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

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# 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: $\mu_F^2 = \mu_R^2$

NLO Pythia

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

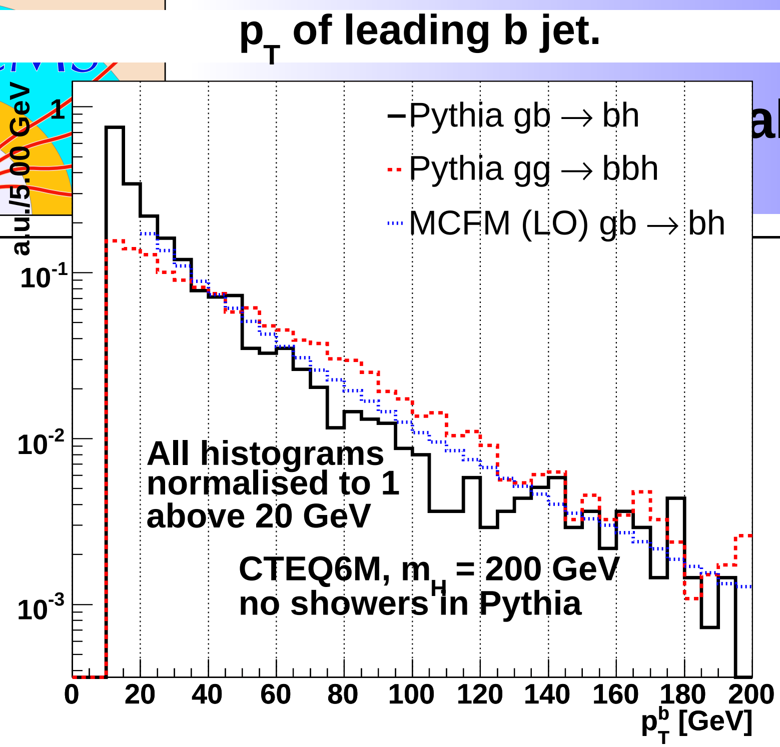
PYCELL jets

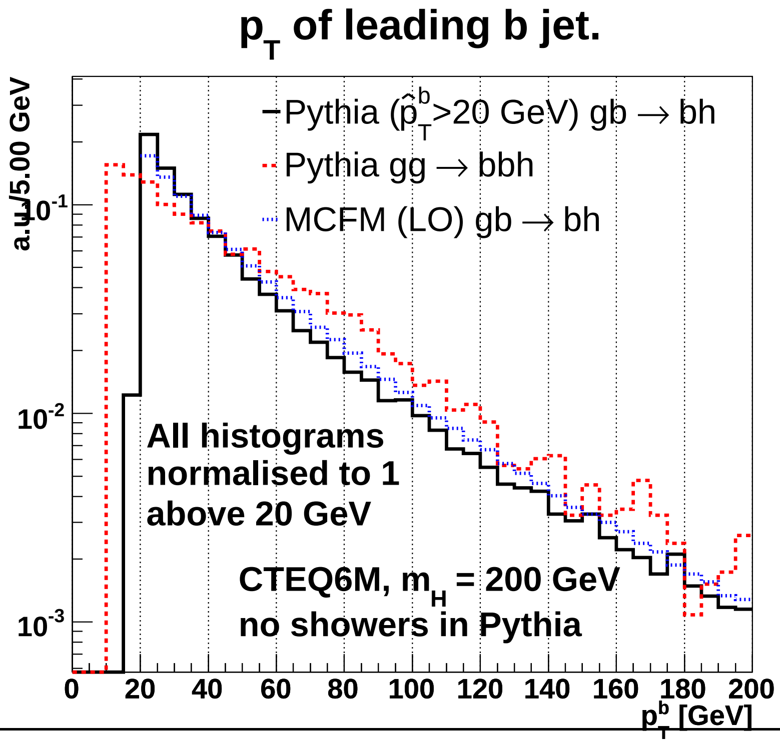
- PARU(51) = 5.0 ! rapidity range
- PARU(52) = 0.5 ! initiator cell
- PARU(53) = 10 ! cut on jet Et
- PARU(54) = 0.7 ! jet cone size
- MSTU(51) = 100 ! rapidity bins
- MSTU(52) = 72 ! phi bins
- MSTU(54) = 3 ! jet presented in list as 4 vector with mass

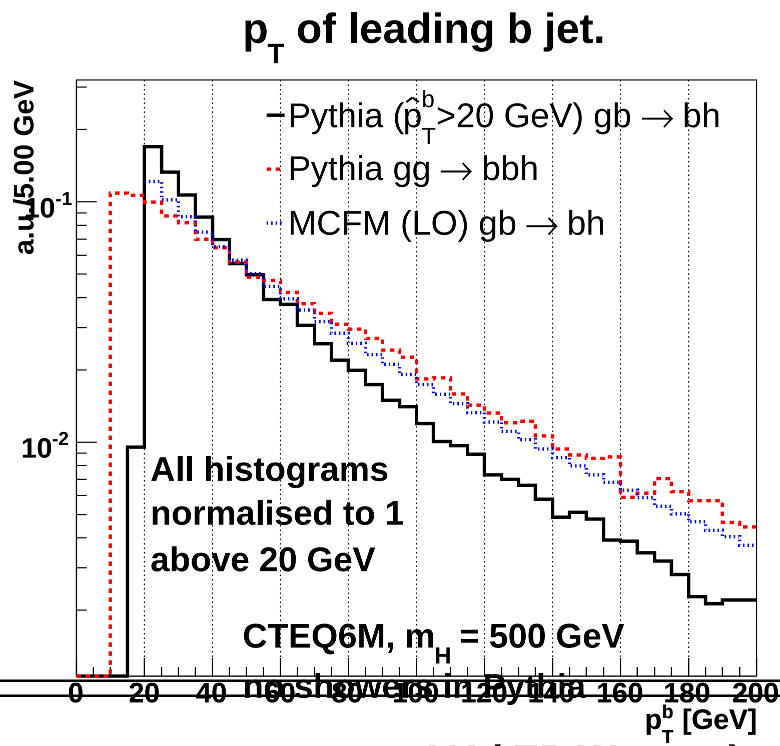
# Pythia vs. theoretical calculations for $gb \rightarrow bh$. LO b jet.No ISR, FSR

To be away from the collinear limit for $gb \to bh$ in Pythia generate events with $p_T^b > 20\ GeV$ (CKIN(3)=20)

