International Workshop on Future Linear Colliders

Monday, 15 May 2023 - Friday, 19 May 2023

Book of Abstracts

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Accelerator: Normal Conducting RF / 3

Distributed Coupling Linac for Efficient Acceleration of High Charge Electron Bunches

Authors: Ankur Dhar[1]; Mohamed Othman[1]; Glen White[1]; Zenghai Li[1]; Mei Bai[1]; Emilio Nanni[1]; Sami Tantawi[1]

[1] *SLAC*

Corresponding Author: adhar@slac.stanford.edu

Future colliders will require injector linacs to accelerate large electron bunches over a wide range of energies. For example the Electron Ion Collider requires a pre-injector linac from 4 MeV up to 400 MeV over 35 m [1]. Currently this linac is being designed with 3 m long traveling wave structures, which provide a gradient of 16 MV/m. We propose the use of a 1 m distributed coupling design as a potential alternative and future upgrade path to this design. Distributed coupling allows power to be fed into each cavity directly via a waveguide manifold, avoiding on-axis coupling [2]. A distributed coupling structure at S-band was designed to optimize for shunt impedance and large aperture size. This design provides greater efficiency, thereby lowering the number of klystrons required to power the full linac. In addition, particle tracking analysis shows that this linac maintains
lower emittance as bunch charge increases to 14 nC and wakefields become more prevalent. We present the design of this distributed coupling structure, as well as cold test data and plans for higher power tests to verify on the structure's real world performance.

[1] F. Willeke, "Electron ion collider conceptual design report 2021,"tech. rep., United States, 2021.
[2] S. Tantawi, M. Nasr, Z. Li, C. Limborg, and P. Borchard, "Design and demonstration of a distributed-coupling linear accelerator structure,"Phys. Rev. Accel. Beams, vol. 23, p. 092001, Sep 2020.

Physics and Detectors: Track 1 / 4

Physics with the XFEL Compton γγ Collider (XCC) Higgs Factory

Author: Michael Peskin[1]

[1] *SLAC*

Corresponding Authors: timb@slac.stanford.edu, mpeskin@slac.stanford.edu

The XFEL Compton γγ Collider (XCC) Higgs factory concept is an alternative to e+e colliders which could possibly: (1) begin operation on an earlier time scale due to its lower cost and smaller footprint, and (2) provide comparable Higgs coupling measurements, with some unique advantages With the XCC, 62.8 GeV electron beams collide with 1 keV X-ray free electron laser (XFEL) beams at points 60 μm upstream of the e-e- interaction point to produce tightly focused colliding beams of 62.5 GeV photons. The Higgs boson production rate is 80,000 Higgs bosons per 107 seconds at 4 MW total beam power. For the triple Higgs coupling measurement, the γγ center-of-mass energy can be upgraded to 380 GeV, where the rate for γγ-> HH is twice the rate for e+e- ZHH at √s=550 GeV. The Higgs physics potential of the XCC is discussed, with emphasis on its unique challenges and opportunities. The measurement of the Higgs self-coupling measurement is also reviewed where, due to the simpler final state (HH vs. ZHH), the improvement in Higgs self-coupling sensitivity at the XCC could extend beyond its $1/\sqrt{(2}$) statistical advantage.

Accelerator Plenary / 5

C3 Accelerator and Demonstrator R&D

Authors: Emilio Nanni[1]; Caterina Vernieri[1]; Martin Breidenbach[1]; Mei Bai[1]; Faya Wang[1]

[1] *SLAC*

Corresponding Author: nanni@slac.stanford.edu

In this talk we will present the C3 - Cool Copper Collider - accelerator complex design and the R&D Demonstration that is needed.

Joint Plenary / 6

C3

Author: Caterina Vernieri[1]

[1] *SLAC*

Corresponding Author: caterina@slac.stanford.edu

A program to build a lepton-collider Higgs factory, to precisely measure the couplings of the Higgs boson to other particles, followed by a higher energy run to establish the Higgs self-coupling and expand the new physics reach, is widely recognized as a primary focus of modern particle physics. We propose a strategy that focuses on a new technology and preliminary estimates suggest that can lead to a compact, affordable machine. New technology investigations will provide much needed enthusiasm for our field, resulting in trained workforce. This cost-effective, compact design, with technologies useful for a broad range of other accelerator applications, could be realized as a project in the US. Its technology innovations, both in the accelerator and the detector, will offer unique and exciting opportunities to young scientists. Moreover, cost effective compact designs, broadly applicable to other fields of research, are more likely to obtain financial support from our funding agencies.

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Coffee Break

Joint Plenary / 9

Overview of accelerator technology development relevant to ILC and other future lepton linear collider options

Author: Sergey Belomestnykh[1]

[1] *Fermilab*

Corresponding Author: sbelomes@fnal.gov

Over the last several years a significant progress was made in developing accelerator technology for future lepton linear colliders. In this talk I review recent progress in high-gradient normal conducting and superconducting RF structures and some other recent technological advances.

Physics and Detectors Plenary / 10

ECFA Higgs Factories Study: Physics Analysis Tools

Author: Dirk Zerwas[1]

[1] *IJCLab and DMLab*

Corresponding Author: dirk.zerwas@in2p3.fr

ECFA kicked off a series of workshops in 2021 on Higgs/EW/top factories to bring together the efforts of various e+e- projects. Working groups on Physics (WG1), Physics Analysis Tools (WG2) and more recently on Detectors (WG3) were created. The activities of the Physics Analysis Tool group will be summarized with an emphasis on KEYHEP which was chosen as the software framework.

Physics and Detectors: Track 2 / 11

Reconstruction of long-lived particles at the ILD

Author: Jan Klamka[1]

[1] *University of Warsaw*

Corresponding Author: jklamka@fuw.edu.pl

In recent years, long-lived particles (LLPs) have been widely considered in a variety of Beyond the Standard Model (BSM) scenarios and in many different experimental searches for new particles. Future e^+e^- colliders, thanks to their clean environment and triggerless operation, offer a unique opportunity to search for such states at sub-TeV energies. Considered in this contribution are promissing prospects for LLP searches offered by the International Large Detector (ILD) at the International Linear Collider (ILC), with a Time Projection Chamber (TPC) as the core of its tracking systems, providing almost continuous tracking.

Based on the full detector simulation, we study the possibility of reconstructing decays of heavy LLP at the ILD. We consider a challenging scenario with low mass splitting between LLP and the dark matter candidate, resulting in only a very soft displaced track pair in the final state, not pointing to the interaction point. We consider the soft beam-induced background (from measurable e^+e^- pairs and $\gamma\gamma \rightarrow$ hadrons processes), expected to give the dominant background contribution due to a very high cross section, and show the possible means of its reduction. We also present corresponding results for an alternative ILD design, where the TPC is replaced by a silicon tracker modified from the design presented for the Compact Linear Collider detector (CLICdet).

Physics and Detectors: Track 1 / 12

A short overview on low mass scalars at future lepton colliders

Author: Tania Robens[1]

[1] *Rudjer Boskovic Institute (HR)*

Corresponding Author: trobens@irb.hr

I give a short summary on scenarios with new physics scalars that could be investigated at future e+e– colliders. I concentrate on cases where at least one of the additional scalar has a mass below

125 GeV, and discuss both models where this could be realized, as well as studies which focus on such scenarios.

Accelerator: Normal Conducting RF / 13

A design of the C-band RF photoinjector cavity for testing photocathodes under extreme fields

Authors: Haoran Xu[1]; Petr Anisimov[2]; Evgenya Simakov[2]

[1] *Los Alamos National Laboratory*

[2] *LANL*

Corresponding Author: haoranxu@lanl.gov

We present an RF and engineering design of a 1.6-cell RF photoinjector at 5.712 GHz. Two designs were developed: one for the room temperature and another one for cryogenic temperature operations. At Los Alamos we are constructing a facility for testing photocathodes that produce high-quality electron bunches under an intense RF electric field in excess of 100 MV/m. The basic 1.6-cell RF photoinjector geometry was designed at SLAC and UCLA. The cavity had an optimized shape to increase the shunt impedance and minimize the surface fields. The two cells were coupled individually, from a waveguide on the side of the cells. The coupling was designed to ensure a phase difference of 180 degree between the two cells, for a pi-mode operation. The room temperature RF injector is currently in fabrication and will be tuned and tested in Los Alamos this year. The cryo-temperature design will be fabricated and tested at UCLA.

Accelerator: Normal Conducting RF / 14

Two-cell high-gradient C-band RF accelerator cavity for high power HOM absorber testing

Authors: Haoran Xu[1]; Dongsung Kim[1]; Evgenya Simakov[2]

[1] *Los Alamos National Laboratory*

[2] *LANL*

Corresponding Author: haoranxu@lanl.gov

High-gradient RF accelerator cavities must have absorbers for the suppression of the higher order modes (HOM). It was proposed that NiCr deposited into thin waveguide slots that run along a distributed coupling structure may provide adequate HOM absorption, for the proposed Cool Copper Collider (C3) accelerator design. Fabrication methodology for NiCr was recently developed at SLAC. At LANL we conducted electromagnetic design of the proposed HOM absorbers. We also designed a two-cell structure with the HOM absorbers and a fundamental mode coupler for high power testing. This presentation will summarize the latest HOM absorber design, the design of the two-cell test structure, and our plans to conduct breakdown testing of the two-cell structure to evaluate the performance of the NiCr coating during the high gradient RF conditioning.

Physics and Detectors: Track 1 / 15

P-even, CP-violating Signals in Scalar-Mediated Processes

Author: Howard Haber[1]

[1] *UC, SANTA CRUZ*

Corresponding Author: hehth@slac.stanford.edu

New sources of neutral scalar-mediated CP violation that arise in extended Higgs sectors can originate in the Yukawa sector or in the structure of the scalar potential. Most treatments in the literature focus on CP-violating Yukawa interactions of neutral scalars, which is an example of P-odd CP violation since it derives from the mixing of two C-even operators of opposite sign P. In contrast, CP-violation arising from the scalar potential is P-even CP-violation, which can be observed by detecting three bosonic processes (suitably chosen) that are incompatible with the presence of a CP-symmetric scalar potential and/or vacuum. The discovery potential of such signals at various future multi-TeV lepton (and γγ) colliders is assessed.

Physics and Detectors: Track 1 / 16

Highlights on top quark physics with the ATLAS experiment at the LHC

Authors: ATLAS Collaboration[None]; Benedikt Gocke[None]

Corresponding Author: benedikt.gocke@cern.ch

The large top quark samples collected with the ATLAS experiment at the LHC have yielded measurements of the production cross section of unprecedented precision and in new kinematic regimes. They have also enabled new measurements of top quark properties that were previously inaccessible, enabled the observation of many rare top quark production processes predicted by the Standard Model and boosted searches for flavour- changing-neutral-current interactions of the top quark, that are heavily suppressed in the SM. In this contribution the highlights of the ATLAS top quark physics program are presented, as well as projections of the expected sensitivity after the High Luminosity phase of the LHC.

Physics and Detectors: Track 1 / 17

Probing the nature of electroweak symmetry breaking with Higgs boson pairs in ATLAS

Authors: ATLAS Collaboration[None]; Shuzhou Zhang[1]

[1] *University of Michigan*

Corresponding Author: shuzhouz@umich.edu

In the Standard Model, the ground state of the Higgs field is not found at zero but instead corresponds to one of the degenerate solutions minimising the Higgs potential. In turn, this spontaneous electroweak symmetry breaking provides a mechanism for the mass generation of nearly all fundamental particles. The Standard Model makes a definite prediction for the Higgs boson self-coupling and thereby the shape of the Higgs potential. Experimentally, both can be probed through the production of Higgs boson pairs (HH), a rare process that presently receives a lot of attention at the LHC. In this talk, the latest HH searches by the ATLAS experiment are reported, with emphasis on the results obtained with the full LHC Run 2 dataset at 13 TeV. Non-resonant HH search results are interpreted both in terms of sensitivity to the Standard Model and as limits on the Higgs boson self-coupling and the quartic VVHH coupling. The Higgs boson self-coupling can be also constrained by exploiting higher-order electroweak corrections to single Higgs boson production. A combined measurement of both results yields the overall highest precision, and reduces model dependence by allowing for the simultaneous determination of the single Higgs boson couplings. Results for this

combined measurement are also presented. Finally, extrapolations of recent HH results towards the High Luminosity LHC upgrade are also discussed.

Physics and Detectors: Track 1 / 18

Searches for new phenomena with the ATLAS detector

Authors: ATLAS Collaboration[None]; Inês Ochoa[1]

[1] *LIP Portugal*

Corresponding Author: ines.ochoa@cern.ch

Many theories beyond the Standard Model (BSM) have been proposed to address several of the Standard Model shortcomings, such as the origin of dark matter and neutrino masses, the fine-tuning of the Higgs Boson mass, or the observed pattern of masses and mixing angles in the quark and lepton sectors. Many of these BSM extensions predict new particles or interactions directly accessible at the LHC. This talk will present some highlights on recent searches based on the the full Run 2 data collected by the ATLAS detector at the LHC with a centre-of-mass energy of 13 TeV, and prospects for searches in the High-Luminosity LHC.

Joint Plenary / 19

ILC Technology Network

Author: Shinichiro Michizono[1]

[1] *KEK*

Corresponding Author: shinichiro.michizono@kek.jp

tbd

Accelerator: Beam Dynamics / 20

C3 Main Linac Beam Dynamics

Author: Glen White[1]

[1] *SLAC*

Corresponding Author: whitegr@slac.stanford.edu

A preliminary design for the main Linac for the 250 GeV center-of-mass energy version of the Cold Copper Collider (C3) is presented. This design was used to understand the beam dynamics for the C3 accelerator and specify expected alignment and vibration tolerances.

Accelerator: Normal Conducting RF / 21

C3 demonstration plan and applications

Author: Faya Wang[1]

[1] *SLAC*

Corresponding Author: fywang@slac.stanford.edu

In the talk, I'll briefly introduce the C3 staged demonstration plan and its possible applications. The talk will cover technical demonstration and test setup for each stage.

Physics and Detectors: Track 1 / 22

Experimental prospects for indirect BSM searches in $e^+e^- \to q\bar{q}$, $q = c, b$ processes at ILC

Authors: Adrian Irles[1]; Jesús Pedro Márquez Hernández[1]

[1] *IFIC (CSIC/UV)*

Corresponding Author: jesus.marquez@ific.uv.es

Future Higgs Factories will allow the precise study of $e^-e^+ \to q\bar{q}$ with $q = s, c, b, t$ interactions at different energies, from the Z-pole up to high energies never reached before.
In this contribution, we will discuss the experimental prospects for the measurement of differential observables in $e^-e^+ \to b\bar{b}$ and $e^-e^+ \to c\bar{c}$ processes at high energies, 250 and 500 GeV, using full simulation samples and the full reconstruction chain from the ILD concept group.
These processes call for superb primary and secondary vertex measurements, a high tracking efficiency to correctly measure the vertex charge and excellent hadron identification capabilities using dE/dx. This latter aspect will be discussed in detail together with its implementation within the standard flavour tagging tools developped for ILD (LCFIPlus). In addition, prospects associated to potential improvements of the dE/dx reconstruction using cluster counting techniques will be also discussed. Finally, we will briefly discuss the potential of discovery of BSM models such as Randall-Sundrum models with warped extra dimensions, profiting from measurements of b/c quark related observables at different beam energies and polarisations.

Physics and Detectors: Track 1 / 23

Probing CPV mixing in the Higgs sector at an e+e- collider at around 1 TeV center-of-mass energy

Authors: Ivanka Bozovic[1]; Natasa Vukasinovic[2]; Goran Kacarevic[2]

[1] *VINCA Institute of Nuclear Sciences, University of Belgrade (RS)*

[2] *VINCA Institute of Nuclear Sciences, Uni. Belgrade*

Corresponding Author: nvukasinovic@vinca.rs

Abstract: Although the studies of tensor structure of the Higgs boson interactions with vector bosons and fermions at CMS and ATLAS experiments have established that the JPC quantum numbers of the Higgs boson should be 0++, small CP violation in the Higgs sector (i.e. app. 10% contribution of the CP-odd state) cannot be excluded with the current experimental precision. We review possibilities to measure CP violating mixing angle PSI(CP) between scalar and pseudoscalar states, at a linear electron-positron collider, at center-of-mass energies of 1 TeV and 1.4 TeV.

Physics and Detectors: Track 1 / 24

Stau searches at the ILC

Authors: María Teresa Núñez Pardo De Vera[1]; Jenny List[1]; Mikael Berggren[1]

[1] *DESY*

Corresponding Author: maria-teresa.nunez-pardo-de-vera@desy.de

The colour neutral sector is the one most relevant for the suggestions SUSY presents to the problems of the the SM - the hierarchy problem, naturalness, dark matter, the muon g-2 enigma. This sector is both for theoretical reasons, and from the results of global fits, expected to be light. But, unfortunately, it is also the sector for which current energy frontier colliders, viz. the LHC, is less well adapted.

In contrast, any future high energy electron-positron collider offers an excellent facility for SUSY searches in general, and for searches in the colour neutral sector in particular.

Among the particles in this part of the SUSY spectrum, the superpartner of the tau-lepton, the stau, plays an important role. The stau is likely to be the lightest of the sfermions, so to be the first SUSY particle that could be observed. As a benchmark for the power of SUSY searches, the stau is the prime candidate, as it can for good reasons be regarded as the worst and thus most general scenario for the searches: If one can find the stau, then any alternative next-to-lightest SUSY particle (NLSP) will also be findable.

In this contribution, a detailed study of the direct stau pair-production at the International Linear Collider (ILC) has been performed, showing the capability of this collider for determining stau exclusion/discovery limits in a model-independent way.

The studies were done using the full detector simulation and reconstruction procedures of the International Large Detector concept (ILD) at the ILC. The simulation included all SM backgrounds, as well as the beam induced ones. A detailed study of the effect of beam induced backgrounds, as overlay-on-physics and - for the first time - overlay-only events, in the stau limits was performed. The analysis of the worst mixing for stau searches at the ILC conditions is also included.

We have thus carefully evaluated all possible complications, both theoretically and experimentally, and are confident that this analysis indeed confirms the statement that at a linear e+e- collider, SUSY *will* be discovered if the NLSP mass is up to just a few GeV below the kinematic limit of the collider.

Physics and Detectors: Track 1 / 25

Probing non-perturbative QED and new physics with a LUXE-type experiment at the ILC

Authors: Jenny List[1]; Adrian Irles[2]

[1] *DESY*

[2] *IFIC (CSIC/UV)*

Corresponding Authors: adrian.irles@ific.uv.es, jenny.list@desy.de

The proposed LUXE experiment (LASER Und XFEL Experiment) at DESY, Hamburg, using the 16.5 GeV electron beam from the European XFEL, aims to probe QED in the non-perturbative regime created in collisions between high-intensity laser pulses and high-energy electron or photon beams. In this strong-field regime, where the electromagnetic field of the laser is above the Schwinger limit, physical electron-positron pairs will be created from the QED vacuum, similar to Hawking radiation from black holes. LUXE intends to measure the positron production rate in an unprecedented

intensity regime, in and beyond the regime expected in the beam-beam interaction of future electron-positron colliders. This setup also provides a unique opportunity to probe physics beyond the standard model by leveraging the large photon flux generated at LUXE, probing axion-like-particles (ALPs) at a reach comparable to FASER2 and NA62. In this contribution we will give an overview of the LUXE experimental setup and its challenges, and explore the sensitivity of a LUXE-type experiment using the ILC's or another future Higgs factory's electron beam instead of the EU.XFEL one.

Physics and Detectors: Track 1 / 26

Higgs self-coupling measurement at ILC500

Authors: Julie Torndal[1]; Jenny List[1]

[1] *DESY*

Corresponding Author: julie.munch.torndal@desy.de

The Higgs sector of particle physics is still largely uncovered, where establishing the Higgs mechanism is central to advance the field. The Higgs self-coupling is the key ingredient missing and an important puzzle piece for potentially uncovering new physics beyond the standard model.
With the energy reach and precision reach of linear e^+e^- colliders, the Higgs self-coupling can be measured directly and well enough that certain BSM scenarios can be evaluated. A new analysis of the capability to measure the Higgs self-coupling at ILC500 is ongoing and have identified aspects concerning the reconstruction tools which are expected to improve precision reach and will be presented. Other aspects such as the the centre-of-mass energy and BSM effects might also influence the reachable precision and will be considered.

