

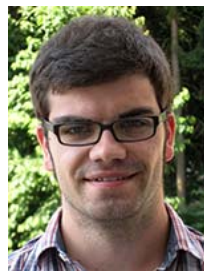
Empirical characteristics of different types of pedestrian flows

15. April 2014

| Jun Zhang

Jülich Supercomputing Centre
Forschungszentrum Jülich GmbH

Civil Security and Traffic



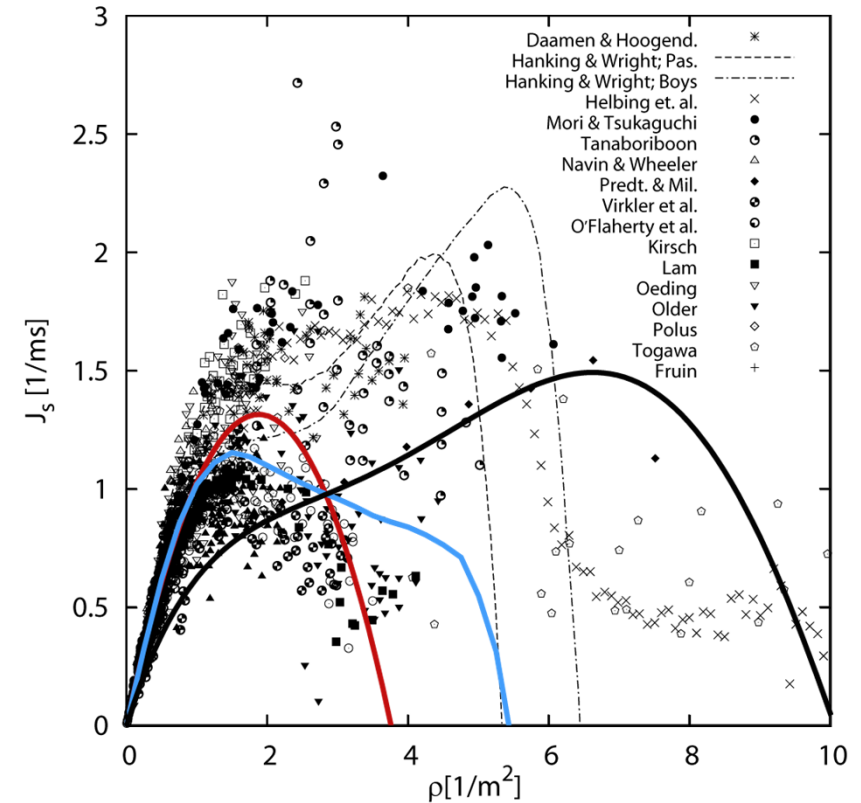
Overview

- Introduction
- Summary of experiments
- Comparison between uni- and bidirectional flow
- BaSiGo experiments

Introduction

Different fundamental diagrams due to variations of

- Measurement method
- Uni- and multidirectional streams
- Fluctuations
- Culture
- Population demographics
- Psychological factors (e.g. motivation)



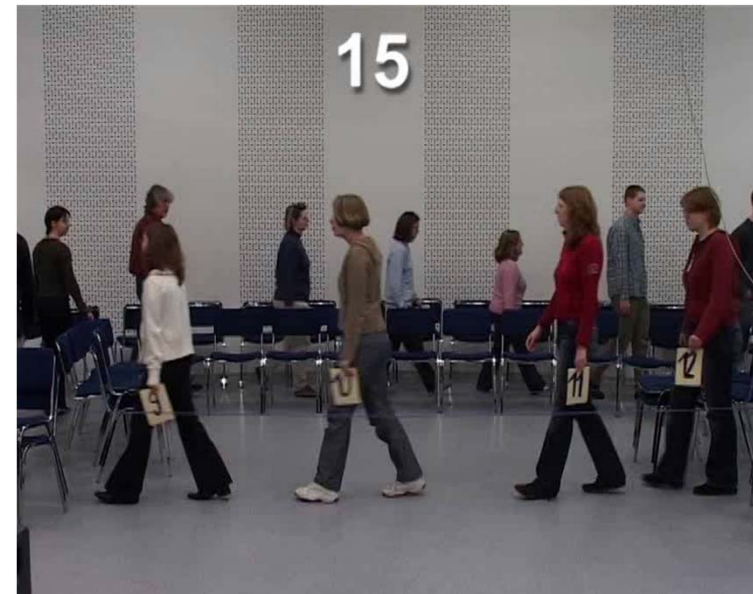
SFPE P. J. DiNenno (2002) *SFPE Handbook ...*
 PM V. M. Predtechenskii and Milinskii (1978)
 WM U. Weidmann (1993) *Transporttechnik ...*

Summary of experiments

Date	Place	N	Capturing
2005	Jülich	34	manually
2005	Jülich	60	manually
2006	Düsseldorf	200	automatically
2008	India	64	manually
2008	Wuppertal	50	manually
2009	Düsseldorf	400	automatically
2013	Düsseldorf	> 1000	automatically

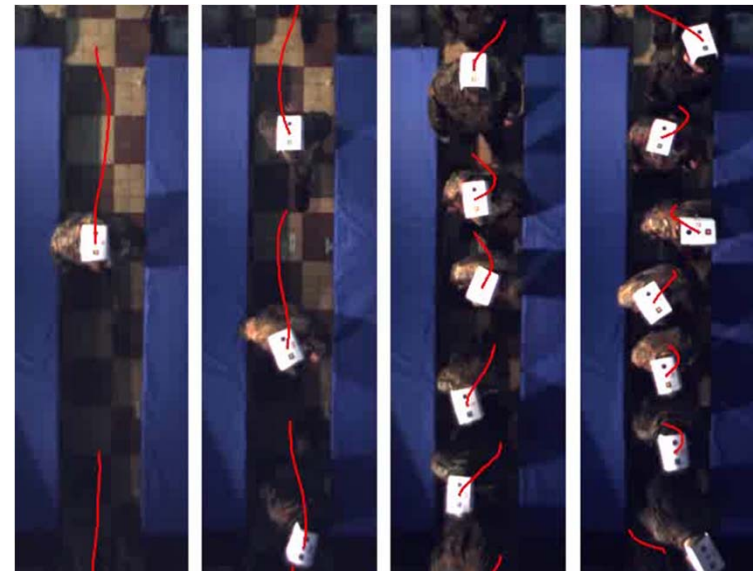


15. April 2014 | Jun Zhang



Summary of experiments

Date	Place	N	Capturing
2005	Jülich	34	manually
2005	Jülich	60	manually
2006	Düsseldorf	200	automatically
2008	India	64	manually
2008	Wuppertal	50	manually
2009	Düsseldorf	400	automatically
2013	Düsseldorf	> 1000	automatically

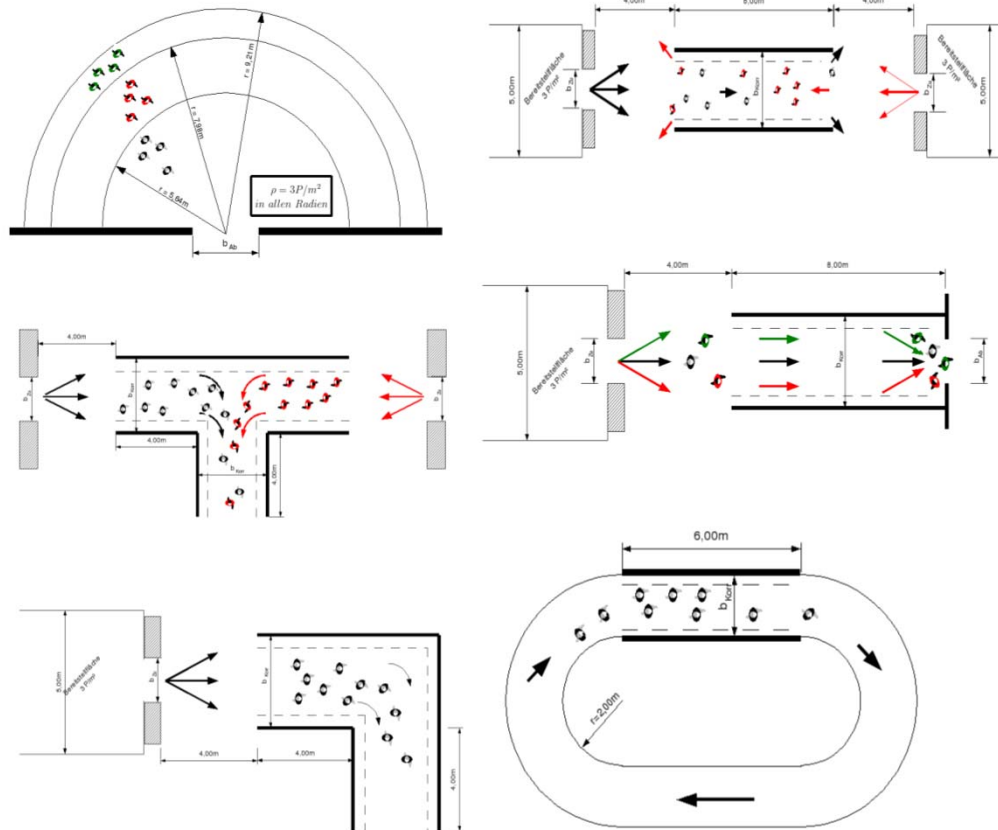


Summary of experiments

Date	Place	N	Capturing
2005	Jülich	34	manually
2005	Jülich	60	manually
2006	Düsseldorf	200	automatically
2008	India	64	manually
2008	Wuppertal	50	manually
2009	Düsseldorf	400	automatically
2013	Düsseldorf	> 1000	automatically

