

Gift Arrives at CSU in Forty Foot Shipping Containers

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Colleagues at CSU are busy unpacking a very large gift that arrived in two forty-foot shipping containers in early January. What kind of gift could possibly come in such large packages? An electron linear accelerator and all of its many peripherals of course!

The University of Twente in the Netherlands, a collaborator with several researchers here on campus, graciously donated CSU a 6-MeV electron linear accelerator (“linac”) used for research. Accelerators and their applications are not a new phenomenon at CSU in terms of research. The School of Veterinary Medicine operates an accelerator for both cancer therapy as well as irradiating materials for members of the Environmental and Radiological Health Sciences Department. There are also many other “users” of off-campus accelerators, for example, the high-energy physics researchers in the Department of Physics. This donation adds to the suite of equipment and expertise in the field of charged particle beams.

Professors Sandra Biedron and Stephen Milton are the leads in the build-up of the linac. They arrived at CSU in early 2011 after having worked for nearly twenty years at Argonne National Laboratory. While over the last four years at Argonne, they split their time between accelerator research at Argonne and building an accelerator-based laser system – a “free-electron laser - FEL” at Sincrotrone Trieste in Italy. This FEL is now operating as a user facility, providing variable wavelengths of laser light to users in many fields. Professors Beidron and Milton currently head a research program in accelerator and beam engineering in the Department of Electrical and Computer Engineering (ECE). Presently their group consists of a senior research scientist in ECE, a visiting research associate from the University of Twente, as well as seven graduate students and five undergraduates. They also align closely with other members of ECE including Mario Marconi, Carmen Menoni, Jorge Rocca as well as Thomas Johnson and Alexander Brandl in Environmental and Radiological Health Sciences in the Vet School. Biedron points out that “...beam research is highly multi-disciplinary and involves many subsystems – lasers, optics, pulsed power, microwave devices, magnets, vacuums, radiation safety, controls, interlocks, to name a few – so collaboration is important.” *(continued on page 3)*



Figure 1. Cargo Truck with Gift



Figure 2. Accelerator and Components in the Warehouse



Figure 3. Linear Accelerator



Figure 4. Assembled Instrument



Advanced Beam Laboratory Timeline (Abbreviated) Nov. 2012 Fence off Construction Yard- Begin Site Preparation Jan. 2013 Walls Go Up July 2013 Building Ready for Move in.

Searching for Physics' Most Elusive Particle

According to CNN online news: Last summer, physicists announced that they had identified a particle with characteristics of the elusive Higgs boson, the so called "God particle." But, as often the case with science, they needed to do more research to be certain. On Thursday March 14th, scientists announced that the particle, detected at the Large Hadron Collider, the world's most powerful particle smasher, looks even more like the Higgs boson. The news came at the Moriond Conference in La Thuile, Italy, from scientists at the Large Hadron Collider's ATLAS and Compact Muon Solenoid experiments. These two detectors are looking for unusual particles that slip into existence when subatomic particles crash into one another at high energies. "The preliminary results with the full 2012 data set are magnificent and to me it is clear that we are dealing with a Higgs boson though we still have a long way to go to know what kind of Higgs boson it is," Joe Incandela, spokesperson for the Compact Muon Solenoid experiment, said in a statement.

Scientists have analyzed two and a half times more data than they had when they first announced the Higgs boson results last July 4. The Higgs boson is associated with the reason that everything in the universe- from humans to planets to galaxies- have mass. The particle is a component of something called the Higgs field, which permeates our universe. It is not a perfect analogy, but Brain Greene, theoretical physicist at Columbia University and "NOVA" host, offered this comparison..."You can think of it as a kind of molasses-like bath that's invisible, but yet we are all immersed within it...and as particles like electrons try to move through the molasses-like bath, they experience a resistance. And that resistance is what we, in our big everyday world, think of as the mass of the electron."

The electron would have no mass if it were not for this "substance," the field made of Higgs particles. So without the Higgs boson, we would not be here at all.

Having evidence that the Higgs boson really exists is important for the current understanding of how the universe works.

The RCO asked Dr. Norman Buchanan, Assistant Professor in the Department of Physics at CSU, what this recent discovery means?

"While the recent (almost certain) discovery of the Higgs boson is very exciting, and newsworthy, it wasn't unexpected. Based on the way matter behaves at energies reminiscent of the early universe and at the much lower energies we live in, physicists have known for some time that a mechanism like the Higgs mechanism must exist. The importance of the discovery is that it validates that at some level the universe functions in a manner that is now understood. As a particle physicist the aspects of the discovery I am most interested in are the properties of the Higgs boson that might hint at new, unexpected, physics. The latest results coming from the LHC experiments



seem to show a picture of the Higgs that is consistent with what is predicted by the well tested Standard Model of Particle Physics. For example, the mass and spin of the particle have values that we would predict for the Higgs boson. As more data is collected scientists will be able to carefully examine other features such as the way the Higgs decays into lighter particles. Deviations from expected behavior are an exciting prospect.

