LC NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

AROUND THE WORLD

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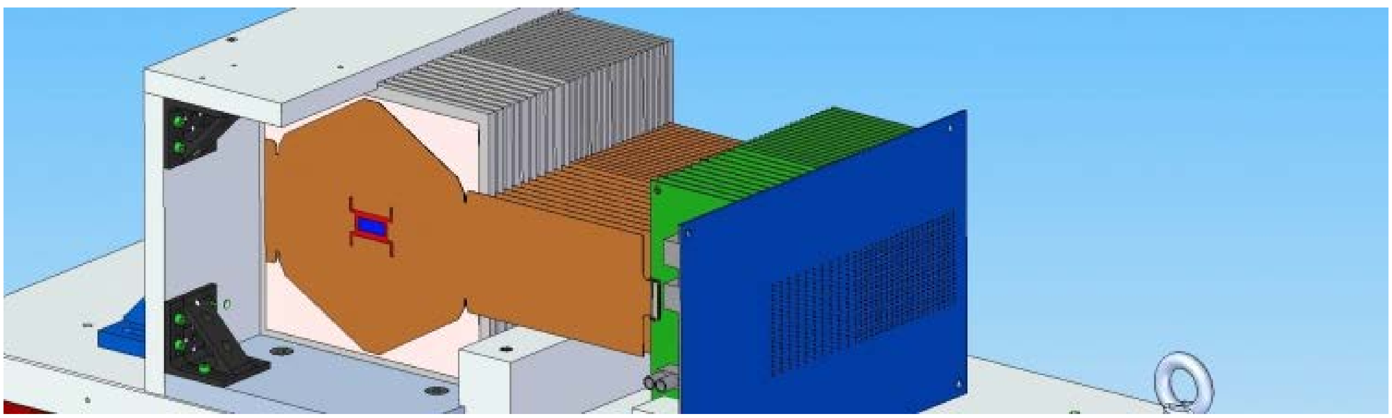
by Julianne Wyrick



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Take two for cryomodule 2

Fermilab reinstalls CM2, plans to be ready for cooldown in July

by Julianne Wyrick

With the repair and reinstallation of the cryomodule known as CM2, Fermilab researchers are back on the road towards achieving the International Linear Collider's R&D "S1" goal: operating a cryomodule at ILC gradient specifications.

DIRECTOR'S CORNER

Steering the direction of US high-energy physics

by Hitoshi Yamamoto

For the realisation of a linear collider, a significant contribution from the United States is essential. A critical step is that the project is positively included in the US strategy for high-energy physics. The long community planning process – the so-called Snowmass process – will end in a final report to be released at the end of September.

VIDEO OF THE WEEK

Higgs: the story of the beginning

Videos: AAA

Hitoshi Murayama, Deputy Director of the Linear Collider Collaboration, explains the Higgs (in Japanese) in a three-part video series entitled “Universe and matter – the story of the beginning.”

IN THE NEWS

from *The Mainichi*
8 July 2013
Mountain regions pull for linear collider project
An evaluation committee is expected to recommend a single candidate location to the national government in August.

from *New Scientist*
4 July 2013
Happy birthday boson! Six outstanding Higgs mysteries
The moment marked the end of a 50-year hunt. But although the boson has been found, there is still plenty we do not know about the celebrated particle. Here are the most interesting unknowns that surround the Higgs boson.

from *Die Zeit*
4 July 2013
Happy Birthday, liebes Higgs!
Mit seiner Geburt machte es die Physiker-Welt fast vollkommen. Sie lieben es, auch wenn es oft nicht einfach ist. Eine Geburtstagsrede an das Higgs-Teilchen.

from *Spiegel online*
4 July 2013
Teilchenphysik-Quiz: Faszination des Winzigen
Winzige Teilchen, riesige Maschinen, um sie zu entdecken – und die Frage, warum das Universum überhaupt existiert: Teilchenphysik fasziniert.

