



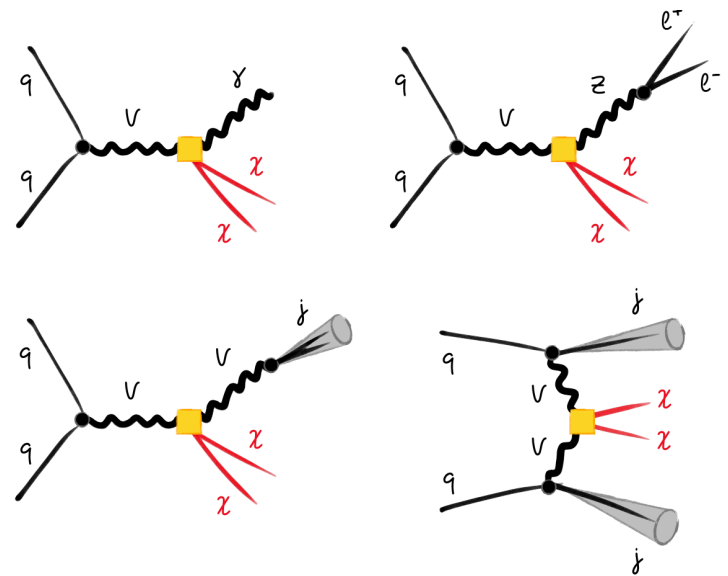
# Monophoton Study

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Inputs from Linda Carpenter and Ulrich Haisch

# + Introduction : Models

- s-channel simplified models with gauge boson couplings to dark matter ([arxiv:1501.00907](#), [arxiv:1307.5064](#))
- Same models can be used for other Mono-X searches.
- EFT model with  $\chi\chi\gamma\gamma$  vertex
- Model UFO files provided by [Linda](#) and [Ulrich](#) to be used in Madgraph.



# + EFT Model (from Linda)

- Dim-7 Operators

- xxFFfermD7

- xxG5FFfermD7

$$\mathcal{L} = \frac{k_1}{\Lambda^3} \chi \bar{\chi} F_{\mu\nu}^1 F_1^{\mu\nu} + \frac{k_2}{\Lambda^3} \chi \bar{\chi} F_{\mu\nu}^2 F_2^{\mu\nu}$$

$$\mathcal{L} = \frac{k_1}{\Lambda^3} \chi \gamma^5 \bar{\chi} F_{\mu\nu}^1 F_1^{\mu\nu} + \frac{k_2}{\Lambda^3} \chi \gamma^5 \bar{\chi} F_{\mu\nu}^2 F_2^{\mu\nu}$$

- where  $\chi$  : Dirac fermion, index 1 : U(1) field tensor and index 2 : SU(2) field strength tensor.

- Can effectively play with parameters  $k_1$  and  $k_2$  to control the coupling of dark matter to four pairs of electroweak bosons.

- The total cross section can be described in terms of 3 parameters :  $k_1$ ,  $k_2$  and  $m_\chi$

$$g_{WW} = \frac{k_2}{s_w^2}$$

$$g_{ZZ} = \left( k_2 \frac{c_w^2}{s_w^2} + k_1 \frac{s_w^2}{c_w^2} \right)$$

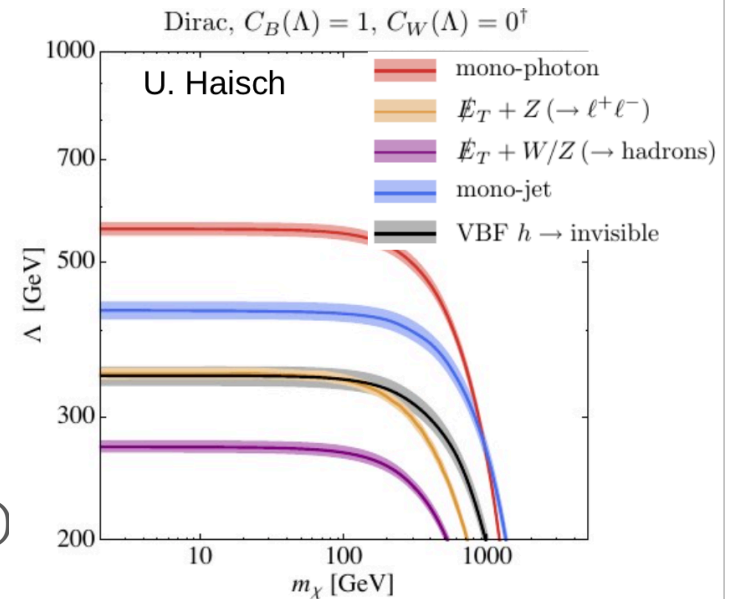
$$g_{Z\gamma} = \left( k_2 \frac{c_w}{s_w} - k_1 \frac{s_w}{c_w} \right)$$

$$g_{\gamma\gamma} = (k_2 + k_1)$$



# Model Testing

- Idea
  - Plot exclusion of  $\Lambda$  vs  $m_\chi$  for various  $k_1/k_2$  values.
  - Model should be shared with mono-W/Z searches
- Default  $\Lambda = 3$  TeV
- Short term plans
  - Agree on the grid parameters
  - Cross check with Uli's model
- Scan the two models :
  - $K_1/k_2$  values (0.01, 0.5, 1.0 independently)
  - $M_\chi$  ( 10, 100, 500, 1000, 2000 GeV)





# Model Testing

- Marie and I tested the model in Madgraph v2.2.2, with pt cut on photon at 135 GeV
- Scan in  $k_1/k_2$  and  $m_\chi$  done
- Cross section for model xxFFfermD7 (Agree with each other)

## ■ Next steps :

- Kinematics
- For Limits : pick a couple of  $k_1/k_2$  ??
- Suggestions...

$M_\chi$	$k_1$	$k_2$	xsec (pb)
10	0.01	0.01	4.683e-11
10	0.01	0.5	1.006e-07
10	0.01	1.0	4.018e-07
10	0.5	0.01	1.171e-08
10	0.5	0.5	1.171e-07
10	0.5	1.0	4.229e-07
10	1.0	0.01	4.652e-08
10	1.0	0.5	1.563e-07
10	1.0	1.0	4.683e-07