Status Report of DLM for Top Mass Measurement in l+4j channel

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Moving to Gen6

- Check methodology of previous analysis(K.Yorita) with Gen5
  - Check consistency with signal sample only
    - ✔ Start with reproducing performance of previous analysis with same methodology
      - ✗ Transfer Function
      - ✗ Joint Likelihood
      - ✗ Pseudo Experiment

- Gen6 Analysis
  - ✔ Is Gen6 comparable to Gen5?
    - ✗ Transfer Function
    - ✗ Likelihood
  - ✔ Plan of DLM for Gen6

Methodology Check

Check the methodology of previous analysis

Per Path Likelihood: Single reconstruction x from y(Bayes' formula)

$$L_{path}(x_i, M; y_j) = N_j \frac{d\sigma}{d\Phi}(x_i; M)\, w(x_i; y_j)$$

$$N_j^{-1} = \int_{min}^{max} dM \int dx \frac{d\sigma}{d\Phi}(x; M)\, w(x; y)$$

Per Event Likelihood

$$L_{ev}(M) = \sum_i L_{path}(x_i, M; y_j)$$

- Check performance of TF
  - ✓ invariant mass of W
  - ✓ invariant mass of Top

Likelihood from sample

$$L(M) = \prod^{ev} L_{ev}(M)$$

- ✓ Check performance of Joint Likelihood
  - → Mass reconstruction for each mass sample
  - → Pseudo Experiment

Transfer Function

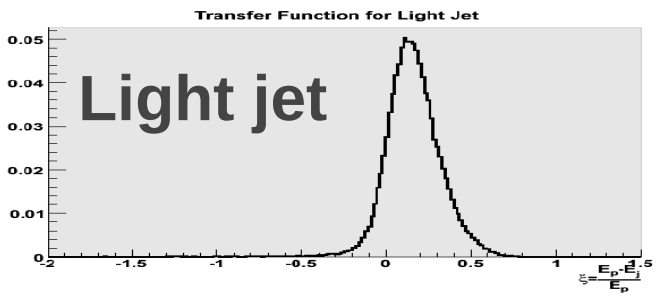
How to make TF

- Exactly 4 jets events
- Jet-parton matching
- Fill $\xi = \frac{E_{parton} - E_{jet}}{E_{parton}}$
- Use histogram as a Transfer Function

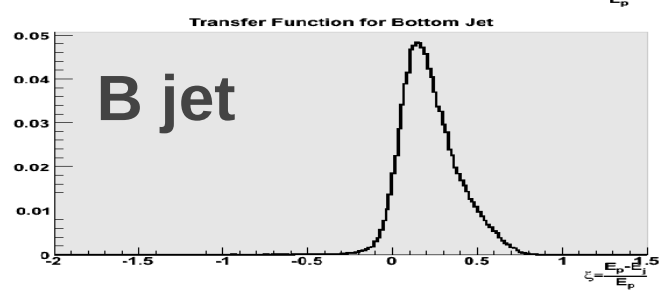
- 175 GeV sample
- <u>No Et and Eta sorting</u>
  - Just one TF for light jet and b jet

How to use TF

<u>For each scan</u>

y(jet) → 

→ x(light quark)

y(jet) → 

→ x(bottom quark)

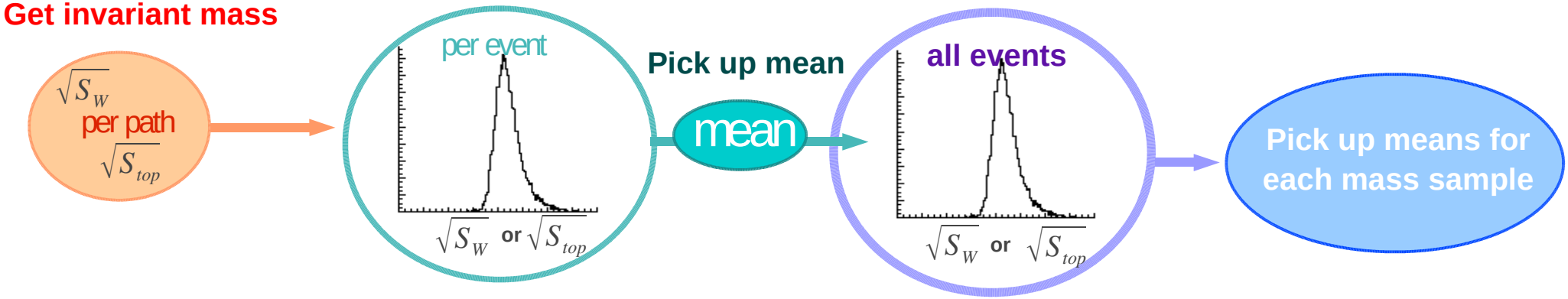
Performance of Transfer Function

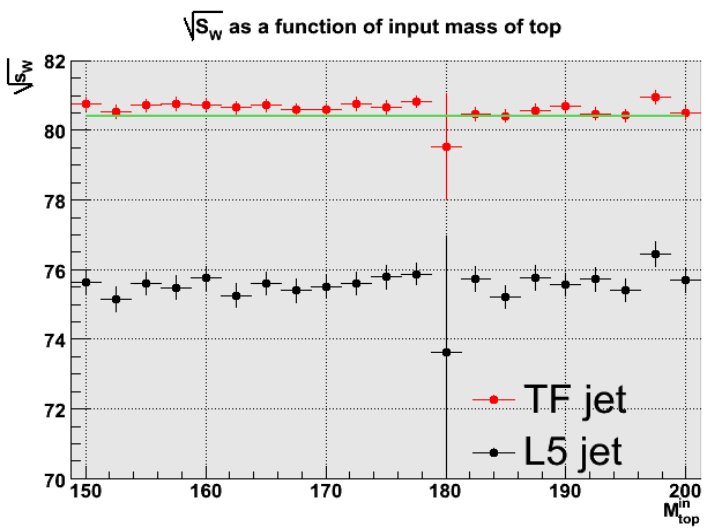
Step1:per path **Step2:per event** **Step3:per mass samples**

