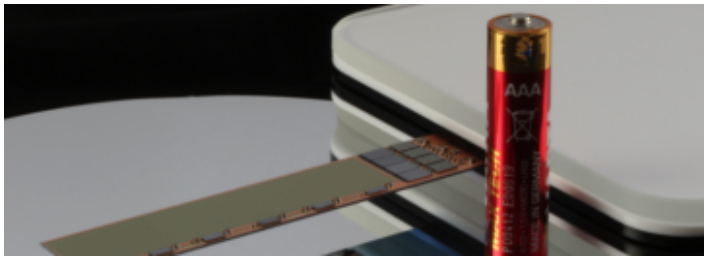
LC NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

AROUND THE WORLD

High-precision vertexing: from concept to reality

by Ladislav Andricek

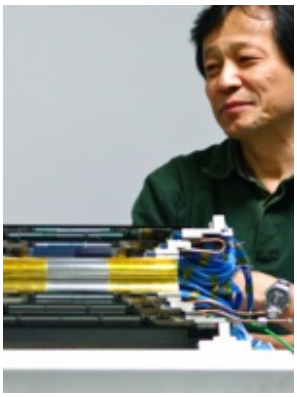


They're all individuals: detectors for particle physics all look very different. However, some of the technologies they (plan to) use can be the same, as this example from Belle II hows: it uses a component originally designed for an ILC detector. An example of technology transfer from the future...

DIRECTOR'S CORNER

Trailguides in difficult terrain: the Physics and Detector Advisory Panel (PDAP)

by Hitoshi Yamamoto



Hitoshi Yamamoto, Associate Director for Physics and Detectors in the Linear Collider Collaboration, is happy to announce that a new, lightweight panel to oversee physics and detector activities has been formed and met for the first time at this year's linear collider workshop.

VIDEO OF THE WEEK

Next generation records #mylinearcollider videos

At the 9th International Accelerator School for Linear Collider, many young scientists joined the #mylinearcollider campaign – video messages from all over the world from people who wish to participate in the project. We have prepared a new playlist of messages from young scientists, #nextgeneration, on YouTube. Have a a look at what the next generation has to say!

IN THE NEWS

from *Iwate Prefecture International Linear Collider Promotion Council*
18 November 2015
Check out the third issue of THE KITAKAMI TIMES, an English newsletter about local ILC news!
from *China Daily*
18 November 2015
Scientists on collision course with future
Chinese physicists have proposed building the world's largest particle collider, making China a global research center. Cheng Yingqi reports.

from *Iwate Nichi Nichi*
18 November 2015
ＩＬＣ実現へ現状紹介　サイエンスカフエ　佐貫准教授（東北大大学院）が講話
一関市の「いちのせきサイエンスカフエ」は15日、同市大手町の一関図書館で開かれた。東北大大学院理学研究科の佐貫智行准教授が、研究者の立場から「国際リニアコライダー（ＩＬＣ）」の北上山地（北上高地）建設に向けた現状を紹介した。(On 15 November, Tomoyuki Sanuki of Tohoku University gave a lecture at "Ichinoseki Science cafe" held at Ichinoseki Public Library.)

from *Japan Daily*
16 November 2015
There's a strange particle in my coffee
Associate Professor Tomoyuki Sanuki of the Department of Physics at Tohoku University spoke about the science of the proposed International Linear Collider (ILC).

from *Iwate Nippo*
13 November 2015
「基礎科学の意義確信」　鈴木県立大学長が受賞会見
「ブレークスルー賞」の基礎物理学賞を受けた県立大の鈴木厚人学長は１２日記者会見し、今回の賞金を活用し、素粒子や宇宙、国際リニアコライダー（ＩＬＣ）などに関する出前講座を展開する構想を示した。(Atsuto Suzuki, president of Iwate Prefectural University who won the Breakthrough Prize in fundamental physics said in press conference held on 12 November that he will start the school visiting lecture program about the ILC with the prize fund.)

