Experimental Assessment of the Two-Phase Flow in a Large Inclined Channel

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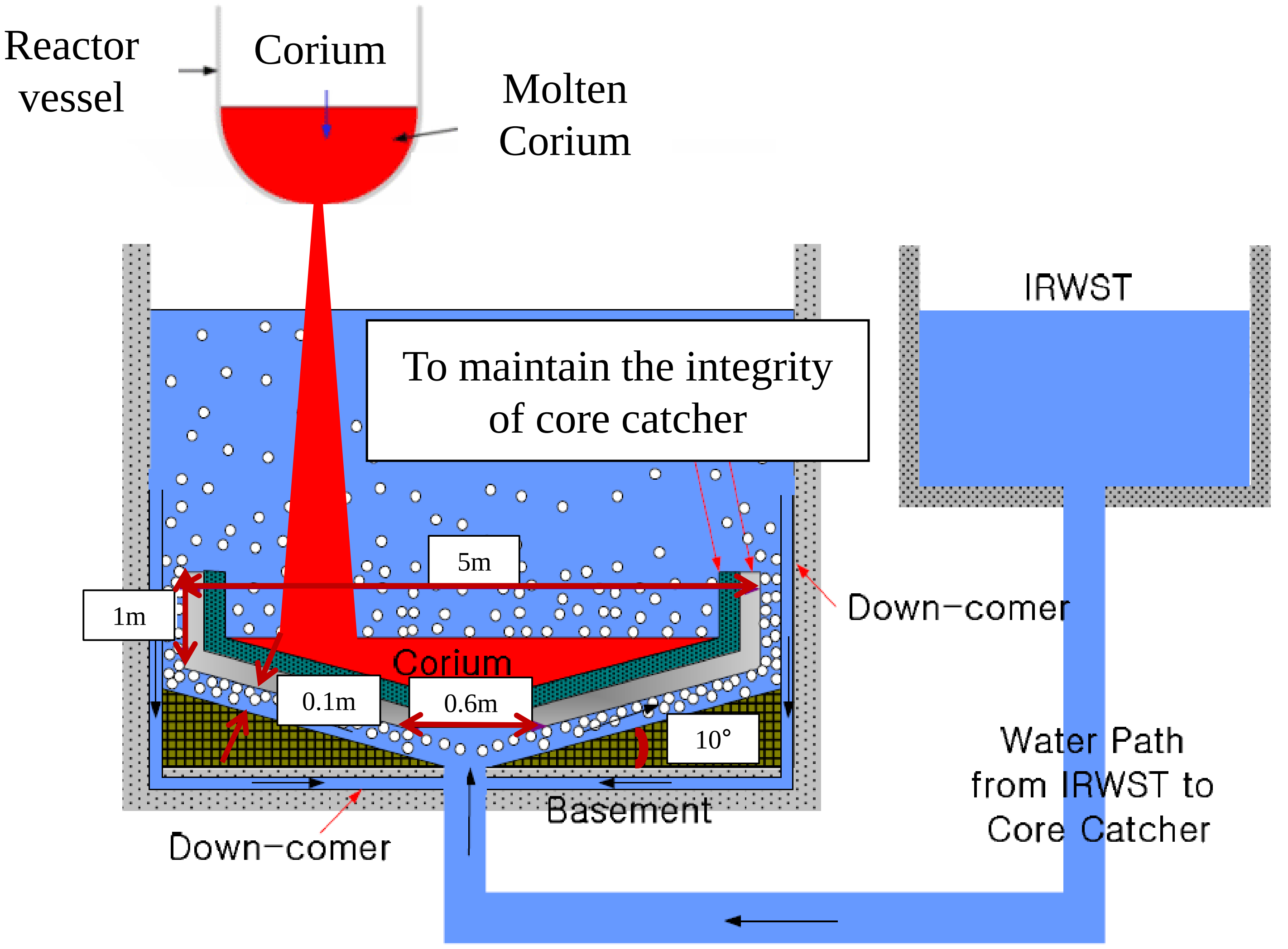
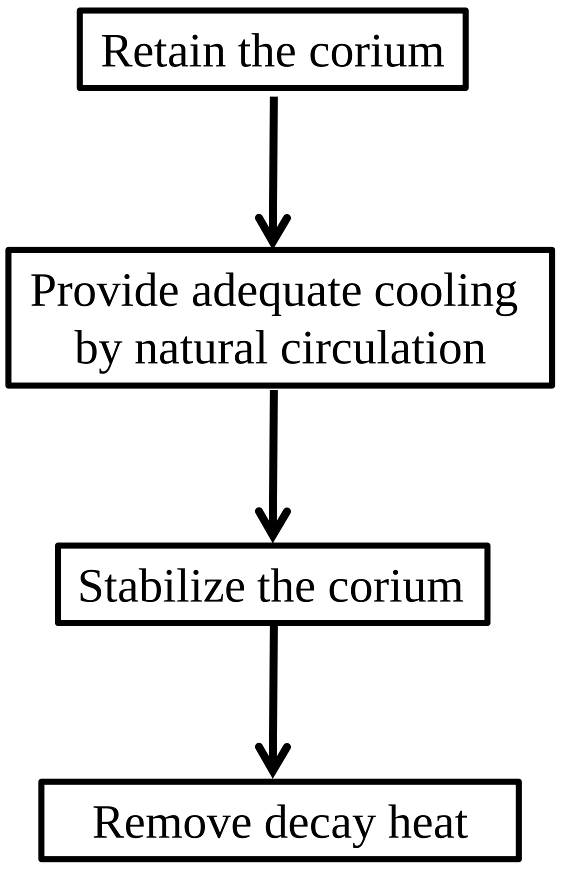
CONTENTS

I. Introduction

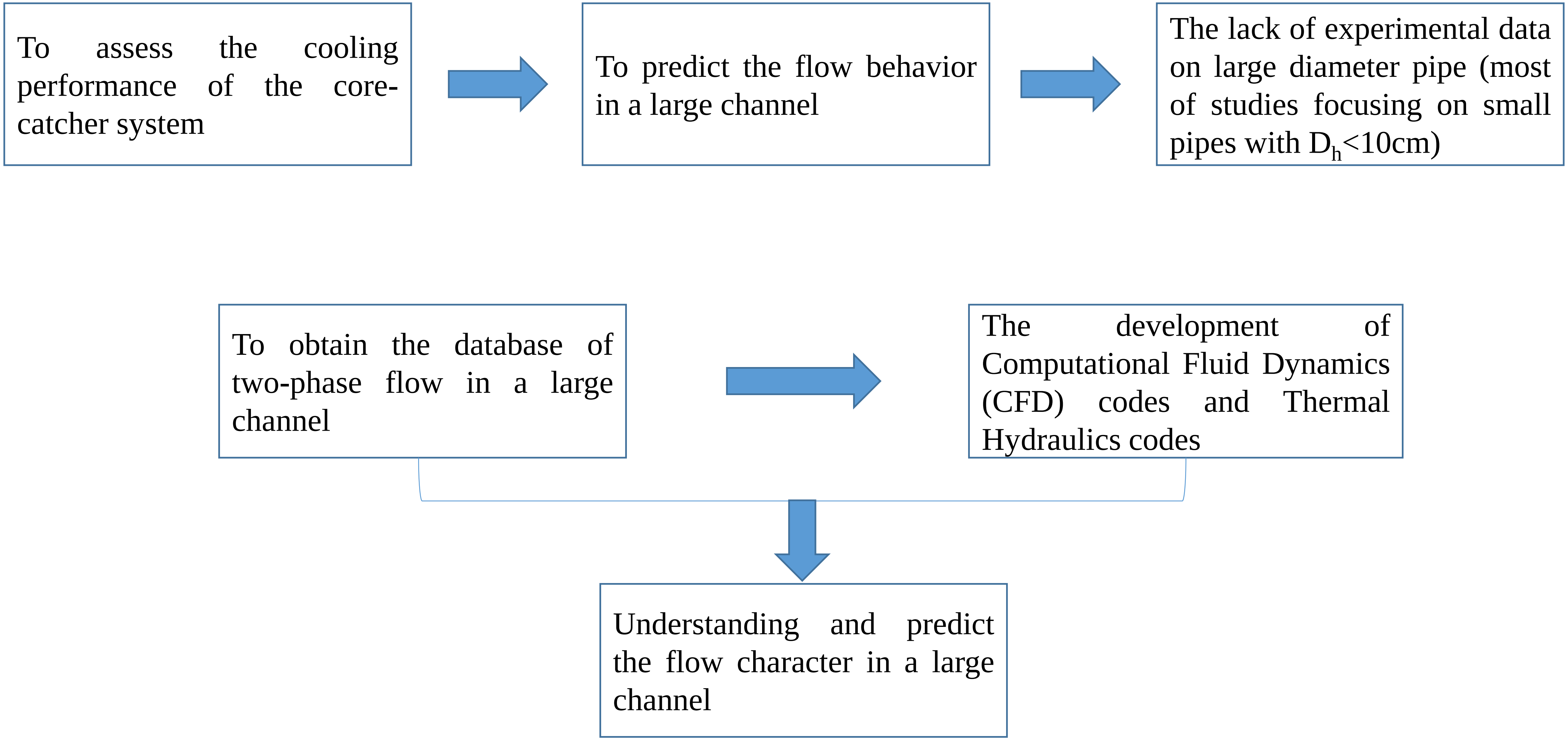
- Core catcher system in APR1400





Kwang Soon Ha et al. PREDICTION OF BOILING-INDUCED NATURAL CIRCULATION FLOW IN AN INCLINED CHANNEL WITH NON-UNIFORM FLOW AREA. 2011.

