

**02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and
co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS**

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PI/PD Name: Matthias Perdekamp

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
(Select one or more)
 Hearing Impairment
 Visual Impairment
 Mobility/Orthopedic Impairment
 Other
 None

Citizenship: (Choose one) U.S. Citizen Permanent Resident Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name):

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project

Ethnicity Definition:

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PI/PD Name: Naomi C Makins

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
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 Hearing Impairment
 Visual Impairment
 Mobility/Orthopedic Impairment
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PI/PD Name: Jen-Chieh Peng

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
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Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race: (Select one or more)
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 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status: (Select one or more)
 Hearing Impairment
 Visual Impairment
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PI/PD Name: John Lajoie

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
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 Hearing Impairment
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PI/PD Name: Kenneth N Barish

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
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 Hearing Impairment
 Visual Impairment
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PI/PD Name: Richard K Seto

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
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 Hearing Impairment
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PI/PD Name: Rusty Towell

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
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 Asian
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PI/PD Name: Larry D Isenhower

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
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 Black or African American
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REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project

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Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

Race Definitions:

American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.

Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

Black or African American. A person having origins in any of the black racial groups of Africa.

Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information received from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational opportunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Ray Arnold, University of Massachusetts
Jens Bisplinghoff, Bonn
Alessandro Bravar, Brookhaven National Laboratory
Franco Bradamante, INFN Trieste
Stanely Brodsky, Stanford Linear Accelerator Center
Volker Burkert, Jefferson Laboratory
Manuel Calderon, Indiana University
Brad Phillipone, California Institute of Technology
Tim Hallman, Brookhaven National Laboratory
Emelyn Hughes, California Institute of Technology
Robert L. Jaffe, Massachusetts Institute of Technology
Kay Koenigsmann, Freiburg University
Krishna Kumar, University of Massachusetts
Alain Magnon, CEA/Saclay
Gerhard Mallot, CERN
Makis Petratos, Kent State University
Stephan Paul, TU Munich
Stephane Platchkov, CEA/Saclay
Terry Sloan, Lancaster University
Jacques Soffer University of Marseilles
Paul Souder, Syracuse University
Bernd Surrow, Massachusetts Institute of Technology
Fluvio Tessarotto, INFN Trieste
Robert Tribble, Texas A&M University
Steve Vigdor, Indiana University
Werner Vogelsang, Brookhaven National Laboratory
Christian Weiss, Jefferson Laboratory
Chien-Peng Yuan, Michigan State University

REVIEWERS NOT TO INCLUDE:

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Not Listed

REVIEWERS NOT TO INCLUDE:

Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Not Listed

REVIEWERS NOT TO INCLUDE:

Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Not Listed

REVIEWERS NOT TO INCLUDE:

Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 04-23					FOR NSF USE ONLY	
NSF 05-515			01/27/05		NSF PROPOSAL NUMBER	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)						
PHY - MAJOR RESEARCH INSTRUMENTATION						
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
				041544081		
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
426004224						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
University of Illinois at Urbana-Champaign			University of Illinois at Urbana-Champaign			
AWARDEE ORGANIZATION CODE (IF KNOWN)			801 South Wright Street			
0017756000			Champaign, IL. 618206242			
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE			
PERFORMING ORGANIZATION CODE (IF KNOWN)						
IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)						
<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE <input type="checkbox"/> FOR-PROFIT ORGANIZATION <input type="checkbox"/> WOMAN-OWNED BUSINESS						
TITLE OF PROPOSED PROJECT Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton						
REQUESTED AMOUNT \$ 747,216	PROPOSED DURATION (1-60 MONTHS) 60 months	REQUESTED STARTING DATE 09/01/05	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE			
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW						
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.A) <input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.6) <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C) Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d) <input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.g.(iv).(c)) <input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j) <input type="checkbox"/> SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1) <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____ <input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)						
PI/PD DEPARTMENT Physics		PI/PD POSTAL ADDRESS 801 South Wright Street 109 Coble Hall Champaign, IL 61820 United States				
PI/PD FAX NUMBER 217-333-1215						
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
Matthias Perdekamp	DPhil	1995	217-333-6544	mgp@uiuc.edu		
CO-PI/PD Naomi C Makins	PhD	1994	217-333-7291	makins@uiuc.edu		
CO-PI/PD Jen-Chieh Peng	PhD	1975	217-333-2187	jcpeng@uiuc.edu		
CO-PI/PD						
CO-PI/PD						

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 04-23. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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(If answer "yes", please provide explanation.)

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(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE	DATE
NAME			
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER	

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

CERTIFICATION PAGE

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE	DATE
NAME			
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER	

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COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE <i>if not in response to a program announcement/solicitation enter NSF 04-23</i>					FOR NSF USE ONLY			
NSF 05-515			01/27/05		NSF PROPOSAL NUMBER			
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) <small>(Indicate the most specific unit known, i.e. program, division, etc.)</small>								
PHY - MAJOR RESEARCH INSTRUMENTATION								
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# <small>(Data Universal Numbering System)</small>	FILE LOCATION			
				627797426				
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)				
956006142								
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE					
University of California-Riverside			University of California-Riverside					
AWARDEE ORGANIZATION CODE (IF KNOWN)			Office of Research Affairs					
0013169000			Riverside, CA. 925210217					
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE			ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE					
PERFORMING ORGANIZATION CODE (IF KNOWN)								
IS AWARDEE ORGANIZATION (Check All That Apply) <small>(See GPG II.C For Definitions)</small>								
		<input type="checkbox"/> SMALL BUSINESS		<input type="checkbox"/> MINORITY BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE		
		<input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> WOMAN-OWNED BUSINESS				
TITLE OF PROPOSED PROJECT Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton								
REQUESTED AMOUNT \$ 834,600		PROPOSED DURATION (1-60 MONTHS) 60 months		REQUESTED STARTING DATE 09/01/05		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE		
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW								
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.A)			<input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.6)					
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)			Exemption Subsection _____ or IRB App. Date _____					
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)			<input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.g.(iv).(c))					
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)								
<input type="checkbox"/> SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)								
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____			<input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)					
PI/PD DEPARTMENT Department of Physics			PI/PD POSTAL ADDRESS					
PI/PD FAX NUMBER 951-827-4529			Riverside, CA 925210217					
United States								
NAMES (TYPED)		High Degree	Yr of Degree	Telephone Number	Electronic Mail Address			
PI/PD NAME Kenneth N Barish		PhD	1996	951-827-5023	kenneth.barish@ucr.edu			
CO-PI/PD Richard K Seto		PhD	1983	951-827-5623	richard.seto@ucr.edu			
CO-PI/PD								
CO-PI/PD								
CO-PI/PD								

CERTIFICATION PAGE

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE	DATE
NAME			
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER	

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2. Project Summary

We propose to develop a new state-of-the-art trigger system to make possible the precise measurement of the flavor structure of the quark polarizations in the proton using a truly novel technique: the observation of W-bosons in polarized proton-proton (p+p) collisions. New instrumentation will be added to the existing PHENIX detector to take advantage of the imminently available high-energy and high-polarization beams at the RHIC accelerator in BNL.

Since the first experimental observation of quark sub-structure, a comprehensive program of measurements in deep inelastic electron-nucleon and muon-nucleon scattering has been carried out at SLAC, FNAL, CERN, and DESY. While significant progress has been made in understanding the quark and gluon structure of the nucleon, many important questions remain—in particular we have only rudimentary understanding of the origin of the proton spin. Parity violating W production in polarized p+p collisions at RHIC will give the unique possibility to decompose the spin-dependent up- and down-quark and anti-quark distributions.

W-bosons can be detected in PHENIX through the appearance of a high energy muon in one of the two existing muon spectrometers. Knowledge of the spin orientations of the colliding protons in these events makes it possible to measure the spin dependent distribution functions of up- and down-quarks and their corresponding anti-quarks in the proton. The measurement resolves the quark distributions as a function of the relative momentum to the proton with excellent statistical precision and systematic accuracy. A fundamental theoretical framework based on perturbative techniques in QCD exists for the interpretation of W-production at RHIC.

The development of the W-boson trigger in PHENIX has been strongly endorsed in a recent review by the NSF-DOE Nuclear Science Advisory Committee, which formulates the overall plan of basic nuclear physics research in the United States. Last year the PHENIX Collaboration formally reviewed and approved a letter of intent describing this research plan.

The W-trigger is based on fast resistive plate counter stations (RPCs), their front-end electronics for read-out, and large fast programmable gate arrays for the implementation of algorithms that can signal the rare formation of a W-boson in a p+p collision. Since a W signal is expected to occur only about once per billion p+p collisions, the trigger allows selection and storage of these interesting rare events and rejection of abundant background events. The RPCs are compact, relatively inexpensive devices that will produce an electronic pulse when an ionizing particle passes through their bulk. The electronics to signal the creation of a W boson consists of custom designed circuit boards that amplify and process the raw electrical pulses from all of the individual elements of the RPCs, followed by electronics to analyze the signals from the individual elements to determine if they are consistent with the creation of a W boson.

The research team has extensive experience in all aspects of the project, and well-established muon trigger technology will be adopted from the CMS experiment. The group includes world leaders who are mapping out proton quark and anti-quark sub-structure (in experiments E866 at FNAL and HERMES at DESY), and groups with extensive experience in similar hardware projects. The fundamental physics research program, salaries and travel is supported by ongoing contracts with NSF and DOE.

This project offers an outstanding training ground for students and young researchers, who will do analysis at the frontier of nuclear physics and will gain experience in the design, construction, and testing of state-of-the-art detectors and readout electronics. Eight graduate students and nine postdoctoral fellows work on the project now. Six DOE ERULF/SULI summer students, two NSF REU summer students, and five UIUC undergraduates have worked on the simulations and R&D thus far, eight of whom have presented their work at Division of Nuclear Physics meetings. More than 80 graduate students from 13 countries currently work on PHENIX, and a large fraction will utilize the new equipment. Historically, a large number of women have been involved in PHENIX research as both undergraduate and graduate students, contributing to the diversity of the science and engineering workforce.

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3. Project Description

a. Research Activities

A proposal is presented to build a fast muon trigger system for the PHENIX detector based on Resistive Plate Chamber (RPC) technology. The trigger will be used to select events with W bosons in polarized proton-proton collisions at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory. Measurements of single longitudinal spin asymmetries A_L in W -boson production in polarized proton collisions make it possible to determine the spin contributions of the sea and valence quarks to the spin of the proton, as described below.

The project will be carried out by a collaboration of nine co-principal investigators and seven senior scientific personnel from nine institutions within PHENIX with their postdoctoral fellows, graduate students, engineering and technician support. The collaboration commands great expertise in the field of proton spin structure and the required experimental technology. This is documented through the wide range of current and previous scientific activities of the group in accelerator laboratories around the world: BNL, DESY, FNAL, Jefferson Laboratory, KEK and LANL; see references [1] to [13] for a listing of recent experimental collaborations. Members of the group include present or previous spokespeople or their deputies of the HERMES collaboration at DESY [2], E866 at FNAL [3], and PHENIX at BNL [1] and current or previous physics conveners and analysis coordinators in PHENIX and HERMES.

The Spin Structure of the Nucleon: Present Understanding

A central goal of high-energy nuclear physics is to determine and understand the quark-gluon structure of the nucleon, the fundamental bound state of QCD [14]. The present understanding is largely empirical and rudimentary. A prime example of this is the surprising fact, now well established from inclusive polarized deep inelastic lepton scattering experiments [15], that only about 25% of the spin of the nucleon arises from the spins of the quarks. While one might expect a significant contribution from the gluon field, this contribution remains almost completely undetermined. Possible contributions from orbital angular momentum are even less well understood, both experimentally and theoretically, although there are recent hints that this contribution is not small [16,17].

The PHENIX experiment, along with the STAR and COMPASS experiments, will make the first direct measurements of the gluon contribution to the nucleon spin, $\Delta G(x)$, over a significant range in momentum fraction x [18,19]. The basic processes exploited at RHIC are polarized gluon-gluon and polarized quark-gluon hard scattering leading to different final states, as shown in Fig. 3.1. First results from PHENIX Run 3 and 4 [20] have been produced that already constrain models with different gluonic spin contributions. With data from future running periods [21,22], the variety and power of these measurements will greatly increase.

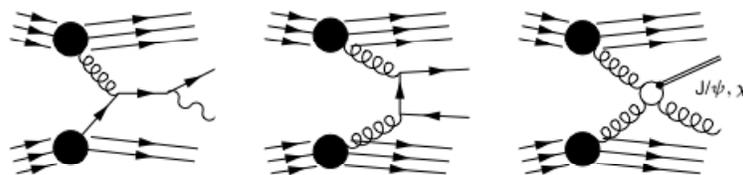


Figure 3.1 Basic processes sensitive to $\Delta G(x)$.

Given a measurement of the gluon spin contribution, a fundamental question will be how the quark and gluon contributions mutually arise in the nucleon bound state. In particular, how is the polarization of the sea quarks, which are formed from the gluon field, affected by the gluon polarization? In order to answer this more detailed question, experiments at CERN [19,23] and DESY [24] have and are attempting to determine the spin contributions of the different quark flavors separately, especially the more difficult-to-measure contributions from the sea quarks. The technique used by the CERN and DESY experiments is the so-called “hadron tagging” and is based on the measurement of semi-inclusive asymmetries, in which a leading hadron (*i.e.*, a hadron containing a large fraction of the energy transferred to the nucleon) is detected in coincidence with a deep-inelastically scattered lepton. Using a statistical analysis and empirical fragmentation models, one can exploit the greater than random probability that the leading hadron contains the struck quark (calculated in a fragmentation model), and use the hadron species to limit the possible flavor of the struck quark. Measuring concurrently a sufficient number of semi-inclusive asymmetries using identified leading pions and kaons allows an extraction of the spin contributions from the different quark and anti-quark (sea) flavors. The results of the analysis of the HERMES data [24] are shown in Fig. 3.2.

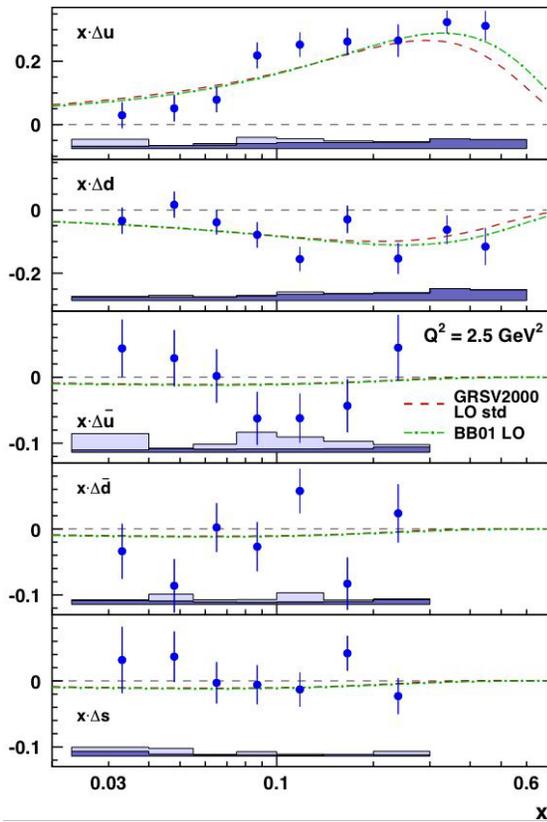


Figure 3.2: Results of HERMES spin-flavor decomposition using a leading order analysis of semi-inclusive deep-inelastic electron scattering (taken from Ref. 24).

Furthermore, both COMPASS and HERMES suffer from the “u-quark dominance” caused by fragmentation to kaons) are not well known due to a general lack of data, especially at lower energies. While there is hope that new (and voluminous) data from the Belle experiment [28] will significantly improve this situation, there will remain issues related to possible differences in how the fragmentation process occurs starting from the initial quark-antiquark pair of e^+e^- colliders and the process starting from a quark struck from a nucleon.

Furthermore, both COMPASS and HERMES suffer from the “u-quark dominance” caused by

To date, this extraction has been performed only within a leading order (LO) QCD “framework”, that is, with the effects of the Q^2 evolution only minimally included and no attempt at inclusion of higher twist effects. The limited statistical accuracy of the data allows no strong conclusions about the polarization of the sea quarks. Several theoretical programs to extend the semi-inclusive analysis procedure to next-to-leading order (NLO) are underway [25,26,27], but progress has been slow.

A chief concern with the HERMES analysis is the relatively low Q^2 of the data ($\langle Q^2 \rangle \sim 2.5 \text{ GeV}^2$), which may result in large NLO corrections. The forthcoming analysis from COMPASS will certainly use a data sample with significantly higher Q^2 which will likely have smaller NLO corrections. Furthermore, it will extend the determination to almost an order of magnitude smaller x value than HERMES. Nonetheless, the HERA collider experiments have shown just how strongly coupled the resolution of the sea distributions are to the Q^2 of the probe, so it remains important to measure the spin-flavor composition of the nucleon up to the highest Q^2 possible.

Despite these efforts with lepton scattering, a common systematic uncertainty to both experiments’ analyses is the hadron-tagging technique itself, which relies on the use of fragmentation function models that in some cases (*e.g.*, s quark frag-

the weighting of the fundamental photon-quark interaction by the square of the quark charge as well as the intrinsic inability of electromagnetic probes to distinguish quarks and anti-quarks. Hence it will remain difficult to extract precise information about the up, down and strange sea quark (and anti-quark) polarized distributions. Since the weak interaction lacks this bias, intense high energy neutrino beams are ideal for this type of semi-inclusive analysis.

Determination of Sea and Valence Polarized Quark Distributions using W Boson Production

The collision of high-energy polarized protons at RHIC provides a completely new means to use the weak interaction as a probe of the polarized parton distributions, namely W^\pm production, leading to a very high energy muon or electron, of the same charge as the W and with an energy of roughly half the W mass, as shown in Fig 3.3. This measurement and estimates of the sensitivity are described thoroughly in Refs. [18], [29], and [30], so we here recall the major points.

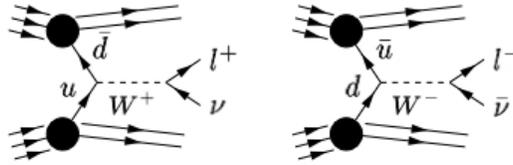


Figure 3.3 W^\pm production in polarized $p+p$ scattering.

The W production mechanism offers a number of advantages over deep-inelastic scattering: (a) there are no systematic uncertainties from fragmentation models, (b) there is no u -quark dominance arising from the intrinsic vertex coupling strength, (c) the parity violating nature of the weak interaction provides a natural polarization measurement so that only a single spin asymmetry is required, and (d) the Q^2 of the measurement is very high, essentially at the mass squared of the W boson. Because the neutrino is not detected, one actually measures the single spin asymmetry in the production of the charged lepton as a function of rapidity and p_T , and then relates these asymmetries to those of the parent W bosons.

The (parity violating) single spin asymmetry $A_L^+(y_W)$ for W^+ from a polarized proton as a function of the W rapidity, y_W , can be written in leading order QCD (ignoring heavy quark contributions) as

$$A_L^+(y_W) \equiv \frac{\sigma_+ - \sigma_-}{\sigma_+ + \sigma_-} = \frac{-\Delta u(x_a)\bar{d}(x_b) + \Delta\bar{d}(x_a)u(x_b)}{u(x_a)\bar{d}(x_b) + \bar{d}(x_a)u(x_b)},$$

where σ_\pm refers to the $\bar{p}p \rightarrow W \rightarrow l\nu$ cross sections for positive and negative helicities of the polarized proton a impinging on the unpolarized proton b . The light cone fractions $x_{a,b}$ are defined as $(Q/\sqrt{s})e^{\pm y_W}$. The expression for W^- production can be found by the substitutions $\bar{d} \rightarrow \bar{u}$ and $u \rightarrow d$. In very asymmetric collisions, these expressions simplify further, since one of the light cone fractions is much larger than the other, and the sea distribution falls rapidly with increasing x :

$$\begin{aligned}
A_L^+(x_a \gg x_b) &\approx \frac{-\Delta u}{u} & A_L^+(x_b \gg x_a) &\approx \frac{\Delta \bar{d}}{\bar{d}} \\
A_L^-(x_a \gg x_b) &\approx \frac{-\Delta d}{d} & A_L^-(x_b \gg x_a) &\approx \frac{\Delta \bar{u}}{\bar{u}}
\end{aligned}$$

In fact, the rapidity of the W cannot be determined precisely from the rapidity of the decay lepton, but at large absolute lepton rapidities, the resulting smearing is manageable.

Precise calculations of these asymmetries, including the effects of the lepton decay distribution as well as the resummation of soft gluon radiation, have been performed by Nadolsky and Yuan [31]. Figure 3.4 shows, for example, the W^+ asymmetry as a function of lepton p_T , integrated over four lepton rapidity ranges. The most forward (graph d) and backward (graph a) rapidities correspond to the acceptance of the muon arms of the PHENIX spectrometer. The three curves show predictions based on different sets of polarized parton distribution functions (PDFs), and show that there is significant sensitivity to the sea quark polarization in particular ranges of p_T . Results for the W^- asymmetry show even stronger sensitivity.

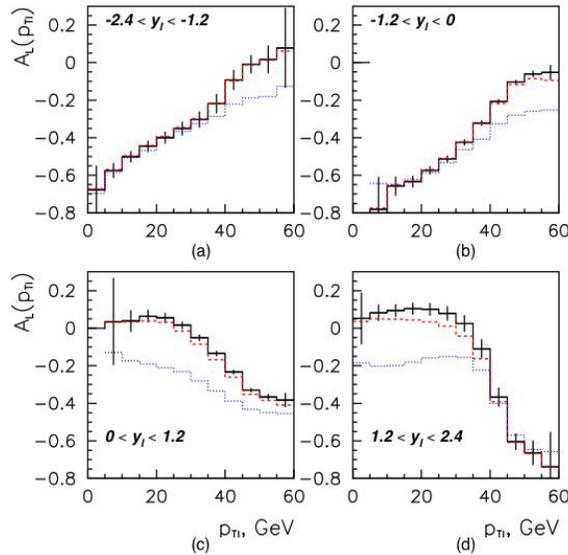


Figure 3.4. Expected single spin asymmetries for leptons from W^+ production as a function of p_T for different regions in rapidity (taken from Ref. 31). The solid and dashed curves are predictions using the Gehrmann-Stirling PDF sets A and B, respectively; the dotted curve is the GRSV valence-like PDF set.

We note here that even a measurement of W production without polarization provides important information about the unpolarized light quark sea distributions. The ratio of unpolarized W^+ to W^- production in p - p scattering at RHIC will directly probe the \bar{d}/\bar{u} ratio, as discussed in Bunce et al. [18] (and references therein).

b. Description of Research Instrumentation and Needs

Overview of Instrumentation Needs

In PHENIX, the production of W bosons can be detected through the observation of muons having large transverse momentum, $p_T > 25$ GeV, with two existing forward muon spectrometers [33]. Each muon spectrometer consists of a magnetic spectrometer with three high-resolution

tracking stations (muTR) placed inside a momentum-analyzing spectrometer magnet and a sandwich of iron absorber walls and streamer tube arrays for muon identification (muID) and first level triggering. The muon spectrometers are located downstream of the iron yoke of the central magnet, which serves as a hadron absorber. The present first level muon trigger accepts charged tracks which penetrate the muID iron absorber walls. Typically the momentum of such muons is larger than 2 GeV; see Fig. (3.5) for a layout of the PHENIX north muon spectrometer.

