Comparison between Pythia “NLO” for b quark and Higgs spectra in $gg \to bbh$ and $gb \to bh$ production

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Outline

- Pythia setup (cards, scales,...)
- $gg \to bbh$ vs $gb \to bh$ in Pythia
  - b jets p_T, η spectra
  - additional jet p_T, η spectra
  - Higgs boson p_T spectrum
- Pythia vs calculations for $gb \to bh$
  - Higgs boson p_T, spectrum
  - b quarks (jets) p_T, η spectra

Pythia parameters and definitions

- b quark mass: **PMAS 5,1=4.62**
- Higgs boson mass: **PMAS 25,1=200 and 500**
- SM Higgs boson production $gg \to Q\bar{Q}h$: **MSUB 121=1**
- SM Higgs boson production $gb \to bh$: **MSUB 32=1**
- b quarks if final state: **KFPR 121,2=5**
- Multiple interactions off: **MSTP 81=0**
- No primodial k_T spectrum: **MSTP 91=0**
- Fragmentation and decay off: **MSTP 111=0**
- PDF: **MSTP 52=2** and **MSTP 51=10042**: CTEQ6L1 LHA
- PDF evolution, and ISR parton showers: $Q^2 = \mu_R^2 = (2 \cdot m_b + m_H)^2/16$
- Factorization scale for PDFs: $\mu_F^2 = \mu_R^2$

Pythia parameters and definitions

NLO Pythia

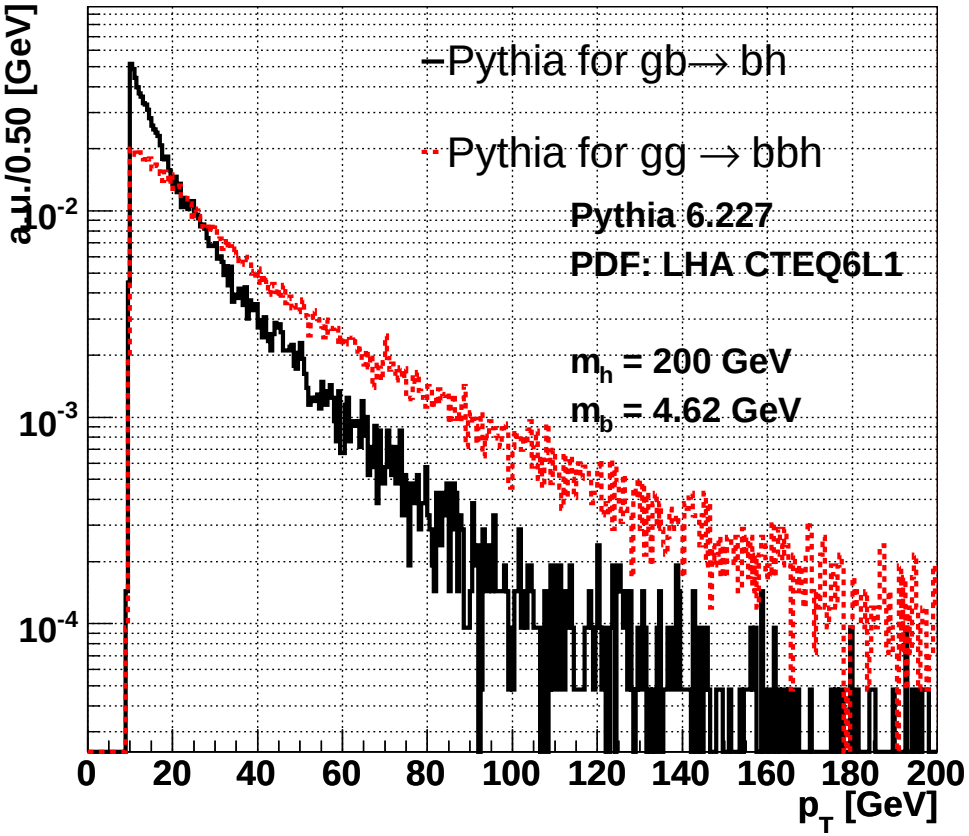
- Initial state radiation (ISR) : **MSTP 61=1**
- Final state radioation (FSR): **MSTP 71=1**
- b quarks after radiation

PYCELL jets

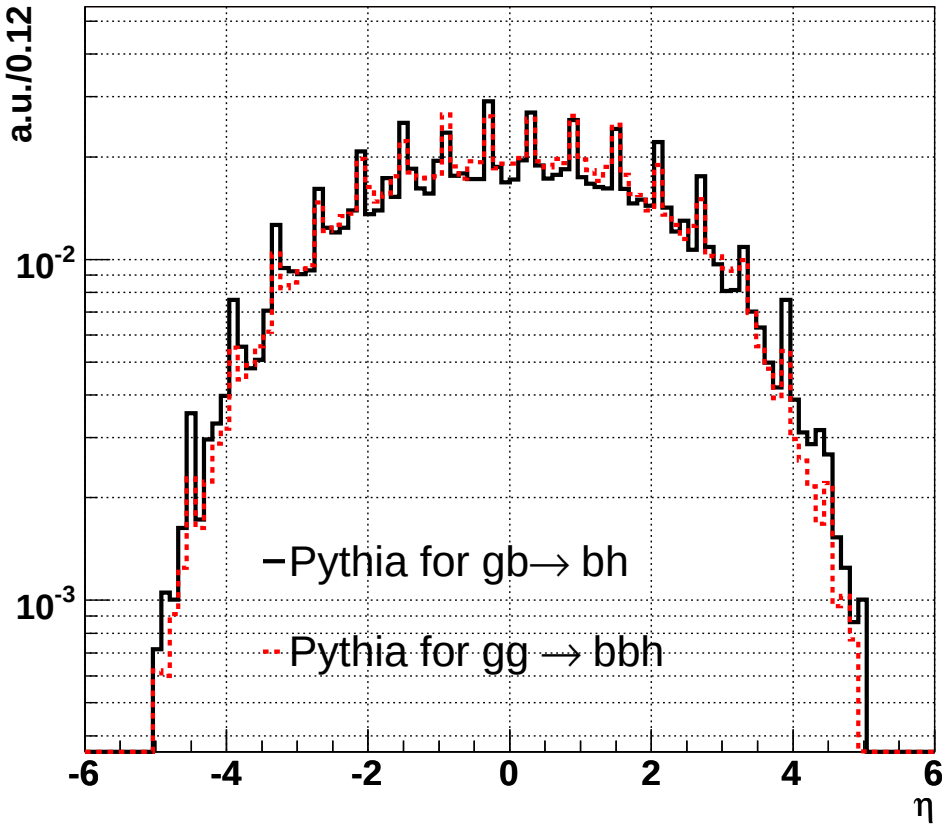
- PARU(51) = 5.0 ! rapidity range
- PARU(52) = 0.5 ! initiator cell
- PARU(53) = 10 ! cut on jet Et
- PARU(54) = 0.7 ! jet cone size
- MSTU(51) = 100 ! rapidity bins
- MSTU(52) = 72 ! phi bins
- MSTU(54) = 3 ! jet presented in list as 4 vector with mass