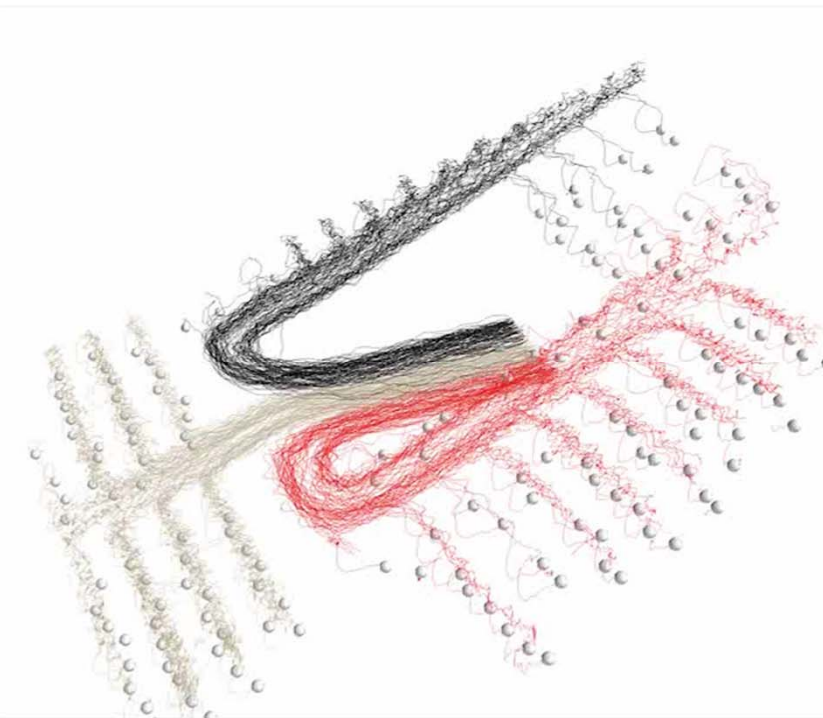


Hermes project 2009



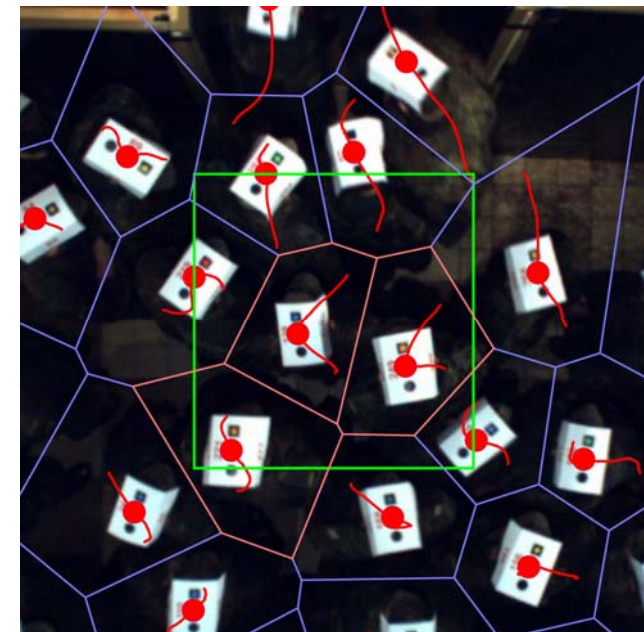
Trajectory extraction

Free software: Petrack

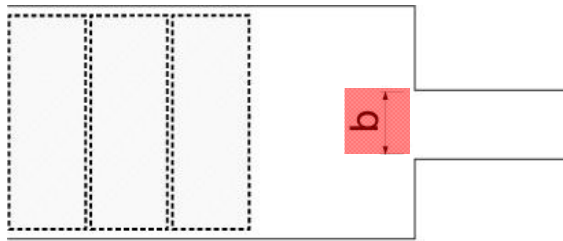


Measurement method

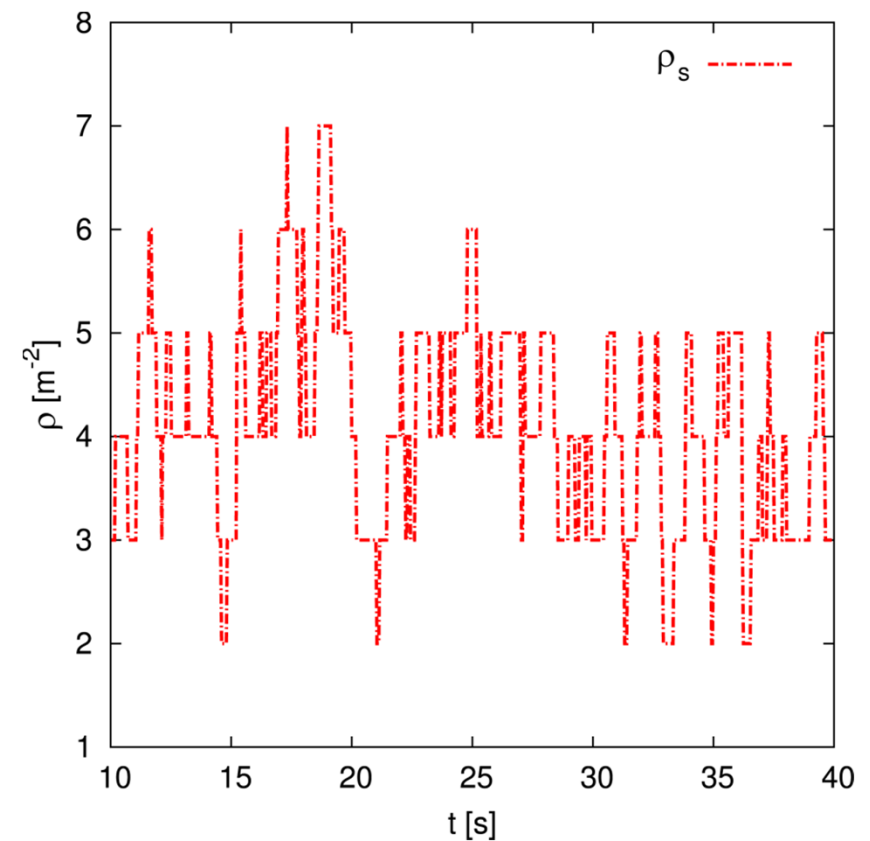
- Size of facilities normally restricted to 1 -10 m
- Number of pedestrians in the measurement area is small
- Mean value and fluctuations have same order of magnitude
- Proportion between particle number and measurement area problematic



