

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

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---

**PI/PD Name:** John C Hill

**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**

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**Ethnicity Definition:**

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---

**PI/PD Name:** John C Hill

**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  
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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:**  
(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

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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:**  
(Select one or more)

Hearing Impairment  
 Visual Impairment  
 Mobility/Orthopedic Impairment  
 Other  
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**Citizenship:** (Choose one)  U.S. Citizen  Permanent Resident  Other non-U.S. Citizen

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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:**  
(Select one or more)  Hearing Impairment  
 Visual Impairment  
 Mobility/Orthopedic Impairment  
 Other  
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**Citizenship:** (Choose one)  U.S. Citizen  Permanent Resident  Other non-U.S. Citizen

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**PI/PD Name:** Rusty Towell

**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  
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**Disability Status:**  
(Select one or more)  
 Hearing Impairment  
 Visual Impairment  
 Mobility/Orthopedic Impairment  
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## List of Suggested Reviewers or Reviewers Not To Include (optional)

---

### **SUGGESTED REVIEWERS:**

John A. Doe

John B. Doe

### **REVIEWERS NOT TO INCLUDE:**

Not Listed

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

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**SUGGESTED REVIEWERS:**

Not Listed

**REVIEWERS NOT TO INCLUDE:**

Not Listed

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

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**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					<b>FOR NSF USE ONLY</b>			
<b>NSF 05-515</b>			<b>01/27/05</b>		<b>NSF PROPOSAL NUMBER</b>			
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)								
<b>PHY - MAJOR RESEARCH INSTRUMENTATION</b>								
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION			
				<b>005309844</b>				
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)				
<b>426004224</b>								
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE					
<b>Iowa State University</b>			<b>Iowa State University</b>					
AWARDEE ORGANIZATION CODE (IF KNOWN)			<b>2207 Pearson Hall, Room 15</b>					
<b>0018697000</b>			<b>Ames, IA. 500112207</b>					
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 <b>Status of NSF-MRI Proposal from UIUC in Fastlane Format</b>								
REQUESTED AMOUNT		PROPOSED DURATION (1-60 MONTHS)		REQUESTED STARTING DATE		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE		
\$ <b>0</b>		<b>0</b> months						
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"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)					
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____								
PI/PD DEPARTMENT			PI/PD POSTAL ADDRESS					
<b>Physics and Astronomy</b>			<b>A309 Physics Addition</b>					
PI/PD FAX NUMBER			<b>Ames, IA 500112207</b>					
<b>515-294-6027</b>			<b>United States</b>					
NAMES (TYPED)		High Degree	Yr of Degree	Telephone Number	Electronic Mail Address			
PI/PD NAME								
<b>John C Hill</b>		<b>DPhil</b>	<b>1966</b>	<b>515-294-6580</b>	<b>jhill@iastate.edu</b>			
CO-PI/PD								
CO-PI/PD								
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).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

### Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

### Debarment and Suspension Certification

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

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes

No

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix D of the Grant Proposal Guide.

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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/if not in response to a program announcement/solicitation enter NSF 04-23					<b>FOR NSF USE ONLY</b>	
<b>NSF 05-515</b>			<b>01/27/05</b>		<b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)						
<b>PHY - MAJOR RESEARCH INSTRUMENTATION</b>						
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)		FILE LOCATION
				<b>005309844</b>		
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)		
<b>426004224</b>						
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
<b>Iowa State University</b>			<b>Iowa State University</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN)			<b>2207 Pearson Hall, Room 15</b>			
<b>0018697000</b>			<b>Ames, IA. 500112207</b>			
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 <b>Development of a Fast Trigger System for the PHENIX Forward Detector Upgrade</b>						
REQUESTED AMOUNT		PROPOSED DURATION (1-60 MONTHS)		REQUESTED STARTING DATE		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
\$ <b>0</b>		<b>0</b> months				
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			PI/PD POSTAL ADDRESS			
<b>Physics and Astronomy</b>			<b>A309 Physics Addition</b>			
PI/PD FAX NUMBER			<b>Ames, IA 500112207</b>			
<b>515-294-6027</b>			<b>United States</b>			
NAMES (TYPED)		High Degree	Yr of Degree	Telephone Number	Electronic Mail Address	
PI/PD NAME						
<b>John C Hill</b>		<b>DPhil</b>	<b>1966</b>	<b>515-294-6580</b>	<b>jhill@iastate.edu</b>	
CO-PI/PD						
<b>John Lajoie</b>		<b>DPhil</b>	<b>1996</b>	<b>515-294-5225</b>	<b>lajoie@iastate.edu</b>	
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## CERTIFICATION PAGE

