Vector/Axial-vector

Technical stuff:
- use POWHEG-BOX process of pp-->DM DM 1j at NLO (need to check how sufficient this will be for multijet+Met processes)
- use generation cut of 30 GeV, 50000 events each model. (previously used 20k events with a cut of 80 GeV, this was sufficient for monojets, but likely not sufficient for multijet analyses)

- vector coupling to both SM and DM
- axial vector coupling to both SM and DM
- no mixed coupling case yet (we can add later)

Width is calculated from couplings from using following formulas

$$\Gamma(Z' \to \bar{\chi}\chi)_{\text{vector}} = \frac{g_{\text{DM}}^2 M_{\text{med}}}{12\pi}\left(1+\frac{2m_{\text{DM}}^2}{M_{\text{med}}^2}\right)\sqrt{1-\frac{4m_{\text{DM}}^2}{M_{\text{med}}^2}}$$

$$\Gamma(Z' \to \bar{q}q)_{\text{vector}} = \frac{3g_q^2 M_{\text{med}}}{12\pi}\left(1+\frac{2m_q^2}{M_{\text{med}}^2}\right)\sqrt{1-\frac{4m_q^2}{M_{\text{med}}^2}}$$

$$\Gamma(Z' \to \bar{\chi}\chi)_{\text{axial}} = \frac{g_{\text{DM}}^2 M_{\text{med}}}{12\pi}\left(1-\frac{4m_{\text{DM}}^2}{M_{\text{med}}^2}\right)^{3/2}$$

$$\Gamma(Z' \to \bar{q}q)_{\text{axial}} = \frac{3g_q^2 M_{\text{med}}}{12\pi}\left(1-\frac{4m_q^2}{M_{\text{med}}^2}\right)^{3/2}.$$

g_q	g_{DM}
M_{med}	M_{DM}

Vector/Axial-vector

g_q	g_{DM}
M_{med}	M_{DM}

Proposal for scans:

- Vary M_{med} and M_{DM} and keep g_q and g_{DM} fixed to 0.3, 0.5, 1.0, 1.45 (weak coupling, semi-weak coupling, strong coupling, max coupling based on width~mass)
- Ranges depend on values of couplings

$g_q=g_{DM}=0.3$
M_{DM} = 25, 50, 75, 100, 125, 150, 175, 200 M_{MED} = 50, 100, 200, 300, 400, 500, 600, 700, 800
$g_q=g_{DM}=0.5$
M_{DM} = 25, 50, 100, 150, 200, 250, 300 M_{MED} = 50, 100, 200, 400, 600, 800, 1000, 1100, 1200
$g_q=g_{DM}=1.0$
M_{DM} = 25, 50, 100, 150, 200, 250, 300, 350 ,400, 450, 500 M_{MED} = 50, 100, 200, 400, 600, 800, 1000, 1100, 1200, 1300, 1400, 1500
$g_q=g_{DM}=1.45$
M_{DM} = 25, 50, 100, 150, 200, 250, 300, 350 ,400, 450, 500, 550, 600, 650 M_{MED} = 50, 100, 200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600

Scalar/Pseudoscalar

- use MCFM
- yukawa coupling to quarks ONLY, not to DM.
- 50k events each with generation cut of 30 GeV

$$\mathcal{L} \supset g^S_{\mathrm{DM}} (\bar{\chi}\chi) S + g^S_{\mathrm{SM}} \sum_q \frac{m_q}{v} (\bar{q}q) S + i g^P_{\mathrm{DM}} (\bar{\chi}\gamma_5\chi) P + i g^P_{\mathrm{SM}} \sum_q \frac{m_q}{v} (\bar{q}\gamma_5 q) P ,$$

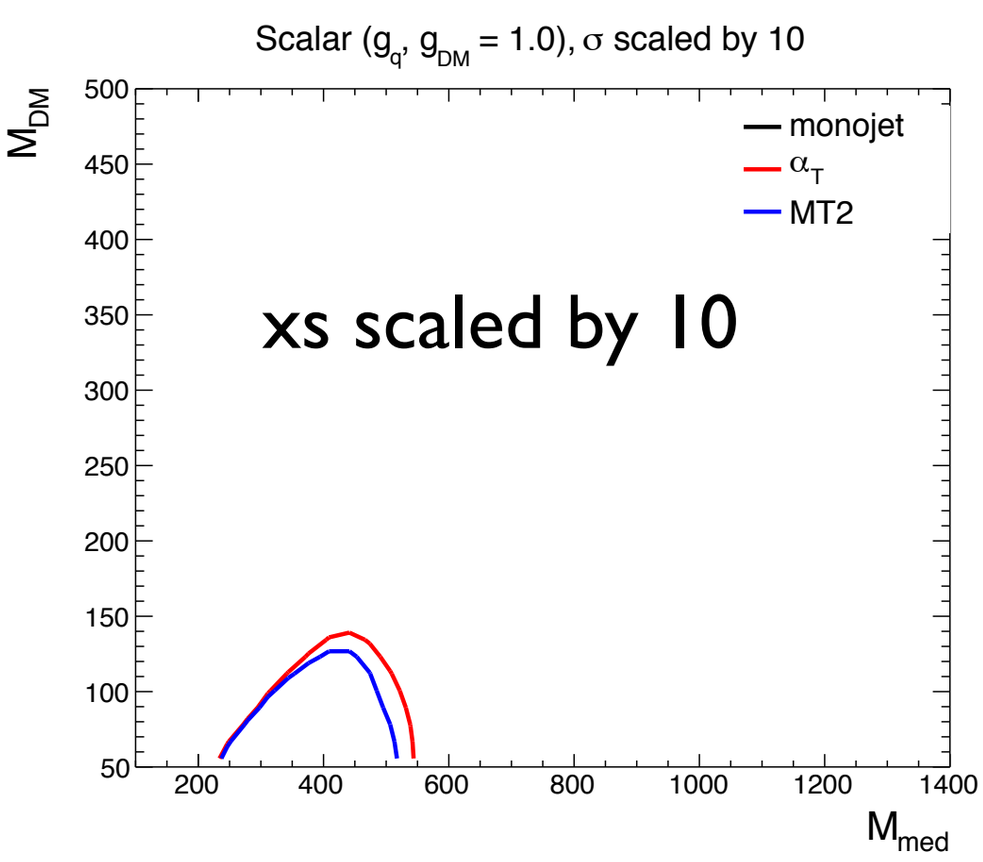
$g_q = g_{DM} = 0.1$ M_{DM} = 25, 50, 75, 100, 125, 150, 175, 200 M_{MED} = 50, 125, 200, 300, 400, 500, 600, 700, 800
$g_q = g_{DM} = 1.0$ M_{DM} = 25, 50, 100, 150, 200, 250, 300, 350 M_{MED} = 50, 100, 200, 400, 600, 800, 1000, 1100, 1200
Higgs invisible scan, g_q = 1.0, g_{DM} = x (value of coupling which gives width of Higgs) M_{MED} = 125, M_{DM} = 50
$g_q = g_{DM} = 2.0$ M_{DM} = 25, 50, 100, 150, 200, 250, 300, 350, 400 M_{MED} = 50, 100, 200, 400, 600, 800, 1000, 1100, 1200,1400
$g_q = g_{DM} = 3.2$ (max coupling for which mass ~ width) M_{DM} = 25, 50, 100, 150, 200, 250, 300, 350 ,400, 450, 500, 550 M_{MED} = 50, 125, 200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000

