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EFT AND NLO CORRECTIONS TO VBF HIGGS BOSON PRODUCTION

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The Higgs boson signal in 2012 was just the beginning for studying its properties: how strongly it interacts with other particles, to see production and decay modes of the Higgs boson connected with information on its couplings to both gauge bosons and fermions. The various Higgs couplings determine Higgs production cross sections. So, understanding the nature of the Higgs boson is associated with its couplings to fermions and gauge bosons [1]. Such coupling measurements are provided by the vector-boson fusion (VBF) processes [2], where the Higgs boson is produced via quark-scattering mediated by weak gauge boson exchange, pp → Hjj, Fig. 1.

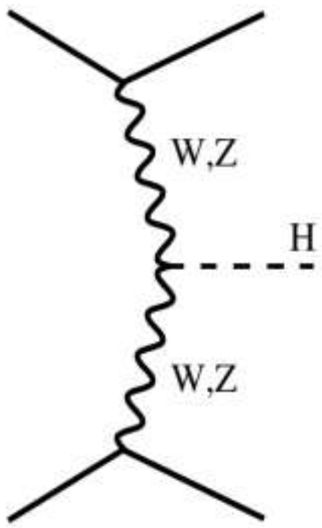

Fig. 1. Illustration of the VBF Hjj process

The efficiently suppressed QCD backgrounds with large cross sections, Next-to-leading order (NLO) QCD corrections to Hjj production with computer program MadGraph5_aMC@NLO [3] are significant advantages for the accuracy of computer modeling of the presented processes.

As part of the search for physics beyond the SM, we carried out modeling of SM, MSSM, and NMSSM processes of the VBF Higgs boson production cross sections with appropriate kinematic restrictions [4], presented in Table 1.

The cuts on the invariant masses of the two tagging jets of M_{jj} > 400, 500, 600 GeV lead to corresponding decreases in the production cross-section, which is the largest for the NMSSM model, and an increase in the proton energy at the LHC leads to an increase in the corresponding cross-sections, Table 2. We carried out process modeling within the framework of QCD parton shower simulations with and without NNPDF30_nnlo_as_0118 pdf function.

Table 1

Parameter restrictions for simulations of Hjj production

minimum pt for the jets	20 GeV
fixed ren scale fixed fact scale for pdf1 fixed fact scale for pdf2	40.21
min invariant mass of a jet pair	400 GeV 500 GeV 600 GeV
minimum pt for at least one heavy final state	20 GeV
minimum pt for at least one jet	20 GeV
minimum pt for the leading jet minimum pt for the second jet minimum pt for the third jet	25 GeV 20 GeV 20 GeV
minimum jet HT=Sum(jet pt)	80 GeV
minimum Ht for the two leading jets	50 GeV
minimum Ht for the three leading jets	80 GeV
$\tan\beta$	4.75
M_{H01}	125.8991

Table 2

Production cross sections for p p → h j j process without pdf function for QCD parton shower

Mmjj $$ w+ w- z	Model	13TeV	14TeV	100TeV
400	SM	1.563 ± 0.007	1.778 ± 0.0062	23.28 ± 0.077
	mssm	1.498 ± 0.0067	1.708 ± 0.0062	22.16 ± 0.074
	nmssm	1.948 ± 0.0088	2.228 ± 0.011	28.96 ± 0.099
500	SM	1.362 ± 0.0054	1.542 ± 0.0092	
	mssm	1.302 ± 0.0066	1.48 ± 0.0098	
	nmssm	1.692 ± 0.0077	1.915 ± 0.011	
600	SM	1.168 ± 0.0061	1.348 ± 0.0082	
	mssm	1.119 ± 0.006	1.293 ± 0.0086	
	nmssm	1.456 ± 0.0073	1.683 ± 0.011	

In the framework of the Higgs effective field theory [5] we considered its link to a few scenarios of physics beyond the SM and received the production cross sections presented in Table 3

Table 3

Production cross sections for p p → h j j process with pdf function within EFT theory

Mmjj	Model	13TeV	14TeV	100TeV
400	SM	1.73 ± 0.0083	1.996 ± 0.01	28.25 ± 0.084
	mssm	1.663 ± 0.0092	1.917 ± 0.0094	26.96 ± 0.083
	nmssm	2.162 ± 0.012	2.489 ± 0.012	35.14 ± 0.12
500	SM	1.498 ± 0.0065	1.996 ± 0.01	
	mssm	1.427 ± 0.0063	1.64 ± 0.011	
	nmssm	1.859 ± 0.0089	2.132 ± 0.01	
600	SM	1.498 ± 0.0065	1.492 ± 0.012	
	mssm	1.225 ± 0.007	1.424 ± 0.0096	
	nmssm	1.593 ± 0.0088	1.853 ± 0.011	

To understand the kinematics of the process, simulations of the distribution by momentum and rapidity were carried out Figs. 2, 3.

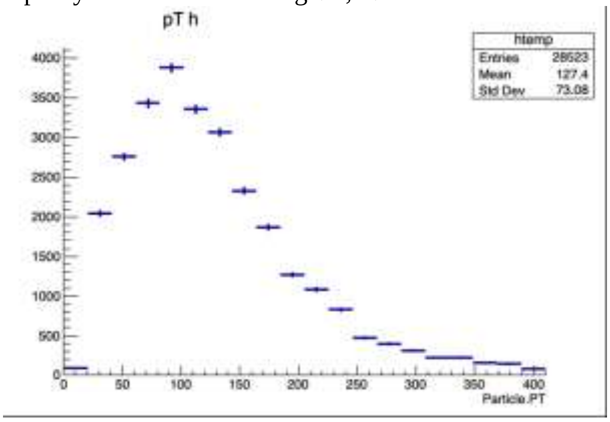

Fig. 2. Transverse momentum distributions for p p → h j j process at 14 TeV

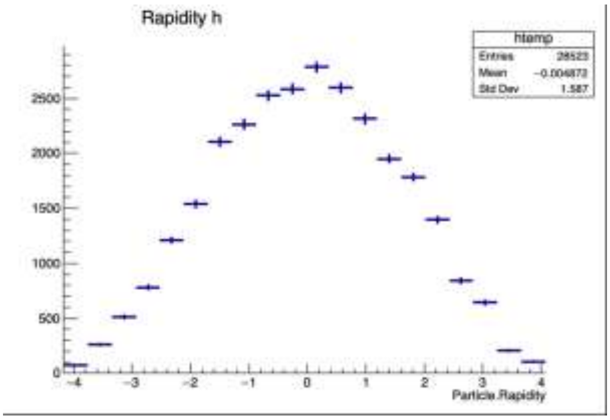

Fig. 3. The distribution for the rapidity for p p →h j j process at 14 TeV

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