Inclusive vector bosons results in CMS

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Introduction

- There are many analysis involving W and Z boson with results obtained with CMS detector.
- The newest results will be presented
- Analysis performed are highly important for several reasons:
  - Important insights into the **partonic structure of hadrons**
  - Well understood final states and experimentally “clean”
    - → **Many precision measurements**
    - → Perfect for **improving and developing theory predictions**
- Probe for **pQCD** as well as **npQCD** in different regions
- Measurement of some **EWK parameters, putting limits**, **coupling constant calculations…**

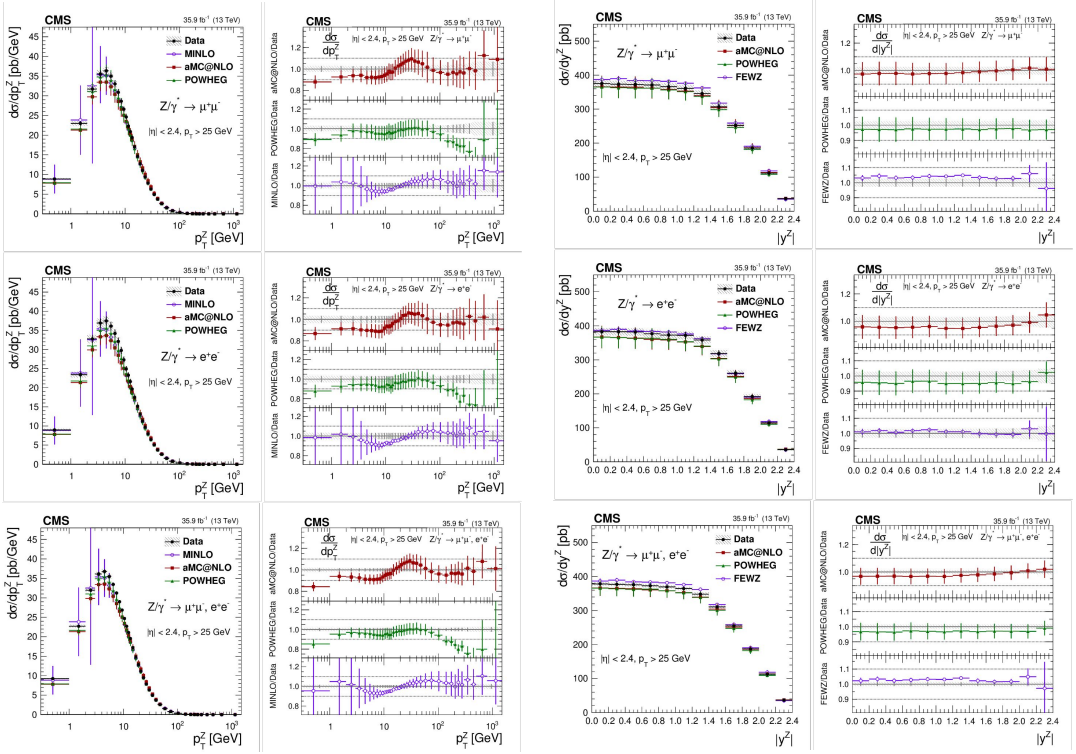
2016 data, 35.9 fb^{-1}

Invariant mass **76 < Mll < 106 GeV**

Lepton **pT > 25 GeV; |η| < 2.4**

Differential Z boson production cross sections

JHEP12(2019)061



- Inclusive fiducial and differential production cross sections as a function of **pT and |y| (also φ*).**
- **Di-electron** and **di-muon** channels.

