Flavour dependence of the Jet Energy Scales

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- (Our) motivation
- Datasets, cuts,....
- p_T(reco) / p_T(truth)
- p_T(reco) / p_T(parton)
- Conclusion / questions

Our motivation

- Top mass measurement requires a precise (1%) knowledge of:
  - the light jet energy scale → possible in-situ from the W mass peak
  - the b jet energy scale, or of the b / light ratio (~ 0.96)

- We tried to measure these energy scales using the P_T balance in γ/Z^0 + light jet , γ/Z^0 + b jet

- We ended up looking at the energy scales for all jet flavours in ttbar, γ/Z^0 + jet events, dijet events

Datasets, cuts

- ttbar:
  - user09.KojiTerashi.mc08.105200.T1_McAtNlo_Jimmy.recon.DPD_NOSKIM.e357_s462_r635_DPDMaker000164_p1
  - Take the 4 quarks in tt → lνb qqb decays, find the closest jet and truth jet ($\Delta R < 0.3$), require ΔR(jet, closest jet) > 1.0

- γ + jet:
  - user09.KojiTerashi.mc08.108001.PythiaPhotonJet1.recon.DPD_NOSKIM.e344_s479_r635_DPDMaker000164_p1 and 108002, 108003.
  - Use events with only 1 jet, require $\Delta\varphi$(jet, γ) > 3, take flavour from parton produced with the γ according to the MC history

- jet-jet:
  - user09.KojiTerashi.mc08.105010.J1_pythia_jetjet.recon.DPD_NOSKIM.e344_s479_r635_DPDMaker000164_p1, and 105011, 105012
  - Take the jets closest to the 2 quarks or gluons, $\Delta R < 0.3$, isolation ΔR(jet, closest jet) > 1.0

Jets

- use as default jets AntiKt4H1TopoJets, look also at AntiKt4LCTopoJets, AntiKt4TopoJets

Flavour content

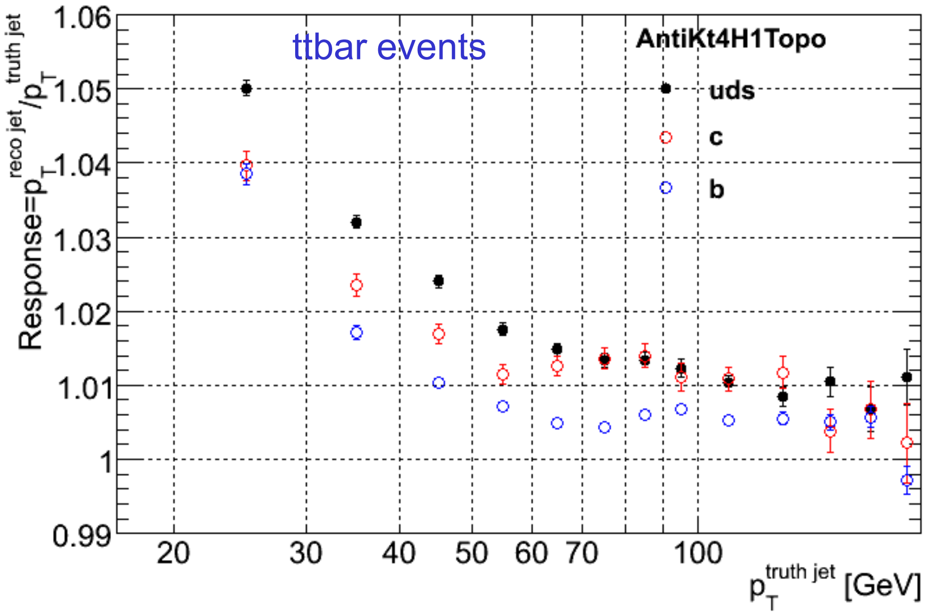
- ttbar contains ~ 50% b jets, 37.5 uds jets, 12.5 c jets. The ultimate goal being to calibrate these jets for mass measurement, we didn't consider gluon jets in these events

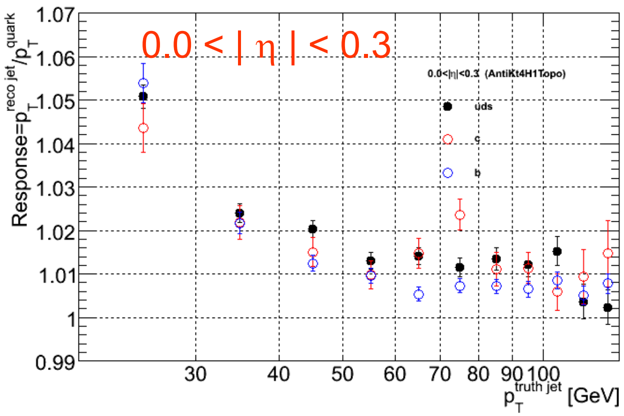
- γ + jet contains about 73% uds, 16% c, 9% g, 2% b
  - Not enough statistics to study correctly the g and b energy scales in this dataset

