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Introduction

The process is the exotic SM Higgs decay into a Z boson plus an Axion Like-Particle (ALP) A via gluon fusion (ggH) and vector boson fusion (VBF) processes. The Z goes to a pair of leptons (electron, muon, tau) and the A in a pair of photons,

$$h \rightarrow Z (\ell\ell) + A(\gamma\gamma)$$

Validation plots

The generation of the events was proceeded with release MCProd,20.7.9.9.19,here

For VBF process, we used the JO found in /afs/cern.ch/user/y/yaamaral/public/JO_VBF

for the following six mass points $m_A = 0.7$ GeV, 1.0 GeV, 2.0 GeV, 4.0 GeV , 6.0 GeV. and 9.0 GeV,

```
source /afs/cern.ch/atlas/software/dist/AtlasSetup/scripts/asetup.sh MCProd,20.7.9.9.19,here
```

```
Generate_tf.py \  
  --evgenJobOpts 'MC15JobOpts-00-13-05_v6.tar.gz' \  
  --ecmEnergy '13000' \  
  --AMITag=e7416 \  
  --jobConfig=MC15.998006.PowhegPy8EG_CT10_AZNLOCTEQ6L1_VBFH125_mA1p0_Cyy0p01_Czh1p0.py \  
  --runNumber=998006 \  
  --firstEvent=1 --maxEvents=10000 --randomSeed=0 \  
  --inputGeneratorFile=/eos/atlas/user/r/rewang/gen/mc15_13TeV.345916.Powheg_NNPDF30_VBFH125_mA1p0_Cyy0p01_Czh1p0.py \  
  --outputEVNTFile=output_998006_0.root
```

For ggH process, we used the JO found in /afs/cern.ch/user/y/yaamaral/public/JO_ggH

for six mass points $m_A = 0.7$ GeV, 1.0 GeV, 2.0 GeV, 4.0 GeV , 6.0 GeV. and 9.0 GeV,

```
Generate_tf.py \  
  --evgenJobOpts=MC15JobOpts-00-10-06_v2.tar.gz \  
  --ecmEnergy=13000 \  
  --AMITag=e6751 \  
  --jobConfig=MC15.999006.PowhegPy8EG_CT10_AZNLOCTEQ6L1_ggH125_mA0p7_Cyy0p01_Czh1p0.py \  
  --runNumber=999006 \  
  --firstEvent=1 --maxEvents=10000 --randomSeed=1 \  
  --outputEVNTFile=output_999006_0.root
```

The TRUTH1 derivation was done with

```
asetup 21.2,AthDerivation,latest,here
```

for VBF:

```
Reco_tf.py --inputEVNTFile=/afs/cern.ch/user/y/yaamaral/work/public/valida998006/output_999006_0.root
```

for ggH:

```
Reco_tf.py --inputEVNTFile=/afs/cern.ch/user/y/yaamaral/work/public/valida998006/output_999006_0.root
```

The validation plots were presented in the HBSM Meeting (06 August 2019) talk [here](#).

The VBF spreadsheets for campaigns MC16a: [HDBS MC Request Spreadsheet_hZa_VBF_period_a](#), MC16d: [HDBS MC Request Spreadsheet_hZa_VBF_period_d](#), and MC16e: [HDBS MC Request Spreadsheet_hZa_VBF_period_e](#).

The ggH spreadsheets for campaigns MC16a: [HDBS MC Request Spreadsheet_hZa_ggH_period_a](#), MC16d: [HDBS MC Request Spreadsheet_hZa_ggH_period_d](#), and MC16e: [HDBS MC Request Spreadsheet_hZa_ggH_period_e](#).

-- YaraCoutinho - 2019-08-16

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