Langston University-High Energy Physics (LU-HEP)
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Final Report
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1 Accomplishments

Introduction - DOE grant funding for the Langston University (LU) High Energy Physics (HEP) group began in April 1999. At the time the group consisted of Dr. Joel Snow the PI and Dr. Tim McMahon the co-PI as well as several undergraduate students hired as research assistants. The group was involved as collaborators in the DØ and ATLAS experiments. Both physicists were on the author lists of both experiments. Langston University was listed as a collaborating institution on the DØ masthead. The group's participation in ATLAS was through their affiliation as adjunct faculty with the University of Oklahoma (OU) which is a collaborating institution on ATLAS. Detailed below are the accomplishments of the group for the period April 1, 1999 to May 14, 2012.

1999-2002 First Funding Cycle - In 1999 as member of the Online Systems group for Run 2 Snow developed a cross-platform Python-based, Graphical User Interface (GUI) application for monitoring and control of EPICS based devices for control room use. This served as a model for other developers to enhance and build on for further monitoring and control tasks written in Python.

Subsequently Snow created and developed a cross-platform C++ GUI utilizing a networked client-server paradigm and based on ROOT, the object oriented analysis framework from CERN. The GUI served as a user interface to the Examine tasks running in the DØ control room which monitored the status and integrity of data taking for Run 2. Snow developed the histogram server/control interface to the GUI client for the EXAMINE processes. The histogram server was built from the ROOT framework and was integrated into the DØ framework, a fully asynchronous interactive framework written in C++ , used for online monitoring programs and offline analysis.

Snow developed the first implementation of displaying histograms dynamically generated by ROOT in a Web Browser. The method entailed the use of the ROOT histogram server program, a CGI program invoked by a Web server, and a virtual frame buffer X display driver. To accomplish this Snow wrote a C++ CGI client for the histogram server. The histogram server, GUI client, and CGI client developed by Snow are software packages in the DØ code repository, and were deployed as part of the online system for DØ in Run 2.

Snow's work developing the ROOT based histogram server, GUI and CGI clients resulted in several talks and papers at international conferences and workshops. The beginnings of this work, "DØ Online Use & Plans for ROOT", was presented by Snow at the US High Energy and Nuclear Physics ROOT Users Workshop, held March 1999 at Fermilab, IL, USA. The early work was presented by another collaborator at the Eleventh IEEE NPSS Real Time '99 Conference in June, 1999 held in Santa Fe, NM, USA, as part of the talk "Online Monitoring in the Upcoming Fermilab Tevatron Run II", and published in Proceedings 11th IEEE NPSS Real Time Conference and as Fermilab Preprint Fermilab-Conf-99/235/E. Snow gave the talk, "DØ Online Use of Root" at the ROOT 2000 Second International HENP Users Workshop held in February, 2000 at CERN, Geneva, Switzerland. Representing the DØ Collaboration, Snow gave the talk "Use of ROOT in the DØ Online Event Monitoring System" at the International Conference on Computing in High Energy and Nuclear Physics held February, 2000 in Padova, Italy, and published in Proceeding of CHEP 2000 and as Fermilab Preprint Fermilab-Conf-00-018-E. At the ROOT 2001 Third International HENP Users Workshop held in June, 2001 at Fermilab, IL, USA,

Snow gave the talk, "Web-based Access to ROOT at DØ". An expanded version of the same talk, "Web-based Access to ROOT at DØ", was given by Snow at the International Conference on Computing in High Energy and Nuclear Physics held in September, 2001 in Beijing, P.R. China.

Snow served as DØ code librarian, software maintainer, and webmaster for the OU/LU group during the first funding cycle. This involved installing and maintaining DØ Run 1 library code for official and test releases at OU, Fermilab software products, and other software needed in a productive research environment at OU and LU. The DØ libraries at OU were used to conduct Run 1 analyses at OU which resulted in publications and theses. As an adjunct professor at OU Snow participated in the establishment of a US ATLAS GRID testbed site at OU.

