

DM searches with VBF topology in the simplified models

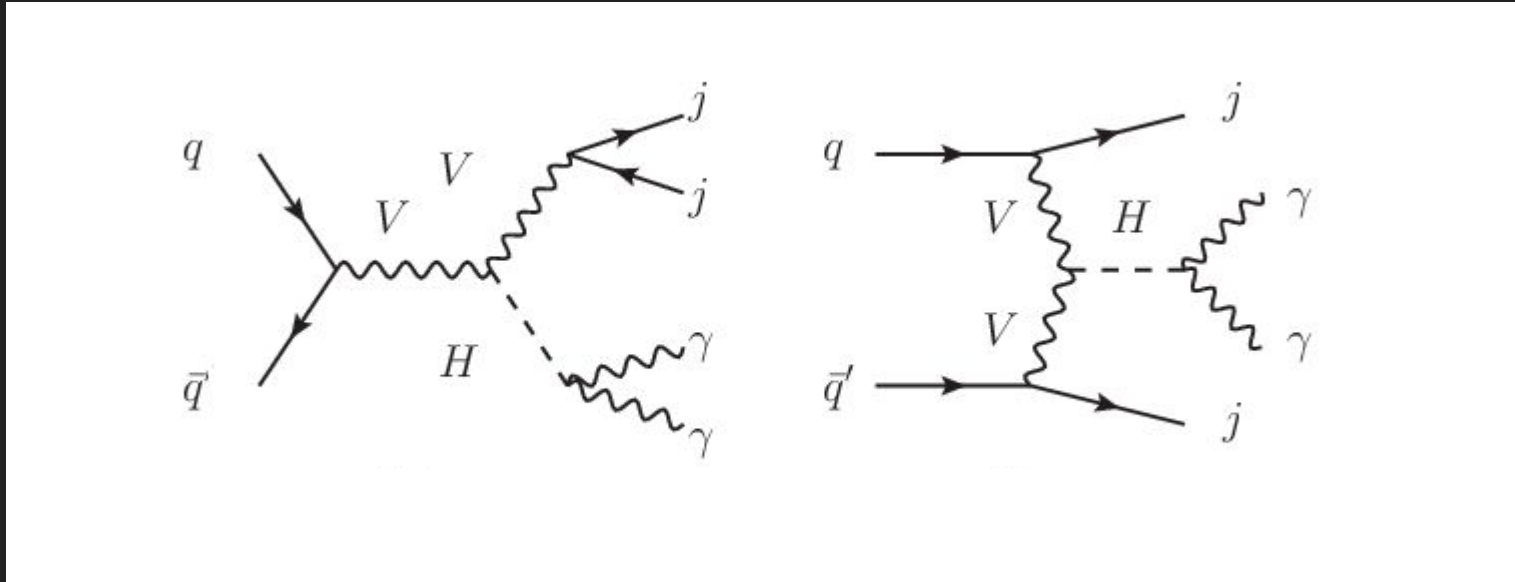
José Ruiz, Daniel Ocampo, Santiago Duque



