

# Tsunami waves generated by subaerial and submarine landslides along a straight sloping coast: new experiments

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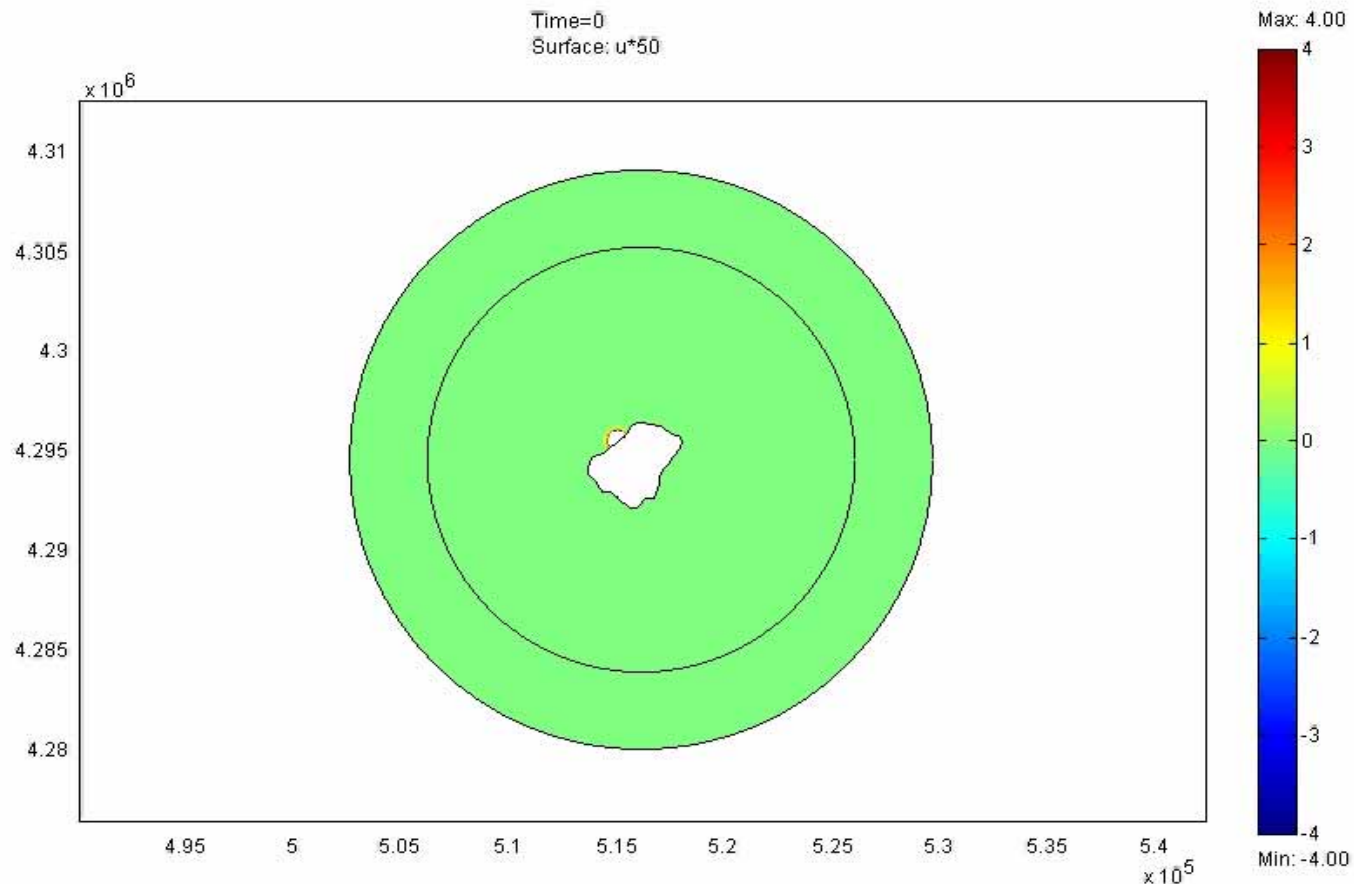


# Layout of the presentation

- Motivations and background
- Overview of the physical processes
- Objectives
- Description of the new experiments
- Preliminary results
- Conclusions and future work

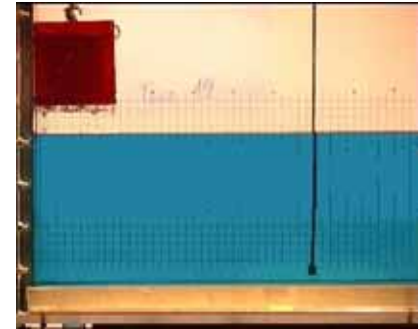
# Motivations and background-1

- On December 30th 2002 a landslide generated a tsunami at Stromboli island
- Damages occurred also in areas “sheltered” by the island itself
- Waves propagated around the island for the combined effect of diffraction and refraction (edge waves)



## Motivations and background-2

- *We have been/currently are* studying the generation-propagation-runup processes around Stromboli island
- We had to face several problems when we applied the available technology to the specific case



**We have applied empirical formulae**

- The work carried out previously by our research group mainly focussed on constant depth configurations
- Most of empirical formulae applicable to sloping coasts are valid in the 2D case (only very recently extension to 3D has been given using numerical results; see Lynett & Liu, 2005, JGR vol. 110)
- ...and for STRAIGHT coasts

## Motivations and background-3

**We have applied numerical models**

- Simplified numerical modelling (2DH: NSW, BTE) carries the problem of reproducing the effects of the landslide, i.e. of generating the waves
  - Direct reproduction of the landslide movement (i.e. the bottom changes), as in Lynett and Liu (2002, Proc. R. Soc. Lond. A, 458): water depth/landslide length should be small
  - Parametric initial conditions as from TOPICS
  - Source function in the modelling eq (Mancini et al., 2004)
- Detailed numerical modelling (3D: SPH) involves huge computational costs

## Motivations and background-4

- Several previous researches (also experimental) investigated the behaviour of tsunamis around island, but the waves were generated somewhere else and attacked the island from offshore
- New experiments on water waves generated along the coast of an island trying to reproduce the basic features of the island of Stromboli



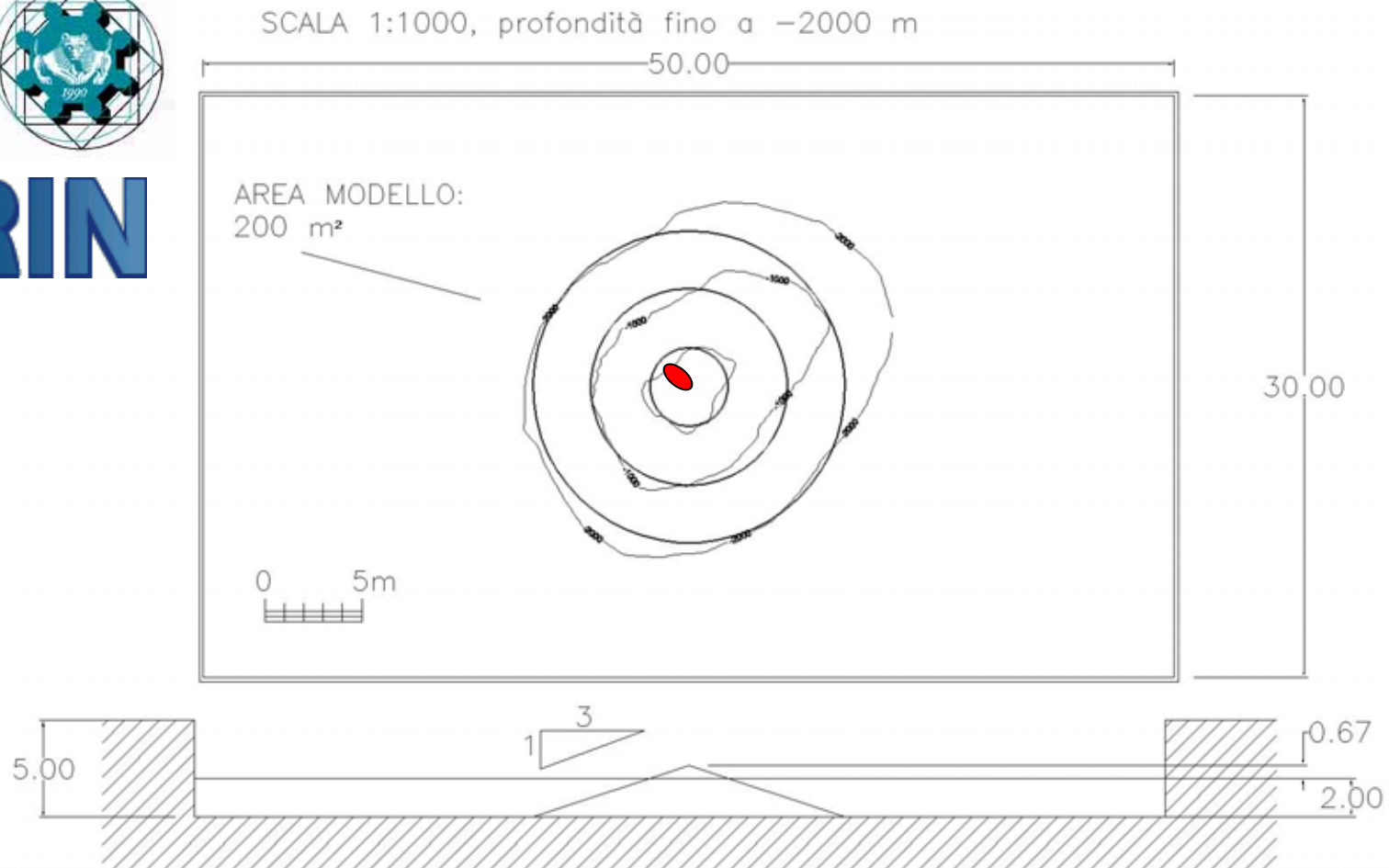
**PRIN**

# Motivations and background-5

Experiments to be carried out at Politecnico of Bari reproducing a circular island similar to Stromboli



**PRIN**



## Motivations and background-6

- Before building such an expensive facility we decided to test the instrumentation in a smaller experiments to be carried out at the LIAM laboratory of the University of L'Aquila
- A simpler version of the “island” experiment is being carried out, representing a straight sloping coast

