DOE/Office of Science Program Office: Office of High Energy Physics
DOE/Office of Science Program Manager Contact: Dr. Abid Patwa
DOE Grant Number: DE-FG02-96ER40970

Closeout Report: Experimental High Energy Physics at the University of South Alabama

Submitted: June 25, 2013
For the period of April 15, 1996 to April 14, 2013

Applicant/Institution: University of South Alabama
VP for Research
307 University Blvd. N., AD 200
Mobile, AL 36688-0002

Principle Investigator:
Dr. Charles Merrill Jenkins
University of South Alabama
Physics
411 University Blvd. N.
ILB RM115
Mobile, AL 36688-0000
Phone: 251.460.6224
E-mail: mjenkins@southalabama.edu

Co-Principle Investigator:
Dr. Romulus Godang
Physics
411 University Blvd. N.
ILB RM115
University of South Alabama
Mobile, AL 36688-0000
Phone: 251.460.6224
E-mail: godang@southalabama.edu

1 A Brief Description of the University of South Alabama and Its High Energy Physics Program

The High Energy Physics group at the University of South Alabama has been supported by this research grant (DE-FG02-96ER40970) since 1996. One researcher, Dr. Merrill Jenkins, has been supported on this grant during this time worked on fixed target experiments at the Fermi National Accelerator Laboratory, west of Chicago, Illinois. These experiments have been E-705, E-771, E-871 (HyperCP) and E-921 (CKM) before it was canceled for budgetary reasons. After the cancellation of CKM, Dr. Jenkins joined the Compact Muon Solenoid (CMS) experiment as an associate member via the High Energy Physics Group at the Florida State University. A second, recently tenured faculty member, Dr. Romulus Godang joined the group in 2009 and has been supported by this grant since then. Dr. Godang is working on the *BABAR* experiment at SLAC and has joined the Belle-II experiment located in Japan at KEK. According to the instructions sent to us by our grant monitor, we are to concentrate on the activities over the last three years in this closeout report.

The University of South Alabama is a comprehensive State University that offers undergraduate and graduate degrees and has a medical school. The current enrollment is approximately 15,000 students. The Department of Physics, contained within the College of Arts and Sciences, does not have a graduate program but confers baccalaureate degrees. The teaching mission is a very important component to this department, so teaching loads for faculty are large: 12 contact hours per semester. However, the University of South Alabama gives 1/3 release time from teaching for members of the experimental high energy physics group.

2 Description of Accomplishments by Dr. Jenkins

2.1 CMS

Dr. Jenkins has worked on the CMS experiment over the past three years. Dr. Jenkins joined the Compact Muon Solenoid (CMS) experiment at the LHC as an associate member via the High Energy Physics Group at the Florida State University. Dr. Jenkins initially started to work on including the CATFISH microscopic black hole event genearator into CMSSW. He has worked with with the Top-Like Beyond the Standard Model (TLBSM) analysis working group with in Exotica. This working group was transferred to the Beyond the Second Generation Analysis group (B2G) and the new analysis working group is the Vector-like Bprime quark search with boosted topology. As part of his service work, he has worked on the HCal offline noise monitoring (trend plots) for the last two years.

2.1.1 Continuation 2009-2010; Activities 2009-2010

Operating funds were not authorized by DoE until September 2009 and did not arrive until November 2009. An awarded was made from the Recovery Act (DE-PS02-09ER09-02) for the procurement of two personal computers and 7 TB of disk space, however funds did not arrive this year.

1) Worked on CATFISH; migrate to several releases of CMSSW and adapt event shape variables from the CMS Top analysis package to look at CATFISH events.
2) Installed the iguana event display on the local software development personal computer.

3) Installed the fireworks event display on the local software development personal computer.
4) Installed a SQUID server on the local software development personal computer.
5) Attended approximately 11 DOSAR meeting via televideo conferencing meetings and the DOSAR workshop at LSU in April 2009.
6) Got a CoLinux condor cluster working on four local instructional laboratory personal computers running Windows XP operating system.