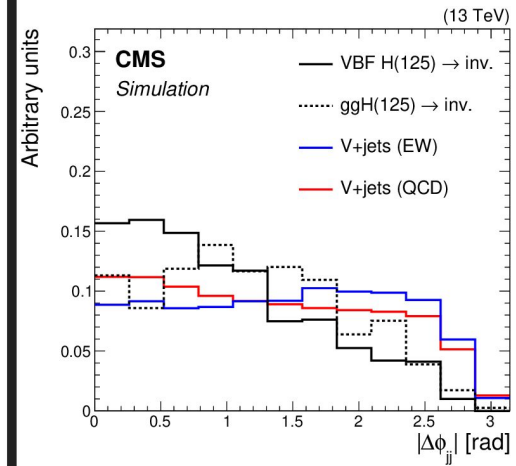
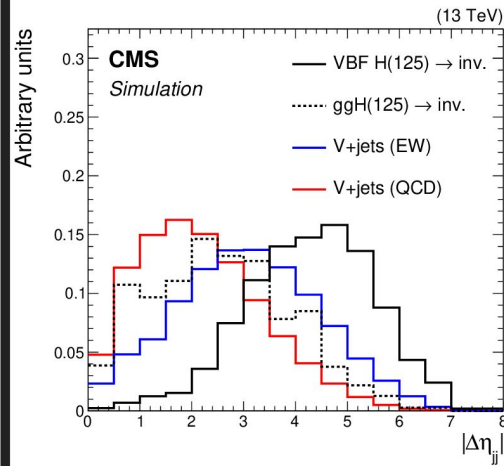
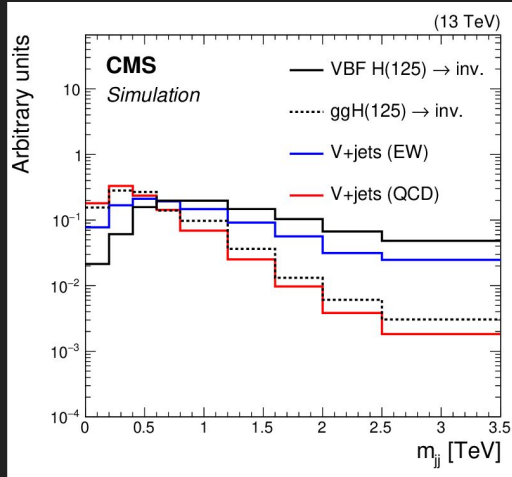
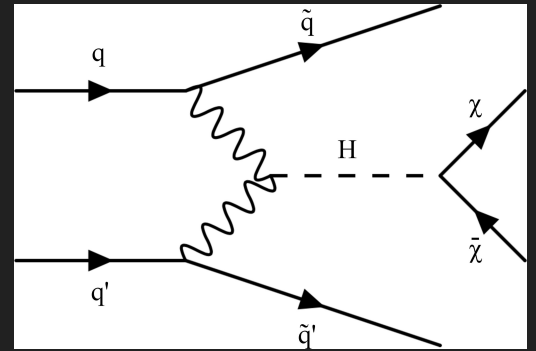
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Vector Boson Fusion @ LHC

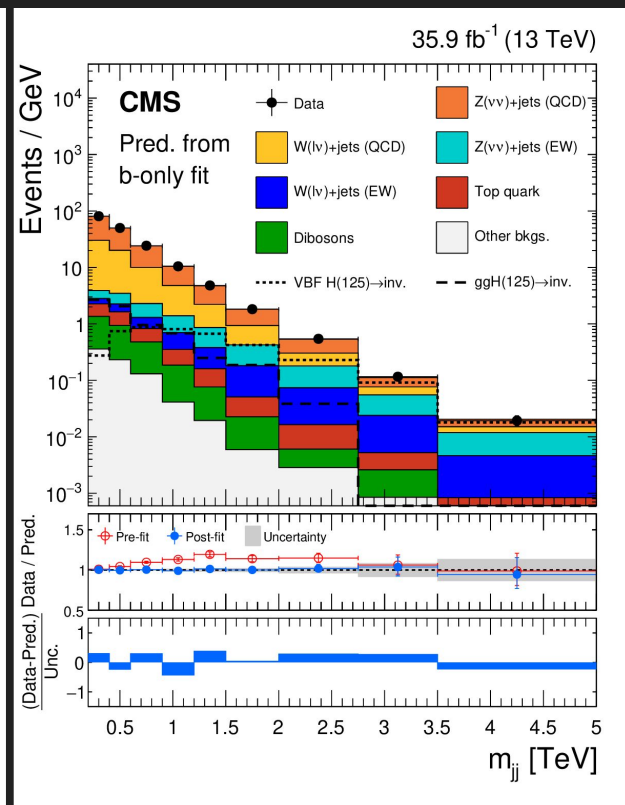
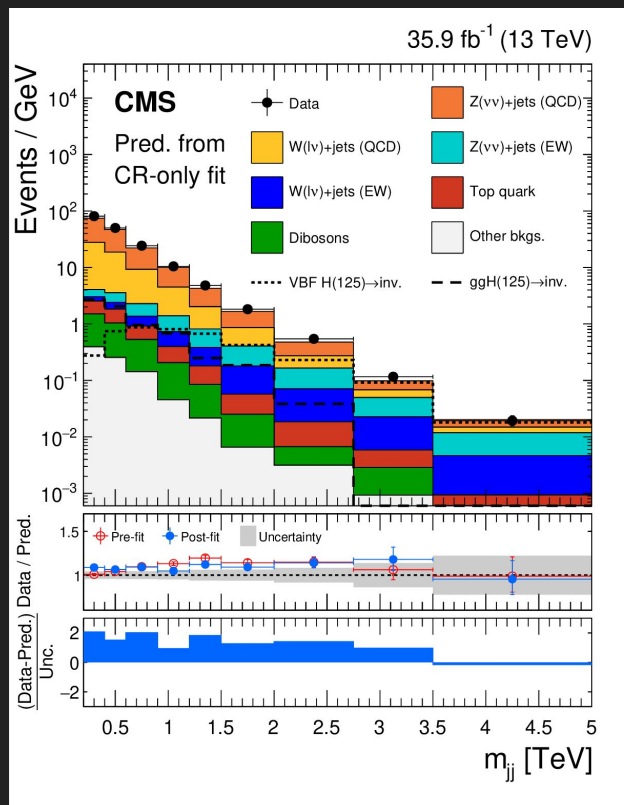
Higgs production