Problems of the classical density definition



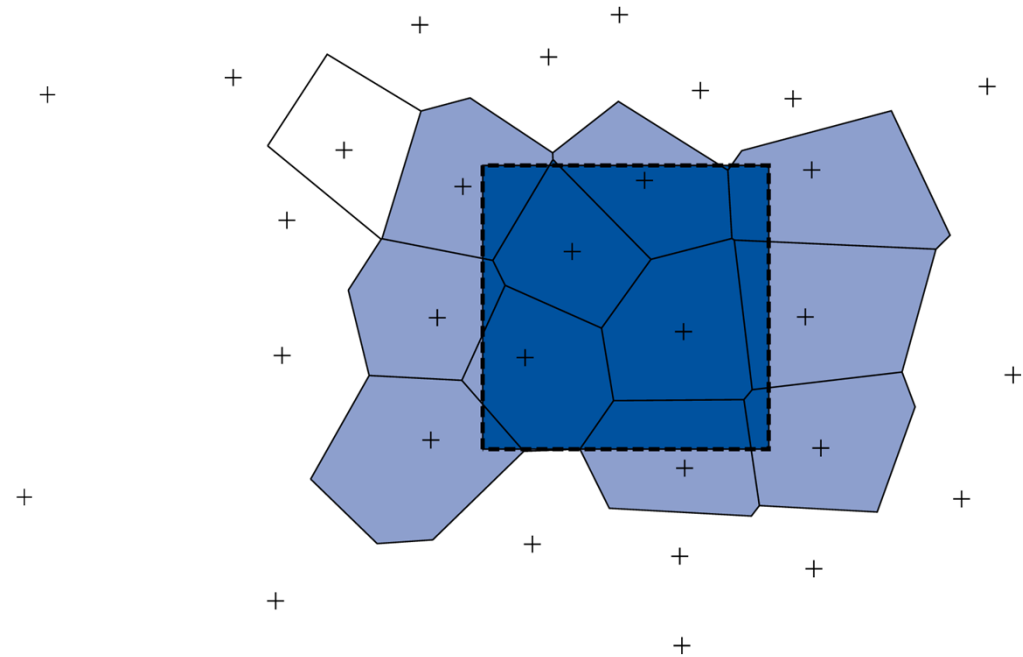
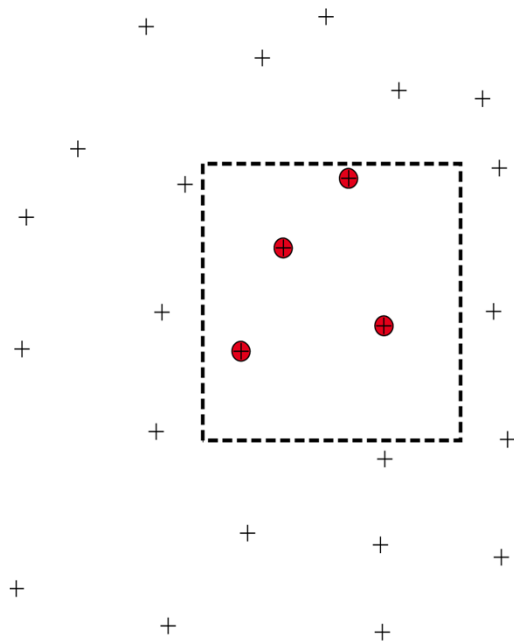
- Large fluctuations
 $\rho_{\min}=2 \text{ m}^{-2}$ to $\rho_{\max}=7 \text{ m}^{-2}$
- Stationary state?
- Mean value?



Voronoi density

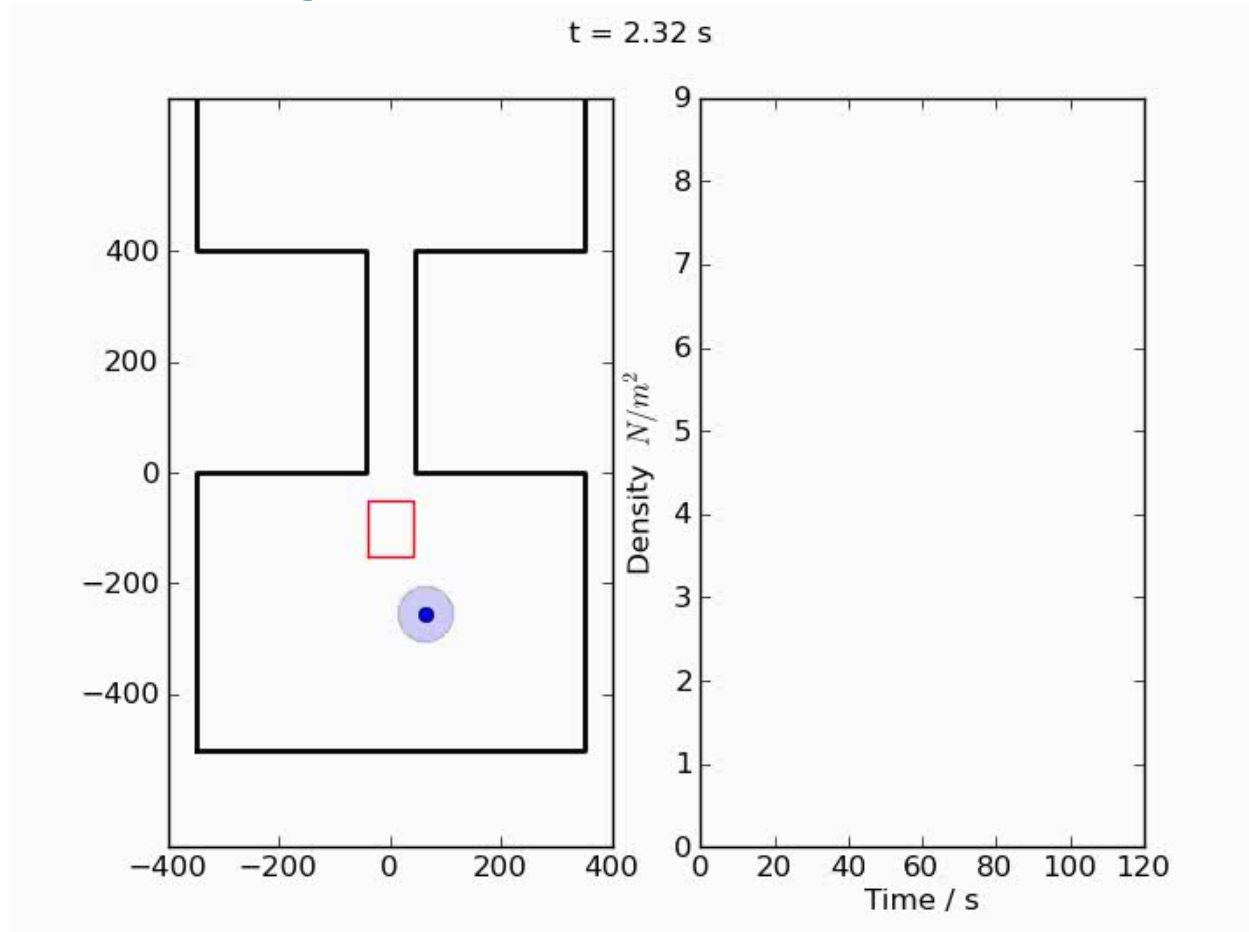
$$\rho_{\text{Class}} = \frac{N}{|A|}$$

$$\rho_{\text{Voronoi}} = \frac{\int_A p(\vec{x}) d\vec{x}}{|A|}, \quad p(\vec{x}) = \begin{cases} 1/A_i : \vec{x} \in A_i \\ 0 : \text{else} \end{cases}$$



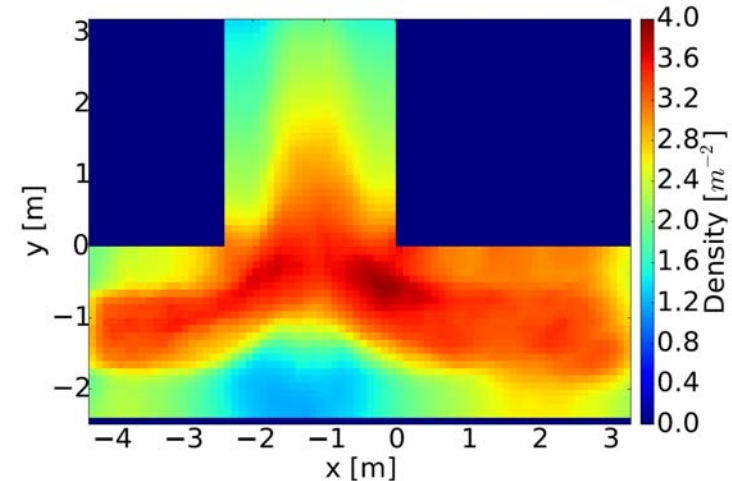
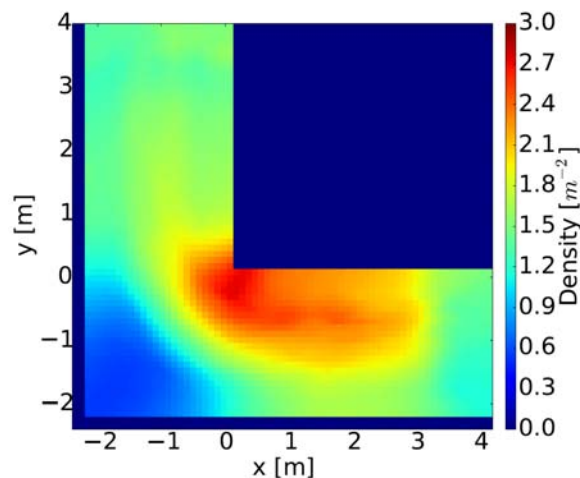
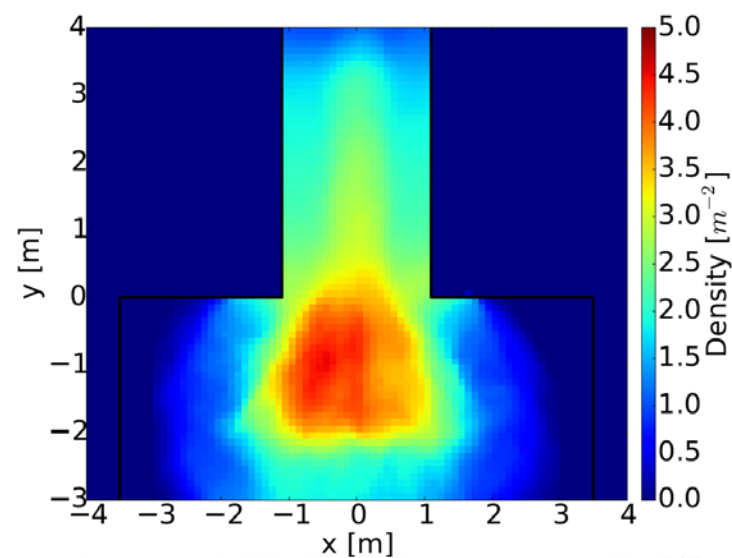
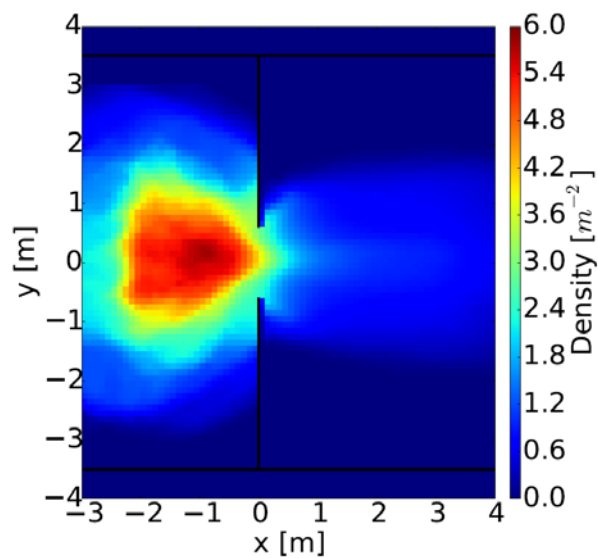
¹B. Steffen and A. Seyfried, *Physica A*, **2010**, 389, 1902-1910

