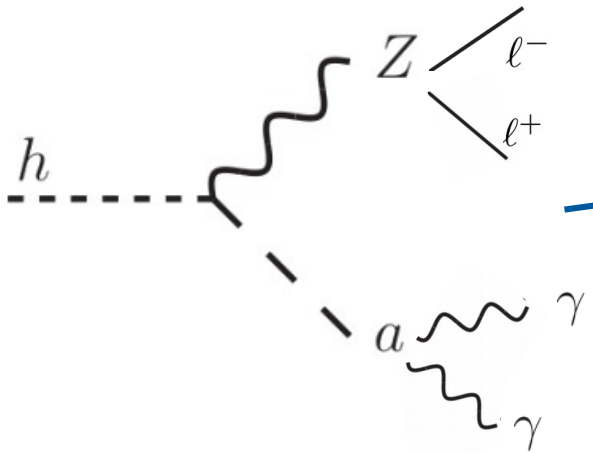
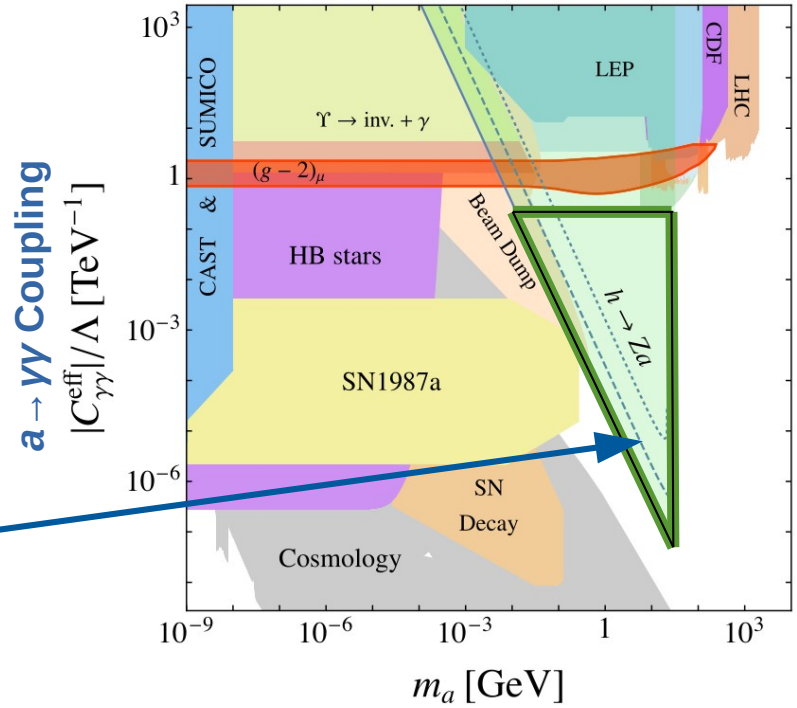
$h \rightarrow Za \rightarrow \ell\ell\gamma\gamma$
Christmas Meeting

Adam Ruby
Supervisors: Nikolaos Rompotis, Sergey Burdin

Theoretical background & Motivation

- Standard Model could break CP symmetry in strong interactions.
- Could be explained by replacing the CP-violating parameter with a dynamical field, giving rise to a new particle, the axion or Axion-like particles (ALPs).
- ALPs could couple to the Higgs boson.

