



# **Towards an improved understanding of the interaction between multiphase flowmeter and testing flow loops**

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# Outlines

- Background of the study
- The testing scenario
- Results and discussion
- Summary of findings



# Background of the research

MPF regimes:

- the **primary factor** influencing the references and metering performance;
- closely related to **the manner of fluids introduced to and leaving** the channel/section



# Background of the research

- Aim: a better understanding of the **interaction between testing flow loops and MPFM** and how the flow regimes are affected
- A WP of EMRP project **MultiFlowMet**, **which is a** supporting study for generating a **MPFM International Standard**



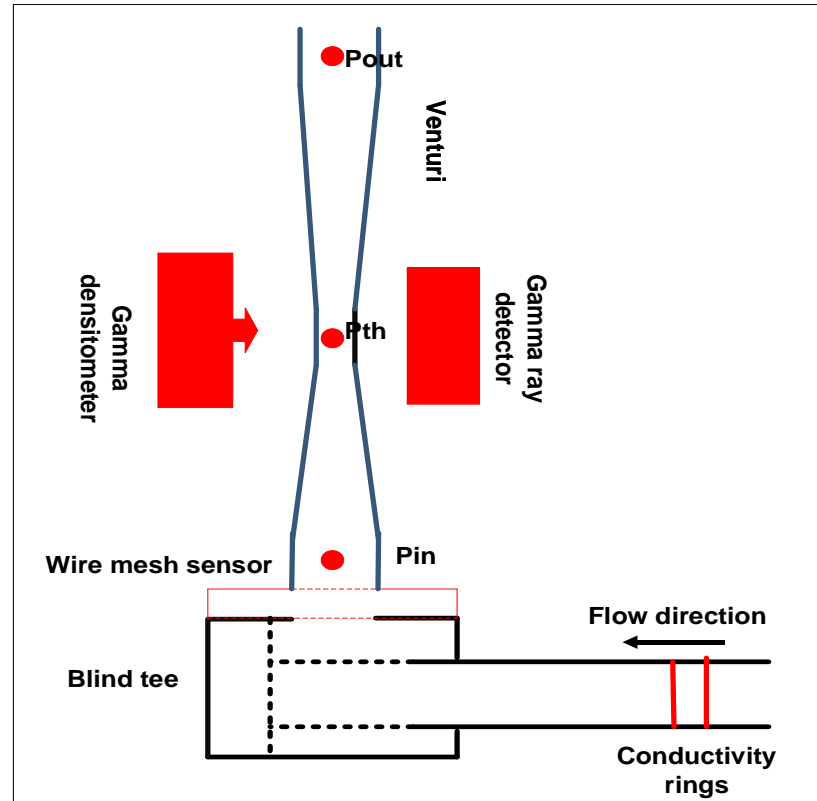
# Background of the research

- Experimental investigations: lab tests and dataset generation
- CFD modelling and simulation (led by Dr P Verdin)

# Testing scenario: MPFM, Air/water tests

Venturi Multiphase Flow meter (VMPFM) (Vertical)  
Measurements:

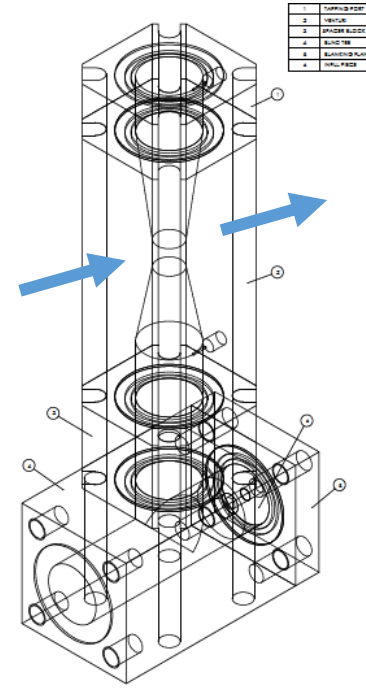
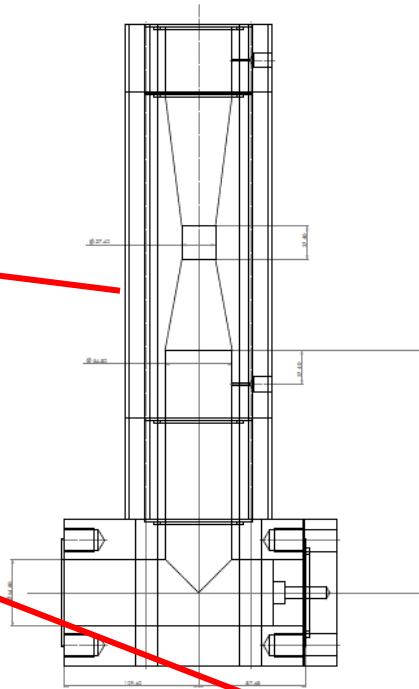
- Void fraction at H section
- Phase distribution at inlet of the metering
- Void fraction at the throat
- Pressures



