B. I. Stepanov Institute of Physics
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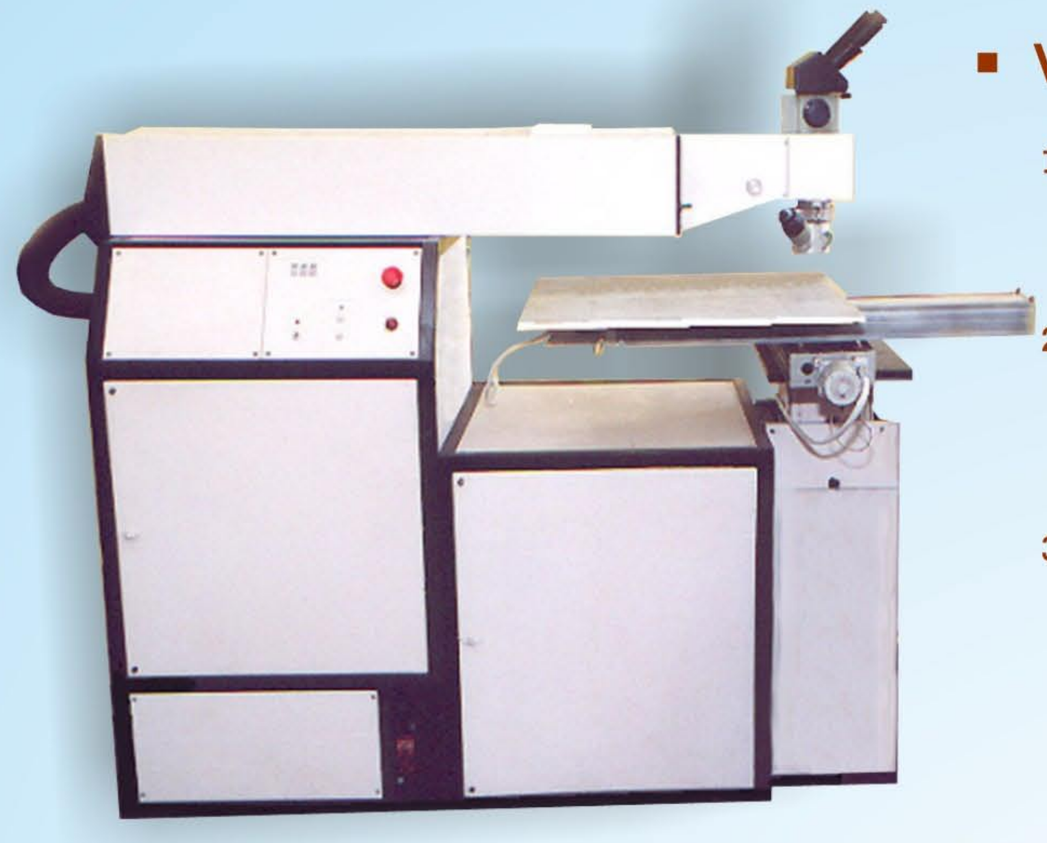
АКСИКОН

Laser processing systems

The apparatus is designed for marking and engraving products of metal, plastics, ceramic and varnish-and-paint products and making of other coatings in the machine-building, instrument-making, and metal-working, and for laser marking of gems and jewelries.



Apparatus for laser scanning marking

- **Variants of engraving of product surfaces:**

1. By moving an object on a coordinate table with a field of 500x500 mm (and up to 1600x1200 mm) with an accuracy of 0.02 mm; the executive device remains immovable. The speed is of up to 20 mm/s.
2. By scanning of a laser beam with the use of a galvanic drive and a wide-angle small-aberration galvanometric objective with a field of 50x50 mm (including from 300 to 2000 points) that forms a plane image in the focal surface; the object and the executive device are fixed. The speed is of up to 300 mm/s.
3. By the use of a scanning objective placed on a two-axis table with a fixed object; the speed is of up to 20 mm/s.

Wavelength of laser emission: 1.064 μm (for possible modification 10.6 μm)
Height of engraved signs: min. 0.6 mm
Average width of lines: 0.05 mm
Dimensions: 1900x900x1200 mm
Weight: 250 kg
Power consumption (380V, 50Hz): 4 kW

Laser radiation wavelength: 1.064, 0.533, 0.266 μm;
Pulse repetition rate: up to 25 Hz;
Energy of a laser radiation pulse:
– for 1.064 μm – up to 200 mJ,
– for 0.533 μm – up to 100 mJ,
– for 0.266 μm – up to 20 mJ;
Height of marks: 30–150 μm;
Output of marking (average): 10 products in an hour;
Magnification of the TV system of the apparatus table: 40–100x;
Overal dimensions of the apparatus:
– Control past: 850x650x1350 mm;
– Apparatus table: 750x1200x1350 mm;
Mass of the apparatus: 250 kg.

Apparatus for laser marking of gems and jewelries

The technological apparatus is designed for cutting of ferrous and non-ferrous metals as well as for manufacturing of products in the machine-building, instrument-making, and metal-working industries.