# ...alculations for $gb \to bh$. LO b jet.No ISR, FSR



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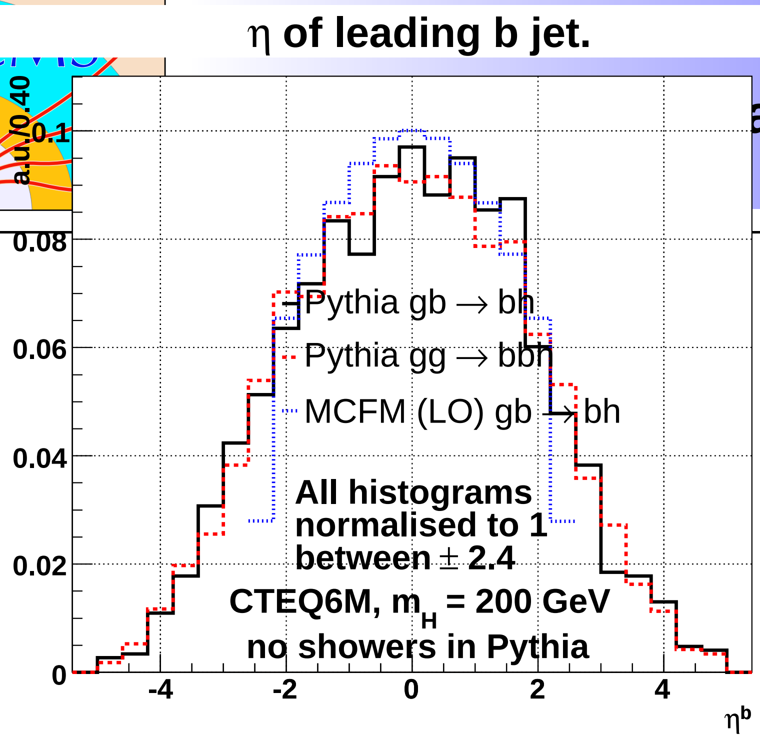
