Off-Shell/Interference effects +Heavy Higgs Status and prospects in MadGraph5_aMC@NLO

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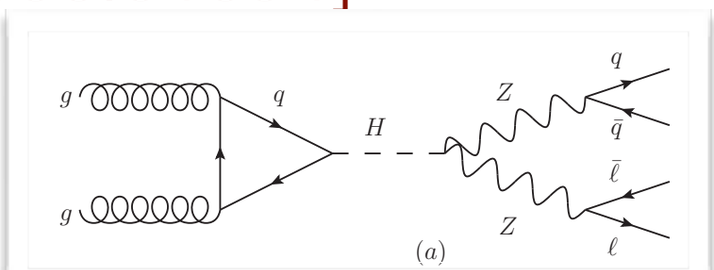
Status of MG5_aMC

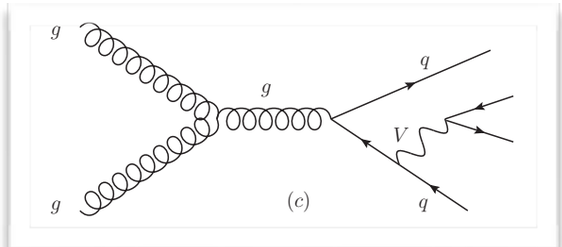
- Loop-Induced processes event generation version now public (in beta):
- https://launchpad.net/mg5amcnlo
- Interference module allows separation of signal, interference and background
- (N)LO+PS or Merged samples for loop induced processes: easy to obtain
- Already available on a process-by-process basis:
  - H+Jets with KT-MLM with loop corrections [Alwall, arXiv:1110.1728]
  - ggF at NLO+PS [Frixione and Wiesemann, https://cp3.irmp.ucl.ac.be/projects/madgraph/wiki/HSushi]
  - HH at NLO+PS (two-loop approx) [Frederix et al. arxiv:1401.7340, Hespel, Lopez-Val, EV arxiv:1407.0281, Maltoni, EV, Zaro, arXiv:1408.6542]
  - gg > HZ in the SM and 2HDM merged 0,1 jet [Hespel, Maltoni, EV, arxiv:1503.01656]

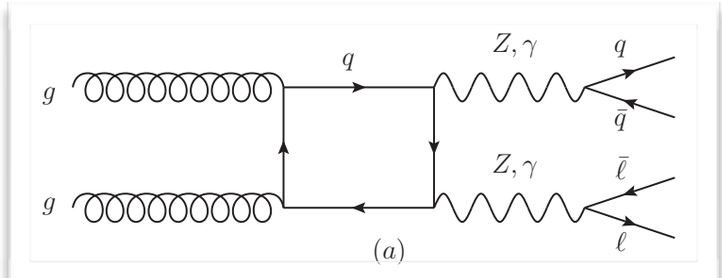
First SM off-shell/Interference study

- Semileptonic decays for gg > ZZ > llqq and gg> WW >lvqq'