Thickness of a material (steel) cut: max. 5 mm
Weight of the treated part: max. 10 kg
Radiation wavelength: 1.064 μm
Laser-radiation power: max. 150 W
Mode of operation: pulsed

Three-axis table:
displacement speed: up to 30 mm/s
linear displacement along X-Y/Z: 500/100 mm
accuracy of the X-Y/ Z displacement: 20/50 μm
Control of the apparatus: IBM PC
Operating system: Microsoft Windows 98
Dimension (without PC) : 2400x1400x1600mm
Weight: 550 kg
Power consumption (380V, 50Hz): 12 kW

- **Complete set of equipment and parameters:**

1. Units for rotation of a treated part around the vertical and cross axes.
2. A light-guide attachment for laser-radiation transportation.
3. A visual-control device with a video camera.

Apparatus for laser cutting of materials

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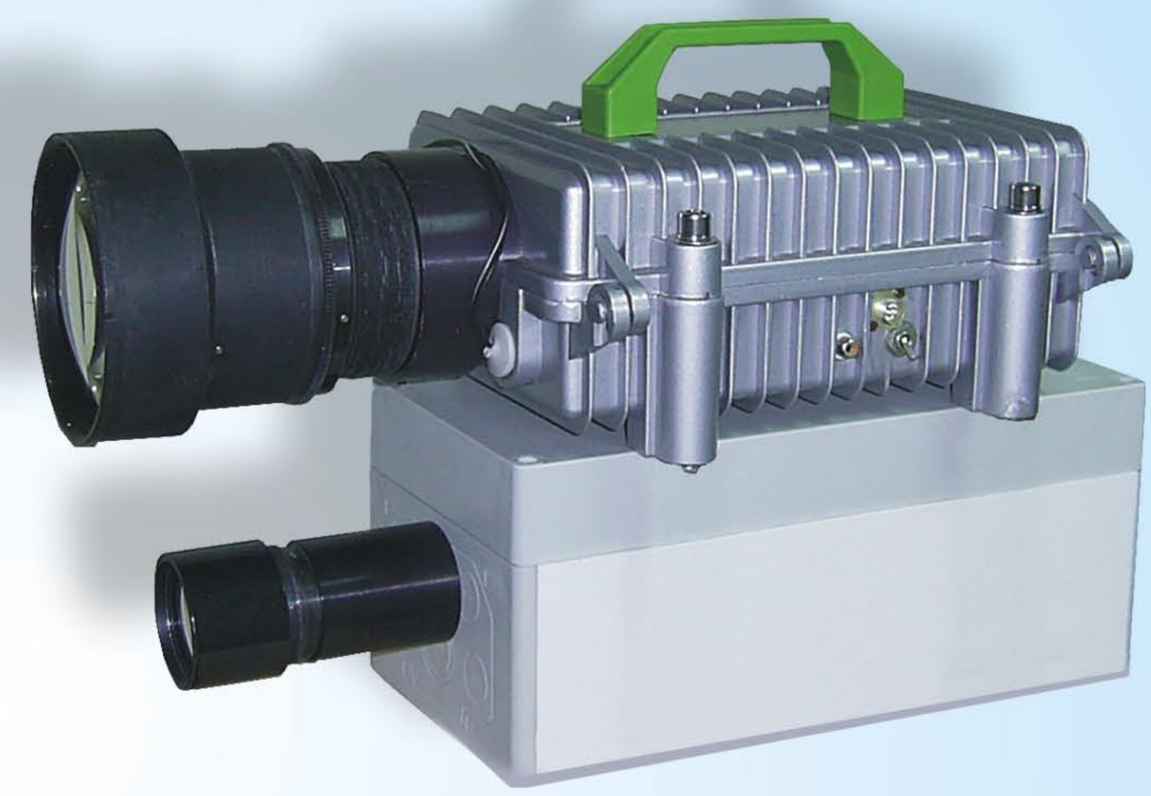
Experimental sample of the optical electronic system for safe driving of heavy-load carrier dump trucks in conditions of limited transparency of atmosphere

The system is based on cutting the background optical signal from a near zone by the method of laser active pulse strobing.

It is intended for reception of habitual image of road conditions at the limited visibility (fog, dust, rain, snow, etc).



■ Technical characteristics:

Distance up to border of the supervision zone:
minimal: **5...10 m**
maximal: **100...200 m**
Length of the supervision zone:
minimal: **3 m**
maximal: **50 m**
Corner of the review:
vertically: **7 °**
horizontally: **15 °**
Working voltage: **18...32 V**
Consumption power: **no more 2 W**
Dimensions: **450 x 220 x 255 mm**
Weight: **3,5 kg**

