

# Perspectives

Fall 2012

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## An intergalactic search

University's contributions give weight to big scientific theory



Scan with smartphone for video of  
Tim Bolton discussing CERN.

Recently scientists at the European Organization for Nuclear Research, or CERN, announced that they have found evidence that the subatomic Higgs boson, or "God particle," exists.

The Higgs boson is the basic building block of the Higgs field – a kind of invisible cosmic molasses that permeates all space. It gives mass to subatomic objects like quarks and electrons. The particle was hypothesized more than 50 years ago and helps explain the foundation of the universe and its creation billions of years ago.

The search for evidence of the particle's existence was performed with the Large Hadron Collider. Built in 2008, the collider is the world's largest energy particle accelerator. Its high energy enables scientists to observe the smallest materials in the universe, effectively making it the world's most powerful microscope.

Kansas State University researchers largely help with collecting and analyzing the data collected by the Large Hadron Collider's Compact Muon Solenoid, or CMS. The Compact Muon Solenoid is one of the four particle detectors operated by many universities throughout the world at the Large Hadron Collider, and one of two particle detectors devoted to hunting the Higgs boson and dark matter.

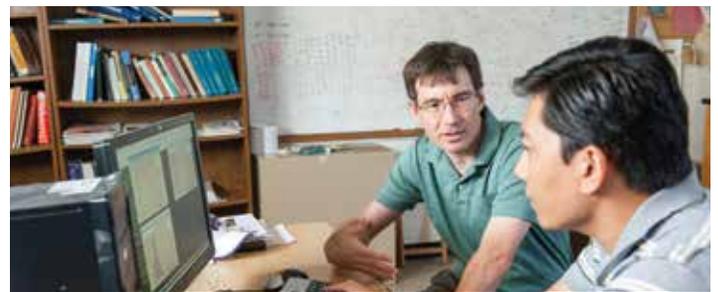
Kansas State University's Electronics Design Laboratory helped build the Compact Muon Solenoid's inner pixel tracker and several sets of the approximately 100 million electronic components that make up the roughly 72-foot-long detector.

Kansas State University physics researchers also helped write the computer software used in the experiments.

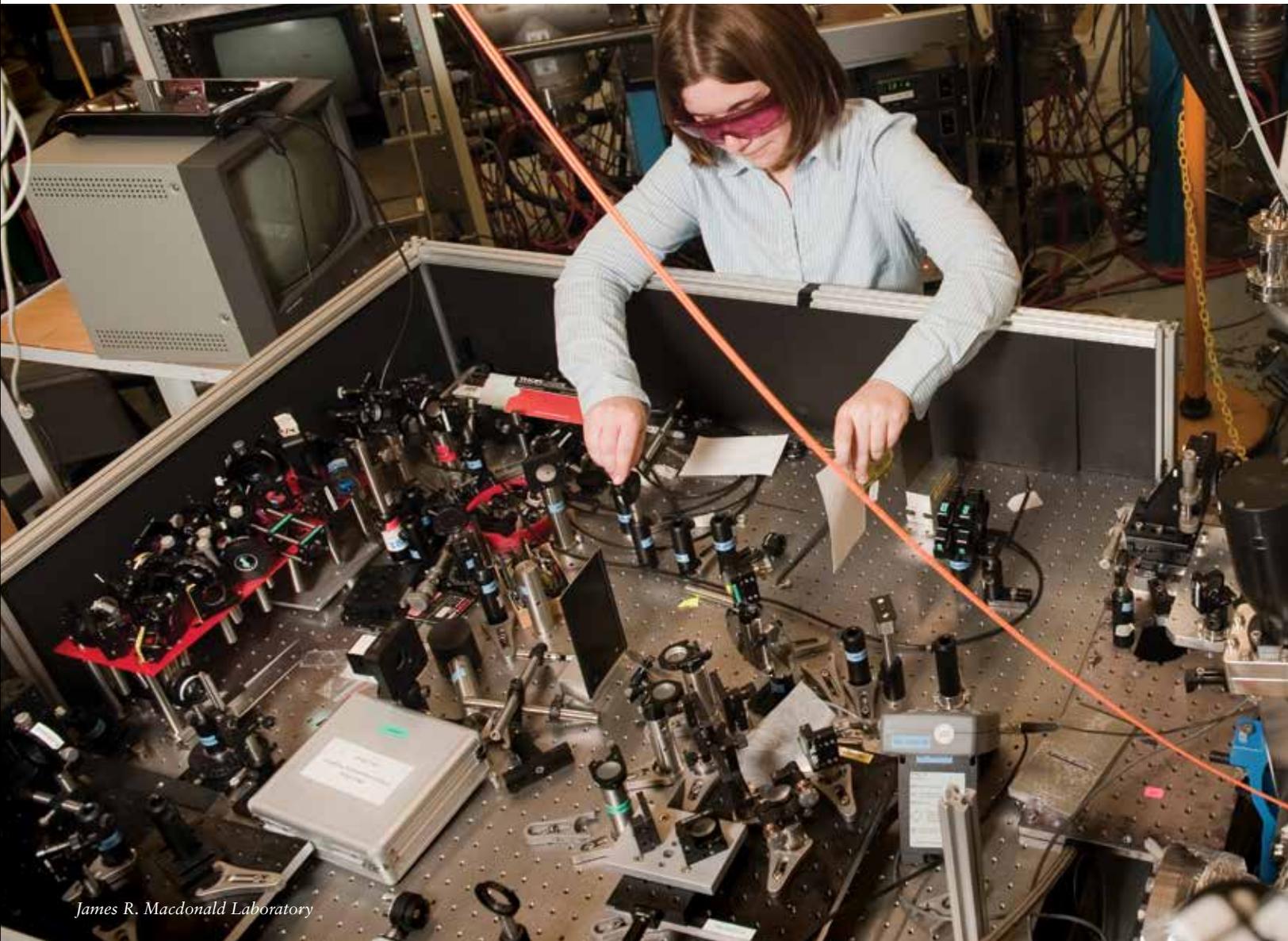
Additionally, several of the university's scientists work with the Fermi National Accelerator Laboratory, or Fermilab, which observes high-energy particle physics.

