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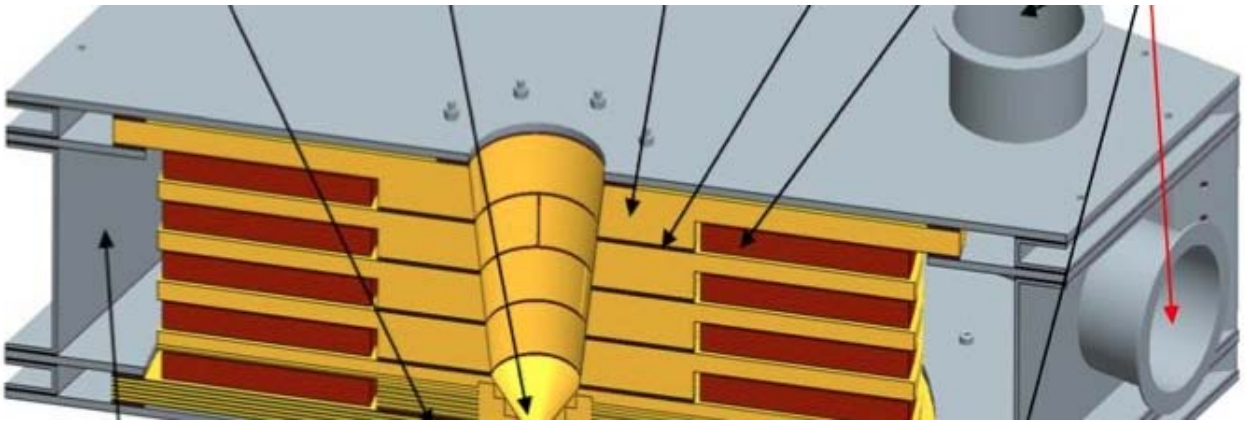
AROUND THE WORLD

The millisecond challenge of the flux-concentrating magnet

Scientists complete the design of a crucial component of the ILC positron source, the flux-concentrating magnet.

by Leah Hesla



The ILC's flux-concentrating magnet operates much like someone in a high-intensity interval workout: it fires for only a small fraction of the time, but when it does, it takes a beating. Scientists at Lawrence Livermore National Laboratory have finished the intense work of designing the flux concentrator, modelling its operation and potential hurdles.

FEATURE

From Symmetry Magazine: Global from the get-go?

Experiments in particle physics have decades of experience as thoroughly international collaborations. Can the giant accelerators that power these experiments make the leap to go global as well? The global physics community has kept the lessons of the Superconducting Super Collider and the LHC in mind while planning for the next international accelerator project. This time, countries are working together

DIRECTOR'S CORNER

FALC discusses future programmes in particle physics

by Barry Barish

Representatives of particle physics funding agencies worldwide met at SLAC in January in an informal forum called FALC. This provided an opportunity to jointly discuss the worldwide program and plans in particle physics on the eve of the much anticipated next data run at the CERN Large Hadron Collider.

from the beginning and physicists have already demonstrated this attitude in developing future accelerators.
Read more in *Symmetry Magazine*.

IMAGE OF THE WEEK

Today's technology in 18th-century framework

Image: Nobu Toge

The TESLA Technology Collaboration Meeting was held from 28 February to 3 March, hosted by the University of Milan and INFN Sezione di Milano.

IN THE NEWS

From New Scientist
2 March 2011
Tevatron closure: There's life in the old dog yet
…Although the Tevatron will stop collecting new data in September, that doesn't mean we will run out of data to analyse. Over the Tevatron's years of operation, the two main experiments, CDF and DZero, have gathered a formidable amount of data.

From UChicago News
2 March 2011
Bruce Winstein, physicist, 1943-2011
Bruce Winstein, an experimental physicist who studied the afterglow of the universe's birth, died Feb. 28 after a four-year battle with cancer. He was 67.

From Science
4 March 2011
Have Physicists Already Glimpsed Particles of Dark Matter?
For decades, astronomers' observations have indicated that some elusive "dark matter" provides most of the gravity needed to keep the stars from flying out of the galaxies. …Now, many physicists expect that within 5 to 10 years they will finally discover particles of dark matter—that is, if they haven't already done so.

