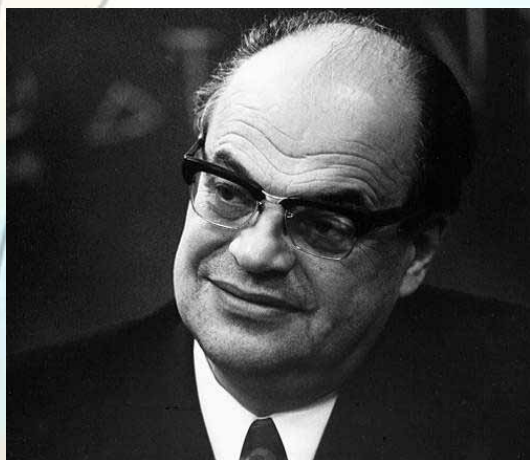


# **P.N.Lebedev Physical Institute Samara Branch (Samara Region Laser Innovative Technological Center)**

Acting director of the branch, Head of the Center  
Dr.Vladimir Kazakevich

Berlin, November 20-24, 2006

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Academician N.G.Basov



Dr.V.A.Katulin

P.N.Lebedev Physical Institute Samara Branch was founded in 1980. At present the Branch consists of 6 laboratories, the staff of the Branch equals 135, the staff of research workers equals 76, including 27 doctors.

## **The research works of the Branch are concerned with:**

1. The investigations and developments of technological lasers and their elements;
2. The development of the methods and facilities of creation and registration of the laser beams with specified parameters;
3. The development of the modern laser technologies;
4. The development of the facilities of no contacts diagnostics for industry and medicine;
5. The educational activity



# 1. The investigations and developments of technological lasers and their elements

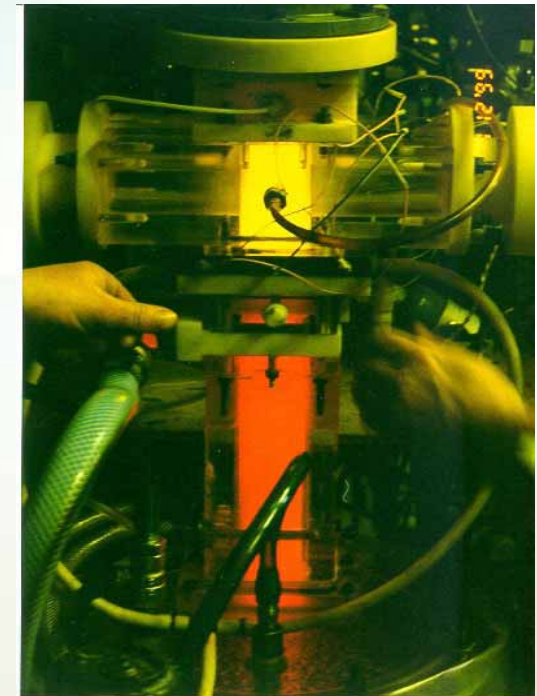
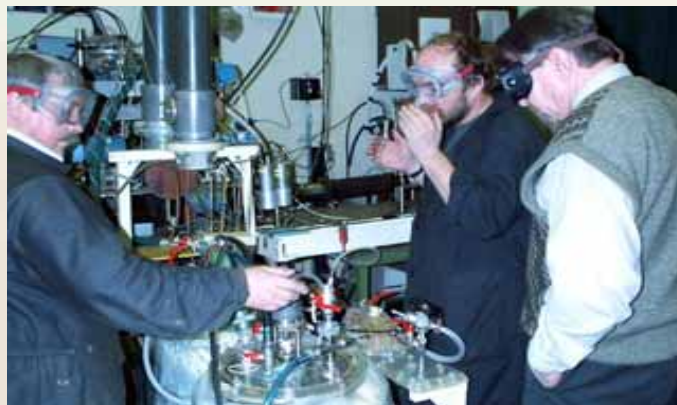
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- Investigations of chemical lasers on the base of photon chain reactions;
- Repetitively pulsed EBCD CO Laser with closed cycle;
- Source of singlet oxygen and chemical oxygen-iodine laser ;
- Pulsed technological laser for high-quality deep welding

# 1. The investigations and developments of technological lasers and their elements

## ➤ Source of singlet oxygen and chemical oxygen-iodine laser

The jet and centrifugal bubble chemical sources of singlet oxygen are created. The compact 1kW oxygen-iodine laser cell with total active medium pressure more than 200 mm. mercury is produced. On the basis of these laser cells it is possible to create CW oxygen-iodine laser with output power more than 20kW for cutting of thick-walled steel structures.