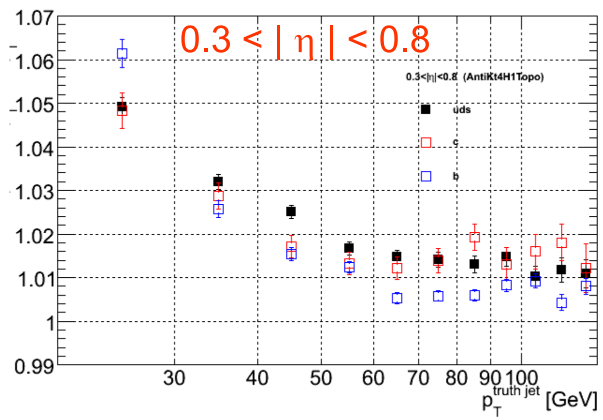
- Jet-jet contains 23% uds, 2% c, 2% b, 73% g
  - Very different than the others

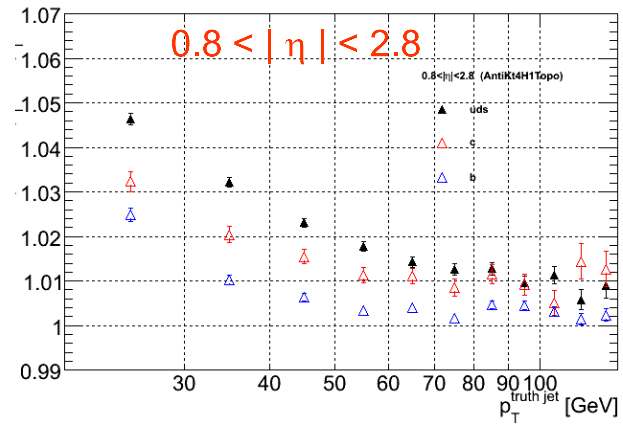
Detector response P_T(reco jet) / P_T(truth jet)

- Values in the plots are mean value of gaussian fits
- All responses agree within 1%, b seems lower than uds
- It seems that all of this difference due to $\eta > 0.8$
  → Any idea why ??

