# LNS Update

LABORATORY FOR NUCLEAR SCIENCE

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## The ATLAS LHC Research Program

**• What is the origin of mass ?**

**• Are there elementary particles which are the 'supersymmetric' mirror images of the known ensemble of spin 1 and spin 1/2 particles ?**

These questions are two of many in elementary particle physics which have remained unanswered by direct experimentation for many decades even though all incisive experimental tests seem to agree with the Standard Model predictions. In order to extend our understanding we must explore new territory. In fact, from a historical prospective, the discovery of new phenomena in elementary particle physics frequently occurs when a new accelerator with higher luminosity and energy is used.

Five universities in the Boston area [Boston University, Brandeis, Harvard, MIT and Tufts] have teamed up to work at the Large Hadron Collider (LHC), presently under construction at CERN in Geneva, Switzerland. The LHC will provide proton-proton collisions at 14 TeV (14 x $10^{12}$ electron volts) center-of-mass energy and will be the highest energy machine in the world when it is commissioned in 2005. With such high energy, the LHC will present a splendid opportunity to search for new phenomena within the next decade.

The 'Higgs mechanism' has been proposed to generate particle masses, which in its most basic form, predicts the existence of a spin 0 particle that interacts with the spin 1 gauge bosons [photon, gluon, $W^{\pm}$ and $Z^0$] and spin 1/2 leptons and quarks. The Higgs particle has not yet been detected. Much theoretical work has been done on the idea of supersymmetry. Like the Higgs particle, there is no direct experimental evidence for this new symmetry. However, there are hints.

One of the recent successes of the Standard Model is the prediction of the mass of the top quark and its recent experimental discovery at FNAL. The same chain of reasoning can be carried out by further examination of precision tests of electroweak theory at SLAC, CERN and FNAL to set limits on the mass and production cross section of the Higgs particle. The present limit determined by precision electroweak tests places the mass of the Higgs at a central value of 130 GeV (130 x $10^9$ electron volts) and an upper limit (95% CL) of 465 GeV. By direct search, we know the Higgs must be heavier than about 66 GeV. Further, theory tells us that if the Higgs is to be an "elementary particle" it must be lighter than about 1 TeV - otherwise new "physics" must be operative. These experimental - theoretical limits, just beyond the present reach, make the experimental quest for the Higgs ever more tantalizing.

The Higgs particle, as well as other exotic particles, have significant decay modes into muons (heavy electrons). Muons are particularly useful and "interesting" because their experimental signature involves the detection of a penetrating charged particle and can be observed behind massive shielding far from the non penetrating and "unin teresting" debris of the p-p collisions. Our Boston group has therefore decided to concentrate on muons and calls itself the Boston Muon Consortium . We have joined the muon subsystem of the ATLAS (A Toroidal LHC ApparatuS) collaboration, one of the two general-purpose detectors under design and construction at the LHC. By focusing common interests and pooling resources in one LHC experiment a critical mass can be reached in the Boston area which will enable the BMC to assume a large responsibility in the design and construction of the ATLAS muon system. The near term focus of our group will be to become one of the two ATLAS endcap muon chamber fabrication sites and ultimately become a physics analysis site.

How are masses generated ? Is the universe "supersymmetric" ? Maybe we will know in 10 years.

**For further information contact:**
**Frank E. Taylor**
**Senior Research Scientist**
**Particle Physics Collaboration**
**(617) 253-7249**
**email: fet@mitlns.mit.edu**

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