Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

von Humboldt Stiftung/Found

gg->HZ in the POWHEG-BOX-V2 with coupling variation

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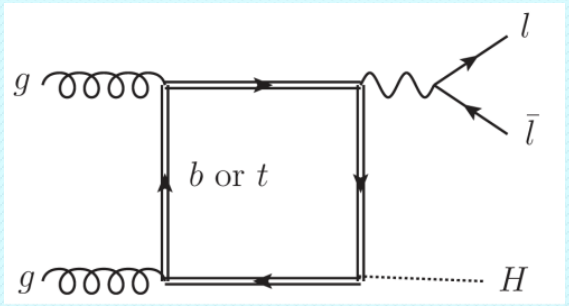
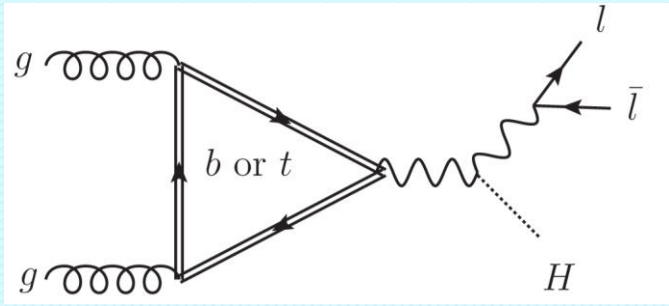
JHEP 1310 (2013) 083, arXiv:1306.2542

gg->HZ with Powheg+GoSam

[Luisoni, Nason, Oleari, Tramontano; **JHEP 1310 (2013) 083**, **arXiv:1306.2542**]

- gg → HZ production:





- square of LO contribution to gg→HZ (via massive b/t loops) with GoSam
  - This is a LO generator, not a NLO one, the POWHEG-BOX does not generate any additional radiation

- possibility to modify the Higgs-top and Higgs-Z coupling by multiplicative factors $\kappa_{\rm Ht}$, $\kappa_{\rm HZ}$ via reweighting of lhe event files:

$$g_{\rm Ht} = \kappa_{\rm Ht} \times g_{\rm Ht}^{SM}$$
$$g_{\rm HZ} = \kappa_{\rm HZ} \times g_{\rm HZ}^{SM}$$

Reweighting of lhe event files

- In a first run the POWHEG-BOX generates lhe files with SM couplings and stores all the information to recompute the kinematics and the integrand ($\tilde{B}(\mathbf{\Phi_n}) = B(\mathbf{\Phi_n}) + V(\mathbf{\Phi_n}) + R(\mathbf{\Phi_n}, \Phi_r)$)

- In subsequent runs the POWHEG-BOX retrives the stored informations and recomputes the $\tilde{\mathrm{B}}$ function with the new settings

- New settings modification may be:
  - factorization and renormalization scales
  - pdfs
  - any parameter as long as this does not affect the generation of the Born phase space

- The same event is stored in a new file with the new weight computed as

$$\text{new weight} = \text{old weight} \times \frac{\text{new integrand}}{\text{old integrand}}$$

  - This procedure can be repeated as many times as desired

Reweighting of lhe event files

- Example:
  - 7-point variation of the pair $(\kappa_{\rm Ht}, \kappa_{\rm HZ})$:

1) $\kappa_{\rm Ht}=1.0$; $\kappa_{\rm HZ}=1.0$
2) $\kappa_{\rm Ht}=1.1$; $\kappa_{\rm HZ}=1.0$
3) $\kappa_{\rm Ht}=0.9$; $\kappa_{\rm HZ}=1.0$
4) $\kappa_{\rm Ht}=1.0$; $\kappa_{\rm HZ}=1.1$
5) $\kappa_{\rm Ht}=1.0$; $\kappa_{\rm HZ}=0.9$
6) $\kappa_{\rm Ht}=1.1$; $\kappa_{\rm HZ}=0.9$
7) $\kappa_{\rm Ht}=0.9$; $\kappa_{\rm HZ}=1.1$

