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PTV-Sizing in turbulent two-phase flow

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Presentation roadmap

- Introduction
- PTV-Sizing
  - Principle
  - Tracking
  - PIVNET images
- Presentation of an experimental setup
- Modification due to droplets
- Conclusion - Future works

Two-phase flows measurement

- Quantities required
  - Particulate properties (size-velocity)
  - Carrier characteristics (U,V,u’,v’,u’v’)
- Available techniques
  - PDA : One point technique
  - Standard PIV : No species discrimination
- Recent Development
  - Multi-layer PIV (Ikeda *et al*., 99)
  - Use of masking technique to separate phases (Merzkirch *et al*., *99*)

PTV-Sizing : principle

Particle detection

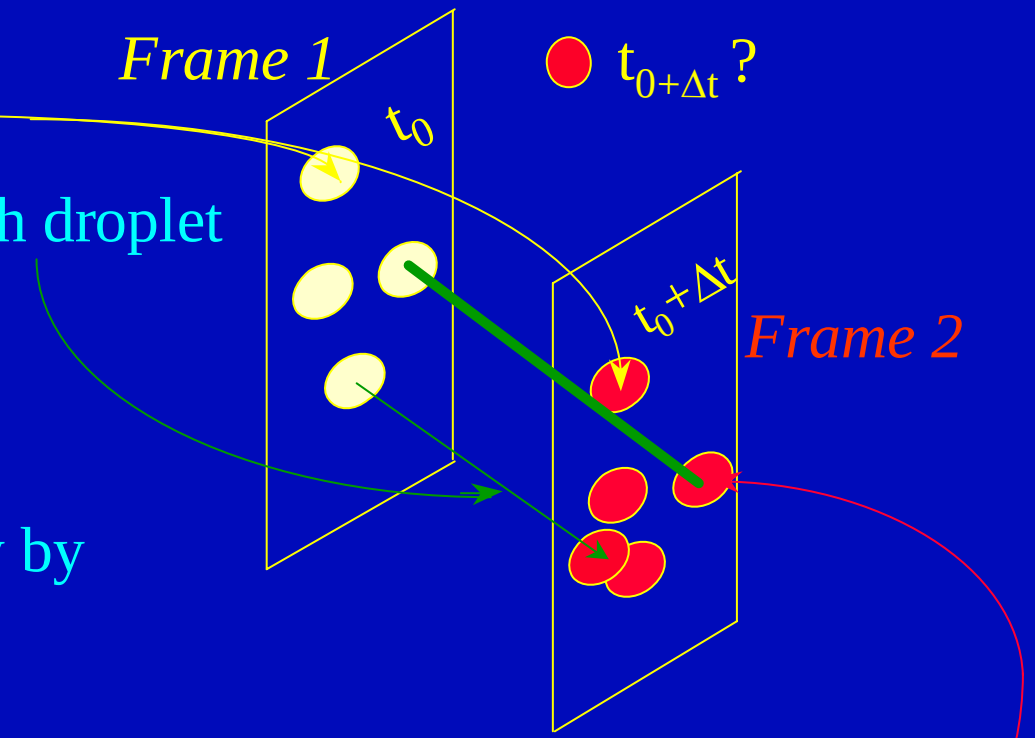
Displacement for each droplet at t_0 (predictor)

Pairs of particles

Compute the velocity by

$$Vx = \frac{\Delta x}{\Delta t}$$

$$Vy = \frac{\Delta y}{\Delta t}$$



Particle sizing after detection

PTV-Sizing : principle

- Detection
  - Locates peak of intensity in the image
  - Defines local threshold (takes non-uniformity into account)
  - Can detect overlapping particles if two peaks still present

PTV-Sizing : principle

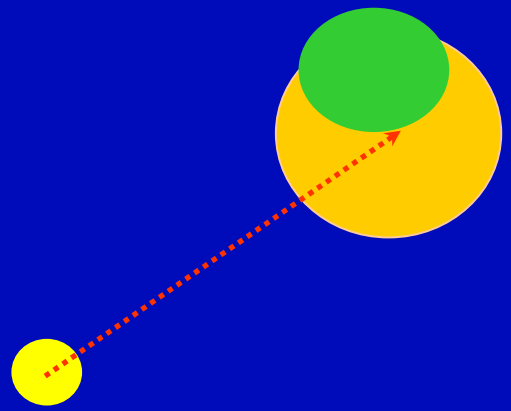
- Sizing
  - Groups all pixels belonging to same object
  - Measures size according to pixel/mm conversion
  - Not dependent on predefined shape as other techniques may be

PTV-Sizing : tracking

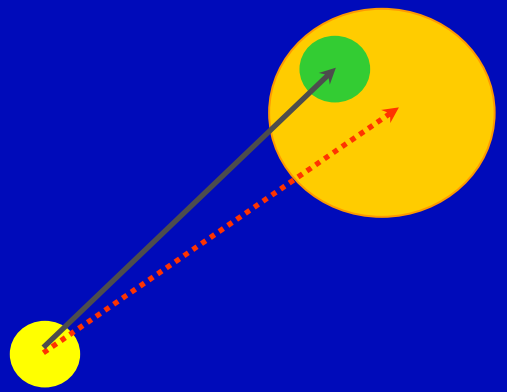
- Predictors obtained by cross-correlation are used to limit the research area
- The knowledge of the size is taken into account to ensure reliability of the pairing process
- The closest droplet having the same size order to the predicted displacement is paired
- Recursive treatment as some pairing may be removed for better one