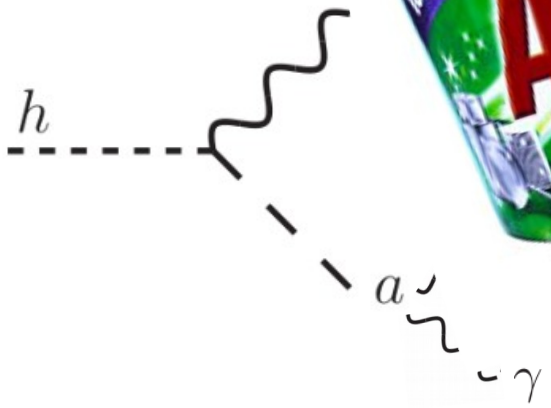


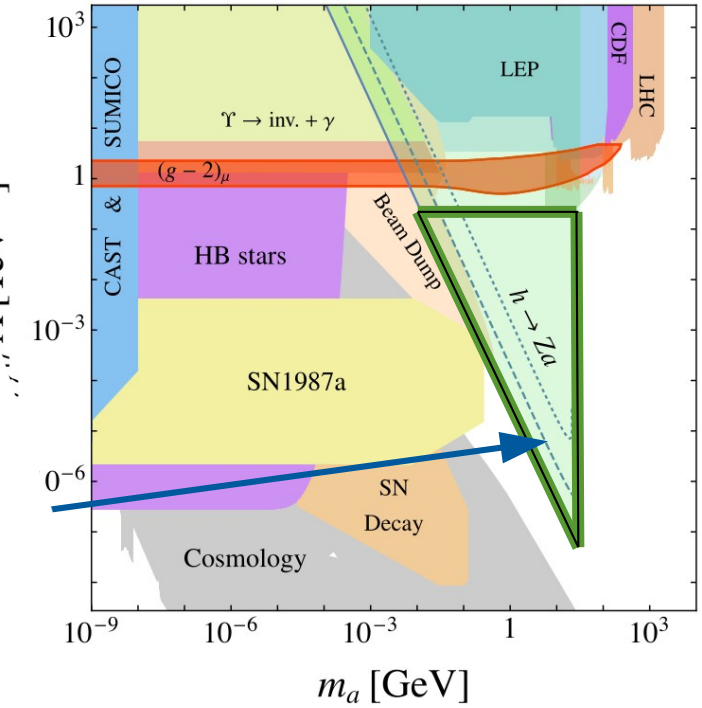


arXiv:1708.00443

Theoretical background & Motivation

- Standard Model could break CP symmetry in strong interactions.
- Could be explained by replacing parameter with a dynamic particle, the axion or Axion
- ALPs could couple to the photon

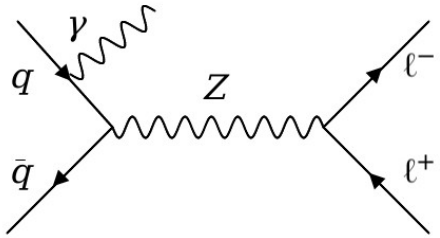




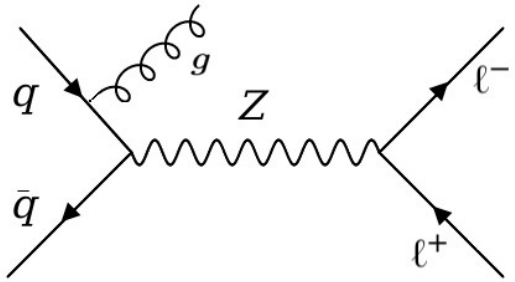
arXiv:1708.00443

Mass of *a* particle

Backgrounds



Zγ

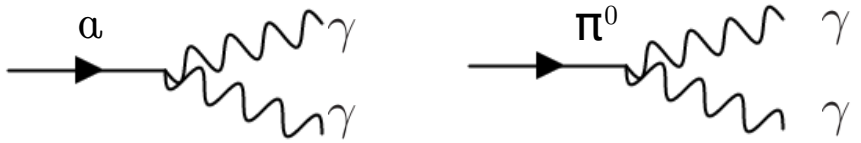


Z+jets

- Main backgrounds are Zγ & Z+jets
- Signal photons could be reconstructed as 1 photon.

π^0 decay

For small m_a, ALP decays will have similar signature to π^0 decay.