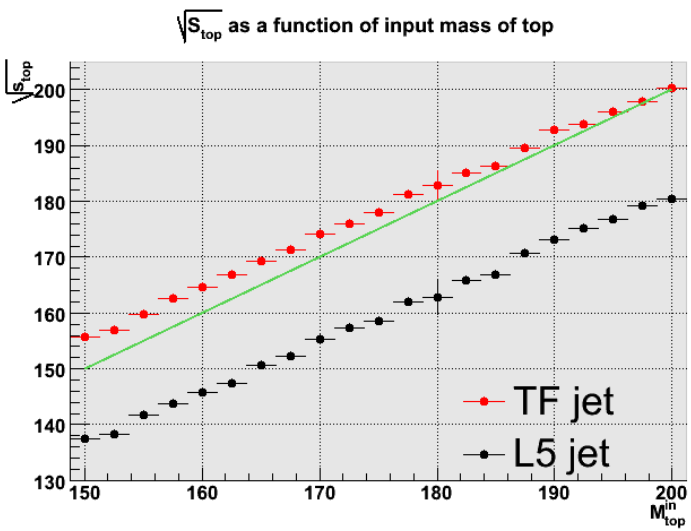
Fill histogram for all paths

Fill histogram for all events

Get invariant mass





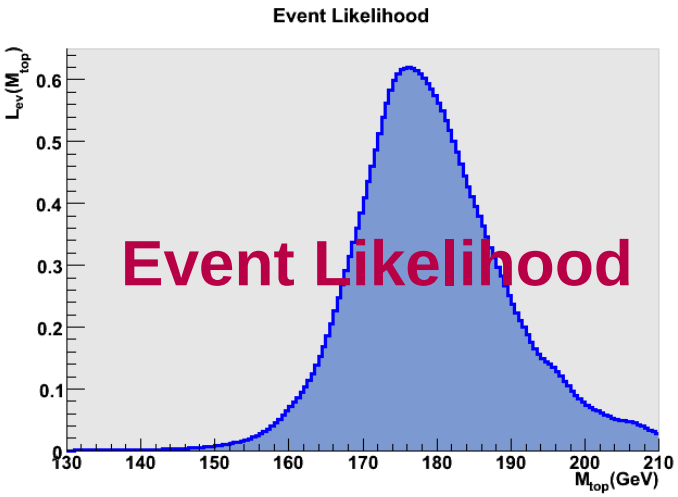


*TF: single function

Likelihood

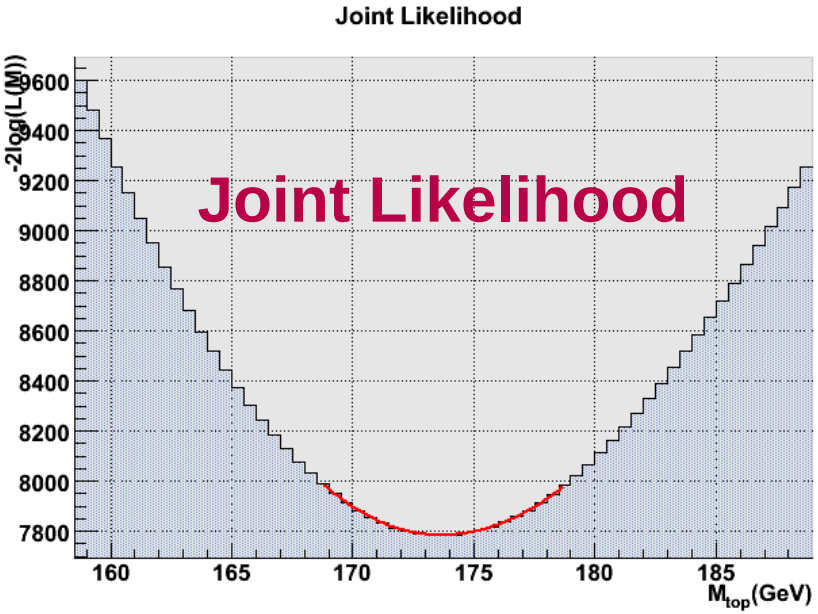
Per Event Likelihood

$$L_{ev}(M, y_j) = N_j \sum_i \frac{d\sigma}{d\Phi}(x_i; M)\, w(x_i; y_j)$$



Joint Likelihood

$$L(M) = \prod_j^{Nev} L_{ev}(M, y_j)$$



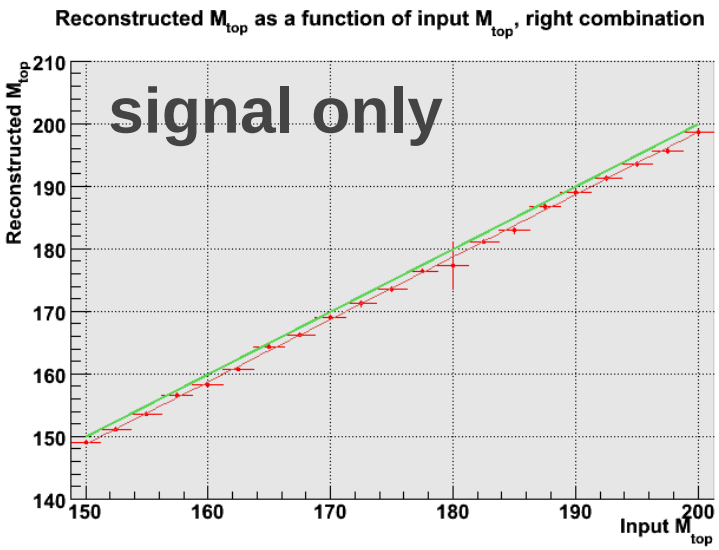
input = 175GeV
Nev = 1.2k
Nscan = 50k

