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University of Virginia High Energy Physics Group

Final Performance Report

1989, 1990, 1991 DOE Contracts
(for the period June 1, 1989 - Jan., 31, 1994)

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Introduction

The US Department of Energy Contracts for 1989 covered the initial year of the University of Virginia High Energy Group. In 1988, B. Cox arrived at the University of Virginia, after several discussions with the US Department of Energy, to set up a High Energy Physics Group in the UVa Physics Department. The first proposal was submitted in the fall of 1988 and the first allocation of funding was received in June of 1989. This first contract which covered the time period June 1, 1989 - Jan. 31, 1990 was in the amount of \$186,000 and covered UVa HEP group operations and equipment during that period. At that point, a regular contract year was established and two subsequent contracts were issued for Feb. 1, 1990 - January 31, 1991 and Feb. 1, 1991 - Jan, 31, 1992 with awards of \$280,000 and \$580,000, respectively. The funding between June, 1989 and Jan, 1992 covered the activities of both the UVa Theory Group (Task A) and the UVa HEP Experimental Group (Task B). Expenditures of all above funds was completed by January 31, 1994.

In this time period, certain initial things were accomplished using the operating funds provided by DOE and the seed funds (\$2.2 million over the period). There were three main areas of activities, the building of the University of Virginia HEP infrastructure (construction of lab space, computer facilities, electronic shop, machine shop and office space), the hiring of personnel (faculty, post docs, and students) and the physics activities of the group.

Personnel

A first priority of Cox after arriving at UVa was the building of the HEP Group by hiring the personnel. The first objective was a faculty search to fill one HEP theory faculty position and three HEP experimental faculty positions. The theory faculty position was filled in September of 1989 when H. Thacker formally of Fermi National Accelerator Lab joined the University of Virginia faculty. Thacker joined three other High Energy theorists, Paul Fishbane, P.Q. Hung and Pasha Kabir who were already on the faculty. The support of these individuals was bundled together into Task A from this point on through the three year period. Some of the previous support of the UVa HEP theorists had been from NSF but with issuance of the 1989 DOE contract, all support was transferred to DOE.

The assembly of the UVa Experimental Group took more time since there was no HEP experimental activity at UVa prior to Cox's arrival. The HEP faculty was assembled with the arrival of S. Conetti (formally of McGill University) as a full professor in the spring of 1990 and the hires of K. Nelson (Univ. of Wisconsin) and E.C. Dukes (Univ. of Michigan/CERN) in the fall of 1990 as assistant professors.

During this early time period, M. Arenton joined UVa as a senior scientist in the HEP Group in the fall of 1988 even before the first contract. He was initially supported by Institute for Nuclear and Particle Physics at the University.

Another early arrival, was D. Bunyard who has filled the role of administrative assistant for the HEP group until the present day.

In order to carry out the physics program of the UVa HEP Experimental Group (discussed below), it was necessary to obtain technical and physics personnel as soon as possible since we were very early on in 1989, 90 and 91 constructing a large experiment, E771, at Fermilab and planning for a very large experiment, the Super Fixed Target B Experiment (the SFT) at the Superconducting Super Collider. We hired during the initial period of the contract, M. Recagni (formerly of Northwestern and Pavia Universities) as a physicist/engineer, J. Segal (University of Wisconsin) as a senior technician and A.P. McManus (Notre Dame) as a research associate. We also supported several graduate students during this period (Hanlet, Ramachandran, Timmons, Wall, White, Sun, Pogosyan, Ledovskoy, Klepitch).

With this complement of people, the UVa HEP Experimental Group undertook to build the group facilities at the same time as we were involved with Fermilab Experiment E771 and planning for the SSC.

Physical Infrastructure

The UVa experimental group were given as their laboratory space a building which had originally been built with NSF funds to house a Tandem Van der Graaff. It had been some years since the building had been occupied and, in any case, many of its areas required considerable modification to be usable by the HEP group. A good deal of construction

was required and this the immediately usable space had to be set up as office and temporary lab space to support our efforts at Fermilab.

In the fall of 1989 and spring of 1990, seed funds were provided by the State of Virginia through the University and the INPP to refurbish the building and Cox, working with the local architects and building and grounds managers at UVA developed plans and let contracts for the necessary construction. At the end of the 1989-92 contract period, the bulk of the work was finished, resulting in over 10,000 ft² of laboratory, office and assembly/construction space available for the growing HEP group. This included a climate controlled computer room with regulated power, a 2000 ft² high bay assembly area with 1.5 ton crane coverage, and a machine shop area (not quite finished) together with an electronics lab and three suites of offices capable of housing the HEP experimental group.

