
Recasting the Search for pair-produced three-jet resonances in p-p collisions at 13TeV

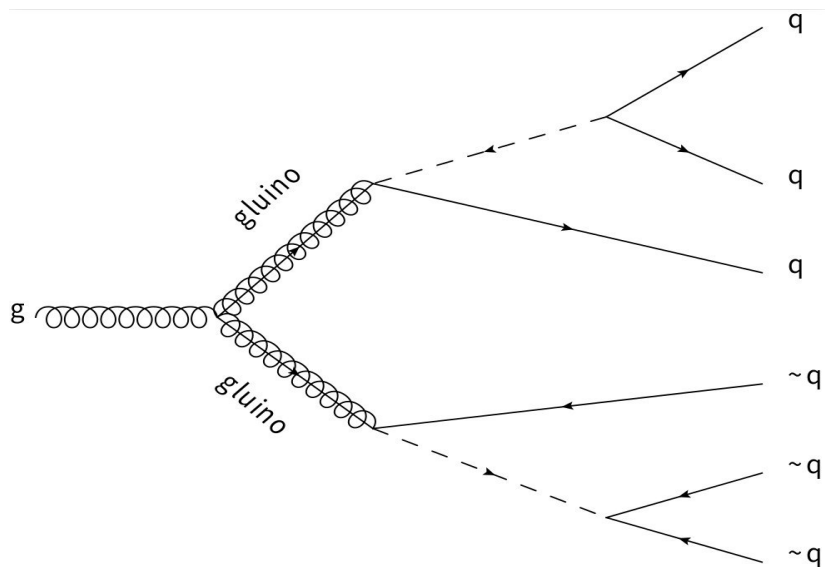
Yechan Kang, Jihun Kim, Jin Choi, SooHyun Yun

The second MadAnalysis 5 workshop on LHC recasting @ Korea
KIAS

1. Introduction

<Model>

- R- parity violating SUSY
- $g g \rightarrow g\tilde{g} \rightarrow$ double trijets



<Contents>

- Completed the MadAnalysis5 Analyzer code
- Validation
: disagreement with paper
- Works to do

2. Status – Event Generation

- MadGraph5

```
import model sm
define p = g u c d s u~ c~ d~ s~
define j = g u c d s u~ c~ d~ s~
define l+ = e+ mu+
define l- = e- mu128
define vl = ve vm vt
define vl~ = ve~ vm~ vt~
import model RPVMSSM_UFO
generate g g > go go, go > u d s, go > u~ d~ s~
```

- Signal Region

Region	Gluino mass range	
1	200–400 GeV	Low Mass Region
2	400–700 GeV	
3	700–1200 GeV	High Mass Region
4	1200–2000 GeV	

200, 500
900, 1600

2. Status – Cut Analysis

-

Region	Gluino mass range	Jet p_T	H_T	sixth jet p_T	$D^2_{[(6,3)+(3,2)]}$	A_m	Δ	$D^2_{[3,2]}$
1	200–400 GeV	>30 GeV	>650 GeV	>40 GeV	<1.25	<0.25	>250 GeV	<0.05
2	400–700 GeV	>30 GeV	>650 GeV	>50 GeV	<1.00	<0.175	>180 GeV	<0.175
3	700–1200 GeV	>50 GeV	>900 GeV	>125 GeV	<0.9	<0.15	>20 GeV	<0.2
4	1200–2000 GeV	>50 GeV	>900 GeV	>175 GeV	<0.75	<0.15	>-120 GeV	<0.25

- D^2 Variable

$$D^2_{[(6,3)+(3,2)]} = \sum_{i < j < k} \left(\sqrt{\hat{m}(6,3)_{ijk}^2 + D^2_{[3,2],ijk}} - \frac{1}{\sqrt{20}} \right)^2. \quad A_m = \frac{|m_{ijk} - m_{lmn}|}{m_{ijk} + m_{lmn}}.$$

$$\hat{m}(6,3)_{ijk}^2 = \frac{m_{ijk}^2}{4 m_{ijklmn}^2 + 6 \sum_i m_i^2}.$$

$$D^2_{[3,2]} = \sum_{i > j} \left(\hat{m}(3,2)_{ij} - \frac{1}{\sqrt{3}} \right)^2.$$