ANNOUNCEMENTS

Early NewsLine because of Thanksgiving

Because of the Thanksgiving holiday in the United States this Thursday, we are publishing *LC NewsLine* on Wednesday. The publication will return to its normal schedule in December.

CALENDAR

Upcoming schools

Joint Universities Accelerator School
Archamps, Haute Savoie, France
11 January- 18 March 2016

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1511.06211
Radiative corrections to the Higgs boson couplings in the model with an additional real singlet scalar field

1511.06002
Neutral Higgs Boson Production at e+e- Colliders in the Complex MSSM: A Full One-Loop Analysis

1511.05815
ASAHEL (A Simple Apparatus for High Energy LEP)

1511.04342
The Quark Flavor Violating Higgs Decay $h \to b\bar{s} + bs\bar{}$ in the MSSM

1511.03571
Usage of Liquid Metals in the Positron Production System of Linear Collider

1511.03427
Non-custodial warped extra dimensions at the LHC

1511.03203
Dark Matter phenomenology of GUT Inspired simplified models

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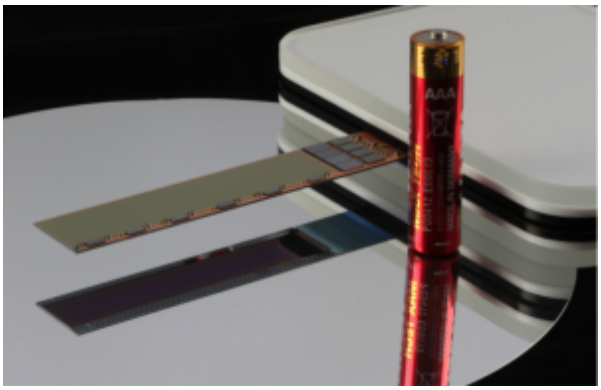
High-precision vertexing: from concept to reality

Ladislav Andricek | 25 November 2015



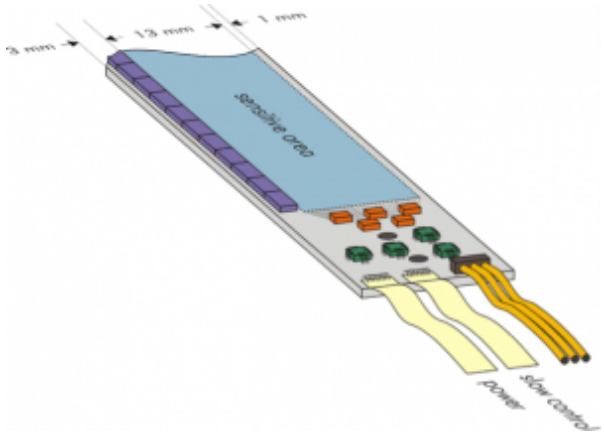
2015: The first fully functional Belle II pixel module seen from the front and back side. The reflection shows the thin sensitive area with the perforated support frame.

Back in the early days of the new millennium when TESLA was not linked to electrically driven vehicles but the name of an ILC predecessor project, a small group of physicist and engineers from Bonn and Munich came together to discuss what they can do to face the challenges in future high-energy physics experiments. The goal was to determine the vertex – the place where the particles collide and interact – with the highest precision at maximum read-out speed. In the end they came up with the idea to use active pixel sensors operated in rolling shutter mode to minimise power consumption and material in the sensitive volume.

Feasibility studies were made and the development gained momentum, first prototypes were built, and with that the concept gained visibility. Scientists working on the Belle II detector at the SuperKEKB accelerator in Japan chose this technology for their vertex detector. The small group developed into the DEPFET Collaboration with institutes from all over Europe. DEPFET stands for “depleted p-channel field-effect transistor.” In the subsequent years the concept was brought to an engineered solution which was recently finalised with the construction of ‘Module-0’ – the first all-silicon module that could be used in the final Belle II experiment.