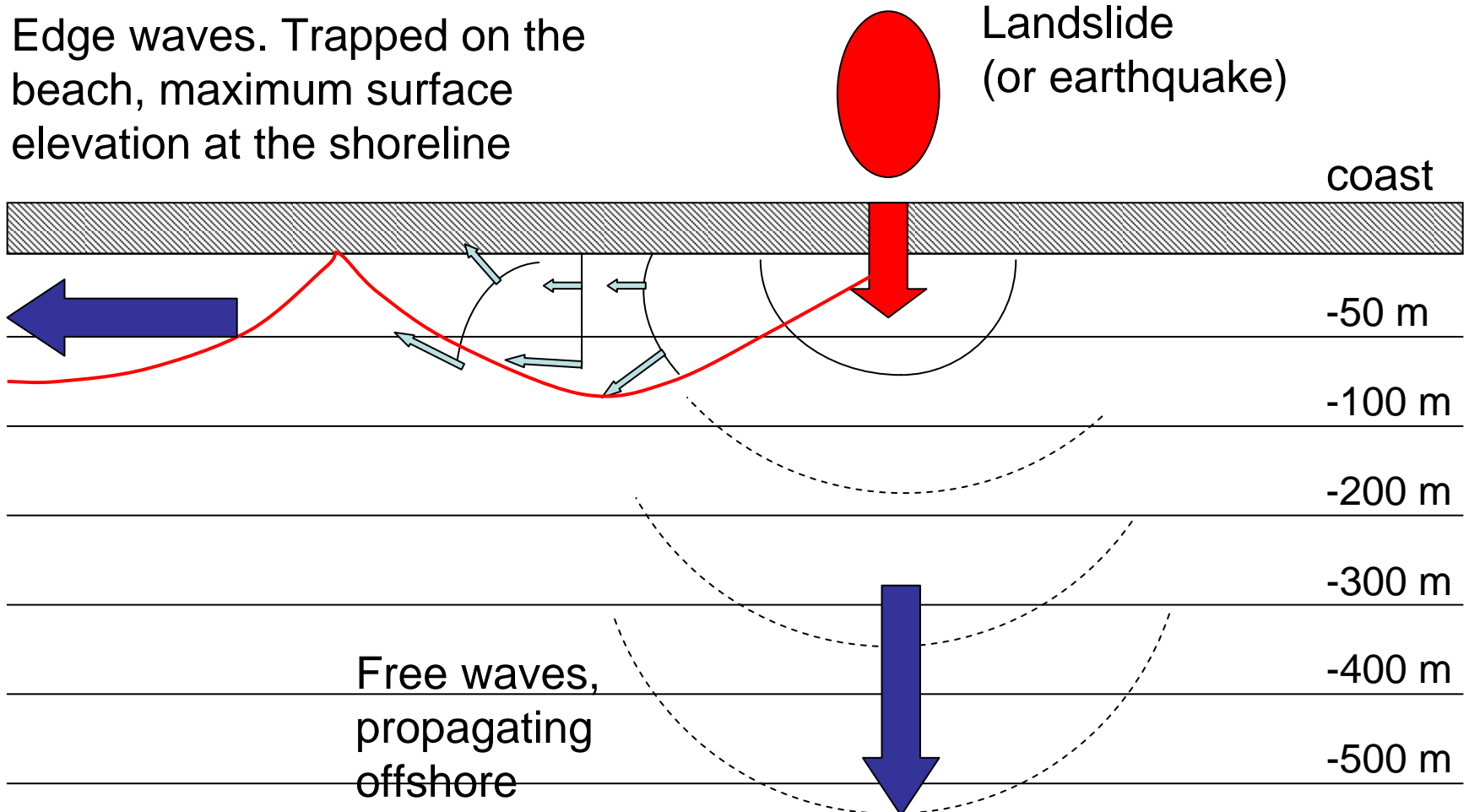
The first objective of these experiments is therefore to explore the feasibility of the “island” experiments.

But some additional and interesting objectives will be introduced later in the presentation...



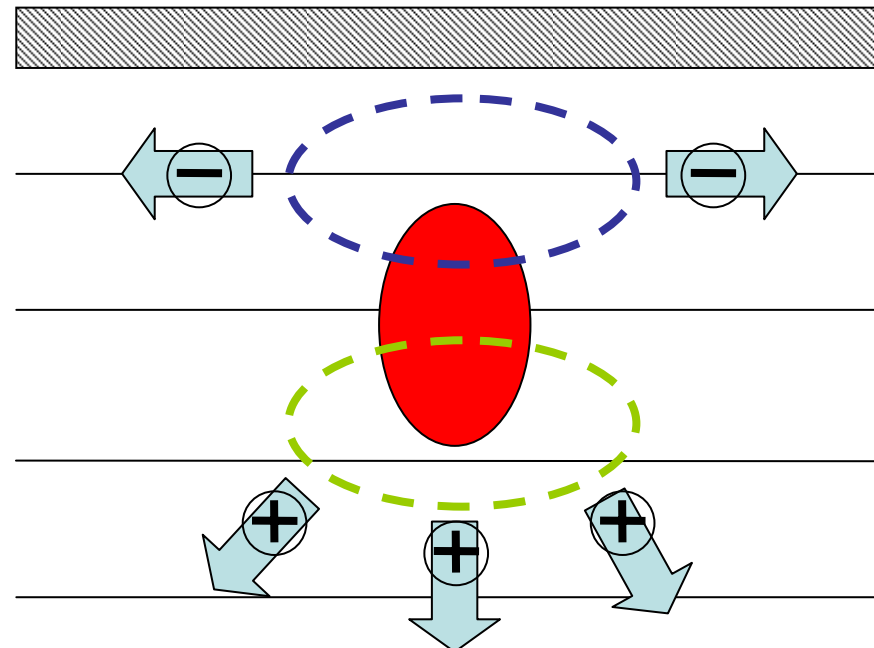
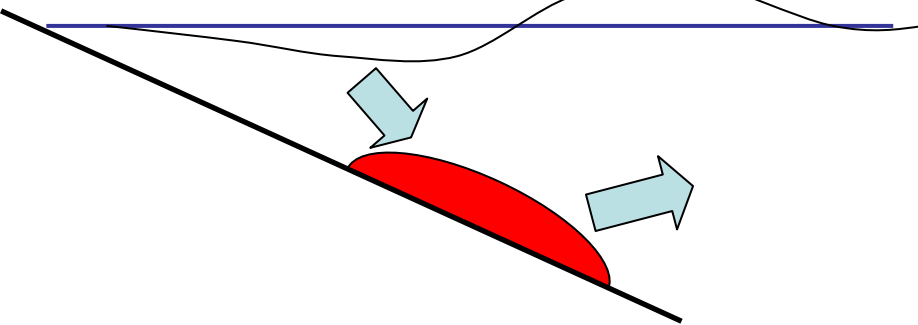
# Overview of the physical processes-1

Edge waves. Trapped on the beach, maximum surface elevation at the shoreline

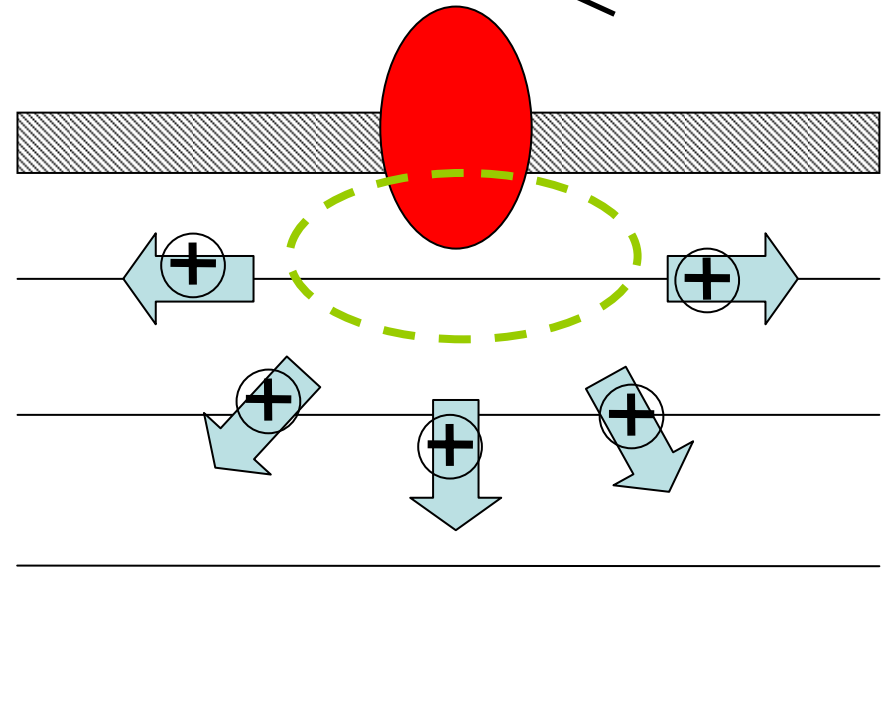
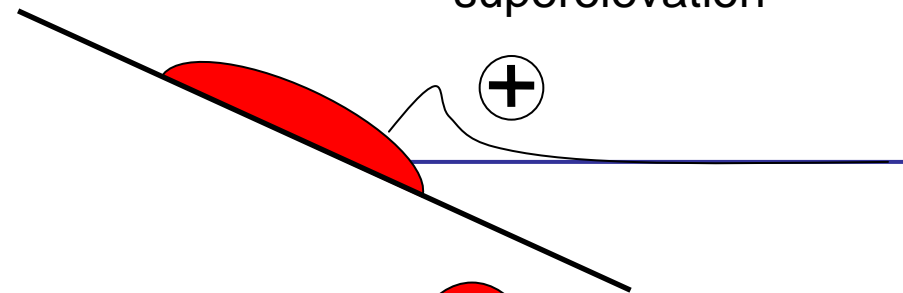


# Overview of the physical processes-2

superelevation  
⊖ depression ⊕



superelevation ⊕



# Objectives-1

## **To explore the physical processes of interest on experimental basis**

- To understand how much energy radiates away from the source as free waves and how much energy remains trapped along the coast as edge waves
- What are the edge waves modes more likely to be excited depending on the characteristics of the landslide
- To study the run-up of edge waves, mostly propagating at a direction parallel to the coast

# Objectives-2

## **To provide with tools useful for practical applications**

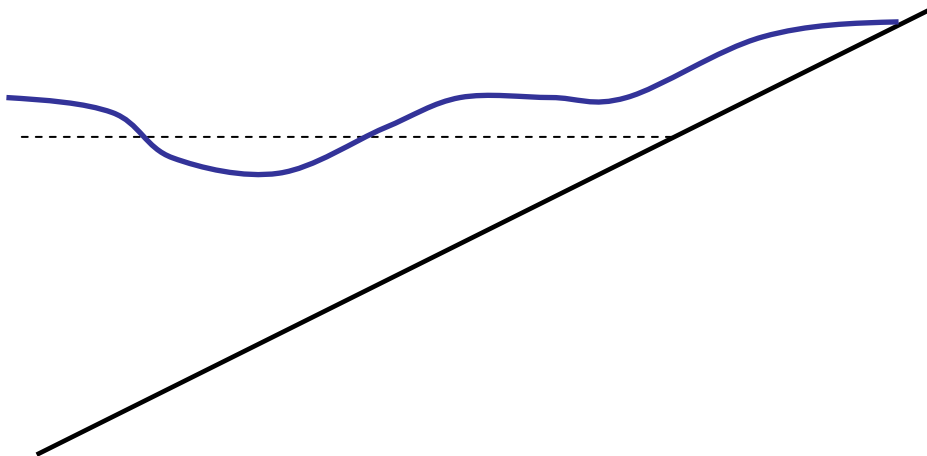
- Develop some new techniques for generating in numerical model the appropriate water waves depending on the characteristics of the landslide
- Develop prediction formulae for forecasting the maximum run-up along the coast

## Objectives-3

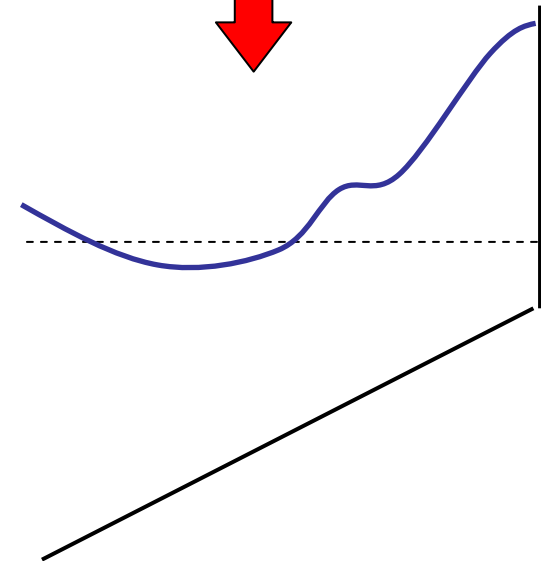
Obtain benchmarks for the validation of

- Numerical models
- Analytical models
- Empirical models

These are the BC used by most of analytical models and by some (simple and useful) numerical model



