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TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

Research Team name:

Research Laboratory of Multiphase Media Physics

Presenter name: **Dr. Sergei Tisler, PhD**
sergei.tisler@ttu.ee

Team Presentation – Annual Workshop, COST Action MP1106
Dublin, September 13-14, 2012

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Team's general info

Research Team Name: **Research Laboratory of Multiphase Media Physics**
Number of team members: **10**

Team leader: **Ülo Rudi,** PhD, power engineering and fluid mechanics

- **Alexander Kartushinsky,** DSc, PhD, computational fluid mechanics
- **Medhat Hussainov,** PhD, experimental and computational fluid mechanics
- **Feliks Kaplanski,** PhD, computational fluid mechanics
- **Igor Krupenski,** PhD, computational fluid mechanics
- **Ants Martins,** PhD, power engineering and experimental fluid mechanics
- **Uku Pihlak,** PhD, chemistry and energetics
- **Igor Shcheglov,** MSc, optics and experimental fluid mechanics
- **Sergei Tisler,** PhD, mechanical engineering and experimental fluid mechanics
- **Alexander Shablinsky**, PhD student, thermal engineering and fluid mechanics

Publications: **JFM, Int. J. Multiphase Flow, Powder Technology, J. Aerosol Science, Rheologica Acta, CES, AIChE**

International co-operation: **COST Action FP1005 "Fibre suspension flow modelling: a key for innovation and competitiveness in the pulp & paper industry"**

Relevance to MP1106

Research interests related to MP1106:

- **gas-solid particles flows, pneumatic conveying, fluidized beds**
- **slurry flows, hydro- and sediment transport**

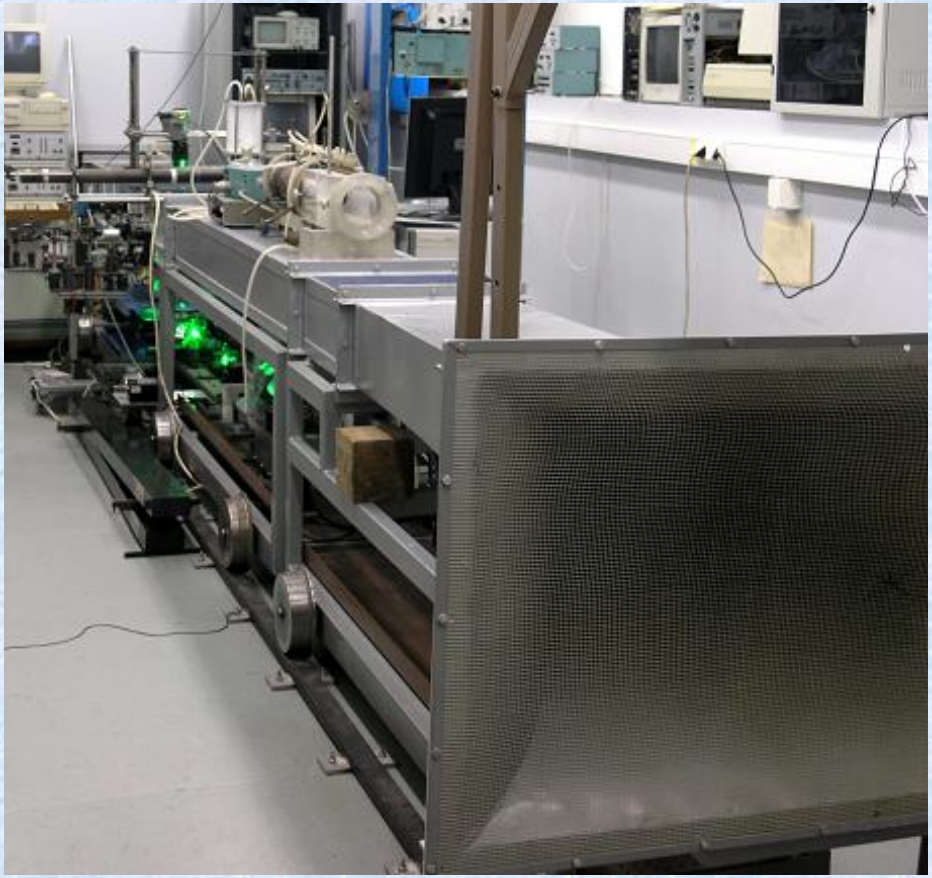
Phenomena being under consideration:

- **interparticle collisions**
- **particle-wall interactions**
- **particles-turbulence interactions**
- **particles dispersion**
- **particles clustering**
- **particles deposition**
- **vortex structures**

Lab description

Basic facilities, equipment, devices:

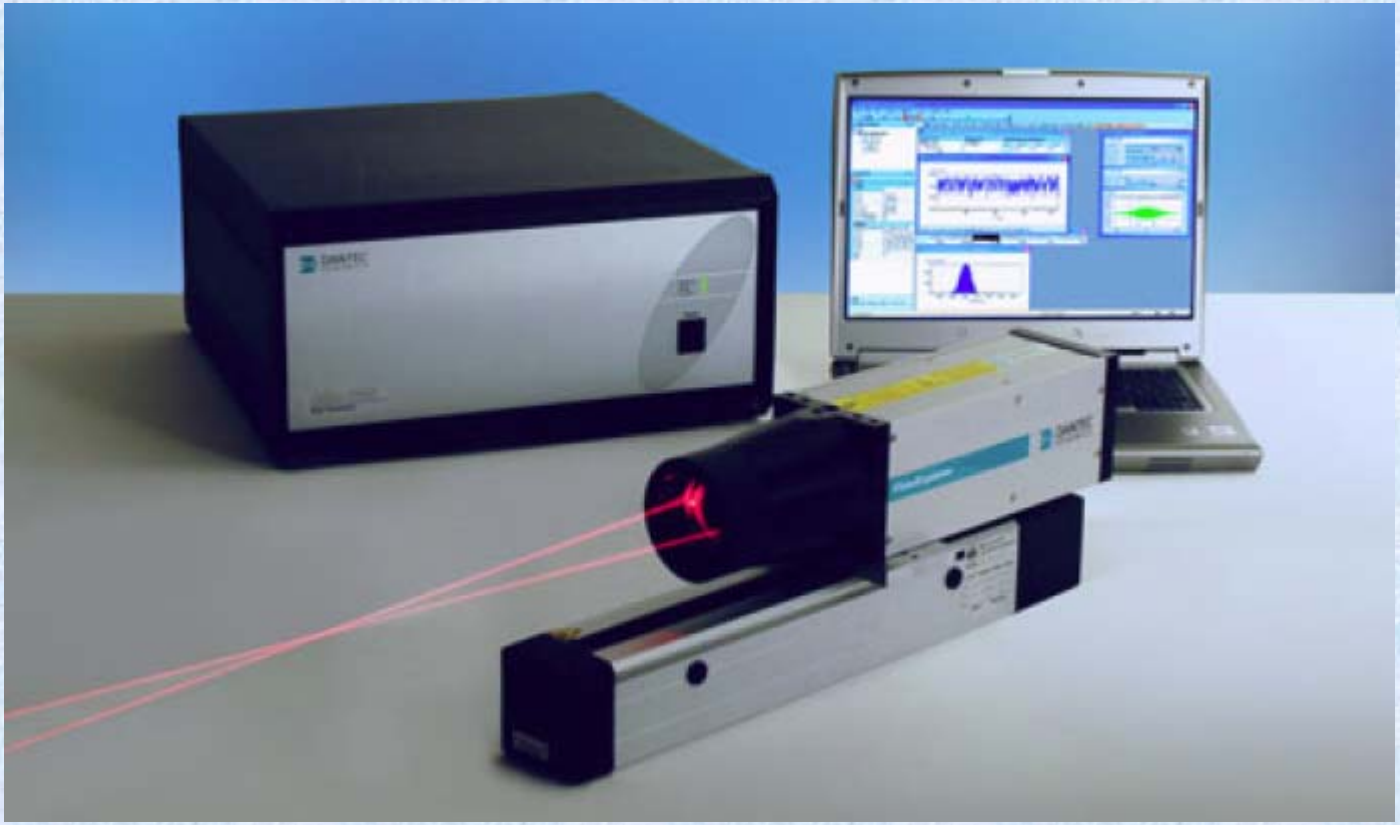
Test rig



Lab description

Basic facilities, equipment, devices:

DANTEC 2D LDA FlowExplorer



Lab description

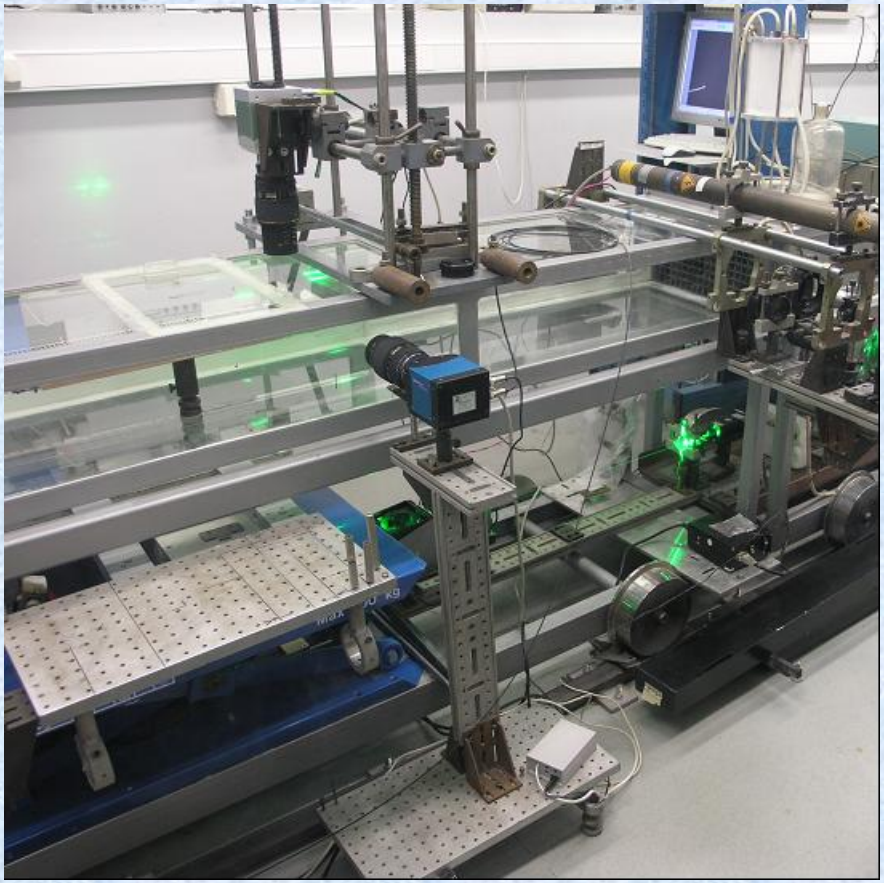
Basic facilities, equipment, devices:

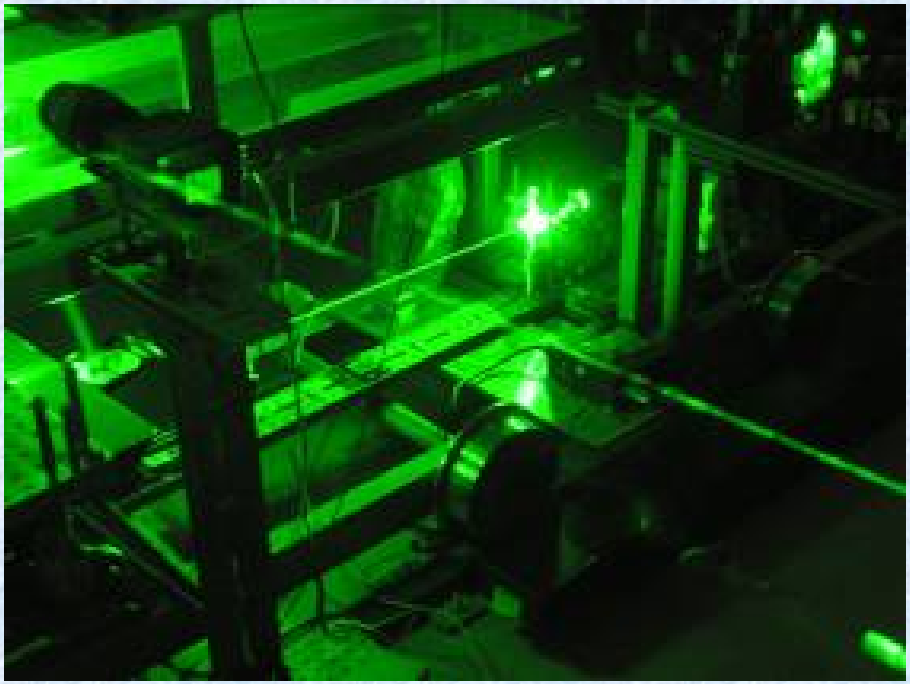
Malvern Mastersizer 3000 powder analysis system

Lab description

Basic facilities, equipment, devices:

Particle Tracking Velocimetry (PTV) system





Description of projects related to MP 1106

Projects

#1 project :