In the same period, we began what has been an evolving task, the setting up of computing facilities. Once again, the funding for these facilities came from the State of Virginia. M. Arenton was mainly responsible for setting up a farm of DEC workstations which represented, at the time, a significant amount of computing power. These workstations were coupled to an assortment of disks, tape units and terminals (Mac's and dumb terminals in that era). This computing power was used for analysis of the E771 data as well as supplying all the usual computer age facilities (word processing, E-mail, etc.).

Finally, J. Segal, K. Nelson and A.P. McManus accumulated and installed a wide variety of electronic gear which allowed us to develop apparatus for the Fermilab experiment.

1989,90 and 91 Physics Program

UVA Experimental HEP Group Program

E705/E705

Much of the physics program of the experimental group revolved around the study of production and decay of heavy flavor (c and b quarks). Some of us (Cox and Conetti) were in the process of analyzing a previous Fermilab experiment, E705, and the entire group was involved in a new Fermilab experiment under construction in 1989,90 and 91 called E771. Both experiment focused on detection of states of heavy flavor by detection of high pt muons and high mass muon pairs from their decays. E705 used

pions at 300 GeV/c to produce these states. E771 was to use 800 GeV/c protons.

During the 1989-91 time period covered by the three contracts, additional equipment funds were received from DOE to help build equipment for the experiment. Cox was the spokesman for both experiments and the UVa group, even though it was very young, was the central group (out of 15 or so groups on E771) in getting E771 built. We had particular roles in the muon trigger (Conetti), the silicon vertex detector (Cox, A.P. McManus, M. Recagni), and the wire chambers (Nelson, Segal) and the electromagnetic detector (E.C. Dukes, Hanlet). Several tens of thousands of channels of electronics were prepared and installed in this time period. We began to test this equipment in the fall of 1991 and had a very brief amount of beam in December, 1991 and January, 1992.

The analysis of this data has gone on since that time and while not strictly a part of this report, we include the list of physics and technical papers that this experiment has generated below.

E771 Papers

E771 Physics Journal Papers

- [1] "Production of J/Ψ , Ψ' and Υ in 800 GeV/c Proton-Silicon Interactions", T. Alexopoulos et al., Phys.Lett. **B374**, 271(1996); "Measurement of J/Ψ , Ψ' and Υ in 800 GeV/c Proton-Silicon Interactions", Fermilab-Pub-95/297-E (1995).
- [2] "Search for the Flavor Changing Neutral Current Decay $D^0 \rightarrow \mu^+ \mu^-$ in 800 GeV/c Proton- Silicon Interactions", T. Alexopoulos et al., Fermilab-Pub-95/286-E (1995); Phys. Rev. Lett. **77**, 2380(1996)
- [3] "Differential Cross Sections of J/Ψ and Ψ' in 800 GeV/c p-Si Interactions", T. Alexopoulos et al., To be published in Phys. Rev D, March, 1997.
- [4] "Beauty Production in 800 GeV/c pSi Interactions", A. Ledovsky et al., in preparation .
- [5] "A Measurement of the Cross Sections for χ_1 and χ_2 Production in 800 GeV/c pN Interactions", K. Hagan-Ingram et al., in preparation .
- [6] "A Measurement of the Branching Ratio for $\eta \rightarrow \mu\mu$ ", P. Hanlet et al. in preparation.
- [7] "Neutral Strange Particle Production at $\sqrt{s}=38.8$ GeV/c in pSi Interactions", C. Durandet et al., in preparation .

