VBF-V: status and plans for YR

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Outline

- Combined Theory+Exp chapter with joint Introduction, Recommendations

Outline

- Introduction

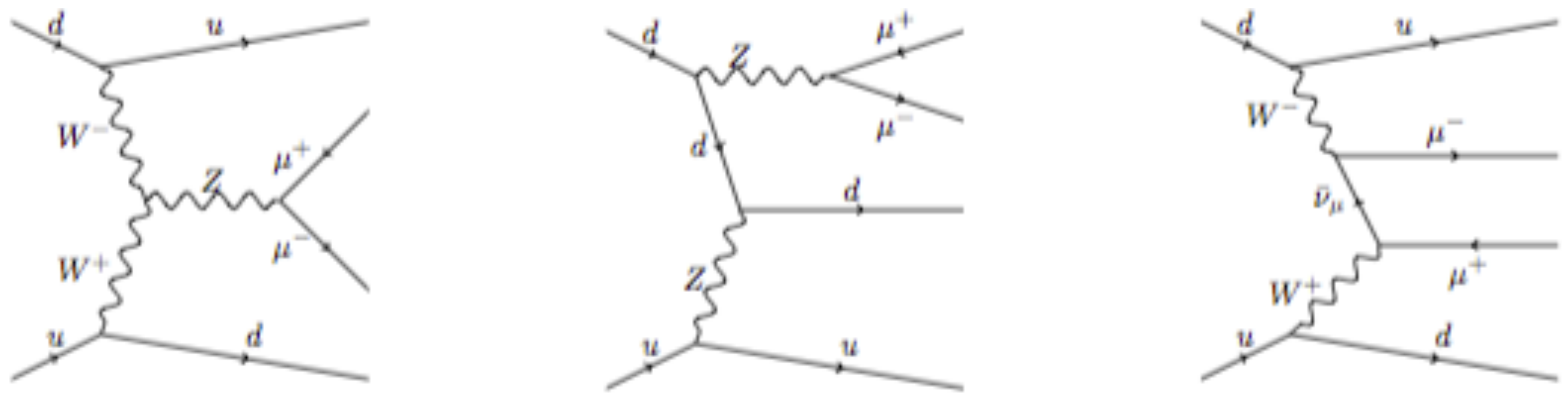
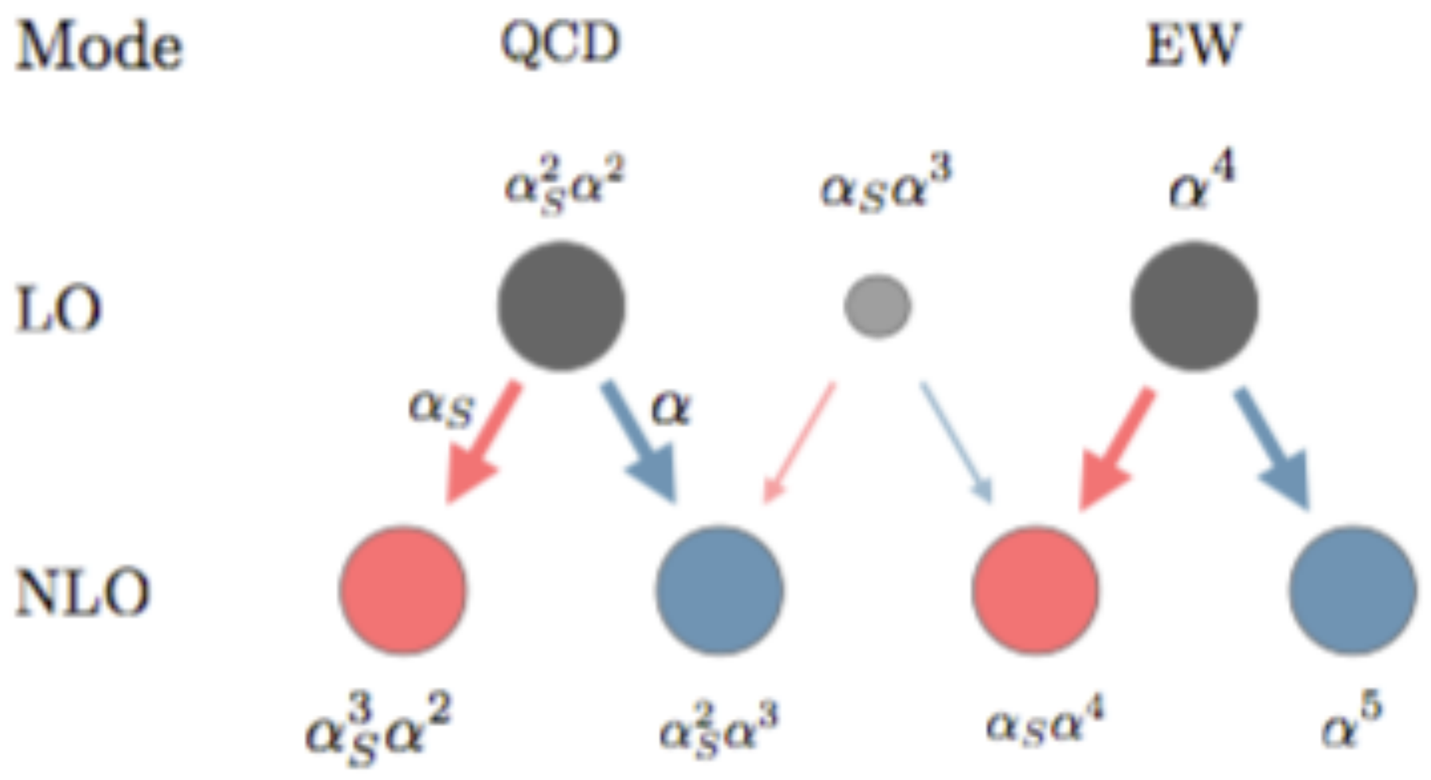


