Final Report
of the Collaboration of Prairie View A&M University with The Lawrence Livermore National Laboratory on the BABAR Detector and Experiment at SLAC

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Summary

The Prairie View A&M University High Energy Physics group with its contingent of three undergraduates physics majors, joined the BaBar Collaboration at SLAC in September 1994. BaBar is the experiment and detector running in the PEP-II ring at SLAC as part of the Asymmetric B Factory project there to study $CP$ violation and heavy flavor physics. The focus of our effort before this year was with the Muon/Neutral Hadron Detector/Instrumented Flux Return (IFR) subgroup within the BaBar collaboration, and particularly with the GEANT simulation of the IFR. With the GEANT3 simulation essentially frozen, and the GEANT4 full simulation of the IFR done, we have decided to redirect our efforts toward other areas. We are now working with the Quality Assurance (QA) group on offline release and production testing, and are getting involved with the analysis of hadronic $B$ decays. This choice of direction also makes it a little easier on the travel budget for because our students can works from our Prairie View via the Internet.

The Prairie View High Energy Physics group is providing package coordinators for two BaBar software packages, gmmuon (IFR simulation) and QaToolsUtils (QA offline reconstruction, simulation, and simulation application tools).

Infrastructure

In the first year after joining BaBar, our group was involved with porting the simulation program BBSIM and its supporting utilities to our Hewlett-Packard HP9000/750 workstations.
These utilities included the GNU gmake utilities, SLAC's CVS and rCVS, BaBar Software Release Tools, and AFS. In the case of the native C++ compiler, Prairie View was the lead institution in adapting the BaBar code to the HP platform. We selected the HP platform because it was the most commonly used workstation with our IFR collaborators at Lawrence Livermore National Laboratory and Genova.

However, there were significant problems with porting the Objectivity database to the HP platform, which required new code from the vendor last year. Eventually, Objectivity was successfully ported to the HP, but in the long wait for this to happen, HP users became accustomed to simply working remotely in SLAC. At the end of last year, HP was dropped as a supported platform of the BaBar collaboration, and IBM was also dropped in 1998. There are now only two platforms officially supported within BaBar—Sun and DEC—with Linux to be added next year. We have since acquired one Sun workstation in addition to our HP workstations, with plans to acquire more Suns and phase-out work on the HPs.

All Prairie View HP workstations are accessible through the Internet—they are called hp71.pvamu.edu, hp72.pvamu.edu, hp73.pvamu.edu, hp75.pvamu.edu, and pvhep1.slac.stanford.edu. Our web page is http://www.hep.pvamu.edu/.

Student Participation

One of our group’s goals in the project is to provide an opportunity for our students to participate in the frontier of high energy physics research. Since the summer of 1995, a number of our students have participated in our group’s research work at Prairie View, SLAC, and LLNL, in order to learn some of the basic concepts of particle physics and the methods of high energy physics research.

During the summer of 1995, the first year of direct activity with LLNL, one of our students, George Aduo, worked at LLNL for ten weeks, in the Physics and Space Science Section running simulation programs. We have been fortunate to have support from LLNL for five other students over the life of grant. Mr. Aduo also spent time in the LLNL Resistive Plate Chamber (RPC) laboratory learning how high energy physicists conduct experimental research and build detectors for a large experiment like BaBar.

In the summer of 1996, three students, Johnson Acheampong, Emmanuel Acheampong, and John Cooney, worked at the Prairie View campus via the internet learning parts of the BaBar simulation software design. Each has departed and now have serious software careers off campus.

Two students, were fully supported by LLNL through the Prairie View high energy physics group working at SLAC in the summer of 1997. The students were Ms. Shanneth Thomas, now earning a Ph.D. at Tuskegee University in medical physics, and Mr. Clayton Simien a physics major graduating from Prairie View in the spring of 2000. Their work at SLAC was primarily on the electrical and mechanical installation of the RPCs in the IFR framework. Pictures of the two during the installation of the BaBar detector can be found.
Mr. Simien spent the summer of 1998 at Hampton University, Hampton, Virginia, working with experimentalists and theorists from that institution who are also working at the Thomas Jefferson National Accelerator Facility in Newport News. Mr. Simien was invited to Hampton University with full NSF support through Hampton.