First (hardest) b jet p_T and η

p_T of leading b jet. "NLO" Pythia 6.227

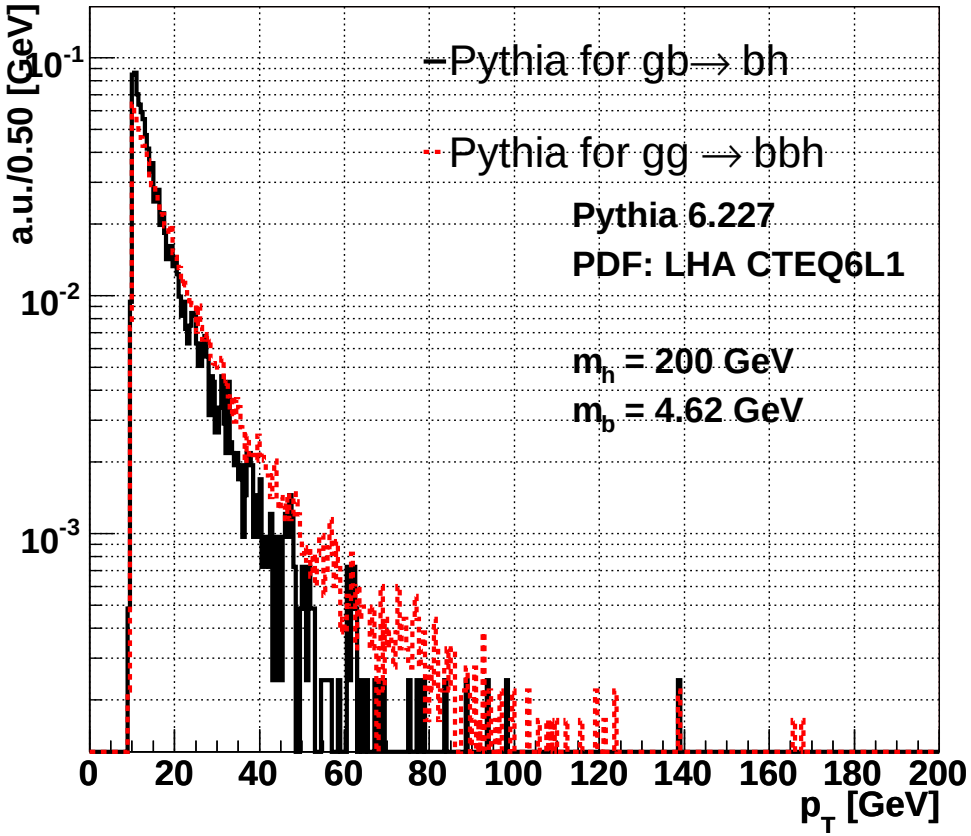


η of leading b jet. Pythia 6.227

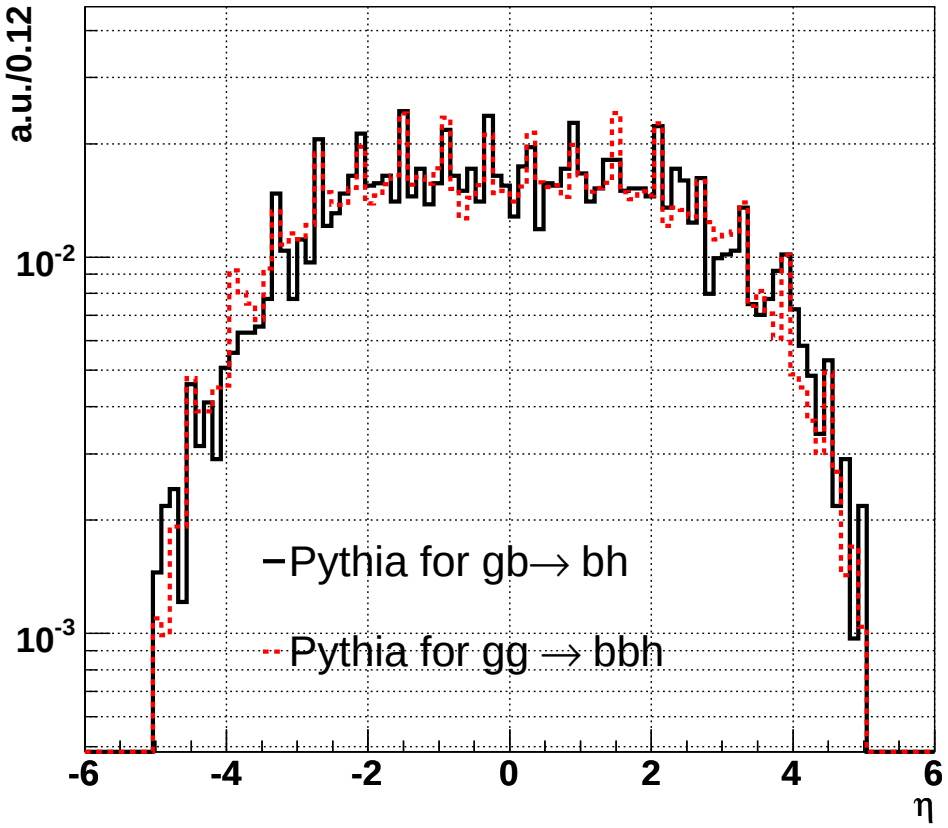


Second b jet p_T and η

p_T of second b jet. "NLO" Pythia 6.227