The technical design of the PHENIX muon arms was originally optimized for the detection of heavy vector mesons in heavy ion collisions at RHIC at rates not exceeding 20 kHz and for the acquisition of comparison data for the heavy ion physics program in proton-proton collisions occurring at rates not exceeding 0.5 MHz at a center of mass energy of $\sqrt{s}=200$ GeV. However, for the proposed physics, with cross sections of about 1 nb for W-production in the relevant leptonic decay channel at $\sqrt{s}=500$ GeV, it will be necessary to operate RHIC at high luminosities reaching $L=1.5 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$. At this luminosity the collision rates will reach 9 MHz, corresponding to 0.9 interactions on average per proton bunch crossing in the collider. It is anticipated that RHIC will reach this luminosity first in FY 2008 [34]. The running conditions for W-physics at RHIC will impose significant additional challenges on the muon spectrometers that were not anticipated by the original design. The utility and readiness of the existing PHENIX muon arms for the future W-physics program in PHENIX was carefully reviewed in detailed simulation studies.

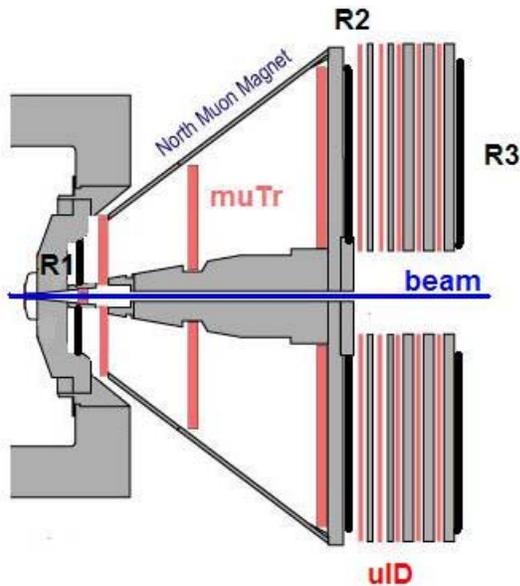


Figure 3.5 The PHENIX north muon arm. The existing muon tracker chambers and muon identifier planes are shown with the resistive plate chamber stations R1-R3.

and $A_L^{W \rightarrow \mu^-} (p_T)$. These measurements translate into the following experimental requirements for the PHENIX muon arms: (a) superior event selection capability in order to reduce the 9-MHz collision rate to the data archiving bandwidth available in PHENIX; (b) the ability to assign the correct proton polarization (that is bunch crossing number) to a given W-event candidate; (c) sufficiently high tracking resolution to correctly determine the lepton charge sign at large momentum; and (d) good signal-to-background ratios in the off-line analysis.

In summary, it was found that the existing muon spectrometers are capable of defining a clean sample of W events for the off-line analysis and the determination of quark and anti-quark polarizations; a requirement of $p_T > 25$ GeV on the transverse momentum of the final state decay muon will remove most of the collision- and beam-related backgrounds and will result in a large W sample with good signal-to-background ratio. In the analysis of the existing detector capabilities, it was further confirmed that the momentum resolution is adequate for the identification of the muon/W charge sign up to the highest muon momentum above 100 GeV.

In contrast to the satisfactory offline performance of the PHENIX muon spectrometer arms for W-physics it was found that the online event selection capabilities needed to filter out rare W-event candidates are not adequate. In PHENIX, fast first-level triggers reduce the collision rate to the input bandwidth of a processor farm hosting the event-builder and the second level

trigger [35]. At the present time this bandwidth is about 4 kHz. For the future, the PHENIX “Level-1 bandwidth” is expected to increase to about 8 kHz. However, this bandwidth will be shared between several first-level triggers of significant physics interest from the PHENIX central detector arms and the two muon systems including the two minimum bias collisions triggers. It is expected that a bandwidth of 1–2 kHz can be made available for the single high-momentum muon trigger for W physics.

A careful analysis of existing PHENIX proton-proton data sets at $\sqrt{s}=200$ GeV and Monte Carlo event samples at $\sqrt{s}=500$ GeV has been carried out. The results of this study show that the rejection power R of the present first level muon trigger is about $R=250$: the present muon trigger rate is dominated by decay muons from jet production and subsequent hadron decay and beam related backgrounds. In contrast, the trigger rejection required for the W-physics program is $R > 9 \text{ MHz}/2 \text{ kHz} = 4500$. Comparisons between simulation studies and measured rejection factors for the EMC-RICH first level trigger in PHENIX suggest that a certain safety margin is needed to account for difficulties in correctly modeling beam related backgrounds: the goal for the design of the W-trigger has been set to a rejection factor of $R > 10000$.

The proposed first level fast muon trigger for W-physics is based (a) on a fast online measurement of the muon momentum to reject low momentum muons from hadron decays in jets and (b) on a coarse timing measurements to remove background correlated with the incoming proton beam bunches. Background traveling with outgoing beam bunches is sufficiently attenuated by the magnet and muon absorber steel in PHENIX (as will be discussed later in more detail). In the offline analysis momentum information is obtained from the muon tracker chambers (muTR). However, there is no provision to send information from muTR front-end electronics to first level trigger processors. Instead information from the muTR stations becomes available for triggering only in the second level trigger, downstream of the anticipated 8-kHz bandwidth limitation. Finally, the muTR cathode strip chambers cannot provide the timing resolution required for the rejection of beam-related backgrounds.

For each arm, the proposed fast muon trigger system for PHENIX consists of three resistive plate chamber stations R1, R2 and R3. R1 is located upstream of the momentum analyzing muon magnets and R2 downstream. R3 will be placed downstream of the muon identifier wall (see Fig. 3.5). The RPCs will be read-out by a combination of two front-end cards, an amplifier-discriminator card (AD-card) followed by a front-end module (FEM), which provides the required buffer latency of about 4 μs (corresponding to 40 bunch crossings in RHIC) for the offline read-out and the fast communication with the first-level trigger processors. The FEMs will communicate via optical fiber links with dedicated trigger processors (local level one trigger processors: LL1). In the LL1 tracking information from R1, R2 and R3 will be used to carry out the fast high-momentum selection required.

We intend to use two-gap RPC technology following the design of the detectors developed for the CMS muon trigger at LHC. The main difference will be in the cathode-pad configuration on the pick-up planes, which must be segmented for the specific application in PHENIX. The amplifier discriminator card will be based on the existing CMS chip design. With the group at Peking University, we have managed to recruit collaborators with significant experience in the CMS RPC project. The front-end electronics will be developed in close collaboration with engineers from Nevis Laboratory who have extensive experience with front-end systems for existing detector systems in PHENIX. For the first-level trigger processors, we will utilize technology developed for the PHENIX experiment by the group at Iowa State University. The reliance and adaptation of existing CMS and PHENIX technology greatly reduces engineering expenses and will make it possible to provide a fully functional fast muon trigger system in time for the first polarized proton run at RHIC in FY 2008.

The proposal has been reviewed and approved by the PHENIX executive council on its scientific merits and the PHENIX detector council on technical grounds. The progress of the fast

muon trigger project has been guided and will continue to be monitored through regular reviews at Brookhaven National Laboratory. PHENIX reviews of instrument development provide expert guidance and support based on the very significant technical and scientific expertise available among the 60 participating institutions in PHENIX.

Collaboration and Institutional Support and Expertise

The fast muon trigger for W-physics will be developed and built by a consortium of four university groups: Abilene Christian University (ACU), the University of California at Riverside (UCR), Iowa State University (ISU) and the University of Illinois at Urbana-Champaign (UIUC), who have submitted this grant proposal. Additional collaborators from University of Colorado at Boulder, Kyoto University, Nevis Laboratory, Peking University (PKU) and the RIKEN BNL Research Center (RBRC) have significant expertise on the relevant instrumentation technology.

The UIUC is the lead institution, and three faculty will participate in the project. Makins and Peng have led the analysis of quark and anti-quark substructure of the proton in Hermes and E866 respectively, and will assume leadership roles in the W-physics program in PHENIX. UIUC has overall project management and specific responsibilities for the development of the RPC detector modules, front-end electronics and the gas system. The electronics group at Nevis Laboratory under the leadership of Cheng-Yi Chi—who is the PHENIX DAQ upgrades manager—will collaborate closely with UIUC on the development of the front-end electronics and has extensive experience with and played an important leadership role in the development of PHENIX front-end (TOF and BBC) and data acquisition electronics. On the RPC development and construction, UIUC will collaborate with PKU. The group at Peking University is led by Yajun Mao and will carry out R&D for and the production of the RPC detector modules. The PKU group will utilize the PKU RPC laboratory for CMS and also can rely on technical and scientific expertise from the CMS group at PKU. Statements of support to this project from Nevis and PKU are included in Section 9 of this proposal. At UIUC, Grosse Perdekamp will coordinate these activities; he has experience with PHENIX trigger systems and PHENIX project management through his work as co-leader (with Barish) of the EMC-RICH first-level trigger, as PHENIX run-coordinator, and as PHENIX deputy spokesperson. At UIUC, a RPC detector laboratory is being set up for development work, primarily to optimize the PHENIX specific RPC pick-up cathodes. The work is supported strongly through UIUC startup money (Grosse-Perdekamp) and the NPL NSF base grant. The support includes one plus two postdoctoral fellows (one NPL-NSF and two UIUC startup), as well as technicians John Blackburn and Eric Thorsland (part-time). The physics department at UIUC has pledged \$100k (in addition to startup money) in support of the W-trigger project; see letter from UIUC department chair in section 9.

UC Riverside has management responsibility for the mass production of front end electronics and the electronics integration in PHENIX. The group includes two faculty, one postdoctoral fellow and one graduate student, who are supported from the base grant of the group. In addition UCR has pledged support for a second postdoctoral fellow (see supplementary documents in section 9), who will be stationed at BNL and will play a central role in the W-trigger integration. Barish co-leads the EMC-RICH trigger group in PHENIX and also serves as coordinator for the spin physics working group in PHENIX. The group has had the management responsibility for and carried out the production of the front-end electronics for the time expansion chambers (TEC) in PHENIX and is well qualified to carry out the proposed work. For the electronics integration at BNL, UCR will closely work with the RIKEN BNL Research Center. RBRC is a institution located at BNL, and Wei Xie will serve as overall integration and W-trigger operations manager. He will coordinate the significant contributions the PHENIX collaboration has pledged in support of the W-trigger integration into the PHENIX detector (labor, racks, crates, power supplies, etc., as per the letter from the PHENIX director of operations in section 9).

Iowa State University is responsible for the development and production of the fast first-level local trigger processors. John Lajoie at ISU has general responsibility for first level trigger elec-

tronics in PHENIX. Experienced engineering personnel who carried out previous projects on PHENIX trigger electronics are available at ISU. In addition to access to expert engineering, the group includes two faculty, one postdoctoral fellow (part time) and a graduate student. The scientific personnel at ISU is supported through the base grant of the nuclear physics group at ISU. In support of the engineering effort at ISU, the university has contributed \$50k to the project (see letter of support from ISU).

Abilene Christian University is responsible for the final assembly of the RPC modules at BNL, the testing of the front-end electronics and the high voltage system. The RPC assembly and electronics testing will be carried out with undergraduate students during two summers at BNL. ACU has a long and excellent record of successful research contributions with undergraduate students. Towell and Isenhower, the participating faculty from ACU, contributed in related efforts to the measurement of the ratio of anti-up to anti-down quark-distributions in the proton in E866 at Fermi National Laboratory and made major contributions, including the work of 18 undergraduate students, to the assembly and integration of the PHENIX muon tracker detector stations. It is planned to organize the assembly of the RPC detector modules and the electronics testing in similar ways. A statement of support from ACU has been included in section 9 of this proposal.

Important support for this project will also come from five institutions that will not receive support from this MRI grant. Collaborators from these institutions are listed on the proposal as senior personnel; bio-sketches are included in section 5. As mentioned above, Nevis and PKU will closely work with UIUC on the electronics and RPC development and RBRC will provide local installation and operations management at BNL. In addition there is very significant support available to the project from Kyoto University and the University of Colorado at Boulder.

The Colorado team includes two faculty, two postdoctoral fellows and two graduate students; a letter of support from Colorado can be found in section 9. Nagle has overall responsibility for triggering in PHENIX and will be overseeing the integration of the fast muon trigger into the PHENIX apparatus from a PHENIX management point of view. Kinney, an ex-spokesperson for the Hermes experiment at DESY, will assume a leadership role in the analysis and has formal management responsibility for simulations and event generators. Colorado personnel are supported through existing grants in the group.

Naohito Saito leads the Kyoto University group, which includes one postdoctoral fellow and two graduate students. On the experimental side, Saito has developed the initial idea to carry out proton structure studies at RHIC with W bosons. His group has assumed the formal responsibility for offline software needed to carry out the W-analysis using information from the present muon detectors and the new RPC stations (see letter from Kyoto University in section 9).

Finally, the PHENIX collaboration, represented by its director of operations, has pledged significant support for the integration of the fast muon trigger for W-physics into PHENIX. The PHENIX support includes technician labor, project engineering and limited hardware support for the integration of the fast muon trigger into the PHENIX detector (see letter from PHENIX supplied in section 9 of this proposal).

Trigger Configuration, Expected Performance and Background Studies

The configuration for the proposed fast muon trigger system is shown in Fig. 3.5. A new fast muon trigger system will be added to both muon spectrometer arms. For simplicity, the discussion will follow the layout in the north arm (the two spectrometers are not perfectly symmetric). The first resistive plate counter station R1 will be placed downstream of the central magnet iron yoke and upstream of the momentum analyzing muon spectrometer magnet at a distance of about $z=1.4$ m from the central collision point. Station R2 will be located immediately downstream of the muon magnet and upstream of the muon identifier (mulD) at $z=6.9$ m. R1 and R2 have identical segmentation of 24 cathode pad-rings in θ and 360 pad-segments in the azi-

muthal direction. R3 will be located downstream of the muID and will have identical θ -segmentation but only 16 azimuthal segments. The front-end electronics will be integrated directly on the detector stations. The signals from the cathode pads are amplified and discriminated and then buffered in the FEM for readout via optical fiber links. We expect to achieve coarse timing resolution of about 5 ns. PHENIX front end electronics is synchronous with the bunch crossing frequency of about 10MHz. The exact spacing between two bunch crossings is 106.5 ns. The buffer latency in PHENIX front-end electronics is 40 clock cycles, the time available to generate a level 1 trigger decision.

In the FEM, the discriminated RPC cathode pad signals will be processed for triggering purposes in a fast programmable gate array (FPGA). First a cut will be placed on the collision time (about ± 15 ns or 3σ). Next for stations R2 and R3, coarse logic pads—segmented into 360Φ and 2θ slices—will be formed as input to the level 1 trigger. The exact configuration of the logic trigger pads will be programmable to adjust, as necessary, for possible high levels of background close to the beam. The latency of the trigger logic in the FEM will be 2–3 beam clock cycles. From the FEM, the trigger pad information will be sent via optical fiber links to first level local trigger processors (LL1). The information flow for the proposed fast muon trigger follows strictly the existing PHENIX trigger architecture. The LL1 boards host large Xilinx FPGAs, which make it possible to carry out complex logic operations.

The fast muon trigger is formed using information from the three RPC stations, R1–R3, as well as information from the existing muon identifier system. For momentum selection the trigger algorithm exploits the radial magnetic field in the muon magnets: bending occurs in the azimuthal direction. The proposed trigger aims to filter out high momentum muons in time with particles arriving from the collision vertex in the muon spectrometers. The timing cut will be carried out at the front-end as discussed above. The LL1 trigger algorithm establishes first a muon

“road”: R1+R2+R3 pointing to the collision vertex region, and in coincidence with the present muID trigger. In a second step, a cut is placed on the azimuthal angle between the track location in R1 and R2, selecting higher-momentum tracks. The requirement of a muon road greatly reduces combinatorial background passing the azimuthal angle cut.

The fast muon trigger layout described above was carefully studied using Monte Carlo event samples. The three RPC stations R1–R3 were introduced into the PHENIX GEANT Monte Carlo description. Software to emulate the response of the LL1 trigger algorithms was written. The rejection power of the trigger was studied using

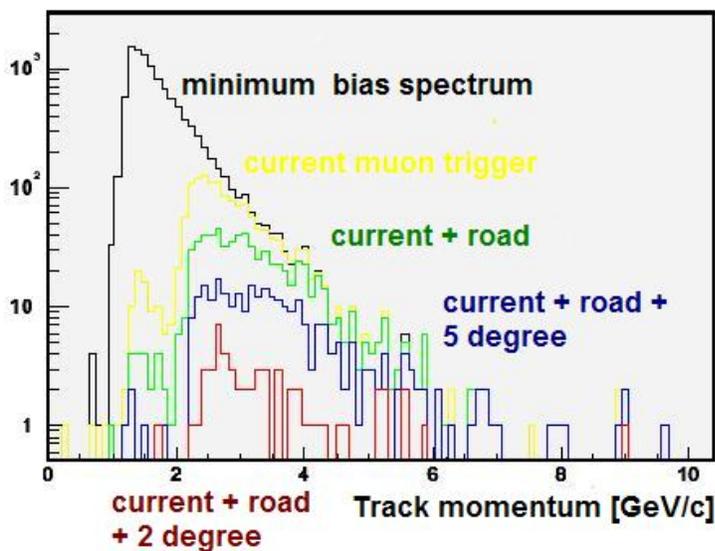


Fig. 3.6 Muon background spectrum from decay hadrons, minimum bias and for different trigger definitions.

as input minimum bias proton-proton events generated with PYTHIA at center-of-mass energies of $\sqrt{s}=500$ GeV. Trigger efficiencies were obtained from a W-event sample generated with PYTHIA. Figure 3.6 shows the impact of increasingly tighter angular cuts between R1 and R2 on the muon background from hadron decays. Close to the beam-pipe the angular resolution will be limited by the finite spatial resolution possible with the RPCs. For the final simulation results we assume a spatial resolution of 4 mm and find the rejection factors and efficiencies in table 3.1. From these Monte Carlo studies it was concluded that the proposed fast muon trigger sys-

tem will provide the required rejection of $R > 10000$ for angular cuts of 1-2 degree with sufficiently high efficiencies for signal muons from W -decay.

angle cut	0.7	1	2	3	none
rejection	42000	29000	13000	8200	2000
efficiency	0.7	0.8	0.93	0.95	0.95

Table. 3.1: Trigger rejection factors R and efficiencies for different angle cuts (angles in degree). Statistical errors on R vary from 5% without cut to 20% with the smallest cut. Efficiencies are known to better than 2%.

In addition to the proposed RPC solution for the trigger system, alternative solutions, including systems based on scintillator hodoscopes for timing resolution and regular wire chambers with cathode-pad read-out for position resolution, were investigated. The proposed solution of fast RPCs was found to be most cost-effective. It is to be noted that both the ATLAS and CMS detectors at LHC at CERN use fast RPCs in their muon triggers. The PKU group has direct access to the RPC technology used for the CMS muon trigger.

The trigger detector and system simulations described in this section are believed to realistically reflect the response of the proposed trigger to p - p collision-related backgrounds. However, the stability of the trigger with respect to beam backgrounds must be also be investigated. Significant levels of beam background were detected during run 2003 with the PHENIX muon arms. Detailed studies with radiation monitors and scintillation detectors, as well as thorough beam-loss Monte Carlo simulations identified beam losses in a set of three quadrupole magnets upstream of PHENIX as the dominating source. The single background rates in the present muon identifier system were found to be dominated by combinatorial background from thermal neutrons (which are the end-products of initially hard showers induced by beam losses). The muon trigger rate however, is most affected by high energetic punch-through hadrons or decay muons emerging from the beam-induced hadron showers. As a consequence of these studies, massive shielding was introduced in the RHIC tunnels upstream of the PHENIX experimental hall. The shielding has decreased the single background rates in the muID by about a factor of 3–4.

The muID does not provide timing information, and therefore the current muon trigger is very sensitive to combinatorial background from neutrons and background shower particles traveling both with the incoming and outgoing proton beam bunches. Background traveling with outgoing beam bunches is in time with collision-related products (signal!). However, incoming beam background can be easily rejected based on a timing cut. The magnet and absorber steel requires approximately 4 GeV for a minimum ionizing particle to penetrate. As a consequence, the outgoing beam background may be significantly attenuated compared to the incoming beam background. In this case, a timing cut on the proper collision time in the muon trigger will yield additional large rejection factors against beam background. During the 2004 run, a test measurement to determine the time dependence of beam-related backgrounds was carried out. It was found that the rate of outgoing beam background is suppressed by more than a factor of 10, compared with incoming beam background. In addition, a timing window of 30 ns in the muon trigger front end will reduce combinatorial background from thermal neutrons by at least a factor of 3. In combination, shielding and timing cut reduce the beam-related background trigger rate by more than 2 orders of magnitude. Based on observed beam backgrounds and beam loss Monte Carlo simulations, we believe that this suppression is sufficient.

Finally, background sources for the W -physics offline analysis were studied using PYTHIA event samples and a full GEANT simulation of the muon spectrometer including the new trigger system. We have generated potential background samples for Z^0 -production, charm- and bot-

tom production, decays of pions and kaons into muons in jets, punch-through of hadrons, punch-through with subsequent decay, and random coincidences from high-momentum cosmic muons. Cosmic muons cannot be ignored due to the expected long integrated running times for the proposed measurement. From these simulation studies, a signal-to-background ratio of about 2:1 or better is expected. We are presently carrying out detailed studies of possibly incorrectly reconstructed high muon momenta. The results from these studies have determined the proposed cathode granularity in stations R1, R2 and R3.

RPC Detectors

Resistive plate counters (RPCs) are gaseous parallel-plate detectors which are well suited for large area fast trigger systems. They are the technology choice for the ATLAS [36] and CMS [37] trigger systems at LHC: RPCs are simple to construct (no wires) and well suited for inexpensive industrial production. RPCs have excellent timing resolution. First large scale applications for RPC technology are the muon/ K_L systems in Belle and Babar. In addition to the trigger application RPCs with higher timing resolution (and lower rate capability) are also used in ALICE, STAR and the PHENIX central spectrometers for time-of-flight applications. The intrinsic timing resolution of the CMS double gap chambers adapted for this project is about 1.5 ns. In the proposed PHENIX muon trigger application, however, the timing resolution will be limited through the resolution available from the timing measurement in the front-end electronics. At the advantage of cost efficiency the timing resolution is limited to 5 ns.

The readout of RPCs occurs via capacitive coupling to external strip or pad electrodes. For PHENIX, the CMS discriminator-amplifier ASIC chip is adapted. The front-end electronics consists of amplifier discriminator cards carrying the CMS chips and a front end module for buffering, read-out, trigger pre-processing and communication to the first level trigger processors. The specific design will follow closely existing PHENIX front-end electronics and can, due to the relative light requirements for timing resolution, focus on cost efficiency.

The weak point of RPCs has been their rate capability. Tests with CMS double gap RPCs indicate that rates of 1–2 kHz/cm² can be sustained with efficiencies of 98%. During run 2004, first surveys of instantaneous rates in the PHENIX muon arms were carried out with scintillators; peak rates were found to not exceed 0.1 kHz/cm². Presently two small area (0.4 m x 0.4 m) double gap prototypes from PKU are integrated into the PHENIX muon arms with the goal to carry out detailed tests on the background rate environment in PHENIX.

c. Impact of Infrastructure Projects

In this section, we address specifically the broader impact of the proposed instrument development project.

Advancing Discovery

The Nuclear Physics Long Range Plan's highest priority is the full exploitation of the newly available facilities (specifically for this proposal—RHIC) for scientific discovery [14]. RHIC's ability to accelerate polarized protons at high energy, high luminosity, and high polarization presents an unprecedented opportunity to examine the detailed spin structure of the nucleon. The proposed instrumentation makes possible the measurement of the proton's individual quark and anti-quark helicity distribution functions, which is required to obtain a complete understanding of the composition of the proton's spin. The PHENIX collaboration has recognized this as the highest priority for polarized protons after the initial measurement of the gluon contribution to the proton spin and has thus endorsed the thrust of this proposal in May 2004. The proposal was further presented to the subcommittee on Heavy-Ion Nuclear Physics of the Nuclear Science Advisory Committee (NSAC) in June 2004. The subcommittee report

dated October 7, 2004, was accepted by NSAC [38]. It strongly endorses the scientific goals of the upgrade proposed in this document. Specifically, it recommended to “Invest in near-term detector upgrades of the two large experiments, PHENIX and STAR...” and in addition “...detector improvements proceed at a rate that allows a timely determination of the flavor dependence of the quark-antiquark sea polarization through W-asymmetry measurements.” The completion of the proposed project will allow the U. S. to lead the world in unraveling the quark-gluon nature of the nucleon’s spin. The large number of U.S. universities that are part of both the PHENIX collaboration and the PHENIX Spin Program will be able to participate in this scientific enterprise at the physics frontier.

