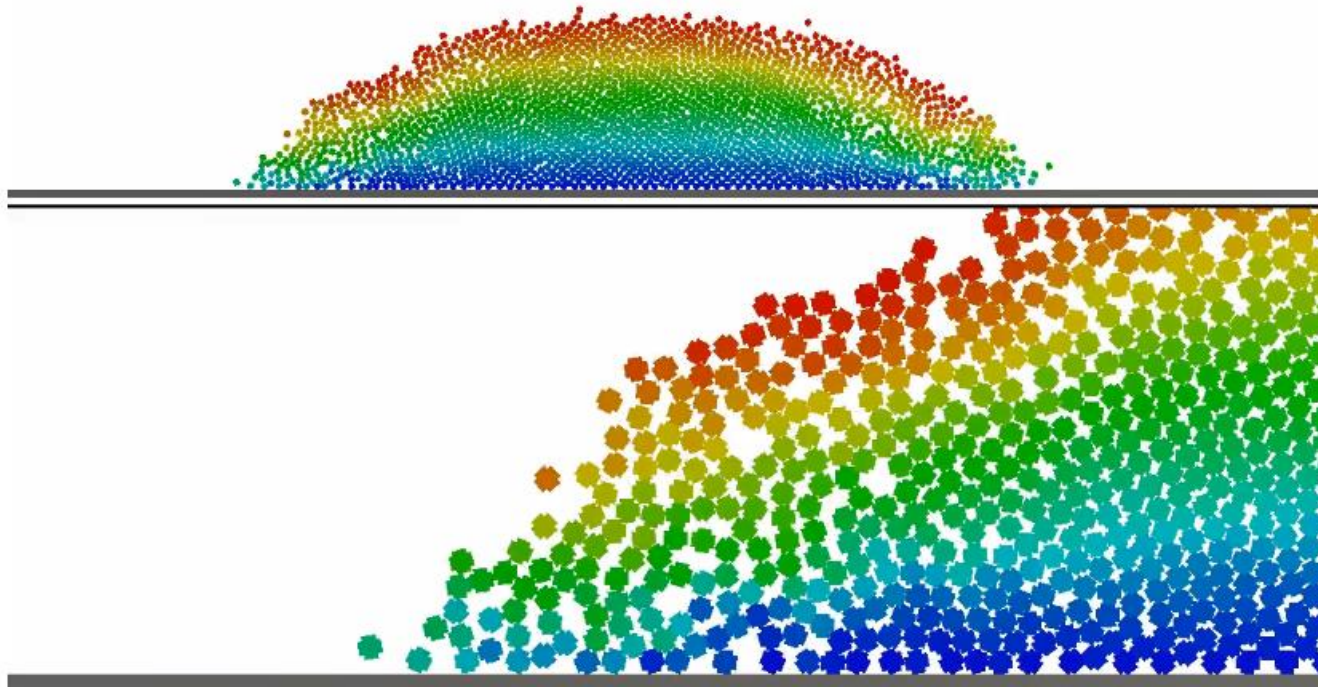
Novelties on v4.2 – New structure

New test cases

- Poiseuille flow
- Many floatings
- Flap and piston wavemakers
- Dike with AWAS where overtopping is computed

CaseManyFloatings
(2000 floating bodies with DEM)

Time: 1.12 s



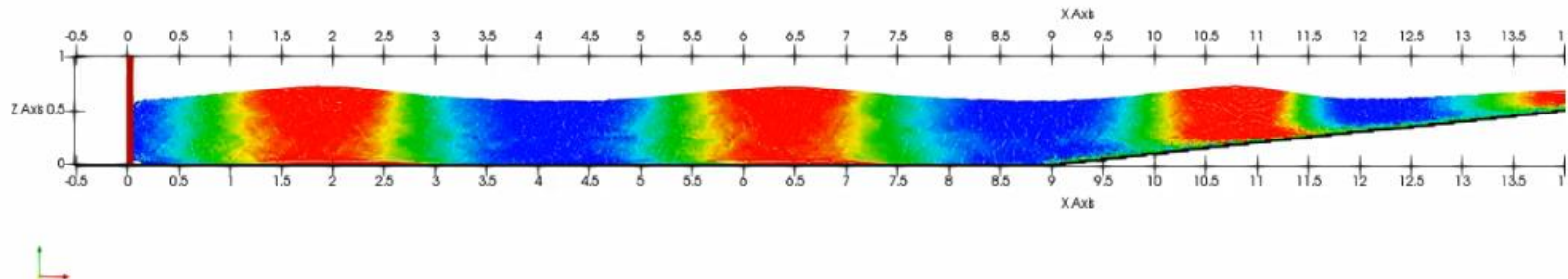
Novelties on v4.2 – New structure

New test cases

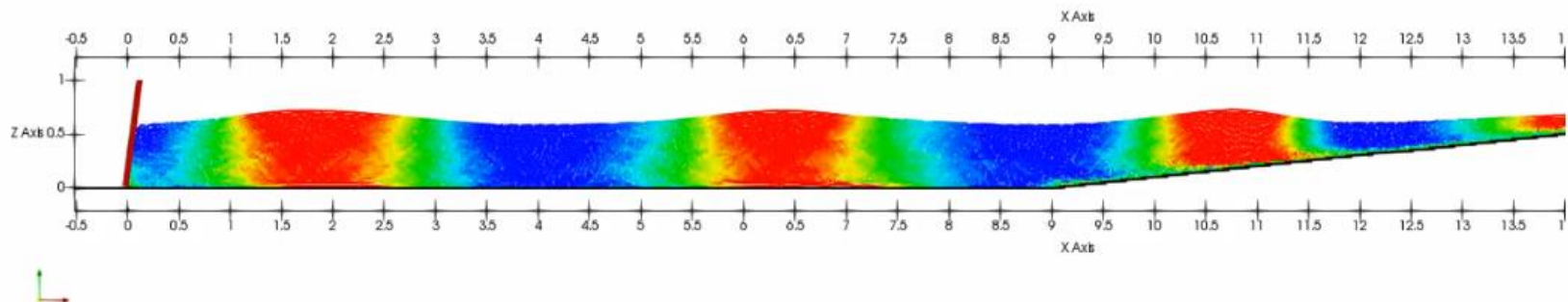
- Poiseuille flow
- Many floatings
- Flap and piston wavemakers
- Dike with AWAS where overtopping is computed

Time: 8.80 s

Piston ($H=0.15\text{m}$, $T=2\text{s}$, $d=0.66\text{m}$)



Flap ($H=0.15\text{m}$, $T=2\text{s}$, $d=0.66\text{m}$)



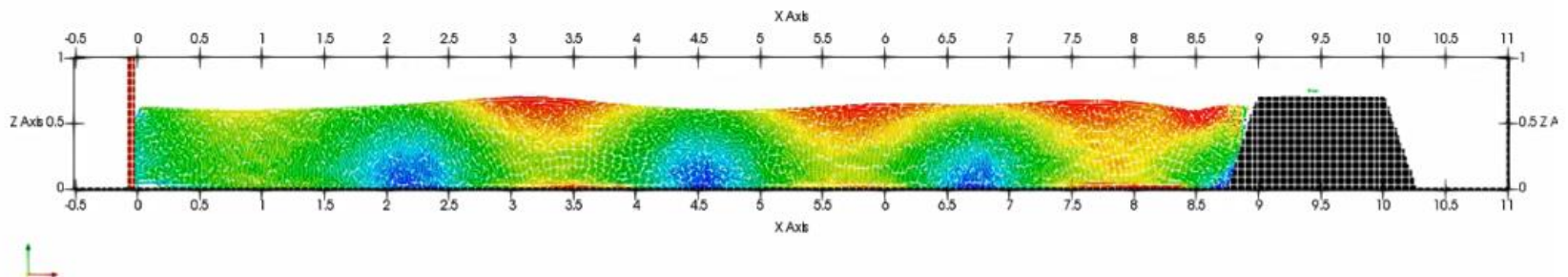
Novelties on v4.2 – New structure

New test cases

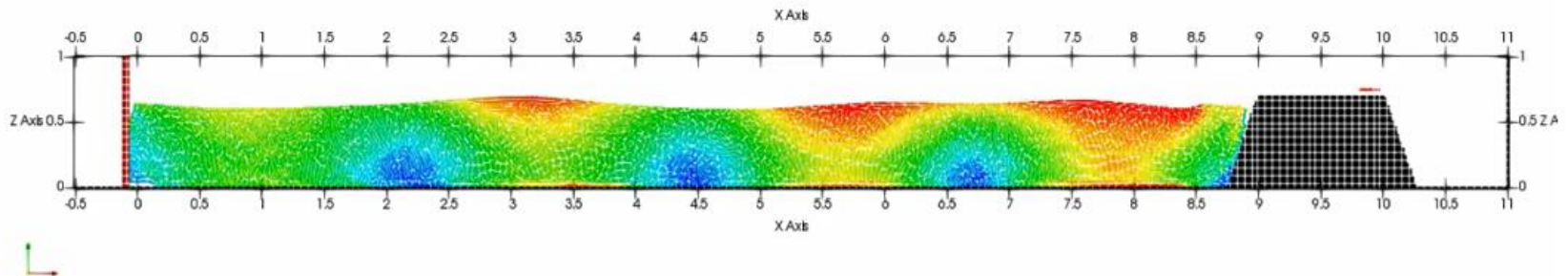
- Poiseuille flow
- Many floatings
- Flap and piston wavemakers
- Dike with AWAS where overtopping is computed

Time: 9.40 s

Piston AWAS (H=0.15m, T=2s, d=0.66m)



Piston NO AWAS (H=0.15m, T=2s, d=0.66m)



Novelties on v4.2 – New structure

New test cases

- More information for validations:

- CaseDambreakVal2D:	experimental data
- CaseSloshing:	experimental data
- CaseWavemaker2D:	experimental data
- CaseFlap:	theoretical solution
- CasePiston:	theoretical solution
- CaseFloatingSphereVal2D:	other numerical solution
- CaseFloatingWavesVal:	experimental data
- CaseFloatingWavesVal2:	experimental data
- CasePoiseuille:	theoretical solution

Novelties on v4.2 – New structure

New test cases

- More information for validations:

- CaseFloatingWavesVal2:

experimental data

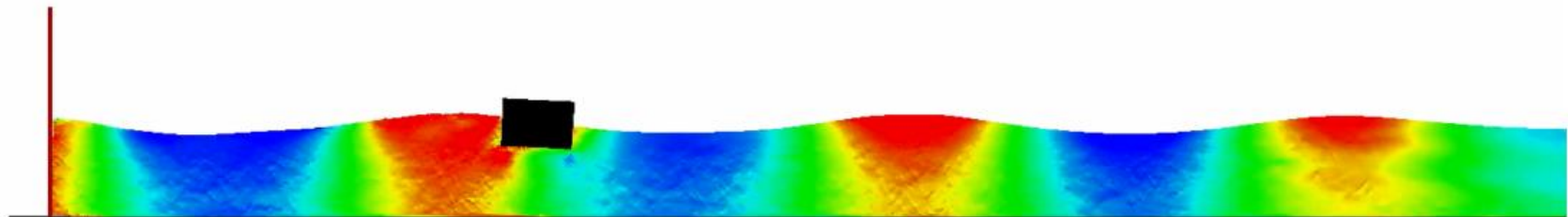
Validation of a floating box interacting with waves



