超対称性事象探索に向けたボトムジェットの研究

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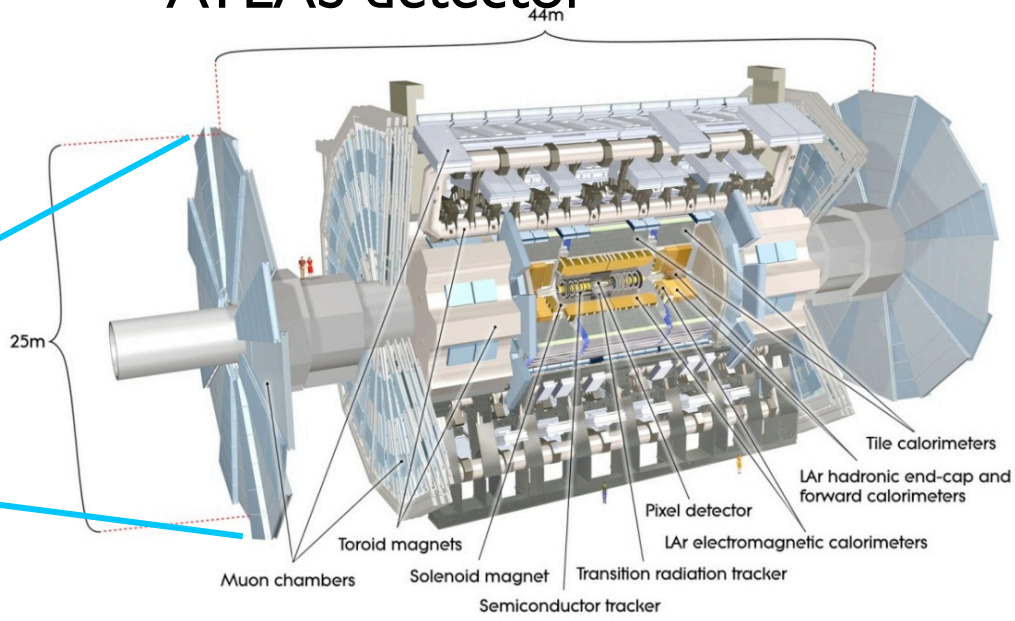
LHC, ATLAS experiment

LHC

ATLAS detector



LHC:

Center of mass energy : 7TeV

Integrated Luminosity (up to September) : 3.4 pb^{-1}

ATLAS:

General purpose detector

One of the **aim**: Search for **SUSY particles**

SUSY

➡Good reasons to believe SUSY particle
- Can solve Hierarchy problem
- have cold dark matter candidate

➡ Lightest SUSY can be ~ O(TeV)

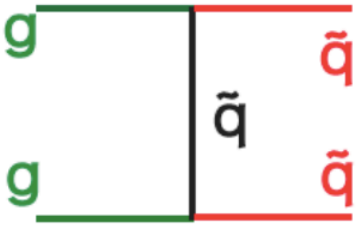
Can be searched at LHC

SUSY

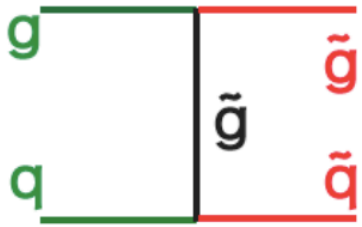
✦ Production : $\tilde{g}\tilde{g}, \tilde{g}\tilde{q}, \tilde{q}\tilde{q}$

$\tilde{g}\tilde{g}$ prod.

$\tilde{q}\tilde{q}$ prod.

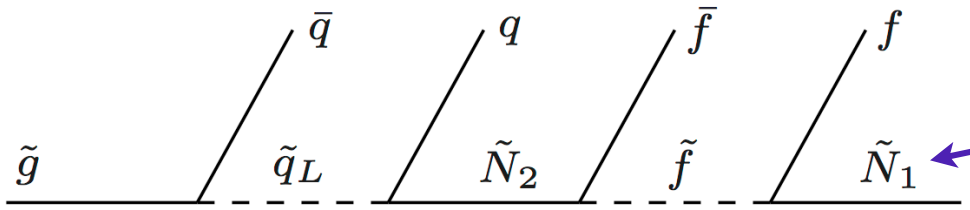


$\tilde{q}\tilde{g}$ prod.



SUSY

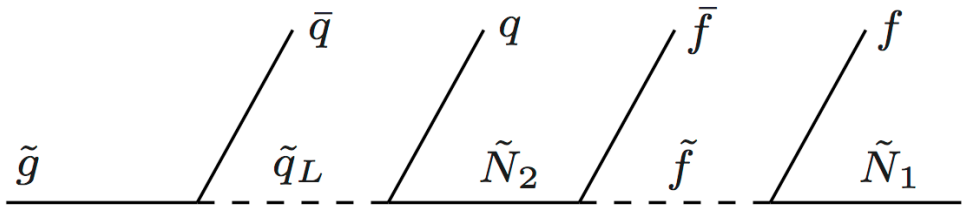
- Production : $\tilde{g}\tilde{g}, \tilde{g}\tilde{q}, \tilde{q}\tilde{q}$
- Decay (example) :



Lightest Supersymmetric Particle (LSP)

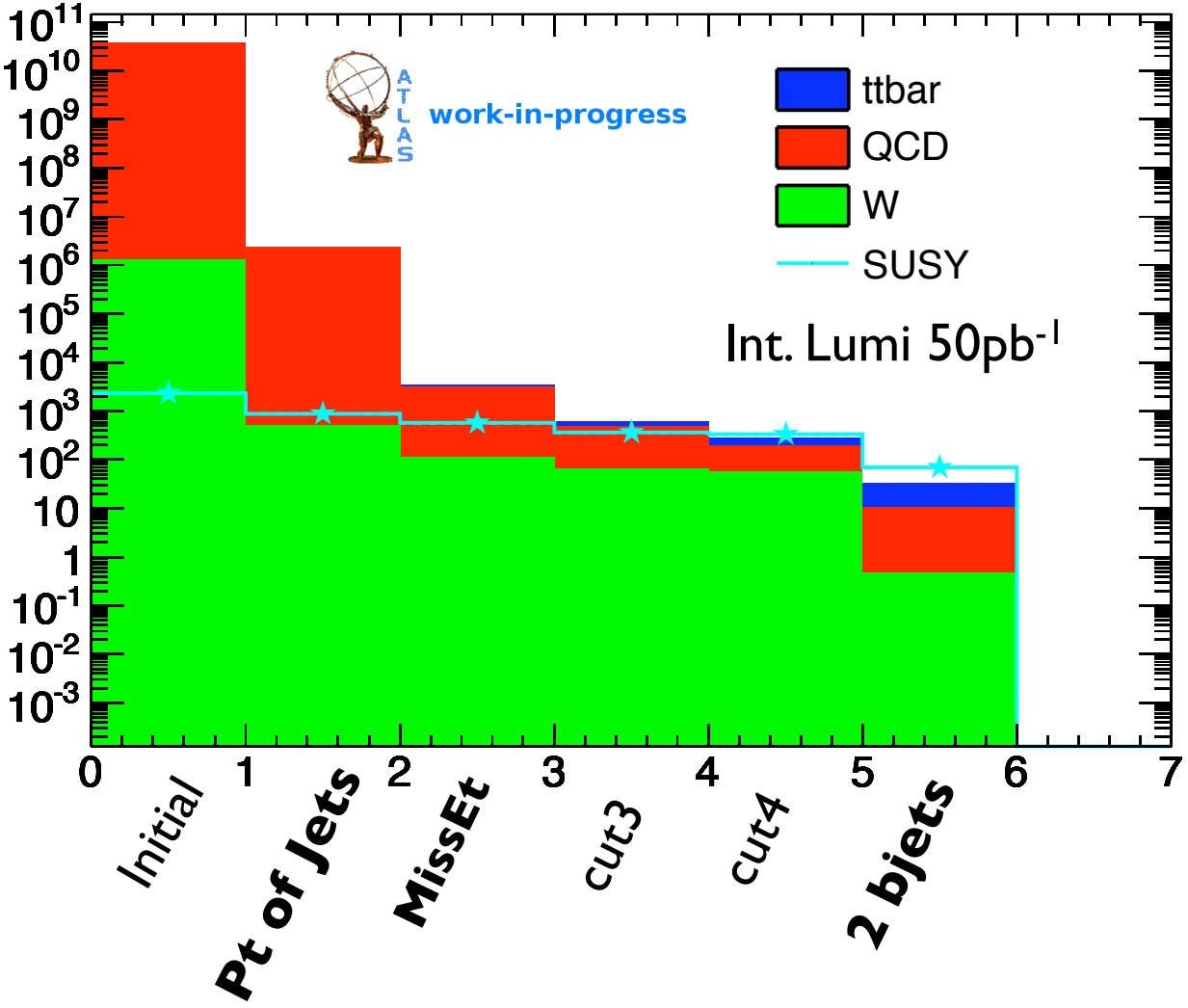
SUSY

- Production : $\tilde{g}\tilde{g}, \tilde{g}\tilde{q}, \tilde{q}\tilde{q}$
- Decay (example) :



