

The Bi-Event Subtraction Technique (BEST) for Hadron Colliders

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Outline

- 1 Combinatoric Background at Colliders
 - Standard Model @ Large Hadron Collider
 - Beyond SM @ LHC Example: SUSY
- 2 Bi-Event Subtraction Technique
 - BEST Explained
 - BEST does $t\bar{t}$
 - BEST does SUSY
- 3 Conclusions

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Standard Model of Particle Physics

Standard Model (SM) Particles

$\begin{pmatrix} u \\ d \end{pmatrix}_L$	u_R d_R	$\begin{pmatrix} e \\ \nu_e \end{pmatrix}_L$	e_R	g	W^+ W^- Z^0	γ	h^0
$\begin{pmatrix} c \\ s \end{pmatrix}_L$	c_R s_R	$\begin{pmatrix} \mu \\ \nu_\mu \end{pmatrix}_L$	μ_R				
$\begin{pmatrix} t \\ b \end{pmatrix}_L$	t_R b_R	$\begin{pmatrix} \tau \\ \nu_\tau \end{pmatrix}_L$	τ_R				

- Explains matter and interactions on our planet.
- Higgs yet to be found.
- Mostly understood. \Rightarrow Room for improvement!
- Beyond SM needed for dark matter, dark energy, inflation...

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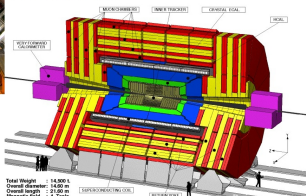
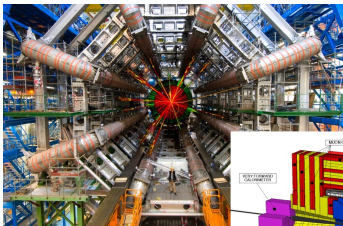
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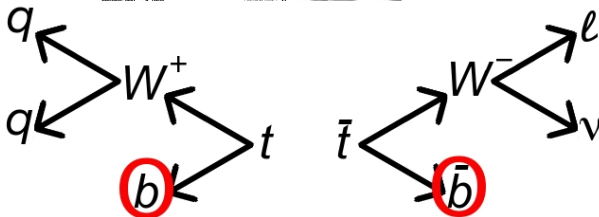
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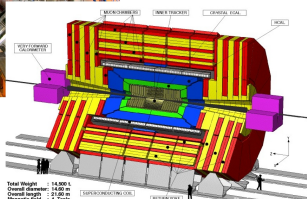
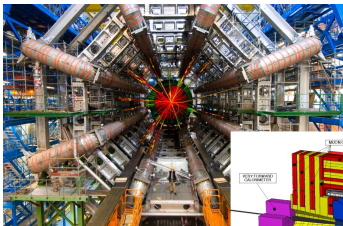


Hadron Colliders

- Standard Model
- Beyond the Standard Model
- ex. Supersymmetry

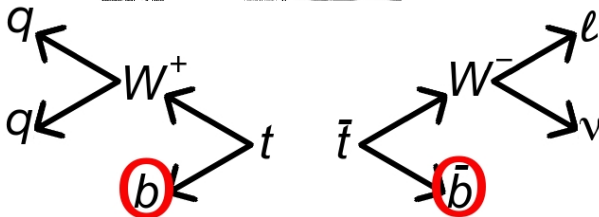


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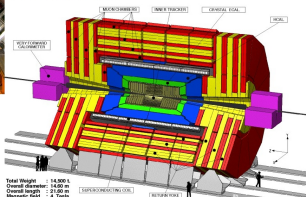
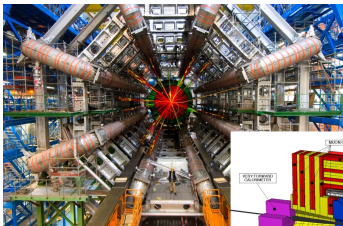