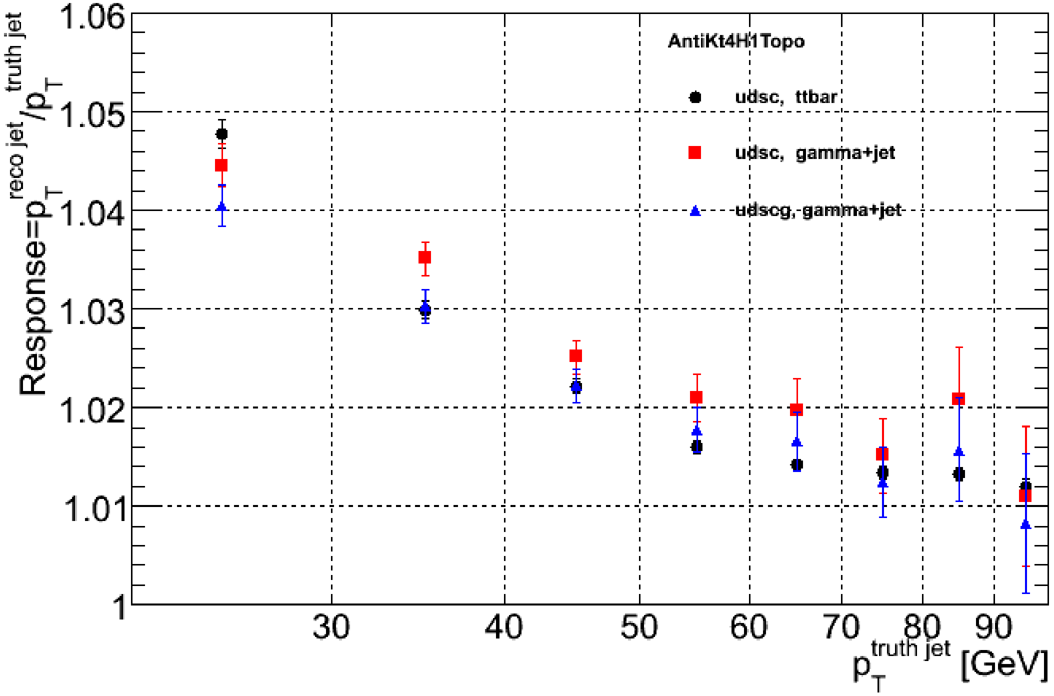








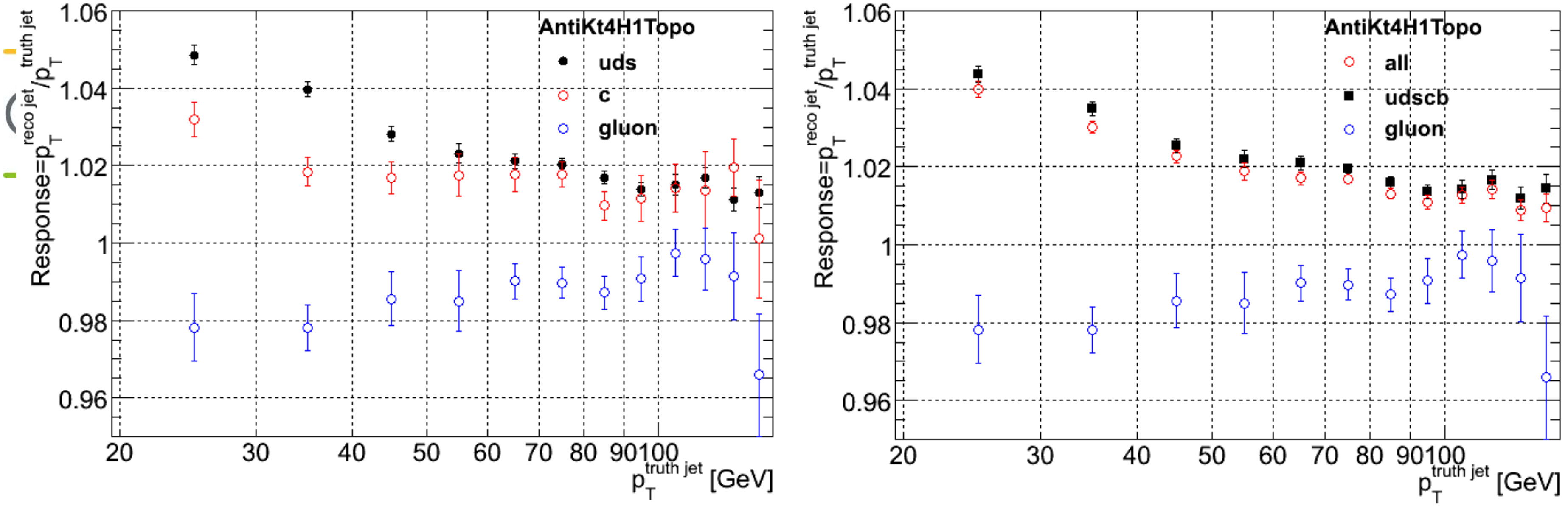
Light jets in ttbar and in γ + jet



- udsc are comparable in ttbar and γ + jet

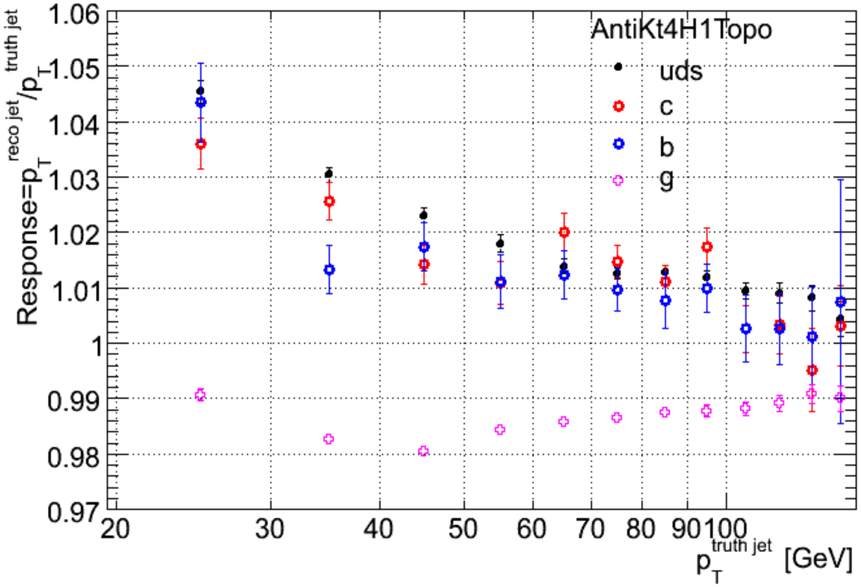
- 9% gluons in γ + jet shift the ratio by ~0.5% → still negligible here, but may be important in other processes (Z+j have 20% of g according to Pythia)

