AROUND THE WORLD

Asian collaboration on ILC superconducting radiofrequency technologies

by Qian Pan

When the New Year's bell was still echoing in the air, physicists from China and Japan gathered in Beijing to attend the fifth IHEP-KEK 1.3-GHz technology collaboration meeting on superconducting radiofrequency (SRF) which was held at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences from 7 to 8 January 2013. Six high-energy accelerator experts from KEK and nearly twenty physicists from IHEP participated.

AROUND THE WORLD

DEPFET active pixel detectors for the linear collider

Marcel Vos reports on behalf of the collaboration

The DEPFET structure is one of the candidate technologies for the creation of the most transparent pixelated detector in history. Originally developed for the ILC'S predecessor TESLA and a firm candidate for the ILC experiments, it has been selected as the baseline technology for the Belle-II experiment in Japan, a shining example of technology transfer in high-energy physics. In a paper submitted to IEEE Transactions on Nuclear Science the collaboration reviews its recent progress in the light of the challenging vertex detector requirements of a linear electron-positron collider at the energy frontier.

DIRECTOR'S CORNER

2013: The year of the snake or the "What if?"

by Ewan Paterson

Ewan Paterson, member of the Global Design Effort Executive Committee, weighs the options that new year, new collaboration and TechnicalDesign Report bring. Will 2013 be the year of the "What if"?

FEATURE

Become a signatory of the Detailed Baseline Design report

We invite you to sign the Detailed Baseline Design (DBD) report of the ILC detectors, which now exists as a nearly final draft. It summarises the R&D achievements of the ILC Letter-of-Intent period. The contents reflect the many contributions of very many collaborators.

While this draft is undergoing minor revision following the recent review by the International Detector Advisory Group (IDAG) and the ILC Project Advisory Committee, it is almost in the final form.

A list of signatories will be included in the report. We wish to include those who contributed already in any way or who wish to join the activity in the next stage. We also would like to include names of anyone who supports advancing further the world ILC effort.

IN THE NEWS

from ***New Scientist***
21 January 2013
Twitter reveals how Higgs gossip reached fever pitch
Anyone who fondly remembers the heady days in early July 2012 when the discovery of the Higgs boson was hotly anticipated, and eventually announced, can now relive the thrilling experience thanks to an analysis of Higgs-related traffic on Twitter.

from ***Saga shinbun***
19 January 2013
ＩＬＣ誘致へ推進協 九経連会長が考え示す
「国際リニアコライダー」（ＩＬＣ）計画で、九州経済連合会（九経連）の松尾新吾会長は１８日、候補地の一つとなっている脊振山地への誘致推進組織を立ち上げる考えを示した。(Shingo Matsuo, chair of the Kyushu Economic Federation announced on 18 January the plan to establish the new body to promote the activity to invite the ILC to Sefuri mountains, one of the two candidate construction sites in Japan.)

from ***Iwate Nippo***
19 January 2013
文科相、ＩＬＣ国内誘致を明言 関係国に協力要請へ
超大型加速器・国際リニアコライダー（ＩＬＣ）について、下村博文文部科学相は１８日の閣議後会見で「わが国としては、ぜひ日本国内に誘致したい」と明言した。今年前半に欧米などの関係各国に資金協力や連携について働き掛ける予定。「政府として今年前半に積極的に関係国に働き掛けながら、今後の準備計画を考えたい」とした。(In the regular press conference held on 18 January, Japan’s science minister, Hakubun Shimomura stated the Japan’s will to invite the ILC. “The government will start the preparation process and call for the international discussion on the cooperation and financial distributions in the first half of 2013.)

from ***Iwate Nippo***
16 January 2013
ILC国内誘致に国が本腰 文科相が政府間協議提唱へ
達増知事らによると下村文科相は国内誘致について、今年前半に欧米の関係国に政府間協議を呼び掛ける考えを示した。(According to the governors who met visited concerned ministries, Minister Shimomura said he will call for the discussion to the U.S. and European countries on the invitation of the ILC in the first half of 2013)

from ***Kahoku Shinpo***
17 January 2013
復興加速きょう要望 東経連、復興相らと会談
東北経済連合会は１６日、安倍政権に対して東日本大震災からの復興の加速を求める要望書をまとめた。国際プロジェクトとして建設される超大型加速器「国際リニアコライダー（ＩＬＣ）」の岩手県南の北上山地への誘致支援なども求めることとした。(Tohoku Economic Federation completed the preparation of the petition to be submitted to the government on 16 January. They included the request for the support on the invitation of the ILC to Iwate prefecture in the petition.)