Title: ***3D original collision models for the particulate channel, shear and vortical flows and its practical application in technologies***

Duration: **2008 - 2013**

Funding organization: ***Estonian Science Foundation***

People involved:

1 DSc

5 PhDs

1 MSc

1 PhD student

Objective: ***3D mathematical models of turbulent particulate channel and shear flows***

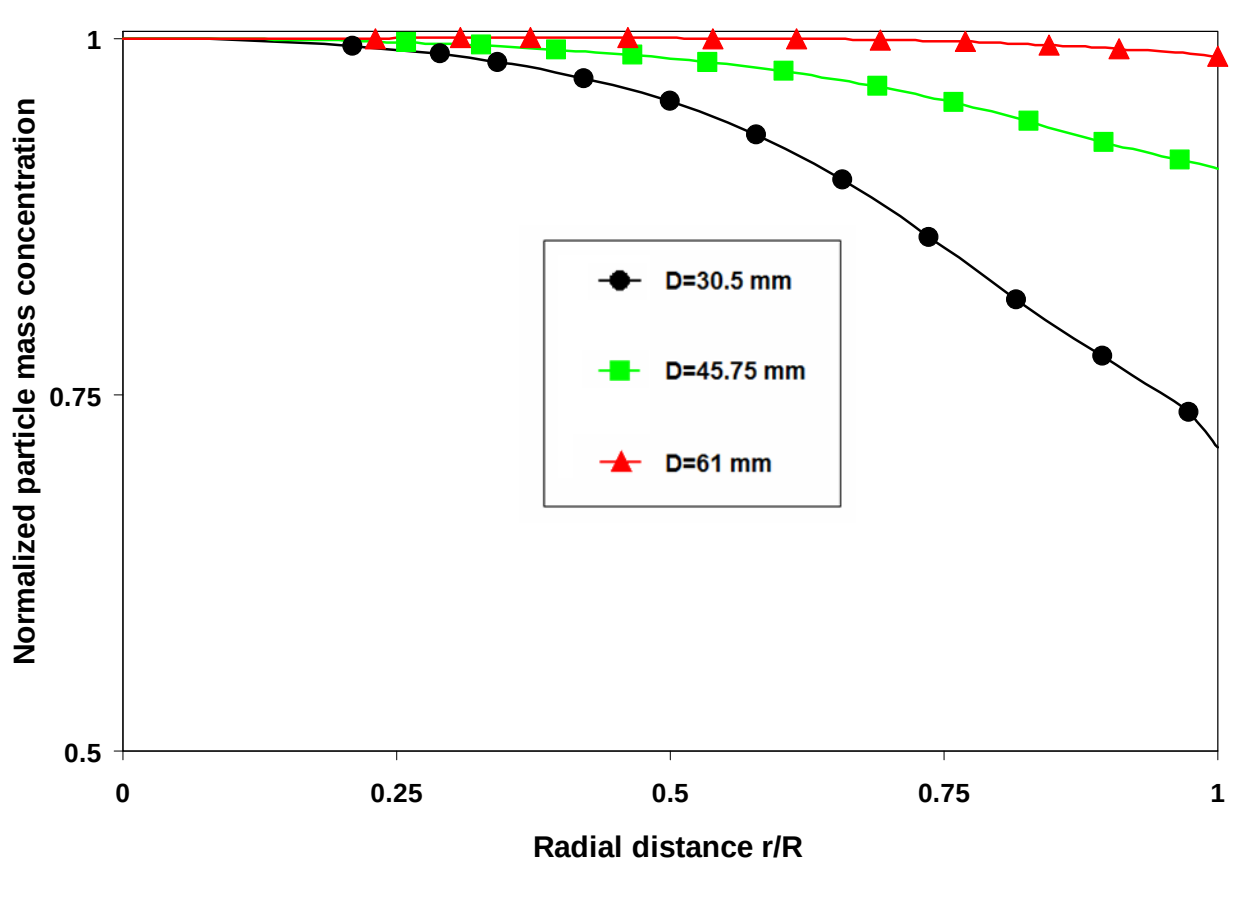
Projects

#1 project :

Numerical study of upward particulate pipe flows at constant Reynolds number

Effect of the pipe diameter on radial distribution of particle mass concentration in upward turbulent particulate pipe flow