In the summer of 1999, three Prairie View students—Clayton Simien, Gilbert Nyandoto, and Inez Sanderson—spent the summer at SLAC working on physics and software projects related to the running of the $\text{BaBar}$ experiment, which finally commenced data-taking in 1999. Ms. Dolly Green spent a month at SLAC working on software and attending lectures at the SLAC summer school. Mr. Simien worked for six weeks in the Accelerator Division doing minor computational task. Clayton, will be accepted at Stanford, we hope, in the fall of 2000. His intent is to earn a Ph.D. in particle physics theory. Mr. Nyandoto and Ms. Sanderson were both supported fully by LLNL funds in at SLAC in the summer of 99. Mr. Nyandoto has applied to The Johns Hopkins University in fall 2001. Ms. Sanderson will complete her undergraduate work in fall 2001.

We have in total 11 students, Prairie View graduates, now in Ph.D. programs at universities outside the State of Texas. The first to complete his doctorate work, out of the 11, is Dr. Julius Barns. He received his Ph.D. from Rice University in the spring of 1999. Dr. Byron Freelon the second of the 11 Prairie View graduates is set to receive his Ph.D. from the University of Minnesota in 2000.

**$\text{BaBar}$ Work at Prairie View**

We continue to work as package coordinators for the IFR simulation software, but since the end of 1998 this has involved only minor changes to the code to maintain compatibility with new versions of CERNLIB and patches to GEANT3 code. The IFR geometry code is now frozen (excluding bug fixes). A GEANT4 version of the full IFR geometry was completed at the beginning of this year, but has not been fully interfaced with other subsystems since only a few other subsystems have working GEANT4 code. The full GEANT4 simulation now has a relatively low priority within $\text{BaBar}$ (except for the fast simulation portion of GEANT4, an area in which we are not involved) since the collaboration is now concentrating on running the experiment and collecting data.

Some pictures of the IFR geometry can be found on the WWW at http://www.hep.pvamu.edu/detector.html, and tests of the simulation at http://www.hep.pvamu.edu/mutest/mutestm.html. The geometry pictures of the barrel and endcap were generated with GEANT3, and the inner RPCs and some of the steel with GEANT4.

Since the summer of 1999 we have been members of the Quality Assurance working group in $\text{BaBar}$, and have become package coordinators for the QaToolsUtils software
package. This work involves checking new releases against reference data to pinpoint any problems with new release code. We are also rewriting some old Fortran code contained in the QaToolsUtils package in C++, and changing HBOOK histogramming code to the \textit{BABAR} online Dhp histogram package. So far all this work has been remotely at SLAC (whenever the network is up), but we plan to begin using our new Sun workstation to run \textit{BABAR} code in the near future, as soon as all needed \textit{BABAR} utilities have been ported to it.

We also plan to become involved in the \textit{BABAR} analysis effort, in the \textit{B} and \textit{C} Hadronic Decay group. At the present time, we are learning how to run the Micro analysis code, and determining what we want to add to it. We will be concentrating more of our effort on this \textit{BABAR} analysis work in the upcoming year.
Planned Research Work with BaBar

Since BaBar met its schedule and began colliding-beam data-taking during Spring 1999, the research work for BaBar at Prairie View A&M University has been shifting from equipment installation/testing and Monte Carlo simulation to data analysis and shift work for data-taking.

Prairie View is planning to perform data analysis of some selected BaBar data subsets, particularly within the $B$ and $C$ Hadronic Decays working group. The High Energy Physics group at Prairie View is currently using four Hewlett-Packard 9000 workstations for the bulk of its data analysis and Monte Carlo work, but since the HP has been abandoned as a supported platform by the BaBar collaboration, we will need to obtain quite quickly more new Sun workstations in order to continue with our BaBar analysis efforts. In addition, we also want to study the use of PCs for BaBar data analysis. We have purchased two PCs and plan to perform some BaBar analysis using the SolarisOS for the PC operating system on one and the Linux operating system on this other. Following this test, we will decide which PC operating system is the most applicable for performing BaBar analysis on the PC, and acquire additional computing resources accordingly.