from *Futura Sciences*
4 July 2013
C’est l’anniversaire de la découverte du boson de Higgs
Récemment, une rumeur a suggéré qu’un second boson pointe le bout de son nez, mais il semble qu’il n’en soit rien.(…) Un an après la découverte du boson de Higgs, des signes d’une nouvelle physique, telle que celle impliquée dans le modèle unitaire d’Alain Connes, se font toujours attendre.

from *Sankei Shimbun*
4 July 2013
国際リニアコライダー 九州誘致へ署名提出 福岡
「国際リニアコライダー」 を脊振山地 福岡、佐賀両県 に誘致しようと、両県の若手経営者らが 日、自民党本部 東京 を訪れ、超党派組織「 建設推進議員連盟」の河村建夫会長 衆院議員 に 万 人分の署名を提出した。(The young business owners in Fukuoka and Saga prefectures visited Takeo Kawamura, Chair of the Diet member’s federation for the ILC, with more than 174 thousands signatures collected for inviting the ILC to Sefuri area)

from *Cornell Chronicle*
3 July 2013
Linear collider gains key insights from Cornell physicists
The National Science Foundation-funded project is called Cornell Electron Storage Ring Test Accelerator (CesrTA). Principal investigator David Rubin, professor of physics, has led the effort to leverage the uniquely flexible design of Cornell’s synchrotron to turn it into a prototype ILC damping ring.

from *Science 2.0*
3 July 2013
Supersymmetry Proponents Advocate The International Linear Collider
How much money would you be willing to spend to find out if supersymmetry – SUSY – is real or not?

from ***Jiji***
1 July 2013

東北か九州か、 月後半決定 次世代加速器の候補地 総予算 割減額へ・学術会議委

「国際リニアコライダー 」を日本が中心となり建設する意義があるか検討する日本学術会議の第 回委員会が 日開かれた。当面の実験に必要な性能に下げれば、約 割減額の建設費 億円、総額 億円になるとの試算を示した。(The 2nd meeting of the committee under the Science Council of Japan to evaluate the ILC as a project housed by Japan on 1 July. Atsuto Suzuki reported that the cost of the accelerator will be 631 hundred million yen for the machine needed for the immediate priority experiment, 20% less than the estimated presented in the technical design report.)

from ***Kahoku Shinpo***
30 June 2013

「 地質調査着手を」 年度予算の政府要望で宮城県

宮城県は 日、 年度予算の政府要望で、超大型加速器「国際リニアコライダー 」の岩手県南部・北上山地への誘致実現に向け、地質や環境の調査に着手するよう求める方針を固めた。(Miyagi prefecture requested the government to include the geological and ecological survey for the ILC in the FY 2014 budget as a part of the measure for the recovery from the major earthquake)

from ***The Japan News***
30 June 2013

Tohoku, Kyushu vie for linear collider

Scientists at home and abroad consider Japan the most likely candidate to host the ILC. A council of Japanese scientists, which evaluates possible ILC sites, is expected to choose one Japanese candidate based on the results of geological and environmental surveys next month.

from ***Yomiuri Shimbun***
29 June 2013

宇宙誕生、日本で再現…実験施設の誘致大詰め

「国際リニアコライダー 」を誘致し、世界の科学者が集まり、関連産業が育つ国際都市をつくろうと、東北の北上山地 岩手県、宮城県 と九州の脊振(せふり)山地 福岡県、佐賀県 が綱引きしている。(A tug of war between Kitakami and Sefuri is getting fiercer to invite the ILC and build an international city in the area)

CALENDAR

Upcoming events

Snowmass on the Mississippi (CSS 2013)
Minneapolis, Minnesota, USA
29 July- 06 August 2013

POSIPOL 2013
Argonne National Lab
04- 06 September 2013

16th International Conference on RF Superconductivity (SRF 2013)
Paris, France
22- 27 September 2013

ILD meeting
Cracow, Poland
24- 26 September 2013

Upcoming schools

Summer camp on ILC accelerator and physics / detectors 2013
Toyama, Japan
20- 23 July 2013

