QCD background to SUSY searches with no leptons at ATLAS

Simon Owen

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Introduction

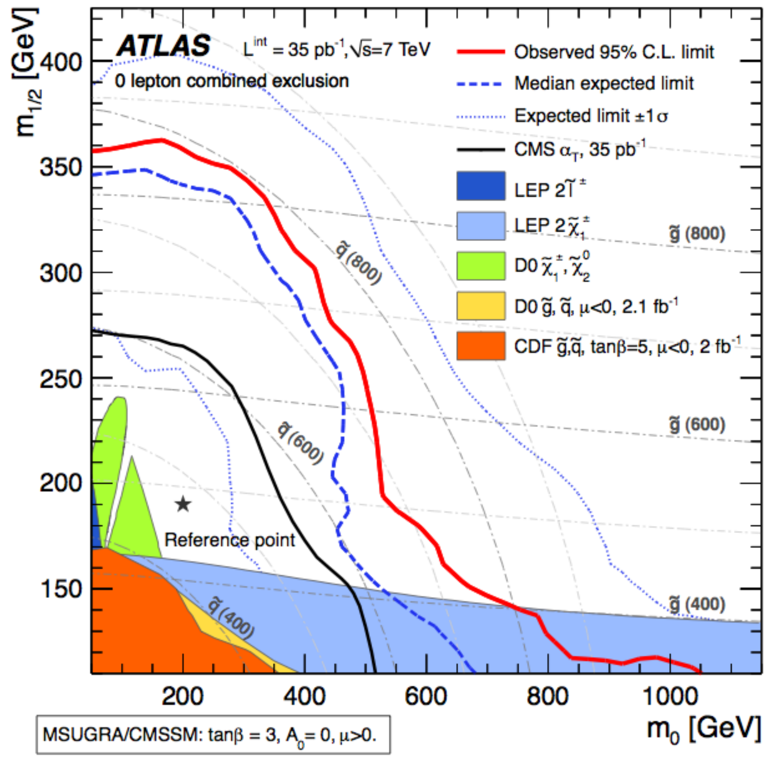
- SUSY searches with no leptons at ATLAS require reconstructed jets and significant **missing transverse energy** (E_T^{miss}).
- QCD multijet production can generate sufficient E_T^{miss} through **detector effects** (fake E_T^{miss}) or from **heavy flavour jets** which contain neutrinos (true E_T^{miss}).
- Cannot solely rely on Monte Carlo simulation (MC) due to **insufficient statistics and large systematic uncertainties**.
- Data-driven estimation vital!

SUSY Searches with no Leptons at ATLAS in 2010

- With 35^{-1} pb of analysed data, ATLAS set **world's best limits** in searches for squarks and gluinos.
- Four signal regions; m_{eff} and m_{T2} used as discovery variables.