$$\hat{m}(3,2)_{ij}^2 = \frac{m_{ij}^2}{m_{ijk}^2 + m_i^2 + m_j^2 + m_k^2}.$$

- Mass Asymmetry

- Delta

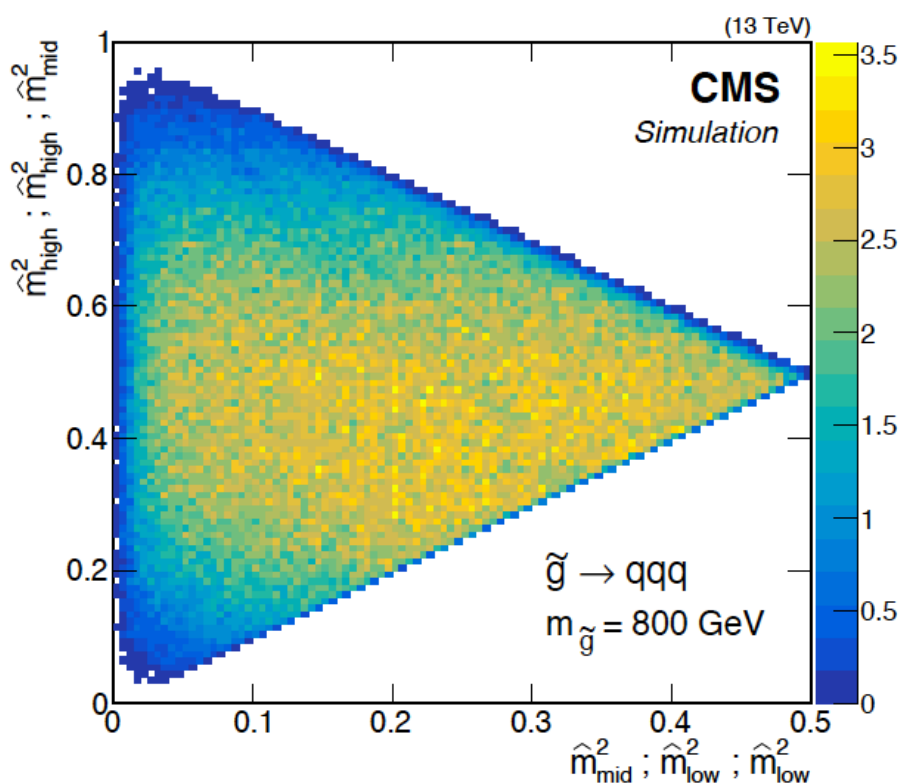
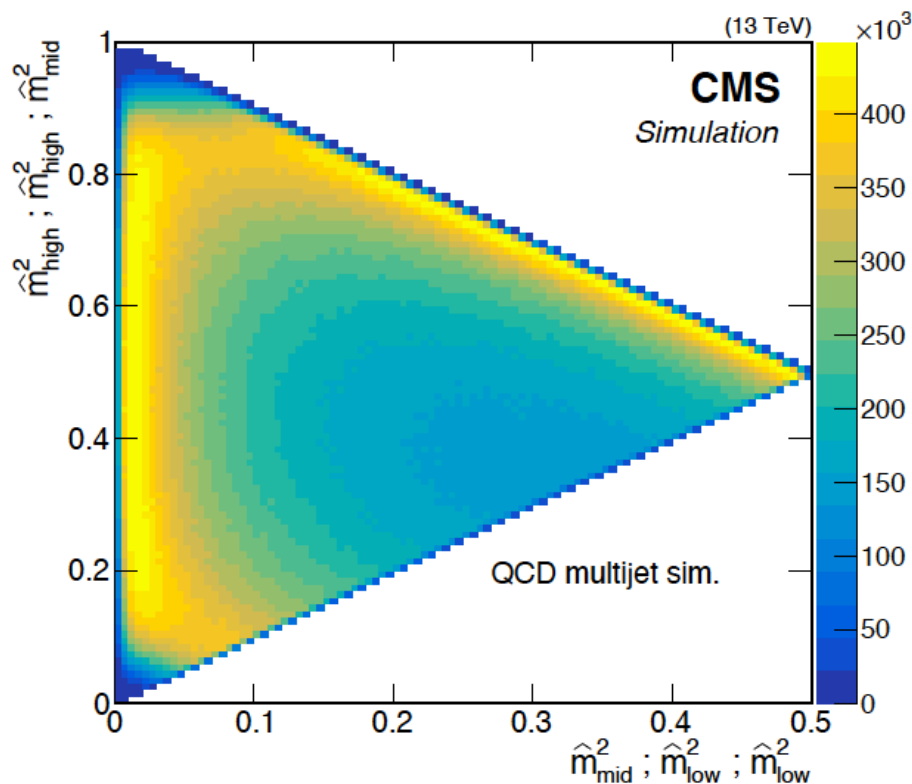
$$m_{ijk} < |p_T|_{ijk} - \Delta,$$

