

The background image shows a modern architectural complex at night. On the left, a curved building with a grid-like facade is brightly lit from within. In the center, a multi-story building with a colorful, modular facade (red, orange, yellow, green) is also brightly lit. To the right, another large building with a similar grid-like facade is partially visible, its lights reflecting off the glass. The sky is dark, and streetlights are visible in the distance.

IHCantabria

UNIVERSIDAD DE CANTABRIA

R+D+i for a Sustainable Development

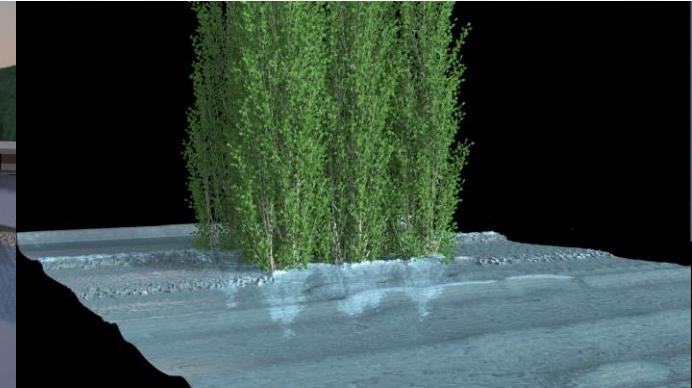
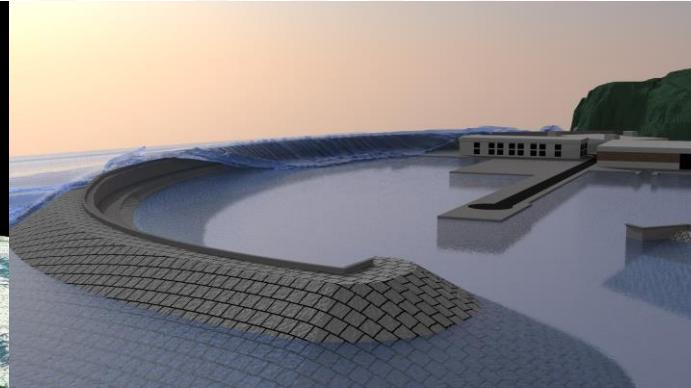
(IHFOAM GUI)



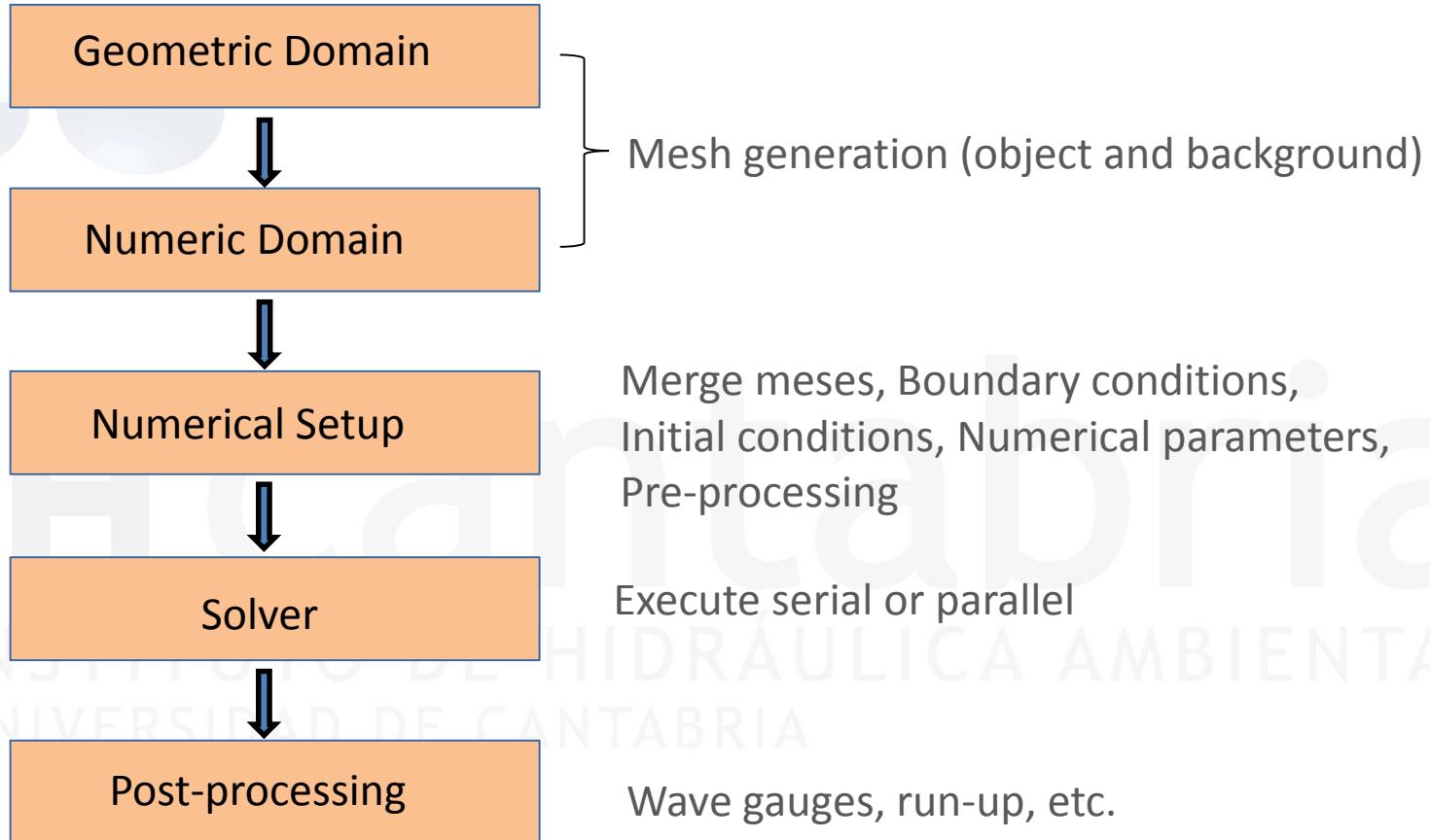
IHFOAM applied to Coastal Engineering

Regular waves interaction with cylinders (3D)

Gabriel Barajas, Javier L. Lara, María Maza, Alejandro Gonzalez



OpenFOAM workflow



OpenFOAM case

0

- alpha.water
 - p_rgh
 - U
- k
 - epsilon
 - nut

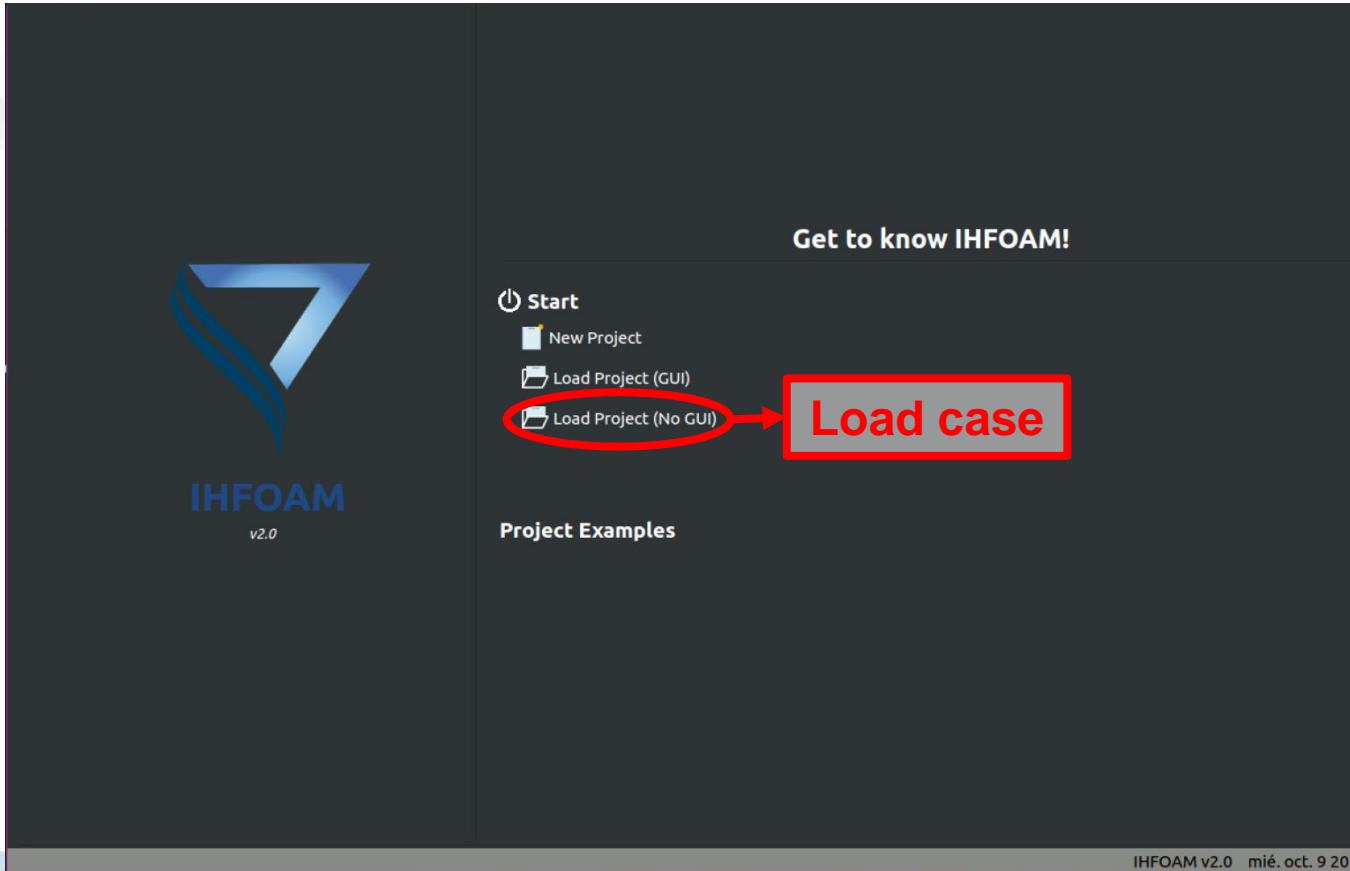
constant

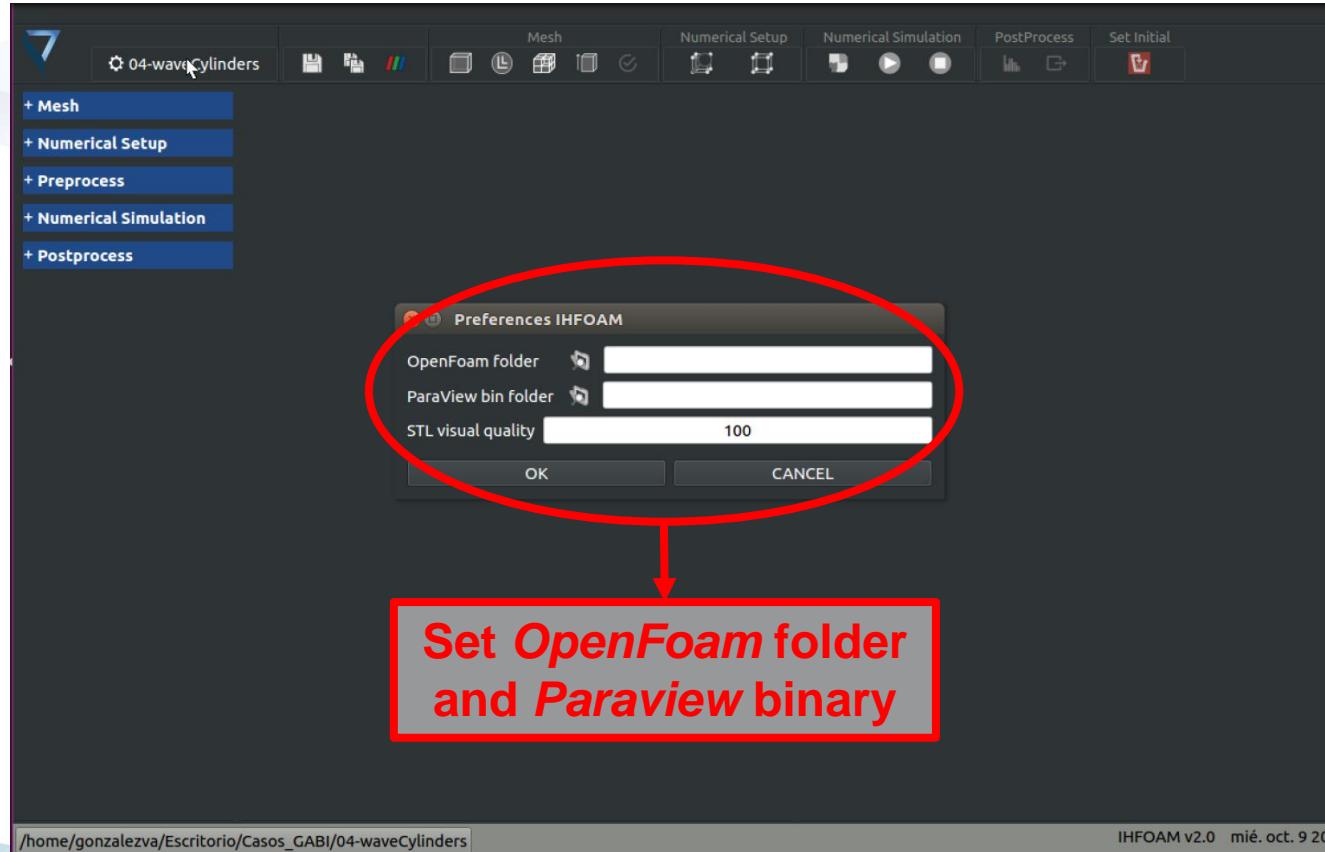
- g
- transportProperties
- turbulenceProperties
- waveProperties

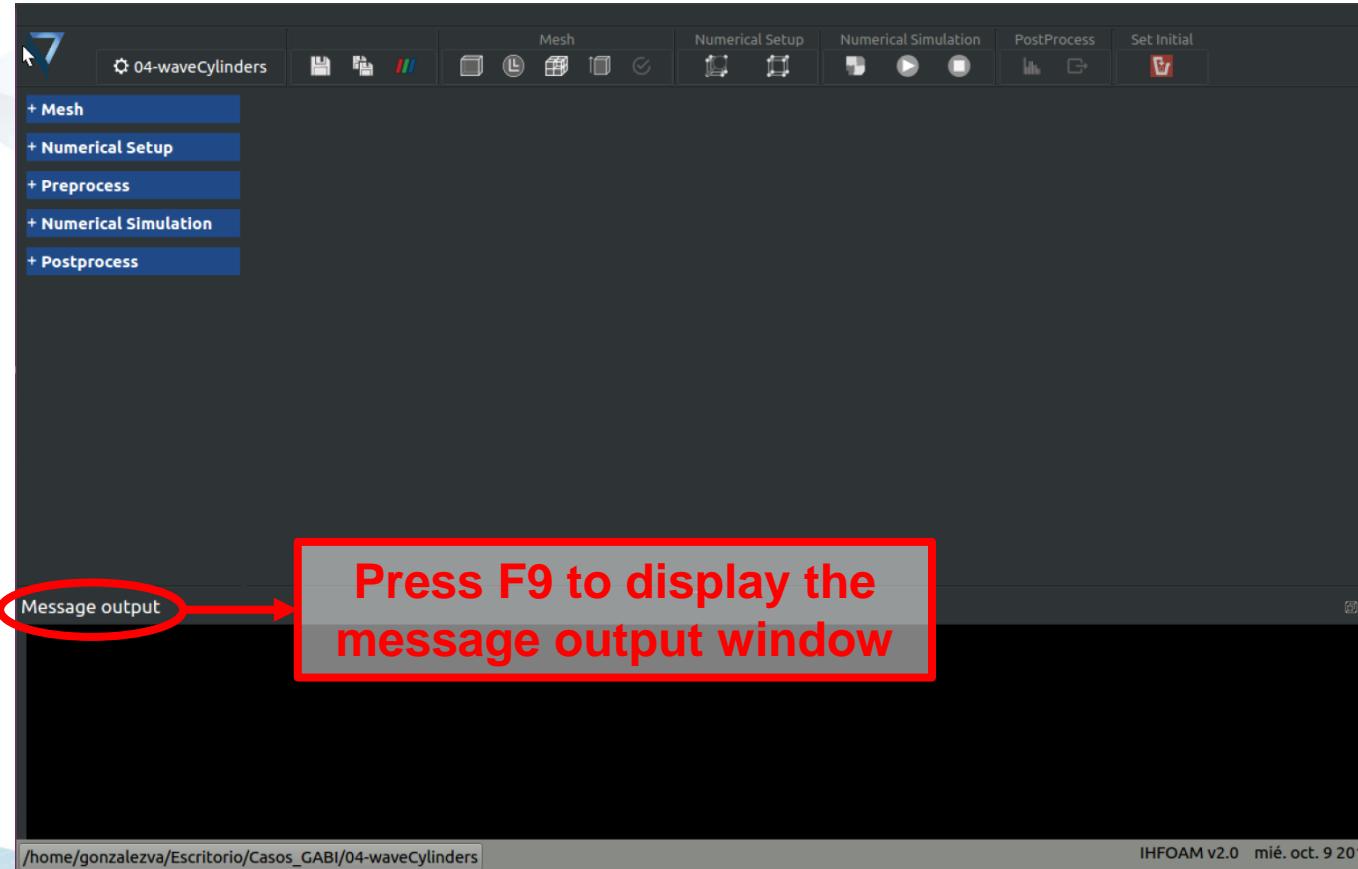
system

- blockMeshDict
 - setFieldsDict
 - snappyHexMeshDict
- fvSchemes
 - fvSolution
 - decomposeParDict
 - controlDict

