Update on Jet Smearing Method

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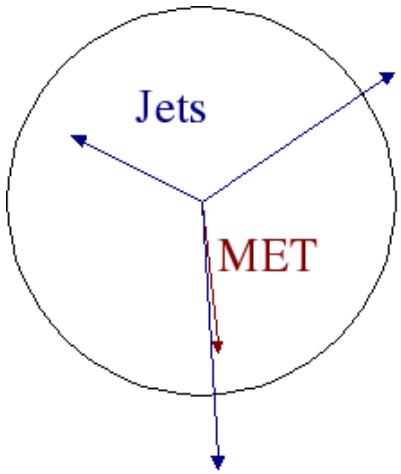
Introduction

- QCD background for zero-lepton SUSY searches is difficult to estimate using MC simulation alone so want data-driven estimation. The jet smearing method is the ATLAS method for this estimation.
- The original analysis (by Rob Duxfield) was performed with release 12 data; my analysis aims to update this with release 14 data, correct useage of the trigger and the use of non-Gaussian tails from multiple p_T ranges.
- This presentation gives an update on this analysis. So far two main parts of the analysis are completed:
  - Trigger comparisons for measurement of non-Gaussian component of jet response function.
  - Comparison of measured non-Gaussian response function with MC simulation truth.

The Jet Smearing Method - a Brief Reminder

- Assume that $\not{E}_T$ in QCD background is from jet fluctuation (neutrinos in jets and mismeasurement). Quantify this using jet response function $R = p_T^{Reco}/p_T^{True}$.
- To work out $\not{E}_T$ in SUSY signal region: calculate response in control region and use the response function to 'smear' $\not{E}_T$ of well-measured jets into signal region. This gives estimate of QCD background to SUSY.
- Response has Gaussian and non-Gaussian components.
  - Measure Gaussian component in $\gamma + \mathrm{Jet}$ channel.
  - Due to insufficient $\gamma + \mathrm{Jet}$ statistics use 'Mercedes' events to measure non-Gaussian component.



Measuring non-Gaussian Jet Response

- Look at the Mercedes events sample where: $nJets \geq 3$, e and μ veto, $|\Delta\phi(j_1, \not{E}_T)| > 0.1$ and $|\Delta\phi(j_2, \not{E}_T)| > 1.0$.

Jet Range	**Jet p_T cuts (GeV)**	$\mathbf{\lvert\Delta\phi(j_{n-1}, \not{E}_T + \pi)\rvert}$ **cut**	$\not{\mathbf{E}}_\mathbf{T}$ **cut (GeV)**
J3	70, 25	0.45	30
J4	140, 35	0.3	45
J5	280, 50	0.2	60

Table: Mercedes sample for different jet p_T ranges. $j_n - 1$ is the jet furthest from the $\not{E}_T$ vector in ϕ.

- Estimate that all $\not{E}_T$ is associated with jet: $R \approx p_T^{Reco}/(p_T^{Reco} + \not{E}_T)$.

Trigger for non-Gaussian Jet Response Measurement

- Standard triggers allow triggering on single jet and $\not{E}_T$. Potential exists for event shape trigger.
- Single jet triggers have large prescaling; $\not{E}_T$ trigger could bias measurement.
- Try event shape $d\pi$ trigger to leave only non-back-to-back event topologies. This reduces rate so can use a lower prescale.

$$d\pi = \pi - |\Delta\phi(j_1, j_2)|$$

- Try different $d\pi$ triggers for different jet p_T ranges and compare to standard triggers.