A typical Venturi meter assembly



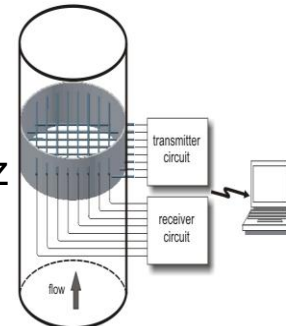
# Testing scenario: MPFM, Air/water tests



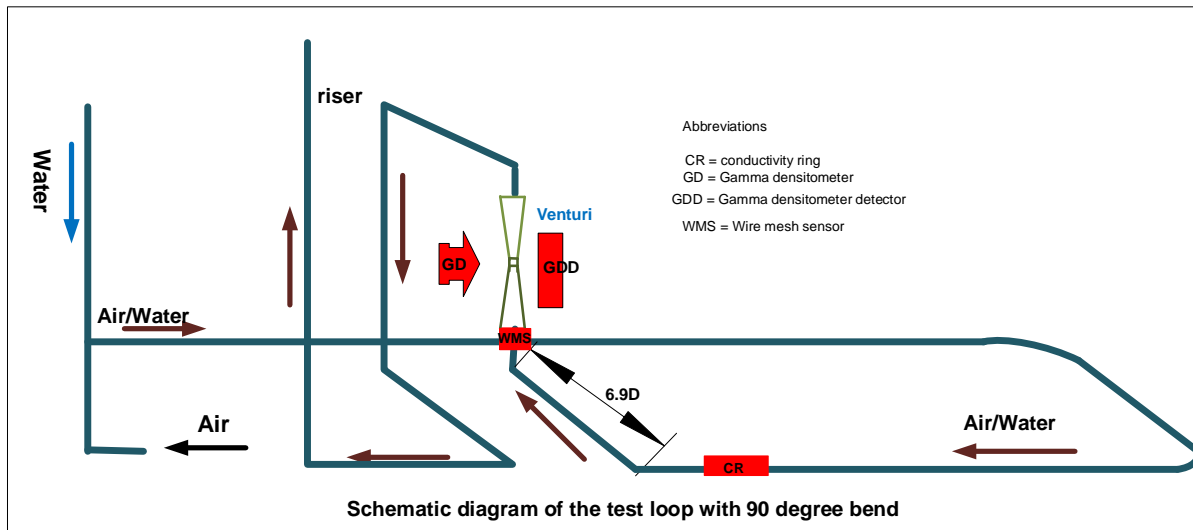
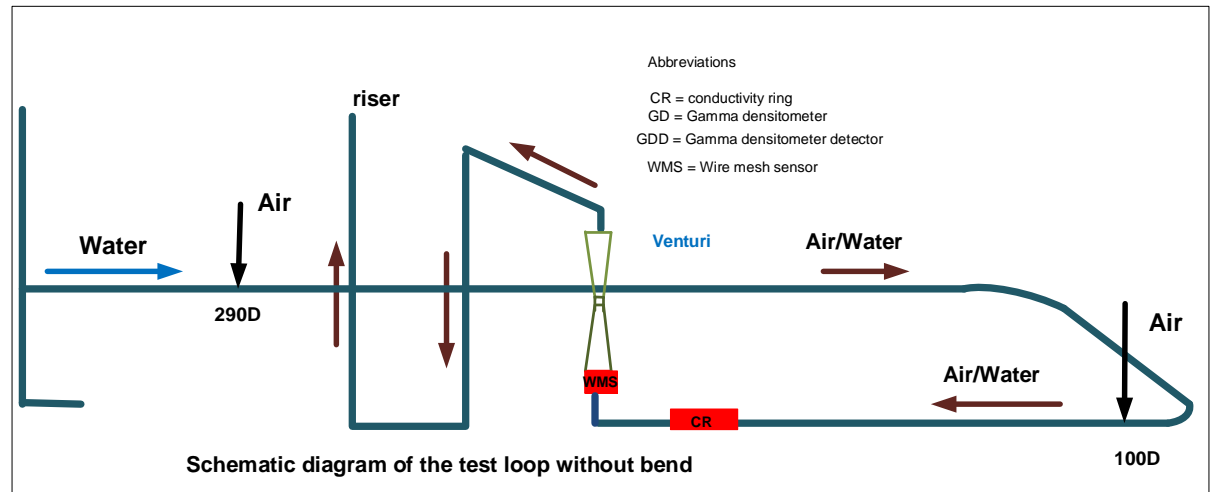
**Gamma  
Densitometer for  
throat void  
fraction/regime**

