Linear Collider Event

The recent discovery of a particle at the Large Hadron Collider (LHC) at CERN, consistent with the long-thought Higgs boson, provides a very clear target for near-future linear collider experiments. A next generation Linear Collider (LC) is currently being designed as the next large-scale experimental facility in elementary particle physics beyond the LHC. It is intended to offer a perfect environment to elucidate the nature of a Higgs particle and allows for precision studies to be conducted that may reveal the next energy scale of physics to be targeted by future big machines.

With the news of the Higgs, public interest in particle physics in general, and the LC in particular, is at an all-time high. Therefore, this year the organizers have chosen to arrange a Special Linear Collider (LC) Event in addition to their nominal IEEE NSS program. The aim of the special event is to bring together academic, industry, and laboratory-based experts on accelerator and detector technologies and applications. It is an excellent opportunity to discuss linear collider technologies with the accelerator and instrumentation community at large.

Particle accelerators are widely perceived as tools for mankind in the service of science. The International Linear Collider (ILC), which is distributed among many labs, and the Compact Linear Collider (CLIC), centered at CERN, are both global projects that would collide electrons and positrons at TeV energies. However, they have different technologies, different time scales, and different energy extensibility. The two-day LC event will: summarize the state-of-the-art of ILC and the CLIC accelerator and detector concepts; include presentations on the impact of LC technologies for different applications; provide a forum for discussion about LC perspectives.

Special attention will be given to the sessions where potential spin-offs of LC accelerator and detector technologies are discussed. In particular, they will include presentations on how accelerator technology developed by the nation's laboratories and universities could directly translate into a competitive strength for industrial partners, as well as advance applications of accelerators for use in service to society. The status of the Advanced Accelerator Association Promoting Science and Technology (from the perspective of 'industry-government-academia collaboration' motivated by AAA, Japan) will be also reported. In the field of detector instrumentation, many spin-offs from ILC detector R&D look valuable for other particle physics detectors, and for detectors in other fields, in particular medical imaging (e.g. novel multi-modality designs in positron emission tomography).

The Linear Collider Forum Discussion will bring together directors of the world-wide High Energy Physics Laboratories and leading experts in LC technologies, both from the academic research sector and industry, to provide an interactive discussion and insight into the long-term technology roadmap for the Linear Collider Facility construction.

We are looking forward to seeing you in Anaheim !

Program Committee of the "Linear Collider Event":

Jim Brau, University of Oregon, USA
Juan Fuster, IFIC Valencia, Spain
Ingrid-Maria Gregor, DESY Hamburg, Germany
Michael Harrison, BNL, USA
Marc Ross, FNAL, USA
Steinar Stapnes, CERN, Switzerland
Maxim Titov, CEA Saclay, France
Nick Walker, DESY Hamburg, Germany
Akira Yamamoto, KEK, Japan,
Hitoshi Yamamoto, Tohoku University, Japan

Program and Abstracts

LC1: Introduction

Monday, Oct. 29,14:00-15:40, Grand Ballroom Center

LC1-1 (14:00, invited): Welcome to the Special Linear Collider Event
R.-D. Heuer, *CERN, Geneva, Switzerland*

LC1-2 (14:10, invited): Brief Overview of the ILC History and Milestones, Summary of ILC TDR, Perspectives
B. Barish, *California Institute of Technology, Pasadena, USA*

LC1-3 (14:25, invited): Brief Overview of the CLIC History and Milestones, Summary of CLIC CDR, Perspectives
S. Stapnes, *CERN, Switzerland*

LC1-4 (14:40, invited): Physics of the Linear Colliders
H. Murayama, *LBNL, Berkeley, CA, USA and Kavli Institute for the Physics and Mathematics of the Universe (IPMU), Tokyo, Japan*
Recent discovery of a particle that looks like a Higgs boson provides a very clear target for the near-future linear collider. I will review the capabilities of a low-energy linear collider in elucidating the nature of this new particle. I will emphasize that a precision study may reveal the next energy scale of physics to be targeted by a later big machine.