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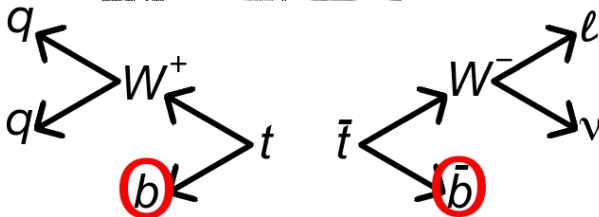


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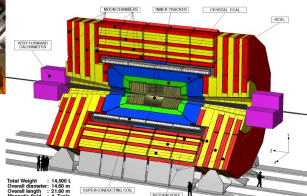
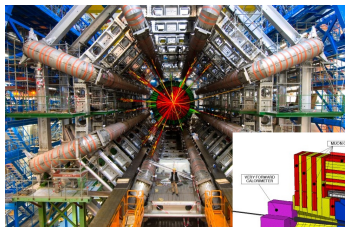


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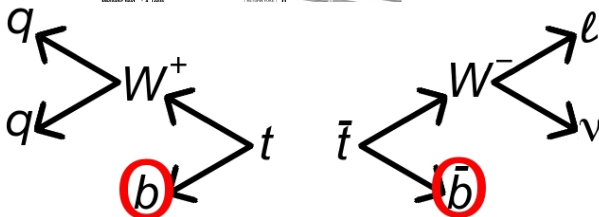


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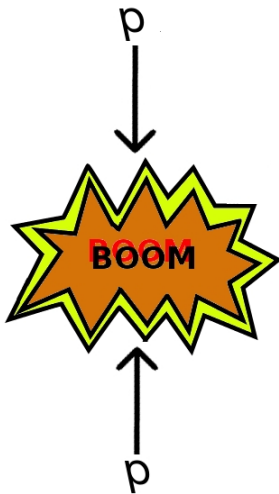
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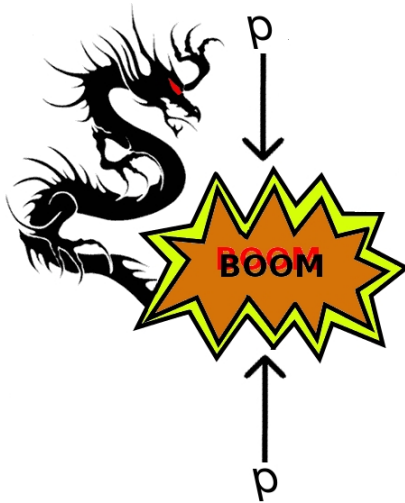
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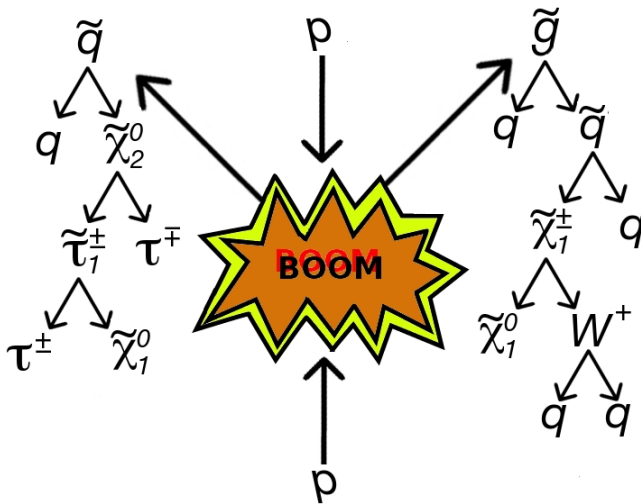
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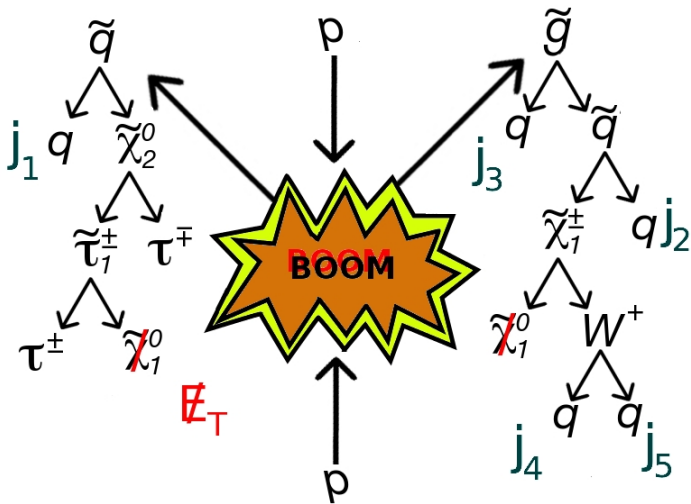
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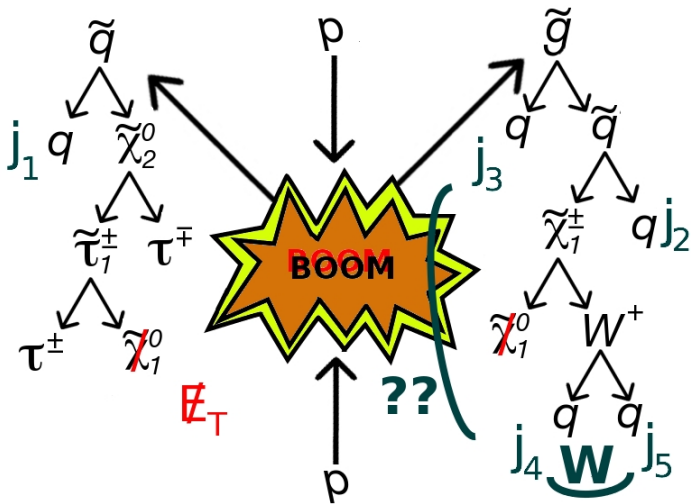
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Bi-Event Subtraction Technique (BEST)

