

Fifty years of laser: world and Latvian experience

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The first laser was born at Hughes Research Laboratories in Malibu, Calif. USA on May 16, 1960 when Theodor Maiman and his assistant Irnee D'Haenens demonstrated their ruby ($\text{Al}_2\text{O}_3:\text{Cr}^{3+}$) laser [1]. However, the acronym „laser” (Light Amplification by a Stimulated Emission of Radiation) refers also to light amplifiers not only to light oscillators. As known, every amplifier can be turned in oscillator by appropriate feedback. This presentation is an attempt to give a brief history of laser including operation principles and main applications. Special attention is paid to lasers in Latvia.

There is a great variety of lasers now [2] emitting light in a broad spectral range from X-rays (0.15 nm minimal wavelength [3]) to millimeter waves [2] with the radiation duration from attoseconds to CW [2]. The minimum achieved pulse length in visible is 1.6 fs at 650 nm [4]. There are two main operation principles of lasers: 1) stimulated emission; 2) population inversion [2]. All lasers can be divided into two parts: bound electron lasers and free electron lasers (FEL's). The first group is dominant. After the ruby laser it was followed by the first (He-Ne) gas laser and by the first diode laser also produced in USA (A.Javan, D.Herriot, W.Bennet, Bell Labs, and G.Fenner, R.Hall, J.Kingsley, General Electric, respectively)[1]. In the same year (1962) A.White and J.D. Rigden from Bell Labs made the first red He-Ne laser oscillating at 632.8 nm which was later widely used, especially in holography. The first FEL was demonstrated much later in 1976 by J.Madey and coworkers at Stanford University [3].

The above mentioned first basic lasers were followed by variety of new lasers (e.g., YAG: Nd^{3+} and dye lasers, CO_2 gas lasers, efficient heterojunction laser diodes, $\text{Al}_2\text{O}_3:\text{Ti}^{3+}$ (Ti:sapphire) lasers, fibre lasers, silicon lasers ,etc.) and new laser beam temporal shaping methods (Q-switching, mode-locking, chirped pulse amplification, etc.) which have considerably improved laser performance. Thus petawatt laser based on chirped pulse amplification method of G.Mourou with a yet highest power of 1.2 PW has been built in Lawrence Livermore Laboratory (USA) having beam intensity of 10^{21} W/cm² [6]. Exotic lasers such as lasers without inversion [2], random lasers [7], two-photon pumped lasers [8] also appeared.

Lasers have found numerous applications in science (laser spectroscopy, nonlinear optics and holography, laser metrology, optical tweezers and gratings, etc.) and technology (optical communications, laser fusion, optical high precision clocks, optical information recording and processing, lidars, optical ranging, material processing, laser weapons, etc.). Laser technology promises also the solution for nuclear waste transformation problem because lasers with intensity higher than 10^{24} W/cm² can radically alter nuclear energy levels and shorten decay half-lives [9].

There are also natural lasers. Fe^{2+} stimulated transitions at 999.7 nm have been found in space near the Etha Carina star [10].

The first laser in Latvia appeared in 1965 when Silins from the Latvian State University built a ruby laser [11]. As far as I know first small red He-Ne lasers were acquired by Latvian State University, Riga Polytechnical Institute, Institute of Physics, Latvian SSR Academy of Sciences, Institute of Civil Aviation, Latvian Agricultural Academy and Daugavpils Pedagogical Institute in the first half of 1970's. The first large 40 mW red He-Ne

laser LG-36A was bought by laboratory of professor K.Schwartz at Institute of Physics in 1973. I used it for the recording of holographic gratings in additively coloured KBr crystals. After that other types of lasers such as Ar⁺, Kr⁺ and N₂ gas lasers as well as ruby and YAG:Nd³⁺ solid state lasers appeared in the Institute of Physics and Latvian State University mainly for spectroscopic studies, holography and material processing.

In 1986, the first picosecond YAG:Nd³⁺ laser with active mode locking was built in the Institute of Solid State Physics, Latvian State University by Guntis Liberts and Vismants Zauls. The first laser shows in Latvia also were organized by them in the same institute. In 1989 I have started my studies of optical fibres with picosecond laser spectrometer at the Institute of Physics. Now lasers are widely used for scientific purposes in the institutes of University of Latvia and Riga Technical University. In March 2007 Innovative Microscopy Centre of Daugavpils University (using femtosecond lasers) was established under the leadership of Guntis Liberts.

Lasers have found not only scientific but also technological applications in Latvia such as in hologram production (Hologramma, Ltd., Riga; Dardedze, Ltd., Riga, Difraks, Ltd., Daugavpils), production of optical communication system elements and optical elements (Optron, Ltd., Riga), medical optical fibres (Z-Light, Ltd, Līvāni).

This description of lasers is far from complete. More details will be given in my report.

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