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ilc NewsLine Quarterly

The ILC—a proposed particle accelerator

International Linear Collider News

Chinese-built quadrupole magnets placed in position at KEK's ATF2.
Photo: Nobu Toge

ATF2

Test facility for an international project

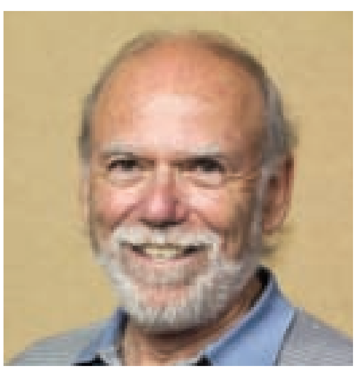
Director's corner

Bumps in the road

It can be a long and bumpy road from an idea to building an ambitious large international science project. Along the way there are many hurdles and challenges to overcome.

For the ILC, we have had to face the first hurdles very early. During the past three months, we have received a double blow, having lost UK support due to their funding agency STFC's (Science and Technology Facilities Council) financial crisis and its decision to concentrate particle physics resources on the CERN programme. Soon after, the US budget bill for the fiscal year 2008 was passed that meant budget cuts at the expense the physical sciences, including the ILC. Although the ILC is only in a conceptual design phase, we fortunately have already established a very strong foundation based on global collaboration that is helping us withstand these disappointing developments.

Barry Barish, GDE Director
Photo: Fermilab



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There is no way to paint a positive face on these funding actions. They are a setback, but in the end, they are slowing, not stopping our progress toward a linear collider. The science imperatives and needs for a linear collider remain as strong as ever, and combined with the GDE reference design it gives us a solid foundation to fall back on and re-build our programme. It is important to note that funding remains stable for the rest of the global ILC collaboration.

We have already outlined a new plan that maintains our central goal of being ready to make a successful project proposal to our governments whenever LHC discoveries justify. We maintain this ambitious goal by establishing strict priorities, by eliminating duplications in different countries and by deferring some less essential tasks. We plan to reintegrate our US colleagues and their work next year, as in the President's FY09 proposed budget, and are hopeful that we will be able to retain the involvement of a few key UK people.

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Feature story

ATF2

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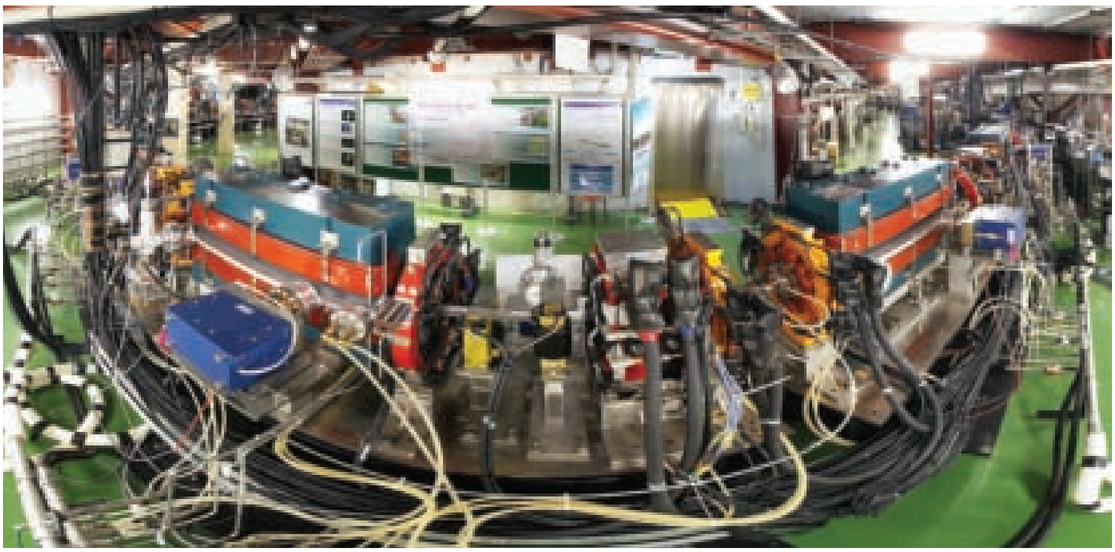


Small emittance beam: A beam where the particles are confined to a small space and have nearly the same momentum, which will lead to the greater likelihood of particle interaction. *Photo: Nobu Toge*

In order to make the discoveries the ILC is aiming for, scientists need large amounts of high-quality data. This requires high luminosity (the rate of collisions per cross sectional area), because the more often particles collide, the larger the amount of interesting data they will produce. For achieving the high luminosity required at the ILC, it is crucial to create low-emittance beams, focus the beams to nanometres and drive the collisions with nanometre-scale stability. These are big challenges.

