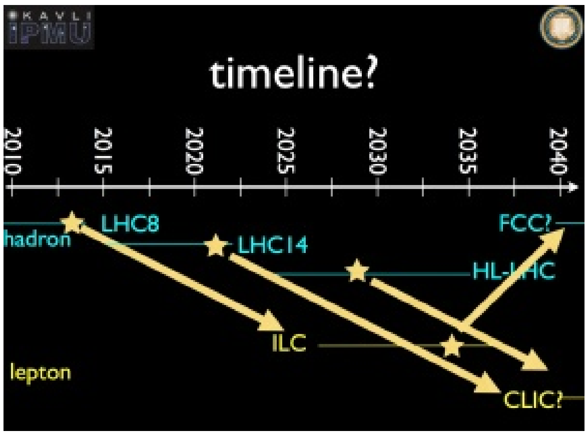
NEWSLINE

THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

DIRECTOR'S CORNER



Collider facts

by Hitoshi Murayama

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AROUND THE WORLD

From Fermilab Today: Fermilab attains unprecedented quality factor for LCLS-II dressed cavity

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FEATURE

Future accelerator scientists' fulfilling twelve days

by Rika Takahashi

Counting down to the ski season, still off-season Whistler, in British Columbia, Canada, was an ideal place for student to concentrate on the study for the 9th International Accelerator School for Linear Colliders.

Higgs found at DESY

More than 18000 visitors flock to DESY campus on its open day

by Barbara Warmbein

The German research centre DESY opened its doors to the public on 7 November, a day now known as DESY DAY. More than 18000 visitors came to see real accelerators, braving long queues and Hamburg drizzle to walk through parts of the European XFEL, PETRA or HERA accelerators, to visit DESY's workshops and partner labs on campus, learn about vacuum, magnetism, cryo technology, molecular biology, crystal and much more. Some of them even discovered the Higgs, which was roaming around on campus, happy to be photographed.

IN THE NEWS

from *CNN*
11 November 2015
Albert Einstein's colossal mistake
We celebrate the 100th anniversary of Albert Einstein's theory of general relativity this November

from *Technisch Weekblad*
11 November 2015
China wil Super Proton-Proton Collider
IEEE Spectrum is een van de vele websites waar men melding maakt van de Chinese plannen voor een Super Proton-Proton Collider (SPPC), een circulaire tunnel van 54 km lengte waarin rond 2040 protonen tegen elkaar moeten gaan knallen met een energie van 100 TeV (tera-elektronvolt); dat is zeven keer de maximale energie van de botsingen in de Large Hadron Collider (LHC) van CERN.

from *Iwate Nippo*
10 November 2015
県立大生「誇りに」　鈴木学長・ブレークスルー賞受賞
県立大の鈴木厚人学長らのニュートリノ研究グループが、世界の顕著な科学研究に贈られるブレークスルー賞を受けた９日、県内外から祝福や科学振興を期待する声が上がった。鈴木学長は東北への国際リニアコライダー（ＩＬＣ）誘致のけん引役でもあり、関係者は朗報を喜ぶ。(On 9 November, people cerebrated for Atsuto Suzuki, president of Iwate Prefectural University winning the Breakthrough prize, and expectation for the promotion of the science and technology rose high, because Suzuki is playing the leading role to invite the ILC to Tohoku .)

from *NTV news*
10 November 2015
岩手県立大・鈴木学長が米「ブレークスルー賞」受賞
今回の賞を受けて鈴木学長は、「ＩＬＣ国際リニアコライダーが建設されれば、精密に宇宙誕生の仕組みが解明される」と期待を寄せている。(Upon the prize winning of Breakthrough award, Atsuto Suzuki commented that "if the ILC would built, we can unravel the mystery of the birth of the universe very precisely.)

from *ARUP*
6 November 2015
Arup Engineer wins International Glossop Award
The benefits of this digital engineering approach has proved a success and it is being further applied on the International Linear Collider (ILC) project, a 34km long particle accelerator tunnel project that is potentially being hosted by KEK in Japan. – See more at: http://www.noodls.com/viewNoodl/30710426/arup-group-limited/arup-engineer-wins-international-glossop-award#sthash.BmdvQP9P.dpuf

from *Asimmetrie*
November 2015
#newphysics
Asimmetrie is the institutional magazine of INFN, targeted at high school teachers and students.

