

# Emerging Jet Analysis Update

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# Comparing Energy of Initial Quark Pairs

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- Only Down quarks are produced for initial SM quarks

- SM Quark Cut

$\text{truthPart\_pdgId} \rightarrow \text{at}(n) == 1 \ \&\& \ n^{\text{th}} \ \text{parent\_pdgId} \rightarrow \text{at}(0) == 4900001$

*SM Down Quark*

*$\chi_d$*

- Dark quark cut

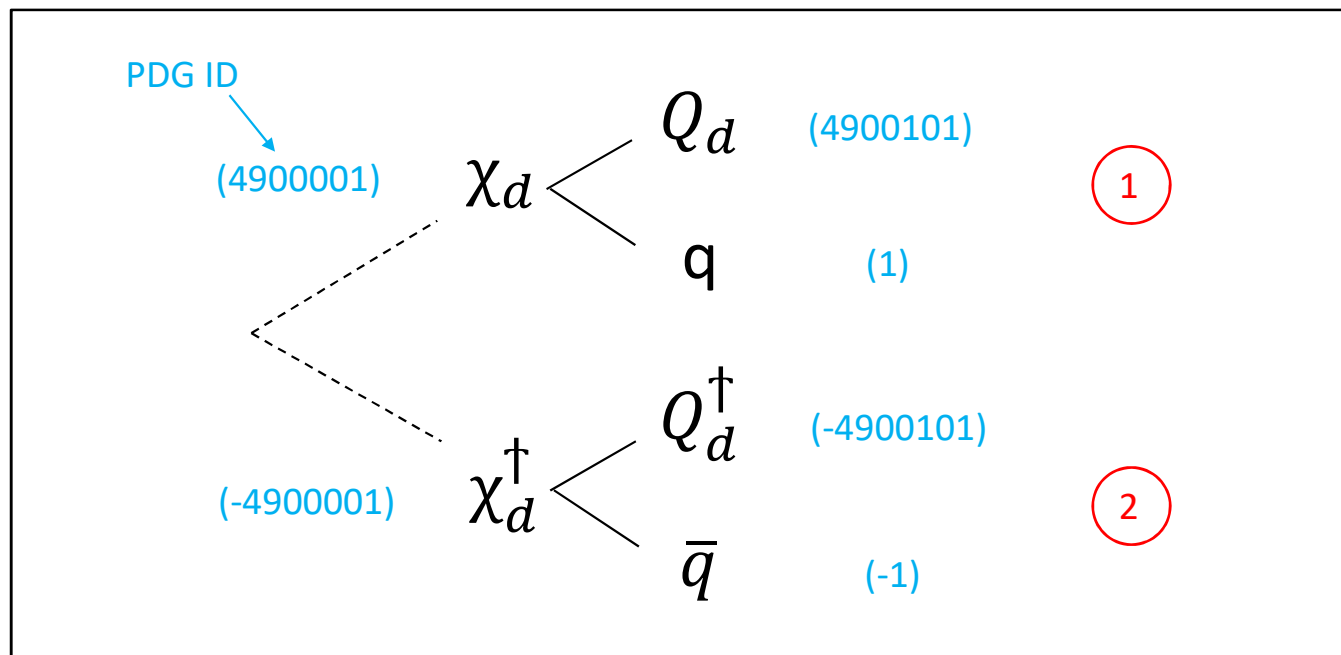
$\text{truthPart\_pdgId} \rightarrow \text{at}(n) == 4900101 \ \&\& \ \text{truthPart\_status} \rightarrow \text{at}(n) == 23$