Voronoi density



Credits: J. Liddle

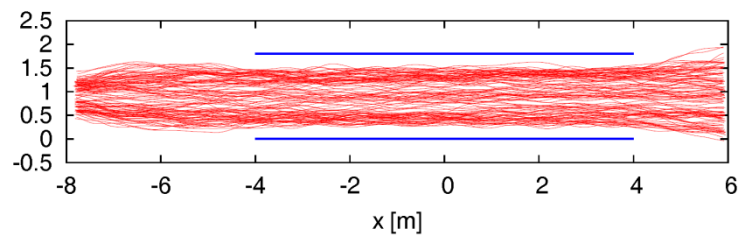
Voronoi density



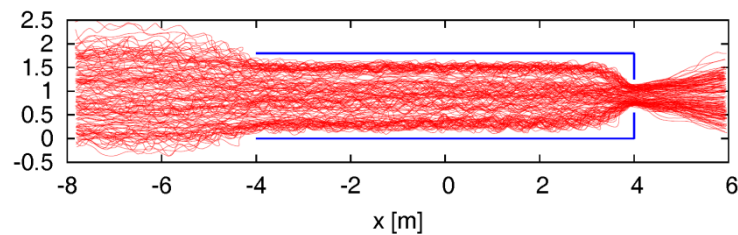
Results from uni- and bidirectional flow experiments

Unidirectional flow

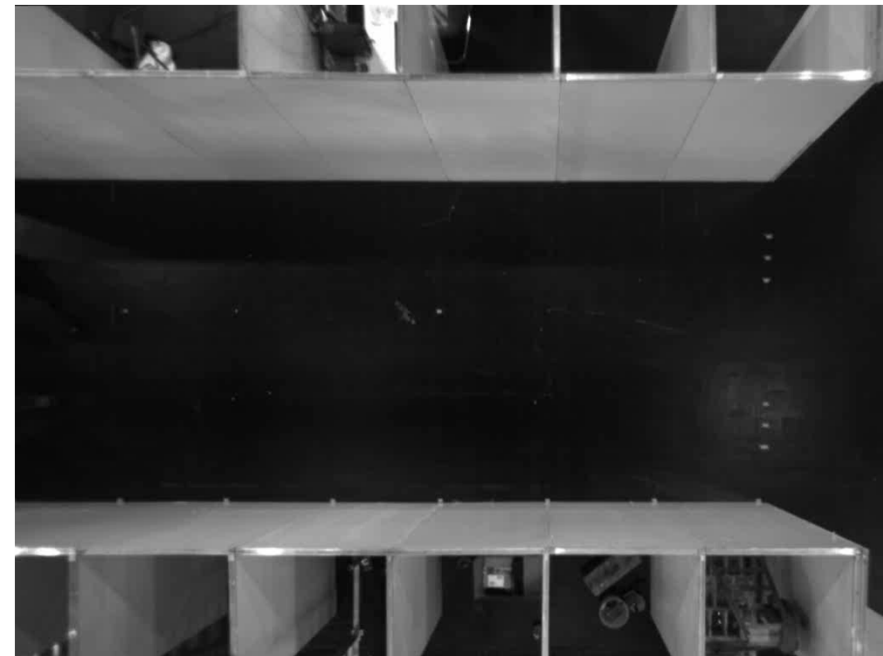
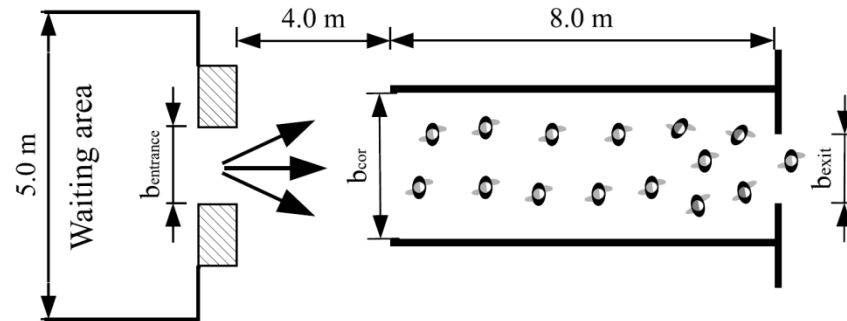
- b_{cor} : 1.8 m, 2.4 m, 3.0 m
- 28 different runs
- b_{entrance} and b_{exit}
- N_{min} : 61
- N_{max} : 351



U-070-180-180



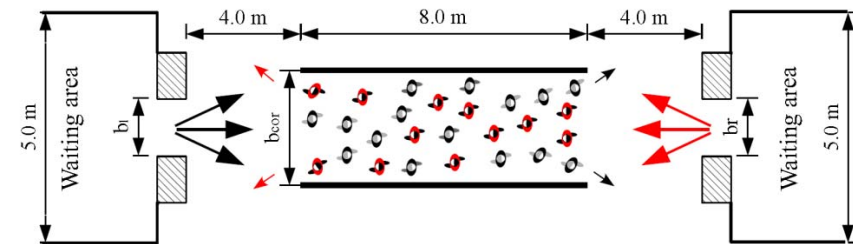
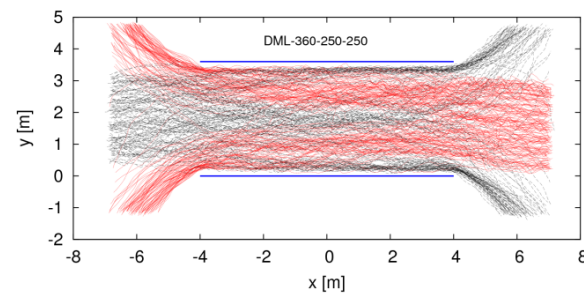
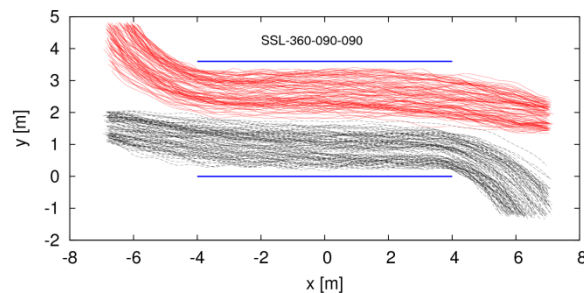
U-180-180-070



