Particle Physics Research

University of BRISTOL

Particle physics is the study of the fundamental building blocks of matter and how they interact with each other. Modern particle physicists build large experiments where particles are made to smash into one another at high energies. Particle detectors are built around where these collisions occur, and we study the particles resulting from the collision interactions.

The Large Hadron Collider (LHC) at CERN is colliding protons at higher energies than previous generations of colliders, allowing us to probe nature at its most fundamental level. The Bristol Particle Physics group is involved in two experiments that run at the LHC: CMS and LHCb.

We are also involved in a variety of research and development projects for future experiments. Now is a very exciting time in particle physics!

CMS experiment at CERN

The Compact Muon Solenoid (CMS) detector is one of two general purpose experiments at the LHC. It has a broad programme of physics that includes the investigation of Higgs boson properties and direct searches for new phenomena, such as Supersymmetric particles.

We are involved with searches for massive, exotic new particles that might show up within the first years of data taking, and devised novel techniques to find them. We also are measuring the production and properties of the top quark, to enhance our understanding of the most massive of the known Standard Model particles.

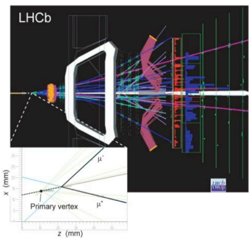
The Compact Muon Solenoid (CMS) detector at CERN

Flavour Physics (LHCb, NA62, and CLEO-c)

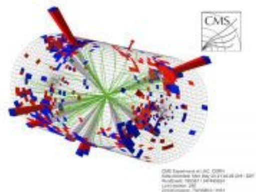
The detailed study of quark transitions provides insights into the structure of the Standard Model, and allows the discovery and study of physics beyond the Standard Model. Precision flavour physics is sensitive to loop effects caused by particles that can be far heavier than those directly produced at colliders — it can see beyond the energy frontier.

Bristol has a comprehensive flavour physics programme, covering B physics (LHCb), charm physics (CLEO-c and LHCb) and kaon physics (NA62). These areas complement each other in their sensitivity to New Physics, providing an unprecedented experimental precision where a whole host of New Physics models could become apparent. Bristol is the only group in the UK with such a far-reaching programme.

Photomontage of the LHCb collaboration and detector at CERN



A rare decay candidate detected by LHCb



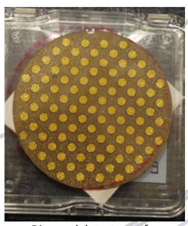
A collision event captured by the CMS detector

Research and Development

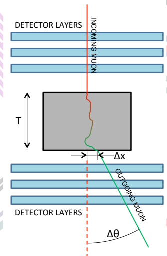
We have been involved with the design and construction of parts of the electromagnetic calorimeter and the first level trigger for CMS, as well as the Grid software that is essential for managing, distributing and processing the vast quantity of data produced at the LHC.

The Bristol group is actively researching and developing new solid-state particle detector technologies, for use both in future particle physics experiments and in other fields. Potential applications range from various upgrades to the LHC experiments to take advantage of future increases in LHC performance (including the novel use of diamonds as particle detectors) and advanced silicon sensors for medical X-ray therapy.

We are also working on the exploitation of natural cosmic rays to scan shipping containers using Resistive Plate Chamber (RPC) detectors, potentially improving homeland security.



Diamond detector wafer



Detector design for scanning containers

We enter a completely new realm of New Physics sensitivity. We do not know which approach will discover evidence of New Physics first, the highly sensitive search for deviations from Standard Model predictions in precision flavour physics at LHCb and NA62, or direct observation of new particles at CMS. However, it is certain that the input from both will be needed if we wish not merely to break the Standard Model, but to understand the physics that lies beyond it.

CMS LHCb NA62 CLEO