250-μm coal particles, $Re=4.4 \cdot 10^4$, u=10, 14, 21 m/s, 1 and 10 kg/kg

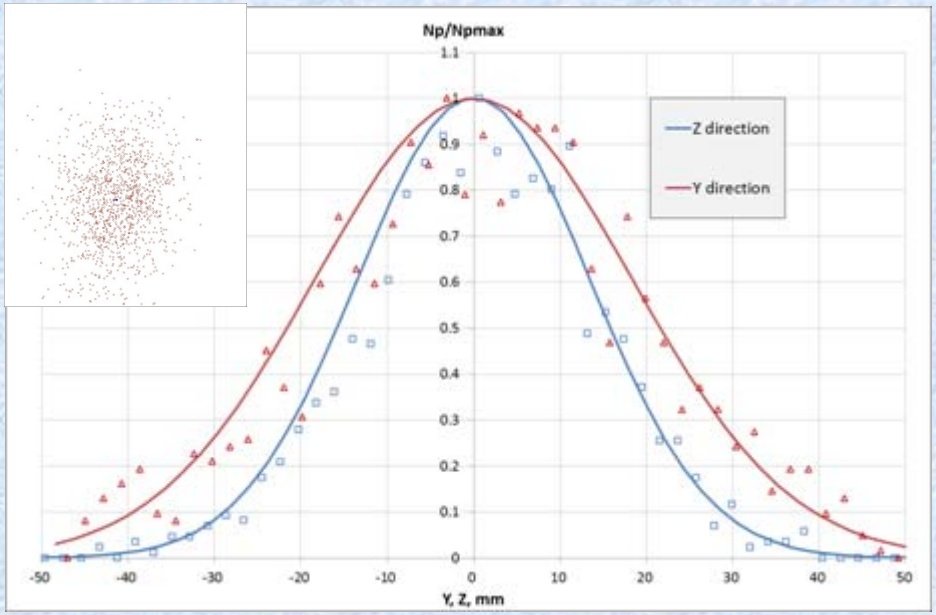


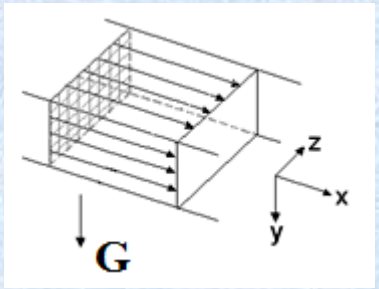
Projects

#1 project :

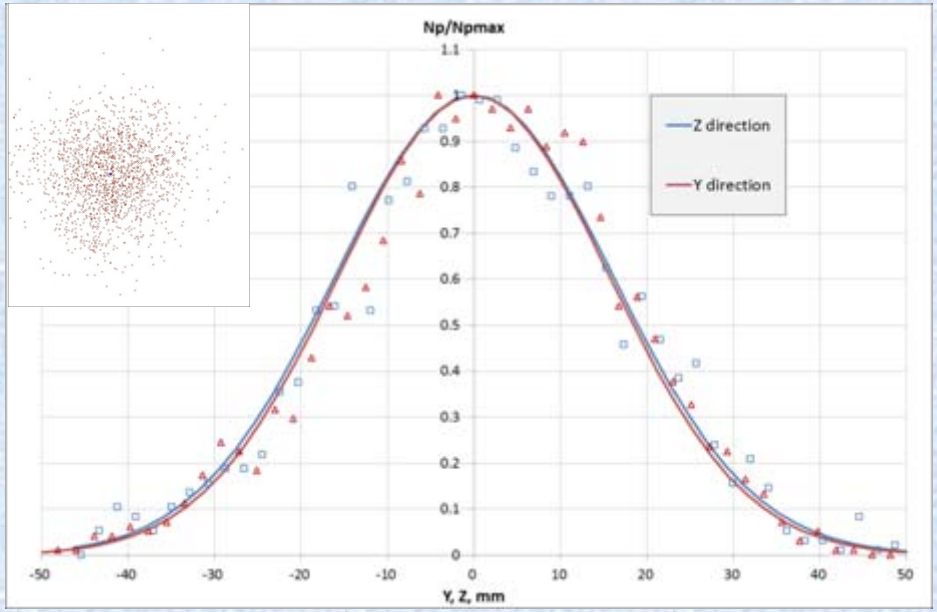
Dispersion of 55-μm glass particles in turbulent flows