The singlet oxygen jet chemical sources

# 1. The investigations and developments of technological lasers and their elements

## ➤ Pulsed technological laser for high-quality deep welding

Result of action on a steel of a commercial technological laser ⇒



Dr.S.V,Kayukov demonstrates the result laser welding

The extended depth of single joint weld	5,0 mm
The extended depth of jointing welding	3,5 mm
The extended depth of single apertures	6,0 mm

Result of action on a steel of the retrofit laser ⇒



## 2. The development of the methods and facilities of creation and registration of the laser beams

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- Spiral beams – the new way of the coherent optics;
- Wave front detector;
- The modal liquid crystal lenses and corrector elements
- The diode astigmatism measurement equipment ;
- Liquid crystal optical isolator cell.



Dr. V.G.Volostnikov

## 2. The development of the methods and facilities of creation and registration of the laser beams

### ➤ Spiral beams – the new way of the coherent optics

The property of the spiral beams:

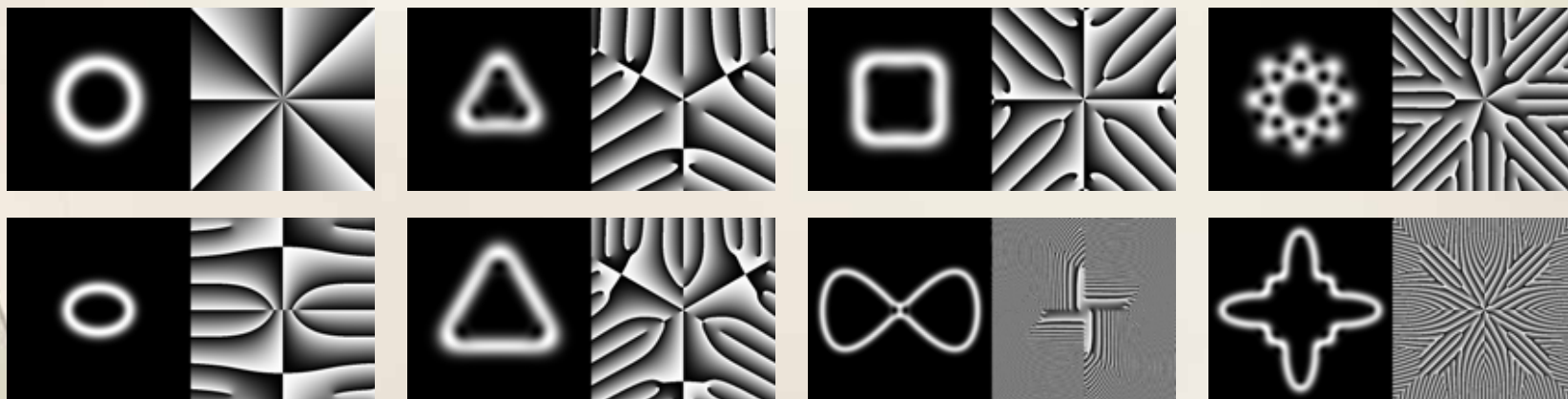
- the beams have various forms and sizes;
- the beams keep form at the propagation and focusing in any plane;
- the beams have angle momentum.



