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10 FEBRUARY 2011

DIRECTOR'S CORNER

A conversation about our future

by Barry Barish

What is the ILC future programme beyond the *Technical Design Report*? How does the ILC project move forward if the decision on a linear collider construction project is delayed a few years? These questions and many others were addressed during the last Funding Agencies for Large Collaborations meeting held on 22 January at SLAC, US.

AROUND THE WORLD

Spreading the positron energy around

ILC scientists develop a robust and reliable positron target

by Leah Hesla

Scientists from the Cockcroft Institute, Daresbury Laboratory and Lawrence Livermore National Laboratory work on a rotating positron target for the ILC that can hold its own while producing about 10^{14} positrons per second for collisions with electrons.

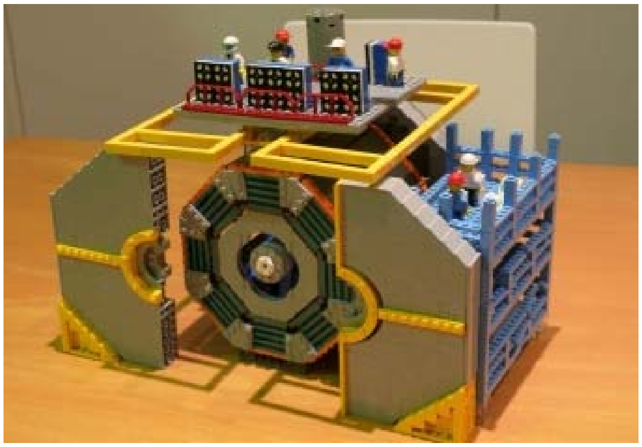
AROUND THE WORLD

Many small klystrons for operability and flexibility

by Rika Takahashi

Scientists at KEK in Japan are currently developing are developping a 'distributed radiofrequency system' for delivering radiofrequency power to the ILC accelerating cavities. An alternative solution to the 'klystron cluster scheme', this powering method accommodates the ILC's new one-tunnel design.

IMAGE OF THE WEEK



Toy model

Image: KEK

Another toy for particle physicists to play with: BELLE-II-detector model made of… LEGO! This work of University of Tokyo students is exhibited in Tokyo till 25 March, at the exhibition hall of the MEXT, KEK's funding agency.

IN THE NEWS

From Hamburger Abendblatt
9 February 2011
Hamburg stärkt seine Spitzenforschung
…Universität und Desy bündeln im neuen Projekt PIER ihre Kompetenzen in der Physik. Auch Entwicklung der Medizintechnik wird davon profitieren.

From Russia and India Report
8 February 2011
Russia takes a leading role in international physics projects
Russia is returning to the big leagues of science by becoming a full-fledged participant in major international projects. One of them, [FAIR], is headed by Boris Sharkov, a Russian physicist.

From Scientific American
7 February 2011
Opposite Spins: The LHC Accelerates Higgs Search as the U.S. Shutters Its Tevatron
After all, if the Higgs proves to be near the lower end of its range of possible masses, as experiments indicate is likely, the Tevatron would have had a good shot at finding it—and maybe even beating the LHC to the punch.

From The Washington Post
7 February 2011
IceCube opens up a window on energy in the universe
IceCube is something different, an observatory built entirely beneath the ice. Along each of the 86 cables are strung 60 three-foot spherical detectors (…). These glass-covered orbs are designed to find evidence of neutrinos.

From datacenterdynamics.com
3 February 2011
Ciena and Renater push LHC data over 100Gbps network
Using technology enabled by Ciena's ActivFlex 6500 Packet-Optical Platform, the trial successfully transmitted data over a network connecting the European Organization for Nuclear Research (CERN) in Geneva and the IN2P3 Computing Center in Lyon, France.

ANNOUNCEMENTS

CALENDAR

Last days for early registration to ALCPG11!

Don't miss the early registration deadline for the Linear Collider Workshop of the Americas and GDE meeting, or ALCPG, to take place this year in Eugene, Oregon, US from 19 to 23 March. After 15 February the registration fee goes up to $US 485!
Register here – Visit workshop website

UPCOMING EVENTS

End Station Test Beam (ESTB) Workshop 2011
SLAC
17 March 2011

2011 Linear Collider Workshop of the Americas (ALCPG11)
University of Oregon, Eugene, Oregon, USA
19- 23 March 2011

2011 Particle Accelerator Conference (PAC'11)
New York Marriott Marquis Hotel, New York, NY, USA
28 March- 01 April 2011

UPCOMING SCHOOLS

Excellence in Detectors and Instrumentation Technologies (EDIT 2011)
CERN, Geneva, Switzerland
31 January- 10 February 2011

