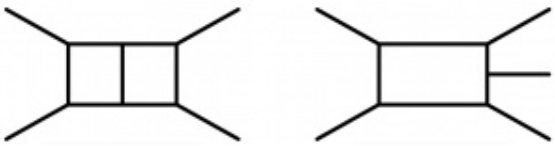
NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

FEATURE

Loops and legs for ILC

by Rika Takahashi



Following in the footsteps of famous thinkers like German poets Goethe and Schiller, a group of scientists has gathered at Weimar, Germany, for the Loops and Legs in Quantum Field Theory conference. They want to improve theoretical calculations, also for ILC studies.

AROUND THE WORLD

From UK News from CERN: Speaking up for CLIC

by Stephanie Hills, STFC's UK Communications and Innovation Officer

The CLIC accelerator collaboration has elected a new spokesperson. Phil Burrows of the University of Oxford succeeds Roberto Corsini of CERN. Over the next three years, Burrows will be engaging with the institutes that are members of CLIC and helping to ensure that CLIC's R&D programme pushes ahead during the critical phase ahead of the next update of the European strategy for particle physics. Corsini will continue his technical leadership of CLIC/CTF3.

DIRECTOR'S CORNER

From shutdown to cooldown: the LHC is preparing to get back online

Former LHC project leader looks back at his developing project and ahead towards the future

by Lyn Evans

The LHC's long shutdown is nearing its end. All magnet interconnects have been opened and checked, and with the first of eight sectors scheduled for cooldown this month, it's well on its way towards new discoveries, says LCC Director Lyn Evans. After all, results from the LHC determine the future of particle physics around the world, and the ILC is no exception.

IMAGE OF THE WEEK

Forum at the Terascale

This week, the German LC Forum took place at the University of Bonn. The LC Forum was initiated by the Helmholtz Alliance "Physics at the Terascale“ to provide a regular discussion platform for all aspects of linear colliders – accelerator, detectors, physics. The meeting was held in the Bethe Center for Theoretical Physics and yielded lively discussion, also in preparation of the American Linear Collider Workshop. Among the focus topics were for example beam polarisation, characterisation of dark matter particles at the ILC, and recent results on LC detector R&D.

IN THE NEWS

from *Sankei Shimbun*
23 April 2014
国内誘致、早期表明を 東北　　推進協議会が決議
国際リニアコライダー」　　の北上山地　岩手、宮城県　への誘致実現を目指す「東北　　推進協議会」の総会が　　日、仙台市青葉区のホテルで開かれ、国に対して早期に国内誘致を表明することなどを求める決議案を採択した。Tohoku Conference for the promotion of the ILC held general meeting at the hotel in Sendai city, and adopt a resolution to make a request for the Japanese government to voice the will of inviting the ILC to Kitakami area)

CALENDAR

Upcoming events

Americas Workshop on Linear Colliders (AWLC14)
Fermilab
12- 16 May 2014

Technology and Instrumentation in Particle Physics 2014 (TIPP 2014)
Amsterdam, the Netherlands
02- 06 June 2014

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1404.6990
Dark matter searches in the mono-Z channel at high energy e+e− colliders

1404.6258
Determining the Dark Matter Particle Mass through Antler Topology Processes at Lepton Colliders

1404.6107
Collider design issues based on proton-driven plasma wakefield acceleration

1404.5835
Complementarity in direct searches for additional Higgs bosons at the LHC and the International Linear Collider

1404.5038
Signal of doubly charged Higgs at e+e− colliders

1404.4845
New Physics in e+e−→Zγ at the ILC with polarized beams: Explorations beyond conventional anomalous triple gauge boson coupling

1404.4669
Plasma wakefield excitation by incoherent laser pulses: a path towards high-average power laser-plasma accelerators

