vol. 3, no. 6 UVic knowlEDGE Research and discovery at the University of Victoria

A particular pursuit

Helping create a huge particle detector

by Margaret Milne

The gleaming metal cylinders surrounding Dr. Michel Lefebvre represent more than five years of creativity and painstaking work by UVic scientists and technicians. With these devices, and the larger project of which they are a part, Lefebvre and his particle physicist colleagues hope to discover such secrets of the universe as why things have mass.

The fact that things have mass is a part of our everyday existence. "But where does the mass of an electron come from?" asks Lefebvre. "It's a very fundamental question." Physicists suspect that particles have mass because of something called the Higgs field. The whole universe is filled with this field, the theory goes, and particles interact with the field to gain their mass.

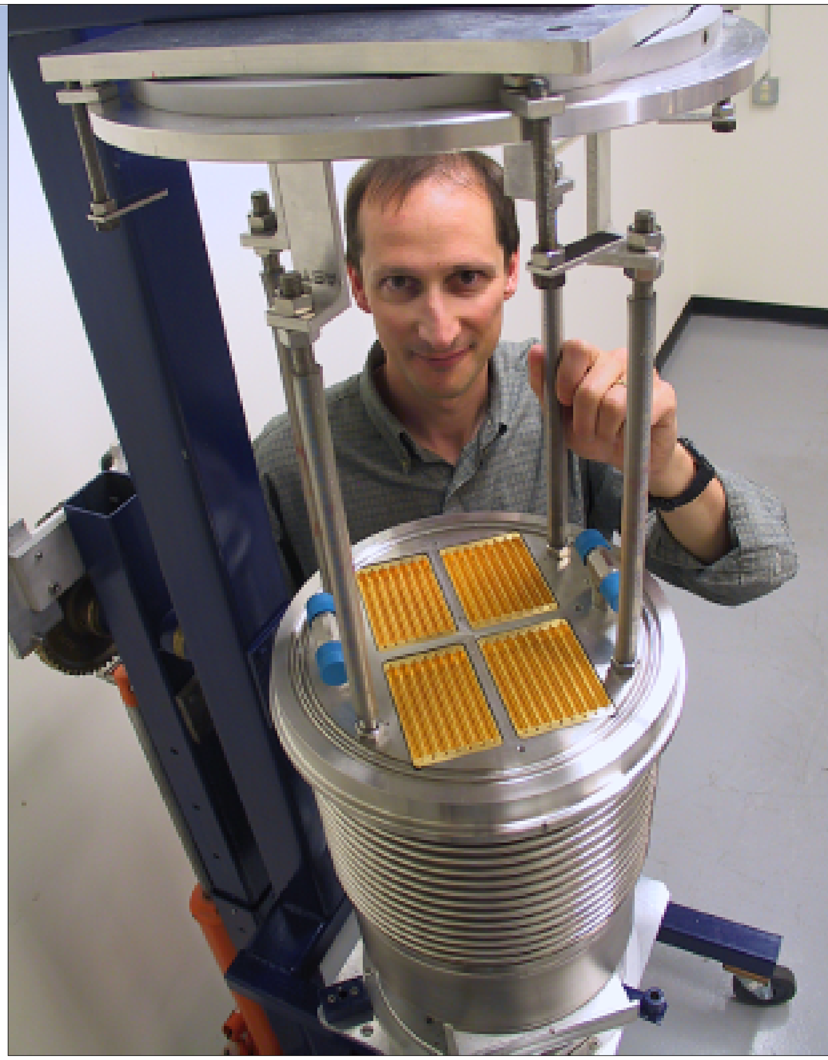
"The Higgs field has a smoking gun," says Lefebvre, "the Higgs particle." If the Higgs field really exists, some kind of Higgs particle must also exist. Finding this particle would prove the whole theory true. So far, no one has found the Higgs particle, but particle physicists are betting that the Large Hadron Collider (LHC) will change all that.

The LHC is a 27km-long ring, buried 100m underground at the CERN Laboratory in Geneva, Switzerland. It whirls beams of protons around its circle, accelerating them to close to the speed of light. When the beams collide, "pure energy freezes out into matter," says Lefebvre. "New particles fly out, and we measure them." The LHC will be able to create higher energies, and so heavier particles, than any experiment before it. It's predicted that the Higgs particle could be found in the results of its collisions.

Building the LHC is a massive undertaking, involving scientists from more than 35 countries. One of Canada's main contributions is work on ATLAS, a detector that will measure the particles created in the collisions. Canada is in charge of building calorimeters, devices that determine the energy of particles.

Since founding the ATLAS Canada collaboration in 1992, the Victoria group has grown to over 20 scientists: students, research associates, technicians and professors. One of their current projects, funded by the Natural Sciences and Engineering Research Council, is building 55 signal feedthroughs. "These are devices that allow signals to go from inside the calorimeter to the outside world," Lefebvre explains. The calorimeters used at ATLAS operate at temperatures around –180 °C. To design an electrical device that works with one end this cold and the other end at room temperature, the UVic researchers spent many years constructing and testing prototype feedthroughs. They also collaborated with experts from other institutions, including TRIUMF — Canada's national laboratory for particle and nuclear physics in Vancouver — and Brookhaven National Laboratories in New York. "Big science like ATLAS is very much a collaborative effort," says Lefebvre.

Lefebvre has recently returned from a trip to Geneva where he saw a sample signal feedthrough being prepared for installation. "More feedthroughs will be shipped to CERN in the coming months," he says, "and members of our team will go to CERN this fall to test them." The last of the signal feedthroughs should be completed by December, and the Victoria collaboration is planning a celebration to mark the milestone.



Darren Stone photo

Lefebvre with one of the signal feedthroughs.

facts from the EDGE

- The LHC will be able to collide not only protons, but heavier particles like gold ions as well. Scientists hope that these collisions will produce a strange form of matter known as a quark gluon plasma, thought to exist only in the cores of the densest stars. Being able to create it on earth would let scientists study how nature behaves under extreme conditions.
- Researchers would also like to know why the universe is made up of matter. Originally, matter and antimatter were created in equal amounts in the universe. When matter and antimatter met, they annihilated each other. The fact that anything remains today means that matter must be subtly different from antimatter. Scientists hope to understand this difference by comparing how matter and antimatter behave after being created in the LHC.

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- The LHC and the ATLAS detector projects are driven by human curiosity about the nature of the universe. They will allow scientists to probe the fabric of nature down to sizes as small as 0.0000000000000000001 metre, revealing features dominant only a millionth of a millionth of a second after the creation of the universe.
- Few components of the LHC and ATLAS detector are available "off the shelf." Most require years of intensive R&D, providing unique training opportunities and sometimes unforeseen practical applications. One component of the UVic feedthrough project may soon be used in the development of a medical physics particle detector.
- A wealth of information about the work of the UVic ATLAS group is available on their Web site: **particle.phys.uvic.ca/~web-atlas/atlas/**

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