



## Short Paper Guidelines Summer 2009

Write a brief (2-3 page) paper discussing your summer research here at LBNL. You should address in relatively broad terms these three areas:

- The background and significance of your subject area (Why is this important?)
- The role of your research group at LBNL (What is the group looking at?)
- Your role as it relates to the research group (What will you be doing specifically?)

This is an informal paper to get you focused on your research, and to help us understand what you are working on. References, Bibliographies, and complex Charts/Graphs/Tables should not be included.

The maximum length of your paper is no more than 3 pages, double-spaced, 12-point Times New Roman font. It may sound obvious, but avoid fonts such as Kid's Script, Comic Sans Serif and Wingdings. Please note also that you are by no means required to use the entire three pages.

Write objectively. In other words, don't write, "Our group is studying..." Instead write, "The research group is studying..." You should also excise comments such as, "I'm meeting Dr. Smith and we're going to talk about my access to the lab equipment." Remember, this is not a narrative, and it's not a journal entry. It's to get you used to writing in a scientific style.

Choose a descriptive title - what will your research be about? Titles such as "My Research" are too generic. **PUT YOUR NAME ON YOUR PAPER!**

**PROOF READ FOR PUNCTUATION, GRAMMAR AND SPELLING MISTAKES!** Run spell check in Microsoft Word. It's not the best, but it will help. A good website for information about grammar and punctuation can be found at: <http://webster.comnet.edu/grammar/index.htm>.

You also might ask someone else to take a look at your paper. They can provide valuable comments and help. Keep in mind that this will eventually become the introduction and background of your final paper, so it is worth putting in a little extra effort now.

Your papers will be read with the following in mind:

- Background/significance
- Explanation of the research group's role
- Explanation of the student's role
- Organization
- Clarity, good writing

Your short paper is due Thursday, 6/18; and can be submitted as a Word document or pdf file to Clyde Lewis at [CHLewis@lbl.gov](mailto:CHLewis@lbl.gov). Please contact him with any questions at ext. 2648.

Please title your file "Short Paper <YOUR NAME> Jun 09"

Following are two examples of short papers that we believe meet the criteria. You should not try to use either as a template for your paper; rather note how it reads and flows and covers the basic points.

### **Stress Response Analysis with *Shewanella oneidensis* MR-1**

The United States Department of Energy (DOE) has three million cubic meters of buried radioactive and hazardous waste, 75 million cubic meters of contaminated soil, 475 billion gallons of contaminated groundwater, and 1,200 nuclear weapons production facilities contaminated with radioactive materials, hazardous chemicals, asbestos, and lead. Since the 1990s, the US DOE has focused on decontaminating, remediating, and decommissioning the soil and water surrounding the facilities where nuclear research, production, and testing had been conducted by DOE and its predecessor agencies. Many remediation strategies exist to treat hazardous and radioactive waste, the most common being the extraction and treatment of the contaminant by physical, chemical, or biological processes. Other methods include natural attenuation (pollutants are biodegraded by the naturally occurring microorganisms), biostimulation (the addition of nutrients to the soil to increase microbial activity), bioaugmentation (the introduction of microorganisms capable of degrading a particular contaminant), phytoremediation (remediation using plants), and mycoremediation (remediation using fungi). Based on current remediation technology, the US DOE estimates that it will take more than 70 years and could cost more than \$300 billion to decontaminate the nuclear production facilities and sites. Bioremediation has shown to be a cost-effective way of eliminating and containing these hazardous areas through the use of microorganisms to reduce, eliminate, contain, or transform the contaminants to non-hazardous or less hazardous forms. However, before these hazardous sites can be decontaminated effectively, further research must be done into the biological, chemical, and physical factors that influence the subsurface mobilization and immobilization of metals and radionuclides. Recent research has shown that some microorganisms are capable of transforming contaminants from one chemical state to another by changing their oxidation state, either fixing the contaminant in place so it no longer spreads through the environment, or mobilizing the contaminant making it easier to flush from the environment.

The Center for Environmental Biotechnology at Lawrence Berkeley National Laboratory is conducting research as a part of the Virtual Institute for Microbial Stress and Survival (VIMSS). VIMSS seeks to identify stress response pathways induced by various environmental factors, such as temperature, pH, oxygen, nitrate and nitrite concentration, and metal and radionuclide concentration. Stress, in relation to bacteria and their environment, can be defined as any deviation from optimal growth conditions that results in a reduced growth rate, or as a situation that stimulates the expression of genes known to respond to a specific environmental condition. Many species have shown extraordinary ability to proliferate in stressful environments, and researchers hope to exploit this unique ability in an effort to detoxify the soil and groundwater surrounding the nuclear production facilities.