View complete calendar

PREPRINTS

ARXIV PREPRINT

1102.1417
QCD correction to single top quark production at the ILC

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DIRECTOR'S CORNER

A conversation about our future

Barry Barish | 10 February 2011

FALC and GDE members listening to reports from the regional director

The major activity for the Global Design Effort in January was centred on the second Baseline Assessment Workshop held at SLAC from 18 to 21 January. Nick Walker reported on the meeting in this column last week, and I will report on the proposed change actions as soon as they occur. But in addition, by chance scheduling, the Funding Agencies for Large Collaborations (FALC), the GDE oversight group for resources, also held their biannual meeting at SLAC on 22 January. We were able to take advantage of this timing coincidence by arranging for an informal meeting between FALC members and the GDE Executive Committee. What resulted was a unique and lively discussion focused on the future of the ILC project once we complete our *Technical Design Report* (TDR) at the end of 2012.

FALC is an informal forum where representatives of funding agencies from different countries exchange information and views on ongoing and future large international projects for particle physics. I participate in their meeting, as do the directors from major laboratories. Brian Foster has been participating over the past year or so to report on our work on ILC governance.

The joint discussions between FALC and the GDE Executive Committee consisted of a two-hour informal session where a set of short presentations were made during the first hour, followed by an interesting free-form discussion during the second hour. The short talks were given by ILC Research Director Sakue Yamada on ILC detector activities and resources, followed by three talks by the GDE regional directors on ILC R&D programmes and resources around the world: Brian Foster for Europe, Mike Harrison for the Americas and Kaoru Yokoya for Asia. At the end of these presentations, Mike Harrison shared some of our recent thinking as to what might be elements of a technically driven ILC programme after 2012.

GDE EC members during discussions with FALC members

The open discussion following these presentations focused mainly on the future programme beyond the TDR. We will have completed the mandate of the GDE after completing the TDR, but we anticipate that will still be too early to propose an ILC construction project. In most timelines, we now expect it will take a few more years before sufficient Large Hadron Collider results will be available to point the way for the next big project in particle physics. However, a recent decision at CERN to extend their coming run period to two years is encouraging and increases the possibilities for significant early results.

Nevertheless, the question we are pondering is what programme would be justifiable and most useful to move the ILC project forward if the decision on a linear collider construction project is delayed a few years? This topic is also being considered by the International Linear Collider Steering Committee and ICFA, especially from an organisational point of view, and that will be a major focus of their meeting in Beijing in February.

During the discussion between FALC and EC, the focus was more on the technical programme, including superconducting radiofrequency R&D, industrialisation, value engineering, and other R&D topics. There was no attempt to draw consensus, but certain themes emerged in the discussion. In general, the tenor of the discussion was receptive to developing a continuing programme, but some valuable points were made. For example, there were several comments that were supportive of a selective technically driven programme, especially one that features topics that would both advance the ILC design and be of value for other projects.

Richard Wade, STFC, during the EC-FALC discussions

Richard Wade, chief operating officer and deputy chief executive of the Science and Technology Facilities Council (STFC) in the UK, gave some rather candid advice that we should be very mindful of the value and legacy of our technological programme, independent of whether the ILC is ever built. This seemed to be a sobering remark, especially for those of us dedicating so much of our efforts towards making the ILC a reality. However, there is much to be said for the intrinsic value of our programme and the impacts it makes, which go far beyond our *raison d'être,* the ILC, and we should take full advantage of exploiting this legacy.

FALC | FUTURE | SLAC | TDR

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AROUND THE WORLD

Spreading the positron energy around

ILC scientists develop a robust and reliable positron target

Leah Hesla | 10 February 2011

The rotating positron target sits in a protective steel bunker. A dipole magnet (rear) creates a one-tesla magnetic field to help with tests related to eddy currents. The two light grey boxes in the foreground measure the wheel rim's temperature. Image courtesy of Ian Bailey.

The ILC's positron target is about to undergo tests of fortitude.

Researchers with the Global Design Effort are developing a positron target for the ILC that can stay cool while producing about 10^{14} positrons per second for collisions with electrons. To accomplish that, it would have to withstand a barrage of photons, stave off feverish heat, and do it all while spinning stably at 2,000 revolutions per minute.

"We're trying to do something no one's done before, and we're on track," said Ian Bailey of the Cockcroft Institute in the UK.

