U. Wisconsin - Madison

HEP Program Overview

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DOE Review

Madison

August 26, 2010

The Wisconsin HEP Program

(> 50 years of HEP research)

Leadership in Experiments

- **ATLAS, Babar (completing), CDF, CMS, Daya Bay, ILC**

Leadership in Theory

- **Cosmology, Phenomenology, String Theory**

Leadership in Education

- **73 Ph.D.s awarded 1999 – 2010 (to date)**
  - 28 in Theory, 45 in Experiment
  - In each 73% stayed in the field & 27% went to industry

Close Collaboration

- **HEP theorists & experimentalists**
- **Experimental groups (CDF & CMS, ATLAS & CMS…)**
  - ATLAS, CMS & UW Comp. Sci. → world's largest LHC simulation facility

UW Investment in the future

- **Five new junior faculty hires in HEP in last five years (*=tenured '09)**
  - 2005: Herndon* (CDF & CMS), Petriello* (OJI – Pheno – Leaves Fall '10)
  - 2006: Everett (Pheno.), Heeger* (Daya Bay, OJI), Mellado (ATLAS)

Task C: Babar, ILC

S. Dasu (PI), **Re. Prepost** (Faculty, Retired 09/09), **H. Band** (Sen. Sci. <5%), **K. Flood** (Asst. Sci.)

BaBar Operations

- Data taking completed in April 08
  - Accumulated ~560 fb^{-1} primarily at $\Upsilon(4S)$
- IFR Muon System Management (HB) and μ ID software & support (HB, KF, CV)

BaBar Physics Analysis

- BaBar is working to complete about 100 *core* analyses in the next two years
- Flood heads Radiative Penguins analysis group searching for new physics signatures in rare decays (responsible for ~10% of the analyses)
- Vuosalo graduated (supervisor SD): Search for new physics in B $\rightarrow K\nu\nu$ decays
- Senior members of the group participate actively in analysis reviews

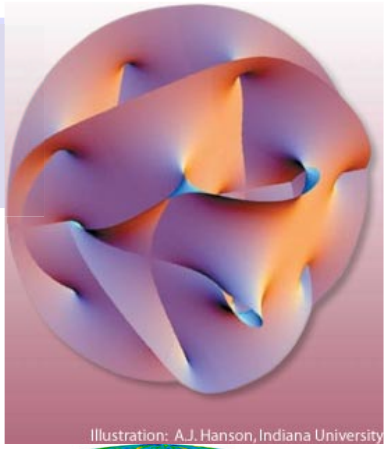
ILC

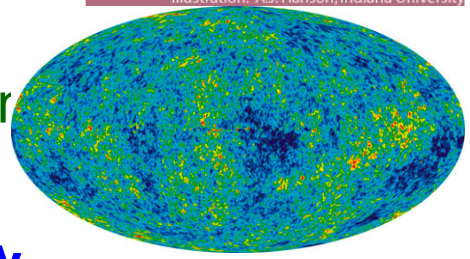
- Polarized Photocathode R&D (RP)
- Source Laser Development (RP)
- SiD Muon System Design and Management (HB)
- KPIX ADC IC Testing (HB)

Daya Bay

- Band joined Daya Bay in FY09 – 100% effort is now in Daya Bay (Task L)

Task D: String Theory Theoretical Cosmology





Daniel Chung

- **Theoretical Cosmology**
  - Interface of high energy theory and cosmology
  - Implications of Higgs sector for cosmology
  - Inflationary cosmology, dark matter, and dark er

Akikazu Hashimoto

- **Formulational & formal aspects of string theory**
  - Gauge theory, QCD, Supergravity, AdS/CFT corresondence
  - Recent Focus: Bagger Lambert/ABJM Theories

Gary Shiu

- **String phenomenology & string cosmology**
  - Connect fundamental physics to particle phenomenology & cosmology
  - Beyond the Standard Model Physics from String Theory
  - String Inflation & the CMB
  - String Compactifications & their Low Energy Effective Action