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FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					<b>NSF PROPOSAL NUMBER</b>	
<b>DATE RECEIVED</b>	<b>NUMBER OF COPIES</b>	<b>DIVISION ASSIGNED</b>	<b>FUND CODE</b>	<b>DUNS#</b> (Data Universal Numbering System)	<b>FILE LOCATION</b>	
				<b>073171951</b>		
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 type="checkbox"/> IF YES, LIST ACRONYM(S)		
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE <b>Abilene Christian University</b>			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE <b>Abilene Christian University Abilene, TX. 79699</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN) <b>0035378000</b>						
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"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE
TITLE OF PROPOSED PROJECT						
REQUESTED AMOUNT \$ <b>0</b>	PROPOSED DURATION (1-60 MONTHS) <b>0</b> months		REQUESTED STARTING DATE		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) Exemption Subsection _____ or IRB App. Date _____			
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)			<input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.g.(iv).(c))			
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)						
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<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 <b>Physics</b>			PI/PD POSTAL ADDRESS <b>ACU Box 27963</b>			
PI/PD FAX NUMBER <b>325-674-2146</b>			<b>Abilene, TX 79699 United States</b>			
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
PI/PD NAME <b>Rusty Towell</b>	<b>PhD</b>	<b>1999</b>	<b>325-674-2034</b>	<b>rusty.towell@acu.edu</b>		
CO-PI/PD						
CO-PI/PD						
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CO-PI/PD						

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## International Programs Cover Page Addendum

Country #1:

Country #2:

Country #3:

Proposal Category:

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### Foreign Counterpart Investigator/Organizer/Host #1:

Name:

Department:

Institution:

Address:

Phone:

Fax:

Email:

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### For Planning Visit or Joint Seminar or Workshop:

Location

City:

Country:

Start Date:

End Date:

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### Demographics(people that will be supported by this project):

- Number of senior U.S. scientists and engineers (excluding those within 6 years of their Ph.D. and graduate and undergraduate students): \_\_\_\_\_
- Number of U.S. scientists within 6 years of the Ph.D.(including the PI and/or Co-PI if applicable): \_\_\_\_\_
- Number of U.S. graduate students: \_\_\_\_\_
- Number of U.S. undergraduate students: \_\_\_\_\_
- Number of foreign scientists and engineers (including post-docs, graduate and undergraduate students) associated with the foreign institution. Include only those who will be supported under this NSF proposal. Do not count foreign participants who will be supported by non-NSF funds: \_\_\_\_\_

## 2. Project Summary

We propose to develop and build a fast trigger for the forward spectrometer upgrade of the PHENIX detector at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL). The motivation of this upgrade is to study how contributions from various quarks and gluons add together to produce the proton spin. We will use the RHIC high-energy polarized proton beams especially designed for this study. Our method involves the isolation of high-energy interactions between the proton's quarks and gluons. Of special interest for us is collisions in which a W boson is formed. The proposed instrument will permit measurement of the direction and momentum of the W with good efficiency and resolution.

The fast trigger will be installed as an upgrade to the two PHENIX forward muon spectrometers. We propose to build Resistive Plate Chambers (RPCs) to track muons from W decay through the forward spectrometers. The RPCs will employ fast readouts to create a signal that can be used to indicate the presence of the rare W particles but reject the much more numerous muons from hadron decays and beam interactions. In addition the RPCs will employ a slower readout with high spatial resolution to accurately determine the W-boson trajectory. It will therefore be necessary to build fast and slow RPC readout electronics. An essential component of the upgrade is a fast trigger working in real time that takes the data from the RPCs and decides in a few microseconds to accept or reject the collision event. The proposal to develop this trigger was reviewed and approved by PHENIX in July, 2004.

A total of four U.S. universities, namely Illinois at Urbana-Champaign, California at Riverside, Iowa State and Abilene Christian will participate in this project. All of these universities will contribute graduate and undergraduate students as well as postdoctoral fellows to work on this project. This will involve projects in building and testing of detectors and electronics and writing of software to process output signals from the detectors and the trigger. Also additional software will be needed to simulate the collision environment expected with the higher beam intensities resulting from the planned RHIC luminosity upgrade. The students involved will thus gain experience in the design, construction and testing of state-of-the-art radiation detectors and readout electronics and the creation of the software needed to obtain physics results.

This project is a critical component in achieving one of the fundamental goals of nuclear physics and the RHIC spin program, which is to understand the quark-gluon structure of the fundamental bound state of Quantum Chromodynamics (QCD), namely the nucleon. Thus upgrade of the PHENIX forward spectrometers to study W spin physics using the weak interaction is needed. This approach has several advantages over previous experiments. In addition to the advantage of large  $Q^2$ , "u-quark dominance" is eliminated resulting in a more accurate study of the role of the d and s quarks. The parity violating nature of the weak interaction provides a natural polarization requiring only a single spin asymmetry measurement. Once the forward upgrade and the upgrade of RHIC luminosity is completed the PHENIX collaboration will undertake precision measurements of W particles produced in collisions of polarized beams to gain a more complete understanding of the roles of various factors that combine to produce the spin of the proton.

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For font size and page formatting specifications, see GPG section II.C.

	<b>Total No. of Pages</b>	<b>Page No.* (Optional)*</b>
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)	1	_____
Table of Contents	1	_____
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) <b>(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	11	_____
References Cited	_____	_____
Biographical Sketches (Not to exceed 2 pages each)	6	_____
Budget (Plus up to 3 pages of budget justification)	0	_____
Current and Pending Support	1	_____
Facilities, Equipment and Other Resources	1	_____
Special Information/Supplementary Documentation	1	_____
Appendix (List below. ) <b>(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	_____	_____
Appendix Items:		

\*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

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For font size and page formatting specifications, see GPG section II.C.