I. Introduction



II. Research objective and scope

OBJECTIVE

Investigation of the two-phase flow characteristics in the large rectangular channel

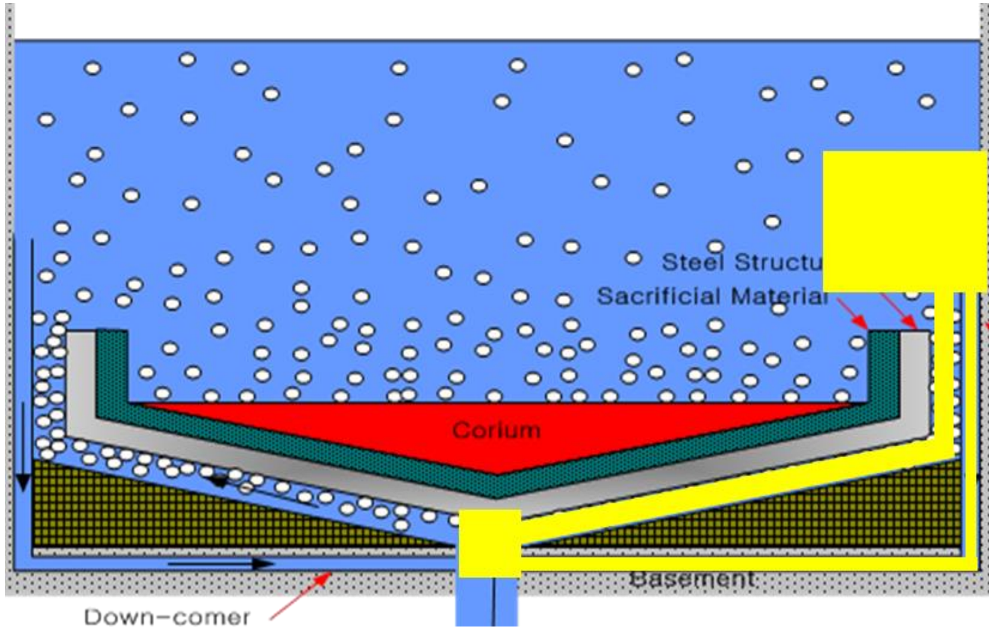
SCOPE

Observing the **local flow structures** and **gas phase behavior** in a **large rectangular channel** through visualization and measurement. The flow parameters of interest consists of:

- Local void fraction and its distribution
- Local bubble velocity
- Bubble chord length

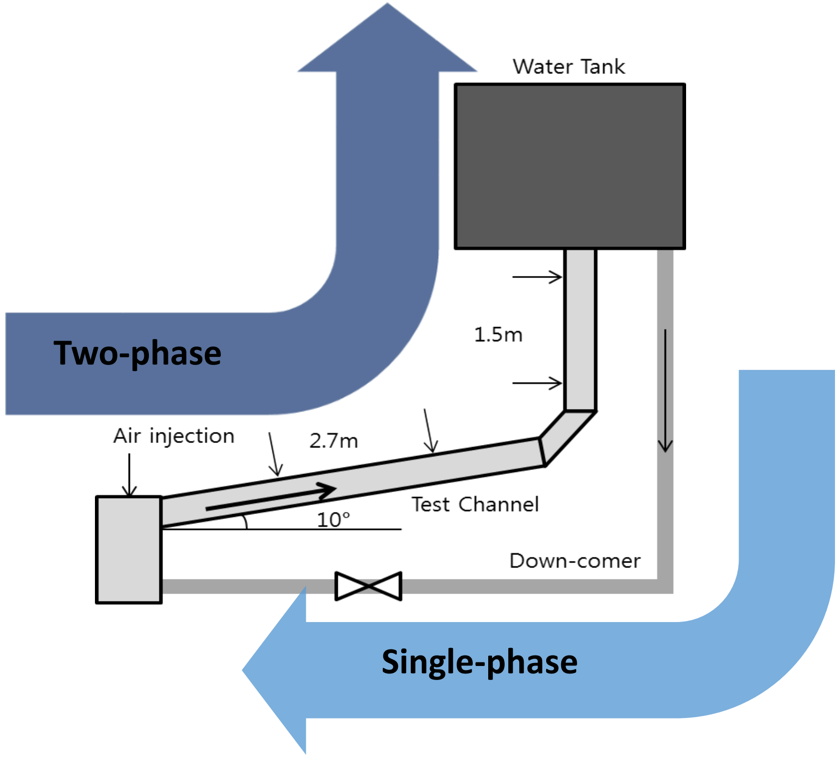
III. Experimental facility and measurement devices

- Core catcher model facility



Prototype

Channel area: 0.1m x 16m

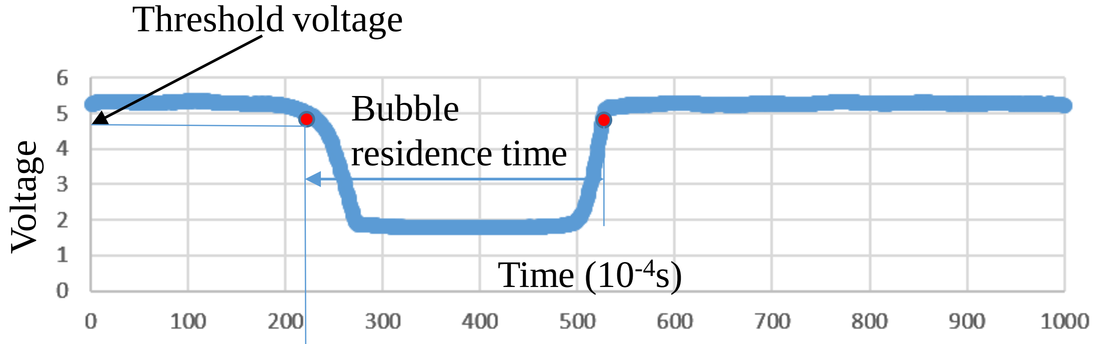


Model facility

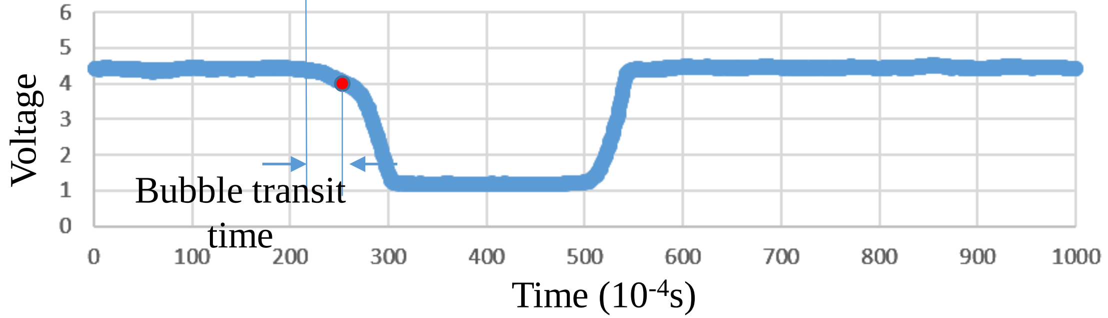
Channel area: 0.1m x 0.3m

III. Experimental facility and measurement devices

1. Double conductivity probe (10000 samples/sec)



Raw signal of the front tip



Raw signal of the rear tip

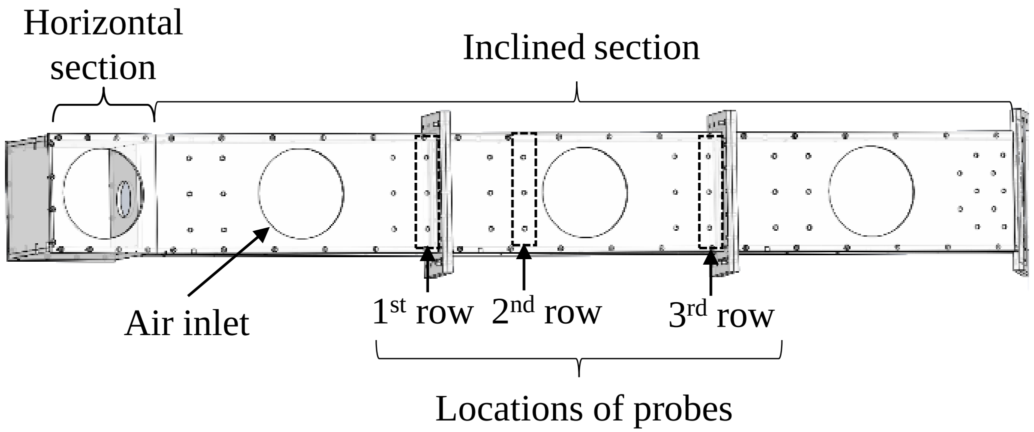
- Local void fraction
- Bubble velocity
- Bubble chord length