RUN UP TESTS

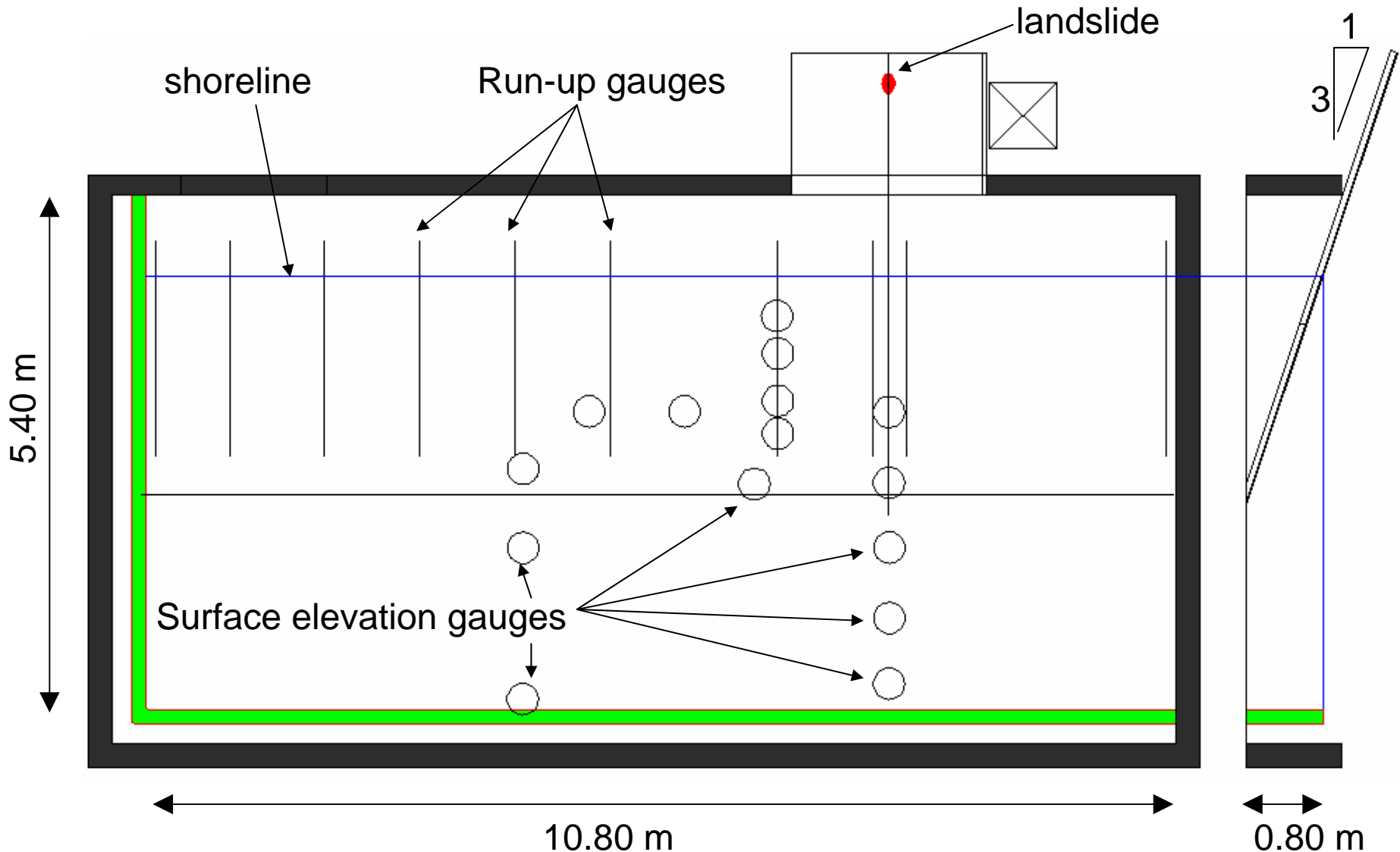


VERTICAL WALL TESTS

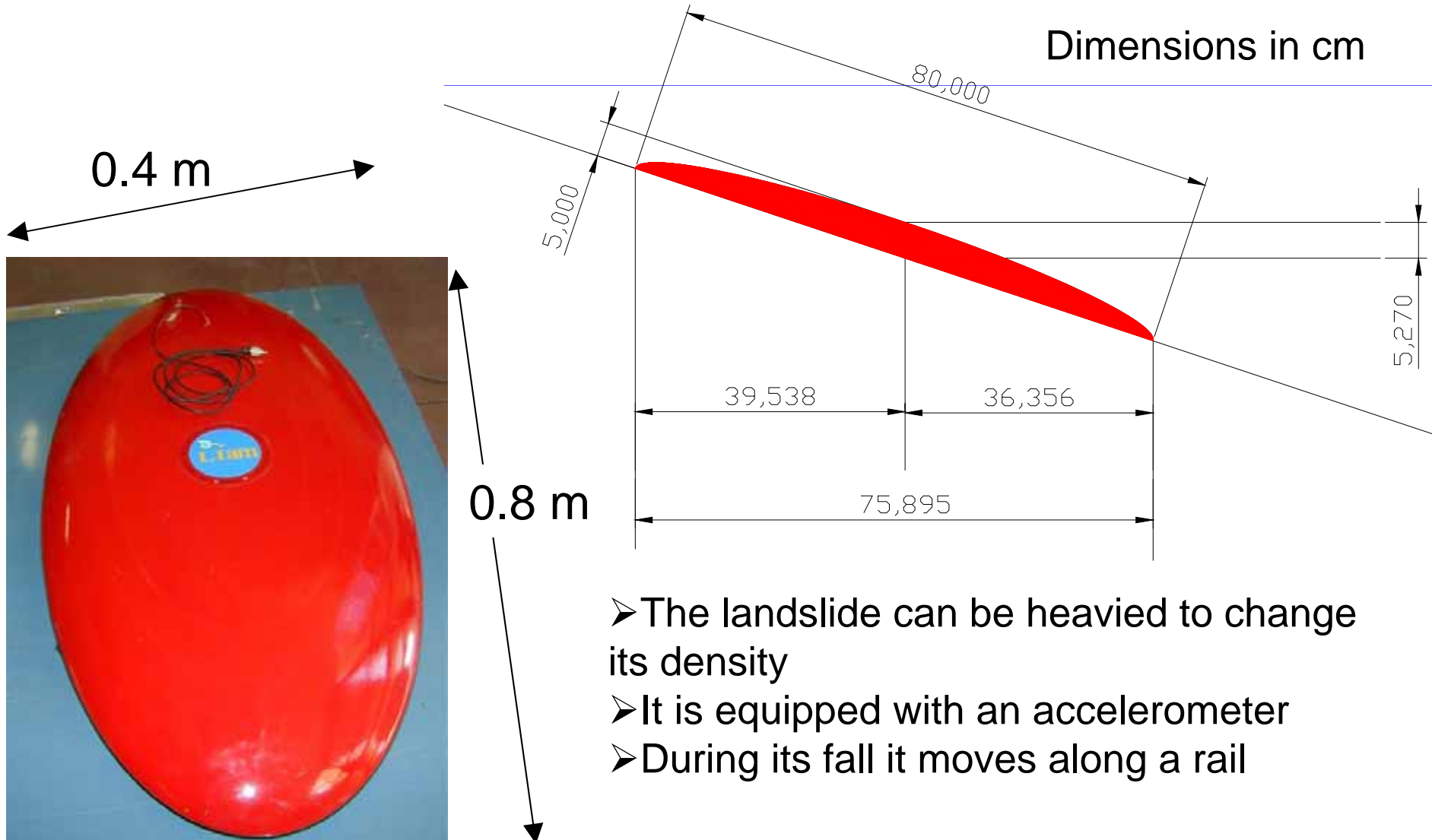
# Description of the new experiments-1



# Description of the new experiments-2

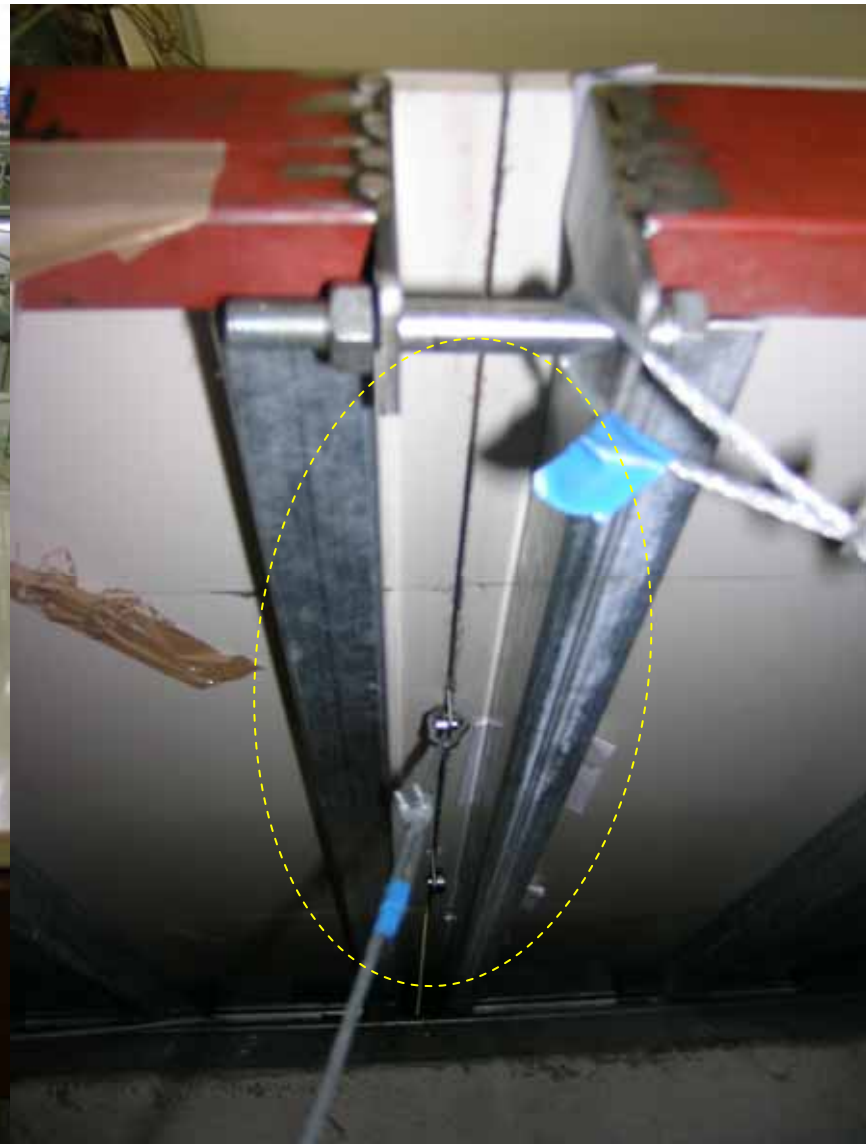
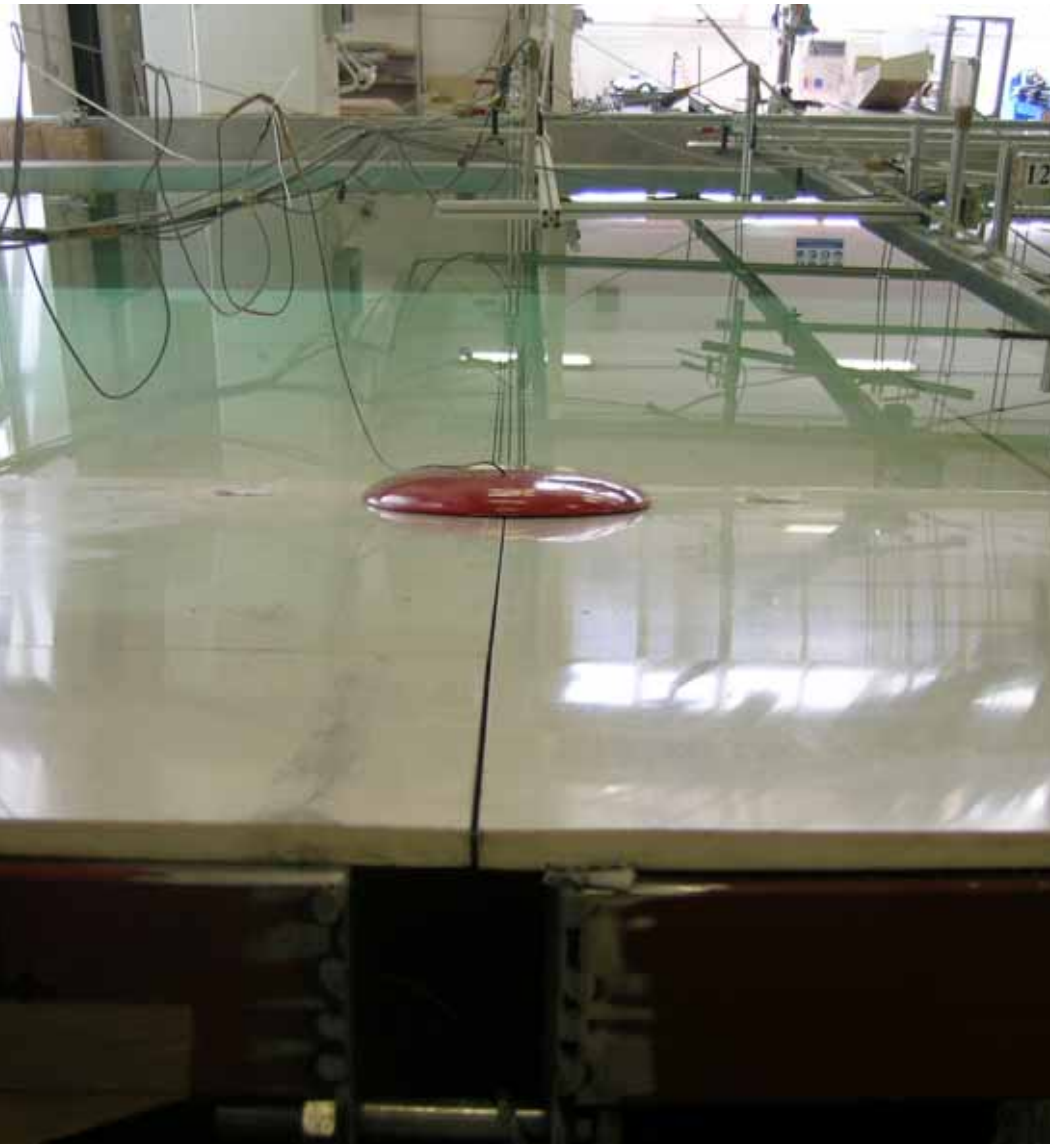