Physics and Detectors: Track 1 / 27

New developments on the WHIZARD event generator

Authors: Juergen Reuter[1]; Pia Mareen Bredt[2]; Wolfgang Kilian[2]; Maximilian Loeschner[3]; Krzysztof Mekala[4]; Thorsten Ohl[5]; Tobias Striegl[2]; Aleksander Filip Zarnecki[6]

[1] *Deutsches Elektron-Synchrotron DESY*

[2] *University of Siegen, Germany*

[3] *Deutsches Elektronen-Synchrotron DESY*

[4] *University of Warsaw / DESY*

[5] *University of Wuerzburg, Germany*

[6] *Faculty of Physics, University of Warsaw*

Corresponding Author: juergen.reuter@desy.de

We give a status report on new developments in the WHIZARD event generator, including NLO electroweak automation for e+e-, loop-induced processes, POWHEG matching, new features in the UFO interface and the current development for matching between exclusive photon radiation and fixed-order LO/NLO EW corrections. We report on several bug fixes relevant for certain aspects of the ILC250 MC mass production, especially on the normalization of matching EPA samples with full-matrix element samples. Finally, we mention some ongoing work on efficiency improvements regarding parallelization of matrix elements and phase space sampling, as well as plans to revive the top threshold simulation.

Accelerator: Normal Conducting RF / 28

RF sources and power distribution for the C3-demo and beyong

Author: Anatoly Krasnykh[1]

[1] *SLAC*

Corresponding Author: krasnykh@slac.stanford.edu

A preliminary study on C3-demo RF system layout has been conducted at SLAC. For the C3 demo facility, the study focused on main commercial off the shelf (COTS) RF components such as modulator, klystron, and waveguide components. A review of some issues for this hardware will be discussed in the frame of the problem future linear colliders.

Physics and Detectors: Track 1 / 29

Probing nature of heavy neutrinos at future lepton colliders

Authors: Krzysztof Mekala[1]; Juergen Reuter[2]; Aleksander Filip Zarnecki[3]

[1] *University of Warsaw / DESY*

[2] *Deutsches Elektron-Synchrotron DESY*

[3] *Faculty of Physics, University of Warsaw*

Corresponding Author: k.mekala@uw.edu.pl

Neutrinos are the most elusive particles known. Heavier sterile neutrinos mixing with the Standard Model partners might solve the mystery of the baryon asymmetry of the universe and take part in the mass generation mechanism for the light neutrinos. From this perspective, if the heavy neutrinos are detected, it is crucial to determine their coupling structure. Future lepton colliders would not only offer excellent discovery reach but also allow for distinguishing between the Dirac and Majorana natures of these particles. In the talk, we will present a method to efficiently discriminate between the two neutrino species, based on the kinematics of their decays.

Accelerator: Conventional Facilities / 30

Cryogenic Design for C3 Main Linacs

Author: Martin Breidenbach[1]

[1] *SLAC*

Corresponding Author: mib@slac.stanford.edu

C3 operates under Liquid Nitrogen (LN) at a temperature of ~80 K to improve the electrical conductivity of Cu by a factor of ~3, resulting in an accelerator structure shunt impedance of ~300MΩ/m. Since the accelerator structures are normal conducting, they dissipate ~2500 watts each. The structures are cooled by nucleate boiling, and the resulting cold saturated Nitrogen vapor is re-liquified, requiring MW scale refrigerators. The linac organization into CryoModules, Sectors, and SuperSectors will be described, along with the basic cryogenic concepts and challenges.

Accelerator: Beam Dynamics / 31

A nanosecond pulse technology for injection/extraction systems

Author: Anatoly Krasnykh[1]

[1] *SLAC*

Corresponding Author: krasnykh@slac.stanford.edu

The emittances of the injected and extracted beams, the structure of the bunch train, and the repetition rate are critical parameters of the damping ring, which indirectly determine the luminosity of future colliders. Injection and extraction systems are one of the main components of damping rings. A pulse kicker in tandem with a DC septum magnet controls the bunch orbit in these systems. The duration of the kicker pulse should be several times shorter than the time between adjacent bunches. The time between neighbor bunches is in a nanosecond range. Kickers must have a rise/fall power rate of MW per nanosecond for many modern collider designs. The technical aspects and experiments with the kicker pulsers will be discussed.

Physics and Detectors: Track 1 / 32

Beyond standard model searches at CMS : Highlights and prospects

Author: Sridhara Dasu[1]

[1] *University of Wisconsin - Madison*

Corresponding Author: dasu@hep.wisc.edu

Intriguing scenarios of new physics provide explanation to several shortcomings of the Standard Model. Such models as extra dimensions, supersymmetric theories or dark sector extensions, are expected to manifest in various topologies including hadronic and leptonic final states. In this talk, we focus on the recent results obtained using the full Run-II dataset collected at the LHC and projections at HL-LHC.

Physics and Detectors: Track 1 / 33

Top measurements at CMS : Highlights and prospects

Author: Arnd Meyer[None]

Corresponding Author: meyera@cern.ch

The LHC's high center-of-mass energy has enabled the production of millions of top quarks, providing an opportunity to investigate top quark-related observables with great precision. Discrepancies between experimental measurements and theoretical predictions in the top quark sector may suggest the presence of new physics. This presentation highlights recent investigations conducted by the CMS experiment, including top quark production measurements, assessments of top quark mass and properties, and rare process searches.

Physics and Detectors: Track 1 / 34

Higgs measurements at CMS : Highlights and prospects

Authors: Ulascan Sarica[1]; Ulascan Sarica[2]

[1] *UC Santa Barbara*

[2] *University of California, Santa Barbara*

Corresponding Authors: ulascan90@gmail.com, ulascan.sarica@cern.ch

We present highlights of CMS measurements and searches in the area of Higgs physics, as well as prospects for the HL-LHC era.

Physics and Detectors: Track 1 / 35

Perspective of CMS legacy on EW precision physics

Author: Arnd Meyer[None]

Corresponding Author: meyera@cern.ch

We present the CMS perspective on the legacy of the CMS experiment in the area of electroweak precision measurements, including the latest measurements as well as prospects for the HL-LHC era.

Physics and Detectors: Track 1 / 36

Electroweak baryogenesis in aligned two Higgs doublet model and collider phenomenology

Authors: Kazuki Enomoto[1]; Shinya Kanemura[2]; Yushi Mura[2]

[1] *Korea Advanced Institute of Science and Technology*

[2] *Osaka University*

Corresponding Author: y_mura@het.phys.sci.osaka-u.ac.jp

Electroweak baryogenesis is a promising scenario, which relies on electroweak symmetry breaking caused by the Higgs potential.
The detail of the Higgs potential would be revealed by the future high energy colliders, so that these are necessary to test the scenario of electroweak baryogenesis.
We have calculated the baryon number density in aligned two Higgs doublet model, in which coupling constants of the lightest Higgs boson with the mass of 125 GeV coincide with those in the standard model at tree level to satisfy the current LHC data [1,2].
In this model, the severe constraint from the electric dipole moment of electrons, which is normally difficult to be satisfied, can be avoided by destructive interferences between CP-violating phases in the model.
We will show some benchmark scenarios for electroweak baryogenesis in this model under the current available data and the basic theoretical bounds.
In addition, we will discuss various predictions for the future experiments such as HL-LHC and ILC.
1 K. Enomoto, S. Kanemura and Y. Mura, JHEP 01 (2022) 104
[2] K. Enomoto, S. Kanemura and Y. Mura, JHEP 09 (2022) 121

Physics and Detectors: Track 1 / 37

Exploring hidden sectors at future e+ e- colliders with particle correlations

Authors: Adrian Irles[1]; Emanuela Musumeci[2]; Imanol Corredoira[3]; Miguel Ángel Sanchis Lozano[4]; Redamy Perez-Ramos[5]; Vasiliki Mitsou[6]

[1] *IFIC (CSIC/UV)*

[2] *Instituto de Física Corpuscular (IFIC), Valencia*

[3] *Universidad de Santiago de Compostela*

[4] *IFIC, Valencia*

[5] *IPSA and LPTHE, Paris*

[6] *IFIC - CSIC and Univ. of Valencia (ES)*

Corresponding Author: emanuela.musumeci@ific.uv.es

The analysis of the long-range particle correlations can yield valuable insights into the initial state of matter and potentially reveal the existence of Beyond the Standard Model scenarios, such as the “Hidden Valley”(HV) one. In this work, we are interested in QCD-like hidden sectors in which the production of HV matter would enhance and enlarge azimuthal correlations of final-state particles. We study the observability of the latter at future e+ e- collider, which provide a much cleaner environment with respect to the LHC one. Specifically, the presence of ridge structures could indicate a possible presence of new physics signals.

Physics and Detectors: Track 1 / 38

SMEFT fits for the top quark sector at LHC and Future Colliders

Author: Fernando Cornet-Gomez[1]

Co-authors: Marcos Miralles López [2]; Víctor Miralles [3]; María Moreno Llácer [2]; Marcel Vos [2]

[1] *CWRU*

[2] *IFIC (UV-CSIC)*

[3] *INFN, Roma 1*

Corresponding Author: fcornetgomez@gmail.com

In this work the prospects for measurements of the top-quark couplings at future colliders are presented. Projections are presented for the high luminosity phase of the Large Hadron Collider and a future Higgs/electroweak/top factory lepton collider. Results are presented for the expected bounds on Wilson coefficients of the relevant SMEFT operators from a global fit to the top-quark physics sector.

Accelerator: Sustainability & Applications / 39

Strong-field QED Experiments for & at Linear Colliders

Authors: Jenny List[1]; Ivanka Bozovic[2]

[1] *DESY*

[2] *VINCA Institute of Nuclear Sciences, University of Belgrade (RS)*

Corresponding Author: jenny.list@desy.de

Appropriately designed, the ILC facility could offer unique applications beyond the main collider program. This contribution will review the possibilities to extract electron and/or positron bunches from the main beam, and focus in particular on their use for a LUXE-type experiment, which would allow strong-field QED to be probed in regimes relevant multi-TeV colliders and for astrophysical plasmas eg in magnetars, and at the same time would offer discovery opportunities for light dark sector particles. The design of the LUXE experiment at the Eu.XFEL will be presented as a basis to discuss the requirements for implementing such an experiment at the ILC.

Physics and Detectors: Track 1 / 40

Isosinglet vectorlike leptons at e^+e^- colliders

Author: Prudhvi Bhattiprolu[1]

Co-authors: Stephen Martin [2]; Aaron Pierce [1]

[1] *University of Michigan*

[2] *Northern Illinois University*

Corresponding Author: prudhvibhattiprolu@gmail.com

Vectorlike leptons are an intriguing possibility for physics beyond the Standard Model. This talk is concerned with the example of weak isosinglet vectorlike leptons that decay through a small mixing with the tau lepton, for which the discovery and exclusion reach of the Large Hadron Collider and future proposed hadron colliders is limited. For this minimal model, I will argue that an e^+e^- collider may act as a discovery machine, and discuss the prospects for observing a mass peak if they are indeed discovered.

Accelerator: Normal Conducting RF / 41

C-Band Distributed Coupling Structure Design and Wakefield Damping

Authors: Dongsung Kim[1]; Emilio Nanni[2]; Evgenya Simakov[3]; Muhammad Shumail,[2]; Sami Tantawi[2]; Zenghai Li[2]

[1] *Los Alamos National Laboratory*

[2] *SLAC*

[3] *LANL*

Corresponding Author: lizh@slac.stanford.edu

An advanced Normal-Conducting RF (NCRF) C-band accelerating structure has been designed for a high gradient, high power e+e- linear collider linac in the TeV class. This design is attributed to the R&D advancement of an emerging class of distributed coupling accelerator topology exploring nominal cavity geometries. The accelerating structure features internal manifolds for distributing RF power separately to each cell, permitting the full structure geometry to be designed for high shunt impedance and low breakdown rate. Structures with such distributed coupling topology can be machined in two halves or quadrans that could lead to savings in fabrication cost. This machining technology also allows naturally to incorporate longitudinal slots that can be used to damp the higher-order-modes (HOM) which is an important requirement for the linear collider linac. We

will present the structure design and wakefield damping studies for a C-Band distributed coupling structure.

Physics and Detectors: Track 3 / **42**

Highly Granular Calorimeters - Impact of different Higgs Factory Options

Authors: Roman Poeschl[1]; Kiyotomo Kawagoe[2]

[1] *IJCLab*

[2] *Kyushu University*

Corresponding Author: roman.poeschl@ijclab.in2p3.fr

Calorimeters optimised for particle flow feature a high segmentation in both longitudinal and transversal direction. The tendency for future Higgs factories is an increase of the beam collision frequency compared to the case of the International Linear Collider (Bunch trains with a repetition rate of 5-10 Hz). For example at circular e+e- colliders as the FCCee the envisaged bunch distance is around 35ns at the Z pole and around 1us for HZ-running. The continuous beam will not allow for the application of power pulsing.
On top an improved timing resolution will yield an increase of the power consumption of the front-end electronics. In addition, the compactness of the readout electronics must remain at the same level as today while being able to cope with significantly increased data fluxes. The R&D for power and space economic solutions for the front-end electronics has to be carried in close coordination with the R&D on cooling systems that may become unavoidable in case of high collision frequencies. A full system study has to include the optimal number of layers and cell sizes that allow for keeping cooling needs at an acceptable level. The integration of cooling systems will likely compromise the acceptance of the detector. The impact on the physics performance will have to be evaluated. Processes that are particularly affected by a lack of acceptance would be events with missing energy such as invisible Higgs decays. The actual data rate will also depend on the corresponding cross-sections and angular distributions of the relevant physics processes. This may allow for different designs in different angular regions.

Physics and Detectors: Track 1 / **43**

Impact of radiative corrections on decays of Higgs bosons in extended Higgs sectors

Author: Masashi Aiko[1]

Co-authors: Shinya Kanemura [2]; Kei Yagyu [2]; Mariko Kikuchi [3]; Kodai Sakurai [4]

[1] *KEK*

[2] *Osaka*

[3] *Nihon University*

[4] *Warsaw University*

Corresponding Author: maiko@post.kek.jp

In various new physics models, the Higgs sector is often extended from its minimal form in the standard model (SM), and there are additional Higgs bosons.
Direct searches of the additional Higgs bosons and precision studies of the SM-like Higgs boson play complementary roles to explore the extended Higgs models.
Recently, it has turned out that the properties of the SM-like Higgs boson are consistent with the prediction in the SM under theoretical and experimental uncertainty.This leads us to investigate

the approximate alignment scenario, where the couplings of the SM-like Higgs boson are close to the predictions in the SM. In this scenario, the sizes of radiative corrections are comparable with the tree-level contribution, especially in the decays of additional Higgs bosons into the SM-like Higgs boson.
In this talk, we discuss the impact of radiative corrections in decays of the CP-odd Higgs boson in the two-Higgs doublet model (2HDM). We show that radiative corrections sizably change the theoretical predictions for the decay branching ratios.
In addition, we discuss how to discriminate the four types of Yukawa interaction in 2HDM at future collider experiments by the decay patterns of additional Higgs bosons.
These calculations are implemented in the program code "H-COUP". This talk is based on NPB976 (2023) 116047 [arXiv: 2207.01032] and work in progress.

Physics and Detectors: Track 3 / **44**

Commissioning and noise study of the ultra-thin chip-on-board PCB for the CALICE SiW-ECAL prototype

Authors: Adrian Irles[1]; Roman Poeschl[2]; Stephane Callier[3]

[1] *IFIC (CSIC/UV)*

[2] *IJCLab*

[3] *OMEGA CNRS/IN2P3*

Corresponding Author: adrian.irles@ific.uv.es

Most future high energy e^+e^- colliders proposals consider using high granular calorimeters in their detectors concepts. One of such high granular calorimeters proposals silicon-tungsten electromagnetic calorimeter (SiW-ECAL) designed and constructed by the CALICE Collaboration. Its key features are: unprecedented high granularity and compactness featuring very low power consumption. This contribution reports on the development of an alternative for the basic unit of detection (Active Signal Unit) of the SiW-ECAL. This alternative consists of an ultra-thin PCB called Chip-on-Board (COB) which is equipped with wirebonded ASICs and pixelated silicon wafers. These COB boards feature an unprecedented low thickness of 1.2\,mm considering the internal complexity of the boards which allows a more compact design of the full calorimeter. This is to be compared with the 3-3.5 mm of the default solution variant using ASICs in BGA packaging. The design, production, equipment and a detailed study of the performance and noise response of such boards in beam tests (DESY, CERN) is reported in this contribution and compared with other PCB designs with less aggressive thickness requirements.

Accelerator: Particle Sources / **45**

Towards robust polarized photoemission electron sources

Author: Jared Maxson[1]

[1] *Cornell University*

Corresponding Author: jmm586@cornell.edu

Superlattice-strained negative electron affinity GaAs photocathodes can produce electron beam polarization in excess of 90%, and if appropriately layered, quantum efficiencies of multiple percent. As such is the go-to source for polarized photoinjector applications and is the planned source for multiple future collider designs. However, it achieves negative electron affinity by virtue of a cesium and oxygen sub-monolayer, which makes it extremely vacuum sensitive, and limits its use in all but DC electron guns, which limits its ultimate brightness potential. In this talk I will describe work at Cornell to explore new means to generate polarized photoelectrons. This includes investigation of

more robust activating coatings for GaAs, as well as studies of other more robust candidate polarized photocathode materials, such as single crystal alkali antimonides and GaN.

Physics and Detectors: Track 2 / 46

Pair Production and Hadron Photoproduction Backgrounds at C3

Authors: Lindsey Gray[1]; Elias Mettner[None]; Dimitris Ntounis[2]; Caterina Vernieri[2]

[1] *Fermilab*

[2] *SLAC*

Corresponding Author: emettner@wisc.edu

Electron-positron pair production and hadron photoproduction are the most important beam-induced backgrounds at linear electron positron colliders. Predicting them accurately governs the design and optimization of detectors at these machines, and ultimately their physics reach. With the proposal, adoption, and first specification of the C3 collider concept it is of primary importance to estimate these backgrounds and begin the process of tuning existing linear collider detector designs to fully exploit the parameters of the machine. We will report on the status of estimating both of these backgrounds at C3 using the SiD detector concept, and discuss the effects of the machine parameters on preliminary detector and electronics design.

Physics and Detectors: Track 2 / 47

Muon Backgrounds from Beam Interactions with the Accelerator Structure at C3

Authors: Lindsey Gray[1]; Elias Mettner[None]; Dimitris Ntounis[2]; Caterina Vernieri[2]

[1] *Fermilab*

[2] *SLAC*

Corresponding Author: dntounis@stanford.edu

Machine-induced muon backgrounds at linear colliders are an important consideration when ensuring a high quality physics dataset, as this background can generate spurious missing-energy signals and degrade the ultimate physics reach in recoil-based measurements and searches. This rare background requires detailed beam-material interaction and transport simulations through many meters of accelerator complex to estimate its rate at the detector. In particular, it is often the subject of dedicated, one-off, simulation studies given the impact of accelerator structure details on the background spectra and total rates and recovery and reproduction of simulation codes can be difficult. We will discuss the status of producing this simulation and any corresponding results.

Physics and Detectors: Track 2 / 48

Columnar Analysis for Lepton Colliders using Coffea

Author: Lindsey Gray[1]

[1] *Fermilab*

Corresponding Author: lagray@fnal.gov

Structured columnar data formats have seen significant adoption in LHC analyses, with more than half of modern CMS analyses using "NanoAOD" and its specialized variations. With this lightweight, 2kb/event, data format analysis groups are able to perform primary physics analysis, scale factor derivation, machine learning training and inference with and without expert features, and low level simulation and reconstruction-level detector studies. Much of the high level functionality expected of object-oriented event loop frameworks is made available through pythonic columnar data processing packages like uproot, awkward-array, and coffea. The lepton collider community, including the US Muon Collider concept, has a columnar data format in the EDM4HEP package. We will discuss the addition of EDM4HEP to the 'nanoevents' data manipulation package within coffea so that more LHC physicists can easily dive into lepton collider data, so that it can serve as a bridge to better analysis data products, and go through some examples of analysis using this software stack.

