ilc newsline

 6 SEPTEMBER 2012

IMAGE OF THE WEEK

I found the Higgs!

by Rika Takahashi

Two little visitors at show off the souvenirs they received at KEK's open house, held on Sunday, 2 September. The girl on the right was very happy to find a "Higgs" in her toy capsule given away at the ILC exhibit. Visitor numbers have increased dramatically from last year's open house, probably due to a special kind of Higgs mechanism that attracts the general public to particle physics.

LCPEDIA

Beam bunch

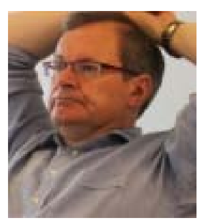
by Daisy Yuhas

Particles in a collider aren't necessarily evenly dispersed along the beam path. Instead they're often clumped together in bunches with space in between. The series of bunches are sometimes called a bunch train, a pulse, or simply 'the beam'.

DIRECTOR'S CORNER

Updating the European Strategy for Particle Physics

by Barry Barish



The particle physics communities worldwide are undertaking strategic planning processes that will set out the course of the field for the coming years. Recent science results, such as the discovery of the Higgs-like particle and the measurement of a relatively large value of theta13, open up exciting future possibilities. In Europe, the process of developing an update to the European Strategy for Particle Physics is under way. The next major step will be an open symposium in Krakow, Poland, from 10 to 12 September, for which a set of linear-collider input documents has been submitted.

FEATURE

From CERN Courier: ECLOUD12 sheds light on electron clouds

A recent workshop reviewed the latest experiences with the phenomenon of electron clouds at the LHC and other accelerators. Electron clouds – abundantly generated in accelerator vacuum chambers by residual-gas ionization, photoemission and secondary emission – can affect the operation and performance of hadron and lepton accelerators in a variety of ways. They can induce increases in vacuum pressure, beam instabilities, beam losses, emittance growth, reductions in the beam lifetime or additional heat loads on a (cold) chamber wall.

IN THE NEWS

from ***ANSA***
5 September 2012
Le future 'fabbriche di Higgs'
Ecco i progetti degli acceleratori che verranno dopo l'Lhc (google translation)

from ***diregiovani.it***
5 September 2012
Il bosone di Higgs si produrrà in fabbrica
ROMA – Produrre bosoni di Higgs: per questo in futuro bisognerà impiantare delle vere e proprie fabbriche. Questa filiera produttiva avrà lo scopo di produrre Bosoni per studiare le caratteristiche di queste particelle.

from ***Wired.it***
4 September 2012
Il futuro della ricerca in fisica dopo il bosone
Soluzione completamente diversa, ma in uno stadio di progettazione molto più avanzato, è quella di un collisore lineare elettroni-positroni, come l' International Linear Collider (Ilc). (google translation)

from ***Physics World***
3 September 2012
Special Report: Japan
The 19-member committee not only recommended that Japan should take a lead in the design for a collider to study the Higgs boson, such as the International Linear Collider, but also that it should lead on plans to build a large-scale neutrino facility to study charge-parity violations in neutrino oscillations.

from ***BBC***
3 September 2012
What is the smallest possible thing in the universe?
Physics has a problem with small things. Or, to be more precise, with infinitely small things.

from ***Discovery News***
31 August 2012
Two pages that sparked Higgs boson hunt
Via the In the Dark blog, we are reminded that today (Aug. 31) is the 48th anniversary of the seminal paper in Physical Review Letters by physicist Peter Higgs ("Broken Symmetries and the Masses of Gauge Bosons"), in which he first mentioned the possibility of a certain boson that now bears his name.

from ***John Adams Institue for Accelerator Science***
31 August 2012
John Adams Institute is expanding
The John Adams Institute for Accelerator Science is expanding, with a new research base at Imperial College London joining two existing centres at Royal Holloway, University of London and the University of Oxford.

from ***Fermilab Today***
30 August 2012
World-record quality factor achieved at Fermilab
This month, Grassellino reported a world-record measurement on a 1.3-gigahertz, single-cell niobium cavity heat-treated in a nitrogen-rich atmosphere.