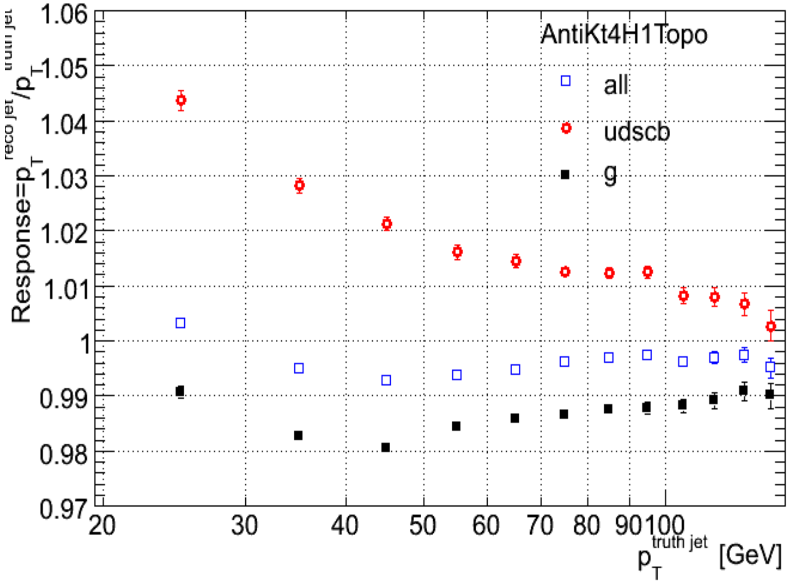
γ + jet events



- c jets seem lower than uds (as in ttbar events)
- Gluon jets are much lower (do we know why ?)