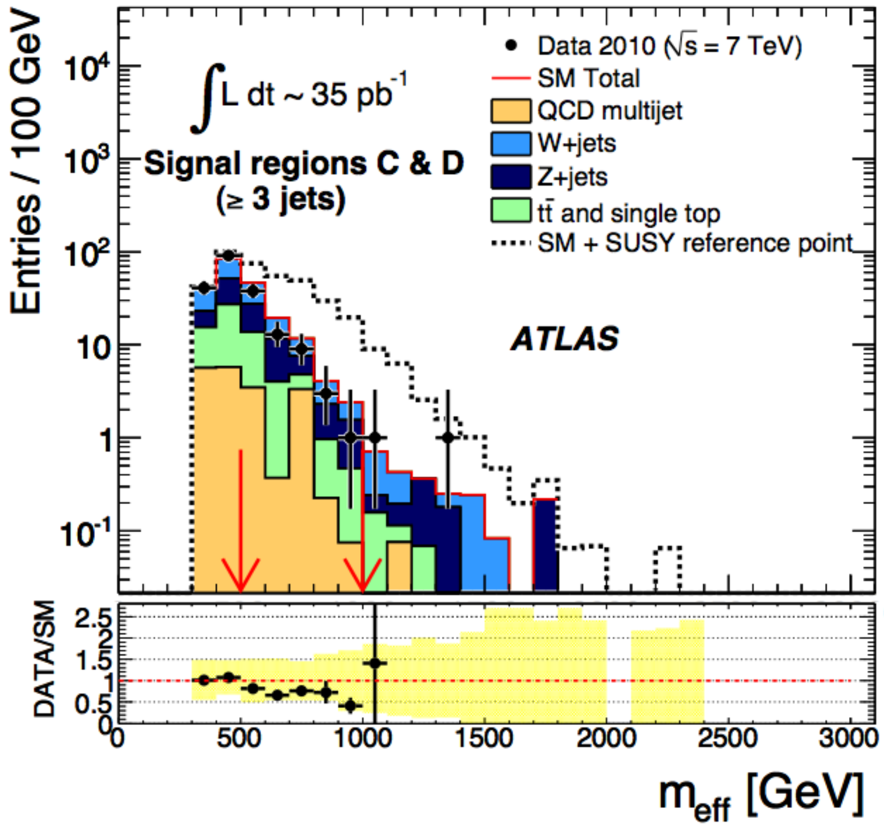
arXiv:1102.5290v1

		A	B	C	D
Pre-selection	Number of required jets	≥ 2	≥ 2	≥ 3	≥ 3
Pre-selection	Leading jet p_T [GeV]	> 120	> 120	> 120	> 120
Pre-selection	Other jet(s) p_T [GeV]	> 40	> 40	> 40	> 40
Pre-selection	E_T^{miss} [GeV]	> 100	> 100	> 100	> 100
Final selection	$\Delta\phi(\text{jet}, \vec{P}_T^{\text{miss}})_{\text{min}}$	> 0.4	> 0.4	> 0.4	> 0.4
Final selection	$E_T^{\text{miss}}/m_{\text{eff}}$	> 0.3	–	> 0.25	> 0.25
Final selection	m_{eff} [GeV]	> 500	–	> 500	> 1000
Final selection	m_{T2} [GeV]	–	> 300	–	–



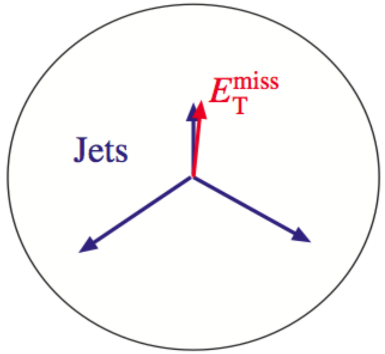
ATLAS QCD Strategy in 2010 Analysis

- Apply **harsh cuts** to reduce QCD background to a very small level.
  - ➢ Even with a large uncertainty, overall impact of background is small.
- **Validate MC performance** in control regions.
- **Correct QCD MC normalisation** by comparing with data in control regions.
- Cross-check estimate with **fully data-driven method**.