Fig. 4.1: Representative Feynman diagrams for the production of two charged leptons in association with two jets at order (α^4): vector boson fusion (left) bremsstrahlung-like (center). multi-peripheral (right),



Outline

- Theory review & best practise

4.2.1 State of the art

VBF production

Higher-order QCD corrections to VBF production are known in the so-called *VBF approximation*, where the VBF subprocess alone (see Section 4.1.1) is considered and higher-order corrections ignore cross-talk between the quark lines [?, ?]. These corrections are available within VBFNLO [], and have been matched to parton showers within POWHEG-BOX [?, ?] and HERWIG7 []. NLO EW corrections to VBF production are currently not known.

QCD background

On the other hand higher-order corrections to the QCD background are very advanced. NLO QCD corrections to the QCD background are widely available in many automated automated Mnte Carlo frameworks. They have first been obtained at fixed-order in Refs. [?, ?, ?] (for $pp \to V + n$ jets with $n > 2$ see e.g. [?, ?, ?, ?, ?, ?, ?].). Also NLO QCD predictions matched to parton showers are readily available within general purpose shower Monte Carlo programs [?, ?, ?, ?], where they typically enter Monte Carlo samples merging NLO predictions for $V + 0, 1, 2$ jets production [?, ?, ?, ?]. Additionally, certain logarithmically enhanced corrections beyond fixed-order NLO are available [?, ?, ?]. NLO EW corrections to the QCD background to VBF production are known at fixed-order [?, ?, ?, ?] and have also been combined with a QCD+QED parton shower in an approximation integrating out the photon radiation as part of the EW corrections [?].