2.1.2 Continuation 2010-2011; Activities 2010-2011

1) Made two trips to Fermilab to take 17 offline DQM shifts at the Fermilab Remote Operations Center.
2) University of South Alabama Academic computing reconfigured the software development PC tower to include a 1 TB disk.
3) Installed Scientific Linux 5.4 (scl5.4) on the local software development personal computers.
4) Procured a 4 TB Network Accessible Storage unit (NAS), which was configured by the University of South Alabama Academic computing.
5) Worked on including CATFISH in a local 64 bit version of the CMSSW release.
    a) Multiple problems due to incompatibles with the legacy Fortran code C++ code; work not successful or completed.
6) Explored using the Alabama Supercomputer resources for use with CMS monte carlo.
    a) Supercomputer uses SUSE/linux which would not run CMSSW.
    b) Alabama Supercomputer staff setup cernVM and configured their system to run it in batch mode.
    c) I was able to run test CMS monte carlo events on the cernVM virtual appliances.
7) Participated in DOSAR: attended 5 meetings via televideo conference.
8) Received ARRA funds.
    a) The University of South Alabama Academic computing assisted with the selection, ordering and setup of the two workstations network accessible storage procured with ARRA funds.
    b) Two HP Z600 workstations with Intel Xeon ES630 processors with two 250 GB disk storage were procured and scl5.5 installed by USA Academic Computing.
    c) A HP Storageworks X1600 Network Accessible Storage System with nine 2TB disk drive. These drives were setup as two 2 TB disk configured in RAID 1, six 2 TB disk configured in RAID 6 and one 2 TB disk for hot swap by USA Academic Computing.
    d) The workstations were released to users in early January 2011 and the network attachable storage was released to users in February 2011.
    e) Close out report for the ARRA grant was submitted May, 2011.

f) Tangible personal property report for the ARRA grant was filed January, 2012.

2.1.3 Comparative Review 2011-2012 / DE-FOA-0000600 (One Year); Activities 2011-2012

The application to the DE-FOA-0000573, the Comparative Review, was declined automatically and without external review because our application did not include a separate Form 4620 (budget) for each task (CMS and BaBaR/Belle-II). In subsequent conversations with our grant monitor, we found that we could submit an application for one-year funding with a constant level of effort (DE-FOA-0000600). We were granted a one-year award and planned to submit another application in the next cycle to be considered under the comparative review. The activities for Dr. Jenkins under the one-year constant level of effort follows.

1) Took two trips to Fermilab to take Offline DQM shifts at the Fermilab Remote Operations Center.
   a) Took 18 offline DQM shifts at the Fermilab Remote Operations center.
2) Started to work on offline HCal Noise monitoring.
   a) Re-started the offline HCAl noise monitoring from legacy code (to web-publish noise trend plots).
   b) Used Prompt-Reco stream interspill cosmics events as input to HCalNoiseAnalyzer.
   c) Produce trend plots for Ionfeed back, HPD discharge rate and RBX noise.
   d) Modified existing code and wrote new code to partially automate the production of trend plots.
   e) Processed approximately 490 Promp-Reco interspill 2011 cosmic runs.
3) Stopped working on CATFISH.
4) Started to work in the Exotica Analysis group; the Top-like Beyond the Standard Model working group.
   a) Responded to E-mail in May 2011 asking for collaborators to join the top-like signatures working group.
   b) Dr. Jenkins used centrally produced Monte Carlo AODSIM data sets and processed them into Top-Like Beyond the Standard Model (TLBSM) Ntuples for the working group (approximately 50 data sets) using the CRAB on the grid.
   c) Many of these data sets were used for a search for an extended Standard Model tprime quark search.
   d) This search resulted in a publication: Phys Lett B 718(2012)307. Again, my contribution was the processing of Monte Carlo AODSIM into TLBSM Ntuples.
   e) Started to look into a search for LQ3 $\rightarrow t\overline{\nu}_{\tau}$.