2. High speed camera (1000 frames/sec)

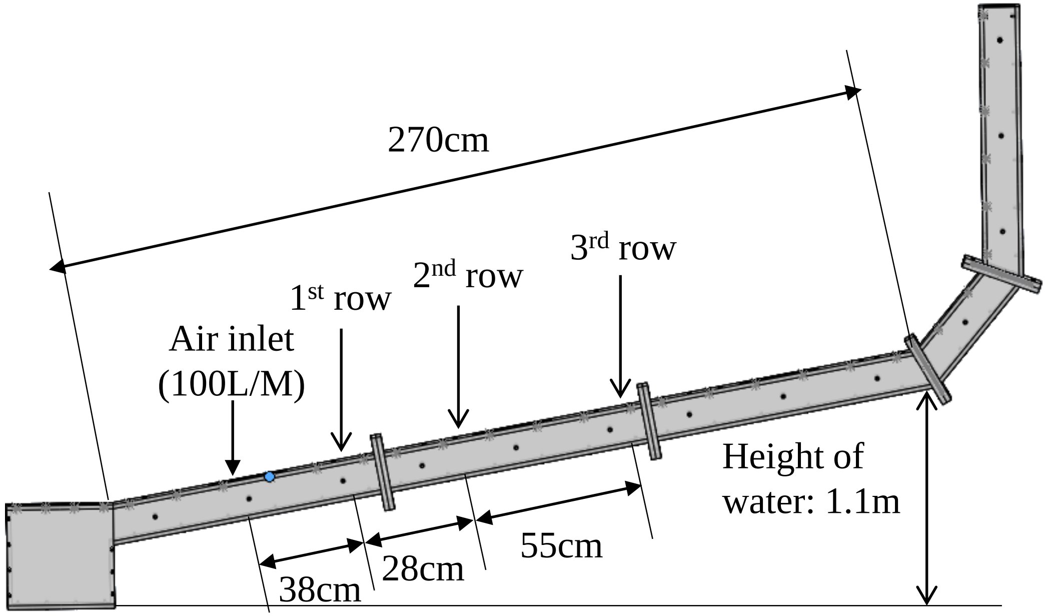
- To observe flow regimes

IV. Experiment and results

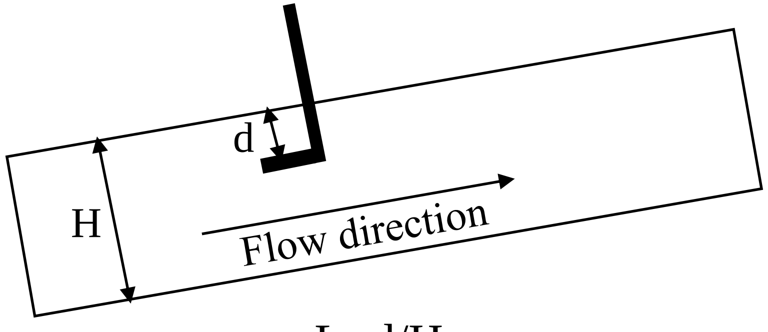
1/ Experiment A



Probe setup (from the top view)



Probe setup (from the side view)



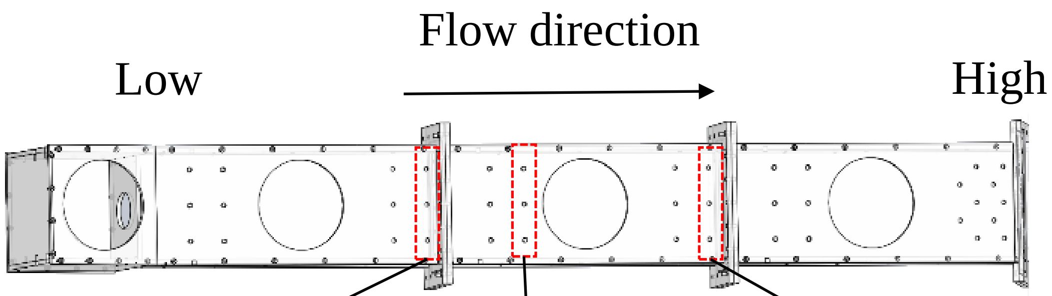
L=d/H

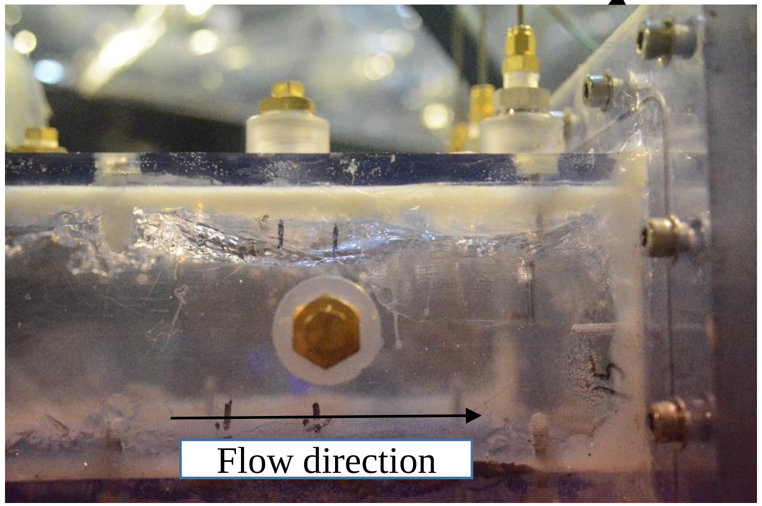
- At each location, a probe was translated to measure local flow parameters
- The data was obtained at 10000 samples/sec in 30 sec and 10 repetitions