1404.4294
A new jet reconstruction algorithm for lepton colliders

1404.4097
A Phenomenological Cost Model for High Energy Particle Accelerators

LC NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

FEATURE

Loops and legs for ILC

Rika Takahashi | 1 May 2014

The International Linear Collider will provide an experimental environment of unprecedented precision. One of the important issues at ILC experiments is the measurement of fundamental parameters with high precision, to match with the precision level of the experiment. The discovery of the Higgs particle brought demands on the ability to make predictions to a new level. Driven by those demands from the experimental results, scientists have been making efforts to develop techniques to calculate what will happen when particles collide, and these techniques have made big leaps in recent years. Sill, more studies are needed for ILC. Scientists gathered at Weimar, Germany for the Loops and Legs in Quantum Field Theory to tackle this challenging task.

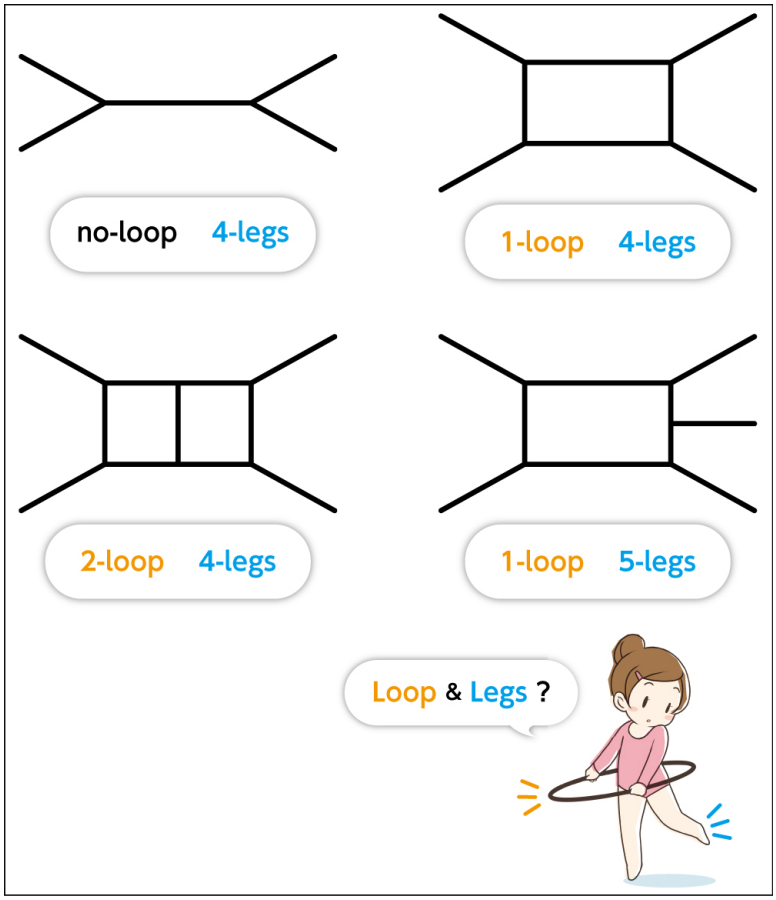


Image: Kaori Kurokawa

This bi-annual workshop on elementary particle theory was organised by the theory group of DESY in Zeuthen. “For more than 20 years this meeting brings together about 100 scientists from all over the world to discuss the latest achievements on precise calculations for high energy particle physics in experiment, theory, computational technology and the associated mathematics. This year the focus was on precision LHC processes, but also those at the ILC. Many talks were dealing with Higgs-physics and challenges for the future. It is needless to say that very many of the burning questions ultimately will request the ILC to be decided,” said DESY theorist Johannes Bluemlein.

So, what are loops and legs?

For particle physics studies, scientists use Feynman diagrams that show what happens when elementary particles collide. When two particles collide and produce two new particles, the diagram has two inbound lines and two outbound lines. “We call the diagram showing this reaction ‘four legs.’ If three particles are produced, ‘five legs,’” said Junpei Fujimoto, a scientist at KEK. The higher the energy of the experiment, the larger the numbers of legs are expected. “For former electron-positron experiments up to 90′s, calculations for four-leg diagrams were enough to provide the reference for the experiments. But for the ILC experiments, we need precise multi-leg calculation to successfully compare theory and experiment,” he said.