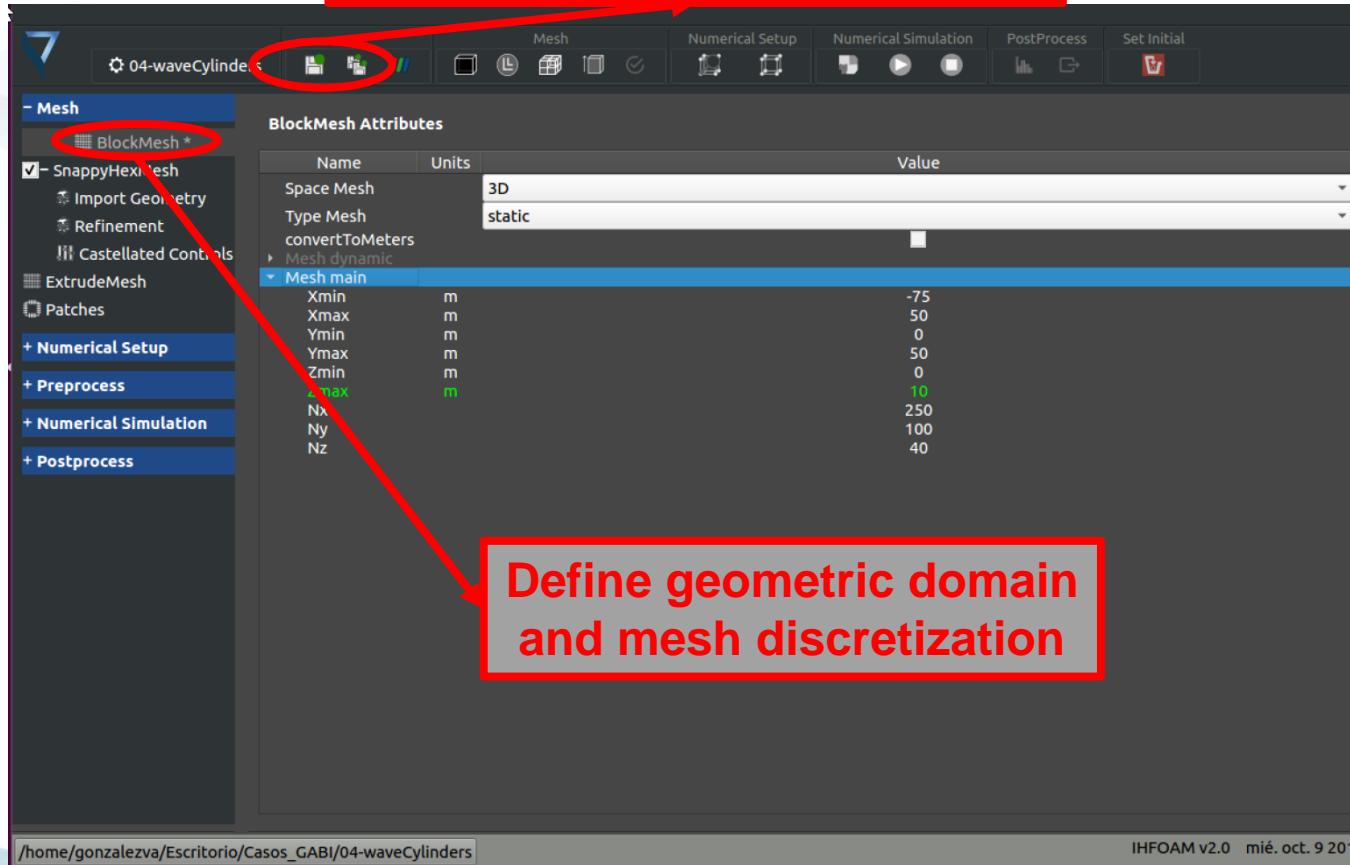
IHFOAM GUI

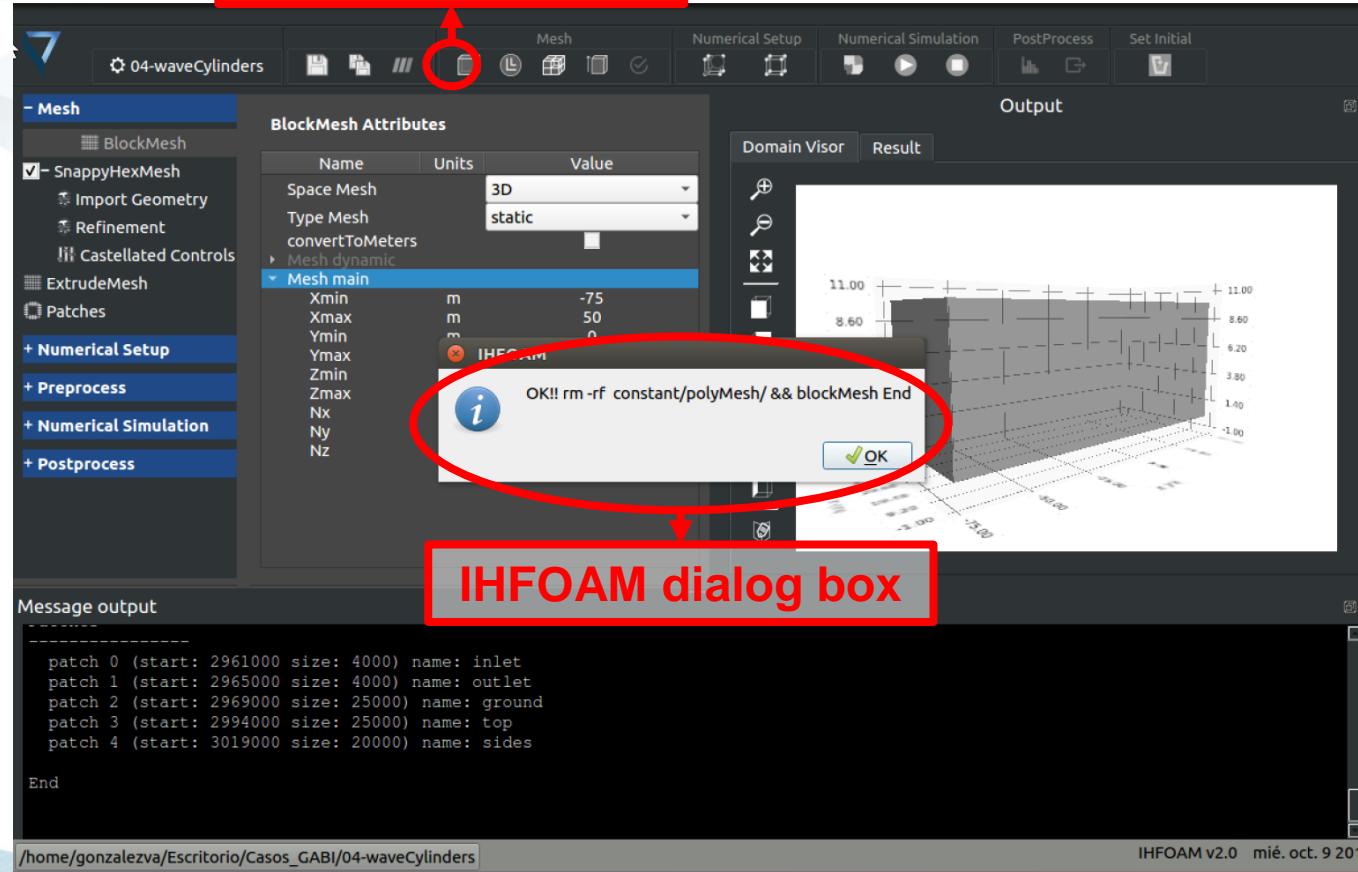


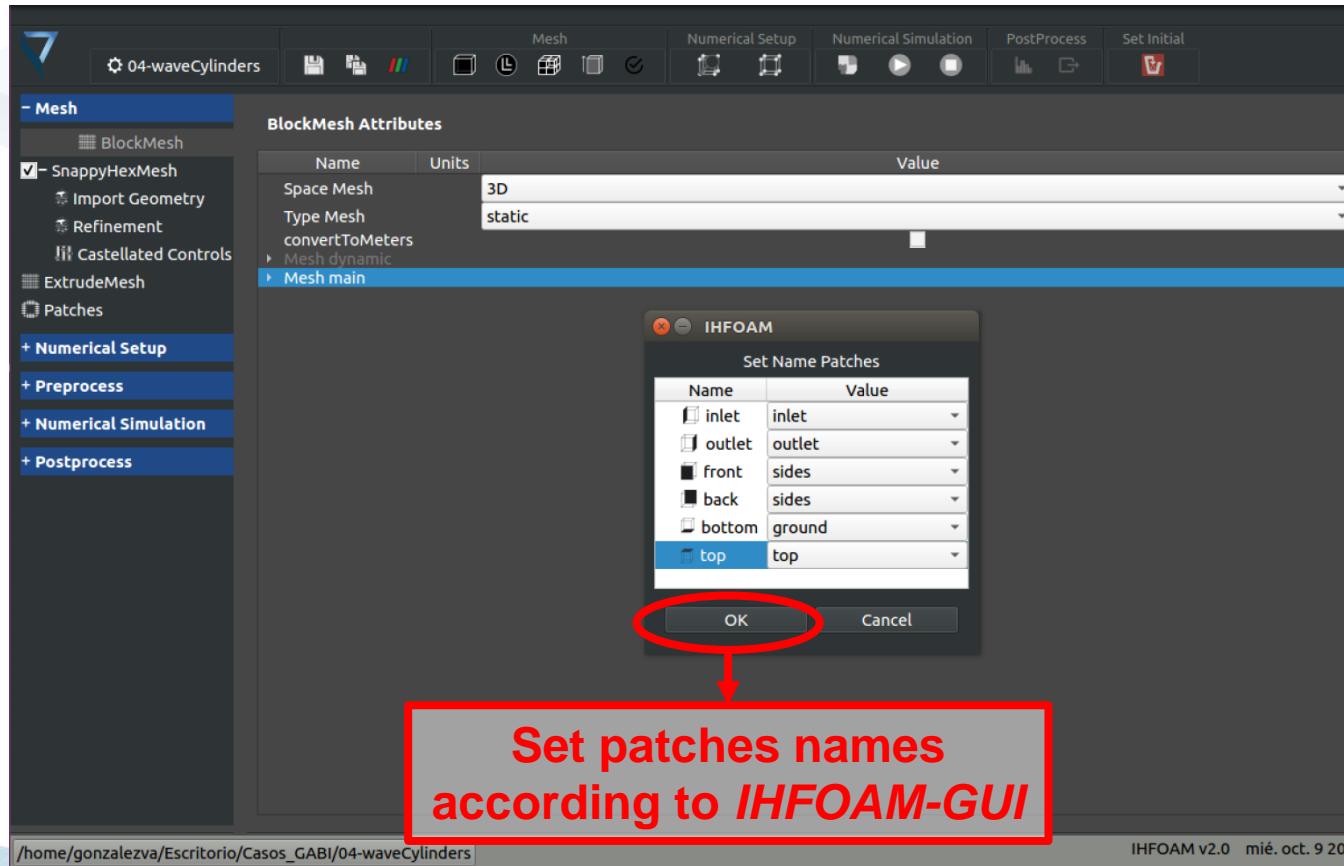




Save single pannel modified
or save all pannels modified.

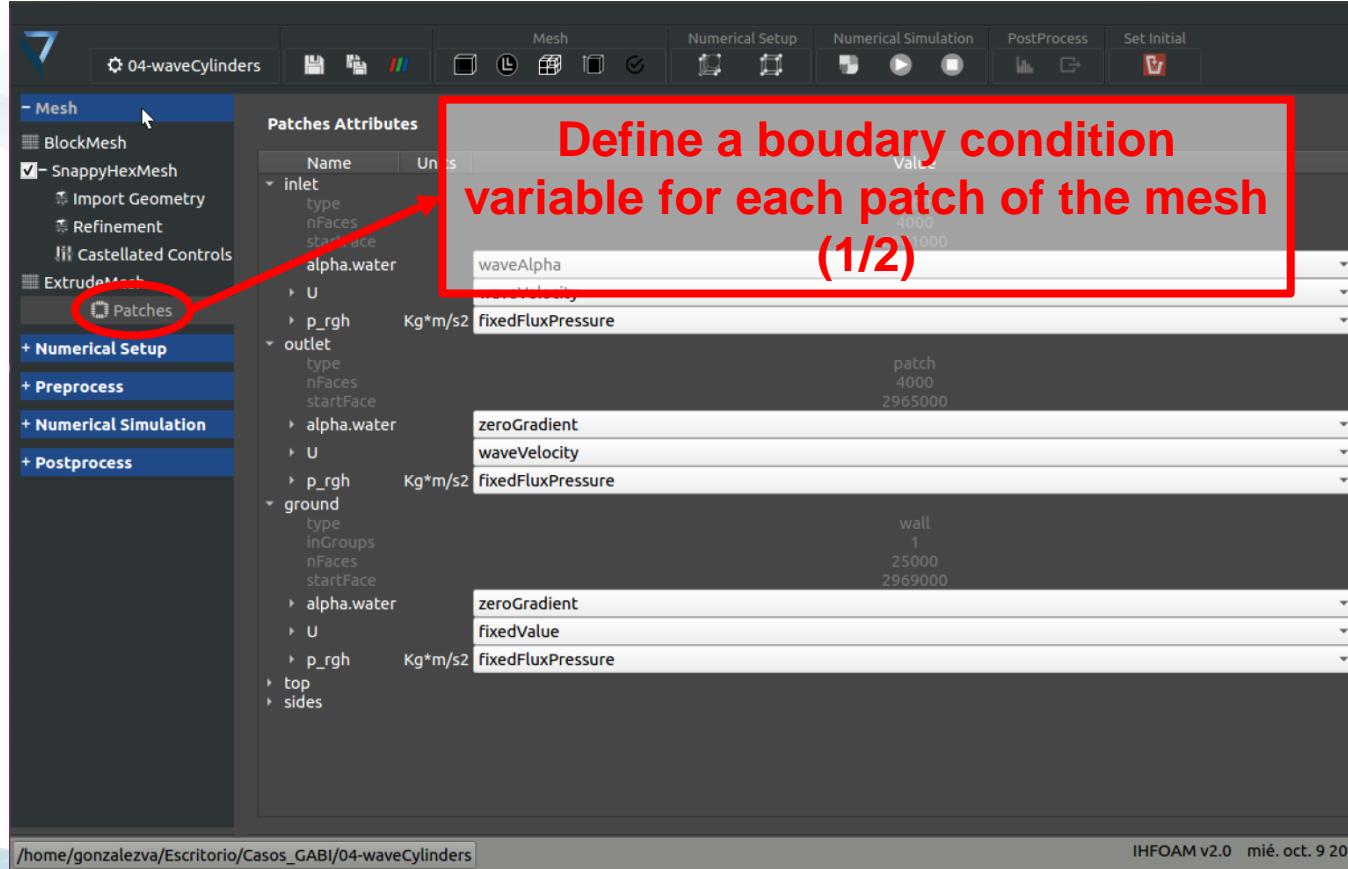






Set patches names
according to *IHFOAM-GUI*

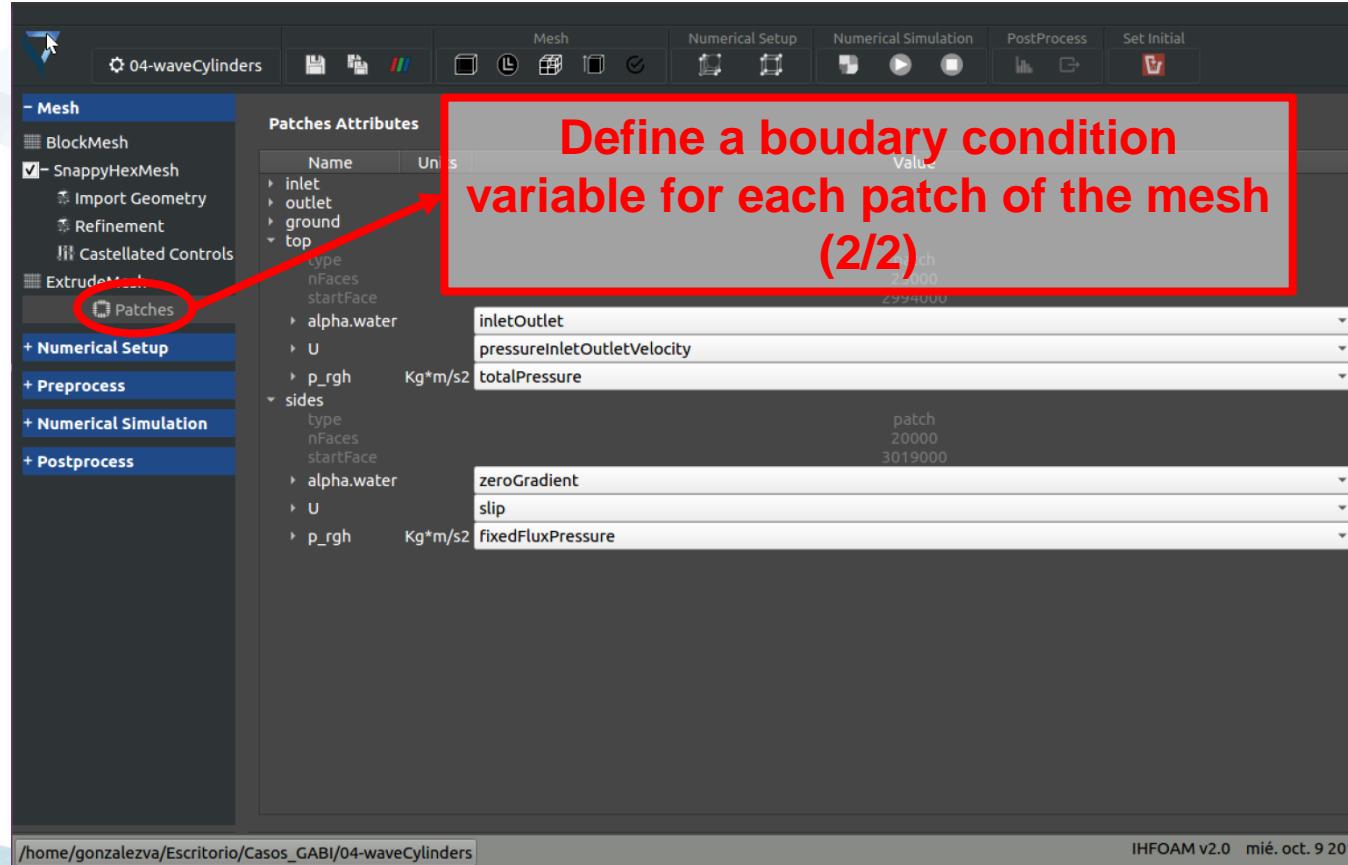
Define a boundary condition variable for each patch of the mesh (1/2)



Name	Units	Value
inlet		waveAlpha
outlet	Kg*m/s ²	fixedFluxPressure
ground		zeroGradient
top		fixedValue
sides		fixedFluxPressure

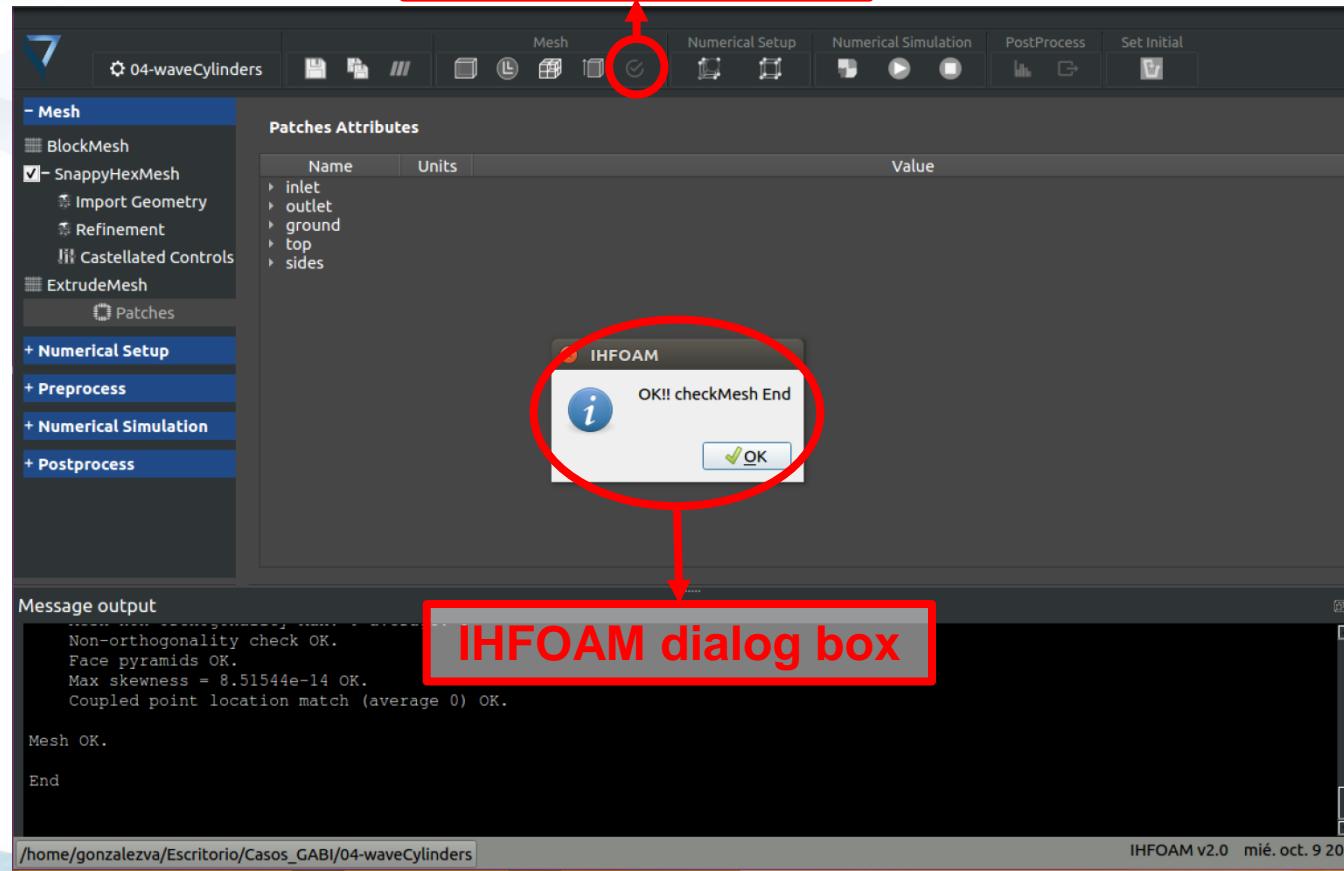
/home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders

IHFOAM v2.0 mié. oct. 9 2019



Define a boundary condition variable for each patch of the mesh (2/2)