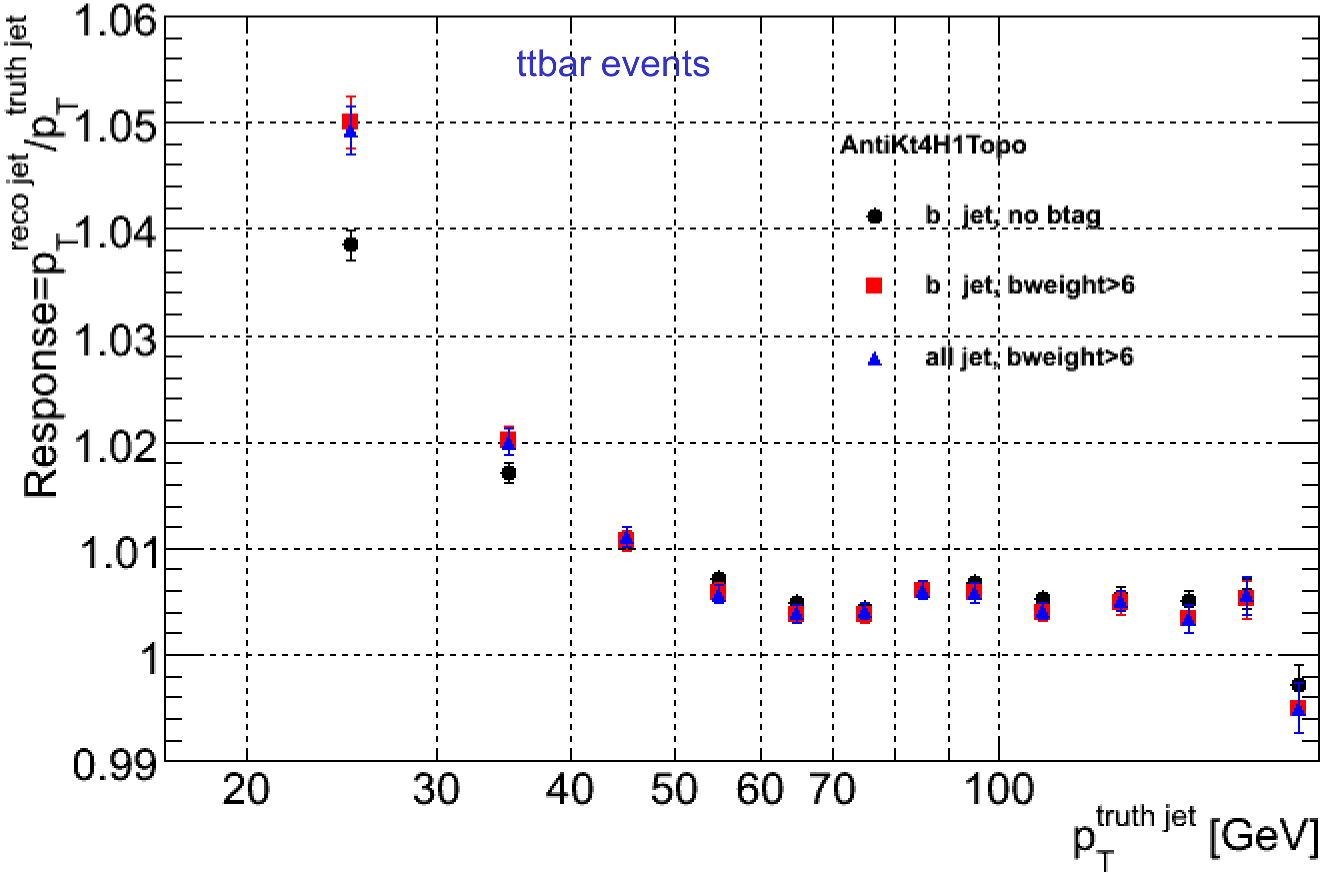
Di-jet events





- Average over all flavours is close to 1
- All quark flavours compatible within 1%, and compatible with the values in ttbar and γ + jet events
- Gluon jets compatible with the ones in γ + jet events, much lower than quark jets

b jets: does the b-tagging affect the response ?

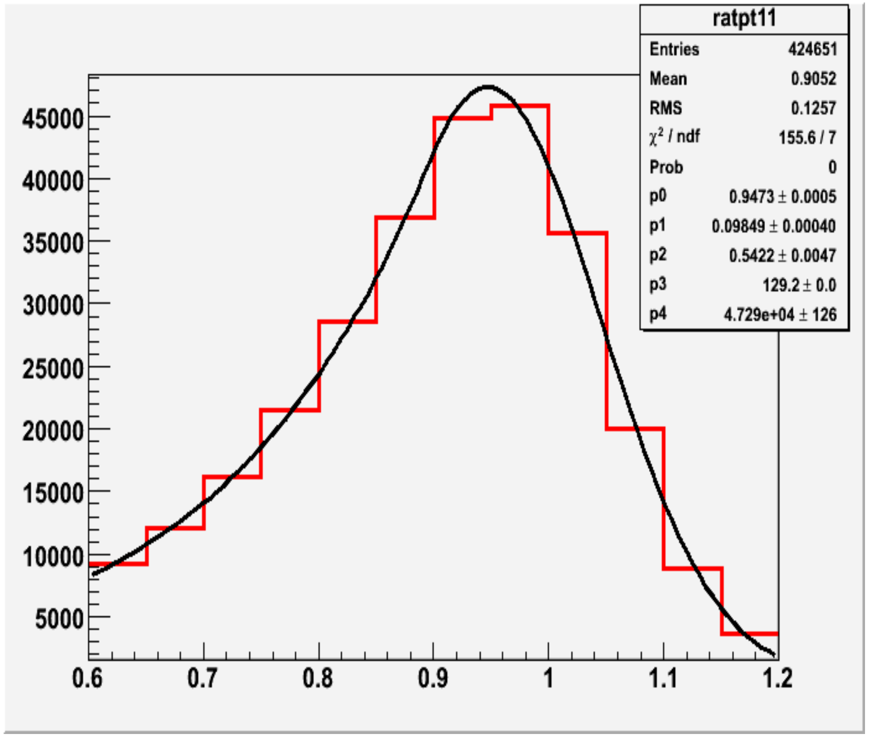


- Apart from first bin (statistical fluctuation ?), neither the b-tagging itself nor the contamination of light jets (=5% in ttbar) affect the ratio
- Statistics of b jets not large enough in γ + jet

