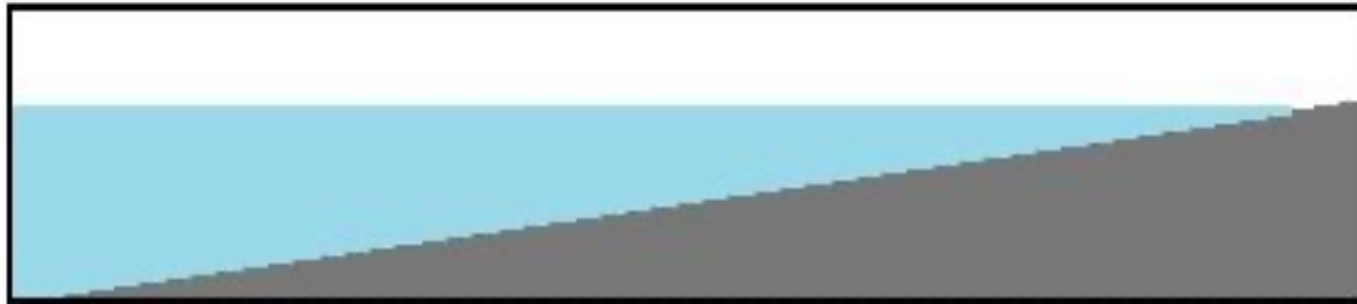


Example 1

Study of a Solitary wave run-up



Maria Maza (mazame@unican.es)

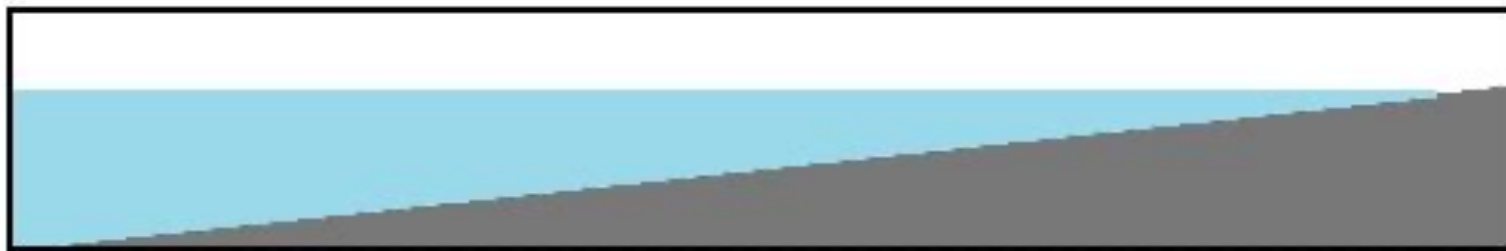
Study of a solitary wave run-up and run-down on a beach

The mechanisms of solitary wave run-up and run-down on a beach are studied.

The selected test problem is a breaking solitary wave run-up on a mild slope. The detailed laboratory setup for the breaking solitary wave study is referred to Synolakis (1986).

A uniform slope 1:0.05 constitutes the unique obstacle considered in this case.

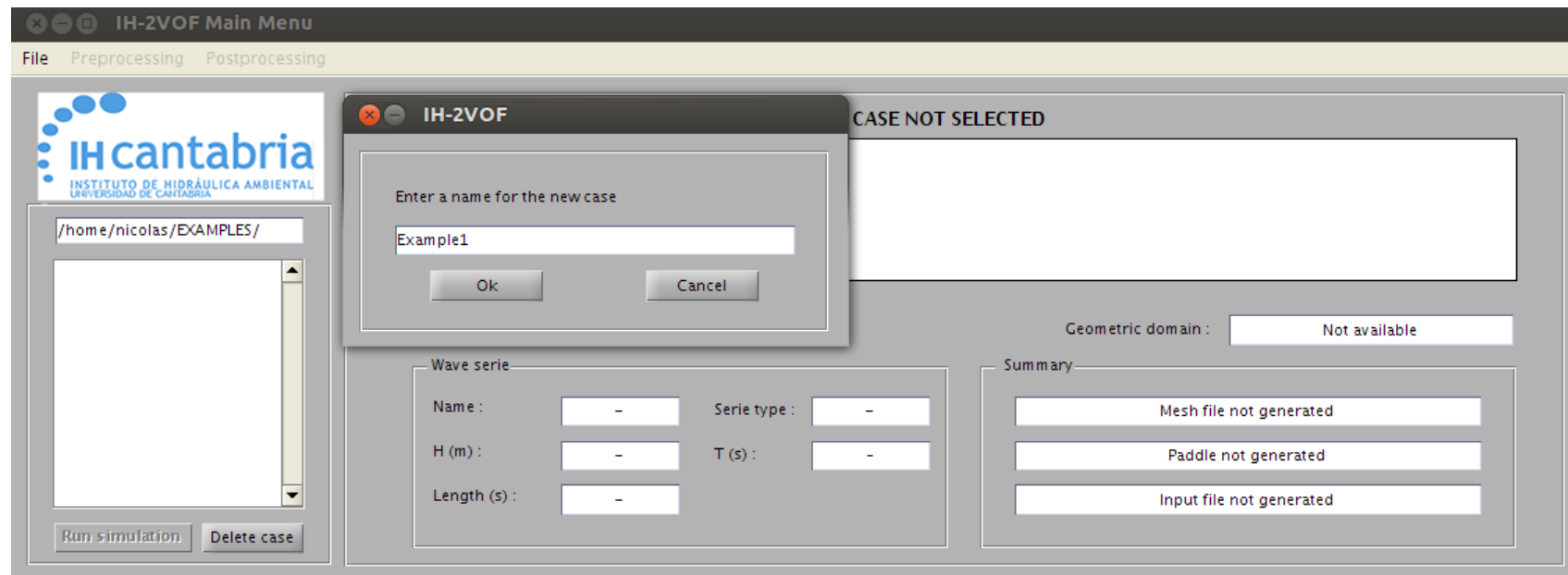
Water depth is equal to 0.25m and a **solitary wave** with a wave height equal to **0.07m** is considered. Grimshaw theory is selected to reproduce this solitary wave.



- **Objectives:** Study the run-up and run-down of a solitary wave on a beach

-Select directory, Select Folder

- Create New Case



PREPROCESSING

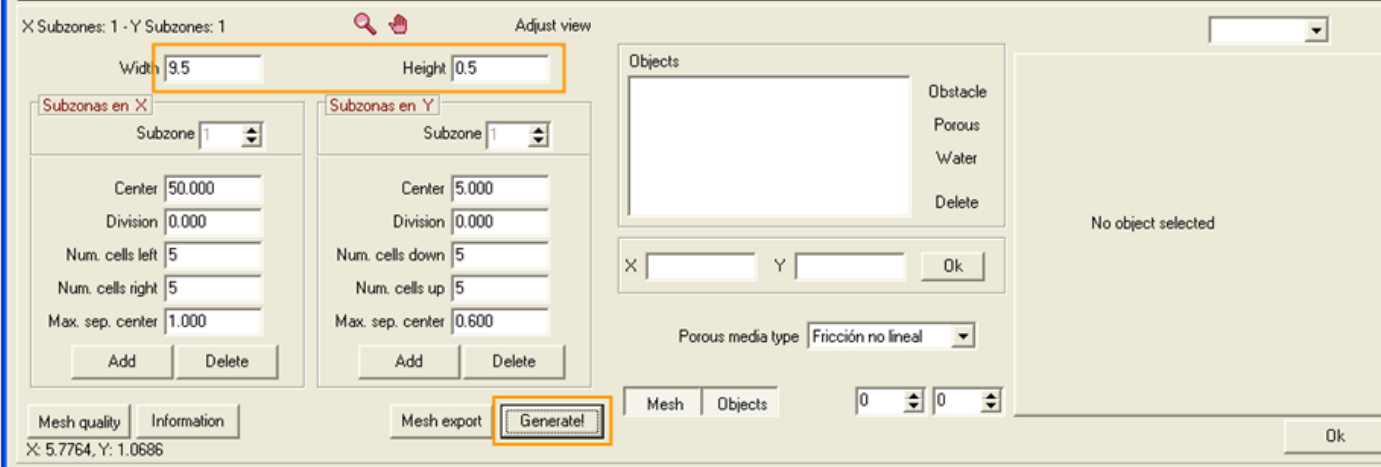
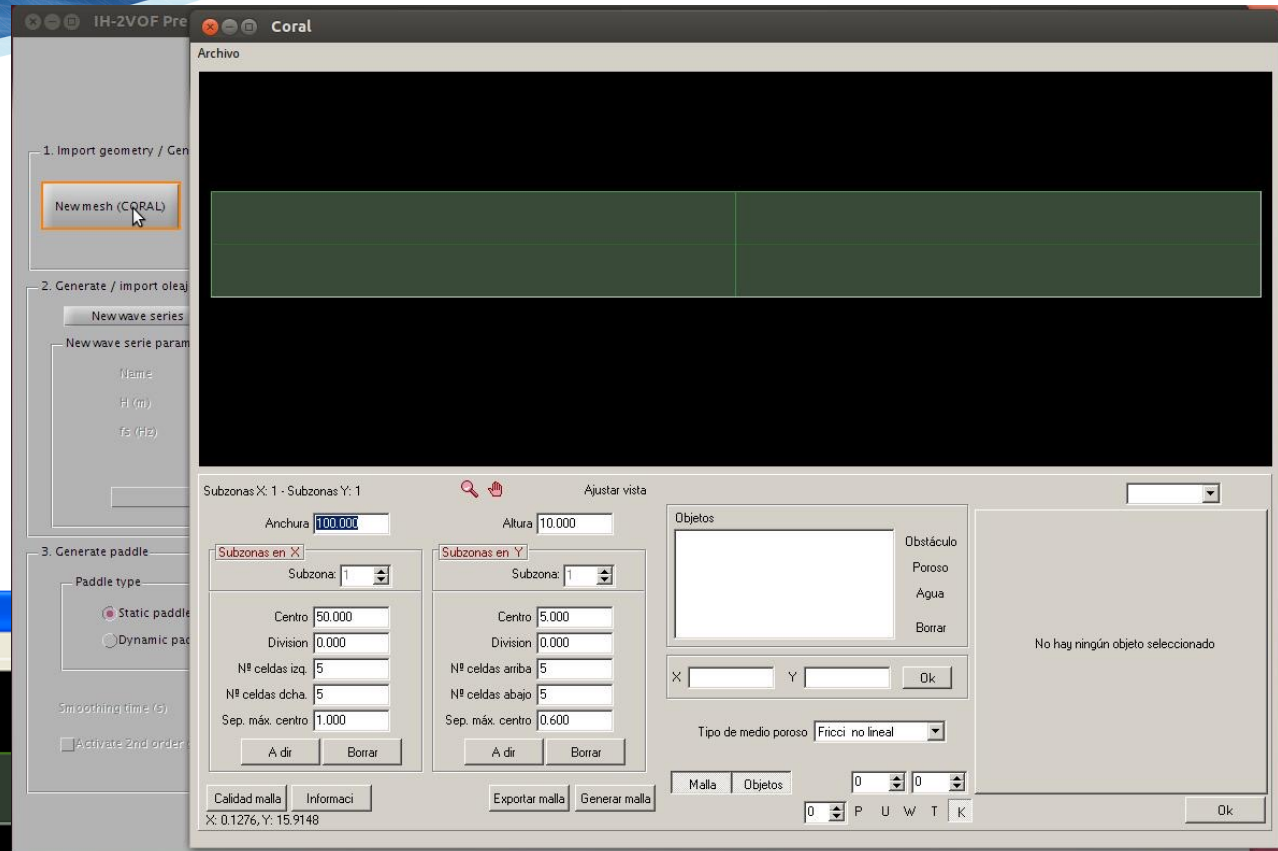
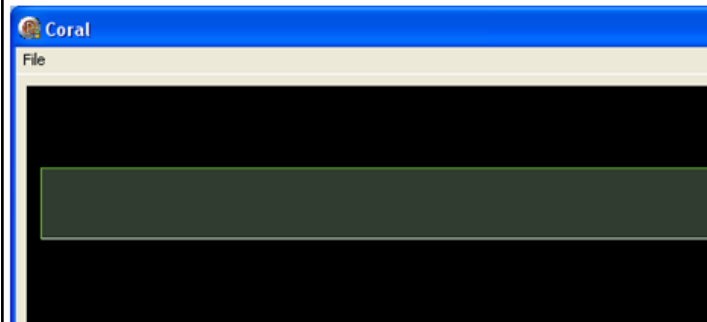
- MESH GENERATION
- SECTION 1: “IMPORT GEOMETRY/GENERATE MESH FILE”
- SECTION 2: “GENERATE/IMPORT WAVE CONDITIONS”
- SECTION 3: “GENERATE PADDLE”
- SECTION 4: “GENERATE INPUT FILE”

