

Search for Dark Matter in a Coannihilation Codex Model With CMS Detector

Introduction

Properties of Dark matter:

Cold

Non-Baryonic

Electrically Neutral

Relic Density $\Omega h^2 = 0.1198 \pm 0.0026$

Coannihilation Codex

General Classification of simplified Models

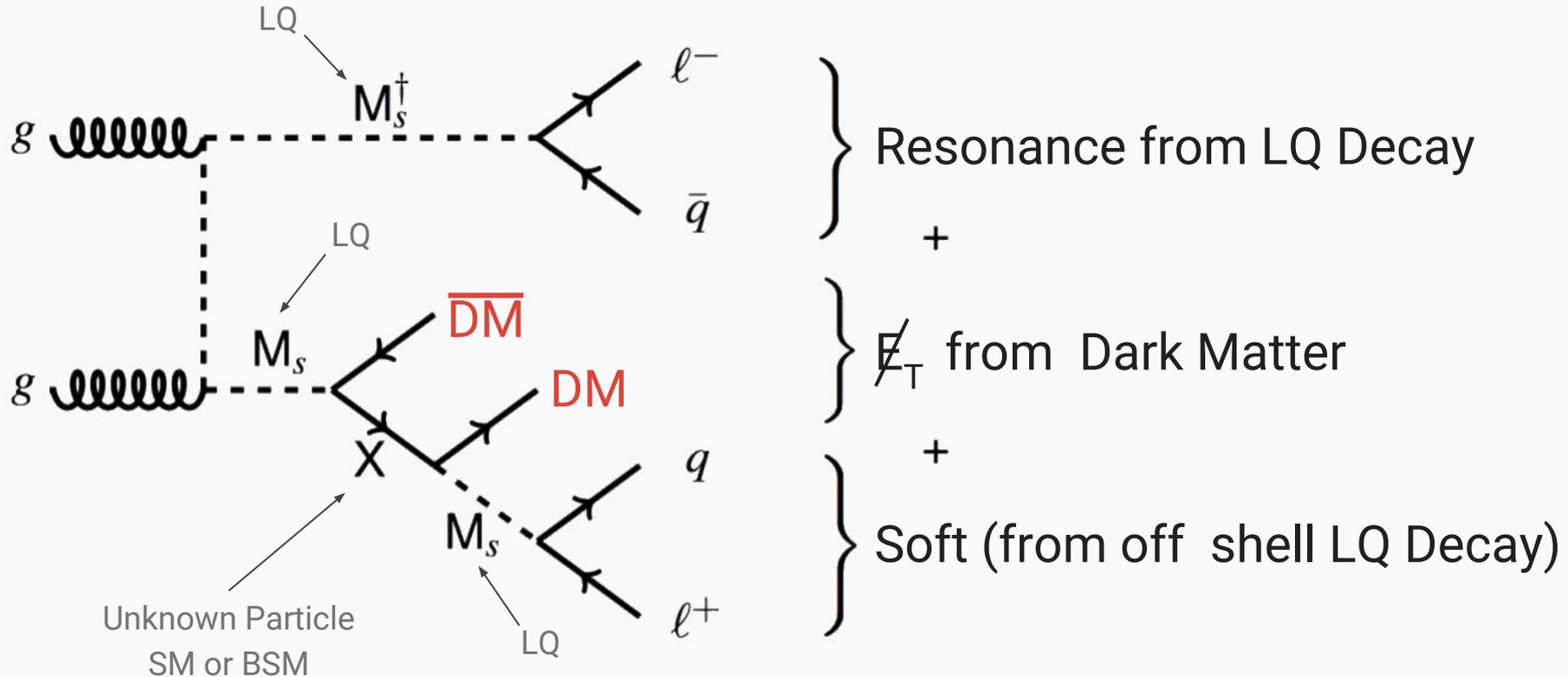
Dark Matter (DM) & Coannihilation partner X