Outline

- Experimental review: inclusive measurements

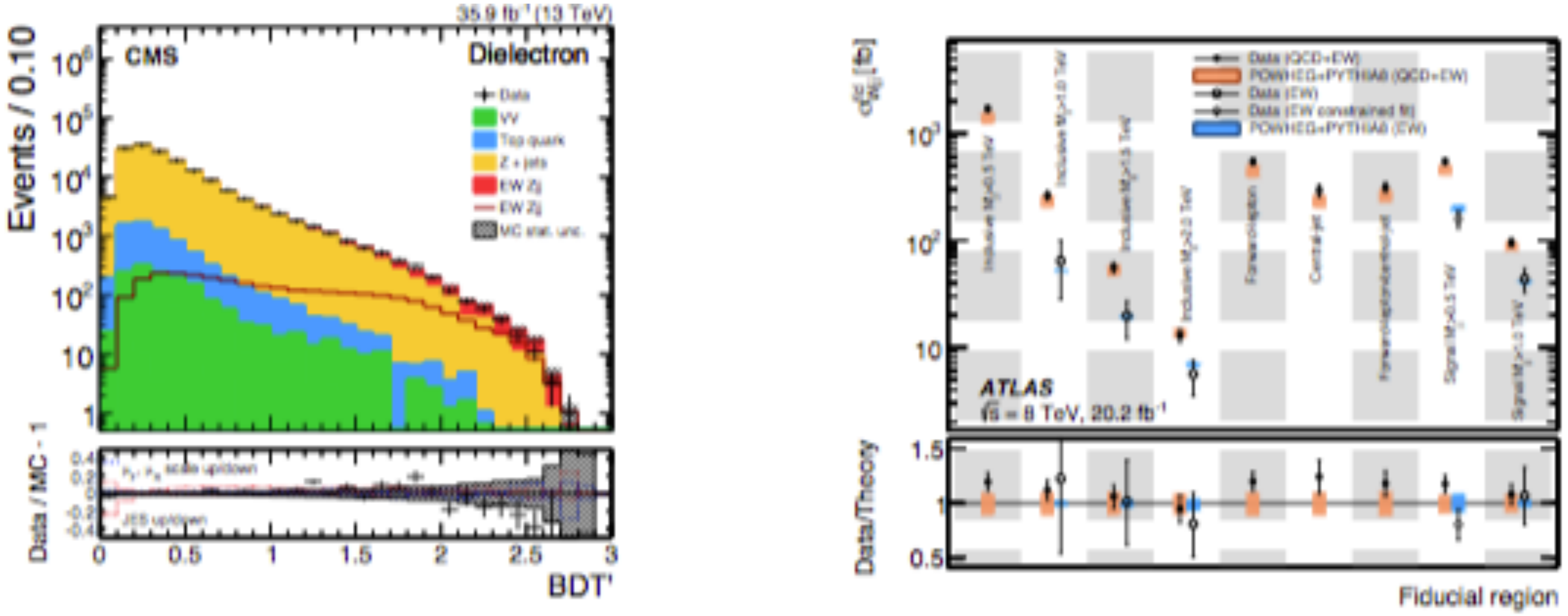


Fig. 4.2: Multivariate signal discrimanat output from Ref. [?] (left) and summary of fiducial cross section from Ref. [?] (right)

