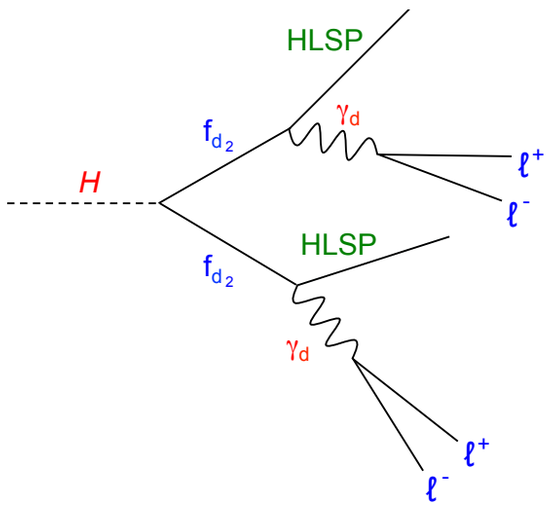
The 7th Conference on Large Hadron Collider Physics – Puebla, Mexico May 2019

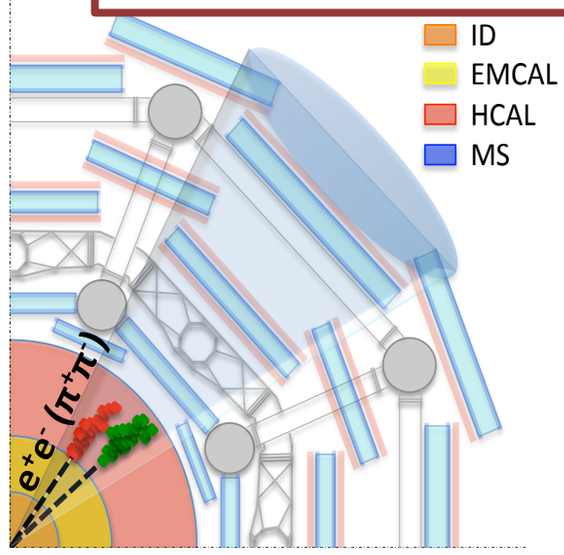
Search for dark-photons decaying to lepton-jets with the ATLAS detector at LHC

1. Dark photons



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

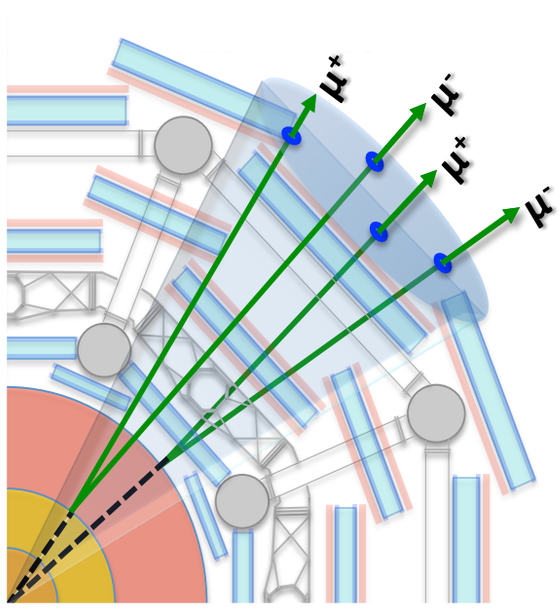
2. How are they reconstructed?



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
Cosmic background

3. Event selection

Discriminating variables

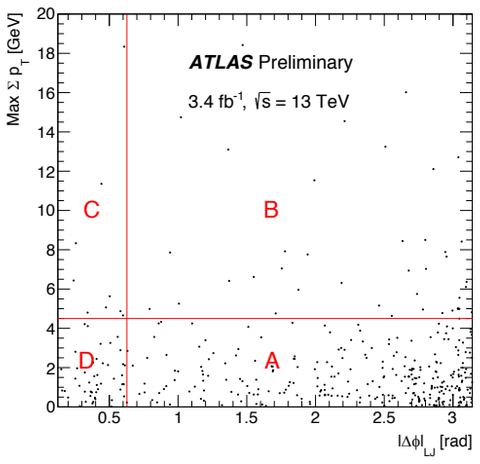
- **Muons vs cosmic:**
  1. Track parameters
  2. Longitudinal impact parameter
  3. Timing
- **Jets vs multi-jet:**
  1. $E_{\{HCAL\}}/E_{\{ECAL\}}$
  2. Width
  3. Jet Vertex Tagger output
  4. Timing