from *IEEE Spectrum*
2 November 2015
China Plans Enormous Particle Collider
What comes after the Large Hadron Collider?
The main successor concept is the International Linear Collider (ILC), which would smash together electrons with a "center of mass energy" of up to one tera-electron volt. It is currently in an advanced state of discussion between scientists mainly from American, European, and Japanese particle physics institutes. The proposed machine would be a "Higgs factory", performing experiments with large numbers of Higgs bosons, allowing a better understanding of the still enigmatic particle.

CALENDAR

Upcoming schools

9th International Accelerator School for Linear Colliders
Whistler, British Columbia, Canada
26 October- 06 November 2015

Joint Universities Accelerator School
Archamps, Haute Savoie, France
11 January- 18 March 2016

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1511.02371
Closing up a light stop window in natural SUSY at LHC

1511.01977
h0(125GeV)→cc¯ as a test case for quark flavor violation in the MSSM

1511.01934
Crystal Ball: On the Future High Energy Colliders

1511.00801
on-QCD contributions to top-pair production near threshold

1511.00405
Exploration of Beyond the Standard Model Physics at the ILC

1511.00390
Future HEP Accelerators: The US Perspective

1511.00286
The Higgs Physics Program at the International Linear Collider

1511.00134
The SiD Detector for the International Linear Collider

1510.09056
Precision measurements of the top quark couplings at the FCC

1510.08141
Prospects for γγ→H and γγ→W+W− measurements at the FCC-ee

1510.08069
Compressing the Inert Doublet Model

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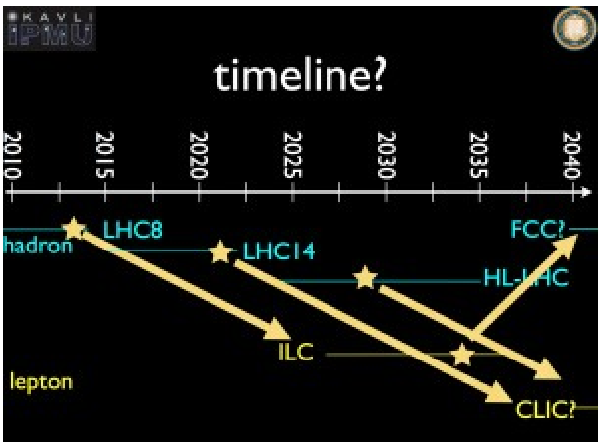
Collider facts

Hitoshi Murayama | 12 November 2015



The timeline for future colliders?

In Whistler, British Columbia, some two hundred physicists gathered to the annual Linear Collider Workshop. As the last speaker of the meeting, I tried to summarise the status of various collider options currently under discussion. In particular, I tried to clarify their readiness and timelines.

The ILC passed the TDR (Technical Design Report) stage back in June 2013 and is considered technically ready to be built. CLIC achieved its CDR (Conceptual Design Report) in October 2012, which needs to proceed to TDR to be considered ready. The electron-positron option of the Future Circular Collider study (FCCee) is being looked at as a stopgap option if the proton-proton option (FCCpp) is going to be built, and is slated to complete its CDR by 2018 to be ready for discussions at the next European Strategy update. However magnet R&D needed for FCCpp won't be finished before 2021. The Chinese electron-positron collider (CEPC) has finished a pre-CDR, and is proposed for R&D funding in the next five years. We hope to know whether the R&D budget is in the next five-year plan of the Chinese government sometime early 2016. If it goes through this time with successful R&D, construction of CEPC will be proposed in the Chinese five-year plan in 2021. The Chinese super proton-proton collider (SPPC) requires the same (or better) magnets as FCCpp. The Muon collider has made a big progress in simulation of muon cooling, but technical demonstration is still needed.

