Same-sign lepton search in mSUGRA

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HH-CMS-Meeting @ DESY
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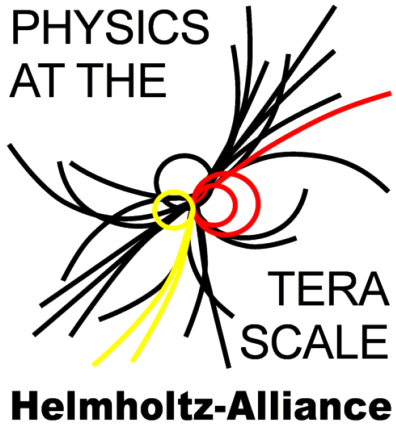


Overview

- Introduction
- (Very) First plots
- Outlook

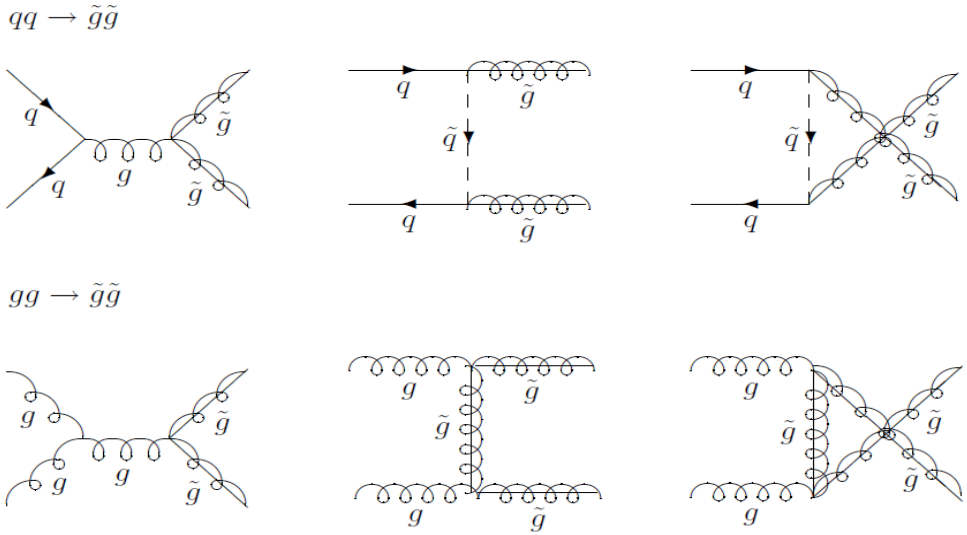
Dirk Krücker, Isabell Melzer-Pellmann, Hannes Schettler, Peter Schleper, Niklas Pietsch

Motivation/ Intro

- Mmm = **M**atze **m**acht **m**SUGRA

- Same-sign di-lepton channel
  ➔ How does one get same-sign di-leptons?