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

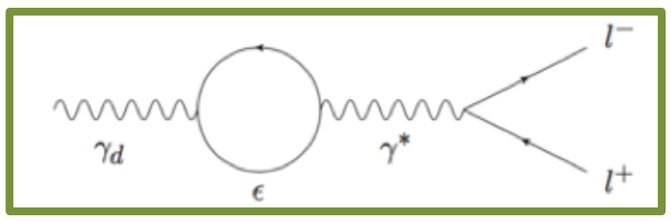
4. Results

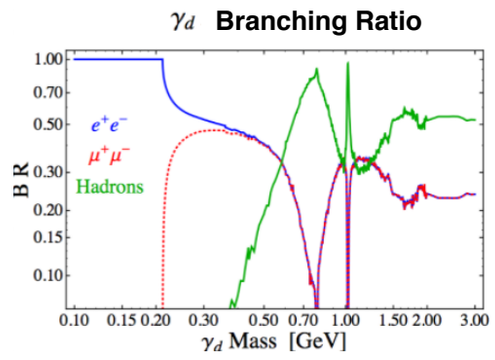
$$\mathcal{L} \subset -\frac{1}{4}\hat{B}_{\mu\nu}\hat{B}^{\mu\nu} - \frac{1}{4}\hat{Z}_{D\mu\nu}\hat{Z}_D^{\mu\nu} + \frac{1}{2}\frac{\epsilon}{\cos\theta}\hat{Z}_{D\mu\nu}\hat{B}^{\mu\nu} + \frac{1}{2}m_{D,\mu}^2\hat{Z}_D^{\mu}\hat{Z}_{D\mu}$$

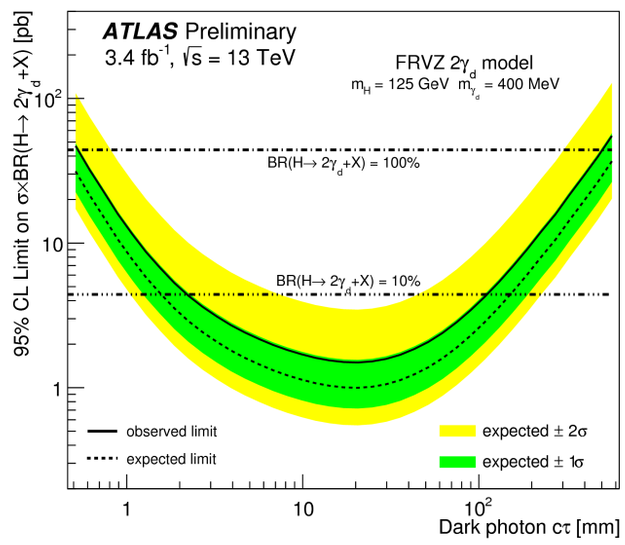
kinetic mixing parameter

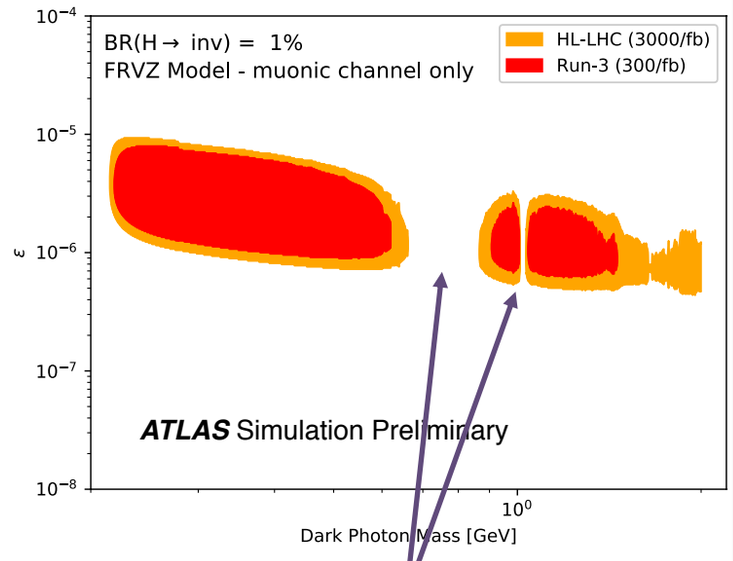
Dark photon mass

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









Excluded $c\tau$ [mm] muonic-muonic	Run-2	Run-3	HL-LHC
BR(H → $2\gamma_d + X$)=10 %	$2.2 \leq c\tau \leq 111$	$1.15 \leq c\tau \leq 435$	$0.97 \leq c\tau \leq 553$
BR(H → $2\gamma_d + X$)=1 %	-	$2.76 \leq c\tau \leq 102$	$2.18 \leq c\tau \leq 142$

Dark photon decay 100% to hadrons

[1] A. Falkowski, J. T. Ruderman, T. Volansky, J.Zupan - 'Hidden Higgs Decaying to Lepton Jets' - JHEP 1005:077,2010
[2] ATLAS Collaboration - 'Search prospects for dark-photons decaying to displaced collimated jets of muons at HL-LHC' - ATLAS-PHYS-PUB-2019-002
[3] ATLAS Collaboration - 'Search for long-lived neutral particles decaying into displaced lepton jets in proton--proton collisions at $\sqrt{s}$= 13 TeV with the ATLAS detector' - ATLAS-CONF-2016-042

Cristiano Sebastiani, on behalf of the ATLAS Collaboration