Where has all the antimatter gone?

April 11 2007

Scientists from the Universities of Liverpool and Glasgow have completed work on the inner heart of an experiment which seeks to find out what has happened to all the antimatter created at the start of the Universe. Matter and antimatter were created in equal amounts in the Big Bang but somehow the antimatter disappeared resulting in the Universe, and everything in it, including ourselves, being made of the remaining matter.

The final modules of the VErtex LOcator (VELO), a precision silicon detector, have been delivered to CERN, the European Particle Physics Laboratory in Geneva. Once assembled VELO will be installed into the LHCb detector, one of four experiments, which make up the Large Hadron Collider (LHC) particle accelerator, which is due to be switched on in November this year.

LHCb is designed to investigate the subtle differences between matter and antimatter in particles containing b (beauty) quarks. The VELO is an essential part of the experiment which will provide the unprecedented precision necessary to isolate them. The LHC, located in a 27km underground tunnel which straddles France and Switzerland, will help answer some of the fundamental questions about the origins of our Universe and is set to change the future path of particle physics research.

Within the LHC, two beams of protons will be accelerated to close to the speed of light and then collided in one of the four experiments, which will each measure the outfall of particles.

Professor Themis Bowcock, lead scientist from the University of Liverpool LHCb team said, "The VELO gives us the precision we need not only to identify b quarks in a proton-proton collision, but to do so in real time. This allows us to isolate samples of b quarks for analysis in a way that would be impossible otherwise. It is the key to LHCb's physics aims."

The VELO is unique in its design with the whole device (about a metre long) consisting of 42 silicon "modules", spread along both sides of the proton beam (21 each side). The VELO actually sits inside a vacuum vessel - with a thin sheet of aluminium, know as RF foil, separating it from the primary vacuum inhabited by the proton beams. The two halves of modules are mechanically moved in to within 7mm of the beam during data-taking, and out to a safe distance afterwards.

Dr Tara Shears, LHCb scientist from the University of Liverpool explains, "To achieve optimal precision the silicon detectors need to be as close as possible to the beam. When operational 40 million proton proton interactions will occur per second inside LHCb and it is no mean feat that measurements of these collisions will take place in real time.

Like all the detector experiments at CERN a worldwide team of scientists are involved in the design and construction of LHCb. The experiment involves 663 scientists from 47 institutes and universities in 15 countries. UK collaborators make up around 20% of this. The individual VELO modules, of which there are 42 in total, were designed and assembled at the University of Liverpool in a state of the art clean room.

Transport of the completed VELO modules from the University of Liverpool occurred by less than traditional means. Each module being couriered via an easyJet flight to Geneva! However, with the onset of tighter baggage restrictions some of the modules made the 1,066 km

(663 mile) journey in the boot of a car.

Scientists from the University of Glasgow are responsible for the reception and testing of the modules at CERN. Dr Chris Parkes from University of Glasgow said, "Now that all 42 modules are on site we are busy testing before final installation in the detector, 100 metres underground.

Source: Science and Technology Facilities Council