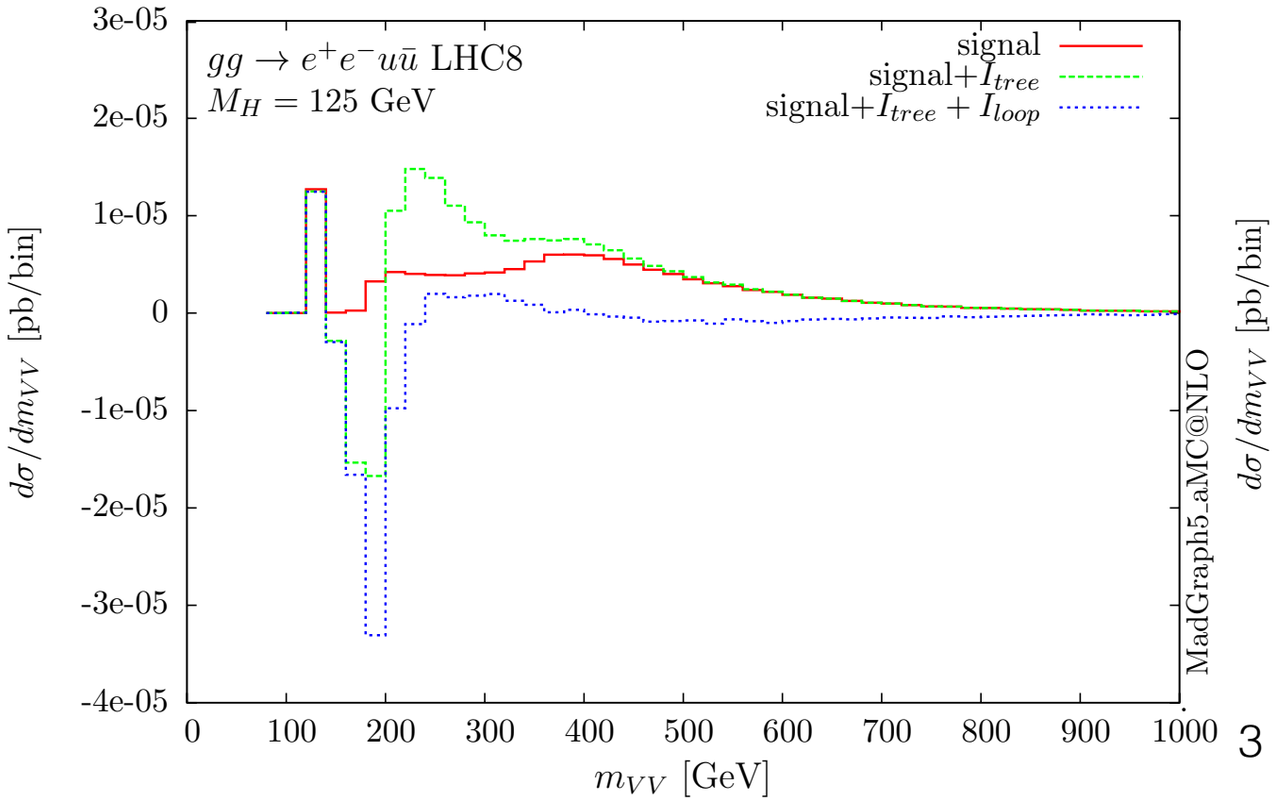
- Signal, Loop and tree-level interference: [Kauer, O' Brien, EV arxiv: 1506.01694]