# Description of the new experiments-3



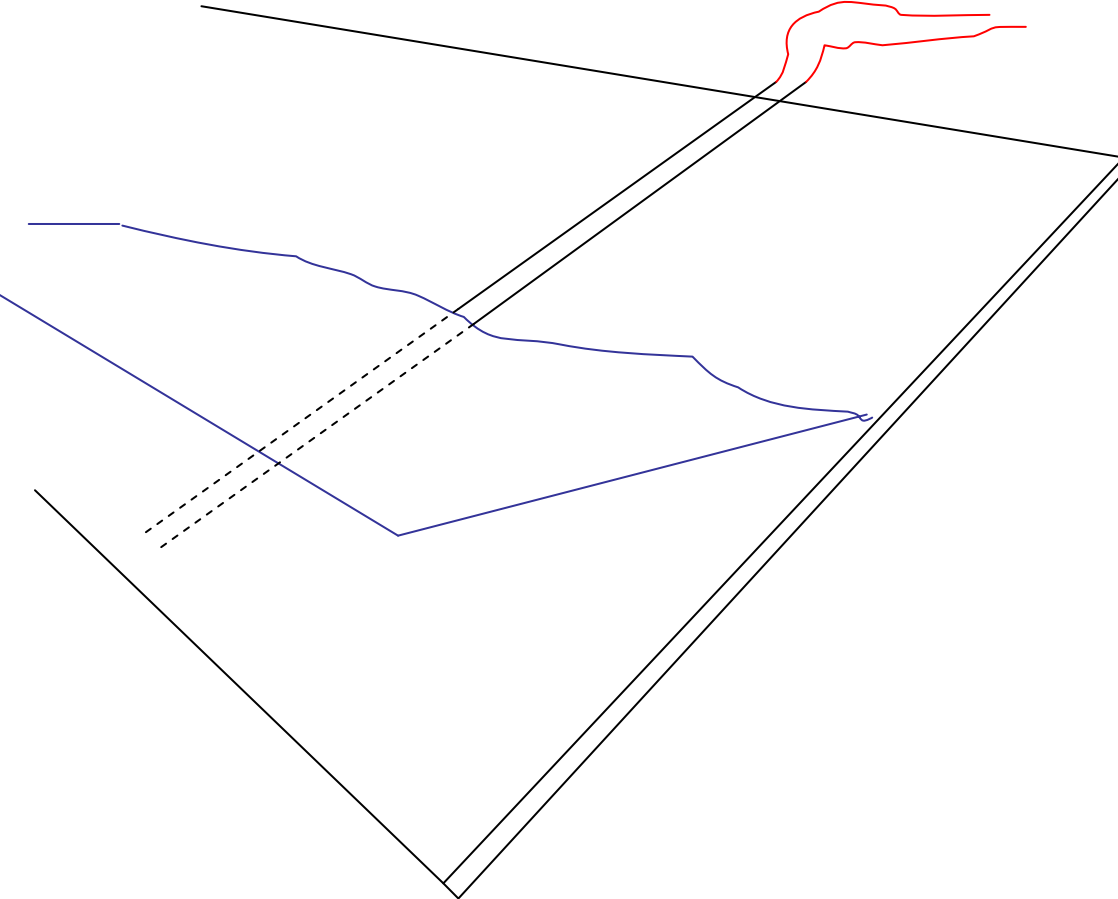


# Description of the new experiments-4

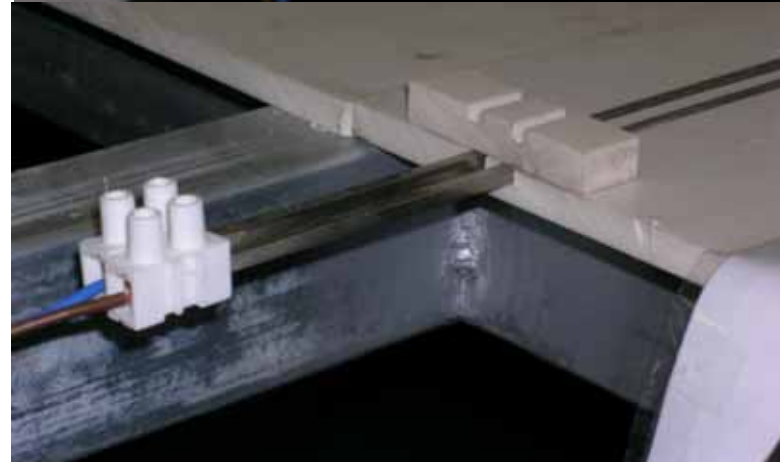
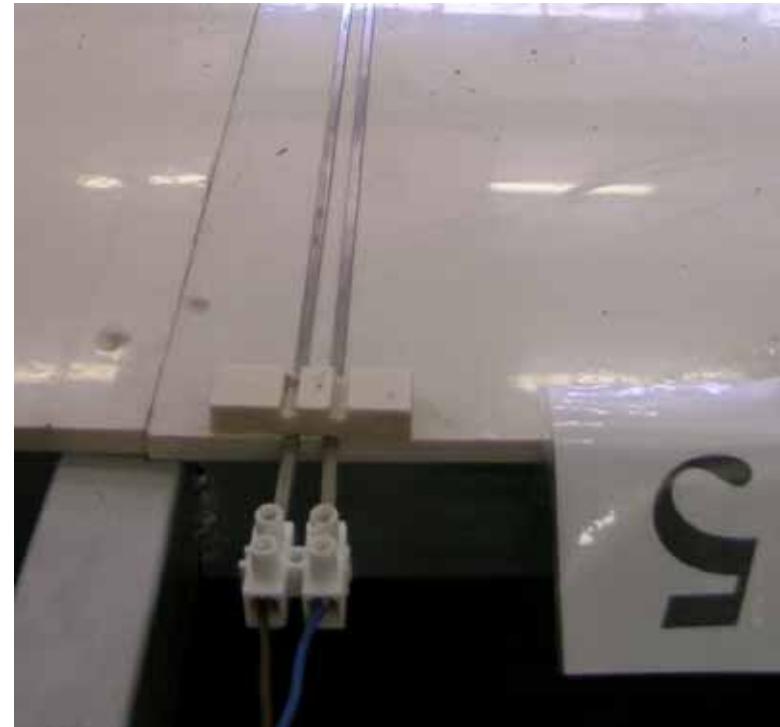
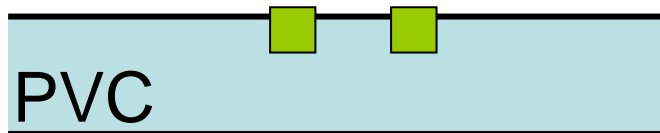