From the physics point of view, it is always wonderful to aim at as highest energies as possible for exploration at the energy frontier. There is mounting enthusiasm behind a 100-TeV pp collider for this obvious reason. FCC proposes a timeline to start physics in 2035 right after the high-luminosity LHC upgrade HL-LHC finishes, which assumes FCC can be built in a shorter time than LHC. Realistically, the earliest time I can imagine for FCC would be sometime around 2040, with a gap in CERN physics programme.

I argued there is a simple and clear physics case for ILC, now that the Higgs boson is discovered. It is the only (apparently) elementary spinless particle, a spooky faceless object. I couldn't believe such a particle would exist, which we have never seen before, and published “Higgsless theories” with collaborators. Now that it is discovered, I've been apologising at international meetings in the past three years, pretending that I'm properly Japanese! Yet the uncomfortable feeling remains. Why is there only one spinless particle in Nature? We introduced it to the Standard Model for its most important job. The theory seems so artificial. Perhaps it has siblings and relatives? This idea is called supersymmetry. Or it is actually secretly spinning in extra dimensions we don't see? Maybe it was wrong to assume it is an elementary particle after all. All of these possibilities can in principle by precision measurements of its properties.

Actually, Nature gave us a big present: the Higgs mass of 125 GeV is such that we will have access to a large number of its decay modes, *bb, cc, ττ, gg, ZZ*, WW*, γγ*, and possibly invisible. She is hanging bait in front of our faces, and it would be *stupid* not to take it. Electron-positron colliders would be uniquely suited for precision measurements of all of these modes (including the capability to separate *cc* and *gg*) in a model-independent fashion. This is a very clear reason why we would like to study this newly discovered particle at an e^+e^- collider.

To me, proposals for circular e^+e^- colliders seem limiting. CEPC does not reach the ttbar threshold. FCCee can't access top Yukawa coupling, a crucial element in electroweak symmetry breaking. It is very difficult to achieve longitudinal beam polarisation without a big hit in luminosity. The beam polarization would prove extremely beneficial if we find new particles to measure its quantum numbers.

It can be frustrating to see that political process for the ILC takes time. When it does take time, there are obvious things we should be working on. Improve superconducting cavities for potential higher gradient and cost saving, demonstrate high yields at X-FEL and LCLS-II, achieve even better emittance at KEK-ATF. And most importantly, stick firm to the clear and obvious physics case.

Especially when it takes time, we should dream big. FCCee and CEPC have gained momentum because of the dream of a bigger pp machine once the circular tunnel is built. In the same way, once we build a linear tunnel for ILC, we can dream about putting CLIC going up to 3 TeV, and in the long run, a plasma accelerator to go up to 30 TeV. Who knows, it will be forty years before we get to that stage.

Our field thrives on dreaming big. And there are no shortages of dreams. Stay firm.

CEPC | CLIC | FCC | ILC | LCWS15 | SPPC

Fermilab attains unprecedented quality factor for LCLS-II dressed cavity

A Technical Division team rallies around a dressed cavity from the LCLS-II project. *Photo: Reidar Hahn*

Members of Fermilab's Technical Division are working on superconducting radio-frequency cavities that are shaped like squatty beads on straight string. These prone, uniformly bulging tubes accelerate the particle beams that shoot through their hollow insides.

The team recently achieved a record-high quality factor with a fully dressed cavity for a SLAC-headed project, Linac Coherent Light Source II.

"This has taken a lot of hard work from a very dedicated crew," said Rich Stanek, Fermilab LCLS-II senior team leader. Stanek acknowledged the entire cavity dressing team and all of the SRF scientists that helped reach this record quality factor.

Quality factor, Q, is a measure of how efficient a particle acceleration cavity is. A higher Q means a cavity is losing less energy, which is more cost-effective.

The two LCLS-II free-electron lasers will produce X-rays to probe a wide variety of materials, exotic and otherwise, at the nanoscale. Fermilab is responsible for designing, developing, building and testing about 150 nine-cell cavities for the LCLS-II superconducting accelerator. The R&D process began one-and-a-half years ago. It includes ensuring that the cavities meet certain Q values during testing.

"This is the first integrated test we did," said Nikolay Solyak, project support group leader. In an integrated test, everything is checked under real conditions. "The conditions were very close to the cavity's final condition in a cryomodule."