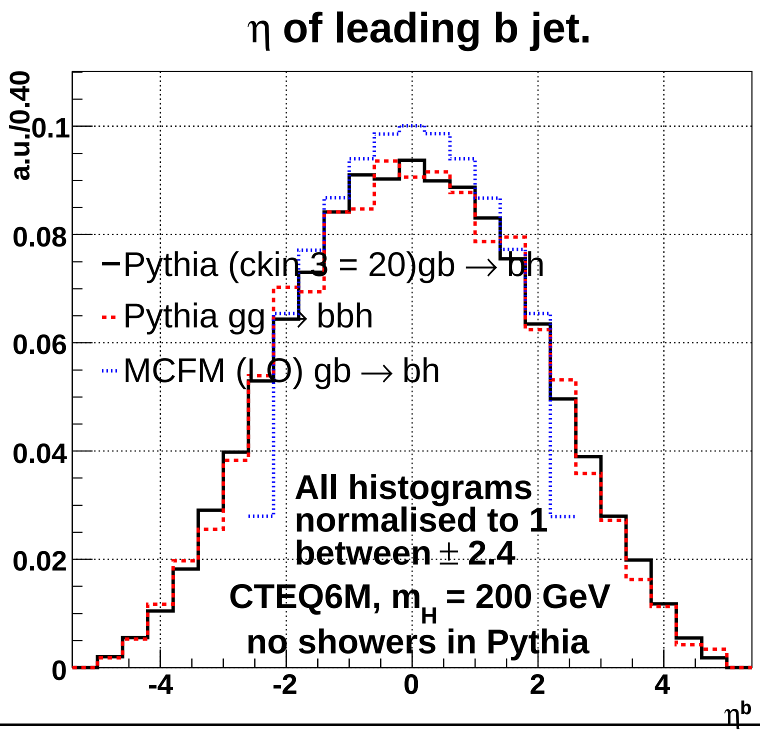
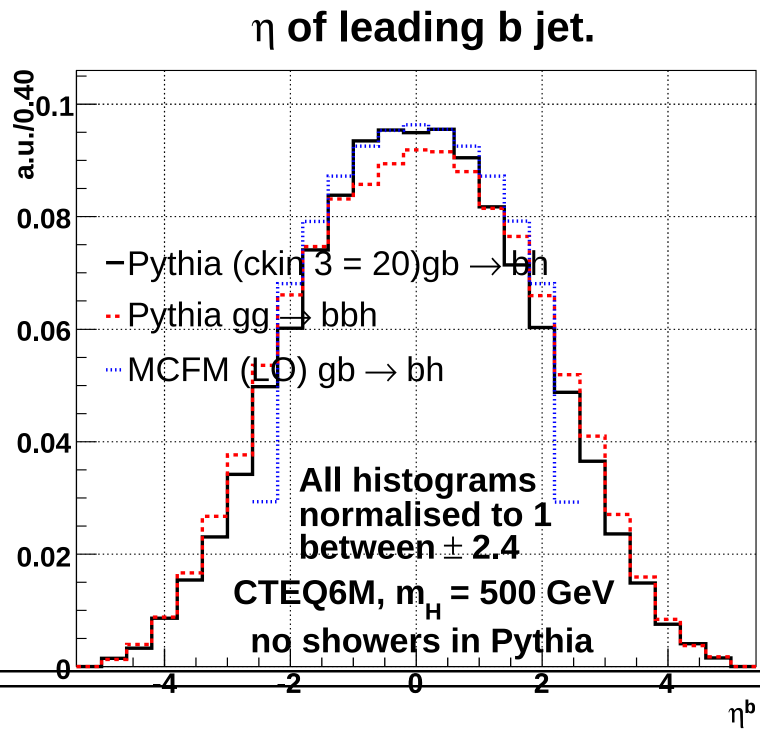
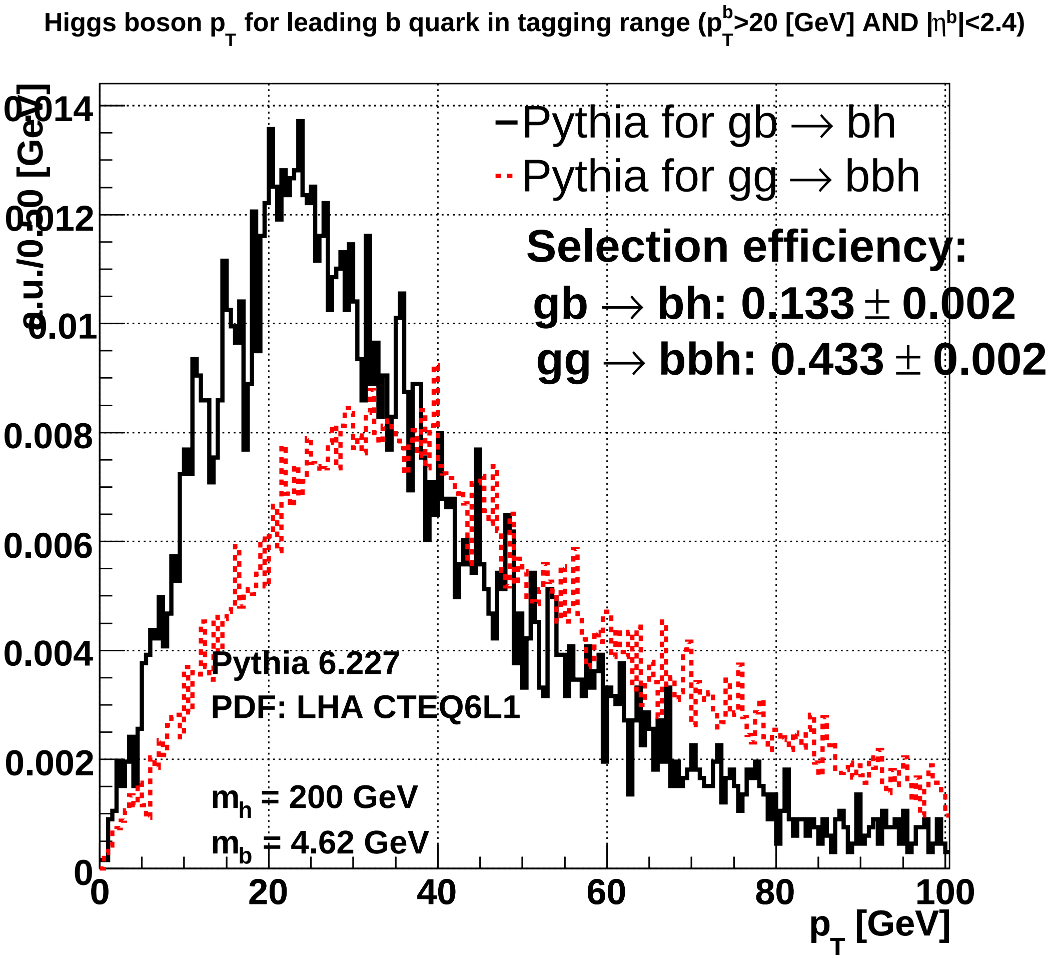
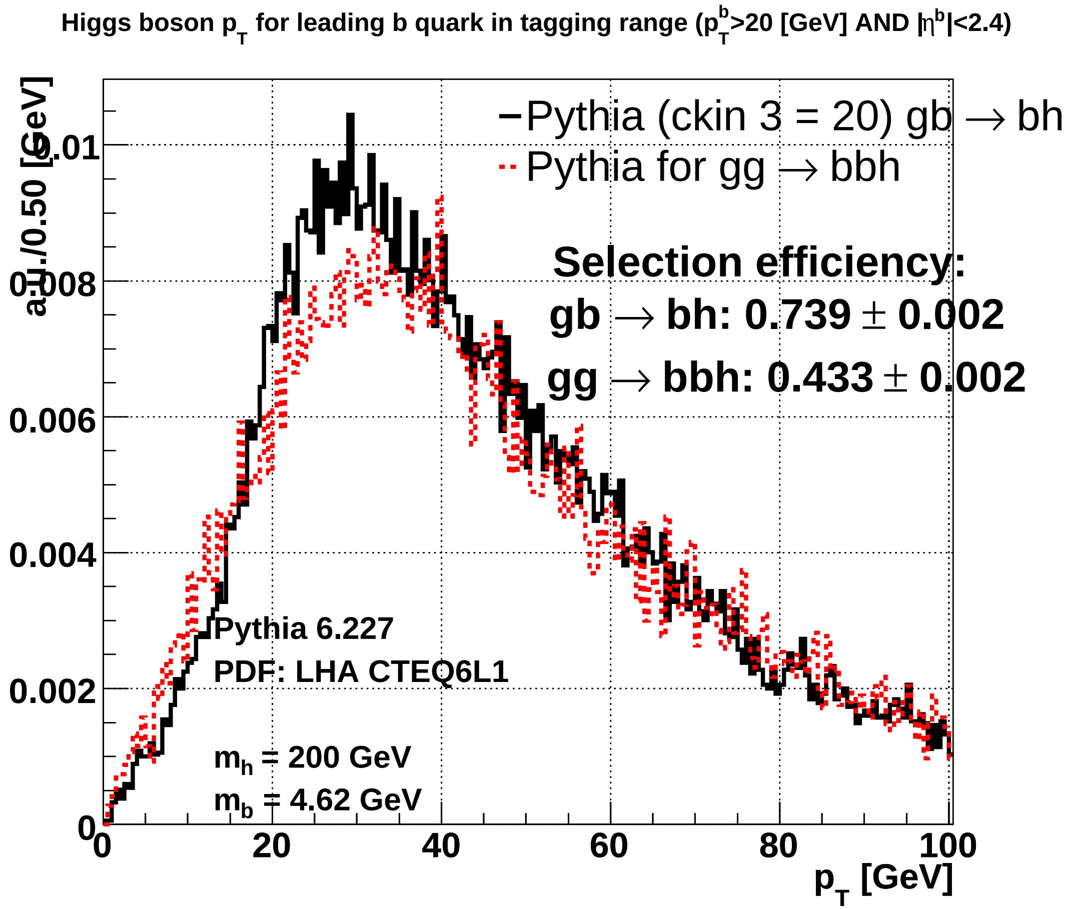


