

# LC NEWSLINE

THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

## DIRECTOR'S CORNER



### Updating the physics case for the ILC

by Hitoshi Yamamoto

The physics case of the ILC boils down to three main points, says Hitoshi Yamamoto, Director for Physics and Detectors in the Linear Collider Collaboration. A physics case is a scientific justification based on studies and theory. And while the case for the linear collider has been made many times, the LC physics community thinks that it is now much clearer.

## LIVE FROM JAPAN

### Morioka: placed at the “crossroads” of Japan

by Dean H. Ruetzler

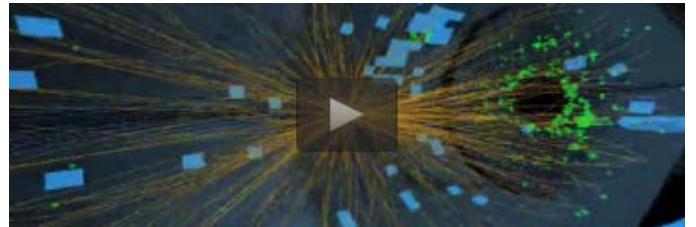


The latest Live from Japan piece proudly presents the city of Morioka, quite possibly a place where ILC researchers would go regularly for a bit of sightseeing. The author is an American who has lived in the city for years.

## FEATURE

### Ready for the jump

by Barbara Warmbein



The Large Hadron Collider is about to start up again as an almost new machine and almost twice the previous collision energy. With first beams possibly circulating by the end of the month and first collisions expected for the beginning of summer, physicists around the world cannot wait to see what the collisions of Run 2 will reveal. Will there be first signs of supersymmetry, a possible key to the as yet locked dark universe? What will the properties of the Higgs boson reveal? Will there be unexpected peaks in the data? And how do these results translate to the ILC? LC NewsLine speaks to two theoretical physicists.

## VIDEO OF THE WEEK



## The ILC is a fantastic accelerator, Nobel says

by Perrine Royole-Degieux

Professor David Gross speaks in strong support for the International Linear Collider, a "fantastic new accelerator". He says that for the exploitation of the properties of the Higgs, the promise of new particles, forces and a new understanding the ILC is one of "the most exciting prospects." He says the he "applauds the Japanese government and Japanese colleagues for leading the effort to host the ILC in Japan, and I trust and hope that the international community will join this effort." David Gross was awarded the Nobel Prize in Physics in 2004 along with Frank Wilczek and David Politzer. He is a theoretical physicist at the Kavli Institute for Theoretical Physics at UC Santa Barbara.

## IN THE NEWS

from **CERN**

17 March 2015

**LHC experiments join forces to zoom in on the Higgs boson**

The combined mass of the Higgs boson is  $m_H = 125.09 \pm 0.24$  (0.21 stat.  $\pm$  0.11 syst.) GeV, which corresponds to a measurement precision of better than 0.2%.

from **Kahoku Shinpo**

16 March 2015

国連防災会議 誘致へ将来構想策定を

石川幹子中央大教授は、北上エリアが環境、文化面で優位性を持つ半面、研究所計画と合わせた広域的な将来構想を欠いていると課題を指摘。「震災復興や人口減少対策とリンクした長期的なビジョンが必要だ」と訴えた。Mikiko Ishikawa, Professor of Chuo University, said that the Tohoku area has environment and cultural superiority. However she pointed out that the area lacks the the broad-based future concept along with the research planning, "we need a long-term vision linked with the earthquake reconstruction and population decline in the area."

from **Le Monde**

16 mars 2015

**LHC : Un projet encore plus ambitieux**

L'idée est de faire de cette machine une sorte d'usine à boson de Higgs, capable de cerner les moindres recoins de la théorie. Si le LHC a identifié quelques centaines de ce nouveau venu, l'ILC en récolterait 70 000 et le FCC 2 millions selon les calculs prometteurs.

from **New Scientist NL**

15 March 2015

**Zal de vernieuwde LHC de natuurkunde maken of kraken?**

Sommige wetenschappers beweren dat botsingen tussen protonen niet de ideale manier zijn om de natuurkunde voorbij het standaardmodel te brengen. Er bestaan plannen voor preciezere elektronenversnellers: de International Linear Collider die misschien in Japan gebouwd gaat worden, of een circulaire deeltjesversneller bij Cern die tot wel 100 kilometer lang kan worden.

from **The Japan Times**

9 March 2015

**Tohoku pins rebound hopes to atom smasher**

As the disaster-hit Tohoku region struggles to recover from the deadly tsunami four years ago, many residents have hopes for what is considered a once-in-a-lifetime opportunity to galvanize the area's resurrection.