LC1-5 (15:10, invited): Overview of Detectors for the Linear Collider
H. Yamamoto, *Tohoku University, Japan*
At an e+ e- linear collider, the 4-momentum and the spin state of the initial state can be well controlled and the environment of interactions are clean. Taking advantage of these experimental conditions, a linear collider provides unique physics opportunities for the detailed studies of the Higgs particle. In order to fully exploit the physics potential, the detectors need to have resolutions that far exceed the past state-of-the-art. Intensive R&D activities have been conducted to meet the requirements and they promoted great advances in the field. In this brief talk, I will review such efforts in detector R&Ds.

LC2: ILC/CLIC Accelerator and Detector Concepts

Monday, Oct. 29, 16:30-18:40, Grand Ballroom Center

LC2-1 (16:30, invited): The Superconducting RF Acceleration and the International Linear Collider
N. Walker, *DESY, Hamburg, Germany*
The benefits of using superconducting radio-frequency (SCRF) acceleration for an electron-positron linear collider have been well documented over the years. The ultra-low cavity wall losses allow the use of long RF pulses, greatly simplifying the RF source, while facilitating high-efficiency acceleration of high-current beams. In addition the low RF frequency (1.3 GHz) significantly

reduces the impedance of the cavities, leading to reduced beam dynamics effects and relatively relaxed alignment tolerances. Over two decades of R&D has lead to an increase in the deployed available gradient of over a factor of six, which, together with a high level of cavity integration into single cryostat (cryomodule) has resulted in an affordable and mature accelerator technology. Following a unique decision in 2004 by the world high energy physics community to develop the International Linear Collider (ILC) based on the established SCRF technology as a truly global project, the Global Design Effort (GDE) has successfully coordinated a worldwide R&D programme which will culminate in the ILC Technical Design Report in 2013. This presentation will chart the history of the SCRF linear collider, with a focus on the quest for higher gradients (35 MV/m and beyond), the 'globalisation' of the technology, and the preparation for a worldwide industrial base for the construction of the ILC.

LC2-2 (17:10, invited): X-Band Acceleration, Two-Beam Acceleration, and the Compact Linear Collider
D. Schulte, *CERN, Geneva, Switzerland*
The Compact Linear Collider (CLIC) Collaboration is developing a multi-TeV linear electron-positron collider for future high energy physics experiments; it has recently published a conceptual design report. The concept is based on the use of 12GHz normal conducting accelerating structures, which allow high gradients and hence a cost effective machine. To minimise cost a novel two-beam scheme is used to power the accelerating structures rather than conventional klystrons. Key technical choices are specified and the status of the technology is discussed. The on-going work-programme and studies towards an implementation plan for the CLIC project will also be briefly covered.

LC2-3 (17:50, invited): State-of-the-art in Vertex Detectors for LC
M. Winter, *CNRS/IN2P3, IPHC Strasbourg, Strasbourg, France*
The Linear Collider physics programme assumes high performance flavour tagging capabilities, particularly in terms of displaced vertex reconstruction originating from charm-quark and tau-lepton decays. A new generation vertex detector, featuring unprecedented spatial resolution and material budget, is therefore developed since several years, based on novel pixel technologies. The talk will overview the status of the different R&D activities, compare their achievements with the ILC and CLIC specifications and summarise their perspectives.

LC2-4 (18:15, invited): State-of-the-art in Silicon Tracking for LC
T. Nelson, *SLAC National Accelerator Laboratory, USA*
During the past few years, the concepts and technologies for solid state tracking at the ILC have matured to the point where they are largely ready for implementation. Meanwhile, the advent of the CLIC detector concepts has introduced some additional challenges, pushing the evolution of these designs and technologies even further. The status of silicon tracking for the ILC detector concepts will be discussed, along with the new challenges that must be met for CLIC and some thoughts about how to achieve the remaining goals.