In this integrated test, the fully dressed 1.3-gigahertz cavity's quality factor was 3.1×10^{10} at 2 Kelvin and at a 16-megavolt-per-meter peak surface electric field. This Q exceeds LCLS-II's goal of 2.7×10^{10} and far surpasses current state-of-the-art standards.

"This quality factor is an extremely important step," said Slava Yakovlev, SRF department head. "It's a victory."

SLAC physicist Marc Ross, LCLS-II cryogenics systems manager, says he's pleased with the results.

"It's definitely a victory," Ross said. "These are some of the highest-quality-factor practical resonators ever built."

A fully dressed cavity is outfitted with all the components it will wear in the LCLS-II accelerator. This includes a titanium jacket filled with liquid helium chilled to 2 Kelvin, a temperature at which niobium is superconducting. It's also furnished with power-providing couplers, cavity-squeezing tuners to control frequency, and magnetic shielding. These components add heat and can lower Q, so the team had to develop a way to carry this heat away and keep Q high.

"This record Q is really the sum, the final point, of many years of research," said Anna Grassellino, Fermilab Technical Division scientist who leads cavity testing and processing for LCLS-II. "It's really a miracle of science and technology and engineering coming together and producing an unprecedented quality factor. It opens up a way for machines to operate much more efficiently at a much lower cost."

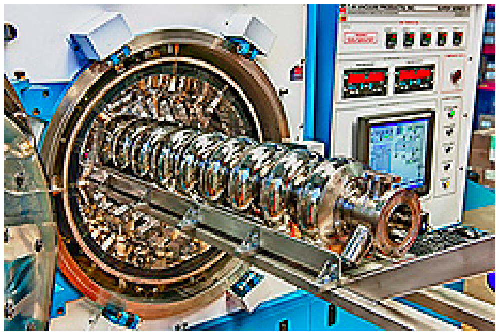
Grassellino led the Fermilab effort to apply the breakthrough technology, dubbed nitrogen doping, that helped achieve this record Q. It involves infusing nitrogen into a cavity's inner niobium surface. Nitrogen doping and other Fermilab discoveries that led to this Q value, such as the removal of magnetic flux through rapid cooling, will become new standards for achieving highly efficient accelerators worldwide.

"This is a critical milestone not only in LCLS-II design, but in other modern accelerator projects including our own project, PIP-II," Yakovlev said.

But there's more to be done for LCLS-II.

"We still need to show that the full cryomodule with eight cavities meets specifications," Grassellino said. "There's always a next step."

—*Chris Patrick*



An LCLS-II-type accelerator cavity prepares to be treated with nitrogen, a process that increases the cavity's quality factor. Fermilab recently reported a record quality factor for LCLS-II-type cavities.*Photo: Reidar Hahn*

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FEATURE

Future accelerator scientists' fulfilling twelve days

Rika Takahashi | 12 November 2015

The poster of the 9th International Accelerator School

Counting down to the ski season, still off-season Whistler, in British Columbia, Canada, was an ideal place for student to concentrate on the study for the 9th International Accelerator School for Linear Colliders.

This school was organised by the Linear Collider Collaboration and the ICFA Beam Dynamics Panel, and hosted by Canadian national laboratory TRIUMF. It is a continuation of the series of schools that began in Hayama, Japan, in 2006. Three continents take turns in providing the venue and close to 500 students have been trained in Erice, Italy in 2007, Oak Brook, United States in 2008, Beijing, China in 2009, Villars-sur-Ollon, Switzerland in 2010, Pacific Grove, United States in 2011, Indore, India in 2012 and Antalya, Turkey in 2013.

The school was offered to graduate students, postdoctoral fellows and junior researchers from around the world, and the organising committee received much more applications than they were able to take, so they made a selection to invite the best students. "The goal of this school is try to prepare the 'young army' to build and operate this machine of the future because ILC is a big global project for the 21st century," said Weiren Chou of Fermilab, one of the organising committee members. "You say "the old soldiers never die", but they will fade away. So before they do, we need a new generation to grow".