Example: Di-lepton channel



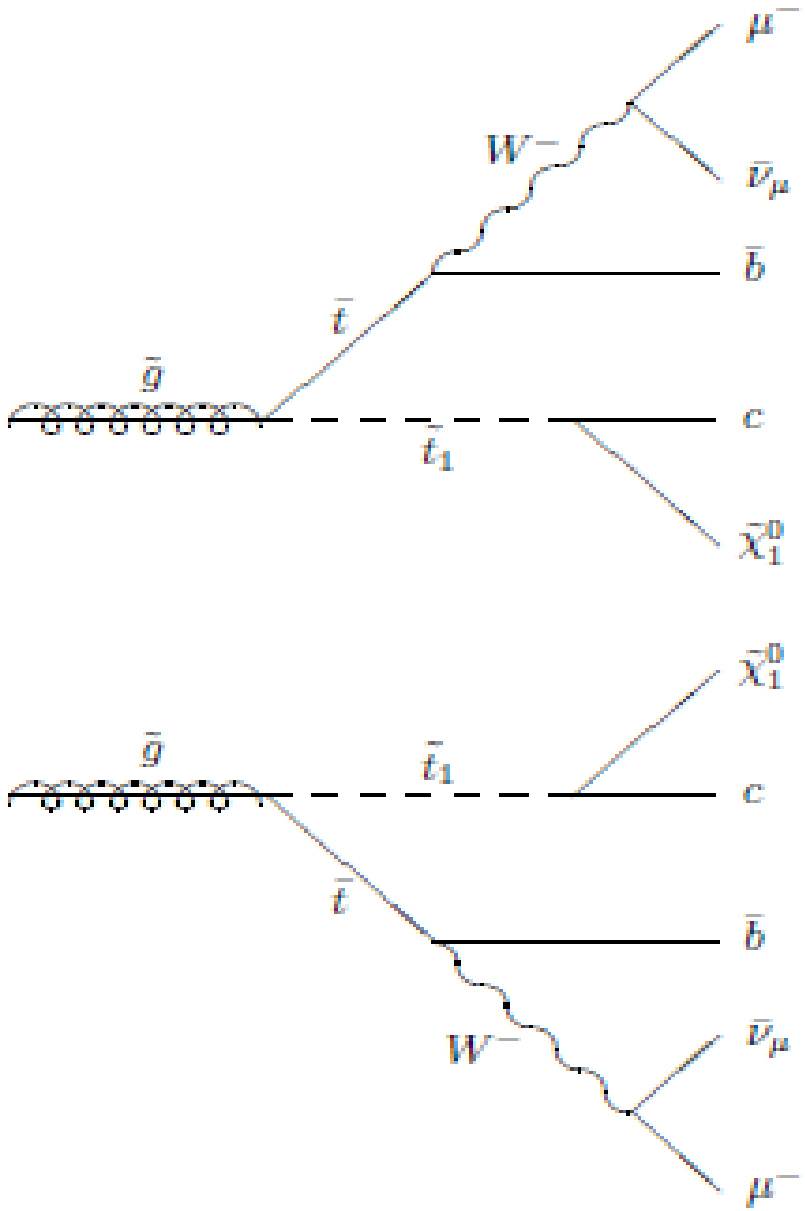


Fig. 6.1: Feynman diagrams of gluino pair production at leading order at a hadron collider

Get hold of Di-lepton channel

- Estimate Background
  - ➔ estimate fake rate

- Methods:
  - ➔ RelIso-Extrapolation method (Data-Driven)
  - ➔ **Fake Rate (FR) Method: Assigns a probability**

  } **CMS AN-10-043**

  - ➔ kNN= **k**-**N**earest-**N**eighbour Technique — **CMS AN-09-131**
  - ➔ Photon conversion removal using a vertex fit with a 3D conversion constraint — **CMS AN-09-173**
  - ➔ CiC = **C**uts **i**n **C**ategories

https://twiki.cern.ch/twiki/bin/viewauth/CMS/SWGuideCategoryBasedElectronID

Origin of Fakes

1) **Jet faking an electron:** a jet may deposit a large amount of energy in the ECAL that is matched to a single high-pT track that is reconstructed as an electron

2) **Heavy quark decaying to a lepton:** although these electrons are usually not isolated, the kick from the quark decay might knock the electron out of the jet enough for it to appear isolated

3) **Photon conversion:** $\gamma \rightarrow e^{+}e^{-}$ via interaction with tracker material

RelIso-Extrapolation Method

- **Idea:**
  1) Do a fit, to a fake-dominated region
  2) Extrapolate to signal region

$$\mathrm{RelIso} = \frac{1}{p_T^{\mathrm{ele}}} \sum_{\Delta R<0.4}^{\text{iso dep}} \left(E_T^{ECAL} + E_T^{HCAL} \right)$$