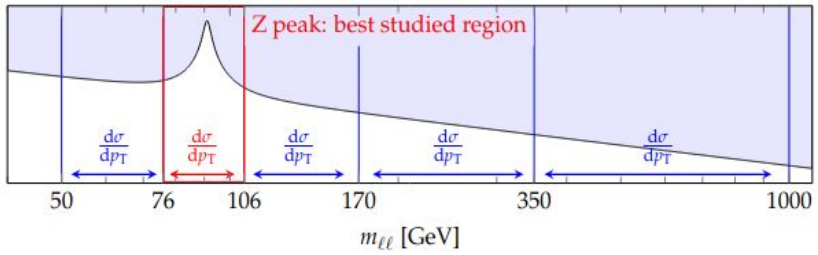
- The measured cross section values **agree with the theoretical predictions within uncertainties**
- The predicted values are σ = 682 ± 55 pb with MadGraph and σ = 719 ± 8 pb with fixed order FEWZ.

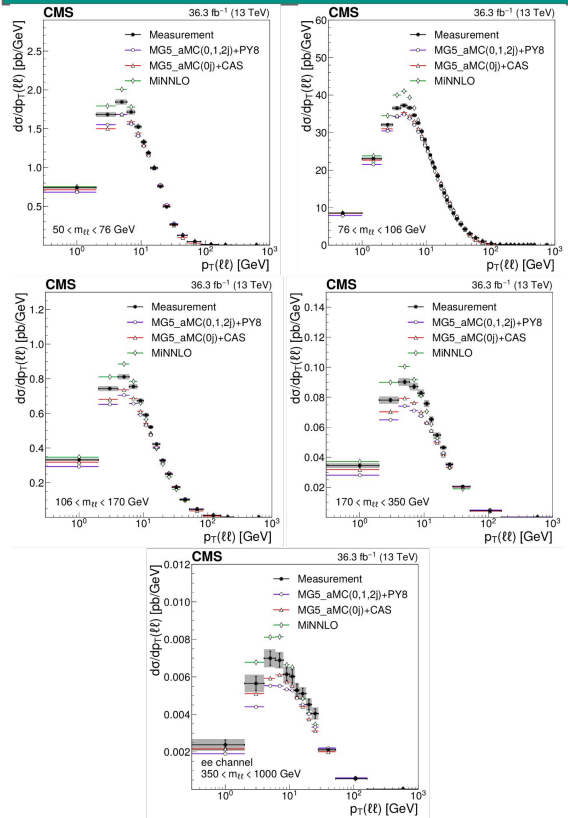
Cross section	$\sigma\,\mathcal{B}$ [pb]						
$\sigma_{Z\to\mu\mu}$	694	±	6	(syst)	±	17	(lumi)
$\sigma_{Z\to ee}$	712	±	10	(syst)	±	18	(lumi)
$\sigma_{Z\to\ell\ell}$	699	±	5	(syst)	±	17	(lumi)

2016 data, 36.3 fb^{-1}

Drell-Yan pT dependance over a wide mass range

CMS-SMP-20-003





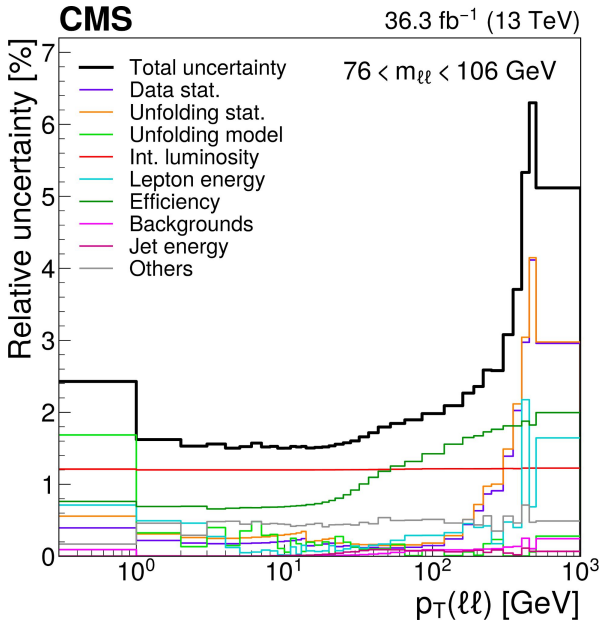
- **Precision measurement**
- The double differential cross sections in function of the **pT of the pair (also φ*)**
- Five mass bins from **50 to 1000 GeV**
- **Di-electron** and **di-muon** channels combined

