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Backing the Big Bang

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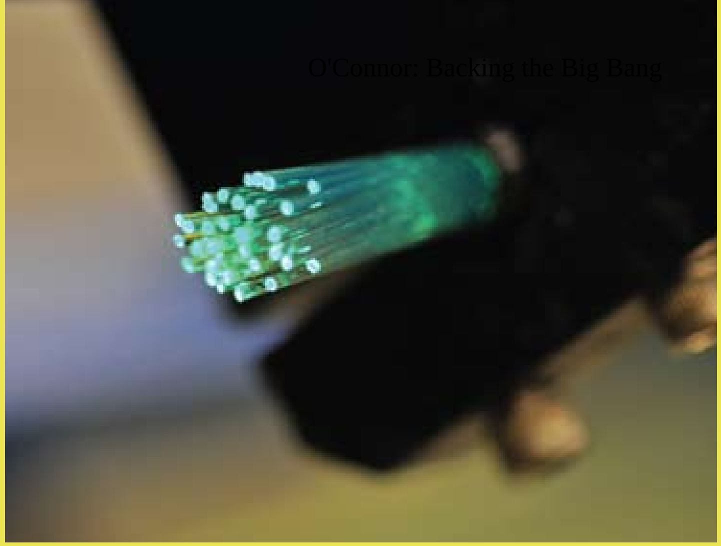

Wayne State University researchers are playing a major role at CERN, one of the world's largest scientific research centers.

Backing the

by Julie O'Connor

CERN, the European Organization for Nuclear Research, one of the world's largest centers for scientific research, is focused on providing new insight into the understanding of matter, fundamental forces, what the universe is made of, and how it works. Thousands of physicists, engineers, computer scientists, and many other scientists have gathered at CERN to build and carry out research at the Large Hadron Collider (LHC), incontestably the world's largest and most complex scientific instrument ever built, to study the basic constituents of matter — fundamental particles and their interactions. And two groups of researchers at Wayne State University are playing a major role in this prestigious project to learn what happens when these particles collide, ultimately helping us to deepen our understanding of the laws of nature.

A new view of the universe

The LHC, the largest and most complex particle accelerator ever built, embarked on a new era of discovery at the high-energy frontier in 2008. It immediately faced technical issues that required a one-year shutdown for repair and upgrades but came back online with a vengeance in November 2009. In just a short time, it has beaten the proton beam energy world record twice, the first time in November 2009 with energy of 1.18 TeV, and then in March 2010 with energy of 7 TeV. This gigantic scientific instrument, located 330 feet in a ring underground 16.5 miles around near Geneva at the border between Switzerland and France, will enable scientists from around the world to understand what gives matter its mass, what 96 percent of the

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invisible universe is made of, why nature prefers matter rather than antimatter, how matter evolved from the very beginning and more. By studying the smallest known particles using the LHC, scientists will peer deep inside the atomic nucleus in an effort to discover more about dark matter that pervades our vast universe.

Inside the LHC, two beams of subatomic particles called "hadrons" – either protons or lead ions –travel in opposite directions inside the circular accelerator, gaining energy with every lap. Physicists will use the LHC to recreate the conditions that were present just after the Big Bang, by colliding two beams head-on at very high energy. Physicists will study the particles created in the collisions using special detectors in a number of experiments.

A team of nuclear physicists at Wayne State is working on the ALICE (A Large Ion Collider Experiment) experiment at the LHC to study the matter produced in lead-on-lead nuclear collisions. These violent collisions will produce nuggets of matter reaching a temperature of one trillion degrees, about one million times the temperature of the core of the sun. At this tremendous temperature, matter dissolves into elementary constituents known as quarks and gluons. This matter, known as Quark Gluon Plasma, or QGP, permeated the universe right after the Big Bang for about one micro-second.

Recreating the past

The team, which includes Rene Bellwied, Ph.D., Thomas Cormier, Ph.D., Claude Pruneau, Ph.D. and Sergei Voloshin, Ph.D., all professors of physics in WSU's College of Liberal Arts and Sciences, along with post-doctoral researchers and graduate students in the Department of Physics, contributed to discover the QGP at the Relativistic Heavy Ion Collider (RHIC) located at Brookhaven National Laboratory, Long Island, NY. They now aim to study its properties in greater detail at the LHC. Essentially, they are interested in recreating the past, which ultimately could impact our future. Their role in the LHC has been to construct the electromagnetic calorimeter (EMCal) for ALICE.

Parts for this huge, heavy calorimeter, or heat detector, are being constructed in the basement of WSU's Physics Building, module by module. In all, WSU is building 2,200 of the 50-pound detector modules, which are layers of lead and insulators, laced with fiber optic bundles attached to complicated electronics. Once constructed, the modules are shipped to Switzerland to be installed on a support structure, with the entire structure ultimately weighing 80 tons.

"Wayne State University has by far made one of the largest hardware contributions to the LHC experiment," said Cormier. "While there are much larger hardware components elsewhere in the project, those have come from mega-collaborations of universities and national laboratories. The ALICE EMCal is exclusively a WSU project that can be associated with a specific set of physics goals."

Searching for Higgs

In addition to the ALICE project, WSU physicists are also collaborating on the Compact Muon Solenoid (CMS) experiment at the LHC. The CMS experiment is searching for the Higgs boson particle and other undiscovered particles that may help explain why matter has mass, and what dark matter consists of.

"This is an exciting and prominent experiment to use the Large Hadron Collider to search for the Higgs boson, which could explain the origin of mass of elementary particles, and to study the previously unexplored million-million volt energy scale of nature, over the next ten years," said Paul Karchin, Ph.D., professor of physics at WSU. According to Karchin, WSU researchers and students are stationed at CERN and at Fermilab in Batavia, Ill, to help maintain round-the-clock operation of these experiments and rapidly analyze the data captured. In addition to Karchin, Robert Harr, Ph.D., associate professor of physics, Mark Mattson, Ph.D., assistant professor of physics and Caroline Milstene, lecturer of physics are working on these experiments.

While there are many ideas of what may result from these unprecedented large energy collisions, Wayne State researchers can say for sure that a whole new world of physics will emerge from the ALICE and CMS projects. Indeed, with the LHC, the scientific world is entering a new era that will bring to life new discoveries and perhaps even unexpected new paradigms. These two Wayne State groups stand proudly with their extensive efforts in this amazing worldwide collaboration.

For more information about this project, visit: http://public.web.cern.ch/public