*Dark Quark*

*Initial State*

- Compared 4-momenta to verify quarks come from same parent

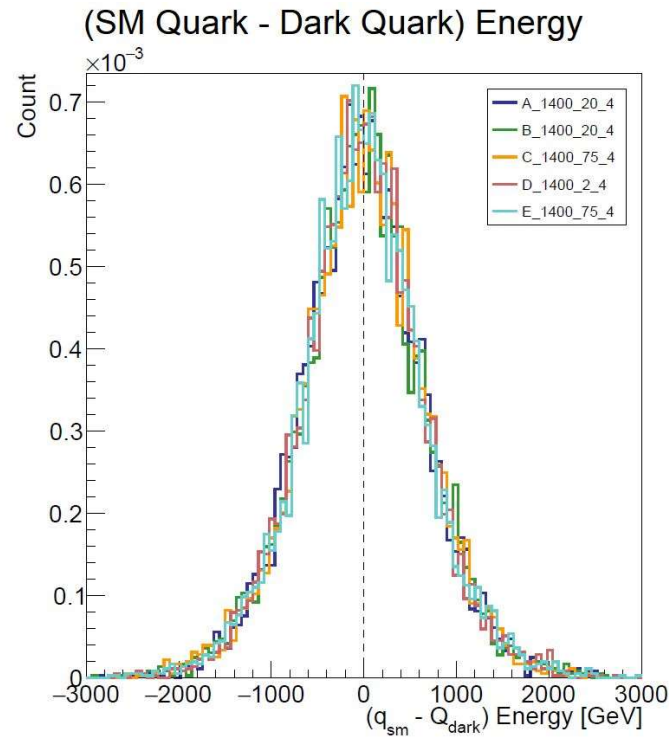
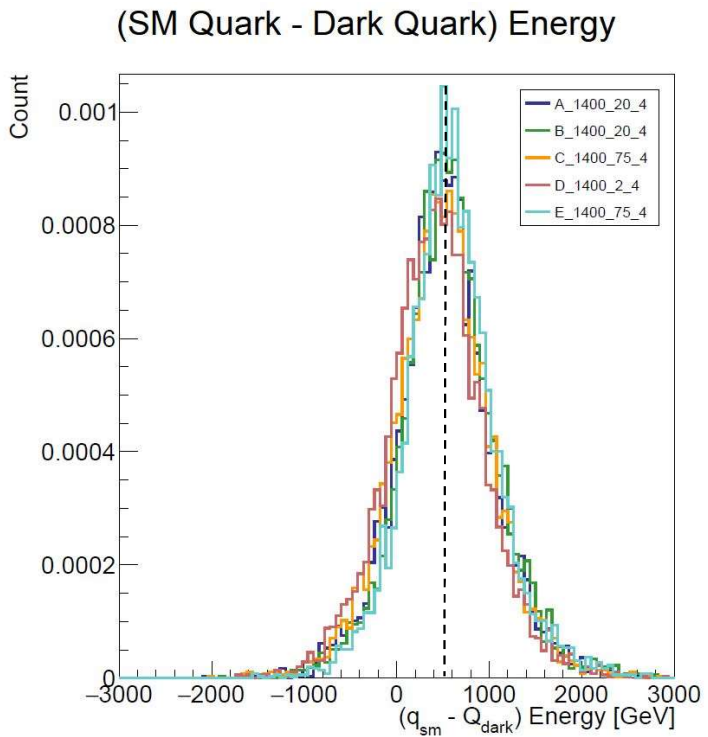
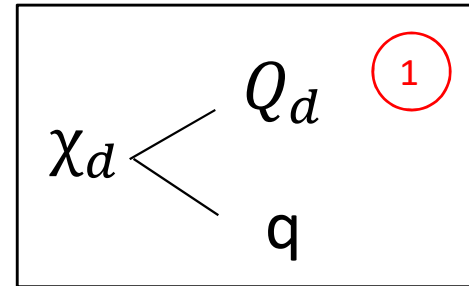
# Quark Pairs



SM quarks are only Down quarks

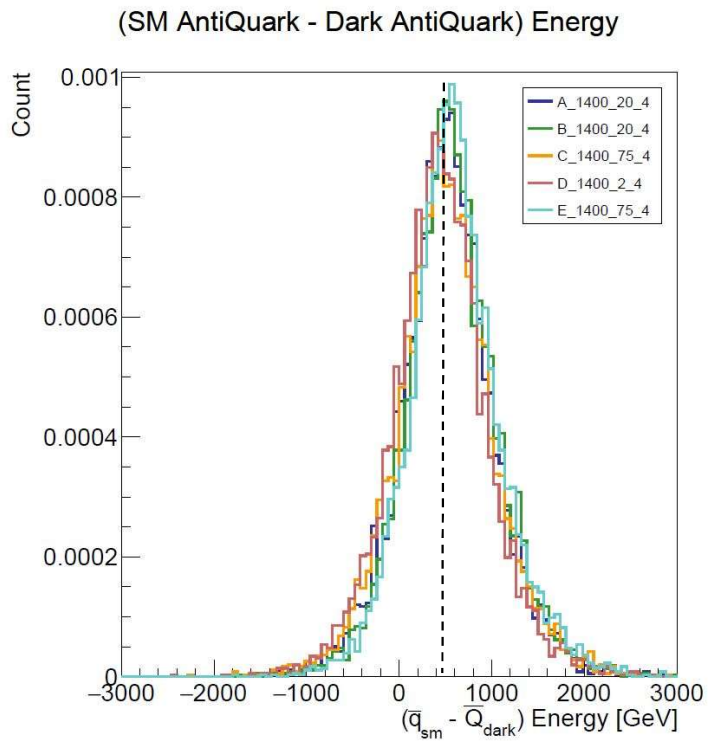
**Status = 71**  
**(Final Dark Quark State)**

**Status = 23**  
**(Initial Dark Quark State)**

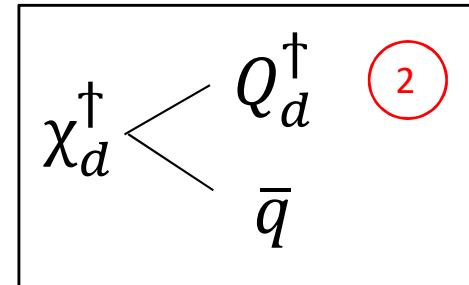
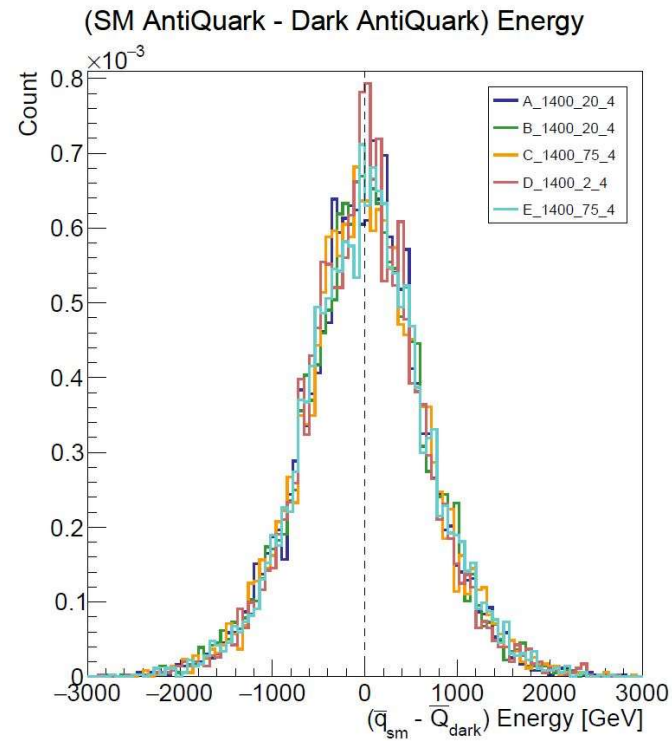