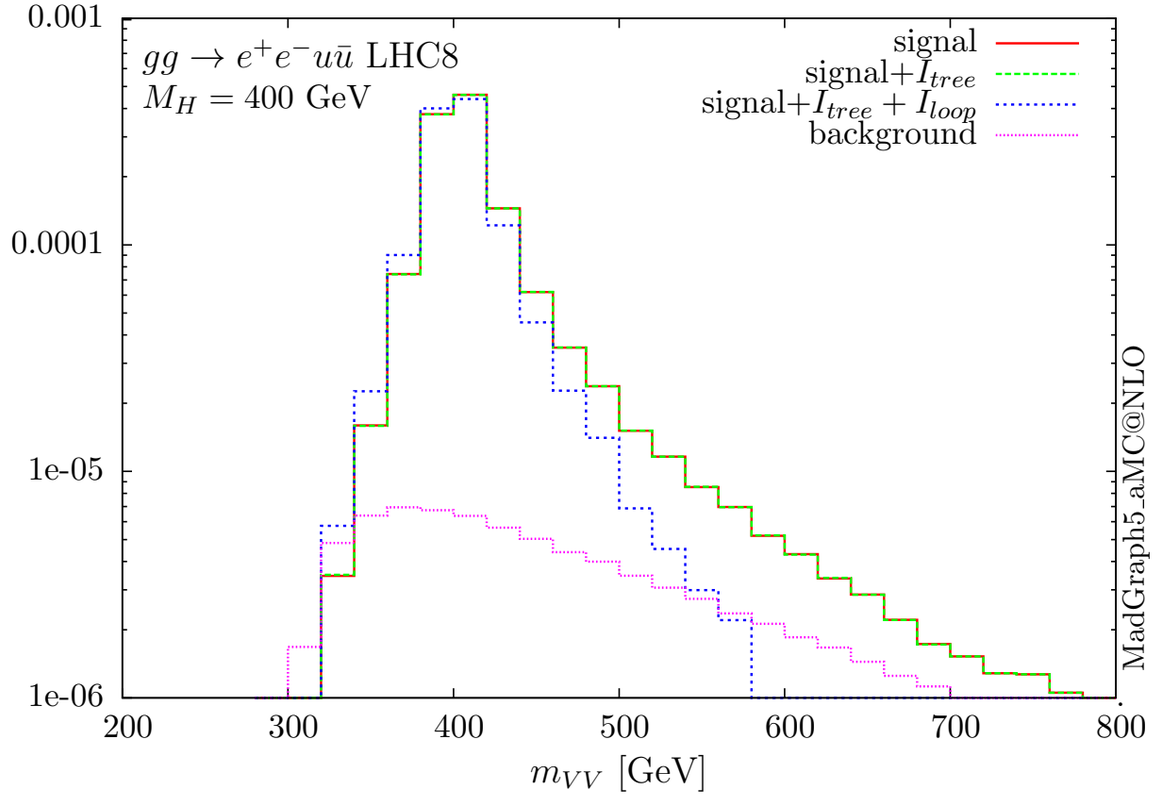




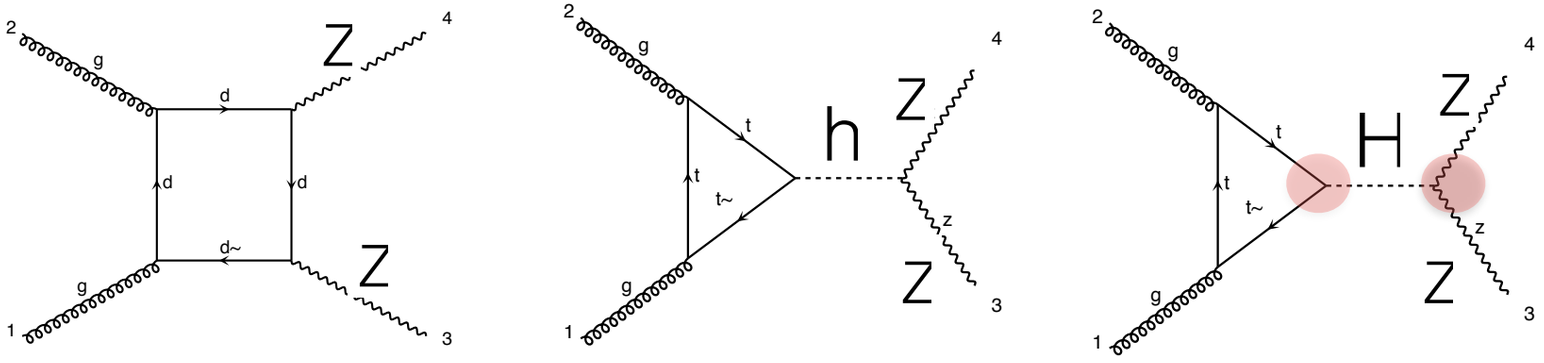


- Comparison with implementation in **gg2VV** for a SM (125GeV) Higgs and a heavy (400GeV) Higgs for different selection cuts