The Accelerator Test Facility (ATF) at KEK, Japan is a test accelerator to develop beam with very low emittance, and has been successful in obtaining an emittance that satisfies the ILC requirements. Another test facility called ATF2 is now under construction at KEK. ATF2 can be described as a small-scale ILC final focus system, since many features of ATF2 are common to the ILC final focus system. The two have an identical optical design. It will address the challenge of beam focusing by establishing the technology associated with ultra-high precision beam control. This creates a tightly focused stable beam by making use of the small emittance beam from the ATF.

ATF2 has another ILC-like feature—it is a truly international project. Laboratories and Universities from over eight countries and one international laboratory, CERN formed a world-wide collaboration that produced the technical design, the construction and installation plans, and schedules and defined responsibilities of the partners. “Now the floor construction has been finished and Chinese magnets are brought in. The components made in the US were tested in France, and have just been delivered to KEK,” said Toshiaki Tauchi, the Project Sub Leader of ATF2. “The project will provide invaluable input for the ILC, both in terms of technical development and management.”

“The project will provide invaluable input for the ILC...”.

Feature story

Two detectors become one

The ILC has a new detector concept: ILD

The ILD community met for their first workshop in January. *Photos: Christine Iezzi*

The International Linear Collider will have two detectors to ensure best possible—and comparable—physics results. Until recently, scientists around the world have worked on four different detector concepts. Two of these, the Large Detector Concept and the Global Large Detector, have now decided to merge into one new project called International Large Detector Concept (ILD). The freshly combined groups are planning to submit one common Letter of Intent—a formal document on the basis of which a committee will select the final detectors—and have just met for the first time at Zeuthen near Berlin, Germany to discuss details of how to combine their formerly independent plans. Almost 120 people attended this first ILD workshop.

The two concepts are similar in many aspects, and by combining them, resources can be used in a more efficient way. Their size is comparable, and they use similar, sometimes identical technologies for the subdetectors. Their innermost detectors called tracker were very alike, while some other sub-detectors differ in layout and the physics they specialise in. Scientists from both concepts have been working together for a long time in collaborations such as the Calorimeter for Linear Collider Experiment and the Linear Collider-Time Projection Chamber collaborations. Since the merger, representatives from both former concepts and all countries of the ILC meet virtually every week to optimise the future ILD. Software and simulations are most important at the moment, while the actual hardware decisions will remain open until after the Letter of Intent to ensure that R&D can continue and the best possible technology is chosen in the end.

NewsLine profile

Imad Laktineh

Imad Laktineh in front of the hadron calorimeter test bench in Lyon, France.
Photos: CNRS/IN2P3

Hunting for the origin of mass

France's Imad Laktineh works on the digital hadronic calorimeter prototype

Even though passionate for fundamental physics, Imad Laktineh was not exactly bound for detector physics R&D from the beginning. After he obtained his PhD in theoretical nuclear physics, he switched to physics analyses on the LEP electron-positron collider at CERN. His work on 'B' physics and on supersymmetry searches were mainly based on analysing data collected from the DELPHI and L3 experiments. After ten years, he drastically changed his activities to work on the R&D of a detector hunting for the rare oscillations of neutrinos at the Gran Sasso laboratory in Italy. "I did not know that R&D could be so exciting. It is really a creative and complete activity which makes you develop engineering skills while demanding precise and profound understanding of the particle behaviour within matter," said Laktineh.

