At the threshold to the "century of the photon"
-Report and Analysis on Laser 99 in Munich

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This report and analysis on laser 99 in Munich was written after the one week visit of the fair LASER. Some contents was extracted from the homepage of LASER 99. It would be for reference only.

1.World's fair LASER closes with record results

The LASER trade fair is one of the leading world fairs in new technology held in Munich. It was launched in 1973 in the Bavarian capital to track and present developments in laser technology in a range of fields. At its new venue, the New Munich Trade Fair Centre in Munich – currently the most modern of its kind in the world – the 14th LASER, took place from 14 to 18 June 1999 in Munich.

For the first time ever, a total of 771 exhibitors and 105 additionally represented companies from 28 countries came together with more than 15,000 trade visitors from 61 countries - including some 1,000 congress participants - for the 14th International Trade Fair and International Congress for Innovative and Applied Laser Technology and Optoelectronics. That corresponds to a 5.6-percent increase in exhibitors and a 7-percent increase in visitors compared to 1997.

In keeping with the growing significance of laser technology in the industrial sector, the share of industry representatives who attended this year's fair was up by approximately 18 percent. The number of visitors from the automotive industry doubled.

There were also **exhibitors from China**. Some of them are: Casix Inc., China Da Heng Corporation, China North Opto-Electro Industries Corp., Coretech Crystal Company (Institute of Crystal Materials of Shandong University) , Fujian Castech Crystal Inc., and Yuguang Company (Institute of Opto-Electronics of Shanxi University).

2. Main theme areas

The concept behind LASER 99 was designed to give maximum benefit to the users. The fair was thus divided into several main theme areas:

- **Laser technology**, with solid state, gas and diode lasers, as well as laser system components, laser components and exhibits for laser radiation protection
- **Optics**, a new area in the fair, covering optical components and systems as well as opto-mechanics and production technology in optics.
- **Fibre optics**, comprising the product groups of optical wave guides and components, installations and exhibits for optical signal transmission.
- **Opto-electronics**, with opto-electronic components, electro and acousto-optics and display technology.
- **Optical sensors**, for geometric, dynamic, optical and other uses.
- **Measuring and test technology**, with laser measurement and test systems, opto-electronic analysis systems, industrial image processing, holographic measurement and test technology, including accessories.
- **Laser production technology**, including material processing systems, the associated system peripherals and laser-assisted product design and construction systems.

- **Laser systems** for application in a range of fields, and
- **Lasers in medical technology**, from an engineering and research point of view.

Some **highlights** at Laser 99 were:

- Rapid prototyping and rapid tooling special themes at LASER 99: Using lasers for modeling and repair work
- New cleaning techniques for industry and craftsmen
- The use of photodynamic lasers for tumor diagnosis and therapy
- Latest LIDAR (Light Detection and Ranging) techniques
- New Dimensions in Laser Technology: Technologies - Applications – Tools
- Diode-pumped solid-state lasers: the focus of LASER 99
- Semiconductor lasers on the march

3. Diode-pumped solid-state lasers: the focus of LASER 99

The first functional laser, which was built by Theodore Maiman in 1960, was a crystal or solid-state laser. Maiman managed to do what the experts of his time said was impossible: to elicit a beam of laser light from a ruby crystal. The red flash of light emitted in a straight line soon became the perfect example of the laser beam. Today lasers come in a variety of colors and are generated by sources other than just crystals. However, competition from gas, liquid and semiconductor lasers has not been detrimental to laser crystals. On the contrary: solid-state lasers have experienced a veritable boom since the advent of diode and semiconductor lasers.

Using diode lasers for pumping is associated with a number of efficiency-improving advantages. They make it possible to simplify cooling concepts, which in turn opens the door for compact and even miniaturized designs, although they can be upscaled for use in high-performance applications, as well. Diode-pumped solid-state lasers are available with a variety of output ratings, from milliwatt to several kilowatts. Because they consume less power than lamp-pumped lasers, they are more efficient to operate and low wear makes them almost maintenance-free.

The driving force behind this technical development is the multitude of applications for compact and affordable solid-state lasers. The more applications, the larger the quantities produced and the lower the prices - which is how new markets are created. In the case of diode-pumped solid-state lasers, the market is far from saturated.

The most important applications include marking, inscribing and engraving, cutting, soldering and welding, trimming electrical resistors, exposing in the printing industry, aligning and measuring, interferometry as well as therapeutic and diagnostic applications in medicine. For most of these tasks, a number of techniques are already available that do not require the use of a laser. However, one of the major advantages of lasers is the ability to work without contact. As a "tool", the laser beam is always sharp, it can be controlled electronically and it can therefore be precision adjusted for any task. And if it is as readily available and cost-effective as the diode-pumped solid-state laser, it will rapidly meet with market acceptance and pay for itself quickly.