From physicsworld.com
8 March 2011
Simon van der Meer: 1925–2011
Simon van der Meer, who shared the 1984 Nobel Prize for Physics with Carlo Rubbia, died on 4 March at the age of 85. The pair were awarded the prize for their roles in discovering the W and Z bosons – the particles that carry the weak force – at the Super Proton Synchrotron (SPS) at the CERN particle-physics lab near Geneva.

ANNOUNCEMENTS

ILC NewsLine is getting a makeover

Dear readers,
Beginning next week, 17 March 2011, *ILC NewsLine* online

CALENDAR

UPCOMING EVENTS

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

and email versions will have a new look and feel. You will still be sent a notification email from the same address (ilcnewsline@ilcgde.org), with [ILC Newsline] and date in the subject line. The email will be sent around 12:00pm, Chicago time. Should you experience any delay in receiving it, please check our web page and report your problem.
We hope you will enjoy your new publication!
– the *ILC NewsLine* team

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

Joint US-CERN-Japan-Russia School on Particle Accelerators
Course on Synchrotron Radiation and Free Electron Lasers
Ettore Majorana Foundation and Center for Scientific Culture, Erice, Sicily, Italy
06- 15 April 2011

View complete calendar

BLOGLINE

7 March 2011
Fermilab
Fermilab in the news: dark matter, budget cuts, Tevatron's staying power

2 March 2011
CERN
Why don't we just say collision rate?

PREPRINTS

ARXIV PREPRINTS

1103.1071
A Search for leptophlic Z_(l) boson at future linear colliders

1103.1069
Physics and measurements of magnetic materials

1103.0952
SUSY Predictions for and from the LHC

1103.0820
The flavor-changing bottom-strange quark production in the littlest Higgs model with T parity at the ILC

1103.0493
Testing Higgs models via the $H^\pm W^\mp Z$ vertex by a recoil method at the International Linear Collider

1103.0481
Estimating the Spin-Independent WIMP-Nucleon Coupling from Direct Dark Matter Detection Data

1103.0069
Supersymmetry Breaking Scalar Masses and Trilinear Soft Terms From High-Dimensional Operators in E_6 SUSY GUT

AROUND THE WORLD

The millisecond challenge of the flux-concentrating magnet

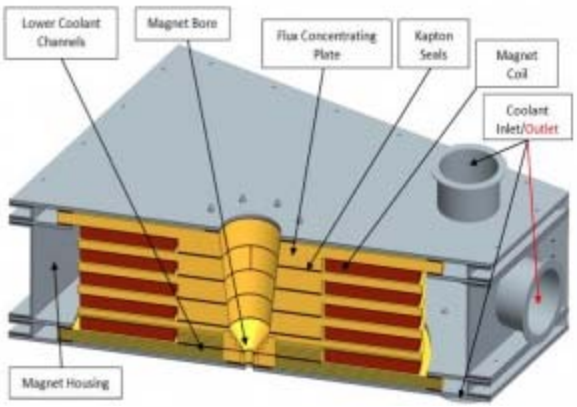
Scientists complete the design of a crucial component of the ILC positron source, the flux-concentrating magnet.

Leah Hesla | 10 March 2011

A lot can happen in a millisecond. Major news agencies compete over milliseconds to be the first to publish breaking stories. In one millisecond, light travels from Geneva, Switzerland to Genoa, Italy.

And for a magnet in the ILC positron source, a millisecond is the length of time it must remain strong enough to focus particles coming from 2,820 positron bunches. For a case such as this, enduring for a millisecond is like running a marathon.

Scientists at Lawrence Livermore National Laboratory in the US have just completed the design of the ILC's flux-concentrating magnet, a device that coaxes positrons down the right path early in their journey through the collider. Magnets of this type are standard in accelerator technology, but they're typically built to maintain their field strength for scant microseconds – thousandths of a millisecond.



Layout of the flux-concentrating magnet. Image courtesy of Jeff Gronberg.