IV. Experiment and results

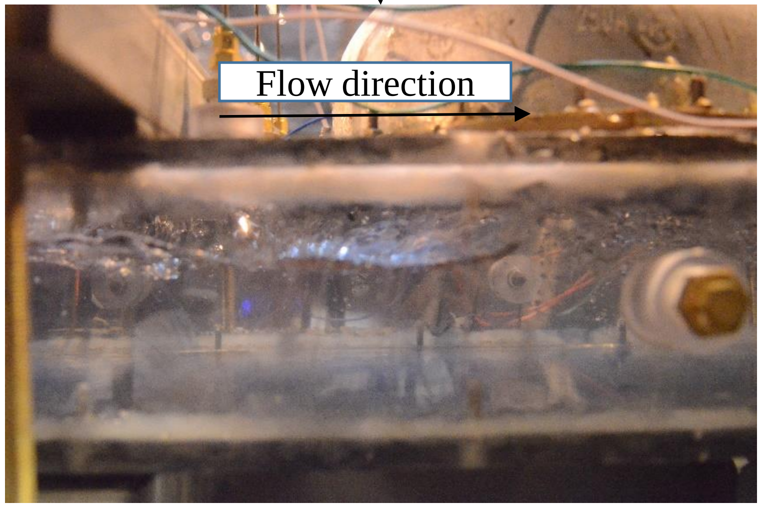
1/ Experiment A

- Flow regime

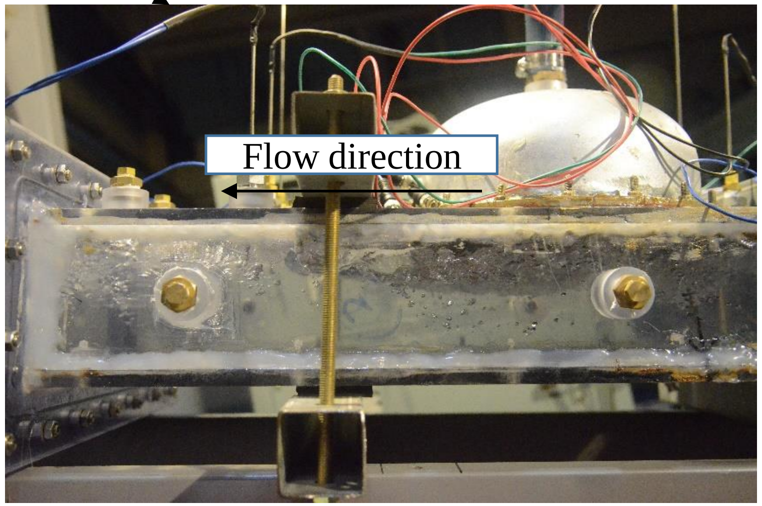




Row I



Row II

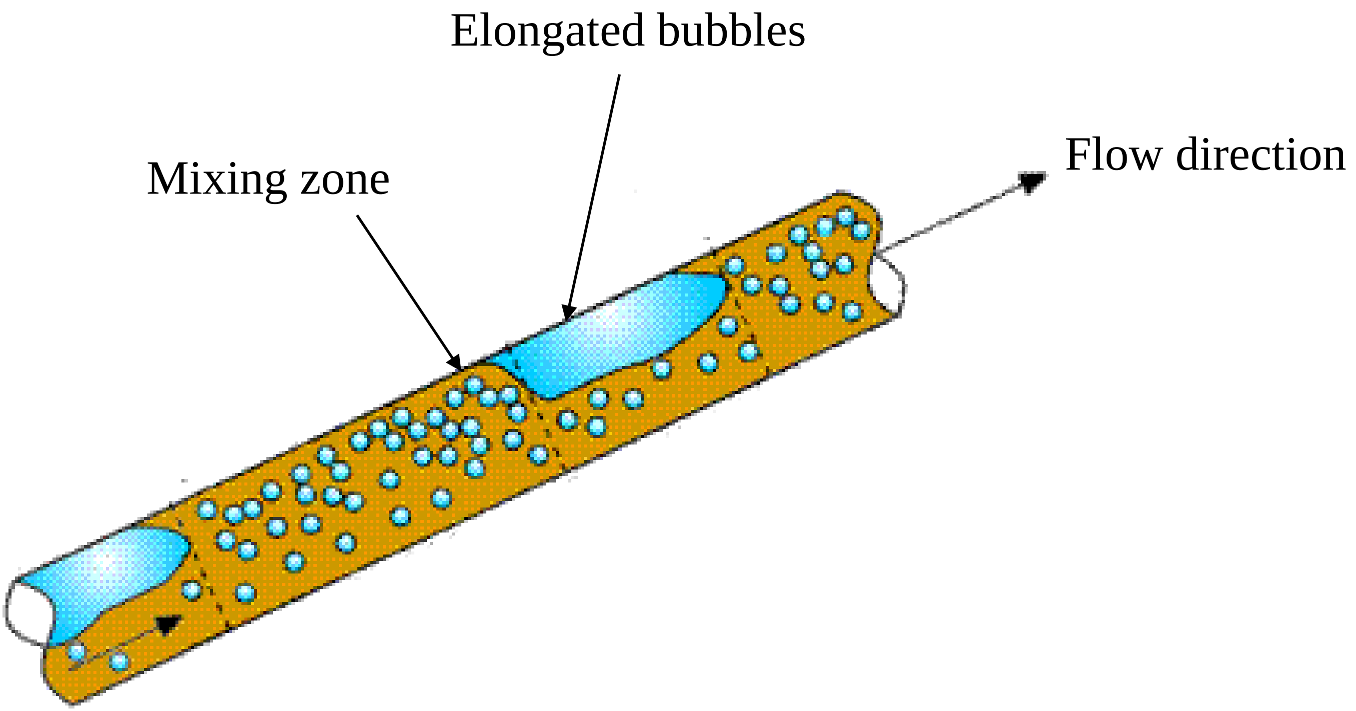


Row III

IV. Experiment and results

1/ Experiment A

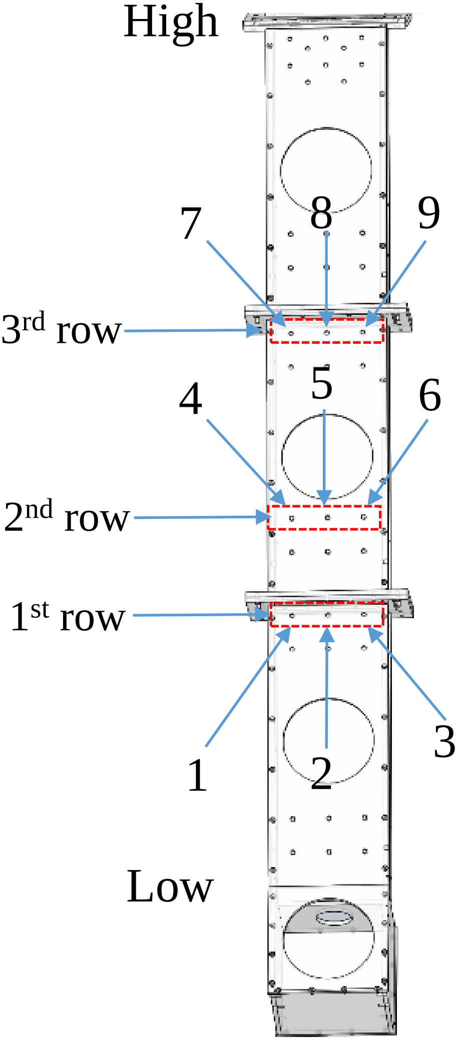
- Flow regime



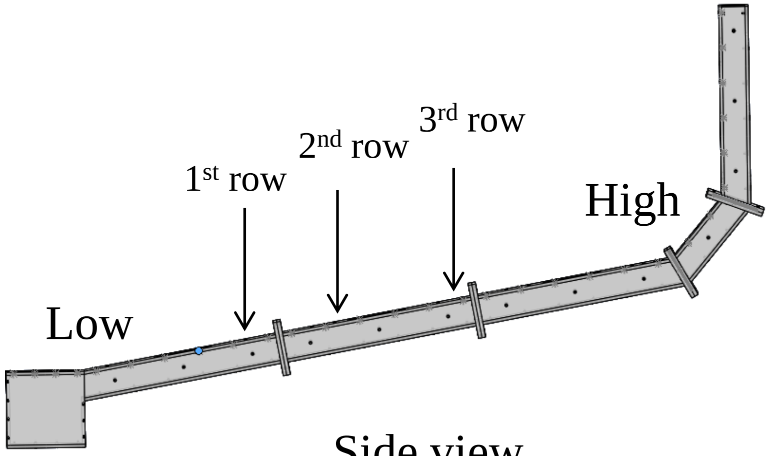
IV. Experiment and results

1/ Experiment A

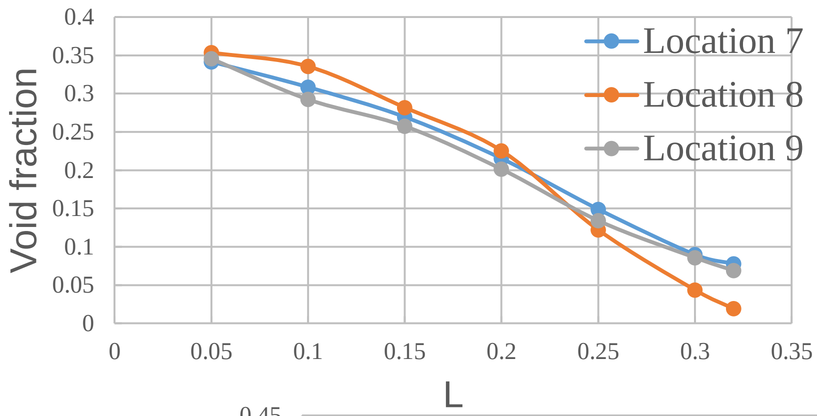
- Local void fraction

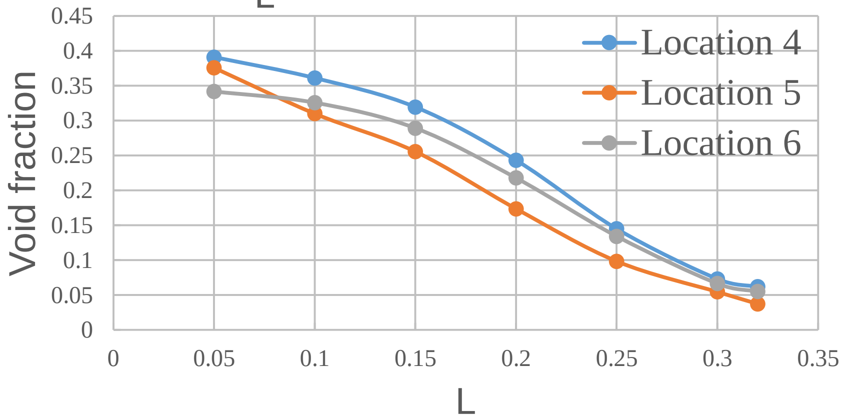


