Annual Report for Period: 05/2006 - 04/2007 **Submitted on:** 03/27/2007
Principal Investigator: Hill, Paul L. **Award ID:** 0554328
Organization: HEPC
Title:
Next Generation Biometrics: Achieving Strength in Molecular Recognition and Transport

Project Participants

Senior Personnel

Name: Hill, Paul
Worked for more than 160 Hours: Yes
Contribution to Project:
Manage, Executive Leadership Team

Name: Peterson, Curt
Worked for more than 160 Hours: Yes
Contribution to Project:
Executive Leadership Team, manage WVU components including EHRDO

Name: Aulick, Louis
Worked for more than 160 Hours: Yes
Contribution to Project:
Executive Leadership Team, manage Marshall RII components

Name: Taylor, Jan
Worked for more than 160 Hours: Yes
Contribution to Project:
Executive Leadership Team, Evaluation Co-ordination

Name: Hornak, Lawrence
Worked for more than 160 Hours: Yes
Contribution to Project:
Executive Leadership Team, Technical PI and director of scientific efforts

Name: Kusimo, A
Worked for more than 160 Hours: Yes
Contribution to Project:
Executive Leadership Team Member
WVSU Campus Coordinator

Name: Famouri, Parviz
Worked for more than 160 Hours: Yes
Contribution to Project:
Functional Building Block Group (FBBG) Leader

Name: Timperman, Aaron
Worked for more than 160 Hours: Yes
Contribution to Project:
Functional Building Block Group (FBBG) Leader

Name: Lederman, David
Worked for more than 160 Hours: Yes
Contribution to Project:
Functional Building Block Group (FBBG) Leader

Name: Barnhart, Phyllis

Worked for more than 160 Hours: Yes

Contribution to Project:
Education Human Resources Development and Outreach (EHRDO) campus coordinator for WVU

Name: Blough, Eric

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, Marshall University

Name: Carroll, Richard

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Edwards, Boyd

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Flynn, Daniel

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Gannett,, Peter

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Georgel, Philippe

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, Marshall University

Name: Harrison, Marcia

Worked for more than 160 Hours: Yes

Contribution to Project:
Education Human Resources Development and Outreach (EHRDO) campus coordinator for MU

Name: Korakakis, Dimitris

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Miksovska, Jaroslava

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, Marshall University

Name: Myers, Thomas

Worked for more than 160 Hours: Yes

Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Name: Norton, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:

Functional Building Block Group (FBBG) scientist, Marshall University

Name: Wu, Nianqiang
Worked for more than 160 Hours: Yes
Contribution to Project:
Functional Building Block Group (FBBG) scientist, WV University

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

West Virginia Department of Education and the Arts

West Virginia Office of the Governor

Marshall University Research Corporation

West Virginia State University

West Virginia High Technology Consortium Foundation
Jack Carpenter, VP, Intellectual Property Management Dept., serves on the WV EPSCoR Advisory Council.

West Virginia University Research Corporation

Other Collaborators or Contacts

-Michael Koon, Administration, West Virginia Northern CTC
-Michael Mays, Mathematics, West Virginia University
-Elizabeth Strong, SMART-Center, West Liberty State College
-Robert Strong, SMART-Center, West Liberty State College
-Margaret Zoeckler, Administration, West Virginia Northern CTC
-Hongxing Jiang, Physics Department, Kansas State University
-Ken Showalter, Chemistry, West Virginia University
-Curtis Taylor, Mechanical Engineering, Virginia Commonwealth University
-Mike Falvo, Physics, University of North Carolina - Chapel Hill
-Aric Agmon, Department of Neurobiology and Anatomy, West Virginia University
-George Spirou, Department of Neurobiology and Anatomy, West Virginia University
-Jarrett Aguliar, Natural Sciences and Mathematics, West Liberty State College
-Kasi Jackson, Women's Studies, West Virginia University
-James Lewis, Physics, West Virginia University
-Xiaodong Shi, Chemistry, West Virginia University

-Gordon Hager, NIH/NCI, NIH/NCI
-Jeffrey Hansen, Biochemistry, Colorado State University, Colorado State University
-Stuart Lindsay, Physics, Arizona State University, Arizona State University
-Richard Niles, Biochemisry and Molecular Biology, Marshall University
-Vincent Sollars, Biochemistry and Molecular Biology, Marshall University
-Christopher Woodcock, Biology, U.MAss Amherst, U. Mass Amherst
-Andrew Cao, CSEE, West Virginia University
-Kenneth Chen, ECE, University of Pittsburgh
-Joel Falk, ECE, University of Pittsburgh
-Mike Shi, Chemistry, West Virginia University
-Sergei Urazhdin, Physics, West Virginia University
-Steven Woodruff, Sensors Group, DOE National Energy Technology Laboratory
-Ken Chen, Electrical and Computer Engineering, University of Pittsburgh
-Robert Davis, Materials Science and Engineering, Carnegie Mellon University
-Joel Falk, Electrical and Computer Engineering, University of Pittsburgh
-David Lambeth, Electrical and Computer Engineering, Carnegie Mellon University
-Lisa Porter, Materials Science and Engineering, Carnegie Mellon University
-Charter Stinespring, Chemical Engineering, West Virginia University
-Michael Fitzsimmons, Neutron Sciences Center, Los Alamos National Laboratory
-Simon George, Physical Biosciences Division, Lawrence Berkeley National Laboratory
-Cohenford Menashi, Integrated Science and Technology, Marshall University
-Alan Doolittle, Electrical Engineering, Gerogia Institute of Technology
-Steve Durbin, CSEE, University of Canterbury, NZ
-Randy Feenstra, Physics, Carnegie Mellon University
-William Schaff, Electrical Engineering, Cornell University
-Darrel Schlom, Materials Science, Penn State
-Annabella Selloni, Chemistry, Princeton
-Vydy Vydyanath, AVYD Devices, Cosa Mesa CA
-Darran Cairns, CEMR/MAE, West Virginia University
-Perena Gouma, Materials Science, Stony Brook University
-Petia Simeonova, Health Effects, NIOSH
-Harry Finklea, Chemistry, West Virginia University
-Peter Perrotta, Pathology, West Virginia University
-Harry Edenborn, Geology Science, DoE/NETL

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)
See attached Activities PDF file

Findings:
During the first six months of the performance period (1 July 2006-31 December 2006), several Functional Building Block Groups (interdisciplinary research teams)reported findings from their work.

The Nano-Microfluidics Functional Building Block Group (FBBG) has reported the discovery that asymmetric Nanofluidic/Microfluidic Interfaces (NMIs)act as a diode or current rectifier. A manuscript is in preparation.

The Nanokinematics FBBG reported these findings in actomyosin transport systems:

Blough's Group has been able to isolate and purify actin and myosin from rabbit muscle and the development of a bacterial expression system to manufacture proteins of interest. Over expressed fascin purified using column chromatography and using expressed protein to bundle actin filaments have been achieved. They also have begun to derive the 'design rules' which govern myosin-mediated actin bundle motility- i.e. how

myosin concentration affects bundle size, velocity, efficiency of translation and trajectory and how bundle size affects bundle stability.

Holland's group has designed a bead coupling strategy that McNair scholar, Lenin Leon is implementing.

The Nanokinematics FBBG reported these findings in Piezoelectricity of Aluminum Nitride (AlN) thin films:

Work continues to document the results of this project in the form of an Applied Physics Letters paper. This involves recalibrating the laser vibrometer (used to measure the piezoelectric coefficient of the AlN films) and further C-V measurements of AlN stacks using p-type and n-type silicon substrates to confirm the results achieved to date.

AlN actuator (cantilever and microbridge) production efforts continue with the refinement/optimization of fabrication techniques using Reactive Ion Etching with tetrafluoromethane gas (RIE-CF4) and with mask design. Fabrication of diaphragms using laser ablation also continues.

The Photonics FBBG reported these findings.

SPARROW: This period the first joint manuscript from the entire group was accepted for publication in Langmuir regarding the work in Chemistry on establishing SAMS on alumina substrates grown in EE and sapphire surfaces. In addition, the relationship between e-beam deposition and ion gun parameters and waveguide film loss was published in a JVST paper. Two MRS conference papers in waveguide film growth and optical loss were presented and submitted for proceedings publication.

Photonic crystal (PC) û based molecular recognition: New modeling of a hexagonal air hole PC structure based on the most recent architecture has been completed including basic defect geometries. Results indicating adequate Q factor and line defect coupling for resonant energy transfer. A preliminary fabrication process for the GaN PC based on ICP etching has been outlined. Initial growth results showing the efficacy of a lateral polarization heterostructure approach for realizing high aspect ratio photonic crystal structures have been concluded.

Quantum Dot û based systems: Shi successfully achieving the anion bridged nano-sheets from self-assembled G-quadruplexes that are a critical element of this work. The result was submitted by Shi to Organic Letters. Wu has published in Small on the shape-controlled growth of micron-Sized Gold Crystals by a Slow Reduction Method which will be used as a foundation for Au nanoparticle synthesis.

Raman source - detector systems: A journal article describing the lasing performance of our initial slab laser geometry was published at the end of this period in Optical Engineering. Grown InGaN Multi Quantum Well structures were characterized and transmission data indicated that the absorption edge of the structures can be engineered to be tuned at the wavelengths of interest.

Training and Development:

More than 80 students worked with research team scientists in interdisciplinary research teams during the first six months. These students have been learning nanoscience and biomolecular research techniques and have been contributing to the work of the Functional Building Block Groups (FBBGs).

Outreach Activities:

WVEPSCoR has begun to implement expanded outreach and communication efforts. As a first step, a Communications Program Manager was hired with state funds. Virginia Painter will be handling the communication efforts of the State Office. Our newsletter, The Neuron, has been redesigned and editorially expanded, and contacts with media have increased to share successes of the West Virginia research enterprise. Our website has also been updated and improved. Ms. Painter is developing a comprehensive communication plan that will serve the RII and other WVEPSCoR programs.

Journal Publications

Gannett, P.M., Kabulski, J., Perez, F.A., Liu, Z., Lederman, D., Locuson, C.W., Ayscue, R.R., Thomsen, N.M., Tracy, T.S., "Preparation, Characterization, and Substrate Metabolism of Gold-Immobilized Cytochrome P450 2C9", Journal of the American Chemical Society, p. 8374, vol. 128, (2006). Published

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", Journal of Medicinal Chemistry , p. , vol. , (2007). Accepted

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", Molecular Cell, p. 669, vol. 22, (2006). Published

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Mashiur Rahman, B. Scott Day, Huan Cao, Heather Butts, Michael L. Norton , "Ordered DNA arrays prepared via soft lithography ", Proceedings of SPIE Volume: 6370, p. NA, vol. 6370, (2006). Published

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, "Changes in Optical Properties of GaAsN During Annealing", Res. Soc. Symp. Proc., p. N/A, vol. 891, (2006). Published

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, "L. E. Rodak, N. J. Berry Ann, Kalyan Reddy Kasarla, Nanying Yang, D. Korakakis", Mater. Res. Soc. Symp. Proc., p. N/A, vol. 892, (2006). Published

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Cheng Zhong, Jin Wang, Nianqiang Wu, Gang Wu, Xiaodong Shi
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J.M. Dawson M.A.F. Harrison C.A. Maxey W.B. McCormick L.A. Hornak , "Utilizing chaotic excitation of microelectromechanical systems (MEMS) for microstructure fault detec", Proc. of SPIE, Smart Electronics, MEMS, BioMEMS, and Nanotechnology, p. 19, vol. 6172, (2006). Published

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Craig H Swartz, Steven M Durbin, Phillip A Anderson, Thomas H Myers, Sandeep Chandril, Roger J Reeves, Damian Carder and John V Kennedy , "Photoluminescence, Capacitance-Voltage, and Variable Field Hall Effect Measurements of Mg-Doped InN ", Proceedings of the Materials Research Society, p. , vol. , (2007). Submitted

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M. Lim, K. Feng, X. Chen, N. Wu, A. Raman, J. Nightingale, E. Gawalt, D. Korakakis, L. A. Hornak, and A. Timperman , "Adsorption and Desorption of Stearic Acid Self-assembled Monolayer on Aluminum Oxide ", Langmuir, p. , vol. , (2007). Accepted

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F. Ganikhanov, C.L.Evans, B. Saar, S-X. Xie , "High-Sensitivity vibrational imaging with frequency modulation CARS-microscopy", Optics Letters, p. 1872, vol. 31, (2006). Published

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", Optics Express, p. 4427, vol. 14, (2006). Published

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Boyd F. Edwards , "Propagation velocities of chemical reaction fronts advected by Poiseuille flow", Chaos, p. 043106, vol. 16, (2006). Published

Books or Other One-time Publications

Web/Internet Site

URL(s):
http://www.wvepscor.org
http://wvnano.wvu.edu
Description:

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:
A grant-writing seminar at WVU was held on July 10, 2006 with 99 faculty participating. Fifteen faculty, including two FBBG scientists, were selected for the 2006 Grant Writing Workshop cohort. The workshop began in September 2006 and will run through February 2007. The workshop entails dedicated one-on-one assistance from grant-writing consultants to produce a competitive proposal.

At Marshall a series of Professional Development Opportunities in Grantmanship seminars were provided by the Marshall University Research Corporation. Human Research Issues, Electronic Research Administration and Shoulda, Woulda, Coulda: A Compliance Primer for a Complex World were offered on October 31, 2006, November 14, 2006 and December 8, 2006, respectively. Another grant writing workshop focusing on NSF and NIH programs is scheduled for April 23 and 24, 2007.

A mentorship program is being developed at WVU to provide additional grant-proposal experience and to aid junior faculty in their professional progress towards tenure and promotion

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Special Requirements

Special reporting requirements:
Special award conditions

1. WVEPSCoR will submit within the first two months of the award's effective date, a three-year strategic plan aimed at ensuring the successful recruitment and retention of the new research positions, including specific timelines and progress indicators.

WVEPSCoR submitted a hiring strategy and plan to our Program Officer on July 18, 2006

Hiring update: The WV RII proposal included the hiring of 11 science and engineering faculty to populate the interdisciplinary research teams. Through December 2006, WVU has hired 5 new faculty to participate in Functional Building Block Group (FBBG) work. Two of these faculty are in the College of Engineering and Mineral Resources and three others have been hired in the Eberly College of Arts and Sciences. Marshall University has hired Dr. Elmer Price to lead the biomolecular research team and the search is underway for a faculty member with interests and experience in molecular biometrics. To date, the applicant pool has been reduced to four and three of the four have visited the Marshall campus.An indicator of growing collaboration is that Dr. Larry Hornak of WVU is serving on the search committee at Marshall to fill this position. Dr. Hornak participates in on campus interviews at Marshall via web-based conferences.

Currently four positions are being advertised at WVU during the 2007 fiscal year. A summary of the search process is provided below:

Nano Bio Device Position:
83 Applications Received.
8 Phone Interviews Completed
2 Candidates Scheduled for Interview

Supra Chemistry Position:
27 Applications Received
3 Phone Interviews Completed
1 Campus Interview Completed
2 Campus Interviews Scheduled/Pending
2 Additional Phone Interviews in Process

Surface Modification Specialist
36 Applications Received
3 Phone Interviews Completed
1 Campus Interview Completed
1 Campus Interview Scheduled/Pending

Structural Biology/Biophysics Position
37 Applications Received
4 Phone Interviews Completed
2 Phone Interviews in process

To date, no females or URM have been hired as part of the previous 5 searches at WVU. Offers were made to 4 females in the first 5 searches, but these individuals chose to accept positions at other institutions or to remain at their current institution. Unfortunately, the pool of applicants for the four searches underway appears to include very few females or URMs. A female candidate is coming in for an interview for the structural biology position. Discussions are underway between the Co-Directors and the Deans Advisory Board to the WVNano Initiative at WVU to identify/determine ways to increase the potential for broadening participation in the final four hires. On a positive note, the final Marshall University position includes three females among the four finalists. An offer is expected to be extended for the position very soon.