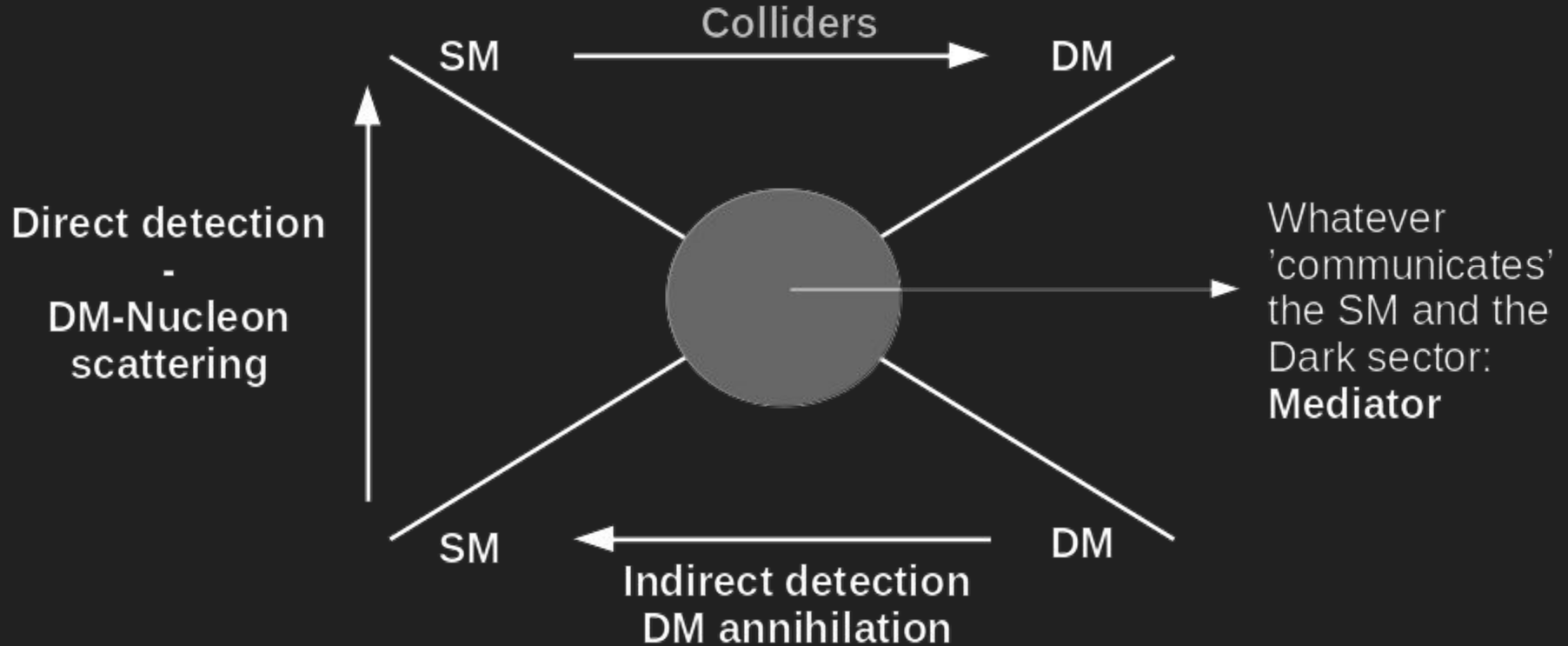
Phys.Lett.B 793 (2019) 520-551



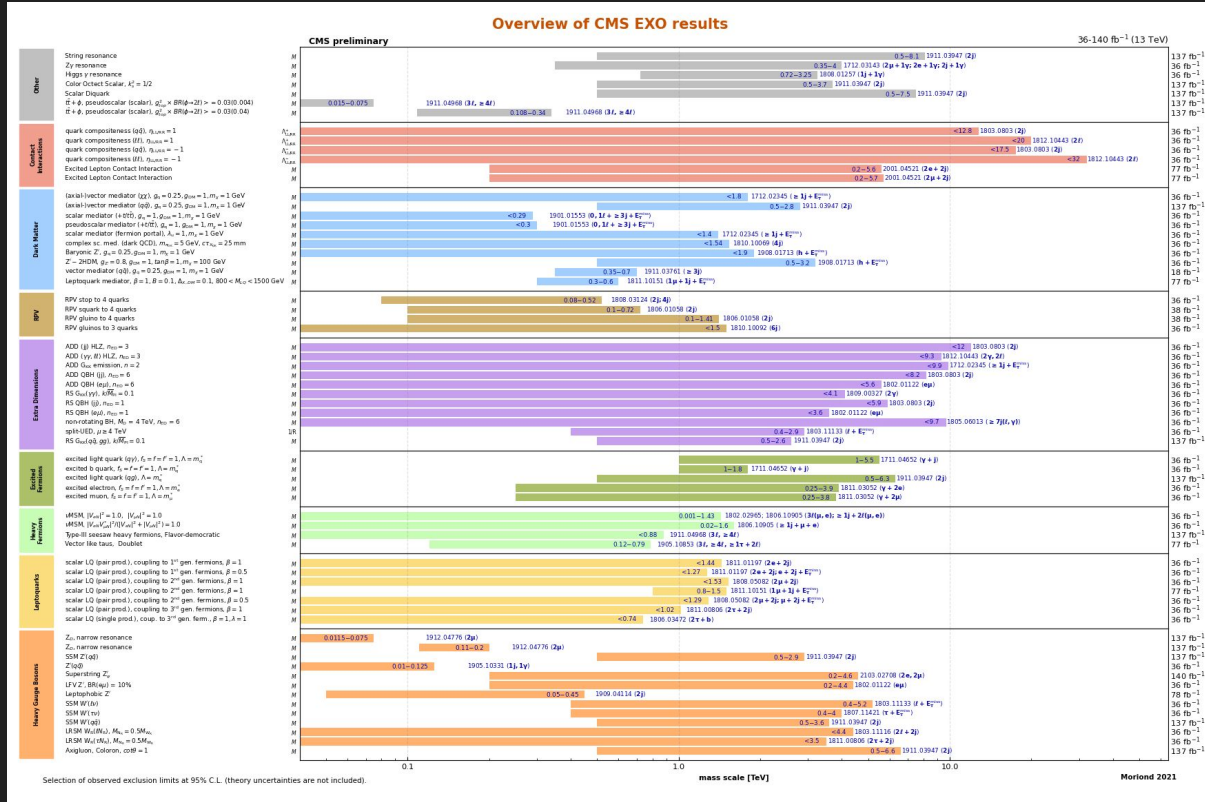