"The real issue is designing something you can run 24-7 for a year and have it hold together without any problems," said Livermore's Jeff Gronberg, who is leading the project to design, build and test the flux-concentrating magnet.

When positrons are first created in a positron target, they are disorderly, carrying many different energies and moving in many different directions. The flux-concentrating magnet, or flux concentrator, captures and focuses as many of these disorganised positrons as it can so they can be more easily accelerated.

"We're very concerned with keeping a constant number of positrons coming off the system's target," Gronberg said.

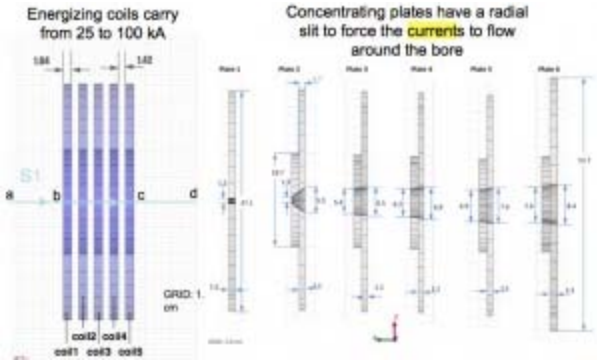
To keep that number constant, the field of the magnet has to last the length of a positron bunch train, about a millisecond. (To meet ILC specifications, it must do so five times every second, which is how often a bunch train is produced.) The magnetic field's endurance depends on the stability of the materials that make up the flux concentrator and on the electrical current that flows through it.

Livermore's flux concentrator is made of six vertical copper plates, each about a centimetre thick. Affixed to each plate is an energising coil of current-carrying wire, which induces another current in its copper plate.

A precisely tapered bore, narrow at one end and wide at the other, runs through the centre of the stack of plates. It is through this bore that the magnetic field, induced by the currents in the plate and in the energising coil, is concentrated.
Almost as soon as positrons are produced, they enter the bore through the narrow end. The magnetic field inside focuses the positron bunches, preparing them for acceleration by the time the exit through the other side.

The effectiveness of the focusing is owed to the specific profile of the magnetic field, optimised for concentrating the positrons

into a nice, narrow beam. Around five teslas at the bore's entrance and about 0.5 tesla at the exit, this is the field profile that must be maintained for one millisecond, five times every second. Scientists at Argonne National Laboratory in the US performed particle simulations to determine the field strengths that best met ILC positron bunch specifications.



Flux-concentrating magnet shown in layer detail. Image courtesy of Jeff Gronberg.

"At Argonne, we developed a magnetic profile with a tremendous focusing effect," said Wei Gai, Global Design Effort positron technical area group leader. "Now the challenge for Livermore is to build it."

The challenges are, of course, numerous.

The magnetic profile depends on the strength of the currents circulating in the copper plates. The plates are kept cold to lower their resistance, allowing them to more easily conduct electricity. But even at temperatures as low as 77 kelvins, the conducting plates can't help losing some current over the time it takes the bunch train to pass through the flux concentrator. As plate currents decrease, so does the magnetic field strength. The concentrator can't do its job well with a flagging, inconstant magnetic field.

To compensate for the inevitable current loss in the plates, the Livermore team modelled how much to increase the current in the energising coil over the millisecond pulse. They are also designing the complicated circuitry that would ensure an ultimately constant plate current.

"We're trying to keep the thing pumped up," Gronberg said.

But constant plate currents do no good if the layers of copper and insulating ceramic can't withstand the stress of the ten-kilowatt heat that is dumped into them or the liquid nitrogen that's meant to combat the heat. These players take their toll on the flux-concentrator's very structure, and do so every time the millisecond-pulse fires.

So Livermore scientists thoroughly modelled every possible factor, force and stress that could affect the integrity of the flux-concentrating magnet: radiation from nearby photons (with help from DESY scientists in Germany), material stress parameters and heat.

"We're trying to create something that both will produce the magnetic field we desire and can be constructed so it won't stress itself apart when you try to fire it," Gronberg said.