*** TF: single function**

Top Mass Reconstruction

Reconstructed Mass for each mass sample

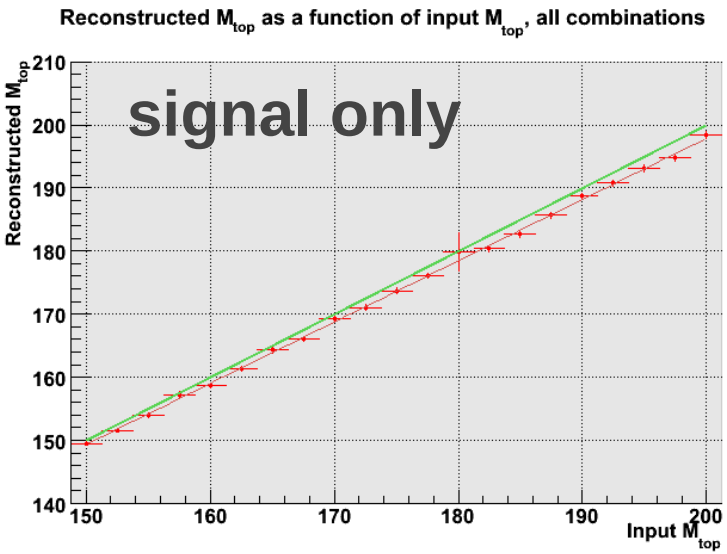
Right combination



slope: 0.998+-0.0053

intercept@175GeV: 173.68

All combination



slope: 0.972+-0.0062

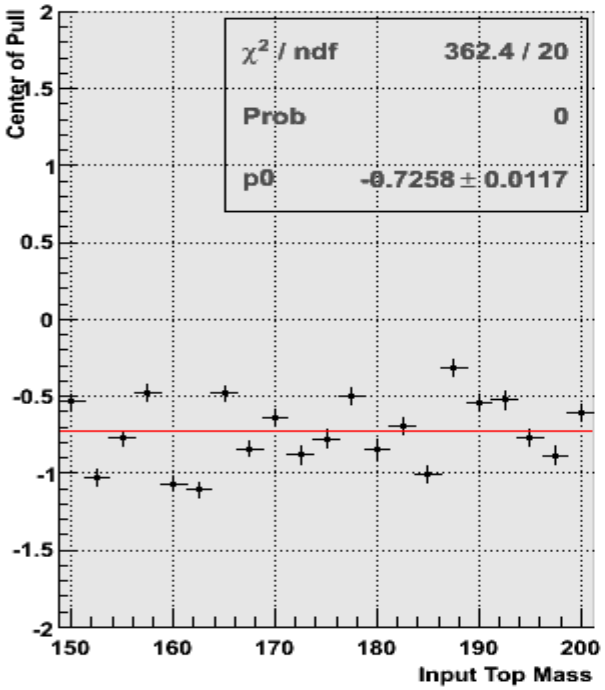
intercept@175GeV: 173.60

*** TF: single function**

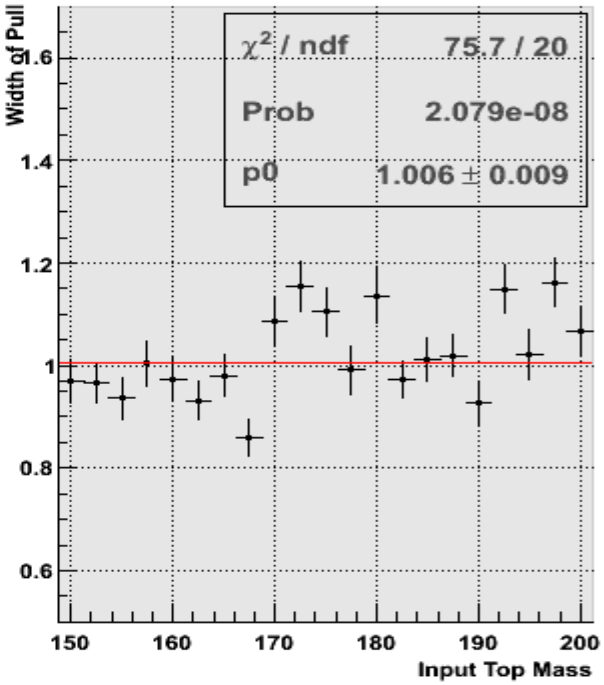
Pseudo Experiment

- 400 PE for each mass sample
- 50 events for each PE
- Signal only
- Right combination