Outline

- Experimental review: differential measurements

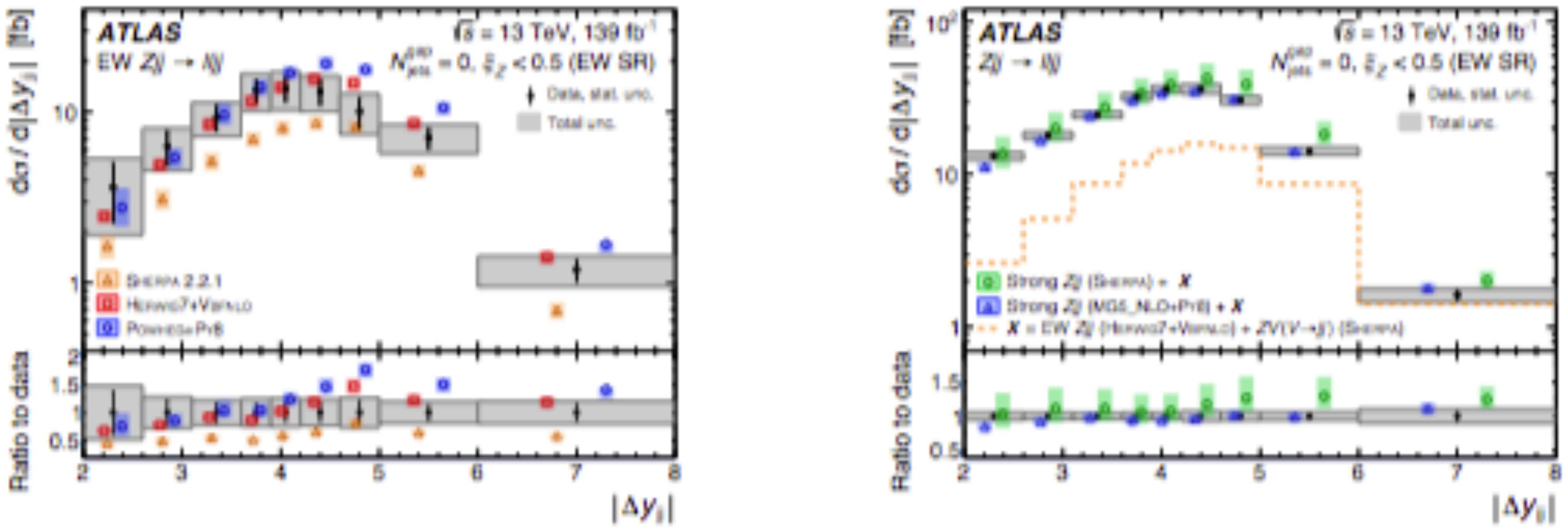


Fig. 4.3: Unfolded differential cross sections from Ref. [?]

