2021 and 2022

Search for Dark Matter of Axion and Dark Photon at the LHC-ATLAS Experiment

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Introduction

- LHC-ATLAS has been searching for the BSM (Beyond the Standard Model) signal including DM. Some analyses have been proposed and built based on so-called "anomaly", for example, muon g-2, B-anomaly. → No hint for BSM so far

- In this project, we have performed two searches using LHC-ATLAS Run2 data (2015-2018):
  [1] O(TeV) Axion-like Particle
  [2] O(MeV-GeV) Dark Photon
  Two PhD students have worked on these subjects:
  the former by **Gen Tateno** and the latter by **Tingyu Zhang**.

- In this Henkaku-A, a similar mass region and physics (dark photon) will be investigated by Belle II, so that our project can be complementary.

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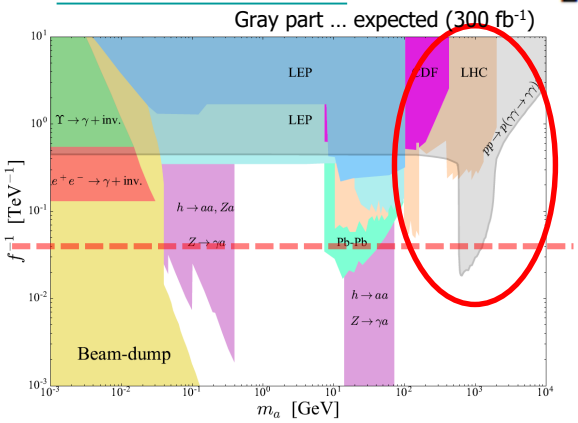
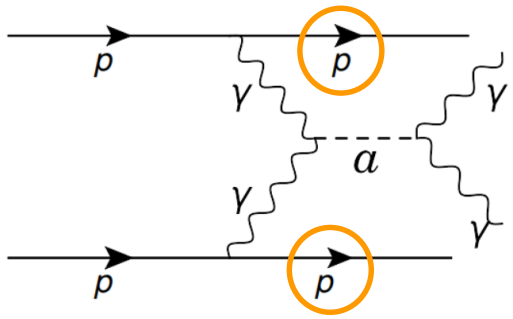
Gen Tateno (PhD student)

Axion-Like Particle (ALP) Search

$$\mathcal{L} = \frac{1}{2}\partial^\mu a \partial_\mu a - \frac{1}{2}m_a^2 a^2 - \frac{1}{f} a F^{\mu\nu}\tilde{F}_{\mu\nu}$$

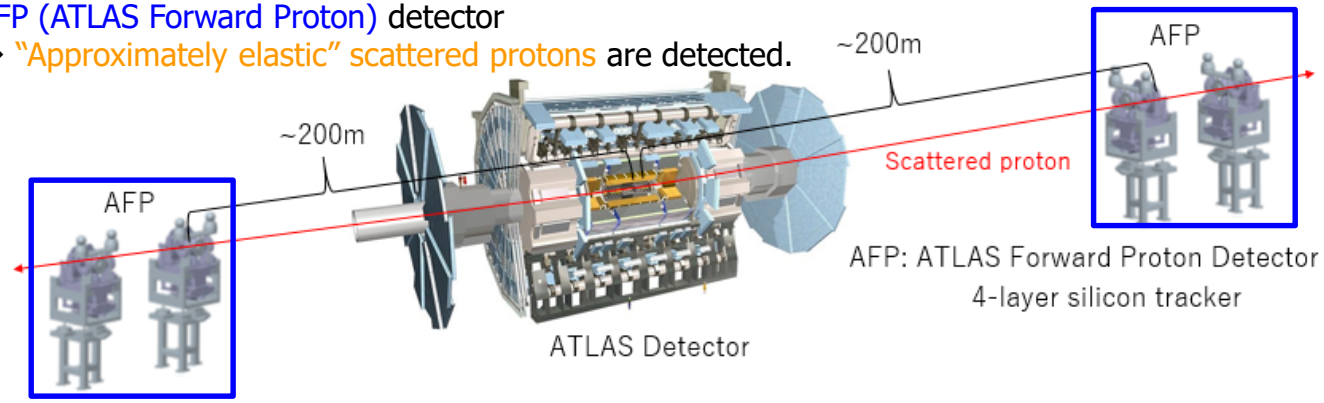
arXiv:1803.10835





Use LHC as a photon-photon collider

AFP (ATLAS Forward Proton) detector
→ "Approximately elastic" scattered protons are detected.