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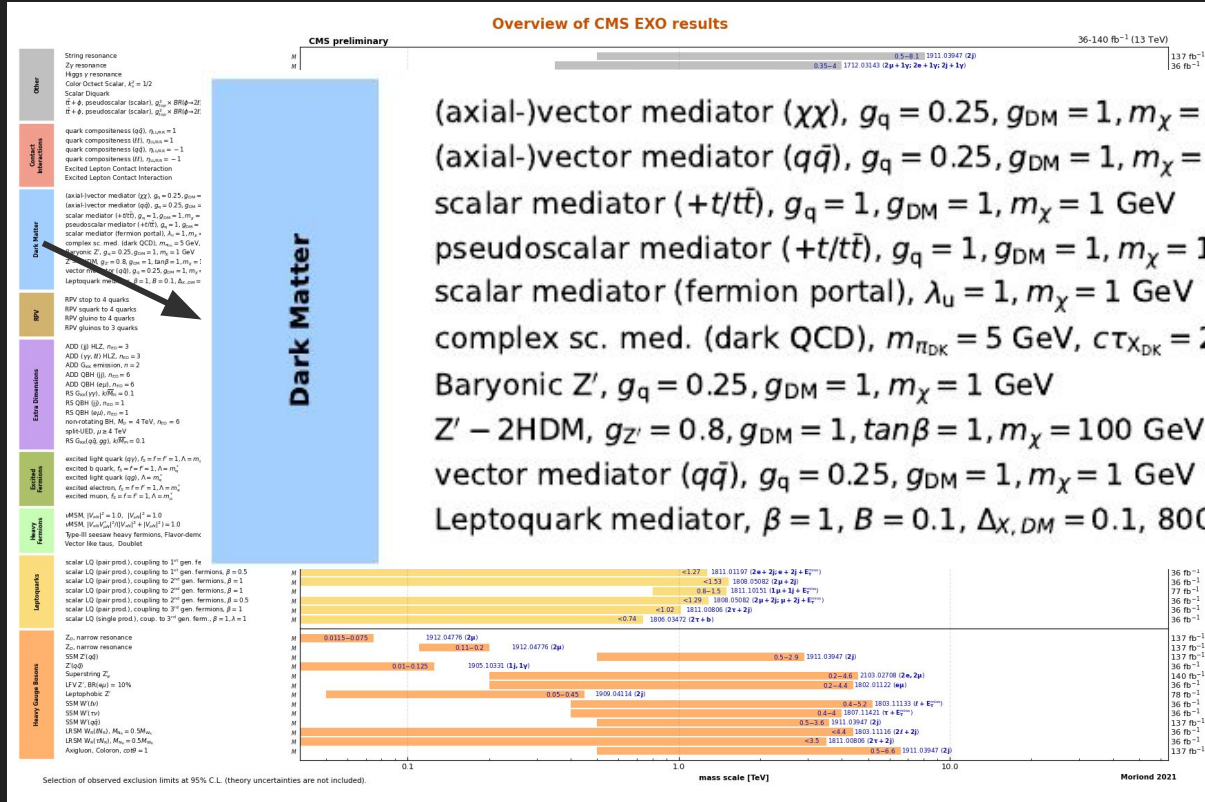
DM detection