Physics and Detectors: Track 3 / 49

Smart pixels for single-silicon-layer tracking with ML

Authors: Jennet Dickinson[1]; Lindsey Gray[1]

[1] *Fermilab*

Corresponding Author: jennetd@fnal.gov

Silicon pixel trackers are at the heart of all modern collider physics design, providing high-quality position measurements close to the beamline and forming the core of modern heavy-flavor tagging algorithms. Recent advances in both silicon pixel size and techniques for rendering machine learning algorithms into hardware allow detailed information about the ionization charge deposition to be used to reconstruct not only the track impact position but also its angles of incidence on the sensor. Including beamspot information allows the full track parameters and their errors to be determined from a cluster in a single sensor using an on-device Mixture Density Network. While this technology is focusing on the HL-LHC, it is also well suited for muon and electron-positron collider concepts where it can be used for cleaning hits from beam-induced backgrounds, and in the latter could help achieve tracking with a vanishing fake rate. We will discuss the various technologies used to achieve this qualitatively new functionality in silicon sensors, and performance in preliminary simulations.

Accelerator: Particle Sources / 50

Adiabatic matching device development at CERN

Authors: Steffen Doebert[1]; Hugo Bajas[2]

[1] *CERN*

[2] *PSI*

Corresponding Author: steffen.doebert@cern.ch

The adiabatic matching device is a critical component of any positron source for capturing the particles and has been as well a limitation of existing sources. CERN studies adiabatic matching devices for CLIC and FCCee. Magnetic design studies have been done to optimise the shape of these pulsed magnets in order to maximise the field and improve their robustness against field breakdowns. Prototypes are under construction to be tested in collaboration with KEK. Beside the traditional copper device obtained by EDM wire cutting a novel approach using 3D printing with Titanium has been tried. The presentation will describe the technical developments in detail.

Accelerator: Sustainability & Applications / 51

High Temperature Superconducting RF cavity

Authors: Gregory Le Sage[1]; Mitch Schneider[1]

[1] *SLAC*

Corresponding Author: lesage@slac.stanford.edu

High Q cavities are an essential component for rf pulse compression. In order to reduce cavity losses and increase compatibility with applications requiring long fill times, we are interested in developing compact superconducting cavities that operate at high temperature (~80 K). We are designing and planning to measure an RF cavity at 11.424 GHz that will include High Temperature Superconductor (HTS) tapes attached to inner cavity surfaces. The cavity uses a TM011 mode and has been designed with eight separate facets. This allows each facet to have a flat surface where the HTS tapes can be applied. A TE10 to TM01 mode converter will feed the cavity through a coupling aperture designed to give the correct value of loaded Q. The cavity Q is designed to allow a fill time (1 exponential step) of 1 microsecond, corresponding at 11.424 GHz to QL = 71,779. The design assumes the HTS surface conductivity is 11.02e9 S/m, which is 190 times that of copper. The TM01 waveguide has been shown in simulation to function correctly even with a small physical gap at the input. The facets can also have small gaps since the wall current for the TM01 mode is axial. That is also important since wall current does not cross gaps between HTS tapes. Cavity tuning is planned by separating the facets with wedges. Addition of the HTS tapes will increase the cavity resonant frequency, so pushing apart the facets will lower the frequency. We only need to stay within the bandwidth of a klystron, which is about 10 MHz. The cavity and mode converter will be cooled with a He compressor in vacuum. Performance of the cavity will be characterize between 4K and the transition temperature of the superconductor at ~90K.

Accelerator: Sustainability & Applications / 52

Sustainability studies for the Cool Copper Collider

Author: Brendon Bullard[1]

Co-authors: Dimitris Ntounis [1]; Martin Breidenbach [1]; Emilio Nanni [1]; Caterina Vernieri [1]

[1] *SLAC*

Corresponding Author: bbullard@slac.stanford.edu

The successful continuation of high energy physics probing regimes of ever-higher energies using conventional experimental methods is unsustainable both fiscally and environmentally. The already visible effects of climate change put additional pressure on the HEP community to develop techniques to mitigate the carbon footprint of large-scale collider experiments through direct and indirect greenhouse gas emissions. We propose a set of benchmark physics measurements that summarize the required physics output of an e+e- Higgs factory. We argue that C^3 fulfills the main goals of a Higgs factory with the lowest environmental impact based on these benchmarks. We will also discuss specific strategies for mitigating C3 ‘s carbon footprint, including powering strategies for the liquid nitrogen plant required for operating the high-gradient accelerating cavities.

Accelerator: Particle Sources / 53

Liquid Xenon Positron Target

Authors: Max Varverakis[1]; Robert Holtzapple[1]; Spencer Gessner[2]; Hiroki Fujii[3]

[1] *Cal Poly, SLO*

[2] *SLAC*

[3] *Nishina Center*

Corresponding Author: mvarvera@calpoly.edu

Positron targets are a critical component of future Linear Colliders. Traditional targets are composed of high-Z metals that become brittle over time due to constant bombardment by high-power electron beams. We explore the possibility of a liquid xenon target which is continuously refreshed and therefore not susceptible to the damage mechanisms of traditional solid targets. Using the GEANT4 simulation code, we examine the performance of the liquid xenon target and show that the positron yield is comparable to solid targets when normalized by radiation length. Additionally, we observe that the peak energy deposition density (PEDD) threshold for liquid xenon is higher than for commonly employed metal targets, which makes it an attractive, non-toxic positron target alternative. We develop parameter sets for demonstration applications at FACET-II and future Linear Colliders.

Physics and Detectors: Track 3 / 54

Dual Readout Calorimeter for Future Colliders

Author: Shuichi Kunori[None]

Corresponding Author: shuichi.kunori@ttu.edu

Calorimeters for future colliders will need unprecedented energy and timing resolution, as well as particle identification capabilities. Our collaboration, CalVision,a collaboration of scientist from FNAL, Argonne, Caltech, Maryland, Michigan, Milano-Bicocca, MIT, Oak Ridge, Princeton, Purdue, Texas Tech, and Virginia, is working on making maximal use of available information to enable this future program. This includes novel measurements and optimized use of information in new particle-flow-like algorithms with Dual Readout Calorimetry. In this talk, we present our goals and preliminary results.

Accelerator: Conventional Facilities / 55

Rasnik as alignment system for linac submodules

Authors: Harry van der Graaf[1]; Joris van Heijningen[2]; Anoop Nagesh Koushik[3]

[1] *Nikhef*

[2] *Centre for Cosmology, Particle Physics and Phenomenology (CP3), Université catholique de Louvain, Louvain-la-Neuve, Belgium*

[3] *Antwerpen University*

Corresponding Author: vdgraaf@nikhef.nl

For the ATLAS Muon Spectrometer, the alignment of the inner, middle and outer tracking detectors is crucial for the precise measurement of the muon momentum. This alignment is monitored by fixing a back-illuminated coded mask on the inner detector, a lens on the middle detector, and an image pixel sensor on the outer detector. An image of the mask is projected, by the lens, onto the image pixel sensor. The alignment of the three detectors can be obtained by analysing the image data, and track sagittas can be corrected for 1. Since 2005, in ATLAS, some 8000 Red Alignment Systems Nikhef (Rasnik) are flawlessly operational.
Rasnik is a 3-point alignment system. Multiple point 'leap frog'alignment can realised by equipping each point with a chainplate carrying closely spaced a mask, a lens and an image sensor, such that any set of three (identical) chainplates in a row form a Rasnik system. With n chainplates, the

alignment of any plate with respect to the outer two plates, can be recorded.
For the alignment of the 2100 accelerator structures of the C3 project, the system should be able to operate in vacuum and in an environment of liquid nitrogen (LN2). Given the index of refraction of LN2 (n = 1.20), lenses can't be applied. This problem is solved by replacing the back-illuminated coded mask by a monochromatic light source emitting spherical waves, and the lens by a zone plate. This results in a well-known Fraunhofer diffraction pattern as image: the position of the pattern on the sensor defines the alignment of three points as before. Here, each chainplate will be equipped with a VCSEL laser and an image pixel sensor, and the zone plate is made by cutting out a hole, or better, an optimised transparent pattern [2].

1 M. Beker, et al., The Rasnik 3-point optical alignment system,
J. Instrum. 14 (08) (2019) P08010,
http://dx.doi.org/10.1088/1748-0221/14/08/P08010.

[2] H. van der Graaf, et al., The ultimate performance of the Rasnik 3-point alignment system
Nuclear Inst. and Methods in Physics Research, A 1050 (2023) 168160
https://doi.org/10.1016/j.nima.2023.168160

Accelerator: Particle Sources / **56**

A Compact Source of Positron Beams with Small Thermal Emittance

Authors: Rafi Hessami[1]; Spencer Gessner[1]

[1] *SLAC*

Corresponding Author: rafimah@slac.stanford.edu

We investigate electrostatic traps as a novel source of positron beams for accelerator physics applications. Penning-Malmberg (PM) traps are commonly employed in low-energy antimatter experiments. Positrons contained in the trap are cooled to room temperature or below. We calculate the thermal emittance of the positrons in the trap and show that it is comparable to or better than the performance of state-of-the-art photocathode guns. We propose a compact positron source comprised of a PM trap, electrostatic compressor, and rf accelerator that can be built and operated at a fraction of the cost and size of traditional target-based positron sources, albeit at a reduced repetition rate. We model the acceleration of a positron bunch up to an energy of 17.6 MeV with a final thermal emittance of 0.60 μm-rad and bunch length of 190 μm. This system may be useful for acceleration physics studies, such as investigations of flat-beam sources for linear colliders and positron plasma wakefield acceleration.

Accelerator: Particle Sources / **57**

High Power Solid Target for Positron Source at CEBAF

Authors: Andriy Ushakov[1]; Silviu Covrig[1]; Joe Grames[1]; Sami Habet[2]; Christine Le Galliard[3]; Eric Voutier[3]

[1] *Jefferson Lab*

[2] *IJCLab/JLab*

[3] *IJCLab*

Corresponding Author: ushakov@jlab.org

The progress in the development of a polarized positron injector for the Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Laboratory is presented. The polarized positron beam is

generated by a high current polarized electron beam (>1 mA @ 120 MeV) via bremsstrahlung radiation and e+e- pair production in the tungsten target. The simulations show that using an optimized target and positron beamline, the positron injector can provide a cw positron beam with a current larger than 50 nA and a polarization as large as 60%. Injected into the North Linac of CEBAF at an energy of 123 MeV, the positron beam can reach a maximum energy of 12 GeV to perform a rich experimental program. The results of the thermal and structural FEA analysis of the heat load in the target are presented, as well as the simulation results of radiation damage in the target. The performed and planned target material fatigue and radiation damage tests are discussed.

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Physics and Detectors: Track 2 / 58

Search for dark photons at future e+e- colliders.

Authors: Mikael Berggren[1]; Jenny List[1]

[1] *DESY*

Corresponding Author: mikael.berggren@desy.de

which interacts gravitationally with ordinary matter. If this dark sector contains a U(1) symmetry, and a corresponding 'dark' photon (A_D) , it is natural to expect that this particle with kineticly mix with the ordinary photon, and hence become a 'portal' through which the dark sector can be studied. The strength of the mixing is given by a mixing parameter (ϵ). This
same parameter governs both the production and the decay of the A_D back to SM
particles, and for values of ϵ not already excluded, the signal would be
a quite small, and quite narrow resonance: If (ϵ) is large enough to
yield a detectable signal, its decay width will be smaller than the detector resolution, but so large that the decay back to SM particles is prompt. For masses of the dark photon above the reach of BelleII, future high energy e+e- colliders are ideal for searches for such a signal, due to the
low and well-known backgrounds, and the excellent momentum resolution and equally
excellent track-finding efficiency of the detectors at such colliders.
This contribution will discuss a study investigating the dependency of the limit on the mixing parameter and the mass of the A_D using the $A_D \to \mu^+\mu^-$ decay mode in
the presence of standard model background, using fully simulated signal and background events in the ILD detector at the ILC Higgs factory. In addition, a more general discussion about the capabilities
expected for generic detectors at e+e- colliders operating at other energies will be given.

Physics and Detectors: Track 1 / 59

"Here be SUSY" - Prospects for SUSY searches at future colliders

Author: Mikael Berggren[1]

[1] *DESY*

Corresponding Author: mikael.berggren@desy.de

Some say SUSY is dead, because LHC has not discovered it yet. But is this really true? It turns out that the story is more subtle. SUSY can be 'just around the corner', even if no signs of it has been found and a closer

look is needed to quantify the impact of LHC limits and their implications for future colliders. In this contribution, a study of prospects for SUSY based on scanning the relevant parameter space of (weak-scale) SUSY parameters, is presented.

I concentrate on the properties most relevant to evaluate the experimental prospects: mass differences, lifetimes and decay-modes. The observations are then confronted with estimated experimental capabilities, including - importantly - the detail of simulation these estimates are based upon.

I have mainly considered what can be expected from LHC and HL-LHC, where it turns that large swaths of SUSY parameter space will be quite hard to access. For e+e- colliders, on the other hand, the situation is simple: at such colliders, SUSY will be either discovered or excluded almost to the kinematic limit.

Physics and Detectors: Track 1 / 61

Tuning Pythia8 for future e^+e^- colliders

Author: Zhijie Zhao[1]

Co-authors: Mikael Berggren [1]; Jenny List [1]

[1] *DESY*

Corresponding Author: zhijie.zhao@desy.de

The majority of Monte-Carlo (MC) simulation campaigns for future e^+e^- colliders has so far been based on the leading-order (LO) matrix elements provided by Whizard 1.95, followed by parton shower and hadronization in Pythia6, using the tune of the OPAL experiment at LEP. In this contribution, we test and develop the interface between Whizard3 and Pythia8. As a first step, we simulate the $e^+e^- \to q\bar{q}$ process with LO matrix elements, and compare three tunes in Pythia8: the standard Pythia8 tune, the OPAL tune and the ALEPH tune. At stable-hadron level, predictions of charged and neutral hadron multiplicities of these tunes are compared to LEP data, since they are strongly relevant to the performance of ParticleFlow algorithms.

Then events are used to perform a full detector simulation and reconstruction of the International Large Detector concept (ILD), as an example for a ParticleFlow-optimised detector. At reconstruction level, a comparison of the jet energy resolution in these tunes is presented. We found good agreement with previous results that were simulated by Whizard1+Pythia6. In addition, the preliminary NLO results are also presented. This modern MC simulation chain, with matched NLO matrix elements in the future, should be introduced to ILC or other future e^+e^- colliders.

Physics and Detectors: Track 1 / 62

RH neutrino pair-production at ILC

Authors: Jurina Nakajima[1]; Daniel Jeans[2]

[1] *KEK / SOKENDAI*

[2] *KEK IPNS*

Corresponding Authors: daniel.jeans@kek.jp, jurina@post.kek.jp

We study the search for Right Handed Neutrinos (RHN) at ILC. RHN are introduced by several extensions of the SM to explain the tiny neutrino mass. If RHN is a Majorana particle, RHN pair

production is allowed in e−e+ collisions. We focus on RHN pair production based on a minimal U(1)B−L model. A distinctive signature is a pair of same sign leptons, a smoking-gun for Lepton Number Violation. This same sign lepton final state is almost free of SM backgrounds.
In our study we use full detector simulation to analyze RHN production at ILC. We generated the signal process, investigated its properties, developed reconstruction and selection strategies and evaluate the sensitivity at ILC, considering full SM backgrounds. We derive exclusion limits on minimal U(1)B−L parameters at ILC.

Accelerator: Sustainability & Applications / 63

Sustainability Considerations for Accelerator and Collider Facilities

Authors: Emilio Nanni[1]; Thomas Roser[None]

[1] *SLAC*

Corresponding Author: nanni@slac.stanford.edu

As the next generation of large accelerator-based facilities are being considered at the Snowmass 2021 study high priority has to be given to environmental sustainability including energy consumption, natural resource use and the environmental impact of effluents. Typically, increased performance - higher beam energies and intensities - of proposed new facilities have come with increased electric power consumption. In the following we discuss the most important areas of development for the sustainability of accelerator-based research infrastructures in three categories - technologies, concepts and general aspects. To achieve the goal of increased performance with reduced energy consumption a focused R&D effort is required with the same or even higher priority as the traditional performance-related R&D. Such a recommendation was included in the recent European Strategy for Particle Physics Accelerator R&D Roadmap.

Physics and Detectors: Track 2 / 64

Measuring tau polarisation at the ILC

Authors: Keita Yumino[1]; Daniel Jeans[2]

[1] *KEK / SOKENDAI*

[2] *KEK IPNS*

Corresponding Author: yumino@post.kek.jp

Two fermion production at the International Linear Collider (ILC) allows sensitive searches for new physics, such as heavy gauge bosons Z′. Combining the ILC's polarized beams with measurement of the tau lepton polarization allow detailed probes of the chirality of new interactions beyond the Standard Model.
The tau polarization can be extracted by measuring the distribution of tau decay products. In this study, we have developed a new method which uses the impact parameter of tau decay products to fully reconstruct the tau leptons, including the invisible neutrino momentum, while being insensitive to the possible emission of unseen ISR. This allows optimal reconstruction of the tau spin orientation in order to best measure the polarization.

Physics and Detectors: Track 2 / 65

Background studies in ILD

Author: Daniel Jeans[1]

[1] *KEK IPNS*

Corresponding Author: daniel.jeans@kek.jp

I will summarize more and less recent studies of machine-related backgrounds in the context of the ILD concept.

Accelerator: Sustainability & Applications / 66

Progress of High-Efficiency L-Band IOT Design for Accelerator Applications at SLAC

Author: Mohamed Othman[1]

[1] *SLAC*

Corresponding Author: mothman@slac.stanford.edu

Recent efforts at SLAC aim at developing high-power accelerators powered by compact, high-efficiency rf sources such as klystrons and Inductive output tubes (IOT). In particular, a high-efficiency IOT is an electron-beam-driven RF source employed in the UHF band that offers high efficiency at variable output power levels. Due to the improved linearity, high efficiency, and reduced size, it is the RF amplifier of choice in the TV broadcast market. Stellant Systems (formerly L3Harris Electron Devices) has long pioneered the IOT design and recently leveraged its power toward various accelerator applications. In this talk, we show the progress of developing a 1.3 GHz HEIOT in terms of design and performance. We also show results of 3D space-charge beam dynamics simulation of an L-Band inductive output tube (IOT) RF electron gun using the accelerator code ACE3P as a transformative approach to HEIOT design. We also show an optimization scheme of the rf output cavities that results in >100 kW of average power with an upward of 80% power efficiency.

Accelerator: Normal Conducting RF / 67

Development of a Compact Periodic Permanent Magnet Focused C-Band Klystron

Author: Brad Shirley[1]

[1] *SLAC*

Corresponding Author: brads@slac.stanford.edu

A C-band klystron is being developed to provide power to a fully integrated compact linear accelerator system. The design of this high-power RF source was centered on minimizing weight and volume. In doing so, a novel periodic permanent magnet focusing circuit was developed alongside a compact RF circuit to achieve > 50% efficiency in simulation. Fabrication of this system is underway and high-power tests will be performed.

Physics and Detectors: Track 3 / 68

Progress towards large ultra-granular Silicon-Tungsten electromagnetic calorimeters

Author: Roman Pöschl[1]

[1] *CNRS/IN2P3/IJCLab - Université Paris-Saclay*

Corresponding Author: roman.poeschl@ijclab.in2p3.fr

Future Higgs factory experiments will require high precision in the jet reconstruction, particle identification and event tagging, all challenges which can addressed by ultra-granular calorimeters, associated with high-precision tracking and performant Particle Flow reconstruction. The technical issues of large ultra-granular calorimeters are numerous, and maximal for the electro-magnetic ones: a high density of channels calls for an embedded readout electronics, whose low power dissipation require either active cooling for continuous operation or passive one for pulsed operation. The Particle Flow approach is based on the unravelling of contributions from individual particle showers, hence having very compact ones, which is obtained by the use of low-profile electronics and Tungsten as absorber. The CALICE collaboration has developed many such prototypes, and the SiW–ECAL is the most advanced one. Recently, a 15-layer stack has been tested in beam at DESY with low-energy electrons, of 1 to 6 GeV and at CERN with high-energy electrons, 10 to 150 GeV as well as with pions and muons of the same energy. The tests included 4 different electronics designs. The performances obtained in the 2021 and 2022 campaign will be presented in this contribution. They allow for a critical review of the status of the SiW ECAL and give directions for future R&D.
The tests at CERN have been carried out in combination with the CALICE analogue hadron calorimeter (AHCAL). Experience combined running will be presented along with, if available, first results of combined data.

