b-jet Energy Scale Using Z→bb

宇宙史拠点実習I 説明会 – 06/19/08

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Introduction

A large sized Z^0 →bb signal can in principle be used as a tool to:

- **measure specific energy scale of b-quark jets:**

  → Reduction of uncertainty in b-JES helps all precision measurement of **top quark mass**

- **improve b-jet energy resolution**

  → **develop and test algorithm to improve b-jet energy resolution:** important for low mass **Higgs** searches.

Analysis objective: extract a signal, measure data/MC b-JES

The applicability of the extracted scale will be subject of additional studies

Unbinned Likelihood Fit

We use an unbinned likelihood procedure to measure the number of signal events and the b-JES scale factor in our data.

$$\mathcal{L}(SF) = \mathcal{L}_{shape}(SF) \times \mathcal{L}_{(n_s+n_b)}, \text{ with}$$

$$\mathcal{L}_{shape}(SF) = \prod_{i=1}^{N} \frac{n_s P_s(m_i; SF) + n_b P_b(m_i)}{n_s + n_b}, \text{ and}$$

$$\mathcal{L}_{(n_s+n_b)} = \frac{e^{-(n_s+n_b)}(n_s+n_b)^N}{N!}$$

n_s and n_b: numbers of signal and background events,

$P_s(m_i,SF)$ and $P_b(m_i)$: signal and background p.d.f's.

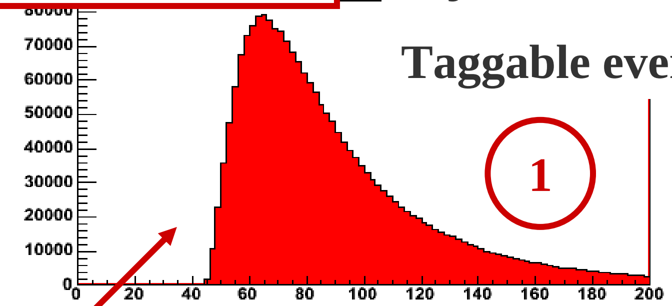
We minimise –ln(L) to find best SF hypothesis. Statistical error is given by the difference between this SF and the SF at $-\ln(L_{max}) + 0.5$.

