Presentations

In numbers IV/2 and IV/3 of „Optica Applicata" a number of Polish Optical Research Centers have been presented in a cycles entitled Presentations. This time we have the pleasure to introduce the Quantum Electronics Division, Institute of Scientific Instruments, Brno, Czechoslovakia to our Readers.

In the review of the Quantum Electronics Division activities two main trends have been distinguished: 1 — instrumental development, and 2 — measuring techniques.

The former comprises: a) He–Ne lasers of great coherence length, including the single frequency lasers, b) laser interferometers, first of which being of a prism type, and the second — developed actually — is a remote interferometer and a member of a whole system.

The latter trend involves: a) interferometric measurements of precise optical components, b) measurements of frequency properties of lasers, and c) reflectivity of losses measurements of laser mirrors.

Survey of the instrument development in the Quantum Electronics Division at the Institute of Scientific Instruments, CSAV Brno

*František Petrů**

The general taks the Quantum Electronics Division deals with is to develop 1) gas lasers of great coherence length, 2) laser interferometers, and 3) measuring techniques, as well as to solve the related problems.

1. Gas lasers with great coherence length

The first solution in this respect was the development of the La 1000 single-frequency He–Ne laser with frequency stabilization [1], which was next introduced to mass production by Metra Works, Blansko, Czechoslovakia. The instrument is shown in fig. 1, while its parameters are given in table 1. It is characterized by high frequency stability, calibrated wavelength, long life and relatively high output power.

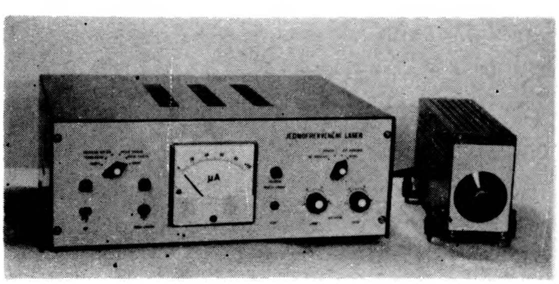

Fig. 1. Single-frequency He–Ne laser

Table 1. Parameters of the single-frequency He–Ne laser

Output power	500 mW
Frequency	4.7361220·10^{14} Hz
Wavelength in vacuum	632.99141 nm
Frequency stability	
long-term stability	$\pm 5\cdot 10^{-8}$/1000 h
short term stability	$\pm 2\cdot 10^{-9}$/8 h
without servo control	$\pm 2\cdot 10^{-7}$/8 h
Mode diameter	0·5 mm
Beam divergence	2 mrad
Life	5000 h

* Institute of Scientific Instruments, Czechoslovak Academy of Sciences, Brno, Czechoslovakia.

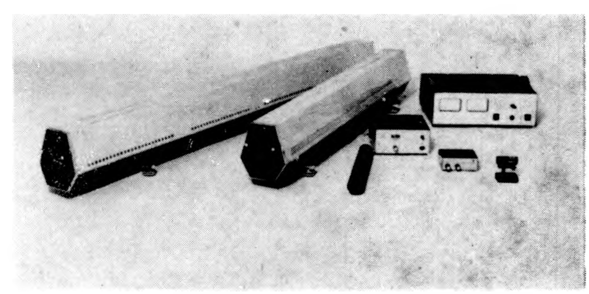

Fig. 2. Series of long He–Ne TEM_{00} lasers with a scanning interferometer

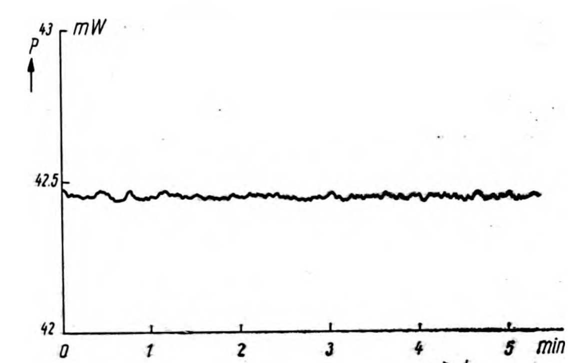

Fig. 3. Stability of the output power: laser 42.5 mW

A new series of long He–Ne lasers [2] which will be manufactured also at the Metra Works, Blansko, as LA 1001, LA 1002, and 1003 types, respectively, is shown in fig. 2. The lasers will find wide scientific and technical applications, e.g. in holography, interferometry, anemometry etc., and will be very useful in many laboratories. Their most essential properties are: high output power at TEM_{00} mode, high stability (fig. 3), and long life time.