Still, diode-pumped solid-state lasers will probably meet with the greatest public appeal in another form altogether: "laser TV". Used to project television pictures onto large surfaces, these systems use frequency converters which transform the lasers into the three primary colors. Prototypes have already been introduced, and laser-based television could even be ready for home use within a few years. The quality of the color is said to be better than anything available to date, and the larger picture allows the viewer to "experience" the scene personally. Just like the CD and digital sound revolutionized the meaning of "listening pleasure", lasers may soon provide us with a new kind "feast for the eyes".

4. Laser market

The world market for lasers and laser systems goes from strength to strength. Volume on the world market for laser sources increased from DM 4.5 billion in 1997 to DM 5.4 billion in1998, which corresponds to a healthy growth rate of 20 percent. If you include the devices and machines that are directly connected to these laser sources (so-called laser systems), worldwide volume amounted to DM 97 billion in 1998 compared to DM 83.3 billion in 1997. In other words, growth on the market for laser systems - which is at a much higher level - was "only" 16 percent. (see the following table)

Market segment	Laser sources (in DM billions)		Growth	Laser systems (in DM billions)		Growth
	1997	1998	%	1997	1998	%
Telecommunications	1,5	1,8	20	9,8	12	22
Materials processing	1,4	1,7	21	4,5	5,2	16
Information technology and consumer electronics	0,65	0,8	23	65	75	15
Medicine	0,6	0,7	17	1,8	1,9	6
Metrology and research	0,35	0,36	3	2,2	2,5	14
Total	4,5	5,4	20	83,3	97	16

(Source: Optech Consulting, Bisingen)

Telecommunications and materials processing accounted for the highest annual sales of laser sources, whereas information technology and consumer electronics had the highest growth rates.

How much the laser has "grown", i.e. how widespread it has become in industrial applications, is illustrated by the low percentage of lasers sold for use in research which - when combined with metrology - accounts for far less than ten percent of overall sales volume. Besides laboratory applications, metrology includes the use of lasers to measure positions, shapes, speed and oscillations. Apparently the laser still has a great deal of "hidden" developmental potential in the metrology sector.

5. At the threshold to the “century of the photo”?

Although it was 38 years ago that the first experimental laser was used, lasers are anything but old hat. On the contrary, laser technology is currently enjoying a boom. This is due mainly to the rapid developments being made in semiconductor lasers. Some areas of application for laser technology are already familiar to us all: scanners in supermarkets, laser scanners in CD players, the light beam for entertainment or advertising purposes. But the use of lasers in an application which at the moment has the greatest market value goes practically unnoticed – in the transfer of data and telephone calls via glass fibre.

Taken as a whole all laser technologies currently account for a world market volume* of $3.2 thousand million per annum.

The semiconductor laser, which has been responsible for the breakneck pace of development in glass fibre technology, only has a low beam power and represents just a small section of the variety offered by the whole spectrum of lasers. This spectrum, from the smallest laser with a beam power of only a few milliwatts, through to the "giants" with kilowatts of output were on display at LASER 99.

Experts are predicting a bright future for laser technology and its applications when other types of lasers join semiconductor lasers in making the great breakthrough into applications. A report from the US National Research Council, prepared in 1998 by pioneers of laser technology in US research labs, analyses the applications possibilities of laser light and optical methods in technology, production technology, communications, medicine and bio-sciences, research and defence. It draws the conclusion that lasers and optics will in future be present in some form or other in all areas of civilisation. Optimists even speak of the 21st century as the "century of the photon" – following on from the 20th century as the “century of the electron”.

This may be a little exaggerated, for the 21st century will without doubt continue to have a need for electronics. The light (photons) of a laser has, however, favourable properties which present a challenge to technical and scientific applications: laser light is a stream of energy which can be directed through free space in the form of a beam, or through "tubes" or light wave conductors. Laser light, in contrast to sunlight, is in general all one colour and the light wave trains are continuous or coherent. There are lasers which emit light continuously at a constant intensity, intensity-modulated lasers and pulsed lasers with emission wavelengths distributed across the light spectrum. Examples from the wide spectrum of laser technology can illustrate this.

The next LASER will be held at the New Munich Trade Fair Center from June 18 - 22, 2001. The detailed information can be found under http://www.laser.de/.