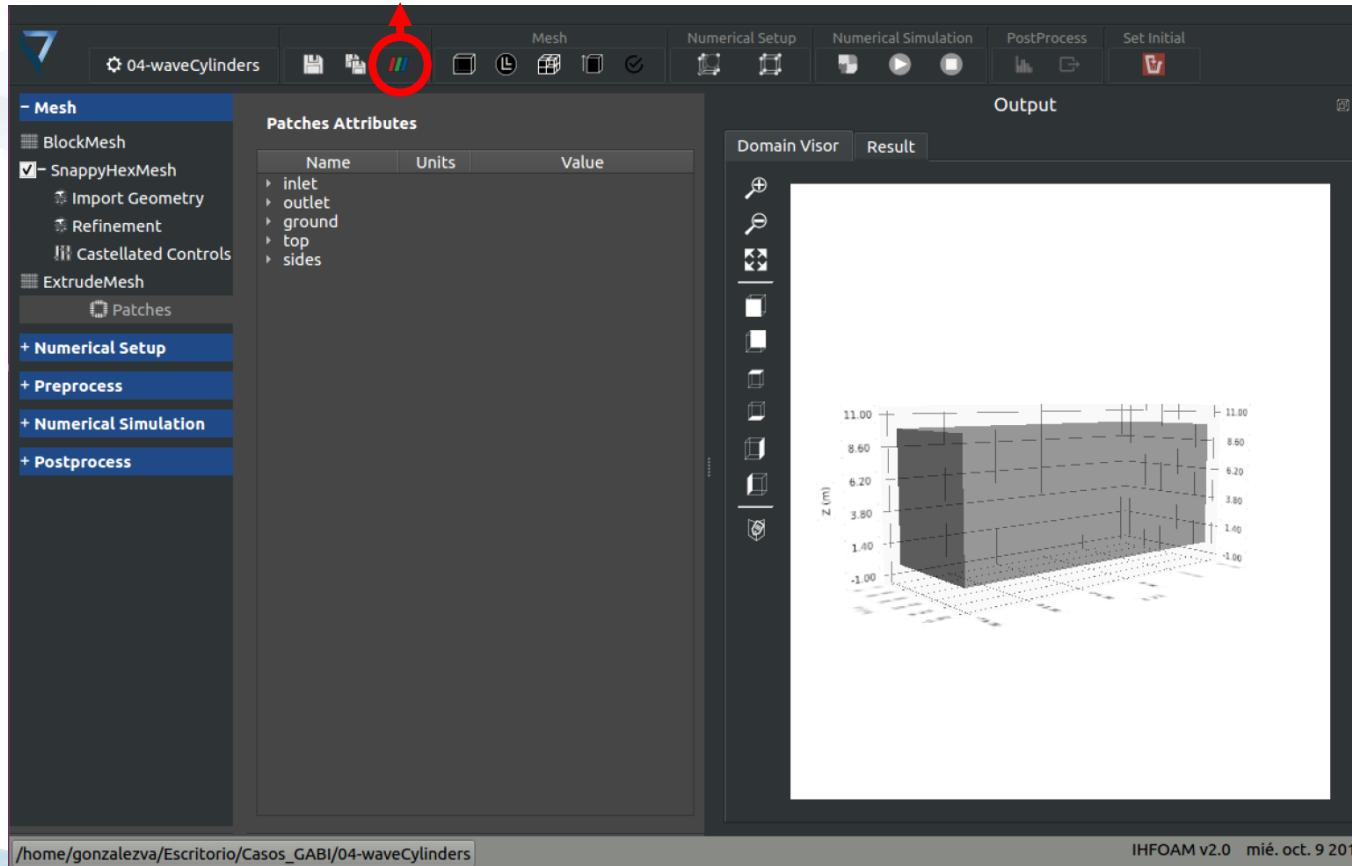
Name	Units	Value
inlet		
outlet		
ground		
top		
alpha.water		
U		
p_rgh	Kg*m/s ²	totalPressure
sides		
alpha.water		patch
U		20000
p_rgh	Kg*m/s ²	3019000

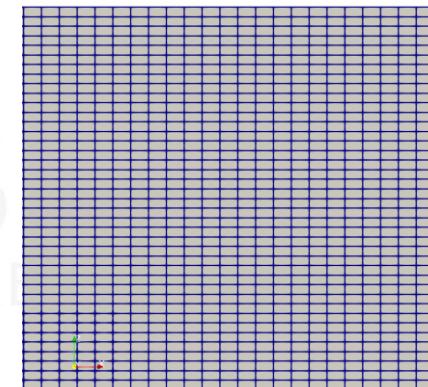
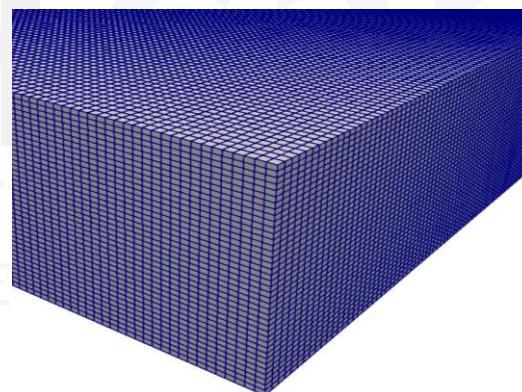
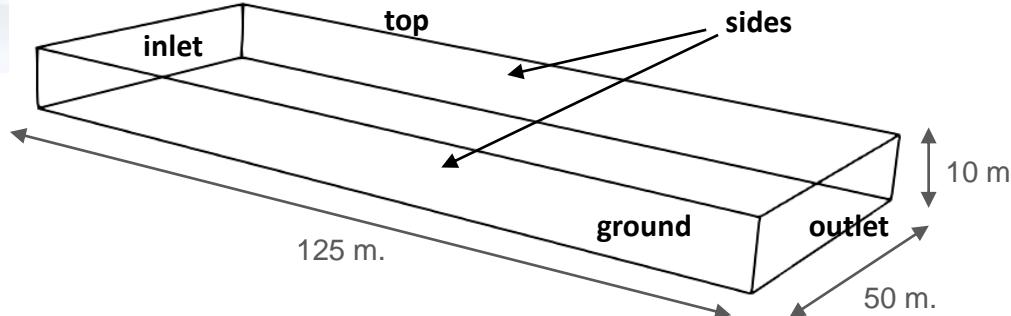


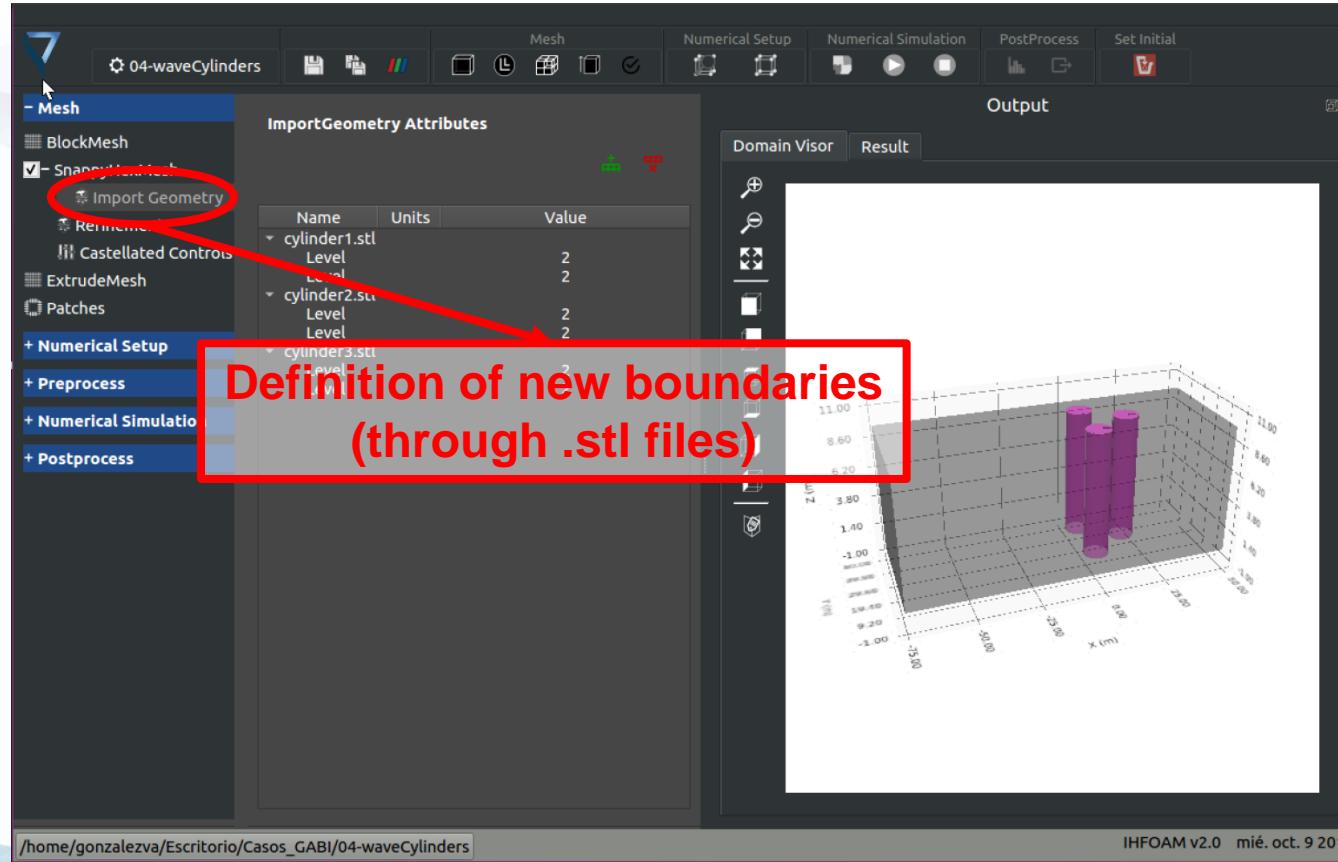
checkMesh button

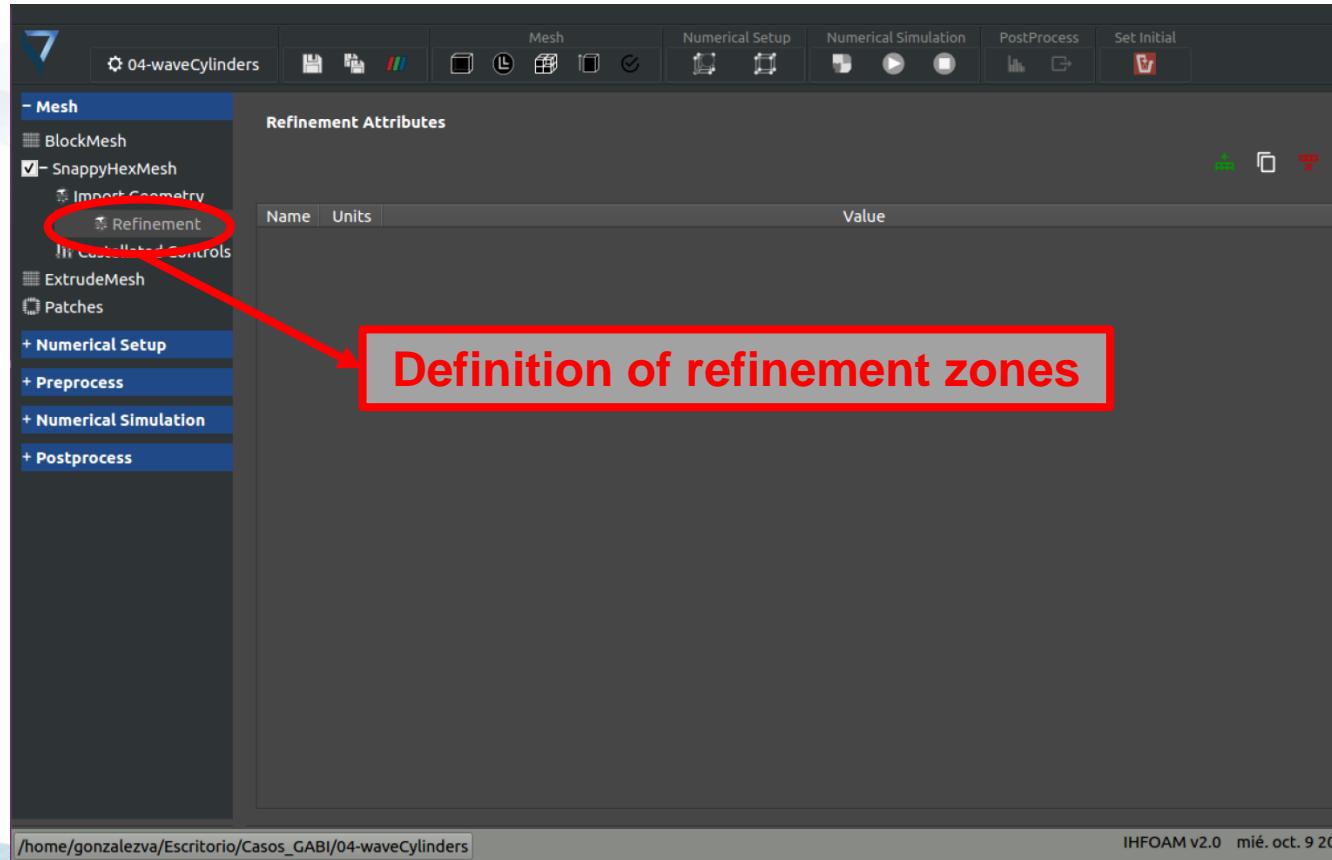
IHFOAM dialog box

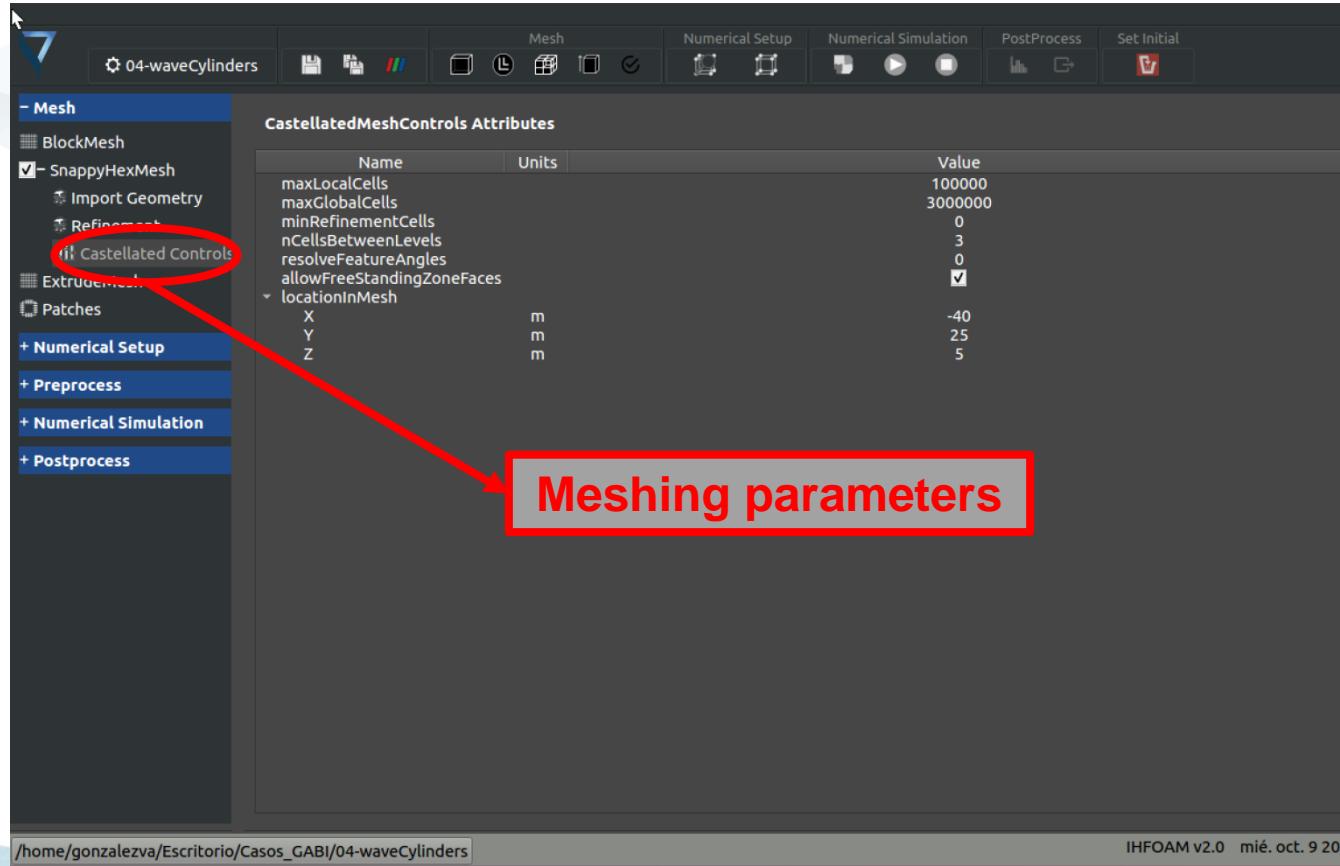
Paraview button









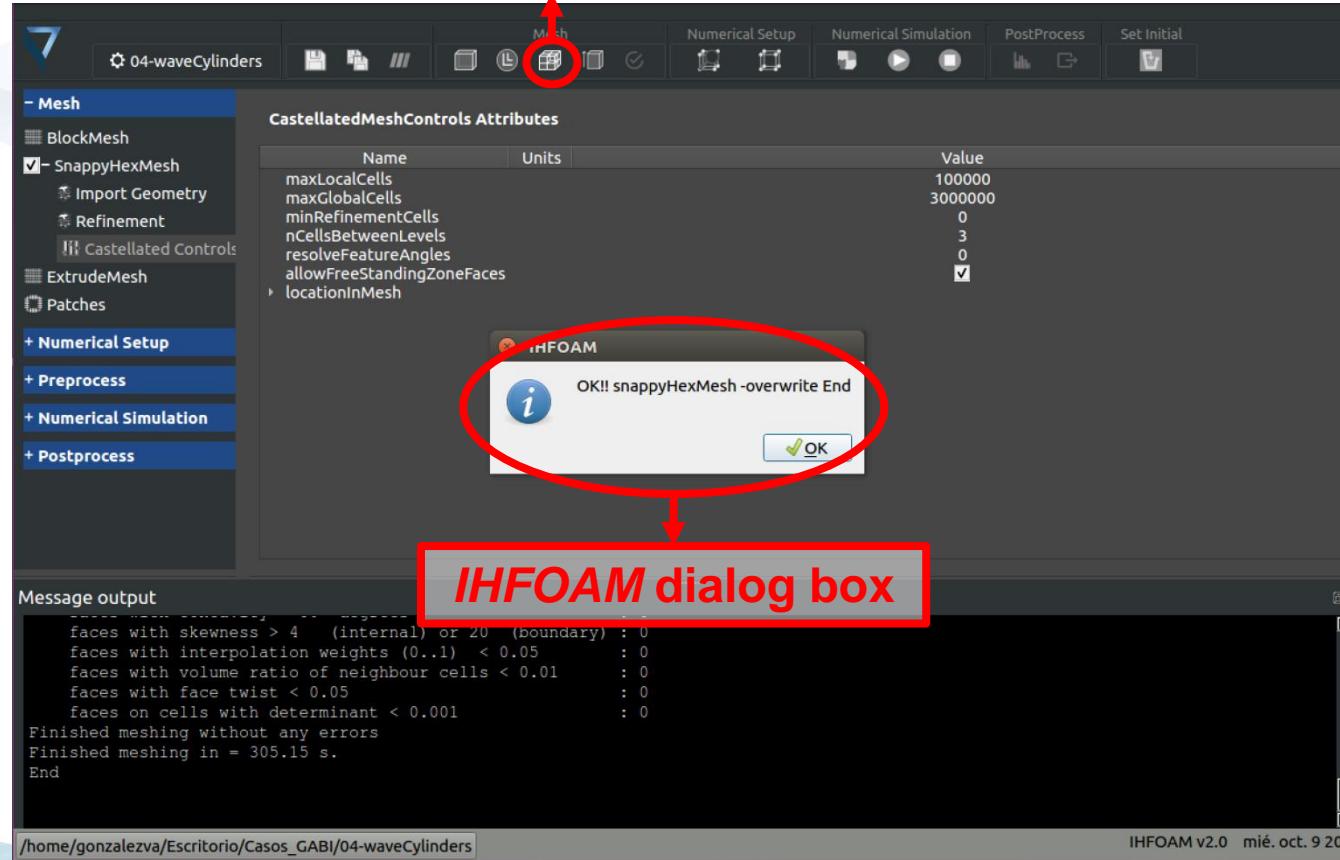


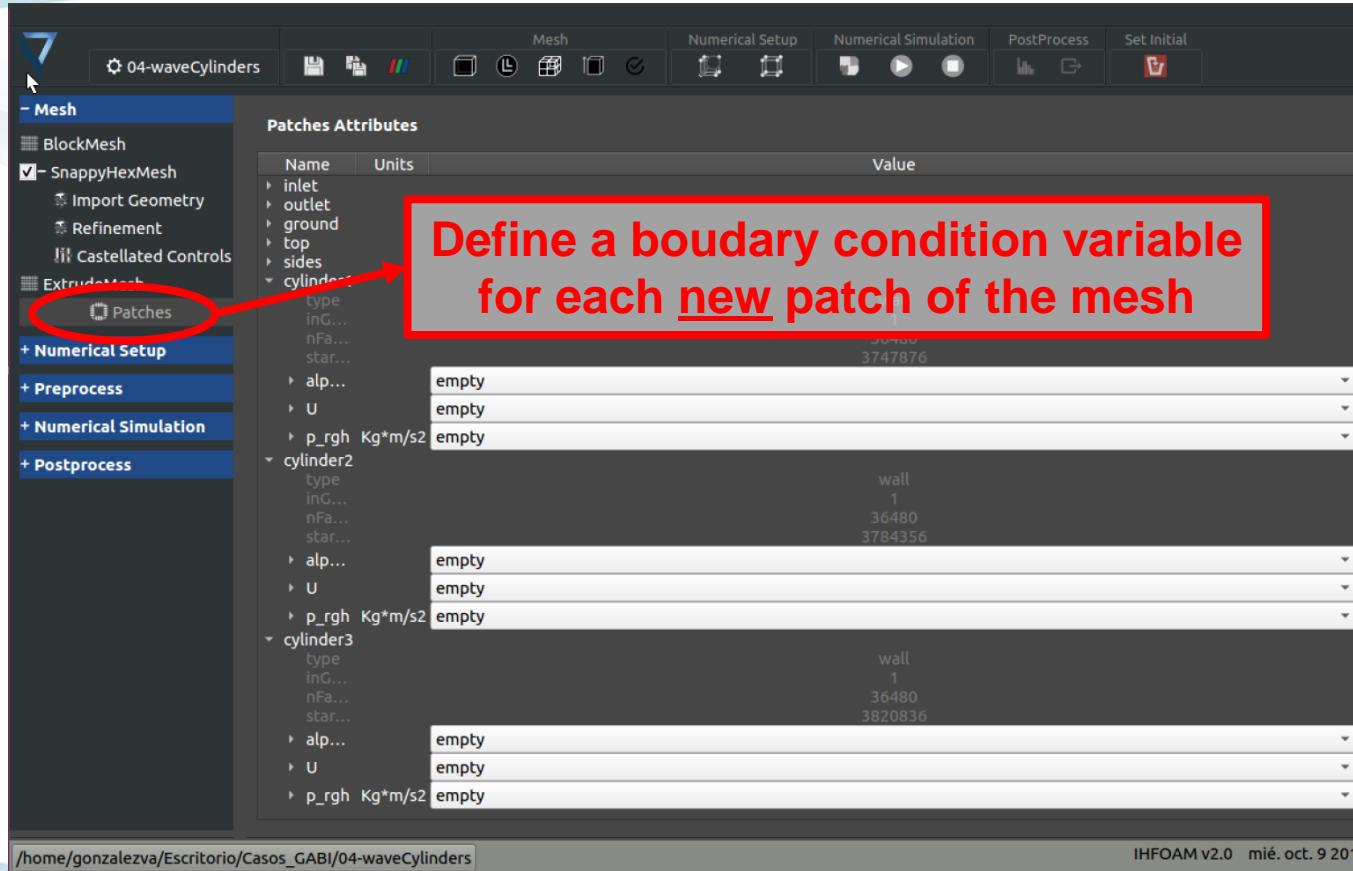
The screenshot shows the IHFOAM v2.0 software interface. The left sidebar has a tree view with categories: Mesh, Numerical Setup, Preprocess, Numerical Simulation, and Postprocess. Under Mesh, 'SnappyHexMesh' is expanded, showing 'Import Geometry', 'Refinement', and 'Castellated Controls'. A red circle highlights 'Castellated Controls', and a red arrow points from it to a red-bordered box containing the text 'Meshing parameters'. The main panel displays 'CastellatedMeshControls Attributes' with the following table:

Name	Units	Value
maxLocalCells		100000
maxGlobalCells		3000000
minRefinementCells		0
nCellsBetweenLevels		3
resolveFeatureAngles		0
allowFreeStandingZoneFaces		<input checked="" type="checkbox"/>
locationInMesh		
X	m	-40
Y	m	25
Z	m	5

At the bottom of the interface, the path is shown as: /home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders. The status bar at the bottom right indicates: IHFOAM v2.0 mié. oct. 9 2019.

snappyHexMesh button

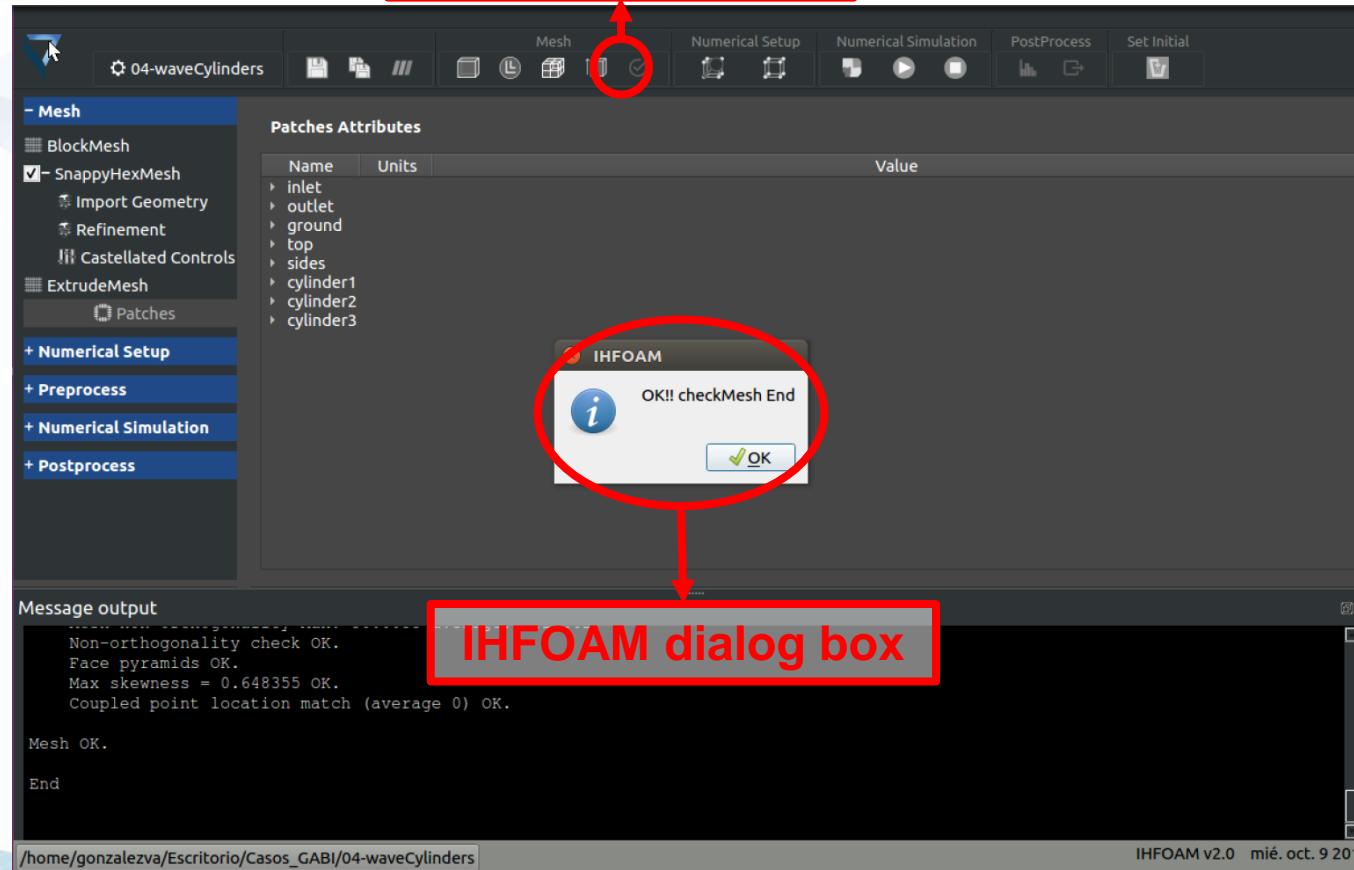


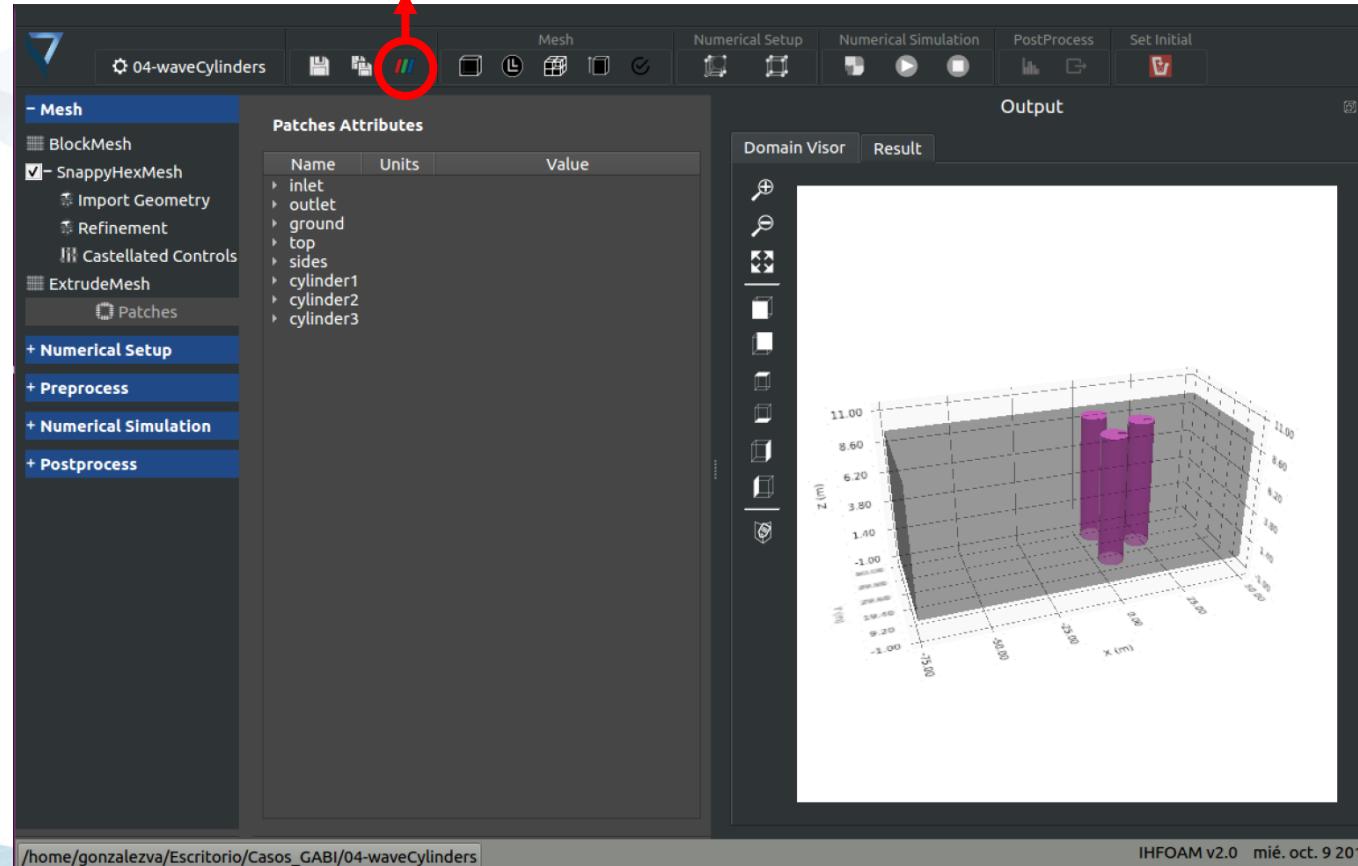


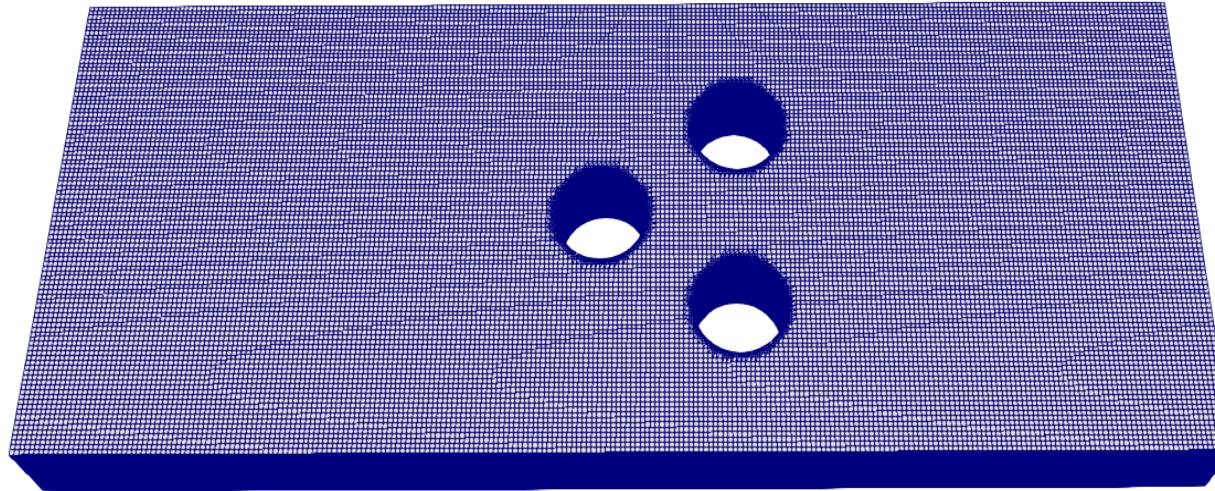
Define a boudary condition variable
for each new patch of the mesh

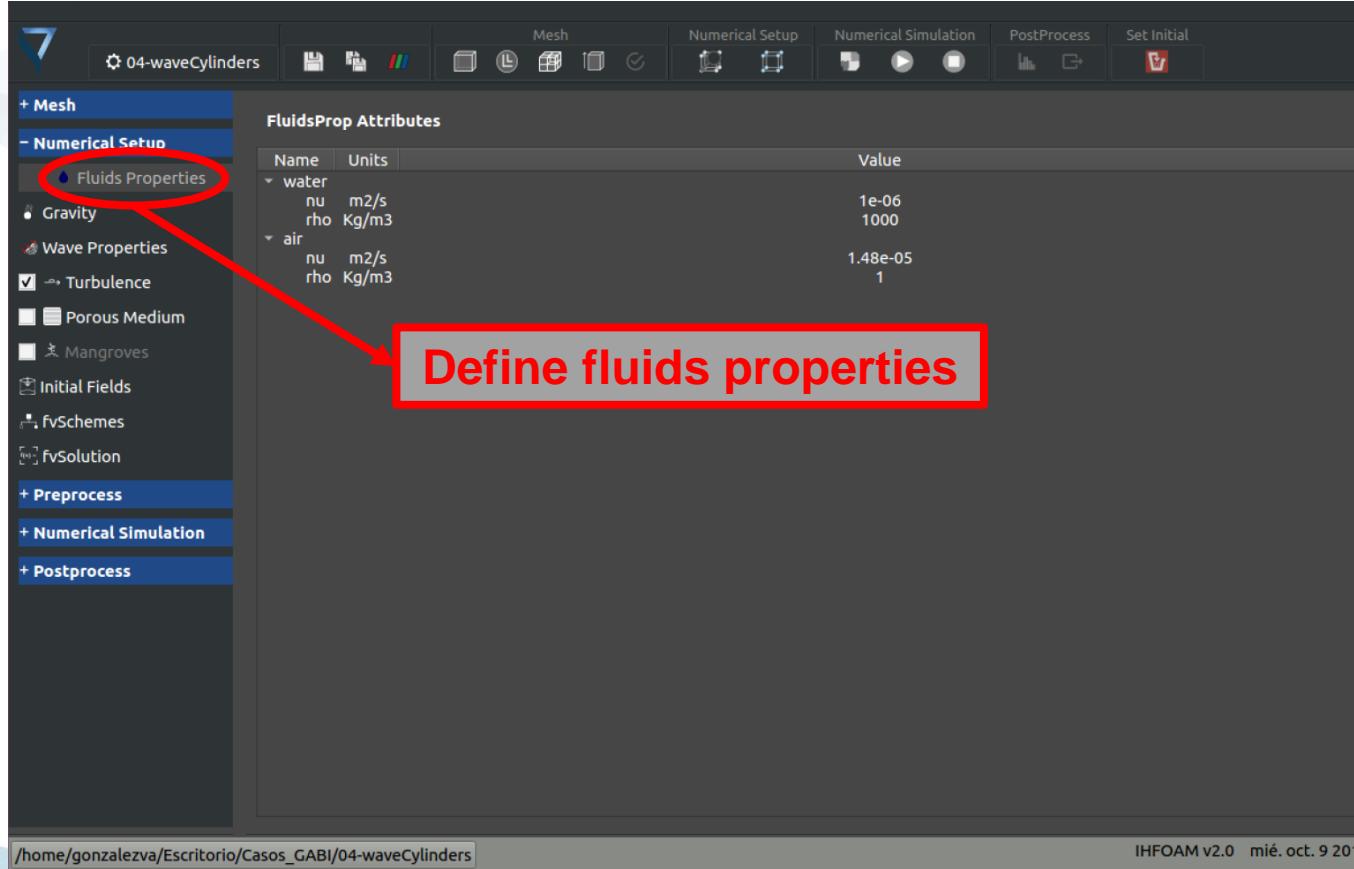
Name	Units	Value
inlet		
outlet		
ground		
top		
sides		
cylinder1		
type	inG...	33400
inG...	nFa...	3747876
nFa...	star...	
alp...	empty	
U	empty	
p_rgh Kg*m/s ²	empty	
cylinder2		
type	wall	
inG...	1	
nFa...	36480	
star...	3784356	
alp...	empty	
U	empty	
p_rgh Kg*m/s ²	empty	
cylinder3		
type	wall	
inG...	1	
nFa...	36480	
star...	3820836	
alp...	empty	
U	empty	
p_rgh Kg*m/s ²	empty	

checkMesh button









The screenshot shows the IHFOAM v2.0 software interface. On the left, there is a navigation tree with the following structure:

- + Mesh
- Numerical Setup
 - Fluids Properties (highlighted with a red circle)
 - Gravity
 - Wave Properties
 - Turbulence
 - Porous Medium
 - Mangroves
 - Initial Fields
 - fvSchemes
 - fvSolution
- + Preprocess
- + Numerical Simulation
- + Postprocess

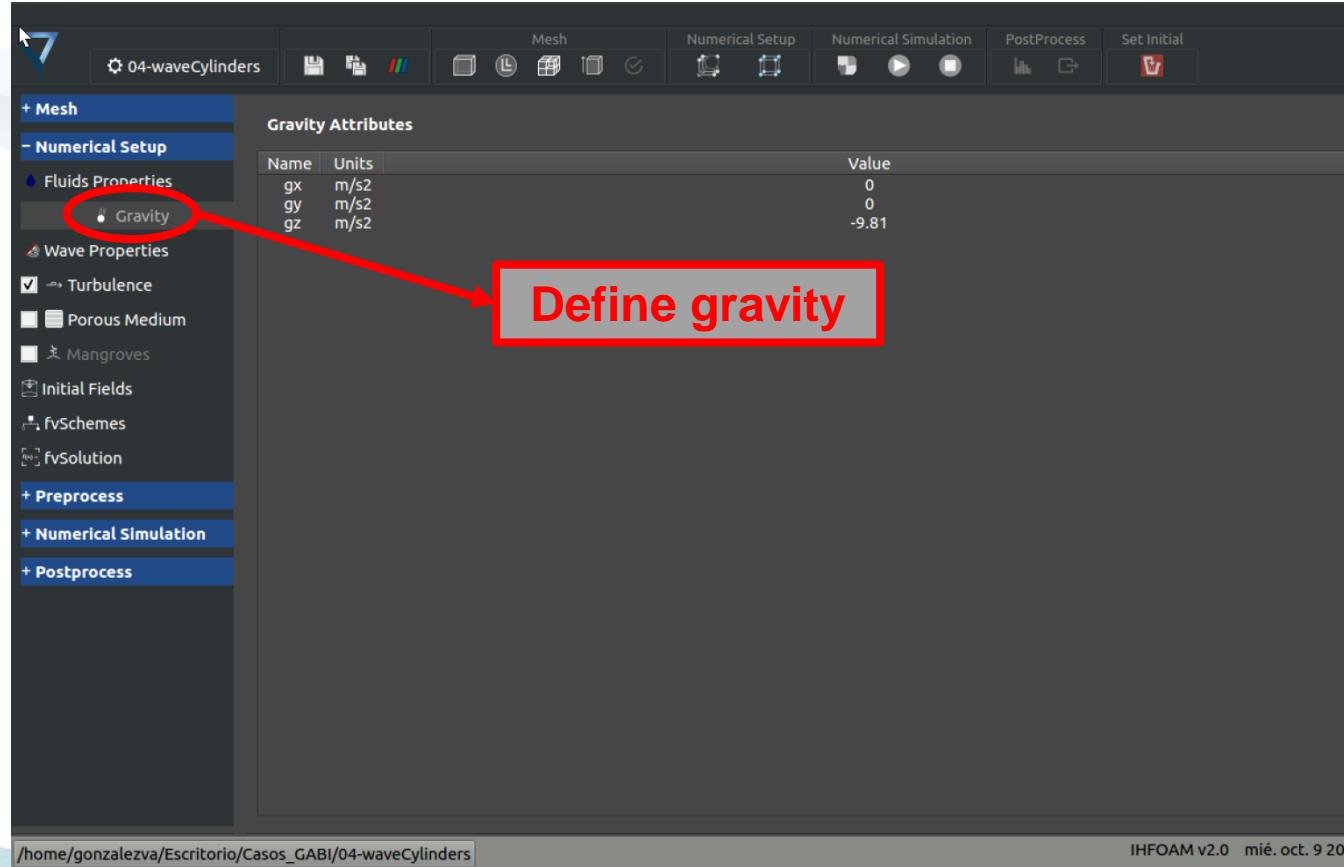
A red arrow points from the text "Define fluids properties" to the "Fluids Properties" item in the tree.