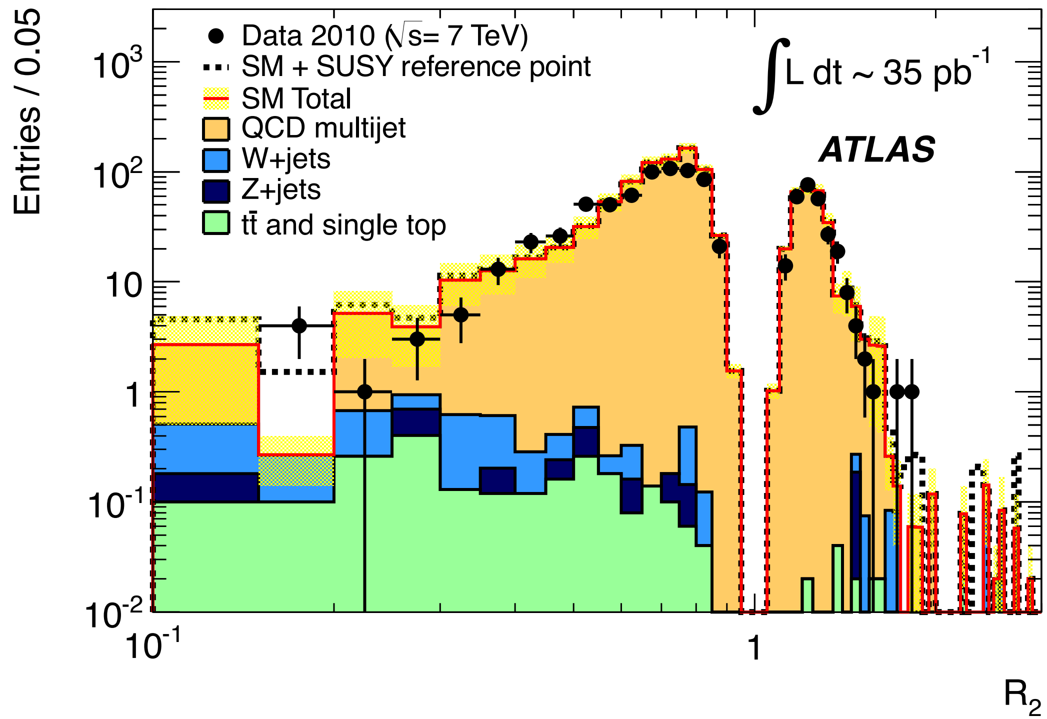


Validating MC Performance in non-Gaussian Jet Response Tail

- Jet response: $R = p_T^{reco} / p_T^{true}$
- Apply topological cuts to select 'Mercedes' events where one jet in **unambiguously associated with E_T^{miss}**.

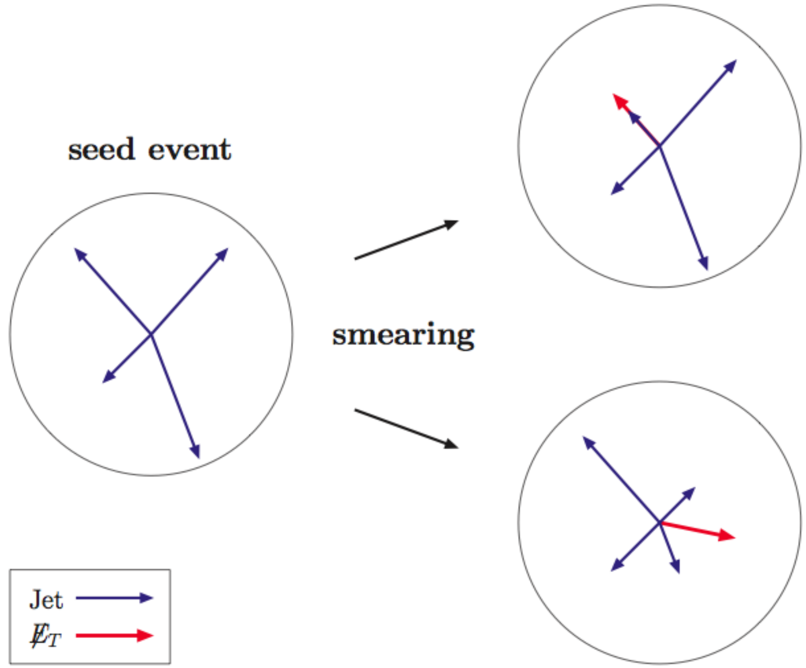


- For this jet, estimate $p_T^{true} \approx p_T^{reco} + E_T^{miss}$.
- Plot estimated R (R_2) in data and MC for events with leading jet $p_T > 200$ GeV.