While pursing his neutrino researches, Laktineh, professor at Lyon University, France, joined the Calorimeter for Linear Collider Experiment collaboration (CALICE) two years ago and created the ILC group at the Nuclear Physics Institute of Lyon, a CNRS/IN2P3 lab. "It was rather natural for me to go from one field to another. Both seek for fundamental questions like the origin of mass origin and grand unification theories," he says. The activities also are not so different since he dedicates his time to R&D on an ILC sub-detector called the hadronic calorimeter (HCal). This calorimeter measures the energy of all those particles that make it through the dense electromagnetic calorimeter.

"The HCal is not only a sub-detector for the ILC. Working on its development gives us a unique opportunity to better understand how hadronic particle jets behave, which is not very well known," said Laktineh. The option on which he is working, called "digital" HCal, gathers scientist from US, Spain, Russia and France. Within CALICE, they work in close collaboration with their colleagues of the "analogue HCal". "With more than 200 scientists, CALICE is already a big collaboration," says Laktineh. Recent additional funding from the French National Research Agency (ANR) will allow the French teams to work on the nearly full-scale- prototype of the DHCal. "We expect to test this prototype in the near future, to accurately compare the digital and the analogue solution," he says.

After his early electron-positron experiences at LEP in the nineties, Laktineh's career came full circle with the ILC. "An electron-positron collider is a highly precise probe of physics theories and I am very happy to come back to it." Laktineh said he has never been bored in his research activities because he always kept an eye on what other particle physicists were doing outside his field. "Change is sometimes good for creativity," he smiles.

In the news

ILC meets the CLIC team

After the Large Hadron Collider, the science community agrees that particle physicists will need an electron-positron linear collider to fully understand and discover the potential new science at high energy regimes. Apart from the ILC, another variant of such collider based on a warm accelerating technology is under study: the Compact Linear Collider Study (CLIC). The two teams recently met to investigate the connections between the two projects and list potential cooperative efforts on common activities.

"Many scientists and engineers face similar challenges while striving to bring these complex tools to reality," said Marc Ross, ILC Project Manager. While working together, sub-systems teams could bring a diversity of skills and tools to bear. "It will not only be educational but also beneficial for both," said Jean-Pierre Delahaye, CLIC study leader at CERN. Such cooperation will be very useful for ILC and CLIC where R&D efforts are themselves large international projects. Both the CLIC collaboration, hosted at CERN, and the ILC-GDE rely on in-kind contributions, where participants provide equipment and effort and receive in return a share of the final product.

The final goal of this cooperation is to develop common project tools and plans, together with evaluation tools, which will make it easier to review and compare both when, and if, it becomes necessary to do so. The meeting was attended also by detector experts from ILC and CLIC projects.

In the future, the two teams will participate broadly in major meetings of both projects and report progress to the ILC Executive Committee and the CLIC Collaboration Board.

The CLIC test facility. *Photo: ILC*

3D chip technology development. *Photo: Fermilab*

3D chips for future detectors

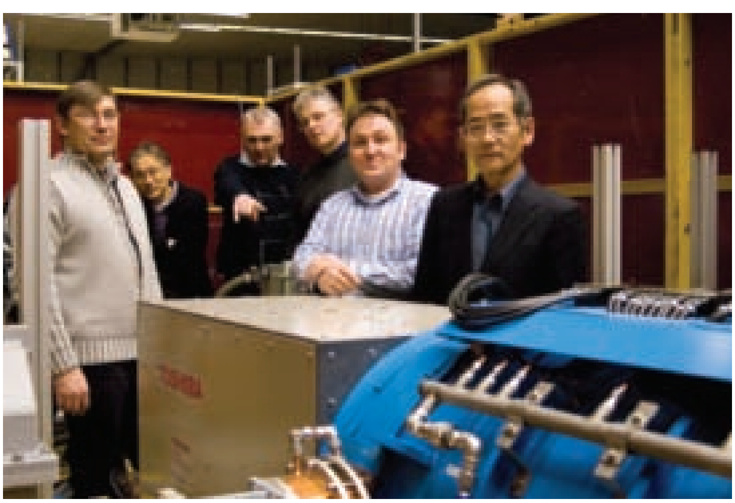
Scientists from Fermilab believe that new 3D vertical integrated silicon technology may help to make future particle detectors lighter, more concise and consume less power. Vertical Integrated Systems, or 3D technology for short, consists of layers of extremely thin silicon stacked on top of each other with interconnections between the layers. This new stacking ability could revolutionise the semiconductor world because it allows engineers to make very thin, low-power devices with optimised technology, meaning lighter, longer-lasting mobile devices with a lot of memory.

