Di-boson simulation and precise measurement of $Z\gamma$ analysis in ATLAS Detector

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Abstract:

Di-boson process is one important test of the Standard Model Electroweak Symmetry Breaking, and also backgrounds for many new physics searches. The study shows the simulation and precise measurement of di-boson process in pp collisions at $\sqrt{s}$ = 13TeV, using a full dataset corresponding to an integrated luminosity of 139 fb^{-1} recorded with the ATLAS detector at the LHC. Di-boson process is also sensitive to anomalous triple gauge coupling which provide an opportunity to perform Beyond Standard Model study.

Di-boson MC simulation with FxFx

Monte Carlo Simulation:

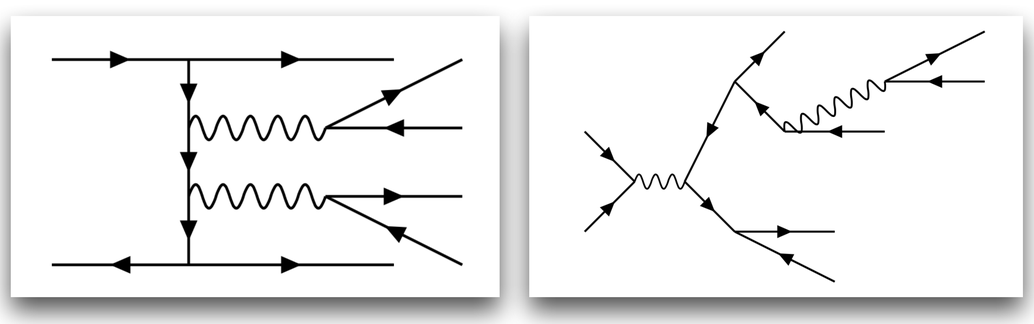
Monte Carlo Simulation is one effective and helpful tool for particle physics.
This tool can be used for :

- Detector design and optimization
- Simulation of particle interactions with detector's material
- Physics analysis

Simulation Setups :

Madgraph5_aMcAtNlo + Pythia8 with FxFx jet merging algorithm

Process Definition :



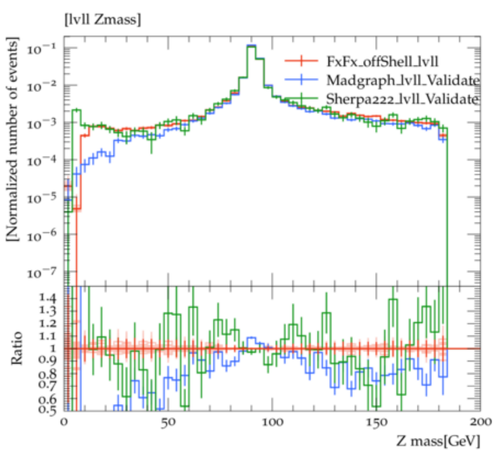
(Feynman diagram example)

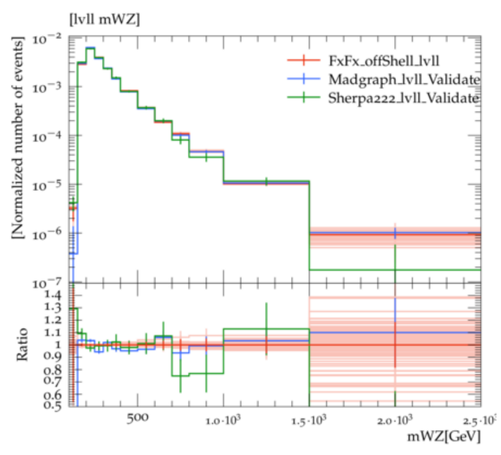
WZ off-Shell process + 0,1 jets @ NLO

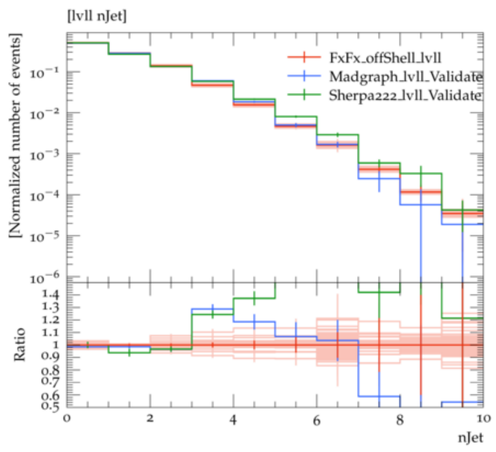
This simulation aims to generate MC events from pp collisions. Mediator particles supposed to be W, Z bosons and with fully leptonic decay final-state

Simulated Results :

Simulated results are crosschecked by other two validated MC samples.
Blue one : generated by Madgraph_aMcAtNlo + Pythia8 with MadSpin, which represents WZ on-shell decay process
Green one : Generated by Sherpa222 + 0,1 jets @ NLO and 2,3 jets @ LO, and with MEPS@NLO merging







Some unique observables are shown above.