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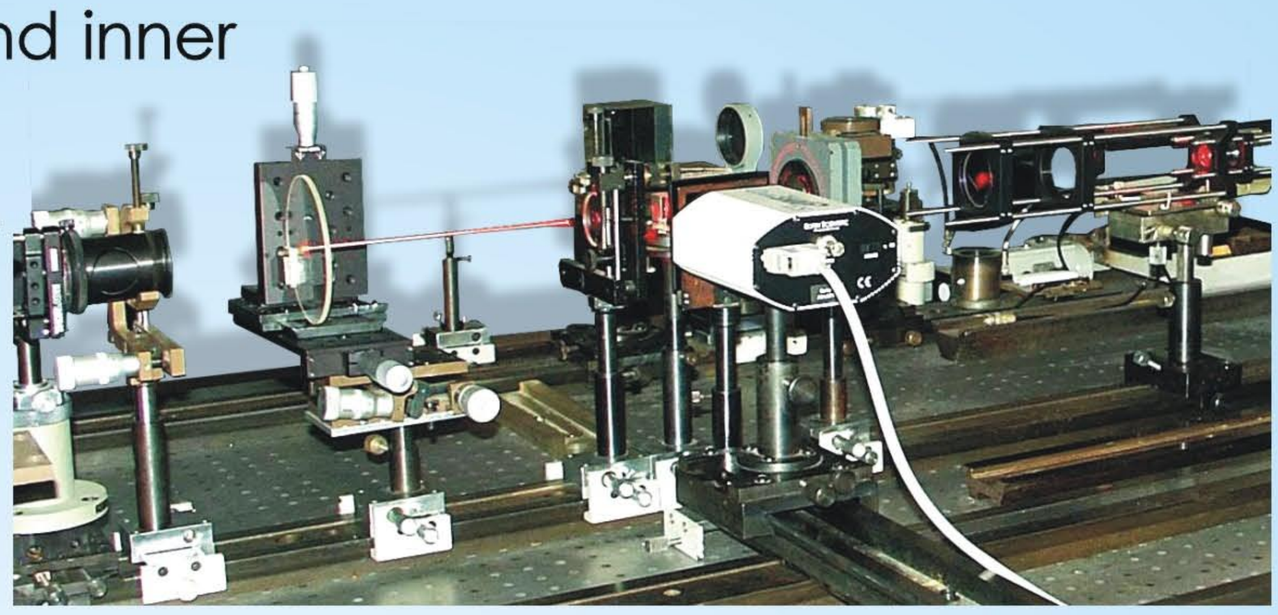
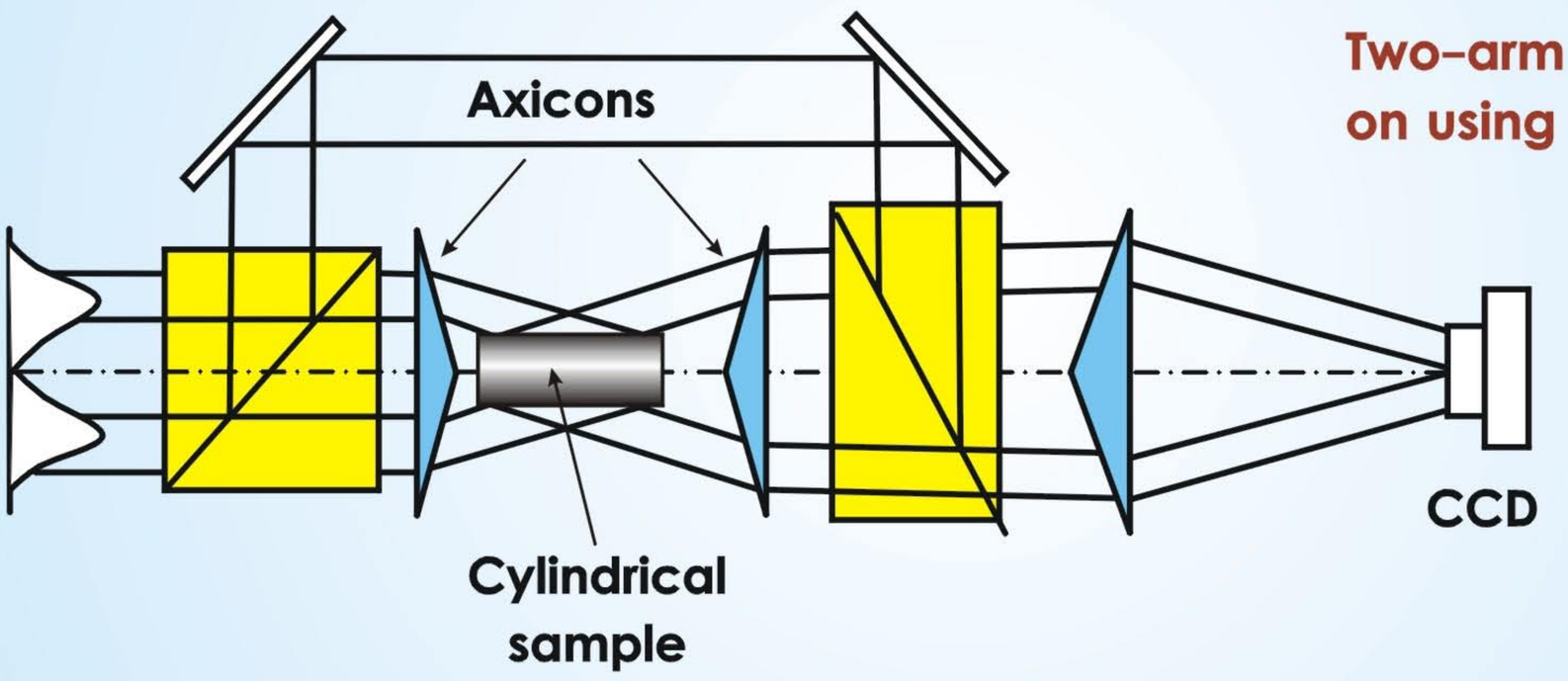
Optical Profilometers for Testing Cylindrical Machinery Parts

Conical beam based optical profilometers have been developed. They intended for nondestructive and noncontact express analysis and testing of the external and inner surfaces of various cylindrical and conical machinery parts. Area application includes surface characterization of real objects like metallic roller bearings and other.