16x16 Wire mesh  
sensor 1000Hz

Conductivity Rings 200Hz

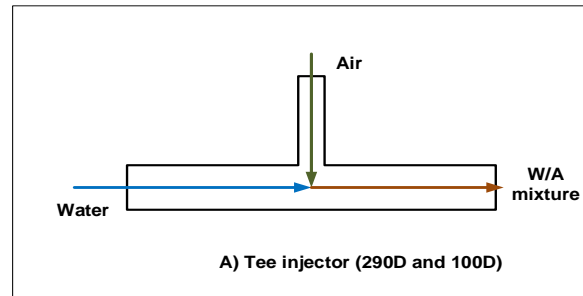


# Testing scenario: Test flow loops

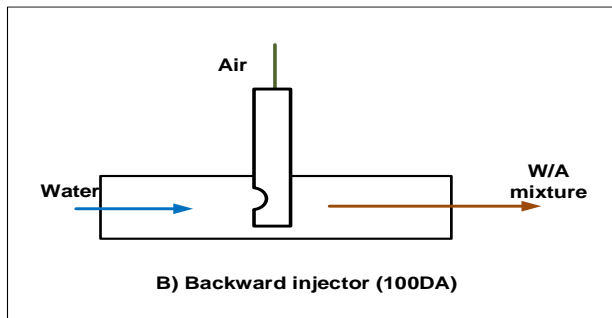




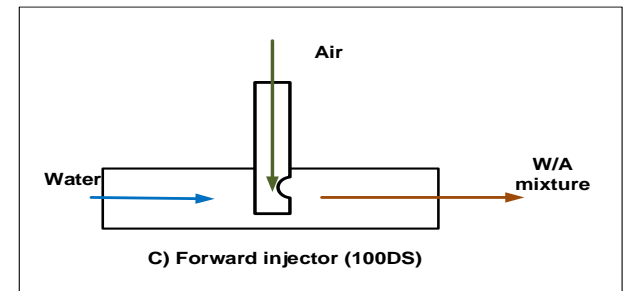
# Testing scenario: Air injectors



**290D &  
100D**



**100DA**



**100DS**



# Test points

Selected test points from overall test matrix

|     | Usl (m/s) | Usg (m/s) |
|-----|-----------|-----------|
| LL  | 0.202     | 0.54      |
| LH  | 0.202     | 5.63      |
| LHH | 0.202     | 13.46     |
| HL  | 1         | 0.53      |
| HH  | 1         | 4.26      |
| HHH | 1         | 9.53      |



# Results

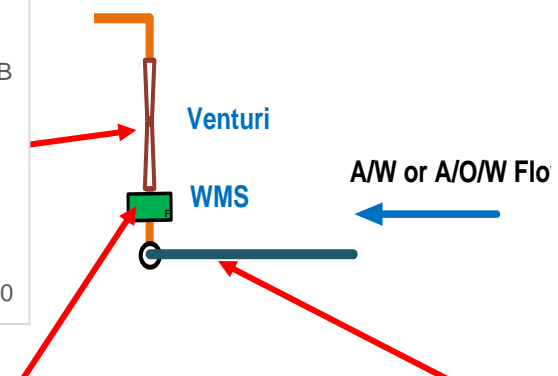
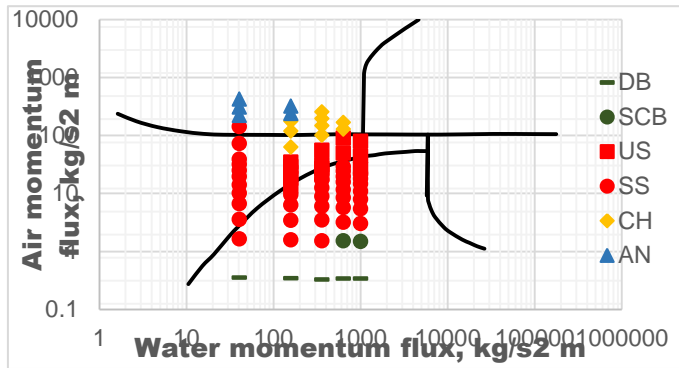
- Flow regimes/Slip ratio/Phase fraction at three key locations.
- Results for four different injection manners.
- Results with/without 90 degree bend



