

R-parity conserving SUSY studies with jets and E_T^{Miss}

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 - E_T^{Miss}
 - S_T
 - M_{eff}
- $\delta\phi$ plots
- QCD background rejection
- $W \rightarrow e\nu$ & $Z \rightarrow \nu\nu$ backgrounds
- Future Studies

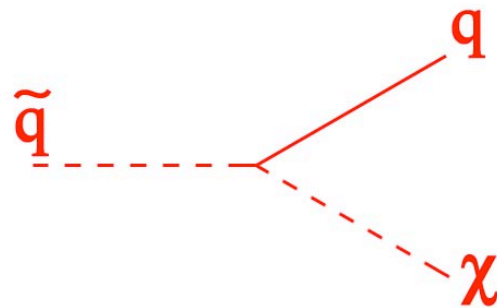
Motivation

- In SUSY we expect lots of:
 - Jets
 - Leptons
 - E_T^{Miss} (R-parity conserving)
- Generic Jets + E_T^{Miss} search is sensitive to most SUSY models
- Low multiplicity jets + E_T^{Miss} not really studied
- Most ATLAS SUSY use $N_{\text{jets}} \geq 4$

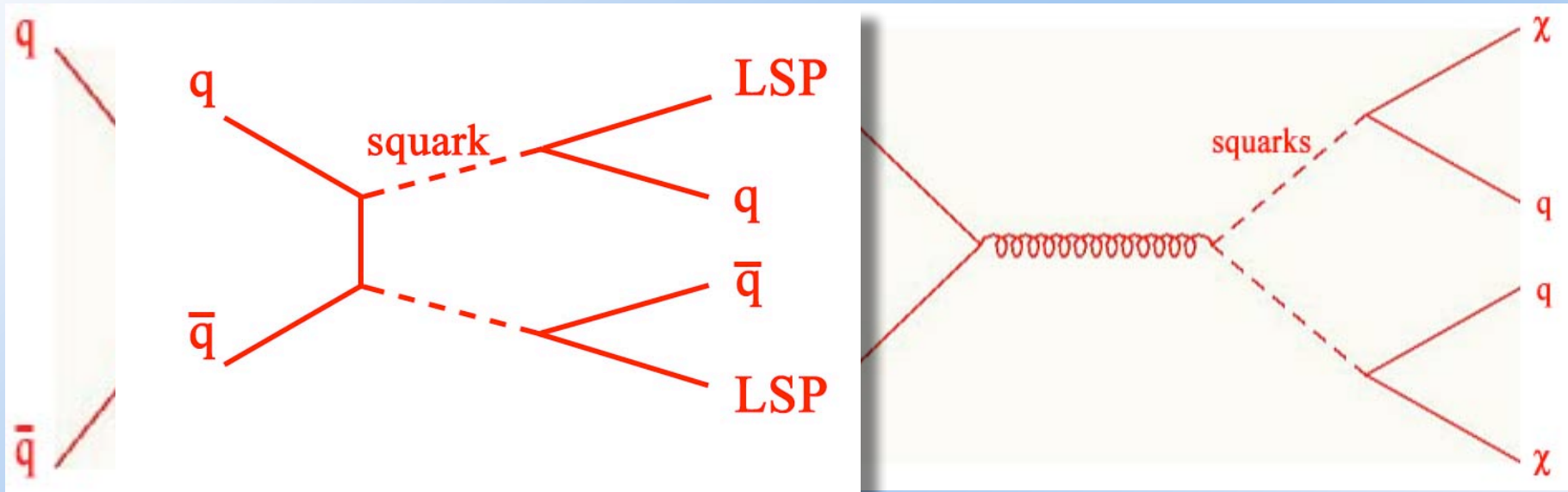
R-Parity

$$R = (-1)^{2j + 3B + L}$$

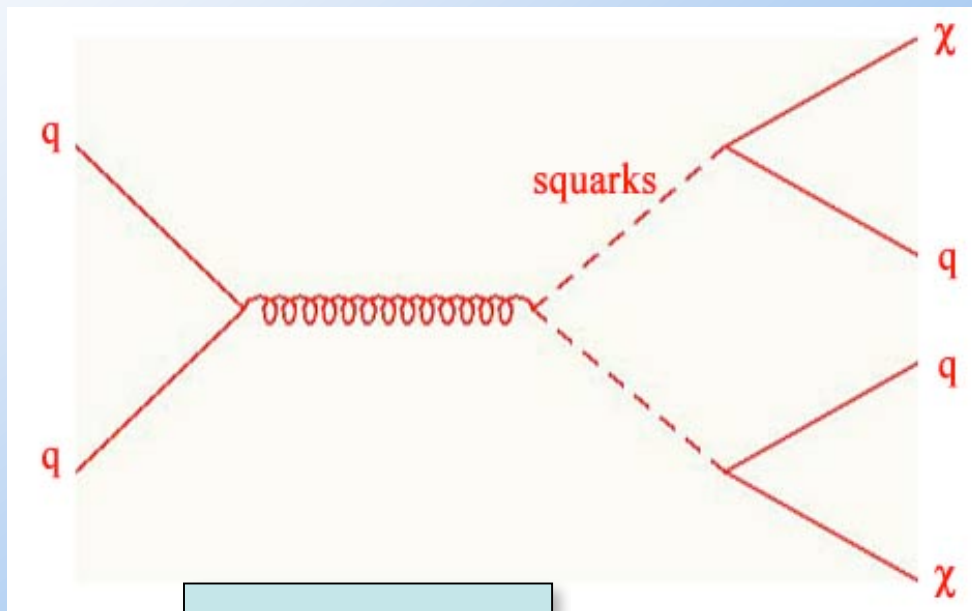
- SM particles have $R = 1$
- SUSY sparticles have $R = -1$
- Multiplicative



QCD jet background



Analysis Aim



Example Signal

- Detect production and decay of squarks and gluinos
- Look for and optimise variable cuts that help discriminate SM backgrounds
- Analysis focused mainly on QCD jet background at the moment.