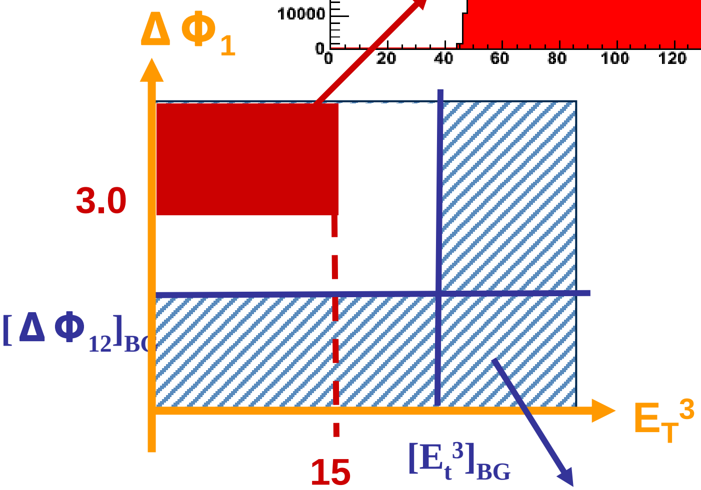
Data-driven BG Modeling

Signal Region

Dijets mass

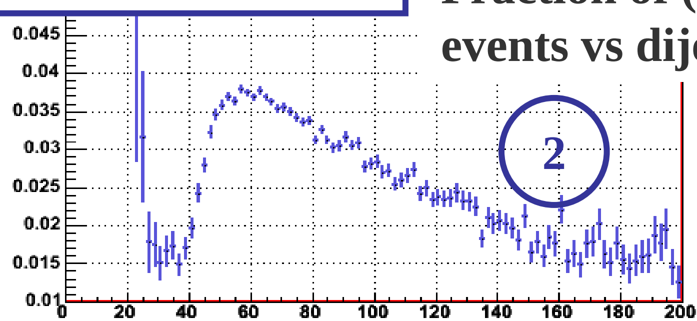
Taggable events





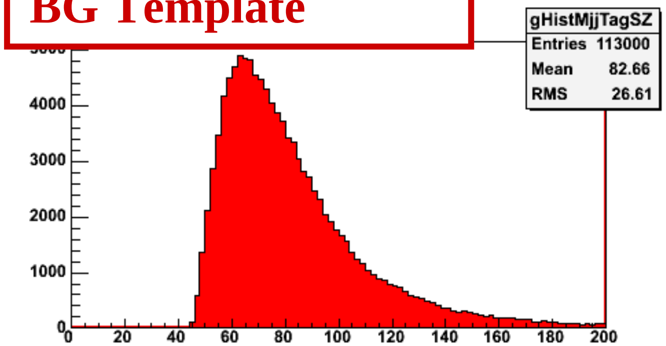
Tag ratio: BG Region

Fraction of (++) events vs dijet mass



1 × 2

BG Template



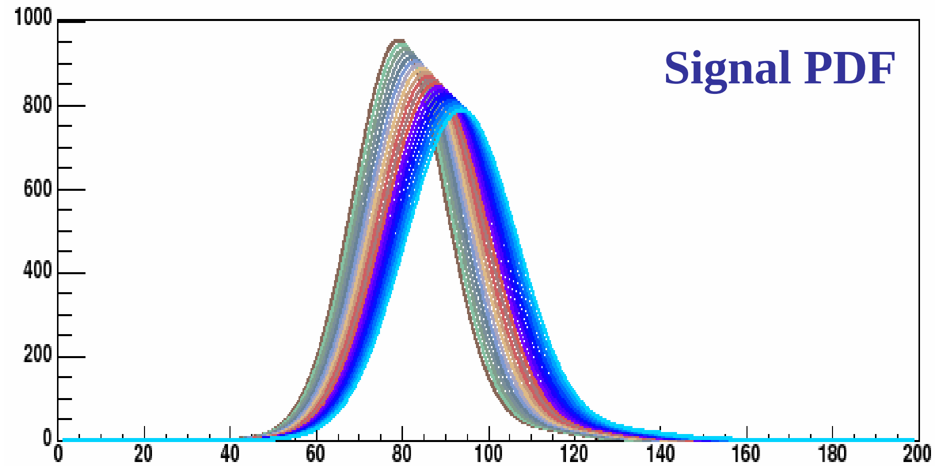
Distribution is then parameterized with a p.d.f.

Probability Density Functions

Signal PDF

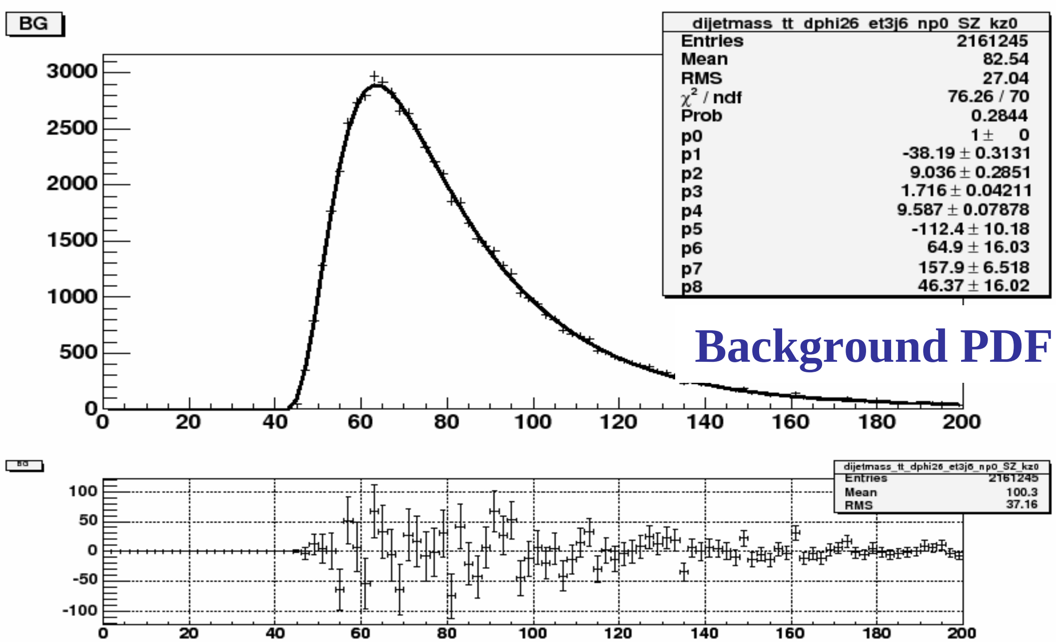
Dijet invariant mass shape is obtained from MC (pythia, Z➔bb + MB events).

We construct one single signal PDF which has **b-jet energy scale factor (SF) as a parameter:** ***Ps(mjj,SF).***



Parameterization of data-driven BG model

BG model is constructed from data and then parameterized.



Systematic Uncertainties

Systematic Source	b-JES factor	N signal events	
Background choice	+0.012 -0.006	+1391 -301	Sideband fit choice
Background statistics	0.0105	445	BG template shape (*)
Background correction	0.0050	36	BG correction method (*)
MC template	0.0027	177	Fit of original mass templates with signal PDF (*)
MC statistics	0.0020	62	Stat. of original template (*)
Total	+0.0170 -0.0135	+1473 -570	

(*) pseudo-exp, assuming signal fraction of 2%, b-JES: 0.96, 0.97 and 0.98

(*) pseudo-exp, assuming signal fraction of 2%, b-JES: 0.974

Other MC Uncertainties

These uncertainties are related to the choice made in the MC generation and they are not to be included in our b-JES factor measurement.