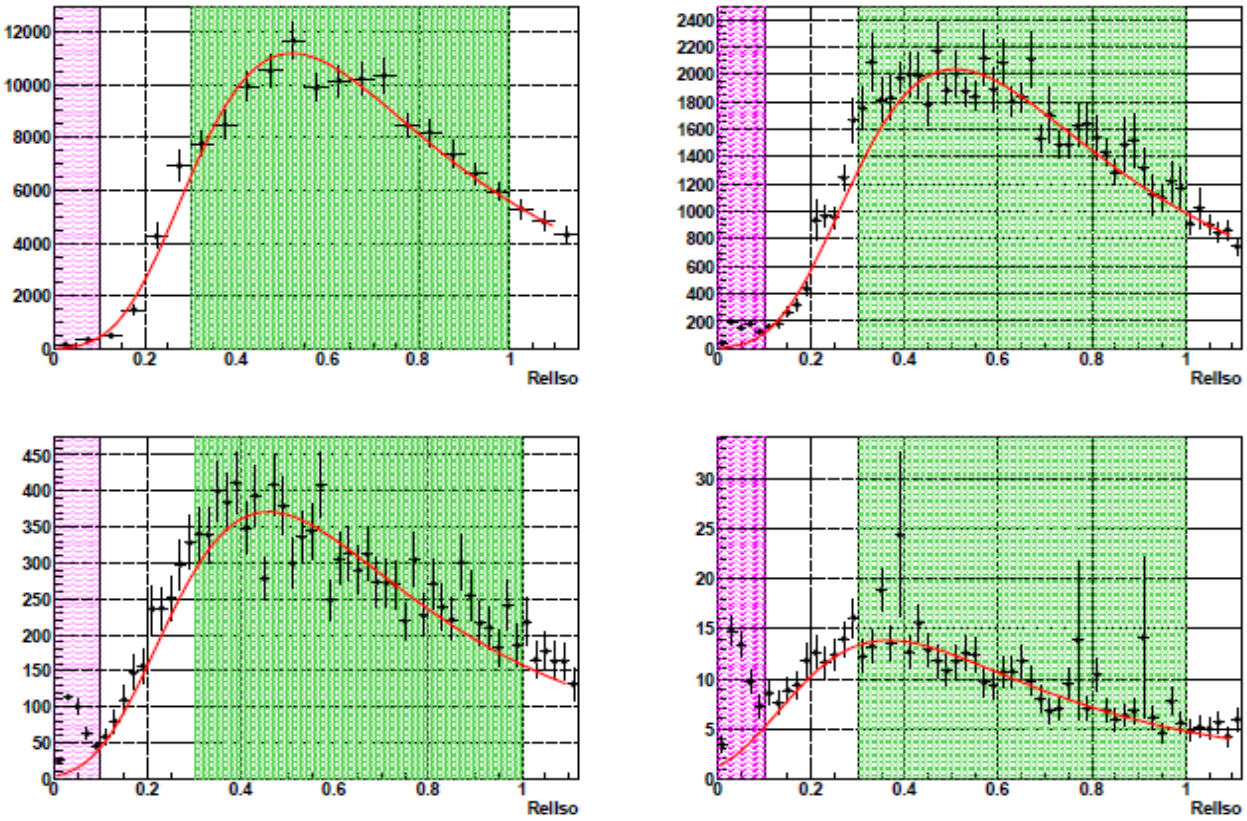


Figure 9: RelIso distribution for all of our MC samples combined after requiring that the electron trigger fired, $N_{jets} \geq 4$, at most one electron passing our full selecion, and a $\not\!\!E_T$ cut of $0 < \not\!\!E_T < 25$ GeV (top left), $25 < \not\!\!E_T < 50$ GeV (top right), $75 < \not\!\!E_T < 100$ GeV (bottom left), and $100 < \not\!\!E_T < 150$ GeV (bottom right). We chose the signal region (purple wavy line region) to be $0 <$ RelIso < 0.1 and the fit region (green cross-hatched region) to be $0.3 <$ RelIso < 1.0.

From:
CMS AN-10-043

Own studies (just for starting)

- Data:
  - /mc/Spring10/TTbar/GEN-SIM-RECO/
  - /LM1/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO

- For MC-Comparison: Fake = if a GenLepton is not matched to a PatElectron (ΔR-matching)

- **But:** History of GenLeptons (of TTbar sample):

Generation[0] = 11
Generation[1] = 11
Generation[2] = -24
Generation[3] = -6
Generation[4] = -2
Generation[5] = -2
Generation[6] = 2212

Generation[0] = -11
Generation[1] = -15
Generation[2] = -15
Generation[3] = 24
Generation[4] = 6
Generation[5] = 1
Generation[6] = 1
Generation[7] = 2212