POSTPROCESSING

- WAVE GAUGES
- RUN UP
- DRAWFAST

MESH GENERATION

-New mesh (CORAL):
CORAL mesh generator is opened



- Domain specification

Width = 9.5m

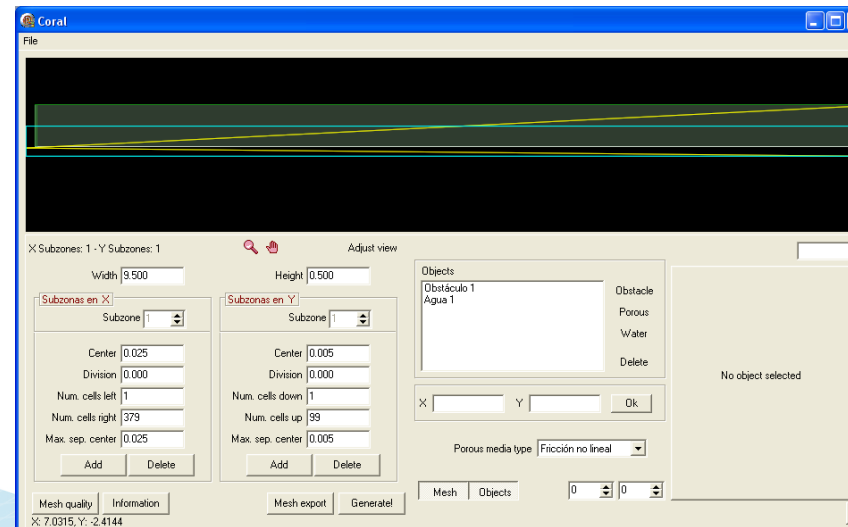
Height = 0.5m

MESH GENERATION: Defining the elements

Introduce the element obstacle which represents the bathymetry (1:20 bottom slope)

Introduce the element water (0.25 m working water depth)

Element	Vertices	X Coordinate	Y Coordinate
Bathymetry	1	-0.1	-0.005
	2	9.6	0.4836
	3	9.6	-0.1
Water	1	-0.1	-0.1
	2	-0.1	0.25
	3	10.6	0.25
	4	10.6	-0.1



MESH GENERATION: Spatial discretization

Uniform grid system in both the horizontal and the vertical directions

At least 10 cells per wave height! ($H=0.07$ m)

$$\Delta y = 0.005 \text{ m}$$

Limit the aspect ratio $\Delta x/\Delta y$!

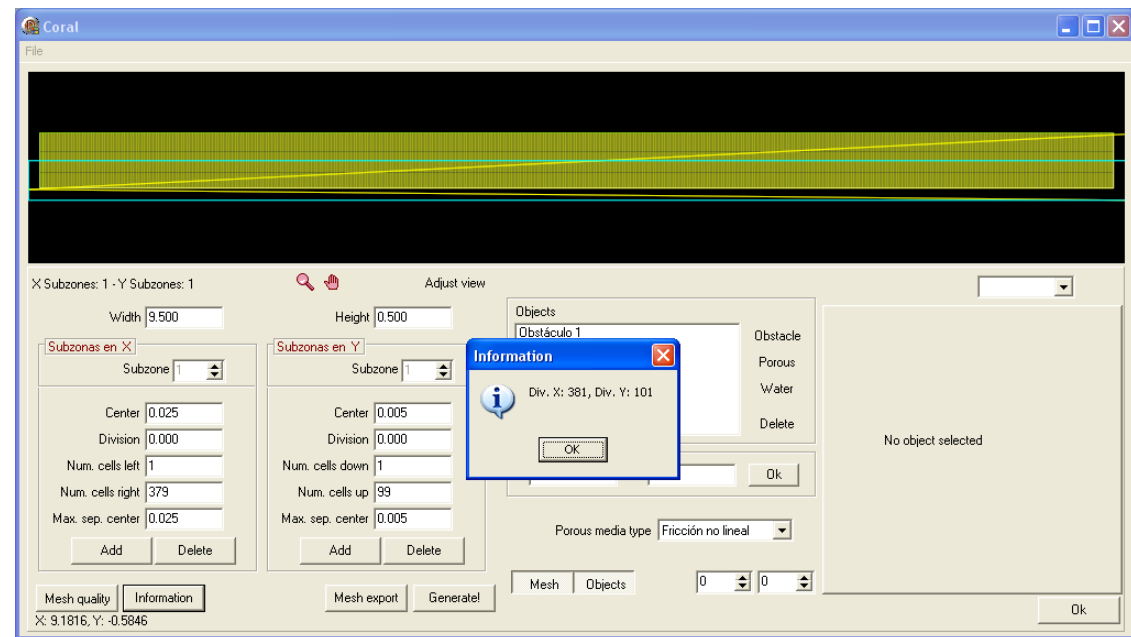
$$\Delta x = 0.025 \text{ m}$$

$\Delta x/\Delta y=5$, it is a bit large value...

However... long wave regime (horizontal velocities \gg vertical velocities)

$\Rightarrow \Delta x/\Delta y=5$ is ok!

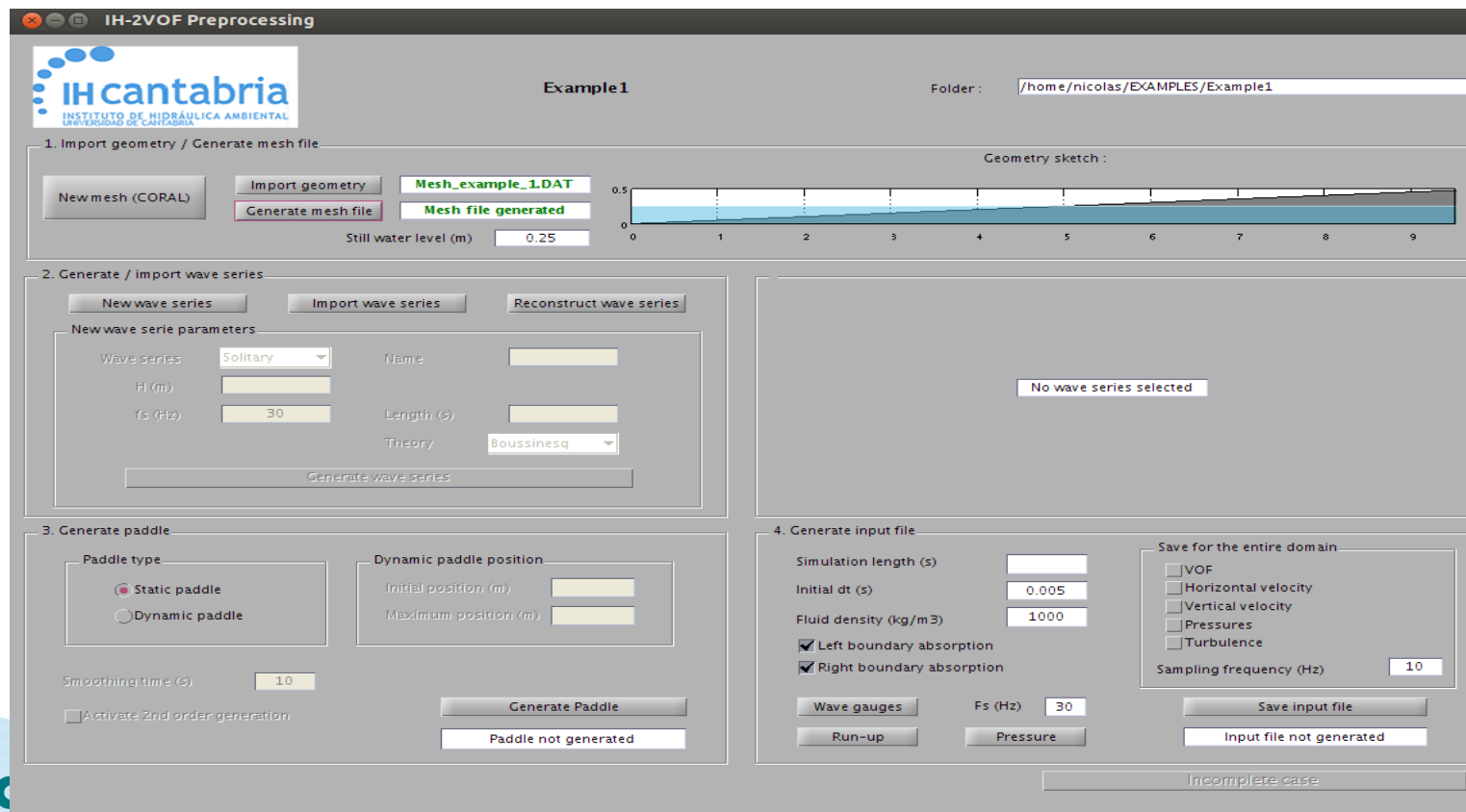
total number of cells in the numerical domain = **381 x 101**