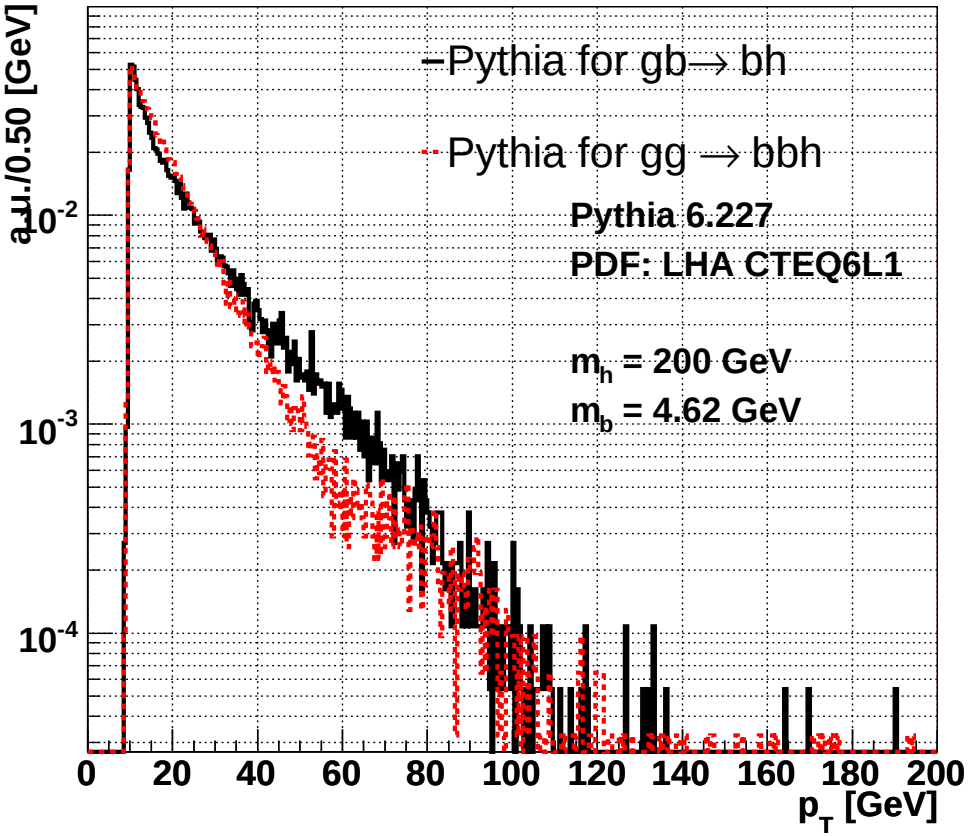


η of second b jet. Pythia 6.227

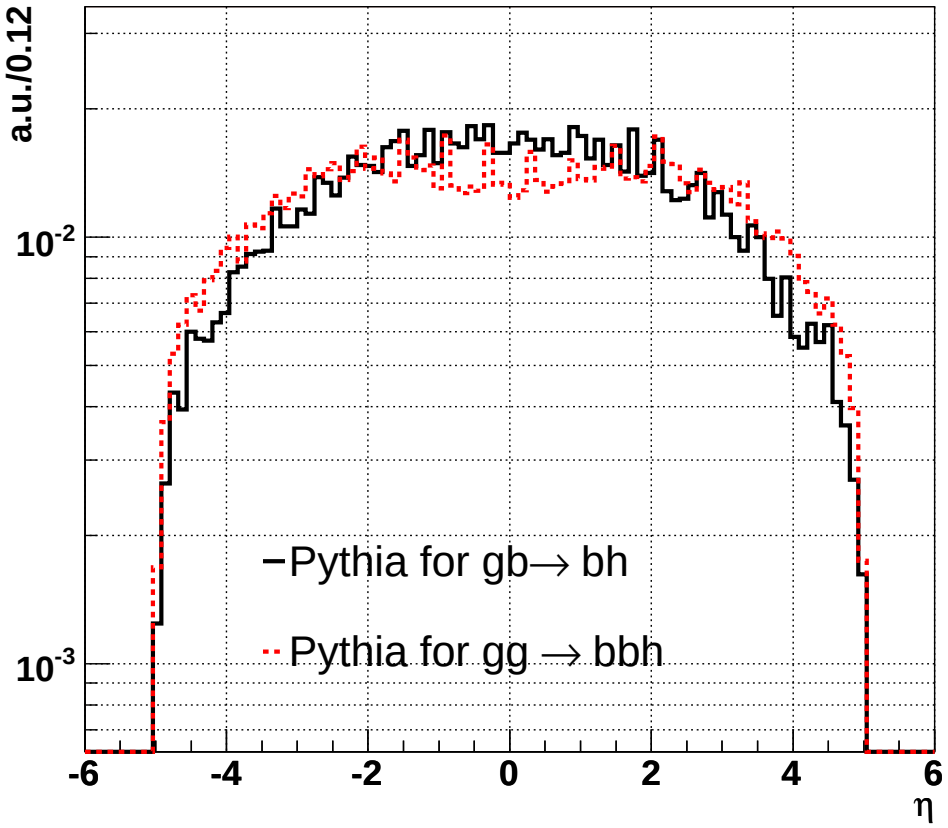


Third jet p_T and η

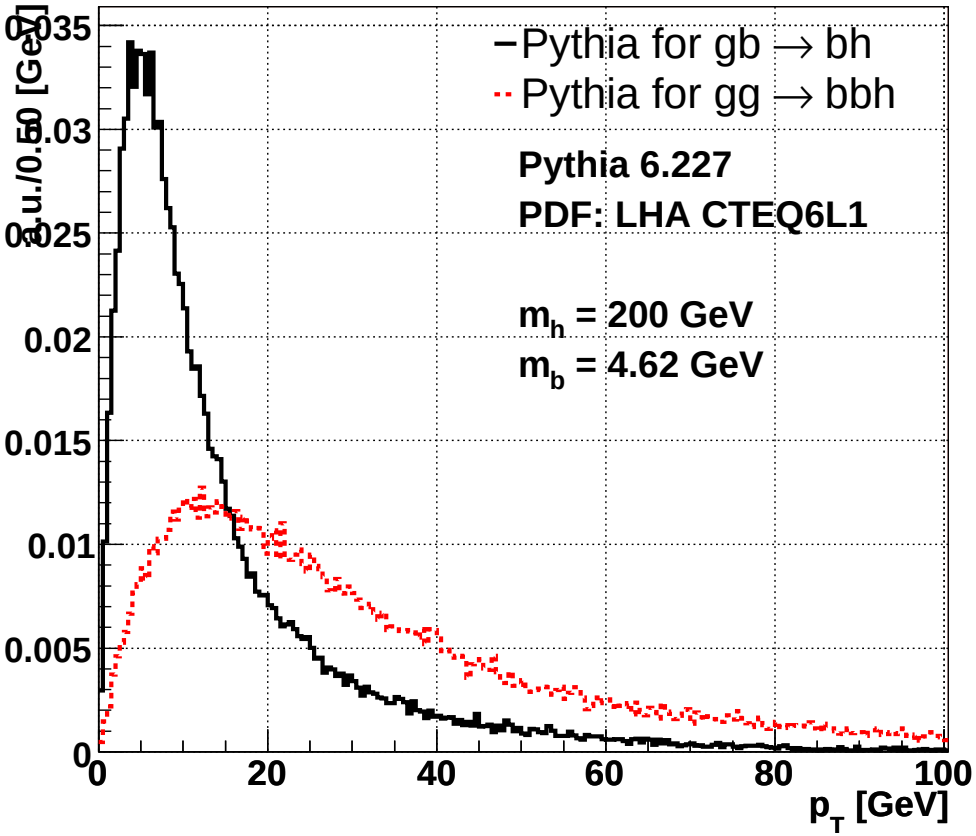
p_T of leading non b jet. "NLO" Pythia 6.227