	Total No. of Pages	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)	_____	_____
Table of Contents	1	_____
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) <b>(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	0	_____
References Cited	_____	_____
Biographical Sketches (Not to exceed 2 pages each)	1	_____
Budget (Plus up to 3 pages of budget justification)	4	_____
Current and Pending Support	2	_____
Facilities, Equipment and Other Resources	1	_____
Special Information/Supplementary Documentation	1	_____
Appendix (List below. ) <b>(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	_____	_____
Appendix Items:		

\*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

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Biographical Sketches (Not to exceed 2 pages each)	1	_____
Budget (Plus up to 3 pages of budget justification)	4	_____
Current and Pending Support	2	_____
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Appendix (List below. ) <b>(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	_____	_____
Appendix Items:		

\*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

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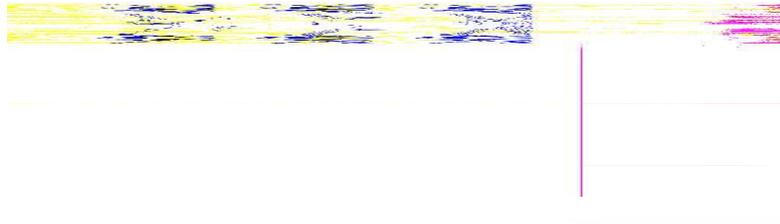
### 3. a) Research Activities

While the instrumentation we propose to develop may have a number of applications both within the PHENIX spectrometer as well as more generally in any apparatus requiring fast, compact, ionizing particle triggering and tracking, the scientific purpose in the present case is the determination of the spin contributions of the sea and valence quarks to the spin of the proton, as described below.

#### The Spin Structure of the Nucleon: Present Understanding

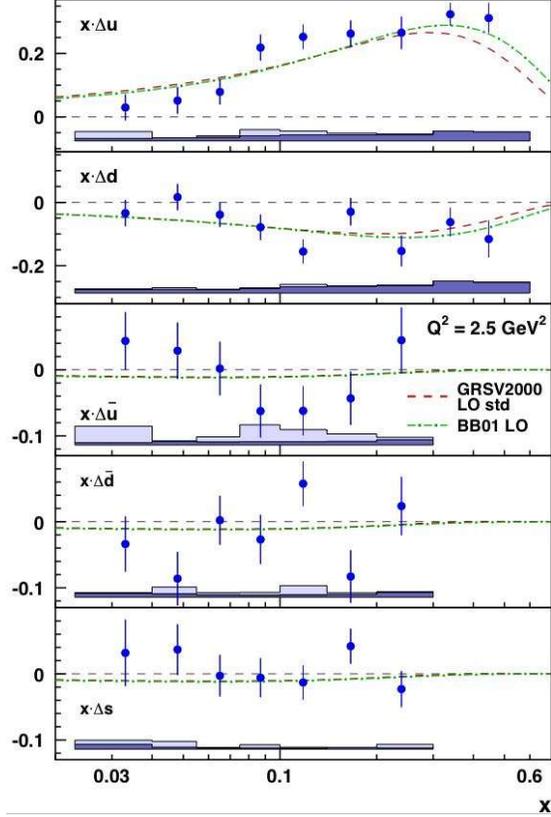
A central goal of high-energy nuclear physics is to determine and understand the quark-gluon structure of the nucleon, the fundamental bound state of QCD. (Ref NSAC LRP). The present understanding is largely empirical and rudimentary. A prime example of this is the surprising fact, now well established from inclusive polarized deep inelastic lepton scattering experiments,(Ref Spin review) that only 20-30% of the spin of the nucleon arises from the spins of the quarks. While one would 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(Refs Jlab Ge/Gm, Sivers).

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  $x$  (Refs RHIC Spin program, COMPASS). The basic processes 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 (Ref A\_LL) have already been produced which constrain models with different gluonic spin contributions. With data from future running periods (Ref decadel plan?), the variety and power of these measurements will greatly increase.



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

Given these measurements, 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 (SMC(ref), COMPASS(ref)) and DESY(HERMES(ref)) have and are attempting to determine the spin contributions of the different quark flavors separately, especially the contributions from the sea quarks. The technique used is so-called “hadron tagging” 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 with 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(ref-HERMES-dq) of the HERMES data 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. (HERMES-dq)

To date, this extraction has only been performed 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 (refs-NLO-SIDIS) to extend the semi-inclusive analysis procedure to next-to-leading order (NLO) are underway, but progress has been slow. A chief concern with the HERMES analysis is the relatively low  $Q^2$  (average about  $2.5 \text{ GeV}^2$ ) of the data, 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. Because COMPASS only will use a polarized deuterium target, some additional assumptions about the proton and neutron parton distributions will be required (Ref DIS04). 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 which in some cases (*e.g.*,  $s$  quark 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 (ref. Belle) 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 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 antiquarks. 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 would be 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 provide 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. 1, 2, and 3, so we here recall the major points (more here?).