Disseminating Understanding to the Broader Community

Initial results from RHIC and PHENIX have attracted a great deal of attention and have been widely disseminated in *Physics Today* [39], as well as in newspapers such as the *New York Times* [40] and the *San Francisco Chronicle* [41]. PHENIX publications (28) have been published in top journals with over 1800 citations, for example 15 *Physical Review Letters* and 4 *Physical Review* publications. A number of the PHENIX publications are already in the “top cite” category, such as Ref. [42] which has 234 citations.

Providing Research Training for Young Scientists

As is the case for many large experiments, a large part of the work is carried out by graduate students and postdoctoral fellows who get experience in forefront research and technology using the PHENIX detector. These young researchers create simulations of the response of the detector to various particles and energy ranges and analyze PHENIX data to extract the physics results. Students work at building detectors and testing them before introduction into PHENIX. Students play a key role in maintaining and upgrading the PHENIX data acquisition (DAQ) system as the luminosity of RHIC increases.

Students and postdoctoral fellows who work at PHENIX develop significant computational and analytical skills, regardless of their ultimate career paths. For example, almost all students become literate in C++. Their tasks range from simulation of the response of the detector to various conditions to the analysis of run data. In the process, these students learn how to model the behavior of a complex system and to extract the relevant information from extremely large data sets. In working with the detectors, students learn how to build various types of state-of-the-art radiation detectors, as well as how to test and install them in a larger experiment. All students whose names appear on PHENIX publications are required to take shifts during operation of the experiment, which gives them experience in running a complex scientific project and responding to the unexpected, time critical problems that periodically occur.

Integrating Research and Undergraduate Education

Of special note is the participation of students from Abilene Christian University (ACU), which is a non-PhD. granting institution who has had 20 undergraduate students working on PHENIX. Many have taken shifts during PHENIX runs and a large number have worked on the installation of the PHENIX muon tracker. Of the 20 students involved in PHENIX, 11 are now in graduate school in such diverse fields as mechanical and aerospace engineering, quantum gravity and hypersonic flight research. Also 35 ACU students have presented posters at the Conference Experience for Undergraduates at the Fall Meeting of the APS Nuclear Physics Division. ACU students were able to participate in physics research of a scale and complexity not available at their home institution. Many undergraduate students from ACU will be employed in the testing and installation of electronics for the PHENIX forward detector upgrade. Other examples include Steve Skutnik at ISU, who as an undergraduate worked on the PHENIX Level-1 trigger software and is now getting an MS degree at ISU. UIUC students have worked in PHENIX on trigger simulations and in setting up the UIUC RPC lab. Students from UIUC have given talks or presented posters at APS-DNP meetings on work related to this MRI. Both

UIUC and ISU have had summer students working on PHENIX in the NSF Research Experience for Undergraduates (REU) program.

Promoting Scientific Literacy

The institutions on this proposal have been engaged in a number of outreach efforts to inform the public and students at smaller institutions of their involvement in the PHENIX experiment and communicate the excitement of the physics being done. At ISU both Profs. Hill and Lajoie have given a number of seminars about PHENIX at small colleges in Iowa, Minnesota, Nebraska, and Kansas as part of a departmental effort to communicate the excitement of frontier physics research to the wider student community. They have written articles about PHENIX results for the news letter of the College of Liberal Arts and Sciences, the *Ames Tribune* and the *Des Moines Register* and are fully prepared to generate a similar set of communications when the first spin results from the forward upgrade become available. ACU has worked with local newspapers to make the local community aware of the involvement of ACU in RHIC physics. Examples are articles about studies at RHIC concerning the search for the quark-gluon plasma and conditions of the early universe.

Benefiting the National Interest

Another benefit for young researchers is the international character of PHENIX. The collaboration involves scientists from countries all over the world, such as Japan, Russia, France, China, Korea, and Brazil. Students learn to work in teams on large collaborative scientific and engineering projects and benefit from the exchange of ideas with researchers from other cultures, thus giving them a valuable global perspective. Students and postdoctoral fellows that participate in the PHENIX experiment ultimately are employed in a variety of settings, thus broadly influencing the nation's scientific infrastructure. Their future employers include academic institutions, national laboratories, industry, and positions in secondary education.

Some student examples from Iowa State are Dr. Paul Constantin who is now a staff member at Los Alamos and Ms. Heather Henneke who now teaches high school math in Texas. Dr. Sergey Belikov who was an Iowa State postdoctoral fellows on PHENIX is now a Brookhaven staff member. UCR has trained a number of postdoctoral fellows on PHENIX. Wei Xie is an RBRC Fellow at BNL, Wen-Chen Chang is a research fellow at the Institute of Physics, Academia Sinica and Basanta Nandi is asst. prof. of physics at the India Institute of Technology in Bombay. UCR postdoctoral fellows who have gone into other professions include Warren Eldredge who is program manager of Submarine Systems for Lockheed Martin, Munir Muniuzzaman who is employed by HiEnergy Technologies Inc. and Hong Yiang who is a senior fellow in medical physics at the Dana Farber Cancer Institute at Harvard. Munir is working on homeland security projects using techniques which are used on many particle physics experiments for the detection of explosives at airports and in automobiles (car bombs). UIUC has three postdoctoral fellows, Mickey Chiu, Hiro Hiejima and Ralf Seidl, working on forward spectrometer upgrade projects.

d. Project Management Plans

The overall responsibility for the management of the PHENIX experiment is shared between spokesperson Bill Zajc of Columbia, project manager Edward O'Brien of Brookhaven (BNL) and upgrades manager Axel Drees of Stony Brook. Matthias Grosse Perdekamp of UIUC, one of the deputy spokespersons of PHENIX, has the responsibility of coordinating the construction and installation of the fast muon trigger. The detailed design of the detector has been led by Perdekamp and Wei Xie of RBRC. The coordination of the project is facilitated by weekly meetings held via internet-based videoconference between all the collaborating institutions. Collaboration meetings have been held semi-annually at BNL since late 2003.

The hardware design and construction phase has three essential components. The RPC detectors themselves will be the responsibility of UIUC (coordination, R&D, gas system) with strong contributions from PKU (R&D and construction, Yajun Mao), ACU (assembly and high voltage, Rusty Towell) and RBRC (installation, Wei Xie): Milestones for the project are (a) test of two small RPC prototypes at BNL during RHIC run 2005; (b) construction of a small telescope of RPCs as relative luminosity monitor (RLT) in PHENIX for run 2007, as first serious test bed for CMS RPC technology; (c) build RPC for half of the south muon spectrometer by September 2007; (d) build remaining modules for both spectrometers by September 2008 (e) complete mechanical integration of RPCs into PHENIX by January 2009.

The second major component is the electronics. R&D and the production of prototypes will be coordinated by Grosse Perdekamp at UIUC in close collaboration with Cheng-Yi Chi at Nevis Laboratory. Ken Barish of Riverside (UCR) will coordinate the mass production of the front end electronics in close collaboration with Rusty Towell (ACU) who is responsible for the quality assurance. Milestones for the project are: (a) first prototype June 2006; (b) prototype series of 500 channels for RLT and labs at PKU and UIUC November 2006; (c) 9642 channels for half of the south muon arm by November 2007; (d) remaining 28926 channels by October 2008; (e) complete installation into PHENIX by January 2009; (f) commissioning completed by June 2009.

The final component is the LVL-1 triggering system. This will be coordinated by John Lajoie of ISU. Milestones: (a) LL1 for RLT, November 2006; (b) production of LL1 for south arm, August 2007; (c) production of LL1 for north arm, August 2008; (d) complete installation, January 2009; (e) complete commissioning by June 2009; (f) complete trigger algorithm optimization by June 2010.

Wei Xie, a RIKEN-BNL Center Fellow stationed at BNL, will be the operations coordinator in charge of local coordination of R&D, installation and commissioning of the detector with support from PHENIX integration engineers and technicians (see section 9 for statement of support from PHENIX).

We have assembled an extremely strong set of people (see also comments on collaboration in section 3b) to work on software and analysis: Ed Kinney of University of Colorado, a spokesperson of the Hermes experiment at DESY, will be in charge of event generators and simulations. Naohito Saito of Kyoto University, who has been one of the leaders in the RHIC spin program, will be in charge of offline software (see letters from Colorado and Kyoto in section 9). The position of analysis coordinator when data taking begins with the new trigger will be filled by Naomi Makins of UIUC, who was the analysis coordinator for Hermes. She will bring valuable experience to this position.

Before the final construction phase, PHENIX management will convene a Technical Advisory Committee (TAC) of outside reviewers to judge the details of the design as is standard for all PHENIX subsystems before production. The PHENIX collaboration has in place a quality assurance program in which all detector systems are evaluated both in terms of their suitability to perform the necessary measurements and their compatibility with other PHENIX subsystems already in place. Also all equipment that is installed on the PHENIX detector must undergo a rigorous Brookhaven Laboratory safety review. If during these reviews any problems are found, the personnel listed in this proposal will make alterations to the equipment until all reviews judge the equipment to be satisfactory.

The cost of the project is \$1.99M and a breakdown is given in Table 3.2 showing funding for each participating institution. Additional support for the project is available for personnel from the base grants of the participating institutions.

Table 3.2 Breakdown of Requested NSF Funding

ITEM	COST	INSTITUTION
Gas System for RPCs	\$50.0K	UIUC
RPC Development and Construction	\$300.4K	UIUC
Front End Electronics	\$312.0K	UIUC
Travel for RPC Scientists	\$68.4K	UIUC
Overhead on Travel	\$16.416K	UIUC
Design and Construction Local Level-1 Trigger	\$228.1K	ISU
Algorithm Design for Local Level-1 Trigger	\$20.0K	ISU
Overhead on Algorithm Design	\$5.2K	ISU
Construction of RPC Amplifier-Discriminator	\$333.6K	UCR
Construction of FPGA Boards	\$501.0K	UCR
Undergraduate Student Support	\$75.748K	ACU
Two Test Stands	\$10.0K	ACU
RPC High Voltage System	\$77.962K	ACU
Total	\$1.99M	

The detectors should be fully tested and operational by January 2009, on schedule for the high luminosity 500-GeV run for polarized protons at RHIC. In order to meet this goal two prototypes will be tested. The first prototype has been shipped to BNL and will be tested starting in February of 2005 during Run 5. This prototype will be read out using existing front-end electronics. A prototype of a full scale module will be produced in 2006, together with the electronics. This will be tested during the run 2007. Full-scale production of the RPCs and electronics will begin in late 2006 and continue through early 2008. Installation of the RPC trigger in the south muon arm will occur in late summer and fall of 2007. During run 2008, the trigger will be commissioned and will begin operations. In summer and fall of 2008, the remainder of the trigger will be installed in the south and north muon arms to be ready for the 2009 high luminosity 500-GeV run.

The PHENIX collaboration consists of over 460 scientists and engineers from 13 countries. The proposed trigger will serve as a critical part of the PHENIX detector and will be used by the entire collaboration in making measurements of the quark and anti-quark flavor spin distributions. It will also be used in the relativistic heavy ion segment of the program as a trigger for heavy quarks and for improving the triggering and reconstruction of muons from the decay of heavy vector mesons.

4. References

1. PHENIX Collaboration:

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Professional Preparation

Albert Ludwig University Freiburg	Physics	Diplom, 1990
University of California, Los Angeles	Physics	Ph.D., 1995
Yale University	Associate Research Scientist	1995–1998

Appointments

University of Illinois	Joint RIKEN Fellow and Assistant Professor of Physics	2002–Present
RIKEN BNL Research Center	RIKEN BNL Fellow	1999–2002
Johannes Gutenberg University Mainz	Wissenschaftlicher Angestellter	1998–1999
Yale University	Associate Research Scientist	1995–1998

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Double Helicity Asymmetry in Inclusive Mid-Rapidity π^0 Production for Polarized p+p Collisions at $\sqrt{s}=200$ GeV”, *Phys. Rev. Lett. B* **93**, 202002/(1-6) (2004).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Mid-Rapidity Neutral Pion Production in Proton Proton Collisions at $\sqrt{s}=200$ GeV”, *Phys. Rev. Lett.* **91**, 241803/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, et al., “PHENIX Detector Overview”, *Nucl. Instrum. Meth. A* **499**, 469-479 (2003).

SMC Collaboration: B. Adeva, M. Grosse Perdekamp, et al., “Polarized Quark Distributions in the Nucleon from Semi Inclusive Spin Asymmetries”, *Phys. Lett. B* **420**, 180–190 (1998).

SMC Collaboration: D. Adams, M. Grosse Perdekamp, et al., “Measurement of the Spin Dependent Structure Function $g_1(x)$ of the proton”, *Phys. Lett. B* **329**, 399–406 (1994).

Five Most Significant Publications

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s}=130$ GeV”, *Phys. Rev. Lett.* **88**, 022301 (1-6) (2002).

Muon $g-2$ Collaboration: H.N. Brown, M. Grosse Perdekamp, et al., “Precise Measurement of the Positive Muon Anomalous Magnetic Moment”, *Phys. Rev. Lett.* **86**, 2227–2231 (2001).

W. Liu, M. G. Boshier, S. Dhawan, O. van Dyck, P. Egan, X. Fei, M. Grosse Perdekamp, V. W. Hughes, M. Janousch, K. Jungmann, D. Kawall, F. G. Mariam, C. Pillai, R. Prigl, G. zu Putnitz, I. Reinhard, W. Schwarz, P. A. Thompson, and K. A. Woodle, “High Precision Measurements of the Ground State Hyperfine Structure Interval of Muonium and the Muon Magnetic Moment”, *Phys. Rev. Lett.* **82**, 711–714 (1999).

SMC Collaboration: D. Adams, M. Grosse Perdekamp, et al., “Measurement of the Spin Dependent Structure Function $g_1(x)$ of the proton”, *Phys. Lett. B* **329**, 399–406 (1994).

SMC Collaboration: B. Adeva, M. Grosse Perdekamp, et al., “Measurement of the Spin Dependent Structure Function $g_1(x)$ of the Deuteron”, *Phys. Lett. B* **302**, 533–539 (1993).

Synergistic Activities

International collaboration and exchange: (1) Initiated and led collaboration between Orsay, France, and Mainz, Germany, to adapt existing Orsay/G0 front-end-electronics for a trigger application in the COMPASS experiment at CERN (1998). (2) Negotiated DOE “Work for Others” agreement between ORNL and RIKEN and led the resulting bi-national PHENIX trigger electronics R&D and upgrade project for electron and photon first level trigger in PHENIX (UCR, RBRC, Tokyo University, ORNL) involving graduate students from the US and Japan (2000–present). (3) Coordinated data taking and detector operation of the PHENIX collaboration, a collaboration of 450 scientists and engineers from 60 institutions in 13 countries (2002–2003). (4) PHENIX deputy spokesperson.

Contributions to training: Initiated Belle/RHIC Fragmentation Function project, including joint RBRC positions for visiting scientists and graduate students. This project permits a small number of collaborators from STAR and PHENIX, including graduate and undergraduate students, to analyze data taken at the KEK *b*-factory in the search of novel spin dependent fragmentation functions (Collins fragmentation functions) (2002–present).

Contributions to teaching and outreach: Designed and supervised summer physics projects in PHENIX and *g*-2 for local high school students (5 students), 1999–2002. Designed and supervised summer projects in PHENIX for undergraduate students in the DOE ERULF program (5 students), 2000–2002. Undergraduate research projects on RPC R&D at UIUC, starting Fall 2003 with 3–4 students each semester. NSF REU summer projects on R&D for PHENIX RPCs for 2 students at UIUC, 2004.

Development of research tools: (1) Design and construction of large area drift chambers for the magnetic spectrometer of the New Muon Collaboration at CERN. (2) Upgrade of vertex tracking chambers of the Spin Muon Collaboration at CERN. (3) Development of a gain stabilization system for magnet tracking chambers in SMC. (4) Internal beam chamber for the krypton gas target in E1054 at LAMPF (muonium hyperfine structure measurement). (5) Compact beam chamber for the monitoring of injection in the muon storage ring for E821 at BNL (muon *g*-2 experiment). (6) Optical survey system for superconducting coil in the E821 muon storage ring. (7) Fast muon trigger system for the COMPASS experiment at CERN. (8) Fast first-level event selection electronics for the PHENIX EMC and RICH. (9) Normalization Trigger Counter for PHENIX.

Collaborations

Collaborators in Last 48 months: PHENIX collaboration at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory (see reference 1); Belle collaboration at the Japanese Laboratory for High Energy Physics (KEK) in Tsukuba (see reference 4); *g*-2 collaboration at Brookhaven National Laboratory (see reference 5).

Ph. D. Students Supervised in Last 5 years: Christine Aidala (Columbia), Dominik Gabbert (TU München), Viktor Siegle (Heidelberg)

Postdoctoral Fellows Supervised in Last 5 Years: Mickey Chiu (UIUC), Kazumi Hasuko (RIKEN), Hiro Hiejima (UIUC), Ralf Seidl (UIUC)

My Ph. D. Thesis Advisor: G. Igo and C. Whitten (University of California, Los Angeles)

My Postdoctoral Advisor: V. Hughes (Yale University)

Total Ph.D. Students Supervised: 5

Total Postdoctoral Fellows Supervised: 4

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Professional Preparation

B.Sc., Honours Physics	University of Alberta	1989
Ph.D., Physics	Massachusetts Institute of Technology	1994
Enrico Fermi Postdoctoral Fellow	Argonne National Laboratory	1994–1996

Appointments

Associate Professor of Physics	University of Illinois	2002–Present
Assistant Professor of Physics	University of Illinois	1996–2002
Enrico Fermi Postdoctoral Fellow	Argonne National Laboratory	1994–1996

Five Publications Most Relevant to the Proposed Project

HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Flavor Decomposition of the Sea Quark Helicity Distributions in the Nucleon from Semi-inclusive Deep-inelastic Scattering”, *Phys. Rev. Lett.* **92** 012005/(1-5) (2004).

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., Quark Helicity Distributions in the Nucleon for up-, down-, and strange-quarks from Semi-Inclusive Deep-inelastic Scattering”, *Phys. Rev. D*, in press, (2005).

HERMES Collaboration, K. Ackerstaff, E. Kinney, N. Makins, Y. Mao, et al., “Flavor Decomposition of the Polarized Quark Distributions in the Nucleon from Inclusive and Semi-Inclusive Deep-inelastic Scattering”, *Phys. Lett. B* **464**, 123-134 (1999).

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Single-Spin Asymmetries in Semi-Inclusive Deep-Inelastic Scattering on a Transversely-Polarized Hydrogen Target”, *Phys. Rev. Lett.* **94**, 012002/(1-5) (2005).

HERMES Collaboration, K. Ackerstaff, E. Kinney, N. Makins, Y. Mao, et al., “The Flavor Asymmetry of the Light Quark Sea from Semi-inclusive Deep-inelastic Scattering”, *Phys. Rev. Lett.* **81**, 5519-5523 (1998).

Five Most Significant Publications

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Single-Spin Asymmetries in Semi-Inclusive Deep-Inelastic Scattering on a Transversely-Polarized Hydrogen Target”, *Phys. Rev. Lett.* **94**, 012002/(1-5) (2005).

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Flavor Decomposition of the Sea Quark Helicity Distributions in the Nucleon from Semi-inclusive Deep-inelastic Scattering”, *Phys. Rev. Lett.* **92**, 012005/(1-5) (2004).

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the Beam-Spin Azimuthal Asymmetry Associated with Deeply-Virtual Compton Scattering”, *Phys. Rev. Lett.* **87**, 182001/(1-5) (2001).

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NE18 Collaboration: E. Kinney, N.C.R. Makins. et al., “Momentum Transfer Dependence of Nuclear Transparency from the Quasielastic $^{12}\text{C}(e,e' p)$ Reaction”, *Phys. Rev. Lett.* **72**, 1986-1989 (1994).

Synergistic Activities

Innovations in Teaching and Training: Introduced conceptual tutorials in Physics 112, “General Physics – Electricity and Magnetism”. Implemented conceptual “Preflight” exercises, a form of “just-in-time” teaching, in Physics 335 (“Electromagnetic Fields and Sources I”) and 336 (“Electromagnetic Fields and Sources II”).

Science Literacy and Public Outreach: Gave talk for Saturday Physics Honors Program in Fall 2001, “Journey to the Center of the Proton”. Began development with two undergraduate students of a popular website explaining hadronic-structure physics and the HERMES experiment to the science-educated public.

Development of Research Tools: Served as Analysis Coordinator for the HERMES Experiment (1999-2000). This position involves oversight of all physics analyses at the experiment and coordination of analysis manpower. A particular focus during my tenure was the development of a coherent, long-term analysis strategy for the measurement of the quark spin distributions, including the particle-identification algorithm for the newly-installed RICH detector, systematic tuning of the fragmentation Monte Carlo, and development of a fast smearing code for simulation of detector effects. The culmination of this complex analysis was the presentation in a 2004 Physical Review Letter of the only measurement to date of the helicity distributions for five quark flavors.

Service to the Community:

(1) APS Division of Nuclear Physics Executive Committee, 2003-Present. (2) UIUC Senate Committee on Educational Policy, 2002-2004. (3) Participated in the preparation of the Nuclear Science Advisory Committee (NSAC) Long Range (5-year) Plan, including contributions to three white papers and presentation at Hadronic Physics Town Meeting, 2000-2001. (4) APS Division of Nuclear Physics Program Committee, 1998-2000. (5) Fermilab Users’ Executive Committee, 1996-1998.

Collaborations

Collaborators in Last 48 months: HERMES Collaboration (see reference 2)

Ph. D. Students Supervised in Last 5 years: A.E. Andrus (UIUC), P. Bailey (UIUC), L.A. Linden-Levy, (UIUC), J. Rubin (UIUC)

Postdoctoral Fellows Supervised in Last 5 Years: M. Bouwhuis (UIUC)

My Ph. D. Thesis Advisor: R.G. Milner (Massachusetts Institute of Technology)

My Postdoctoral Advisors: D.F. Geesaman (Argonne National Laboratory), H.E. Jackson (Argonne National Laboratory)

Total Ph.D. Students Supervised: 4

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Professional Preparation

Tunghai University	Physics	BS, 1970
University of Pittsburgh	Physics	Ph.D., 1975

Appointments

Professor	University of Illinois at Urbana-Champaign	2002–present
Laboratory Fellow	Los Alamos National Laboratory	1996–present
Staff Member	Los Alamos National Laboratory	1980–2002
Postdoctoral Staff Member	Los Alamos National Laboratory	1979
Research Associate	University of Pittsburgh	1978
Research Associate	CEN, Saclay, France	1976–1977

Five Publications Most Relevant to the Proposed Project

- G.T. Garvey and J.C. Peng, “Flavor Asymmetry of Light Quarks in the Nucleon Sea,” *Prog. Part. Nucl. Phys.* **47**, 203–243 (2001).
- P. L. McGaughey, J.M. Moss, and J.C. Peng, “High-Energy Hadron Induced Dilepton Production from Nucleons and Nuclei,” *Ann. Rev. Nucl. Part. Sci.* **49**, 217–253 (1999).
- E866 Collaboration: J.C. Peng et al., “d-bar/u-bar Asymmetry and the Origin of the Nucleon Sea,” *Phys. Rev. D* **58**, 092004/(1–5) (1998).
- J.C. Peng, “Physics of p-A Collision and its Relation to e-A Collisions,” *AIP Conference Proceedings* **588**, 312–316 (2001).
- J.C. Peng, “Structure Functions: Status and Prospects,” *AIP Conference Proceedings* **698**, 33–43 (2004).