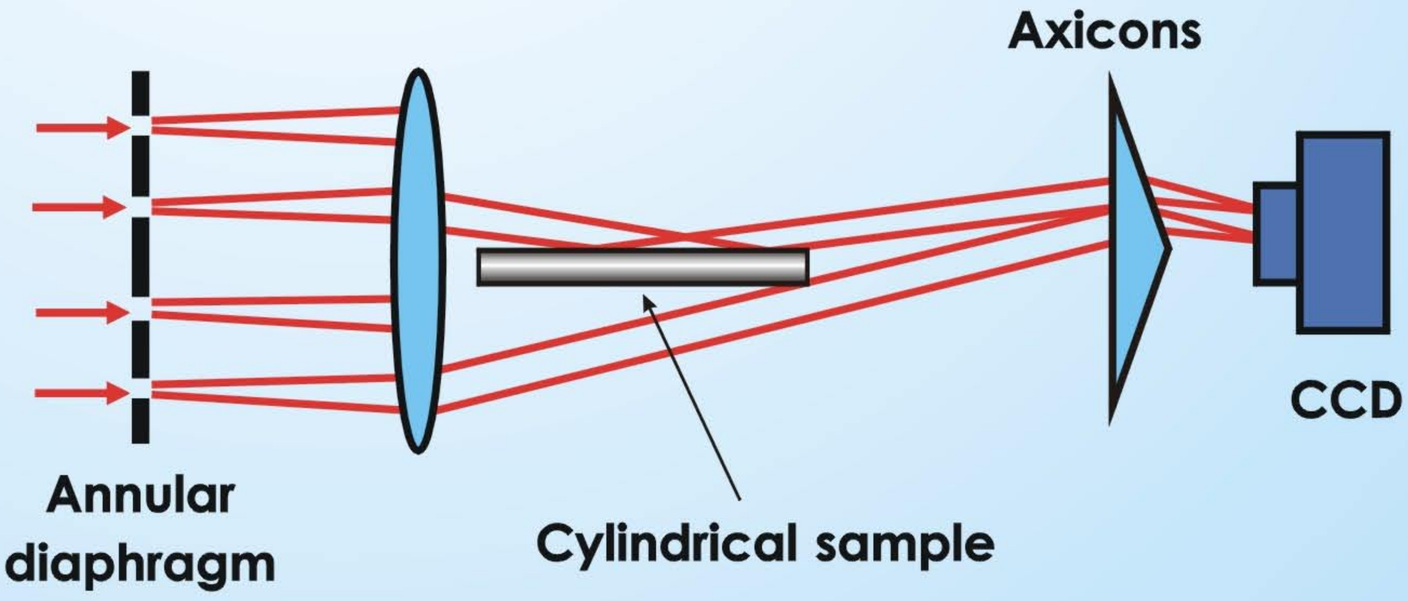
Device prototype of conical beam based profilometer.

Profilometers enable to characterize surfaces of cylindrical objects through all azimuth angles in parallel, excluding mechanical rotation of the sample.



Two–arm profilometer based on using conical beams.

Conical beam based single–arm profilometer for testing cylindrical objects.



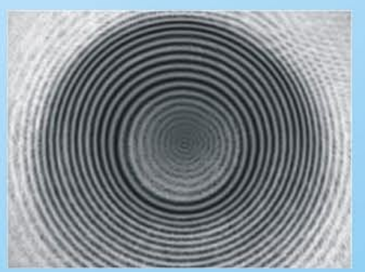
- **The advantages of these profilometers:**
  1. high speed of shape measurement;
  2. capability of optical testing of unpolished surfaces;
  3. high vibro–stability of the single–arm configuration of profilometer;
  4. high measurements accuracy (~ 30 nm).

- **Photographic image of roller bearing under test:**

Roller No. 1	Roller No. 2	Roller No. 3
length: **39 mm**	length: **59 mm**	length: **17,9 mm**
diameter: **3,8 mm**	diameter: **5,8 mm**	diameter: **17,8 mm**

- **Maximum peak–to–valley value for rollers:**

δRmax: **≈14,4 mkm**	δRmax: **≈10,7mkm**	δRmax: **≈0,86 mkm**



Typical profilogram.