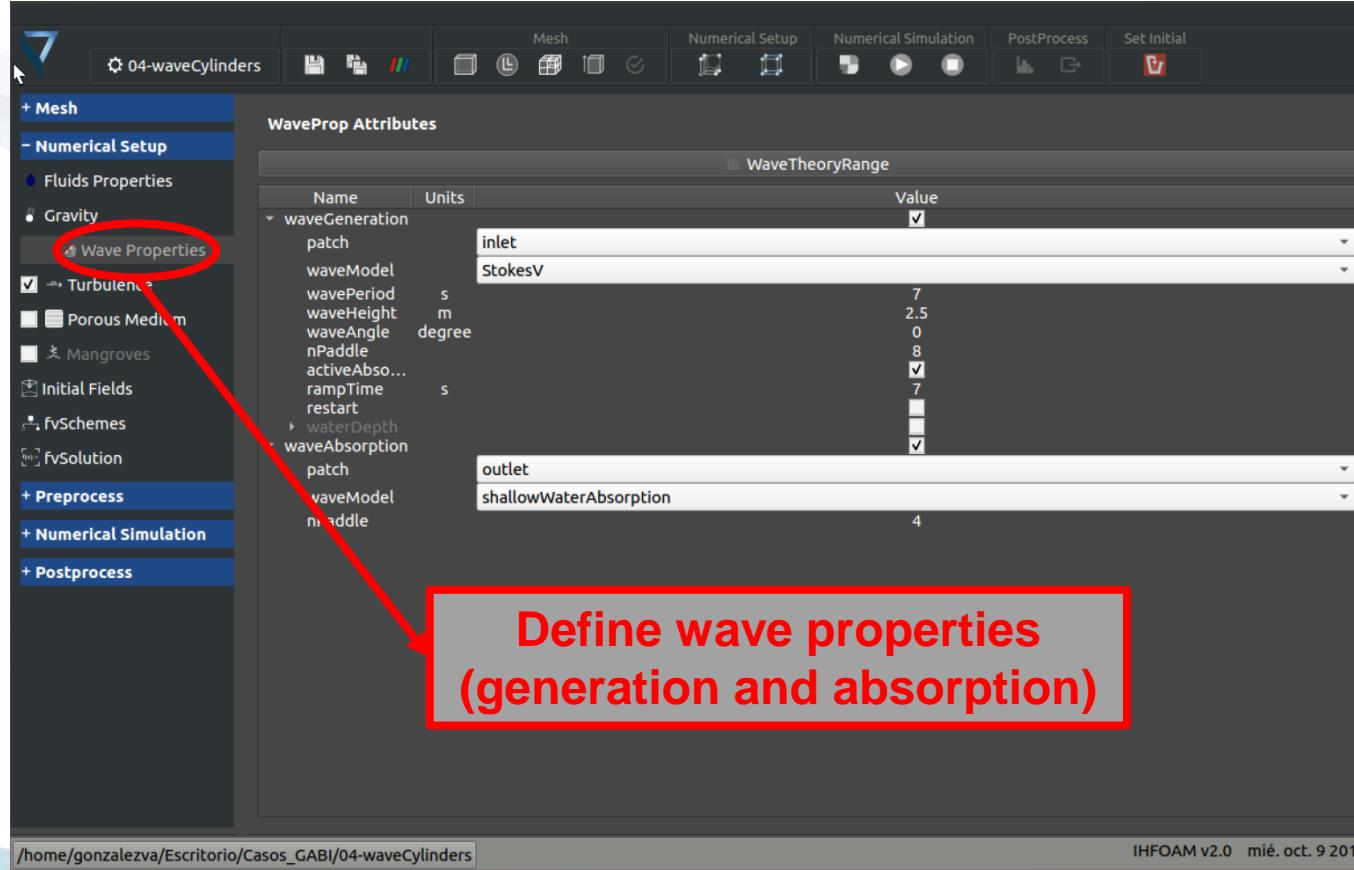
The main panel displays the "FluidsProp Attributes" table:

Name	Units	Value
water	nu	1e-06
	rho	1000
air	nu	1.48e-05
	rho	1

The status bar at the bottom shows the path: /home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders and the version: IHFOAM v2.0 mié. oct. 9 2019.

Define fluids properties





The screenshot shows the IHFOAM v2.0 software interface. The left sidebar has a tree view with nodes like Mesh, Numerical Setup, Fluids Properties, Gravity, Wave Properties (which is circled in red), Turbulence, Porous Medium, Mangroves, Initial Fields, fvSchemes, fvSolution, Preprocess, Numerical Simulation, and Postprocess. The main panel is titled 'WaveProp Attributes' and contains a table for 'WaveTheoryRange'. It includes sections for 'waveGeneration' and 'waveAbsorption'. The 'waveGeneration' section has 'patch' set to 'inlet' and 'waveModel' set to 'StokesV'. The 'waveAbsorption' section has 'patch' set to 'outlet' and 'waveModel' set to 'shallowWaterAbsorption'. A red box highlights the text 'Define wave properties (generation and absorption)'.

Define wave properties
(generation and absorption)

The screenshot shows the IHFOAM v2.0 software interface for a simulation titled "04-waveCylinders". The left sidebar contains a tree view of simulation components: Mesh, Numerical Setup (selected), Fluids Properties, Gravity, Wave Properties (with a red circle around the "Turbulence" node), Porous Medium, Mangroves, Initial Fields, fvSchemes, FvSolution, Preprocess, Numerical Simulation, and Postprocess. A large red arrow points from the text below to the "Turbulence" node in the tree.

Turbulence Attributes

Name	Units	Value
simulationType		RAS
RASModel		kEpsilon
internalField		
k	m ² /s ²	0.06
epsilon	m ² /s ³	0.00022045
omega	1/s	0
nut	m ² /s	0
inlet		
k	m ² /s ²	zeroGradient
epsilon	m ² /s ³	zeroGradient
omega	1/s	empty
nut	m/s	calculated
outlet		
k	m ² /s ²	zeroGradient
epsilon	m ² /s ³	zeroGradient
omega	1/s	empty
nut	m/s	calculated
ground		
k	m ² /s ²	kqRWallFunction
epsilon	m ² /s ³	epsilonWallFunction
omega	1/s	empty
nut	m/s	nutkWallFunction
sides		
cylinder1		
cylinder3		

Define turbulence model and boundary conditions (1/3)

/home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders

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04-waveCylinders

Mesh Numerical Setup PostProcess Set Initial

+ Mesh - Numerical Setup

- Fluids Properties
- Gravity
- Wave Properties
- Turbulence**
- Porous Medium
- Mangroves
- Initial Fields
- fvSchemes
- fvSolution

+ Preprocess + Numerical Simulation + Postprocess

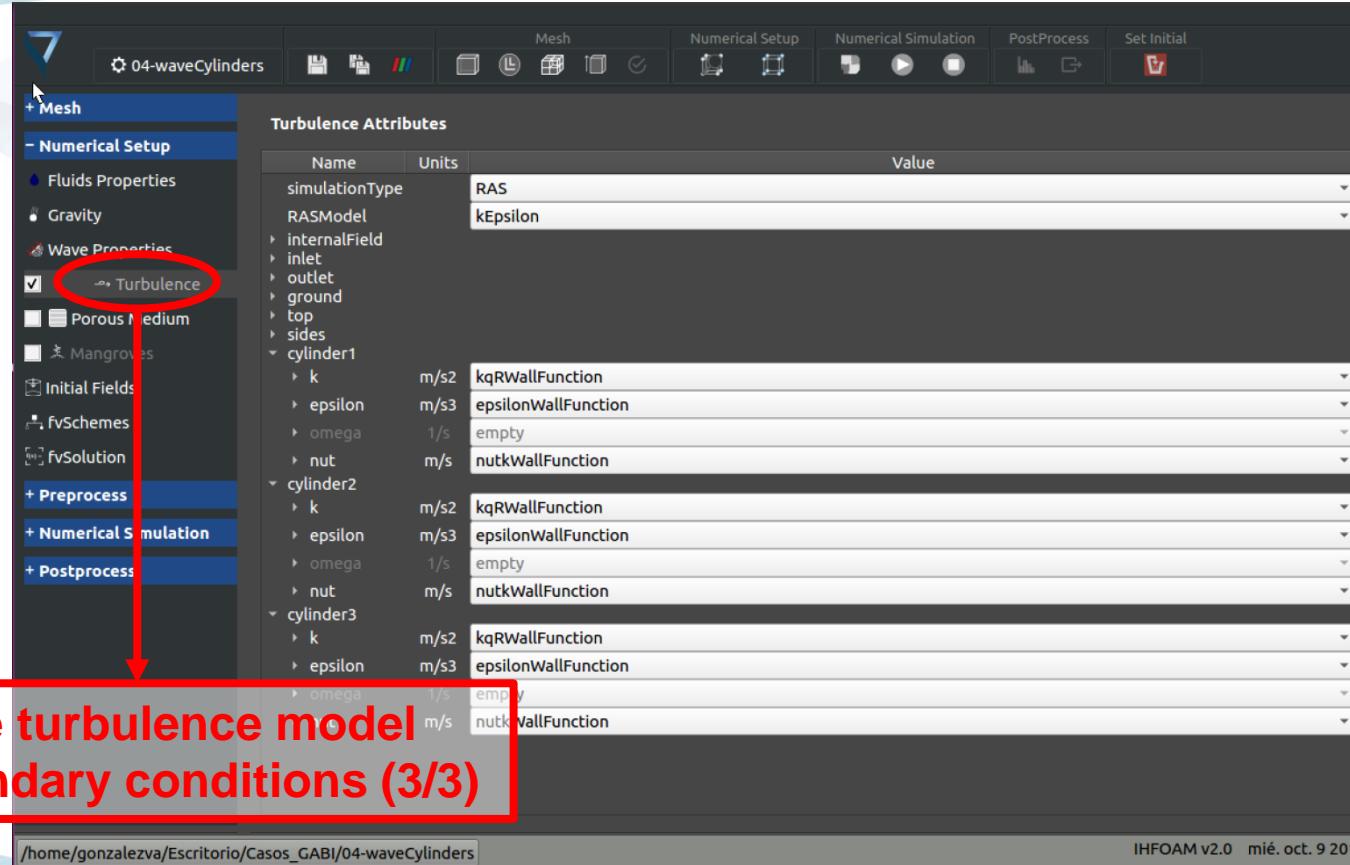
Turbulence Attributes

Name	Units	Value
simulationType		RAS
RASModel		kEpsilon
internalField		
inlet		inletOutlet
outlet		inletOutlet
ground		empty
top		calculated
k	m/s ²	inletOutlet
epsilon	m/s ³	inletOutlet
omega	1/s	empty
nut	m/s	calculated
sides		
k	m/s ²	slip
epsilon	m/s ³	slip
omega	1/s	empty
nut	m/s	slip
cylinder1		
cylinder2		
cylinder3		

Define turbulence model and boundary conditions (2/3)

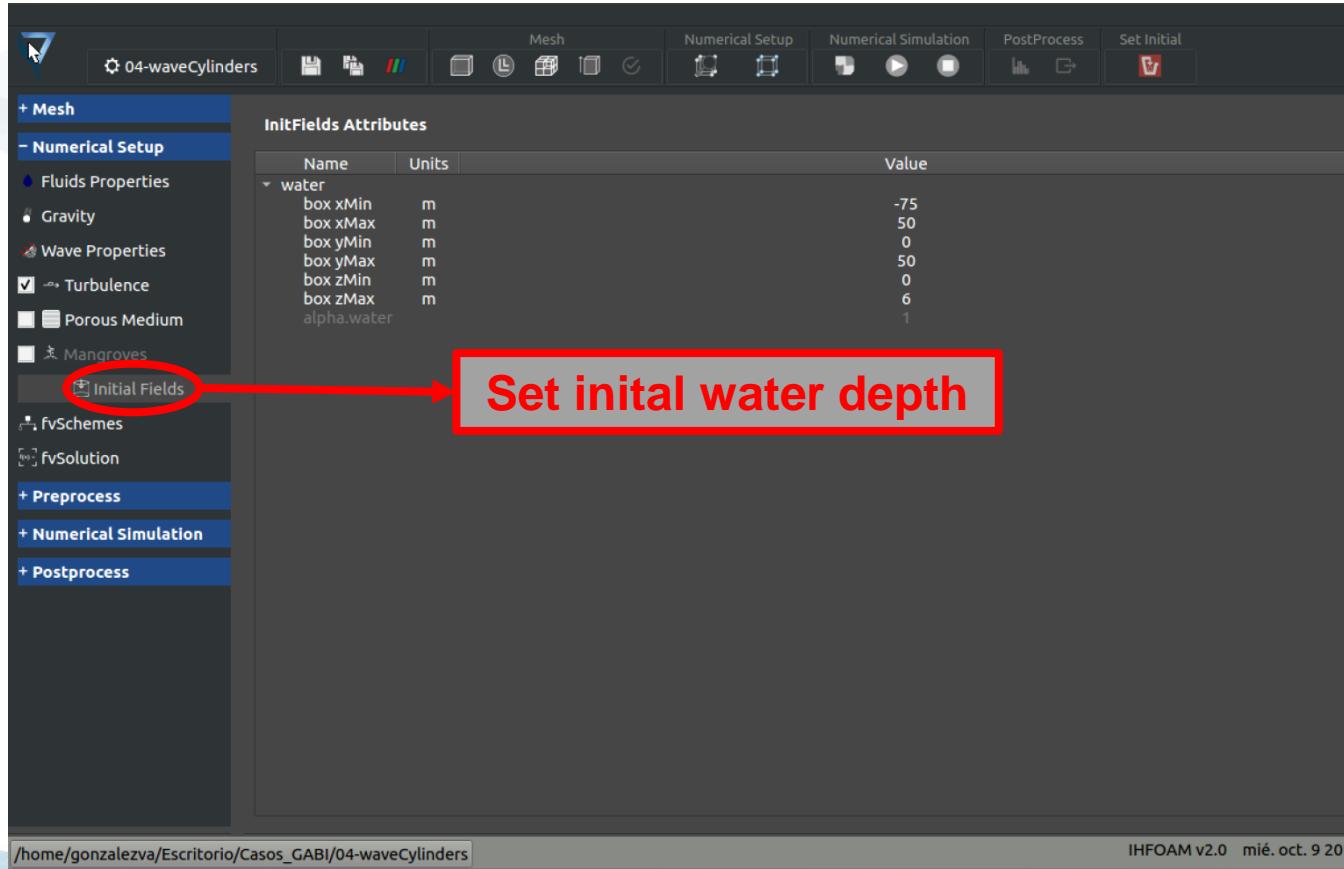
/home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders

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Define turbulence model and boundary conditions (3/3)

Name	Units	Value
simulationType		RAS
RASModel		kEpsilon
internalField		
inlet		
outlet		
ground		
top		
sides		
cylinder1		
k	m/s ²	kqRWallFunction
epsilon	m/s ³	epsilonWallFunction
omega	1/s	empty
nut	m/s	nutkWallFunction
cylinder2		
k	m/s ²	kqRWallFunction
epsilon	m/s ³	epsilonWallFunction
omega	1/s	empty
nut	m/s	nutkWallFunction
cylinder3		
k	m/s ²	kqRWallFunction
epsilon	m/s ³	epsilonWallFunction
omega	1/s	empty
nut	m/s	nutkWallFunction



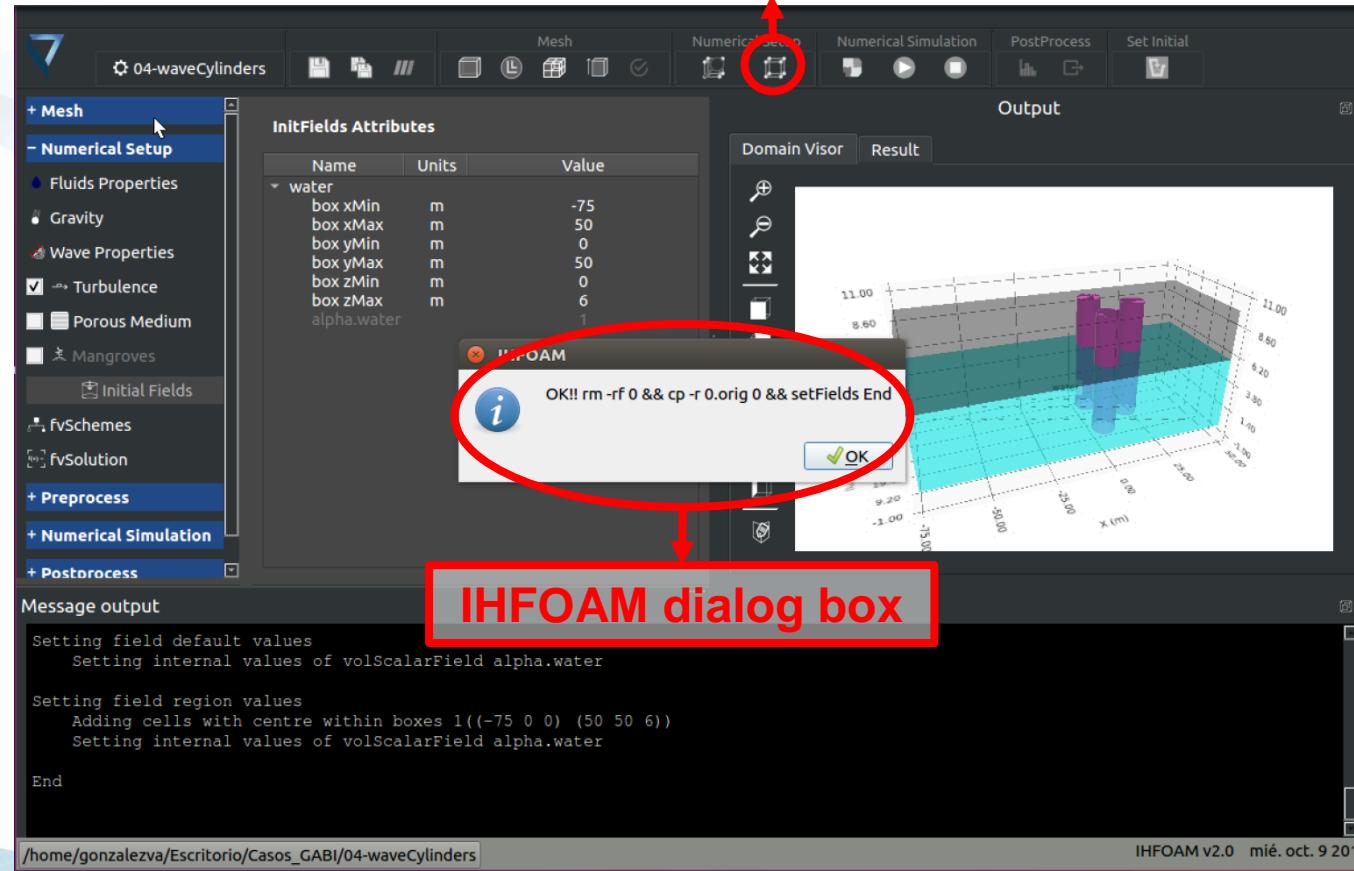
The screenshot shows the IHFOAM v2.0 software interface. The left sidebar contains a tree view of project components: Mesh, Numerical Setup (selected), Fluids Properties, Gravity, Wave Properties, Turbulence, Porous Medium, Mangroves, Initial Fields (highlighted with a red circle and arrow), FvSchemes, FvSolution, Preprocess, Numerical Simulation, and Postprocess. The main panel displays the 'InitFields Attributes' table:

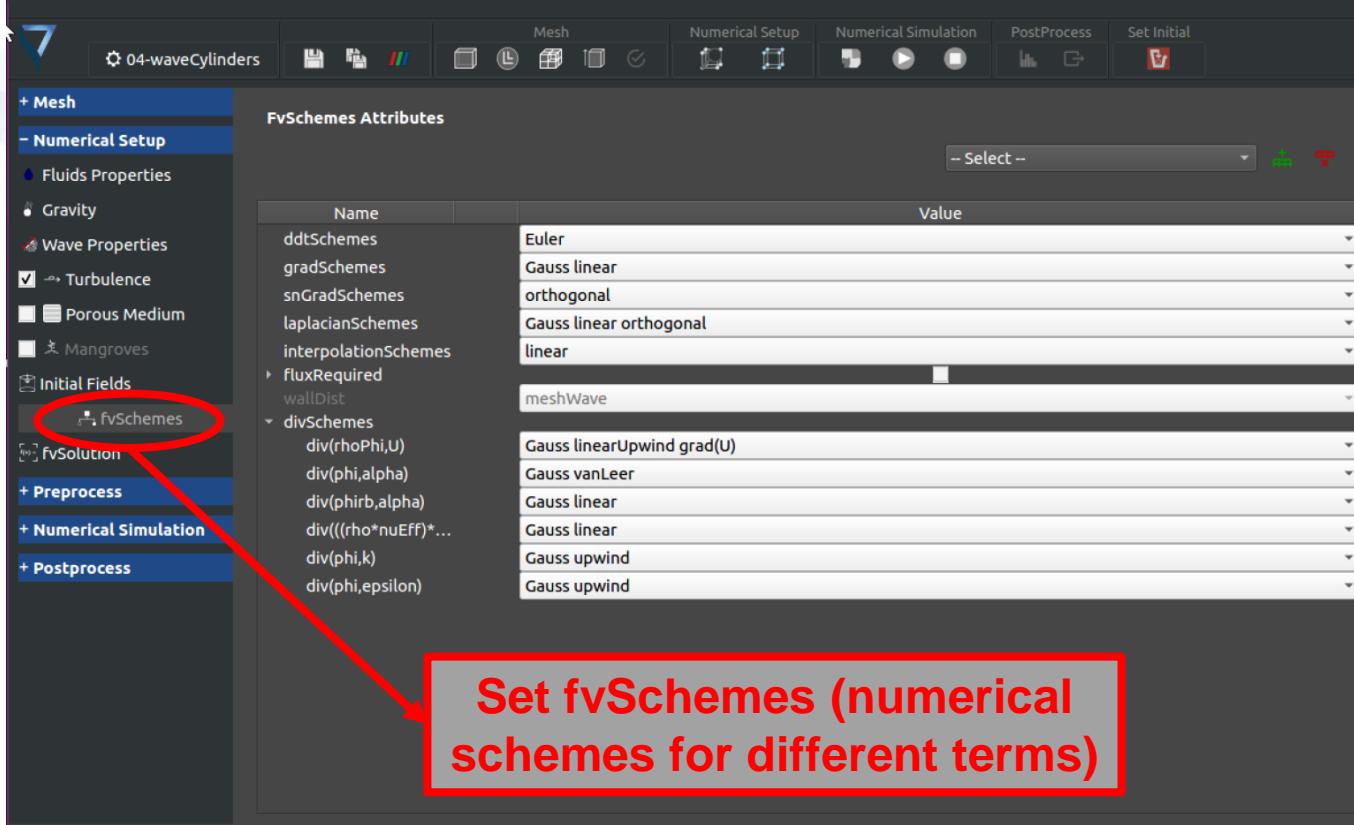
Name	Units	Value
water		
box xMin	m	-75
box xMax	m	50
box yMin	m	0
box yMax	m	50
box zMin	m	0
box zMax	m	6
alpha.water		1

A red box highlights the text "Set initial water depth" next to the "Initial Fields" button in the sidebar.