At Langston Snow manages a Linux cluster. The cluster is registered to receive Fermi software products and has installed Fermilab product distribution software. In accord with the Strong Authentication Program at Fermilab Snow implemented Kerberos Network Authentication Service V5 at OU and LU.

Snow traveled to CERN in July 1999 to participate in the ATLAS pixel test beam. There various pixel module prototypes were irradiated in a pion beam. Analysis of the data was done to determine detector performance as a function of angle and various electronic parameters. A pixel module test station was established at Langston in collaboration with OU.

2002-2005 Second Funding Cycle - Dr. McMahon was not funded at renewal time and was dropped from the grant. In year one the online remote monitoring packages were still under development. Besides bug fixes and maintenance new features were added to the existing packages and another package was added. The new package provided a light-weight multi-threaded server that functioned as an Examine registry. The Examine registry overcame the limitation of hard coded hosts and ports in the code and configuration files.

The LU HEP cluster was upgraded with the addition of four dual 2.2 GHz P4 Xeon machines. Video conferencing became available in the LU HEP lab using the VRVS conferencing system, a sound card, and a USB video camera. Conferencing with DØ and ATLAS colleagues proved to be extremely useful.

In 2002 Snow became a member of the DØ Remote Analysis Coordination Effort. Snow installed and setup the software infrastructure on the OU Linux cluster to maintain and develop the DØ code releases locally at OU. Snow installed the DØ SAM software at OU to accomplish efficient bi-directional network data transfers between OU and central tape storage at Fermilab. SAM is a data grid in today's parlance.

Work on simulation production started at OU in collaboration with U. of Texas at Arlington (UTA). OpenAFS was installed to allow access to the ATLAS code mirror at Brookhaven. Condor and Globus were installed.

The second year effort diminished in online work as development of the software suite ceased but maintenance continued through compiler upgrades and ROOT API changes. At LU the computing infrastructure expanded as additional storage, memory, bandwidth, and CPU's were added to the cluster. At OU and LU Snow established simulation farms to process official DØ Monte Carlo requests. Snow continued to serve as DØ code librarian, software maintainer, and co-webmaster for the OU/LU group.

Snow installed and setup the DØ software infrastructure on both the OU and LU Linux

clusters to maintain and develop the DØ code releases locally at LU and OU. Snow installed the DØ SAM software at OU and LU to accomplish metadata cataloging, data transfer and storage between OU and LU remote clusters, and central tape storage and database at Fermilab. Snow installed Ganglia monitoring software on the LU cluster.

Snow and Dr. Severini of OU co-authored a DØ note detailing how to use a non-dedicated desktop cluster (like at LU and OU) that has interactive users, other batch jobs, and ATLAS grid jobs running on it as a MC production site.

During the third year virtually all effort was spent in the realm of remote analysis and simulation as the implementation of grid enabled Monte Carlo production became a reality for DØ.

Both the OUHEP and LUHEP clusters operated as Monte Carlo production sites for the DØ experiment. In March 2004 at the urging of the DØ spokespersons and the invitation of our São Paulo collaborators, Snow traveled to Brazil to help establish a remote site there with newly acquired hardware. The trip was very successful as SPRACE was producing Monte Carlo for DØ and storing it in SAM at Fermilab within two weeks. Snow installed and configured a SAM station, MC job management software, Condor, and Ganglia on top of the existing DØ release infrastructure on the SPRACE cluster.

The third year saw the deployment of SAMGrid (SG) for Monte Carlo production of the DØ experiment. The SAMGrid is a software suite that addresses the globally distributed computing needs of the Run II experiments at Fermilab. The Job and Information Management (JIM) components complement the Data Handling system of the experiments (SAM), providing the user with transparent remote job submission, data processing and status monitoring.

At the end of 2003 Snow took on the role of global Monte Carlo production coordinator for the DØ experiment. A role which continues til this day. In January of 2004 Snow started working with the SAMGrid development team to help debug, deploy, and integrate SAMGrid with DØ Monte Carlo production. Snow installed and configured SG execution and client sites at LUHEP and OUHEP, and a SG scheduler site at LUHEP. Snow was part of the team that enabled OUHEP to be the first HEP grid site to demonstrate the interoperability of grids, specifically SG and Grid3. Snow was the DØ experiment liaison and the Fermilab SAMGrid project liaison to Open Science Grid (OSG).