Forms a pair of standard model particles



Mediating Particle M

Specific Model for Search



Coannihilation Condition

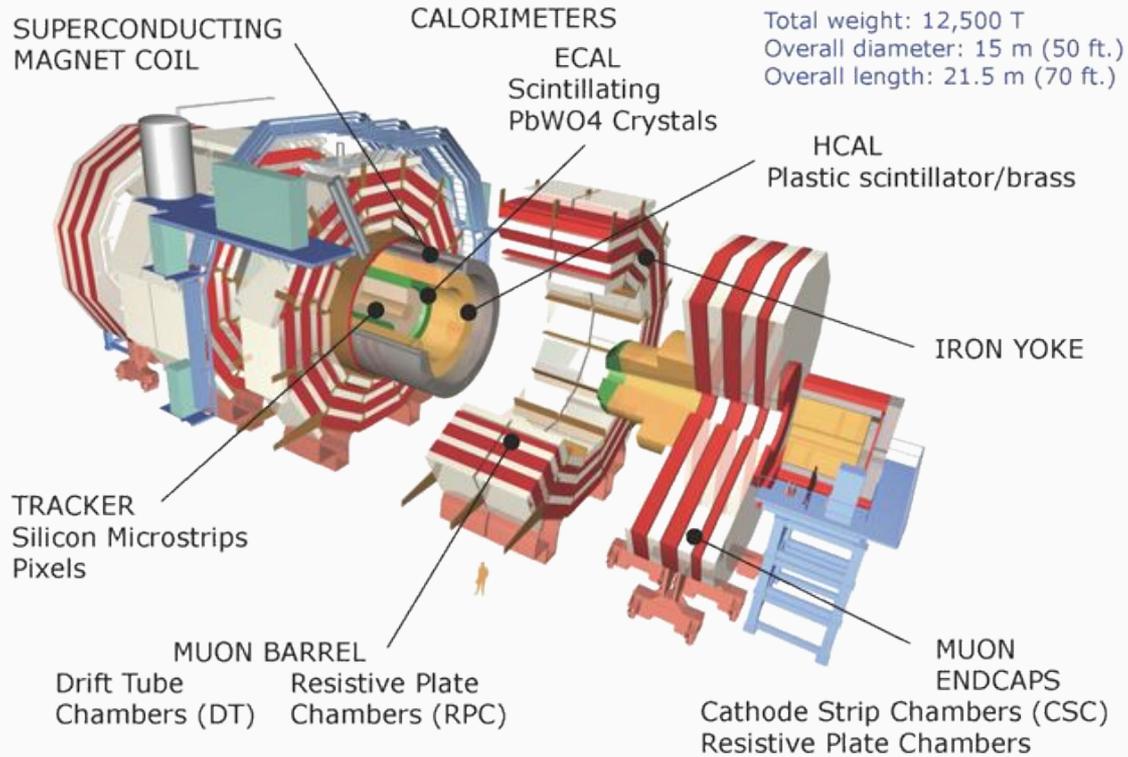
Relative mass splitting small

$$\Delta = \frac{m_X - m_{DM}}{m_{DM}} < 0.2$$

Soft decay product

Pair production of 1st generation LQ

CMS Detector



Analysis Signature

Final Signature:

High Pt Electron

High Pt Jet

High MET

$$\text{LQ} \longrightarrow e^- + u$$

$$\text{LQ} \longrightarrow \text{DM} + X$$

From CMS 2016 Data:

$$\sqrt{S} = 13 \text{ TeV}$$

$$L_{\text{int}} = 35.9^{-1} \text{ fb}$$

Dataset

Background (CMS Simulation):

TT (Powheg)

Single Top (Powheg)

ZTT (Madgraph)

W (Madgraph)

QCD

Signal (CMS Simulation):

Privately produced using
Madgraph

Dataset:

2016 singleElectron Dataset

Preselection Cuts

Electron: $P_T > 60 \text{ GeV}$ & $|\eta| < 2.5$

Jet: $P_T > 100 \text{ GeV}$ & $|\eta| < 2.5$ & LooseJetID

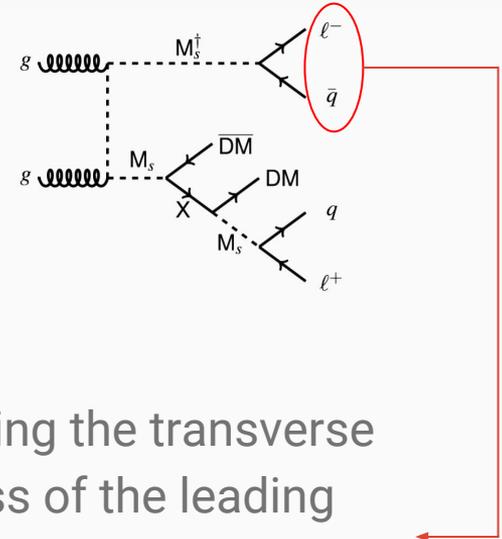
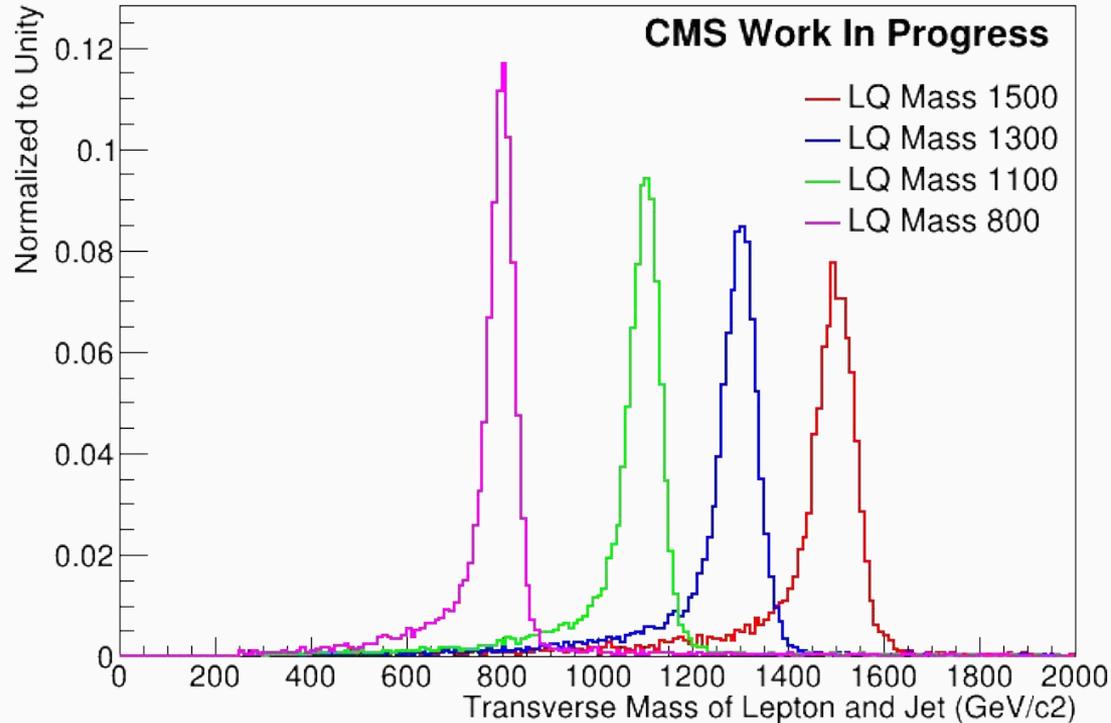
MET: $P_T > 50 \text{ GeV}$ & all MET filters

Tau veto: $P_T > 20 \text{ GeV}$ & $|\eta| < 2.3$ & LooseMVAID

Bjet veto: $P_T > 20 \text{ GeV}$ & $|\eta| < 2.3$ & Tight CSV Discriminant

Leptoquark Transverse Mass

Dark Matter Signal Samples:

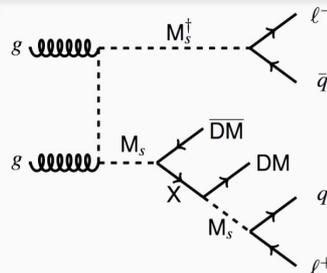


Taking the transverse mass of the leading lepton and leading jet gives us the leptoquark mass