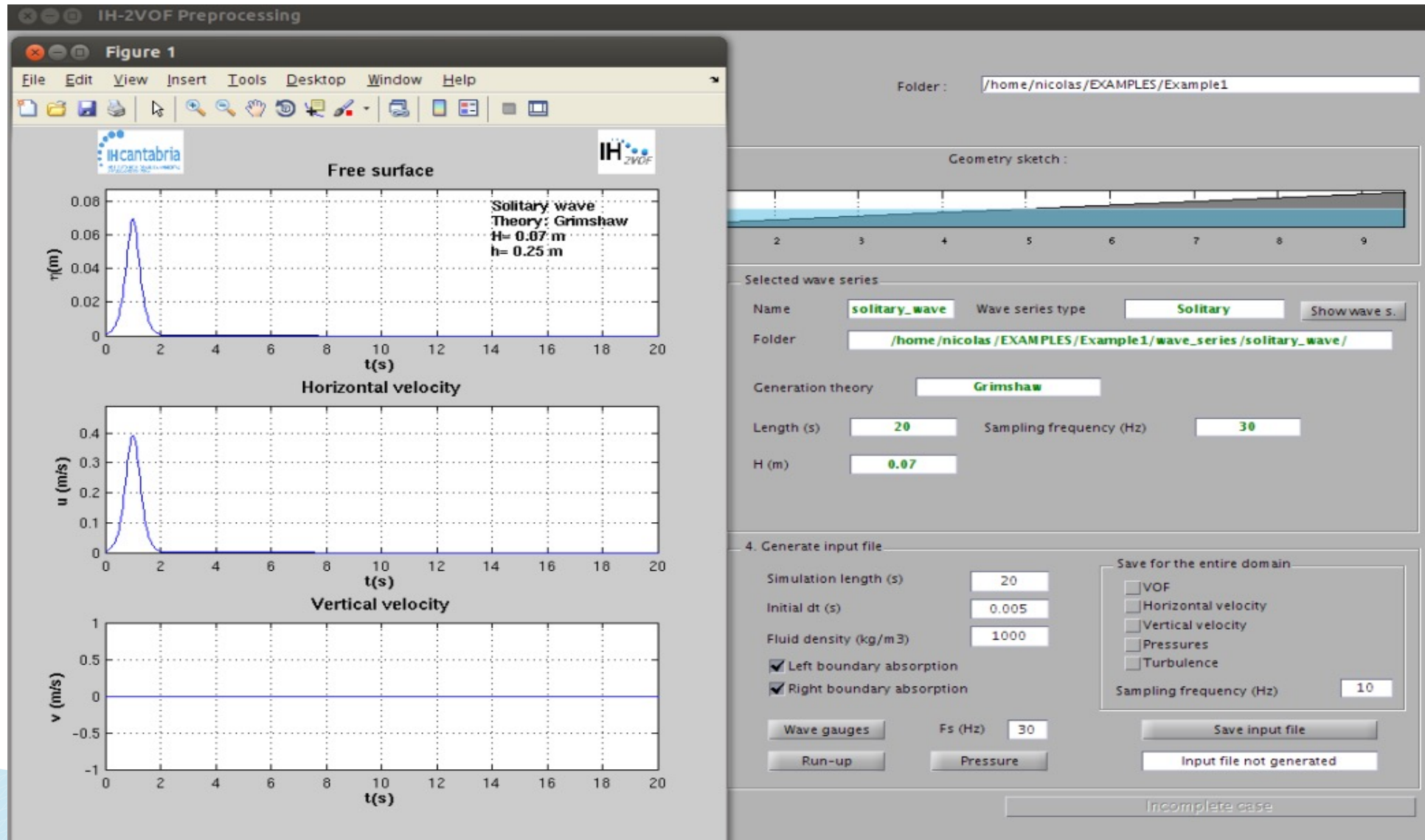
SECTION 1 : “IMPORT GEOMETRY/GENERATE MESH FILE”

-Saving the generated mesh its **“.dat”** file appears in **green** in the GUI .

-Mesh characteristics are exported to a **“Mesh.mes”**



SECTION 2 : “GENERATE/IMPORT WAVE CONDITIONS”



The screenshot displays the IH-2VOF Preprocessing software interface. On the left, a window titled 'Figure 1' contains three plots:

- Free surface:** A plot of η (m) vs t (s) showing a solitary wave pulse. Text in the plot area: Solitary wave Theory: Grimshaw, $H = 0.07$ m, $h = 0.25$ m.
- Horizontal velocity:** A plot of u (m/s) vs t (s) showing a pulse corresponding to the wave.
- Vertical velocity:** A plot of v (m/s) vs t (s) showing a flat line at zero.

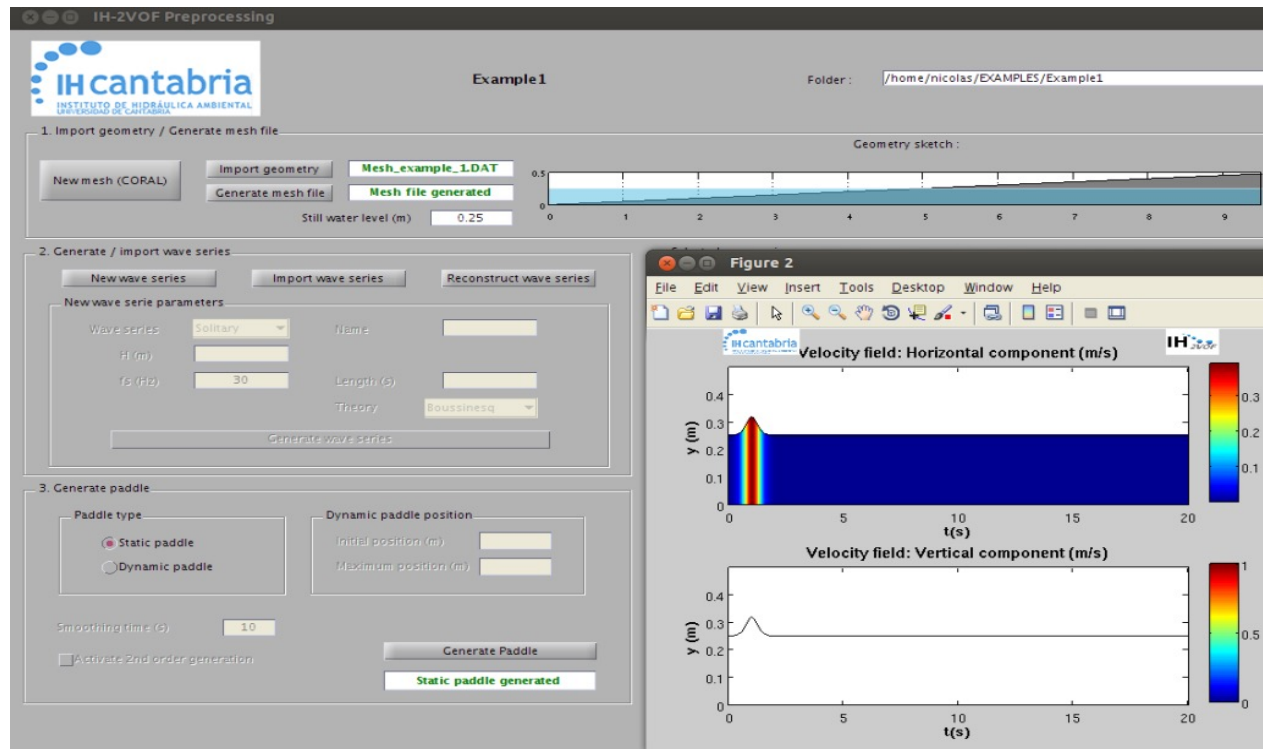
On the right, the main control panel includes:

- Folder:** `/home/nicolas/EXAMPLES/Example1`
- Geometry sketch:** A 2D schematic of the wave domain.
- Selected wave series:**
 - Name: `solitary_wave`
 - Wave series type: `Solitary`
 - Folder: `/home/nicolas/EXAMPLES/Example1/wave_series/solitary_wave/`
 - Generation theory: `Grimshaw`
 - Length (s): `20`
 - Sampling frequency (Hz): `30`
 - H (m): `0.07`
- 4. Generate input file:**
 - Simulation length (s): `20`
 - Initial dt (s): `0.005`
 - Fluid density (kg/m³): `1000`
 - Left boundary absorption
 - Right boundary absorption
 - Buttons: Wave gauges, Run-up, Pressure, Fs (Hz) `30`
- Save for the entire domain:**
 - VOF
 - Horizontal velocity
 - Vertical velocity
 - Pressures
 - Turbulence
 - Sampling frequency (Hz): `10`
 - Buttons: Save input file, Input file not generated
- Incomplete case:** A button at the bottom.

SECTION 3 : “GENERATE PADDLE

Static wave paddle

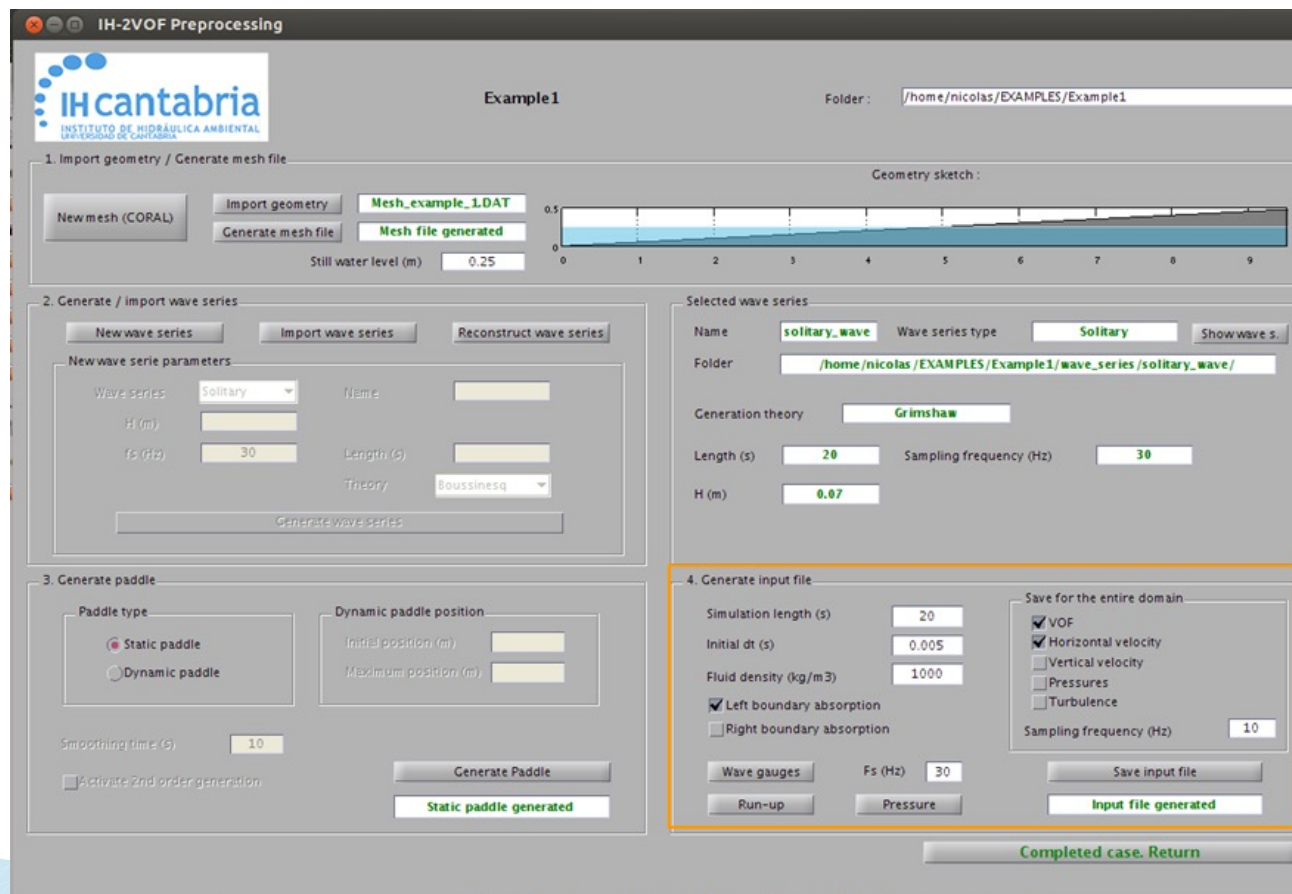
Both the **mean velocities** and **free surface displacement** are specified on the inflow boundary based on the selected analytical solution



The screenshot shows the IH-2VOF Preprocessing software interface. The main window is titled "Example1" and shows the "Generate Paddle" step. The "Paddle type" is set to "Static paddle". The "Dynamic paddle position" is set to "Initial position (m)" and "Maximum position (m)". The "Smoothing time (s)" is set to 10. The "Generate Paddle" button is highlighted, and the status "Static paddle generated" is displayed.