Event #n

j

(W)

j

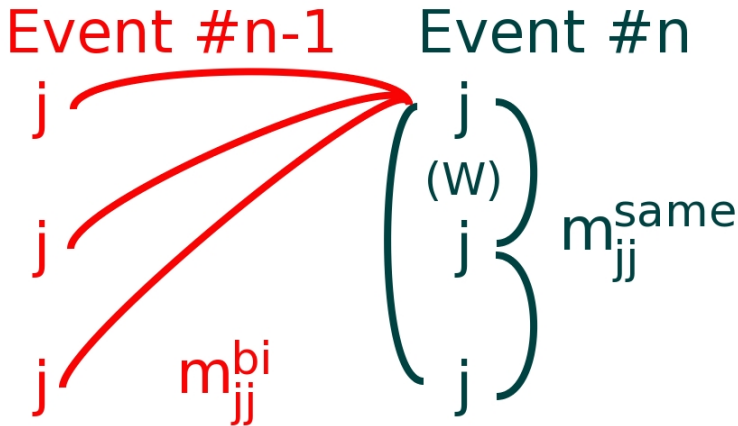
j

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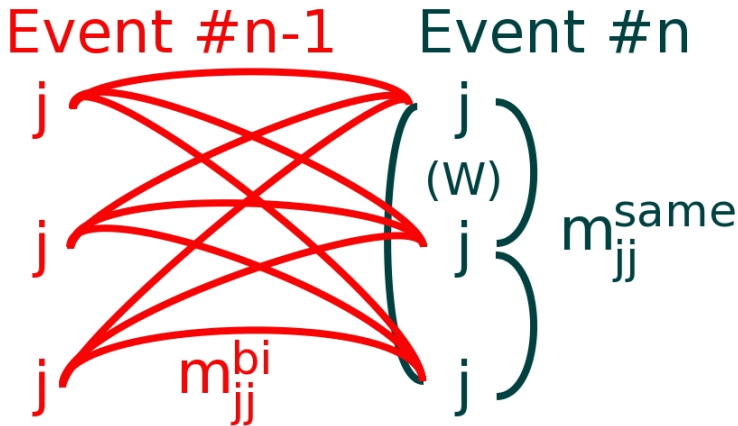
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$$\left. \begin{array}{c} j \\ (W) \\ j \\ j \end{array} \right\} m_{jj}^{\text{same}}$$

