Search for dark-photons decaying to lepton-jets with the ATLAS detector at LHC

1. Dark photons

- Dark sector interaction via dark photon
- Higgs ggF production
- SM decays to leptons and light hadrons
- Back-to-back dark photon production

3. Event selection

**Discriminating variables**

- **Muons vs cosmic:**
  1. Track parameters
  2. Longitudinal impact parameter
  3. Timing
- **Jets vs multi-jet:**
  1. $E_{(HCAL)}/E_{(ECAL)}$
  2. Width
  3. Jet Vertex Tagger output
  4. Timing

**Background estimation**

- Multi-jet: data-driven ABCD method
- Cosmic muons: estimated in empty bunches
- Beam induced background: reduced to negligible level

**ABCD**

- LJ isolation in the ID: signal expected highly isolated
- Angular distance: signal expected back-to-back

2. How are they reconstructed?

- **Hadronic decay (hLJ)**
  - Displaced jet with most of energy deposit in the HCAL (no muons)
  - Very high background form rare QCD event and few handles to play with

- **Muonic decay (μLJ)**
  - Collimated bundle of muon without track in the inner detector (no jets)
  - Difficult to trigger: low pt muons

4. Results

**Dark photon mass**

**For small epsilon very displaced decays (0.5-7.5 m)**

**Angular distance:**

\[ r = \frac{1}{2} \cdot \frac{B_{\mu\nu} \cdot B_{\mu\nu}}{2 \cos \theta} \cdot D_{\mu\nu} \cdot D_{\mu\nu} + \frac{1}{2} \cdot \frac{m_f^2}{D_{\mu\nu} \cdot D_{\mu\nu}} \]

**Branching Ratio**

\[ \mathcal{B}(H \rightarrow \mu \gamma) = 10\% \]

\[ \mathcal{B}(H \rightarrow \mu \gamma) = 2.2 \times 10^{-2} \]

\[ \mathcal{B}(H \rightarrow \mu \gamma) = 1 \times 10^{-3} \]

**Dark photon decay 100% to hadrons**

[3] ATLAS Collaboration - "Search for long-lived neutral particles decaying into displaced lepton jets in proton–proton collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector" - ATLAS-CONF-2016-042

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