Final Report

Development of Advanced Profiling Instrumentation for Measurement of Large Aspheric Optical Components

CRADA No. BNL-C-92-08 between Continental Optical Corporation and Brookhaven National Laboratory

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Effective Dates: 6 January 1993 - 5 January 1994

Abstract

The purpose of this CRADA between Brookhaven National Laboratory (BNL) and Continental Optical Corporation (COC) was to continue the technology transfer process initiated by an earlier collaboration among BNL, COC, and Lawrence Berkeley Laboratory (LBL) that resulted in the design and fabrication of the initial commercial model of the Long Trace Profiler, known as the LTP II. COC obtained an exclusive license from Associated Universities, Incorporated (AUI) in November 1992, to manufacture the LTP II as a commercial product. As a small business with limited resources, COC sought assistance from BNL to enable it to continue the development of additional LTP II systems and to incorporate improvements into the system. Since it was in BNL's best interests to enhance the performance of the LTP II, a CRADA agreement was established to allow BNL and COC to continue a joint development effort. The effort has proven to be quite successful as evidenced by the receipt of two prestigious industry awards in 1993 - the R&D 100 Award from R&D Magazine, and the Photonics Spectra Circle of Excellence Award from Photonics Spectra Magazine. A number of hardware and software improvements were made to the LTP II system during this time period, and planning for future collaborations was initiated.

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Report

Continental Optical Corporation (COC) and Brookhaven National Laboratory (BNL) entered into a CRADA agreement in January 1993 for the purpose of improving the performance of the Long Trace Profiler II (LTP II) as a commercial instrument. A number of items were identified as in need of modification or improvement. Most significant was the replacement of the laser diode source with a helium-neon (HeNe) laser and fiber optics delivery system.

The visible laser diode source used on the original LTP II systems delivered to Lawrence Berkeley Laboratory (LBL) proved to be too unstable for use in the LTP system. The laser diode is mounted on the optical head in close proximity to the beam splitting optics. It was originally thought that the laser diode could be run without active temperature stabilization, relying on the long-term stability of the metrology laboratory environment to provide the necessary temperature control. However, we discovered that we could not count on the customer to provide the proper temperature control to keep the laser source stable. In order to improve the performance of the system, we explored two alternatives: use a thermoelectric cooler to maintain precise temperature control of the diode, or use a fiber optics delivery system with a HeNe laser. We decided against the thermoelectric cooler because its use would have required a large heat source of several watts to be placed on the optical head, which would have produced additional thermal instability problems in close proximity to sensitive optical components. We decided to use a polarization-preserving single mode optical fiber coupled to a HeNe laser as the source. The advantage of the optical fiber system is that the HeNe laser, which is a large source of unwanted heat, can be located in a remote location entirely off of the moving optical head. Thus, the optical head can be isolated from a significant source of error. This improvement was incorporated into the system ordered by the National Aeronautics and Space Administration (NASA), which was delivered early in 1994, and was retrofit to the system in place at the Sincrotrone Trieste in Trieste, Italy.

Midway through the period of this CRADA, one of the key personnel involved in the development of the LTP at Continental Optical left the company. A new optical engineer was quickly hired by

Continental to continue work on the project. The new engineer was able to pick up very quickly and continue with the development effort. Continental was able to make good use of the CRADA to enable a rapid technology transfer process to the new hire.

During the last months of the CRADA, Continental made significant progress in completing the NASA profiler and in initiating a complete redesign of the control and analysis software to make it more user friendly. The new software incorporates a graphical user interface (GUI) which is superior to the command-line menu choice method in the original software package. Additional work needs to be done to make the GUI software fully operational. The major limitation with this software is the inability to make use of hardware interrupts to trigger the detector data acquisition process as the motor maintains a constant velocity during a scan. A temporary solution involves changing the operational mode of the system to do a start-stop motion, rather than a continuous scan. This requires a longer time to complete a scan, which is not desirable from a stability standpoint. We anticipate that this problem can be solved after the next software update from the detector manufacturer.

In July 1993 discussions were initiated with the Advanced Photon Source (APS) at Argonne National Laboratory (ANL) to design an LTP system for in-situ measurements on high heat load mirrors. A collaboration was started among BNL, COC, and Sincrotrone Trieste to investigate the feasibility of modifying the existing LTP II configuration to perform mirror scans in ultra high vacuum conditions. Additional meetings to define a conceptual design were held at Argonne National Lab following the R&D 100 Award ceremony in September 1993 in Chicago.

As a result of negotiations initiated in 1993, orders for new LTP instruments were received early in 1994 from Argonne National Laboratory and from the Berliner Electronenspeicherring-Gesellschaft für Synchrotronstrahlung (BESSY) in Berlin, Germany, and from the Osservatorio Astronomico di Brera-Merate in Milano, Italy. In addition, LBL ordered two new optical heads to replace the old ones in their original LTP II systems.

It is anticipated that follow-on work under a new CRADA agreement will continue over the next few years. This is necessary for several reasons. Firstly, it will enable BNL to participate in the development of the in-situ profiling instrument in collaboration with COC and APS and Sincrotrone Trieste. This is a scientifically challenging project that will require the expertise of all parties to effect a successful outcome. Secondly, it will enable continued development of the control and analysis software to incorporate improvements and make changes according to customer feedback. And finally, it will allow BNL and COC to share resources that are unique to each facility to continue improving the performance of the instrument.