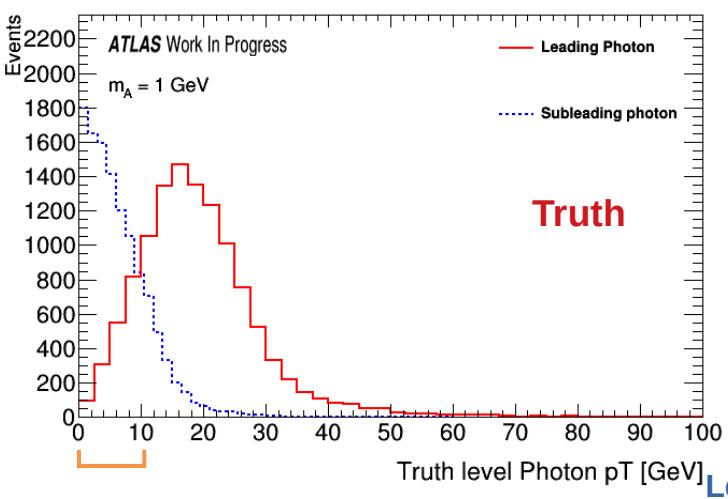
Signal Photon Properties

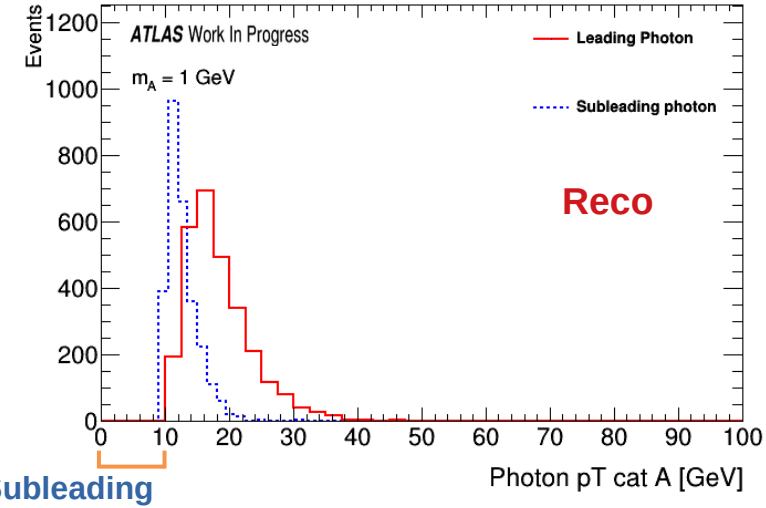
- Photons have different pT values.
- A minimum pT cut of 10 GeV cuts out a lot of signal.
- ≈ half of events contain 1 signal photon, only 30% have 2 photons.

nPhotons >= 2 pT >10 GeV [%]	nPhotons = 1 pT >10 GeV [%]	nPhoton = 0 [%]
29	52	19

Average fraction over all samples

Forced to categorise selection based on number of reconstructed photons.





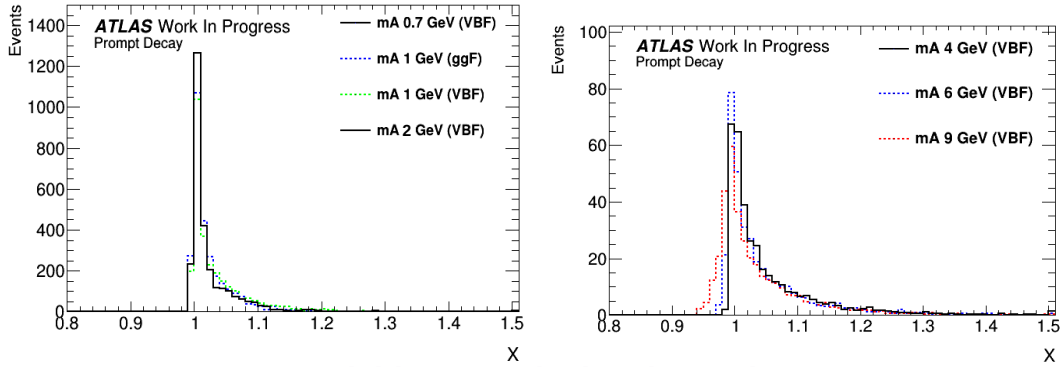
Leading & Subleading photon pT

Category Definitions

$$X = \Delta R_{\gamma\gamma} \frac{pT_{\gamma\gamma}}{m_{\gamma\gamma}}$$

From kinematics we can create variable X.

