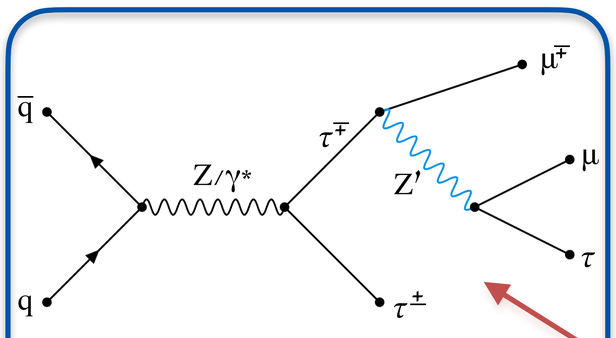
Search for new phenomena in 4 lepton final states with the full Run 2 dataset

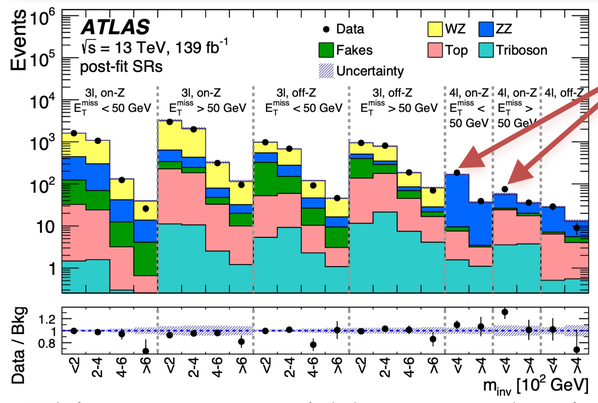
Shreyas Bakare, IISER Pune, India

CERN Summer Student Program
Poster Session 2023

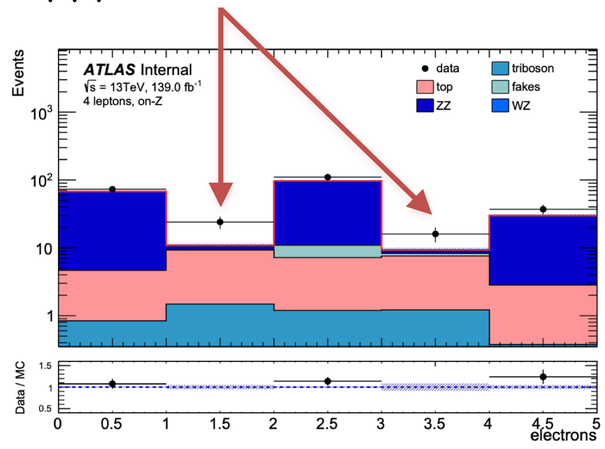


Flavour off-diagonal Z′coupling to the μ and τ sectors

Motivation

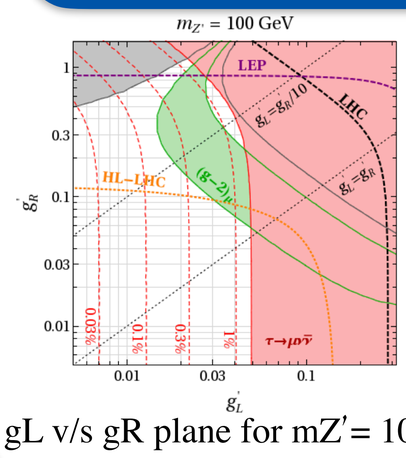


- Small excess in 4l signal regions from our previous multilepton general search in 3l/4l final states[1] was found to be significantly larger when considering particular low-background sub-channels split by lepton flavour. Mostly in eeeμ or eμμμ events



- This excess could be new physics with lepton flavour violating processes including taus. Therefore, we search for this process in the μμττ, eμμτ, eμμμ, μμμτ, etc. final states.
- The idea of the analysis is to do a general search such that we don't search for a particular model but interpret some, and one of them is Z′. This model could also address the $(g\text{-}2)_\mu$ tension.

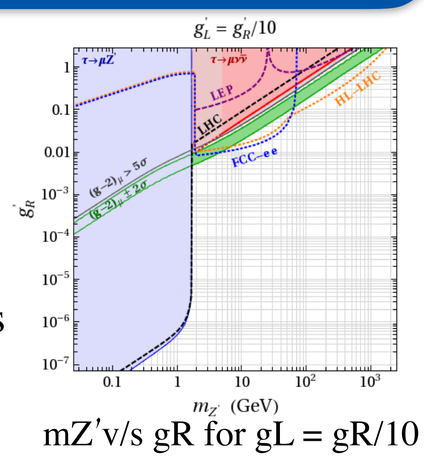
Z′coupling to μ & τ



gL v/s gR plane for mZ′= 100 GeV

- In these two plots, from Lepton flavour violating Z′explanation of the muon anomalous magnetic moment[2], the green band is preferred at 2 σ by the $(g\text{-}2)_\mu$ anomaly, whereas the grey region is disfavored at > 5 σ. The red region is excluded by lepton flavour universality in tau decays.
- Based on these two plots[2], we adjust the couplings as a function of Z′mass (mZ′) as

$$g_{23R} = 0.003\ \text{GeV}^{-1} \times mZ'/\text{GeV}$$
$$g_{23L} = g_{23R}/10.$$