Outline

- Experimental review: aTGC/EFT measurements

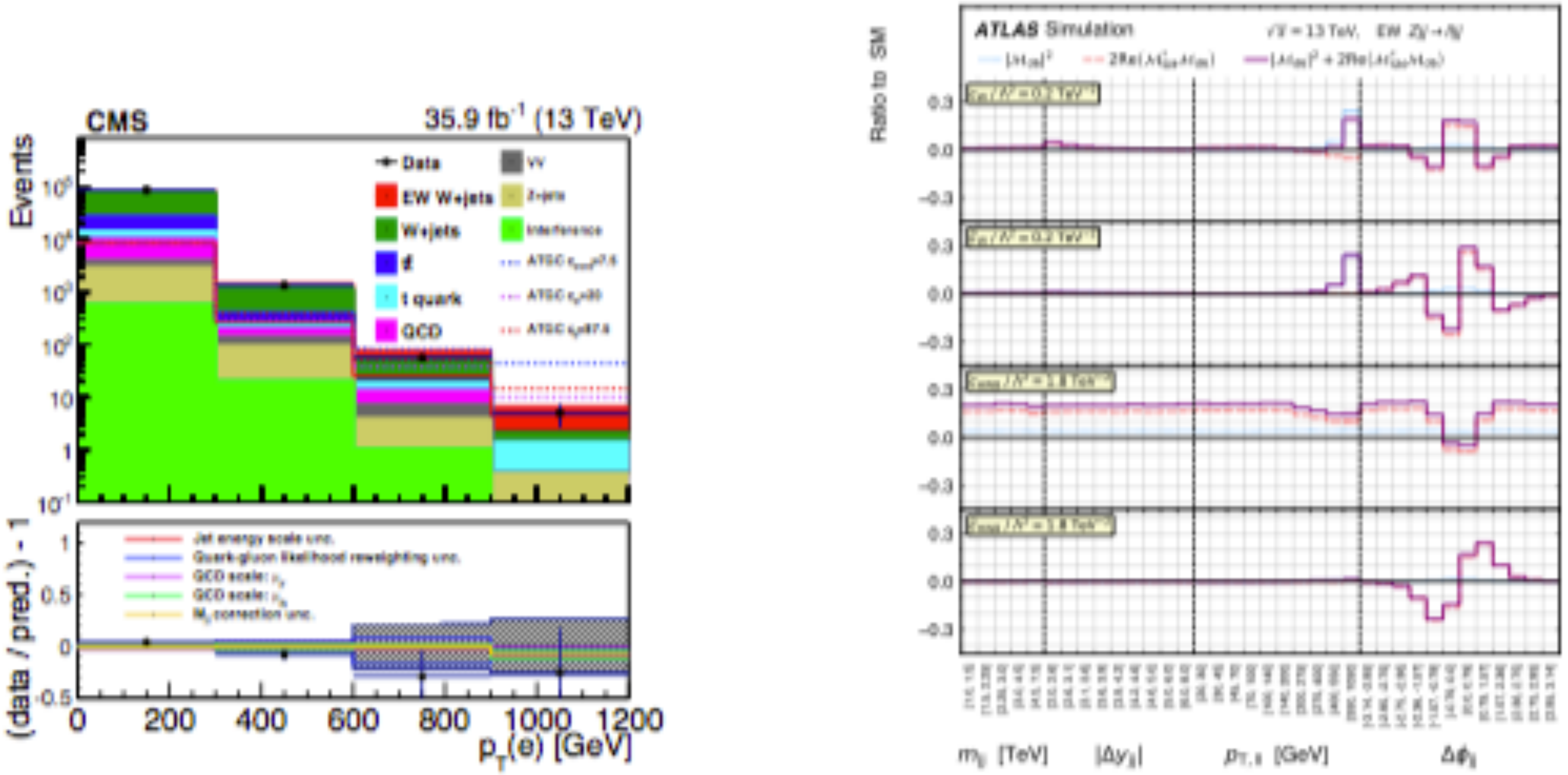


Fig. 4.3: TGC/EFT interpretations from Ref [?] (left) and Ref. [?] (right)

Outline

- Challenges: background modelling

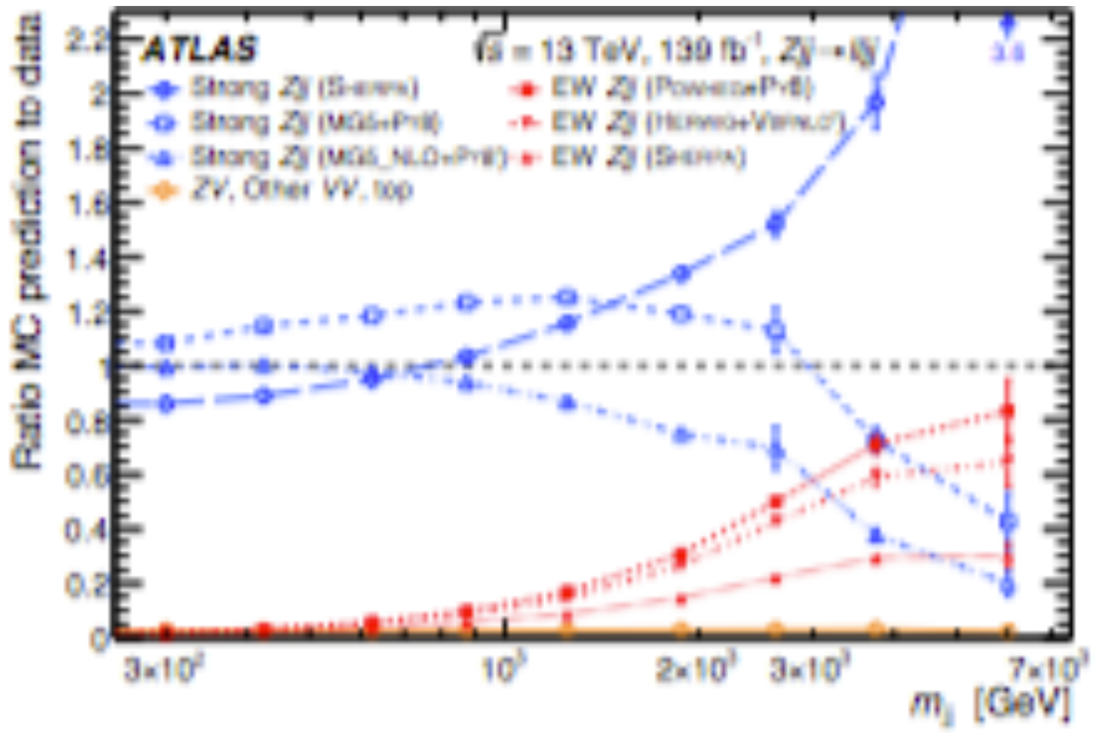


Fig. 4.4: Comparison of Monte Carlo predictions and data for the dijet invariant mass distribution from Ref. [?]

