

# Validation of ATLAS-EXO-2016-32 (Mono-photon)

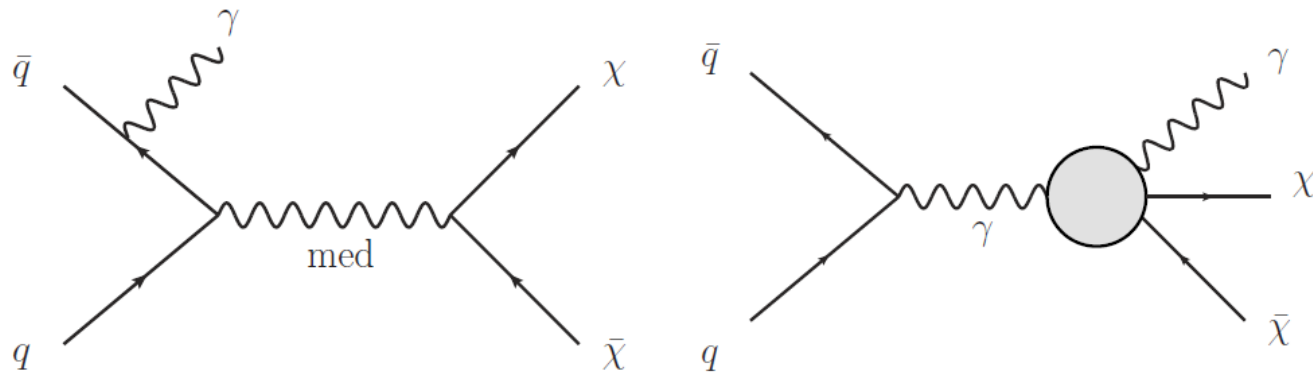
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Other two students ran away...

# Introduction

- Motivation of this channel : dark matter
- Signal diagram



- You can consider any other DM models.
- Background : Mostly coming from Z gamma and W gamma  
(consider replacement of med- $\rightarrow$ Z (or W) and  $\chi \rightarrow \nu$  in the left diagram)

# Event Reconstruction

- Photon :  $E_T > 10$  GeV,  $\eta < 1.37$  or  $1.52 < \eta < 2.37$ ,

Isolated in  $\Delta R < 0.4$  by excluding energy in the cone other than photon to be less than  $2.45 \text{ GeV} + 0.022 E_T$ ,

- Electron :  $p_T > 7$  GeV,  $\eta < 2.47$
- Muon :  $p_T > 6$  GeV,  $\eta < 2.7$
- Jets : anti-kt algorithm with  $R=0.4$

candidate:  $p_T > 20$  GeV,

event selection :  $p_T > 30$  GeV  $\eta < 4.5$

The missing transverse momentum vector  $E_T^{\text{miss}}$  is obtained from the negative vector sum of the momenta of the candidate physics objects, selected as described above. Calorimeter energy deposits and tracks are matched with candidate high- $p_T$  objects in a specific order: electrons with  $p_T > 7$  GeV, photons with  $E_T^\gamma > 10$  GeV, muons with  $p_T > 6$  GeV and jets with  $p_T > 20$  GeV [59]. Tracks from the primary vertex<sup>3</sup> not associated with any such objects are also taken into account in the  $E_T^{\text{miss}}$  reconstruction ("soft term") [61].

# Event Selection (Signal Regions)

Table 2: Criteria for selecting events in the SRs and the numbers of events selected in data.