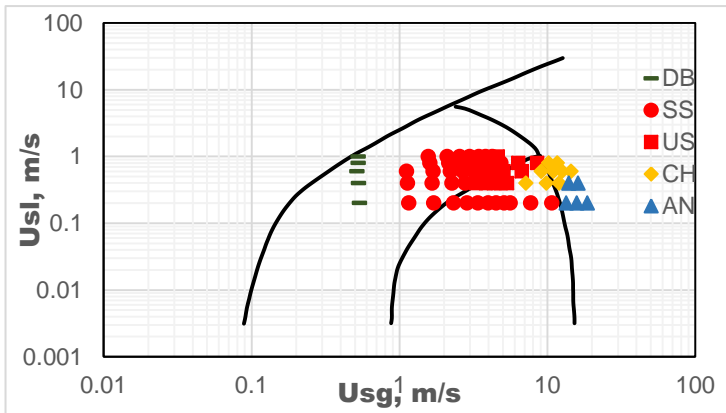
# Results: with H 90 degree bend

## Flow regimes at different locations

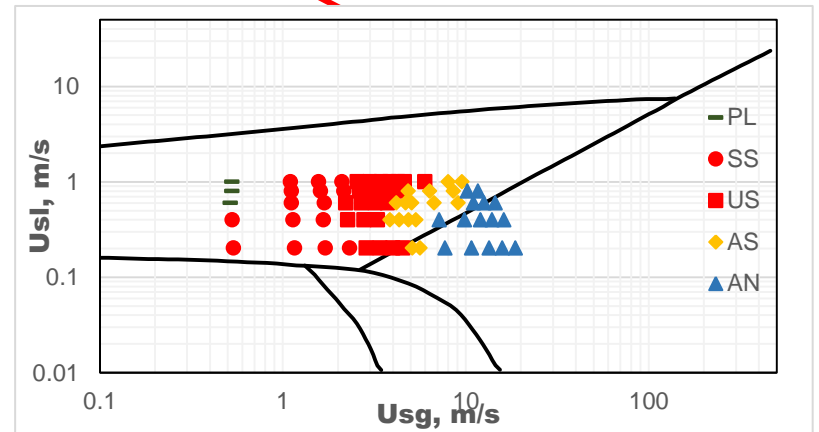
Throat



- Key**
- SCB: Spherical bubble
  - PL: Plug
  - SS: Stable Slug
  - US: Unstable slug
  - SS: Stable Slug
  - AS: Annular-Slug
  - A: Annular



Venturi entrance

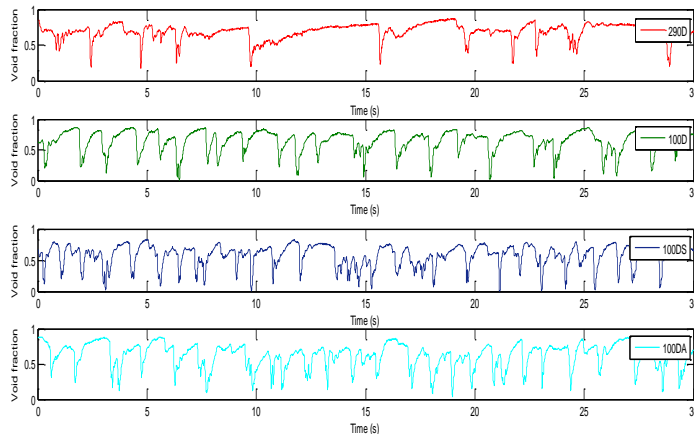
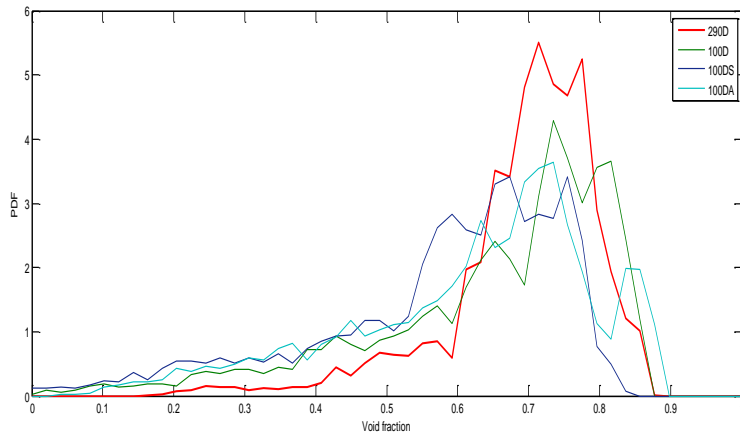


Horizontal

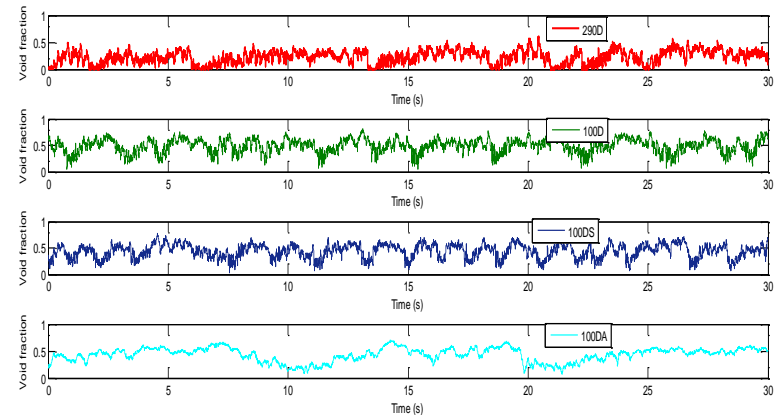
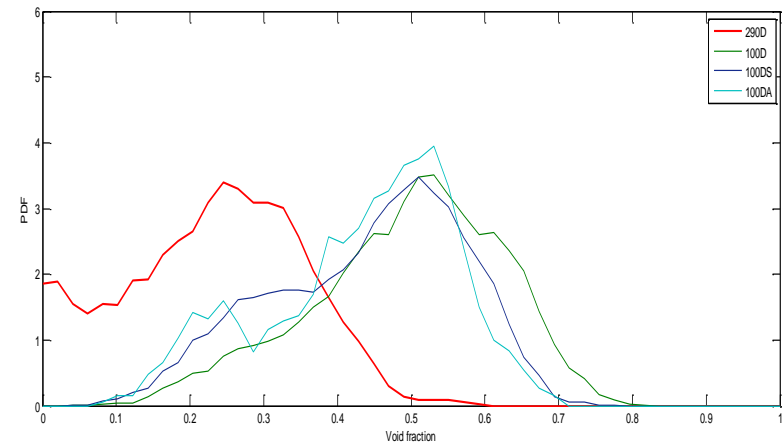