Path: /home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders

IHFOAM v2.0 mié. oct. 9 2019





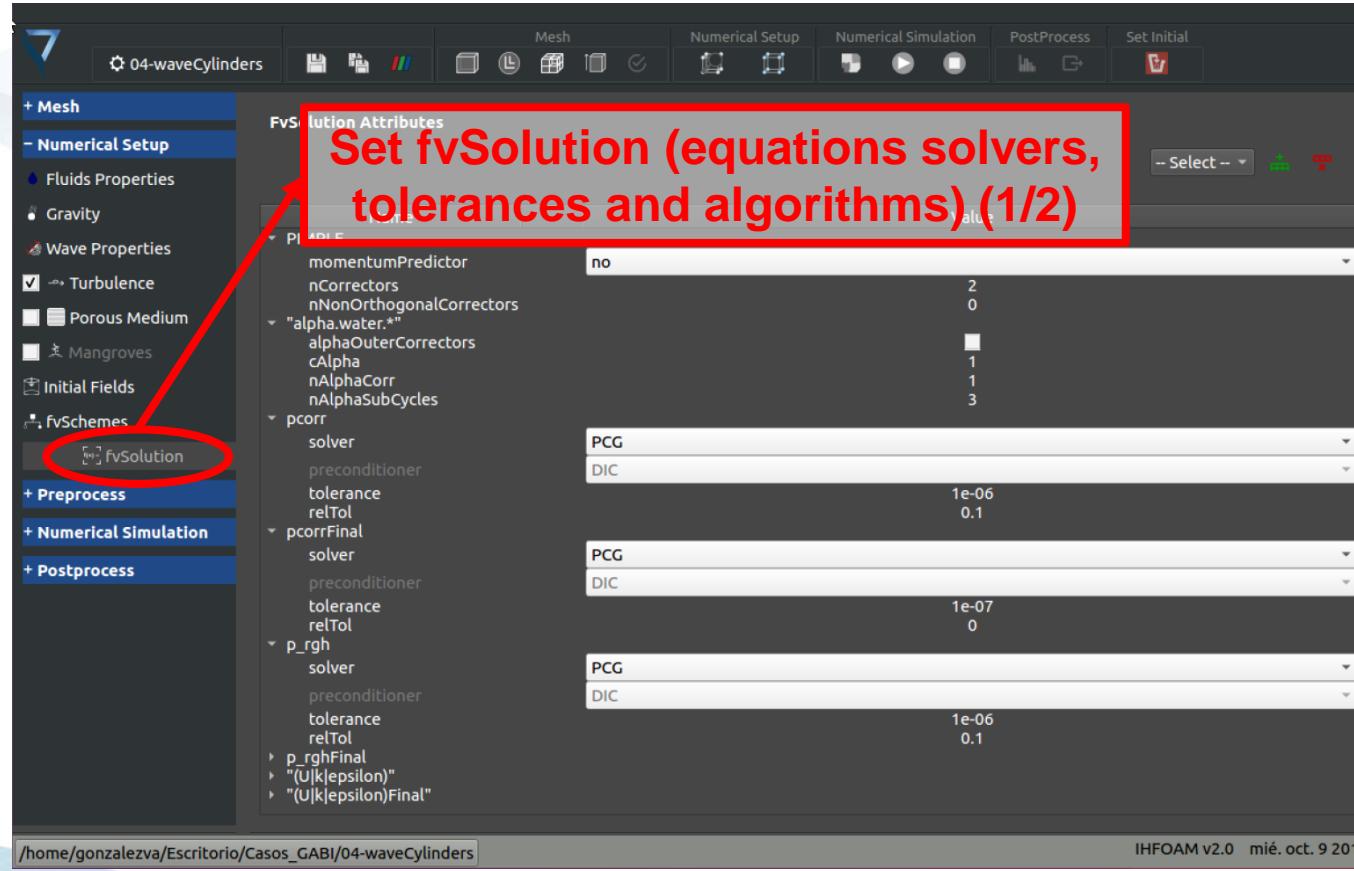
The screenshot shows the IFOAM v2.0 software interface. On the left, there is a navigation tree with sections like Mesh, Numerical Setup, Fluids Properties, Gravity, Wave Properties, Turbulence, Porous Medium, Mangroves, Initial Fields, fvSchemes (which is circled in red), fvSolution, Preprocess, Numerical Simulation, and Postprocess. The main panel displays 'fvSchemes Attributes' with a table of numerical schemes:

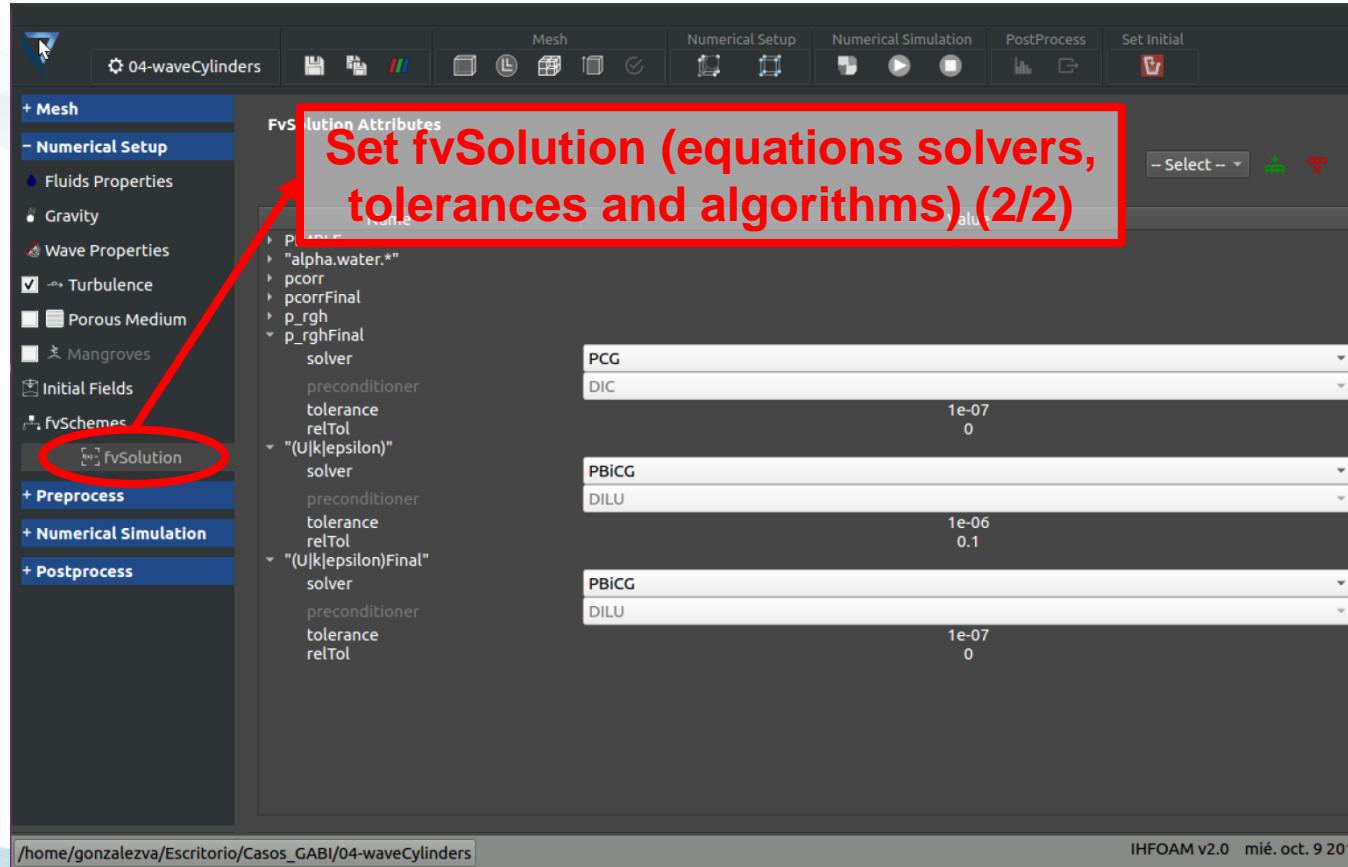
Name	Value
ddtSchemes	Euler
gradschemes	Gauss linear
snGradSchemes	orthogonal
laplacianSchemes	Gauss linear orthogonal
interpolationSchemes	linear
fluxRequired	meshWave
wallDist	
divSchemes	
div(rhoPhi,U)	Gauss linearUpwind grad(U)
div(phi,alpha)	Gauss vanLeer
div(phibar,alpha)	Gauss linear
div((rho*nuEff)*...	Gauss linear
div(phi,k)	Gauss upwind
div(phi,epsilon)	Gauss upwind

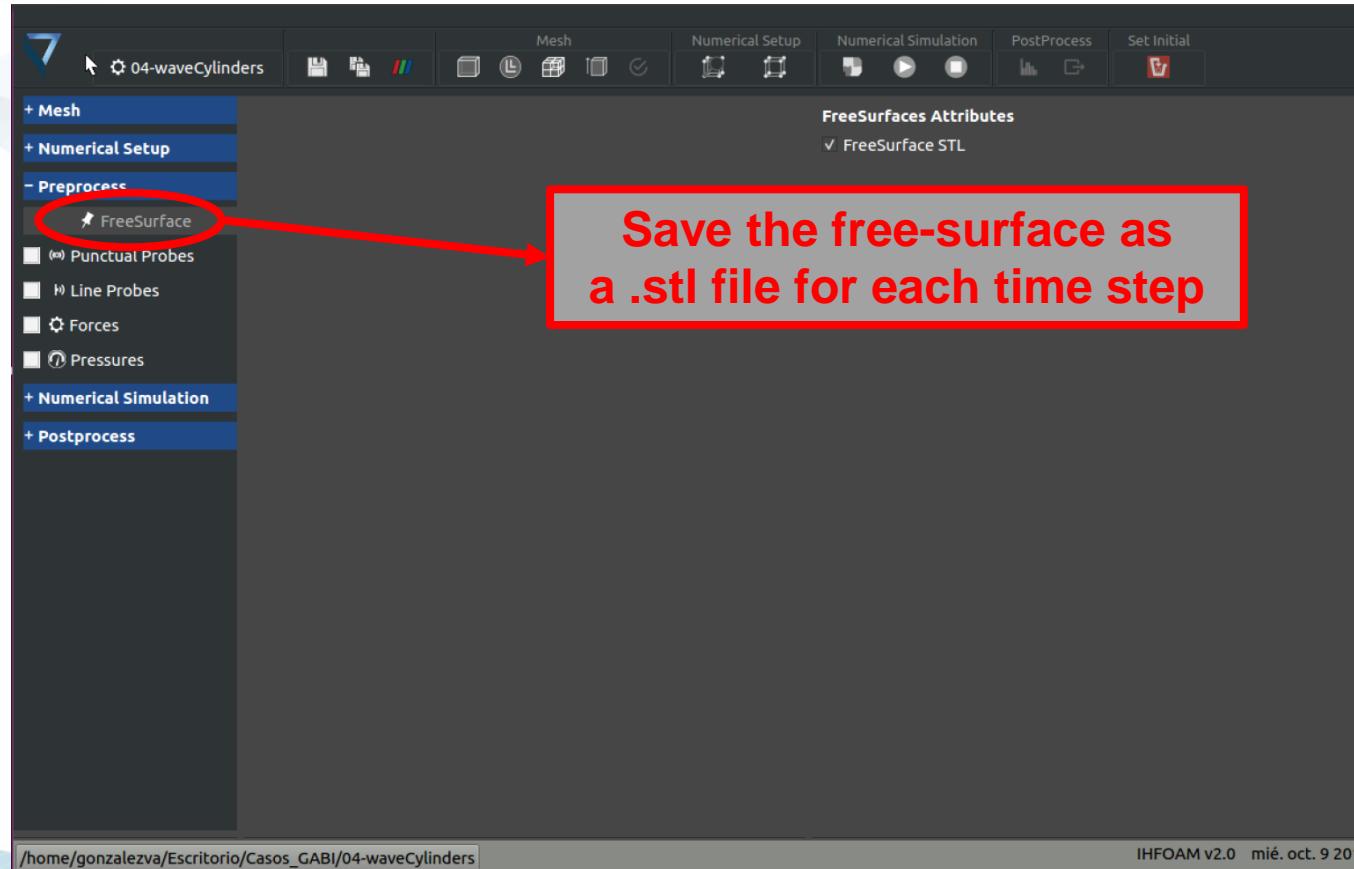
Set fvSchemes (numerical schemes for different terms)

/home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders

INFOAM v2.0 mié, oct. 9 2019







INFOAM

File Edit View Help

04-waveCylinders

Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

Attributes

Name	Units	Value
forcescylinder1	timeStep	0
outputControl		
outputInterval		
writeFields		<input checked="" type="checkbox"/>
CofR		
CofR X	m	0
CofR Y	m	0
CofR Z	m	0

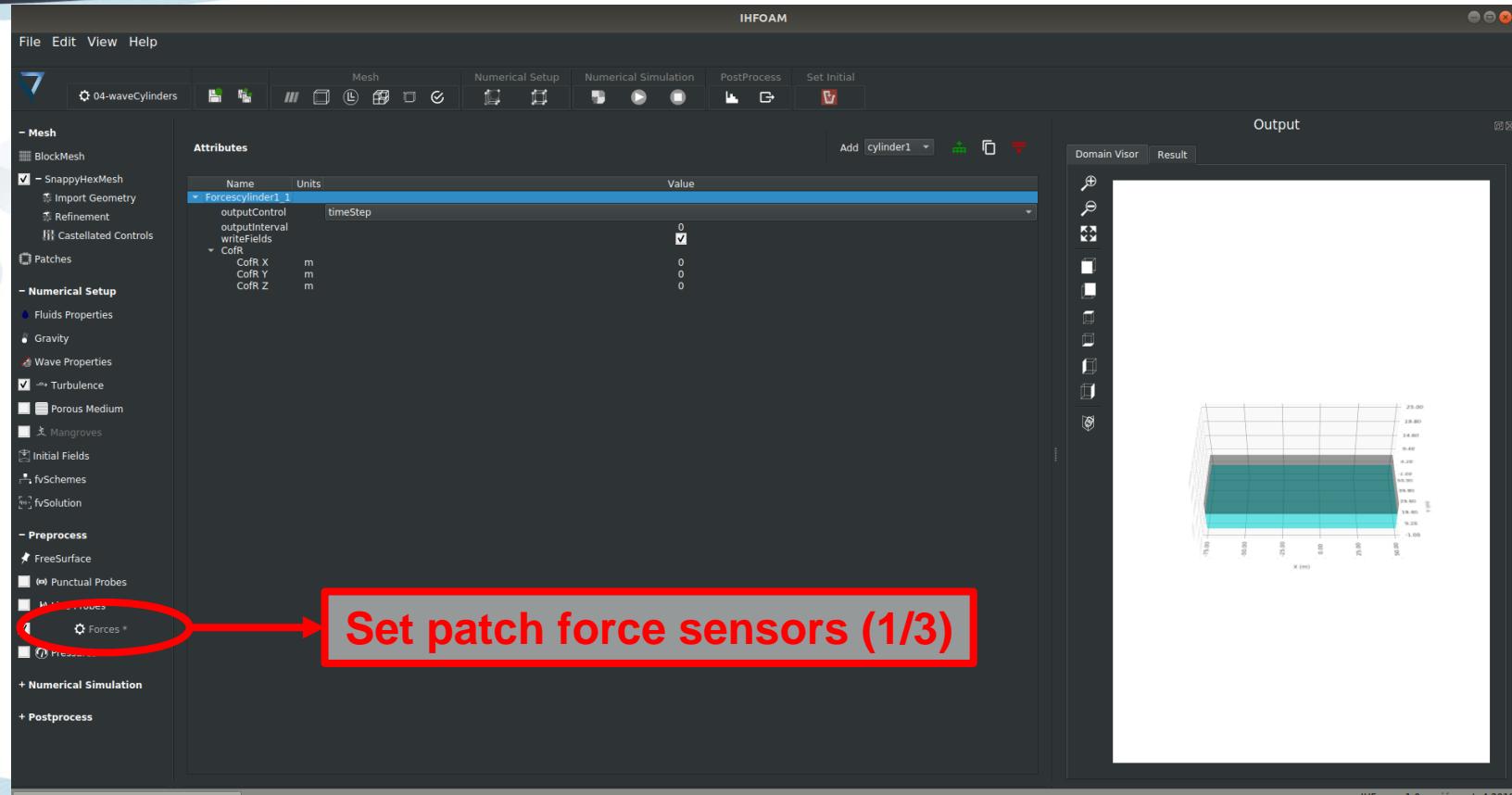
Add cylinder1

Output

Domain Visor Result

Set patch force sensors (1/3)

X (m) Y (m) Z (m)



File Edit View Help

04-waveCylinders Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

Attributes

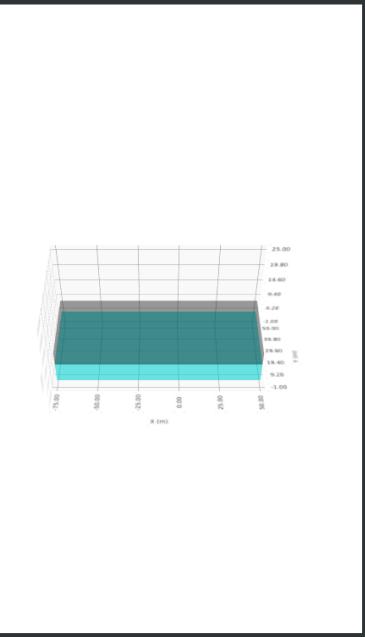
Name	Units	Value
Forcescylinder2_1		
outputControl	timeStep	0
outputInterval		<input checked="" type="checkbox"/>
writeFields		
CofR		
CofR X	m	0
CofR Y	m	0
CofR Z	m	0

Add cylinder2

Output

Domain Visor Result

X (m) Y (m)



/home/gabi/Desktop/IHFOAM/04-waveCylinders

IHFOAM v1.0 mié. sept. 4 2019

Set patch force sensors (2/3)

INFOAM

File Edit View Help

04-waveCylinders Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

Attributes

Name	Units	Value
Forcescylinder3_1		
outputControl	timeStep	0
outputInterval		<input checked="" type="checkbox"/>
writeFields		
CofR		
CoFR X	m	0
CoFR Y	m	0
CoFR Z	m	0

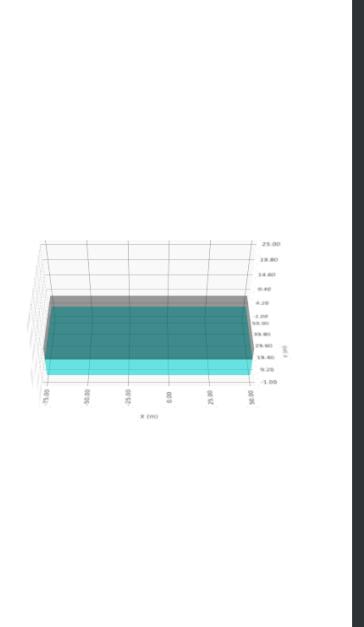
Add cylinder3

Output

Domain Visor Result

Set patch force sensors (3/3)

X (m) Y (m) Z (m)