View complete calendar

PREPRINTS

KEK REPORT

2013-3
S1-Global Report

ARXIV PREPRINTS

1307.1373
Supersymmetric SU(5) Grand Unification for a Post Higgs Boson Era

1307.0782
Post LHC8 SUSY benchmark points for ILC physics

1306.6353
The International Linear Collider Technical Design Report – Volume 3.I: Accelerator R&D in the Technical Design Phase

1306.6352
The International Linear Collider Technical Design Report – Volume 2: Physics

1306.6329
The International Linear Collider Technical Design Report – Volume 4: Detectors

1306.6328
The International Linear Collider Technical Design Report – Volume 3.II: Accelerator Baseline Design

1306.6327
The International Linear Collider Technical Design Report – Volume 1: Executive Summary

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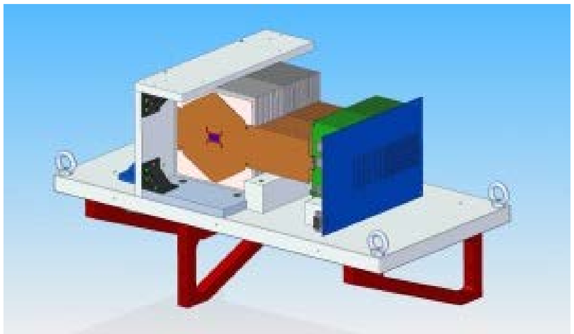

Engineering drawing of the electromagnetic calorimeter at SLAC. This drawing shows the full depth of the ECAL, but unlike the real calorimeter, it is only one sensor wide. The sensor, though not visible in the drawing, is located underneath the hexagonal brown cable. Image courtesy of Marco Oriunno.

Researchers are taking a step towards the realisation of the International Linear Collider's (ILC) SiD detector with a test beam of a SiD-specific electromagnetic calorimeter (ECAL) planned for this month at SLAC.

This initial test beam could actually be considered a "test" test beam, as this run will utilise a partial calorimeter. Researchers involved in the SLAC, University of Oregon, UC Davis and UC Santa Cruz (US) collaboration hope to identify any early problems with the beam and the calorimeter's sensors and electronics. They plan to conduct the initial test on 23 July and hope to complete the second "real" run by the end of the year.

"The (initial) beam test is a focus on pulling things together enough to see what the next steps are going to be," said Marty Breidenbach, SLAC researcher and member of the SiD Executive Committee. "We don't expect it to be a good calorimeter, but we expect to see what the issues are."

Work on this silicon-tungsten ECAL began prior to the selection of the ILC design in 2004, when SLAC was still working toward its Next Linear Collider design. Major steps along the way have involved developing the current sensors, which convert the energy of particles into electronic signals, and the readout electronics, which process these signals.

The current SLAC ECAL system is a prototype for the ECAL needed for SiD, one of the ILC's two proposed detectors. Both detectors will use an algorithm called particle flow to identify and measure the energy of the jets of particles formed when the electrons and positrons collide in the ILC. The role of the ECAL system is to measure the energy and direction of certain particles – photons, electrons and positrons – as they hit the calorimeter. To do this, the ECAL must have very high spatial resolution and good energy resolution to distinguish the location and energy of different particles.

For the SLAC ECAL, achieving this high resolution while remaining compact and cost-effective involves several innovative features. Two of these features are the small pixel size of the sensors and the small gaps between the calorimeter's tungsten plates, where the sensors are located. Each of the calorimeter's sensors has 1024 pixels, and the gaps in the test calorimeter are only 1.25 millimetres wide, though researchers hope to reduce them to 1 millimetre. Keeping the pixel size and the gaps small allows the particles depositing energy in the calorimeter to be more easily distinguished from one another.

In addition, the ECAL's readout electronic chips are attached directly to the sensors, a setup that saves space by removing the need for bulky signal cables.