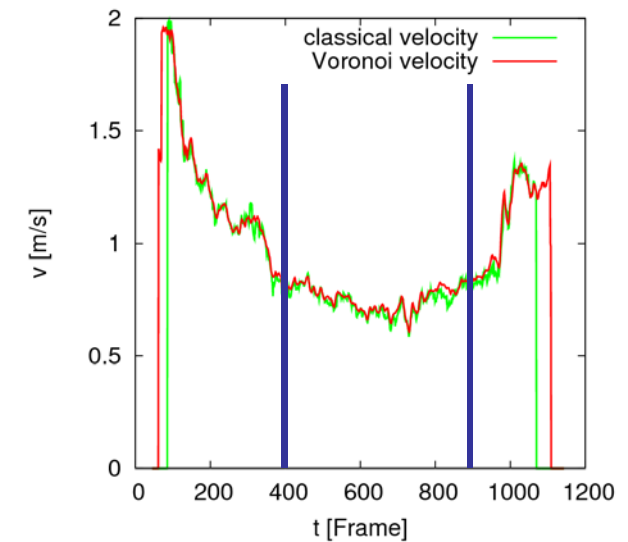
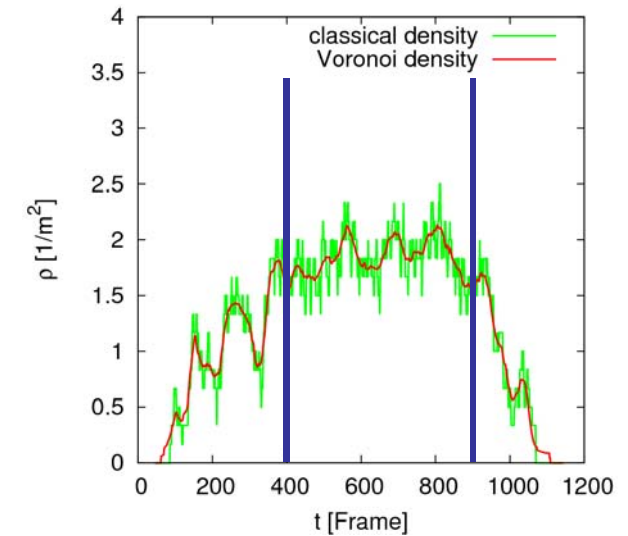
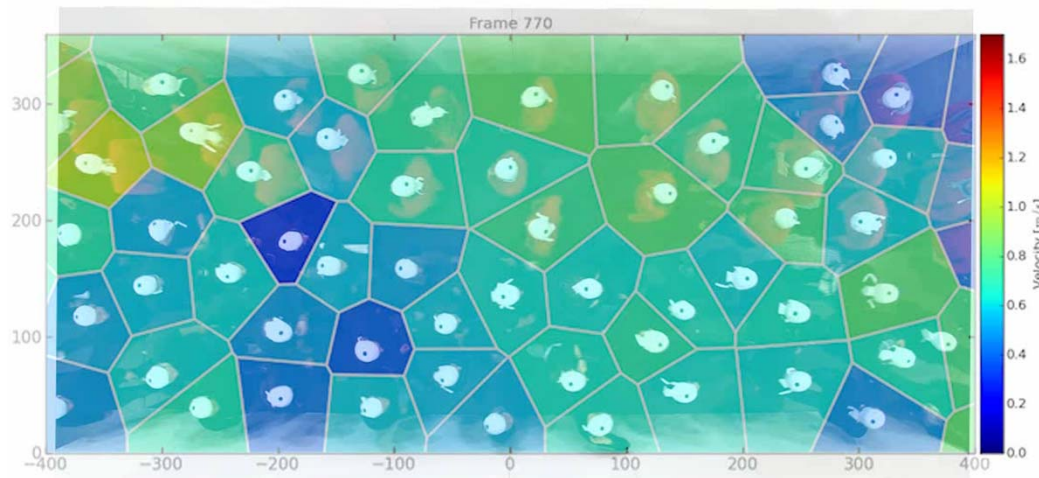
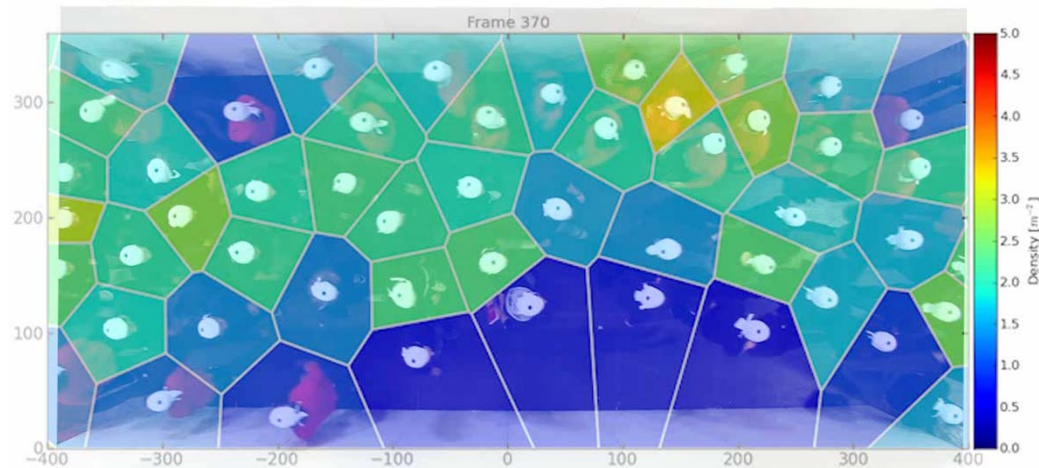
Extracted automatically with *Petrack* developed by Maik boltes

Bidirectional flow

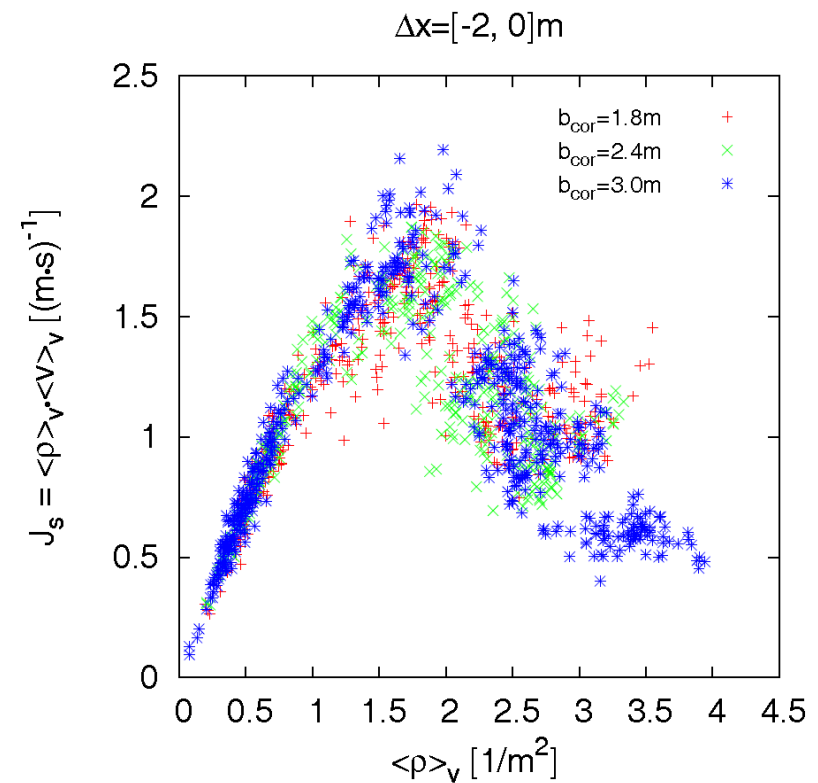
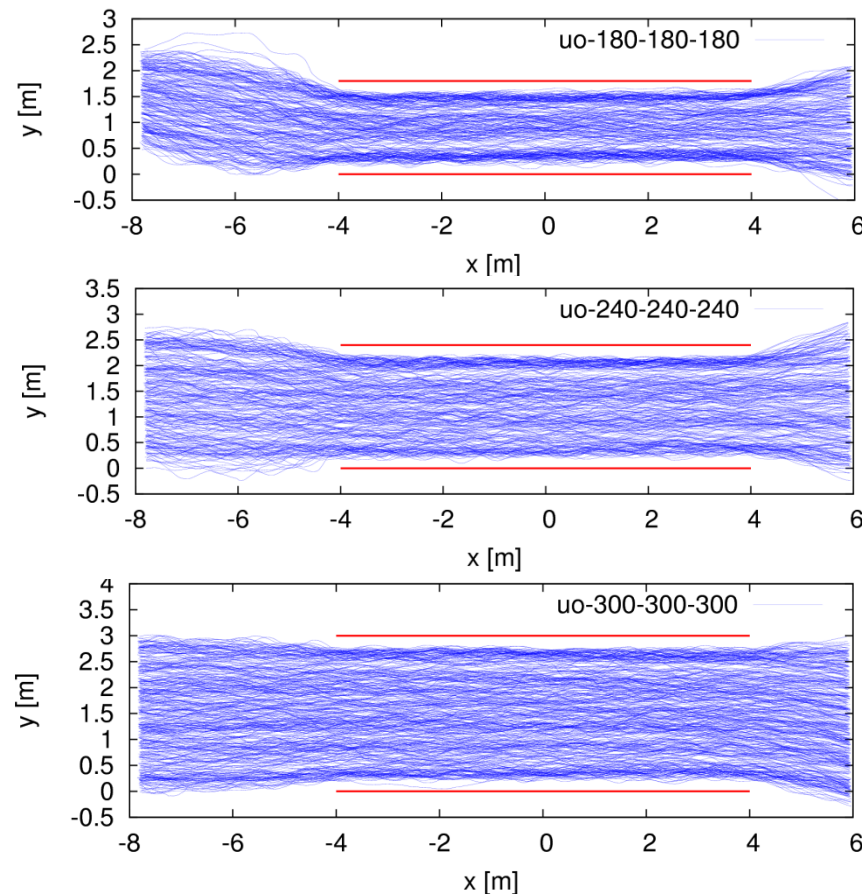
- b_{cor} : 3.0 m, 3.6 m
- 22 different runs
- b_l and b_r
- Stable Separated Lanes (SSL)
- Dynamical Multi-Lanes (DML)