Five Most Significant Publications

- E866 Collaboration: R.S. Towell et al., “Improved Measurement of the d-bar/u-bar Asymmetry in the Nucleon Sea,” *Phys. Rev. D* **64**, 052002/(1–16) (2001).
- E866 Collaboration: J.C. Peng et al., “d-bar/u-bar Asymmetry and the Origin of the Nucleon Sea,” *Phys. Rev. D* **58**, 092004/(1–5) (1998).
- E789 Collaboration: D.M. Jansen et al., “Measurement of the Bottom Quark Production Cross-Section in 800 GeV/c Proton-Gold Collisions,” *Phys. Rev. Lett.* **74**, 3118–3121 (1995).
- E772 Collaboration: D. Alde et al., “A Dependence of J/Ψ and Ψ' Production at 800 GeV/c,” *Phys. Rev. Lett.* **66**, 133–136 (1998).
- E772 Collaboration: D. Alde et al., “Nuclear Dependence of Dimuon Production at 800-GeV,” *Phys. Rev. Lett.* **64**, 2479–2482 (1998).

Synergistic Activities

Contributions to education: Supervised three undergraduate REU students during 2003–2004.

Contributions to international collaborations: Served on the Japanese J-PARC committee for Nuclear and Particle Physics Experimental Facility to develop the physics program for the 50-GeV Proton Synchrotron being constructed (2003–2004) in Japan. Elected President of the Overseas Chinese Physics Association (OCPA) (2005–2006). Award chair for the “Outstanding Young Researcher Award” and the “Achievement in Asia Award” of OCPA (2000, 2004). Served on the Executive Committee of the APS Forum on International Physics (2000–2001).

Service on Scientific Committees: Program Advisory Committee of the Jefferson Lab (2002-2004); Steering Committee of the Electron-Ion Collider Project (2002–present); APS committee of International Freedom of Scientists (2004); Program Committee of the Division of Nuclear Physics of APS (2000–2001).

Co-organizer of Physics Conferences: Workshop on “Charm Production: from Threshold via SPS to RHIC and LHC”, ECT, Trento, Italy, 2002; “Workshop on pA Physics at RHIC”, BNL Oct. 2000; “Workshop on Key Issues in Hadron Physics”, Sanderling, NC, Nov. 2000; “Workshop on Hard Processes and RHIC Physics”, Los Alamos, June 2000; CIPANP 2000, Quebec City, May 2000; “Workshop on Dilepton Experiments at 50 GeV PS”, KEK, Oct. 1999.

Development of research tools: Designed the two-arm spectrometer for eta meson detection at LAMPF. Implemented the silicon vertex detectors for measuring charm and bottom particles in a high-rate environment at Fermilab.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see Reference 1); Fermilab E866 Collaboration (see Reference 3); Neutron EDM Collaboration (see Reference 13)

Ph. D. Students Supervised in Last 5 years: Andrea Esler (UIUC), Ying Yin (UIUC)

Postdoctoral Fellows Supervised in Last 5 Years: H. Heijima (UIUC), P. King (UIUC), B. Park (LANL), P. Reimer (ANL), L. Zhu (UIUC)

My Ph. D. Thesis Advisor: J. V. Maher (University of Pittsburgh)

My Postdoctoral Advisor: Michel Mermaz (CEN Saclay)

Total Ph.D. Students Supervised: 4

Total Postdoctoral Fellows Supervised: 8

Cheng-Yi Chi

Department of Physics • Columbia University
136 South Broadway, Irvington, NY 10533 USA
914-591-8132; 914-591-4540 (fax); chi@nevis.columbia.edu

Professional Preparation

Soochow University, Taiwan	Physics	B.S., 1977
Tsing Hwa University, Taiwan	Physics	M.S., 1979
Columbia University	Physics	Ph.D., 1990

Appointments

Columbia University	Associate Research Scientist	1994-Present
Columbia University	Postdoctoral Research Fellow	1991-1994

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration, S.S. Adler, K. Barish, C.Y. Chi, J. Hill, J. Lajoie, J. Nagle, R. Seto, W. Xie, W.A. Zajc, et al., "PHENIX On-line Systems", *Nucl.Instrum.Meth.A* **499**, 560-592 (2003)

PHENIX Collaboration, M. Allen, C.Y. Chi, R. Seto, et al., "PHENIX Inner Detectors," *Nucl. Instrum Meth. A* **499**, 549-559 (2003).

C.Y. Chi, B. Cole, J. Nagle, W. Sippach, W. Zajc, "Data Collection Modules for The PHENIX experiment", *IEEE Trans.Nucl.Sci.* **45**, 1913-1916 (1998).

M. Atiya, C.Y. Chi, R. Seto, et al., "A Large System of Flash ADC for a Neutrino Detector", *Nucl. Instrum .Meth. A* **300**, 542-551 (1991).

PHENIX Collaboration, S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Double Helicity Asymmetry in Inclusive Mid-Rapidity π^0 Production for Polarized P + P Collisions at $S^{*}(1/2) = 200$ GeV," *Phys.Rev.Lett.* **93**, 202002/(1-6) (2004).

Five Most Significant Publications

PHENIX Collaboration, S.S. Adler, K. Barish, C.Y. Chi, J. Hill, J. Lajoie, J. Nagle, R. Seto, W. Xie, W. Zajc, et al., "PHENIX On-line Systems," *Nucl.Instrum.Meth.A* **499**, 560-592 (2003).

PHENIX Collaboration, K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $S^{*}(1/2)=130$ GeV," *Phys.Rev.Lett.* **88**, 022301/(1-6) (2002).

C.Y. Chi, B. Cole, J. Nagle, W. Sippach, W. Zajc, "Data Collection Modules for The PHENIX experiment," *IEEE Trans.Nucl.Sci.* **45**, 1913-1916 (1998).

L. Borodovsky, C.Y. Chi, R. Seto, et al., "Search for Muon-Neutrino Oscillations Muon-Neutrino \rightarrow Electron-Neutrino (Anti-Muon-Neutrino \rightarrow Anti-Electron-Neutrino In a Wide Band Neutrino Beam)," *Phys.Rev.Lett.* **68**, 274-277 (1992).

B. Blumenfeld, C.Y. Chi, R. Seto, et al., "Search for Muon-Neutrino \rightarrow Electron-Neutrino Oscillations," *Phys.Rev.Lett.* **62**, 2237-2240 (1989).

Synergistic Activities

International collaboration and exchange: Led collaboration on the PHENIX Time-of-Flight and Beam-Beam electronics effort between Columbia University, Tsukuba and Hiroshima University in Japan. Worked with international collaboration on the PHENIX Front End Electronics specification and construction, including a co-leadership role in the DAQ design.

Development of research tools: Built the PHENIX Data Collection Modules which are used to readout all of PHENIX's Front End Modules. Built Time-Of-Flight and Beam-Beam (BB) Front-end Electronics for the PHENIX experiment, and later modified BB electronics for additional use in the NTC and ZDC readout. Oversaw the E917 DAQ development. Oversaw the PHENIX Muon Tracking Electronics. Served as PHENIX DAQ Detector Council Member and currently serving as PHENIX DAQ Upgrade Manager.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1)

Ph. D. Students Supervised in Last 5 years: Mickey Chiu (UIUC), Chun Zhang (Columbia University)

Postdoctoral Fellows Supervised in Last 5 Years: J. Nagle (Columbia University)

My Ph. D. Thesis Advisor: WonYong Lee (Columbia University)

My Postdoctoral Advisor: WonYong Lee (Columbia University)

Total Ph.D. Students Supervised: 2

Total Postdoctoral Fellows Supervised: 1

Edward R. Kinney

Department of Physics • University of Colorado at Boulder
390 UCB, Boulder, CO 80309-0390 USA
303-492-0455; 303-492-3352 (fax); *Edward.Kinney@colorado.edu*

Professional Preparation

Massachusetts Institute of Technology	Physics	S.B., 1981
Massachusetts Institute of Technology	Physics	Ph.D., 1988
Argonne National Laboratory	Postdoctoral Appointee	1988–1991

Appointments

University of Colorado	Professor of Physics	2004–Present
University of Colorado	Associate Professor of Physics	1998–2004
HERMES Experiment, DESY	Spokesman	1997–1999
University of Colorado	Assistant Professor of Physics	1991–1998
Argonne National Laboratory	Postdoctoral Appointee	1988–1991

Five Publications Most Relevant to the Proposed Project

- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Flavor decomposition of the sea quark helicity distributions in the nucleon from semi-inclusive deep inelastic scattering,” *Phys. Rev. Lett.* **92**, 012005/(1-5) (2004).
- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the spin asymmetry in the photoproduction of pairs of high p_T hadrons at HERMES,” *Phys. Rev. Lett.* **84**, 2584-2588 (2000).
- HERMES Collaboration: K. Ackerstaff, E. Kinney, N. Makins, Y. Mao, et al., “Flavor decomposition of the polarized quark distributions in the nucleon from inclusive and semi-inclusive deep inelastic scattering,” *Phys. Lett. B* **464**, 123-134 (1999).
- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the proton spin structure function g_1^p with a pure hydrogen target,” *Phys. Lett. B* **442**, 484-492 (1998).
- HERMES Collaboration: K. Ackerstaff, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the neutron spin structure function g_1^n with a polarized ^3He internal target,” *Phys. Lett. B* **404**, 383-389 (1997).

Five Most Significant Publications

- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the beam spin azimuthal asymmetry associated with deeply virtual Compton scattering,” *Phys. Rev. Lett.* **87**, 182001/(1-6) (2001).
- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Observation of a single spin azimuthal asymmetry in semi-inclusive pion electroproduction,” *Phys. Rev. Lett.* **84**, 4047-4051 (2000).
- HERMES Collaboration: A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the proton spin structure function g_1^p with a pure hydrogen target,” *Phys. Lett. B* **442**, 484-492 (1998).
- HERMES Collaboration: K. Ackerstaff, E. Kinney, N. Makins, Y. Mao, et al., “Measurement of the neutron spin structure function g_1^n with a polarized ^3He internal target,” *Phys. Lett. B* **404**, 383-389 (1997).
- E665 Collaboration: M.R. Adams, E. Kinney, et al., “Proton and deuteron structure functions in muon scattering at 470 GeV,” *Phys. Rev. D* **54**, 3006-3056 (1996).

Synergistic Activities

International collaboration and exchange: Led the HERMES collaboration at DESY as spokesman from 1997 through 1999. This is an international collaboration of over 150 scientists from nations around the world.

Contributions to training: Have trained undergraduates, graduates, and postdocs in large scale data analysis typical of high energy spectrometers, and also a smaller number of students in drift chamber design, construction, and operation.

Contributions to teaching and outreach: Supervised seven undergraduates in research projects at the HERMES experiment.

Development of research tools: Small high rate drift chambers for the HERMES experiment, including operational and readout electronics.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration [see Reference 1]; HERMES Collaboration [see Reference 2]; Jefferson Lab Hall C Collaboration [see Reference 7].

Ph. D. Students Supervised in Last 5 years: J. Ely (NWNL), G. Rakness (Penn State), J. Seele (Colorado)

Postdoctoral Fellows Supervised in Last 5 Years: F. Ellinghaus (University of Colorado), B. Fox (industry), D. Gaskell (TJNAF), A. Glenn (University of Colorado), U. Stoesslein (DESY)

My Ph. D. Thesis Advisor: J.L. Matthews (Massachusetts Institute of Technology)

My Postdoctoral Advisors: D. Geesaman (ANL), R. Holt (ANL), H. Jackson (ANL)

Total Ph.D. Students Supervised: 4

Total Postdoctoral Fellows Supervised: 8

Yajun Mao

School of Physics • Peking University
Beijing 100871 P. R. China
(86)-10-62752175; (86)-10-62751875(fax); maoyj@hep.pku.edu.cn

Professional Preparation

Peking University	Physics	Diploma, 1983
China Institute of Atomic Energy	Physics	M.S., 1986
China Institute of Atomic Energy	Physics	Ph.D., 1995

Appointments

Peking University	Professor of Physics	2001-Present
RIKEN	Cooperative Scientist	1996-2001
China Institute of Atomic Energy	Associate Research Scientist	1991-1993
California Institute of Technology	Visiting Scientist	1989-1991
China Institute of Atomic Energy	Research Fellow	1986-1989

Five Publications Most Relevant to the Proposed Project

HERMES Collaboration: A. Airapetian, E. Kinney, Y. Mao, N. Makins, et al., “Single-spin asymmetries in semi-inclusive deep-inelastic scattering on a transversely-polarized hydrogen target”, *Phys. Rev. Lett.* **94**, 012002/(1-5) (2005).

PHENIX Collaboration: S. S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Double helicity asymmetry in inclusive mid-rapidity π^0 production for polarized p+p collision at $\sqrt{s}=200\text{GeV}$ ”, *Phys. Rev. Lett.* **93**, 202002/(1-6), (2004)

PHENIX Collaboration, H. Akikawa, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, N. Saito, et al., “PHENIX muon arms”, *Nucl. Instrum. Meth. A* **499**, 537-548, (2003)

PHENIX Collaboration, N. Saito, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Spin physics with the PHENIX detector system”, *Nucl. Phys. A* **638**, 575-578 (1998)

Five Most Significant Publications

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Evidence for a narrow $|S| = 1$ baryon state at a mass of 1528 MeV in quasireal photoproduction”, *Phys. Lett. B* **585**, 213-220 (2004).

HERMES Collaboration, A. Airapetian, E. Kinney, N. Makins, Y. Mao, et al., “Single-spin asymmetries in semi-inclusive deep-inelastic scattering on a transversely-polarized hydrogen target”, *Phys. Rev. Lett.* **94** 012002/(1-5) (2005)

X. Chen, Y. Mao, B.-Q. Ma, “Decay probability ratio of pentaquark Θ^+ state”, *Int. J. Mod. Phys. Lett. A* **19**, 2289-2298, (2004)

PHENIX Collaboration, H. Akikawa, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, N. Saito, et al., “PHENIX muon arms”, *Nucl. Instrum. Meth. A* **499**, 537-548 (2003)

Yajun Mao, *continued*

C. Ching, T. Ho, D. Liang, Y. Mao, S. Chen, H. Sun, "A Possible explanation of the negative values of m_N^2 obtained from the b spectrum shape analyses", *Int. J. Mod. Phys. Lett.* **A10**, 2841-2850 (1995)

Synergistic Activities

International collaboration and exchange: Visited Caltech, US (1989-1991, L3) and RIKEN, Japan (1996-2001) as an exchange scholar, to work on the R&D and construction of PHENIX muon identifier with limited streamer tubes; Led Peking University (PKU) group in HERMES. experiment, to maintain polarized target system and to analyze lambda/exotics production (2001- present). Lead PKU group in PHENIX experiment for RPC R&D and mass production.

Contributions to training: Initiated PHENIX muon software tutorial, which has been an important step for those who want to do PHENIX muon-related physics (2001).

Development of research tools: Limited streamer tubes for PHENIX muon identifier; Linux farm for HEP group in PKU. RPC test system in PKU.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1); HERMES Collaboration (see reference 2); BES Collaboration (see reference 8)

Ph. D. Students Supervised in Last 5 years: Ran Han (Peking University), Hongtao Liu (Peking University), Hongxue Ye (Peking University)

Postdoctoral Fellows Supervised in Last 5 Years: Jun Ying (Georgia State University)

My Ph. D. Thesis Advisor: Z. Sun (China Institute of Atomic Energy, Beijing, China)

My Postdoctoral Advisor: Hideto En`yo (RIKEN)

Total Ph.D. Students Supervised: 3

Total Postdoctoral Fellows Supervised: 1

James L. Nagle

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390 UCB, Boulder, CO 80309, USA
303-735-2560; 303-492-3352 (fax); Jamie.Nagle@Colorado.Edu

Professional Preparation

Massachusetts Institute of Technology	Physics	B.S. 1991
Yale University	Physics	Ph.D. 1997
Columbia University	Associate Research Scientist	1997-1998

Appointments

University of Colorado, Boulder	Assistant Professor of Physics	2002-Present
Columbia University	Assistant Professor of Physics	1998-2002

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Double Helicity Asymmetry in Inclusive Mid-Rapidity Pizero Production for Polarized P+P Colisions at $\sqrt{s}=200$ GeV", *Phys. Rev. Lett.* **93**, 202002/(1-6) (2004).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "J/Psi Production from Proton-Proton Collisions at $\sqrt{s}=200$ GeV", *Phys. Rev. Lett.* **92**, 051802/(1-6) (2004).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Midrapidity Neutral Pion Production in Proton-Proton Collisions at $\sqrt{s}=200$ GeV", *Phys. Rev. Lett.* **91**, 241803/(1-6) (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, J. Hill, J. Lajoie, J. Nagle, R. Seto, W. Xie, W. Zajc, et al., "PHENIX On-Line Systems", *Nucl. Instrum. Meth. A* **499**, 560-592 (2003).

C.Y. Chi, B. Cole, J.L. Nagle, W. Sippach, W.A. Zajc, "Data Collection Modules for the PHENIX Experiment", *IEEE Trans. Nucl. Sci.* **45**, 1913-1916 (1998).

Five Most Significant Publications

S. Batsouli, S. Kelly, M. Gyulassy, J.L. Nagle, "Does the Charm Flow at RHIC?", *Phys. Lett. B* **557**, 26-32 (2004).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Suppressed Pizero Production at Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s}=200$ GeV", *Phys. Rev. Lett.* **91**, 072301/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Measurement of Single Electrons and Implications for Charm Production in Au+Au Collisions at $\sqrt{s}=130$ GeV", *Phys. Rev. Lett.* **88**, 192303/(1-6) (2002).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al.,

James L. Nagle, *continued*

"Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s}=130$ GeV", *Phys. Rev. Lett.* **88**, 022301/(1-6) (2002).

J.L. Nagle, B.S. Kumar, D. Kusnezov, H. Sorge, R. Mattiello, "Coalescence of Deuterons in Relativistic Heavy Ion Collisions", *Phys. Rev. C* **53**, 367-376 (1996).

Synergistic Activities

International collaboration and exchange: The PHENIX experiment is a large international collaboration. I coordinated a one month PHENIX muon analysis workshop in Boulder, Colorado in the 2004. It was attended by researchers from the United States, Korea, France, and other states. In addition, our group hosted multiple visitors in 2003 from within the PHENIX collaboration.

Contributions to training: In working with my first two graduate students (Chun Zhang and Justin Frantz), they both developed data acquisition electronics expertise. Both received their Ph.D's in 2004.

Contributions to teaching and outreach: I have supervised four graduate students, two of whom have now completed their Ph.D's. I have also worked with multiple undergraduate students on research projects. Three students worked with me at Brookhaven National Laboratory during summer periods and then continued research during the academic year. Three of these students received awards through the Conference Experience for Undergraduates in the Division of Nuclear Physics (DNP). John Freeman, John Conley, Matthew Aiello-Lammens all presented their work at the DNP meetings through this program.

Development of research tools: In collaboration with Cheng Yi-Chi and W. Sippach at Nevis Laboratories, we designed and implemented a Smart Trigger Pre-Processor digital electronics module. The module uses high speed Field Programmable Gate Arrays to replace slower signal processor capabilities. Previously we collaborated on construction of the Data Collection Modules for the PHENIX experiment. These modules read out all of the PHENIX front end electronics. I also worked on the development of a precision Time-of-Flight Scintillator Detector for the E864 Experiment (1989-1997).

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1).

Ph. D. Students Supervised in Last 5 years: A. Adare (University of Colorado), J. Frantz (Columbia University), M. Wycsocki (University of Colorado), C. Zhang (Columbia University)

Postdoctoral Fellows Supervised in Last 5 Years: S. Batsouli (Columbia University), A. Bickley (University of Colorado), S. Kelly (University of Colorado and Columbia University)

My Ph. D. Thesis Advisor: S. Kumar (Yale University)

My Postdoctoral Advisor: W.A. Zajc (Columbia University)

Total Ph.D. Students Supervised: 4

Total Postdoctoral Fellows Supervised: 3

Naohito Saito

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Professional Preparation

Kyoto University	Physics	Master, 1991
Kyoto University	Physics	Ph.D., 1995
RIKEN	Special Post Doctoral Fellowship	1995-1996

Appointments

Kyoto University	Associate Professor of Physics	2002–Present
RIKEN	Vice Chief Scientist	2001–2002
RIKEN	Researcher	1996–2002
RIKEN	Special Post Doctoral Fellowship	1995–1996
Japan Society for the Promotion of Science	Junior Research Fellow	1993–1995

Five Publications Most Relevant to the Proposed Project

- G. Bunce, N. Saito, J. Soffer, W. Vogelsang, “Prospects for Spin Physics at RHIC” *Ann. Rev. Nucl. Part. Sci.* **50**, 525-575 (2000).
- M. Hirai, S. Kumano and N. Saito, “Determination of Polarized Parton Distribution Functions and Their Uncertainties,” *Phys. Rev. D* **69**, 054021/(1-10) (2004).
- I. Alekseev, N. Saito, et al., “Polarized Proton Collider at RHIC” *Nucl.Instrum.Meth.A* **499**, 392-414 (2003).
- PHENIX Collaboration: H. Akikawa, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, N. Saito, R. Towell, et al. “PHENIX Muon Arms,” *Nucl. Instrum. Meth. A* **499**, 537-548 (2003)
- N. Saito, “Spin Physics Program at RHIC: The First Polarized-Proton Collider,” *Nucl.Phys.A* **698**, 275-286 (2001)

Five Most Significant Publications

- G. Bunce, N. Saito, J. Soffer, W. Vogelsang, “Prospects for Spin Physics at RHIC,” *Ann. Rev. Nucl. Part. Sci.* **50**, 525-575 (2000).
- E704 Collaboration: D.L. Adams, N. Saito, *et al.*, “Analyzing Power in Inclusive pi+ and pi- Production at High x_F with a 200 GeV Polarized Proton Beam,” *Phys. Lett. B* **264**, 462-466 (1991).
- Asymmetry Analysis Collaboration Y. Goto, N. Saito, *et al.*, “Polarized Parton Distribution Functions in the Nucleon,” *Phys. Rev. D* **62**, 034017/(1-51) (2000).
- R.L. Jaffe and N. Saito, “QCD Selection Rules in Polarized Hadron Collisions,” *Phys. Lett. B* **382**, 165-172 (1996).
- E704 Collaboration: D.L. Adams, N. Saito, *et al.*, “Measurement of Single Spin Asymmetry for Direct Photon Production in pp Collisions at 200 GeV/c,” *Phys. Lett. B* **345**, 569-575 (1995).

Synergistic Activities

International collaboration and exchange: Initiated and led collaboration between RIKEN and BNL to start the spin physics program at RHIC; initiated and led experimental group in RIKEN BNL Research Center together with Dr. Gerry Bunce (1998-2002).

Contributions to training: Initiated and led the RHIC spin program including Fellow and Research Associate positions at RIKEN BNL Research Center, as well as supervised graduate students (1998-2002).

Contributions to teaching and outreach: Designed and supervised winter school in Japan for QCD physics (3 times); more than 40 students in the last one (March, 2002).

Development of research tools: Large Area Muon Identifier using Iarocci Tubes for PHENIX at BNL; Proton Beam Polarimeter using pC elastic scattering for RHIC; compact electro-magnetic calorimeter with lead-tungstate; hadron calorimeter with position sensitivity for polarimetry of high energy polarized proton beam for PHENIX; single-sided two-dimensional Si sensor (stripixel sensor) for PHENIX Si tracker.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1); E950 Collaboration (See Reference 11); Asymmetry Analysis Collaboration (see Reference 12).

