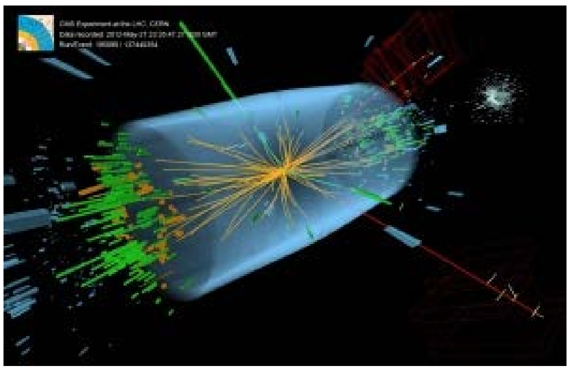
ILC NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

FEATURE



The future of Higgs physics

by Joykrit Mitra

The Large Hadron Collider, the collider that helped find the Higgs particle, will resume operations again in a few months. Scientists will dig deeper into the properties of the Higgs particle. How can the ILC help? By studying how it couples to light particles, for example, and measuring its lifetime, say theorists.

AROUND THE WORLD

Green ILC: towards sustainable colliders

by Barbara Warmbein

Smashing particles together at high energies is power-consuming business. People around the world are discussing to see if the ILC could be made green in the hope to finally reach complete sustainability. More efficient klystrons and cryocoolers, recovering and recycling heat wastes, embedding renewable energies and storage technologies are some of the main issues. The ILC could bring back high-energy physics to one of its core businesses: energy.

DIRECTOR'S CORNER

Voice your dream for the ILC!

by Lyn Evans

The ILC may be the first science project in the world that gets approval by video message. But only if there are enough of them, says LCC Director Lyn Evans. Everybody is invited to share his and her enthusiasm for the project.

IN THE NEWS

from *Kahoku Shinpo*
29 Oct 2014
誘致 先端施設、共存モデルに
の東北誘致を目指す産学官組織、東北 推進協議会は 日、仙台市青葉区のウェスティンホテル仙台で、 計画とまちづくりなどに関する講演会を開いた。(A lecture about ILC and urban development was held on 28 October in Sendai by Tohoku Conference fro the Promotion of the ILC, an organisation aims to realise the ILC in Tohoku area.)

from *Iwate Nippo*
24 October 2014
本県の未来描く意見次々 盛岡・見前南中でILC授業
On October 22 in Nishimirumae Middle School of Morioka City, the Iwate Nippo newspaper company held the first of a series of fall ILC special classes for middle school students in Iwate prefecture. The lecturers were reporters, Iwate Nippo`s ILC correspondents, and talked to 136 third-year students about the increased importance of learning foreign languages and what kind of job opportunities would be brought about. The students then split into groups and discussed. A sample of opinions: “Shouldn`t there be an exhibition building to introduce the ILC?” “Iwate becoming more prosperous is a good thing, but I also want the government to remain devoted to recovery from the tsunami.” “I want to show the good points of Japan to the world.” “I want to become a teacher when I grow up and get my students interested in science.”
Last spring the newspaper gave ILC classes for 8 schools and 1244 students.

from *CERN Bulletin*
20 October 2014
Mystery photos from CERN’s history
However, many albums are still in need of titles, the names of the people in the photos, descriptions of equipment, etc., and we believe that much of this information could be crowd-sourced from the CERN community.

from *SLAC*
1 October 2014
Martin L. Perl, Winner of 1995 Nobel Prize for Discovery of Tau Lepton, Dead at 87
Martin L. Perl, a professor emeritus of physics at Stanford University and SLAC National Accelerator Laboratory and winner of the 1995 Nobel Prize in physics for discovery of the tau lepton, died Sept. 30 at Stanford Hospital in Palo Alto at the age of 87.

