EW gamma + 2 jets (VBF photon)
Plans for Snowmass

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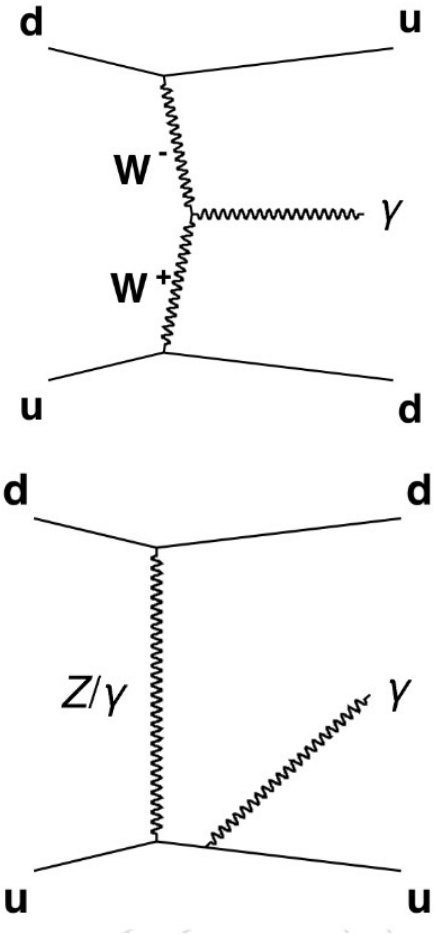
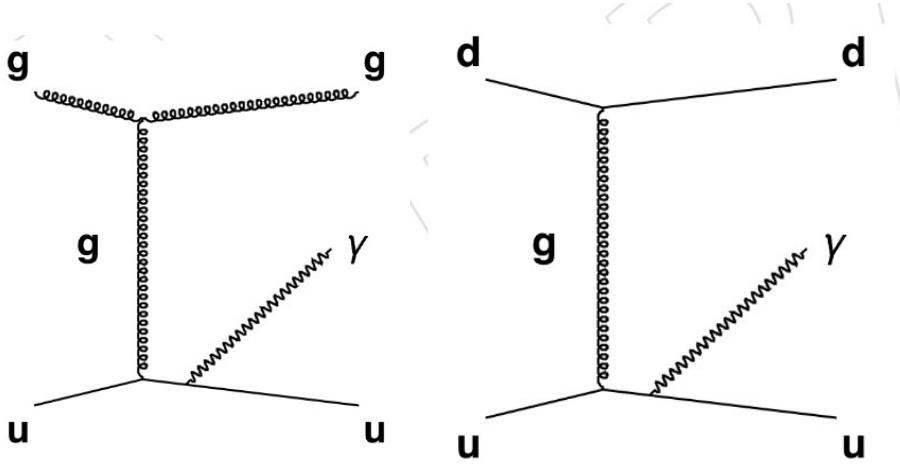
Introduction

- **Pure electroweak Vjj production**
  - Produced via “vector boson fusion” (VBF)
    - + other diagrams with negative interference in SM
  - Crucial to verify the unitarity of boson scattering
  - Sensitive to triple gauge coupling vertex
- **Zjj and Wjj:**
  - Have been studied in CMS and ATLAS
- **γjj**
  - Direct access to WWγ vertex
  - Well motivated (arXiv:1004.0825)
  - Not covered yet in LHC experiments



VBF Photon production

- **Larger cross section (compared to Zjj and Wjj)**
  - ~30 pb (m_{jj} > 120 GeV, γp_T>50 GeV)
- **Main background**
  - QCD γ+2jets
  - Very high xsection (>20K pb)
  - Difficult to model
    - Specially in high mjj bins (arXiv:1912.09866)
  - Available samples in CMS
    - LO: MadGraph, **for 2016/2017/2018**
      - With and without DR cut
    - NLO γ+1jet: amc@NLO, **for 2016 only**
      - Initial cross checks show good agreement with data
    - NLO: Sherpa, **only for 2016**



Concerns about MC samples

- **Signal**
  - LO gridpack is ready (ewk and interference)
  - Details for PS (arXiv:2003.12435):
    - For pythia some additional options are needed (dipole-recoil)
    - HERWIG works out of the box
- **Background**
  - Binned in $\gamma p_{T:}$
    - Low γp_T region is essential (main signal region, very high bkg xsection)
  - amc@NLO gridpacks (γ+1jet) are available
    - We can work on NLO(Sherpa) with the help of experts
  - VBF filter (at least 2jets, m_{jj}>50 GeV) can save a lot of resources
    - To investigate its efficiency, we need help from GEN experts