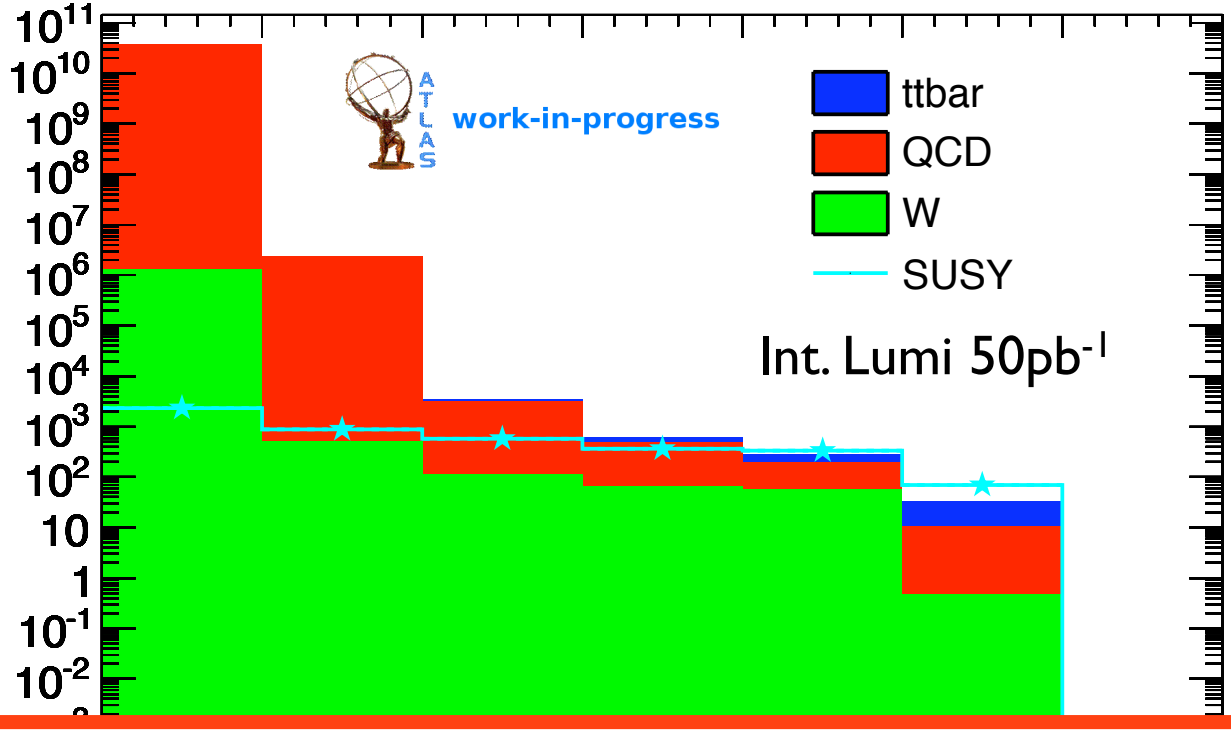
- SUSY signature :
  - Multiple jets ←Cascade decay
  - Missing E_T ←Lightest Supersymmetric Particle (LSP)
  - b-jets ←$m_{\tilde{t}}, m_{\tilde{b}}$ << other squark masses

SUSY search with **MissingEt** + **b-jet(s)**



- ttbar, QCD are main backgrounds
- B-tagging is very important

SUSY search with **MissingEt** + **b-jet(s)**



In this talk:

1. Basic distributions for the analysis
1. Study of b-tagging algorithm
2. QCD background estimation

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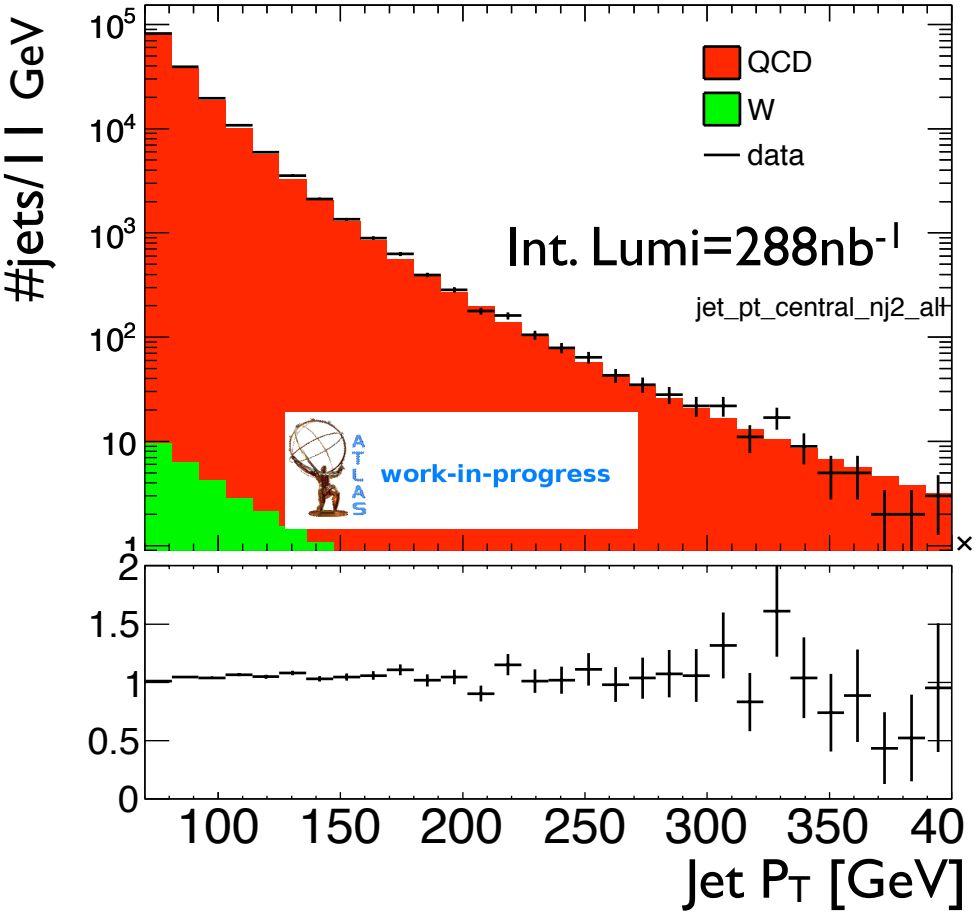
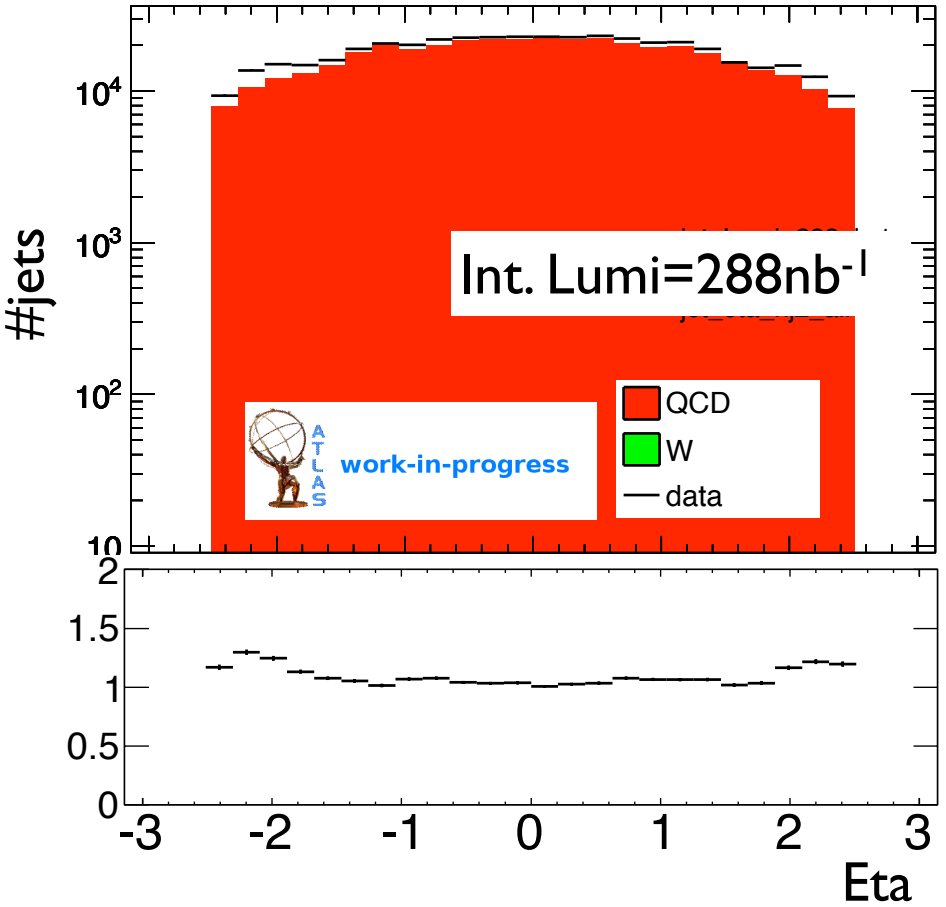
Basic Distributions