Snow developed a python based GUI (DAJ) that acts as a front end for job submission to SAMGrid. The GUI interfaces to the DØ MC request system that uses SAM to manage MC requests by the physics analysis groups. DAJ significantly simplified SG job submission and was deployed in DØ in an effort to increase the user base of SG. Snow presented the talk "High Energy Physics at OSCER: A User Perspective" at the Oklahoma Supercomputing Symposium 2003 held at OU in September.

2005-2009 Third Funding Cycle - For the entire funding cycle Snow continued serving as Monte Carlo production coordinator for the DØ experiment, and Grid enabled MC production continued at the LU and OU HEP clusters. The first year of the funding cycle was the advent of SAMGrid job submission to the Open Science Grid (OSG) and LHC Computing Grid (LCG) through a forwarding mechanism.

For the first time in HEP, data taken at the accelerator was initially processed at sites remote from the central laboratory by DØ using SAMGrid at sites on three continents. Snow was the expert leading a team submitting the primary processing jobs.

Part of the production coordinator's work in 2006 was to transition resources from version 5 of SAM to version 7 while maintaining continuity of production. Tools and infrastructure needed to be re-written and deployed to accomplish this. Snow re-wrote the MC request queuing system and the MC request page generation system for SAM V7.

Snow wrote a GUI for MC job submission was deployed at various sites. He also developed an automatic MC (Automc) request processing system capable of operating without user intervention (other than getting grid credentials), and able to submit to any number of sites. The system manages production at all but 2 sites. Job submission, bookkeeping, and error recovery are all automated. Written initially for SAM V5 were updated for V7. The Automc system was developed to make more effective use of dwindling manpower. The system was deployed at Fermilab and remains operating there today. Fermilab bought out Snow's teaching time and appointed him to a guest scientist position for 2006-2009.

UTA, OU, and LU were chosen as the collaborating institutions that form the Southwest Tier 2 Center (SWT2) for ATLAS. For the SWT2 OU and LU pooled resources and purchased a 40 node cluster with 5 TB of dedicated storage. The cluster is housed at OU where infrastructure is adequate for such a facility. LUHEP purchased additional maintenance contracts for the SWT2 hardware and 18.5 TB of additional disk storage. The following year LUHEP purchased 23 dual quad-core Xeon 64-bit 2.33 GHz machines for the ATLAS SWT2. The funds were provided by a DOE EPSCoR grant.

Snow presented an invited talk at the International Conference on Computing in High Energy and Nuclear Physics in Mumbai, India, February 13-17, 2006, describing DØ's data reprocessing with SAMGrid. Snow gave an invited talk entitled "High Energy Physics Computing At OSCER" at the Oklahoma Supercomputing Symposium on October 4, 2006 at the University of Oklahoma in Norman Oklahoma.

At OUHEP Snow began maintaining SAM servers which provide a durable storage location and cache disks for the SAMgrid-OSG infrastructure for DØ. It's operation is crucial for SAMgrid-OSG jobs at remote sites. This support continues today.

DØ reprocessed its data in early 2007 using the SAMGrid-OSG mechanism and other resources. Snow served as an on-call expert to assist the teams of job submitters.

AutoMC's initial deployment served only native SAMGrid sites but was soon expanded to serve OSG and LCG sites. Snow served as a member of DØ's Computing Planning Board (2007-2008).

In the spring of 2008 Snow did a study of MC production job efficiency at OSG sites. The results suggested that efficiencies were significantly higher at sites where files were cached in a physically nearby location, rather than coming from a remote storage cache somewhere on the grid. This generated an initiative by OSG and DØ to deploy more Storage Element's (SE) for DØ use. As a result additional SE's were deployed for DØ MC production and these sites showed a step function like increase in efficiency. The program was successful and initiated a similar program for the CDF experiment by the OSG. Snow served as co-representative for the DZero Virtual Organization to the OSG.

