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Projects in the Accelerator Division suited for University collaboration

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INSTRUMENTATION

1) MI Beam Position Monitors (BPMs)

Discussion with Bob Webber on 03/13/2006

project: There are 250 Main Injector BPMs (the ones currently installed) which have been measured/characterized at a test stand. Measurements collected from four electrodes are being used to calculate the best possible position. The data exist in ascii format. A program will need to be written which will perform a statistical analysis on the data and interpret them.

qualifications: Programming and analysis skills.

duration: ~ three months for one student

contact person: Bob Webber

time to start: As soon as possible.

COMMENT: One student and a faculty member to start working on this in June 2006

2) Developing a Learning Tool for FPGA-Based Instrumentation

Discussion with Bill Ashmanskas on 02/13/2006

project: A group within the Accelerator Division has been designing, and will soon try to build, a low cost, Ethernet-based, NIM format circuit board that will include two analog RF down-converter inputs, one ADC input, two DDS (synthesizer) outputs, one DAC output, various digital I/Os, an FPGA (Field-Programmable Gate Array) for real-time data acquisition, and a uCdimm Linux-based CPU for data processing and interfacing. The basic idea is to have a convenient, adaptable package that can both receive and synthesize signals typical of the Fermilab accelerator complex (e.g. 53 MHz beam and RF signals). There are several specific applications for this board, one of which is being described below.

The goal is to lower the barrier to entry for people interested in learning to develop FPGA-based instrumentation. The idea is to develop a set of clean, simple, well commented firmware and software that demonstrates the basic functionality of the board's analog inputs and outputs and interfaces the board to ACNET. For example, one could implement both a turn-by-turn BPM signal processor and a test-signal source for a turn-by-turn BPM signal processor. Once that is done, the plan is to teach a seminar in which interested parties could learn to program their own instances of the board for their

own applications, starting from the example code above.

qualifications: One should be a confident C programmer. It would be useful to know or learn VHDL(Very High Speed Integrated Circuit Description Language). One will need to know how to work with an oscilloscope.

duration: two-five months for one student/postdoc

contact person: Bill Ashmanskas, Dave Peterson

time to start: May 2006. Schedule is flexible but the project needs to be finished by the end of summer or mid fall 2006.

3) Diagnostic Software for BPMs

Discussion with Manfred Wendt on 05/18/2006

project: This task requires writing a self-diagnostic program, which activates test signals at times of no-beam and routinely checks the system for errors, malfunctions, drifts, etc. The software to be written should include data storage and visualization, and (with appropriate modifications) should be useable in all Beam Position Monitor systems.

qualifications: Programming (C). It is also required to learn some basics of the control system.

duration: one year for one student/postdoc working ~50% of the time

contact person: Jim Crisp, R. Webber, M. Wendt from the instrumentation side and a representative from the side of the corresponding machine.

time to start: As soon as possible

4) Automating the calibration of the Beam Current Monitors (toroids)

Discussion with Manfred Wendt on 05/18/2006

project: Putting together self-diagnostic hardware and software which will calibrate the toroids routinely during times of no-beam. This includes harware modifications to supply remotely controlled test signals to the toroid. The control software has to be applicable for all toroid current monitors and include system checks, data storage and visualization.

qualifications: For the hardware component, competence on electronics design as well as on building and testing hardware. For the software component, programming skills (C) are required. It is also required to learn some basics of the control system.

duration: *Hardware*:1 year for one student/postdoc and a technician/engineer working ~50% of the time. Software: 1 year for one student/postdoc working ~50% of the time.

contact person: Jim Crisp from the instrumentation side and a representative from the side of the corresponding machine.

time to start: As soon as possible

5) Projects on optical transition radiation (OTR) monitors

Discussion with Manfred Wendt on 05/18/2006

project: There are several possible projects on OTR monitoring:

- a) design for an OTR detector for 8 GeV beams
- b) modification of the Tevatron OTR for turn-by-turn measurements
- c) investigation, designing and building OTR profile detectors for the Fermilab ILC test facility

qualifications: MS or PhD in Physics and programming skills. Knowledge of LabView would be very useful as well as some competence in optics, CCD cameras and electronics. b) needs in addition some competence in mechanical design.

duration: ~ one year for one student/postdoc, 100% of the time for a) and b). ~ 2 years for one student/postdoc, 100% of the time for c).

contact person: Vic Scarpine

time to start: As soon as possible for b). a) and c) are R&D projects.

