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FEATURE

P5 report supports Higgs factory including the ILC, says the chair

by Rika Takahashi



What will the future of particle physics in the US look like? That's the question the Particle Physics Project Prioritization Panel (P5) tried to answer in its report that was released in December after a long process of meetings, deliberations and editing. The ILC community is very familiar with the chair of this panel: Hitoshi Murayama, the former Research Director and chair of Physics and Detectors in the ILC International Development Team. NewsLine interviewed him about what the report meant for the ILC.

AROUND THE WORLD

Federation of Diet Members learn R&D status of ILC during KEK tour

by Rika Takahashi



Four Japanese diet members went on a grand tour of KEK last November, not only visiting ILC hotspots like the Superconducting RF Test Facility and the Accelerator Test Facility, but also discussing prospects for a career in science with Japanese students. Find out what they learned out and advised.

AROUND THE WORLD

From Symmetry: Scientists design program for the future of US particle physics research



IN THE NEWS

from *BNN*
16 February 2024
CERN's Bold Leap into the Future: The Proposed Future Circular Collider
While the FCC's scientific potential is indisputable, its hefty price tag of 17 billion euros has sparked debate. Critics argue for cheaper alternatives—like a linear collider—or suggest that these funds could be better allocated to tackling pressing global issues such as climate change. The onus now rests on CERN's member nations to weigh the economic implications against the potential scientific breakthroughs as they mull over financing the project.

from *Physics World*
14 February 2024
Superfluidity: the mysterious quantum effect that became a backbone of experimental physics
In the 1990s, the Tera Electron Volt Energy Superconducting Linear Accelerator (TESLA) project at DESY in Germany led the drive to develop SRFs for an International Linear Collider (ILC), which could be a successor to the Large Hadron Collider (LHC).

from *Physics World*
09 February 2024
New positron source could give lepton colliders a boost
Building better positron sources is a goal of physicists and engineers working on designs for future lepton colliders. These include the International Linear Collider and a version of the FCC called FCC-ee, which would collide positrons with electrons. The PSI Positron Production, or P-cubed experiment is one such design effort.

from *TBS News*
08 February 2024
「積極姿勢を世界に示すべき」　鈴木厚人・岩手県立大学長が講演　岩手・宮城両県議会のＩＬＣ議員連盟が講演会開催
ILC=国際リニアコライダーの誘致を目指す岩手、宮城両県議会の議員連盟は、8日専門家を招いた講演会を盛岡市で開き、誘致実現の課題を探りました。(The Federation of Diet Members of Iwate and Miyagi Prefectural Assemblies, which aims to invite the International Linear Collider (ILC), held a lecture meeting in Morioka City on August 8, inviting experts to explore the challenges of attracting the ILC to Iwate and Miyagi.
)

from *FNN prime online*
08 February 2024
ＩＬＣ・国際リニアコライダーの建設実現目指し講演会　県立大の鈴木厚人学長＜岩手県＞
ＩＬＣ・国際リニアコライダーの建設実現を目指し、２月８日に岩手県盛岡市で県立大の鈴木厚人学長による講演会が開かれました。(A lecture by Atsuto Suzuki, President of Iwate Prefectural University, was held on February 8 in Morioka City, Iwate Prefecture, with the aim of realizing the construction of an ILC/International Linear Collider.)

from *Nature*
06 February 2024
CERN's supercollider plan: $17-billion 'Higgs factory' would dwarf LHC
Meanwhile, other 'Higgs factory' designs are in the works around the world. The Japanese government has shown interest in hosting the long-planned International Linear Collider, while China is designing a ring-shaped machine called the Circular Electron Positron Collider. Gianotti said that the European Strategy for Particle Physics had found that the FCC had greater physics potential than a linear collider, because it could produce Higgs bosons at a higher rate and because the same tunnels could later be used for a much higher-energy machine that collides protons.

from *Iwate Nippo*
24 January 2024
ILC実現へ取り組み加速を要望　岩手と宮城両議連が文科相に
岩手、宮城両県議会の国際リニアコライダー（ＩＬＣ）建設実現議連は２３日、政府などに対して誘致実現や取り組みの加速を要望した。(On January 23, the ILC Construction Realization Council of the Iwate and Miyagi Prefectural Assemblies requested the government and other parties to realize and accelerate efforts to attract the ILC to Iwate and Miyagi.)