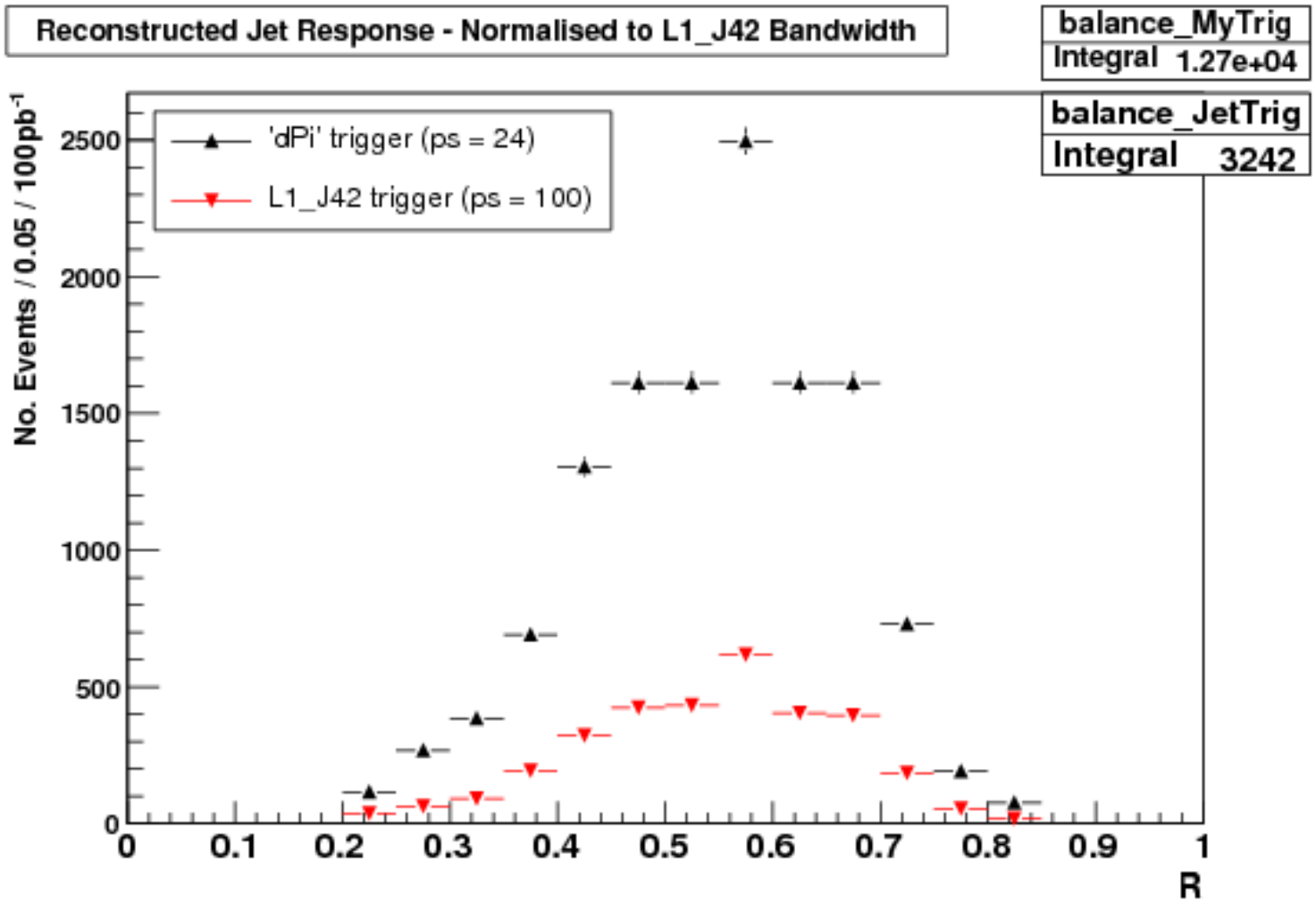
Triggers Used for Comparison Analysis

- Note that jet triggers are due to be used with **HLT passthrough** in early running.

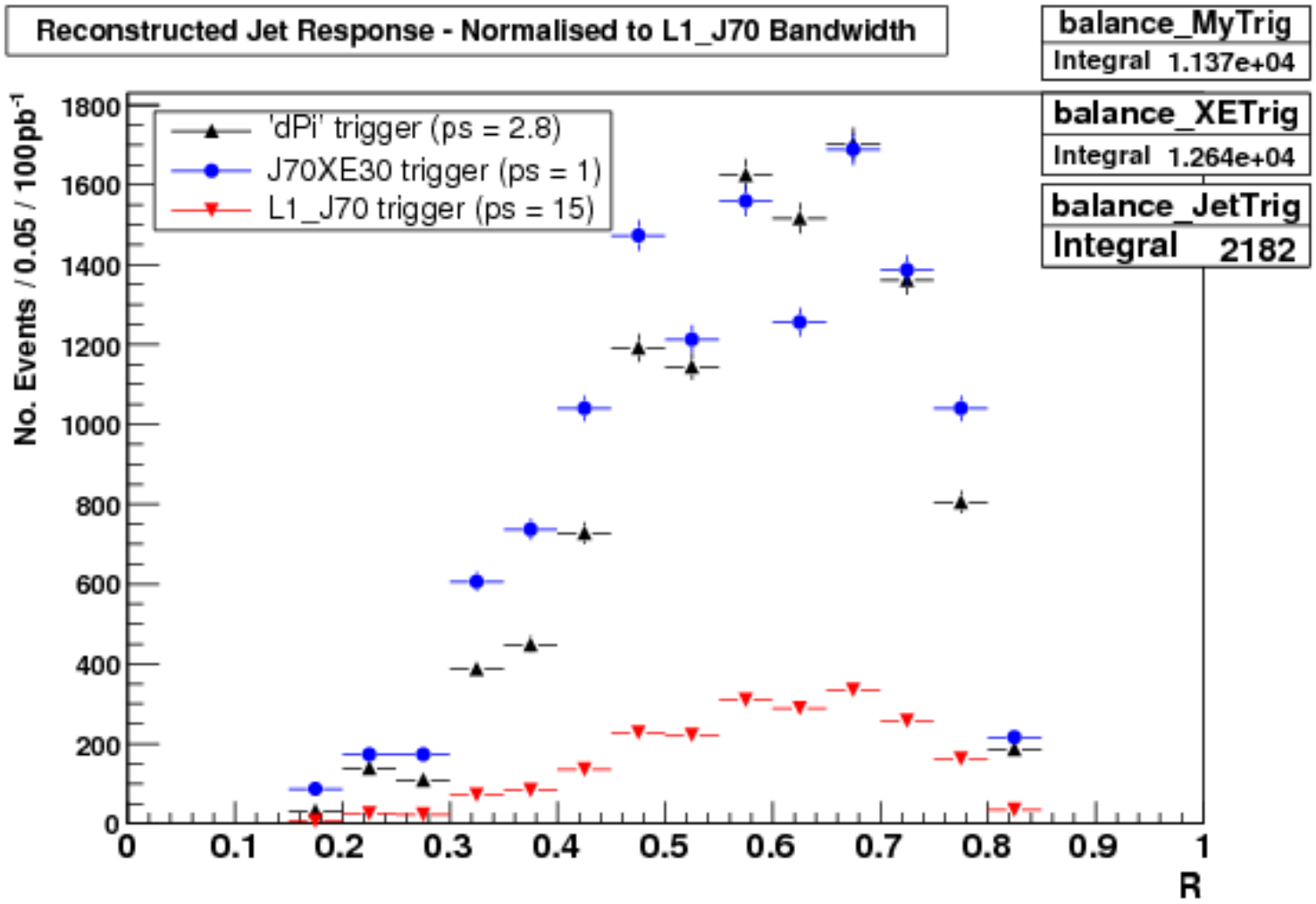
Sample	**Jet Trigger**	$\not{E}_T$ **Trigger**	**dπ Trigger**
J3	L1_J42	**N/A**	L1_J42 passed, $nJets \geq 2$, $j_1(p_T) > 55$ GeV, $j_2(p_T) > 18$ GeV, $d\pi > 0.4$
J4	L1_J70	J70XE30	L1_J70 passed, $nJets \geq 2$, $j_1(p_T) > 110$ GeV, $j_2(p_T) > 23$ GeV, $d\pi > 0.25$
J5	L1_J120	J70XE30	**N/A**