2. Laser interferometers

The first developed laser interferometer of prism type — because of its precision (1 μm/m) and measuring range (about 20 m) — is especially useful in machinery industry as far as length and speed measurements are concerned. It is produced by Metra Works, Blansko under type designation LA 3000.

The next type of laser interferometer [3], included in the laser interferometer system, is shown in fig. 4. Its superiority over the equipment developed previously is gained by its high stability, large measuring range, automatic data processing and easy variability for different measuremens The stability record of remote interferometer for the distance of 1m is given in fig. 5. The application of remote interferometer to check num-

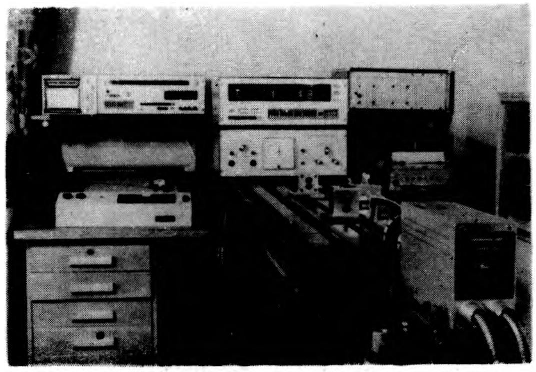

Fig. 4. Remote interferometer

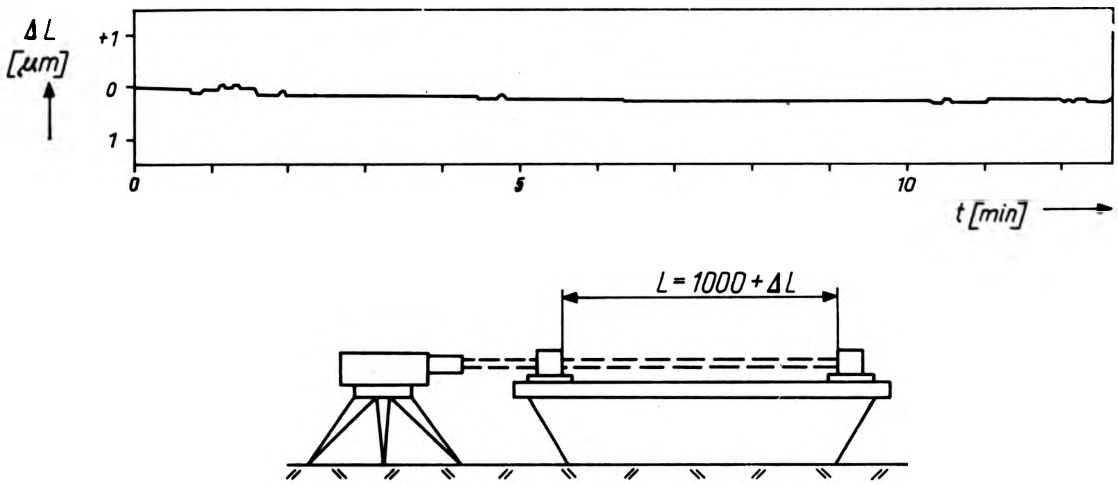

Fig. 5. Stability of the remote interferometer for working length 1 m

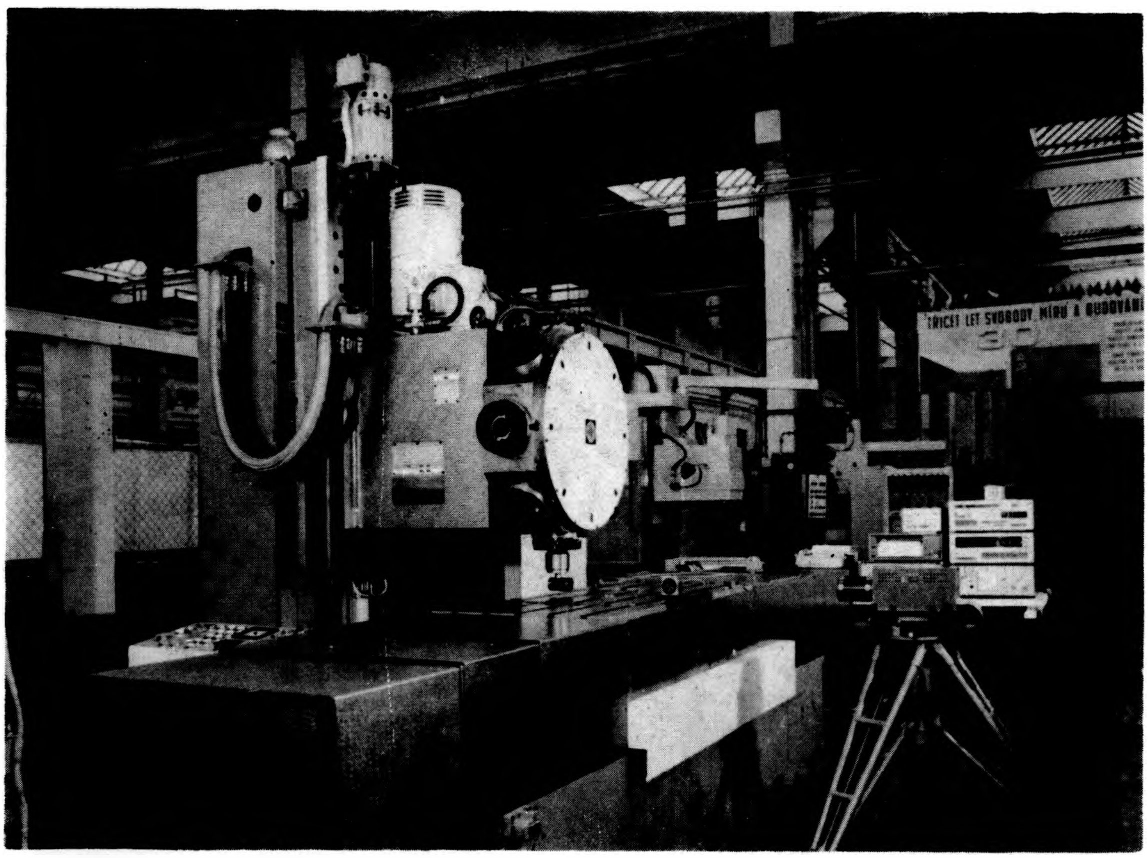

Fig. 6. Testing of an NC machine with the remote interferometer

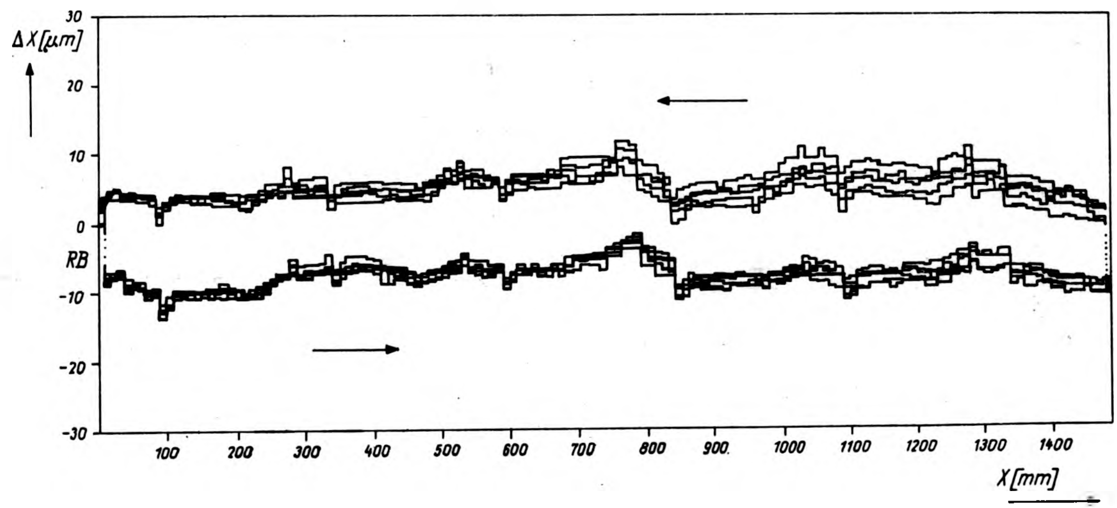

Fig. 7. Deviation record in the x-axis direction of an NC machine

erically controlled machines is shown in fig. 6. The measurements are fully automatized being controlled in NC machine by its punched tape equipment. Deviation record in the x-axis direction is given in fig. 7.