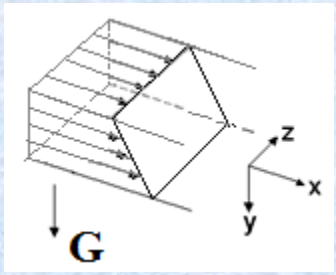
Grid-generated turbulent flow





Uniform velocity shear flow



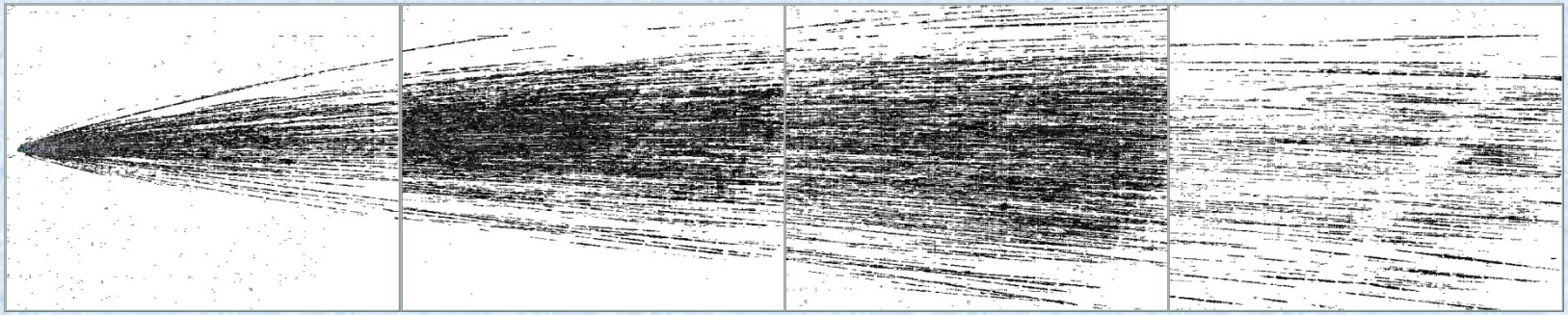


Projects

#1 project :

Dispersion of 55-μm glass particles in turbulent flows

Particle trajectories along the turbulent flow in vertical plane obtained by PTV



Projects

#2 project :

Title: ***Mathematical modelling of turbulent dense flows and applications***

Duration: **2012 - 2014**

Funding organization: ***Estonian Science Foundation***

People involved:

1 DSc

3 PhDs

1 MSc

1 PhD student

Objective: ***mathematical model for turbulent dense particulate flow in real long channels of rectangular cross-section***

