

DOE/ER/03072-T6

Princeton University

DEPARTMENT OF PHYSICS: JOSEPH HENRY LABORATORIES

JADWIN HALL

POST OFFICE BOX 708

PRINCETON, NEW JERSEY 08544

DOE/ER/03072--T6

DE82 021135

August 30, 1982

Dr. William A. Wallenmeyer, Director
Division of High Energy Physics, J-309
U. S. Department of Energy
Washington, D. C. 20545

DISCLAIMER
This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Dear Dr. Wallenmeyer:

Subject: Research Highlights Under Contract DE-AC02-76ER03072 for the period February 1, 1982 - July 31, 1982.

MASTER

1. Study of Rare Muon Induced Reactions
(FNAL Experiment 203/391)

(G. Gollin (thesis student), F. C. Shoemaker, P. Surko; LBL, T. Markiewicz, P. Meyers, W. Smith (thesis students), A. Clark, K. Johnson, R. Kerth, S. Loken, M. Strovink, W. Wenzel; FNAL, R. Johnson, C. Moore, M. Mugge, and R. Shafer)

The paper based on W. H. Smith's Ph.D. thesis, "Study of rare processes induced by 209 GeV muons" has been published.

Reference: Phys. Rev. D 25, 2762 (1982).

2. Measurement of $\pi^- p \rightarrow n + \gamma$'s and search for the η_c .

(A. M. Halling, K. T. McDonald, A. J. S. Smith, Y. Kitazawa (graduate student), C. Lu, M. Ye, with collaborators from Brookhaven National Laboratory).

The analysis is nearly complete at this time, and drafts of papers have been written. We have set a limit of $\sigma B \lesssim 80$ pb on the process $\pi^- p \rightarrow \eta_c n$ at 13 GeV/c. We have also observed an enhancement at 1640 MeV

$\downarrow \rightarrow \gamma\gamma$
in the reaction $\pi^- p \rightarrow \pi^0 \pi^0 n$ at 8.5 GeV/c.

Although one doesn't have sufficient data to determine all its quantum numbers, we know, of course, that $I = 0$, $C = +$, $P = +$, $G = +$ just from the $\pi^0 \pi^0$ state, as well as that J is even. (Similar structure has been seen by the Crystal Ball in the mode $J/\psi \rightarrow \eta \eta \gamma$.)

EDW

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

3. Production of High-Mass Dimuons by Pions
(FNAL Experiment E-326)

(P. A. Piroué, B. G. Pope, D. P. Stickland, R. L. Sumner, and R. Röhm and C. Whitmer (graduate students) in collaboration with the University of Chicago).

During Spring 1982 E-326 had a second major data taking run. The improvements made to the apparatus enabled us to run efficiently at twice the previously attainable beam intensity. The modified trigger processor performed reliably and new drift chambers installed at the inner edge of the first chamber plane were fully efficient. Although the running period was very short we were able to increase our dimuon sample by more than a factor of 6. We are currently performing a first level analyses of these data which we expect to complete by this fall.

We have continued with the analysis of the 1981 data. Preliminary results on the pion structure function were presented at the International Conference on High Energy Physics in Paris this July. Our measurement was in excellent agreement with theoretical prejudices and the results of the NA3 experiment at CERN. A preliminary determination of the Drell-Yan normalisation, or K-factor has been made but we are awaiting confirmation, and the improved statistical and systematic accuracy, from the 1982 data.

We expect to have over 10,000 events with p_t greater than 1 GeV/c and in the 4 to 8 GeV/c² mass range. This will enable a detailed study of the origin of transverse momentum in massive lepton pair production.

4. Production of High Mass Mu Pairs in the Forward Direction in π -Nucleus Collisions
(FNAL Experiment E-615)

(J. Greenhalgh, W. C. Louis, K. T. McDonald, S. Palestini (graduate student), J. Powelson (graduate student), R. Tromp (graduate student), F. C. Shoemaker, A. J. S. Smith, with collaborators from the University of Chicago and Iowa State University)

This experiment was set up at FNAL during the spring run, (first useful access to the experimental hall was not obtained until about March 15). We were extremely pleased to get the entire experiment set up and also to accumulate three weeks of data at a beam momentum of 250 GeV/c, with an intensity of $\sim 2 \times 10^8$ pions/pulse. Even our most optimistic goals were thus met. We are analyzing the data now to guide us to what modifications we will need for our next run in 1983.

It is already clear that further improvements to the trigger processor, and associated with this, development of the pad chambers, are important for our next run. Both are long lead-time projects and will need support during the summer and fall.

A very preliminary mass plot from ~ 1 hour of running shows that the experiment is working. As chamber alignments are improved the mass resolution will improve further.

5. Crystal Ball Group

(C. Newman-Holmes)

In April, 1982 the Crystal Ball detector was moved from SPEAR to the DORIS II storage ring at the Deutsches Elektronen Synchrotron (DESY), Hamburg, West Germany. The move proceeded very smoothly and the Ball, as well as associated electronics and on-line computer, arrived safely. Between May and July, 1982, the Crystal Ball was installed at DORIS II. The crystals were recalibrated with radioactive sources and the whole detector was checked out with cosmic rays. There were no major hardware or software problems. In addition, the upgrade of the DORIS machine proceeded on schedule.