2jets event
(1st Jet > 70, 2nd Jet > 30 GeV)
Normalized by #events

Jet P_T



Jet Eta



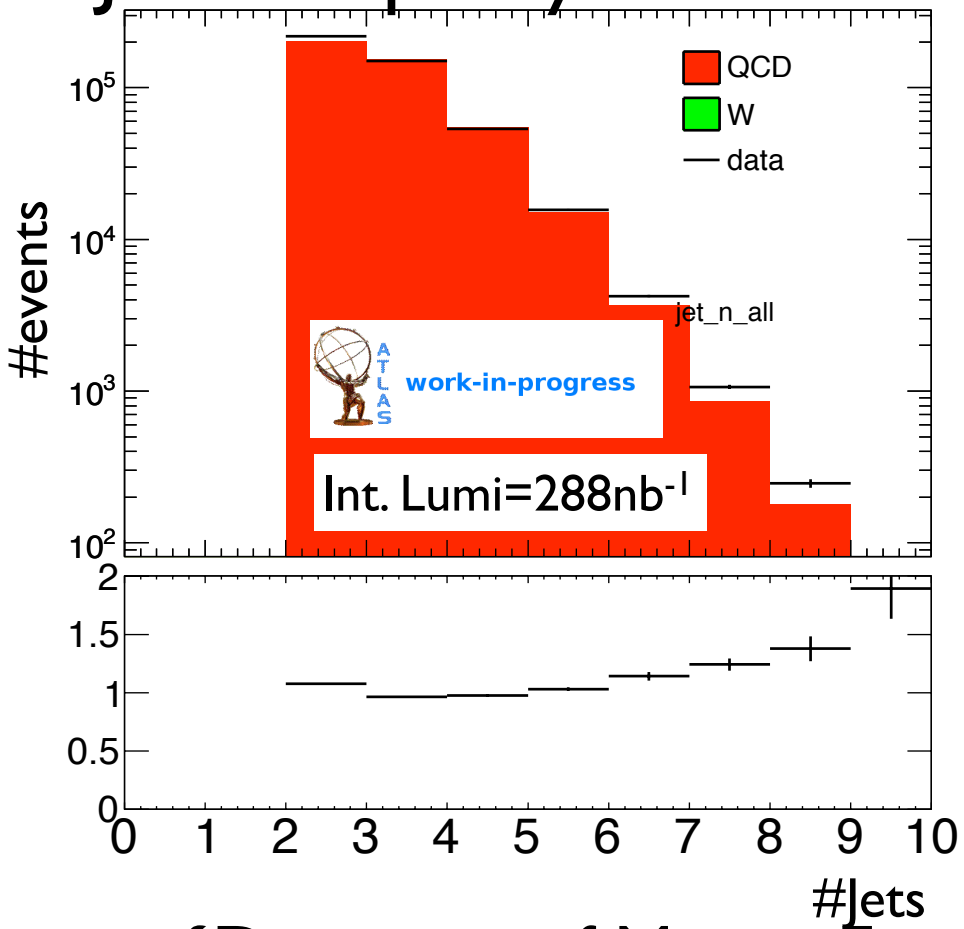
✓Kinematics distributions show good agreement

Basic Distributions

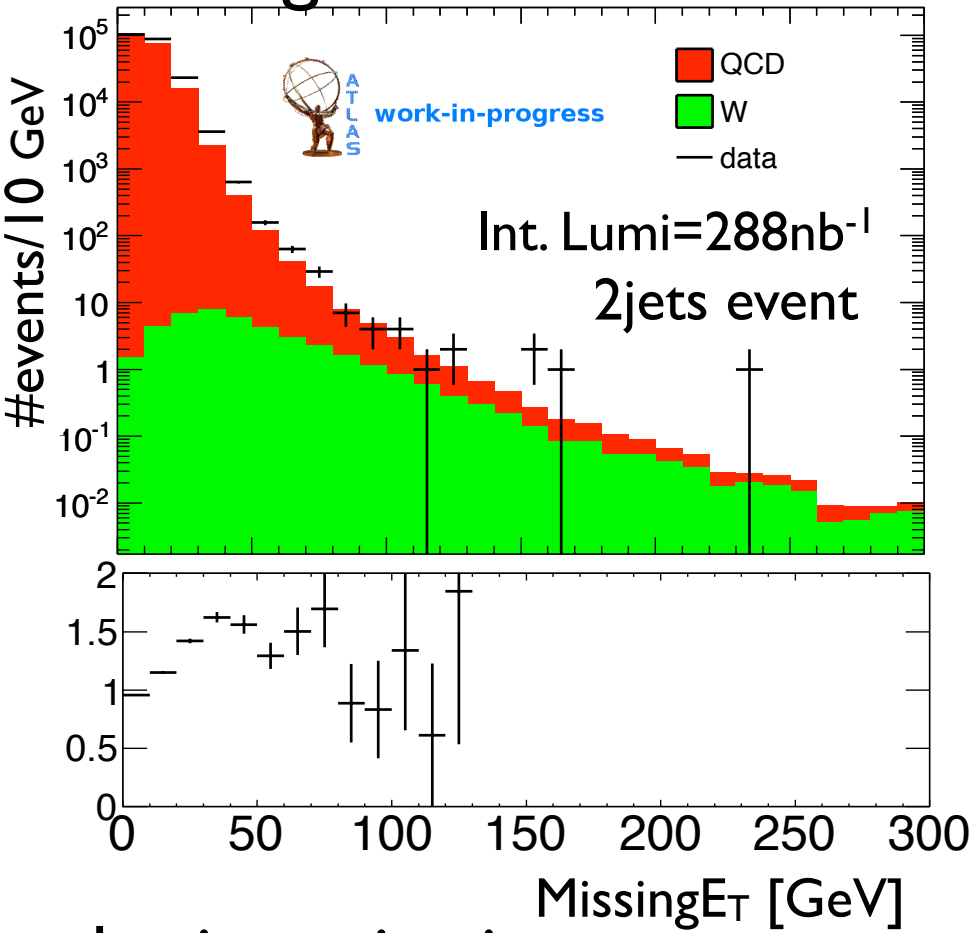
Normalized by #events

2jets event
(1st Jet > 70, 2nd Jet > 30 GeV)
Normalized by #events

Jet Multiplicity



MissingEt



✓Deviation of MissingE$_T$ is under investigation

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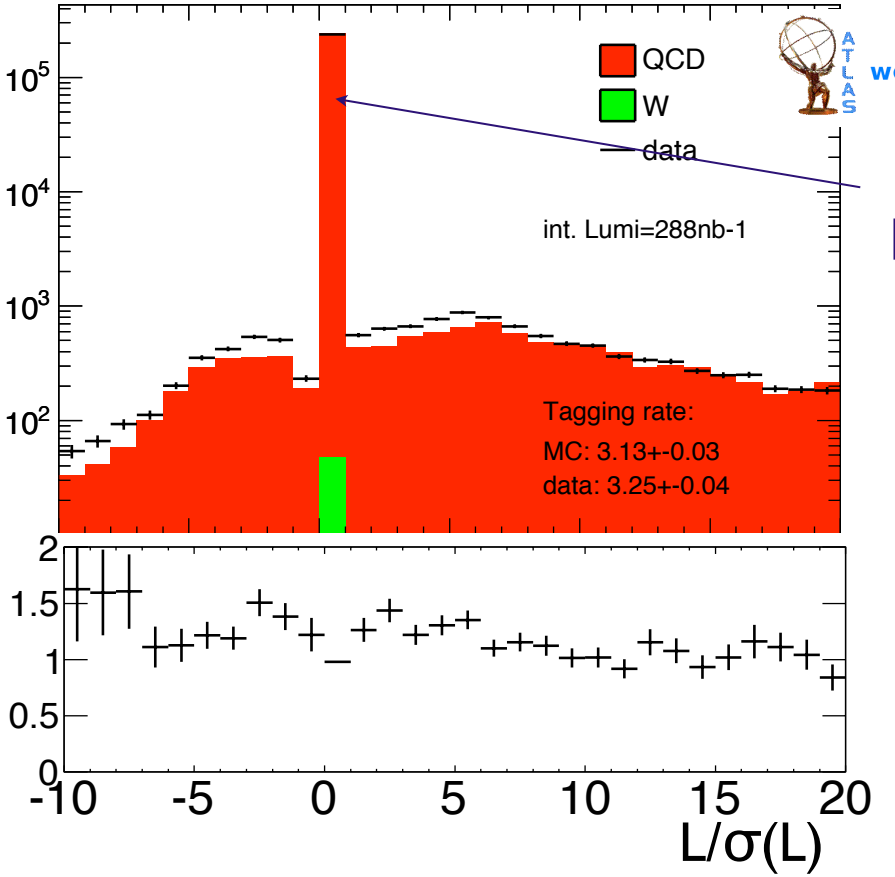
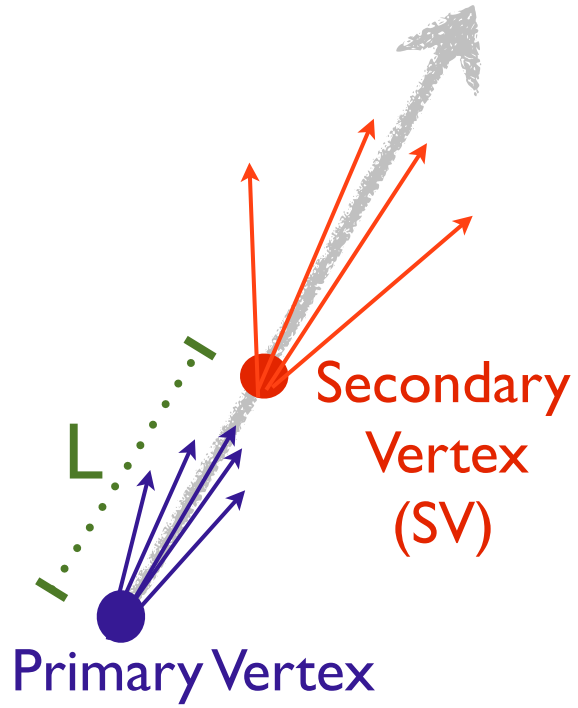
1. Study of b-tagging algorithm
2. QCD background estimation

