

RESEARCH DIRECTOR'S REPORT

Important meetings to come, important discussions to happen

by Sakue Yamada



The high-energy physics community is gearing up to learn the latest from the world's large particle colliders, to be presented at conferences this summer. The reports may guide the future efforts of the ILC community coming after the detector community's detailed baseline design.

AROUND THE WORLD

Pushing the limits with high-voltage electron guns

Jefferson Lab's electron gun group explores new designs for spin-polarised photoelectron guns

by Christine Herman (FNAL)



Scientists at Jefferson Lab advance high-voltage electron gun research to create tight, spin-polarised electron beams.

DIRECTOR'S CORNER

ILC accelerator interim report elicits positive responses

by Barry Barish



Following the recent release of the ILC accelerator interim report, *The International Linear Collider: A Technical Progress Report*, we have received positive and encouraging responses from the chairman and other members of the International Linear Collider Steering Committee, our scientific oversight committee. This interim report is a useful summary of our

ILC R&D programme and accomplishments to date, in preparation for the ILC *Technical Design Report*, which we are on track to complete by the end of 2012.

IMAGE OF THE WEEK



Up in the air

Image: DESY

The PCMAG – the magnet of the large prototype time projection chamber – will travel from DESY in Germany all the way to KEK in Japan. Before the magnet can begin its journey it must be properly wrapped and lifted out of the DESY test beam facility. Have a safe trip PCMAG!

IN THE NEWS

from **Black Hills Pioneer**

19 July 2011

[DOE lab funding not approved yet](#)

While international panel advocates for DUSEL science, \$15M in necessary operating funds hang in budget balance

from **Physics Viewpoint**

18 July 2011

[A new neutrino oscillation](#)

Now, a paper from the T2K (Tokai to Kamioka) experiment in Japan, reports the first possible observation of muon neutrinos oscillating into electron neutrinos at 500 km/GeV. They see 6 candidate signal events, above an expected background of 1.5 events.

from **space.com**

14 July 2011

[New Spin Revealed on Mysterious Antimatter](#)

The puzzling prevalence of matter over antimatter in the universe might be related to the bizarre space-time stretching caused by our galaxy's spin, a new study suggests.

CALENDAR

UPCOMING EVENTS

[International Europhysics Conference on High-Energy Physics \(EPS-HEP 2011\)](#)

Grenoble, France

21- 27 July 2011

[The 2nd workshop on SCRF Cavity Technology and Industrialization for the ILC](#)

Sheraton Chicago Hotel & Towers, Chicago, IL

24 July 2011

[15th International Conference on RF Superconductivity \(SRF2011\)](#)

Sheraton Chicago Hotel & Towers, Chicago, IL

BLOGLINE

Frank Simon

[CALICE Test Beams: Shift at CERN](#)

PREPRINTS

ARXIV PREPRINTS

[1107.3321](#)

Top quark effects on the virtual photon structure function at ILC

25- 29 July 2011

Meeting of the Division of Particles and Fields of the
American Physical Society (DPF 2011)

Brown University, Providence, Rhode Island, USA
09- 13 August 2011

Lepton Photon 2011 XXV International Symposium on Lepton
Photon Interactions at High Energies

Tata Institute of Fundamental Research, Mumbai, India
22- 27 August 2011

ILC positron collaboration meeting

IHEP, Beijing, China
27 August 2011

POSIPOL 2011

IHEP, Beijing, China
28- 30 August 2011

Supersymmetry 2011 (SUSY 2011)

Fermilab, Batavia, IL
28 August- 02 September 2011

XXXI Physics in Collision (PIC 2011)

Simon Fraser University, Vancouver, Canada
28 August- 01 September 2011

[View complete calendar](#)

RESEARCH DIRECTOR'S REPORT

Important meetings to come, important discussions to happen

Sakue Yamada | 21 July 2011

Summer is a season for big international conferences for high-energy particle physics. Communication tools are highly developed today and any news can spread around the world within a few minutes. Nevertheless, summer conferences are special. Each experimental group concentrates a great deal of effort to prepare the latest, hottest results for these conferences, and the community also looks forward to new announcements. This year the world is waiting for news from Large Hadron Collider (LHC) experiments at CERN, Switzerland, which are very rapidly collecting data at 7 teraelectronvolts (TeV), the highest collision energies ever made. Also, Tevatron experiments are refreshing their analyses of their accumulated data.