# Description of the new experiments-5

Run up gauge



Section view



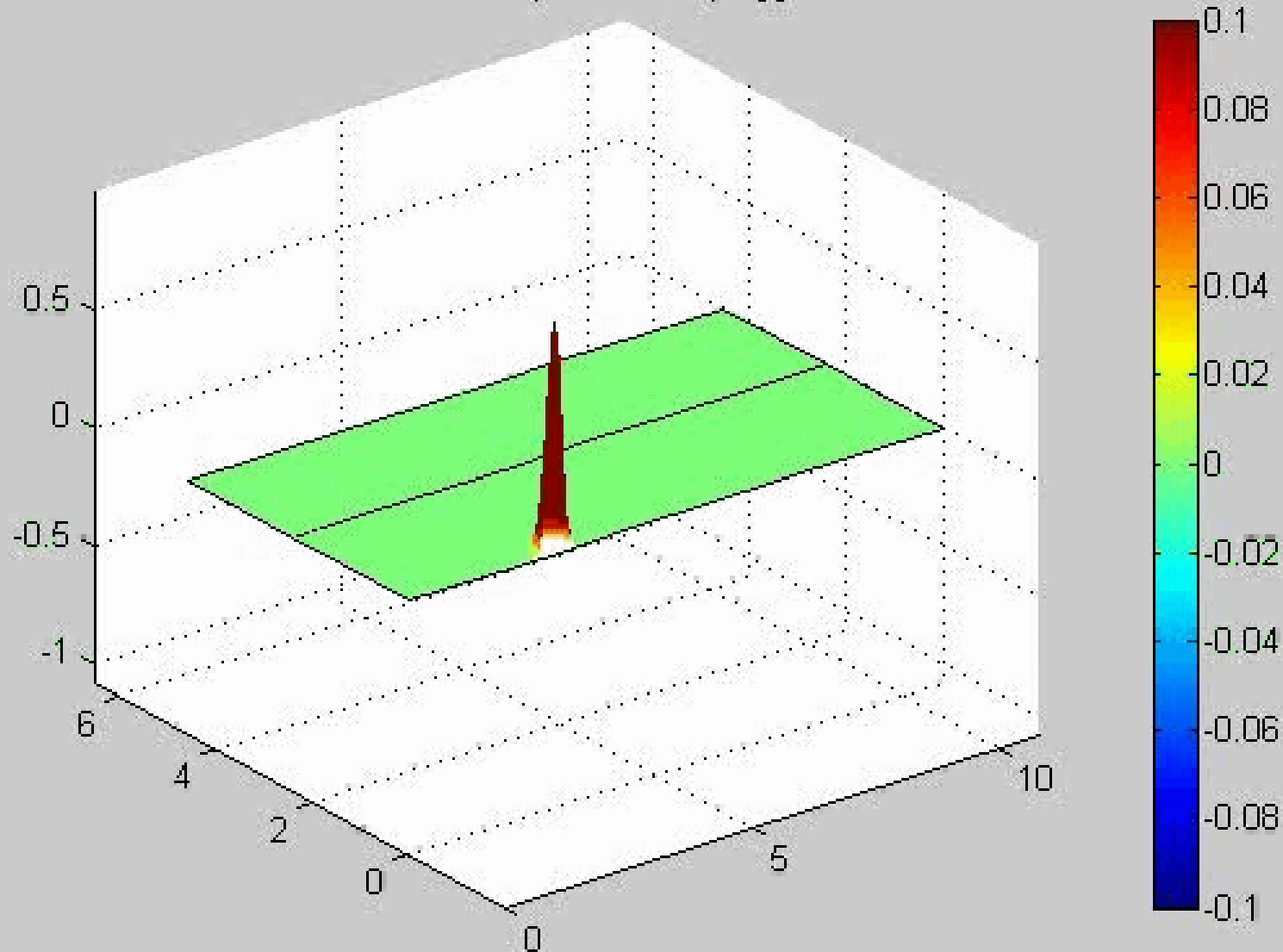
# Description of the new experiments-6

## Surface elevation gauge and acquisition system

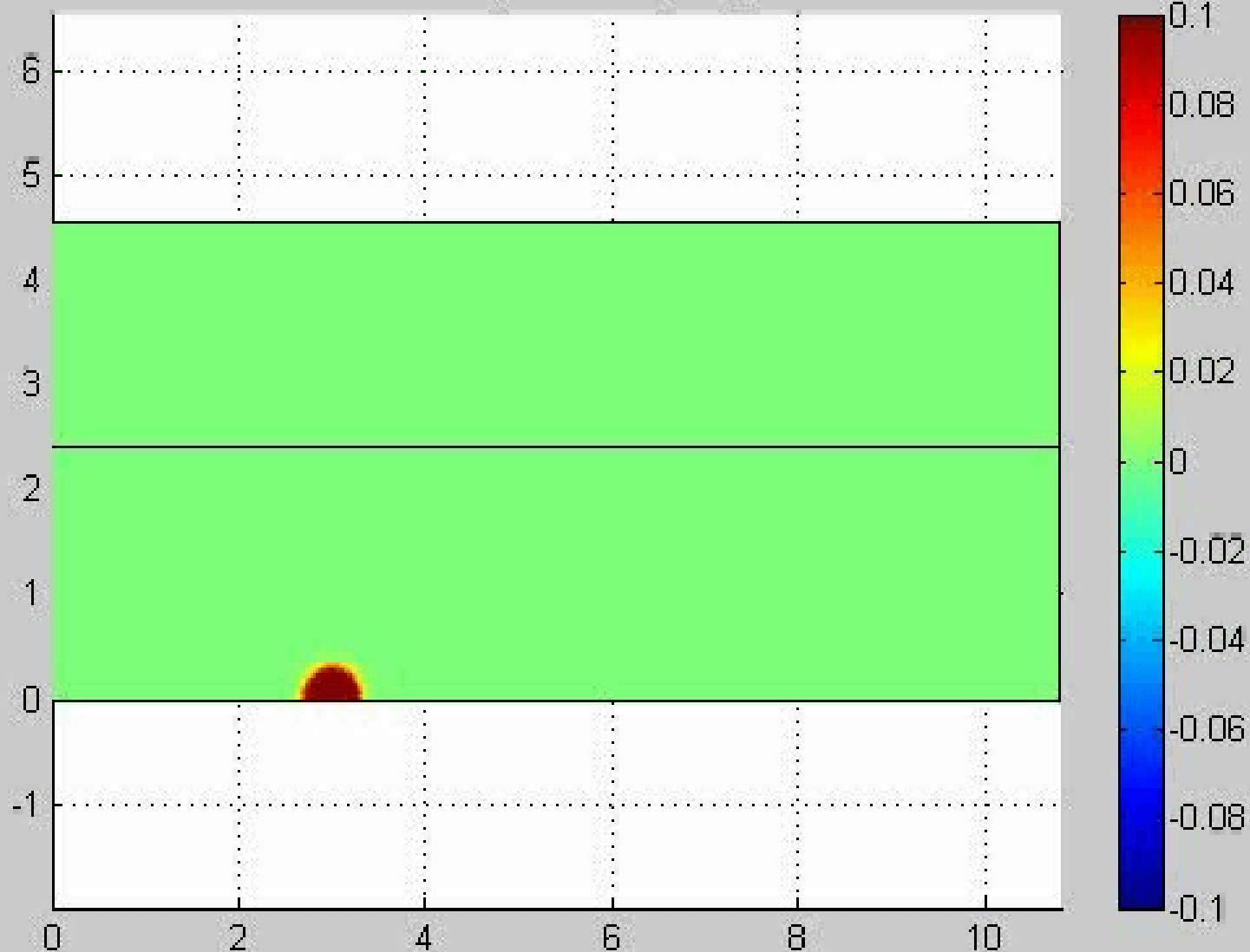
- 15 elevation gauges
- 10 run-up gauges
- 1 accelerometer



### Esperimento spiaggia



### Esperimento spiaggia



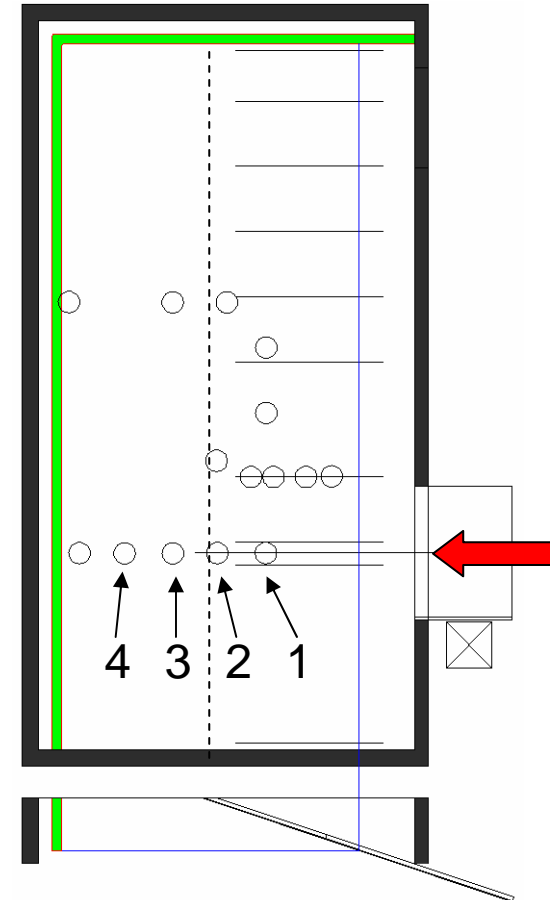
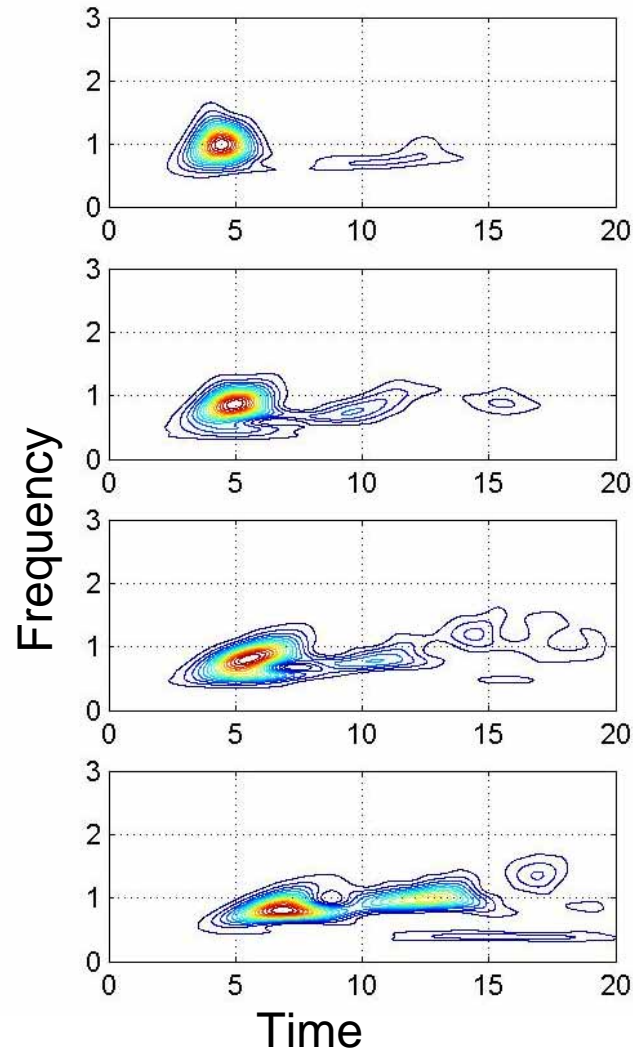
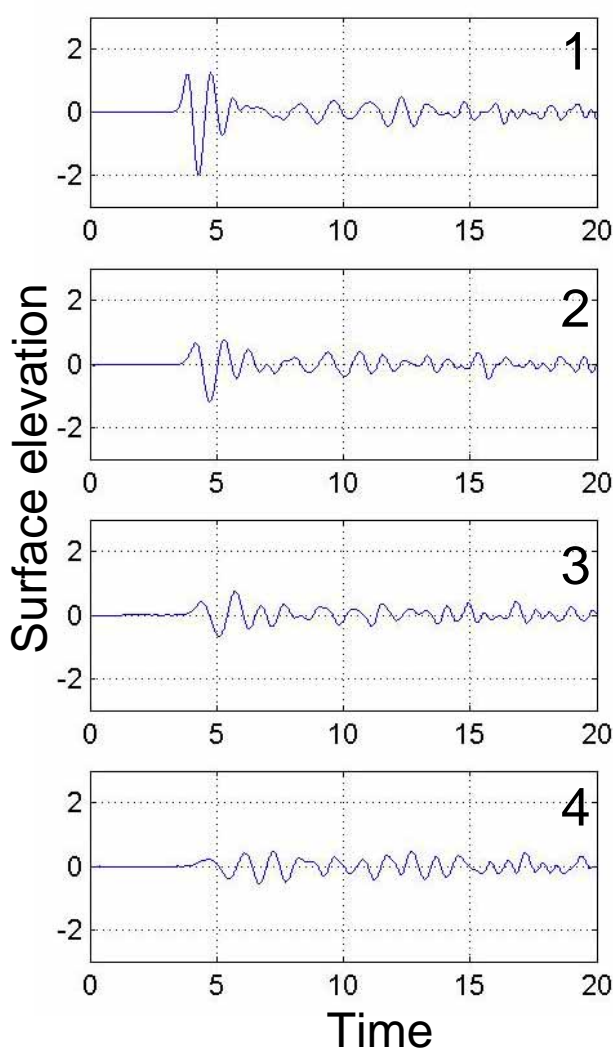
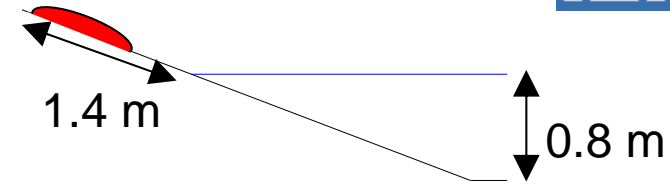
# Preliminary results-1

