PROFILE

The science of showers

PhD student Christian Soldner studies time, tungsten and scintillators

by Barbara Warmbein

Good timing is a virtue. Just as comedians have to wait for just the right moment to deliver their punch line, linear collider physicists need to know when to make cuts. These cuts separate phenomena called particle showers from each other, making it possible for the physicists to tell which reaction originated from which collision. Two German PhD students have built a test device that is supposed to get behind the precise timing of showers.

AROUND THE WORLD

Pushing technology, expanding industry

PAVAC Industries has a way with electron beams, and with the help of a boost developing superconducting radiofrequency technology, they're taking their beams to the next level

by Leah Hesla

Canada-based PAVAC Industries recently set up a second shop in Fermilab's backyard. Their work in superconducting cavities pushes their technological capabilities, enabling them to expand into other accelerator applications such as flue gas treatment for coal plants.

DIRECTOR'S CORNER

Timely Technical Review

by Barry Barish

The ILC Project Advisory Committee met in Prague last November to carry out a technical review of the accelerator and detector R&D and design programmes. This timely review provided a technical assessment of our R&D programme goals and ILC baseline for the task of producing the ILC *Technical Design Report*.

IMAGE OF THE WEEK

Breaking ground for IARC

Image: Reidar Hahn

Just before the holiday, members of the US and Illinois governments gathered for a groundbreaking ceremony to officially begin construction on the future Illinois Accelerator Research Center, or IARC.

From left to right: Bob Kephart, IARC project director; Jim Siegrist, associate director of the Office of Science for the DOE Office of High Energy Physics; Michael Weis, DOE Fermilab site manager for the Office of Science; William Brinkman, director of the Office of Science for the DOE; Pier Oddone, Fermilab director; Warren Ribley, director of the Illinois Department of Commerce and Economic Opportunity; Linda Holmes, Illinois state senator; and Michael Fortner, Illinois state representative.

IN THE NEWS

from ***New Scientist***
11 January 2012
Largest dark matter map holds clues to dark energy
We may not know what dark matter is, but we can still put it to work. The largest map of dark matter ever made is one of several new ones that will help to nail the properties of the equally mysterious dark energy, which is thought to drive the universe's accelerating expansion.

from ***Fermilab Today***
10 January 2012
Leveraging technologies
When the International Linear Collider's international committee selected superconducting RF technology for the ILC in 2005, one of the motivations for the decision was the potential utility of SRF technology for other fields of science and for even broader applications.

from ***KEK***
10 January 2012
Belle Discovers New Heavy 'Exotic Hadrons'
The Belle Experiment*4 has discovered two new unexpected particles at the KEK B Factory (KEKB). These new particles, termed Zb, contain both one 'bottom' quark (the second-heaviest quark among the known six types of quarks) and one 'anti-bottom' quark (the anti-particle of the bottom quark).

from ***NHK News***
7 January 2012
巨大加速器 産官学挙げ誘致へ
Japan's industry, academia and government collaborate towards the bid for the huge collider…The geological survey will be launched this year in two candidate construction sites for world largest accelerator. [also video clip]

from ***Fermilab Today***
5 January 2012
First successful test run for J-PARC after earthquake
Ten months after the earthquake and tsunami that devastated northern Japan, the Japan Proton Accelerator Research Complex (J-PARC) completed the first full test run for their system.

from ***BBC News***
4 January 2012
Neutrino hunting underwater telescopes probe origins
The number of "eyes" scanning deep space in search of a particle that could shed light on our universe's formation is about to multiply.

from ***Nature***
4 January 2012
Survey tunes in to dark energy
David Schlegel's tool for exploring dark energy, one of nature's biggest mysteries, is deceptively simple.

ANNOUNCEMENTS

Accelerators for our future – an online discussion
Weigh in on accelerators' place in the world. Share your thoughts, relevant news or stories on accelerator technology transfer. Engage in a forum about accelerators and their use in industry, medicine, security, environment, energy and discovery. View or post on the Accelerator R&D Task Force blog.

