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PYTHIA vs LO/NLO comparizon

for b quark spectra in gg->bbh and gb->bh production

HERA-LHC Workshop. MC tools group, 27 March 2004, CERN

Motivation

precision of tan(β) measurement in MSSM using bbH, H->2τ

R. Kinnunen, S. Lehti, F. Moortgat, A. Nikitenko, M. Spira ; contribution to Les Houches 2003

Idea: $N_S = \sigma \times L \times \varepsilon_{sel} = \tan^2(\beta)_{eff} \times F(M_A) \times L \times \varepsilon_{sel}$; at high tan(β)

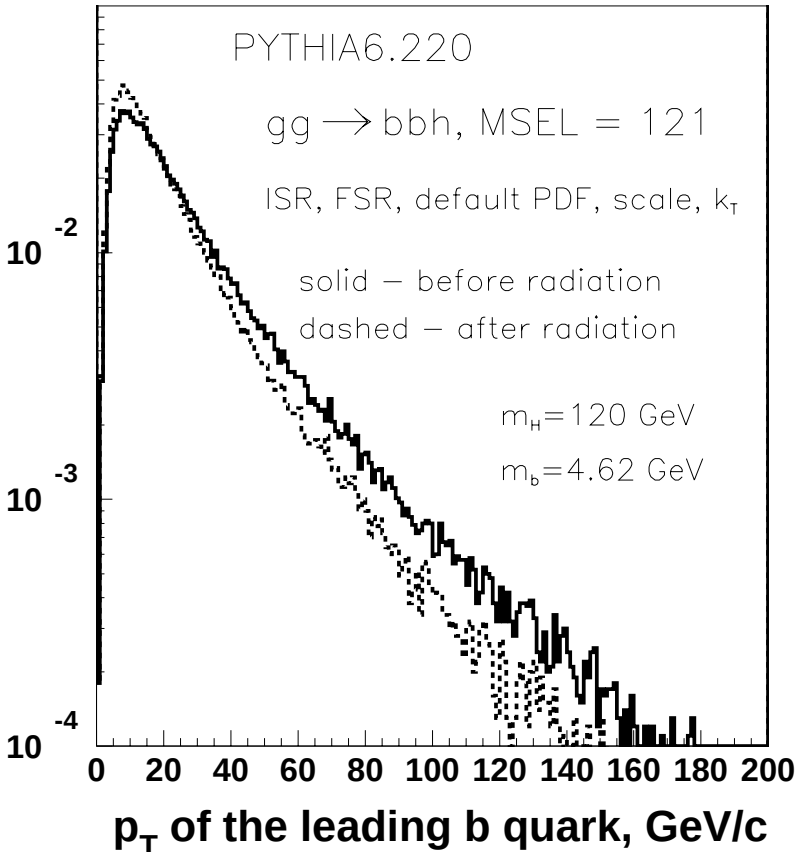
(F also depends on other SUSY parameters)

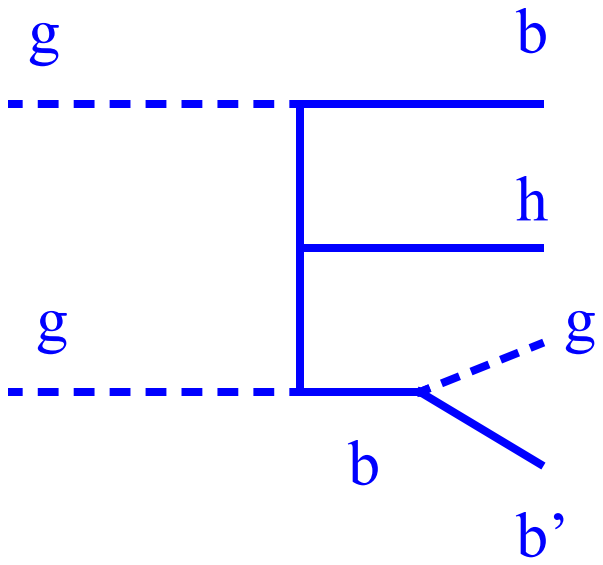
experimental selections use single b-tagging : $E_T^j > 20$ GeV, $|\eta_j| < 2.4$

source of uncertainty	contribution to tan(β) uncertainty
gg->bbh NLO cross section	10 %
h->2τ NLO Branching ratio	1.5 %
luminosity	2.5 %
statistics	4.0 %, M_A=200 GeV, tan(β)=20
mass M_A reconstuction precision	2.0 %, M_A=200 GeV, tan(β)=20
experimental selections	~ 2.5 % (preliminary)
accuracy of μ, M_2, M_{SUSY}, A_t	not considered
correct kinematics generation: b jet spectra for single b-tagging	**??? subject of this talk**