The International Linear Collider community is keen about what will be announced in particular since these experiments may provide a clear guide for the future plans of the ILC. It is said that the energy range of the future lepton collider can be set by looking at LHC results. A surprise may come from Tevatron, too. Detector activity after the completion of the detailed baseline design (DBD) will also be affected by the results of the experiments. For instance, if hint of a possible Higgs particle is found in the low-mass range, as is predicted by comprehensive electroweak fits to the existing data, we can hope the motivation for the ILC will be enhanced. Then we will have to complete the detector R&D for each component very soon and proceed towards engineering studies. There is a strong hope that by 2012 we shall know whether such a case is real. If things deviate from this expectation, we need to think seriously about which way to go. There are different possibilities, and detailed studies will be needed to come to the correct provision that leads to the key physics. Cooperation with theorists will be very important for such an investigation. We expect the newly formed group, which prepares a chapter of the DBD on the physics prospect of the ILC, will scrutinise many of the possible cases. The group will carefully watch what is presented this summer and meet in Granada, Spain, for the first discussions.

During the Lepton Photon Symposium to be held in Mumbai, India, in August, there will also be an important meeting of the ILC Steering Committee (ILCSC). We expect that at this meeting further discussions will be held about the post-2012 scheme to promote the ILC project. When there was a call for comments last autumn on the white paper on the Comprehensive Project Design Guidance by ILCSC, the community responded through different channels. Following the discussions during the previous meeting in February, ILCSC will advance the plan in the upcoming meeting. We should keep participating in such discussions as we did last



Scientists will gather at the 2011 International Workshop on Future Linear Colliders in Granada, Spain, to discuss possible directions for the International Linear Collider project and the Compact Linear Collider study.



The ILC Steering Committee will meet in Mumbai, India, at the Lepton Photon 2011 conference to move forward with plans on the post-2012 scheme to promote the ILC project.

autumn by sending comments so that the new scheme will be realistic and effective. We wish to continue the remaining R&D and physics studies in the hope that the project will materialise. For these activities the new scheme is crucially important. The detector groups and theorists are putting in enormous efforts to make the DBD. My wish is that the new scheme helps encourage the community to continue similar efforts and to strive for the realisation of the project. For this to happen, we have to contribute actively in the planning, too.

[DBD](#) | [ILCSC](#) | [LCWS11](#) | [LEPTON PHOTON SYMPOSIUM](#)

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AROUND THE WORLD

Pushing the limits with high-voltage electron guns

Jefferson Lab's electron gun group explores new designs for spin-polarised photoelectron guns

Christine Herman (FNAL) | 21 July 2011



Suspended from the white ceramic insulator, the cathode electrode is lowered into the high-voltage chamber by Phil Adderley and Jim Clark, members of Jefferson Lab's Electron Gun Group, during assembly of an ILC-like prototype spin-polarised electron photogun. This photogun was later installed at Jefferson Lab's Continuous Electron Beam Accelerator Facility and successfully operated for their nuclear physics programme. Image: Jefferson Lab

Opposites attract and like charges repel. This simple phenomenon explains why electron beams spread out over space and time, much to the dismay of physicists who need tight particle beams for collision experiments.

To counter this phenomenon, known as space charge-induced emittance growth, the electron gun group at Jefferson Lab in the US is pushing the limits of high-voltage electron guns with new and improved designs.

This work is motivated and funded by the International Linear Collider R&D programme, the goal of which is to develop a 140-kilovolt (kV) electron gun to produce spin-polarised electron beams.

"The more energy you give the electron beam from the start, the stiffer the beam becomes," said Matt Poelker, leader of Jefferson Lab's Electron Gun Group. "The space charge forces that frustrate us get smaller and the beam is much more manageable."

Electron guns are electrical components that produce electron beams. They can be found in devices ranging from televisions to electron microscopes and particle accelerators.

An electron's spin is a quantum-mechanical property describing its intrinsic angular momentum. Spin-polarised electron beams are made up of electrons with uniformly aligned spins. They provide an

additional tool in physicists' toolboxes to help probe what goes on inside the nucleus, Poelker said.