DM searches @ LHC



DM searches @ LHC



(axial-)vector mediator ($\chi\chi$), $g_q = 0.25, g_{DM} = 1, m_\chi = 1$ GeV

(axial-)vector mediator ($q\bar{q}$), $g_q = 0.25, g_{DM} = 1, m_\chi = 1$ GeV

scalar mediator ($+t/\bar{t}\bar{t}$), $g_q = 1, g_{DM} = 1, m_\chi = 1$ GeV

pseudoscalar mediator ($+t/\bar{t}\bar{t}$), $g_q = 1, g_{DM} = 1, m_\chi = 1$ GeV

scalar mediator (fermion portal), $\lambda_U = 1, m_\chi = 1$ GeV

complex sc. med. (dark QCD), $m_{TDK} = 5$ GeV, $c\tau_{X_{DK}} = 25$ mm

Baryonic Z' , $g_q = 0.25, g_{DM} = 1, m_\chi = 1$ GeV

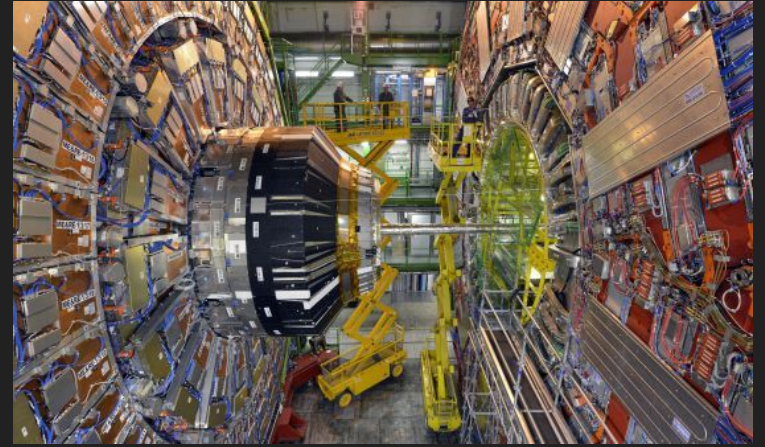
$Z' - 2HDM$, $g_{Z'} = 0.8, g_{DM} = 1, \tan\beta = 1, m_\chi = 100$ GeV

