Feasibility Study of Measuring the Higgs Self-coupling Using the Muon Collider

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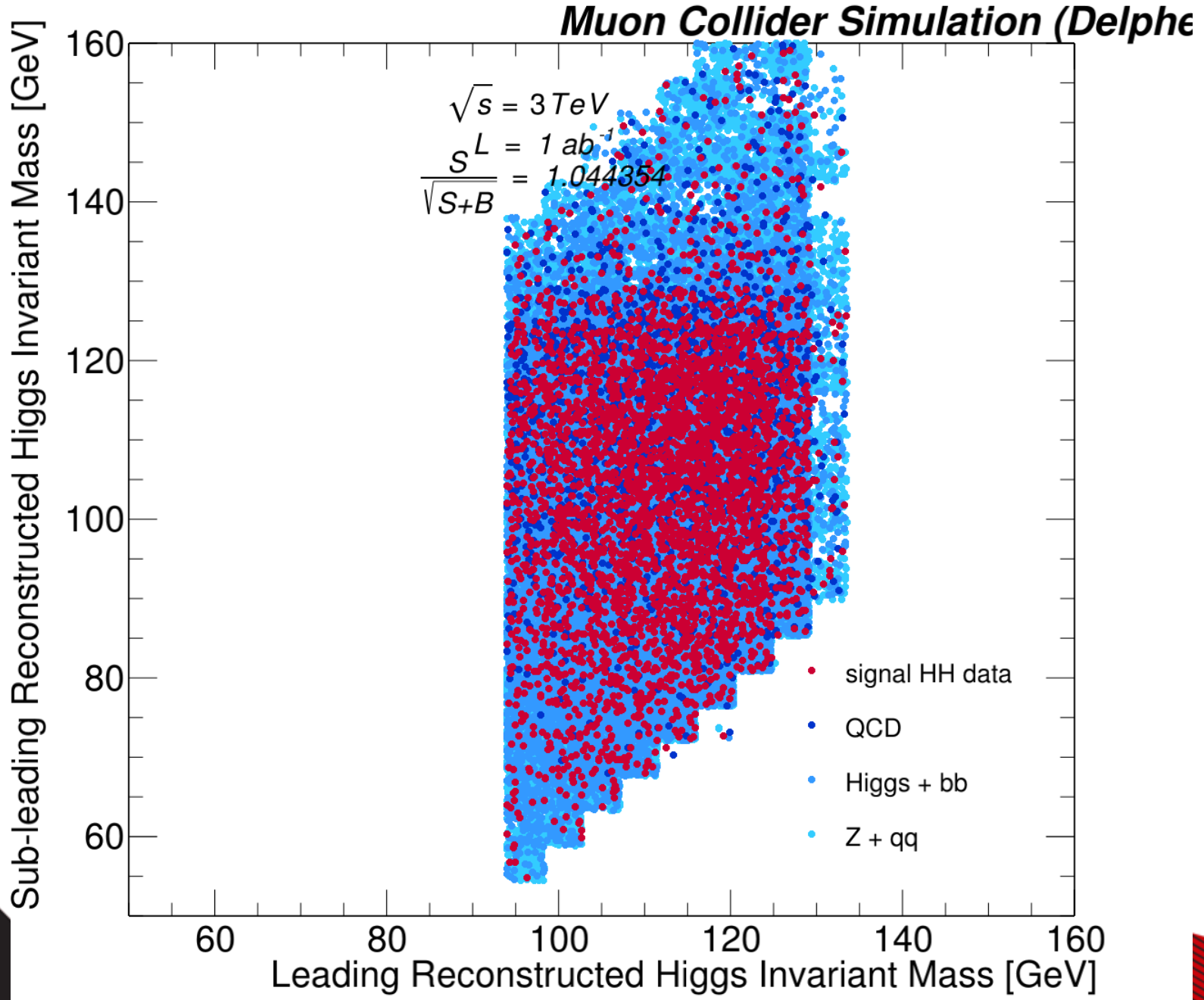
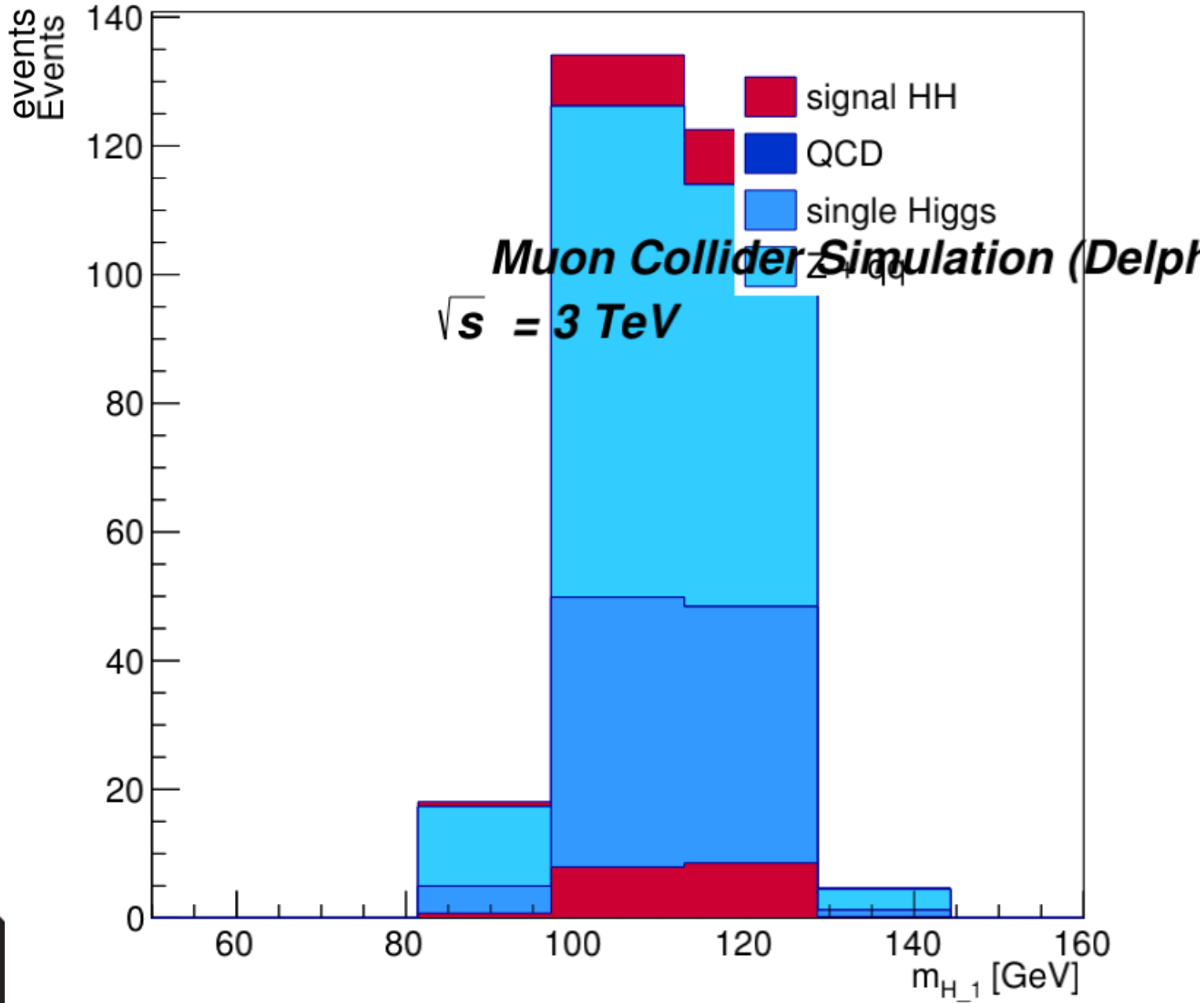
3TeV