Polarised electron sources have four components: a gallium-arsenide photocathode, high voltage, a laser and a gun vacuum assembly.

A photocathode generates spin-polarised electrons upon laser-excitation with the appropriate wavelength of light. Once they leave the photocathode, at higher voltages, electrons are accelerated to higher energy and faster speed, making them travel together more tightly. But as with most things in life, this advantage comes with a trade-off: higher levels of field emission, the uncontrolled liberation of electrons from metallic surfaces near the photocathode.

"Those electrons don't go where you want them to go," Poelker said. "They degrade the vacuum in the gun chamber, and

worst case, they might actually punch a hole in your gun chamber.”

The source of field emission is the cathode electrode, a metal structure that holds the photocathode inside the gun and provides electrostatic focusing of the beam. By employing a compact ceramic insulator that extends into the high-voltage chamber, the team reduced the amount of metal that could contribute to field emission, said Joseph Grames, deputy head of Jefferson Lab's Electron Gun Group.

While the previous gun design operated well up to 100 kV, two newer designs are pushing the limits: Jefferson Lab's CEBAF accelerator currently operates an electron gun at 130 kV, and a Jefferson Lab test facility operates another gun at 225 kV with no observable field emission.

The goal now is to further optimise the designs and test them at even higher voltages – up to 350 kV.

“My hope is that we can achieve this 350-kV bias voltage goal relatively soon so that it can be included in the *Technical Design Report* that will get written up before the ILC R&D programme comes to a conclusion,” Poelker said.

The ILC would collide a spin-polarised electron beam with a spin-polarised positron beam. While initial Jefferson Lab efforts focused on the development of high-voltage electron beams, more recent efforts have shifted toward making polarised positrons.

The traditional approach to generating positrons is to send a very high-energy electron beam into a tungsten target. The resulting photons can convert into electron-positron pairs. The limitations of this technique are that it requires a large accelerator and provides unpolarised positrons. The ILC has evaluated alternative approaches, such as helical undulators and Compton backscattering, which still require the high-energy accelerator but will produce polarised positrons.

As an alternative approach, the Jefferson Lab group plans to shoot relatively low-energy spin-polarised electrons at a millimetre-thick piece of tungsten foil, collect the resulting spray of positrons, and measure the fraction of polarisation that is transferred from the electron beam, Grames said.

“You don't create as many positrons with this method but it doesn't require a big accelerator,” he said. The method is now being explored largely because of relatively recent advances in spin-polarised electron sources, which have demonstrated sustained milliamp beam intensity.

While this work is motivated and funded by the ILC R&D programme, Poelker said it has greatly benefitted Jefferson Lab's other research areas, including its nuclear physics programme.

“What we're able to do now, not too long ago we thought was crazy,” said Grames, who got his Ph.D. in the late '90s, nearly two decades after the first spin-polarised electrons were injected into a high-energy accelerator at SLAC. “It has been very rewarding to contribute to developments over the last ten years as a scientist and observe the excitement it generates for ongoing experiments and the potential for future facilities.”

To learn more, see these two papers, which describe the electron gun:

- [Charge and fluence lifetime measurements of a dc high voltage GaAs photogun at high average current](#)
- [Load-locked dc high voltage GaAs photogun with an inverted-geometry ceramic insulator](#)

[ELECTRON GUN | JEFFERSON LAB](#)

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DIRECTOR'S CORNER

ILC accelerator interim report elicits positive responses

Barry Barish | 21 July 2011



Letter from Jon Bagger, chair of the International Linear Collider Steering Committee (ILCSC)



Jon Bagger, ILCSC chair, addressing the ILC community

Despite the various ups and downs in resources to support the ILC R&D and design programmes, the Global Design Effort has been able to continue to make impressive progress towards establishing ILC design parameters and technologies. In our new [report](#), we present results that demonstrate superconducting radiofrequency high-gradient technology consistent with our goals, outline results on electron cloud mitigation that back up our simulations and give a detailed mitigation strategy, record impressive progress on final focus studies (before the Japanese earthquake), and report on other progress in establishing our baseline design. The responses to our report have been positive and encouraging, as we move on to the next step in developing the ILC *Technical Design Report* (TDR).