2. Status – Cut Analysis

- Dalitz Variable : $\hat{m}(3,2)_{ij}^2 = \frac{m_{ij}^2}{m_{ijk}^2 + m_i^2 + m_j^2 + m_k^2}$

$$\rightarrow D_{[3,2]}^2 = \sum_{i>j} \left(\hat{m}(3,2)_{ij} - \frac{1}{\sqrt{3}} \right)^2.$$

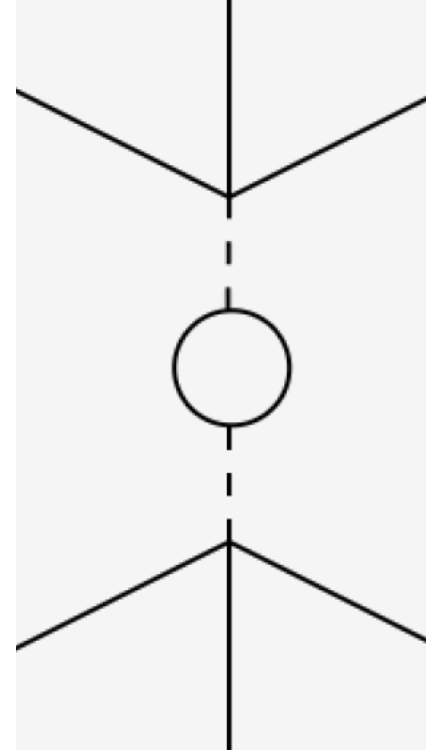
Region	Gluino mass range	$D_{[3,2]}^2$
1	200–400 GeV	<0.05
2	400–700 GeV	<0.175
3	700–1200 GeV	<0.2
4	1200–2000 GeV	<0.25



2. Status – Cut Analysis

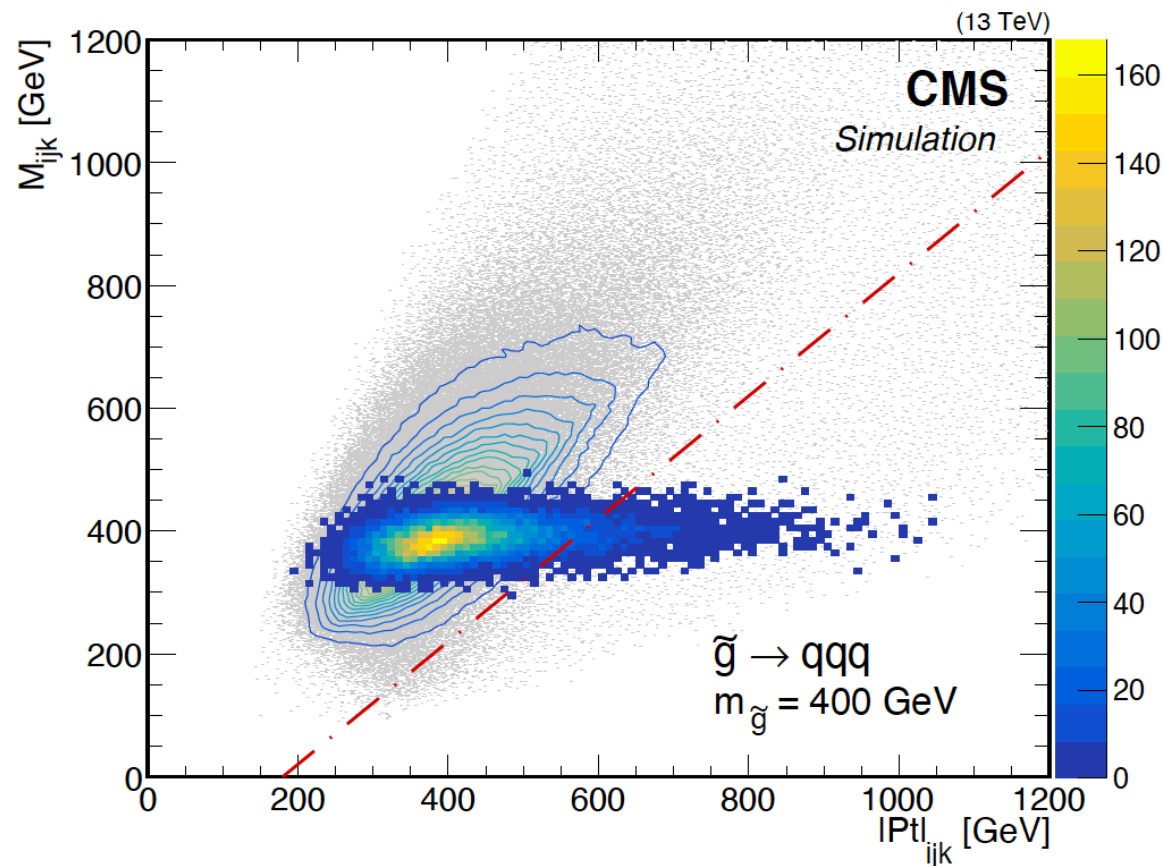
- Mass Assymetry : $A_m = \frac{|m_{ijk} - m_{lmn}|}{m_{ijk} + m_{lmn}}.$