E771 Technical Journal Papers

- [1] "The Fermilab E771 Spectrometer. A Large Aperture Spectrometer to Study Charm and Beauty States as Detected by Decays into Muons", T. Alexopoulos et al., NIM **A376**, (1996); Fermilab-Pub-95/348-E, (1995).
- [2] "FNAL E771 RPC Muon Trigger", G. Introzzi et al., NIM **A360**, 334 (1995).
- [3] "FNAL E771 Fast Muon Trigger", L. Antoniazzi et al., NIM **A355**, 320 (1995).
- [4] "Characteristics of the Radiation Damage Seen in a Silicon Microstrip Detector of Fermilab Experiment E771", A. Boden et al., NIM **A340**, 491 (1994).
- [5] "Performance of the E771 RPC Muon Detector at Fermilab", G. Cataldi et al., NIM **A337**, 350 (1994).
- [6] "Effects of High Energy Protons on the E771 Silicon Microstrip Detector", A.P. McManus et al., Radiation Physics and Chemistry **41**, 427, (1993).
- [7] "The E771 RPC Muon Detector", L. Antoniazzi et al., NIM **A315**, 92 (1992).
- [8] "The TRIGA Board for a Fast Muon Trigger for E771", L. Antoniazzi et al., NIM **A314**, 563 (1992).
- [9] "A High Pt Muon Trigger Processor", S. N. Zhang et al., IEEE Transactions on Nuclear Science, Vol. **39**, 814 (1992).
- [10] "Resistive Plate Counters Readout System", L. Antoniazzi et al., NIM **A307**, 312 (1991).

E771 Publications/Conference Reports/Preprints

- [1] "Beauty Hadroproduction Cross Section in 800 GeV/c pN Interactions", F. Grancagnolo et al., Proceedings of the Beauty 96 Conference, Rome, (1996).
- [2] "Results on $B\bar{B}$ production at $\sqrt{s}=38.8$ GeV, S. Ramachandran et al., Proceedings of the 1996 DPF Conference, Minneapolis, MI (1996).
- [3] "Ratio of χ_1/χ_2 Production in 800 GeV/c pN Interactions", K. Hagan-Ingram et al., Proceedings of the 1996 DPF Conference, Minneapolis, MI (1996).
- [4] "A Measurement of the Branching Ratio for $\eta \rightarrow \mu\mu$ ", P. Hanlet et al., Proceedings of the DPF96 Conference, Minneapolis, MI (1996).
- [5] "High Mass Dimuon States produced in 800 GeV/c pSi Interactions", G. Corti et al., Proceedings of the DPF94 Conference, Albuquerque, NM, S. Seidel, ed. World Scientific, 1272(1995).
- [6] "A Search for New Charmonium States Decaying into J/Ψ plus Charged Pions", A.P. McManus et al., Proceedings of the DPF94 Conference, Albuquerque, NM, S. Seidel, ed. World Scientific, 547 (1995).
- [7] "Search for the Flavor Changing Neutral Current Decay $D^0 \rightarrow \mu^+\mu^-$ in 800 GeV/c Proton- Silicon interactions", G. H. Mo et al., Proceedings of DPF94 Conference, Albuquerque, NM, S. Seidel, ed., World Scientific, 956 (1995).
- [8] "Rare Charm Decays in E789, E771 and WA92", K. Lau, Proceedings of HQ94 Workshop on Heavy Quark Physics at Fixed Target, B. Cox, ed., Published by Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati, Charlottesville, VA, 53 (1994).

- [9] "Results on Charmonium Production at High Energy", A. P. McManus, Proceedings of HO94 Workshop on Heavy Quark Physics at Fixed Target, B. Cox, ed., Published by Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati, Charlottesville, VA, 39 (1994).
- [10] "High Mass Dimuon Production in 800 GeV/c pN Interactions", S. Conetti et al., XXVII International Conference on High Energy Physics, ICHEP94, SC470, Glasgow, UK; Fermilab-Conf-94/178-E (1994).
- [11] "Search for the Flavor Changing Neutral Current Decay D^0 to $\mu^+\mu^-$ in 800 GeV/c Proton-Silicon Interactions, K. Lau et al. XXVII International Conference on High Energy Physics, ICHEP94, SC471, Glasgow, UK, (1994).
- [12] "Performance of E771 RPC Muon Detector", E. Gorini, *Scientifica Acta*, VIII 3, 13 (1993).
- [13] "Fixed Target B physics at Fermilab and the SSC", S. Conetti, *NIM A333*, 142 (1993).
- [14] "Fixed Target Beauty Physics at FNAL", Proceedings of the HO93 Workshop on Heavy Quark Physics at Fixed Target, A. P. McManus, S. Bianco and F.L. Fabbri, ed., Published by Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati, 99 (1993).
- [15] "Fixed Target B Physics with E771 Experiment at Fermilab", E. Gorini, Proceedings of Les Rencontres de Physique de la Vallee D'Aoste, Edition Frontières, La Thuile, Italy, C60, 153 (1993).
- [16] "Measurement of Localized Efficiency Loss in a Silicon Microstrip Detector Operated at High Intensity", L. Fortney, Proceedings of 1992 DPF Conference, Fermilab, Batavia, IL, C. Albright et al., ed., World Scientific, 1684(1993).
- [17] "Di-Muon and Single-Muon Events from a Beauty Experiment", W. Selove, Proceedings of 1992 DPF Conference, Fermilab, Batavia, IL C. Albright et al., ed., World Scientific, 701 (1993).
- [18] "B Physics at FNAL E771", G. Introzzi et al., *Nucl. Phys. B27*, 257 (1992).
- [19] "Status of the Silicon Strip High-Rate FASTBUS Readout System", H. Gonzales et al., Proceedings of the 1991 IEEE Nuclear Science Symposium, Santa Fe, NM, Vol.2, 747 (1991).
- [20] "A Combination Drift Chamber/Pad Chamber for Very High Readout Rates", L. Spiegel et al., Proceedings of the 1991 IEEE Nuclear Science Symposium, Santa Fe, NM), Vol. 1, 381(1991).
- [21] "Performance of a Silicon Microstrip Detector in a Very High Rate Environment", A. P. McManus et al., Proceedings of the 1991 IEEE Nuclear Science Symposium, Santa Fe, NM, Vol. 1, 298 (1991).
- [22] "The RPC System of E771, Cosmic Rays Test Results", F. Grancagnolo, Proceedings of the 4th Topical Seminar on Experimental Apparatus for High Energy Particle Physics and Astrophysics, San Miniato, Italy, (1990).