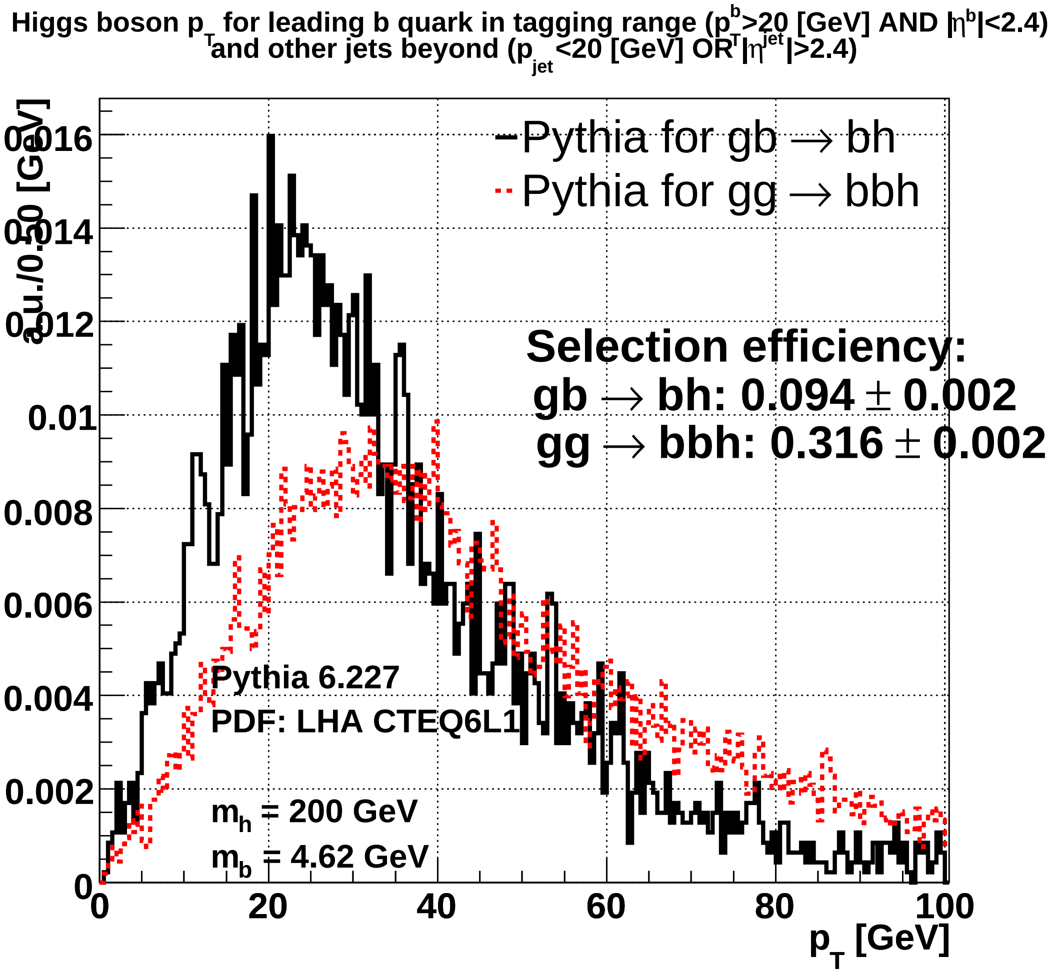



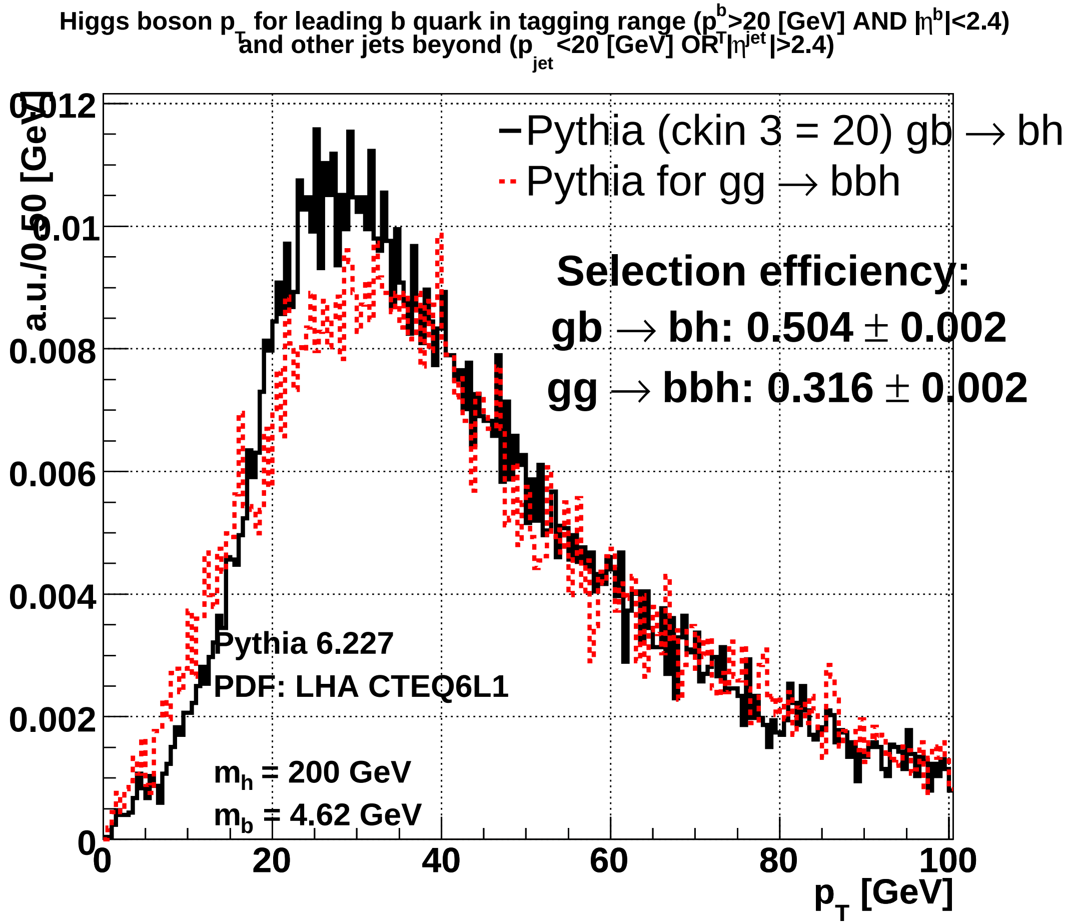



# Higgs $p_T$ with first b jet in tagging range




Higgs boson p_T for leading b quark in tagging range (p_T^b>20 [GeV] AND |η^b|<2.4)
and other jets beyond (p_T^jet<20 [GeV] OR |η^jet|>2.4)
Pythia for gb → bh
Pythia for gg → bbh
Selection efficiency:
gb → bh: 0.094 ± 0.002
gg → bbh: 0.316 ± 0.002
Pythia 6.227
PDF: LHA CTEQ6L1
m_h = 200 GeV
