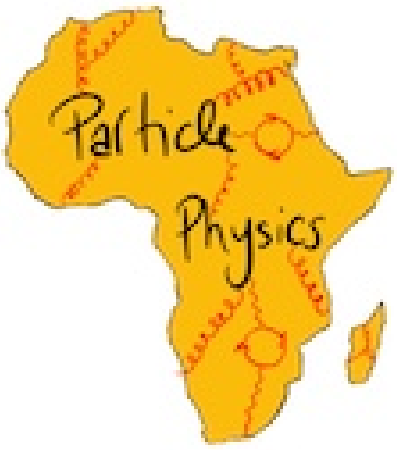
ASFAP Particle Physics Day - PhD and postdocs day

Friday 27 May 2022 - Friday 27 May 2022

Online



Book of Abstracts

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Searches for top-antitop quark resonances at √s = 13 TeV with the ATLAS detector

Authors: Badr-eddine Ngair [1]; Farida Fassi[1]

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A search for resonances produced in 13 TeV proton-proton collisions and decaying into top-quark pairs is described. In this talk events where the top-quark decay produces a single isolated charged lepton, missing transverse momentum and jet activity compatible with a hadronic top-quark decay recorded with the ATLAS detector at the Large Hadron Collider are considered. We investigate the observed invariant mass spectrum in a model- independent approach to seek for any significant deviation from the Standard Model (SM) background expectation. Matrix Method was used to estimate the QCD multi-jet background, which has large statistical and systematic uncertainties when modelled using Monte Carlo techniques. To quantify sensitivity results are interpreted in terms of specific benchmark models such as Z′ bosons, Kaluza–Kein gluons and Kaluza–Klein gravitons that decay into top-quark pairs. Within the scope of the uncertainties, the results are in line with the expectations according to SM. A synopsis of the results followed by an explanation of key findings will be presented.

2

Sensitivity to longitudinal vector boson scattering in same sign WW events at a 100 TeV proton-proton collider

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The Vector Boson Scattering (VBS) process of massive vector bosons is predicted by the Standard Model (SM) as being sensitive to ElectroWeak Symmetry Breaking (EWSB). Prior to EWSB, all vector bosons are massless and have transverse polarization states. However, after EWSB, W and Z bosons become massive and gain an extra polarization state - the longitudinal polarization, whereas photons and gluons remain massless. In the absence of the SM Higgs boson, cross-sections of the scattering of longitudinal components would keep increasing as a function of center of mass energy. These deviations from the SM behavior are predicted in physics models beyond the SM via the presence of additional new resonances or modifications of the Higgs boson couplings to vector bosons. VBS is sensitive to interactions between the longitudinal components of massive vector bosons, hence making it a good platform for the study of EWSB. There have been various studies of prospects for the cross-section measurement of longitudinally polarised vector bosons at the high luminosity Large Hadron Collider (LHC) and also at a future high-energy muon collider.
This talk will present a study on the sensitivity to longitudinal VBS at a future 100 TeV pp collider in the same sign WW VBS process.

3

Jet energy scale and resolution in the High-Granularity Timing Detector in ATLAS upgrades at HL-LHC

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The large increase of pileup is one of the main experimental challenges for the High Luminosity-Large Hadron Collider (HL-LHC) physics program. HL-LHC is expected to start in 2027 and to provide an integrated luminosity of 3000fb-1 in ten years, a factor 10 more than what will be collected by 2023. A powerful new way to address this challenge is to exploit the time spread of the interactions to distinguish between collisions occurring very close in space but well separated in time. A High-Granularity Timing Detector (HGTD), based on low gain avalanche detector technology, is proposed for the ATLAS Phase-II upgrade. Covering the pseudo-rapidity region between 2.4 and 4.0, with a timing resolution of 30 ps for minimum-ionizing particles. The impact of HGTD in reducing pileup track contamination in the jets reconstruction in the forward region is investigated. The improvement of the jet energy scale and resolution in the forward region by reducing the pileup track contamination in hard scatter jets from nearby pileup interactions is presented. The performance is evaluated in terms of jet energy response and resolution as a function of pseudo-rapidity η, transverse momentum pT.

4

New charged Higgs boson discovery channel at the LHC

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The ATLAS and CMS experiments have an ambitious search program for charged Higgs bosons. The two main searches for $H^{\pm}$ at the LHC have traditionally been performed in the $\tau\nu$ and tb decay channels, as they provide the opportunity to probe complementary regions of the Minimal SuperSymmetric Model (MSSM) parameter space. Charged Higgs bosons may decay also to light quarks, $H^{\pm} \to cs/cb$, which represent an additional probe for the mass range below m_t. In this work, we focus on $H^{\pm} \to \mu\nu$ as an alternative channel in the context of two Higgs doublet model type III. We explored the prospect of looking $pp \to tbH^{\pm}$, followed by $H^{\pm} \to \mu\nu$ signal at the LHC. Such a scenario appears in 2HDM type-III where couplings of the charged Higgs are enhanced to $\mu\nu$. Almost all the experimental searches rely on the production and decay of the charged Higgs are taken into account. We show that for a such scenario, the above signal is dominant for most of the parameter space, and $H^{\pm} \to \mu\nu$ can be an excellent complementary search.