from ***Kahoku Shinpo***
13 January 2013
被災４県が政府に要望書提出 １５日合同で

青森、岩手、宮城、福島の４県は合同で、東日本大震災からの復旧、復興に向けた財政措置などを求める要望書を１５日、安倍晋三首相に提出する。国際プロジェクトで建設される超大型加速器「国際リニアコライダー（ＩＬＣ）」の東北誘致も求める。(Local governments of Aomori, Iwate, Miyagi, and Fukushima jointly present the petition to Minister Shinzo Abe on 15 January, which include the request for the invitation of the ILC to Tohoku area.)

from ***Kahoku Shinpo***
10 January 2013
ＩＬＣ誘致、岩手が要望 知事、文科相と会談
達増拓也岩手県知事は８日、下村博文文部科学相を訪れ、科学者らが建設を目指している次世代加速器「国際リニアコライダー（ＩＬＣ）」について、「東日本 全体の復興の象徴として、国家プロジェクト、国際協力事業としてぜひ進めていただきたい」と岩手県・北上山地への誘致に協力を求めた。(Takuya Tasso, the governor of Iwate prefecture visited Hakubun Shimomura, Japan's science minister asking for the support to invite ILC as one of the measure to recover from the major earthquake)

from ***Iwate Nippo***
10 January 2013
達増知事、自民本部で要望活動 「復興意欲伝わった」
達増知事は８日、東京・永田町の自民党本部と各省で、震災復興や２０１３年度政府予算編成、国際リニアコライダー（ＩＬＣ）の誘致などについて要望活動を行った。(Governor Takuya Tasso visited the headquarter of Liberal Democratic Party and concerned government ministries on 8 January, and made representation on the issues such as recovery from the earthquake and inviting the ILC to Japan)

from ***Japan Times***
9 January 2013
Stronger science foundation
Following the discovery, the design specifications for the 31-km-long, powerful International Linear Collider were completed. The ILC is expected to contribute to broadening human knowledge of the universe. Japan should consider inviting the ILC project by choosing a candidate site.

CALENDAR

UPCOMING EVENTS

SiD Workshop
SLAC
16- 18 January 2013

CLIC Workshop 2013
CERN
28 January- 01 February 2013

Les Rencontres de Physique de la Vallée d'Aoste (La Thuile 2013)
La Thuile, Italy
24 February- 04 March 2013

UPCOMING SCHOOLS

Joint Universities Accelerator School (JUAS 2013)
Archamps, France
07 January- 15 March 2013

CERN - Latin-American School of High-Energy Physics
Arequipa, Peru
06- 19 March 2013

Excellence in Detectors and Instrumentation Technologies (EDIT 2013)
KEK, Japan
12- 22 March 2013

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1301.4673
Effects of RF breakdown on the beam in a CLIC prototype accelerator structure

1301.4224
Emergence of the Electroweak Scale through the Higgs Portal

1301.2494
Physics background at ILC at 500GeV and 1TeV

1301.2324
Unraveling The Physics Behind Modified Higgs Couplings — LHC vs. a Higgs Factory

1301.1773
Hidden sector dark matter and Higgs physics

1301.1449
Correction of beam-beam effects in luminosity measurement in the forward region at CLIC

1301.1322
Measuring Higgs Couplings at a Linear Collider

1301.1222
Positron Source Simulations for ILC 1 TeV Upgrade

ANNOUNCEMENTS

2013 European School of High-Energy Physics

The 2013 European School of High-Energy Physics will be held in Hungary from 5 to 18 June. Details can be found here.

The deadline for applications is 15 February 2013. The lectures will cover a broad range of high-energy physics topics at a level suitable for students working for a PhD in experimental particle physics. One or two students from developing countries could be considered for financial support.

Register now for ECFA-LC 2013 in Hamburg

The next ECFA Linear Collider Workshop ECFA-LC2013 will be held at DESY in Hamburg, Germany, from 27 to 31 May. This is the first topical workshop after the formation of the Linear Collider Collaboration (LCC). It is dedicated to the physics potential of future high energy electron-positron colliders, especially in view of the recent results from the LHC. The status of the detectors and the accelerator designs for both technology options, ILC and CLIC, will be reviewed.