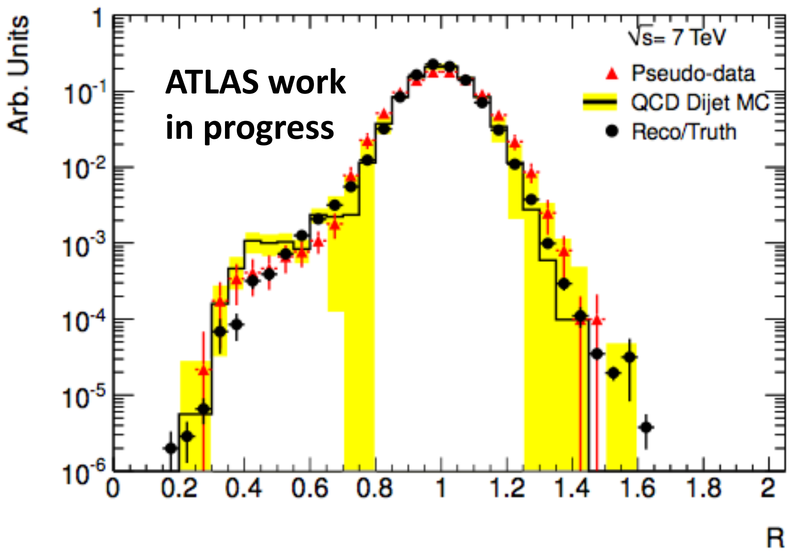
Jet Smearing Method

- Fully data-driven technique to estimate QCD background:
  - Measure jet response in data.
  - Smear **low-E_T^{miss} seed events** on jet-by-jet basis with measured response to produce ‘**pseudo-data**’ (with potentially high-E_T^{miss}).
  - Use pseudo-data as QCD estimate in SUSY signal regions.

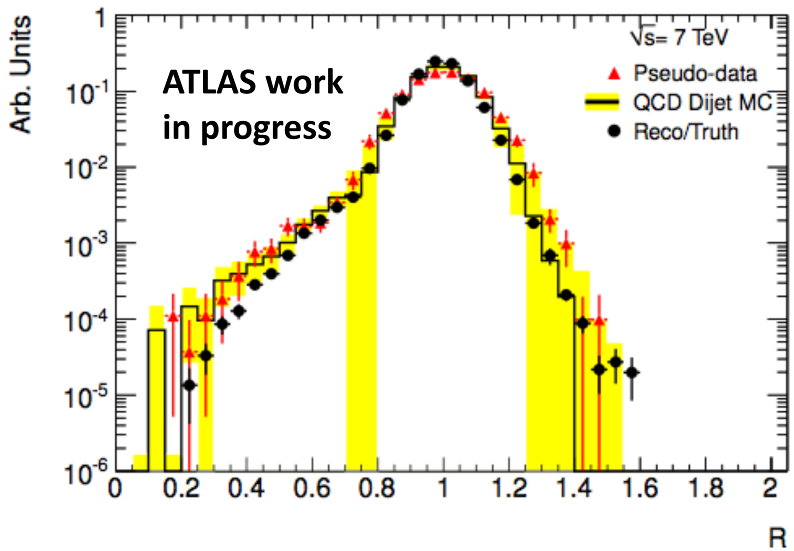


Measuring Jet Response

- Non-Gaussian response measured as shown on slide 5.
- Gaussian response parameterised by applying Gaussian smearing to seed events and ensuring agreement between pseudo-data and data in low-E_T^{miss} region.
- Normalisation between Gaussian and non-Gaussian components determined from dijet balance distribution.



