SCIPP Internship Program, 2005

Congratulations on being selected for this year's program.
You will have the opportunity to learn a great deal about particle physics, electronics, & mathematical analysis; while working in a research lab.

You will spend one part of your time in the lab building detectors and testing them. Another will be in the research library learning more about topics that arise and a third part in colloquia meetings where you will be the expert presenting to a group of your peers as well as professors.

Following is a partial list of objectives and topics. It is expected that you will be working on most of these and likely others as the internship progresses.

1. Construct scintillation detectors for use in classrooms.
2. Measure singles rates, coincidence rates and efficiencies of these detectors.
3. Statistically evaluate data: conditional probabilities, standard deviation, confidence levels, hypothesis testing.
4. Design simple digital circuits, test digital circuit boards, evaluate alternative electronic designs.
5. Understand the sources and interactions of cosmic rays.
6. Understand exponential decay of muon particles. Measure muon lifetimes.
7. Learn to use research grade equipment such as digital storage oscilloscopes.
8. Learn to program and use FPGA devices (Field Programmable Gate Array) to measure muon lifetimes.
9. Test silicon detectors for deployment on the GLAST space telescope.
10. Keep thorough & complete lab notebooks. Write professional lab reports. Create an interesting, useful, and accurate website as a record of work accomplished and as a reference source for others.

Our work this year will center on development and test of cosmic ray scintillation detectors and silicon detectors. We will be using statistical analyses to measure the efficiencies of the detectors

Before we begin on July 11, 2005, you will need to do some preliminary research on selected topics so that you can prepare a presentation for our first colloquium that week.

Each of you will choose one of the following areas to research. You will become especially familiar with that chosen area so that you can present and teach it to each other.

Pre-Internship Research Assignments:

1. Cosmic Rays ....._____
2. Statistical Analysis....._____
3. CCRT & Berkeley DAQs....._____
4. WALTA DAQ & Quarnet Grid ....._____
5. Muon Lifetime experiment ....._____

Research Topics:

Cosmic Rays

Research cosmic rays; their origin, make-up, energies, interactions, decay products, and lifetimes. Learn about strong force & ionization interactions; quarks, baryons (e.g. proton, neutron), mesons (e.g. pion & kaon), leptons (e.g. electron, positron, & muon). Learn about Interaction depth and air showers.

Statistical Analysis

Statistically evaluate data: conditional probabilities, standard deviation, confidence levels, hypothesis testing. Compare binomial, Poisson, & Normal distributions. Use probability models to determine confidence levels and test hypotheses. Analyze data sets for mean, mode, & variance using non-parametric statistics.

CCRT & Berkeley DAQs

Study the manuals and schematic diagrams for the electronics board (DAQ) developed by the Stanford Linear Accelerator Center (SLAC) and called the Compact Cosmic Ray Telescope (CCRT). Do the same for the DAQ developed by the Lawrence-Berkeley National Lab (LBNL). Research each IC used on either board. Download and printout a copy of each ICs data sheet. Explain the operation of each stage of the electronics.

Reseach the construction & operation of scintillation panels. Understand the process of testing the detectors: PMT voltage, threshold voltage, singles rates, coincidence rates, & efficiencies.

WALTA DAQ & Quarnet Grid

Study the manuals and schematic diagrams for the electronics board (DAQ) developed by QuarkNet at Fermi National Accelerator Laboratory (FNAL) and used as part of the WAshington Large area Time coincidence Array (WALTA). Look at the group collaboration on the QuarkNet GRID. Research each IC used on the board. Download and printout a copy of each ICs data sheet. Explain the operation of each stage of the electronics.
Reseach the construction & operation of scintillation panels. Understand the process of testing the detectors: PMT voltage, threshold voltage, singles rates, coincidence rates, & efficiencies.

Muon Lifetime experiment

Understand the sources and interactions of cosmic rays. Study the Standard Model of Fundamental Particles and Interactions. Understand exponential decay of muon particles. Measure muon lifetimes.

Learn about the operation of digital storage oscilloscopes and FPGA devices (Field Programmable Gate Array).

Resources

Following is a list of useful resources. Be sure to explore each thoroughly.

Top level Resources:
SCIPP Outreach: http://scipp.ucsc.edu/outreach/index.html
The Cosmic Ray Experiment:
http://www.lbl.gov/abc/cosmic/SKliewer/Index.htm
Particle Physics: http://www-pdg.lbl.gov/pdg.html
SLAC Virtual Visitors Center:
http://www2.slac.stanford.edu/vvc/Default.htm
APS Physics Links: http://pdg.lbl.gov/~aerzber/aps_index.html
FPGA: http://www.xilinx.com/

Products of Prior Interns:
Webpage: http://scipp.ucsc.edu/outreach/Students.html
Resources:
http://scipp.ucsc.edu/outreach/internships/2004Internship/resources.html

Detector Designs:

CR detectors: http://quarknet.fnal.gov/toolkits/ati/crdetectors.html
SLAC CCRT detector:
http://scipp.ucsc.edu/outreach/internships/2004Internship/Resource/slac-tn-95-001.pdf
LBNL Berkeley detector: http://quarknet.fnal.gov/toolkits/ati/lbnldet.html
FNAL WALTA detector: http://neutrino.phys.washington.edu/~walta/
FNAL Grid Project: http://quarknet.uchicago.edu/elab/cosmic/home.jsp

Books for loan:

"Cosmic Bullets" by Roger Clay & Bruce Dawson
"Practical Electronics for Inventors" by Paul Scherz
"Space-Time Physics" by Taylor and Wheeler
"Particle Physics" by Abe Seiden
"The Nature of Science" by James Trefil
"Teach Yourself Statistics" by Alan Graham
"The cartoon Guide to Statistics" by Larry Gonick
"The Cartoon Guide to Physics" by Larry Gonick