Discriminating Variables

Jet Cuts:

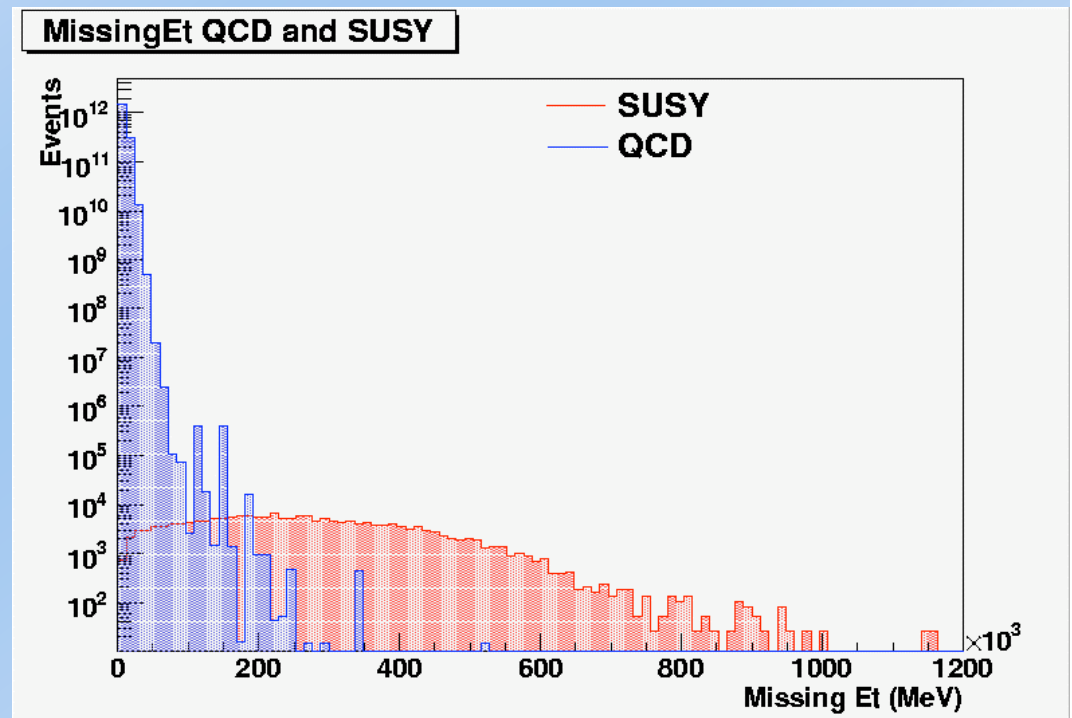
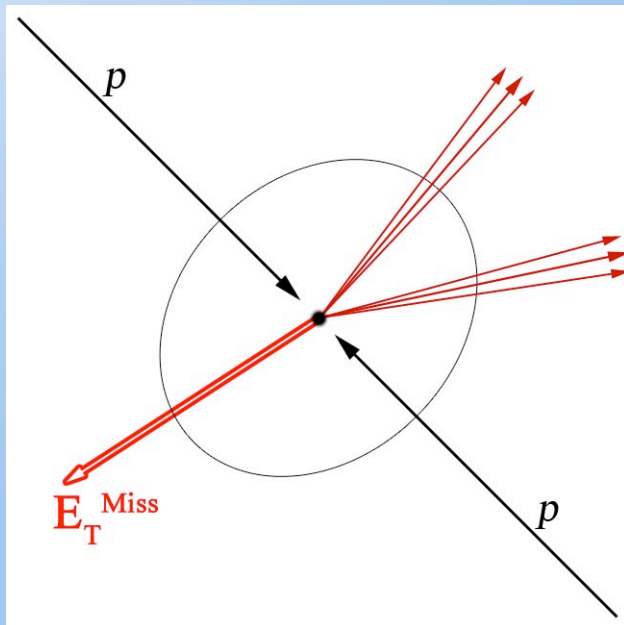
- $N_{\text{jets}} \geq 3$
- $E_T^{\text{jet1,2,3}} = 180 \text{ GeV}, 110\text{GeV}, 100\text{GeV}$
- $|\eta^{\text{jet1}}| < 1.7$
- $|\eta^{\text{jet2,3}}| < 3$

In addition to these jet cuts, 3 SUSY variables investigated:

- E_T^{Miss}
- S_T
- M_{eff}

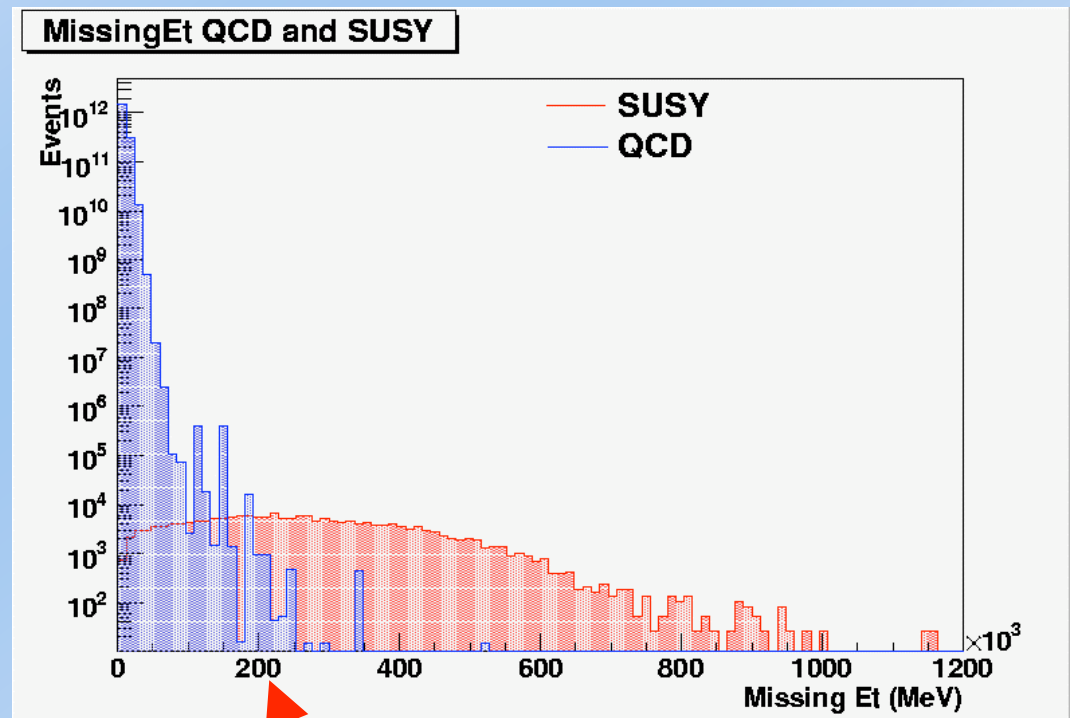
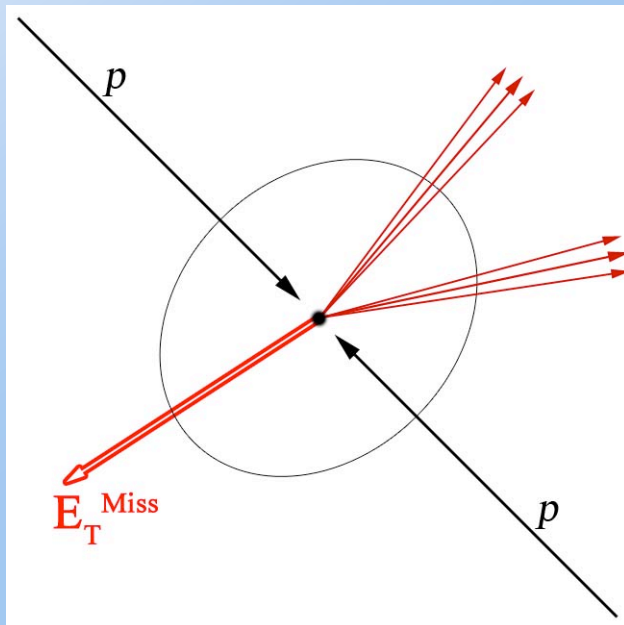
Missing Transverse Energy, E_T^{Miss}