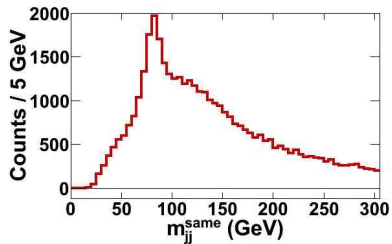
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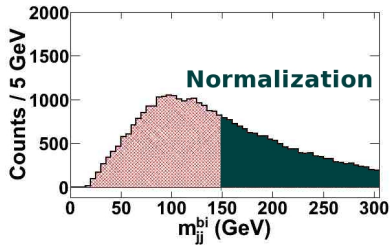
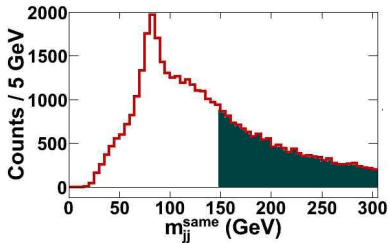
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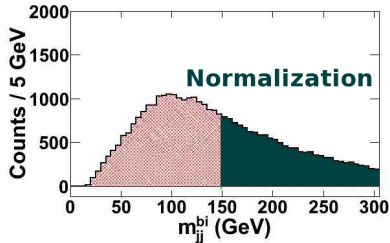
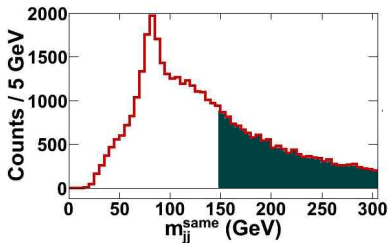
What BEST Looks Like...



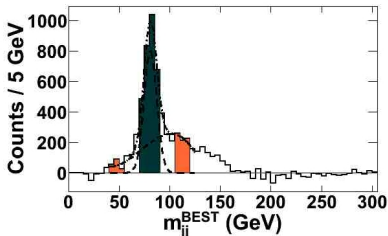
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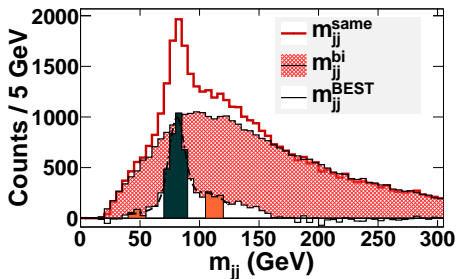
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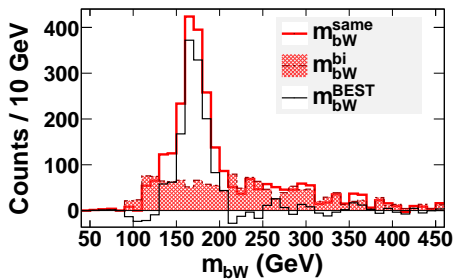
t Reconstruction with BEST

Even with backgrounds, BEST triumphs.