Theory



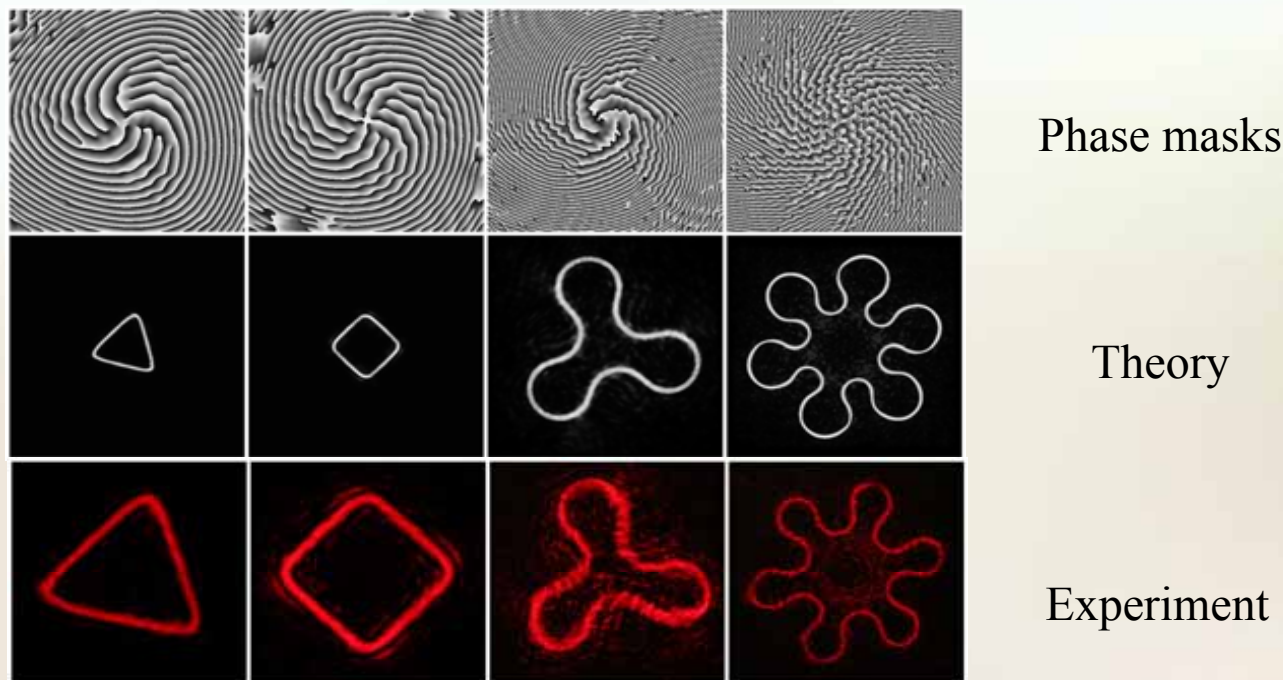
Experiment



## 2. The development of the methods and facilities of creation and registration of the laser beams

### ➤ The phase masks for spiral beams

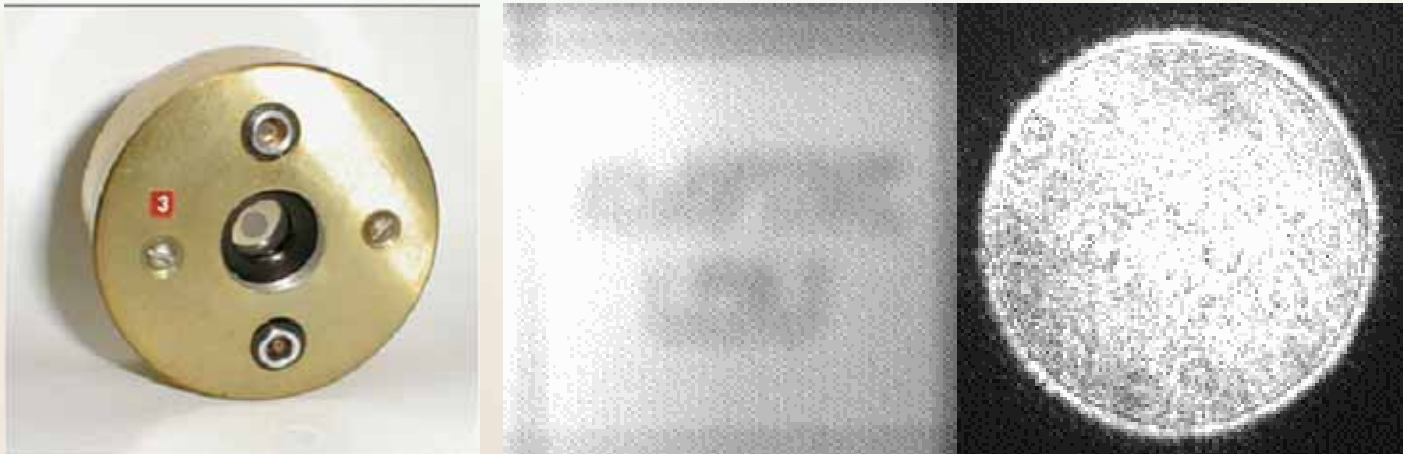
- enable to create the light fields with the given profile of intensity;
- have the energy efficiency of about 70%;
- generate the light fields with angular momentum



## 2. The development of the methods and facilities of creation and registration of the laser beams

- The electrical and optical control modal liquid crystal lenses – new type of the lenses with the variable focal distance

Configuration	Spherical or cylindrical
Turndown of the focal distance	Up 0.5 m ad infinitum
Frequency range of the control voltage	40-1000 Hz
Working voltage	Less than 10 V, usually 4-5 V



Spherical adaptive lens

## 2. The development of the methods and facilities of creation and registration of the laser beams

- The modal liquid crystal waveform corrector with variable response function .