Connecting these electronic chips to the sensors through a method known as bump bonding has been one of the recent challenges in the preparation of the calorimeter for the test beam. In fact, this challenge is one reason the calorimeter will be only partially assembled at the time of the first test, having only 12 of the 31 sensors that it will ultimately include.

In addition to testing the function of the beam and electronics, the researchers plan to use the initial test beam to evaluate the calorimeter's signal-to-noise ratio.

"These are very small signals that we deal with," said Breidenbach. "We have to see if everything can work at this low level."

The initial test will take place in SLAC's End Station A, with 5 pulses per second of beam taken from SLAC's Linac Coherent Light Source (LCLS) laser.

This End Station A Test Beam will provide a beam of particles similar to that which would emerge from the ILC interaction region, where the electrons and positrons collide. The test beam can function in two modes, for use in developing both detector and accelerator components. Like the beam coming from the interaction region, the mode that will be used includes only a few particles per pulse.

"It's difficult to test (this calorimeter) with other test beams," Breidenbach said, referring to beams that would provide a continuous stream of particles rather than the ILC-type pulses. "The ECAL electronics have been very much optimised for the ILC."

After the July test, the researchers will finish adding the remaining sensors and make adjustments to the ECAL.

"For the real run, then, we'll be interested in measuring calorimeter performance," Breidenbach said. These measurements include uniformity of the signal across a sensor, as well as spatial resolution and energy resolution.

"I think it's a necessary demonstration for SiD," Breidenbach said of the test beams.

DETECTOR R&D | ELECTROMAGNETIC CALORIMETER | SID | SLAC | TEST BEAM

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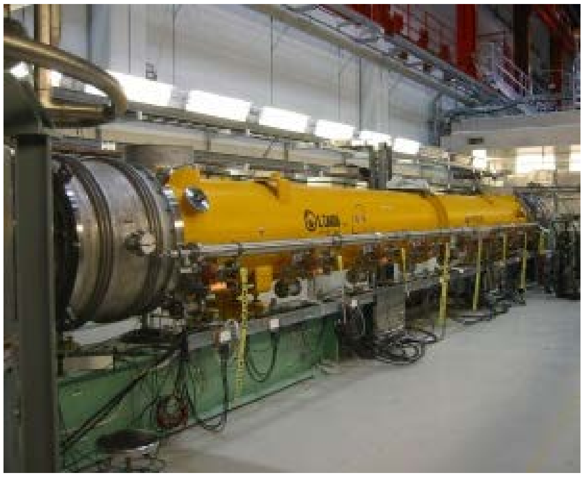

CM2 in Fermilab's NML facility. Image: Jerry Leibfritz

With the repair and reinstallation of the cryomodule known as CM2, researchers at Fermilab, US, are back on the road towards achieving the International Linear Collider's R&D goal (named task force "S1"): operating a cryomodule at ILC gradient specifications.

Originally installed in May 2012 as a part of the Advanced Superconducting Test Accelerator (ASTA) in Fermilab's NML facility, CM2 is the first ILC-type cryomodule built in the United States with cavities expected to meet the ILC's specifications. But a helium leak detected in the cryomodule put the project on hold until April 2013, when CM2 was reinstalled at NML.

"We expect to be ready for cooldown of CM2 this month, " said project engineer Jerry Leibfritz. "Then we'll start testing the cavities after that."

In order to meet the ILC programme's S1 goal, the average accelerating gradient over each of the cryomodule's eight superconducting radiofrequency (SRF) cavities will need to reach at least 31.5 megavolts per metre (MV/m) after installation and cooldown.

A GDE team made an attempt to meet this goal in October 2010 at KEK, in a global collaboration known as the S1-Global experiment. They combined components from Fermilab, DESY (Germany), INFN (Italy), KEK (Japan) and SLAC (US) to build two short 4-cavity cryomodules that were then combined into an eight-cavity cryomodule. The cavities in this cryomodule fell slightly short of the goal, achieving an average gradient of 30.0 MV/m before installation and 26.0 MV/m for simultaneous operation of seven cavities after cooldown, as one cavity did not work properly. S1-Global showed that it is possible to operate a cryomodule close to ILC specifications, and Fermilab researchers hope CM2 will take the achievement one step further by meeting the requirements.