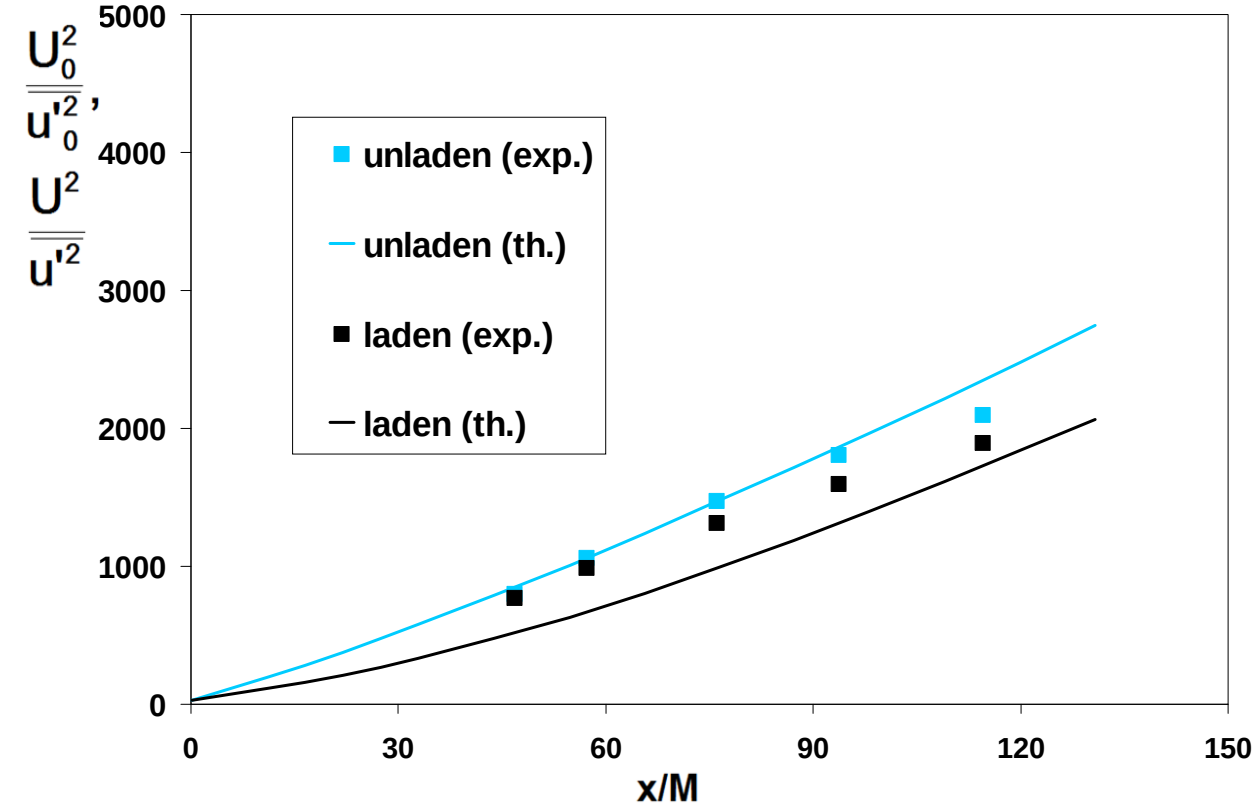
Projects

#2 project :

Numerical simulation of particulate grid-generating turbulence by 3D Reynolds Stress Turbulence Model (RSTM)

Effect of solid particles on the initial turbulence decay in rectangular downward grid-generated channel flow

700-μm glass beads, u=9.5 m/s, 0.14 kg/kg



Projects

#3 project :

Title: ***Deposition of solid particles in horizontal two-phase turbulent channel flow***

Duration: **2008 – 2010**

Funding organization: ***Estonian Science Foundation***

People involved:

2 PhDs

1 MSc

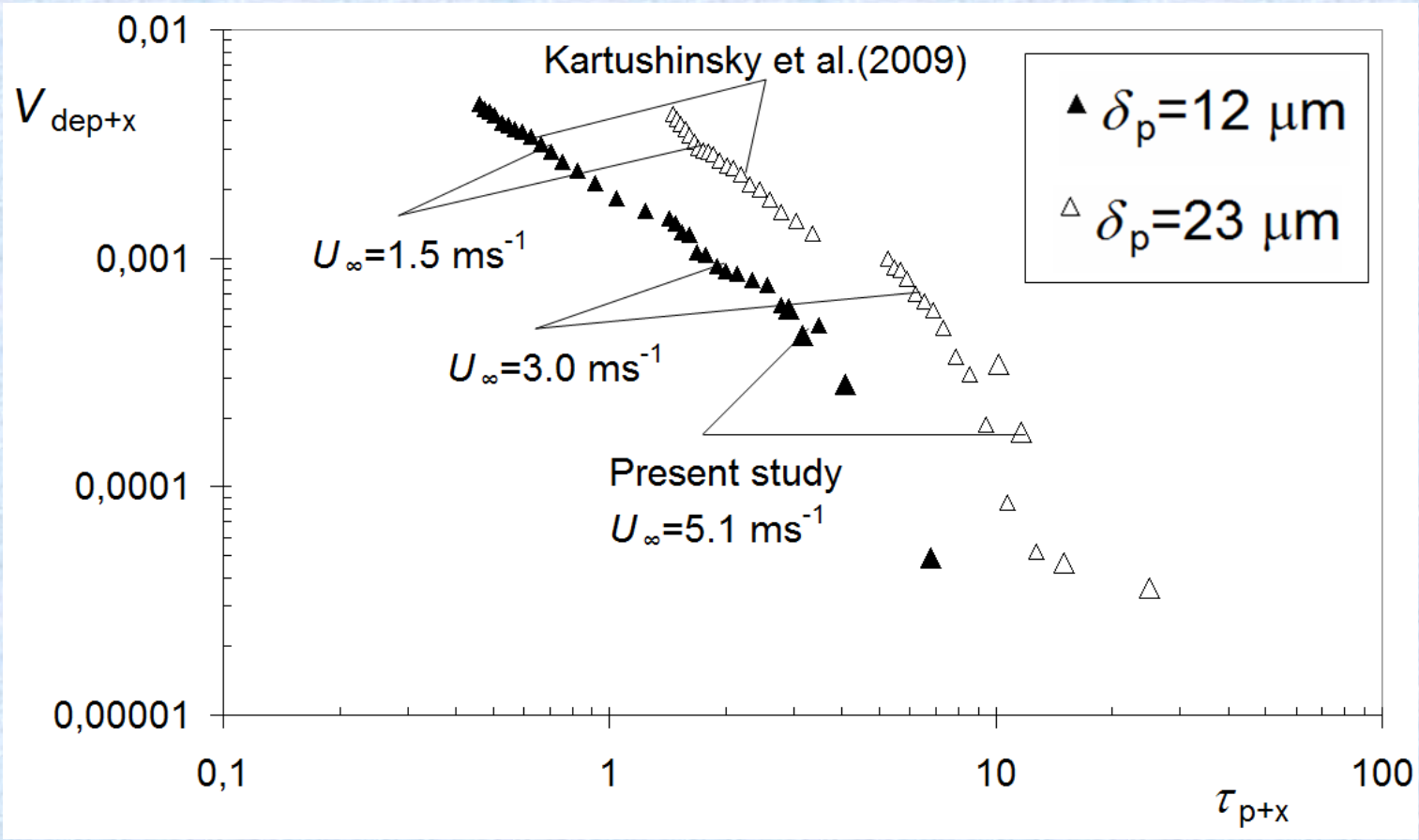
Objective: ***establishment of the generic relationships between the amount of the deposited particles and the hydrodynamic and adhesive aspects of deposition in turbulent channel flow***