3. Measuring techniques

In our Division a great care has been devoted to the development of measuring methods and means, because of their basic importance in solution of all planned problems. The techniques presented below result from the previous tasks, and are used to check the design of the equipment, as well as to search new ways in the domain of our interest.

The emphasis was put on three main problems:

3.1. Interferometric measurement of precise optical components

Interferometric measuring methods are used for checking precise optical components (precise geometrical optics). They allow to measure flatness, parallelism and perpendicularity of surfaces, as well as imaging properties of colimating systems [4].

3.2. Measurement of laser frequency properties

These measurements can be performed by: optical resonator [5] and radiofrequency methods.

In the latter the beats are measured in the RF region. The equipment for signal measurement and record in RF region [6] yields the resolution up $1 \cdot 10^{-13}$ and allows recording, of e.g. the frequency stability of laser radiation. The beats between the modes of one laser or beat frequencies between several lasers can be equally measured.

3.3. Reflectivity and losses measurements of laser mirrors

The instrument, called reflectometer [7], is shown in fig. 8 It was designed for visible and near IR region. Measurement is performed twice, the first is taken when the measured object is put in the way of the light beam. The influence of auxiliary optical components is eliminated by the second measurement. Examples of measured values of laser mirrors for wavelength 633 nm are given in table 2.

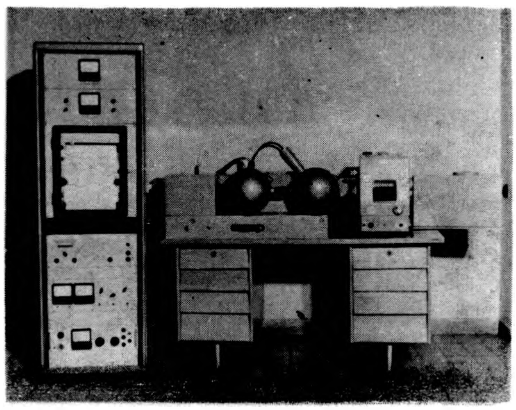

Fig. 8. Reflectometer for measuring the reflectivity and losses of laser mirrors

Table 2. Measured values of laser mirrors by the reflectometer

Specimen No.	T_m			
	A_{10}	A_{11}	K_2	T_m[%]
S∞/∞ No. 03, ⌀24×10	80·25	0·725	1	0·90
S∞/∞ No. 04, ⌀24×10	95·71	1·13	2	0·59
S∞/∞ No. 05, ⌀24×10	80·25	0·730	1	0·91
S∞/∞ No. 07, ⌀24×10	80·35	0·730	0·5	1·82
S∞/∞ No. 20, ⌀25×5	88·90	4·85	2	2·73

Specimen No.	R_m				Z %
	A_{20}	A_{21}	R_m^2	R_m[%]	
S∞/∞ No. 03, ⌀24×10	96·92	94·88	0·9790	98·95	0·15
S∞/∞ No 04, ⌀24×10	96·00	94·61	0·9855	99·28	0·13
S∞/∞ No. 05, ⌀24×10	96·56	94·46	0·9783	98·91	0·18
S∞/∞ No. 07, ⌀24×10	96·56	92·87	0·9618	98·07	0·11
S∞/∞ No. 20, ⌀25×5	95·96	90·18	0·9398	96·94	0·33

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