Event selection:

- Two **opposite charged** isolated leptons
- Dressed with photons in **ΔR (*l*, γ) < 0.1**
- Lepton **pT > 25, 20 GeV**; **|η| < 2.4**

Theoretical predictions:

- **ME + parton shower**:
  - Madgraph + Pythia 8
- **TMD approach:**
  - Cascade + Pythia 6
  - Artemide
- **Ressumation:**
  - Geneva



➔ Total uncertainty **1.5 to 2 %** around the Z peak

2016 data, 36.3 fb^{-1}

Drell-Yan pT dependance over a wide mass range

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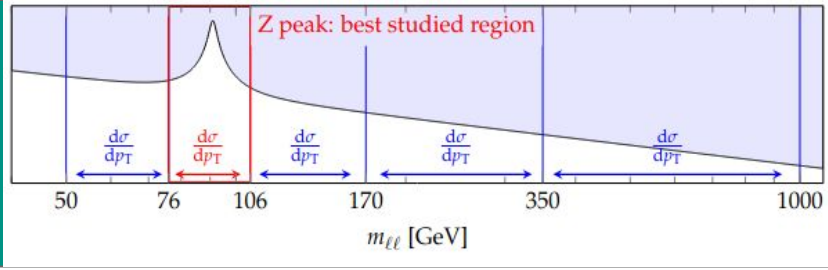
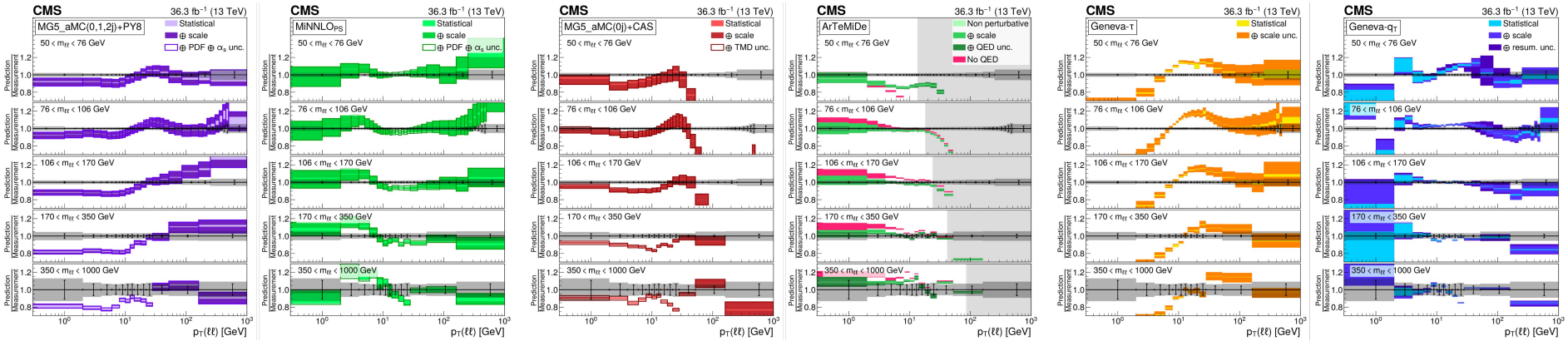




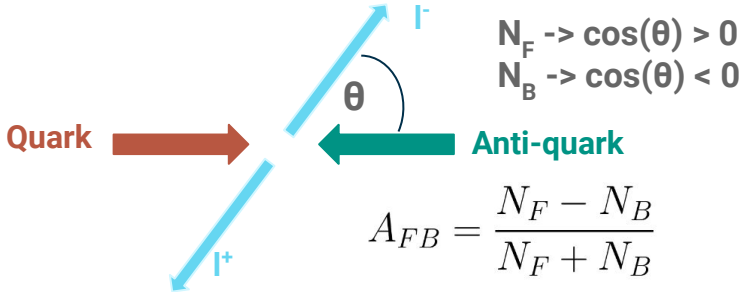
- MadGraph good overall agreement, disagrees with data at low pT — up to 20 %
- MiNNLO has the best agreement among all the predictions
- TMD based predictions (Artemide, CASCADE) give better description at low pT, CASCADE gives very nice predictions for moderate pT but for high pT region miss higher fixed-order calculations.
- Significant improvement in data description for Geneva qT for all the distributions