At the beginning of August we had our first beams with DORIS II. A week was spent on radiation studies. Eventually machine performance was improved sufficiently to allow us to scan for the $T(1s)$ resonance. The peak was found by the Crystal Ball and the remainder of this first high energy physics run was spent collecting data and studying trigger rates. The run ended in mid-August. During the 2 week shutdown, the Crystal Ball group will install a new system of time-of-flight scintillation counters for muon detection. We also expect improvements to DORIS II. In particular, the vacuum in the beam pipe should be improved to increase beam lifetimes. There will be a long run for high energy physics in Fall, 1982.

Meanwhile, analysis of the SPEAR data continues with new results still appearing. The latest results on radiative decays of the J/ψ were presented at the XXI International Conference on High Energy Physics at Paris, France (July, 1982). This was a study of the process $J/\psi \rightarrow \gamma\eta\pi\pi$. A publication is in preparation. Other results on resonances seen in radiative J/ψ decay have now been published. (Phys. Rev. Lett. 49, 259 (1982), Phys. Rev. Lett. 48, 903 (1982), Phys. Rev. D 25, 3065 (1982) and Phys. Rev. Lett. 48, 458 (1982)). Also the reconstruction of data taken last Fall at SPEAR is now underway. Results on production of the F meson should be available soon.

6. Detector Studies

(K. T. McDonald, with G. Tian and S. Yost (graduate students)).

- a. CathodePad Readout Chambers. This device is a variation on the proportional wire chamber. The cathode plane is segmented into a rectangular grid of "pads", each of which can be read out yielding a simultaneous X and Y coordinate of the ionizing particle. Such a signal is useful in a fast trigger of a high energy physics experiment where ambiguity-free X-Y signals are required. Our recent work has been directed towards elimination of cross-talk between pads, and to a study of gas mixtures for optimal timing characteristics.

b. Self-Quenching Streamer Chamber. This interesting device uses a kind of gas discharge in which the avalanche grows transverse to the anode wire but quenches before longitudinal growth takes place. The streamer size is relatively insensitive to the amount of initial ionization, and large enough that only simple readout electronics are required. Our studies have included photography of the discharge through an image intensifier system, and use of the current division technique for measurement of position along the anode wire.

7. Proposed Experiment at LEP

(P. A. Piroue, A. J. S. Smith, D. P. Stickland, and R. L. Summer, with collaborators from ~ 20 other institutions (8 from the U.S.)

As indicated in the last technical highlights, we submitted, in January 1982, a letter of intent to CERN to build a detector for the new 100-GeV e^+e^- collider (LEP) now under construction near Geneva, Switzerland. Our detector consists of:

- (1) A very large-volume, low-field solenoid magnet ($BL^2 = 16 \text{ T}\cdot\text{m}^2$, 8000 ton Fe).
- (2) A small vertex detector of very high precision.
- (3) A high resolution e.m. calorimeter encapsulating the central detector.
- (4) A hadron calorimeter acting also as muon filter.
- (5) High-precision muon tracking chambers.

Essentially this is a very large "magnetic cave" optimized for the measurement of leptons (e, μ) and photons. Because of the modularity and compactness of the central part there is flexibility. The cost of the detector is estimated to be ~ 40-50 million '82 dollars of which the U.S. would hopefully contribute ~ 40%.

The Princeton group is actively working on the \$15 million electromagnetic calorimeter which will use, as absorber, ~ 12,000 crystals of a novel crystal material, BGO (Bismuth Germanate). More specifically we are interested in the readout system of the calorimeter. As 24,000 readout channels are being planned the compactness and relative inaccessibility of the detector elements make standard, commercial electronics wholly inappropriate. (24,000 RG8 cables have a total cross-section of $2 \times 2 \text{ m}^2$; twisted pairs, $0.7 \times 0.7 \text{ m}^2$!). We are proposing, instead, a design which multiplexes to the outside of the detector only digital signals while putting the preamplifier, integrator, ADC, and MPU of each channel, inside. This approach should result in ~ 800 cables to the outside.

We have also been involved in exploring various methods of making BGO. At present BGO crystals are made by the Czochralski method, a very expensive process (about \$1,000 for a 1" x 1" x 10" crystal). We have approached three firms specializing in crystal growing to see whether other and hopefully cheaper ways to make BGO can be found. Djvahirdjian and Co. of Monthey, Switzerland,

August 30, 1982

and Baikowski and Co., of Annecy France will investigate the Verneuil method, the standard technique to grow large sapphire crystals. In the U.S. Crystal Systems, Inc. of Salem, Mass. has proposed another approach (Heat Exchanger Method) which appears especially promising for big crystals. A feasibility test is being arranged too.

On July 15, in a meeting with Dr. H. Schopper, Director-General of CERN and the contact persons of our collaboration, we were told to assume that our detector will be approved provided it can be financed as proposed. We are also asked to make some modifications to our apparatus which appear minor. This, of course, is a most encouraging news. It is clear that the U.S. contribution (40%) is crucial.

8. Proposal to Study Electron-Proton Collisions

(W. C. Louis, K. T. McDonald, F. C. Shoemaker, D. P. Stickland, in collaboration with several American and Canadian Universities)

The proposal to build a 5 GeV electron ring at Fermilab to collide with the Tevatron proton ring has been joined by a number of Canadian physicists, and re-named P-719. This proposal was discussed at the June 1982 Fermilab PAC, but no formal action was taken on it. As such, the Nevis and Princeton collaborators have not been able to act on our desire to construct a linac and booster at the universities, which would later be installed at Fermilab.

An alternative option to build a 20-30 GeV electron ring at Brookhaven to collide with a 400 GeV proton ring remains under consideration.

Very truly yours,

✓
Frank C. Shoemaker
Professor of Physics
Principal Investigator ✓

FCS:gd