CALENDAR

Upcoming events

The 11th ICFA Seminar on Future Perspectives in High-Energy Physics 2014
IHEP, Beijing, China
27- 30 October 2014

Upcoming schools

The Second Asia-Europe-Pacific School of High-Energy Physics
Puri, India
04- 17 November 2014

Joint International Accelerator School: Beam Loss and Accelerator Protection
Newport Beach, California, USA
05- 14 November 2014

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1410.7500
A natural Little Hierarchy for SUSY from radiative breaking of PQ symmetry

1410.7345
Non-Custodial Warped Extra Dimensions at the LHC?

1410.7331
Dark Matter, Parallel Universe and Multiple Higgs Signals at the ILC

1410.4824
Exploring CP Violation in the MSSM

1410.4505
Modern Particle Physics Event Generation with WHIZARD

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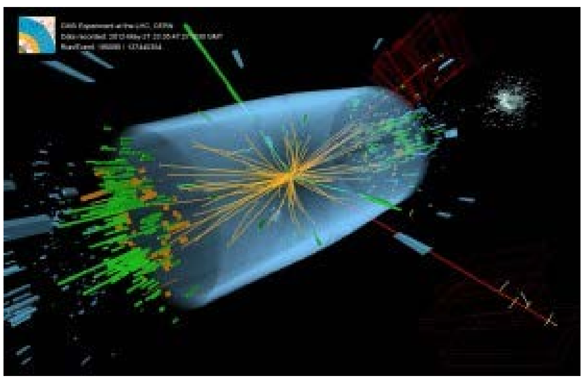
FEATURE

The future of Higgs physics

Joykrit Mitra | 30 October 2014



Event recorded with the CMS detector in 2012 at a proton-proton centre of mass energy of 8 TeV. The event shows characteristics expected from the decay of the SM Higgs boson to a pair of photons (dashed yellow lines and green towers). Image: L. Taylor, CMS collaboration /CERN

In 2012, the ATLAS and CMS experiments at CERN's Large Hadron Collider announced the discovery of the Higgs boson. The Higgs was expected to be the final piece of the particular jigsaw that is the Standard Model of particle physics, and its discovery was a monumental event.

But more precise studies of it are needed than the LHC is able to provide. That is why, years earlier, a machine like the International Linear Collider had been envisioned as a Higgs factory, and the Higgs discovery set the stage for its possible construction.

Over the years, instruments for probing the universe have become more sophisticated. More refined data has hinted that aspects of the Standard Model are incomplete. If built, a machine such as the ILC will help reveal how wide a gulf there is between the universe and our understanding of it by probing the Higgs to unprecedented levels. And perhaps, as some physicists think, it will uproot the Standard Model and make way for an entirely new physics.

In the textbook version, the Higgs boson is a single particle, and its alleged progenitor, the mysterious Higgs field that pervades every point in the universe, is a single field. But this theory is still to be tested.

"We don't know whether the Higgs field is one field or many fields," said Michael Peskin of SLAC's Theoretical Physics Group. "We're just now scratching the surface at the LHC."

The LHC collides proton beams together, and the collision environment is not a clean one. Protons are made up of quarks and gluons, and in an LHC collision it's really these many component parts – not the larger proton – that interact. During a collision, there are simply too many components in the mix to determine the initial energies of each one. Without knowing them, it's not possible to precisely calculate properties of the particles generated from the collision. Furthermore, Higgs events at the LHC are exceptionally rare, and there is so much background that the amount of data that scientists have to sift through to glean information on the Higgs is astronomical.

"There are many ways to produce an event that looks like the Higgs at the LHC," Peskin said. "Lots of other things happen that look exactly like what you're trying to find."

The ILC, on the other hand, would collide electrons and positrons, which are themselves fundamental particles. They have no component parts. Scientists would know their precise initial energy states and there will be significantly fewer distractions from the measurement standpoint. The ILC is designed to be able to accelerate particle beams up to energies of 250 billion electronvolts, extendable eventually to 500 billion electronvolts. The higher the particles' energies, the larger will be the number of Higgs events. It's the best possible scenario to probe the Higgs.

If the ILC is built, physicists will first want to test whether the Higgs particle discovered at the LHC indeed has the properties predicted by the Standard Model. To do this, they plan to study Higgs couplings with known subatomic particles. The higher a particle's mass, the proportionally stronger its coupling ought to be with the Higgs boson. The ILC will be sensitive enough to detect and accurately measure Higgs couplings with light particles, for instance with charm quarks. Such a coupling can be detected at the LHC in principle but is very difficult to measure accurately.