2. Broadening participation: Using FY 2005 as a baseline, the annual progress report must identify the numbers of women and members of other underrepresented groups in staff positions and as participants in the activities funded by the award.

Our pursued outcome is a diverse, internationally competitive, and globally-engaged West Virginia workforce of scientists, engineers and well-prepared citizens. A table in the Evaluation Plan submitted to Program Officer, Julio Lopez-Ferrao (20 Sept 2006) shows the FY2005 levels and our pursued levels throughout the grant period.

Currently, there are 3 women scientists participating in FBBG activities, up from 1 in 2005. One FBBG scientist is Hispanic.

3. The project's annual report must include a description of efforts, accomplishments, commitments, and plans to ensure that the positive outcomes of the project will be sustained beyond the duration of the grant. This may include quantitative data (e.g., numbers of new hires recruited and retained, proposal submissions, and award success rates, and students involved in research). The report may also include descriptions of policies or programs proposed or implemented to enhance the competitive research culture, integration of research and education, and broadening participation of underrepresented groups.

Through the first six months of the project, progress has been made on implementing policies and programs to enhance research competitiveness. At WVU, the Research Corporation has sponsored a one day grant writers seminar and a subsequent 4.5 month workshop for 15 faculty members of the 99 who attended the one-day seminar. In addition, the Office of the AVP for Research is facilitating a technical review of proposals prior to their submission to federal agencies through the WVEPSCoR office. All of these activities are intended to increase the competitiveness of submitted proposals. At Marshall University, the Research Corporation has initiated an electronic purchasing program and issued purchase cards to the vast majority of researchers in order to expedite these activities. In addition, two Research Corporation staff are physically located within the College of Science and School of Medicine to facilitate faculty proposal submissions and to provide budget services. A key output of the first six months of the RII project was the development of intellectual property and non-disclosure agreements between WVU and Marshall so that collaboration can continue unimpeded.

In addition to these procedural changes, the Technical PI and project scientists have developed a Shared Resources Plan along with a fee schedule to make instrument maintenance self-sustaining. The Shared Resources Plan covers all shared instrumentation in clean rooms and in other laboratories at WVU and will provide sustained post award support of faculty research. The plan is the first such comprehensive approach to shared facilities at WVU. The plan is intended to serve as a model to be implemented as appropriate at other institutions.

The principal advance at Marshall has been the opening of the Robert C. Byrd Biotechnology Science Center in September 2006. This 144,000 sq. ft. facility offers state-of-the-art research and educational space to faculty from the College of Science and School of Medicine. All current (Blough, Georgel, Miksovska, Norton, and Price) and future RII faculty are housed in this building with basic science colleagues from the School of Medicine. The removal of the eight-mile barrier separating these two science communities will vastly improve opportunities for interdisciplinary research at Marshall.

Integration of research and education is further enhanced by a state-funded STEM Fellows program. At both WVU and MU, the state funds fellowships for Ph.D. students who are working with FBBG faculty. At WVU, the STEM Fellows are involved in cancer nanotechnology and at MU, the fellows are working in a variety of biomolecular laboratories which may link with FBBG work. While this integration is not required by the award, its linkage is encouraged and supported by the state of West Virginia.

FBBG faculty at WVU have prepared a preproposal to the NSF IGERT competition and will be submitting it during the second quarter of 2007. An MRI proposal was submitted in the first quarter of 2007. Dr. David Lederman has received a REU Site Award leveraging the RII research activity which is targeting underrepresented students. The REU students will be working in FBBG research projects.

During the first 6 months of the project, 88 students have worked in the laboratories of FBBG scientists. Five of these students were African-American/Black, two males and three females. One female and four male Hispanic students were also included in the total. Overall, 62 male students and 26 female students have participated in FBBG research.

4. The project's annual report must include evidence of linkages, coordination, and collaboration with other NSF-funded projects in the State that enhance the WV-proposed Research Infrastructure Improvement activities.

At WVU, Dr. David Lederman, one of the FBBG Leaders, and his co-PI, Dr. Michelle Richards-Babb, have recently received a Research Experience for Undergraduates grant from NSF entitled Multifunctional Nanomaterials REU Site. The main objective of the REU is to motivate underrepresented minorities, women, and economically disadvantaged STEM students from West Virginia and the Appalachian region to pursue careers in science. This will be done by providing the REU Site participants with a challenging and stimulating interdisciplinary scientific research program in nanobio/solid state multifunctional materials. The Site will fall under the umbrella of the WVNano Initiative, whose mission is to accelerate research and education in the nanosciences at West Virginia University. This REU Site is expected to increase the retention of underrepresented minorities and women in science and engineering programs and to encourage them to pursue post-graduate advanced degrees.

At Marshall, Dr. Marcia Harrison of the Department of Biology is PI of an ADVANCE grant from NSF. The grant is an institutional transformation program which was awarded in September 2006. The MU-ADVANCE Program will impact STEM faculty in four MU Colleges through an integrated approach comprised of: 1) The Recruitment and Networking Initiative to apply aggressive strategies to increase the number of female STEM faculty; 2) The Faculty Development Initiative to provide multiple methods to help new faculty balance and integrate teaching and research responsibilities, and to foster collaboration among STEM faculty; and 3) The State and Institutional Policy Changes Initiative specifically focused on changing university and state policies identified to be significant barriers to the advancement of female STEM faculty at Marshall. The MU ADVANCE team is working with the search committee working to fill the second RII position at Marshall.

Finally, the KY-WV LSAMP was awarded in the fall of 2006 as well. The WV RII Education, Human Resource Development and Outreach program is working closely with campus LSAMP coordinators to leverage our programs intended to broaden participation. The three institutions collaborating through the RII are also the WV sites for the LSAMP.

5. The project's annual report must include evidence of the implementation of its evaluation plan, including its use for project performance and documentation of progression and attainment of the stated project goals and objectives.

The project evaluation plan which was developed by the external evaluator, Dr. Rose Shaw, in collaboration with the Executive Leadership Team sets out goals, strategies, objectives, activities, outputs, and pursued outcome. The evaluation plan was submitted to the Program Officer, Julio Lopez-Ferrao, on September 20, 2006 via email.

The Goals are:
Goal 1 (Ideas): Enable research in molecular biometrics for innovation and service to WV and the nation.
Goal 2 (Tools): Establish research equipment infrastructure and supporting academic culture necessary to develop and sustain state-of-the-art nanoscale research by WV scientists and engineers.
Goal 3 (People): Build a diverse interdisciplinary group of WV scientists competitive in molecular biometrics.

During July and early August 2006, the evaluator and the Executive Leadership Team (ELT) worked to establish baseline data for the project. Also in early August, the evaluator conducted a survey of FBBG scientists to evaluate university climate. The survey provided valuable data to the ELT for meeting Objective 2.5 - Transform university culture and realize a substantially expanded research and development agenda by enhancing faculty support systems, adding support staff, and modifying administrative policies on teaching loads and hiring strategies.

The aforementioned programs to aid improvements in proposal preparation, submission and improving the quality of submissions are examples of enhanced faculty support systems that have been implemented. In addition, the development of a targeted hiring strategy to increase women and minority candidates for RII positions is a change in university hiring practices. Another service provided by WVEPSCoR to support quality proposal submission is proposal review by experts in both the discipline and in grant-writing. This service is provided at no cost to the faculty member.

Other needed improvements mentioned by faculty in the climate survey included reducing FBBG research faculty work load, increasing research-related incentives, increased graduate student recruitment programs and better financial support to recruit high quality graduate students. The ELT is working to improve graduate student stipends and fellowships to allow faculty to better recruit high quality graduate students. The RII is allowing newly hired faculty at both WVU and MU to have a greatly reduced teaching load during the first three years of their appointment, so they can set up labs, recruit graduate students and begin their research program. On the campuses, faculty and administrators are working to ensure tenure practices reward success in multidisciplinary research and in development of intellectual property. Changing faculty evaluation practices will require time to ensure success.

The ELT meets quarterly to review scientific activities and EHRDO programs. The evaluator provides quarterly formative evaluation updates which are also reviewed by the ELT. Action items are identified at each meeting with ELT members implementing activities to address those items.

The evaluator provided a table that identified the EHRDO population of interest, the EHRDO component that applies to the population and the data needed to evaluate the success of the EHRDO component. This table was provided to the EHRDO coordinators on each campus. They are working to set up data collection systems that will be adequate for evaluation. EHRDO coordinators on each campus are also meeting quarterly to assure coordination and implementation of EHRDO components.

Change in Objectives or Scope: None

Unobligated funds: $ 0.00

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Book
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering

Evaluation Plan for WVEPSCoR's RII

Next Generation Biometrics: Achieving Strength in Molecular Recognition and Transport

PREFACE

This document presents the evaluation plan developed by the project's External Evaluator and the Executive Leadership Team (ELT). A workgroup comprised of the project's ELT, Consultants and the External Evaluator met for a full day on July 11, 2006 at WVEPSCoR in Charleston, WV to develop the project's full evaluation plan as requested by the National Science Foundation in the Award Letter dated May 8, 2006. Members of the ELT in attendance were Paul Hill, Jan Taylor, Lawrence Hornak, Curt Peterson, Howard Aulick and Joseph Kusimo. The Consultants were Joseph Danek and Robert Gillespie. The External Evaluator is Rose Shaw. Members of the workgroup commented on the version of the plan developed on July 11th during the first editing cycle (week of July 17th) and again during the final editing cycle (week of July 24th). Available baseline data were provided during the final editing cycle.

EVALUATION PLAN STRUCTURE

The evaluation plan is structured around the project's three goals: ideas, tools and people. Objectives for attaining each goal and assessing goal strategies are supported by activities, expected outputs, pursued outcomes, data to be gathered, metrics, performance measures, progress indicators and sustainability indicators. A summary data collection table summarizes the implementation, outcome and sustainability data collection components, timeline and collection methods.

FY 2005[1] is the specified baseline year defined by the National Science Foundation award letter and is used for all metrics except for data provided by the KY-WV LSAMP (baseline data are five-year averages). Sustainability indicators are continued from the progress indicators for two years after the project.

Some of the indicators in the evaluation plan are essential for project management and will be collected using WVEPSCoR's MARS data collection system. These data will be utilized by the ELT and some data will be shared with the External Evaluator as progress and outcome indicators.

Definitions used in this evaluation plan are provided in the appendix along with other definitions that will be used to maintain consistency and accuracy of data collected during this RII.

EVALUATION SCOPE

The evaluation plan does not include assessment of project compliance which is the sole responsibility of WVEPSCoR. Compliance factors include documentation that the expertise of each of the new hires is interdisciplinary, the number of hires from each participating institution, financial records (including purchasing of tools) and leadership's required reporting to the National Science Foundation. The evaluation of this project also does not include cost benefit analysis.

[1] FY 2005 is the state of West Virginia's fiscal year from July 1, 2004 to June 30, 2005.

<u>Goal 1 (Ideas):</u> Enable research in molecular biometrics for innovation and service to WV and the nation.

Strategies: Organize discovery and innovation around the functional building blocks with which to construct integrated molecular recognition testbed devices. Build and bridge these crosscutting functional building block groups (FBBGs) of faculty through strategic cluster hires and development of early career faculty and hires of postdoctoral associates both at WVU and MU. Build strategic collaborative relationships with regional academic and industry partners to bridge capability voids, complement strengths and accelerate targeted research. Enhance, institutionalize, and continually improve the academic support necessary for promoting research discovery and learning.

Objective 1.1: During the first two project months (July and August 2006), the functional building block groups (FBBG) under the leadership of the Technical co-PI will develop research/management plans for the four building blocks: 1) Photonic Transduction, 2) Nanokinematics, 3) Nanofluidics and Microfluidics, and 4) Electronic Transduction.

Objective 1.2: Collaboratively monitor and assess the FBBG research/management plans' components according to the following digressive schedule: quarterly for project year one, biannually for project year two, and annually for year three. This schedule engenders a gradual institutionalization of reporting activities by establishing a rigid reporting framework during the early stages that becomes incorporated into typical operations during the project and self-sustaining after the project.

Objective 1.3: Within 6-months after their contracts begin, the eleven (two MU and nine WVU) research faculty hires will be full collaborative FBBG research partners because all hires will be from inter-disciplinary groups. RII resources will provide startup packages, summer salary, graduate students, and augmented materials support for each hire to immediately link their new ideas and tool capabilities to specific elements of the project research plan.

Objective 1.4: Participation of MU scientists in the FBBGs will increase incrementally each of the three-years of the RII with research, publication and grant-seeking efforts of MU and WVU scientists becoming increasingly collaborative in molecular biometrics.

Objective 1.5: Strengthen research cohesiveness, accelerate development of targeted research, connectivity and collaborative dynamics by increasing collaborative interactions between FBBGs and their partners (e.g., other academic institutions, government agencies, private sector business) including the mini-sabbaticals of WVSU faculty and student experiences with FBBG scientists and engineers.

Objective 1.6: Within the first quarter, develop an intellectual property agreement between institutions (WVU and MU), and partners within 90 days of their engagement in the project.

Activities: Write, update, monitor and assess research plans, conduct research, conduct meetings, develop intellectual properties (i.e., disclosures, applications, licenses, copyrights, etc.), partner intra- and inter-institutionally, initiate and grow external partnerships, write proposals, prepare collaborative intellectual property agreements, and provide support to colleagues.

Outputs: Publications, proposals, NSF and other competitive awards that meet project objectives and intellectual property actions.

Pursued Outcome: Self-sustaining, nationally competitive collaborative molecular biometric research

Progress and Sustainability Indicators[2]:

Progress Indicators*						
	Invention disclosures	Refereed Publications	NSF and other Proposals	NSF and Other Awards	Inter-disciplinary Awards	Average award size
FY05 Baseline	1	27	42	8	3	$361,974
FY 2007	3	30	46	8	3	$400,000
FY 2008	6	35	50	10	4	$450,000
FY 2009	10	43	54	12	6	$500,000
Sustainability Indicators						
FY 2010	12	51	58	14	8	$600,000
FY 2012	15	55	60	16	10	$700,000

* Note: Baseline data are for the 12 faculty members of the FBBGs.

Implementation Evaluation Data:

- (Goal 1) Progress and quality of collaborative research will be reviewed biannually by the External Technical Advisory Board (ETAB).
- (Goal 1) In the springs of 2007-2009 the External Evaluator will interview FBBG faculty about strengths/areas needing improvement of collaborative proposal writing teams including: In what ways are your NSF and other proposals of higher quality this year than they were last year? Are you writing more collaborative NSF proposals this year than last year? If not, why not; if yes, why? How much larger are your proposals to NSF and other agencies this year than last year? What accounts for this?
- (Objectives 1.1 and 1.2) The External Evaluator will receive written summary reports from WVEPSCoR within 30-days of WVEPSCoR's receipt of the FBBG reports from the Technical PI. These summary reports will provide objective evidence that the research/management plans are being used as part of the implementation process along with summaries of the time-gauged accomplishments, outputs, targets and obstacles contained within the FBBG reports.
- (Objectives 1.3, 1.4 and 1.5) The External Evaluator will administer web accessible "collaboration effectiveness" surveys to all FBBG faculty.
- (Objectives 1.4 and 1.5) In January (for July-December) and July (for January-June) the Executive Leadership Team (ELT) will report evidence that collaboration between MU and WVU scientists is increasingly collaborative in molecular biometrics. The report will also summarize FBBG collaborative activities external to the project.
- (Objective 1.5) In early fall each project year, the External Evaluator will interview the WVSU coordinator by email and/or telephone regarding the successes of the previous summer's mini-sabbaticals and student experiences.
- (Objective 1.6) WVEPSCoR will maintain records of intellectual property[3] agreements and will report agreement dates and dates of partner engagement.