PREPRINTS

ARXIV PREPRINTS

1201.1653
Construction and performance of a silicon photomultiplier/extruded scintillator tail-catcher and muon-tracker

1201.0197
Flavor violation in the MSSM and implications for top and squark searches at colliders

CALENDAR

UPCOMING EVENTS

ILC ML & SCRF Baseline Technical Review
KEK, Tsukuba, Japan
19- 20 January 2012

3rd LC FORUM meeting
DESY, Hamburg
07- 09 February 2012

UPCOMING SCHOOLS

Physics and Technology of Particle Accelerators (JUAS 2012)
Geneva, Switzerland
09 January- 16 March 2012

USPAS sponsored by the University of Texas at Austin
Austin, Texas
16- 27 January 2012

Excellence in Detectors and Instrumentation Technologies (EDIT 2012)
Fermilab, Batavia, IL, USA
13- 24 February 2012

View complete calendar

PROFILE

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Barbara Warmbein | 12 January 2012

PhD student Christian Soldner won a 'best student paper' prize for his work. Image: Lars Weuste

Good timing is a virtue. Just as comedians have to wait for just the right moment to deliver their punch line, linear collider physicists need to know when to make cuts. These cuts separate phenomena called particle showers from each other, making it possible for the physicists to tell which reaction originated from which collision. Two German PhD students have built a test device that is supposed to get behind the precise timing of showers.

The calorimeter currently under study by the CALICE collaboration for a future CLIC detector is using tungsten because the density of the material would make the final calorimeter much more compact than any other absorber material. However, tungsten has the annoying habit of emitting neutrons from time to time, and these neutrons would jumble the results from the hadronic calorimeter because the energy bill would not add up. In order to keep the balance right, physicists need to be able to pair collision and particle shower, thus 'timestamping' the shower. The better they know their particle showers, the easier it is for them to tell where to separate one from the other.

This is where PhD student Christian Soldner and his colleague Lars Weuste, both working at the Max-Planck-Institute for Physics in Munich, Germany, come in. Fifteen silicon photomultipliers or SiPMs, each attached to a scintillator tile and connected to four oscilloscopes with extremely high time resolution, make up their test device called "T3B", for tungsten timing test beam. "We can tell with a precision of about one nanosecond when a SiPM pixel has fired because it was hit by a photon," says Soldner. "The trick is to really understand hadronic showers by knowing exactly how much energy was deposited where and at precisely which time – sort of a high resolution in 4D."

The row of scintillator tiles for the T3B experiment's timing measurements. Image: Christian Soldner

Under the supervision of MPI's Frank Simon, the pair designed and built the T3B device, ran simulations, wrote the code and tested it in test beams at CERN together with the CALICE analogue HCal and the semi-digital HCal. They started in 2010 and have collected a lot of data with different absorber materials, with first analyses looking interesting not only for them, but also for the makers of the GEANT4 simulation software and even the organisers of the IEEE conference in Valencia last year – Christian Soldner won one of four 'Best Student Paper' prizes at the IEEE for the presentation of their results so far.

By the end of next year, Soldner will have analysed all the data and written his PhD about the results. He's keeping an open mind about what to do next: "I might look at post-doc options, for example at CERN, but I also think that project work in the industry can be really fascinating," says the 28-year-old from Munich.

Four really fast oscilloscopes. Image: Frank Simon

Read more in Frank Simon's blog

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ilc newsline

AROUND THE WORLD

Pushing technology, expanding industry

PAVAC Industries has a way with electron beams, and with the help of a boost developing superconducting radiofrequency technology, they're taking their beams to the next level

Leah Hesla | 12 January 2012

Electron beams aren't just for colliding. They also happen to be useful tools for welding metals and treating greenhouse gases.