Pull as function of Mtop



Pull Width as function of Mtop



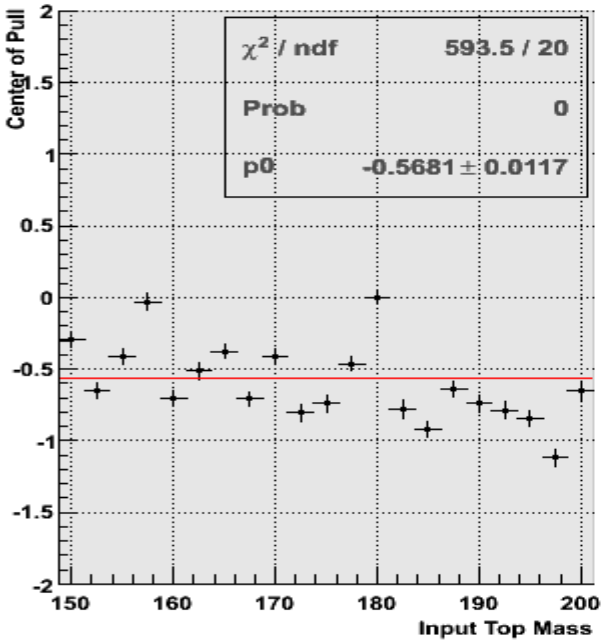
Expected Stat Error: ~1.7GeV

* TF: single function

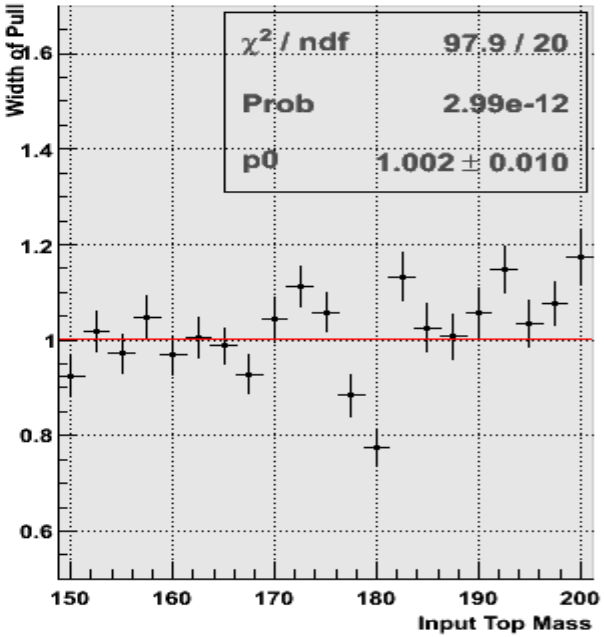
Pseudo Experiment

- 400 PE for each mass sample
- 50 events for each PE
- Signal only
- All combinations

Pull as function of Mtop



Pull Width as function of Mtop



- Expected Stat Error: ~2.3GeV
  - Almost consistent with previous analysis(318pb-1)

*** TF: single function**

Moving to Gen6

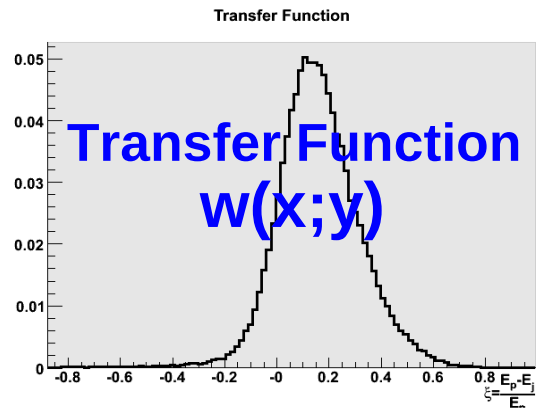
- Our analysis should be done with Gen6

- Improvements for Gen6
  - Importance sampling
    - Importance sampling for hadronic decay W
  - Improvements of Transfer Function
    - Use TF sorted by Et and Eta regions
    - Fit and parametrize?
  - Jet Energy Scale
    - Estimate Jet Energy Scale with 2D likelihood

Importance sampling

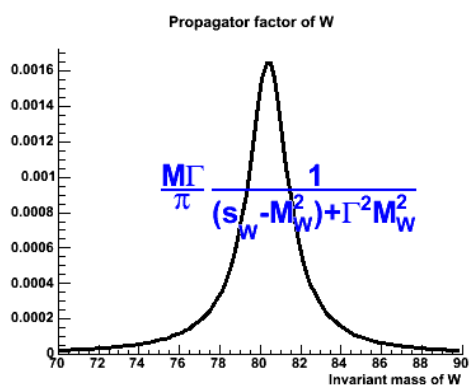
Importance sampling has been used to get likelihood

Jet reconstruction

y(jet) → 

→ x(parton)

Invariant mass of leptonic decay W



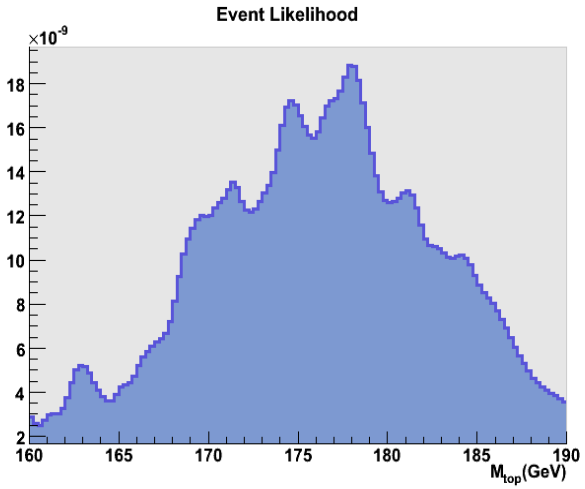
→ $s_W = l^2 + \nu^2$ → ν_z

Hadronic Sw from Propagator

Importance sampling with hadronic W propagator to reconstruct jets from W

Why?