Goal 1 Outcome Evaluation Data:

- Evidence of current and potential future societal impact of project research in security, health, energy and environmental applications including but not be limited to: types of inventions and applications, licenses, peer reviewed publications, use of project intellectual property by business partners.
- Evidence of increased competitiveness including but not limited to: citations[4], numbers of peer reviewed publications by FBBG faculty, types of intellectual property, types and amounts of NSF and other awards, (WVU, MU and WVSU) theses and dissertations that include molecular biometrics, types of partnerships both within and outside WV, and ETAB external review findings.

[2] The population for these progress and sustainability indicators data is current FBBG faculty and new hires.
[3] A product of the intellect including inventions, patents, laboratory discoveries and copyrighted work.
[4] Publications by FBBG faculty recorded by the Science Citation Index.

- Triangulation[5] of progress and outcome data pertaining to three outcome metrics: Quantity,[6] Quality,[7] and Leverage[8] will be used to assess the impact of research collaboration.
- Qualitative evidence from the MU, WVSU, WVU, and WVEPSCoR leadership teams will be gathered through interviews regarding the impact of the research component of the project on the ultimate goal of advancing WV's academic and industrial infrastructure to compete on a national level including evidence of sustained MU and WVU collaborative research intra-institutionally, inter-institutionally and external to the two institutions. The three case studies[9] planned to assess project impact will include evidence of how Goal 1 activities and outputs contributed to these advances.

[5] A method of establishing the accuracy of information by comparing three or more types of independent points of view on data sources (for example, interviews, observation, and documentation; different times) bearing on the same findings.
[6] Increases in research productivity attributable to collaboration.
[7] The types of collaborative partnering and business plans
[8] The amplifying effect of collaborations on research productivity.
[9] A case study is an intensive study of a specific individual or specific context using in-depth interviewing, observation and written documentation.

<u>Goal 2 (Tools):</u> Establish research equipment infrastructure and supporting academic culture necessary to develop and sustain state-of-the-art nanoscale research by WV scientists and engineers.

Strategies: Build capacity and accelerate competitiveness by acquiring tools to improve the research capabilities of each of the functional building block groups. These critical instruments will be used for interdisciplinary research by MU, WVSU, and WVU. Access to these instruments will also be used to increase undergraduate and graduate students' awareness of molecular biometric research and their motivation to conduct research at the nanoscale level. Enhance, institutionalize, and improve the shared facility and academic environments necessary to promote discovery, innovation, and learning activities of interdisciplinary groups.

Objective 2.1: Acquire essential equipment throughout the project that is aligned with FBBG collaborative research needs. Tools are currently anticipated to include: a Beckman-Coulter XL-A analytical ultra-centrifuge, XPS and XRD for characterization, advanced e-beam lithography system, high resolution fluorescence imaging, automated DNA synthesizer, and Cl-based reactive ion etching system.

Objective 2.2: Enhance, institutionalize, and continually improve the environment necessary to promote discovery and learning of all participants through the acquisition, organization, and use of state-of-the-art molecular research tools at the nanoscale level.

Objective 2.3: Extend use of the acquired and established research tools to users within, and external to, the participating institutions.

Objective 2.4: Include acquired and established molecular research tools in educational and research experiences for the continuum from undergraduate to postdoctoral fellows as appropriate for all three institutions.

Objective 2.5: Transform university culture and realize a substantially expanded research and development agenda by enhancing faculty support systems, adding support staff, and modifying administrative policies on teaching loads and hiring strategies.

Activities: Purchase tools and organize their use, establish and institutionalize sustained support of shared facilities, conduct research, provide tool use training/mentoring through on-site/virtual tours and develop usage agreements for external users. Work to modify university policies to better support research pursuits.

Outputs: Tools, publications, proposals, intellectual properties (i.e., disclosures, applications, licenses, copyrights, etc.), onsite/virtual tours, tool use, executed usage agreements.

Pursued Outcome: WVU and MU will be increasingly competitive nationally in nanoscale research with increased publications, citations, NSF and other awards, interdisciplinary awards, and intellectual property. The targeted student continuum from undergraduate to postdoctoral will have increased interest and awareness of opportunities in nanoscale science research.

Progress and Sustainability Indicators: The Goal 1 progress and sustainability indicators are also indicators for Goal 2.

Progress Indicators						
	Productivity	Culture Change		Number of Students in Tours and Mentoring		
	Research Tool Usage in Hours	Number of Institutional Unit Users	Users from Outside WVU and MU	Undergraduate	Graduate	Postdoctoral
FY05 Baseline *	0	0	0	0	0	0
FY 2007	160	15	5	10	5	2
FY 2008	260	20	8	30	7	4
FY 2009	420	25	12	50	10	6
Sustainability Indicators						
FY 2010	500	30	15	60	15	8
FY 2011	700	40	20	80	20	10

* Note: These data are for the research tools that will be acquired by this project.

Implementation Evaluation Data:

- (Objective 2.1) WVEPSCoR will maintain records of purchases in coordination with WVU and MU.
- (Objective 2.2) Progress indicators will be used to assess implementation.
- (Objective 2.3) ELT members will be interviewed by the External Evaluator to assess (a) how use of research tools by others within and outside WVU and MU has improved and enhanced the institutions and their partners, (b) implementation obstacles and (c) steps being taken to overcome obstacles.
- (Objective 2.4) Each fall and spring semesters of the three project years, the External Evaluator in coordination with WVU, MU and WVSU EHRDO leadership, will develop and administer brief surveys (e.g., What did you think of the experience? How has it influenced you? Has it changed your perspective on your future plans?) to the continuum of participants who have been exposed to the acquired tools by either on-site or virtual tours or mentored in the use of the tools.
- (Objective 2.5) The ELT will develop a strategic time-based priority plan for WVU and MU to proactively modify policies and support systems to increase researchers' productivity and foster research collaboration (Fall 2006). This plan along with attainment of the time-based changes will be reported to the External Evaluator after each of the ELT meetings during the project. At appropriate times, the External Evaluator will interview the project's scientists and engineers about the impact of these changes on research at their university.

Goal 2 Outcome Evaluation Data:

- Evidence that project advances in molecular recognition have had or have the potential for societal impact in security, health, energy and environmental applications will include but will not be limited to: types of invention disclosures and applications, licenses, types of intellectual property, peer reviewed publications, use of project discoveries by business partners in security, health, energy and/or environment.
- Evidence of project impact on increased competitiveness will include but will not be limited to: citations, numbers of peer reviewed publications by FBBG faculty, types of intellectual property, types and amounts of NSF and other awards, WVU, MU and WVSU theses and dissertations that include molecular biometrics, types of partnerships both within and outside WV, and ETAB external review findings.
- In year 3 the External Evaluator will conduct a group interview of the ELT regarding ways this RII grant has added value to the realization of WVEPSCoR's ultimate goal to advance WV's academic and industrial infrastructure to compete on a national level. The three case studies planned to assess project impact will include evidence of how Goal 2 activities and outputs contributed to these advances.
- The pre/post (beginning of year 1 and end of year 3) institutional climate survey of WVU and MU FBBG faculty will be developed by the ELT and the External Evaluator; the survey will be administered by the External Evaluator in coordination with the Technical co-PI.

<u>Goal 3 (People)</u>: Build a diverse interdisciplinary group of WV scientists competitive in molecular biometrics.

Strategies: A collaborative program among the three participating universities will focus on strengthening and broadening participation in science, technology, engineering and mathematics (STEM) disciplines to encourage undergraduate and graduate study within STEM disciplines that support research and education in nanoscale science and engineering. Based on the premise that it is more effective to work to retain and enhance existing human resources than to recruit replacements, this RII will focus the majority of its EHRDO efforts on college or university students, early-career faculty, and mid-level faculty who are making the transition from individual research investigators to interdisciplinary educators and research cluster leaders. The strategies for transitioning early-career and mid-level faculty to interdisciplinary and collaborative ventures are extensions of successful existing programs for students.

Objective 3.1: Better integrate RII research and education by providing a summer research experience in labs of RII faculty to sophomores under the supervision of postdoctoral or senior doctoral students.

Objective 3.2: Transform the academic culture and environment in a way that increases undergraduate retention and graduation rates of students in STEM fields by implementing a six-week summer bridge program and recruiting undeclared majors interested in STEM fields, peer and proactive mentoring during the undergraduate experience, supplemental instruction for gatekeeper courses to improve performance and retention and other strategies and programs aligned with the Louis Stokes Alliance for Minority Participation. Pre-collegiate recruiting strategies at WVSU will focus on broadening participation within STEM disciplines.

Objective 3.3: Build the graduate pool by recruiting minority and women STEM students to enter doctoral programs related to molecular biometrics and supporting them with a program patterned after the NSF Alliances for Graduate Education and the Professoriate, especially a summer bridge program for first year graduate students, a GRE preparation class and mentoring by RII graduate students/faculty.

Objective 3.4: Enhance research performance of faculty in molecular biometrics through a developmental program for faculty modeled after the Meyerhoff Scholars program: faculty grant development support (annual grant writing seminars, release time for grant writing, 4-6 month guidance), mentoring by research faculty, mentoring/training seminars (Presidential Award Mentoring Seminars), and the focused minority and women STEM faculty enhancement initiative (WVSU faculty participation in research experiences at MU and WVU).

Objective 3.5: Enhance opportunities for project participants to effectively transfer technologies through industry partners.

Objective 3.6: Project-specific staffing will include efforts to promote diversity consistent with existing university policies pursuant to Item #2 in the NSF award letter dated May 8, 2006.

Activities: Adapt Meyerhoff Scholars program for project participants; recruit and train peer mentors; recruit and train graduate students and faculty as student mentors; mentor faculty, doctoral and post-doctoral personnel in grant-writing; identify and pair-off junior faculty or postdoctoral fellows with senior faculty; provide seminars twice yearly by recipients of NSF's Presidential Award for Mentoring; provide mini-sabbaticals for WVSU faculty and intensive summer experience for their students; coordinate professional development activities to nurture biometric, nanoscale or biomolecular research interests; and work with WVHTC on transfer technologies.

Outputs: Undergraduate and Graduate Summer Bridge Programs, Peer Mentoring and Supplemental Instruction, Summer Undergraduate Research Experiences (SURE), 3-day Mentor Training Workshop, GRE preparation classes, graduate student mentoring, Grant Writing Seminars and follow-up workshops, Presidential Award Mentoring Series, WVSU faculty enhancement initiative, and IP commercialization.

Pursued Outcome: A diverse, internationally competitive, and globally-engaged West Virginia workforce of scientists, engineers and well-prepared citizens

Progress and Sustainability Indicators: The UREP[10] minority STEM undergraduate and graduate student data will continue to be coordinated with the KY-WV LSAMP.

Progress Indicators									
	STEM Enrollment of UREP Minority Students			UREP Minority STEM Bachelors Degrees			UREP Minority STEM Graduate PhD and Masters Degrees Awarded		
	WVU	MU	WVSU	WVU	MU	WVSU	WVU	MU	WVSU
LSAMP Baseline	142	45	60	22	6	3	4	2	0
FY 2007	152	50	66	23	7	4	4	2	1
FY 2008	174	55	76	25	8	5	5	3	2
FY 2009	214	60	86	30	9	7	6	3	3
Sustainability Indicators									
FY 2010	244	70	96	40	12	8	7	4	4
FY 2011	284	90	120	45	15	9	8	5	5

Progress Indicators								
	Total Number of Women and Minorities in FBBG Faculty Positions		Number of Women and Minorities in Project Activities			Number of Women and Minorities as Role Models in HRDO Activities		
	WVU	MU	WVU	MU	WVSU	WVU	MU	WVSU
FY 05 Baseline	0	1	0	0	0	0	0	0
FY 2007	0	2	IE[11]	IE	IE	IE	IE	IE
FY 2008	1	2	IE+15%	IE+15%	IE+15%	IE+4	IE+4	IE+4
FY 2009	2	2	IE+30%	IE+30%	IE+30%	IE+7	IE+6	IE+6
Sustainability Indicators								
FY 2010	2	3	IE+60%	IE+60%	IE+60%	IE+10	IE+9	IE+9
FY 2011	3	3	IE+100%	IE+100%	IE+100%	IE+14	IE+10	IE+10

Progress Indicators (All these data will be disaggregated by minority and gender)							
	MS, PhD, and Post-docs	Junior Faculty and Post-doctoral Fellows Mentoring/Training Participants					
	Number Working with FBBG faculty	Number Grant Proposals for Those Never Writing Before	Proposals Funded		Number of Collaborative Proposals		
			No.	Average Amount	External to the project	Within each institution	Between institutions
FY05 Baseline	63	0	0	0	0	0	0
FY 2007	65	2	0	0	0	1	0
FY 2008	67	6	3	$150K	1	1	1
FY 2009	70	8	4	$200K	1	2	2
Sustainability Indicators							
FY 2010	72	10	5	$250K	2	3	3
FY 2011	75	12	6	$300K	2	4	4

[10] Underrepresented minority which includes African American, Hispanic, Native American and Pacific Islander
[11] IE will be the number of women and minorities initially enrollment or participating in each of the grant activities.

Implementation Evaluation Data

- (Objective 3.1) Records of the number of sophomores enrolled and completed along with their gender, minority status and STEM field will be maintained by the institutions and reported to the External Evaluator at the end of each summer. Post surveys[12] of students (Reaction, Learning and Behavior) and delayed post surveys of the same students (Results) will be completed online.
- (Objective 3.2) Records of the number enrolled and completed along with their gender, minority status and STEM field will be maintained by the institutions. Post-bridge student surveys (Reaction and Learning) will be collected at the end of the bridge experience. Participating students' university semester and cumulative GPAs will be collected and the means will be plotted over time. The External Evaluator will conduct "lessons learned" interviews of instructors and mentors.
- (Objective 3.3) Records of the number enrolled (Graduate Bridge, GRE Preparation, and Mentoring) and completed along with their gender, minority status and STEM field will be maintained by the institutions. Post-bridge and post-GRE preparation (repeated measures) student surveys (Reaction and Learning) will be collected at the end of these experiences.
- (Objective 3.4) Number of faculty participants in all activities (seminar, released time, advising program, mentoring and faculty enrichment program) along with gender and minority status will be maintained by the institutions. Faculty post (Reaction, Learning) and delayed-post surveys (Behavior and Results) will be collected.
- (Objective 3.5) Documentation of activities and results by each of the participating institutions. Counts and types of invention disclosures will be collected and analyzed qualitatively and quantitatively.

Goal 3 Outcome Evaluation Data:

- Trend displays of baseline, years 1-3 KY-WV LSAMP-coordinated longitudinal disaggregated UREP and non-UREP STEM undergraduate and graduate GPA, enrollment, completion rates and advancement of UREP students into STEM graduate programs and/or STEM workforce.
- Graduate student major, research topic, race/ethnicity, gender and tracking after completion (degree obtained, current position, research focus).
- Trend displays of baseline and years 1-3 number and size of proposals and awards of faculty participants.
- Trend displays of tech transfer data.
- Trend displays of women and other UREP in faculty positions and serving as role models.
- Longitudinal tracking interviews of one undergraduate, one graduate and one faculty member highlighting the impact of EHRDO (Education, Human Resource Development and Outreach) participation on each of the individuals will be conducted and triangulated.