Selection of steady states

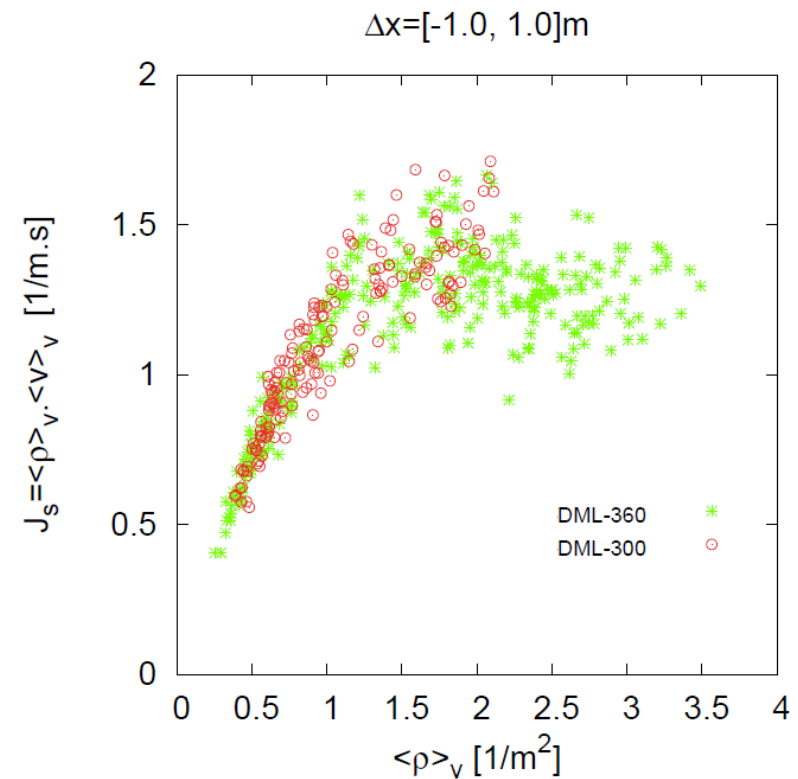
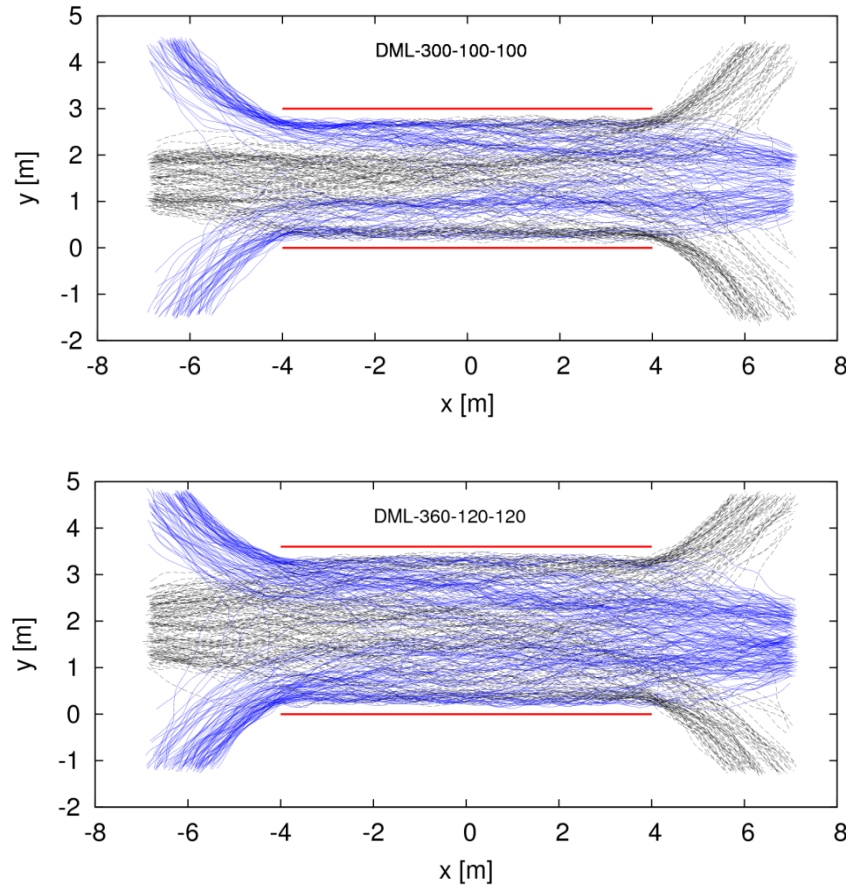


Specific flow concept



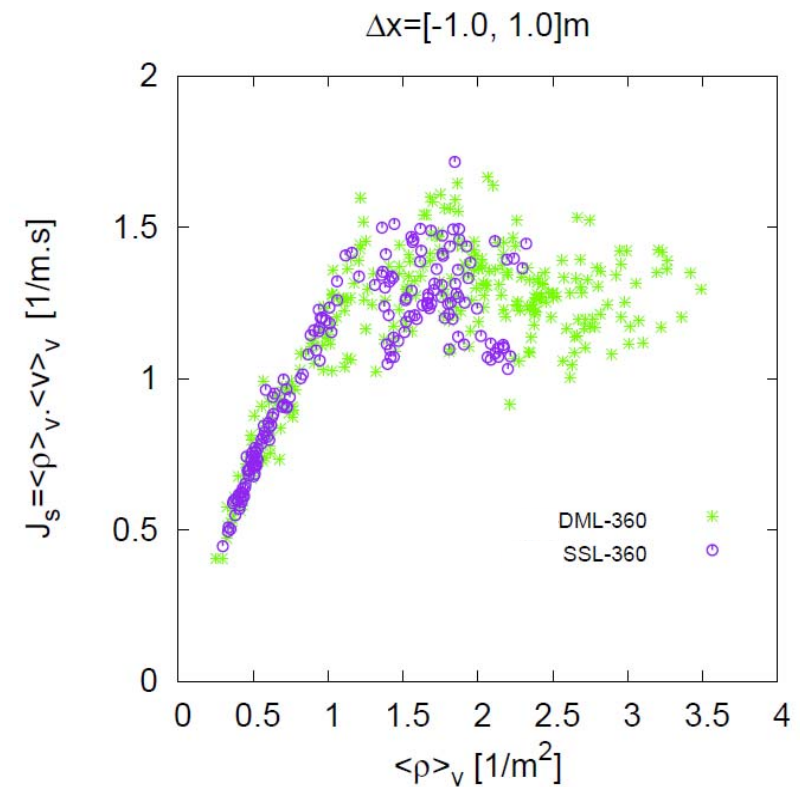
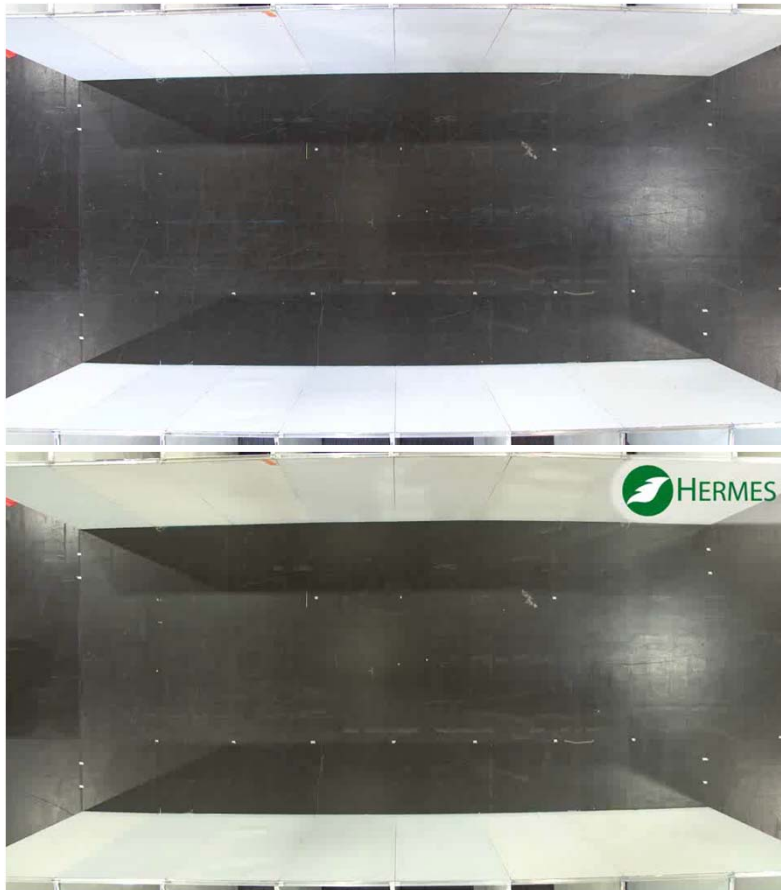
The fundamental diagrams for different widths could be unified in one diagram for specific flow