- **Get smooth event likelihood**
  - **Importance sampling can avoid making many spikes in event likelihood**
- **Fit likelihood well**
  - **Joint likelihood for multiple event likelihood can be fitted easily**
- **Reduce CPU time**
  - **We don't have to wait long before getting smooth event likelihood**



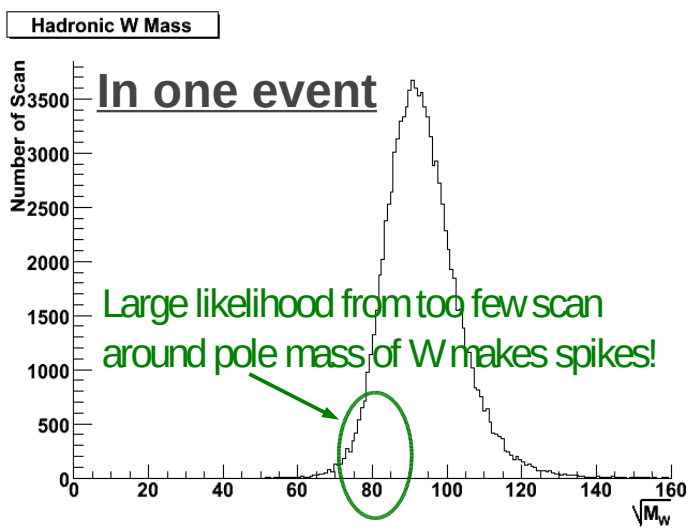
Hadronic Sw from Propagator

What makes spike in event likelihood?

Hadronic decay matrix element in likelihood

$$|D_{th}|^2 = \frac{g_w^4}{4}\frac{1}{2}\sum \frac{(t\cdot l)(b\cdot \nu)}{(\boxed{S_w} - M_W^2)^2 + M_W^2 \Gamma_W^2}$$

input

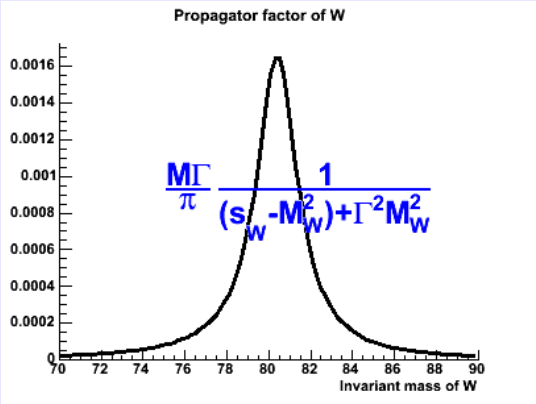


- If 2 jets are reconstructed with TF
  - Mostly $S_w \neq M_W^2$
  - Make likelihood small
  - Need many scans to make likelihood distribution smooth
- If start with propagator to reconstruct jets from W
  - $S_w \approx M_W^2$
  - Make likelihood large

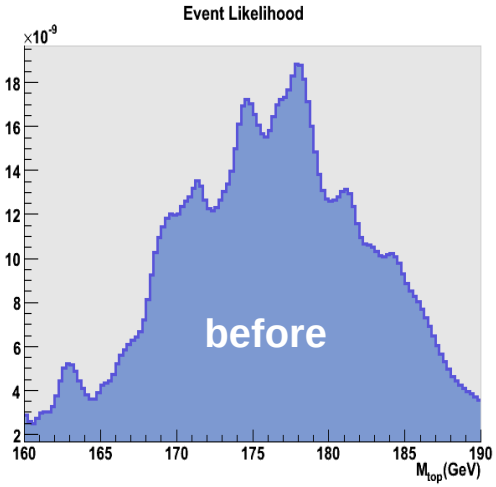
Hadronic Sw from Propagator

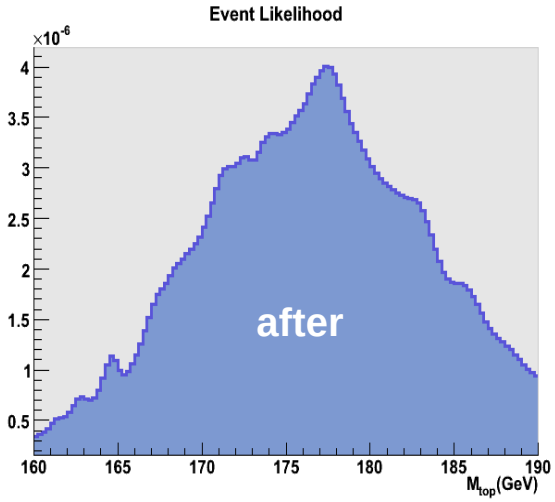
How to reconstruct 2 jets from W

- Generate Sw along Breight-Wigner function randomly
- Reconstruct one of 2 jets from W with TF
- Solve equation Sw=j1+j2 to get momentum of j2
- Multiply weight of j2 from TF to likelihood