Chances are the region may host the International Linear Collider, a state-of-the-art research facility physicists worldwide hope

will shed light on the secrets of the universe.

## from *Tokyo Shinbun*

1 March 2015

復興の地 人と科学育む 今春退任する高エネ研機構長 鈴木 厚人さん

KEK機構長を二〇〇六年度から務め、任期満了に伴い三月末で退任する。四月からは岩手県立大の学長として、人材育成や国内誘致の実現に力を注ぐ。(Suzuki will leave KEK to Iwate Prefectural University as a President in April. He will contribute his energy for the development of human resources, and realization of the ILC construction in Japan)

## CALENDAR

### Upcoming events

#### ALCW2015

KEK and University of Tokyo, Japan

20- 24 April 2015

### Upcoming schools

#### Joint Universities Accelerator School (JUAS)

Archamps, Haute Savoie, France

12- 20 March 2015

[View complete calendar](#)

## PREPRINTS

### ARXIV PREPRINTS

#### 1503.04880

Low-energy Supersymmetry Breaking Without the Gravitino Problem

#### 1503.04830

Experimental constraints on the coupling of the Higgs boson to electrons

#### 1503.04247

Probing New Physics using top quark polarization in the  $e^+e^- \rightarrow t \bar{t}$  process at future Linear Colliders

#### 1503.04204

The Dark Penguin Shines Light at Colliders

#### 1503.04203

Stealth Dark Matter: Dark scalar baryons through the Higgs portal

#### 1503.02996

Higgs Decays into Charginos and Neutralinos in the Complex MSSM: A Full One-Loop Analysis

#### 1503.01500

Signatures of Majorana dark matter with t-channel mediators

#### 1503.00114

Impact of Family Non-universal  $Z'$  Boson on Pure Annihilation  $B_s \rightarrow \pi^+\pi^-$  and  $B_d \rightarrow K^+K^-$  Decays

## ANNOUNCEMENTS

### Register now for ALCW2015: Early registration extended

There are only a few days left to register at more favorable price for The Asian Linear Collider Workshop 2015 (ALCW2015). The Early registration has been extended – but only until **Sunday, March 29**. [Register](#) today!

Being different from the past regional workshops in Asia this workshop is co-organised by KEK, ACFA, and LCC and a new session organisation is attempted; detector sessions consists of several mini-workshops of detector concept and R&D groups.

The workshop, being organised at a critical time for the ILC project development in Japan, will have a special focus on the ILC progress in Japan. Your attendance for his workshop will greatly influence the future of the ILC. Join us from 20 to 24 April 2015, at KEK!

A must-attend is the [Tokyo Event](#) on Wednesday – a sSymposium and a special Food Festa to be held on 22 April. Please see [ALCW2015](#) website for details. Seeing you in Tsukuba and Tokyo !

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# NEWSLINE

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## DIRECTOR'S CORNER

### Updating the physics case for the ILC

[Hitoshi Yamamoto](#) | [19 March 2015](#)

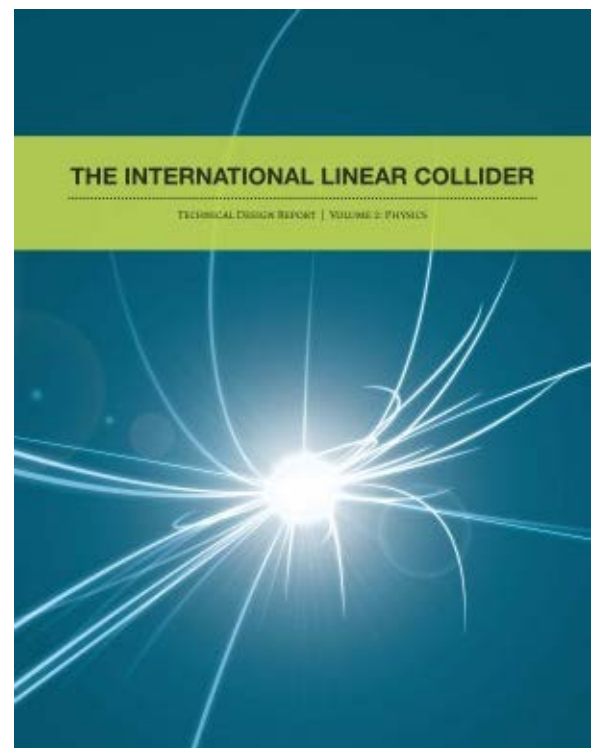
The physics case of the ILC has been studied intensively for many years, culminating in the physics volume of the [Technical Design Report](#) (TDR). It was followed by efforts to compare various machines such as the European Strategy studies and the Snowmass studies. Still, the scientific and political environments surrounding the ILC keep changing. On the scientific front, the LHC has found the Higgs particle and placed limits on new physics. The LHC is now upgrading the energy and a new run is about to start. On the political side, the committees of the MEXT in Japan are evaluating the case for the ILC both technically and scientifically. It is thus important that we continue to update the physics case for the ILC and communicate it to relevant people.