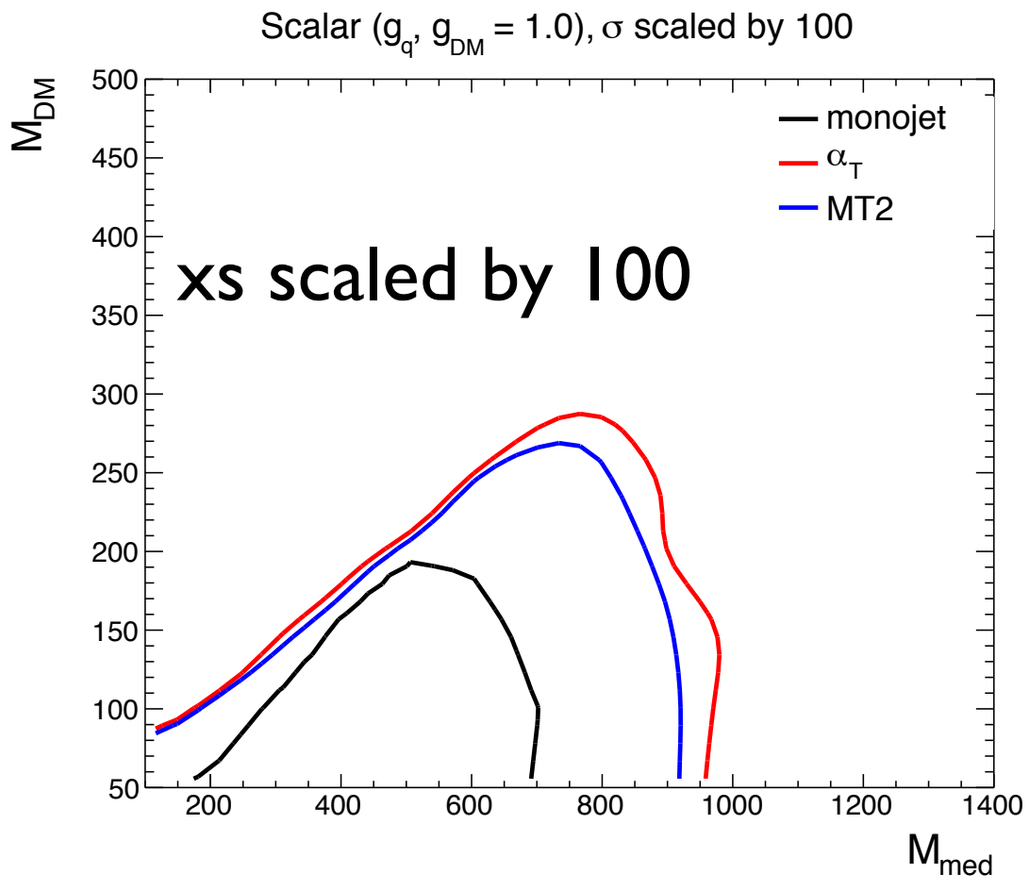
Implementation of scalar model in POWHEG

$$\mathcal{L} \supset g^S_{\mathrm{DM}} (\bar{\chi}\chi) S + g^S_{\mathrm{SM}} \sum_q \frac{m_q}{v} (\bar{q}q) S + i g^P_{\mathrm{DM}} (\bar{\chi}\gamma_5\chi) P + i g^P_{\mathrm{SM}} \sum_q \frac{m_q}{v} (\bar{q}\gamma_5 q) P \,,$$

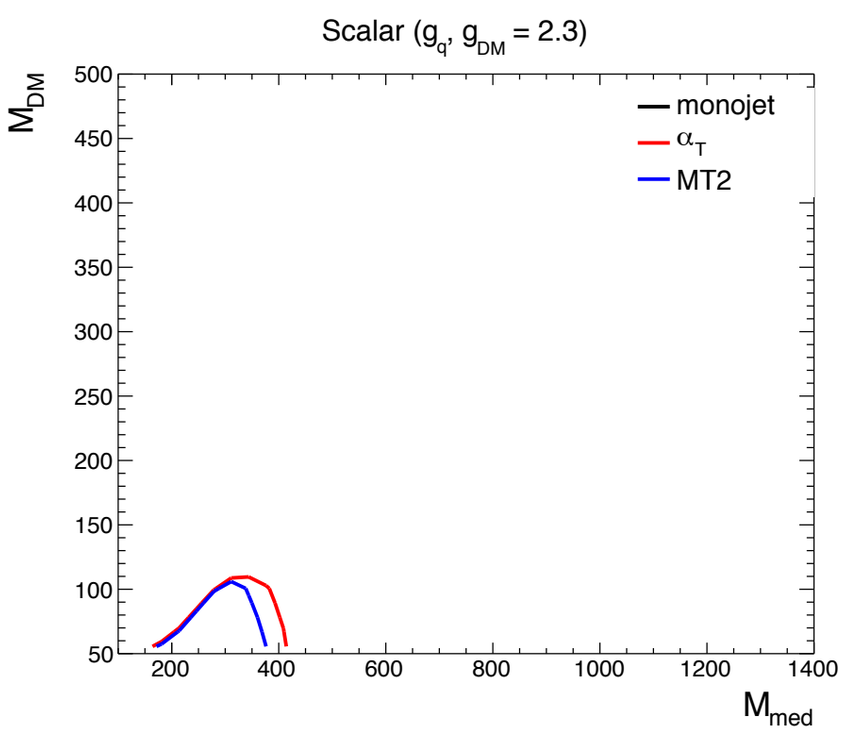
No yukawa coupling to DM

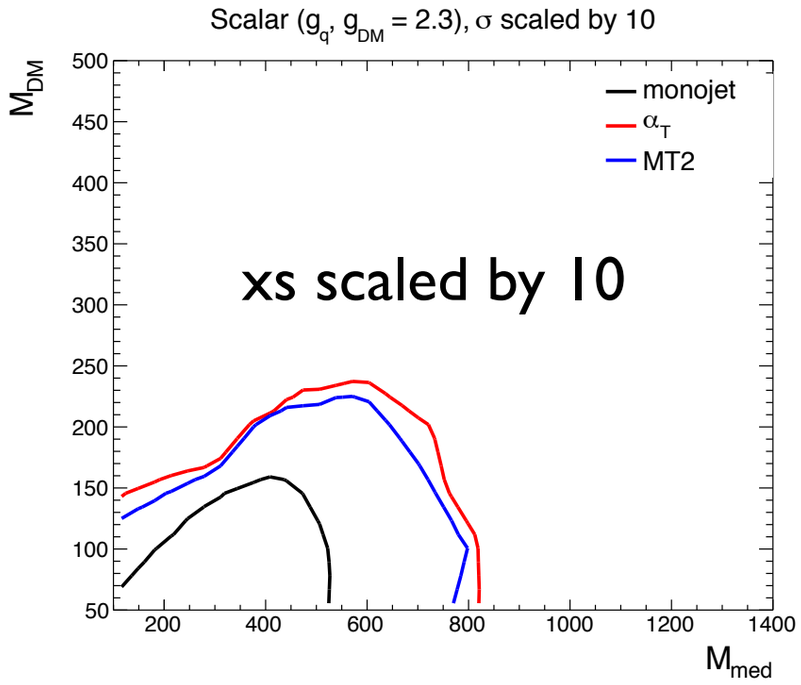
No limit from any of these searches on scalar mediators for g=1, start to place constraints when cross section scaled by factor of 10