Distributions related to b-tagging

Secondary Vertex(SV) Tagger discriminant: **L/σ(L)**



No SV

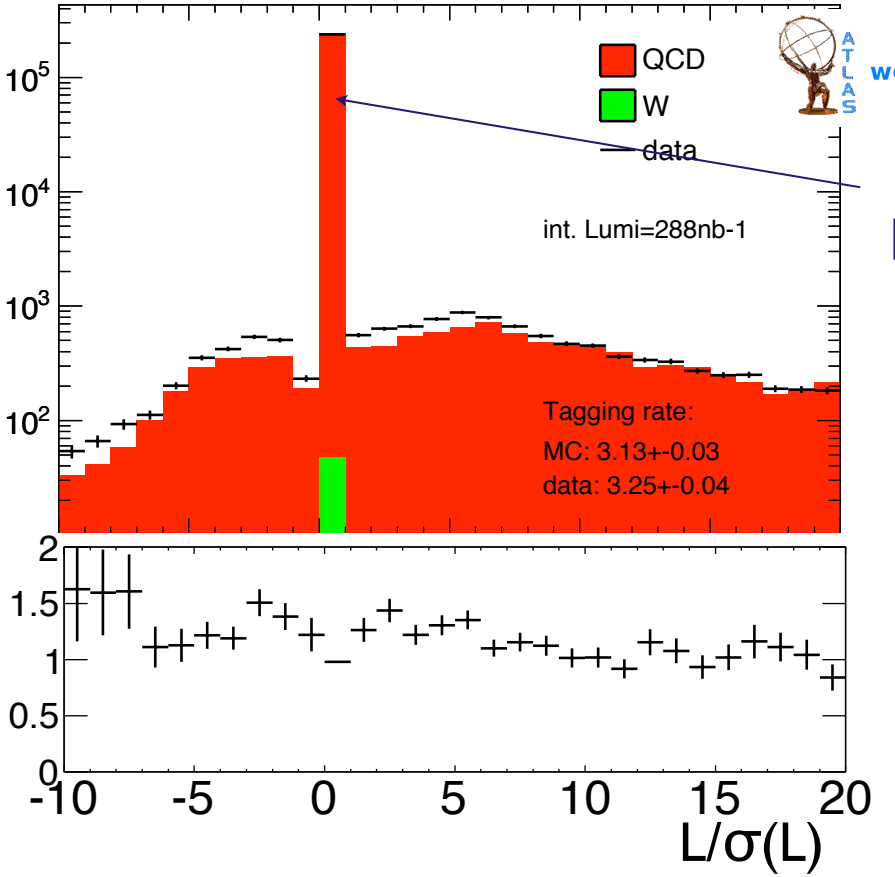


Tagging rate (L/σ(L)>6):
data : 3.13+-0.03 %
MC : 3.25+-0.04 %

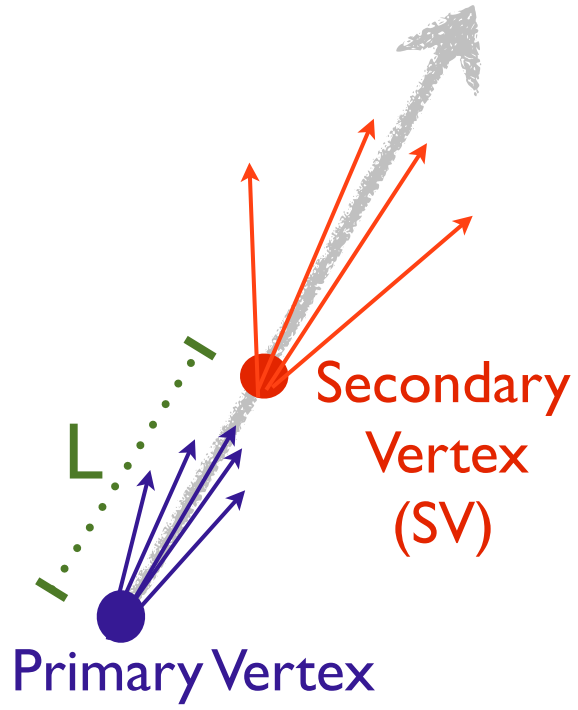
✓Tagging rate shows good agreement.
- F_b, F_c, F_l (**Flavor composition**)
- ε_b, ε_c, ε_l (**Efficiencies**) to be checked...

Distributions related to b-tagging

Secondary Vertex(SV) Tagger discriminant: **L/σ(L)**



No SV



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~~- ε_b, ε_c, ε_l (**Efficiencies**)~~ to be checked...

Estimate Jet Flavor composition

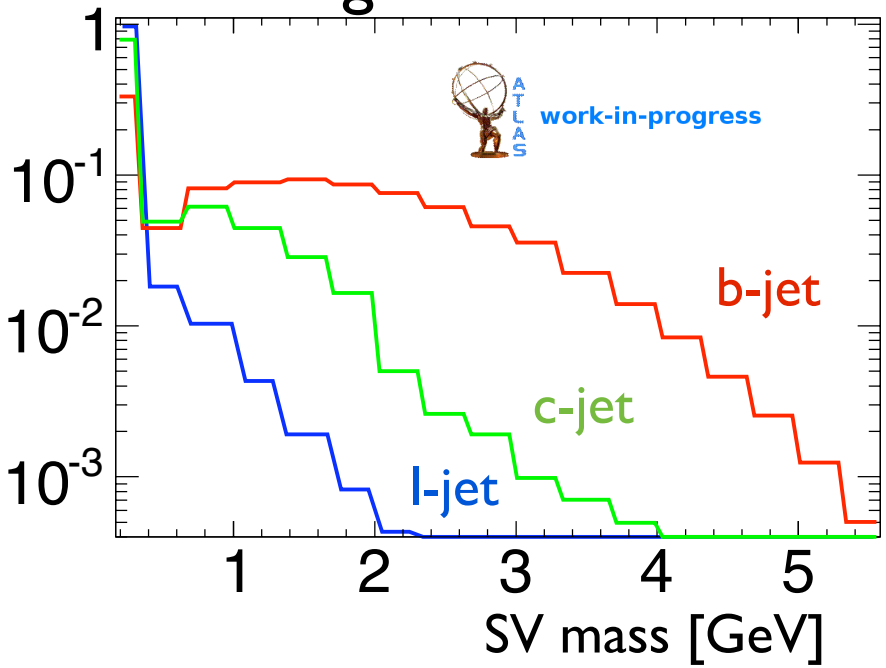
Using Secondary Vertex mass template fit

Basic idea

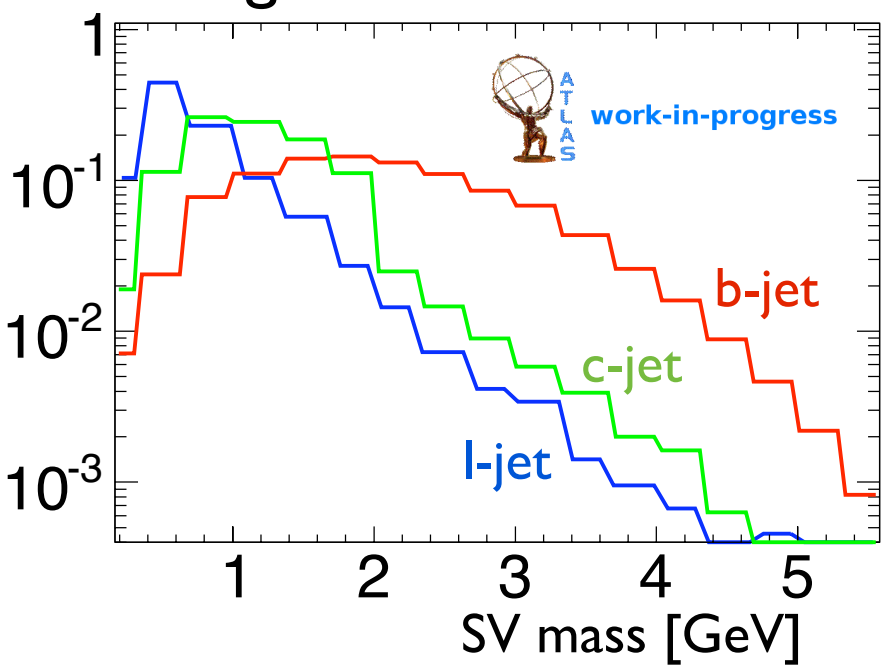
- Reconstruct a SV with charged particles.
- B-hadron has ~5GeV