from *Iwate Nippo*
10 January 2024
ILC計画、求められるビジョン明確化　諮問委･村山委員長に聞く
2014年以来となる報告書をまとめる際、現在の予算では米国内にヒッグスファクトリーを整備できないと判断したが、素粒子物理学の研究は国際的なパートナーと一緒に実現することにした。欧州のFCC（次世代型大型円形加速器）とILC（国際リニアコライダー）の計画は、われわれが考えている素粒子物理学の目標を達成できるので、ぜひ参加するべきだ。(When we compiled our first report since 2014, we determined that our current budget would not allow us to develop a Higgs Factory in the United States, but we have decided to work with international partners to make particle physics research a reality. The European FCC and ILC projects can achieve the particle physics goals we have in mind and should be included.)

from *Iwate Nippo*
07 December 2023 7
ILCの実現は「日本にとって重要」　一関・笹川財団理事長ら講演

ILCの誘致を目指す建設地域期成同盟会は６日、一関市内のホテルで、初の講演会を開いた。笹川平和財団（東京）の角南篤理事長は「科学技術外交や経済安全保障の観点から日本にとって重要だ」と強調。岩手、宮城両県から集った約１７０人は実現に向け、結束を図った(The Alliance for the Construction of the ILC held its first lecture at a hotel in Ichinoseki City on June 6. Atsushi Kakunan, president of the Sasakawa Peace Foundation in Tokyo, stressed that the ILC is important for Japan from the viewpoints of science and technology diplomacy and economic security. About 170 people from Iwate and Miyagi prefectures gathered to unite for the realization of the alliance.)

from ***Nikkei***
01 December 2023
東北ILC推進協議会の増子代表、「誘致契機に人材網を」
巨大加速器「国際リニアコライダー」（ILC）の誘致を目指す東北ILC推進協議会は1日、増子次郎共同代表（東北経済連合会会長）による講演会を仙台市で開いた。増子代表は9月にスイス・ジュネーブ郊外にある欧州合同原子核研究機関（CERN）などを視察した内容を報告。「ILC誘致を契機に、欧米などの優秀な人材とのネットワークを強化することが不可欠だ」と強調した。(The Tohoku ILC Promotion Council, which aims to attract the ILC, a giant accelerator, held a lecture by Jiro Masuko, co-chairman of the Tohoku Economic Federation, in Sendai City on September 1. Mr. Masuko reported on his visit to CERN in September. He stressed that it is essential to take advantage of the ILC's attraction to strengthen the network with excellent human resources in Europe, the U.S., and other countries.)

from ***INFN News***
30 Novenber 2023
SUPER-B FACTORY AND NEUTRINO PHYSICS: AN INSIGHT INTO THE KEK LABORATORIES IN JAPAN
The idea of the ILC was proposed over 20 years ago by the international high energy physics community: it is a large-scale project, and it is very expensive. Such a big project can be developed only as a global project, not only by KEK or by the Japanese government. So, we must collaborate with as many governments and institutions as possible, and we are now proposing people to get together to discuss how we can do this.

PREPRINTS

ARXIV PREPRINTS

2402.02072
Searching for singlet vector-like leptons via pair production at ILC

2401.13402
One-loop electroweak radiative corrections to polarized e+e−→ZZ process

2312.08152
Key4hep: Progress Report on Integrations

2312.08151
The Key4hep software stack: Beyond Future Higgs factories

2312.07347
Determination of CP-violating Higgs couplings with transversely-polarized beams at the ILC

2311.17220
Exploring the Electromagnetically Interacting Dark Matter at the International Linear Collider

2311.16774
Higgs self-coupling measurement at future e+e− colliders

2311.16768
Detecting the coupling of axion-like particles with fermions at the ILC

2311.13924
Search for the production of dark matter in the framework of Mono-Z′ portal at the ILC simulated electron-positron collisions at s√=500 GeV

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FEATURE

P5 report supports Higgs factory including the ILC, says the chair

Rika Takahashi | 22 February 2024



The Particle Physics Project Prioritization Panel (P5) is a panel established under High Energy Physics Advisory Panel (HEPAP) that advises the U.S. Department of Energy (DOE) Office of High Energy Physics and the National Science Foundation (NSF) Division of Physics. On December 7th of last year, this panel released a report called “Exploring Quantum Universe –Pathways to Innovation and Discovery in Particle Physics–.” The report outlines a strategic plan for the particle physics research in the United States.