# Flow behaviour for different injection manners

## Horizontal Section behaviour



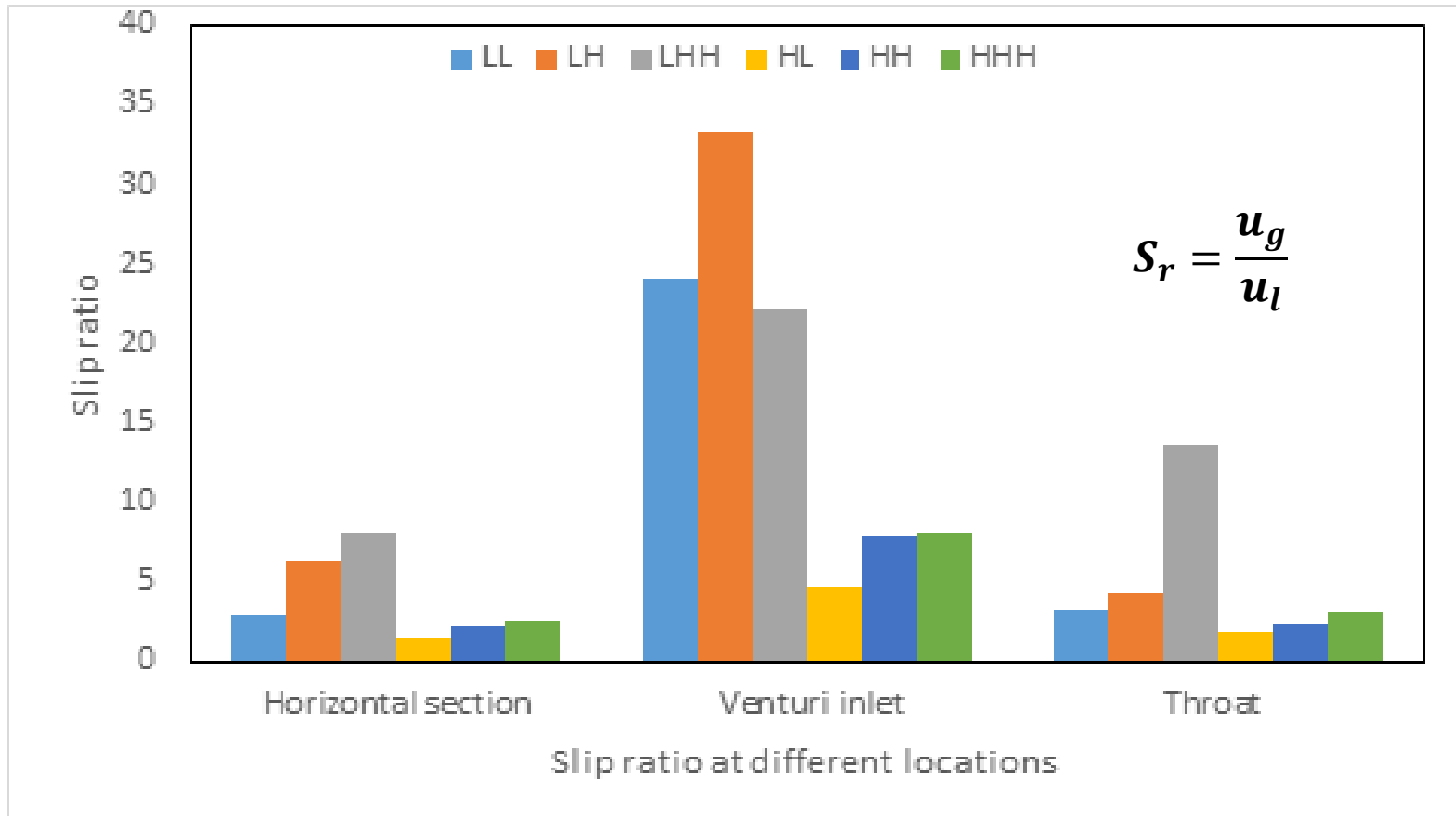
## Venturi inlet behaviour



( $U_{sl}=0.2$  m/s,  $U_{sg} = 5.4$  m/s)



