**Search for Long-Lived Dark Photon signatures with the ATLAS detector at LHC**

### A Dark Sector of new particles...

- **Dark Sectors** are predicted as possible Standard Model extensions
- Minimal approach: $U(1)$ gauge field (Dark Photon, $\gamma_d$) [1] coupled to the SM photon via kinetic mixing ($\epsilon$)
- Low $\epsilon \rightarrow$ long dark photon lifetime
- Low $\gamma_d$ mass $\rightarrow$ highly collimated decay products
- The experimental signature is a pair of back to back Displaced Dark Photon Jets (DPJs) [2]
- This search aims to find this particular signature, looking for long-lived light Dark Photons ($\gamma_d$) with the ATLAS detector [3]

### ... and how to find them

- **Dedicated triggers** are used to perform a preliminary event selection, searching for collimated muons and narrow jets with low electromagnetic (EM) fraction, both with no associated track in the ID
- **Muonic DPJs** are discriminated from the cosmic muon background exploiting RPC timing and muon track parameters ($\eta, \phi, z$)
- **Hadronic DPJs** can be discriminated from the QCD multi-jet background exploiting EMFraction, jet width, Jet Vertex Tagger output, jet timing, charge and mass
- **2 back-to-back DPJs** are requested for each event
- **BDT cuts on each DPJ**: for each DPJ type a dedicated BDT is used, with variables mentioned above as input

### Results with 2015+2016 dataset

- **No excess** found in data, different exclusion regions are set, following various assumptions on Higgs decay branching ratio to a pair of Dark Photons
- **Analysis sensitivity** dominated by muonic channel, improvements are under study

### (Deep) Learn from raw data

- Jet calorimetric energy deposits as images (Jet Images), alongside with jet high-level variables can provide new features for a better event selection
- Images are processed with a Convolutional Neural Network, exploiting Jet Images to improve selection for dark photon decays in the calorimeter
- Multiple images processing to exploit the whole calorimeter

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