A letter from Jon Bagger, chair of the ILCSC, specifically comments that our new report “lays out the GDE’s many R&D successes and the difficult choices necessary to keep project costs under control.” There actually is no costing presented in the report, as we are just beginning our cost studies for the TDR. However, Jon has witnessed that the choices we have made for the new baseline and much of the focus of our R&D programme is on areas where costs are an issue and are being attacked aggressively in our evolving design. With the completion of the interim report and having established the TDR baseline, we are now beginning our costing studies in earnest. This week, we are in the midst of a set of meetings at Caltech, including a dedicated two-day meeting on costing for the TDR.

In addition to the letter from Jon Bagger, we are issuing a [press statement](#) at the time of the [International Europhysics Conference on High Energy Physics](#) (HEP 2011) at Grenoble, France, also this week, that publicises our progress and the release of this new report. In that statement, Joachim Mnich, who is also an ILCSC committee member

and DESY Director in charge of High-Energy Physics and Astroparticle Physics in Germany, is quoted as saying, “There is a strong physics case for a linear collider and we are confident that it will become even stronger with the incoming results from the LHC. This report, a prime example for global collaboration, demonstrates that we have the technology at hand to rapidly move to a real project.”



Joachim Mnich, ILCSC committee member and DESY Director in charge of High-Energy Physics and Astroparticle Physics

The next meeting of the ILCSC will be held during the *Lepton-Photon 2011* meeting in Mumbai, India next month. We will formally present the interim report to ILCSC at that meeting and cover our last Program Advisory Committee review report. I have discussed both topics in recent Director's Corners, and both were quite positive. The main item that I expect will receive the most discussion at ILCSC is what future organisational structure, technical goals and strategy should follow for the ILC once we complete the *Technical Design Report* at the end of 2012.

[ILCSC](#) | [INTERIM REPORT](#) | [TDR](#) | [TECHNICAL DESIGN REPORT](#)

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**The Henry A. Rowland Department of
Physics and Astronomy**

Bloomberg Center
3400 N. Charles Street
Baltimore MD 21218-2688
410-516-5419 / Fax 410-516-7239
bagger@jhu.edu

June 27, 2011

Prof. Barry Barish, Director
ILC Global Design Effort
PO Box 500, MS 123
Batavia, IL 60510

Dear Barry,

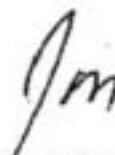
On behalf of the ILCSC, I would like to express my appreciation to you and your colleagues on the Global Design Effort for the Technical Progress Report that you have just issued. The Report documents the GDE's impressive achievements towards realizing the International Linear Collider.

Arriving half way on the path towards the TDR, the Technical Progress Report provides an important reference point for ILC scientists, the physics community, and our government sponsors. It lays out the GDE's many R&D successes and the difficult choices necessary to keep project costs under control.

The GDE should feel proud of the progress it has made to date. The strong international consensus behind the ILC is reflected in the worldwide scope of the R&D and in the spirit of the GDE itself. Congratulations!

We all look forward to the delivery of the TDR as the next major step in the global effort to realize the International Linear Collider

Your sincerely,



Jonathan A. Bagger
Chair, ILCSC



Interim report on the International Linear Collider R&D programme released

13 July 2011

The International Linear Collider is designed as the next large-scale experimental undertaking in elementary particle physics beyond the Large Hadron Collider, now in operation at CERN, Switzerland. The ILC Global Design Effort, led by Barry Barish, announces the release of the first of two progress reports on the ILC R&D programme and progress. The first report, *The International Linear Collider: A Technical Progress Report*, focuses on accelerator R&D and is oriented at establishing the technical viability of the design that will be presented in a future *Technical Design Report* by the end of 2012.

Complementing the Large Hadron Collider (LHC), the International Linear Collider (ILC) will continue the exploration of matter at the distance scale of 10^{-18} metres – one-thousandth the size of an atomic nucleus. Scientists' current understanding of particle physics points to this distance scale as the key to the origin of the masses of the known elementary particles. It suggests that here, also, they could discover the particles that make up the dark matter of the universe.