Specific flow concept



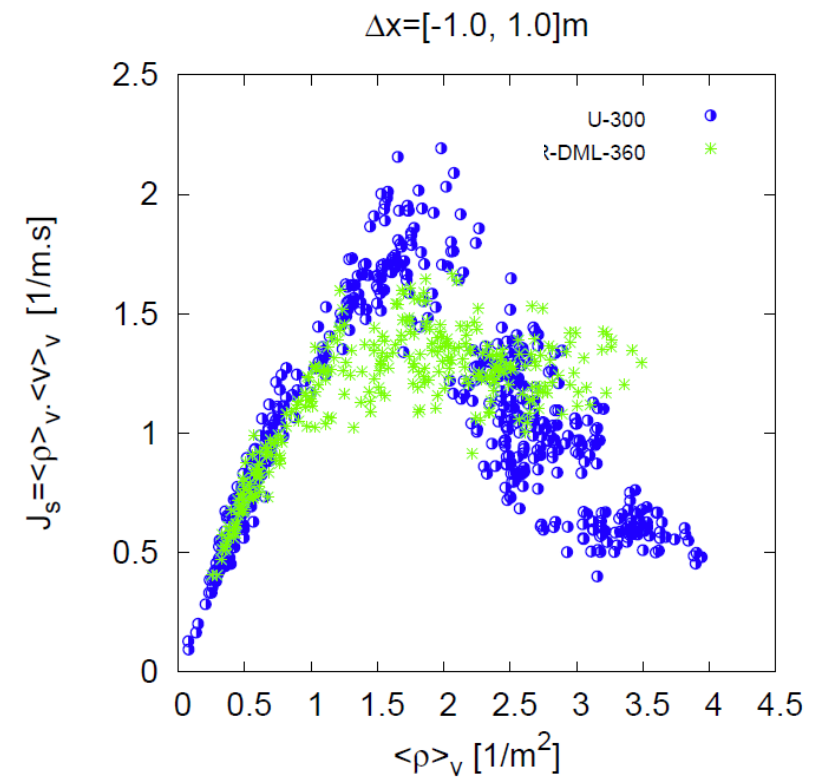
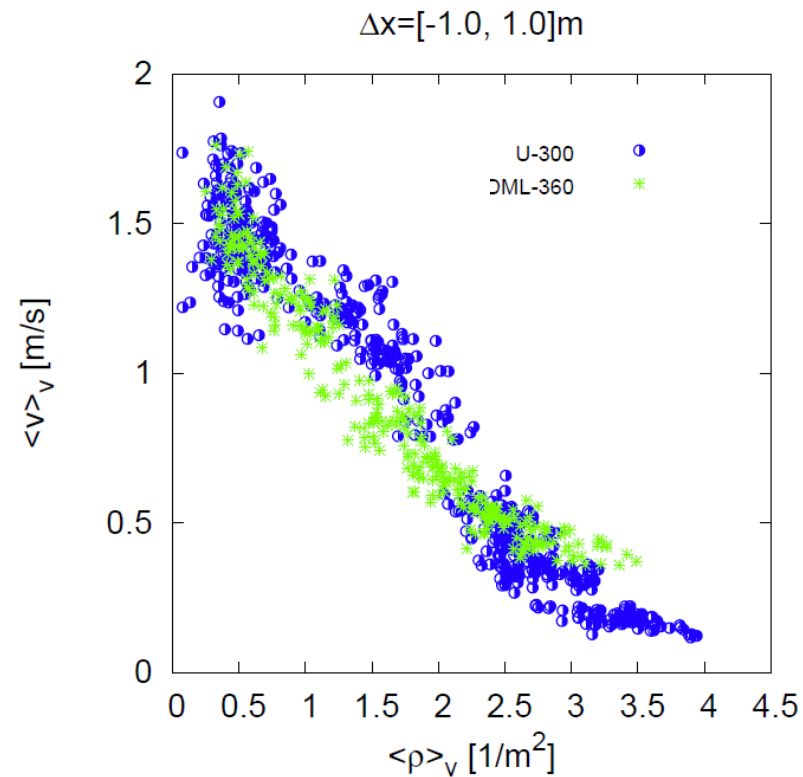
For $\rho < 2 \text{ 1/m}^2$, the specific flow concept works also well for bidirectional flow

SSL vs. DML



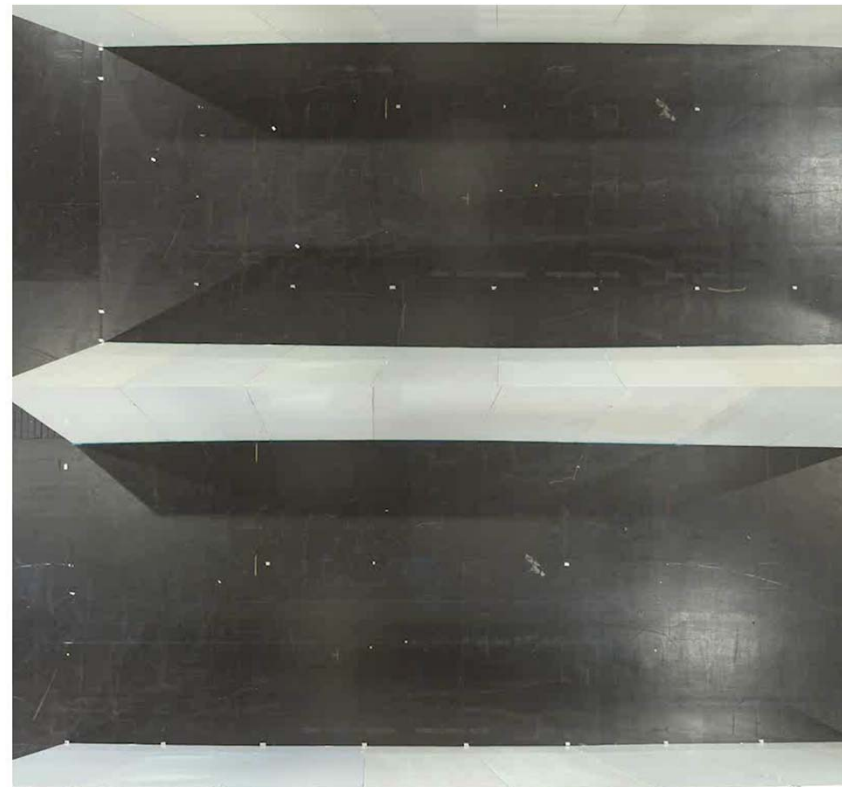
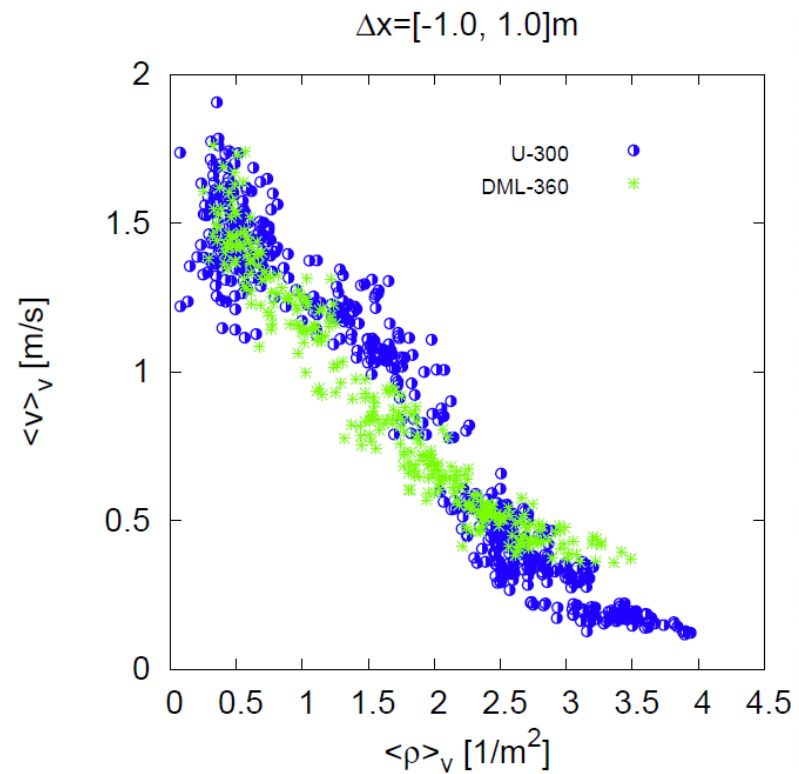
Fundamental diagrams of bidirectional flow with various lane formations