vector mediator ($q\bar{q}$), $g_q = 0.25, g_{DM} = 1, m_\chi = 1$ GeV

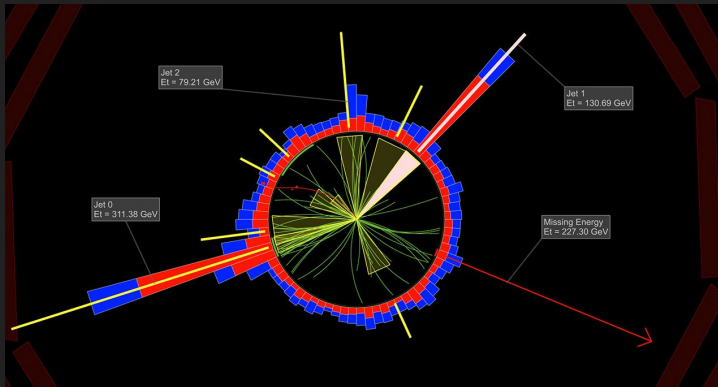
Leptoquark mediator, $\beta = 1, B = 0.1, \Delta_{X,DM} = 0.1, 800 < M_{LQ} < 1500$ GeV



LHC provides pp collisions



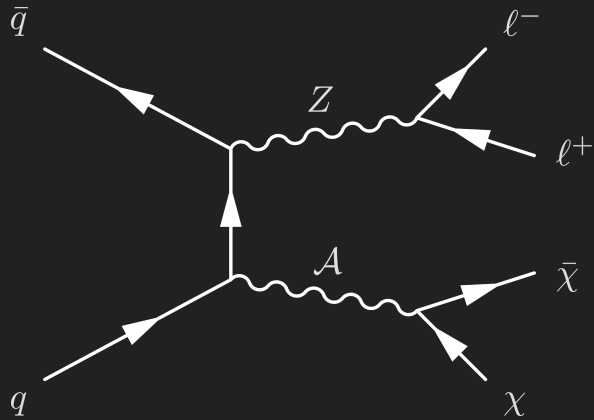
Experiments record the products of LHC collisions



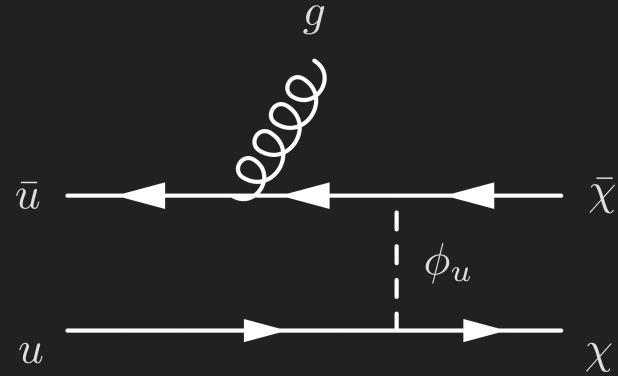
Non-interacting particles
cause momentum imbalance
in the transverse plane
of the beam

$p_{T,miss} \rightarrow$ "Missing energy"

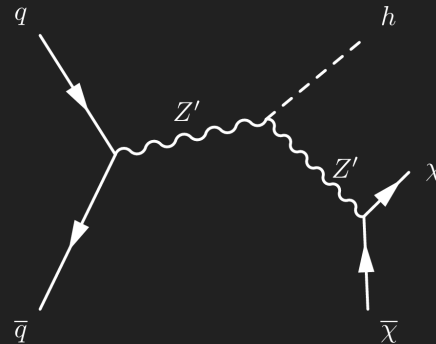
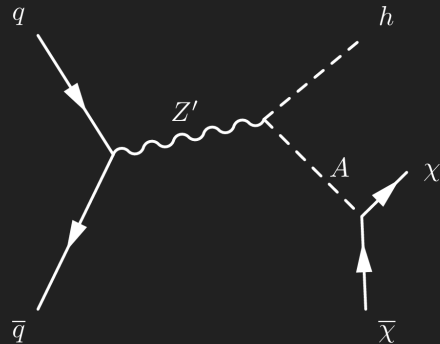
Many searches, many signatures



[Eur. Phys. J. C 81 \(2021\) 13](#)