Ph. D. Students Supervised in Last 5 years: H. D. Sato (Kyoto), J. Tojo (Kyoto), H. Torii (Kyoto),

Postdoctoral Fellows Supervised in Last 5 Years: A. Bazilevsky (RBRC), O. Jinnouchi (RIKEN), K. Okada (RIKEN), M. Wagner (Kyoto)

My Ph. D. Thesis Advisor: A. Masaike (Kyoto University, Japan)

My Postdoctoral Advisor: M. Ishihara (RIKEN)

Total Ph.D. Students Supervised: 3

Total Postdoctoral Fellows Supervised: 4

Wei Xie

Physics Department • Brookhaven National Laboratory
Upton, NY 11973-5000 USA
631-344-3744; 631-344-3251 (fax); xiewei@bnl.gov

Professional Preparation

Shandong University, P.R.China	Physics	Diplom, 1991
Shandong University, P.R.China	Physics	Ph.D., 1997
Weizmann Institute of Science, Israel	Postdoctoral Research Fellow	1997–2000
University California, Riverside, CA	Postdoctoral Research Fellow	2000–2003

Appointments

RIKEN BNL Research Center, University California, Riverside, CA	RIKEN BNL Fellow Assistant Research Physicist	2004–present 2003–2004
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Five Publications Most Relevant to the Proposed Project

Wei Xie for PHENIX Collaboration, “PHENIX J/Psi Measurement at $\sqrt{s}=200\text{GeV}$,” *proceedings of the 19th Winter Workshop on Nuclear Dynamics*, 235–240, Feb.8-15, 2003, Breckenridge, Colorado, USA.

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “J/psi production from proton-proton collisions at $\sqrt{s} = 200 \text{ GeV}$,” *Phys.Rev.Lett.* **92**, 051802/(1-6) (2004).

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “J/Psi Production in Au-Au Collisions at $\sqrt{s} = 200 \text{ GeV}$ at the Relativistic Heavy Ion Collider,” *Phys. Rev. C* **69**, 014901/(1-11) (2004).

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Midrapidity Neutral Pion Production in Proton-Proton Collisions at $\sqrt{s} = 200 \text{ GeV}$,” *Phys.Rev. Lett.* **91**, 241803/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Measurement of Single Electrons and Implications for Charm Production in Au+Au Collisions at $\sqrt{s} = 130 \text{ GeV}$,” *Phys. Rev. Lett.* **88**, 192303/(1-6) (2002).

Five Most Significant Publications

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “J/psi production from proton-proton collisions at $\sqrt{s} = 200 \text{ GeV}$ ” *Phys. Rev. Lett.* **92**, 051802/(1-6) (2004).

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Scaling properties of proton and anti-proton production in $\sqrt{s} = 200 \text{ GeV}$ Au+Au collisions,” *Phys. Rev. Lett.* **91**, 172301/(1-6) (2003).

PHENIX Collaboration: S.S.Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Suppressed π^0 Production at Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s} = 200$ GeV," *Phys. Rev. Lett.* **91**, 072301/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s} = 130$ GeV" *Phys.Rev.Lett.* **88**, 022301/(1-6) (2002).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Measurement of Single Electrons and Implications for Charm Production in Au+Au Collisions at $\sqrt{s} = 130$ GeV," *Phys. Rev. Lett.* **88**, 192303/(1-6) (2002).

Synergistic Activities

International collaboration and exchange: Led the development of PHENIX level-2 single electron and electron pair trigger (2002). Lead the PHENIX J/Psi analysis in d-Au and p-p collisions. Co-lead the design and development of a relative-luminosity telescope for PHENIX. Play a key role in the conceptual study of PHENIX hadron-blind detector. Play the key role in the PHENIX level-1 electron and photon trigger R&D. Played the key role in the design and development of PHENIX pad chamber #1.

Contributions to teaching and outreach: Designed and supervised summer physics projects in PHENIX in 2004 (1 student),

Development of research tools: multi-wire proportional pad chamber station 1 for PHENIX at BNL. Background detector for PHENIX at BNL (2004). Level-2 electron trigger for PHENIX at BNL. Time projection chamber for CERES experiment at CERN.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1);

Ph. D. Students Supervised in Last 5 years: none

Postdoctoral Fellows Supervised in Last 5 Years: none

My Ph. D. Thesis Advisor: J.R. Ren (Institute of High Energy Physics, Beijing, P.R. China)

My Postdoctoral Advisor: K. Barish (UCR), R. Seto (UCR), I. Tserruya (Weizmann Institute of Science, Israel)

Total Ph.D. Students Supervised: 0

Total Postdoctoral Fellows Supervised: 0

William A. Zajc

Department of Physics • Columbia University
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914-591-2811; 914-591-4540 (fax); zajc@nevis.columbia.edu

Professional Preparation

California Institute of Technology	Physics	B.S., 1975
University of California at Berkeley	Physics	Ph.D., 1982

Appointments

Columbia University	Professor of Physics	1996-Present
Columbia University	Associate Professor of Physics	1990-1996
Columbia University	Assistant Professor of Physics	1987-1990
University of Pennsylvania	Assistant Professor of Physics	1984-1986
University of Pennsylvania	Post-Doctoral Research Fellow	1982-1984

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “PHENIX Detector Overview”, *Nucl. Instrum. Meth. A* **499**, 469-479 (2003)

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, J. Hill, D. Isenhower, J. Lajoie, J. Nagle, N. Saito, R. Seto, W. Zajc, et al., “PHENIX On-line Systems”, *Nucl. Instrum. Meth. A* **499**, 560-592 (2003)

PHENIX Collaboration: P. Steinberg, C.Y. Chi, J. Nagle, W. Zajc, et al., “Data Collection Modules and ATM Based Event Builder for the PHENIX Experiment at RHIC”, *IEEE Trans. Nucl. Sci.* **47**, 304-308 (2000)

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Double Helicity Asymmetry in Inclusive Mid-Rapidity π^0 Production for Polarized p+p Collisions at $\sqrt{s}=200$ GeV”, *Phys. Rev. Lett. B* **93**, 202002/(1-6) (2004)

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “J/Psi Production from Proton Proton Collisions at $S^{*(1/2)} = 200$ GeV”, *Phys. Rev. Lett.* **92**, 051802/(1-6) (2004)

Five Most Significant Publications

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s}=130$ GeV”, *Phys. Rev. Lett.* **88**, 022301/(1-6) (2002).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, E. Kinney, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Centrality Dependence of Charged Particle Multiplicity Au+Au Collisions at $\sqrt{s}=130$ GeV”, *Phys. Rev. Lett.* **86**, 3500-3505 (2001).

E802 Collaboration: L. Ahle, W. Zajc, et al., “Particle Production at High Baryon Density in Central Au + Au Reactions at 11.6 A GeV/c”, *Phys. Rev. C* **57**, 466-470 (1998)

W. Zajc, et al., “Monte Carlo Computational Methods for the Generation of Events with Bose-Einstein Correlations”, *Phys. Rev. D* **35**, 3396-3445 (1987)

W. Zajc, et al., “Two Pion Correlations in Heavy Ion Collisions”, *Phys. Rev. C* **29**, 2173-2187 (1984)

Synergistic Activities

International collaboration and exchange: (1) As spokesperson for PHENIX, have led and still lead a large collaboration of 450 engineers and scientists from 60 institutions covering 13 different countries through all phases, from construction, running, and publication of over 32 papers (1995-2005). (2) As co-spokesperson for BNL AGS E859, led an international collaboration of 13 institutions from the U.S. and Japan. (3) As a member of the International Organizing Committee for Quark Matter 2002 and 2005, Particles and Nuclei in Collision 2005, PANIC 2002, Pan American Study Institute (PASI) on New States of Matter in Hadronic Interactions 2002, and numerous others, have helped to organize international participation and discussion. (4) Co-Principal Investigator on “Joint Theoretical and Experimental Research on the Quark-Gluon Plasma”, proposal funded under NSF International Programs to support participation of Hungarian physicists in PHENIX.

Contributions to Training: Responsible for insuring physics opportunities for all graduate students participating in PHENIX Experiment; formalized their participation in PHENIX Physics Working Groups.

Contributions to teaching and outreach: (In addition to 18 years of teaching at Columbia University) Web-based seminar on first RHIC results. Instructor at Pan-American Advanced Studies Institute (Brazil, 2003), RHIC Summer Study (BNL, 2002) and NATO Advanced Study Institute (Italy, 1992), Speaker at Student Session, Quark Matter 2001.

Development of research tools: Principal investigator of the Columbia Heavy Ion Group, which has major responsibility for the PHENIX DAQ and Trigger electronics. These responsibilities include the design and construction of the Data Collections Modules, Beam-Beam Front End Electronics (FEE), Time-Of-Flight FEE, and Event Builder. Participated in conceptual design of PHENIX DAQ and Trigger; determination of performance parameters and overall architecture. Design and construction of the E859 Second Level Trigger to extend capability of E802 experiment via physics-sensitive triggering.

Collaborations

Collaborators in Last 48 months: PHENIX collaboration at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory (see reference 1)

Ph. D. Students Supervised in Last 5 years: C. Aidala (Columbia), M. Chiu (UIUC), M. Moulson (unknown), X. Yang (Columbia), C. Zhang, (Columbia)

Postdoctoral Fellows Supervised in Last 5 Years: S. Batsouli (Columbia), D. d’Enterria (Columbia) J. Jia (Columbia), S. Kelly (Xlinx), F. Mattathias (Columbai), J. Nagle (U. Colorado), P. Steinberg, (Brookhaven National Lab)

My Ph. D. Thesis Advisor: Prof. K.M. Crowe (University of California)

My Postdoctoral Advisor: Prof. S. Frankel (University of Pennsylvania)

Total Ph.D. Students Supervised: 6

Total Postdoctoral Fellows Supervised: 9

John C. Hill
Department of Physics and Astronomy, Iowa State University
Ames, IA 50011
515-294-6580: 515-294-6027 (fax); jhill@iastate.edu

Professional Preparation

Davidson College	Physics	B.S. 1957
Purdue University	Physics	PhD. 1966
University of Michigan	Postdoctoral	1966-8

Appointments

Iowa State University	Prof.	1981-present
Iowa State University	Assoc. Prof.	1977-1981
Iowa State University	Asst. Prof.	1975-1977
Texas A&M University	Asst. Prof.	1968-1975

Five Publications Most Relevant to the Proposed Project

J.C. Hill, K.N. Barish, J.G. Lajoie, J.L. Nagle et al., "A high mass trigger for the E864 experiment at the AGS accelerator," *Nucl. Instr. and Meth. A* **421**, 431-446 (1999).

T.A. Armstrong, K.N. Barish, J.C. Hill, J.G. Lajoie, J.L. Nagle et al., "A spectrometer for study of high mass objects created in relativistic heavy ion reactions," *Nucl. Instr. and Meth. A* **437**, 222 (1999).

PHENIX Collaboration: S.S. Adler, K.N. Barish, C.Y. Chi, J.C. Hill, J.G. Lajoie, J.L. Nagle, R. Seto et al., " PHENIX on-line systems," *Nucl. Instr. and Meth. A* **499**, 560-592 (2003).

H. Akikawa, J.C. Hill, L.D. Isenhower, J.G. Lajoie, J.L. Nagle, R.S. Towell et al., "PHENIX muon arms," *Nucl. Instr. and Meth. A* **499**, 537-548 (2003).

PHENIX Collaboration : S.S. Adler, K.N. Barish, M. Grosse-Perdekamp, J.C. Hill, L.D. Isenhower, J.G. Lajoie, J.L. Nagle, R. Seto, R.S. Towell et al., "Double Helicity Asymmetry in Inclusive Mid-Rapidity Pi-zero Production for Polarized P+P Colisions at sqrt(s)=200 GeV", *Phys. Rev. Lett.* **93**, 202002/(1-6) (2004).

Five Most Significant Publications

R.L. Gill, R.F. Casten, D.D. Warner, A. Piotrowski, H. Mach, J.C. Hill, F.K. Wohn, J.A. Winger and R. Moreh, "The half-life of Zn-80: the first measurement for an r-process waiting-point nucleus." *Phys. Rev. Lett.* **56**, 1874 (1986).

J.C. Hill, F.K. Wohn, J.A. Winger, and A.R. Smith, "Electromagnetic dissociation for high-Z projectiles and at ultrarelativistic energies," *Phys. Rev. Lett.* **60**, 999-1001 (1988).

J.C. Hill, A. Petridis, B. Fadem, and F.K. Wohn, "Electromagnetic dissociation of Au targets by relativistic Pb projectiles," *Nucl. Phys. A* **661**, 313-316 (1999).

T.A. Armstrong, K.N. Barish, J.C. Hill, J.G. Lajoie, J.L. Nagle et al., "Search for strange quark matter produced in relativistic heavy ion collisions," *Phys. Rev. C* **63**, 054903/(1-35) (2001).

S.S. Adler, K.N. Barish, M. Grosse-Perdekamp, J.C. Hill, L.D. Isenhower, J.G. Lajoie, R. Seto, R.S. Towell et al., "Absence of Suppression in Particle Production at Large Transverse Momentum in $\sqrt{s_{NN}} = 200$ GeV d+Au Collisions", *Phys. Rev. Lett.* **91**, 072303/(1-6) (2003).

Synergistic Activities

Contributions to research:

I along with collaborators from Purdue University developed the late-energy trigger for the E864 experiment at the AGS accelerator. I was also involved in building the level-1 trigger for the PHENIX detector in a project led by Prof. Lajoie of our department. I was Period Coordinator for the PHENIX experiment for 3 runs. The citation from my recent election to Fellowship in the American Physical Society states in part "--and for his leadership in the development of triggers for the E864 and PHENIX experiments," I have been the PI on the Iowa State base grant entitled Relativistic Heavy Ion Physics supported by the U.S. Department of Energy since 1992.

Contributions to training:

Have trained a number of graduate students and postdoctoral fellows in techniques related to particle measurements and analysis of the physics results. These people have positions in universities, colleges, national laboratories and university hospitals. Every year I give talks at small colleges on RHIC physics. These talks have been given in Iowa, Minnesota, Nebraska, Missouri, and Kansas.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1)

Ph. D. Students Supervised in Last 5 years: B. Fadem (Muhlenburg College)

Postdoctoral Fellows Supervised in Last 5 Years: B. Libby (University of Pittsburg Medical Center)

My Ph. D. Thesis Advisor: R. Steffen (Purdue University)

My Postdoctoral Advisor: M. Wiedenbeck (University of Michigan)

Total Ph.D. Students Supervised: 5

Total Postdoctoral Fellows Supervised: 4

John Lajoie

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Ames, IA 50011
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Professional Preparation

Iowa State University	Physics	B.S. 1989
Yale University	Physics	PhD. 1996
Yale University	Postdoc	1996-1997

Appointments

Iowa State University	Assoc. Prof.	2003-present
Iowa State University	Asst. Prof.	1997-2003

Five Publications Most Relevant to the Proposed Project

E864 Collaboration: J. Hill, K.N. Barish, J. Lajoie, J. Nagle et al., "A high mass trigger for the E864 experiment at the AGS accelerator," *Nucl. Instr. and Meth. A* **421**, 431-446 (1999).

J. Lajoie et. al., "The PHENIX Level-1 Trigger System," IEEE Real Time '99, New Mexico, June 1999.

PHENIX Collaboration: S.S. Adler, K.N. Barish, C.Y. Chi, J.C. Hill, J.G. Lajoie, J. Nagle, R. Seto, et al., "PHENIX on-line systems," *Nucl. Instr. and Meth. A* **499**, 560-592 (2003).

PHENIX Collaboration: H. Akikawa, J.C. Hill, L.D. Isenhower, J.G. Lajoie, Y. Mao, J. Nagle, N. Saito, R.S. Towell, et al., "PHENIX muon arms," *Nucl. Instr. and Meth. A* **499**, 537-548 (2003).

E864 Collaboration: T. A. Armstrong, K. Barish, J. Hill, J. Lajoie, J. Nagle, et al., "The E864 Lead-Scintillating Fiber Hadronic Calorimeter," *Nucl. Instr. Meth. A* **406**, 227-258 (1998).

Five Most Significant Publications

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "High-pt Charged Hadron Suppression in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV", *Phys. Rev. C* **69**, 034910/(1-22) (2004).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Absence of Suppression in Particle Production at Large Transverse Momentum in $\sqrt{s_{NN}} = 200$ GeV d+Au Collisions", *Phys. Rev. Lett.* **91**, 072303/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., "Suppression of Hadrons with Large Transverse Momentum in Central Au+Au collisions at $\sqrt{s_{NN}} = 130$ GeV," *Phys. Rev. Lett.* **88** 022301/(1-6) (2002).

E864 Collaboration: T. A. Armstrong, K.N. Barish, J.C. Hill, J. Lajoie, et al., "Antiproton Production and Antideuteron Limits In Relativistic Heavy Ion Collisions," *Phys. Rev. C* **59**, 2699-2712 (1999)

John Lajoie, *continued*

E864 Collaboration: T. A. Armstrong, K.N. Barish, J.C. Hill, J. Lajoie, et al., "Antiproton Production in 11.5A GeV/c Au+Pb Collisions," *Phy. Rev. Lett.* **79**, 3351-3354 (1997)

Synergistic Activities

Contributions to research

Service on as the PHENIX Level-1 Detector Council member, where I am responsible for the maintenance and upgrade of the Global Level-1 as well as the Beam-Beam, Muon Identifier, Zero-Degree Calorimeter and Electron-Rich Local Level-1 Trigger systems. I am also serving as the PHENIX Run Coordinator for RHIC Run-5, where I am responsible for the day-to-day operations of the experiment as well as interfacing with the collider operations.

Contributions to training

Graduate student Paul Constantin worked on the online monitoring for the PHENIX Beam-Beam Level-1 Trigger, as well as a Level-2 trigger for high-pt charged particles. He got a Ph.D. in 2004 and is now at Los Alamos National Laboratory. Heather Henneke and Steve Skutnik were both involved in the early hardware and prototype testing for the PHENIX Muon Identifier Local Level-1 trigger. Heather graduated with an M.S. in 2004 and is teaching junior high mathematics in Texas. Steve is completing his M.S. degree on a Level-1 related project to measure radiation-induced upsets in modern field programmable gate arrays.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1)

Ph. D. Students Supervised in Last 5 years: P. Constantin (LANL)

Postdoctoral Fellows Supervised in Last 5 Years: S. Belikov (BNL) and C. Vale (ISU)

My Ph. D. Thesis Advisor: J. Sandweiss (Yale University)

My Postdoctoral Advisor: J. Sandweiss (Yale University)

Total Ph.D. Students Supervised: 1

Total Postdoctoral Fellows Supervised: 2

Kenneth N. Barish

Department of Physics • University of California, Riverside
Riverside, CA 92521 USA
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Professional Preparation

University of California, Santa Cruz	Physics	B.A., 1989
Yale University	Physics	Ph.D., 1996
University of California, Los Angeles	Postgraduate Research Fellow	1996–1998

Appointments

University of California, Riverside	Associate Professor of Physics	2004-Present
University of California, Riverside	Assistant Professor of Physics	1998–2004
University of California, Los Angeles	Postgraduate Research Fellow	1996-1998

Five Publications Most Relevant to the Proposed Project

PHENIX collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al. “Double helicity asymmetry in inclusive mid-rapidity π^0 production for polarized p+p collisions at $s^{1/2}=200\text{-GeV}$ ”, *Phys. Rev. Lett.* **93**, 202002/(1-6) (2004).

PHENIX collaboration, S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al. “Mid-rapidity neutral pion production in p+p collisions at $s(\text{nn})^{1/2}=200\text{GeV}$ ”, *Phys. Rev. Lett.* **91**, 241803/(1-6) (2003).

K.N. Barish “Measuring ΔG in PHENIX using electrons to tag heavy-flavor production”, 15th International Spin Physics Symposium, Brookhaven National Laboratory, 9-14 September, 2002, *AIP Conf. Proc.* **675** 323-327 (2003).

K.N. Barish, R. Seto, W. Xie, et al “TEC/TRD for the PHENIX Experiment”, *Nucl. Instrum. Meth. A* **522** 56-61 (2004).

PHENIX collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al. “Suppressed π^0 production at large transverse momentum in central Au+Au collisions at $s(\text{nn})^{1/2}=200\text{ GeV}$ ”, *Phys. Rev. Lett.* **91**, 072301/(1-6) (2003).

Five Most Significant Publications

PHENIX Collaboration. K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al “Formation Of Dense Partonic Matter In Relativistic Nucleus-Nucleus Collisions At RHIC: Experimental Evaluation”, Oct 2004. 127pp. Submitted to *Nucl.Phys.A*

K.N. Barish, “Heavy ions in RHIC”, invited plenary talk, published in *Les Rencontres de Physique de la Vallée d'Aoste*, (Results and Perspectives in Particle Physics), La Thuile, Aosta Valley 3-9 March, 2002., editor M. Greco, Istituto Nazionale di Fisica Nucleare (INFN), 205-223 (2002)

K.N. Barish, “Heavy flavor physics in PHENIX”, invited plenary talk, published in Proceedings of the 18th Winter Workshop on Nuclear Dynamics., editors R. Bellwied, J. Harris and W. Bauer, EP Systema Bt., Debrecen (2002). (9pp).

Kenneth N. Barish, *continued*

K.N. Barish, "Recent results from PHENIX", published in Proceedings of the XXXI International Symposium on Multiparticle Dynamics, Datong, China 1-7 Sep 2001., editors B. Yuting et al., World Scientific, Hong Kong (2002) 139-144.

E864 Collaboration: T. A. Armstrong, K. Barish, J. Hill, J. Lajoie, J. Nagle, et al. "Search for charged strange quark matter produced in 11.5-A/GeV/c Au+Pb Collisions", *Phys. Rev. Lett.* **79**, 3612-3616 (1997).

Synergistic Activities

Convenor PHENIX spin physics working group
Institutional Board member, PHENIX collaboration
Physicist in charge of the PHENIX TEC Electronics, 1998-2001
Co-leader of PHENIX ERT Trigger, 2000-present
Quark Matter 2004, member organizing committee
International Symposium on Multiparticle Dynamics 2004, co-organizer
Strange Quark Matter 2006, member organizing committee

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1).

Ph. D. Students Supervised in Last 5 years: T. Hester (UCR), A. Morreale (UCR)

Postdoctoral Fellows Supervised in Last 5 Years: S. Bathe (UCR), F. Bauer (left physics), W. Emam (UCR), X.H. Li (UCR), B. Nandi (Indian Institute of Technology Bombay), W. Xie (RBRC)

My Ph. D. Thesis Advisor: J. Sandweiss (Yale University)

My Postdoctoral Advisor: H. Huang (University of California, Los Angeles)

Total Ph.D. Students Supervised: 2

Total Postdoctoral Fellows Supervised: 7

Richard K. Seto

Department of Physics • University of California, Riverside
Riverside, CA 92521 USA
951-827-5623; 951-827-5433 (fax); richard.seto@ucr.edu

Professional Preparation

Yale University	Physics	BS, 1976
Columbia University	Physics	Ph.D., 1983
Columbia University	Research Associate	1983-1985

Appointments

University of California, Riverside	Professor of Physics	2001–Present
University of California, Riverside	Associate Professor of Physics	1995–2001
University of California, Riverside	Assistant Professor of Physics	1990–1995
Columbia University	Assistant Professor of Physics	1985–1990

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Mid-rapidity neutral pion production in p+p collisions at $s(\text{nn})^{1/2}=200\text{GeV}$ ”, *Phys. Rev. Lett.* **91** 241803/(1-6) (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “J/psi production in Au+Au collisions at $s(\text{nn})^{1/2}=200\text{ GeV}$ at the relativistic heavy ion Collider”, to appear in *Phys. Rev. C*, accepted September 6, 2003 (11 pp).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Absence of suppression in particle production at large transverse momentum in $s(\text{nn})^{1/2}=200\text{ GeV}$ d+Au collisions”, *Phys. Rev. Lett.* **91**, 072303/(1-6) (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Suppressed pi-0 production at large transverse momentum in central Au+Au collisions at $s(\text{nn})^{1/2}=200\text{ GeV}$ ”, *Phys. Rev. Lett.* **91**, 072301/(1-6) (2003).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Formation Of Dense Partonic Matter In Relativistic Nucleus-Nucleus Collisions At RHIC: Experimental Evaluation By The Phenix Collaboration”, Oct 2004. 127pp. Submitted to *Nucl.Phys.A*

Five Other Significant Publications

Richard Seto (University of California, Riverside), “The First 3 Years At RHIC: An Overview.” Nov 2004. 16 pp. Presented at 34th International Symposium on Multiparticle Dynamics (ISMD 2004), Rohnert Park, California, 26 July - 1 August, 2004.