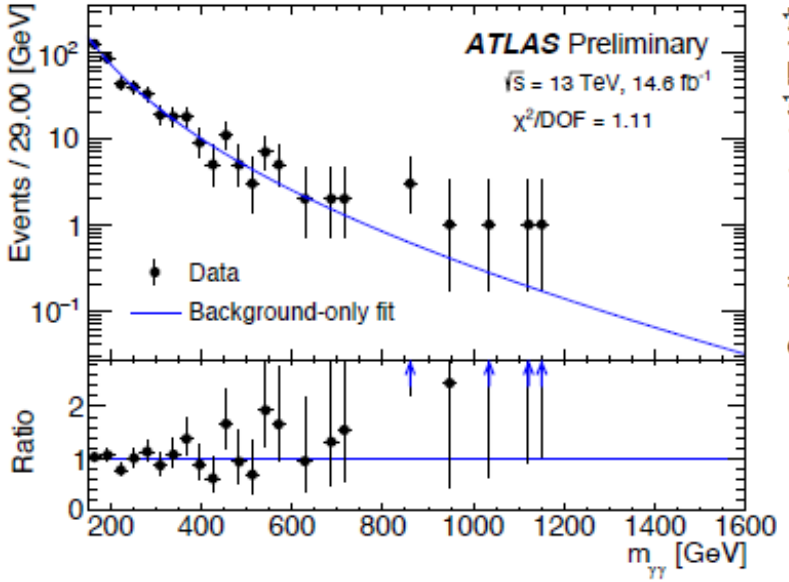


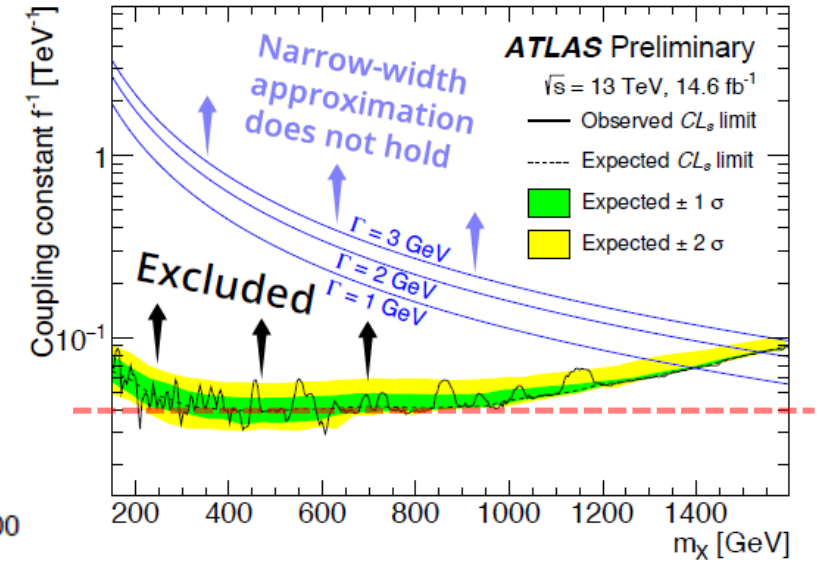
Due to the limitation of AFP availability,
we used only a part of Run 2 data (14.6 fb^{-1}).

Developed how to estimate BG using real data.
Most (99%!?) of analysis was done by Gen!!!
Gen will get the PhD with this subject this month.

Gen presented the result at the La Thuile 2023 yesterday.

- A conf-note and its journal paper will be published soon.





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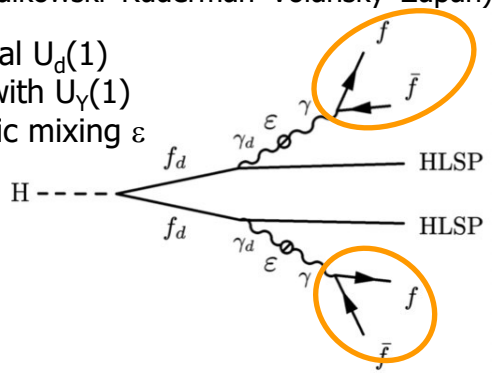
Tingyu Zhang (PhD student)