The Kansas State University physics department has several faculty members currently involved in the international project focused on the Higgs boson. Also collaborating are several of the university's graduate students and postdoctoral research associates.

— Greg Tammen



Glenn Horton-Smith, center, works with researchers in the high energy physics group. For more influential physics research, see inside.



*James R. Macdonald Laboratory*

## Accelerating Research

Physicists receive international recognition with high-profile science, prominent funding

Faculty in the department of physics at Kansas State University consistently bring in some of the university's highest total research dollars and produce large numbers of publications. Through the James R. Macdonald Laboratory, the high energy physics group and other research teams, the department continues to bring national and international recognition to the university.



## James R. Macdonald Laboratory

The James R. Macdonald Laboratory focuses on atomic, molecular and optical physics and is supported by \$2.5 million each year from the Department of Energy. U.S. News and World Report has ranked the atomic, molecular and optical physics program, which includes the Macdonald Laboratory, as the 13th best in the nation.

Some of the affiliated researchers include:

**Itzik Ben-Itzhak**, university distinguished professor and director of the Macdonald Laboratory

Research funding: Department of Energy, National Science Foundation, U.S.-Israel Binational Science Foundation

Ben-Itzhak is overseeing the installation of a major new laser system, funded by a \$1.3 million Department of Energy grant. He studies the interaction of intense ultrashort laser pulses with molecular ions. He was part of the team to recently show that double ionization events occur earlier than thought — a key factor to improving knowledge of correlated electron dynamics.

**Chii-Dong Lin**, university distinguished professor and associate director for theoretical research at the Macdonald Laboratory

Research funding: Department of Energy, National Science Foundation

Lin's research focuses on attosecond physics and new light generation. He studies basic scientific issues behind the development of technology for the detection and use of ultrafast light pulses. Lin recently helped develop a technique to capture the first image of two atoms bonding to form a molecule. The accomplishment can help scientists control chemical reactions at a molecular level.

**Brett Esry**, university distinguished professor and associate director for research at the Macdonald Laboratory

Research funding: Department of Energy, National Science Foundation, Air Force Office of Scientific Research, U.S.-Israel Binational Science Foundation

Esry studies ultracold three-body collisions and intense laser-matter interactions. He led the team that recently discovered a new quantum state in which three atoms stay together even though the atoms try to repel each other and break the connection. The discovery may help scientists better understand matter and its composition.

Esry also studies the basic scientific principles that can help scientists control chemical reactions at the quantum mechanical level.

**Matthias Kling**, assistant professor

Research Funding: Department of Energy

Kling recently received a \$750,000 Early Career Research Program Award to explore controlling and tracing of electrons in nanosystems — the first step to improving electronics and communication technology. This research was enabled by his work on steering electrons in molecules, for which he was awarded the Nernst-Haber-Bodenstein Prize of the German Bunsen Society in 2012.

**Carlos Trallero**, assistant professor

Research Funding: Department of Energy, National Science Foundation, Air Force Office of Scientific Research

Trallero researches strong field molecular spectroscopy, higher-order harmonic generation, attosecond physics and coherent quantum control. He recently was awarded two instrumentation grants: a nearly \$1 million National Science Foundation Major Research Instrumentation grant and nearly \$200,000 from an Air Force Office of Scientific Research Defense University Instrumentation Program grant for the acquisition of a high intensity tunable femtosecond laser.