Toy model: Additional heavy scalar



Free parameters

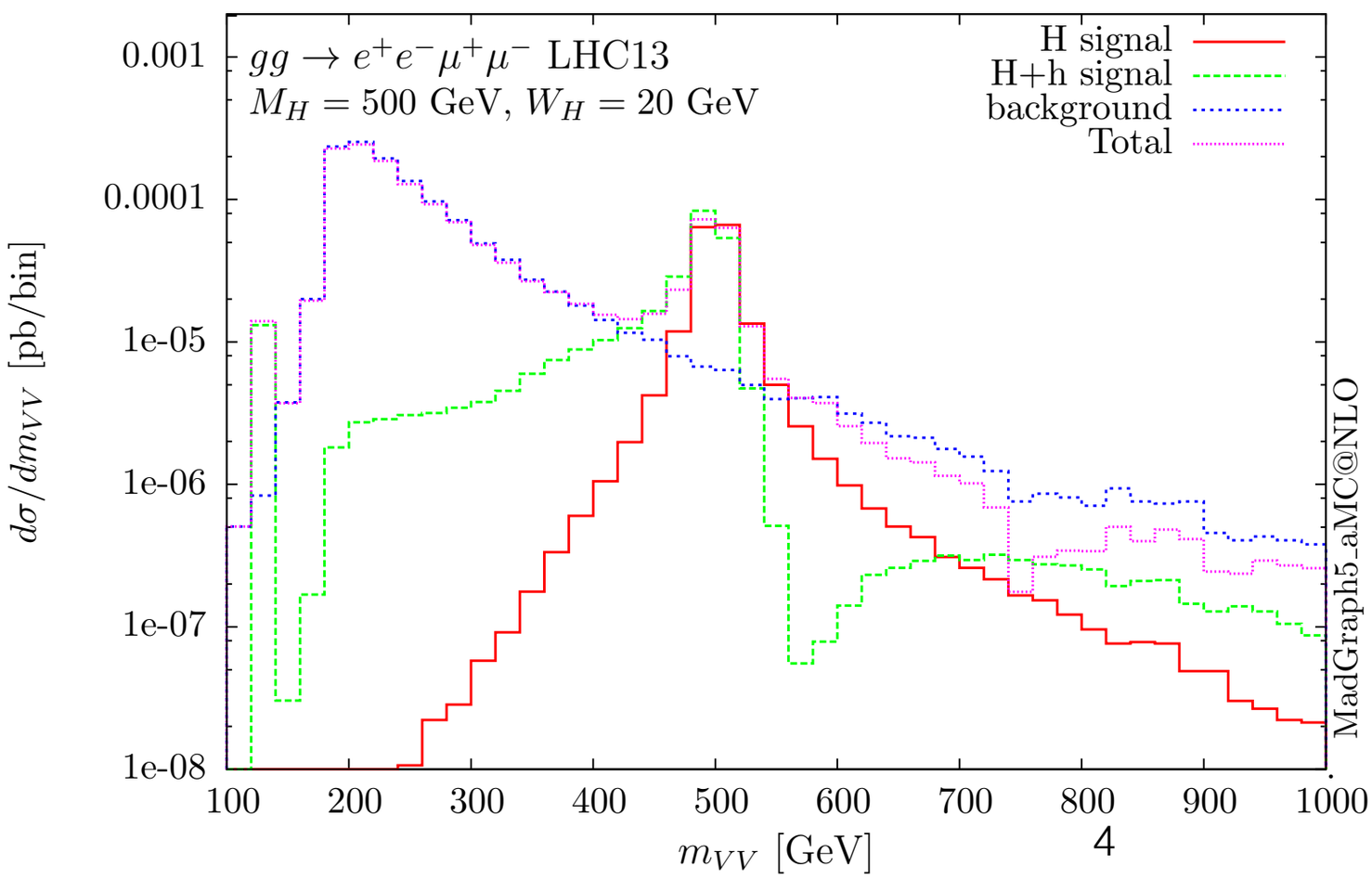
M_H

W_H

$Y_{t,b}$

$g_{w/Z}$

Parameters can be matched to one's favourite model

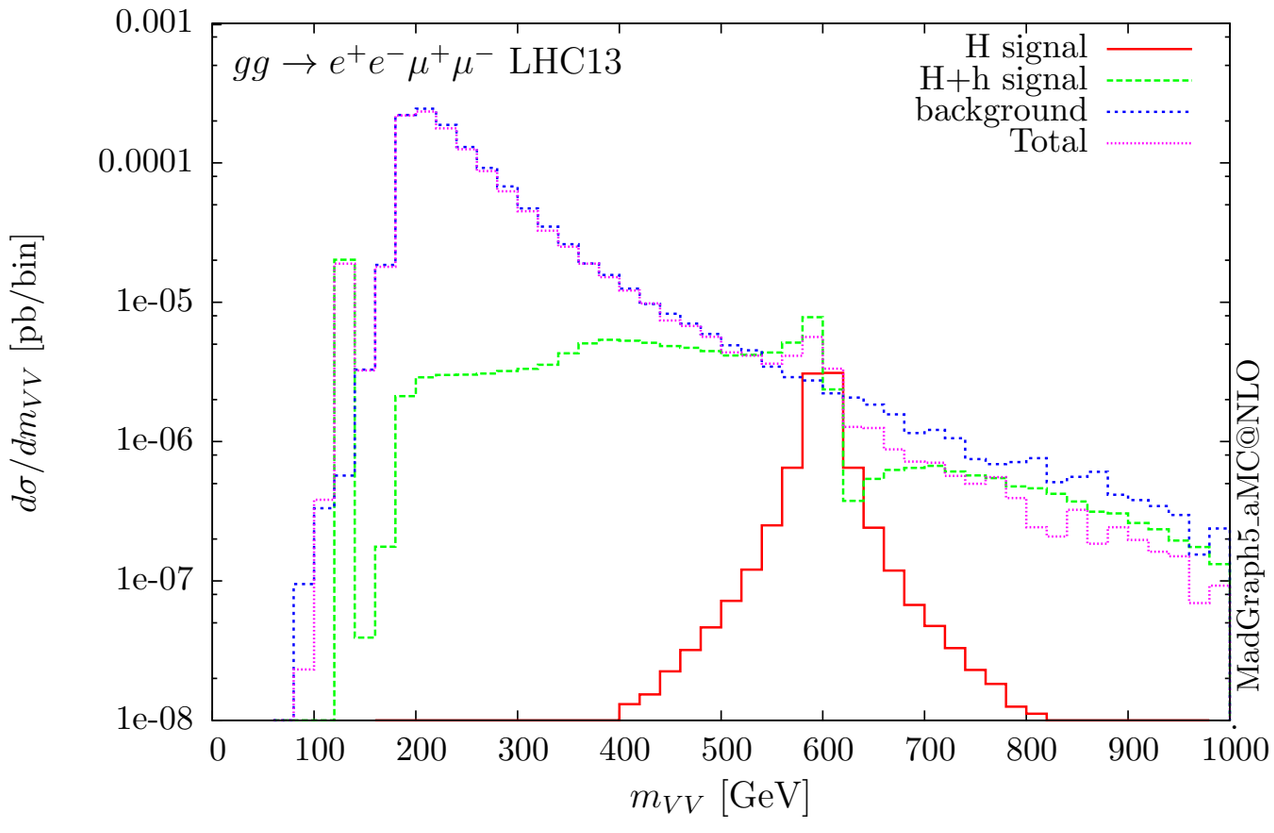


Signal+background
+interference
All loop-induced

Fixed-width propagator

A better defined 2HDM example

- NLO 2HDM model available through NLOCT [Degrande arxiv:1406.3030]
- 2HDM Benchmarks can be imported in MG5_aMC@NLO through parameter cards



2HDM parameters:

	$\tan\beta$	α/π	m_{H^0}	m_{A^0}	$m_{H^\pm}$	m_{12}^2
Z2	0.9	-0.775	600	700	700	120000