The topics for the school were TeV-scale linear colliders including the ILC, CLIC and other advanced accelerators. An important change of this year's school from previous ones was that it also included the topic free-electron lasers (FEL) because the FEL is a natural extension for applications of the ILC/CLIC technology.

"I tried to not make it too technical," said Masao Kuriki from Hiroshima University, who gave an overview talk about the ILC, and also a lecture about the particle source. "I was impressed by some of the insightful questions from the students, in the area of generation of polarised electrons and positrons or correcting chromatic aberration. Also, we had an animated discussion on how the ILC can search for dark matter."

There was one more difference for this school from the previous ones. Because a Linear Collider Workshop was held in the same place at the same time, there was a joint plenary where the students could participate in the conference. The session entitled "LC Future directions" lasted one whole afternoon. The first half of the session was about the status of the linear collider study, and the other about future technologies such as laser plasma or plasma wakefield acceleration, and its possible application for the linear colliders. "A joint plenary with student was a good opportunity to drive students' interests by presenting the future possibilities and associated issues," said Kuriki.

Students were given homework assignments and a final examination, and students with excellent results were given a "Student Award," in the banquet held the last day. This is the list of awarded students: Jim Ogren, Uppsala University, Sweden, Fernando Maldonado Millan, University of Victoria, Canada, Weiwei Tan, Peking University, China, Yasuhiro Fuwa, Kyoto University, Japan, Jorge Giner Navarro, Instituto mixto del Consejo Superior de Investigaciones Científicas (CSIC) University of València, Michele Bertuccia, INFN, Italy, Robin Rajamaki, CERN/Aalto University, Finland, Douglas Story, TRIUMF/University of Victoria, Canada, Dario Pellegrini, CERN/École

Polytechnique Federale de Lausanne, Switzerland, Liu Yang, TRIUMF, Canada, Lianmin Zheng, Tsinghua University, China, and Juergen Pfingstner, University of Oslo, Norway.

“Students form the early schools have already become leaders or are playing leading roles in this field, so I am so happy to see so many young people who decided on and want work on this project. I really hope that Japanese government will give a green sign for these excellent future scientists,” said Chou.

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IMAGE OF THE WEEK

Higgs found at DESY

More than 18000 visitors flock to DESY campus on its open day

Barbara Warmbein | 12 November 2015

Guest of honour on #DESYDAY: the Higgs. Visitors posting selfies could win a prize.

Inside the tunnel of the European XFEL.

Visitors stood patiently in line to see real particle accelerators, including that of the European XFEL.

Future scientists at work during DESY DAY.

In DESY's carpentry workshop during the open day.

Cryomodules make a nice backdrop for the open day stand in the Accelerator Module Test Facility

A cavity and real detector prototypes were on display at the ILC stand on DESY DAY

The German research centre DESY opened its doors to the public on 7 November, a day now known as DESY DAY. More than 18000 visitors came to see real accelerators, braving long queues and Hamburg drizzle to walk through parts of the European XFEL, PETRA or HERA accelerators, to visit DESY's workshops and partner labs on campus, learn about vacuum, magnetism, cryo technology, molecular biology, crystal and much more. Some of them even discovered the Higgs, which was roaming around on campus, happy to be photographed.

At the stand of DESY’s linear collider groups, visitor could try a magnetic linear accelerator, cable a detector prototype and even play electron in an accelerator tunnel. In a mocked up linac tunnel stretching a couple of metres and ending in a crash mat, children accelerated like electrons in a cavity and even had their average speed measured. “We recorded every of the approximately 3000 runs,” explained Marc Wenskat of DESY’s linear collider accelerator group, one of more than 1200 volunteers who tirelessly explained to visitors what they do all day, and why. “Considering that most kids had more than one go, we estimate that some 1500 kids visited our stand – probably about equal to the number of children on site!” For the next open day – planned again to coincide with Hamburg’s Night of Science in two years – the team is considering to turn the crash mat into a calorimeter to measure the runner’s impact and make it even more of a linear collider experience.

All images: Axel Heimken, DESY/European XFEL

ACCELERATOR R&D | DESY | DESYDAY | DETECTOR R&D | EUROPEAN XFEL