/home/gabi/Desktop/IHFOAM/04-waveCylinders

IHFOAM v1.0 mié. sept. 4 2019

File Edit View Help

04-waveCylinders Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

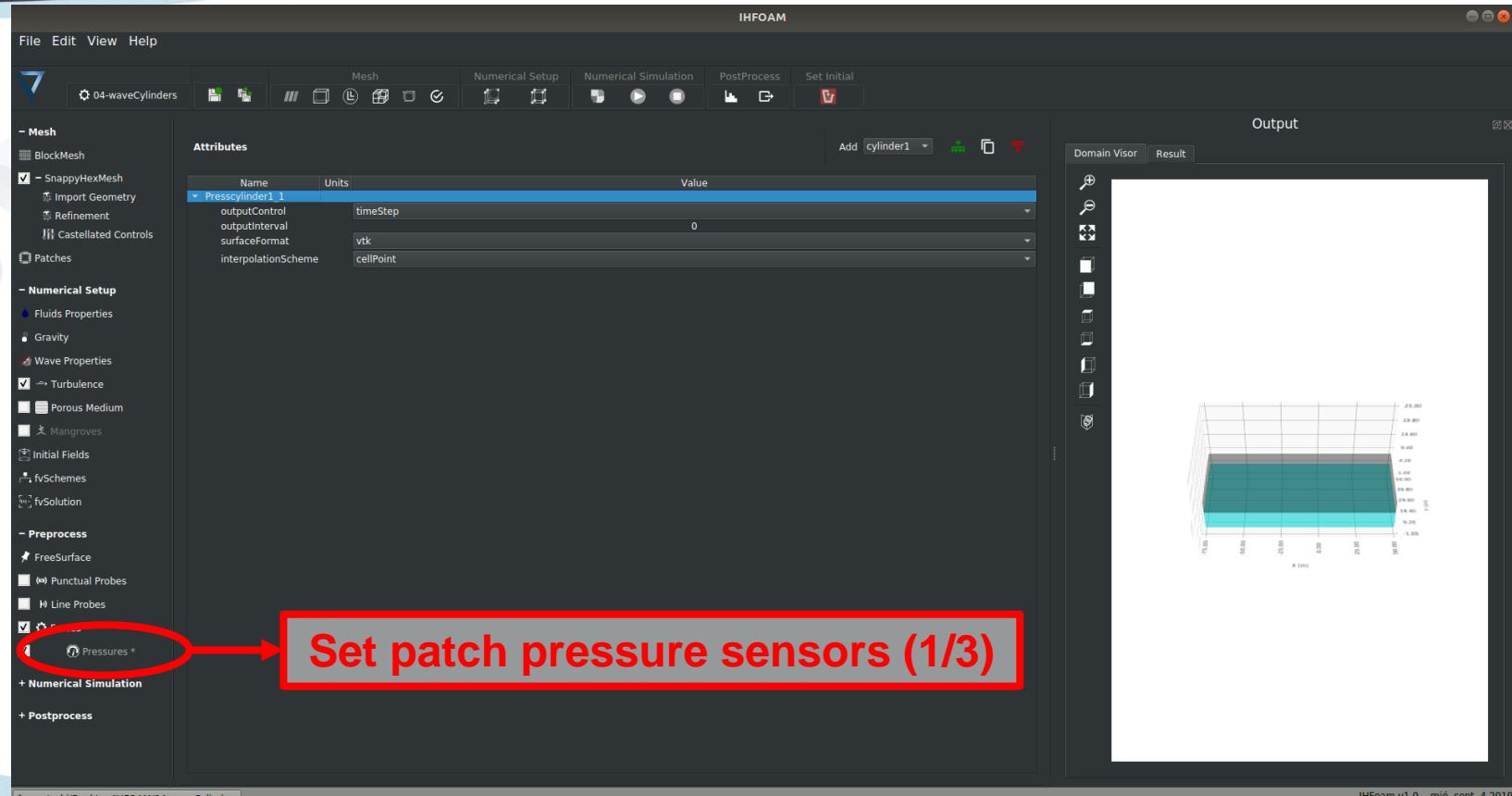
Attributes

Name	Units	Value
Presscylinder1_1	timeStep	0
outputControl		
outputInterval		
surfaceFormat	vtk	
interpolationScheme	cellPoint	

Output

Domain Visor Result

Set patch pressure sensors (1/3)



File Edit View Help

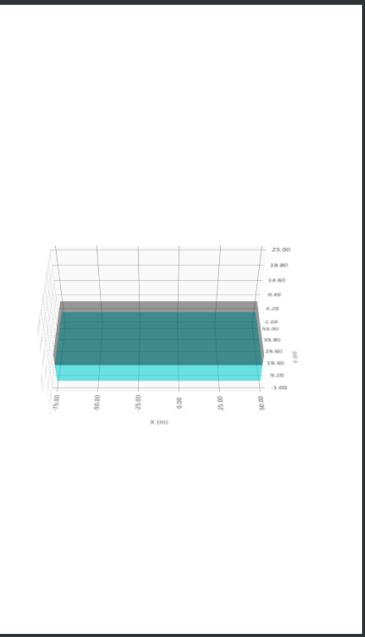
04-waveCylinders Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

Attributes

Name	Units	Value
Presscylinder2_1	timeStep	0
outputControl		
outputInterval		
surfaceFormat	vtk	
interpolationScheme	cellPoint	

Output

Domain Visor Result



Set patch pressure sensors (2/3)

File Edit View Help

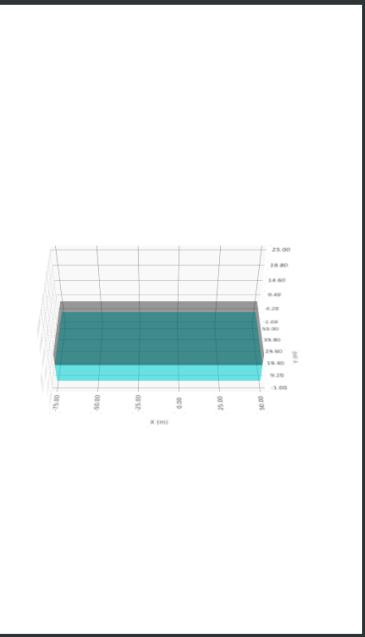
04-waveCylinders Mesh Numerical Setup Numerical Simulation PostProcess Set Initial

Attributes

Name	Units	Value
Presscylinder3_1	timeStep	0
outputControl		
outputInterval		
surfaceFormat	vtk	
interpolationScheme	cellPoint	

Output

Domain Visor Result

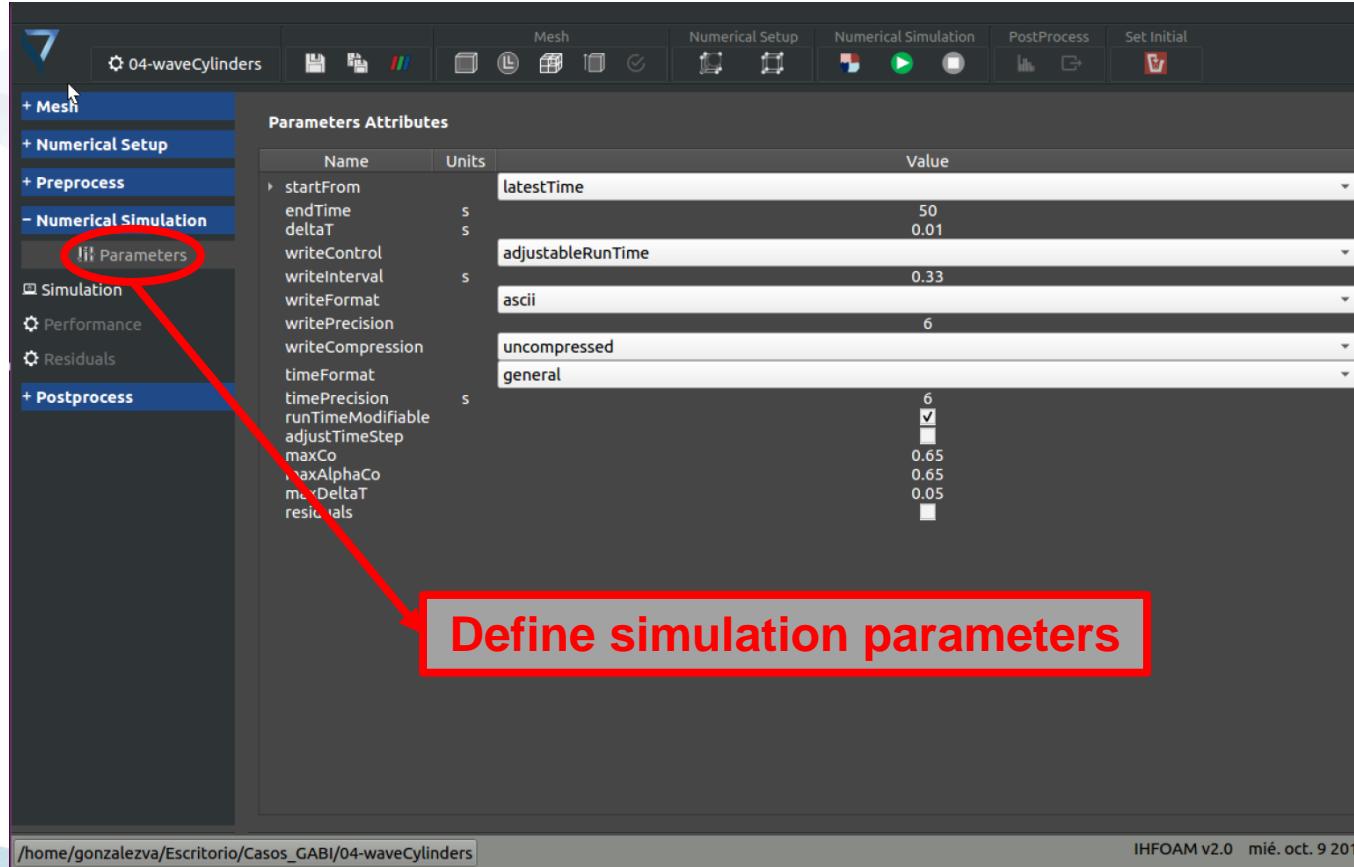


X (m) Y (m)

Set patch pressure sensors (3/3)

/home/gabi/Desktop/IHFOAM/04-waveCylinders

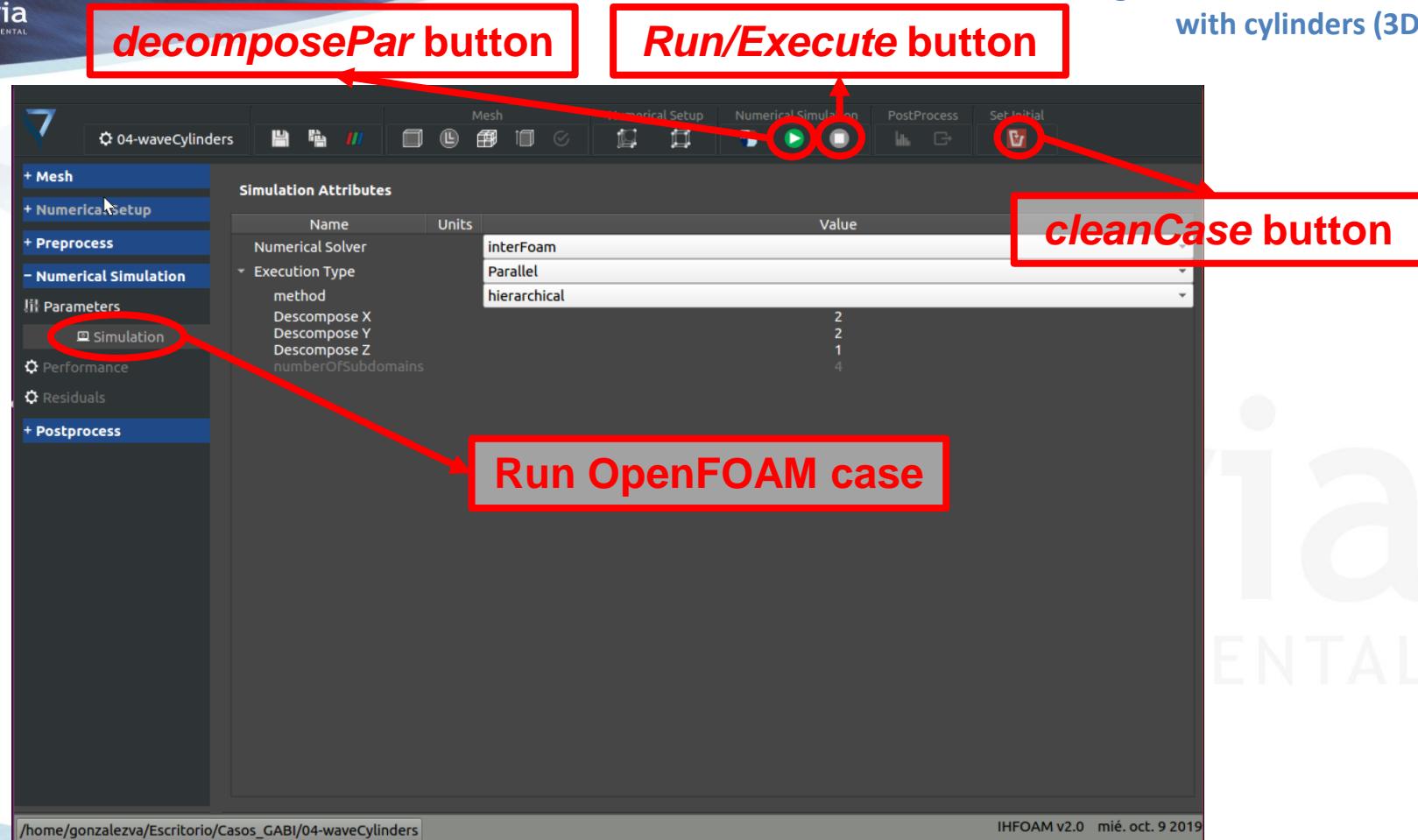
IHFOAM v1.0 mié, sept. 4 2019

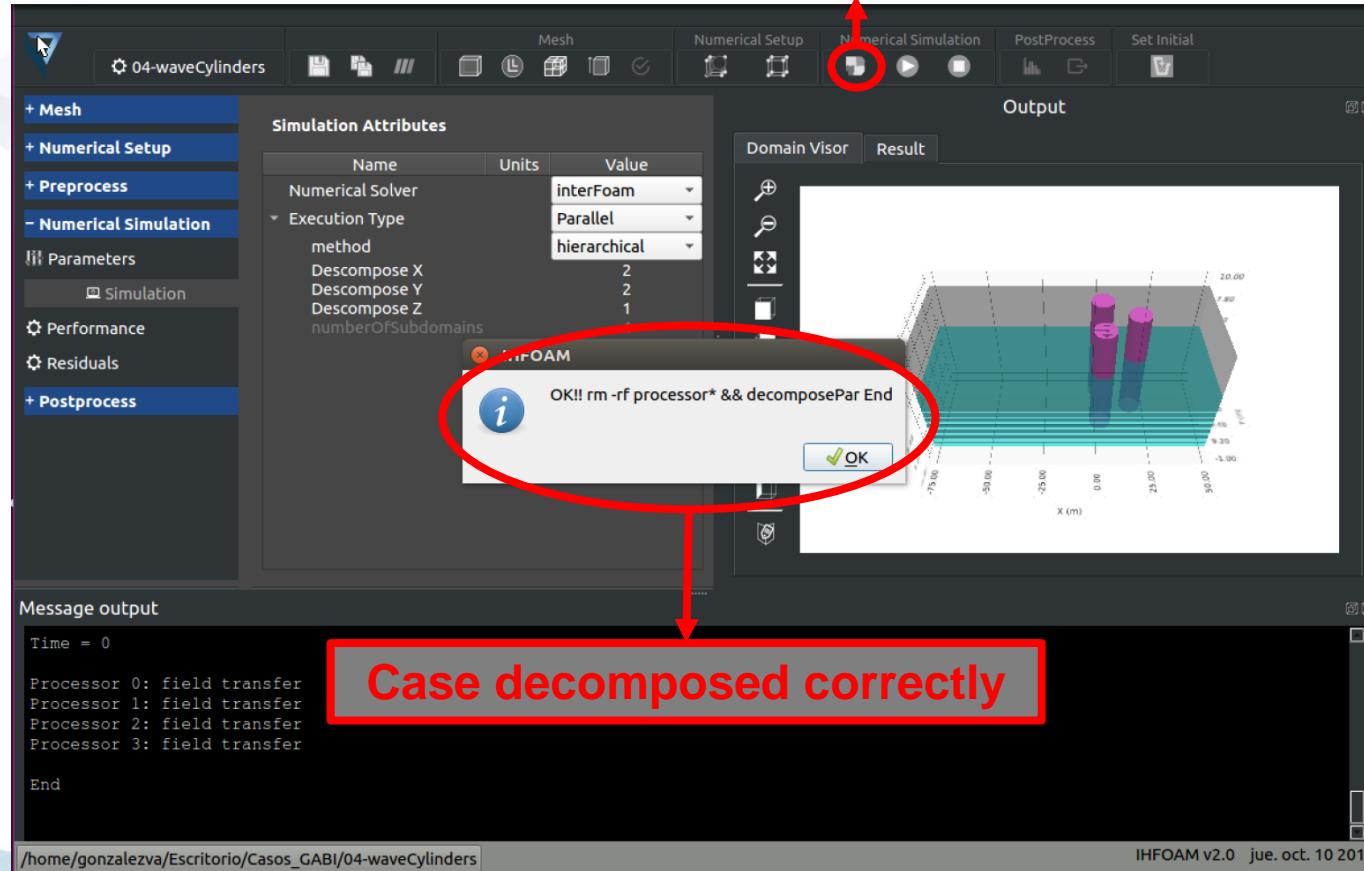


The screenshot shows the IHFOAM v2.0 software interface. On the left, there is a sidebar with various tabs: Mesh, Numerical Setup, Preprocess, Numerical Simulation (which is expanded), Parameters (circled in red), Simulation, Performance, Residuals, and Postprocess. The main area is titled "Parameters Attributes" and contains a table with columns for Name, Units, and Value. The table includes parameters like startFrom, endTime, deltaT, writeControl, writeInterval, writeFormat, writePrecision, writeCompression, timeFormat, timePrecision, runTimeModifiable, adjustTimeStep, maxCo, maxAlphaCo, m., DeltaT, and residuals. A red arrow points from the "Parameters" tab in the sidebar to a red-bordered box containing the text "Define simulation parameters". The status bar at the bottom shows the path "/home/gonzalezva/Escritorio/Casos_GABI/04-waveCylinders" and the version "IHFOAM v2.0 mié. oct. 9 2019".