Event likelihood after applying importance sampling

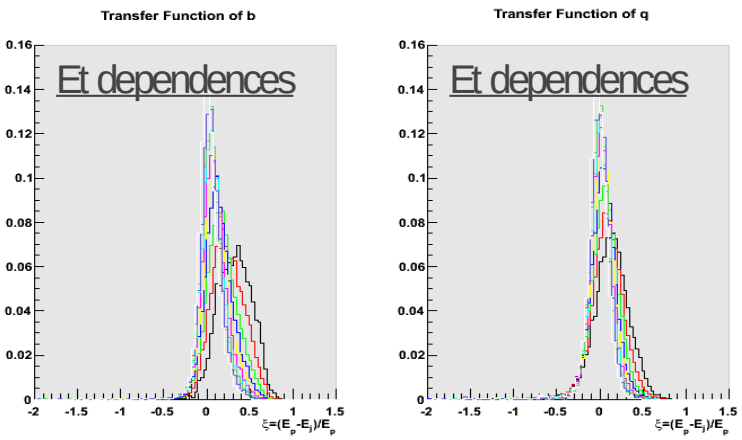




Transfer Function for Gen6

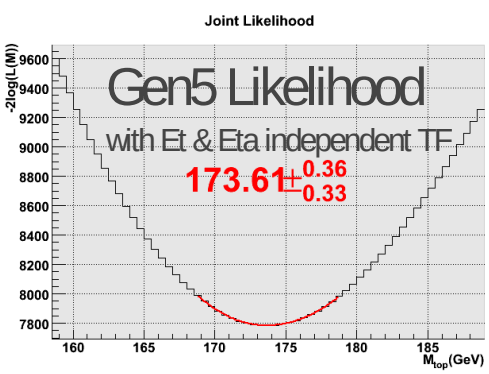
TF depending on Et and Eta

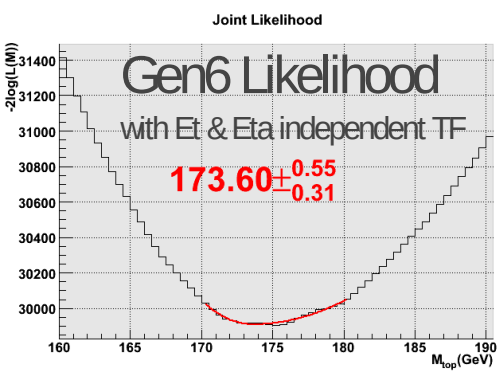
- TF depends on Et and Eta
  - Divide 10 regions for Et
  - Divide 3 regions for Eta

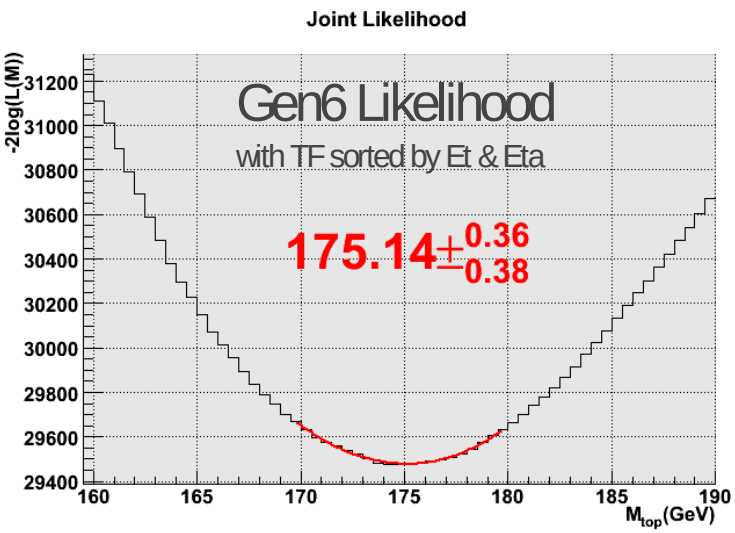


Check performance of TF sorted by Et & Eta

input mass = 175



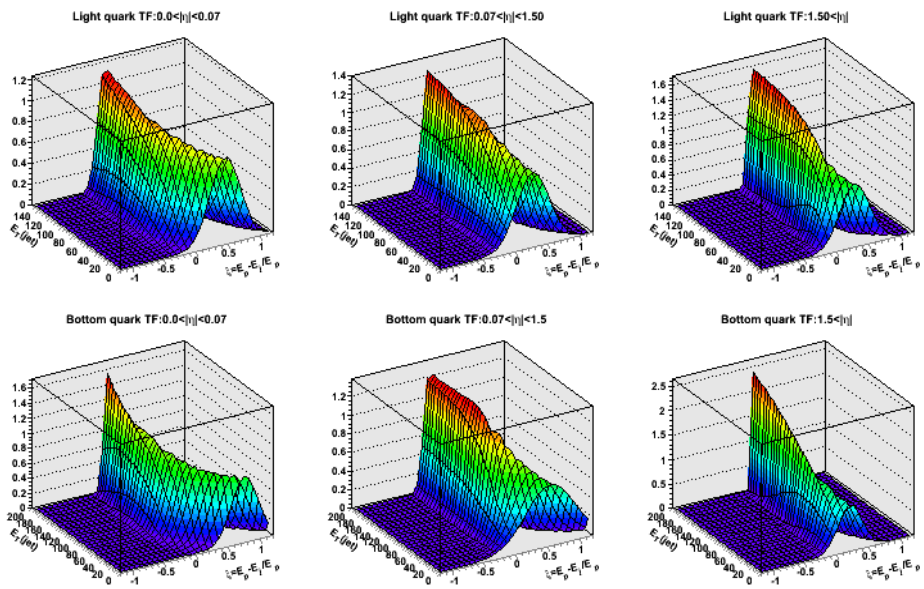




Parametrized Transfer Function?