E917 Collaboration: B.B. Back, et al., “Production Of Phi Mesons In Au+Au Collisions At 11.7-A-GeV/c”, *Phys.Rev.C* **69**, 054901/(1-10) (2004).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al.,

Richard K. Seto, *continued*

“Centrality Dependence Of π^+ / π^- , K^+ / K^- , P And Anti-P Production From $S(Nn)^{1/2} = 13-17$ GeV Au+Au Collisions At RHIC”, *Phys.Rev.Lett.* **88**, 242301/(1-6) (2002).

E917 Collaboration: B. B. Back, R. R. Betts, J. Chang, W. C. Chang, C. Y. Chi, Y. Y. Chu, J. B. Cumming, J. C. Dunlop, W. Eldredge, S. Y. Fung, R. Ganz, E. Garcia, A. Gillitzer, G. Heinzelman, W. F. Henning, D. J. Hofman, B. Holzman, J. H. Kang, E. J. Kim, S. Y. Kim, D. McLeod, A. Mignerey, M. Moulson, V. Nanal, C. A. Ogilvie, R. Pak, A. Ruangma, D. E. Russ, R. K. Seto, P. J. Stankas, G. S. F. Stephans, H. Wang, F. L. H. Wolfs, A. H. Wuosmaa, H. Xiang, G. H. Xu, H. B. Yao, C. M. Zou, “Antilambda Production in Au+Au Collisions at 11.7A GeV/c”, *Phys. Rev. Lett.* **87**, 242301/(1-6) (2001).

L. Borodovsky, C. Y. Chi, N. Kondakis, W. Lee, B. Rubin, R. Seto, C. Stoughton, G. Tzanakos, B. Blumenfeld, L. Chichura, J. Krizmanic, E. Lincke, L. Lueking, W. Lyle, A. Pevsner, W.P. Hogan, E. O’Brien, K. Reardon, P. D. Sheldon, and G. W. Sullivan, “A Search for Muon Neutrino Oscillations in a Wide Band Neutrino Beam”, *Physical Rev. Lett.* **68**, 274-277 (1992).

Synergistic Activities

PHENIX Executive Council, 1997-present

Spokesman - Experiment E917, 1996-present

NSAC Long Range Plan Working Group 2000-2001

Nuclear Science Advisory Committee (NSAC) 2000-2002

Chair AGS Users Executive Committee, 2001-2003

American Physical Society, Division of Nuclear Physics Program Committee, 1998-2001

Convener - Low Mass Vector Meson Physics Group (PHENIX), 1998-2000

Collaborations and Other Affiliations

Collaborators in Last 48 months: PHENIX Collaboration (see Reference 1), E917 Collaboration (see reference 6)

Ph. D. Students Supervised in Last 5 years: Dmitri Kotchetkov (UCR), Munir Miniruzzamann (UCR), Hong Xiang (UCR), Zafar Yasin (UCR)

Postdoctoral Fellows Supervised in Last 5 Years: W. C. Chang (Institute of Physics - Academia Sinica, Taipei, Taiwan), Vasily Dzordzhadze (UCR)

Graduate Advisor

W. Lee (Columbia University)

Total Ph.D. Students Supervised: 6

Total Postdoctoral Fellows Supervised: 5

Rusty Shane Towell

Department of Physics • Abilene Christian University
ACU Box 27963, Abilene, TX 79699 USA
325-674-2034; 325-674-2146 (fax); *rusty.towell@acu.edu*

Professional Preparation

Abilene Christian University	Engineering Physics	BS, 1990
University of Texas, Austin	Physics	Ph.D., 1999

Appointments

Abilene Christian University	Assistant Professor of Physics	2001–Present
Los Alamos National Laboratory	Postdoctoral Research Associate	1999–2001
University of Texas at Austin	Research Assistant	1994–1999
Naval Nuclear Power School	Instructor	1990-1994
Abilene Christian University	Research Assistant	1988–1990

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “ J/ψ production from proton-proton collisions at $(s_{NN})^{1/2} = 200$ GeV,” *Phys. Rev. Lett.* **92**, 051802/(1-6) (2004).

Muon Arms Subsystem of PHENIX: K. Adcox, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, N. Saito, et al., “PHENIX Muon Arms,” *Nucl. Inst. Meth.* **A499**, p. 537-548 (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Absence of Suppression in Particle Production at Large Transverse Momentum in $(s_{NN})^{1/2} = 200$ GeV d+Au Collisions,” *Phys. Rev. Lett.* **91**, 072303/(1-6) (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Double Helicity Asymmetry in Inclusive Mid-Rapidity Neutral Pion Production for Polarized p+p Collisions at $(s_{NN})^{1/2} = 200$ GeV,” *Phys. Rev. Lett.* **92**, 202002/(1-6) (2004).

FNAL E866/NuSea Collaboration: M.J. Leitch, D. Isenhower, J.C. Peng, R. Towell, et al., “Measurement of Differences Between J/ψ and ψ' Suppression in p-A Collisions,” *Phys. Rev. Lett.* **84**, 3256-3260 (2000).

Five Most Significant Publications

FNAL E866/NuSea Collaboration: R.S. Towell, D. Isenhower, N. Makins, J.C. Peng, et al., “Improved Measurement of the $d\bar{u}/u\bar{d}$ Asymmetry in the Nucleon Sea,” *Phys. Rev. D* **64**, 052002/(1-7) (2001).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $(s_{NN})^{1/2} = 130$ GeV,” *Phys. Rev. Lett.* **88**, 022301/(1-6) (2002).

Rusty Shane Towell, *continued*

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Centrality Dependence of Charged Particle Multiplicity in Au+Au Collisions at $(s_{NN})^{1/2} = 130$ GeV,” *Phys. Rev. Lett.* **86**, 3500/(1-6) (2001).

FNAL E866/NuSea Collaboration: J.C. Peng, D. Isenhower, N. Makins, R. Towell, et al., “ $d\bar{b}ar/ubar$ Asymmetry and the Origin of the Nucleon Sea,” *Phys. Rev. D* **58**, 092004/(1-4) (1998).

FNAL E866/NuSea Collaboration: E.A. Hawker, D. Isenhower, N. Makins, J.C. Peng, R. Towell, et al., “Measurement of the Flavor Asymmetry in the Nucleon Sea,” *Phys. Rev. Lett.* **80**, 3715-3718 (1998).

Synergistic Activities

International collaboration and exchange: Collaborate with hundreds of international physicists on the PHENIX experiment. (1999–present)

Contributions to training: Supervised more than twenty undergraduate students who have worked on the PHENIX experiment. (1999–present).

Contributions to teaching and outreach: Taught physics courses for both majors and non-majors each semester. Have taught for the Upward program which is designed to prepare underrepresented high school students for college. Organized a weekly physics seminar at ACU.

Development of research tools: Data acquisition work and construction of hodoscopes for FNAL E866/NuSea. Supervised the construction of the muon tracking chambers for PHENIX.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration (see reference 1); FNAL E866/NuSea (see reference 3), FNAL E906(see reference 10)

Ph. D. Students Supervised in Last 5 years: none

Postdoctoral Fellows Supervised in Last 5 Years: none

My Ph. D. Thesis Advisor: Peter Riley (University of Texas at Austin), Donald Isenhower (Abilene Christian University)

My Postdoctoral Advisor: Patrick McGaughey (Los Alamos National Laboratory)

Total Ph.D. Students Supervised: 0

Total Postdoctoral Fellows Supervised: 0

Larry Donald Isenhower

Department of Physics • Abilene Christian University
ACU Box 27963, Abilene, TX 79699, USA
325-674-2165; 325-674-2146 (fax); isenhowe@acu.edu

Professional Preparation

Abilene Christian University	Physics	BS, 1981
Iowa State University	Physics	Ph.D., 1986

Appointments

Abilene Christian University	Professor and Physics Dept. Chairman	1999–Present
Brookhaven National Laboratory	Visiting Scientist	1998
Abilene Christian University	Associate Professor	1993–1999
Abilene Christian University	Assistant Professor	1986–1993
CERN	NSF/NATO Postdoctoral Fellowship	1990-1991
Los Alamos National Laboratory	AWU Summer fellowship (8 weeks)	1987
Ames Laboratory, Iowa State U.	Visiting Scientist (6 weeks)	1987

Five Publications Most Relevant to the Proposed Project

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “ J/ψ production from proton-proton collisions at $(s_{NN})^{1/2} = 200$ GeV,” *Phys. Rev. Lett.* **92**, 051802/(1-6) (2004).

Muon Arms Subsystem of PHENIX: K. Adcox, J. Hill, D. Isenhower, J. Lajoie, Y. Mao, J. Nagle, N. Saito, et al., “PHENIX Muon Arms,” *Nucl. Inst. Meth.* **A499**, p. 537-548 (2003).

PHENIX Collaboration: S.S. Adler, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Absence of Suppression in Particle Production at Large Transverse Momentum in $(s_{NN})^{1/2} = 200$ GeV d+Au Collisions,” *Phys. Rev. Lett.* **91**, 072303/(1-6) (2003).

FNAL E866/NuSea Collaboration: M.J. Leitch, D. Isenhower, J.C. Peng, R. Towell, et al., “Measurement of Differences Between J/ψ and ψ' Suppression in p-A Collisions,” *Phys. Rev. Lett.* **84**, 3256-3260 (2000).

FNAL E789 Collaboration: M.J. Leitch, D. Isenhower, J.C. Peng, et al., “Nuclear Dependence of Neutral D meson Production by 800-GeV/c Protons,” *Phys.Rev.Lett.* **72**:2542-2545 (1994).

Five Most Significant Publications

FNAL E866/NuSea Collaboration: R. Towell, L.D. Isenhower, N. Makins, J.C. Peng, et al., “Improved Measurement of the $d\bar{u}/u\bar{d}$ Asymmetry in the Nucleon Sea,” *Phys. Rev. D* **64**, 052002/(1-7) (2001).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al., “Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at $(s_{NN})^{1/2} = 130$ GeV,” *Phys. Rev. Lett.* **88**, 022301/(1-6) (2002).

PHENIX Collaboration: K. Adcox, K. Barish, C.Y. Chi, M. Grosse Perdekamp, J. Hill, D. Isenhower, E. Kinney, J. Lajoie, Y. Mao, J. Nagle, J.C. Peng, N. Saito, R. Seto, R. Towell, W. Xie, W. Zajc, et al.,

Larry D. Isenhower, *continued*

“Centrality Dependence of Charged Particle Multiplicity in Au+Au Collisions at $(s_{NN})^{*1/2} = 130$ GeV,” *Phys. Rev. Lett.* **86**, 3500-3505 (2001).

FNAL E866/NuSea Collaboration: J.C. Peng, D. Isenhower, N. Makins, R. Towell, et al., “ $d\bar{u}/u\bar{d}$ Asymmetry and the Origin of the Nucleon Sea,” *Phys. Rev. D* **58**, 092004/(1-4) (1998).

FNAL E866/NuSea Collaboration: E.A. Hawker, D. Isenhower, N. Makins, J.C. Peng, R. Towell, et al., “Measurement of the Flavor Asymmetry in the Nucleon Sea,” *Phys. Rev. Lett.* **80**, 3715-3718 (1998).

Synergistic Activities

International collaboration and exchange: Collaborate with many international physicists on the PHENIX experiment (2001–present). New Crystal Ball Collaboration at BNL’s AGS (1995-present). NATO Postdoctoral Fellowship to work at CERN on DELPHI experiment (1990-91); Split Field Magnet Collaboration at CERN ISR (1982-88).

Contributions to training: Supervised undergraduate students who have worked on experiments at LAMPF, Fermilab, PNPI (Russia), and BNL.

Contributions to teaching and outreach: Began teaching electronics/instrumentation/microprocessor labs as a sophomore at ACU. Have taught electronics/instrumentation courses/labs since returning to ACU as a professor. Primary person responsible for beginning a computational physics program at ACU, and have developed courses in simulation/modeling and pattern recognition. Teach non-majors astronomy course each semester. Served as Society of Physics Students/Sigma Pi Sigma chapters at ACU since 1987, who have done volunteer outreach to the community such as hosting open-house nights at ACU’s observatory, physics demonstrations, and other such activities.

Development of research tools: Began work on implementing microprocessor control of surface physics equipment, such as mass spectrometers for flash desorption experiments to make old equipment more capable, such as allowing single mass spectrometer to operate recording data for five masses rather than just one. Built various interface devices for surface physics equipment and worked on ultra high vacuum equipment. First worked on nuclear physics experiment as a junior on LAMPF E120 constructing a module to digitize and read out ionization chamber data. Since earning Ph.D. have monitored and assisted building hodoscopes, drift chambers, RICH detectors, and calorimeters for various experiments at LAMPF, Fermilab, CERN, PNPI, and BNL. Have developed labs for teaching students DAQ methods using GPIB, RS-232, VME, and CAMAC along with Labview software. Assisted in construction of the muon tracking chambers for PHENIX.

Collaborations

Collaborators in Last 48 months: PHENIX Collaboration 2001-present (see reference 1); BNL/AGS New Crystal Ball Collaboration E913/914/ff 1995-present (data taking completed 2002) (see reference 9); FNAL E866/NuSea, 1994-present (data taking completed 1997) (see reference 3); FNAL E906 (scheduled to run 2008-10) (see reference 10).

Ph. D. Students Supervised in Last 5 years: Rusty Towell (Abilene Christian University), jointly with Dr. Peter Riley (UT-Austin).

Postdoctoral Fellows Supervised in Last 5 Years: none

My Ph. D. Thesis Advisor: Dr. Alex Firestone (Iowa State)

My Postdoctoral Advisor: Not applicable for NATO Fellowship (research was completely independent)

Total Ph.D. Students Supervised: 2 (plus 2 M.S. students)

Total Postdoctoral Fellows Supervised: none

SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
		CAL	ACAD	SUMR			
1.	Matthias Perdekamp - PI	0.00	0.00	0.00	\$ 0	\$	
2.	Naomi C Makins - co-PI	0.00	0.00	0.00	0		
3.	Jen-Chieh Peng - co-PI	0.00	0.00	0.00	0		
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7.	(3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0		
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3.	(0) GRADUATE STUDENTS				0		
4.	(0) UNDERGRADUATE STUDENTS				0		
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6.	(0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)					0		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					0		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					0		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.) See Budget Justification				\$ 234,000			
TOTAL EQUIPMENT					234,000		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					0		
2. FOREIGN					0		
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____	0					
2.	TRAVEL _____	0					
3.	SUBSISTENCE _____	0					
4.	OTHER _____	0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS					0		
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES					0		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0		
3. CONSULTANT SERVICES					0		
4. COMPUTER SERVICES					0		
5. SUBAWARDS					0		
6. OTHER					0		
TOTAL OTHER DIRECT COSTS					0		
H. TOTAL DIRECT COSTS (A THROUGH G)					234,000		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) % of MTDC Base (Rate: 24.0000, Base: 0)							
TOTAL INDIRECT COSTS (F&A)					0		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					234,000		
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)					0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					\$ 234,000	\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 2

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
	CAL	ACAD	SUMR				
1. Matthias Perdekamp - PI	0.00	0.00	0.00	\$ 0		\$ 0	
2. Naomi C Makins - co-PI	0.00	0.00	0.00			0	
3. Jen-Chieh Peng - co-PI	0.00	0.00	0.00			0	
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00			0	
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00			0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00			0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00			0	
3. (0) GRADUATE STUDENTS						0	
4. (0) UNDERGRADUATE STUDENTS						0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0	
6. (0) OTHER						0	
TOTAL SALARIES AND WAGES (A + B)						0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.) See Budget Justification				\$ 253,000			
TOTAL EQUIPMENT						253,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						0	
2. FOREIGN						22,800	
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____			0				
2. TRAVEL _____			0				
3. SUBSISTENCE _____			0				
4. OTHER _____			0				
TOTAL NUMBER OF PARTICIPANTS (0)				TOTAL PARTICIPANT COSTS		0	
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES						0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0	
3. CONSULTANT SERVICES						0	
4. COMPUTER SERVICES						0	
5. SUBAWARDS						0	
6. OTHER						0	
TOTAL OTHER DIRECT COSTS						0	
H. TOTAL DIRECT COSTS (A THROUGH G)						275,800	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) % of MTDC Base (Rate: 24.0000, Base: 22800)							
TOTAL INDIRECT COSTS (F&A)						5,472	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						281,272	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)						0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$ 281,272		\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1.	Matthias Perdekamp - PI			0.00	0.00	0.00	\$ 0
2.	Naomi C Makins - co-PI			0.00	0.00	0.00	0
3.	Jen-Chieh Peng - co-PI			0.00	0.00	0.00	0
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(3) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.) See Budget Justification						\$ 175,400	
TOTAL EQUIPMENT							175,400
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							22,800
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____			0			
2.	TRAVEL _____			0			
3.	SUBSISTENCE _____			0			
4.	OTHER _____			0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							198,200
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) % of MTDC Base (Rate: 24.0000, Base: 22800)							
TOTAL INDIRECT COSTS (F&A)							5,472
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							203,672
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 203,672
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 4

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
	CAL	ACAD	SUMR				
1. Matthias Perdekamp - PI	0.00	0.00	0.00	\$ 0		\$ 0	
2. Naomi C Makins - co-PI	0.00	0.00	0.00	0			
3. Jen-Chieh Peng - co-PI	0.00	0.00	0.00	0			
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0			
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0			
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0			
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0			
3. (0) GRADUATE STUDENTS				0			
4. (0) UNDERGRADUATE STUDENTS				0			
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0			
6. (0) OTHER				0			
TOTAL SALARIES AND WAGES (A + B)						0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT						0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						0	
2. FOREIGN						22,800	
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____			0				
2. TRAVEL _____			0				
3. SUBSISTENCE _____			0				
4. OTHER _____			0				
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS						0	
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES						0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0	
3. CONSULTANT SERVICES						0	
4. COMPUTER SERVICES						0	
5. SUBAWARDS						0	
6. OTHER						0	
TOTAL OTHER DIRECT COSTS						0	
H. TOTAL DIRECT COSTS (A THROUGH G)						22,800	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) % of MTDC Base (Rate: 24.0000, Base: 22800)							
TOTAL INDIRECT COSTS (F&A)						5,472	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						28,272	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)						0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ 28,272 \$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 5

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted
				NSF Funded Person-months		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. Matthias Perdekamp - none				0.00	0.00	0.00
2. Naomi C Makins - none				0.00	0.00	0.00
3. Jen-Chieh Peng - none				0.00	0.00	0.00
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. () POST DOCTORAL ASSOCIATES						
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)						
3. () GRADUATE STUDENTS						
4. () UNDERGRADUATE STUDENTS						
5. () SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. () OTHER						
TOTAL SALARIES AND WAGES (A + B)						0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						
2. FOREIGN						
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____						
2. TRAVEL _____						
3. SUBSISTENCE _____						
4. OTHER _____						
TOTAL NUMBER OF PARTICIPANTS () TOTAL PARTICIPANT COSTS						0
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						
3. CONSULTANT SERVICES						
4. COMPUTER SERVICES						
5. SUBAWARDS						
6. OTHER						
TOTAL OTHER DIRECT COSTS						0
H. TOTAL DIRECT COSTS (A THROUGH G)						0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)						
TOTAL INDIRECT COSTS (F&A)						0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)						
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$		0 \$
M. COST SHARING PROPOSED LEVEL \$				AGREED LEVEL IF DIFFERENT \$		
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
		Date Checked	Date Of Rate Sheet	Initials - ORG		

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION University of Illinois at Urbana-Champaign				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Matthias Perdekamp				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1.	Matthias Perdekamp - PI			0.00	0.00	0.00	\$ 0
2.	Naomi C Makins - none			0.00	0.00	0.00	0
3.	Jen-Chieh Peng - none			0.00	0.00	0.00	0
4.							
5.							
6.	() OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(3) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
				\$	662,400		
TOTAL EQUIPMENT							662,400
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							68,400
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____						0
2.	TRAVEL _____						0
3.	SUBSISTENCE _____						0
4.	OTHER _____						0
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							730,800
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							16,416
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							747,216
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 747,216 \$
M. COST SHARING PROPOSED LEVEL \$ 0 AGREED LEVEL IF DIFFERENT \$							
PI/PD NAME Matthias Perdekamp				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Section 6. Budget Justification

The proposed Fast Muon Trigger for W-bosons, in combination with the PHENIX detector and the colliding polarized proton beams developed at Brookhaven National Laboratory, give rise to a truly novel scientific technique for the study of proton sub-structure: the observation of W-bosons in polarized proton-proton collisions. The scientific goal of the proposed instrumentation is the precise measurement of the flavor structure of the quark and anti-quark polarizations in the proton.

The proposed physics program has been strongly endorsed in a recent review of the RHIC physics program by the NSF-DOE Nuclear Science Advisory Committee¹. The Executive- and Detector-Councils of the PHENIX collaboration have evaluated the scientific merits and the technical feasibility of the proposed trigger. As a result, the PHENIX collaboration strongly endorses the proposed W-boson trigger and has pledged the support needed for the integration of the instrument into the PHENIX detector. As documented in section 9 of this proposal, this support includes (a) laboratory space for R&D and detector assembly at BNL, (b) project engineering support, (c) technician labor for detector integration including the gas system, (d) hardware for the mechanical installation, and (e) hardware for the system integration into the PHENIX data acquisition system². The budget for this project takes into account the PHENIX contributions for the integration of the proposed instrument into the PHENIX apparatus.

The project will be carried out by a consortium of four universities under the leadership of the University of Illinois (UIUC): Abilene Christian University (ACU), Iowa State University (ISU), University of California at Riverside (UCR) and UIUC. All four groups have base grants for their work in PHENIX and do not require NSF support for personnel or travel (except for the support of significant undergraduate student labor for detector assembly and electronics testing at ACU). Project and management responsibilities which require support from the NSF are distributed among the four member institutions of the NSF consortium:

- UIUC - Overall project management
 - RPC development and construction
 - Development of front-end electronics and prototypes
 - Design and construction of the RPC gas system
- UCR - Mass production and Integration of the Front-End Electronics
- ISU - Development of the Local Level 1 trigger processor (LL1)
 - Production of the LL1 trigger processors
- ACU - High voltage system
 - Assembly of RPC modules into detector stations at BNL
 - Quality assurance for the front-end electronics

Other members of the collaboration—Colorado University, Kyoto University, Nevis Laboratory/Columbia University, Peking University and the RIKEN BNL Research Center—are not part of the NSF-MRI consortium but have pledged support for the collaborating senior personnel from these institutions³.

In this section, we discuss the budget required in support of the project responsibilities at UIUC: in total, funds of \$747,216 are requested from the NSF. Separate budgets and budget justifications are also provided for the other three member universities. Section numbers used below correspond to the line items used on NSF form 1030.

A. Senior Personnel

No funds are requested from the NSF for the PI or the two Co-PIs on this project.

B. Other Personnel

No funds are requested from the NSF for students (graduate and undergraduate) or postdoctoral fellows.