Fermilab is further developing this 3D chip technology for future particle detector use. In 2006, a team of Fermilab scientists designed their own 3D chip, dubbed the Vertical Integrated Pixel chip. After processing and assembly they are now trying to characterise the behaviour of the chip.

Horizontal challenge

The world's first horizontal multi-beam klystron has started its site acceptance test at DESY. Built by the Japanese company Toshiba, it is the first of three prototypes from different companies to arrive for the test that will determine whether the new klystron design works. The 10-megawatt horizontal klystron was developed for the European X-ray Free Electron Laser (XFEL) and is also part of the reference design for the ILC.

Klystrons provide the crucial driving force of millions of watts of radiofrequency power at 1.3 gigahertz to the particle bunches in the accelerator before they collide in the middle at 500 GeV. Traditional klystrons stand about two metres tall and provide single electron beams. For the XFEL and the ILC, multiple beams are needed because they are more efficient, and in order to fit into the tunnel, klystrons were redesigned to function horizontally—a major challenge. First tests already showed an efficiency of 67 percent. The tests continue in the beginning of the new year, in order to analyse all observed data in further detail and to fine tune the klystron.



The world's first horizontal multi-beam klystron and its team. *Photo: DESY*

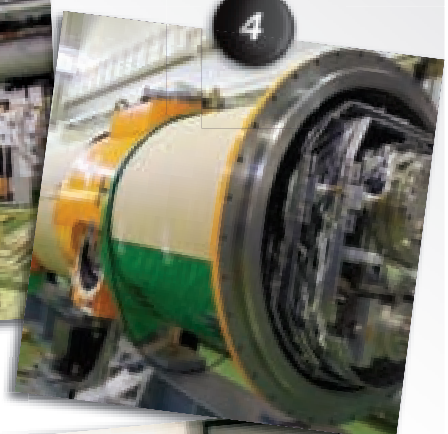
SNS cryomodule in the new test stand. *Photo: Oak Ridge National Laboratory*

New SCRF test facility at Oak Ridge

Oak Ridge National Laboratory in Tennessee, US, has tested its first cryomodule in their new superconducting radiofrequency test facility. Oak Ridge runs the Spallation Neutron Source (SNS), a neutron source used for materials driven by a superconducting linear accelerator. It is also a routinely operating pulsed superconducting linear accelerator, making it one of the ILC's closest living relative, next to FLASH at DESY. Within a few weeks of completing the test facility the first cryomodule was fully tested and installed in the linac afterwards.

The new cryomodules test facility has a five-megawatt and 805-megahertz dedicated radiofrequency (rf) source for full investigation of SNS rf structures. The rf system is set up to power on single or multi-cavity operation, which makes it possible to charaterise all of the cavities' limits, including collective ones. The cryogenics are supplied from a new transfer line off the central helium plant and are operated from the main control room. "The need for this facility comes from the power ramp up plan in which the beam power is to increase from currently 200 kilowatts to 1.4 megawatts in the next few years," explains Oak Ridge's John Mammosser. "Other superconducting rf structures can be prepared and assembled at our new test facility. For example, we are planning to build several new cryomodules using standard preparation techniques developed from other labs such as DESY and Jefferson Lab."

Snapshot gallery



1 Superconducting Test Facility (STF), KEK, Japan: four units of TESLA-like cavities are assembled in the clean room…

2 …and rolled out of the clean room for cold mass assembly work.

3 During cold mass assembly…

4 …and the finished cryomodule

Photos: Nobu Toge, KEK

5 A new high-resolution camera could drastically improve cavity inspection. Photo: KEK

6 Vinod Sahni, the director of India's Raja Ramanna Center for Advanced Technology, toured U.S. laboratories. Photo: Fermilab

7 The International Linear Collider Steering Committee (ILCSC) met at DESY, Hamburg, in January. Photo: DESY