[12] Reaction (What did participants think of the training?), Learning (How and by how much did the training increase knowledge, improve skills and/or change attitudes?), Behavior (What changes in individual performance resulted from what was learned?), and Results (What were the final results?) are the four levels of the Kirkpatrick Model which is used to evaluate training and (faculty and student) professional development.

DATA SUMMARY CHART

Description of Data Collected	Responsible Party(ies)	When Collected	Data Type	Purpose		Sustainability Marker
				Implement-ation	Project Impact	
Intellectual property activity (types, number)	Institutions and WVEPSCoR	Bi-annually	Quantitative and qualitative	X	X	X
Publication inform-ation (journals, titles, citations)	Institutions and WVEPSCoR	Bi-annually	Quantitative and qualitative	X	X	X
NSF and other proposals (PI and co-PI names, types, collaboration)	Institutions and WVEPSCoR	Bi-annually	Quantitative and qualitative	X		
NSF and other awards (names, amount, collaboration)	Institutions and WVEPSCoR	Bi-annually	Quantitative and qualitative	X	X	X
Interdisciplinary awards (names, amount, collaboration)	Institutions and WVEPSCoR	Bi-annually	Quantitative and qualitative	X	X	X
Faculty retention	Institutions and WVEPSCoR	Annually	Quantitative	X	X	X
Institutional culture changes	Institutions and WVEPSCoR	Annually	Quantitative and qualitative			X
Updates on research/ management plans	Institutions & WVEPSCoR	Quarterly	Qualitative	X	X	
ETAB findings	WVEPSCoR	Within one month of site visits	Qualitative	X	X	
Theses, dissertations, degrees conferred in targeted areas	Institutions and WVEPSCoR	Biannually	Quantitative	X	X	X
Collaboration effectiveness surveys	Shaw	6, 12, and 24 months	Qualitative	X		
Review of project leadership collaboration activities and results	Shaw	Ongoing from leadership teams	Qualitative	X	X	
Interviews of proposal writing teams	Shaw	Annually	Qualitative	X	X	
Qualitative reports on mini-sabbaticals and student experiences	WVSU leadership and Shaw	Annually	Qualitative	X	X	
Collaboration outcome metrics	Shaw and WVEPSCoR	Ongoing	Qualitative and quantitative		X	X
Qualitative evidence of strengthening of infrastructure and competitiveness	Shaw, WVEPSCoR and institutions	Year 3	Qualitative		X	X
Purchase records	Institutions	Bi-annually	Quantitative	X		

Description of Data Collected	Responsible Party(ies)	When Collected	Data Type	Purpose		Sustainability Marker
				Implement-ation	Project Impact	
	and WVEPSCoR					
Summary of tool use	Institutions & WVEPSCoR	Bi-annually	Quantitative & qualitative	X		
Surveys of continuum of participants regarding tool usage	Shaw	Post-usage	Qualitative	X	X	
Impact of research and tools on business partners	Institutions & WVEPSCoR & Shaw	Annually	Qualitative	X	X	X
Undergrad , graduate, post-docs, and faculty data (STEM enroll-ment, GPA, grad-uation, demographics)	Institutions, WVEPSCoR and Shaw	Annually	Quantitative	X	X	X
Student (Obj. 3.1, 3.2, 3.3) surveys	Shaw	Post & one-year delayed	Qualitative	X	X	
Summer bridge enrollment & completion (disaggregated) data	WVU RII leadership and Shaw	Summers	Quantitative	X	X	
GRE prep class and mentoring surveys	Shaw	Post-class	Qualitative	X		
Bridge session observations	Shaw	2 times/year	Qualitative	X		
Tech transfer data	Institutions, WVEPSCoR & Shaw	Ongoing	Qualitative Quantitative	X	X	X
Faculty participant demographic data for Meyerhoff-type professional development	Institutions, WVEPSCoR & Shaw	Ongoing	Qualitative Quantitative	X		
Meyerhoff-participant post-completion undergraduate and graduate student tracking	Shaw	After completion	Qualitative		X	X
Campus climate survey	Shaw	Baseline & Year 3	Quantitative		X	X
Case studies	Shaw	Year 3	Qualitative		X	X

NOTE: Analysis and summarizing of qualitative and quantitative evaluation data are the External Evaluator's responsibility. Standard qualitative methods (organization, meaningful reduction, cross-case analysis, themes, and trends) will be used to analyze the qualitative data. Quantitative data will be analyzed using descriptive statistics and frequency distributions charts (with bar and line graphs illustrating disaggregated data); association tests (e.g., Chi-square and correlation); and repeated measures ANOVA.

Appendix: Definitions

Award: All grants for competitive research or science education awarded by NSF or other federal agencies as indicated by an award letter received from the federal agency.

Culture Change: A measure of sustainability that reflects policy changes, cross disciplinary initiatives, innovative hiring practices and inter-institutional partnerships.

Goal: A broad-based description of an intended outcome.

Objective: A specific description of an intended outcome.

Strategy: A systematic plan of action to reach predefined goals.

Activity: Project actions (conduct, deliver, develop, train, provide, assess, facilitate, partner, work with).

Interdisciplinary Awards: Grants for competitive research or science education awarded by NSF or other federal agencies that have two or more investigators from different departments or disciplines.

Outputs: Products and services project plans to deliver/implement.

Outcomes: Changes or benefits resulting from activities and outputs.

Management Plan Updates: Progress reports from the FBBG and EHRDO team leaders regarding the implementation and progression of planned research, hiring, acquisition of equipment and data required for management and evaluation.

Metrics: A system of (qualitative or quantitative) measurement that includes the item being measured, the unit of measurement and the value of the unit.

Participants: All individuals directly involved in research or EHRDO project activities. This includes undergraduate and graduate students, post-docs and faculty within the FBBGs.

Progress Indicators: A metric or combination of metrics to assess progress in meeting the goals of the project and to provide information for improvement (e.g., efficiency, effectiveness).

Proposal: Research or science education proposals submitted to competitive NSF or other federal grant programs.

Publications: Scientific research publications in peer reviewed journals that have actually been in print. (i.e., a full bibliographic citation is provided, including date of publication).

Tech Transfer Data: Quantitative and qualitative data on technology transfer actions recorded by the Research Corporations. The numbers of actions, general descriptions and commercialization successes will be reported.

Tool Use: Measure of usage of equipment purchased by the RII and used by FBBG faculty, students, external research associates and business partners.

Activities and Findings

The West Virginia Experimental Program to Stimulate Competitive Research (WVEPSCoR) received a Research Infrastructure Improvement (RII) award on May 8, 2006. This award is focused on creating a world-class research capability in molecular recognition, more specifically "molecular biometrics." Robust, low-cost instruments that can quickly and reliably identify minute quantities of molecular species will provide great advances in homeland security, health, energy, forensic science, and other fields. Creating a center of research excellence in this field is a logical and realistic extension of established and emerging research and education programs in biometrics, nanotechnology, forensics, and molecular biology at West Virginia University (WVU), Marshall University (MU), and West Virginia State University (WVSU).

The WV RII strategy has four primary objectives: 1) Organize discovery and innovation around the functional building blocks needed to build integrated molecular testbed systems; 2) aggressively build and bridge these crosscutting faculty groups through strategic cluster hires of faculty and postdoctoral associates at both WVU and MU; 3) solidify strategic collaborative relationships with industry, government, and academic partners including WVSU and institutions outside of WV; and 4) enhance, institutionalize, and improve the shared facility environment as well as the academic environment necessary to promote discovery and learning activities of these groups and the institutional culture changes they have helped to launch.

West Virginia is contributing substantial financial resources to support this strategy in concert with the RII award. Consequently, the WVEPSCoR Director and Council decided that it would be better to officially start the project at the beginning of the West Virginia fiscal year. Project activities and spending began on July 1, 2006, and this first annual report is actually reporting six months of activities through December 31, 2006.

Administrative Activities

WVEPSCoR central office staff prepared sub-awards to university partners before the official project start date of July 1, 2006. These were sent to the fiscal offices of West Virginia University, Marshall University, and West Virginia State University for their approval and signature. Sub-award agreements are in place and invoice processing is occurring according to approved budgets.

WVEPSCoR has begun to implement expanded outreach and communication efforts. As a first step, a Communications Program Manager was hired with state funds. Virginia Painter will be handling the communication efforts of the State Office. Our newsletter, *The Neuron*, has been redesigned and editorially expanded, and contacts with media have increased to share successes of the West Virginia research enterprise. Ms. Painter is developing a comprehensive communication plan that will serve the RII and other WVEPSCoR programs.

Reporting activities from project scientists and education, human resources development and outreach (EHRDO) coordinators are collected on-line via the WVEPSCoR Management, Application and Reporting System (MARS). MARS is a secure, web-based system that allows WVEPSCoR to efficiently manage applications and project reports. WVEPSCoR continues to upgrade MARS to make it as user-friendly as possible for project participants.

WVEPSCoR staff and Council are also continuing to work toward increased state funding for the state's Science and Technology strategic plan, *Vision 2015*. We are pleased to report that an additional $10 M in research funding has been approved by the WV Legislature in the WV Higher Education Policy Commission budget for FY2008. This new research funding will be administered by WVEPSCoR.

Special award conditions

1. *WVEPSCoR will submit within the first two months of the award's effective date, a three-year strategic plan aimed at ensuring the successful recruitment and retention of the new research positions, including specific timelines and progress indicators.*

WVEPSCoR submitted a hiring strategy and plan to our Program Officer on July 18, 2006.

Hiring update: The WV RII proposal included the hiring of 11 science and engineering faculty to populate the interdisciplinary research teams. Through December 2006, WVU has hired 5 new faculty to participate in Functional Building Block Group (FBBG) work. Two of these faculty are in the College of Engineering and Mineral Resources and three others have been hired in the Eberly College of Arts and Sciences. Marshall University has hired Dr. Elmer Price to lead the biomolecular research team and the search is under way for a faculty member with interests and experience in molecular biometrics. To date, the applicant pool has been reduced to four and three of the four have visited the Marshall campus.

An indicator of growing collaboration is that Dr. Larry Hornak of WVU is serving on the search committee at Marshall to fill this position. Dr. Hornak participates in on-campus interviews at Marshall via web-based conferences.

Currently four positions are being advertised at WVU during the 2007 fiscal year. A summary of the search process is provided below:

Nano Bio Device Position
83 Applications Received.
8 Phone Interviews Completed
2 Candidates Scheduled for Interview

Supra Chemistry Position
27 Applications Received
3 Phone Interviews Completed
1 Campus Interview Completed
2 Campus Interviews Scheduled/Pending
2 Additional Phone Interviews in Process

Surface Modification Specialist
36 Applications Received
3 Phone Interviews Completed
1 Campus Interview Completed
1 Campus Interview Scheduled/Pending

Structural Biology/Biophysics Position
37 Applications Received
4 Phone Interviews Completed
2 Phone Interviews in process

To date, no females or other underrepresented minorities (URM) have been hired as part of the previous 5 searches at WVU. Offers were made to 4 females in the first 5 searches, but these individuals chose to accept positions at other institutions or to remain at their current institution. Unfortunately, the pool of applicants for the four searches underway appears to include very few females or URMs. A female candidate is coming in for an interview for the structural biology position. Discussions are underway between the Co-Directors and the Deans Advisory Board to the WVNano Initiative at WVU to identify/determine ways to increase the potential for broadening participation in the final four hires. On a positive note, the final Marshall University position includes three females among the four finalists. An offer is expected to be extended for the position very soon.

2. *Broadening participation: Using FY 2005 as a baseline, the annual progress report must identify the numbers of women and members of other underrepresented groups in staff positions and as participants in the activities funded by the award.*

Our pursued outcome is a diverse, internationally competitive, and globally-engaged West Virginia workforce of scientists, engineers and well-prepared citizens. The table below shows the FY2005 levels and our pursued levels throughout the grant period.

Progress Indicators								
	Total Number of Women and Minorities in FBBG Faculty Positions		Number of Women and Minorities in Project Activities			Number of Women and Minorities as Role Models in EHRDO Activities		
	WVU	MU	WVU	MU	WVSU	WVU	MU	WVSU
FY 05 Baseline	0	1	0	0	0	0	0	0
FY 2007	0	2	IE	IE	IE	IE	IE	IE
FY 2008	1	2	IE+15%	IE+15%	IE+15%	IE+4	IE+4	IE+4
FY 2009	2	2	IE+30%	IE+30%	IE+30%	IE+7	IE+6	IE+6
Sustainability Indicators								
FY 2010	2	3	IE+60%	IE+60%	IE+60%	IE+10	IE+9	IE+9
FY 2011	3	3	IE+100%	IE+100%	IE+100%	IE+14	IE+10	IE+10

IE is the number of women and minorities initially enrolled or participating in each of the grant activities.

Currently, there are 3 women scientists participating in FBBG activities, up from 1 in 2005. One FBBG scientist is Hispanic.

3. *The project's annual report must include a description of efforts, accomplishments, commitments, and plans to ensure that the positive outcomes of the project will be sustained beyond the duration of the grant. This may include quantitative data (e.g., numbers of new hires recruited and retained, proposal submissions, and award success rates, and students involved in research). The report may also include descriptions of policies or programs proposed or implemented to enhance the competitive research culture, integration of research and education, and broadening participation of underrepresented groups.*

Through the first six months of the project, progress has been made on implementing policies and programs to enhance research competitiveness. At WVU, the Research Corporation has sponsored a one-day grant writers seminar and a subsequent 4.5 month workshop for 15 faculty members of the 99 who attended the one-day seminar. In addition, the Office of the AVP for Research is facilitating a technical review of proposals prior to their submission to federal agencies through the WVEPSCoR office. All of these activities are intended to increase the competitiveness of submitted proposals. At Marshall University, the Research Corporation has initiated an electronic purchasing program and issued purchase cards to the vast majority of researchers in order to expedite these activities. In addition, two Research Corporation staff are physically located within the College of Science and School of Medicine to facilitate

faculty proposal submissions and to provide budget services. A key output of the first six months of the RII project was the development of intellectual property and non-disclosure agreements between WVU and Marshall so that collaboration can continue unimpeded.

In addition to these procedural changes, the Technical PI and project scientists have developed a Shared Resources Plan along with a fee schedule to make instrument maintenance self-sustaining. The Shared Resources Plan covers all shared instrumentation in clean rooms and in other laboratories at WVU and will provide sustained post-award support of faculty research. The plan is the first such comprehensive approach to shared facilities at WVU. The plan is intended to serve as a model to be implemented as appropriate at other institutions.

The principal advance at Marshall has been the opening of the Robert C. Byrd Biotechnology Science Center in September 2006. This 144,000 sq. ft. facility offers state-of-the-art research and educational space to faculty from the College of Science and School of Medicine. All current (Blough, Georgel, Miksovska, Norton, and Price) and future RII faculty are housed in this building with basic science colleagues from the School of Medicine. The removal of the eight-mile barrier separating these two science communities will vastly improve opportunities for interdisciplinary research at Marshall.

Integration of research and education is further enhanced by a state-funded STEM Fellows program. At both WVU and MU, the state funds fellowships for Ph.D. students who are working with FBBG faculty. At WVU, the STEM Fellows are involved in cancer nanotechnology and at MU, the fellows are working in a variety of biomolecular laboratories which may link with FBBG work. While this integration is not required by the award, its linkage is encouraged and supported by the state of West Virginia.

FBBG faculty at WVU have prepared a preproposal to the NSF IGERT competition and will be submitting it during the second quarter of 2007. An MRI proposal was submitted in the first quarter of 2007. Dr. David Lederman has received a Research Experience for Undergraduates (REU) Site Award leveraging the RII research activity which is targeting underrepresented students. The REU students will be working in FBBG research projects.