Physics and Detectors: Track 2 / 69

Full simulation of the IDEA detector at FCC-ee using the key4hep framework

Author: Armin Ilg[1]

[1] *University of Zürich*

Corresponding Author: armin.ilg@cern.ch

The FCC-ee is a proposed future e^+e^- collider capable of producing all SM particles in large quantities and clean experimental conditions. Up to four experiments can detect the collision products, with IDEA being one of the proposed detector concepts at FCC-ee. IDEA needs to fulfil requirements similar to experiments at other proposed lepton colliders such as reliable particle identification, efficient flavour tagging and superior momentum resolution.

IDEA consists of a vertex detector made out of depleted monolithic active pixel sensor (DMAPS), an extremely light drift chamber and timing layer for tracking, a dual-readout calorimeter and muon chambers in the low-mass solenoid return yoke. This contribution presents the progress of the implementation of the IDEA detector in full simulation using the key4hep and DD4hep framework used by many future collider communities.

An emphasis will be put on the design and full simulation implementation of the vertex detector which is crucial for many of the experimental goals of the FCC-ee program. The related R&D on DMAPS will be briefly discussed as well.

Sustainability Plenary / 71

Linear Collider Carbon Assessments: A Life Cycle Assessment of the CLIC and ILC Linear Collider Feasibility Studies

Author: Suzanne Evans[1]

Co-author: Yung Loo [1]

[1] *Arup*

Corresponding Author: suzanne.evans@arup.com

Linear colliders are a promising technology for exploring the frontiers of particle physics. However, the construction and operation of these large-scale scientific instruments have significant environmental impacts, particularly in terms of carbon emissions. In this talk, we present a comprehensive life cycle assessment (LCA) of both the Compact Linear Collider (CLIC) and International Linear Collider (ILC) feasibility studies, focusing on the assessment of LCA construction phases A1 to A5. The LCA considers the materials and construction methods proposed for both the CLIC and ILC and assesses the carbon footprint of each phase of the construction process, from the extraction of raw materials to the disposal of waste. In addition, our study identifies opportunities for reducing the embodied carbon of linear colliders, including the use of low-carbon materials. We conclude that a careful consideration of the environmental impact of linear colliders is crucial for the future of particle physics research, and that reducing the embodied carbon of these large-scale scientific instruments should be a priority for the scientific community.

Accelerator: Conventional Facilities / **72**

Latest Plans for FCC Civil Engineering and Site Investigations

Author: Liam Bromiley[1]

[1] *CERN*

Corresponding Author: liam.bromiley@cern.ch

The Future Circular Collider (FCC) project is a major international effort aimed at designing and constructing the next-generation particle accelerator for high-energy physics research. As part of the FCC project, civil engineering feasibility studies are being conducted to assess the feasibility of building a large-scale collider, including tunnel excavation, site preparation, and infrastructure development. In this talk, we provide an update on the latest civil engineering design for the FCC, including progress made on the feasibility studies ahead of the mid-term review and plans for future geotechnical site investigations.
Overall, the civil engineering feasibility studies for the FCC project are critical to ensuring the successful implementation of this ambitious project. Our ongoing work will help to identify potential challenges and opportunities for optimization, providing valuable insights for the design and construction phases of the project.

Physics and Detectors: Track 2 / **73**

High level reconstruction with DNN for Higgs factories

Author: Taikan Suehara[1]

[1] *Kyushu University*

Corresponding Author: suehara.sl@mail.trinotes.info

There are emerging interest to improve performance of the event reconstruction using deep-learning techniques. We are working on algorithms based on Graph Neural Networks for both particle flow algorithm and quark flavor tagging. For the particle flow, we imported GravNet-based structure from CMS HGCal study and applied it for photon separation at ILC calorimeter. For the quark flavor tagging, we developed an algorithm based on Graph Attention technique and compared the performance with the current algorithm, LCFIPlus. The algorithms and preliminary results of the performance will be presented.

Accelerator: Particle Sources / 74

Building the next high voltage dc photogun polarized source for the ILC at JLab

Authors: Carlos Hernandez-Garcia[1]; Phillip Adderley[1]; Max Bruker[1]; Joe Grames[1]; Gabriel Palacios-Serrano[1]; Matthew Poelker[1]; Marcy Stutzman[1]; Shukui Zhang[1]

[1] *Jefferson Lab*

Corresponding Author: chgarcia@jlab.org

During the ILC Global Design Effort (2007) two 200 kV high voltage photoguns based on an inverted insulator geometry were developed in 2010 and successfully tested at Jefferson Lab (JLab). One of the photoguns has been operated at 130 kV in the CEBAF accelerator for the JLab nuclear physics program. The inverted insulator replaces the electrode support structure, consequently significantly less metal prone to field emission is biased and surfaces contributing to the vacuum load are significantly reduced. Implementing a biased anode, and using a larger laser spot size has made this the state of the art polarized beam source with ~200 C charge lifetime from SSL GaAs photocathodes. However, operating at the design 200 kV voltage has been hindered by field emission at ~190 kV. To reliably operate without field emission requires lengthy conditioning applying 50-100 kV beyond the voltage needed for beam operations, without breakdown or damage to the insulator. Over the past decade, JLab has developed two photoguns with a larger version of the commercial inverted insulators used in the ILC design. One photogun operated at 300 kV for magnetized beam studies, and the concept has been implemented in the BNL polarized photogun. The second photogun has recently been installed in CEBAF to operate at 200 kV field emission free. Higher voltage photoguns help the ILC and CLIC achieve higher bunch charge (2013 TDR), and additionally provide margin for operating with shorter laser pulse length and/or smaller laser spot size (better emittance at higher peak current). Such photogun designs need to reach ~400 kV without breakdown or insulator damage to operate field emission free at > 300 kV. This also allows for direct injection into a SRF booster. JLab submitted a proposal to HEP for developing in partnership with industry an inverted geometry insulator to fit commercial 400 kV cables. This contribution describes JLab experience developing and testing high voltage photoguns, and what is needed to sufficiently condition for voltage levels higher than beam operational voltage.

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Physics and Detectors: Track 1 / 75

Simultaneous Higgs Boson Branchin Fraction Measurements

Authors: Andrej Saibel[1]; Marcel Vos[2]; Adrian Irles[3]; Hector Garcia Cabrera[None]

[1] *IFIC/CSIC*

[2] *IFIC (UV-CSIC)*

[3] *IFIC (CSIC/UV)*

Corresponding Author: andrej.saibel@ific.uv.es

Since the observation of a spin-0 particle at LHC by the ATLAS and CMS collaborations, efforts have been made to confirm that the newly discovered particle is indeed the Standard Model (SM) Higgs boson.
Precise measurements of the Higgs boson couplings are essential for the confirmation of the SM nature of the Higgs boson, the search for physics beyond the SM, and global fits of Effective Field Theory.
Linear e^+e^- colliders provide a well-defined initial state and clean environment to enable precise measurements of the couplings.
However, the challenge of these colliders is to provide a large integrated luminosity required to achieve low statistical uncertainty on the measurements.
Therefore, it is advantageous to include several decay channels in one measurement to benefit from increased statistical power.

In this talk, machine learning algorithms are presented developed to improve the classification of events into Higgs decay channels.
Recent studies are presented with the main focus on the simultaneous measurement of the $H \to b\bar{b}$ and $H \to c\bar{c}$ decay channels.
It is concluded that machine learning can play a crucial role in overcoming the challenges for physics at future linear colliders and enabling to achive the ultimate precision in the measurements.

Accelerator: Sustainability & Applications / **76**

Applications of High Gradient Accelerator Research for Novel Medical Accelerator Technology

Authors: Emma Snively[1]; Emilio Nanni[1]; Sami Tantawi[1]; Christopher Nantista[1]; Zenghai Li[1]; Valery Borzenets[1]; Valery Dolgashev[1]; Gordon Bowden[1]; Marco Oriunno[1]; Bill Loo[2]; Anatoly Krasnykh[1]; Xueying Lu[1]; Ann Sy[3]

[1] *SLAC*

[2] *Stanford University*

[3] *SLAC National Accelerator Laboratory*

Corresponding Author: esnively@slac.stanford.edu

Accelerator technology developed for future collider designs can form the basis for components in a broad range of medical accelerator applications, enabling new treatments like Very High Energy Electron (VHEE) therapy and new high-speed beam scanning systems for proton therapy. For example, the large aperture of the proposed C3 linac design is optimized to transport long and high charge bunches and, if adapted for a beam energy modulation system for protons or acceleration for VHEE, could increase transmission of the beam for therapeutic purposes. An RF-based approach to changing the proton beam energy would be significantly faster than current methods which typically rely on the beam passing through a range shifter controlled with mechanical motion. Techniques like cryogenic cooling, implemented for the C3 concept to improve RF efficiency, can be applied to novel medical accelerator designs to reduce the size and power consumption in a clinical facility. We discuss the synergistic design efforts for medical accelerator projects currently underway at SLAC funded by the DOE's Accelerator Stewardship program.

Accelerator: Particle Sources / **78**

Optimization of CW Polarized Positron Source for JLab

Author: Sami Habet[1]

Co-authors: Joseph Grames [2]; Eric Voutier [3]; Yves Roblin [2]; Andriy Ushakov [2]

[1] *IJCLab/JLab*

[2] *JLab*

[3] *IJCLab*

Corresponding Author: samih@jlab.org

This contribution describes optimized layouts of a positron injector anticipated for generating polarized and unpolarized positron beams for the CEBAF accelerator at the Thomas Jefferson National Accelerator Facility (JLab). This injector should provide polarized beams (>60%) with intensity >50 nA, or higher intensity "unpolarized"beam with intensity >3 uA.
The layouts of the positron injector were optimized to meet the beam requirements needed for injection into the CEBAF accelerator and to enable acceleration to 12 GeV. The optimized positron injector layouts were designed to accommodate the CEBAF high acceptance experimental program, with a continuous wave (CW 1497 MHz) positron bunch structure necessary for injection and acceleration. The positrons are created by bremsstrahlung and pair production in a single solid rotating target (presented at the same workshop). The strategy, layouts and optimizations for forming the positron beams will be presented.

Joint Plenary / **79**

A hybrid, asymmetric, linear Higgs factory based on plasma-wakefield and radio-frequency acceleration

Author: Brian Foster[1]

Co-authors: Richard D'Arcy [2]; Carl Lindstrom [3]

[1] *University of Oxford*

[2] *DESY*

[3] *University of Oslo*

Corresponding Author: b.foster@physics.ox.ac.uk

The construction of an electron-positron collider "Higgs factory" has been stalled for a decade, not because of feasibility but because of the cost of conventional radio-frequency (RF) acceleration. Plasma-wakefield acceleration promises to alleviate this problem via significant cost reduction based on its orders-of-magnitude higher accelerating gradients. However, plasma-based acceleration of positrons is much more difficult than for electrons. We propose a collider scheme that avoids positron acceleration in plasma, using a mixture of beam-driven plasma-wakefield acceleration to high energy for the electrons and conventional RF acceleration to low energy for the positrons. We emphasise the
benefits of asymmetric energies, asymmetric bunch charges and asymmetric transverse emittances. The implications for luminosity and experimentation at such an asymmetric facility are explored and found to be comparable to conventional facilities; the cost is found to be much lower.

Accelerators: Advanced Accelerator Concetps / **80**

High energy plasma injector for future electron-positron collider

Authors: Shiyu Zhou[None]; Wei Lu[1]; Weiming An[2]

[1] *Tsinghua University*
[2] *Beijing Normal University*

Corresponding Author: zhousy11@gmail.com

The next generation high energy electron-positron collider is crucial for the precision measurements of the Higgs boson and searching new physics beyond the Standard Model. At present, the cost of linear or circular colliders based on traditional radio-frequency accelerators is enormous to meet the requirement for Higgs factory. Advanced accelerator concepts such as the plasma wakefield accelerator (PWFA) can provide acceleration gradient orders of magnitude larger than rf cavities, which may greatly reduce the scale and cost of the facility. However, the state-of-the-art developments for these schemes are still far away from the beam parameters required by the collider. We propose a hybrid electron-positron collider scheme which uses PWFA as a high energy injector for the future collider. The plasma wakefield accelerators greatly boost the energy of the electron and positron beams from the rf accelerators, and then injects them into the collider rings. This combination can effectively reduce the cost of the circular collider and the relatively low requirements of the injector makes it more viable for PWFA. The investigation of this scheme will pave the way for the future plasma based linear colliders.

Physics and Detectors: Track 2 / 81

k4Clue: Empowering Future Collider Experiments with CLUE

Authors: Erica Brondolin[1]; Marco Rovere[1]; Felice Pantaleo[1]

[1] *CERN*

Corresponding Author: erica.brondolin@cern.ch

CLUE is a fast and innovative density-based clustering algorithm to group digitized energy deposits (hits) left by a particle traversing the active sensors of a high-granularity calorimeter in clusters with a well-defined seed hit. It was developed in the context of the new high granularity sampling calorimeter (HGCAL) which will be installed in the forward region of the Compact Muon Solenoid (CMS) experiment as part of its HL-LHC upgrade. Its outstanding performance in terms of high efficiency and excellent computing timing has been proven in the context of the CMS Phase-2 upgrade using both simulated and test beam data.

Initially, CLUE was developed in a standalone repository to allow performance benchmarking with respect to its CPU and GPU implementations, demonstrating the power of algorithmic parallelization in the coming era of heterogeneous computing. In recent years, CLUE's capabilities outside CMS and, more specifically, at experiments at future colliders, were tested by adapting it to run in the Turnkey Software Stack (key4hep) framework. The new package, k4Clue, is now fully integrated into the Gaudi software framework and it now supports EDM4hep data format for inputs and outputs.

This contribution will start from CLUE's state-of-the-art in the CMS software reconstruction context, to then move to describe the enhancements needed for the algorithm to run on several detector geometries and for both the barrel and the forward region of the detector. The preliminary performance will also be presented for several types of high-granularity calorimeters proposed at linear and circular e^+e^- colliders.

Physics and Detectors: Track 3 / 82

Status of and plans for CLD detector (re-)optimization studies

Author: Leonhard Reichenbach[1]

[1] *CERN / University of Bonn*

Corresponding Author: leonhard.reichenbach@cern.ch

Reaching the physics goals of future e^+e^- colliders requires excellent detectors and software tools optimized towards the highest precisions.
The CLD detector model establishes a conservative baseline for an experiment for the proposed FCC-ee collider.
However, the quickly evolving silicon-detector landscape will allow building a detector with parameters beyond the currently established state of the art.
We present here, the status of and the plans for (re-)optimization studies of the CLD detector model.
This includes a re-evaluation of the silicon tracking detector design, regarding the material budget and single-point resolution, and updates of the track reconstruction algorithm, in particular for electron reconstruction.

Physics and Detectors: Track 2 / 83

A new algorithm for jet flavor identification for FCC-ee

Authors: Loukas Gouskos[1]; Michele Selvaggi[1]

[1] *CERN*

Corresponding Author: loukas.gouskos@cern.ch

The Future Circular Collider (FCC) is designed to provide unprecedented luminosity and centre-of-mass energies via three options, namely FCC-ee, FCC-eh, and FCC-hh. At this stage, one of the priorities of the FCC program is the optimization of the detector concepts and physics reach. A critical component to maximize the physics reach is the identification of the flavor of the jet. To this end, in this talk, we are presenting the latest developments in jet-flavour identification using state-of-the Deep Learning techniques that hence allow exploring much more of the true potential of the different detector configurations. A possible calibration strategy is also briefly discussed. Lastly, we include highlights from their application on physics analyses focusing on the Higgs sector. Despite these developments being designed for the FCC-ee case, they are certainly relevant for all other electron-positron collider options.

Physics and Detectors: Track 2 / 84

A Particle Identification Framework for Linear Colliders

Author: Uli Einhaus[1]

[1] *DESY*

Corresponding Author: ulrich.einhaus@desy.de

The particle physics community has concluded that the next collider should be an e+e– Higgs factory. Such a collider would also enable many other precision measurements, e.g. of the top quark and in the electroweak sector, as well as searches for exotic particles. In the ongoing discussions it has become increasingly clear that particle identification including charged hadron ID is a key feature that enables a number of analyses and improves many. A number of different PID systems - from the simple muon ID to gaseous dE/dx and dN/dx to calorimeter shower shapes and time of flight (and more) - are being envisioned for the proposed future Higgs factory detector concepts. It is desirable to assess their impact and the effect of combining them in a common tool to enable fair comparisons.
This talk presents a new modular approach to a generic PID framework for the different possible

future Higgs factories, embedded in the Key4HEP framework. It discusses implementation questions, performance measures and possible physics applications, exampling the International Large Detector (ILD) concept for the International Linear Collider (ILC).

Accelerator: Beam Dynamics / 85

Beam Breakup Studies for the C^3 Linear Collider

Author: Fabio Bosco[1]

Co-authors: Martina Carillo [2]; Daniele Francescone [3]; Lucia Giuliano [2]; Andrea Mostacci [2]; Luigi Palumbo [2]; Gilles Jacopo Silvi [4]; Mauro Migliorati [2]; Bruno Spataro [5]; Luigi Faillace [5]; Mostafa Behtouei [5]; Anna Giribono [5]; Obed Camacho [6]; Atsushi Fukasawa [6]; James Rosenzweig [6]; Nathan Majernik [7]; Zenghai Li [7]; Sami Tantawi [7]; Luca Ficcadenti [8]; Gerard Lawler [6]

[1] *University of California, Los Angeles*

[2] *Sapienza University of Rome*

[3] *Sapienza University of Romw*

[4] *Sapienza University of Roma*

[5] *Frascati National Laboratories*

[6] *UCLA*

[7] *SLAC*

[8] *INFN-Sez Roma1*

Corresponding Author: fabio.bosco@uniroma1.it

High luminosity electron-positron linear colliders constitute a fundamental instrument in the field of elementary particle physics. The "Cool copper collider", or C^3, is a proposal for a 250 COM GeV Higgs factory, with possible extension to the TeV-scale, and it represents a promising candidate for the near future high energy physics. The C^3 infrastructure is conceived as a modular facility utilizing cryogenic, distributed coupling standing wave accelerating sections. Although the acceleration process is optimized by the high shunt impedance, such structures are also accompanied by stronger wakefield effects due to the smaller irises. The transport of intense beams is thus endangered by beam break-up effects responsible for emittance dilution and unstable motion. Here we utilize the tracking code MILES to study both long and short-range beam breakup effects in distributed coupling structures as well as their mitigation. In addition, we initiate the investigation of configurations alternative to the standard standing wave π-mode phase advance which offer advantages in both the RF power distribution and efficiency.

Accelerator: Beam Dynamics / 86

Design of CLIC Beam Delivery System at 7 TeV

Author: Enrico Manosperti[1]

Co-authors: Rogelio tomas garcia [1]; Andrii Pastushenko [1]

[1] *CERN*

Corresponding Author: enrico.manosperti@cern.ch

The Compact Linear Collider (CLIC) is a proposed linear accelerator designed to collide electrons and positrons at energies up to 3 TeV. In order to explore new physics and to be more competitive with other collider projects, CLIC is exploring the increase of the center-of-mass energy to 7 TeV. The CLIC Beam Delivery System (BDS) transports the lepton beams from the exit of the Main Linac to the

Interaction Point (IP). This paper reports on the studies and the challenges of the new BDS design, such as minimizing the extent of trajectory bending for collimation and chromaticity correction to reduce the effects from synchrotron radiation, ensuring a good transverse aberration control at the IP.

Accelerator: Beam Dynamics / **87**

MAD-NG for Final Focus Design

Author: Enrico Manosperti[1]

Co-authors: Rogelio tomas garcia [1]; Andrii Pastushenko [1]; Laurent Deniau [1]

[1] *CERN*

Corresponding Author: enrico.manosperti@cern.ch

The CLIC Beam Delivery System (BDS) transports the lepton beams from the exit of the Main Linac to the Interaction Point (IP). The Final Focus System (FFS) is the last part of the BDS and its role is to focus the beam to the required size at the IP and to cancel the chromaticity of the Final Doublet (FD). MAD-X and MAD-NG are simulation codes for beam dynamics and optics that are used for particle accelerator design and optimization. This paper presents a comparison between the two codes to achieve the best performance of the design of the FFS, including the optimisation methods, the speed performance and the physics accuracy.