Projects

#3 project :

Deposition of solid particles at streamlined flat plate in horizontal turbulent flow

Effect of the particles size on the deposition velocity
12 and 23 μm corundum particles, u=1.5, 3 m/s



Projects

#4 project :

Title: ***Combined sol-gel and solid-liquid phase separation processes in elaboration of novel shaped metal oxide nanoceramics***

(jointly with Institute of Physics, University of Tartu, Estonia)

Duration: **2012 - 2015**

Funding organization: ***Estonian Science Foundation***

People involved:

4 PhDs

4 PhD students

Objective: ***design and preparation of novel metal oxide micro and nano structures through the combined sol-gel/solid-liquid phase separation processes***

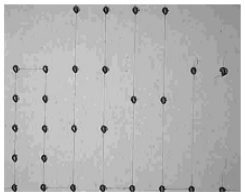
Our part: ***- rheological characterization of alkoxide-dased precursors***

- numerical simulation of microfibers and microtubes formation

Projects

#4 project :

Combined sol-gel and solid-liquid phase separation processes in elaboration of novel shaped metal oxide nanoceramics

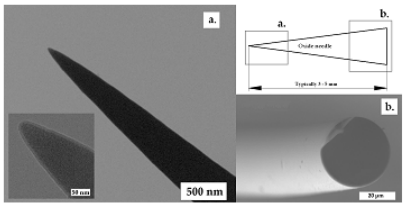


metal oxide fibres, down to 200nm diameter, pulled directly from point to point on the surface of solid substrates

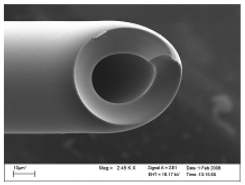
Initial liquid jet, obtained by direct drawing or by combination of extrusion and „spinning„

solidification of the jets

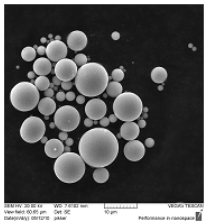
break up of the jet into droplets.



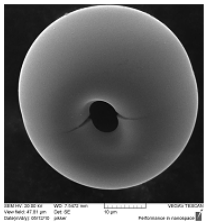
imideate solidification of pinched fiber results in formation of metal oxide needles with 15-25nm tip radii



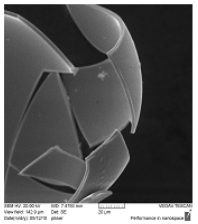
metal oxide microtubes are obtained when solidification of the jets occures simultanously with solid-liquid phase separation



when liquid jets are brokened and let to form spherical particles under surface tension of the precursor, metal oxide spheres can be



when droplets are solidified in limited space, metal oxide torroidals can be prepared



metal oxide bubbles can be solidified as emthy or filled containers (brokened emphty bubble on the image).

Topics for Research Proposal

Title: ***Transport and deposition of droplets onto various surfaces in turbulent air flows***

Phenomena for future investigations:

- **droplets-turbulence interactions**
- **droplets interactions (coalescence and breakup)**
- **droplets-surface interactions**
- **droplets deposition**

Our participation:

hydrodynamic aspects (numerical modelling and experimental validation)

Expertise required: **physical chemist who is competent in surface effects**

Equipment required: **droplets generator, Malvern Spraytec droplets analyzer, rheological instrumentation**

Thank you for your attention