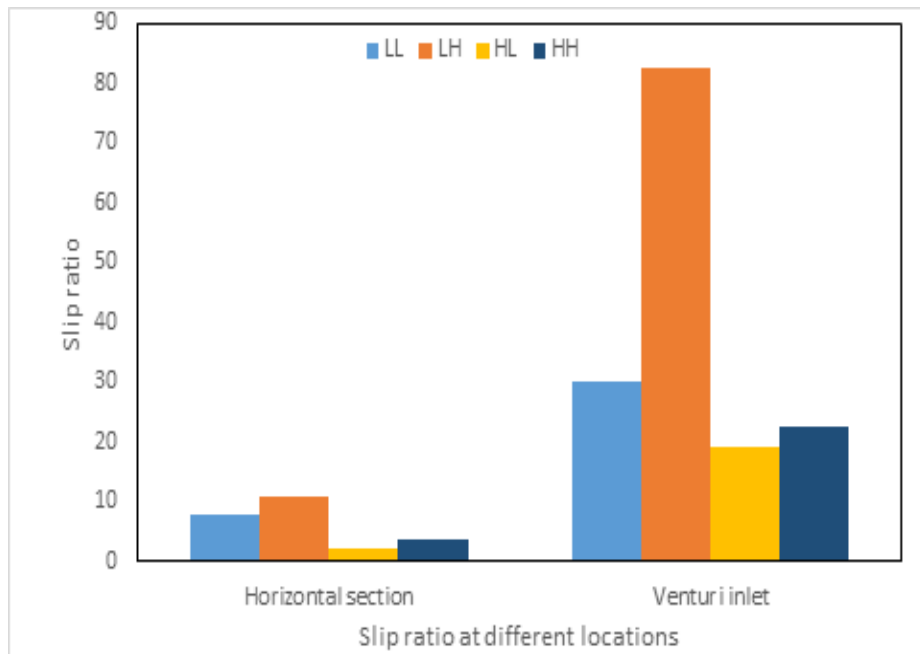
# Slip ratio at different locations



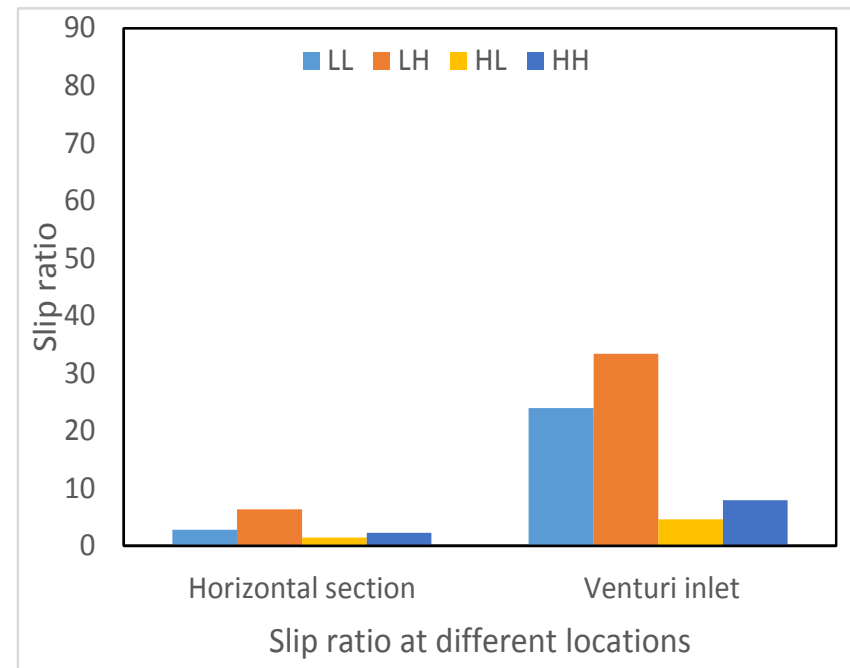


# Slip ratios with/without 90 degree bend

Without 90 degree bend



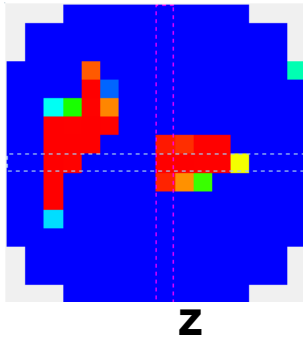
With 90 degree bend



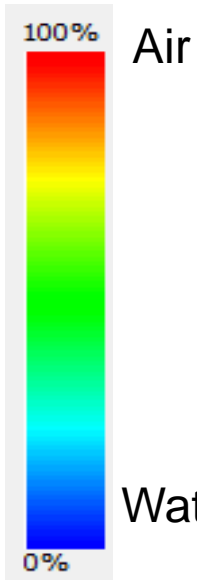


# WMS results

## LL

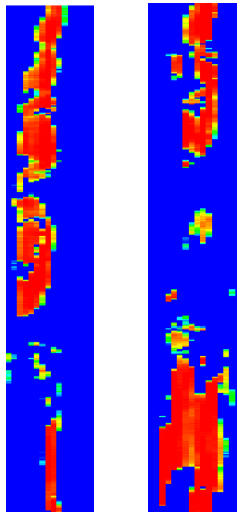


z



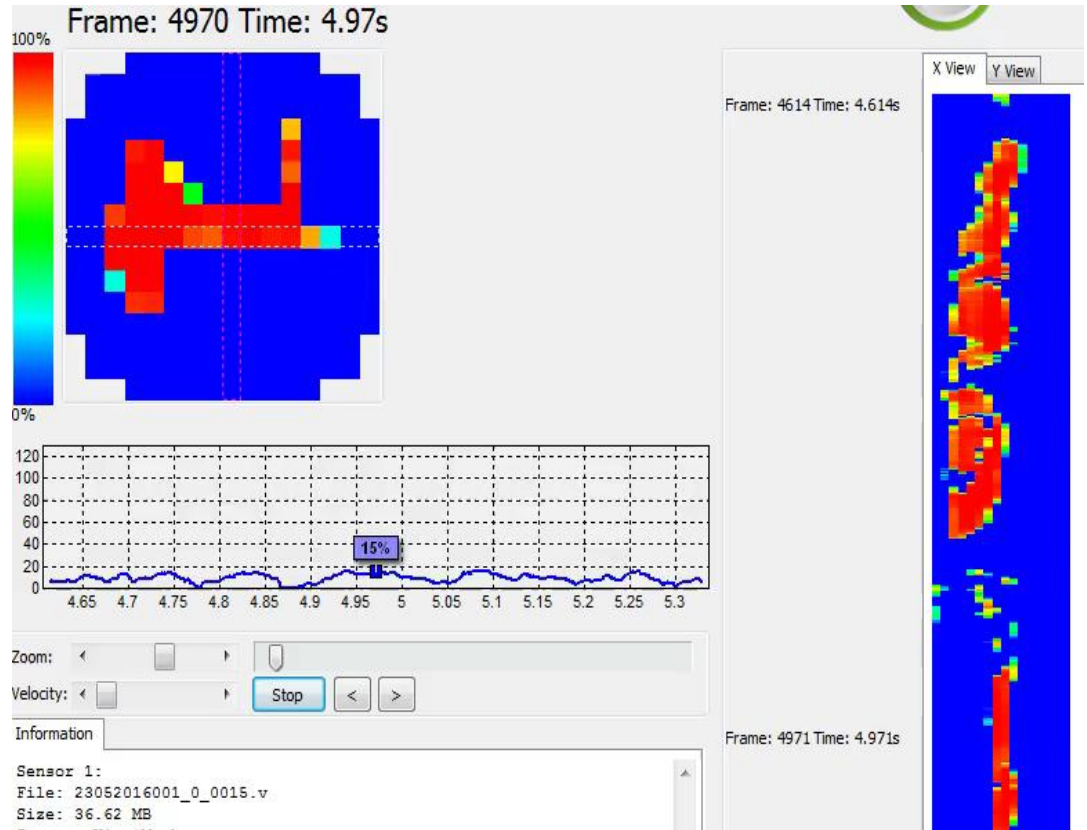
Air

Water

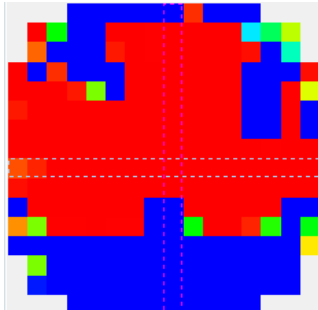


X

Y





