


# PARTICLE PHYSICS GROUP

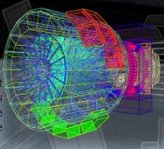
## TOP PHYSICS

The Top quark is by far the heaviest quark; it is nearly as heavy as a gold atom! Due to its high mass, it was discovered only in 1995. The generation of enormous numbers of Top quarks at the LHC, together with their unique coupling behaviour, will enable the ATLAS experiment to conduct detailed studies of their properties. The Atlantis event display image shows a top-antitop pair decaying into a cascade of particles including an electron and numerous jets.



## QUARK-GLUON PLASMA

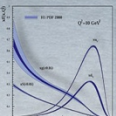
The ALICE experiment will probe the mysteries surrounding the structure of matter, and the nature of the strong force. In particular, we will create and explore the first instants of the Universe, a few microseconds after the Big Bang when a primordial state of matter, the Quark-Gluon Plasma, is thought to have existed.



## DEEP IN THE PROTON

It is well known that the proton is built from 2 up quarks and 1 down quark. Lesser known is the fact that due to the strong nuclear force, these valence quarks can radiate gluons, which in turn can split into sea quark-antiquark pairs, ultimately resulting in a very complex structure.

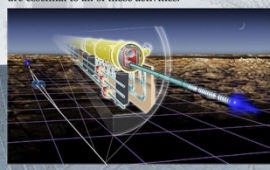
The H1 experiment studies high energy electron-proton collisions, equivalent to viewing the proton with an ultra-high resolution ( $\sim 10^{-4}\text{m}$ ) microscope. The plot shows the resulting measurements of the valence and sea quark densities and the gluon density as a function of the fraction,  $x$ , of the proton's momentum which they carry.



AS ONE OF THE LARGEST RESEARCH GROUPS IN THE SCHOOL OF PHYSICS AND ASTRONOMY, WE INVESTIGATE AND SEARCH FOR THE SMALLEST CONSTITUENTS OF THE ATOM AND MAKE PRECISE MEASUREMENTS OF QUARKS AND LEPTONS. MOST OF OUR EXPERIMENTS ARE CARRIED OUT AT PARTICLE COLLIDERS IN LABORATORIES AROUND THE WORLD (INCLUDING CERN) WHERE PARTICLES ARE ACCELERATED TOWARDS ONE ANOTHER AT NEAR LIGHT SPEED. THE HIGH ENERGY COLLISIONS PRODUCE MASSIVE PARTICLES INCLUDING THE Z BOSON AND THE TOP QUARK. THESE EXPERIMENTS WILL ALLOW US TO FIND OUT WHETHER SUPERSYMMETRY, TECHNICOLLOUR OR DARK MATTER ARE INVOLVED WHEN THE SYMMETRY OF THE STANDARD MODEL IS BROKEN.

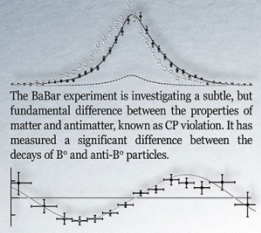
## LOOKING AHEAD

The International Linear Collider is the next generation, high energy  $e^+e^-$  accelerator. We are studying both the novel use of CMOS MAPS sensors and more established technologies to measure electromagnetic energy with unprecedented precision. We are also leading global design efforts for collimation in the beam delivery system. Extensive test beam experiments world wide are essential to all of these activities.




## CP VIOLATION

The BaBar experiment is investigating a subtle, but fundamental difference between the properties of matter and antimatter, known as CP violation. It has measured a significant difference between the decays of  $B^+$  and anti- $B^+$  particles.



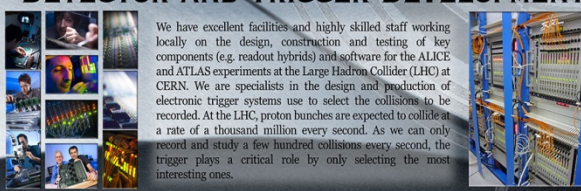
## GRID COMPUTING

The LHC experiments have built truly massive detectors that will create about 15 PB (petabytes) of data annually. That's enough to fill more than 500000 30GB iPods with 3 billion songs, 4 billion photos or more than 2000 years of video! No single institute is capable of providing the required computing and storage capacities. Birmingham, through its involvement in the GridPP collaboration, is contributing to the development of the world-wide grid which will pool together resources of participating institutes worldwide and give scientists access to resources levels never before available.



## DETECTOR AND TRIGGER DEVELOPMENT

We have excellent facilities and highly skilled staff working locally on the design, construction and testing of key components (e.g. readout hybrids) and software for the ALICE and ATLAS experiments at the Large Hadron Collider (LHC) at CERN. We are specialists in the design and production of electronic trigger systems used to select the collisions to be recorded. At the LHC, proton bunches are expected to collide at a rate of a thousand million every second. As we can only record and study a few hundred collisions every second, the trigger plays a critical role by only selecting the most interesting ones.



Dr. Rupnathji ( Dr. Rupak Nath ) is a scholar who has earned the Master's Degree in Radiation Physics ; and the Doctorate Degree in Medicinal Science from numerous universities. He also earned the equivalent of a second Master's Degree in Environmental Health and is a graduate of the Business School's prestigious Program for Management Development. He is an author who has numerous publications, both technical and educational. He is a Professor and has been Distinguished Honors Visiting Professor at numerous universities throughout the Nation. Recipient of many medals and honours, Dr. Rupnathji is at once a Physician, an astrophysicist and an applied mathematician.