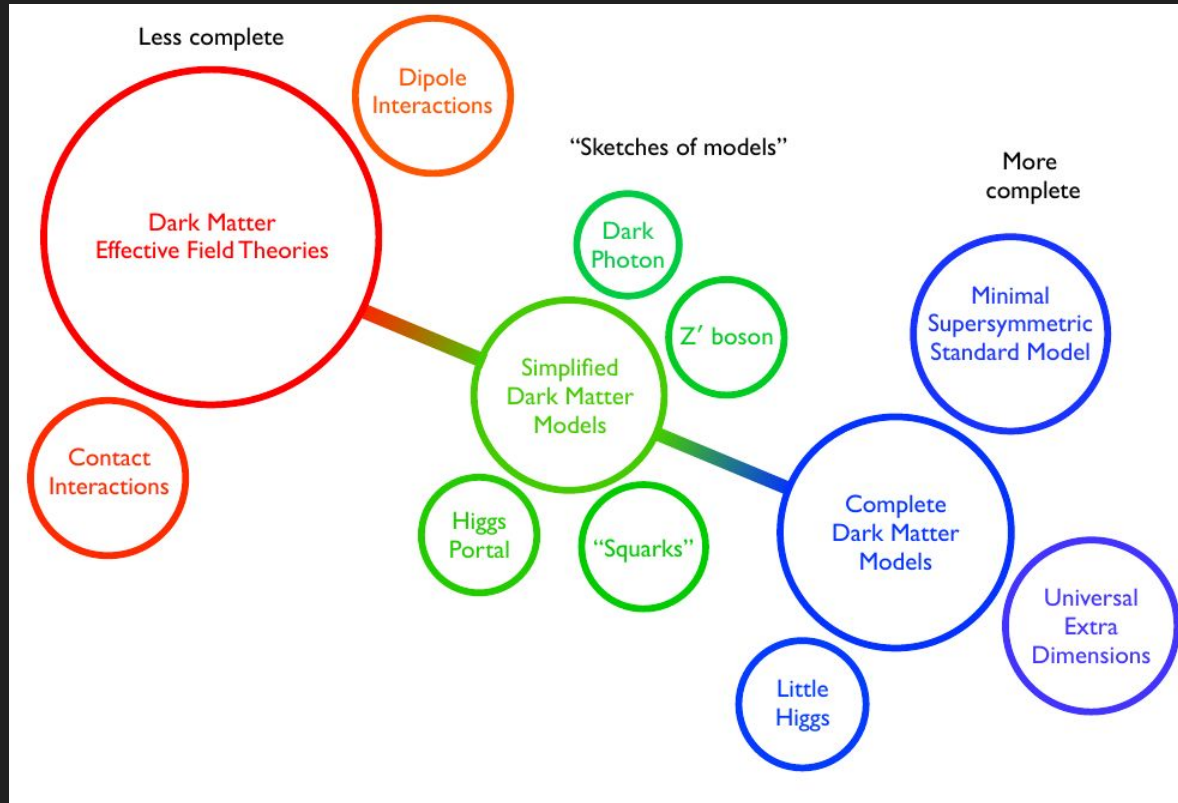


[Phys. Rev. D 97 \(2018\) 092005](#)