Their effect is interesting to be measured though.

Source	b-JES factor	N signal events
Monte-Carlo ISR	0.0040	263
Monte-Carlo FSR	0.0116	111
Monte-Carlo PDF's	+0.0052 -0.0054	+617 -574

Source	b-JES syst.	N_{sig} syst.
CTEQ6Mx	+0.0039 -0.0041	+358 -277
MRST72/CTEQ5L	+0.0034	-414
MRST72/MRST75	-0.0034	+286
Total	+0.0052 -0.0054	+617 -574

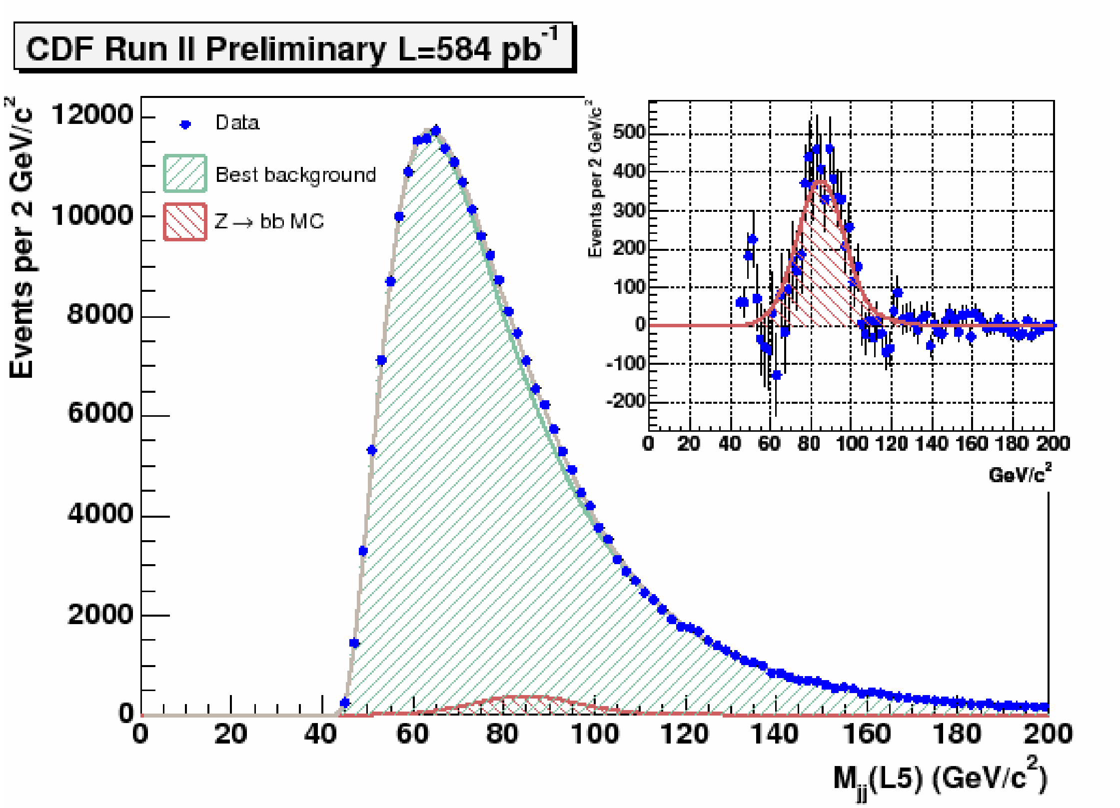
Result

We measured **data/MC b-jet energy scale factor using Z→bb** reconstructed signal

Preliminary measurement gives:

b-JES = $0.974 \pm 0.011(stat.)\ ^{+0.017}_{-0.014}\ (syst.) = 0.974\ ^{+0.020}_{-0.018}$

$N_{sig} = 5674 \pm 448(stat.)\ ^{+1473}_{-570}(syst.) = 5674\ ^{+1540}_{-725}$ events



Nexp = 4630 ± 727 events.

Reasonable agreement.

Goodness of fit:
χ^2/NDF = 104/75

To Do

Redo the analysis with jet cone size 0.4

- The previous result were obtained using cone size 0.7.
- Many analyses (top, higgs, etc.) are using cone size 0.4.
- To apply Z->bbbar result to other analyses, we need **b-jet energy scale with cone size 0.4**.

All the tools are ready. We just need remake/recalculate:

- Ntuples ← Done by Y. Sudo.
- MC Templates
- BG Modeling
- Acceptance Study ← Done by Y. Sudo.
- Systematics