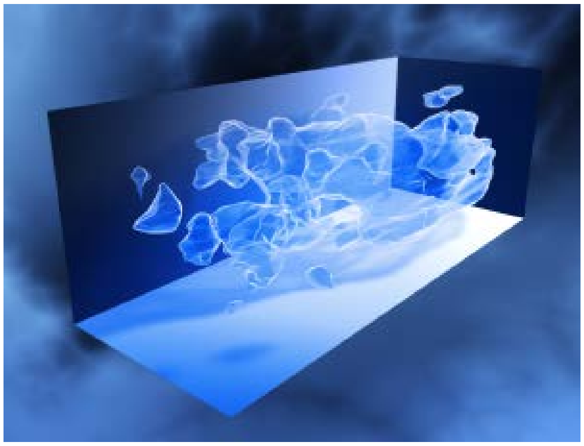
The ILC can also help measure the exact lifetime of the Higgs boson. The more particles the Higgs couples to, the faster it decays and disappears. A difference between the measured lifetime and the projected lifetime—calculated from the Standard Model—could reveal what fraction of possible particles—or the Higgs' interactions with them— we've actually discovered.

"Maybe the Higgs interacts with something new that is very hard to detect at a hadron collider, for example if it cannot be observed directly, like neutrinos," speculated John Campbell of Fermilab's Theoretical Physics Department.

These investigations could yield some surprises. Unexpected vagaries in measurement could point to yet undiscovered particles, which in turn would indicate that the Standard Model is incomplete. The Standard Model also has predictions for the coupling between two Higgs bosons, and physicists hope to study this as well to check if there are indeed multiple kinds of Higgs particles.

"It could be that the Higgs boson is only a part of the story, and it has explained what's happened at colliders so far," Campbell said. "The self-coupling of the Higgs is there in the Standard Model to make it self-consistent. If not the Higgs, then some other thing has to play that role that self-couplings play in the model. Other explanations could also provide dark matter candidates, but it's all speculation at this point."

The Standard Model has been very self-consistent so far, but some physicists think it isn't entirely valid. It ignores the universe's accelerating expansion caused by dark energy, as well as the mysterious dark matter that still allows matter to clump together and galaxies to form. There is speculation about the existence of undiscovered mediator particles that might be exchanged between dark matter and the Higgs field. The Higgs particle could be a likely gateway to this unknown physics.



3D plot showing how dark matter distribution in our universe has grown clumpier over time. (Image: NASA, ESA, R. Massey from California Institute of Technology)

With the LHC set to be operational again next year, an optimistic possibility is that a new particle or two might be dredged out from trillions of collision events in the near future. If built, the ILC would be able to build on such discoveries, just as in case of the Higgs boson, and provide a platform for more precise investigation.

The collaboration between a hadron collider like the LHC and an electron-positron collider of the scale of the ILC could uncover new territories to be explored and help map them with precision, making particle physics that much richer.

HIGGS | ILC | LHC

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AROUND THE WORLD

Green ILC: towards sustainable colliders

Barbara Warmbein | 30 October 2014

Image of future Green ILC centre: courtesy of GRID4EU

When planning a new research lab, an important step is to see how others have done similar things in the past and learn from their experiences. The ILC, with its many contributors from research labs all over the world, has this step firmly embedded in its planning procedure. But planning a new research lab also means you've got a chance to do things differently. A small collaboration is starting to form that is looking at ways of making the ILC green from the very start.

The "green ILC" movement started two years ago at a workshop on energy for sustainable science at CERN, which covered all areas related to energy in research, from data servers and infrastructure to accelerators. Leading by example, the European Spallation Source ESS in Sweden, for which construction has just started, will be the world's first sustainable research facility. Can the ILC follow suit?

The electricity consumption of the ILC will be everything but negligible. The ILC is certainly the less "energy hungry" of all future projects thanks, in particular, to its superconducting radiofrequency (RF) technology. However with 164 megawatts of peak power its consumption will be similar to CERN running the Large Hadron Collider, which in turn roughly equals the consumption of half of the 500,000 residents in the canton of Geneva. At the same time, the total beam power for the ILC's e+e- collisions amounts to some 10 megawatts, leading to an overall efficiency of six percent – a lot of energy is lost in wasted heat from RF, powering the cooling plants or normal conducting magnets and in the beam dumps. "We increase the fundamental knowledge of mankind, but we waste a lot of energy doing that," says Denis Perret-Gallix of IN2P3/CNRS, France. "I think we have a role to play in society, so let's tackle the important aspect of the environment from the very beginning." It might also mean substantial savings in the running costs.