Table: Trigger for trigger comparison analysis. For $d\pi$ trigger jet cuts are at L2.

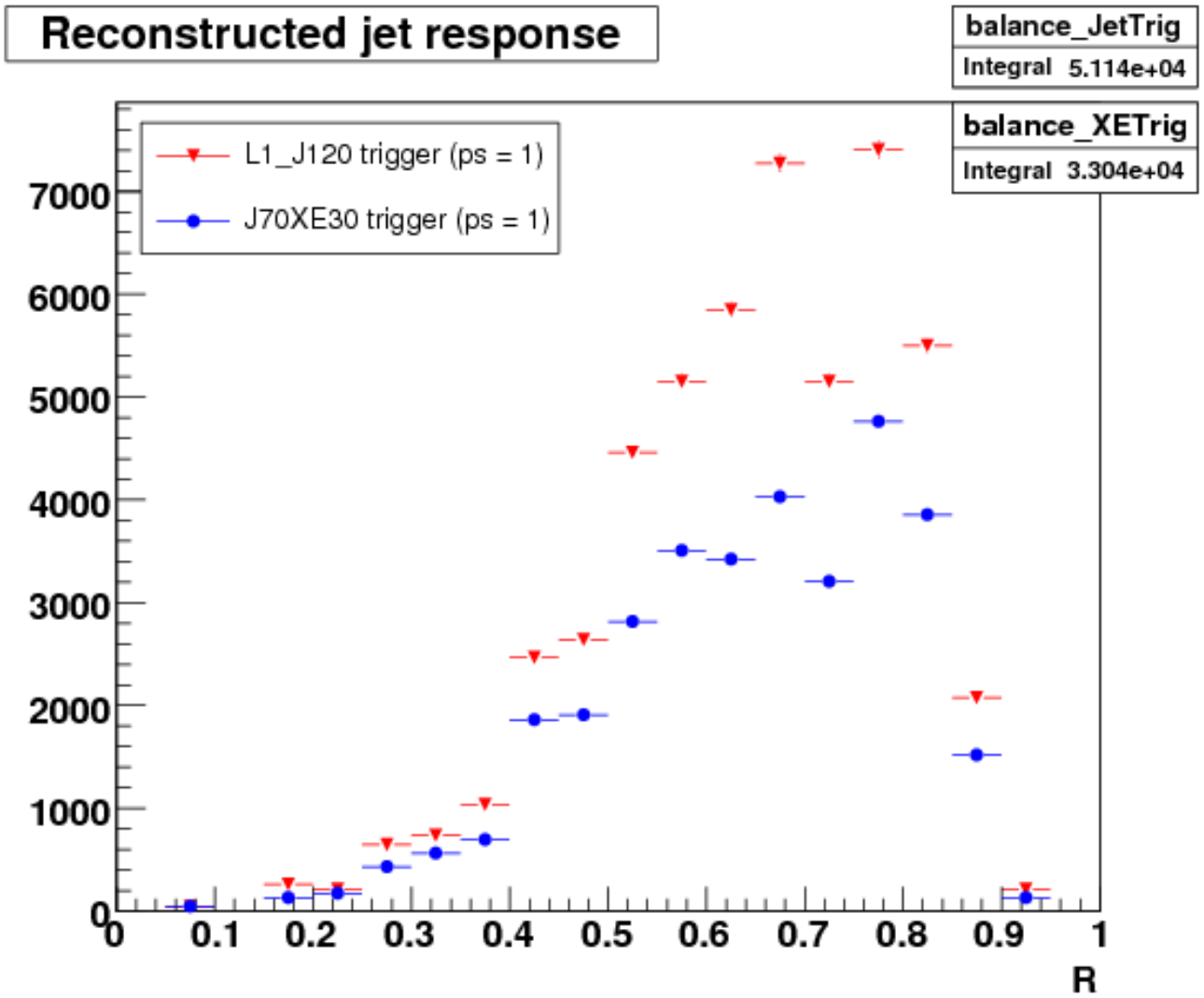
Trigger Comparison Results - J3



Trigger Comparison Results - J4



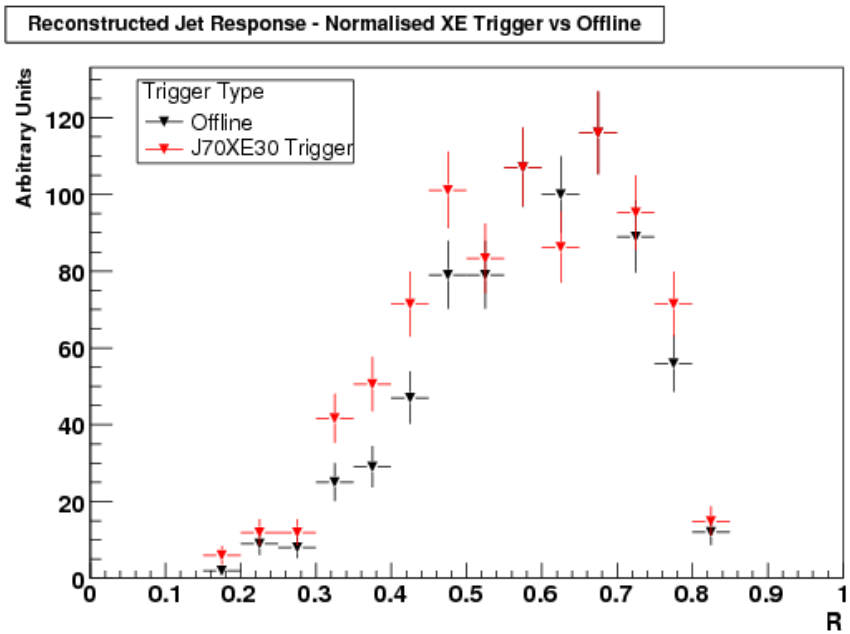
Trigger Comparison Results - J5



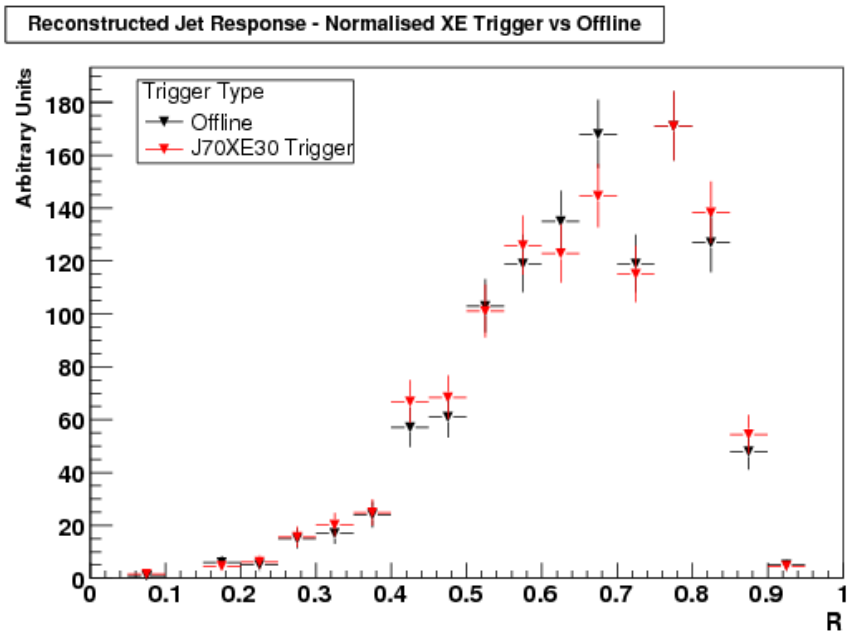
$\not{E}_T$ Trigger Bias Results

- $\not{E}_T$ trigger can introduce bias as long turn-on curve can bias sample to high $\not{E}_T$ and therefore measured response to low R.