LC3: ILC/CLIC Detector Concepts and Summary of Detector Spin-Offs

Tuesday, Oct. 30, 08:00-10:00, Grand Ballroom South AB

LC3-1 (08:00, invited): State-of-the-art in Gaseous Tracking for LC
T. Matsuda, *KEK/IPNS, Japan*
R&D for a high-precision TPC is ongoing in the international ILC-TPC collaboration. The main topics are the construction of a low material-budget field cage and the development of gas amplification end-plates using GEM or Micromegas. In this talk we discuss the state-of-art in gaseous tracking detector for LC, in particular, the concept and the current status of R&D of MPGD TPC for LC.

LC3-2 (08:25, invited): State-of-the-art in Electromagnetic Calorimetry for LC
J.-C. Brient, *CNRS/IN2P3, Paris, France*
The physics program at a future linear collider requires a novel design of the electromagnetic calorimeter (ECAL), very different to equivalent detectors used at the LHC. The Particle Flow Approach (PFA) to jet reconstruction implies an ECAL whose primary goal is to identify individual particle showers in the dense environment of high energy hadronic jets. This consideration leads an ultra granular device with many readout layers and small pixel size. Possible technological solutions and their respective advantages and drawbacks will be discussed.

LC3-3 (08:50, invited): State-of-the-art in Hadronic Calorimetry for LC
J. Repond, *Argonne National Laboratory, USA*
To fully exploit the physics potential of a future Lepton Collider will require unprecedented jet energy and (di)-mass resolution. Currently two complementary approaches are being pursued to achieve this goal: Particle Flow Algorithms (PFAs) and Dual Readout (DR) calorimetry. The former requires imaging calorimeters with extremely fine spatial segmentation. The latter requires the measurement and identification of both scintillation and Cerenkov light in the calorimeter. This talk reviews the main developments in hadron calorimetry geared towards implementation in a future Lepton Collider detector. The talk covers recent results from the large prototypes of the CALICE collaboration, such as the Scintillator Analog Hadron Calorimeter (AHCAL) and the Digital Hadron Calorimeters (DHCAL and SDHCAL), as well as results from the various development projets.

LC3-4 (09:15, invited): State-of-the-art in Forward Calorimetry and other Miscellaneous Detector Applications
S. Kulis, *AGH University of Science and Technology, Cqracow, Poland*
A report will be given about the design of the very forward calorimeters, their functionality, and the performance of prototype sensor planes assembled with dedicated FE ASICs in test beams. These sensor planes constitute the key components to built compact and finely segmented sampling calorimeters as prototypes of very forward calorimeters. Also the R&D on special detectors for muon identification is summarised.

LC3-5 (09:30, invited): Summary of the Spin-off Document "ILC Detector R&D: its Impact"
M. Demarteau, *Argonne National Laboratory, Argonne, USA*
Although the actual construction date of the ILC accelerator and its detectors is uncertain, the impact of the R&D for ILC detectors is very real. The deep impact of the work initiated by and carried out within the ILC detector community on the particle physics community and beyond will be discussed.

LC4: ILC/CLIC Detector Spin-offs and ILC/CLIC Accelerator Instrumentation

Tuesday, Oct. 30, 10:30-12:30, Grand Ballroom South AB

LC4-1 (10:30, invited): From ILC Imaging Calorimeter to a PET Detector
E. Garutti, *Faculty of Mathematics, Informatics and Natural Sciences, University of Hamburg, Hamburg, Germany*
From imaging calorimeters for particle physics to imaging cancerous cells in a human body, the detector technologies established for particle flow calorimeters at linear collider detectors enable unprecedented spatial resolution and novel multi-modality designs in positron emission tomography detector. A brief overview is given of the current medical projects profiting from ILC research.