6) Cavity BPMs

Discussion with Manfred Wendt on 05/18/2006

project: Bench measurements of a cavity BPM, RF measurements on a prototype cavity BPM on a teststand, by use of a network analyzer.

qualifications: Some RF/microwave background/interest as well as instrument control programming (e.g. LabView)

duration: six months for a student/postdoc, ~75% of the time.

contact person: Jim Crisp, Manfred Wendt

time to start: As soon as possible

MAIN INJECTOR

Discussion with Ioannis Kourbanis on 03/31/2006

1)
project: Study the MI IPM data and measure beam size and other beam parameters. Compare with MI FW data when both available. (The IPM has the advantage of providing turn by turn data). Direct comparison in beam size measurements between the two horizontal detectors; one with the permanent magnet and one without.

qualifications: Willing to participate in measurements. Data will be collected with Labview. Programming skills needed. Knowledge of JAVA or C++ would be useful.

duration: four-six months for one student/postdoc, ~50% of the time.

work with: Alberto Marchionni and Jim Zagel

time to start: As soon as possible

PBAR

Discussion with B. Ashmanskas on 02/13/2006

project: Debuncher 53 MHz BPM Firmware/Software/Commissioning

The Debuncher Beam Position Monitor (BPM) System is being adapted to be capable of recording orbits of antiprotons, bunched at 53.1 MHz, during every stacking cycle. (Currently, the BPM system is used to record orbits of reverse protons, bunched at 2.5 MHz, during study periods). For filtering, digitizing and processing the 53 MHz signals we will probably use a revised version of the circuit-board design that is already working for the AP2 transfer-line BPM system. While most of the basic software and firmware will carry over from the AP2 line, some programming will be needed to: a) accommodate circuit-board changes (e.g. increased number of ADC bits) and b) to integrate a closed-orbit beam signal over 20 milliseconds instead of a single-pass beam signal over 1.6 microseconds.

The task would be some combination of FPGA firmware programming (to receive and filter the raw ADC signals), C programming for an embedded CPU (for readout and housekeeping), and hardware/system installation and troubleshooting.

The benefit to the accelerator complex will be the ability to monitor Debuncher orbits while running. This will allow us to see drifts, e.g. due to temperature changes or component failures. It will also allow some kinds of acceptance-improvement studies that currently require dedicated study time to be done parasitically while running. One can hope that this feature may contribute positively to the average stacking rate.

qualifications: Comfortable in writing C code and good at debugging problems. One should know from some electronics course what is a flip-flop, a counter, a RAM, a state machine and a pipeline.

duration: ~ three months for one student/postdoc

work with: Bill Ashmanskas, Dave Peterson

time to start: As soon as possible. Would like to have the system up and running as soon as possible after the end of the spring 2006 accelerator shutdown.

PROTON SOURCE

1) Radiation Robot

Discussions with Eric Prebys on 01/19/2006 and with Ray Tomlin on 04/10/06

project: Monitor beam loss and radiation in real time. The Robots currently calibrate the loss monitors installed in the Booster ring. Two Robots are available and two more are under construction to be used in other rings or for additional purposes. The goal is to complete the assembly of the two new Robots and help program them.

qualifications: some hardware and programming skills

duration: ~ three months for a student

work with: Ray Tomlin, Eric Prebys

time to start: As soon as possible.