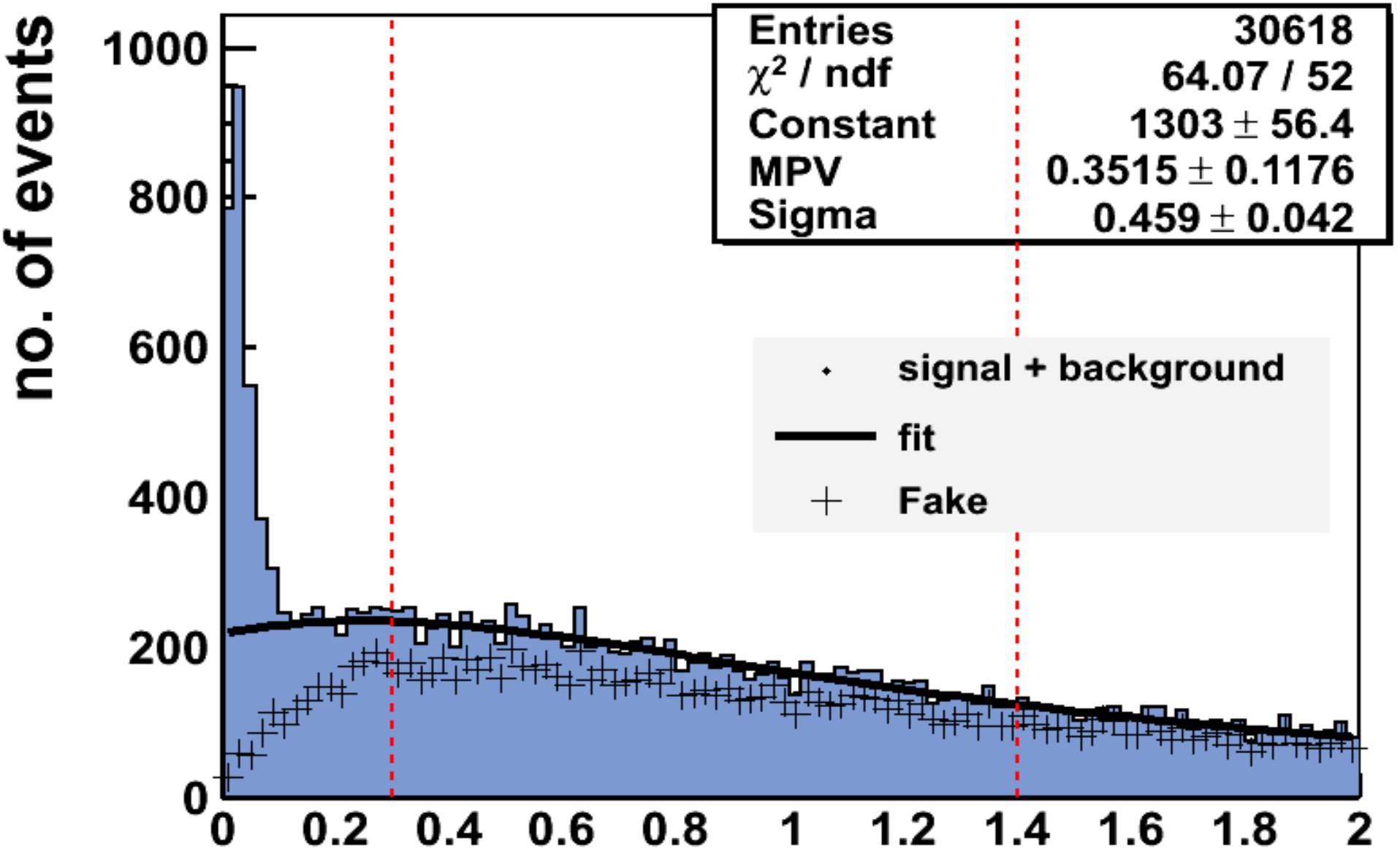
Generation[0] = -11
Generation[1] = 421
Generation[2] = 413
Generation[3] = 92
Generation[4] = -3
Generation[5] = -3
Generation[6] = 24
Generation[7] = 6
Generation[8] = 21
Generation[9] = 21
Generation[10] = 2212

Generation[0] = -11
Generation[1] = 421
Generation[2] = 423
Generation[3] = -521
Generation[4] = -523
Generation[5] = 92
Generation[6] = -1
Generation[7] = -1
Generation[8] = 2212

➔ How to define a fake ???