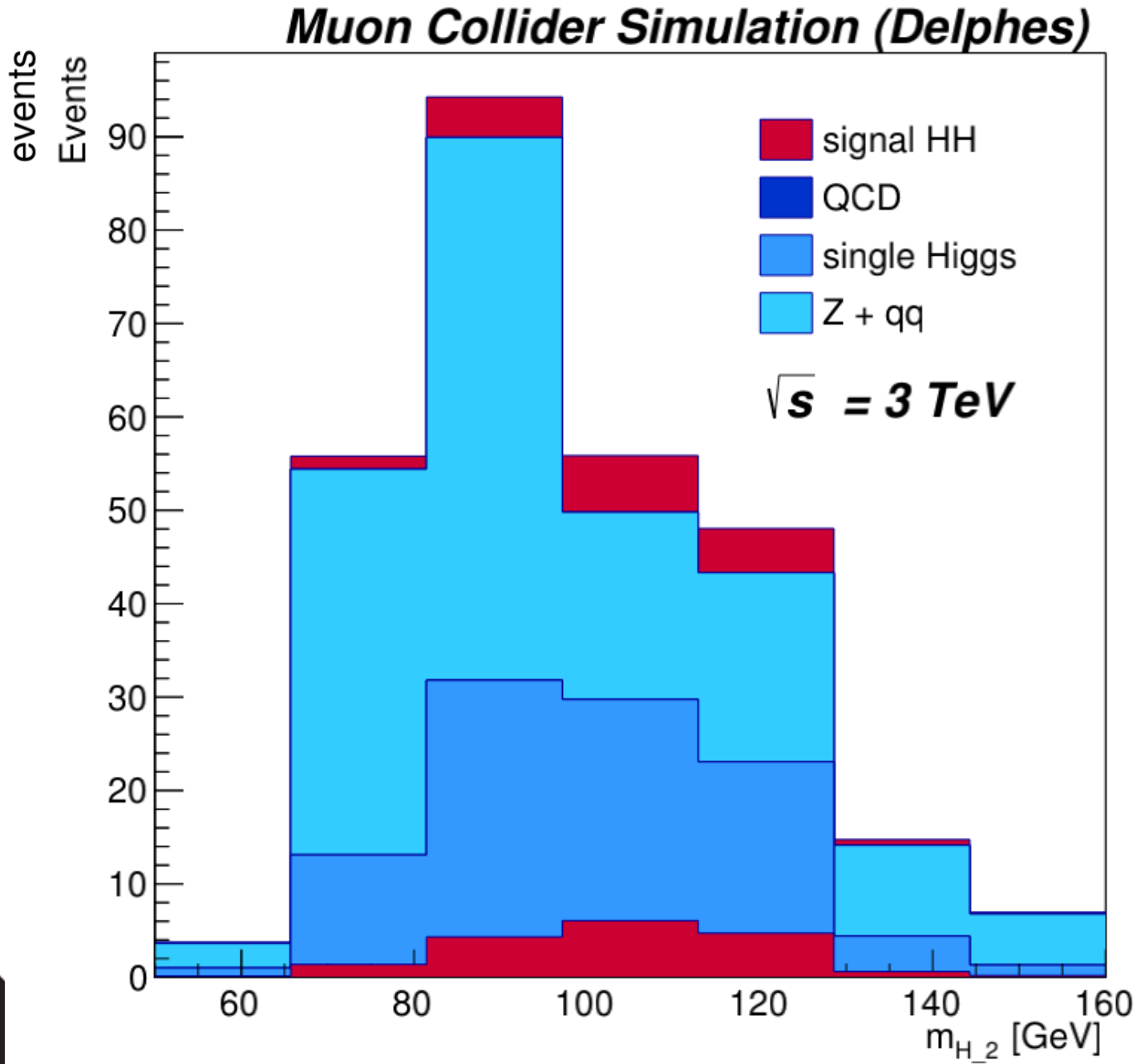
- Signal: $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + H + H$ (0.0008182 pb)
- Background:
  - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + \boldsymbol{q} + \overline{\boldsymbol{q}} + Z$ (0.05685 pb)
  - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + H$ (0.003771 pb)
  - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + b + \bar{b}$ (0.0009237 pb)