- 7 TeV collision energy @ LHC, 2 fb^{-1} .
- ALPGEN - $t\bar{t}$ signal and W +jets background
- PYTHIA - shower
- PGS - detector



$$m_W = 81.11 \pm 0.32 \text{ GeV}$$

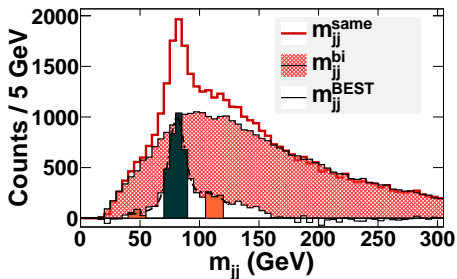


$$m_t = 170.5 \pm 1.5 \text{ GeV}$$

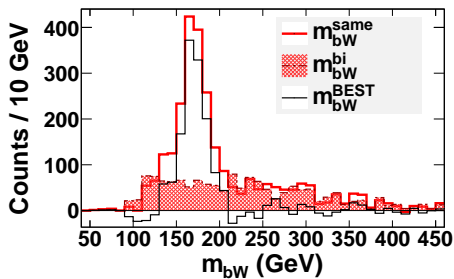
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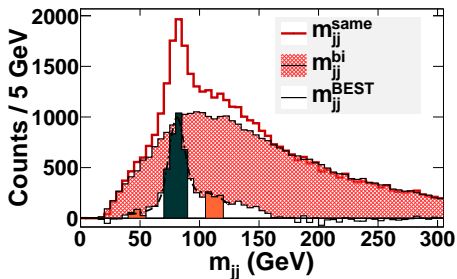


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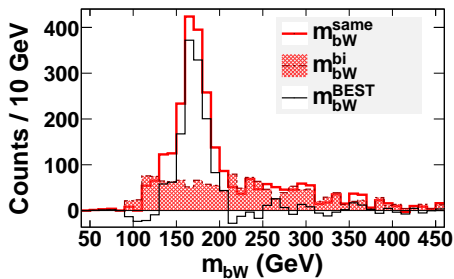
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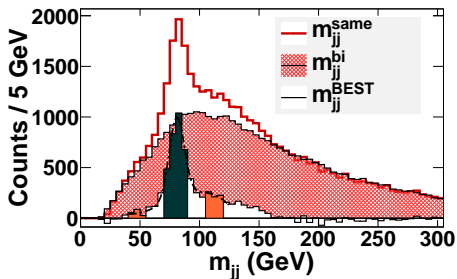


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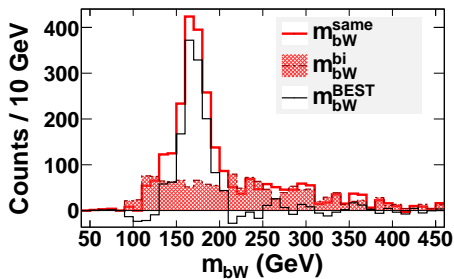
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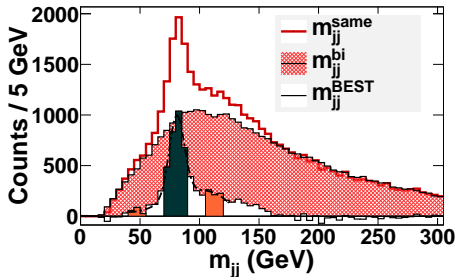


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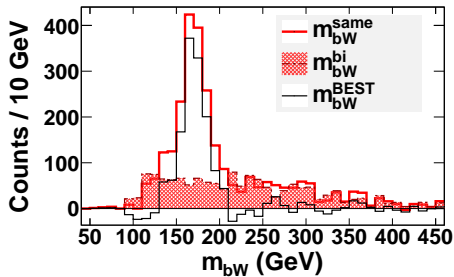
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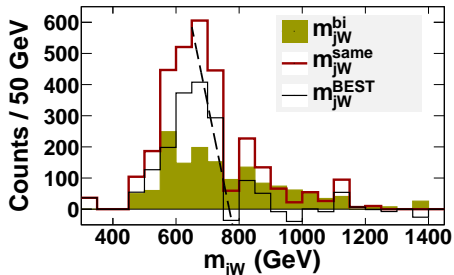
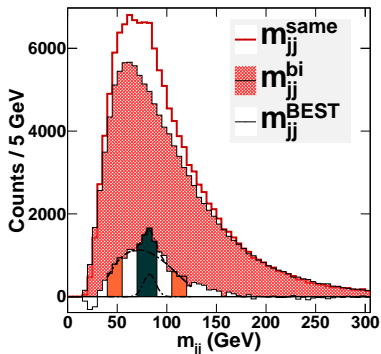


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Endpoint Techniques with BEST

Even with backgrounds on top of SUSY, BEST triumphs.