For rough estimations, the diagrams have only branches and legs. But in order to get more accurate predictions, the diagrams will have circular shaped lines. Those are called ‘loops’. “When loops are involved, the difficulty level of the calculation goes up drastically. To make precise theoretical predictions, we need to have knowledge of the higher loop computation, which is not easy. It is important to discuss about the new ideas and formulas, new way of calculations or new findings.”

Fujimoto is a member of the GRACE group, which is working on constructing the systems to calculate Feynman amplitudes including loop diagrams. The group’s final goal is to construct the fully automatic computation system of multi-loop integrals. “We confirmed that the GRACE system is successfully working for one-loop calculation for both the Standard Model and the supersymmetric Standard Model. Now, we need to have a crack at the multi-loop integrals. I hope to have good worldwide cooperation for this challenge”.

In addition to the need of discussion, Fujimoto has another aim to attend the Weimar meeting.

“I wanted to report the latest information on ILC in Japan to prominent theorists in the world. ILC is really moving forward, and we have a good chance to start the experiment in the next decade. The power of the people who came to the Weimar meeting is quite important to the ILC’s success, and I wanted to remind them of that.”

Participants know very well that some calculations demanded by ILC are quite tough, and also request much CPU power. Nevertheless now it is just the time to start consideration to attack such a huge calculations, and to seek a new way to overcome.

FEYNMAN DIAGRAMS | GERMANY | GRACE | THEORY

NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

AROUND THE WORLD

From UK News from CERN: Speaking up for CLIC

Stephanie Hills, STFC's UK Communications and Innovation Officer | 1 May 2014

Phil Burrows is the new CLIC accelerator spokesman. Image: Jesus College, Oxford

The CLIC accelerator collaboration has elected a new spokesperson. Phil Burrows of the University of Oxford succeeds Roberto Corsini of CERN. Over the next three years, Burrows will be engaging with the institutes that are members of CLIC and helping to ensure that CLIC's R&D programme pushes ahead during the critical phase ahead of the next update of the *European strategy for particle physics*. Corsini will continue his technical leadership of CLIC/CTF3.

Burrows, who is an expert on fast-feedback and feed-forward beam correction systems (studied at KEK's ATF2 and CERN's CTF3 test facilities for future linear colliders) and on the machine-detector interface, is the first non-CERN CLIC accelerator spokesman. "I hope to cultivate the collaboration spirit and maximise opportunities for the international CLIC accelerator collaboration," he says. The CTF3 test facility will probably stop operating in its current mode within the next couple of years, so changes are ahead for CLIC. "There are several promising avenues to explore, including exploring opportunities for novel applications of CLIC technologies."

The most recent *European strategy for particle physics* was published in 2013. Recognising the international collaborations that will be needed to make scientific advances, it sets out the future priorities for European particle physics research. The strategy is due to be updated in 2018, and that's likely to be the timescale for decisions on the future direction for CLIC. With other potential successors to the Large Hadron Collider (LHC) on the table, Burrows says there will be tough decisions to be made about the best choice for the next big particle physics machine in Europe. "Any future proposed project would be expensive to build. We might be able to afford one in Europe, but definitely not two or more."

"CLIC remains the only viable technology today that could take us to multi-TeV centre of mass electron-positron collisions," he says. "But we need more LHC results to assess whether it is the right machine to take us into new areas of physics research. LHC results over the next few years of running at higher energy and luminosity will be key to determining the way forward."

Using the CLIC Test Facility (CTF3), the key concepts of CLIC have already been tested and proved. Probably the most innovative element of the CLIC design is that it has two beams – a drive beam and a main beam. "We've demonstrated that it is possible to transfer energy from the drive beam and feed it to the main beam," says Burrows. "Now we need to work on more of the technical implementation and system optimization, not least how to mass produce the components that we need – essential for keeping the cost of the project as low as possible."