The "Figure 2" window shows two plots of the velocity field. The top plot is "Velocity field: Horizontal component (m/s)" and the bottom plot is "Velocity field: Vertical component (m/s)". Both plots show the velocity field over time (t(s)) and space (y(m)). The horizontal component plot shows a peak velocity of approximately 0.3 m/s at t=0, which then decays to zero. The vertical component plot shows a peak velocity of approximately 1 m/s at t=0, which then decays to zero.

SECTION 4 : “GENERATE INPUT FILE”



- Simulation length = 20 s

- Initial dt = 0.005 s

- Absorption on at the left boundary only!

- VOF and horizontal velocity fields are saved

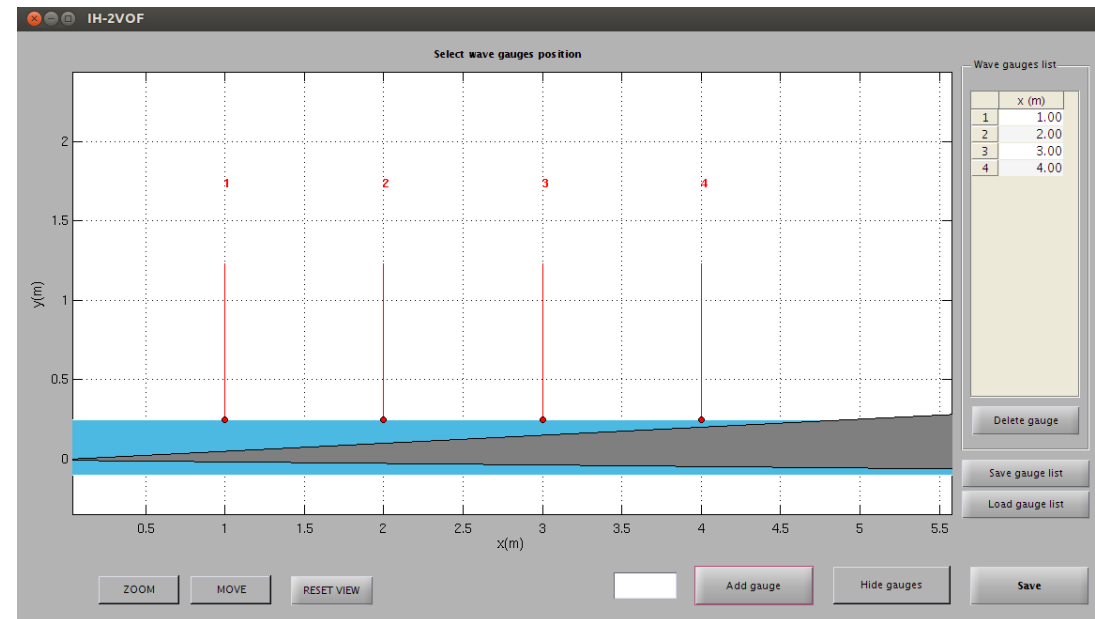
SECTION 4 : “GENERATE INPUT FILE” – *Wave gauges*

Different wave gauges are disposed in the domain to measured the wave conditions and overtopping.

Gauge	X(m)
1	1
2	2
3	3
4	4

Press the button Wave gauges - Add gauge

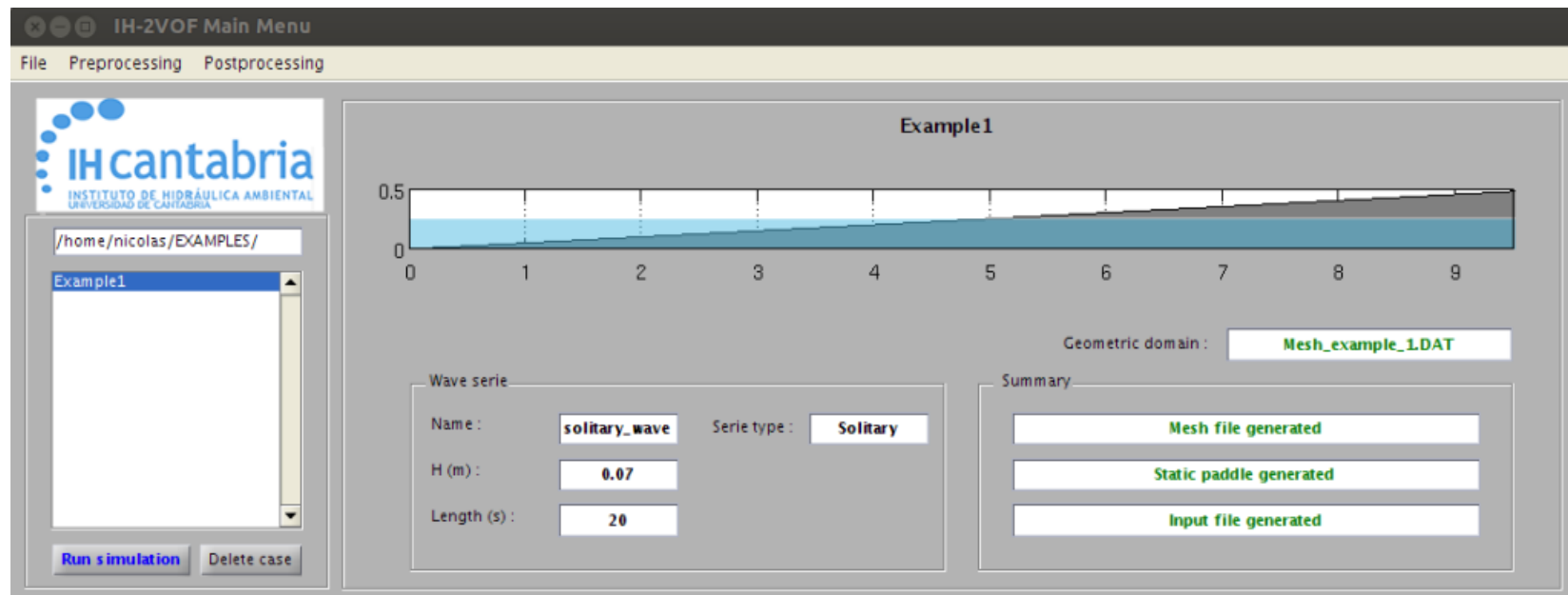
Gauges positions are specified



SUMMARY

All the variables are defined
The input file is saved

→ the case is ready to be simulated



The simulation which will starts by pressing the button

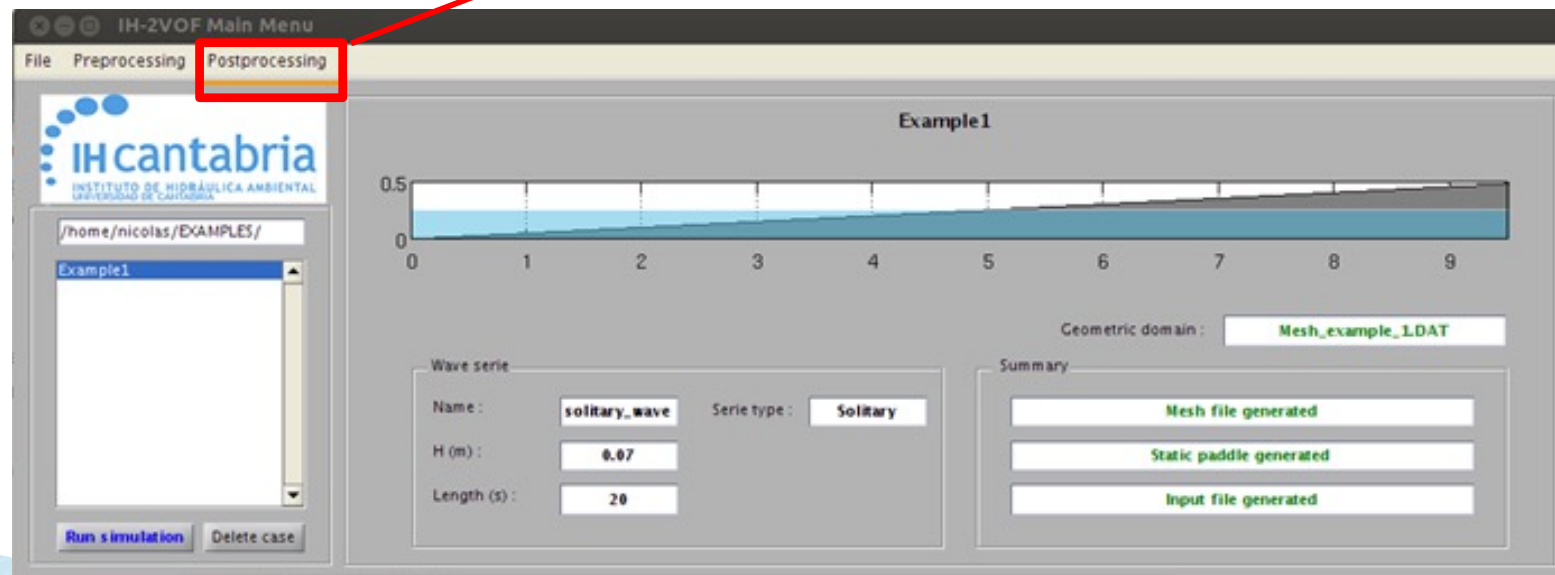
Run simulation

POSTPROCESSING

In the present example different aspects are analyzed:

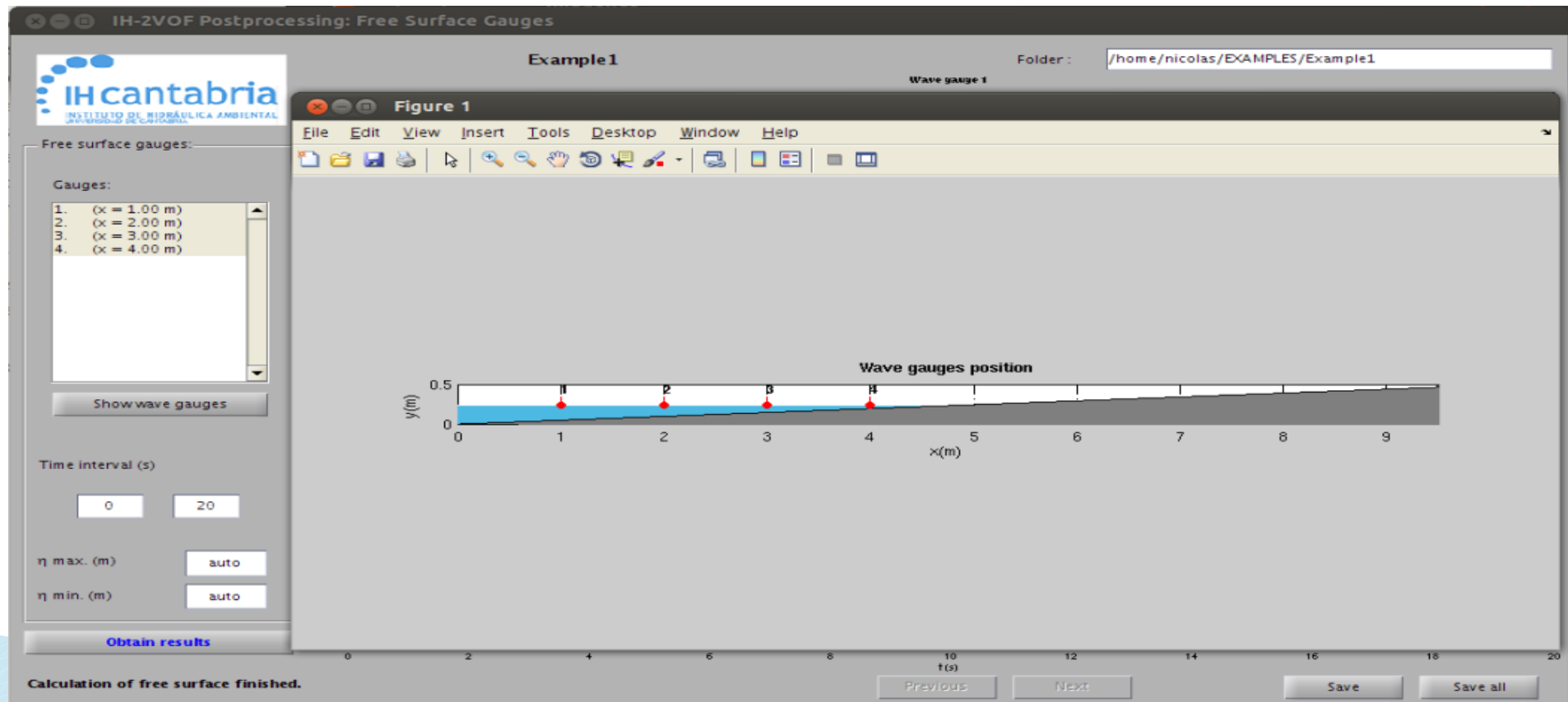
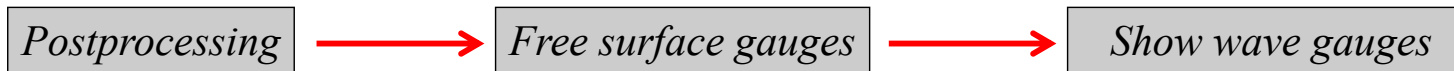
- Free surface evolution
- Visual analysis
- Validation with laboratory data

Click “*Postprocessing*”



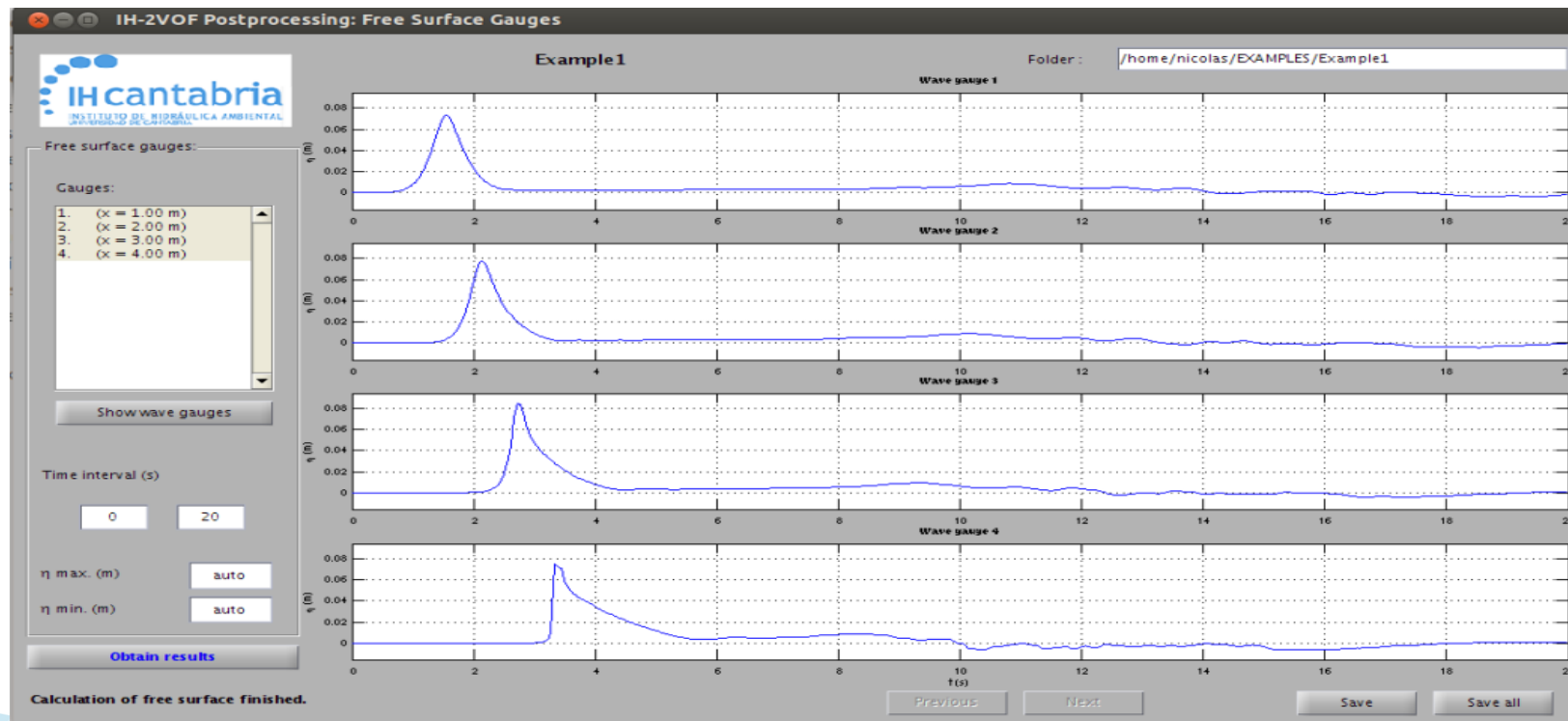
WAVE GAUGES – Show wave gauges

- 4 wave gauges were disposed along the domain.



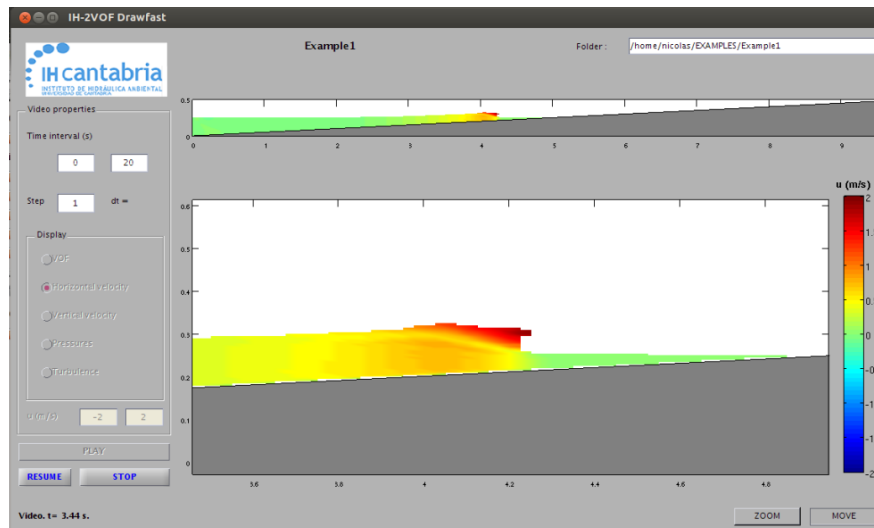
WAVE GAUGES – Time series

-Results of the free surface elevation are obtained by pressing the button

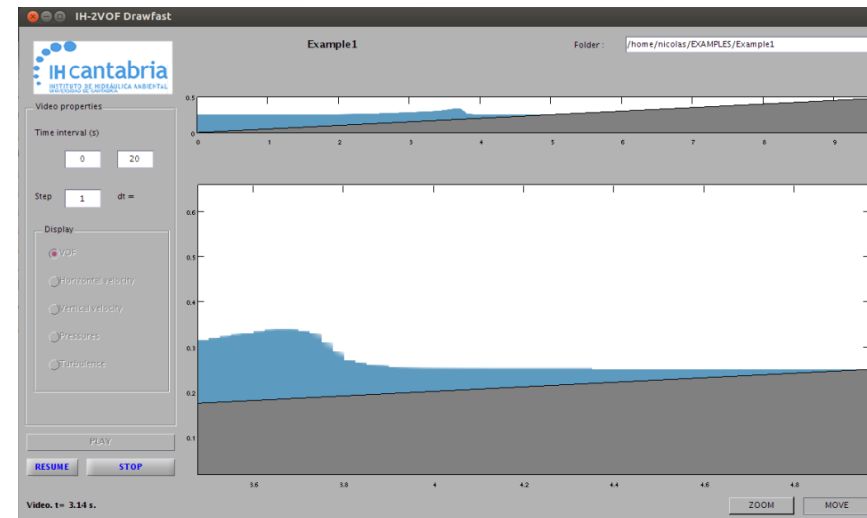


DRAWFAST

- A video of the different variables chosen before the simulation can be seen.
- Choose the initial time, final time and time step
- The lower panel allows a zoom of the area of interest