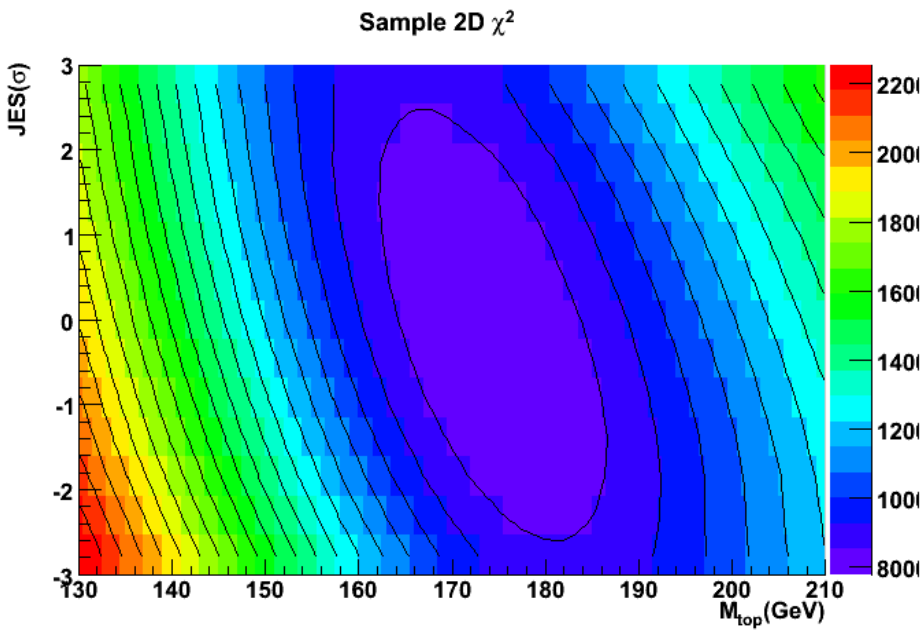
We are discussing about a parametrization of TF if we can get improvements.

Sample Transfer Function



Jet Energy Scale

- JES Uncertainty for light jets will be integrated as a statistical uncertainty
- Decay Matrix Element in Likelihood can constrain Jet Energy Scale
- Use Transfer Function depending on JES
- Fit 2D likelihood to measure Mtop and JES Uncertainty simultaneously



Summary

- Methodology check with Gen5 has been done.

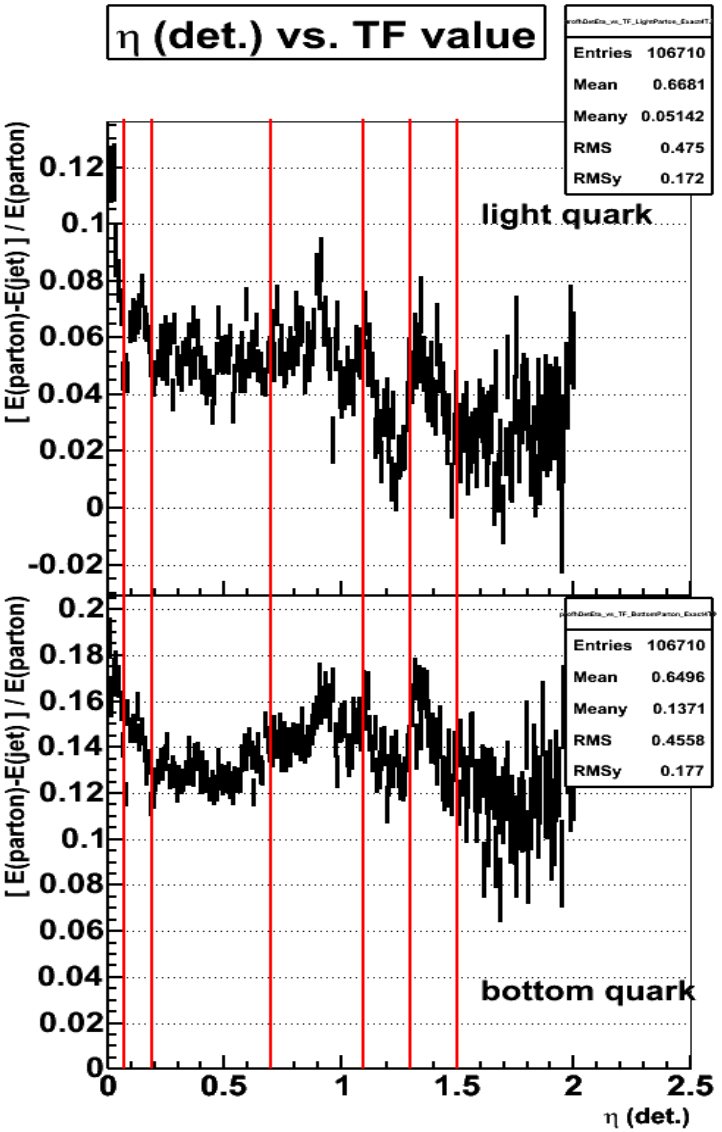
- We are moving to Gen6
  - Gen6 likelihood is almost equivalent to Gen5 likelihood
  - Reconstruction of W->jj from propagator is taken into Gen6 analysis
  - TF sorted by Et and Eta seems to work well.
  - JES Uncertainty will be estimated as statical uncertainty

- Blessing will be by the end of February(1.2fb-1)

