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Talks

Dark matter production via light mediator exchange at future e+e- colliders

- Speaker: Aleksander Filip Zarnecki
- Status: accepted as oral presentation
- Abstract: One of the primary goals of the proposed future collider experiments is to search for dark matter (DM) particles using different experimental approaches. High energy 𝑒+𝑒− colliders offer unique possibility for the most general search based on the mono-photon signature. As any 𝑒+𝑒− scattering process can be accompanied by a hard photon emission from the initial state radiation, analysis of the energy spectrum and angular distributions of those photons can be used to search for hard processes with invisible final state production and to test the nature and interactions of the DM particles. Dedicated procedure of merging the matrix element calculations with the lepton ISR structure function was developed to model the Standard Model background processes contributing to mono-photon signature with WHIZARD. We consider production of DM particles at the International Linear Collider (ILC) and Compact Linear Collider (CLIC) experiments. Detector effects are taken into account within the DELPHES fast simulation framework. Limits on the light DM production in a generic model are set as a function of the mediator mass and width based on the expected two-dimensional distributions of the reconstructed mono-photon events. Limits on the mediator coupling to electrons are presented for a wide range of mediator masses and widths. For light mediators, for masses up to the centre-of-mass energy of the collider, results from the mono-photon analysis are more stringent than the limits expected from direct resonance search in SM decay channels.
- Slides

Search for the pair-production of charged IDM scalars at high energy CLIC

- Speaker: Jan Franciszek Klamka
- Status: accepted as oral presentation
- Abstract: Compact Linear Collider (CLIC) was proposed as the next energy-frontier infrastructure at CERN, allowing to study 𝑒+𝑒− collisions at three centre-of-mass energy stages: 380 GeV, 1.5 TeV and 3 TeV. The main goal of its high-energy stages is to search for the new physics beyond the Standard Model (SM). The Inert Doublet Model (IDM) is one of the simplest SM extensions and introduces four new scalar particles: 𝐻±, 𝐴 and 𝐻; the lightest, 𝐻, is stable and hence it is a natural dark matter (DM) candidate. A set of benchmark points is considered, which are consistent with current theoretical and experimental constraints and promise detectable signals at future colliders. Prospects of observing pair-production of the IDM scalars at CLIC were previously studied for signatures with two leptons in the final state. In the current study, discovery reach for the IDM charged scalar pair-production is considered for the semi-leptonic final state at the two high-energy CLIC stages. Full simulation analysis, based on the new CLIC detector model, is presented for five selected IDM scenarios. Results are then extended to the larger set of benchmarks using DELPHES fast simulation framework. The CLIC detector model for DELPHES has been modified to take pile-up contribution from the beam-induced 𝛾𝛾 interactions into account, which is crucial for the presented analysis. Results of the study indicate that heavy, charged IDM scalars can be discovered at CLIC for most of the proposed benchmark scenarios, with very high statistical significance.
- Slides

CLIC sensitivity to invisible scalar decays

- Speaker: Krzysztof Mekala
- Status: accepted as oral presentation
- Abstract: The Compact LInear Collider (CLIC) is a proposed TeV -scale high-luminosity electron-positron collider at CERN. CLIC will allow us to study the Higgs boson properties with very high precision. These measurements can also result in a direct or indirect discovery of "new physics", Beyond the Standard Model (BSM) phenomena, which could help us to understand the nature of dark matter (DM). SM-like Higgs boson or new heavy scalar decays with the emission of invisible DM particles can be the only way to observe "new physics" effects at achievable energy scales and establish the connection between Standard Model (SM) and BSM sectors. We studied the possibility of measuring invisible Higgs boson and additional heavy scalars decays with experiment at CLIC running at 380 GeV and 1.5 TeV. The analysis is based on the WHIZARD event generation and fast simulation of CLIC detector response with DELPHES. We estimated the expected limits on the invisible decays of the 125 GeV Higgs boson, as well as the cross section limits for the production of an additional neutral Higgs scalar, assuming its invisible decays, as a function of its mass. Extracted model-independent branching ratio and cross section limits were then interpreted in the framework of the vector-fermion dark matter model to set limits on the mixing angle between the SM-like Higgs boson and the new scalar of the "dark sector".
- Slides

Optimising top-quark threshold scan at 𝑒+𝑒− colliders using genetic algorithm

- Speaker: Kacper Nowak
- Status: accepted as oral presentation
- Abstract: One of the important goals at the future 𝑒+𝑒− colliders is to measure the top-quark mass and width in a scan of the pair production threshold. However, the shape of the pair-production cross section at the threshold depends also on other model parameters, as the top Yukawa coupling, and the measurement is a subject to many systematic uncertainties. Presented in this work is the most general approach to the top-quark mass determination from the threshold scan at CLIC, with all relevant model

parameters and selected systematic uncertainties included in the fit procedure. Expected constraints from other measurements are also taken into account. The top-quark mass can be extracted with precision of the order of 30 to 40 MeV, including considered systematic uncertainties, already for 100 fb−1 of data collected at the threshold. Additional improvement is possible if the running scenario is optimized. With the optimisation procedure based on the genetic algorithm the statistical uncertainty of the mass measurement can be reduced by about 25%. Influence of the beam energy profile on the optimisation procedure and the expected statistical precision of the measurement is verified by comparing results obtained assuming luminosity spectra of CLIC, ILC and FCCee.