- Some trial tests have been carried out at the beginning of June 2005
- Preliminary analysis has been carried out to test the ability of the experimental facility and of the instrumentation to reproduce and measure the processes of interest
- Here we show some sample results just to show the analysis techniques we are going to apply



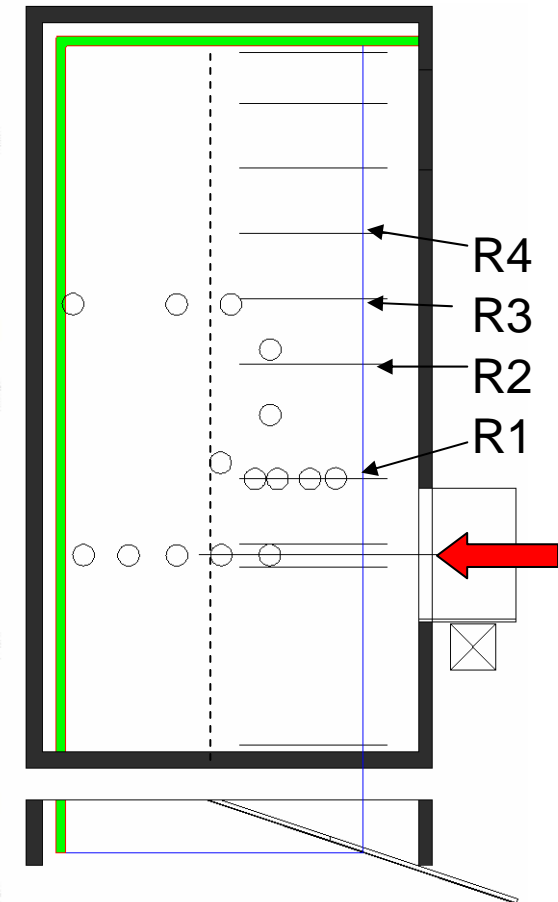
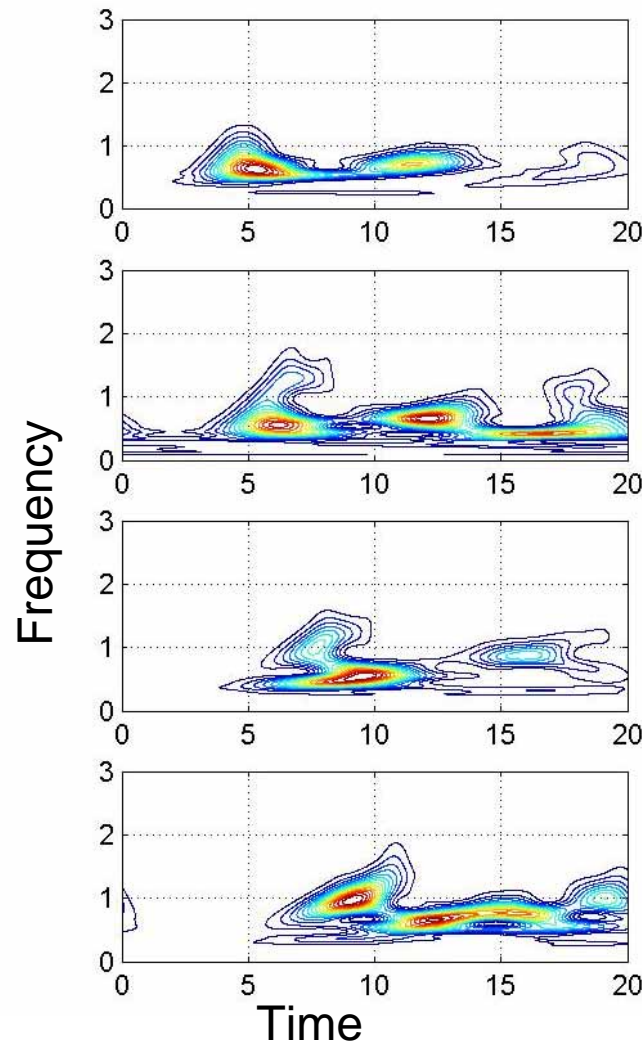
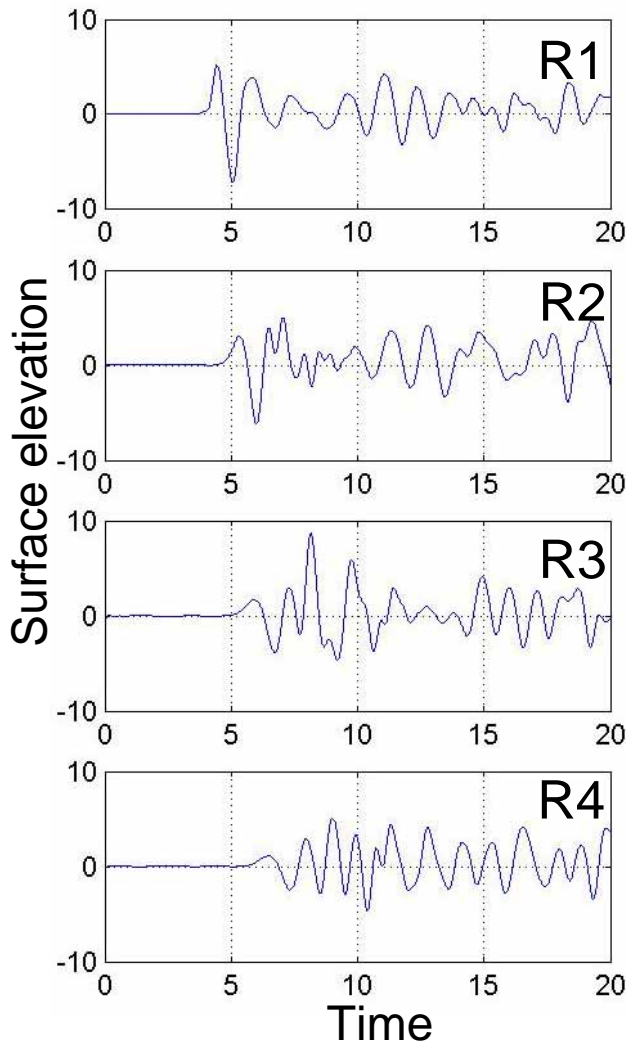
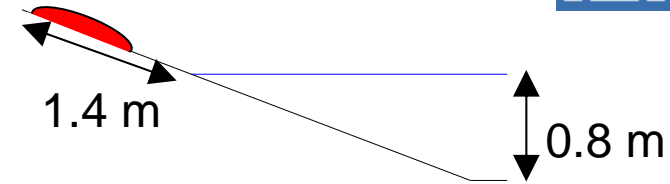
# Preliminary results-2

## Surface elevation gauges



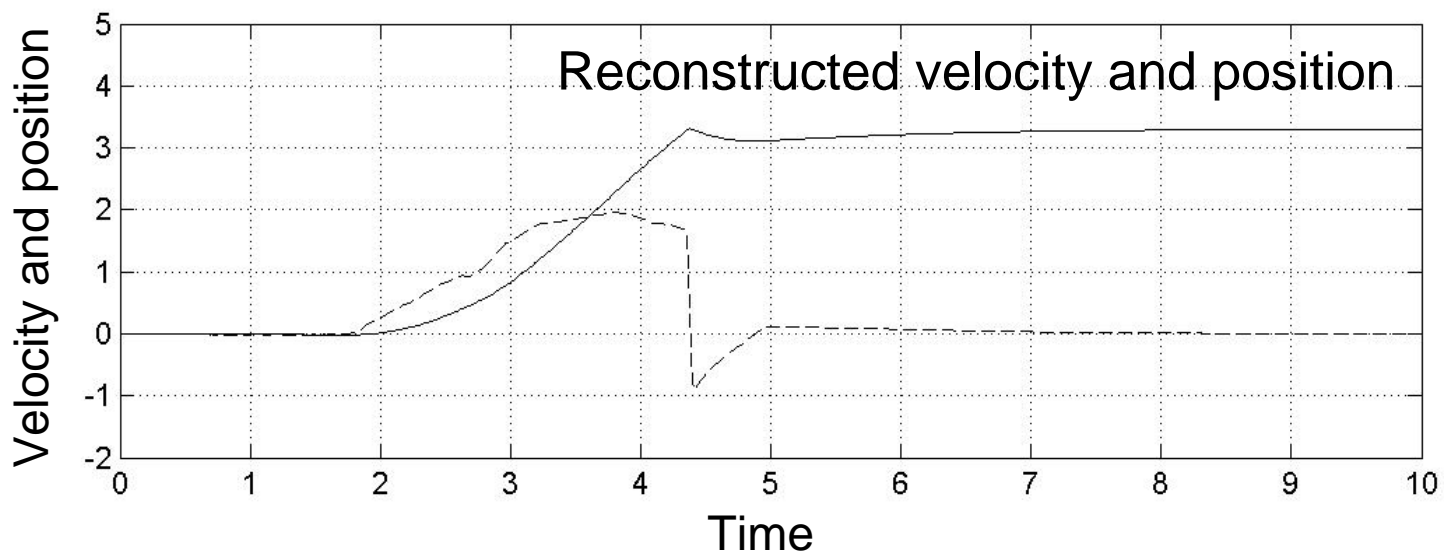
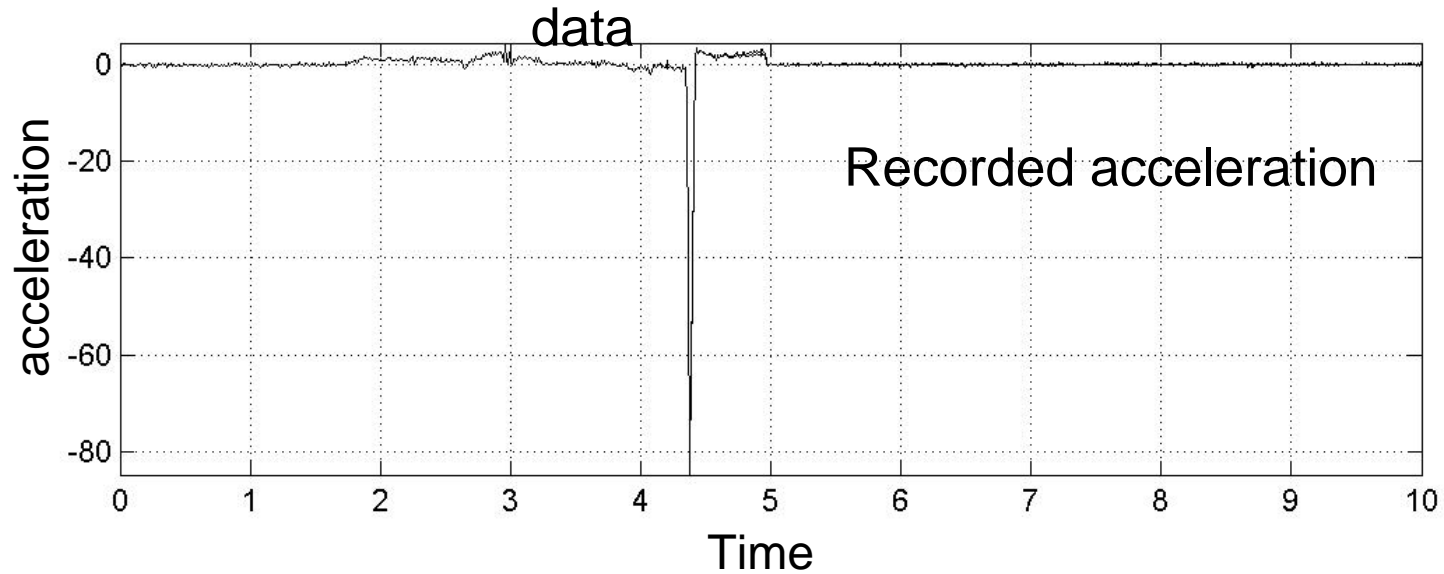
# Preliminary results-3