m_b = 4.62 GeV
a.u./0.50 [GeV]
p_T [GeV]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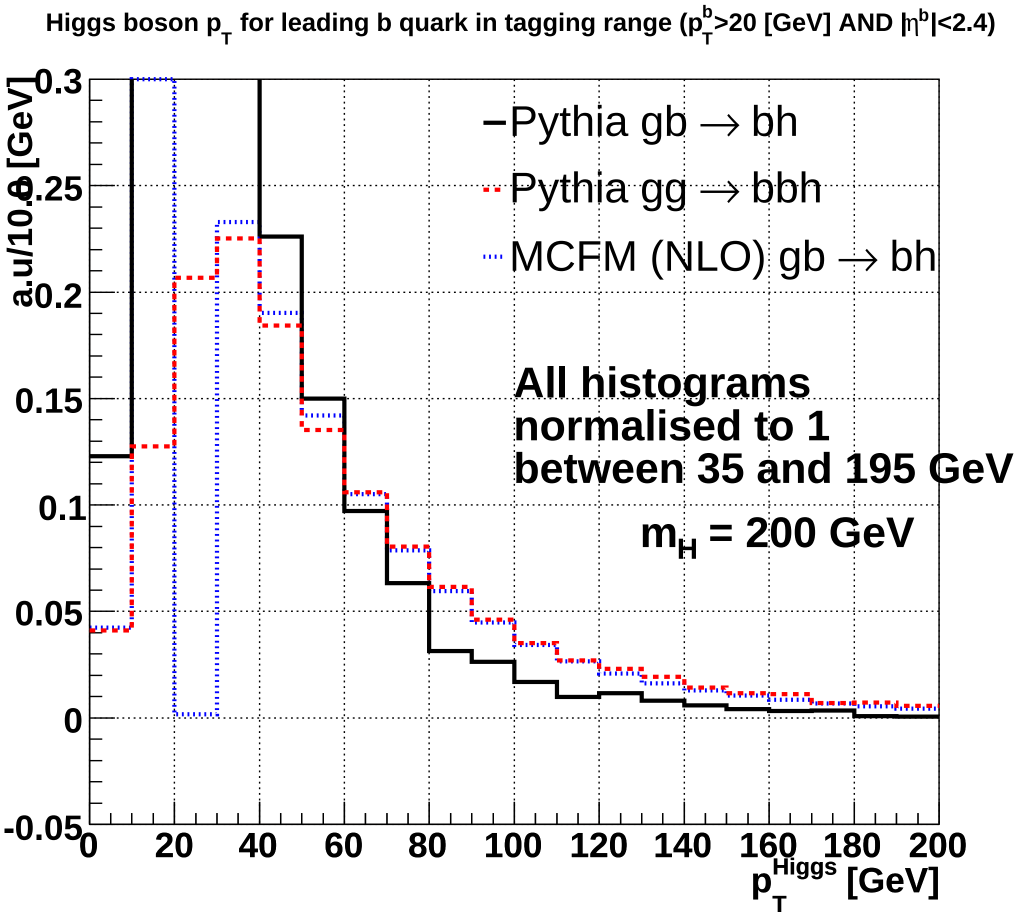
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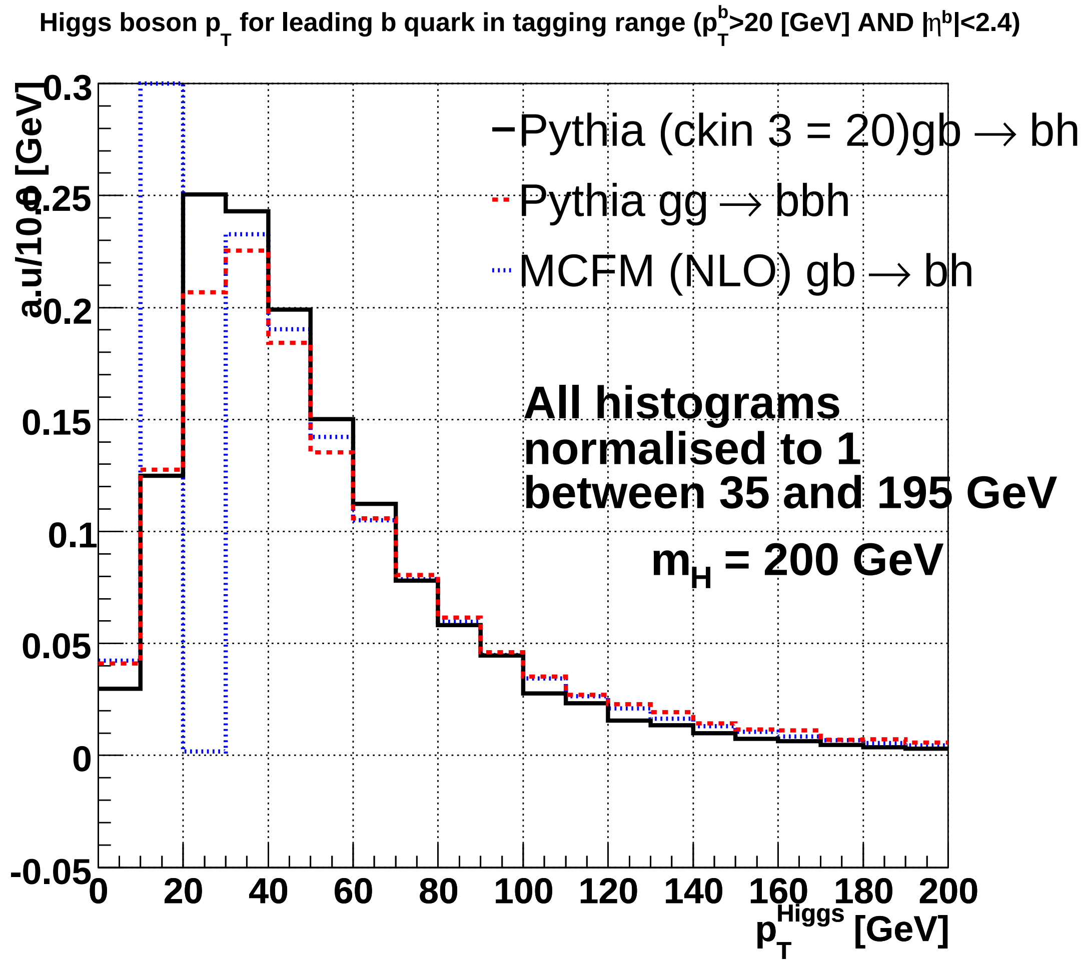
MCFM (NLO) gb → bh
All histograms normalised to 1 between 35 and 195 GeV
m_H = 200 GeV
a.u/10.0 [GeV]
p_T^Higgs [GeV]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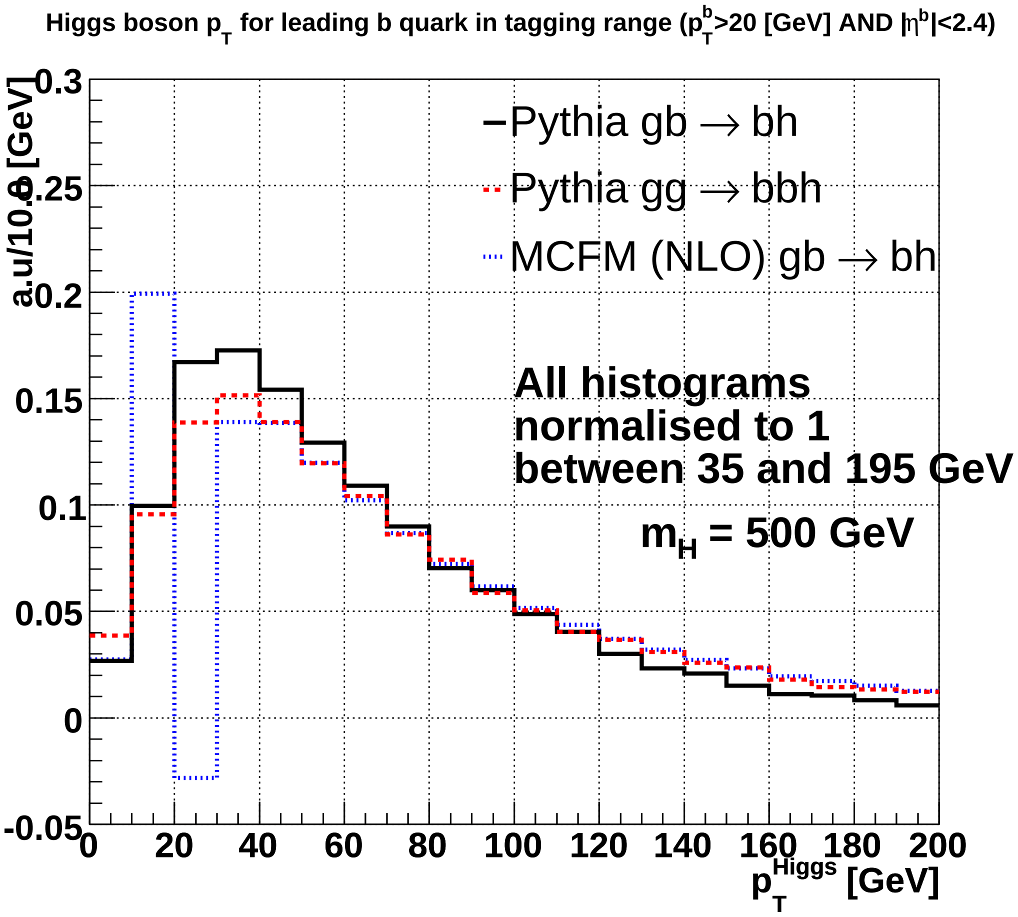