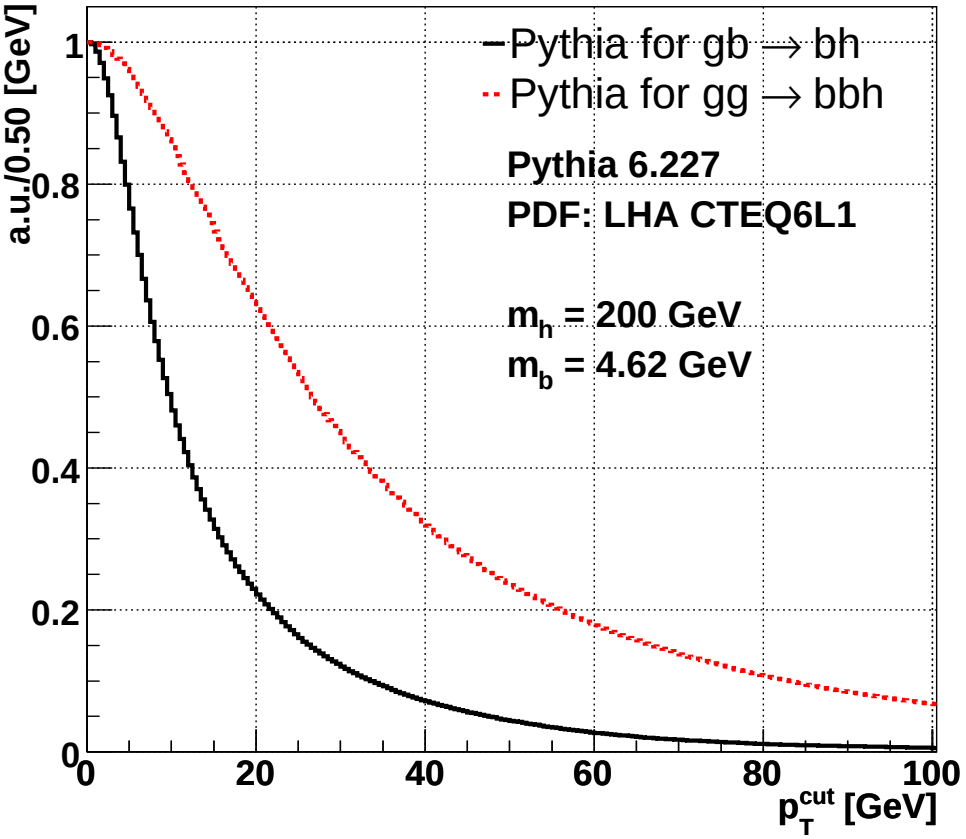


η of leading non b jet. Pythia 6.227

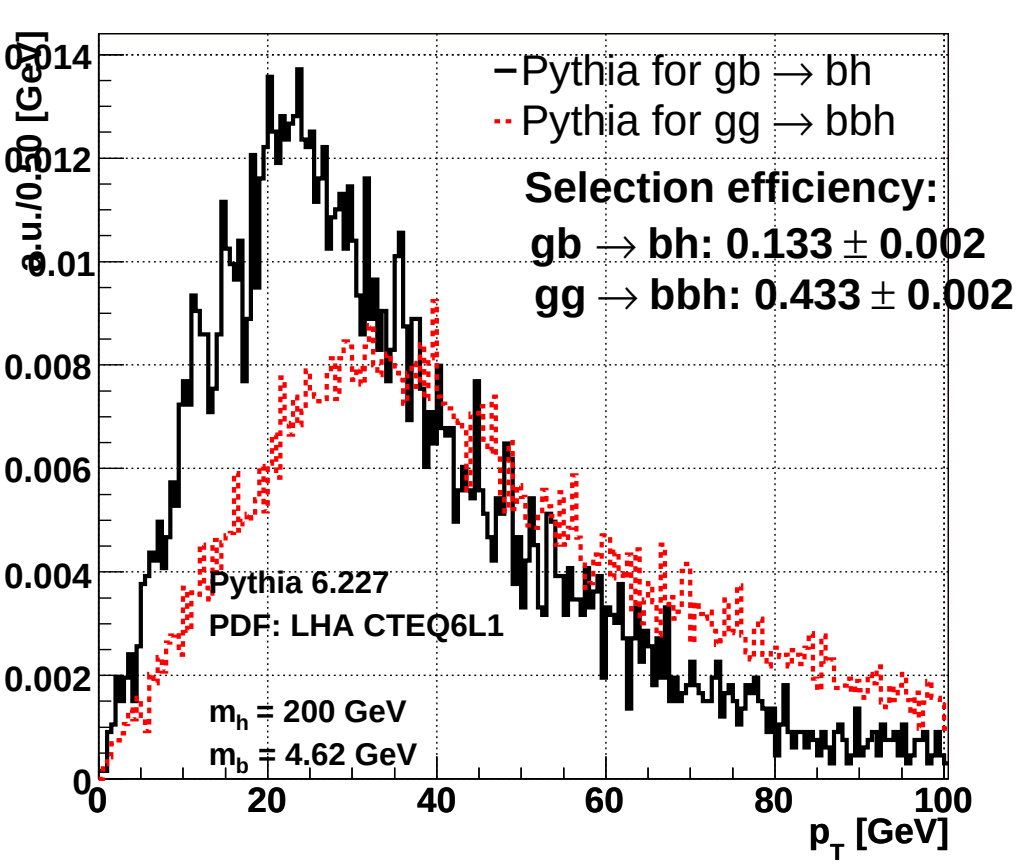


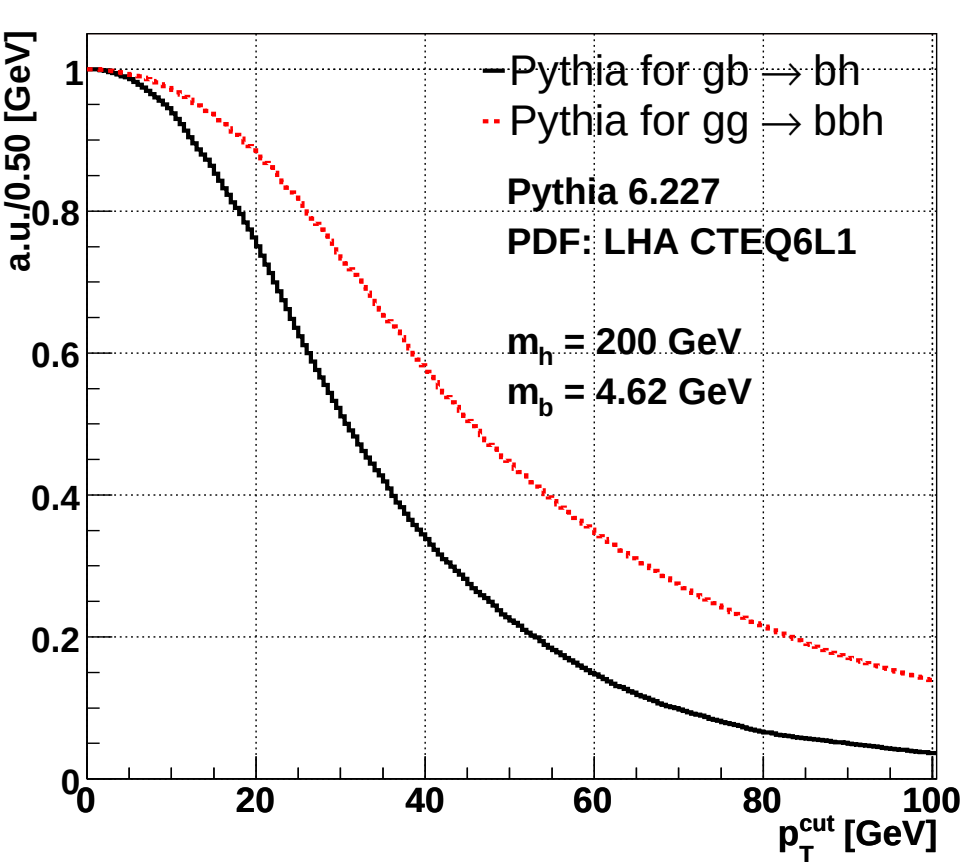