Dark Photon Search

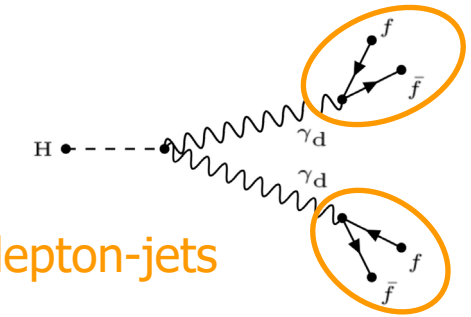
125GeV Higgs as a portal to access the dark photon sector

FRVZ (Falkowski–Ruderman–Volansky–Zupan) model

Additional $U_d(1)$
→ mix with $U_Y(1)$
by kinetic mixing ε



HAHM (Hidden Abelian Higgs Model)

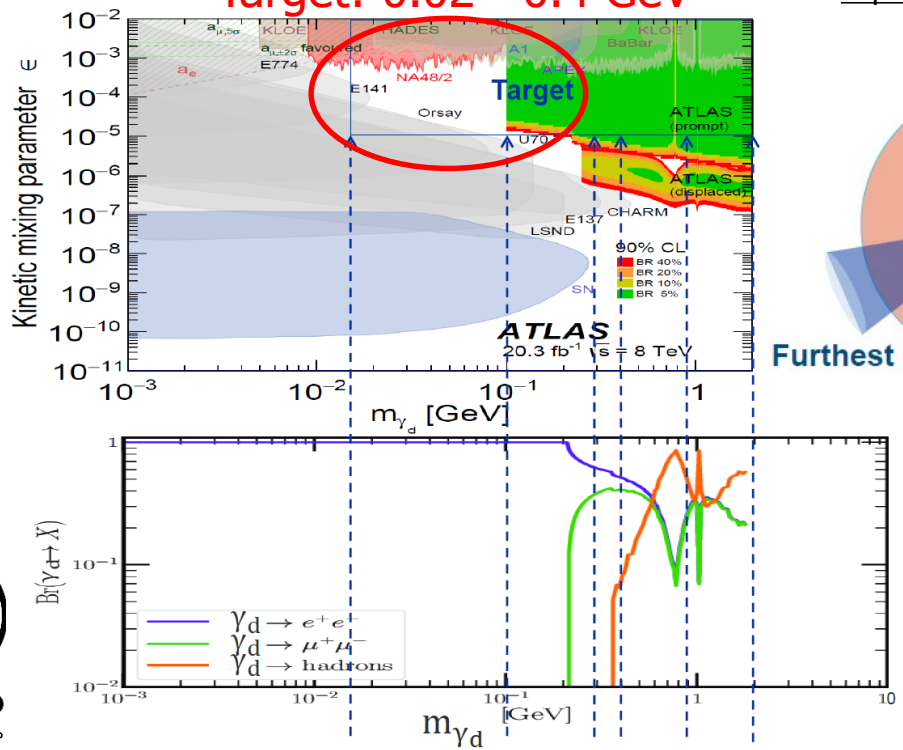


Two lepton-jets

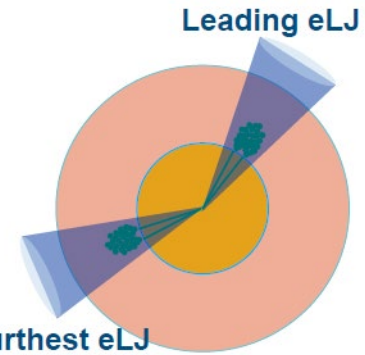
The target mass of dark photon is O(100 MeV-GeV).
→ The dark photons can be boosted.
→ Two fermions from a dark photon are collimated.
We reconstruct this "two collimated fermions" as a lepton-jet (LJ).

In our team, we focus on $\gamma_d \to e^+e^-$. ($\gamma_d \to \mu^+\mu^-$ by Italian team)
→ our target mass is mainly 0.02 - 0.4 GeV. (almost prompt decay)

Target: 0.02 - 0.4 GeV



Experimental signature



Use Run 2 full data (139 fb^{-1})
Tingyu is based at CERN.
He collaborates with LJ analysis team members.

Done for
- Trigger choice
- Event selection optimization
- Develop. of analysis framework with μ-channel
- R&D of LJ/BG-jets separation using ML/DL tech.

Talks at JPS

Working for BG estimation with real-data!!!

Plan: the target conference is one around autumn this year.