Accelerator: Beam Dynamics / **88**

Cool Copper Collider Demonstrator Beam Dynamics and Diagnostics

Authors: Juhao Wu[1]; Glen White[None]; Muhammad Shumail[None]

[1] *SLAC*

Corresponding Author: jhwu@slac.stanford.edu

Cool Copper Collider (C3) offers a unique opportunity to study the Higgs physics. A C3 Demonstration R&D Plan, or the C3 Demonstrator (C3Demo), is an on-going effort to address the R&D and answer the technical questions in a staged approach, ending with a multi-cryomodule linac of 2 GeV electron beams. We report simulation on C3Demo beam dynamics with injector, acceleration, and compression. Emittance preservation is studied including the collective effects and machine jitter. The accompanying diagnostics at different stages will also be discussed with emphasis on emittance measurements with different approaches including utilizing undulator radiation. Multi-dimensional measurements integrating a transverse cavity and dipole magnet will be elaborated. Schemes with one bunch and two-bunches then provide a thorough mapping of the electron bunch properties and the wakefields in the RF cavities. The understanding of the beam dynamics challenges from both simulation and measurements then paves the base for a full beam dynamics performance optimization for the C3 main linac design.

Accelerator: Particle Sources / **89**

Mechanical and thermal stress on a pulsed solenoid for positron capture at the ILC undulator-based positron source

Authors: Carmen Tenholt[1]; Gregor Loisch[1]; Sabine Riemann[1]; Peter Sievers[2]; Gudrid Moortgat-Pick[None]; Samanwaya Patra[3]

[1] *DESY*

[2] *CERN*

[3] *Indian Institute of Technology Kharagpur*

Corresponding Authors: gregor.loisch@desy.de, carmen.tenholt@desy.de

The performance of positron source in the International Linear Collider (ILC) is critical for the luminosity and therefore the physics output of this planned, future high energy physics machine. In the undulator-based source proposed for the ILC, positrons are produced by generation of electron-positron pairs by an incident high energy photon on a high-Z target material. The amount of positron that can be transported downstream the adjacent accelerator section and finally the interaction point is to a large extent defined by the so-called optical matching device. This beam-optics element matches the phase space of the high-divergence, large-energy-spread positron beam into the acceptance of the accelerating section beam optics. As conventional matching devices like the quarter-wave transformer do not fulfill the stringent requirements of the ILC, a pulsed solenoid was proposed and shown in simulation to outperform other proposed devices. In this contribution we discuss the current status of this pulsed solenoid with respect to positron capture efficiency, cooling, mechanical stability, and other critical performance aspects.

Accelerator: Particle Sources / **90**

Status Undulator-based Source

Authors: Gudrid Moortgat-Pick[None]; Sabine Riemann[1]; Peter Sievers[2]

[1] *DESY*

[2] *CERN*

Corresponding Authors: peter.sievers@cern.ch, gudrid.moortgat-pick@desy.de, sabine.riemann@desy.de

The undulator-based positron source offers even polarized longitudinally as well as transversely polarized beams.
Both cases are very substantial for matching the promised physics and precision goals.
An overview will be given about the baseline undulator source set-up and technical open issues will be addressed.
Recent progress on the field simulations, the rotating wheel design, the optic matching device and the capture system will be given.
Ongoing and for this year foreseen R&D work will be reported.

Accelerator: Particle Sources / **91**

Studies on the Impact of a Non-Ideal ILC Helical Undulator on the Photon Beam Parameters and Protection of the Undulator Wall Against Synchrotron Radiation

Authors: Khaled Alharbi[1]; Sabine Riemann[1]; Gudrid Moortgat-Pick[None]; Andriy Ushakov[2]; Ayash Alrashdi[3]

[1] *DESY*

[2] *IJCLAB*

[3] *KACST*

Corresponding Author: khaled.alharbi@desy.de

Detailed simulations of the helical undulator with both ideal and realistic parameters have been performed in detail. The power deposited in walls due to secondary particles, which are produced when a photon passes through the mask material, are included. A possible mask design with a high photon absorption efficiency has been studied for three different materials.
The photon masks must be placed along the undulator line to keep the heat load in the undulator wall below the acceptable limit, which is 1 W/m.

Accelerator: Particle Sources / **92**

Status Report on the Magnetohydrodynamic Simulations of a Tapered Plasma Lens for Optical Matching at the ILC e+ Source

Authors: Manuel Formela[1]; Gudrid Moortgat-Pick[None]; Gregor Loisch[2]; Niclas Hamann[1]; Maxence Thévenet [None]; Gregory Boyle [None]; Jens Osterhoff[2]

[1] *University of Hamburg*

[2] *DESY*

Corresponding Authors: jens.osterhoff@desy.de, niclas.hamann@desy.de, manuel.formela@desy.de

The International Linear Collider is a planned electron-positron linear collider with its positron source producing positrons by aiming undulator radiation onto a rotating target. The resulting, highly divergent positron beam requires immediate optical matching to improve the luminosity and therefore the success of the intended collision experiments. Here, optical matching refers to the process
of capturing particles and making them available for downstream beamline elements like accelerators.
In the past, this has been done with sophisticated coils, but more recently the usage of a current-carrying plasma, a so-called plasma lens, has been proposed as an alternative. For the International Linear Collider idealized particle tracking simulations have already been done with the purpose of finding the optimal plasma lens design with respect to the captured positron yield. The proposed design is characterized by a linearly widened radius in beam direction. Now further research and development of this design is required, including both experiments with a prototype set-up as well as corresponding simulations modeling the hydrodynamics of the current-carrying plasma and the resulting magnetic field. The accuracy of the latter will benefit greatly from the former.

Accelerator: Particle Sources / **94**

CURRENT STATUS OF PLASMA DIAGNOSTICS OF A PROTOTYPE PLASMA LENS AS AN OPTICAL MATCHING DEVICE FOR THE ILC e+ SOURCE

Authors: Niclas Hamann[1]; Manuel Formela[1]; Gregor Loisch[2]; Gudrid Moortgat-Pick[None]

[1] *University of Hamburg*

[2] *DESY*

Corresponding Author: niclas.hamann@desy.de

In recent years, high-gradient, symmetric focusing with active plasma lenses has regained significant interest due to
the potential advantages in compactness and beam dynamics compared to conventional focusing elements.

One potential application is the optical matching of highly divergent positrons from the undulator-based ILC positron source into
the downstream accelerating structures. In a collaboration between University Hamburg and DESY Hamburg a downscaled prototype for this application
has been developed. Here, we discuss first plasma diagnostics results, such as electron and current density measurements, as well as future plans for measuring the
magnetic field distribution, and a possible fullscale prototype version.

Accelerator: Particle Sources / **95**

Status Target Tests

Authors: Tim Lengler[1]; Dieter Lott[1]; Sabine Riemann[2]; Andriy Ushakov[3]; Gudrid Moortgat-Pick[None]

[1] *Hereon*

[2] *DESY*

[3] *IJCLAB*

Corresponding Author: tim.lengler@hereon.de

For the planned International Linear Collider (ILC) a material for the positron source target is required which can withstand the high energy deposition needed for a high luminosity positron source. To distribute the load and keep the target at a reasonable temperature, the target is rotated with high velocity. Therefore, the material needs not only withstand the cyclical thermal load but also the simultaneous mechanical load. In this work, the behaviour of the material Ti-6Al-4V, which is considered as an appropriate target material, was studied via high energy X-ray diffraction during a cyclical heating process to gain information about changes in the crystal structure and consequently phase fractions. The material was heated homogeneously via induction to temperatures between 300 ℃ and 800 ℃ with heating rates of 100 ℃/s and cooling rates in the range of 25 ℃/s and 100 ℃/s. Here, the influence of the maximum and minimum temperature as well as the cooling rate was investigated. Status of recent target tests at the Microtron MAMI, where different target materials irradiated by high energy electron beams will be given as well.

Physics and Detectors: Track 3 / **96**

Testbeam measurements with ALICE MAPS prototype

Author: Mirella Vassilev[1]

Co-authors: Caterina Vernieri [1]; Miljenko Šuljić [2]; Magnus Mager [2]

[1] *SLAC*

[2] *CERN*

Corresponding Author: mvassil@slac.stanford.edu

In light of upgrades such as the High Luminosity LHC (HL-LHC) and proposals for future collider experiments, continued development of particle tracking technology is crucial. Monolithic Active Pixel Sensors (MAPS) are established vertex detectors, which combine the readout electronics and sensitive volume in one sensor, providing excellent spatial resolution, while maintaining a low power consumption and material budget. The Digital Pixel Test Structure (DPTS) is a MAPS prototype for the inner tracker of the ALICE experiment (ITS3) manufactured in the Tower Partners Semiconductor Co. 65 nm process for their upgrade for the HL-LHC. It is important to characterize the DPTS performance, in particular their radiation tolerance, given their estimated yearly radiation exposure of up to 10 kGy and 10^{13} 1 MeV neq cm^{-2}.
Here, we will present the results of a 2022 testbeam at CERN PS. DPTS sensors were irradiated to various levels up to 100 kGy and 10^{15} 1 MeV neq cm^{-2} and characterized in a 10 GeV/c positive

hadron beam. The detection efficiency and spatial resolution were measured for each chip. It is shown that all the chips can be operated at 99% efficiency and with a spatial resolution of around 4.3 μm. The demonstrated performance and radiation hardness of the DPTS sensor makes the 65 nm technology a viable candidate not only for the ALICE inner tracker, but also a technology with potential applications, such as future e+e- colliders.

Physics and Detectors: Track 1 / 97

Prospects for light Higgs measurements at the 250 GeV ILC.

Author: Aleksander Filip Zarnecki[1]

[1] *Faculty of Physics, University of Warsaw*

Corresponding Author: zarnecki@fuw.edu.pl

A light Higgs boson, with mass of the order of 100 GeV, is still not excluded by the existing experimental data, provided its coupling to gauge bosons is strongly suppressed compared to a SM-like Higgs boson at the same mass. Also other couplings of such a scalar could be very different from the SM predictions leading to non-standard decay paterns. Considered in the presented study is the feasibility of direct observation of the 96 GeV Higgs boson of N2HDM model with dominant decays to tau lepton pairs.

Accelerator: Sustainability & Applications / 98

High Efficiency, 1 MW, 1 MeV Accelerator for Environmental Applications

Authors: Muhammad Shumail[1]; Valery Dolgashev[1]; Gordon Bowden[1]; Philipp Borchard[2]; Drew Packard[3]

[1] *SLAC*

[2] *Dymenso*

[3] *General Atomics*

Corresponding Author: shumail@slac.stanford.edu

We present design of a normal conducting, high efficiency linac that would provide a CW beam of 1 MW
electrons at 1 MeV energy for various environmental applications. For example, when a flowing sheet of
wastewater is exposed to such a beam, various radiation-induced reactants are generated that lead to water
purification by decomposing the chemical and biological pollutants therein. The implemented linac could
treat 24 million gallons of wastewater per day with an ample dose of 1 kGy. Our design is based on three
accelerating rf cavities operating at 476 MHz. The shunt impedance of each cavity is optimized according
to its position in the linac. A compact rf distribution manifold is designed to split the power from a 1 MW
klystron in the appropriate ratio and phase for each accelerating cavity. The beam capture efficiency is 80%
and the rf to beam efficiency is 94%. The total length of our accelerator - including the 30 keV gun, the buncher
cavity, and the accelerating cavities - is 2 m. In this paper, we present the corresponding beam dynamics, the

implementation of rf couplers and feeding manifold, the thermo-mechanical simulations, and the fabrication
and test plan.

Physics and Detectors: Track 2 / 99

Modeling Center-of-Mass Energy Precision using Dimuons and Bhabhas at ILC

Author: Brendon Madison[1]

Co-author: Graham Wilson [1]

[1] *University of Kansas*

Corresponding Author: brendon_madison@ku.edu

Energy precision at the International Linear Collider (ILC) at 250 GeV is evaluated. To do so two difermion final states of $\mu^+\mu^-$ (dimuon), and e^+e^- (Bhabha) are used. Beam dynamics are simulated using GuineaPig++ and event generation by KKMC for dimuons and BHWIDE for Bhabhas. A new Monte Carlo, GP2X, is written to convolve the beam dynamics with event generator output. The detector resolution is approximated with the ILD detector concept. In the analysis we investigate the energy precision of $\sqrt{s}$ as well as the energy spread of the beams.

Physics and Detectors: Track 1 / 100

YFS Resummation in SHERPA

Author: Alan Price[1]

[1] *CERN*

Corresponding Author: alan.price@cern.ch

The proposed physics programs at future lepton colliders will deliver a level of experimental precision that is unseen in our field. To ensure a successful physics program, significant improvements are needed in theoretical calculations to reach or surpass the experimental accuracy. One such theoretical avenue that can be improved is the treatment of electroweak radiative corrections in lepton-initiated processes. These corrections, in particular the QED contribution, can lead to large logarithmic enhancements in regions of the phasespace that experiments will probe. In this talk, I will present an update on Sherpa's implementation of the Yennie-Frautschi-Suura resummation, where all soft logarithms are resumed to infinite order, and I will also discuss its matching to one-loop and two-loop electroweak corrections. The inclusion of one-loop corrections has been semi-automated within the Sherpa framework while the inclusion of two-loop amplitudes is highly process dependent. However, with the recent advances in two-loop electroweak corrections, some preliminary results are available.

Physics and Detectors: Track 2 / 101

Evaluating Detector and Physics Limitations on Center-of-Mass Energy Determination in e+e- Colliders Using Dileptons.

Author: Graham Wilson[1]

[1] *University of Kansas*

Corresponding Author: gwwilson@ku.edu

Methods for measuring the absolute center-of-mass energy using dileptons from e+e- collision events are further developed with an emphasis on detector and physics limitations.
We discuss three main types of estimator, the lepton momentum-based and angles-based center-of-mass
energy estimators discussed in arXiv:2209.03281, and a new estimator for
the electron and positron collision beam energies. In this work we focus on the
underlying limitations from beam energy spread, detector resolution, and the modeling
of ISR and FSR. We study the consequent implications for the potential of these methods
at center-of-mass energies ranging from 90~GeV to 1~TeV for a number of potential
accelerator realizations in the context of measurements of masses of the Z, W, H, top quark,
and new particles.

Accelerator: Normal Conducting RF / 102

High Efficiency Traveling Wave Linac

Author: Valery Dolgashev[1]

[1] *SLAC*

Corresponding Author: dolgash@slac.stanford.edu

The accelerating structure is a critical component of particle accelerators for medical, security, industrial and scientific applications. Standing-wave side-coupled accelerating structures with small apertures and nosecones are used when available rf power is at a premium and average current and average power lost in the structure are large. Meanwhile, typical on-axis coupled traveling wave structures have relatively low shunt impedance because rf power flows through the aperture, which therefore cannot be small. Here, we present a traveling wave accelerating structure that combines the high shunt impedance of nosecone standing wave structures with the advantages of traveling wave structures such as easier fabrication and tuning. As an example of its application, we will show the physics design of a compact X-band linac with pulse-to-pulse tunable output energy.

Physics and Detectors: Track 3 / 104

POTENTIAL AND LIMITS OF MAPS FOR LARGE AREA SENSORS WITH NANOSECOND TIMING

Authors: Alexandre Habib[1]; James Brau[2]; Martin Breidenbach[1]; Lorenzo Rota[1]; Caterina Vernieri[1]; Angelo Dragone[1]

[1] *SLAC*

[2] *University of Oregon*

Corresponding Author: alexhab@slac.stanford.edu

The detectors at future e+e- linear colliders will need unprecedented precision on Higgs physics measurements. These ambitious physics goals translate into very challenging detector requirements on tracking and calorimetry. High precision and low mass trackers, as well as highly granular calorimeters, will be critical for the success of the physics program. To develop the next generation of ultra-light trackers, a further reduction of dead material can be obtained by employing Monolithic Active Pixel Sensor (MAPS) technology. In MAPS, sensors and readout circuitry are combined in the same pixels and can be fabricated with commercial CMOS processes. Currently MAPS are widely used in

different applications in High Energy Physics (HEP), in astronomy and in photonics. This technology has been utilized for the Inner Tracking System Upgrade (ITS2) of the ALICE experiment at the LHC characterized by a very low power consumption and O(μs) timing capabilities.

Future Colliders can benefit from fast detectors with O(ns) timing capabilities. This is feasible at the cost of a relatively high power consumption that could not be compatible with large area constraints. Today some commercial imaging technologies offer the possibility to produce large stitched sensors (with a rectangle area ~30 cm × 10 cm). Such large sensors are very interesting from a physics point of view, but they are very challenging from an engineering point of view.
The first part of this talk will discuss the limits and potentials of MAPS technology for detectors at future colliders.

The second part of the talk will present a first MAPS prototype designed by SLAC that was submitted this year in CMOS Imaging 65 nm technology. The prototype has dimensions of 1.5 mm × 1.5 mm with a pixel pitch of 25 μm. This work benefits from our collaboration with CERN, capitalizing on the improved sensor's performance after a decade of optimizations. This prototype will set the baseline for the sensor and the electronics performance which will serve future developments.

Joint Plenary / **106**

IDT Report

Author: Tatsuya Nakada[1]

[1] *EPFL*

Corresponding Author: tatsuya.nakada@cern.ch

IDT Report

Joint Plenary / **107**

Status and Plans for CLIC Studies

Author: Steinar Stapnes[1]

[1] *CERN*

Corresponding Author: steinar.stapnes@cern.ch

Status and Plans for CLIC Studies

Joint Plenary / **108**

Physics Case for Precision Measurements at a Higgs Factory

Author: Nathaniel Craig[1]

[1] *UC Santa Barbara*

Corresponding Author: ncraig@physics.ucsb.edu

Physics Case for Precision Measurements at a Higgs Factory

Joint Plenary / 109

Physics Case for e+e- collisions at High Energy

Author: Maxim Perelstein[None]

Corresponding Author: m.perelstein@cornell.edu

Physics Case for e+e- collisions at High Energy

Joint Plenary / 110

Beyond-collider physics opportunities at a Linear Facility

Author: Yasuhito Sakaki[1]

[1] *KEK*

Corresponding Author: sakakiy@post.kek.jp

Beyond-collider physics opportunities at a Linear Facility

Accelerator: Normal Conducting RF / 111

An Integrated Simulation Tool for Dark Current Radiation Effects using ACE3P and Geant4

Authors: Lixin Ge[1]; Zenghai Li[1]; Cho-Kuen Ng[1]; LIling Xiao[1]; Hiroyasu Ego[2]; Yoshinori Enomoto[2]; Hiroshi Iwase[2]; Yu Morikawa[2]; Takashi Yoshimoto[2]

[1] *SLAC*

[2] *KEK*

Corresponding Authors: lge@slac.stanford.edu, liling@slac.stanford.edu, cho@slac.stanford.edu, lizh@slac.stanford.edu

A simulation workflow is under development to interface particle data transfer and matching of geometry interface between the electromagnetic (EM) cavity simulation code ACE3P and radiation code Geant4. The target is to simulate dark current (DC) radiation effects for the KEK 56-cell S-band accelerating structure using ACE3P and Geant4, and benchmark against KEK experiment data. As a first step, ACE3P DC simulations using a 7-cell structure have been performed by first calculating the operating mode in the structure and then tracking field-emitted electrons under the influence of the EM fields of the mode. The ACE3P simulation results agree well with the EM software CST for an accelerating gradient of 21.8 MV/m. The reader/writer I/O in ACE3P and the transfer of particle data from Track3P to Geant4 for DC radiation effects studies have been implemented. The simulation workflow between the two codes will be demonstrated with the goal of performing large-scale simulations for the KEK 56-cell structure. In addition to modeling DC effects in linacs, the integrated simulation workflow will be applicable to studying positron source and capture structure for future lepton colliders.

Accelerator: Superconducting RF / 112

LCLS-II-HE Cavity and Cryomodule Testing

Author: James Maniscalco[1]

[1] *SLAC*

Corresponding Author: jamesm@slac.stanford.edu

LCLS-II-HE is an ongoing upgrade project to the superconducting accelerator complex at SLAC. 23 new LCLS-II-style cryomodules are being built at partner laboratories Fermilab and Jefferson Lab. 192 new 9-cell niobium cavities prepared with the "2/0" nitrogen doping recipe are being procured from an industrial SRF cavity supplier. In this report we present an update on the status of acceptance testing of the cavities and on the construction and testing of the cryomodules.

