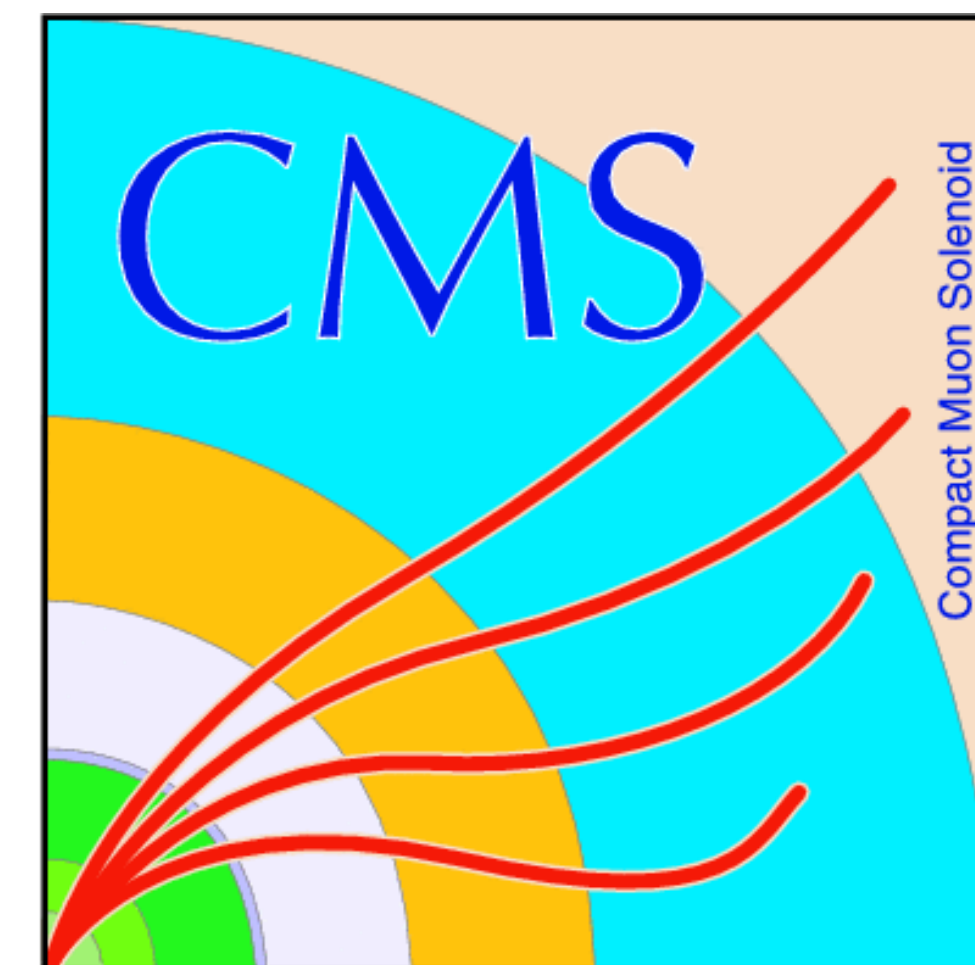


Missing transverse energy significance at CMS

Jim Alexander, Nathan Mirman, Yimin Wang



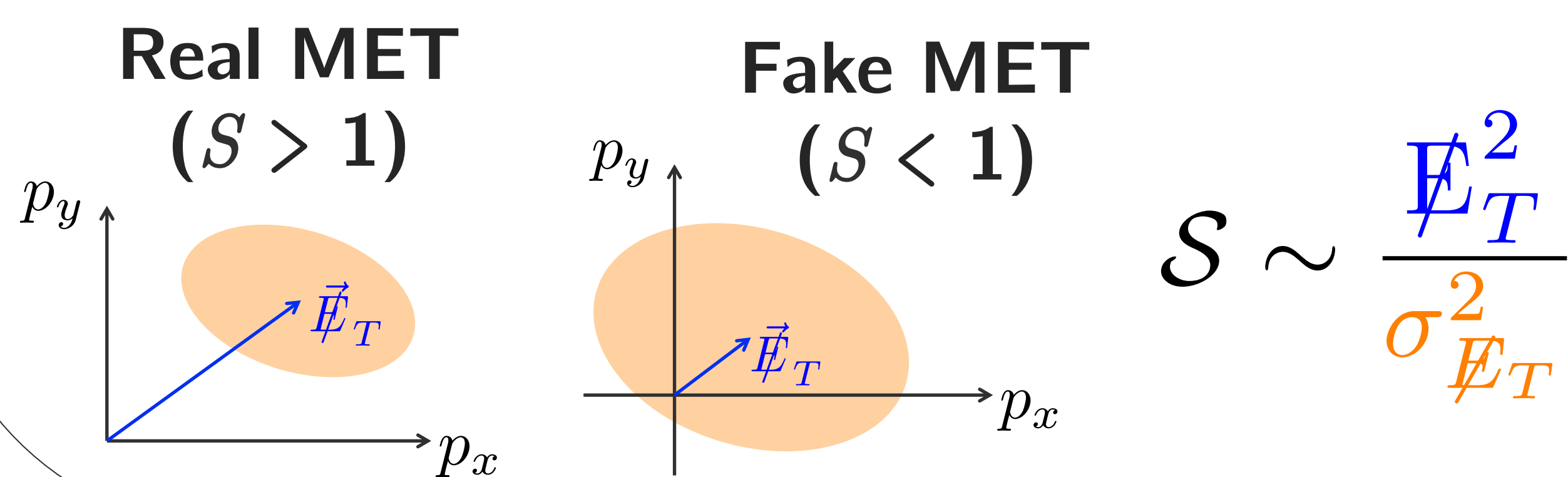
\vec{E}_T Significance

Defined in terms of the *true* MET $\vec{\epsilon}$ and *measured* MET $\sum_i \vec{\epsilon}_i$ as the log-likelihood ratio

$$S \equiv 2 \log \left(\frac{\mathcal{L}(\vec{\epsilon} = \sum_i \vec{\epsilon}_i)}{\mathcal{L}(\vec{\epsilon} = 0)} \right)$$

In the Gaussian case, the Significance is a χ^2 variable with two degrees of freedom.

$$S = \left(\sum_i \vec{\epsilon}_i \right)^\dagger \mathbf{V}^{-1} \sum_i \vec{\epsilon}_i$$



Jet Resolutions

The MET resolution captured in the **total covariance matrix V** is determined mainly by the hadronic components of the event.