- 14 TeV collision energy @ LHC, 100 fb^{-1} .
- nuSUGRA: $m_0 = 360 \text{ GeV}$, $m_{1/2} = 500 \text{ GeV}$,
 $\tan \beta = 40$, $A_0 = 0$, and $m_H = 732 \text{ GeV}$.
- SM: $t\bar{t}$, W +Jets, and Z +Jets.

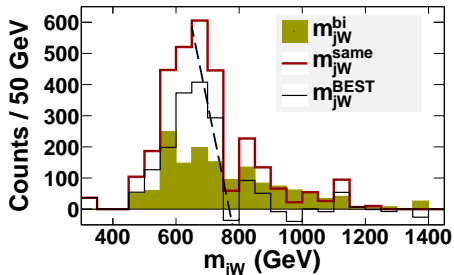
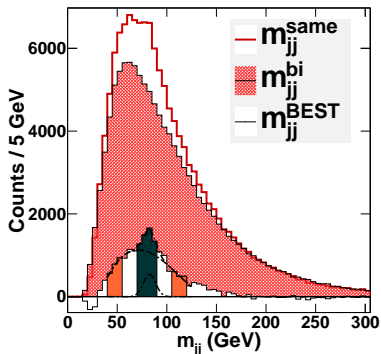


$$m_{jW}^{\text{max}} = 769 \pm 18 \text{ GeV}$$

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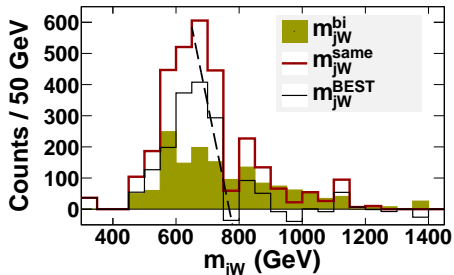
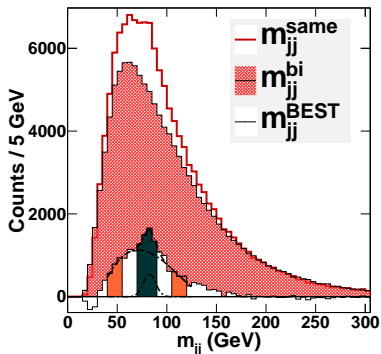


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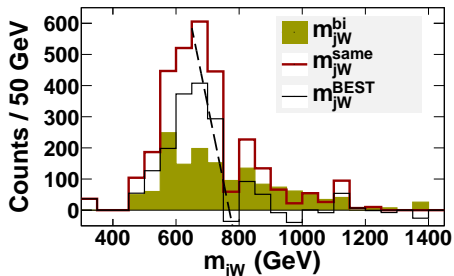
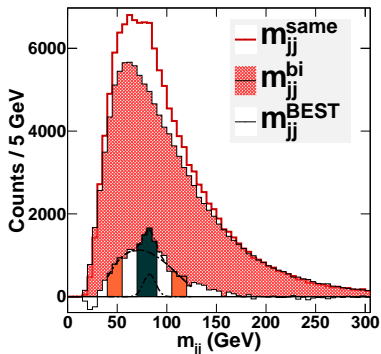


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The Power of BEST

- Removes combinatoric background of jets.
- Useful without charge or flavor.
- Can help to uncover nearly invisible signals.
- Useful for any hadron collision experiment.

arXiv:1104.2508

Also see:

Phys.Rev.D82:115009,2010. [arXiv:1008.3380]