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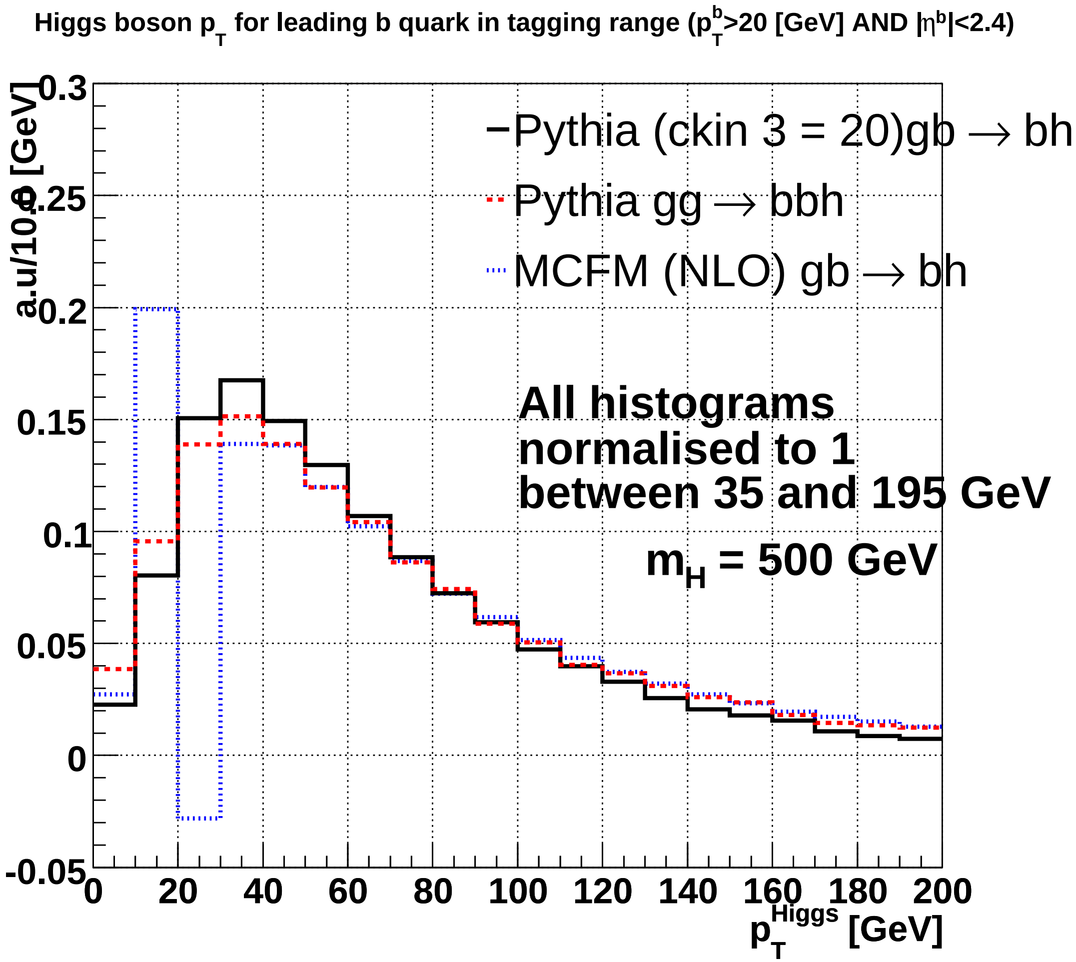
m_H = 500 GeV
p_T^Higgs [GeV]

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