Run up gauges



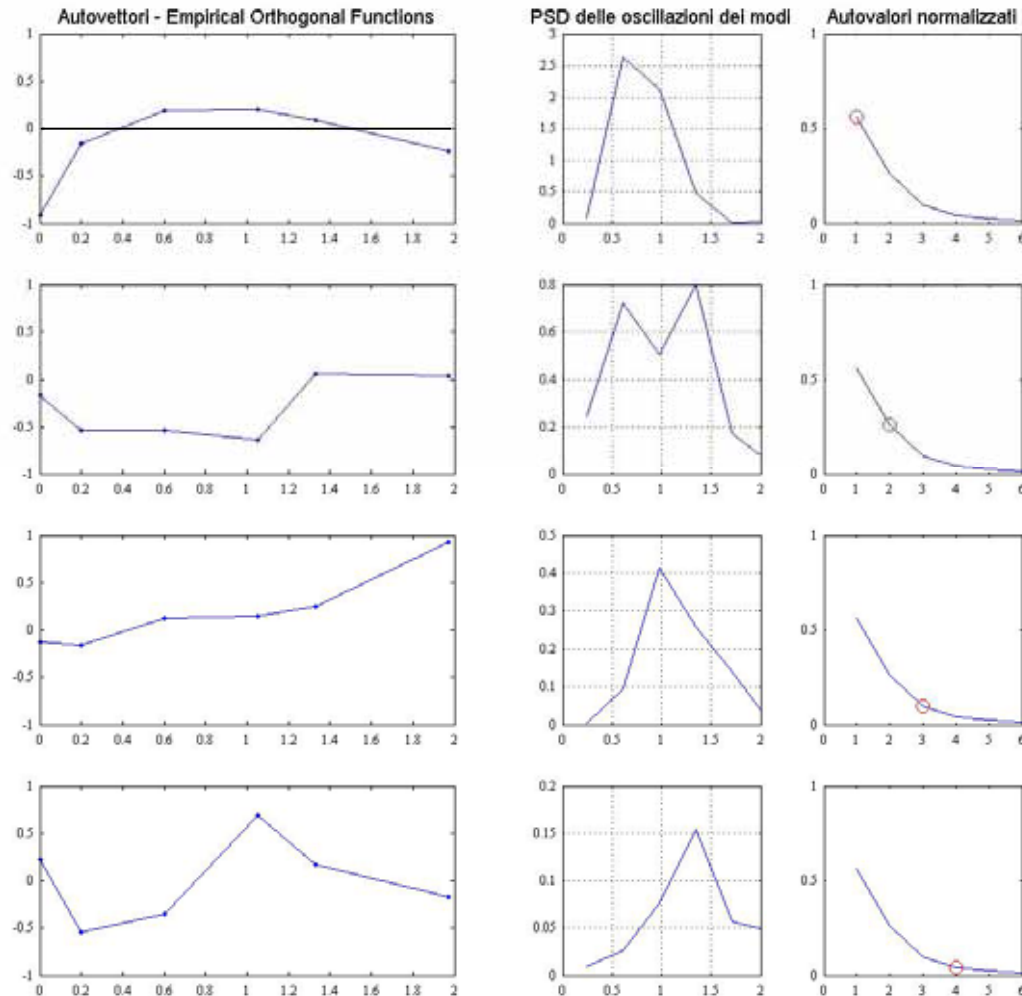


# Preliminary results-4 Accelerometer



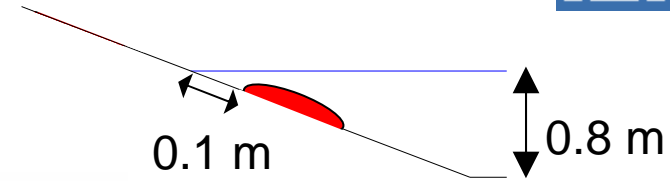
# Preliminary results-5

## EOF analysis

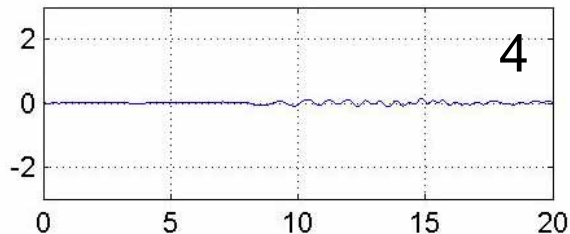
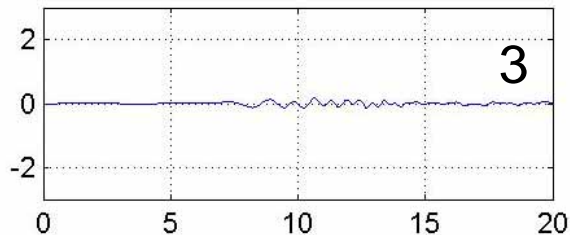
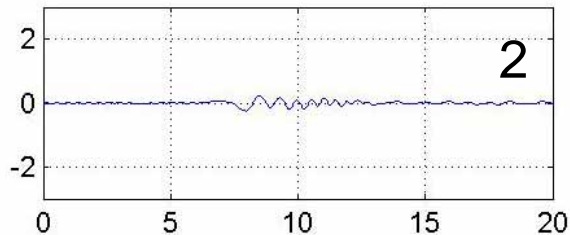
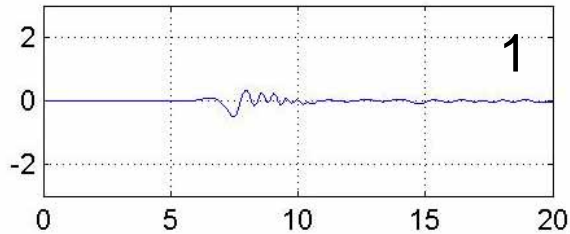


# Preliminary results-6

## Surface elevation gauges

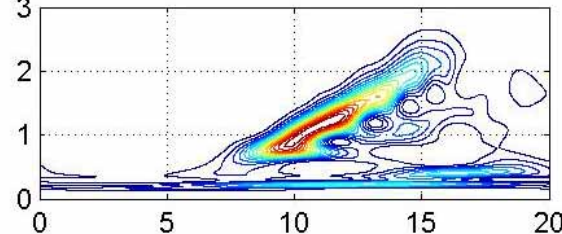
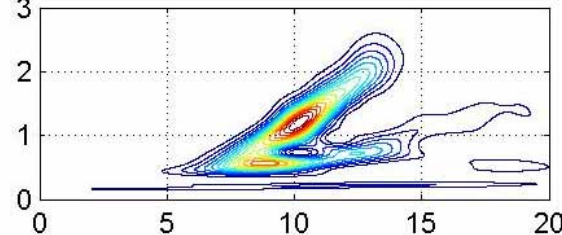
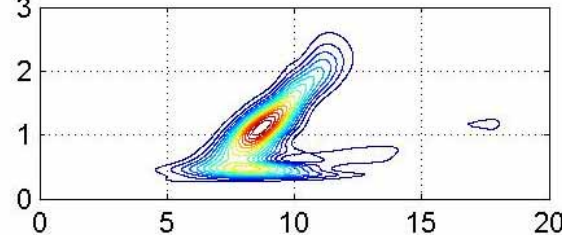
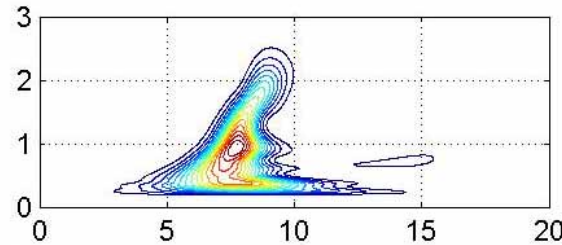


