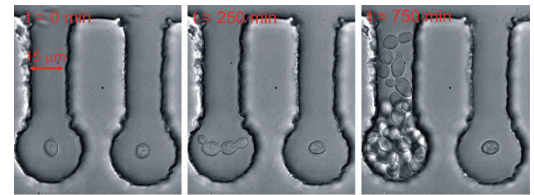
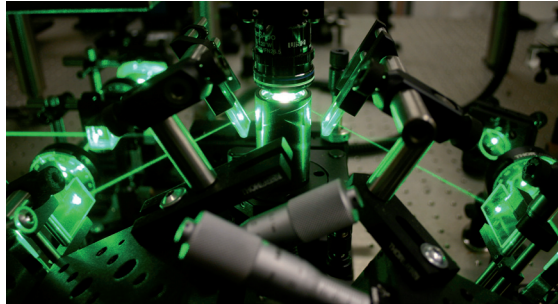


RESEARCH GROUP CONTACT >>

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## THEMATIC RESEARCH FOCUS >

### RESEARCH AREA

- » Optics
- » Micro(nano)technologies
- » Laser spectroscopy
- » Microfluidics

### EXCELLENCE

- » Optical micromanipulation techniques and laser microspectroscopy

### MISSION

To be at the forefront in looking for new optical methods appropriate for contactless, nondestructive investigation of both living and nonliving parts of the microworld.

## DEVELOPED TECHNOLOGIES >

### CONTENT OF RESEARCH

- » Theoretical and experimental activities related to optical micromanipulations with microobjects and nanoobjects (light scattering, optical tweezers, optical sorters, optical scalpel, optical delivery, optical binding, localized plasmons, photonic force microscope, force spectroscopy, microfluidics)
- » Raman microspectroscopy, Surface enhanced Raman spectroscopy, Raman tweezers

## MAIN CAPABILITIES

### Basic research

- » Theoretical simulations of light scattering and optical forces acting on microparticles and nanoparticles illuminated by spatially structured laser beams
- » Experimental activities related to micromanipulation with microparticles or nanoparticles using laser beams (sample preparation, laser beam shaping and positioning, microobjects precise position measurement, pN force measurement, optical sorters)
- » Spatially resolved Raman spectroscopy combined with optical micromanipulation techniques

### Application research + protection forms

- » Manufacturing of on-demand opto-mechanical systems using focused laser beams
- » Design and manufacturing of microfluidic chips by soft-lithography
- » Photopolymerization of microstructures

## FIELDS OF RESEARCH RESULTS APPLICATION

### Fields of research results application

- » Optical microscopy
- » Microtechnology, nanotechnology
- » Biophotonics
- » Cell biology
- » Colloidal chemistry
- » Laser spectroscopy
- » Microfluidics
- » Lab-on-a-chip systems
- » Algal research



## NUMBER OF RESEARCH POSITIONS ↘

### SENIOR RESEARCH STAFF (FTE/HC)

2/2

### JUNIOR RESEARCH POSITIONS (INCL. PH.D. STUDENTS) (FTE/HC)

10/11

## KEY RESEARCH EQUIPMENT ↘

### LIST OF DEVICES

- » Various CW high power lasers working at 1064 nm, 532 nm, 680-1000 nm (Coherent, Spectra Physics)
- » Femtosecond laser system Mira HP
- » Raman microspectrometer made by the research team
- » Raman tweezers made by the research team
- » Photonic force microscope made by the research team
- » Optical sorters made by the research team
- » Several different flexible systems for advanced optical micromanipulation experiments (holographic tweezers, dual-beam traps)
- » Fast CCD cameras (thousands fps)

## BUDGET ↘

### TOTAL (MIL. CZK)

8

### PART OF THE TOTAL BUDGET FROM PRIVATE RESOURCES (%)

5

### PART OF THE TOTAL BUDGET FROM FOREIGN RESOURCES (%)

3

## MAIN PROJECTS ↘

**2004–2007:** Advanced Techniques for Optical Manipulation using novel 3D light field synthesis (project financed by the European Commission 6th Framework Programme NEST ADVENTURE Activity: 508952 ATOM 3D)