2.1.4 Comparative Review 2012-2013 (Declined); Activities 2012-2013

Our application under the Comparative review was declined; hence this close out report.

1) Stopped the LQ3 $\rightarrow t\overline{\nu}_{\tau}$ analysis because not enough progress was made and other working groups had started similar analysis with 2012 8 TeV data.
2) Took two trips to Fermilab to stand a total of 9 offline DQM shifts at the Fermi Lab Remote Operation Center (ROC).
3) Continued to work on the offiline HCAL noise monitoring for the 2012 data run.
    a) The 2012 run used CalHPDNoise Raw stream interspill events as input to HCalNoiseAnalyzer.
    b) Extra CPU processing time required batch mode production on the Fermilab condor cluster.
    c) This required writing new python scripts to submit runs on the condor cluster for production through the analyzer, then running the script that produce individual run web pages and the trend plot.
    d) Three EVO presentations to the HCal Noise working group on the status of the offline HCal noise monitoring.
    e) Two EVO presentation to the HCal PF2G working group on the status of the offline HCal noise monitoring.
    f) Combined the 2011 and 2012 trend plots.
    g) Processed approximately 320 CalHPDNoise Raw stream interspill 2012 cosmic runs.
4) The Top-Like Beyond the Standard Model working group (inside the Exotica analysis group) was moved to the Beyond the Second Generation (B2G) analysis group. The new working group is now the Vector-like Bprime quark search with boosted topology.
5) One 2011 TLBSM Working group analysis, a search for a bPrime type quark (EXO-11-86) was transferred to the B2G Analysis group and the analysis was renamed: B2G-11-004.
    a) This analysis has resulted in one publication: JHEP 01(2013)154.
6) Dr. Jenkins' contribution to the B2G Bprime quark search with boosted topology group includes:
    a) Processed approximately 20 CMSSW_5_3_2 TLBSM Ntuple datasets from centrally produce signal Monte Carlo AODSIM datasets.
    b) Processed approximately 140 signal and 10 background CMSSW_5_3_3 TLBSM Ntuple datasets from centrally produce signal and background Monte Carlo AODSIM datasets.
    c) One private sample ($t\prime \rightarrow tZ$, $m_{t\prime} = 650GeV$) for the B2G-11-004 analysis.
    d) Processed 40 signal TLBSM Ntuple datasets into b-tagging efficiency maps.
    e) Processed 20 background TLBSM Ntuple datasets into EDM NTuples using EDSHyFT.
7) Deleted obsolete data TLBSM sets that I produced in order to free up space on the `lpctlbsm` area.

Dr. Jenkins applied for and received a no cost extension for one year on the current project. Finally, Dr. Jenkins has recently applied to join the Belle-II collaboration. He has been granted Belle-II computer accounts at KeK.

2.1.5 List of Publications

1) CMS Collaboration, "Search for pair produced fourth generation up-type quarks in pp collisions at $\sqrt{s} = 7$ TeV with a lepton final state", Physics Letters B 718(2012)307-328; arXiv:1209.0471.
2) CMS Collaboration, "Search for heavy quarks decaying into a top quark and a W or Z boson using lepton + jets events in pp collisions at $\sqrt{s} = 7$ TeV", JHEP 01(2013)154; arXiv:1210.7471.

2.1.6 List of Presentations

1) C. M. Jenkins for CMS, "Exploring the Use of the Alabama Supercomputer Authority resources to supplement CMS Monte Carlo Production", Bulletin of the APS Vol 54, page 14 77^{th} Annual Meeting of SESAPS, October 2010, Baton Rouge, LA.
2) C.M.Jenkins for CMS, "Search for a Fourth Generation t' Quark via Wb Decays into a Lepton Plus Jets Final States", Bulletin of the APS Vol 56, page 54, 78^{th} Annual Meeting of SESAPS, October 19-22, 2011, Roanoke, Virginia.
3) Charles Jenkins for CMS, "Search for a Fourth Generation Top-Like Quark with a Single Charged Lepton Final State in 7 TeV pp Collisions", Bulletin of the APS, Vol 57, page 23, 79^{th} Annual Meeting of SESAPS, November 14-17, 2012, Tallahassee, FL.