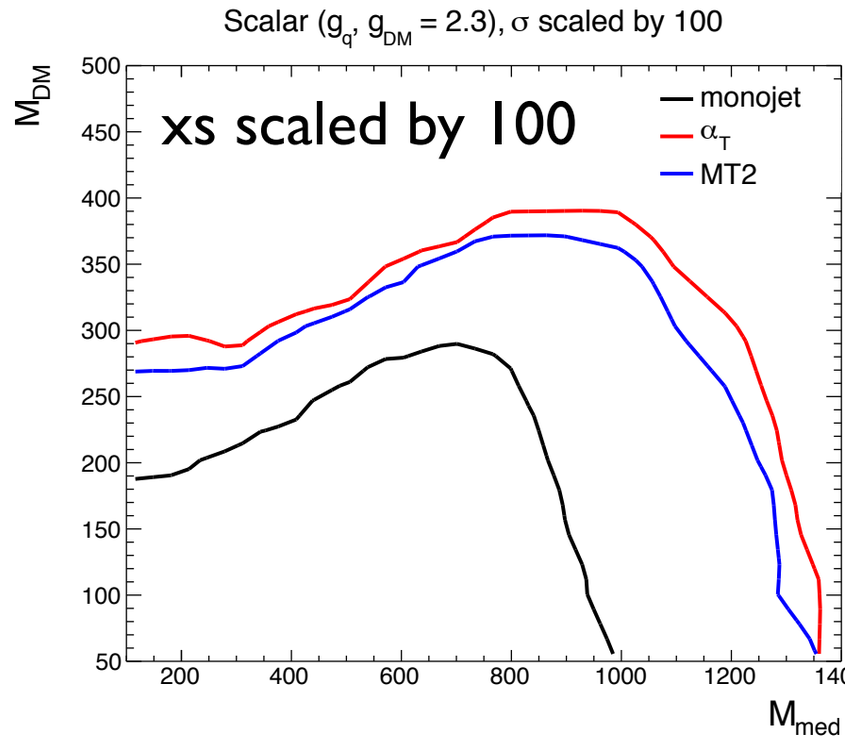




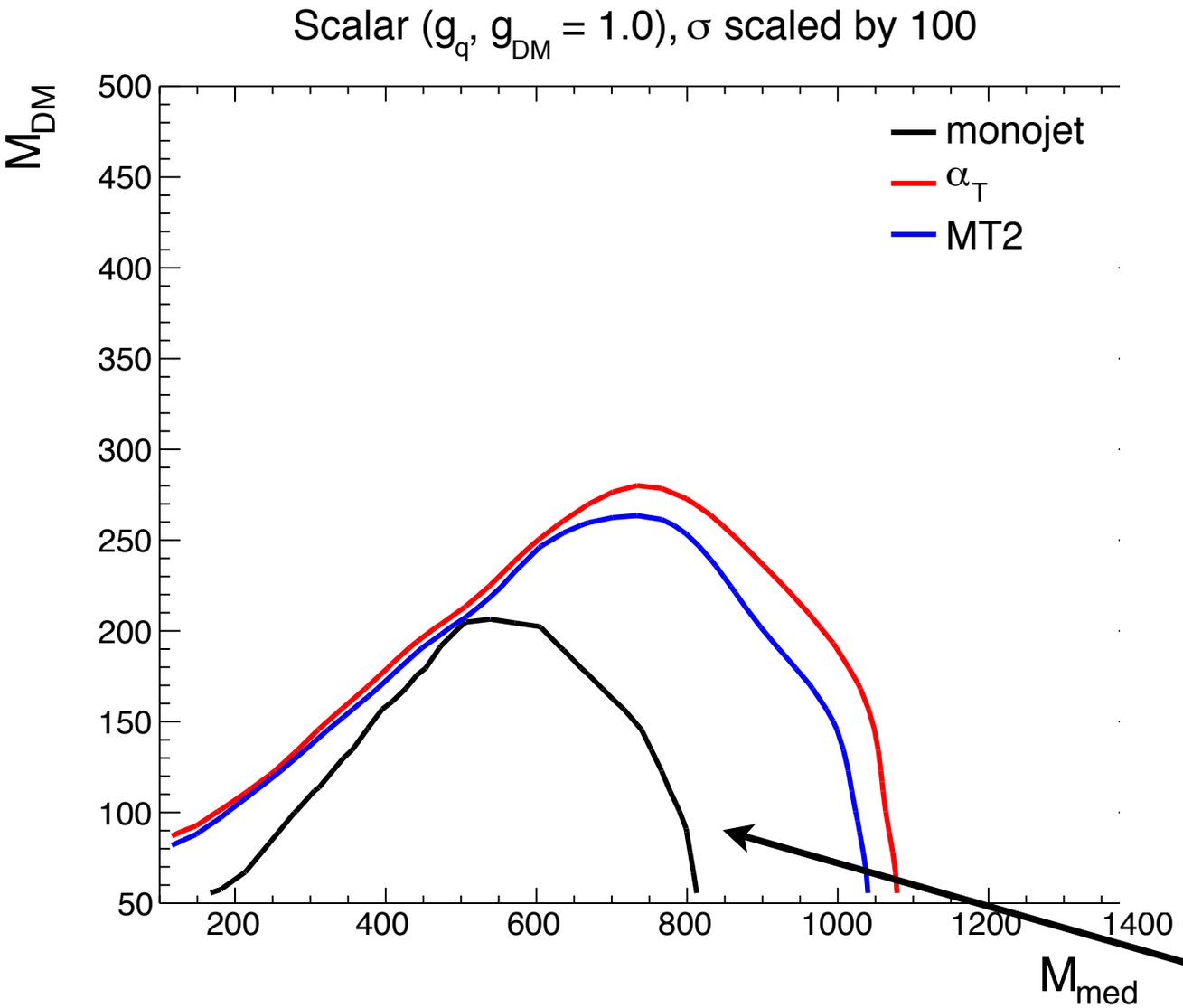
For coupling scenario of g=2.3, which for mediator masses ~1 TeV and above corresponds to width =0.5 medmass (The limit when width~ mass occurs is at g=3.2)