For more information and registration, please visit the workshop webpage. The deadline for early registration is 31 March.

ilc newsline

AROUND THE WORLD

Asian collaboration on ILC superconducting radiofrequency technologies

Qian Pan | 24 January 2013

When the New Year's bell was still echoing in the air, physicists from China and Japan gathered in Beijing to attend the fifth IHEP-KEK 1.3-GHz technology collaboration meeting on superconducting radiofrequency (SRF) which was held at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences from 7 to 8 January 2013. Six high-energy accelerator experts from KEK and nearly twenty physicists from IHEP participated.

The meeting was co-chaired by Jie Gao, member of the future Linear Collider Board, chair of the Asian Linear Collider Steering Committee and chief scientist of the ILC group at IHEP, and Kaoru Yokoya, member of the ILC steering committee and the Asian regional director of the GDE.


Paticipants of the fifth IHEP-KEK 1.3-GHz technology collaboration meeting on superconducting radiofrequency (image/IHEP)

"The aims of this meeting are to review the progress of the IHEP-KEK collaboration on 1.3-GHz superconducting radiofrequency (SRF) technology, to promote the future collaboration on ILC superconducting linac, and to be better prepared for the formal construction of the ILC project through international collaboration," said Gao.

During the meeting, experts from KEK and IHEP gave ten talks to review the progress on the1.3-GHz SRF technology collaboration and proposed the next collaboration plan. Six years of research and development work from KEK scientists and industrial collaborators has successfully led to the satisfying fact that an average accelerating gradient of 35 MV/m was achieved with 90% yield of the TESLA-like nine-cell cavities in industry, which meets the technical design specification for the ILC project. KEK has developed a 40-MeV linac where a collision experiment between electron beams and a laser was successfully realised. Four nine-cell cavities passed the test on STF phase-1, and eight nine-cell cavities (four of them developed through the collaboration with FNAL and DESY) were successfully tested in the S1-Global experiment.

Based on these successful experiences, KEK is planning to build an 800-MeV test facility to develop and operate 26 new nine-cell superconducting cavities, called STF phase-2. KEK has also built an advanced manufacturing centre for superconducting cavities to conduct research on the polishing and electro-assembling of the cavities. These efforts could definitely help reduce the costs, improve manufacturing efficiency and lay the foundation for technology transfer and future large-yield production.

Supported by technology innovation funds at IHEP, the key project of 1.3-GHz superconducting accelerating unit has made important progress. All the key-component R&D tasks have been completed and are under test, which include full large-grain low-loss nine-cell superconducting cavities, high-power input couplers, tuners, LLRF, cryomodules, etc. The assembling of the unit will be conducted in 2013, and a test is scheduled in 2014. This would be the first ILC superconducting linac test unit developed in China and is of great significance to the ILC R&D and key technology research on XFEL and ERL projects in China.

The ILC group at IHEP participated in the R&D of TESLA-like 1.3-GHz nine-cell superconducting cavities with KEK. In the meeting, both sides exchanged ideas on the R&D problems of the key components and discussed the arrangement for the test of the IHEP 1.3-GHz high-power input coupler and TESLA-like nine-cell cavities at KEK this year. Scientists achieved consensus on future cooperation on ILC SRF technology and promotion of the industrialisation of the 1.3-GHz nine-cell cavities and cryostat.

Kaoru Yokoya concluded: “The draft of the ILC *Technical Design Report* has been finished, and the final version which included the cost estimation chapter will be released to the public in June 2013. Lyn Evans was appointed to be the Director of the new Linear Collider Collaboration under the new oversight committee, the new Linear Collider Board. In the following three to five years, the location selection for the ILC project will be the main task. Japan has now emerged as a possible host for the ILC project. As neighbours in Asia, Japan and China should play a more active role in the R&D and construction of ILC project.”

ASIAN COLLABORATION | SUPERCONDUCTING RF

AROUND THE WORLD

DEPFET active pixel detectors for the linear collider

Marcel Vos reports on behalf of the collaboration

24 January 2013

Solid-state devices for charged particle tracking proved their value in high energy physics in the most internal layers of the experiments of the Large Electron Positron Collider LEP at CERN, where they provided precise information on the production vertex of charged particles. These silicon micro-strip detectors consisted of a thin reverse-biased *pn*-junction segmented in narrow strips, each of which was read-out by an amplifier and analog-to-digital converter on a read-out ASIC. After a rapid evolution fueled by the advances in silicon technology, today these detectors are at the heart of virtually every collider experiment. In LHCb, ATLAS and CMS up to 200 square metres are equipped with these detectors. The innermost layers of the ATLAS, ALICE and CMS tracking systems, where the particle density is highest, require greater granularity than can be achieved with micro-strip detectors. The *pn*-junction is therefore segmented further into small rectangular pixels with sides of order 100 microns.