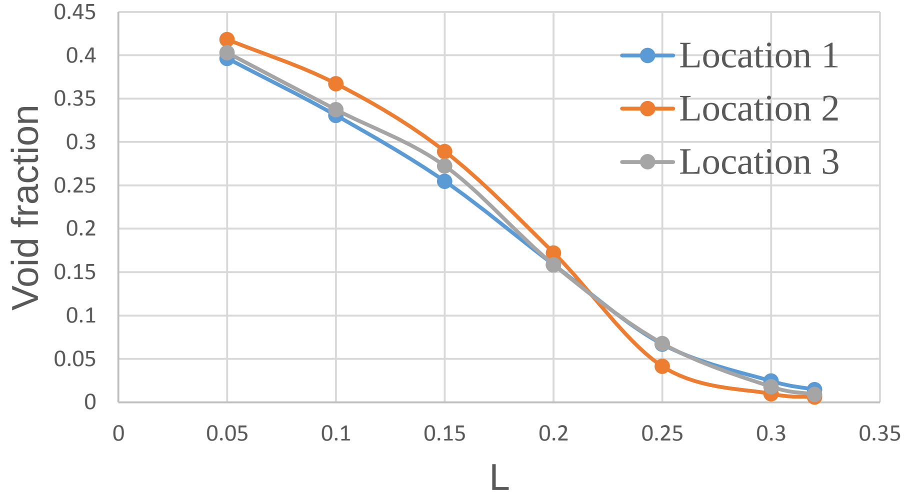
Top view



Side view



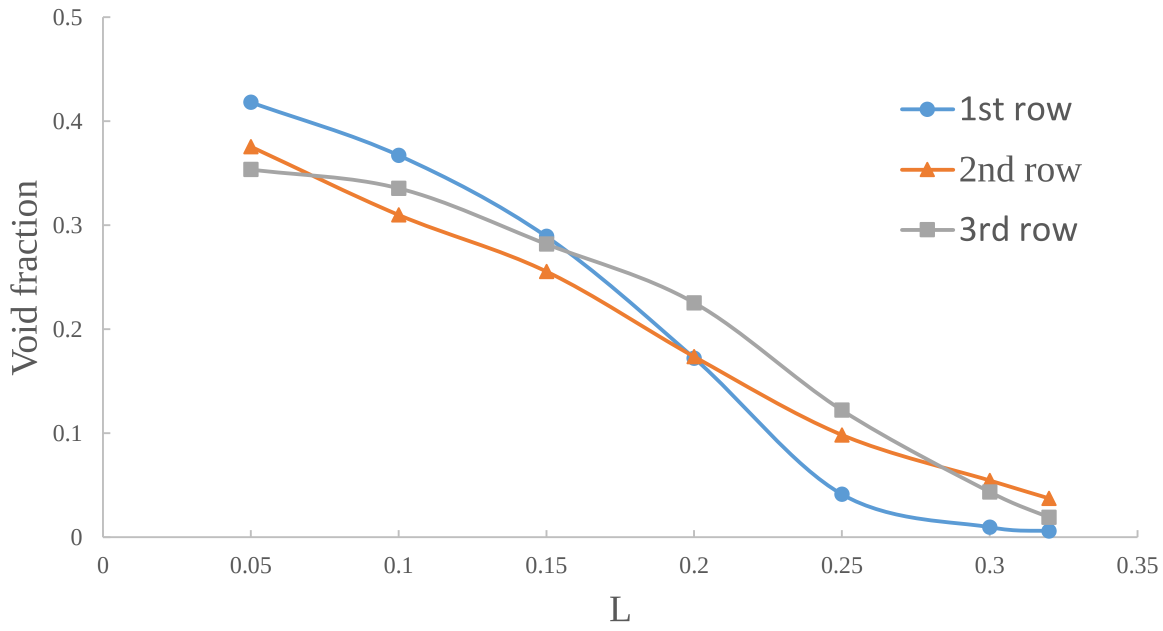




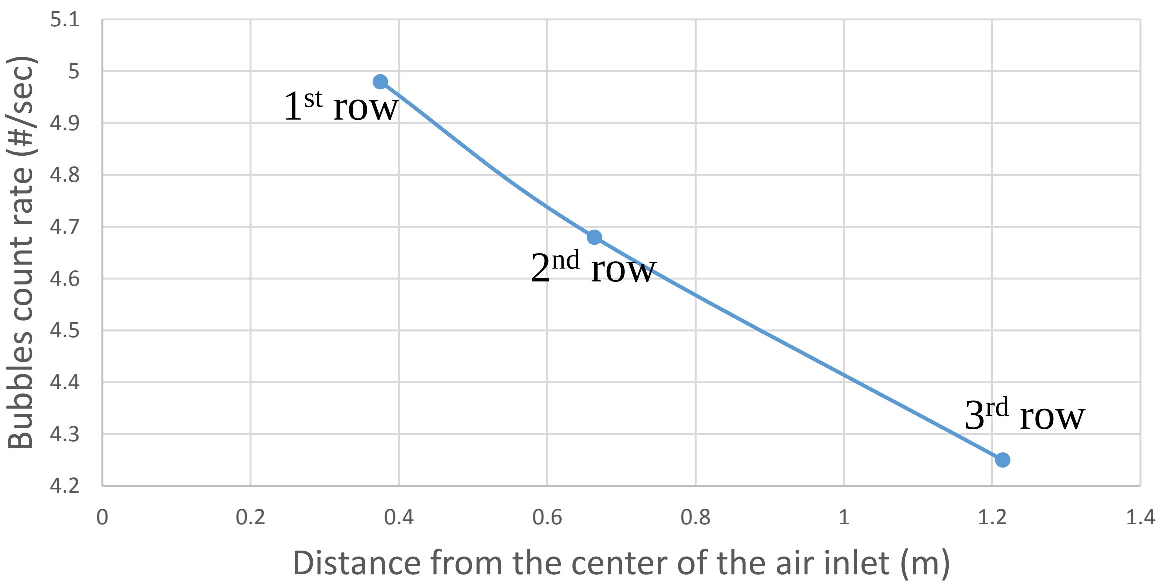
IV. Experiment and results

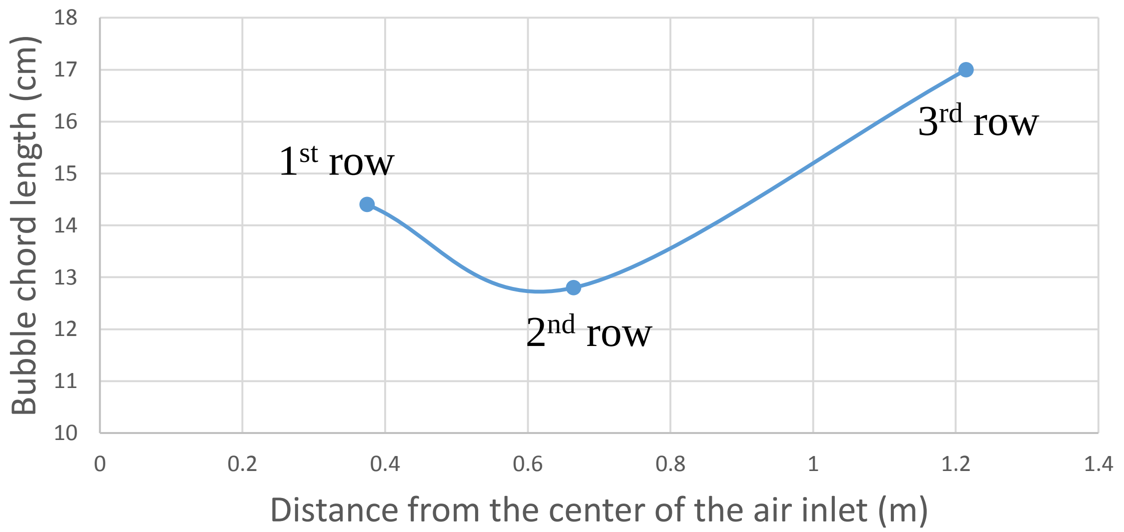
1/ Experiment A

- Local void fraction



Void fraction at the center of each row



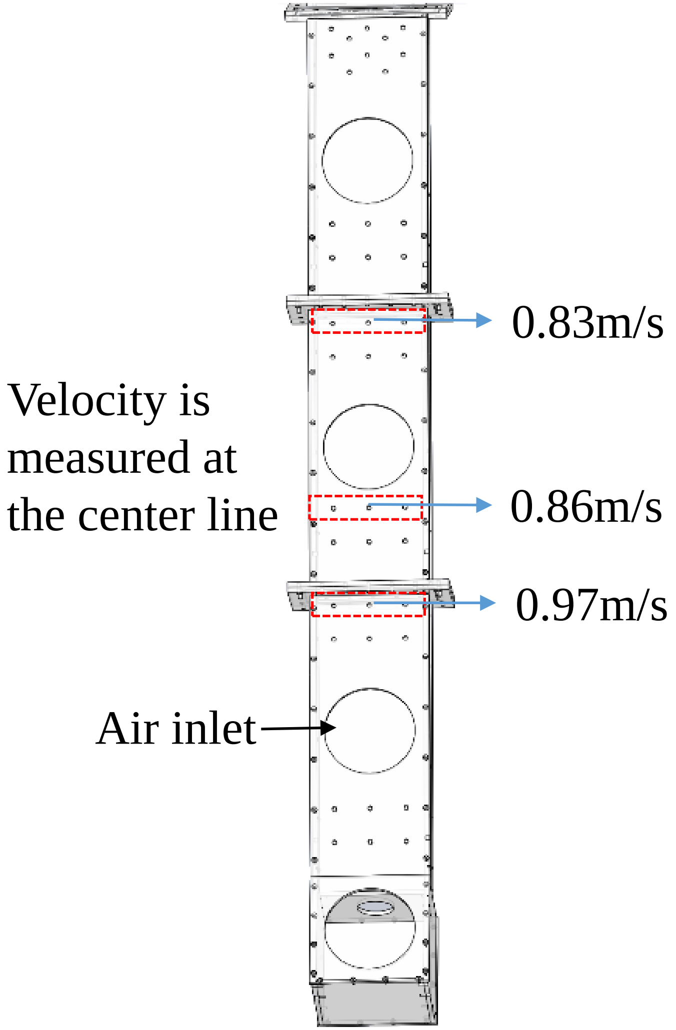


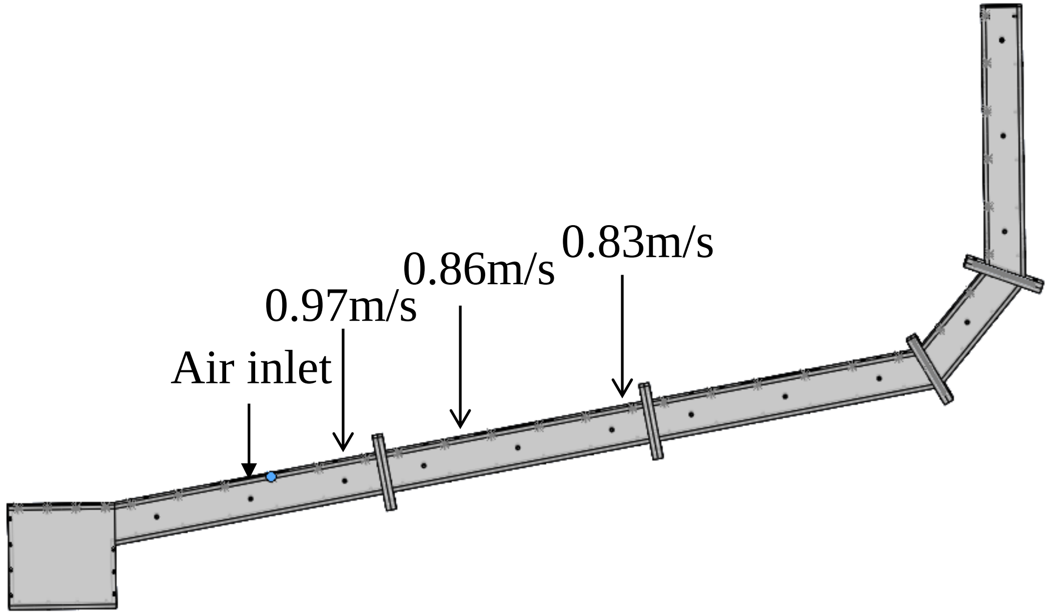
➡ Because of bubble coalescence, bubbles at higher positions are bigger and longer than the ones at lower positions.