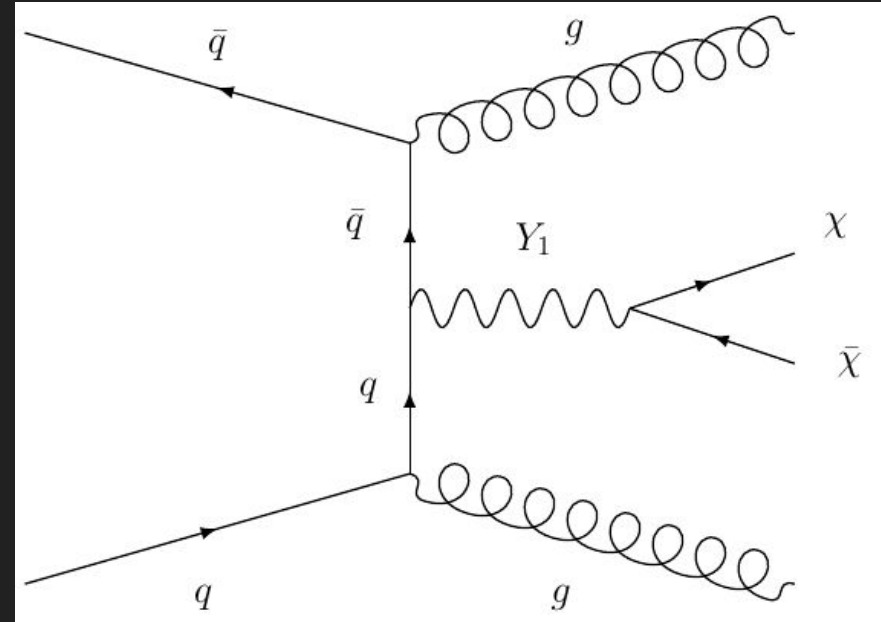
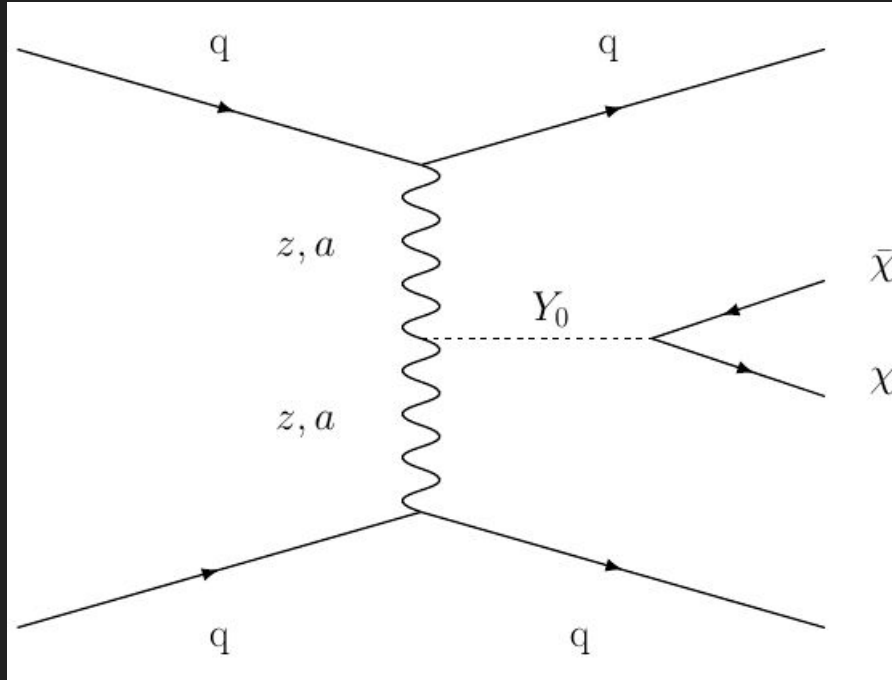


[JHEP 09 \(2018\) 046](#)

Simplified models - [Phys.Dark Univ. 9-10 \(2015\) 8-23](#)



VBF topology in Simplified Models



Selection criteria

Jet selection

$$N(j) > 1$$

$$p_T(j_1), p_T(j_2) > 30 \text{ GeV}$$

$$|\eta(j_1, j_2)| < 5$$

$$H_T > 200 \text{ GeV}$$

$$|\Delta\phi(j_1, j_2)| > 2.3$$

$$|\Delta\eta_{jj}|^{max} < 3$$

Di-jet mass

$$m_{jj}^{max} > 1000 \text{ GeV}$$

Cut	S ₁	S ₂	S ₃	B
No cuts	50000	50000	50000	984393
Trigger	37154	49966	49998	511066
$\eta(j_1) \cdot \eta(j_2) < 0$	11766	22842	37940	218193
$ \Delta\phi(j_1, j_2) > 2.3$	9766	20610	37597	61432
$max(m_{jj}) > 1000 \text{ GeV}$	2742	18344	37597	11640
$\min \Delta\phi(MET, j_i) > 0.5$	842	5315	8348	7560
$ \Delta\eta_{jj} ^{max} < 3$	227	2406	7183	1641

S₁ = M(DM)=10 GeV, M(Y)=100 GeV

S₂ = M(DM)=100 GeV, M(Y)=1 TeV

S₃ = M(DM)=1 TeV, M(Y)=5 TeV

B = Z+jets

Raw MC events

Conclusions

1. Delta Eta cut might be optimized for different mediator masses.
2. Competitive and complementary results with monojet searches.
3. VBF topology is a promising window for searching for DM at the LHC.
4. Simplified models provide a generic framework for DM searches at the LHC.

Perspectives

1. Completing studies with other backgrounds and more signal points.
2. Parameter coverage compared with other searches.

Thanks!!!