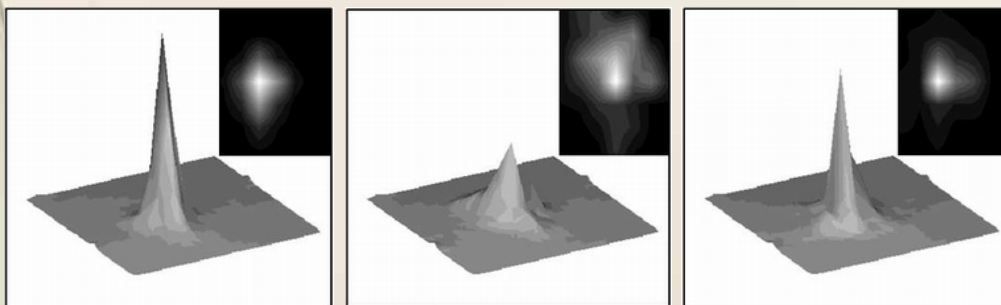
Aperture	30 и 70 mm
Number of control electrodes	37, 61
Depth of phase modulation for 633 nm	Up to $10 \lambda$
Spectral range	0.44 – 2 $\mu\text{m}$
Refltction	More than 70%
Frequency range of control voltage	1-20 kHz
Working voltage	Less than 10 V



Corrector with 30mm aperture



Corrector with 70mm aperture



Operational demonstration of the modal LC corrector in closed adaptive system (Durham University, UK, 2002 г.)

### 3. The development of the modern laser technologies

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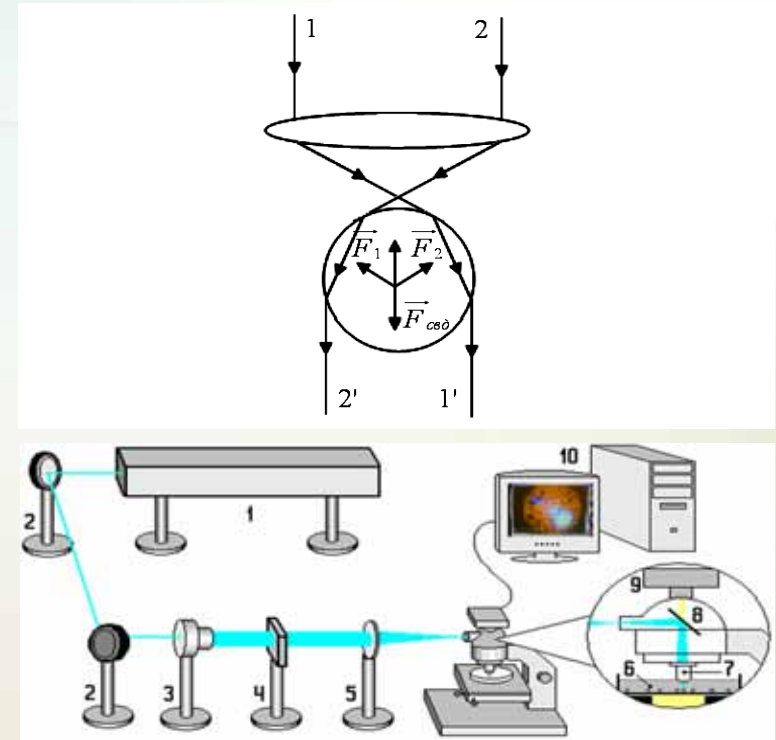
- Laser manipulation by microobjects;
- Technology and setup for fastening of steel kite bearing demiseparators by means of pulse laser welding;
- Technology and setup for fastening of bearing protective ring plates by means of pin laser welding;
- Synthesis of functional examples by means of selective laser sintering (SLS);
- Synthesis of functional bio implants by means of SLS;
- Laser synthesis of gradient porous filter cells with planned simulated structure of the filter substance and its interstices;
- Level-to-level synthesis of ceramics with gradient of the electrophysics properties by means of SLS;
- Laser all-carbon composites and carbon materials;
- Pulse laser strengthening of metal-cutting tools;
- Technology and setup for lap and butt laser weld of aluminum bands for communications cables

### 3. The development of the modern laser technologies

#### ➤ Laser manipulation by microobjects

Differences:

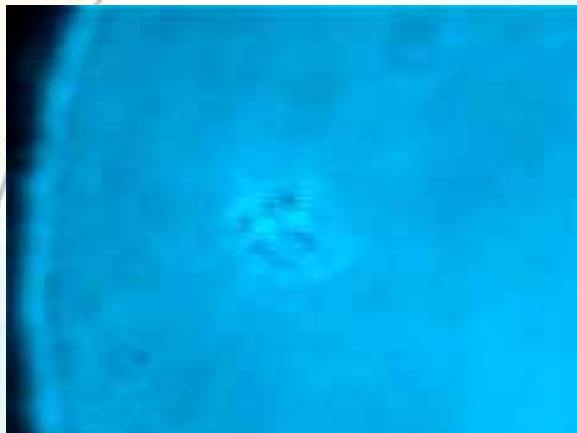
- Using of the vortex laser fields for manipulation;
- Moving of the particles along reference trajectory without mechanical subsystem displacement;
- The size of captured particulars – up  $0,5 \mu\text{m}$  to  $30 \mu\text{m}$  ;
- Particle traverse speed - up to  $5 \mu\text{m} / \text{sec}$
- It is possible to manipulate by biological objects



### 3. The development of the modern laser technologies

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#### ➤ Laser manipulation by microobjects



2  $\mu\text{m}$  latex particle movement

### 3. The development of the modern laser technologies

- Synthesis of functional examples by means of selective laser sintering (SLS)



Synthesised metal-polymer samples



SLS process

Used powder materials:

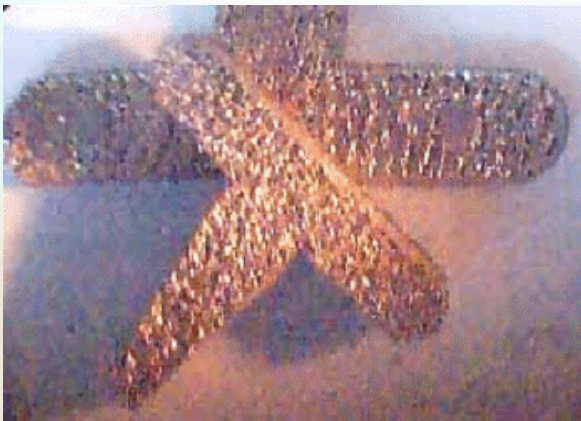
- metal-polymer mixtures;
- bimetallic compounds;
- ceramics;
- gradient materials

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### 3. The development of the modern laser technologies

#### ➤ Synthesis of functional bio implants by means of SLS

Bio compatible porous Ti and NiTi implants synthesized by SLS method



Cranioplastic samples (Ti).



Di-molar (NiTi)



3D level-to-level welding deposition of Ti powder on Ti stomatological pin

### 3. The development of the modern laser technologies

- Laser synthesis of gradient porous filter cells with planned simulated structure of the filter substance and its interstices



Filter elements for oil and gas industry

Main advantages:

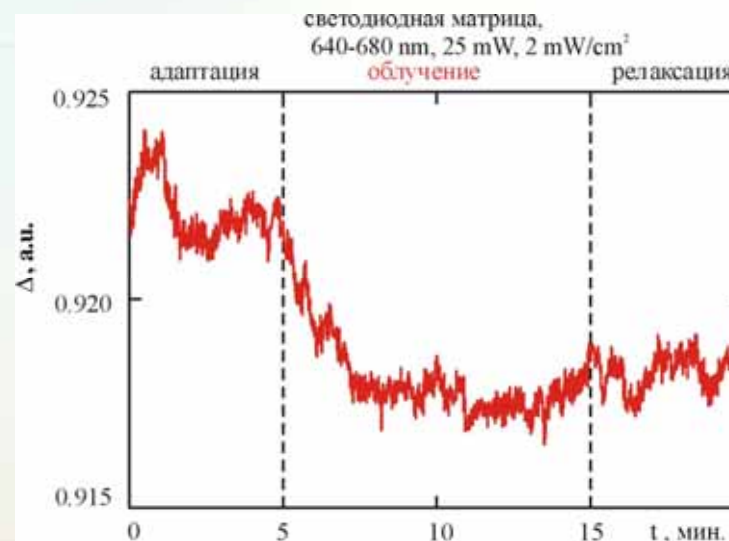
- Making of filters with any irregular shapes;
- Making of the gradient filter cells;
- Implantation of catalytic dopes.

## 4. The development of the facilities of no contacts diagnostics for industry and medicine

### ➤ Indicator of vascular organism responses



Clinical trials



Typical laser radiation organism response

# 5. The educational activity



Teaching



Scientific advisory activity



Conferencing for young scientists and engineers

**Thank you for  
your  
Attention!**

Berlin, November 20-24, 2006