2016, 2017, 2018 data; 138 fb^{-1}

Drell-Yan forward-backward asymmetry at high dilepton masses

JHEP 08 (2022) 063

- **Asymmetry(A_{FB})** and **the angular coefficient (A_0)** as a function of lepton pair mass for masses **larger than 170 GeV** in **7 mass ranges.**
- The difference between the dimuon and dielectron asymmetries - **a test of lepton flavor universality**
- To set limits on the presence of additional gauge bosons
- **Di-electron** and **di-muon** channels combined



- Measure the **angle** between **final state lepton** and **initial quark**

- Results obtained by **template fitting approach** - 2D templates binned in **cos(θ)** and **rapidity**
- Additional **fiducial correction** applied so final result represents **generator-level A_{FB} in full phase space**

Event selection:

- Two **opposite charged** isolated leptons
- **Muon pT > 15 GeV**; **|η| < 2.4**
- **Electron pT > 15 GeV**; **|η| < 2.5**

2016, 2017, 2018 data; 138 fb^{-1}

Drell–Yan forward–backward asymmetry at high dilepton masses

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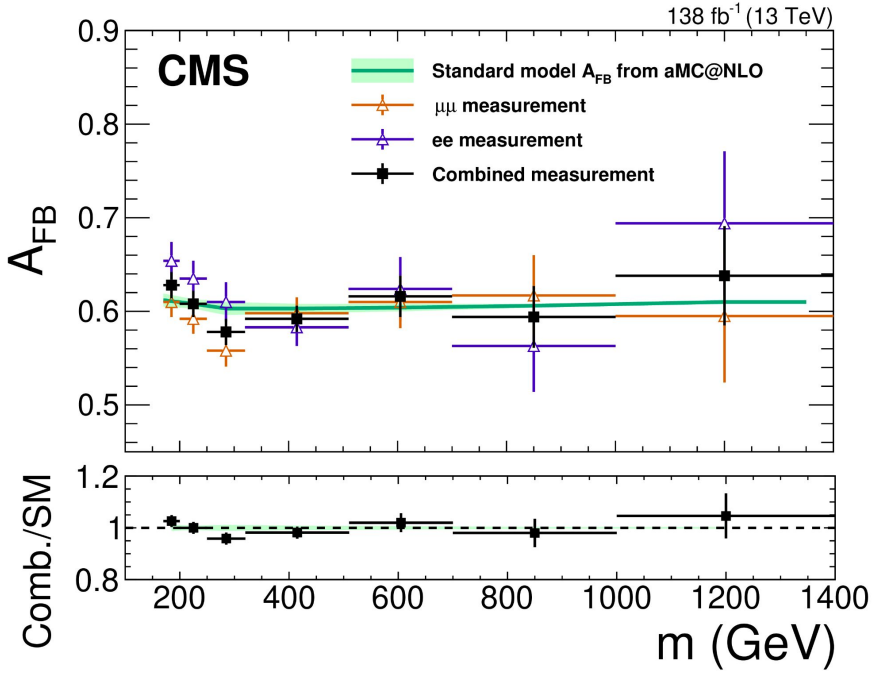
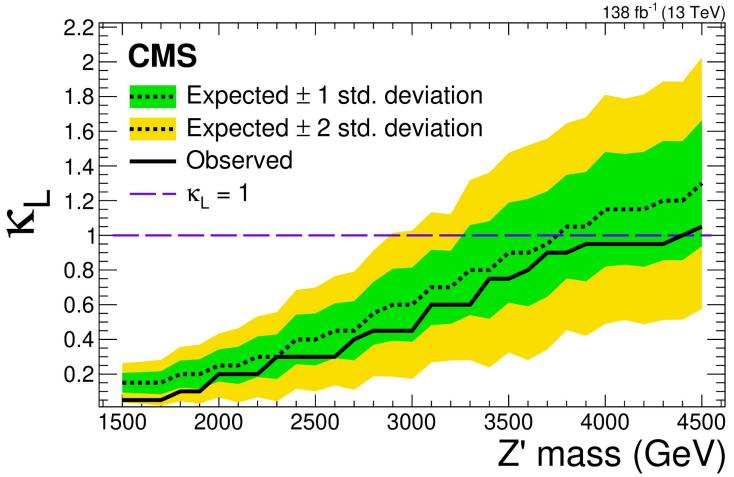