Region	Gluino mass range	A_m
1	200–400 GeV	<0.25
2	400–700 GeV	<0.175
3	700–1200 GeV	<0.15
4	1200–2000 GeV	<0.15



2. Status – Cut Analysis

- Delta : $m_{ijk} < |p_T|_{ijk} - \Delta$,



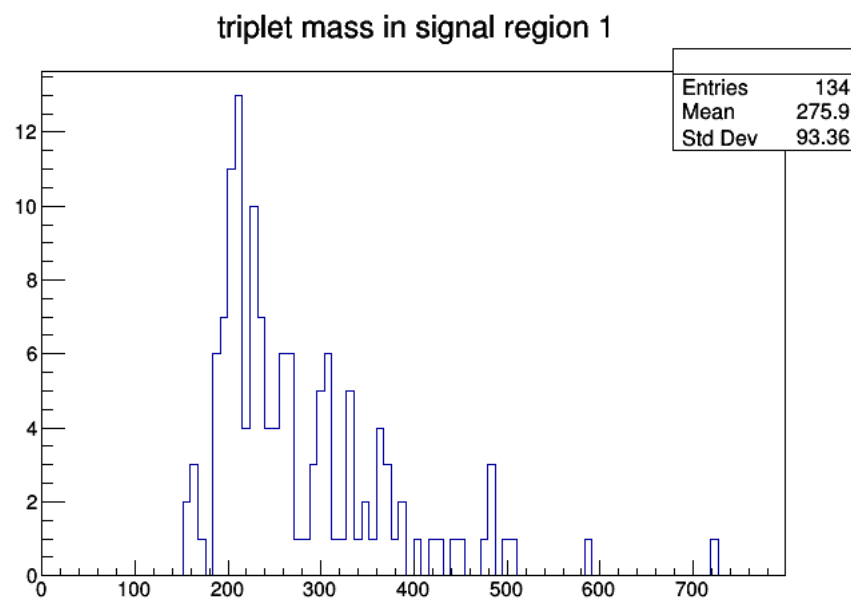
Region	Gluino mass range	Δ
1	200–400 GeV	$>250 \text{ GeV}$
2	400–700 GeV	$>180 \text{ GeV}$
3	700–1200 GeV	$>20 \text{ GeV}$
4	1200–2000 GeV	$>-120 \text{ GeV}$

2. Status - Validation

$$\text{Acceptance} = \frac{\# \text{ of triplets passing the selection}}{\# \text{ of events generated}}$$