Template shape

before tag



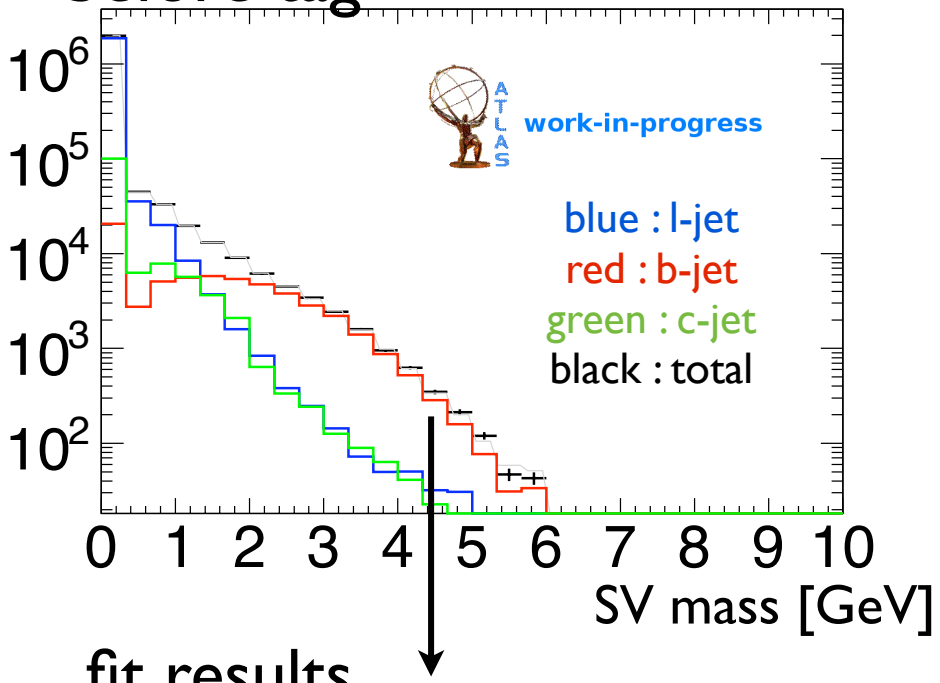
after tag



Estimate Jet Flavor composition

Test using MC

before tag



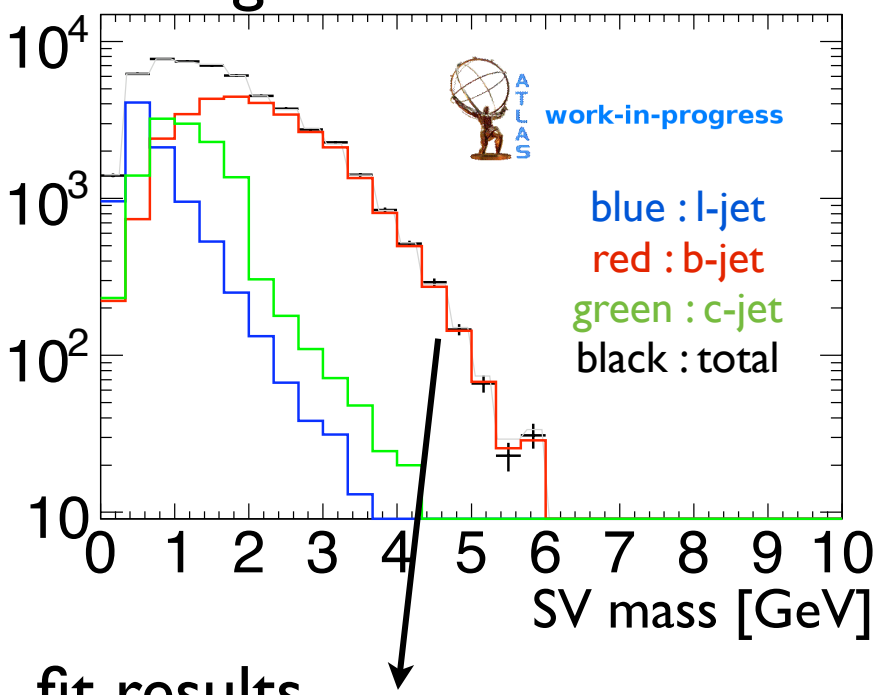
fit results

Estimated:

#l-jet : 1944452 (input 1943608)

#b-jet : 62774 (input 62867)

after tag



fit results

Estimated:

#l-jet : 9093 (input 9058)

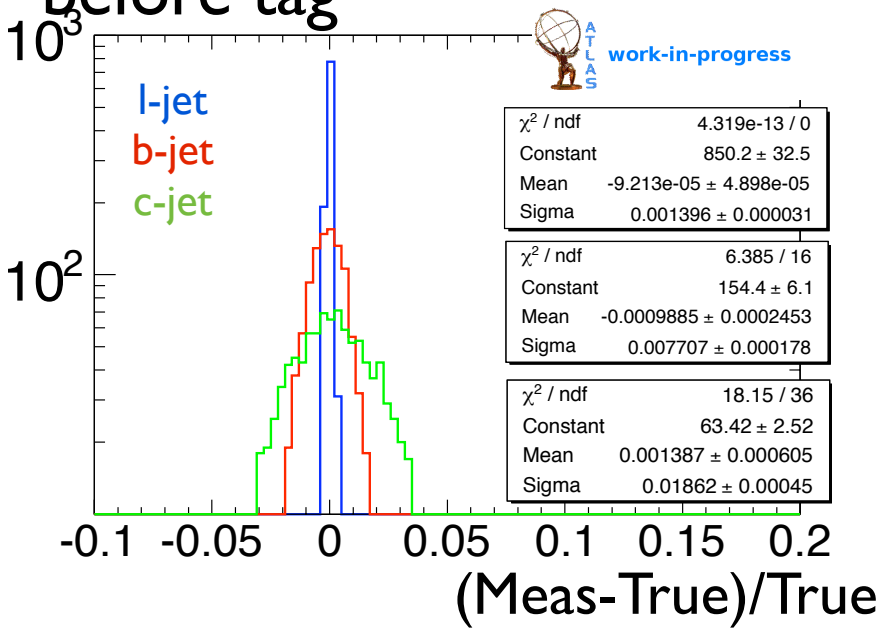
#b-jet : 30827 (input 30856)

✓ Template fit method works very well for MC !!

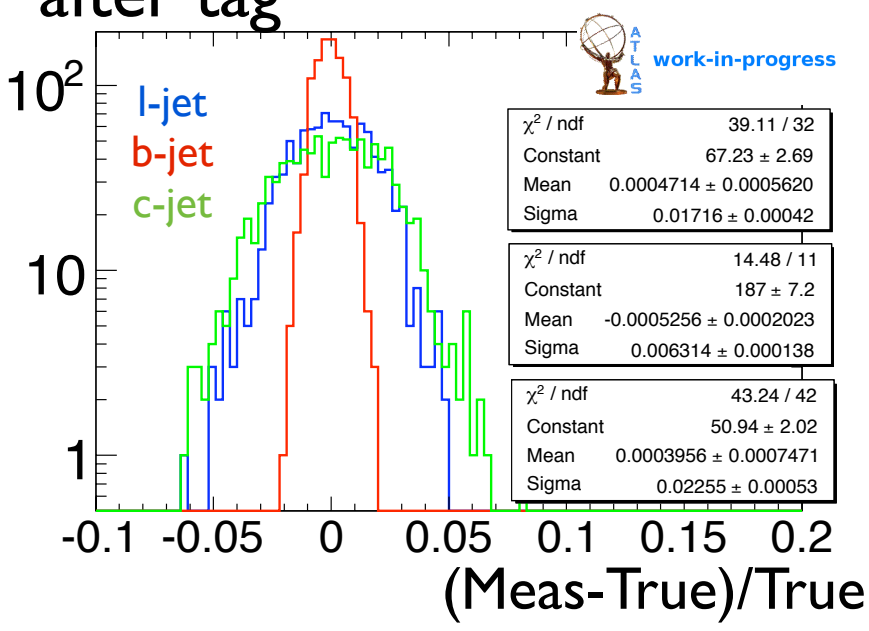
Estimate Jet Flavor composition

ToyMC : estimate statistical uncertainty

before tag



after tag



No Bias!!

Stat. uncertainty

b-jet : 0.4 %

l-jet : 0.1 %

No Bias!!