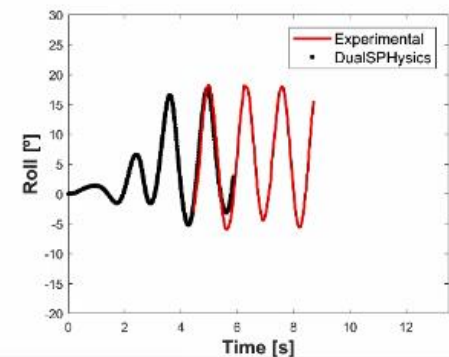
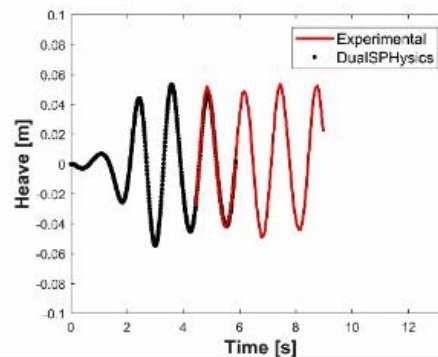
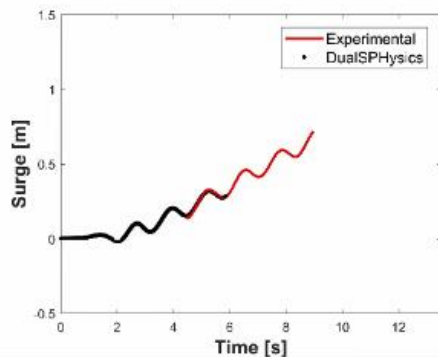
Regular waves:
 $H=0.1\text{m}$, $T=1.2\text{s}$, $d=0.4\text{m}$

Box dimensions:
 $0.3\text{m} \times 0.2\text{m}$

Wave absorption



Time: 5.86 s

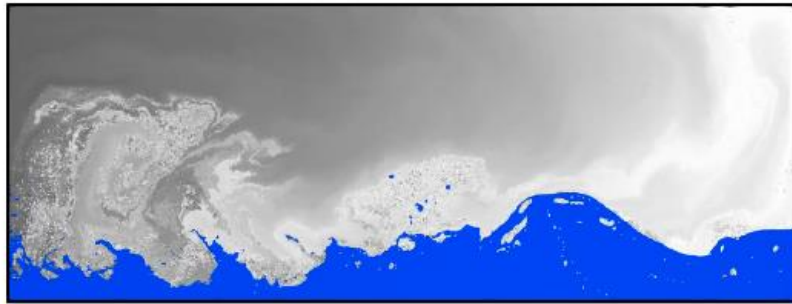


Novelties on v4.2 – New structure

Multiphase code: LiquidGas

- Source code and examples

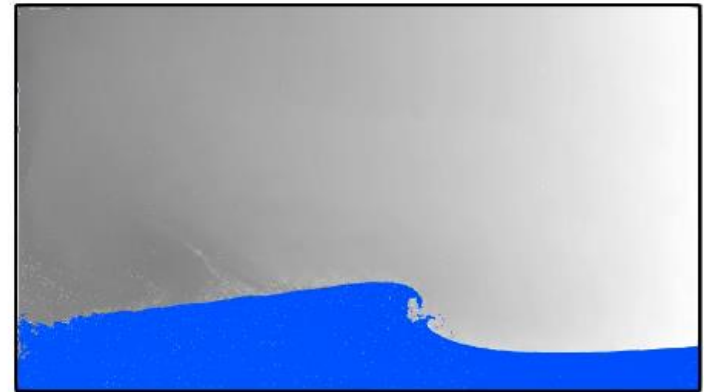
Case_Dambreak_LiquidGas



particles: 172,125
physical time: 3.0 s
runtime (GTX 1080 Ti): 1.6 h

Time: 2.22 s

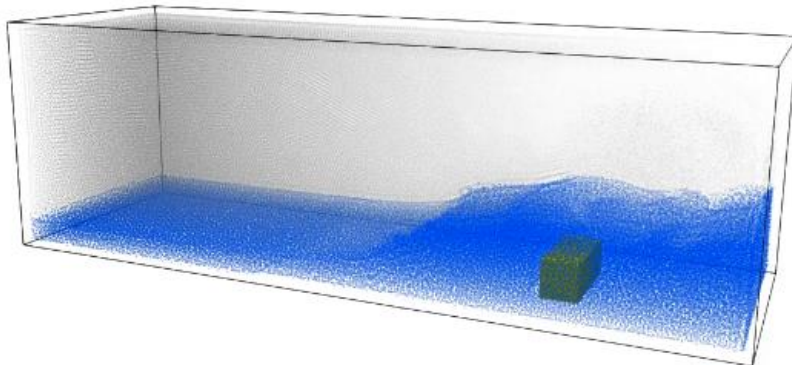
Case_SloshingAcc_LiquidGas



particles: 115,007
physical time: 8.35 s
runtime (GTX 1080 Ti): 6.4 h

Time: 3.00 s

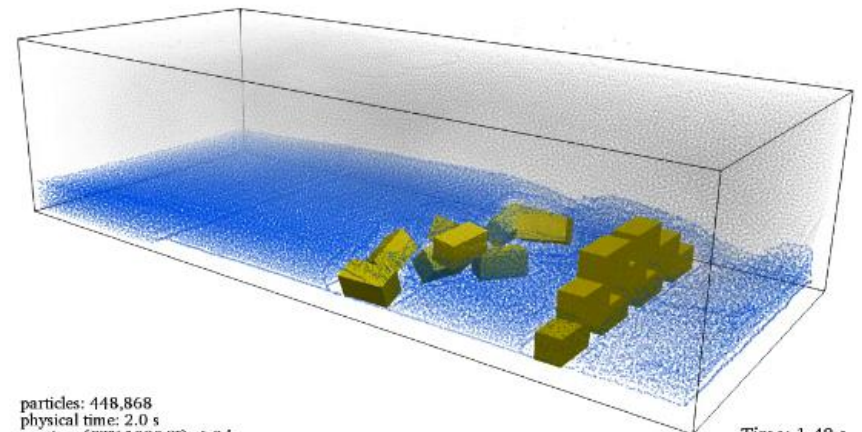
Case_Obstacle_Impact_LiquidGas



particles: 460,472
physical time: 3.0 s
runtime (GTX 1080 Ti): 2.4 h

Time: 2.20 s

Case_DEM_Interaction_LiquidGas

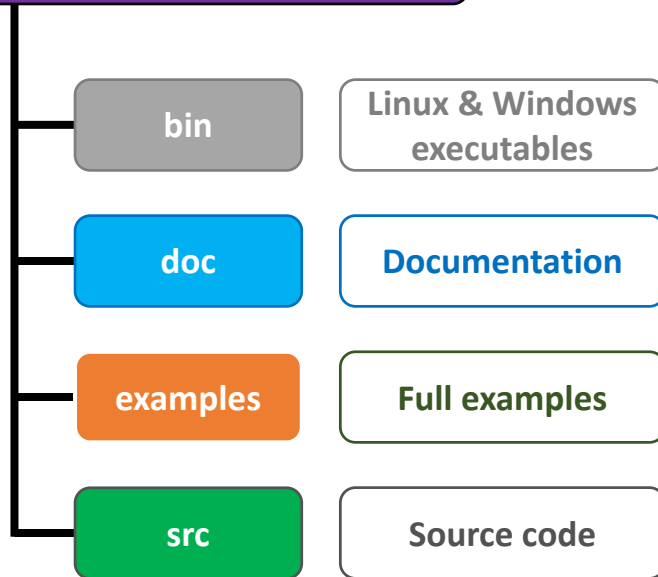


particles: 448,868
physical time: 2.0 s
runtime (GTX 1080 Ti): 6.9 h

Time: 1.48 s

Novelties on v4.2 – New structure

DualSPHysics Package v4.2



Source code ready to compile:

Codes:

- DualSPHysics v4.2
- DualSPHysics v4.0 LiquidGas
- ToVTK (data usage example)

Precompiled libraries:

- Linux (gcc4 & gcc5)
- Windows (Visual Studio 2015)

Compiling:

- Makefiles for Linux
- Project for Visual Studio 2015
- CMake file

CUDA 9.2

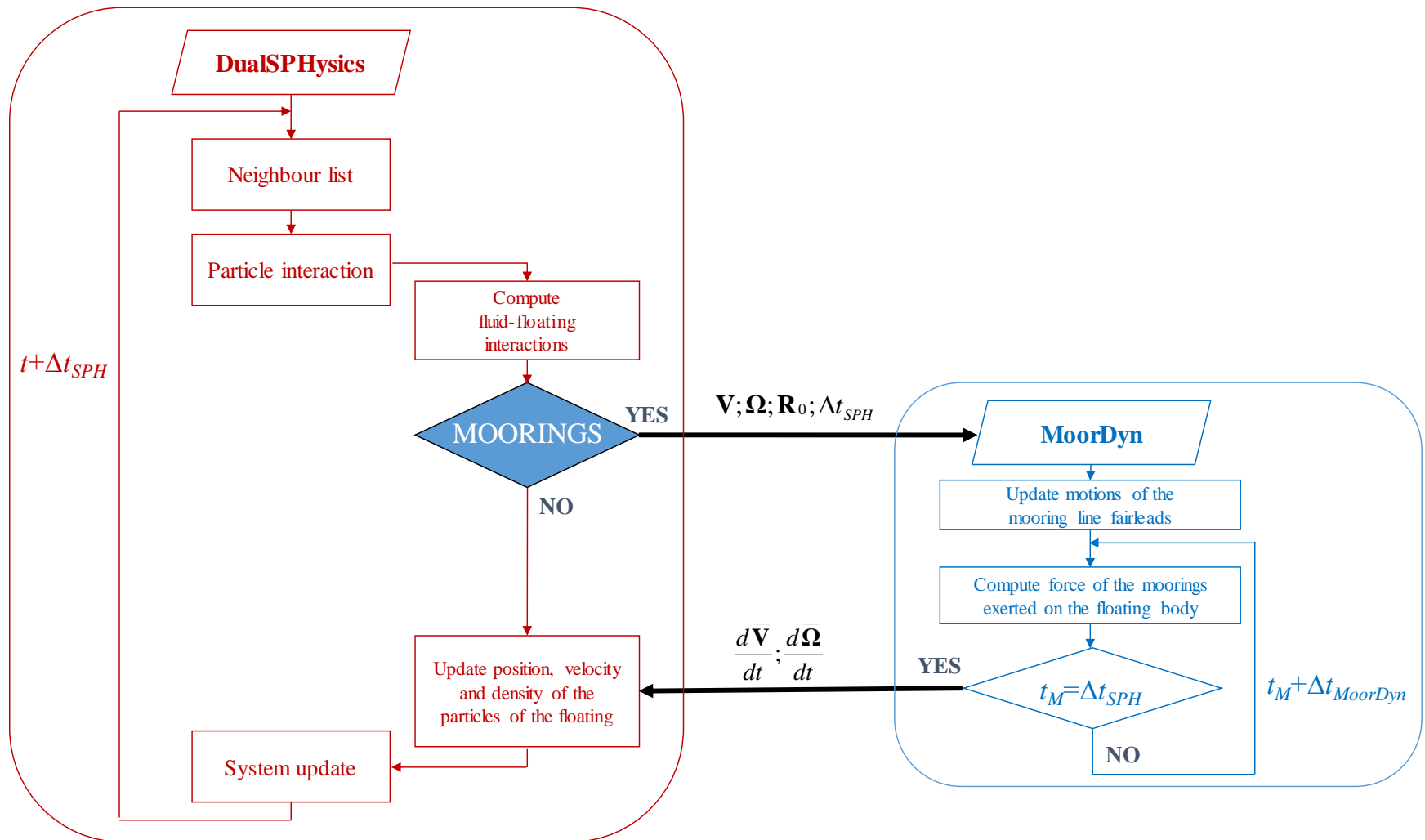
Linux (gcc4 & gcc5)

Visual Studio Community 2015 (free)