During the first 6 months of the project, 88 students have worked in the laboratories of FBBG scientists. Five of these students were African-American/Black, two males and three females. One female and four male Hispanic students were also included in the total. Overall, 62 male students and 26 female students have participated in FBBG research.

4. *The project's annual report must include evidence of linkages, coordination, and collaboration with other NSF-funded projects in the State that enhance the WV-proposed Research Infrastructure Improvement activities.*

At WVU, Dr. David Lederman, one of the FBBG Leaders, and his co-PI, Dr. Michelle Richards-Babb, have recently received a **Research Experience for Undergraduates** grant from NSF entitled "Multifunctional Nanomaterials REU Site." The main objective of the REU is to motivate underrepresented minorities, women, and economically disadvantaged STEM students from West Virginia and the Appalachian region to pursue careers in science. This will be done by providing the REU Site participants with a challenging and stimulating interdisciplinary scientific research program in nanobio/solid state multifunctional materials. The Site will fall under the umbrella of the WVNano Initiative, whose mission is to accelerate research and education in the nanosciences at West Virginia University. This REU Site is expected to increase the retention of underrepresented minorities and women in science and engineering programs and to encourage them to pursue post-graduate advanced degrees.

At Marshall, Dr. Marcia Harrison of the Department of Biology is PI of an **ADVANCE grant** from NSF. The grant is an institutional transformation program which was awarded in September 2006. The MU-ADVANCE Program will impact STEM faculty in four MU Colleges through an integrated approach comprised of: **1)** *The Recruitment and Networking Initiative* to apply aggressive strategies to increase the number of female STEM faculty; **2)** *The Faculty Development Initiative* to provide multiple methods to help new faculty balance and integrate teaching and research responsibilities, and to foster collaboration among STEM faculty; and **3)** *The State and Institutional Policy Changes Initiative* specifically focused on changing university and state policies identified to be significant barriers to the advancement of female STEM faculty at Marshall. The MU ADVANCE team is working with the search committee working to fill the second RII position at Marshall.

Finally, the **KY-WV LSAMP** (Louis Stokes Alliance for Minority Participation) was awarded in the fall of 2006 as well. The WV RII Education, Human Resource Development and Outreach program is working closely with campus LSAMP coordinators to leverage our programs intended to broaden participation. The three institutions collaborating through the RII are also the WV sites for the LSAMP.

5. *The project's annual report must include evidence of the implementation of its evaluation plan, including its use for project performance and documentation of progression and attainment of the stated project goals and objectives.*

The project evaluation plan which was developed by the external evaluator, Dr. Rose Shaw, in collaboration with the Executive Leadership Team (ELT) sets out goals, strategies, objectives, activities, outputs, and pursued outcome. The evaluation plan was submitted via email to the Program Officer, Julio Lopez-Ferrao, on September 20, 2006.

The Goals are:

Goal 1 (Ideas): Enable research in molecular biometrics for innovation and service to WV and the nation.
Goal 2 (Tools): Establish research equipment infrastructure and supporting academic culture necessary to develop and sustain state-of-the-art nanoscale research by WV scientists and engineers.
Goal 3 (People): Build a diverse interdisciplinary group of WV scientists competitive in molecular biometrics.

During July and early August 2006, the evaluator and the ELT worked to establish baseline data for the project. Also in early August, the evaluator conducted a survey of FBBG scientists to evaluate university climate. The survey provided valuable data to the ELT for meeting Objective 2.5 – Transform university culture and realize a substantially expanded research and development agenda by enhancing faculty support systems, adding support staff, and modifying administrative policies on teaching loads and hiring strategies.

The aforementioned programs to aid improvements in proposal preparation, submission and improving the quality of submissions are examples of enhanced faculty support systems that have been implemented. In addition, the development of a targeted hiring strategy to increase women and minority candidates for RII positions is a change in university hiring practices. Another service provided by WVEPSCoR to support quality proposal submission is proposal review by experts in both the discipline and in grant-writing. This service is provided at no cost to the faculty member.

Other needed improvements mentioned by faculty in the climate survey included reducing FBBG research faculty work load, increasing research-related incentives, increased graduate student recruitment programs and better financial support to recruit high quality graduate students. The ELT is working to improve graduate student stipends and fellowships to allow faculty to better recruit high-quality graduate

students. The RII is allowing newly hired faculty at both WVU and MU to have a greatly reduced teaching load during the first three years of their appointment, so they can set up labs, recruit graduate students and begin their research program. On the campuses, faculty and administrators are working to ensure tenure practices reward success in multidisciplinary research and in development of intellectual property. Changing faculty evaluation practices will require time to ensure success.

The ELT meets quarterly to review scientific activities and EHRDO programs. The evaluator provides quarterly formative evaluation updates which are also reviewed by the ELT. Action items are identified at each meeting with ELT members implementing activities to address those items.

The evaluator provided a table that identified the EHRDO population of interest, the EHRDO component that applies to the population and the data needed to evaluate the success of the EHRDO component. This table was provided to the EHRDO coordinators on each campus. They are working to set up data collection systems that will be adequate for evaluation. EHRDO coordinators on each campus are also meeting quarterly to assure coordination and implementation of EHRDO components.

Activities and Findings: Research – FBBG Efforts Summary

Our project goal is to build competitiveness in molecular recognition and transport and to develop approaches that can be used as building blocks for integrated sensor systems in security, health, energy, and environmental applications. This is being achieved by building, bridging, and equipping our core collaborating faculty groups in electronic and photonic materials and devices, and biomolecular science and systems. These core groups are collaboratively undertaking research in the functional building block groups that advances recognition, transduction, and transport functions which can be integrated together to achieve molecular recognition test bed devices for targeted applications.

Our research efforts are organized and reported at the FBBG level. Each detailed FBBG report captures activities, findings and output from both the interdisciplinary research in the building block area as well as the core groups upon which the interdisciplinary work is based. The table below captures the totals from the first 6 months of the program and compares them relative to the milestone targets for the first year.

FBBG	**Proposals**		**Awards**		**J Publ.**		**Degrees**		**Patents**		**Disclosures***	
Current vs. **T**arget	C	T	C	T	C	T	C	T	C	T	C	T
Electronic	3	4	0	3	3	15	-	-	1	2a	1	0
Photonic	3	8	1	1	6	11	-	-	0	1a	2	0
Nano/microfluidic	0	1	0	0	2	3	-	-	0	1p	0	0
Nanokinematic	4	5	1	1	0	9	-	-	0	2a	0	0
Totals	**10**	**18**	**2**	**5**	**11**	**38**	**-**	**-**	**1**	**6**	**3**	**0**

Notes:
This past round, no information on graduate degree production was collected via MARS.
Proposal and Award size information was incomplete and not included.
"a" under Patents refers to an application, "p" refers to provisional.
* Disclosures are not a specified milestone, but indicate initial intellectual property activities in addition to patent applications and patents.

Overall performance to date indicates the research effort is largely on track at its six month point, though some global areas of concern must be addressed (see below) to enable efforts. As indicated from the FBBG reports, many projects are in a building phase in terms of labs, personnel, and initial results, therefore outputs for the second half of the initial year are expected to be on or near targets. Linkages continue to grow between recognition/transduction and transport FBBGs. These are occurring currently

between the Photonic and Nano/microfluidic FBBGs. The nanokinematic FBBG is also linking to the Nano/microfluidic FBBG to achieve needed fluidic addressing functions.

Marshall research activity is integrated with the Nanokinematic (Blough), Photonic (Georgel), and Electronic (Miksovska, Norton) FBBGs. Interaction has been to varying extents given the early stages of the work. Norton has had his personnel trained and has used the WVU fabrication facilities. Blough's f-actin and myosin preparation and characterization is integral to the nanokinematic efforts. Contact and reporting for MU faculty is through their respective FBBG leaders. Conventional teleconferencing has been used and the means to web conference via NetMeeting has been disseminated and used, though sparingly. While levels of interaction vastly exceed past RIIs, they must be further improved and made regular. Additional modes of conferencing will be implemented soon and meetings scheduled on a periodic basis.

External collaborations have developed between the FBBG efforts and the DOE National Energy Technology Laboratory, the CDC NIOSH Facility, the Mary Babb Randolph Cancer Center, and a local biotech companies in Morgantown (Protea Biosciences) and Huntington (Vandalia Research). These collaborations span the application areas of health and energy and their value is evidenced by resulting proposal development, activity co-funding, and IP actions. Regionally, increased research and professional interaction has been developed with the University of Pittsburgh and Carnegie Mellon University through interdisciplinary awards and with faculty at the University of North Carolina.

A number of areas of concern exist however. A common denominator in most all efforts is the recurring need for quality graduate students, post doctoral associates, and research assistant professor(s). Significant sharing of capable personnel (grad students and post docs) already on the ground must occur to advance FBBG projects. This creates both a beneficial sharing as well as detrimental issues due to excessive time sharing and loss of focus. The challenge in staffing with quality personnel and the interdisciplinary complexity of some building block efforts have resulted in a longer time to achieve initial results than anticipated. WVEPSCoR has begun addressing the need to improve the graduate student pool. A key impediment to attracting high quality graduate students has been identified as low, non-competitive stipends and fellowships. The WVEPSCoR STEM Fellows grant program provides WVU and Marshall with fellowships that are competitive and nearly as high as NSF Fellows. Currently, the STEM Fellows program supports 20 doctoral students, but more funding may become available to enhance this program.

Another issue which is systemic is the time to full activation of new faculty labs. New faculty members requiring renovations and purchase of major equipment have had to wait up to a complete academic year before their lab modifications are ready, resulting in a delay of productivity. Moreover, they have had to navigate a purchasing system that has added months of delay to purchases. While these issues have only become modestly apparent in the metrics to date, these factors have and will continue to result in continuing challenges in meeting output targets.

At Marshall, the biggest concern is faculty salaries. The data indicate Marshall hires assistant professors in the College of Science at a nationally competitive salary, but falls well behind national standards for rank and discipline at associate and full professor ranks. The Dean of the College and Vice President for Research have reviewed this problem with the Provost and Senior Vice President for Finance and were asked to construct a merit salary plan for nationally competitive research faculty. A draft of that plan is currently under review.

Bridging Expertise – Faculty and Post Doctoral Hires

WVU activated the search this past period for the final four technical faculty positions of the total of 9 to be hired at WVU under this award. The search was operated as a university level cluster search with faculty participating from the WVNano group as well as the departments and colleges in which likely candidates would seek tenure homes. These four positions were in the areas of supramolecular chemistry, surface modification, structural biology/biophysics, and active nanodevices. By the close of this period, phone interviews had commenced and one position's search had moved to the point of on-campus interviews. (See hiring update under Special Award Conditions)

An entirely new website was planned and implemented this period. The website at http://wvnano.wvu.edu was put in place in advance of the ads being placed in order for applicants to be able to receive a comprehensive summary of the organization, research, and education activities of WVNano. Through this website, a password protected site was provided and is being used by the search committee to disseminate applications. This is the first such use of the web for a search at WVU. In addition, the WVNano website look has been modified and provided to the partners so that MU and WVSU can create their own websites that link to both WVU and to each other's RII programs in nano.

Challenges
The supramolecular and nanodevice positions are in their first search cycle. The structural biology/biophysics position is in its third cycle while the surface modification position is in its second. The advertisements for these two positions were modified based on perceived needs from past searches in order to increase their clarity and better direct them to the targeted candidate pool. The FBBG groups have expressed continued immediate need for improved surface modification and characterization.

Three searches for Post Doctoral Associates in Nano/microfluidics (2) and Nanokinematics (1) are ongoing with one unsuccessful offer being tendered in fluidics. A post doc has been committed to accelerate the supramolecular efforts of Shi through the Photonic FBBG. A Research Asst Professor search was initiated by the WVNano co-directors to help fill the productivity void left by their commitment of half time each to WVNano administration.

Tools – Shared Resource Development

Shared Resource Working Group Established: We have established the *Shared Resource Working Group* (SRWG) at WVU and made it a part of the WVNano organizational structure. This group has representatives from each college which is a major user or steward of NSE resources. This past period, this group developed the criteria for classification of shared equipment and then identified the set of shared equipment.

The Shared Resources Working Group has either launched or are near to launching the processes necessary to support the coordinated and collective operation and management of Nanoscale Science and Engineering (NSE) equipment resources on the WVU Campus. Efforts to date have focused on the WVU campus given the majority of the State's NSE equipment resources resides at this location. Documentation and process information is being shared with Marshall as it evolves. One Marshall faculty member already is using the facilities and another is planning for use.

WVNano Shared Resources Group Established: We have formed this campus-wide group presently comprised of Dr. Kolin Brown as coordinator and Eric Schires, a bachelor's level staff technical associate. Both these individuals previously worked separately in CSEE (Computer Science and Electrical Engineering) and in Physics for our respective NSE facilities and now work together and

coordinate the operations of the equipment resources they oversee across the colleges of Arts and Sciences and Engineering. This group worked with the SRWG to develop the cost structure for support of the shared resources.

Shared Resource Financial Operations Integrated: The finances associated with the NSE Shared Resources operation (Shared Resources Group salaries, maintenance and operations costs) have all been placed under a single accounting umbrella enabling effective management and assessment. This integration enables complete accounting of fund income and expenditures for shared resources. Efforts should be concluded next quarter that will establish a recharge account to collect user fees.

WVNano Shared Resource Support Plan Finalized: A plan for the support of the shared resources identified by the SRWG was developed in coordination with the WVNano Deans Advisory Group, the Research Office, and the WVEPSCoR Office representing the State of West Virginia. The version finalized at the end of 2006 will put in place a plan that by its fifth year will establish a shared commitment on the part of users (40%), WVU (40%), and the State (20%) to support this set of shared resources. An agreement on the part of the state and university was signed at the close of 2006. The internal university agreement distributing the commitment among colleges is anticipated to be signed early next period. The plan will be implemented beginning in the spring 2007 semester and will enhance FBBG research including collaborators from Marshall and WVSU.

Challenges: Needs continue to be expressed by the FBBGs in the areas of surface characterization and high resolution lithography. A NSF MRI was in development for a Raith e-beam writer for submission in January 2007 that will leverage RII state and university commitments. A scheduled order for an XPS system under the RII is in process. A major issue that is emerging is that of major equipment resource placement. Indications from faculty and administration reveal that there is definite need for a process that takes a global view of benefits and needs of research and education and weighs these against real and perceived expectations and unit concerns in an open and evaluative process. The SRWG will be addressing this major issue beginning next quarter and be seeking the cooperation of the deans and chairs as this process moves forward. Finally, the SRWG will consider accessibility of these resources beyond the walls of WVU since they will be a primary avenue of interaction for the statewide WVNano program.

FBBG Report: Electronic Transduction

Period of Performance: July 1 – Dec 31 2006

The Electronic Transduction Functional Building Block Group focuses on the ability to obtain electronic signals from nanostructures. Work during this period emphasized obtaining signals from biomolecular systems. This included molecular electronics, protein immobilization, multifunctional electronic materials, and microcantilever biomarker detectors.

<u>Molecular Electronics</u>

Electronic Structure of Heme: Lederman and Gannett have been working on measuring the electronic signatures of single heme-containing proteins, namely CP450 and myoglobin. Lewis' group has performed some preliminary calculations to understand the electronic states of the Heme group. We are currently trying to make comparisons with the experimental work so that we can better comprehend the experimental results and new experiments are underway. Additional work by Norton at Marshall U. and Lederman has been performed to immobilize DNA via Pt nanodots to create novel electronic circuits. Bionanowires composed of tropomyosin and actin are also being studied in this way. Magnetic nanoparticles are also being explored to be studied via electronic means in collaboration with Carroll.

