Search for Dark Matter with CMS

Mono-X searches at $\sqrt{s} = 8$ TeV

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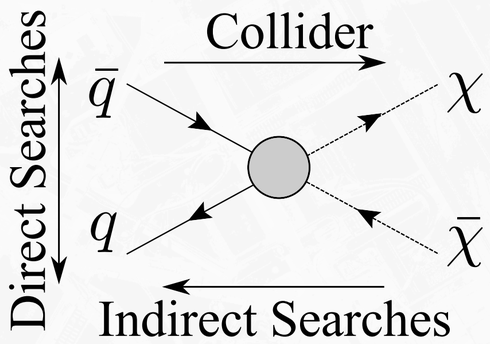
Dark Matter at the LHC

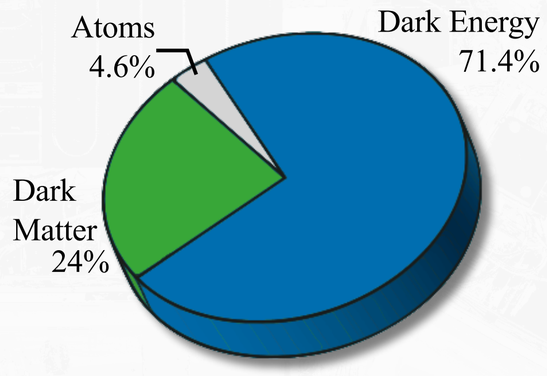
- Dark Matter is an astrophysical fact since 1930's
- Particle physics description as **weakly interacting** massive particle χ



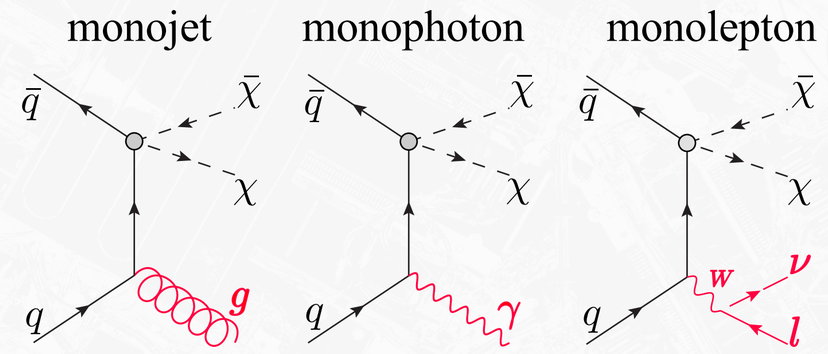
Effective Field Theory (EFT) can be used to describe:

- production at **colliders**
- **direct** interaction
- **indirect** annihilation

Of the matter content in the universe 84% is Dark Matter.



Dark Matter does not interact with the CMS detector. It is only detectable in channels with **initial state radiation**.



Monolepton

arXiv:1408.2745

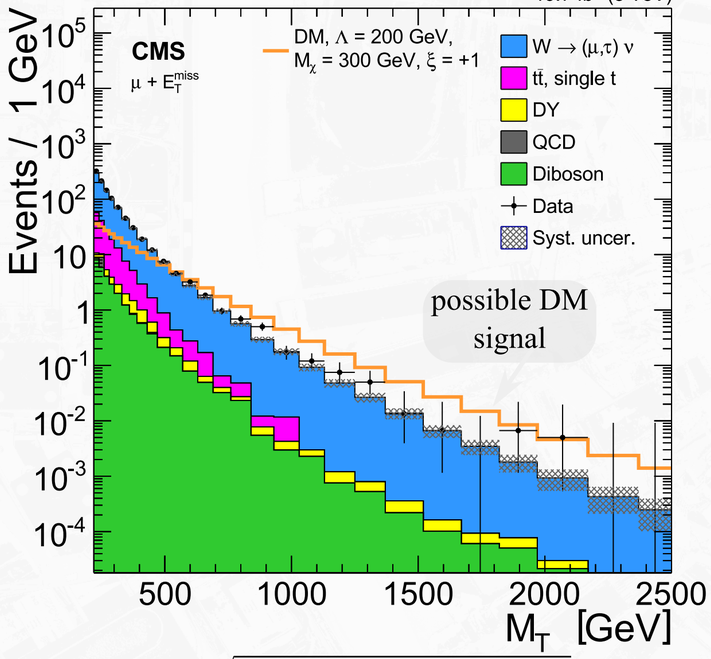
Selection:

muon	$p_T > 45\,\text{GeV}, \lvert\eta\rvert < 2.1$
or electron	$p_T > 100\,\text{GeV}, \lvert\eta\rvert < 2.5$
	$0.4 < p_T/E_T^{\text{miss}} < 1.5$
	$\Delta\varphi(E_T^{\text{miss}}, l) > 2.5$

Background:

$W \to l\nu$ (80%)
top quark (12%)
others (8%)