Higgs p_T. No selection



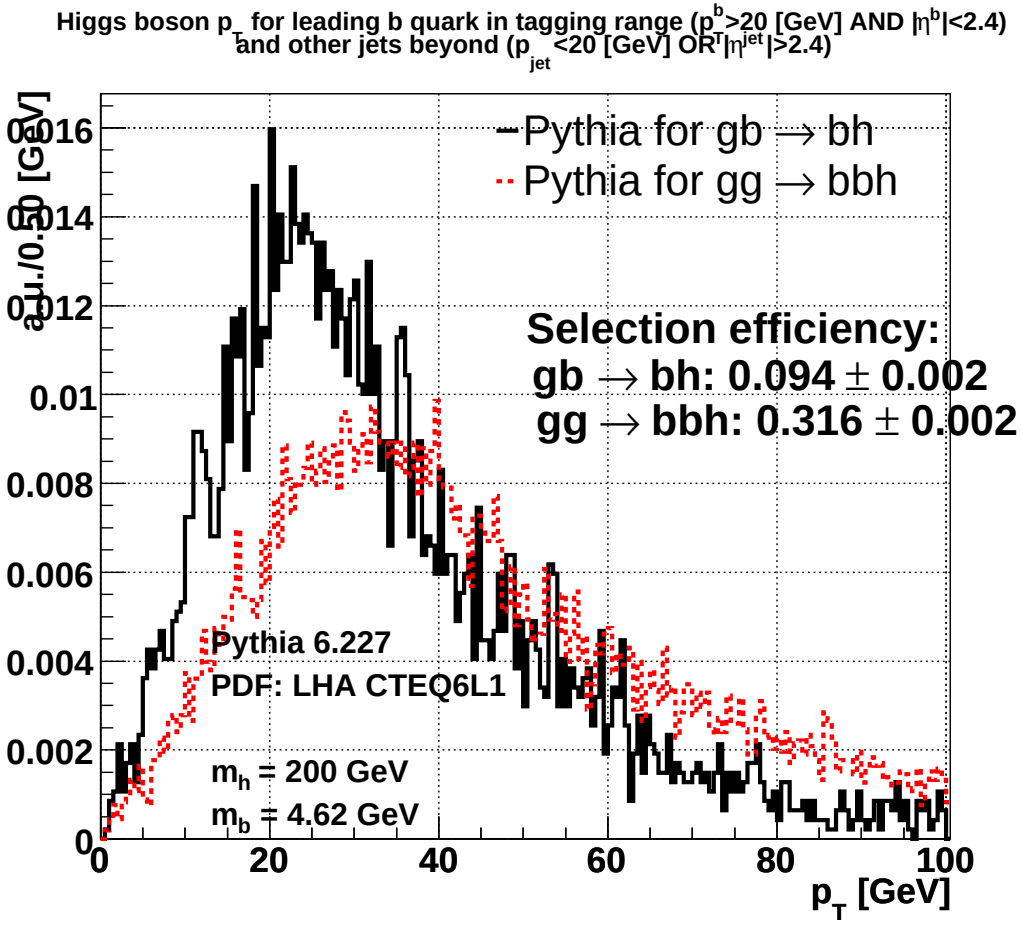


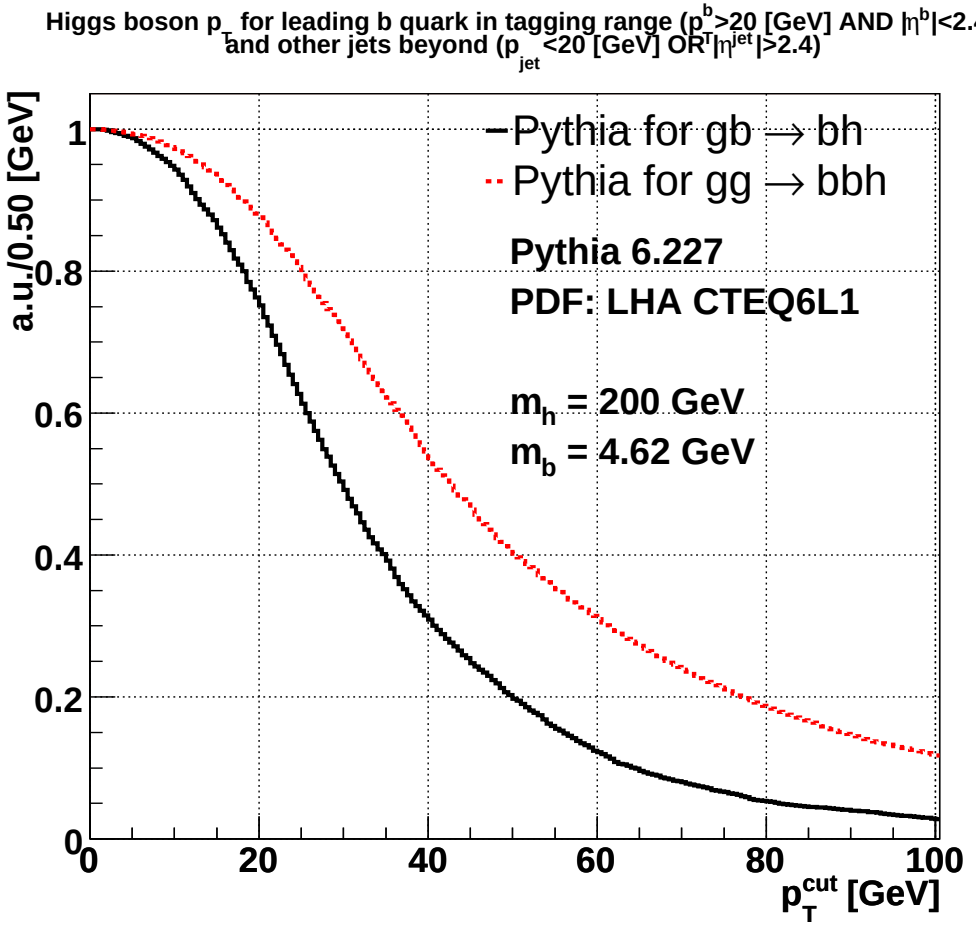
Higgs p_T with first b jet in tagging range