Protein Immobilization

Gannet and Lederman have been developing cytochrome P450 2C9 (CYP2C9) immobilized on chips with the overall construct displaying enzymatic activity analogous to its in vivo activity. This has never been achieved but has been a sought after target as it could be used for fundamental mechanistic studies and also practical applications. We have successfully attached CYP2C9 to gold substrates via a carboxy bearing shelf assembled monolayer (SAM). The attachment is by formation of an amide with the carboxy group of the SAM and the N-terminus of the protein. The resulting construct retains the ability to reversibly bind model substrates and conditions that utilize endogenous co-factors have been discovered which permit the enzyme to metabolize model substrates in a fashion analogous to what is observed in vitro and in vivo. Novel methods for detection binding have been developed and were based on magnetometry (SQUID). We are currently working to optimize these chips with respect to metabolite formation, devising methods for improved sensitivity for metabolite detection, and generation of regular arrays for mechanistic studies of protein-protein interactions. Additional work in optical characterization of these proteins is being performed by Miksovska at Marshall.

Multifunctional Electronic Materials

Myers and Lederman have synthesized ferroelectric layers on wide bandgap semiconductors that can then be used for developing new device functionality. This effort is a high-risk/high payoff investigation into understanding the physics of such a disimilar heterostructure, which has the potential to make structures with tunable doping, for example, or high sensitivity stress or temperature sensors. One possible application is to detect the polarity of biomolecules selectively bound to field effect transistor sensors.

Microcantilever Biomarker Detectors

The second project is the development of a microcantilever-based method of detection for a cancer marker protein, VEGF, and a related protein, MMP-9. The initial studies were conducted prior to July, 1, 2006. The focus since July 1, 2006 has been to refine the fabrication of the microcantilevers (attachment of the molecular probe, etc) so that they can be reproducibly prepared and results, from different cantilevers can be compared. The long term application is a rapid, highly specific and sensitivity assay that can be used as a pre-screen for cancer, especially in patients identified as at risk for cancer (e.g., smokers). This work is being carried out by Lederman, Flynn, Gannett and Holland.

Tools

The needs of the Electronic FBBG research efforts are being met by the following resources:

Biomol. Synthesis – Lederman and Gannett Labs at WVU (Physics, Pharmacy)
Biolayer Characterization – AFM, MFM Lab at WVU (Physics)
Basic Fabrication – Nanosystem Engineering Shared Cleanroom at WVU (NESC)
Materials Growth – Evaporation, sputtering, MBE and MOCVD at WVU (Physics, EE)
Imaging – SEM Lab, AFM at WVU (Physics)
Collaborators:
X-ray magnetic circular dichroism (XMCD) – Lawrence Berkeley Lab, Advanced Light Source.

Current Challenges and Unmet needs:

Spatially resolved Chemical Characterization of surfaces – Requires a local system for rapid turnaround. An order for a XPS system is now at WVU purchasing. Enhancements to our current FTIR system will be explored.

SEM access – A number of SEMs exist on campus of varying quality, most with parochial management plans. For example, the ChE SEM system is excellent, however it is available only one day a week and only to EE since this department, among others, pays for access within a engineering college centric

system. The system is not under the newly formulated WVNano Shared Resources Plan. As the efficacy of the Plan is established over the coming year, extension to other major equipment will be discussed. In the interim, access via co-funding of the EE time block will be explored as will access to other systems such as those in Forensics.
Robust, easily used e-beam direct write – The current SEM-based system is inadequate for efficient research use. An MRI was in preparation this period for a Raith e_LiNE.
High quality transmission electron microscopy (TEM) – There is no state of the art TEM facility on the WVU campus. This is crucial for multilayer and nanoparticle characterization.

People

Faculty:
1) Nick Wu: A RII/WVNano hire in nanoimaging and characterization who joined in Fall 2005, he is a WVU MAE faculty and has established his lab in engineering. He will be a key participant in XPS characterization.

2) Feruz Ganihkanov: A RII/WVNano hire in optical spectroscopy joining WVU in Fall 2006, he is establishing his lab in the Physics department and targeting establishing a lab in neurosciences in the Health Sciences Center. While not a yet participant in the group's current projects, he has begun these discussions. His ultrafast optical measurement and biophotonics capability should be enabling to projects.

3) Lloyd Carroll: A RII/WVNano hire in NEMS joining WVU in Fall 2005, Carroll has played a key role in nanoparticle fabrication.

4) James Lewis: A RII/WVNano hire in theory who joined the Physics faculty in Fall 2006, Lewis has established a computer modeling lab for the simulation and analysis of electronic, photonic, and biomolecular materials.

5) Surface Modification Position. This position remains unfilled and is now in its second year. This has been a major detriment to our efforts. This position is of central importance to all our projects.

Technical Personnel:
Post Doctoral Associates - The FBBG has two PD's. Odille Myers is funded 50% by Protea Biosicences for the cantilever project and 50% by a NIH COBRE award. Jianhua Gu is funded by the project and has played a key role in the molecular electronics portion of the project.

Graduate Students.: Quality graduate students remain a critical issue for our FBBG.

Progress towards reaching milestones

Several publications have been submitted in this time frame as well as three proposals to external funding agencies.

FBBG Project	Inputs	6-12 Mo Target	6 Mo Analysis
Molecular Properties Building Blocks			
Microcantilever Detection	Biomolecular detection feasible; Private funding (Protea); dedicated cantilever sensor electronics People: Lederman, Gannett, Flynn Tool needs: dedicated electronics ($35K) Enabling people needs:1/2 postdoc, 1 GRA	1 patent application 1 new publication 1 new proposal (NIH) 1 new award	1 Proposal NIH R21 submitted but declined 1 manuscript submitted 1 patent disclosure Strong interaction with Protea Biosciences Inc., funded ½ postdoc Tools: Extensive use of e-beam lithography and facilities in HSC People: 2 posdocs, 3 ug students
Single Molecular Characterization	Nanojunction fab available; 1 NIRT submitted (declined) People: Lederman, Gannett, Flynn Tool needs: Advanced electrical characterization Enabling people needs:1/2 postdoc, 1 GRA, Theorist faculty position, Optical Spect. faculty position.	2 new publications 1 new award	Obtained preliminary data on CP-450 Prepared 1 MRI proposal (Urazhdin PI) Tools: E-beam lithography; photolithography; Enabling people: 1 postdoc; 1 graduate student
Magnetoelectronic Transduction and Biomolecular Detection	Demonstrated ability to immobilize proteins & demonstrate metabolism; Determine properties of functionalized magnetic nanoparticles; 1 NIRT & 1 NER submitted (declined) People: Lederman, Gannett, Carroll, Seehra, Urazhdin, Tracy (U. of Minnesota); Nanodevice & nanofab faculty positions. Tool needs: Magnetoelectrical characterization (available); Enabling people needs:1/2 postdoc,	2 new publications 1 patent application 1 new award	1 new publication in JACS; 1 patent disclosure 1 NIH R01 proposal - declined Tools: Surface attachment chemistry; SQUID magnetometry; Enabling people: 1 postdoc; 2 graduate students
Fabrication and Characterization of Molecular Environment	Ebeam writing available People: Norton, Gannett, Lederman Tool needs: Improved ebeam writing Enabling people needs: 1 postdoc	1 new publication 1 new proposal	2 postdocs (1 from Marshall; 1 from WVU) working on this; Initial dots fabricated via nanolithography at WVU
Biomolecular characterization of lactoperoxidase using novel photothermal techniques.	Characterization of conformational changes associated with spin transition in biomolecules. People: Miksovska, Lederman Tool needs: Optical characterization Enabling people needs: 1 GRA; Optical Spectroscopist faculty position;	2 new publications accepted or published in target journals (Biochemistry, J. Phys Chem.) 1 proposal submitted	N/A

Multifunctional Electronics Building Blocks			
Multifunctional Devices	Demonstrate fabrication of high quality multiferroic/semiconductor heterostructures People: Myers, Lederman Tool needs: Ferroelectric tester (acquired) Enabling people needs: 1 GRA; 1 technician, Nanofab; Optical Spectroscopist faculty position.	ONR/AFOSR funded 3 published papers	1 DOE proposal submitted (Lederman, Myers, Lewis), pending; 2 new publications 4 presentations at conferences Tools: MBE growth, SPM microsocopy People: 3 graduate students
Nanowire sensors	Synthesize & characterize free-standing nanowires People: Wu, Famouri, Perrotta, Gannett Tool needs: Characterization tools; electrochemical cell Enabling people needs: 1 GRA; Nanofab; Optical Spectroscopist faculty position.	1 new proposal 3 new publications	1 invited talk at intl conference;

FBBG Report: Nano-Microfluidics

Period of Performance: July 1 – Dec 31 2006

The Nano and Microfluidics Functional Building Block Group focuses on the exploration of mass transport through nanoscale channels. Nanoscale channels have particularly large surface area to volume ratios and small diameters allow for double layer overlap inside of the channels. These unique characteristics create true nanoscale behavior as mass transport through nanoscale channels differs from their larger counterparts and is not fully understood. Nanofluidic/microfluidic interfaces (NMIs) are being explored to use as analyte concentrators and as valves in microfluidic systems. In particular, mechanisms of ion transport are being investigated in electrically driven systems, through a combined experimental and theoretical modeling approach.

Additionally, microfluidic systems are being used to couple real-world samples with nanoscale transducers, such as nanoparticles. For the microfluidic systems a revolutionary electrophoretic separation has been disclosed by Edwards, Carroll, and Timperman.

Both the nano and microfluidic systems are essential functional elements of integrated sensor systems in security, health, energy and environment applications. Therefore this FBBG will serve projects in all of the other FBBGs while having its own focus on NMIs.

Nanofluidic/Microfluidic Interfaces (NMIs): Timperman, Edwards

Analyte concentrators and microfluidic valves are examples of functional modules that have been constructed from nano/microfluidic interfaces (NMIs). NMI concentrators can provide rapid on-chip concentration of analytes, such as proteins, metabolites, and nucleic acids reaching concentrator factors of 300 to 10^6 in time range from 3 min to a few hours. Their simple construction makes it possible to make use of numerous concentrators or valves on a microfluidic chip with a reasonable success rate for the entire device. Although valves have been created for microfluidic devices, effective valves that can be fabricated at a high success rate are not available. Our NMI will be used to develop novel devices for proteome analysis.

Recent evidence indicates that concentration polarization created by non-uniform ionic transport through a permselective membrane plays an essential role in NMI concentration processes in electrokinetically driven systems. Permselectivity is caused by the double layer overlap in the capillaries or channels of nanoscale dimensions. Therefore, the most general experimental requirements are that the electrolyte or buffer system must create double layer overlap. When the nanofluidic channels or capillaries are integrated into microfluidic systems, the complexity of the system is increased greatly as many other processes play an important role in mass transport.

To date, NMI concentrators have not been integrated into microfluidic systems. Successful integration requires that bulk flow rates are compatible with upstream and downstream processes. NCMs create particular challenges because they provide great frictional resistance to pressure driven flow. One great challenge in the development of electrokinetic microfluidic systems is maintaining stable flows for reliable transport of samples through a system. Whenever a fluid passes through an intersection, the bulk solution driven by electroosmotic flow (EOF) in the inlet channel section will follow the path of least frictional resistance. This concept has been used to create electroosmotic pumps. Because there is a tendency for electroosmotic pumping to occur at all intersections, integration of a functional module, such as an analyte concentrator, into a microfluidic system is best achieved when bulk flow rates are similar. The NCM concentrators investigated in this work are designed to work in low to moderate EOF regimes when compared with microchannel electrophoresis.

Our main contribution to understanding the mechanisms of NMI concentration is considering the contributions of EOF. Timperman's group is fabricating devices in which EOF is varied, and Edward's lab is developing theoretical models that integrate the effects of EOF into ionic mass transport from first principles.

Traveling Wave electrophoresis: Edwards, Carroll, Timperman

The traveling wave electrophoresis device is a microfluidic separation platform that has not been demonstrated previously, and therefore represents a new method of electrophoretic separation. This idea came about directly as a result of the NMI work and a research presentation in a WVNano group meeting. Edwards has modeled the device and Carroll and Timperman are building the device. The most exciting aspect of this separation is that it should provide a non-dispersing separation. Zone dispersion degrades the quality of the separation, and no current method is capable of providing dispersion separation while transporting analytes through a capillary or channel.

Tools

The needs of the research efforts are being met by the following resources:

Experimental Microfluidics – Tmperman lab at WVU (Chemistry)
Fluorescence imaging of microfluidics – Timperman lab
Theoretical Modeling – Edward Lab at WVU (Physics)
Microfabrication – Lloyd Carroll lab at WVU (Chemistry)

Current Challenges and Unmet needs:
Real-time imaging of EOF using both: Particle Imaging Velocimetry and Photobleaching – need 200-1000mW Ar/Kr Ion Laser. Have inverted fluorescent microscope.

People

Post Doctoral Associates
Search to hire new experimental and theory post-doc initiated. National ad in C&EN news and on web sites. Offered position to top candidate who rejected offer at $50K/yr. Looking deeper into pool.

Graduate Students.
Quality graduate students remain the primary unmet need for our FBBG. The number one problem is that our graduate student stipends are not competitive.

Findings

NMI:
Manuscript in preparation. Have discovered that asymmetric NMI acts a diode or current rectifier.

Inputs and Outputs

IP Actions: Traveling Wave Electrophoresis disclosure submitted in September 2006 to WVURC.

Progress towards reaching milestones

Aggregate 6 month milestones are as follows:

FBB Project	Inputs	6-12 Mo Target	6 Mo. Analysis
Nanofluidic/Microfluidic Interface (NMI) Building Blocks:			
NMI	People: Timperman, Edwards Tool needs: PIV and laser needed. Enabling people needs: Post-doc and graduate student	2 new publications 1 new proposal	1 Journal paper accepted for publication. Tools: Need PIV and laser. People: Post-doc and graduate student.
Microfluidic:			
Traveling wave electrophoresis	People: Timperman, Carroll, Edwards Tool needs: PIV and laser needed. Enabling people needs: Post-doc and graduate student	1 new publication 1 provisional patent application	1 Disclosure Tools: Need PIV and laser. People: Post-doc and graduate student.

FBBG Report: Nanokinematics

Period of Performance: July 1 – Dec 31 2006

The Nanokinematics Functional Building Block Group focuses on the exploration of molecular motion and transport approaches that can be used as building blocks for integrated Lab-on-Chip or sensor systems in security, health, energy and environment applications. Our FBBG focuses on all molecular transport, characterization, and sensor transducer and actuator functions that are photonic in nature.

The group is currently exploring two areas of research in nanokinematics. 1.) The actomyosin molecular transport systems, 2.) piezoelectricity of Aluminum Nitride (AlN) thin films.

Actomyosin transport systems: Blough (MU), Carroll, Famouri, Holland, Hornak, Li, Wu

A fundamental understanding of the governing mechanics of biological molecular transport mechanisms can serve as a foundation for their direct use in integrated biomolecular systems or the development of nanoengineered systems that mimic these biological processes. The actin-myosin system represents a protein-based system being explored as basic building blocks for realization of linear biomolecular motors based on biological nanoscale transport phenomena. Harnessing the motion of these biomolecular systems to achieve nanokinematic functions requires actuation rate control, directional control, cargo attachment to filament or motor molecules, and the viability of the proteins in a non-cellular environment. Moreover, as these biomolecular transport systems evolve and mature, it is critical that an interface be established between their nanoscale motion and the chip-level microelectronic environment that will enable reconfigurable control of their nanoscale motion via electronic signaling. Building on prior work which has established the macroscale electromotility characteristics of the myosin-actin (actomyosin) system, the scope of this FBBG research encompasses the first fundamental exploration of the interaction of electric fields localized on the micron scale with the nanoscale actin-myosin motility assay. Electric fields established with integrated electrode structures under the assayed surface are used to experimentally characterize their effect on nanoscale linear biomolecular motor filament alignment, direction of motion, and assay ambient. Fluorescence techniques are being used to optically observe actin motion in assay. This work will lay the groundwork for subsequent research of electronically controllable nanoscale cargo delivery systems able to arbitrarily address chip surface locations.