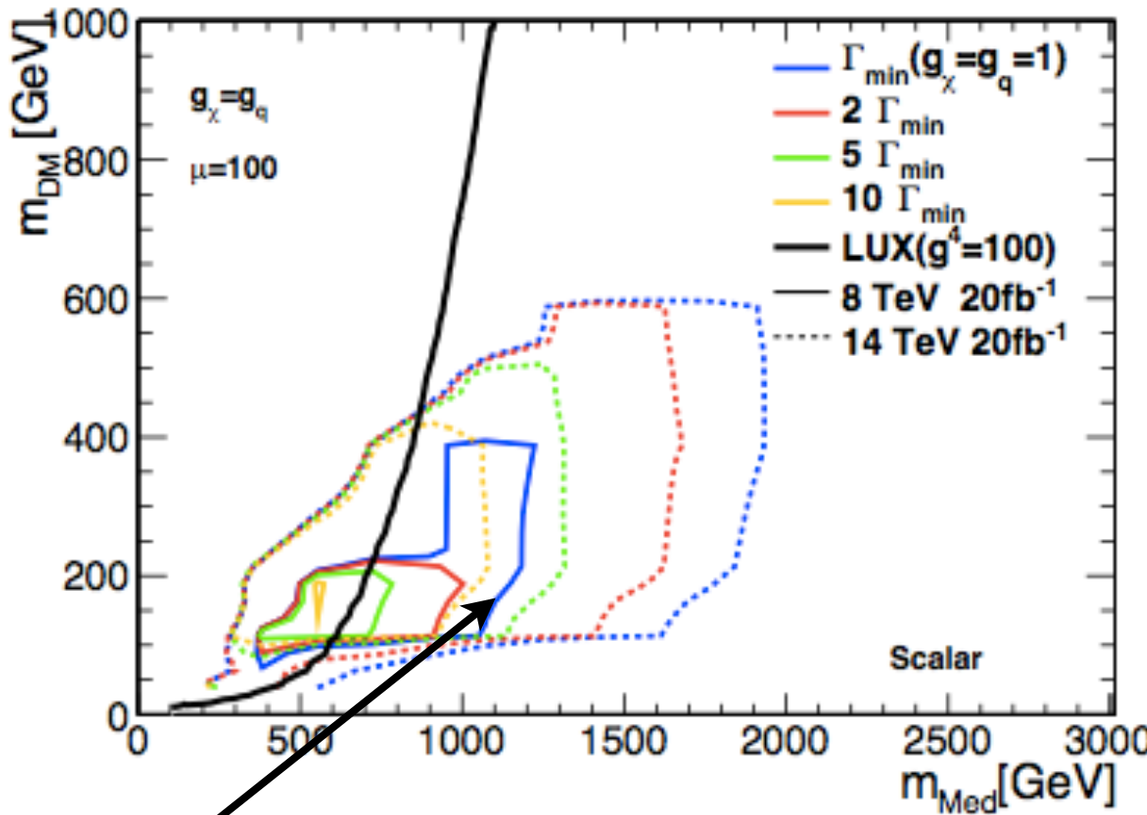






Using width calculated by assuming yukawa coupling to DM





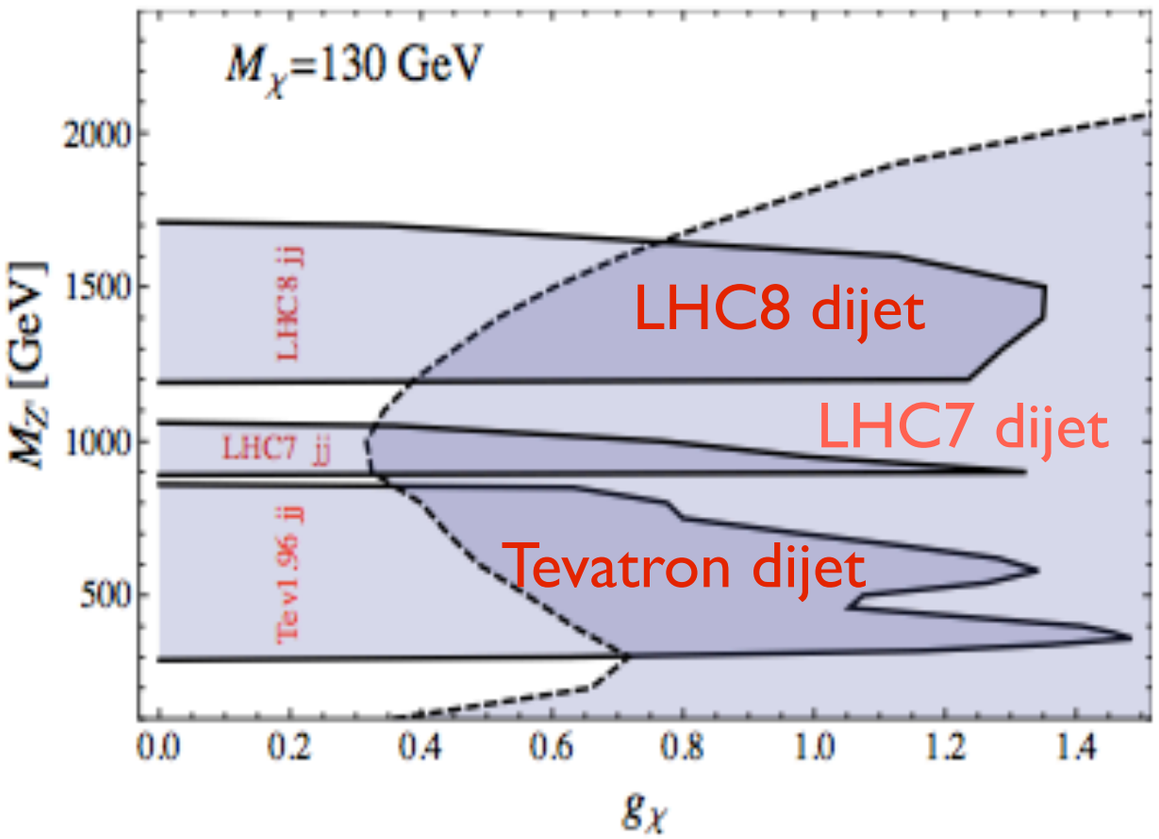
Black curve on left to be compared to blue curve on right, I assume the difference in exclusions is due to yukawa coupling to DM, right plot excluding to higher DM masses