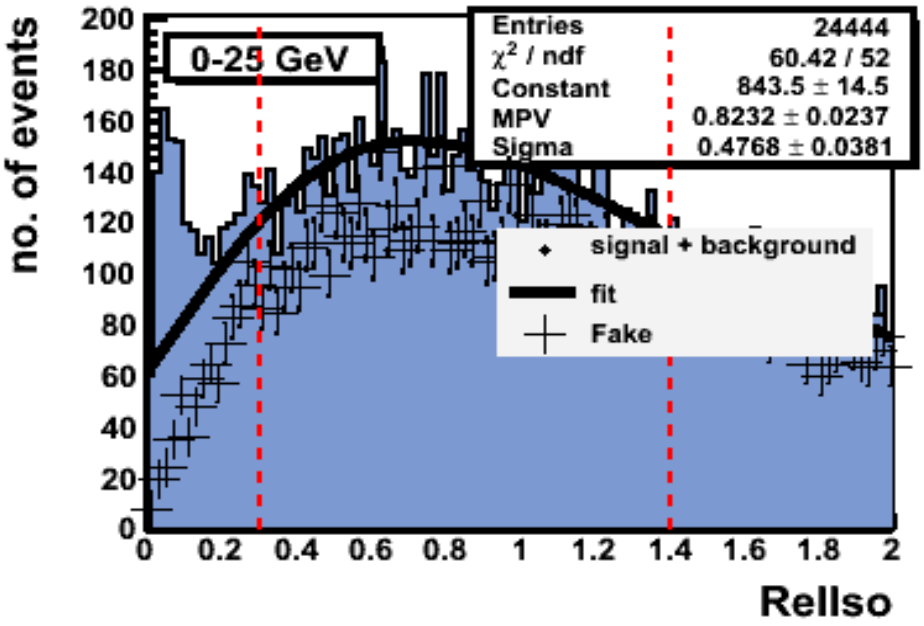
92 = string
421 = d0
523 = B*+

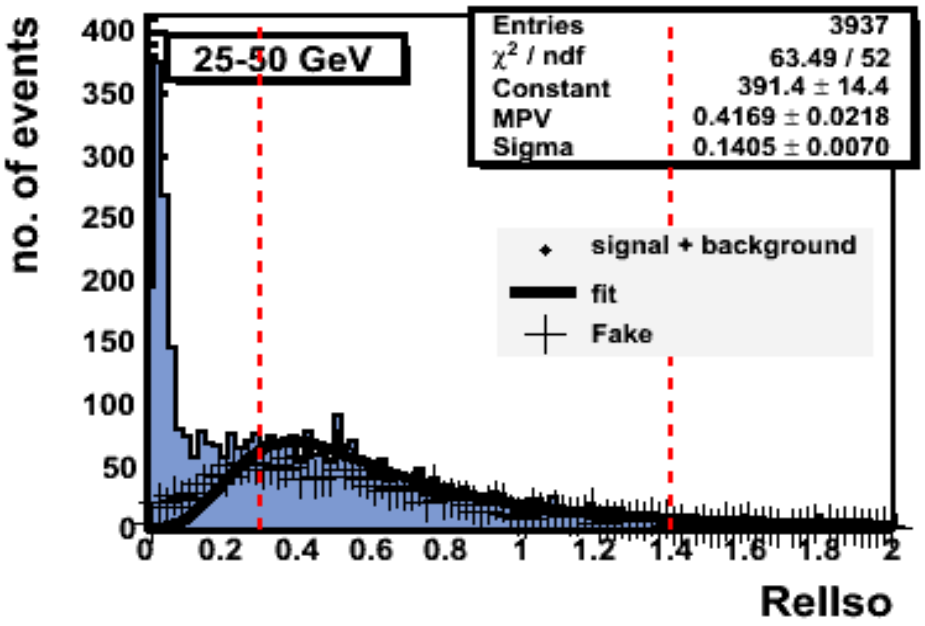
TTbar