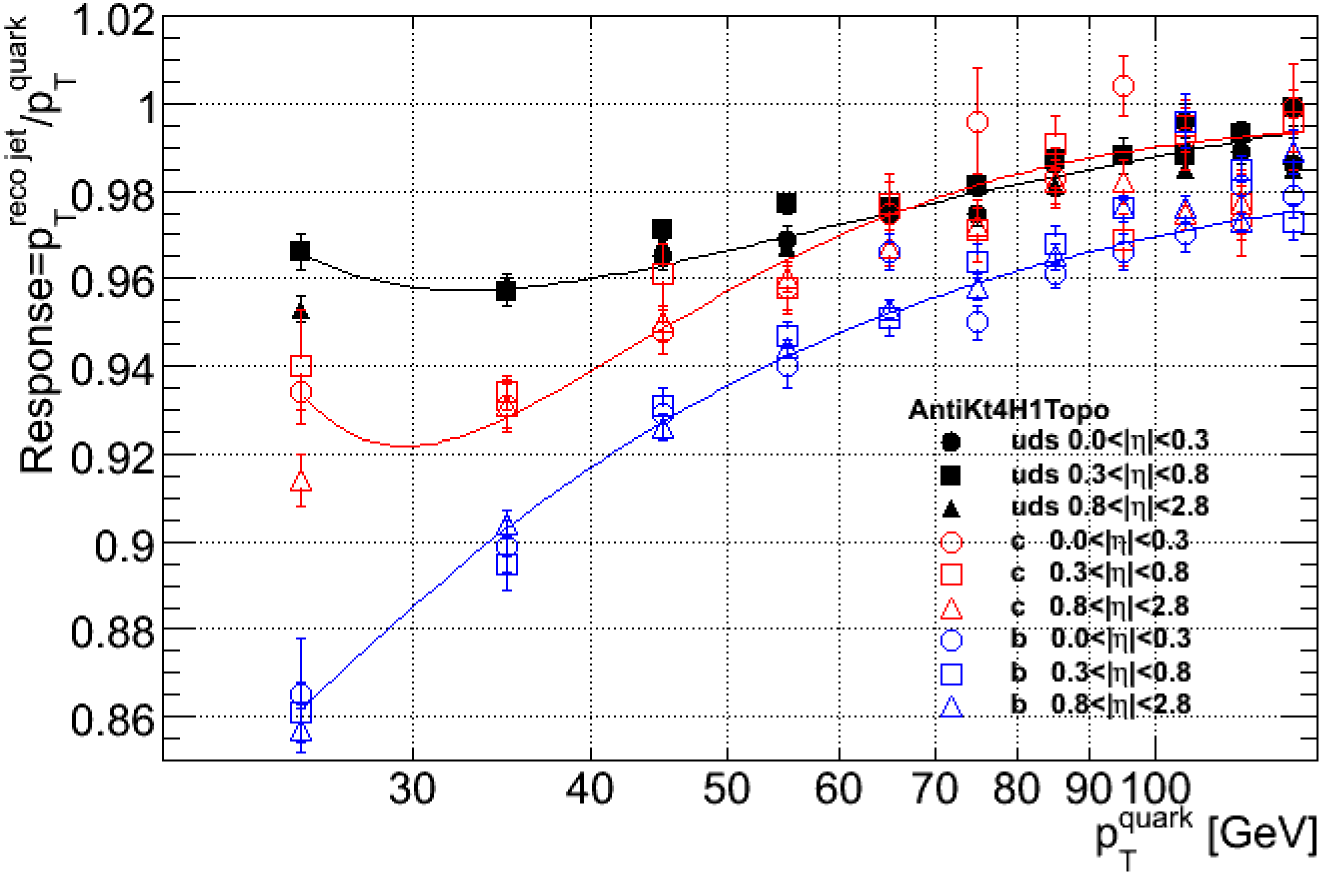
Going to P_T(reco jet) / P_T(parton)

- This is both:
  - What we need at the end, for example for top mass measurement
  - What we can measure, for example using the PT balance in g + jet (up to additional gluon radiation effects), or by using the W mass peak in ttbar

- Distributions no longer gaussian:
  - Fit gaussian + power law
  - Plot position of gaussian peak (p_0) in following plots