Impact of dijet searches on simplified models

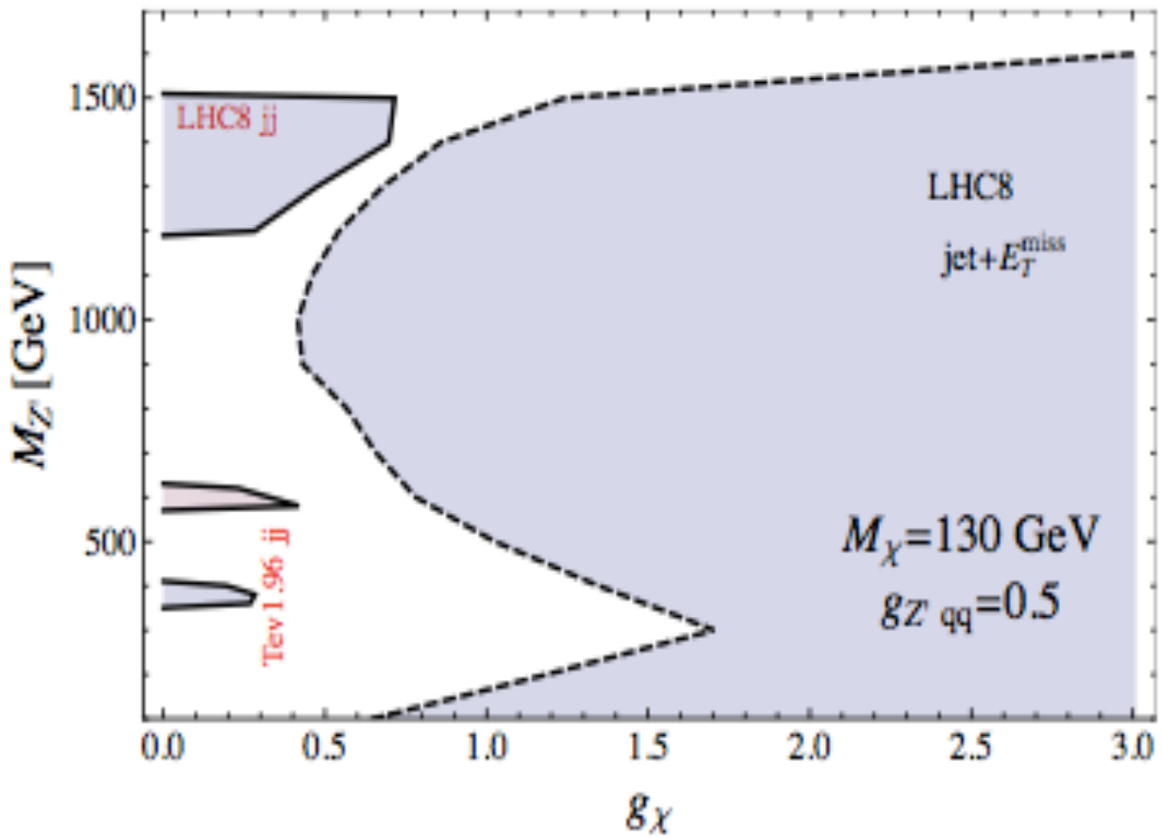
Imperial College London

arXiv:1312.5281

$g_q = 0.9$



$g_q = 0.5$

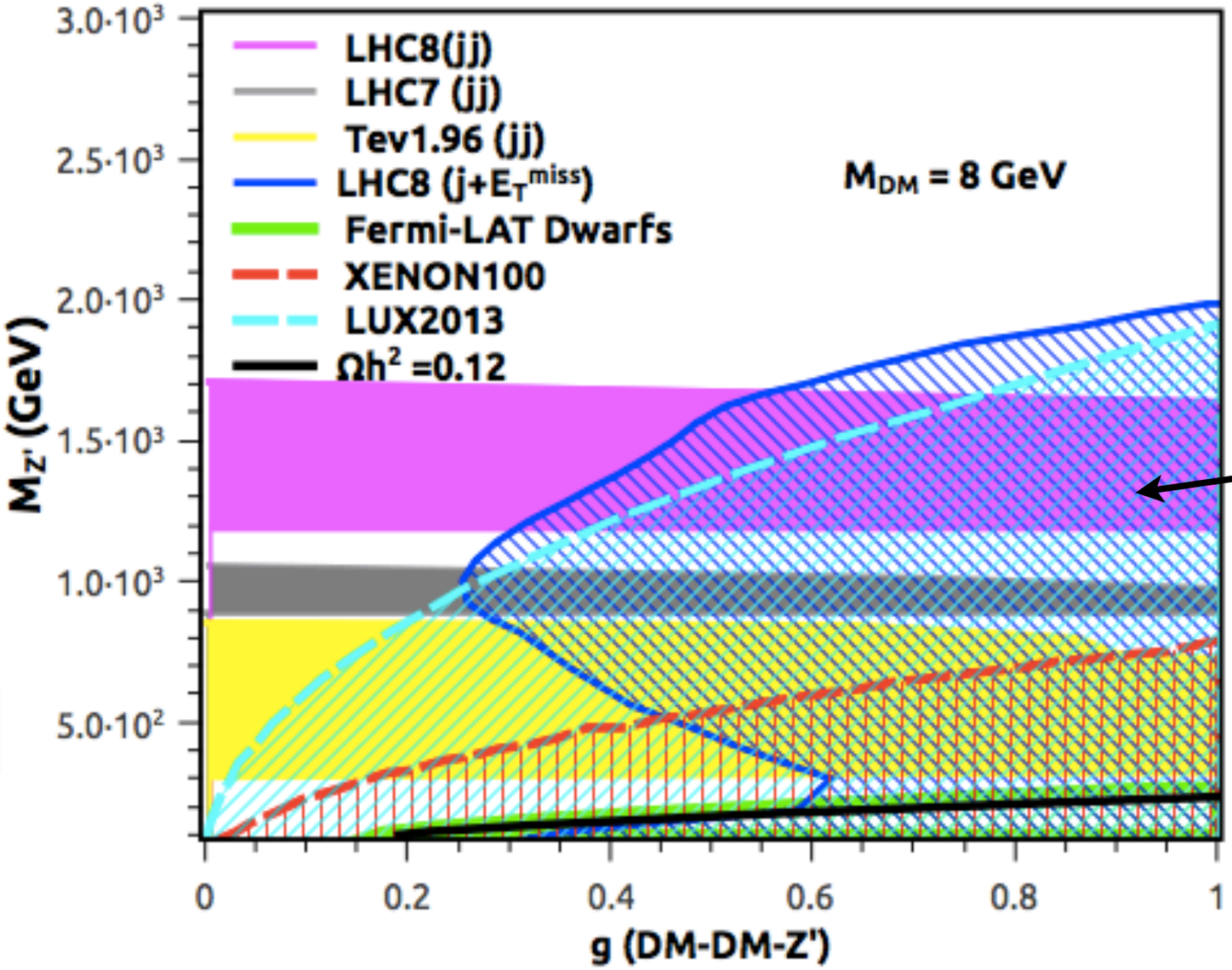


- As discussed yesterday, dijet searches can carve out a region of the simplified model parameter space

- Data scouting and resulting increase in sensitivity to lower mediator masses of ~400 GeV or so will really help