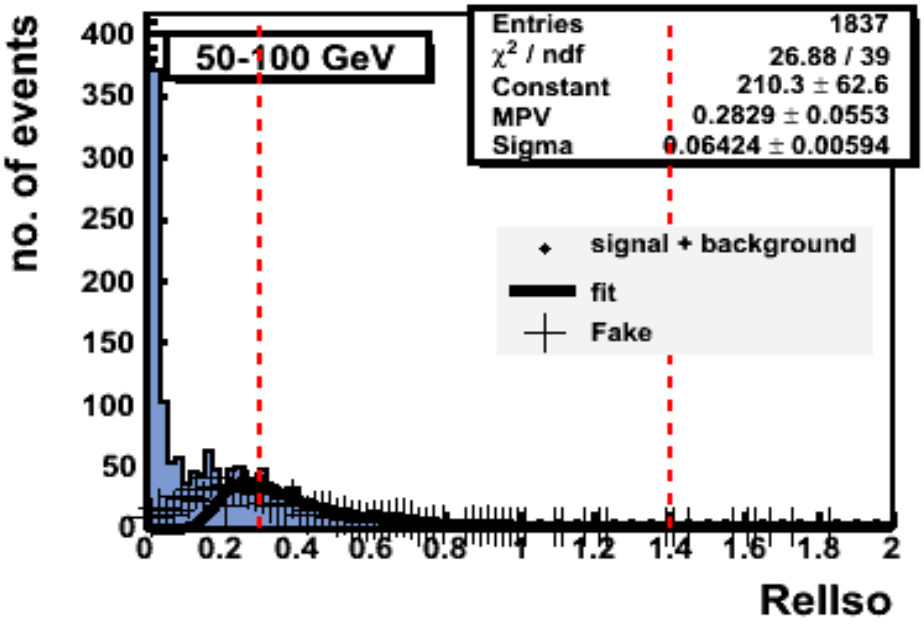


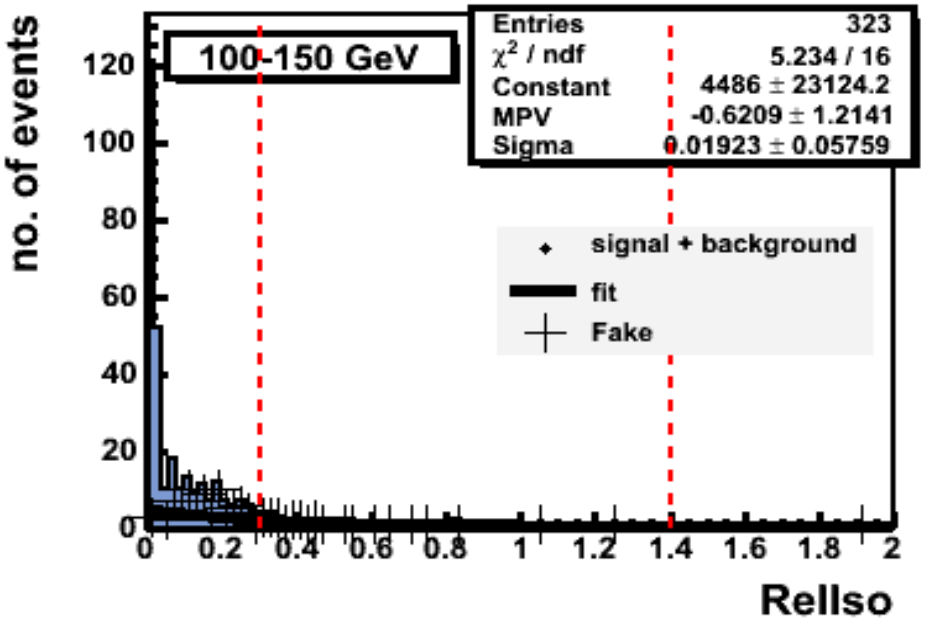
➔ Fake overestimated (but better than underestimating)