- [23] "The Resistive Plate Counter Muon System of E771", E. Gorini, Proceedings of the 2nd International Conference on Advanced Technology and Particle Physics, Como, Italy, (1990).
- [24] "The RPC as a Muon Detector: The E771 Experience", F. Grancagnolo, Proceedings of the Symposium on Detector Research and Development for the Superconducting Super Collider, Fort Worth, TX, (1990).
- [25] "SSD Module Specification and As-Built Hardware Descriptions", A. Bowden et al., Fermilab TM-1747 (1990).
- [26] "Upgrade of the Proton West Secondary Beamline", L. Spiegel, Fermilab TM-1630 (1989).
- [27] "Single Muon Distributions from Beauty in 800 GeV/c pp Interactions", D. E. Wagoner, Proceedings of the workshop on High Sensitivity Beauty Physics at Fermilab, Batavia, IL, A. J. Slaughter, N. Lockyer and M. Schmidt, ed., 437 (1988).
- [28] "Steps Toward High-Rate Fixed-Target B Physics", W. Selove, Univ. of Pennsylvania Report UPR-161E, (1988).
- [29] "A High Rate Trigger System for E771", W. Selove, Univ. Pennsylvania Report UPR-0147E, (1987).
- [30] "Studies of B-Physics with FNAL E771", F. Grancagnolo, Workshop on High Energy Hadronic Interactions - XXV Rencontre de Moriond, Les Arcs, France, (1990).
- [31] "Detector Elements for a High-Rate Fixed-Target Beauty Experiment", W. Selove, Physics at Fermilab in the 1990's, Breckenridge, CO, (1989).
- [32] "Fixed Target Hadroproduction of Beauty: In Fermilab Experiment E771 and at the SSC", B. Cox, Proceedings of the 2nd International Symposium on the 4th family of Quarks and Leptons, Annual of the New York Academy of Sciences, Edited by A. Soni and D. Cline, 224 (1989).
- [33] "Fixed Target B Experiments: A Prelude to B Physics at the SSC", B. Cox, Proceedings of the 2nd International Symposium on the 4th family of Quarks and Leptons, Annuals of the New York Academy of Sciences, Edited by A. Soni and D. Cline (1989).
- [34] "E771 and Beyond", Workshop on "CP Violation and Fixed Target B Physics at Ultra-High Energies at UNK, B. Cox, Dubna, USSR, (1989).
- [35] "Beauty Hadroproduction", B. Cox, Heavy Flavor: Status and Perspectives - 5th International Erice Workshop, Erice, Italy, (1988).
- [36] "Hadroproduction of Heavy Flavors", B. Cox, Les Rencontres de Physique de la Vallee D'Aoste, La Thuile, Italy, (1988).
- [37] "Prospects for B Physics Spectroscopy in the Fermilab Fixed Target Experiments", B. Cox, Exotics, Glueballs and Hybrids, American Institute of Physics Conference Proceedings 185, Particles and Fields 36, Suh-Urk Chung, ed., 228 (1988).