In 2008 the LU HEP computing infrastructure was upgraded with an equipment rack, gigabit switch, and a quad-core rack mounted machine. The machine forms the gateway from the Internet to a private network on which sits the workers of a cluster forming a Condor pool. The Condor pools of the old and new clusters were configured to flock so that DØ MC jobs obtained from the grid via the old cluster's gatekeeper run on the new cluster also.

2009-2012 Fourth Funding Cycle - The following occurred for the entire fourth funding cycle: Snow served as Monte Carlo production co-coordinator for DØ; DØ MC production continued at LU; the automated MC production system (AutoMC) created by Snow continued in operation at FNAL and under went continual development and refinement; Fermilab bought out Snow's teaching time and appointed him to a guest scientist position; Snow served as co-representative for the DZero Virtual Organization to the OSG; Snow maintained the SAM servers at OU that provide a durable storage location and SAM stager disks for the SAMGrid-OSG infrastructure of DØ.

In 2009 the LU HEP computing infrastructure was upgraded with the addition of a quad-core dual-CPU rack mount machine and dual-CPU desktop. The LU HEP machines were configured into two clusters. The two multi-core rack mounted machines form a cluster on a private network (LUHEP-OSG) with one of the machines acting as the gateway to the Internet. This cluster uses the OSG Computing Element (CE) software stack. The other cluster (LUHEP) is on the public network and has grid gatekeeper that accepts SAMGrid jobs. Both clusters receive their workload via the grid from the Automated Monte Carlo Production system running at FNAL. Snow created MC production monitoring tools.

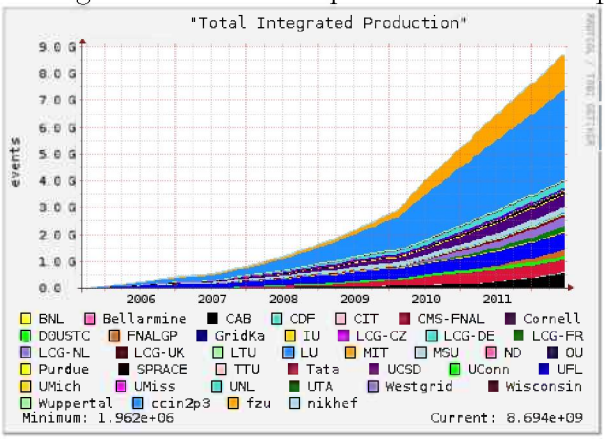
On behalf of the DØ collaboration Snow presented the talk "Distributed Monte Carlo Production For DZero" at the Computing in High Energy and Nuclear Physics Conference held in Prague, Czech Republic March 21-27, 2009, and the talk "Open Science Grid Use By DZero" at the OSG School held in São Paulo, Brazil, December 6-10, 2010.

In 2010 the LUHEP-OSG cluster was augmented with the addition of an OSG Storage Element (SE) associated with the LUHEP-OSG CE. The SE runs the Bestman Gateway stack as a front end to Storage Resource Management (SRM) technology. During 2011 and 2012 the LUHEP-OSG cluster added 36 cores in 3 machines and several terabytes of additional storage, quadrupling the computing power of the cluster. In 2010 LU HEP purchased an additional 100 TB of disk storage for the OU/LU ATLAS SWT2 and 23 octal core compute nodes. The funds were provided by a DOE EPSCoR grant renewal.

Conclusion - During the project period the PI contributed to the online and offline software infrastructure through his work with the Run 2 online group, and played a major role in Monte Carlo production for DØ. During the part of the project period in which the PI served as MC production coordinator MC production increased very significantly. In the first year of Snow's tenure as production coordinator production was 159M events and 6.7 TB of data. During the last year of the project period production was 2,342 M events and 262 TB of data. That is a factor of 15 increase in events and 39 in data volume. The increase occurred with improvements in computer hardware and networks, through the use of grid technology on diverse resources, and through increased automation and efficiency of the production process. LU HEP developed and deployed the automatic MC request processing system in use at FNAL. The complementary strategies of automation and grid production served DØ well. Fermilab has recognized LU HEP's contribution to DØ by allowing the PI to devote full time to research activities by appointing him a guest scientist for the last six years of the project period.