Impact of dijet searches on simplified models

arXiv:1312.5281



LHC8 jj

LHC7 jj

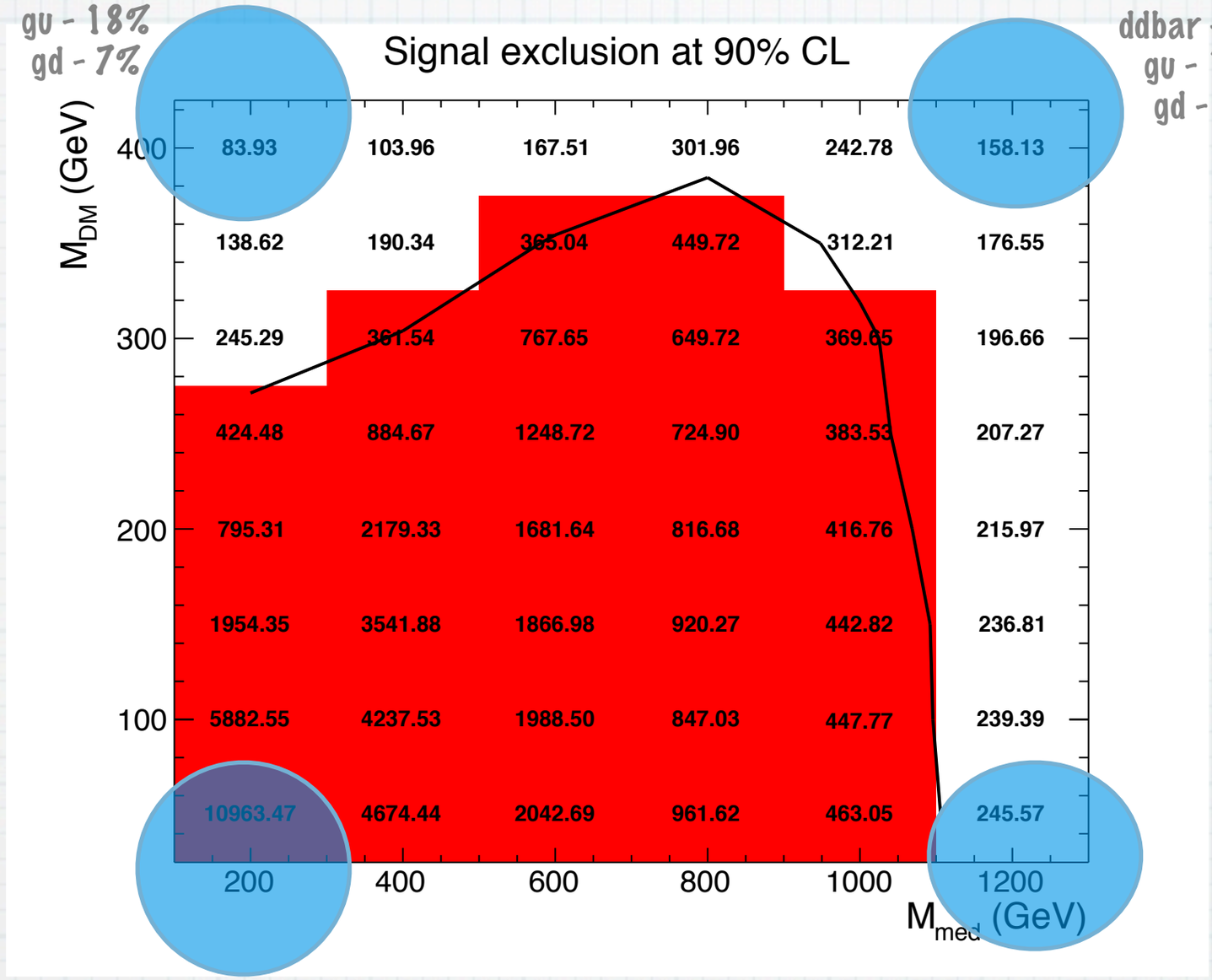
Tev1.96 jj

monojet takes out blue chunk

- Dijet searches take out sizeable region of parameter space for low coupling
- If we open up decay channels of mediator to leptons etc, then dilepton searches also become relevant

uubar - 46%
ddbar - 22%
gu - 18%
gd - 7%

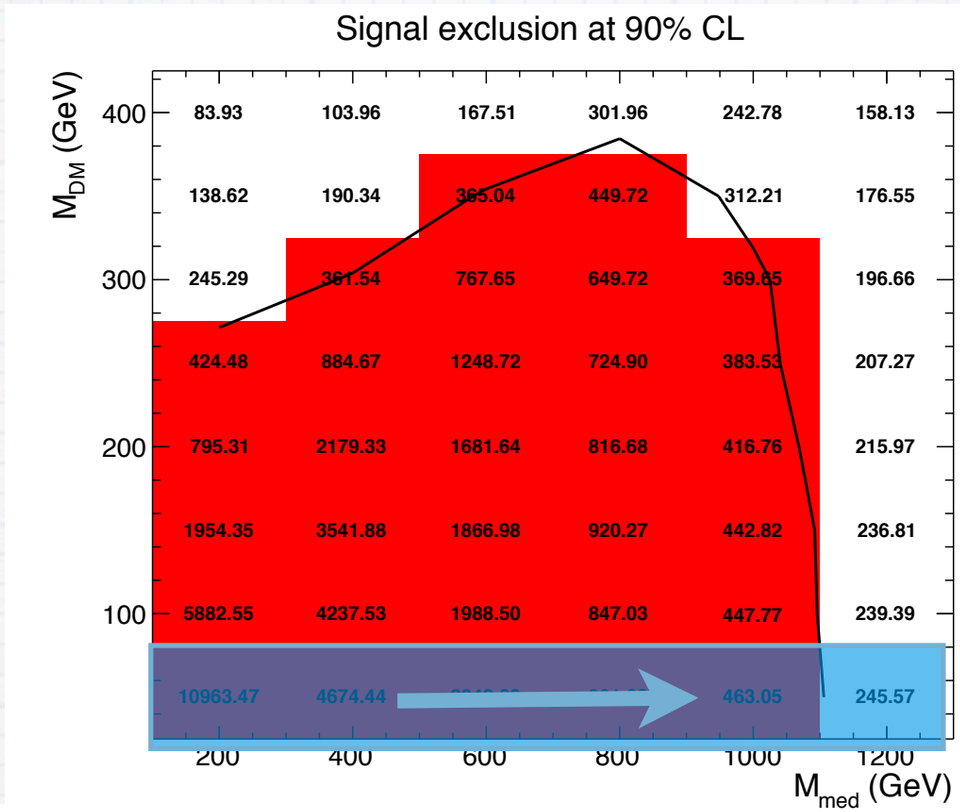
uubar - 49%
ddbar - 22%
gu - 17%
gd - 6%