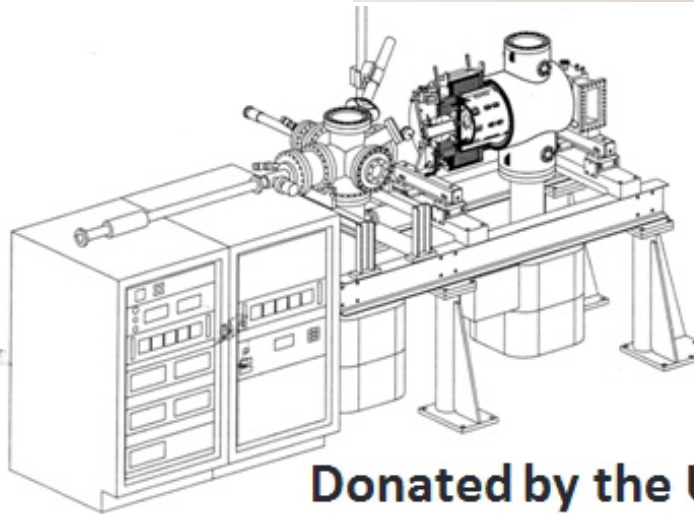
So, where do we go now that the Higgs appears to have been found? The Higgs boson tells us how the particles making up the things around us obtain their mass but it doesn't tell us why their masses are what they are. Why is an electron 200 times lighter than one of its closest relatives, the muon? There are other unanswered questions as well. Why can matter be categorized into three generations? What is dark matter? Is it something that we already know about or something new and exotic? Studying the Higgs in an experimental environment might point us in the right direction but we need to move beyond the Standard Model to answer these questions. Physicists already know that the Standard Model, while an excellent predictor of particle physics processes, is broken and incomplete. A particle called the neutrino was recently, within the past two decades, found to have mass even though the Standard Model predicted it would have none. This discovery was the first direct evidence that the Standard Model was not completely correct. Physicists, both theoretical and experimental, will now focus on discovering a more complete model of matter and matter interactions.

The road to discovering the Higgs has been an exciting theoretical and experimental journey involving tens of thousands of scientists, engineers, and many other people from across the globe. While we may never directly use a beam of Higgs bosons to transmit information, heat our homes, or cure disease, the technology associated with the discovery already does. From unimaginably powerful super conducting magnets to global computer networks to novel semiconducting devices the technologies associated with high-energy physics touch all of our lives in one way or another. Pursuing fundamental science at this level requires tremendous innovation and the benefits go well beyond even the most exciting discovery, like the Higgs boson."

The New CSU Accelerator (continued)

Biedron and Milton and many of the above CSU researchers are working with Twente's lead collaborator, Peter van der Slot, on a number of research initiatives, such as generating Terahertz radiation, compact light sources, high-gradient acceleration, and seeding schemes for next-generation light sources. "We are looking forward to expanding our partnership with our colleagues at CSU with the unique linear accelerator test bed tool," said van der Slot. "This test bed will enable the types of research necessary to move particle accelerators to the next generation."

Assembly has begun by sorting through equipment and starting to do necessary component checks with plans to have the system operational within a year. Component tests will be completed prior to assembling the system in the accelerator vault in the new building (ABL) being constructed at the Foothills campus. The Advanced Beam Laboratory will house not only the accelerator but also two high-power lasers. The building is set for completion in the summer 2013. The accelerator portion of the building will house the vault/accelerator, a control



Donated by the Univ. of Twente

The CSU Accelerator Laboratory

- 6 MeV photocathode linac system with state-of-the-art drive laser
- Capable of delivering pulse trains at 81.25 MHz over 10 microseconds

Will be used for

- Basic beam research and diagnostic development
- Training
- Small, relatively high average power THz FEL
- Other, as yet undisclosed, research projects

Purpose-Built Building

- Ready for move in 31 July 2012

room, a laser room, and an area for control racks and the microwave systems. The team is hoping to generate its first beam in early spring 2014 pending all of the proper safety procedures and approvals.

What's new in Health Physics

Conferences/Workshops

The Society for Radiological Protection (SRP) 50th Annual Conference
Harrogate, England
May 21-23, 2013

[more info >>>](#)

Canadian Radiation Protection Association (CRPA) Annual Conference
Sherbrooke, Quebec, Canada
May 26-30, 2013

[more info >>>](#)

Harvard School of Public Health In-Place Filter Testing Workshop
Boston, MA
August 19-23, 2013

[more info >>>](#)

Radiation Do's and Don'ts

Radioactive Material Labels

All Radioactive Material labels and symbols must be completely obliterated from vials or containers before they are placed in a short half-life waste pail and disposed of through the CSU waste stream. The RCO recommends keeping a thick heavy duty permanent marker and a pair of scissors in the waste area so labels can be immediately obliterated before they go into the waste pails. The word "Radioactive" and the trefoil symbol must be completely blacked out so it is not recognizable. If you have any questions or concerns about labels please do not hesitate to contact our office.