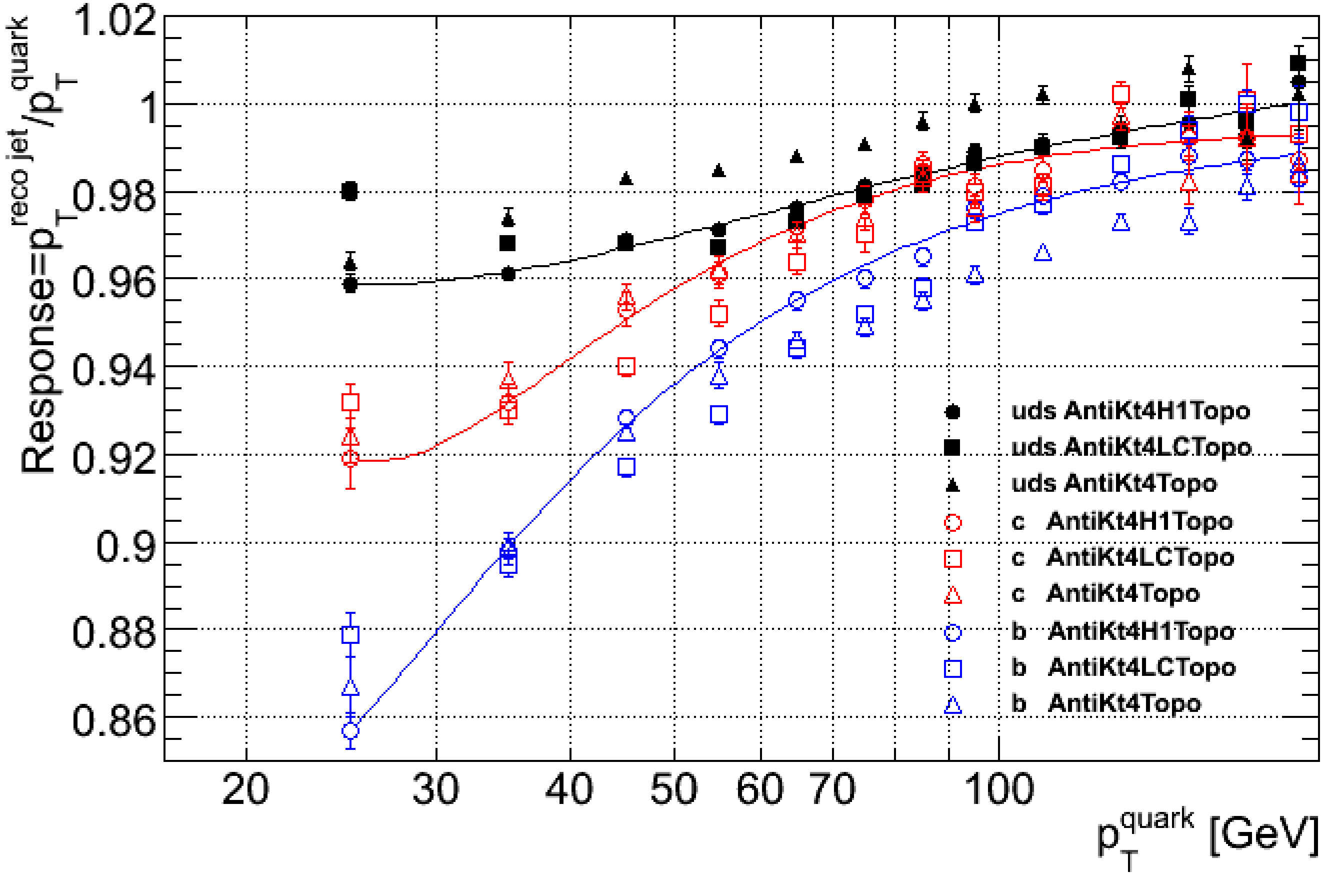


JES of different flavor in different eta range (ttbar)



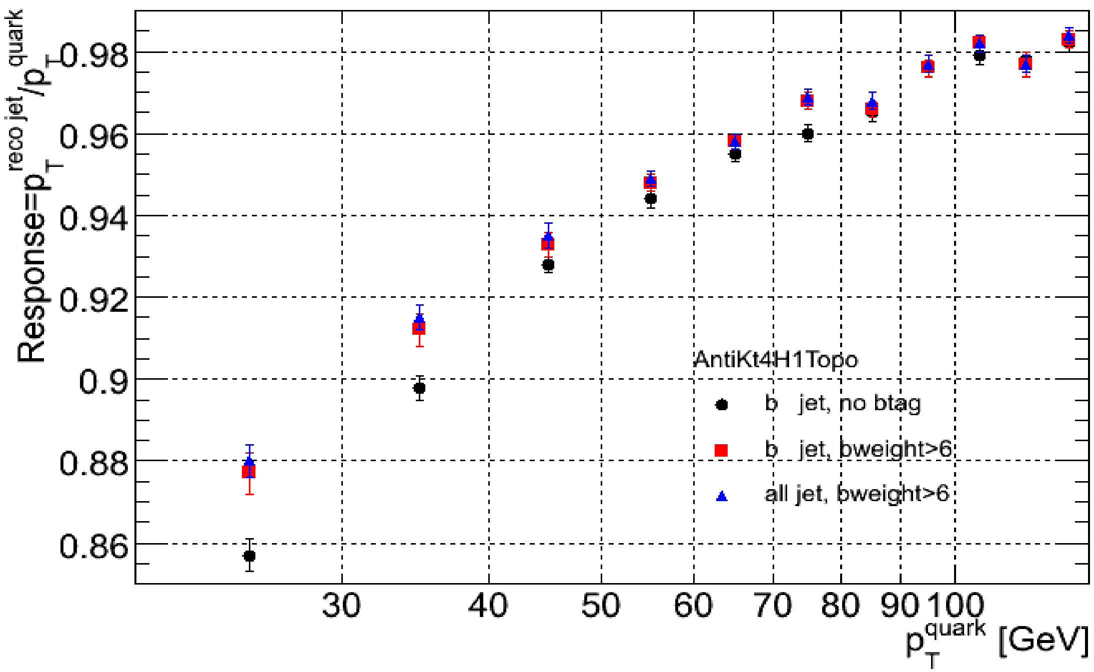
JES depends on jet flavor. The flavor dependence of the jet energy scale doesn't depend on eta (thus on other plots we will always integrate over all eta values)

JES of different flavor in different jet calibration scheme (ttbar)



The flavor dependence of the JES is not very dependent on the jet calibration scheme. The difference is smaller than the difference due to the flavor

The effect of the b-tagging (SV1+IP3D) on the JES (ttbar)



	bweight>6		no bweight	
	JES	N	**JES**	N
b	0.967±0.001	123258	0.963±0.001	227001
all	0.968±0.001	128159		