Task E: CDF

Profs. Carlsmith, Pondrom, Assoc. Prof. Herndon

Scientists: J. Bellinger, W. Chung, J. Pursley (left for Harvard Med-Physics July)
Grad Students: V. Ramakrishnan, J. Nett (Graduated June 2010):

Intermediate Muon System, IMU (led by Prof. Carlsmith)

- M&O: Chung and Ramakrishnan
- Software: Muon simulation & reconstruction (Bellinger) and Id (Ramakrishnan)

Operations Pursley CDF Operation Manager 08-09

Tracking Software and trigger

- Monitoring of silicon data quality. Tracking reconstruction software (Herndon)
- Silicon Vertex Trigger monitoring, CDF release and operating system validation (Bellinger)

CDF Higgs Discovery Group (led by Prof. Herndon 2007-08)

- High M_H: $H \rightarrow WW \rightarrow l\nu l\nu$: Pursley, Nett, Prof. Herndon adv.
  - Includes Id using BMU. Have reached SM sensitivity at CDF. Higgs excluded 158-175 GeV

Muon based Electroweak Physics and Searches for New Physics

- W production forward backward asymmetry (Chung)

Jet Physics: QCD and New Physics

- Double parton interactions: Ramakrishnan -- Prof. Carlsmith adv.
- Quark substructure: Prof. Pondrom

CDF B Physics Group (led by Prof. Herndon 2005-06)

- Discovery of new hadrons B** and Σ_b (Pursley), $B_s \rightarrow \mu\mu$ (Herndon)

Task G: Phenomenology

Faculty: Vernon Barger, Lisa Everett, Francis Halzen, Tao Han

History & Mission of Phenomenology Institute:

- Group formed in mid-1960's for research at theory/experiment interface. Institute established at critical juncture in HEP in 1984 for U.S. phenomenology upon W,Z discovery at CERN
- Comparable in research function and influence to theory groups at national labs

Impact:

- Frontier phenomenology research in all major areas of HEP:
  - colliders, neutrinos, astrophysics, cosmology: Standard Model & New Physics
- Ongoing support to experimental groups in all areas:
  - Tevatron, LHC, Neutrino & Muon programs, ILC, IceCube,…
- UW Pheno research widely recognized and cited

Seminal Research Advances:

- Transverse mass/top signal, first proposal for H --> WW at Tevatron, jet veto/jet-tagging for Higgs searches, SUSY RGEs/models & search strategies, charged Higgs in b --> s gamma, large extra dimensions/Feynman rules, matter effects/CPV in neutrino oscillations

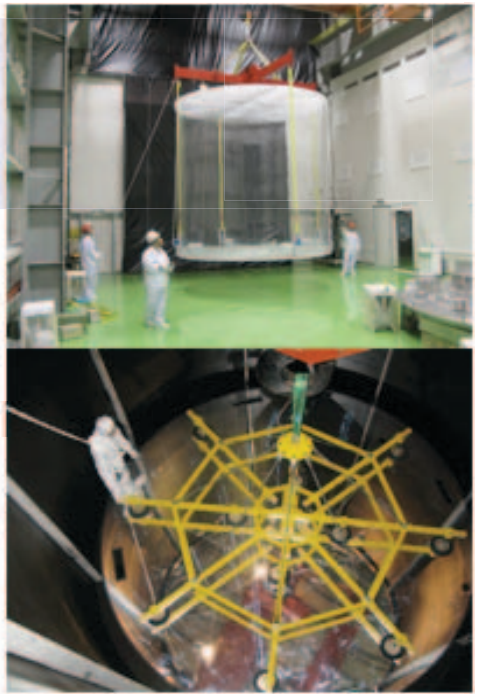
Conference Sponsorship:

- Pheno Symposium (32nd annual meeting in 2010): largest student participation of any U.S. HEP meeting, now regarded as first-level international meeting; CTEQ summer school

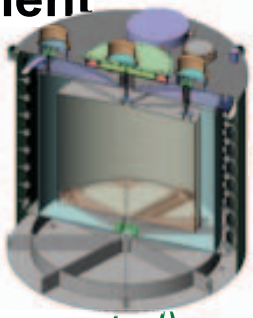
Students, Postdocs, and Visitors:

- More postdocs & grad students trained in phenomenology at UW than at any other university
- Thriving visitor program for short-term & long-term/sabbatical visitors

Task L: Daya Bay
Assoc. Prof. Karsten Heeger



Daya Bay is most sensitive θ_{13} reactor experiment



Physics Goal $\sin^2 2\theta_{13} < 0.01$ **by 2012**

provides critical input for future HEP neutrino program

UW Responsibilities

- US L2 manager of antineutrino detectors *(Heeger)*
- design & construction of acrylic detector target vessels *(Heeger et al)*
- precision measurement of target protons to <0.1% *(Wise et al)*
- characterization of physical detector properties *(Heeger et al)*
- detector integration, assembly, installation planning *(Band et al)*

Physics Studies

2009: detector design and sensitivity studies
2010: characterization of detectors, detector dry run data analysis

Progress and Schedule

May 2009	start of detector assembly
Fall 2010	detectors #1,2 complete
Spring 2011	begin data taking

Personnel Supported

Karsten Heeger	- faculty
Henry Band	- scientist (now 100%)
Wei Wang	- postdoc
Bryce Littlejohn	- grad student
Mike McFarlane	- grad student

Other Daya Bay Personnel at UW

Baha Balantekin (chair, theory faculty)
Tom Wise (researcher, project funded)
Christine Lewis (graduate student)
5 engineers from Physical Sciences Laboratory

Tasks H & T: LHC: ATLAS & CMS

2010: LHC now L=10^{31} with 50 bunches, 9E10 p/bch

Expect 10^{32} with 400 bunches, 1E11 p/bch, end Oct.

➔ 50 pb^{-1}

2011:

3.5 TeV, 3.5m, 3.75 um,

1e11 p/bch, 800 bunches

$$L = H \cdot T \cdot \frac{f\ k_b\ N^2}{4\pi\ \beta^*\ \varepsilon_T} = 1\ \text{fb}^{-1}$$

2e32 Hz/cm² x 9 months operation (23.3e6 seconds)

x 0.6 (turn-around & machine availability)

x 0.5 (lumi decay)

x 0.7 (physics running time)

} H = 0.21

= **1 fb^{-1}**

Task H: ATLAS

Faculty: S. L. Wu (Prof.), Y. Pan (Assoc. Prof.) & B. Mellado (Asst. Prof. since 2006)
DOE support : 1 Assistant Scientist, 2 Postdocs and 6 Graduate Students

ATLAS (since 1993 - 1st US group):

- **Responsible for design, production & commissioning of Read-out Driver (ROD) system for pixel & silicon strip detectors.**
- **Leading role in design, development & commissioning of High Level Trigger.**
- **Participation in Tile Calorimeter effort (new).**
- **Contributions to US ATLAS computing operations.**
- **Contributions to detector performance studies and software development.**
- **Leading role in Higgs studies and expanded efforts in SUSY, Exotic particle searches and Standard Model measurements.**
  - Improved analysis strategy reduced the luminosity needed for Higgs observation.
  - Bruce Mellado: H→WW group convener.
  - Assistant scientist Luis Flores: Lepton + X exotics group convener
- **Since April, 2010, contribute 20 results from data (15 physics results from data) to summer conferences.**

Education:

- **Granted 48 Ph.D. degrees in total – since 2004, 8 in BaBar and 6 in ATLAS.**
- **In 2004-2009, seven NEW faculty appt's awarded to former postdocs & graduate students.**
- **27 Former Postdocs & Graduate Students are (or have been) faculty members mainly in major U.S. universities & in addition 9 are permanent staff members at major HE Labs.**

Task T - CMS at LHC
(since 1993)

Personnel supported:

- **Profs. Dasu, Carlsmith, Herndon, Smith, Distinguished Sci. R. Loveless**
- **Scientists: Grothe, Klabbers, Lanaro, Savin, Bellinger (50%)**
- **Postdoc: Efron; 14 Graduate Students**

Activities (sampler):