LC4-2 (11:00, invited): LC Spin-offs Outside Medical Imaging
C. De La Taille, *IN2P3/CNRS, Paris, France*
Detectors designed for particle-flow calorimetry at the Linear Collider will feature unprecedented granularity (tens of millions of channels) to reconstruct the "image" of showers and accurately reconstruct them. With embedded ultra

low power readout electronics, they allow to design large area smart detectors. Various technologies have been studied over the last ten years, from highly granular Resistive Plate Chambers or MicroMegas and Gems, to Silicon PM scintillating tiles or large area PIN diodes. These "square meter" detectors or their readout electronics with accurate charge and time measurement not only find applications in medical imaging but also in muon tomography for volcano studies (MuRay or TOMUVOL projects), astrophysics experiments (PEBS) and Nuclear physics (HN diffusion). Future perspectives will be also discussed.

LC4-3 (11:30, invited): Linear Collider Instrumentation
T. Lefevre, *CERN, Geneva, Switzerland*
Linear collider relies on tight beam parameters while colliding short bunches focused down to nanometer beam sizes. The conservation of ultra-low emittances requires a precise control of the beam alignment over very long distances. The talk will present the state of the art in Linear collider beam instruments, with an emphasis on non-invasive techniques.

LC4-4 (11:50, invited): Linear Collider Module Control and Stabilization
A. Jeremie, *CNRS/IN2P3, LAPP, Paris, France*
A future linear collider will rely of having the possibility to monitor and control reliably a significant number of key module and environmental parameters along its full length. Novel module data acquisition systems based on integrated radiation hard and low power readout electronics are being studied, including systems and methods for stabilisation of key elements of the machine to a very high precision.

LC4-5 (12:10, invited): Alignment Challenges for a Future Linear Collider
H. Schmickler, *CERN, Geneva, Switzerland*
The alignment and stability requirements for a future linear collider are very demanding. The talk will cover the specifications and solutions being studied for pre- aligning and aligning linear collider elements within the CLIC and ILC projects.

LC5: ILC/CLIC Accelerator Technologies for Industrial Applications I

Tuesday, Oct. 30, 14:00-16:05, Grand Ballroom South AB

LC5-1 (14:00, invited): Opportunities for Applications of LC Technology (Institutional Perspective)
M. C. Ross, *SLAC National Accelerator Laboratory, Palo Alto, CA, USA*
Particle accelerators are widely perceived as tools for mankind in the service of science. The next generation will see applications of accelerators broadly expanded and adapted for use in service to society. This transition has been enabled by an era of work to extend the frontiers of technology in terms of performance, reliability and cost. The surprising richness of the micro-universe has motivated accelerator builders over the last few decades to push their art to the limits and we now begin to doubt if these limits have been reached and if machines much larger than LHC, ILC or CLIC are realistic. The term 'high-technology' characterizes work on linear colliders and related accelerators, and generally indicates a high level of investment and return on investment (ROI), in other words: high risk. Following the unique decision in 2004 by the world high energy physics community to develop the International Linear Collider an unprecedented degree of global focus and participation allowed this investment in, for example, superconducting RF technology and precision beam control. As we now move forward to realize the linear collider, it is time to consider the ROI, especially toward industrial applications. In this talk we will review this remarkable era and consider the next steps to be taken toward applying what has been learned.

LC5-2 (14:25, invited): Overview of Industrial, Medical, Energy and Security Related Accelerator Use (Industry Perspective)
N. Holtkamp, *SLAC National Accelerator Laboratory, USA*
Based on the 2009 workshop "Accelerators for America's Future," (AfAF) an assessment was made on how accelerator technology developed by the nation's laboratories and universities could directly translate into a competitive strength for industrial partners and a variety of government agencies in the research, defense and national security sectors. The workshop report provides comprehensive and up to date information with respect to the broad applications of accelerators. In addition in September 2011 the US Senate Appropriations Committee requested a ten-year strategic plan from the Department of Energy (DOE) that would describe how accelerator R&D today could advance applications directly relevant to society in those fields. An overview of the applications and an assessment where DOE funded national laboratories and their programs can have a major impact will be described.