C. Fringe Benefits

No fringe benefits are requested from the NSF.

D. Equipment

Funds of \$662,400 are requested for equipment in context of the UIUC responsibilities in the W-trigger project:

(I) Gas system for RPCs, \$50,000:

The design work for the gas system will be carried out by PHENIX project engineering. PHENIX technicians will also work on the assembly and installation of the gas system at BNL. This work is part of the PHENIX contribution to detector integration. At UIUC, John Blackburn will assist with design drawings. The acquisition of the necessary equipment is UIUC responsibility and will be carried out by John Blackburn and Erik Thorsland. Both are technicians supported by the NPL NSF grant at UIUC. The cost estimate for the gas system has been made by PHENIX project engineering and is based on the cost of the gas system for the muon tracker system in PHENIX; the muon tracker wire chambers are of similar volume and in similar location. The cost also takes into account the BNL safety requirements for flammable and oxygen deficient gas systems. The gas system for the RPCs in each muon spectrometer will require \$25,000. The gas system for the south arm will be built in year 2 and for the north arm in year 3.

(II) RPC development and construction, \$300,400:

The cost of the RPC laboratory and R&D at UIUC is covered through the NPL NSF grant and institutional contributions from UIUC (startup funds for Prof. Grosse-Perdekamp). This includes support for the RPC detector modules in a new luminosity monitor for PHENIX, which will serve as a test bed in PHENIX for CMS RPC technology in the early stages of the project. Technician support for the RPC laboratory and R&D at UIUC (Eric Thorsland and John Blackburn) is covered by the NPL NSF grant.

The RPC modules will be purchased by UIUC from Peking University. The cost estimate for the RPC modules is based on the cost for the double gap RPCs used in the CMS muon trigger, which were built with strong PKU participation. The costs for these RPC modules are \$650/module for station I and \$7800/module in stations II and III. The project requires 16 modules + 2 spares for each station. As documented in section 9 of this proposal, PKU will contribute the support of PKU scientific personnel involved in the production of the modules.

The assembly and integration of the RPC modules into detector stations will be carried out with support from PHENIX, see section 9. In addition, \$7,900 will be required for the development of cathode planes at UIUC having sufficient granularity for the PHENIX trigger application. The production of the PHENIX specific cathode planes is covered through an institutional contribution from the UIUC physics department (see section 9).

(III) Development and production of prototype front-end electronic boards, \$312,000:

The design work for the Amplifier-Discriminator Cards and the Front-End Modules (FEMs) will be carried out by the electronics group at Nevis Laboratory. Nevis engineers have custom-designed and build the front-end electronics for two major detector systems in PHENIX: the time-of-flight system (TOF) and the beam-beam-counters (BBC). Cost estimates have been provided by Cheng-Yi Chi from Nevis and are based on the previous experience at Nevis with PHENIX front-end electronics. The cost estimate includes the production of 500 channels of prototype Amplifier-Discriminator Cards and Front-End Modules. The engineering and design work for the Amplifier-Discriminator Card is estimated to cost \$115,000. The Amplifier-Discriminator Card will be based on the existing CMS ASIC chip. For the Front-End Modules the estimate is \$175,000. The prototyping and production of 500 channels of both cards will cost \$22,000. The prototype electronics will be needed for RPC R&D and test efforts at UIUC, PKU and BNL. In particular, they will be used to outfit a small dedicated RPC-based detector for luminosity monitoring in PHENIX. This detector will serve as an early test bed for CMS RPC technology in PHENIX.

E. Travel

We request \$68,400 in travel funds for this project. The requested support covers housing and per diem at Brookhaven National Laboratory for two scientists from Peking University to spend 50% of their time at BNL over a period of three years: September 2006 to August 2009. We have used typical rates for PHENIX support for collaborators from China and Russia: \$27/day for a dormitory room and \$1090/month for per diem and a contribution to the required health insurance, for 180 days each year.

The two scientists from PKU are experts on the RPC technology developed at PKU for experiments at CERN. They will significantly contribute to R&D, construction, assembly, installation and initial operation of the new muon trigger in PHENIX. We believe that the existing expertise on RPC technology at PKU will be critical input to our goal to provide the new instrument on time and fully operational for the RHIC run in 2009.

Travel support for UIUC personnel—three faculty, two to three postdoctoral fellows and two to four graduate students—will be covered by the existing NPL NSF grant.

G. Other Direct Costs

No other direct costs are requested from the NSF.

I. Indirect Costs

Indirect costs of \$16,416 are requested. These charges are calculated on the requested travel support for our collaborators from Peking University at Brookhaven National Laboratory. The modest off-campus rate of 24% is applicable.

¹ See <http://www.sc.doe.gov/production/henp/np/nsac.html>.

² See letters from PHENIX project management and the PHENIX director of operation in Section 9 (Supplementary Documents).

³ See letters from Colorado, Kyoto, Nevis, PKU and RBRC in Section 9 (Supplementary Documents).

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. John C Hill - PI				0.00	0.00	0.00	\$ 0 \$
2. John Lajoie - co-PI				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
Level-1 Trigger				\$	77,990		
TOTAL EQUIPMENT							77,990
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							77,990
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							77,990
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 77,990 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 2

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. John C Hill - PI				0.00	0.00	0.00	\$ 0
2. John Lajoie - co-PI				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
Local Level-1 Trigger				\$	82,800		
TOTAL EQUIPMENT							82,800
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							82,800
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							82,800
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 82,800 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1.	John C Hill - PI			0.00	0.00	0.00	\$ 0
2.	John Lajoie - co-PI			0.00	0.00	0.00	0
3.							
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(2) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
	Local Level-1 Trigger			\$		67,310	
TOTAL EQUIPMENT							67,310
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____						0
2.	TRAVEL _____						0
3.	SUBSISTENCE _____						0
4.	OTHER _____						0
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							67,310
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							67,310
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 67,310
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 4

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. John C Hill - PI				0.00	0.00	0.00	\$ 0 \$
2. John Lajoie - co-PI				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ 0							
2. TRAVEL _____ 0							
3. SUBSISTENCE _____ 0							
4. OTHER _____ 0							
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 5

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1.	John C Hill - PI			0.00	0.00	0.00	\$ 0
2.	John Lajoie - co-PI			0.00	0.00	0.00	0
3.							
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(2) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____			0			
2.	TRAVEL _____			0			
3.	SUBSISTENCE _____			0			
4.	OTHER _____			0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							20,000
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							20,000
H. TOTAL DIRECT COSTS (A THROUGH G)							20,000
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) consultant services (Rate: 26.0000, Base: 20000)							
TOTAL INDIRECT COSTS (F&A)							5,200
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							25,200
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 25,200
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION Iowa State University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR John C Hill				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. John C Hill - PI				0.00	0.00	0.00	\$ 0
2. John Lajoie - co-PI				0.00	0.00	0.00	0
3.							
4.							
5.							
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
				\$	228,100		
TOTAL EQUIPMENT							228,100
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							20,000
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							20,000
H. TOTAL DIRECT COSTS (A THROUGH G)							248,100
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							5,200
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							253,300
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 253,300 \$
M. COST SHARING PROPOSED LEVEL \$ 0 AGREED LEVEL IF DIFFERENT \$							
PI/PD NAME John C Hill				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Section F. Budget Justification

The Fast Muon Trigger for study of W-bosons described in this proposal will be carried out by a consortium of four Universities under the leadership of the University of Illinois. The other three are Iowa State University (ISU), University of California at Riverside and Abilene Christian University. ISU has the responsibility for the development and production of the Local Level-1 Trigger processors. The base grant of the ISU group will support our work at PHENIX so we do not require funds for personnel or travel. In addition the ISU administration has committed a total of \$50,000 to support this project (see section 9).

An itemized budget for each year of the five-year proposed project and a cumulative budget are presented. A total of \$253,300 for the ISU sub-award is requested from the National Science Foundation (NSF) for the five years of this project. In this section, we provide detailed justification for each line item for Years 1, 2, 3, and 5. No funds are requested for year 4. Section headings used below correspond to the respective sections of Form 1030.

A. Senior Personnel

No funds are requested for senior personnel. Summer salaries for the PI and co-PI will be supplied by their Department of Energy base grant.

B. Other Personnel

No funds are requested for other personnel.

C. Fringe Benefits

No fringe benefits are requested.

D. Equipment

Funds totaling \$228,100 are requested for equipment to fulfill the ISU responsibilities in the Fast Muon Trigger project.

Funds are requested to build a prototype and the final Local Level-1 Trigger system for both the PHENIX north and south muon arms. The trigger in the south muon arm will be built and installed in year 2 and the trigger in the north muon arm will be built and installed in year 3. We request \$77,990 for the first year, \$82,800 for the second year and \$67,310 for the third year. This includes funds for both engineering and parts. A total of 6 boards (one prototype and five regular) will be produced. The engineering will be carried out at the Electronics Design Center in the Physics Department at ISU. The availability of the Design Center to carry out this project is covered in a letter from the ISU Provost, see section 9. The rate at the Design Center for engineering is \$65/hour. The above cost estimates are based on the experience of Profs. Lajoie and Hill and engineer Gary Sleege in building the Level-1 Trigger system for the PHENIX detector and the Local Level-1 Trigger for the PHENIX muon arms. A significant cost is due to parts and fabrication and the major cost items are listed below:

Optical GLINK receivers and Agilent transceivers	\$27,000
FPGA programmable logic (Xilinx, Virtex)	\$72,000
Other electronic parts	\$4,200
Fabrication of boards	\$12,000
Population of boards	\$12,000
Transceiver card and backplanes	\$11,000
VME crate and controller	\$4,500

E. Travel

Funds for travel of the PI, the co-PI, and ISU students and postdoctoral fellows will be supplied by the ISU base grant for the duration of this project.

G. Other Direct Costs

Consultant Services

A total of \$20,000 for consultant services is requested. These funds will be used in year 5 for algorithm development. This will be necessary after we get the first results from taking data using the Local Level-1 trigger in years 3 and 4. The consulting will be done with engineers at the Electronics Design Center in the Physics Department at ISU. The hourly rate at the center is about \$65/hour.

I. Indirect Costs

In year 5 a total of \$5,200 is requested for ISU overhead associated with the consultant services listed above. ISU applies an off-site overhead rate of 26%.

SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION University of California-Riverside				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Kenneth N Barish				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Kenneth N Barish - Associate Professor				0.00	0.00	0.00	\$ 0 \$
2. Richard K Seto - Professor				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ 0							
2. TRAVEL _____ 0							
3. SUBSISTENCE _____ 0							
4. OTHER _____ 0							
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Kenneth N Barish				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 2

ORGANIZATION University of California-Riverside				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Kenneth N Barish				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Kenneth N Barish - Associate Professor				0.00	0.00	0.00	\$ 0 \$
2. Richard K Seto - Professor				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
Production for amp/disc-board				\$	125,100		
Production of FPGA board					187,875		
TOTAL EQUIPMENT							312,975
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							312,975
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							312,975
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 312,975 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Kenneth N Barish				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION University of California-Riverside				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Kenneth N Barish				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Kenneth N Barish - Associate Professor				0.00	0.00	0.00	\$ 0
2. Richard K Seto - Professor				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
Production for ampd/disc-board				\$	208,500		
Production of FPGA board					313,125		
TOTAL EQUIPMENT							521,625
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							521,625
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							521,625
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 521,625
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME Kenneth N Barish				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 4

ORGANIZATION University of California-Riverside				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Kenneth N Barish				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. Kenneth N Barish - none				0.00	0.00	0.00	\$ 0 \$
2. Richard K Seto - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. () POST DOCTORAL ASSOCIATES							
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)							
3. () GRADUATE STUDENTS							
4. () UNDERGRADUATE STUDENTS							
5. () SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							
6. () OTHER							
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							
2. FOREIGN							
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____							
2. TRAVEL _____							
3. SUBSISTENCE _____							
4. OTHER _____							
TOTAL NUMBER OF PARTICIPANTS () TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							
3. CONSULTANT SERVICES							
4. COMPUTER SERVICES							
5. SUBAWARDS							
6. OTHER							
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Kenneth N Barish				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION University of California-Riverside				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Kenneth N Barish				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Kenneth N Barish - none				0.00	0.00	0.00	\$ 0
2. Richard K Seto - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
				\$	834,600		
TOTAL EQUIPMENT							834,600
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0)							
TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							834,600
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							834,600
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 834,600
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Kenneth N Barish				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Section F. Budget Justification

The proposed Fast Muon Trigger for W-bosons makes possible precise measurement of the flavor structure of the quark and anti-quark polarizations in the proton. The hardware will be added to the PHENIX detector to fully utilize high-luminosity high-polarization colliding polarized proton beams at Brookhaven National Laboratory's RHIC accelerator.

The project will be carried out by a consortium of four universities: the University of California at Riverside (UCR), the University of Illinois at Urbana (UIUC), Abilene Christian University (ACU), and Iowa State University (ISU). Project and management responsibilities which require support from the NSF are distributed among the four member institutions of the NSF consortium. In this section, we discuss the budget required in support of the project responsibilities at UC Riverside for the mass production of the Front-End Electronics boards. UC Riverside has a base grant with DOE for work in PHENIX and does not require NSF support for personnel or travel.

An itemized budget for each year of the five-year proposed project and a cumulative budget are presented on NSF Forms 1030. A total of \$834,600 is requested from the National Science Foundation (NSF); \$312,975 for the first year of this project and \$521,625 for the second year of the project. In this section, we provide detailed justification for each line item. Section headings used below correspond to the line items used on NSF form 1030.

A. Senior Personnel

No funds are requested from NSF for the PI or the Co-PI on this project.

B. Other Personnel

No funds are requested from NSF for other personnel on this project.

C. Fringe Benefits

No fringe benefits are requested as no personnel are requested on this project.

D. Equipment

Funds of \$834,600 are requested for equipment necessary to fulfill the UC Riverside responsibilities in the W-trigger project. In the following paragraphs, we outline the UC Riverside instrument responsibilities and provide details of how costs were determined for the hardware portion of this request. UC Riverside is responsible for the mass production of the front-end electronics boards. The front-end electronics consists of two different boards: the amplifier/discriminator board and the FPGA board. The equipment will be delivered directly to Brookhaven National Laboratory located in Upton, New York.

The design work for the Amplifier-Discriminator Cards and the Front-End Modules (FEMs) will be managed by the University of Illinois, and the design will be done by electronics group at Nevis Laboratory. Nevis engineers have vast experience with electronics for PHENIX, since they have custom-designed and built the Front-End Electronics (FEE) for two major detector systems in PHENIX: the Time-of-Flight system (TOF) and the Beam-Beam Counters (BBC).

The Amplifier-Discriminator Cards read out the signals directly from the RPC's, and provide early discrimination plus amplification of the signal to be sent to the FEM. There are 38,568 channels to be read-out, and it is estimated to cost \$333,600. The cost includes purchase of all required parts as well as assembly of the Amplifier-Discriminator

Card. We plan to use the same custom ASIC developed for the CMS detector at CERN, so the cost is based on the actual cost of similar electronics.

The Front-End Modules process the signals from the Amplifier-Discriminator board and send them to our Data-Acquisition system (DAQ). The 38,568 channels to be processed are estimated to cost \$501,000. This cost estimate has been provided by Cheng-Yi Chi from Nevis and are based on previous experience at Nevis with building the BBC and TOF Front-End Electronics for PHENIX. The cost includes all parts, boards, and assembly of the Front-End Modules.

The Quality Assurance for these boards will be performed by ACU. Integration into PHENIX (electronics racks, low voltage supplies, and cooling) has been pledged by PHENIX (see section 9), so no funds are requested for these tasks.

E. Travel

No travel funds are requested for this project. Required travel to BNL by the PI and Co-PI will be supported by the existing UC Riverside DOE Nuclear Spin Physics grant.

G. Other Direct Costs

No other direct costs are requested for this project.

I. Indirect Costs

No indirect costs are required for this project.

SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. Rusty Towell - none				0.00	0.00	0.00	\$ 0 \$
2. Larry D Isenhower - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (2) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ 0							
2. TRAVEL _____ 0							
3. SUBSISTENCE _____ 0							
4. OTHER _____ 0							
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 2

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1.	Rusty Towell - none			0.00	0.00	0.00	\$ 0
2.	Larry D Isenhowe - none			0.00	0.00	0.00	0
3.							
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(2) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(8) UNDERGRADUATE STUDENTS						37,874
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							37,874
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							37,874
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
	10 A1526 Modules		\$ 57,610				
	120 CME connectors and 1200 m cable		6,240				
	SY 1527 High Voltage Mainframe		14,112				
	Others (See Budget Comments Page...)		10,000				
TOTAL EQUIPMENT							87,962
E. TRAVEL							
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____		0				
2.	TRAVEL _____		0				
3.	SUBSISTENCE _____		0				
4.	OTHER _____		0				
TOTAL NUMBER OF PARTICIPANTS (0)							
TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							125,836
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							125,836
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 125,836
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

**** D- Equipment**

Test stand for amp/disc boards (Amount: \$ 5000)

Test stand for fpga boards (Amount: \$ 5000)

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1.	Rusty Towell - none			0.00	0.00	0.00	\$ 0
2.	Larry D Isenhower - none			0.00	0.00	0.00	0
3.							
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(2) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL ASSOCIATES			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(8) UNDERGRADUATE STUDENTS						37,874
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							37,874
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							37,874
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS \$ _____			0			
2.	TRAVEL _____			0			
3.	SUBSISTENCE _____			0			
4.	OTHER _____			0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							37,874
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							37,874
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 37,874 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 4

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
				CAL	ACAD	SUMR	
1. Rusty Towell - none				0.00	0.00	0.00	\$ 0 \$
2. Larry D Isenhower - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____ 0							
2. TRAVEL _____ 0							
3. SUBSISTENCE _____ 0							
4. OTHER _____ 0							
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 5

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Rusty Towell - none				0.00	0.00	0.00	\$ 0 \$
2. Larry D Isenhower - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. () POST DOCTORAL ASSOCIATES							
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)							
3. () GRADUATE STUDENTS							
4. () UNDERGRADUATE STUDENTS							
5. () SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							
6. () OTHER							
TOTAL SALARIES AND WAGES (A + B)							0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							0
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							
2. FOREIGN							
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____							
2. TRAVEL _____							
3. SUBSISTENCE _____							
4. OTHER _____							
TOTAL NUMBER OF PARTICIPANTS () TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							
3. CONSULTANT SERVICES							
4. COMPUTER SERVICES							
5. SUBAWARDS							
6. OTHER							
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							0
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							0
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 0 \$
M. COST SHARING PROPOSED LEVEL \$				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION Abilene Christian University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Rusty Towell				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Rusty Towell - none				0.00	0.00	0.00	\$ 0 \$
2. Larry D Isenhowser - none				0.00	0.00	0.00	0
3.							
4.							
5.							
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00	0
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL ASSOCIATES				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (18) UNDERGRADUATE STUDENTS							75,748
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							75,748
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							75,748
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
				\$	87,962		
TOTAL EQUIPMENT							87,962
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							163,710
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							163,710
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 163,710 \$
M. COST SHARING PROPOSED LEVEL \$ 0 AGREED LEVEL IF DIFFERENT \$							
PI/PD NAME Rusty Towell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked		Date Of Rate Sheet		Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Section F. Budget Justification

The Fast Muon Trigger for W-bosons project proposes a novel new technique – the measurement of W-bosons in polarized proton-proton interactions – to determine the flavor structure of the quark and anti-quark polarizations in the proton. This W-boson trigger will be based on Resistive Plate Chamber (RPC) technology and will be utilized along with the existing PHENIX detector to leverage the capabilities of both. The trigger is especially timely considering the high-luminosity and high-polarization colliding proton beams that are expected at RHIC.

The project will be carried out by a consortium of four universities: Abilene Christian University (ACU), the University of Illinois at Urbana-Champaign (UIUC), the University of California at Riverside (UCR), and Iowa State University (ISU). UIUC has overall management responsibility, and ACU has project responsibility for the following tasks:

1. Installation of High Voltage System.
2. Quality assurance for the Front-End Electronics.
3. Assembly of RPC modules into detector stations at BNL.

An itemized budget for each year of the five-year proposed project and a cumulative budget are presented in NSF Form 1030. A total of \$163,710 is requested from the National Science Foundation (NSF). The detailed justifications for each expense are given below; the section headings correspond to the sections in NSF Form 1030.

A. Senior Personnel

No funds are requested from NSF for the PI on this project.

B. Other Personnel

During the second and third years of this grant, funds are requested for eight undergraduate students (full time for 2 months). These students will provide a large fraction of the manpower for the assembly of individual RPC modules into full detector stations. The requested \$36,002 per summer is based on the following costs:

Compensation (8 students * 2 months * \$1400/month)	=	\$22,400
Travel allowance to BNL (\$500/student)	=	\$4000
Summer housing at BNL (\$1665/month)	=	\$3330
FICA (8% of compensation)	=	\$1792
University overhead on compensation (20%)	=	\$4480
Total cost	=	\$36,002

Funds are also requested to support two undergraduate students for Quality Assurance of the Front-End Electronics using test stands at ACU. This cost will be spread over years two and three, corresponding to the years UCR will mass produce the electronics. The \$3744 cost is based on an estimated 480 hours of labor at \$6.50/hour plus the 20% university required overhead.

C. Fringe Benefits

Fringe benefits have been included in the cost estimate in part B above and were calculated in accordance with University requirements at ACU.

D. Equipment

Funds are requested for the Front-End Electronics test stands. There will be two test stands, one for the Preamplifier-Discriminator Cards and the other for the Front-End Modules. Cost estimates are \$5000 per test stand, and are based on previous experience with building test stands for the PHENIX Muon Tracker FEE. Funds are also requested to purchase the high voltage supplies for the RPC's. The high voltage supplies will be bought from commercial vendors and the estimated cost is a quote from the vendor. The total estimated cost for the high voltage modules, mainframes, connectors, and cables is \$77,962. Technician support for racks, installation, and cable assembly has been pledged by PHENIX (see section 9).

E. Travel

No funds are requested for travel other than the travel allowance for undergraduate students to travel to BNL from Abilene, Texas. This cost was included in part B. Funds for travel of the PI are covered by the ACU base grant for the duration of this project.

G. Other Direct Costs

No funds are requested.

I. Indirect Costs

No funds are requested except those included in part B above.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Cheng-Yi Chi	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton (THIS PROPOSAL) Source of Support: National Science Foundation Total Award Amount: \$ 747,216 Total Award Period Covered: 09/01/05 - 08/31/10 Location of Project: University of Illinois at Urbana-Champaign Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 1.00 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Wei Xie	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton (THIS PROPOSAL) Source of Support: National Science Foundation Total Award Amount: \$ 747,216 Total Award Period Covered: 09/01/05 - 08/31/10 Location of Project: University of Illinois at Urbana-Champaign Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 1.00 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Kenneth Barish	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Spin Physics with PHENIX at RHIC (one of two co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 117,000 Total Award Period Covered: 07/01/04 - 06/30/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: 2004 International Symposium on Multiple Dynamics (one of three co-PIs)	
Source of Support: National Science Foundation Total Award Amount: \$ 5,000 Total Award Period Covered: 05/01/04 - 03/31/05 Location of Project: University of California, Riverside, Sonoma State University Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.45 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: DPF 2004 (one of 12 co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 35,000 Total Award Period Covered: 03/15/04 - 03/14/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.45 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Spin Physics with PHENIX at RHIC (one of two co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 282,000 Total Award Period Covered: 07/01/05 - 06/30/07 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Central Collisions of Heavy Ions	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 440,000 Total Award Period Covered: 01/01/05 - 12/31/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Summ: 0.00	
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.	