Stat. uncertainty

b-jet : 0.5 %

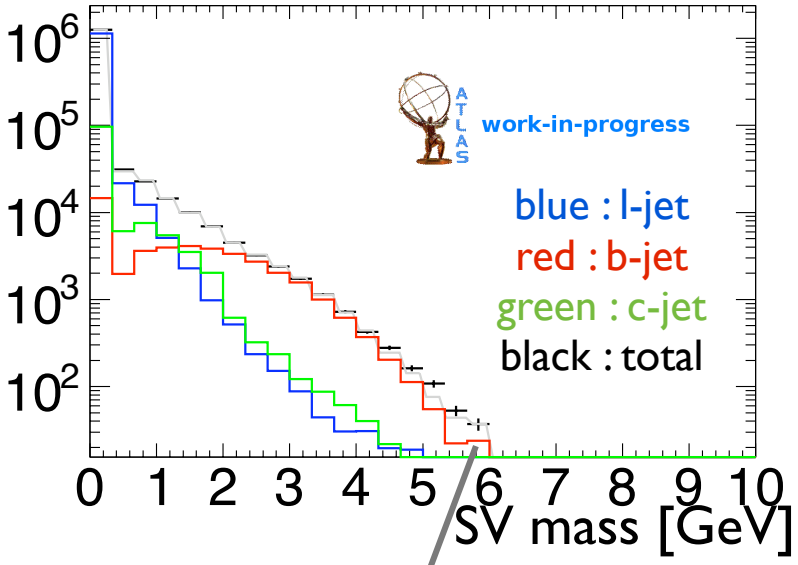
l-jet : 1.0 %

✓ Template fit method works very well for MC !!
(Small statistical uncertainty)

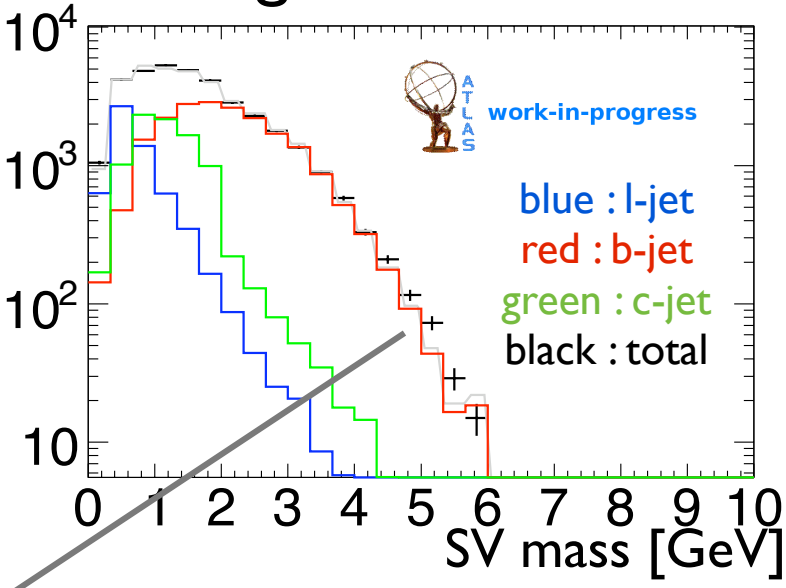
Estimate Jet Flavor composition

Apply to data

before tag



after tag



Flavor composition (%)

		l-jet	b-jet	c-jet
before tag	measured	87.7	3.3	9.1
	MC expectation	90.9	3.0	6.1
after tag	measured	17.3	57.2	25.5
	MC expectation	15.8	60.9	23.3

uncertainty.

+- <0.2%

+- <0.5%

✓Small difference. After tag would be more robust.

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QCD background

- Have to be estimated with data
- Effective Mass (Meff) will be used as a discriminant

※ $M_{\mathrm{eff}} = \sum_{i \leq 4} p_T^{\mathrm{jet},i} + \sum_i p_T^{\mathrm{lepton},i} + \not{E}_T$

1, Make Control Region (CR)
using a variable with correlation(Variable, Meff) ~ 0
2, Estimate QCD background in Signal Region

Scheme:
correlation($\Delta\Phi_{\mathrm{min}}$, Meff) ~ 0
→ Make Control Region using $\Delta\Phi_{\mathrm{min}}$(jets,miss$E_T$)

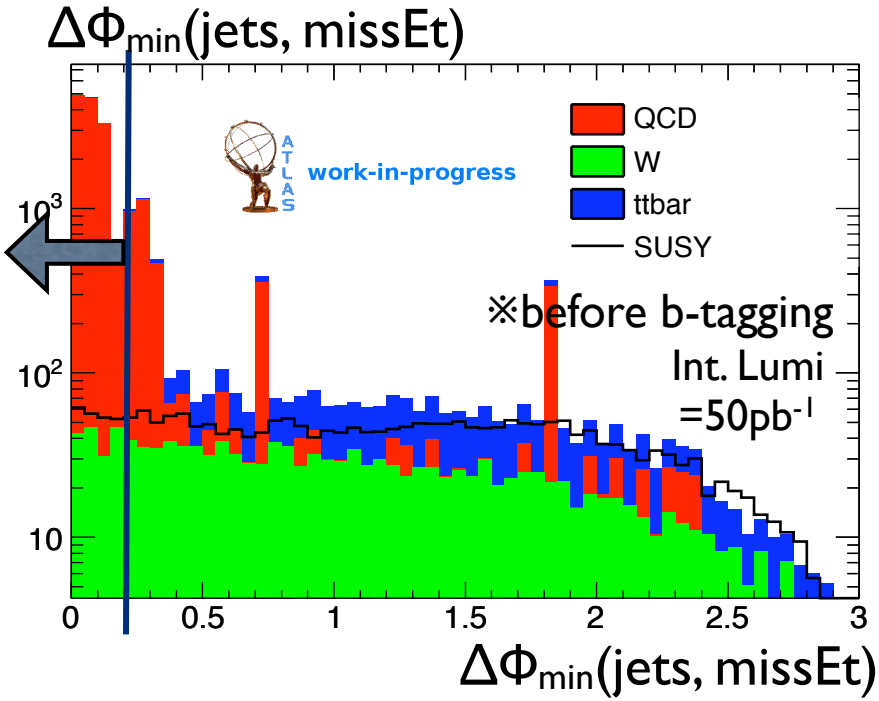
$\Delta\Phi_{\mathrm{min}}$(jets, miss$E_T$)
=min($\Delta\Phi$(jet1,missE_T), $\Delta\Phi$(jet2,missE_T), $\Delta\Phi$(jet3,missE_T))