PTV-Sizing : tracking

- PTV (High resolution PIV) with size discrimination routine



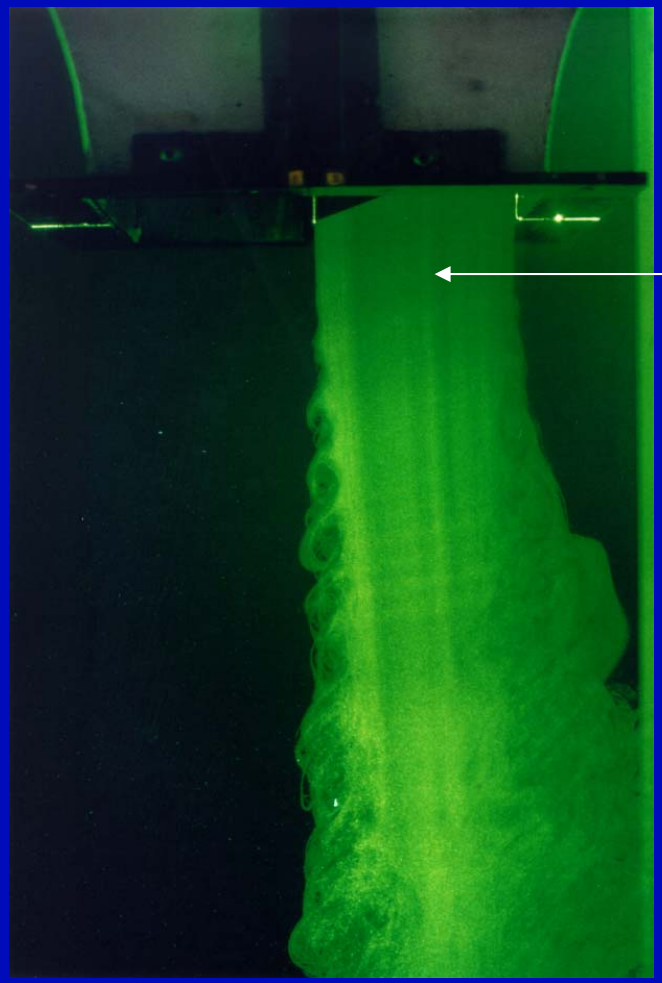
In this case, the sizes are completely different and no pairing is done : the size factor assigned by the user (15%)



In this case, no ambiguity

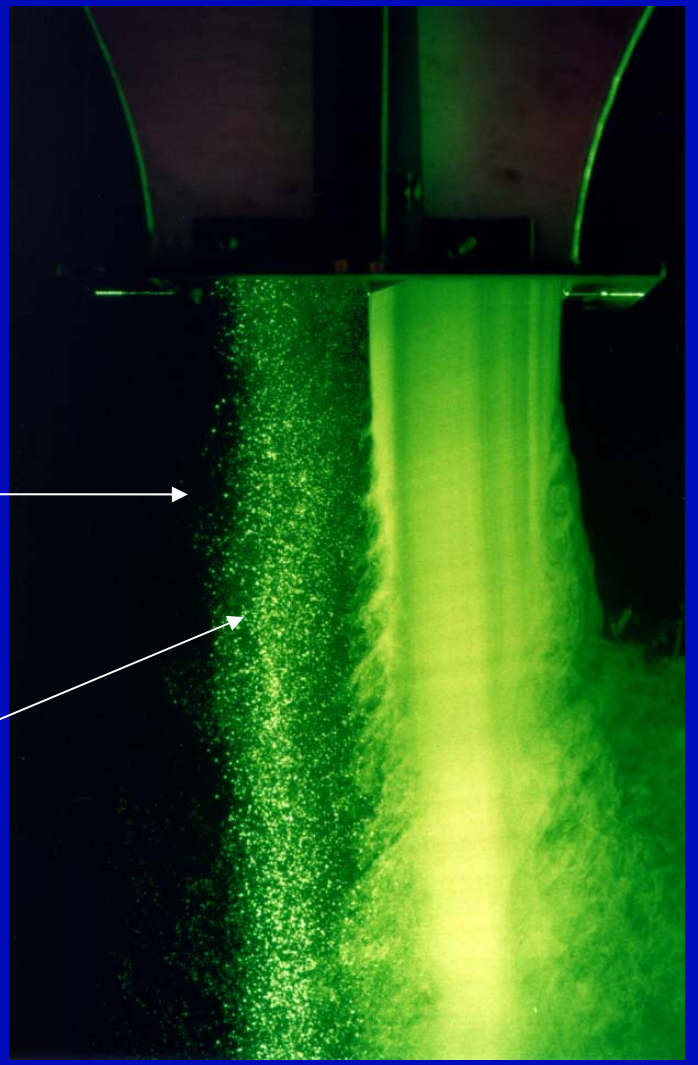
Experimental setup

Shear layer Flow , velocity ratio = 0.5



1.0 $m.s^{-1}$

2.0 $m.s^{-1}$



Droplets (created by ultra-sonic atomiser, low momentum)

