LHC particle accelerator begins lead ion collisions

Bryan Dyne, Don Barrett
13 November 2010

A new milestone in the commissioning of the world's most powerful particle accelerator was reached last week. Scientists shut down proton-proton collisions to begin colliding lead nuclei, which are much more massive particles.

The Large Hadron Collider (LHC), located across the Swiss/French border near Geneva, operates under the auspices of CERN, the European Organization for Nuclear Research. It is a collaboration of nearly ten thousand physicists and engineers from eighty nationalities.

Particle accelerators allow the study of the innermost structure of nature through collisions of fundamental particles at extremely high energies. The physical laws of quantum mechanics make it possible to determine the behavior of extremely small subatomic particles through the interactions of particles traveling at greater and greater velocities.

At full capacity, the LHC will have a maximum energy seven times higher than the next most powerful accelerator, Fermilab's Tevatron, located near Chicago, Illinois. Currently, the LHC is operating at half of its maximum capacity, but even at these energies, the data collected in 2010 and 2011 could be as significant scientifically as all the data collected in the fifteen years of the Tevatron's operation.

The Large Hadron Collider is primarily designed to collide protons, which are positively charged particles that are a building block of every atom in the universe. However, about one month per year scientific operations will instead concentrate on colliding the nucleus, or core, of lead atoms, which contain 82 protons and a variety (about 125) of neutrons.

The collisions of lead nuclei briefly recreate the enormously hot conditions of the early universe. Under these conditions, the even more primitive constituents of atomic nuclei—quarks and the particles that bind quarks together, or gluons—can travel freely instead of being bound together. Such a state, called a quark-gluon plasma, with temperatures as high as ten trillion degrees, has now been fully realized experimentally at the LHC.

Identifying and understanding the origin and actions of the fundamental forces has been a core endeavor of physics research of the past century. Gravitation, electromagnetism, the strong force and the weak force govern all interactions in the universe, from the Earth's orbit around the Sun to radioactive decays that provide nuclear power.

One of the aims of physicists at the LHC is achieve a greater understanding of the strong nuclear force. Unlike gravity and electromagnetism, the strong force acts on extremely short distances. However, it dwarfs both forces in strength. It is responsible for holding nuclei together against the repulsive force of large amounts of positively-charged protons.

In the decay products that accompany each lead ion collision, measurements will reveal in ever greater detail aspects of the strong force interaction, ultimately leading to an understanding of why it is so powerful, and short-ranged, compared to all the other forces.

The primary detector at the Large Hadron Collider for such collisions is the ALICE Collaboration. ALICE uses an intricate tracking system to identify and study the particles generated by the collisions of lead nuclei. In addition, ALICE uses the proton-proton collisions as a baseline for the higher energy collisions of lead nuclei. Alongside ALICE, the two general purpose detectors of the Large Hadron Collider, CMS and ATLAS, are also studying the lead collisions, although those collaborations are largely focusing on analyzing the data collected since June.

© World Socialist Web Site

The beginning of the lead nuclei collisions saw a renewed effort by anti-science groups to shut down the Collider. In particular, the Heavy Ion Alert group has issued a report claiming that the Earth is in serious danger of being consumed by a chain reaction of particles called strangelets that will be generated by the current reactions.

Physicists at the Large Hadron Collider have called this claim nonsense, and rightly so. Collisions of such high energies occur in the Earth's upper atmosphere and all throughout the universe. The only difference at the Large Hadron Collider is that the collisions will happen in a controlled environment that can be studied.

Unlike the Tevatron at Fermilab, the Large Hadron Collider, and indeed all of CERN, is an international physics experiment. It is the largest gathering of scientists and engineers from across the globe that has ever occurred, in spite of ever increasing tensions between rival nation-states. Its existence speaks to the productive capacity of humanity when put to use for the purpose of scientific inquiry and not the oppression of other humans. It is worthy to note that the operation of the Large Hadron Collider costs the same as a single US Nimitz class aircraft carrier.

The questions asked at the Large Hadron Collider speak to the fundamental building blocks of matter. Scientists are ever closer to finding out what is the true “atom” postulated by the ancient Greeks. The past forty years have seen an extraordinary growth in the collective understanding of the nature of the universe. The zoo of subatomic particles that have been discovered have steadily been classified by theoretical models of great mathematical beauty.

The beginning of lead nuclei collisions is a very exciting phase of the Large Hadron Collider. The inner workings of the strong force have long been elusive, but the most recent experiments are attempting to shed light on these problems. Technology has reached the point at which some of the questions that have been plaguing fundamental physics for decades are on the brink of being answered.

To contact the WSWS and the Socialist Equality Party visit:

wsws.org/contact

© World Socialist Web Site