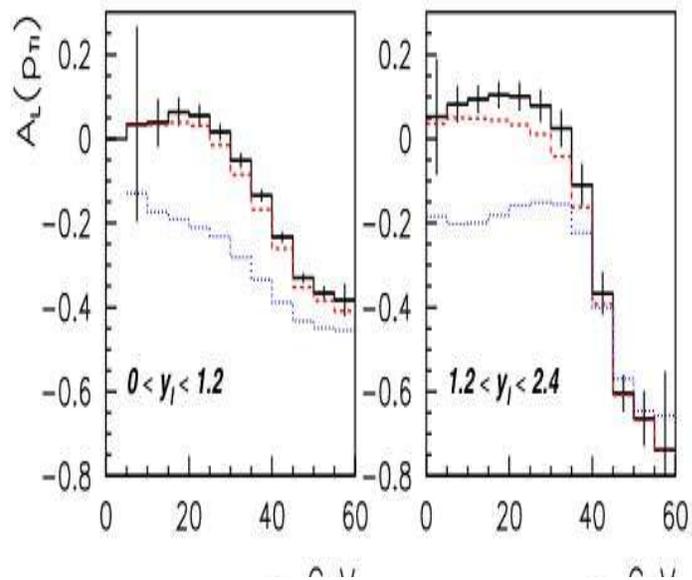
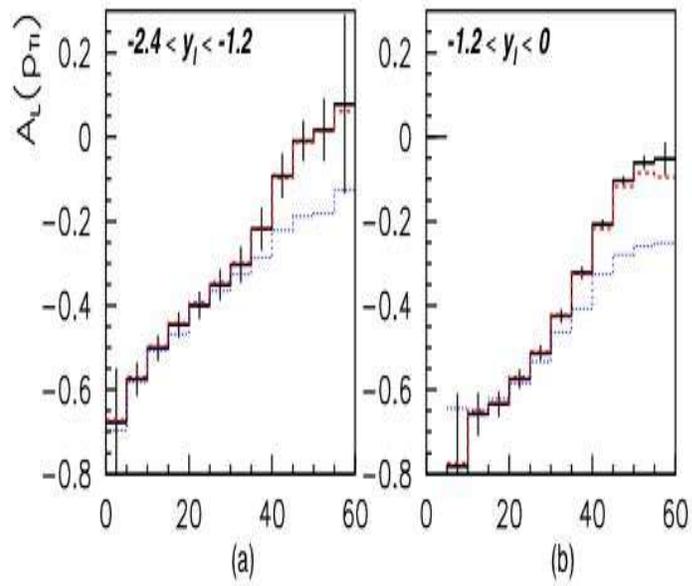


**Figure 3.3**  $W^\pm$  production in polarized  $pp$  scattering.

This reaction mechanism offers a number of advantages over deep-inelastic scattering: there are no systematic uncertainties from fragmentation models, there is no  $u$ -quark dominance arising from the intrinsic vertex coupling strength, the parity violating nature of the weak interaction provides a natural polarization measurement so that only a single spin asymmetry is required, and 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 via relates these asymmetries to those of the parent  $W$  bosons. Calculations of these asymmetries, including the effects of NLO QCD and resummation, have been performed by Nadolsky and Yuan (Ref. 3). Figure 3.4 shows the results at forward rapidity in the PHENIX acceptance

(More here on kinematics, explanation of Fig 3.4)

Since the instantaneous rate of observed  $W$  decay leptons is not high, it is critical that the muon trigger have both high efficiency and discrimination. Specifically, it should be sensitive to the higher average momenta of the  $W$  decay muons and insensitive to muons resulting from hadron decay, especially from hard jets.



**Figure 3.4** Expected single spin asymmetries for leptons from W production as a function of  $p_T$  for different regions in rapidity.

### **3.(b) Description of Research Instrumentation and Needs (Matthias)**

### **3.(c) Impact of Infrastructure Projects (Ken & Celia)**

### **3. d) Project Management Plans**

The overall responsibility of the experiment is PHENIX management, led by the spokesperson of PHENIX, Zajc together with the project manager Edward O'Brien, and upgrades manager Axel Drees. Matthias Grosse Perdekamp of UIUC, one of the deputy spokespersons of PHENIX has the responsibility of coordinating the muon trigger upgrade. The detailed design of the detector has been led by Perdekamp and Wei (of RBRC) who is in charge of simulations. The hardware design and construction phase has three essential components.

The RPC detectors themselves will be the responsibility of UIUC, PKU, and RBRC and under the coordination of Perdekamp of UIUC and Mao of PKU. PKU brings a great deal of expertise on the construction of RPC's having constructed detectors for the CMS detector at CERN. A small prototype has been completed and is now undergoing testing at PKU. It will be shipped to BNL to be in the beam by February. We plan to construct a full scale module for testing next year. Full production which will take place at PKU will begin in early 2007 for installation in the third quarter of 2008. Mechanical engineering support will be provided by BNL.

The second major component is the electronics which will be coordinated by Barish of the University of California, Riverside. Barish has had experience as the coordinator of two other electronics projects – the first for the electronics for the Time Expansion Chamber – the second, together with Perdekamp – for the design and implementation of one of the most important triggers systems in PHENIX – the so called EMCAL-RICH trigger which provides the trigger for electrons, high  $p_T$  photons, and high  $p_T$  hadrons. Much of the electrical engineering support will come from Nevis. Cheng-Yi-Chi and Sippach who has designed many of the electronics systems in PHENIX will actively be involved in both the pre-amp shaper electronics and the readout electronics. Nevis Lab engineers have had extensive experience with the CMS pre-amp shaper chip to be used in

the front end electronics. A prototype readout system is now being developed which will be used in the full scale prototype to be tested in 2006.