Surface elevation

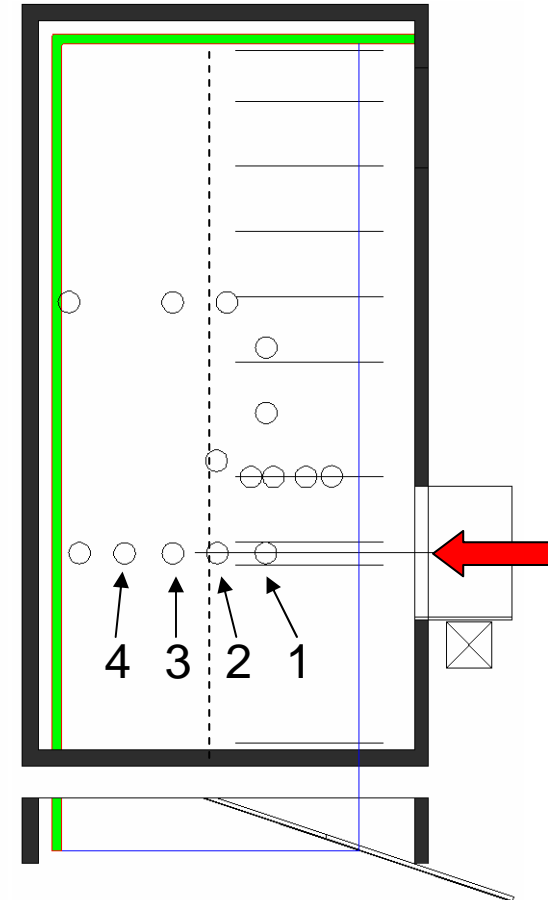


Time

Frequency

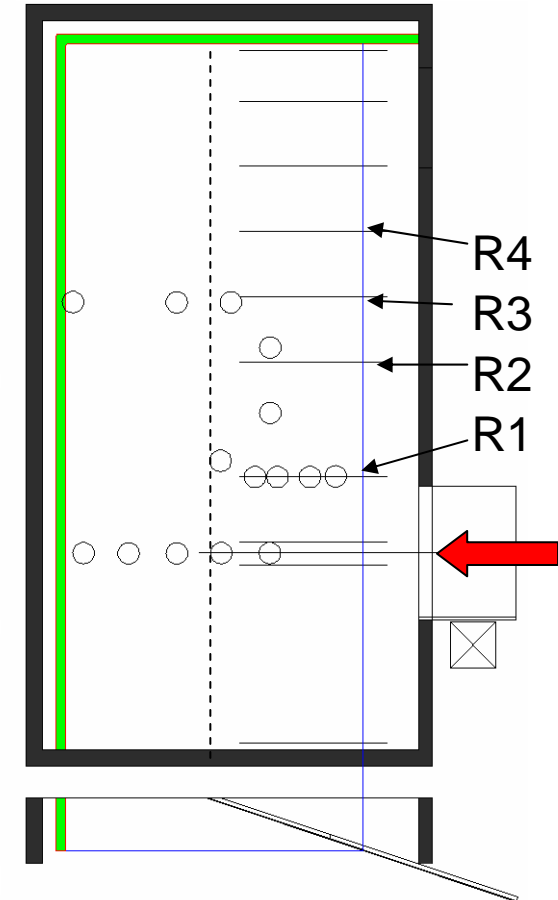
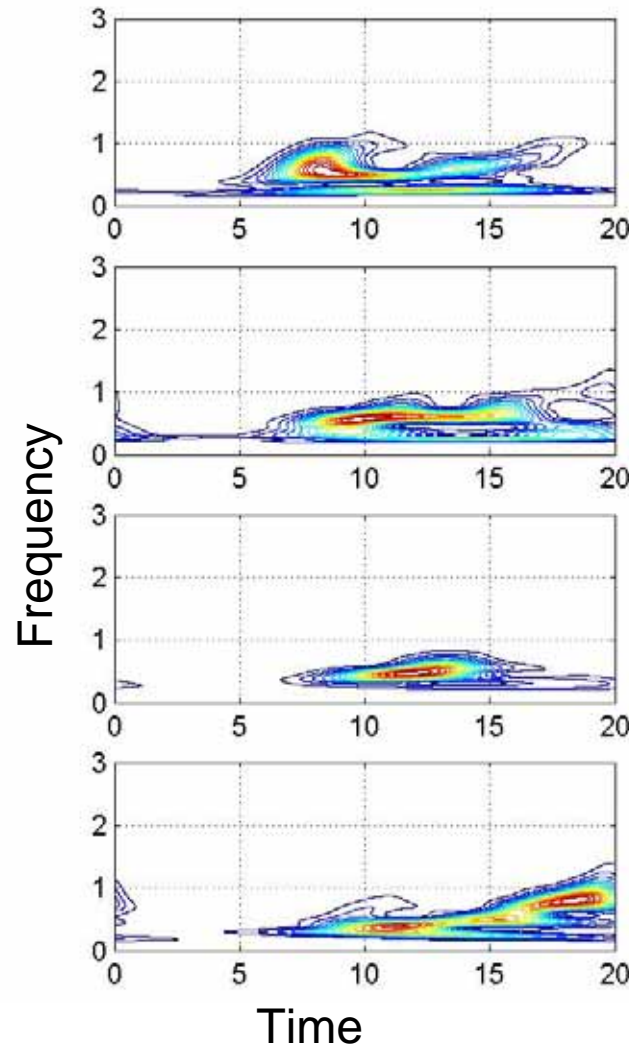
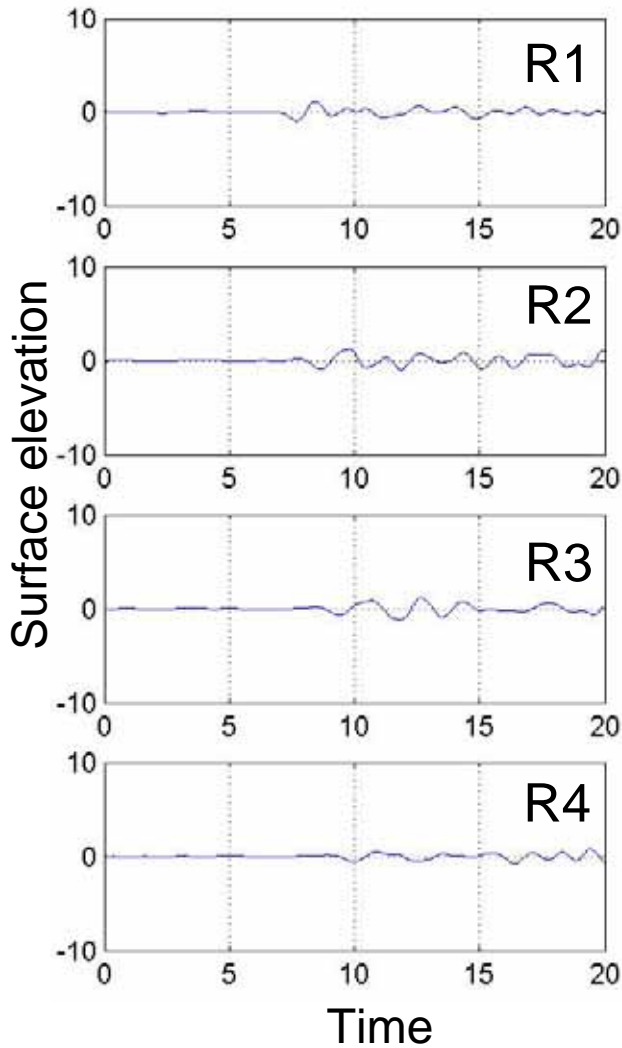
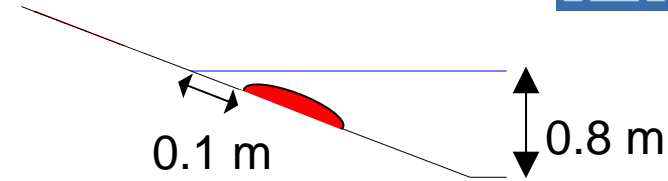


Time



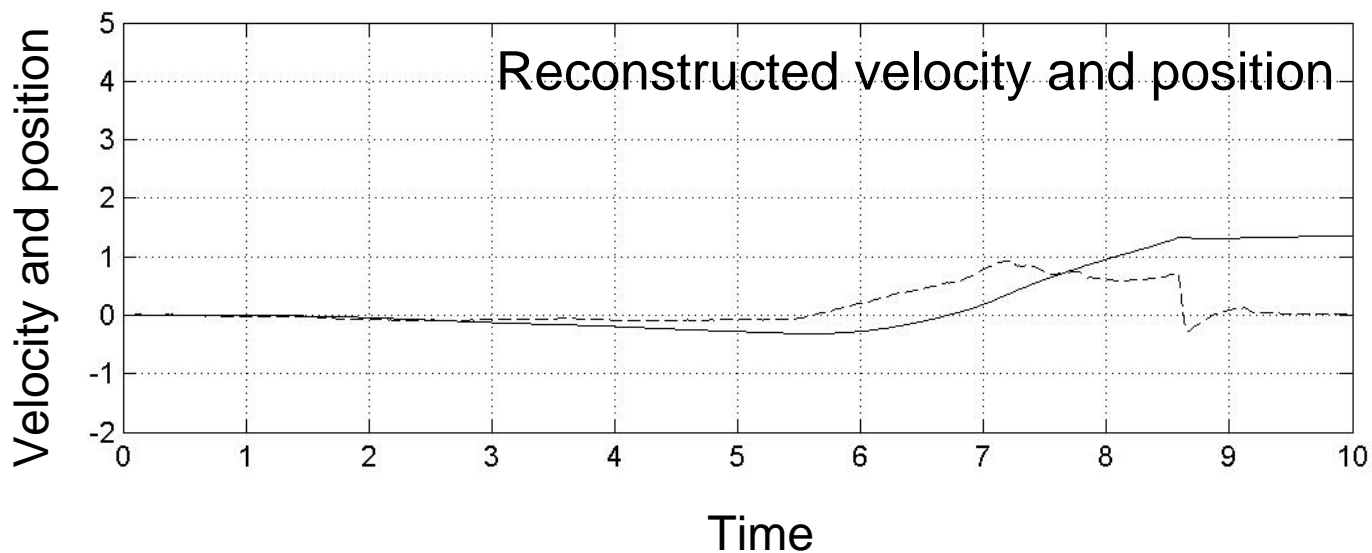
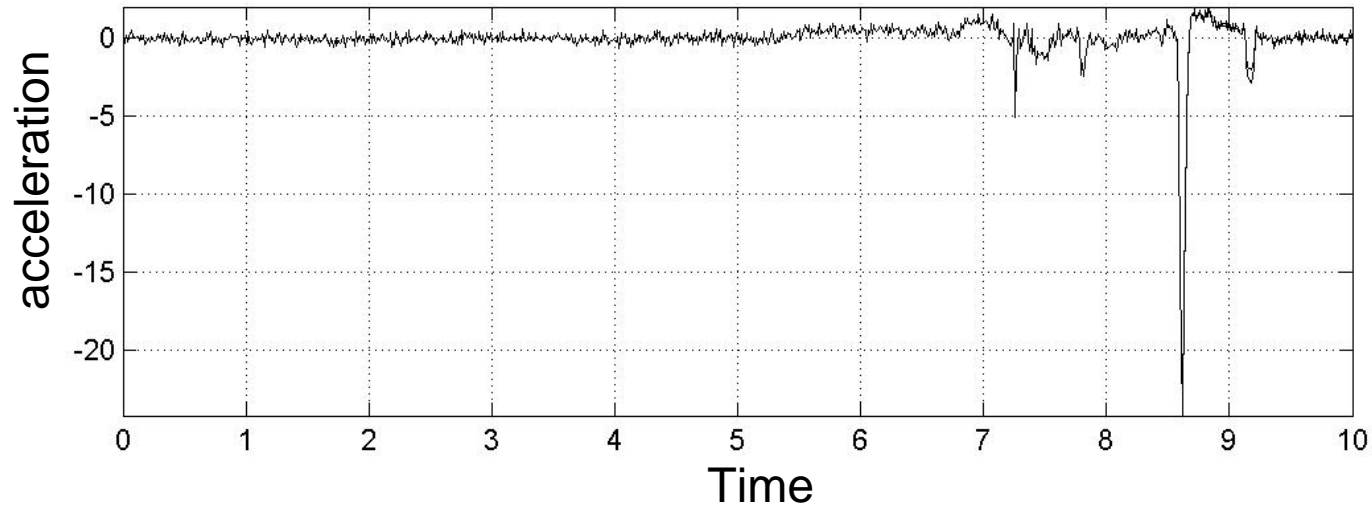
# Preliminary results-7

Run up gauges



# Preliminary results-8 Accelerometer

data  
Recorded acceleration



# Conclusions

- We are carrying out new experiments on tsunamis generated by a landslide along a sloping straight coast
- Instruments are used to record the acceleration of the landslide, the surface elevation and the run up at selected points in the tank
- We just started the test program and performed the first analysis
- The position of some of the run up gauges will be modified-we shall use a new accelerometer
- A video camera will be probably used to measure run up behind the landslide