Guest Editorial

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Optics and Battelle

Colonel John Battelle was an early Ohio industrialist with major interests in the iron and steel industry and subsidiary interest in other metals. His son, Gordon Battelle, developed a consuming interest in industrial research mainly as a result of trying to recover zinc from ores for which the usual roasting process did not work. When Gordon Battelle died in 1923, he left his residual estate to the founding of an institute ". . . for the purpose of education in connection with the encouragement of creative and research work and the making of discoveries and inventions . . . ." When his mother, Annie Norton Battelle, died in 1925, she left the bulk of her estate to the institute her son had founded. Battelle Memorial Institute opened its doors for business in 1929.

Considering the origins of the institute, it is hardly surprising that the early research was concerned with iron and steel. There was, however, an early diversification into other metals which laid a foundation for future work in the industrial application of exotic metals. The institute grew substantially and steadily, gradually adding staff and facilities in chemistry, physics, and engineering. During World War II, the first involvement with atomic energy began through the Manhattan District. By then the contract research concept was well established and Battelle was working actively to solve problems for industry and government on a cost reimbursement basis. Growth continued after World War II and in the early 1950s new laboratories were started in Europe, one in Frankfurt (BF) and the other in Geneva (BG). Still later, in 1965, the Hanford Laboratories of the AEC became the Pacific Northwest Laboratories (BNW) of Battelle Memorial Institute. This addition brought Battelle essentially to its present state. The worldwide staff exceeds 6100, mainly located at the four laboratories in Columbus, Ohio; Frankfurt, Germany; Geneva, Switzerland; and Richland, Washington. This staff represents highly qualified individuals in substantially all of the academic disciplines: physical and life sciences, metallurgy, engineering, economics, social sciences, etc. In 1974, research was done for literally thousands of sponsors all over the world.

Throughout the early years optics at Battelle, as at many other institutions, played primarily a service role. Microscopy, spectroscopy, metallography, and related topics were important tools, but they were not really the subjects of research. There was, of course, one well-known exception in the case of Battelle and that was Xerography. This process was invented by Chester Carlson, but research and development on it were started at Battelle in the mid-1940s. This effort, which included a great deal of work on photoconductivity and electrostatic imaging, led eventually to the huge commercial success which Xerography enjoys today. However, until the arrival of the laser with its ability to produce coherent light very conveniently, and holography with its unique features, there was little extensive research in optics at Battelle.

In the last 15 years, optics research has become increasingly important at Battelle and currently ranges over a wide variety of optics. Although many independent programs exist, much of the optics activity is centered around three major facilities, the Rattlesnake Mountain Observatory at BNW, the Laser Application Center at the Battelle Columbus Laboratory (BCL), and the CO_2 laser facility at BF.

The Rattlesnake Mountain Observatory (Fig. 1) is equipped with a 31-inch reflecting telescope as well as with a radio telescope facility. In addition to the astronomical activities, represented in this issue by the article on the new astronomical polarimeter, a major current activity involves instrumentation for insolation measurements. Also at BNW are signifi-

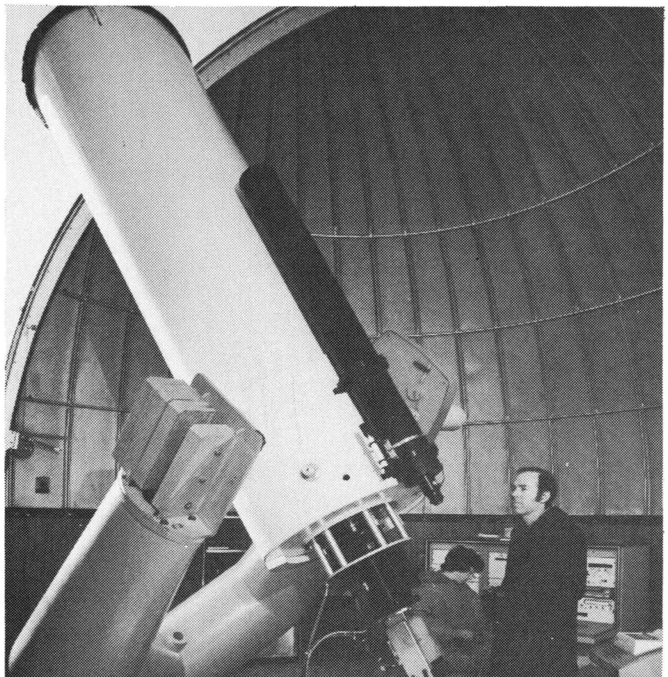

Fig. 1. The 31" optical telescope at the Battelle Northwest Laboratory Rattlesnake Mountain Observatory near Richland, Washington.

cant programs in optical inspection, optical and acoustical holography and high speed optical digital recording.

The major facility at the BCL Laser Application Center is the 1500 joule Nd glass laser system (Figs. 2 and 3) which is

Fig. 2. Oscillator and six amplifier stages of the 1500 joule Nd-glass laser at the Battelle Columbus Laboratory Laser Application Center.