Higgs p_T with first b jet in tagging range and jet veto





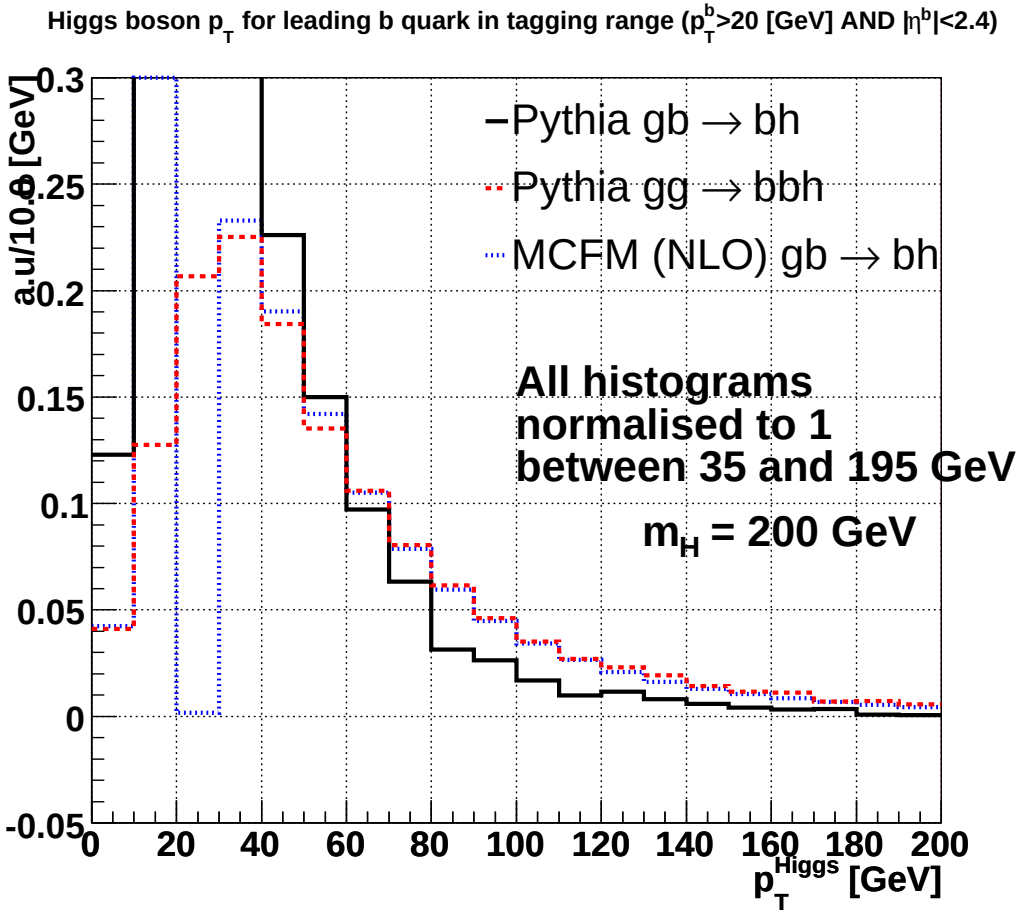
Selection efficiency summary

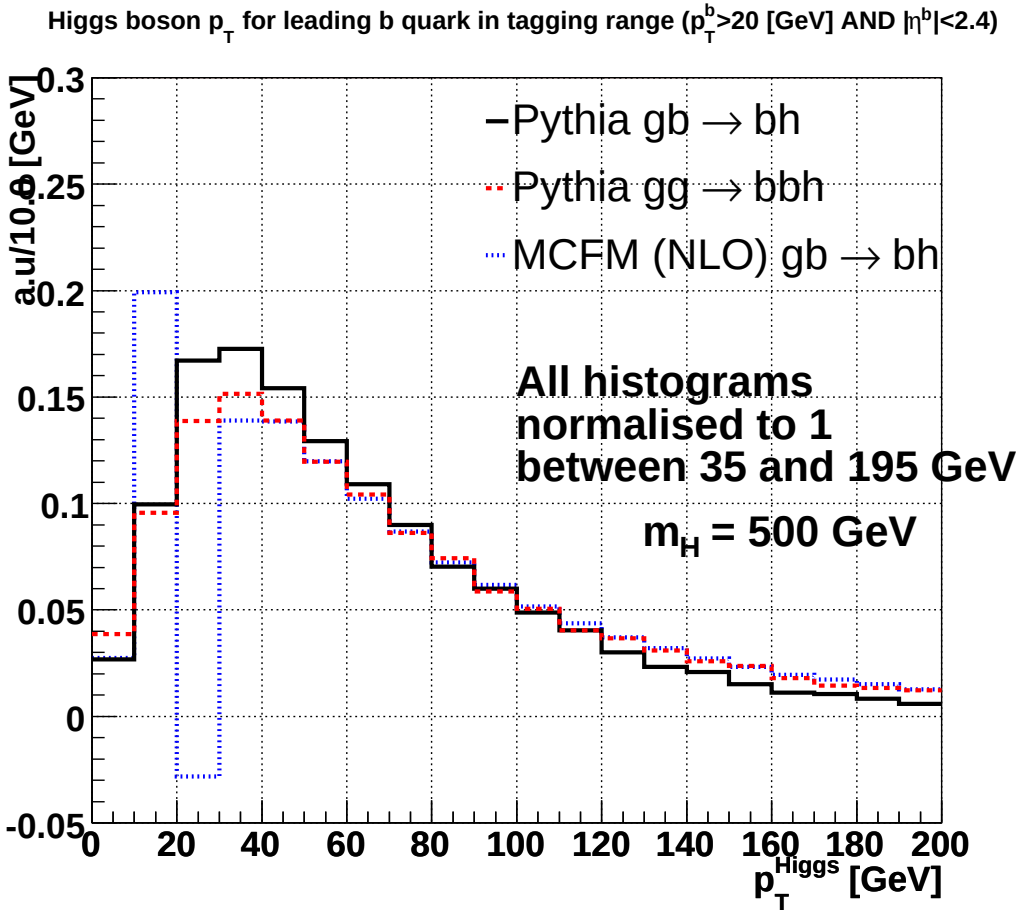
Cut:	single tag		sigle tag + jet veto	
Higgs mass [GeV]:	200	500	200	500
$gb \to bh$	0.133 $\pm$ 0.00152	0.366 $\pm$ 0.00215	0.0939 $\pm$ 0.0013	0.191 $\pm$ 0.00176
$gg \to bbh$	0.433 $\pm$ 0.00222	0.57 $\pm$ 0.00221	0.316 $\pm$ 0.00208	0.257 $\pm$ 0.00195
Ratio:	0.306 $\pm$ 0.00357	0.643 $\pm$ 0.00404	0.297 $\pm$ 0.00417	0.743 $\pm$ 0.00699
MCFM (NLO) $gb \to bh$	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
Theory ($gg \to bbh$)	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0

Selection efficiency summary. Jet veto efficiency

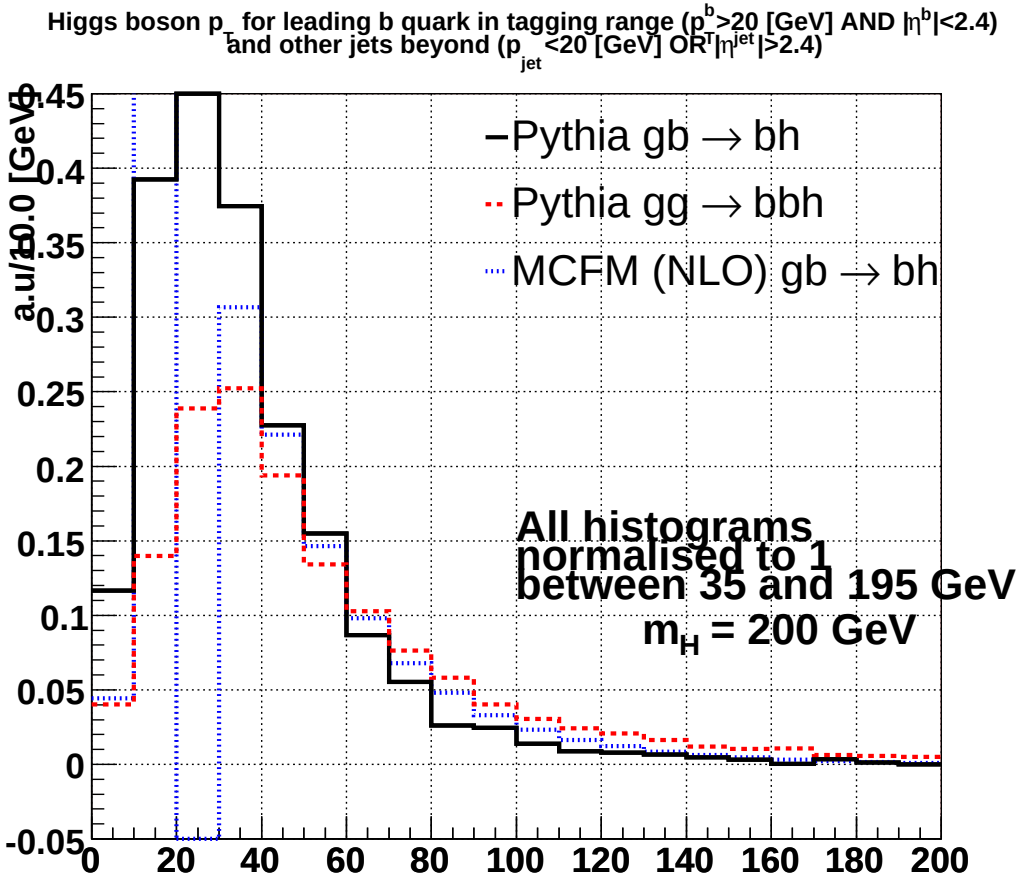
Cut:	jet veto (w.r.t single b tag)	
Higgs mass [GeV]:	200	500
$gb \longrightarrow bh$	0.708	0.52
$gg \longrightarrow bbh$	0.731	0.45
MCFM (NLO) $gb \longrightarrow bh$	0.592	0.429
$gg \longrightarrow bbh$	0	0