- background from simulation
- NLO QCD + electroweak shape and normalisation



$$M_T = \sqrt{2 \cdot p_T^l \cdot E_T^{\text{miss}} \cdot (1 - \cos\Delta\phi(l, E_T^{\text{miss}}))}$$

Monojet

arXiv:1408.3583

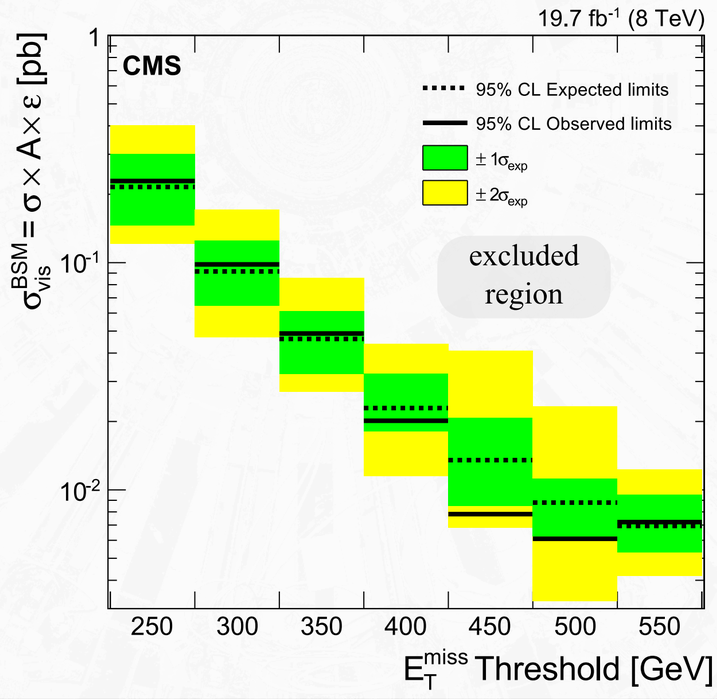
Selection:

first jet	$p_T > 110\,\text{GeV}, \lvert\eta\rvert < 2.4$
second jet	$p_T > 30\,\text{GeV}, \lvert\eta\rvert < 4.5$
E_T^{miss}	$> 250\,\text{GeV}$

Background:

$(Z \to \nu\nu) + jets$ (62%)
$(W \to l\nu) + jets$ (34%)
Other backgrounds less than 4%.

The background is mainly estimated from $Z \to \mu\mu$ and $W \to \mu\nu$ data events.



statistical analysis

Monophoton

arXiv:1410.8812

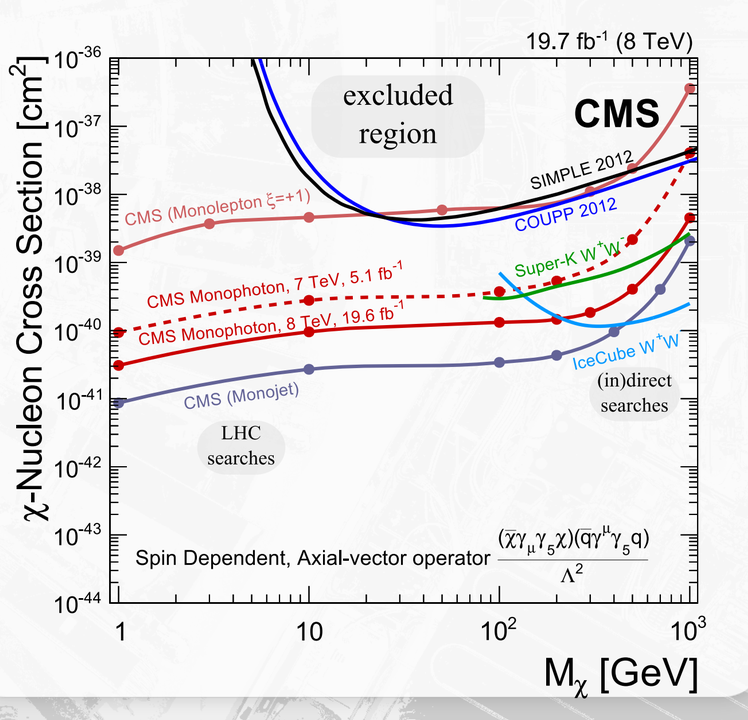
Selection:

photon	$p_T > 145\,\text{GeV}, \lvert\eta\rvert < 1.44$
E_T^{miss}	$> 140\,\text{GeV}$

Background:

$(Z \to \nu\nu) + \gamma$ (51%)
$(W \to l\nu) + \gamma$ (17%)
e, jet misidentified as $gamma$ (17%)
non-collision backgrounds (4%)

- detector response from data sideband
- misidentification background derived from data