A common property of each signal sample



X variable for each signal sample

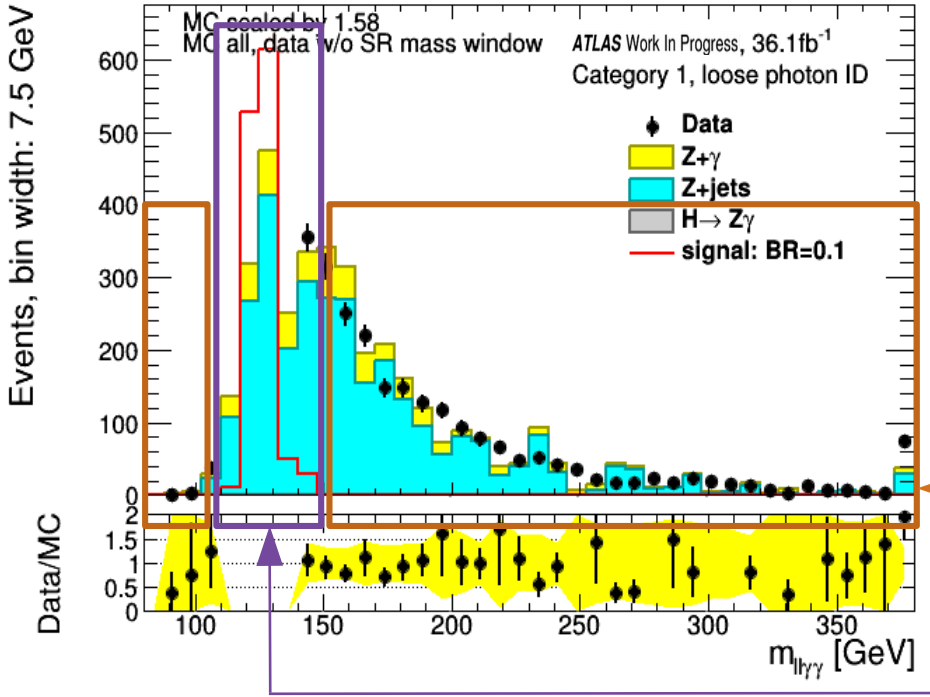
Categorisation

Category 1: Events for which the highest pT di-photon pair has $0.98 < X < 1.2$.
Photon pT cut of 10 GeV

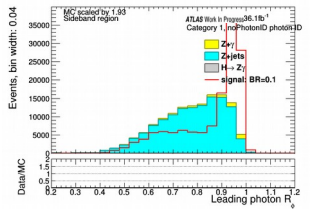
Category 2: The event fails Category 1; it includes a photon with
pT > 20 GeV.

Categorisation and Next steps

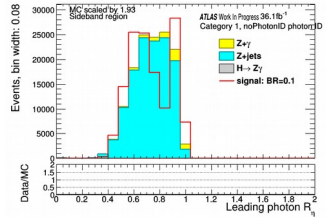
- Combined categorisation ≈ 20-33% with respect to initially selected events.
- Next steps: Select on Photon ID variables to remove background