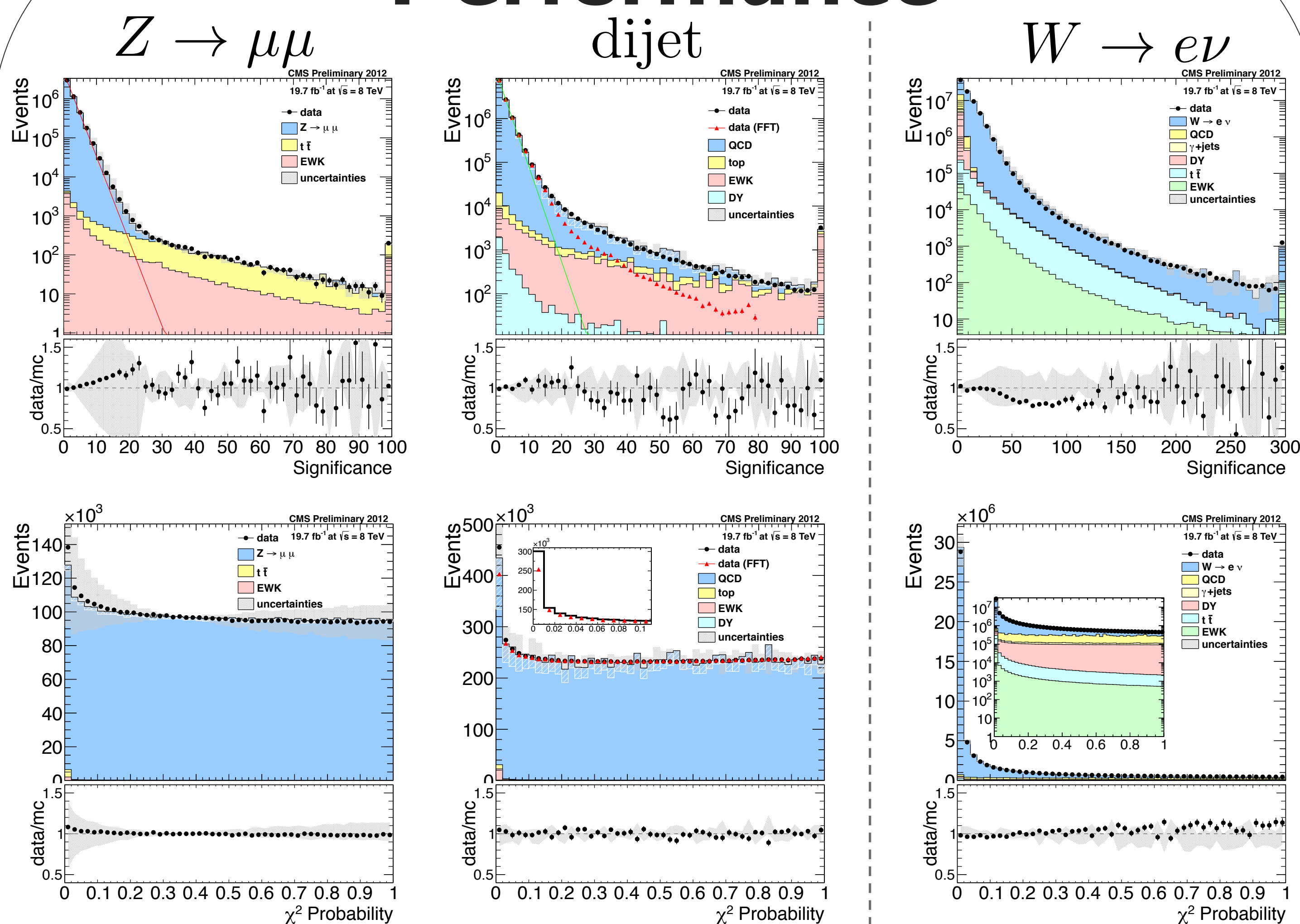
$$\mathbf{V} = \sum_i R(\phi_i) \begin{pmatrix} \sigma_{p_{T_i}}^2 & 0 \\ 0 & p_{T_i}^2 \sigma_{\phi_i}^2 \end{pmatrix} R^{-1}(\phi_i)$$

Objects in the total covariance matrix:

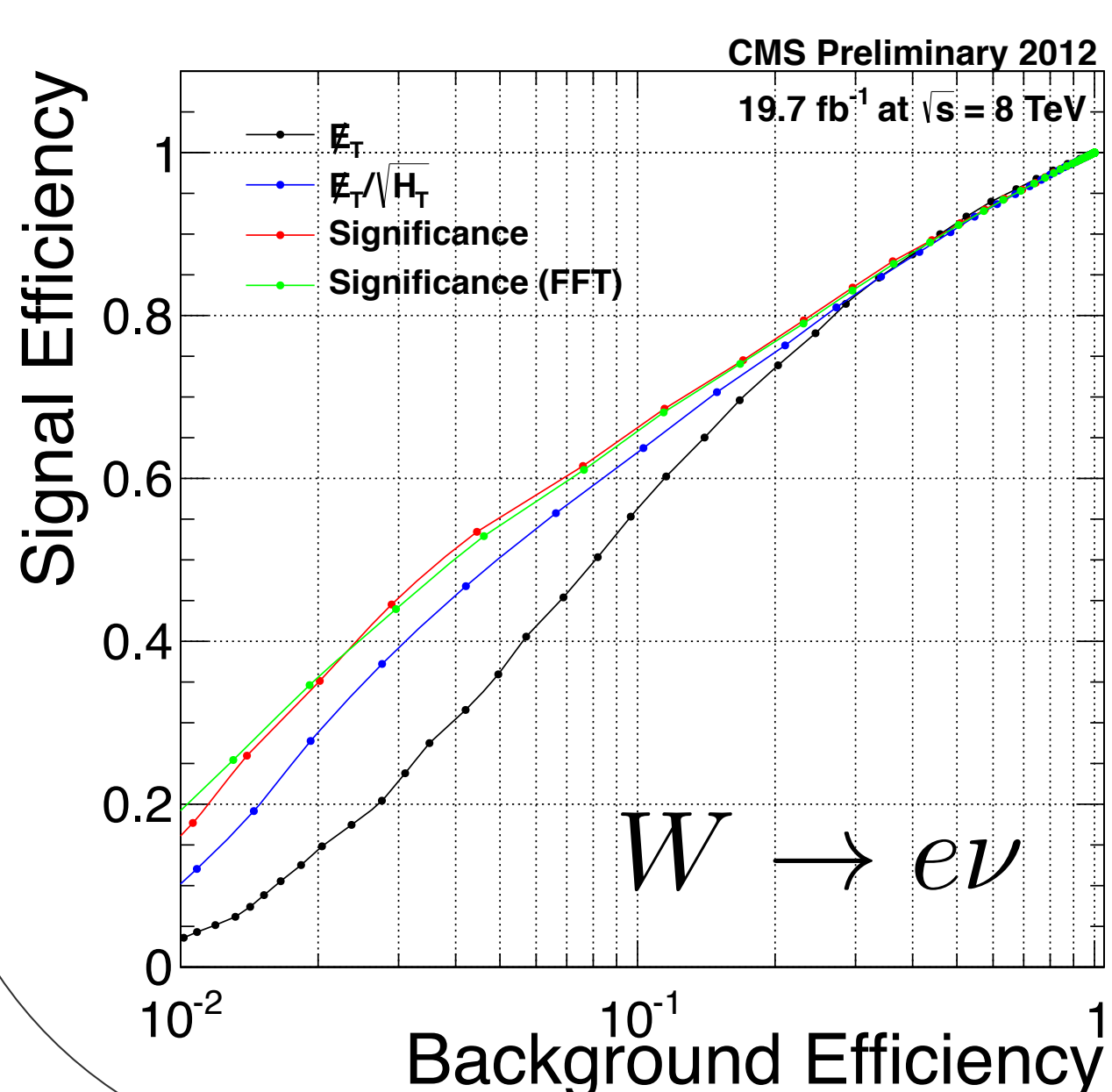
- A. Jets with $p_T > 20$ GeV
 - Resolutions of the form: $\sigma_{p_T} = \sigma^{mc} \times a_i$
 - 5 bins in η , 5 tuning factors a_i . $a_i \sim 1$.
- B. Jets with $p_T < 20$ GeV \rightarrow unclustered energy.
 - These objects are all lumped into a "blob" with $\vec{p}_T^{tot} = \sum_j (\vec{p}_T)_j$.
 - Resolution of the form: $\sigma_{p_x}^2 = \sigma_{p_y}^2 = N^2 + S^2 \times \sum |p_T|$

The values of the **7 free parameters** are determined in a ML fit in $Z \rightarrow \mu\mu$ events (nominally a zero-MET sample).