2.1.7 List of Presentations, Internal to the University of South Alabama

Every spring the University of South Alabama Faculty Development Council and the Graduate School sponsors a Research Forum. This Research Forum is a vehicle to showcase research done by University of South Alabama Faculty. The format is a poster. I list the posters submitted, that were constructed from the talks presented at SESAPS for that year.

1) C. Merrill Jenkins et. al., "A colinux/Condor Computing Cluster at the University of South Alabama", **Poster 15**, 17^{th} University of South Alabama Annual Research Forum, University of South Alabama, March 8-11, 2010, Mobile, AL.
2) C. Merrill Jenkins et. al., "Running the CMS Monte Carlo Event Generator on an Alabama Super Computer Cluster", **Poster 21**, 18^{th} University of South Alabama Annual Research Forum, University of South Alabama, March 28-April 1, 2011, Mobile, AL.
3) C. M. Jenkins (for the CMS Collaboration), "Search for a Fourth Generation t' Quark via Wb Decays into Lepton Plus Jets Final State in 7 TeV pp Collisions", **Poster 10**, 19^{th} University of South Alabama Annual Research Forum, University of South Alabama, March 26-30, 2012, Mobile, AL.
4) C. M. Jenkins (for the CMS Collaboration), "Search for a Fourth Generation Top-Like Quark with a Single Charged Lepton in the Final State at 7 TeV pp Collisions", **Poster 50**, 20^{th} Annual Research Forum, University of South Alabama, March 18-21, 2013, Mobile, AL.

2.2 Description of Accomplishments by Romulus Godang

2.2.1 *BABAR* Experiment

The *BABAR* detector was built at SLAC to study the millions of B mesons produced by the PEP-II storage ring in 1995. The *BABAR* Collaboration consists of approximately 600 physicists and engineers from 72 institutions in 12 countries. The *BABAR* experiment has been continuing to produce excellent science publication. *BABAR* speakers presented 44 analyses including 9 brand new analyses at the 36^{th} International Conference on High Energy Physics in Melbourne, Australia in early July 2012. Dr. Romulus Godang presented "Charm Decays and Spectroscopy at *BABAR*" on behalf of the *BABAR* collaboration at the ICHEP 2012.

DOE has supported Dr. Godang and few physics undergraduate students at the University of South Alabama for conducting research on *BABAR* data. The students presented talks and/or poster presentations at several Southeastern Section of the American Physical Society (SESAPS) conferences, USA undergraduate symposium, and undergraduate mini conferences. One of Dr. Godang's students, Christopher Buchanan, had submitted an honors thesis using *BABAR* data. He is currently continuing his PhD program in physics at the Louisiana State University.

2.3 Description of Accomplishments on *BABAR* 2010-2013

1. Served as the American Physical Society Reviewer 2010-present.
2. Served as the *BABAR* representative to the Heavy Flavor Averaging Group 2005-2010.
3. Served as consultant to the Particle Data Group 2005-present.
4. Served as the *BABAR* paper committee chairs and members 2010-present.
5. Conducted a preliminary result on the branching fraction of $\Upsilon(4S) \to B^0\bar{B}^0$ known as f_{00} value using the entirely *BABAR* data sets in Release 22.
6. Worked with undergraduate students from University of South Alabama and a postdoc from University of Mississippi (Peter Sonnek). He graduated from University of Mississippi.
7. (Invited) Presented a plenary talk on behalf of the *BABAR* Collaboration at the 16^{th} International Seminar on High Energy Physics, Kolomna, Russia June 2010.
8. Presented two talks at the *BABAR* Collaboration meetings, one at SLAC, June 2010 and one in Berlin, Germany via phone conference, October 2010.
9. Presented other two talks at the *BABAR* Analysis Working Group via phone conference.
10. Presented a talk at the 77^{th} Annual Conference Meeting of the Southeastern Section of APS (SESAPS), Baton Rouge, LA October 2010.
11. Chaired a session at the 77^{th} Annual SESAPS Conference Meeting, October 2010.
12. Advised USA undergraduate students: Christopher Buchanan, Shannon Eynon, Rafi Qumsieh, Eric Urban, Jie Zhou, and Jeffrey Mizell.