Horizontal Velocity drawfast



VOF drawfast

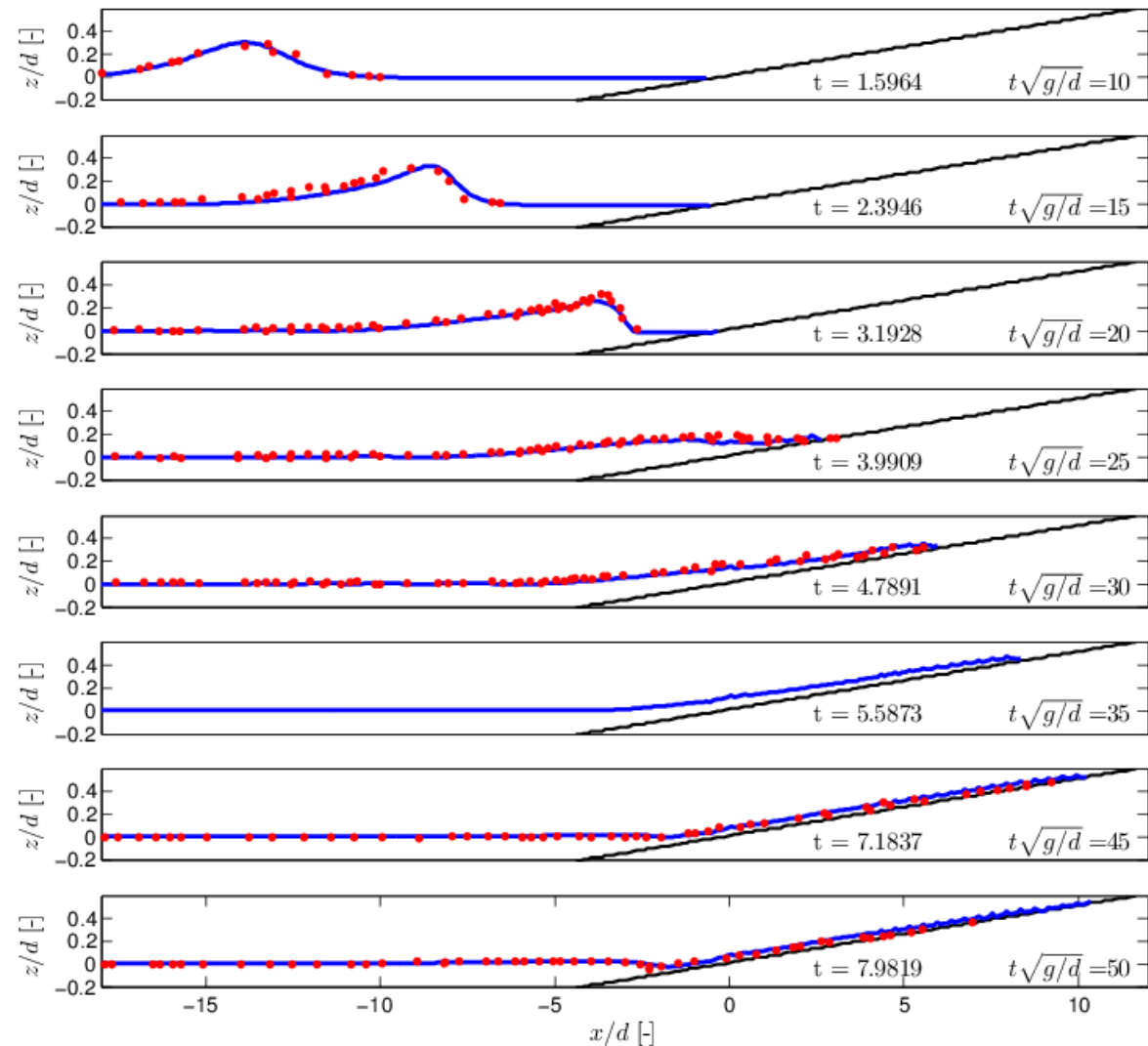
VALIDATION

Validation against laboratory data (Synolakis 1986)

The length scale is normalized by the still water depth d

The time scale is normalized by $t(g/d)^{1/2}$

Use the matlab script `validation_example1.mat` to generate the plot



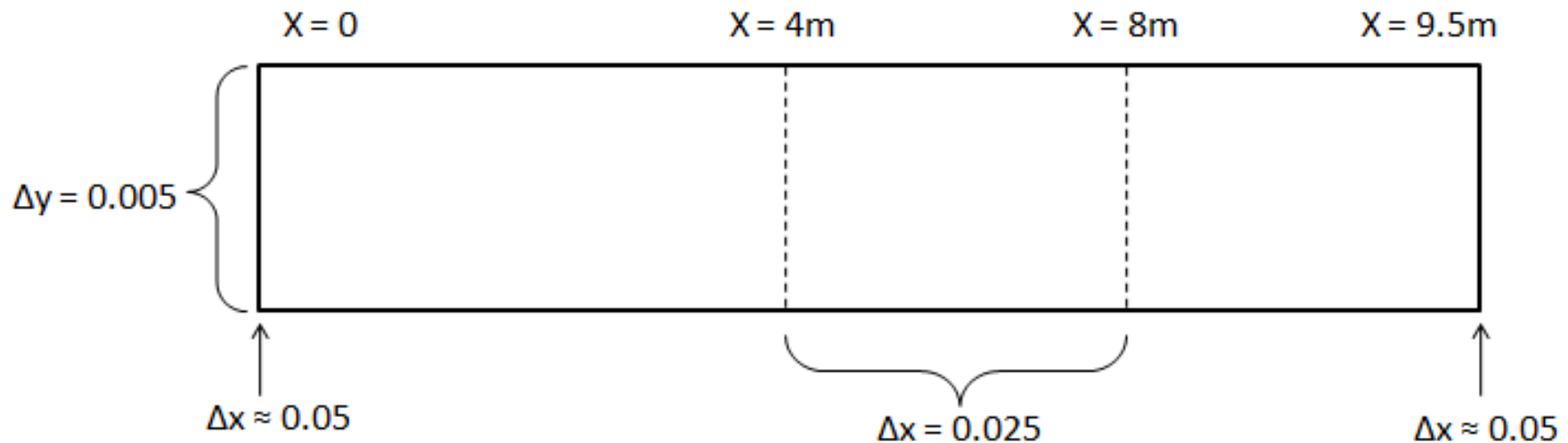
numerical results (blue line) and laboratory data (red circles)

Run-up produce by a regular wave train

The same geometry studied in order to test **regular wave conditions** over uniform slope.

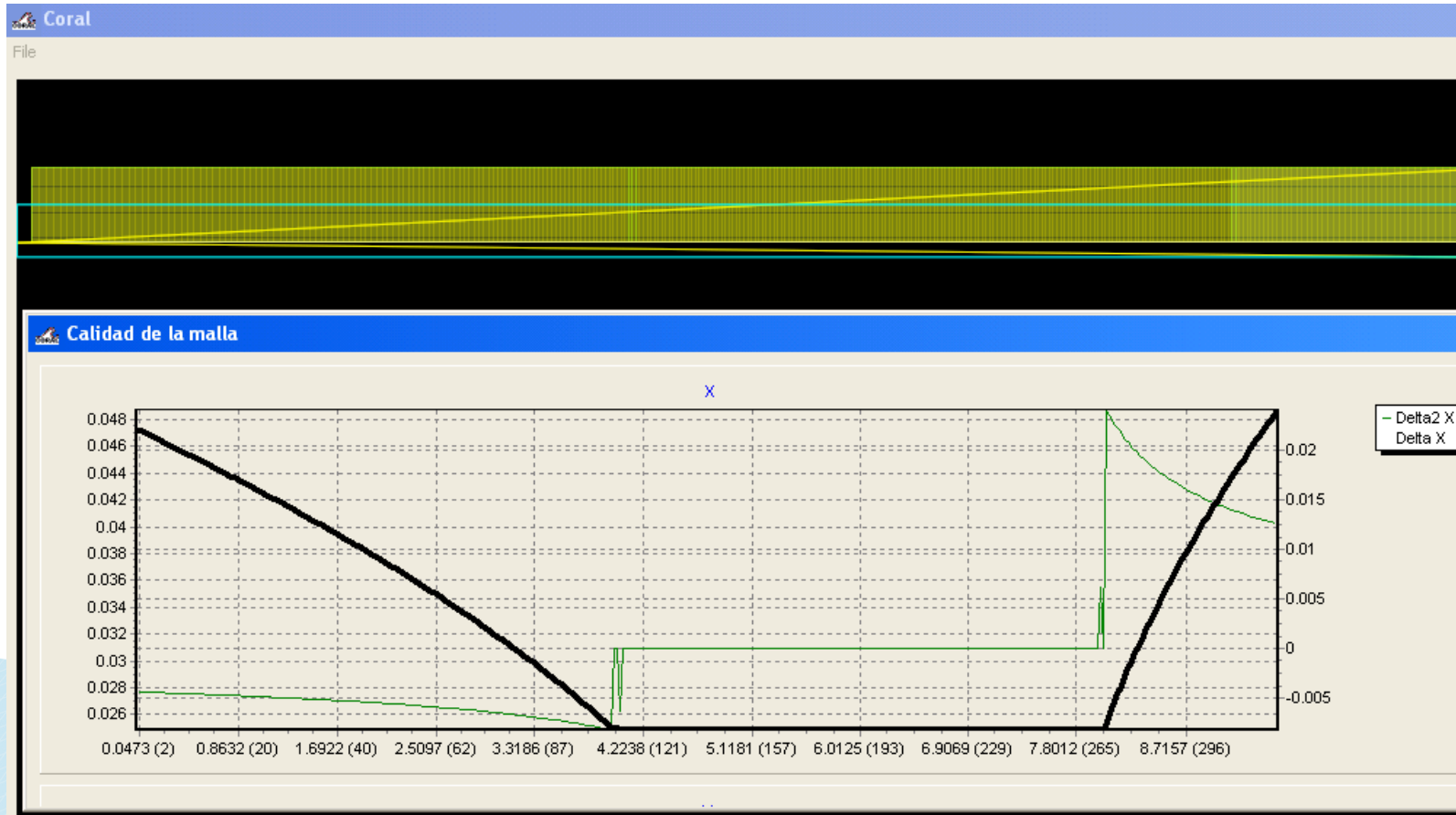
In this case, the run-up produced by a **regular wave train** with wave height equal to **0.10m** and a wave period of **1.5s** is analysed.

A **variable mesh grid** is considered:



Generated mesh

	X Direction			Y Direction
	Subzone 1	Subzone 2	Subzone 3	Subzone 1
Center	3.975	4.025	8.025	0.005
Division	0	4	8	0
Num. cells left	110	1	1	1
Num. cells right	1	160	40	99
Max. sep.center	0.025	0.025	0.025	0.005