The approach is to recycle and recover as much as possible of the energy that you can't save in the first place. Klystrons, the accelerator's pulse, currently operate at an efficiency of 60 percent in the best case; but "it might be possible to get them up to 80 percent if current R&D succeeds," reports Hitoshi Hayano of KEK, Japan. This would mean a big dent in the power wasted in operations.

The beam energy in the beam dumps could be recovered and used not only to heat buildings or, more ingeniously, to cool equipment but, by vaporising liquid nitrogen, could produce electricity again.

But the prime interest in liquid nitrogen is that it can be used as a pre-cooling for the cryogenics, which could save a lot of power, even if safety and more complex operation issues should be addressed. "We could even produce it ourselves with the resources we have in Iwate – wind energy, geothermal energy, marine energy – and then retrieve this energy when needed," suggests Takayuki Saeki from KEK.

Another possibility for the beam dumps currently being studied is to decelerate the beams through the formation of a wakefield in a gas plasma chamber. The microwaves produced by the exited plasma could then be recycled as electricity.

The group also proposes to build an energy centre on campus which would make sure the power is used well and innovations are put forward to society fast and efficiently by working hand in hand with power companies.

After the 2011 earthquake and tsunami and the Fukushima power plant accident, energy is a topic of concern in Japan, and the Japanese “Advanced Accelerator Association promoting science & technology” (AAA) decided to create a Green-ILC Working Group, which met in February this year. In fact sustainability is a topic that concerns all future colliders, from ILC and CLIC to the Chinese CepC-SppS project and the Future Circular Colliders discussed at CERN, so that during the recent LCWS14 workshop in Belgrade the future projects got together in a joint meeting to discuss sustainability options. The first starting point is a joint model of how energy is consumed in a collider so that projects can be compared accurately, which does not exist yet. “A greener ILC is just the first step towards sustainability” predicts Atsuto Suzuki, Director general of KEK. In order to make progress in fundamental science, projects need a lot of energy. But maybe in the long run this research can lead to progress in energy production and consumption as well.

Leading by example: ESS

The European Spallation Source ESS (europeanspallationsource.se) employs the “4R” strategy to make the facility as sustainable as possible. The four Rs stand for Responsible, Renewable, Recyclable and Reliable. Responsible refers to the power consumption, which will be monitored to stay below 270 GWh per year; renewable refers to the kinds of energy sources, which must all be renewable (for example wind energy) while being cost-competitive at the same time, and recyclable means that any surplus heat produced in the facility should be recycled, for example by replacing cooling towers with a cooling system that is based on heat recycling. Finally, all critical equipment like the cooling and power systems must be operated in a Reliable way to secure the facility’s operational availability for the researchers.

ESS | GREEN ILC | POWER CONSUMPTION | SUSTAINABILITY | TOHOKU

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DIRECTOR'S CORNER

Voice your dream for the ILC!

Lyn Evans | 30 October 2014

As you probably know, the International Linear Collider is under discussion in Japan. Expert panels are evaluating whether Japan should host the project. The panel is seeking compelling and articulate arguments to justify a project of this scale. Of course, the scientific case and technical and social value of the ILC are important, however, the most important factor is the passion of the scientists who wish to realise the ILC.

We, the Linear Collider Collaboration, are actively reaching out to our collaborators and supporters to participate in a #mylinearcollider video campaign. It is be a series of short, informal videos that will be shared with the relevant committees and organizations in Japan that are overseeing the evaluation process.

This is a chance to show your support and passion. If you¹ve always dreamed of realising the ILC, this is the time to share those dreams and help the ILC project come to fruition. Share your feelings on why the ILC matters to you and to particle physics. Share the anticipation with which you have waited for the realisation of the ILC.

Your voice matters, because you are the one who moves this project forward. Details about the campaign and how to participate can be found here.

Your message really makes difference. Participate in a #mylinearcollider video campaign, and ask your colleagues and friends to join, too. Let¹s realize the ILC together!

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