  - After running the reweighting the lhe files have 7 new lines:

```
<event>
      6  10001  6.41360E-04  3.52414E+02 -1.00000E+00  1.02597E-01
     21     -1     0     0   501   502  0.0000E+00  0.0000E+00  2.6808E+02  2.6808E+02  0.0000E+00  0.00000E+00  9.000E+00
     21     -1     0     0   502   501  0.0000E+00  0.0000E+00 -1.1581E+02  1.1581E+02  0.0000E+00  0.00000E+00  9.000E+00
     25      1     1     2     0     0  1.1104E+02  3.0398E+01 -3.9117E+00  1.6997E+02  1.2499E+02  0.00000E+00  9.000E+00
     23      2     1     2     0     0 -1.1104E+02 -3.0398E+01  1.5618E+02  2.1392E+02  9.0088E+01  0.00000E+00  9.000E+00
    -11      1     4     4     0     0 -7.4266E+01 -1.4500E+01  2.9770E+01  8.1314E+01  5.1100E-04  0.00000E+00  9.000E+00
     11      1     4     4     0     0 -3.6777E+01 -1.5898E+01  1.2641E+02  1.3261E+02  5.1099E-04  0.00000E+00  9.000E+00
#rwgt             1             1    9.4492101687935321E-004             1           24           0
#new weight,renfact,facfact,pdf1,pdf2   6.4136000000000000E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   5.7810614301729711E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   7.0817598970347056E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.1841681792954364E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.6472274249281156E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.0027409982560951E-004   1.000000        1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.8403802194849585E-004   1.000000        1.000000        21200       21200  lha
</event>
```

- #rwgt line generated at first run: contains the integrand, the seeds for the random number generator and information on the kinematic region
- #new weight . . . lines are generated in subsequent runs (only a single call to the cross section for each event) --> VERY QUICK!