The final component is the LVL-1 triggering system. This will be coordinated by John Lajoie of ISU. ISU has been responsible for the PHENIX level -1 trigger for the entire PHENIX detector and are well suited for this project. Engineering support will be provided by Ames Lab at ISU.

Wei Xie, who is now a Riken-BNL Center Fellow, and stationed at BNL will be the operations coordinator in charge of local coordination of testing, assembly, installation commissioning of the detector with support from PHENIX integration engineers and technicians. Rusty Towell of Abilene Christian, an undergraduate institution, will be responsible for the high voltage system together with much of the testing for electronics. He was an active member of a proton structure experiment at Fermilab (E866) and together with his students has been an important part of the construction of the PHENIX muon arms.

We have assembled an extremely strong set of people to work on software and analysis beginning with Ed Kinney (who is an ex-spokesperson of the Hermes experiment at DESY) who will be in charge of simulations. Colorado, because of the expertise of a second faculty member – Jamie Nagle – who has a great deal of experience will also be involved with the front end electronics. Naohito Saito, who has been one of the leaders in the RHIC spin program, will be in charge of offline software. A position which will be much more important as data taking begins with the new instrumentation is the analysis coordinator for our group – this will be done by Naomi Makins, who has been the analysis coordinator for Hermes. Finally, before the final construction phase – PHENIX management will convene a TAC (Technical Advisory Committee) of outside reviews to review details of the design. Such reviews are standard to all of the subsystems of the PHENIX detector before production begins.

The cost of the project is \$2.05M. A breakdown of costs is given in table? Table ? gives a breakdown of funding to be spent by each participating institution. The funding will be through the PI's of the proposed grant as shown in the table.

<b>Item</b>	<b>Cost</b>	<b>Institution</b>
RPC Hardware	\$470K	UIUC
RPC Installation	\$34K	ACU
Front End Electronics		
Engineering	\$312K	ISU
Amp/Disc board production	\$334K	UIUC
ReadOut electronics (FPGA board)	\$500K	UCR

Testing	\$13K	ACU
Local Level 1 system		ISU
Engineering	\$91K	ISU
Production	\$167K	ACU
HV	\$78K	ACU
Gas	\$50K	UIUC
Total	\$2.05 M	
Match from ISU+UIUC	-\$150K	
Undergraduate Grant	-\$100K	
Cost to NSF MRI	\$1.8M	

<b>Institution totals</b>	Cost to NSF MRI
ISU	\$520K (+\$50K match from ISU)
UC Riverside	\$470K
UIUC	\$754K (+\$100K match from UIUC)
ACU	\$40K (+\$100K for undergrad institution)
<b>Total (NSF MRI)</b>	<b>\$1.8M</b>
<b>Undergrad grant</b>	<b>\$100K</b>

The detectors should be fully tested and operational by 2008 when the high luminosity 500 GeV run for polarized protons is scheduled. In order to meet this goal two prototypes will be tested. A timeline is shown in figure???. The first prototype has been shipped to BNL and will be tested in February of 2005 during the next period of RHIC running. This prototype will be read out using electronics which was designed for the PHENIX Pad Chambers. A prototype of a full scale module will be produced in 2005, together with electronics. This will be tested during the Dec 2005 (run-6). Full scale production of the RPC's and electronics will begin in late 2006 and continue through early 2008. Installation of the RPC trigger in the one-half of the south muon arm will occur in late summer of 2007. During the fall of 2007, the trigger will be commissioned and will begin operations. Early in 2008, the remainder of the trigger will be installed in the south and north muon arms to be readied for the 2008 high luminosity 500 GeV run.