$$\Delta E = (E_q - E_{Q_d}) \simeq 0$$

**Status = 71**  
**(Final Dark Quark State)**



**Status = 23**  
**(Initial Dark Quark State)**



$$\Delta E = (E_q - E_{Q_d}) \simeq 0$$

# Residual 4-momenta

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- Calculated 4-momenta components for  $\chi_d, q, Q_d$

$$\begin{aligned} px &= pT * \cos(\phi) \\ py &= pT * \sin(\phi) \\ pz &= pT * \sinh(\eta) \end{aligned}$$

- Calculated residual 4-momenta for each component ( $E, px, py, pz$ )

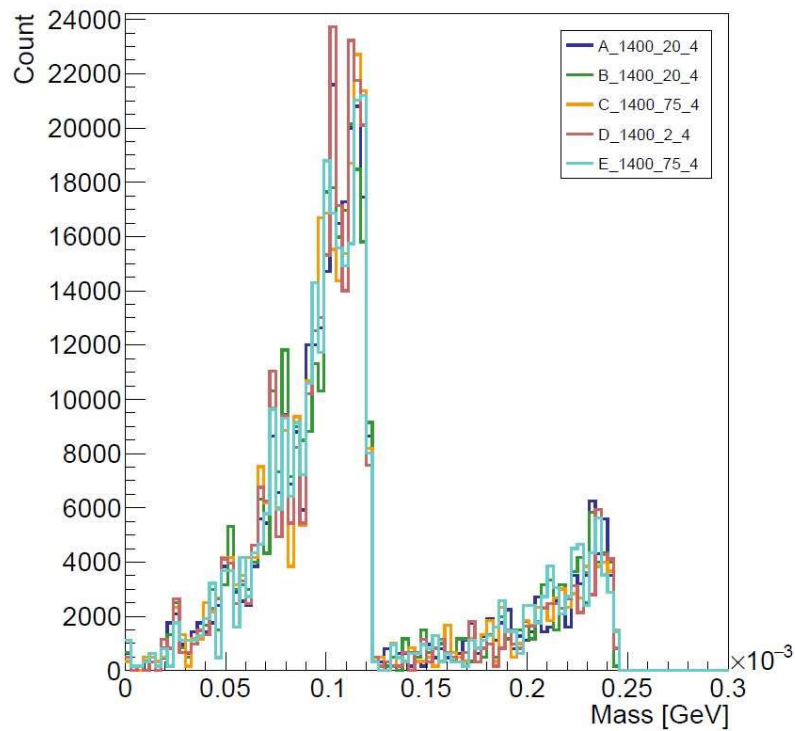
- eg. 
$$\Delta E_{res} = E_{\chi_d} - (E_q + E_{Q_d}) \simeq 0$$

- Noticed values aren't exactly 0
- Seemed to be repeating values
- Plotted results in histograms