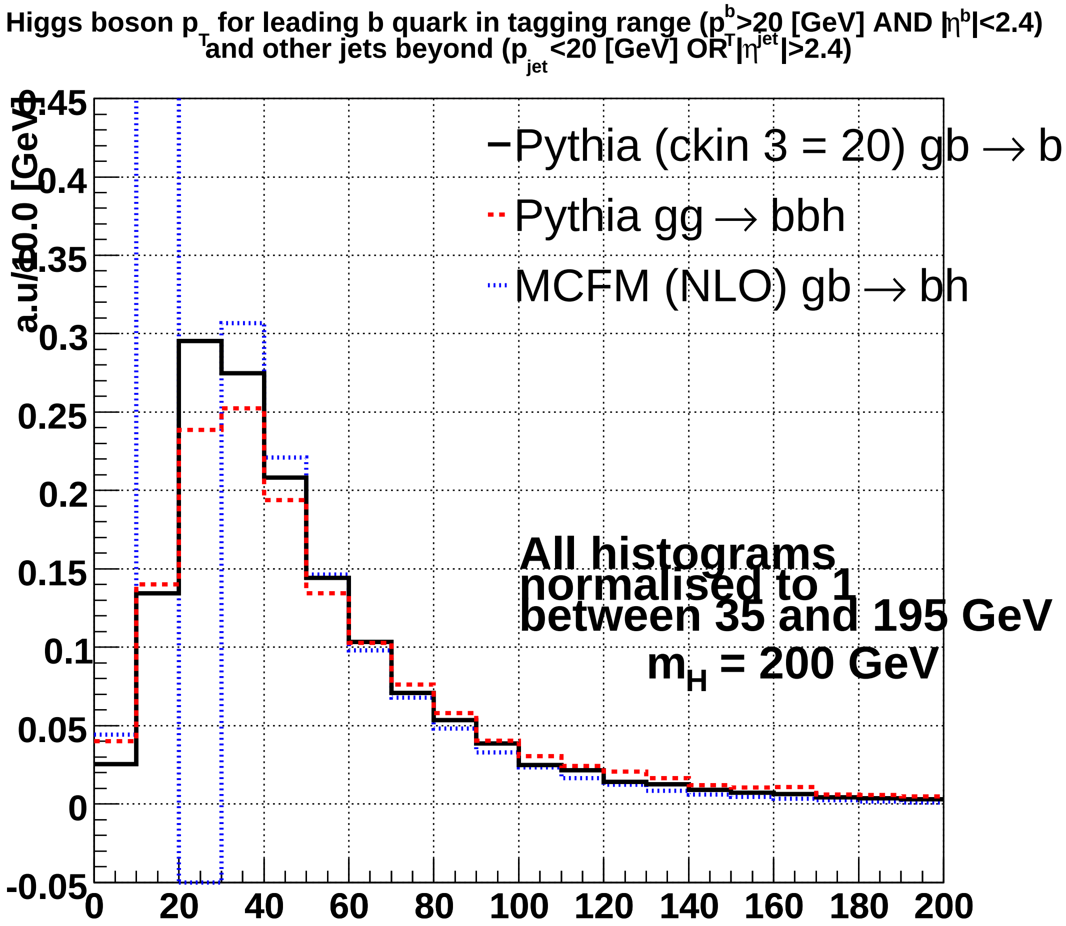
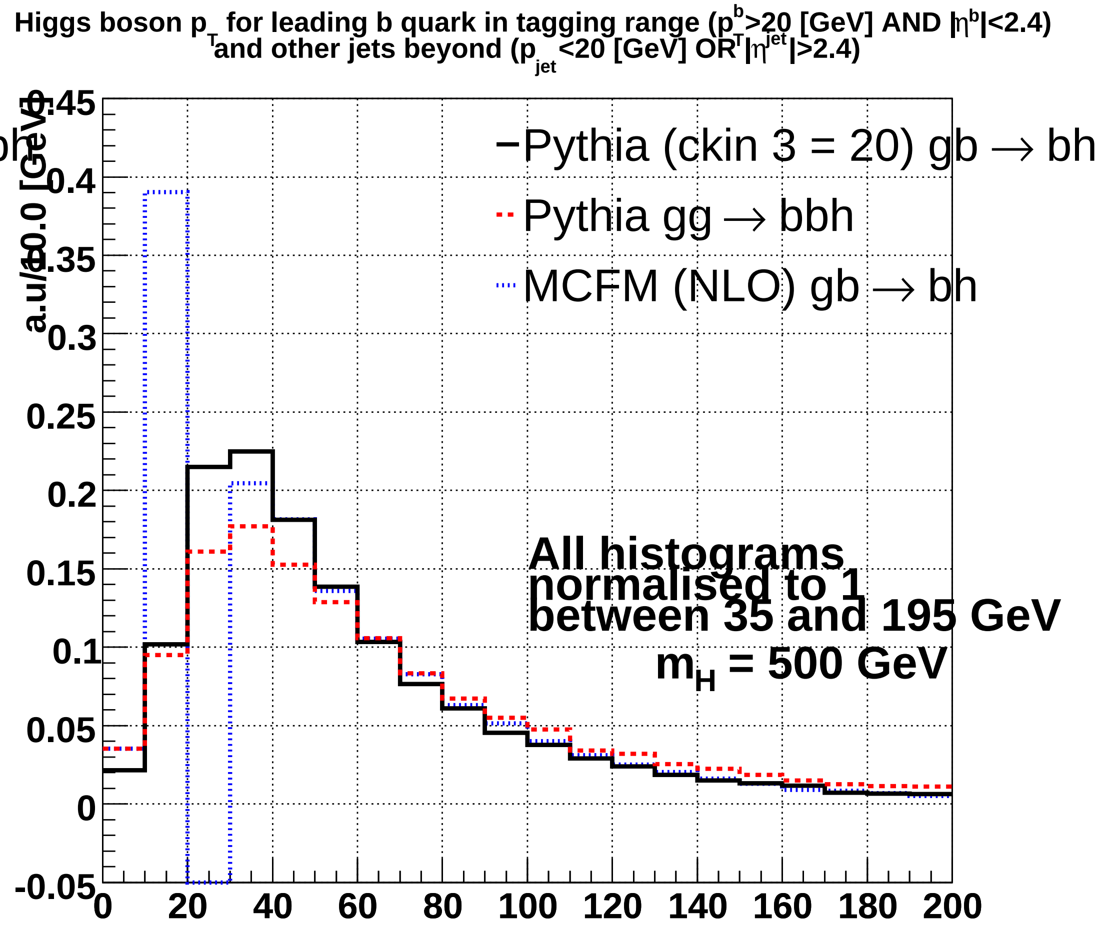
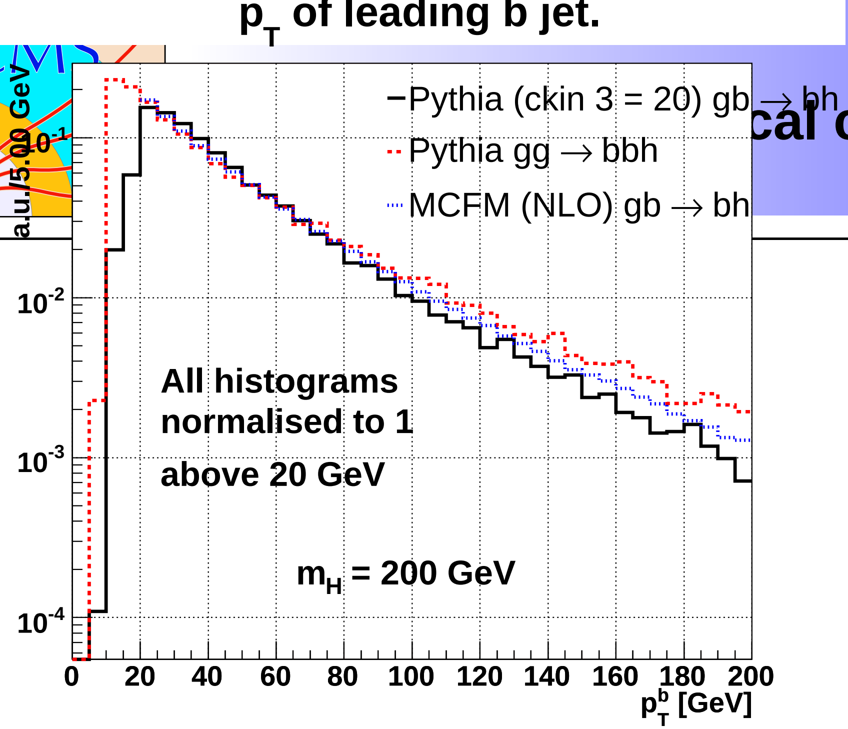
# Pythia vs. theoretical calculations for $gb \to bh$. Higgs $p_T$.