The reason for this interest in the use of PCs as platforms on which to conduct BaBar data analysis is that compared to Unix workstations PCs present an advantage in terms of cost per CPU cycle. However, the system that runs on the PCs must be one that is compatible within BaBar. The BaBar collaboration has already migrated to a reduced set of standard platforms. Currently BaBar supports only the Sun Solaris and the DEC Alpha operating systems. BaBar has abandoned support for the IBM AIX and Hewlett-Packard HPUX operating systems. Although Windows/NT and Linux are not yet officially supported by BaBar, the plan to is make Linux the third officially supported platform in BaBar in early 2000. Windows/NT is not being supported by BaBar because of security concerns, proprietary concerns, and lack of the necessary utilities for Windows/NT. Since Prairie View's computing relies at present primarily on HPUX, we need to upgrade our computing resources at Prairie View to those platforms supported by BaBar in order to contribute fully to our BaBar research work. The use of Suns running SolarisOS is our preference for new computing resources as we retire our old systems and expand our capabilities, although we also want to study the use of PCs running Linux or SolarisOS for the PC.

In addition as colliding beam data-taking continues, Prairie View plans to continue to participate on data-taking shift work and will continue with analysis of a portion of this data. One of several physics interests that Prairie View would like to pursue with this BaBar data is to identify and analyze events containing possible charmed baryons along with other hadronic decays within the BaBar $B$ and $C$ Hadronic Decays working group.

Finally Prairie View will continue to act the gmnuon and QAToolsUtils program coordinators for BaBar, and Prairie View also plans to participate in the shift from the GEANT3 Monte Carlo system to the C++-based GEANT4 system.
Network Upgrade at Prairie View

The computer network at Prairie View that the High Energy Physics group uses to connect to SLAC and BaBar needs to be upgraded and improved. To this end, the Prairie View High Energy Physics group would like to investigate the possibility of joining the Internet2 project, possibility in collaboration with other research groups at Prairie View. The following is a brief description of the Internet 2 project and the estimated financial and personnel requirements.

The University Corporation of Advance Internet Development (UCAID) is a non-profit consortium, led by university members working in partnership with corporate and affiliate members, to provide leadership and direction for advance networking development within the university community.

Its mission is to facilitate and coordinate the development, deployment, operation and technology transfer of advanced, network-based applications and network services to further U.S. leadership in research and higher education and accelerate the availability of new services and applications on the Internet.

Currently, only institutions of higher education located in the United States are eligible to apply for Regular membership. Applicants must be making a definitive, substantial and continuing commitment to the development, evolution and use of advanced networking facilities and applications in the conduct of research and education. In addition, since the primary goal of UCAID is the Internet2 project, all member applicants should be committed to the goals of the Internet2 project.

The requirements that must be met in order to qualify for Regular membership are:

(a) Establish broadband Internet connectivity on an end-to-end basis between and among Regular member institutions and other related development sites;

(b) Prepare to make use of local aggregation points known as “Gigapops” and make plans to join and/or form a gigapop to achieve access to the Internet2 interconnect;

(c) Develop and demonstrate advanced network-based applications for the purposes of research and/or education and create a project team within the organization to support the development of such applications;

(d) Participate at the executive level in the overall management of the Internet2 project;

(e) Contribute necessary financial support to the above activities and to the central management and administrative expenses of UCAID.

The financial commitments the UCAID members are required to make are:

- $25,000 per year in member dues;
It has been estimated that expenditures allocated to upgrading campus infrastructure, connecting to a gigapop, and supporting applications development could run approximately $500,000 per campus, per year. Connecting to the nearest gigapop at Rice University would require at least a DS-3 connection.

At this time, UCAID membership operates on an institutional/organizational basis and is not open to individuals. In addition, Prairie View will need to hire a network manager to work full-time on the Internet2 project. In this region, a typical salary for a network manager ranges from $67,100 to $88,700.
Publications

The following is a list of the publications from the Prairie View High Energy Physics group contributed during 1997–1999.