IV. Experiment and results

1/ Experiment A

- Bubble velocity measured by probes (L=0.03)

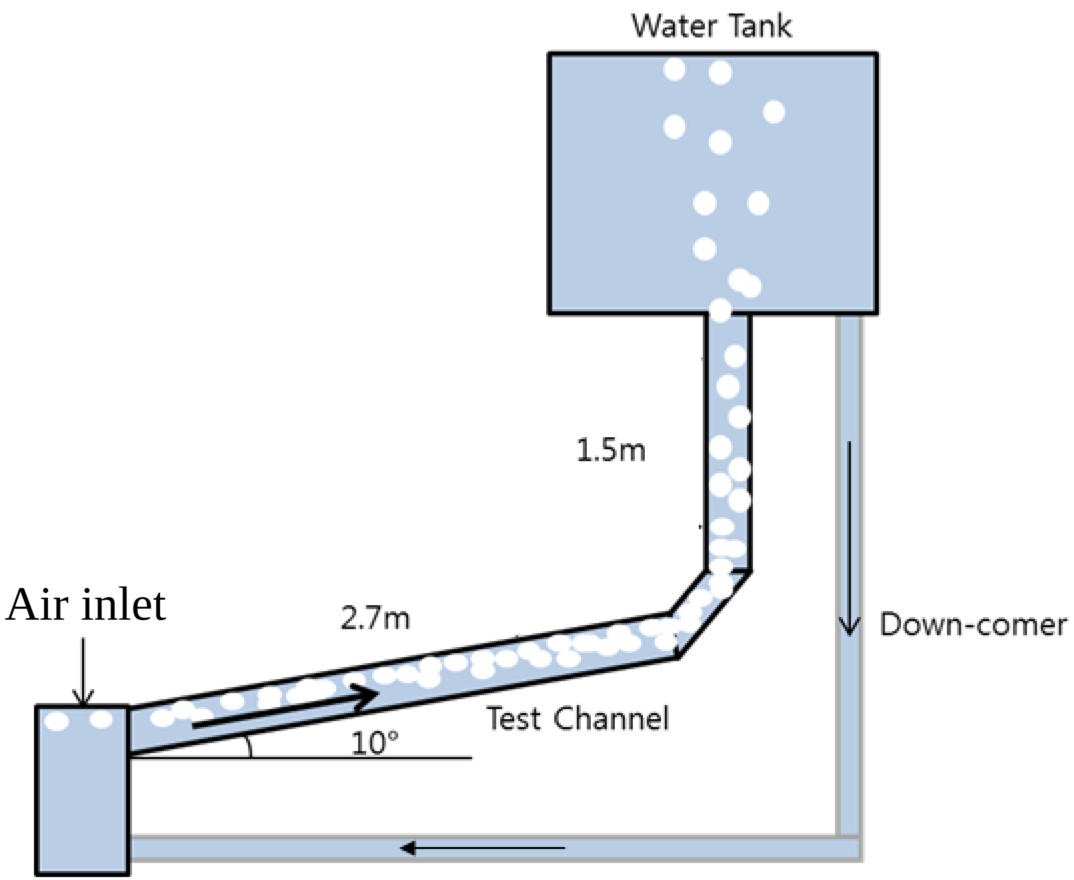




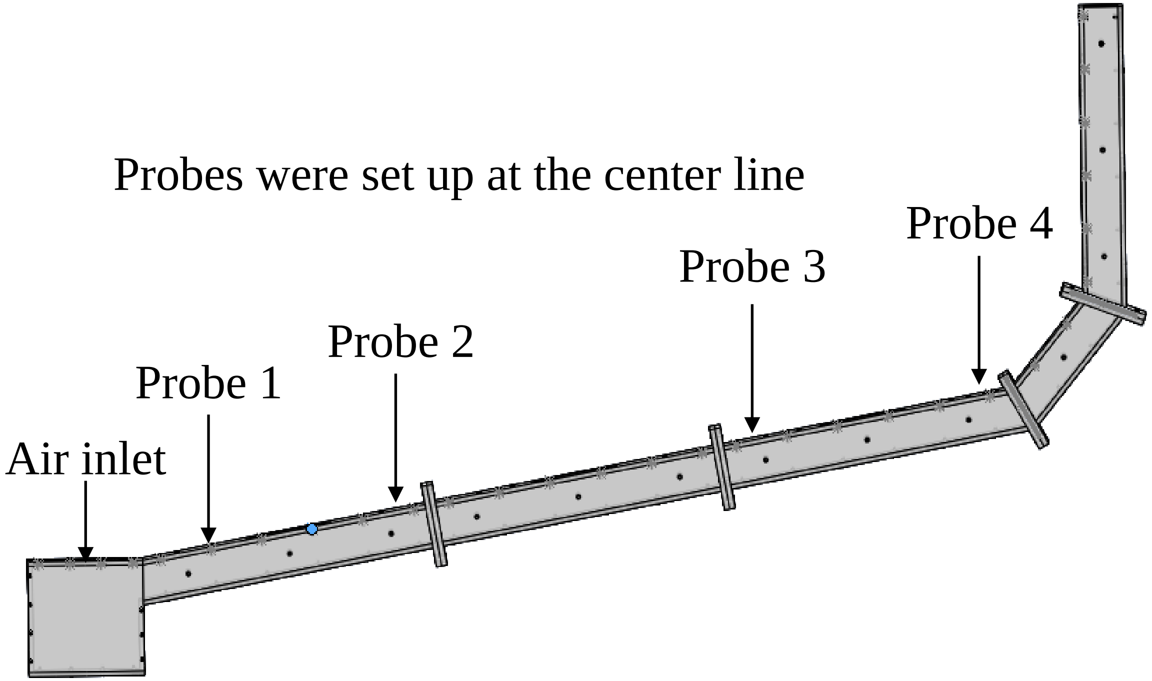
As becoming larger, bubbles move slower

IV. Experiment and results

2/ Experiment B



Probes were set up at the center line



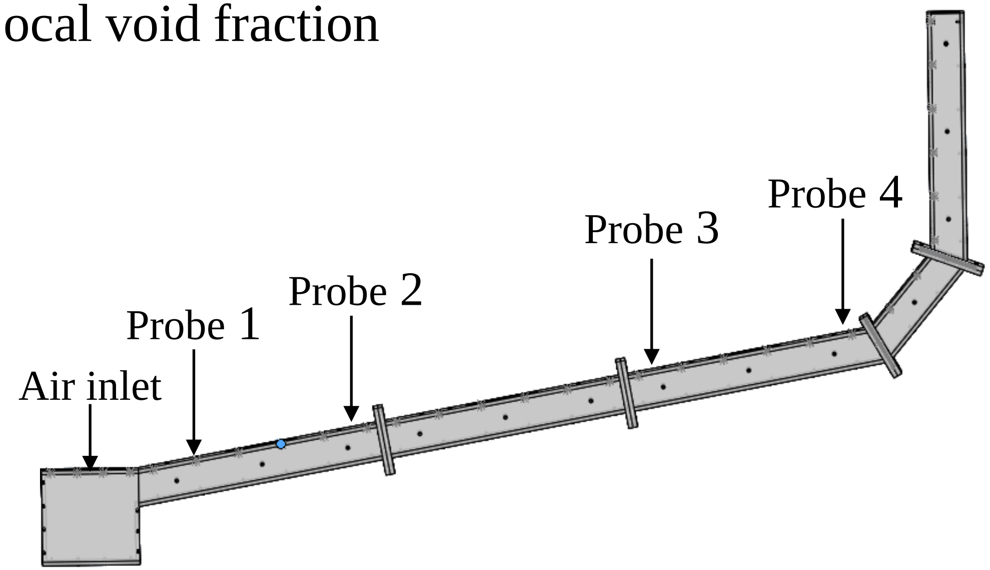
Volumetric flow rate	Gas superficial velocity (j_g)
100 liters/min	0.033m/s
129.6 liters/min	0.0432m/s
153.6 liters/min	0.0512 m/s