The task of updating the physics case for the ILC largely lies on the shoulders of the physics working group of the LCC. With the members of the MEXT committees as audience in mind, they have produced a document called 'Precis of the Physics Case for the ILC.' This turned out to be an extremely useful document for newcomers such as incoming graduate students to learn about the physics of the ILC. It was, however, a little too technical for the audience originally intended. To fill the gap, it was followed by a shorter document intended really for general public – 'Scientific Motivations for the ILC'. This latter document is now mostly ready for distribution. The content of these documents are used by members of those committees in their discussions.

When evaluating the competitiveness of the ILC, we need to consider circular electron-positron colliders as well as a luminosity-upgraded LHC. At present, there are two studies on next-generation circular electron-positron collider: one at CERN and another in China. The one at CERN is called the [FCC](#) (Future Circular Collider) study the main part of which is a proton-proton collider with an optional electron-positron collider to start with. It would start after the LHC ends around 2035. The stated timing of the Chinese circular electron-positron collider, called [CEPC](#), is earlier and about the same as that of the ILC. The CEPC is a Higgs factory with the design luminosity per collision point is about three times that of the baseline ILC running as a Higgs factory. It should be noted, however, that the upgraded ultimate ILC luminosity as a Higgs factory is four times that of the baseline. A merit of a circular collider is that multiple collisions points can be arranged. The CEPC would run with two collision points. All in all, the ILC

as a Higgs factory is quite similar in luminosity to the CEPC. The wall plug power for the ultimate ILC Higgs factory is 187 MW, which is about the same as the current LHC, while that of CEPC is more than twice as much.

At the latest LCB (Linear Collider Board) meeting, the way to communicate



*The long version of the ILC's physics case*

the physics case of the ILC to public was one of the topics intensively discussed. The LCB has then agreed that we need a short bulleted list of the physics case for the ILC. Several of us then sat down and came up with three points. Here they are with some editing:

\* the Higgs is a special particle; the more accurately you measure it, the more new laws of physics one can reach.

Important properties are the interaction strength between Higgs and other particles. ILC can measure them 3 to 10 times more accurately than the ultimate LHC. This means that the ILC is equivalent to 10 to 100 ultimate LHCs running simultaneously.

\* the LHC can reach higher energy than the ILC, but can miss important phenomena.

At the Tevatron collider, which is similar to the LHC, more than 10,000 Higgs particles were created but no clear signal was detected. At the ILC, about 100 Higgs particles are enough.

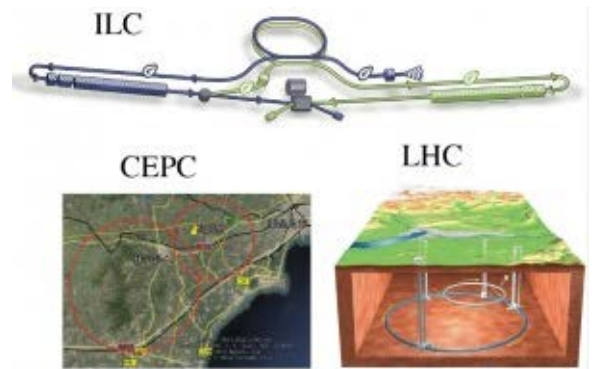
\* Circular electron-positron colliders have fundamental limits for energy increase due to synchrotron radiation.