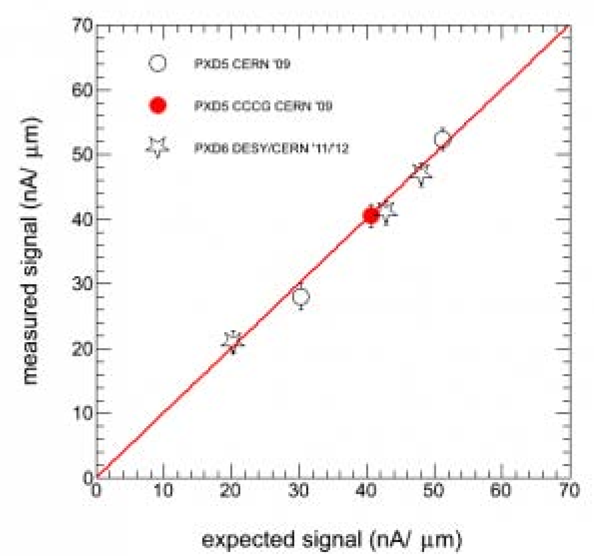

Figure 1: The signal (drain current) in response to minimum ionising particles traversing the sensor. The result is normalised to the thickness of the detector and plotted versus the expected gain. The markers correspond to different detector designs.

Despite the impressive achievements of solid-state detector R&D, the state-of-the-art devices installed in the LHC cannot meet the requirements of the experiments at a future linear electron-positron collider. To perform the precision physics that such a machine enables it is mandatory to reduce the detector material by an order of magnitude – getting it down to roughly one tenth of its original size. Several other specifications, in particular those on the spatial resolution performance, are also tighter than at the LHC. A challenge roughly comparable to that of building a car that weighs only 200 kilograms, but has greater maximum speed and the same action radius and safety of a conventional car! And there’s a catch; thin silicon sensors yield a tiny signal (80 electrons per micron) and the noise performance is degraded by the increasing capacitance to the backplane. At this point our traditional detector concept hits a solid wall and new ideas are required to make further progress.

Several groups have proposed novel detector concepts that can – in principle – meet this challenge. The key to achieve the required reduction of the material is a further integration of the active material and the read-out electronics. The DEPFET concept incorporates an amplifying circuit (a “FET”) that is traditionally part of the read-out electronics in fully depleted (hence the “DEP” in DEPFET), high resistivity, detector-grade silicon, which is exactly the kind of silicon used to build conventional detectors. Thus the sensor becomes *active*; the tiny signal due to the ionising particle is amplified in situ. Figure 1 shows how the amplification stage in realistic DEPFET sensor prototypes allows to extract a comfortable signal – tens of nanoAmperes as opposed to 80 electrons per micron of sensor material – from extremely thin layers of silicon.

The DEPFET R&D collaboration for the Linear Collider was born at the time of the TESLA proposal (2004). A matrix of tiny DEPFET structures yields an *active* pixel detector that can satisfy the extremely demanding requirements on the vertex detector of a linear collider experiment. Several groups decided to join in an effort to prepare demonstrators for the TESLA experiments. Prototype sensors and Front End ASICS were designed and a mechanical concept was developed.

Figure 2: Photograph of mechanical sample of a thin, self-supporting DEPFET ladder

Results on early DEPFET prototypes were very encouraging, but unfortunately TESLA didn't fly. By 2006 we had developed an excellent solution, but were desperately looking for a problem. Rough weather followed for LC-specific detector R&D projects. Severe budget cuts forced many promising detector concepts to look for other applications than the linear e^+e^- collider to ensure sufficient funding to realise a full-scale demonstrator. DEPFET found a shelter in Belle II, the detector of the upgrade project (SuperKEKB) of the B-factory at KEK in Japan. SuperKEKB was approved by the Japanese government and DEPFET was selected as the baseline technology for the vertex detector. Accepting this new challenge the collaboration received an influx of new members and has been able to ensure that the required funding for DEPFET technology reached maturity. This is not the only example of such positive side-effects of the harsh funding environment – see Marcel Demarteau's report about spin-offs from LC-initiated detector R&D.