Cmake

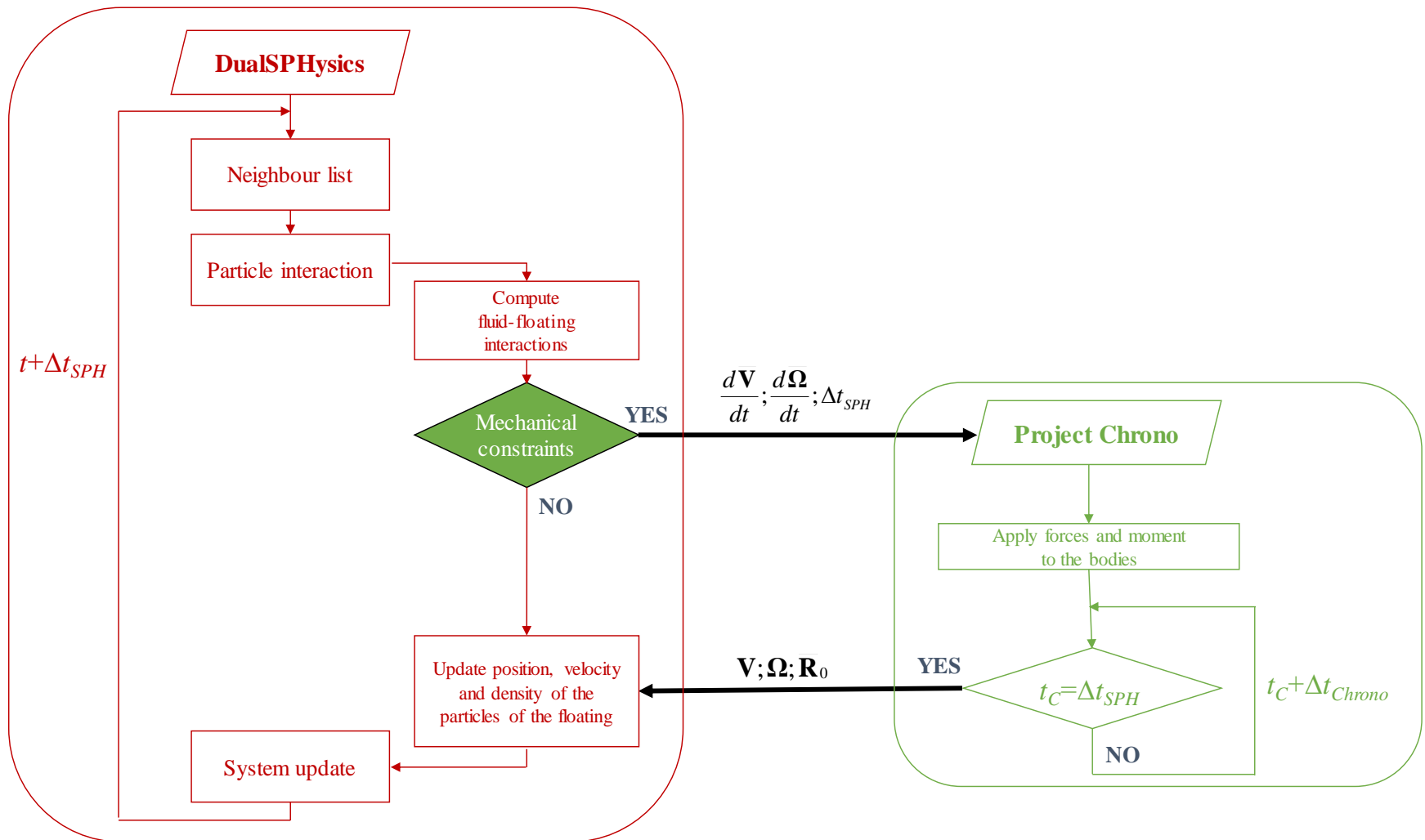
Novelties on v4.2 – New structure

Improved implementation of floating objects to facilitate coupling with other models



Novelties on v4.2 – New structure

Improved implementation of floating objects to facilitate coupling with other models



Novelties on v4.2 – New LICENSE



LGPL v2.1- GNU Lesser General Public License (LGPL)

- Software can be incorporated into both free software and proprietary software
- Developers and companies can integrate LGPL software into their software without being required to release the source code of their own software-parts
- Libraries linked to DualSPHysics can be closed source
- LGPL can be used in commercial applications

Novelties on v4.2

Novelties on pre-processing

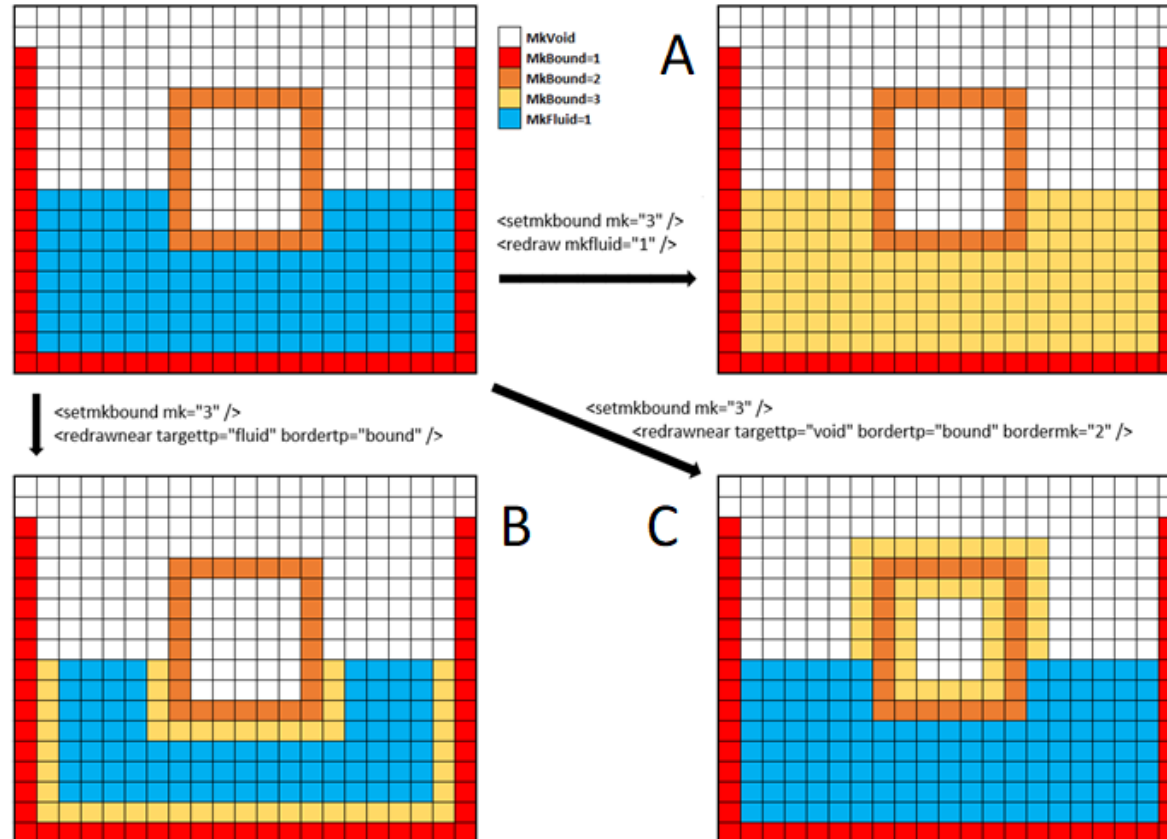
Novelties on post-processing

Novelties on v4.2 – Pre-processing

RedrawGenCase

examples\others\RedrawGenCase

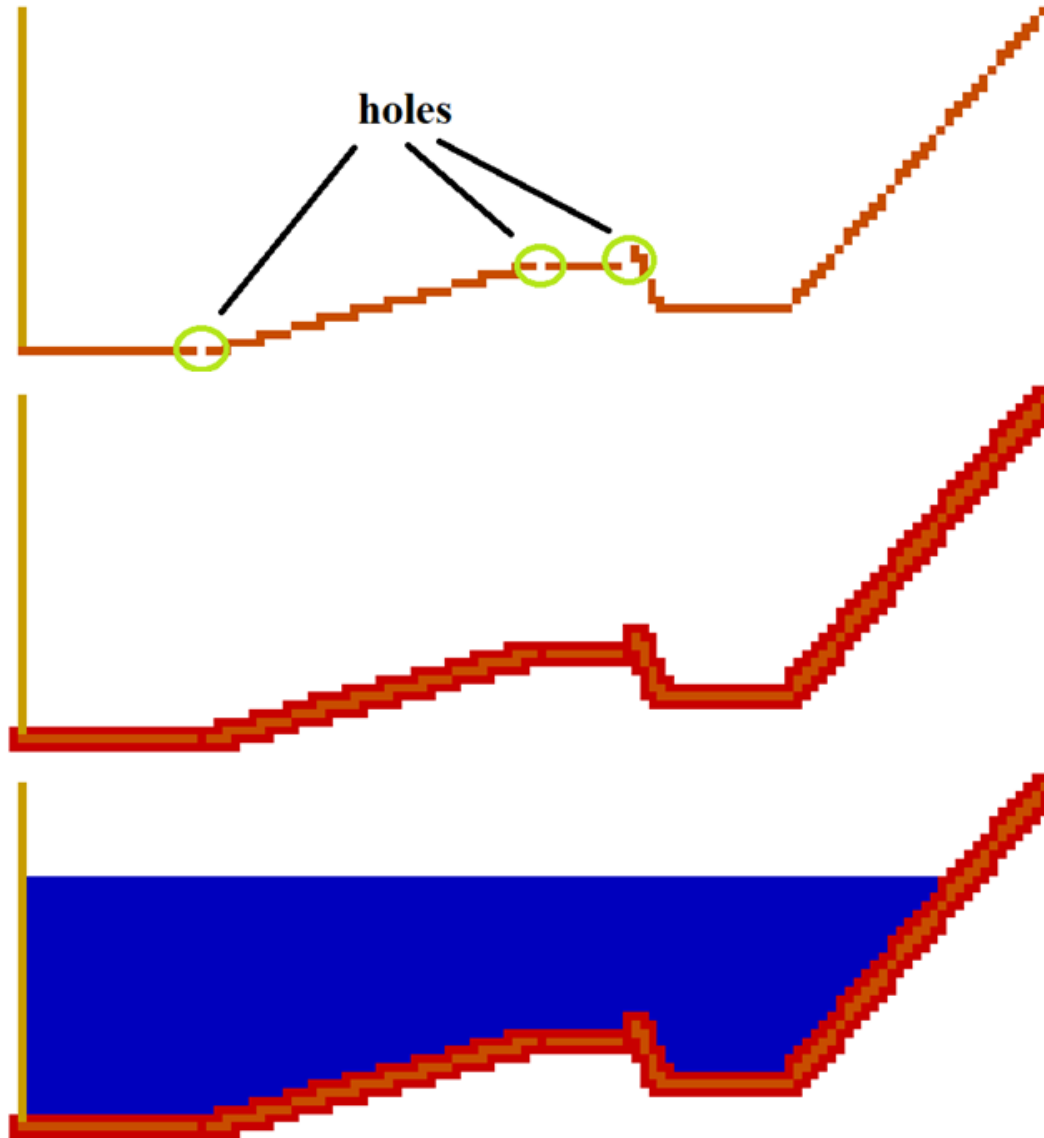
- The <redraw> command assigns the “mk” defined by the last <setmkvoid>, <setmkbound> or <setmkfluid> to all nodes that follow a given condition.
- The <redrawnear> command allows to indicate the nodes that will be modified if there is a neighbouring node that follows some given condition



