Instructions for MadGraph5_aMC@NLO

- Use MG5_aMC v2.7.0 and process folders bbH_4FS_yb2 and bbH_4FS_ybyt v2.6.1 from [1] and [2]
- For the setup, follow the instructions from [3]
- For each process folder bbH_4FS_yb2 and bbH_4FS_ybyt:
  - adjust `shower_scale_factor` (fraction of Q_{sh}) in `run_card.dat`
    we used 1/(2sqrt(2))≈**0.35**, 1/sqrt(2)≈**0.71** and **1.0**
  - Launch Madgraph: `./bin/generate_events`
- Add cross sections from both processes to get the total bbH cross section

[1] https://launchpad.net/mg5amcnlo
[2] https://cp3.irmp.ucl.ac.be/projects/madgraph/wiki/bbH#no1
[3] https://indico.cern.ch/event/891566/contributions/3760273/attachments/1991862/3321469/madgraphp_bbH_intructions.txt

Instructions for POWHEG BOX V2

- Newest version of POWHEG-BOX-V2 and bbH package.
  Downloaded and setup as described in [4] with some modifications:

- To use the dynamical running scale from YR4:
  Copy `/afs/cern.ch/user/z/zimmerc/public/POWHEG/Born_phsp.f` to `POWHEG-BOX-V2/bbH/`

- Compile with `make pwhg_main`

- Copy `/afs/cern.ch/user/z/zimmerc/public/POWHEG/powheg.input` to `POWHEG-BOX-V2/bbH/testrun`

- Start Powheg with `echo <SEED> | ../pwhg_main`

- Change in powheg.input: `xgriditeration 1` to `xgriditeration 2` and execute the command above

- Change in powheg.input: `parallelstage 1` to `parallelstage 2` and run again, repeat for stages 3 and 4

[4] https://indico.cern.ch/event/891566/contributions/3760273/attachments/1991862/3321470/powheg_bbH_instructions.txt

b-jet selection

- Showering of generated events using Pythia8

- Jet reconstruction:
  - anti-kT algorithm with jet-radius in rapidity-azimuth (y-Φ) plane: r = 0.4
  - all stable particles after hadronization are selected
  - charged leptons and neutrinos are excluded from jets
  - p_T(jet) > 3 GeV

- If the angular separation between a jet and a bottom meson or baryon is smaller than 0.4, the jet is considered a b-jet:

$$\Delta R(\text{jet}, B) < 0.4 \quad \Rightarrow \text{jet} = \text{b-jet}$$

- Additional cuts on b-jets:
  - p_T(jet) > 25 GeV
  - $|\eta(\text{jet})| < 2.5$

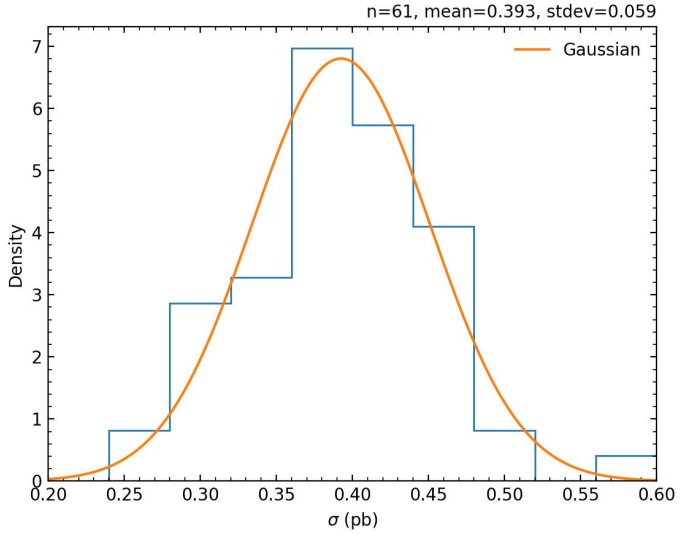
Results

MadGraph5 (4FS)	paper	YR4	my results		
Q_{sh}	$s^{1/2}$	$s^{1/2}$	$0.35*H_T/2$	$0.71*H_T/2$	$1.0*H_T/2$
inclusive σ (pb)	0.411 +0.101 -0.117	0.369 +0.076 -0.069	0.336	0.333	0.344
≥1 b-jet acceptance	0.287	0.341	0.209	0.228	0.249

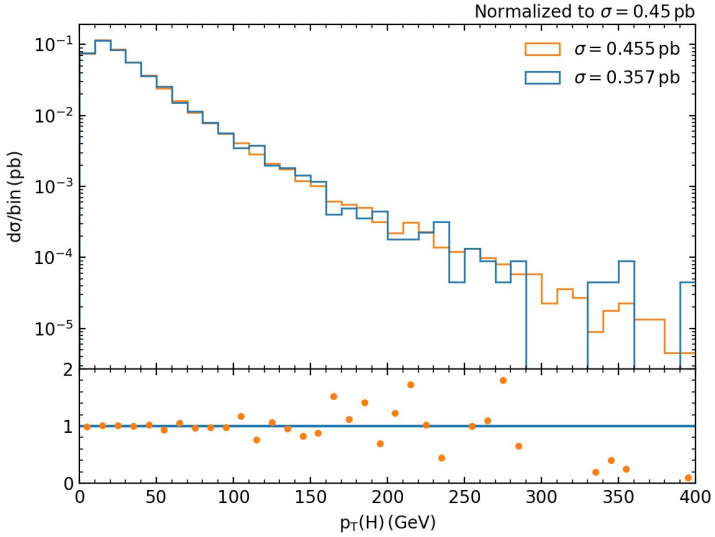
POWHEG BOX V2 (4FS)	paper (fixed scale)	my results (fixed scale)	YR4 (dynamic scale)	my results (dynamic scale)
inclusive σ (pb)	0.477 +0.086 -0.086	0.431	0.375 +0.075 -0.066	0.455
≥1 b-jet acceptance		0.270	0.251	0.251

New findings for POWHEG BOX V2

- Powheg uses a seed to initialize the random number generator
- The computed cross section changes by using different seeds
- For some seeds the cross section calculations fail completely ⇒ Looking into this



For different seeds we get a wide range of different cross sections. A gaussian fit leads to σ = 0.393 ± 0.059 pb.



Normalized to the same cross section, samples with different seeds predict the same b-jet acceptances and kinematic behaviour.