

## Search for Rare Decay Modes of the Muon

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FINAL TECHNICAL REPORT FOR DOE CONTRACT  
DE-AM03-76SF00326, PA #DE-AT03-80ER10688

The work carried out under this contract relates to a major experimental effort in progress at the Clinton P. Anderson Meson Physics Facility (LAMPF) to search for extremely rare decay modes of the muon (those decays violating lepton number conservation). The experimental apparatus, known as the Crystal Box detector, consists of a large solid angle modular NaI(Tl) detector, enclosing a cylindrical set of drift chambers and a trigger hodoscope. Stanford University had a major responsibility in the design and production of the Crystal Box itself, which contains 396 optically isolated NaI(Tl) crystal modules. This detector can provide excellent energy and time information for electrons and gamma rays striking the NaI(Tl) modules. The electronics associated with this detector must provide for the measurement of electron and gamma ray energies and their arrival times with the necessary resolution, dynamic range and stability, and supervise the efficient transfer of this data to the main experiment computer. It is the design and production of this specialized electronics that is the subject of this contract.

The read-out and recording of the required data from the 396 NaI(Tl) crystal modules involves an integrate-and-hold circuit for the charge pulse and a time-to-amplitude converter circuit for the time information from each crystal. Also required is that these analog signals, in four parallel groups (or detector quadrants), be multiplexed under the control of an LSI-11/23 microprocessor to a precision ADC for digitization. The digitized results are read into the LSI's, after which the LSI's identify those channels with non-zero information, label each data word, and prepare for the efficient transfer of the useful event data to the main experiment computer. The electronics system necessary to accomplish these functions was designed, built, and tested under this contract. Technical reports describing, in detail, the performance of this electronics have been prepared and are listed below. The electronics is delivered in full to LAMPF and is currently operating in association with the overall Crystal Box experiment.

112 integrate-and-hold modules, 112 time-to-amplitude modules, and 5 multiplexers were prepared under this contract. The integrate-and-hold and time-to-amplitude circuits were designed at the Hansen Laboratories at Stanford and prototypes were first built and tested. Assembly of components in pre-production fabrication runs (10 modules of each type) and in the subsequent production runs was done by local commercial labor. Final test and calibration of all modules were done by Hansen Laboratories personnel. Both prototype and modules from the limited pre-production runs were delivered to LAMPF and operated in association with the NaI(Tl) detectors in test runs both before and after delivery of the Crystal Box.

The data multiplexers were developed at the Hansen Laboratories, and incorporated LSI-11/23 microprocessors and Tracor Northern TN1213 precision ADC's. They were delivered to LAMPF and tested in association with the Crystal Box.

It is expected that all of the equipment fabricated under this contract will be regarded as permanently associated with the Crystal Box project at LAMPF and therefore available to all future users of this facility.

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## REPORTS

"Intelligent Trigger Processor for the Crystal Box", (G.H. Sanders, H.S. Butler, M.D. Cooper, G.W. Hart, C.M. Hoffman, G.E. Hogan, H.S. Matis, V.D. Sandberg, R.A. Williams, J. Rolfe, E.B. Hughes, S. Wilson, H. Zeman) Proceedings of the Topical Conference on the Application of Microprocessors to High-Energy Physics Experiments, CERN, Geneva, May 4-6, 1981.

"An Application of Parallel Preprocessors in Data Acquisition", (H.S. Butler, M.D. Cooper, R.A. Williams, E.B. Hughes, J.R. Rolfe, S.L. Wilson, and H.D. Zeman) Proceedings of the Topical Conference on Computerized Data Acquisition in Particle and Nuclear Physics: Oak Ridge National Laboratory, Oak Ridge, Tennessee, May 28-30, 1981.

"Signal Processing for the NaI(Tl) Crystal Box Detector at LAMPF", (J. Rolfe, E.B. Hughes, S.L. Wilson, J.D. Bowman, G.E. Hogan, R.E. Mischke, V.D. Sandberg, G.H. Sanders, J. Sandoval and R.A. Williams) Presented at the IEEE 1982 Nuclear Science Symposium, October 20-22, 1982, Washington, D.C.

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