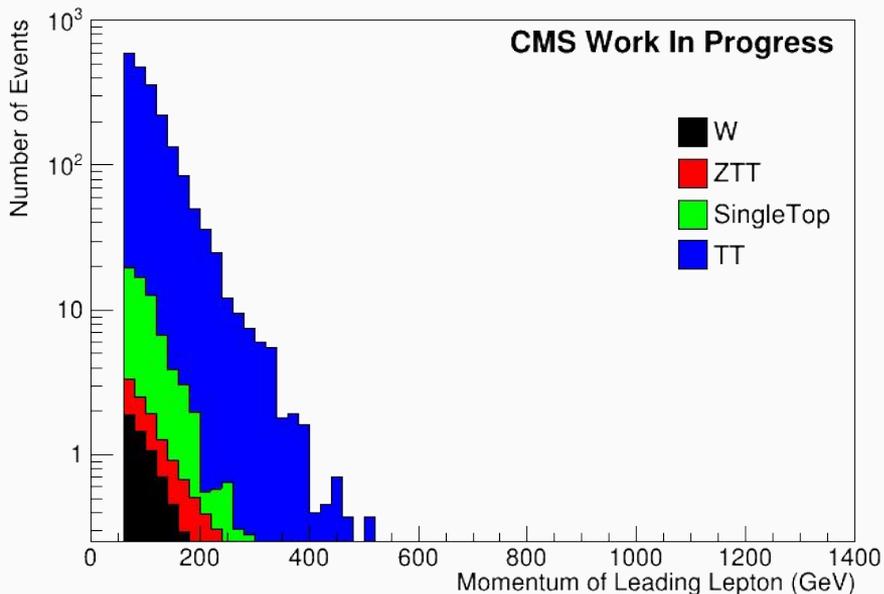
CMS Simulation
Preselection applied

Kinematics: Momentum of Lepton

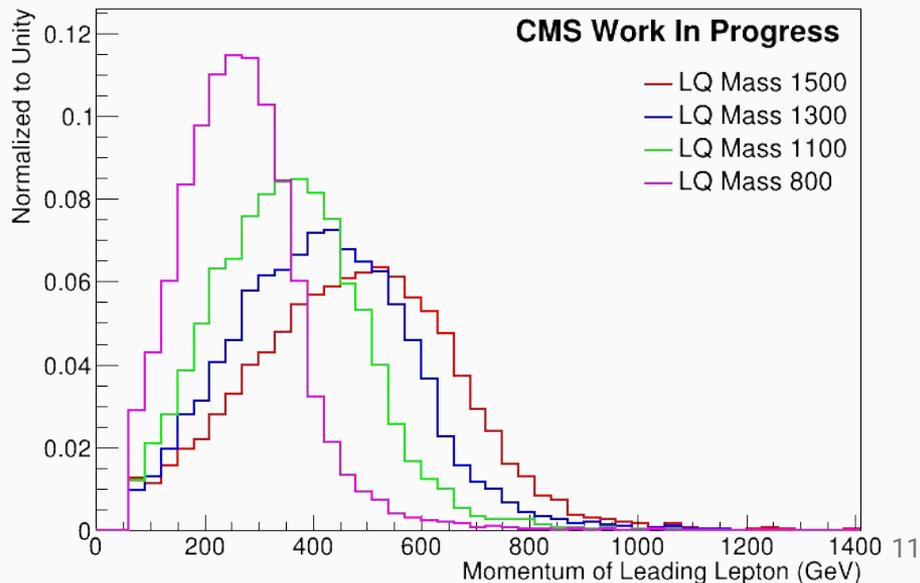
CMS Simulation
Arbitrary normalization applied
Preselection applied



Standard Model Background Samples:

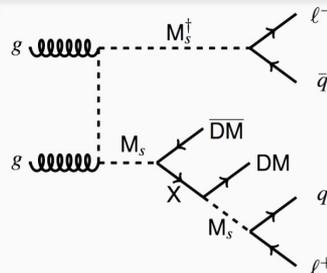


Dark Matter Signal Samples:

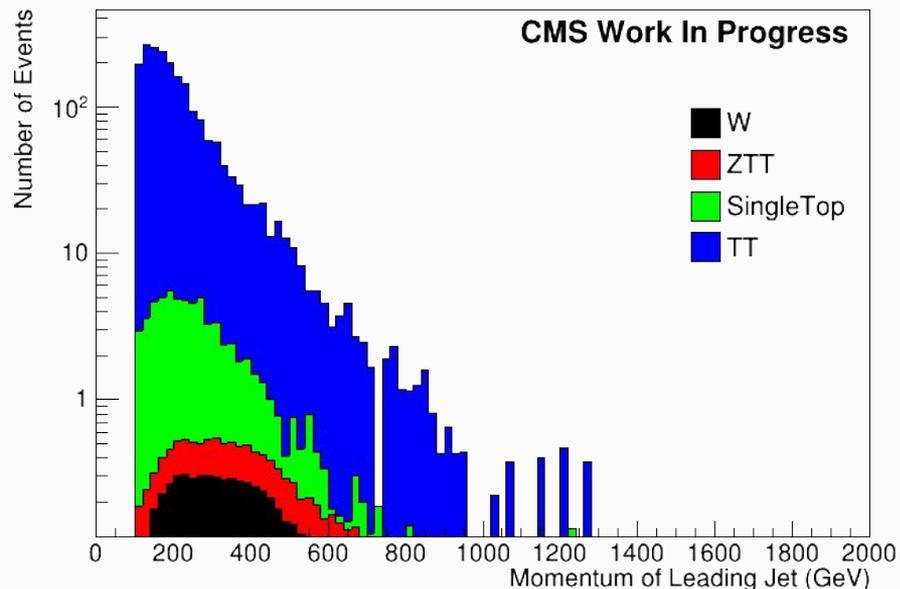


Kinematics: Momentum of Jet

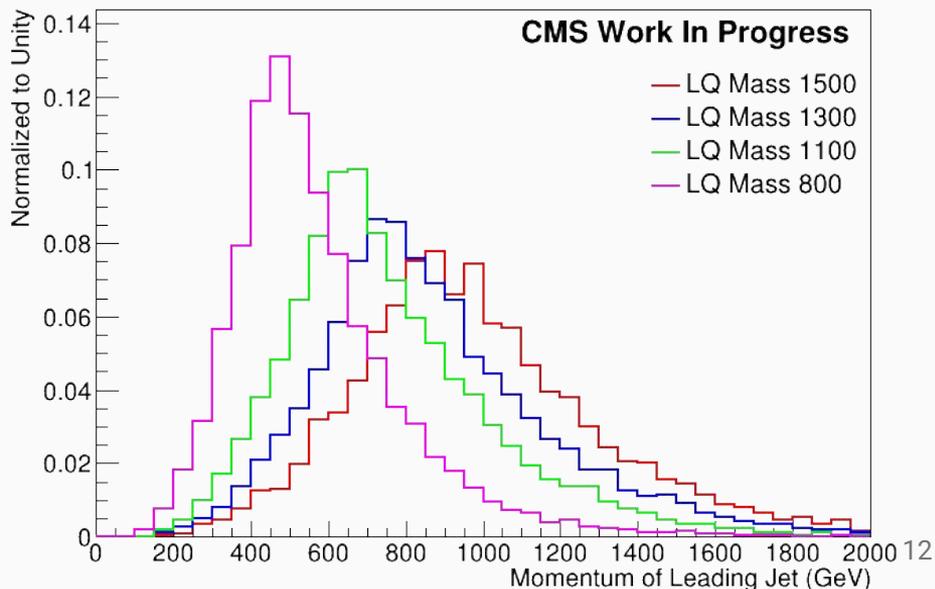
CMS Simulation
Arbitrary normalization applied
Preselection applied



Standard Model Background Samples:

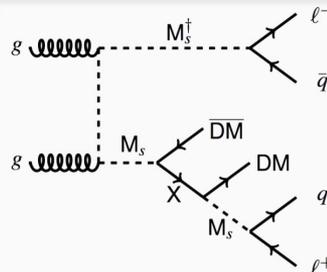


Dark Matter Signal Samples:

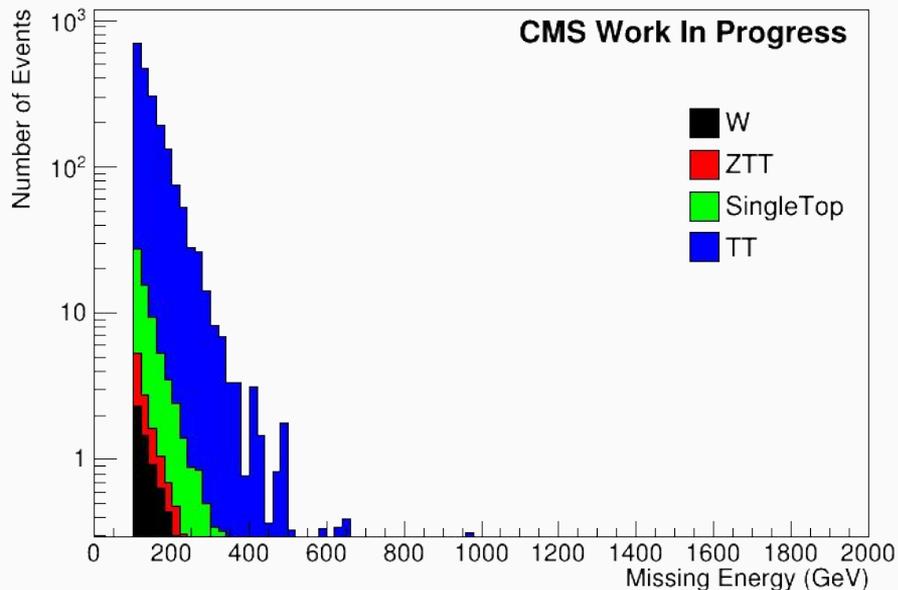


Kinematics: Missing Transverse Energy

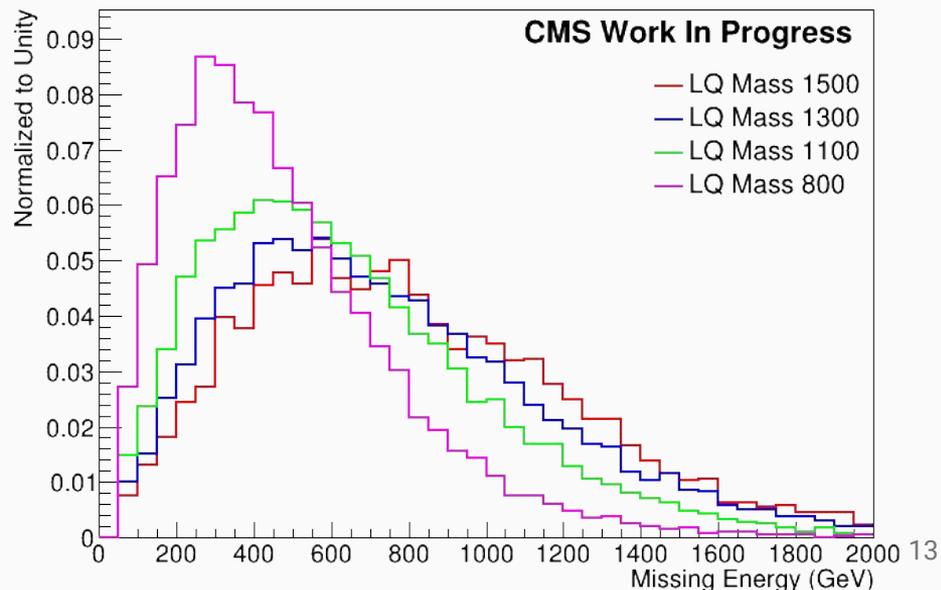
CMS Simulation
Arbitrary normalization applied
Preselection applied



Standard Model Background Samples:



Dark Matter Signal Samples:



Summary

We have begun a search for interesting signature from a coannihilation codex model

Kinematic features

High Pt Lepton & High Pt Jet

Missing ET

Optimizing selection

Hope to find something exciting in 2016 data