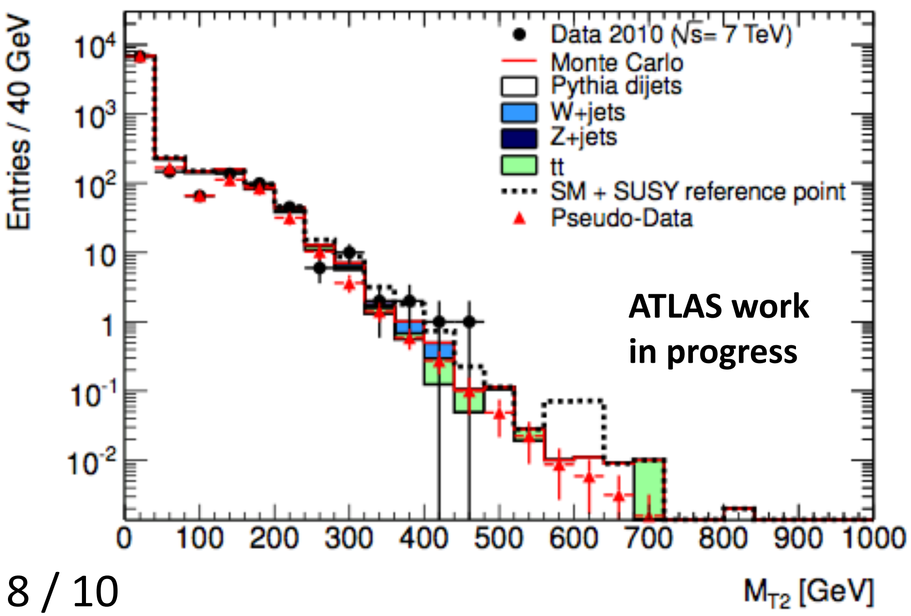
(a) p_T = 140 GeV

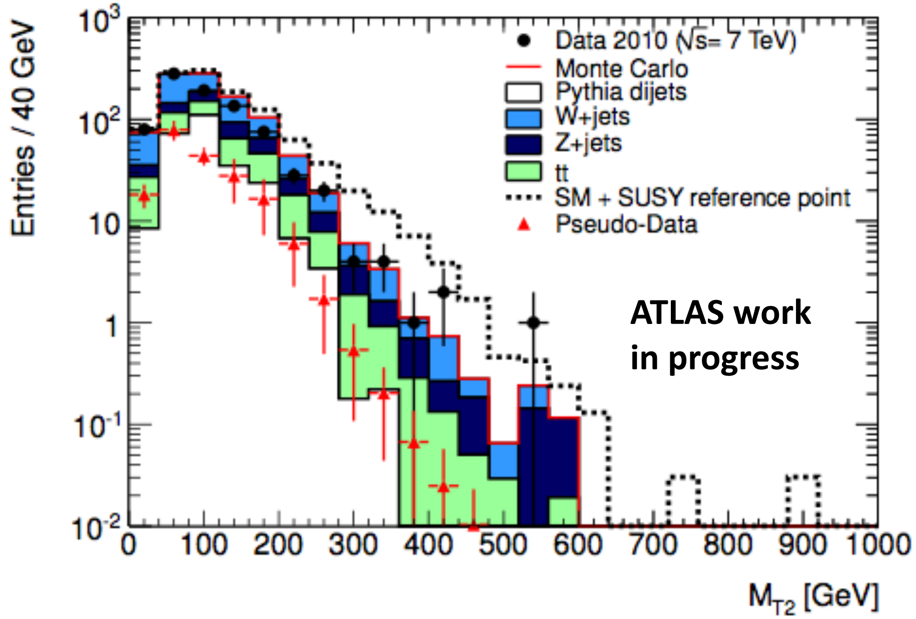


(b) p_T = 210 GeV

Jet Smearing Final Estimation – Some Examples

- Jets in **seed events** are smeared using the response functions to produce estimated distributions.
  - e.g. m_{T2} distribution in QCD normalistion (left) and SUSY signal (right) regions.





Summary

- In 2010, harsh cuts ensured QCD background to SUSY searches with no leptons was small.
- Significant work was done to ensure the systematic uncertainty was under control; **MC**, **partially data-driven** and **fully data-driven** methods were used.
- The 2010 results have demonstrated the validity and performance of the fully data-driven technique so expect more jet smearing in 2011…

Future Work

- In 2011, data-driven QCD background estimation will likely be the baseline method.
- Statistics for this method will increase by **orders of magnitude**, MC statistics will not!
- Use dedicated **topological triggers** to ensure increased statistics for non-Gaussian tail measurement.
- Currently looking at improvements to jet response measurement.
- More work needed in **understanding the sources of large E_T^{miss}** in QCD multijet events.