Mesh quality

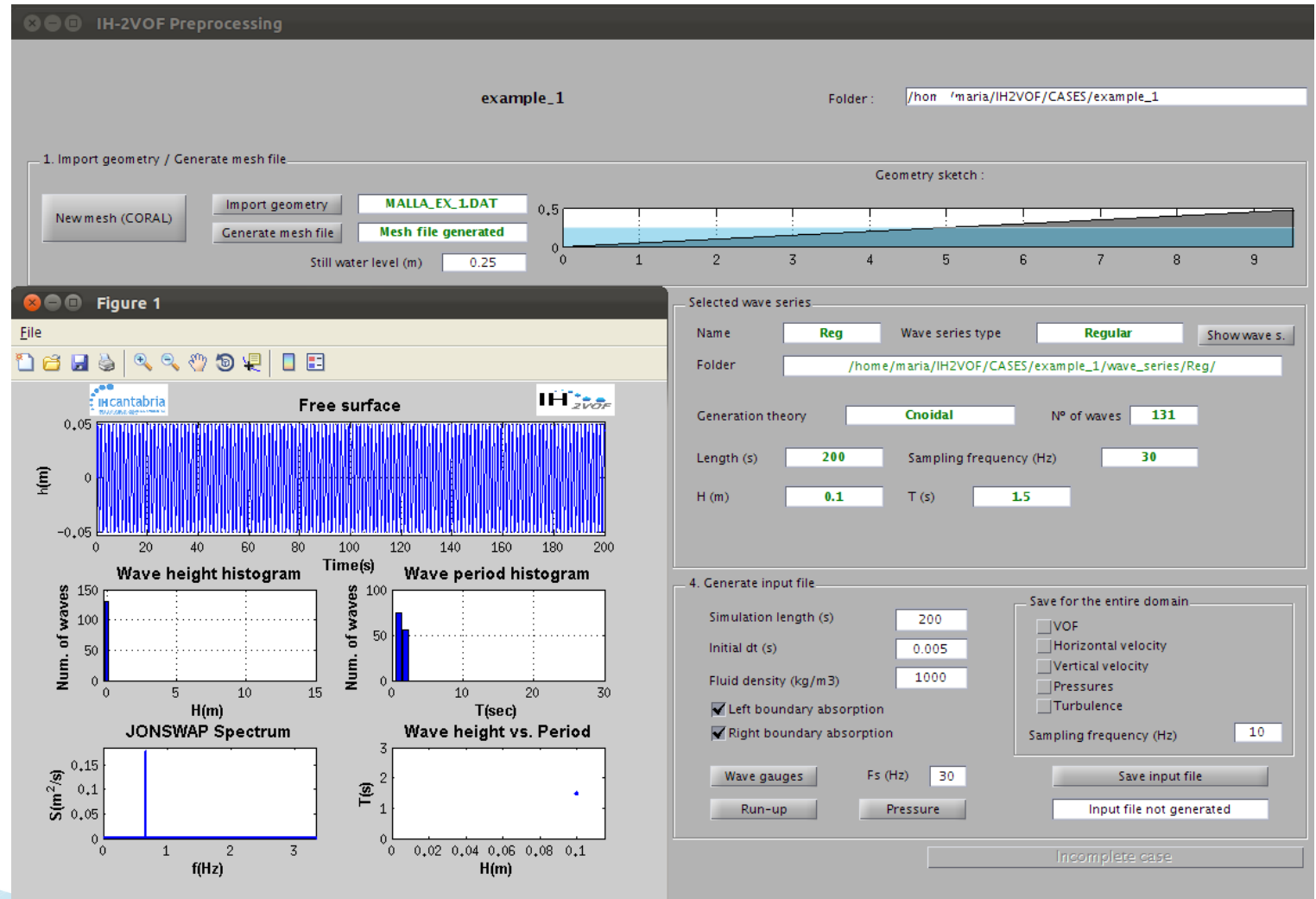
GENERATE WAVE CONDITIONS

Regular wave

$H = 0.10\text{m}$

$T = 1.5\text{s}$

Cnoidal theory



The screenshot displays the IH-2VOF Preprocessing software interface for generating wave conditions. The main window shows a 'Geometry sketch' with a still water level of 0.25 m. A 'Figure 1' window is open, displaying several plots: a 'Free surface' plot showing a regular wave oscillating between -0.05 m and 0.05 m; a 'Wave height histogram' showing a single peak at 0.1 m; a 'Wave period histogram' showing a single peak at 1.5 s; a 'JONSWAP Spectrum' plot showing a single peak at 0.67 Hz; and a 'Wave height vs. Period' plot showing a single point at (1.5 s, 0.1 m).

The 'Selected wave series' panel on the right shows the following settings:

- Name: **Reg**
- Wave series type: **Regular**
- Folder: `/home/maria/IH2VOF/CASES/example_1/wave_series/Reg/`
- Generation theory: **Cnoidal**
- Nº of waves: **131**
- Length (s): **200**
- Sampling frequency (Hz): **30**
- H (m): **0.1**
- T (s): **1.5**

The '4. Generate input file' panel shows the following settings:

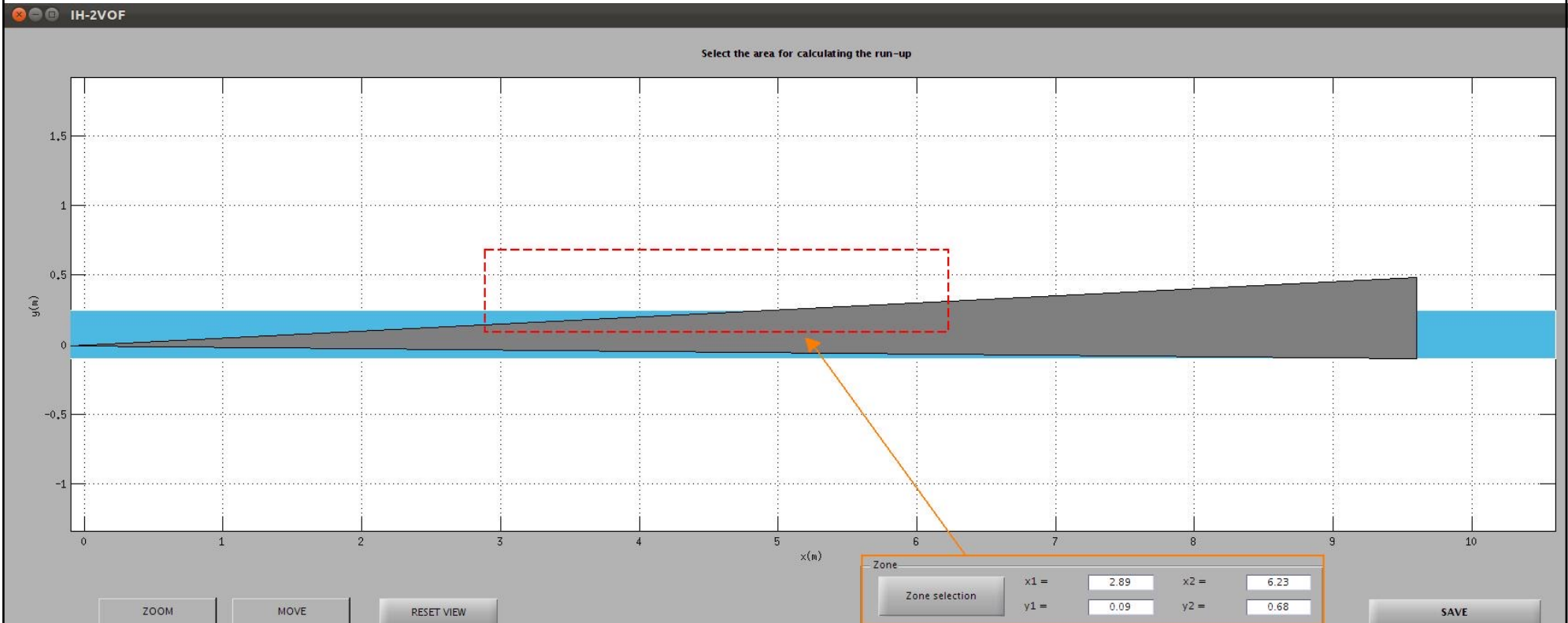
- Simulation length (s): **200**
- Initial dt (s): **0.005**
- Fluid density (kg/m³): **1000**
- Left boundary absorption
- Right boundary absorption
- Save for the entire domain:
 - VOF
 - Horizontal velocity
 - Vertical velocity
 - Pressures
 - Turbulence
- Sampling frequency (Hz): **10**
- Buttons: **Wave gauges**, **Run-up**, **Pressure**, **Save input file**, **Input file not generated**
- Status: **Incomplete case**

INPUT FILE

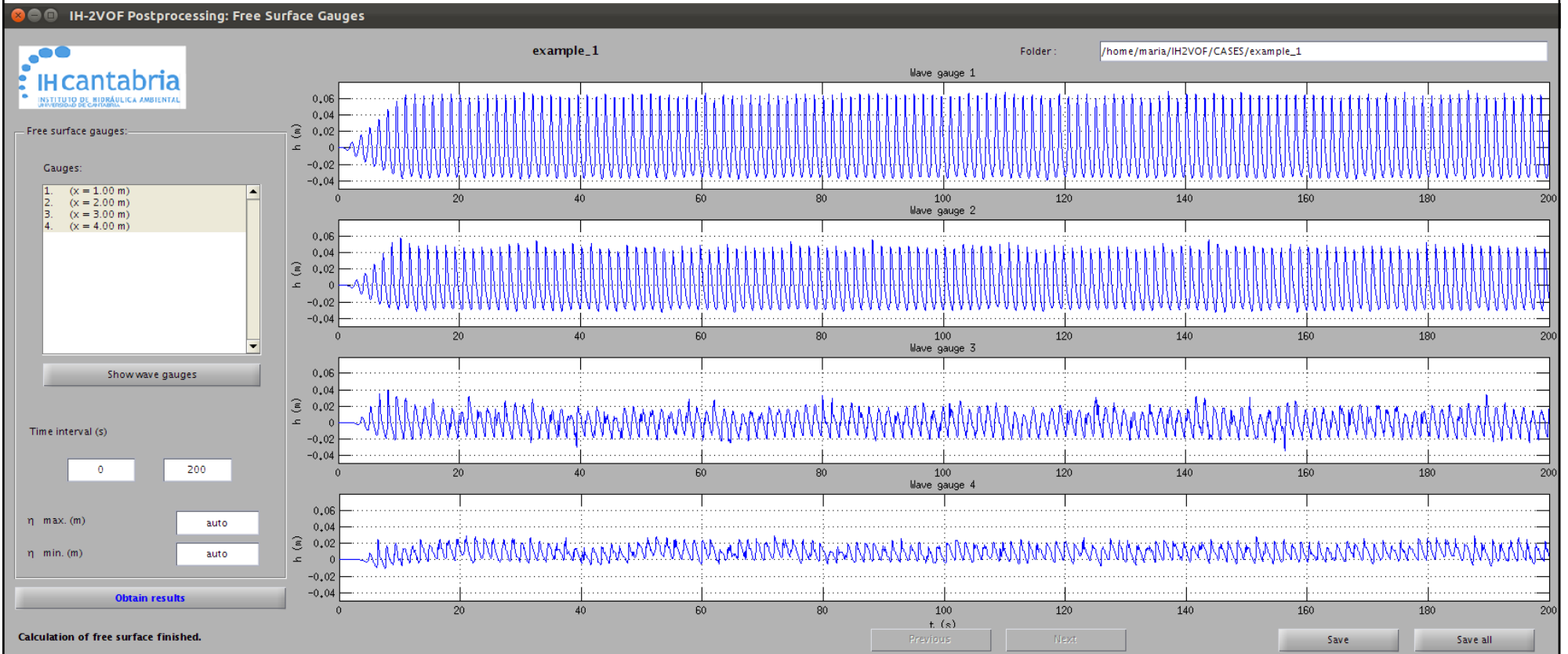
-Wave gauges

-Wave run-up

Gauge	X(m)
1	1
2	2
3	3
4	4



POST-PROCESSING: Wave gauges



POST-PROCESSING: Run-up Analysis

IH-2VOF Postprocessing: Run-up Analysis



example 1

Folder : /home/nicolas/IH2VOF/CASES/example1

Run-up

Time interval (s)

0

200

Time series properties:

Upper RU (m)

auto

Lower RU (m)

auto

Histogram properties:

n° bins

auto

y ax. lim.

auto

x ax. lim.

auto

auto

Envelopes properties:

Envelopes displayed area

AX

3.75

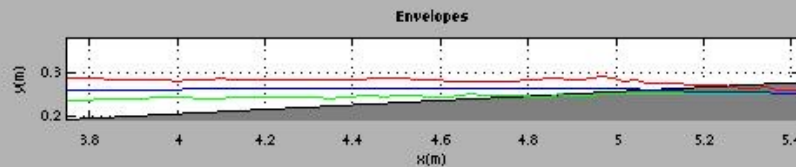
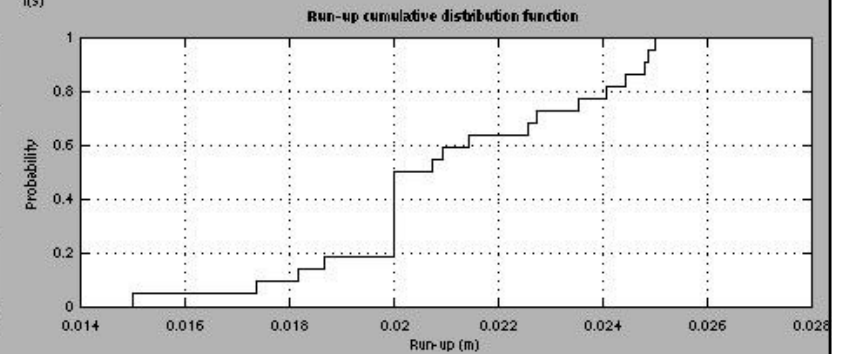
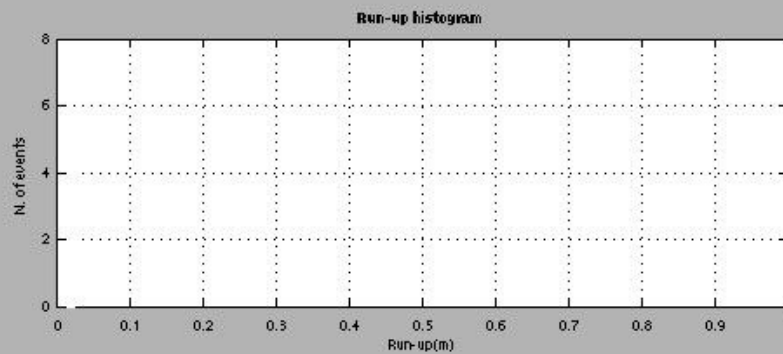
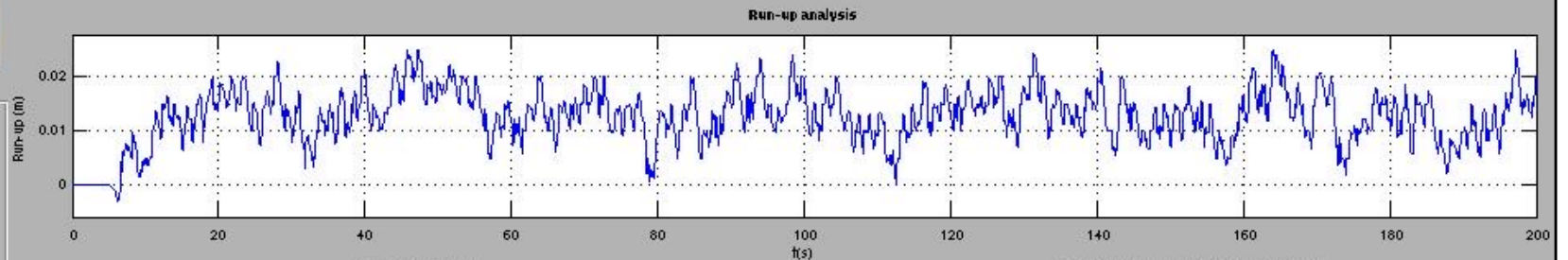
5.42

AY

0.19

0.38

Obtain results



Results report:

Mean Run-up = 0.02 m

Max Run-up = 0.03 m

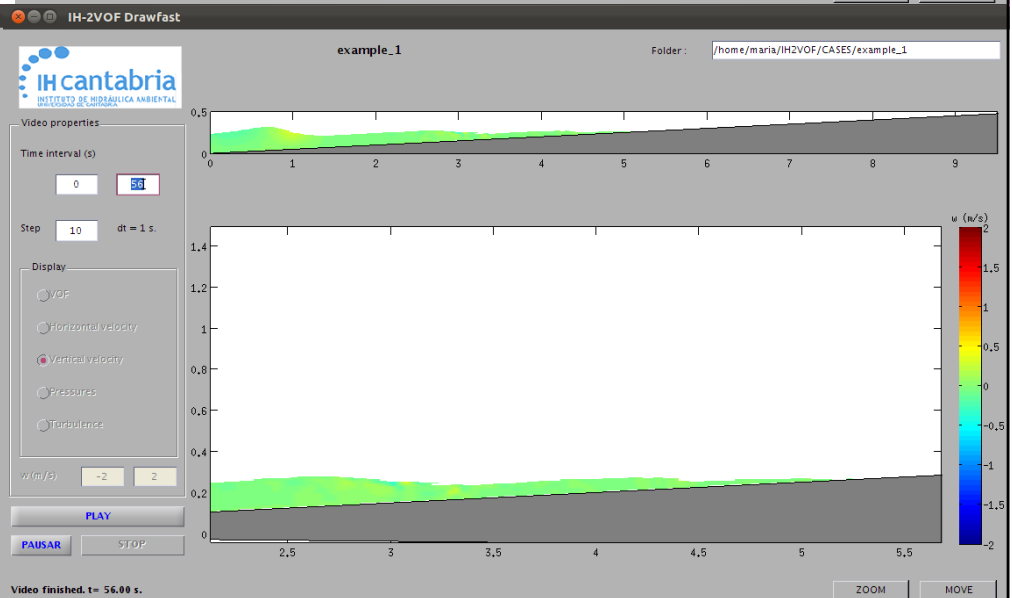
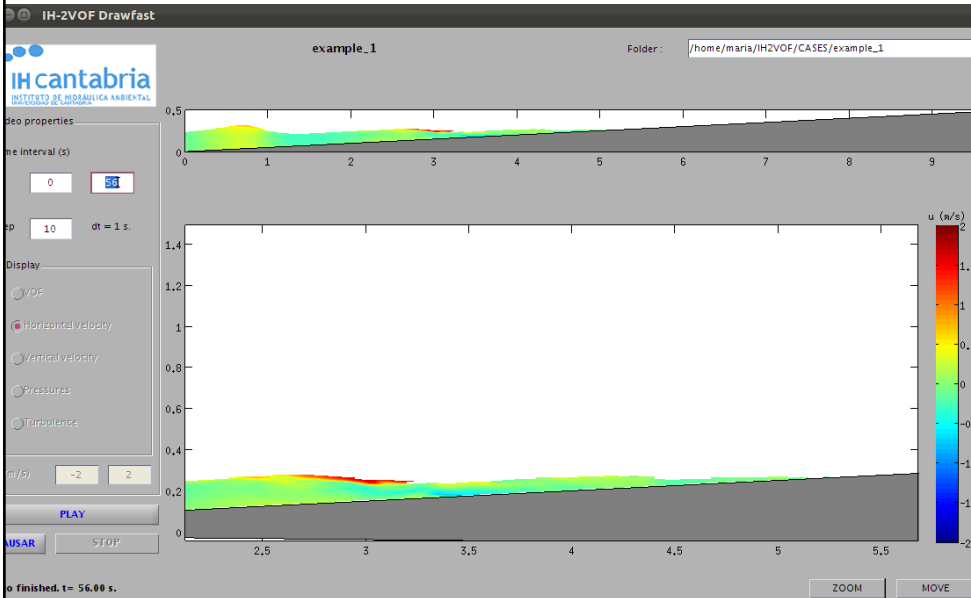
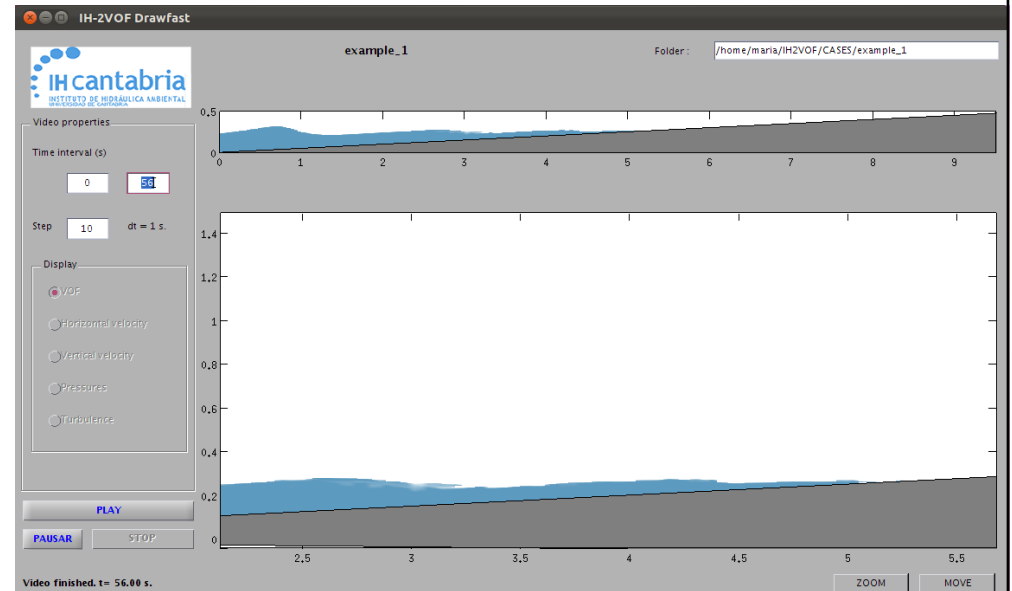
Run-up 2% = 0.02 m

Calculation of run up finished.

Save

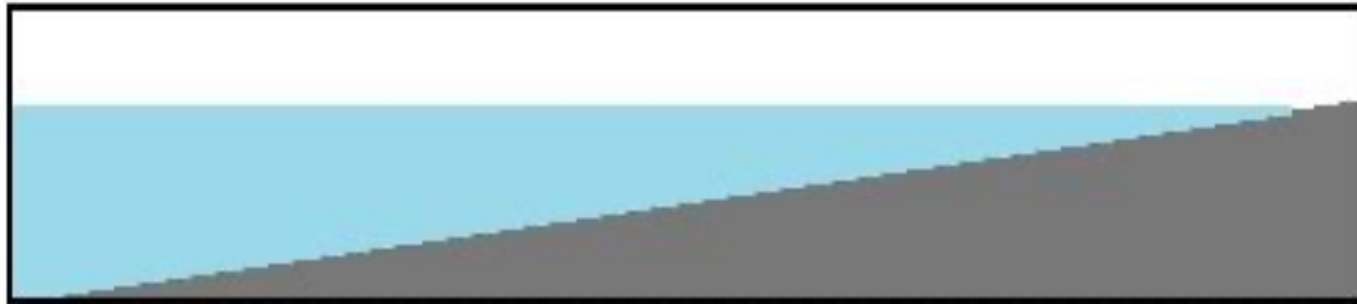
POST-PROCESSING: Drawfast

VOF drawfast
Horizontal velocity Drawfast
Vertical velocity Drawfast



Example 1

Study of a Solitary wave run-up



Maria Maza (mazame@unican.es)