Accelerators: Advanced Accelerator Concetps / **113**

BDS design considerations for AAC concepts

Author: Glen White[1]

[1] *SLAC*

Corresponding Author: whitegr@slac.stanford.edu

We overview the key subsystems of a Beam Delivery System (BDS) for Linear Colliders, highlighting important aspects pertaining to the Advanced Acceleration community and consider possible extensions to higher collision energies.

Accelerator: Particle Sources / **114**

US Target and Sources Roadmap

Author: Spencer Gessner[1]

[1] *SLAC*

Corresponding Author: sgess@slac.stanford.edu

As part of the Snowmass process, a number of recommendations were made for research topics that can improve the performance and target capabilities of high-power target and sources for HEP applications. The DOE has commissioned a Roadmap for this research, with the Roadmap Workshop held on April 11-12. This talk will summarize the results of the workshop and present the Roadmap.

Accelerator: Beam Dynamics / **115**

Optimisation of the BC2 RF structures for the CLIC RTML

Authors: Yongke Zhao[1]; Andrea Latina[1]

[1] *CERN*

Corresponding Author: yongke.zhao@cern.ch

The previous designs of the CLIC RTML BC2 RF accelerating structures are found to be either not optimal in terms of consumption powers and costs, or problematic in the structure performance test or in the BBA test. Threfore, we optimised the structures for a minimum cost and a successful BBA test, based on an existing X-band structure design that was designed for the CLIC klystron-based main linac. The matching sections are also re-optimised for the structures. The short-range and long-range wakefield effects, as well as the bunch phase shift effect from the DR, are also studied.

Accelerator: Beam Dynamics / 116

Efficient treatment of steady state and transient beam loading in electron linacs

Authors: David Bruhwiler[1]; Sergey Kutsaev[2]; Ilya Pogorelov[1]; Yury Eidelman[3]

[1] *RadiaSoft LLC*

[2] *RadiaBeam Technologies*

[3] *Eidelman's Scientific Consulting*

Corresponding Author: bruhwiler@radiasoft.net

The two-beam accelerator is one of two primary concepts for the structure wakefield acceleration approach to an e+e- collider. Transient beam loading effects are a significant challenge for the drive beam in a TBA structure, where energy droop in ~50 nC electron bunch trains must be understood and compensated. This problem is being studied at the Argonne Wakefield Accelerator (AWA), where the need for new algorithmic approaches is pressing. The Hellweg code 1 accurately models steady state beam loading for traveling wave RF structures with a reduced model that is 1,000x faster than full electromagnetics. These capabilities can leverage technological synergies between electron-positron colliders and industrial/medical applications for electron linacs. We will discuss present Hellweg capabilities and plans for implementing transient beam loading capabilities in the future.
1 S.V. Kutsaev, Y. Eidelman and D.L. Bruhwiler, "Generalized 3D beam dynamics model for industrial traveling wave linacs design and simulations,"NIM A 906 (2018), p. 127.
Acknowledgments: This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of High Energy Physics, under Award # DE-SC0022799.

Physics and Detectors: Track 3 / 117

The International Large Detector (ILD): Status and Plans

Author: Ties Behnke[1]

[1] *DESY*

Corresponding Authors: daniel.jeans@kek.jp, ties.behnke@desy.de

The International Large Detector (ILD) is a detector designed primarily for the International Linear Collider (ILC), a high-luminosity linear electron-positron collider with an initial center-of-mass energy of 250 GeV, extendable to 1 TeV.

The ILD concept is based on particle flow for overall event reconstruction, which requires outstanding detector capabilities including superb tracking, very precise detection of secondary vertices and high-granularity calorimetry. In the past years ILD has focused on building and testing technological prototypes of the key sub-detector technologies, scalable to the full ILD size, studying their integration into a coherent detector, benchmarking the ILD performance and preparing for an optimization of the overall ILD size and costing. The current status has been made public in the ILD Interim Design Report (IDR, 2020) of interest for any future e+e–collider detector. A particular strength of the

ILD concept is the integration of a well developed concept for a detector, based on well understood prototypes, with a well-developed and available suite of simulation and reconstruction tools, which allow detailed and reliable studies to be performed.

ILD as a general purpose detector optimized for high precision science at a e+e- collider can also serve as an excellent basis to compare the science reach and detector challenges for different collider options. ILD is actively exploring possible synergies with other Higgs/ EW factory options.

In this talk we will report on the state of the ILD detector concept, report on recent results and discuss selected examples of studies of an ILD detector at other colliders than ILC.

Joint Plenary / 118

Report from Japan

Author: Shoji Asai[1]

[1] *U-Tokyo*

Corresponding Author: shoji.asai@cern.ch

In this talk I summarize the Promotion status of ILC in Japan.
1) Japanese HEP community makes promotion scheme, ILC-Japan.
2) We have tight collaboration with IDT.
3) KEK just starts the international R&D framework, ILC technology network
4) I also show our expected timeline.

Accelerators: Advanced Accelerator Concetps / 119

medium term particle physics applications of plasma based accelerators

Author: Allen Caldwell[None]

Corresponding Author: caldwell@mpp.mpg.de

I will report on studies and ideas for medium term particle physics applications of plasma based accelerators

Accelerator: Normal Conducting RF / 120

Application of CrYogenic Brightness-Optimized Radiofrequency Gun (CYBGORG) for Future Collider Studies

Authors: Gerard Lawler[1]; James Rosenzweig[1]

Co-authors: Fabio Bosco [2]; Evgenya Simakov [3]; Zenghai Li [4]; Atsushi Fukasawa [1]; Bruno Spataro [5]; Sami Tantawi [4]; Obed Camacho [1]; Yusuke Sakai [1]; Paul Carriere [6]; Martina Carillo [7]; Andrea Mostacci [7]

[1] *UCLA*

[2] *University of California, Los Angeles*

[3] *LANL*

[4] *SLAC*

[5] *Frascati National Laboratories*

[6] *Radiabeam Technologies*

[7] *Sapienza University of Rome*

Corresponding Author: gelawler@protonmail.com

Concepts for future electron colliders such as the Cool Copper Collider (C^3) benefit from normal conducting radiofrequency (NCRF) cavities operated at cryogenic temperatures in many ways, including potential cost reduction and increased beam brightness. It is then advantageous to consider implementations of cryogenic electron linacs in order to study this new regime of cryogenic NCRF cavities. To this end we have developed a robust experimental program at the Multi-Objective Testing of High Gradient Radiofrequency Accelerators (MOTHRA) laboratory at UCLA. In general, we have developed several low-level and high-power cavity experiments and fabricated a new 0.5 cell CrYogenic Brightness-Optimized Radiofrequency Gun (CYBGORG). CYBORG serves three functions: a steppingstone to an ultra-high gradient cryogenic photoinjector; a prototype for infrastructure development; and a test bed for cathode studies in a heretofore unexplored regime of cryogenic temperatures and extreme high gradients. We present here in further detail the basic physics motivations for the CYBORG beamline from the perspective of cryogenic electron emission along with relevant results from RF cavity work. We also will present the commissioning status of CYBORG and the associated beamline focusing on the thermal balancing of the gun in the cryostat environment.

Physics and Detectors: Track 3 / 121

TPC Development for the ILD Detector at ILC (On behalf of the LCTPC Collaboration)

Authors: Peter Kluit[1]; Maxim Titov[2]

[1] *Nikhef*

[2] *CEA Saclay, Irfu*

A large, worldwide community of physicists is working to realize
an exceptional physics program of energy-frontier, electron-positron
collisions with the International Linear Collider (ILC)
and other collider projects (summarized and evaluated in
https://arXiv.org/abs/2208.06030).
The International Large Detector (ILD) is one of the proposed detector concepts at the next \ee collider. The ILD tracking system consists of a Si vertex detector, forward tracking disks, a large volume Time Projection Chamber (TPC) and silicon tracking detectors inside and outside of the TPC, all embedded in a 3.5 T solenoidal field. An extensive research and development program
for a TPC has been carried out within the framework of the LCTPC
collaboration. A Large Prototype TPC in a 1 T magnetic field, which allows
to accommodate up to seven identical Micropattern Gaseous Detector (MPGD)
readout modules of the TPC-design being studied, has been built as
a demonstrator at the 5 GeV electron test-beam at DESY. Three MPGD concepts
are being developed for the TPC: Gas Electron Multiplier, Micromegas and
Pixel, aslo known as GridPix, ($\equiv$ MicroMegas integrated on a Timepix chip).
Successful test beam campaigns with the different technologies have
been carried out during the last decade. Fundamental parameters such as transverse and longitudinal spatial resolution and drift velocity have been measured. In
parallel, a new gating device based on large-aperture GEMs has been
researched and successfully developed. Recent R\&D also led to a design of a
Micromegas module with monolithic cooling plate in 3D printing and 2-phase
CO2 cooling. In this talk, we will review the track reconstruction
performance results and summarize the next steps towards the TPC
construction for the ILD detector. The TPC with pad/(pixel) electronics is designed to have about 10^6 pads/ (10^9 pixels) per endcap for continuous tracking and a momentum resolution of $\delta(1/p_t)$~1×10^{-4}/GeV/c (TPC only)/({$\delta(1/p_t)$~$0.8\times$~10^{-4}/GeV/c (60\% coverage, TPC only)}), and the dE/dx resolution is

$\simeq$ 5~\%/($\simeq$ 4~\%). The momentum resolution including all tracking subdetectors is ~2~10^{-5}/GeV/c.

Accelerator: Superconducting RF / **122**

Progress with plasma processing and plans

Author: Bianca Giaccone[1]

[1] *Fermilab*

Corresponding Author: giaccone@fnal.gov

Plasma processing can be used to mitigate hydrocarbon-related field emission in SRF cavities in situ in cryomodules. We developed plasma cleaning for LCLS-II 1.3GHz N-doped cavities and we successfully applied it to the LCLS-II High Energy verification cryomodule (vCM). This test demonstrated that plasma processing can be a valuable tool to mitigate both field emission and multipacting in situ in cryomodules. This would result in a significant decrease of the CMs testing time, of the linac commissioning time and cost, and in an increase in the accelerator reliability.
Building upon this successful experience, we are now working on developing plasma processing for different cavity geometries, focusing both on the ignition method and on the gas mixture recipe.

Accelerator: Normal Conducting RF / **123**

Development of Dielectric Disk Accelerators

Author: Chunguang Jing[1]

[1] *ANL/Euclid Techlabs*

Corresponding Author: jingchg@anl.gov

The progress on developing of dielectric disk accelerator will be presented. General challenges and future directions will be mentioned as well.

Accelerators: Advanced Accelerator Concetps / **124**

Structure Wakefield Accelerator for Linear Collider

Author: Chunguang Jing[1]

[1] *ANL/Euclid Techlabs*

Corresponding Author: jingchg@anl.gov

We review the status and challenges on the path of SWFA toward a TeV class linear collider.

Accelerator: Superconducting RF / **125**

Traveling wave SRF cavity status and R&D plan.

Author: Vyacheslav Yakovlev[1]

[1] *Fermilab*

Corresponding Author: yakovlev@fnal.gov

Utilization of a Superconducting Travelling Wave Acceleration (STWA) structure with small phase advance per cell for future high energy linear colliders such as ILCs may provide an accelerating gradient 1.2–1.4 times larger than a standing wave structure. In the present paper, the status of development of high gradient STWA for collider application is presented.

Physics and Detectors: Track 3 / 126

Gaseous RICH detector for future Higgs factory.

Authors: Ariel Schwartzman[1]; Dong Su[1]; Jerry Vavra[1]; Matthew Basso[2]; Valentine Cairo[2]

[1] *SLAC*

[2] *CERN*

Corresponding Author: jjv@slac.stanford.edu

J. Va'vra, A.G. Schwartzman, V. Cairo, M. Basso and Su Dong

One important physics goal of future Higgs Factories is to probe the Higgs coupling to strange

Physics and Detectors Plenary / 127

ALICE ITS3: A next generation vertex detector based on bent, wafer-scale CMOS sensors

Author: Magnus Mager[1]

[1] *CERN*

Corresponding Author: magnus.mager@cern.ch

ALICE is developing a novel vertex detector, "ITS3", to upgrade its experiential apparatus in LHC Long Shutdown 3 (LS3), in 2026-2028. The three inner-most tracking layers will be replaced by ultra-thin (<50 μm), wafer-scale (up to ~10 ⊠ 26 cm² in size on 300 mm wafers) Monolithic Active Pixel Sensors (MAPS) that are fabricated in a 65 nm CMOS process. At these thicknesses the sensors become flexible enough to be formed into cylindrical shapes of radii of 18, 24, and 30 mm. Stitching is employed to build single sensors that exceed the reticle size and are large enough to cover full half-cylinders. This allows constructing "modules" without mechanical and electrical supports. Finally, the power consumption of the sensors will stay below 20 mW/cm², enabling the use of forced air cooling. ITS3 will have extremely low material budget (<0.05% X0 per layer), consisting essentially of the sensors themselves, held in place by carbon foam slices. Together with its proximity to the interaction point and the intrinsically good spatial resolution of MAPS (O(5 μm) at pixel pitches of O(20 μm)), it will provide unprecedentedly good tracking and vertexing capabilities, improving the pointing resolution by a factor of 2 with respect to the current detector arrangement.

This contribution will report on selected recent key R&D achievements: the qualification of the 65 nm technology for particle tracking and radiation hardness, the integration of wafer-scale silicon

detectors, and the first production of stitched sensor prototypes. The results show that the developed technology largely exceeds the needs for the ALICE ITS3, exemplarily seen in the measured radiation hardness of first sensor prototypes, which reaches 1e15 1MeV n-eq/cm² at room temperature –two orders of magnitude more than required. An outlook towards the integration of the detector will be given and emerging opportunities for future detectors based on bent, wafer-scale sensors will be highlighted.

Physics and Detectors: Track 1 / 128

Multi-photon signatures at LHC and future linear colliders as a probe of CP-Violation in 2HDMs

Authors: Kei Yagyu[1]; Kento Katayama[2]; Shinya Kanemura[1]; Tanmoy Mondal[2]

[1] *Osaka*

[2] *Osaka U.*

Corresponding Author: k_katayama@het.phys.sci.osaka-u.ac.jp

We discuss signatures of CP-violating (CPV) two Higgs doublet models at LHC and future linear colliders, where CPV appears from Yukawa interactions and the Higgs potential. In particular, we consider the scenario with the Yukawa alignment to avoid tree level flavor changing neutral currents. In addition, we consider the Higgs alignment in which the couplings of the discovered Higgs boson are taken to be the same as those in of the SM Higgs boson at tree level. We find that branching ratios of both the extra neutral Higgs bosons into diphoton can be simultaneously significant due to the constructive effect of the fermion and charged Higgs loops if CPV phase in the potential is nonzero. We show that the CPV of the Higgs sector can be tested via the three or four photon final states from the pair production of the extra Higgs bosons at LHC and future linear colliders under constraints from electric dipole moments.

Accelerators: Advanced Accelerator Concetps / 129

DiMuonium (true muonium) collider options in the US

Author: Vladimir Shiltsev[1]

Co-authors: Spencer Gessner [2]; Fox Patrick [1]; Jindariani Sergo [1]

[1] *Fermilab*

[2] *SLAC*

Corresponding Author: shiltsev@fnal.gov

While dimuonium (mu+mu-) – the “smallest QED atom” – has not yet been observed, it is of utmost fundamental interest. By virtue of the larger mass, dimuonium has greater sensitivity to beyond the standard model (BSM) effects than its cousins positronium or muonium, both discovered long ago, while not suffering from large QCD uncertainties.
Dimuonium atoms can be created in e+e- collisions with large longitudinal momentum, allowing them to decay a small distance away from the beam crossing point and avoid prompt backgrounds. We consider two opportunities for dimuonium production in the US. First, there is a unique cost-effective and fast-timeline opportunity for copious production of mu+mu- atoms at the production threshold via a modest modification of existing Fermilab Accelerator Science and Technology (FAST) facility to arrange collisions of 408 MeV electrons and positrons at a 75 degree angle. This compact 23 m circumference collider (DIMUS) will allow for precision tests of QED and open the door for searches for new physics coupled to the muon. The FAST facility is perfectly suited for DIMUS as there are existing SRF accelerators and infrastructure, capable of producing high energy, high current electron and positron beams, sufficient for O(10^32) cm-2s^-1 luminosity and O(0.5 million)

dimuons per year. The expansion will require installation of a second SRF cryomodule, positron production and accumulation system, fast injection/extraction kickers and two small circumference intersecting rings. An approximately meter-sized detector with several layers of modern pixelated silicon detector and crystal-based electromagnetic calorimeters will ensure observation of the decays of dimuonium to electron-positron pairs in presence of the Bhabba scattering background. An expansion of the system to include solenoidal magnet outside of the calorimeter system, a layer of steel shielding behind the magnet, and a set of dedicated muon detectors would extend the physics program of DIMUS to include precision studies of rare processes with muons, pions, and eta-mesons produced in e+e- collisions. Another intriguing opportunity is to employ advanced plasma accelerators to arrange collisions of e+ and e- beams at the dimuonium production threshold cme. Such a compact collider might have sufficient luminosity for the dimuonium discovery and initial studies.

Accelerator: Superconducting RF / **130**

1.3 GHz RF-Dipole Crabbing Cavity System for International Linear Collider

Author: Subashini De Silva[1]

[1] *Old Dominion University*

Corresponding Author: sdesilva@jlab.org

The International Liner Collider requires a crabbing system to increase the luminosity of the colliding electron bunches. There are several frequency options proposed for the crabbing cavity design. We have designed a 1.3 GHz compact rf-dipole crabbing cavity to compensate for the luminosity degradation due to large crossing angle. The rf-dipole design has been selected as one of the two cavity designs to be prototyped following the Down Selection Review on Crab Cavity Design held in April 2023. We will be presenting the complete rf-dipole cavity designed to meet both electromagnetic and mechanical specifications.

Accelerator: Superconducting RF / **131**

High Gradient Cryomodule (HGC)

Authors: Sergey Belomestnykh[1]; Sam Posen[1]

[1] *Fermilab*

Corresponding Author: sbelomes@fnal.gov

High Gradient Cryomodule (HGC) is a collaborative effort to demonstrate cryomodule gradients ~10-20% higher than ILC TDR. Applications of high gradient SRF include ILC, Fermilab Accelerator Complex Evolution (ACE), muon collider. In this presentation we report on progress towards assembly and testing HGC.

Joint Plenary / **132**

Calorimetry for Higgs Factory Detectors

Author: Adrian Irles[1]

[1] *IFIC (CSIC/UV)*

Corresponding Author: adrian.irles@ific.uv.es

This contribution will summarise the status and R&D challenges of the calorimetry concepts to meet the high performance requirements of future Higgs Factories.

Joint Plenary / **133**

Recent Developments in Detector Concept Studies

Author: Jinlong Zhang[None]

Corresponding Author: zhangjl@anl.gov

Overview of recent developments in detector concept studies.

Joint Plenary / **135**

Fast Timing in Higgs Factory Detectors

Author: Ariel Schwartzman[1]

[1] *SLAC*

Corresponding Author: sch@slac.stanford.edu

Fast Timing in Higgs Factory Detectors

Accelerator: Superconducting RF / **136**

New Nb material for cost saving

Author: Akira Yamamoto[1]

[1] *KEK and CERN*

Corresponding Author: akira.yamamoto@kek.jp

It has been a fundamental requirement to realize high-performance superconducting RF cavities with highly cos-effective production. New, medium grain (MG) niobium (Nb) material and clean disc production has been realized with a cos-effective production process with (i) forging pure Nb ingot, (ii) annealing, and (ii) direct slicing. It has provided very clean surface, without rolling process causing contamination, and optimized grain-size condition for stable and reliable cavity forming process. The successful development of the MG Nb material for cost saving will be presented.

Accelerator: Superconducting RF / **137**

Surface Engineering Research for High Q and High Gradient CW Accelerators

Author: Daniel Bafia[1]

[1] *Fermilab*

Corresponding Author: dbafia@fnal.gov

This talk will discuss Fermilab's recent progress in the surface engineering of superconducting radio-frequency (SRF) cavities geared toward producing simultaneously high quality factors and high accelerating gradients in cryomodules. We investigate possible microscopic mechanisms that drive improved performance by carrying out sequential RF tests on cavities subjected to a variety of surface engineering treatments. We compare performance evolution to observations made with material science techniques and find correlations with material parameters.

