Workshop on the physics of HL-LHC, and perspectives at HE-LHC

Report of Abstracts

Abstract ID : **1**

Upper bounds on sparticle masses from natural SUSY compared to the reach of HL- and HE-LHC

Content

Recent calculations of upper bounds on sparticle masses,
from requiring 3% or better naturalness within the MSSM,
imply m(gluino)<4-5 TeV and m(t1)<3 TeV.
Meanwhile, higgsino masses should be lighter than about 350 GeV
although these are difficult to see at LHC.
Compared to current LHC mass limits, we see that LHC has only probed a fraction of natural SUSY parameter space. While HL-LHC can probe most of parameter space in SUSY models with gaugino mass unification, it may take HE-LHC to conclusively test models with compressed gauginos such as natural mirage mediation.

Primary author(s) : BAER, Howard (University of Oklahoma)

Status: SUBMITTED

Submitted by **BAER, Howard** on **Monday 03 July 2017**

Abstract ID : **2**

Heavy Neutrinos at Future Hadron Colliders

Content

We provide an update of the discovery potential of heavy neutrinos (N) at hadron collider experiments. In particular, we emphasize that for actively discussed energy upgrades of the CERN LHC, the production of electroweak- and TeV-scale N is dominated by the gluon fusion mechanism and not the widely-believed-to-be-dominant charged current Drell-Yan process.

Primary author(s) : RUIZ, Richard (University of Durham (GB))

Comments:

Hello, the submitted abstract would best fall into the BSM working group. Thank you.

Status: SUBMITTED

Submitted by **RUIZ, Richard** on **Tuesday 04 July 2017**

Abstract ID : **3**

WG3: Demystifying compressed top squark region with kinematic variables

Content

Searching for the top squark is very important in the context of stabilizing the Standard Model (SM) Higgs boson mass against large quantum correction and gauge coupling unification. While Large Hadron Collider has already excluded large parameter space in supersymmetry, it poorly constrains the light top squark if the mass difference between the top squark and the neutralino is very small. Existing search strategy breaks down here mainly due to two reasons first, huge SM background and the second is unique compressed kinematics which makes all the decay products extremely soft. Here we propose a class of novel kinematic variables designed uniquely for the compressed region to control the huge SM background giving complimentary scheme in leptonic searches. We have considered the top squark undergoing four body decay in the leptonic channel and using this topology information our new kinematic variables significantly improve the current LHC limit.

Primary author(s) : SWAIN, Abhaya Kumar (Physical Research Laboratory)

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Status: SUBMITTED

Submitted by **SWAIN, Abhaya Kumar** on **Tuesday 04 July 2017**

Abstract ID : **4**

Determination of $|V_{cb}|$ from baryonic Λ_b decays

Content

We perform the first extraction of $|V_{cb}|$ as the Cabibbo-Kobayashi-Maskawa matrix element from the semileptonic $\Lambda_b \to \Lambda_c \ell \bar{\nu}_\ell$ decay. In addition, the hadronic $\Lambda_b \to \Lambda_c M_{(c)}$ decays
with $M = (\pi^-, K^-)$ and $M_c = (D^-, D_s^-)$ measured with high precisions are involved in the extraction. Explicitly, we find $|V_{cb}| = (45.0 \pm 2.8) \times 10^{-3}$, which agrees with the value of $(42.11 \pm 0.74) \times 10^{-3}$
from the inclusive $B \to X_c \ell \bar{\nu}_\ell$ decays.

Primary author(s) : Prof. HSIAO, Yu-Kuo (Shanxi Normal University); Prof. GENG, Chao-Qiang (National Tsing Hua University)

Status: SUBMITTED

Submitted by **HSIAO, Yu-Kuo** on **Monday 10 July 2017**

Abstract ID : **5**

The conjecture of the parallel universe

Content

ABSTRACT: The theory of a Parallel universe or an “alternate reality” is a prodigy for the world of fantasies as it dates back to the time of Plato. The model for this conjecture has been proposed in 4 levels, each with a reasonable description in terms of theory as submitted by physicist Max Tegmark. Level -1 states a possibility of a parallel universe which includes Hubble volumes sharing the same laws of nature and initial conditions as our universe.Level-2 is a group of domains of many parallel universes that are constantly moving away from each other due to inflation owing to unexplained forces, now known as ‘dark energy’, which could have any number of dimensions and the physical constants differ as well. Level -3 has been discretely carved as the MANY WORLDS THEORY in which a single event can lead to multiple outcomes each leading to a different branch or a different reality rooting from a unary universe. Level -4 describes the possibility of alternate dimensions in the form of mathematical structures. This paper is an alternate version of the paper proposed by Max Tegmark with my individual outlook and arguments on the subject.