One such bacterium is *Shewanella oneidensis* MR-1, an organism that has been found at many of DOE's sites contaminated with heavy metals and radionuclides. This bacterium is of particular interest because of its metabolic versatility for electron acceptor use; it can use oxygen, nitrate, trimethylamine-N-oxide, fumarate, sulfur compounds such as dimethyl sulfoxide, sulfite, thiosulfate, and elemental sulfur, as well as oxidized metals such as manganese (III) and (IV), iron (III), chromium (VI), and uranium (IV) as electron acceptors. Also, the entire genome of *S. oneidensis* has been sequenced, providing the genetic blueprint necessary to conduct high-throughput analysis of gene regulation under stressed conditions.

I will be exploring and determining minimum inhibitory concentrations (MIC) of stressors, defined as the amount of stressor needed to double the organism's generation time. The initial stressors of interest are nitrate, nitrite, and sodium chloride, all of which are common contaminants found in high concentrations at DOE sites contaminated with metals and radionuclides. Once the MIC's have been determined, large scale production of *S. oneidensis* under stressed conditions will be

conducted. These stressed cells will then be sent to VIMSS collaborators for proteomic, metabolomic, lipidomic, transcriptomic, and phenomic analyses to measure the flux of biomolecules under stressed conditions.

### **Module Testing and Troubleshooting for the ATLAS Pixel Project**

ATLAS (A Toroidal LHC ApparatuS) is an international collaboration to build the next-generation high energy particle detector for the LHC (Large Hadron Collider) at CERN (European Center for Particle Physics) in Geneva, Switzerland. Among its principal goals is to discover the Higgs boson, which in the Standard Model is the source of mass in the universe. ATLAS will track charged particles via three concentric detectors arranged within a magnetic field generated by a superconducting solenoid. The innermost of these detectors is a pixel detector positioned directly outside the LHC beam pipe. This pixel detector is the only detector technology currently able to handle the high projected particle densities, radiation dose, and interaction rate resulting from its proximity to the LHC collisions.

The module is the building block of the pixel detector, and it is a rectangular unit approximately 6cm by 2cm with 46,080 pixels. Modules are arranged in 3 concentric cylinders with the axis along the beam (the barrel), plus 3 disks concentric with the beam at each end of the barrel. There are 1456 barrel modules and 288 disk modules in all. Extensive work is needed to test, troubleshoot, and assemble module components to be used in the pixel detector. This will prevent premature failure in the ATLAS detector and ensure valid data for particle physics analysis.

A bare module consists of one sensor tile that is bump bonded to 16 Front End chips (FE's), one of four types of integrated circuits on the detector electronics. In particular, each sensor pixel is read out by an independent electronics channel on an FE, which is accomplished by a bump bond from each sensor pixel to an FE input. An FE contains 2880 individual pixel channels, each with continuous reset charge-sensitive amplifier with leakage current subtraction, signal shaping, programmable threshold discriminator, and time over threshold (TOT) output. This amounts to 67 million channels (and pixels and bumps) in the barrel and an additional 13 million channels (and pixels and bumps) in the disks. The reason such complex electronics is needed is that the beam collision rate at the LHC will be 40MHz with multiple interactions per crossing, and the detector must be able to distinguish the interactions within each crossing.

The FE's used are produced by IBM in circular sheets called wafers. Each wafer needs to be probed with a semiautomatic microprobe, which is controlled through computer. Automatic probes are controlled through a program called TurboDAQ, which performs numerous electrical tests such as pixel registration and threshold current scans. The electrical test results need to be analyzed in order to troubleshoot wafer problems, which often entails selective alteration of computer settings for reprobing. Although this vital analysis is at the crux of the wafer testing, the technical complexity of the analysis puts it outside the scope of this paper (details can be found in the references). After wafers have been probed, they are sent out for bumping, thinning, and dicing into individual chips. An important task is to convert the C++ code to operate with another microprobe available, which would increase our production rate by allowing us to utilize multiple probe stations in parallel.

The bumped FE chips then need to be photographed and visually examined under a microscope. There are two types of bump bonds on the FE's, indium and solder, because a single vendor cannot meet the necessary production rate. However, the LBNL Pixel group utilizes only indium bump bonds. Defects in the bump structure need to be identified, typically consisting of excess photoresist (unremoved protective coating on the wafers), smeared or missing bumps, and merged bumps. Smeared or merged bumps are not properly connected at bonding, and manifest themselves during later module testing as channels with no hits, but which behave normally from

the electronic point view. Meanwhile, merged bumps show up as channels with no hits but in which one of the neighbors either is very noisy because of the increased channel capacitance or has a count rate higher than normal. By performing cross checks of bump defects with electrical failures of the modules, bump defects will be categorized according to their resultant failures. This will provide an easy way to later troubleshoot and fix defective modules.

After visual examination, the FE chips need to be reprobbed with TurboDAQ to discriminate against defects introduced during bumping, thinning, and dicing. Another set of electrical tests is performed, and its results again need to be analyzed to illuminate any new problems. Good chips that pass reprobbing will be used for module assembly; these modules also need to be tested and troubleshooted. Good modules will be sent out for use in the ATLAS detector, which begins operation in 2007.