Novelties on v4.2 – Pre-processing

RedrawGenCase

RedrawSimple.xml

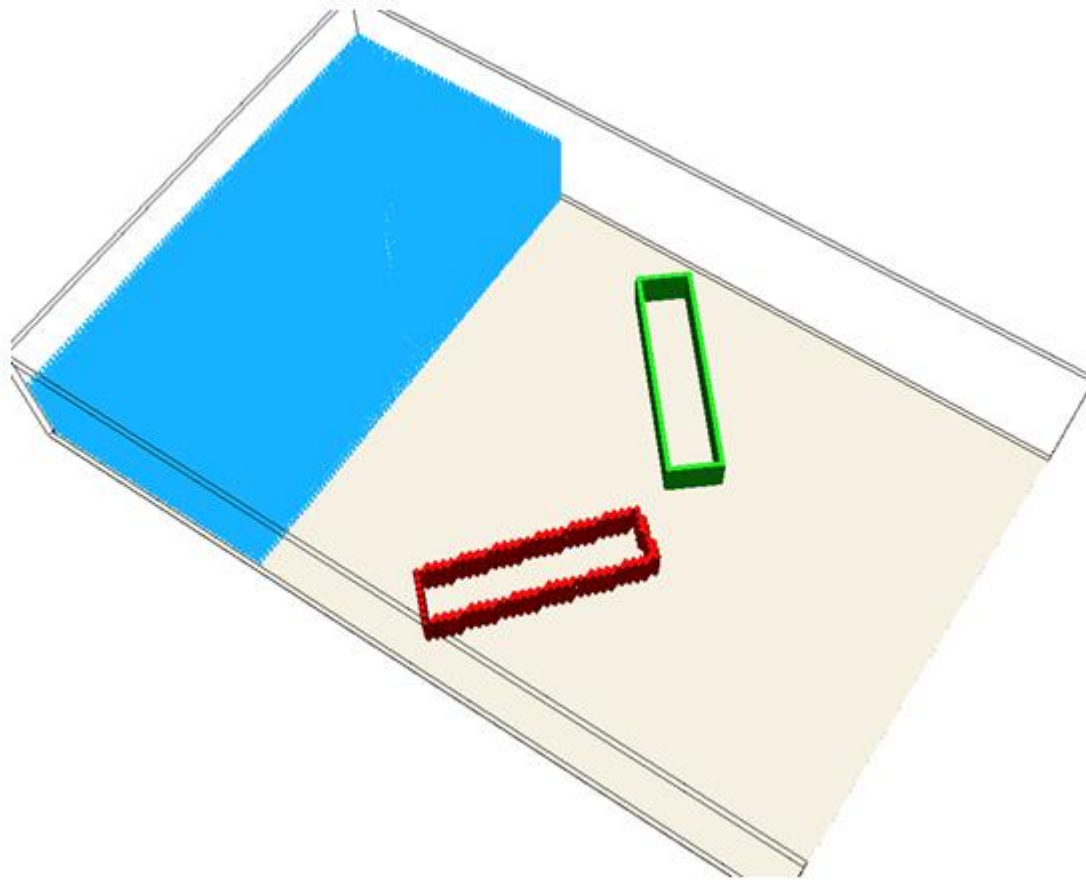


Novelties on v4.2 – Pre-processing

RotatedBox

examples\others\RotatedBox

i) one box is created based on the 3-D Cartesian lattice used by GenCase



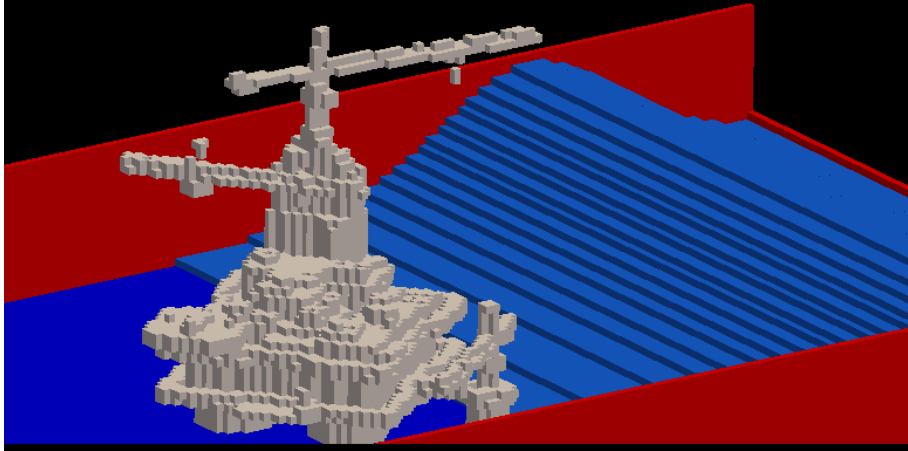
ii) the second box, is initially created using <drawbox> and later uses <rotateaxis> to apply a matrix that rotates the position of the particles of the box, so that, particles are finally created in global positions that are not linked to the nodes of the 3-D lattice

Novelties on v4.2 – Pre-processing

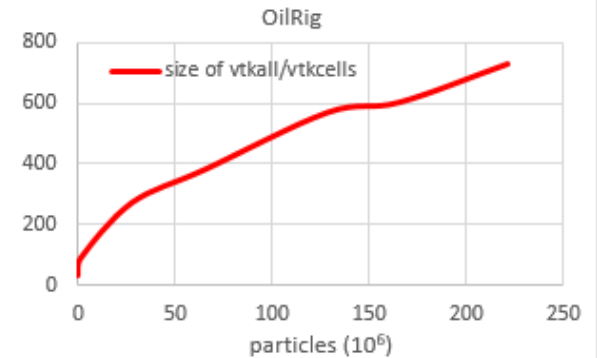
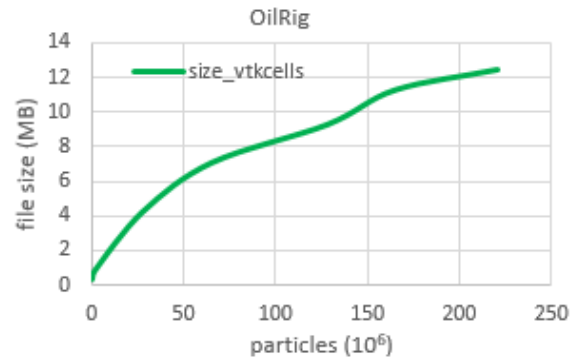
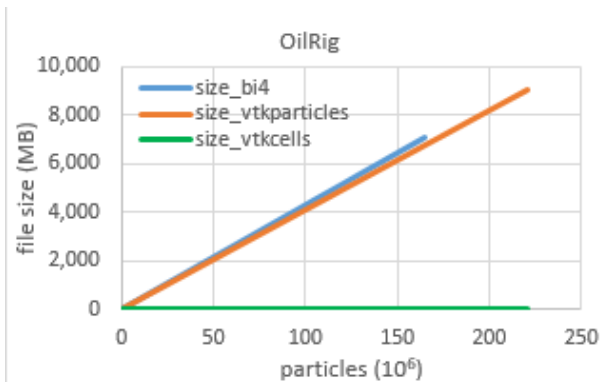
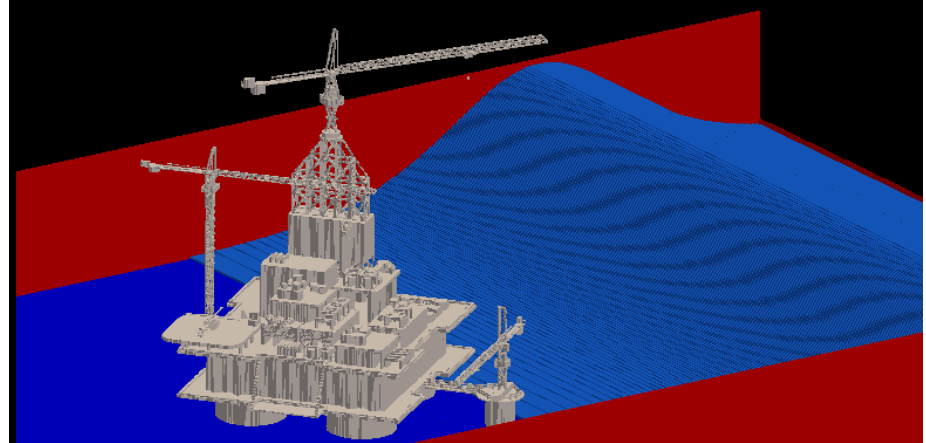
New output VTK file one thousand times less heavy to easily visualise huge cases

Case_MkCells.vtk

dp=1.00 m (243,327 particles)



dp=0.10 m (220,800,164 particles)



Novelties on v4.2 – Post-processing

FlowTool

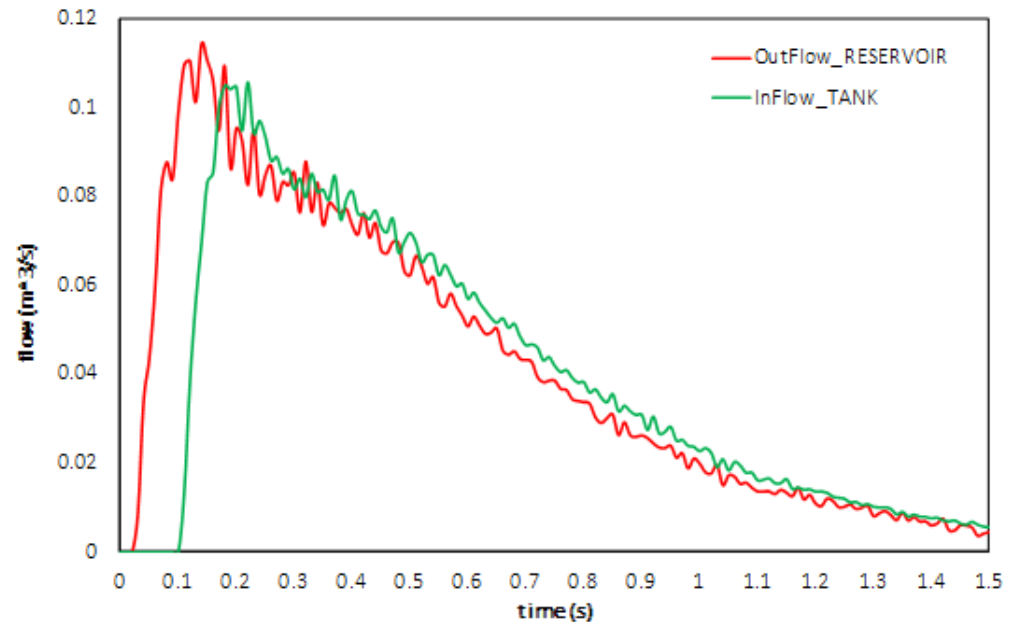
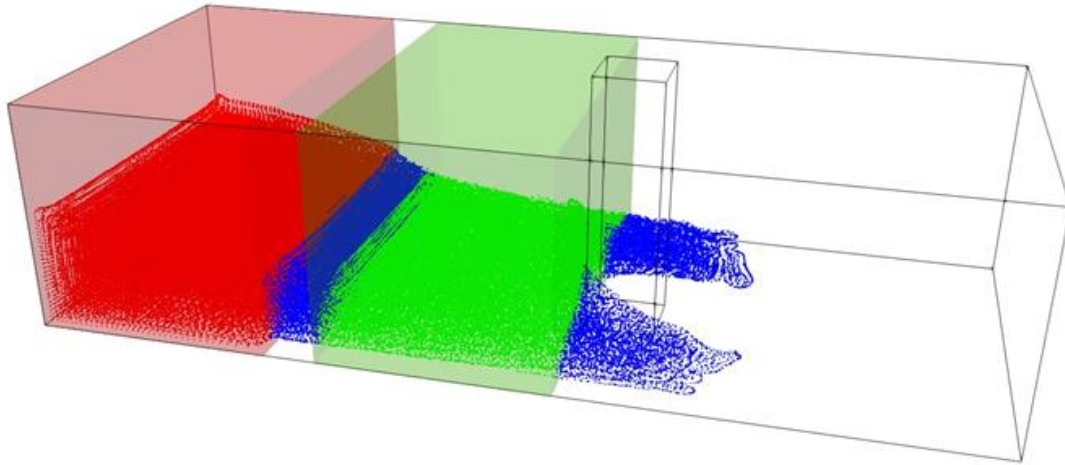
Calculates:

- number of fluid particles that enters or leaves domains defined by the user
- average velocity of the particles that enters that domain since last output time
- volume calculated by multiplying the volume of one particle by the number of particles
- inflow and outflow by dividing volume with the interval time (output time)

This post-processing tool is therefore very useful to compute discharges or overtopping in the case of coastal protection

Novelties on v4.2 – Post-processing

FlowTool: to compute inflow, outflow... overtopping



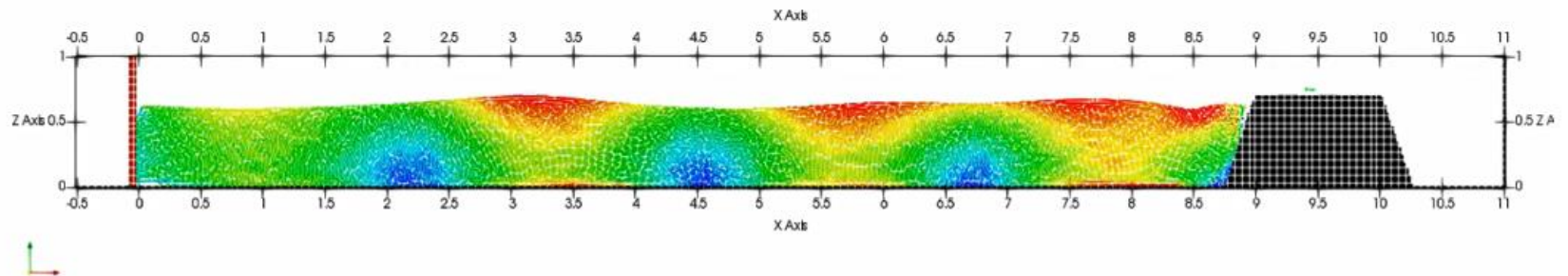
Novelties on v4.2 – Post-processing

FlowTool: to compute inflow, outflow... overtopping

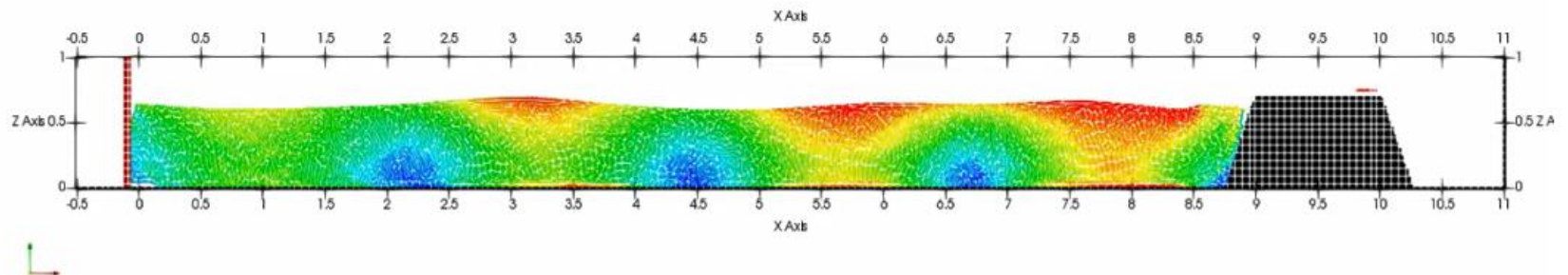


Time: 9.40 s

Piston AWAS (H=0.15m, T=2s, d=0.66m)

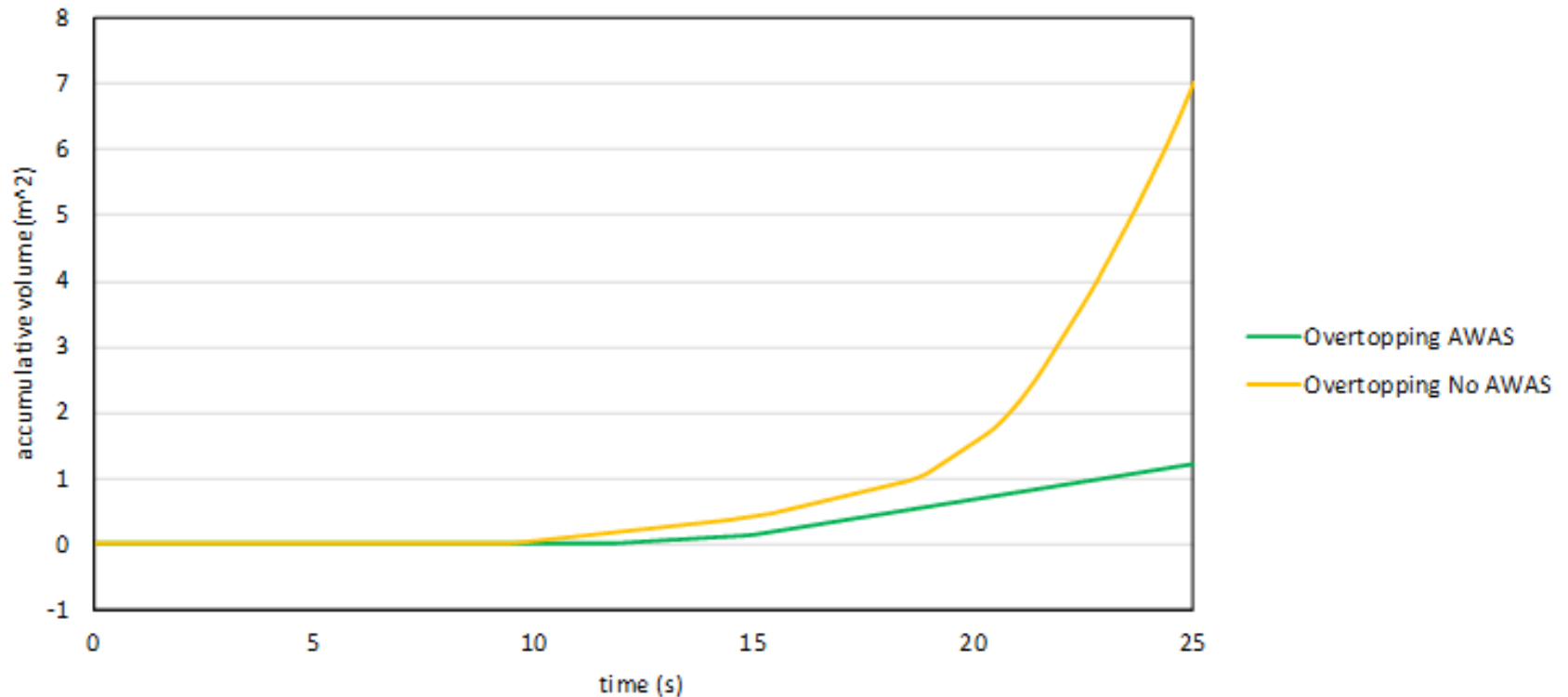


Piston NO AWAS (H=0.15m, T=2s, d=0.66m)



Novelties on v4.2 – Post-processing

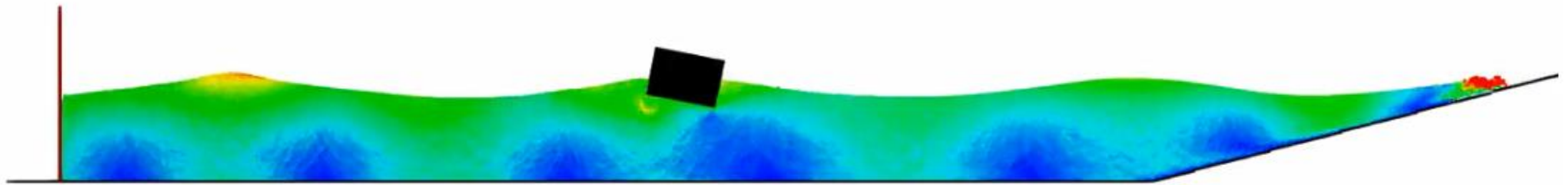
FlowTool: to compute inflow, outflow... overtopping