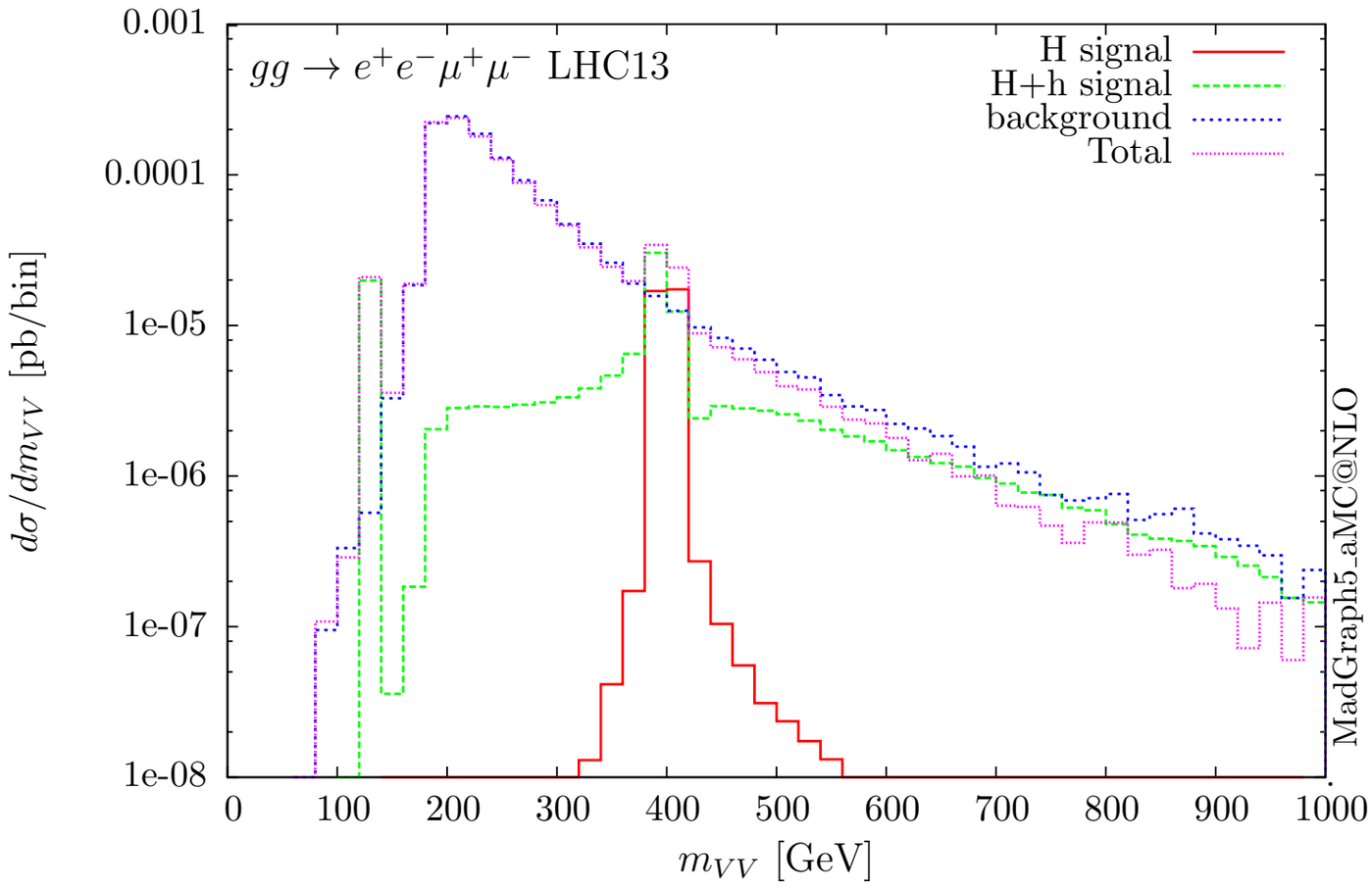
Couplings

	$\hat{g}_{h^0tt}$	$\hat{g}_{h^0bb}$	$\hat{g}_{H^0tt}$	$\hat{g}_{H^0bb}$	$\hat{g}_{ZZh^0}$	$\hat{g}_{ZZH^0}$
Z2	1.07	0.94	-1.05	0.96	0.998	0.063

Non-excluded scenario

Preliminary: Work in progress with B. Hespel

A second 2HDM example



2HDM parameters:

	$\tan\beta$	α/π	m_{H^0}	m_{A^0}	$m_{H^\pm}$	m_{12}^2
Z3	1.3	-0.605	400	400	400	20000