ILC NewsLine asked the P5 Chair Hitoshi Murayama what this report meant for the future of the ILC.

– **What is the position of the ILC in this report?**

Regarding the ILC, I believe that the report we have compiled is the best one possible, given the current situation surrounding the project. The report highlights five key priorities, the third priority being the establishment of a Higgs Factory. We all agree on the significance of constructing an accelerator that can generate a significant number of Higgs bosons for precision measurements.

There were some proposals to build a Higgs Factory in the U.S., but they just wouldn’t fit into the budget profile given by DOE. Therefore, we should actively participate in the projects that have already begun, such as FCC-ee and ILC, and establish a process for the US to take the lead.

However, we do not know at this time which Higgs Factory will be realized and when. So, we also recommend that an interim panel be set up so that when new developments and information become available, a decision can be made to decide the level of the US contribution without waiting for the next P5.

–**The ILC being listed together with the FCC-ee has caused some to think that the importance of the ILC has decreased. What are your thoughts on that?**

I would say this report is actually very supportive of the ILC, even more so compared to the previous report. The last P5 report said, *If the budget scenario is unlimited, then we should commit to the ILC.* And this time, it says that we should commit to a Higgs Factory, whatever the scenario may be. We don't know if that will be the ILC or FCC-ee, but we must do it. We recommended investing in collider R&D, including Higgs Factory and ILC technology networks, as well as detector R&D for Higgs Factory experiments. That means we have put much effort into ensuring that the US program would have a significant component in a Higgs Factory.

At the beginning of the discussion, certain panel members were under the impression that the ILC was dead and that the Higgs Factory had to be FCC-ee. But after looking at the details, it became clear that the ILC is shovel-ready and technologically mature, with no technological showstopper. The only thing missing is a global framework that would allow ILC to be put together somewhere in the world. On the FCC side, there is no guarantee that it can actually be built. It is an expensive machine, and the financial feasibility is still not clear. So, in that sense, neither one of them is guaranteed. Based on these findings, we came to the conclusion of listing two projects in parallel. After all, we are all researchers, and we make decisions based on data. However, I would like to mention that there was one thing repeatedly pointed out during the discussion: the ILC has no host. CERN is the host of the FCC-ee, but the ILC has no foundation, so it is unclear who will lead the project. Anyway, whatever would happen to either of the possibilities, the U.S. doesn't want to miss the opportunity.

– **An interim panel will be set up when "crucial information is available, but what is the "crucial information?**

In the case of the ILC, once the dialogue among the interested governments is realized and the prospect for a global project is identified, a panel will be set up. For the FCC-ee, if the results of the feasibility study currently underway show that it is feasible not only in terms of technology but also in terms of finance, the US will decide to participate. After the feasibility study of FCC-ee, further discussions will be needed by the next European Strategy Update followed by the Council decision. CERN is also participating in R&D for linear colliders and other future collider projects, even at a low priority. The DOE will look at the situation and decide on when to convene a panel.

– What is your vision for the future of particle physics research in the U.S.?

For the past 20 years, the US budget for particle physics research has not kept pace with inflation. It finally caught up with inflation when the neutrino experiment DUNE, the second highest priority for the US in the last P5 report, started and was budgeted. But due to the higher than anticipated budget of DUNE, we are in a difficult situation where we will not be able to do any new projects for the next five years or so. This time, our goal was to create a program that would cover not only DUNE but also many other things in the subsequent five years. We took the time to listen to various opinions and believe that we have produced a well-balanced report. We have expressed our aspiration that is quite far in the future, which is to aim for an energy equivalent to 10 times the energy of the HL-LHC, and if possible, we would like to build a muon collider on US soil. It is very difficult, but if would like to work in developing the technology, and the accelerator technology in the US will get a boost, and it may support next experiments in many different areas. I think the right way to go is to build a system that allows us to do various kinds of science along the way while running toward the muon collider as a distant goal. Without a dream, everyone will stop, so we need to have a destination to run toward.

-Thank you!