- J4 Sample



- J5 Sample

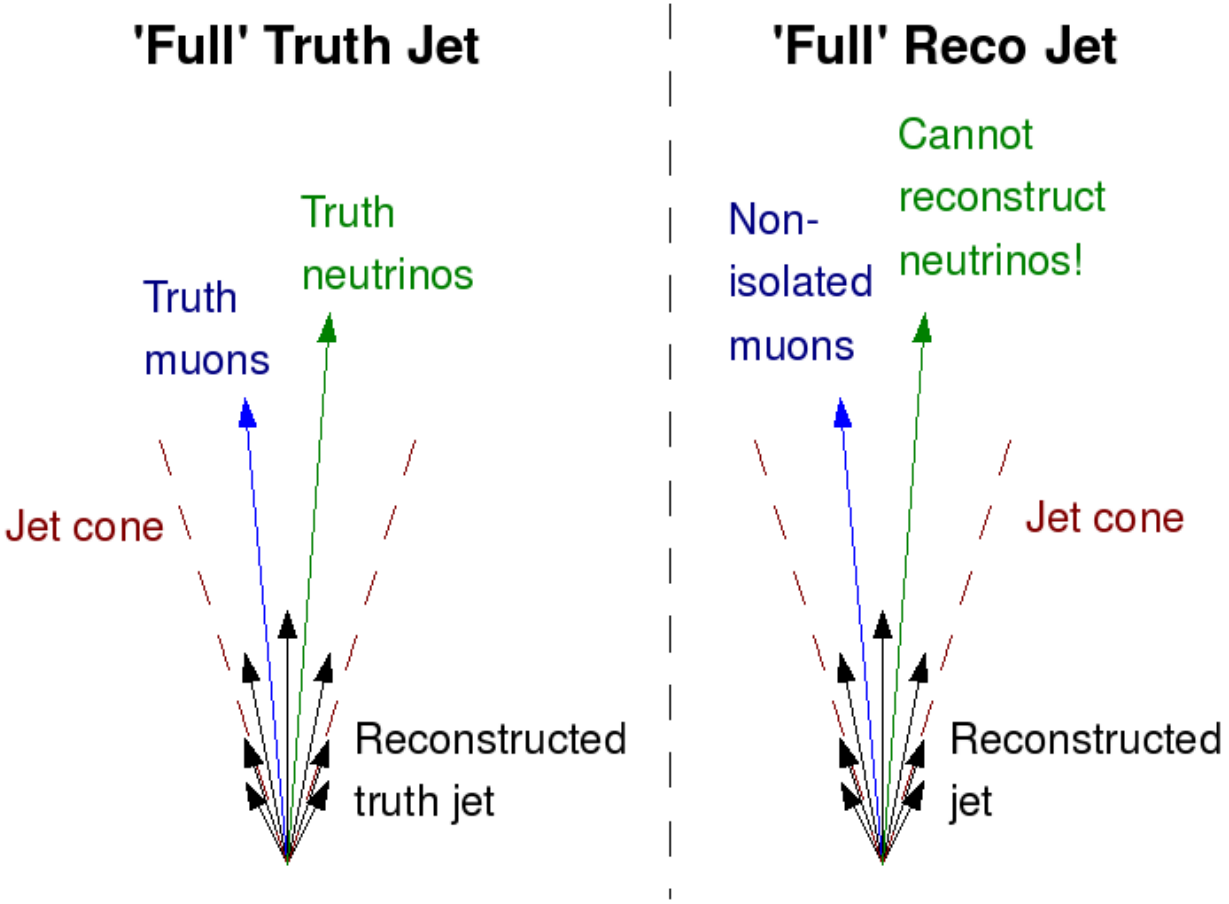


Trigger Comparison Conclusions

- $d\pi$ trigger provides a large increase in statistics for J3 and J4 p_T ranges without introducing any bias.
- This is because $d\pi$ trigger favours Mercedes topologies and therefore a lower prescale can be used than the corresponding jet trigger for the same trigger output rate.
- $\not{E}_T$ trigger J70XE30 can be used in J5 sample without introducing significant bias.
- Future work - complete full jet smearing analysis and compare estimation with & without $d\pi$ trigger.
- Future work - construct $d\pi$ triggers for use when HLT jet triggers are used. This could prove very important as full jet chains will seriously reduce available statistics.

Non-Gaussian Jet Response Truth Comparison

- To see whether the **measured jet response** function gives an accurate estimation of the **true jet response** a simulated truth comparison can be performed.