In the Standard Model of particle physics, the Higgs particle is the key particle and top quark is the heaviest particle. Higgs-Higgs, Higgs-top interactions cannot be directly measured at the circular electron colliders since they cannot reach high enough energy. When a new particle sits at just above the energy limit, the ILC could be upgraded to reach the energy by making it longer or using higher accelerating gradient while it is difficult for a circular collider.

[CEPC](#) | [FCC](#) | [HIGGS](#) | [ILC](#) | [LHC](#) | [PHYSICS CASE](#) | [TDR](#)

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*ILC, LHC and the Chinese CEPC in overview*

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LIVE FROM JAPAN

## Morioka: placed at the “crossroads” of Japan

Dean H. Ruetzler | [19 March 2015](#)

When the ILC hopefully comes to Iwate it will be in the vicinity of a few decent-sized cities. Ichinoseki (2014 pop. estimate: 122,000) and Oshu (120,000) will be the hosts and the more concentrated Hanamaki (95,000) and Kitakami (93,000) are within an hour's drive away. They will be able to supply good restaurants, shopping centers, department stores, cinemas, bars, and other forms of entertainment. A UNESCO cultural site at Hiraizumi and a good ski area with snow aplenty at Geto are in that same accessible sphere.

However, humans have desire to explore, a wish to select and purchase from a greater variety of products, an innate need to explore with one's leisure time, and in more succinct terms, a drive to experience different activities on occasion. When this wanderlust arises, the most logical place to go will be to Iwate's prefectural capital, Morioka and its environs. Approximately 65 kilometres away, the Tohoku expressway will get one there from the ILC area in a little less than an hour, the commuter train, a little bit more than that hour. A bullet train can do the job in fifteen or twenty minutes without getting anywhere near top speed, and a Sunday drive on Japan's most traveled highway will have you there in a the 90 to 120-minute range.

Simply put, to me Morioka represents the “crossroads” of Japan. It encapsulates where cutting-edge, uber-modern Japan faces its feudal past. Where urban and cosmopolitan are surrounded by rice fields, hamlets, lush forests, and craggy mountains. Where traffic jams and shopping malls give way to bear sightings, volcanic hot springs, and orchards the next town over.

Quite possibly, it is the largest town of consequence between Sendai, Japan's eighth largest city, in Miyagi prefecture, and Sapporo, the main city of Japan's northern island Hokkaido. At worst, Morioka duels similarly-sized Hakodate, the port city at the Southern tip of Hokkaido for that title. Its central location makes it an ideal conduit for commerce coming from Tokyo and Sendai heading west to Akita prefectures capital Akita City, north to Aomori's capital, Aomori-City and northeast to Aomori's port city Hachinohe. In fact, before the expansion of the bullet train's reach during the past fifteen years, Morioka was indeed the “*shuuten*” or “last stop” for all bullet trains going north.

Is Morioka big enough to meet up to the capricious whims and sensibilities of London-ites, Los Angelenos, Romans, Bostonians, and others accustomed to living in the major cities of the world? Of course not, but let's be fair, few places in the world can provide that. Morioka provides just enough of that lifestyle to satisfy cravings for the urban and upscale. Morioka is comparable in size and population to cities such as Honolulu and Anaheim in the US, Brno, Bologna, Bonn, Canberra, the metropolitan areas of Zurich and Nice, and its Canadian sister city, Victoria. It can provide enough of the accoutrements of city dwelling to eliminate the need for weekly trips to Japan's major cities like Sendai (a two-hour bus trip away), Tokyo (two hours by bullet train), and the Osaka/Kyoto/Kobe corridor (about an hour away by plane).

Morioka gives one a wide and delicious variety of restaurants serving fare from around the world and also plenty of local treats worth trying. To underscore this point, not only does Morioka have about a half-dozen each of the ubiquitous chains Starbucks, McDonald's and KFC, it has nearly a dozen places where you can sample authentic, Indian/Nepali cuisine. In addition you will find two huge multi-level malls, and several large department stores exist to meet shoppers' needs. The city centre, like many across the developed world lost out its shopping pre-eminence to the large box stores taking root in its suburbs. The city planners adroitly re-invented it as its urban playground with hip novelty stores, restaurants aplenty, revamped movie theatres, coffee shops, dance clubs, bars, a weekend pedestrian mall in good weather, and plenty of special events to attract customers. It even has a few book sellers who have decent selections of foreign language books and magazines. It will not be impossible to find the latest issue of The Economist or Sports

Illustrated, or a best-seller off the New York Times list.