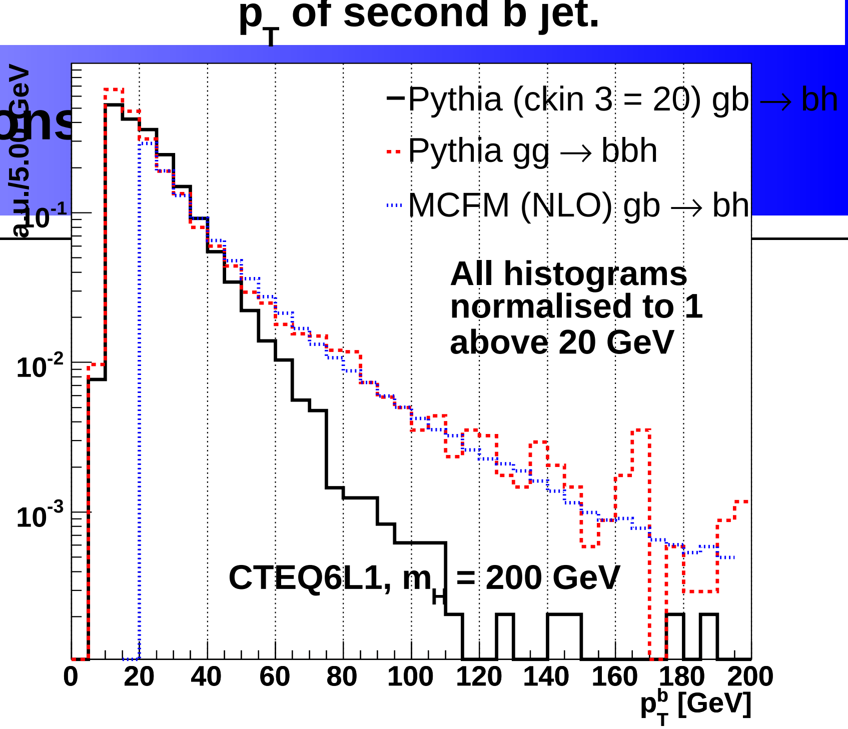


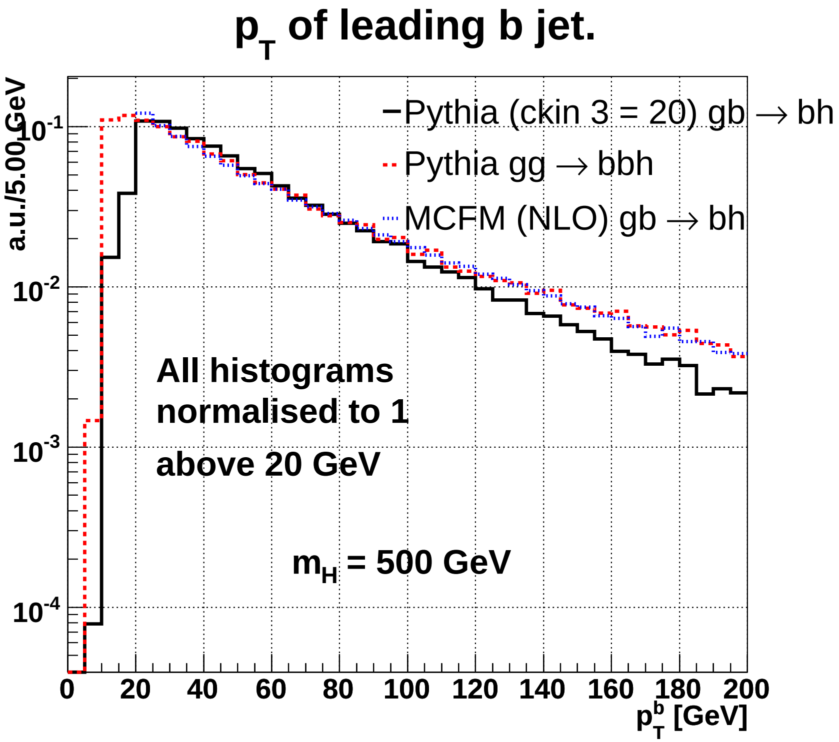



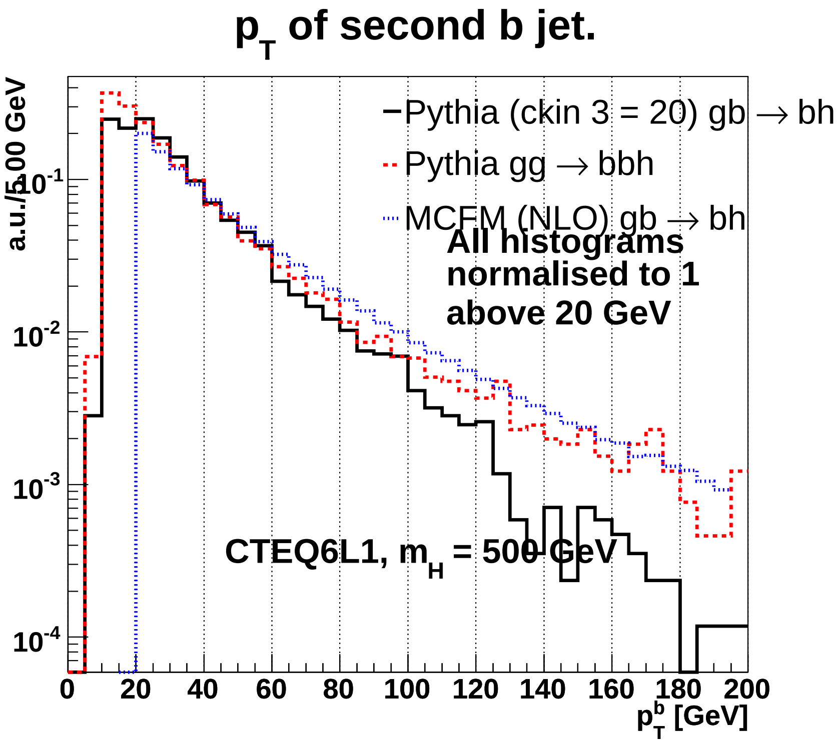
# Pythia vs. theoretical calculations for $gb \to bh$. b quark $p_T$.

## ...cal calculations

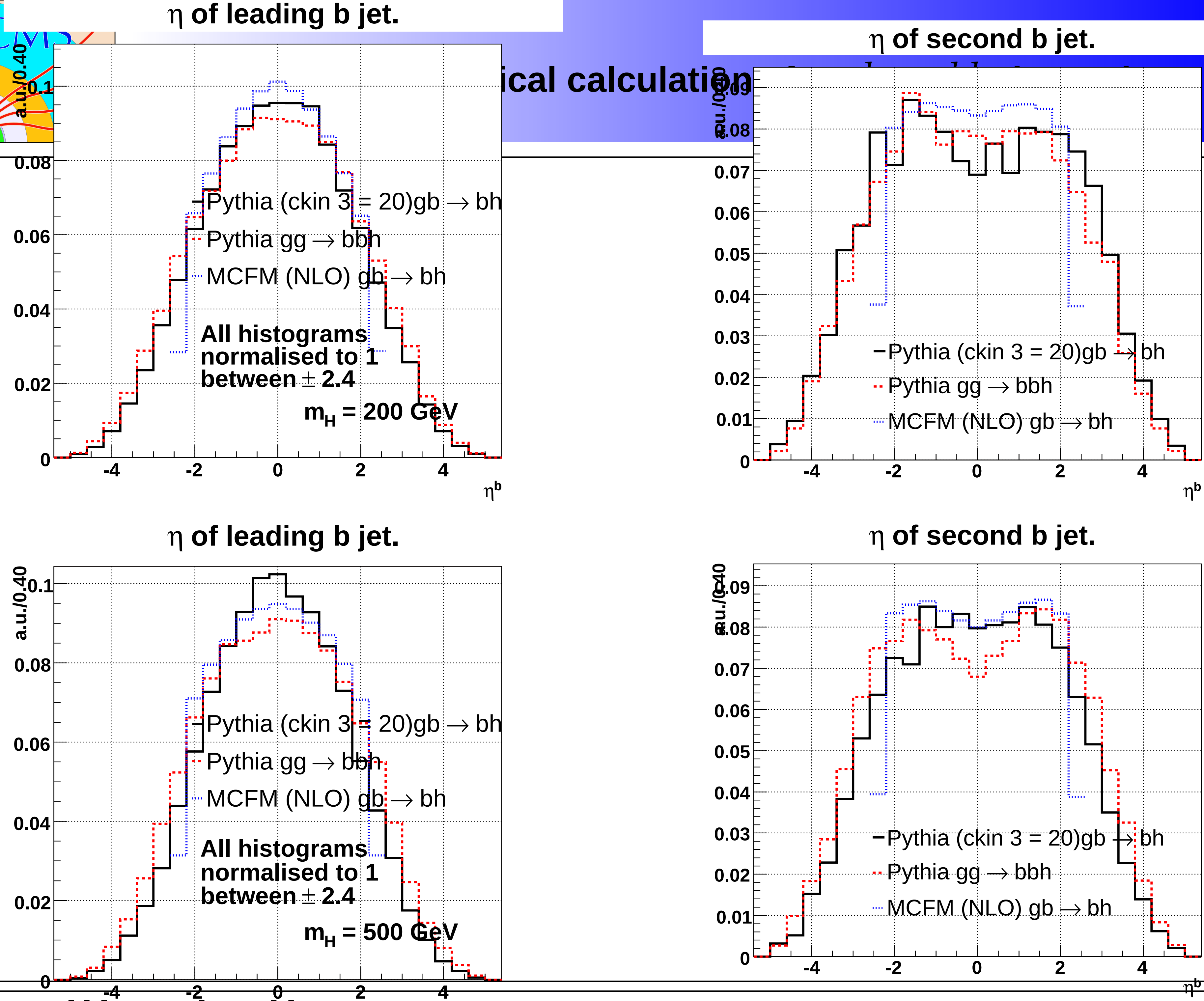


## ...ical calculation



For generation of b(b)H in Pythia use $gg \to bbH$ process.

(If you want to tag one b in your analysis)

Because:

- $p_T^b > 20\ GeV$ is to close to experimental cut on the b jet $E_T$, which is equal to $20\ GeV$.
- Second $p_T$ spectrum *b* is prperly generated only with $gg \to bbH$

Still there is an issue about $\eta$ distributions