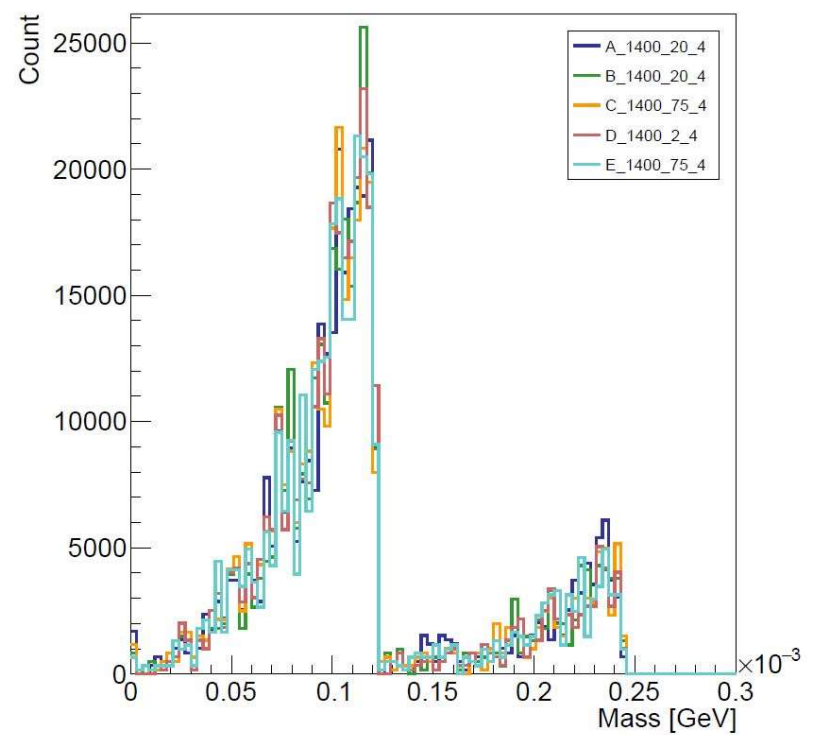
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-----  
E = 0.000000  
px = -0.000122  
py = 0.000061  
pz = 0.000031  
-----  
E = -0.000122  
px = 0.000015  
py = -0.000061  
pz = -0.000061  
-----  
E = 0.000000  
px = 0.000031  
py = 0.000000  
pz = 0.000061  
-----  