CALENDAR

UPCOMING EVENTS

6th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging (PIXEL2012)
Inawashiro, Japan
03- 07 September 2012

POSIPOL 2012
DESY, Zeuthen
04- 06 September 2012

XXVI International Linear Accelerator Conference (LINAC 12)

Tel-Aviv, Israel
09- 14 September 2012

CERN Council Open Symposium on European Strategy for Particle Physics
Crakow, Poland
10- 13 September 2012

12th International Workshop on Accelerator Alignment (IWAA 2012)
Fermilab
10- 14 September 2012

CALICE collaboration meeting
Emmanuel College, Cambridge, UK
16- 19 September 2012

5th International Workshop on Top Quark Physics (TOP 2012)
Winchester, UK
16- 21 September 2012

52nd ICFA Advanced Beam Dynamics Workshop on High-Intensity and High-Brightness Hadron Beams
Beijing, China
17- 21 September 2012

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1208.6128
QCD studies and discoveries with e+e- colliders and future perspectives

1208.5759
Project X – a new multi-megawatt proton source at Fermilab

1208.5685
An analysis on the photoproduction of massive gauge bosons at the LHeC

1208.5533
Allowed slepton intergenerational mixing in light of light element abundances

1208.4607
Dark Matter, Baryogenesis and Neutrino Oscillations from Right Handed Neutrinos

ilc newsline

IMAGE OF THE WEEK

I found the Higgs!

Rika Takahashi | 6 September 2012

On 2 September, KEK in Japan held a laboratory open house. About 4600 people visited KEK’s Tsukuba campus, one-and-a-half times as many as last year. Presumably one of the reasons for the pushed-up number of visitors was the discovery of Higgs-like particle at CERN.

At the ILC exhibit, particle badges exclusively designed for the open house were given away as a souvenir. Visitors who called upon three ILC-related exhibits at KEK, namely the Accelerator Test Facility (ATF), Superconducting RF Test Facility (STF) and a poster exhibit at the Kenkyu-Honkan building, were eligible for one turn on a “Gachapon”, or a capsule toy vending machine. Eight badge designs were available: electron and positron, dark matter, top quark, gluon, W boson, Higgs, SUSY Higgs, and ILC.

The machine contained many more electrons and gluons than Higgses, so only the lucky visitors could find the Higgs in their capsules. On top of that, the luckiest eight visitors found a piece of paper in their capules reading “I found a Higgs!?”. They also received a Higgs action figure.

The little girl on the right with big smile was the first winner of the Higgs figure. Her sister got an electron-positron badge.

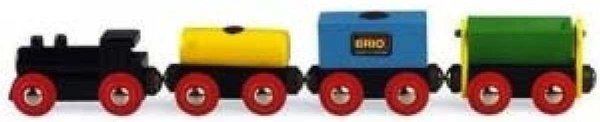
This ILC stamp rally event was also pretty popular among the visitors. Almost the entire stock of 1300 badges disappeared.

HIGGS | ILC | JAPAN | KEK

LCPEDIA

Beam bunch

Daisy Yuhas | 6 September 2012


A real ILC bunch train has 1312 bunches (and no wheels).

Particles in a collider aren't necessarily evenly dispersed along the beam path. Instead they're often clumped together in bunches with space in between. The series of bunches are sometimes called a bunch train, a pulse, or simply 'the beam'.

When particles enter a collider, the source sends them out in bunches. In the ILC, for example, each bunch will contain 20 billion electrons, which then pass through accelerating cavities. Each accelerating cavity has a radio-frequency electromagnetic field that gives particles energy. The field changes over time, creating waves. These electromagnetic waves also maintain particle bunches: just as a surfer finds a 'sweet spot' on an ocean wave, particles group together around the 'sweet spot' of the electromagnetic wave in a cavity. But why bunch particles together at all?

First, having more particles present creates more collisions, and more collisions will provide more information for scientists. Accelerator builders and experimenters work together to determine the ideal number and frequency of beam bunches to facilitate the data taking. "Sometimes experiments want a continuous distribution," says Fermilab scientist Elvin Harms. "But often detectors need some dead time—time to process the results of a collision and re-arm the detector before the next bunches of particles enter the detector and collide."