Piezoelectricity of Aluminum Nitride (AlN) thin films: Famouri, Korakakis, Hansel[1], Thornton[1]
[1]DOE National. Energy Technology. Laboratory (NETL)

A new collaboration has developed with the DOE National Energy Technology Laboratory for a potential additional application of our nanokinematic work. We have the ability to grow high quality III-V materials which provides an opportunity to investigate Aluminum Nitride (AlN) as a micro-valve material, first through growth, using sputtering of amorphous or polycrystalline layers, to prove its reliability at high temperature and then through MOCVD growth to investigate the fundamental material properties that can distinguish it in high temperature micro-valve applications.

The objective of this research collaboration is to evaluate materials suitable for a high temperature actuator design primarily targeted for distributed flow control in advanced power systems. Basic cantilevers are being designed with amorphous and crystalline AlN for proof of concept with basic room temperature and eventually at high temperature testing.

MEMS micro-valves have been proposed as a means of performing cell-to-cell flow balancing in PEM fuel cell stacks to allow these stacks to be run at the highest possible fuel utilization. A study at NETL has already demonstrated the negative effects of steady-state flow imbalances on stack performance and a dynamic cell-to-cell flow control system is currently being evaluated to determine the level of performance improvement that such flow control might provide. NETL is considering bringing this kind of technology to the area of solid oxide fuel cells (SOFCs). The SOFC environment presents a whole new set of challenges to this endeavor, especially at much higher operating temperature (up to 1000°C).

Tools

The needs of the research efforts are being met by the following resources:

Biomol. Manipulation – Holland Lab at WVU (Chemistry)
Biolayer Characterization – AFM, MFM Lab at WVU (Physics), FTIR (EE),
Basic Fabrication – Nanosystem Engineering Shared Cleanroom (NESC) at WVU
Materials Growth –MOCVD (EE) at WVU
Imaging – SEM Lab, Wu Lab at WVU(ChE, MAE)
Biomolecular Synthesis – Blough Lab at MU (Biology)

Collaborators:
High Temperature Chamber – Hansel/Thornton Lab (DOE – NETL)

Current Challenges and Unmet needs:
SEM access – See Electronic FBBG above.
Robust, easily used e-beam direct write – The current SEM-based system is inadequate for efficient research use. An MRI was in preparation this period for a Raith e_LiNE. This proposal builds on current RII resources with a more advanced and adequate system. This strategy was shared with NSF in January 2007.

People

Technical Personnel
Post Doctoral Associates: We are in process of hiring a post-doc for nanobiokinematics research. 22 applications have been received worldwide thus far.

Graduate Students: Hiring qualified and self motivated post-doc and graduate students continues to be a major obstacle.

Findings

Actomyosin transport systems:
The nanokinematics work has been progressing in the past quarter, developing steadily towards successful proposals and publications.

Blough's Group has been able to isolate and purify actin and myosin from rabbit muscle and the development of a bacterial expression system to manufacture proteins of interest. Over-expressed fascin purified using column chromatography and using expressed protein to bundle actin filaments have been achieved. They also have begun to derive the "design rules" which govern myosin-mediated actin bundle motility- i.e. how myosin concentration affects bundle size, velocity, efficiency of translation and trajectory and how bundle size affects bundle stability.

Holland's group has designed a bead coupling strategy that McNair scholar, Lenin Leon is implementing.

Piezoelectricity of Aluminum Nitride (AlN) thin films:
Work continues to document the results of this project in the form of an Applied Physics Letters paper. This involves recalibrating the laser vibrometer (used to measure the piezoelectric coefficient of the AlN films) and further C-V measurements of AlN stacks using p-type and n-type silicon substrates to confirm the results achieved to date.

AlN actuator (cantilever and microbridge) production efforts continue with the refinement/optimization of fabrication techniques using Reactive Ion Etching with tetrafluoromethane gas (RIE-CF4) and with mask design. Fabrication of diaphragms using laser ablation also continues.

Progress towards reaching milestones

Aggregate 6 month milestones are as follows:

FBB Project	Inputs	6-12 Mo Target	6 Mo. Analysis
Actomyosin Building Blocks:			
Actomyosin transport systems	People: Blough, Carroll, Famouri, Holland, Hornak, Li Tool needs: Florescence microscopy imaging Enabling people needs: 1 Grad student, post-doc, surface modification faculty position	2 new publications 2 new proposals Hiring a post-doc	2 conference publications 4 proposals Tools: XPS on order to partially fill need. People: Applied Surface Mod person major unmet need.
AlN Thin Films Building Blocks:			
Piezoelectricity of Aluminum Nitride (AlN) thin films	People: Famouri, Korakakis Enabling people needs: nanofabrication faculty position	2 new publications 1 Proposal 1 new award	1 Award 2 conference papers

FBBG Report: Photonics

Period of Performance: July 1 – Dec 31 2006

The Photonic Functional Building Block Group focuses on exploration of photonic molecular recognition and transduction approaches that can be used as building blocks for integrated sensor systems in security, health, energy and environment applications. Therefore our FBBG brings under one umbrella all molecular recognition, characterization, and sensor transducer functions that are photonic in nature.

The group is currently exploring four primary photonic sensor test beds. 1.) The SPARROW device, 2.) Photonic crystal (PC) – based molecular recognition systems, 3.) Quantum Dot – based systems, and 4.) Raman source - detector systems. The application inspiration for these testbeds is broad-based and currently spans security (SPARROW – Anthrax), health (SPARROW – chromatin, PC – enzyme), energy (Raman - NG gas constituents), and environment (Hg detection via QD-Au DNA binding).

SPARROW: Georgel, Hornak, Korakakis, Shi, Timperman, Wu

This project combines the guided-wave and materials core expertise in the Photonic FBBG with the microfluidics core competency ion the Fluidics FBBG to establish a portable evanescent wave biosensor device capable of nano to picogram per mm LODs and surface regeneration and reprogramming for detection of multiple analytes. This effort is now in year four under NCE of a three year ONR award. Two journal publications came from the work this period based on advances in waveguide layer and biolayer growth, in addition to two conference proceedings papers. Full test by microfluidically addressing the sensor surface with sucrose solution of latex beads has been hampered by difficulties with

e-beam system that have made it difficult to maintain good waveguide stack growth. These system variables are now becoming understood and coming under control. In addition, achieving and maintaining adequate biotin functionalized bead attachment to the functionalized SAM is an area of continued investigation. Both these areas are the objects of our attention this quarter. Results from full test are required for follow-on funding using the basic microfluidically addressed device as a platform for other analytes.

In addition to bioagent detection, Chromatin detection is a targeted use for the SPARROW in the health application domain. Georgel's laboratory has been working on histone purification from different cell lines. The cells were treated with specific chemical that induce specific post-translational modifications that will be used as targets for detection of histones. The presence of modifications and quality of histones was assessed by gel electrophoresis and used to assemble mono-nucleosomes (the building blocks of chromatin). To assay for recognition and detection of nucleosomes, Georgel and Timperman have designed a procedure involving quantum dots that should be functional in the context of the SPARROW biosensor that will be pursued this coming quarter.

Photonic crystal (PC) – based molecular recognition: Cao, Hornak, Korakakis, Myers, Shi, Timperman, Wu

This thrust focuses on architectures using the optical properties of photonic crystals for molecular detection. Current studies emphasize PC architectures with fluidic addressing. Our prior broad focus resulted in positive NIRT reviews and a disclosure now being finalized but were strongly tempered by recognition of the challenges in obtaining needed preliminary results for the complex approaches and architectures proposed. As a result, significant time was spent reassessing and focusing our efforts this past period. The group arrived at a single architecture in which the materials growth, biomolecular, and PC components are largely separable enabling smaller scale proposals better suited to a broader range of solicitations.

This single, simplified architecture is the basis of a disclosure filed late last quarter and another now is receiving signatures. The new PC architecture uses conventional tagging of the molecules of interest with a fluorescent species or quantum dot. The means whereby this tagging is achieved can itself be novel under a separable research thrust. What is required is that the tagged molecules be charged so they can be moved electrophoretically. The PC channels the motion of the charged molecules through a small volume, focuses the fluorescence excitation on this volume, provides resonance enhancement of the molecule's fluorescent emission when in the volume, and transfers the resonantly enhanced emission for detection.

Our new architecture relies on the use of a GaN photonic crystal so that the visible fluorescence excitation wavelengths lie in the PC pass band and the molecule fluorescence emission lies in the PC bandgap. The PC is a thin plane that will be fabricated to separate two fluidic regions, one with the source of the tagged molecules, the other the region into which the molecules will be drawn with suitably engineered potential application to the two fluids. The PC is a sealed structure with the exception of one or more PC cells that connect the two fluidic regions through a volume in the nano to attolitter range. These cells are now being designed to serve simultaneously as a crystal defect or defect cluster. This defect serves as a resonator to the radiation at the fluorescence wavelength. The passage of the molecule through the volume will result in resonance enhancement of its emitted electric field enabling enhanced detection out of the PC plane or in plane through design of a line defect waveguide in the PC.

We are targeting proposal submissions this spring and summer when newly identified preliminary analysis and experimental results are planned. These include definition and of the biomolecular species and fluorescent tag and its optical pump and emission efficiency, fluidic characterization of species

transit dynamics through the PC, PC modeling of the new PC structure and the hole defect based on the new fabrication process, and experimental validation of the etch and patterned growth approaches to PC fabrication.

Quantum Dot – based systems: Edenborn[1], Hornak, Perrotta, Shi, Wu
[1]DOE National Energy Technology Laboratory (NETL)

This new thrust looks at the development of new classes of synthetic nanoparticle assays for detection applications in health and environmental applications. The health science effort links the capabilities of Wu, Perrotta, and Shi to explore the use of quantum dots - gold nanoparticle assays for monitoring blood coagulation proteins. This synthetic nanoparticle assay is intended to monitor levels of blood coagulation (clotting) proteins in physiologic media. An NIH proposal was developed and submitted for this work.

The other effort builds on a new collaboration with NETL in Pittsburgh and explores a nanosensor based on a DNA hybridization – driven quantum dot – gold nanoparticle optical assay. The effort builds on prior work and significantly advances the state of the art for detection of toxic metal ions in water. If successful, the molecular recognition approach established through this work can be integrated to achieve needed portable, rapid monitoring of water quality for drinking, industrial and agricultural applications.

This nanosensor system is expected to be capable of simultaneously detecting multiple heavy metals with high sensitivity, selectivity and reliability. This nanosensor system is created by utilizing fluorescent (Föster) resonance energy transfer (FRET), whereby the luminescent emission of quantum dots (QDs) is quenched by the gold nanoparticles (NPs). Green, yellow and red QDs are employed to sense Hg^{2+}, Cu^{2+} and Pb^{2+} ions, respectively. The target ions selectivity can be achieved by selected DNA sequences. Specifically, the thymine-thymine mismatching in the DNA double helixes is known to be a good base pair to selectively bind with Hg^{2+}, while non-nature nucleobase hydroxypridone produce stable helixes through the cooperation with Cu^{2+}. The G-riched DNA-conjugated system can serve as an excellent binding sequence for Pb^{2+} in the course of the formation of G-quartet quadruplexes.

The effort draws on preliminary results from Shi on G-quartet quadruplexes, Shi on Au nanoparticles and QDs, and Edenborn on preliminary FRET Hg detection, with Hornak providing optical characterization and integration architectures. A proposal is under development for submission next quarter. Shi has submitted a number of proposals in support of the G-quartet and other supporting supramolecular components.

Raman source - detector systems: Chen[2], Falk[2], Hornak, Korakakis, Woodruff[1]
[1]DOE Nat. Energy Technol. Laboratory, [2]University of Pittsburgh.

Our regional team is focusing on a proof-of-concept prototype of a Raman-based optical detection system for gas detection suitable for operation over wide pressure and temperature range conditions and consistent with integration and economical manufacture. The work brings together the Nd:YAG slab laser research at WVU and NETL, fiber source and sensor technology from the University of Pittsburgh, and wide band gap semiconductor detector materials and devices at WVU to establish a sensor system testbed in which the viability, benefits, and trade-offs of Raman gas detection in the near IR and visible range will be determined. This initial application of this system will be for the NETL application of natural gas constituent detection. The source and detector components investigated through this effort provide important functional building blocks for integrated optical spectroscopy systems.

This work has successfully received funding for the first of three years via the DOE – NETL Regional University Initiative. Slab laser work over the past period focused on hybrid integration of the slab with the pump laser and coupling optics as well as optimization of the slab for maximum output power for

introduction of the saturable absorber and assessment of Q-switching capability. Over the past period, InGaN Multi Quantum Well structures have been grown and characterized as a first step towards achieving MQW photodetectors. Further studies are underway to determine the mechanism and the dependence of the absorption edge on InN mole fraction and quantum well width.

Tools

The needs of the research efforts are being met by the following resources:

SAM, biolayer growth – Timperman lab at WVU (Chemistry)
Biomol. Synthesis – Timperman, Shi Lab at WVU (Chemistry)
Biolayer Characterization – AFM, MFM Lab at WVU (Physics), FTIR (EE),
Basic Fabrication – Nanosystem Engineering Shared Cleanroom (NESC) at WVU
Materials Growth – MBE and MOCVD at WVU (Physics, EE)
Waveguide layer growth – Ion-beam assisted e-beam deposition (NESC) at WVU
Imaging – SEM Lab, Wu Lab at WVU (ChE, MAE)
Optical Waveguide Characterization and Measurement - Prism coupler, video capture, ellipsometry (EE)
Biomolecular sample prep – Georgel Lab at Marshall (Biology)
Collaborators:
Spatially resolved Chemical Characterization of surfaces – XPS (Northwestern University)
Biolayer Characterization – FTIR (Duquesne University)
Laser Design and Characterization – Woodruff Lab (DOE – NETL)

Current Challenges and Unmet needs:
Spatially resolved Chemical Characterization of surfaces – Requires a local system for rapid turnaround. An order for a XPS system is now at WVU purchasing. Enhancements to our current FTIR system will be explored.
High Power ICP – Dry etching capability for vertical sidewalls in the fabrication of PCs, and other nanoscale electronic and optical structures. Order bid out, vendor chosen at end of current period.
High End Workstations – 2 large memory workstations for rapid PC modeling are needed. Now being evaluated for purchase expected next period.
SEM access – The ChE SEM system is excellent, however it is available only one day a week and only to EE students. This stems from the fact it is paid for under a College of Engineering departmental arrangement and open 5 days a week from 9-5. The system is not under the newly formulated WVNano Shared Support Plan.
Robust, easily used e-beam direct write – The current SEM-based system is inadequate for efficient research use. An MRI was in preparation this period for a Raith e_LiNE.

People

Faculty: There are a number of key areas that we identified where expertise is needed to grow the foundation needed for the FBBG's work.

1. Optoelectronic devices and fabrication
2. Supramolecular design and synthesis
3. Nanostructure and material characterization
4. Biophotonic and ultrafast phenomena and characterization
5. Surface modification chemistry

As part of the hiring processes of RII/WVNano and that of WVU departments, the following individuals have begun to make contributions to the Photonic FBBG in a subset of these areas over the reporting period: Numbering corresponds to the list above:

1.) Andrew Cao: A RII/WVNano hire in Fall 2006 at WVU. His core expertise is opto-electronics and device fabrication. He builds our core competency base in devices and materials enabling us to pursue optoelectronic sensor device and solid-state lighting and research. He is now building his lab in EE and establishing shared facilities for his work. He is currently engaged in FBBG through the PC work.