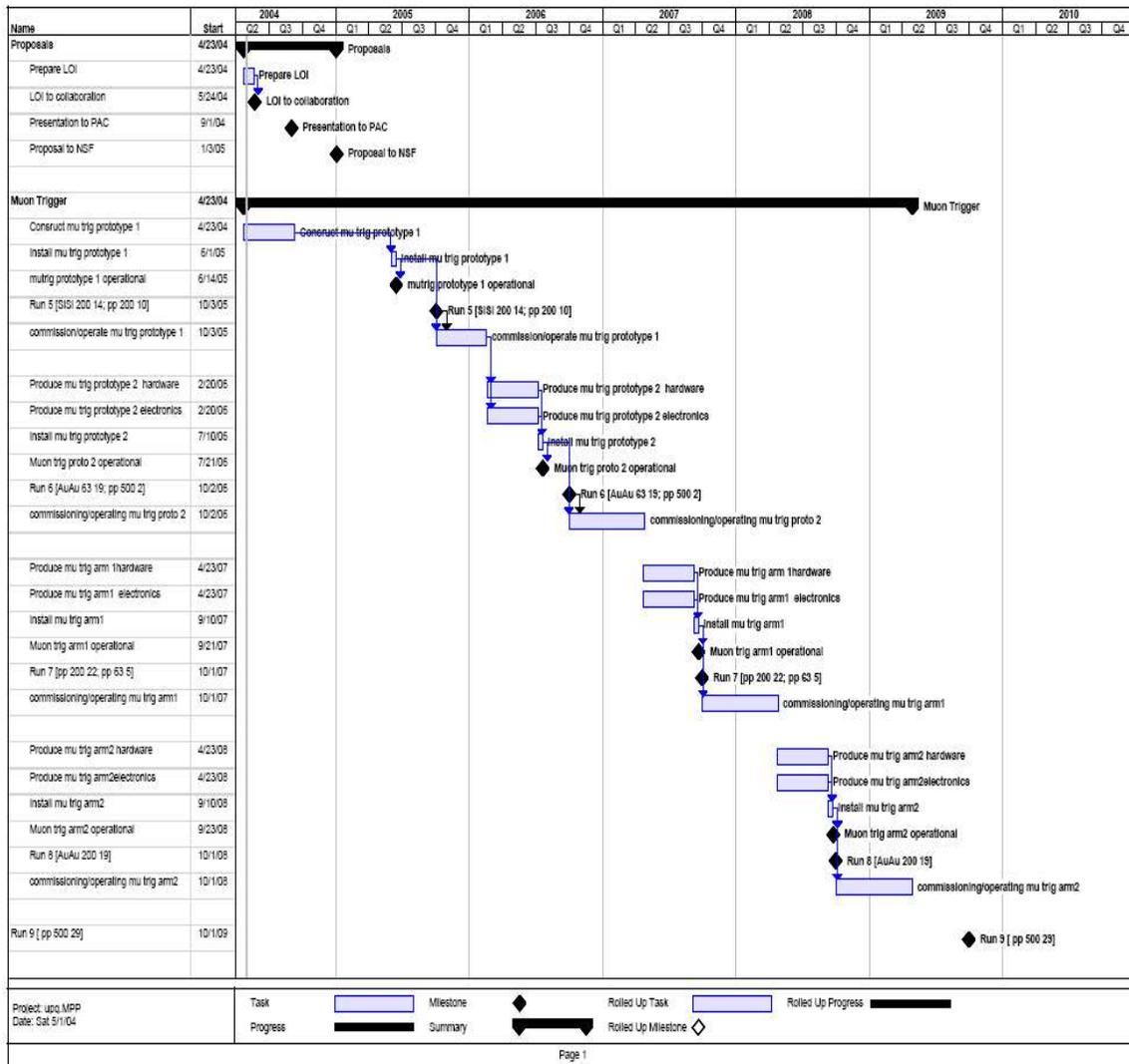


Fig. 7. An estimated project timeline assuming funding beginning in the ??? (to be updated by John Hill)

The PHENIX collaboration includes 400 scientists from 30 countries and ?? institutions.

As mentioned in the design section, this trigger will serve as a critical part of the PHENIX detector and will be used by the entire collaboration in making measurements of the anti-quark spin structure functions. 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 for the J/psi and epsilon.



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 degrees and training

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.	1977-81
Iowa State University	Asst. Prof.	1975-7
Texas A&M University	Asst. Prof.	1968-75

Five Publications Most Relevant to the Proposed Project:

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

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

K. Adcox---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---  
J.G. Lajoie---R. Seto---, "Centrality dependence of charged particle multiplicity in Au-Au collisions at 130 GeV," Phys. Rev. Lett. 86, 3500 (2001). (first PHENIX publication)

K. Adcox---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---  
J.G. Lajoie---R. Seto---, "PHENIX detector overview," Nucl. Instr. and Meth. A 499, 469 (2003).

S.S. Adler---K.N. Barish---J.C. Hill---J.G. Lajoie---R. Seto---, PHENIX on-line systems," Nucl. Instr. and Meth. A 499, 560 (2003).

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 (1988).

J.C. Hill, A. Petridis, B. Fadem, and F.K. Wohn, "Electromagnetic dissociation of Au targets by relativistic Pb projectiles," Nucl. Phys. A661, 313c (1999).

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

S.S. Adler---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---J.G. Lajoie---R. Seto---, "Absence of suppression of particle production at large transverse momentum in 200 GeV d+Au collisions," Phys. Rev. Lett. 91, 172301 (2003).

#### Synergistic Activities:

Contributions to training: Have trained a number of graduate students and postdoctoral fellows in techniques related to particle measurements. These people have positions in universities, colleges, national laboratories and university hospitals.

Development of research tools: 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.

#### Collaborations

Collaborators in Last 48 Months: PHENIX Collaboration [see Reference X]

PhD. Students Supervised in Last 5 Years: B. Fadem (Muhlenburg College)

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

PhD. Thesis Advisor: R. Steffen (Purdue University)

Postdoctoral Advisor: M. Wiedenbeck (University of Michigan)

Total PhD. Students Supervised: 5

Total Postdoctoral Fellows Supervised: 4

## 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 et al., “Single-spin asymmetries in semi-inclusive deep-inelastic scattering on a transversely-polarized hydrogen target”, *Phys. Rev. Lett.* **94**, 012002, 2005.

PHENIX Collaboration, S. S. Adler et al., “Double helicity asymmetry in inclusive mid-rapidity  $\pi^0$  production for polarized p+p collision at  $\sqrt{s}=200\text{GeV}$ ”, *Phys. Rev. Lett.* **93**, 202002, 2004.

PHENIX Collaboration, H. Akikawa et al., “PHENIX muon arm”, *Nucl. Instrum. Meth.* **A499**, 537, 2003

PHENIX Collaboration, N. Saito et al., “Spin physics with the PHENIX detector system”, *Nucl. Phys.* **A638**, 575, 1998.