While the collaboration is working hard to be ready for installation of the Belle II detector in 2015, linear-collider specific activities have moved to the background. Fortunately, the experiments are quite similar and a good fraction of the new developments for Belle II are relevant also for the linear collider. Both projects share the main challenge for vertex detectors; the possibility to reduce the detector thickness to 50-75 microns makes all the difference. The emphasis on a strict control of the material budget may in fact be even more pronounced at Belle II, where most particles are very soft (hundreds of MeV) and even the thinnest sensors distort their trajectories.

A good example of the synergy between both experiments is DEPFET's self-supporting all-silicon ladder concept, initially proposed for TESLA and adopted by Belle II. A sample image is shown in Figure 2. The material in the active area of the sensor is reduced to 75 microns. Thanks to the thicker areas around the edges the ladder has excellent mechanical properties and no external support structure is needed. The material budget for the Belle II ladder, including the silicon frame, metal layers, bump bonds and steering ASICs, is thus reduced to 0.21% of a radiation length.

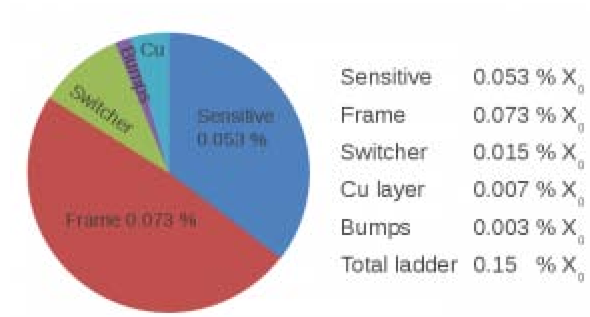

Figure 3: The material budget in radiation lengths broken down by contributions of the different ladder components for the ILC design.

A detailed finite-element simulation has been set up to predict the thermal properties of ultra-thin silicon ladders. We moreover equipped a mock-up of the Belle-II vertex detector with *dummy* sensors that are mechanically identical to the final sensors. The structure was used to characterise the temperature distribution of the sensors after application of a forced air flow in realistic conditions. Measurements such as those in Figure 3 have allowed for a careful validation of the finite element model. This hands-on experience has greatly increased our confidence in the viability of a cooling concept based entirely on forced gas flow.

With these new tools and the experience gained on fully engineered prototypes, it is relatively straightforward to evaluate to what extent a fully engineered DEPFET ladder meets the linear collider requirements. To stick to the previous example: we can now replace our earlier educated guesses with a much more reliable prediction of the material budget developed for Belle II. In Figure 3 the result is shown; material averaged over the ladder area in the LC design broken down by ladder components. The sum for yields 0.15 % of a radiation length. In a similar manner many other aspects of LC vertex detector performance can be extrapolated more reliably. This is – in a nutshell – the scope of our recent paper in IEEE Transactions in Nuclear Science.

Perhaps the most important milestone reported in the paper is the operation of thin (50 micron) DEPFET sensors with final-design prototypes of the read-out and steering ASICs. Extrapolation of the achieved read-out speed shows that the current scheme can satisfy the ILC requirements. With this rolling shutter scheme the readout can be sped up by a factor of 2 to 4, which is adequate for ILC operation. However, single bunch time stamping at CLIC, where bunches cross twice per nanosecond, is currently impossible. A number of such read-out modules were subjected to a beam of charged pions with a momentum of 120 GeV from the CERN SPS. The signal distribution due to minimum ionising particles collected in 50 microns of silicon shows the pronounced

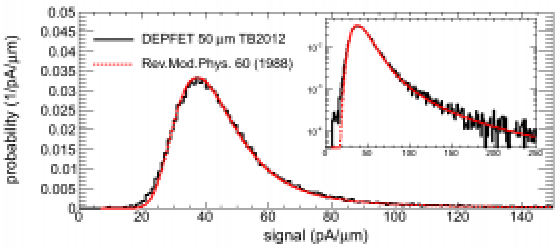

Figure 4: Signal due to perpendicularly incident charged particles. The DEPFET drain current after the integrated amplification stage is expressed in pA and normalised to the detector thickness in microns.

Landau fluctuations expected from the theory for thin sensors (Figure 4). A spatial resolution is found between 1 micron, for thick DEPFETs with 20×20 mm^2 pixels, and 8 micron for Belle II design sensors. A detailed model of the detector response is validated with test beam data on devices with pixel sizes between 20 and 75 microns, and then used to predict a spatial resolution of 3-4 microns for minimum ionising particles that traverse the detector under normal incidence angle, and slightly better for inclined tracks.