- [38] "Beauty Physics at Fermilab Fixed Target Energies", B. Cox, Proceedings of the SLAC B Meson Factory Workshop, SLAC Report **324**, 59 (1987); Fermilab-Conf-88/48 (1988).
- [39] "Dimuon Experiments at the Fermilab High Intensity Laboratory", S. Conetti, QCD Hard Hadronic Processes, B. Cox, ed., Plenum Press, 411 (1988).

E771 Theses

- [1] Zi-lie Cao, "Differential Cross Section Measurements of J/Ψ and Ψ' Production in 800 GeV Proton-Silicon Interactions", PhD thesis, University of Virginia, Charlottesville, VA, (in progress).
- [2] K. Hagan-Ingram, "Cross Sections for χ Production in 800 GeV Interactions", PhD thesis, University of Virginia, Charlottesville, VA, (in progress).
- [3] A. Ledovskoy, "Beauty Cross Sections in 800 GeV pN Interactions", PhD thesis, University of Virginia, Charlottesville, VA, (in progress).
- [4] V. Pogosian, "Charm Production in 800 GeV pN Interactions", PhD thesis, University of Virginia, Charlottesville, VA, (in progress).
- [5] Sathyadev Ramachandran, " $B\bar{B}$ Hadroproduction at $\sqrt{s} = 38.8$ GeV, University of California, Los Angeles (California), Ph.D. thesis, (in progress).
- [6] C. Durandet, "A Study of Neutral Strange Particle Production at $\sqrt{s} = 38.8$ GeV in Proton-Silicon Interactions", University of Wisconsin, Madison, WI, Ph.D. thesis, (Nov. 1995).
- [7] Pierrick Hanlet, "Inclusive Measurements of the η Cross Section at $\sqrt{s} = 38.8$ GeV and the Branching Ratio for η to $\mu^+\mu^-$ ", University of Virginia, Charlottesville, VA Ph.D. thesis, (May, 1995).
- [8] Elena Evangelista, "Produzione e Decadimento della $\Psi(2s)$ in Interazioni Adroniche a $E(\text{cm})=38.7$ GeV", Università degli studi di Lecce, Lecce, Italy., Tesi di laurea, (Feb., 1995).
- [9] Alan Blankman, "Search for B Mesons in High Transverse Momentum Single Muon Events in Experiment 771 at Fermilab", University of Pennsylvania, Philadelphia (Pennsylvania), Ph.D. thesis, (July 1994).
- [10] Guanghui Mo, "Search for Flavor Changing Neutral Current Decay $D^0 \rightarrow \mu^+\mu^-$ in 800 GeV/c Proton-Silicon Interactions", University of Houston, Houston (Texas), Ph.D. thesis, (Dec., 1993).
- [11] Pierrick Hanlet, "Observation and Measurement of the Cross Section Times Branching Ratio for the 1P_1 State of Charmonium into $J/\Psi\pi^0$ ", University of Virginia, Charlottesville, VA, Master thesis, (Sept., 1993)
- [12] Andrew Boden, "Observation and Reconstruction of B Mesons in p-Si Collisions at 800 GeV/c", University of California, Los Angeles, CA, Ph.D. thesis, (Aug. 1993).
- [13] Germano Bonomi, "Misura di Sezioni d'urto Totale e Differenziale di J/Ψ in un

- Esperimento di Adroproduzione", Università degli studi di Pavia, Pavia, Italy, Tesi di laurea, (July, 1993).
- [14] Valerio Elia, "Misura delle Sezioni d'urto Totale e Differenziale di Produzione Adronica di J/Ψ a FNAL/E771", Università degli studi di Lecce, Lecce, Italy, Tesi di laurea, (March, 1993).
- [15] Marco Panareo, "L'esperimento E771 a Fermilab: Misura Preliminare delle Sezioni d'urto di Produzione Adronica di J/Ψ e Ψ' a 800 GeV/c", Università degli studi di Bari ed. Università degli studi di Lecce, Bari, Italy, Tesi di dottorato, (Jan., 1993).
- [16] Gianluca Introzzi, "Un Trigger Programmabile per l'Adroproduzione di Mesoni B a FNAL E771", Università degli studi di Pavia, Tesi di dottorato, (Feb. 1992).