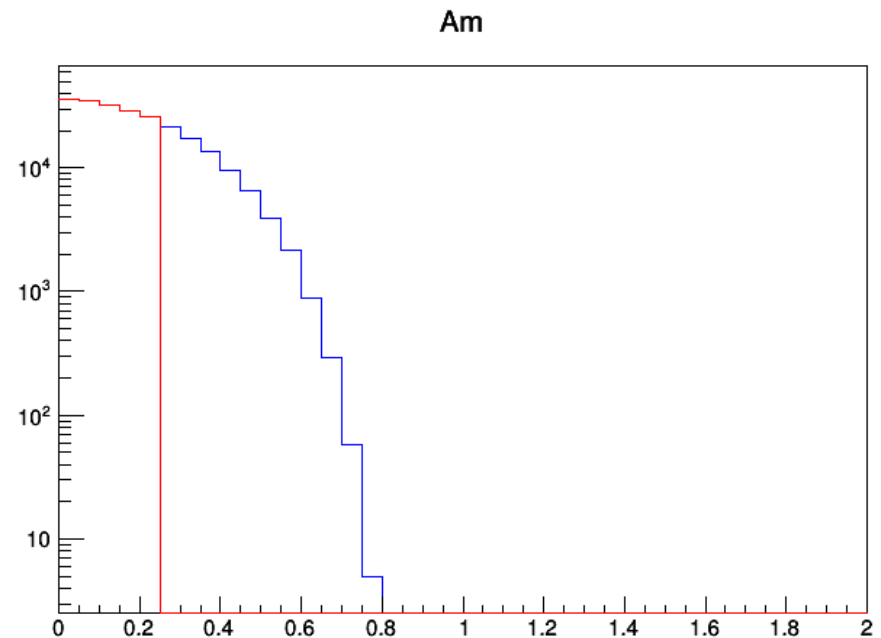
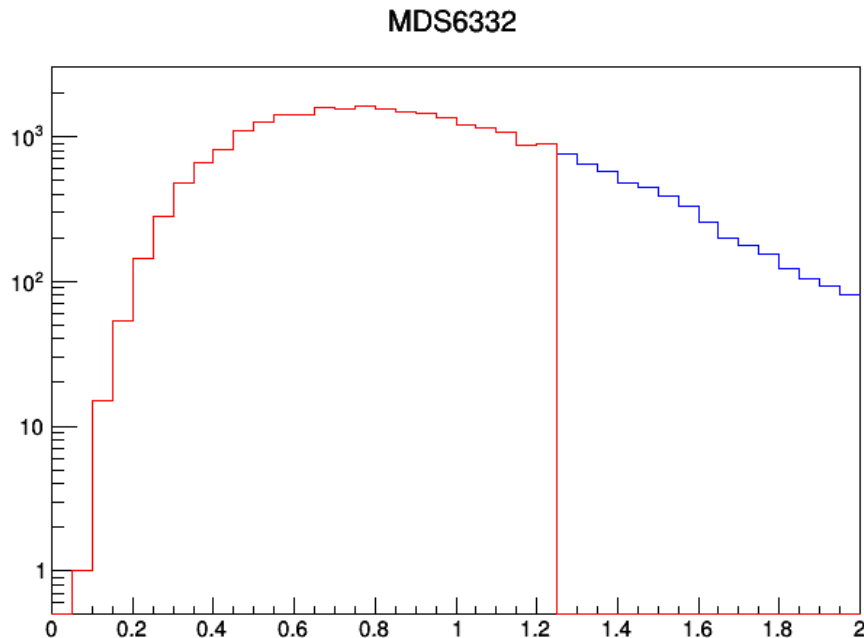
- Low Mass Region ($m_{\tilde{g}} = 200 \text{ GeV}$) : Acceptance 2.6×10^{-4}

Cutflow			
Cut	event	triplet paris	triplets
Jet ID	399847	3998470	7996940
Njets > 6	148171	1481710	2963420
HT > 650GeV	36956	369560	739120
pt(j6) > 40GeV	28464	284640	569280
MDS6332 < 1.25	23366	233660	467320
Am < 0.25	22761	157507	315014
Delta > 250GeV	310		342
MDS32 < 0.05	134		134
acceptance(passed triples / total events)			0.000335
acceptance(passed events / total events)			0.000335