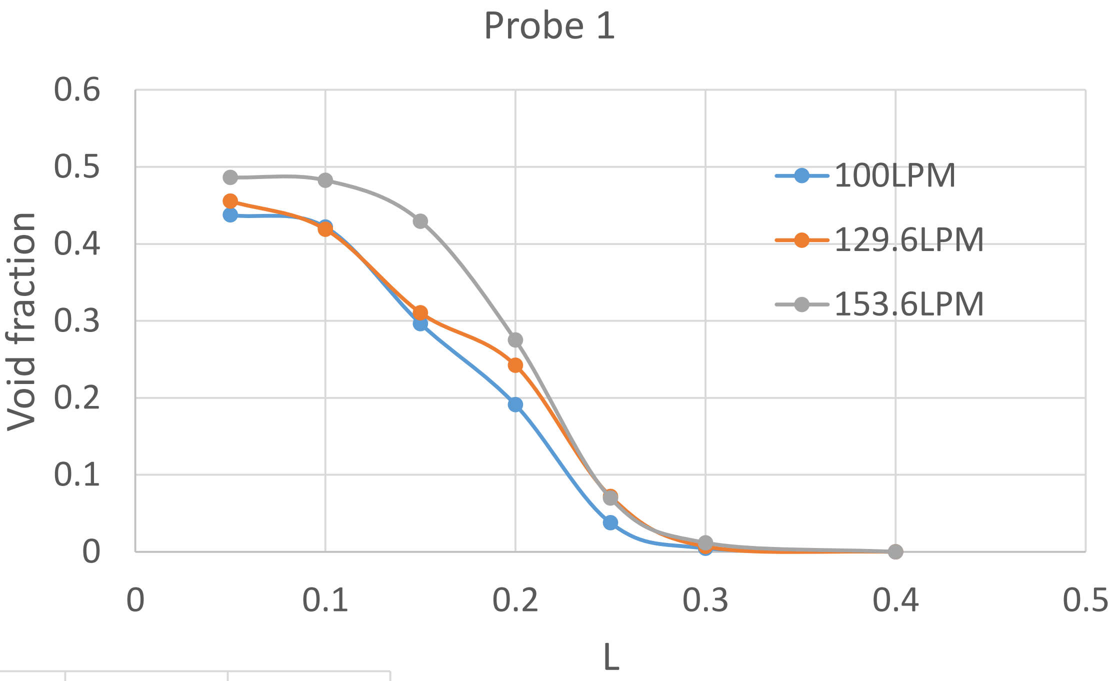
Air inlet condition

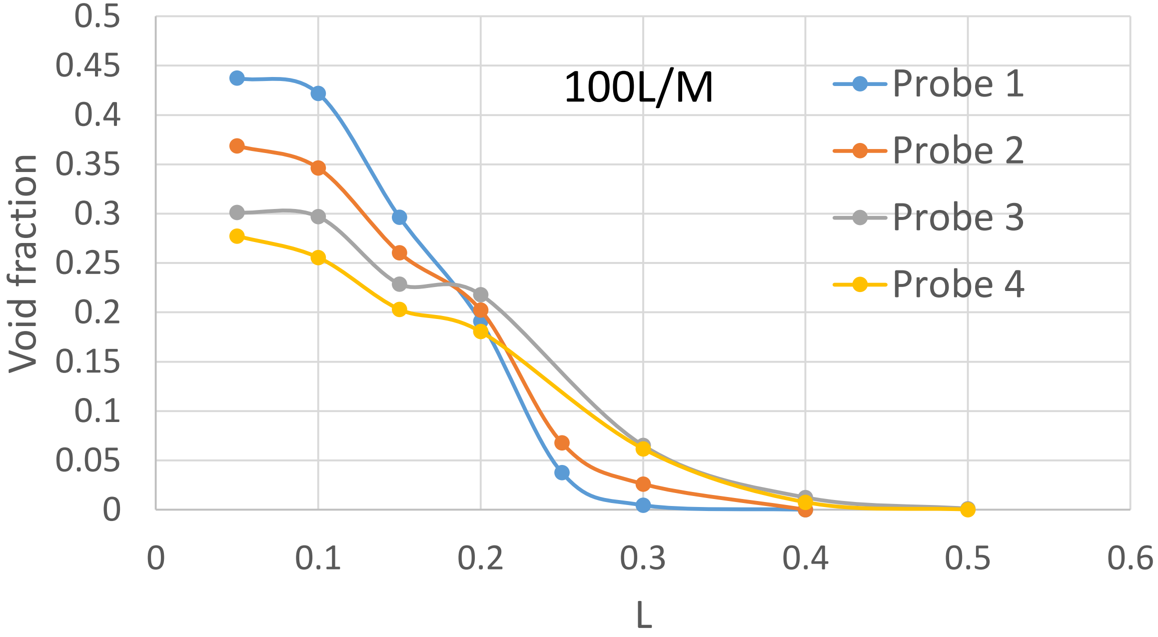
IV. Experiment and results

2/ Experiment B

- Local void fraction



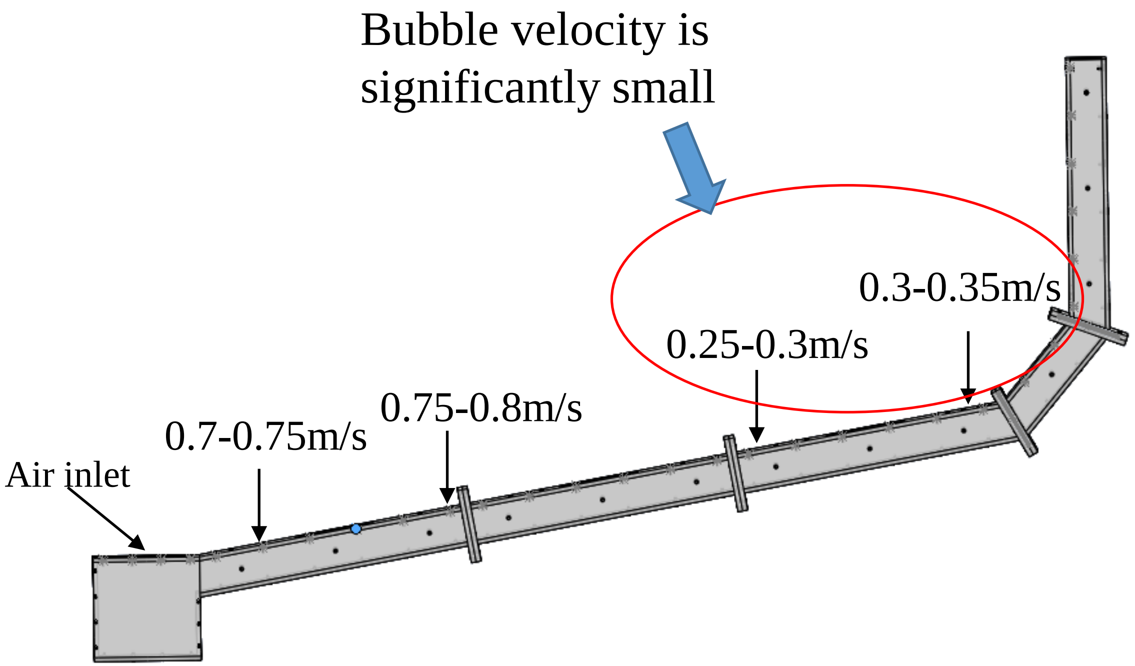


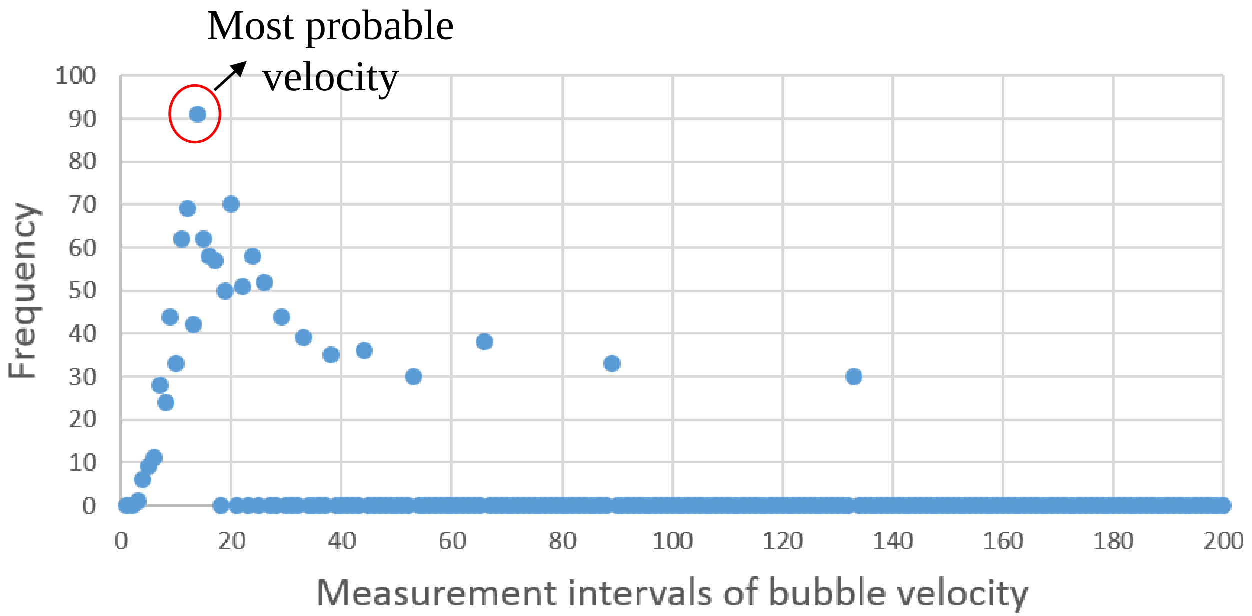


IV. Experiment and results

2/ Experiment B

- Bubble velocity (L=0.03)