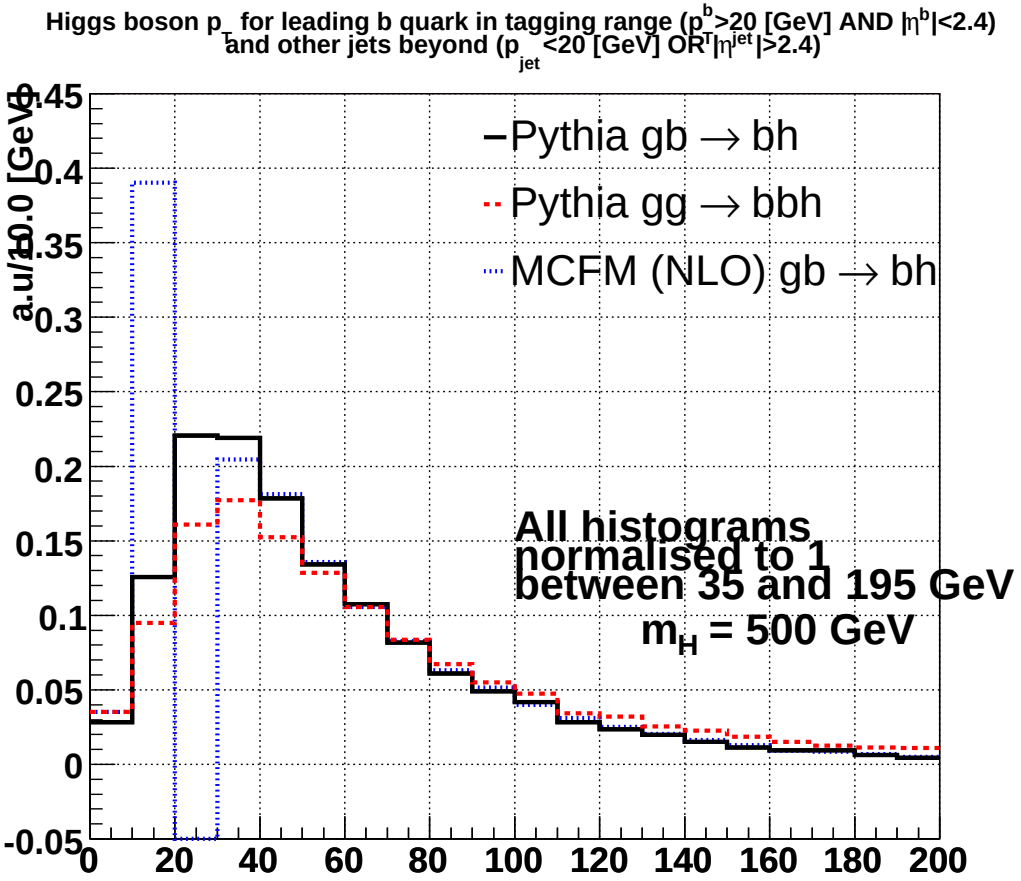
Pythia vs. theoretical calculations for $gb \to bh$. Higgs p_T.

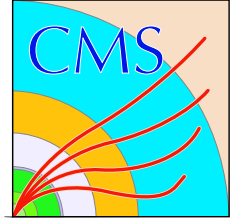




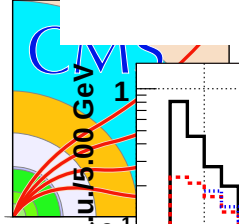
Pythia vs. theoretical calculations for $gb \to bh$. Higgs p_T.





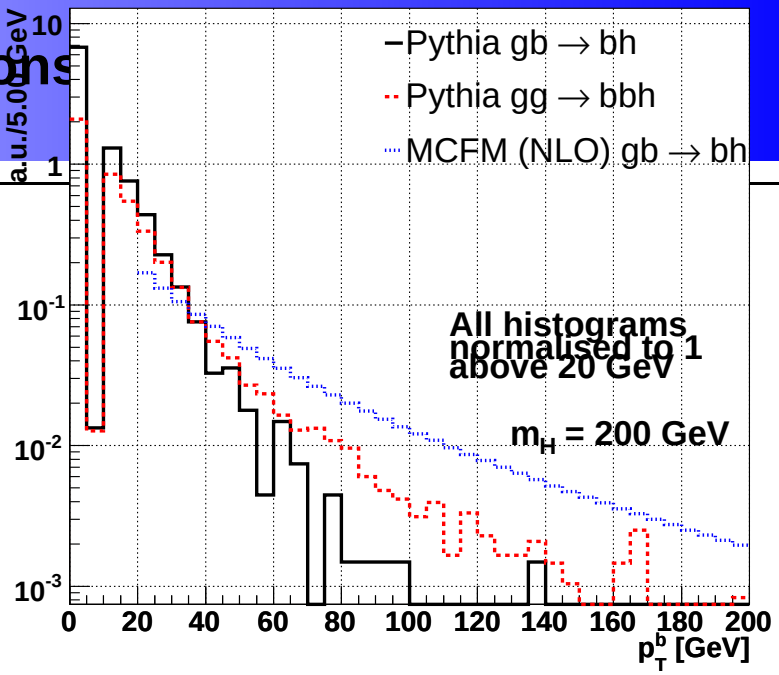


Pythia vs. theoretical calculations for $gb \to bh$. b quark p_T.

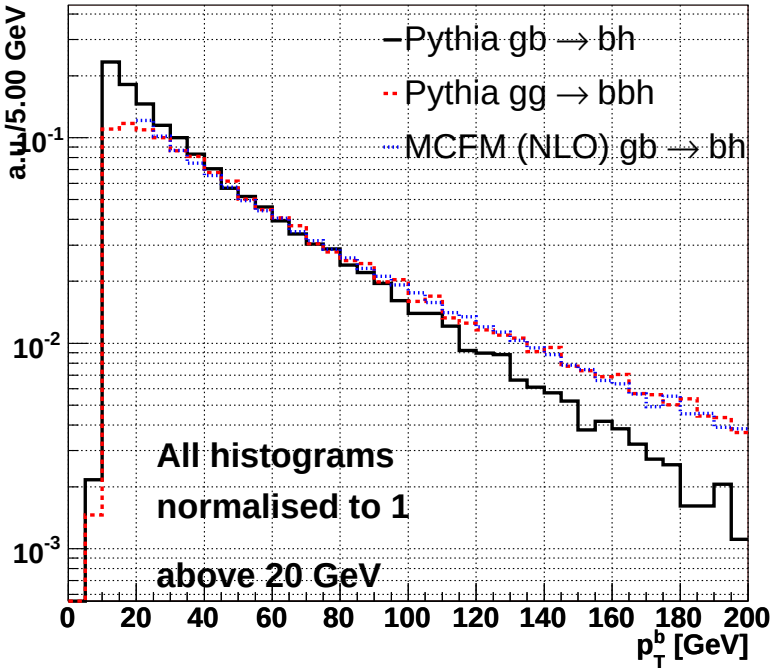


p_T of leading b jet.