PAVAC Industries of Richmond, Canada is all about electron beams – manipulating them and manufacturing machines that use them. The company is currently contracted to develop superconducting radiofrequency technology (SRF) for the ILC. That assignment, along with an entrepreneurial desire to expand, has given the business both impetus and incentive to grow.

Last year PAVAC successfully expanded into the US, establishing a second location a stone's throw from Fermilab in Batavia, where they'll eventually produce ten accelerator cavities for ILC research.

"I wanted to go to Arizona because there's sun and it's warm – a nice place to be, especially in winter," said PAVAC President Ralf Edinger.

PAVAC President Ralf Edinger (left) and associate Doug LaPointe inspect a vacuum chamber the company is manufacturing for an electron beam welder. Image: Ralf Edinger

The opportunity to develop forward-leaning accelerator know-how for a major science project trumped happy weather. Edinger recognised that developing SRF was beneficial, not only for physics programmes, but for positioning PAVAC at the cutting edge of technology.

In the early days of PAVAC, the company made its mark on electron beam systems by manufacturing electron beam welding (EBW) machines. Selling machines continues to bring in the greatest portion of its revenue.

Then in 2004, TRIUMF laboratory in Vancouver, Canada, approached PAVAC to develop SRF cavity prototypes for a project called ISAC 2. SRF looked to be a viable market, but as the company was looking to expand beyond the Canadian border, it seemed that expansion through SRF was a goal without an application.

"The problem was, we had a target, but no purpose," Edinger said.

In 2008, Fermilab's Mark Champion recruited PAVAC in his search for potential North American cavity vendors for the ILC.

"The work on the ILC, having to achieve milestones, gave us a purpose," Edinger said. "You don't get rich developing cavities, but it's a very good way to drive your technology. That's the key element."

About that time the International Atomic Energy Agency began pushing for cutting-edge ways to clean up greenhouse house gas

emissions. Edinger participated in an IAEA working group to develop beam sources to deliver high power to gas treatment processes.

“If all this technology is developing with ILC-type RF accelerators, can’t that knowledge base be used to develop a new accelerator that we can then introduce into industrial facilities?” Edinger said.

Last month PAVAC and Fermilab entered into a US Department of Energy Work for Others agreement in which Fermilab lends to PAVAC its accelerator-based capabilities, enabling the company to develop a gas treatment system. In the longer term, PAVAC could be a resident at the future Illinois Accelerator Research Center, perhaps building a prototype electron beam flue gas treatment plant in Saskatchewan, Canada.

“So from the work on cavities, we’re branching out into other areas,” Champion said. “It’s a great example of accelerator applications.”

Though the move to the Chicago suburb will provide little respite from Richmond’s rain, it’s a good fit for PAVAC. The area has an established machine-making and tool-building infrastructure. Machine part wholesalers are right around the corner. Subassembly manufacturing is increasingly drawn to the city.

The move also positions the company to work closely with and provide electron beam welding for Argonne National Laboratory, also outside Chicago, and Michigan State University in nearby Lansing.

Beyond America, the company has a contract to sell an EBW machine to the RRCAT laboratory in Indor, India.

“Ralf became better known in the community,” Champion said. “Many things have come from PAVAC’s work with SRF. But it was the ILC programme that really stimulated it and enabled this.”

The company has also continued developing methods to ablate materials with electron beams, vapourising metals and then depositing the vapour on various surfaces.

“There is a need for a lot of cool technologies that really drive the future and SRF is probably one way of doing that,” Edinger said. “It might not be SRF as we do it today, but if you push this envelope further, maybe you come up with something out of it.” And that something may very likely be as good for business as it is for science applications.