Comparizon of PYTHIA with LO/NLO for gg->bbh (I)

"LO / NLO" b quark spectra in PYTHIA6.220





LO - b quark before gluon radiation

NLO - b' quark after gluon radiation

this definition is in consistency with one used in LO/NLO calculations by S. Dittmaier, M. Kramer and M. Spira hep-ph/0309204, so we may compare p_t^b and $p_t^{b'}$ between PYTHIA and their LO/NLO calculations

Comparizon of PYTHIA with LO/NLO for gg->bbh (II)

Cross section as a function of p_T cut on the leading p_T b quark

- σ_{PYTHIA} is normalized at $\sigma_{NLO/LO}$ for $p_T > 0$ GeV
- LO (NLO) uses CTEQ6L1(CTEQ6M), $\mu = (2m_b+M_H) / 4$
- default settings in PYTHIA; work in progress to use the same PDF and scale as in LO/NLO calculations
- $M_H = 120$ GeV, $m_b=4.62$ GeV, Standard Model

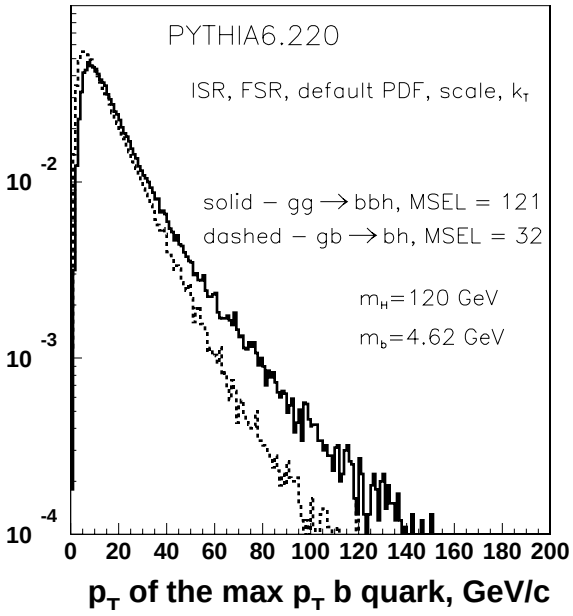
pT cut, GeV	0	10	20	30	40	50
σ_{NLO} (pb)	734	507	294	173	106	68
σ_{PYTHIA} (pb)	734	523	275	156	92	60
σ_{LO} (pb)	528	393	241	152	102	71
σ_{PYTHIA} (pb)	528	407	245	154	101	70

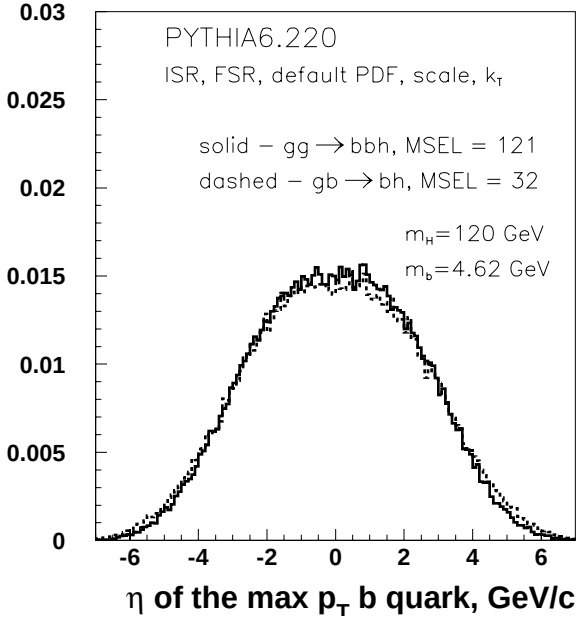
Agreement between PYTHIA and NLO at 5-10 % level

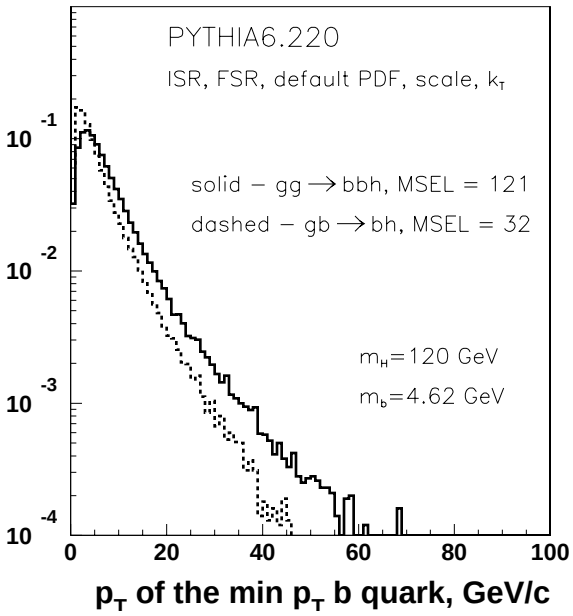
Agreement between PYTHIA and LO at the level of 1-2 %