13. Presented two talks and chaired a plenary session at the 78^{th} Conference Meeting of the Southeastern Section of APS (SESAPS), Roanoke, VA October 2011

14. Presented "Charm Decays and Spectroscopy at *BABAR*" at 36^{th} International Conference on High Energy Physics (ICHEP 2012), Melbourne, Australia, [arXiv:1301.0141], 2012.

15. Presented "*BABAR* Results on CP Violation in B Decays" DPF-2011 [arXiv:1109.3223], 2011.

16. Producing analysis documentation on the Isospin Breaking at Upsilon(4S), *BABAR* Analysis Documentation, BAD 2168, 2012.

17. Supervised one undergraduate honors student, Christopher Buchanan, who had submitted his Honors Thesis requirement "Measurement of B Meson Properties at the *BABAR* experiment". Christopher is currently at the Louisiana State University, Physics Department, 2012

18. Presented "The Nobel Prize in HEP and the B-Factory experiments" Physics Colloquium, National University of Singapore, Singapore, 2012.

19. Presented "CP Violation and Hot Topics From *BABAR* " Physics Colloquium, Kyoto University, Japan, 2012.

20. Presented "Branching Fraction of Semileptonic $\bar{B}^0$ Meson", poster presentation at 19^{th} Annual USA Research Forum, 2012.

21. Chaired more than 25 *BABAR* practice talks for *BABAR* invited speakers, 2012 - 2013.

22. Submitted abstract on "Searches for Low-Mass Higgs in Υ Decays" at the th International Workshop on heavy Quarkonium, Beijing, China, 2013.

2.4 Belle II Experiment

Dr. Romulus Godang joined the Belle II experiment at SuperKEKB as a full member in April 2011. The Belle II is the experimental research at the intensity frontier which is one of the five broad sub-programs within the Office of High Energy Physics. In 2010-2013 the Belle II group at the University of South Alabama consists of one faculty member (Dr. Godang) and two undergraduate physics major.

The B-factory experiments, Belle at the KEKB accelerator at KEK and *BABAR* at the PEP-II accelerator at SLAC have confirmed with significant precision the theoretical predictions of the Standard Model. The successful confirmation of the theory of CP Violation led to the 2008 Nobel Prize for physics awarded to M. Kobayashi and T. Maskawa. Much larger data sample than the B-factory is needed for high-precision measurements to provide further important information on the details of new physics processes beyond the Standard Model. These studies are expected to provide unique information to be uncovered by the energy frontier at the Large Hadron Collider (LHC). The Belle II experiment is one of the intensity frontier experiments within the Office of High Energy Physics, Department of Energy.

The upgraded KEKB accelerator, SuperKEKB, is designed to deliver a factor of 40 higher than the highest luminosity of the KEK accelerator. The SuperKEKB accelerator will operate at an instantaneous luminosity of $8 \times 10^{35}\ cm^{-2}s^{-1}$. The planned commissioning of the SuperKEKB

accelerator is in 2015 so that a data sample of 50 ab^{-1} can be collected until 2021. The Belle II collaboration was formed in 2008 and the US institutions membership has expanded over the last years to 31 members from 8 US institutions: University of Hawaii, Virginia Tech, University of Cincinnati, Wayne State University, Indiana University, University of South Alabama, Luther College, University of Pittsburgh, and one national laboratory, the Pacific Northwest National Laboratory (PNNL).