- No statistically significant deviations from standard model predictions are observed.
- Measured asymmetry **0.612 ± 0.005 (stat) ± 0.007 (syst)** and angular coefficient is **0.047 ± 0.005 (stat) ± 0.013 (syst)**
- Observed lower limit on the **Z' mass is 4.4 TeV**

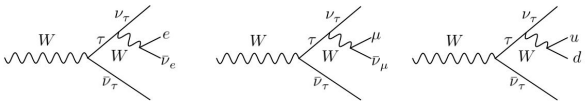


2016 data,35.9 fb^{-1}

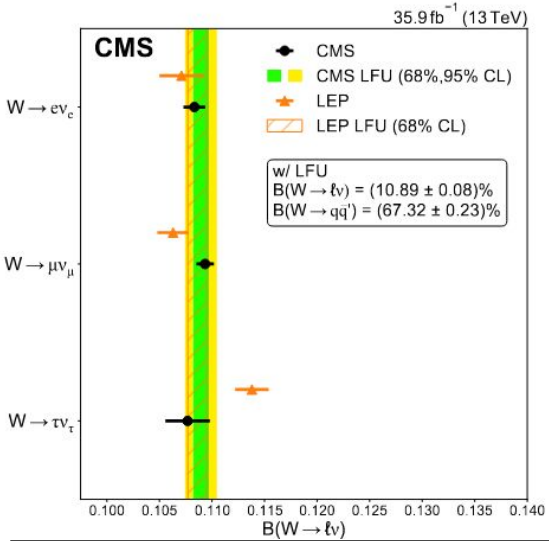
W boson decay branching fractions

Phys. Rev. D 105, 072008

- **Precision measurement**
- The leptonic and inclusive hadronic decay branching fractions
- **Lepton flavor universality (LFU) violation** test
- Features are made for the best isolation of **W → τ decays**



- Binned maximum likelihood estimation fitting templates
- Event categorisation done based on number of leptons, jets and b-tagged jets