DOE | ILC | P5 | REPORT | USA

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AROUND THE WORLD

Federation of Diet Members learn R&D status of ILC during KEK tour

Rika Takahashi | 22 February 2024



On 13 November last year, four Japan's Federation of Diet Members for the International Linear Collider (ILC) visited KEK. The group included Ryu Shionoya, Chairperson of the Caucus, member of the House of Representatives and former Minister of Education, Culture, Sports, Science and Technology (MEXT); Keitaro Ohno, member of the House of Representatives and Secretary-General of the Diet Members Caucus; Shinsuke Okuno, also a member of the House of Representatives, and Megumi Hirose, member of the House of Councilors. KEK Director General Masanori Yamauchi provided an overview of KEK's research activities, after which the group toured the experimental facilities for about an hour.

The delegation's first stop was at the Superconducting RF Test Facility (STF). The STF is a facility for developing and testing superconducting radio frequency (SCRF) accelerating cavities, which accelerate electrons and positrons to near the speed of light. The STF also plays a vital role in testing the SCRF accelerating system, which is one of the crucial technologies for realizing the ILC. Since producing 9,000 superconducting accelerating cavities is essential for the ILC, KEK is also working hard to improve the quality of these cavities and find ways to achieve efficient mass production.

The next stop was the Advanced Accelerator Test Facility (ATF), where researchers from around the world collaborate to develop technology to generate and precisely control the extremely small beams required for the ILC. ATF is the only facility of its kind.

The particle beams to be used for the ILC experiments will consist of bunches of 20 billion electrons or positrons. Although there are 20 billion particles inside, they are so tiny that the bunches are mostly empty. Scientists are cramming particles into nano-sized beams to

increase particle density and, thus, collision efficiency. ATF has already achieved a beam size of 41 nanometers (41 millionths of a millimeter). This is a world record. The international team of scientists will continue researching to narrow the beam size further and develop techniques to maintain stable beam collisions.

Their final destination was the SuperKEKB accelerator and the Belle II detector, where physics experiments are currentry conducted. The accelerator collides electrons and positrons, the same particles to be used at the ILC. Both projects have the same mission to explore the mysteries of the beginning and laws of the universe, but their approaches are different. While the ILC aims for collisions at very high energies, the Belle II experiment aims to find very rare phenomena with the help of very high luminosity. When the ILC becomes a reality, both would complement each other. The Belle II International collaboration started taking data in 2019, searching for new physical phenomena beyond the standard model of particle physics.

During the tour, curious attendees asked many questions, such as the technology being developed for the ILC and their potential for applications or R&D activities during COVID-19. They all seemed genuinely impressed, and Shionoya said, “I regret not coming earlier. I hope you will share this research with the world, highlighting its greatness”.

Following the tour of the facility, the delegations had a discussion with six graduate students of particle physics and accelerator science from the International Center for Particle Physics (ICEPP) at the University of Tokyo and the Graduate University for Advanced Studies (SOKENDAI).

Keitaro Ohno asked graduate students about their ambitions for the future. Yuki Abe of SOKENDAI, who is working on the research at the ATF, said he has been attracted to the accelerator, the precision machine. “I would like to be involved in research from a manufacturing perspective. My ambition is that the device I am currently developing will be implemented in the ILC in the future.”

Shinsuke Okuno inquired about the best way to describe the ILC. “ If you have good ideas, please share them with us. We would like to use it when explaining about the ILC.” The students said they often struggle to explain their work to friends and family. Some presented the ILC as a stepping stone toward understanding the underlying principles of physics, and others explained the ILC as a machine to recreate the Big Bang or the experiments to learn what we don’t know now. After listening to the students’ opinions, Okuno commented that it would be easier to understand if they were explained using analogies related to daily life.

From the student side, sincere wishes were expressed to the delegation. The students told the reality of the situation: due to the limited number of openings in particle research in Japan, they are either forced to continue their research abroad or give up their academic career to work in the industry. They emphasized the significance of having places and opportunities to apply the advanced expertise obtained during graduate school.

Ryu Shionoya stated that the slogan used by ITER “地上に太陽を(A Small Sun on Earth)” was influential in promoting the project in Japan. “The word was helpful in enabling people to easily visualize the project. I would like to find similar words for the ILC.” This could be a homework assignment for the entire ILC community to contemplate. He concluded by saying, “seeing the KEK facilities and ongoing R&D, I once again felt the importance of the ILC,” encouraging the graduate students to do their best to demonstrate Japan’s research capabilities to the world.

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