2.5 Description of Accomplishments on Belle II 2011-2013

1. Developing physics modules using EvtGen Monte Carlo generator into Belle II analysis software system, BASF2
2. Simulating and studying the Barrel KLM subdetector at Belle II, 2011
3. Maintaining and updating the EvtGen Monte Carlo package into BASF2
4. Presented by EVO "Monte Carlo Production" at PNNL
5. Presented by EVO "Shower Parameterization" at the 4^{th} Belle II Computing Workshop, Slovenia
6. Developing EvtGen into BASF2 at KEKB and PNNL clusters
7. Installed BASF2 package into PNNL cluster for Monte Carlo production study
8. Participated in "Belle II Computing/OSG Workshop" at PNNL, 2011
9. Presenting "EvtGen Monte Carlo Study" at the Belle II Workshop at PNNL, 2012
10. Participating in weekly Belle II software developers meeting
11. Participating in weekly US Belle II group meeting
12. Participating in weekly US Belle II software meeting
13. Participating in Belle II software meeting, 2012-2013
14. Presenting EvtGen generator at the Belle II physics meeting, 2012
15. Participating in ITOP sub-detector software and hardware meeting, 2013
16. Presenting EvtGen generator (PHOTOS) at the Belle II physics meeting, 2013
17. Presenting $B^0 \to K^+\pi^-$ study at the Belle II physics meeting, 2013
18. Presenting $B^0 \to K^{*0}\gamma$ study at the Belle II physics meeting, 2013
19. Presenting $B^0 \to K^{*0}\gamma$ study at iTOP weekly meeting, 2013
20. Participating in weekly US PI meeting, 2012-2013

2.6 Student's Presentations

1. Christopher Buchanan presented a talk at the 19^{th} Annual USM/USA/SELU Mini-Conference, Hattiesburg, MS April 2010.

2. Eric Urban presented a talk at the same Mini-Conference, Hattiesburg, April 2010

3. Christopher Buchanan presented a talk at the 77^{th} Annual SESAPS Conference, October 2010

4. Shannon Eynon presented a talk at the 77^{th} Annual SESAPS Conference, October 2010

5. Shannon Eynon presented a poster presentation at the USA 12^{th} Annual Undergraduate Symposium, Mobile, October 2011

6. Christopher Buchanan presented a talk at the 78^{th} SESAPS Conference, Virginia 2011

7. Christopher Buchanan presented a poster presentation at the USA Faculty Forum, Mobile, 2012

8. Jie Zhou presented $B^0 \to K^+\pi^-$ study at the 21^{th} Annual USM/USA/SELU Mini-Conference, Hattiesburg, 2013

2.7 Journal Publications

1. **R. Godang**, Search For New Physics at *BABAR* the Proceedings of the Hadron Collider Physics Symposium 2012, arXiv:1302.2171, 2013

2. **R. Godang**, Charm Decays and Spectroscopy at *BABAR* , the Proceedings of the 36^{th} International Conference on High Energy Physics, arXiv:1109.3223, 2012.

3. **R. Godang**, *BABAR* Results on CP Violation in B Decays, arXiv:1109.3223, the Proceedings of The Division of Particles and Fields of APS, 2011.

2.8 List of People Working on the Projects 2010-2013

1. **Romulus Godang**, faculty, working on *BABAR* and Belle II, 2010-2013

2. **Christopher Buchanan**, undergraduate student, working on *BABAR*, 2010-2012

3. **Shannon Eynon**, undergraduate student, working on *BABAR*, 2011-2012

4. **Jie Zhou**, undergraduate student, working on Belle II, 2012-2013

3 Current List of People Working on this Research Activity

The following list of personnel working currently on this project follows

Name	Position	Support
Charles Merrill Jenkins	Professor	2 Months (summer, 1 FTE on Demographics form)
Romulus Godang	Assistant Professor	2 Months (summer, 1 FTE on Demographics form)
Jie Zhou	Undergraduate Student	0.17 FTE on Demographics form

4 Unexpended Funds

The current balance for unexpended funds as of April 2013 is $9,570.25. Almost half of this total is in the form of Fringe benefits and indirect cost (overhead). Our group have applied and was granted a no cost extension that expires on April 14, 2014 (04/14/2014).