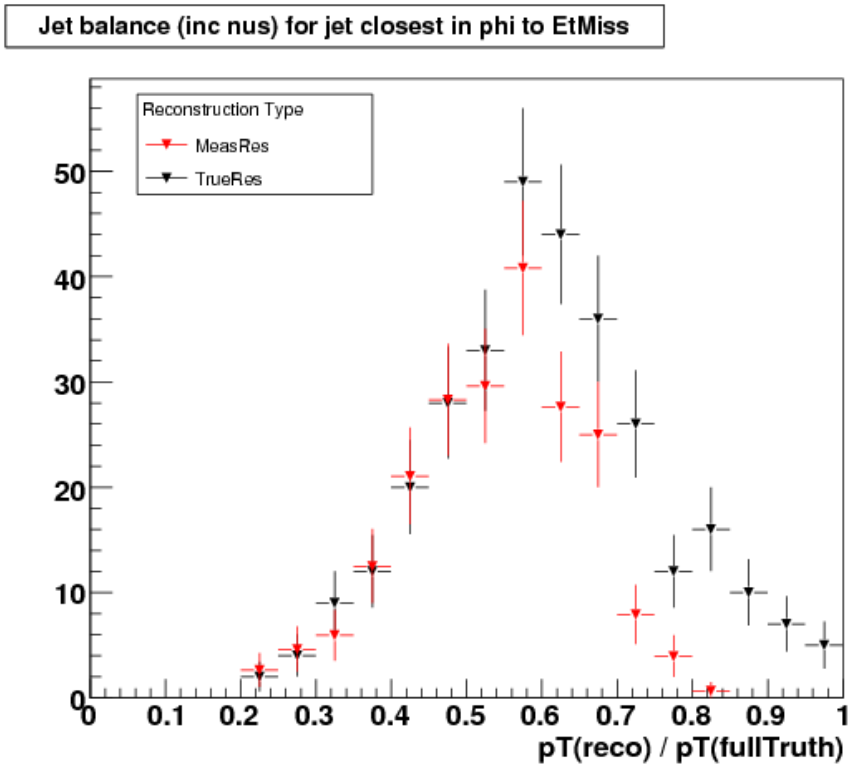
Non-Gaussian Jet Response Truth Comparison Method

- Match truth jets (in ΔR) to reco jets.
- Calculate true response from $R = p_T^{Reco}/p_T^{True}$.
- Calculate measured response $R \approx p_T^{Reco}/(p_T^{Reco} + \not{E}_T)$.

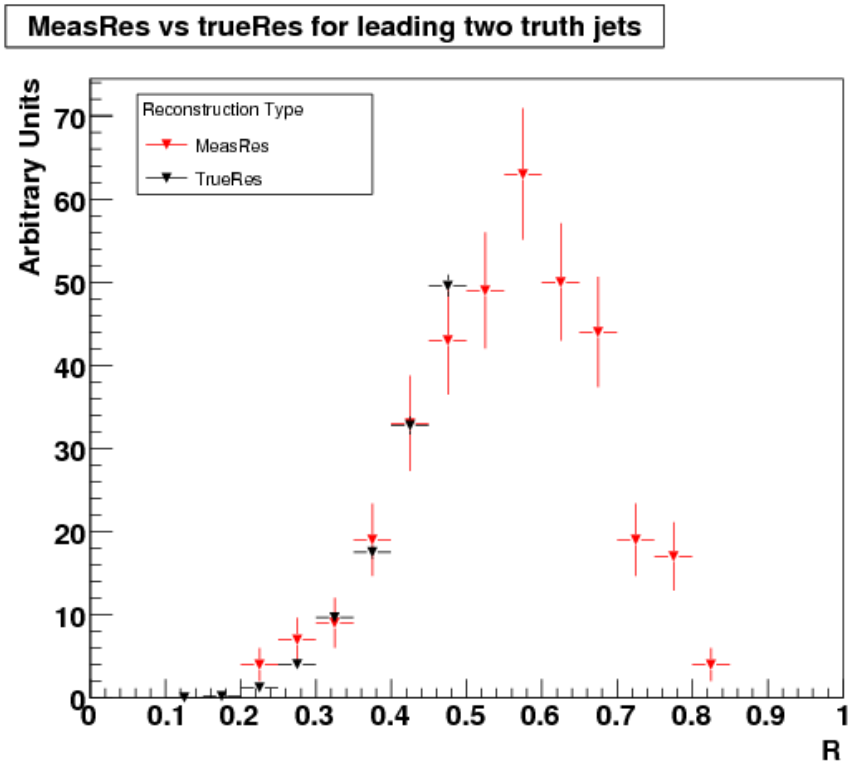
- Perform measured vs true response comparison for two cases:
  - Only use events which pass the Mercedes selection. Compare R_{True} and R_{Meas} for jet parallel to $\not{E}_T$ vector.
  - Use any events which pass e and μ veto and trigger. Compare R_{True} and R_{Meas} for leading two truth jets.

Jet Response Truth Comparison - J3

- Mercedes Sample , normalised for $R < 0.5$.