For the next few years, the focus is definitely on CLIC R&D, but Phil will undoubtedly have more than half an eye on results coming out of the LHC when it starts operating again in 2015.

A version of this story first appeared in *UK News from CERN* .

ATF2 | CLIC | CTF3 | FAST FEEDBACK | FEED FORWARD | MACHINE DETECTOR INTERFACE

NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

DIRECTOR'S CORNER

From shutdown to cooldown: the LHC is preparing to get back online

Former LHC project leader looks back at his developing project and ahead towards the future

Lyn Evans | 1 May 2014

Consolidation works in the LHC tunnel during LS1 are nearing their end. Image: CERN

The LHC has been shut down for consolidation since the beginning of 2013. This break is called Long Shutdown 1 or LS1. One of the biggest jobs has been the opening and inspection of all the 1695 magnet-magnet interconnects. They had to be carefully checked and sometimes repaired to make sure that they can take the current needed for running the LHC at up to 14 TeV after LS1. One interconnect had failed spectacularly right after the start-up of the LHC in 2008 and it was decided that the LHC would only run at 7 TeV in its first years. The inspection of all interconnects was completed at the end of March (photo courtesy Michael Struik/CERN) and more than a quarter of the accelerator has already been permanently closed and leak-tested again. Now begins the long job of re-commissioning, starting with the testing of all high-current circuits with short-circuit loads instead of the superconducting magnets.

At the beginning of May, the cooldown of the first of eight sectors will start. Since nitrogen is not allowed in the tunnel, the first phase of cooldown from room temperature to 80K (-193 degrees Centigrade) is made by circulating helium gas, which is cooled by liquid nitrogen in a heat exchanger on the surface, through the magnets. Each sector requires 1200 tons of liquid nitrogen, that means 60 trucks each carrying 20 tons, and the cooldown will take about 3 weeks. To get from 80K to 4.5K, the main refrigerators are used to circulate liquid helium. Finally, to get from 4.5K to 1.9K, the final operating temperature, the “cold compressors” are switched on, reducing the pressure above the helium to 15 mbar.

Once the first sector is closed, power tests can begin in earnest. It was found during initial commissioning in 2008 that some of the main dipoles have “memory loss”, meaning that even though they were trained on the test benches to above their operating level, at high current some re-training still occurs and needs to be done in the tunnel. All this is to avoid quenches, loss of superconductivity that can be due to small mechanical movements in the coils under the very high magnetic forces. Experience shows that the magnets can be brought very quickly up to a field corresponding to 6.5 TeV, but that the last half-a-TeV (to get to the nominal 7 TeV) requires quite a lot more time. It has therefore been decided to start high-energy running at 6.5 (centre-of mass energy 13) TeV, using the end of physics runs for machine studies to push the field higher thereby training to full current in masked time.

The cooldown of the whole machine should be complete by the end of September. It is foreseen to start commissioning with beam at the beginning of February 2015. Physics data taking can start at the end of March. Then we will see what this new energy range has in store for us and how it will guide the planning of the ILC.

FUTURE COLLIDERS | LHC | LS1 | PHYSICS

NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

IMAGE OF THE WEEK

Forum at the Terascale

1 May 2014

This week, the German LC Forum took place at the University of Bonn. The LC Forum was initiated by the Helmholtz Alliance “Physics at the Terascale“ to provide a regular discussion platform for all aspects of linear colliders – accelerator, detectors, physics. The meeting was held in the Bethe Center for Theoretical Physics and yielded lively discussion, also in preparation of the American Linear Collider Workshop. Among the focus topics were for example beam polarisation, characterisation of dark matter particles at the ILC, and recent results on LC detector R&D.

GERMAN LINEAR COLLIDER FORUM | POLARISATION