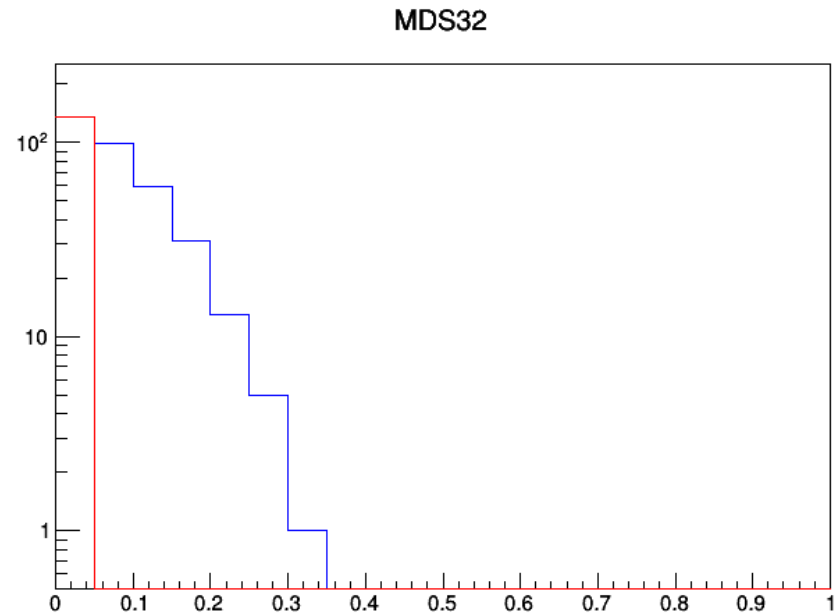
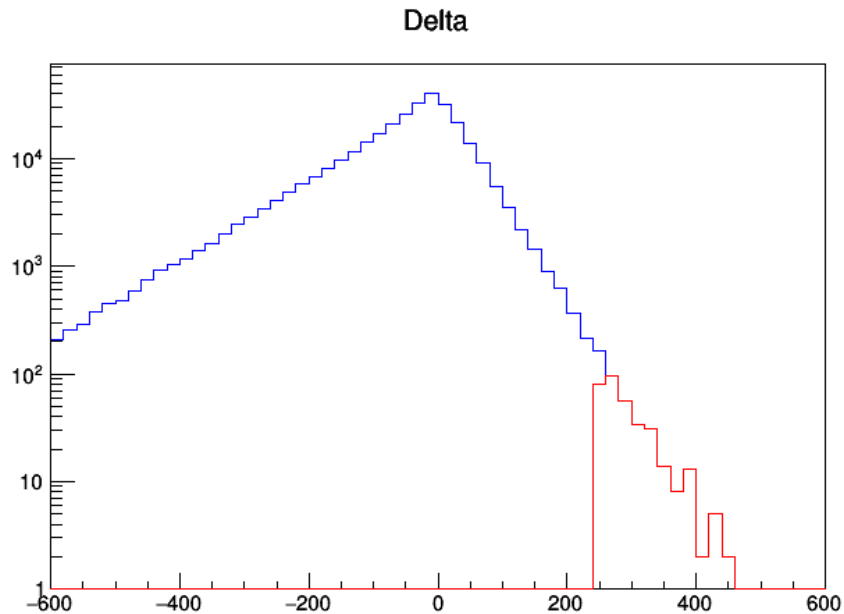
2. Status - Validation

- Low Mass Region ($m_{\tilde{g}} = 200 \text{ GeV}$) : Acceptance 2.6×10^{-4}



2. Status - Validation

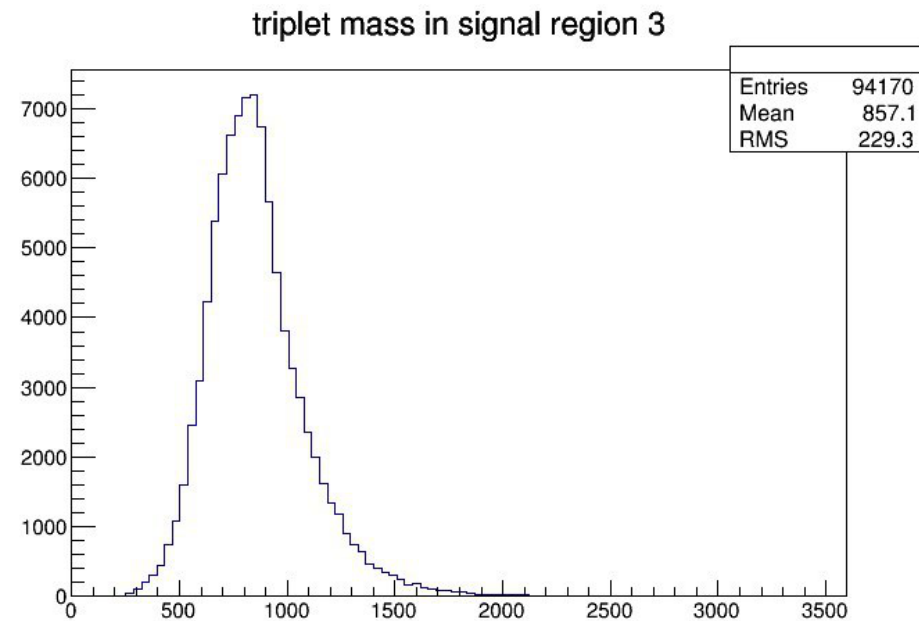
- Low Mass Region ($m_{\tilde{g}} = 200 \text{ GeV}$) : Acceptance 2.6×10^{-4}