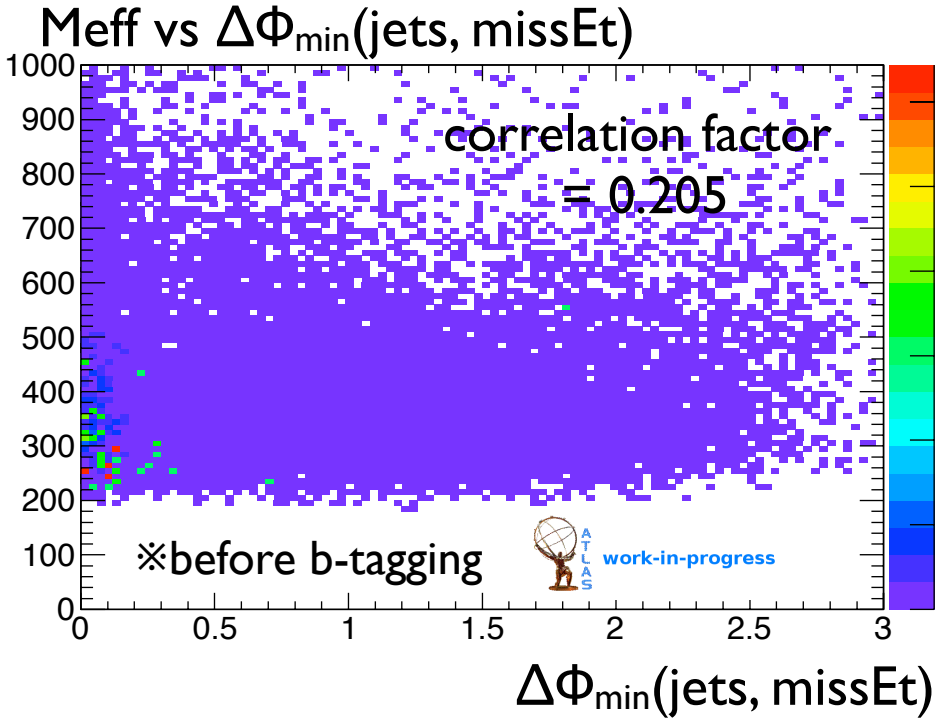
QCD background

Check quality of the Control Region

1, Control region should be dominated by QCD

2, Correlation($\Delta\Phi_{min}$, Meff) should be small



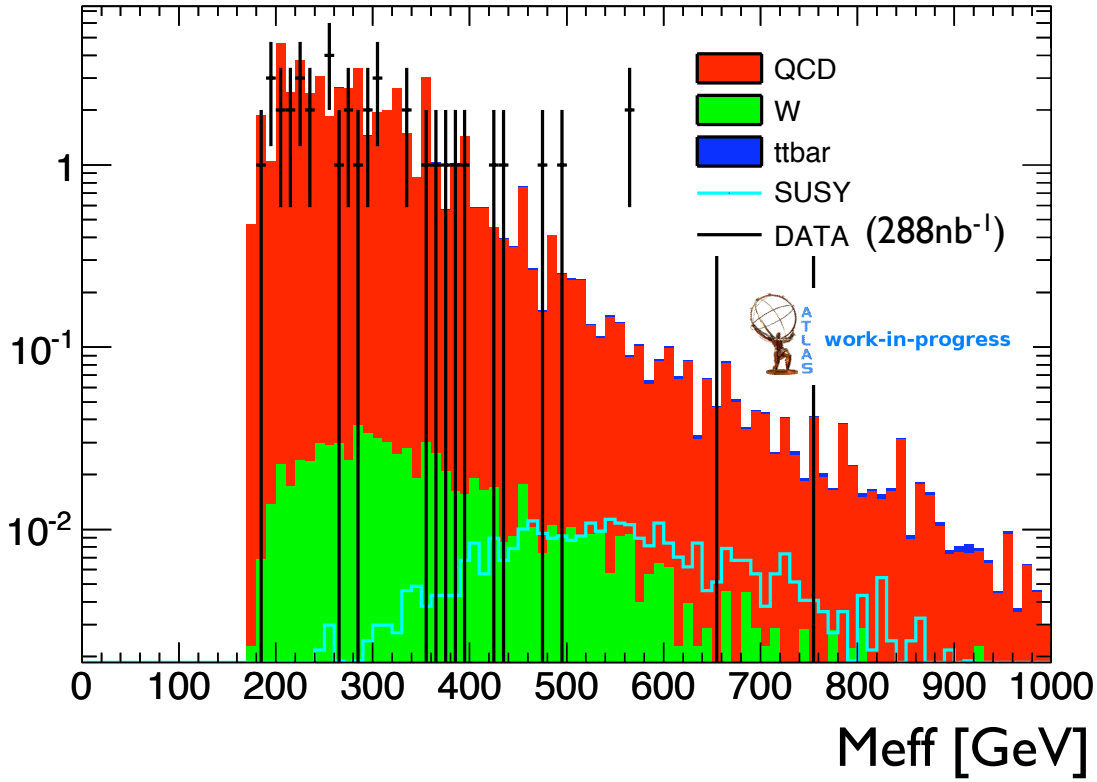


Control Region

- Other BG in Control Region <2.1%
- Correlation factor ~ 0.205

QCD background estimation

Effective Mass comparison between MC and data
(normalized by #events)



Good agreement !!
More statistics needed.

summary

✓ ATLAS experiment already has 3.4 pb^{-1}

✓ Kinematic distributions agree well between MC and data

- MissingET distribution need to be studied further

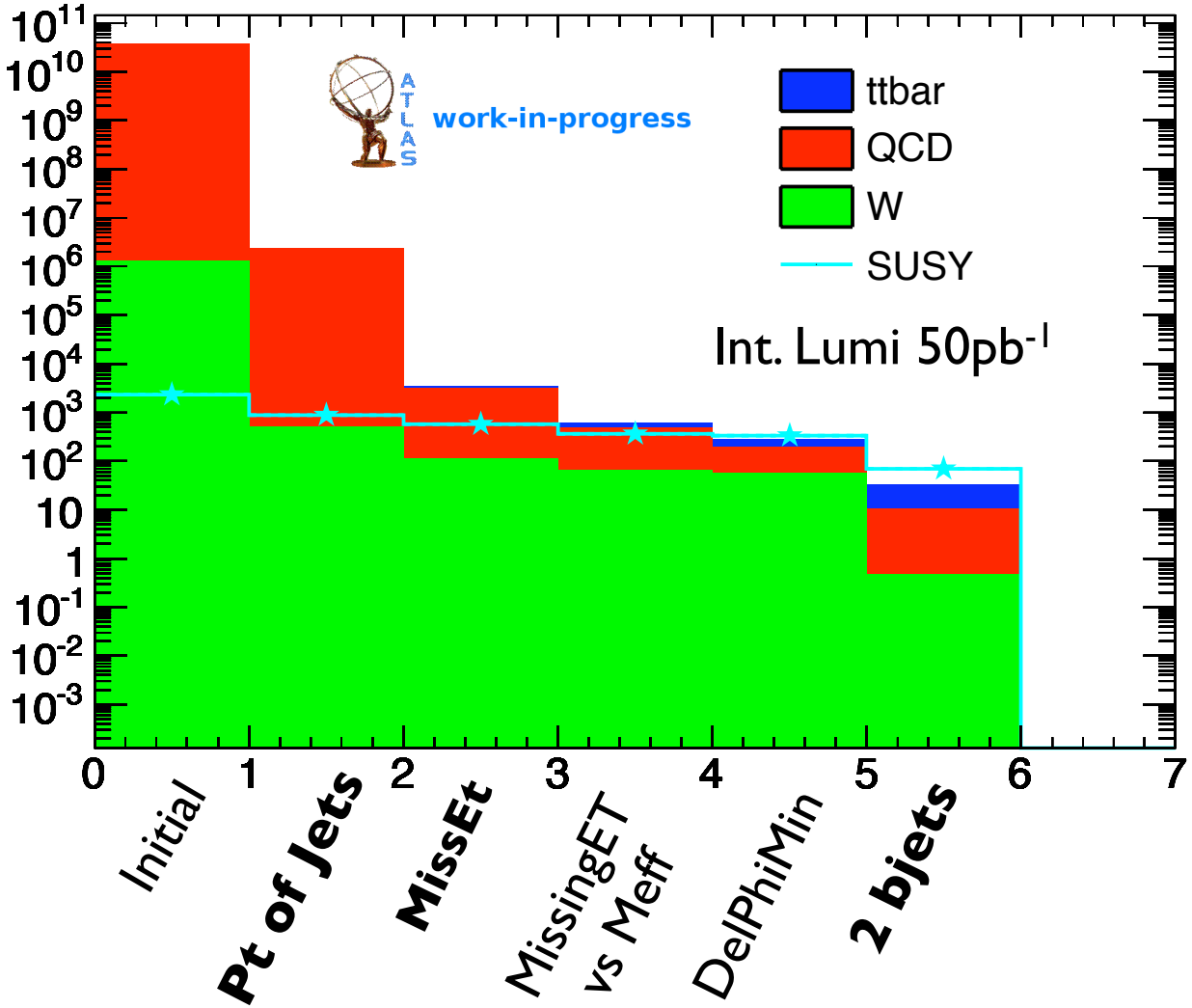
✓ b-tagging algorithm seems working well

- Studied the method of estimating jet flavor composition

✓ QCD background estimation is under development

background

SUSY search with **MissingEt** + **b-jet(s)**

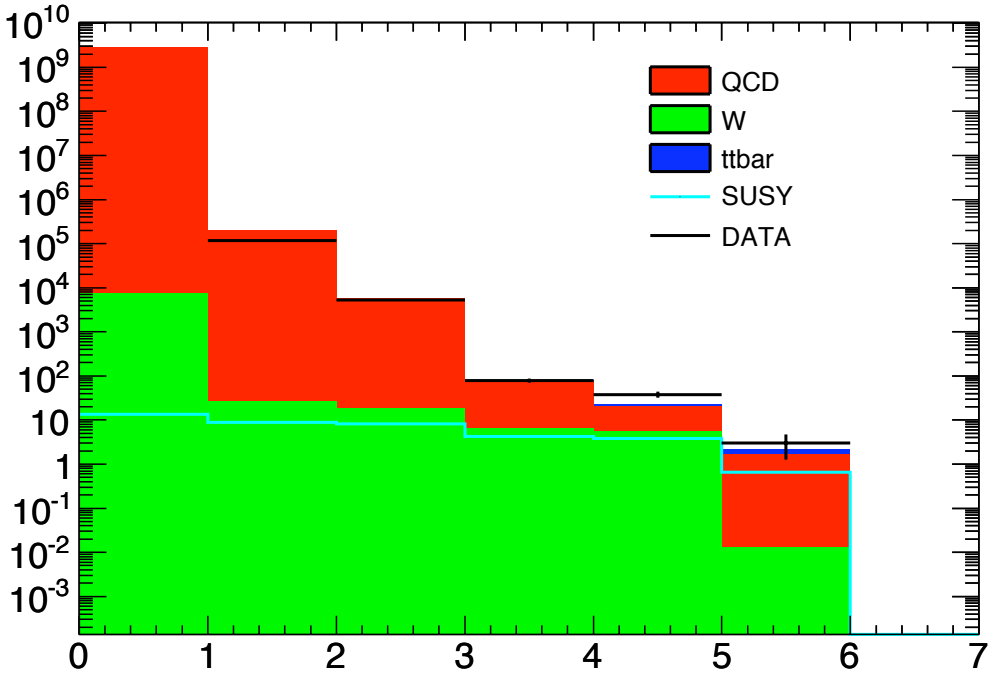


EventSelection
0, Initial
1, Jet_pt
(1st>80, 2nd>40, 3rd>40GeV)
2, MissingE_T>80GeV
3, MissingE_T > 0.2*Meff
4, DelPhiMin(jets,MissingE_T)>0.2
5, #tagged jets >= 2