E = 0.000122  
px = 0.000031  
py = 0.000031  
pz = 0.000046  
-----  
E = -0.000122  
px = -0.000061  
py = -0.000015  
pz = 0.000000  
-----
```

Snapshot of some residual component results

Residual Mass (Quark Pair)

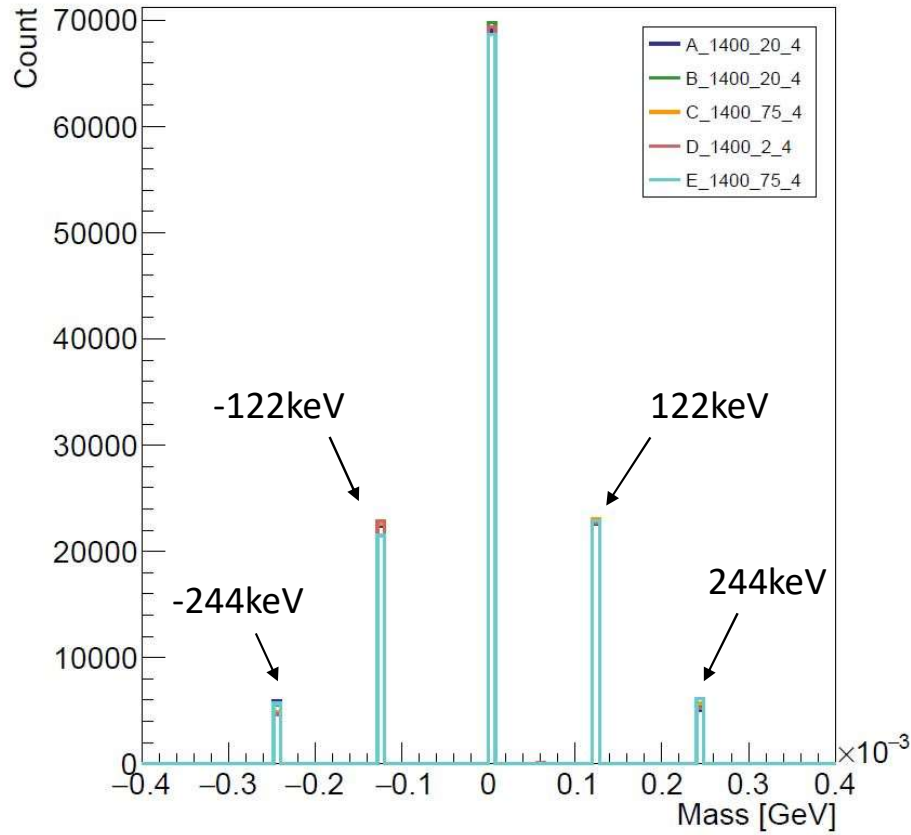


Residual Mass (Anti-Quark Pair)

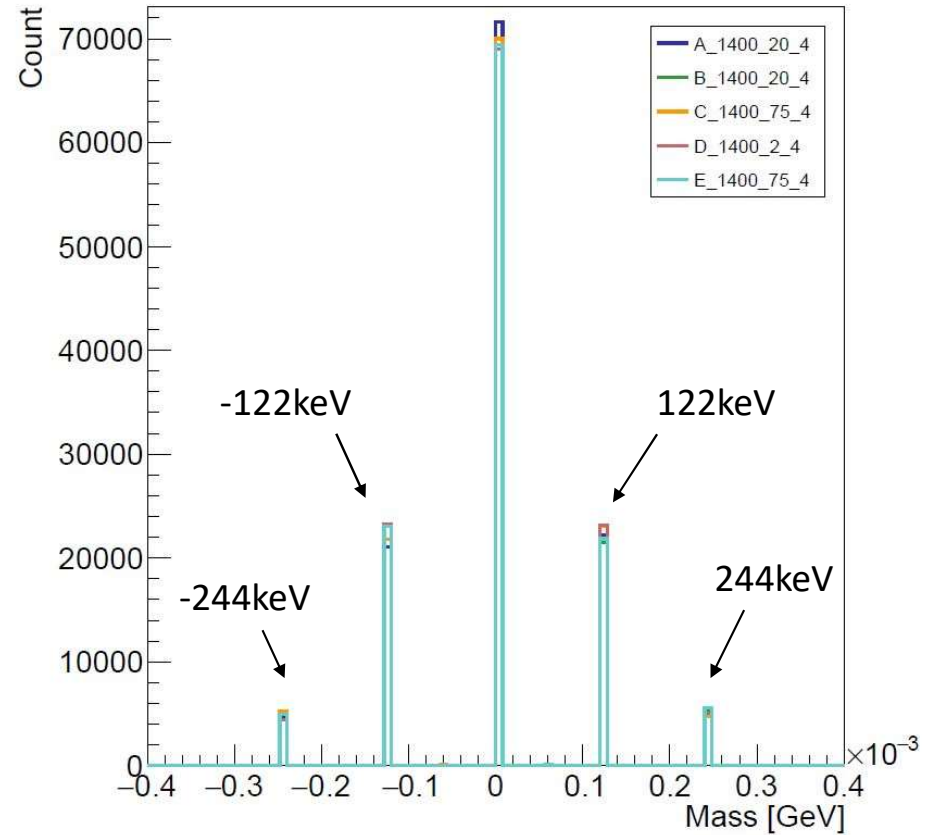