The ILC will bring new high-precision tools that will help us solve these mysteries. Using unprecedented technology, the 31-kilometre-long ILC will hurl electrons and their anti-particles, positrons, toward each other at nearly the speed of light to collide 14,000 times every second at energies of 500 billion electronvolts (GeV). These spectacular collisions create an array of new particles that will answer some of the most fundamental questions about the nature of the universe, such as the origin of mass, dark matter, dark energy, extra dimensions and beyond.

Organised by the Global Design Effort (GDE), a team of more than 60 scientists, the ILC is an international endeavour that brings together more than 1000 scientists and engineers from more than 100 universities and laboratories in over two dozen countries. *The International Linear Collider: A Technical Progress Report* marks the halfway point towards the GDE fulfilling its mandate with a more optimised *Technical Design Report* (TDR) by the end of 2012. The TDR will be based on much of the work reported here and will contain all the elements needed to propose the ILC to collaborating governments, including a technical design and implementation plan that are realistic and have been better optimised for performance, cost and risk.

"We are on track to develop detailed plans for the ILC, such that once results from the LHC establish the main science goals and parameters of the next machine, we will be in good position to make a strong proposal for this new major global project in particle physics," said GDE director Barry Barish. "LHC results will likely affect the requirements for the machine design and the detectors, and we are monitoring that very closely, intending to adapt our design as those results become available."

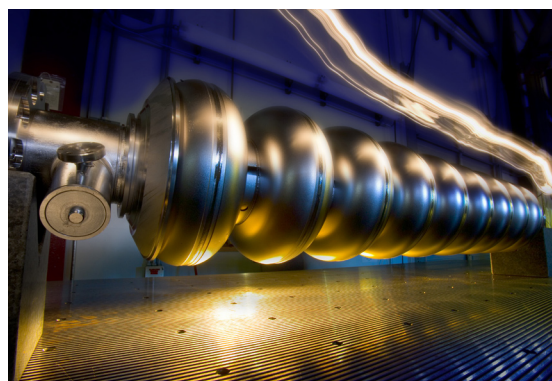


Image: Fermilab Visual Media Services

This document represents a snapshot of the R&D status: a large fraction of the R&D projects continue through to the publication of the *Technical Design Report* in 2012, and in some cases beyond. Highlights of the achievements include the successful construction and commissioning of superconducting radiofrequency test facilities for accelerators all over the world, great strides in the improvement of accelerating cavities production processes, and plans for mass-production, as 16,000 superconducting cavities will be needed to drive the ILC's particle beams.

"There is a strong physics case for a linear collider and we are confident that it will become even stronger with the incoming results from the LHC," said Joachim Mnich, member of the International Linear Collider Steering Committee and DESY Director in charge of High-Energy Physics and Astroparticle Physics in Germany. "This report, a prime example for global collaboration, demonstrates that we have the technology at hand to rapidly move to a real project."

The report also offers an extensive outline of the geological and civil engineering studies conducted for siting the ILC in the three major regions of consideration: the Americas, Asia and Europe.

The ILC has already adopted international models for collaborative R&D programmes. All three regions involved in the ILC contributed to the report, reflecting the true international cooperation of the project.

The report is the first of two volumes and focuses on the collider, its design and technical aspects, and siting and safety considerations together with a realistic implementation plan, optimised for performance, cost and risk. A second volume, soon to follow, will focus on the ILC scientific case and on the design of the detectors associated with the collider.

Resources

The International Linear Collider: A Technical Progress Report is available online as a pdf and can be ordered at:
<http://www.linearcollider.org/interim-report>

Additional information about the ILC:
<http://www.linearcollider.org>

Press information, fact sheets and images:
<http://www.linearcollider.org/press/>

Contacts

Americas

Leah Hesla, FNAL, USA, +1-630-840-5136, leah@fnal.gov

Asia

Rika Takahashi, KEK, Japan, +81 29 879 6247, rika.takahashi@kek.jp

Min Zhang, IHEP, P.R. China, +86 10 88235910, zhangmin@ihep.ac.cn

Europe

Perrine Royole-Degieux, CNRS/IN2P3, France, +33-6-74-11-73-78, royole@in2p3.fr

Monika Illenseer, DESY, Germany, +49 40-8998-2516, monika.illenseer@desy.de