- ttbar, QCD are main backgrounds
- B-tagging is very important

QCD background estimation

CutFlow



EventSelection
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1, Jet_pt
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2, MissingE_T>30GeV
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4, DelPhiMin(jets,MissingE_T)>0.2
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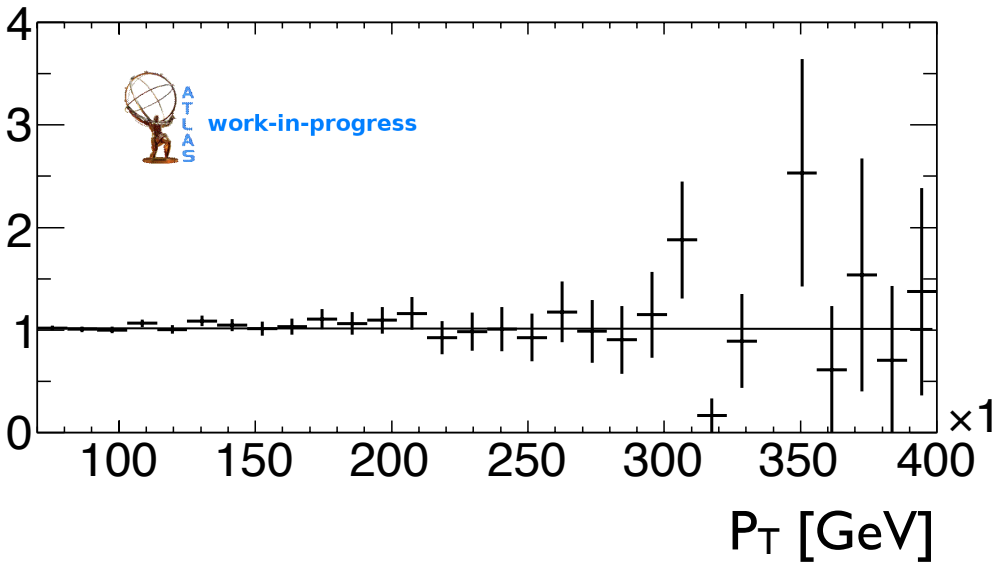
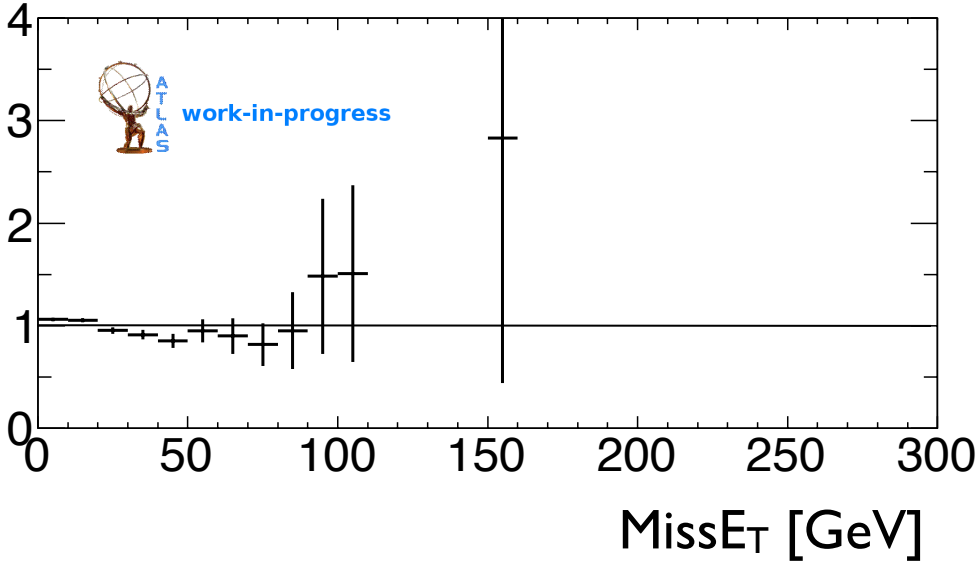
Comparison of tagging rate

$$\frac{\text{tag rate (data)}}{\text{tag rate (MC)}} \left(= \frac{\text{After tag(data)/Before tag(data)}}{\text{After tag(MC)/Before tag(MC)}} \right)$$

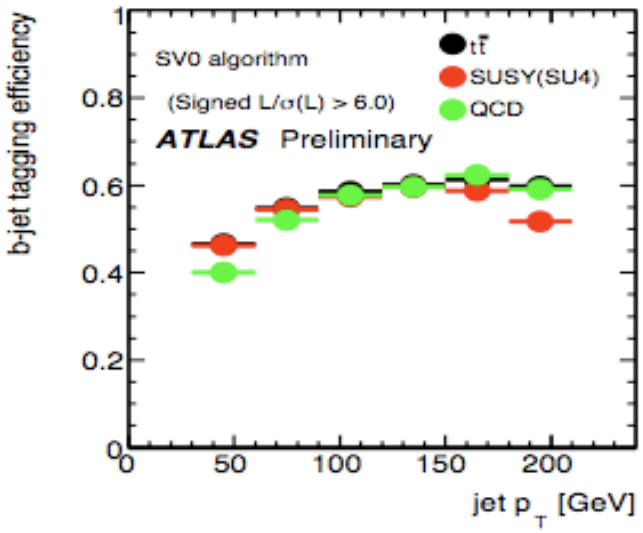
Tagging rate ratio (Pt dependence)



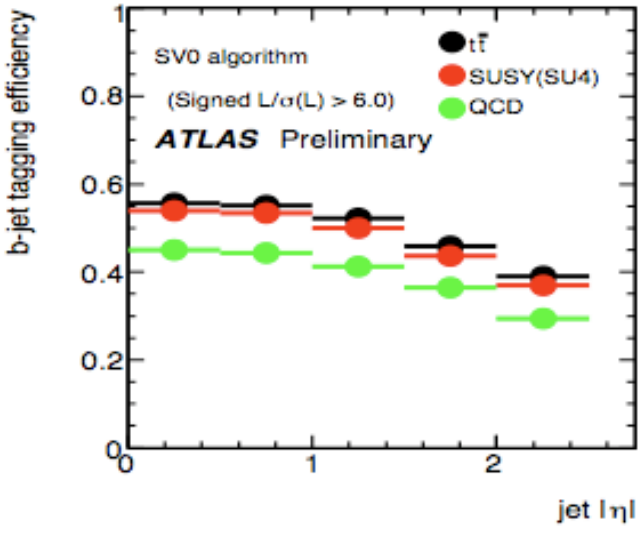
Tagging rate ratio (MissE$_T$ dependence)



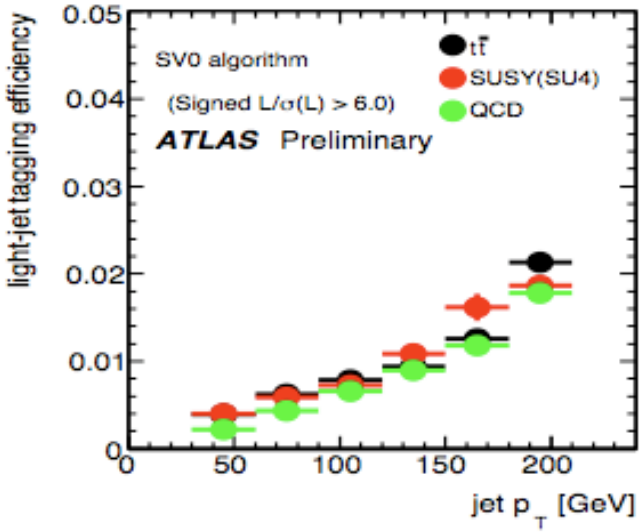
b-tagging performance



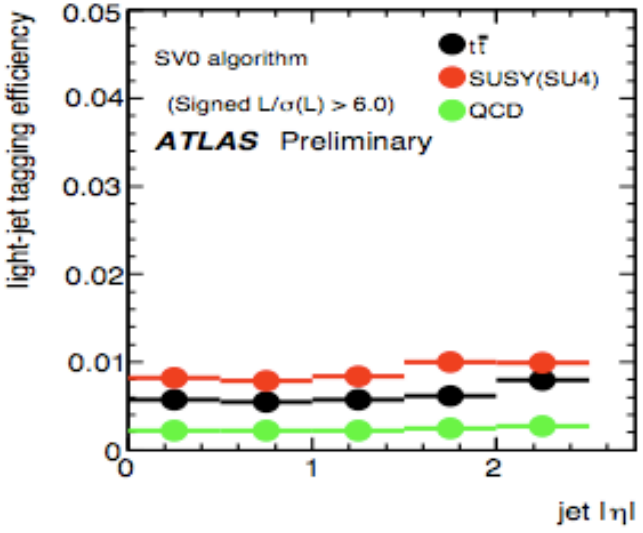
(a) b-tagging efficiency as a function of jet p_{T}.



(b) b-tagging efficiency as a function of jet $|\eta|$.



(c) Light-jet efficiency as a function of p_{T}



(d) Light-jet efficiency as a function of $|\eta|$