Made from silicon a thousand times more pure than conventional transistors or memory chips, the module integrates 200,000 DEPFET pixel cells on a surface area of eight square centimeters. It was invented at the Semiconductor Lab of the Max Planck Society (MPG HLL) and is fabricated here exclusively.

The DEPFET component enables the detection of photons – or, as in this case, of high-energy particles – with the utmost efficiency and precision. The fundamental process is very similar to the one in a conventional photo or video camera. However, the primary signal from individual photons or particles is very much smaller.



2003: First conceptual sketch for the all-silicon module comprising a thin sensitive area with active pixels and supported by a rigid frame carrying read-out and steering ASICs.

This is where the major advantage of the DEPFET comes into play: the tiny primary signal is amplified within the sensor itself. Thus the DEPFET is the sensor material and the first stage of amplification rolled into one. Arranging many DEPFETs in a matrix forms an image sensor with which a particle’s point of interaction can be precisely determined. In the present configuration for the Belle II experiment this can be done with an accuracy of around one-hundredth of a millimetre.

Control of the pixels in a matrix and ultra-fast processing of the DEPFET signals require additional electronics, which have been developed and produced in collaboration with University Bonn, University Heidelberg and KIT Karlsruhe. These electronics, in the form of

application-specific integrated circuits (ASICs), are placed directly on the sensor substrate. The ASICs allow digitisation of signals from the pixel matrix, as well as lossless data compression, to transmit them off-module at the highest speed (50,000 frames per second).

With this, the DEPFET matrix becomes a very complex module with maximal integration density, which despite all its complexity is extremely thin and light, so that the measurement accuracy of particle tracks is not distorted by the sensor material itself.

The MPG HLL has developed a unique technology for this purpose that makes it possible to fabricate extremely thin and highly integrated sensor modules. In the fabrication process, the sensitive part of the module, the DEPFET matrix, is thinned by a customised etching technique to 75 micrometers, roughly the thickness of a human hair.

These bendable silicon films are supported by a monolithically integrated silicon frame, on which the readout and control electronics are mounted. The power supply and data lines run through a flexible ribbon cable, which is attached to the end of the module.

The MPG HLL technology makes it possible to arrange the thin DEPFET matrices in a cylindrical form, without any further support, around the interaction point of the experiment. With that, the highly precise measurement of particle tracks is becoming reality.

More information:

- The home page of the Semiconductor Lab of the Max-Planck-Society
- The Belle II Experiment at the Max Planck Institute for Physics
- “Here’s one we made earlier”, LC NewsLine 17 September 2015

BELLE-II | DEPFET | DETECTOR R&D | KEK | MPI

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DIRECTOR'S CORNER

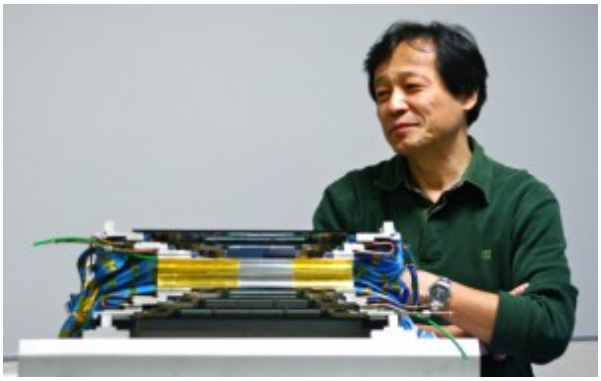
Trailguides in difficult terrain: the Physics and Detector Advisory Panel (PDAP)

Hitoshi Yamamoto | 25 November 2015


Paul Grannis, chair of the PDAP

The Linear Collider Collaboration (LCC) was established in February 2013, and the organisation of the physics and detector part started to form over the following several months with regional representatives, concept group representatives, and working groups. One important ingredient for the organisation was the physics and detector advisory panel (PDAP) that advises the Associate Director for Physics and Detectors (currently me) in executing his or her mandate. The charge for the PDAP that has been approved by the Linear Collider Board states that '*the PDAP monitors the physics and detector activities of the ILC and its synergies with CLIC*', and that it '*makes recommendations such that appropriate progresses are made toward realization of linear collider detectors and collaborations.*' Its function is similar to that of the International Detector Advisory Group (IDAG) that existed before the time of the LCC.