Outline

- Challenges: gap activity studies

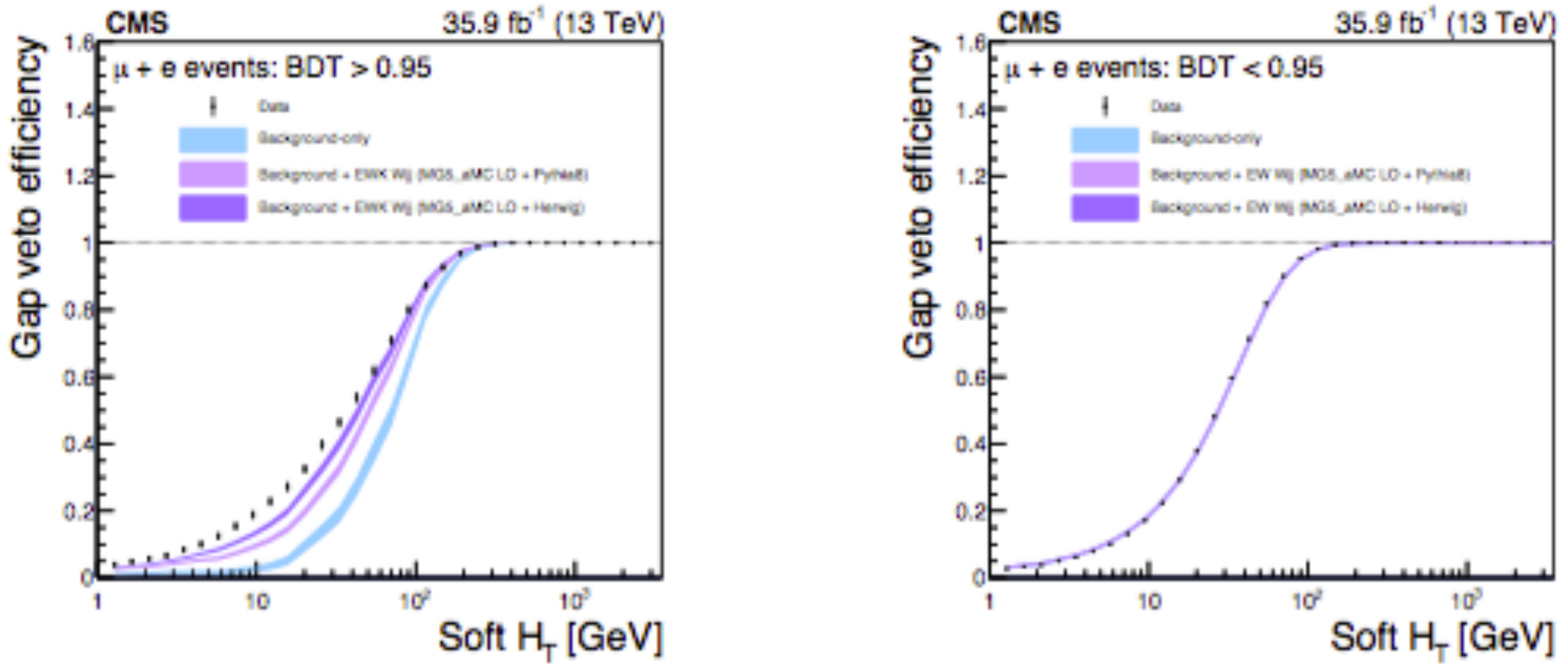


Fig. 4.6: Event veto efficiencies of hadronic gap activity [?], evaluated with charged particles in (left) signal-enriched and (right) background-enriched regions. The data are compared with the background-only prediction as well as background plus signal with PYTHIA or HERWIG parton showering.

Outline

- Monte Carlo comparison
  - Like-for-like comparison of MC samples in ATLAS and CMS
  - Based on ATLAS VBF-Z rivet routine ATLAS_2020_I1803608

Outline

- Recommendations
  - What to measure
    - Always measure actual (differential) cross section
    - Always produce results for sum of QCD+EW+interference modes and separation in EW only
  - Fiducial definition
    - Proposed benchmark cuts. CMS and ATLAS should try to adapt (avoid slightly different cuts). Can we even agree on the exact definition (also for lepton pT,eta)?
    - Always particle level definitions, parton level optional for easy of comparison to fixed order
    - Always use dressed leptons, dR=0.1
    - Use real four vector quantities, i.e pT not ET, y not eta
  - Observables
    - Mjj
    - ...
  - Modelling
    - Ensure PS modelling is suitable for VBF/VBS processes: recoil scheme etc
  - Perform studies for gap activity
    - Measure third jet activity: pTj3, HT
    - Charged hadrons in the rap gap
  - BSM interpretation
    - Stick to SMEFT models
    - Consider both, interference-only and quadratic EFT

Input regarding recommendations?