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DIRECTOR'S CORNER

Timely Technical Review

Barry Barish | 12 January 2012

The culmination of the work of the ILC Global Design Effort is to produce a *Technical Design Report* (TDR), which will be comprehensive and can be used as the basis of project proposals to collaborating governments. We are finalising the design that will be documented in the TDR as well as planning the pre-TDR R&D to be completed in 2012. An external assessment of our technical status and plans at this time can be particularly valuable in making changes for the TDR. We had just such an assessment in November 2011 when the Project Advisory Committee for the ILC met in Prague. Their review report provides both validations of the technical status and plans for the TDR, as well as some very useful guidance for the future.

Lyn Evans (CERN, chair) and PAC member Jai-er Chen (Beijing University) at the review closeout. Image: GDE

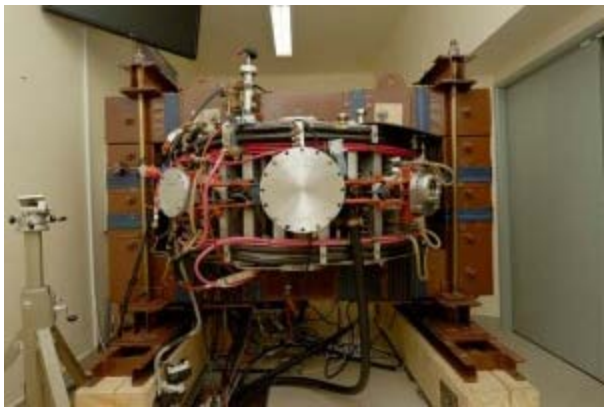
PAC members Robert Orr (University of Toronto), Stuart Henderson (Fermilab) and Hans Weise (DESY) at the closeout. Image: GDE

The main recommendations and conclusions of the report are quoted below:

1. *The PAC is pleased to learn of the additional emphasis on cavity field emission.*
2. *The current cavity tuner status is far from optimum, and the PAC would like to see one tuner design developed sufficiently to demonstrate its reliability.*
3. *The Committee is following with interest the developments on tumbling as a cavity conditioning method.*
4. *The Committee is impressed with the enormous effort at KEK and Fermilab to produce cavity strings that can be fully tested with beam. The Committee requests that a program of work be established post-2012 to maximize the information obtained from these facilities, in particular the long-term behavior under realistic fully loaded conditions so that the final design of the ILC can proceed with maximum operational experience.*
5. *The Committee strongly endorses the continuation of cavity development past 2012.*
6. *The PAC is interested to learn further on the need (or not) to have cavity location sorting.*
7. *ATF is congratulated on its recovery from the earthquake, and the Committee reiterates its opinion that ATF2 is a very valuable community resource.*
8. *The Committee agrees that the PPP approach to costing is the correct method to use for the TDR, but does note that there may be some exceptions for items where there is only a single supplier.*
9. *It should be noted that there is a cost to the host-lab coordination of multiple in-kind contribution of the same item.*
10. *The PAC supports the General Issues Working Group's current and proposed activities as presented to this PAC meeting.*

Overall, we believe this review is supportive and validates our preparations for the TDR and main goals in the future. Of special

interest are recommendations 4 and 5, which give endorsement to the major thrust of the programme being planned to follow the completion of the TDR. The committee endorses carrying out a detailed programme of systems tests with fully loaded beam, using the mentioned superconducting radiofrequency facilities. We believe that in addition to the TDR, results from these systems tests will give confidence proceed with a construction project. The continued cavity work will also be beneficial in enhancing the flexibility to go to higher energies.



The GOLEM Tokamak at the Czech Technical University. Image: FNSPE

While in Prague, I also was invited to give a special general lecture at the Czech Technical University and while there was given a tour of the GOLEM Tokamak. This tokamak – a device that confines plasma in a toroidal shape – has an exceptional history. It was constructed in 1960 in Moscow under the name TM-1 as one of the first tokamaks built and is now the oldest tokamak in operation in the world. It serves as part of the fusion science programme as a learning device in a field that is now building the very large international project ITER, a step towards eventually creating fusion energy. An interesting feature of the GOLEM setup is that it is used remotely as a teaching instrument through their website.

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