Uni- vs. bidirectional flow



For $\rho > 1$ 1/m², the difference can be observed for uni- and bidirectional flow

Uni- vs. bidirectional flow

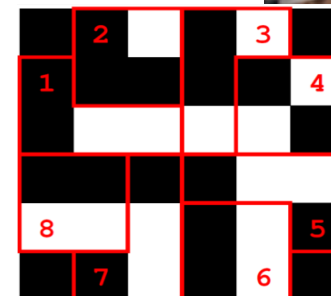




Experiments in BaSiGo project

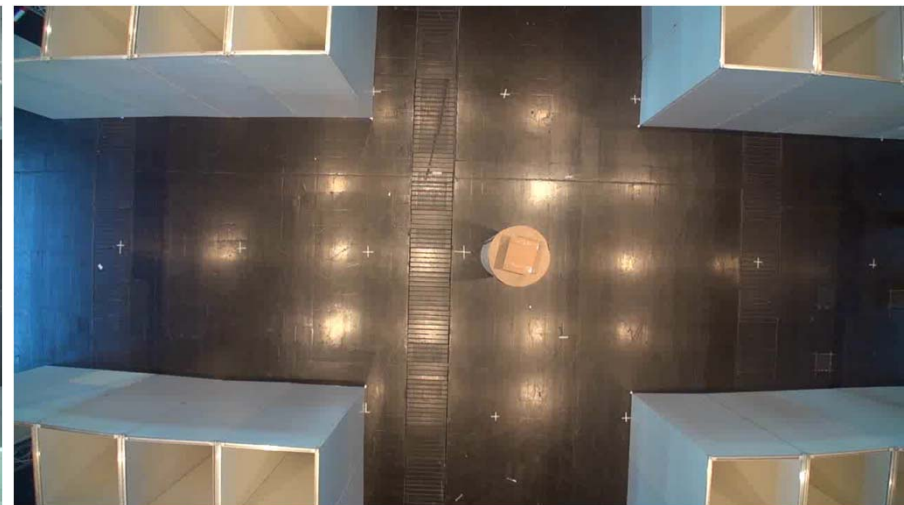
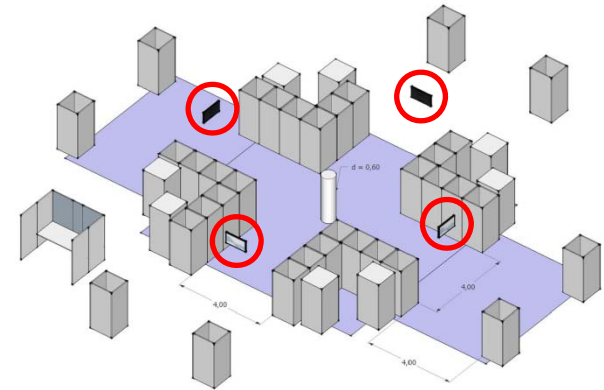
Facts

- Messe Düsseldorf
- 17 to 22 June 2013
- Organization and support
Forschungszentrum Jülich
University of Siegen
University of Wuppertal
University of Essex
- Individual tracking by Red-Solomon-Code



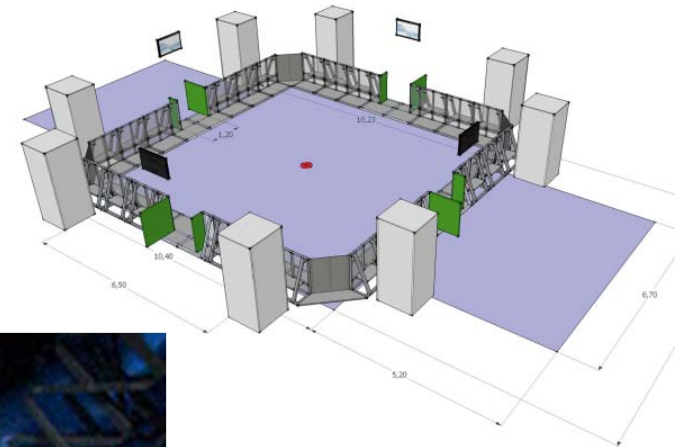
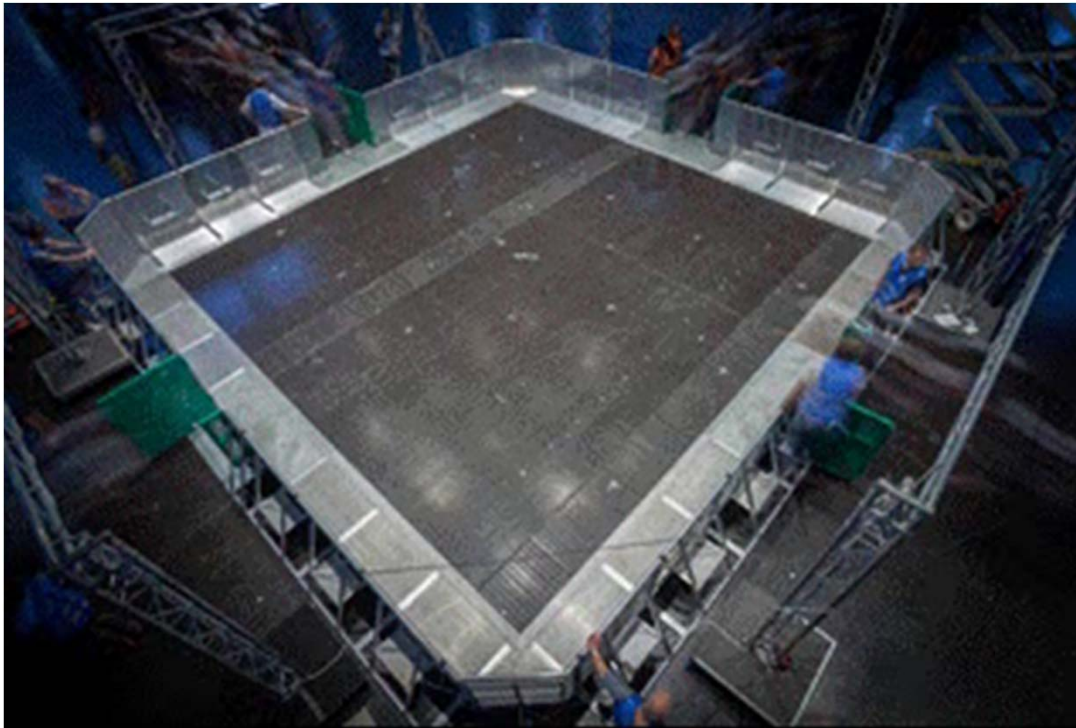
Traffic signs

- Without pillar, without traffic signs
- Without pillar, with traffic signs
- With pillar, with traffic signs



Barrier

- Different densities in a closed area
- Social cohesion
- Distribution near exits



Others



1D – stop and go



Inflow process



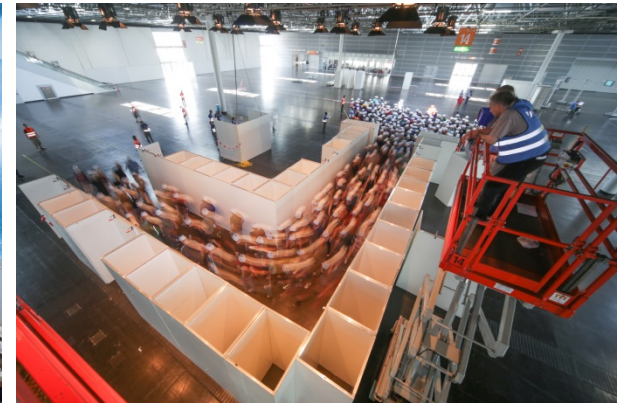
crosswalk



Routing



Crossing_120



Corner