Primary author(s) : Ms. SHAH, shreya (saurashtra university)

Status: SUBMITTED

Submitted by **SHAH, shreya** on **Wednesday 19 July 2017**

Abstract ID : **6**

Small-x resummation: from PDFs to HL- and HE-LHC

Content

We present a new determination of parton distribution functions (PDFs) which includes the resummation of large logarithms at small momentum fraction x, relevant at high energies. The description of the HERA data at small x, small Q improves considerably. The new PDFs, obtained from a global fit, exhibit smaller uncertainty at small x, and differ significantly to their fixed-order counterparts in this region. Small-x resummation will be a fundamental ingredient for precision at HL-LHC, and even more substantial in the HE phase, which will depend more crucially on PDFs at small x.

Primary author(s) : BONVINI, Marco (Sapienza University of Rome and INFN, Rome 1 Unit); NNPDF

Status: SUBMITTED

Submitted by **BONVINI, Marco** on **Wednesday 26 July 2017**

Abstract ID : **7**

Top-quark mass from diphton mass spectrum

Content

We study $gg \to \gamma\gamma$ amplitudes by including $t\bar{t}$ bound-state effects near their mass threshold. In terms of the non-relativistic expansion of the amplitude, the LO contribution is an energy-independent term in the one-loop amplitude, and a part of the NLO contribution is described by the non-relativistic Green function. We find that due to the interference of these terms, the diphoton mass spectrum shows a characteristic dip-and-bump shape near the threshold. In addition, the position of the dip and the bump is determined by the 1S mass of the $t\bar{t}$ resonance which is well predicted in terms of the short-distance mass of top-quark in NRQCD. Thanks to the simple and clean nature in its experimental measurement, it can give a superior method to determine the top-quark short-distance mass at hadron colliders.

Primary author(s) : YOKOYA, Hiroshi (KIAS, QUC)

Status: SUBMITTED

Submitted by **YOKOYA, Hiroshi** on **Tuesday 08 August 2017**

Abstract ID : **8**

Left-Right Symmetry and Lepton Number Violation at the HL-LHC and LHeC

Content

We explore the complementarity between the proposed Large Hadron electron Collider (LHeC), HL-LHC, and neutrinoless double beta decay in the search for right-handed neutrinos in the context of the Left-Right symmetry.

Primary author(s) : Dr. QUEIROZ, FARINALDO (Max Planck Institute for Nuclear Physics - Heidelberg)

Co-author(s) : Dr. RODEJOHANN, Werner (MPIK, Heidelberg); LINDNER, Manfred (Max Planck Institut fuer Kernphysik, Heidelberg, Germany); YAGUNA, carlos (MPIK, Heidelberg)

Status: SUBMITTED

Submitted by **Dr. QUEIROZ, FARINALDO** on **Wednesday 09 August 2017**

Abstract ID : **9**

WG3: Beyond WIMP freeze-out - dark matter and exotic signatures at the LHC

Content

Despite impressive efforts to search for weakly interacting massive particles (WIMPs) in (in)direct detection experiments and at the LHC no conclusive hint has been found and the nature of dark matter (DM) remains one of the most pressing questions in particle physics. It is therefore of utmost interest to investigate mechanisms for the generation of DM in the early Universe that go beyond the widely studied paradigm of thermal WIMP freeze-out, and that can point towards non-standard signatures. In this talk we present new ideas of DM generation and discuss their search strategies for the upcoming LHC runs and upgrades. In particular, we detail the mechanism of conversion-driven freeze-out that predicts long-lived particles providing a wide range of exotic signatures at the LHC.

Primary author(s) : HEISIG, Jan (RWTH Aachen University)

Status: SUBMITTED

Submitted by **HEISIG, Jan** on **Thursday 10 August 2017**

Abstract ID : **10**

WG3:Particle correlations at HL-LHC: probing new phenomena

Content

During decades, the study of inclusive correlations among final-state particles in multiparticle production has provided essential information about soft dynamics of the strong interaction in cosmic rays, fixed target and collider experiments. Here we employ old and renewed techniques [arXiv:1510.08738, 1510.08738, 1706.05231] to explore new phenomena (e.g. ridge effect) and possible new physics (e.g. hidden sectors) beyond the Standard Model in high-energy proton-proton and heavy ion collisions with special emphasis on the current and future high-luminosity and high-energy LHC.