Earlier that year, CM2's cavities had already met the gradient goal individually, as eight industry-made nine-cell 1.3-gigahertz (GHz) SRF cavities were selected based on their capability to reach the 31.5- MV/m gradient in preinstallation tests. Horizontal tests, the final individual-cavity tests, reached 35 MV/m, according to Fermilab engineering physicist Elvin Harms, who is leading the effort to make CM2 operational. After eight good cavities were chosen, the Fermilab team strung the cavities together inside the cryomodule, which was then placed in Fermilab's NML facility.

However, when the helium leak was discovered, the entire cryomodule had to be removed from the NML facility and taken to the lab's Industrial Building Complex for repair. Fortunately, the Fermilab team discovered the leak before attempting cooldown.

"If we had tried to cool it down, it would have leaked helium into the insulating vacuum, and you wouldn't be able to keep it cold," Leibfritz said. "You just couldn't operate it."

Since CM2's return to the NML facility, Fermilab engineers have aligned it with the eventual path of the accelerator's electron beam and have completed cleanroom vacuum work to prepare the SRF cavities for operation. All cavities have undergone warm coupler conditioning, which involves testing the devices that will provide radiofrequency power to the cavities after cooldown. All that remains is to finish the welding and pressure testing of the cryogenic pipes, which supply the helium and nitrogen that will cool CM2 to its operating temperature of 2 kelvins.

Once cold, the cavities will be tested to see if they reach the expected S1 goal of 31.5 MV/m. The radiofrequency power for the tests will come from a single klystron source to all eight cavities simultaneously, through a wave guide system that was built at SLAC.

Harms said there may be degradation of a few percent from the 35 MV/m gradient measured prior to installation, though even a small decrease is not ideal. To test achievement of the S1 goal, the team will only measure the performance of the cavities up to 31.5 MV/m. After this testing is complete, they will consider increasing the power to determine the practical limit.

“We’re going to bring the gradient up very conservatively,” Harms said. “We don’t want to do anything to damage these cavities.”

CM2 is the second eight-cavity cryomodule to be built at Fermilab. The first cryomodule, CM1, allowed Fermilab researchers gain experience building and operating a cryomodule. It was replaced by CM2 last year.

“We always knew CM1 was not going to be high-gradient and that it was going to come out,” Leibfritz said. “We plan on keeping CM2 here. It will be the first cryomodule for our test accelerator.”

CM2 is just one part of Fermilab’s Advanced Superconducting Test Accelerator, a superconducting linear accelerator originally conceived as an ILC prototype.

Fermilab scientists and engineers are currently commissioning a photocathode electron gun for the test accelerator. They have recently generated the first photoelectrons that will eventually provide the beam for the accelerator.

“Our goal by the end of the year is to be able to send beam through the full injector up to the cryomodule,” Leibfritz said, “and then, hopefully, beam through the cryomodule next year.”

After S1, the ILC programme’s S2 goal is to test an entire ILC RF unit, which is composed of three cryomodules. Fermilab’s NML facility has the ability to house up to six cryomodules with the recently completed extension of the concrete cave which houses the linear accelerator.

“CM2 is really just one more step along the way towards realising the ILC,” Harms said. “It’s another data point that we can put multi-cavity cryomodules together and make them work.”

ASTA | CAVITY GRADIENT | CM1 | CM2 | CRYOMODULE | FERMILAB | INTERNATIONAL COLLABORATION | S1-GLOBAL | SRF CRYOMODULE

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DIRECTOR'S CORNER

Steering the direction of US high-energy physics

Hitoshi Yamamoto | 11 July 2013

The US particle physics strategy "Snowmass process" will culminate in the 'Snowmass on the Mississippi' workshop from 29 July to 6 August, in Minneapolis. Image: Katie Schalow.