Novelties on v4.2 – Post-processing

IsoSurface.exe: now also creates slices

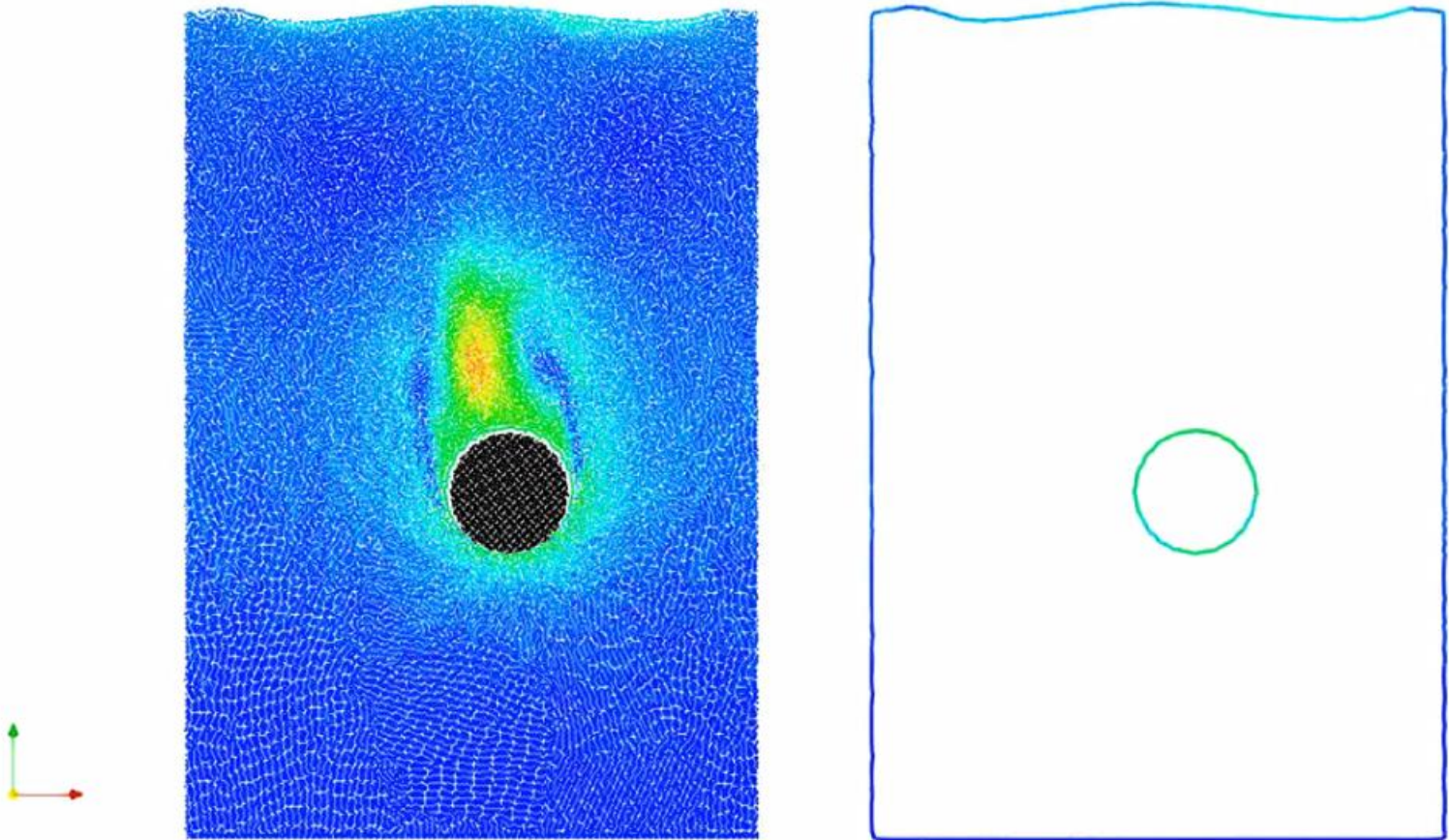
Time: 12.45 s



Novelties on v4.2 – Post-processing

IsoSurface.exe: now also creates slices

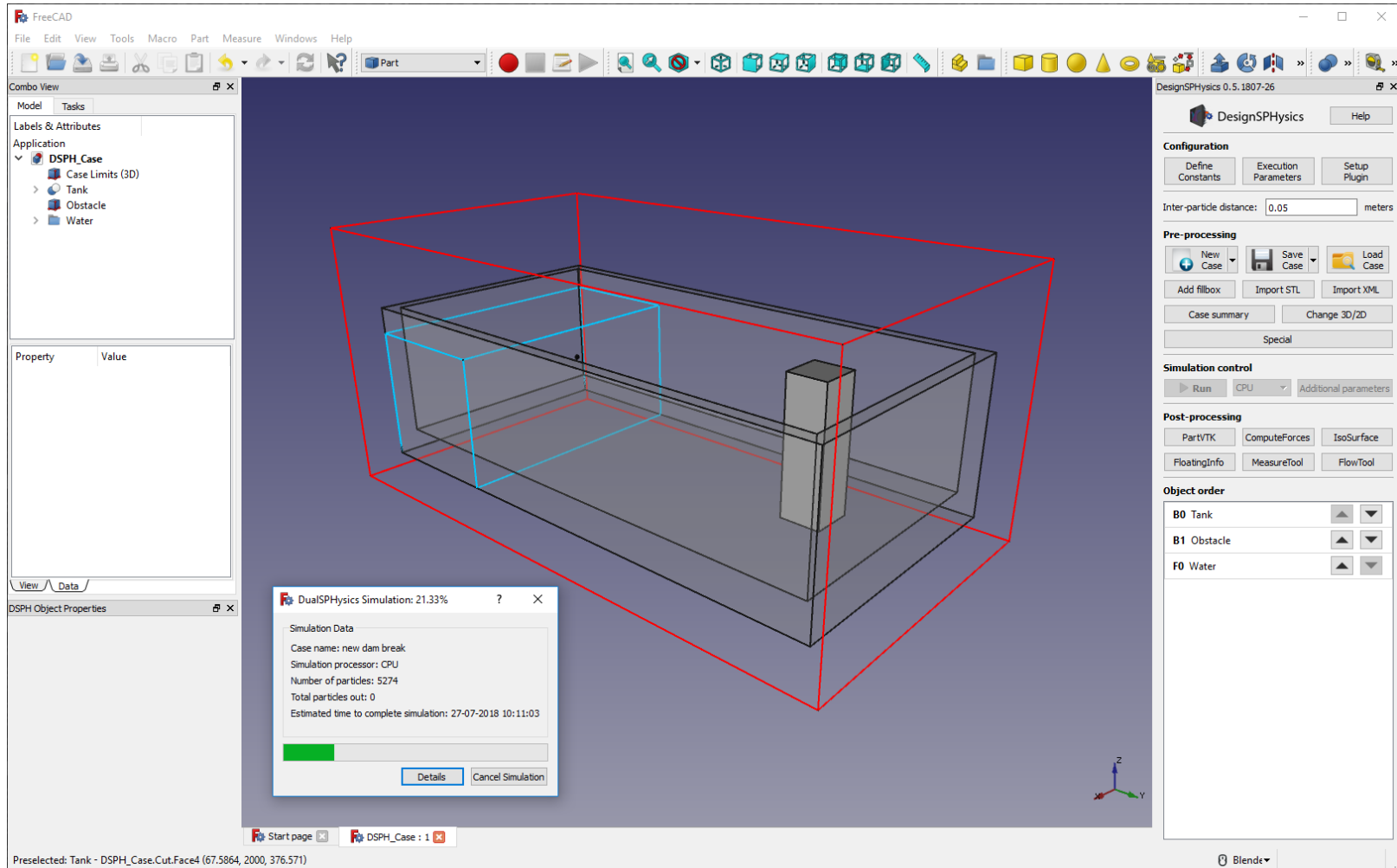
Time: 6.8 s



Novelties on v4.2 – Graphical User Interface

Graphical User Interface using FreeCAD with **DesignSPHysics**: <http://design.sphysics.org/>

Source code available at <https://github.com/DualSPHysics/DesignSPHysics>



Novelties on v4.2 – Graphical User Interface

22 October 2018

4th DualSPHysics Users Workshop, Instituto Superior Tecnico, Lisbon, Portugal

27 September 2018

Short Course on “Computational Fluid Dynamics for Free Surface Flows by Smoothed Particle Hydrodynamics”, University of Florence, Italy

25 June 2018

13th SPHERIC Workshop, National University of Ireland, Galway, Ireland

19 June 2018

Course: “DualSPHysics: Numerical tool in coastal engineering and marine energy”, Centro de Estudios de Técnicas Aplicadas del CEDEX, Madrid, Spain

10 April 2018

SPH 2-day CPD Course, University of Manchester, UK

13 November 2017

3rd DualSPHysics Users Workshop, University of Parma, Italy

17 October 2017

SPHERIC Beijing International Workshop, Peking University (PKU), China

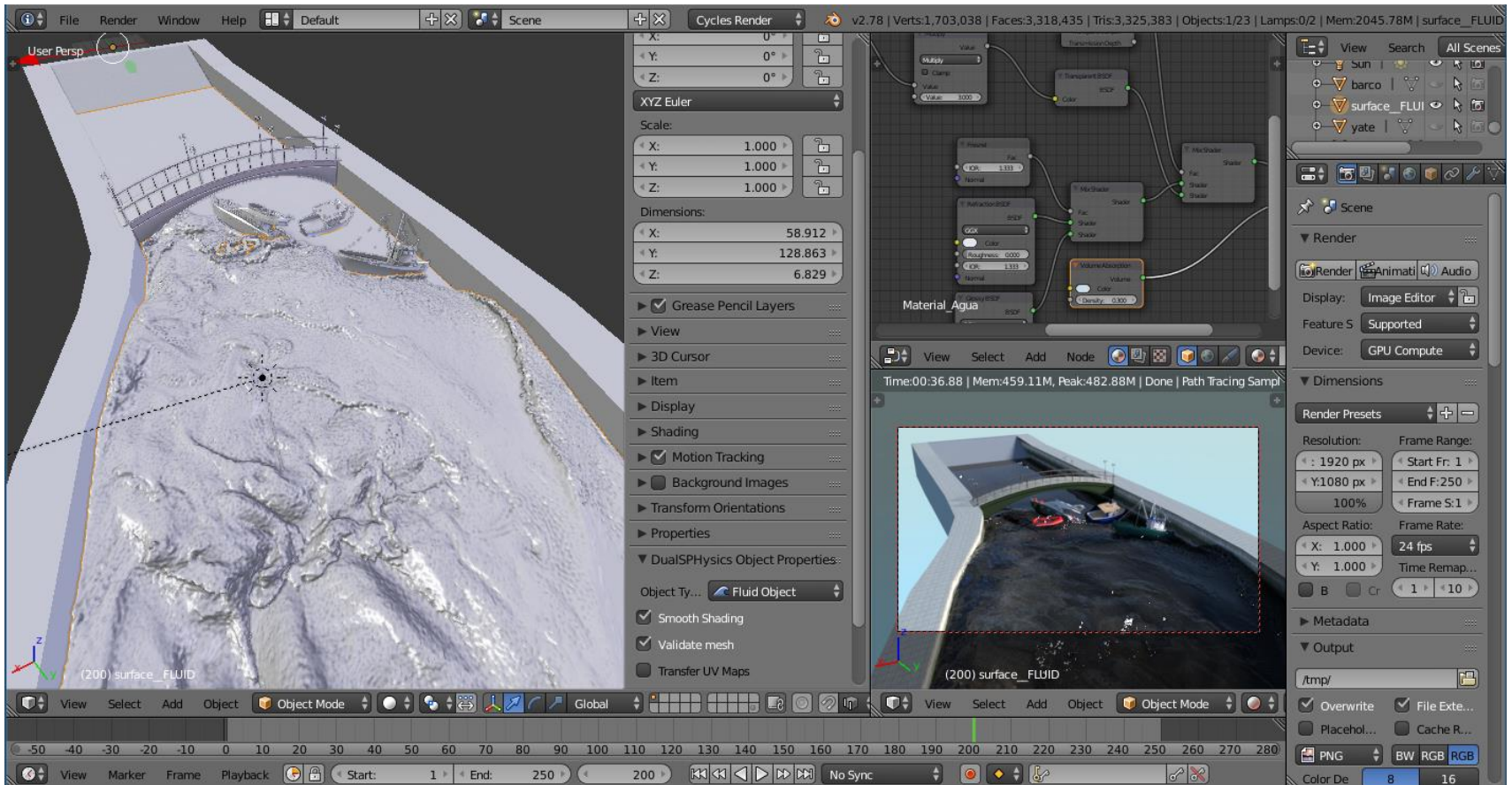
12 June 2017

12th SPHERIC Workshop, Universidade de Vigo, Ourense, Spain

Novelties on v4.2 – Advanced visualisation

Advanced visualisation using Blender with **VisualSPHysics**: <http://visual.sphysics.org/>

Source code available at <https://github.com/EPhysLab-UVigo/VisualSPHysics>



Novelties on v4.2 – Advanced visualisation

Advanced visualisation using Blender with **VisualSPHysics**: <http://visual.sphysics.org/>

Source code available at <https://github.com/EPhysLab-UVigo/VisualSPHysics>



Novelties on v4.3

- i) Coupling with wave propagation models
(SWASH, Relaxation zone, etc)**
- ii) Coupling with Project Chrono
(Multi-physics)**
- iii) Open boundaries
(Inlet & Outlet)**
- iv) Correction for Dynamic Boundary Conditions**

Novelties on v4.3

Day 3 (24/10/2018)		
09:00 - 09:40	DualSPHysics modelling sea waves. New developments, capabilities and practical examples.	Dr Corrado Altomare, Ghent University
09:40 - 10:20	Multiphase simulations in DSPH. New developments, capabilities and practical examples.	Dr Georgios Fourtakas, University of Manchester
10:20 - 10:50	Coffee Break	
10:50 - 11:30	Open Inlet/Outlet boundary conditions. New developments, capabilities and practical examples.	Dr Angelo Tafuni, New Jersey Institute of Technology
11:30 - 12:10	Presenting DualSPHysics with a Chrono Project implementation. New developments, capabilities and practical examples.	Dr Ricardo Canelas, University of Lisbon
12:10 - 13:00	Open discussion: questions, DualSPHysics now and in the future	Developer team

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**PPTs will include detailed information and explanation of the examples
They will be converted into PDF and uploaded at the website**