2. Status - Validation

- High Mass Region ($m_{\tilde{g}} = 900 \text{ GeV}$) : Acceptance 8.4×10^{-2}

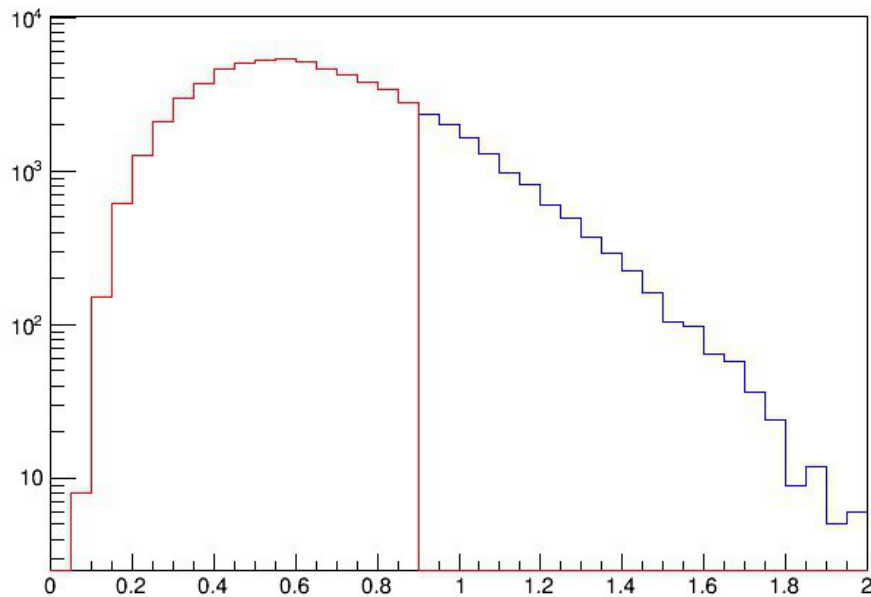
Cutflow			
Cut	event	triplet paris	triplets
Jet ID	199585	1995850	3991700
Njets > 6	174485	1744850	3489700
HT > 900GeV	173646	1736460	3472920
pt(j6) > 125GeV	66475	664750	1329500
MDS6332 < 0.9	54849	548490	1096980
Am < 0.15	53852	316110	632220
Delta > 20GeV	14646		149278
MDS32 < 0.2	12232		94170
acceptance(passed triples / total events)			0.471829045
acceptance(passed events / total events)			0.061287171