|   |  |         |         |         |         |
|---|--|---------|---------|---------|---------|
| Event cleaning                          | Quality and Primary vertex   |         |         |         |         |
| Leading photon                          | $E_T^\gamma > 150 \text{ GeV}$ , $ \eta  < 1.37$ or $1.52 <  \eta  < 2.37$ ,<br>tight, isolated, $ z  < 0.25 \text{ m}$ ,<br>$\Delta\phi(\gamma, E_T^{\text{miss}}) > 0.4$ |         |         |         |         |
| $E_T^{\text{miss}} / \sqrt{\Sigma E_T}$ | $> 8.5 \text{ GeV}^{1/2}$  |         |         |         |         |
| Jets                                    | 0 or 1 with $p_T > 30 \text{ GeV}$ , $ \eta  < 4.5$ and $\Delta\phi(\text{jets}, E_T^{\text{miss}}) > 0.4$   |         |         |         |         |
| Lepton                                  | veto on $e$ and $\mu$  |         |         |         |         |
|   | SRI1   | SRI2    | SRI3    | SRE1    | SRE2    |
| $E_T^{\text{miss}}$ [GeV]               | $> 150$  | $> 225$ | $> 300$ | 150–225 | 225–300 |
| Selected events in data                 | 2400   | 729     | 236     | 1671    | 493     |
| Events with 0 jets                      | 1559   | 379     | 116     | 1180    | 263     |

# Official Information(simplified model)

MG5\_aMC : 2.4.3 at NLO mode (We used the latest one 2.6.0)

PYTHIA : 8.212 (We used the latest one)

PDF : NNPDF3.0 at nlo with alphas=0.118 (Same)

Axial vector mediator coupling with universal quark flavor and coupling equals to 0.25.

Coupling to Dirac fermion DM equals to 1.0.

Decay width = 44.01 GeV

Mediator mass = 800 GeV

DM mass = 10 GeV

(model parameters : same)

Cutflow is public at webpage →

| Cut  | $N_{\text{events}}$ |
|--|---------------------|
| Nominal  | 1198                |
| Skimming (incl. trigger)   | 858                 |
| $E_T^{\text{miss}} > 150 \text{ GeV}$                                      | 736                 |
| At least one loose photon with $E_T > 150 \text{ GeV}$ ( $ \eta  < 2.37$ ) | 700                 |
| $z_0 < 250 \text{ mm}$   | 696                 |
| The leading photon is tight  | 658                 |
| The leading photon is isolated   | 622                 |
| $\Delta\phi(\gamma, E_T^{\text{miss}}) > 0.4$                              | 620                 |
| $E_T^{\text{miss}} / \sqrt{\Sigma E_T} > 8.5 \text{ GeV}^{1/2}$            | 596                 |
| Jet veto   | 461                 |
| Lepton veto  | 460                 |

# Validation

| cuts   | MA5           | Official     | error   |
|--|---------------|--------------|---------|
| Initial  | 9446          | 1198         |         |
| $E_T^{\text{miss}} > 150 \text{ GeV}$                                      | 6955(−26.37%) | 736(−38.56%) | 19.85%  |
| Leading photon $p_T > 150 \text{ GeV}$ and $ \eta  < 2.37$                 | 5386(−22.56%) | 700(−4.89%)  | −2.41%  |
| Tight leading photon   | 4494(−16.56%) | 658(−6.00%)  | −13.38% |
| $\Delta\phi(\gamma, E_T^{\text{miss}}) > 0.4$                              | 4483(−0.24%)  | 620(−5.78%)  | −8.30%  |
| $E_T^{\text{miss}} / \sqrt{\sum E_T} > 8.5 \text{ GeV}^{1/2}$              | 4379(−2.32%)  | 596(−3.87%)  | −6.81%  |
| $N_{\text{jet}} < 2$ and $\Delta\phi(\text{jet}, E_T^{\text{miss}}) > 0.4$ | 3529(−17.13%) | 461(−22.65%) | −0.16%  |
| Lepton veto  | 3529(−0.00%)  | 460(−0.21%)  | −2.7%   |

$$\text{error} = \frac{\text{MA5}/\text{MA5}(\text{initial})}{\text{official}/\text{official}(\text{initial})} - 1$$

## Further Issues

1. Pythia8 card from ATLAS person will be delivered by Guillaume.
2. We do not know Delphes card. (here, we used ATLAS default card.)
3. We did not take into account tracks from primary vertex when we calculate MET.
4. We do not know how to use auto-generation of tex file (definition, weight, and so on..)
5. We will update our analysis page and upload cpp code soon.

Thank you everyone!