Novelties on v4.3

STRUCTURE:

doc

xml_format

_FmtXML_MLPistons.xml

_FmtXML_RelaxationZones.xml

_FmtXML_Chrono.xml

_FmtXML_BoundCorr.xml

_FmtXML_InOut.xml

examples

main

twophases

others

wavecoupling

chrono

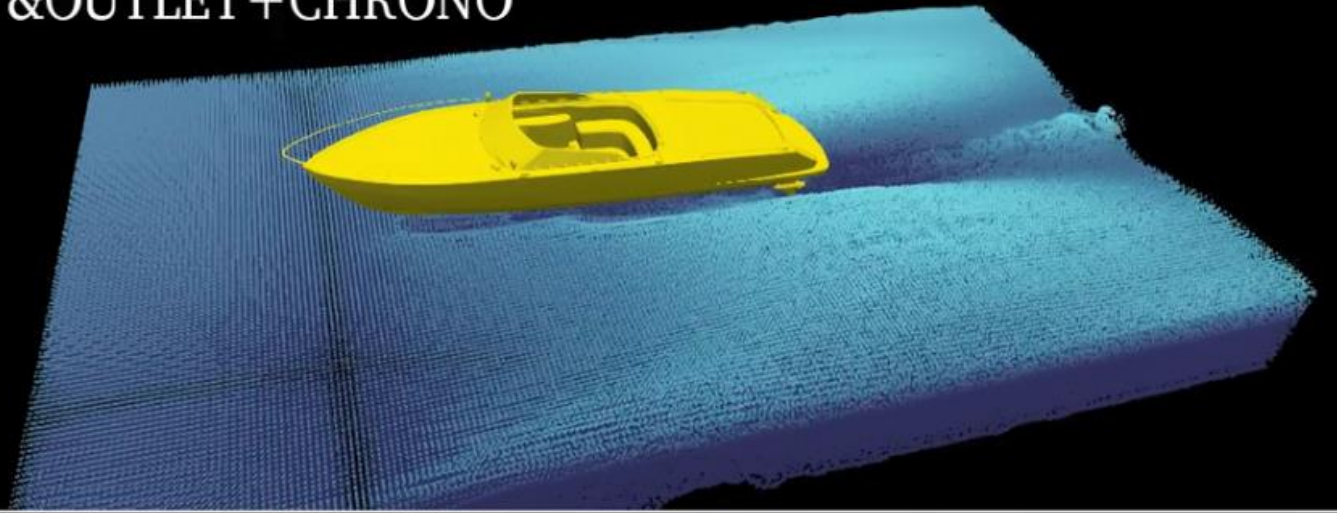
inletoutlet

boundcorrection

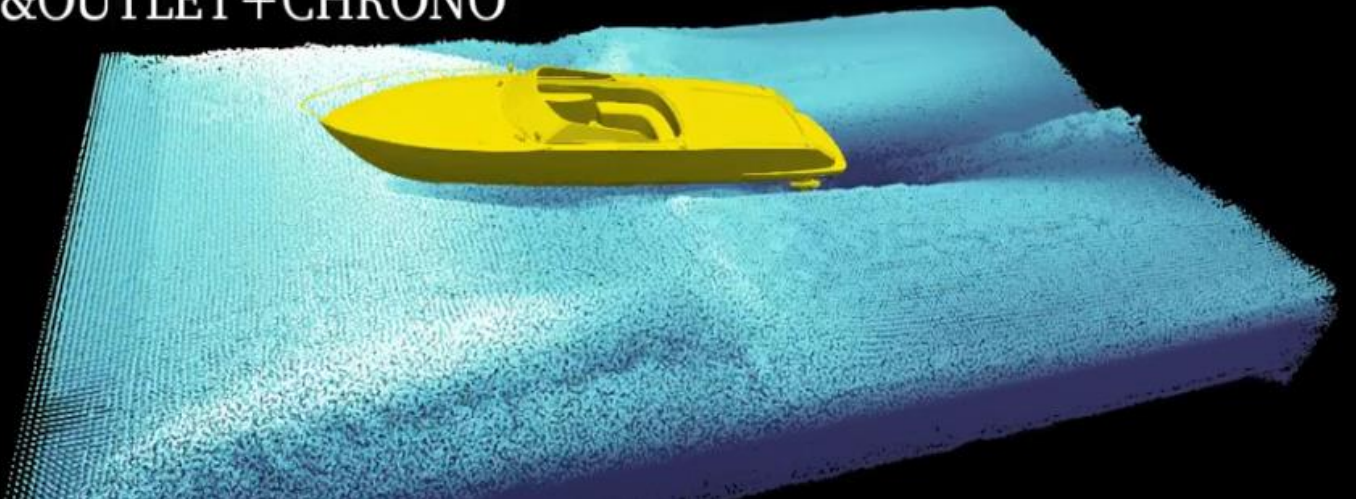
Novelties on v4.3

Planning HULL: CHRONO + INLET&OUTLET

Current: INLET&OUTLET+CHRONO



Waves: INLET&OUTLET+CHRONO



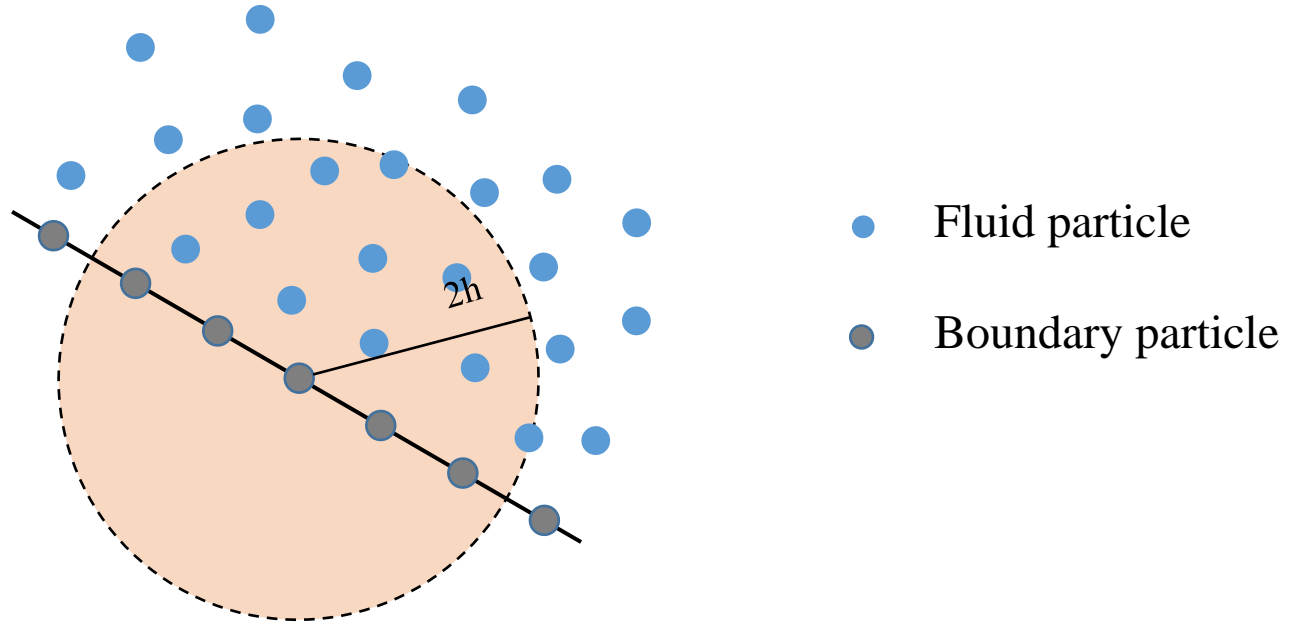
Novelties on v4.3

Correction for Dynamic Boundary Conditions

- It has been obtained as a special case of Open boundary conditions
(see presentation of Dr. Tafuni)
- The aim is to fix some issues of Dynamic BC
- Similar to “Fixed Ghost Particles” of Marrone et al. (2011)

Novelties on v4.3

Dynamic boundary condition



Dynamic boundaries updated with continuity equation

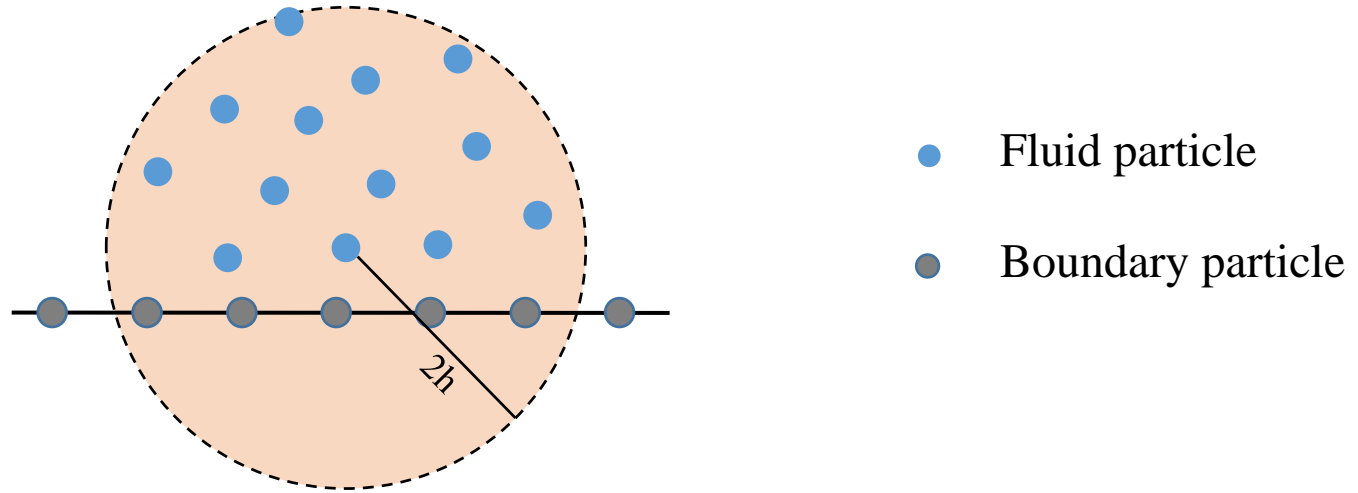
$$\Rightarrow \frac{d\rho_a}{dt} = \sum_b (\mathbf{v}_a - \mathbf{v}_b) \cdot \nabla W_{ab}$$

No momentum Equation

$$\Rightarrow \mathbf{v}_a = 0$$

Novelties on v4.3

Fluid – Boundary Interaction



Fluid – Boundary interaction:



$$\frac{d\rho_a}{dt} = \sum_b m_b (\mathbf{v}_a - \mathbf{v}_b) \cdot \nabla W_{ab}$$

$$\frac{d\mathbf{v}_a}{dt} = \sum_b m_b \frac{p_a + p_b}{\rho_a \rho_b} \cdot \nabla W_{ab}$$

Novelties on v4.3

DYNAMIC BOUNDARY CONDITIONS

ADVANTAGES

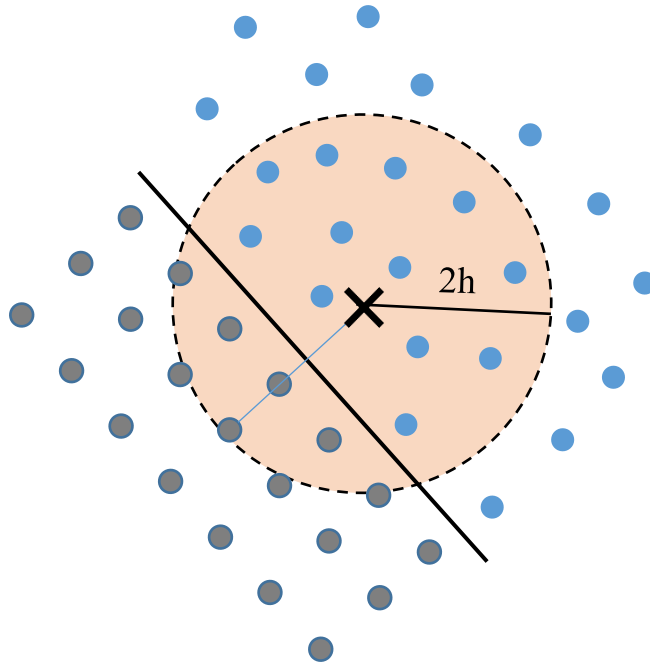
DBC can be applied to arbitrary 2-D and 3-D geometries
provide good validation in many engineering problems

DISADVANTAGES

unphysical density/pressure values of the boundary particles
high repulsive force resulting in a separation distance (GAP)

Novelties on v4.3

Correction for DBC



- ✕ Ghost node
- Fluid particle
- Boundary particle

Corrected SPH sum at ghost point:

$$\rho_g = \sum_b m_b \bar{W}_{gb} \quad \nabla \rho_g = \sum_b m_b \bar{\nabla} W_{gb}$$