Accelerator: Superconducting RF / 138

SRF 5-year plan in Japan for ILC

Author: Yasuchika Yamamoto[1]

[1] *KEK*

Corresponding Author: yasuchika.yamamoto@kek.jp

KEK is starting the 5-year plan related to SRF for ILC. The main goal is the production and evaluation of prototype cryomodule including cavities with high-Q/high-G, input power couplers, frequency tuners, magnetic shields, superconducting quadrupole magnet and cold BPM, etc. Since the ILC is a global project, this five-year plan also has to be carried out under global collaboration. KEK expects that some cavities to be installed in the cryomodule will come from overseas. In such cases, the problem to be solved is high-pressure gas safety (HPGS) regulation of Japan. And, KEK also would like to proceed with the design, production and testing of other ancillaries through global collaboration. After signing MOUs with each institute, a number of task forces related to the SRF will be created and this five-year plan will be proceeded. In this presentation, I will explain the 5-year plan and the expected task forces in detailed.

Joint Plenary / 139

Physics Close out

Corresponding Author: dirk.zerwas@in2p3.fr

Joint Plenary / 140

Accelerator Summary #2: SRF, NCRF, Sustainability and Applications, Conv. Facilities

Corresponding Author: esnively@slac.stanford.edu

Joint Plenary / 141

The CXFEL Project at Arizona State University

Corresponding Author: wsg@asu.edu

The CXFEL Project encompasses the Compact X-ray Light Source (CXLS) that is now commissioning in the hard x-ray energy range 4-20 keV, and the Compact X-ray Free-Electron Laser (CXFEL) designed to lase in the soft x-ray range 300 –2500 eV. CXFEL has recently completed a 3-year design phase and just received NSF funding for construction over the next 5 years. These instruments are housed in separate purpose-built laboratories and rely on inverse Compton scattering of bright electron beams on powerful lasers to produce femtosecond pulses of x-rays from very compact linacs approximately 1 m in length. Both instruments use recently developed X-band distributed-coupling, room-temperature, standing-wave linacs and photoinjectors operating at 1 kHz repetition rates and 9300 MHz RF frequency. They rely on recently developed Yb-based lasers operating at high peak and average power to produce fs pulses of 1030 nm light at 1 kHz repetition rate with pulse energy up to 400 mJ. This presentation will discuss the current commissioning performance and status of CXLS. It will also review the design and initial construction activities of the large collaborative effort to develop the fully coherent CXFEL.

Joint Plenary / **142**

Panel Discussion

Corresponding Authors: jens.osterhoff@desy.de, shoji.asai@cern.ch, caterina@slac.stanford.edu, steinar.stapnes@cern.ch, mpeskin@slac.stanford.edu

Accelerator: Superconducting RF / **143**

Development of vertical electropolishing (VEP) for surface treatment of 9-cell Nb cavities at KEK

Authors: Takeyoshi Goto[1]; Hitoshi Hayano[2]; Kensei Umemori[2]; Hideaki Monjushiro[2]

[1] *High Energy Accelerator Research Organization (KEK)*

[2] *KEK*

Corresponding Author: gototа@post.kek.jp

Installation of a vertical electropolishing (VEP) system for surface treatment of Nb cavities was just completed at KEK and started the test operation in December 2022. Although the horizontal EP (HEP) system has already been in operation for nearly 15 years at KEK, VEP system was adopted to process 9-cell Nb cavities, because of the simpler operational processes and the higher work safety. We have introduced some new equipment to overcome the technical issues of VEP, including Ninja cathode, cavity water cooling system, and two-flow system of the electrolyte solution. At this time, we have done one bulk EP (80 μm polished at ~35 V) and one fine EP (10 μm at ~11 V) without any major safety issues. The internal surface inspection of the treated cavities has confirmed the presence of the pits around the equator positions caused by hydrogen gas bubbles, and the introduction of a de-aeration mechanism for the electrolytic solution is under consideration.

Accelerator Plenary / **144**

ILC Crab Cavity Development

Authors: Laxdal Bob[1]; Peter Mcintosh[2]

[1] *TRIUMF*

[2] *STFC Daresbury Laboratory*

Corresponding Author: lax@triumf.ca

For the 14 mrad crossing angle proposed, crab cavity systems are fundamentally anticipated for the viable operation of the International Linear Collider (ILC), in order to maximise its luminosity performance. Since 2021, a specialist development team have been defining optimum crab cavity technologies which can fulfil the operational requirements for ILC, both for its baseline centre-of-mass energy of 250 GeV, but also extending those requirements out to higher beam collision intensities. Five design teams have established crab cavity technology solutions, which have the capability to also operate up to 1 TeV centre-of-mass. This presentation showcases the key performance capabilities of these designs and their associated benefits for both manufacture and integration into the ILC Interaction Region. The recommended outcome of the recently conducted crab cavity technology down-selection, will also be highlighted.

Accelerator: Superconducting RF / 145

High pressure gas regulation for SRF cavity fabrication in Japan

Author: Kensei Umemori[1]

[1] *KEK*

Corresponding Author: kensei.umemori@kek.jp

One of the critical issue to fabricate ILC-type cryomodule is compliance with the high pressure gas regulation(HPGR) in Japan. Currently most of our effort against HPGR is devoted for the Nb SRF cavity fabrication. Pre-assessment application form is under preparation, which is based on the results of mechanical tests of material and stress calculation of the cavity. Our strategy against HPGR and some of typical topics will be presented.

Accelerator: Beam Dynamics / 146

ITN contribution of KEK in the areas of DR and BDS

Author: Toshiyuki OKUGI[1]

[1] *KEK*

Corresponding Author: toshiyuki.okugi@kek.jp

ILC technology network (ITN) is currently being promoted to facilitate the development of ILC-related technologies for the engineering design of ILC. ITN contribution of KEK in the areas of DR and BDS will be presented.

Accelerator: Beam Dynamics / 147

Start-to-end beam dynamics simulation

Author: Ji Qiang[1]

[1] *LBL, BERKELEY*

Corresponding Author: jiqiang@slac.stanford.edu

The start-to-end beam dynamics simulation plays an important role in accelerator design performance optimization.
A parallel beam dynamics framework, IMPACT code suite, has been used in start-to-end beam dynamics optimization of linear accelerator design of an x-ray FEL light source. In this talk, we will present the physical and numerical models in this framework, show an application example, and discuss what needs to be included for the future linear collider study.

Accelerator: Beam Dynamics / **148**

Beam Tuning for ATF/ATF2 using Machine Learning

Author: Masakazu Kurata[1]

[1] *KEK*

Corresponding Author: kurata@post.kek.jp

Beam parameter optimization is the most important topic in beam operation.
I will present the automatic beam tuning and the tuning technique for better optimization using machine learning at ATF/ATF2.

Accelerator Plenary / **149**

AAC Developments: Plasma Wakefield for High Energy

Author: Cameron Geddes[None]

Corresponding Author: cgrgeddes@lbl.gov

AAC Developments: Plasma Wakefield for High Energy

Accelerator Plenary / **150**

Leveraging Experience from Production, Commissioning & Early Operations of LCLS-II and HE for ILC

Author: Dan Gonnella[1]

[1] *SLAC*

Corresponding Author: gonnella@slac.stanford.edu

The commissioning of LCLS-II, a superconducting linac upgrade to the world's first x-ray free-electron laser, is nearly complete following 10 years of SRF and FEL technology development. The technology used to build this upgrade significantly leveraged experience from EU-XFEL and ILC R&D. Here results from the production and commissioning of SRF cryomodules, primarily the cavities, will be discussed in the context of the requirements for ILC's superconducting linac. Early

results from the LCLS-II-HE production, a further upgrade to bring the total beam energy to 8 GeV will be presented, including techniques used to reach high gradients and high Q0 simultaneously in the SRF cavities.

Physics and Detectors Plenary / 151

PID Capabilities

Author: Taikan Suehara[1]

[1] *Kyushu University*

Corresponding Author: suehara.sl@mail.trinotes.info

PID Capabilities

Physics and Detectors Plenary / 152

Collider Background Studies

Author: Lindsey Gray[1]

[1] *Fermilab*

Corresponding Author: lagray@fnal.gov

Collider Background Studies

Physics and Detectors Plenary / 153

Muon Collider and Detector Synergies with e+e-

Author: Maximilian Swiatlowski[1]

[1] *TRIUMF*

Corresponding Author: mswiatlowski@triumf.ca

A muon collider presents an exciting and affordable medium-term possibility for a TeV-scale collider to explore the energy frontier, enabling a physics program would be extremely complementary to precision e+/e- Higgs factories. While detectors at a muon collider would face unique challenges due to the extreme backgrounds arising from beam decays in-flight, there are many complementary directions of detector development that could serve both e+/e- and muon collider communities. This talk highlights several areas where collaborative R&D could benefit both communities in the areas of timing detectors, high-granularity calorimetry, and magnet developments. These synergies can help maximize the physics impact of ongoing detector development projects.

Physics and Detectors Plenary / 154

ILC-Japan Detector R&D Collaboration Task Force

Author: MASAO KURIKI[1]

[1] *Hiroshima University*

Corresponding Author: mkuriki@hiroshima-u.ac.jp

ILC-Japan Detector R&D Collaboration Task Force

Physics and Detectors Plenary / 155

ECFA Higgs Factory Study

Author: Aidan Robson[1]

[1] *University of Glasgow*

Corresponding Author: aidan.robson@cern.ch

ECFA Higgs Factory Study

Physics and Detectors Plenary / 156

ECFA Detector R&D: Roadmap + International Context

Author: Didier Contardo[1]

[1] *IP2I CNRS/IN2P3*

Corresponding Author: didier.claude.contardo@cern.ch

ECFA Detector R&D: Roadmap + International Context

Accelerator Plenary / 157

Status and future programme for LC studies at ATF3.

Author: Angeles Faus Golfe[1]

[1] *IJCLab*

Corresponding Author: fausgolf@ijclab.in2p3.fr

Status and future programme for LC studies at ATF3.

Physics and Detectors: Track 3 / 158

Report from Detector Magnet Workshop

Author: Karsten Buesser[1]

[1] *DESY*

Corresponding Author: karsten.buesser@desy.de

Large detector solenoids are crucial for all future Higgs Factory detectors. Since the production of the last big magnets, industry has cut its capacities for the production of aluminum stabilised conductors which represent the accepted standard technology for big detector magnets.

A workshop at CERN in September 2022 brought together experts from detectors, magnet designers, and industry. I will report on the findings.

Physics and Detectors: Track 3 / 159

ILD Detector Assembly Timelines - a Reminder

Author: Karsten Buesser[1]

[1] *DESY*

Corresponding Author: karsten.buesser@desy.de

Construction and assembly of future Higgs Factory detectors is a complex endeavour and the related time lines might be longer than anticipated. In recent years, possible assembly scenarios for the ILD detector concept at the ILC have been studied in some detail. I will summarise the results which might be interesting for other detectors at future Higgs Factories.

Accelerator: Beam Dynamics / 161

Beam Loading Effect in the tracking code RF-Track

Authors: Javier Olivares Herrador[1]; Andrea Latina[2]

[1] *CERN and Universidad de Valencia*

[2] *CERN*

Corresponding Author: javier.olivares.herrador@cern.ch

The beam loading (BL) effect results in the reduction of the gradient due to the interaction of the beam with the accelerating cavity. This phenomenon leads to energy losses for long trains of particles. Such an energy degradation is non-negligible in compact and high-intensity linear accelerators, whose popularity is increasing due to their industrial and medical potential. To account for this effect, a self-consistent BL module has been developed in the tracking code RF-Track. With this, BL effects in the CLEAR facility at CERN have been studied, where transient BL is present in both travelling- and standing- wave structures.

Accelerator: Beam Dynamics / 162

Overview of Low Emittance Transport and Beam Dynamics Studie of ILC Linacs

Author: Arun Saini[1]

Co-author: Nikolay Solyak [1]

[1] *Fermilab*

Corresponding Author: asaini@fnal.gov

The scientific mission of the International Linear Collider (ILC) relies on achieving high-energy high-luminosity beam collisions, which necessitate a low emittance beam transport section to ensure the maintenance of high-quality beam along the accelerator. Thus, the preservation of beam emittance during acceleration represents a fundamental design and operational objective of the ILC accelerator. This presentation aims to discuss crucial beam dynamics studies that review some of the critical sources of emittance dilution, including the dispersion arising from the Earth's curvature, misalignments of beamline elements, and coupler transverse kick. Additionally, we will address the implications of component failures at critical locations in the linac and resulting beam loss. The mitigation strategies developed in the context of the ILC linac are equally applicable and adaptable for newly proposed electron-positron colliders, such as the Cold Copper Collider (C3) and High Energy Lepton Collider (HELEN) collider.

Accelerator: Particle Sources / **163**

High voltage DC gun using Super lattice GaAs photocathode for EIC polarized electron source

Author: Erdong Wang[1]

[1] *BNL*

Corresponding Author: wange@bnl.gov

The high-intensity, polarized electron source is a critical component for the electron-ion collider, requiring a polarized electron gun with higher voltage and higher bunch charge than any existing polarized electron source. At Brookhaven National Laboratory, we have built and successfully conditioned an inverted HVDC photoemission gun up to 350 kV. In this study, we report on the performance of a GaAs photocathode in generating 70 μA average current and up to 16 nC bunch charge with a long lifetime using a circularly polarized laser at a wavelength of 780 nm. We discuss the performance and limitations of the Distributed Bragg Reflector GaAs/GaAsP Super Lattice photocathode in the DC gun. We will also show the impact of anode bias and voltage on the lifetime of the superlattice GaAs. The gun is equipped with an integrated cathode cooling system, which has potential applications in high-current electron sources. Various novel features have been implemented and demonstrated in this polarized HVDC.

Accelerator: Superconducting RF / **164**

Recent SRF Activities at CEA Saclay

Author: Fabien EOZENOU[1]

Co-authors: Stéphane BERRY [1]; Thomas PROSLIER [1]; Yasmine KALBOUSSI [1]; Enrico CENNI [1]; Christophe SERVOUIN [1]

[1] *CEA Saclay IRFU/DACM*

Today, Superconducting Radio Frequency technology is based on bulk niobium and is now reaching its intrinsic limitation. Increasing the performance of SRF cavities while reducing manufacturing and operating costs poses real technological challenges. At CEA, we pursue a multiscale material functionalization approach compatible with mass production without performance degradation. The first scale is the development of bulk cavity material with optimization of vertical electropolishing. Gradient over 50MV/m on 1300MHz single cell and above 40MV/m on 704MHz single cell cavities have been achieved. The second scale aims at exploring the growth of superconducting films and

multilayers as well as thermal treatments to go beyond performance of bulk niobium. Finally we will discuss the challenges to maintain the achieved performances with updated clean-room procedures with the development of a robot, presently used for the cleaning of some flanges during the ESS cryomodule assembly. The latest lab activities will be presented.

Accelerator: Superconducting RF / 165

Discussion

Joint Plenary / 166

The CEPC Studies, R&Ds and Status, and Synergies with the LC Community

Author: Ye Jingbo[None]

Corresponding Author: yejb@physics.smu.edu

Circular Electron-Position Collider and the detector on it are the proposed Higgs factor in China. It will produce Higgs, Z and W bosons, and top quarks, for precision measurements and searches of new physics beyond the Standard Model. I will report, on behalf of the CEPC study group, about the progresses and results of the studies in the physics programs, R&Ds for the accelerator and the detector. This includes key elements (RF cavities, Klystrons and magnets) in the accelerator, detector concepts and the R&Ds on the subsystems (vertex detector, drift chamber and TPC for the inner tracker, and calorimeter options and prototypes). Where ever possible, synergies with the LC community will be mentioned.

Joint Plenary / 167

Panel Discussion

Corresponding Authors: jens.osterhoff@desy.de, steinar.stapnes@cern.ch, mpeskin@slac.stanford.edu, caterina@slac.stanford.edu, shoji.asai@cern.ch

Physics and Detectors: Track 3 / 168

Double readout sandwich calorimeter

Authors: Tohru Takeshita[1]; Reima Terada[1]

[1] *Shinshu University*

Corresponding Author: tohru@shinshu-u.ac.jp

We propose a sandwich calorimeter which aims at both ECAL and HCAL for the future collider experiments. It consists of Lead glass layers and Glass scintillator layers of sandwich structure where both layers are active for Cherenkov and scintillation lights respectively. The materials are chosen to be the calorimeter as inexpensive as possible. The expected energy resolution for high energy

hadrons and electrons / photons are close to that of homogeneous calorimeters with fine segmentation capability. Here the simulation work for the calorimeter will be presented and discussed our development of the elements.

Accelerator: Conventional Facilities / **169**

Safety Measures Taken in High-Gradient Accelerating-Structure Test Facility at KEK

Author: Tetsuo ABE[1]

[1] *KEK*

Corresponding Author: tetsuo.abe@kek.jp

In the X-band high-gradient test stand at KEK, Nextef, various normal-conducting high-gradient accelerating structures were high-power tested for, e.g., the CLIC prototype and SLAC distributed-coupling structures. However, April 3, 2019, significant fire occurred at Nextef, and all the high-gradient tests were terminated. It took three yours to recover the test facility focused on safety. We report various safety measures in the facility taken through the experience. In larger facilities, such as linear colliders, it is more difficult to reduce the risk of significant accidents. This report might be helpful for future large accelerator facility developments.

Joint Plenary / **170**

Muon Collider

Author: Tianhuan Luo[None]

Corresponding Author: tluo@lbl.gov

Muon Collider and synergies with LC.

Accelerator Plenary / **171**

X-band technology developments and use in small medical, industrial and research linacs.

Author: Steffen Doebert[1]

[1] *CERN*

Corresponding Author: steffen.doebert@cern.ch

X-band technology developments and use in small medical, industrial and research linacs.

Accelerator: Sustainability & Applications / **172**

Permanent magnet technology for sustainable accelerators

Author: Ben Shepherd[1]

[1] *STFC Daresbury Laboratory*

Corresponding Author: ben.shepherd@stfc.ac.uk

Permanent magnet technology is a path to reducing energy usage and carbon emissions for accelerator facilities. This talk presents some examples of where PM technology has been adopted in place of electromagnets, and highlights the advantages and disadvantages of this technology.

Physics and Detectors: Track 3 / 174

The time to fund ILC-IDT WP16 is now!

Author: Brett Parker[1]

[1] *Brookhaven National Laboratory*

Corresponding Author: parker@bnl.gov

In preparing to secure commitments to approve the ILC in Japan, the ILC International Design Team (IDT) has identified a prioritized list of critical R&D Work Packages (WPs) that should be pursued in a timely matter. Among these WPs, WP-16 has been identified by an ICFA sponsored Machine Advisory Committee review as having very high priority. WP-16 consists of two sub-tasks with the first task being to complete the construction (90% already done) and vibration stability cold cryostat testing of the QD0 Final Focus (FF) prototype that was left unfinished after the ILC TDR was published. Note when colliding two few nanometers sized beams, transverse displacement of the FF magnetic centers by this same amount would result in luminosity loss that can only be recovered by a dedicated beam-based feedback system. Presently the motion budget assigned for the FF magnets that can be accommodated by the state-of-the-art foreseen bunch train feedback system is 50 nanometers; however, we have no measurement data available for the FF magnets in the QD0 prototype cryostat to compare to and it is easy to postulate causes for magnet motion that could be much larger than 50 nanometers. The second WP-16 task takes note that in the years since the 2017 ILC TDR writing, there have been significant advances in IR magnet manufacturing technology and conceptual designs, for instance spurred by the FCC-ee IR FF magnet work. Accordingly with WP-16 task two, we have an opportunity to study and update the IR magnet and Machine Detector Interface (MDI) layout to take advantage of all such advances (such as side-by-side self-consistent external field crosstalk compensating coil designs from the FCC-ee). At this point we want to point out that for any proposed future very-high luminosity lepton collider, the vertical beam spot collision size will be of order a few nanometers and vibration stability of cryostated FF magnets is quite relevant to understand luminosity performance. And results obtained from reoptimizing the ILC FF magnet designs and other MDI improvements are also more widely applicable to other colliders. Certainly, the ILC needs this R&D done and since we argue that this work has fundamental general applicability, WP-16 should be funded as soon as possible.