- R-parity conserving SUSY $\rightarrow$ LSP stable
- SUSY signals have large E_T^{Miss}
- Highly Discriminating variable for SUSY searches



Missing Transverse Energy, E_T^{Miss}

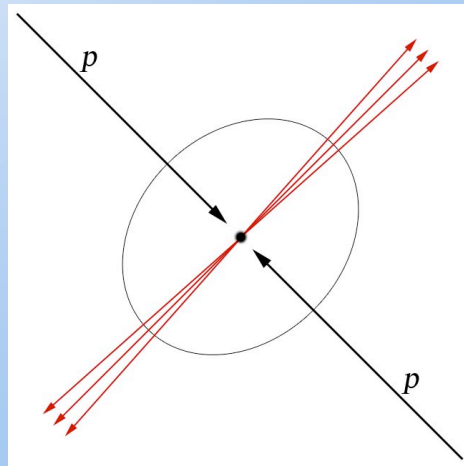
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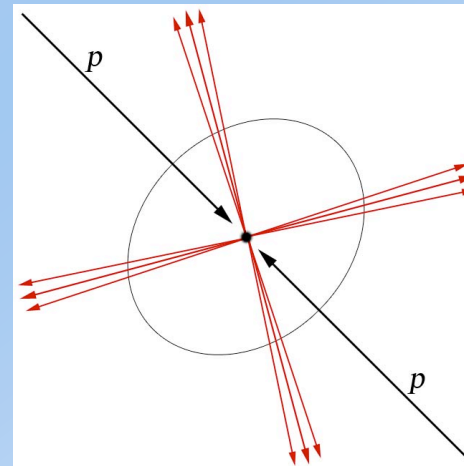
$E_T^{\text{Miss}} > 200 \text{ GeV}$

Transverse Sphericity, S_T

- A measure of the isotropy of the event perpendicular to beam axis.
- $0 \leq S_T \leq 1$



$$S_T = 0$$



$$S_T = 1$$

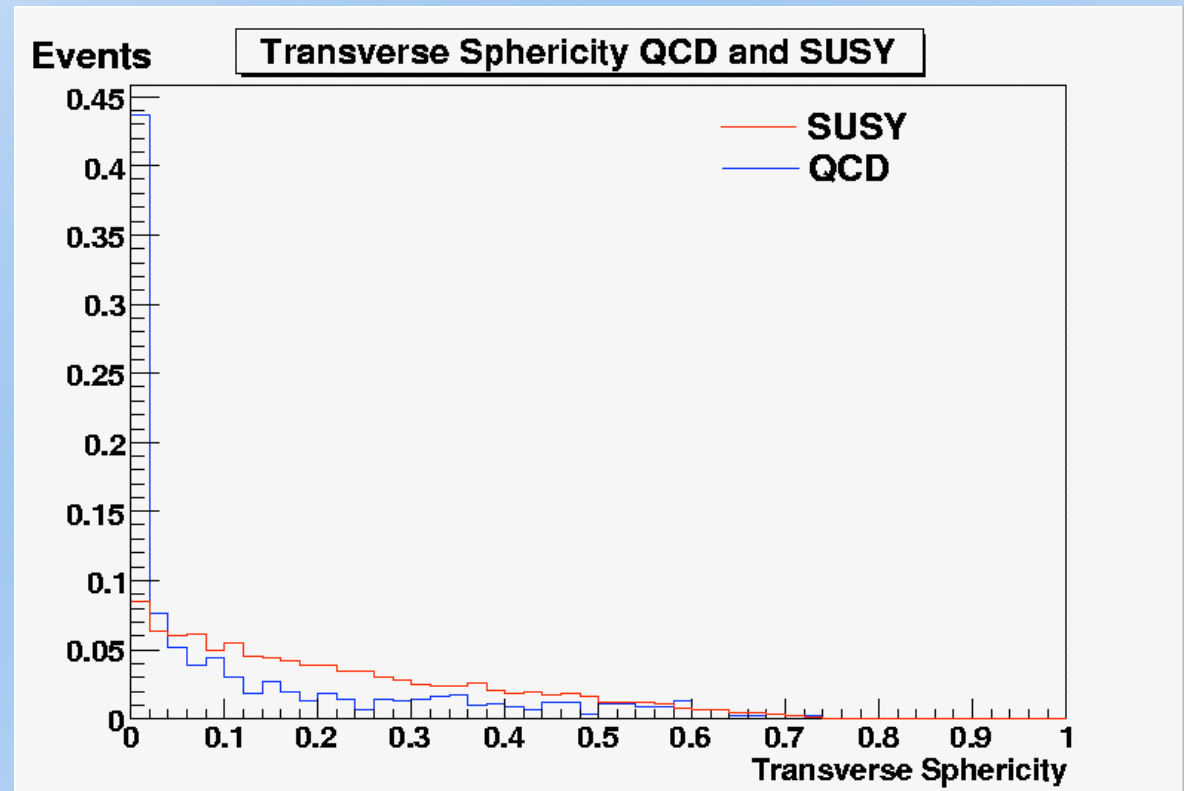
Transverse Sphericity, S_T

S_T is defined as:

$$S_T = \frac{2\lambda_2}{(\lambda_1 + \lambda_2)}$$

Sphericity Tensor:

$$S_{ij} = \sum_k p_{ki} p_{kj}$$



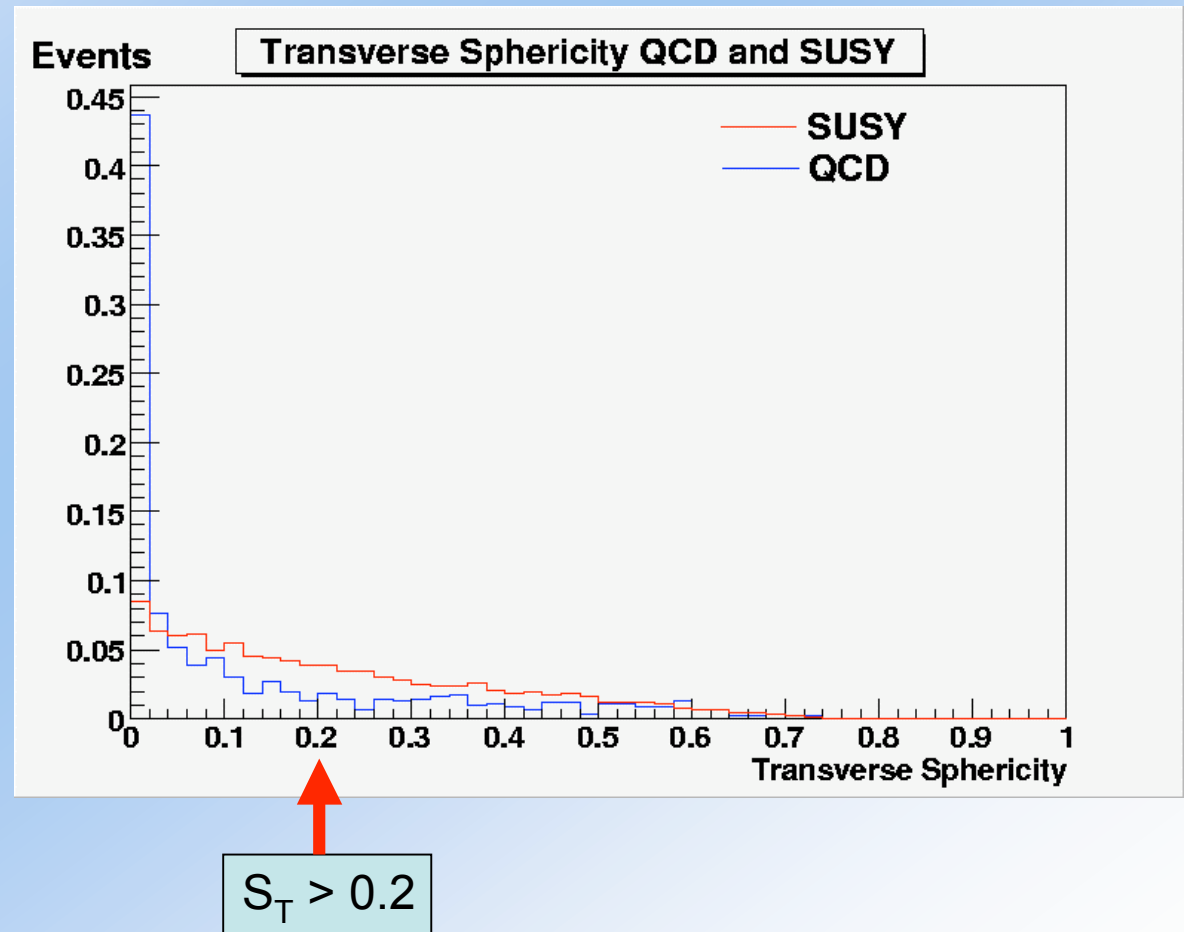
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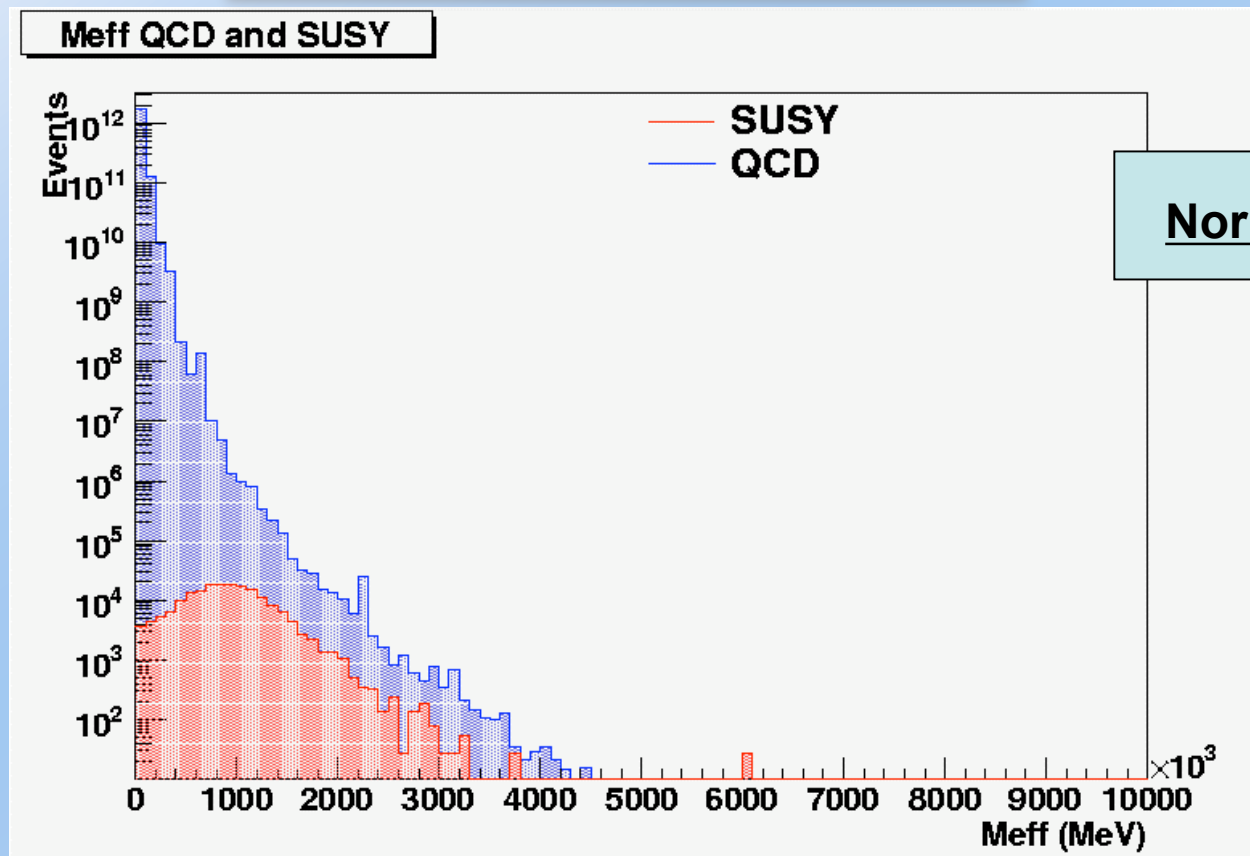
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Effective Mass, M_{eff}

Defined as:

$$M_{\text{eff}} = E_{\text{T}}^{\text{Miss}} + p_{\text{T}}^{\text{jet1}} + p_{\text{T}}^{\text{jet2}} + p_{\text{T}}^{\text{jet3}}$$