For those adventurous visitors who do want to dive into Japan's storied and historic native culture, Morioka has plenty to offer. The city park is built around the ruins of a feudal castle. Shrines and temples dot the landscape, including some with easy access from the main part of town. For four days in the summer, the world largest taiko drumming exhibition takes place at the Guinness world-record holding *Sansa Odori* dance festival. Being little more than two hours from both the Sea of Japan and the Pacific Ocean, there is a good chance the sushi and sashimi you are enjoying today was swimming yesterday. If you want to move beyond a pint of Guinness and a decent plate of nachos (Morioka has a place that will serve you both!), why not head to a traditional Japanese *izakaya* watering hole and sample rice wine (*sake*), salted soybeans in the husk (*edamame*), and some of the local fish, vegetables, and meaty treats. Before I came to Japan I never thought I'd eat pickled jellyfish, let alone ask for seconds.

Now that we have established that Morioka is a little more substantial than the proverbial "cow town", I'm sure your next question is: "What about the great outdoors? Where is THAT?" Well, it literally surrounds Morioka. The Ou Mountains which are the western border of the prefecture dot the horizon. Including Mt. Iwate the third tallest in Tohoku, a mere twelve miles away. The Kitakami River, Japan's second longest contributes to a confluence in the center of town.

Lake Tazawako, Japans deepest, is a mere twenty miles away, just over the border of neighboring Akita prefecture. Needless to say, alpine cross country, and telemark skiers, ice skaters, snowmobilers, hikers, campers, hunters, fishermen and women, jet skiers, wake-boarders, boaters, outdoor enthusiasts and dilettantes of all types will find places to play.

For those who hear the calling of the ocean, it will be close enough to answer. The eastern border of Iwate is the Pacific Ocean, with most coastal towns within two or three hours of Morioka by car or train. The Sea of Japan borders neighboring Akita and is only slightly further to reach. Though not a surfer myself, I do know of plenty who have found some decent Iwate surf to explore. I am a sushi enthusiast, and can promise you the best I ever had was on the Iwate coastline, probably because it was most likely swimming earlier that day. Of course, the Iwate coast is rebuilding from the tsunami of March 2011, and it provides many worthwhile volunteer and philanthropic opportunities.

To the foreign visitor, the two biggest gems, aside from Mt Iwate, which towers over Morioka the same way Mt. Fuji does to Tohoku, near Morioka would be Koiwai Farms and Appi Ski Resort.

Koiwai, in Shizukuishi, which borders Morioka, is one of Japan's leading producers of high quality dairy and agricultural products. In addition they have created a combination of restaurants, exhibitions, gift shops and a petting zoo on their scenic property. It is a truly appropriate place to take either a date or your children. Think of it as a Japanese version of Ben-and-Jerry's factory tours, the biggest tourist attraction in my home state.

Appi, which is about twenty miles from Morioka, is a ski resort that consistently finds itself on top-five lists for both Japanese and Asian ski resorts.



*Morioka Landmarks: Marios & Aiina. Image: Dean H. Ruetzler*



*Appi: one of Asia's best. Image: Dean H. Ruetzler*

They have a very good business model, having seen that investing money in the resort will come back to them in consumer visits and money. On any given day there you will hear not only Japanese, but also plenty of Chinese, English, Korean, and even some Russian, being spoken by their numerous foreign visitors. Of course the outdoors in Iwate would not be complete without the "onsen" or volcanic hot springs that dot the landscape. They are probably also the most popular with domestic tourists. Though I still don't understand the Japanese habit of a mid-summer soak in hot water, I can vouch for the sublime treatment your aching muscles and psyche will get from one from September to May or June.

Morioka may not be the epitome of big-city living nor nature in its infinite splendor. However, it will supply enough of both to provide a good place to live and recreate, and can be a good candidate city to live when ILC comes to Kitakami.