At the same time, we were analyzing the data from E705. We include below the references to the physics papers generated by that collaboration in approximately the time period of this proposal.

E705 Papers

- [1] "High Energy Electromagnetic Shower Position Measurement by a Fine Grained Scintillation Hodoscope", with G. Hale et al., Fermilab Conf-82/76, NIM **219**, 487 (1984).
- [2] "A Measurement of the Response of an SCG1-C Scintillation Glass Shower Detector to 2-17.5 GeV Positrons", with G. Hale et al., Fermilab Conf-82/76, NIM **219**, 491(1984).
- [3] "Cherenkov and Scintillation Light Measurements with Scintillating Glass", SCG1-C, with G.E. Theodosiou et al., Proceedings of the 1983 Nuclear Science Symposium, San Francisco, CA (1983).
- [4] "A Measurement of the Response of an SCG1-C Scintillation Glass Array to 4-14 GeV/c Pions", with C.M. Jenkins et. al, Fermilab Conf-84/23 E, NIM **A238**, 321 (1985).
- [5] "Measurement of Electromagnetic Shower Position and Size with a Saturated Avalanche Tube and a Fine Grained Scintillation Hodoscope", with R. Rameika et al., NIM **A236**, 42 (1985).
- [6] "A Measurement of the Energy Resolution and Related Properties of an SCG1-C Scintillation Glass Shower Counter Array for 1-25 GeV Positrons", with R. Rameika et al., NIM **A238**, 315 (1985).
- [7] "Nuclear Target Effects in J/Ψ Production in 125 GeV/c Antiproton and π^- Interactions", E. Anassontzis et. al, Phys. Rev. Lett., **60**, 2121 (1988).
- [8] "E-705 Electromagnetic Shower Position Detector", with C.M. Jenkins et al., Proceedings of the Gas Calorimetry Workshop II-Fermilab (1986).
- [9] "Fermilab Experiment E705", Fermilab Report 88/5, 5 (1988).
- [10] "Prospects for B Physics Spectroscopy in the Fermilab Fixed Target Experiments", Exotics, Glueballs and Hybrids, American Institute of Physics Conference

Proceedings No. 185, Particles and Fields 36, edited by Suh-Urk Chung, 228(1988).

- [11] "Results from the E-705 Electromagnetic Shower Position Detector", with C.M.Jenkins et al., *IEEE Trans. Nucl. Sci.* **NS-36**, 117 (1989).
- [12] "Performance of 0.75 mm Pitch MPWC's Operating at High Rate", S. Conetti et al., *IEEE Trans. Nucl. Sci.* **NS-36**, 112 (1989).
- [13] "Precision Charge Amplification and Digitization System for a Scintillating and Lead Glass Array", with S.W. Delchamps et al., *IEEE Trans. Nucl. Sci.* **NS-36**, 680(1989).
- [14] "An On-Line Trigger Processor for Large Transverse Energy Events", with G. Zioulas et al., *IEEE Trans. Nucl. Sci.* **NS-36**, 375(1989).
- [15] "Performance of a Lead Radiator Gas Tube Calorimeter", with L. Spiegel et al., *IEEE Trans. Nucl. Sci.* **NS-36**, 86 (1989).
- [16] "Direct Photon Production in π -Li⁷ Interactions at 300 GeV/c", with G. Zioulas et al., *Bull. Am. Physical Society*, Vol. 34.4, 1208 (May 1989).
- [17] "Hadronic Production of Charmonium at 300 GeV/c", with T. Premantiotis et al., *Bull. Am. Physical Society*, Vol. 34.4 (May 1989).
- [18] "Report of the Fixed Target Hadroproduction Group", Proceedings of the Workshop on Physics at Fermilab in the 1990's, World Scientific, Breckenridge CO, 418 (Aug.1990).
- [19] "A Measurement of J/Ψ and Ψ' Production in 300 GeV/c Proton, Antiproton and π^\pm Interactions with Nuclei", with L. Antoniazzi et al., *Phys. Rev.* **D46**, 4829(1992).
- [20] "Production of J/Ψ via Ψ' and χ Decay in 300 GeV/c Proton and π^\pm Nucleon Interactions", with L. Antoniazzi et al., *Phys. Rev. Lett.* **70**, 383(1993).
- [21] "Performance of the E-705 Electromagnetic Calorimeter", with T. Turkington, et al., Proceedings of the 1988 Division of Particles and Fields Meeting of the Am. Physical Society, Storrs, CT, (1988).
- [22] "Hadronic Production of Charmonium at 300 GeV/c", with C.M. Jenkins et al., Proceedings of the 1988 Division of Particles and Fields Meeting of The Am. Physical Society, Storrs, CT, (1988).
- [23] "Preliminary Results from Fermilab Experiment 705: 300 GeV/c Pion and Proton Induced Interactions Containing High p_t Photons", with S. Delchamps et al., Proceeding of 1988 Division of Particles and Fields Meeting of The Am. Physical Society, Storrs, CT (1988).
- [24] "High P_t Pizero and Charmonium Production in 300 GeV/c Pion and Proton Induced Interactions: Preliminary Results from Fermilab Experiment 705", with R. Tesarek et al., Proceedings of the Division of Particles and Fields Meeting of the Am. Physical Society, Houston, TX,(1990).
- [25] "Charmonium and Direct Photon Production from Fermilab E-705", with S. Conetti et al., Proceeding of the XXIV th Rencontre de Moriond, Les Arcs, France, (1989).
- [26] "High Transverse Momentum Pizero and Direct Photon Production", with Q. Shen et al., Proceedings of XXI International Symposium on Multiparticle Dynamics, Wuhan, PRC, (1991).
- [27] "High P_t Production of Pizero and Eta at 300 GeV/c", with L.Fortney et al., Proceeding of Division of Particles and Fields Meeting of the Am. Physical Society, Vancouver, Canada, (1991).