Accelerator Plenary / 175

FCC-ee

Author: Tor Raubenheimer[1]

[1] *SLAC*

Corresponding Author: tor@slac.stanford.edu

Overview of FCC-ee.

Accelerators: Advanced Accelerator Concetps / 176

Detector Considerations for a multi-TeV Plasma Wakefield Collider

Author: Maximilian Swiatlowski[1]

[1] *TRIUMF*

Corresponding Author: mswiatlowski@triumf.ca

There have been several recent proposals for advanced accelerator designs at extremely high energy that involve potentially challenging experimental environments. For example, a plasma lens could be used to focus beams to significantly increase luminosity of collisions, but the presence of a plasma lens at the heart of a particle detector can create unprecedented experimental challenges. This talk will examine some of these challenges, and sketch the path towards a detector design that can deliver the physics goals of these accelerators.

Accelerators: Advanced Accelerator Concetps / 177

Luminosity Spectra of Multi-TeV Plasma Wakefield gamma-gamma Colliders

Author: Timothy Barklow[1]

[1] *SLAC*

Corresponding Author: timb@slac.stanford.edu

Please find the abstract here

Accelerator: Normal Conducting RF / 178

TEX (TEst stand for X-band) at LNF

Author: Claudio Di Giulio[None]

Corresponding Author: claudio.digiulio@lnf.infn.it

TEX facility if commissioned for high power testing to characterize accelerating structures and validate them for the operation on future particle accelerators for medical, industrial and research applications. At this aim, TEX is directly involved in the LNF leading project EuPRAXIA@SPARC_Lab.
The brief description of the facility and its status will be provided.

Accelerator: Conventional Facilities / 179

The Frascati Beam Test Facility

Author: Claudio Di Giulio[None]

Corresponding Author: claudio.digiulio@lnf.infn.it

From 2004 the Frascati Beam Test Facility (BTF) in the DAFNE accelerator complex provides to the external user up to 1E10 electron per bunch or up to 1E9 positron per bunch to develop their detector. After an upgrade program terminated in 2020 of the beam test facility a description of the status and available beam lines will be done.

Industry Plenary / 180

Introduction to the Industry and Sustainability Sessions

Corresponding Author: maxim.titov@cea.fr

Physics and Detectors: Track 3 / 181

Recent progress and future plans for ultra-high granularity CMOS ECAL

Author: Nigel Watson[1]

[1] *University of Birmingham*

Corresponding Author: nigel.watson@cern.ch

The concept of a digital electromagmetic calorimeter using MAPS sensors as the active layers has been demonstrated using the EPICAL-2 prototype, a 24 layer, ~20 radiation length device. Each layer has an active area of 30×30 mm^2 provided by two ALPIDE sensors. Final results characterising the performance in terms of energy resolution, linearity and lateral shower profile using $1-6$~GeV electrons are presented. The results, obtained using sensors developed and optimised for the ALICE ITS upgrade, are comparable to those from an analogue silicon-tungsten calorimeter. Improvements using sensors designed with calorimetry as a target application are likely to be able to further enhance performance. Future prospects for futher development of the digital electromagnetic calorimeter concept will be discussed.

Accelerator: Particle Sources / 182

E-driven and flux concentrator status and plans

Authors: Yoshinori Enomoto[1]; Yoshinori Enomoto[1]

[1] *KEK*

Corresponding Authors: yoshinori.enomoto@kek.jp, enomotoy@post.kek.jp

Status of E-driven positron source for ILC including R&D plan is presented. A test stand to operate a proto-type Flux concentrator will be constructed in the STF facility. The status of Flux concentrator design and the test stand will be presented.

Accelerator: Particle Sources / 183

Start to end positron source simulation

Authors: MASAO KURIKI[1]; H Tajino[1]

[1] *Hiroshima University*

Corresponding Author: mkuriki@hiroshima-u.ac.jp

Start to end simluation of ILC E-Driven Positron source is presented.

Accelerator: Particle Sources / 184

Beam loading compensation on the booster linac

Author: S Kuroguchi[1]

[1] *Hiroshima Univesity*

Corresponding Author: m236009@hiroshima-u.ac.jp

Beam loading compensation in the booster linac by traveling wave linac is disscussed.

Accelerator: Particle Sources / 185

APS cavity study

Authors: Hitoshi Hayano[1]; M Fukuda[1]

[1] *KEK*

Corresponding Author: hitoshi.hayano@kek.jp

APS cavity is designed for the capture linac of E-Driven positron source. In addition to the RF load, a large heat load by the beam is expected. The experiment to simulating the detuning is being carried out at Iwate ILC lab. The status will be reported.

Accelerator: Particle Sources / 186

Target Status and plan

Author: Yu Morikawa[1]

[1] *KEK*

Corresponding Author: yu.morikawa@kek.jp

A water-cooled target with a rotation rod is designed for the E-Driven positron source. The test operation of the rotating rod examining the vacuum performance of the ferr-fluid seal is ongoing. The status and a new design improving the performance will be presented.

Physics and Detectors: Track 1 / 187

Physics with the XFEL Compton gamma gamma Collider (XCC) Higgs Factory

Authors: Timothy Barklow[1]; Ariel Schwartzman[1]

[1] *SLAC*

Corresponding Author: timb@slac.stanford.edu

Please find the abstract here

Accelerators: Advanced Accelerator Concetps / 188

Modeling of extreme environments - beam generation, acceleration and interactions within intense fields

Author: Marija Vranic[1]

[1] *Instituto Superior Tecnico, University of Lisbon*

Corresponding Author: marija.vranic@tecnico.ulisboa.pt

The next generation of lasers will access intensities above 10^{23} $\mathrm{W/cm^2}$. Extreme laser-plasma interactions can be explored to form optical traps, create&accelerate particles and produce novel radiation sources. I will present a QED module coupled with the particle-in-cell framework OSIRIS that allows studying nonlinear plasma dynamics in the transition from the classical to the quantum-dominated regime of interaction. Studies relevant for (near) future experiments will be discussed, as well as the developments relevant for lepton and gamma-gamma colliders approaching this regime.

Accelerator: Normal Conducting RF / 189

Measurements/Xboxes and structure manufacturing and methods

Corresponding Author: boronat.arevalo@cern.ch

Accelerator: Normal Conducting RF / 190

CERN's High Gradient X-Band Test Stands: Status and Update

Author: Marca Boronat[1]

[1] *Cern*

Corresponding Author: boronat.arevalo@cern.ch

Industry Plenary / 191

Japan - AAA activity

Corresponding Author: tohru-takahashi@hiroshima-u.ac.jp

The Advanced Accelerator Association Promoting Science & Technology (AAA) is a general incorporated association aimed at promoting accelerator science by fostering collaboration among academia, government, and industry. The primary focus of the AAA is the International Linear Collider, and the organization is actively involved in project promotion, technical liaison, and public relations to achieve its objective. This presentation will provide an overview of the latest developments in the Project Promotion, Technology, and Public Outreach working groups.

Industry Plenary / **192**

US Office of accelerator R&D and Production (ARDAP)

Corresponding Author: camille.ginsburg@science.doe.gov

Particle accelerators are the fundamental tools enabling discovery science at many of the Department of Energy (DOE) Office of Science (SC) facilities, supporting roughly 20,000 users per year in the areas of Basic Energy Sciences, Fusion Energy Sciences, High Energy Physics, and Nuclear Physics. Accelerators are also used by the DOE Isotope Program to develop and produce radioactive and stable isotopes that are used worldwide for medical diagnosis and treatment, and are used in medicine, national security, and industrial processes, among other applications. These accelerator-based SC programs contribute to the economic, technical, and scientific strength of the United States. The Accelerator R&D and Production (ARDAP) program helps ensure that new and emerging accelerator technology will be available for future discovery science, medicine, industry, and national security needs by helping leverage and coordinate accelerator science and technology investments made through the other SC programs. ARDAP also makes its own investments in fundamental accelerator technology R&D and in the commercialization of these technologies. This presentation will describe the mission and activities of the ARDAP office.

Industry Plenary / **193**

Advances in Spanish Science Industry

Corresponding Author: efernandez@ineustar.com

Spanish Science Industry is developing technology, components systems and subsystems for particle accelerators world wide. The relationship of the industry with the scientific and technological institutes in Spain makes possible the advance of critical technologies that will be applied in the future accelerators as the International Linear Collider. During the presentation, key characteristics of Spanish Science Industry Sector and some developments related to advanced accelerators and specifically to ILC project will be presented

Industry Plenary / **194**

Development of C-band RF infrastructure and initial experiments at RadiaBeam

Corresponding Author: murokh@radiabeam.com

RadiaBeam is a small business providing systems, components, instrumentation, as well as testing, consulting and engineering services to the industrial and scientific accelerator communities. In this paper we'll discuss the projects most relevant to the high energy physics community with the emphasis on a recent development of the in-house C-band infrastructure for accelerator R&D. We'll also present more general case studies, which illustrate successes as well as challenges of serving the discovery science accelerator laboratories market, and discuss the current business outlook.

Industry Plenary / **195**

Experience in participating in the development of an electron-driven positron source as a company in the Tohoku region

We have participated in the R&D work for an electron-driven positron source ordered by KEK and awarded by the Iwate Industrial Promotion Center, and oversaw one part of the work. We worked on this project in collaboration with industry, government, and academia, and we oversaw the design, manufacturing, installation, and operation of the cooling water system. Two companies in Iwate Prefecture and one company headquartered in Tokyo participated in the technical aspects of the project, and the Iwate Industrial Research Center and the Iwate Industrial Promotion Center participated in the governmental aspects. Technical guidance was provided by KEK and Hiroshima University.
We are a newcomer to the accelerator-related industry. However, we already have experiences in the piping of cooling water systems for the newly constructed synchrotron radiation facility at Tohoku University and in the drawing of existing piping systems of the electropolishing system for SRF at KEK.
Examples of our core businesses are the piping system for a semiconductor plant and the design, manufacturing, and on-site construction of the turf curing system for the New National Stadium. Our factory is located only about 30 km from the proposed ILC candidate site, and we are confident that we have the technology and manufacturing and installation capabilities to handle large-scale piping work once construction of the ILC begins.

Industry Plenary / **196**

Development of Nb3Sn SRF cavity using electroplating method

Nb3Sn is a material with about twice the superheating field and superconducting transition temperature of Nb. By forming an Nb3Sn film on the inner surface of an Nb cavity, the cavity length can be shortened and the system can be operated with a small refrigerator, thus realizing a compact superconducting accelerator system with low operating cost and low price. At KEK, the electroplating method is being investigated as an alternative to the conventional method for forming Nb3Sn films. Based on this research, we have been studying the formation of Nb3Sn films in 3GHz single-cell cavities as our ultimate goal. In this presentation, we will report on the Nb3Sn film formation process and the evaluation results of the fabricated samples.

Sustainability Plenary / **197**

Sustainability Studies for ILC and CLIC

Corresponding Author: benno.list@desy.de

Sustainability has become a prioritized goal in planning and implementation of future large accelerators, where ILC and CLIC have been collaborating to study novel design and technology solutions to address power efficiency and reduce the environmental impact of the facilities. Recent activities include studies on high efficiency components and life cycle assessments of civil engineering and accelerator construction and operation.

Sustainability Plenary / **198**

High Efficiency Klystrons project at CERN: Status and u

Corresponding Author: igor.syratchev@cern.ch

Klystron is a key element of almost all particle accelerators. The High Efficiency Klystron Project at CERN is targeted to develop, fabricate and commission the new devices with improved efficiency for various particle accelerators and other applications. This activity is conducted in a close collaboration with industrial partners and scientific Labs. We will review the status and ongoing activities within HE project at CERN with emphasis given to their application in the Linear Colliders.

Sustainability Plenary / **199**

Green ILC Concept

Corresponding Authors: masakazu.yoshioka@psgtokyo.jp, masakazu.yoshioka@kek.jp

The Kitakami Highlands of Iwate Prefecture, where the ILC candidate site is located, is served by Tohoku Electric Power Co. The company's CO2 emission coefficient for FY2021 is 0.483 kg- CO2/kWh. This is about twice the figure for Europe. The Japanese government has set a goal of achieving carbon neutrality by 2050. This report presents a scenario in line with that policy.

Sustainability Plenary / **200**

Permanent magnet technology for sustainable accelerators

Corresponding Author: ben.shepherd@stfc.ac.uk

Permanent magnet technology is a path to reducing energy usage and carbon emissions for accelerator facilities. This talk presents some examples of where PM technology has been adopted in place of electromagnets, and highlights the advantages and disadvantages of this technology.

Sustainability Plenary / **201**

IHEP high efficiency, high power klystron development

Corresponding Author: zhouzs@ihep.ac.cn

After the discovery of the Higgs boson at LHC, Chinese scientists have planned to build a "Great Collider,"which is a next-generation multinational particle accelerator research facility proposed as

a circular electron-positron collider (CEPC) and a super proton–proton collider (SPPC). The CEPC synchrotron radiation power is supposed to be more than 60MW. Institute of High Energy Physics (IHEP) is developing a higher efficiency klystron of frequency 650 MHz/800 kW with an efficiency goal of around 80%. Several klystron prototypes have been manufactured in the last five years to achieve this goal. The prototype was developed in March 2020 with 62% efficiency at 800 kW pulsed output power. The first stage of the high-power test for the second prototype was also completed in July 2022 with 70.5% efficiency at 630 kW CW power. The third prototype (Multi-beam klystron) is being manufactured, and it will be tested by the middle of 2023. In addition, the beam dynamics of 2860MHz (80MW) klystron are completed and will be manufactured in 2023. The design of 5720 MHz (80 MW&50 MW) klystron for CEPC Linac is also in progress.

Sustainability Plenary / 202

Basic research using synchrotron radiation and commercialization of waste heat recovery technology from ILC

We are conducting research to recover and utilize the energy discharged from the ILC facility under the concept of Green ILC. As the candidate site for construction, Iwate Prefecture, which has the Kitakami site, is 80% mountainous, and an effective model for heat energy circulation and utilization that suits the regional characteristics is required. Therefore, we aim to commercialize an off-line waste heat circulation model using an innovative adsorption-type heat storage material called "HASClay," which can be regenerated at low temperatures. Here, we introduce fundamental research aimed at understanding the structural changes caused by the adsorption and desorption of water molecules into the fine pore structure of HASClay using a synchrotron radiation facility, as well as conducting demonstration tests to achieve commercialization.

Sustainability Plenary / 203

Town planning in the vicinity of ILC candidate site as a regional company

: In cooperation with Iwate University, Iwate Prefectural University, and several private companies, we are constructing a 20-hectare facility within a 40-minute drive time and 30-40 km from the ILC candidate site to provide residential facilities and outdoor activities to promote health and familiarity with nature. This facility can serve as a model for town planning where ILC-related people can live. The basic policy of this project is to be in line with the Japanese government's policy of "achieving carbon neutrality by 2050". We will report the concept, status, and future vision of the facility under construction.

Physics and Detectors: Track 3 / 204

Conceptual plan of ILD solenoid magnet manufacture –Onsite winding

Yasuhiro Makida, Tomoyuki Sanuki, Takahiro Okamura, Yasuhiro Sugimoto, Toshiaki Tauchi

While referring to CMS fabrication experience, we have been discussing manufacturing process of ILD superconducting solenoid with production companies and specified freight carriers. In case of CMS, five coil modules were transported from the winding factory to the assembly building in the

CMS site where the CMS solenoid was completed. We has investigated the transit route where the ILD coil modules are transported and has recognized that there are too many obstructs to be removed and some bridges to be reinforced. So, we started to investigate alternative processes including the on-site winding. We have also found some subjects to be solved in them. Status of consideration about solenoid manufacture process is to be presented.

Joint Plenary / **205**

Send Off

Corresponding Author: mpeskin@slac.stanford.edu

Accelerator: Normal Conducting RF / **206**

CERN Xband Acc. structure update

Author: Pedro Morales Sanchez[1]

[1] *CERN*

Corresponding Author: pedro.morales.sanchez@cern.ch

Accelerator: Normal Conducting RF / **207**

Wakefield Damping in a Distributed Coupling Accelerating Structure for CLIC

In this talk we develop a standing wave cell design to be used in a distributed coupling structure that satisfies the CLIC transverse wake potential limit. We start by designing a standing wave cell based on the middle cell of the CLIC-G* traveling wave structure. Next we adapt the cell to be suitable for distributed coupling and simulate its wake potentials in an ideal case where open boundaries are applied to all waveguides connected to the cell. Once we reduce the wake potentials below the threshold in this optimistic scenario, we add an electric boundary to the model to simulate total reflection at a distribution network. We analyze the resulting reflected wake potentials and present a damping solution.

Accelerator: Conventional Facilities / **208**

Site-specific Studies for the ILC in Tohoku

Corresponding Author: tomoyuki.sanuki.e8@tohoku.ac.jp

Accelerator Plenary / **209**

ALEGRO - an international study group to promote advanced accelerators for particle physics applications

Corresponding Author: jens.osterhoff@desy.de

The development of advanced acceleration techniques has been rapid over the last decade. Nowadays, acceleration concepts based on plasmas have not only demonstrated field strengths in the multi-GV/m regime enabling ultracompact high-energy machines, but have also made strides in terms of short- and long-term stability and control aided by novel machine learning algorithms, and demonstrated the beam-quality required to support free-electron laser gain and medical applications. ALEGRO, the Advanced LinEar collider study GROup of the ICFA ANA panel, recently held their first post-pandemic workshop to review current developments in the context of a future application of GV/m acceleration techniques for particle physics. This workshop highlighted that while many challenges remain for a future plasma-based collider, substantial progress could be achieved on the path to this ultimate goal. This presentation discusses these developments in the context of ALEGRO and the European Strategy for Particle Physics Accelerator R&D Roadmap.

Accelerators: Advanced Accelerator Concetps / 210

High energy physics studies at PW-class laser and advanced accelerator linear collider facilities

Corresponding Author: sbulanov@lbl.gov

It is widely accepted that the next lepton collider beyond a Higgs factory would require center-of-mass energy of the order of up to 15 TeV with advanced and novel accelerators (ANAs) being the leading candidates for it. However, intermediate facilities at 20-100 GeV are required to test the technology and demonstrate key subsystems. Here possible design and science case for a 20-100 GeV center-of-mass energy ANA-based lepton collider that can be a candidate for an intermediate facility are presented. A special attention is paid to the study of strong field quantum electrodynamics effects. They are expected to start to manifest themselves at PW-class laser facilities and to dominate the charged particle interactions with strong fields at ANA-based lepton collider.

ILD collaboration meeting: everyone is welcome to join / 211

Agenda

https://agenda.linearcollider.org/event/10048/

ILD collaboration meeting: everyone is welcome to join / 212

Additional Discussion Time

https://agenda.linearcollider.org/event/10048/

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Group Photo

Joint Plenary / **214**

Lab Welcome, Chair's Welcome and Announcements

Corresponding Author: caterina@slac.stanford.edu

Joint Plenary / **215**

Accelerator Summary #1: Beam Dynamics, Beam Delivery, Particle Sources, Damping Rings, Plasma

Corresponding Author: sgess@slac.stanford.edu

Early Career Poster Session / **216**

Early Career Posters

Corresponding Authors: rafimah@slac.stanford.edu, sgess@slac.stanford.edu, brendon_madison@ku.edu, mitchs@slac.stanford.edu, angabrie@slac.stanford.edu, haoranxu@lanl.gov, mothman@slac.stanford.edu, esnively@slac.stanford.edu, jklamka@fuw.edu.pl, adhar@slac.stanford.edu, whtan@slac.stanford.edu, dntounis@stanford.edu, jesus.marquez@ific.uv.es

Joint Plenary / **217**

Detector Closeout

Corresponding Author: adrian.irles@ific.uv.es

SiD Collaboration Meeting / **218**

Welcome

Corresponding Authors: marcel.stanitzki@desy.de, awhite@uta.edu

SiD Collaboration Meeting / **219**

Higgs Factory Detector R&D

Corresponding Author: jimbrau@uoregon.edu

SiD Collaboration Meeting / **220**

SiD & PiD

Corresponding Author: marcel.stanitzki@desy.de

SiD Collaboration Meeting / **221**

Discussion

SiD Collaboration Meeting / **222**

Adjourn for Dinner

Joint Plenary / **223**

Announcement

Corresponding Author: mpeskin@slac.stanford.edu

Joint Plenary / **224**

Message from Organizers