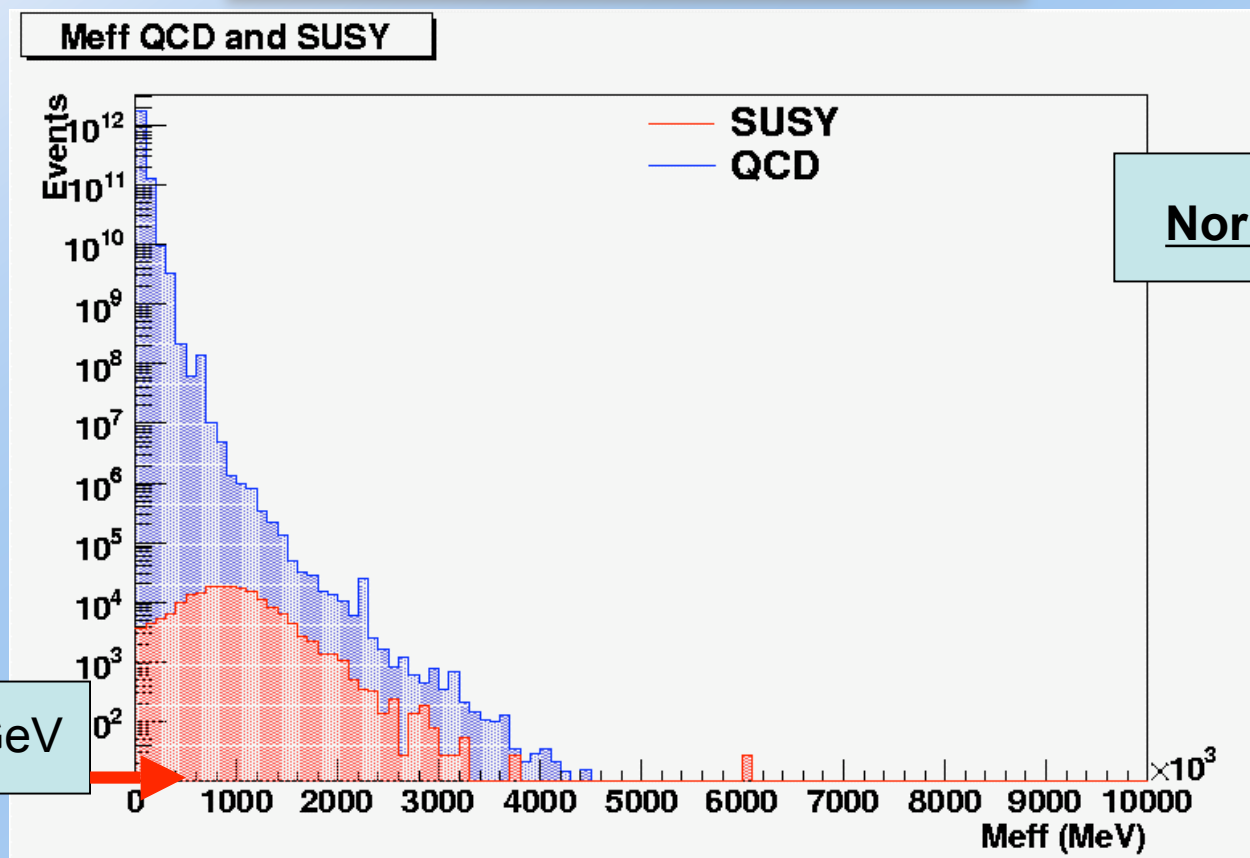


Normalised 10fb^{-1}

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$$M_{\text{eff}} = E_{\text{T}}^{\text{Miss}} + p_{\text{T}}^{\text{jet1}} + p_{\text{T}}^{\text{jet2}} + p_{\text{T}}^{\text{jet3}}$$



Normalised 10fb⁻¹

$M_{\text{eff}} > 500\text{GeV}$

$\delta\phi$ plots

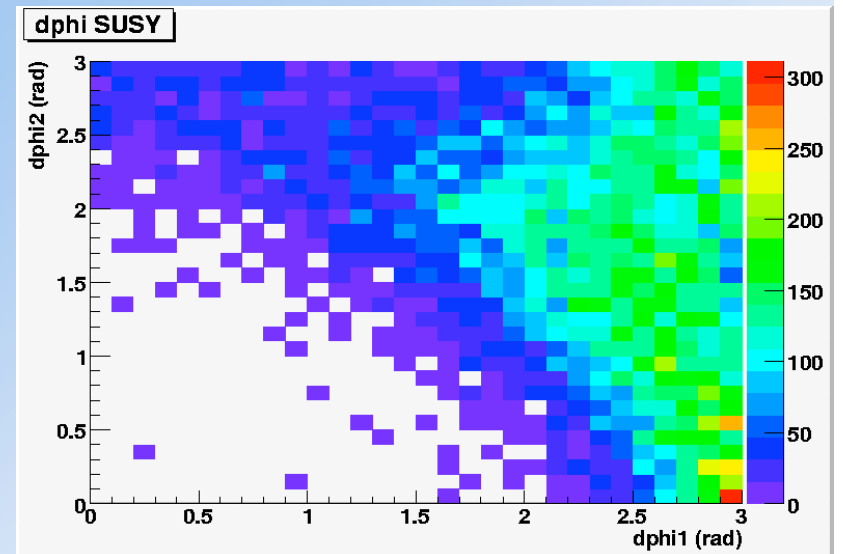
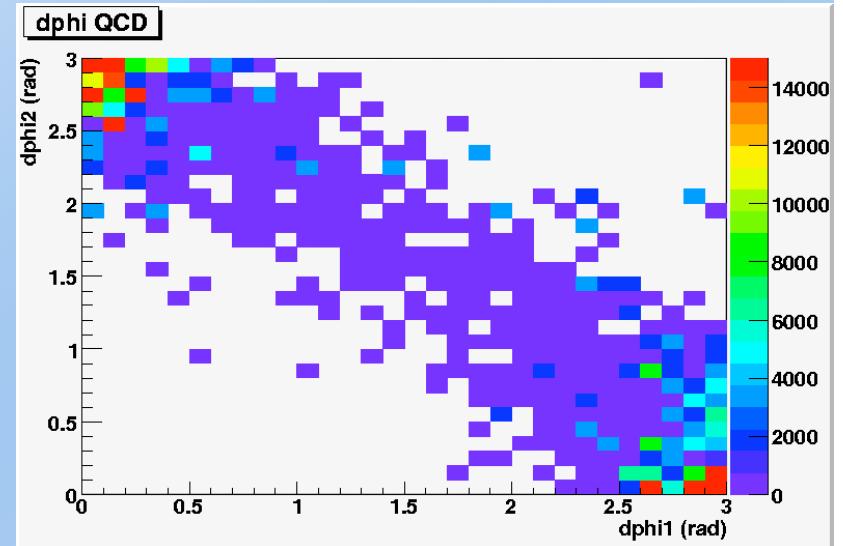
where:

$$\delta\phi_1 = |\phi_{\text{jet1}} - \phi(E_T^{\text{Miss}})|$$

$$\delta\phi_2 = |\phi_{\text{jet2}} - \phi(E_T^{\text{Miss}})|$$

Jet Cuts:

- $N_{\text{jets}} \geq 3$
- $E_T^{\text{jet1,2,3}} > 180\text{GeV}, 110\text{GeV}, 100\text{GeV}$
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$\delta\phi$ plots

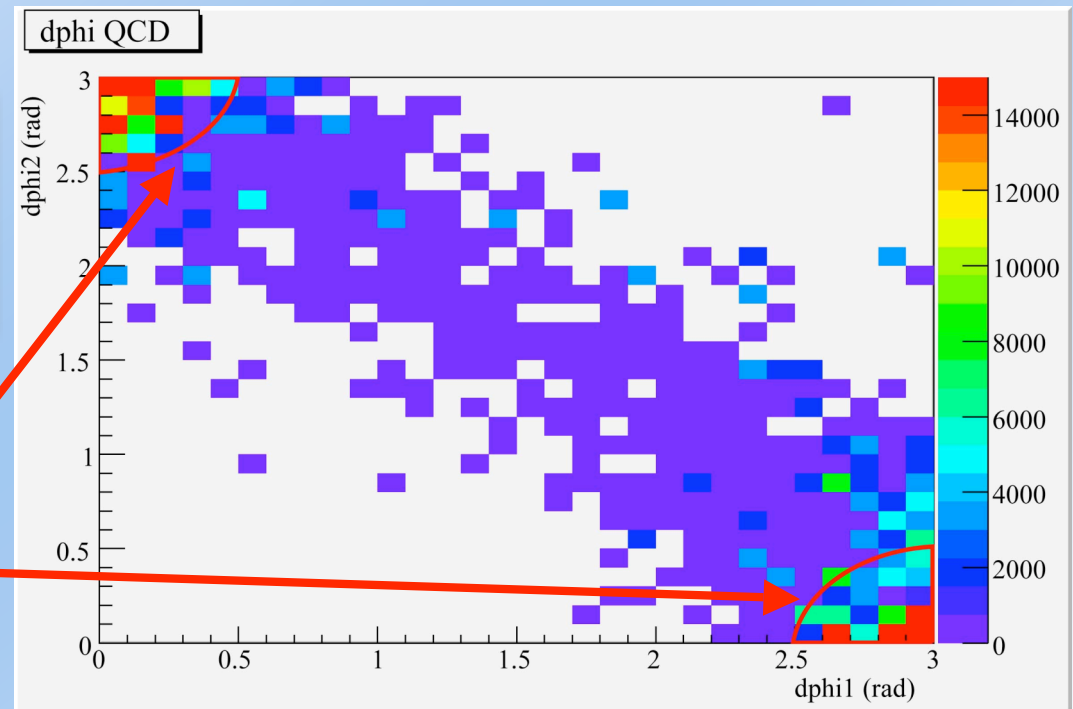
$\delta\phi$ cuts:

$$R_1 = \{\delta\phi_2^2 + (\pi - \delta\phi_1)^2\}^{1/2}$$

$$R_2 = \{\delta\phi_1^2 + (\pi - \delta\phi_2)^2\}^{1/2}$$

$$R_1 > 0.5 \text{ radians}$$

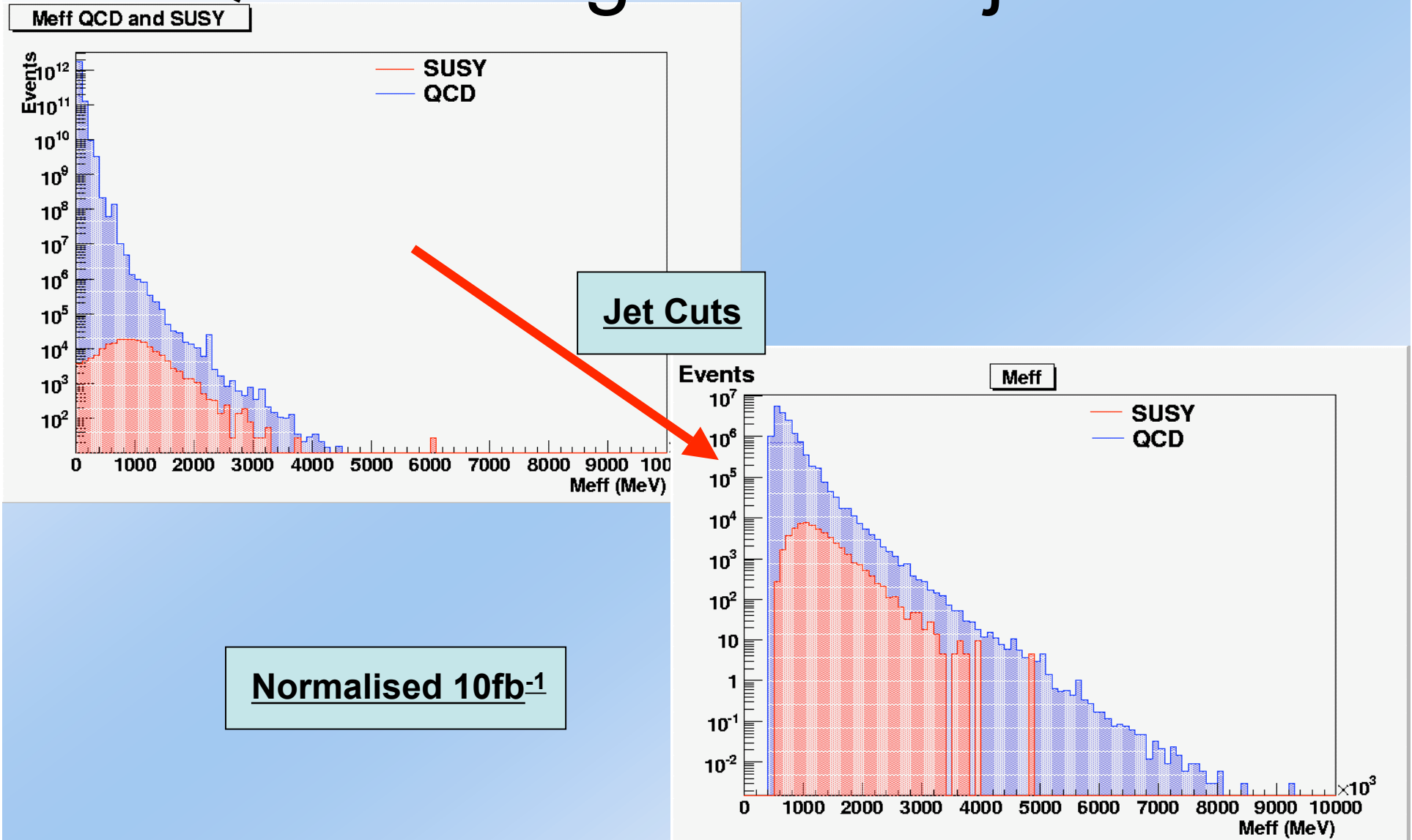
$$R_2 > 0.5 \text{ radians}$$



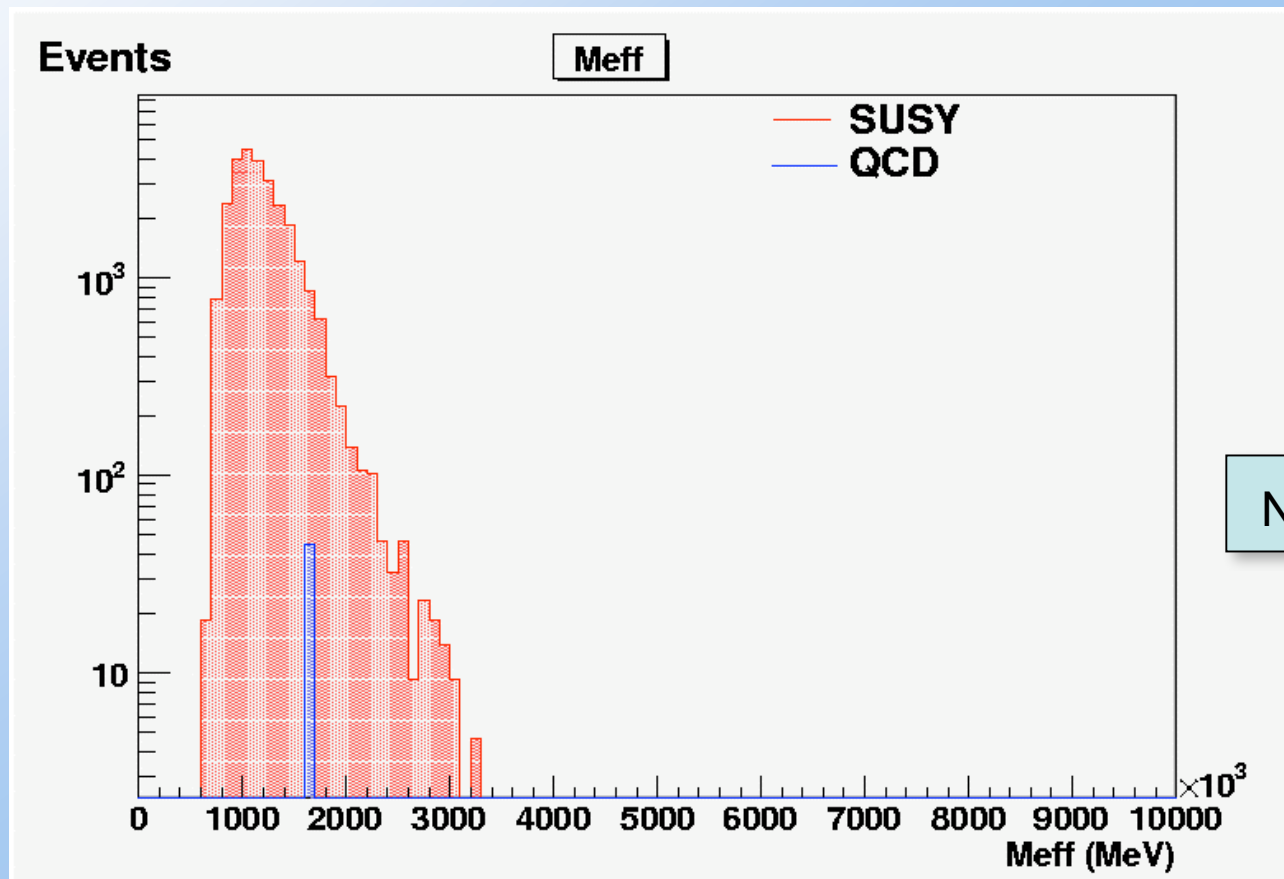
Cuts Summary

<u>Jet Cuts</u>
$N_{\text{jets}} \geq 3$ $E_{\text{T}}^{\text{jet1,2,3}} > 180\text{GeV}, 110\text{GeV}, 100\text{GeV}$ $ \eta^{\text{jet1,2,3}} < 1.7, 3, 3$
<u>SUSY Variable Cuts</u>
$E_{\text{T}}^{\text{Miss}} > 200\text{GeV}$ $S_{\text{T}} > 0.2$ $M_{\text{eff}} > 500\text{GeV}$
<u>$\delta\phi$ Cuts</u>
$R_1 > 0.5$ radians $R_2 > 0.5$ radians