Reweighting of lhe event files

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     25      1     1     2     0     0  1.1104E+02  3.0398E+01 -3.9117E+00  1.6997E+02  1.2499E+02  0.00000E+00  9.000E+00
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#rwgt             1             1   9.4492101687935321E-004             1            24             0
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#new weight,renfact,facfact,pdf1,pdf2   5.7810614301729711E-004  1.000000       1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   7.0817598970347056E-004  1.000000       1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.1841681792954364E-004  1.000000       1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.6472274249281156E-004  1.000000       1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.0027409982560951E-004  1.000000       1.000000        21200       21200  lha
#new weight,renfact,facfact,pdf1,pdf2   6.8403802194849585E-004  1.000000       1.000000        21200       21200  lha
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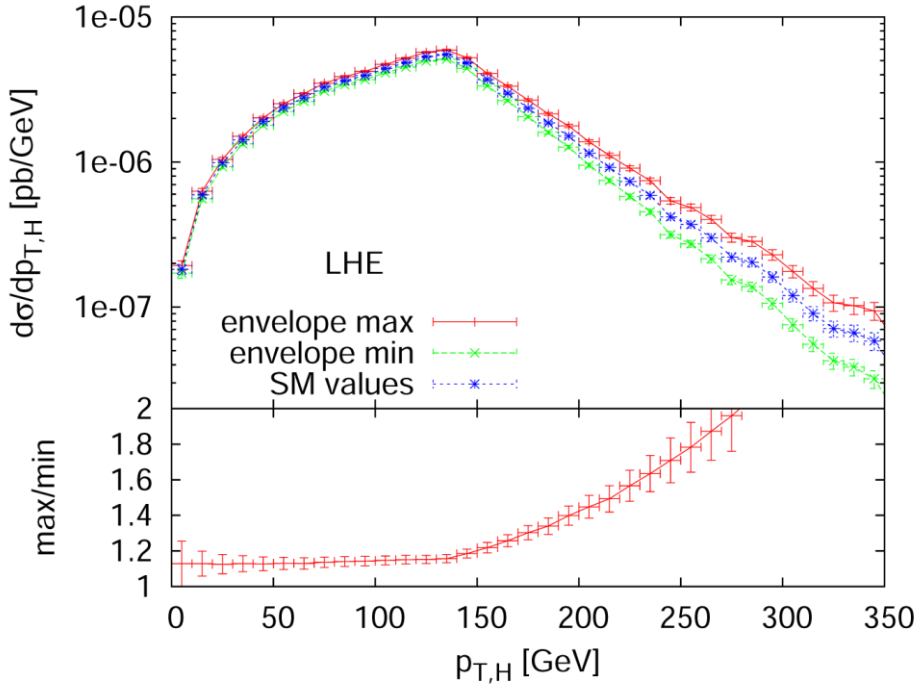
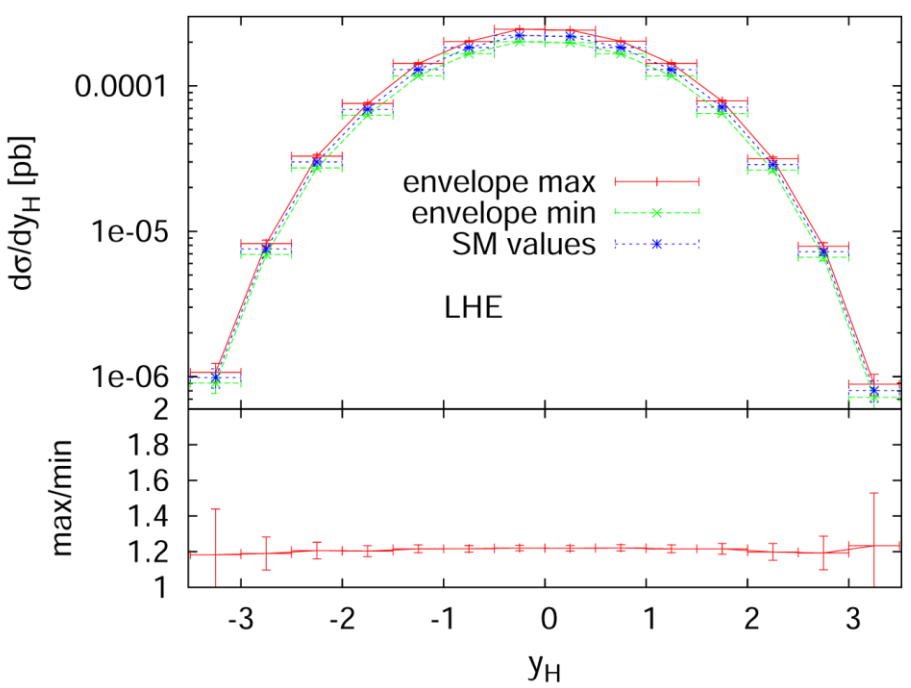
gHt/gHZ – coupling variation

- Results of 7-point variation:
  - SM prediction compared to max & min of the variation-envelope





Conclusions

[Luisoni, Nason, Oleari, Tramontano; **JHEP 1310 (2013) 083, arXiv:1306.2542**]

- gg→HZ production in the POWHEG-BOX-V2
  - Code allows to study easily the effects of variations of Higgs-top and Higgs-Z couplings of SM
  - Fast generation of the new weights of the events using the reweighting tecnique
  - Information on how to run with reweighting in the directory
    POWHEG-BOX-V2/Docs
  - Generators can be downloaded from: [web: http://powhegbox.mib.infn.it/]
    svn://powhegbox.mib.infn.it/trunk/User-Processes-V2/ggHZ
  - Is modification of g_{Hb} needed?
  - Although this is a 1-loop calculation, it is only a LO process.

Jets in the final state come only from the parton shower (Pythia, Herwig, …).