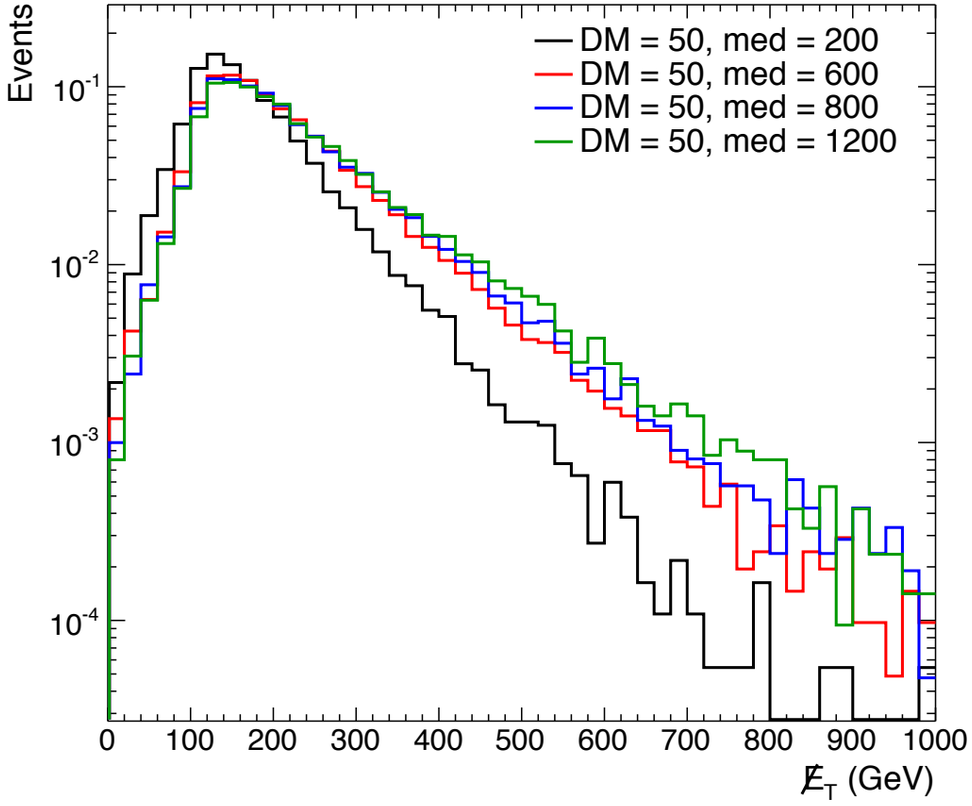
uubar - 15%
ddbar - 9%
gu - 31%
gd - 16%

uubar - 41%
ddbar - 20%
gu - 20%
gd - 8%

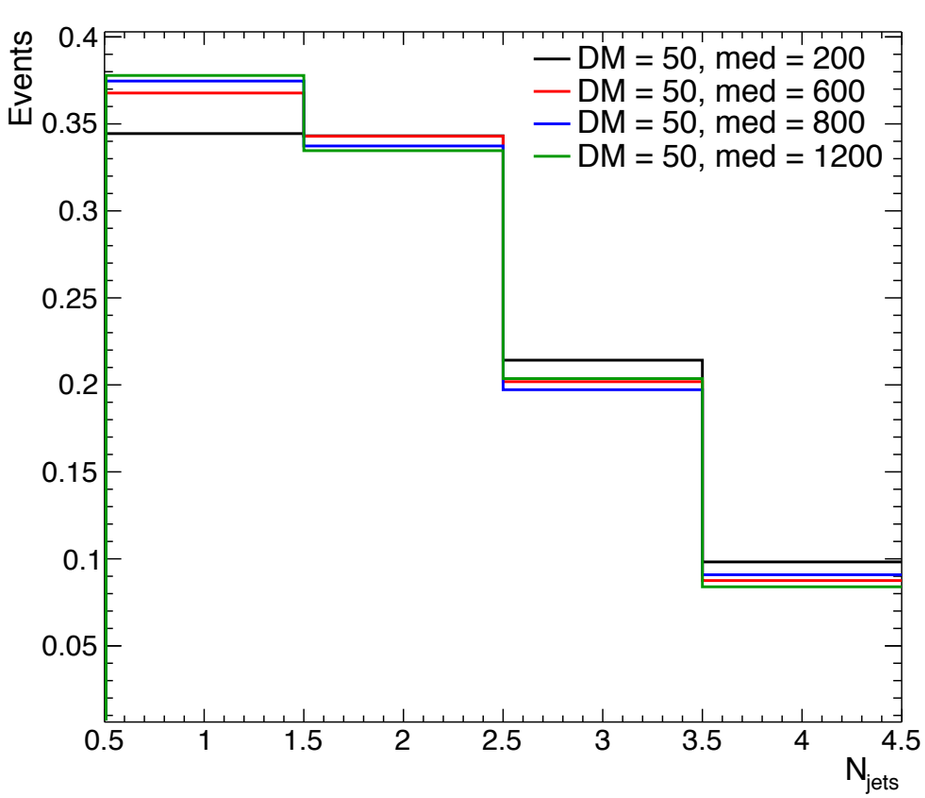
Look at MET distribution across this grid