QCD Background Rejection

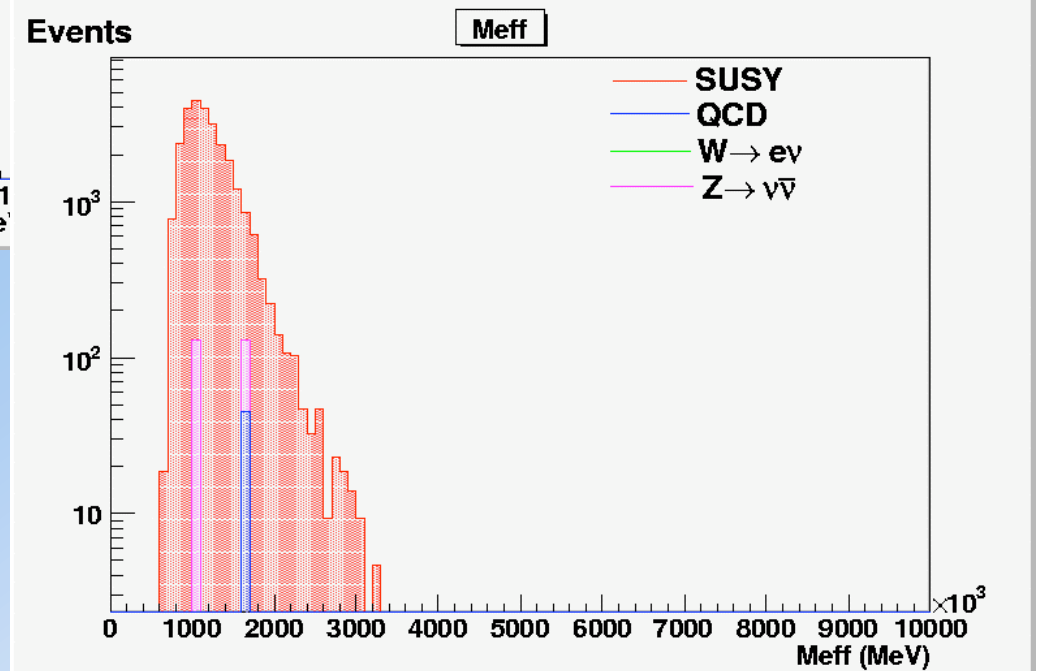
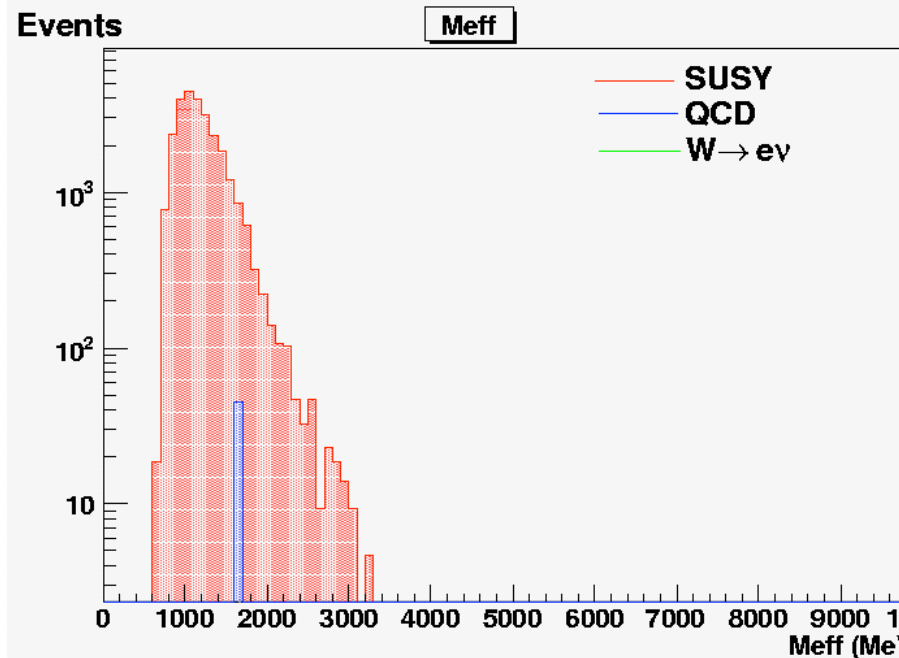


QCD Background Rejection

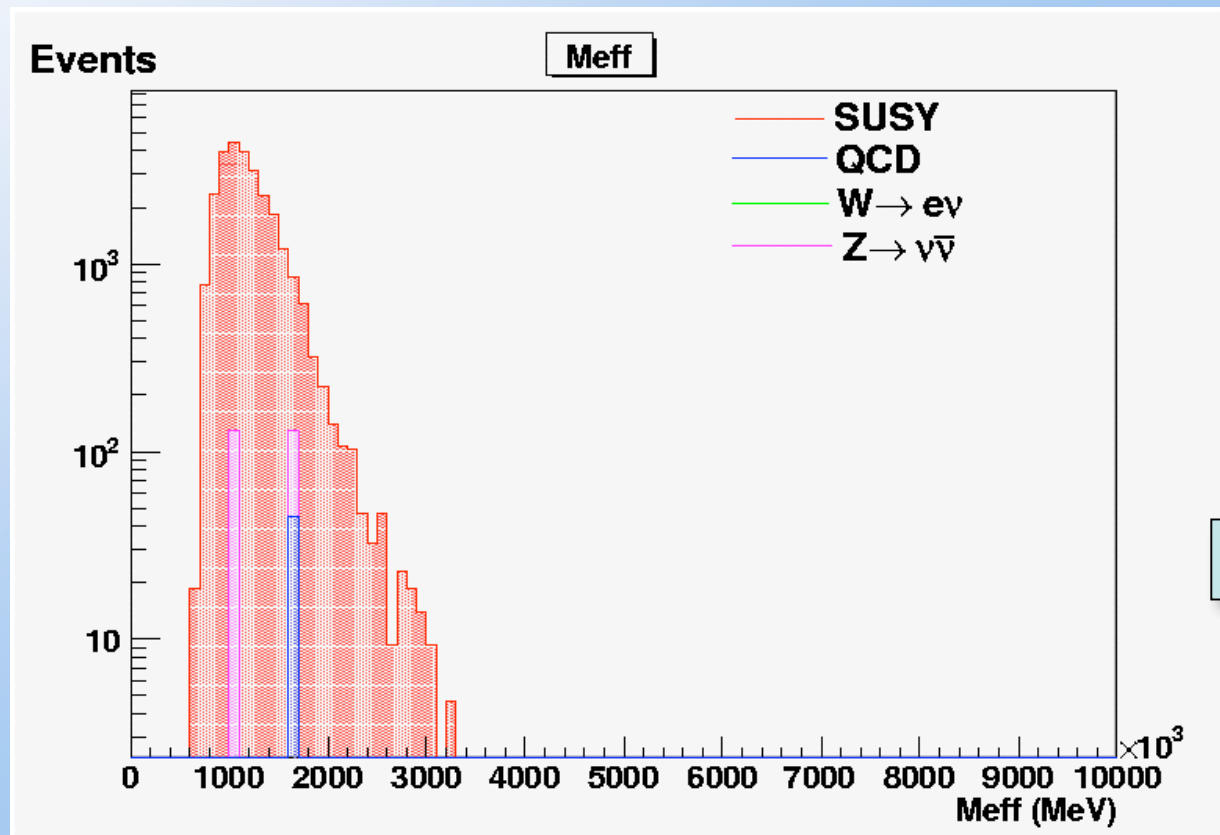


Normalised 10fb^{-1}

$W \rightarrow e\nu$ & $Z \rightarrow \nu\nu$ backgrounds



$W \rightarrow e\nu$ & $Z \rightarrow \nu\bar{\nu}$ backgrounds



- same cuts as for QCD jet background
- Unfortunately low statistics

Normalised 10fb^{-1}

Future Study

- More statistics
- Include additional backgrounds (ttbar etc.)
- Optimise cuts
- Look at 2 jets inclusive
- Trigger study

Summary

- jets + E_T^{Miss} looks promising for R-parity conserving SUSY search
- Low multiplicity -> more statistics -> better for early discovery?