LU HEP contributed substantial assets to the ATLAS Tier 2 facility at OU using funds provided by a DOE EPSCoR grant to a OK State, OU, and LU collaboration. The PI established LU as distributed computing resource through the establishment of a grid computing facility for DØ MC production.

Figure 1: Integrated DZero MC production since Sept. 2005.



2 Publications

Snow has been on the author list of DØ and ATLAS for the entire project period. Snow contributed to the publications of DØ through his work in the Online Group and his over 11 year service as DØ's MC production coordinator. An adequate and timely supply of simulation data is an important component of producing publications for the DØ experiment. The publication list is available in the Inspire HEP publication database. The collaborators of the experiments are funded by the DOE, the NSF, and various national research funding agencies.

3 Personnel

Dr. Joel Snow was supported by this grant for the entire project period, from April 1, 1999 until May 14, 2012. Dr. Tim McMahon was supported by this grant from April 1, 1999 until March 31, 2002. Numerous undergraduate research assistants were employed over the project period using grant funds.

4 Unexpended Funds

Unexpended funds at the end of the project period total $41,253.57.

5 Budget

The budgets for the years 1999-2012 and a cumulative budget are included in this package as files luhep_budget_final_*.pdf.

6 Budget Narratives

1999-2000

Task A - The budget includes 2 months research salary for the faculty to work full time on the DØ experiment in the summer. The salary has been calculated at competitive rates for researchers. The student salaries are for 3 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 7 trips for 2 faculty to work on DØ at Fermilab at $1000 per trip, and for travel to 2 conferences and workshops per year and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and apartment rental during the summer for faculty and students.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

Task B - The student salaries are for 2 undergraduate research assistants, to be paid at an average rate of $7.50 per hour. Included in the budget is support for an Electrical Engineer at 0.33 FTE. The engineer will help establish a detector testing facility at Langston by setting up the facility and instructing research assistants in its use.

The travel is for 4 trips for 2 faculty to work attend ATLAS meetings and workshops in the U.S. and at CERN at $1500 per trip, and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, and car rental for faculty.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

2000-2001

Task A - The budget includes 2 months research salary for the faculty to work full time on the DØ experiment in the summer. The salary has been calculated at competitive rates for researchers. The student salaries are for 3 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 6 trips for 2 faculty to work on DØ at Fermilab at $1000 per trip, and for travel to 2 conferences and workshops per year and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and apartment rental during the summer for faculty and students.

Supplies are miscellaneous items for running a laboratory including tools, cables, hardware, computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

Task B - The student salaries are for 3 undergraduate research assistants, to be paid at an average rate of $7.50 per hour. Included in the budget is support for an Electrical Engineer at 0.3 FTE. The engineer will help establish a detector testing facility at Langston by setting up the facility and instructing research assistants in its use.

The travel is for 3 trips for 2 faculty to attend ATLAS meetings and workshops in the U.S. and at CERN, and participate in the test beam running at CERN at $1500 per trip, and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, and car rental for faculty.

Supplies are miscellaneous items for running a laboratory including tools, cable, hardware, computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

2001-2002

Task A - The budget includes 2 months research salary for the faculty to work full time on the DØ experiment in the summer. The salary has been calculated at the same rate as the academic salary. The student salaries are for 3 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 4 trips for 2 faculty to work on DØ at Fermilab at $1000 per trip, and for travel to conferences and workshops per year and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and apartment rental during the summer for faculty and students.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

Task B - The student salaries are for 2 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 3 trips for 2 faculty to attend ATLAS meetings and workshops in the U.S. and at CERN at $1500 per trip, and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, and car rental for faculty.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

2002-2003

Task A - The budget includes 2 months research salary for the faculty to work full time on the DØ experiment in the summer. The student salaries are for 4 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 8 trips for 2 faculty to work on DØ at Fermilab at $1000 per trip, and for travel to 2 conferences and workshops per year and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and apartment rental during the summer for faculty and students.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

Task B - The student salaries are for 3 undergraduate research assistants, to be paid at an average rate of $7.50 per hour.