- [28] "Production of Charmonium States from Experiment 705 at Fermilab", with M. Rosati et al., Proceeding of Division of Particles and Fields Meeting of the Am. Physical Society, Vancouver, Canada, (1991).
- [29] "Preliminary Results from Fermilab E-705", with T. Murphy, et al., Proceeding of XXVIth Rencontre de Moriond, Les Arcs, France, (1991).
- [30] "A Combination Drift Chamber/Pad Chamber for Very High Readout Rates", with L. Spiegel et al., IEEE Transactions on Nuclear Science, Vol. 1, 381(Santa Fe, 1992).
- [31] "The Experiment E705 Electromagnetic Shower Calorimeter", with L. Antoniazzi et al., NIM A332, 57(1993).
- [32] " Ψ Production in pN and π -N Interactions at 125 GeV/c and a Determination of the Gluon Structure Functions of the p and π^- ", with C. Akerloff et al., Phys. Rev. D48, 5067(1993).
- [33] "Production of Chi Charmonium via 300 GeV/c Proton and π^\pm Interactions on a Lithium Target", with L. Antoniazzi et al., Phys. Rev. D49, 543(1994).
- [34] "Search for Hidden Charm Resonance States Decaying into J/Ψ or Ψ' Plus Pions", with L. Antoniazzi et al., Fermilab-Pub-92/265E, Phys. Rev. D25, 54(1994).

SFT at the SSC

In the 1989-91 time period, we were busy developing a new proposal (B. Cox, spokesperson) for a large facility at the Superconducting Super Collider (SSC) under construction then near Dallas, Texas. This work resulted in an "Expression of Interest", EOI-14, which we submitted to the SSC Laboratory in May of 1990. More than 35 institutions world wide were signers of this EOI and UVa again was the leader of the effort.

After a defense of the EOI in the summer of 1991, we received considerable encouragement from the management of the SSC Lab and the SSC Program committee. We continued our development of our ideas into the next contract period (beyond 1991) until the demise of the SSC in October of 1993.

Once again, since most of the papers, were generated after the contract period in question, this is not strictly a part of this report. However, it is useful to examine the product of this effort.

SFT Papers

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UVa HEP Theory Group Program

The UVa theoretical group in the time period, 1989-91 concentrated its research in the areas of electroweak interactions, CP violation, symmetry breaking mechanisms leading to the Standard Model family structure, models for quantum chromodynamics at long distances, lattice gauge calculations of QCD and exactly solvable models in statistical physics. This work had both phenomenological and purely theoretical aspects.

As stated above, in 1988, the UVa theory group was composed of two professors, P. Fishbane and P. Kabir and an assistant professor, P.Q. Hung. With the arrival of the experimental group their support was

combined under the present DOE grant and the group was strengthened in 1989 by the arrival of a fourth professor, H. Thacker who founded a lattice gauge effort at UVa.

The varied work of the UVa group is best summarized by their publications since the 1989-91 startup period.

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