Primary author(s) : Prof. SANCHIS-LOZANO, Miguel-Angel (IFIC-University of Valencia); Prof. SARKISYAN-GRINBAUM, Edward (CERN & University of Texas at Arlington)

Status: SUBMITTED

Submitted by **SANCHIS LOZANO, Miguel** on **Tuesday 05 September 2017**

Abstract ID : **11**

WG3: Dissecting Multi Photon resonances at the Large Hadron Collider

Content

We examine the phenomenology of the production, at the 13 TeV Large Hadron
Collider (LHC), of a heavy resonance X, which decays via other new on-shell particles n into multi- (i.e.\ three or more) photon final states. In the limit that n has a much smaller mass than X, the multi-photon final state may dominantly appear as a two photon final state because the γs from the n decay are highly collinear and remain unresolved. We discuss how to discriminate this scenario from $X \to \gamma\gamma$: rather than discarding non-isolated photons, it is better instead to relax the isolation criterion and instead form photon jet substructure variables. The spins of X and n leave their imprint upon the distribution of pseudorapidity gap $\Delta\eta$ between the apparent two photon states. Depending on the total integrated luminosity, this can be used in many cases to claim discrimination between the possible spin choices of X and n, although the case where X and n are both scalar particles
cannot be discriminated from the direct $X \to \gamma\gamma$ decay in this manner. Information on the mass of n can be gained by considering the mass of each photon jet.

Primary author(s) : Dr. IYER, Abhishek (INFN Sezione di Napoli)

Co-author(s) : Prof. ALLANACH, Benjamin (University of Cambridge (GB)); BHATIA, Disha (TIFR)

Status: SUBMITTED

Submitted by **IYER, Abhishek** on **Thursday 07 September 2017**

Abstract ID : **30**

Precision searches for physics beyond the Standard Model using dijets at HL-LHC

Content

Searches for di-jet (b-jets) resonances in pp collision events with identified leptons offer a potentially promising way to find a new physics beyond the Standard Model (SM) at HL-LHC. While searches in inclusive dijets are dominated by significant QCD multi-jet background, an additional requirement of an associated lepton increases sensitivity to a new physics in the electroweak sector. We illustrate the potential of HL-LHC data for high-precision searches in dijet invariant masses in semi-inclusive final states, including b-jets. We demonstrate the precision with which such searches can be performed using an integrated luminosity of 3 ab−1, and calculate the exclusion limits for new models predicting dijet (and b-jet) resonances accompanied by a lepton. The studies were performed using Monte Carlo event generators.

Primary author(s) : CHEKANOV, Sergei (Argonne National Laboratory (US)); CHILDERS, Taylor (Argonne National Laboratory (US)); FRIZZELL, Dylan (University of Oklahoma (US)); PROUDFOOT, James (Argonne National Laboratory (US)); WANG, Rui (Argonne National Laboratory (US))

Comments:

Can be presented in person at the BSM working session

Status: SUBMITTED

Submitted by **CHEKANOV, Sergei** on **Wednesday 27 September 2017**

Abstract ID : **31**

WG3: Disentangling top partners properties at present and future hadron colliders

Content

The existence of coloured states with spin one-half, i.e. extra-quarks, is a striking prediction of various classes of New Physics models. Should one of these states be discovered during the 13 TeV or future higher-energy runs of the LHC, understanding its properties will be crucial in order to shed light on the underlying model structure. Depending on the extra-quarks quantum number under SU(2)L, their coupling to Standard Model quarks and bosons have either a dominant left- or right-handed chiral component. By exploiting the polarisation properties of the top quarks arising from the decay of pair-produced extra quarks with charge 2/3 and 5/3, we show how it is possible to discriminate among the two hypothesis in the whole discovery range currently accessible at the LHC, thus effectively narrowing down the possible interpretations of a discovered top partner or exotic 5/3 state in terms of New Physics scenario. Moreover, we estimate the discovery and discrimination power of high energy prototype hadron colliders with centre of mass energies of 33 and 100 TeV.