With the design phase now complete, simulations show that the magnetic fields should hold up just fine. What remains is to compare those simulations against physical constructions. The Livermore team will complete construction of the magnet later this year. Initially, scientists will test it at room temperature and at low repetition rates to isolate how much degradation the current may cause. Later, Gronberg said, they'll cool it to cryogenic temperatures.

"That's when we'll be able to make sure it has the very long time that we need, the millisecond lifetime," he said.

FLUX CONCENTRATOR | FLUX-CONCENTRATING MAGNET | LAWRENCE LIVERMORE | LLNL | POSITRON SOURCE

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DIRECTOR'S CORNER

FALC discusses future programmes in particle physics

Barry Barish | 10 March 2011

FALC Chair Walter Davidson and Secretary Anne-Marie Brugger, NRC Canada.

The Funding Agencies for Large Collaborations (FALC), an informal committee of particle physics funding agency representatives, held their eighteenth meeting at SLAC on 22 January 2010. I previously reported on an interesting exchange meeting between the Global Design Effort Executive Committee and FALC that took advantage of the fact that their meeting immediately followed our second Baseline Assessment Workshop, which was also held at SLAC. I report today on some highlights from the FALC meeting.

FALC is a unique forum that provides the opportunity for representatives of the world's particle physics funding agencies to regularly meet and jointly discuss their planning and programmes for large international projects and collaborations. Its original purpose was to carry out such discussions solely for the ILC and has continued that role while broadening its mandate. It now includes discussions ranging from major international projects to strategic planning.

In addition to the reports on the ILC from the GDE there were reports on long-term plans and R&D projects (2011-2014) of the major laboratories in the three regions.

Importantly for the ILC, Rolf Heuer, director general of CERN, gave a detailed and very encouraging report on the LHC progress and the prospects for the next data run. He showed that with the higher beam intensity and a long data run through 2012, the LHC will have good sensitivity to discover or rule out the Higgs boson in the favoured mass range. As we prepare the ILC *Technical Design Report*, we will be keeping close tabs on LHC results, which could well inform the motivation and even the parameters of the ILC.

Rolf Heuer discussing LHC progress and plans with FALC.

Roberto Petronzio, INFN president, made a presentation by video on the status of the Super *B* project in Italy, which was approved at the end of 2010 along with a schedule for funding and construction. He discussed the siting, where the choice is anticipated soon. He said that Super *B* is on the list of flagship programmes in Italy that has been established for the period 2010-2015. The Italian government is seeking international collaborations through memoranda of understanding. The plans anticipate the re-use of the PEP magnets as a major US contribution. Petronzio noted that US participation was very welcome, but not critical to the implementation of the project.

Atsuto Suzuki, director of KEK, reports to FALC. Jon Bagger, chair of ILC Steering Committee and Michel Spiro, chair of the CERN Council, are in the foreground.

Atsuto Suzuki, director general of KEK, also presented the status of JPARC, KEK and SuperKEKB. He reported on progress toward SuperKEKB, which he said was on track, with initial budgets approved and growing international commitments.
In addition to the various laboratory and project reports, Michel Spiro, president of the CERN Council, provided an update on the plan to establish a European Draft Strategy Document, which would constitute the proposal for the update of the European strategy for particle physics/), adopted in 2006. The European strategy update will be submitted for approval by the CERN Council in September 2012. A major point on the strategy update timeline will be the International Committee for Future Accelerators (ICFA) seminar discussions, to be held in October 2011, on global perspective on roadmap(s). The next meeting of FALC will be held immediately following that meeting at CERN.

FALC in session.

One conclusion from this FALC meeting is that timing of the ILC *Technical Design Report* appears well aligned with other timelines, including the ICFA seminar next fall, the conceptual design report for the Compact Linear Collider (CLIC) Study in early 2012, the European strategy update and the results from the next LHC data run. We will take these various developments into account, as well as be able to make inputs into the European strategy update.

CERN | EUROPEAN STRATEGY FOR PARTICLE PHYSICS | FALC | FUNDING | FUNDING AGENCIES | INFN | KEK | SUPER B | SUPERKEKB