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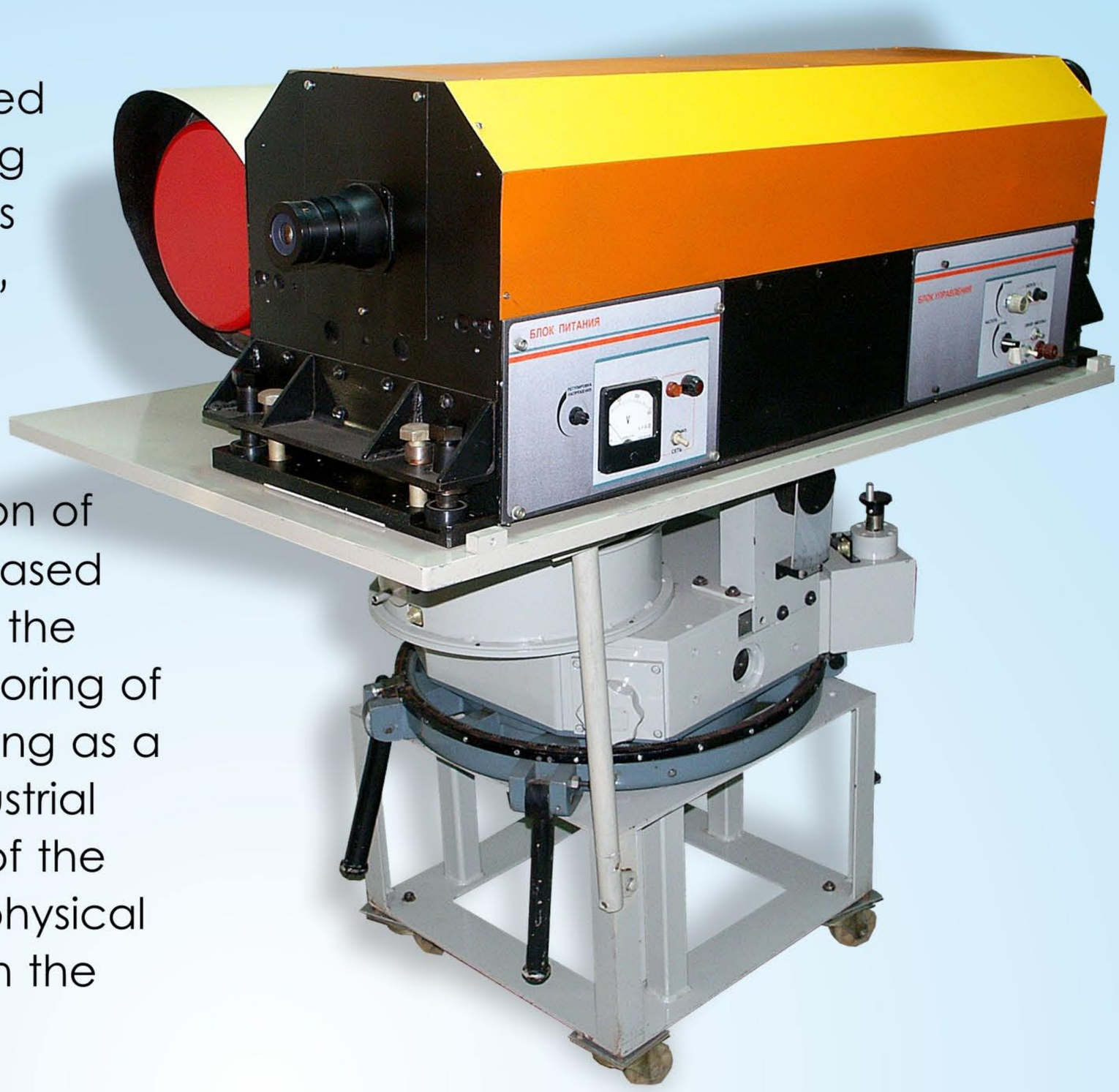
Gas-analyzer based on a TEA CO_2 laser for remote monitoring of atmospheric pollutions

The gas-analyzer is designed for high-sensitive monitoring of a large amount of gases in the atmosphere of cities, industrial zones, transport highways, etc.



Application: rapid detection of the background and increased concentrations of gases in the atmosphere, remote monitoring of atmospheric pollutions arising as a result of transport and industrial emissions, and estimation of the action of thermal, electrophysical and radiating processes on the environment.

Advantages: large number (some tens) of detected gases, service of large areas from one site, high sensitivity for small concentrations, possibility of round-the-clock measurements, high efficiency, automation of measurements, possibility of connection to information networks.

▪ Technical characteristics:

Type of laser: TEA CO_2 laser with automated spectral tuning
Output pulse energy (power): 3 J (15 MW) in powerful lines
Pulse duration ($\tau_{0.5}$): 80 ns for the leading edge and 1.5 μs for the "tail"
Pulse duration with an optical plasma shutter: ~5 ns
Repetition frequency: 0.1–3 Hz or single
Wavelength: 9 – 11 μm; 4.5 – 5.5 μm
Trace length: up to 4 km
Telescope aperture: 250 mm

▪ Detected gases:

	Range of measured concentrations, **mTorr**
NH_3	0.003 — 0.5
C_2H_4	0.002 — 20.0
O_3	0.01 — 0.5
SO_2	0.5 — 10.0
HNO_3	0.015 — 0.5
NO_2	1.6 — 20.0
CO	0.15 — 30.0
NO	0.3 — 5.5