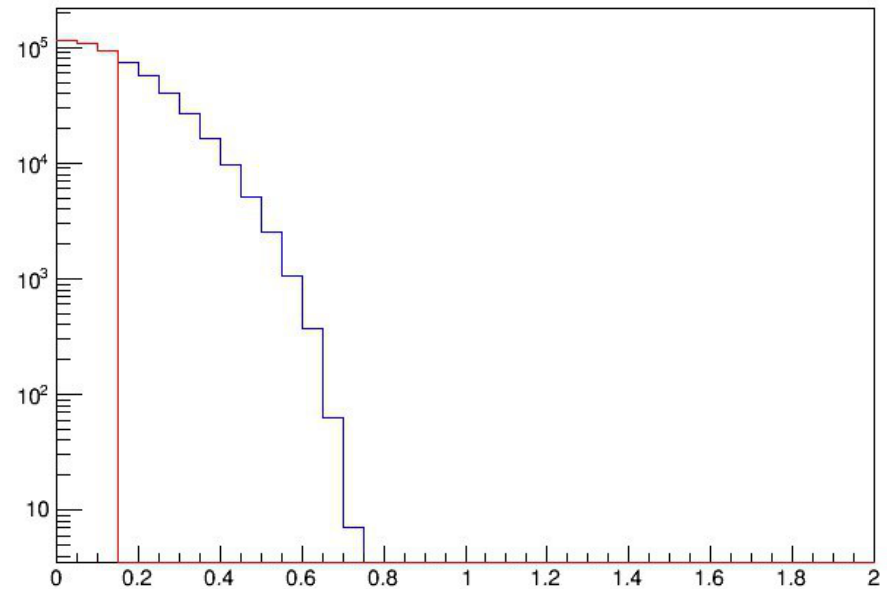
2. Status - Validation

- High Mass Region ($m_{\tilde{g}} = 900 \text{ GeV}$) : Acceptance 8.4×10^{-2}

MDS6332

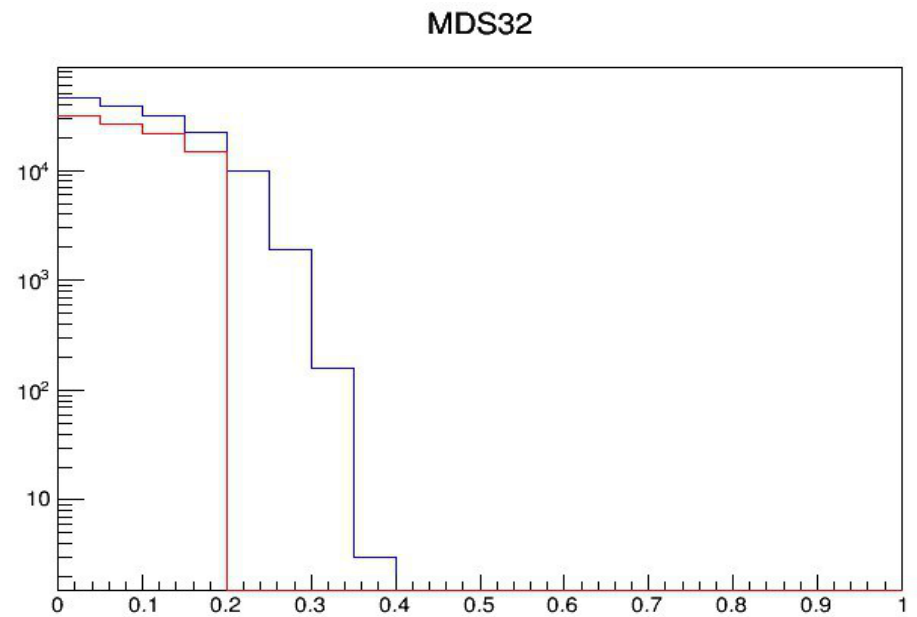
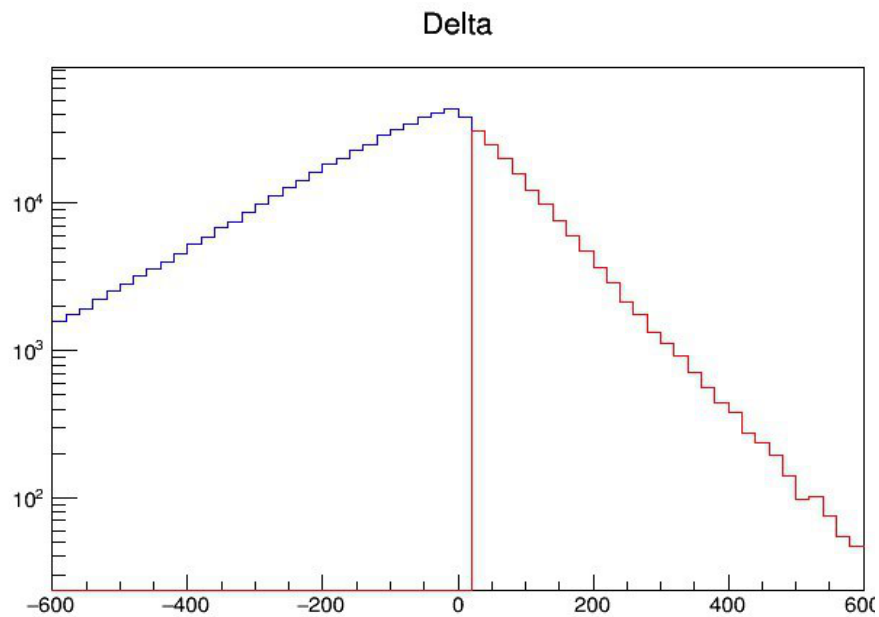


Am



2. Status - Validation

- High Mass Region ($m_{\tilde{g}} = 900 \text{ GeV}$) : Acceptance 8.4×10^{-2}



3. Future Plan

- Validate the plots in the paper (e.g. Delta plot)
- Too many triplets / event in the high mass region...
- might check Njets in every events & Pt distributions

Thank you!