- Slides

Heavy Neutrinos at Future Linear e+e- Colliders

- Speaker: Krzysztof Mekala
- Status: accepted as oral presentation
- Abstract: Neutrinos are probably the most mysterious particles of the Standard Model. The mass hierarchy and oscillations, as well as the nature of their antiparticles, are being currently studied in experiments around the world. Moreover, in many models of the New Physics, baryon asymmetry or dark matter density in the universe are explained by introducing new species of neutrinos. Among others, heavy neutrinos of the Dirac nature were proposed to solve mysteries of the Universe. Such neutrinos with masses above the EW scale could be produced at future linear e+e- colliders, like the

Compact LInear Collider (CLIC) or the International Linear Collider (ILC).We studied the possibility of observing decays of heavy Dirac neutrino in qql final state at ILC running at 1 TeV and CLIC at 3 TeV. The analysis is based on the WHIZARD event generation and fast simulation of detector response with DELPHES. Dirac neutrinos with masses from 200 GeV to 3.2 TeV are considered. We estimated the limits on the production cross sections and on the neutrino-lepton coupling, and compared them with current limits coming from the LHC running at 13 TeV, as well as the expected future limits from hadron colliders. Obtained results are stricter than any other limit estimates published so far.
- Slides

Potential of the Compact Linear Collider (CLIC) to measure branching fraction of the Higgs to ZZ* decays 350 and 3 center-of-mass energy

- Speaker: Natasa Vukasinovic
- Status: accepted as oral presentation
- Abstract: As a multi-TeV energy-staged machine, CLIC offers millions of Higgs bosons to be produced in a low-background environment enabling measurements of most of the Higgs couplings at a few per mille level. To this end, individual measurements at different CLIC energy stages, in various Higgs production and decay channels, are subjects of global fits of the Higgs properties in model-independent or dependent way (𝜅-framework, EFT fit). In this talk we discuss measurements of 𝐵𝑅(𝐻 𝑍𝑍 𝑞𝑞𝑙&#x1D4 at 350 GeV and 3 TeV center-of-mass energies from the perspective of their statistical precision.
- Slides

Measurement of the Higgs to di-photon branching fraction at 3 CLIC

- Speaker: Goran Kacarevic
- Status: accepted as oral presentation
- Abstract: In this talk we address a potential of 3 TeV center-of-mass energy Compact Linear Collider (CLIC) to measure the Standard Model (SM) Higgs boson decay to two photons. Since photons are massless, they are coupled to the Higgs boson at a loop level, in exchange of heavy particles either from the Standard Model or beyond. Any deviation of the Higgs to di-photon branching fraction and consequently of the Higgs to photon coupling may indicate a New Physics. Measurement is fully simulated on 5000 samples of pseudo-experiments assuming integrated luminosity of 5 ab-1 with unpolarized beams.
- Slides

Test-beam studies of the monolithic CMOS silicon sensor CLICTD

- Speaker: Katharina Dort
- Status: accepted as oral presentation
- Abstract: The CLIC Tracker Detector (CLICTD) is a monolithic pixel sensor featuring pixels of 30 microns x 37.5 microns and a small collection diode. The sensor is fabricated in a 180 nm CMOS imaging process, using two different pixel flavours: the first with a continuous n-type implant for full lateral depletion, and the second with a segmentation in the n-type implant for accelerated charge collection. Moreover, it features an innovative sub-pixel segmentation scheme that allows the digital footprint to be reduced while maintaining a small sub-pixel pitch. CLICTD was developed to target the requirements for the tracking detector of the proposed future Compact Linear Collider CLIC. Most notably, a temporal resolution of a few nanoseconds and a spatial resolution below 7 microns are demanded. In this contribution, test-beam measurements of CLICTD are presented and the performance of the sensor is evaluated with regard to the CLIC requirements.
- Slides

Pixel detector hybridization and integration with Anisotropic Conductive Films

- Speaker: Mateus Vicente Barreto Pinto
- Status: accepted as oral presentation
- Abstract: The precision-measurement goals for the Linear Collider detectors place strict constraints on the pixel size and the amount of material allowed in the vertex and tracking layers. Low-mass interconnect technologies suitable for small pitch hybridization as well as for the integration of modules are therefore required. An alternative pixel-detector hybridization technology based on Anisotropic Conductive Films (ACF) is under development to replace the conventional fine-pitch flip-chip bump bonding. The new process takes advantage of the recent progress in industrial applications of ACF and is suitable for time- and cost-effective in-house processing of single devices. This new bonding technique developed can also be used for the integration of hybrid or monolithic detectors in modules, replacing wire bonding or solder bumping techniques. This contribution introduces the new ACF hybridization and integration technique, and shows the first test results from Timepix3 hybrid pixel assemblies and from the integration of ALPIDE monolithic pixel sensors to flex circuits.
- Slides

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