- **Physics**
  - Electroweak (led by Dasu 08, 09): W/Z/photon+Jets, DiBoson with resonant searches
  - Vector Boson Fusion Higgs production, Higgs to ττ, Higgs to muons, Higgs to photons
  - Z', W', SUSY production of same sign di-leptons, Technicolor, B-jets, Diffractive Signals
  - Online event selection, Upgrade physics and trigger justification with simulations
- **Trigger**
  - Regional Calorimeter Trigger (full construction, M&O)
  - Level-1Trigger Project Management & CMS Trigger Coordination
  - Higher Level Trigger management, Upgrade (SLHC) Calorimeter Trigger
- **Endcap Muon**
  - Chamber operations, EMU Project Management
  - Detector Performance Analysis & Management, Alignment, all infrastructure
- **Tracking**
  - Tracking Integration Facility (TIF) Infrastructure, Tracker Patch Panels
- **Computing**
  - One of largest Tier-2 computing centers, US CMS production management
    - **Integrated with Grid Laboratory of Wisconsin (GLOW) & Open Science Grid (OSG)**
  - 21 M CPU hours of computing time delivered since Oct. 2005

University Support

	2010	1995-2010 Totals
Semester Leave	$10,000.00	$562,940.00
RA Support	$166,634.60	$630,827.10
Staff Support	$38,000.00	$614,958.33
Post Doc Support	$180,500.00	$1,034,500.00
Equipment	$78,200.00	$1,333,353.00
Summer Salary	$0.00	$357,622.68
Travel	$25,000.00	$338,500.00
Flexible	$20,000.00	$447,666.67
	$518,334.60	$5,320,367.78

Notes:

The HEP group has negotiated a 26% "off-campus" overhead rate for all of the HEP grant. This represents a substantial University contribution.

The amount shown does not include the personnel contribution that the University provides for HEP Faculty who receive 50% (per teaching semester) leave to support their research; nor does it include the 1.00 FTE contribution to the High Energy Administrative & Budget Offices.

History of Awards & FY10 Request

Base Program Awards (plus supplements) since 2008 and the FY11 funding request (does not include Lab Service Accounts)

Task	2011 (request)	2010	2009	2008
B - ZEUS				100,000
T - CMS	1,609,190	1,463,000	1,517,000	1,346,500
E - CDF	368,274	451,000	449,000	465,000
H - ATLAS I	793,839	978,000	977,000	970,000
H - ATLAS II	478,865			
C - BaBar	100,000	155,000	373,000	380,000
L - Daya Bay	452,261	330,000	210,000	115,000
D - String/Cosmo	315,460	180,000	280,000	205,000
J - Cosmo		80,000	80,000	75,000
G - Pheno	767,250	718,177	598,000	560,000
Q - QCD			95,000	95,000
Totals	4,885,139	4,355,177	4,579,000	4,311,500

FY10-11 Funding Change Summary

Task C (BaBar):	Band remaining 25% → 100% Task L (Daya Bay)	
	Computing support → Task L	
	Only Flood @ 100%	
Task E (CDF):	Pondrom retires!	
	Bellinger 50% support → 25% (25% to Task T)	
	100% Post Doc Pursley'	
Task G (Pheno):	Petriello leaves to Argonne/Northwestern	
	10K for Pheno Symposium Support	
Task H (ATLAS):	two groups:	ATLAS I (Wu)
		ATLAS II (Pan & Mellado)
Task J (Cosmology):	Combines with Task D (String Theory)	
Task L (Daya Bay):	Increase Band 75% → 100%	
	Add 1 grad	
	Add remainder Computing support from Task C	
Task T (CMS):	Add 2.8 grads	

Summary

Wisconsin HEP Grant Strongly Supports National HEP Goals with excellent present and future experimental programs:

- ATLAS, CDF, CMS, Daya Bay, ILC R&D, SLHC R&D
- Successfully completed Babar

Superb Theory programs:

- Cosmology, Phenomenology, String Theory

Strong collaboration within & between programs

- Theory ↔ Experiment (e.g. pheno & CDF, LHC, ν)

& training the leaders of the future:

- 73 Ph.D.s awarded 1999 – 2010 (to date)

We look forward to telling you about it.