In addition, the oscillating nature of radio-frequency acceleration generally requires that particles are bunched. An accelerating system has neutral and reverse capabilities, so particles must be clumped together so that they are kept away from these regions. Riding the 'sweet spot' keeps the bunch intact.

An ILC bunch train will consist of 1,312 bunches. The current bunch design of the ILC foresees bunch trains that are a scant five nanometers high and last one millisecond, with a distance of 369 nanoseconds between each bunch, colliding 14,000 times per second.

BEAM | BUNCH | BUNCH TRAIN | LUMINOSITY

DIRECTOR'S CORNER

Updating the European Strategy for Particle Physics

Barry Barish | 6 September 2012


Brian Foster, who masterminded the GDE ILC submission to the European Strategy update.

Strategic planning has become central to organising and prioritising the worldwide programme in particle physics. In Europe, the process of developing an update to the "European Strategy for Particle Physics" is under way, while in Japan, KEK is updating their roadmap and in the US, the Snowmass workshop on the future of the US programme is being organised for next year. The future course of the ILC and, more generally, for a linear collider will be heavily influenced by the results of these planning exercises. As a result, we have put together a set of input documents for the update of the European Strategy open symposium that will take place in Krakow, Poland from 10 to 12 September.

Juan Fuster wrote a Research Director's Report on the coming open meeting in Krakow where he discusses the seven linear collider submissions. Today, I want to emphasise specifically a couple of points that we made in the submission from the Executive Committee (EC) of the GDE, a note that served as a cover letter for the ILC submissions.

At this point in time, we are deep into the process of putting together the final deliverable of the GDE, our design for a 500-GeV electron-positron collider based on superconducting RF technology for the main linac. Our main focus has been to optimise our design for cost, performance and risk of a 500-GeV machine and present it in our *Technical Design Report*. A crucial underlying feature that should not get lost by presenting a specific design for the ILC is the underlying "flexibility" of such a facility.

This importance of flexibility has been emphasised in the cover letter, making the powerful point how a broad programme of important precision measurements related to the Higgs and other phenomena will be possible with the ILC.

Excerpting from this submission, the cover letter states:

> *"A characteristic of linear colliders in general and the ILC in particular is the high degree of flexibility of operation. While the design of the ILC has been optimized for operation at 500 GeV, scanning down to low energies, for example the regime around 200 GeV and upwards which is of interest for the newly discovered Higgs-like object at LHC, is rather straight-forward."*

It goes on to point out the broad flexibility to pursue physics goals beyond the scope of the TDR:

> *"Further flexibility is demonstrated by optional running modes not costed or designed in detail in the TDR but which can clearly be implemented relatively easily given strong user interest and consensus. Such options include electron-electron collisions, operation as a gamma gamma collider and operation at the Z pole with luminosity significantly higher than was possible at LEP, the so-called "GigaZ" option."*

And finally, and more specifically, the cover letter points how this flexibility results in the broad capability of the ILC to address specific questions:

> *“The most powerful and unique property of the LC is its flexibility. It can be tuned to well-defined initial states, including polarisation, allowing numerous model independent measurements, from the Higgs threshold to multi-TeV operation, as well as the possibility of unprecedented precision at the Z-pole (GigaZ). Furthermore, the relative simplicity of the production processes and final state configurations makes complete and extremely accurate reconstruction and measurement possible. The envisioned physics programme includes precision measurements of many Higgs decay widths, some of which are uniquely accessible at the LC (cc, gg, the invisible mode and the full width), decisive tests of the spin-parity properties of the Higgs candidate, and determinations of the top-Higgs and trilinear Higgs self couplings, also uniquely accessible at the LC. For a LC operating up to and beyond 500 GeV, the complete SM, including Higgs, top quark and VV interactions can be studied, both at tree level and through quantum corrections. In addition to precision tests of minimal EWSB and its Higgs boson(s), the LC also reaches well into new physics territory, where the potential exists to discover dark matter, aspects of supersymmetry, evidence for composite Higgs, or to test other well motivated BSM ideas. The physics reach of the LC is essentially limited by statistics, not systematics. Its discovery reach exceeds that of the LHC at any integrated luminosity in many cases, and discoveries of new particles or interactions at either machine can be subjected to further precision analysis at the LC to reveal deeper structures of the nature.”*

As we particle physicists begin to grapple with the physics implications of the discovery of a Higgs-like particle at the LHC, as well as other discoveries that will almost certainly soon follow, the flexibility of the ILC becomes perhaps its greatest asset. It is not much of an exaggeration to assert that whatever physics emerges from the LHC, the ILC will be capable of powerfully focusing on and exploiting that science.