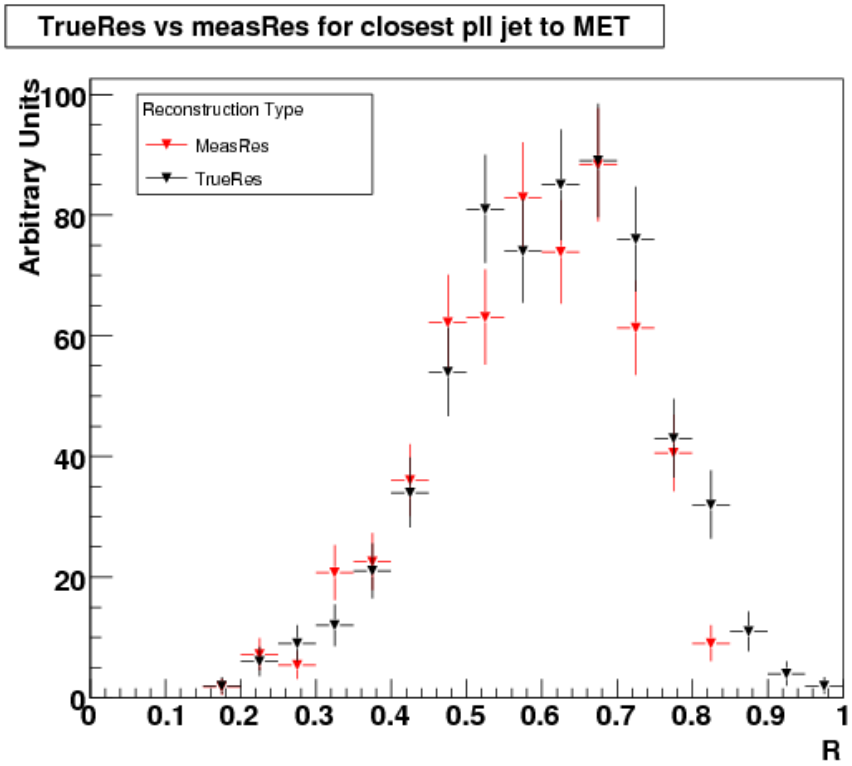


- Full Sample, normalised for $R < 0.5$.

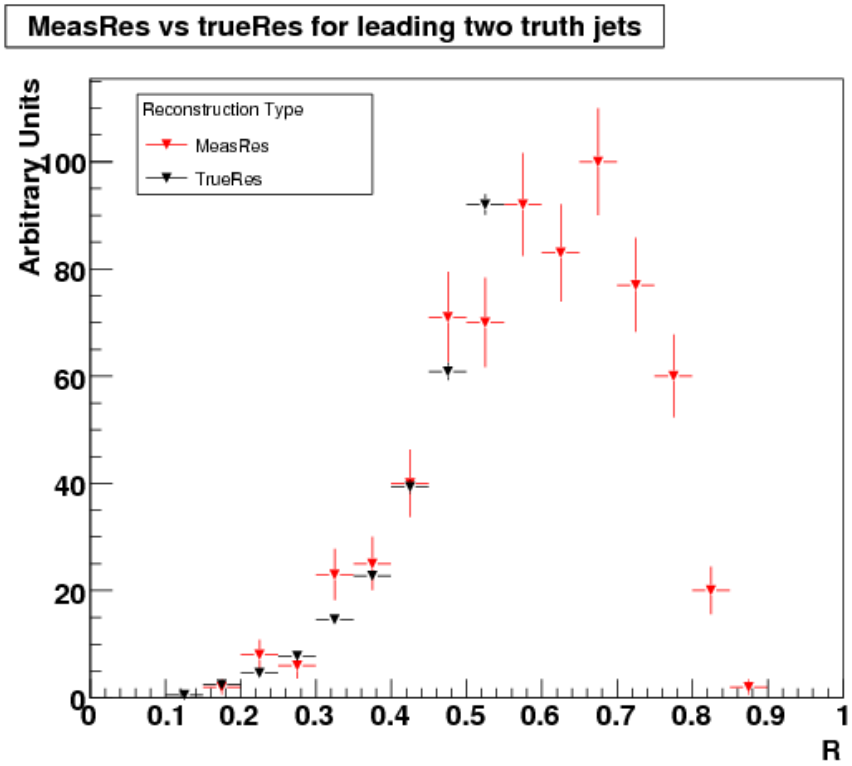


Jet Response Truth Comparison - J4

- Mercedes Sample, normalised for $R < 0.55$.