The travel is for 4 trips for 2 faculty to attend ATLAS meetings and workshops in the U.S. and at CERN at $1500 per trip, and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, and car rental for faculty.

Supplies are miscellaneous items for running a laboratory including computer paper, magnetic tapes, laser printer cartridges, electronic components, tools, and office supplies.

Dr. Snow requests equipment funds for 4 dual processor 1 Ghz Pentium III computers with 512 Mb of ECC memory, and 72 Gb of SCSI disk space, a workstation quality UPS and a monitor for each machine, and a small work group capacity laser printer to replace obsolete equipment in the HEP lab. The specifications of the equipment and the typical cost at the time of proposal preparation as advertised on the Web by Global Computer Solutions (`http://www.globalcomputer.com`) can be found in Appendix A. The requested equipment will be used to replace and augment existing antiquated facilities in order to implement the DØ distributed data access system SAM and ATLAS Data Grid software for physics data analysis and simulation.

There are no other direct costs.

2003-2004

Task A - The budget includes 2 months research salary for faculty to work full time on the DØ experiment in the summer. The student salaries are for 2 undergraduate research assistants, to be paid at an average rate of $8.00 per hour.

The travel is for 4 trips for faculty to work on DØ at Fermilab at $1200 per trip, and for travel to 2 conferences and workshops per year and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and apartment rental during the summer for faculty and students.

Supplies are miscellaneous items for running a laboratory including tools, cables, hardware, computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

Task B - The student salaries are for 2 undergraduate research assistants, to be paid at an average rate of $8.00 per hour.

The travel is for 3 trips for faculty to attend ATLAS meetings and workshops in the U.S. and at CERN, and participate in the test beam running at CERN at $2000 per trip, and for travel to work with our collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, and car rental for faculty.

Supplies are miscellaneous items for running a laboratory including tools, cable, hardware, computer paper, magnetic tapes, laser printer cartridges, electronic components, and office supplies.

There are no other direct costs.

2004-2005

A. "Senior Personnel" The budget includes 2 months research salary for the faculty to work full time on the DØ experiment in the summer. The Langston fringe benefit rate is 38% for faculty.

B. "Other Personnel" The student salaries are for 4 undergraduate research assistants, to be paid at an average rate of $8.00 per hour. The Langston fringe benefit rate is 10% for students.

C. "Equipment" No permanent equipment is requested.

D. "Travel" The travel funds are for 4 trips for faculty to work on D at Fermilab at $1100 per trip; 3 trips for faculty to attend ATLAS meetings and workshops in the U.S. and at CERN at $1800 per trip; travel to 2 conferences and workshops per year; and travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and housing during the summer for faculty and students.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and keeping the cluster operating securely including tools, cable, hardware, computer paper, magnetic tapes, laser printer cartridges, electronic components, replacement hardware, and office supplies. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $54,633.

H. "Indirect Costs" Indirect costs are $15,367 per year which is 40.5% of the Salaries & Wages base of $37,953.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $70,000 for year one.

J. "Fee" None

2005-2006

A. "Senior Personnel" No additional costs.

B. "Other Personnel" No additional costs.

C. "Equipment" None

D. "Travel" No additional costs.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" None.

G. "Total Direct Costs" Total direct costs are $0.

H. "Indirect Costs" Indirect costs are $0.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $0.

J. "Fee" None

2006-2007

A. "Senior Personnel" No additional costs.

B. "Other Personnel" No additional costs.

C. "Equipment" None

D. "Travel" The domestic travel is for 8 trips for faculty and postdoc to work on D-Zero and attend meetings at Fermilab at $1000 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 5 trips to work on ATLAS, international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $1500-$2000 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including paper, CD's, DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $0.