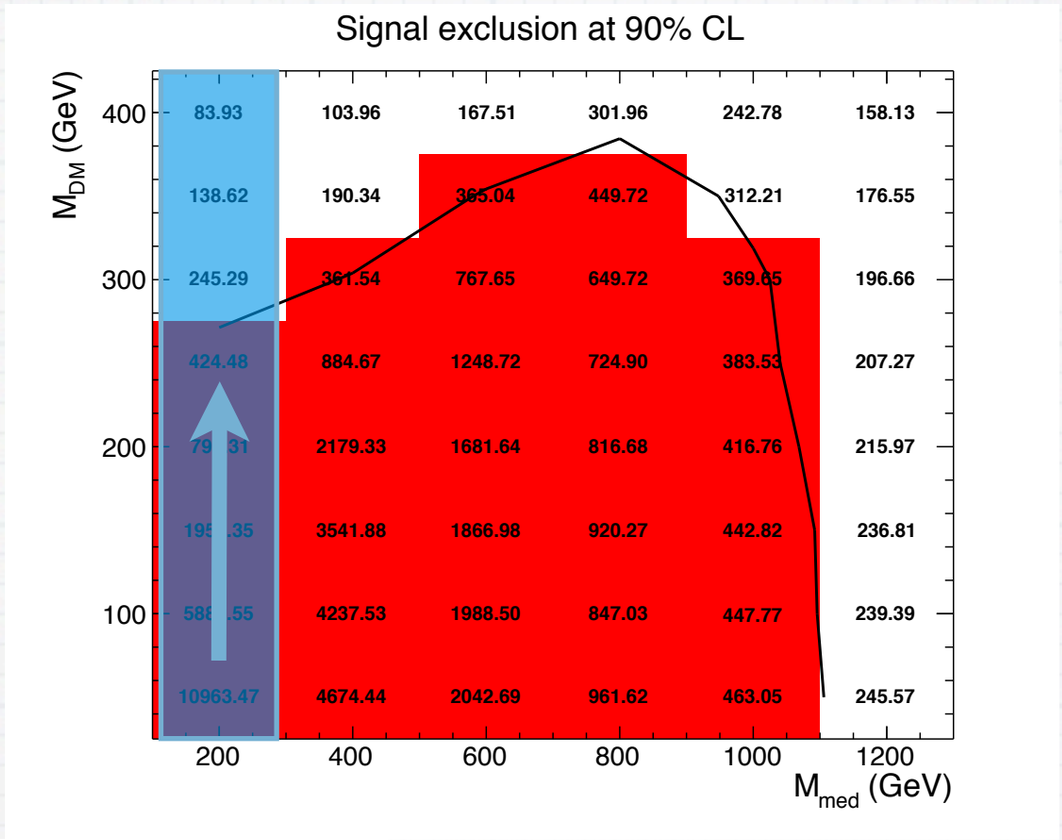


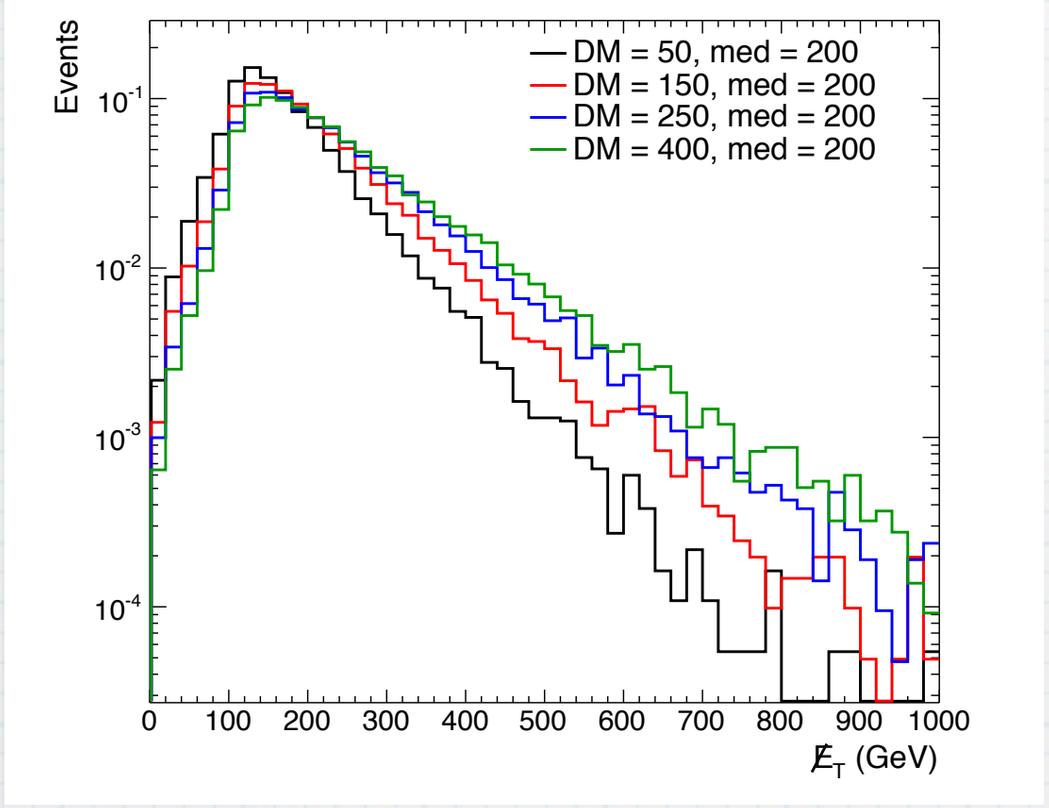
after ptjet1 > 110

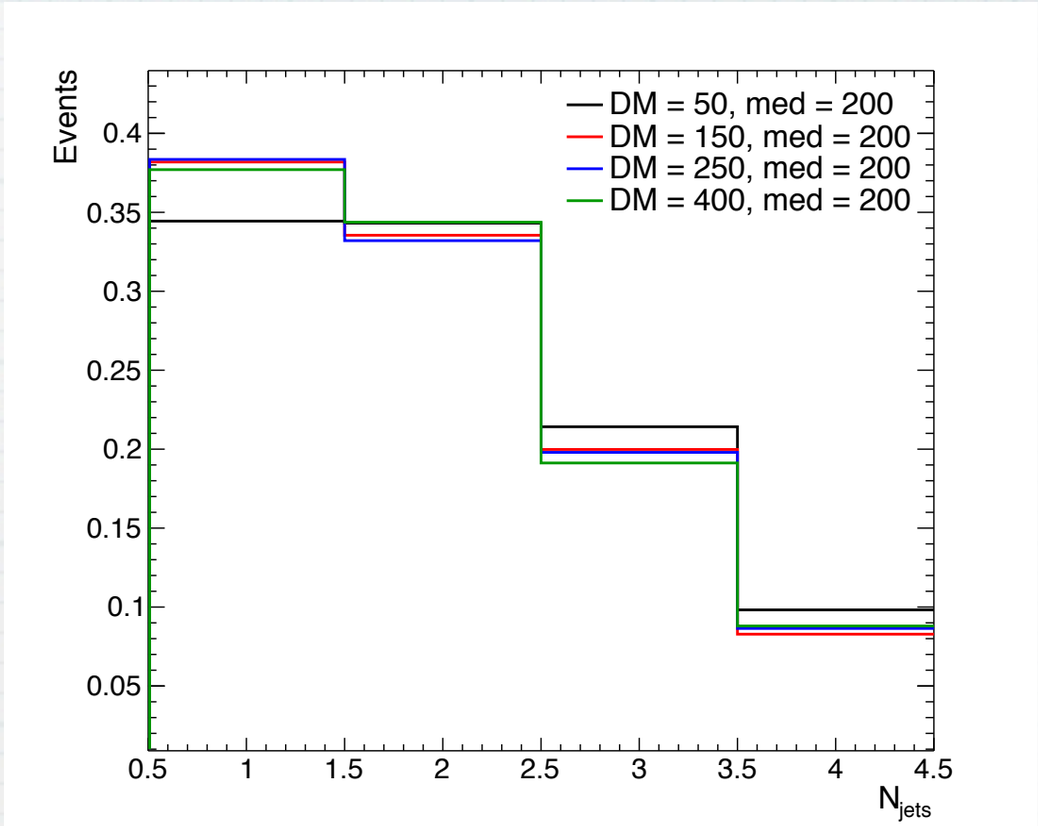


after ptjet1 > 110, MET > 250




Signal exclusion at 90% CL
M_{DM} (GeV)
M_{med} (GeV)
83.93
103.96
167.51
301.96
242.78
158.13
138.62
190.34
365.04
449.72
312.21
176.55
245.29
361.54
767.65
649.72
369.65
196.66
424.48
884.67
1248.72
724.90
383.53
207.27
2179.33
1681.64
816.68
416.76
215.97
3541.88
1866.98
920.27
442.82
236.81
4237.53
1988.50
847.03
447.77
239.39
10963.47
4674.44
2042.69
961.62
463.05
245.57


Events
DM = 50, med = 200
DM = 150, med = 200
DM = 250, med = 200
DM = 400, med = 200
$\not{E}_T$ (GeV)


Events
DM = 50, med = 200
DM = 150, med = 200
DM = 250, med = 200
DM = 400, med = 200
N_{jets}