After the experience gained in developing a fully engineered vertex detector design we can be more confident that ultra-thin, self-supporting DEPFET active pixel detectors are a promising venue to provide precise space point measurements with a very competitive material budget. DEPFET technology is therefore a solid candidate to meet the strict requirements of the vertex detector at a future linear electron-positron collider. The installation of a DEPFET detector in Belle II in 2015 is expected to yield a demonstration of the complete detector concept.

BELLE-II | DEPFET | DETECTOR R&D | SYNERGY | TRACKER

ilc newsline

DIRECTOR'S CORNER

2013: The year of the snake or the “What if?”

Ewan Paterson | 24 January 2013

EC member Ewan Paterson looks at the cost-related “What ifs” for the ILC. Image: DESY, Evelyn Steinbrück

We are beginning the new year of 2013 with the draft of the Technical Design Report (TDR) almost complete. The ILC cost estimates are about to be critically reviewed and the organisations such as the International Linear Collider Steering Committee (ILCSC) and the Global Design Effort (GDE) will be handing over responsibility for the leadership of the ILC programme to the new Linear Collider Collaboration, led by Lyn Evans, and to a new oversight group, the Linear Collider Board led by Sachio Komamiya. So what can we expect in 2013 and beyond?

We hope that various governments and related organisations will study the TDR volumes and try to analyse their possible roles in such a global collaboration and project. One predictable outcome will be that several new groups will be asked to review the TDR to report back to their individual governments. This will lead to revisiting many old “what if?” questions and some new ones. I see 2013 as the ‘Year of the “What if”?’.

Some of the questions will be routine,such as “What if you lower the average gradient?” Or alternately, as there has been so much progress with superconducting RF accelerating technology: “What if you raise the average gradient?” A much more complex question which will have to be addressed in the near future is “What if we stage the construction and operation of the ILC beginning at an energy of twice of the Higgs mass, 250 gigaelectronvolt (GeV)?” There are several possible construction and operating schedules that can be considered, and one has to project realistic timelines for desirable physics programmes at the Higgs mass and at higher-energy steps leading up to the baseline energy of 500 GeV. These then should be evaluated along with these alternate accelerator construction schedules.

One option is to build all the baseline facilities but install only what is required for 250 GeV operation. Another is to build only the minimum conventional facilities required for the first stage and complete the construction at a later time. The latter option means only 30% less tunnel, as the whole central region of injectors, damping rings and beam delivery systems are required in all scenarios. Many people are also surprised that construction schedules do not change much because in the Mountain Sites the linac tunnel is constructed in several sections simultaneously. I obviously show my bias towards continuous underground construction because I think stopping and restarting construction might be costly and disruptive of an ongoing physics programme. My thinking is that as we cannot know today what will be the hot topic in the ILC physics programme after a few years with the Higgs, and therefore we need the maximum flexibility by having all the baseline facilities available from the beginning. In fact having the whole baseline ILC would be my first choice—- but “ WHAT IF?”

CAVITY GRADIENT | LINEAR COLLIDER COLLABORATION | STAGED APPROACH | TECHNICAL DESIGN REPORT

FEATURE

Become a signatory of the Detailed Baseline Design report

24 January 2013

Dear Colleagues,

We invite you to sign the Detailed Baseline Design (DBD) report of the ILC detectors, which now exists as a nearly final draft. It summarises the R&D achievements of the ILC Letter-of-Intent period. The contents reflect the many contributions of very many collaborators. The draft is now open to the community under this address.

While this draft is undergoing minor revision following the recent review by the International Detector Advisory Group (IDAG) and the ILC Project Advisory Committee, it is almost in the final form.

A list of signatories will be included in the report. We wish to include those who contributed already in any way or who wish to join the activity in the next stage. We also would like to include names of anyone who supports advancing further the world ILC effort. We invite you, as an interested physicist, to review the draft and to add your name as a signatory.

Please note that signing the DBD does not indicate any formal commitment by you. It does not indicate commitment to the specific detector designs presented, nor exclusive support for ILC over other collider programmes.

Please sign as soon as possible, and definitely before the end of January.

After the final editing, the DBD will serve as one of the volumes of the ILC *Technical Design Report* (TDR). The combined accelerator/physics/detector signatory list will appear in each volume.

The DBD editing group
(Ties Behnke, James Brau, Phillip Burrows, Juan Fuster, Michael Peskin, Marcel Stanitzki, Yasuhiro Sugimoto, Sakue Yamada, Hitoshi Yamamoto)

DETAILED BASELINE DESIGN | TECHNICAL DESIGN REPORT