100k for each

Here are original plot without signal enhancement:


Muon Collider Simulation (Delphe
$\sqrt{s} = 3\,TeV$
$L = 1\ ab^{-1}$
$\frac{S}{\sqrt{S+B}} = 1.044354$
signal HH data
QCD
Higgs + bb
Z + qq
Sub-leading Reconstructed Higgs Invariant Mass [GeV]
Leading Reconstructed Higgs Invariant Mass [GeV]
60
80
100
120
140
160


events
Events
140
120
100
80
60
40
20
0
60
80
100
120
140
160
m_{H_1} [GeV]
signal HH
QCD
single Higgs
Muon Collider Simulation (Delph
$\sqrt{s}$ = 3 TeV


Muon Collider Simulation (Delphes)
events
Events
90
80
70
60
50
40
30
20
10
0
60
80
100
120
140
160
m_{H_2} [GeV]
signal HH
QCD
single Higgs
Z + qq
$\sqrt{s}$ = 3 TeV

Fit in (60-160) but the signal is spreading?

10 TeV and 30TeV

- Wrote the script for splitting MadGraph jobs

```
#!/bin/bash

mkdir jobHome
mv madgraph.sh jobHome
WORKDIR='pwd'/jobHome

#Download package and unzip
tar xvf transferInputFiles.tar.gz
cp -r ../Delphes ./
cp -r ../MG5_aMC_v3_3_1 ./
cp ../vvqqz.txt ./
rm -r runMG_job
export mg5dir=$PWD/MG5_aMC_v3_3_1
export Delphesdir=$PWD/Delphes
export workdir=$PWD
export datadir=$workdir/data;
echo "Using ROOTSYS=$ROOTSYS"
echo "Using mg5dir=$mg5dir"
echo "Using Delphesdir=$Delphesdir"
echo "Using workdir=$workdir"
echo "Using datadir=$datadir"
echo "Current directory set to $datadir"
mkdir -p $datadir

#Edit script for each MadGraph job
cd $mg5dir
cp ../vvqqz.txt $mg5dir/vvqqz_${jobHome}.txt
export textdir=$mg5dir/vvqqz_${jobHome}.txt
export random='date + "%S%M%H%S"'
echo "random" > "$textdir"

#Run MadGraph job
source /cvmfs/sft.cern.ch/lcg/views/LCG_101/x86_64-centos7-gcc11-opt/setup.sh
export PYTHIA8DATA=$PWD/HEPTools/pythia8/share/Pythia8/xmldoc/
./bin/mg5_aMC ./vvqqz_${jobHome}.xt
cd ../bkgvvqqz_10TeV/Events/run_01
gunzip tag_1_pythia8_events.hepmc.gz

#Move the result file under jobHome and clean the MadGraph directory
cp tag_1_pythia8_events.hepmc ../../../../tag_1_pythia8_events.hepmc
cd $mg5dir
cd ..
rm -r MG5_aMC_v3_3_1

#Run Delphes simulation for each job result from MadGraph
cd $Delphesdir
pushd /cvmfs/cms.cern.ch/slc7_amd64_gcc820/cms/cmssw/CMSSW_11_1_6; cmsenv;popd
```