Performance



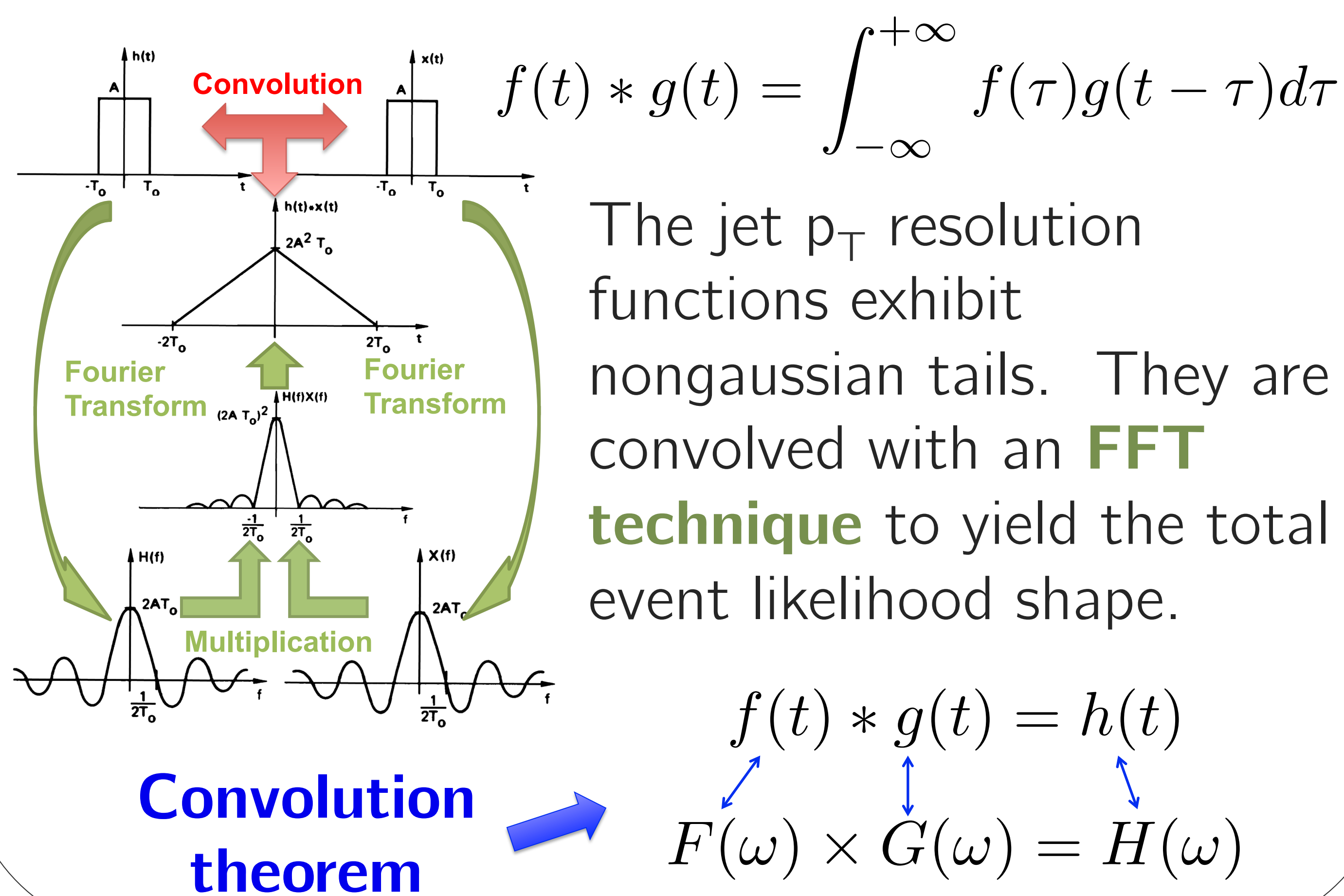
Distribution of \vec{E}_T Significance (top), and χ^2 probability (bottom). In the nominally zero-MET channels, the Significance follows an ideal χ^2 distribution with two degrees of freedom.