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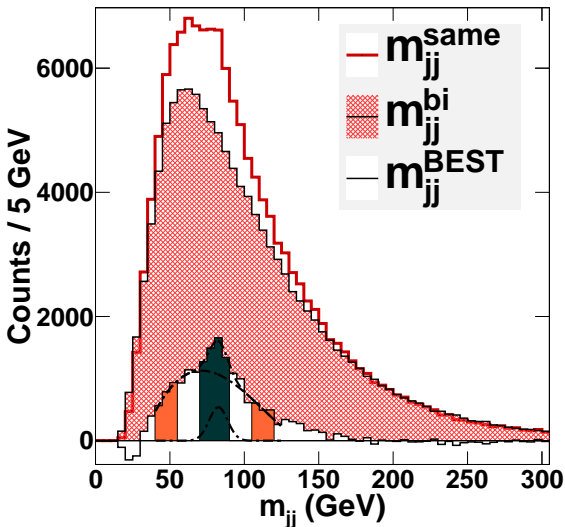
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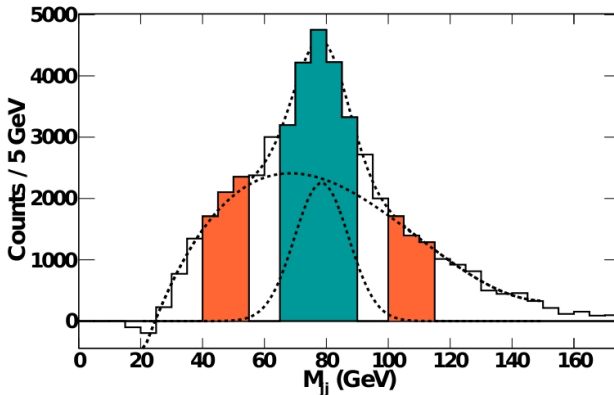
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Backup Slide: Huge W finding plot for SUSY.



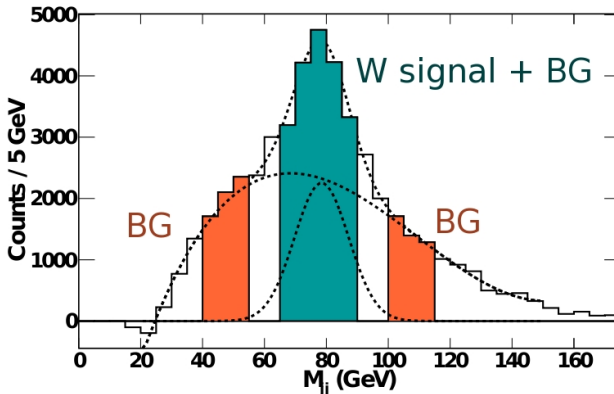
Backup Slide: Sideband Subtraction



Sideband Subtraction

$$N_{SB} = \frac{\int_{W \text{ band}} f(m_{jj}) dm_{jj}}{\int_{\text{sideband}} m_{jj} dm_{jj}} \Rightarrow m_{Jjj}^{Sub} = m_{Jjj}^{W \text{ band}} - N m_{Jjj}^{sideband}$$

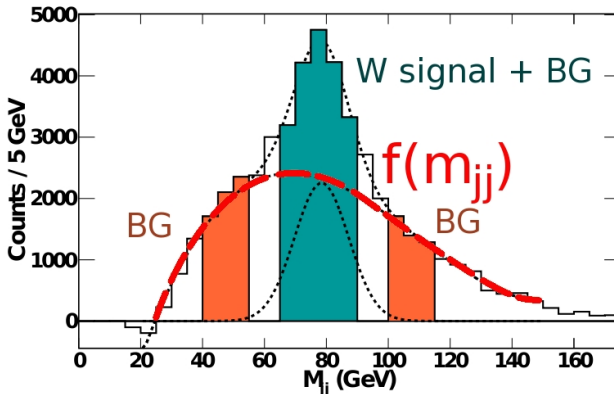
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