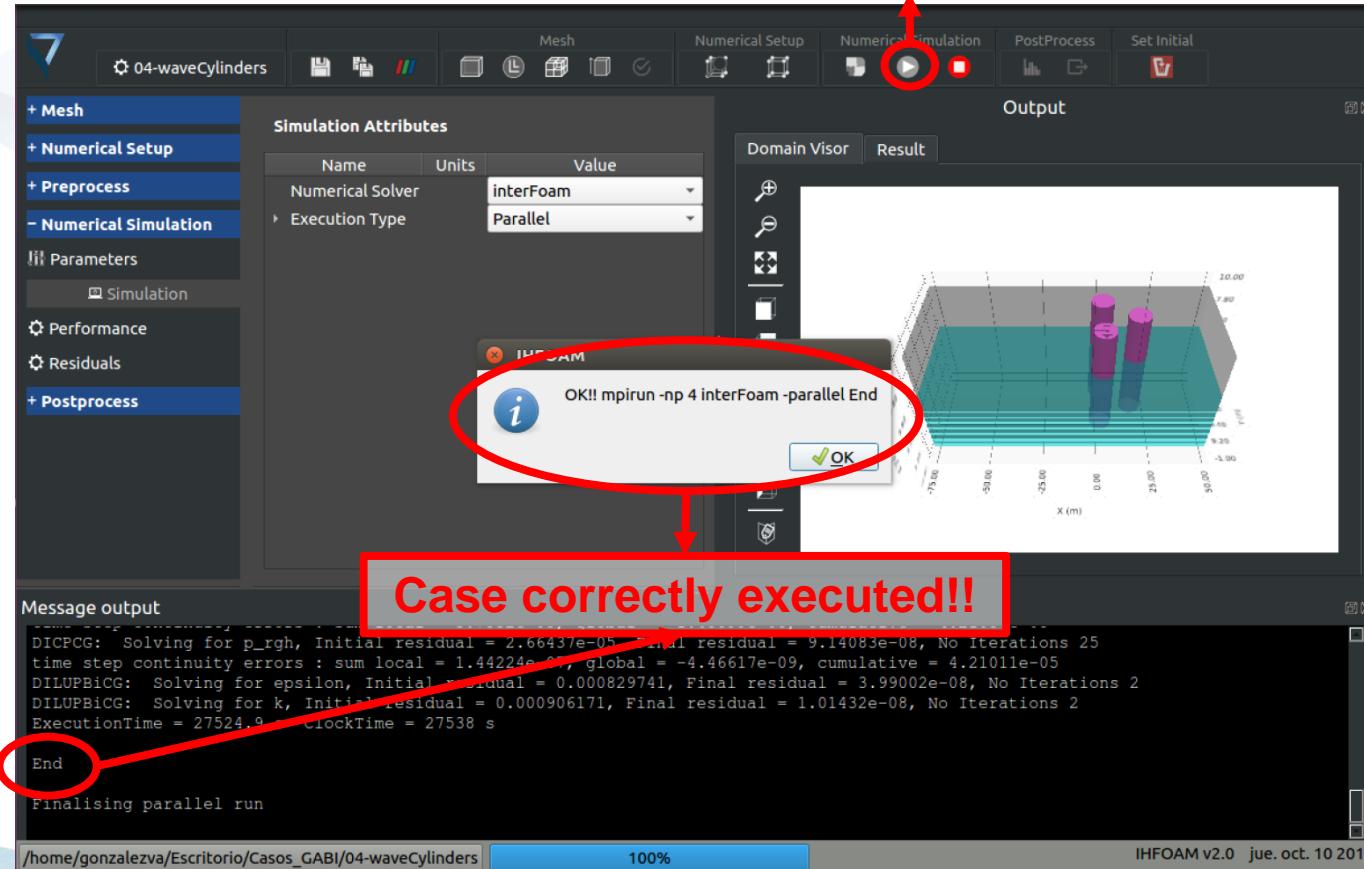
Name	Units	Value
startFrom		latestTime
endTime	s	50
deltaT	s	0.01
writeControl		adjustableRunTime
writeInterval	s	0.33
writeFormat		ascii
writePrecision		6
writeCompression		uncompressed
timeFormat		general
timePrecision	s	6
runTimeModifiable		<input checked="" type="checkbox"/>
adjustTimeStep		<input type="checkbox"/>
maxCo		0.65
maxAlphaCo		0.65
m.		0.05
DeltaT		<input type="checkbox"/>
residuals		<input type="checkbox"/>

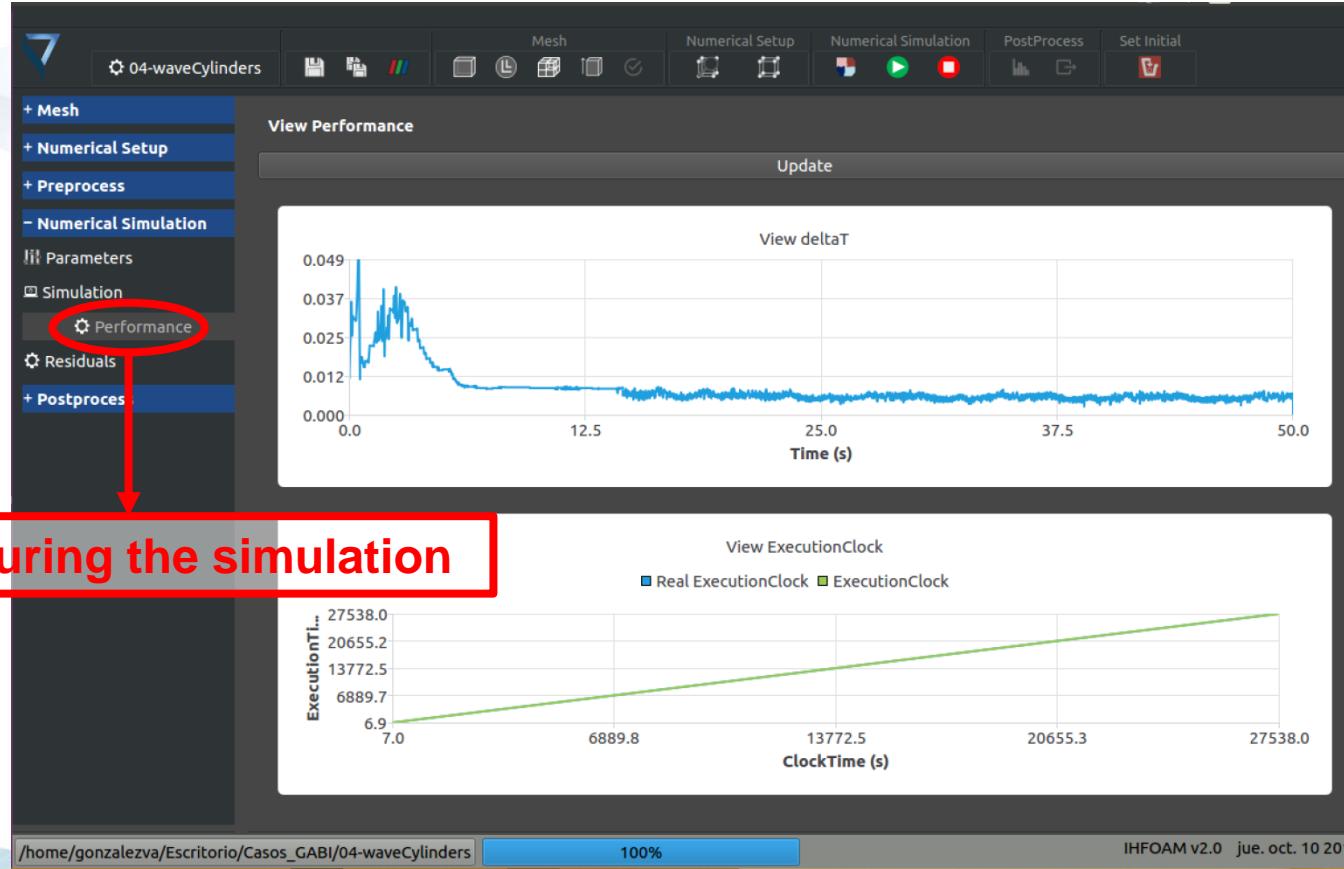
Define simulation parameters

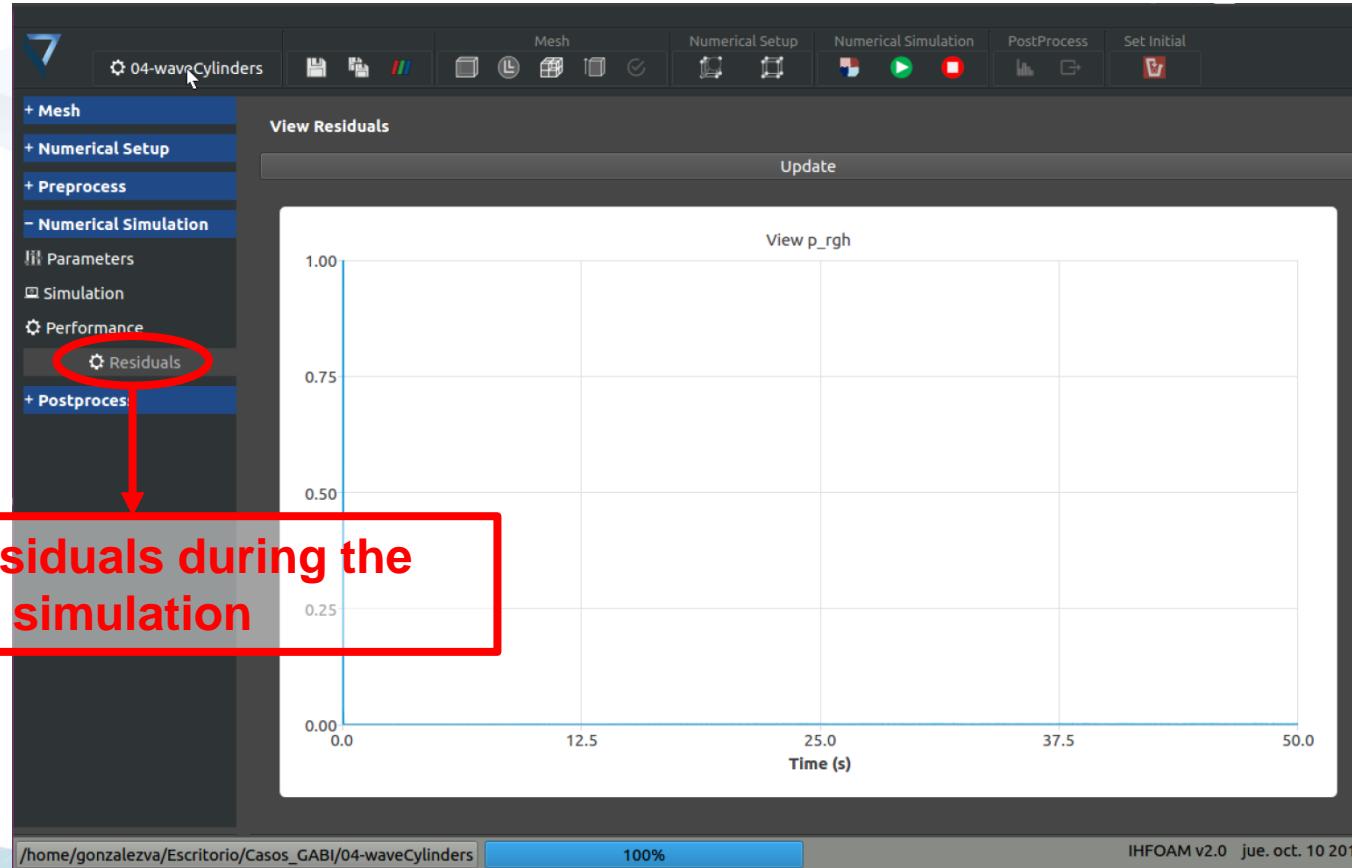


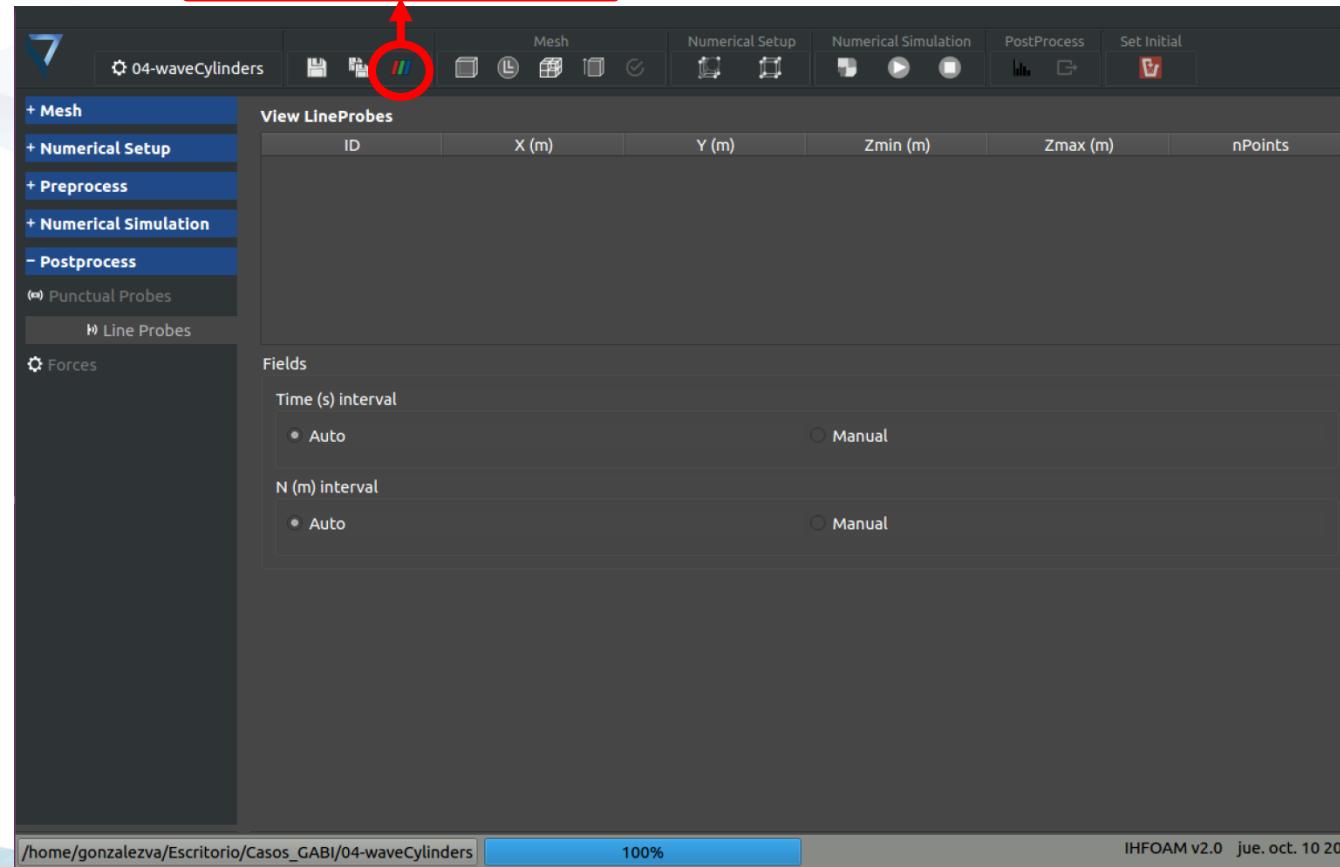


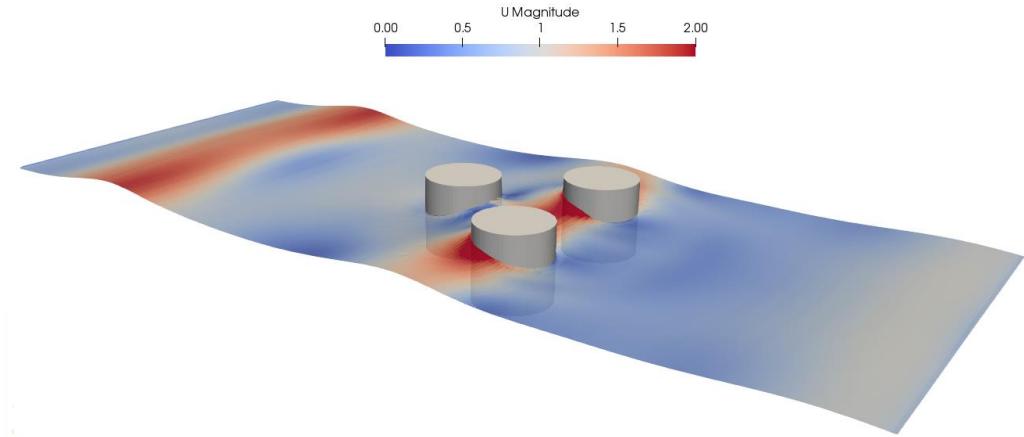
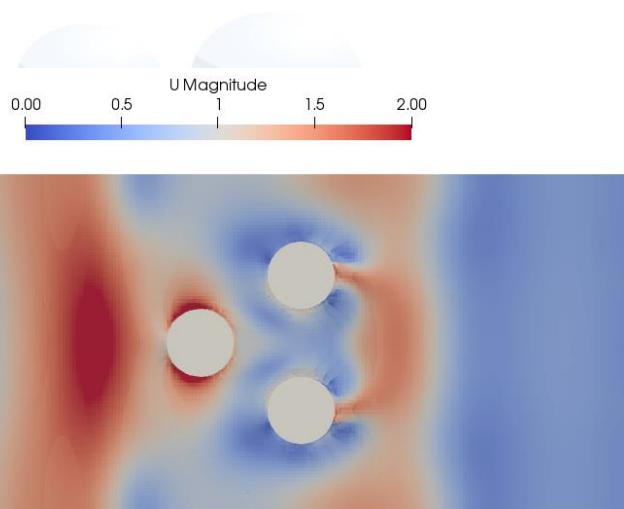
Run/Execute button





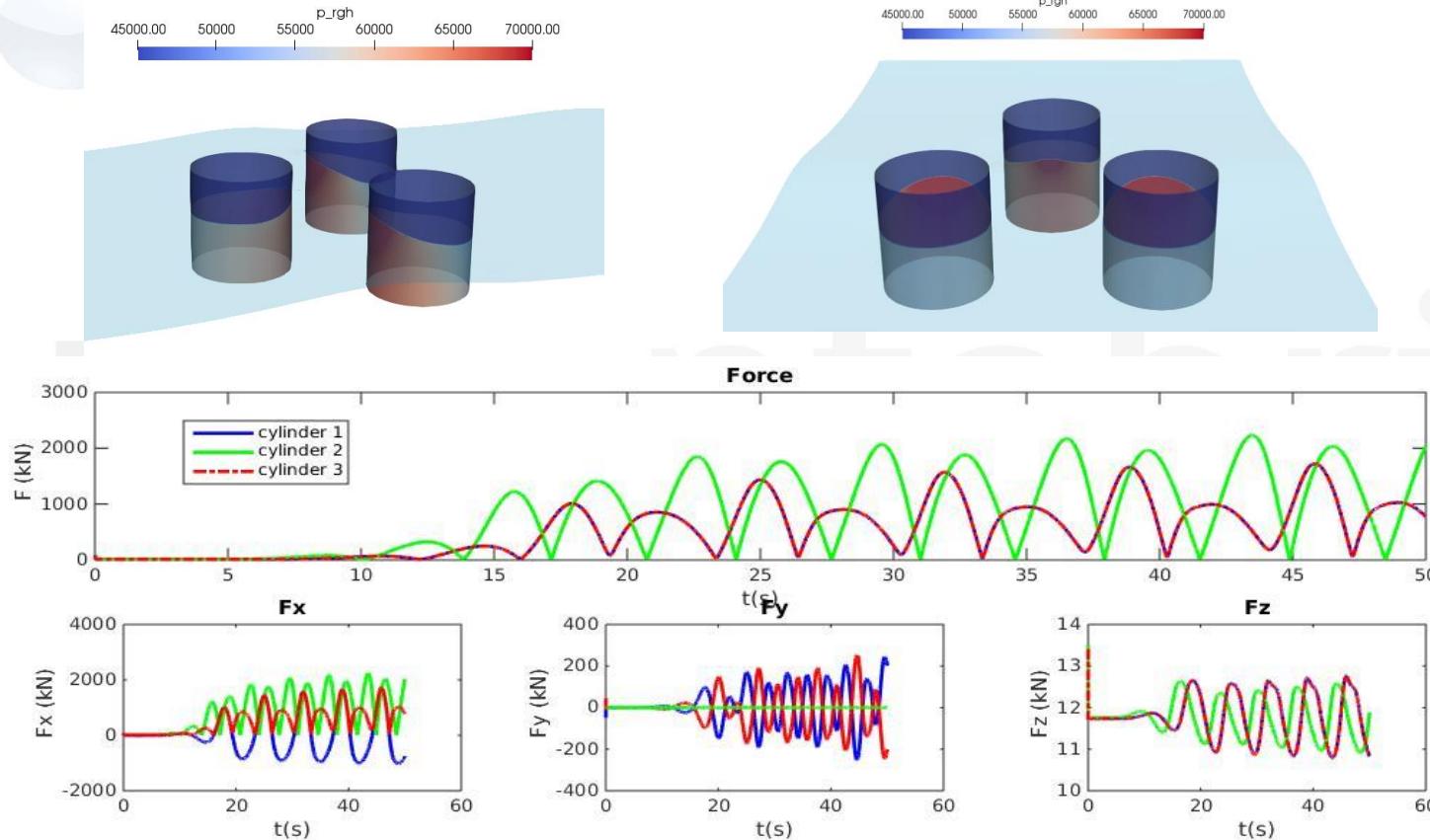






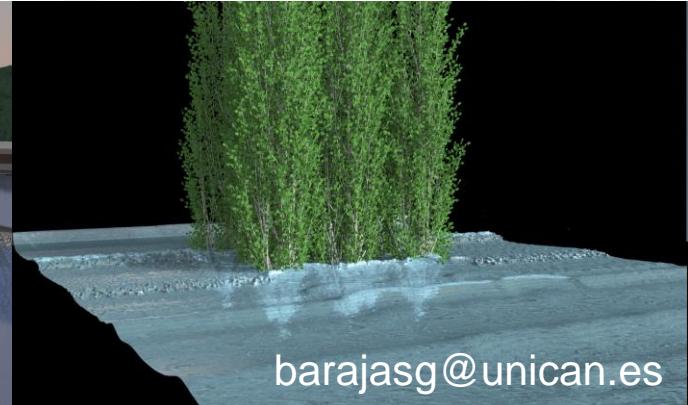
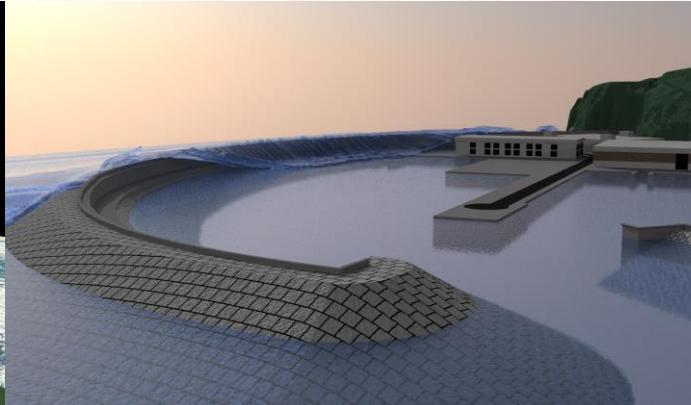
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- Postprocessing using Matlab (forces on each cylinder , taken from the **postProcessing** folder):





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