$$m_{res} = \sqrt{E^2 - (p_x^2 + p_y^2 + p_z^2)} \quad \leftarrow \text{Using residual components}$$

Residual E (Quark Pair)

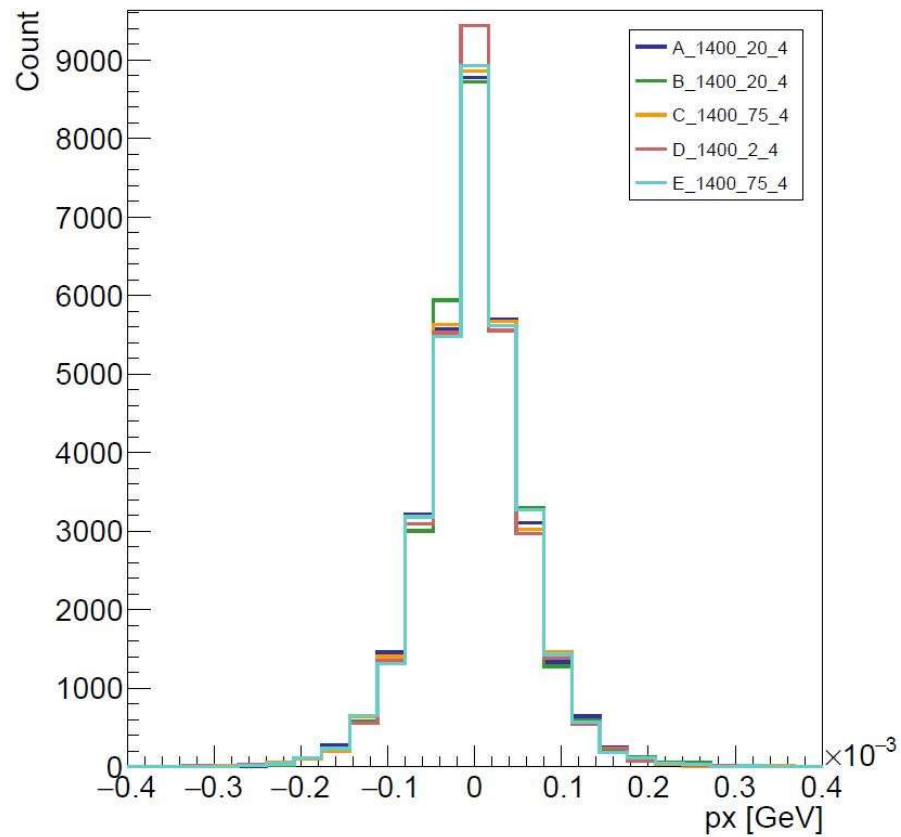


Residual E (Anti-Quark Pair)

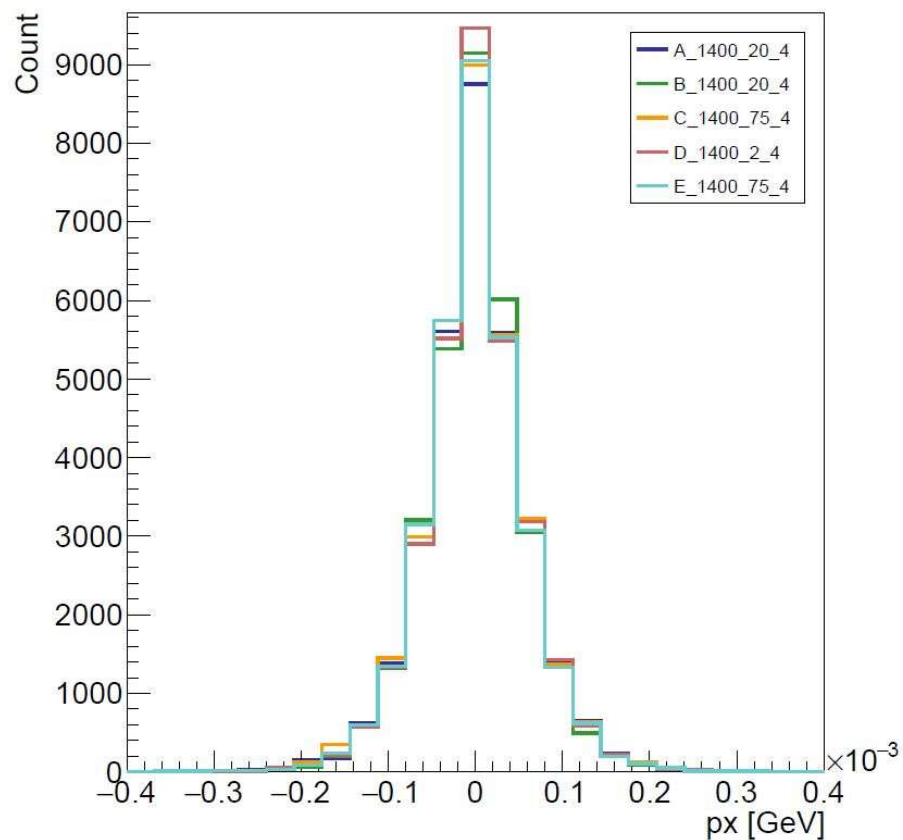




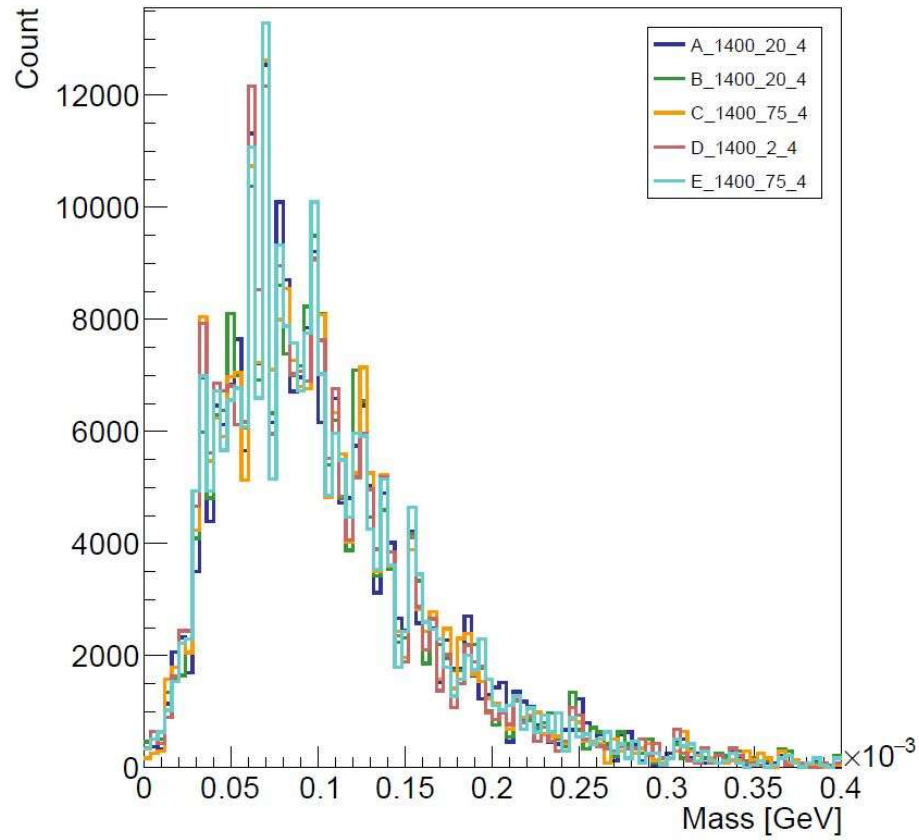
Residual px (Quark Pair)