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Charged Higgs boson at the LHC in the 2HDM

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In this talk, we discuss the charged Higgs boson searches at the Large Hadron Collider (LHC) in the Two-Higgs Doublet Model (2HDM). After considering all available experimental and theoretical constraints, we review the possible processes that would enable the detection of such a particle with a mass below the top quark mass. We find the signature arising from a charged Higgs boson decaying into a lighter neutral Higgs boson and a W boson could be a promising experimental avenue that would greatly complement the existing LHC search programme for charged Higgs boson.

6

Laser-assisted processes in standard model and beyond

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In this work, we have theoretically studied the neutral Higgs pair production in Two Higgs Doublet Model (THDM) in the presence of a circularly polarized laser field. The laser-assisted differential partial cross section is derived in the centre of mass frame at the leading order including Z diagram. The total cross section is computed numerically by integrating the differential cross section over the solid angle dΩ. Two benchmark points are discussed for the THDM parameters. In the first step, we have analyzed the total cross section of e + e − ⟶ h 0 A 0 by considering H 0 as the standard model-like Higgs boson. Then, the process e + e − ⟶ H 0 A 0 is studied by taking h 0 as the Higgs boson of the standard model. For both benchmark points, the laser-assisted total cross section of the studied processes depends on the produced neutral Higgs masses, the centre of mass energy and the laser field parameters. In addition, the maximum cross section occurs at high centre of mass energy for the process e + e − ⟶ H 0 A 0 as compared to that of e + e − ⟶ h 0 A 0 .

7

Search for invisible Higgs bosons produced via vector boson fusion at the LHC using the ATLAS detector

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A variety of astrophysical observations showed direct evidence for the existence of dark matter which accounts for about 85\% of matter in the universe and does not interact with ordinary matter, except through gravity. Despite its abundance, dark matter particles are very elusive and hard to spot and no experiment confirmed their existence.
Many studies are in hunt for these elusive dark matter particles, using different techniques and technologies either via direct detection investigations (i.e: PandaX, Xenon, DarkSide, etc.) or colliders searches like the LHC, which is exploiting the high discovery potential of its detectors like ATLAS and CMS.

In this work the invisible Higgs sector was investigated where Higgs bosons are produced via the vector boson fusion (VBF) process and subsequently decay into invisible particles.
The expectation for the branching fraction of invisible decays from the standard model is $O(0.1)\%$ but several scenarios beyond the standard model allow larger values of $O(10)\%$. The hypothesis

under consideration is that the Higgs boson might decay into a pair of weakly interacting massive particles (WIMPs) which are candidates to explain the existence of dark matter.
The experimental signature in the detector is a pair of energetic jets and large missing energy. The analysis uses data samples of an integrated luminosity of 139 fb^{-1} of proton proton collisions at $\sqrt{s} = 13$ TeV recorded by ATLAS detector at the LHC.
The observed number of events are found to be in agreement with the background expectation from standard model processes. Assuming a 125 GeV Higgs boson with a standard model production cross section, the observed and expected upper limits on the branching fraction of its decay into invisible particles are found to be 0.13 at 95\% confidence level.
Combination of searches for an invisibly decaying Higgs boson
produced via the four main Higgs production modes at the LHC using 2011–2018 data is conducted and discussed.

8

Search for VV resonances with the ATLAS detector

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Many theories beyond the standard model predict new phenomena which decay to pairs of W and Z bosons. This talk summarizes results for these resonances in semileptonic final states in which one boson decays leptonically and the other boson decays hadronically, using full Run 2 data-sets collected with the ATLAS detector at the LHC between 2015 and 2018 at a center of mass energy of $\sqrt{s} = 13$ TeV.

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Welcome

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Search for Higgs boson decays to beyond-the-Standard-Model light bosons in four-lepton final states with the ATLAS detector at the LHC

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Hidden sector or dark sector states appear in many extensions to the Standard Model (SM), to provide particle mediators for dark matter in the universe. A new probe of this hypothetical hidden or dark sector may have become available at the energy frontier opened up by the LHC with the Higgs boson and its distinct couplings to SM particles. A search is conducted for a beyond-the-Standard-Model vector boson using events where a Higgs boson with mass 125 GeV decays to four leptons. This decay is presumed to occur via an intermediate state which contains one or two decaying light exotic bosons, H $\longrightarrow$ ZX/XX $\longrightarrow$ 4l(l = e,μ), where X is a new boson with mass between 1 and 60 GeV. The search uses pp collision data collected with the ATLAS detector at the LHC with an integrated luminosity of 139 fb−1 at the center-of-mass energy of 13 TeV. No significant excess of events above SM background predictions is observed; therefore, upper bounds on the branching ratios BR(H $\longrightarrow$ XX $\longrightarrow$ 4l) are set as a function of the mass of the dark boson at 95% confidence level.