For the realisation of a linear collider, a significant contribution from the United States is essential. A critical step is that the project is positively included in the US strategy for high-energy physics.

The formation of the US strategy is currently in progress through a multi-step process. First, the High Energy Physics Advisory Panel (HEPAP) facility subpanel has reviewed large projects costing more than 100 million dollars that could start within the next ten years ("CD1 approval" to be precise). HEPAP gave the ILC a high mark, but this was just a start. A long community planning process – the so-called Snowmass process – is in progress with some fifteen workshops culminating in the Snowmass on the Mississippi workshop, from 29 July to 6 August, in Minneapolis. A meeting of the American Physical Society Division of Particles and Fields (DPF 2013) will then be held in the following week, and findings from the Snowmass process will be presented there. The final report will be released at the end of September.

Taking the outcome of the Snowmass process as an input, the HEPAP particle physics project prioritisation panel (called "P5") will aim at forming a strategic plan that is feasible and executable over a 10-to-20-year timescale. Such a process was last happening in 2008, and it was one of the key inputs to the agencies in deciding the US strategy for high-energy physics. The P5 deliberations are expected to be interleaved with town meetings where further inputs from the community will be made.

The outcome of the Snowmass process is being watched attentively from outside of the US as well. When a group of Japanese Diet members wrote a letter to solicit US participation in the ILC if it is hosted by Japan, William Brinkman, at the time Head of DOE's of Office of science, replied "Once these studies and the community inputs are complete, we will be in a better position to evaluate future US priorities for the HEP programme", referring to the Snowmass and P5 process. The Japanese government very well recognises the importance of the process.

As the European strategy for particle physics update document clearly states, "there is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and who energy can be upgraded." According to the current timelines, the ILC would run in parallel with the high-luminosity upgrade of the LHC (HL-LHC) and would provide precision measurements of the Higgs particles. One should note, however, that the precision numbers themselves are not enough to tell the power of the ILC. The experimental and theoretical cleanliness and abilities to control the initial state and even the intermediate states of electron-positron interaction would elucidate delicate effects that might signify new physics.

The specifications of the ILC *Technical Design Report* are conservative ones, and very significant increases in luminosity are feasible by increasing the power consumption of the ILC within a reasonable range. The ILC has the flexibility to increase energy up to somewhat beyond one TeV to study any particle or phenomenon that the LHC might find in this energy range in the coming decades. It also has the sensitivity that may allow us to discover new phenomena that would be impossible to detect at the LHC. The LHC is learning rapidly while dealing with the real data and a linear collider will certainly follow a learning curve as well. As a result, expected precisions would improve for both machines over current projections. It would be a great picture to see two fantastic machines in operation, keeping active the field of high-energy physics and also of science in general, stimulating young minds from around the world.

The Snowmass workshops are open and researchers from outside of North America are encouraged to attend. This makes particular sense since the direction of the US high-energy physics choices will have global implications. The US has always been a driving force in the design of both the ILC machine and detectors; many of us from outside the US who will attend the Snowmass meetings as guests look forward to interesting discussions and to learning how the US can continue this leading role in the future.

APS | EUROPEAN STRATEGY FOR PARTICLE PHYSICS | HEPAP | JAPAN | LHC | SNOWMASS PROCESS | US STRATEGY

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VIDEO OF THE WEEK

Higgs: the story of the beginning

Videos: AAA | 11 July 2013

Hitoshi Murayama, Deputy Director of the Linear Collider Collaboration, explains the Higgs (in Japanese) in a three-part video series entitled “Universe and matter – the story of the beginning.”

Part 1: “What is Higgs?”

Part 2: “Beyond the standard model”

Part 3: “ILC-the future accelerator”

The Japanese Advanced Accelerator Association Promoting Science & Technology produced the video series.

HIGGS | ILC | OUTREACH | STANDARD MODEL