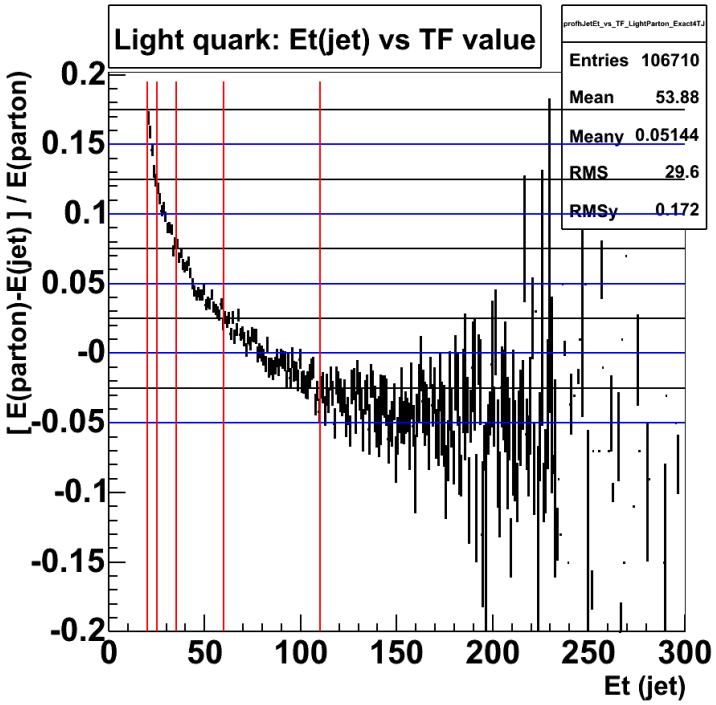
Backup

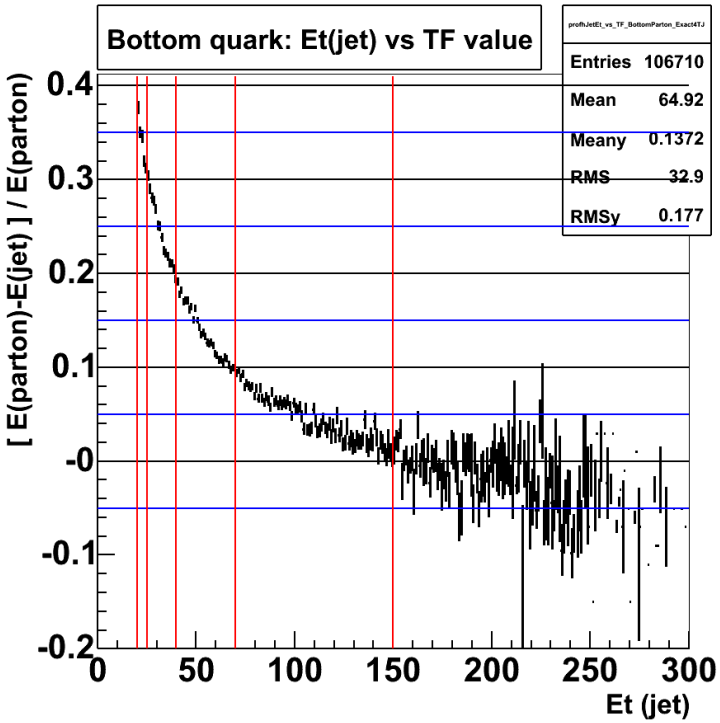
Transfer Function for Gen6

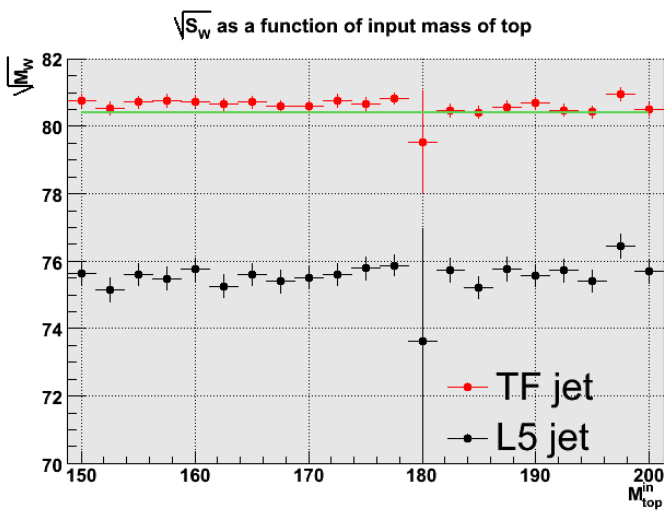
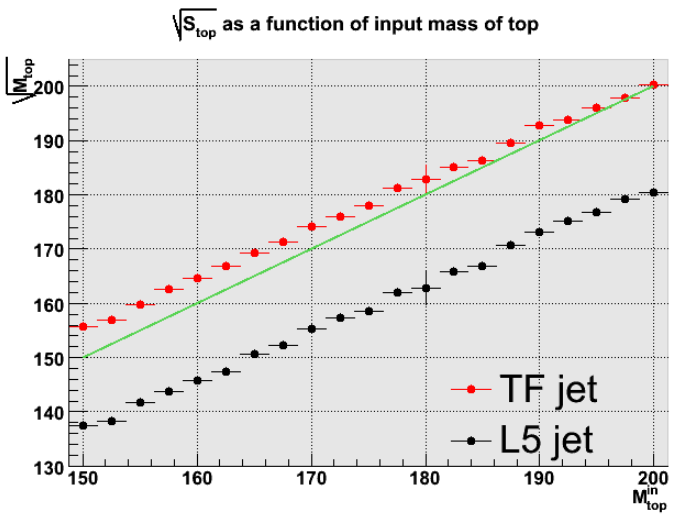
- TF depends on detector Eta.
- Eta should be divided in three region
  - |Eta|<0.07
  - 0.07<|Eta|<1.50
  - 1.50<|Eta|



Transfer Function for Gen6





Performance of TF

- Get invariant mass per scan and fill histogram
- Pick up mean of histogram per event and fill histogram
- Pick up mean of histogram filled with mean per event