**2006–2010:** Centre of Modern Optics (project LC06007 financed by the Ministry of Education, Youth and Sports of the Czech Republic)

**2009–2013:** Development of instrumentation and methodology for the selection of photoautotrophic microorganisms for production of higher-generation biofuels (project FR-TI1/433 financed by the Ministry of Industry and Trade of the Czech Republic)

**2011–2014:** Non-invasive contactless methods of identification and characterization of living microorganisms by optical spectroscopy and micromanipulation (project GAP205/11/1687 financed by the Czech Science Foundation)

**2009–2013:** ALISI (Application laboratories of microtechnologies and nanotechnologies), project financed by the Ministry of Education, Youth and Sports of the Czech Republic + EC CZ.1.05/2.1.00/01.0017

### ACHIEVEMENTS

Almost one hundred outputs in impacted journals, conference proceedings or local journals with strong citation response.

#### **Simultaneous optical trapping and delivery of thousands of sub-micrometer particles in non-diffracting laser beams or evanescent waves**

- » Particle delivery in travelling periodic interference structures (standing waves, co-propagating beams) – so called Optical conveyor belt (together with Prof. K. Dholakia's group at St. Andrews). This tool attracted attention in 2005 and was mentioned in American Institute of Physics News, Physics Update in Physics Today, Czech TV program „Czech heads“, and was also mentioned by Czech TV among the most important Czech scientific achievements in 2005.
- » Generation of 1 mm long array of 5000 optical traps with thousands optically trapped sub-micrometer particles and their simultaneous delivery.
- » Optical confinement and arrangement of sub-micrometer objects on surface using interfering evanescent waves
- » Theoretical model for fast calculation of optical forces in non-diffracting beams and evanescent waves.

#### **Optical sorting of microobjects**

- » Discovery of two original methods of spontaneous optical sorting of polydisperse sample of sub-micron size objects according to their sizes in interfering laser beams (optical sorter). Up to now the smallest difference in the sizes of sorted objects was 60 nm for polystyrene beads of diameters 350 a 410 nm (together with Prof. K. Dholakia's group at St. Andrews). Presented also in Czech TV program „Czech heads“.
- » New methods of two-dimensional sorting of microobjects using travelling interference structures (together with Prof. K. Volke Sepúlveda and A. Arzola from Instituto de Física Universidad Nacional Autónoma de México).
- » Optical cell-sorted based on fluorescences or Raman spectra (together with PSI).

#### **Pioneering theoretical and experimental activities related to the optical self-arrangement of microparticles in laser beams**

#### **Manufacturing of polymer fibres of diameters in units of micrometers and length in centimetres by non-diffracting beams.**

#### **Compact optical tweezers compatible with majority of optical microscopes without their modifications (utility model awarded)**

#### **Combination of Raman microspectroscopy and optical tweezers and its utilization for optical trapping of microobjects together with identification of their composition**

For more details and publications see [www.isibrno.cz/omitec](http://www.isibrno.cz/omitec)



## MAIN COLLABORATING PARTNERS ↘

### COLLABORATION WITH ACADEMIC PARTNERS

- » University of St. Andrews (St. Andrews, GB)
- » University of Naples Federico II (Naple, IT)
- » University of Texas (Austin, US)
- » Koc University (Istanbul, TR)
- » Universidad Nacional Autonoma de Mexico (Mexico City, MX)
- » Palacky University (Olomouc, CZ)
- » Max Planck Institute of Molecular Cell Biology and Genetics (Dresden, DE)
- » Brno University of Technology (Brno, CZ)
- » Masaryk University (Brno, CZ)

### COLLABORATION WITH COMPANIES

- » Photon Systems Instruments (Drasov, CZ)
- » Meopta (Přerov, CZ)
- » Measurement Technic Moravia Ltd. (Omice, CZ)

## EXPECTATIONS ↘

### REQUIREMENTS

- » We are looking for cooperation with academic partners as well as companies in the fields of optics, biophotonics, microtechnologies, nanotechnologies, applications of optical methods in biology and medicine.

### OFFERS

- » We offer our know-how in the areas of our expertise.