H. "Indirect Costs" Indirect costs are $0.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $0.

J. "Fee" None

2007-2008

A. "Senior Personnel" The budget includes 2 months research salary for faculty to work full time on the D and ATLAS experiments during the summer. Langston University fringe benefit rate is 38% for faculty.

B. "Other Personnel" Funds are requested for support of 1 undergraduate research assistant (URA). The student will work 8 months at 10 hours per week and 2 months at 40 hours per week, at the rate of $8.00 per hour. The Langston University fringe benefit rate is 10% for undergraduate students. The URA will assist in operating the grid enabled computational site, initially producing Monte Carlo for D. Later the site integrates into Open Science Grid activities for ATLAS in which the URA will participate. The URA will also learn the methods, tools, and environment of globally distributed computing.

C. "Equipment" Funds are requested for a rack mounted computing cluster to be obtained in stages over 2 years. The first year a RAID storage system, rack, power management, networking, and 2 nodes will be obtained. The anticipated cost is $11,000. This cluster will build on the existing cluster and be used for Monte Carlo production for D-Zero initially and will eventually be used for ATLAS related Open Science Grid activities and development. The cluster will be a satellite facility of the ATLAS Southwest Tier 2 center.

D. "Travel" The domestic travel is for 6 trips for faculty to work on D-Zero and attend meetings at Fermilab at $1200 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 5 trips to work on ATLAS, international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $1500-$2000 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including paper, CD's, DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $58,304.

H. "Indirect Costs" Indirect costs are $9696.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $68,000.

J. "Fee" None

2008-2009

A. "Senior Personnel" The budget includes 2 months research salary for faculty to work full time on the D and ATLAS experiments during the summer. Langston University fringe benefit rate is 38% for faculty.

B. "Other Personnel" Funds are requested for support of 2 undergraduate research assistants (URA) per year. Each year each student will work 8 months at 10 hours per week and 2 months at 25 hours per week, at the rate of $8.00 per hour. The Langston University fringe benefit rate is 10% for undergraduate students. The URA will assist in operating the grid enabled computational site, initially producing Monte Carlo for D. Later the site integrates into Open Science Grid activities for ATLAS in which the URA will participate. The URA will also learn the methods, tools, and environment of globally distributed computing.

C. "Equipment" Funds are requested for a rack mounted computing cluster to be obtained in stages over 2 years. The second year additional compute nodes are to be added. The anticipated cost is $10,000. This cluster will build on the existing cluster and be used for Monte Carlo production for D-Zero initially and will eventually be used for ATLAS related Open Science Grid activities and development. The cluster will be a satellite facility of the ATLAS Southwest Tier 2 center.

D. "Travel" The domestic travel is for 6 trips for faculty to work on D-Zero and attend meetings at Fermilab at $1000 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 4 trips to work on ATLAS, international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $1500-$2000 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including paper, CD's, DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $55,912.

H. "Indirect Costs" Indirect costs are $11,088.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $68,000.

J. "Fee" None

2009-2010

A. "Senior Personnel" Each year's budget includes 2 months research salary of $13,462 and fringe of (38%) $5,116 for the faculty to work full time on the DØ and ATLAS experiments in the summer.

B. "Other Personnel" Funds are requested for support of 3 undergraduate research assistants (URA's). Each year each student will work 8 months at 10 hours per week and 2 months at 25 hours per week, at the rate of $8.32 per hour. The URA's will assist in operating the grid enabled computational site, initially producing Monte Carlo for DØ. Later the site integrates into OSG and Tier 2 activities in which the URA's will participate. The URA's will also learn the methods, tools, and environment of globally distributed computing. The students will work approximately 25% on DØ and 75% on ATLAS. Wages amount to $13,636 and fringe (10%) is $1,364. The total is carry-over from unexpended funds of the present project period.

C. "Equipment" Funds are requested for one rack mounted dual CPU quad-core server ($2,500) to expand the new computing cluster, and one workstation ($2,500) to replace a seven year old machine which is used for interactive research work. The server will be used 25% for DØ and 75% for ATLAS. The workstation will be used 85% for DØ and 15% for ATLAS.