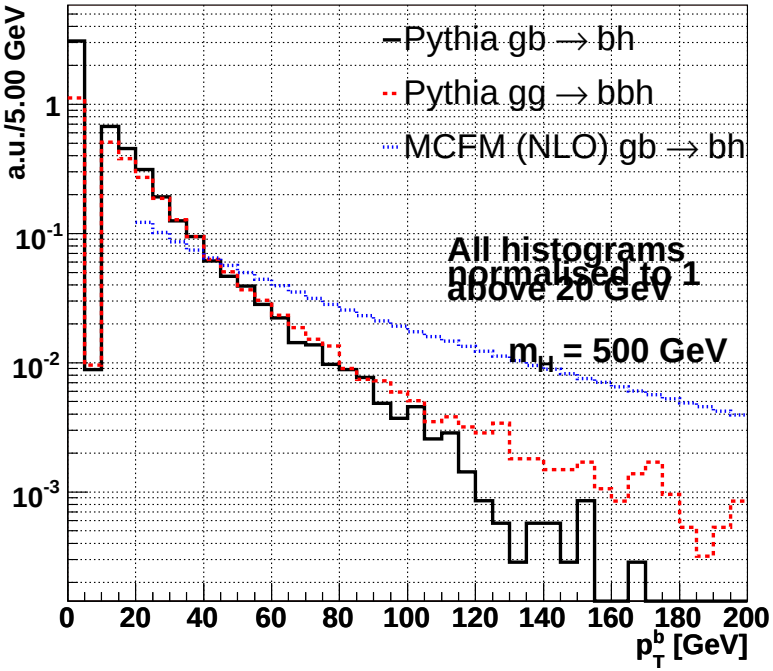
p_T of second b jet.

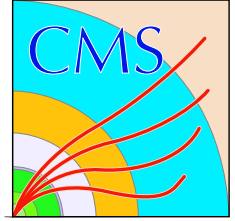


p_T of leading b jet.



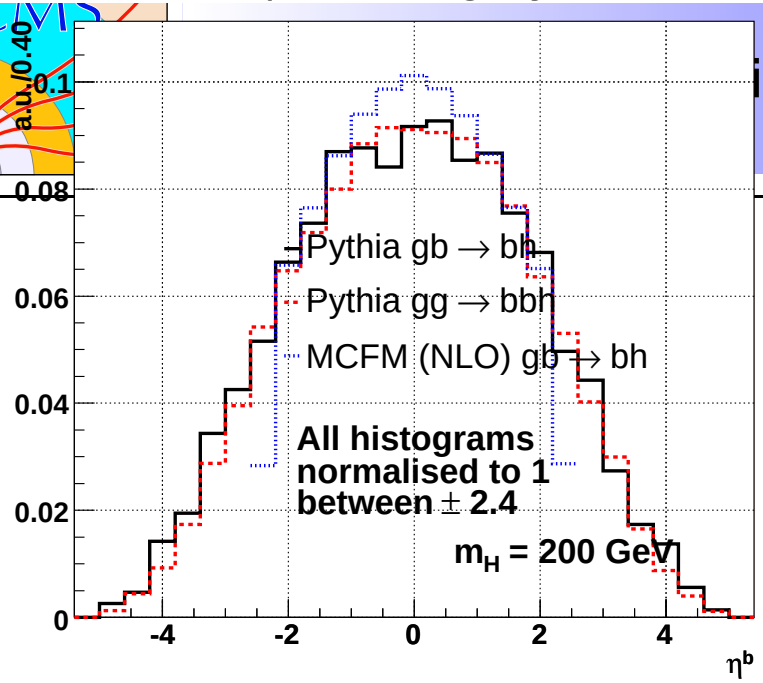
p_T of second b jet.





Pythia vs. theoretical calculations for $gb \longrightarrow bh$. b quark η.

η of leading b jet.



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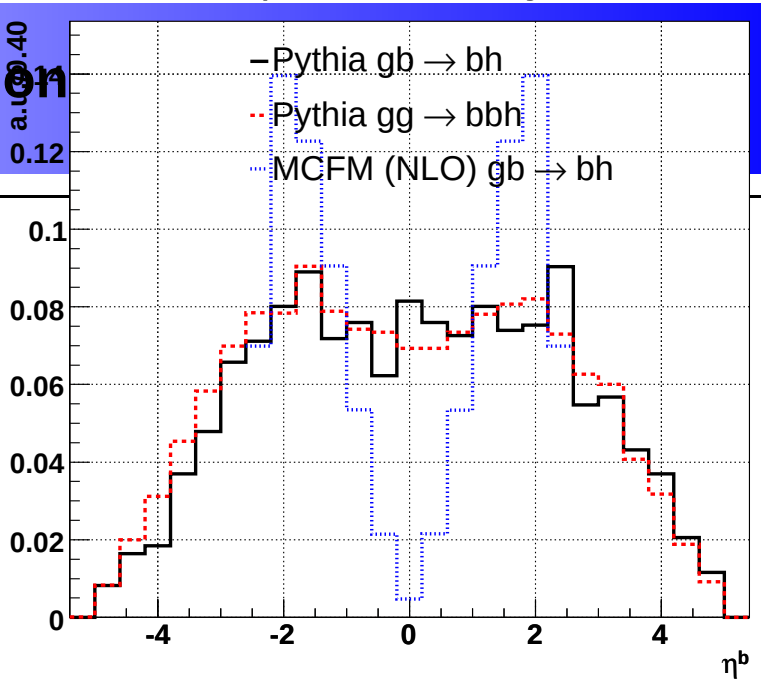

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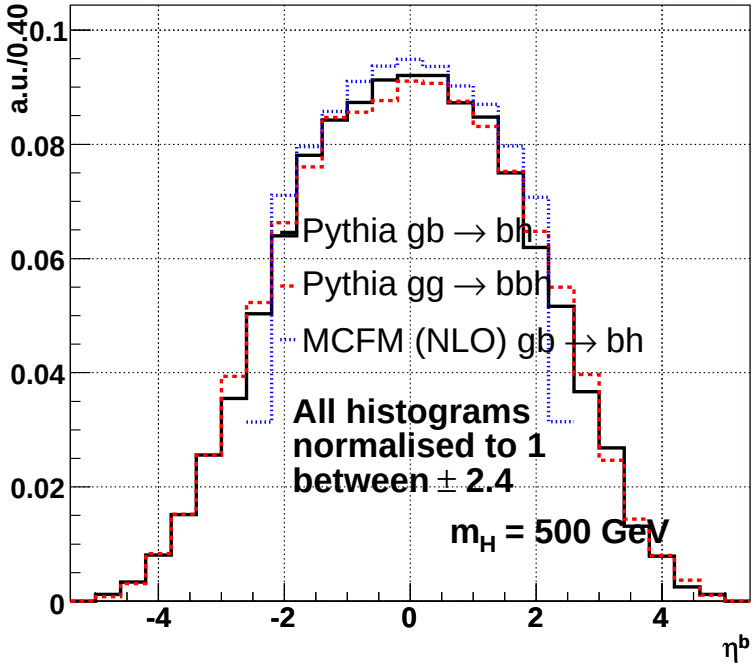

η of second b jet.