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Lidars for monitoring of the atmosphere

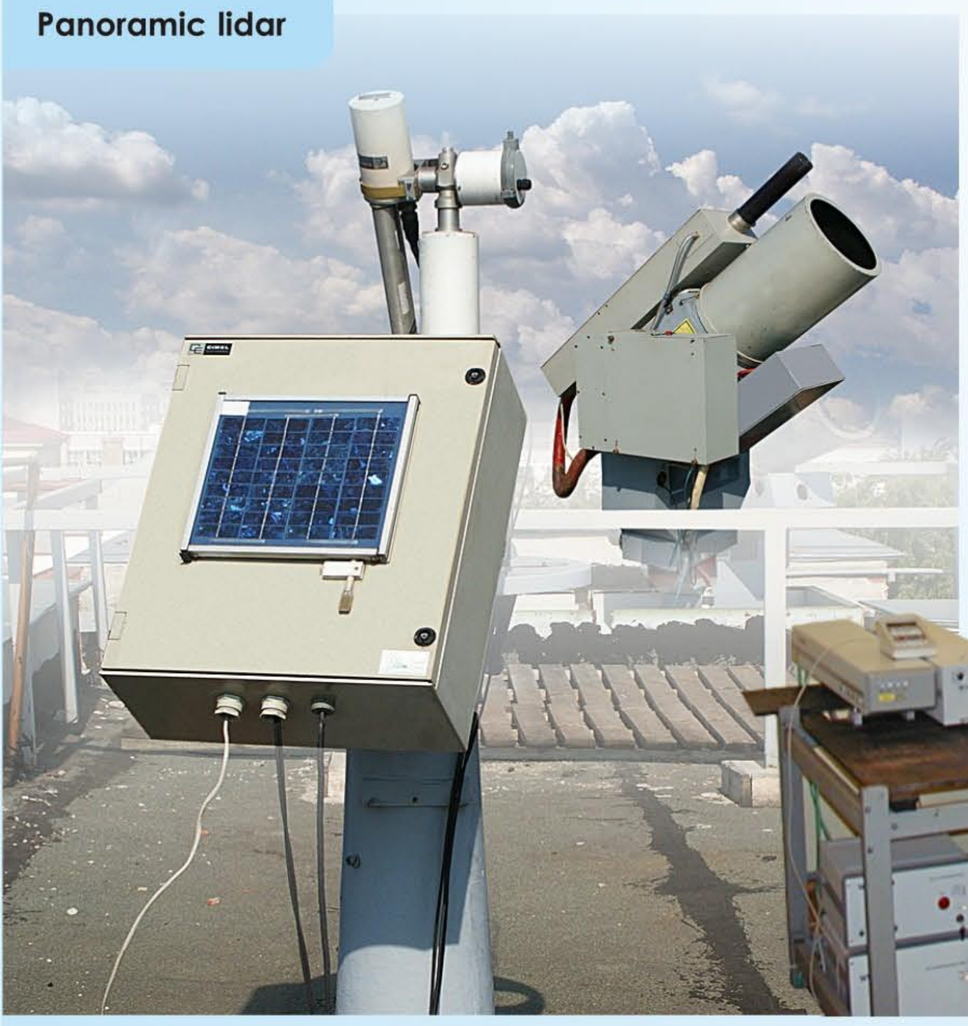
The lidars developed at the Institute of Physics are designed for the use in the National and International (EARLINET and AERONET) monitoring systems for control of the atmospheric spectral transparency, altitude aerosol and ozone profiles, and pollutions in Belarus.

- **The lidars make it possible to measure:**

– concentration of the dominant portion of natural and anthropogenic gases and aerosols;
– wind direction and velocity, the air density, and pressure and temperature profiles;
– high spatial resolution in the range of a tens meters;
– atmospheric parameters at the distance up to 35 km.

- **The World photometric network AERONET**, including the Institute of Physics, is designed for the control of the transborder transfer of the atmospheric pollution.
- **The CIS Lidar Network.** The Institute of Physics plays one of the key roles in the development of the CIS Lidar Network.

The lidar stations are used for realizing the State program "National system for monitoring the environment"



Mobile lidar station for monitoring the contamination of the lower atmospheric layer

The lidar station is designed for remote monitoring the aerosol and gas contaminants in the atmosphere and investigating the processes of discharge and transfer of contaminants in the atmosphere of industrial centers and other regions where contaminating discharges can occur. It can be used for monitoring the air near industrial objects in the process of control of the situation in the region of accidents and catastrophes. The controlled components are aerosol particles and contaminating gases (NH_3, C_2H_3, O_3, CO, NO, NO_2, and others).