## High Energy Physics Group

Researchers with the high energy physics group are involved with multiple international projects, including the Compact Muon Solenoid, or CMS, experiment at the European Center for Nuclear Research, known as CERN; the D-Zero Experiment at Fermilab; the Double Chooz neutrino detector in France; and the KamLAND neutrino detector in Japan.

Some of the affiliated researchers include:

**Glenn Horton-Smith**, associate professor and principal investigator of the high energy physics group

Research funding: Department of Energy

Horton-Smith is collaborating on international research with the Double Chooz neutrino detector in France. He has also been involved in international research at the KamLAND neutrino detector in Japan and contributed to the discovery that nearly half of the Earth's heat comes from the radioactive decay of materials inside.

**Tim Bolton**, professor and principal investigator of the high energy physics group from 2002 to 2012

Research funding: Department of Energy, National Science Foundation, Fermilab

Bolton helped analyze data collected by the Large Hadron Collider's Compact Muon Solenoid experiment and was part of the recent finding of evidence for the Higgs particle. His current research has shifted to neutrino physics utilizing the new liquid argon time projection chamber technology at Fermilab. Bolton is taking on an assignment with the Department of Energy's Office of Science from 2012 to 2014.

**Andrew Ivanov**, assistant professor

Research funding: National Science Foundation

Ivanov works on the Compact Muon Solenoid experiment and was part of the recent finding of evidence for the Higgs particle. His work is supported by a K-STAR National Science Foundation EPSCoR First Award and a Fermilab LHC Physics Center Fellowship.

**Yurii Maravin**, associate professor

Research funding: Department of Energy, National Science Foundation

Maravin is serving a two-year appointment to the physics leadership team of the Compact Muon Solenoid experiment and was part of the recent finding of evidence for the Higgs particle. Maravin co-leads a team of international physicists who ensure that the Compact Muon Solenoid detector and its complex reconstruction software programs provide the best possible measurements of photons, electrons and positrons.

## University Distinguished Professors

Kansas State University has chosen four faculty members as the newest university distinguished professors, a lifetime title that is the highest honor the university bestows on its faculty.



**Christer Aakeroy**, university distinguished professor of chemistry

**Number of publications:** More than 120

**Total research funding:** More than \$3.5 million in individual and collaborative grants

**Funding organizations:** National Science Foundation, the National Institutes of Health, the Department of Defense and

industrial collaborators

**Recent research:** Aakeroy's team recently signed a collaborative research agreement with Syngenta, a world-leading agribusiness. The research aims to develop more efficient and environmentally benign pesticides and herbicides. His work with molecular capsules has achieved international recognition. Long term, these capsules are intended as microscopic delivery vehicles for drugs, where the release of the drug can be initiated and controlled using external stimuli.



**Itzik Ben-Itzhak**, university distinguished professor of physics

**Number of publications:** More than 130

**Total research funding:** More than \$9.8 million in individual and collaborative grants

**Funding organizations:** Department of Energy, the National Science Foundation and the U.S.-Israel Binational Science Foundation

**Recent research:** Ben-Itzhak's collaborative research has recently provided clear experimental and theoretical evidence for the dissociation of hydrogen molecular ions seemingly without absorbing any photons from the strong laser field. This knowledge allows the team to control this process by changing the laser-pulse bandwidth or by chirping the pulse — that is, increasing or decreasing the laser frequency with time during the pulse.



**Susan Brown**, university distinguished professor of biology

**Number of publications:** More than 95

**Total research funding:** More than \$18 million in individual and collaborative grants

**Funding organizations:** Department of Agriculture, National Science Foundation, National Institutes of Health and the Human

Frontiers Science Program

**Recent research:** Brown's current studies include comparative analysis of the genomes of several beetles related to *Tribolium*. She also studies early embryonic patterning and segmentation mechanisms in *Tribolium*. In recent publications, Brown's group describes patterning and segmentation mechanisms in the beetle that are very similar to those used by vertebrates. This makes the beetle a model organism to understand how segments are produced one at a time.



**Ruth Welti**, university distinguished professor of biology

**Number of publications:** More than 100

**Total research funding:** More than \$9.4 million in individual and collaborative grants

**Funding organizations:** National Science Foundation, the National Institutes of Health and other organizations

**Recent research:** Welti recently received a \$440,000 National Science Foundation grant to purchase the most advanced mass spectrometer, which will be used for identification and quantification of lipids. The research aims to increase understanding of plant responses to heat and cold, plant infection by pathogens, and the development of plants and seeds.

— Jennifer Tidball