Primary author(s) : Dr. BARDUCCI, Daniele (SISSA); Dr. PANIZZI, Luca (Universita' di Genova & INFN (Italy))

Status: SUBMITTED

Submitted by **Dr. BARDUCCI, Daniele** on **Thursday 28 September 2017**

Abstract ID : **32**

WG2: An alternative approach to Higgs self-coupling determination at the LHC

Content

We study one-loop effects induced by an anomalous Higgs trilinear coupling on total and differential rates of single Higgs production and decays at the LHC. We provide a public code to calculate these effects, and study the sensitivity of HL-LHC to determine the trilinear coupling via inclusive and differential measurements.

Primary author(s) : ZHAO, Xiaoran

Status: SUBMITTED

Submitted by **ZHAO, Xiaoran** on **Monday 09 October 2017**

Abstract ID : **33**

”Poster: Adding timing to the VELO”

Content

The LHCb experiment is designed to perform high precision measurements of matter-antimatter asymmetries and searches for rare and forbidden decays, with the aim of discovering new and unexpected particles and forces. In 2030 the LHC beam intensity will increase by a factor of 50 compared to current operations. This means increased samples of the particles we need to study, but it also presents experimental challenges. In particular, with current technology it becomes impossible to differentiate the many (>50) separate proton-proton collisions which occur for each bunch crossing. A Monte Carlo simulation was developed to model the operation of a silicon pixel vertex detector surrounding the collision region at LHCb, under the conditions expected after 2030, after the second upgrade of the Vertex Locator(VELO).The main goal was studying the effect of adding ‘4D’ detectors which save high-precision timing information, in addition to the usual three spatial coordinates, as charged particles pass through them. With the additional information on the particle timing, it is possible to separately reconstruct the individual 50+ collisions, allowing the next generation of high-precision measurements to be made at the LHCb.

Primary author(s) : Ms. MITRESKA, Biljana (Ss. Cyril and Methodius University); Mr. WILLIAMS, Mark (University of Manchester)

Status: SUBMITTED

Submitted by **MITRESKA, Biljana** on **Tuesday 10 October 2017**

Abstract ID : **34**

WG3: Fermion dark matter at the HL-LHC

Content

New fermions with renormalizable couplings to the Higgs boson are good candidates for thermal dark matter at the weak scale. While sharing many features of supersymmetric electroweakinos, the possibility of large Higgs couplings leads to a wider phenomenology. At the LHC, fermion dark matter can manifest itself in two ways: as missing energy in resonant production via weak interactions, and through virtual corrections in Higgs couplings. In this talk, I discuss the complementarity of both signatures. The high luminosity phase of the LHC is needed to discover such a thermal relic.

Primary author(s) : WESTHOFF, Susanne (Heidelberg University); FREITAS, Ayres (University of Pittsburgh); ZUPAN, Jure (University of Cincinnati); VOIGT, Alexander (DESY Hamburg)

Status: SUBMITTED

Submitted by **WESTHOFF, Susanne** on **Wednesday 11 October 2017**

Abstract ID : **35**

WG1: Large corrections in ttW and four-top hadroproduction from supposedly subleading NLO contributions

Content

We present the calculation of the complete-NLO predictions for $t\bar{t}W$ and four-top production in proton-proton collisions. All the non-vanishing contributions of order $\alpha_s^i\alpha^j$ with $i+j=3,4$ for $t\bar{t}W$ and $i+j=4,5$ for four-top production are evaluated without any approximation.

For $t\bar{t}W$ we find that, due to the presence of $tW \to tW$ scattering, the contribution of order $\alpha_s\alpha^3$ is larger than the so-called NLO EW corrections (the terms of order $\alpha_s^2\alpha^2$) and has opposite sign.

In the case of four-top production, large contributions from electroweak $tt \to tt$ scattering are already present at LO, in the terms of order $\alpha_s^3\alpha$ and $\alpha_s^2\alpha^2$. For the same reason, we find that both NLO terms of order $\alpha_s^4\alpha$, the so-called NLO EW corrections, and order $\alpha_s^3\alpha^2$ are large and their relative contributions strongly depend on the value of the renormalization scale. However, large cancellations are present (at the inclusive level) between these two contributions. On the other hand, NLO corrections to four-top production strongly depend on kinematics and even the relative contribution from terms of order $\alpha_s^2\alpha^3$ amounts to tens of percents close to threshold.

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Status: SUBMITTED

Submitted by **PAGANI, Davide** on **Thursday 12 October 2017**