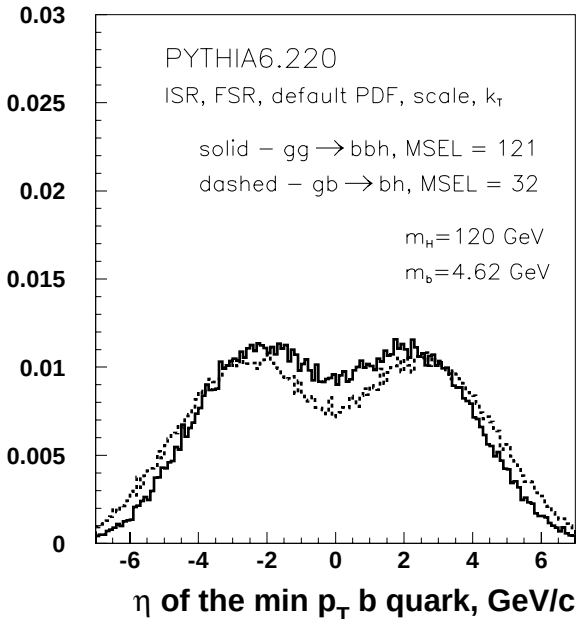
gg->bbh vs gb->bh in PYTHIA. what use to generate signal ?

p_T^b, η^b after radiation normalized on the same value









gg->bbh vs gb->bh : difference in "b-tagging" efficiency

parton "b tagging" : b quark of $p_T^b > 20$ GeV, $|\eta^b| < 2.4$

single and double "b-tagging" efficiency
with PYTHIA gg->bbh and gb->bh; $M_H = 120$ GeV

	gg->bbh	gb->bh
single b tagging	0.304	0.223
double b tagging	0.032	0.015

Difference of 27 % for single "b-tagging" efficiency

Difference of 47 % for double "b-tagging" efficiency

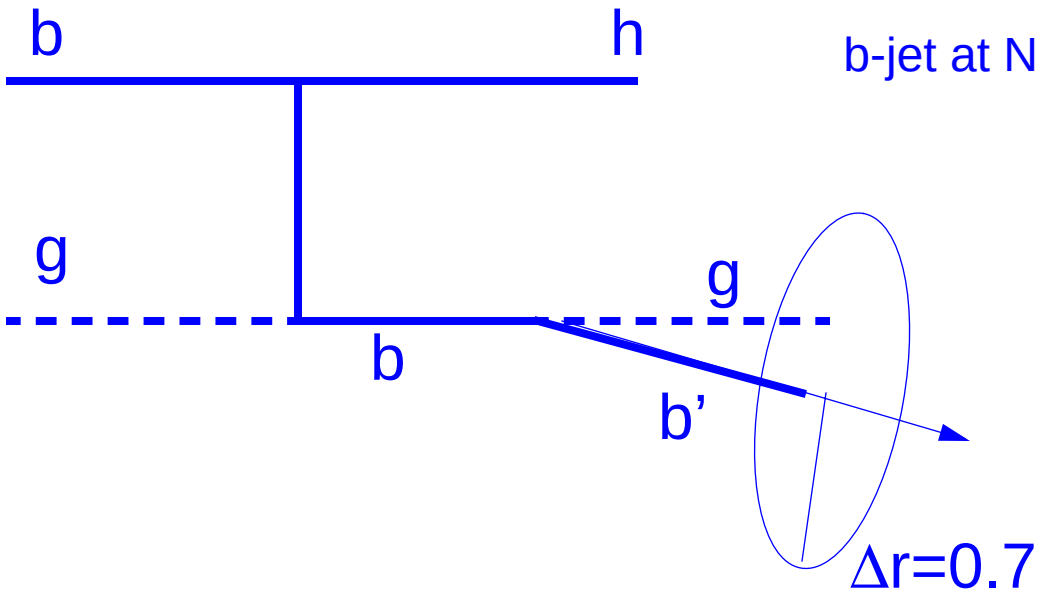
gb->bh : PYTHIA vs LO/NLO (I)

NLO for gb->bh :