Example Photon ID variables



R_φ



R_η

Overall Plan

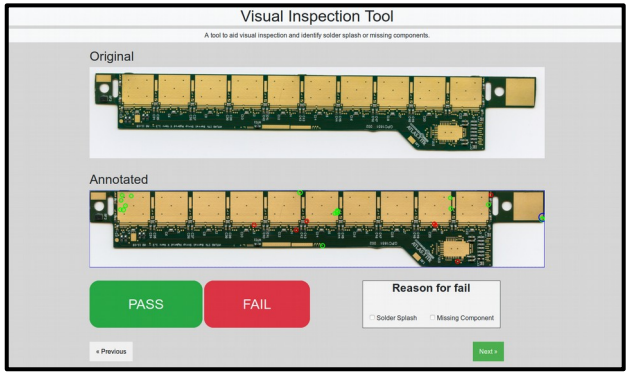
- Select on $m_{llγγ}$ mass region 105-140 GeV
- Fit on $m_{γγ}$ background

$m_{llγγ}$ Sidebands

Signal region

Things to come in 2020!

- Started ATLAS Qualification Task; Tool to help Visual Inspection of strip modules for ITK.
- Will go on LTA from March, at CERN!
- Preliminary results with conf-note for summer conferences



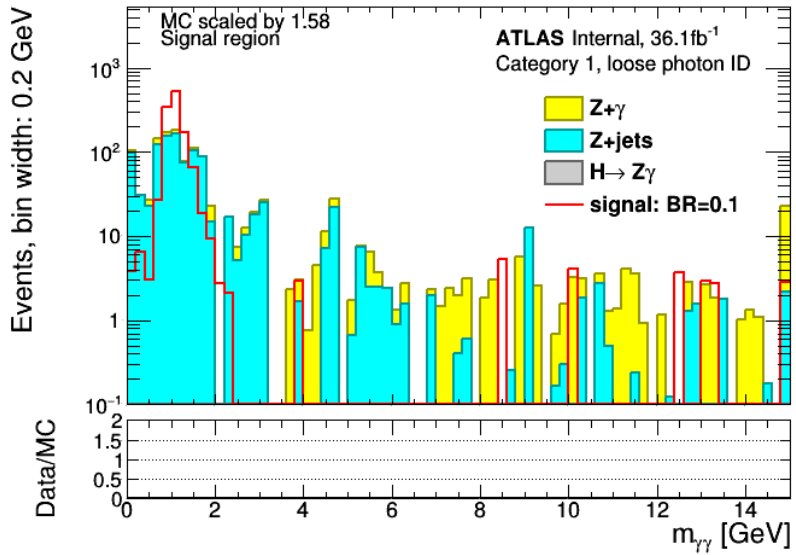
Qualification Task

CERN

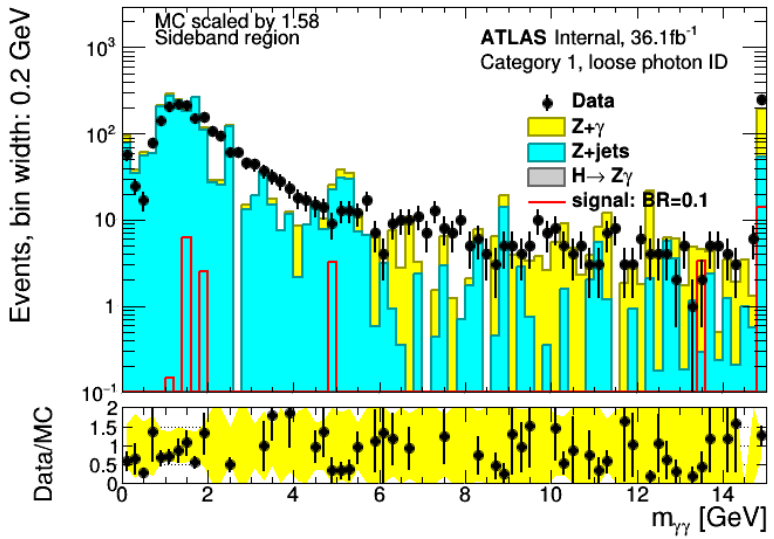
Merry Christmas

Back-up

Categorisation and Next steps



Signal region



m_{llyy} Sidebands