CLIC | EUROPEAN STRATEGY FOR PARTICLE PHYSICS | FUTURE | HIGGS | ILC

Aug 23, 2012

ECLOUD12 sheds light on electron clouds

A recent workshop reviewed the latest experiences with the phenomenon of electron clouds at the LHC and other accelerators.

Résumé

ECLOUD12 : en savoir plus sur les nuages d'électrons

Les nuages d'électrons produits dans les enceintes à vide peuvent avoir des effets sur le fonctionnement et la performance des accélérateurs. Ces phénomènes ont été reconnus au milieu des années 1990 comme pouvant présenter un problème pour le LHC, et le premier atelier consacré à ce phénomène a eu lieu au CERN en 2002. Dix ans plus tard, voici le 5e atelier sur les nuages d'électrons. Plus de 60 physiciens et ingénieurs du monde entier se sont réunis à l'île d'Elbe début juin, pour parler de l'état de la technique et évoquer l'expérience acquise récemment en matière de nuages d'électrons au LHC et dans d'autres accélérateurs.

ECLOUD12 participants

Electron clouds – abundantly generated in accelerator vacuum chambers by residual-gas ionization, photoemission and secondary emission – can affect the operation and performance of hadron and lepton accelerators in a variety of ways. They can induce increases in vacuum pressure, beam instabilities, beam losses, emittance growth, reductions in the beam lifetime or additional heat loads on a (cold) chamber wall. They have recently regained some prominence: since autumn 2010, all of these effects have been observed during beam commissioning of the LHC.

Electron clouds were recognized as a potential problem for the LHC in the mid-1990s (*CERN Courier* July/August 1999 p29) and the first workshop to focus on the phenomenon was held at CERN in 2002 (*CERN Courier* July/August 2002 p15). Ten years later, the fifth electron-cloud workshop has taken place, again in Europe. More than 60 physicists and engineers from around the world gathered at La Biodola, Elba, on 5–8 June to discuss the state of the art and review recent electron-cloud experience.

Valuable test beds

Many electron-cloud signatures have been recorded and a great deal of data accumulated, not only at the LHC but also at the CESR Damping Ring Test Accelerator (CesrTA) at Cornell, DAΦNE at Frascati, the Japan Proton Research Complex (J-PARC) and PETRA III at DESY. These machines all serve as valuable test beds for simulations of electron-cloud build-up, instabilities and heat load, as well as for new diagnostics methods. The latter include measurements of synchronous phase-shift and cryoeffects at the LHC, as well as microwave transmission, coded-aperture images and time-resolved shielded pick-ups at CesrTA. The impressive resemblance between simulation and measurement suggests that the existing electron-cloud models correctly describe the phenomenon. The workshop also analysed the means of mitigating electron-cloud effects that are proposed for future projects, such as the High-Luminosity LHC, SuperKEKB in Japan, SuperB in Italy, Project-X in the US, the upgrade of the ISIS machine in the UK and the International Linear Collider (ILC).

An international advisory committee had assembled an exceptional programme for ECLOUD12. As a novel feature for the series, members of the spacecraft community participated, including the Val Space consortium based in Valencia, the French aerospace laboratory Onera, Massachusetts Institute of Technology, the Instituto de Ciencia de Materiales de Madrid and the École Polytechnique Fédérale de Lausanne (EPFL). Indeed, satellites in space suffer from problems that greatly resemble the electron cloud in accelerators, which can be modelled and cured by similar countermeasures. These problems include the motion of the satellites through electron clouds in outer space, the relative charging of satellite components under the influence of sunlight and the loss of performance of high-power microwave devices on space satellites. Intriguingly, the "Furman formula" parameterizing the secondary emission yield, which was first introduced around 1996 to analyse electron-cloud build-up for the PEP-II B factory, then under construction at SLAC, is now widely used to describe secondary emission on the surface of space satellites. Common countermeasures for both accelerators and satellites include advanced coatings and both communities use simulation codes such as BI-RME/ECLOUD and FEST3D. A second community to be newly involved in the workshop series included surface scientists, who at this meeting explained the chemistry and secrets of secondary emission, conditioning and photon reflections. Another important first appearance at ECLOUD12 was the use of Gabor lenses, e.g. at the University of Frankfurt, to study incoherent electron-cloud effects in a laboratory set-up.