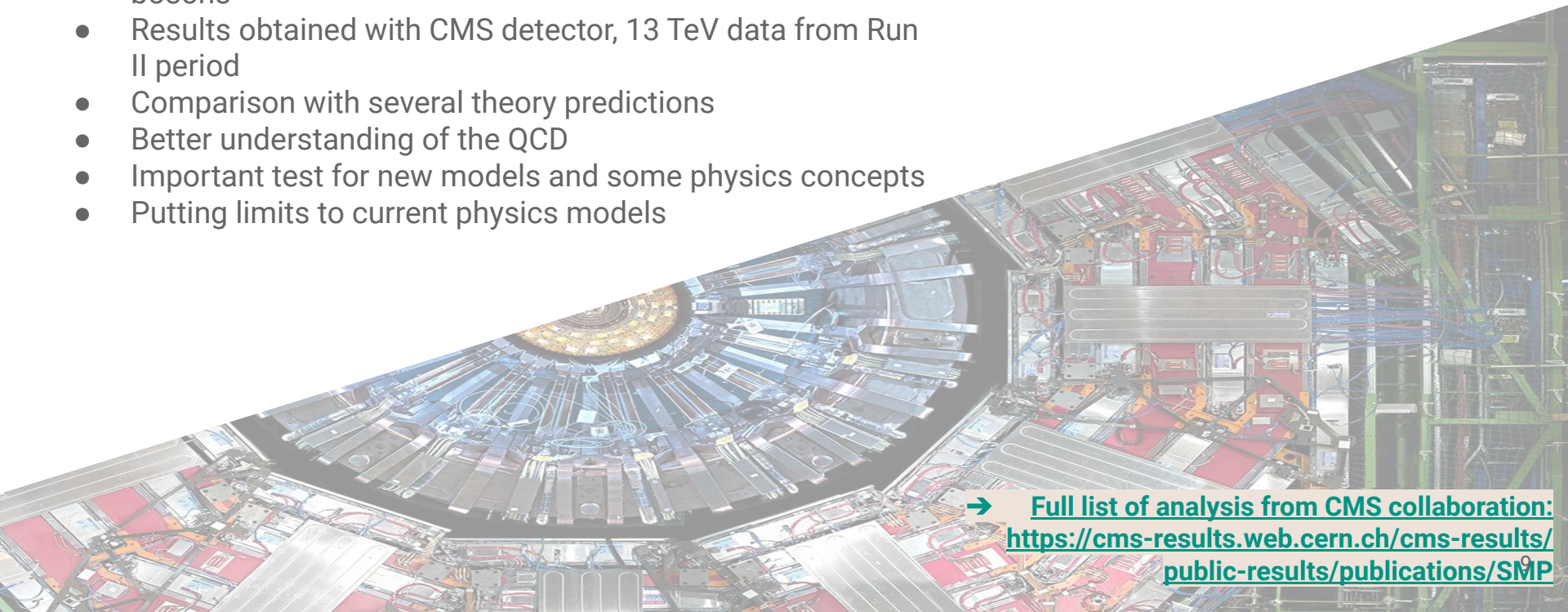


- The results are **consistent with the LFU** hypothesis for the weak interaction
- **More precise** than previous measurements based on data collected by the **LEP experiments**
- **Ratio of hadronic-to-leptonic branching fractions** to the theoretical prediction is used to derive some **standard model parameters**
- Strong coupling constant at the W boson mass scale **α_s = 0.095 ± 0.033**

	CMS	LEP
$\mathcal{B}(W \to e\bar{\nu}_e)$	$(10.83 \pm 0.01 \pm 0.10)\%$	$(10.71 \pm 0.14 \pm 0.07)$ %
$\mathcal{B}(W \to \mu\bar{\nu}_\mu)$	$(10.94 \pm 0.01 \pm 0.08)\%$	$(10.63 \pm 0.13 \pm 0.07)$ %
$\mathcal{B}(W \to \tau\bar{\nu}_\tau)$	$(10.77 \pm 0.05 \pm 0.21)\%$	$(11.38 \pm 0.17 \pm 0.11)$ %
$\mathcal{B}(W \to q\bar{q}')$	$(67.46 \pm 0.04 \pm 0.28)\%$	—
Assuming LFU		
$\mathcal{B}(W \to \ell\bar{\nu})$	$(10.89 \pm 0.01 \pm 0.08)\%$	$(10.86 \pm 0.06 \pm 0.09)\%$
$\mathcal{B}(W \to q\bar{q}')$	$(67.32 \pm 0.02 \pm 0.23)\%$	$(67.41 \pm 0.18 \pm 0.20)\%$

Summary

- Overview of several current analysis involving W and Z bosons
- Results obtained with CMS detector, 13 TeV data from Run II period
- Comparison with several theory predictions
- Better understanding of the QCD
- Important test for new models and some physics concepts
- Putting limits to current physics models



➔ Full list of analysis from CMS collaboration: https://cms-results.web.cern.ch/cms-results/public-results/publications/SMP