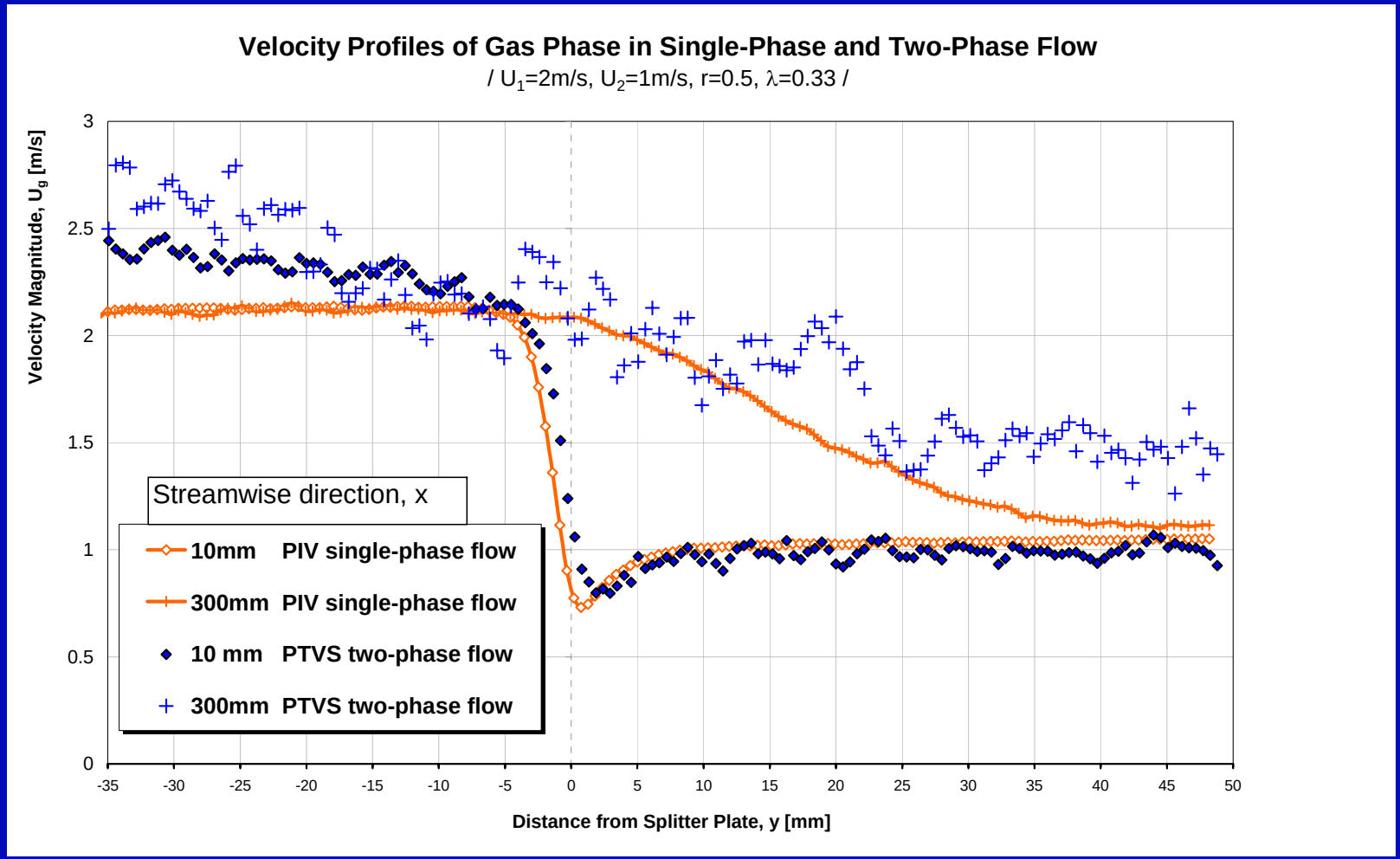
Taken from J.M. Suda “Experimental investigation on turbulence modification by particles in shear layer flow using L6 twin-jet wind tunnel”, VKI DC00-27

Experimental setup

- Droplets were ranging from 25 to 200 μm with a Sauter diameter of 120 μm
- Field of view : 85 by 50 mm with a PCO camera (1280 by 1024) combined with Nd:YAG laser
- PTV-sizing used for all particles found with size criteria of 20% (because typical dimensions were 2-3 pixels)
- Interpolation on structured grid performed only for the tracer particles : smaller than 4 pixels of diameter

Typical PTV-Sizing results

- Evolution of the mixing layer and influence of droplets



Conclusions

- PTV-Sizing
  - Well suited for two-phase flow application because of tracking procedure
  - Works also as Super resolution technique for single phase measurement

- Future extension
  - Further assessment of sizing capability, especially for small particles (droplets used up to now were larger than 100 μm)