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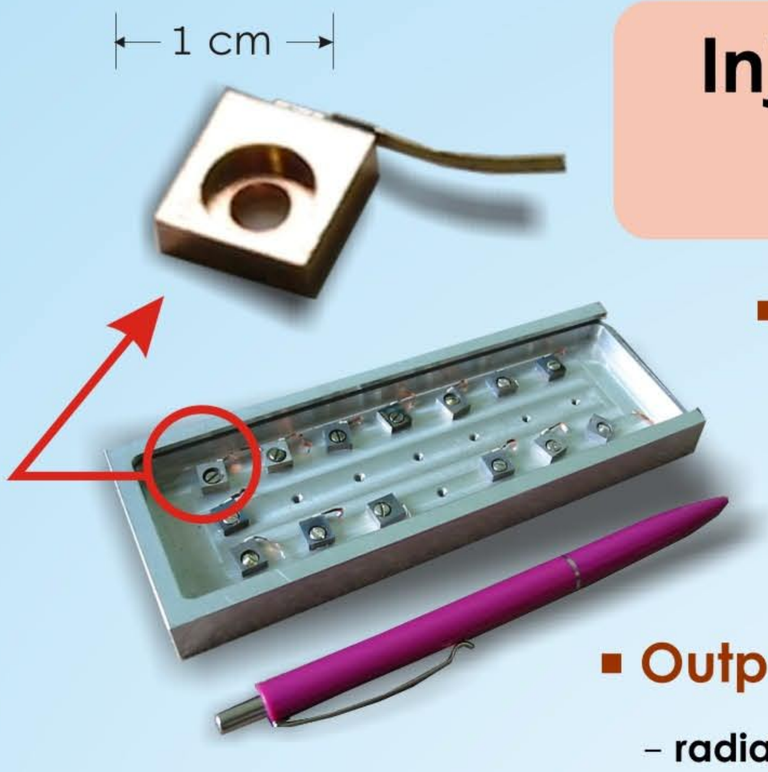
PELENG

Powerful semiconductor emitters and LD pumped solid-state lasers

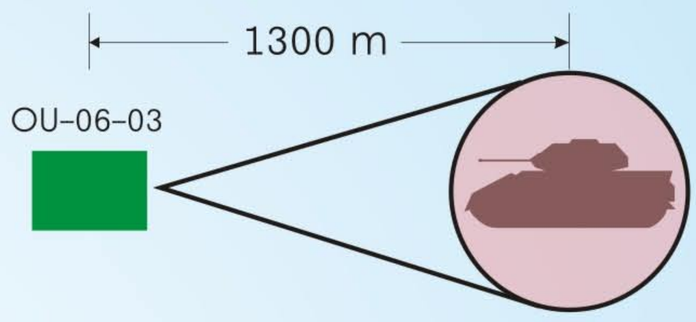
Injection laser diodes and laser diode arrays



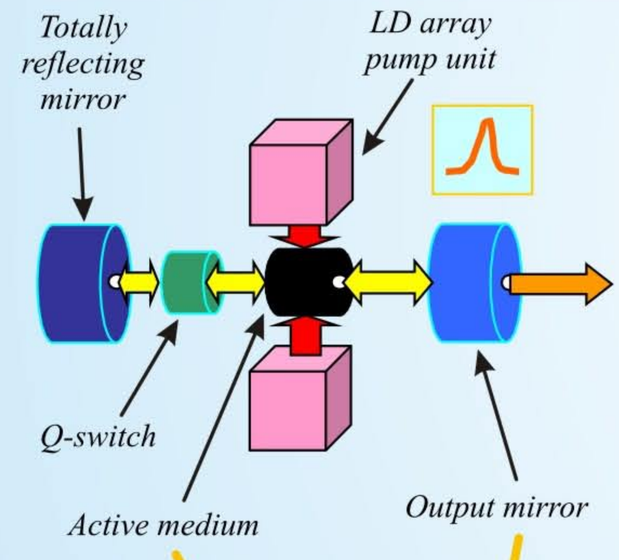
- **Application areas:**
  - pumping of solid-state lasers,
  - laser illumination of targets (laser floodlight),
  - control of moving objects by a laser beam,
  - micromarking,

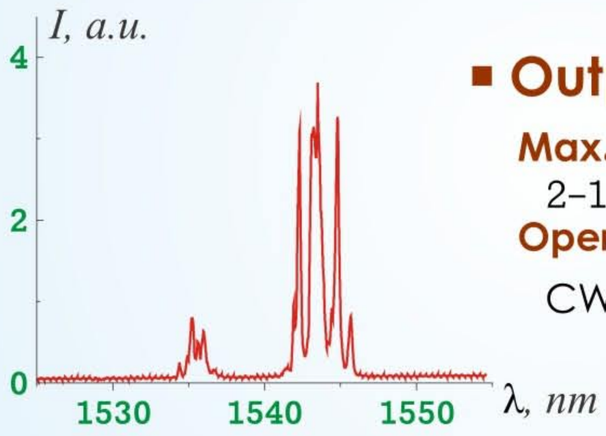
- **Output parameters:**
  - **radiation wavelength:** 0.8–1.06 μm,
  - **output power:** 2–100 W,
  - **operating regime:** CW, pulsed,
  - **operating temperature range:** from –50 to +60 °C