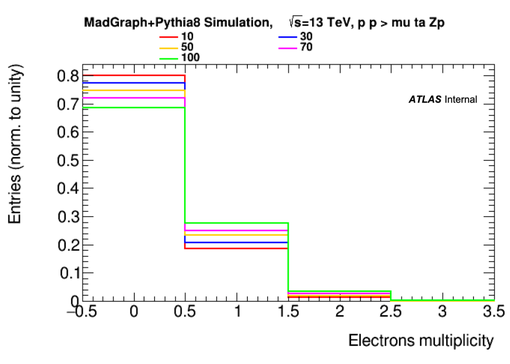


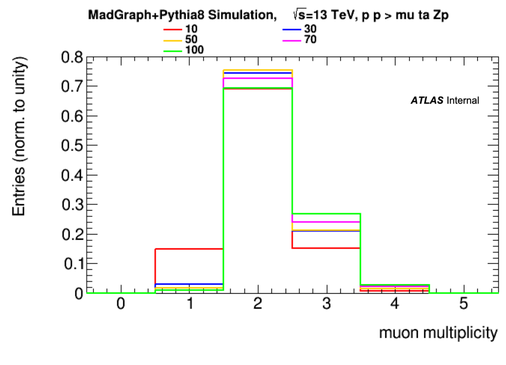
mZ′v/s gR for gL = gR/10

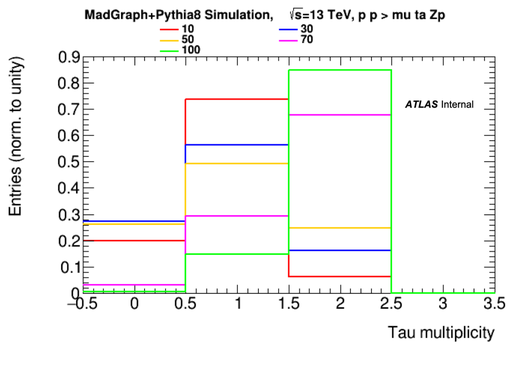
Workflow

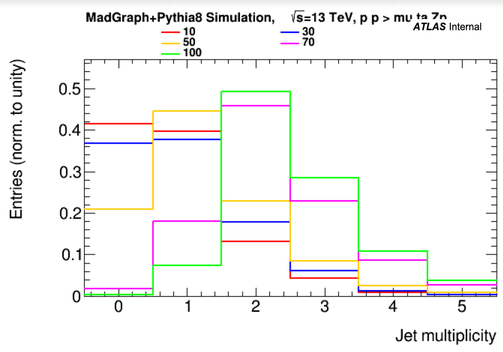
MC generation using MadGraph + Pythia → Comparing kinematics as a function of mZ′ → Calculating signal events at √s = 13 TeV for different mZ′

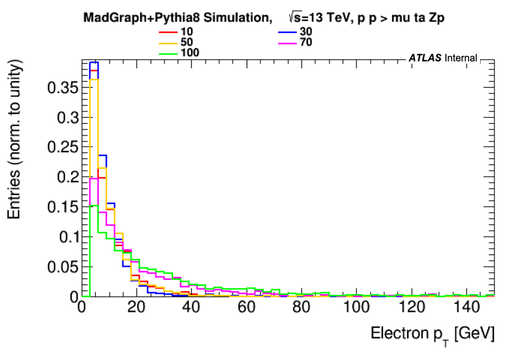
- First-ever Monte Carlo generation of the p p > τ μ Z′process.
- Probing Z′mass in the range of 10 GeV to 100 GeV as the cross-section of the process turns out 13.76 fb for mZ′= 10 GeV whereas 0.25 fb for mZ′= 100 GeV.

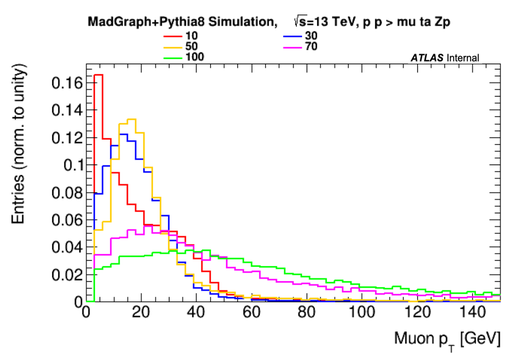


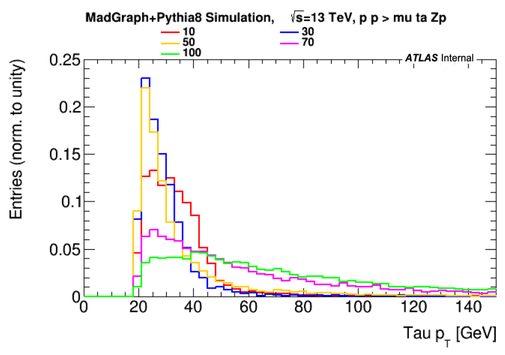












Work in progress

- Subdividing signal based on the number of light leptons & the net charge in the final state.
- Plotting the number of signal events with center of mass energy at 13TeV w.r.t. the number of light leptons in the final state and net charge in the final state for different Z′mass in the range from 10 GeV to 100 GeV

References:
[1]. The Model-Independent Multilepton Search, arXiv:2107.00404
[2]. Lepton flavour violating Z′ explanation of the muon anomalous magnetic moment, arXiv:1607.06832

IISER Pune · IFAE Institute for High Energy Physics · ATLAS EXPERIMENT