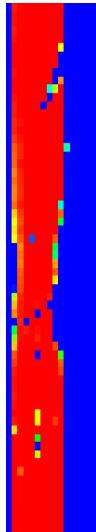


Z

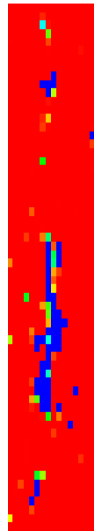


Air

Water

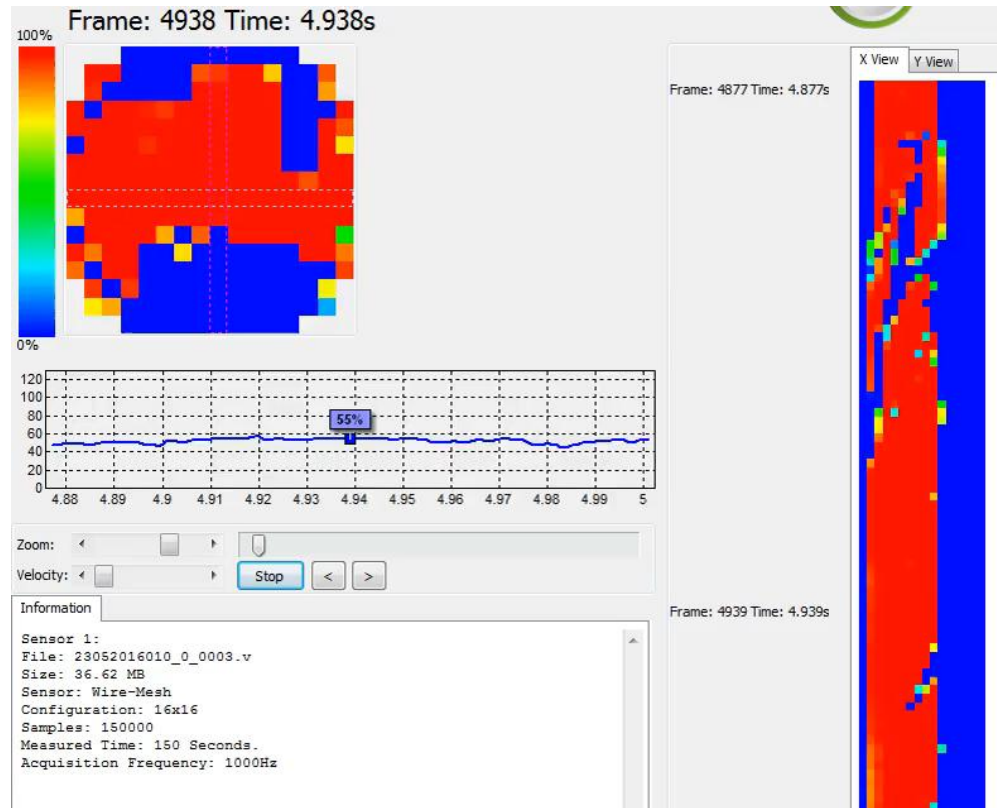


X

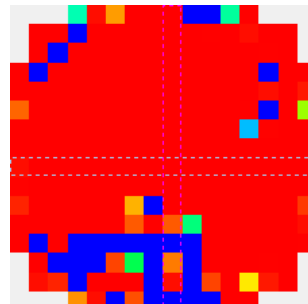
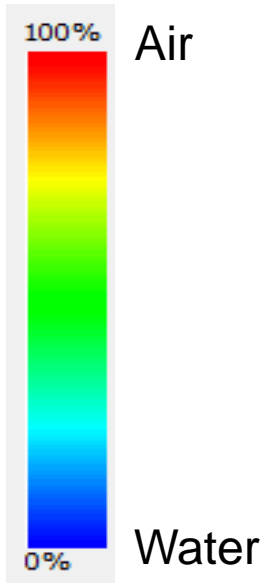


Y

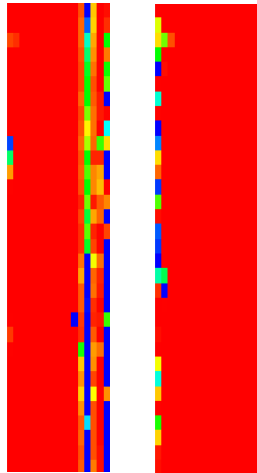
# LH



# LHH

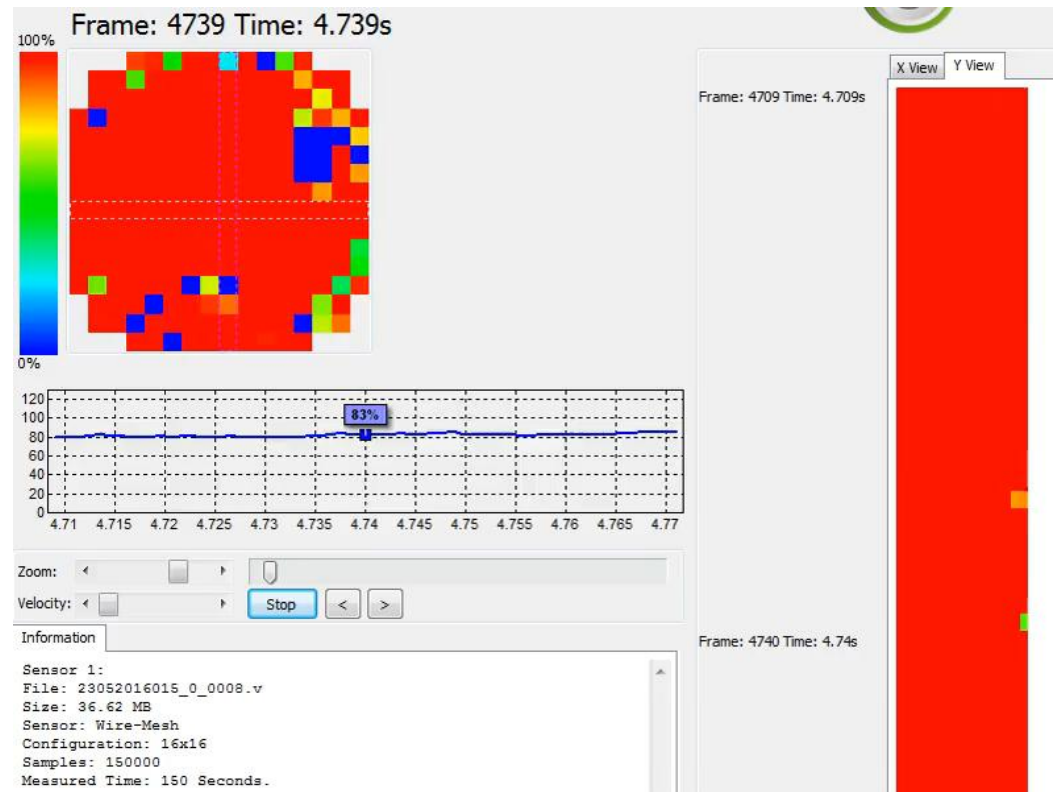


Z



X

Y





# Brief summary of findings

- The flow development lengths required by different flow conditions may quite different each other.
- The local phase separation enhanced at the blind tee section, however the centrifugal effect, as the gas velocity increased from low to high, experiences a maxima
- 90 degree bend on the upstream of the blind tee suppressed the local phase separation
- Flow structure at the throat cannot be predicted using the conventional flow regime map



# Acknowledgement

The researchers will like to acknowledge the support from





Thanks being  
patient!

Questions?