Several powerful new simulation codes were presented for the first time at ECLOUD12. These novel codes include: SYNRAD3D from Cornell, for photon tracking, modelling surface properties and 3D geometries; OSMOSEE from Onera, to compute the secondary-emission yield, including at low primary energies; PyECLOUD from CERN, to perform improved and faster build-up simulations; the latest version of WARP-POSINST from Lawrence Berkeley National Laboratory, which allows for self-consistent simulations that combine build-up, instability and emittance growth, and is used to study beam-cloud behaviour over hundreds of turns through the Super Proton Synchrotron (SPS); and BI-RME/ECLOUD from a collaborative effort of EPFL and CERN, to study various aspects of the interaction of microwaves with an electron cloud. New codes also mean more work. For example, the advocated transition from ECLOUD to PyECLOUD implies that substantial code development done at Cornell and EPFL for ECLOUD may need to be redone.

ECLOUD12 could not solve all of the puzzles, and several open questions remain. Why, for example, does the betatron sideband signal – characterizing the electron-cloud related instability – at CesrTA differ from similar signals at KEKB and PETRA III? Why was the beam-size growth at PEP-II observed in the horizontal plane, while simulations had predicted it to be vertical? How can the complex nature of intricate incoherent effects be described fully? Which ingredients are missing for correctly modelling the electron-cloud behaviour for electron beams, e.g. the existence of a certain fraction of high-energy photoelectrons? How does the secondary-emission yield of the copper coating on the LHC beam-screen decrease as a function of incident electron dose and incident electron energy (looking for the "correct" equation to describe the variation of the primary energy at which the maximum yield is attained as a function of this maximum yield, ε_{max} (δ_{max}) and the concurrent evolution in the reflectivity of low-energy electrons, R)? Does the conditioning of stainless steel differ from that of copper? If it is the same, then why should the SPS's beam pipe be coated but not the LHC's? Can the secondary-emission yield change over a timescale of seconds during the accelerator cycle (a suspicion based on evidence from the Main Injector at Fermilab)? Can the surface conditioning be speeded up by the controlled injection of carbon-monoxide gas?

As for the "electron-cloud safety" of future machines, ECLOUD12 concluded that the design mitigations for the ILC and for SuperKEKB appear to be adequate. The LHC and its upgrades (HL-LHC, HE-LHC) should also be safe with regard to electron cloud if the surface conditioning ("scrubbing") of the chamber wall progresses as expected. The situations for Project-X, the upgrade for the Relativistic Heavy Ion Collider, J-PARC and SuperB are less finalized and perhaps more challenging.

ECLOUD12 was organized jointly and co-sponsored by INFN-Frascati, INFN-Pisa, CERN, EuCARD-AccNet (*CERN Courier*November 2009 p16) and the Low Emittance Ring (LER) study at CERN. In addition, the SuperB project provided a workshop pen "Made in Italy". The participants also enjoyed a one-hour football match (another novel feature) between experimental and theoretical electron-cloud experts – the latter clearly outnumbered – as well as post-dinner discussions until well past midnight. The next workshop of the series could be ECLOUD15, which would coincide with the 50th anniversary of the first observation of the electron-cloud phenomenon at a small proton storage-ring in Novosibirsk and its explanation by Gersh Budker.

• For all of the presentations at ECLOUD12, seehttp://agenda.infn.it/conferenceOtherViews.py?view=standard&confId=4303.

The ECLOUD12 workshop was dedicated to the memory of the late Francesco Ruggiero, former leader of the accelerator physics group at CERN, who launched an important remedial electron-cloud crash programme for the LHC in 1997.

About the author
Roberto Cimino, LNF/INFN, and Frank Zimmermann, CERN, chairs of ECLOUD12.