[ICHINOSEKI](#) | [ILC SITE](#) | [KITAKAMI](#) | [MORIOKA](#) | [OSHU](#) | [TOURISM](#)

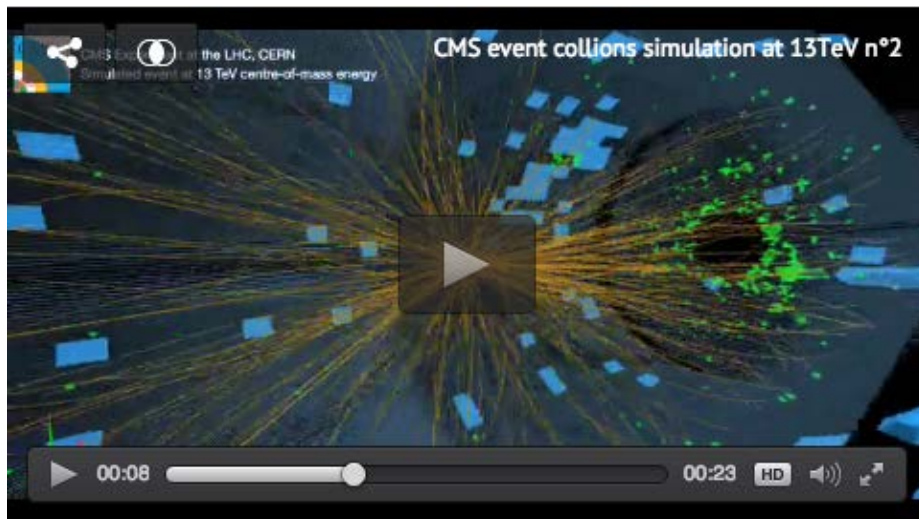
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## FEATURE

### Ready for the jump

Barbara Warmbein | [19 March 2015](#)



*A simulated event at 13 TeV in the CMS detector at the LHC. Animation: Thomas McCauley, Copyright: CERN, for the benefit of the CMS Collaboration*

The LHC's so-called Run 2 kicks off when first beam circulate in the 27-kilometre tunnel. After a period of getting to know the consolidated and improved LHC, the machine operators think they can deliver first collisions at 13 TeV to the LHC's experiments in late May or early June. This is a 60% increase in energy, opening up doors to new physics territory. "The start of Run2 represents a jump forward almost as significant as the transition from the Tevatron to LHC's Run 1, and it promises the biggest extension of the discovery reach of the whole future of the LHC programme," says CERN theorist Michelangelo Mangano. "We can expect spectacular surprises. It opens the door to a very very exciting period.

The discovery potential is high. Not only will scientists look at the Higgs boson in more detail to get a clearer picture of its properties, maybe even spot discrepancies with the Standard Model of particle physics. They will also look for signs of supersymmetry (SUSY) or new particles that could hint at forces we did not know before. The theory of supersymmetry says that all known particles have heavier superpartners, new particles that bring a new dimension to the subatomic world. The lightest superpartner is a likely candidate to be dark matter, and could thus also explain the structure of the cosmos. The candidate for the lightest superpartner (the so-called neutralino) could appear in the decays of the gluon's superpartner (the gluino), and Mangano says that he is "ready to bet the SUSY will show up one way or another."

While many collisions are needed to confirm a discovery, Mangano says that signs of as yet undiscovered and unexpected things could show up in the data already after the first few months of Run 2. One contender for physics beyond the Standard Model is a force carrier particle called  $Z'$  – a heavy version of the Z boson, carrier of the weak force and well known to particle physicists. A new force carrier particle means there must be a new force we did not know about – a discovery that would rewrite textbooks.

Hitoshi Murayama agrees: within a year the data should reveal what is lurking in the new energy realm, he says. Murayama, who is a theoretical physicist at Berkeley, Director of the Kavli Institute for the Physics and Mathematics of the Universe (IPMU) and Deputy Director of the LCC, also has the gluino and the  $Z'$  on top of his wish list for discoveries at the LHC, with the gluino being "our best shot" at detecting dark matter. "However, we would of course not know right away what it is – it would take years to learn about its spin, its mass and other properties," he says. "That's where the ILC would excel, nailing all the properties of the new finds and of course of the Higgs." Even if the LHC does not discover anything new beyond the Higgs, he considers the ILC a crucial machine to study its precise



nature – “it’s a new brand of particle, we need to learn more about it, and even the long-term LHC programme couldn’t reveal as much as the linear collider could.”

In [a recent paper](#), he pitches the idea of a new model of dark matter that is nearly an exact copy of QCD, the theory associated with the strong force that relies on the gluon. What if dark matter also interacts strongly? A detailed study of the  $Z'$ , if produced at the LHC, may show it decays into these strongly interacting dark matter particles and would help answer parts of these questions. More answers could come from electron-positron collisions by measuring the coupling of  $Z'$  to dark matter particles.