TTbar

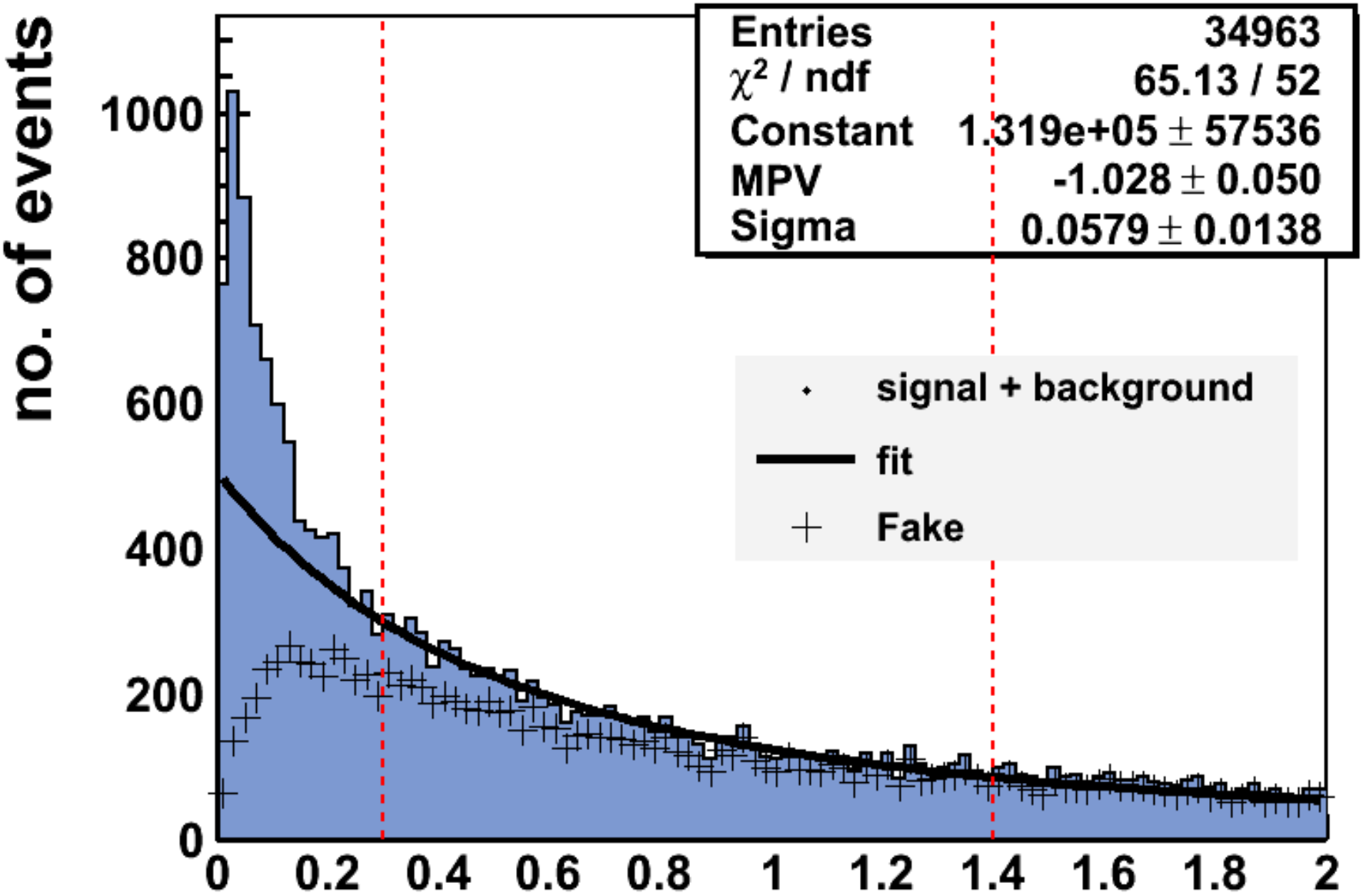

0-25 GeV
Entries 24444
χ² / ndf 60.42 / 52
Constant 843.5 ± 14.5
MPV 0.8232 ± 0.0237
Sigma 0.4768 ± 0.0381
signal + background
fit
Fake
no. of events
RelIso


25-50 GeV
Entries 3937
χ² / ndf 63.49 / 52
Constant 391.4 ± 14.4
MPV 0.4169 ± 0.0218
Sigma 0.1405 ± 0.0070
signal + background
fit
Fake
no. of events
RelIso


50-100 GeV
Entries 1837
χ² / ndf 26.88 / 39
Constant 210.3 ± 62.6
MPV 0.2829 ± 0.0553
Sigma 0.06424 ± 0.00594
signal + background
fit
Fake
no. of events
RelIso

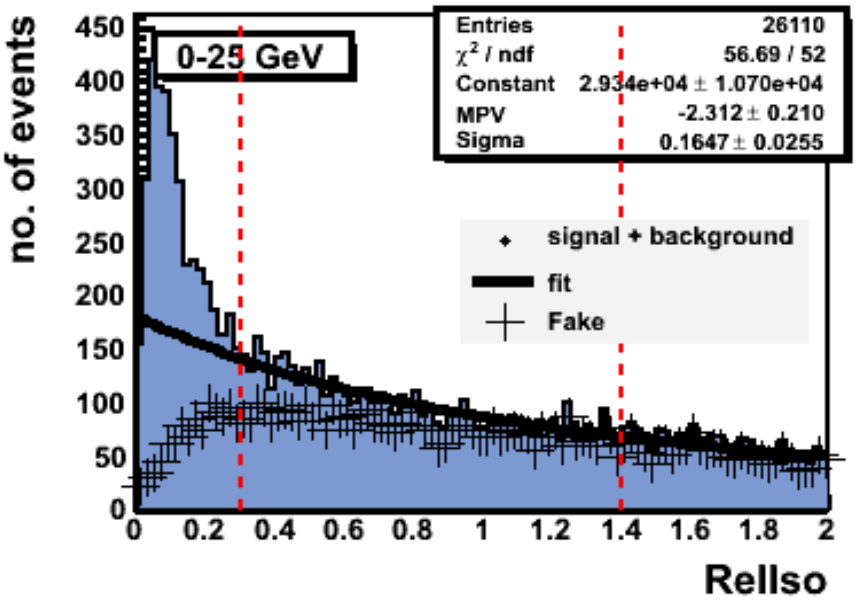

100-150 GeV
Entries 323
χ² / ndf 5.234 / 16
Constant 4486 ± 23124.2
MPV -0.6209 ± 1.2141
Sigma 0.01923 ± 0.05759
signal + background
fit
Fake
no. of events
RelIso