LC5-3 (14:50, invited): Applications of Superconducting RF Linear Accelerators (Industry Perspective)
J. Rathke, *Advanced Energy Systems, Princeton, NJ, USA*
This paper will discuss the criteria for use of SRF technology for industrial applications i.e. when does it make sense to use SRF. Criteria such as capital costs, operating costs and space considerations will be covered. Based on these criteria applications such as flue gas and water treatment as well as most medical applications do not meet the criteria. Applications such as isotope production, defense and ADS do.

LC5-4 (15:15, invited): Applications of Normal-Conducting RF Linear Accelerators (Industry Perspective)
W. Wuensch, *CERN, Geneva, Switzerland*
Normal conducting linacs are used in a wide variety of industrial applications. Basic RF parameter choices, such as peak input power and accelerating gradient, are influenced by a number of factors but are often conservatively matched to performances achieved in other machines. Now the normal conducting linear collider R&D programs have led to practical accelerating gradients above 100 MV/m. How might this result influence future industrial accelerators? The field of normal conducting industrial accelerators is reviewed and the possibilities of benefiting from linear collider R&D are considered.

LC5-5 (15:50, invited): Applications of Linear Collider Supporting RF Technology (Industry Perspective)
S. Lenci, *Communications & Power Industries LLC, Palo Alto, CA, USA*
The presentation will provide an overview of RF Technology that supports Linear Colliders, as various RF sources (klystrons and IOT's), components (Power Couplers and Barrier Windows), and other related technology. It will include a future outlook towards future devices and the use of similar technologies in a wider research and industry perspective.

LC6: ILC/CLIC Accelerator Technologies for Industrial Applications II

Tuesday, Oct. 30, 16:30-17:30, Grand Ballroom South AB

LC6-1 (16:30, invited): Applications of Linear Collider Supporting Instrumentation Technology (Industry Perspective)
M. Ross, *SLAC National Accelerator Laboratory, USA*
The recently - published Department of Energy Report ' Accelerators for America's Future' (http://www.acceleratorsamerica.org/report/index.html), lists Reliability, Beam Power/RF and Beam Transport and Control as the top R & D needs for various accelerator applications. While it is unlikely the Grand Challenges formulated in response to the report will target these needs specifically, we can expect follow-on work to focus on these top R & D needs as high-priority by-products. Instrumentation of different kinds is used to support the operation of modern accelerators through beam measurements, component monitoring and control and RF feedback and will therefore have a strong role in this work. The example of RF feedback, to be presented in this talk, uses leading-edge technology digital signal processing to achieve the required stabilization. Other examples to be discussed include radiation effects

on electronics (LHC and ILC), low latency feedback (ILC / CLIC), ultra-low noise receivers (ILC) and mechanical stabilization systems (CLIC).

LC6-2 (16:55, invited): The status of Advanced Accelerator Association Promoting Science and Technology

M. Matsuoka, *Secretary General, Advanced Accelerator Association Promoting Science & Technology, Tokio, Japan*

Advanced Accelerator Association Promoting Science and Technology (AAA) was established in June 2008 in Japan. The functions of AAA are to facilitate Industry- Government-Academia collaboration and to promote and seek various industrial applications of advanced accelerator and technologies derived from R&D on such accelerator. International Linear Collider (ILC) is one of the main themes of our study. Members of AAA have increased to 90 companies and 38 academic institutions since starting our activity. We held 11 times symposiums to gain broad public understanding of ILC and other accelerators. And our members of industry side have been studying the accelerator technologies and their applications in collaboration with the academia members. Some R&D project started by virtue of this activity. The detail of these activities will be presented.

LC7: Forum Discussion about LC perspectives

Tuesday, Oct. 30, 17:30-18:30, Grand Ballroom South AB

Rolf-Dieter Heuer, *CERN, Switzerland,* Joachim Mnich, *DESY, Germany,* Atsuto Suzuki, *KEK, Japan,* Pier Oddone, *FNAL, USA*