### Five Most Significant Publications

HERMES Collaboration, A. Airapetian et al., “Evidence for a narrow  $|S| = 1$  baryon state at a mass of 1528MeV in quasireal photoproduction”, *Phys. Lett.* **B585**, 213 (2004).

HERMES Collaboration, A. Airapetian et al., “Single-spin asymmetries in semi-inclusive deep-inelastic scattering on a transversely-polarized hydrogen target”, *Phys. Rev. Lett.* **94** (2005) 012002.

X. Chen, Y. Mao, B.-Q. Ma, “Decay probability ratio of pentaquark  $\Theta^-$  state”, *Int. J. Mod. Phys. Lett.* **A19**, 2289, 2004.

PHENIX Collaboration, H. Akikawa et al., “PHENIX muon arm”, *Nucl. Instrum. Meth.* **A499**, 537, 2003

C. Ching, T. Ho, D. Liang, Y. Mao, S. Chen, H. Sun, “A Possible explanation of the negative values C. of  $m_v^2$  obtained from the b spectrum shape analyses”, *Int. J. Mod. Phys. Lett.* **A10**, 2841, 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). Will lead PKU group in PHENIX experiment for RPC R&D and massive 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).

***Contributions to teaching and outreach:***

***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 ; HERMES Collaboration; BES Collaboration;

***Ph. D. Students Supervised in Last 5 years:*** 3

***Postdoctoral Fellows Supervised in Last 5 Years:*** 1

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

***My Postdoctoral Advisor:***

***Total Ph.D. Students Supervised:*** 3

***Total Postdoctoral Fellows Supervised:*** 1

## Wei Xie

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Upton, NY 11973-5000 USA  
631-344-3744; 631-344-3251 (fax); [xiewei@bnl.gov](mailto:xiewei@bnl.gov)

### Professional Preparation

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

### 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 as  $\sqrt{s}=200\text{GeV}$ ,” *proceedings of the 19<sup>th</sup> Winter Workshop on Nuclear Dynamics*, 235–240, Feb.8-15, 2003, Breckenridge, Colorado, USA.

PHENIX Collaboration: S.S.Adler, et al, “J/psi production from proton-proton collisions at  $\sqrt{s} = 200$  GeV” *Phys.Rev.Lett.* **92**, 051802 (2004).

PHENIX Collaboration: S.S.Adler, et al., “J/Psi Production in Au-Au Collisions at  $\sqrt{s} = 200$  GeV at the Relativistic Heavy Ion Collider,” *Phys. Rev. C* **69**, 014901 (2004).

PHENIX Collaboration: S.S.Adler, et al., “Midrapidity Neutral Pion Production in Proton-Proton Collisions at  $\sqrt{s} = 200$  GeV” *Phys.Rev. Lett.* **91**, 241803 (2003).

PHENIX Collaboration: K. Adcox, 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 (2002).

### Five Most Significant Publications

PHENIX Collaboration: S.S.Adler, et al, “J/psi production from proton-proton collisions at  $\sqrt{s} = 200$  GeV” *Phys.Rev.Lett.* **92**, 051802 (2004).

PHENIX Collaboration: S.S.Adler, et al., “Scaling properties of proton and anti-proton production in  $\sqrt{s} = 200$  GeV Au+Au collisions” *Phys. Rev. Lett.* **91**, 172301 (2003).

PHENIX Collaboration: S.S.Adler, et al., “Suppressed  $\pi^0$  Production at Large Transverse Momentum in Central Au+Au Collisions at  $\sqrt{s} = 200$  GeV,” *Phys. Rev. Lett.* **91**, 072301 (2003).

PHENIX Collaboration: K. Adcox, et al, “Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at  $\sqrt{s} = 130$  GeV” *Phys.Rev.Lett.* **88**, 022301 (2002).

PHENIX Collaboration: K. Adcox, 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 (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 training:** none

**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 #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;

**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:** R. Seto, K. Barish (University California, Riverside), I. Tserruya (Weizmann Institute of Science, Israel)

**Total Ph.D. Students Supervised:** 0

**Total Postdoctoral Fellows Supervised:** 0

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 degrees and training

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

Appointments

Fellow American Physical Society		2003
Iowa State University	Prof.	1981-present
Iowa State University	Assoc. Prof.	1977-81
Iowa State University	Asst. Prof.	1975-7
Texas A&M University	Asst. Prof.	1968-75

Five Publications Most Relevant to the Proposed Project:

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

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

K. Adcox---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---J.G. Lajoie---R. Seto---, "Centrality dependence of charged particle multiplicity in Au-Au collisions at 130 GeV," Phys. Rev. Lett. 86, 3500 (2001). (first PHENIX publication)

K. Adcox---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---J.G. Lajoie---R. Seto---, "PHENIX detector overview," Nucl. Instr. and Meth. A 499, 469 (2003).

S.S. Adler---K.N. Barish---J.C. Hill---J.G. Lajoie---R. Seto---, "PHENIX on-line systems," Nucl. Instr. and Meth. A 499, 560 (2003).

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 (1988).

J.C. Hill, A. Petridis, B. Fadem, and F.K. Wohn, "Electromagnetic dissociation of Au targets by relativistic Pb projectiles," Nucl. Phys. A661, 313c (1999).