Signal vs. background efficiency with increasing cuts in $W \rightarrow e\nu$ events. **Background efficiencies** at 50% signal efficiency:

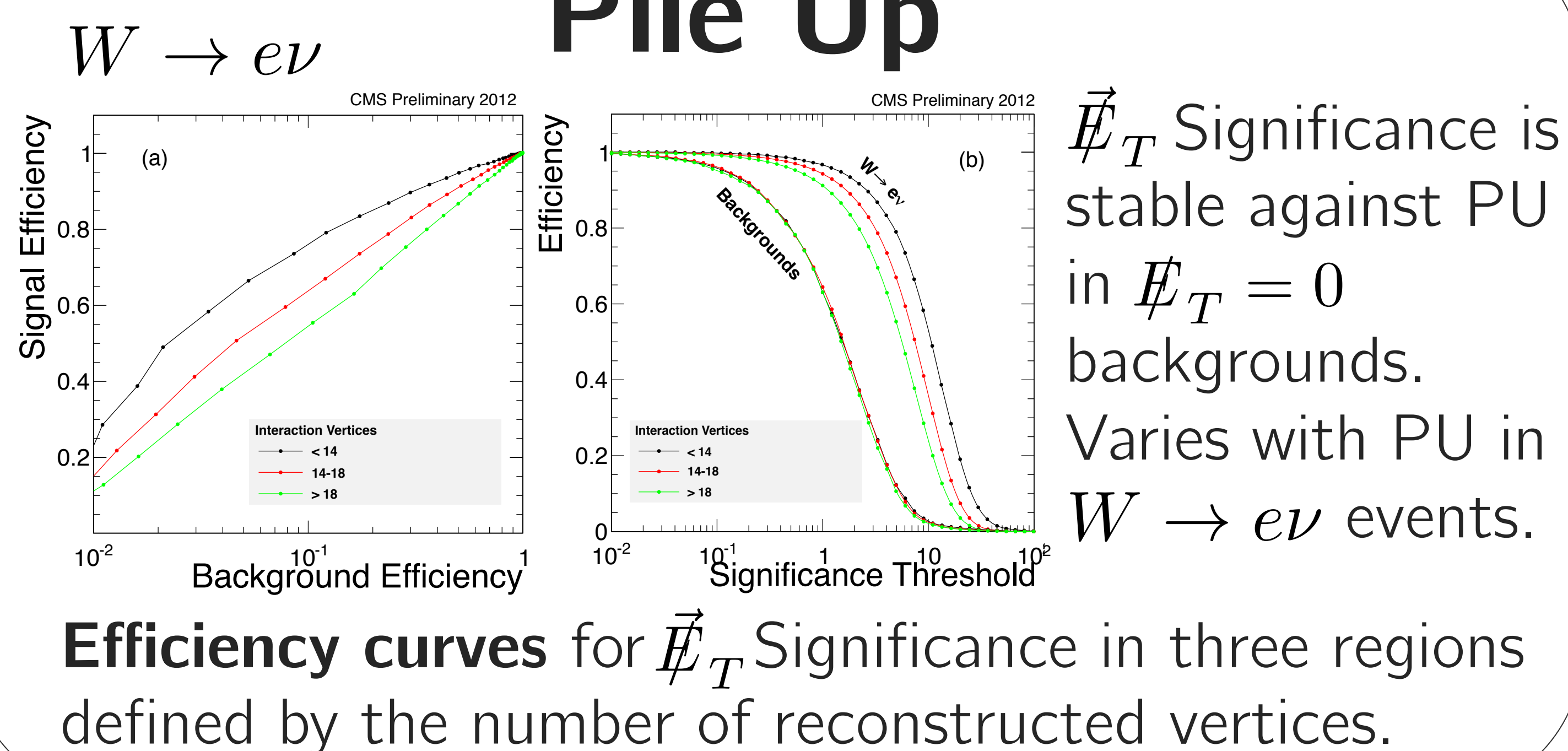
\vec{E}_T	8.2%
$\vec{E}_T / \sqrt{\sum E_T}$	5.1%
\vec{E}_T Significance	4.0%

Nongaussian Resolutions



The jet p_T resolution functions exhibit nongaussian tails. They are convolved with an **FFT technique** to yield the total event likelihood shape.

Pile Up



Efficiency curves for \vec{E}_T Significance in three regions defined by the number of reconstructed vertices.