2.) Mike Shi: Hired through WVU Chemistry in Fall 2005 and is now a WVNano participant. He has completed establishment of his laboratory in Chemistry for organic synthesis and is enabling work on the supramolecular design of biomolecular recognition elements in the QD and SPARROW work.

3.) Nick Wu: A RII/WVNano hire in nanoimaging and characterization who joined in Fall 2005. He is a WVU MAE faculty and has established his lab in engineering. He has led the QD work and assisted in SPARROW SAM characterization and contributes in the area of PC structure characterization.

4.) Feruz Ganihkanov: A RII/WVNano hire joining WVU in Fall 2006. He is establishing his lab in the Physics department and targeting establishing a lab in neurosciences at the Health Sciences Center. While not a yet participant in the group's current projects, he has begun these discussions. His ultrafast optical measurement and biophotonics capability should be enabling to projects such as the DNA hybridization-activated QD-Au optical assay project.

5.) Surface Modification Chemist. This position remains unfilled and is now in its second year. This has been a major detriment to our efforts. This position is of central importance to all our projects.

Technical Personnel
Research Asst Professor: Myers and Hornak are currently searching for a research assistant professor who can replace the time they have lost in the lab for the FBBG efforts due to their co-director appointments. The search will begin interviewing candidates next quarter.

Post Doctoral Associates: The FBBG has one PD, Min Soo Lim, who is funded full-time by ONR through the SPARROW project. He has provided limited surface modification capability for this and other projects. Dr. Lim will be leaving in spring 2007. Other PDs are those of specific faculty (Shi, Wu) and become involved as required with the efforts.

Graduate Students: Quality graduate students remain a critical issue for our FBBG.

Findings

SPARROW:
This period the first joint manuscript from the entire group was accepted for publication in *Langmuir* regarding the work in Chemistry on establishing SAMS on alumina substrates grown in EE and sapphire surfaces. In addition, the relationship between e-beam deposition and ion gun parameters and waveguide film loss was published in a *JVST* paper. Two MRS conference papers in waveguide film growth and optical loss were presented and submitted for proceedings publication.

Photonic crystal (PC) – based molecular recognition:
New modeling of a hexagonal air hole PC structure based on the most recent architecture has been completed including basic defect geometries. Results indicating adequate Q factor and line defect coupling for resonant energy transfer. A preliminary fabrication process for the GaN PC based on ICP etching has been outlined. Initial growth results showing the efficacy of a lateral polarization heterostructure approach for realizing high aspect ratio photonic crystal structures have been concluded.

Quantum Dot – based systems:
Shi successfully achieving the anion bridged nano-sheets from self-assembled G-quadruplexes that are a critical element of this work. The result was submitted by Shi to *Organic Letters***.** Wu has published in *Small* on the shape-controlled growth of micron-Sized Gold Crystals by a Slow Reduction Method which will be used as a foundation for Au nanoparticle synthesis.

Raman source - detector systems:
A journal article describing the lasing performance of our initial slab laser geometry was published at the end of this period in *Optical Engineering*. Grown InGaN Multi Quantum Well structures were characterized and transmission data indicated that the absorption edge of the structures can be engineered to be tuned at the wavelengths of interest.

Inputs and Outputs

IP Actions
1.) *Amplifying Detection Events Using Cleavage Gels and Linkers*, Timperman, Hornak
2.) *Integrated Molecular Detection Device Using Photonic Crystal Fluidic and Optical Excitation Focusing and Resonant Fluorescence Emission Enhancement*, Hornak, Timperman, Korakakis, Myers, Shi, Cao, Wu.

Progress towards reaching milestones

Aggregate 6 month milestones are as follows:

FBB Project	Inputs	6-12 Mo Target	6 Mo. Analysis
Evanescent Wave Interaction Building Blocks:			
SPARROW – fluidic Co-integration	People: Timperman Shi, Korakakis Hornak Tool needs: Spatial, chem mapping needed Enabling people needs: surface mod. faculty position	3 new publications 1 new proposal	1 Journal publications accepted. 1 Journal publication published. New proposal pending testbed LOD result. Tools: XPS on order to partially fill need. People: Applied surface mod faculty hire major unmet need.
Fluidically Addressed SPARROW Test bed - Histones and Chromatin-Associated Proteins Interaction	People: Georgel, Timperman, Shi, Korakakis, Hornak Tool needs: Space, Analytical centrifuge (MU) Enabling people needs: Technician, 1 Grad student (MU)	3 Journal publications 2 proposals submitted	1 Proposal submitted to NSF in core area. Tools: New space in RCB Biotech Ctr.

Photonic Crystal (PC) Building Blocks:			
Key Interdisc. Proj. Elements: PC Modeling Photonic Crystal Fab - Si Photonic Crystal Growth and Fab - GaN PC void gel Formation Enzyme, FRET incorporation Co-design	Tool needs: New e-beam lithography and support critically needed. Chlorine RIE People: Wu, TImperman, Shi, Korakakis Hornak, Myers Enabling people needs: nanofab. Faculty position, Research Asst Prof. 2-3 Grad students	2 new publications 2 Proposals 1 patent application 1 new award	2 Invention disclosures Redesign and refocus of approach will enable smaller more flexible proposals as well as large efforts built on these. Tools: e-beam MRI under development, ICP Etcher ordered. People: Urgent need for hire of Research Asst Prof to replace admin time of Hornak, Myers.
Source/Detector Building Blocks:			
Frequency Doubled Nd:YAG chip laser MQW multiwavelength Detector for Raman Integrated Detection	Tool needs: Cl RIE, tunable test source People: Korakakis, Hornak, U Pitt EE, Woodruff, NETL Enabling people needs: Optical spectroscopy, nanofabrication faculty position.	1 Journal paper 2 Conf. publications 1 new proposal	1 Award received 1 Journal publication 2 Conference publications Tools: Cl ICP ordered NETL facilities used. People: Faculty hired for future proposals/efforts
Quantum Dot Building Blocks:			
Quantum dots based biosensor for protease or Hg detection	People: Wu, Shi, Perrotta Tool needs: fluorimeter/PL spectrometer, Enabling people needs: one postdoc	1 new publications (if there is a postdoc) 2 new proposals	1 Journal publication and one manuscript submitted 2 Proposals (NSF, NIH) submitted People: Reallocate WVNano funding for organic syn. postdoc.
Biophotonic Building Blocks:			
Nonlinear Biological Optical Imaging	People: Agmon (neurosciences), Ganikhanov	New faculty effort TBD	2 Journal publications

EDUCATION, HUMAN RESOURCE DEVELOPMENT, & OUTREACH (EHRDO)
Summary Report for July 1 – December 31, 2006

Education, Human Resource Development, & Outreach (EHRDO) is an integral component of the RII. Striving for cost-effectiveness and greater impact, the WV RII not only initiates opportunities but partners with, builds upon, and extends other NSF-funded EHRDO projects and University-supported efforts. An EHRDO Working Group of RII participants meets periodically with the Science Education Coordinator, Phyllis Barnhart.

Threaded throughout the development of the EPSCoR RII proposal grant was a heightened awareness of the need to diversify the WV workforce by providing increased access to individuals underrepresented in STEM and, in particular, the nanoscale science and engineering fields. Model programs for retention and enhancement of students in STEM, including those focused on underrepresented and minority (URM) groups including minorities, women, persons with disabilities, the economically disadvantaged, and first generation college students have been examined. The RII is weaving proven components from successful strategies and national model programs that focus on education and human resource issues.

Joint Efforts with LSAMP. Due to low minority populations in both states, Kentucky and West Virginia forged a regional partnership to form a multi-institutional alliance, a strategy that secured NSF-funding under the Louis Stokes Alliance for Minority Participation (LSAMP) program. Of the ten colleges and universities, West Virginia University, Marshall University, West Virginia State University and West Virginia State Community & Technical College are participants in West Virginia. The RII and the WVU-LSAMP have partnered to maximize resources to enhance URM student opportunities for undergraduate students. Dr. Michael Mays, LSAMP Campus Coordinator, is collaborating with Phyllis Barnhart, EHRDO Coordinator for RII, to implement EHRDO activities.

EHRDO Planning. Due to the timing of the award, the majority of the EHRDO activities will not be implemented until Summer 2007. Thus, the first six months have been devoted to comprehensive and detailed planning of all EHRDO components; development of a brochure and website; and identification and development of on-campus and inter-campus collaborations. In-depth meetings have been held with lead personnel of the following at WVU:

- Center for Black Culture
- Social Justice
- Admissions
- University Honors Program
- Seamless Transition Program
- Health Careers Opportunities Program
- Health Sciences Technology Academy
- NSF STEP Grant: Engineers of Tomorrow Program
- Engineering Lead Program

And at Marshall:

- Center for African American Students' Programs
- Marshall University Multicultural Affairs
- The Health Sciences and Technology Academy (HSTA)
- MU ADVANCE program

A meeting of EHRDO and LSAMP representatives from West Virginia University, Marshall University, West Virginia State University and West Virginia State Community & Technical College was held on August 31, 2006, in Institute, WV, on the campus of West Virginia State University. The goal of the meeting was to identify components for collaboration and work toward state-wide consistency in the EHRDO efforts.

URM Retention Initiative at WVU. The design of this initiative includes a comprehensive set of enhancement activities ranging from academic support to mentoring, research experiences, and social and cultural development activities for undergraduates. Dr. Charles Woolston, former Assoc. Provost and co-founder of the University of Maryland–Baltimore Campus Meyerhoff Scholars program, serves as an expert advisor in this endeavor. Dr. Woolston visited the WVU campus on October 23-24, 2006. During his two day visit, he met with WVNano participants, the RII EHRDO Working Group, the Deans of Arts & Sciences, Engineering, and Pharmacy, and the LSAMP/RII EHRDO Advisory Council. Representatives from West Virginia State University, West Virginia State Community Technical College, Marshall University, and WVEPSCoR participated in Dr. Woolston's visit. In addition to consultation meetings, Dr. Woolston provided a campus-wide presentation.

The RII EHRDO initiative will implement a modified version of the Meyerhoff Scholars program. To date, detailed planning has occurred for the following components:

- Summer Bridge Program for Rising Freshman
- Peer Mentoring and Tutoring
- Freshman Academic Year Program for "Gatekeeper" Courses
- NSE Authentic Research Summer Program for Rising Sophomores/Juniors/Seniors

Summer Bridge Program for Rising Freshman. A four-week summer bridge program will be implemented to better prepare URM students entering STEM fields, especially those closely related to nano-biosciences. Promising first-year students accepted at WVU who express interest in STEM disciplines are targeted. Admission will be by competitive application. URM students will enroll in a pre-calculus course (Math 129) and university orientation course (University 101); interact with peer mentors and faculty; and engage in special academic support including class scheduling, career workshops, and other opportunities to become familiar with campus life including service activities. During the period, planning continued for a summer bridge program at Marshall.

Peer Mentoring and Tutoring. Intrusive (peer and proactive) mentoring during the summer program and the undergraduate experience will ensure URM students are culturally and academically integrated into campus life and will encourage retention in STEM disciplines through degree completion. A Mentoring Team will be established for each student and will consist of a faculty member, an upper-class peer mentor and the student. Proactive mentoring is key to retention of URM students in STEM disciplines. Peer mentors from both WVU and Marshall will be trained in April-May 2007 regarding campus resources, community resources, and life skills techniques.

Freshman Academic Year Program for "Gatekeeper" Courses. Students participating in the summer programs have the opportunity to continue to receive support from peer mentors, enroll in a dedicated calculus course in Fall 2007, and receive supplemental instruction outside of the classroom for gatekeeper courses (e.g., calculus and chemistry) to improve performance and encourage retention in STEM disciplines.

Authentic Research Program for Sophomores/Juniors/Seniors. Through a competitive application process, a cohort of rising sophomores, juniors and/or seniors will be selected to participate in a six-week summer research program that will engage students in the research laboratories of FBBG faculty. This

program will be offered in collaboration with the Honors College SURE and the Marshall University SURE (Semester/Summer Undergraduate Research Experience) program sponsored by WVEPSCoR. Students will learn the RII research agenda and be exposed to specialized equipment. The students will 'shadow' an assigned research team member (post-doctorate or graduate fellow), assisting when appropriate based on their level of skills. The cohort will also participate in a weekly Seminar Series presented by faculty, post-doctoral fellows, and graduate students. Enrichment activities for cohort members will include visits to other research facilities such as the National Radio Astronomy Observatory and the National Energy Technology Laboratory.

Graduate Student Recruitment & Retention Initiative at WVU. The design of this initiative includes the provision of supplemental funds to attract highly qualified URM graduate students for a summer bridge program prior to the first semester of their Ph.D. program. Work with STEM department chairs to provide the incentive is planned for recruitment of graduate students during Spring 2007.

Early-Career/Junior Faculty Development Initiative at WVU and MU. A grant-writing seminar at WVU was held on July 10, 2006, with 99 faculty participating. Fifteen faculty, including two FBBG scientists, were selected for the 2006 Grant Writing Workshop cohort. The workshop began in September 2006 and will run through February 2007. The workshop entails dedicated one-on-one assistance from grant-writing consultants to produce a competitive proposal. At Marshall, a series of Professional Development Opportunities in Grantmanship seminars were provided by the Marshall University Research Corporation. Human Research Issues, Electronic Research Administration and Shoulda, Woulda, Coulda: A Compliance Primer for a Complex World were offered on October 31, 2006, November 14, 2006, and December 8, 2006, respectively. Another grant writing workshop focusing on NSF and NIH programs is scheduled for April 23 and 24, 2007. A mentorship program is being developed at WVU to provide additional grant-proposal experience and to aid junior faculty in their professional progress towards tenure and promotion

Focused underrepresented STEM Faculty Enhancement Initiative: West Virginia State University EHRDO Planning and Activities. At West Virginia State University the Center for the Advancement of Science, Technology, Engineering and Mathematics (CASTEM) began the process of establishing a work group to coordinate the RII EHRDO programs. CASTEM met with University administrators, STEM discipline department chairs and STEM faculty and various STEM organizations to begin the process of identifying students and establish an internal EPSCoR advisory team. CASTEM and the advisory team established project goals and began recruiting students.

CASTEM identified and recruited a STEM research faculty member and three (3) students for the summer research project. The faculty member and his students visited WVU FBBG members and Marshall FBBG members and their laboratories to discuss potential research ideas. Dr. Philippe Georgel and a Post-doc from Dr. Michael Norton's lab at Marshall have visited scientists at WVSU to explore collaboration possibilities. Dr. Giri Sura from WVSU will be spending several weeks during the summer with three of his students in one of the FBBG laboratories to develop research that may allow him to become a collaborator or a member of one of the FBBGs.

A Program Coordinator is being recruited who will assist in identifying and selecting teachers and instructors for the summer programs, assist in recruiting resident advisors/mentors and assist in identifying and contacting eligible students. The Pre-College Math & Science Program is a two week residential program for rising 8^{th}, 9^{th},10^{th} and 11^{th} grade high school students. The program is scheduled for July 9 through July 20, 2007. Student math and science skills and interest will be enhanced by academic activities and visits to FBBG labs as well as the National Radio Astronomy Observatory in Green Bank, WV.

A reception was held for recruiting purposes. The CASTEM office began outreach to other WVSU campus organizations and secondary school systems to introduce the programs available to students. The development of brochures, contracts for teachers, resident advisors, applications for students, website and obtaining housing and meal information began in late December. Recruiting students continues at the present time and is targeting female and minority students, although others will be accepted, including low income and potential first-generation college attendees.