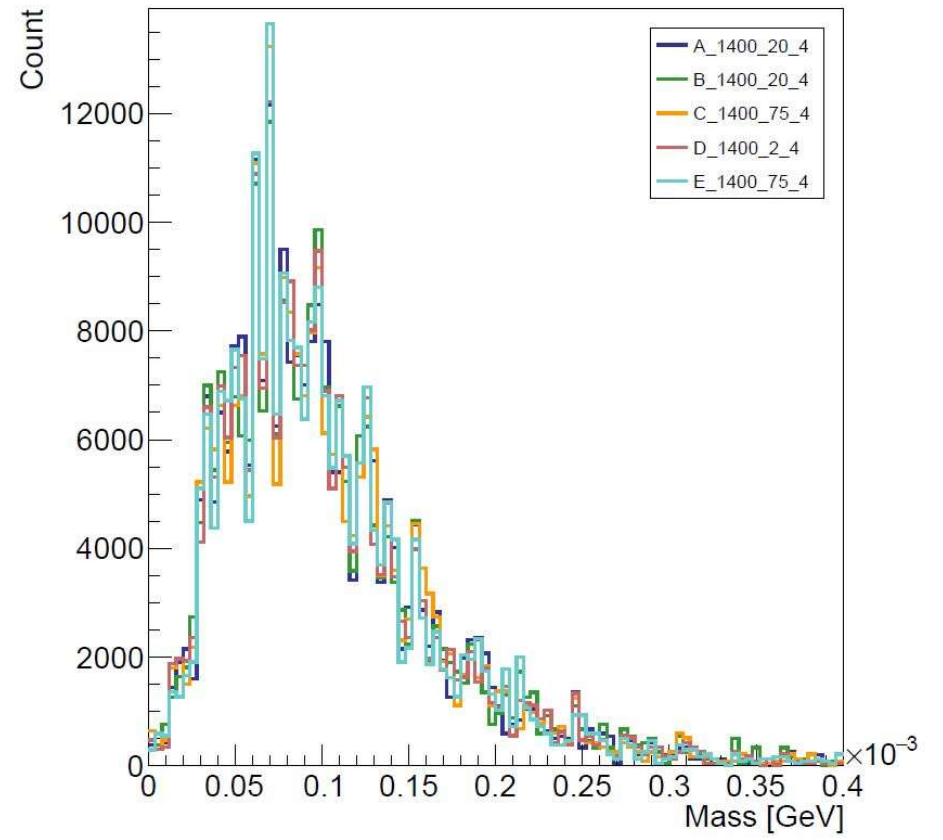
Residual px (Anti-Quark Pair)



Residual  $|\mathbf{p}|$  (Quark Pair)



Residual  $|\mathbf{p}|$  (Anti-Quark Pair)

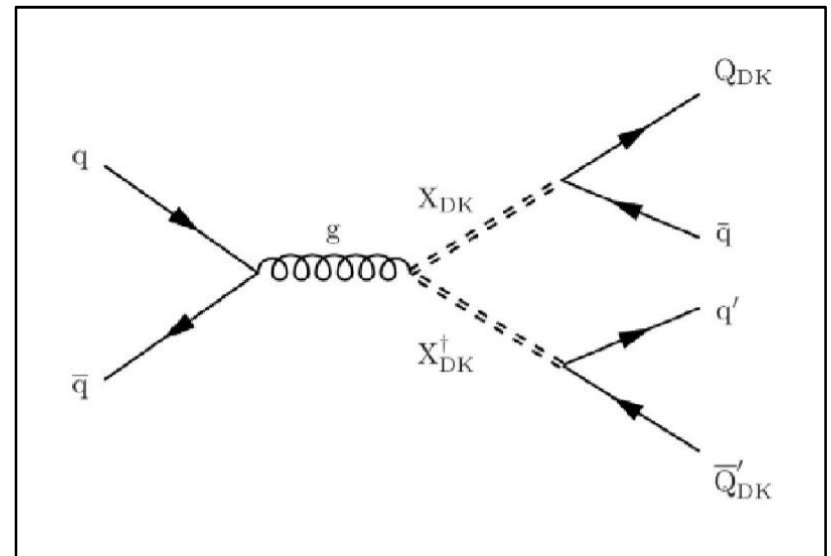
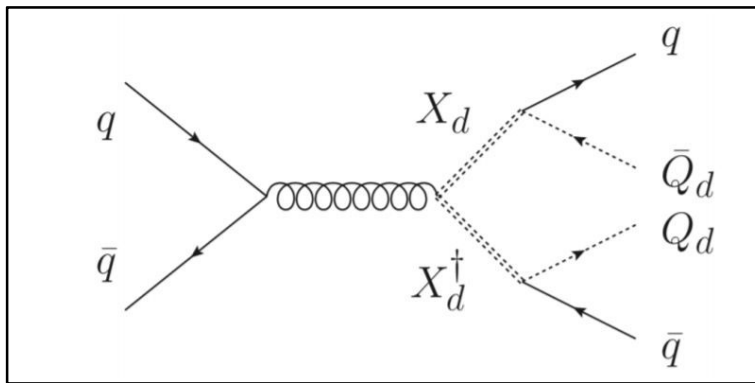
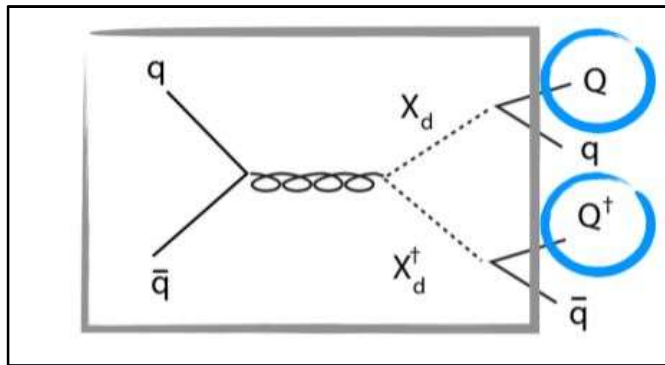