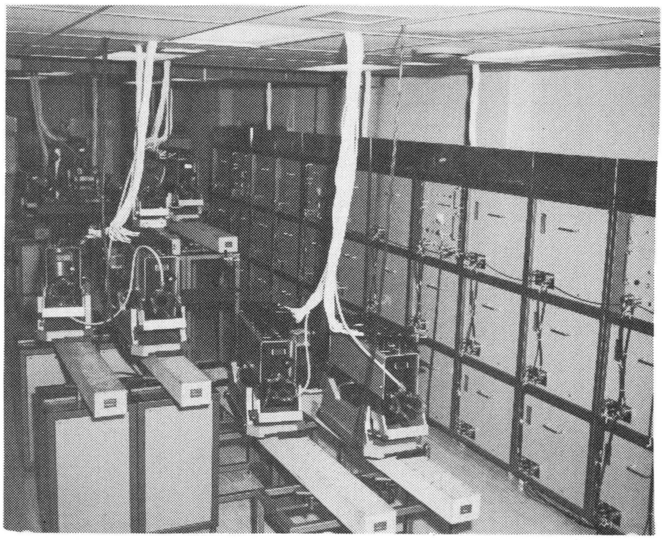

Fig. 3. Final stages of the 1500 joule 12-beam laser amplifier. The output beams are directed and timed to provide simultaneous quasi-isotropic irradiation of the target.

being used for x-ray production and plasma fusion studies. The automated diagnostic system for monitoring the behavior of this laser is described in this journal. Other work at the center deals with various aspects of material processing by lasers and medical application of lasers.

A major effort at BCL in the late 1960s dealt with the development of a variety of holographic systems and techniques. Under this proprietary program, major advances were made in back beam, focused image, three color, and large scene holography. The holographic approach is presently being incorporated in some of the current integrated optics work (Fig. 4) as reported in this issue. Other current work in the holography area is directed toward the develop-

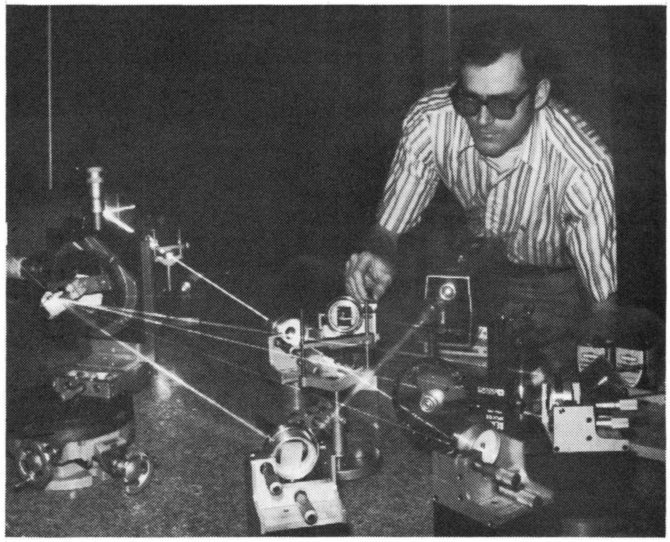

Fig. 4. Experimental arrangement for forming phase gratings in optical waveguides by holographic techniques in the Integrated Optics Laboratory at the Battelle Columbus Laboratory.

ment of improved organic materials for a read-write-erase digital memory system.

In another area of applied optics, spectroscopic techniques emphasizing laser fluorescence phenomena are being developed for the study of combustion processes. Laser techniques are also being used in the study of atomic and molecular excited states.

At Battelle Frankfurt, the 1000 watt CO_2 laser, which for a number of years was the largest CO_2 laser in Europe, provides the facility for laser growth of crystals in a free-floating zone configuration, and has led to work in communication and in photochemistry and isotope separation. Another area of long standing at Battelle Frankfurt has been the use of optical scattering phenomena to produce a variety of instruments for dust and particulate measurements. More recent Battelle Frankfurt work has been in the use of optical techniques in biological cell studies and in medical applications of pattern recognition techniques.

At Battelle Geneva, there is a significant effort in the physics, chemistry, and technology of optical materials. This work ranges from the fabrication of low-loss optical fibers to the study of various forms of vanadium oxide for optical switching and memory applications. There has also been a long-standing program involving the boracites, a class of materials which exhibit both ferroelectricity and ferromagnetism. Since the birefringence of some of these components can be switched electrically, the possibility of electro-optic device applications exists.

As an outgrowth of the Battelle Energy Program, an internally funded effort to consider approaches to the alleviation of the energy shortage, a variety of approaches to the use of solar energy are currently being pursued. Development efforts on a solar-powered field irrigation pump, a process for making inexpensive solar cell materials and a photochemical method for solar energy storage are underway at BCL, while at BNW a new technique for photovoltaic cell fabrication is being pursued. At BF studies of solar collector geometries and economics are in progress.

The overall Battelle optics activities thus span the size range from astronomical to microscopic, and the concept range from systems to materials. A representative selection of current activities in optics research is presented in the following series of articles.