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Richard Seto	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Spin Physics with PHENIX at RHIC (one of two co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 117,000 Total Award Period Covered: 07/01/04 - 06/30/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: DPF-2004 (one of 12 co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 35,000 Total Award Period Covered: 03/15/04 - 03/14/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.45 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Spin Physics with PHENIX at RHIC (one of two co-PIs)	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 282,000 Total Award Period Covered: 07/01/05 - 06/30/07 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Central Collisions of Heavy Ions	
Source of Support: U.S. Department of Energy Total Award Amount: \$ 440,000 Total Award Period Covered: 01/01/05 - 12/31/05 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton (This Proposal)	
Source of Support: National Science Foundation Total Award Amount: \$ 830,000 Total Award Period Covered: 09/01/05 - 08/31/09 Location of Project: University of California at Riverside Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.90 Summ: 0.00	
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.	

Section 9. Supplementary Documents

As called for in the program announcement, in this section we provide a statement classifying the submitting organizations as to their degree-granting status. We also include in this section letters of support and intent from PHENIX managers and directors and from administrators of the participating universities.

1. Classification of participating organizations, per NSF 05-515
2. Letter from A. Drees, PHENIX upgrades manager, W.A. Zajc, PHENIX spokesperson, and E.J. O'Brien, PHENIX director of operations
3. Letter of commitment of project support from Edward J. O'Brien, PHENIX director of operations
4. Letter of commitment from the Department of Physics, University of Illinois at Urbana-Champaign (lead institution)
5. Letter of support from the Vice Provost for Research, Iowa State University
6. Letter of support from the principal investigator, University of California, Riverside
7. Letter of support, University of California, Riverside, Assistant Dean Carlson
8. Letter of support, University of California, Riverside, Vice Chancellor for Research
9. Letter of support, University of California, Riverside, Director, CAAPP
10. Letter of support from the principal investigators, Abilene Christian University
11. Letter of intent from Nevis Laboratory
12. Letter of intent from the senior personnel at the University of Colorado
13. Letter of support from the RIKEN BNL Research Center
14. Letter of support from Kyoto University
15. Letter of intent from Peking University

Degree-Granting Status of Organizations Participating in this Proposal

Four U.S. universities have partnered to submit this proposal to the National Science Foundation in response to NSF 05-515, Major Research Instrumentation Program. They are the University of Illinois at Urbana-Champaign (lead institution), Abilene Christian University, Iowa State University, and the University of California, Riverside. Support is requested from the NSF for only these four institutions. However, non-co-PI senior personnel from other institutions, for whom biosketches (Section 5) and current and pending support (Section 7) are provided in the corresponding sections of this proposal, will also contribute to the instrument development described in the project description (Section 3). We thus include the degree-granting status of those institutions in the summary table presented below. It should be emphasized that these institutions, which are indicated by an asterisk, are not subawardees and will receive no support on this MRI grant from the NSF.

Table 9.1 Degree-Granting Status of Organizations Participating in this MRI Proposal

Name of Institution	Degree-granting Status	Support from NSF
University of Illinois at Urbana-Champaign	PhD-granting	Yes
Abilene Christian University	non-PhD-granting	Yes
Iowa State University	PhD-granting	Yes
University of California, Riverside	PhD-granting	Yes
*Nevis Laboratory, Columbia University	PhD-granting	No
*University of Colorado, Boulder	PhD-granting	No
*RIKEN BNL Research Center	non-degree granting	No
*Kyoto University (Japan)	PhD-granting	No
*Peking University (China)	PhD-granting	No



PHENIX Office
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631 344-8594
Fax 631 344-3253

The National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

To whom it may concern:

We are writing on behalf of the PHENIX collaboration at Brookhaven National Laboratory in strong support of the Major Research Initiative proposal, "Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton". The proposal is a collaborative effort of four University groups in PHENIX under the leadership of Professors Grosse Perdekamp, Makins and Peng at the University of Illinois in Urbana Champaign.

As you may know, the PHENIX Experiment is an international collaboration of over 400 scientists and engineers from 59 institutions in 13 nations. The experiment explores the nature of matter found in the first microseconds after the Big Bang and measures the fundamental structure of the proton, using beams of very high energy nuclei and protons provided by BNL's Relativistic Heavy Ion Collider (RHIC). Since beginning operation in the summer of the year 2000, the experiment has published 25 papers in the refereed literature that have accumulated in excess of 1500 citations.

The scientific goal of the proposed muon trigger is a precision measurement of the individual quark and anti-quark flavor contributions to the proton spin as function of the quark momentum in the proton by exploiting the parity violating nature of the weak interaction. The proposed experimental method is new and far superior to past efforts to measure the flavor structure of quark polarization in the proton at SLAC, CERN and DESY. The proposed measurement is not possible without the new muon trigger and will dramatically expand our knowledge of the spin structure of the proton.

The muon trigger upgrade project has been reviewed and approved by both the PHENIX Executive and Detector councils in the spring of 2004. Subsequently, the sub-committee for RHIC physics of the Nuclear Science Advisory Committee (NSAC) has reviewed the proposed muon trigger for W-physics and has strongly endorsed the upgrade and its physics goals in its report from October 7th, 2004 to NSAC.

The new instrument will be developed by a consortium of four university groups: Abilene Christian University, University of California at Riverside, Iowa State University and University of Illinois at Urbana with additional collaborators from University of Colorado at Boulder, Kyoto University, Nevis Laboratory, Peking University and the RIKEN BNL Research Center. The group of collaborators has significant technical expertise with the hardware and electronics used in the PHENIX detector and is highly qualified to carry out the proposed work. PHENIX and BNL have pledged the engineering, technician and hardware support required for the integration of the new instrument into PHENIX.

In PHENIX we have at the present time more than 80 graduate students from the various participating institutions. In addition to the outstanding scientific merit of the proposed upgrade, the new W boson-trigger will present exciting research and educational opportunities to a significant fraction of these



students. The project plan anticipates contributions from a large number (eight students each during two summers) of undergraduate students from ACU to the assembly of the required trigger detectors and the testing of the front end electronics.

Sincerely,

A handwritten signature in black ink that reads "A. Drees".

Prof. Dr. A. Drees
PHENIX Upgrades Manager
Stony Brook University, Stony Brook, NY 11794-3800

A handwritten signature in blue ink that reads "W.A. Zajc".

W.A. Zajc
Professor of Physics, Columbia University
PHENIX Spokesperson

A handwritten signature in black ink that reads "Edward J. O'Brien".

Dr. Edward J. O'Brien
PHENIX Director of Operations
Brookhaven National Laboratory

PHENIX Office
Brookhaven National Laboratory
Building 510C
P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-4007
631 344-8594
Fax 631 344-3253

Professor Matthias Grosse Perdekamp
Department of Physics
University of Illinois at Urbana Champaign
1110 W. Green Street
Urbana, IL 61801

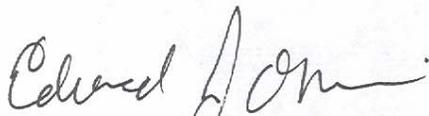
Dear Matthias,

You and your colleagues are in the process of submitting a proposal to the MRI program of the National Science Foundation to implement a Forward Muon Trigger Upgrade in the PHENIX experiment at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. PHENIX Management, on behalf of the PHENIX collaboration strongly supports this initiative. We understand that the MRI grant application, if successful, would require certain specific support from the PHENIX-BNL Operations group, which I lead. The MRI project support would include:

- Engineering support and technical labor for Forward Muon Trigger detector integration and installation
- Labor for cable assembly and installation
- Labor for gas system assembly
- Hardware and expert support for integration of the Forward Muon Trigger system into the PHENIX Data Acquisition and Trigger system
- Lab space for detector tests and final detector assembly at BNL

PHENIX Management agrees to provide this support to the Forward Muon Trigger project. We consider this project to be an extremely important component of the future physics program of the PHENIX experiment.

Sincerely,



Dr. Edward J. O'Brien
PHENIX Director of Operations
Brookhaven National Laboratory

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Department of Physics

Loomis Laboratory of Physics
1110 West Green Street
Urbana, IL 61801-3080, USA



January 20, 2005

The National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

To whom it may concern:

If the multi-university Major Research Initiative proposal, “Collaborative Research: Development of a Fast Muon Trigger to Study the Quark-Gluon Structure of the Proton” requesting \$747,216.00, is funded, I pledge that the Department of Physics of the University of Illinois at Urbana-Champaign will provide \$100,000 of funds from its own resources to the initiative. I make this commitment because I am confident the improvements the initiative will make to capabilities of the Phoenix Detector at the Brookhaven RHIC will enable it to do experiments that probe fundamental questions of subnuclear physics.

The department has made major investment in RHIC physics through the recruitment of professors Matthias Gross Perdekamp and Jen-Chieh-Peng and is proud of their accomplishments. I hope very much that this MRI is supported. The physics is new and important.

Sincerely,

A handwritten signature in black ink that reads "Jeremiah D. Sullivan".

Jeremiah D. Sullivan
Head and Professor

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Office of the Vice Provost for Research
2610 Beardshear Hall
Ames, Iowa 50011-2036
515 294-6344
FAX 515 294-6100

January 19, 2005

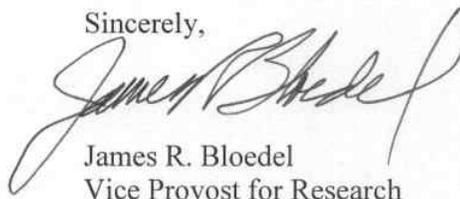
Prof. Matthias Grosse-Perdekamp
Department of Physics
University of Illinois at Urbana/Champaign
Urbana, Illinois

Dear Prof. Grosse-Perdekamp:

I am sending you this letter to indicate the support of the Iowa State University administration for your NSF-MRI proposal which includes an Iowa State collaborative proposal. Iowa State has agreed to provide a total of \$50,000 to support this work if the proposal is funded by NSF. The Office of the Vice Provost for Research will contribute \$20,000; the College of Liberal Arts & Science \$20,000; the ISU Department of Physics and Astronomy \$3,000 and Professor Hill \$7,000 (from an ISU account). The Electronics Design Center, which is a unit in the Department of Physics and Astronomy is available and has the capabilities to do the engineering work needed to design and build the Local Level-1 Trigger for the upgrade proposed to the NSF-MRI program. I also understand from Professor Hill that there will be one or more graduate students available to work on this project, with the help of a postdoctoral fellow.

The Iowa State University administration enthusiastically supports this opportunity for Professors Hill and Lajoie to participate in this proposal to NSF to upgrade the facilities of the PHENIX detector at the RHIC accelerator at Brookhaven National Laboratory.

Sincerely,



James R. Bloedel
Vice Provost for Research



KENNETH N. BARISH
DEPARTMENT OF PHYSICS
RIVERSIDE, CALIFORNIA 92521
TEL: (951) 827-5023
FAX: (951) 827-4529
E-MAIL: Kenneth.Barish@ucr.edu

18 January, 2004

Dr. Matthias Grosse Perdekamp
Department of Physics
University of Illinois
1110 W. Green St.
Urbana, IL 61801

Dear Professor Grosse Perdekamp,

I am pleased to confirm our strong support for the W-trigger upgrade project in PHENIX. This project will be the key focus of our group and include contributions from the personnel that are being supported from my continuing DOE spin physics grant and travel support. This includes Ken Barish, Richard Seto, one postdoctoral fellow (Waled Emam), one graduate student (Astrid Morreale), and several undergraduate summer students. In addition it includes 2 postdoc years contributed by UC Riverside to help with the early operations of this project. I am looking forward to the realization of this exciting project.

Sincerely,

A handwritten signature in blue ink that reads 'Kenneth N. Barish'.

Kenneth N. Barish, PhD
Associate Professor of Physics
PHENIX Spin PWG Convenor

January 25, 2005

To: Kenneth N. Barish
Associate Professor of Physics

From: Georgianne Carlson 
Assistant Dean, Administration

Re: NSF Proposal – Collaborative Research: Development of a Fast Muon Trigger to
Study the Quark-Gluon Structure of the Proton

I am pleased to inform you that the Dean's Office will commit to provide funding in support of the NSF grant referenced above.

Specifically, if the proposal is funded, the College will encumber up to \$34,000, to be used to support the operation and maintenance of the instrument, in the form of a postdoctoral fellow during the 4th and 5th project years. If the grant is not funded at the full proposed amount, this contribution will be reduced proportionately.

Best wishes in your research efforts.

CC: Steve Angle, Dean
Charles Louis, Vice Chancellor for Research
Jory Yarmoff, Associate Dean
Gail Hanson, Professor
Ben Shen, Physics Chair
Carrie Thompson, MSO Physics
Linda Pletcher, Principal Analyst



CHARLES F. LOUIS, VICE CHANCELLOR
OFFICE OF RESEARCH
RIVERSIDE, CALIFORNIA 92521
TEL: (951) 827-5535
FAX: (951) 827-4483
EMAIL: clouis@ucr.edu

January 24, 2005

Professor Kenneth Barish
Department of Physics

Dear Ken:

This is to confirm that the Office of the Vice Chancellor for Research at UC Riverside will commit up to \$33,000 to support operations and maintenance (in the form of a postdoctoral fellow during the 4th and 5th years) for your project "Development of a Muon Trigger for PHENIX." If the grant is not funded at the full proposed amount, this contribution will be reduced proportionately.

Sincerely,

A handwritten signature in blue ink, appearing to read "Charles F. Louis".

Charles F. Louis
Vice Chancellor for Research

cc: Steve Angle
Georgianne Carlson
Kathrine Fruge
Gail Hanson
Jane Schultz

UNIVERSITY OF CALIFORNIA, RIVERSIDE

BERKELEY - DAVIS - IRVINE - LOS ANGELES - RIVERSIDE - SAN DIEGO - SAN FRANCISCO



SANTA BARBARA - SANTA CRUZ

DEPARTMENT OF PHYSICS
UNIVERSITY OF CALIFORNIA
RIVERSIDE, CA 92521-0413
(951) 827-5033

January 24, 2005

Professor Kenneth N. Barish
Department of Physics
University of California, Riverside
Riverside, California 92521-0413

Dear Prof. Barish:

This letter is to confirm the commitment of funds for your Major Research Instrumentation proposal to the National Science Foundation if it is successful. These funds, in the amount of \$33,000 from my initial complement for the Center for Accelerator, Astroparticle, and Particle Physics, will be used for operation and maintenance.

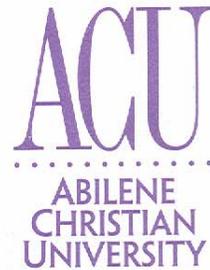
Please accept my best wishes for the success of your proposal.

Sincerely,

Gail G. Hanson

Gail G. Hanson
Distinguished Professor, Department of Physics
and Director, Center for Accelerator, Astroparticle and
Particle Physics

Abilene, Texas 79699
325-674-2000



ACU Box 27963
Abilene Christian University
Abilene, TX 79699

January 14, 2005

Matthias Grosse Perdekamp
Department of Physics
University of Illinois
1110 W. Green Str.
Urbana, IL 61801

Dear Matthias,

We are writing to express our support for the new PHENIX W-trigger upgrade proposal and project. Both of us commit to actively participate in the development and construction of this upgrade. In addition to our personal involvement, we will also bring a group of undergraduate students to help with the construction tasks.

We expect that we will contribute to this task in much the same manner that we helped with the construction, installation, and commissioning of the PHENIX muon tracking cathode strip chambers. The efforts of our group were instrumental in completing that project on time. Of the 18 ACU undergraduate students that have worked on the muon tracker system over the past 5 years, 10 are currently in graduate school and 6 are still students at ACU.

While we are excited about all of the improvements this project will bring to the PHENIX detector, we are particularly excited about improving the measurement of the light anti-quark flavor asymmetry of the proton. We were heavily involved with a similar measurement as a member of the FNAL E866/NuSea collaboration. The complete analysis of this measurement was the topic of Towell's Ph.D. thesis.

Sincerely,

A handwritten signature in cursive script, appearing to read "Rusty Towell".

Rusty Towell
Assistant Professor of Physics
Abilene Christian University

A handwritten signature in cursive script, appearing to read "L. Donald Isenhower".

L. Donald Isenhower
Professor of Physics
Abilene Christian University

Columbia University

Department of Physics

538 West 120th Street, New York, NY 10027
Telephone (212)-854-3366, FAX (212)-854-3379

Professor W.A. Zajc
Zajc@Nevis.Columbia.Edu
<http://www.nevis.columbia.edu/~zajc/>
(914)-591-2811
(212)-854-8175
(914)-591-8120 (FAX)

January 24, 2005

Department of Physics
University of Illinois
1110 W. Green St.
Urbana, IL 61801

Dear Matthias:

I am writing to express our strong interest in the instrumentation development project for a fast first level W-trigger in PHENIX and, in particular, in the resulting physics program studying the flavor structure of quark-spin distribution in the proton.

As you know, our group has had major leadership responsibilities for the PHENIX data acquisition and trigger systems from the first conceptual designs to their latest implementations. As part of this system-wide design, our engineers have also developed the front end electronics for two detector systems in PHENIX: the time-of-flight system and the beam-beam counters.

We look forward to strongly supporting the W-trigger project through our engineering expertise at Nevis Laboratory.

Sincerely,



W.A. Zajc
Professor of Physics
PHENIX Spokesperson

Campus Box 390
Boulder, Colorado 80309-0390
(303) 492-0455

Prof. Matthias Grosse Perdekamp
Department of Physics
University of Illinois at Urbana-Champaign
1110 West Green Street
Urbana, Illinois 61801-3080

Dear Prof. Grosse Perdekamp,

We strongly support the NSF proposal to add new instrumentation to the PHENIX spectrometer to allow a precise determination of the quark sea polarization in the nucleon, using the novel technique of polarized W boson production in high polarized pp collisions. This measurement is essential to testing our understanding of the quark-gluon structure of the nucleon, which is a major goal in our field.

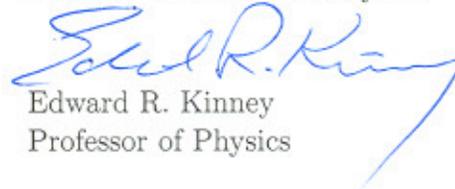
The nucleon structure group at Colorado brings considerable experience to this project. We have played a major role in the HERMES experiment at HERA(DESY) since its initial proposal. To date, this experiment has produced the most precise determination of the quark sea polarizations using semi-inclusive deep-inelastic scattering. In addition to data analysis, we have built the high-rate front drift chambers and electronics for the spectrometer. In particular, over the last four years, Prof. Nagle has served as Trigger Coordinator for the PHENIX Experiment in addition to building new trigger pre-processor custom electronics.

We expect this project to be the major focus of the nucleon structure research group at Colorado. We plan to lead the data analysis effort in the development of the computer simulations necessary for a detailed understanding of the experimental results. Subject to future funding of our base DOE grants, we expect to involve 2 postdocs, 2 graduate students, 2 undergraduate students as well as 2 faculty in this project.

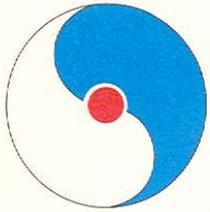
Sincerely,



James L. Nagle
Assistant Professor of Physics



Edward R. Kinney
Professor of Physics



RIKEN BNL Research Center

Building 510A, Brookhaven National Laboratory, Upton, NY 11973 USA

January 18, 2005

Dr. Matthias Grosse Perdekamp
Department of Physics
University of Illinois
1110 W. Green Street
Urbana, IL. 61801

Dear Professor Grosse Perdekamp,

We are pleased to confirm our strong support for the W-trigger upgrade project in PHENIX. Dr. Wei Xie, a Fellow at the RIKEN BNL Research Center, has been actively involved in the planning and proposal effort for the future W-trigger in PHENIX and will continue to play a leading role for the project as the "Integrations and Operations Manager" for the W-trigger at BNL. As integrations and operations manager Dr. Xie will oversee the detector assembly, installation, commissioning and operations of the W trigger on site. In doing this he takes advantage of RBRC's location at Brookhaven National Laboratory.

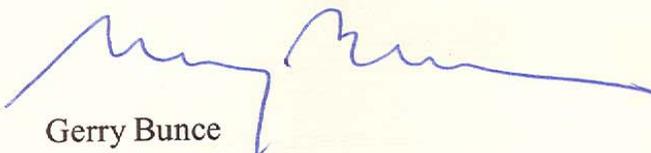
In addition Dr. Xie will play an important role in supervising the graduate students in PHENIX who will work on the analysis of the resulting data sample. Dr. Xie has made many important contributions to the physics analysis in PHENIX and presently leads the analysis in the heavy vector meson physics working group.

For the present upgrade R&D at BNL and later usage for the trigger operations and commissioning we have acquired for the project

1 CAEN HV main frame SY1527 at \$14112
1 CAEN HV modules A1526 at \$5761
1 Tektronix Oscilloscope TDS3054B at \$9495

We are looking forward to close collaboration!

Best Regards,



Gerry Bunce

/tas
cc: file



DEPARTMENT OF PHYSICS, FACULTY OF SCIENCE

NAOHITO SAITO
ASSOCIATE PROFESSOR OF PHYSICS

TEL:+81-(75)-753-3871
FAX:+81-(75)-753-3887
E-MAIL: SAITO@NH.SCPHYS.KYOTO-U.AC.JP

KITASHIRAKAWA OIWAKE-CHO, SARYOKU, KYOTO, 606-8502, JAPAN

January 18, 2005

Dr. Matthias Grosse Perdekamp
Department of Physics
University of Illinois
1110 W. Green St
Urbana, IL 61801

Dear Professor Grosse Perdekamp,

We are pleased to confirm our strong support for the W-trigger upgrade project in PHENIX. We have been actively involved in the planning and proposal effort for the future W-trigger in PHENIX and will continue to play a leadership role in the project. Particularly I agree to serve as the "Offline Analysis Manager" for the physics of W-trigger. We have currently two graduate students working on this project, Kazuya Aoki and Kohei Shoji, and plan to add one more student and a postdoctoral fellow next year.

In the past, our group has made important leadership contributions to several experiments using polarized beams and/or polarized targets. We have acquired significant experience in experiments with polarization, both in instrumentation as well as in the offline analysis and are looking forward to lead PHENIX in the analysis and software effort for W-physics. Polarized proton physics at RHIC is highly recognized in the Japanese nuclear and particle-physics community and we expect the strong support for RHIC spin physics from Japan to continue in the future. We are looking forward to close collaboration.

Sincerely,

Naohito Saito



School of Physics
Fax: (86)-10-62751875
Tel: (86)-10-62752175
Jan. 16, 2005

Prof. Matthias Grosse Perdekamp
Department of Physics
University of Illinois
1110 W. Green Str.
Urbana, IL 61801, USA

Dear Prof. Perdekamp,

I am writing to you to show our great interesting on the physics program via W production created from polarized proton-proton collision at RHIC. The project of "Development of a fast trigger system for forward upgrade of PHENIX detector" could make PHENIX an unique detector to precisely probe the spin contributions from components of a nucleon.

Peking University (PKU) in China strongly supports this project and plans to play a major role in the Resistive Plate Chamber (RPC) development and construction and later in the data analysis. As you may know that PKU has started RPC R&D since 1997 and constructed 1/4 of RPCs for the muon trigger system of CMS detector at CERN-LHC. Our experience on CMS RPC R&D and construction and the laboratory built in PKU could ensure us successfully to take the responsibility of the RPC R&D and construction for PHENIX forward upgrade.

We have officially signed the Memorandum of Understanding (MoU) among Peking University, the PHENIX Collaboration and the BNL Physics Department regarding institutional responsibilities and participation in the PHENIX Collaboration. PKU will manage to provide about 2 faculties, 1-2 post-docs and 2 – 4 students involved in this project, and 2 scientists from the group will spend 50% of their time at BNL in a period of 3 years to work on RPC R&D, tests, software, installation and commissioning if NSF support becomes available. If you need any further information regarding PKU involvement, please let me know without hesitation.

Sincerely yours,

Yajun Mao
Professor of Physics
PKU group leader of PHENIX Collaboration