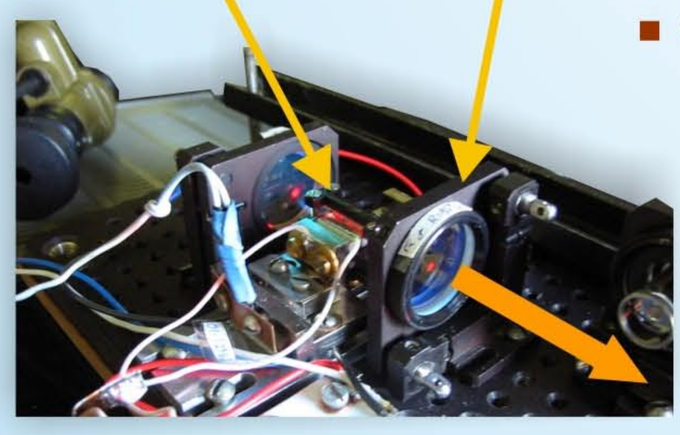
IR laser floodlight OU-06-03



Solid-state lasers with transversal LD (arrays) pump unit







- **Output parameters:**
  - **operating wavelength:** 1.06–1.55 μm, *(eye-safe spectral region)*
  - **pulse energy:** 2–30 mJ,
  - **operating regime:** pulsed

- **Application areas:**
  - range finding,
  - geodesy

Power supply units for laser diodes and laser diode arrays

- **Output parameters:**
  - **Max. current:** 2–150 A
  - **Operating regime:** CW, pulsed

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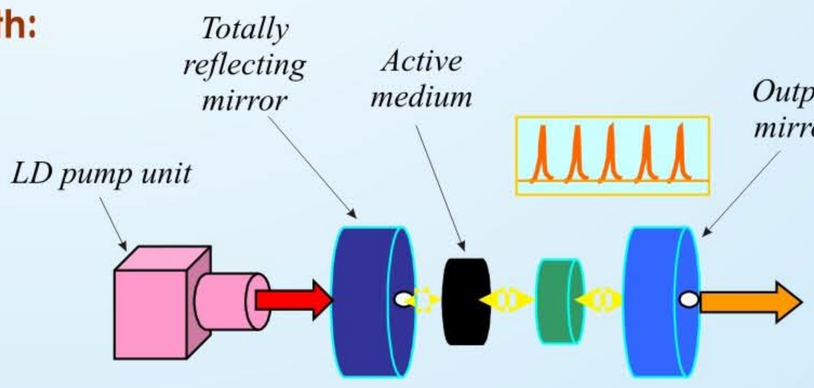
"Axikon"

Solid-state lasers with longitudinal LD (arrays) pump unit



- **Output parameters:**
  - **operating wavelength:** 1.06–1.55 μm
  - **output power:** up to several W
  - **operating regime:** CW, pulsed

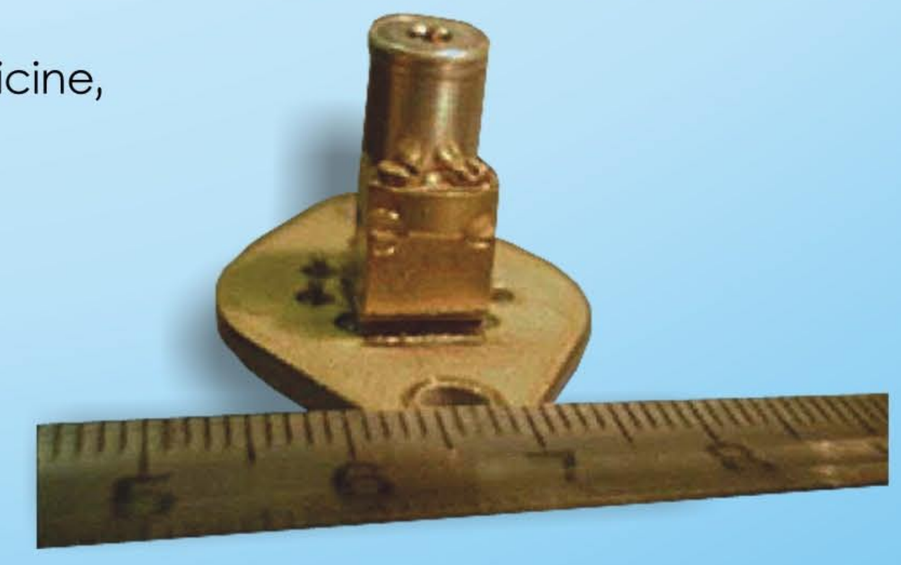
- **Application areas:**
  - control of moving objects by a laser beam

Diode-pumped pulsed microchip lasers with intracavity SRS conversion

The lasers are designed for use in distance-measuring devices, spectroscopy apparatus, and other systems and represent miniature completely solid-state lasers generating short light pulses with a high repetition rate (of duration less than 10–9 sec.). At the output of such lasers, additional nonlinear elements can be installed for obtaining a radiation with a frequency falling within the range 300–600 nm. These lasers are pumped by a standard diode laser with an output power of up to 1 W.

Field of application: precise distance measurements, ecology, medicine, spectroscopy, photochemistry.

Wavelength: 1.06 and 1.18 μm;
Peak output power: no less than 25 kW;
Pulse duration: 200 nsec;
Pulse repetition rate: 5–10 kHz;
Length of an emitter: 1 cm.



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