FLUORESCENT MATERIALS CONSULTATION

FINAL REPORT TO RDA SUBCONTRACT 9-X3H-2081N-1

15 August 1987 through 30 September 1989

Prepared by

Don Locker

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SECTION 1

INTRODUCTION

The stated purpose of this subcontract has been to provide technical assistance to Los Alamos National Laboratories/CLS (LANL/CLS) in the general area of Neutral Particle Beam (NPB) direction sensing, especially for the Wire and Fluorescent Fiber Offset Grid (WAFFOG) scaled device. The principal investigator (PI) and CLS-3 investigator, Graydon Anderson, have achieved all aspects of the 1987 NPB sensing agenda related to practical sensing phenomena and techniques through innovative techniques and the application of sound physical principles. The extent of these accomplishments is best covered in the major poster paper by G. K. Anderson and D. R. Locker, "WAFFOG Fluor Development", to be published in the proceedings of the NPB Technical Symposium and Scientific Interchange, July 1989.

SECTION 2

E-BEAM MACHINE

A major early effort of the subcontract was to assist in making the CLS e-beam machine functional. Working with G. K. Anderson, we designed and built, in quick succession, three rf coil sets for coupling an induction furnace into the refractory grid structure of the e-beam source tube, to convert cathode carbonate to oxide. The rapid evolutionary coil design progressed from too weak to too strong in about three days. In this exercise, we learned to work well together.

It was necessary to provide a special Helmholtz-like coil set to remove the vertical component of the Earth's field over the entire range of the e-beam drift space. For this, the PI analytically calculated an optimal spacing for cylindrical coils above and below the apparatus center line, based upon zeroing the second derivative of the magnetic field at the C/L with respect to the coil spacing. The design works well.

SECTION 3

THE WAFFOG SUPPORT

The PI performed brief analysis on optical generation, light gathering and focussing onto fluor ribbons and wires, and subsequently concluded, as did others, that it would be highly beneficial to employ high aspect detector element formats to achieve good noise equivalent angle performance from WAFFOG experiments. Further, ribbons rather than rods, seem to minimize the adverse aspects of compound angle viewing, if preselecting the ribbon twist orientation is provided for.

Brief analysis of wire tensioning and ribbon tensioning methods was performed for the WAFFOG. It was concluded that the exponential friction strain relief concept, used for centuries in tuning of stringed instruments, was going to be hard to improve upon any time soon. Consequently, Mr. Locker suggested using worm drive types for their ease of operation. Others may also have suggested this method. It was decisively adopted and has proved highly successful.

Through Anderson's careful work, various preparations of fluor materials had become possible. However, we lacked a quick, reliable method to uniformly coat ribbons and rods, the direction our work had carried us. One elaborate jig we developed could handle long ribbon lengths wound loosely about a ventilated cylinder. Using a vertical axis concept, it allowed a regular solution stirrer to transport the slurry up around the spool and then down through the spool. While elaborate, the results were poor. Dielectric surfaces touching the ribbons strongly degraded the results. Finally, a non-conductive, vertical delivery system employing a separate, magnetic drive pump was conceived and designed. This system works very well and is scalable to almost any length piece, while being suitable for both ribbons and rods, and is the method by which the ribbons were prepared for the subscale WAFFOG.

SECTION 4

INNOVATIVE ADVANCEMENTS

During the course of this subcontract, there has been a high degree of innovation demonstrated wherever it was needed. In two notable instances, such innovation greatly exceeded the expectations of the scope of the original work and has resulted in heightened expectations for the project and for the near-term realization of function. At the beginning of this subcontract, the PI supplied an idea which could extend the usefulness of the WAFFOG concept into considerably more hostile parameter space. This was attractive since the sensing concept was useful but limited. In some instances, it appeared possible to control the geometry and to supply direct cooling. Mr. Locker supplied a very approximate calculation based upon questionable assumptions which tended to support the claims. Then, working with Anderson, it was demonstrated that Anderson's closer modeling and our collaborative experiment were in agreement. The technique was valid. This work is found written in a CLS report this past year.

Midway through the subcontract, the subscale WAFFOG work had progressed far enough that it was clear that the fluor ribbons would be delivered on time and would be of good quality and function. Bill McCulla, the CLS-3 deputy, asked Mr. Locker to spend some time considering the WAFFOG boresighting problem. This problem had received almost no attention at the laboratory, while outside the laboratory, other workers seemed to be avoiding the most fundamental of all considerations which must be made to give reliable, fast, bottom-line performance. For these reasons, and because of the innovative bent of this new team, consisting of Mr. Locker and Dr. Anderson, CLS-3, the progress was rapid and significant. It resulted in the conceptual, calculational, and experimental paper, "WAFFOG Boresighting, a Registration Concept", by Locker and Anderson, to appear in the Proceedings of the 1989 NPB Technical Symposium soon.

Subsequent extensions to the developed technology include registered NPB scoring and methods to emulate or impress acquisition, tracking, and pointing (ATP) functions into an NPB facility function.