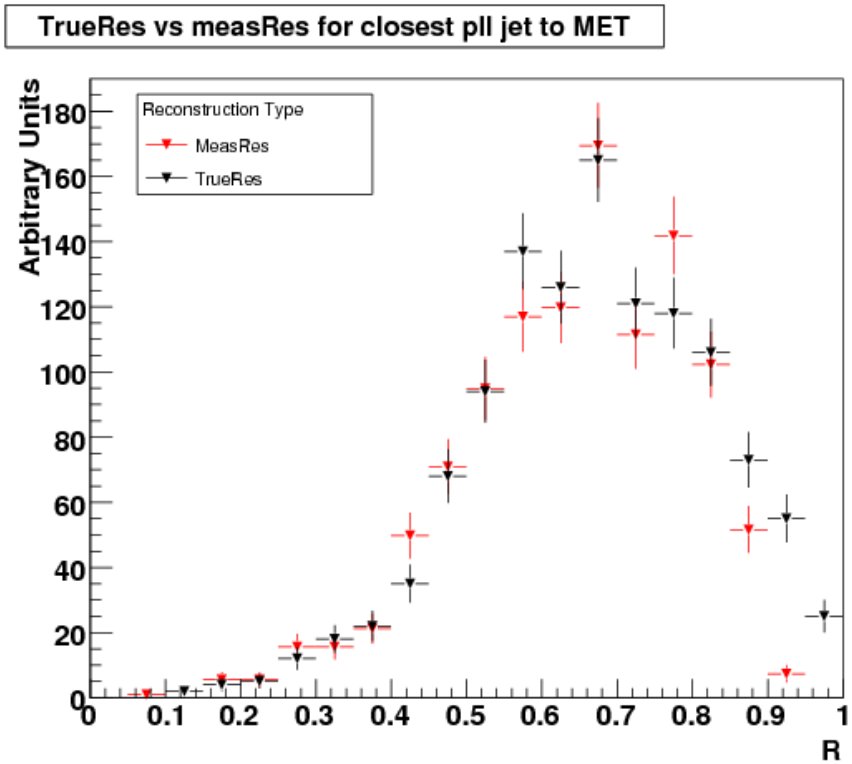


- Full Sample, normalised for $R < 0.55$.

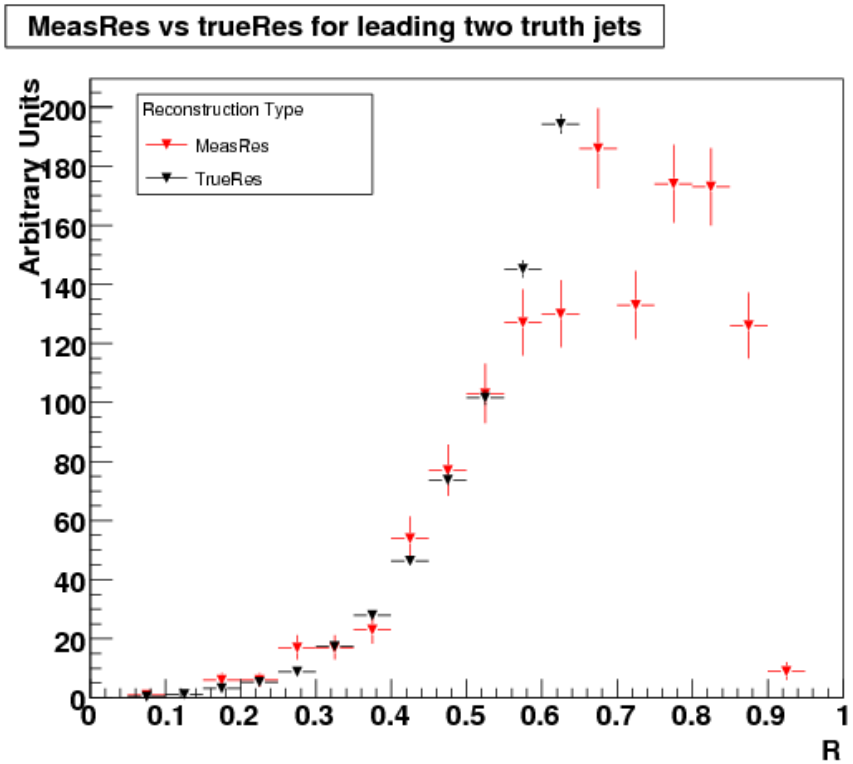


Jet Response Truth Comparison - J5

- Mercedes Sample, normalised for $R < 0.6$.



- Full Sample, normalised for $R < 0.6$.



Jet Response Truth Comparison Conclusions

- Measured jet response compares well with true response across all jet ranges for appropriate ranges of R.
- This is true in both the Mercedes sample and full sample therefore the Mercedes selection appears not to bias the comparison.
- This means that the method is producing an unbiased estimate of the true non-Gaussian jet response function.

Conclusions

- A novel event shape $d\pi$ trigger has been shown to provide ~ 4 times more statistics than the standard jet trigger in the J3 and J4 ranges without introducing bias in the non-Gaussian response function measurement.
- The $\not{E}_T$ trigger J70XE30 could be used as well as the standard jet trigger to increase statistics in the J5 range without introducing bias.
- The non-Gaussian response function measurement has been shown to accurately reproduce the true jet response in the J3, J4 and J5 ranges.

Future Work

- Complete jet smearing method analysis. This will expand on the CSC analysis in the follwing ways:
  - Use of an ARA based release 14 analysis (CSC note used release 12 data).
  - Full use of trigger.
  - Include non-Gaussian component from J3, J4 and J5 ranges (CSC note analysis only used J5).
- Investigate effect of using different triggers on the full background estimation. Should we use a $d\pi$ trigger?
- Develop a trigger scheme for when the HLT jet triggers come into use.
- Investigate whether smearing method can reproduce jet response function in the presence of significant $\not{E}_T$ anti-parallel to the jet (see talk by Kathrin Störig at EtMiss signatures meeting 15th April 2009).