Since the function of the PDAP was considered to be important in guiding the development of the physics and detector efforts, its chair was selected and appointed at an early stage. Because of his wisdom in issues regarding physics and detector activities in general, his wide and deep knowledge on the linear colliders as well as his long-time commitment to our efforts, I was very happy to have Paul Grannis on board as the PDAP chair. He was also a member of the IDAG in the past.


Junji Haba, KEK

The composition of the PDAP and that start of its real activities took longer and were more difficult. One problem is that the current organisation does not have a clear benchmark goal such as the detailed baseline report (namely, Volume 4 of the ILC TDR), which guided the reviewing activities of the IDAG during the period preceding the LCC. The natural next benchmark after the detailed baseline report would be a real engineering design report; such a report, however, would be produced by a real collaboration after a linear collider laboratory is formed or at least known to be formed in the near future. We are unfortunately not at such a stage yet. Intense discussions took place in many physics and detector executive board meetings on how to define the concrete charge for the PDAP in this uncertain time. There also was a strong point expressed that heavy reviews conducted by the PDAP at this time of low resources would be counter productive. It is only recently that we came to an agreement on the nature of the PDAP and its reviews.

In the end, we decided to form a 'lightweight' review panel that does not require a large amount of work for the reviews, neither for those who review nor those who are being reviewed, but still can extract recommendations useful for the physics and detector activities. Thus, two additional members were selected: Sandro Palestini from Europe and Junji Haba from Asia. Sandro is knowledgeable about CERN-related issues and also used to be a member of the IDAG. Junji is an internationally known expert on detector R&D, and he was a member of a committee that reviewed the ILC detector R&D efforts in the past. With Paul being from Americas, they are well balanced regionally and in expertise.

At the linear collider workshop held at Whistler, Canada, the PDAP had its first review. The total allotted time was two hours and within its limited time, presentations on status and plans for the ILC detector concept groups (ILD and SiD) as well as on synergy of physics and

Sandro Palestini, CERN. Image: ATLAS Experiment © 2014 CERN

detector efforts of ILC and CLIC were made, followed by discussions. Then there was a session where representatives of major detector R&D groups were invited to discuss possible technical review to be conducted in the future. The report is now public and posted here. I encourage you to take a look at the report for the content, but here I quote one sentence in the preamble which describes the nature of the review well: "*The reviews offered an opportunity to take a snapshot of the current status and to look toward future activities when a decision to proceed with linear collider construction is made*."

DETECTOR CONCEPTS | DETECTOR R&D | PDAP | PHYSICS AND DETECTORS

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Yasuhiro Fuwa from Kyoto University, Japan, said the school was very informative and valuable, and would like to take part in the development and construction of the klystron system using the experience and knowledge gained at the school. His message is “Let’s work together to successfully realise the ILC!”

Teodora Jelisawcic, a 13-year-old school student from Serbia, said, “I think building of the ILC is important. It is a powerful tool to explore our nature, because we don’t understand most of it.”

Elena Vasilica GaftonKatie Malone, a PhD student at Alexandru Ioan Cuza University, Romania, said, “Here at the school, we learned more about the physics behind the ILC. So, don’t kill our dream, please!”

Now is the time to really show our ambition to realise the International Linear Collider. The LC communication team is producing a collection of #mylinearcollider video messages from all over the world to support the ILC. Please join the team and give the ILC project a final push! Contact the communicators to find out more.