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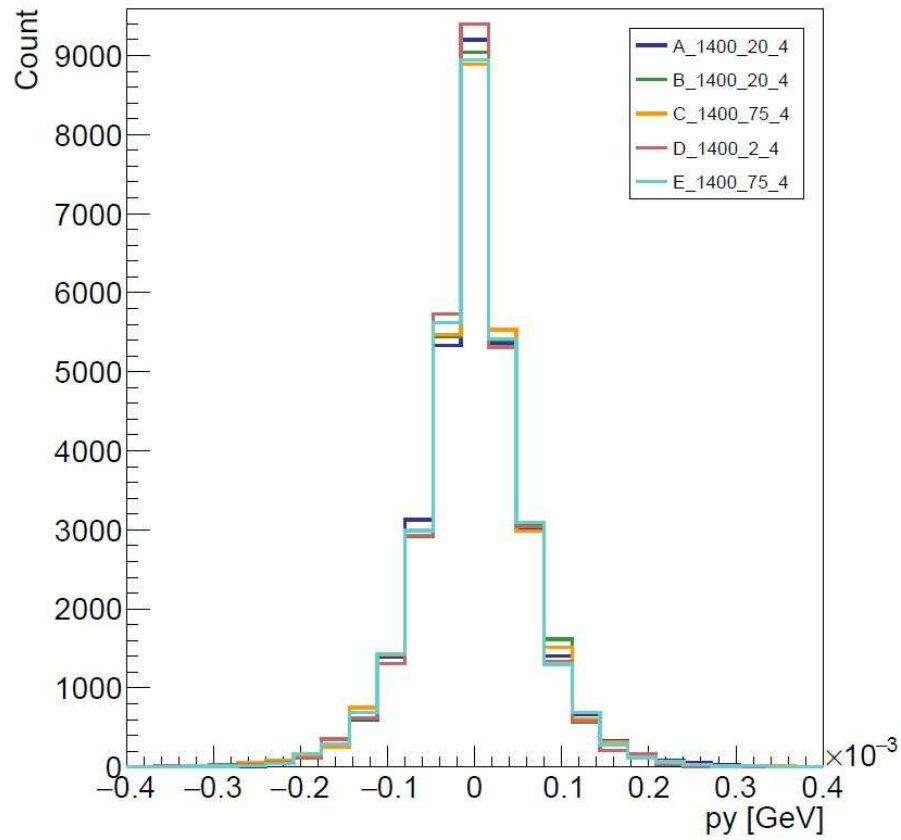
# Backup Slides



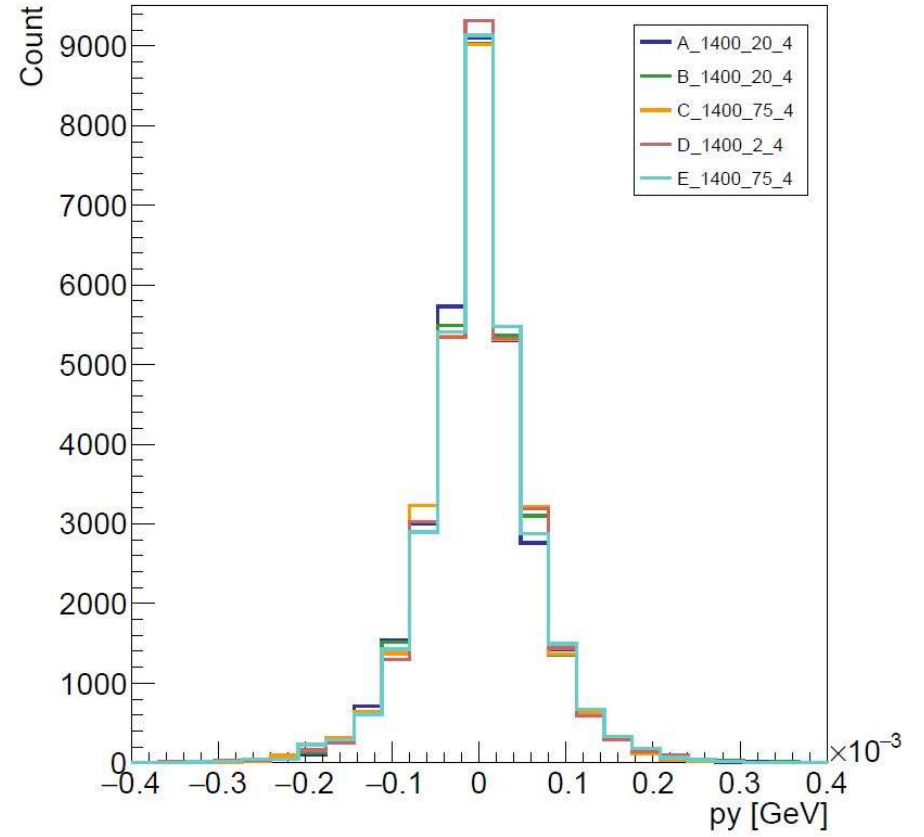
# Different Quark Pairs



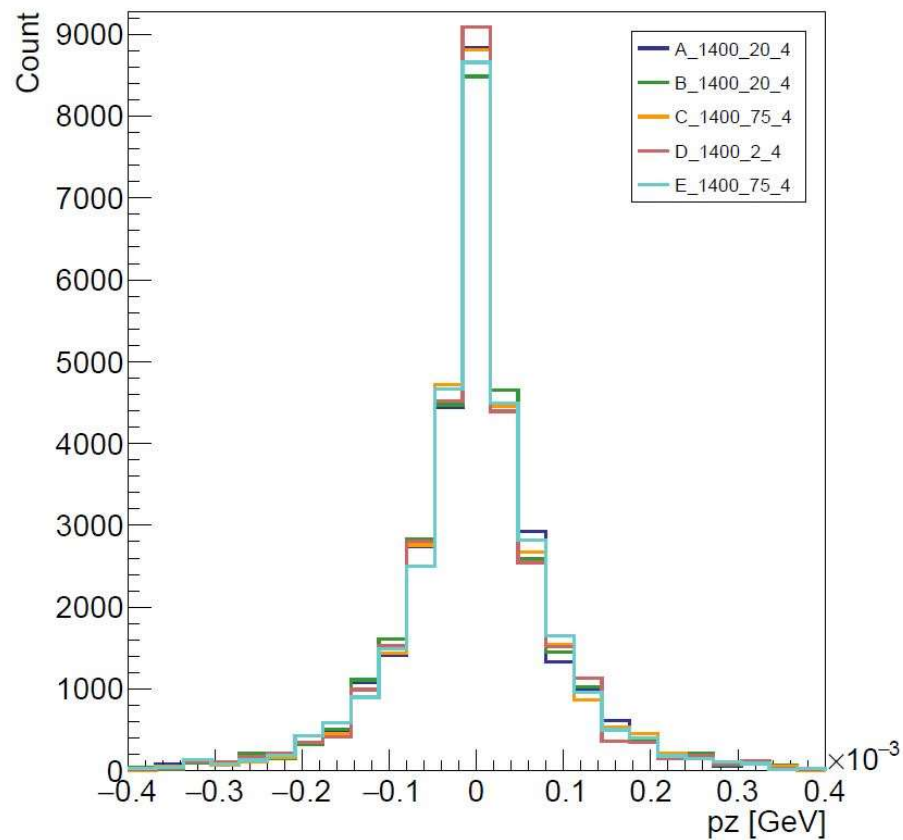
### Residual $p_T$ (Quark Pair)



### Residual $p_T$ (Anti-Quark Pair)



### Residual pz (Quark Pair)



### Residual pz (Anti-Quark Pair)