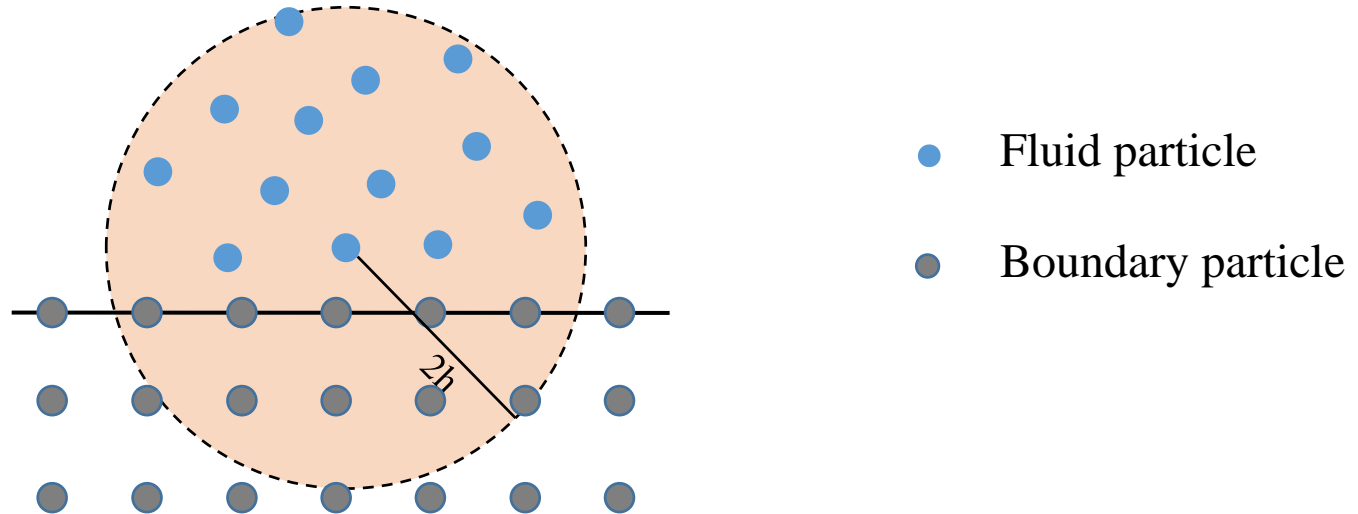


$$\begin{aligned} \rho_a &= \rho_g + (\mathbf{r}_a - \mathbf{r}_g) \cdot \nabla \rho_g \\ \mathbf{v}_a &= 0 \end{aligned}$$

Novelties on v4.3

Correction for DBC

Fluid – Boundary Interaction



Fluid – Boundary interaction:



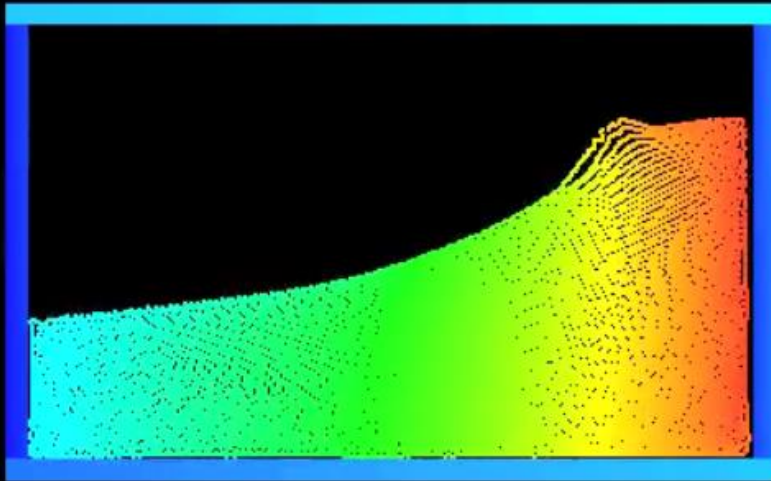
$$\frac{d\rho_a}{dt} = \sum_b m_b (\mathbf{v}_a - \mathbf{v}_b) \cdot \nabla W_{ab}$$

$$\frac{d\mathbf{v}_a}{dt} = \sum_b m_b \frac{p_a + p_b}{\rho_a \rho_b} \cdot \nabla W_{ab}$$

Novelties on v4.3

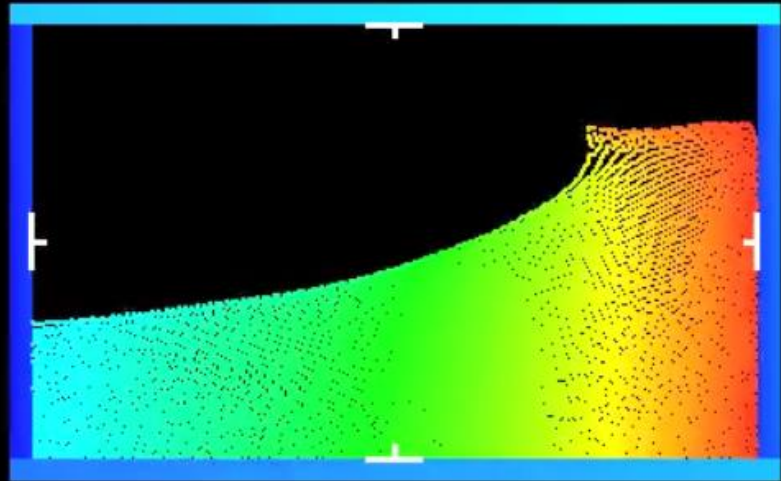
Correction for DBC: NO GAP

Sloshing tank with DBC



Sloshing tank with DBC & BoundCorr
NO GAP!!!

Time: 0.96 s



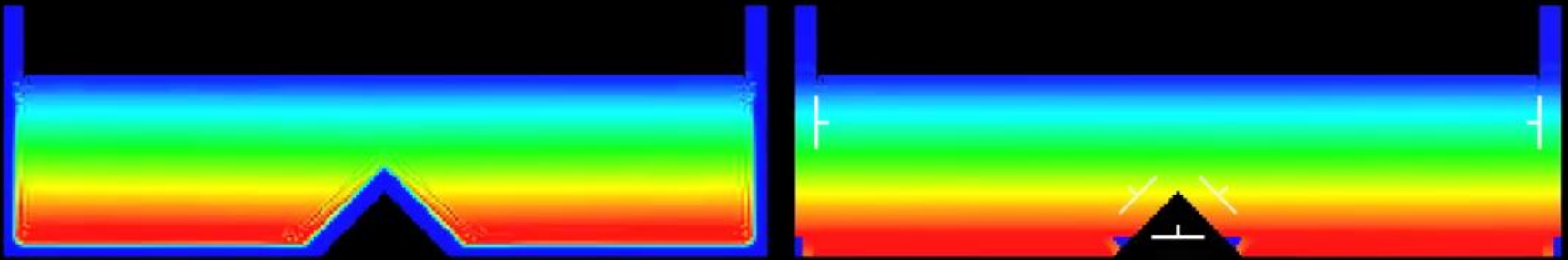
Novelties on v4.3

Correction for DBC: NO DENSITY FLUCTUATIONS

WedgeStill2d with DBC

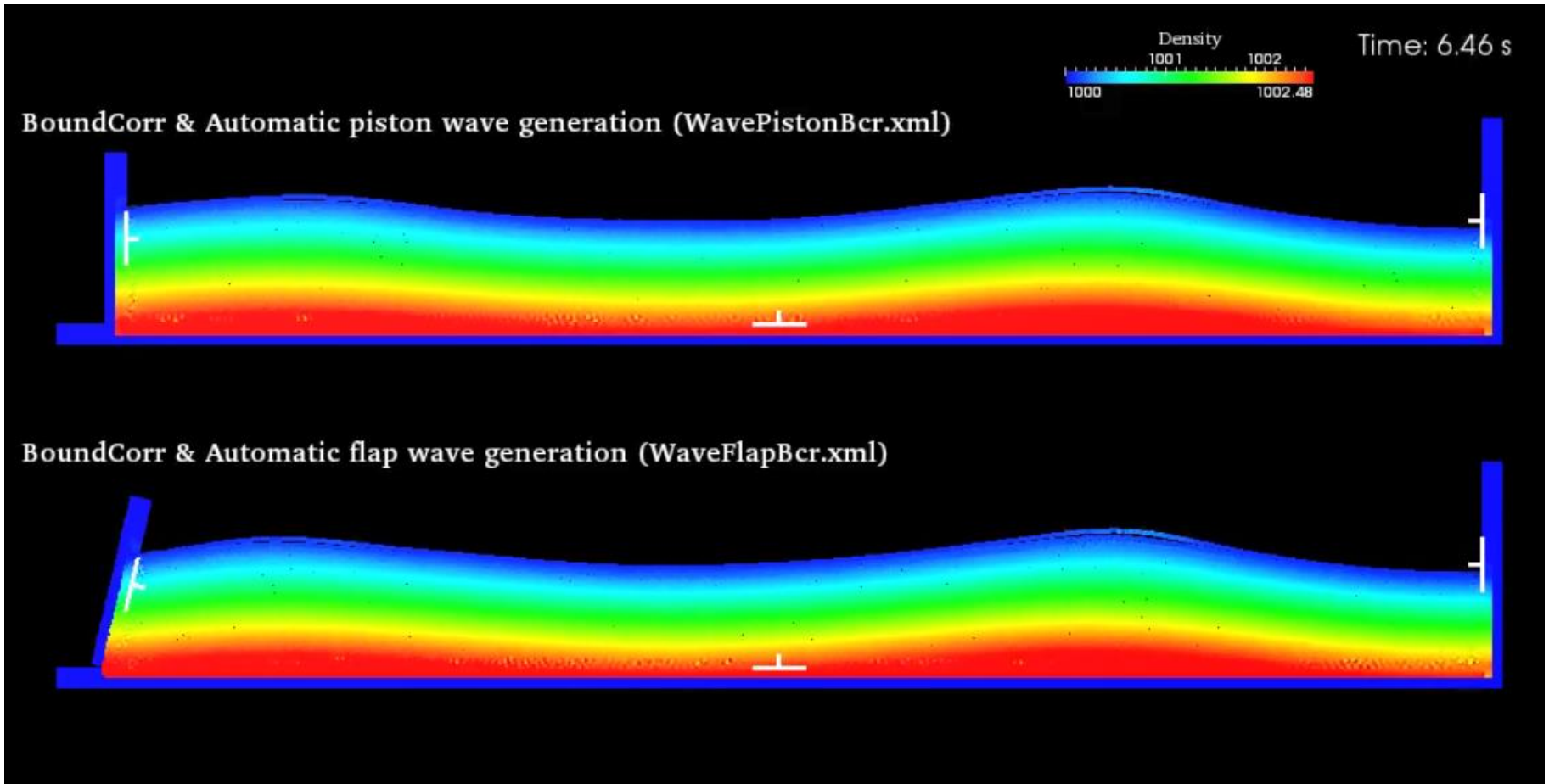
WedgeStill2d with DBC & BoundCorr
NO DENSITY FLUCTUATIONS!!!

Time: 1.36 s



Novelties on v4.3

**Correction for DBC:
NO GAP & NO DENSITY FLUCTUATIONS**



Novelties on v4.3

Correction for DBC

- No unphysical gap between fluid and boundary
- Less oscillation in the pressure field
- More computationally expensive
- Unit vector for each boundary particle has to be calculated
- At the moment only available $\mathbf{v}=0$, but it can be generalized for slip and no slip.

Novelties on v4.3

- i) Coupling with wave propagation models
(SWASH, Relaxation zone, etc)**
- ii) Coupling with Project Chrono
(Multi-physics)**
- iii) Open boundaries
(Inlet & Outlet)**
- iv) Correction for DBC**

Future novelties

Beta v4.3  **Release of v4.4**

NEXT VERSIONS

- Coupling with MoorDyn library
- Other BCs
- Incompressible SPH
- Variable particle resolution
- Multi-GPU implementation**