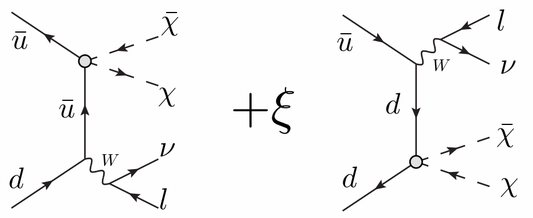
model analysis

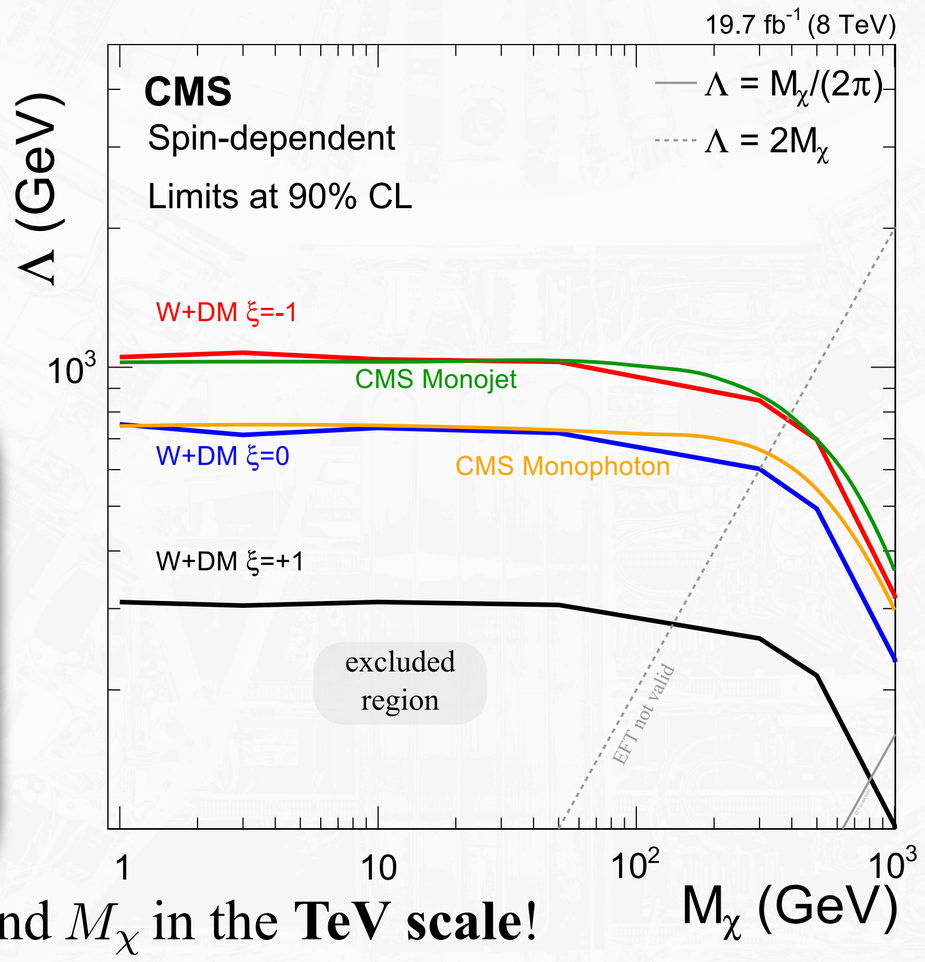
Limit on Dark Matter production

- mediator absorbed in contact interaction
- limit is set on the effective scale $\Lambda = \frac{M_{med}}{\sqrt{g_\chi g_q}}$ with couplings g_χ and g_q
- flat w.r.t M_χ at low M_χ
- at high M_χ the production cross section drops

Interference

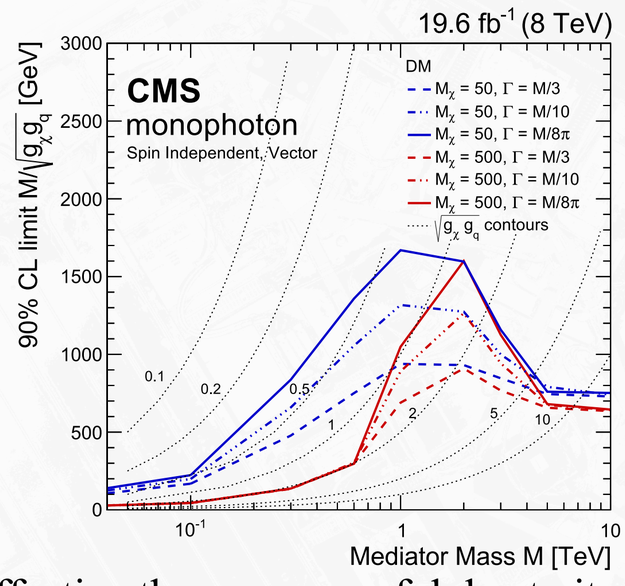
$\xi = 1$ with $g_u = g_d$
$\xi = 0$ with $g_u = 1$ and $g_d = 0$
$\xi = -1$ with $g_u = -g_d$





Limits on Λ and M_χ in the **TeV scale**!
No hints for **light Dark Matter**!

Beyond effective theory



- effective theory successful due to its wide usability and comparability
- numerous Dark Matter topologies were
- next searches include mediator modelling