The heart of the ILC positron source is a one-metre-diameter, five-spoke titanium alloy wheel. A beam of ten-megaelectronvolt photons strikes the wheel's rim, the positron target, as it spins. The overall impact of the photon beam is thus spread around the target, helping to mitigate the damage that would occur if the particle onslaught were concentrated on a single spot. Photons striking the target create electromagnetic showers in which positrons are born.

Scientists completed a prototype of the wheel at Cockcroft and at Daresbury Laboratory in the UK in 2008. Tests have shown that it should be able to survive not only a photon fusillade, but also overwhelming heat.

"The photon beam that's hitting the target is intense," said Jim Clarke of Daresbury Lab, who, as group leader of the GDE Positron Technical Area Group, headed the effort to construct the hardy wheel.

The photon radiation is one source of heat. Yet another arises thanks to a device that's positioned directly behind the target, the flux-concentrating magnet.

An integral part of the ILC positron source, the flux-concentrating magnet captures positrons coming off the target and steers them on the path toward the accelerating cavities. Unfortunately, the magnetic fields near the spinning wheel also create so-called eddy currents within the metal. Those currents, in turn, kick up its temperature.

Modelling eddy currents is a thorny business. Three different teams simulating the problem produced three very different responses to it. With an additional 20 kilowatts of heat potentially circulating the wheel, it was worrisome.

"A rotating wheel in a magnetic field is a nineteenth-century physics problem," Bailey said. "It doesn't sound cutting edge, but it isn't as simple as physicists think it's going to be when they first look at it." So the team took to the problem by actually constructing a target, then comparing it with various models.

"It turned out the best way to get the right model was just to build a wheel, put it in a magnetic field and turn it," said Clarke. Tests show that the current target prototype should handily overcome any adverse effects from the eddy currents. But the team will continue comparing experiment against models to reconcile the two.

They will also aggressively combat the unavoidable heat by sending cold water through the target's spokes and around its rim, where the photons strike.

“To get the water in the wheel and out again is quite complicated,” said Clarke. Now a team at Lawrence Livermore National Laboratory in the US will test a mockup of the target, in part to make sure the wheel’s shaft can handle the cooling water flow.

Heat is not the only peril of rotation – rotation itself can create its own dangers.

Ian Bailey holds one of the wheel’s off-cuts next to the rotating positron target prototype. Off-cuts are used for wheel material studies. A motor sits behind the wheel.

“You could be nervous that it could come off its bearing and fly across the building,” Clarke said, which is why the target is kept under a steel bunker with extra protection. And while it is assuring to know the bunker will protect it, Daresbury Lab tests demonstrate the fast-moving wheel won’t fly off the handle under the force of its own spin.

Future tests at Livermore will also vet the system’s mechanical stability.

“We’re trying to build exactly what we would build for the real experiment,” said Livermore’s Jeff Gronberg. They’ll examine the rotordynamics of the support system to make sure it hits no resonant frequencies, which could cause undesirable vibrations.

Studies of the rotordynamics must also include tests on vacuum seals. The wheel is situated on a shaft that passes from vacuum into air. Even as the shaft spins at 2,000 turns per minute, the material that seals the space where the rotating shaft makes contact with the vacuum chamber wall has to hold. That isn’t trivial.

The Livermore team is currently inspecting a ferrofluidic seal, which should allow the shaft to spin freely even as it keeps the air out.

The Livermore mockup target system will run continuously for six months. It may seem like a long time to be running 24-7, but Gronberg reminds us of the real-life target stamina that’s called for in the actual ILC.

“We’ll never be running the main accelerator with this wheel *not* running,” he said.

“The positron target is a complicated engineering object,” Bailey said. “The ILC is the most challenging positron source project out there, that I’m aware of. But so far, the baseline’s looking good.”

COCKCROFT INSITUTE | DARESBURY LABORATORY | POSITRON SOURCE | POSITRON TARGET | WHEEL

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AROUND THE WORLD

Many small klystrons for operability and flexibility

Rika Takahashi | 10 February 2011

Hardware equipment for DRFS has been installed and being tested at KEK's STF. Image: Nobu Toge

The design of the International Linear Collider has recently changed from featuring two tunnels to just one. This means many aspects of the tunnel design have to be re-thought – including the distribution of the radiofrequency power, the acceleration technology of choice for the ILC's superconducting cavities. In addition to the klystron cluster scheme, the power-delivery system for radiofrequency cavities introduced in last week's *ILC NewsLine*, an alternative scheme is being developed at KEK, Japan.