J. Campbell, R.K. Ellis, F. Maltoni and S. Willenbrock, Phys. Rev. D 67 (2003), 095002

The leading b jet p_T spectra at NLO (and LO) was provided by

Scott Willenbrock, Fabio Maltoni and John Campbell

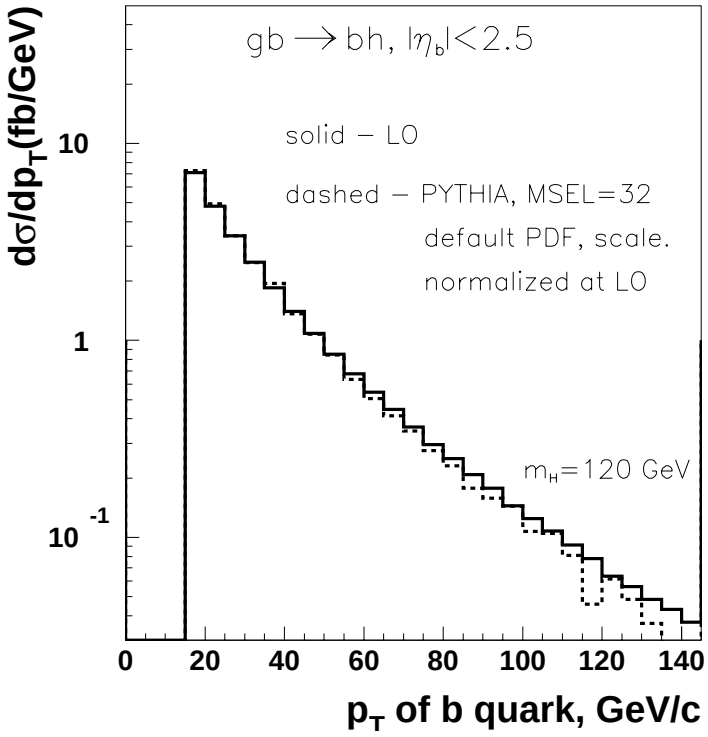


b-jet at NLO - b' quark and gluon(s) in cone 0.7 arownd b' quark direction. This definition is used in both NLO and PYTHIA generation.

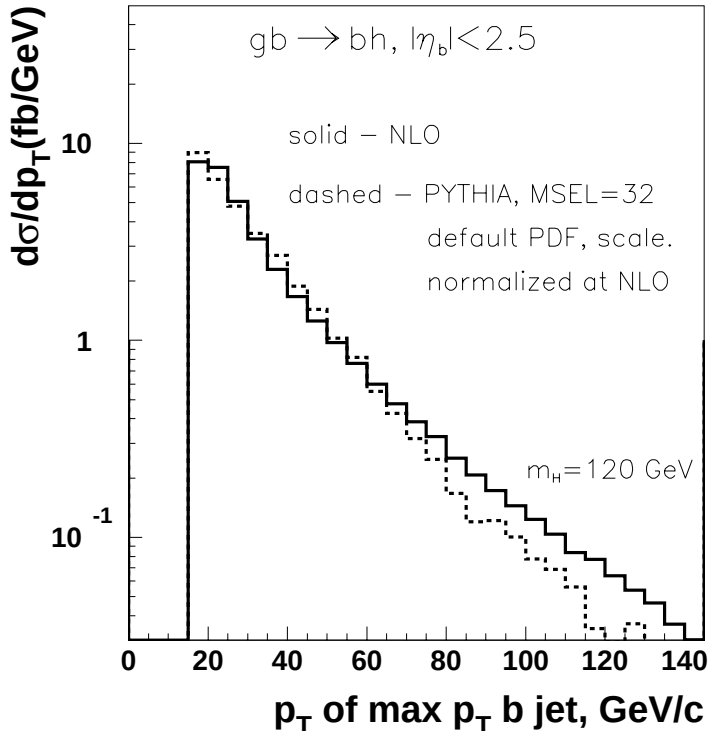
CTEQ6L1(M) for LO (NLO) calculations. $\mu_R = \mu_F = m_H$. Default settings in PYTHIA

gb->bh : PYTHIA vs LO/NLO (II)

PYTHIA cross section is normalized on LO and NLO cross sections



preliminary



Dood agreement between LO and PYTHIA, but worse for NLO.

Would be good to have LO/NLO spectra from 0 GeV : in MC generation we did not cut on p_T^b ; we cut later on E_T of the reconstructed and tagged b jet (~ 20 GeV)

Conclusion

gg->bbh production in PYTHIA provides agreement within ~ 10 % as compared with NLO for b quark spectra. It is another source of uncertainty for tan(β) measurement : signal generation uncertainty.

gb->bh - need more study before making conclusion.

for both gg->bbh and gb->bh : dependance on scale, pdf, η^b still has to be investigated