2) New corrector magnet system in Booster - Proton Plan

Discussion with Eric Prebys on 01/19/2006

project: The Booster has a corrector system comprised of horizontal and vertical trim dipoles as well as regular and skew quadrupoles. This system is not sufficiently powerful to control either the beam position or the tune at high field and severalof the corrections are happening in a manual way. The new corrector system will allow for higher level tuning. Need to decide on final configuration and algorithm for correction. A simulation package will need to be put together as well as interpretation of the results.

qualifications: Ph.D in Accelerator Physics. Programming skills.

duration: ~ one year for a postdoc.

work with: Eric Prebys

time to start: As soon as possible. By mid 2007 the first half of the corrector needs to be installed and the simulation has to be completed well before then.

TEVATRON

HLS:

Discussion with Jim Volk on 03/09/2006

project: Hydrostatic water level monitoring of the Tevatron

There are 250 water levels in the Tevatron, one for each quadrupole magnet. They are read out once a minute through ACNET. The task is to write some Java scripts that will collect the data and make plots of the sensor levels, correlations between sensors, and differences between sensors. These plots should be available on a day by day basis and also for an entire month of data. Programs exist already to get the data and can be used as a starting point for programs that will deal with the 250 sensors. We will try also to correlate the vertex positions for both CDF and D0 with water level data.

qualifications: Programming and analysis skills needed. Knowledge of Java would be very useful.

duration: ~three months for one student/postdoc. Two students working together would be very efficient here.

work with: Jim Volk

time to start: As soon as possible

SDA

SDA Reports and Reports MT:

Discussion with Timofei Bolshakov and Vaia Papadimitriou on 04/19/2006

project:
Improve and enhance the functionality of two Web-based JSP/Java programs that work with SDA (Sequenced Data Acquisition/Shot Data Analysis) and produce user defined tables and plots.

qualifications: Programming skills in Java, JSP and basic Web-design.

duration: ~three months for one student/postdoc

work with: Timofei Bolshakov, Vaia Papadimitriou

time to start: June 2006

R&D

1) Accelerating Radioactive Ions in the Tevatron

Discussion with Andreas Jansson on 03/13/2006

project: Accelerating Radioactive Ions in the Tevatron

To generate a very pure and intense neutrino beam for Neutrino Physics experiments, it has been proposed to use the beta-decay of radioactive ions (eg. 6He and 18Ne) stored in a high energy decay ring. The original proposal was to use the CERN SPS to accelerate the ions to 100GeV, but recent work has shown that it would advantageous to go to even higher energies. The Tevatron will be retired from collider physics in a few years, and could perhaps be used for the purpose. However, the decay products will present a significant heat load to the cryogenic magnets, which will limit the number of ions that can be accelerated. To understand where the limit is, a simulation of heat deposition from secondaries is needed.

One can find more info on beta-beams at: http://cern.ch/beta-beam/

qualifications: Some experience with particle tracking codes, such as Fluka, Geant or Mars. General knowledge of Accelerator Physics, energy deposition, heat transfer and superconductivity.

duration: ~three months for three people (depending on background).

contact person: Andreas Jansson, N. Mokhov

time to start: As soon as possible

COMMENT: Two students and a faculty member to start working on this in June 2006

2) Proton Driver

Discussion with Bob Webber on 03/13/2006

project: Proton Driver

The 325 MHz Klystron will be powered in May 2006. (Its power modulator is to arrive at the Lab in April). Programming will be needed in order to develop EPICS screens (real time user interface for controls) for monitoring the interlocks and parameters of the RF power system.

qualifications: Programming and analysis skills. Knowledge of C or C++ would be very useful. Will need to become familiar with EPICS.

duration: ~ six months for a student/postdoc, 50% of the time.

contact person: Bob Webber

time to start: As soon as possible after April 2006

3) Proton Driver

Discussion with Doug Moehs on 04/19/2006

project: Testing diamond foils for the Proton Driver project. Testing will be done at 750 KeV where the energy deposition into the foil is comparable to that of the multi-turn injection schemes proposed for the Proton Driver. As part of this work the student will build two small Faraday cups to measure the beam current passing through the foils. The student will then proceed to test carbon and diamond foils using the H- pre accelerator.

qualifications: A physics background. Some electrical skills, such as soldering and some oscilloscope experience. Over the age of 18.

duration: Two to three months for a student.

contact person: Doug Moehs

time to start: As soon as possible.