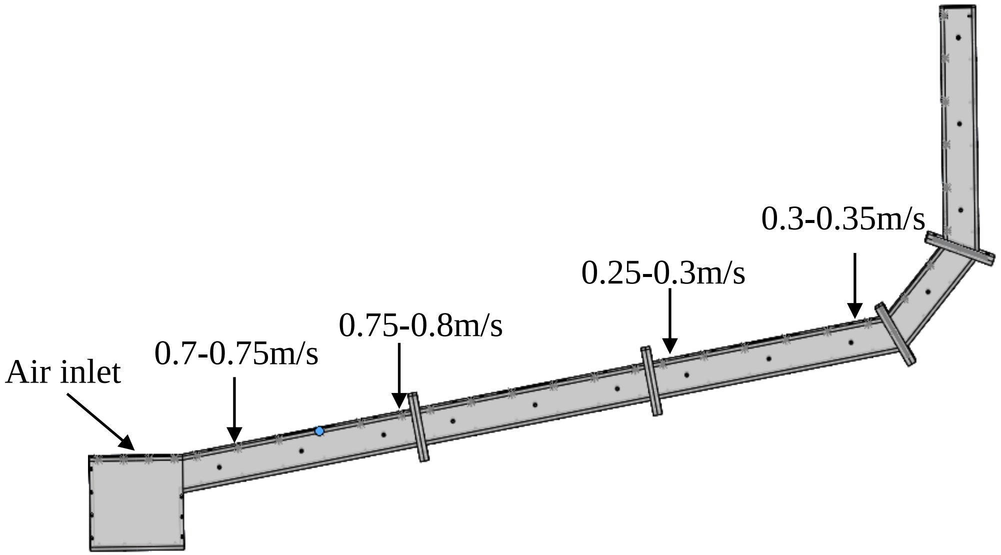


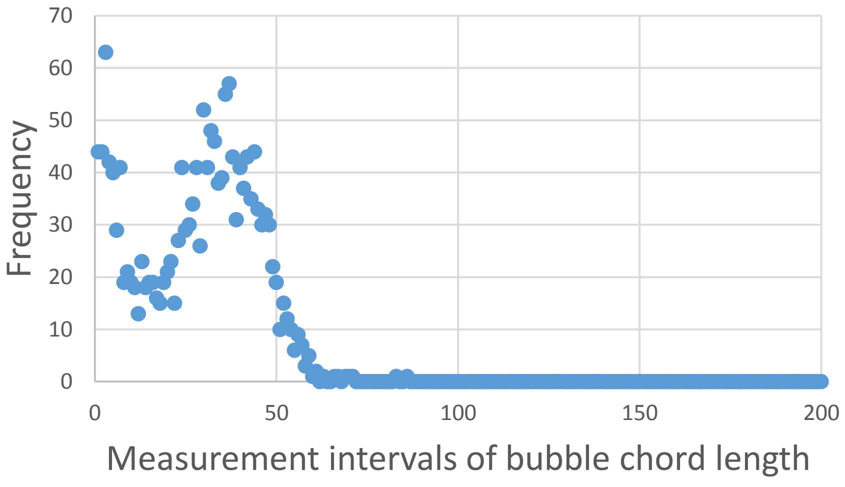
Velocity distribution at probe 1

IV. Experiment and results

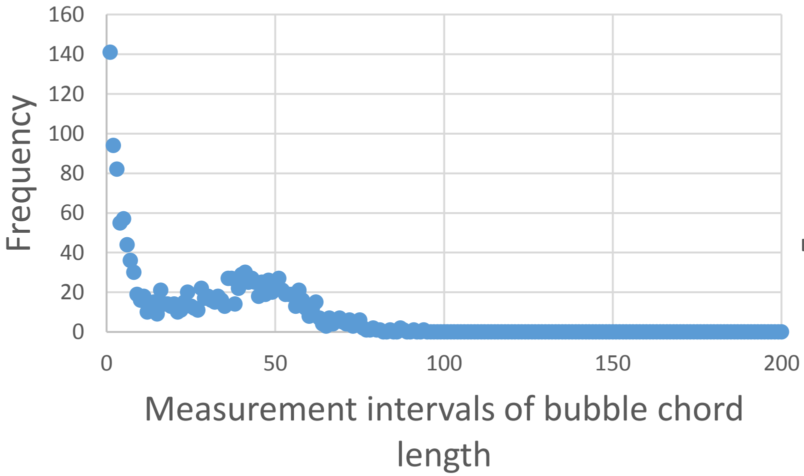
2/ Experiment B

- Bubble chord length distribution (L=0.03)

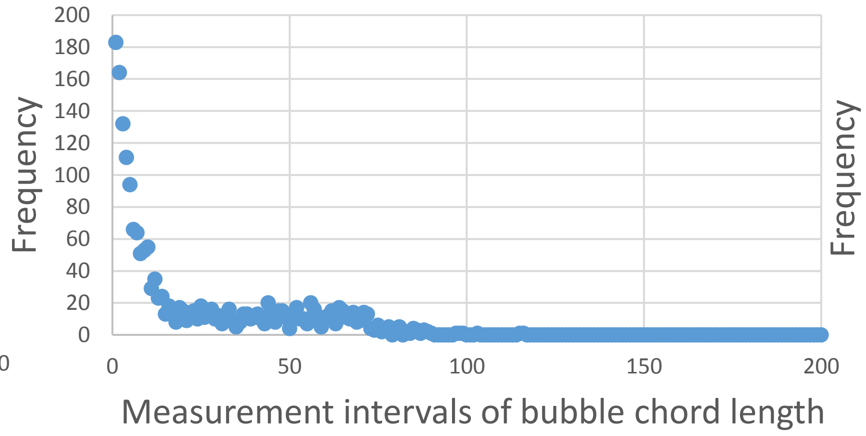




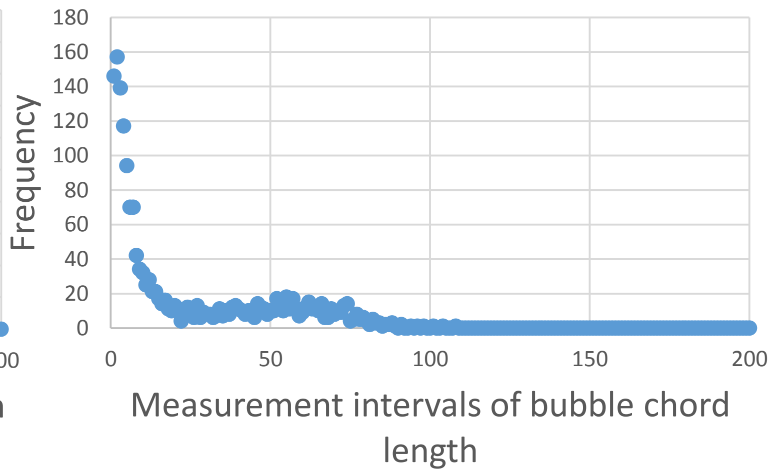
Bubble chord length distribution at probe 1



Bubble chord length distribution at probe 2



Bubble chord length distribution at probe 3



Bubble chord length distribution at probe 4

V. Conclusions

1. The data sets of the structure of two-phase flow in the large rectangular channel was acquired.
2. The plug flow occurs in the channel which results in most bubbles attached to the top surface wall.
3. The result of local void fraction profiles at different locations indicates that the void distribution primarily changes because of the concentration of bubbles near the top of the channel. The bubble breakup and coalescence impact the local void fraction at different locations along the channel.
4. Increasing gas injection flow rate not only results in the rise of local void fraction but also the change of its distribution pattern.
5. The bubble velocity measured by double conductivity probes was strongly affected by the size of bubbles and the existence of small turbulent bubbles especially at the positions far from the air inlet.
6. The bubble chord length distribution indicated the different sizes of bubbles at a specific location. The small bubbles (chord length<1cm) have considerable effect on the flow parameters.

THE END

THANK YOU FOR YOUR ATTENTION