Couplings

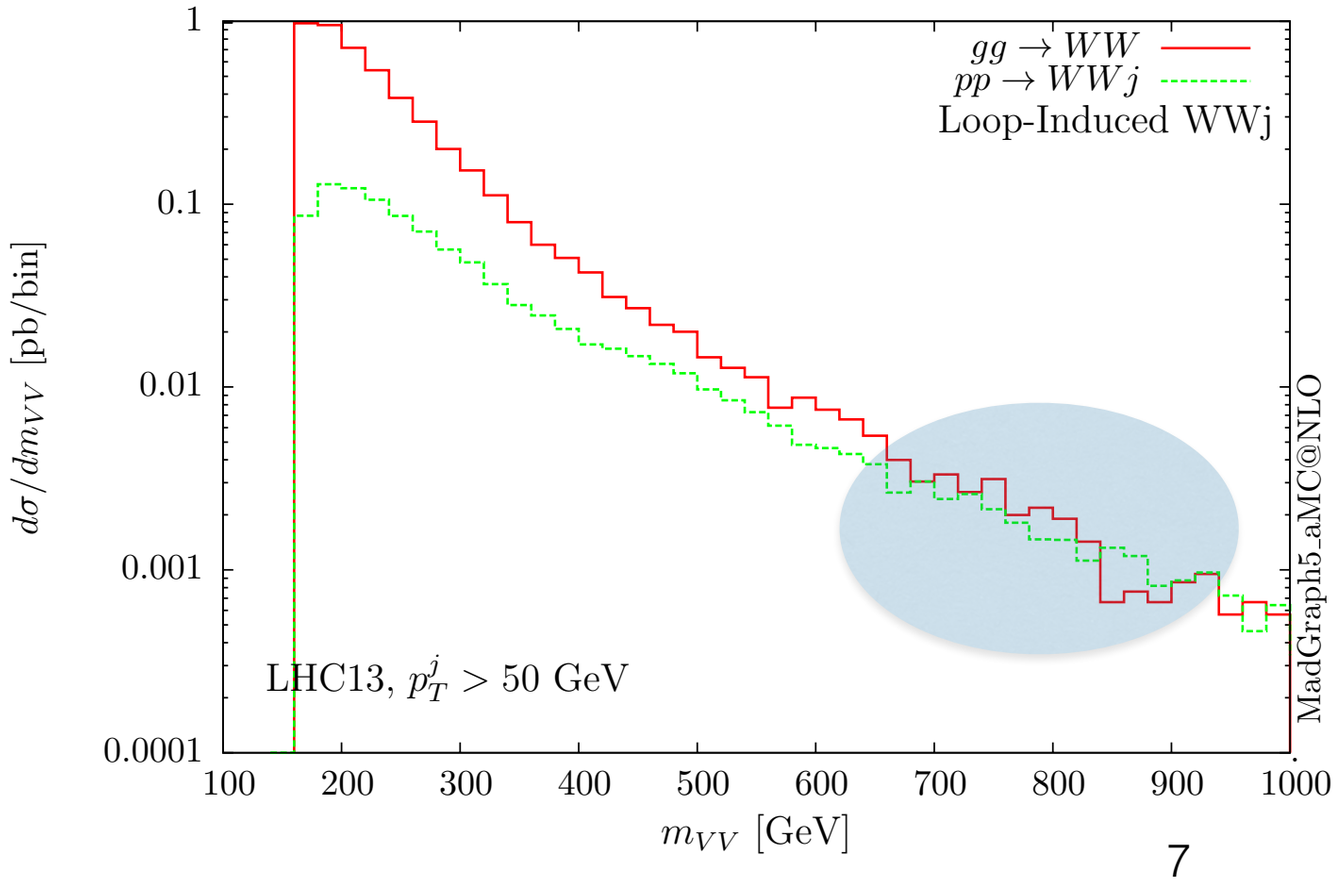
	$\hat{g}_{h^0tt}$	$\hat{g}_{h^0bb}$	$\hat{g}_{H^0tt}$	$\hat{g}_{H^0bb}$	$\hat{g}_{ZZh^0}$	$\hat{g}_{ZZH^0}$
Z3	1.04	0.93	-0.72	1.35	0.9987	0.051

Compatible with LHC higgs measurements

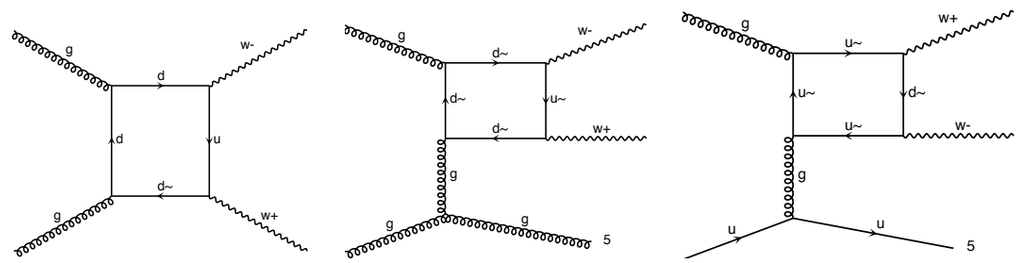
- Resonance peak suppressed by small HZZ coupling ∝ cos(β-α)
- Peak-dip or dip-peak structures possible depending on the input

Extension: gg>VV+0,1-jet

- Automated event generation for loop-induced processes at LO
- Additional jet contributions important at high invariant masses
- Better description of the kinematics: merging and matching to the PS
- **Plan:** Study VV + jets KT-MLM merged samples



SM WW production in gluon fusion 0,1 jet samples Unmerged



Summary

- Event generation for loop-Induced processes now released in beta in MG5_aMC@NLO
- Signal-Background interference studies are straightforward
- Merged samples for loop induced processes: can be obtained
- In addition to the SM, the Signal-Background interference effects can be studied in BSM extensions such as the 2HDM, singlet etc