The LHC programme is mapped out until the year 2035, by which time it will have collected a massive 3000 inverse femtobarns of data, where one inverse femtobarn corresponds to approximately 100 trillion –  $10^{12}$  – proton-proton collisions. “There’s plenty of room for a deeper exploration of nature,” says Mangano.

[DARK MATTER](#) | [EXTRA FORCES](#) | [FCC](#) | [GLUINO](#) | [HIGGS](#) | [ILC](#) | [LHC](#) | [QCD](#) | [SUPERSYMMETRY](#) | [Z'](#)

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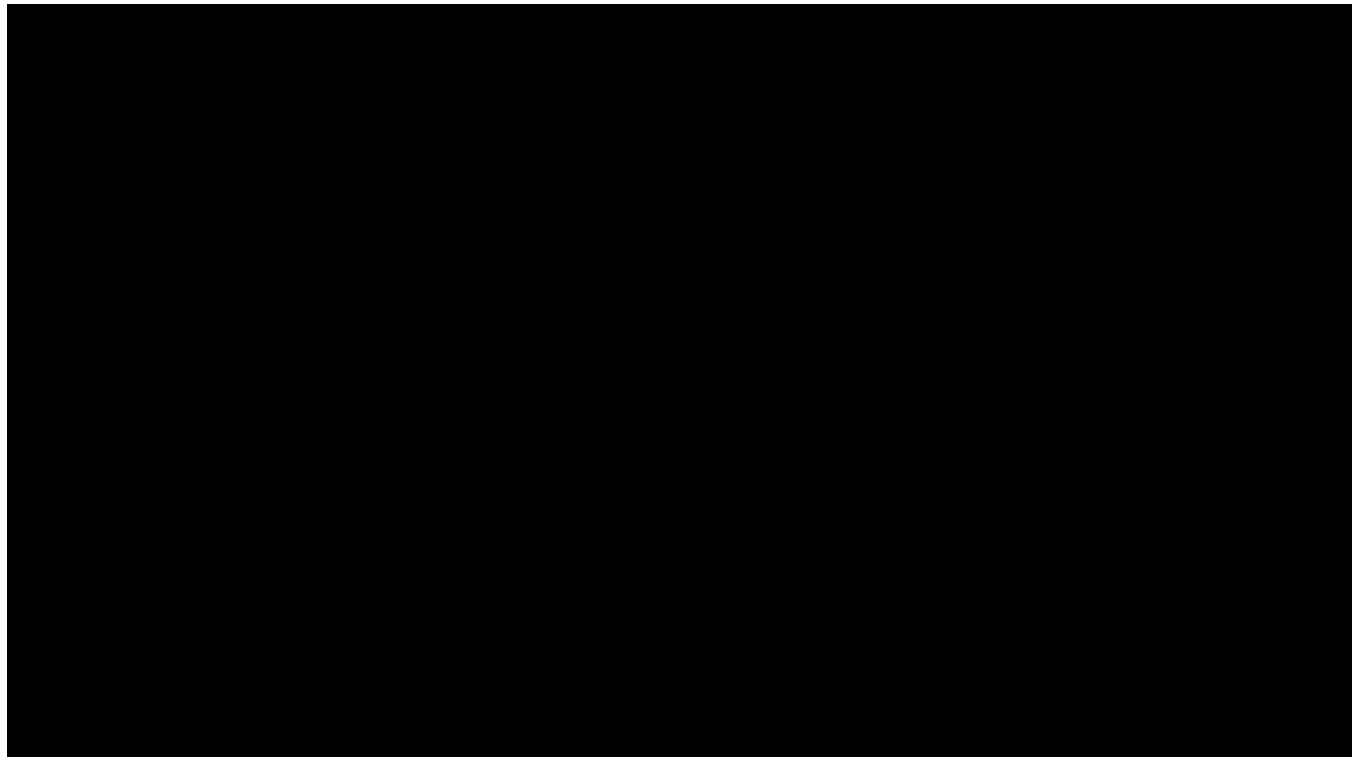
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## VIDEO OF THE WEEK

### The ILC is a fantastic accelerator, Nobel says

[Perrine Royole-Degieux](#) | [19 March 2015](#)

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