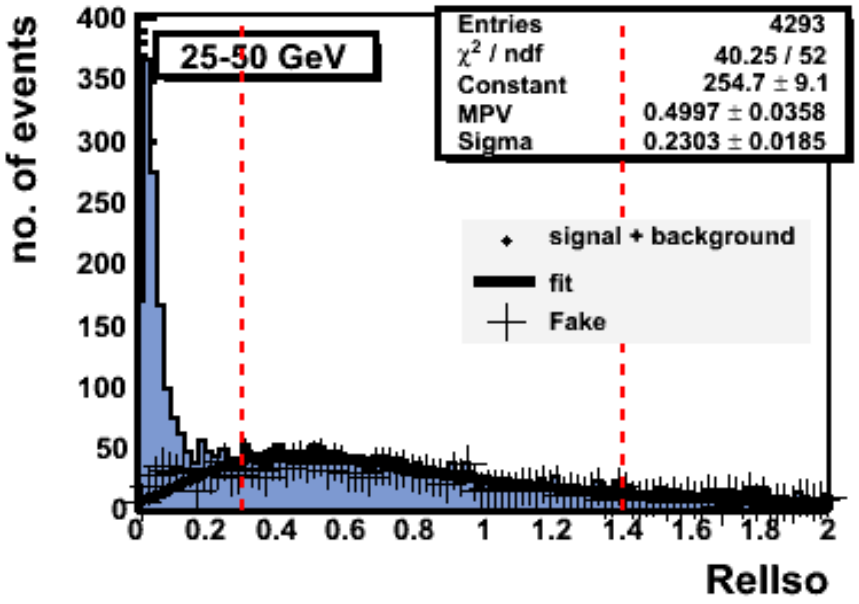
LM1

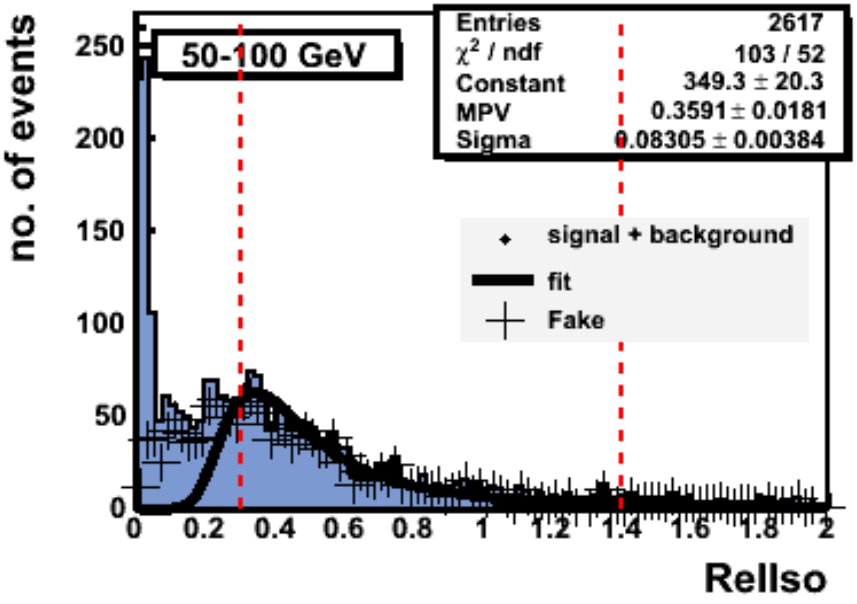


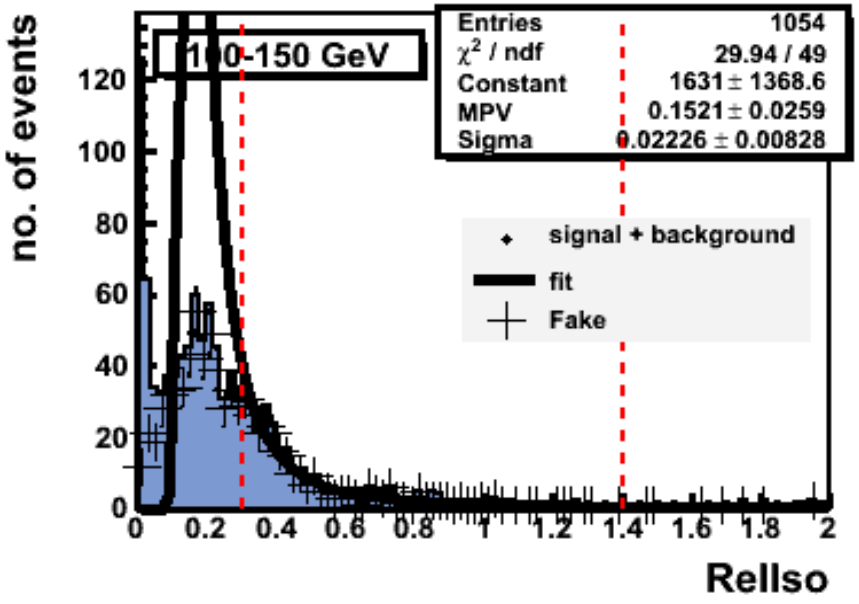
➔ Isolation worse than for TTbar sample

LM1









➔ Adjust fit region?

Outlook

- Investigate low-pT region more carefully
- Play with fit regions
- Properly define fake-objects
- Run with more/ other data
- Itemize fakes

- Reproduce RA5 results
- How strong is the influence of multiple interactions?

Backup

Template

- Mmm = **M**atze **m**acht **m**SUGRA

- Same-sign di-lepton channel
  ➔ How does one get same-sign di-leptons?

➔ Distinguish between
- em showers
- had showers

Signal	Material
Scintillator radiation	BGO, BaF_2, CeF_3
Cherenkow radiation	lead crystal
Ionisation	liquid inert gases

☺ **Best possible energy resolution**
☹ **Expensive**
☹ **Large**

→ Homogeneous calorimeters are solely used for em calorimeters