MC Sample request

Signal

Pure electroweak	1M
Interference	500K

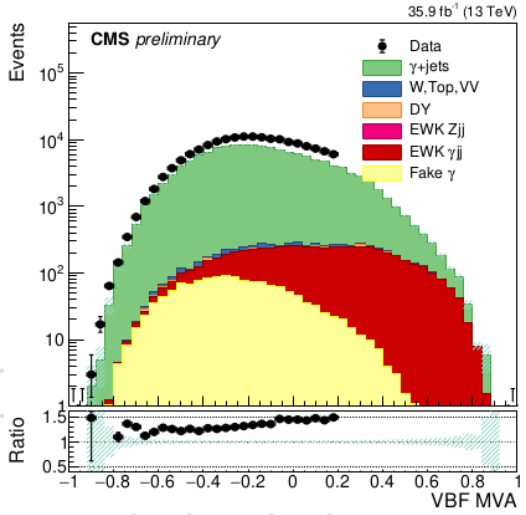
QCD Background (no VBF mjj filter)

		Eq. Lum (/fb)
50 GeV < $p_T\gamma$ < 100 GeV	100M	7.39
100 GeV < $p_T\gamma$ < 250 GeV	100M	67.5
250 GeV < $p_T\gamma$ < 400 GeV	10M	78.5
400 GeV < $p_T\gamma$ < 700 GeV	5M	636
700 GeV < $p_T\gamma$	2M	6800

The request my be optimized considering VBF filter

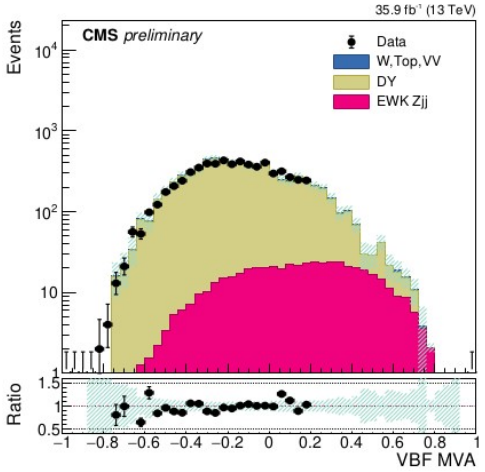
Plans for the Run-II analysis

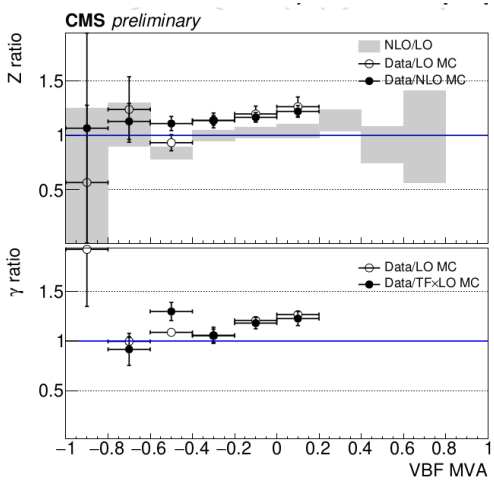
- SMP-19-005
- A dedicated **trigger** for **low pt photons+2 vbf jets**
- Detailed study of the **signal production** at **NLO** and possible **parton showers** (pythia vs. herwig)
- Detailed comparison of different modelings of the QCD background with data
- Data/MC discrepancy (for LO background
- **Idea**: correct LO QCD background using DY information



How DY can help?

- **LO DY:** behavior is similar to QCD γ background in SR (high m_{jj} region)
  - **NLO DY** shows **perfect agreement** with data
- Corrections to LO sample can be extracted from data in DY CR (as a function of MVA var)
  - Corrections are consistent with NLO/LO k-factors
- The corrections will be applied on γ+jets QCD background





Plans for snowmass

- **Use NLO QCD sample to estimate the main background contribution**
  - take amc@NLO as the baseline and report comparison with Sherpa
- **Validate the modeling of the QCD background using NLO/LO ratio in DY and photon+jet**
  - Needs LO samples for both processes

Efficient simulation of the background is the main key for the success of this analysis

- **Estimate the sensitivity to EFT parameters**
  - Follow the same recipe as ewk-Zjj analysis at CMS (SMP-16-018)