D. "Travel" The domestic travel is for 4 trips for faculty to work on DØ and attend meetings at Fermilab at $1,500 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 3 international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $2,500 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including computer paper, blank CD's and DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. It is estimated that approximately $1,800 keep the lab and clusters running. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $56,401.

H. "Indirect Costs" Indirect costs are $13,599 per year which is 40.5% of the Salaries & Wages base of $33,577.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $70,000 for year one.

J. "Fee" None

2010-2011

A. "Senior Personnel" The budget includes 2 months research salary of $13,462 and fringe of (38%) $5,116 for the faculty to work full time on the DØ and ATLAS experiments in the summer.

B. "Other Personnel" Funds are requested for support of 3 undergraduate research assistants (URA's). Each year each student will work 8 months at 10 hours per week and 2 months at 25 hours per week, at the rate of $8.32 per hour. The URA's will assist in operating the grid enabled computational site, initially producing Monte Carlo for DØ. Later the site integrates into OSG and Tier 2 activities in which the URA's will participate. The URA's will also learn the methods, tools, and environment of globally distributed computing. The students will work approximately 25% on DØ and 75% on ATLAS. Wages amount to $13,636 and fringe (10%) is $1,364.

C. "Equipment" Funds are requested for two rack mounted dual CPU quad-core servers ($5,000) to expand the new computing cluster. The servers will be used 25% for DØ and 75% for ATLAS.

D. "Travel" The domestic travel is for 4 trips for faculty to work on DØ and attend meetings at Fermilab at $1,500 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 3 international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $2,500 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including computer paper, blank CD's and DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. It is estimated that approximately $1,824 keep the lab and clusters running. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $56,401.

H. "Indirect Costs" Indirect costs are $13,599 per year which is 40.5% of the Salaries & Wages base of $33,577.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $70,000 for year two.

J. "Fee" None

2011-2012

A. "Senior Personnel" Each year's budget includes 2 months research salary of $13,462 and fringe of (38%) $5,116 for the faculty to work full time on the DØ and ATLAS experiments in the summer.

B. "Other Personnel" Funds are requested for support of 3 undergraduate research assistants (URA's). Each year each student will work 8 months at 10 hours per week and 2 months at 25 hours per week, at the rate of $8.32 per hour. The URA's will assist in operating the grid enabled computational site, initially producing Monte Carlo for DØ. Later the site integrates into OSG and Tier 2 activities in which the URA's will participate. The URA's will also learn the methods, tools, and environment of globally distributed computing. The students will work approximately 25% on DØ and 75% on ATLAS. Wages amount to $13,636 and fringe (10%) is $1,364.

C. "Equipment" Funds are requested for 100 TB of local network storage to allow the new computing cluster to function as a grid storage element. The servers will be used 10% for DØ and 90% for ATLAS.

D. "Travel" The domestic travel is for 4 trips for faculty to work on DØ and attend meetings at Fermilab at $1,500 per trip, for travel to 2 conferences and workshops per year, and for travel to work with collaborators at the University of Oklahoma. Costs include airfare, lodging, per diem, car rental, and mileage for faculty. The foreign travel is for 3 international conferences, workshops, and meetings with international collaborators regarding Monte Carlo production, grid infrastructure and remote computing, at $2,500 per trip.

E. "Trainee/Participant Costs" None.

F. "Other Direct Costs" Funds are requested for Materials & Supplies. These are miscellaneous items for running a laboratory and computing cluster including computer paper, blank CD's and DVD's, laser printer cartridges, magnetic tapes, electronic components, office supplies, cables, connectors, repairs, and replacement components for broken or exhausted equipment. It is estimated that approximately $1,500 keep the lab and clusters running. There are no other direct costs.

G. "Total Direct Costs" Total direct costs are $57,078.

H. "Indirect Costs" Indirect costs are $13,599 per year which is 40.5% of the Salaries & Wages base of $33,578.

I. "Total Direct and Indirect Costs" Total direct and indirect costs are $70,000 for year three.

J. "Fee" None