For b JES, 0.5% shift due to bweight cut

In ttbar, the effect of contamination by udsc jet can be neglected

Conclusion / questions

- P_T(reco jet) / P_T(truth jet) doesn't seem very dependent on quark flavour
- For the same flavour, the ratio doesn't depend on the process
- But P_T(reco jet) / P_T(parton) does depend on flavour
  - → Because of different flavour content (for example fraction of gluon jets), average energy scale in different processes will be different
  - → When trying to measure the b energy scale, contamination by light jets should be taken into account

- Questions:
  - – To which level do we believe the fraction of gluons (and other flavours) given by Pythia in γ/Z^0 + jet , jet-jet events ?
  - – Do we know why the ratio P_T(reco jet) / P_T(truth jet) for gluon jets is much lower than for quark jets

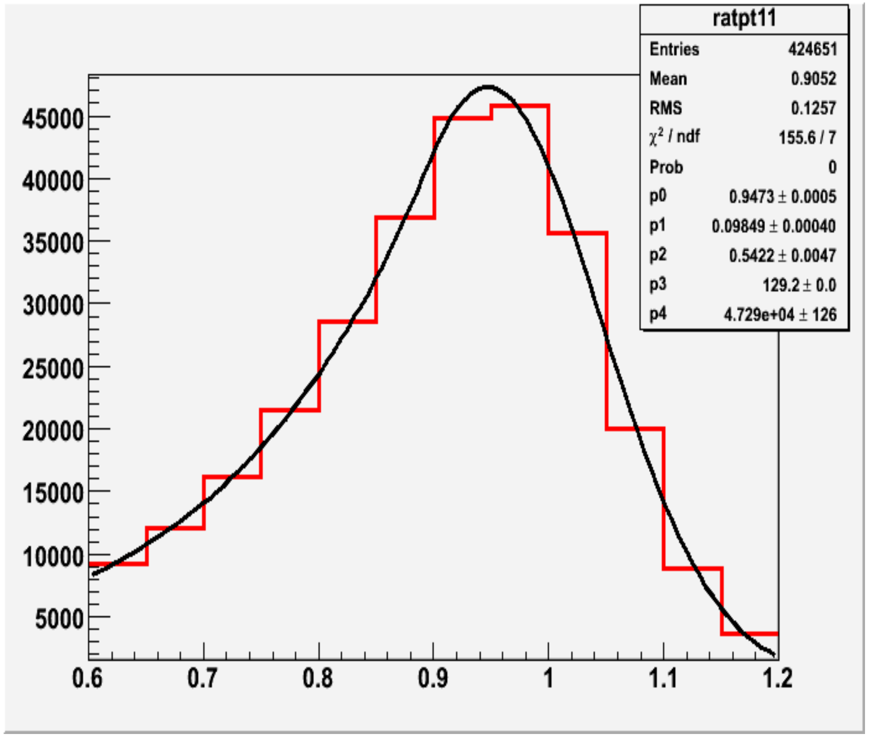
Backup

Fit function details

look at P_T_jet/P_T_q(g), fit with function f(x):

When $(x-p_0)/p_1 \geq -abs(p_2)$, $f(x)=p_4*exp(-0.5*(x-p_0)**2/p_1**2)$;

When $(x-p_0)/p_1 < -abs(p_2)$, $f(x)=p_4*exp(-0.5*p_2*p_2)*TMath::Power(p_3/abs(p_2), p_3)$
$/TMath::Power(p_3/abs(p_2)-abs(p_2)-(x-p_0)/p_1, p_3)$



Gaussian + Power Law.

p_0 : the position of peak;

p_1 : width;

p_2 : # of sigmas from which the power law takes precedence over the Gaussian;

p_3 : for power law tails;

p_4 : normalization.

Flavour content details

- Di-jet events

	N before cuts	Frac bef. cuts	N after cuts	Frac after cuts	<JES>
u	60590	11.3%	16877	10.4%	1.022±0.001
d	42151	7.8%	14594	9.0%	1.022±0.001
s	18542	3.4%	8342	5.2%	1.012±0.001
c	13689	2.5%	6286	3.9%	1.018±0.001
b	8975	1.7%	3928	2.4%	1.013±0.002
g	394415	73.3%	111941	69.1%	0.986±0.001

- γ + jet events

	N before cuts	Frac bef. cuts	N after cuts	Frac after cuts	<JES>
u	178367	55.9%	16516	56.2%	1.027±0.001
d	35878	11.3%	3464	11.8%	1.027±0.001
s	17702	5.6%	1661	5.7%	1.022±0.001
c	52468	16.4%	4570	16.6%	1.022±0.001
b	7797	2.4%	521	1.8%	1.016±0.005
g	26643	8.4%	2622	8.9%	0.987±0.002