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

S.S. Adler---K.N. Barish---M. Grosse-Perdekamp---J.C. Hill---J.G. Lajoie---R. Seto---, "Absence of suppression of particle production at large transverse momentum in 200 GeV d+Au collisions," Phys. Rev. Lett. 91, 172301 (2003).

#### Synergistic Activities:

Contributions to training: Have trained a number of graduate students and postdoctoral fellows in techniques related to particle measurements. These people have positions in universities, colleges, national laboratories and university hospitals.

Development of research tools: 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.

#### Collaborations

Collaborators in Last 48 Months: PHENIX Collaboration [see Reference X]

PhD. Students Supervised in Last 5 Years: B. Fadem (Muhlenburg College)

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

PhD. Thesis Advisor: R. Steffen (Purdue University)

Postdoctoral Advisor: M. Wiedenbeck (University of Michigan)

Total PhD. Students Supervised: 5

Total Postdoctoral Fellows Supervised: 4

John Lajoie  
Department of Physics and Astronomy, Iowa State University  
Ames, IA 50011  
515-294-6952; 515-294-6027 (fax); lajoie@iastate.edu

Professional degrees and training

Iowa State University	Physics	B.S. 1989
Yale University	Physics	PhD. 1996
Yale University	1996-7	

Appointments

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

Five Publications Most Relevant to the Proposed Project:

K. Adcox et al., "PHENIX Online Systems," Nucl. Instr. Meth. A 49, 560 (2003)

S.S. Adler et al., "PHENIX Muon Arms," Nucl. Instr. Meth. A 49, 537 (2003)

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

J. C. Hill et al., "A High Mass Trigger for the E864 Experiment at the AGS Accelerator," Nucl. Instr. Meth. A421, 431 (1999)

T. A. Armstrong et al., "The E864 Lead-Scintillating Fiber Hadronic Calorimeter," Nucl. Instr. Meth. A406, 227 (1998)

Five Most Significant Publications:

S. S. Adler et al., "High-pt Charged Hadron Suppression in Au+Au Collisions at  $\sqrt{s_{NN}} = 200$  GeV", Phys. Rev. C 69, 034910 (2004)

S.S. Adler 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 (2003)

K. Adcox 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 (2002)

T. A. Armstrong et al., "Antiproton Production and Antideuteron Limits In Relativistic Heavy Ion Collisions," Phys. Rev. C59, 2699 (1999)

T. A. Armstrong et al., "Antiproton Production in 11.5A GeV/c Au+Pb Collisions," Phy. Rev. Lett. 79, 3351 (1997)

#### Synergistic Activities:

Activities that are synergistic with this proposal include my work 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 X]

PhD. Students Supervised in Last 5 Years: P. Constantin (LANL)

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

PhD. Thesis Advisor: J. Sandweis (Yale University)

Postdoctoral Advisor: J. Sandweiss (Yale University)

Total PhD. Students Supervised: 1

Total Postdoctoral Fellows Supervised: 2

## BIOGRAPHICAL SKETCH

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**No Bio Data Provided**

## BIOGRAPHICAL SKETCH

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**No Bio Data Provided**

# SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION <b>Iowa State University</b>				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>John C Hill</b>				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. <b>John C Hill - none</b>				0.00	0.00	0.00
2. <b>John Lajoie - none</b>				0.00	0.00	0.00
3.						
4.						
5.						
6. ( <b>0</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. ( <b>2</b> ) 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 <b>John C Hill</b>				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 <b>Iowa State University</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>John C Hill</b>				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.	<b>John C Hill - none</b>	0.00	0.00	0.00	\$ 0	\$	
2.	<b>John Lajoie - none</b>	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) <b>(Rate: , Base: )</b>							
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 <b>John C Hill</b>				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



## Budget Justification Page

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**Here is where the budget justification will go.**

## 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: <b>John Hill</b>	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: <b>Relativistic Heavy Ion Physics</b>	
Source of Support: <b>U. S. Department of Energy</b> Total Award Amount: \$ <b>1,710,000</b> Total Award Period Covered: <b>11/15/03 - 11/14/06</b> Location of Project: <b>Department of Physics, Iowa State University, Ames, IA 50011</b> Person-Months Per Year Committed to the Project.    Cal: <b>7.00</b> Acad: <b>5.00</b> Sumr: <b>2.00</b>	
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.





## FACILITIES, EQUIPMENT & OTHER RESOURCES

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**FACILITIES:** Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

**Laboratory:** To be written by Hill

**Clinical:** Not applicable

**Animal:** Not applicable

**Computer:** To be written by Hill

**Office:** BNL will provide office space for scientists while they are installing and testing the trigger. ISU will provide office space for engineers and scientists who will design and test the local level-1 trigger.

**Other:** To be written by Hill

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**MAJOR EQUIPMENT:** List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

To be written by Hill

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**OTHER RESOURCES:** Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

To be written by Hill

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## SUPPLEMENTARY DOCS

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**The University of Illinois at Urbana/Champaign (UIUC) is the submitting organization. UIUC is a Ph.D. granting organization. The University of California at Riverside (UCR) and Iowa State University (ISU) are subawardees who are Ph.D. granting organizations. Abilene Christian University (ACU) is a subawardee that is a non-Ph.D. granting organization. UCR, ISU and ACU will be submitting linked collaborative proposals.**

**We also list partners here but I am not sure what is a partner??**

**We can also scan in documents here. Need to find how to do this.**