Even if with different generator setups and different merging schemes, MC samples from different generators still have same shape

Small differences can still be found between difference MC samples

Precise measurement in $Z\gamma$ + jets analysis

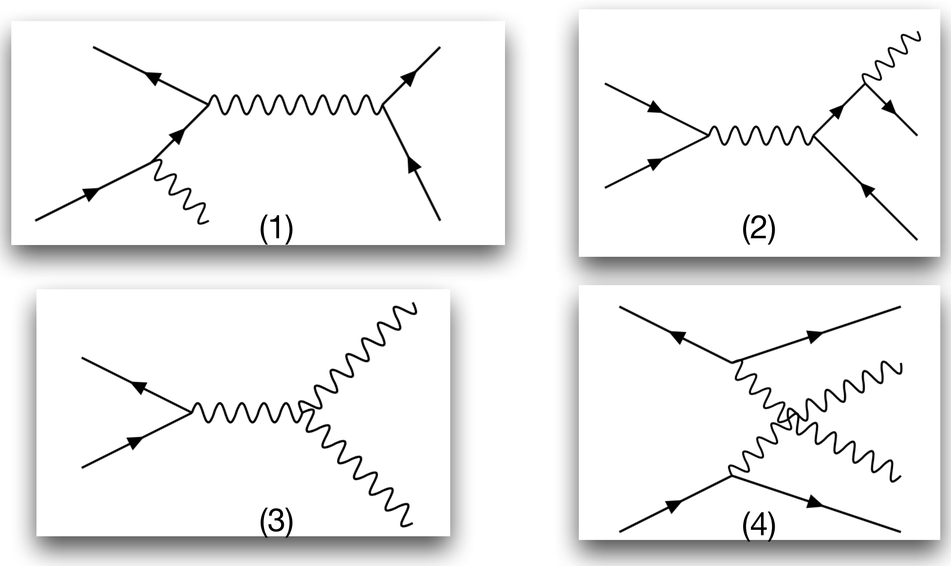
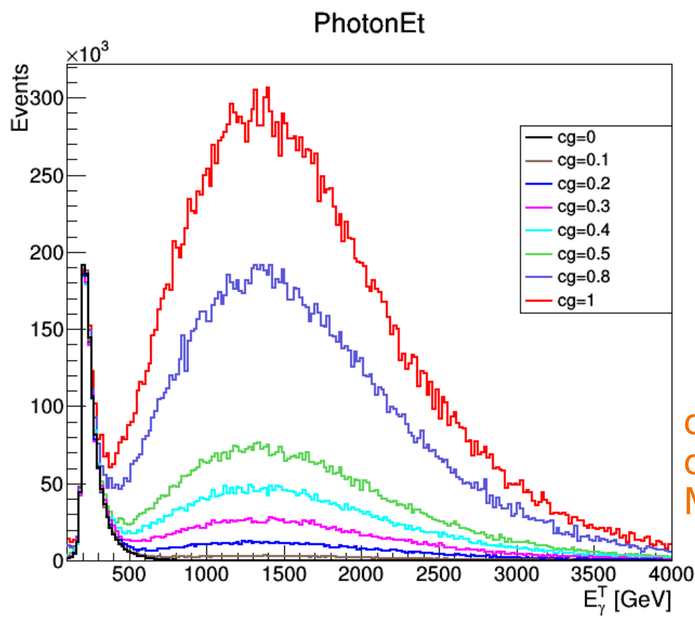


Fig 1, 2 : non-VBS EWK Z(ll)γ process with ISR and FSR
Fig 3 : anomalous triple gauge couplings
Fig 4 : VBS Z(ll)γ process

Good Opportunity for aTGC search

Dimension-8 effective Lagrangian:

$$\Delta L(dim-8) = \sum_j \frac{\tilde{c}_j}{\tilde{\Lambda}_j^4} O_j = \sum_j \frac{sign(\tilde{c}_j)}{\Lambda_j^4} O_j$$



cg : $\tilde{c}_j$ parameter in Lagrangian expression

O_j : CP-even dimension-8 operator

cg == 0 : Standard Model
cg != 0 : Beyond Standard Model

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Conclusion :

- off-Shell lvll process is well simulated by Madgraph5_aMcAtNlo+Pythia8 with FxFx jet merging algorithm, in good agreement w/ Sherpa MEPS@NLO merging.
- In $Z\gamma$ + jets analysis, some kinematic observables are well reconstructed by final-state leptons
- New model (**N**eutral **T**riple **G**auge **C**ouplings) are used in ATLAS Official Madgraph and MC samples are generated
- More studies in on-going about aTGC search

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