Undergraduate Research Assistants Program

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Software Simulation for Measurement of the Top Quark Mass

Quarks are currently understood to be among the most fundamental particles in nature. The majority of the observed matter in the universe is composed of subatomic protons and neutrons, which are in turn comprised of quarks. Although quarks were hypothesized 40 years ago, there remains considerable mystery about what determines the properties of these particles. These questions lie at the very foundation of physics. For instance, 'What is mass, and where does it come from?' Answering these questions is hampered by the fact that forces between quarks are so strong that it is virtually impossible to study each one in isolation. One quark, however, does not suffer from this problem: the top quark. Discovered in 1995, this particle has such unusual properties that it is currently viewed to hold important clues to the important longstanding questions. One of these properties of the top quark is its mass.

Precisely measuring the top quark mass appears to tell us quite a bit about the way in which mass is 'created' at the level of fundamental physics. The ability to measure this mass well rests primarily with how well the energies can be measured of the 'daughter' particles it produces in the detector. SMU is involved in the top mass measurement and we have two separate projects that can fruitfully be pursued in undergraduate research.

A) Development of software to compare important energy measurements of the detector with the expected performance. Adjustments to the simulation will be implemented so that the expected performance more closely reflects the actual detector behavior.

B) The ability to measure the top mass is confused by backgrounds which accidentally look like the top quark because of imperfect detector performance. It is important to have an accurate understanding, or 'model' of these backgrounds so that the true top mass can be extracted from the real top events. This is done in part by comparing different 'models' of the backgrounds to see how they effect the mass measurement. This project entails an estimation of this effect.

These projects benefit from other work carried out by SMU on these topics, and fit into a broader research project being carried out. Depending on the specific project undertaken, this research will involve the use of basic C++ programming and/or introductory statistics. The student will have the opportunity to study actual particle physics data on the top quark and compare it to simulated expectations. The research will result in a project note.