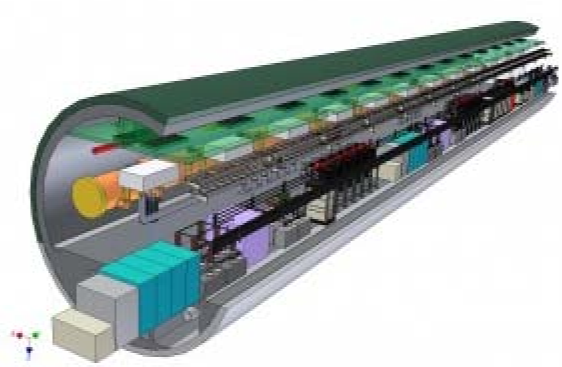
Since 70 percent of Japan is mountainous, naturally the candidate sites are considered to be in a mountainous area. It would not be practicable to have large buildings on the surface. Also, the shaft pipes in the klystron cluster scheme, which will feed power underground, are planned to have a fixed length. This wouldn't fit into a mountainous area either, where sloped tunnels with different lengths instead of vertical shafts to reach underground will be needed.

"So we proposed a very simple solution for the single-tunnel plan, the distributed radiofrequency system (DRFS)," said Shigeki Fukuda, the high-level radiofrequency (HLRF) specialist at KEK.

DRFS is a complete single-tunnel plan and there are no extra HLRF-related facilities on the surface. All the equipment to generate the radiofrequency (RF) power will sit inside the underground tunnel, together with the RF waveguide. In this scheme, many small HLRF units will provide RF power, and each unit will feed two or four superconducting cavities. How many in total? The ILC will have more than 16,000 superconducting cavities, which means that it is necessary to make about 8,000 klystrons and 975 DC power supplies and pulse modulators (including 325 backup units).

The plan is to use three different kinds of cavity units coming from three regions. This feature will make it possible to appropriately operate those cavity units with different characteristics. In the present technology of manufacturing superconducting cavities, their quality varies greatly, and scientists have to accept the field gradient variation of 31.5 megavolts per metre plus or minus 20 percent. DRFS technology will enable engineers to appropriately operate those cavity units with the possibility of adjusting to individual characteristics. "It is also useful for dealing with the deterioration of units after installation," said Fukuda. "If some cavities quench or couplers fail, others are operated instead of deteriorated units, and the influence of these effects becomes negligible."

The klystron adopted in the DRFS scheme is called the modulated-anode-type klystron. "This type of klystron has superior cost effectiveness, and actually, is adopted in many big facilities such as J-PARC (Japan Proton Accelerator Complex, Tokai, Japan) or the Spallation Neutron Source in the US."



Bird's eye view of DRFS in a single tunnel. Required

Since the HLRF system is costly in general, reducing the total numbers of RF units tends to become one of the main topics in the cost-reduction discussions. And naturally, there are concerns that DRFS may be too expensive a choice. "We are trying to develop cheaper manufacturing ways through mass production, and we are confident that it is possible," says Fukuda. Also, small klystrons have potential applications in many fields if they can be manufactured in *components except for the infrastructure are all installed in a single tunnel.*

reasonable way: for example, they could be an RF source for a medical accelerator, perhaps for use in PET or cancer therapy, or an RF source for handy X-ray inspection. It is also applicable as an RF source for an energy recovery linac or the proposed Project X at Fermilab, US.

There is another concern with DRFS: the faults rates. Since the number of units is large, it might be a good guess that the number of failures will be similar. “In order to keep or even raise availability, we showed that the realistic mean time between klystron failures is long, and it is not a serious problem if there are two maintenance terms a year,” Fukuda believes. The team also plans to have backup units of power supplies and modulators. “We calculated that the probability of having a serious failure, which would cause a stop of operation, will be very small,” said Fukuda.

Important tasks for the team are first to complete the prototype DRFS currently under setup at KEK and then to carry out some further R&D to reduce the cost.

The KEK team introduced the first DRFS system at the S1-Global experiment at KEK. The system comprises two DRFS klystrons connecting with a DC power supply and pulse modulator, the minimum unit of DRFS to demonstrate the feasibility of the DRFS system. This test will be performed over three weeks in February. After that, one DRFS unit will be operated through 2011 for the so-called quantum beam project. Larger-scale tests with the DRFS system consisting of four to five DRFS klystrons with a DC power supply and a modulator are planned at the phase-two plan for KEK’s Superconducting RF Test Facility from 2012 to 2013. “At the same time we continue to have an R&D aiming for more cost reductions,” said Fukuda.

DRFS | KEK | KLYSTRON | POWER | RADIOFREQUENCY | SINGLE TUNNEL | SUPERCONDUCTING CAVITY